The Housing and Construction Industry in Egypt

INTERIM REPORT WORKING PAPERS 1979/80

By
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This report from on-going research is a part of a series of publications which describe various studies undertaken under the sponsorship of the Technology Adaptation Program at the Massachusetts Institute of Technology.

In 1971 the United States Department of State, through the Agency for International Development, awarded the Massachusetts Institute of Technology a grant, the purpose of which was to provide support for the development at M.I.T., in conjunction with institutions in selected developing countries, of capabilities useful in the adaptation of technologies and problem-solving techniques to the needs of those countries. At M.I.T. the Technology Adaptation Program provides the means by which the long-term objective for which the A.I.D. grant was made can be achieved.

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INTERIM REPORT WORKING PAPERS 1979/80

THE JOINT RESEARCH TEAM
ON THE HOUSING AND CONSTRUCTION INDUSTRY
CAIRO UNIVERSITY/MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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THE HOUSING AND CONSTRUCTION INDUSTRY IN EGYPT

Summary: Interim Report 1979/80

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This summary is apart of the Housing and Construction Industry Research Program carried out under the Technological Planning Program, a joint research project by Cairo University and the Massachusetts Institute of Technology. The views and opinions expressed in this section do not necessarily reflect those of AID, MIT, or Cairo University.

الأسكان وصناعه البناء فى مصر

ملخص التقرير المرحلى ١٩٧٩/١٩٨٠

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هذا الكتيب يمثل ملخص تقارير مشروع الاسكان وصناعة البناء الذى يجرى تحقيقه تحت اشراف برنامج التخطيط التكنولوجى وهو المشروع المشترك بين جامعة القاهرة ومعهد ماستشوستس للتكنولوجيا . الاراء المثلة فى هذا التقرير لاتمثل بالضرورة أراء هيئة المعونة الدولية ، معهد ماستشوستس للتكنولوجيا أو جامعة القاهرة .

INTRODUCTION

This section of the report contains a summary of the work carried out in the third phase (July 1, 1979 - June 30, 1980) of the Housing and Construction Industry Research Project.

This summary of the working papers of 1979/80 only provides an overview of the work and the reader is directed to the remainder of the report for the complete text of the individual subprojects.

CONTEXT

The underlying constraints which affect all sectors in Egypt have been well known for many years. Population growth, limited habitable land, and a lack of developed economic resources other than agriculture are the three aspects with the strongest impacts on the country.

The land available for agriculture, the traditional backbone of the country, represents 3% of all Egypt. The population growth rate of Egypt is 2.4%, but in urban areas it is approximately 4%, of which half is due to natural increase and half is due to migration. This growth, together with the lure of the cities, have both forced and attracted the excess population to the larger cities of Egypt, and in particular to Cairo. It is estimated that each day 1000 new migrants crowd into Cairo alone. This shift is very clear from the statistics: in 1960, 38% of the population was urban; in 1970, 44%.

This increasing growth of the urban areas has placed a severe demand on housing, and most believe that Egypt is

مقدمـــــة

يشمل هذا الكتيب ملخص الاعمال التى تم انجازها فى المرحلة الثالثة من بحـــث الاسكان وصناعة البناء فى مصر (١ يوليو ١٩٧٩-٣٠ يوليو ١٩٨٠) • علـــى القارىء أن يتذكر أن هذا الكتيب يمثل فقط عرض للمواضيع التى تم بحثها فى الفـــترة المذكورة وعلية الرجوع للتقارير المفصلة لكل مشروع فرعى •

المحتوى

لايخفى على احد أن العوامل الرئيسية التى تعوق تقدم مصر تكمن فى الزيـــادة الكبيرة فى عدد السكان والافتقار الى الاراضى الصالحة للسكنى والى الوسائل اللازمـــة لتنمية الموارد الاقتصادية الاخرى عدا الزراعة • ومما لاشك فيه أن هذه العوامـــل الثلاث لها تأثير قوى على التنمية العامة للدولة فالاراضى الصالحة للزراعة التى كانـــت تعتبر السند التقليدى للامة اصبحت مساحتها الان مالايزيد عن ٣ ٪ من المسطـــح الاجمالى للدولـــة أما معدل الزيادة السكانية فيصل الى ٤ر٢ ٪ سنويا وأن كان نفس هذا المعدل يصل فى المناطق الحضرية الى ٤ ٪ حيث أن الهجرة الى تلك المناطـــق الحضرية تشكل نصف هذه النسبة •

وقد أدى هذا النمو الكبير والاغراءات التى تقدمها المدن الى زيادة عدد سكـــان المدن الكبيرة وخاصة القاهرة التى يقدر عدد المهاجرين اليومى لها بما يزيد علـــى الالف ويمكن ملاحظة التحول الواضح من خلال متابعة الاحصاءات عامى ١٩٦٠ ، ١٩٧٠ حيث كانت نسبة سكان الحضر فى الاولى ٣٨ ٪ وفى الثانية ٤٤ ٪ وبالطبع أدى هذا النمو الضخم الى زيادة الطلب على الاسكان ويتفق الجميع على أن مصر تعانى من نقص شديـــد

experiencing an acute shortage of urban housing in most of the cities, affecting people of all incomes. Moreover, it is predicted that the demand will double within 10 years. The shortage is attributed to several interacting factors: the rapid rise of urban population coupled with the inability to produce sufficient units fast enough; shortage or misallocation of basic construction materials, in particular, cement; loss of skilled laborers to other Middle Eastern countries; the destruction of housing in certain areas during the 1973 war; the large percentage of people (estimated at 76% of the population in a recent study for a standard public housing unit) who would require substantial subsidization to be able to afford standard housing; and the discouragement of new construction because of apparant barriers in the economic structure.

There is a genuine desire by the government of Egypt to respond to the housing needs of its people. The government has recognized the serious nature of the problems and has directed all available resources into the housing effort. Although significant achievements have already been made, there is a continuing committment to housing action. The high priority of housing is reflected by the committment of personnel directed toward exploring policies toward alleviating the shortages and through continued budget support which has remained high despite cutbacks in other areas. Various studies have been undertaken to provide a reference for, and to suggest policy alternatives. Several new laws have already been enacted concerned with the housing shortage, including enactment in 1976 of a law creating a National Low Cost Housing Fund.

The research on the Housing and Construction Industry is directed towards assisting the government's efforts in the development of appropriate policies alleviating the serious housing problems.

فى الوحدات السكنية فى معظم المدن المصرية وعلى كل مستويات الدخل المختلفة واكثر من ذلك أنه من المتوقع أن يتضاعف الطلب خلال العشر سنوات القادمة • ويمكن تلخيص الاسباب المؤدية لهذا النقص فى الاتى : نمو سريع فى عدد سكان الحضر مصاحب بعدم قدرة على انتاج عدد كافى من الوحدات بنفس المعدل ، نقص أو سوء توزيع مواد البناء الرئيسية وخاصة الاسمنت ، هجرة العمالة الماهرة الى دول الشرق الاوسط الاخرى ، الدمار الذى حل بمبانى الاسكان فى بعض المناطق بسبب حرب ١٩٧٣ وجود نسبة كبيرة من فئات السكان (تم تقديرها بـ ٧٦ ٪ فى بحث حديث) تتطلب دعم اساسى حتى تستطيع ان تتحمل نفقات تكلفة الوحدة •

واخيرا عدم تشجيع مشاريع الانشاء والبناء الجديدة لمعوقات الوضع الاقتصادى

هناك رغبة خالصة من جانب الحكومة المصرية للاستجابة للسكان فى توفير الاسكان لهم ولقد ادركت الحكومة طبيعة المشكلة ووجهت جميع الجهود الممكنة نحو حلها • وعلى الرغم من أن هناك العديد من المشاريع التى تم انجازها فأن الحكومة مستمرة فى ايلاء مشكلة الاسكان اهمية كبرى اذ يظهر ذلك فى استمرار الحكومة فى الاستفادة من خبرة المتخصصين فى البحث عن مجالات جديدة لحل الازمة كما يظهر ذلك ايضا فى نسبة الاستثمارات المخصصة للاسكان التى ظلت عالية على الرغم من تخفيض الاستثمارات فى كافة المجالات الاخرى • وقد تم الانتهاء من مجموعة دراسات متعددة بحثت امكانيات السياسات البديلة كما تم تطبيق عدة قوانين جديدة لمعالجة المشكلة بما فى ذلك القانون الصادر عام ١٩٧٦ لانشاء الصندوق الوطنى لاسكان محدودى الدخل •

لذلك فأن معظم جهود الفريق المشترك لابحاث الاسكان وصناعة البناء قد وجهت نحو تدعيم جهود الحكومة فى البحث عن وتطوير السياسات المناسبة التى قد تساعد فى حل مشكلة الاسكان •

TECHNOLOGY ADAPTATION PROGRAM (TAP)
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The Technology Adaptation Program is a major program at M.I.T. concerned with the technological issues involved in the transfer and adaptation of technology to the conditions prevailing in other countries. TAP was initiated under a grant from the Office of Science and Technology of the U.S. Agency for International Development.
Its objectives are to develop an understanding of the characteristics of technologies that are appropriate to countries in various stages of development; to identify criteria for the selection and adaptation of appropriate technologies; and to develop an understanding of the processes by which technological knowledge and skills can be effectively introduced, disseminated, and used in nations. The program is concerned with promoting an awareness of and expertise in the technological problems facing developing countries on the part of both faculty and students at M.I.T. as well as foreign students and scholars who attend M.I.T. TAP's activities thus lie in three interacting areas: development of institutional ties between M.I.T. and educational and governmental organizations in various countries; collaborative research; and educational opportunities at M.I.T.

برنامج تطويع التكنولوجيا (TAP)
معهد ماساتشوستس للتكنولوجيا (MIT)

يعالج برنامج تطويع التكنولوجيا • هو برنامج اساسى فى معهد ماساتشوستش للتكنولوجيا الموضوعات التكنولوجية المتعلقة بنقل واستخدام التكنولوجيا وتطويعها وفقا للظروف السائدة فى البلاد الاخرى ، ولقد قام هذا البرنامج منذ ست سنوات بناء على منحة من مكتب العلوم والتكنولوجيا التابع لوكالة التنمية الدولية (AID) ويهدف البرنامج الى تطوير مفهوم خصائص التكنولوجيا التى تلائم البلاد فى المراحل المختلفة من مراحل التنمية والى تحديد ضوابط اختيار وتطويع التكنولوجيات الملائمة والى تنمية وتفهم العمليات التى يتم عن طريقها ادخال ونشر وسائل المعرفة الى الدول النامية •

كذلك يهتم البرنامج بنشر الوعى بالمشاكل التكنولوجية التى تواجه الدول النامية وذلك بالنسبة لكل من اعضاء هيئة التدريس وطلبة معهد ماساتشوستس للتكنولوجيا (MIT) والطلبة الاجانب الذين يدرسون به وتغطى انشطة برنامج تطويع التكنولوجيا (TAP) ثلاث مجالات متداخلة ومتفاعلة هى تنمية العلاقات العلمية بين معهد ماساتشوستس للتكنولوجيا (MIT) وبين المؤسسات التعليمية والحكومية فى البلاد المختلفة وتنمية التعاون فى مجال البحوث والتعليم فى المعهد •

TECHNOLOGICAL PLANNING PROGRAM (TPP)
CAIRO UNIVERSITY/M.I.T.

Under the auspices of TAP, the Cairo University/M.I.T. Technological Planning Program, which is funded by the USAID Mission in Egypt, began several years ago with a a focus on improved planning of development projects in Egypt. The overall objective of the program is to expand the capabilities of Egyptian ministries and other government agencies to formulate and implement technical programs designed to achieve national development goals. The research projects focus on a broad range of engineering, economic, and social service topics. The key element in each of these efforts is the interdisciplinary team drawn from faculty and staff from M.I.T., Cairo University, and government projects in the topic area. Effective utilization of the Egyptian academic and government resources has been one of the principal reasons for the success of the program to date. In addition to the specific research projects, emphasis has been placed on the training of in-country personnel in the techniques of project identification, evaluation, and management, and the development and maintenance of the data necessary to design and monitor their projects. To provide a channel for continuous, convenient communication between government agencies and the academic expertise involved in this program, a permanent institute for technological planning is being established at Cairo University. This institute will eventually organize a centralized body of technological, economic, and social science expertise both internal and external to Egypt in the general area of development planning.

برنامج التخطيط التكنولوجي (TPP)
جامعة القاهـرة/معهد ماساتشوستس للتكنولوجيـا

قام برنامج التخطيط التكنولوجي (TPP) منذ عامين بين جامعة القاهـرة ومعهد ماساتشوستس للتكنولوجيا (MIT) على اساس تمويل موقت من بعثـة (AID) الامريكية في مصر وتحت رعاية برنامج تطويع التكنولوجيا (TAP) بهدف تحسين تخطيط مشروعات التنمية في مصر والهدف العام للبرنامج هو توسيع قدرات الوزارات المصرية والمؤسسات الحكومية الاخرى في اعداد البرامج التكنولوجية وتنفيذهـا بحيث تحقق اهداف خطط التنمية القومية ، و تركز مشاريع البحث على نطاق واسع يشمـل موضوعات هندسية واقتصادية ومجلات الخدمة الاجتماعية ويشكل الفريق التنظيمي المشـترك العنصر الاساسي في اي من هذه الابحاث فهو مشكل في كوادر المتخصصين العاملـين بمعهد ماساتشوستس للتكنولوجيا وجامعة القاهرة والمشاريع الحكومية ذات الطابع المماثل • ولقد كان التعاون الفعال بين الجهات الحكومية والاكاديمية في مصر السبب الرئيسـي وراء نجاح المشروع حتى الان •

وبالاضافة الى مشروعات البحث المحددة كان هناك تركيز على تدريب الكوادر المحليـة في كل بلد على اسلوب التعرف على المشروعات وتقييمها وادارتها وتطوير وحفظ المعلومـات اللازمة لمتابعة المشاريع •

ويجري حاليا انشاء معهد دائم للتخطيط التكنولوجي بجامعة القاهرة ليكون وسيلـة اتصال دائمة وملائمة بين المؤسسات الحكومية والخبراء الاكاديميين في البرنامج وستكون مهمـة هذا المركز تكوين هيئة مركزية من الخبراء في مجالات التكنولوجيا والاقتصاد والعلوم الاجتماعيـة من المصريين وغيرهم المتخصصين في مجال التنمية بصفة عامة •

HOUSING AND CONSTRUCTION INDUSTRY RESEARCH PROGRAM
CAIRO UNIVERSITY/M.I.T.

The provision of housing in Egypt today is a diverse and complicated sector in which both private enterprise and public regulation are struggling to adapt the country's limited resources towards solving serious housing problems. The several closely-linked research projects reported here attempt to assist the Egyptian government in developing a housing policy which better enables it to cope with the country's housing needs.

The overall objective of the research on the Housing and Construction Industry is to provide a set of pragmatic recommendations and guidelines for the public agencies concerned with housing and to construct a methodology through which these agencies can organize and monitor performance in this sector.

The research intends to develop the technical and economic basis for a national housing policy. The focus is on investment policies, controls and regulations, provision of services, and other instruments of government intervention in housing. The goal is to assist the Egyptian government in developing a housing policy which better enables the various supply institutions to meet the country's housing needs.

The research was directed toward a wide range of issues in several disciplines. The initial year was spent in reviewing and identifying critical issues and problem areas; and the subsequent years were devoted to more focused research in each of the areas with the goal of making specific recommendations arising from the research. Several separate but complimentary problem areas were investigated:

1) Public Policy and the Economics of Housing, with focus on investigating policy options affecting housing;
2) Management of the Resources of Construction, with focus on the inter-relationships of the prime actors in the construction industry.

الاسكان وصناعة البناء
مشروع جامعة القاهرة / معهد ماساتشوستس للتكنولوجيا

يعتبر قطاع الاسكان فى مصر من اكثر القطاعات تعقيدا وتنوعا فى مشاكله حيث تتصارع المؤسسات الخاصة والتنظيمات العامة من اجل تطويع موارد الدولة المحدودة لحل مشاكل الاسكان الهامة وتحاول مجموعة الابحاث هنا أن تساعد الحكومة المصرية فى التوصل لسياسة اسكانية تمكنها من تلبية احتياجات البلاد فى مجال الاسكان بطريقة افضل .

ان الهدف العام للبحث المتعلق بالاسكان وصناعة البناء هو الدخول لمجموعة من التوصيات والتوجيهات العملية لترشيد المؤسسات العامة التى تعنى بالاسكان فى مصر ، ووضع منهاجا لهذه المؤسسات يمكنها على اساسه تنظيم ومراقبة التنفيذ فى هذا المجال .

كان القصد من البحث هو تطوير القاعدة الاقتصادية والتقنية التى تقوم عليها السياسة القومية للاسكان ، والتركيز على سياسات الاستثمار والضوابط التنظيمية وتوفير الخدمات ، ومختلف وسائل التدخل الحكومى فى مجال الاسكان . ويهدف البحث الى مساعدة الحكومة المصرية على التوصل الى سياسة اسكانية تمكن مؤسسات التمويل المختلفة من تلبية احتياجات البلاد فى مجال الاسكان بطريقة افضل .

وقد وجه البحث فى نطاق عريض من الموضوعات فى مجالات عدة وقد تم خلال السنة الاولى التعرف على المواضيع الحرجة والمشاكل الهامة ثم وجهت الجهود فى السنوات التالية الى تركيز البحث فى كل المجالات بهدف الوصول الى توصيات محددة . وقد تمت دراسة مجموعة متكاملة من مشاكل الاسكان المنفصلة الاتية :

١) دراسة السياسة العامة للاسكان واقتصاديات الاسكان مع التركيز فى البحث على السياسات البديلة التى تؤثر على الاسكان .

٢) دراسة ادارة موارد البناء مع التركيز على العلاقات المتبادلة بين المعنيين الاساسيين بصناعة البناء .

3) Materials and Techniques of Construction, with focus on utilizing indigenous materials and available skills;
4) Housing Construction Systems and Design Norms: Prefabrication, with focus on modifications of the new prefabrication systems required to reach lower income groups and to make better use of the elements; and
5) Housing for the Low Income and Informal Sectors, with focus on site and services planning approaches, compact physical development models, and core house options as an alternative to existing public housing models.

A brief summary follows. The full reports follow in separate sections.

٣) دراسة مواد وتقنيات البناء مع التركيز على استخدام المواد المحلية والمهارات المتاحة .

٤) دراسة نظم تشييد المبانى السكنية وقواعد التصميم (البناء سابق التجهيز) مع التركيز على استخدام وتعديل نظم البناء سابق التجهيز حتى يمكن استخدامها للبناء لذوى الدخل المحدود واستخدام المواد المتوفرة بطريقة افضل .

٥) دراسة الاسكان لذوى الدخل المحدود والقطاعات الغير رسمية مع التركيز على استخدام اسلوب تخطيط الموقع والخدمات ونماذج التطوير الطبيعى المكثف كبديل لنماذج الاسكان العامة الحالية .

وسيتبع ذلك ملخصا مختصرا للتقارير الكاملة التى ستصدر فى اجزاء منفصلة

• *Public Policy and the Economics of Housing*

For the last three years the subproject has investigated the housing market in Egypt and the role of current and past public policy in that market. The research has focused on four issues, considered of primary concern today by Egyptian policy makers.

(1) The shortage of dwelling units and the rapid rise in their cost.
(2) The impact and repercussions of Egypt's widespread system of rent control.
(3) The economic advantage of constructing new towns in the desert.
(4) The comparative costs of alternate building technologies.

In each of these areas, the subproject has prepared a report analyzing and evaluating the issue. These reports, dealing respectively with the four topics listed above, are included in a subsequent section of the report.

The conclusions of each of these reports, while different, do appear to have a common theme - that current housing

• السياسة العامة واقتصاديات الاسكان :

قام المشروع خلال السنوات الثلاث الماضية بدراسة سوق الاسكان فى مصر وتأثير السياسة العامة الحالية والسابقة عليه .

وقد ركز المشروع على اربعة نقاط رئيسية يعتبرها صانعو السياسة فى مصر اليوم ذات اهمية كبيرة :

١) ازمة الوحدات السكنية والارتفاع السريع فى تكاليفها (الايجارات) .
٢) آثار وتبعيات نظام قانون الايجارات المصرى .
٣) الفوائد الاقتصادية لانشاء مدن جديدة فى الصحراء .
٤) التكاليف النسبية لوسائل البناء التكنولوجية البديلة .

وقد قام المشروع باعداد تقارير فى كل من هذه المجالات لتحليل وتقييم هذه النقاط الرئيسية . وهذه التقارير التى تتناول النقاط الاربع المذكورة قد الحقت بجزء لاحق من هذا التقرير .

ورغم اختلاف النتائج المستخلصة فى كل من هذه التقارير الا انها تندرج تحت موضوع واحد هو أن مستوى سياسة الاسكان فى مصر حاليا ادنى من المطلوب .

policy in Egypt today is less than desirable. The subproject has found that there does not exist a housing shortage per se in Egypt, rather a large amount of unregistered building in fact provides everyone with a home. In spite of rapid rising construction costs, the level of housing consumption has not fallen - due to high government subsidies on new housing, and rent control in existing units. Given a significant increase in the real cost of housing, consumption should fall for efficient resource allocation. Current policy, therefore, is encouraging "over consumption" of housing- at least where the policy is being applied. The subproject has found that little is being done in Egypt to assist the housing of the truly poor, rather the rent control system and subsidized new construction seem to be benefiting primarily the middle class.

On the third question, current Egyptian policy strongly emphasizes the preservation of agricultural land, by redirecting urban growth to new communities in the desert. The subproject's report suggests that the costs of this plan are very high. Even when valued at its true shadow price, farm land at the edges of existing cities cannot compete with the higher urban rent. Such rents in many ways reflect the productive advantages of large cities in the developing economy. Smaller towns in the desert, will therefore require enormous subsidization. This money would probably be better spent on agricultural reclamation, allowing urbanization to continue around existing settlements.

On the final issue, the subproject has found that the prefabrication technologies, imported into Egypt in the mid-1970's, are more expensive - even in operation - than are present building techniques. With the current system of government housing subsidies, however, contractors do not bear this additional expense - the government does.

The Egyptian reaction to these findings has also been fairly constant over the last three years. Many government officials and colleagues agree with the conclusions

وقد وجد المشروع انه لاتوجد فى مصر ازمة اسكانية بذاتها بل على العكس فانه كما كبيرا من البناء غير المسجل يوفر منزلا لكل فرد • وعلى الرغم من الارتفاع المضطرد فى تكاليف البناء فأن مستوى الاستهلاك الاسكانى لم يقل اويتأثر وذلك نتيجة للدعم المالى الكبير الذى تقدمه الحكومة للمشاريع الاسكانية الجديدة وسيطرتها على الاجور فى المشاريع الموجودة فعلا •

ولو وضعنا فى الاعتبار التزايد الملحوظ فى التكاليف الحقيقية للاسكان لوجدنا ان مستوى الاستهلاك يجب ان يقل ليتناسب مع الموارد المالية المرصودة له •

وعلى هذا نرى ان السياسة الحالية تشجع على الاستهلاك الاسكانى الزائد حيثما تطبق • وقد وجد المشروع أن الجهود التى تبذل لاسكان ذوى الدخل المنخفض قليلة جدا حيث لايستفيد من قوانين الايجارات ، وتدعيم الانشاءات سوى فئة متوسطى الدخل •

اما عن النقطة الثالثة فان السياسة الحالية فى مصر تؤكد بشدة على ضرورة الحفاظ على الارض الزراعية وذلك بتوجيه النمو العمرانى نحو مجتمعات جديدة فى الصحراء وتقرير المشروع يجد ان تكاليف هذه الخطة مرتفعة جدا فالاراضى الزراعية الموجودة على حواف المدن القائمة • لو قيمت باسعارها الشكلية الحقيقية لايمكنها أن تدخل مجال المنافسة مع ايجارات الاراضى العمرانية المرتفعة •

وعلى هذا فأن أى مدنا صغيرة فى الصحراء ستكون فى حاجة الى تدعيم ضخم جدا حتى انه ليكون من الافضل لو انفقت اموال هذا الدعم فى استصلاح الاراضى التى تسمح بالامتداد العمرانى حول المدن القائمة •

اما عن النقطة الاخيرة فقد وجد المشروع ان نظام البناء سابق التجهيز الذى ادخل الى مصر فى اواسط السبعينات هو فى الواقع اكثر تكلفة من انظمة البناء الحالية اما فى ظل سياسة دعم الاسكان لحالية فان شركات المقاولات لاتتحمل شيئا من التكاليف الاضافية ولكن تتحملها الحكومة •

كان رد الفعل المصرى تجاه نتائج هذه الابحاث ثابتا خلال السنوات الثلاثة الماضية وقد يتفق كثير من المسئولين الحكوميين والسادة الزملاء مع نتائج هذه الابحاث

of the reports, but at the same time feel that there are considerations which make it difficult to readily change the current policy. The view seems to be that the research has touched on the most important and pressing housing policies in Egypt, but by their very nature, such policies will be difficult to change.

ولكنهم سوف يحسون فى الوقت نفسه بأن هناك اعتبارات تحتم عدم تغيير السياسة الاسكانية الحالية •

ويمكننا أن نخلص فى النهاية الى أن البحث قد تناول أهم سياسات الاسكان فى مصر واكثرها الحاحا ولكن مثل هذه السياسات بطبيعتها ستكون من الصعب تغييرها •

• Management of the Resources of Construction

This area grew out of the previous year's research on Institutional and Organizational Aspects. The previous work focused on defining and understanding the basic nature and inter-relationships of the prime actors in the housing and construction industry: the owner/investor, the architect/engineer, the contractor/subcontractor, the material/equipment supplier, and the government.

From this initial research it was clear that the issue of project management/organization was recognized as important. One serious constraint, however, to developing appropriate research on these issues and possible associated policies is the lack of a well-organized group of Egyptian experts in the project management area. Interest and support of organizing these experts comes from diverse areas related to construction.

Therefore as a means of establishing this base of concerned construction professionals, a symposium on Engineering Management was held in Cairo during January, 1980. The overall symposium goals were 1) to create a better understanding of the basic management issue; 2) to allow key people to assist in defining future research; and 3) to create a setting for future research (See report: "Seminar Proceedings", TAP 80-6, Spring 1980). Subsequently, based in part on the ideas, issues, and contacts which arose during the Seminar, several possible areas were identified on which to base research efforts. A proposal was made, and funding was sought to support the work in the coming year.

• ادارة موارد البناء :

قد برز هذا المجال فى بحث السنة الماضية عن الجوانب التأسيسية والتنظيمية قد تركزت الاعمال السابقة على تعريف وفهم الطبيعة الاساسية والعلاقات بين المعنيين الرئيسيين فى صناعة البناء والاسكان ، المالك / المستثمر المعمارى / المهندس ، المقاول / المقاول الفرعى ، المواد / الادوات ، والحكومة •

وقد وضح من هذا التقرير الاولى اهمية موضوع ادارة / تنظيم المشاريع ويعتبر الافتقار الى مجموعات جيدة التنظيم من الخبراء المصريين فى مجال ادارة المشاريع واحدا من أهم العوائق التى تعوق وضع تقارير ملائمة عن هذه الموضوعات والسياسات المختلفة المتعلقة بها ويأتى الاهتمام بدعم تنظيم مثل هذه المجموعات ن قطاعات عديدة مختلفة متصلة بصناعة البناء •

وقد عقدت ندوة عن الادارة الهندسية فى القاهرة خلال يناير ١٩٨٠ — كوسيلة لتكوين قاعدة من المعنيين والمختصين بصناعة البناء •

وكانت أهداف الدورة هى :

١) تكوين مفهوم واضح عن اساسيات الادارة •

٢) توفير الفرصة لافراد القطاعين الخاص والعام للمشاركة الفعالة فى الابحاث القادمة •

٣) خلق خلفية مناسبة للبحث مستقبلا (انظر التقارير التفصيلية) •

وعلى اساس نتائج الندوة تم تحديد المواضيع ذات الاهمية التى يمكن أن للباحثين ان يتطرقوا اليها فى السنة القادمة

● *Materials and Techniques of Construction*

The principal goals of this subproject were (a) to complete the research work on gypsum blocks and panels and to design a small components and framing system with possible development of a full-scale model at Cairo University, (b) to complete the research work on surface bonding of masonry, (c) to continue the investigation of low-cost cement and lightweight aggregate as opportunities develop, and (d) to collaborate in the proposed overall small-components program.

The primary efforts were directed as follows:

a. Gypsum and small-components framing system. Current laboratory investigation of unreinforced and reinforced gypsum blocks and panels was completed. Design of a small reinforced-concrete framing system was completed and fabrication was begun of molds for the production of sufficient components for a full-scale prototype to be erected at Cairo University. Possible commercial exploitation of the gypsum components was explored with commercial and financial interests.

The gypsum blocks and panels are technically feasible and appear to be economically promising on the basis of preliminary studies. They can readily be fitted into standard construction processes, and require no particularly new or exceptional skills. They can easily be adapted to the small-components framing system currently being developed.

b. Laboratory work on surface-bonding masonry units (instead of mortar between units) including various types of bricks, was undertaken, employing fiber-reinforced mortar and fiber-reinforced sulfur.

Problems associated with handling molten sulfur and poor properties of the resulting fiber-reinforced surface-bonded masonry, led to a decision to suspend this approach in favor of fiber-reinforced mortar.

Surface bonding of masonry units with fiber-reinforced

● مواد وتقنيات البنـــاء :

كانت الاهداف الرئيسية لهذا المشروع هى :

أ) اكمال الابحاث المتعلقة بالقوالب والقواطع المصنوعة من الجبس ، ونظـــام الهياكل صغيرة • العناصر وذلك بعمل نماذج بالحجم الطبيعـــى فى جامعة القاهرة •

ب) اكمال الابحاث المتعلقة باللصق السطحى فى اعمال البناء •

جـ) استئناف الابحاث المتعلقة بالاسمنت منخفض التكاليف والخلطات الاسمنتية خفيفة الوزن كوسائل للتنمية •

د) الاشتراك فى البرنامج العام المتعلق بالعناصر الصغيرة

وقد وجهت الجهود المبدئية نحو المواضيع التالية :

١) فى موضوع القوالب والقواطع المصنوعة من الجبس ونظم الهياكل صغيـــرة العناصر اكتملت الابحاث المعملية المتعلقة بالقوالب والقواطع المصنوعـــة من الجبس المسلح وغير لمسلح • انتهى من تصميم نظام هيكلى مصغـــر يعتمد على الخرسانة المسلحة ويبدأ فى تصنيع القوالب اللازمة لانتـــاج عناصر صغيرة تكفى لانشاء نموذج بالحجم الطبيعى فى جامعة القاهـــرة تحت دراسة اوجه الاستثمار التجارى للوحدات الجبسية (المصنوعـــة من الجبس) وفقا للصلاحيات لتجارية والمالية وقد ظهر من الدراســـات الاولية أن القوالب والقواطع المصنوعة من الجبس ملائمة عمليا وناجحـــة تجاريا • فهى قابلة للتركيب فى عمليات البناء القياسية ولاتحتاج لايـــة مهارات جديدة او اضافية • كما انها يمكن تطويعها بسهولة لتلائـــم نظام الهياكل صغيرة العناصر الذى يعد حاليا •

٢) تمت الابحاث المعملية المتعلقة بمواد اللصق السطحى (بخلاف مونـــة اللصق) فى اعمال البناء التى تشمل مختلف انواع الطوب واستعمل فيهـــا المونة المدعمة بالالياف والكبريت المدعم بالالياف وتم اختبار خواص الحوائط الناتجة ووضع فى الاعتبار طرق تطويع هذه المواد للحقل العملى وقد فضلت المونـــة المدعمة بالالياف على الكبريت المدعم بالالياف نتيجة للمشاكل المتعلقـــة بالتعامل مع الكبريت المصهور ولضعف خواص اللصق السطحى .

mortar is technically feasible. Properties of the resulting panels were tested. Relatively unskilled labor can be utilized. Procedures for on-site adaptation by either fabrication in place or by prelaid panels need further study but no great difficulties are anticipated.

c. Studies of low-cost cements as produced in the United States and elsewhere were begun. Low-cost cements and lightweight aggregates should be feasible in Egypt, but await the availability of manufacturing facilities. A survey of protective and decorative coatings was undertaken. Possible studies of stabilized earth were deferred until an actual construction site is selected. Studies of lightweight aggregate were deferred until facilities for their production are available in Egypt.

وجد أن مواد اللصق السطحى للوحدات البنائية باستخدام المونة المدعمة بالالياف ملائمة عمليا ويمكن ان يقوم بها عمال ليسوا على مستوى عالى من المهارة كما أن اجراءات تطويعها لملائمة موقع العمل اما بتصنيعها فى الموقع او عن طريق سابق التجهيز تحتاج لدراسات لايتوقع ان تلاقى صعوبات كبيرة .

٣) تمت دراسات عن الاسمنت منخفض التكاليف اعتمادا على امثلة مما ينتج فى الولايات المتحدة وفى مناطق اخرى فى العالم ووجد أنه من الملائم جدا ان يستعمل هذا الاسمنت منخفض التكاليف والخلطات الاسمنتية الخفيفة الوزن فى مصر بعد ان توفر لهما وسائل التصنيع وتمت دراسات لعمل تغطيات وقائية وجمالية له كما أرجأت دراسات توازن الارض لحين اختيار الموقع الفعلى للبناء وارجأت أيضا دراسات الخلطات الاسمنتية خفيفة الوزن حتى توفر الوسائل اللازمة لانتاجه فى مصر .

- *Housing Construction Systems and Design Norms*

Past and current production of the eleven prefabrication factories has not been a function of effective demand, but is largely based on technical and design characteristics of their respective European country of origin. Thus, the factories are able to produce only subsidized apartments of layouts not fully suited to the needs of the target user groups. (See "Interim Report 1978," TAP 79-5, Spring 1979.)

In order to alleviate this problem, one of the major recommendations was to normalize and simplify the proliferating number of elements, each suitable only for application in proprietory closed systems in such a way that a few simple and globally standardized elements would be capable of : (1) application in so-called "open" (non-proprietory) systems; (2) producing a greater variety of plan options, without sacrifice of the advantages of rationalization and mass production.

- أنظمة البناء الاسكانى ومعايير التصميم :

لم يتفق الانتاج الحالى والسابق للاحد عشر مصنعا للبناء السابق التجهيز مع المتطلبات الفعلية وانما قام على قاعدة من المميزات الفنية والتصميمية السائدة فى الدول الاوربية التى أنشأتها .

ولذلك فان هذه المصانع لايمكنها الا أن تنتج نماذج البناء المدعم الذى لايلائم الاحتياجات المستهدفة للجماعات المستخدمة .

ولكى نيسر حل هذه المشكلة فقد كان من بين التوصيات الرئيسية ، أن تقلل عدد العناصر وتبسطها ، حتى يكون كل منها صالحا للتطبيق فقط فى نظم مغلقة ، بحيث يكون عدد قليل من العناصر المتفق عليها عالميا صالحا :

١) للتطبيق فيما يسمى بالنظم (المفتوحة) .

٢) وليتيح الفرصة الاكبر للاختيار بين التصميمات المختلفة دون أن نضحى بالقواعد المترتبة على الانتاج الوفير او الواسع .

ولكى تثبت صحة هذا الرأى ، وجهت جهود فريق العمل فى هذه المرحلة من

In order to prove this point, the efforts of the team during this phase of the research were directed toward the elaboration of a methodology (by example) which would allow the utilization of prefab large reinforced concrete elements in the above recommended manner.

In view of the realities in Egypt, it was decided that the best way to demonstrate the merit of an "open" approach to housing systems is by example.

The factory in Helwan was chosen as representative of both the capacity and the nature of large reinforced concrete panel production in Egypt.

The aim was to combine the versatility and adaptability of conventional construction methods with the mass-production capacity and rationalized standards of the prefabrication sector by designing a set of general "supports" (i.e., primary, permanent, and predominantly structural elements), which have the spatial and technical capacity to accept a wide range or pre-coordinated (secondary, less permanent, and predominantly non-structural elements) "infill" elements, which can be combined into variable and flexible plan configurations, without sacrifice of economy and design efficiency, thus leading not only to a better utilization of existing construction techniques, but also to a closer satisfaction of user needs in a situation of rapid change and growing expectations for a higher living standard among all segments of the Egyptian population.

Based on the methodology developed by Prof. N.J. Habraken--called the SAR method--both conventional and prefabricated housing solutions were analyzed to determine which elements were to be considered as "support" and which could be allocated as "infill."

This analysis led to the adaptation of both conventional and modified prefabrication elements to flexible/variable "basic plan variants," which--in turn--were

مراحل البحث الى التوسع فى دراسة الطريقة (على سبيل المثال) التى تسمح بأستخدام عناصر المبانى سابقة التجهيز المقواة خرسانيا فى هذه الحالة المقترحة آنفا •

وفى ضوء الواقع المصرى رؤى ان احسن السبل لاظهار نبرة الاسلوب المفتوح فى نظم البناء هو هذا المثال •

فقد تم اختيار مصنع حلوان كمثال لكل من الطاقة وطبيعة الانتاج الضخم لبانوهات الخرسانة المسلحة فى مصر •

وكان الهدف هو ان تربط التنوع والملاءمة فى طرق البناء المتفق عليها تقليديا ، مع القدرة على الانتاج الواسع ، والمعايير المتفق عليها والمقبولة فى قطاع المبانى سابقة التجهيز ، وذلك بتصميم مجموعة من العناصر المعززة لذلك (عناصر البناء الاساسية والدائمة والسائدة) والعناصر التى لها القدرة المكانية والتكنولوجية لتقبل المجال الاوسع (عناصر البناء الثانوية والاقل دواما والشائعة) مع العناصر البديلة التى يمكن ان ترتبط بالخطة المتغيرة المرنة دون ان يضحى بالاقتصاد وبكفاءة التصميم بما يؤدى لا الى الاستخدام الافضل لاسلوب البناء القائم فحسب بل والى اشباع حاجات المستغلين للبناء فى ظروف التغير السريع ، والتوقعات المتزايدة فى مستوى معيشة على بين قطاعات المجتمع المصرى •

وعلى اساس الاسلوب الذى وضعه البرفسور ن •ج • هيراكن والذى يعرف بطريقة (SAR) ودرسة حلول مشكلة الاسكان الشائع والاسكان سابقة التجهيز لتحديد العناصر التى يمكن اعتبارها "معززة " والتى يمكن ان نسميها " بديلة" •

وقد ادت هذه الدراسة التحليلية الى تبنى عناصر لكل من البناء الشائع والمبانى سابقة التجهيز المعدلة ووضع متغير مرن هو "خطة اساسية مختلفة منهما " •

وتخضع كل الخطط وشأنها شأن العناصر الانشائية وغير الانشائية الى قواعد الموديول فنائى العصب سامحة بذلك بالتبادل المتعاوض بين المكونات كجزء من نظام معيارى مفتوح •

elaborated into a series of possible "sub-variants."

All plans, as well as all structural and non-structural elements, obey the rules of a band-grid position coordination system (modular "tartan" grid), thus allowing interchangeability of elements as part of an "open" system of standardization.

As a result, a great variety of plan types becomes possible, while the number of standard, primary structural elements was reduced by more than one half. The resulting precast concrete elements are not only simpler in shape, but also consume less steel and cement, as stipulated by the recommendations of the materials sub-group of the housing research team. The analysis of traditional plans helped as well to design a "Modular Pattern" that could be used for large housing projects. In order to show the inherent flexibility of the proposed "pattern", it was used for the design of four different housing types, and in a study of the variations in layouts that could be achieved.

A simple cost estimating format was developed to provide the builder or developer with: (a) a separate record for both the "support and "infill" elements of a project; (b) a means by which to estimate "trade-off" options (viz 1977 report) for various finishing operations.

Part of the advantage of separating both conceptually and technically the "support" from "infill" is the feasibility of offering "pre-coordinated" plan variants of great diversity, and also the possiblity of staged completion, based on explicit or implicit user requirements (over time or in space), or on economic ability to afford certain options of dwellings (i.e., trade off space against finishes, etc.)

As a corrollary to the fact that much if not the majority, of recently completed housing in and around Cairo is built by conventional means, consisting of an in-situ cast reinforced concrete frame structure with brick infill for facades and partitions, it was decided to develop a rationalized prototype of "small components,"

وقد اعطى ذلك تنوعا كبيرا فى انماط الخطط وفى نفس الوقت قلل من عدد المكونات الانشائية اولية بما يزيد عن النصف • وكما ورد فى توصيات المجموعة المختصة بالمواد المتفرعة من فريق البحث ، فأن المكونات الخرسانية السابقة الصب تجمع بين البساطة فى الشكل والاستخدام الاقل من الاسمنت والحديد •

وقد ساعد تحليل المساقط الافقية للمساكن الاعتيادية فى مصر على الوصول الى نمط موديولى يمكن تطبيقه فى تصميمات المشاريع الاسكانية الجديدة ولاظهار مرونة هذا النمط تم تصميم أربعة نماذج اسكان مختلفة به •

وقد تم اعداد جدول بسيط لتقدير اسعار المواد لتزويد القائمين لعمليات الاعداد والبناء بالاتى :

أ) سجل منفصل يشمل المكونات الاساسية والثانوية المستخدمة فى المشروع •

ب) وسيلة يمكن عن طريقها تقدير ومفاضلة الوسائل المتعارضة فى مختلف عمليات التشطيب بعضها ببعض •

ومن مميزات الفصل فى المفهوم والتطبيق بين " الاساسيات " " والثانويات " مايعطيه ذلك من تنوع كبير فى الخطط المقترحة بل وامكانية التكملة المرحلية للخطط على اساس من الاحتياجات الصريحة او الضمنية للمستخدمين والامكانية الاقتصادية لتحمل اختيارات محددة من الوحدات السكنية الغير مكتملة التشطيب كليا او جزئيا (اى امكانية المفاضلة بين الفراغ والتشطيبات والادوات •• الخ •) •

ونتيجة لان غالبية المشاريع الاسكانية المقامة حديثا فى القاهرة او حولها قد بنيت بالوسائل التقليدية التى تعتمد على هياكل انشائية من الخرسانة المسلحة تملأ فراغاتها بالطوب لتكون الواجهات والقواطع الداخلية ، فقد تقرر اعداد نموذج من " المكونات الصغيرة " التى تستخدم اسمنت وحديد اقل والتى تقبل مواد اخرى مختلفة لعمل القواطع الداخلية خلاف الطوب الطفلى التقليدى الذى يجب أن يقل استهلاكه لعدة اسباب •

وقد تم اعداد نموذج لنظام يستخدم مكونات خرسانية بسيطة وخفيفة الوزن فى تكون هياكل انشائية اساسية تتراوح بين طابق واحد واربعة طوابق تماثل تلك

which would consume less steel and cement, of lightweight elements, and capable of accepting other materials for internal partitions than the traditonal clay bricks, the consumption of which needs to be reduced for various reasons.

A prototype system of relatively simple and light weight concrete components was developed, forming a basic frame for 1 - 4 storey structures, similar to those produced by conventional techniques, but capable of being cast in series either off-site or on-site, and able to be erected quickly.

A one bay prototype version of this system is now being erected on the grounds of Cairo University. The purpose of the prototype is to: test production and assembly characteristics (i.e., form-work, steel placement, tolerances, ease of erection, etc.); obtain feedback from potential users of the system by actual field demonstration, rather than publication of paper documents; test viability of modular coordination (position) band grid system to accept rationalized "infill" elements, etc; demonstrate to the ministries and large construction companies that the erection of demonstration systems and experimental projects is not only essential to research and progress, but relatively cheap (considering overall volume and investment in the housing sector).

المنتجة بالوسائل التقليدية ولكنها تتميز عنها بامكانية الصب المتسلسل في الموقع او خارجه وبسرعة تركيبها •

ويجرى الان اقامة نموذج هذا النظام على ارض جامعة القاهرة بهدف :

١) اختبار خصائص انتاجه وتجميعه (مثل: الشدات ، التسليح ، قوة الاحتمال سهولة التنفيذ) •

٢) استطلاع تقيم مستخدمى النظام المختصين للنموذج الحى بدلا من كتابة منشورات عنه •

٣) اختبار ما اذا كان نظام الموديول ثنائى العصب يقبل اضافة مكونات ثانوية معقولة أم لا •

٤) ان نظهر للوزارات وشركات الانشاءات الكبيرة مدى اهمية الدور الذى تلعبه هذه النماذج الحية للمشاريع التجريبية فى البحث والتطوير ولنظهر انخفاض سعرها النسبى اذا ما قورنت بالحجم الكلى للاستثمارات فى قطاع الاسكان •

• *Housing for the Low Income and Informal Sector*

The objectives of the continued work were focused towards a further understanding of the mechanisms and operation of the informal sector which represents the vast majority of the housing stock in urban Egypt. Focus has been on developing and providing an apprropriate reference for housing for this sector; specifically, on site and services/ core housing types of programs. The scope of the work in-

• اسكان ذوى الدخل المنخفض والقطاع الغير قانونى :

ركزت اعمال الفريق على تحديد مفهوم واضح لميكانيكية ونظم التطبيق التى يعمل بها القطاع غير القانونى الذى يشكل اكثرية عظمى من الرصيد الاسكانى فى المناطق العمرانية فى مصر •

وقد كان التركيز منصبا على تكوين وتطوير مرجع ملائم من الاسكان فى هذا القطاع وعلى الاخص فى مواضيع : اراضى البناء والخدمات ، البرامج الاسكانية

cluded an evaluation of the proposed project designs and the design of the core house units. In addition - within the imposed limitations - basic reference studies were undertaken to provide essential data for determining appropriate policies.

The tasks were directed into several areas:

1) Study of core housing to develop an understanding of the design of the units as has been used or proposed in projects in Egypt.

2) Determination of the size, growth, and patterns of development of the informal sector of the Greater Cairo area, with the goal of providing basic data for determining appropriate government intervention; specifically, toward policies of control and direction, and perhaps upgrading of these areas. This study experimented with LANDSAT digitalized computer images and aerial photographs as a tool for providing basic data in policy determinations.

3) Study of the family/dwelling/location cycle in Cairo to determine how the proposed site and services project fit the requirements of the low income.

TASK 1: Comparative studies of existing and proposed site and services/core housing projects.

Evaluation was at two scales: the lot/core house, and the block/lot subdivision. Projects that were evaluated included: Sadat City New Town (core housing sector), Ameriyah New Town, 10th of Ramadan New Town (core housing sector), Cabanon New Community (Suez), El Hekr Demonstration Project (Ismailia), Helwan New Community (MOH-AID), Alexandria Project (MOH-World Bank), and Port Said New Community.

a) Comparisons of core house and lot. The study evaluated and compared the design proposals in their context as a solution for low income people. A detailed assessment of the characteristics and an analytical review of their potentialities was undertaken. For each proposal, 2 examples were selected: one small lot situation and one large lot

على غرار برنامج اسكان النواة

وقد تضمن العمل تقييم تصميمات المشروع المقترحة وتصميم وحدات المنزل النـــواة وبالاضافة فقد تمت دراسات مرجعية اساسية ـ في حدود القيود المفروضـــة لجمع المعلومات الضرورية لتحديد سياسات ملائمة •

وقد وجهت الاعمال الى مجالات عديدة :

١) دراسة اسكان النواة لتطوير مفهوم اوضح لتصميم الوحدات المستخدمـــة او المقترحة في المشاريع في مصـر •

٢) تحديد حجم البنود ودراسة امثلة للتطور القطاع الغير قانوني في نطـــاق القاهرة الكبرى بهدف توفير بيانات ومعلومات اساسية تحدد على اساسهـــا التدخل المناسب للاجهزة الحكومية وعلى الاخص تجاه سياسات تنظيم وترشيد وتحسين هذه المناطق وقد استخدمت في هذه الدراسات صور رقميـــة للحاسبات الالكترونيـــة (LANDSAT) وصور فوتوغرافيـــــــة جوية كوسائل توفير المعلومات الاساسية اللازمة لتحديد السياسات •

٣) دراسة دورة العائلة / المسكن / الموقع في القاهرة تحديد مدى ملائمـــة الموقع المقترح ومشروع الخدمات الاحتياجية لذوي الدخل المنخفض •

المهمة الاولى :

دراسات مقارنة بين مشاريع اراضي البناء والخدمات / اسكان النـــواة الموجودة فعلا والمقترحة •

وقد كان التقييم على مستويين : الاول مسطح الوحدة / مسطـح النـواة والثاني مسطح التقسيم / مسطح الوحدة •

وقد تضمنت المشاريع المقيمة كلا من مشاريع اسكان النواة في كل من مـــدن السادات والعامرية الجديدة والعاشر من رمضان ومشاريع حي الكبانـــون الجديد بالسويس والحركة بالاسماعيلية والحي الجديد بحلوان (MOH-AID) ومشروع الاسكندرية (MOH-WORLD BANK) ومشروع الحـــــي الجديد ببورسعيـــد •

أ) المقارنة بين مسطح النواة ومسطح الوحدة • تمت الدراسة لمضمـــون

situation. Comparisons were made for the following: width/depth relationship of plot; core area/total plot area ratio; location of core and number of initially built rooms; wall areas; functional relationships in plots; growth and flexibility; stair access/location; maximum potential developments; construction; utilities; and doors and windows.

A similar type of comparison was made for a "vertical" core house type proposal in Port Said.

b) Block layout comparison. This study deals with the comparison and evaluation of the basic land subdivsion element - the block. The same 8 projects as in the core house/lot are used, with the addition of three reference patterns from the spectrum of low income areas in Cairo: Medieval Cairo, public housing (Ain El Sira), and informal housing (Imbaba sector).

The goals were: 1) to determine key elements and factors that disproportionately influence a layout through obvious cost penalties or advantages, 2) to point out a possible methodology for evaluating projects in order to improve performance, i.e., lower costs without sacrificing design parameters, and 3) to increase awareness of the cost implications of physical layouts, to shift away from aesthetic reasons as a rationale for land subdivision.

The block or patterns of blocks, determines the essential street/lot relationships and effectively fixes the basic capital costs of urbanization: water supply, sewage disposal, electricity networks, and street paving, as well effects the continuing costs of operation and maintenance. An inefficient block width/length relationship can never be improved through a clever arrangement of other land subdivision elements (open spaces, schools areas, etc.). Conversely, however, the cost effectiveness of an efficient block is only partially mitigated through wasteful practices in allocation of other land areas. The land subdivision pattern and utility networks will remain, long after financing, construction, and allocation issues have been forgot-

التصميمات المقترحة باعتبارها تقدم الحل لاسكان منخفضى الدخل ، وقمنا بتقييم تفصيلى لخصائصها وباستعراض تحليلى لطاقاتها .

وقد اختير مثالان لكل من الاقتراحات : احدهما للقطع الصغيرة والاخر للقطع الكبيرة .

وقد عقدت المقارنات التالية : علاقة عرض القطعة وطولها ، نسبة مساحة النواة الى مساحة القطعة الكلية ، موقع النواة وعدد الحجرات الاساسية مساحة الحوائط ، العلاقات الوظيفية فى القطعة ، امكانية النمو والمرونة موقع السلالم ، اقصى نمو محتمل ، الانشاء ، الخدمات ، الابواب والنوافذ .

وقد عقدت مقارنة مماثلة لمشروع منزل النواة الرأسية المقترح فى بورسعيد

ب) مقارنة تقسيمات الاراضى : تتناول هذه الدراسة مقارنة وتقييم تقسيمات الاراضى الاساسية وقد قامت الدراسة على المشاريع الثمانية السابقة التى قامت عليها دراسات مساكن النواة بالاضافة الى ثلاثة امثلة اخرى من واقع مناطق اسكان منخفضى الدخل فى القاهرة وهى القاهرة القديمة الاسكان الشعبى (عين الصيرة) الاسكان غير القانونى (قطاع امبابة) .

وكانت الاهداف هى :

١) تحديد العناصر والعوامل الرئيسية التى تؤثر تأثيرا غير متجانس على التخطيط الاولى من خلال تحديدات او ميزات .

٢) ابراز منهج لتقييم المشاريع يمكن بواسطته تحسين الاداء او بمعنى اخر خفض التكاليف دون التضحية بالقيم التصميمية .

٣) زيادة الوعى بعواقب تكاليف وآثار تخطيط المواقع العامة والتحول عن الاسباب الجمالية كأساس لتقسيم الارض .

تحدد تقسيمات الارض العلاقة الضرورية بين مسطح الشارع والمسطح العام كما تحدد التكاليف الاساسية للعمران : شبكات المياه والمجارى والكهرباء ، تعبيد الطرق والتكاليف المتواصلة المتعلقة بالاستخدام والصيانة . واذا كانت علاقة طول وحدة التقسيم بعرضها ليست بالكفاءة المطلوبة فان امكانية تحسينها ، من خلال التنسيق

ten. The geometry determined costs of operation and maintenance will always continue.

General conclusions were as follows:

1) Maintain narrow streets, perhaps 6 meters, with wider streets only at clear vehicular circulation streets and at large intervals, minimum 200 meters.

2) Keep block lengths a minimum of 75 meters, with 100-125 meters desirable.

3) Avoid undefined, smaller open spaces; combine open spaces into larger useful sports fields, preferably in combination with other facilities (schools, etc.) which can provide a minimum responsibility and control. Block layouts interspersed with many small open spaces (of ambiguous use) tend to lower any advantage which a layout may otherwise have.

4) Use cluster lot layouts to lower public streets and utility network lengths, this readily allows staged provision of services.

TASK 2: Exploratory studies in the size and growth of the informal sector in Cairo. Two approaches were used in this part of the research: a) LANDSAT digitized computer data for the larger Cairo region, and b) time-phased aerial photographs of a selected informal area.

a) LANDSAT EXPLORATORY STUDY: Because of the difficulty in acquiring sufficient time-phased aerial photograph coverage of Cairo, it was decided to experiment with LANDSAT imagery as a means of determining the size and as a means of monitoring the growth of urbanized Greater Cairo. The imagery was to be used for exploratory studies in three ways: 1) to calculate the aggregate size of the urbanized area, 2) to determine the growth of built-up area over a several year period, and 3) to determine if specific housin types/sectors - particularly informal and formal - could be identified.

Close monitoring of the growth - direction and magnitude - through LANDSAT imagery would provide a readily accessible and inexpensive tool to update Census data, and

الجيد لعناصر تقسيم الارض الاخرى (الفراغات المفتوحة ، مناطق المدارس ... الخ) . تصبح عسيرة جدا بل ويمكن القول بأنها مستحيلـــة .

وبالعكس فان فاعلية تكاليف وحدة تقسيم جيدة لاتقلل الا بدرجة بسيطة مـــن خلال ممارسات غير مجديدة فى تقسيم مساحات الارض .

ولسوف تبقى نماذج تقسيم الارض وشبكات الخدمات طويلا بعد تطوى قضايـــا التمويل والانشاء والتقسيم فى طى النسيان .

وستتواصل دائما تكاليف التنفيذ والصيانة المحددة فى البحث الهندسى .

وكانت النتائج العامة كما يلـــى :

١) الابقاء على الشوارع الضيقة ربما بعرض ٦ امتار على صلة بالشوارع الواسعـــة التى فيها حركة واضحة لمرور المركبات وعلى مسافات متباعدة لاتقل عـــن ٢٠٠ متر .

٢) الاحتفاظ بامتدادات الكتل المبينة لمسافة ٧٥ متر على الاقل والافضـــل ان يكون امتدادها بين ١٠٠ ، ١٢٥ متر .

٣) تجنيب مفراغات المكشوفة الصغيرة وغير المحددة ، وبجميع الفراغات فى مساحات رياضية اكبر ناتجة والافضل ان ترتبط مع التسهيلات الاخرى كالمدارس مثـــلا حتى لايتوفر لها الحد الادنى من الرقابة والمسئولية . فنسق المبانى التى يفصلها عن بعضها مساحات صغيرة من الفراغ تقلل من اى فائدة اخـــرى يمكن ان تجنى من النسق .

٤) استخدام الانساق العنقودية لتقليل الشوارع العامة والانقطاع بشبكـــة اطوالها وسيتيح هذا على الفور توفير الخدمات مرحليا .

المهمة الثانيـــة :

دراسات استكشافية لحجم ونمو القطاع الشعبى فى القاهرة وقد استخدم منهجان فى هذا الجزء من البحث :

أ) بيانات الحاسبة الموضحة لمنطقة القاهرة الكبرى .

ب) الصور الجوية لمنطقة شعبية مختارة .

to provide relatively accurate information on the housing situation. Yearly monitoring perhaps would be readily feasible. This study essentially intended to identify the problems with this promising technique and to establish a base from which a definitive method could be developed.

The facilities of the Remote Sensing Center in Cairo were used for all of the technical work. All technical assistance was provided by personnel at the Center.

The years 1978 and 1973 were used as the base with which to experiment. Several supervised and unsupervised categorizations of agriculture/desert, build-up areas and housing types were carried out for both years. 1977 aerial photographs (scale 1/5000) and 1967 aerial photographs (scale 1/10,000) were used as ground data controls to determine specific housing sectors/categories, and to determine urbanized/agriculture/desert edges.

The research indicated the following conclusions: 1) LANDSAT is a feasible and very attractive method for monitoring urban growth on an aggregate basis. Quick, relatively inexpensive images and area calculations can readily be generated; 2) There was limited success in determining various housing categories. Although some types were readily identifiable, (for example, old, very dense areas like Boulak), it is still unclear if the types can be consistently differentiated throughout the urban area and from other types; 3) Change could readily be ascertained, in terms of urbanized land, agriculture land, and desert land. Saturation of housing areas was not readily apparent, only change in built-up areas could be seen.

b) TIME-PHASED AERIAL PHOTOGRAPHS STUDY: Photographs were used at the more detailed scale to trace the growth of a selected informal area over an approximate 30 year period. The goals were: 1) to determine if aerial photographs are a useful tool in data collection and in area development predictions; and 2) to determine growth rates of the informal area using a specific area as a test case.

أ) دراسة LANDSAT الاستكشافية : نظرا لصعوبة الحصول على صور جوية للموقف الراهن تغطى القاهرة كلها ، فقد تقرر تجريب تخيل لاندسات كوسيلة لتحديد الحجم وكمؤشر للنمو الحضرى للقاهرة الكبرى وقد استخدم التخيل فى الدراسات الاستكشافية فى ثلاثة مجالات

١) لحساب الحجم الاجمالى للمنطقة الحضرية •

٢) لتعيين نمو المنطقة المبينة على مدى عدة سنين •

٣) لتحديد ما اذا كان من الممكن تعريف انماط معينة من المبانى القطاعات وبصفة خاصة الشعبية وغير الشعبية •

ستوفر المراقبة الدقيقة للنمو الحضرى اتجاها ومقدارا من خلال تخيل اداة رخيصة سهلة المنال فى المعلومات الاحصائية كما انها ستوفر معلومات على درجة من الدقة عن حالة الاسكان وتكون هذه المراقبة اكثر عملية لو كانت مراقبة سنوية •

قد عنيت هذه الدراسة بالدرجة الاولى بتعريف المشكلة (الاسكانية) بهذه التقنية العالية وارساء قاعدة يمكن على اساسها تطوير طرق محددة •

وقد استخدمت فى الاعمال العملية الخدمات التى يقدمها مركز الاستشعار عن بعد بالقاهرة وقد قدم العاملين بالمركز كل المساعدات الممكنة •

اتخذت السنتين ١٩٧٣ ، ١٩٧٨ قاعدة للتجريب واجريت للسنتين المعنيتين تصنيفات عديدة مراقبة وغير مراقبة على اساس الزراعة والصحراء ، ومساحات البناء وانماط الاسكان وقد استخدمت صور جوية مأخوذة عام ١٩٧٦ (بمقياس ١ : ٥٠٠٠) واخرى مأخوذة عام ١٩٦٧ (بمقياس ١ / ١٠,٠٠٠) كأساس للمعلومات التى ساعدت فى تحديد الاطراف العمرانية / الزراعية / الصحراوية وفى تحديد قطاعات / تصنيفات الاسكان المحددة •

وقد إنتهى البحث الى النتائج التالية :

١) ان طريقة LANDSAT طريقة عملية وفعالة لمراقبة النمو الحضرى على اساس اجمالى ويمكن بها توفير صور سريعة وغير مكلفة نسبيا وحسابات مناسبة للمسطحات •

٢) نجح العمل نجاحا محدودا فى تحديد تصنيفات الاسكان المختلفة ورغم

The Imbaba sector was selected because of the availability of aerial photographs. The time periods considered are 1957, 1966, and 1977. The latter two years are of high quality and at a large scale.

It was clear from the data that the area, very approximately, more than doubled in each of the 10 year periods, a growth rate of over 10% per year in area. In addition, the photographs allow the monitoring of the dwelling changes: those which are being constructed, or in the process of vertical expansion. This data aids in predication of expected densities, market demand/interest in the area, the level of construction activity, and perhaps - when coupled with field checks - an indication of the type of area, whether a recption area for new migrants, a stable center, etc. A growth model was developed for informal areas consisting of three steps: initial rapid, scattered horizontal development, slower horizontal infill, and a final vertical saturation.

A brief field check was undertaken in the Imbaba sector of 20 dwellings at various stages in the development (1957, 1966, and 1977). The attempt was to relate the photographic images with other "real" data. Particular interest was to investigate the process of area selection (why did people settle in Imbaba?) and land and dwelling development.

TASK 3: Study of the family/dwelling/location trajectory in Cairo.

There are indications that the bulk of the low income sectors, which surged into Cairo starting in the 1940's, follow a specific trajectory in securing housing in the Greater Cairo Urban area. This trajectory may be simply described through functional characteristics relating location, dwelling characteristics (tenure, size) and family characteristics (age, size of family, skill level). The success of any housing policies proposed would be greatly enhanced through recognition and consideration of this tra-

ان بعض هذه الانماط معرف فعلا (مثل المناطق القديمة الشديدة الكثافة مثل بولاق فانه ليسهن الواضح بعدم امكانية تميز هذه الانماط بعضها عن بعض وما اذا كان هذا التميز ثابتا فى كل المساحة الحضرية ام لا •

٣) يمكن تحقيق التغيير فيما يختص بالاراضى الحضرية والأراضى الزراعية والاراضى الصحراوية • تشبع المساحات الاسكانية لم يظهر بشكل واضح وكان كل ماظهر هى المساحات المكتظة بالمبانى •

ب) دراسات الصور الجوية على فترات زمنية مختلفة :

استخدمت الصور الفوتوغرافية على المستوى الاكثر تفصيلا لتتبع النمو فى منطقة اسكان غير قانونى على مدى ثلاثية سنة تقريبا بهدف :

١) لتحديد ماذا كانت الصور الجوية اداة مفيدة فى جميع المعلومات والتكهن بتنمية المناطق السكنية أم لا •

٢) لتحديد معدلات النمو فى منطقة اسكان غير قانونى مستخدمين فى ذلك منطقة محددة كعينة للاختبار •

وقد اختير قطاع امبابة لامكانية تصويرة جويا بسهولة وكانت الفترات الزمنية المختارة وهى اعوام ١٩٥٧ ، ١٩٦٦ ، ١٩٧٦ وبالاخص الاخيرتين •

وقد كان واضحا من البيانات أن المنطقة تتضاعف كل عشر سنوات بمعدل نمو يزيد على ١٠ ٪ لكل سنة • وبالاضافة فقد سمحت الصور بمراقبة التغيرات السكنية اى فى الانشاءات الجديدة او فى التوسعات الرأسية •

تساعد هذه البيانات فى التكهن بالكثافات المتوقعة ، ومتطلبات السوق ومصالحة فى المنطقة ومستوى نشاط البناء ، كما يمكنها ان تساعد اذا قرنت بفحوص ميدانية فى تحديد نوع المنطقة ما اذا كانت منطقة استقبال وافدين (مهاجرين) جدد ام هى مركز مستقر •

وقد اعد نموذج لنمو الاسكان فى المناطق الغير قانونية وتكون هذا النموذج من خطوات ثلاث هى : النمو الافقى الاولى المتفرق والسريع ، والاكتفاء الافقى البطىء والتشبع الرأسى النهائى •

jectory, particularly those policies concerned with the upgrading of older sections in Cairo and the development of housing projects on the periphery.

A paper prepared in this area only briefly addresses the dynamics of the internal migration issues in Cairo, and was not intended as a detailed study but only to raise basic issues: it is not included in the full report.

The basis of the study was drawn from existing sources. For simplicity of dealing with areas and to relate data to census events, the kisms had been used as basic units of identification. In addition, a small field survey was undertaken of 20 families in the Imbaba low income area to be used as a field check.

The migration trajectory in Cairo tended to follow a similar pattern as in other rapidly urbanizing areas: a typical migrant settles in dwelling units which tend to be inexpensive (the result of no income, little savings), centrally located (for access to casual, marginal employment, with no transportation, expenses, etc.) and rental properties (desire for realtively short term, quickly terminable tenure). These families or individuals may be characterized as being nonurbanized (strong, traditional, conservative views), no marketable skills and poorly educated, if at all. At a later stage, these families undergo an internal migration, most often to the outskirts of the cities into the vast "informal" or squatter areas since they are effectively excluded from the formal housing market.

Variations exist in Cairo, which do not follow the "classic" pattern: In the initial reception areas, one finds a more stable population than one would expect. The trajectory is slower than in other countries, for several reasons speculated as follows: 1) the general shortage of housing, there is no place to go; 2) the reluctance to leave relatives and their familiar surroundings; and 3) rent control, which encourages people not to move be-

وقد اجرى فحص ميدانى بسيط فى قطاع امبابة لعشرين منزلا فى مختلف مراحل النمو (١٩٥٧ ، ١٩٦٦ ، ١٩٧٦) وذلك فى محاولة لربط الصور الفوتوغرافية ببيانات اخرى " حقيقية " وقد تركز الاهتمام على استقصاء عملية اختيار المنطقة (لماذا استقر الناس بامبابة) وعلى نمو الارض والمساكن .

المهمة الثالثة :

دراسة دورة العائلة / السكن / الموقع فى القاهرة تشير الدلالات الى ان معظم قطاعات ذوى الدخل المنخفض التى تدفقت على القاهرة ابتداء من الاربعينات اتبعت دورة محددة فى تأمين اسكانها فى منطقة القاهرة الكبرى الحضرية . هذه الدورة يمكن تحديدها بسهولة من خلال الخصائص الوظيفية التى تربط الموقع ، بخصائص السكن (الحجم ، الملكية) ، وبخصائص العائلة (السن ، عدد الافراد ، المهارات) .

وقد تم اعداد بحث فى هذا الموضوع يناقش باختصار ديناميكية قضية الهجرة الداخلية فى القاهرة وكان القصد منه اثارة القضية الاساسية وليس الدراسة المفصلة ولم يضم هذا البحث الى التقرير العام .

وقد استخلصت اسس الدراسة من مصادر موجودة فعلا لتسهيل التعامل مع المناطق ولربط البيانات بالوقائع الاحصائية اتخذت الاقسام وحدة اساسية للتعريف وبالاضافة الى ذلك اجرى مسح ميدانى بسيط لعشرين عائلة فى منطقة ذوى الدخل المنخفض بامبابة للتأكد من صحة المعلومات ، تميل دورة الهجرة الداخلية فى القاهرة الى اتباع مسار مشابه للمتبع فى المناطق سريعة التحضر الاخرى فالمهاجر الوافد التقليدى يستقر فى وحدة سكنية تتميز بانخفاض السعر (وذلك نتيجة لانعدام الدخل وقلة المدخرات) وبتمركز الموقع (لتسهيل الوصول الى التوظف العرضى بدون مواصلات أو تكاليف ... الخ .) . فى المرحلة المتقدمة تقوم هذه العائلات بهجرة داخلية الى ضواحى المدن حيث المناطق الواسعة التى استبعدت من سوق الاسكان القانونى لتملكوها بوضع اليد .

ولكن توجد فى القاهرة اختلافات لاتتبع الامثلة الكلاسيكية فمثلا فى مناطق الاستقبال الاولية نجد استقرارا سكانيا اكثر من المتوقع فالدورة منا ابطأ مما هى عليه فى دول اخرى للاسباب الاتية :

cause of the rent advantages.

Several tentative conclusions - for further discussion- were considered: 1) It is clear that a "classic" pattern exists in a "typical" lower income family in Cairo; 2) Secondary reception areas have been forming in Cairo, due to the saturation of central areas in Cairo. Shoubra and Zeitoun, as indicated by their density, may be classified as in this category; 3) the more mobile, better educated, higher motivated families tend to move (and more quickly) to the outskirts of Cairo. Several studies point out that indexes indicate that people in the 2nd stage "consolidating" housing areas are of a generally higher level of education and socio-economic position (income, persons per room, degree of illiteracy, articles owned).

Some possible policies which are suggested as a result of the study include: 1) To prevent further inflow of rural migrants into congested center city Stage 1 reception areas (Gamalia, and now Shoubra) short term rental housing should be inlcuded in peripheral areas which already are shown to generate sufficient employment opportunities to sustain a transient labor force. 2) The 3 new towns proposed adjacent to Cairo are already considered to draw off the population from Central Cairo but this would happen only if sufficient reception area housing and transient employment opportunities are included. This would imply small, rental units in central locations, coupled with sites and services type of opportunities on the periphery. Existing public housing type of development would not be appropriate. 3) Proposed upgrading attempts to stabilize, "improve", center city areas - as in Gamalia, etc. - would perhaps only result in shifting short-term rental housing elsewhere. At the same time, a large percentage of the transient labor force would be lost, to the detriment of the small scale industries now heavily concentrated in that area. Any proposals for these areas need to be evaluated in the context of the family trajectory.

١) الازمة الاسكانية العامة التى لاتترك مكانا يمكن ان يذهب اليه المهاجر •

٢) كرة الانفصال عن الاقارب والبيئة المحيطة المتعود عليها •

٣) قوانين الايجارات التى تشجع الناس على الاستقرار بسبب الميزات الايجارية •

وقد تم الوصول الى عدة استنتاجات غير نهائية قابلة للمناقشة وهى :

١) انه توجد فى القاهرة امثلة كلاسكية فى عائلات ذوى الدخل المنخفض التقليدية

٢) بدأ تتكون فى القاهرة مناطق مستقبلة فرعية نتيجة لتشبع مناطق وسط القاهرة ويمكن ان تدخل احياء شبرا والزيتون بعد لولات كثافتهما ضمن هذا التصنيف •

٣) تميل العائلات الاكثر حركة والافضل تعليما الى الانتقال الى ضواحى القاهرة وتشير المعايير الى ان افراد الدورة السكنية الثانية عادة مايكونوا من المتعلمين ذوى المركز الاقتصادى والاجتماعى المعقول (من حيث : الدخل ، عدد الافراد فى الحجرة ، درجة التعليم ، الملكيات الخاصة) •

وتشمل السياسات المقترحة التى تنتهى اليها الدراسة :

أ) منح المهاجرين الريفيين من التدفق على مناطق الاستقبال المركزية فى المدينة (الجمالية والان شبرا) • كما يجب ان تتضمن المناطق المقامة على اطراف القاهرة الاسكان ذى الايجارات قصيرة الاجل لتوفير فرص عمالة كافية لاعاشة الوافدين الباحثين عن عمل •

ب) قد تصد بالمدن الثلاثة الجديدة المنشأة قريبا من القاهرة ان تكون مناطق جذب سكانى تخفف من الازدحام السكانى فى مناطق وسط القاهرة ولن يتحقق هذا الا اذا وفرت مناطق سكنية مستقبلة مع توفير فرص للعمل • وهذا يعنى انشاء وحدات ايجارية صغيرة من مواقع متمركزة مقترنة بنوعية مماثلة للفرص التى تقدمها اراضى البناء والخدمات ، حول المواقع وقد اثبت نمط الاسكان الشعبى الحالى عدم جداوة وملائمته لمثل هذه المدن •

ج) محاولات تحسين وبث الاستقرار فى مناطق وسط المدينة مثل الجمالية قد لاتسفر الا عن تحويل الاسكان ذو الايجارات قصيرة الاجل الى مناطق اخرى • وفى نفس الوقت فان نسبه كبيرة من الوافدين للعمل سوف تفقد ، لتعانى اضرار الصناعات الصغيرة الغير مرتكزة فى هذه المنطقة •

ORGANIZATION OF THE RESEARCH

The research was structured into several subprojects, each addressed to a specific housing area. The staff was drawn from the wide range of expertise available at both universities and assigned to the subprojects appropriate to their background. Counterparts were selected from each University to assure collaborative research and interchange of skills. This multi-disciplinary approach to housing questions allowed a broad research base encompassing a wide spectrum of issues and fields simultaneously. Co-principal investigators, representing each university, coordinated the overall efforts, and provided the long term strategies of the project. Affiliates - ministry officials, as professionals in the housing field - were identified in the course of the research to serve in an advisory capacity, to provide general assistance, and to allow direct communication with the government ministries.

Specific tasks of the project were established in joint meetings, which were held at both Cairo and Cambridge. Additional meetings were held at appropriate intervals to coordinate and discuss the progress of the work. Meetings were of three types: 1) Between principal investigators: to coordinate overall efforts, to develop long term strategies; 2) Between counterparts of subprojects: to assist and discuss individual tasks, to collect specific data, to initiate contacts with Ministry officials; 3) Full team meetings: to assure integration of efforts, to avoid duplicating data collection, and to ensure communication among personnel.

Underlying all of the research was the intent of assisting the government in development of national housing policies. To this end, all of the subprojects stressed frequent meetings with ministry officials to keep them informed as well as to seek their advice. Whenever possible, strong relations were set up with the ministries to ensure long term interaction/involvement in the continuation of the research.

تنظيم البحث :

تفرع البحث على عدة مشاريع فرعية تناول كل منها مجالا اسكانيا محددا • اختيرت هيئة البحث من الخبرات المتعددة المتوفرة فى كل من الجامعتين ثم تعين كل فرد على المشروع الفرعى الذى يتناسب مع خلفياته ثم اختيار النظراء من كل من الجامعتين لتأكيد التعاون فى البحث وتبادل الخبرات وقد سمحت هذه الطريقة المنظمة لتناول التساؤلات عن الاسكان بتوفير قاعدة عريضة للبحث غطت نطاقا كبيرا من مشاكل الاسكان فى نفس الوقت • وقد قام الباحثون الاساسيون الممثلون لكل من الجامعتين بتنسيق الجهود واعداد الاستراتيجيات طويلة الاجل للعمل فى المشروع • وقد قام بعض مسئولو الوزارات بصفتهم مختصون فى ميدان الاسكان بتقديم مساعدات كثيرة مثل الاراء الاستشارية وتوفير فرص الاتصال المباشر بالوزارات المنفذة •

تم تحديد المهمات المحددة للمشروع خلال اجتماعات مشتركة عقدت فى كل من القاهرة وكمبريدج • كما عقدت اجتماعات اضافية على فترات زمنية مناسبة للتنسيق ولمناقشة تطور العمل • وكانت هناك ثلاثة انواع من الاجتماعات :

١) اجتماعات بين الباحثان الاولان للتنسيق بين الجهود الكلية ولاعداد الاستراتيجيات طويلة الاجل للعمل •

٢) اجتماعات بين النظراء فى المشاريع الفرعية : لتحديد ومناقشة المهمات الفردية ولجمع المعلومات وليدة الاتصالات بمسئولى الوزارات •

٣) اجتماعات فريق العمل كله : للتأكد من تكامل الجهود ولتفادى جمع المعلومة الواحدة مرتين ولتأكيد الاتصال بين افراد الفريق بعضهم ببعض •

وقد كان الهدف الاساسى من البحث هو مساعدة الحكومة فى تنمية وتطوير سياسة قومية للاسكان وعلى هذا فقد ركزت المشاريع الفرعية على الاجتماع كثيرا بمسئولى الوزارات لاستشارتهم ولاعلامهم بنتائج الابحاث •

وقد وثقت العلاقات مع الوزارات للتأكد من اشتراكها الفعال لضمان تأييدها على المدى الطويل للابحاث فى مجال الاسكان •

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This summary is a part of the Housing and Construction Industry Research Program carried out under the Technological Planning Program, a joint research project by Cairo University and the Massachusetts Institute of Technology. The views and opinions expressed in this report are those of the authors and do not necessarily reflect those of AID, MIT, or Cairo University.

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SUMMARY

For the last three years the Housing Economy subproject has investigated the housing market in Egypt and the role of current and past public policy in that market. The research has focused on four issues, considered of primary concern today, by Egyptian policy makers.

(1) The shortage of dwelling units and the rapid rise in their cost.
(2) The impact and repurcussions of Egypt's widespread system of rent control.
(3) The economic advantage of constructing new towns in the desert.
(4) The comparative costs of alternative building technologies.

In each of these areas, the subproject has written a paper analyzing and evaluating the issue. These reports, dealing respectively with the four topics listed above, are included as attachments to this summary, except for the paper on building technologies, which was included in the last year's report. (See "Interim Working Papers 1978")

The conclusions of each of these reports, while different, do appear to have a common theme - that current housing policy in Egypt today is less than desirable. The subproject has found that there does not exist a housing shortage per se in Egypt, rather a large amount of unregistered building in fact provides everyone with a home. In spite of rapid rising construction costs, the level of housing consumption has not fallen - due to high government subsidies on new housing, and rent control in existing units. Given a significant increase in the real cost of housing, consumption should fall for efficient resource allocation. Current policy, therefore, is encouraging "over consumption" of housing - at least where the policy is being applied. The subproject has found that little is being done in Egypt to assist the housing of the truly poor, rather the rent control system and subsidized new construction seem to be benefiting primarily the middle classes.

On the third question, current Egyptian policy strongly emphasizes the preservation of agricultural land, by redirecting urban growth to new communities in the desert. The subproject's report suggests that the costs of this plan are very high. Even when valued at its true shadow price, farm land at the edges of existing cities cannot compete with the higher urban rent. Such rents in many ways reflect the productive advantages of large cities in the developing economy. Smaller towns in the desert, will therefore require enormous subsidization. This money would probably be better spent on agricultural reclamation, allowing urbanization to continue around existing settlements.

On the final issue, the subproject has found that the prefabrication technologies, imported into Egypt in the mid-1970's, are more expensive, even to operate, than are present building techniques. With the current system of government housing subsidies, however, contractors do not bear this additional expense - the government does. The complete paper was included in the 1978 Report.

The Egyptian reaction to these findings has also been fairly constant over the last three years. Many government officials and colleagues will privately agree with the conclusions of the reports, but at the same time feel that "political" considerations prevent changing current policy. The view seem to be that the most important pressing housing policies in Egypt have been studied, but by their very nature, such policies will be difficult to change.

APPENDIX A: PUBLIC POLICY AND THE "SHORTAGE" OF HOUSING IN EGYPT

I. INTRODUCTION

In the last three years, there has been a growing view in official circles that housing in Egypt has become some kind of a "problem". The press speaks of a housing "shortage" and the government describes a housing "crisis" which is second only to that of food. A number of consulting studies have been commissioned and most have recommended several standard and well-known changes in the way housing is priced, built or financed. These studies have not really investigated the nature or character of the housing shortage nor have their recommendations been particularly sensitive to the various financial or political constraints that might exist in Egypt. The objective of this report, then, is to first evaluate the nature of the housing "problem" in Egypt, then to evaluate the nature of the government's current attempts to deal with the problem, and finally to suggest some alternative actions.

Based on our experience in Egypt, four various phenomena are often cited as being evidence of a housing "shortage". Each of these definitions of the housing "problem" is quite different, although they are not mutually exclusive - that is they all may be at least partial contributors to the perceived crisis. The validity and implications of each phenomenon are discussed in turn below.

II. A PHYSICAL SHORTAGE OF UNITS OR SPACE?

The most common definition of a housing shortage is that there are too "few" units. Few in this context means that housing production is not keeping up with population growth. As a consequence, household formation slows, couples "double up", and housing units start to become informally partitioned and then sublet as rooms.

There is a strong belief today in Egypt that this has been a serious problem over the last decade. The belief was initially encouraged by many early studies of the Egyptian housing problem which relied on data concerning recorded housing production. Such data is displayed in Table 1.

Table 1: RECORDED PRODUCTION OF HOUSING

"Urban"	1960-64(1)	1965-76(2)
Dwelling Units		
Low	6.8	218.7
Middle	1.0	76.9
High	9.7	11.6
Total	137.5	307.2
Estimated "Urban" Population Growth(3)	1.6 million	5.1 million

(1) Arab Republic of Egypt (ARE), Central Agency for Public Mobilization and Statistics (CAPMAS), Statistical Handbook. Cairo, Egypt; June 1967, p. 158.

(2) 1965-66: ARE, CAPMAS. Statistical Handbook. Cairo,Egypt; June 1967, p. 158.
1967-68: ARE, CAPMAS. Statistical Handbook. Cairo,Egypt; June 1973, p. 126.
1969-71: ARE, CAPMAS. Statistical Handbook. Cairo,Egypt; June 1974, p. 142.
1972-76: ARE, CAPMAS. Statistical Handbook. Cairo,Egypt; June 1978, p. 142.

(3) ARE, CAPMAS. Family Budget Study, Results of the first-round in Family Budget Study 1974-75. Cairo,Egypt; December 1976, p. 28-29.

As can be seen, the number of "urban" housing units recorded as being built has been totally inadequate to house estimates of the growth in "urban" population. In fact, when the estimated 200,000 (The Joint Housing Team, Immediate Action Proposal for Housing in Egypt, p. 56) or so demolitions which occurred over the 1960-76 period are added to the picture, it appears that the net growth of the housing stock was less than 300,000 while urban population increased by roughly seven million. On the average, each new unit would have to have been occupied by at least twenty new people! From this data then, it certainly appears that there has been an increasing physical shortage of housing.

In the last year or so, there has been some recognition that the official production statistics may substantially understate the actual construction of housing. It is argued that much housing is built without building permits, although the extent of this activity is uncertain. Government officials downplay such ideas - contending that most of this "informal" housing is just that - mostly temporary, mud brick structures. Surveys by MIT staff, however, clearly suggest that an enormous number of permanent brick and cement structures are being built without permits. While many of these have been constructed by the lowest income groups, a great deal of conventional, middle-class housing is also so built. To estimate the role of this activity, Table 2 compares the stock of housing, as defined by census counts, at three points in time.

As can be seen in the first part of Table 2, there has been an enormous expansion in urban housing between 1960-1976. In fact, while official statistics show only 550,000 urban units built, the net change in the stock is four times that or 2 million! The most common official reaction to these figures is to suggest that much of the growth in urban dwellings has come from self made, one-room units. It this were true, however, the average rooms/unit should have taken a sharp drop over the 1960-76 period. Unfortunately, the

Table 2: GROWTH OF THE HOUSING STOCK

	1960	1964	1966	1976
"Urban"				
Dwelling Units				
Cairo	585 (1)	800 (2)	-	1140 (3)
Giza	-	117 (2)	-	338 (3)
Alexandria	230 (1)	344 (2)	-	477 (3)
TOTAL	1675 (1)	2307 (2)	-	3587 (3)
"Urban" & "Rural"				
Rooms				
Cairo	1439 (4)	-	-	2676 (4)
Giza	662 (4)	-	-	1344 (4)
Alexandria	752 (4)	-	-	1230 (4)
TOTAL	13,473 (4)	-	-	20,364 (4)
Population				
Cairo	3349 (5)	-	4023 (5)	5084 (5)
Giza	1336 (5)	-	1650 (5)	2419 (5)
Alexandria	1516 (5)	-	1717 (5)	2318 (5)
TOTAL	25,984 (5)	-	28,681 (5)	36,658 (5)

(1) Arab Republic of Egypt (ARE), Central Agency for Public Mobilization and Statistics (CAPMAS). Building and Housing Statistics in the year 1960 and Investments in the New Buildings 1954-58. Cairo, Egypt; 1962, p. 8.
(2) ARE, CAPMAS. ARE Statistical Indicators, 1952-72. Cairo, Egypt; December 1973, p. 211.
(3) ARE, CAPMAS. Statistical Yearbook. Cairo, Egypt; July 1978, p. 34.
(4) ARE, CAPMAS. The Preliminary Result of the General Population and Housing Census, 22/23 November 1976 in Egypt. Cairo, Egypt; 1976, p. 51.
(5) Ibid, p. 34.

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room data that exists is not separately reported for "urban" and "rural" housing. In the case of Cairo and Alexandria, in 1976, there were 1,150 thousand dwellings (Arab Republic of Egypt, Statistical Yearbook, p. 80) which had more than one room. If fully 50% of these units had halls then 575,000 rooms could be considered "halls" in 1976 - a generous count by any stretch of the imagination. If all of these "halls" are subtracted off of the 1976 room count, then the growth in rooms is still 52% - in this case exactly matching the population growth in Cairo and Alexandria!

In summary then, it appears that between 1960 and 1976 there has been no significant "lag" or shortage in the construction of either dwelling units or rooms. The true nature of Egypt's housing shortage must lie elsewhere - at least if the census data is to be believed.

III. A DETERIORATION OF HOUSING QUALITY?

An alternative view of the housing problem is that while the actual construction of housing may have kept up with population, the housing built has been "informal" housing - of a distinctly smaller size and lower quality. The ability of local governments to service such housing has also lagged, and thus infrastructure standards have declined as well. Such a hypothesized decline in quality could represent every bit as much of a "crisis" as a decline in unit construction. Fortunately, the 1960 and 1976 census allow some comparisons between the qualitative aspects of the housing stock in those two years. These results are reported in Table 3.

The first aspect of housing quality in space, and as can be seen in Table 3, between 1960 and 1976, the person/room ratio decreased and space consumption increased! Officials have pointed out, however, that the 1976 figures include "halls" as space. If a correction is made (as was suggested in the previous section), it still appears that space consumption has remained constant. Of course space

Table 3: CHANGES IN HOUSING QUALITY

	1960	1964	1966	1976
Person/room				
Cairo	2.3 (3)	-	2.0 (2)	1.9 (2,3)
Alexandria	2.0 (3)	-	-	1.9 (3)
TOTAL	1.9 (3)	-	-	1.8 (3)
% Building with Sewage				
Cairo	54 (5)	-	67 (1,4)	58
Alexandria	53 (5)	-	-	58
TOTAL	21 (5)	-	-	29
% Building with Electricity				
Cairo	55 (5)	-	59 (1,4)	77
Alexandria	77 (5)	-	-	79
TOTAL	37 (5)	-	-	62

(1) % of dwellings meeting criteria rather than buildings
(2) Counting halls as rooms. If 50% of multi-room units have halls then the 1976 corrected person/room figures are almost identical to the 1960 numbers.
(3) Arab Republic of Egypt, Central Agency for Public Mobilization and Statistics. "The Preliminary Result of the General Population and Housing Census, 22/23 November 1976 in Egypt." Cairo, no date, p. 51.
(4) The Joint Housing Team: Ministry of Housing and Reconstruction, Ministry of Planning, Arab Republic of Egypt with Office of Housing, Agency for International Development, USA. Immediate Action Proposal for Housing in Egypt, Cairo, Egypt, June 1976, p. 55.
(5) Private communication, CAPMAS, Cairo, Egypt, January 1980.

usage is measured in rooms, and if room sizes were decreasing, then space consumption would be as well. Unfortunately there is no data on m^2 in the stock, but one does sense that in the last few years, at least public housing units have become somewhat smaller.

The second aspect of housing quality, for which there is data, concerns the provision of utilities. With respect to sewage (and water), there have been slight improvements over the 1960-1976 period. While the figures are not dramatic, a greater percentage of units have sewage now than in 1960. With electricity, on the other hand, there has been a rather dramatic improvement. During the 16 year period reported on, the national electrification rate jumped from 37 all the way to 62%. In Cairo, there were similarly larger gains while in Alexandria the rate increased only slightly. Clearly, the Government has been very successful in bringing electricity to the majority of Egyptian families.

In short, it would seem difficult to argue that there has been any deterioration in the quality of the housing stock - at least as measured by space and utility provision. Rather in some areas, it seems that there have been significant gains. Thus the nature of the perceived housing "problem" in Egypt involves neither a quantitative nor a qualitative "shortage" of housing.

IV. LESS FOR MORE - HOUSING INFLATION AND THE GROWTH OF INCOME

The preceding sections have fairly clearly demonstrated that the per capita consumption of housing in Egypt, as broadly defined, has probably remained roughly constant over the 1960-76 period. This in itself, however, might constitute a problem if real incomes have been rising at the same time. Where is the promise of economic development? Shouldn't income growth improve housing consumption?

Turning to Table 4, GNP per capita has risen 170% from 1960 to 1976. Of course prices have also increased (113%), and so the net effect has left real GNP per capita 29% higher at the end of 16 years. Median disposable family income, on the other hand, rose 62%, from 274 to 446 LE, between 1964 and 1976. Retail prices over this same period rose 77% and real family income seems to have declined. Based on this modest, if any, growth in real income, little improvement in housing consumption should have been expected.

Unfortunately, this lack of real income growth understates the problem because the price movements in housing have far exceeded those for the general price index. In fact, as Table 4 makes clear, housing construction costs rose 300% while the consumer price index rose by less than half of that. The nominal income of Egyptian families only slightly more than doubled, while housing became four times as expensive. In terms of housing then, the real purchasing power of Egyptian income sharply decreased. To afford the same house, the typical Egyptian would have had to have spent twice as much of his income in 1976 as he did in 1960.

The reasons for this sharp inflation are now quite apparent. From 1960 until 1970, the cost of housing construction rose only slightly more than the overall retail price index. It is therefore in the more recent years that the "problem" has occurred. In terms of building materials, it is clear that the war effort from 1969 to 1975 drained enormous supplies from private construction - sharply raising prices. From 1972 to 1975, the cost of building materials increased at close to 30% per year. Since then, the inflation rate has dropped off to 15%. In the labor market, the boom in Arab Construction following the formation of OPEC attracted an enormous number of construction workers abroad. Eckaus et al. has

Table 4: TRENDS IN INCOME, WAGES, AND HOUSING COSTS

	1960	1966	1970	1972	1973	1974	1975	1976	1977
RETAIL PRICE INDEX	100	128	144	152	-	176	-	213	-
Housing Costs (M^2) (2)	10	12.5	15.4	17.0	24.3	28.7	33.0	40.0	47.0
Construction Wages Index (3)	100	121	159	-	220	262	374	492	523
Construction Material Index (3)	100	137	160	178	-	278	328	382	440
GNP/Popultion (4)	55	82	92	98	-	115	-	152	-
Median Family Income	-	274 (5) (1964)	-	-	-	-	-	446 (6)	-
Average Wages (Annual) (7)	-		142	168	180	195	231	246	-

(1) International Bank of Reconstruction and Development (IBRD). World Tables 1980. Baltimore, Maryland; The Johns Hopkins University Press, 1980, p. 74-75.
(2) 1960-75: The Joint Housing Team: Ministry of Housing and Reconstruction, Ministry of Planning, Arab Republic of Egypt with Office of Housing, Agency for International Development, USA. Immediate Action Proposal for Housing in Egypt. Cairo, Egypt; June 1976. 1975-77: author's surveys with builders, January, 1980.
(3) 1960-74: The Joint Housing Team: Ministry of Housing and Reconstruction, Ministry of Planning, Arab Republic of Egypt with Office of Housing, Agency for International Development, USA. Immediate Action Proposal for Housing in Egypt. Cairo, Egypt; June 1976. 1975-77: author's estimates.
(4) IBRD. World Tables 1980. Baltimore, Maryland; The Johns Hopkins University Press, 1980, p. 74-75.
(5) The Joint Housing Team, op. cit., p.46.
(6) Arab Republic of Egypt (ARE), Central Agency for Public Mobilization and Statistics (CAPMAS). Family Budget Study, Results of the first-round in Family Budget Study 1974-75. Cairo, Egypt; December 1976, p. 5.
(7) 1970: ARE, CAPMAS. Statistical Yearbook. Cairo, Egypt; 1975, p. 206-07. 1972-77: ARE, CAPMAS. Statistical Yearbook. Cairo, Egypt; 1979, p. 224-25.

estimated that 50% of the 1970 construction work force in Egypt moved abroad, and that only by 1978 did the domestic supply of workers expand to replace them. The result obviously has been a sharp increase in construction wages - fully 40% per year from 1973 to 1976. Again with the growth of domestic supply in the last two years, this wage inflation has subsided now to under 10% per year.

Fortunately, it seems that the rampant housing inflation of the last seven years should be coming to an end. With peace, and greater investment in current production, the cost of materials should stabilize near their international values. Similarly, the labor markets in the Persian Gulf appear to be fully satisfied, so that as more Egyptians become trained in construction, the domestic work force will grow while real wages stabilize and perhaps even fall. It would seem quite likely that overall construction costs could stabilize in the 50 LE/m^2 range for the next several years. Given continued inflation and income growth, this could mean that the real cost of housing would start to slowly fall.

What is perhaps most interesting about the Egyptian housing inflation of the last decade is that it had no effect on housing consumption. Any reasonable housing demand function would suggest that with a 300% rise in costs and only a 100% increase in income, housing consump-

tion per family should have fallen in half! There would appear to be three reasons why this did not occur. First, Egyptian rent control meant that the higher costs were paid only by those new households added to the population during the inflationary period. Fully 80% or more of the population never had to pay the higher costs - as long as they remained in their existing dwellings. It was primarily the young, and the poor rural-to-urban migrants who bore much of the burden. Secondly, in periods of housing inflation, the demand for housing sometimes seems to rise as investment becomes a motive in addition to consumption. Many Egyptians who could not afford to consume housing at such high costs, were willing to invest speculatively in housing rather than other forms of enterprise. Finally, the primary cause of housing inflation - worker immigration abroad - also brought Egypt an enormous flow of scarce foreign exchange. Remittances sent home by these workers have now become the largest source of export earnings in Egypt. What is especially important to remember is that the propensity to save and invest such funds is extremely high - and in Egypt, the best and easiest investment was housing!

As intriguing as this configuration is, it still does not fully explain the nature of the Egyptian housing "problem." To be sure, no one likes housing inflation, but only 20% of the population (those occupying new units) were affected, and the remittances flowing into the country provide far more than enough wealth to purchase such housing. The answer, it would seem, lies in the distribution of those benefits and burdens. The price of obtaining the valuable remittances was domestic housing inflation, but those benefitting from the remittances may not have experienced the inflation, while those most affected by the inflation, need not have benefitted from the remittances.

V. THE ALLOCATION OF HOUSING AND THE INFLATIONARY BURDENS

The immigration of Egyptian workers abroad has yielded the country an essential flow of remittances and wealth. The price paid for these advantages, however, has been the rapid housing inflation of the last decade. It is important to remember that for the country as a whole, the net benefit is clearly positive. Inflation in housing represents only a transfer of resources, within Egypt, from tenants and home buyers to landlords and construction workers. The remittance income from abroad constitutes an increase in national income. While the country as a whole may have gained from this chain of events, particular individuals may have been made much better or worse off. The crucial determinant is how housing is priced and allocated in the regulated Egyptian housing market.

The essential feature of the Egyptian housing economy is that housing rents are officially controlled, but that this is fully circumvented for newly constructed units or vacant units. The vehicle of circumvention is an initial cash payment, or key money, and most units changing hands since 1970 have involved substantial payments of this type. A little intuition validates this, for both formal and informal private construction have continued (Tables 2 and 3) despite the fact no one could afford to cover current housing costs with the meagre rental income allowed by law.

The Egyptian system of rent control-with-circumvention has both advantages and disadvantages. The main advantage has been that the enormous windfall profits which would have accrued to landlords in the face of housing inflation have been curtailed. Why should someone who built an apartment for 10 LE/m^2 suddenly be able to sell it for 50 LE/m^2? Rent on existing units is just that, a pure transfer of income, and since landlords are surely wealtheir than tenants, allowing a full pass-through of infla-

tion would have been enormously regressive. Thus, rent control protected the 80% of the population that existed prior to 1970 from the impact of housing inflation.

The disadvantages of rent control are unfortunately several, but it is important to remember that a disincentive to construction is not one of these. Circumvention has apparently allowed construction to fully continue. What rent control has done is to freeze the use of the existing housing stock - preventing subdivision, adaptation and rehabilitation. Higher prices, without the protection of rent control, would have led tenants and landlords to more efficiently use existing housing - thereby perhaps necessitating less new construction. A second advantage of the rent control system is that the inherent avoidance which occurs, requires that wealth be used to "buy" an apartment - not income. Without legal collateral, no one would lend or finance a tenant's key money payment. In all societies, wealth is far more concentrated or unequally distributed than income. In some sense, the main disadvantages of the rent control system is that the 20% of the population which has been added to Egypt since 1970 has been worse off than they would have been without any rent control. For this group, key money is harder to come by than higher rents would have been, and the inefficient use of the existing stock has probably necessitated more (costly) new construction.

Thus the current system of allocating housing in Egypt has created a great deal of horizontal inequity in the way different families have experienced the events of the last decade. Some have benefitted greatly, while others have only suffered. A young, college graduate, working for the government has received no remittances, his salary has barely kept up with inflation, and yet he is expected to pay the staggering cost of key money. An older skilled craftsman has either received remittances or benefitted greatly from a substantial real growth in his wage - all of this while at the same time paying almost nothing for an apartment! The gap between these two is enormous.

VI. THE GOVERNMENT'S RESPONSE AND ITS CONSEQUENCES

The current housing policy in Egypt is essentially to try and protect the population from the impact of housing inflation. Continuing rent control will protect the 30 million people who already had apartments by 1970, and recent laws relating to the inheritability of those occupancy rights will perpetuate this protection. But what about the six or eight million inhabitants added to the population since then, and the million or more people to come each year in the future? The Government's hope has been to expand the construction of subsidized new units. In general, the government is trying to build housing which costs 4000 LE/unit, and rent or sell it to families for somewhere between 7 and 20% of their income. For the average household in Egypt, these payments would be between 50 and 120 LE per year. The annual costs of a 4000 LE unit are closer to 400 LE per year, so the magnitude of the subsidies planned is enormous. If this policy is successful, it could insure that all Egyptians enjoy the housing they expected to have in the late 1960's - at the low rents which prevailed then - despite the housing inflation of recent years. Is this reasonable, is it feasible, and what are the likely consequences?

The reasonableness of the policy depends to some extent on whether the housing inflation is viewed as temporary or longer term. Even the staunchest economist would admit that buffering a market from short term fluctuation, and the windfall gains or losses that accompany it, can be very desirable. Unfortunately, it seems that the housing inflation occurring in Egypt is also being experienced throughout the Middle East - as a permanent change. Market parity clearly requires that domestic workers receive

the same net compensation as holds in the Persian Gulf. As long as construction activity and wages hold up there, Egyptian wages will have to remain at their current real levels. Thus, unless there is some significant change in the larger regional labor market, construction costs in Egypt should stabilize but probably not decrease by much. Only with a long run increase in aggregate labor supply would the regional wage begin to fall. It would seem likely, therefore, that the cost of housing in Egypt and numerous other middle eastern countries will stabilize at its high current level over the foreseeable future. If this is true, then any long run government policy of subsidizing new construction will have four important consequences.

1) Subsidization will encourage people to consume more housing than they would choose on their own were they simply given the subsidy as a cash transfer. In other words, the households receiving the subsidized housing would rather have the money than the housing. There is an obvious "loss" in "forcing" them to choose housing.
2) Subsidization on a large scale will probably cause further housing inflation. By concentrating the country's resources in construction (where there have been shortages), the government will probably only exacerbate that sector's past inflation. Encouraging people to build more housing than they would otherwise should only increase the costs of housing materials and labor even more.
3) Attempting to provide subsidization on a large scale will use up scarce government tax revenue. As in many developing countries, the Egyptian government has had difficulty raising taxes from general broad-based sources such as income or sales Expanding the subsidization of housing may make it more difficult to assist other commodities - such as basic foods - which are extremely important to the very poor.
4) Subsidizing housing on a large scale will also use up scarce capital and probably inhibit economic growth. Were the government to attempt to insure that 4000 LE housing was provided to each newly formed family in Egypt (roughly 250,000 per year), the total cost would be 1000 mLE - or the entire 1976 investment budget and roughly 50% of last year's budget. Industrial development and other infrastructure would have to be seriously curtailed as a consequence.
5) Trying to restrict the subsidized housing to selected groups in the population would cause sharp horizontal inequities and exacerbate social tension. If only urban housing is subsidized, for example, rural migration would increase, further exacerbating urban crowding and unemployment. If only the employers of government or nationalized industries receive subsidized housing, then wages in the private sector will have to increase to maintain parity. Productivity differences between sectors will be worsened, and so selective subsidization can only further exacerbate the duality of the Egyptian economy.

VII. AN ALTERNATIVE APPROACH

In considering an alternative housing policy for Egypt, it would seem of paramount importance to at least partially accept the housing inflation of the past decade. Rather than trying to insulate the population from it, a realistic policy should help the country adapt to it. It seems to me, that a socially responsible adaptation to higher housing costs, would eliminate subsidization and try to achieve the following four objectives.

1) Any responsible policy of adaptation must avoid the transfer of large rental payments to landlords that might occur without rental control. The regressive hardship this would cause is politically unpalatable, morally unjust, and economically unwise.
2) The stock of existing housing should be better maintained and more effectively used. Families should use existing housing as if it cost 40 LE/m^2. To do otherwise, is to waste the real resources of Egypt.
3) The financing of housing, particularly for the young, must be made easier and more equitable. Families must be able to acquire housing services from their income rather than only through saved or inherited wealth.
4) Whenever possible, the goverment should assist in easing the housing inflation at its source - the cost of factors. To do this the government can continue to expand labor training policies and perhaps encourage college graduates to enter skilled trades. It can also invest more resources in material production - and perhaps most importantly - significantly increase the servicing of land. Current land servicing lags far behind development demand creating land shortages and price inflation. At the same time antiquated subdivision laws create great uncertainty about tenure and property rights. Rectifying these problems would create more planned housing, open up new land, and therefore bring down land and housing costs.

In order to accomplish these objectives, two major changes are necessary. First, better government policies in the areas of labor training, land servicing and housing finance have all been suggested by numerous other studies. These policies are of the greatest urgency. Second, though, it is believed that the first three objectives can be achieved by carefully restructuring the current legal relationships between tenant and landlord. A specific policy recommendation, in this respect, is suggested in an accompanying paper.

APPENDIX B: A PROPOSAL FOR IMPROVING THE LEGAL RELATIONSHIP BETWEEN TENANT AND LANDLORD IN EGYPT

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I. HISTORICAL BACKGROUND

Since the early 1950's, the A.R.E. has enacted a series of laws which defined the rents for housing and changed the rights of tenants and landlords. Under Egyptian law, the ownership of property normally carries with it all the rights of occupancy, use and utilization. Between 1952 and 1961, the rights of property owners were successively restricted in two ways. First, the rental income received by the owner was limited to a fixed amount - set by law. Second, the owner was denied the right to determine the utilization of his property within this rental income. The latter right was lost since the current tenants of a property were given the permanent right to occupy it as long as they paid the rents specified by law. The owner, therefore, was unable to: change tenants, alter the use of his buildings, or collect a market rent. At the same time, these utilization rights were not wholly transferred to tenants. The tenant acquired only the right to use the property himself - not to utilize it in any other manner economically desirable. Thus, the rights lost by landlords were only partially given to tenants. The residual power - to use property in ways besides self-occupancy - was lost altogether.

During the early years of these laws, their impact was relatively modest. With little inflation occurring, the difference between market income of property and that allowed by law, was small. In addition, the number of tenants wishing to move, and the number of owners desiring to change the use of property was also few. As time progressed, however, the effect of the laws became more severe. Housing costs, and therefore, market rents, grew substantially greater than those permitted under rent control. The growth of Cairo and other Egyptian cities created new needs and demands for buildings, which could not be met, since no one has full control over utilization. Under these circumstances, the implicit "value" of the utilization rights lost by landlord, began to grow. In an attempt to recapture some of this new "value", landlords began to charge black market key money for new or vacant apartments. Tenants objected, but made payments, realizing that the occupancy which they were achieving was in fact worth more than the official rent. Both parties seemed to be growing more dissatisfied with the system.

This paper presents an analysis of how the Egyptian rent control system currently works in practice as well as law. The paper also presents a proposal to remedy the growing dissatisfaction with the system. The proposal has two objectives. First, to at least partially compensate property owners for the loss of the utilization rights that occurred with the original law. Second, to alter the nature of tenants rights so that full utilization of property is allowed. In this sense, the proposal is to recapture the full right of utilization that was originally lost to both parties, and insure that the benefits which result are equitably distributed between tenant and owner.

II. THE EFFECTS OF EGYPTIAN RENT CONTROL

The impact of Egyptian rent control may well be different from that in other countries because it appears to be widely circumvented in a particular manner. Since the rights of tenants in Egypt are fully preserved as long as the official rent is paid, landlords are unable to charge any additional black market rent. On the other hand, the widespread reliance on cash, in business transactions, makes it very difficult to prevent the charging by landlords of an initial entrance fee (key money) to cover some or all of the unit's cost. Over the last decade, housing costs have increased to four or five times the level which can be financed with official rents alone. The current evidence is that during this period, key money has become very widespread, and in fact has been the major source of income - especially in newer buildings. Much

of the analysis of rent control in Egypt, therefore, is based on the assumption that this particular form of circumvention widely occurs. The effects of rent control are not likely to be similar in other countries unless comparable systems of avoidance exist.

(1) Rent control has had a very beneficial effect on the distribution of income by preventing enormous windfall profits to Egyptian landlords. Without control, the housing cost inflation of the last decade would have increased the rental income from existing real property five-fold. Since landlords as a class are much wealthier than tenants, any such transfer of income would have been extremely regressive. Any change in tenant-landlord relationships that might release enormous profits, must in turn insure that they are redistributed in a manner which is socially equitable and economically progressive.

(2) A system of rent control which is circumvented with key money acts implicitly like a "turnover" or transaction tax. Key money payments are made only when a vacant unit (either new or old) is occupied or re-occupied. In the case of an existing apartment, a tenant can bargain with his landlord for only some fraction of the key money a new tenant might offer, while being forced to pay the full amount himself to acquire a different apartment. Thus, there is a strong incentive not to move. This prevention of turnover creates several serious inefficiencies in the operation of the housing and labor markets. a) The movement of labor may be inhibited between cities. By discouraging relocation, rent control with key money can prevent the utilization of labor in the most productive regions. b) Within cities, the rent control system discourages families from seeking a new, and presumably closer, apartment if the family head's job changes. Over time, this may force workers either to commute farther, or seek better employment less often, than would be the case without rent control. c) As family structure varies over time, the housing needs of people change substantially. By encouraging people to live in the same apartment over their life, and then their children as well, the rent control system prevents the best utilization of housing. Families will normally exchange housing in the market to better satisfy their needs. Such trading is discouraged with rent control.

(3) The rent control system with key money circumvention creates a great deal of horizontal inequity, that is, there is unequal treatment of otherwise equal families. One's fate in the Egyptian housing market may depend more on chance, inheritance, history, or the presence of relatives with housing - rather than effort or work. This can result in envy, spite and general social tension.

(4) The current rent control system penalizes younger families and those who migrate while benefitting families which are older and more established. The young and the migratory (mostly rural-to-urban) are generally poorer, and so the implicit effect of requiring payments for only new or vacant housing is probably regressive. Equally important, among the new families trying to acquire housing, those with wealth are far better off than those working hard to earn good income. One cannot finance key money and, therefore, pay for housing from income, since there is no collateral to secure the loan. Instead the payment must come from saved or inherited wealth. In all countries, wealth is much more concentrated and unequally distributed than income. This is an additional reason why the current system is regressive.

(5) Because of circumvention, rent control has not had as serious an effect as it might have on the incentives for constructing new housing. The official rents allowed for newly constructed units do not come near to covering costs. The major redeeming feature of the key money circumvention system is that it allowed some new con-

struction to continue thereby avoiding a more serious housing shortage.

(6) Rent control, even with key money circumvention, has hastened the deterioration of buildings and prevented the more efficient adaptation or conversion of the existing housing stock. Since key money is a lumpsum payment, there is no incentive for a landlord to maintain a building after the payment has been made. Similarly since tenants cannot move, it is impossible to convert or subdivide older units into a number of newer, smaller ones. Only if a unit becomes vacant, and the key money is higher for improvements or alterations, will the landlord have an incentive, during vacancy, to remodel. Since the key money system prevents turnover and vacancies, however, such improvements rarely occur. Thus fewer, and less useful housing units are obtained from the existing stock of buildings.

III AN EVALUATION OF SOME ALTERNATIVES

The M.I.T./Cairo University Housing Economy Subproject has considered five alternative changes in the current Egyptian rent control system. While all of them may not be politically feasible or economically desirable, each has at some point been either discussed or implemented in other countries. As will become apparent, the subproject team clearly believes that the last alternative is feasible in Egypt, and would represent a marked improvement over the current system.

A. The Status Quo - Continuing Control with Circumvention

The subproject team believes that circumvention is at present an inherent aspect of the current rent control system. In effect, then, continuing the present system amounts to continuing the six impacts discussed in the previous section. The advantage of doing so is clearly that excessive profits to landlords, and economic hardship to tenants, is avoided. The disadvantages are that the housing stock will continue to deteriorate and be inefficiently used, mobility will be inhibited, and selected groups in the population will suffer, while other groups benefit, more than would otherwise occur.

B. Complete Decontrol

The complete decontrol of all housing in Egypt would exactly reverse the effects discussed before. Mobility in the housing market would increase, maintenance and conversion would occur, and young people seeking new apartments would be better able to afford the high rents than current key money. The majority of the population, however, would experience great hardship while a smaller minority of landlords would greatly benefit. As between this and the status quo, the subproject prefers the latter. The team does <u>not</u> advocate complete decontrol.

C. Adjustments in Legally Specified Rents

This alternative has been frequently suggested to the team in Egypt. It would raise the controlled rents on existing units slightly (so as to encourage maintenance), and then set the rents of new units to cover <u>true</u> cost (so as to prevent key money). This proposal would not seriously change the distribution of income between tenant and landlord (impact 1), but then it would also not improve the efficiency and mobility of the existing stock or restore horizontal equity (impacts 2 and 3). What it would do is to allow young people to pay for new apartments more from their income rather than wealth (impact 4). Finally, the project does not believe that raising official rents would have the desired effect of improving the maintenance of units. For there to exist an incentive to building owners, rent must visibly change as a consequence of maintenance. Any fixed rent does not have this incentive.

D. Adjustments in Legal Rents with the Proceeds going to New Construction

This option, like that above, would increase the rents somewhat on existing housing, but unlike option C, the increased rents would go mainly to the government fund rather than landlords. The government, in turn, would use the fund to subsidize the cost of new construction. This proposal would not encourage greater housing maintenance, nor would it increase residential or employment mobility (impacts 2 and 6). It would, however, assist younger families through subsidization (impact 4) and this, in turn, could encourage new construction (impact 5). In these respects, then, it is like option C, except that through the government fund, the higher rents in older units are transferred to younger families in newer units. This may at least somewhat improve horizontal equity (impact 3), although it continues a policy of subsidizing new construction. The costs of this subsidization would increase over the years becoming an ever larger burden. Administering this system would also be a problem, because at some time after construction, each unit must switch from receiving a subsidy to paying for them, and the rents on all old units must be adjusted upwards.

E. Vacancy and New Construction Decontrol

This system has been used sometimes in developed countries as a way of eliminating rent control gradually over time. New units are completely decontrolled, and old units are as well, whenever the current tenants move or pass away. It again does not change the relative income of tenants and landlords, nor does it improve horizontal equity, mobility and occupancy efficiency (impacts 1 through 3). Like option C above, however, it would allow new families to rent housing with their income rather than being forced to buy occupancy from their wealth. Finally, slowly over time, vacancy decontrol would allow portions of the existing stock to be upgraded, improved or converted. To this extent, it is slightly superior to option C.

F. Reforming Ownership and Tenancy Rights

The M.I.T./Cairo University Subproject believes that by carefully restructuring the legal rights of property owners and tenants, all of the adverse effects of rent control can be overcome without losing any of its advantages. The suggested restructuring of rights involves four points:

(1) An occupancy right or permanent legal lease will be created for each housing unit - separate from the property or ownership right. The occupancy right and the property right are fully transferrable and any individual may own either, neither or both of them.

(2) The property right to a unit is a legal entitlement to permanent rental income - as specified by law - to be paid by the holder of the occupancy right.

(3) The occupancy right is a legal entitlement to the use of the apartment in any manner. It may be lived in, sublet or rented, altered or improved. The holder of the occupancy right is legally responsible for: paying the fixed rent to the property owner, paying taxes, maintaining the unit in any manner specified by other laws.

(4) For units now under construction, or to be constructed in the future, the developer and/or builder will receive both the initial property and occupancy rights. For existing units, there could be two options: a) Owners would receive the property right whose fixed income would equal the official rent. Tenants would be able to acquire the proposed occupancy right if they accepted a modest increase in the official rent - to be specified by law. This new rent would then become the fixed income of the property right. If tenants chose not to exercise this option, their rent and rights remain as currently specified by law.

This proposal attempts to accomplish two objectives. The first is to free up the housing market and make it easier for young people to acquire units. This is achieved in the proposal by making the occupancy rights transferrable. Since tenants can sell their right and buy another, or convert and sublet their existing units, personal mobility and the adaptability of housing are improved. Subletting will create market rents, whose variability will also provide an incentive for maintenance and allow young families to find rented housing without the constraint of wealth. New construction should also be somewhat encouraged because owners can charge rents to cover their costs without engaging in any "illegal" activity. Thus is most respects, the proposal creates a free housing market with all of its advantages.

The second objective of this proposal is to divide the profits or gains that result from this market activity in a way that is socially just. In proposal 4a, landlords would be no worse off, while most of the gains would to to tenants. The income to landlords would remain constant, and in fact would be freed from the current burden of taxes. Tenants, on the other hand, would receive the entire "value" of a transferrable occupany right. In the market that develops, these should be worth no more than current key money payments. As progressive as this scheme might be, two objectives could be raised. It might deny landlords too much to be politically acceptable, while at the same time the gains to tenants would vary substantially by when they acquired their apartment. Older tenants have a lower official rent andso their occupancy right would be worth more. Thus, in a sense, the horizontal inequity of the present system would not be corrected. Option 4b attempts to rectify both of these issues. By giving landlords some increase in rent, they receive, in effect, some of the "value" which accrues to tenants. In fact, as the official rent associated with the owners property right goes up, the market value of the occupancy right will fall*. At the same time, it would seem possible to specify the pattern of new rental payments so as to correct current horizontal inequities. For example, a tenant in an old building might obtain his occupancy right by doubling his rent (from say 5 to 10 L.E./month) while tenant in a new, similar, unit could do so with no rent increase (because his rent was already 10 L.E.). If the rent, increases necessary to obtain occupancy rights are equal, then the gains to all landlords will be the same, while the value of occupancy rights for identical housing will vary across tenants. If the increases in rent equalize payments for identical housing, then the gains to landlords will vary, while the value of tenant occupancy rights for equivalent housing will be the same. Clearly, the exact system used must be discussed and debated at some length.

In summary, the proposal would seem to overcome all of the inhibiting effects that the current system has had on the housing market, while at the same time not adversely affecting the distribution of income. Landlords would gain from a higher received rent, and tenants would gain from finally acquiring the true value of their occupancy rights.

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* See example following.

EXAMPLE SITUATION

Assume two apartments similar in all respects, quality, size and location. Assume that the first is rented out now for L.E. 40 a month. Assume that the landlord has estimated the rent to be high enough not to ask the new tenant for key money. Since the landlord expects to receive 5% from his real estate assets, the apartment is worth L.E. 9,600 to him.

Assume now that the same landlord owns another apartment. It was rented out 15 years ago at the official rent of L.E. 10. Since at that time L.E. 10 appeared a fair rent, the landlord did not request any key money. Since the landlord expects a return of 5% a rent of L.E. 10 a month is worth L.E. 2,400 to him. He also perceives that he has a slight chance, let us assume it is 1:10, that he can either receive key money or an increase of rent because the tenant wishes to move. If we assume that the key money is worth roughly L.E. 7,200 (the difference of the worth of the partment rented at market rent and at official rent) and that key money is equally shared between tenant and landlord, the chance of receiving key money is worth about L.E. 360 to the landlord. He thus estimates the total worth of the rent controlled apartment at L.E. 2,760 (L.E. 2,400 + L.E. 360).

The tenant, on the other hand, knows that he holds an apartment worth L.E. 40 a month. The tenancy in the rent controlled apartment is an asset worth L.E. 30 a month or L.E. 7,200 if one assumes a 5% return on real estate assets. However, the tenant can only cash in this asset to the landlord.

Let us now analyze the effect of our proposal. Let us assume that the official rent is doubled and that the tenant is granted a leasehold. The value of the building to the landlord will almost double from L.E. 2,760 to L.E. 4,800. The tenant can remain in his apartment and pay the new official rent, or he can move and let out his apartment for L.E. 40 and rent an apartment somewhere else for the same price. He can also sell the leasehold right for L.E. 4,800 and use the proceeds to invest in another leasehold right either more or less expensive. Alternatively, he can use the money to invest in business, or car or anything else he wishes.

The main result is that the landlord will be partly compensated for the loss of ownership he suffered through rent control and the tenant will finally have the opportunity to cash in the leasehold he has owned since the beginning of rent control or the chance to move without losing money.

APPENDIX C: AN ECONOMIC APPRAISAL OF THE NEW TOWN POLICY IN EGYPT

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I. There is a remarkably widespread view in the developing nations that current rates of urbanization and spatial concentration are by some standards "excessive", and that major cities have grown "too" large. The reaction has been a range of proposals to encourage rural development, regional growth poles and new towns formation. Initial experience with such policies, however, has made planners aware that successful decentralization schemes frequently involve massive infrastructure investments and heavy initial subsidization. The Arab Republic of Egypt is currently facing many of these same decisions. The purpose of this paper, therefore, is to study the relative merits of a proposed decentralization policy involving the construction of several new cities in the desert regions closely adjoining the Nile valley. The hope is that by carefully evaluating the arguments for and against this program, some general insights will be gained, possibly applicable to the situation in other developing countries.

The next section of the paper briefly reviews the pattern of urbanization in Egypt and the proposed new towns plan. Sections III through V then discuss, in turn, each of the three central arguments used in the new towns debate. The first of these is that valuable farmland is being used up by current urbanization, and that imperfect market pricing does not capture the true costs of this loss. The analysis done here, however, suggests that the rent for land at the urban fringe does roughly equal the shadow rent from the more lucrative vegetables and fruits grown there. Black markets is these crops are commonplace, and consequently actual land rents seem to reflect "real" economic profits. It is mainly in the cotton crop cycle, where government pricing prevails, that agricultural rents may be below their true shadow value. Land devoted to this use, however, is generally far away from the larger cities. Any price distortion in these areas should exercise little influence over urban development decisions. As a first estimate then, the current pattern of converting rural land to urban use seems to be based on the correct evaluation of costs and benefits. Computed shadow rents from agriculture, however, appear to exceed current reclamation costs, and so the conversion of desert land for farming probably should proceed faster.

A second argument, normally used against the new towns, is that their per capita infrastructure costs are excessively high. An analysis of this argument suggests that a different problem may underlie this issue. The unit price, or cost of a given level of infrastructure, is roughly equivalent in both new towns and the current urban fringe. The level of infrastructure proposed for the new towns, however, is higher than current and planned infrastructure around existing urban areas. Thus there is no technological reason for why the new towns are so expensive. Rather, it is argued below that the high standards may be a necessary form of subsidy which reflects a different kind of cost.

The final arguments involve the very difficult calculation of economic benefits. Based on a comparison of industry specific wages in different sized Egyptian cities, it does appear that larger urban areas offer significant agglomeration economies. Thus there will be a cost (requiring a compensating subsidy) to locating employment in new towns as opposed to existing larger cities. At the same time, wage differentials indicate that living costs may be lower in small cities. Thus it might be argued that workers in the new towns could be willing to accept the lower wages necessary to attract industry. This latter line of reasoning, however, has to be regarded skeptically. The willingness of labor to migrate between areas is far from elastic, and several studies have failed to find significantly higher living costs in larger cities. In fact, a common view in Egypt is that the new desert towns will have lower amenity levels than the larger cities. To measure this difference, it is suggested that the higher standards of infrastructure which have been planned in the new towns

could be viewed as "necessary subsidies" to encourage families to move.

Combining these results, it is difficult to find many economic merits to the new towns. For at least the first years it will be necessary to subsidize both labor and industry in the settlements, and the major social gain from this would be a preservation of agricultural land. The analysis suggests it might be better to reclaim the desert for agriculture and continue developing small amounts of existing farmland on the fringe of urban areas.

II. The Arab Republic of Egypt is a realtively poor country (per capita income $250.00) with about 36 million inhabitants. The population has been growing recently at about 2.2% annually, although urban population is growing faster, at 3.2%. The spatial distribution of Egypt's sixteen million "urban" inhabitants is quite concentrated. As Table 1 makes clear, close to 50% of the urban population lives in the greater Cairo area along. Another 15% lives in Alexandria. Five smaller cities account together for 10% and the remaining 25% is spread over many towns, most less than 50 thousand in size.

Against this background the Egyptian government has proposed building three new towns. Two will occupy land roughly 50 miles east and west of Cairo in the desert. The third will be located along the Mediterranean Sea, 50 miles west of Alexandria. Each is intended to be a self sufficient industrial development rather than a commuting satellite for the larger existing city. The planned population profiles of each are identical and these along with employment targets are shown in Table 2.

The impact of the new towns on Egyptian urbanization can be discerned by comparing Tables 1 and 2. If the three new towns are built, together they will accommodate between 50 and 100 thousand new urban occupants annually - or about fifteen to thirty percent of the new growth that presently occurs around Cairo and Alexandria each year. The policy

Table 1: Egyptian Population Distribution

	Population	Growth Rate
Total Urban Population	16,000,000	3.2%
Cairo-Giza	7,800,000	3.8%
Alexandria	2,350,000	2.8%
Ismalia	358,000	2.8%
Port Said	266,000	2.0%
Suez	198,000	4.0%
Other cities	5,000,000	2.8%
Rural Population	20,000,000	1.2%
TOTAL	36,000,000	2.2%

Table 2: Typical New Town Profiles

Year	Population	Industrial Emp.	Service Emp.
1	10,000		
5	75,000		
10	150,000	20,000	20,000
15	300,000		
20	425,000		
25	500,000	60,000	90,000

choice confronting the Egyptian government, therefore, is whether there is a net gain from constructing these new towns and concomitantly slowing the growth of the two largest existing cities by about 25%.

III. The most frequently-heard argument in favor of diverting development to the new desert towns involves the loss of agricultural land. Most existing Egyptian cities are located in the Nile valley, and as such are surrounded by fertile farmland. Continued urban expansion comes at the expense of some of this land. While Egypt's farming is highly productive, domestic capacity has not been able to feed a growing population in recent years. In addition, cotton is still the nation's most important export commodity. There is, therefore, considerable concern over the gradual loss of farmland to urban development (estimated at 25,000 acres or four tenths of a percent annually).

It must be remembered that urban development also has a "value" or rent, which can easily make agricultural conversion profitable. The physical and human capital that exists in the larger cities is a valuable base for commercial and industrial expansion. Allowing existing cities to grow may increase gross national product by more than the loss of farmland. The correct test for determining this is a comparison of the true economic rents for agricultural as opposed to urban land. If urban development brings a higher shadow rent to the land than farming - then conversion should occur. At the urban fringe, of course, the two uses should yield roughly comparable revenues.

Individual decision making in a competitive land market will follow this efficiency criteria, if there are no price distortions in other parts of the economy which may use land as a factor. Since these conditions do not always prevail in Egypt, a more direct computation of shadow rents is necessary to determine if the current conversion of rural land is, in fact, optimal.

The use of urban land in Egypt is largely determined by a competitive market, on which is relatively free of direct regulation. Housing, on the other hand, is highly regulated, and so there is some question about whether prices in the land market reflect the true economic value of urban uses. The existence of rent control, for example, reduces the supply of housing and this in turn decreases the demand for housing inputs such as land. With housing rents controlled, prices in the land market should be below their shadow value. Despite such housing regulations in Egypt, several studies have shown that widespread black market activity exists and that this substantially circumvents the controls. Thus current market prices for urban land are in fact probably only slightly below their economic shadow values. With this in mind, several sources suggest that the following market prices prevail for urban land.

Unlike the urban land market, the rents for rural or agricultural land are directly controlled - at least in theory. Tenants, by law, need pay only a multiple of the land's tax. Despite this formidable control, recent studies by the Ministry of Agriculture suggest that most price controls are effectively circumvented. Much land is now leased per crop rather than per year (a loophole in the law allows crop rents to go unregulated). Landlords also appear only to pay tenants to vacate the land - at which point it becomes unregulated. Thus there is good reason to expect that the market price of farmland does not at all reflect an allowed rent which averages 20LE. In fact, unofficial estimates of productive farmland prices are vastly higher - in the 4,000-6,000LE range.

Even if the land market does circumvent direct government controls, there is good reason to believe that the prices which evolve are still not true shadow prices. This is because the prices received by farmers for their crops are also set by law. In the case of cotton, for example, the government is the major buyer (for export) and the market rent for cotton land is based on the official rather

Table 3: Urban Land Prices

Location	Price (LE/Acre)
Fringe (No access to services)	6,000 - 12,000
Fringe (access to paved road)	40,000 - 120,000
Built up intermediate area	120,000 - 600,000
Central city	600,000 +

Table 4: Estimated Agricultural Rents[1]

	Cotton	Rice	Wheat	L.Ber.	S.Ber.	Tomatoes	Oranges
Export Price (1972-76, ton)	600/800	120/200	60/120	3.5	3.5	150-200	80-120
Farm Gate Controlled Price (1976, ton)	480	45	50	3.5	3.5	40	35
Yield (tons/harvest/acre)	.3	2.3	1.5	10	28	6	7
Harvest Cost	85	65	45	17	24	90	130
Harvests/year	1/3	2/3	1/3	1/3	1/3	3	2
Annual Shadow Rent			212/383			2400/3300	830/1400
Annual Regulated Rent			84			450	420

[1]All monetary values in Egyptian pounds (1LE - $1.50)

than shadow price of the crop. For other farm products, however, there frequently exists a black market, and in these cases it might be possible that land prices would reflect a shadow value of the produce grown there. Given this range of possibilities it would be best not to rely on market prices, but to compute agricultural shadow rents directly. To do this, the true value of crop revenues is estimated and growing costs are subtracted off. Costs involve mostly labor (which is unregulated), chemicals, and water. Estimated shadow prices for the latter two are used and the net revenue is then multiplied by annual yields per acre. The results are shown in Table 4. Regulated rents are based on government crop prices while shadow rents use estimated export prices. These latter are average contract prices over several recent years taken from the cheapest export countries located in the North Africa-Middle East region. The first five crops represent a typical 3-year (6 harvest) rotation scheme, while tomatoes and oranges are grown similarly.

The first result of Table 4 is that export prices dramatically increase the profitablity of farming - so much so that questions should be raised about the validity of the data and calculations. The harvest costs, yields and export price figures all come from annual World Bank statistics, although the computations in Table 4 do not include domestic transportation costs nor farm-to-port crop losses. Both of these could reduce profits somewhat.

The second conclusion drawn from Table 4 is that Egypt may be overlooking some highly profitable export products. The potential revenues yielded by fruits and vegetables dwarf those of the cotton-rice-berseem cycle. While some such crops are perishable, a large export market for many of them has developed recently in the Middle East. Using discount rates of 10-15% suggests that land planted in fruit and vegetables might be worth from 5000 to 15,000LE/acre.

Comparing Tables 3 and 4 reveals a predictable Von Thunen location pattern. The shadow price of land farmed in the cotton cycle is far below that of urban land - and Ministry of Agriculture data shows that most such cultivation occurs in portions of the Nile Valley away from the larger cities. The shadow price from fruits and vegetables on the other hand, is roughly comparable to the estimated urban price for unimproved land - and much cultivation of these crops occurs just beyond the urban fringe. All of this suggests that the land market is working remarkably well. The shadow price of farmland ranges from around 2000LE in the heart of delta (cotton crops) to about 8000LE for fruites and vegetables around the larger cities. The market price profile for urban land (a lower bound on shadow prices) starts at about 8000LE on the outer fringe and steeply rises towards the urban center. If rural land costs were based only on the returns from official farming, then urban land prices at the fringe would be much lower. Thus it appears that urban development at least approximately faces its true opportunity cost. This is because black markets for many crops bring agricultural land prices closer to their shadow value (reported farmland prices are in the 5000LE range). Thus while it is still possible that urban development receives some subsidy, it is not likely to be very large.

The final issue here is how these results bear upon the new towns policy. The answer is that even in the unlikely case that urban development were receiving some subsidy - the solution would be to eliminate the subsidy - not to correct the distortion with a forced policy of redirecting development. This argument receives further support when desert reclamation is considered. Recent studies suggest that the total cost for reclaiming desert areas varies in 1200-1800LE per acre range. Assuming such costs occur over an initial five year period, and that after that, net revenues on the scale of Table 4 occur, reclamation has internal rates of return ranging from 14% to 40%[1]. Now of course re-

Table 5: Per Capita Capital Costs, New Towns[1]

Investment Category	Sadat City (10 years)	10th Ramadan (25 years)
Housing	354	441
Utilities	316	209
Water	147	
Sewage	61	
Electricity	42	
Telephone	19	
Other	47	
Transportation	231	134
Education		205
Cultural	640	92
Health		132
Total	1540	1213

[1]From official Planning reports, all figures in Egyptian pounds.

[1]Solving for i in the equation: $\int_0^5 300e^{-it}dt = \int_5^\infty Re^{-it}dt$ where R is the net revenue from Table 4.

Table 6: Per Capita Investment in Infrastructure Expansion in Existing Urban Areas: 5-Year Plan 1978-82

Investment Category	Average Investment Annually (MLE)	Reported Investment (MLE) for New or Expanded services (non-replacement)[1]	Expansion Investment divided by population growth[2] (LE)
Housing	208	165	273
Utilities	380	135	225
Water	62	37	61
Sewage	56	44	73
Electricity	185	36	60
Telephone	71	15	25
Other	7	3	5
Transportation	154	16	26
Education	82	55	91
Culture	29	15	25
Health	26	14	23
Total	879	399	665

[1]Based on project descriptions in 5-year Plan

[2]Assumes 18 million urban inhabitants growing at 3.25% annually.

Table 7: Urban Expansion-vs-New Towns Infrastructure Costs[1]

	Sewage	Water	Total
Cairo/Alexandria	140-160	42	192
Sadat City/10th Ramadan	55-60	110-145	185

[1]All figures in LE per capita of service beneficiaries.

claimed land may have lower yields than those of Table 4, but by using estimated agricultural shadow prices, the suggestion is clearly that it may be more desirable to reclaim the desert for farming than for cities.

IV. The second question raised by the new towns is is their enormous expense. Turning to Table 5, per capita infrastructure costs are reported for the two most likely new cities. To give an idea of how large these figures are, several calculations can be made. To begin with, if such investment levels were provided for each of Egypt's estimated 600,000 new urban residents annually, the yearly expense would be between 750 and 924 MLE. Egypt's gross domestic product is only 8,000-10,000 MLE, so roughly 10% of GDP would be required to construct this infrastructure, for all of the incremental growth in population. The cost of providing such infrastructure for every inhabitant is even greater. Using a "low" interest rate of 10%, the annualized cost per person would be 120-150LE. Per capita income in Egypt is currently around 175LE. In short the country would eventually have to devote 75% of its total output every year to afford such infrastructure outlays.

Clearly expenses of this magnitude would create an impossible drain on the Egyptian economy. The question of why the new towns have turned out to be so expensive could have two possible answers. First, the price of a unit of infrastructure might be much more expensive in the desert than in existing cities. A different technology and the absence of scale economies could generate excessive costs. Secondly, for a variety of reasons, the level of infrastructure planned in the new towns may be far higher than that which exists around already developed cities. As an example of this difference, the Egyptian government's 5-year investment plan (1978-82) has been analyzed in Table 6. Under each investment category, a project-by-project evaluation was made to estimate the fraction of investment going for maintenance and replacement as opposed to capacity expansion.

The results vary widely.

In transportation, for example, most investment is being used to replace a very deteriorated bus fleet. Little is being spent on new routes and expansion of the overall level of service. With regard to sewage, on the other hand, new treatment plants and lines are clearly aimed at handling population growth. If it is assumed that expanded services are meant to handl the increase in urban population, then expansion around existing cities is less than half of that anticipated in the new towns.

The question still remains, in comparing Tables 5 and 6, whether the differences in dollar investments are due to unit price differences, as opposed to planned differences in level of infrastructure consumption. To investigate this, the water and sewage expansion plans for the Cairo and Alexandria areas were compared with those in the new towns. All water systems were designed to essentially identical capacity and quality standards. The per capita cost comparisons are shown in Table 7, and by definition these reflect only differences in unit prices.

In the case of sewage, new town construction is cheaper because of its desert location. Sewage can be treated less there and is used to fertilize and help reclaim desert lands. As for water, the new town desert sites are more expensive, again because of their desert location rather than any size-associated economy or diseconomy. Conversations with contractors, planners and utility companies revealed similar conclusions - that it was generally difficulty to identify significant overall differences in unit costs between the smaller desert towns and the fringe of larger existing cities.

The only conclusion that can be drawn from this analysis is that most of the difference in infrastructure costs between the new towns and current cities is due to "over planning". The level of utilities, quality of housing, miles of roadway and particularly numbered social services far exceed what the current Egyptian population enjoys. On first examination, such overplanning could reflect the failure of consultants to properly consider the resources of Egypt. The Egyptian government, however, appears to be aware of thenew towns' high cost. Thus it may well be that such "over planning" is not really a problem, but rather an implicit policy. The government may feel that workers and their families will have to receive substantial incentives to take up residence in a small town, with few amenities, at a less desirable desert location. Since wages in the new towns are to be comparable with Cairo, it seems reasonable to suggest that "over planning" is really a form of subsidization. This is particularly true when the pattern of "over planning" is examined. Again comparing Tables 5 and 6, it is clear thatprivate consumption is not as overplanned as are public goods. Housing and utility investment is only slightly greater in the new towns, while transportation, education, culture and health are 300% greater. This could well represent a calculated attempt to make up for the low level of social amenities normally associated with smaller sized cities. If this is the case, then the new towns have an inherent cost which is not due to poor planning, but rather may be thought of as an initial subsidy to labor. The magnitude of the subsidy is at least 600-900LE per person, or in annual terms roughly 30-50% of the average Egyptian wage.

V. While the previous section suggests that the movement of labor to the new towns may require subsidization, there is even better evidence that industry will as well. In fact, much of the research done to date on the general issue of urban decentralization has focused on the question of urban agglomeration. Larger cities are normally felt to have greater productivity, at least over a large range. Although the explanations offered for such agglomeration effects are varied (scale effects, risk pooling, diversity) all suggest that output per unit of input increases with

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Table 8: Wages by Industry and City or Region[1]

	Area			
	Cairo/Giza	Alexandria	Canal Cities[2]	Gharbia/Dakahlia
City Size	8,000,000	2,500,000	200,000	200,000
Average Wages:[3]				
- Wholesale/Retail				
Clerical/Tech.	21.20	19.00	16.7	8.5
Laborer	7.2	7.0	8.9	4.6
- Manufacturing				
Clerical/Tech.	20.3	16.7	-	9.8
Laborer	6.2	5.5	-	4.05
- Finance/Business				
Clerical/Tech.	26.5	18.4	-	13.2
Laborer	8.5	8.4	7.2	5.4

[1]Source: Survey of Area Wages 1971, Central Agency for Mobilization Cairo.

[2]Suez, Port Said, Ismalia

[3]Equal to average weekly earnings adjusted by average hours worked.

city size and so factor payments should as well. The theories receive generally strong support from empirical evidence which shows that incomes and wages almost invariably are higher in larger cities. If firms are willing to pay these higher wages, then the argument is made that they must reflect comparable differences in marginal (or average) productivity.

To examine the degree of agglomeration present in Egyptian urban economies, data was reviewed from a recent survey of wages conducted by the Central Organization for Mobilization and Statistics. Average weekly wages are reported in Table 8 by industry, skill, and city, for the private sector only. Egypt has nationalized many enterprises - especially in manufacturing, and although such industries face the same competitive labor market as private firms, they may not compete against one another. Without such competition there is no guarantee that wages reflect productivity.

The results of Table 8 are remarkably consistent and quite significant. Wages for ostensibly identical employment are 50-100% higher in Cairo than in the smaller towns. Even with respect to Alexandria, Cairo enjoys an average 20% greater productivity. In fact the only inversion in the size ranking occurs with wholesale/retail laborers in the canal cities. It should be pointed out that this observation came only from a Port Said sample - and did not include the two other canal cities. Thus based on the information in Table 8 it seems reasonable to suggest that industrial location in the new cities will have to be subsidized the equivalent perhaps of 35% of current Cairo wages.

While Table 8 strongly suggest less agglomeration and hence lower productivity in the new towns, it can also indicate lower costs of living. Just at the table suggests that firms are willing to pay labor more in Cairo, it also suggests that workers are willing to accept less in smaller towns. In such a case why couldn't the workers be paid less

in the new towns as well? Might this not compensate industries for the loss of agglomeration, and make location there profitable? There are several answers to this question. First, costs of living and amenity levels are not strongly related to city size in western countries. To be sure land rents and transportation are more expensive in larger cities, but food and clothing tend to be less (because of retailing economies). There is strong evidence therefore that the lower wages in smaller towns probably reflect imperfect labor mobility - and differences in workers' skills. Small towns and cities are normally the first destination of rural-to-urban migrants, while large cities in turn receive their labor primarily from these smaller urban centers. The relative rates of migration flow can be quite different - creating continuing wage differences. Even if labor flows are fairly elastic, the amenity level of an existing city of 200,000 will be different than a new town in the desert. There are family ties in an existing city which tend to keep younger workers there, and these will not be present in the new towns for at least a generation. The labor market is far more imperfect and idiosyncratic than the capital market. Therefore the wage differences in Table 8 probably provide good evidence for estimating productivity loss in the new towns, but little evidence for estimating any labor subsidies or surpluses.

VI. Of the three arguments examined in the new towns debate, this paper has shed considerable light on two. It would seem to be difficult to argue that an imperfect land market significantly underprices farm land and therefore leads to overly rapid urban expansion. In fact, housing on the urban fringe appears to roughly pay its true opportunity cost. Even if some distortion is present, the correct solution is to change agricultural pricing policy not to force urban development into the desert. It seems also clear from the previous ection that industries will have to be significantly subsidized in order to locate in the new towns - perhaps the equivalent of as much as 50% of their wages. Finally, the cost of the new towns is high because the level of services provided there appears greater than is found in existing cities. There is the suggestion that this may also be an implicit subsidization to labor in order to ensure occupancy of the towns. This latter point is only a hypothesis, however, it cannot, at this stage, be verified. Based on these arguments then, an alternative to spending large sums of money on the new towns would be to reclaim desert land for agriculture and build more modest levels of infrastructure around existing urban areas.

Materials and Techniques of Construction

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This summary is a part of the Housing and Construction Industry Research Program carried out under the Technological Planning Program, a joint research project by Cairo University and the Massachusetts Institute of Technology. The views and opinions expressed in this report are those of the authors and do not necessarily reflect those of AID, MIT, or Cairo University.

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I. INTRODUCTION

1. INITIAL RESEARCH 1977

The part of research activites undertaken by the Materials Group in 1977 was divided into three general phases. The first phase consisted of the overall structuring of the research, the identification of the materials traditionally used in the housing construction in Egypt and those which might be used, and the classification of data required. The second phase was detailed data collection and compilation, with efforts focused on cement, steel, bricks, and extended to glass, lumber, sanitary fixtures and floor cement tiles as time permitted. Activities of this phase were also extended to cover non-conventional materials, such as gypsum, strong mortars, lightweight concrete, stabilized earth, plastics and sulfur. The third phase was concerned with the identification of apparent materials shortages and inefficiencies in their use in housing construction and the underlying causes, together with the formulation of recommendations to alleviate these difficulties.

The summary of the first year's findings was presented as a working paper in the Interim Report "Housing and Construction Industry in Egypt Project", 1977.

2. RESEARCH IN 1978/1979

Based on the studies of alternative materials carried out during 1977, and in light of the indications received from other subgroups, it was decided to concentrate most efforts of the Materials Group on gypsum and gypsum products, foamed slag as lightweight aggregates, stabilized earth, and some other additional topics as time might permit. The research work undertaken through the period January 1978-June 1979, was thus divided into three phases as follows:

Phase A:

This phase was concerned with an overall feasibility assessment of the following topics:

i. Gypsum and Gypsum Components:

This included data on modes of application in other

countries, gypsum industry in Egypt, prefabricated gypsum panels formerly locally manufactured under the name "Bell-rock", future plans for the gypsum industry in Egypt, review of available pertinent research on reinforced gypsum panels and components, and some advantageous characteristics of gypsum, such as its fire resistance and suitability for use with walls and partitions.

ii. Foamed Slag as Lightweight Agrregate:

Data on this topic included main methods of slag foaming, local production and future expansion of slag, chemical analysis and different characteristics of locally produced foamed slag, main advantages of using foamed slag as lightweight aggregate in concrete components, and review of available pertinent research work on foamed slag as lightweight aggregate; including two full-scale models erected in Cairo.

iii. Stabilized Earth:

This covered the main methods used for soil stabilization, types of stabilizers, determination of soil suitability for stabilization, soil formation of Egypt and in Cairo, examples of previous experience in producing Egyptian stabilized mud-bricks, and description of an experimental rural house built in Marg, Egypt, twenty years ago and still in existence.

iv. Feasiblity Exploration of Local Materials:

A feasibility exploration was undertaken in the local market to study the availability of some materials suggested for use as reinforcement, filler or paint for gypsum; as strong mortar for masonry, and as stabilizers for soil.

In most cases, the survey convered the producing companies, the annual production and expected expansions, the current market prices, and dimensional ranges. The study included date-palm midribs, bamboo, reeds, jute and burlap, polypropylene woven mats, stretched metal mesh, glass wool, expandable polystyrene, (styrofoam beads), plastics, sulfur, sodium silicate (waterglass), plastic paints, asphaltic emulsions, and lime.

v. Utility Infrastructure:

Compilation of data on this topic was intended to focus interest on a new vital area of reasearch, to clarify and collect basic redumentary information, and to provide a basis for future more detailed research.

The study covered water supply, sewage disposal, refuse collection, electricity and street lighting, and streets and sidewalks.

The information compiled included general data pertinent to the overall utility infrastructure, such as the initiator, designer, constructor and maintainer of each utility the sources of funding, the standards applicable, and the general problems encountered. The study included, as well, specific data related to tiems and components of each utility surveyed.

The detailed outcome of Phase A was included in the progress report of the Materials Group dated April 30, 1978.

Phase B:

This phase covered the following two main activities:

i. Preparation of a brief technical report ont he potentialities and techniques of earth stabilization for upgrading unpaved roads within sites of informal and low-income groups.

ii. Compilation of data on alternatives for flooring materials, and on finishes for internal walls and facades currently used in Egypt and in other countries.

Phase C:

This phase covered an extensive experimental research program on gypsum, intended to assess the suitability of the material for use as blocks for walls, panels for partitions, and reinforced planks for roofs and floors.

The undertaken experimental investigation was divided into two parts. The first part was carried out on locally-produced plain gypsum to determine its physical and mechani-

cal properties and to assess its resulting modified characteristics as affected by the percentage of mixing water, the degree of compaction, the method of drying, the amount of setting retarder, the addition of sand, the presence of sawdust, and the amount of sodium bicarbonate added to foam gypsum.

The second part of the program was undertaken on relatively small gypsum panels with varying thicknesses ranging between 1.0 and 8.0 cm. The panels were tested mainly under flexural and impact loading to determine the effect of the type and amount of reinforcement and panel thickness on the strength and deformation characteristics. The studied reinforcing materials were either natural fibers; namely reeds, bamboo, date-palm mid-ribs, and burlap, or artifical; namely, glass wool, polypropylene woven mats, and galvanized stretched wire mesh. The gypsum mix used in manufacturing all the tested panels was the optimum determined from the first part of the program.

Based on the findings attained from the undertaken experimental program, the most suitable panel thickness with the most efficient reinforcing material could be chosen depending on the intended usage, as an outer layer for a sandwich system, for planks in roofs and floors, or for partitions and walls.

The detailed results of phases B and C were presented as a working paper in the Interim Report of "The Housing and Construction Industry in Egypt Project, 1978."

3. RESEARCH IN 1979/1980

The research program undertaken during the period (July 1979 - June 1980) covered the following main activities:

i. Continuing the on-going study on gypsum by developing masonry solid and cored blocks of unreinforced gypsum, to which a filler could be added, to decrease weight, cost or both.

ii. Preparation of a technical report on the potentialities and possibilities of producing low-cost types of cement characterized by an adequate strength suitable for many applications which currently employ costly types of cement of higher quality and strength.

iii. Undertaking a research program on surface-bonded bricks and blocks for walls and partitions using available local materials.

iv. Studying the suitability of a new technique of construction comprising a system of small structural components. A full-scale model is to be erected to test and demonstrate the advantages of the system.

The papers following cover two aspects of the research: "Gypsum Masonry Blocks" and "A New Technique of Surface-Bonding Brick Walls for Housing."

II. GYPSUM MASONRY BLOCKS

This undertaken research program was intended to develop masonry wall units made of unreinforced gypsum, to which a filler could be added, if needed, to decrease weight, cost, or both.

The dimensions of wall units had to give a thickness allowing the grip of the hand and at the same time give a reasonable stiffness and impact resistance to the plain gypsum wall unit. The overall size had to be as large as possible to decrease handling labor during constructaon and the quantity of mortar required. Yet, the size was limited by weight, allowing the unit to be lifted by one or two hands. Taking the above consideration into account, a wall unit with overall dimensions 11.42 x 11.42 x 3.94 in. (29 x 29 x 10 cm.) was chosen, satisfying a module of 11.81 in. (30 cm.) and allowing for 0.39 in. (1 cm.) thick mortar joints.

1. MANUFACTURING OF GYPSUM WALL UNITS

Gypsum wall units were cast in aluminum forms consisting of a base and four sides connected by quick-release bolts. Three types of forms were used. The first gave a tongue-and-groove type block as shown in Figure (II-1), the second gave a block with flat sides, and the third had flat sides containing circular openings in two opposite sides through which plastic pipes could be inserted and removed, giving a cored gypsum block as shown in Figure (II-2).

Sand, sawdust and sodium bicarbonate were tried as fillers or additives to gypsum for producing both solid and cored gypsum wall units. The mix proportions are recorded in Tables (II-1) and (II-2). In all mixes, the percentage of setting retarder (keratin) to gypsum was 0.1 percent by weight. Sand used passed a No. 14 and sawdust a 3/8 in. (0.95 cm) sieve.

The cast gypsum blocks could be demolded 30 to 45 minutes after casting.

2. TEST PROCEDURE

The gypsum blocks were weighed just after demolding and placed in relatively high humidity for 24 hours, then removed to the open air and weighed every day until completely dry. All types of solid and cored gypsum blocks were then tested in compression up to ultimate failure. Blocks with tongue and groove were first prepared by trimming the protruding tongue and filling the groove on the opposite side with appropriate mortar.

3. TEST RESULTS

The effects of type and percentage of additive on the resulting compressive strength and dry weight of solid and cored gypsum blocks are plotted in Figures (II-3) to (II-8). The resulting material cost of solid and cored gypsum block as affected by the added percentage of sand or sawdust is plotted in Figures (II-9) and (II-10)*.The effect of the existence of cores on drying time needed for pure gypsum blocks and blocks of gypsum mixed with sand is illustrated in Figures (II-11) and (II-12).

The tests indicated that cored blocks dry eight to ten days earlier than equivalent solid blocks, and that higher percentages of filler or additive, especially sawdust, result in shorter drying periods.

* These two figures were prepared before January, 1980, when the price of gypsum was suddenly raised to 25 L.E./ton.

4. RECOMMENDATIONS

Based on these test result, the following types of blocks are recommended :

a) Solid blocks with a sand filler, where sand to gypsum ratio by weight is 2.8, are recommended for load-bearing walls ; as their expected compressive strength is about 639 psi (45 kg/cm^2) and their weight is about 32 lb. (14.50 kg.) per block, whereas the cost is about 0.063 L.E. ($0.09) per block. The required water to gypsum ratio is o.77 by weight to give excellent workability .

b)Cored blocks with a sawdust as a filler and sawdust to gypsum ratio of 0.8 by volume may be used as non-bearing wall as their compressive strength is about 213 psi (15 kg/cm^2). The corresponding weight is about 15.4 lb.(7.0 kg.) per block and the cost is nearly 0.078 L.E. ($0.11) per block. The required water to gypsum ratio by weight is 0.66 to give excellent workability.

c) Whenever weight is not a problem, a lower cost can be obtained by using cored blocks for non-bearing walls with sand to gypsum ratio by weight of 2.5 giving an approximate cost per block of only 0.05 L.E.($0.07). The corresponding weight is 24.2 lb. (11.0kg) per block and the compressive strength about 213psi (15 kg/cm^2). The water to gypsum ratio by weight is 0.75.

The cost of all the above recommended blocks compares quite well with the cost of an equivalent wall area of traditional red bricks, which would be not less than 0.15 L.E. ($0.21).

5. MORTAR FOR SUGGESTED GYPSUM BLOCKS

In an effort to study the type of mortar suitable for the suggested gypsum blocks, and avoiding the use of cement mortars to save cement for better usage, several gypsum mixes were prepared with different percentages of sand and lime. Keratin was added in all mixes as o.1 percent by weight of gypsum. The resulting compressive and tensile strengths after 7 days were recorded for the different mortar mixes. The water to gypsum ratio by weight was varied for different mixes to attain good workability. The compressive strengths for the different mortar mixes are plotted in Figure (II-13). Test results indicated that a mix proportion of gypsum: sand: lime by volume of 1:1:0.2 and a ratio of water to gypsum by weight of 0.70 would give a compressive strength after 7 days of 1107 psi (78 kg/cm^2) and a corresponding tensile strength of about 255 psi (18 kg /cm^2), which is quite satisfactory for use as mortar.

The average maximum bond strength between gypsum blocks and the recommended type of mortar, tested on six bond samples as shown in Figure (II-14), was found to be 64 psi (4.5 kg/cm^2) which is satisfactory.

6. GROUP ACTION OF SUGGESTED GYPSUM BLOCKS

In an effort to study the group action of the developed gypsum blocks, a series of test walls were built using the suggested blocks and recommended mortar and tested in compression and flexure. Six test walls were built using load-bearing gypsum blocks with connections, two to be in pure compression, one in pure flexure and the rest in combined compression and flexure with ratios of applied compression to ultimate pure compression (P/P_o) of 0.71, 0.41 and 0.28. Three test walls were also built using load-bearing gypsum block, with tongue and groove connections, with one to be tested in pure compression, one in pure flexure and the third in combined compression and flexure with (P/P_o) of 0.50. A test wall was built using non-bearing cored blocks of gypsum with sawdust as a filler and was tested in pure flexure. All the above ten test walls were 3.94 in. (10 cm) thick, 23.62 in. (60 cm) wide and 47.29 in. (120 cm) high. To provide for comparison, a test wall of sandlime bricks and two test walls of conventional red bricks were built with the same dimensions as the gypsum test walls except for the thickness which was 4.72 in. (12 cm), and conventional cement mortar was used for their construction.

A full description of the different test walls and their corresponding recorded test results is given in Table (II-3) while the characteristics of the types of blocks used in building the test walls are given in Table (II-4).

A test set-up shown in Figure (II-15) was specially constructed in this investigation to be mounted on a 500-ton Amsler Compression Testing Machine to give a simultaneous flexure load on the tested walls.

For walls tested under combined compression and flexure, the total predetermined compression load (P) was applied first, then the flexural load was applied in increments up to ultimate failure.

An interaction diagram between flexural and compressive stresses was experimentally developed for load-bearing gypsum blocks with plane connections, and is shown in Figure (II-16). Such an interaction diagram gives the different combinations of flexural and compressive stresses causing failure of the loaded gypsum wall.

The program on test walls indicated that the pure compressive strength of load-bearing gypsum walls is nearly twice that of conventional red-brick walls, and is greater by at least 30 percent than that of sand-lime brick walls.

The pure flexural strengths of the different bearing and non-bearing gypsum walls were found to be nearly equal, and greater by about 60 percent than the pure flexural strength of a corresponding conventional red-brick wall. On the other hand, gypsum walls with both plane and tongue-and groove connections seemed to have no particular difference in behavior under load. Tongue-and-groove blocks, however, required more care during construction and consumed a longer time and a larger amount of mortar than the blocks with plane flat sides.

7. CONCLUSIONS

Based on the foregoing tests, it is recommended that :

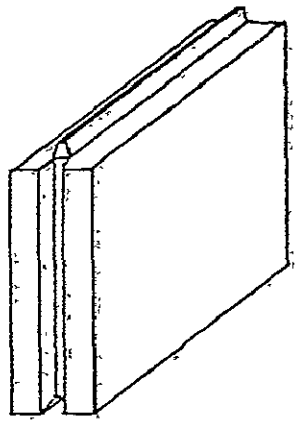
1. Solid gypsum-sand blocks be carefully considered for load-bearing walls and partitions carrying moderate loads at least equal to those traditionally supported by conventional sand-lime and red-bricks.

2. Cored gypsum blocks with sawdust filler where weight is important, or sand where cost predominates, be similarly considered for non-bearing walls and partitions.

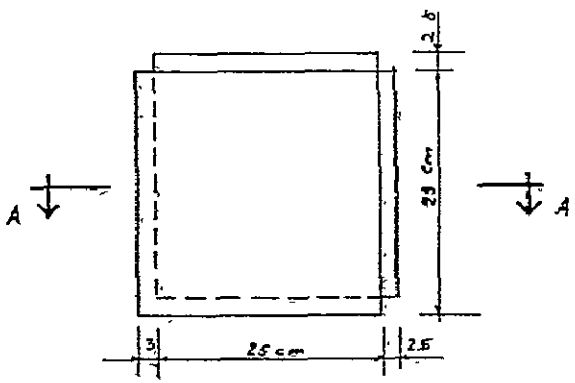
Table (II-1)-Mix Proportions of Tested Solid Gypsum Blocks.

Filler Material or Additive	Block Number	Mix Proportions by Weight				
		Gypsum G	Water W	Sand S	Saw-dust* D	Sodium Bicar-bonate N
None	1,2,3	1	0.5	-	-	-
Sand	S1,S2,S3	1	0.7	2	-	-
	S4,S5,S6	1	0.8	3	-	-
	S7,S8,S9	1	0.9	4	-	-
	S10,S11,S12	1	1.0	5	-	-
Sodium Bicarbonate	F1,F2,F3	1	0.5	-	-	0.006
	F4,F5,F6	1	0.5	-	-	0.010
	F7,F8,F9	1	0.5	-	-	0.015
	F10,F11,F12	1	0.5	-	-	0.020
Sawdust	D1,D2,D3	1	0.6	-	0.5	-
	D4,D5,D6	1	0.7	-	1.0	-
	D7,D8,D9	1	0.8	-	1.5	-
	D10,D11,D12	1	0.9	-	2.0	-
Sodium Bicarbonate + Sawdust	M1,M2,M3	1	0.6	-	0.5	0.006
	M4,M5,M6	1	0.6	-	0.5	0.010
	M7,M8	1	0.7	-	1.0	0.010

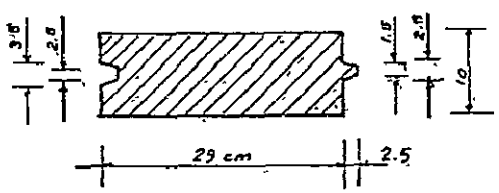
*Sawdust to gypsum ratio is by volume.



GROOVE & TONGUE
GYPSUM WALL UNIT



PLAN



SEC. A-A

Fig. (II-1)- Gypsum Wall Unit Provided with Grooves and Tongues

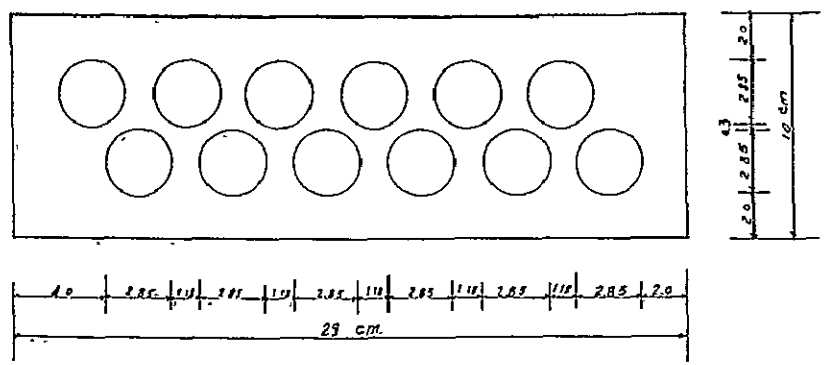


Fig. (II-2)- Cross Section of a 29 x 29 x 10 cm Cored Wall Block

Table(II-2) -Mix Proportions of Tested Cored Gypsum Blocks.

Filler Material or Additive	Block Number	Mix Proportions by Weight				
		Gypsum G	Water W	Sand S	Sawdust* D	Sodium Bicarbonate N
None	C1,C2,C3	1	0.5	-	-	-
Sand	CS1,CS2,CS3	1	0.7	2	-	-
	CS4,CS5,CS6	1	0.8	3	-	-
	CS7,CS8	1	1.0	5	-	-
Sodium Bicarbonate	CF1,CF2	1	0.5	-	-	0.010
Sawdust	CD1,CD2,CD3	1	0.6	-	0.5	-
	CD4,CD5,CD6	1	0.7	-	1.0	-
	CD7,CD8,CD9	1	0.8	-	1.5	-
	CD10,CD11,CD12	1	0.9	-	2.0	-
Sawdust and Sodium Bicarbonate	CM1,CM2,CM3	1	0.0	-	0.3	0.006
	CM4,CM5,CM6	1	0.6	-	0.5	0.010

*Sawdust to gypsum ratio is by volume.

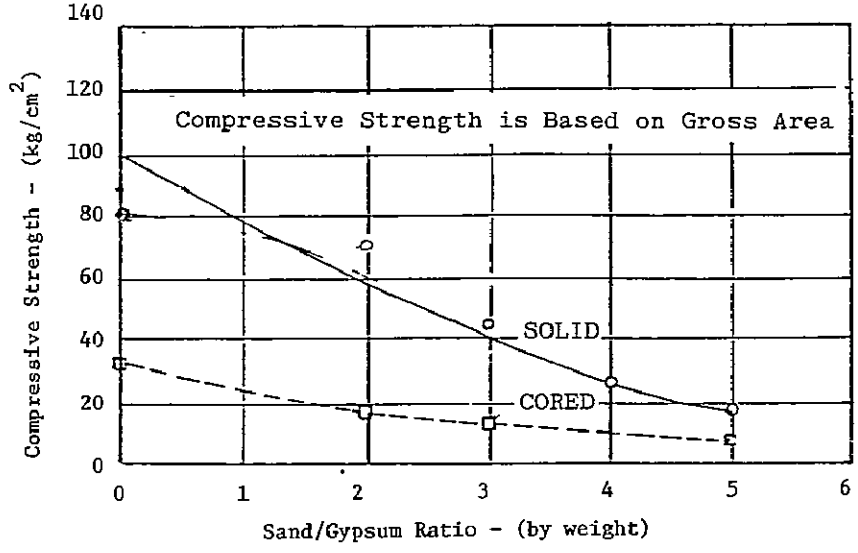


Fig.(II-3) - Effect of Sand/Gypsum Ratio on Compressive Strength of Solid and Cored Gypsum Blocks.

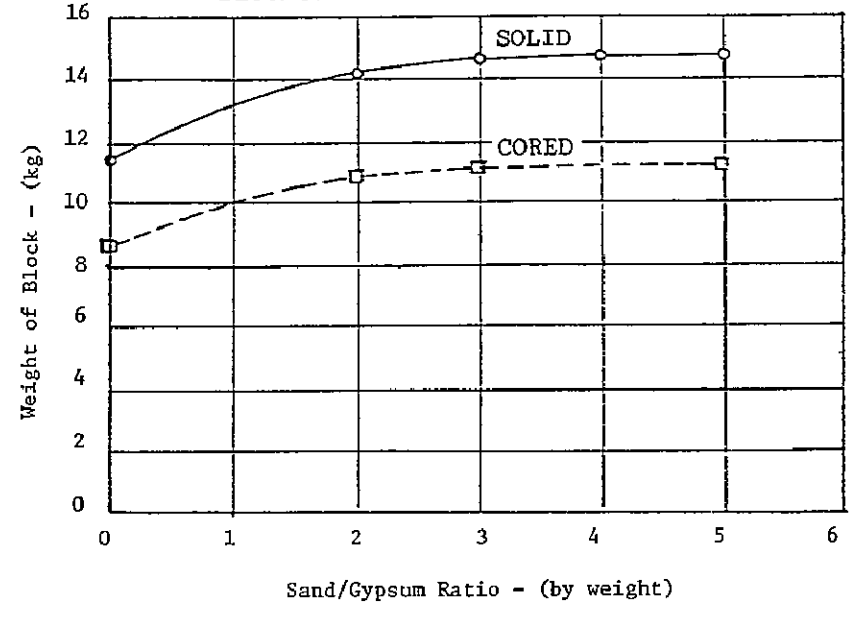


Fig.(II-4) - Effect of Sand/Gypsum Ratio on Dry Weight of Solid and Cored Gypsum Blocks

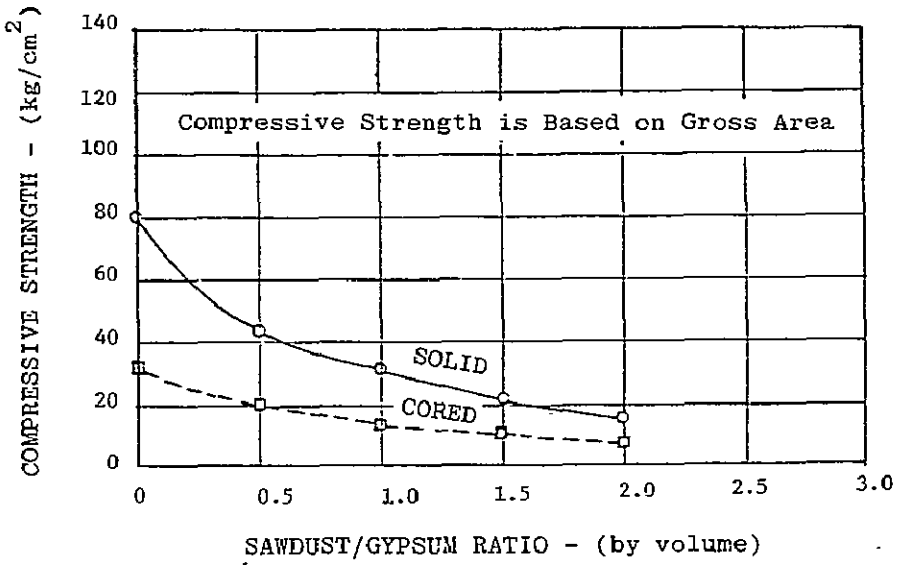


Fig. (II-5) - Effect of Sawdust/Gypsum Ratio on Compressive Strength of Solid and Cored Gypsum Blocks.

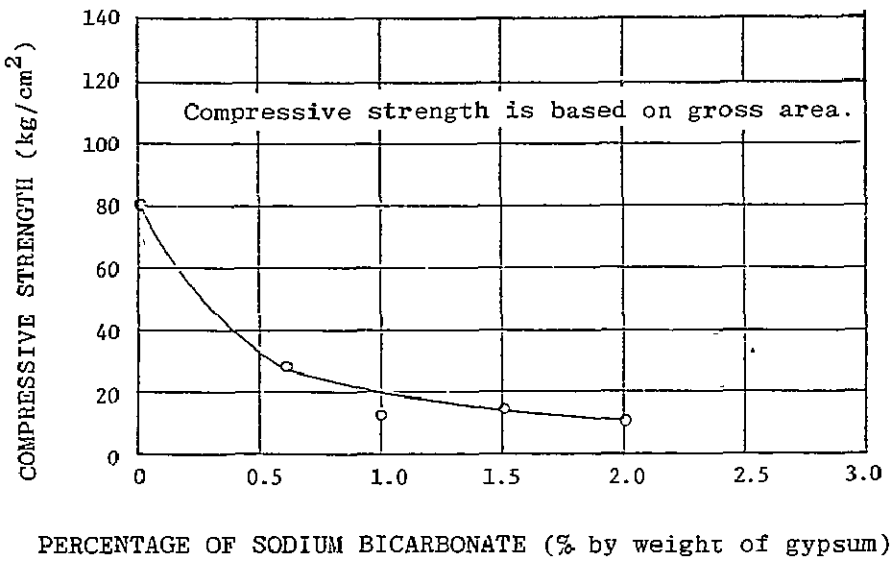


Fig. (II-7) - Effect of Percentage of Sodium Bicarbonate on Compressive Strength of Foamed Gypsum Solid Block.

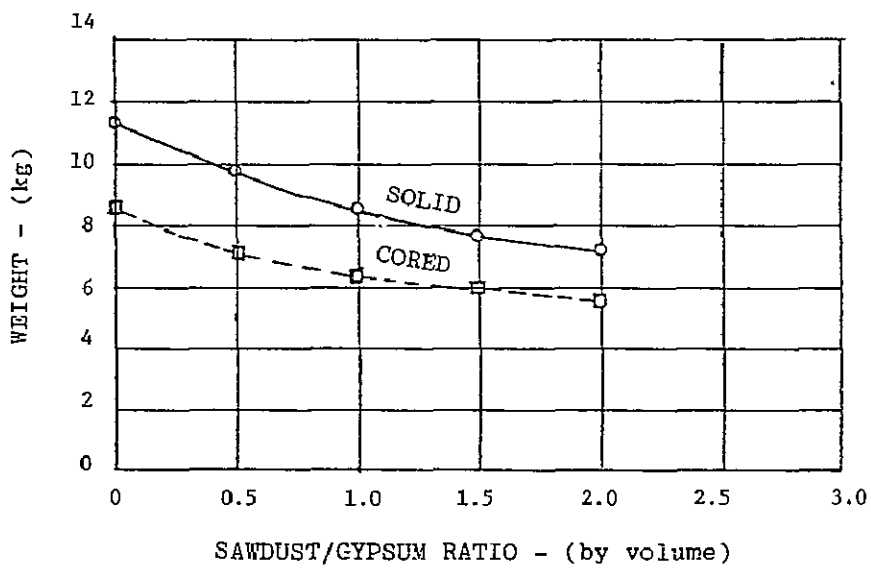


Fig. (II-6) - Effect of Sawdust/Gypsum Ratio on Dry Weight of Solid and Cored Gypsum Blocks

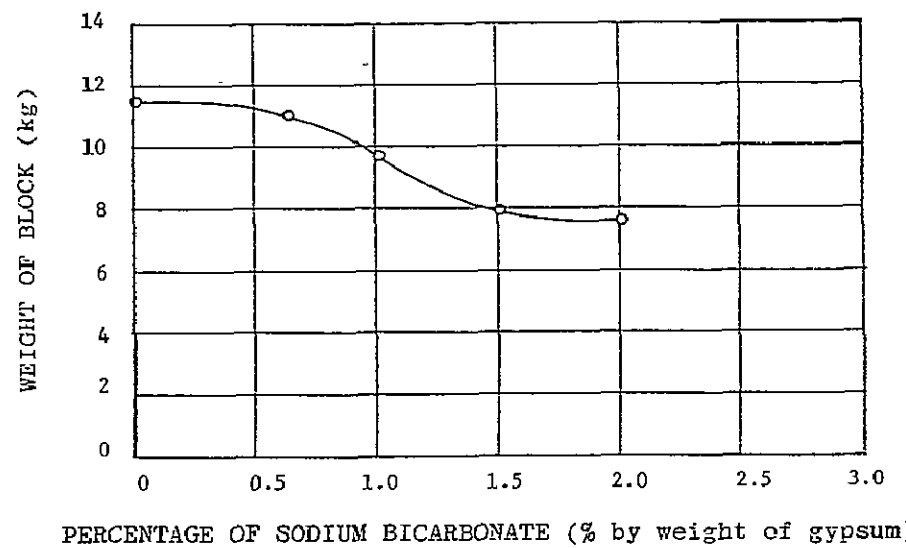


Fig. (II-8) - Effect of Percentage of Sodium Bicarbonate on Dry Weight of Foamed Gypsum Solid Blocks

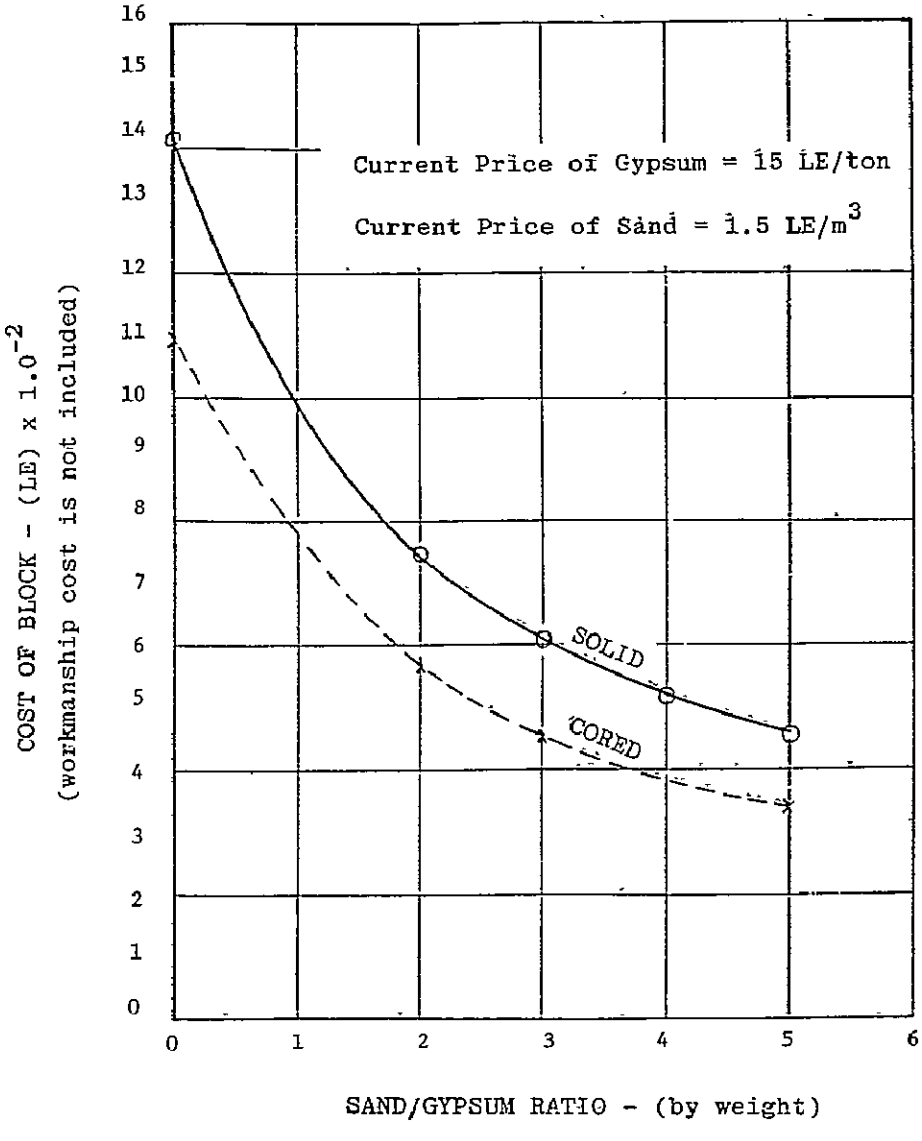


Fig.(II-9) - Effect of Sand/Gypsum Ratio on Cost of Solid and Cored Gypsum Block 29 x 29 x 10 cm

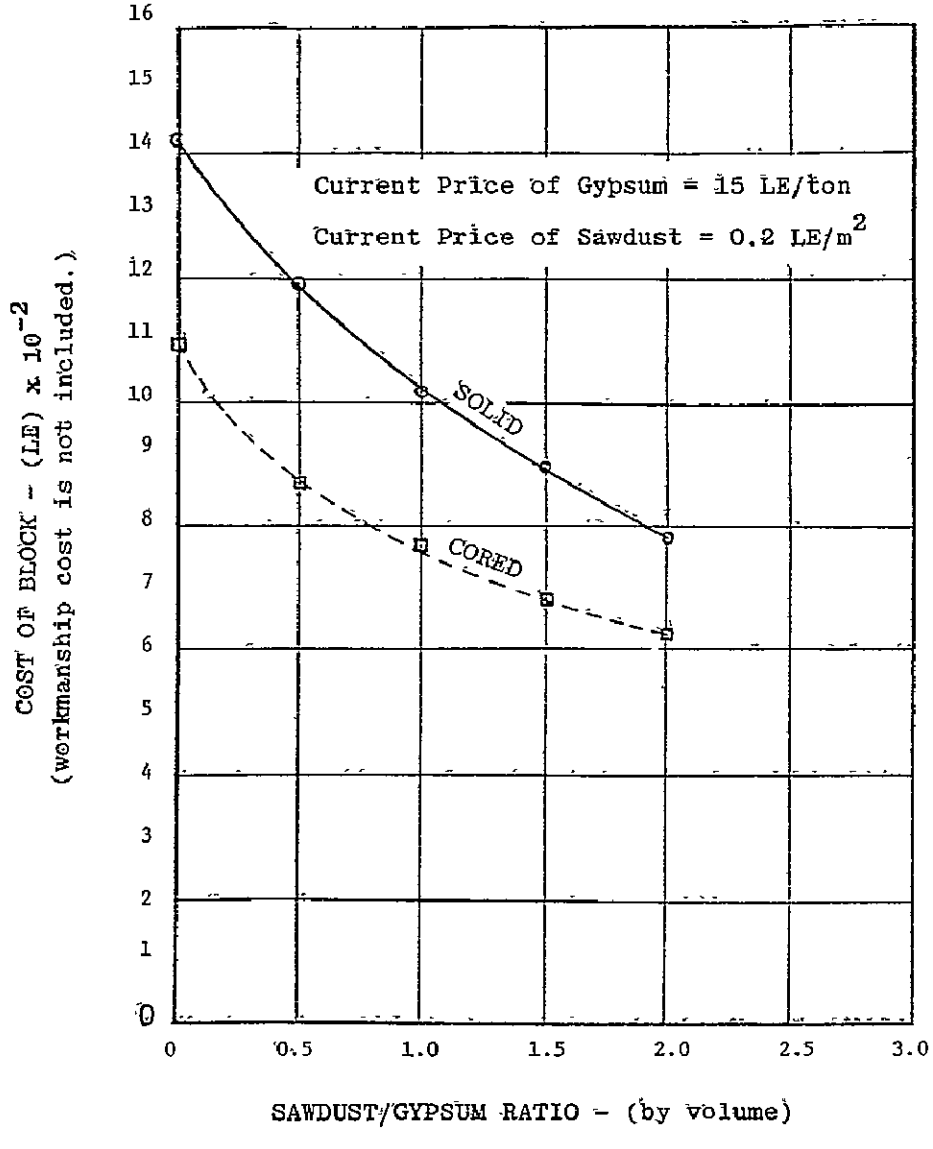


Fig.(II-10)-Effect of Sawdust/Gypsum Ratio on Cost of Solid or Cored Gypsum Block 29 x 29 x 10 cm

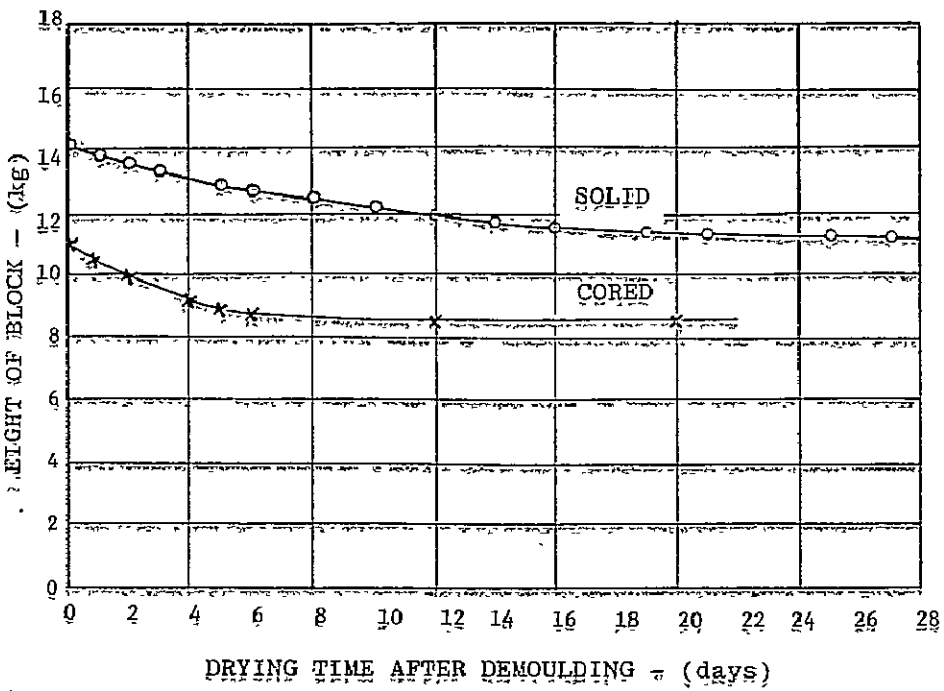


Fig.(II-11)- Decrease in Weight of Solid and Cored Pure Gypsum Blocks with Drying Time.

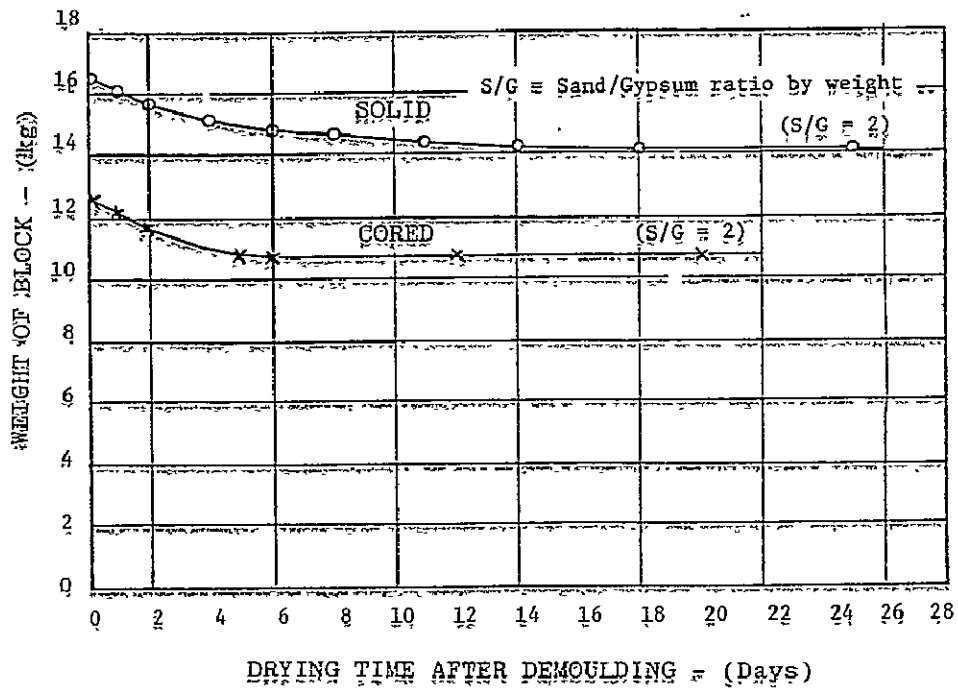


Fig.(II-12)- Decrease in Weight of Solid and Cored Gypsum Blocks with Sand as a Filter as Affected by Drying Time

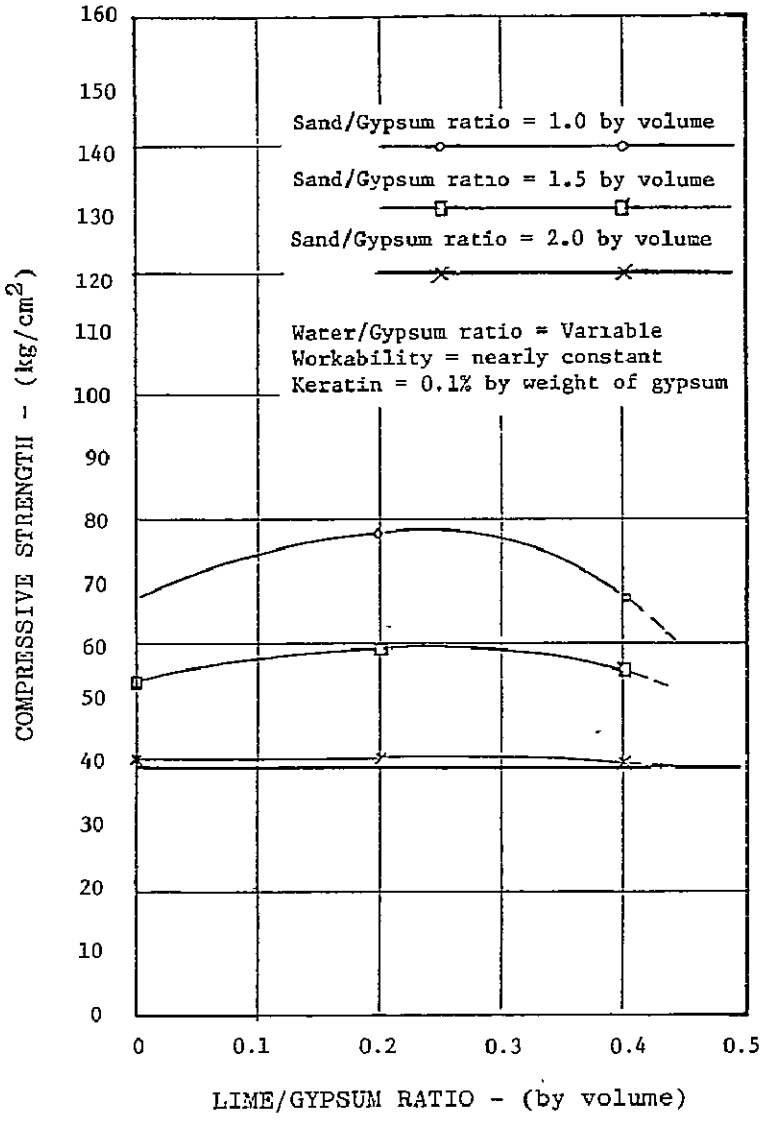


Fig.(II-13)- Effect of Lime/Gypsum Ratio by Volume and Sand/Gypsum Ratio by Volume on the Compressive Strength of Gypsum Mortar

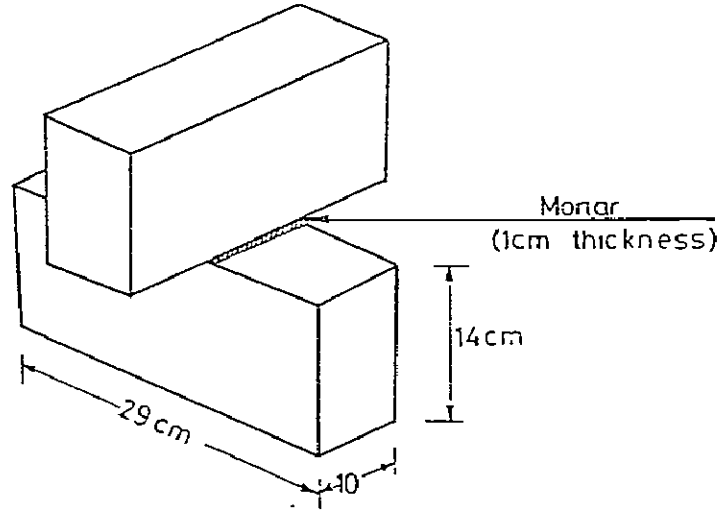


Fig.(II-14)- Bond Strength Test Samples

Table(II- 3)-Test Results of Wall Samples Loaded in Combined Compression and Flexure

Type of Wall Blocks	Wall Sample Number	Average Overall Dimensions			P/P_o *	Maximum Compressive Load P (kg)	Maximum Bending Moment (kg.cm)	Ultimate Compressive Stress (kg/cm^2)	Ultimate Flexural Stress (kg/cm^2)	Remarks
		Height (cm)	Width (cm)	Thickness (cm)						
Gypsum Load-Bearing Blocks (plane connections)	P1	120.0	59.0	10.0	1	18,500	0	31.4	0	Vertical crack through wall
	P2	120.0	59.0	10.0	1	21,000	0	35.0	0	Vertical crack in upper row only
	P3	120.0	60.0	10.0	0.71	14,000	28,675	23.33	28.68	Horizontal failure at mid height
	P4	120.0	60.0	10.0	0.41	8,100	32,250	13.33	32.35	Ditto
	P5	120.0	59.0	10.0	0.28	5,500	27,750	9.17	28.22	Ditto
	P6	120.0	60.0	10.0	0	0	4,625	0	4.62	Horizontal split at mid height bet. block and mortar
Gypsum Load-Bearing Blocks (groove and tongue)	G1	120.0	60.0	10.0	1	23,000	0	38.33	0	Vertical crack in upper row only
	G2	120.0	60.0	10.0	0.5	11,500	31,450	19.17	31.45	Horizontal failure at mid height
	G3	120.0	60.0	10.0	0	0	4,440	0	4.44	Horizontal split at mid ht. between block and mortar
Cored Gypsum **	C1	120.0	60.0	10.0	0	0	4,625	0	4.63	Horizontal split at mid ht. between block and mortar
Traditional Red Bricks	R1	120.0	60.0	12 0	1	10,600	0	17.72	0	Vertical crack through wall
	R2	120.0	60.0	12.0	0	0	2,405	0	2.89	Horizontal split at mid ht. between block and mortar
Sand-lime Bricks	S1	120.0	60.0	12.0	1	18,500	0	25 69	0	Vertical crack through wall

* P/P_o = ratio of applied compressive load to the ultimate pure compressive load

** Non-bearing blocks.

Table (II-4) Characteristics of Block Types Used in Tests

Type of Block	Weight (kg)	Average Overall Dimensions			Weight/ Volume (kg/m^3)	Ultimate Compressive Strength (kg/cm^2)
		Length (cm)	Width (cm)	Height (cm)		
Load-bearing Gypsum Block	14.45	29.0	10.0	29.0	1718.1	48.0
Cored Non-bearing Gypsum Block	6.50	29.0	10.0	29.0	772.8	15.5*
Traditional Red Brick	2.62	24.0	12.0	6.0	1516.2	37.3
Sand-Lime Brick	3.22	24.0	12.0	6.0	1863.4	171.3

*Based on gross area of cored block.

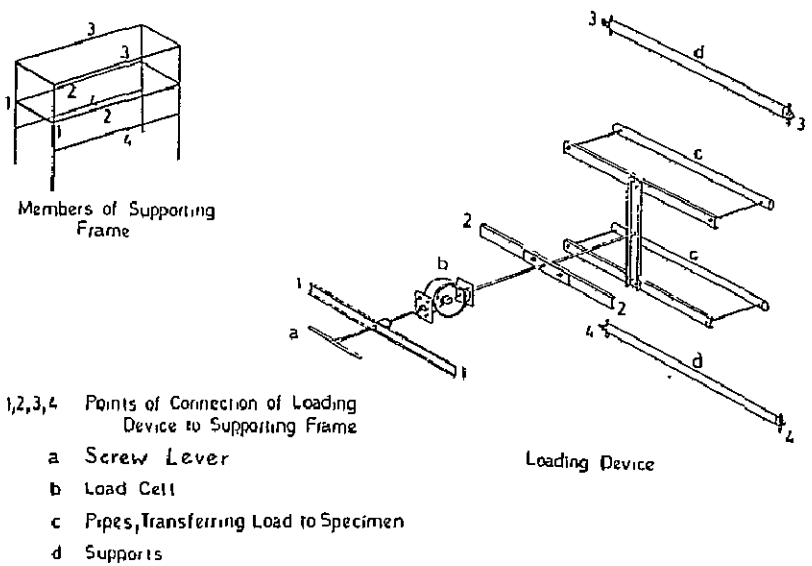


Fig. (II-15) Schematic Sketch of Loading Test Set-up and Supporting Frame for Flexural Loading on Walls.

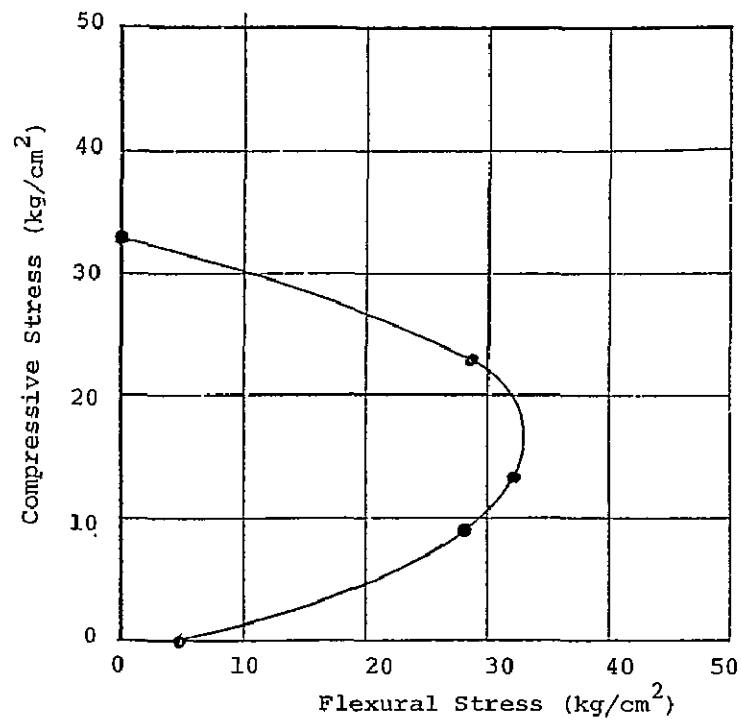


Fig. (II-16) Experimental Compression-Flexure Interaction Diagram for Gypsum Load-Bearing Blocks with Plane Connections.

III. A NEW TECHNIQUE OF SURFACE-BONDING BRICK WALLS FOR HOUSING

1. INTRODUCTION

The conventional technique of brick-wall construction by placing mortar between successive courses of bricks and between individual bricks of the same course, proved to have many disadvantages. On one hand, the erection time including the process of plastering is relatively long, resulting in less productivity of labor. Considerable amounts of cement are consumed in binding mortar and trowelled plaster, raising final cost. Furthermore, the mortar used usually has low strength properties and poor adhesion to the masonry bricks, affecting the service life and bearing capacity of the resulting wall.

Many trials were made, therefore, to replace this conventional technique of construction by newly-developed methods. The new technique of surface-bonding of masonry units utilizes a surface-bonding cement mortar or a sulfur-based mixture to bond the bricks together in one step.

The main goal of the undertaken study described below was to investigate the possibility of adapting the new technique of surface-bonding for the construction of brick walls and partitions for housing using available indigenous materials, in an effort to overcome the different disadvantages of the conventional construction technique.

2. OBJECTIVES

To achieve the ultimate goal of the study, the following main objectives were set forth :

a) To recommend a new mix of appropriate local materials as a surface bonding mortar achieving desired strength characteristics and reasonable saving in cost.

b) To investigate the suitability of locally-available jute and sisal fibers as reinforcement added to the surface-bonding mortar mix.

c) To study the main characteristics of surface-bonded brick walls as expressed by their compressive, flexural and impact strengths.

d) To undertake a comparative study and cost analysis between surface-bonded walls of sand-lime or shale bricks and conventional red brick walls.

e) To conduct a limited preliminary study to investigate the suitability of utilizing sulfur as a surface bonding material.

3. RESEARCH PROGRAM

The research program was divided into three main stages. In the first stage, the work was devoted to the study of different characteristics of trial mixes of mortar to determine the most suitable mix for use as a surface bonding material. The second stage was concerned with the study of the effects of incorporating reinforcing fibers in the mortar on the resulting characteristics. The third stage included the study of the main properties of the types of bricks used and the behavior of brick walls built both by conventional methods and surface-bonding technique.

3.1 Preliminary Test Program On Plain Mortar

The following were considered the main requirements that need to be fulfilled by the most-suitable surface bonding mortar :

- Adequate strength in tension, flexure, compression and impact;
- Sufficient bond strength between mortar and bricks;
- Good workability during mixing of the ingredients;
- Reasonable cost;
- Water proofing as much as possible.

Trials were first made on plain mortar without fibers and the effects of varying the ratios of cement to sand, lime to cement, and the type of cement, were studied on the resulting compression, tensile and flexural strengths of mortar.

All tests were carried out on two types of Egyptian cement, namely ordinary portland and slag cements. Three ratios of sand to cement by weight were used: 0.0, 0.5, and 1.0. No lime was added to slag-cement mortar. For ordinary cement, however, four ratios of lime to cement were used: 0.0, 0.1, 0.2 and 0.4 by weight. The water to cement ratio by weight necessary to give the desired workability was kept constant for all mixes and was 0.40. Sand used in all mixes passed sieve No. 14.

Cubes 7x7x7 cm for compression test, standard briquettes for tension test, and beams 4x4x16 cm for flexure test were cast from each trial mix, demolded after 24 hours, then left in a humid atmosphere for 7 days before testing. Beam specimens were tested on a span of 12 cm using one central load.

The obtained test results shown in Figs. (III-1) to (III-6) indicated the following :

1. Increasing sand to cement ratio from zero to 1.0 decreased the resulting compressive strength of mortar by about 25% to 37%, depending on the ratio of lime added.

2. Increasing lime to cement ratio from zero to 0.1 decreased the compressive strength by about 30%, and the increase of lime ratio to 0.40 resulted in as high as 70% decrease in the compressive strength.
3. Compressive strength of mortar tend decrease significantly by increasing both sand and lime in the mix.
4. A decrease in tensile strength of mortar of about 45% was recorded for an increase of lime to cement ratio from zero to 0.40. The corresponding decrease in tensile strength due to increasing sand to cement ratio from zero to 1.0 was only about 20%.
5. In mixes without lime, slag cement gave lower values for the tensile and flexural strengths of mortar than those of ordinary portland cement for the same sand to cement ratios.
6. Increasing lime to cement ratio from zero to 0.40 decreased the flexural strength by up to 53%.
7. An increase in sand to cement ratio from zero to 1.0 decreased the flexural strength by up to 32%.

Based on the above inferences, it was recommended to use a mortar mix with the following proportions by weight :

Cement		Sand		Water
1.0	:	1.0	:	0.4

This mix proved to give acceptable results in compressive, tensile and flexural strengths as well as desired workability.

3.2 Test Program On Fiber-Reinforced Mortar

The intention was to replace the expensive imported fiber glass, which is usually used elsewhere as the reinforcement for mortar, by indigenous materials that are commercially available and of low cost. Sisal and jute were the two kinds of fibers chosen for this study.

The parameters studied were length of fiber, percentage of fiber by volume, and percentage of a water-repellent agent (Bara) added to the mix to decrease permeability. The effects of different parameters on compressive, tensile, flexural, and impact strengths were studied. The mortar mix chosen from the preliminary test program was used in this experimental part after adding the fibers in different percentages by volume varying from 1.0 to 3.0%. Fiber lengths used were 1, 2, 3, and 4 cm.

3.2.1 Compressive strength tests

Specimens used were cubes 7x7x7 cm. The mix was prepared in the following procedure :

1- Cement and sand were mixed for 2 minutes then fibers were added and mixed for one minute.

2- Water was then added and mixing continued for four additional minutes, then molds were filled and vibrated for one minute.

3- The cubes were demolded after 24 hours and all specimens (6 for each group) were left in a humid atmosphere for six days before testing.

Results of tests are shown in Figs. (III-7) to (III-10).

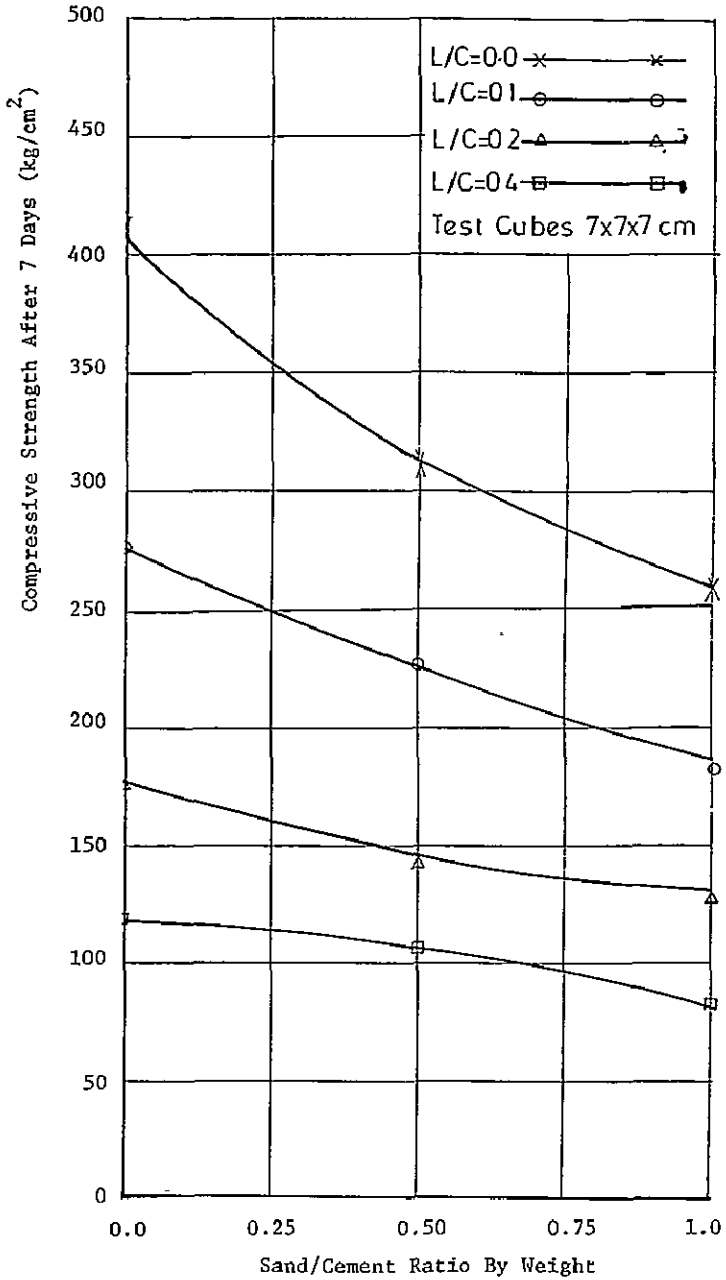


Fig. (III-1)- Effect of Lime/Cement Ratio by Weight on Compressive Strength of Mortar

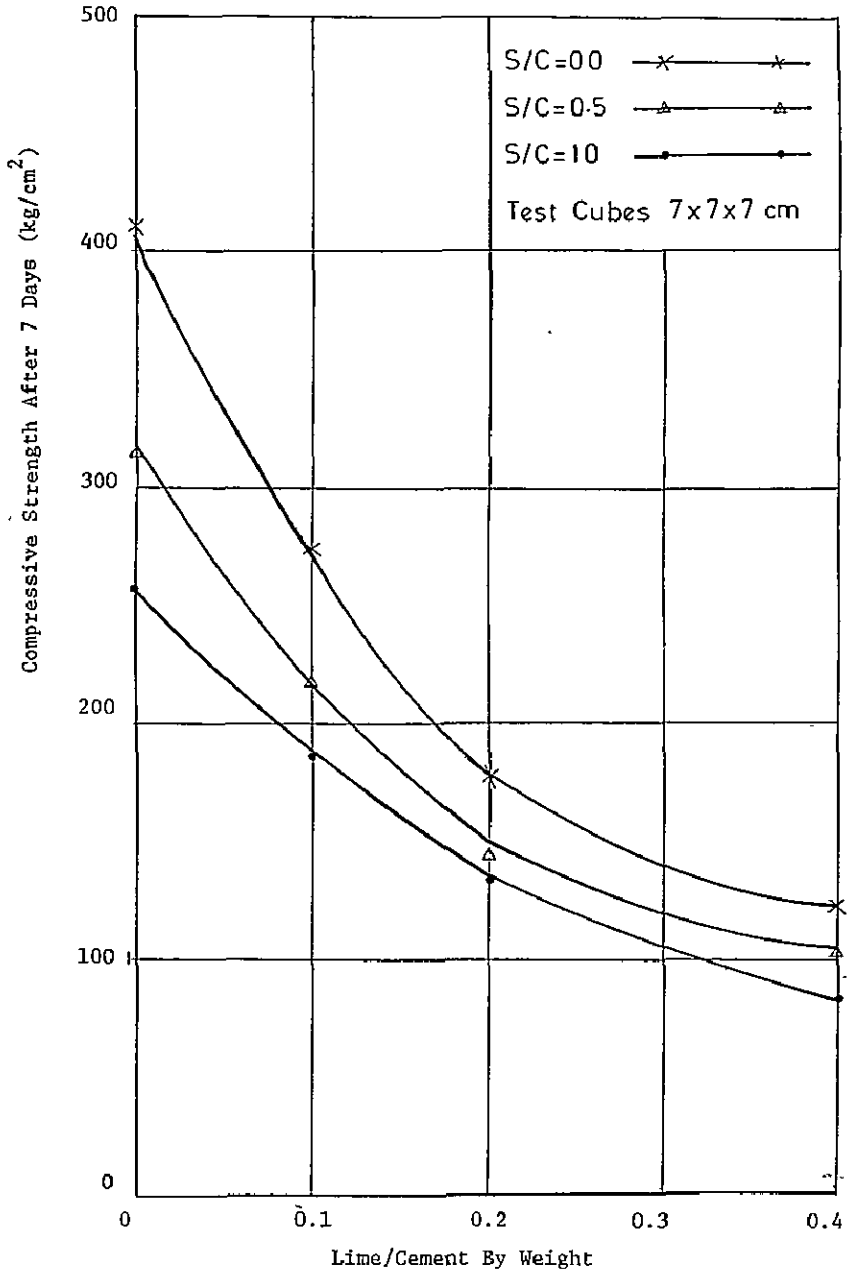


Fig. (III-2)- Effect of Sand/Cement Ratio by Weight on Compressive Strength of Mortar

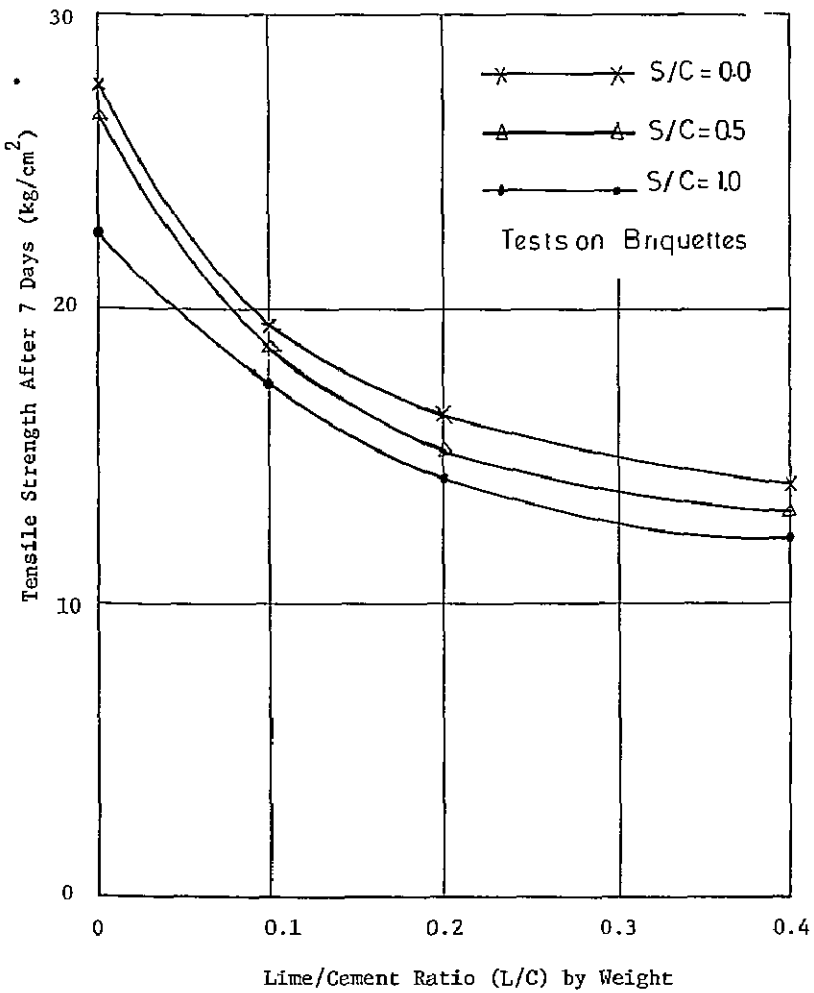


Fig. (III-3) - Effect of Lime/Cement Ratio by Weight on Tensile Strength of Mortar

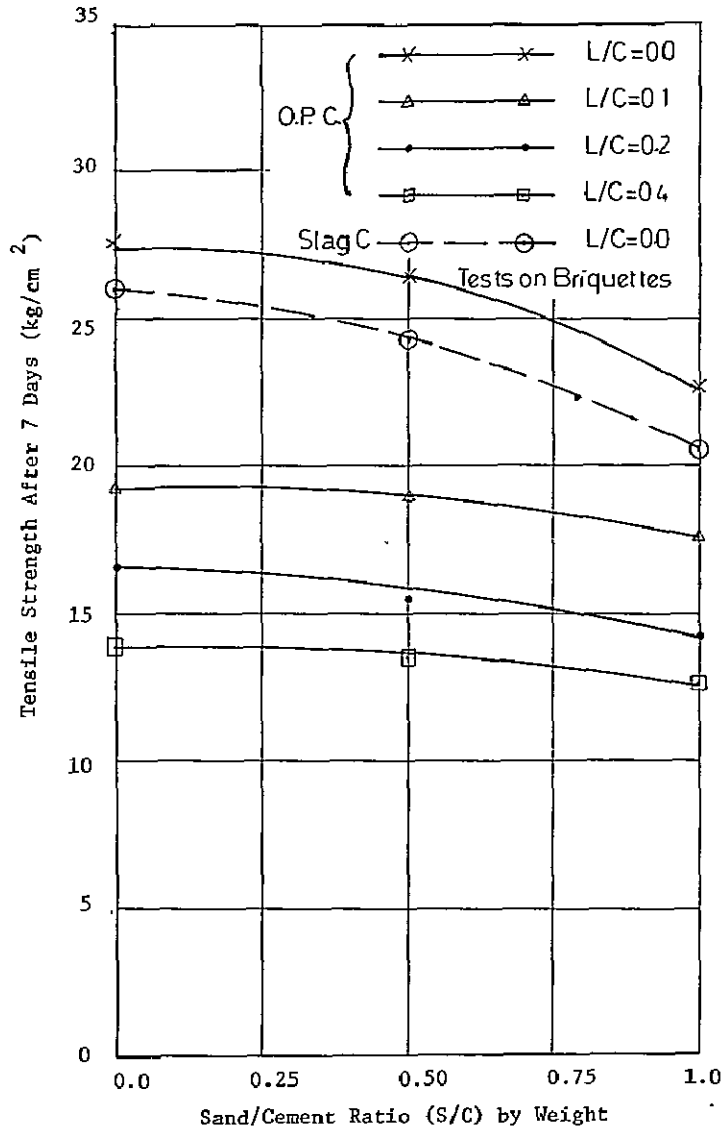


Fig. (III-4) - Effect of Sand/Cement Ratio by Weight on Tensile Strength of Mortar

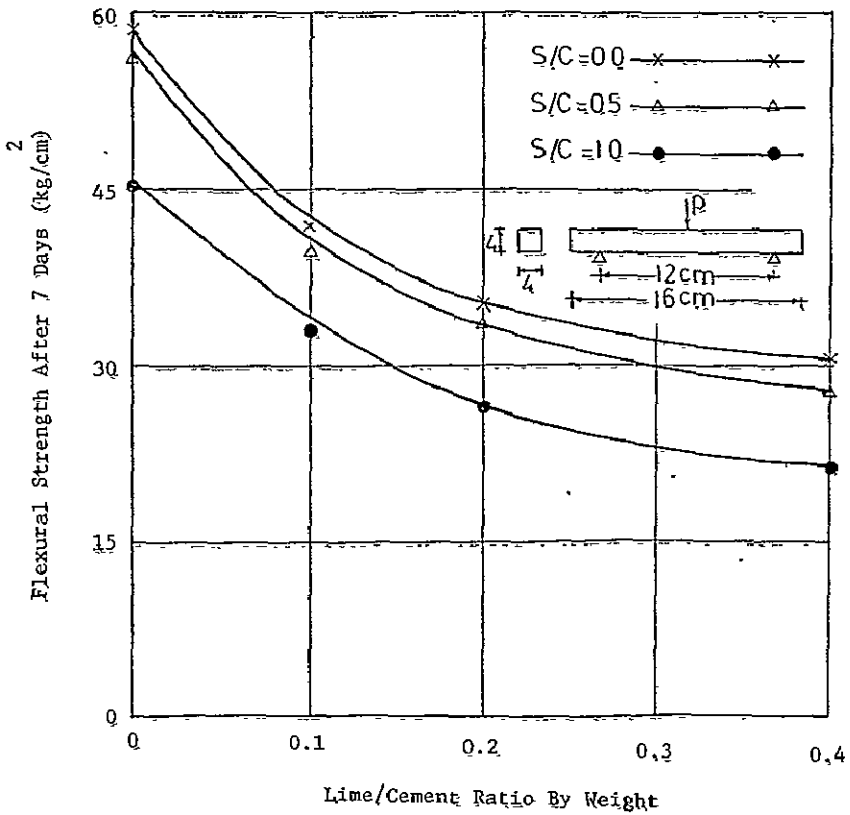


Fig. (III-5) - Effect of Lime/Cement Ratio by Weight on Flexural Strength of Mortar

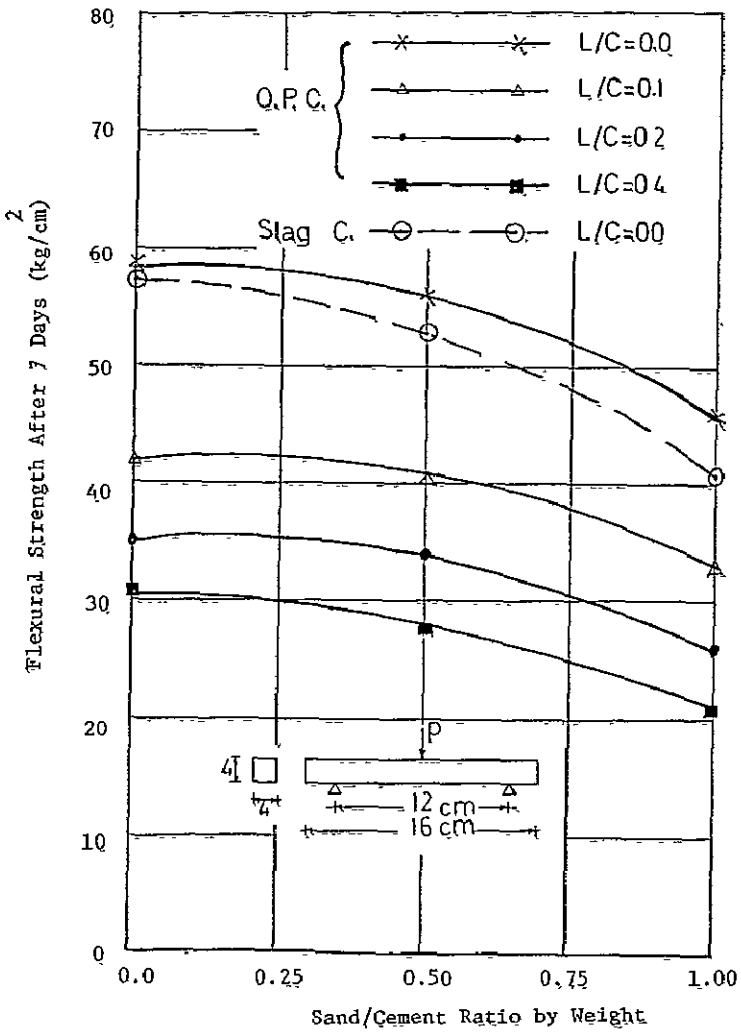


Fig. (III-6) - Effect of Sand/Cement Ratio by Weight on Flexural Strength of Mortar

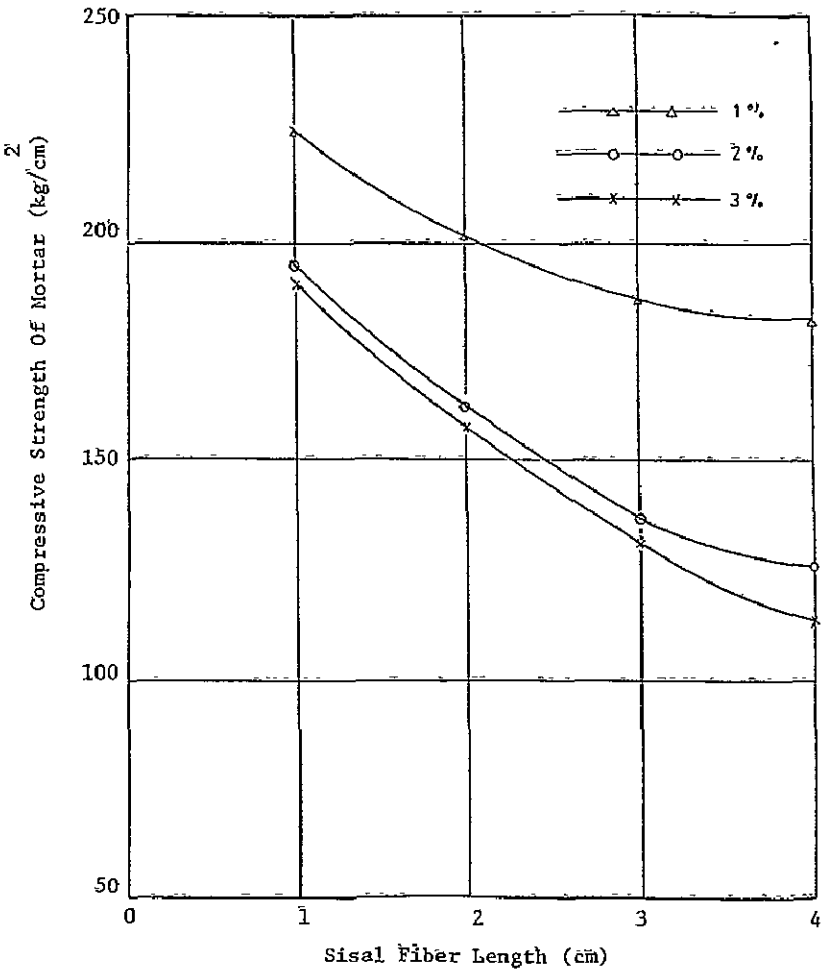


Fig. (III-7) - Effect of Sisal Fiber Length on Compressive Strength of Mortar

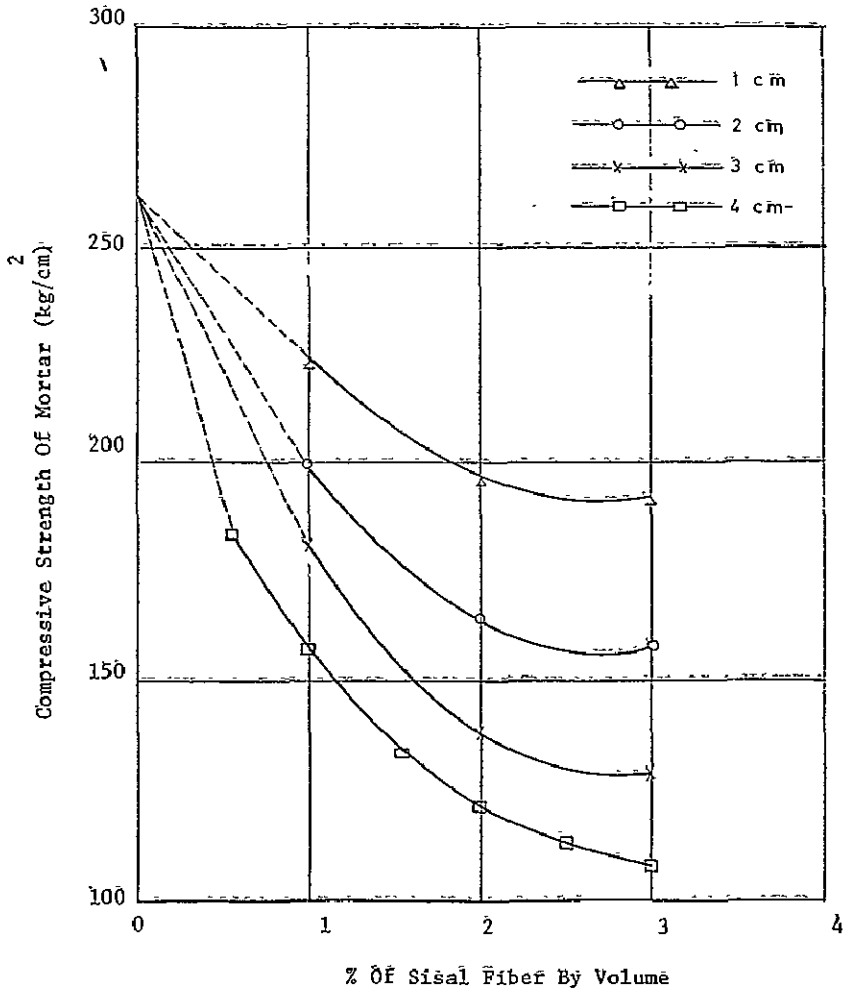


Fig. (III-8)- Effect of Percentage of Sisal Fiber by Volume on Compressive Strength of mortar

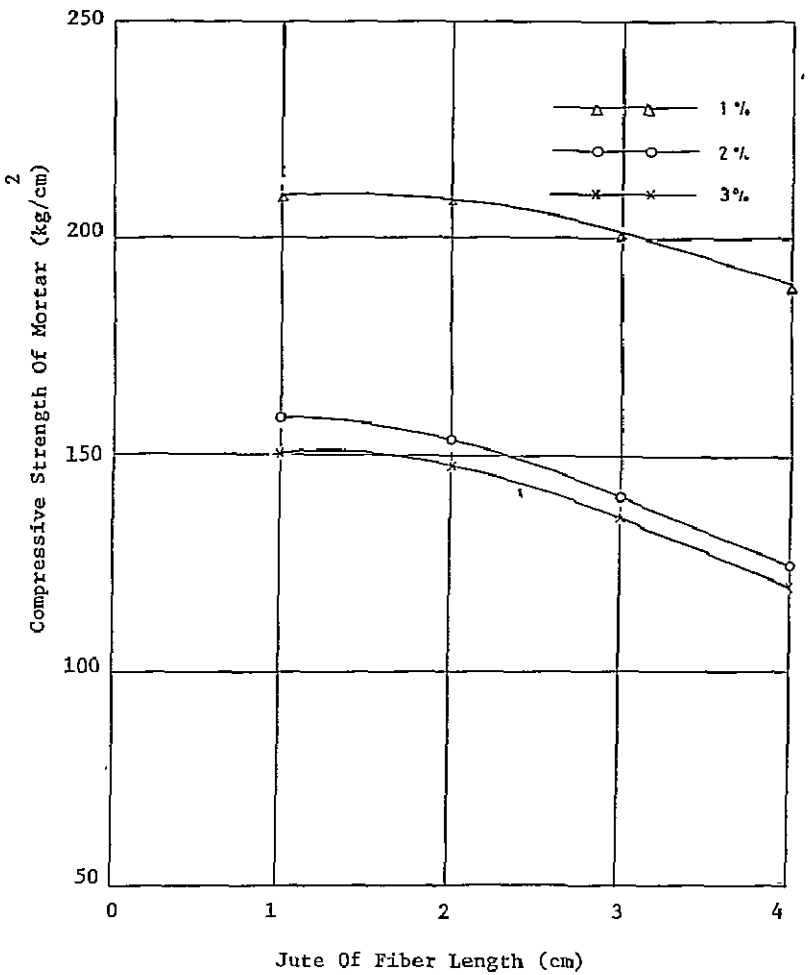


Fig. (III-9)- Effect of Jute Fiber length on Compressive Strength of Mortar

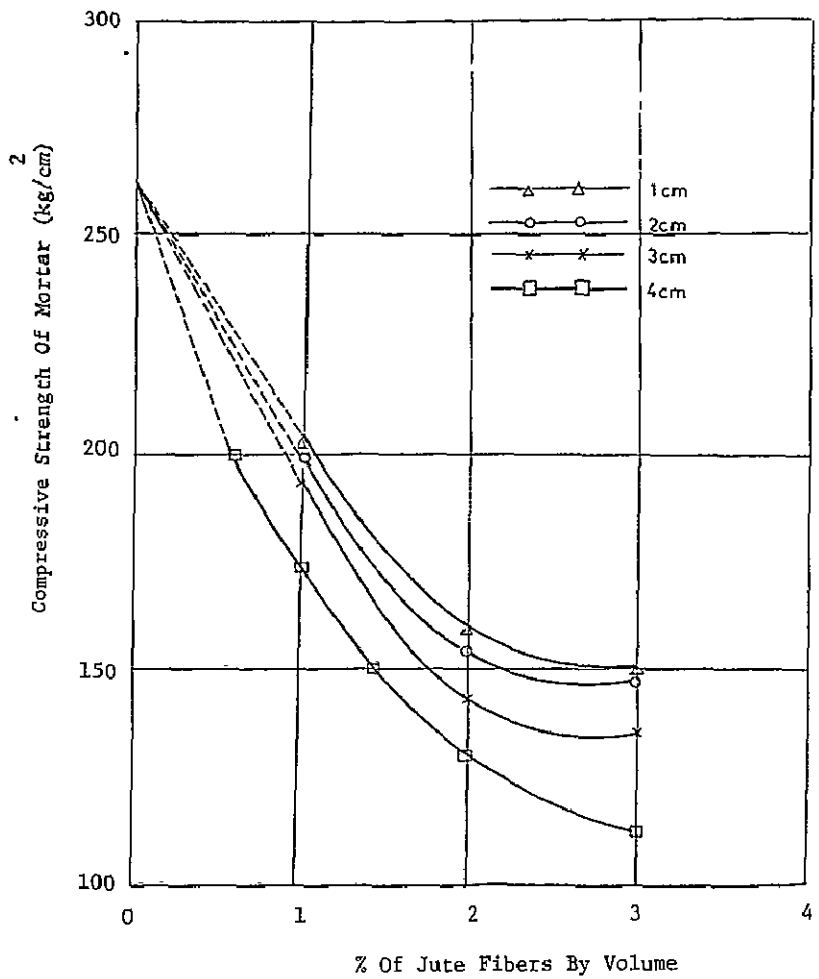


Fig. (III-10)- Effect of Percentage of Jute Fibers by Volume on Compressive Strength of mortar

3.2.2 Tensile strength tests

Wooden forms as shown in Fig. (III-11) were used for casting the tensile test specimens.

The mix was prepared and cast in the same way as for compressive specimens. Bolts fixed to the base were removed after half an hour leaving two holes in the specimen to be used later in fixing to the grips of testing machine. The forms were demolded after 24 hours and specimens were kept in a humid atmosphere for six days before testing.

Results of tensile tests were plotted into curves shown in Figs. (III-12) to (III-15).

3.2.3 Flexural strength tests

Flexural test specimens 5 cm wide, 1 cm thick and 30 cm long were cast in wooden forms and cured in the same manner as the tensile specimens. Each specimen was tested on a 20-cm span using one central load.

Flexural test results are plotted in Figs. (III-16) to (III-19).

The following inferences were drawn from the obtained test results :

1. For both sisal and jute fibers, the resulting compressive strength of mortar was decreased by the increase in fiber length and fiber percentage by volume.
2. Mortars reinforced with sisal fibers exhibited higher values in compression than those for jute fibers.
3. The tensile strength of mortar reinforced with sisal or jute was increased by increasing fiber length.
4. Incorporating fibers in percentages up to 1% increased the tensile strength of plain mortar to almost four times for the case of sisal, and about 2.5 times, when jute was used. Beyond this percentage, however, a remarkable decrease in the tensile strength was recorded for both types of fibers.
5. For the same fiber percentage, increasing the length of sisal fibers increased the flexural strength of mortar, while the opposite was true for jute fibers. This may be attributed to the observed tendency of longer jute fibers to gather and interlock together.
6. Adding fibers in percentages up to 1% increased the flexural strength of plain mortar but to a lesser degree compared to the increase in the tensile strength. Beyond this percentage of fibers, a decrease in flexural strength was recorded for both types of fibers.

Based on the above-drawn inferences, sisal fibers were chosen for further experimental study.

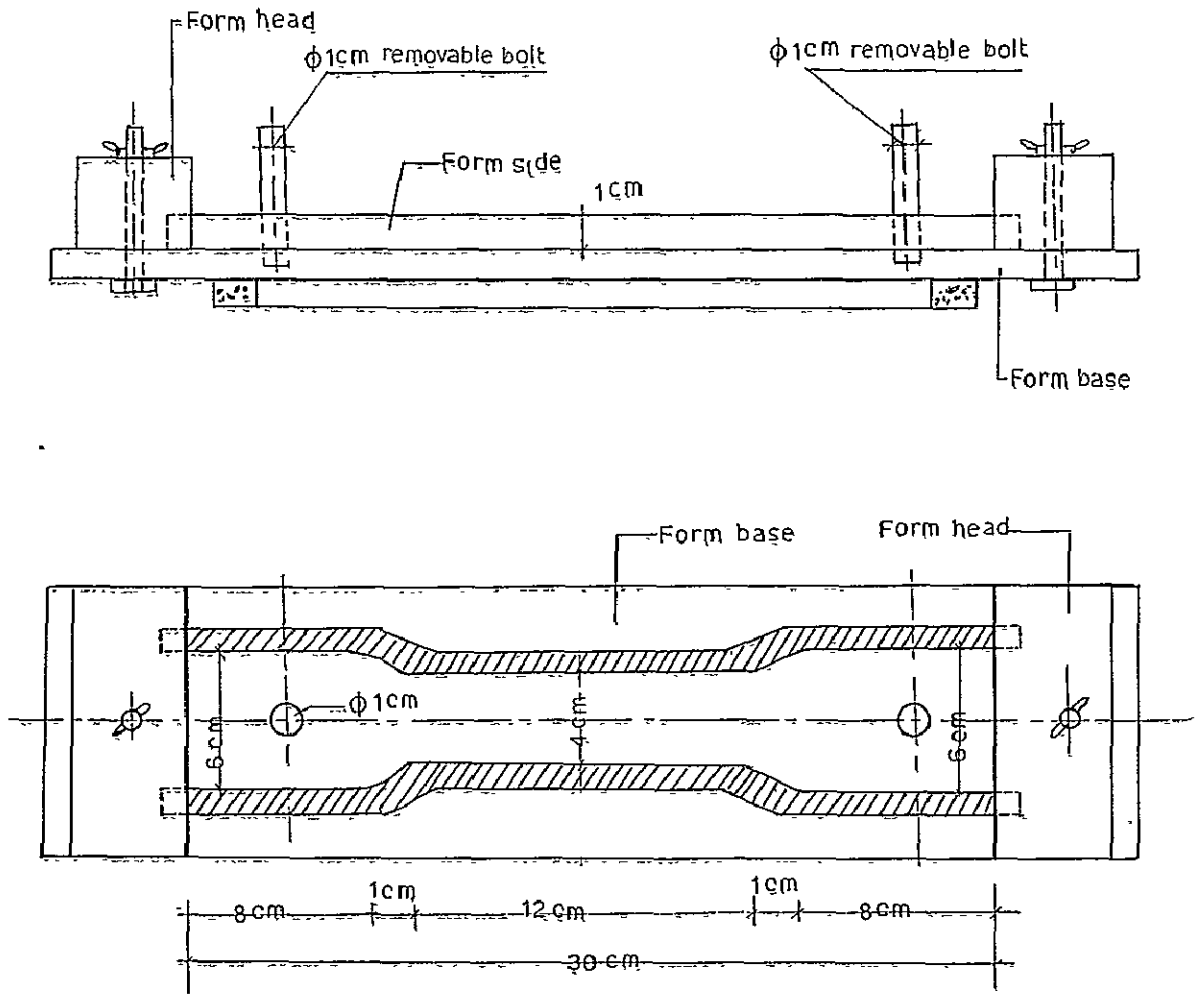


Fig. (III-11)- Form for Manufacturing Tensile Test Specimens

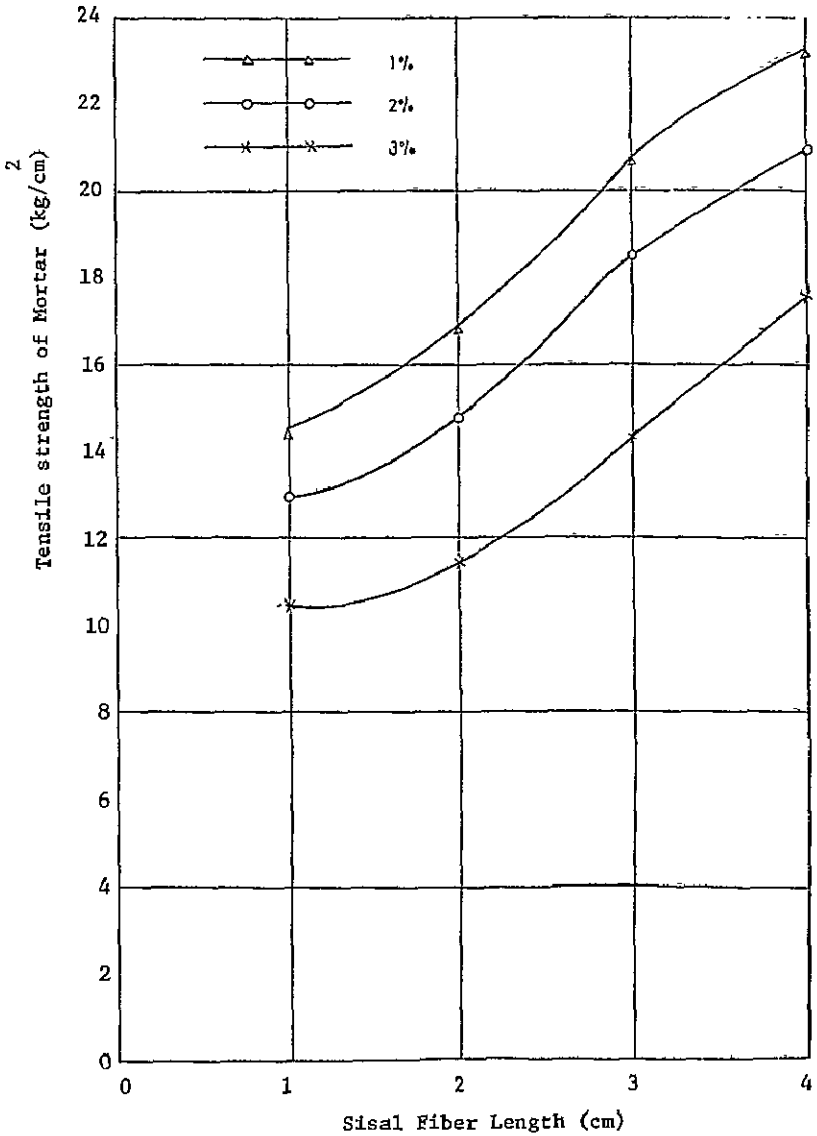


Fig. (III-12)- Effect of Sisal Fiber Length on Tensile Strength of Mortar

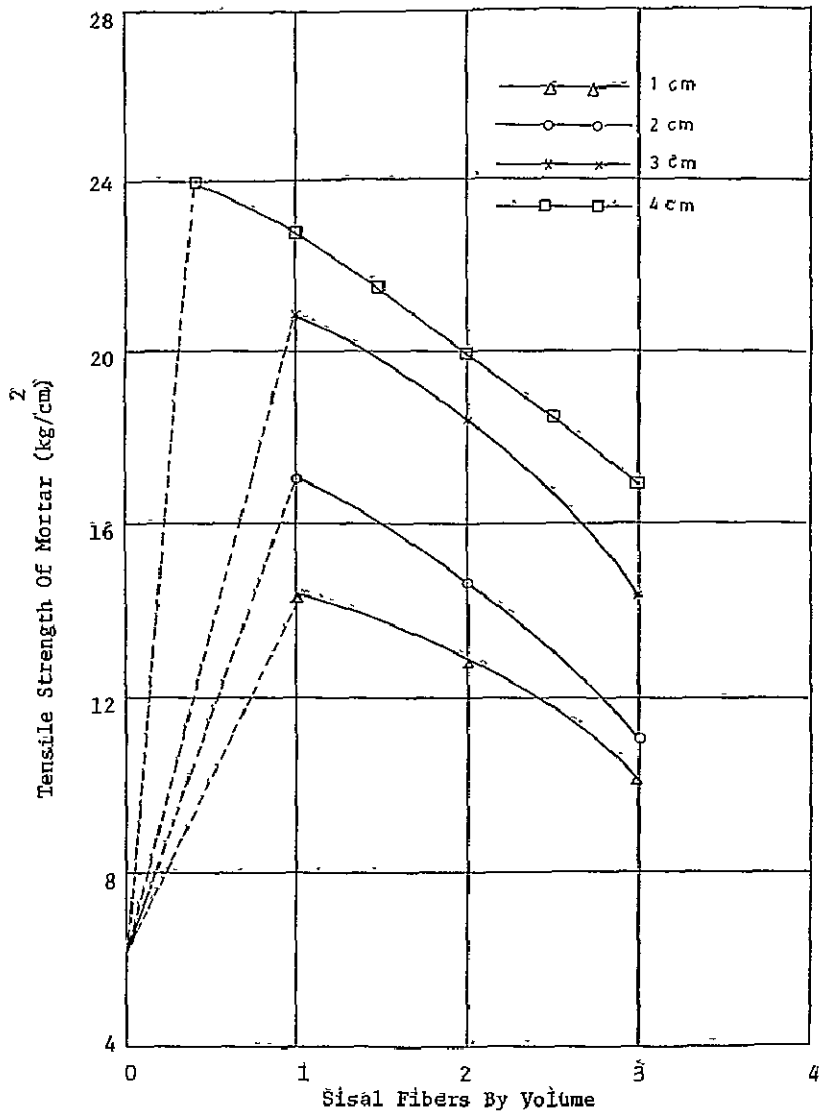


Fig. (III-13)- Effect of Percentage of Sisal Fibers by Volume on Tensile Strength of Mortar

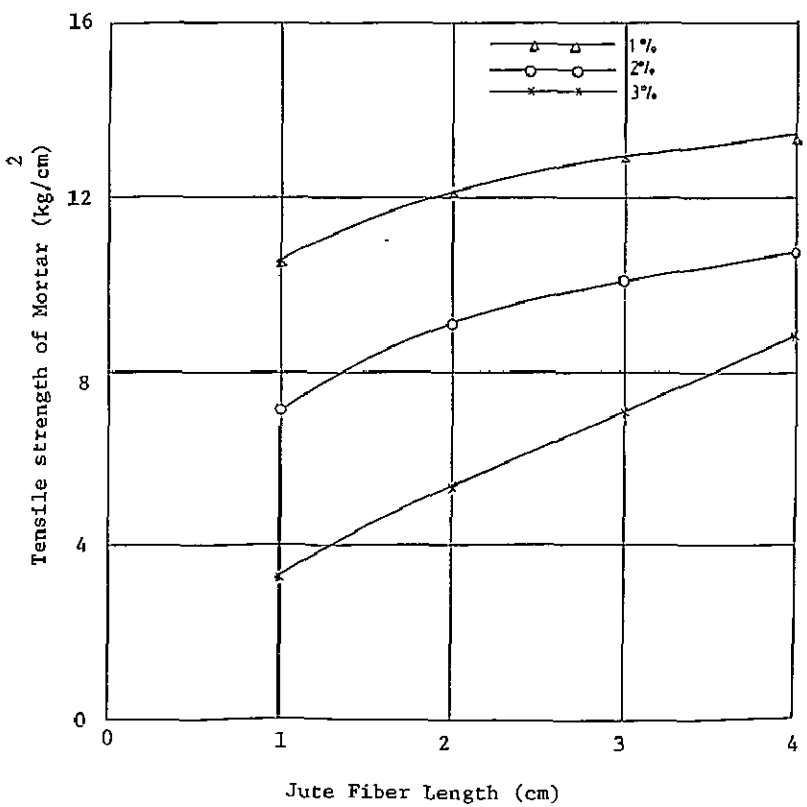


Fig. (III-14)- Effect of Jute Fiber Length on Tensile Strength of Mortar

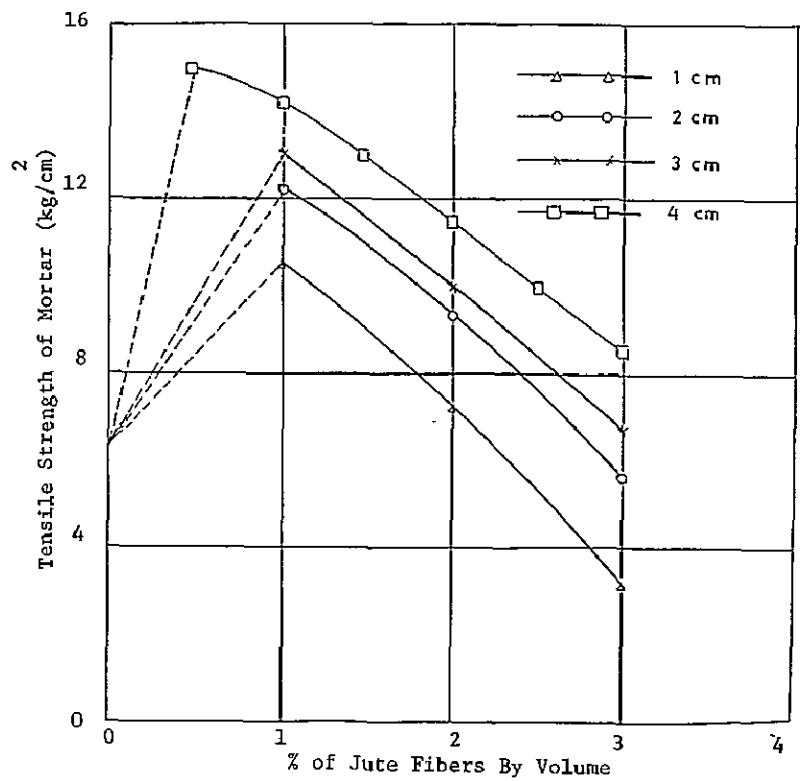


Fig. (III-15)- Effect of Percentage of Jute Fibers by Volume on Tensile Strength of

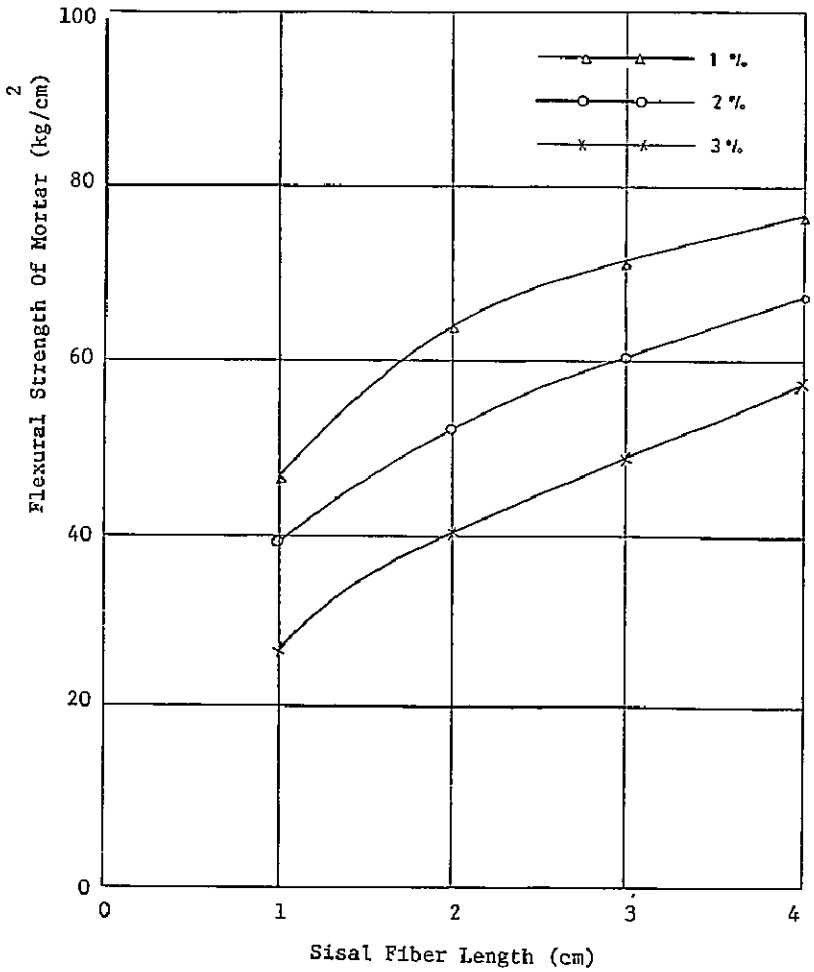


Fig. (III-16)- Effect of Sisal Fiber Length on Flexural strength of Mortar

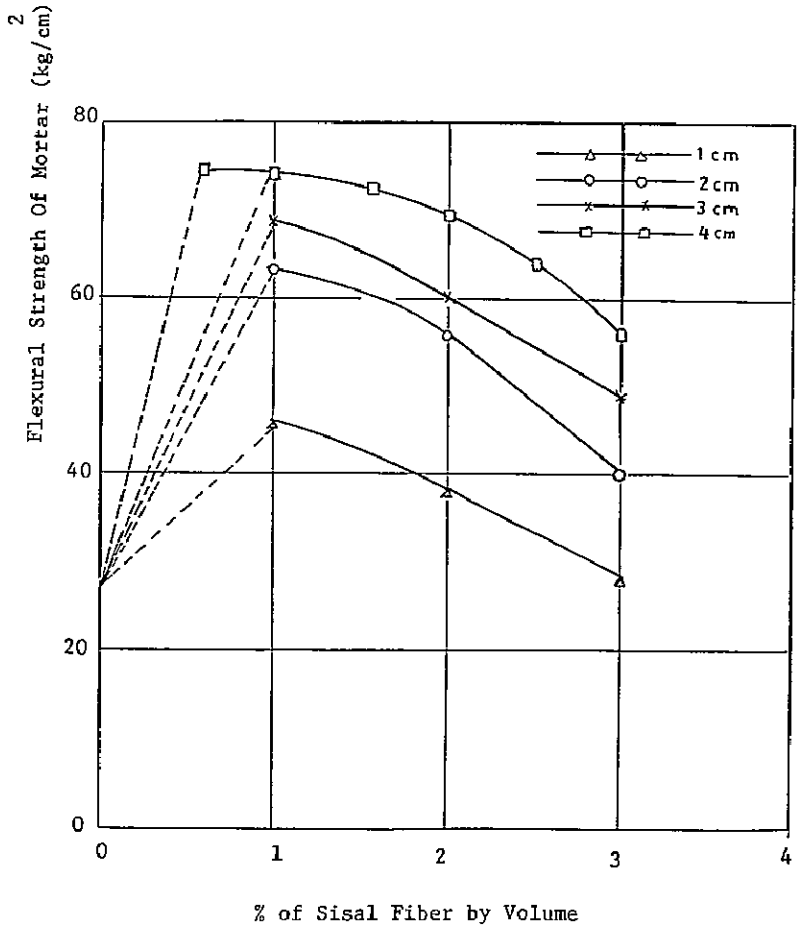


Fig. (III-17)- Effect of Percentage of Sisal Fiber by Volume on Flexural Strength of Mortar

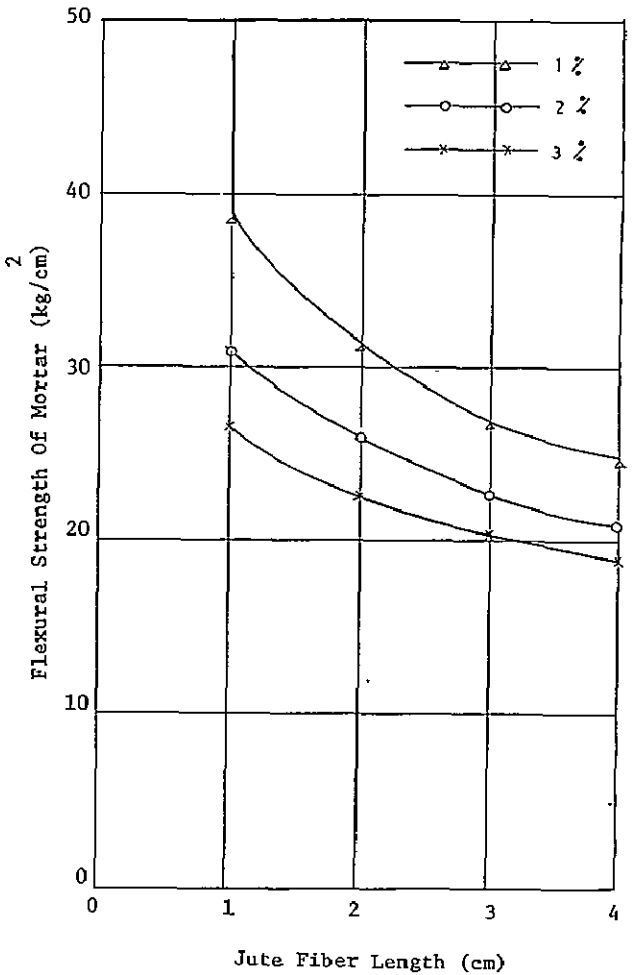


Fig. (III-18)- Effect of Jute Fiber Length on Flexural Strength of Mortar

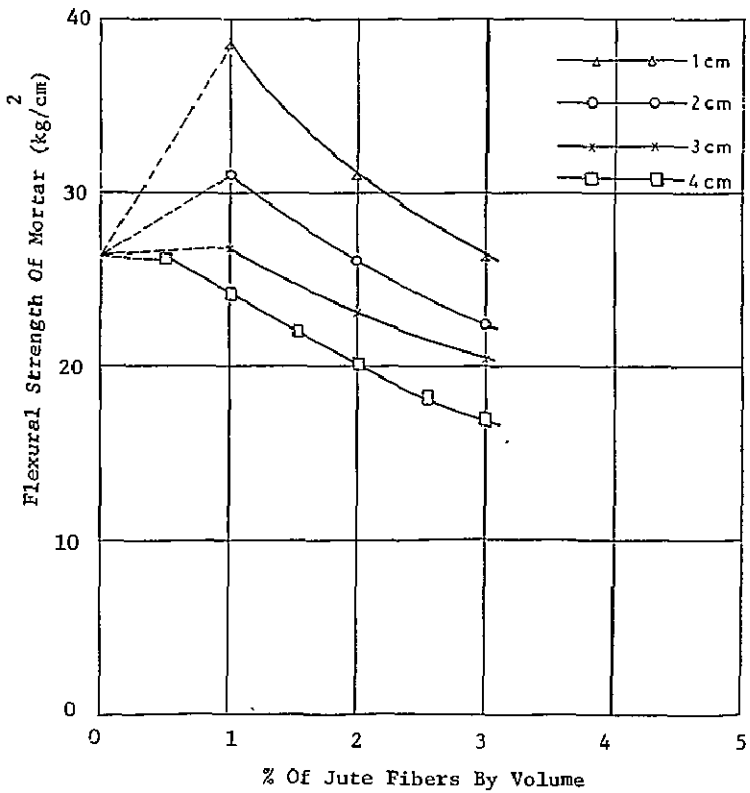


Fig. (III-19)- Effect of Percentage of Jute Fibers by Volume on Flexural Strength of Mortar

3.2.4 Impact strength tests

Impact tests were carried out on plain mortar as well as mortar reinforced with sisal fibers with different fiber lengths varied from 1 cm to 4 cm, and percentages by volume of 1,2 and 3%. Mixing procedure was carried out as previously described. Specimens were 4 X 4 X 16 cm, tested as simple beams with 12 cm span. Impact load acting at mid-span was provided by a steel ball weighing 180 gm, falling freely from a height of 30 cm as shown in Fig. (III-20). The average number of blows causing failure of specimens of each mix was recorded. Results are illustrated in Figs. (III-21) and (III-22).

The impact test results indicated the following :

1. Fiber-reinforced mortar gives higher impact resistance than plain mortar.
2. For the same fiber length, the increase in the percentage of sisal fibers by volume increased the impact strength considerably.
3. The increase in fiber length for the same percentage of fibers by volume caused a considerable increase in the impact strength of mortar .

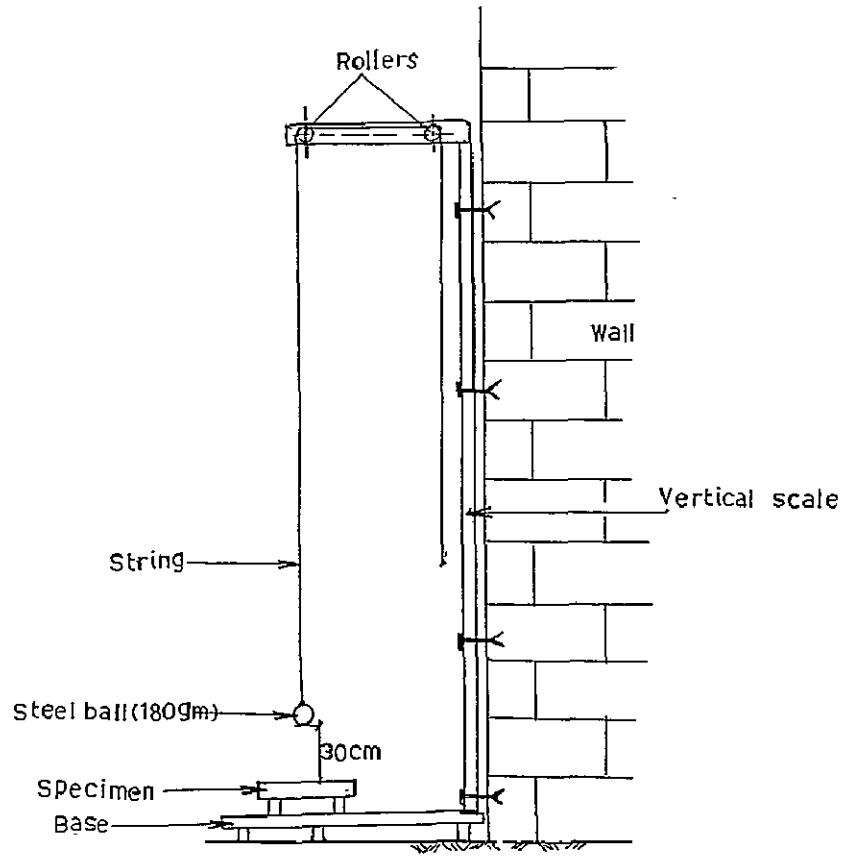


Fig. (III-20)- Arrangement for Impact Test on Mortar

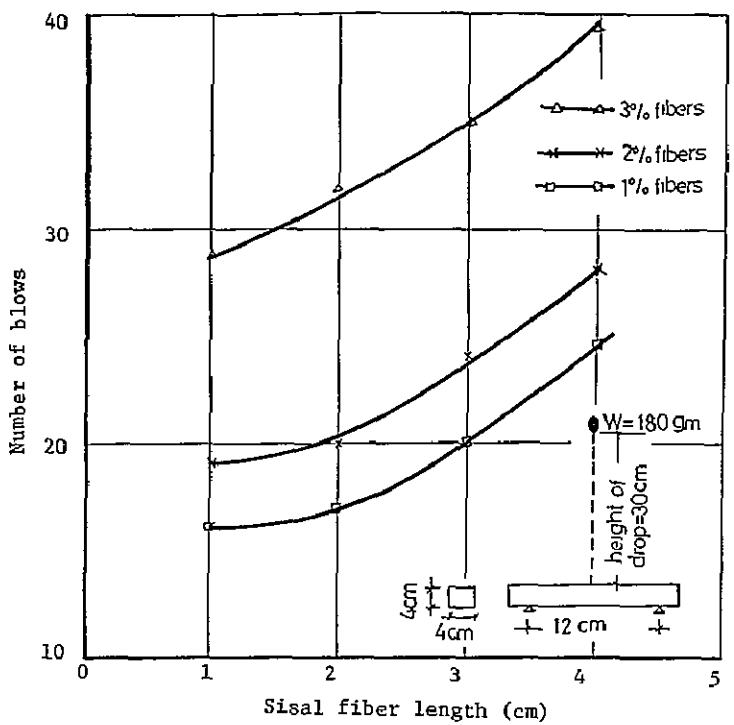


Fig. (III-21)- Effect of Sisal Fiber Length on Impact Resistance of Mortar

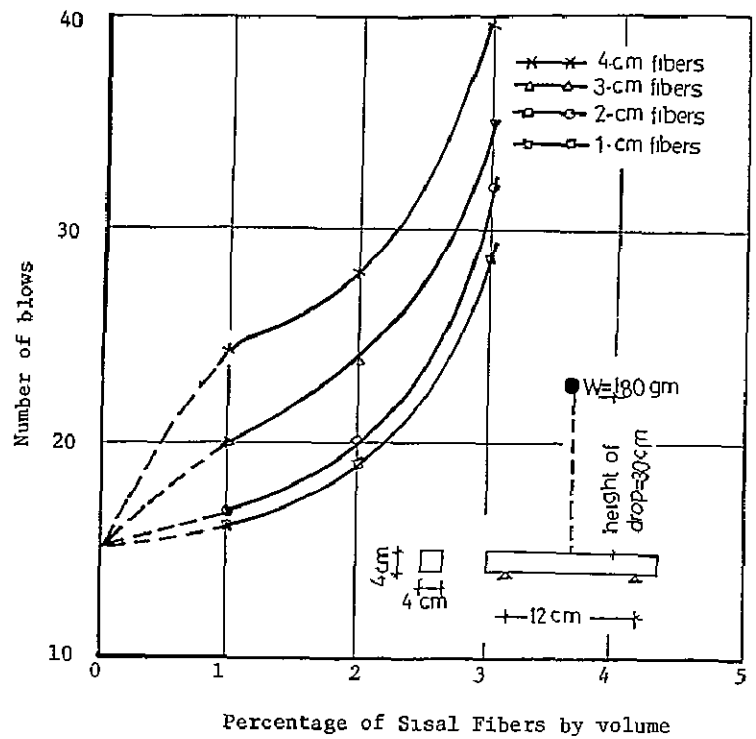


Fig. (III-22)- Effect of Percentage of Sisal Fibers by Volume on Impact Resistance of Mortar

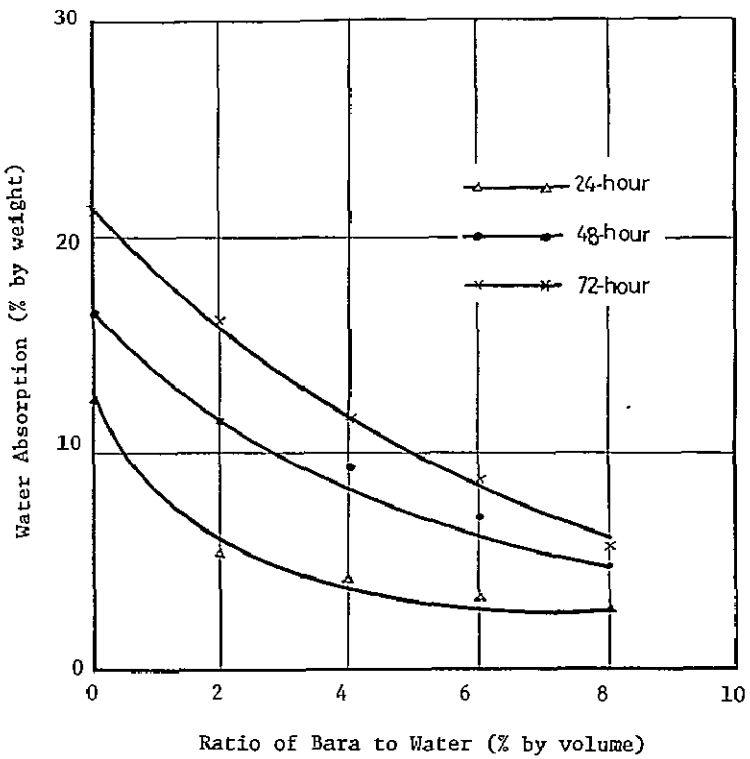


Fig. (III-23)- Effect of (Bara/Water) Ratio on Water Absorption of Mortar

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3.2.5 Effect of addition of water-repellent agent

Based on the results obtained from the previously-described tests, the following mix proportions were decided upon to give a suitable surface-bonding material :

Cement :	Sand :	Water
1.0	1.0	0.40

with sisal fibers of 4 cm length added as 1% by volume.

For this mix, a locally-produced water repellent agent commercially known as Bara was added to mixing water in different percentages by volume of 2, 4, 6, and 8%. For each of these percentages, three groups of test specimens were cast, comprising twelve cubes 7x7x7cm, six standard tensile briquettes and six flexural beam 4x4x4cm. The cubes were divided into two sets; one tested in compression after 7 days, and the other for determining water absorption after submersion in water for 24, 48 and 72 hours.

The effect of the addition of Bara on water absorption of mortar was plotted into curves shown in Fig. (III-23). The corresponding effects on the compressive, tensile, and flexural strengths of mortar are shown in Figs. (III-24) to (III-26).

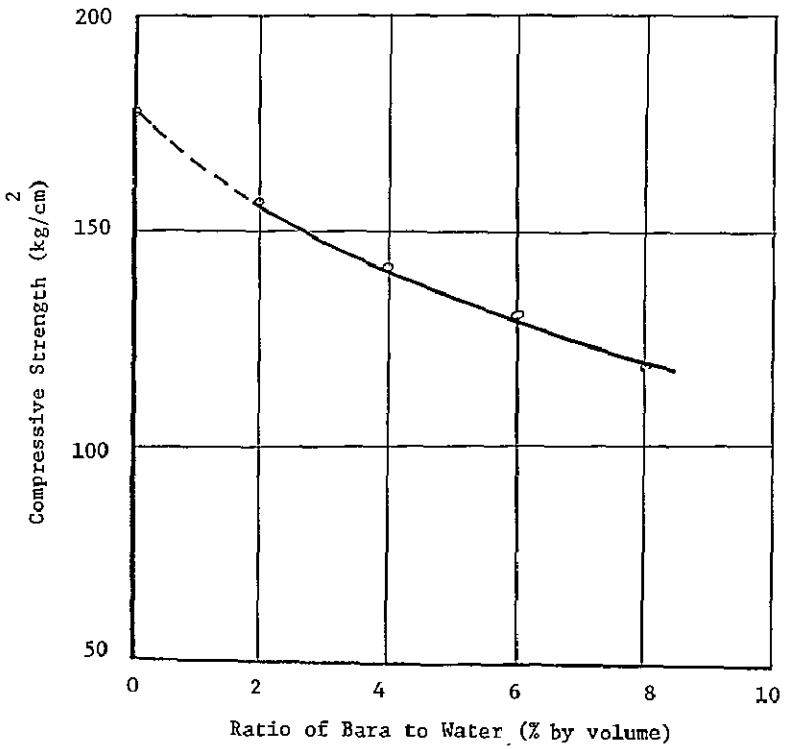

Fig. (III-24) - Effect of (Bara/Water) Ratio on Compressive Strength of Mortar

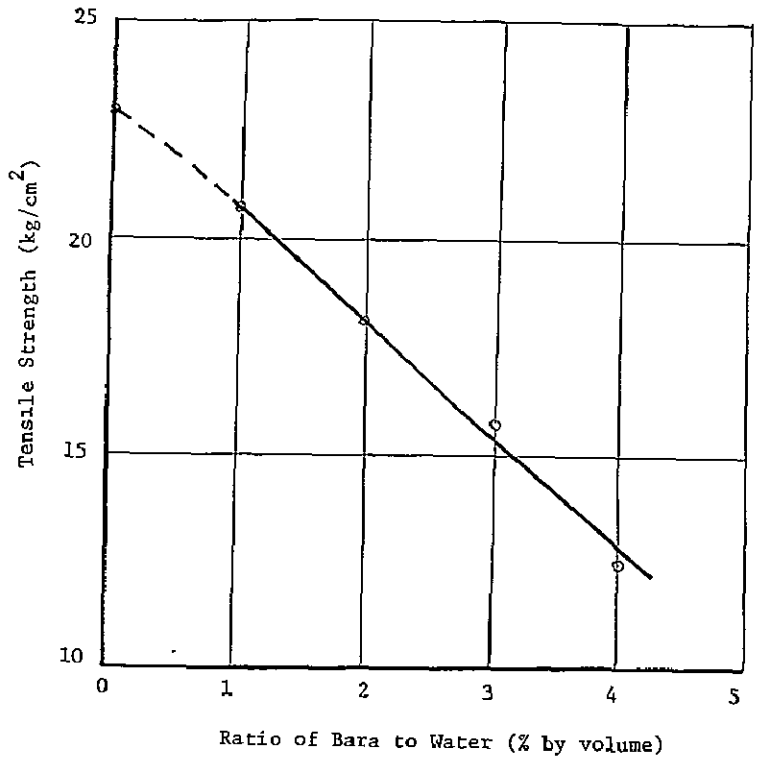

Fig. (III-25) - Effect of (Bara/Water) Ratio on Tensile Strength of Mortar

The obtained test results clearly indicated that the addition of Bara caused a marked decrease in the compressive and flexural strengths of mortar, and an even greater decrease in tensile strength. It was that reason, in addition to the cost of Bara, that led to the decision to exclude the water-repellent agent from the surface-bonding mixture.

3.3 Experimental Program On Surface-Bonded Walls

This part of the research program covered the main characteristics of the bricks used in tests, the bond strength between bricks and suggested surface bonding mortar, and the behavior of surface-bonded brick walls under compression, flexure and impact loading.

3.3.1 Characteristics of used bricks

The test program was carried out on sandlime bricks, and shale bricks newly produced in Egypt, compared with conventional red clay bricks.

Randomly chosen samples of the three types of bricks were tested to determine the compressive strength and water absorption after submersion in water for 24 hours. The results of tests are given in Table (III-1) as an average of ten test specimens.

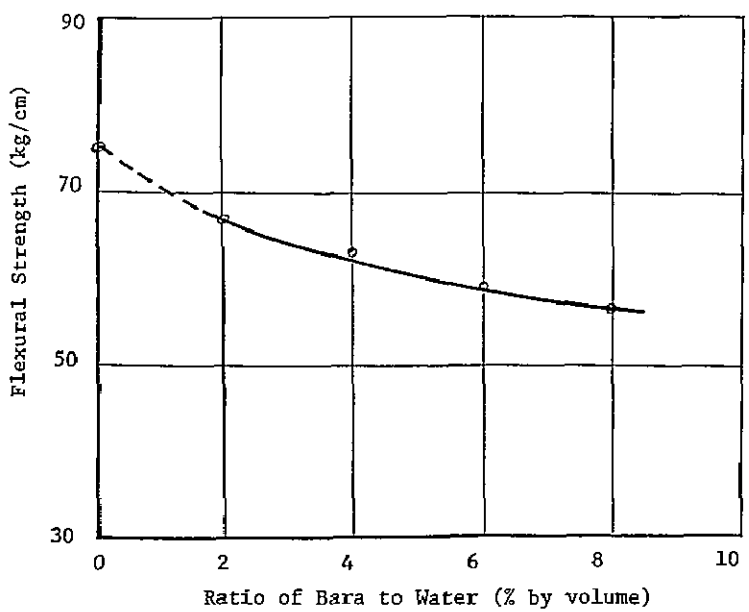

Fig. (III-26) - Effect of (Bara/Water) Ratio on Flexural Strength of Mortar

Table (III-1) – Compressive Strength and Water Absorption of Red, Sand-Lime and Shale Bricks

Type of Brick	Dimensions (cm)	Weight (gm)	Volume Weight (kg/m^3)	Average crushing Strength (kg/cm^2)	Water absorption* (% of dry weight)
Conventional red bricks	5.5X11.6X23.8	2550	1680.0	38.2	20.0
Sand-lime bricks	6 X 12 X 25	3520	1955.0	178.0	23.3
Shale bricks	10 X 12 X 25	3500	1166.0	109.3	12.7

* After submersion in fresh water for 24 hours.

3.3.2 Bond between brick and mortar

Six test specimens were prepared for each of sand-lime and shale bricks, as shown in Fig. (III-27). Each test specimen was composed of two bricks placed with their longitudinal axes prependicular to each other, with 1-cm thick freshly mixed mortar in between. The mortar used was the surface bonding mix with sisal fibers recommended earlier. The test specimens were cured for 14 days by sprinkling daily with water, then tested for bond failure. The average ultimate bond strength for sand-lime bricks was 3.6 kg/cm^2, and for shale bricks was 4.7 kg/cm^2, which are satisfactory.

3.3.3 Testing of surface-bonded walls

A total number of 19 test walls were constructed using sand-lime, shale, and red bricks; and adopting two methods of construction of surface bonding and conventional technique. All test walls had the same nominal dimensions of 12 cm thickness, 60 cm width and 110 cm height. The walls were divided into three groups depending on the type of brick used.

The first group consisted of eight sand-lime brick walls, three of which were built by the conventional method to be tested in compression, flexure , and impact, and the remaining five walls were surface-bonded using the recommended mortar mix containing sisal fibers of 4 cm length added as 1% by volume. One surface-bonded wall was tested in compression, two in flexure, and two under impact loading.

The second group consisted of eight shale brick walls, three of which were built in the conventional way, and five were surface-bonded and tested similar to the sand-lime brick walls.

The third group consisted of three red brick walls built in the conventional way to provide basis for comparison in compression, flexure and impact.

A summary of the experimental work program on walls is given in Table (III-2).

a) Manufacturing of test walls

Each test wall was built on a 10-cm steel channel to facilitate handling and placing in the testing machine.

The exact verticality of the wall was ensured through a wide vertical wooden framed board placed in contact with the back of the wall during its construction. The exact dimensions of the wall and thickness of surface bonding mortar were ensured by using a wooden frame as a guide.

In the conventional method of wall construction the mortar used had a cement/sand ratio of 3 by weight, with water/cement ratio by weight of 0.40. A thickness of approximately 1.0 cm was used for the mortar in all joints between successive courses of bricks and between individual bricks of each course.

Table (III-2) - Summary of Experimental Work Program on Walls

Types of bricks		Red		Sand-lime		Shale	
Type of construction		conventional	surface-bonded	conventional	surface-bonded	conventional	surface-bonded
type of test	Compression test	R - C	——	L - C	LS - C	S - C	SS - C
	flexure test	R - B	——	L - B	LS - B1 LS - B2	S - B	SS - B1 SS - B2
	Impact test	R - I	——	L - I	LS - I1 LS - I2	S - I	SS - I1 SS - I2

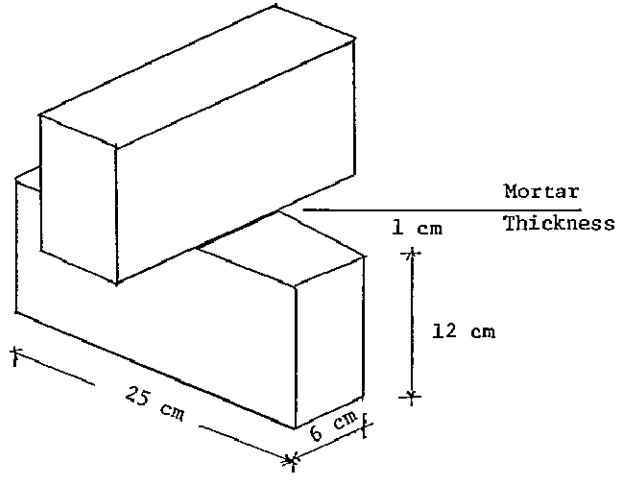

Fig. (III-27) - Specimens for Bond Strength Test Between Mortar and Brick

In preparing the surface-bonded walls, the bricks were stacked side-by-side inside the guide frame and wetted with water. The freshly-mixed surface bonding mortar was then applied to one vertical face of the wall using a regular trowel to give a flat smooth surface. The thickness of the surface-bonding coat was ensured to be 1 cm with the aid of the guide frame which protruded by 1 cm from the wall vertical face. The wall was left for 24 hours before the guide frame was slipped backward to give a protrusion of 1 cm from the other vertical face of the wall, which was thoroughly wetted. The surface-bonding mortar was then applied similar to the other face of the wall. The wall was then daily sprinkled with water for two weeks before being tested.

b) Compression test

The axial load was transmitted to the top of the compression test wall through a 20 cm steel I-beam resting on a 3-cm thick fiberboard strip 20 cm wide. The contraction at mid-height of wall was recorded and plotted versus the applied load, as shown in Fig. (III-28).

The analysis of obtained test results led to the following inferences :

1. The compressive strength of surface-bonded walls is slightly higher than that of the corresponding conventional walls.

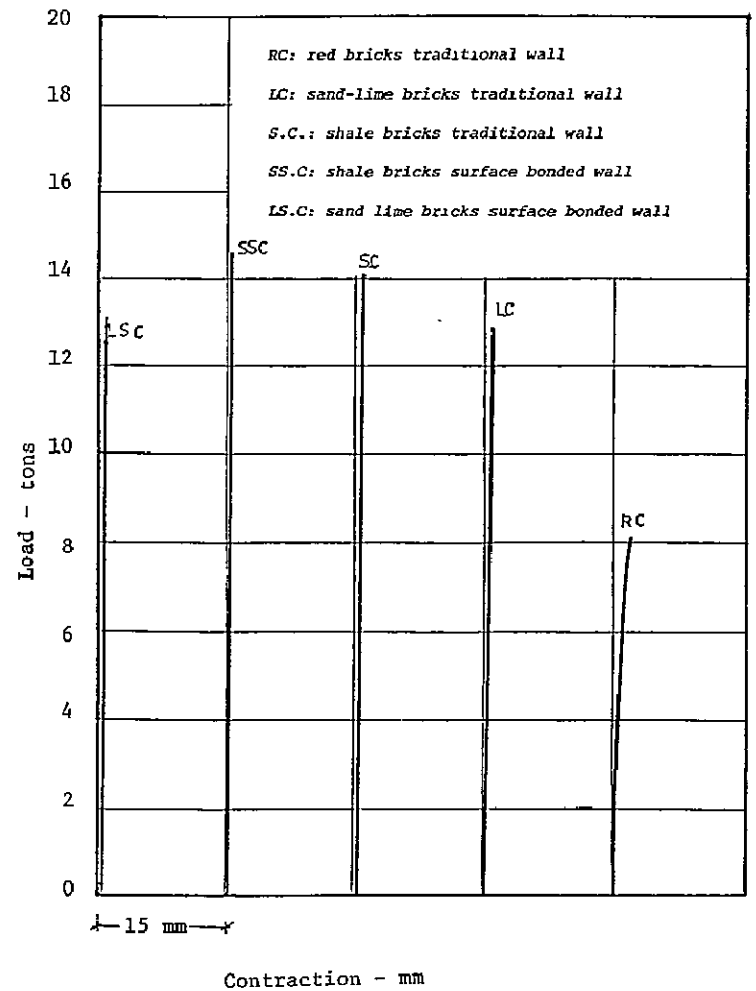

Fig. (III-28) - Load-Contraction Diagrams of the Different Wall Samples Tested in Pure Compression

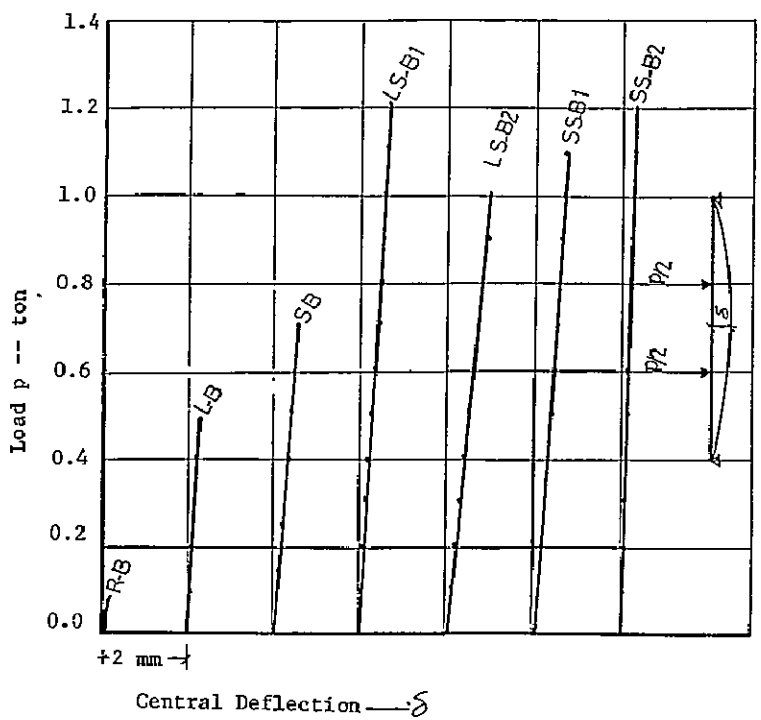

Fig. (III-29) - Load-Central deflection Curves of the Different Wall Samples Tested in Flexure

2. Surface-bonded walls experienced lower contraction values than the corresponding conventional walls, which implies that the stiffness of such walls is higher.

3. The compressive strength of conventional shale and sand-lime brick walls was almost twice that of conventional red brick wall. This is primarily due to the higher quality of these two types of bricks.

In summary, it may be stated that the surface bonding technique has no considerable effect on the compressive strength of wall, as the increase in strength was not more than 10% compared to the conventional walls. However, the effect was more pronounced on the deformation and stiffness characteristics.

c) Flexure test

Each flexural test wall was supported on a 100-cm span and loaded at the span third-points using a turnscrew lever, fitted to a loading frame and attached to a 5-ton capacity calibrated load cell. The central deflections of the wall versus the applied flexural loads were recorded and plotted into curves shown in Fig. (III-29).

The analysis of test results indicated the following :

1. Red brick conventional wall had a significant low flexural strength, as the load resisted by the wall was only about 20% of those of surface-bonded walls.

2. The maximum flexural load resisted by conventional sand-lime brick walls was almost doubled

when the surface bonding technique was adopted.

3. Shale brick conventional wall had higher flexural strength than conventional sand-lime brick wall. This may be possibly attributed to the reinforcing action of mortar filling the holes in the shale bricks and forming dowel-shaped rods participating in the wall resistance to lateral loads. However, this has the disadvantage of consuming higher quantities of mortar.

In conclusion, it can be stated that the surface bonding technique has a significant favorable effect on increasing the flexural load resistance of brick walls.

d) Impact test

A test set-up shown in Fig. (III-30) was constructed to give impact loads on the test wall from one of three fixed heights of 30 cm, 60 cm and 122 cm. All tested walls were supported on a span of 100 cm. The impact force acting on the wall at its mid-height was applied by a sand bag, weighing 8.8 kg, fixed to a steel rod hinged at its other end to have a free movement like a pendulum.

The number of blows required to cause impact failure was recorded for each tested wall and the impact energy calculated therefrom.

A complete record of the results of tested walls in compression, flexure and impact is given in Table (III-3).

The following inferences were drawn from obtained test results :

1. The impact resistance of conventional sand-lime brick wall was increased to almost seven times when the surface bonding technique was used for constructing the wall.

2. The surface-bonded sand-lime brick wall exhibited a higher impact resistance than the surface-bonded shale brick wall.

3. Red brick conventional wall had the lowest value of impact resistance among all types of tested walls.

4. The impact resistance of shale brick conventional wall was about three times that of surface-bonded shale and sand-lime brick walls. This could be attributed to the high reinforcing action of mortar filling the holes in the bricks and forming dowel-shaped rods considerably increasing the wall resistance to impact loads.

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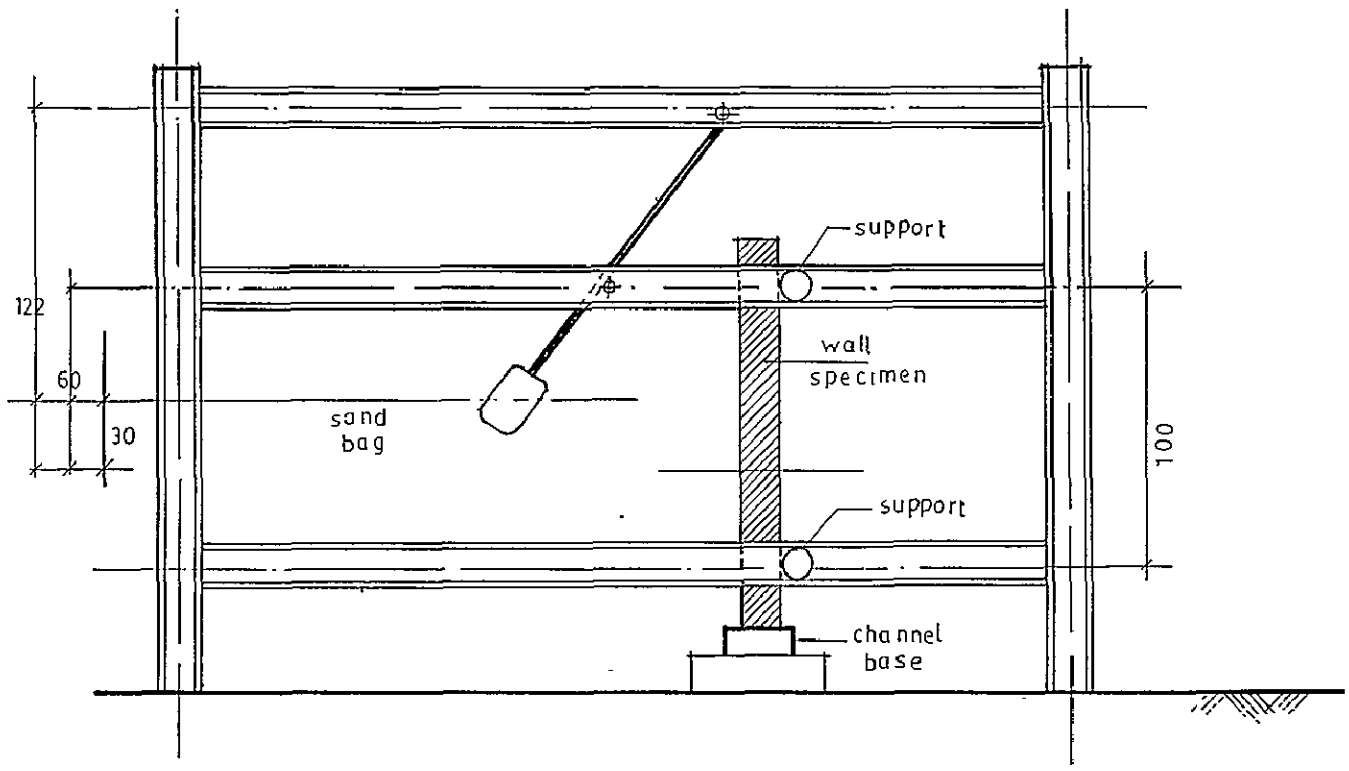

Fig. (III-30) - Set-Up for Impact Test of Brick Walls

Table (III-3) - Results of Tested Walls

type of Brick	type of construction	failure compression Load (kg)	compressive strength ** (kg/cm^2)	failure flexural load P - (kg)	ultimate flexural strength (kg/cm^2)	Impact Resistance (kg/.m)
Red	conventional	8000	11.1	75	0.86	2.64
Sand-Lime	conventional	13000	18.05	480	5.50	18.40
	Surface-bonded	13500	18.75	1000 1200	9.26	128.83*
Shale	Conventional	14000	19.44	700	8.02	339.15
	Surface-bonded	14500	20.13	1200	9.66	113.00*

* Average of two test walls

** Based on the whole cross section of bricks (12 X 60) cm

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In conclusion, the test results clearly indicated that surface bonding technique has an extremely significant effect on increasing the impact resistance of brick walls, and this is more pronounced for sand-lime bricks.

3.4 Sulfur Surface-Bonding Of Walls

Some preliminary trials were carried out in this study to test the possibility of using sulfur as a surface bonding material for brick walls. These trials, however, were faced with the following difficulties :

1. Melting sulfur has to be in a special clayey container to avoid any possible chemical reaction if a metallic container is used.
2. It was difficult to prepare a controlled heating source that can maintain a constant temperature below the burning limit of molten sulfur.
3. Molten sulfur exhibits a bad odour that causes chest irritation for those handling the melting process.
4. Brushes used for painting brick walls were burnt easily and could not be used more than once.
5. Trials made to mix sisal fibers with molten sulfur failed since fibers would burn the moment they are added in the molten sulfur container.

4. ESTIMATION OF COST

In this section an attempt is made to undertake a comparative cost analysis on the surface bonding technique as compared to the conventional procedure for wall construction.

The cost estimates include construction and labor cost, and is based on current prices of materials as well as labor wages.

4.1 Conventional Red Brick Walls

In the conventional technique of wall construction, the materials cost includes, beside the brick price, mortar for jointing bricks and for wall plastering.

4.1.1 Materials cost

Cement	current price	45 L.E./ton
Red brick	current price	33 L.E./1000
Lime	current price	12 L.E./m^3
Sand	current price	2 L.E./m^3
Area of wall considered		1.0 m^2
Thickness of wall		12 cm
Average dimensions of red brick		6 X 12 X 25
Average number of bricks/m^2 of wall		50
Net area of 50 bricks		0.75 m^2
Area of joints filled with mortar		0.25 m^2
Volume of mortar for joints		0.25 X 0.12 = 0.03 m^3

Assuming mix proportions by weight for mortar used for joints as follows :

Cement	:	Sand	:	Water
1	:	3	:	0.4

and assuming a specific gravity of 2.65 and 3.15 for sand and cement, respectively, the materials needed for 0.03 m^3 of mortar would be :

Cement	16.22 kg
Sand	48.66 kg
Water	6.50 kg

Assuming two centimeters thickness of plastering for each face of wall, then

Volume of mortar for plastering = 0.04 m^3

According to common practice, the following mix proportions by weight are adopted :

Cement	:	Lime	:	Sand	:	Water
1		3		5		0.5

The corresponding materials for 0.04 m^3 mortar would be :

Cement	10.8 kg
Lime	32.4 kg
Sand	54.0 kg
Water	5.4 kg
Volume weight for lime	1.2 t/m^3

Total materials of mortar for joints and plastering comprising cost elements would be :

	Quantity (kg)	Cost (L.E.)
Cement	27.02	1.215
Sand	102.66	0.124
Lime	32.40	0.324
Total		1.663

4.1.2 Labor cost

Based on an 8-hour shift, one mason and two assistants can produce about 25 m^2/day of brick walls. Three workers can produce about 30 m^2/day of plastering of walls.

The average wage per person is about 4 L.E./day.

Total cost of brick laying and plastering	0.88 L.E.
Cost of bricks	1.65 L.E.
Total cost of materials and labor	4.193 L.E.

4.2 Surface-Bonded Walls

Cost estimates are presented herein for surface-bonded walls of both sand-lime and shale bricks.

4.2.1 Materials cost

Considered surface-bonded area of wall 2 x 1 = 2m^2. While the thickness of mortar coat will be 1.0 cm for the case of sand-lime brick walls,

an average thickness of about 1.5 cm will result for shale brick walls due to the corrugated surface of the bricks. Hence,

Volume of mortar for sand lime-brick wall = 0.02 m^3
Volume of mortar for shale brick wall = 0.03 m^3

The mix proportions by weight for surface bonding mortar

cement	:	sand	:	water
1		1		0.4

with sisal fibers 4 cm long added as 1% by volume.
Specific gravity of sisal = 1.5

The materials needed for 2 m^2 of surface-bonded wall will be :

	Sand-lime brick wall	Shale brick wall
Cement	18.1 kg	27.15 kg
Sand	18.1 kg	27.15 kg
Water	7.24 kg	10.86 kg
Sisal	0.30 kg	0.45 kg

Sisal current price in local market = 100 L.E./ton
Current price of sand-lime bricks = 35 L.E./1000
Current price of shale bricks = 35 L.E./1000
Average dimensions of sand-lime brick 6 X 12 X 25 cm
Average dimensions of shale brick 10 X 12 X 25 cm

a) Case of sand-lime brick walls

Number of bricks/m^2 of wall = 50

Cost of bricks	1.750 L.E.
Cost of cement	0.815 L.E.
Cost of Sand	0.023 L.E.
Cost of sisal	0.030 L.E.
Total	2.618 L.E.

b) Case of shale brick walls

Number of bricks/m^2 of wall = 40

Cost of bricks	1.400 L.E.
Cost of cement	1.220 L.E.
Cost of sand	0.033 L.E.
Cost of sisal	0.045 L.E.
Total	2.698 L.E.

4.2.2 Construction procedure :

The suggested construction procedure of surface bonding technique lies in the following steps :

1) The first course of bricks is laid in a mortar bed and levelled horizontally. The successive courses are then stacked on top of each other to a height of approximately 1.0 m along the axes of partitions all over the housing unit, without using any mortar between horizontal or vertical joints.

2) The stacked courses of bricks are then wetted thoroughly with water.

3) The surface bonding mortar with added sisal fibers is then prepared in the required quantity and with the recommended proportions, and applied to one face of the short wall to the height and shape shown in Fig. (III-31), (Step I). The slope of surface bonding mortar at top would ensure better overlapping and bond with the new surface bonding coat to be applied to the next group of brick courses on top.

4) After allowing for the proper time for setting of the applied mortar (about 3 hours), surface bonding mortar is applied to the other face of wall to a less height, as shown in Fig.(III-31) (Step II).

5) Next day, another height of approximately 1.0m of brick courses is added to the top, and coated from one face, as indicated by (Step III) and similarly the second face will be coated later during the day (Step IV).

6) This procedure will be followed until the full height of the wall is attained.

4.2.3 Labor cost

According to the above mentioned suggested procedure, three workers of skilled labor can daily produce a minimum of 20 m^2 of wall, surface-bonded from both sides, based on an 8-hour shift.

The labor cost, then, for 1 m^2 of wall surface bonded from both sides would be 0.60 L.E.

The total cost of materials and labor for both sand-lime and shale surface-bonded walls will be:

For sand-lime brick wall = 0.60 + 2.618 = 3.218 L.E.
For shale brick wall = 0.60 + 2.698 = 3.298 L.E.

Based on the above cost estimate, it can be clearly stated that the surface bonding technique results in a considerable saving in cost of more than 20% as compared to the conventional brick laying construction technique.

Sand-lime bricks proved to be the most appropriate type of brick for such a new technique, giving lower cost and less brick and mortar waste than shale bricks.

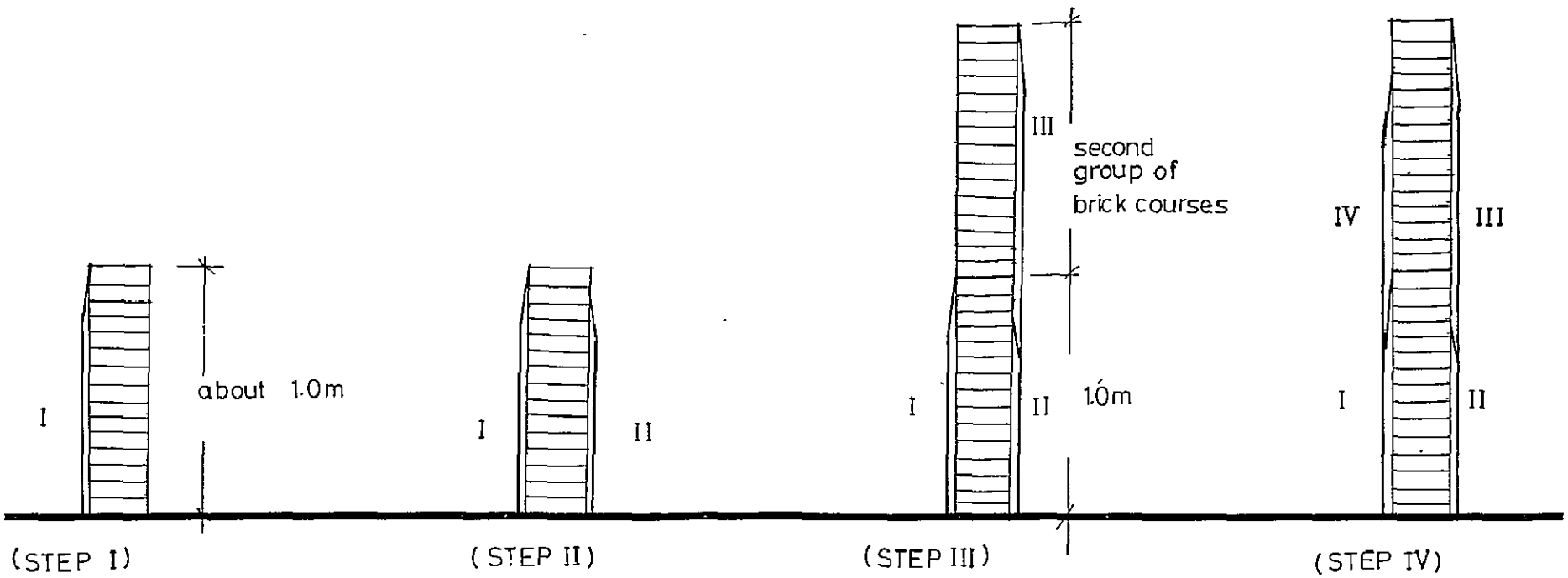

Fig. (III-31) - Suggested Procedure of Wall Construction
Using Surface Bonding Technique

5. CONCLUSIONS AND RECOMMENDATIONS

1. The technique of surface bonding of brick walls, which is new to local practice, is recommended for the construction of walls and partitions in residential units due to its practicality, lower cost, speed of construction, and the significant saving in cement consumption.

2. Sand-lime brick proved to be the most appropriate type for use with the new technique of surface bonding, giving lower cost and less brick and mortar waste than shale brick.

3. The surface bonding technique coupled with the use of sand-lime bricks would achieve a considerable saving in cement of about one third of that consumed in a similar wall of red brick constructed by the conventional technique. In other words, an equal amount of cement would produce an area of surface-bonded wall 1.5 times that of a conventional wall.

4. Shale bricks are also suitable for such a new technique achieving almost an equal saving in the total cost as for the sand-lime bricks, although consuming 1.5 times the quantity of cement needed for surface-bonded sand-lime brick walls.

5. The recommended surface-bonding mortar is composed of one part by weight cement, one part by weight sand, and 0.4 part water, to which 1% by volume sisal fibers of 4 cm length is added.

6. The construction procedure suggested in detail in section 4.2.2 and illustrated in Fig. (III-31) is recommended for erecting walls and partitions by the surface-bonding technique. This procedure avoids the possible collapse of brick courses during construction and ensures sufficient bond and monolithic action between successive layers of surface bonding coats.

7. The surface bonding mortar coat, a day after application to the brick wall, needs to be sprinkled with water twice a day for a minimum period of 3 days, to ensure proper setting of cement.

8. Preliminary trials conducted to study the possibility of utilizing sulfur as a surface bonding material indicated the impracticality and difficulty of such usage due to many problems encountered.

IV. LOW-COST CEMENTS

1. INTRODUCTION

The studies initiated by the Materials Group in 1977 on materials technical coefficients, and continued later by the Economy Group in 1978/1979, clearly indicated that at least 40 to 60% of the total cement consumption in different housing categories goes to many applications that do not require cements of high strength qualities.

Mortars for brick and tile laying, plastering of brick walls by cement surface coatings, concrete masonry blocks, and base layer (back) of cement tiles, are all examples of such applications currently utilizing costly portland cement of needless high strength qualities.

The production of portland cement clinker in Egypt, on the other hand, is no longer able to meet the continuously growing demands. The lack of necessary funding and new investments allocated to the cement industry added to the problem.

The need has become, therefore, more urgent to start producing new types of low-cost cement achieving the full utilization of the yearly local production of clinker. The idea is to intergrind and blend portland cement clinker with various additives of percentages higher than those currently used in Egyptian slag and blended (Karnak) cements. The percentages of additives used would depend upon the application needed and properties required, and can be determined by trial mixes.

2. LOW-COST CEMENTS IN OTHER COUNTRIES

Various types of blended cement were produced by some countries during the Second World War for economy reasons, and this practice is currently adopted all over the world by many developed and developing countries, including the U.S. and Russia, where different types of blended cement are produced according to special standard

specifications giving their specific recommended applications. The practice is to intergrind and blend standard portland cement clinker and various additives such as blast-furnace slag, fly ash, crushed limestone, and sand. The resulting products are called Blended Hydraulic Cements or Masonry Cements. The additive is usually an available low-cost material or a by-product and essentially a waste material. Blast-furnace slag is produced in the manufacture of pig iron in the first step of the steel-making process. Because of its constituents and the high temperatures at which it is produced, blast-furance slag has properties similar to portland cement in that it can be made to set in the presence of water. Similarly, fly ash is produced at high termperatures by the burning of fuels and is collected in smoke stacks. It also has hydraulic properties not unlike portland cement or, more nearly, like the volcanic pozzolans used by the Romans. It can readily be blended with portland cement.

Blast-furnace slag is granulated and interground with portland cement clinker in a mill following the burning of the clinker in a kiln. There is no essential change in the kiln operation itself, only the grinding operation needs to accommodate the addition of the slag. The resulting product is called Portland Blast-Furnace Slag Cement.

Fly ash is blended with portland cement. Again there is no essential change in the kiln operation. The resulting product is called Portland Pozzolan Cement from the ancient Roman pozzolans. Replacement of standard portland cement with 15 to 20 percent of fly ash is common in the manufacture of concrete blocks, with reportedly little or no effect upon properties. Ready-mix concrete producers frequently use the Portland-Pozzolan Cement or add 15-20 percent fly ash directly to their mixes with little or no effect upon properties of the concrete.

A principal difference between furnace slag and fly ash, on one hand, and portland cement is that the slag and ash are more variable in their properties. In the small percentages commonly used, these variations do not cause great variability in the final product. Larger percentages cause greater variability, which may or may not be important.

Another common practice for producing Masonry cement is by direct intergrinding portland cement clinker and crushed limestone to a high degree of fineness.

In Egypt, two types of blended cements are produced. Portland blast-furnace slag cement containing 35% slag, and Blended cement (Karnak) containing 25% sand. These two percentages, however, need to be increased to produce cements of lower strength qualities and much lower cost but still suitable for many applications.

3. TECHNICAL ASPECTS

3.1 Composition

A blended low-cost cement consists essentially of the following components :

- Ordinary portland cement clinker
- An additive material such as sand, basalt, limestone, sandstone, granite, air-cooled slag, fly ash, and diatomite.
- Gypsum added in normal proportions to retard setting.

3.2 Process

Blended cement can be obtained by either of the following two processes :

a) The components are blended in the required proportions and interground in the ordinary cement mills to the desired degree of fineness. This technique is preferable in the case of hard additives where the material helps in

grinding the clinker to a high degree of fineness without the need for additional grinding capacity. This technique is locally used to produce (Karnak) cement.

b) Clinker is milled with gypsum to a high degree of fineness. The additive material is ground separately and then the two components are mixed in the set proportions.

3.3 Importance of Intergrinding

The reaction between cement and water takes place only at the surface of the solid particles. The continuation of this hydration process is hindered by the accumulation of a gelatinous impervious layer covering the internal part of bigger particles. It was found that cement particles of 30-micron size or less can fully react with water, while larger sizes usually representing about 35% by weight of cement can only partially react with water. Much larger sizes, evenmore, may not react at all. Hence, the more finely ground the cement and the greater the surface area exposed in proportion to its weight, the more rapid is the rate of hydration and the greater is the portion of cement which reacts.

In the case of blended cement, when grinding portland cement clinker with an additive to the same degree of fineness of ordinary portland cement or finer, the added material helps during milling to grind the clinker until all its particles are of approximately the same size below 30 microns. The bulk of bigger particles, however, exceeding 30 microns would be of the added material itself. This means that intergrinding a solid additive with the clinker would turn the latter into an active material effective with its full proportion in the hydration process, while the additive replaces the ineffective internal parts of the bigger particles of clinker.

Obviously, the addition of inactive material such as sand to the cement in the field without grinding, in the same proportion as in the blended cement, would be no more than changing the ratio of sand to cement in the concrete mix, and it would not lead to the realization of the same resulting properties and advantages of blended cement.

4. ADVANTAGES OF PRODUCING LOW-COST CEMENTS

Many advantages can be realized by producing low-cost blended cements, among which are the following :

1. Increasing the total annual production of cement without any increase in the existing furnaces, and with full utilization of the surplus milling capacity in the existing factories.
2. Meeting the continuously increasing local demands for cement and avoiding cement imports.
3. Realizing a significant reduction in cost of produced cement, as well as the total construction cost.
4. Achieving rationalization of national resources by producing various types of low-cost cement of different levels of strength qualities, each suitable for a particular application, and saving more portland cement for reinforced concrete works where high strength is a major requirement.
5. Satisfying the needs of projects consuming large quantities of cement, but where the utmost in cement strength is not required and variability in properties can be permitted. These projects are such as the lining of irrigation and drainage canals, land reclamation, and rural housing.

Housing Construction Systems and Design: Prefabrication

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This summary is a part of the Housing and Construction Industry Research Program carried out under the Technological Planning Program, a joint research project by Cairo University and the Massachusetts Institute of Technology. The views and opinions expressed in this report are those of the authors and do not necessarily reflect those of AID, MIT, or Cairo University.

1/2

A LIGHT WEIGHT SMALL COMPONENT SYSTEM FOR HOUSING

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1. DESCRIPTION OF LIGHT COMPONENT SYSTEM

1.1 Some Aspects Recommending the System to the Egyptian Housing Sector

Based on previous studies of prevalent construction practices, widely used in and around Cairo, the system represents a rationalized and dimensionally coordinated "kit of parts", which may be precast either on site, or off site, used as a complete set, or selectively.

Rationalization has been based on the following criteria:

1. Use of skeleton elements for the main supporting structure. This reduces the use of deficit materials, i.e., steel and cement, if compared to reinforced concrete conventional structures (systems).
2. Non-bearing wall elements may be selected from non-deficit materials, or new materials, e.g., brick, block, gypsum, etc.
3. Skeleton design offers more flexibility, both in terms of overall layout and shape, and internal distribution of spaces (plan).
4. Based on the proposed modular band grid, positional and dimensional coordination permit standardization of all elements, without giving up flexibility and variability.
5. Positional coordination allows the integration of standard non-structural elements with a minimum of waste, due to unnecessary cutting, fitting, bending, etc. at joints.
6. The system can be adapted to a variety of structural grid patterns, and hence be used for other functions than housing (e.g., garages, small industrial facilities, schools, storage, etc.)

The system was initially proposed in 1979 for application to core housing types of 1-2 storey height only. Consequently, applications for 4-5 storey structures were included, resulting in a number of modifications of the original concept. The following document shows only the latest 4-5 storey version, which remains applicable to 1-2 storey solutions as well (with minor reductions in cross-section and reinforcing steel).

1.2 Prototype

Currently (spring 1980), a one bay prototype of the system is being erected at Cairo University under the supervision of Dr. Mohmoud Reda.

This prototype will serve two main purposes:

(1) Test casting and erection sequences, including ability to be assembled by relatively unskilled labor.

(2) Test application of experimental "infill" materials, such as cored gypsum panels developed in the previous phase of the research, as partitions and/or enclosures, as well as other materials for facades, finishing, stairs, etc.

1.3 Application

Once tested in prototype, drawings and specifications of the system may be published for use by public or private builders to be used for the construction of 1-4 storey houses.

If utilized in large projects, mass casting facilities will have to be designed for guaranteeing a steady flow of components to the site.

If utilized in small projects, relatively simple and inexpensive on-site casting may be done on-site in wood forms prepared as per specifications.

The following documentation includes:

1. Engineering drawings of the structure and its

components.

2. Assembly sequence drawings.
3. Architectural plans for various generic applications.
4. Coordination by means of modular band grid.

Note: All generic plans are based on examples surveyed and found to be prototypical for each generic type in and around Cairo during the preceding research phase.

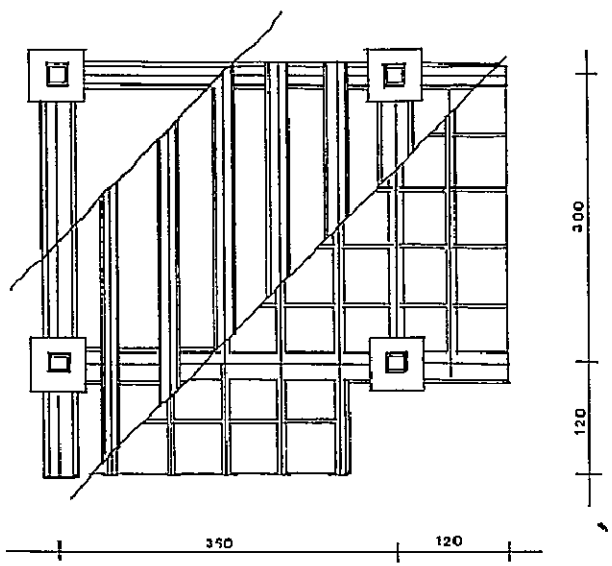
1.4 Prototype Design Criteria

The proposed "Light Component" system has been conceived on the basis of the following design criteria:

1- All elements of the system are light and small enough to be carried by 2-4 workers.
2- All elements of the structure may be cast either on or off site in simple wood or metal forms.
3- The system acts as its own scaffolding.
4- The system distinguishes between PRIMARY (structural, long-term use, essential) "support" elements, and SECONDARY (non-structrual, medium to short term use, optional, variable) "infill" elements.

Note: Formwork for one bay of the system has been built in the shop of Cairo University under the engineering supervision of Dr. Mahmoud Reda.

PLAN



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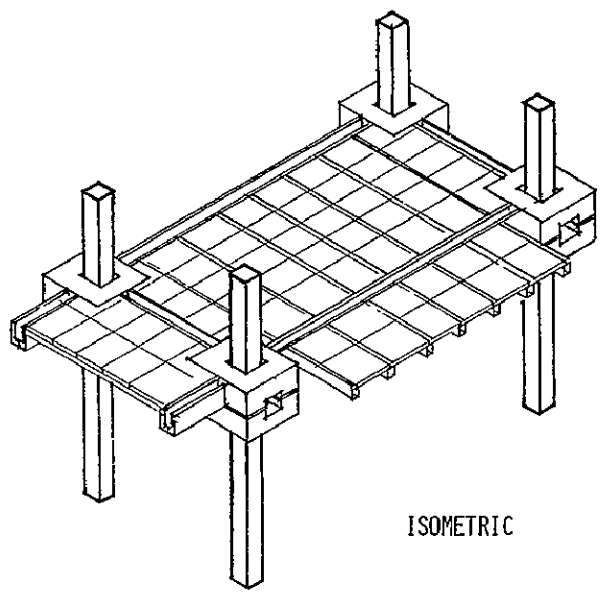

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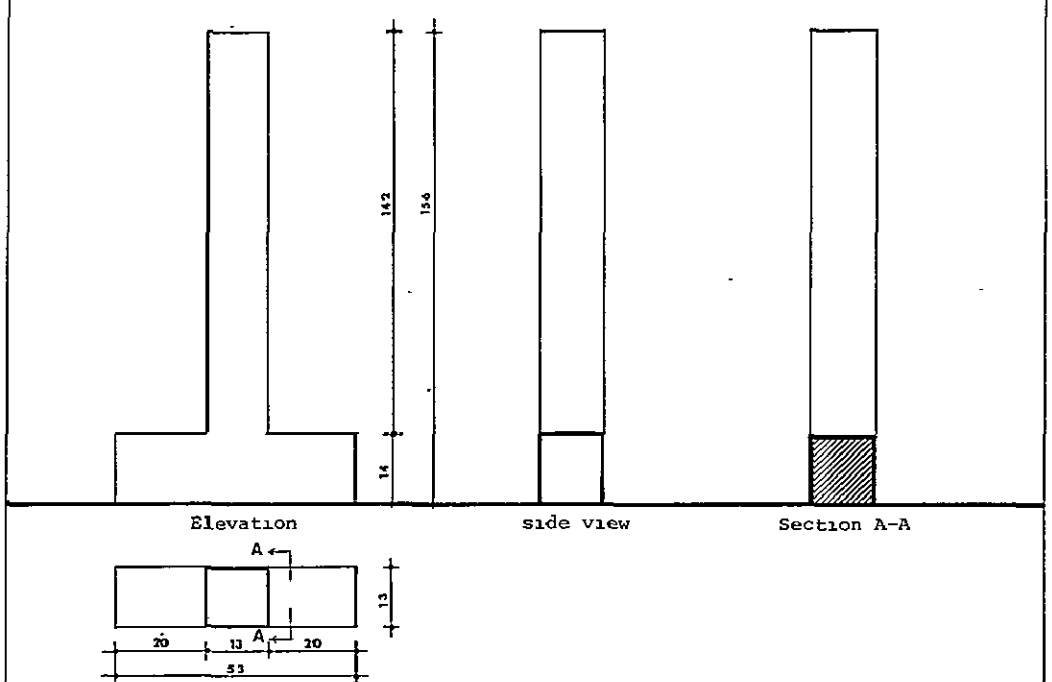
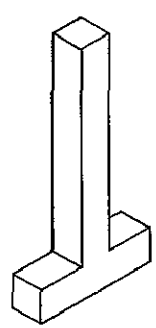
CATALOG OF PARTS

CONCRETE
SMALL COMPONENT
SYSTEM

8/11

PLAN	SECTION	ISOMETRIC	DESCRIPTION





Unit No. 1

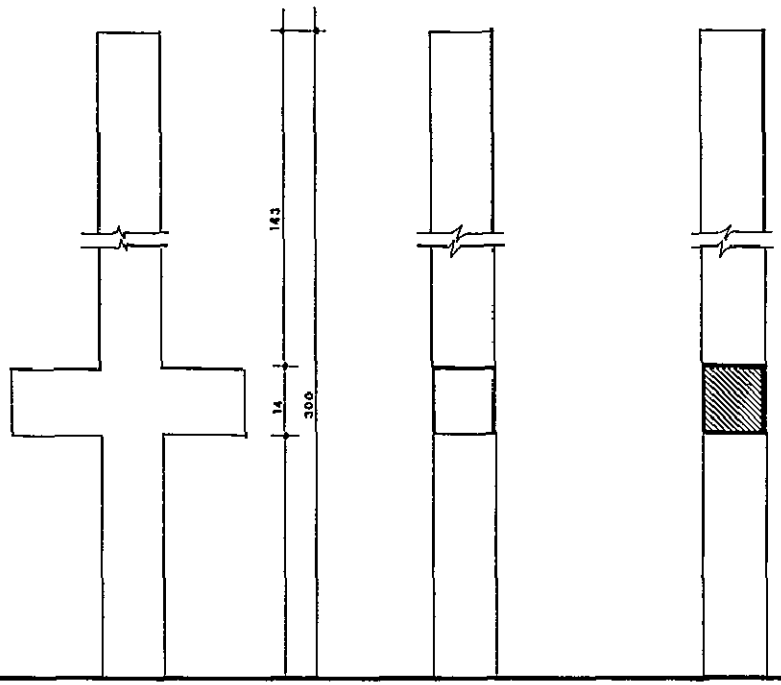
A reinforced concrete unit serving as initial and final core of each column.

CATALOG OF PARTS

CONCRETE SMALL COMPONENT SYSTEM

UNIT NO: 1

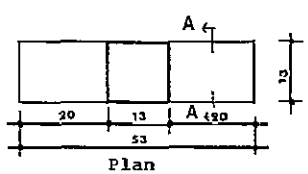
PLAN	SECTION	ISOMETRIC	DESCRIPTION



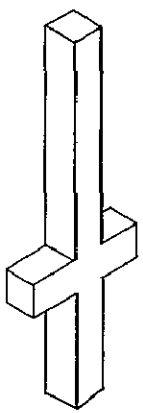
Elevation

side view

Section A-A



Plan



Unit No. 2

A reinforced concrete unit serving as a core for intermediate columns.

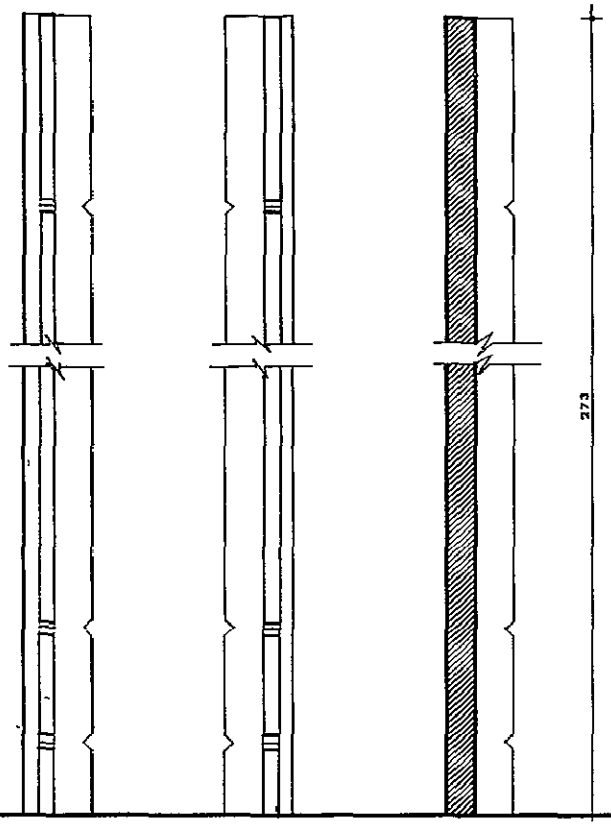
CATALOG OF PARTS

CONCRETE SMALL COMPONENT SYSTEM

UNIT NO: 2

119

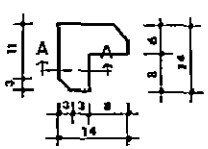
PLAN	SECTION	ISOMETRIC	DESCRIPTION



Elevation

Side view

Section A-A



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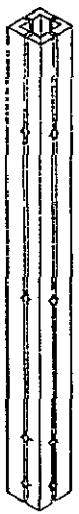


Unit No. 3

A reinforced concrete angle, four of which form exterior part of each column.

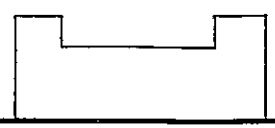
CATALOG OF PARTS

CONCRETE SMALL COMPONENT SYSTEM

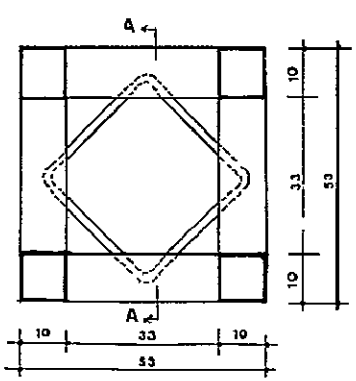
UNIT NO: 3

PLAN	SECTION	ISOMETRIC	DESCRIPTION

Elevation



Side view



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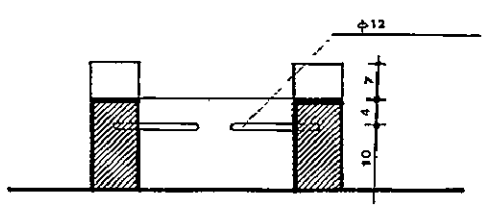

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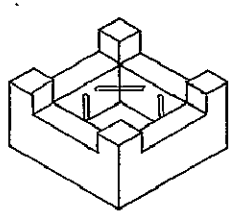

Unit No. 4

A reinforced concrete hollow block, two of which form a column capital and one block alone forms the base of the column.

CATALOG OF PARTS

CONCRETE SMALL COMPONENT SYSTEM

UNIT NO: 4

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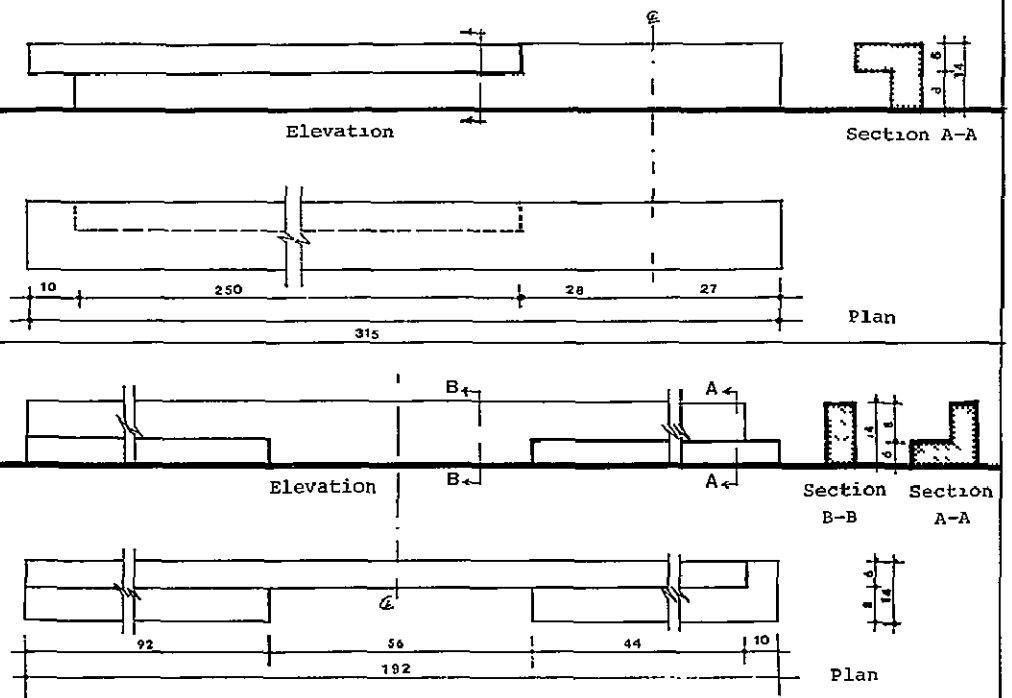
Unit 5A

PLAN | SECTION



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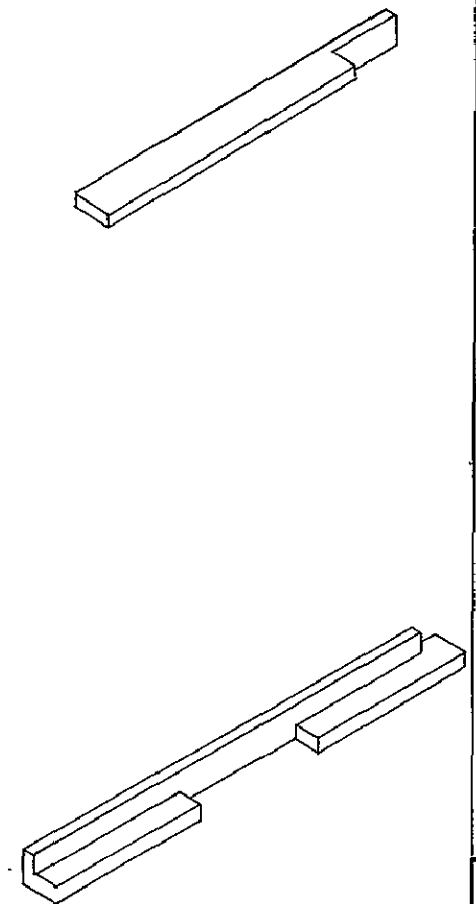
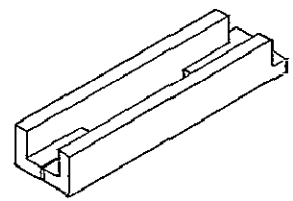


DESCRIPTION



Unit No. 5

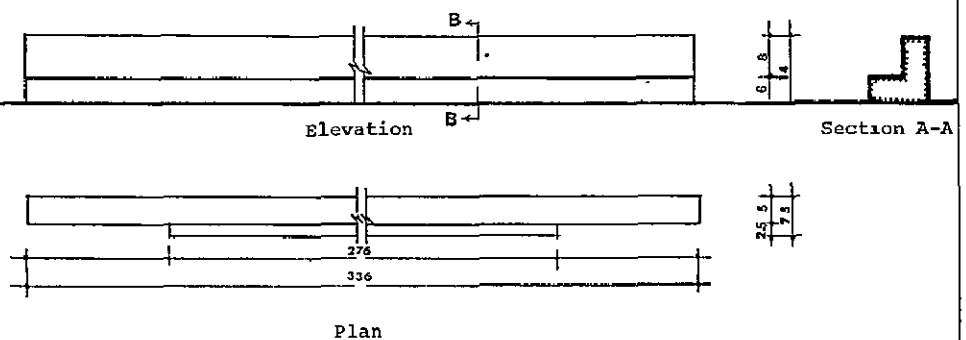
A reinforced L shaped element, each couple represents part of main beam integrated with the column.

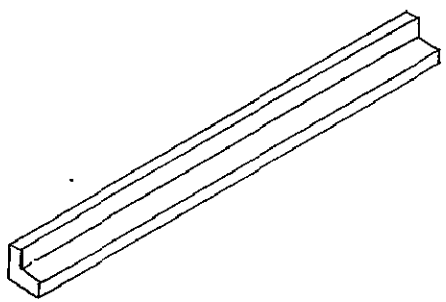
CATALOG OF PARTS

CONCRETE SMALL COMPONENT SYSTEM

UNIT NO: 5

PLAN	SECTION	ISOMETRIC	DESCRIPTION





Unit No. 6

A reinforced concrete L shaped element, two of which form secondary beam.

CATALOG OF PARTS

CONCRETE

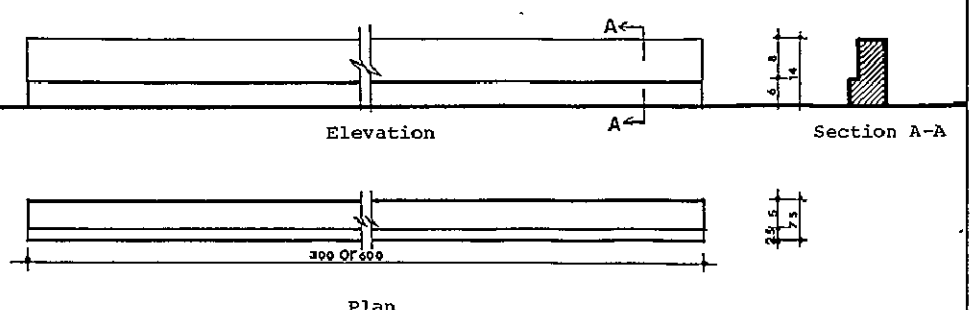
SMALL COMPONENT

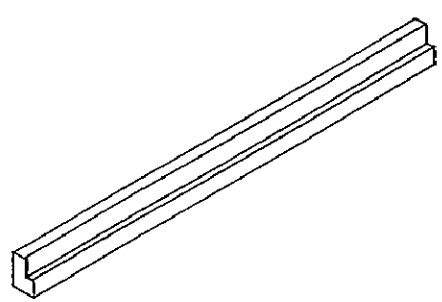
SYSTEM 6

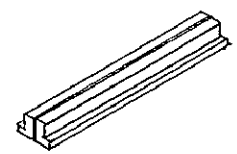
UNIT NO: 6

23

PLAN	SECTION	ISOMETRIC	DESCRIPTION







Unit No. 7

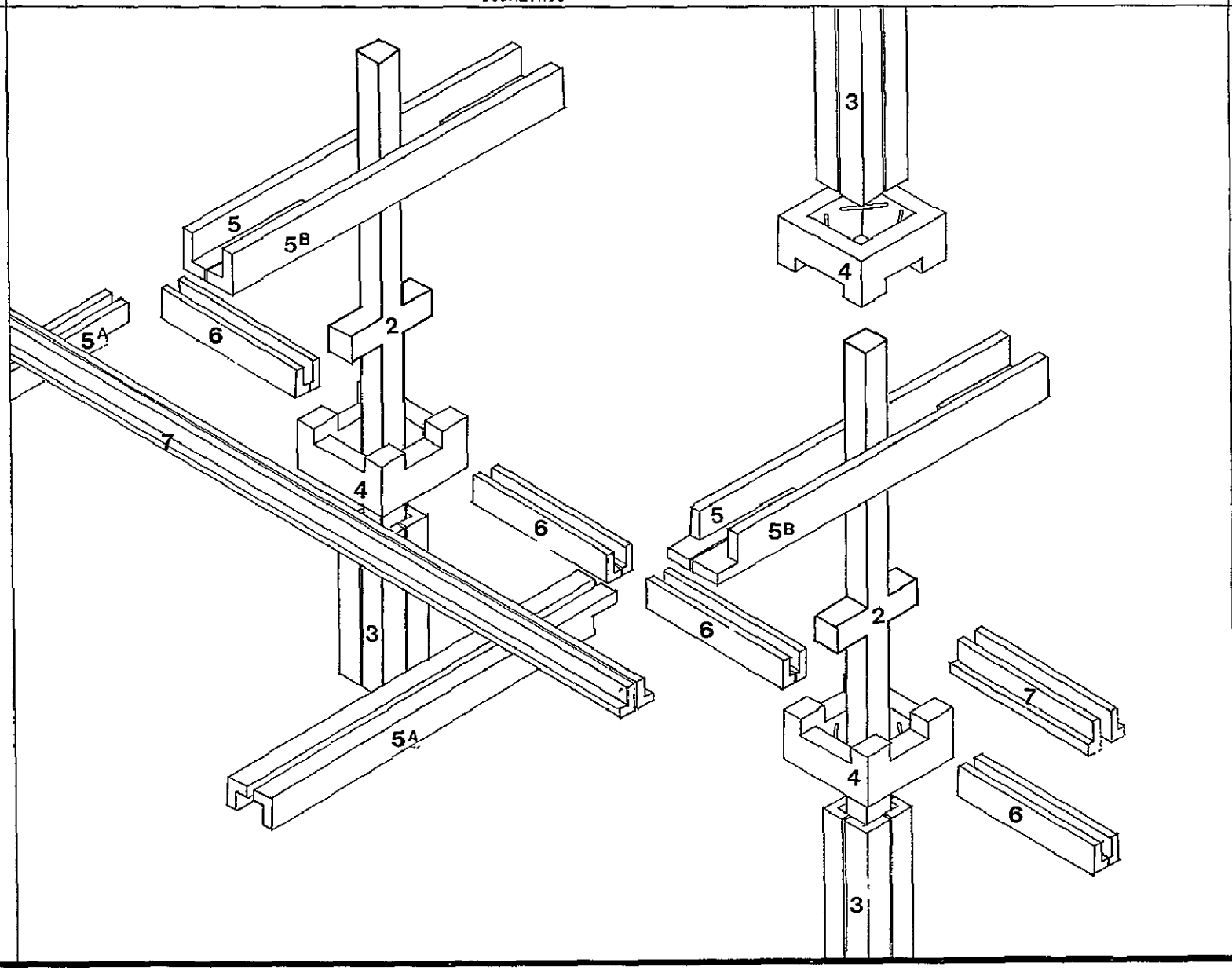
A reinforced concrete L shaped unit provided in 2 different lengths. Two of them form a floor joist supported by main beams or cap.

CATALOG OF PARTS

CONGRETE SMALL COMPONENT SYSTEM

UNIT NO: 7

ISOMETRIC



DESCRIPTION

ASSEMBLY SEQUENCE

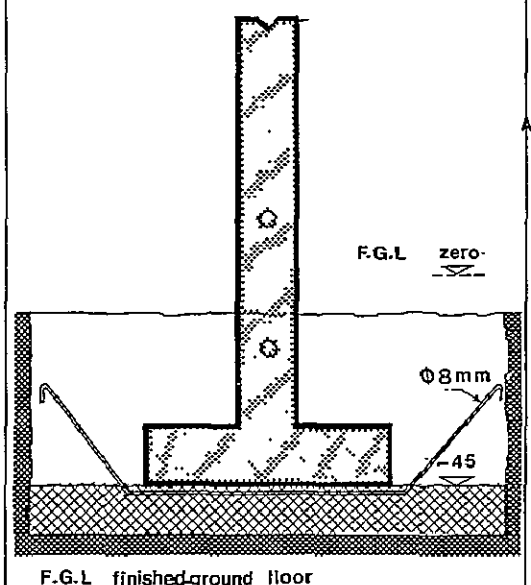
An isometric showing the whole sequence of assembly and all components of structure.

ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

125

SECTION	PLAN	ISOMETRIC



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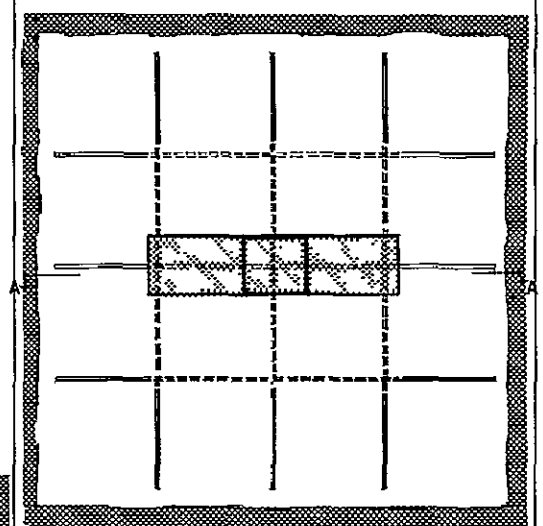

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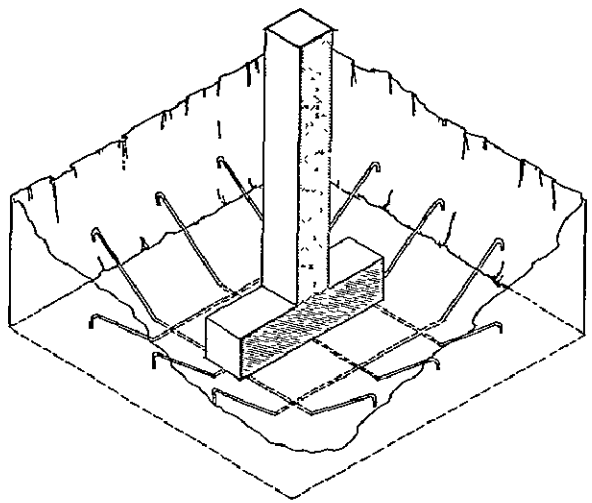


ASSEMBLY SEQUENCE
No. 1

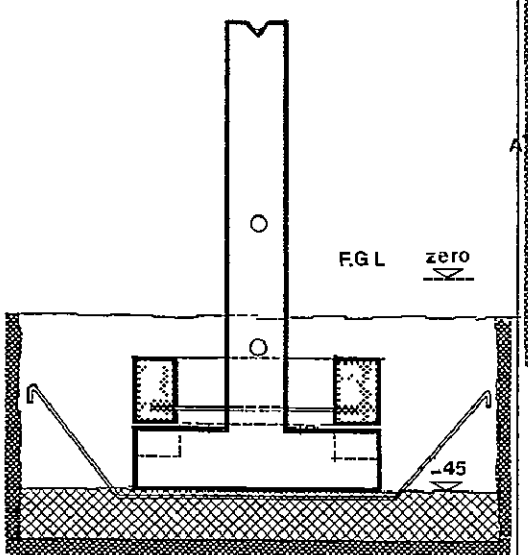
Assembling of first element (Unit No. 1) starts on level 45 cm on prepared concrete base (10 cm min. thickness) reinforced by 6 bars at 6 cm.

ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

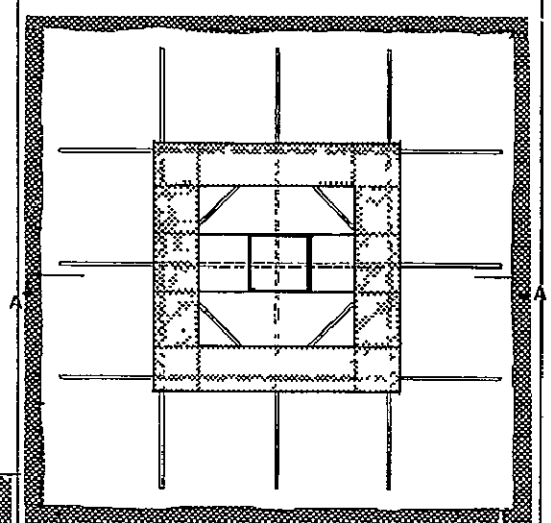
SEQUENCE NO: 1

SECTION



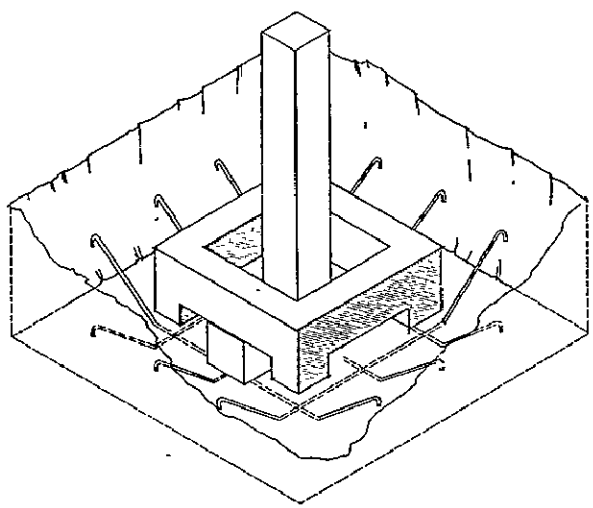
Section A-A

PLAN



Plan

ISOMETRIC



ASSEMBLY SEQUENCE
No. 2

Place Unit No. 4 on
Unit No. 1

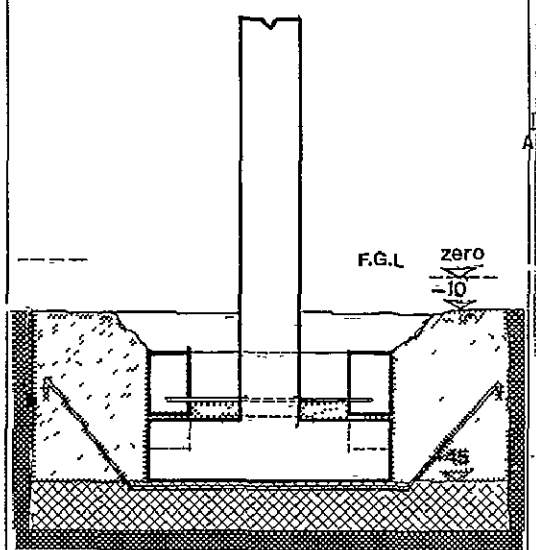
ASSEMBLY SEQUENCE

CONCRETE
SMALL COMPONENT
SYSTEM

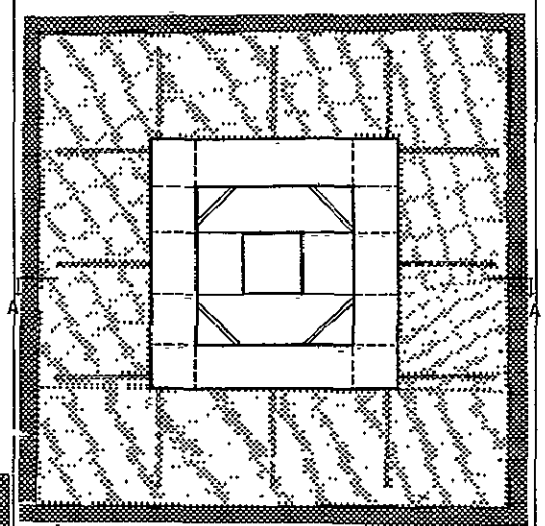
SEQUENCE NO: 2

127

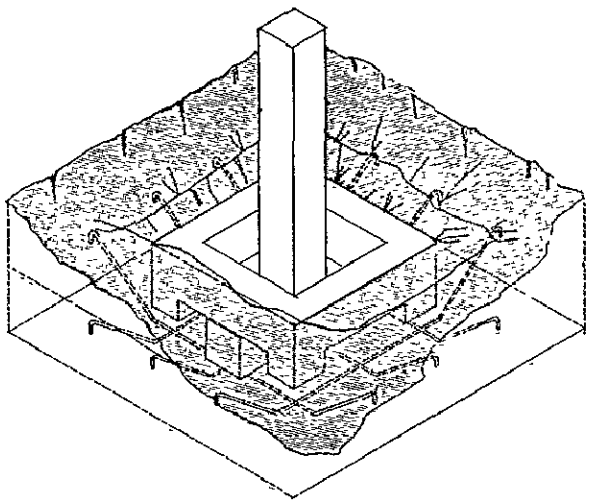
SECTION	PLAN	ISOMETRIC



Section A-A



Plan



ASSEMBLY SEQUENCE
No. 3

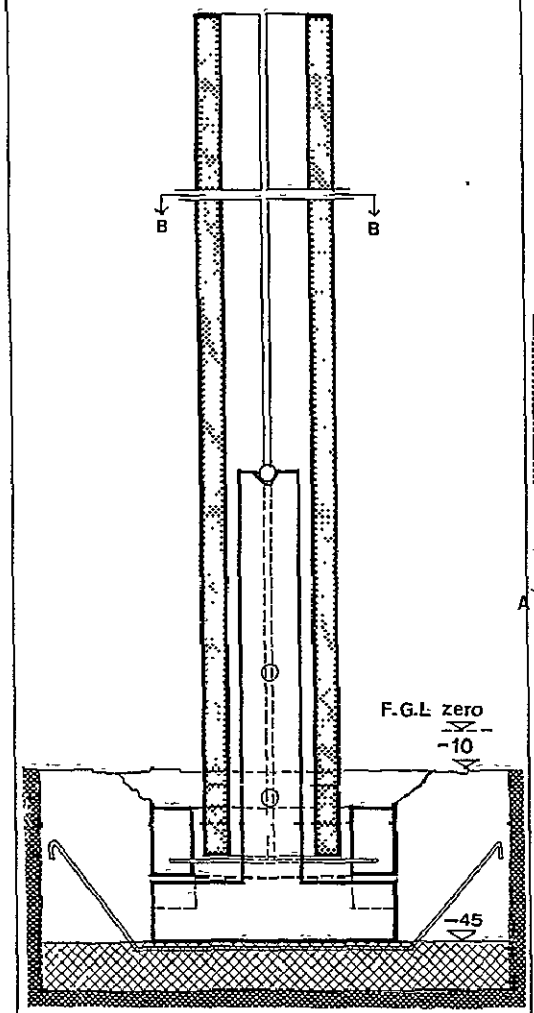
Pour a concrete layer of 25 cm covering all reinforcement.

ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

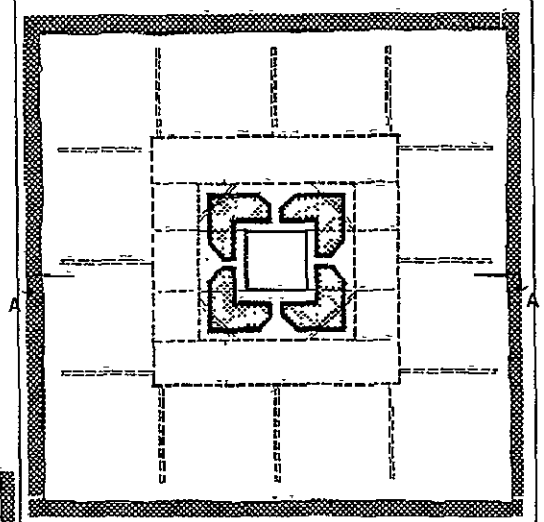
SEQUENCE NO: 3

SECTION



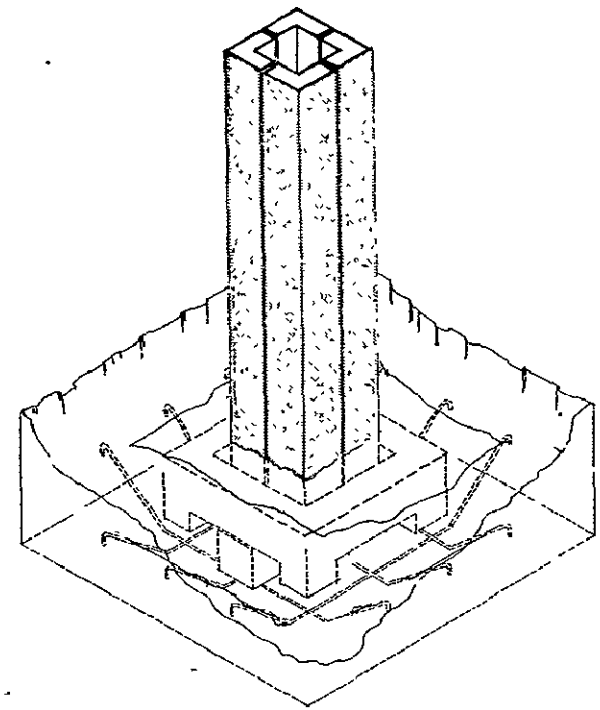
Section A-A

PLAN



Plan B-B

ISOMETRIC



ASSEMBLY SEQUENCE
No. 4

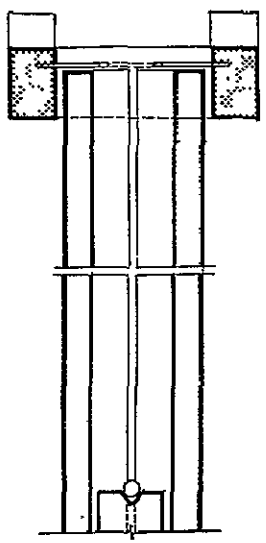
Place 4 units of Unit No. 3, forming exterior part of column.

ASSEMBLY SEQUENCE

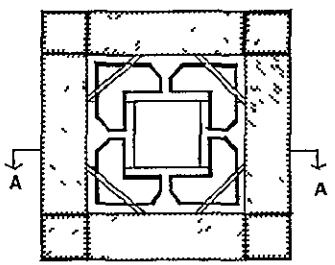
CONCRETE SMALL COMPONENT SYSTEM

SEQUENCE NO: 4

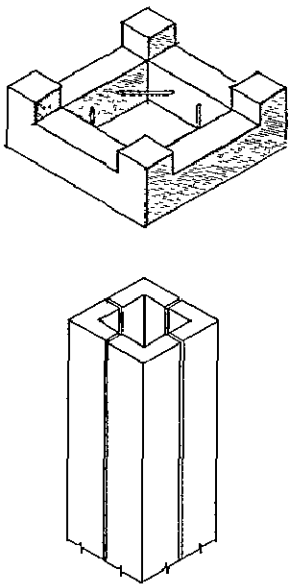
SECTION	PLAN	ISOMETRIC



Section A-A



Plan



ASSEMBLY SEQUENCE
No. 5

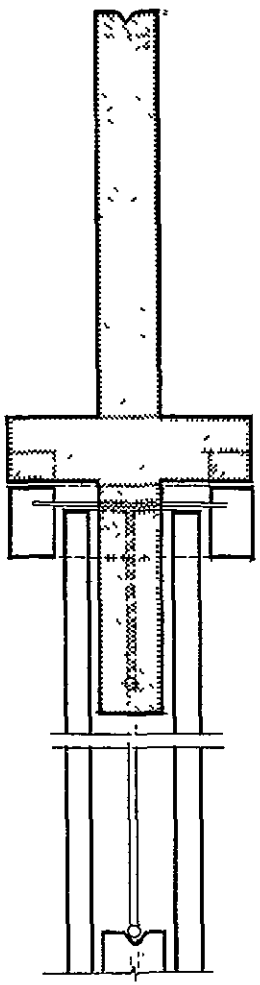
Place Unit No. 4 on exterior part of column.

ASSEMBLY SEQUENCE

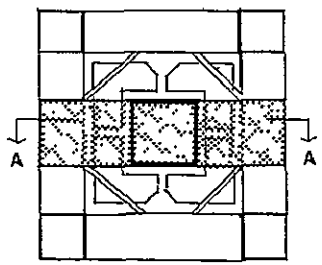
CONCRETE SMALL COMPONENT SYSTEM

SEQUENCE NO: 5

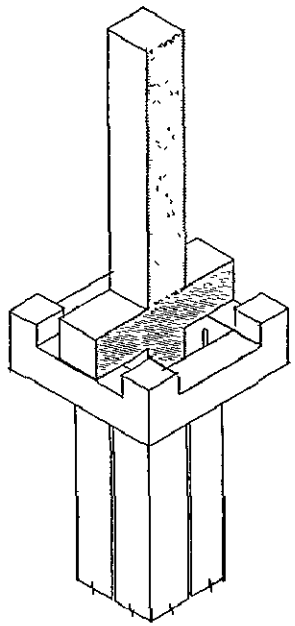
SECTION	PLAN	ISOMETRIC



Section A-A



Plan



ASSEMBLY SEQUENCE
No. 6

Place Unit No. 2 in the void between the four reinforced concrete angles. Place wires for capital connection.

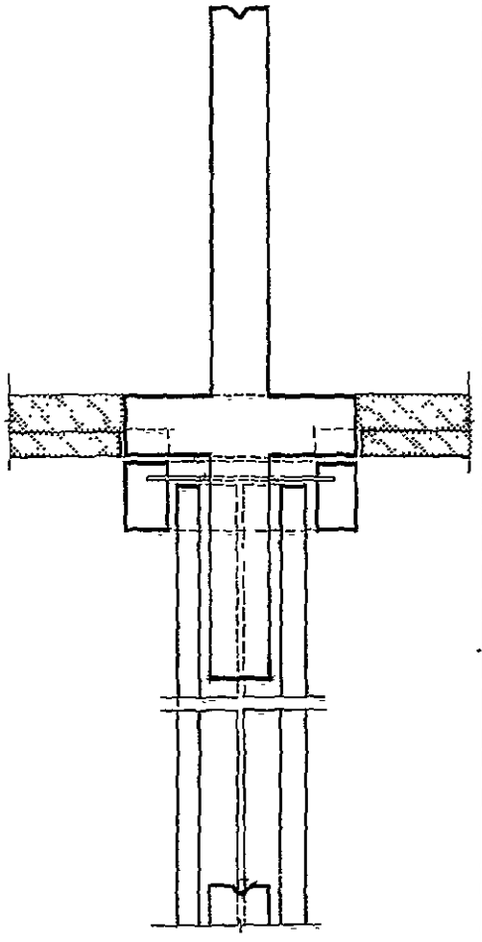
ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

SEQUENCE NO: 6

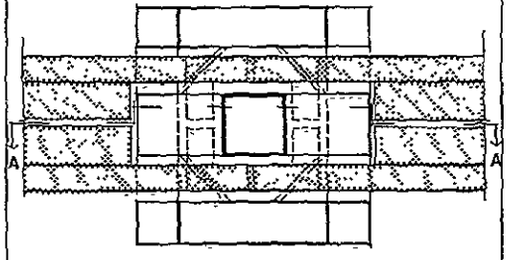
15

SECTION



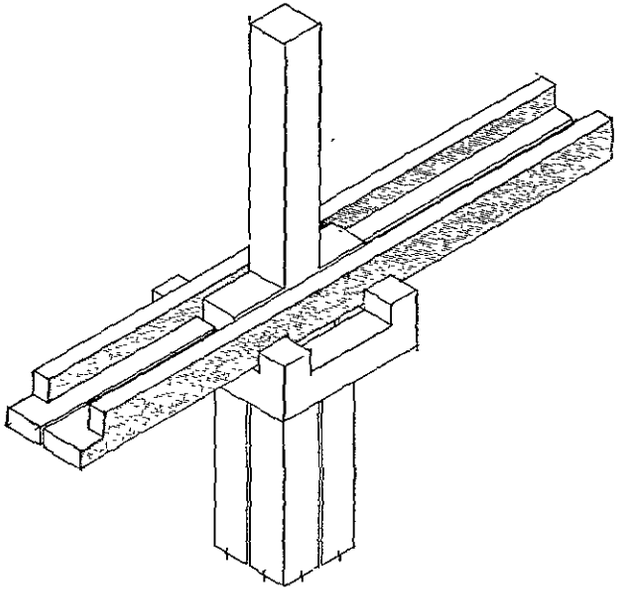
Section A-A

PLAN



Plan

ISOMETRIC



ASSEMBLY SEQUENCE
No. 7

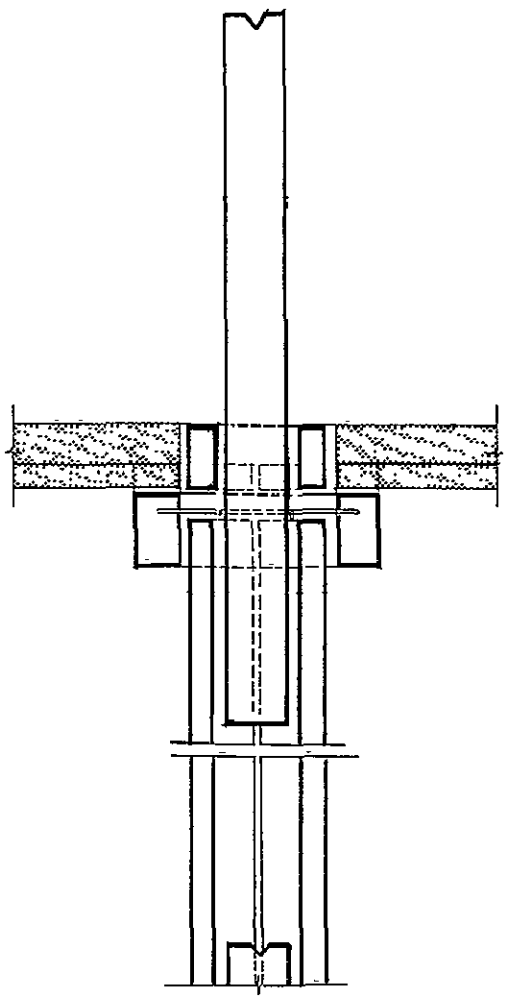
Place a couple of Unit No. 5 representing part of the main beam integrated with the column.

ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

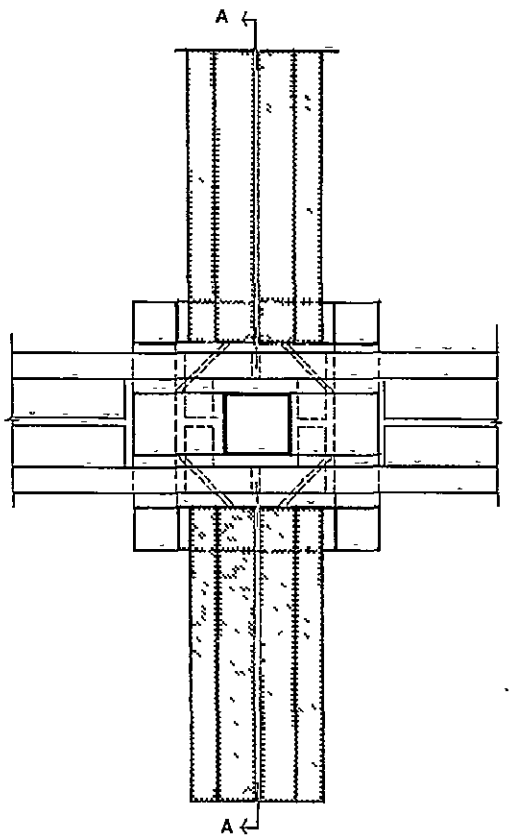
SEQUENCE NO: 7

PLAN



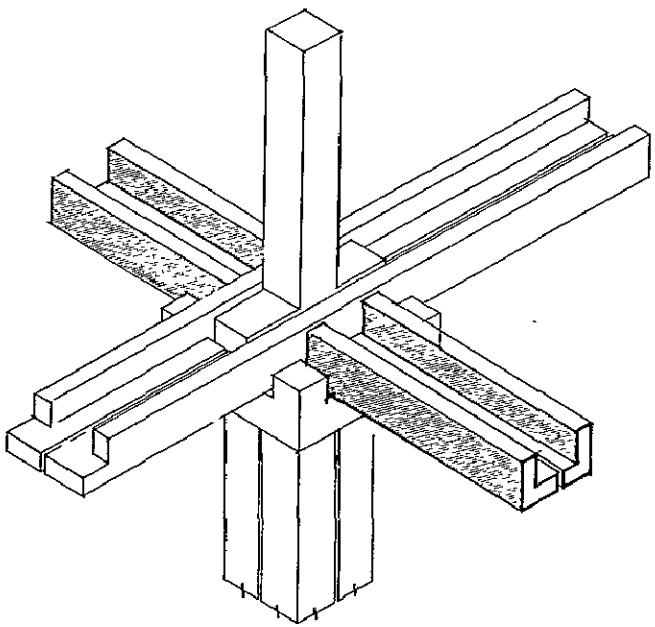
Section A-A

SECTION



Plan

ISOMETRIC



ASSEMBLY SEQUENCE
No. 8

Place a couple of
Unit No. 7 forming
the secondary beams.

ASSEMBLY SEQUENCE

CONCRETE

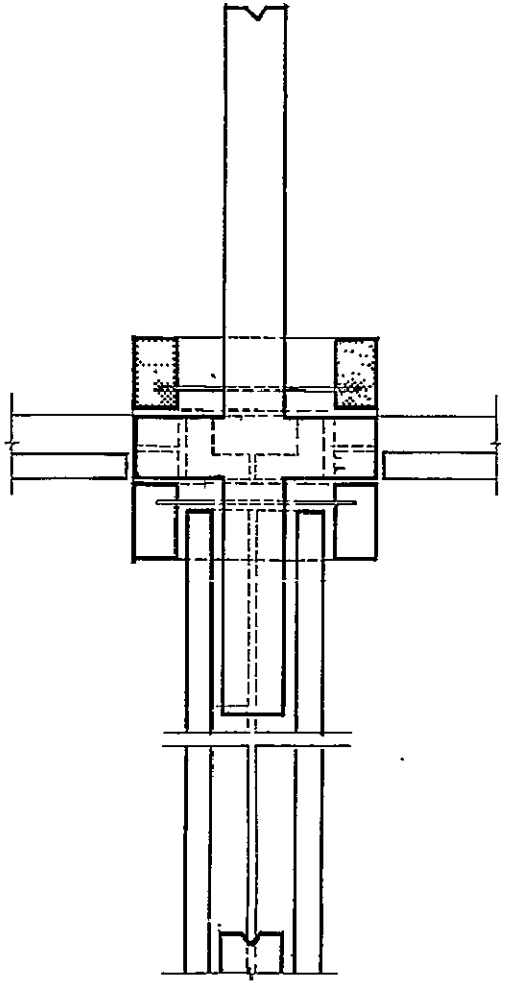
SMALL COMPONENT

SYSTEM

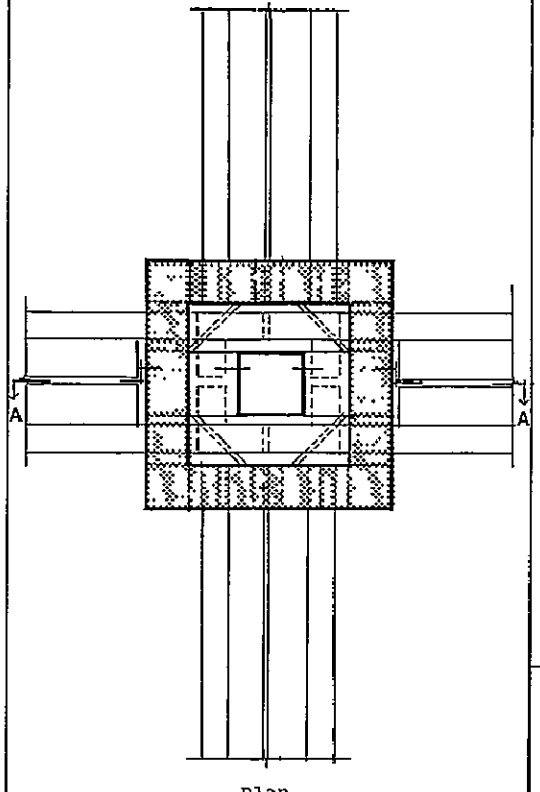
SEQUENCE NO: 8

33

SECTION

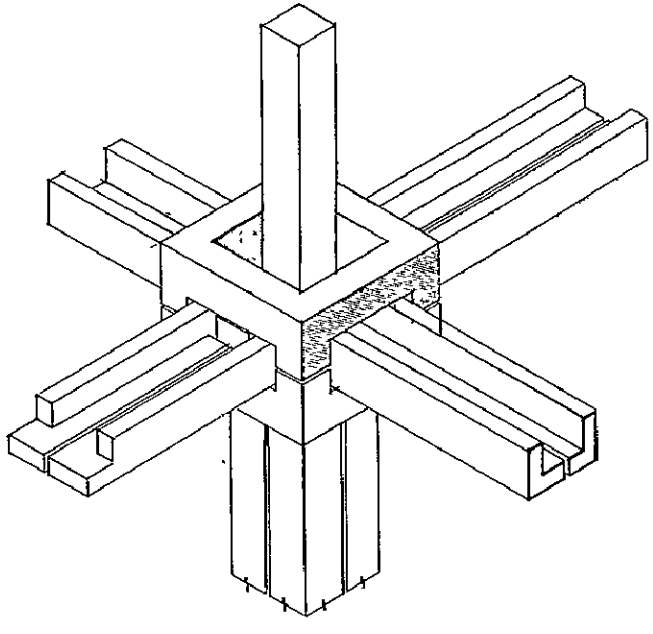


PLAN



Plan

ISOMETRIC



ASSEMBLY SEQUENCE
No. 9

Place Unit No. 4 forming the upper part of the capital.

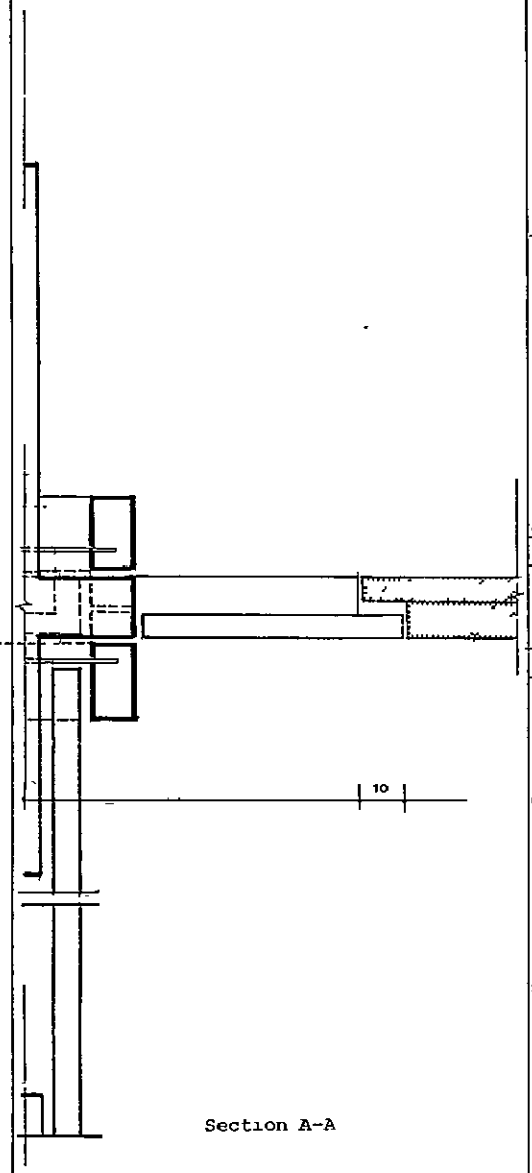
Connect exposed bars (12 mm) of both upper and lower parts of capital by means of mild thin wire.

ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

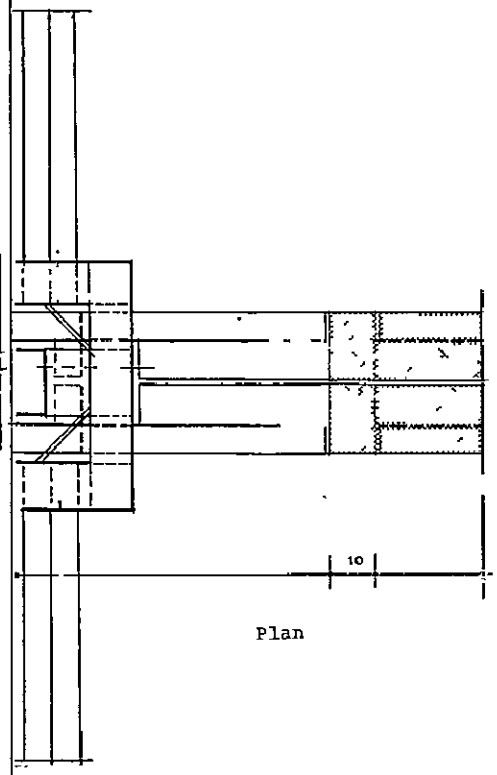
SEQUENCE NO: 9

SECTION



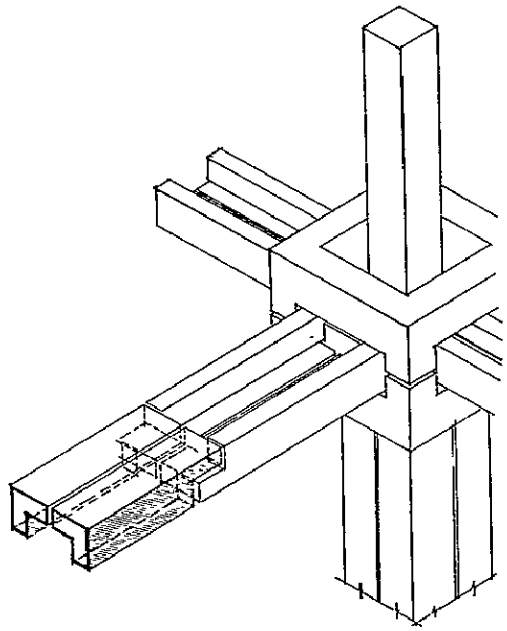
Section A-A

PLAN



Plan

ISOMETRIC



ASSEMBLY SEQUENCE
No. 10

Place a couple of Unit No. 5 forming the central part of the main beam.

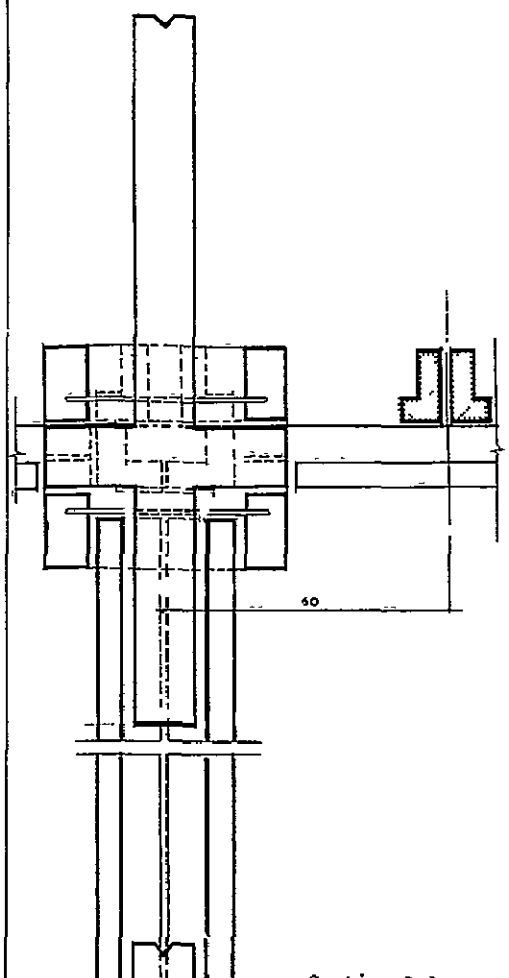
ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

SEQUENCE NO: 10

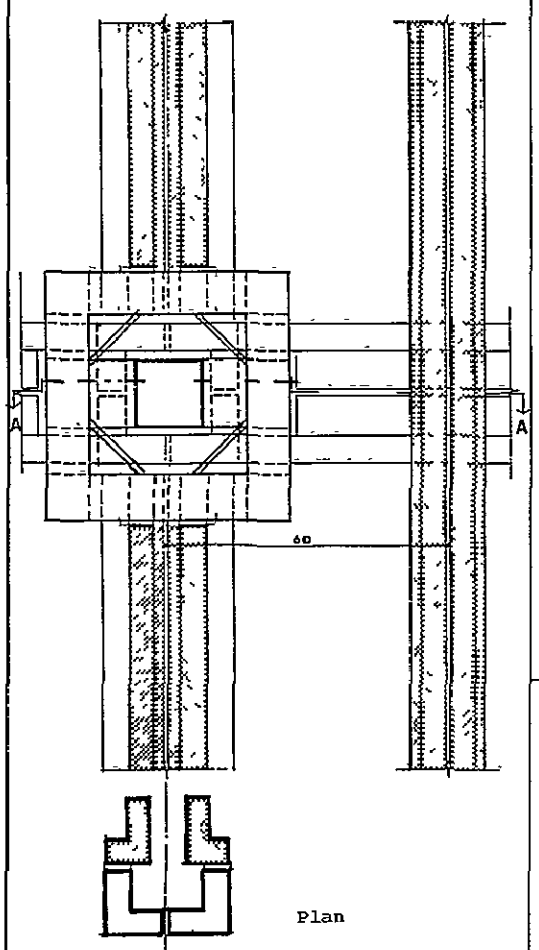
135

SECTION



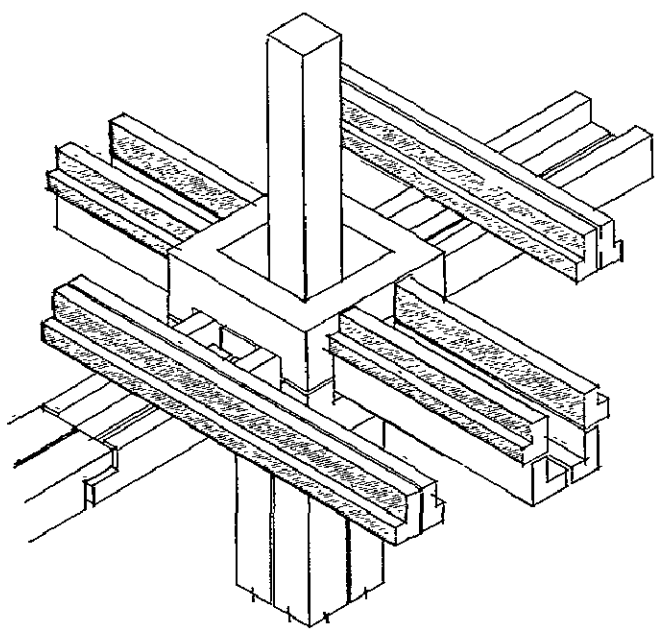
Section A-A

PLAN



Plan

ISOMETRIC

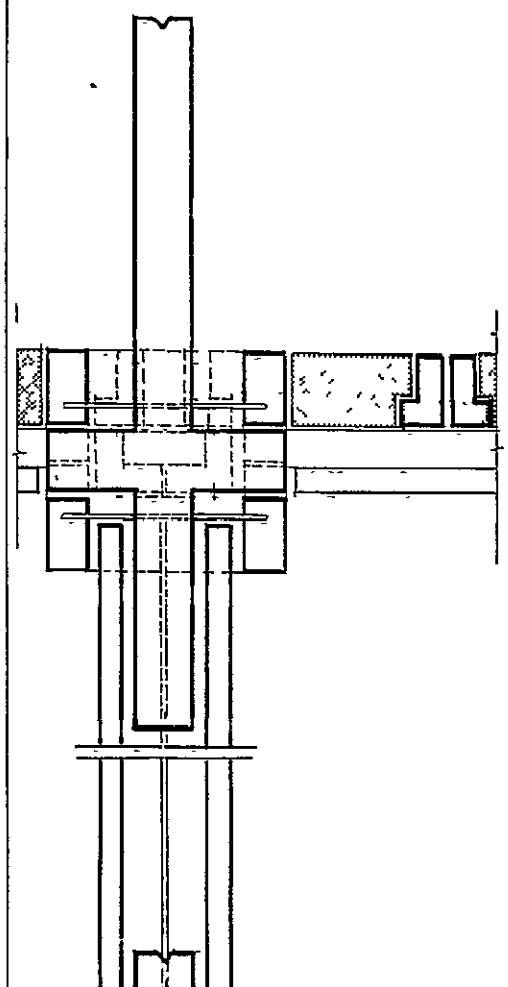


ASSEMBLY SEQUENCE
No. 11

Place Units No. 7 on secondary beams and main beams forming floor joists.

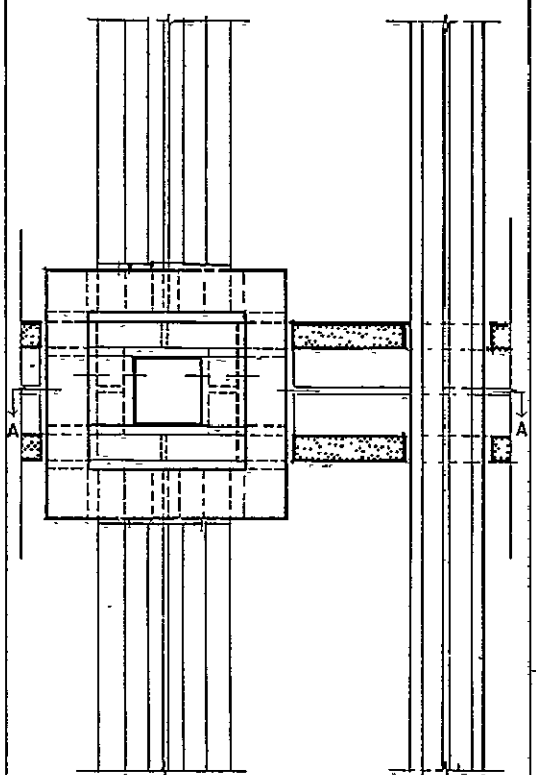
ASSEMBLY SEQUENCE
CONCRETE SMALL COMPONENT SYSTEM
SEQUENCE NO: 11
PAGE 20 OF 24

SECTION



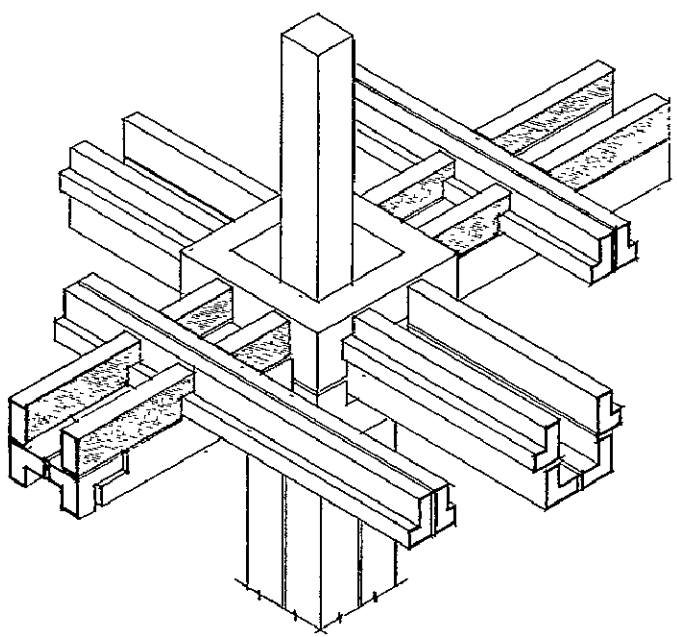
Section A-A

PLAN



Plan

ISOMETRIC



ASSEMBLY SEQUENCE
No. 12

Place side panels of any appropriate material (gypsum, concrete, brick etc.) to prevent spilling of concrete.

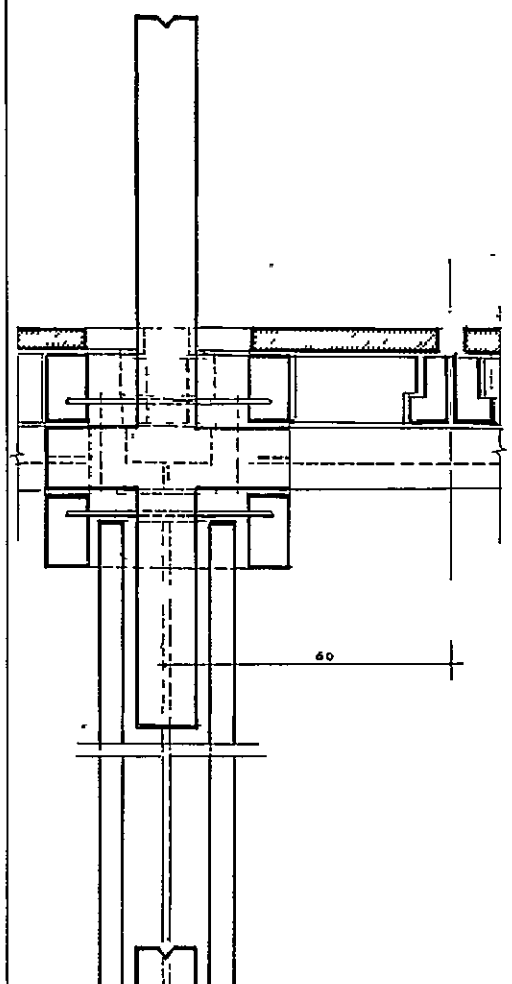
ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

SEQUENCE NO: 12

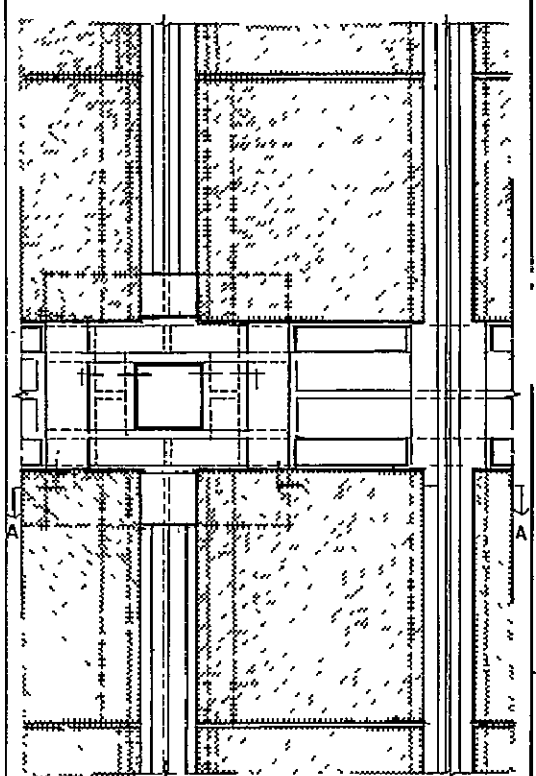
137

SECTION



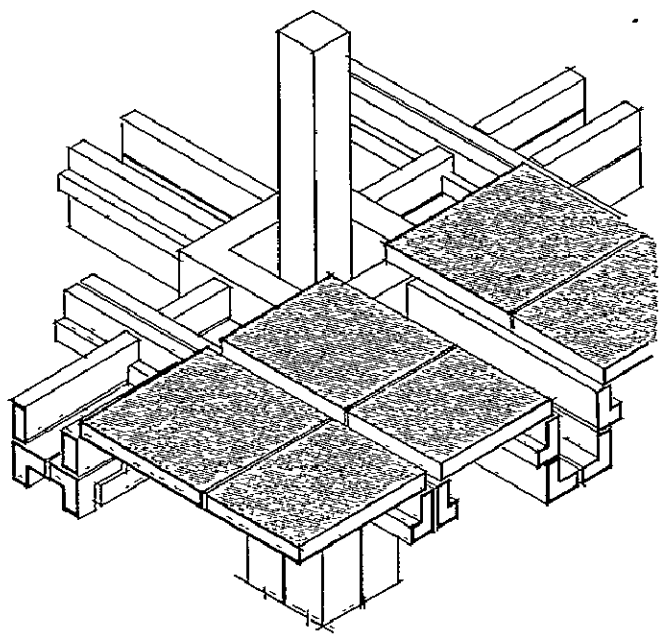
Section A-A

PLAN



Plan

ISOMETRIC



ASSEMBLY SEQUENCE
No. 13

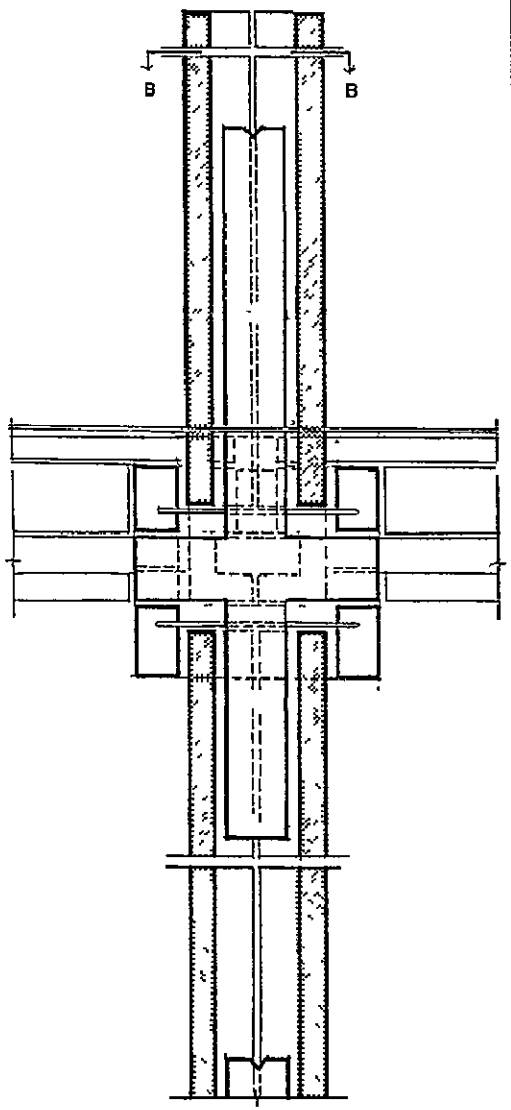
Place gypsum floor panels.

ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

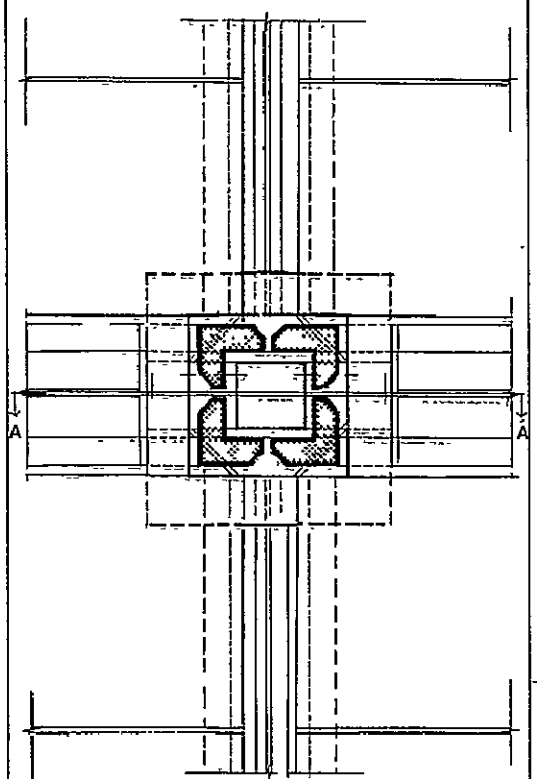
SEQUENCE NO: 13

SECTION



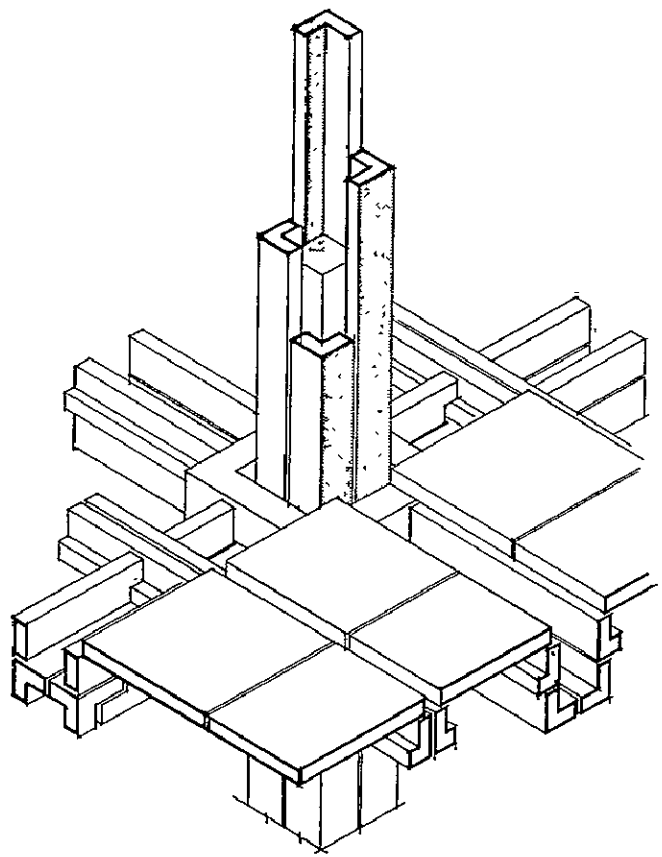
Section A-A

PLAN



Plan B-B

ISOMETRIC



ASSEMBLY SEQUENCE
No. 14

Place 4 units of Unit No. 3 forming exterior part of the column. Place main and secondary beams reinforcement.

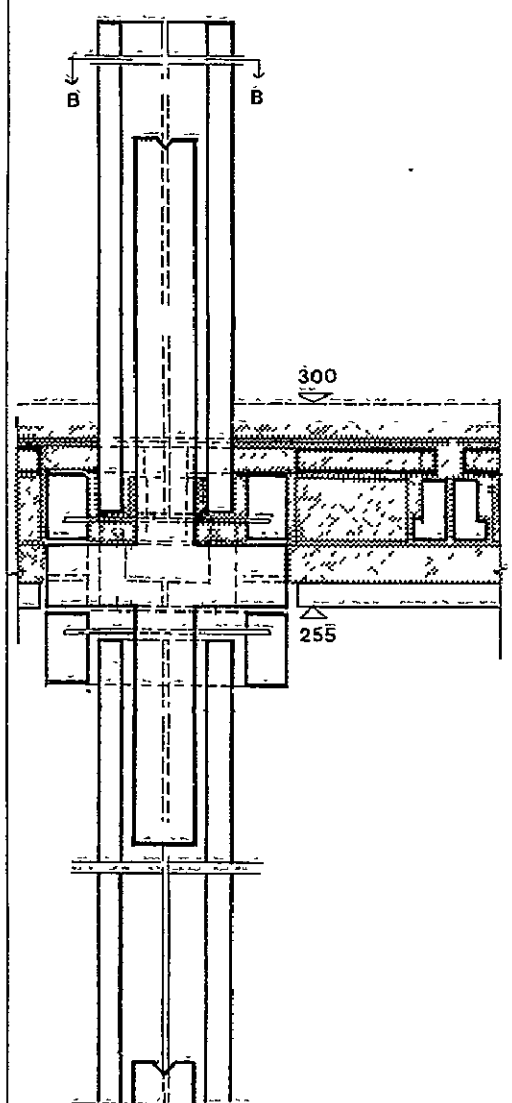
ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

SEQUENCE NO: 14

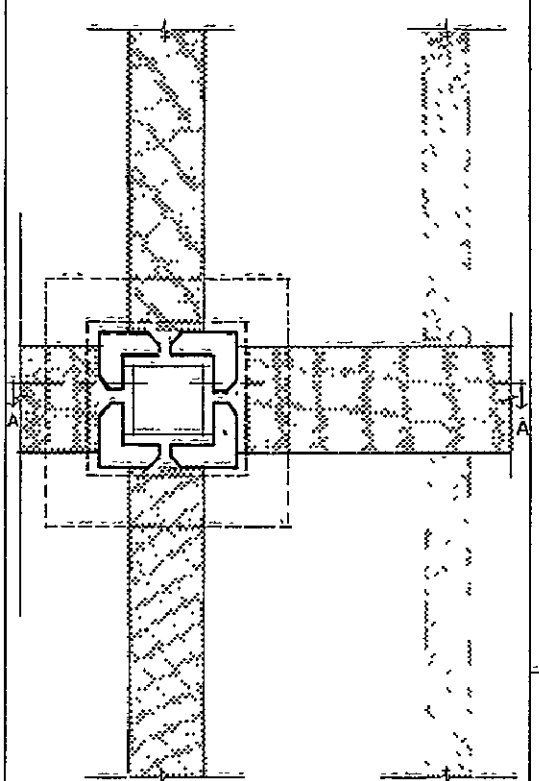
39

SECTION



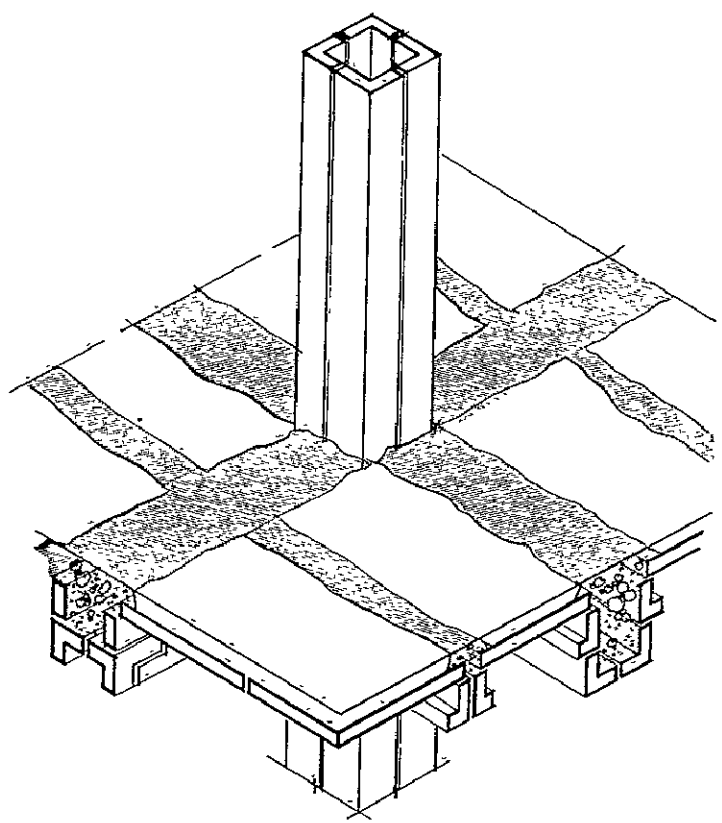
Section A-A

PLAN



Plan B-B

ISOMETRIC



ASSEMBLY SEQUENCE
No: 15

Pour concrete in beams and joists, fill the areas between them with sand.

The surface is ready for any kind of flooring.

ASSEMBLY SEQUENCE

CONCRETE SMALL COMPONENT SYSTEM

SEQUENCE NO: 15

2.0 POSITIONAL CORRDINATION

2.1 The Tartan (Band) Grid as a Positional Coordination System

2.1.1. General Rules

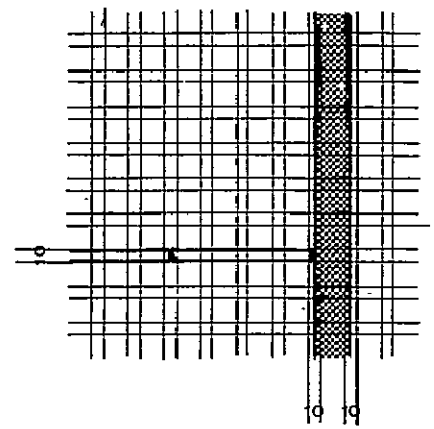
(a) All structural elements will be placed in the 20 cm bands, or their intersection.

(b) All partitions and/or "infill" elements (secondary elements) will be placed in the 10 cm bands (or end in 10 cm bands).

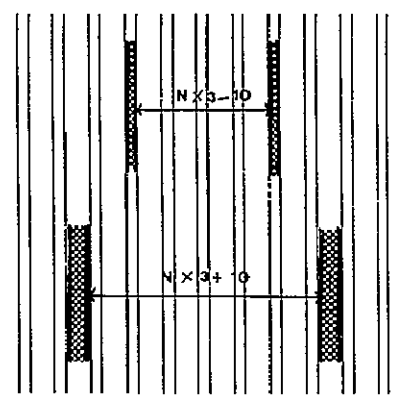
(c) The vertical module is based on a simple 20 cm line grid (i.e., no bands).

2.1.2. Location of Components

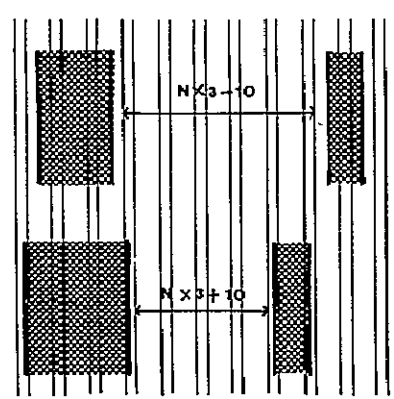
All Components Are Placed With Their Edges in the 10 cm Band.



A Component is located within a Band



Faces of Components occur



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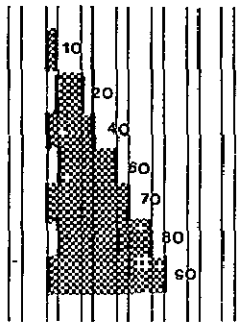
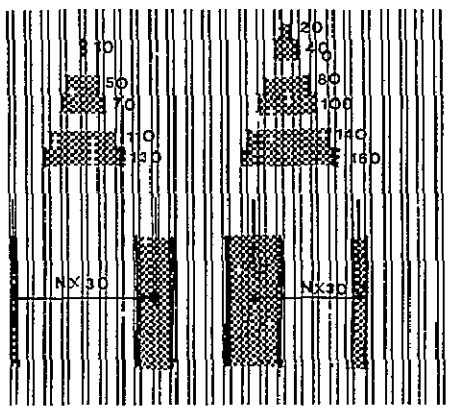
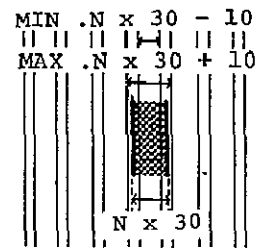
2.1.3. Thickness of Components

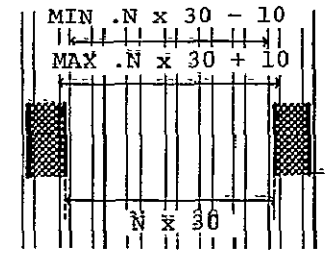


Depending upon the distance between the two bands, there is a series of possible thicknesses.

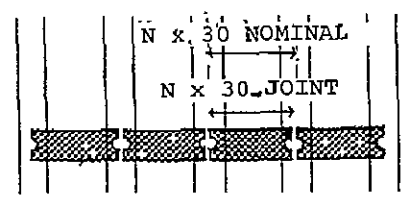


2.1.4. Nominal Dimensions





A nominal dimension is always a multiple of the Module of the Grid that is being used.



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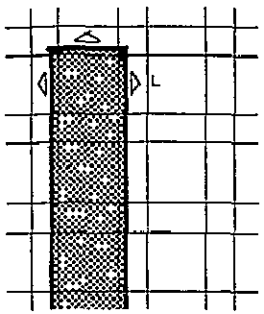
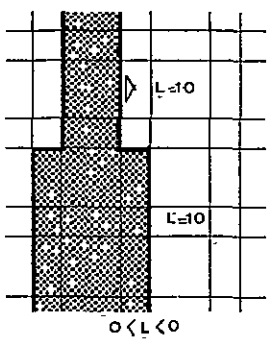
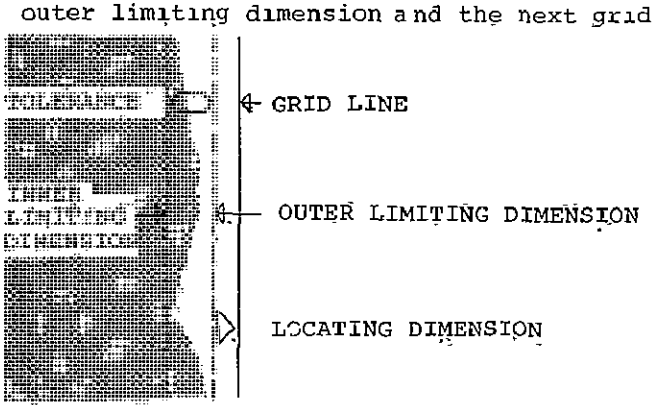
2.1.5. Locating Dimensions



The locating dimension is the distance between the component and the next grid line.



The locating dimension is the distance between the outer limiting dimension and the next grid line.



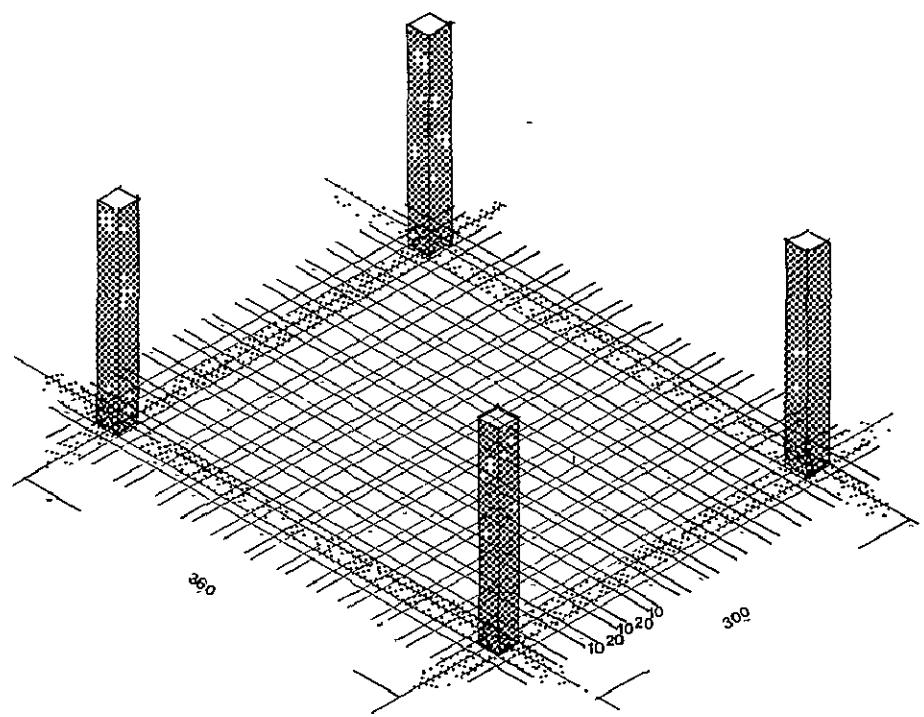
2.1.6. The Vertical Plane

Advantages of band method of modular positioning:

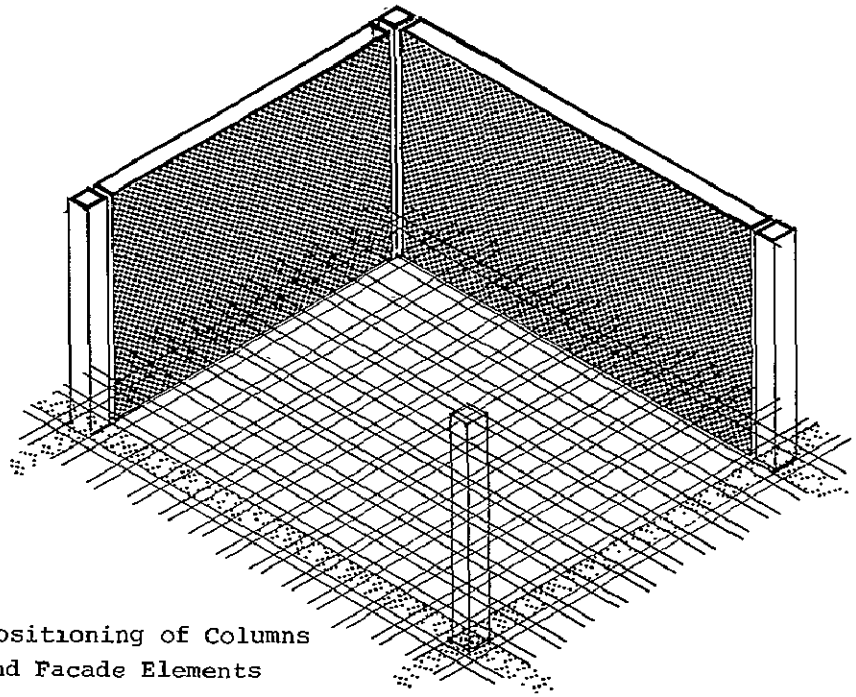
(1) Engineer works on center-lines (of bands), i.e., 10 cm and 30 cm = standard internationally accepted modular order.

(2) Architect works with bands (i.e., from band edge to band edge). Positioning of walls and partitions can be done independently of technical and structural determinations, without necessary major adjustments later.

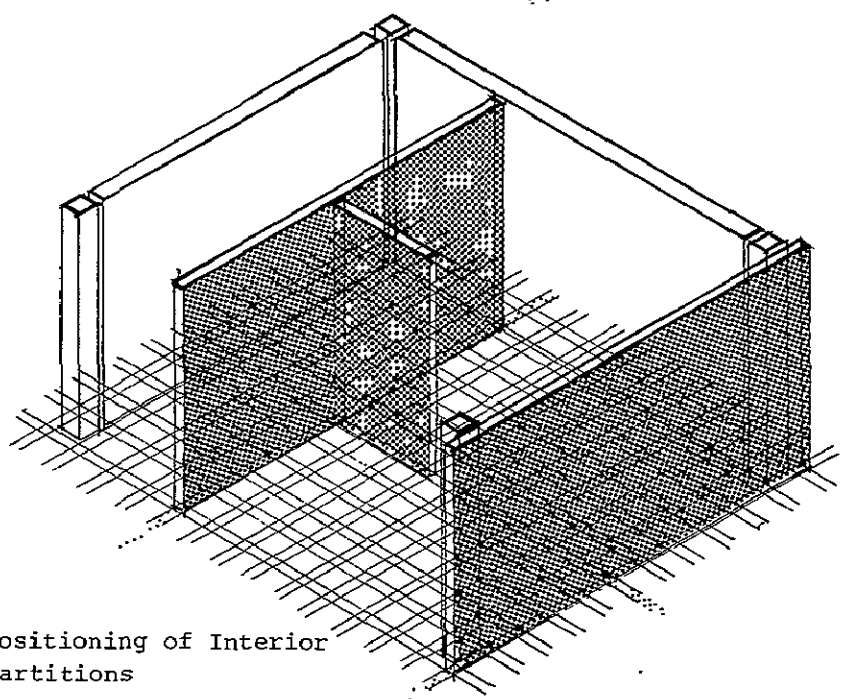
(3) Supplies of other elements are provided with guaranteed "free" space (i.e., space between bands).



Schematic of Location of Columns on Band Grid



Positioning of Columns and Facade Elements



Positioning of Interior Partitions

2.2 Example of Positional Coordination

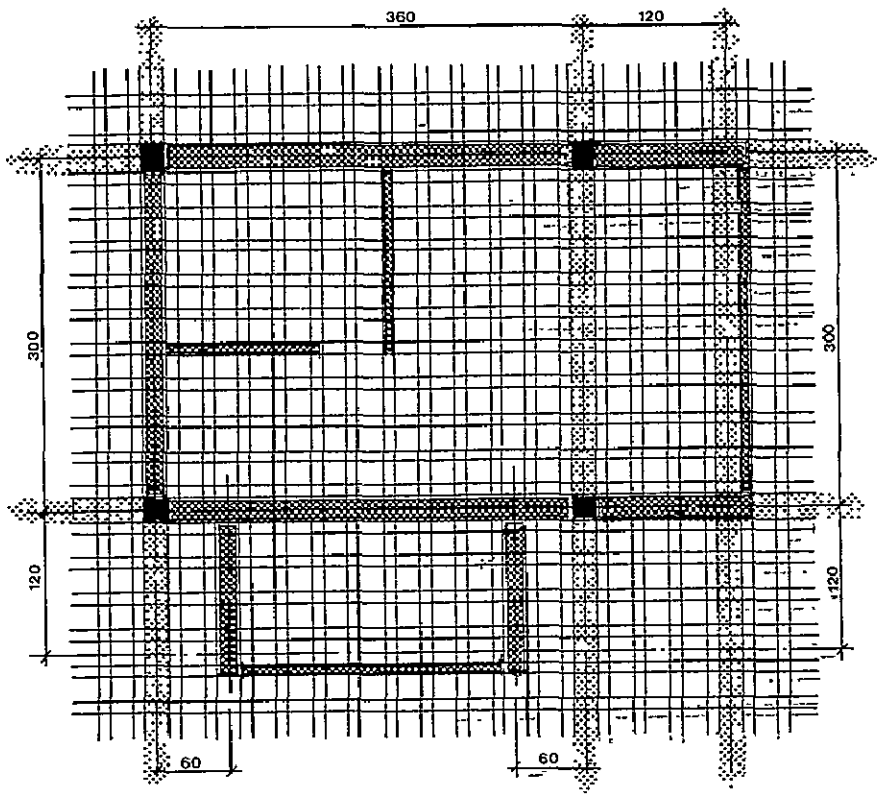
2.2.1 Positioning of Columns and Facade Elements

According to rule 2.1.1.1(a) all structural elements are placed in 20 cm band, but are assumed to terminate in 10 cm bands on each side, to provide "guaranteed free space" for planning of layout (and infill elements) of the nominal dimension N x 30 + 10.

This means that all secondary elements are effectively pre-coordinated to fit into "guaranteed free space", and that only irregular conditions at joints need to be considered.

2.2.2 Positioning of Partitions

According to Rule 2.1.1.1 (b), all interior partitions are placed in 10 cm band, or end in a 10 cm band. See remarks made above (2.2.1) for conditions of compatibility with primary structure elements.



Relationship of Structural Elements to Basic Plan

3.0 BASIC PLAN DETERMINANTS

3.1 STRUCTURAL

The basic structural bay dimensions of 300 x 360 cms is based on the weight to span ratio, which, in turn is the result of portability.

Two options for cantilevered elements are provided:

(1) A full width 120 x 300 cms cantilever, which allows either a full terrace, or an extension of the 360 cm dimension to 480 cms.

(2) A balcony cantilever of 120 x 240 cms.

Combinations of these dimensions allow different basic size variations, as shown on facing page. (3.2)

3.2 Dimensional

The internationally accepted 30 cm planning module (3 x 10 cm) has been accepted throughout the study as the basic increment for room size.

4.0 FLEXIBILITY, VARIABILITY, ADAPTABILITY

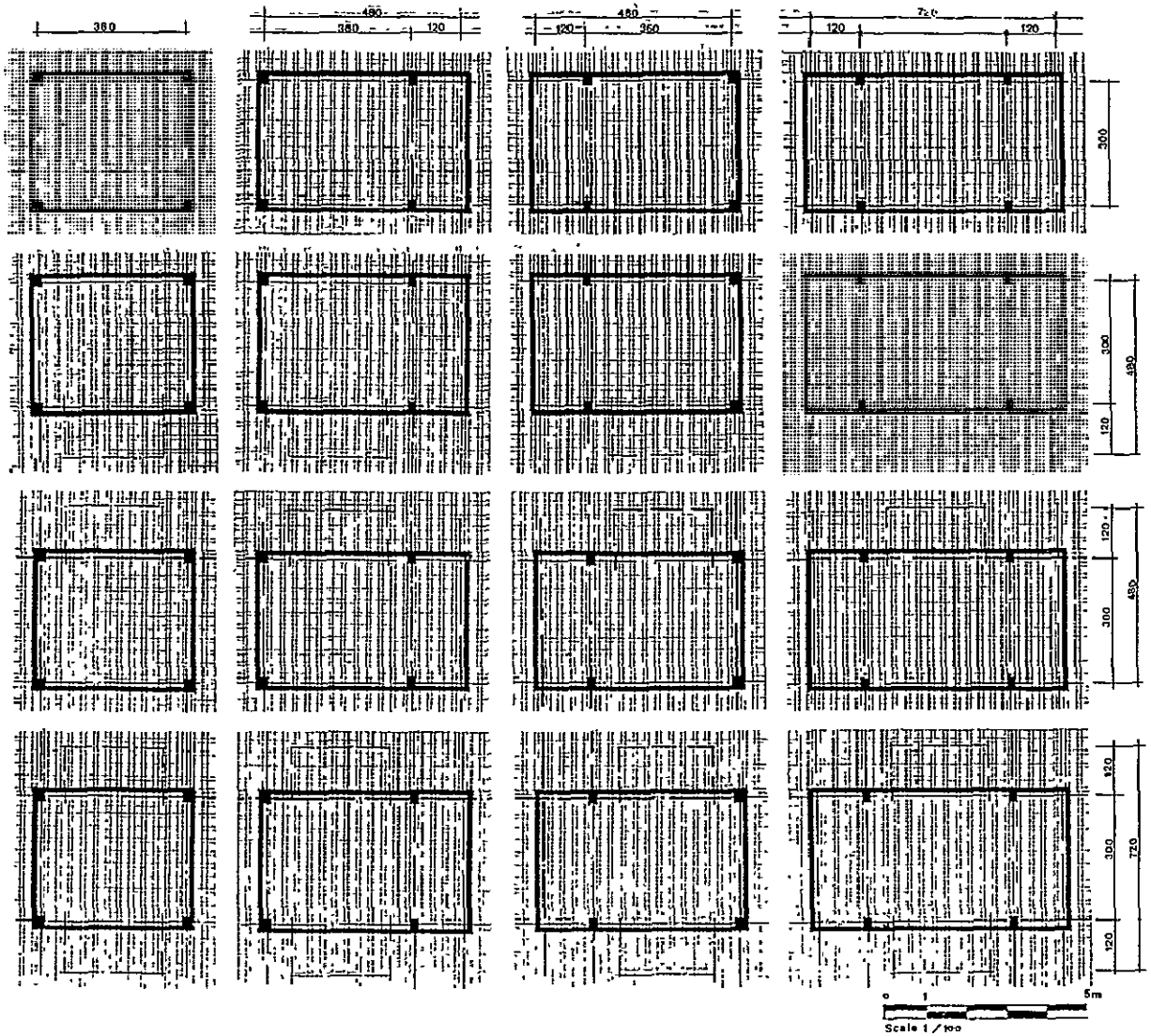


Chart showing possible variations of enclosed volume with or without cantilever

4.1 VARIATIONS BASED ON CANTILEVER UTILIZATION

146

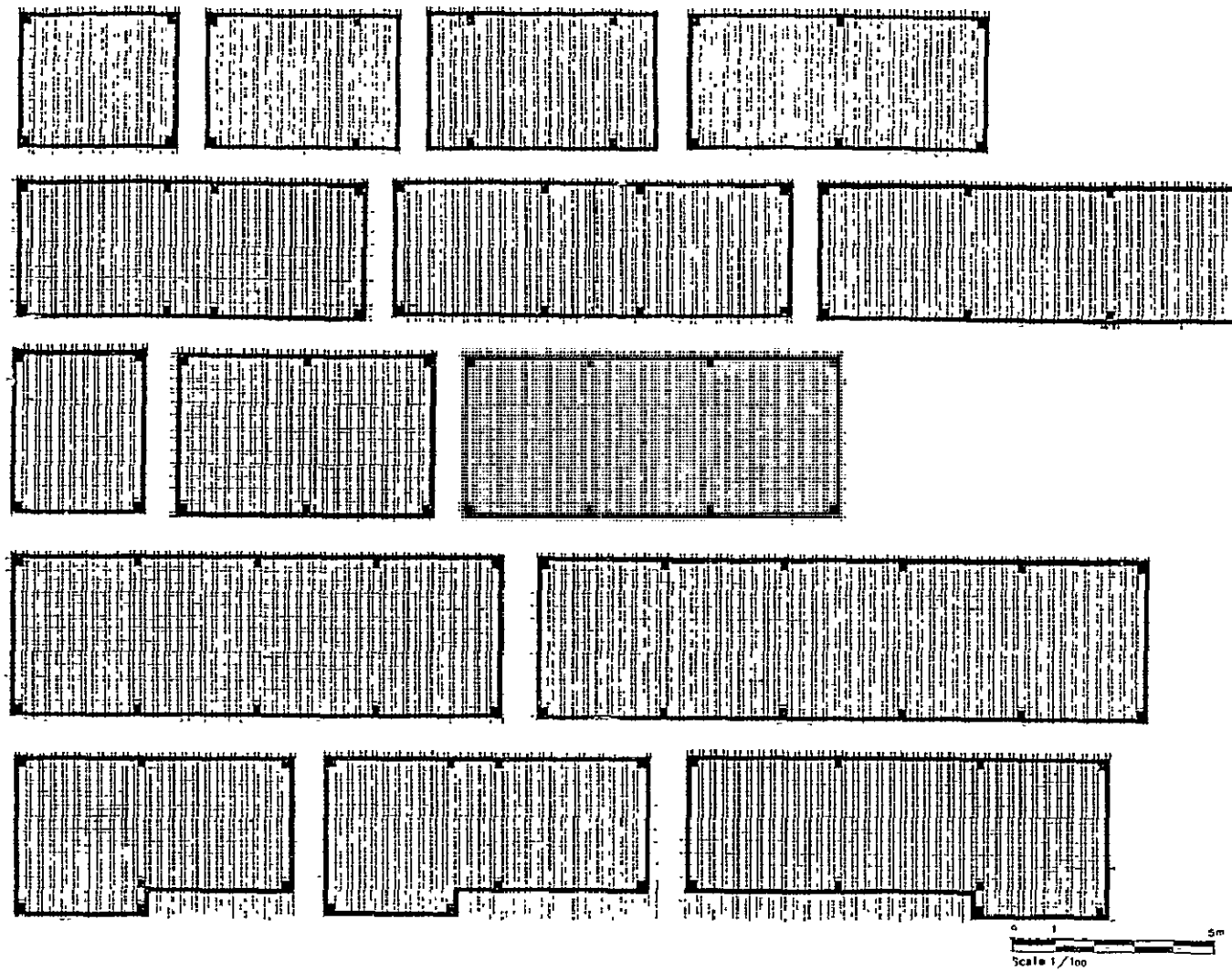
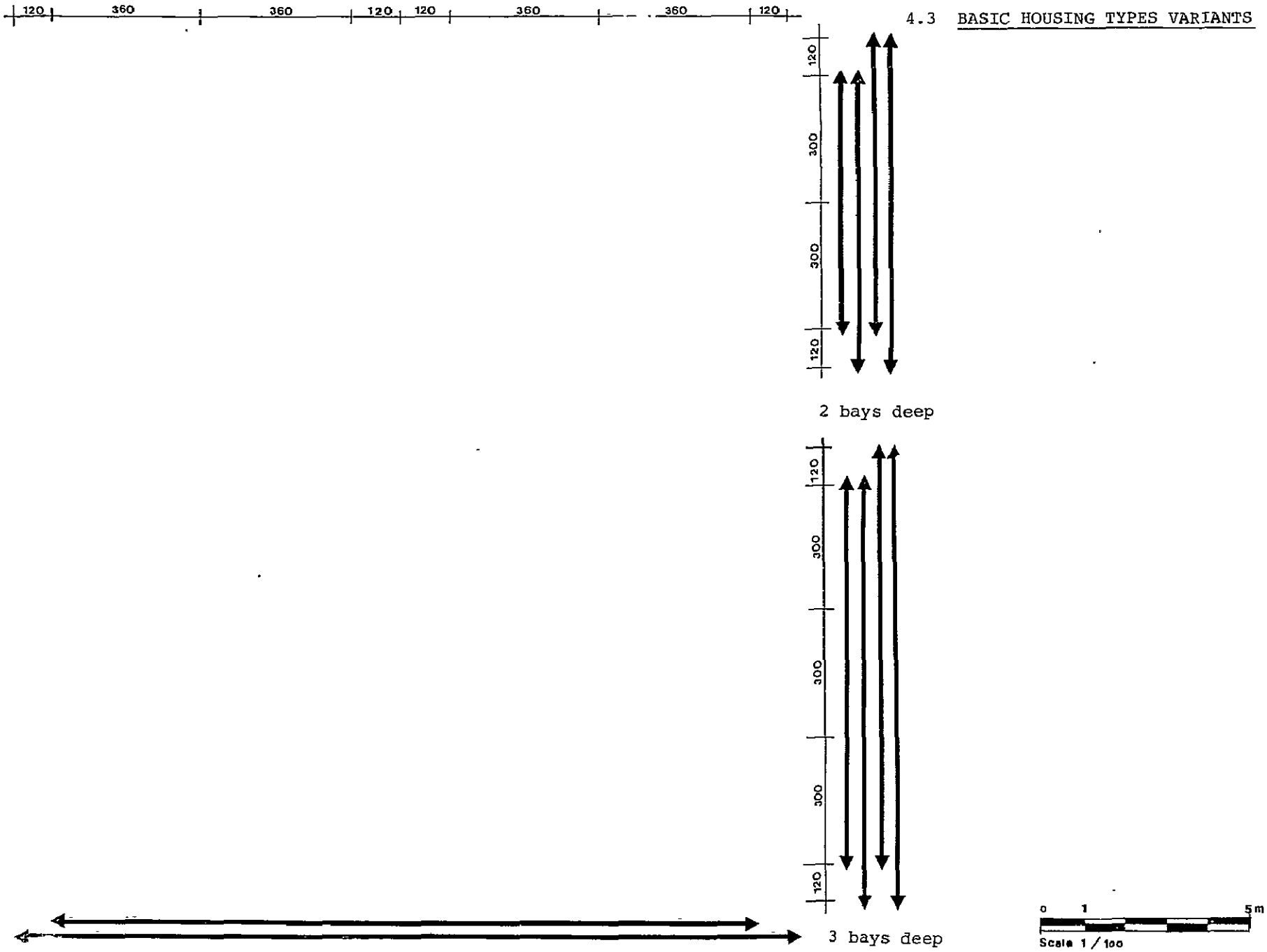
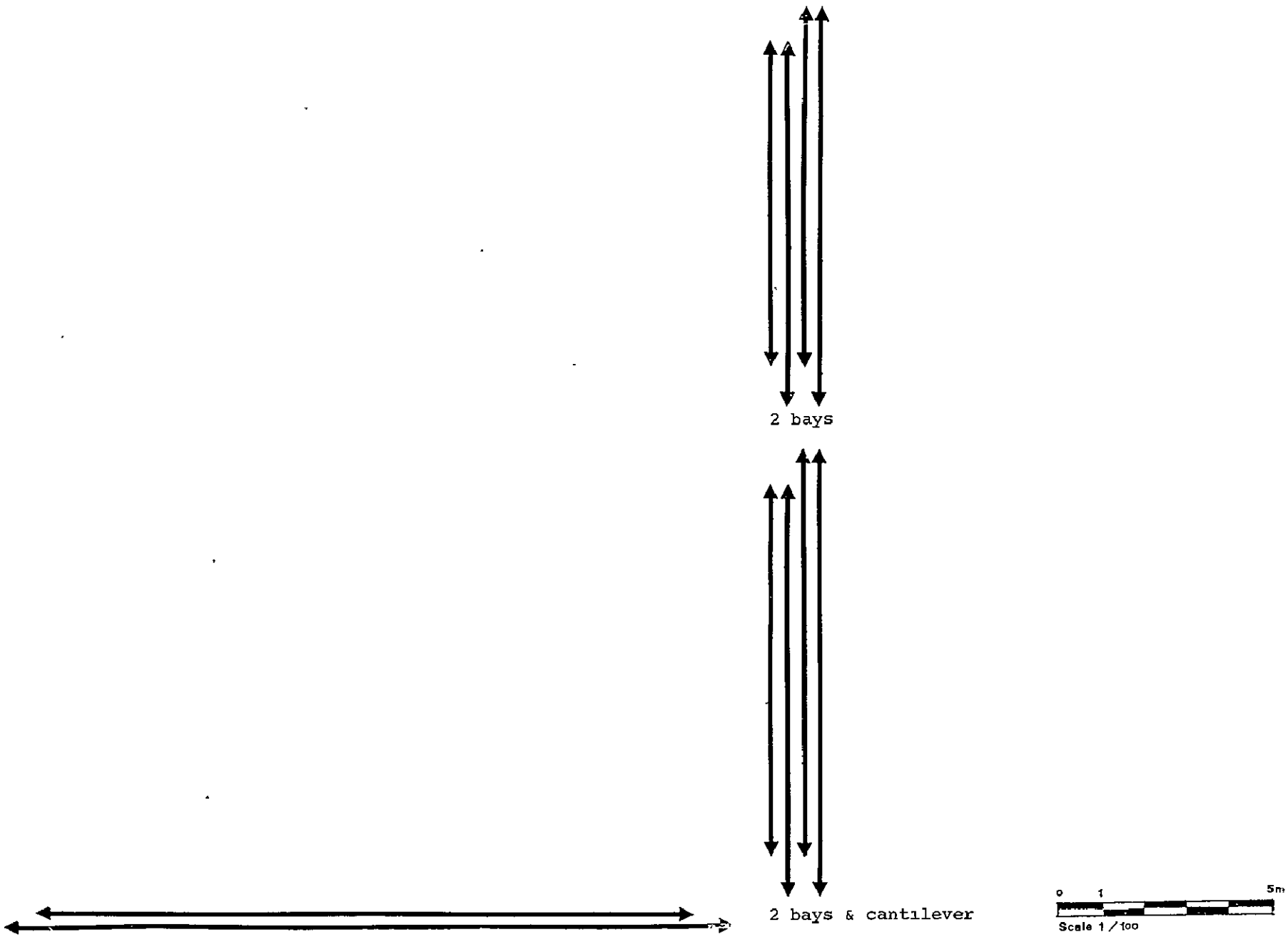


Chart of possible generic configurations, by combining volumes shown on page 11

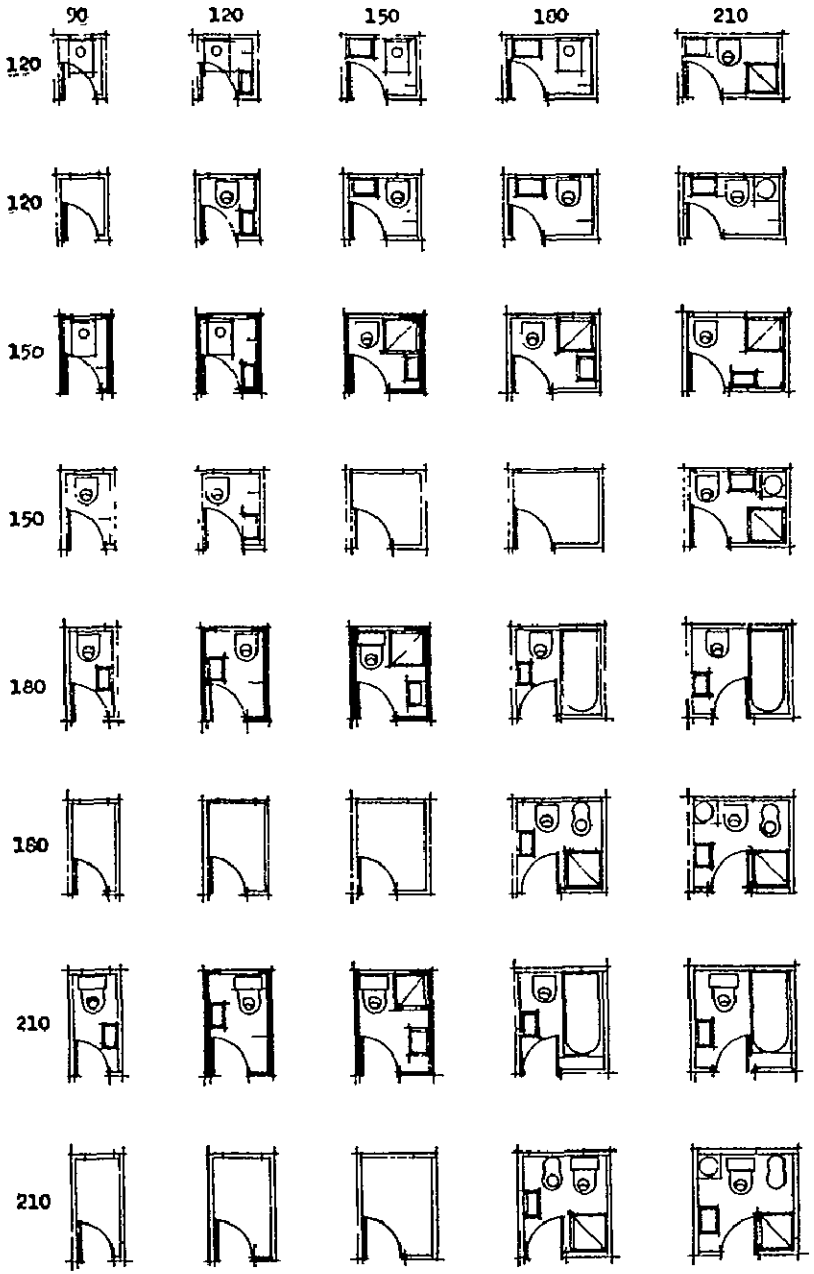
4.2 VARIABILITY BASED ON COMBINATIONS OF BASIC VOLUMES (FROM 4.1)

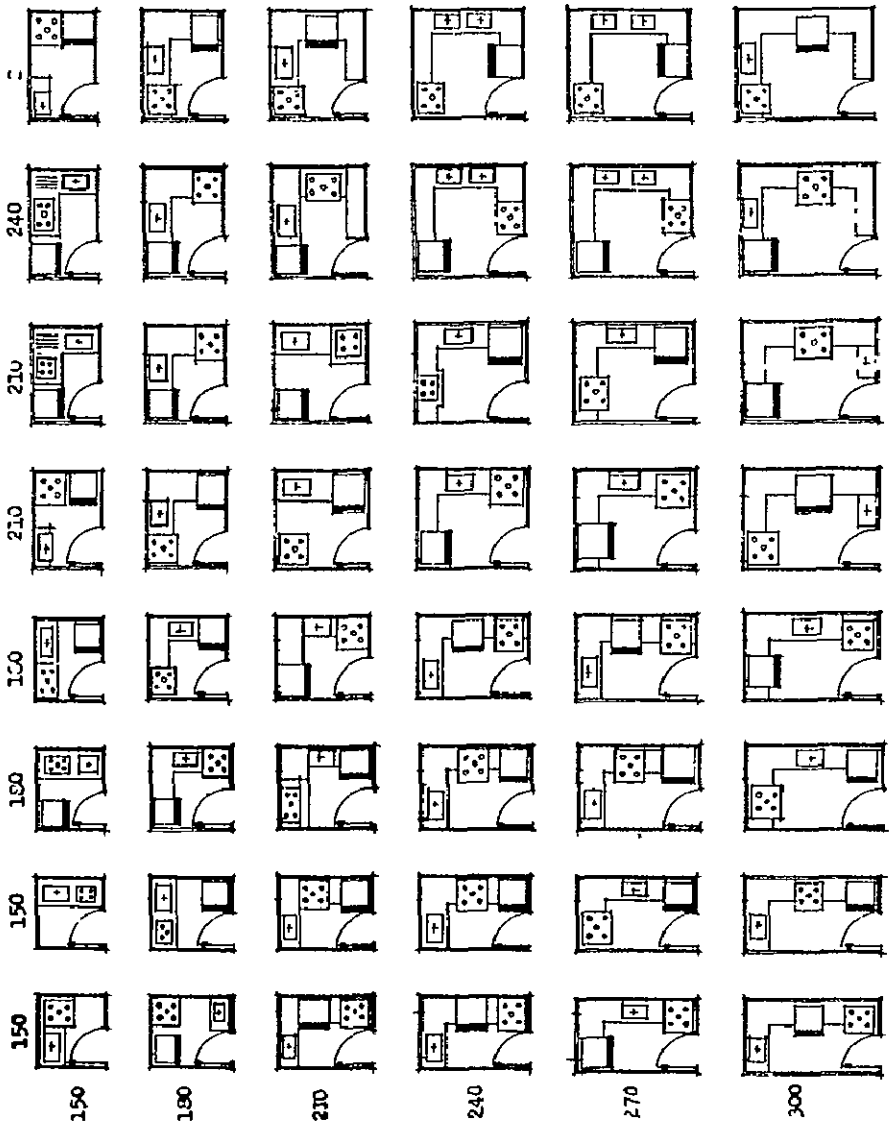
4.3 BASIC HOUSING TYPES VARIANTS




2 bays
2 bays & cantilever
0 1 5m
Scale 1/100

.4 FUNCTION LAYOUTS FOR BATHS, TOILETS & KITCHENS





Possible Layouts for Standard Baths

Possible Layouts for Standard Kitchens

150

5. GENERIC HOUSE TYPE PLANS

5.1 Types of Plans

The following generic plans have been selected to test the versatility of the Light Weight/Small Component System:

1. Core House
2. Higher Income Apartments
3. Traditional Private Developer Town House
4. Conventional (Concrete Panel) Prefabricated System

5.2 Origin of Plans

All the above listed plans have been found to be widely used in and around Cairo, as determined by surveys and actual site visits during preceding phase of research (viz.: "The Housing and Construction Industry in Egypt; Interim Report Working Papers, 1977 and 1978").

5.3 System Application

The plans shown here have been "adjusted" to conform to:

(a) The band grid (10 cm/20 cm)

(b) The structural span of the horizontal components

Care has been taken to avoid increasing the overall floor area, and to maintain the basic integrity of the layouts, while at the same time integrating the structural system with the plans with the least disruption of its structural and construction integrity.

Joint conditions between the primary structural components and the secondary "infill" elements will be elaborated in conjunction with the erection and testing of the prototype at Cairo University.

6. EXAMPLES OF GENERIC PLANS

6.1 Core House

6.2 Traditional; Conventional Construction by Private Developers

6.3 Apartment Building

6.4 4-Story Walk-up Court House

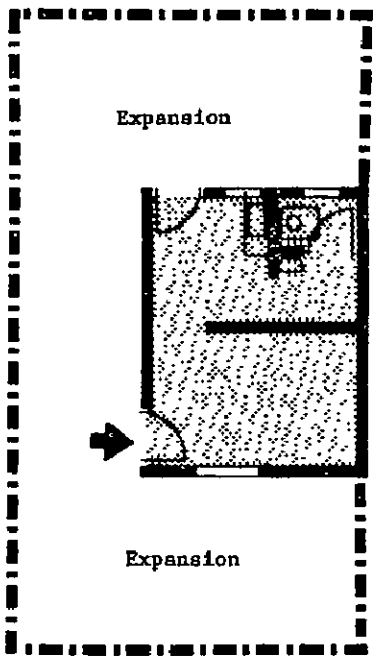
6.5 Prefabricated Large Concrete Panel System

152

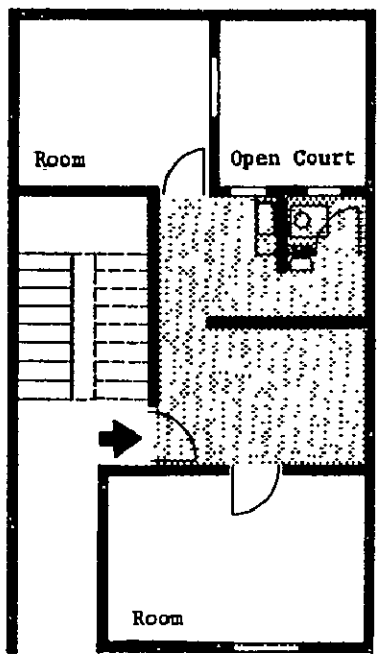
153

6.0 EXAMPLES OF GENERIC PLANS

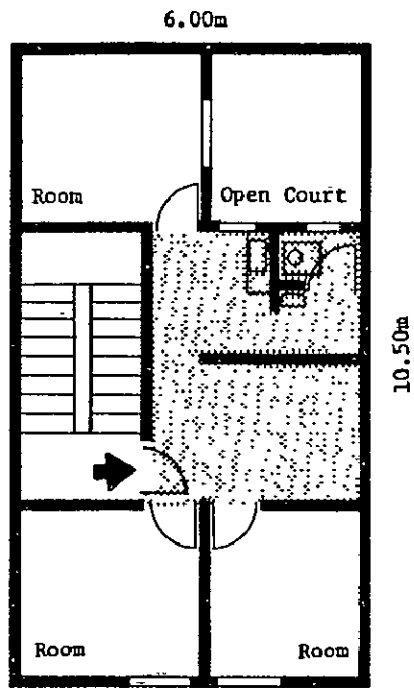
6.1 CORE HOUSE



BASIC UNIT



POSSIBLE FINAL STAGE:
UPPER FLOORS

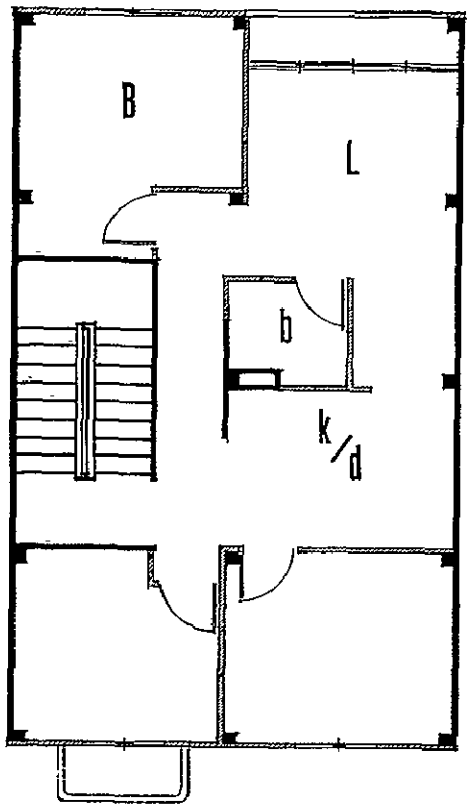


POSSIBLE FINAL STAGE
GROUND FLOOR

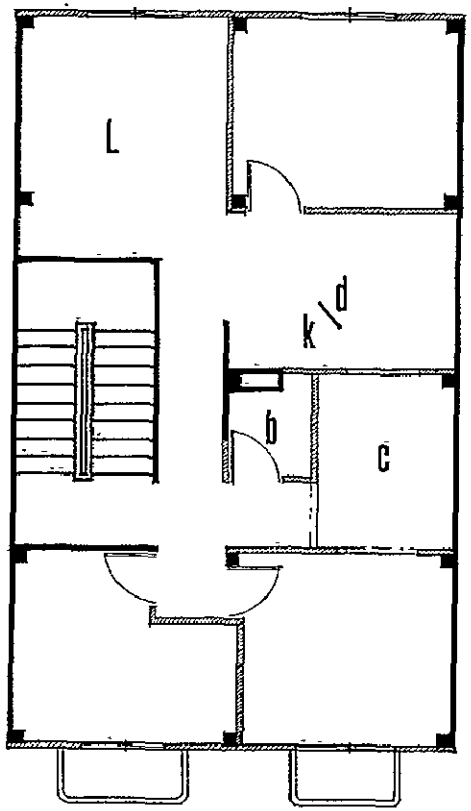
TYPE "A"

Original plan

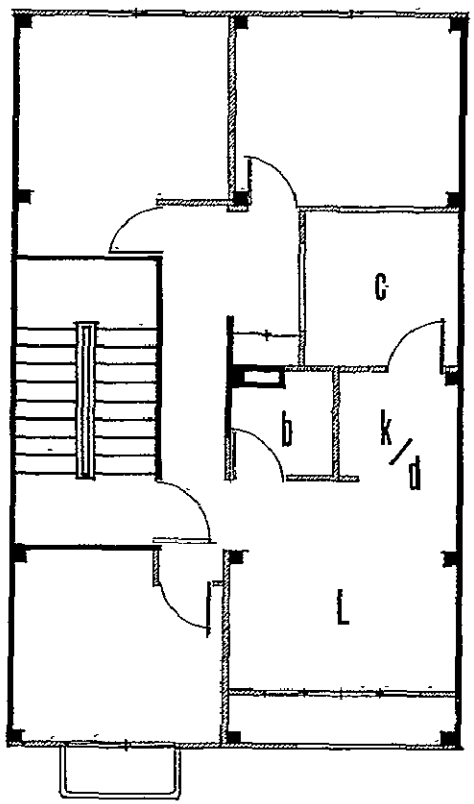
15f



A VARIATION OF BASIC VARIANT 1



A VARIATION OF BASIC VARIANT 2



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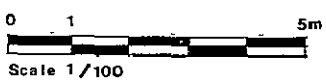
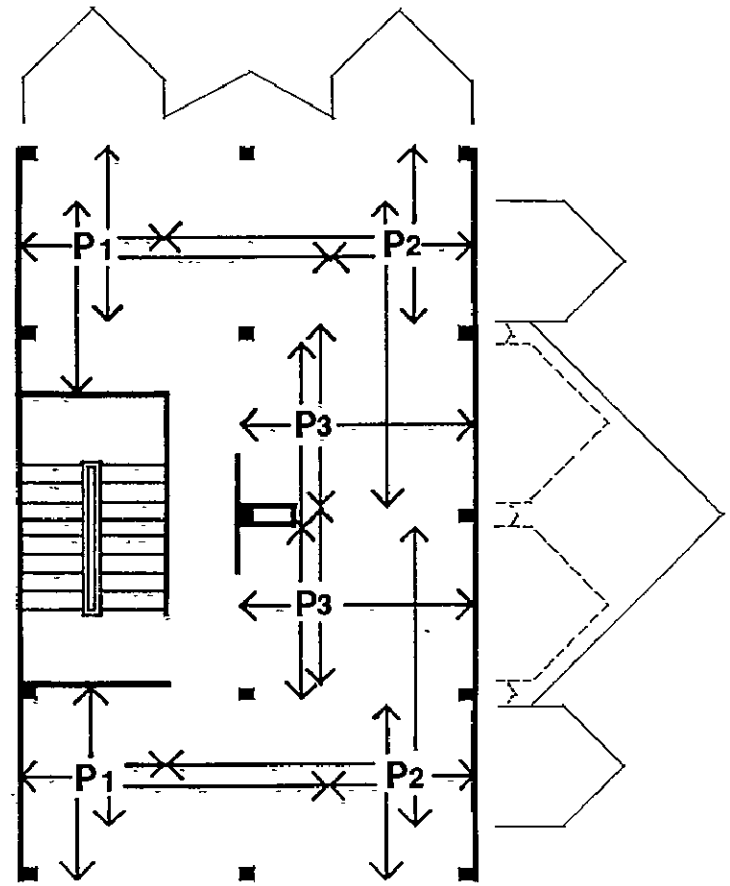
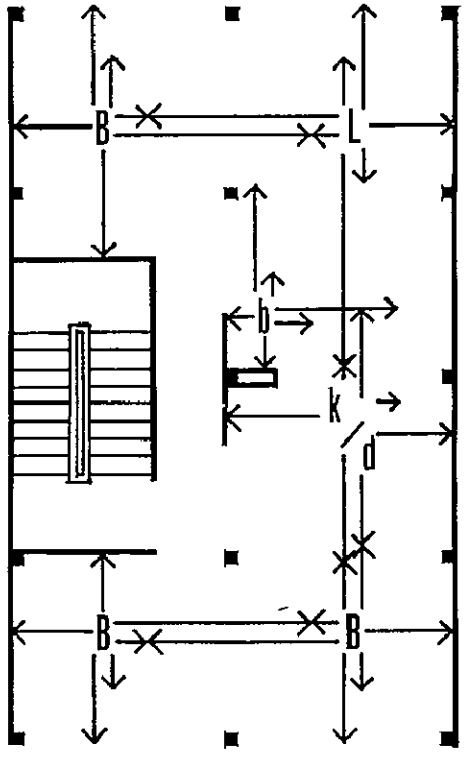


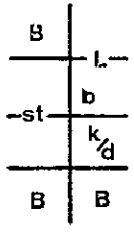


SUPPORT STRUCTURE AND ZONE ANALYSIS

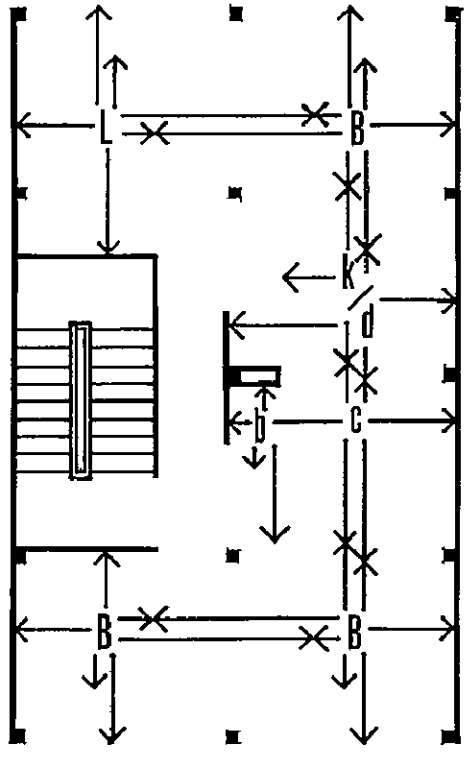
ANALYSIS OF POSITIONING

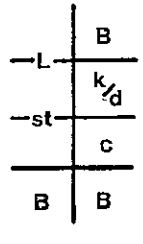
156





POSSIBLE BASIC VARIANT 1





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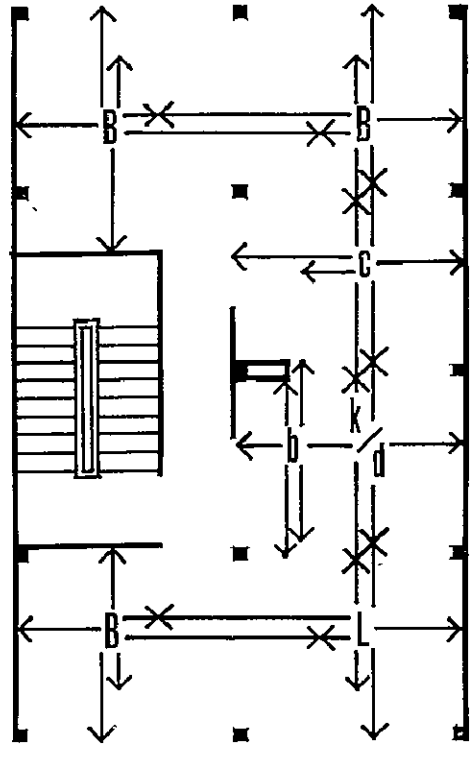
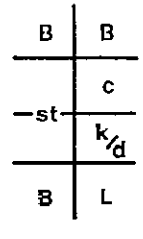
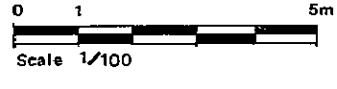
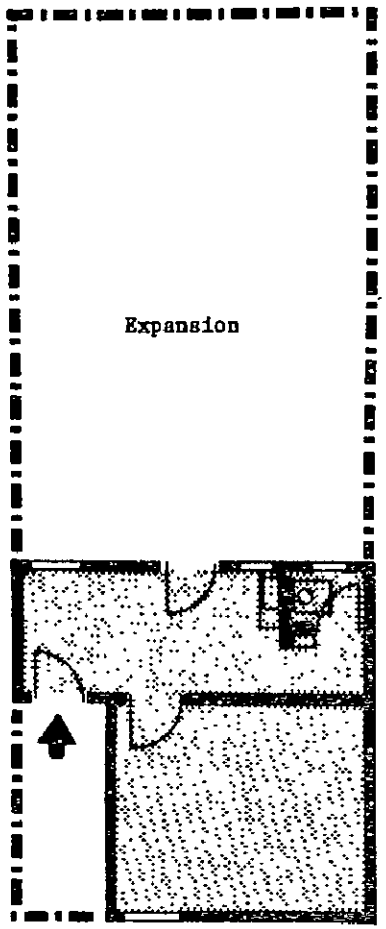


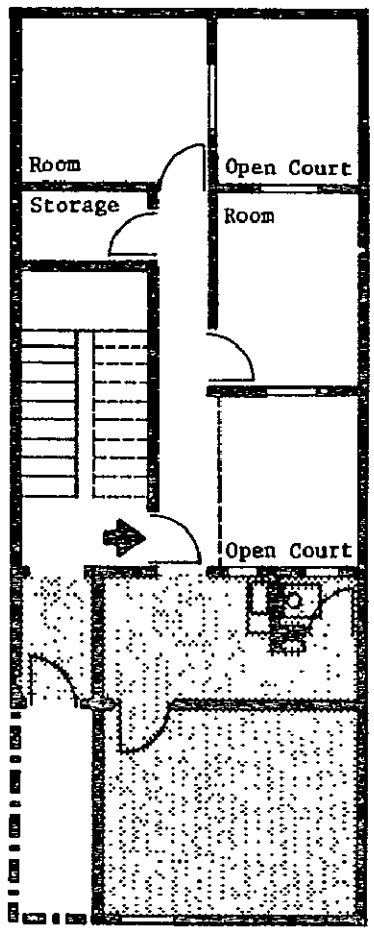


POSSIBLE BASIC VARIANT 3

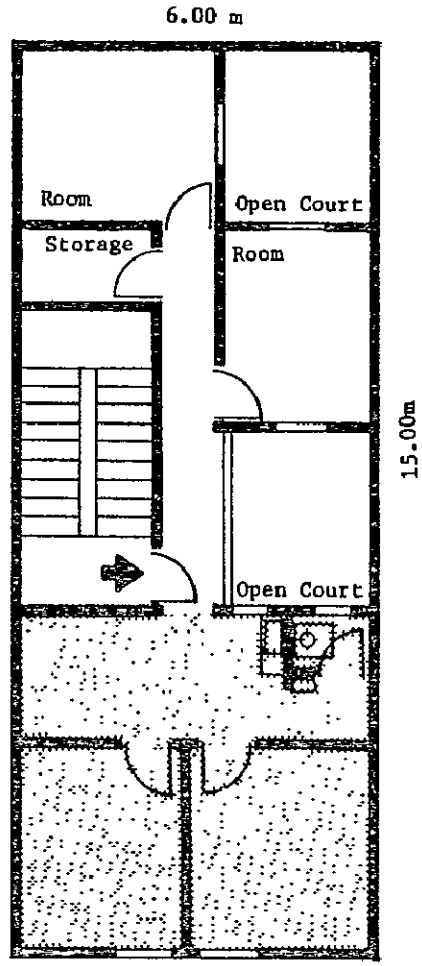




BASIC UNIT



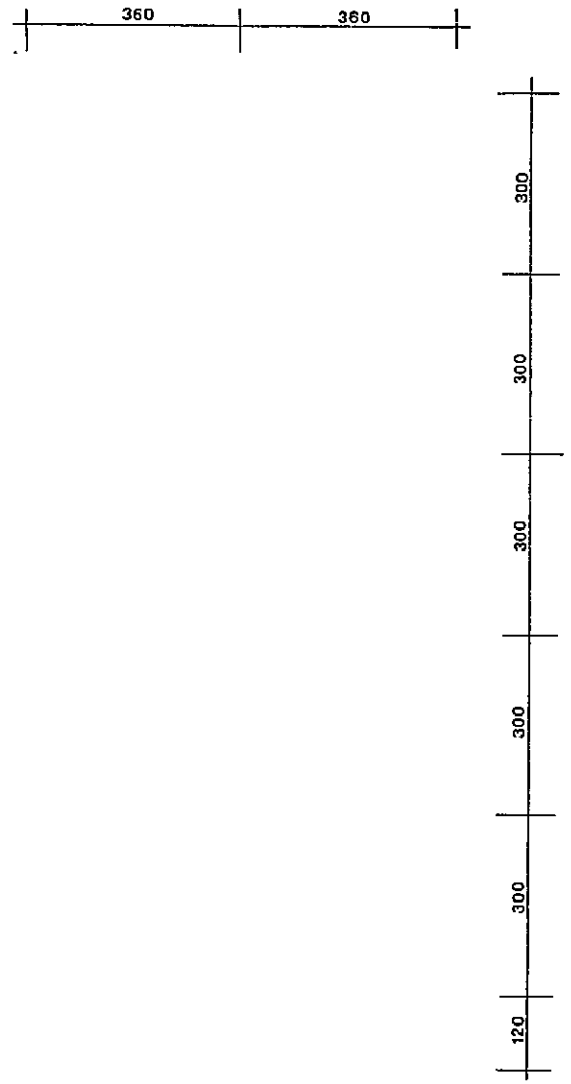
POSSIBLE FINAL STAGE
GROUND FLOOR



POSSIBLE FINAL STAGE
UPPER FLOORS

TYPE "B"

Original plan



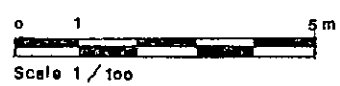
BASIC UNIT

POSSIBLE FINAL STAGE
GROUND FLOOR

POSSIBLE FINAL STAGE
UPPER FLOORS

Adjusted plan

TYPE "B"



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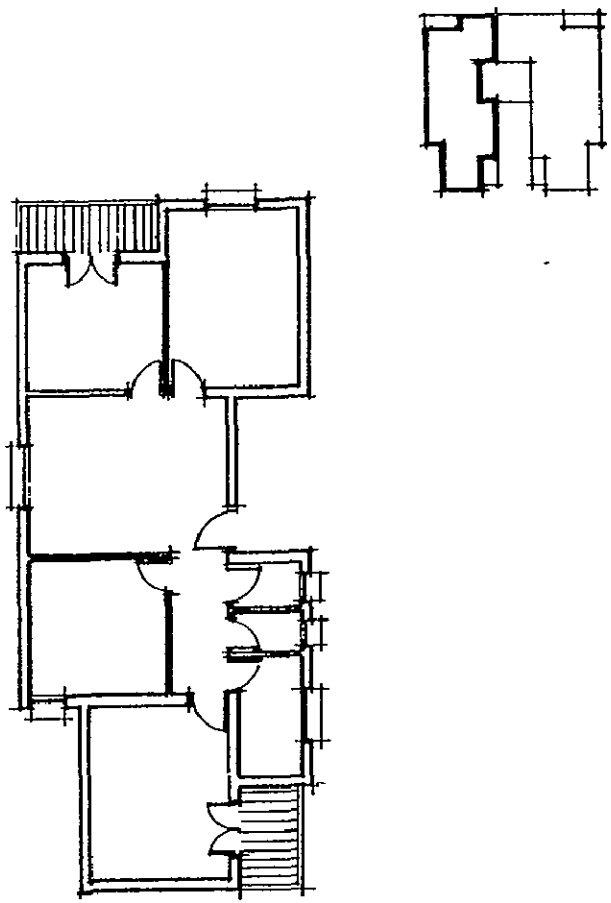
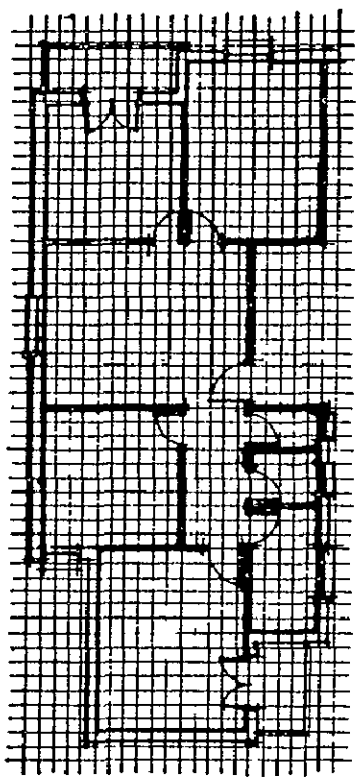
6.2 Traditional: Conventional Construction by Private Sector

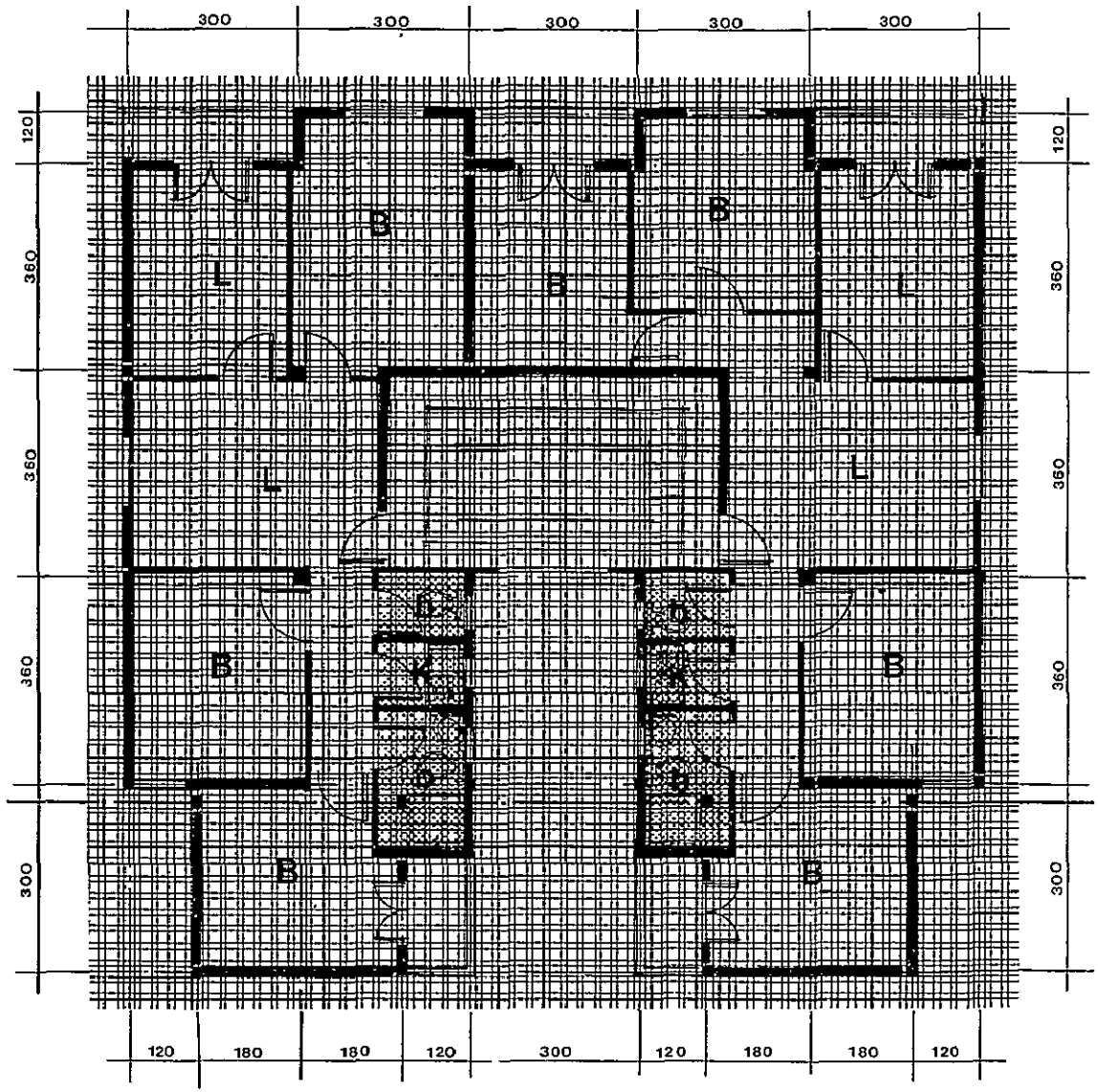




Traditional Plan Redrawn on a 30 cm Grid

TYPE "A" "Original" traditional plan

Housing Working Papers 1978 (Construction Systems) p. 104



"Adjusted" Traditional Plan

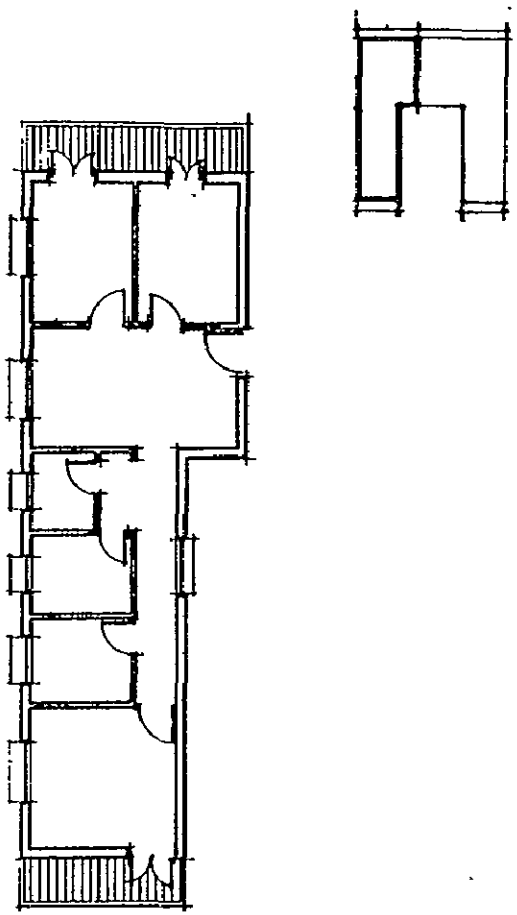
TYPE "A"

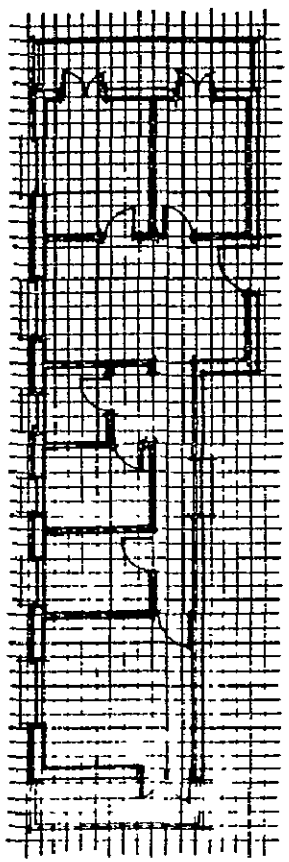
0 1 5m

Scale 1/100

19

291

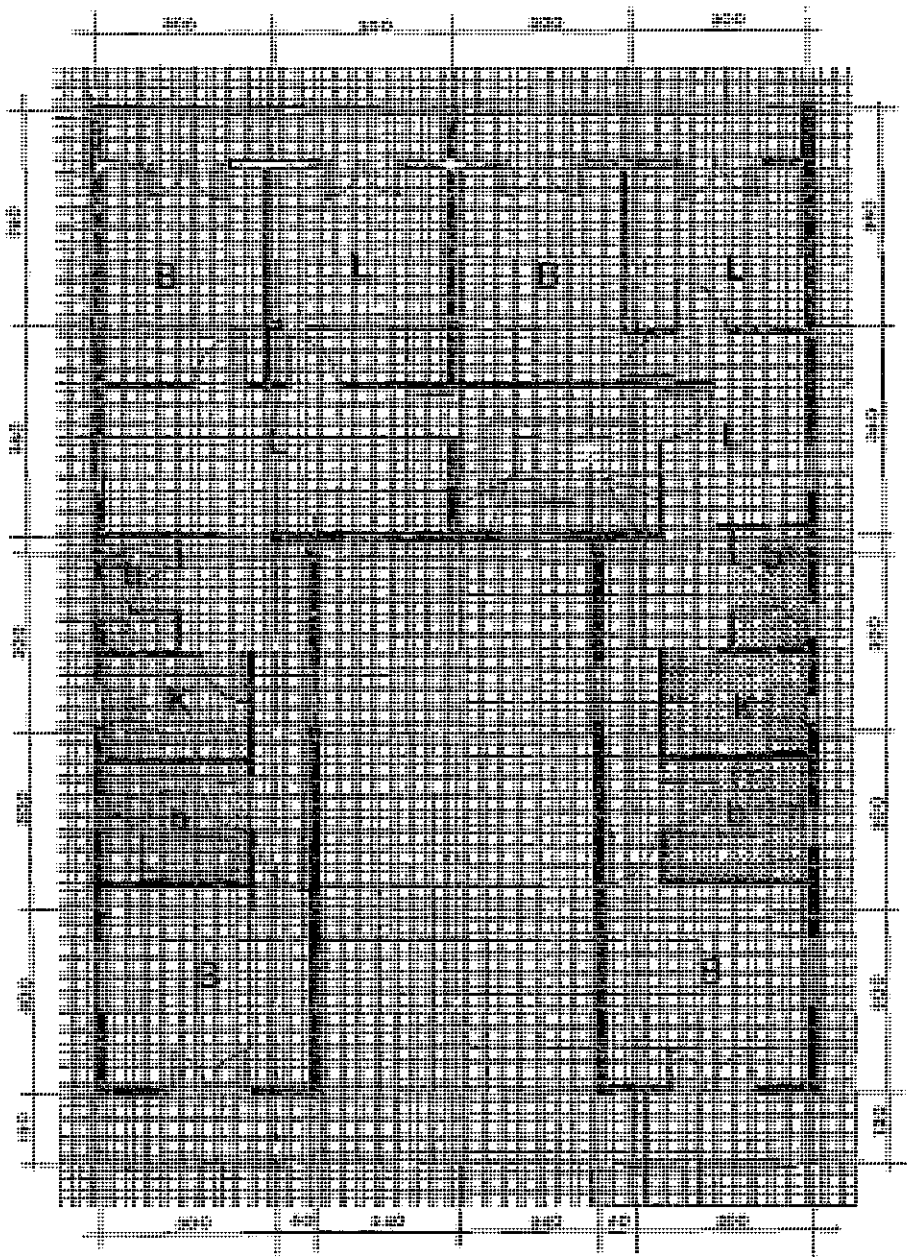




Traditional Plan Redrawn on a 30 cm Grid

TYPE "B" "Original" traditional plan

Housing Working Papers 1978 (Construction Systems) p. 106

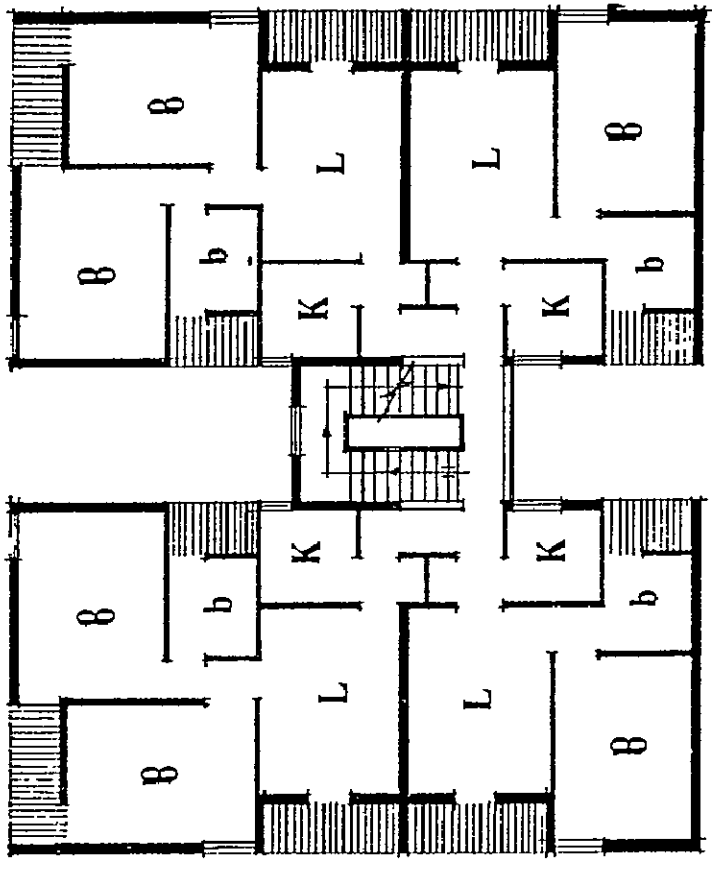


"Adjusted" Traditional Plan

TYPE "B"

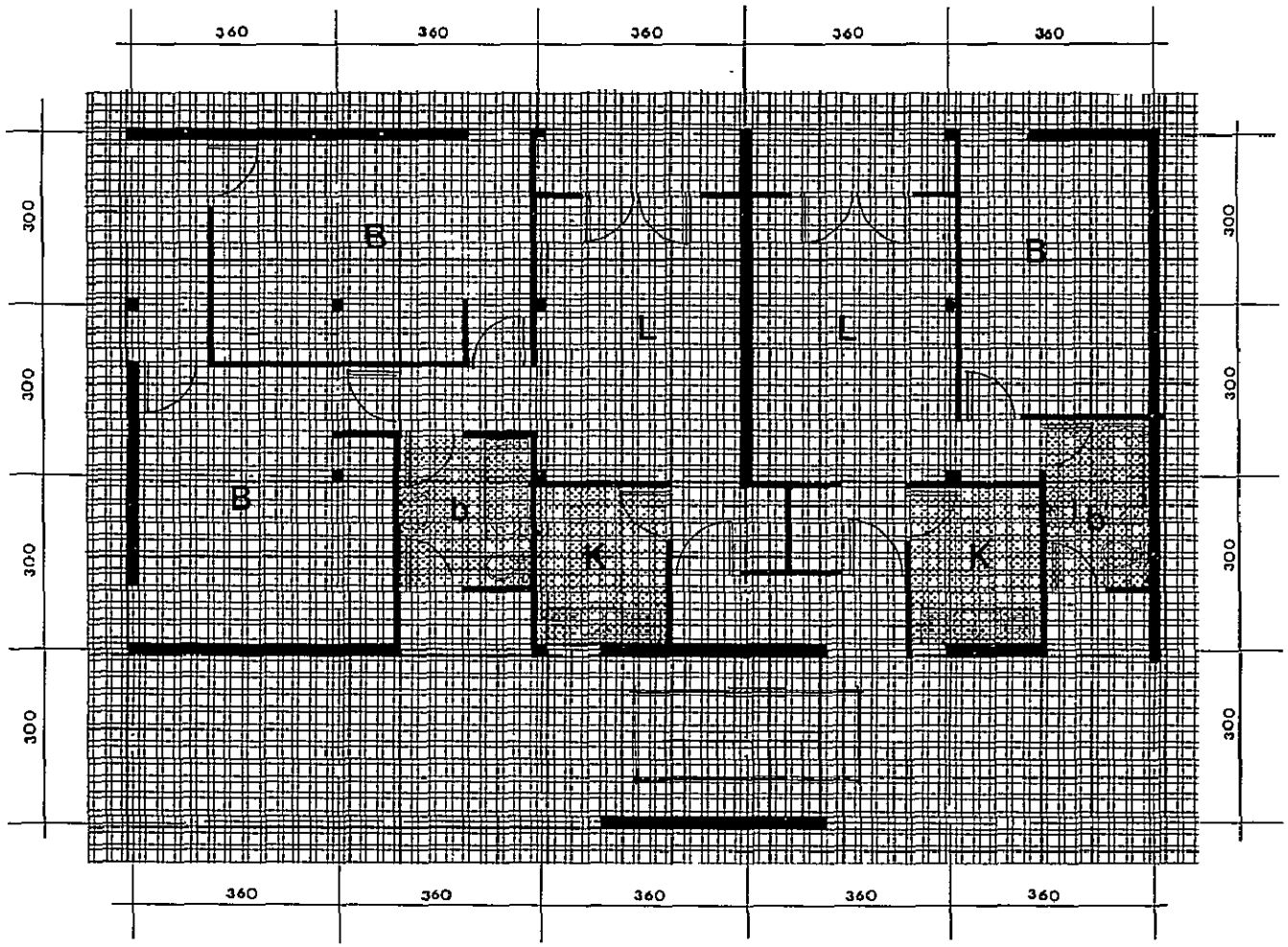
163

6.3 Apartment Building



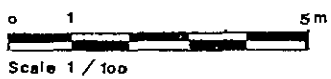
TYPE "A"

"Original" Apartment Building plan



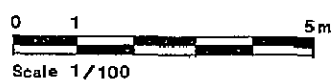
"Adjusted" Apartment Building plan

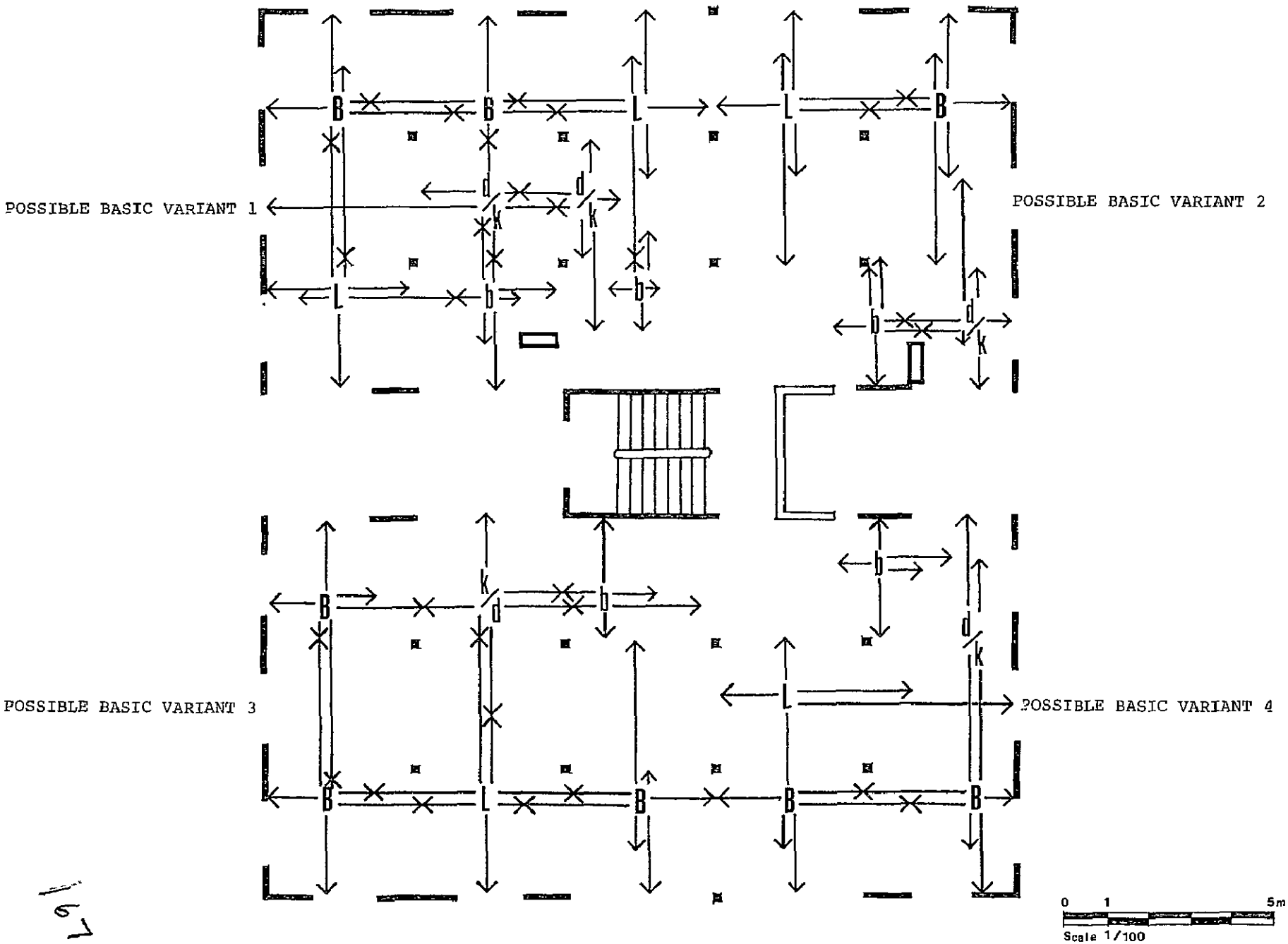
TYPE "A"



165

SUPPORT STRUCTURE AND ANALYSIS OF ZONING AND POSITIONING




POSSIBLE BASIC VARIANT 1
POSSIBLE BASIC VARIANT 2
POSSIBLE BASIC VARIANT 3
POSSIBLE BASIC VARIANT 4
0 1 5m
Scale 1/100

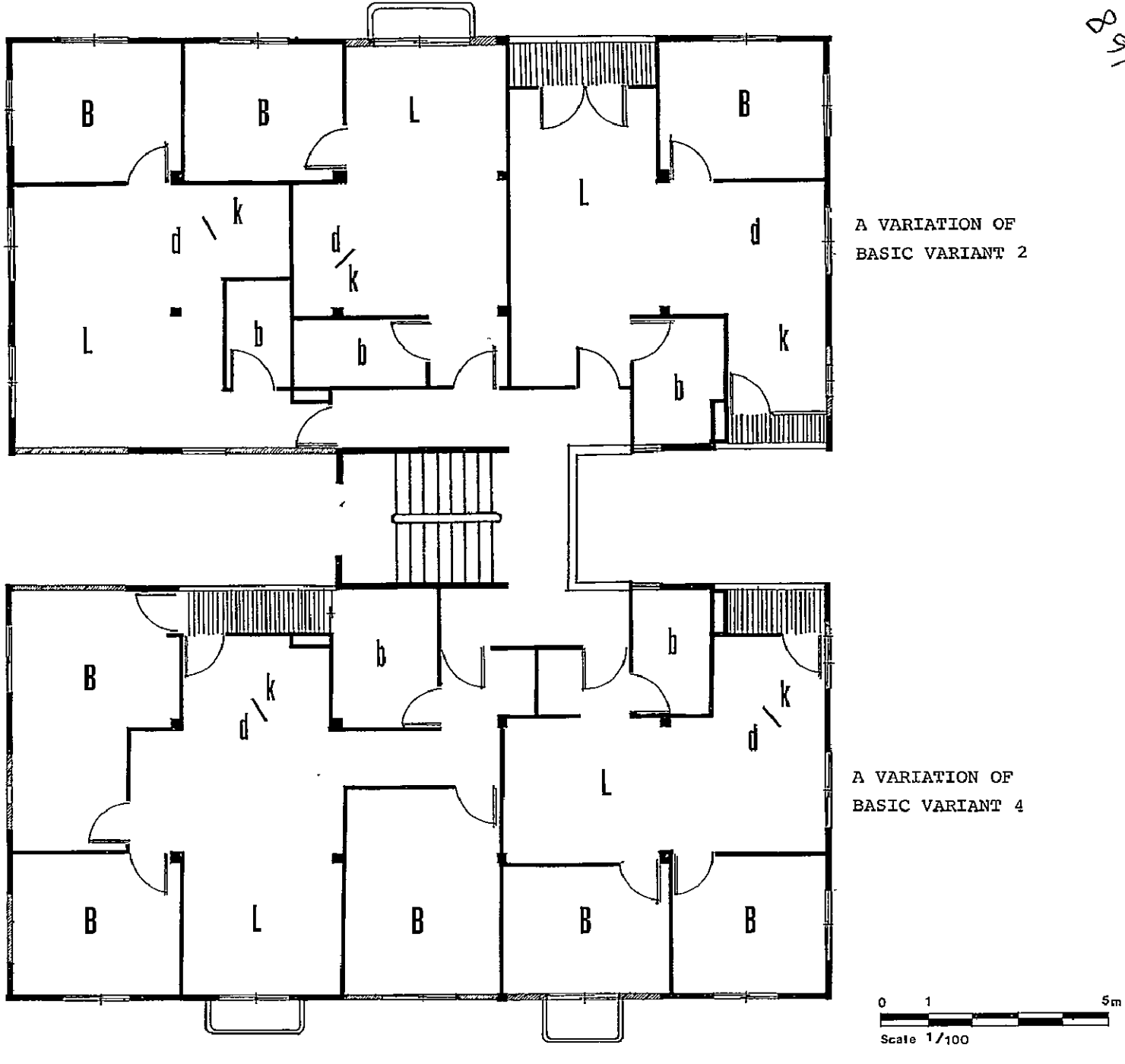
167

A VARIATION OF BASIC VARIANT 1

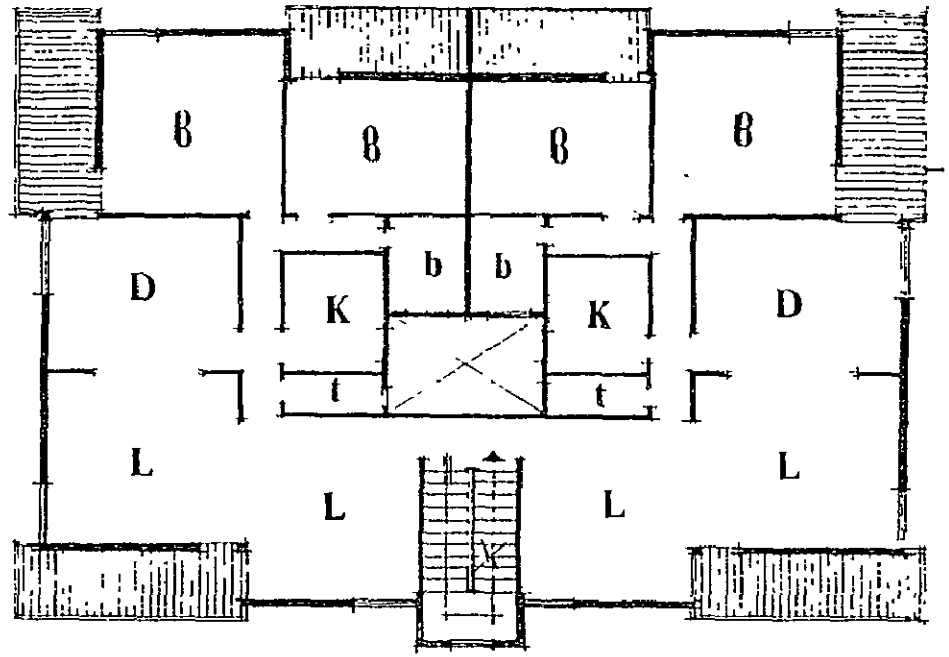
A VARIATION OF BASIC VARIANT 2

A VARIATION OF BASIC VARIANT 3

A VARIATION OF BASIC VARIANT 4

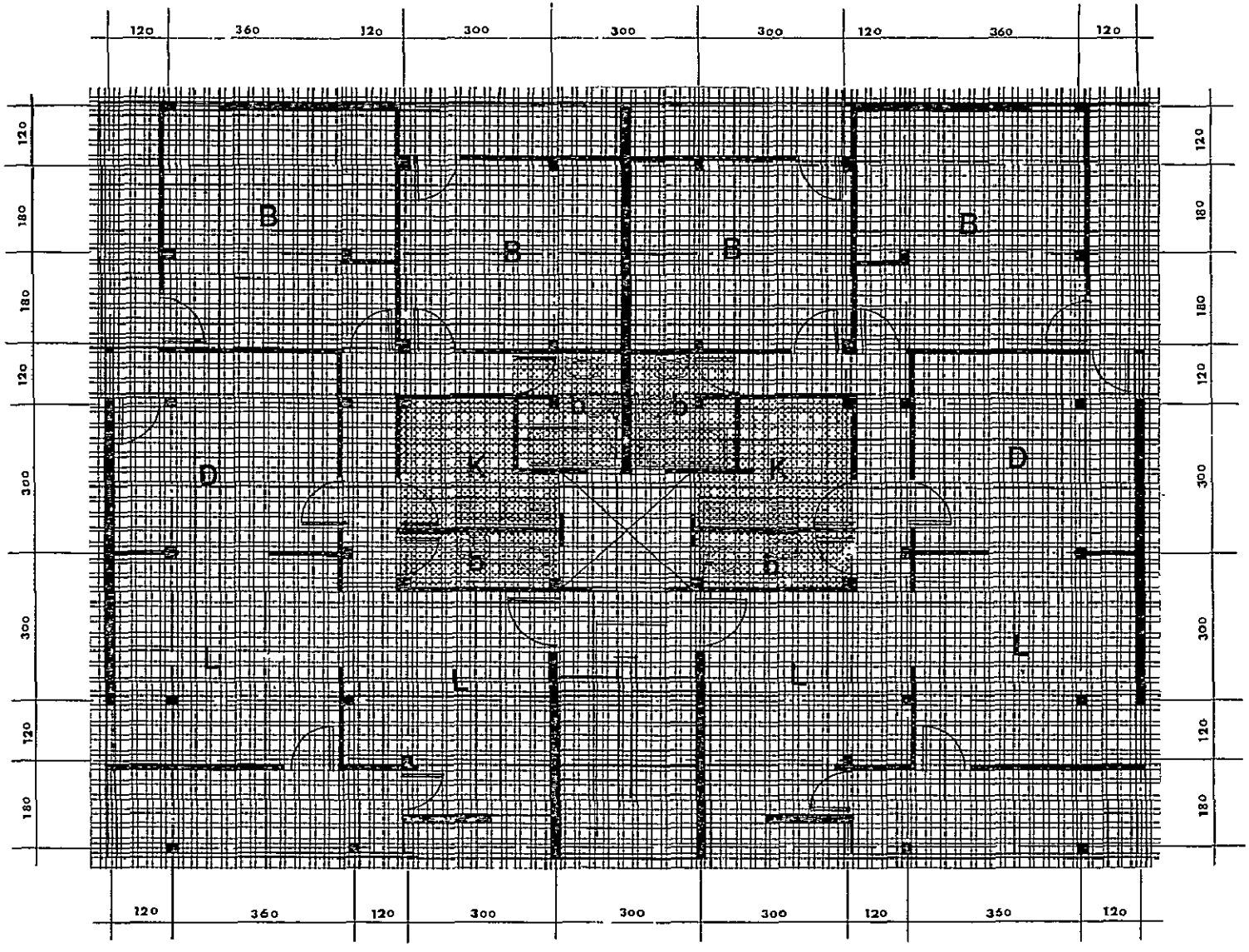


697



TYPE "B"

"Original" Apartment Building plan



"Adjusted" Apartment Building plan

TYPE "B"

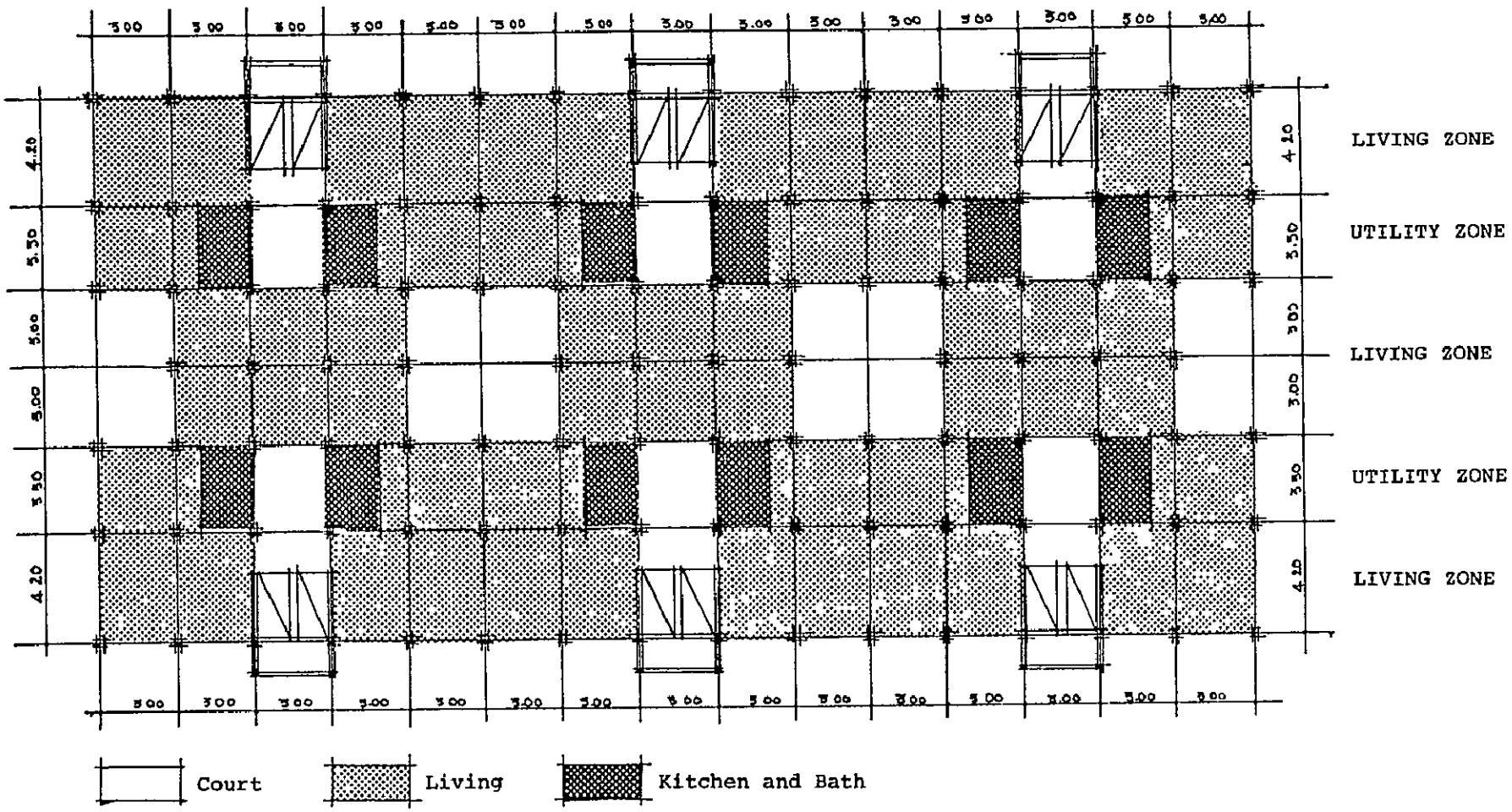
0 1 5m

Scale 1 / 100

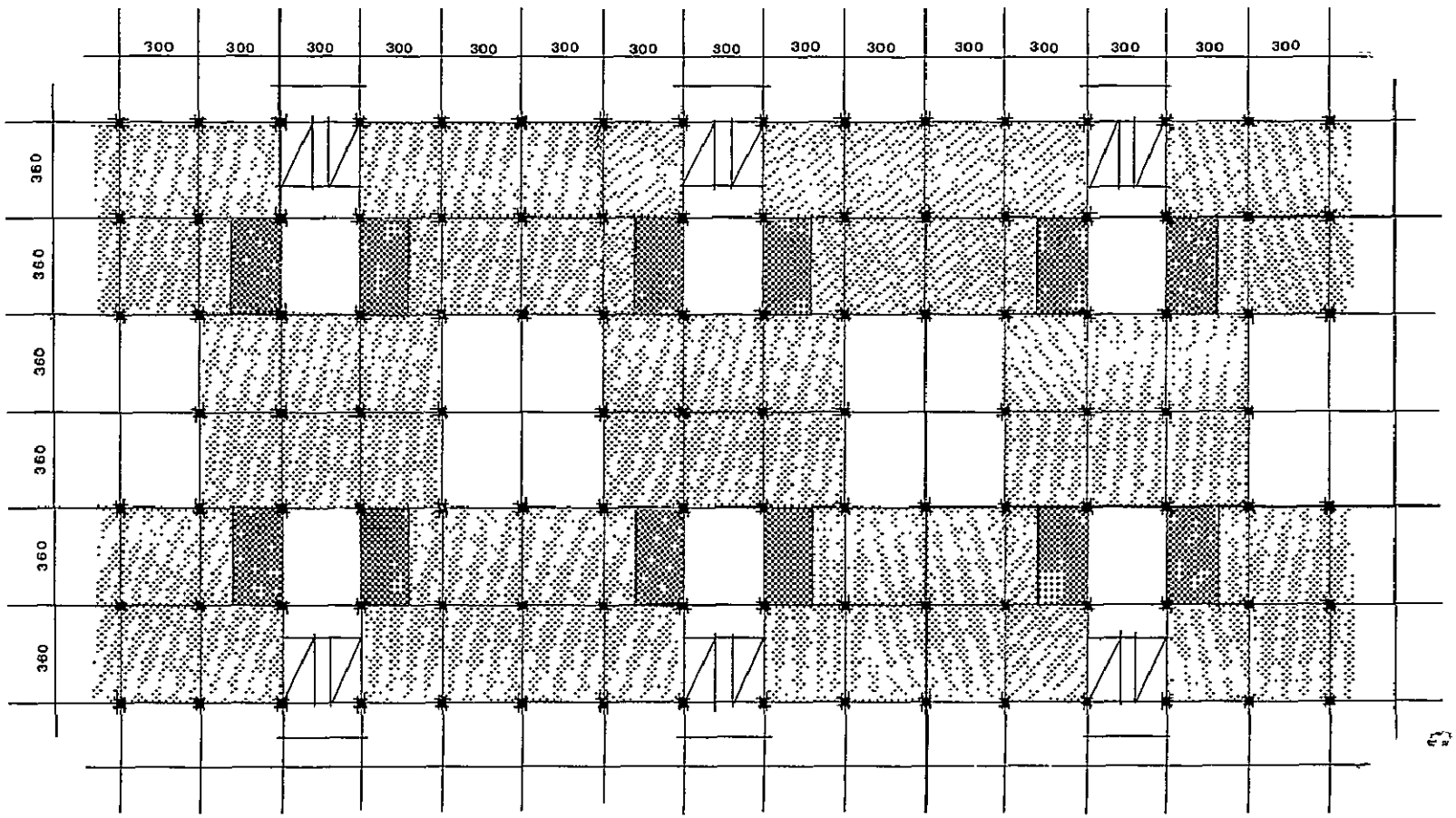
170

121

6.4 4 Story Walk-up Court House

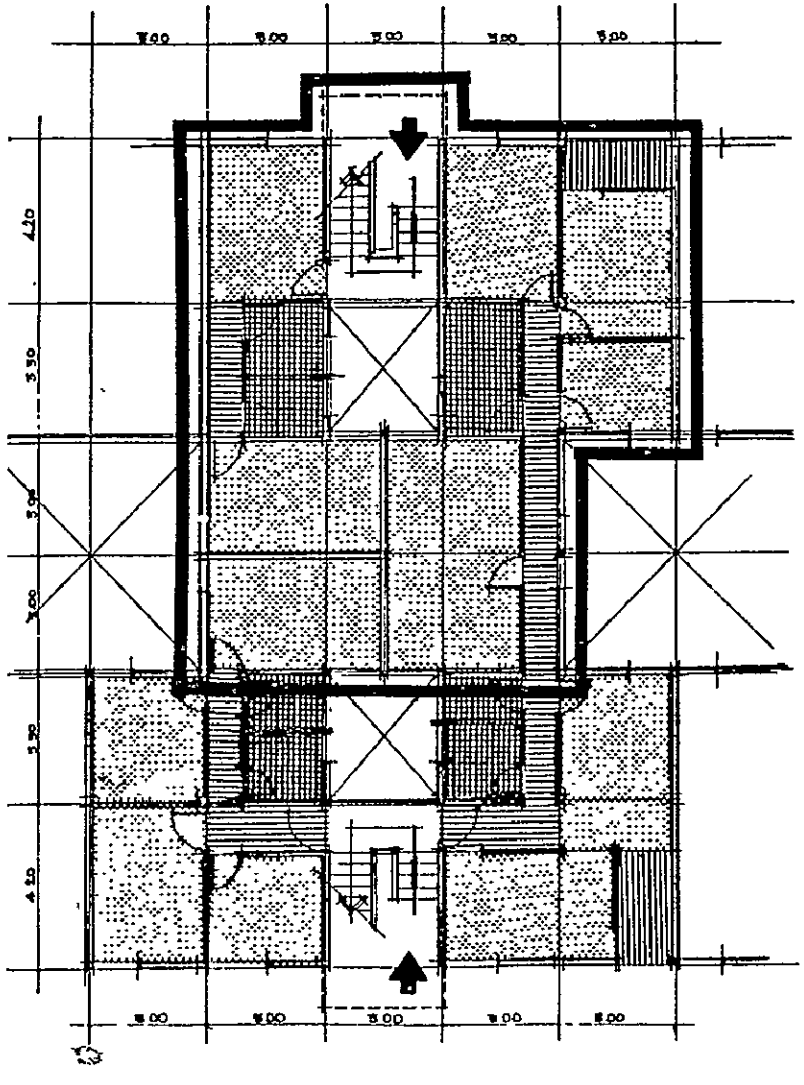


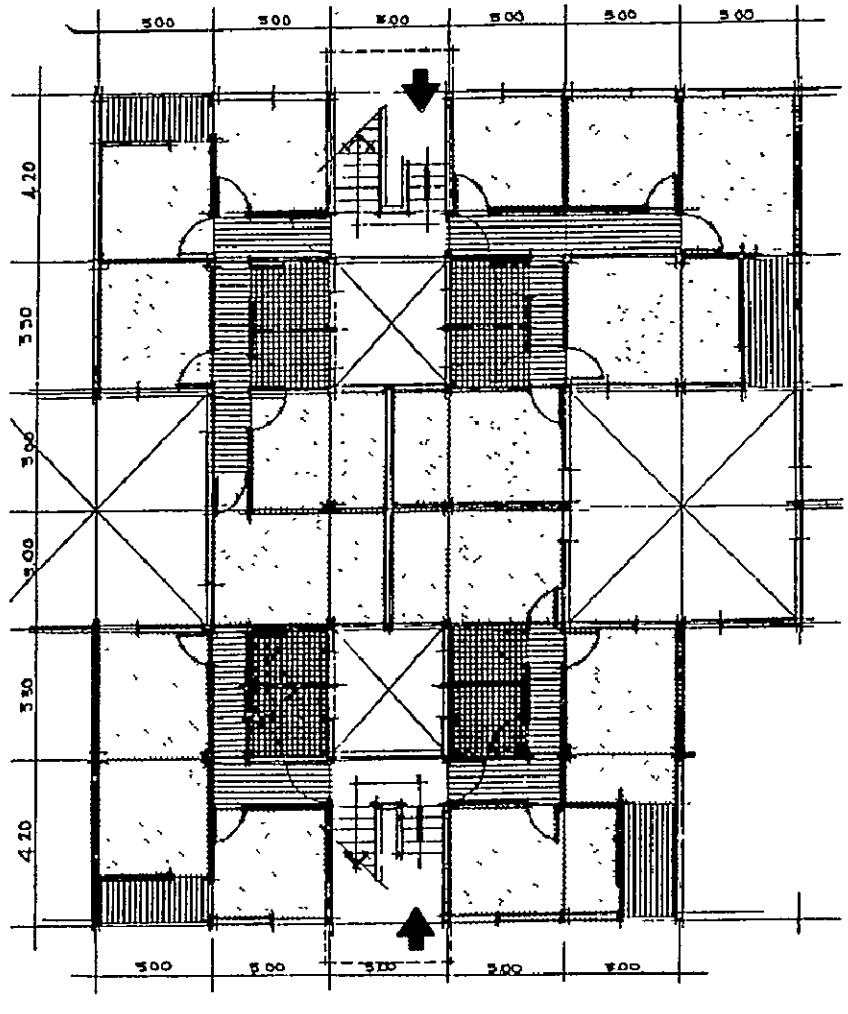
"Original" layout plan



"Adjusted" layout plan

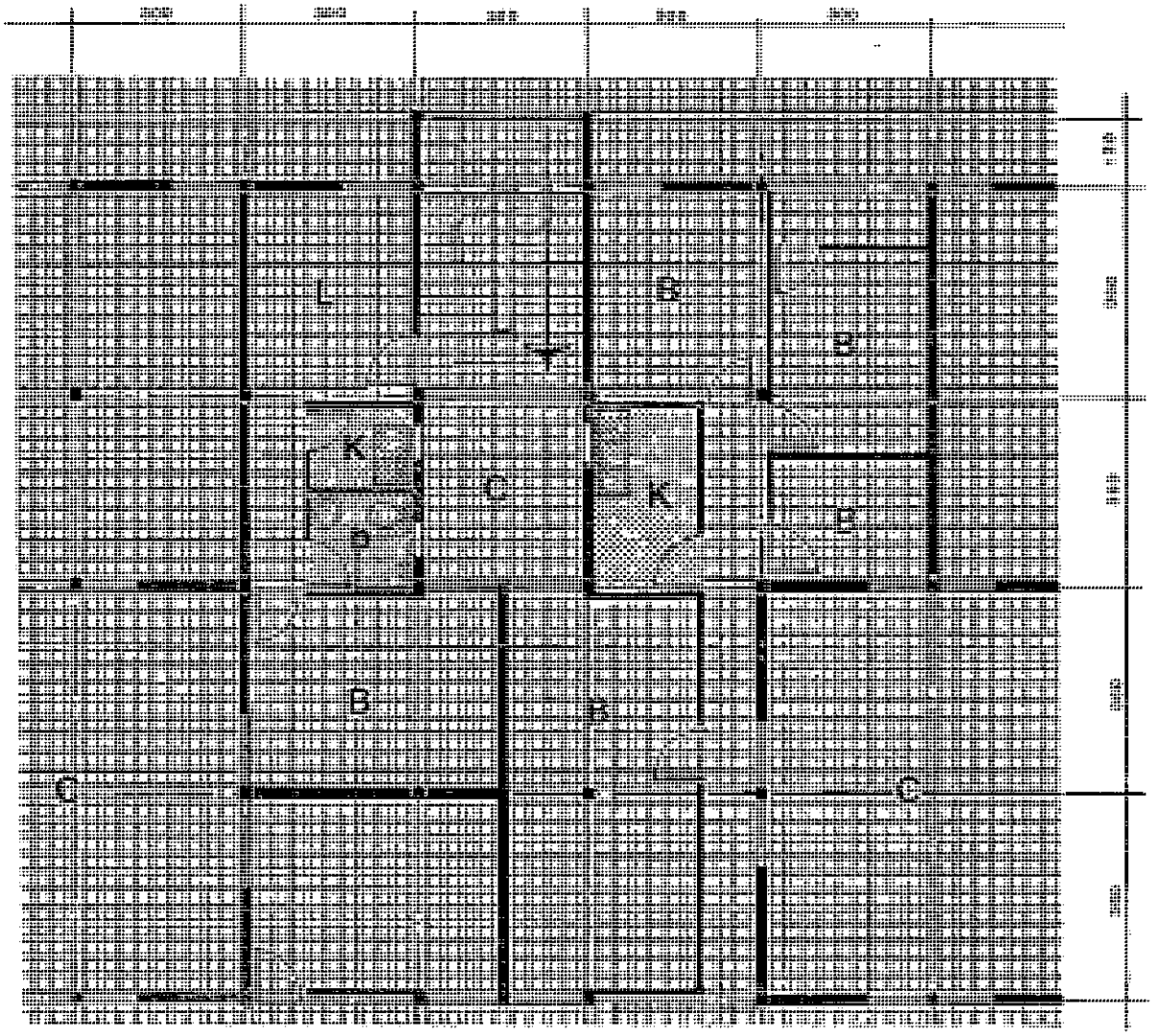
172





Court
Bath and Kitchen
Balcony and Corridor
Rooms

"Original" Apartment plan



"Adjusted" Apartment plan

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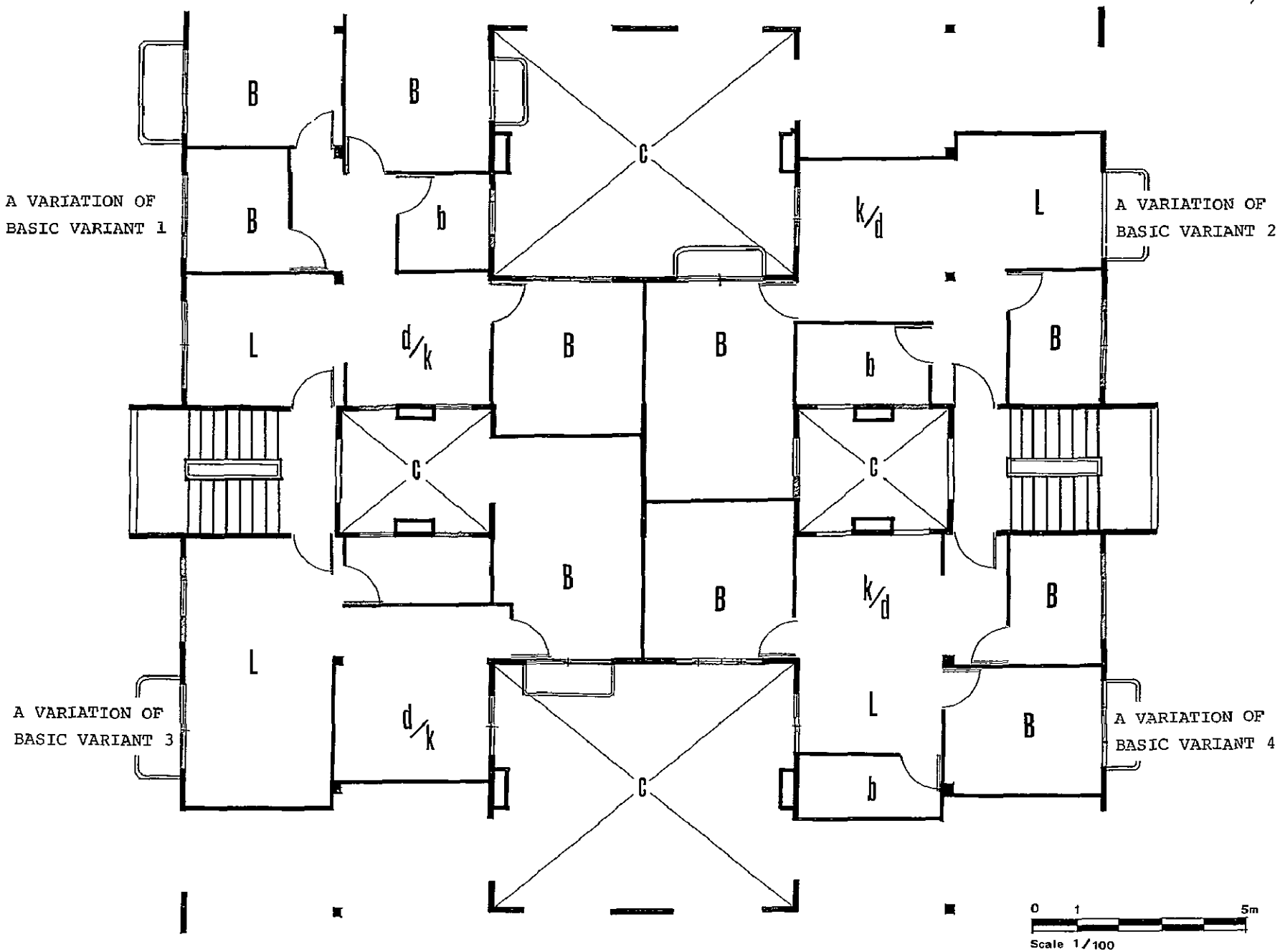
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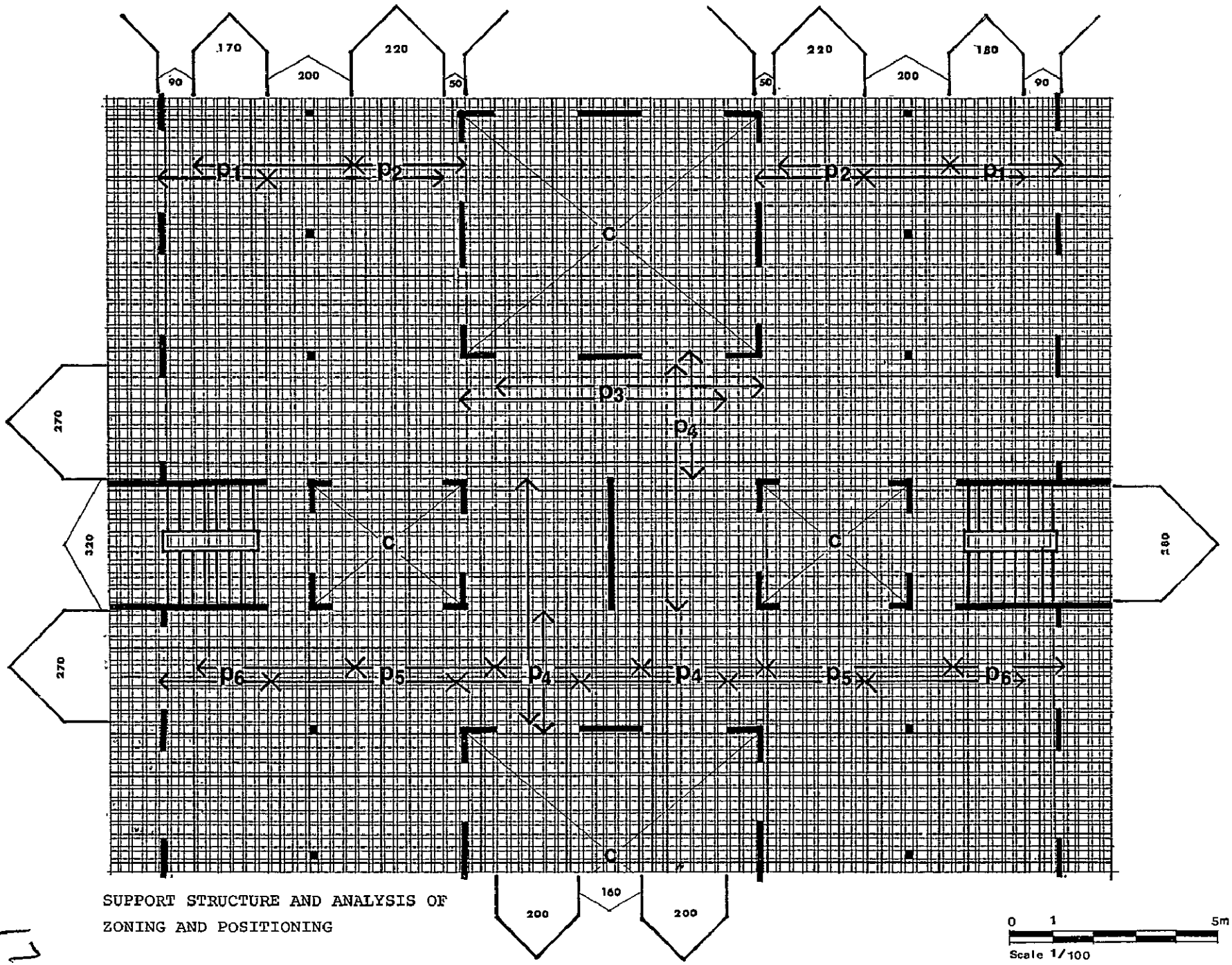

SUPPORT STRUCTURE AND ANALYSIS OF ZONING AND POSITIONING

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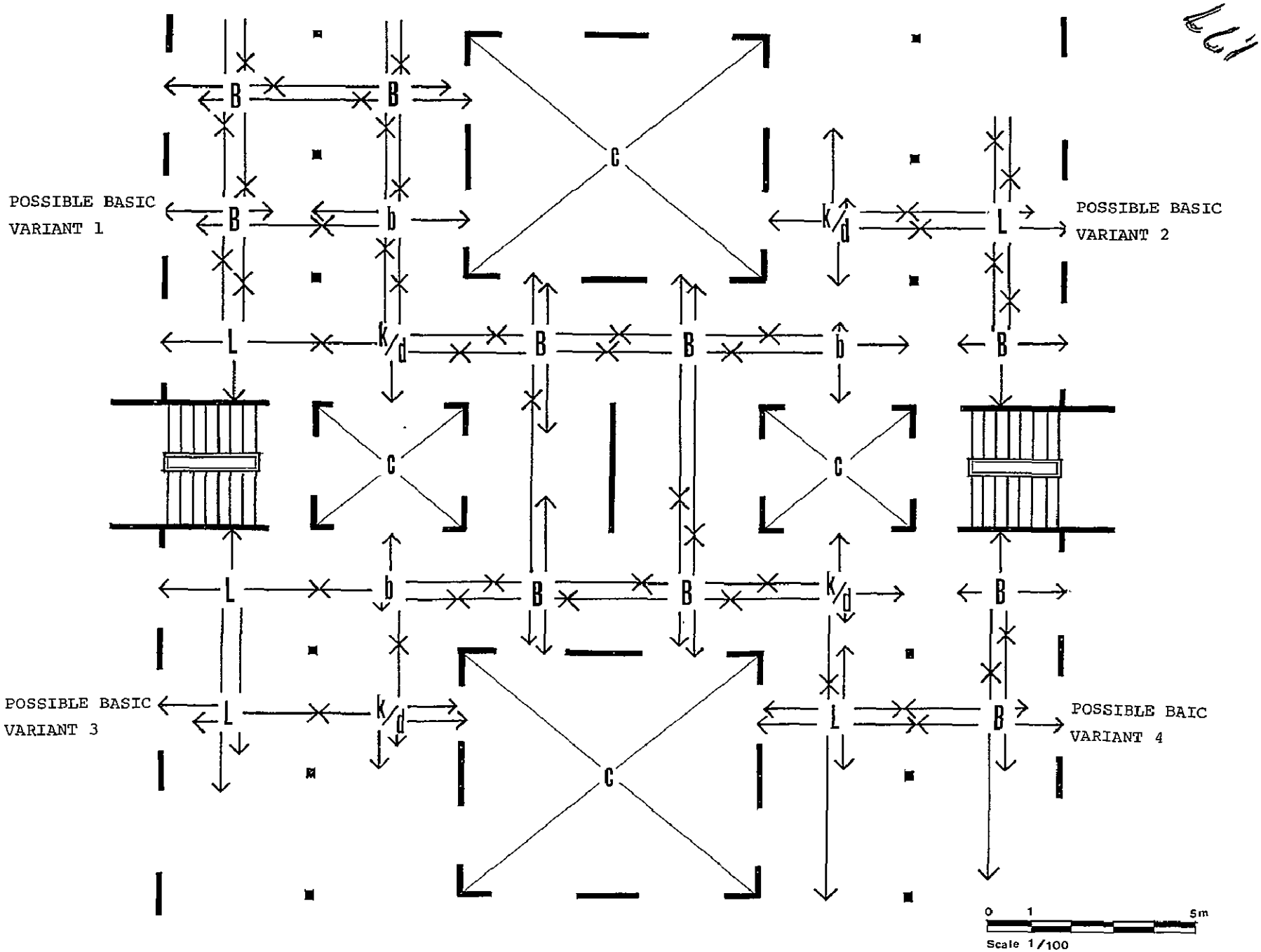
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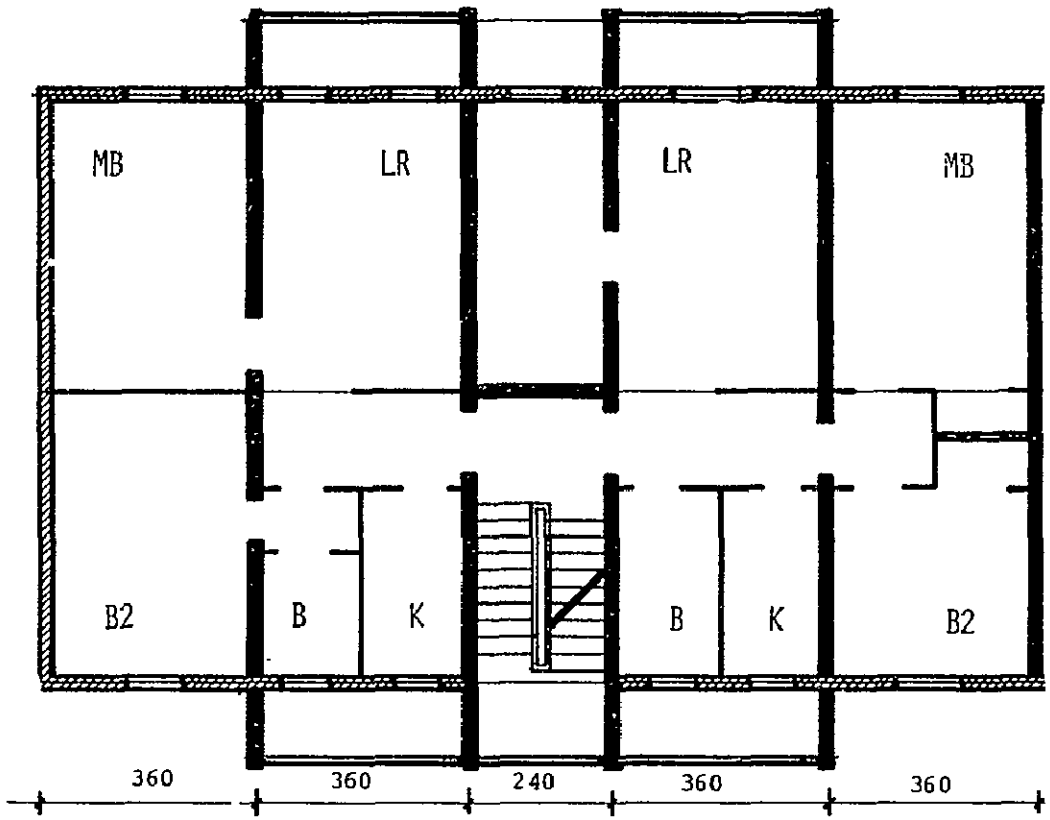
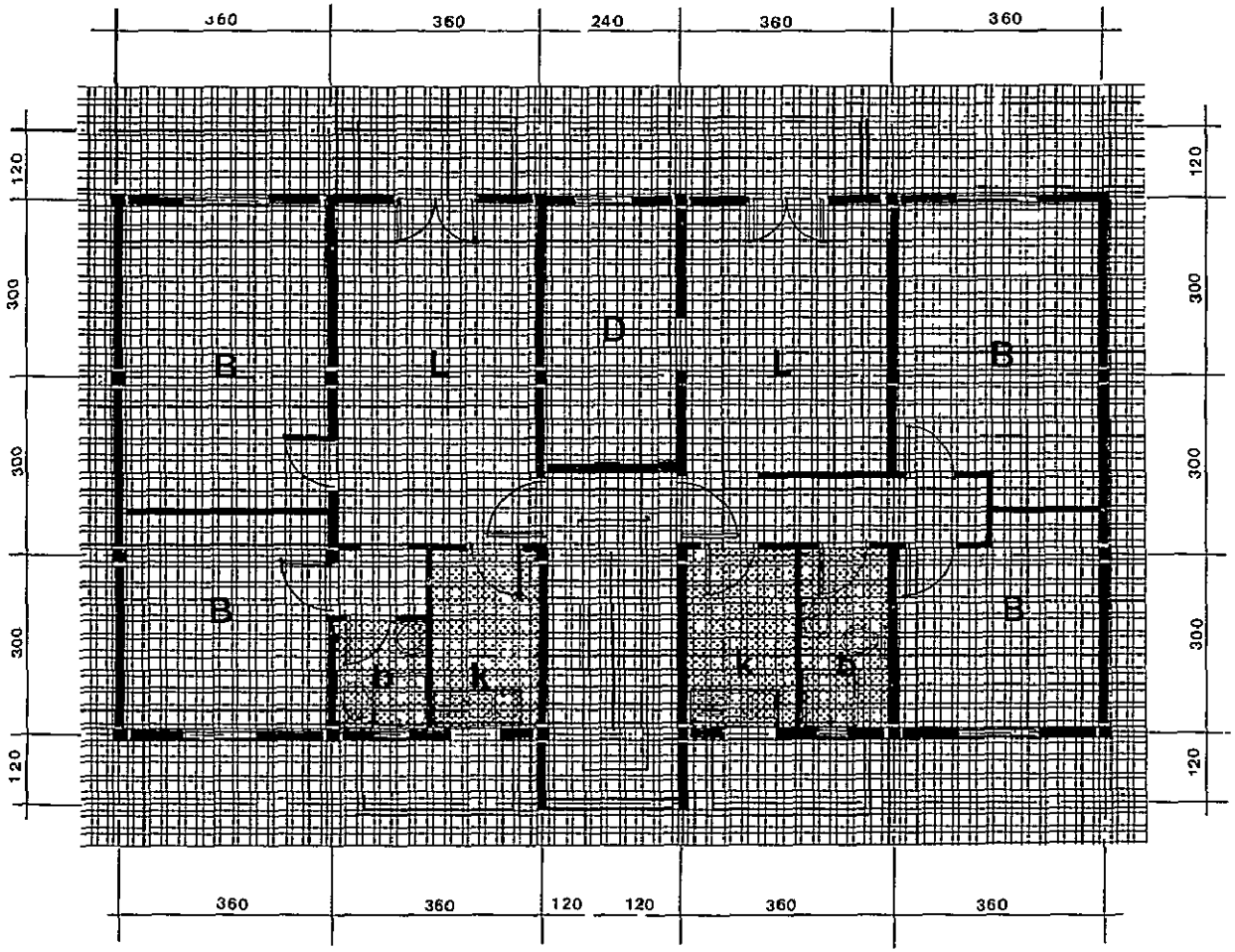
6.5 Prefabricated (Panel) System - Helwan

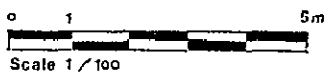


"Original" "Helwan" Reinforced Concrete Panel System plan.

Housing Working Papers 1978 (Construction Systems) p. 49



"Adjusted" Prefab Plan



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APPLICATION OF THE PERFORMANCE CONCEPT TO FACADES AND BALCONIES

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1. Introduction

In the first report by the Joint Cairo University/ MIT Research Team ("Interim Report 1977"), section on "prefabrication (p. 15), user categories were defined not only by income, but also by other socioeconomic factors. Based on these, "supply and resource categories" and "demand or user categories" were related to "locality/ dwelling systems." It was suggested in the "Conclusion" that, rather than compiling "a full list of the "content" of the various user needs of the various income and life style groups in Egypt,"... an outline for a general methodology for the establishment of basic performance standards (emphasis added) for these user requirements should be provided.

As mentioned on page 17 of the same report, standards in Egypt were set in a somewhat ambiguous way until 1976, at which time a new law was promulgated, covering grade of finishes in a more or less general way. Since the law did not attempt to "prescribe" finishes in detail, but rather established grade of finish by categories, such as "economic," "average," and "above average," this may be construed as an incipient "performance standard," even though no precise details were given, concerning the definition in technical terms of these categories, nor tests to determine level of performance (other than "grade of finish on a scale of 0-10).

The following pages are an attempt to demonstrate the method used to establish performance criteria, based on specific user needs (i.e., use of balconies in Egypt), and translated into a set of quantitative as well as qualitative as well as qualitative performance terms.

The underlying rationale for the elaboration of a specific set of performance requirements for building elements is the ability to express user activities by means of user requirements, which -- in turn -- are defined as performance requirements for a building or its parts, to be realized in the design of a building in use.

The case study presented here is primarily a demonstration of method, rather than attempt to promulgate or formulate a legal standard.

Illustrations 1.1 to 1.10 are a photographic record of the way in which facades and balconies have undergone change as a result of user needs in Cairo, both in space and over time.

Illustration 1.1
A Balcony-Loggia in Old Cairo.
Superb ability to manipulate control of air, light and view by shutters, glazed elements, solid panels and curtains.

Illustration 1.2
A Turn of the Century Apartment House in Heliopolis
The generous space of the gallery permits multi-purpose use and activieties, while at the same time providing adequate shading. Size allows conversion to enclosed loggia.

Illustration 1.3
A Street in Old Cairo
Here street itself furnishes shade. Balconies are kept small with shutters to doors behind. Maximum height of houses is four stories. Streets are narrow, thus need for visual privacy.

Illustration 1.4
Anonymous Apartment in Downtown Cairo
Urbanized life-style renders small balconies adequate for air, dusting and view of street. Adequate size of apartment prevents "spilling over" of activities. No animals kept..

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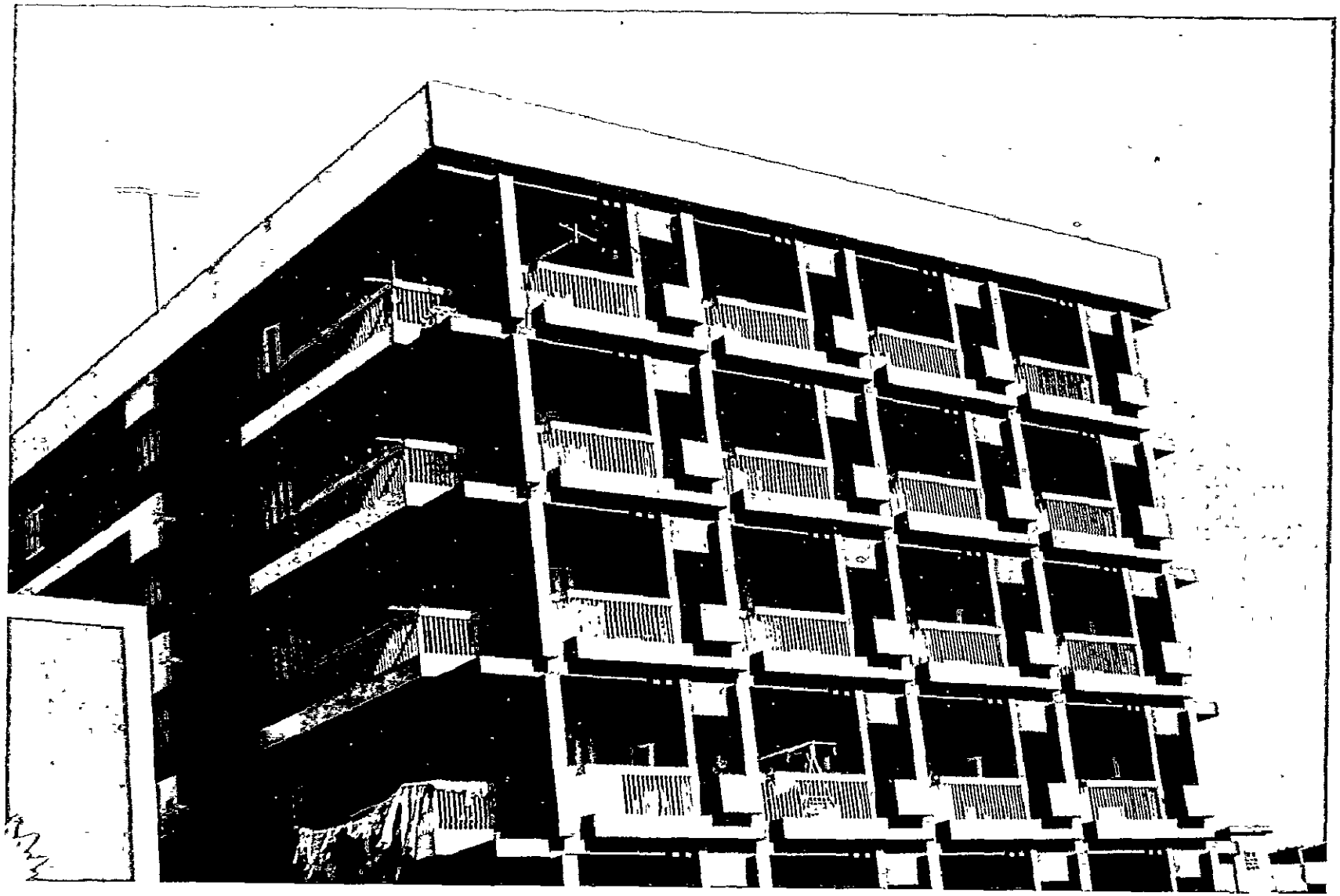

Illustration 1.5
New Private Sector Apartment in Giza.
"Designed" balconies, to provide formal aesthetic pattern, without much thought given to performance. While expected to provide adequete shading, depth of balcony and orientation require help of air-conditioners behind. Thus, first cost may have been minimized, but at the expense of high life-cycle cost for years of energy consumption. Also note that "aesthetics" mitigate against adaptations and modifications by users.

Illustration 1.6
Public Housing Near Citadel in Cairo
Here, inadequacy of balconies to perform adequately as extension of space behind, shading device and support for desirable uses is clearly evident. "Spilling over" of objects and activities indicates this inadequacy. User modifications provide clear clues for design criteria and performance criteria for this user category. As is, the modifications are not only illegal, but potentially dangerous, due to inability of supporting elements to adapt to needed change.

Illustration 1.7
Conventional Private Sector Apartment in Cairo
Even though the building is not yet finished, already user generated changes in the facade are being made. Also, note provisions for adding another floor, by leaving reinforcing steel protrude from roof slab, which is used as open terrace in the interim.

Illustration 1.8
Apartment Building in Giza Road in Cairo
Balconies provide only way by which to add a room to apartment, by glazing in space. Simple original design of the balcony has made such an alteration relatively easy. Large openings behind balconies can be easily modified into open archways, thus the room is extended. Note also adjustable shading devices.

Illustration 1.9
Informal Sector Dwellings in Cairo
Balconies provide only space to accommodate change and outdoor activities for apartments. They may also be walled in to extend room size beyond facade. Also note that the finishing of facade is carried out only where needed most, and as financial ability allows.

Illustration 1.10
Conventionally Constructed Typical 3+ story Dwellings
House is being comleted while in use. Facades are finished in stages, and only when adequate financing is available, and after satisfaction of other priority needs. Roof acts as large open terrace until addition of one or two stories. In the meantime, it is useful for drying laundry, keeping animals, and accommodating service personnel in temporary quarters.

2. Performance Concept

2.1 General Principles

The Performance Concept as a tool for generating a more responsive basis for the design and evaluation of buildings and their components, is recognized as a prerequisite for integrating user needs and requirements into all phases of the production process in comtemporary building.[1]

The implied goal of the performance concept is to fulfill implicitly as well as explicitly stated user requirements and needs in terms of space and equipment provided, while at the same time providing maximum leeway for innovation in the building industry. Therefore, it is important to *specify user requirements in such a way as to allow for a variety of design solutions to develop, rather than favoring a single option or a single solution only.* In the process of specifying environmental characteristics for dwellings, the aim of using performance standards is to *offer a sufficiently broad range of solutions which remain open to both the user's and the builder's interpretation* on the one hand, while mandatory or imposed constraints, on the other hand are introduced only if a clear case can be made for the protection of the user or to guarantee technical compatibility between the various building subsystems.

> "The performance approach demands a statement of performance in terms of function. Since buildings serve people, function is defined by the attributes necessary to satisfy human requirements. . . In the performance approach, a specific system, component or material is subservient to the delivery of an attribute."[2]

EXAMPLES OF ACTIVITIES, SUBSYSTEMS, AND TECHNICAL SOLUTIONS

ACTIVITY	ATTRIBUTES OF THE BUILDING WHICH IN COMBINATION MAKE UP THE SUBSYSTEM	SOME TECHNICAL SOLUTIONS WHICH BELONG TO THE SUBSYSTEM
TO HEAR/ LISTEN	-sound insulation -sound reflection -sound generation -potential for screening off -.....	-walls, partitions -floor-ceilings -openings -sources of sound (installations etc.) -.....
TO PREPARE FOOD	-cooking facilities -storage space -lighting -ventilation -sewage -.....	-stove, heating equipment -refrigerator, cabinets -lighting fixtures, windows -fans, windows -gargage disposal, pipes

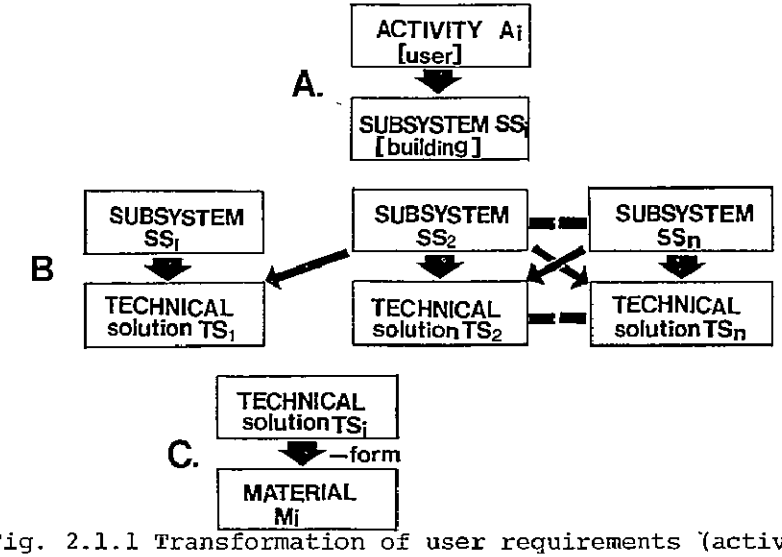

Fig. 2.1.1 Transformation of user requirements (activities) into performance requirements for subsystems (A), technical solutions (B), and materials (C), in a building.

Consequently, *the form of the performance specifications is quite different from the form of prescriptive specifications* which often fix solutions for the various parts of the building in terms of material, dimensions, shape and so forth, i.e.:

> "Performance specifications do not describe dimensions, materials, finishes, or methods of manufacture--they describe the performance the user/consumer requires."[3]

Accordingly a different procedure is required to set up other performance specifications than those used in the elaboration of prescriptive norms and regulations. A survey of Egyptian housing norms and standards, made during preceding phases of the research,[4] provides sufficient evidence that many--if not all--can be traced to European prescriptive specifications and/or regulations of the past decades, and that few, if any, have been revised or updated to be brought into conformance with prevailing conditions and needs in the housing sector. Virtually no effort has been made to consider the introduction of performance specifications in Egypt, where this would be most appropriate or useful, in spite of the wide acceptance of the performance concept in Europe, e.g., England, France, Holland, Sweden, and other countries, including the U.S.A.

Starting with the above objectives, the satisfaction of users' requirements and needs in technical terms must first be described in terms of the activities involved. Based on the relationship of specified (or assumed) user activities and/or activity patterns, performance requirements for corresponding spaces, and/or building subsystems and selected environmental characteristics can be stated in performance terms. These are subsequently translated into spatial and technical performance criteria, which may also be used to establish performance standards for design and post-construction evaluation. Based on these criteria, a range of hardware solutions can be established, even though not all performance stated in behavioral terms is capable of direct translation in technical terms. See figures 2.1.2 to 2.1.4.

SANITERY APLIANCES						JOINERY		FLOOR			EXTERNAL RENDERING	INTERNAL PLASTER	GRADE	
cold hot	kit sink	bath	wall finish	wc	lav	panel	frame	bed rooms	living	kit + bath				
			cem			straw board	0.37	cement rendering			cement rendering		1	ECONOMIC
			"			"	05	cement tiles			sprayed plaster	render and pointed lime wash	2	ECONOMIC
			"			straw board veneered	"	terrazo tiles			"	"	3	ECONOMIC
			"			"	"	terrazo and timber			"	render and water paint	4	AVERAGE
c			terra plast			block board	"	vinil	vinil	terrazo	"	"	5	AVERAGE
			ceram tiles 20 m			"	"	timber	vinil	ceram	"	"	6	AVERAGE
			"			block board veneered	"	timber blocks on tiles		ceram	facings and good rendering	gyp plaster	7	ABOVE AVERAGE
c h			"			"	"	parquet		"	marble, granolite, etc	gyp plaster + oil and plastic paints	8	ABOVE AVERAGE

Figure 2.1.2
Egyptian Ministry of Housing
Standarts 1976

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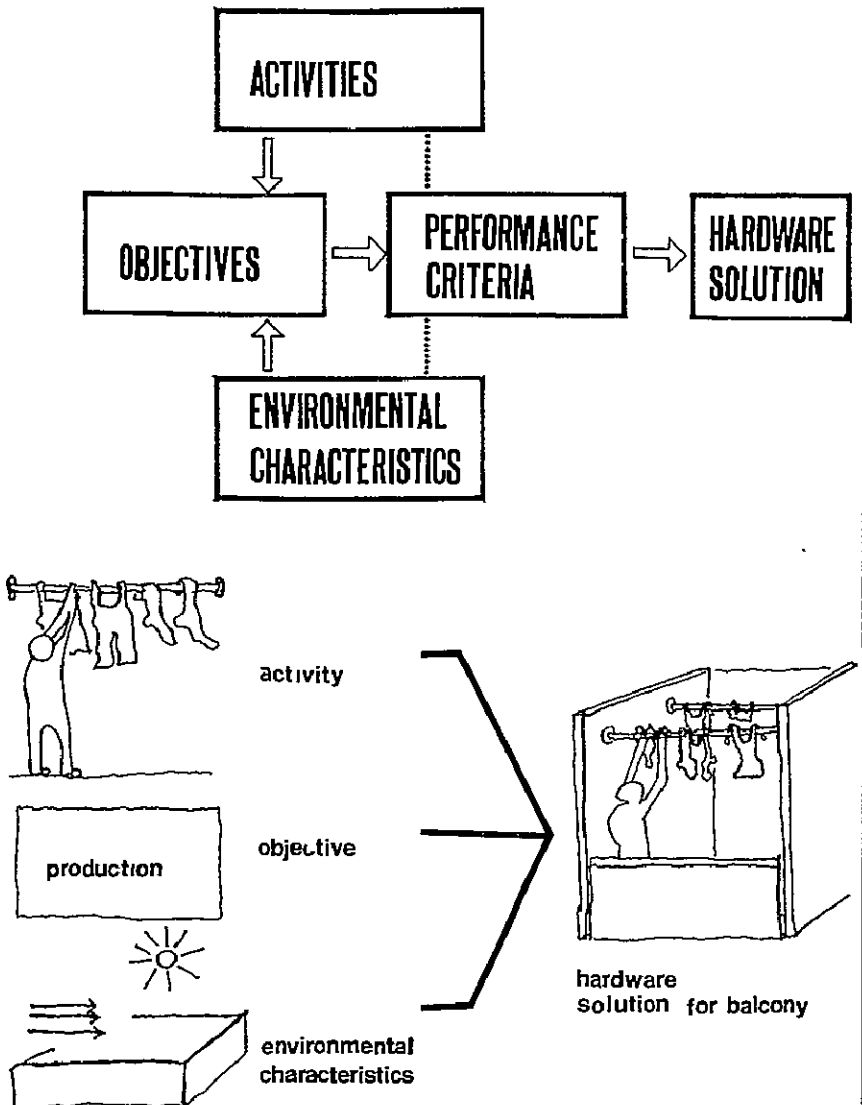

Figure 2.1.3
Translation of objectives to hardware solutions by means of performance criteria.

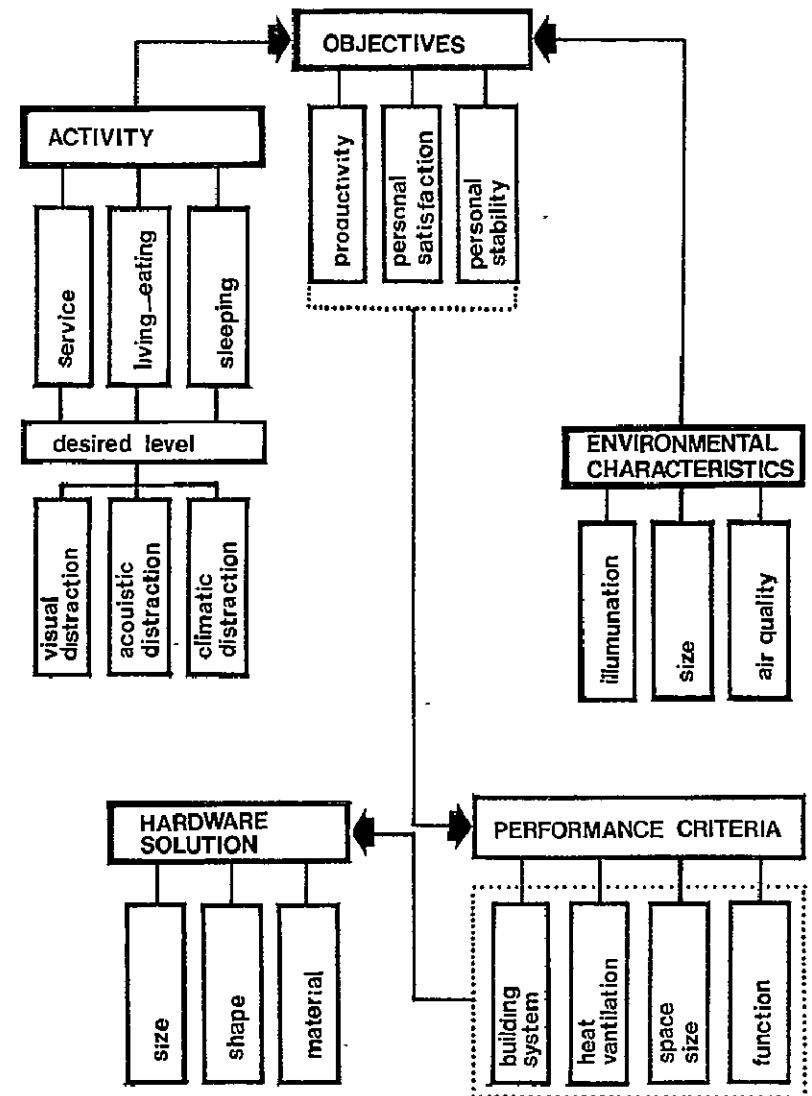

Figure 2.1.4
Flow-Chart, showing use of performance criteria in process

In general, any formal attempt to translate human factors into performance specification (and thus, into technical performance criteria), should include the following elements:

1. A simple method to determine general human factor data requirements, based on the realistic needs of the target user group.
2. Existing information of operational and equipment information (i.e., technical base data and specifications) should be developed to reveal their potential for being translated in performance terms.
3. Formats for user surveys need to be designed to allow eventual translation of the data obtained into technical criteria or performance specifications.
4. Impact on industry operation, practices, skills, training, design, etc. needs to be assessed in terms of a switch to performance standards from prescriptive norms.

The above procedure has been used by applying the performance concept for user oriented and environmentally appropriate solutions for elements of the external envelope for housing projects based on the "support/infill" concept in Egypt.[5]

Using balconies, loggias, terraces and open roofs as an example, the following steps were taken to develop a performance-based set of design criteria for these behavior settings:

1. A set of criteria for appropriate user requirements in the Egyptian context was developed.
2. The elements of the external envelope subsystems were analyzed in view of selected physiological and anthropometric criteria, thought to be appropriate to the Egyptian situation.[6] On a more empirical level, users' activities, as found in existing residential urban environments in Cairo were used to check assumptions made on the basis of other sources. Traditional, prescriptive approaches to environmental control were taken into consideration, to check their validity, and to propose improvements.
3. Based on the above, a systematic coordination of the activities and their need for related equipment was carried out for different types of outside spaces, generally found adjacent to the house facade. Based on the behavioral interrelationship between inside and outside spaces near the facade and using the "Helwan" prefab system as an example,[7] rules for a variable system of facade configurations were established.
4. Finally, after examining dimensional and technical compatibility criteria between various facade elements and components, a number of subvariations for each set of previously catalogued facades was proposed.

The above procedure has been used by applying the performance concept for user oriented and environmentally appropriate solutions for elements of the external envelope for housing projects based on the "support/infill" concept in Egypt.[8]

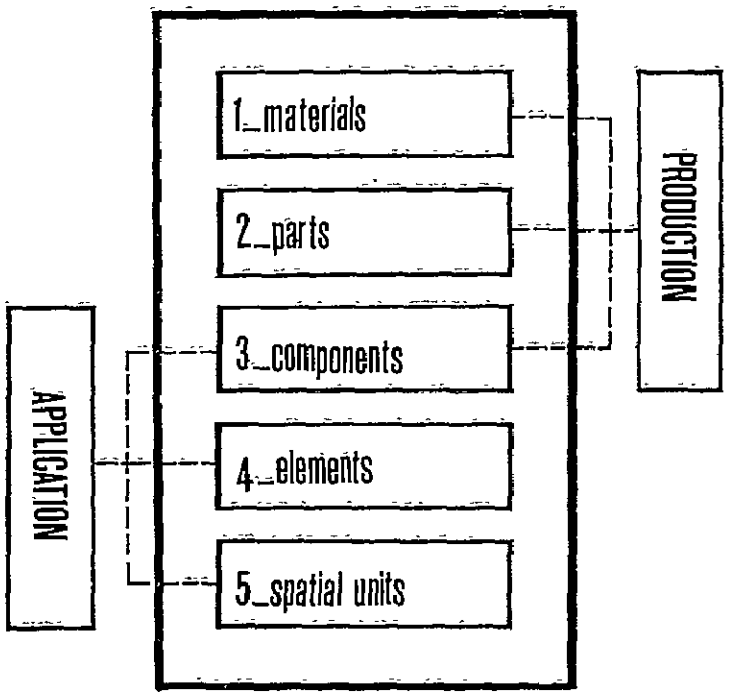

Figure 2.1.5
Module of Possible Production/Application System

2.2 Performance Criteria

The first step was to develop a set of basic general environmental characteristics for elements of the external envelope, i.e., openings, exterior walls, shadings, and balconies, and relate these to a set of essential user requirements: Table 2.2.1.

The combination of user-need criteria and their impact on facade-related space and elements led to the elaboration of a set of essential performance criteria for the subsequent design proposals. Most are stated in general spatial terms, and are relatively independent of any specific hardware solutions.

The following table of criteria represents the first step in providing a generic check-list for subsequent elaboration of more detailed performance criteria.

USER'S REQUIREMENTS	PRIMARY CRITERIA	SECONDARY CRITERIA	PERFORMANCE CRITERIA
PHYSIOLOGICAL		*air	*adequate ventilation through openings
	*protection	*illumination	*adequate illumination thourgh openings
		*acoustic	*acoustic insulation (affecting openings, materials, shading)
		*stability	*safe construction materials
		*health	*selection of materials maintenance and upkeep

USER'S REQUIREMENTS	PRIMARY CRITERIA	SECONDARY CRITERIA	PERFORMANCE CRITERIA
PHYSIOLOGICAL		*temperature	*thermal insulation (affecting openings, materials, shadings)
		*safety	*windows, parapets with safety heights
	*anthropometric	*activity support	*room for external activities
		*accessibility	*dimensions of walls, openings in relation with the external, internal activities. *provision of installation
		*visual privacy	*provision of means for visual protection (shadings)
PSYCHOLOGICAL	*privacy		*possibility for visual isolation of rooms
		*acoustical privacy	*provision of acoustical privacy (affecting openings, materials, shadings)

USER'S REQUIREMENT	PRIMARY CRITERIA	SECONDARY CRITERIA	PERFORMANCE CRITERIA
PSYCHOLOGICAL	*self expression	*user's control	*possibility for choice, variety, changeability of facade elements
	*life style	*family type	*changeability due to change of family needs
SOCIOLOGICAL		*behavioral patterns	*traditional rural vs. urban patterns
	*community patterns	*community relationships	*contextual design *community patterns
ECONOMICAL	*income		*materials, components, finishes corresponding to future users' income
		*maintenance *change	*components easily manipulated by the user

Fig.2.2.1 General Performance Criteria for Spaces Near Dwelling Facades

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ACTIVITIES ISSUES	PERFORMANCE CRITERIA	ENVIRONMENTAL CHARACTERISTICS
.light	.activities sensitive to view	.possibility for temporal protection of the balcony from the view e.g. movable shadings
disturbance influence	.activities requiring view	
.acoustic	.activities-noise generating	.no disturbance of quiet internal activities separation of balcony areas according to each activity subgroup (e.g. kitchen balcony from bedroom balcony)
.climatic	.activities sensitive to wind and sun	.possibility for protection of the balcony from climatic conditions
relationship with internal activities	.communication with related internal activities	.available accesses to balcony
installations	.water and electricity supply	.water supply for washing and planting

Chart 2.2.2

Relation Between Activities, Performance Criteria, andEnvironmental Characteristics.

3. Hierarchy of Elements of the Building Task

For the purpose of this study, and to provide a basis for an actual example, related to Egyptian conditions, the "Helwan" Concrete Panel Prefabrication system (described in "Interim Report Working Papers 1977, section Prefabrication,") was used as an example for the possible application of the results of this study.

The following elements were considered:

- Materials
- Sections
- Units or parts (assembly of materials and section)
- Components (assembly of parts, e.g., walls panels, doors, window)
- Elements (assembly of components, e.g., facade elements)
- Spatial units (assembly of elements, e.g., balcony spatial units).

For a detailed description and catalog of the above elements, see: T.A.P. Report 79-5, the Housing and Construction Industry in Egypt, Interim Working Papers 1978, published Spring 1979, Section: "Construction Systems," pp. 80-93.

In fact, given the separation of "primary" (structural/support) elements from "secondary" (infill) elements, this portion of the report is contiguous with and dependent upon the rules and method developed in the 1978 report.

For example, Figure 2.4.3 of the 1978 report, entitled "Facade Elements," represents the conceptual basis for the evolution of the contextural and case-specific solution presented at the end of this chapter (see Figure 7.1).

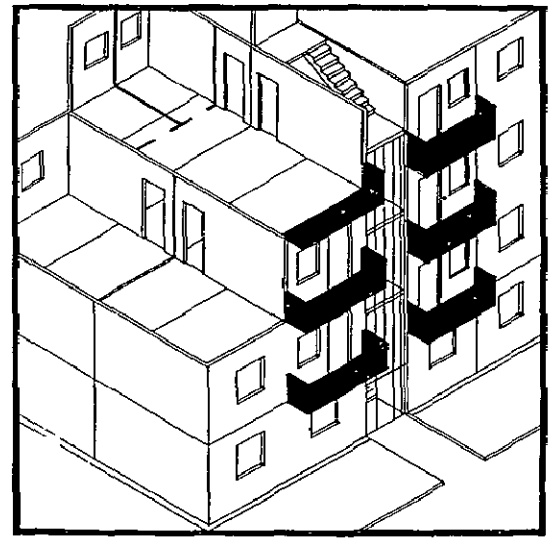


Fig. 3.1
Balconies, Loggias, Terraces, Etc.

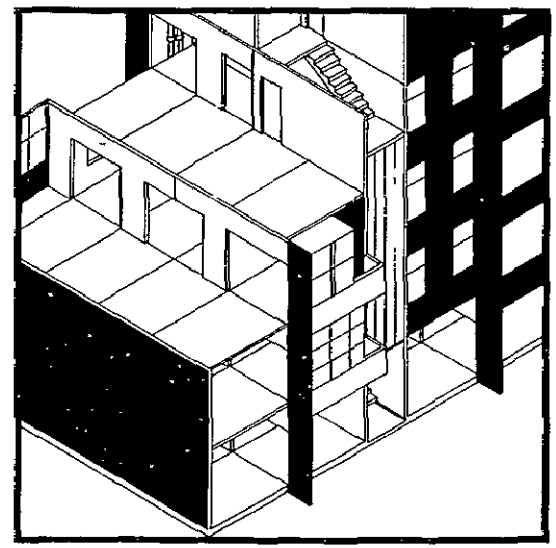


Fig.3.2
External Envelope
Balconies, Loggias, Terraces, Etc.

4. Physiological/Anthropometric Criteria

Typology of User Activities, Related to Physical Elements: The external envelope functions as an interface between the interior and the outside world, and/or between internal and external use spaces. In order to propose a set of design solutions, based on essential performance criteria as shown in Table 4.7 a comprehensive analysis was carried out for the activities occuring in habitable spaces, located adjacent to the external envelope--inside and outside.

For the purpose of this analysis, existing dwelling habits in the Eygptian urban context (i.e., Cairo) were considered. Activities and related equipment were classified into three spatial categories, i.e., bathrooms, kitchens, and balconies.

The following Tables show how the various sizes of each of the three categories affect facade elements. All layouts are based on a 10-20 tartan grid, which has been accepted as the best and most efficient means of positional and dimensional coordination throughout the whole process of research.[9] From the above typology, minimum and maximum sizes of various components of the external envelope (walls, openings, balcony floors) were derived, and examples showing their free but coordinated combination are shown at the conclusion of the report.

Matrix 4.1 shows the general relationships between "User Needs" and "Subsystem Affecting Satisfaction," with elements dealt with in this study emphasized by dark lines.

Flow Charts 4.2 and 4.3 show the example of one activity--cooking--as translated into sub-activity requirements, and equipment to satisfy these requirements. Figure 4.4 shows an example of standard European kitchen types, which include all the equipment required by Chart 4.3. A similar determination of requirements for balconies is attempted by this study, but based on Egyptian needs and requirements, which clearly differ from those of Northern European solutions.

Figures 4.5 and 4.6 show the influence of internal functions on size (width) of balcony.

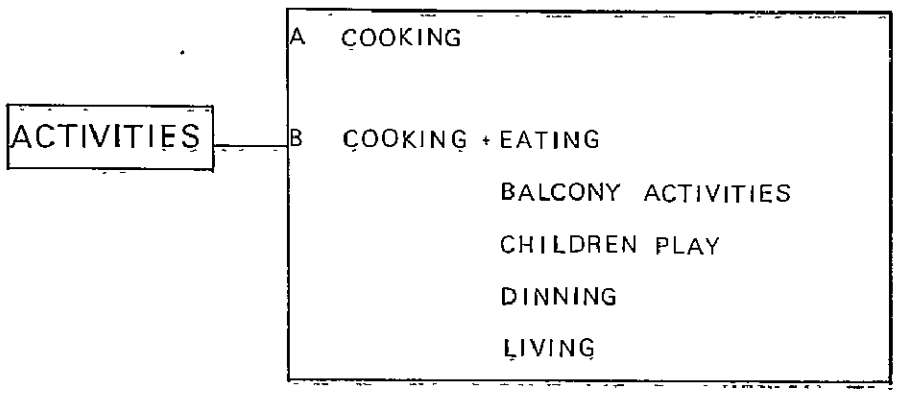
Table 4.7 summarizes activity patterns related to expected performance of balconies in Cairo.

MATRIX 4.1
Measurement of Functional Performance

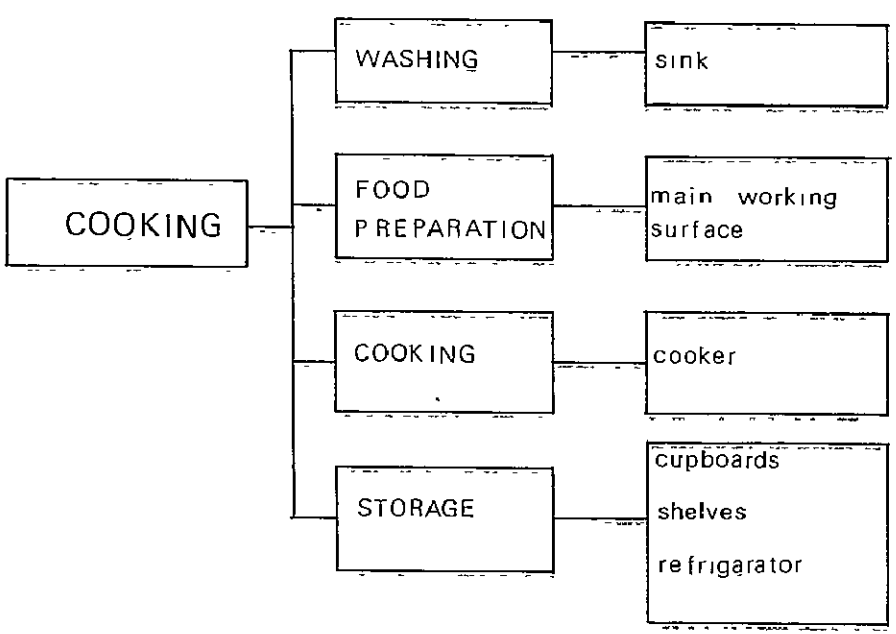
X -Primary effect
O -Secondary effect
-No effect

		SUBJECT		SUBSYSTEM AFFECTING SATISFACTION							
		direct user	indirect user	structure	exterior wall	roof/ceiling	floor/ceiling	interior partitions	plumbing	HVAC	electrical
	good lighting conditions	X			O	O	O				X
USER NEED	good appearence	X		X	X	X	X	X	O	O	X
	good acoustical environment	X		O	O	X	X	X	O	X	O
	bodily comfort	X			X	X				X	
	odor control	X								X	
	short-term flexibility	X	X			X	X	X	X	X	X
	long-term flexibility		X			X	X	X	X	X	X
	expendability		X	X	X	X	O	O	O	O	O

Matrix 4.1



COOKING ACTIVITY/RELATED EQUIPMENT



Flow Charts 4.2 and 4.3
Cooking: activities and Equipment

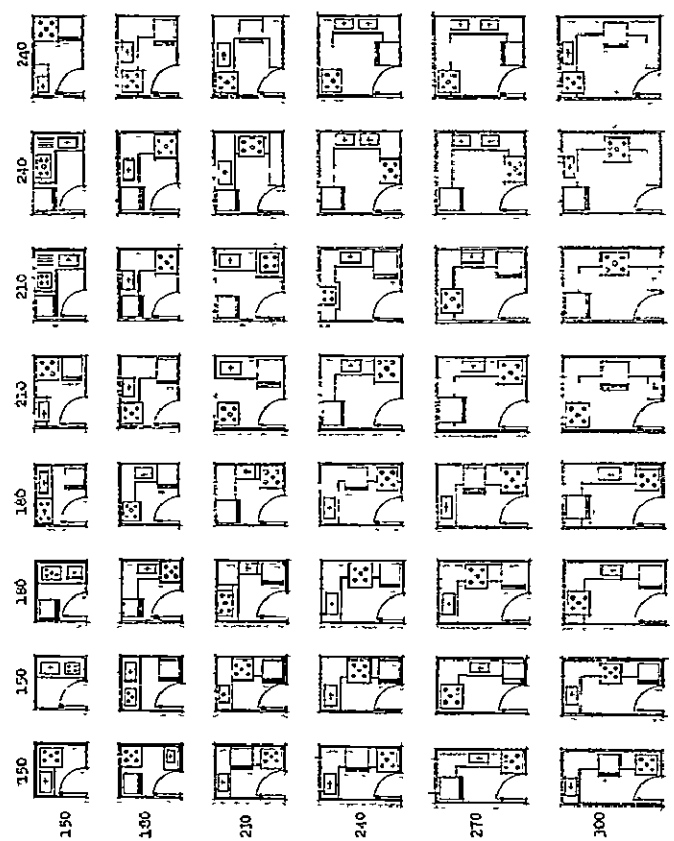


Figure 4.4
Possible Layouts for European Type Kitchen Layouts
(A similar modularly coordinated chart may be worked out for other types)

ACTIVITIES	NATURE OF GROUPINGS	DISTURBANCE INFLUENCE							TIME DURATION							RELATIONSHIP TO DWELLING FUNCTIONS		INSTAL-LATION		OBJECTS
GROUPINGS = B : baby, SC: small child, C : child, A : adult, O : old person		generating / sensitive / necessary		wholly ▼ ■ ●		partially ▽ □ ○			noise sensitive / noise generating / weekly ★ / daily •						FREQUENCY	RELATIONSHIP TO ACTIVITY AREAS WITHIN (INSIDE) OF APARTMENT MEANS BY WHICH RESPECTIVE OBJECTS, IMPLEMENTS OR FURNITURE ARE ACHIEVED		mand-atory ●	optio-nal ○	
		LIGHT		ACOUSTIC		CLIMATIC			4–6	6–8	8–12	12–16	16–20	20–				water	electricity	
sleep																				
rest																				
privacy																				
eat,drink																				
sport,exercise																				
play,hobbies																				
pets,plants																				
parties																				
talk																				
radio,tv																				
visitors																				
read																				
fix																				
store																				
work																				
CONSEQUEN-CES		SHADING	VISUAL BARRIERS	SOUND BAFFLES	SOUND ABSORBED	WIND BREAK	SUN SHADE	TEMPERATURE CONTROL	ACTIVITIES EVALUETED ON THE BASIS OF FREQUENCY AND DURATION IN A SEQUENTIAL ORDER.											
	ON	CONSTRUCTION, POSITION ORIENTATION							MINIMUM SIZE (depends on furniture and space)							ASSIGN	EQUIMENT			MINIMUM SIZE

Table 4.7
Activity/performance Characteristics of Balconies in Cairo

Figure 4.8 shows the levels of feasible functional and spatial options for balconies, loggias, terraces and open yards.

1=Generally feasible
2=Partially feasible
3=Not feasible

Balcony	Loggia	Terrace	Open Yard	
1	1	1	1	Deep
1	1	1	2	Shallow
3	2	3	3	Small area
2	3	1	1	Large area
3	3	3	1	Accessible from outside
3	3	2	1	Open to sky
1	1	2	3	Covered
2	2	2	1	Orientation E - W
3	3	3	2	Orientation free
3	3	2	1	Subdividable
2	2	1	1	Addition and modification
2	2	1	1	Changing use
2	2	1	1	Keep domestic animals
1	1	1	1	All year use
1	1	1	1	Sitting
3	3	2	1	Storage of large items
1	1	1	1	Sleeping (over night)
1	2	1	1	Individual, private activities
2	2	1	1	Group activities
1	2	1	1	Eating (with groups)
2	2	2	2	Reading
2	3	2	2	Worshipping
3	3	3	3	Bathing
2	2	2	2	Passive play
2	2	2	2	Active play
3	3	2	1	Parties, gatherings
2	2	1	1	Barbecueing
2	3	1	1	Physical work
1	1	1	1	Gardening
3	3	3	3	Noise
3	3	2	2	Direct contact with earth
1	1	2	3	No direct contact with earth

Figure 4.8
A Comparison Among Balcony, Loggia, Terrace and Open Yard

Figures 4.9 to 4.11 show possible activities that take place on balconies, as observed in Cairo (see Illustrations 1.1 to 1.10) and the minimum space (dimensions) required to accommodate each activity. Dimensions were adjusted to conform to a 30 cm. centerline to centerline grid, with 10/20 cm. bands superimposed (tartan grid).

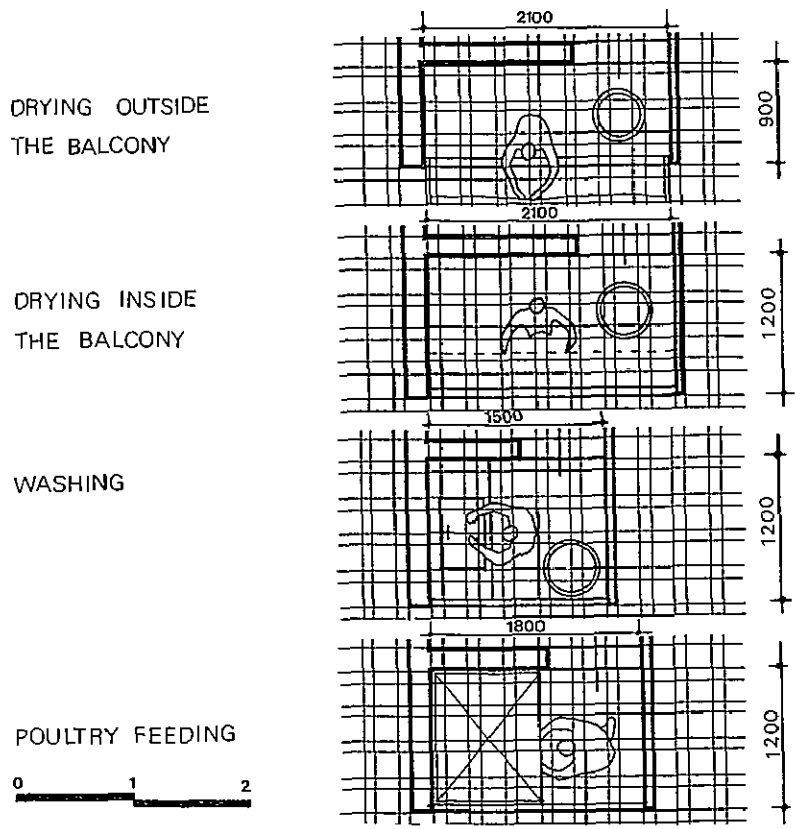


Figure 4.9
Possible Activities on Balconies and Space Required

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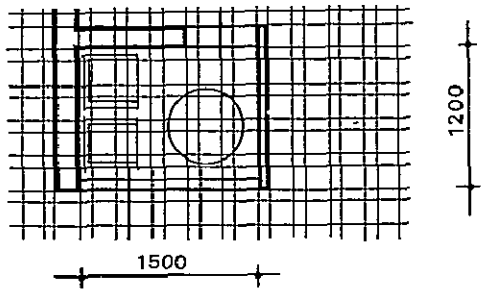
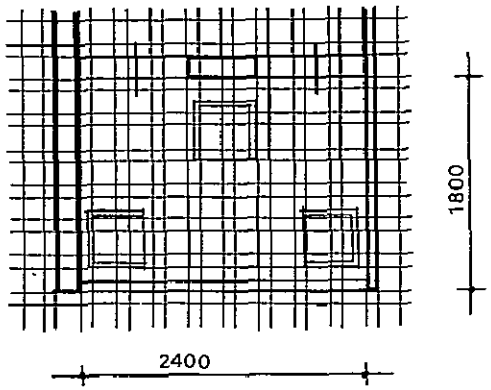
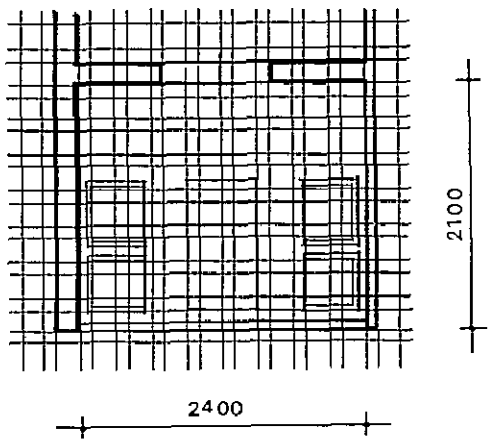
EATING - 2 PERSONS



EATING. 3 PERSONS



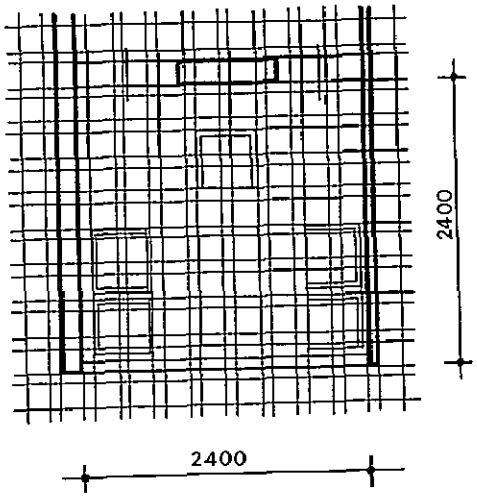
EATING. 4 PERSONS



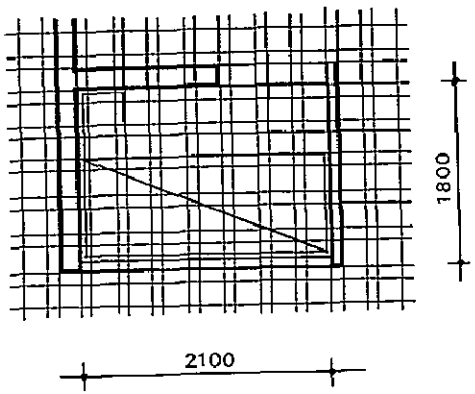
0 1 2

Figure 4.10
Possible Activities on Balconies and Space Required

EATING 5 PERSONS



SLEEPING 1 PERSON



0 1 2

Figure 4.11
Possible Activities on Balconies and Space Required

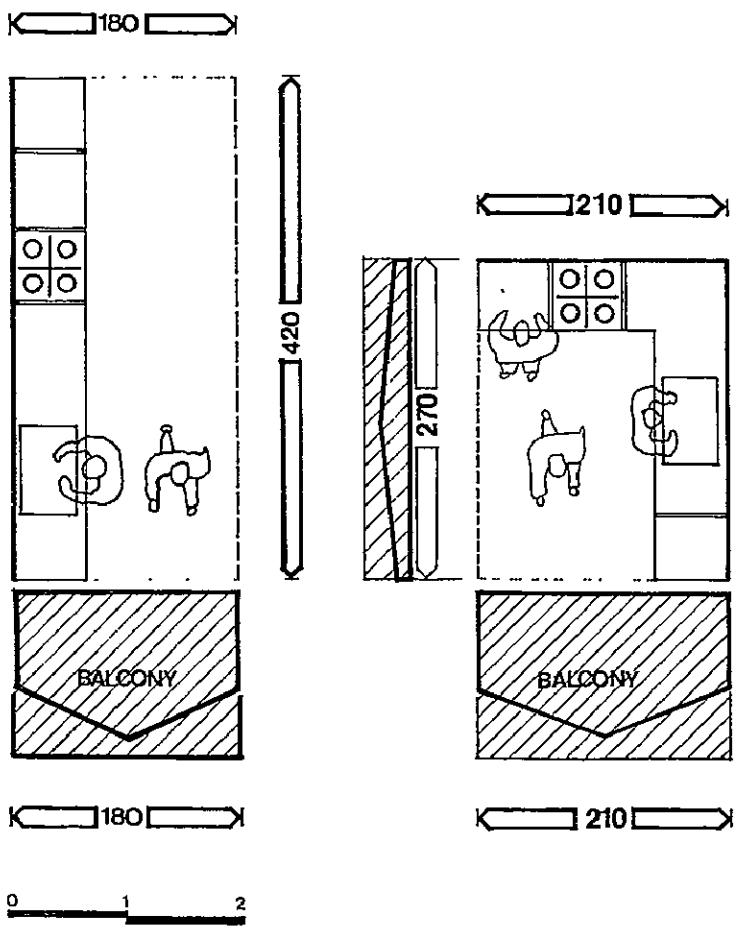


Figure 4.5
Influence of Size of Kitchen on Width of Balcony

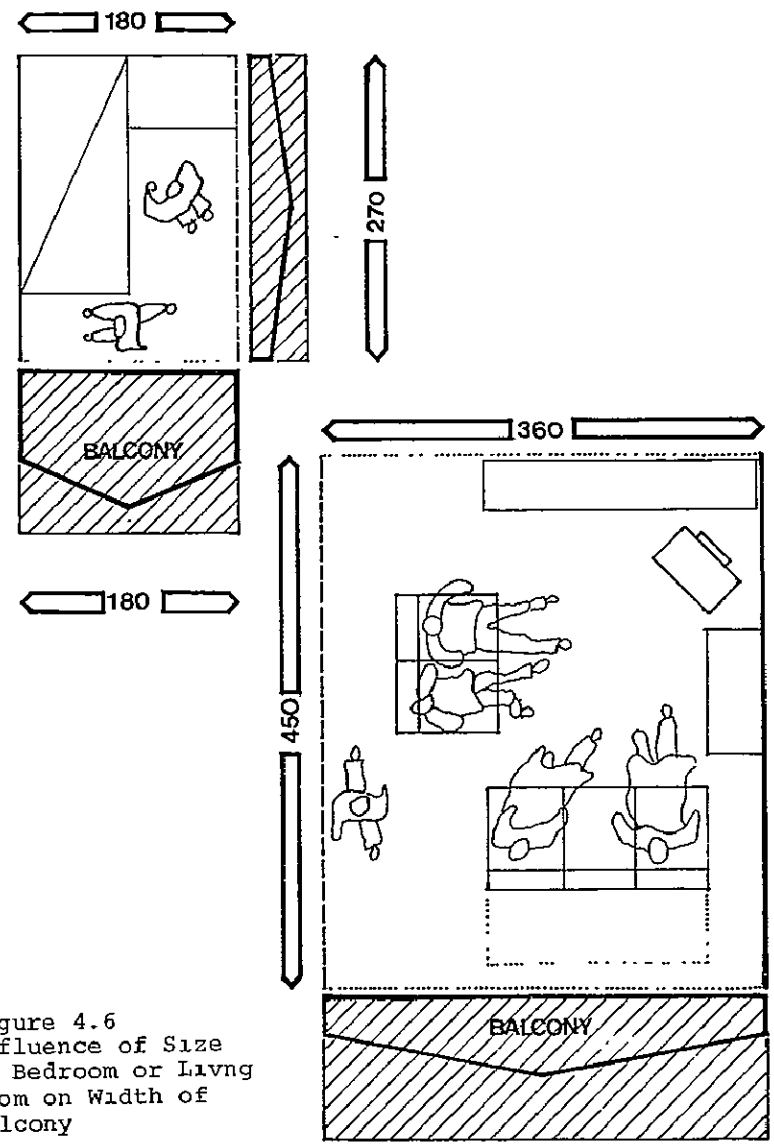


Figure 4.6
Influence of Size of Bedroom or Living Room on Width of Balcony

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5. Climatic Factors

5.1 Sunlight

In Egypt, the need of capturing sunlight inside the dwelling is less important than the need for an additional (shaded) outdoor space, which supplements adjacent indoor functions, and which acts as a shading device to help cool and ventilate the interior of the dwelling--especially during the hot months of July and August.

Another factor of climatic importance is the possibility to use the balcony as an extension of functions or activities recuring near or adjacent to the balcony location indoors, or to enclose the balcony permanently to expand inadequate indoor spaces. The enclosure may also serve as a climatic device to insulate the unheated indoor spaces against the night chills of the cold months of January and February.

Given the above possibilities, the current tendency--especially in public housing projects--to provide minimum-size balconies on the model of North-European solutions seems not only inappropriate in functional terms, but essentially uneconomical as far as the life-cycle of dwelling layouts is concerned.

While view and the possibility to step out into fresh air justify to some extent the modest size of European balcony solutions, the Egyptian context must respond to different environmental and/or life-style imperatives. It is the purpose of this study to determine both environmental and life-style factors in terms of their impact on the performance criteria for Egyptian urban conditions.

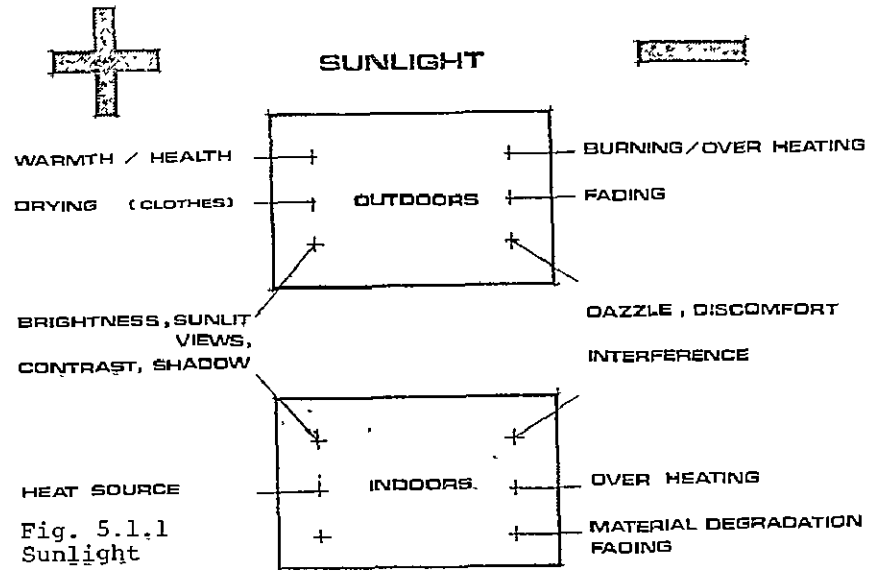


Fig. 5.1.1 Sunlight

	22nd JUNE			21st MAR.			22nd DEC.		
Time	V.	H	Direction	V.	H.	Direction	V.	H.	Direction
8 am	37	82	NE-E	28	107	SE-E	12	125	SE-E
10 am	63	57	SE-E	48	132	S E	30	148	S E
12.00	83	180	S	60	180	S	47	180	S
2 pm	63	262	SW-W	48	230	SW	30	212	SW-S
4 pm	37	278	NW-W	25	255	SW-W	12	235	SW
6 pm	12	292	NW	0	0	—	0	0	—

Fig. 5.1.2 SUN POSITIONS VERTICAL & HORIZONTAL ANGLES LATITUDE 30°

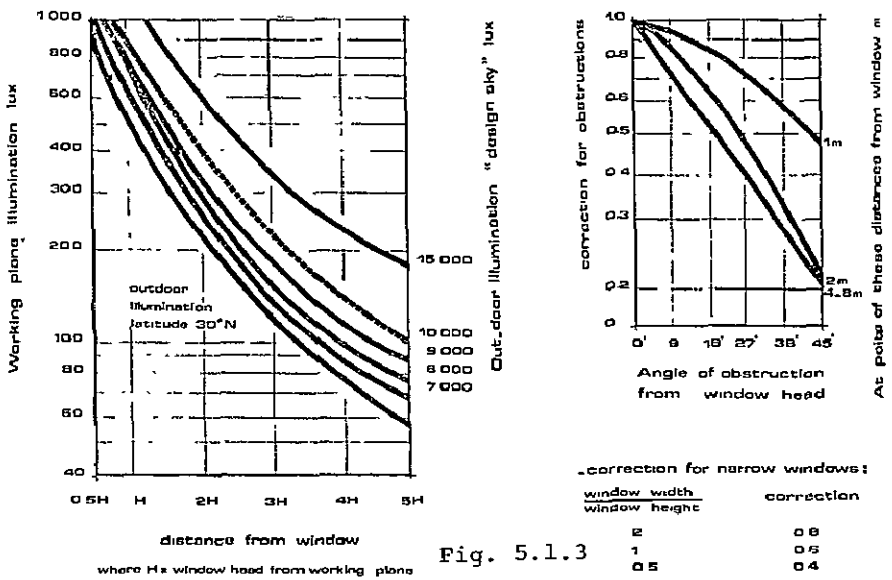
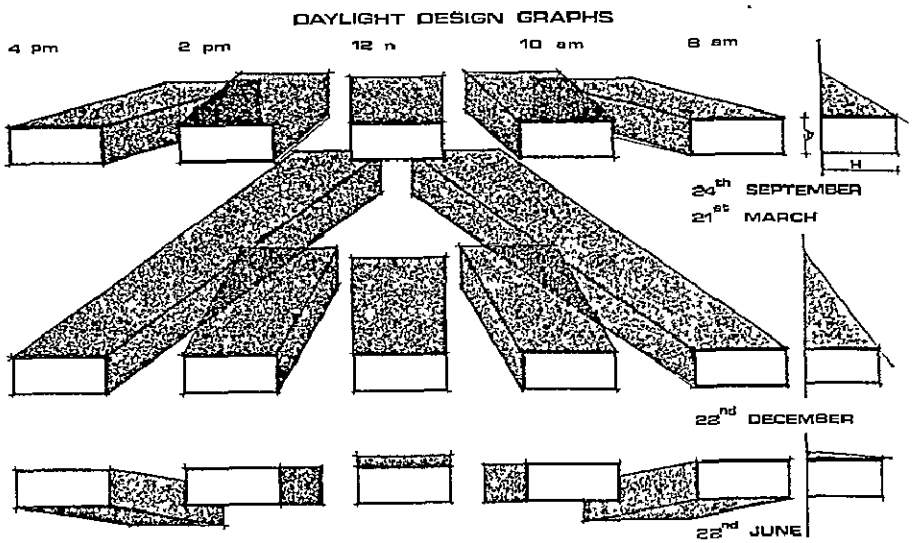


Fig. 5.1.3



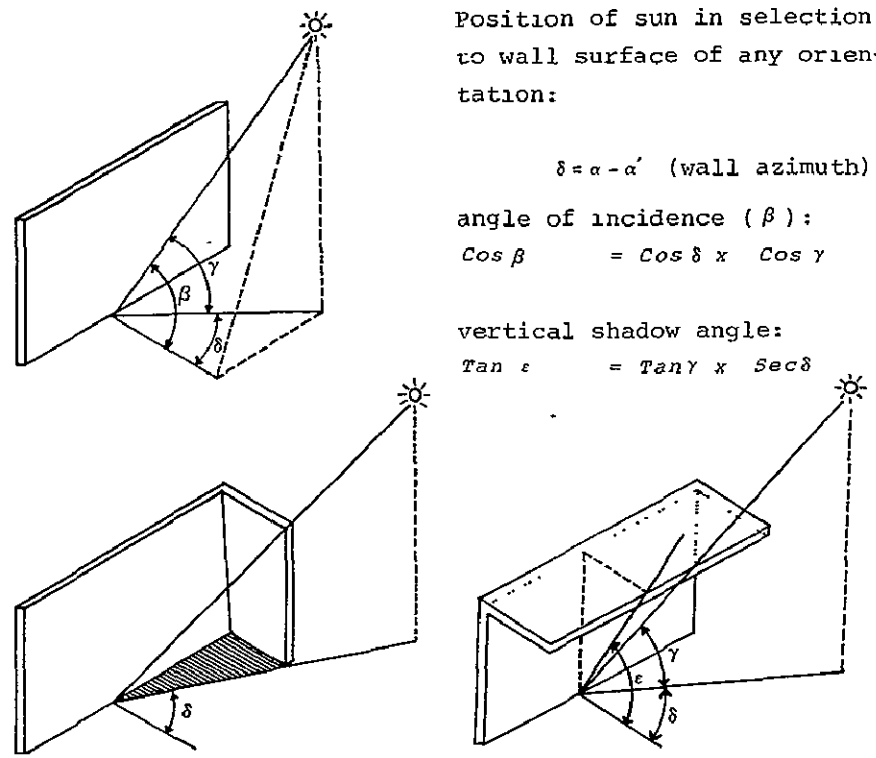
A DETACHED BLOCK; SHADOW PATTERNS

LATITUDE 30° N.

Fig. 5.1.4

DAYLIGHTING VS SPACING (OBSTACLES ETC.)

Apart from satisfying functional and technical performance criteria, the balcony also performs as a year around shading device, depending on the position of the sun in a particular geographic location, e.g., Cairo: 29°52'N latitude, 31°21'E longitude. Sun path charts should be used to determine both solar altitude angle ( ), and solar azimuth angle ( ), (see figure 5.1.5., below).



Solar Shadow Angle Calculations

Fig. 5.1.5

(Source: Koenigsberger et al., "Manual of Tropical Housing." Part 1, Longman Group Ltd., 1973, p. 112)

5.2. Wind

While cross-ventilation in hot climates is a desirable feature in generic terms, the Egyptian climate is characterized by additional wind-related peculiarities, such as periodic wind-sand storms (*kamsim*), wind-borne dust, and considerable wind-borne pollution, especially in Cairo. Thus, the balcony must not only fulfill the function of shading and/or ventilating, but must be capable to provide devices for preventing sand and dust to be blown into the interior of the dwelling. In performance terms, the following environmental functions must be satisfied by the balcony design:

- shading
- ventilation and cooling
- deflection of air-borne dust and sand
- possibility of full closure.

Technically, these performance specifications affect balcony elements in the following manner:

shading--balcony slab and side enclosure
ventilation--railings and facade openings
closure--facade openings or special enclosures.

Balcony size and shape will relate to shading and to functional performance criteria of use.

The following analysis of the various spatial and structural elements of a "generic" balcony is an attempt to provide a method for the translation of performance criteria based on varying user requirements, environmental function, and the exigencies of standardization and production coordination, without producing single option solutions, or solutions based on Northern climate precedents.

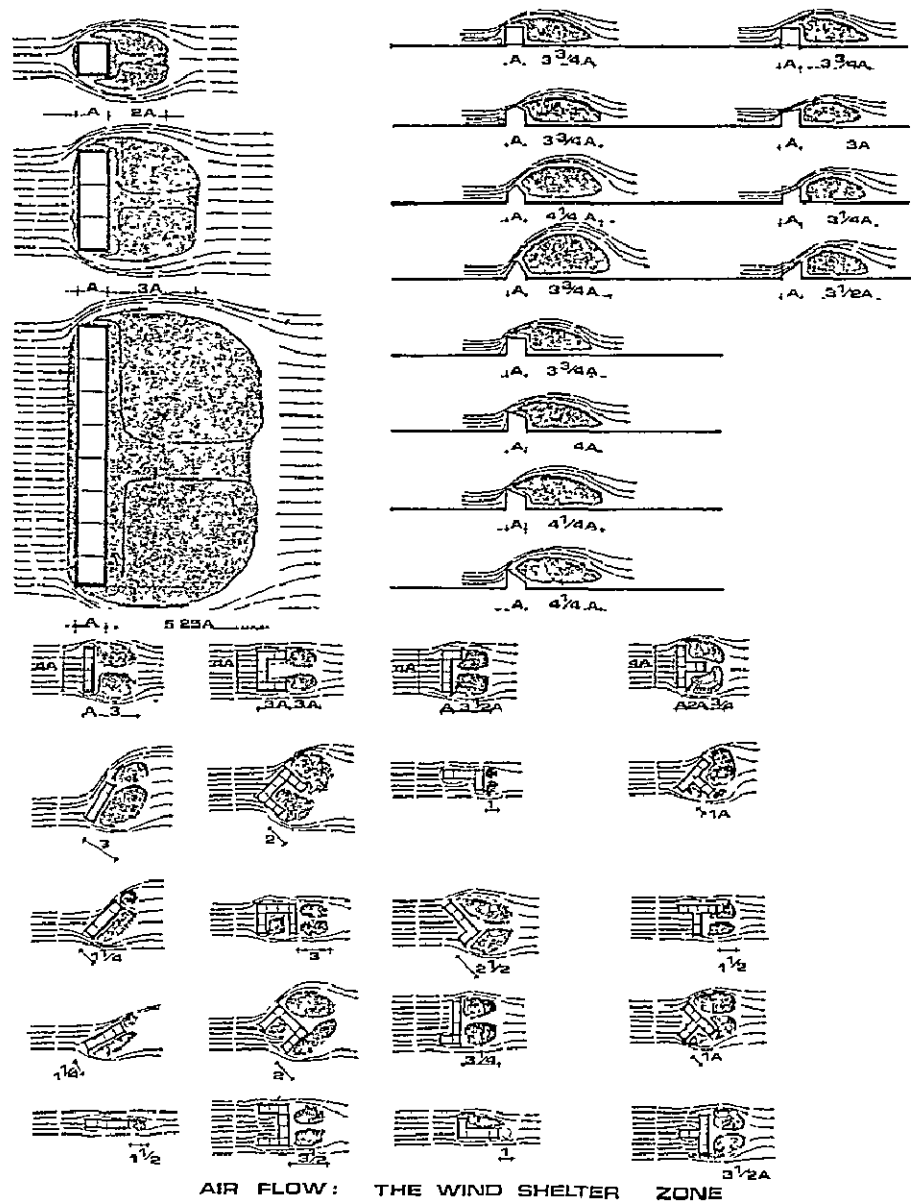


Fig. 5.2.1

6. The Balcony as a System of Elements Determined by Performance Criteria

In order to be able to translate both environmental and behavioral performance requirements into spatial and technical performance criteria, the balcony may be analyzed as a system of *spatial* and *material* elements, responding to both *functional* and *structural* requirements, defined best in terms of *volumes* and *planes*, both having *positional* and *dimensional* characteristics.

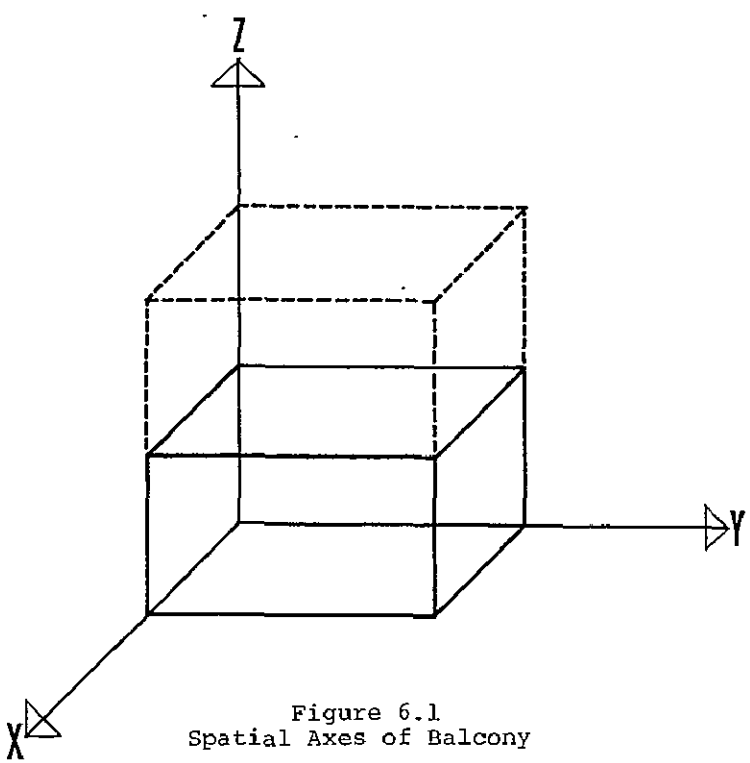


Figure 6.1
Spatial Axes of Balcony

Axis "X"

Structural Criteria:

The ability to support dead and live loads.
The ability to cantilever beyond the line of the facade.
The ability to be supported by bearing walls or columns.

Functional Criteria:

Fuction and use of available space (horizontal plane).

Axis "Y"

Structural Criteria:

Joint between external enclosure (facade) and balcony. Size of bay defines structural system. May or may not coincide with structural bay size.

Functional Criteria:

Relationship of indoor to outdoor functions.
Room size and function adjacent to balcony.
Nature of opening or openings.
Environmental protection.

Axis "Z"

Structural Criteria:

Support of slab(s) above
Possible foundation for bearing walls or columns.

Functional Criteria:

Enclosure function and type for balcony.
Possibility of alteration or adaptation.
Environmental sheilding.

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Conceptually, a balcony consists of the following generic space-enclosing elements:

1. Horizontal plane (slab)
2. Vertical (side) plane
3. Vertical posts (columns)
4. Vertical (front) plane

plus, combinations of 2 and 3

The manipulation and combination of the above elements in response to a specified range of environmental and functional performance criteria leads to the following basic potential performance functions:

- Horizontal planes as shading devices, to hang objects, or to fasten temporary or permanent enclosure elements.
- High vertical planes as surfaces on which to place furniture, or to attach devices, and/or attach objects.
- Low vertical planes acting as railing, shelves, grilles, privacy shields, viewing openings, etc.

Figure shows the basic three ways in which a balcony enclosure may be realized.

Figure shows possible variations of type C.

Thus, depending on orientation, structural system, building height, plan configuration, and various functional requirements, a number of coordinated design strategies for variable and adaptable balcony solutions may be developed, based on a set of performance criteria, which are compatible with the social, technical, and economic context of the problem to be solved, rather than imported prototypes and solutions.

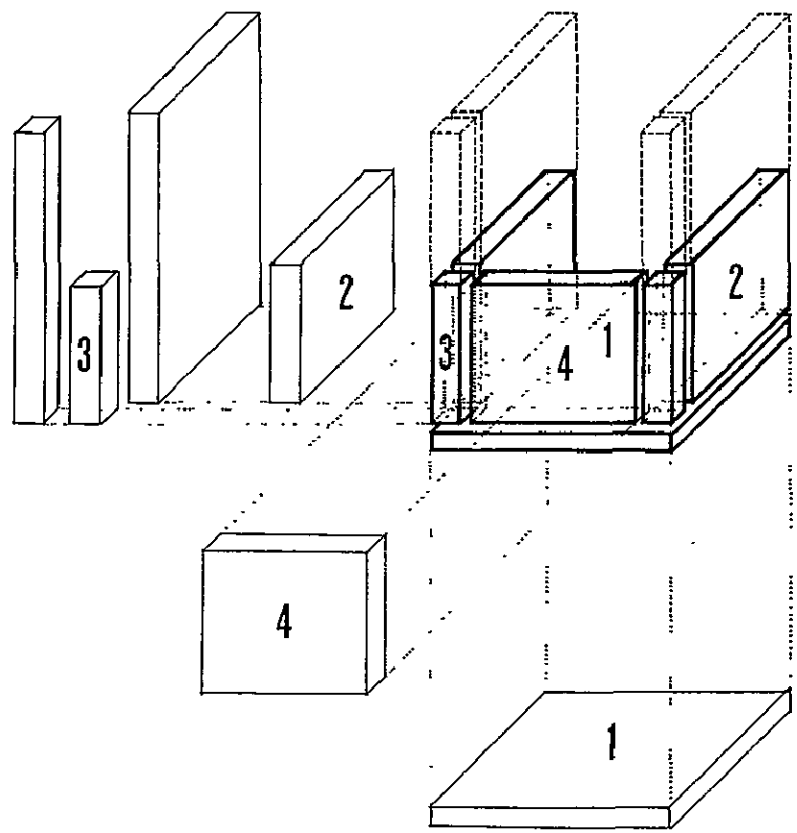
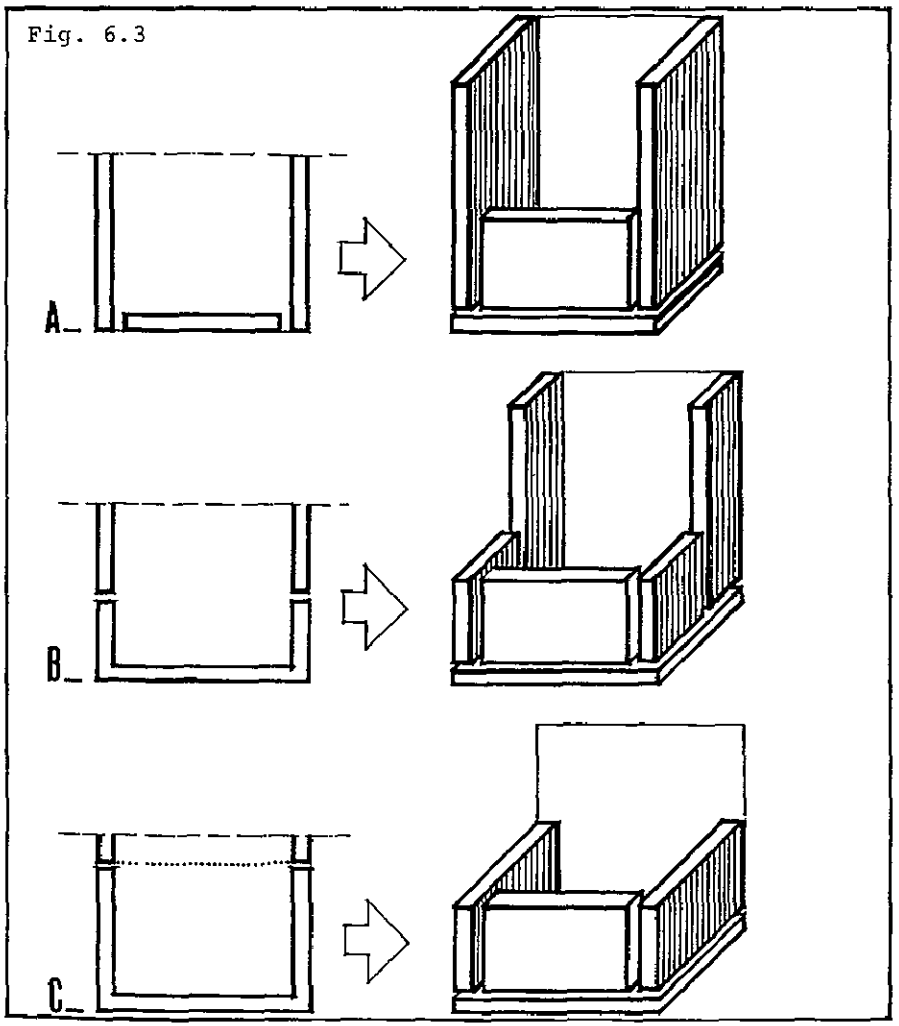
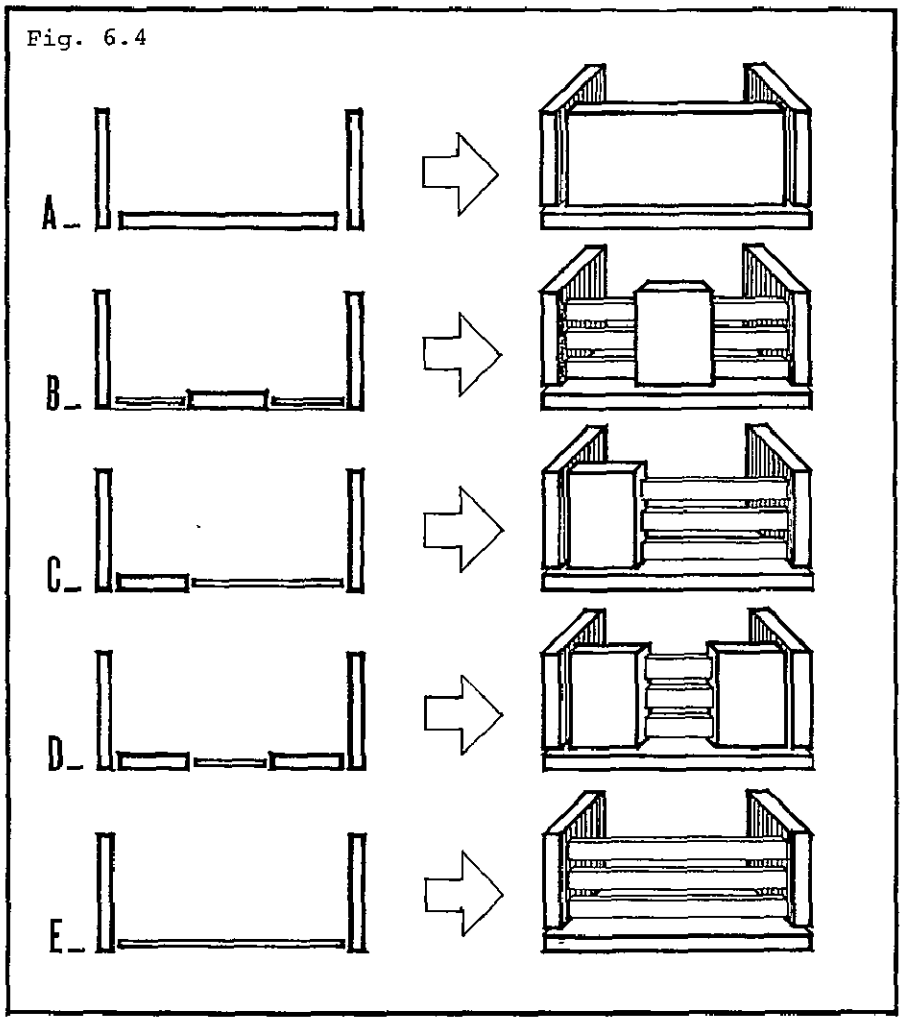


Figure 6.2
Generic Space Enclosing Elements of Balcony

Beyond that, and given a basic rule system for positional and dimensional coordination, a typology of sub-elements and/or sub-variations may be evolved over time, to allow adaptation both in terms of changed user needs, higher technical standards, or functional change.

Fig. 6.3 Schematic Balcony Configurations
Fig. 6.4 Schematic Balcony Front Configurations





7. Design Proposal: Typology of the Elements for Spaces Near the External Envelope

For all design proposals, the so-called support/infill concept was considered.

In addition, the proposed support system of Phase II of the Cairo Univ./M.I.T. research project, was used to show how the variable plan solutions can be implemented technically by equally variable facade-balcony solutions.[10]

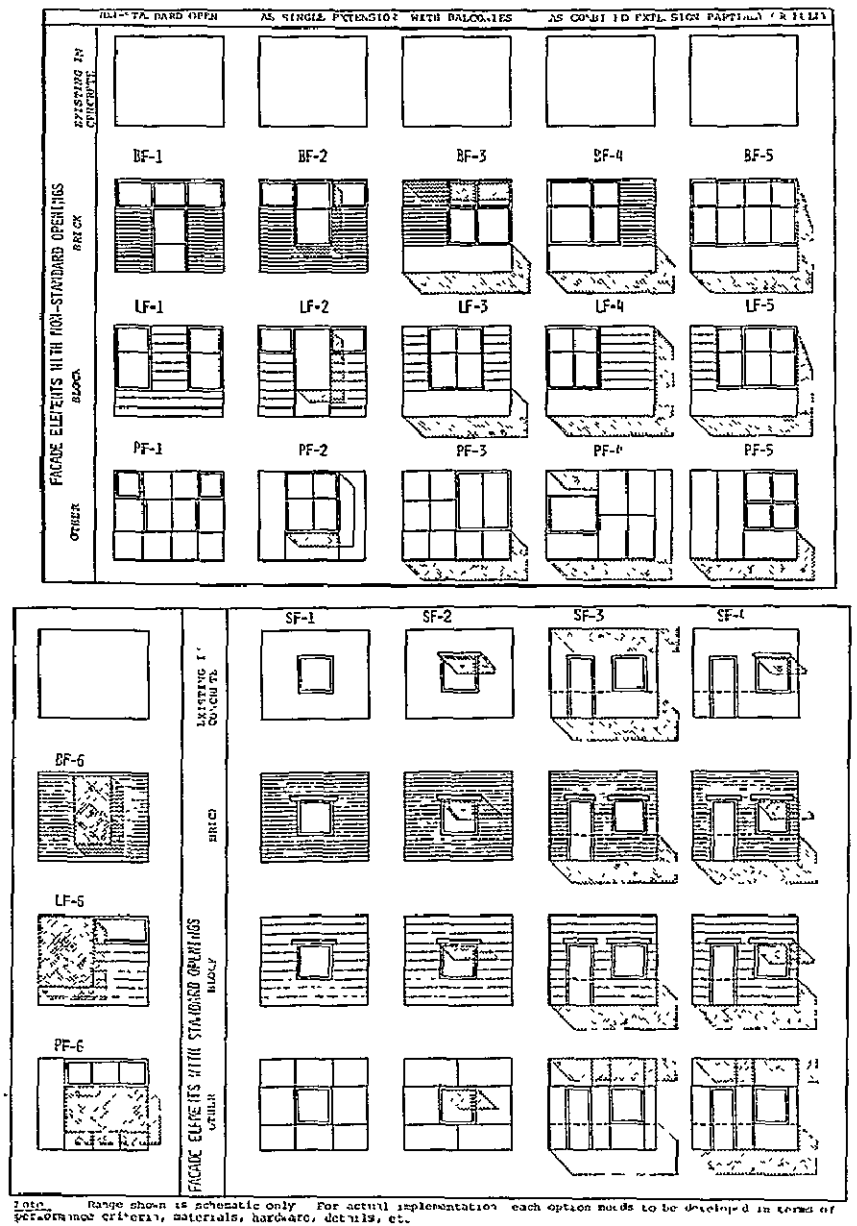
Variations that deal with facade elements common to all uses were proposed for the support structure.

As various facade infill elements were considered, those in the activities/spatial unit typology (see Part 4) were assumed as variable, such as balcony floor, exterior walls, openings, doors, etc.

Traditional Egyptian patterns for ventilation and sunlight were also considered for specific proposals of the support/infill elements. As a result, the meaning of the facade system may be defined as the meaning of its basic structure plus a set of conventional infill (or secondary) elements, responding to performance criteria which respond to social roles or cultural traditions of the Egyptian user.

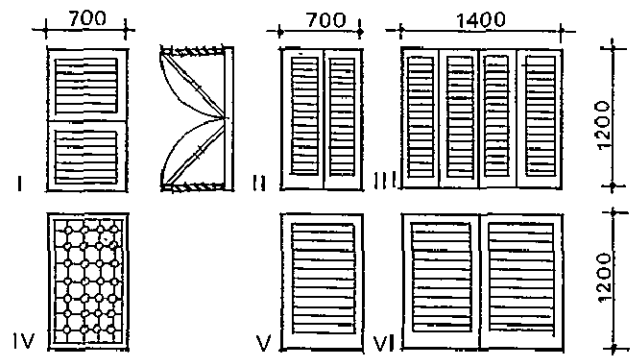
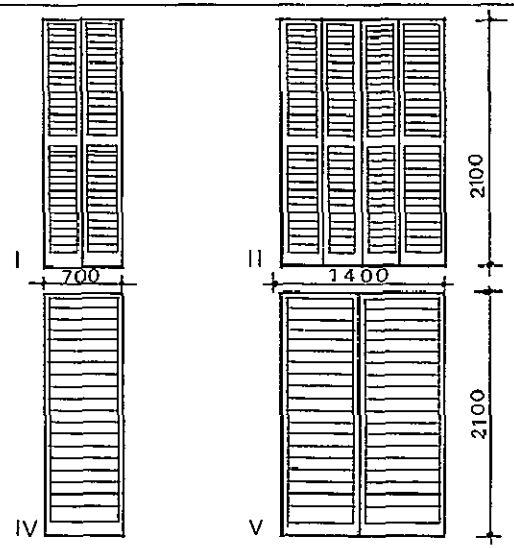
Based on this analysis, an example of a possible facade subvariation was designed, showing the compatibility of the various proposed "standard" elements in terms of an alternative and flexible overall facade organization. Here the "sectors" form the global space for the arrangement of the elements of the facade system.

The result is a proposal for a set of compatible types of the infill elements, to be developed by the workshops, craftsmen, or industry, as an economic and viable substitute to the inflexible, monotonous and functionally inappropriate solutions imported from Europe.



Note: Range shown is schematic only. For actual implementation each option needs to be developed in terms of performance criteria, materials, hardware, details, etc.

Fig. 7.1
Schematic Facade Elements With Openings

GENERAL CATEGORY	TYPES	MATERIAL
shadings windows		wood
shadings doors		wood

Table

Example of Basic Modular Shutter Types.

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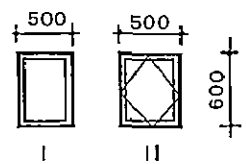
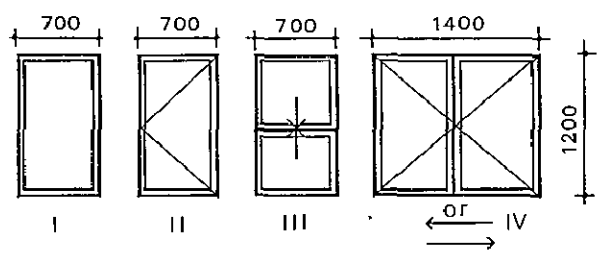
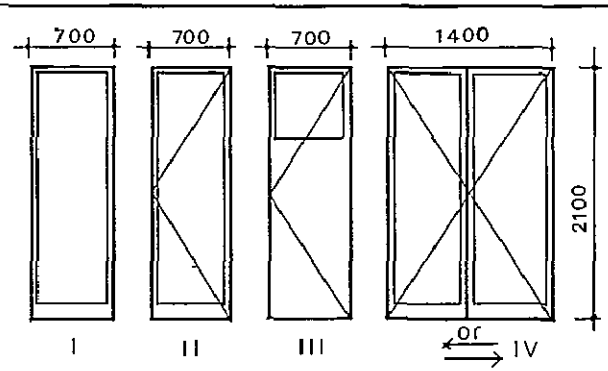
GENERAL CATEGORY	TYPES	MATERIALS
skylights		wood metal
windows		wood metal
doors		wood metal

Table 7.3

Example of Basic Modular Window/Door Types.

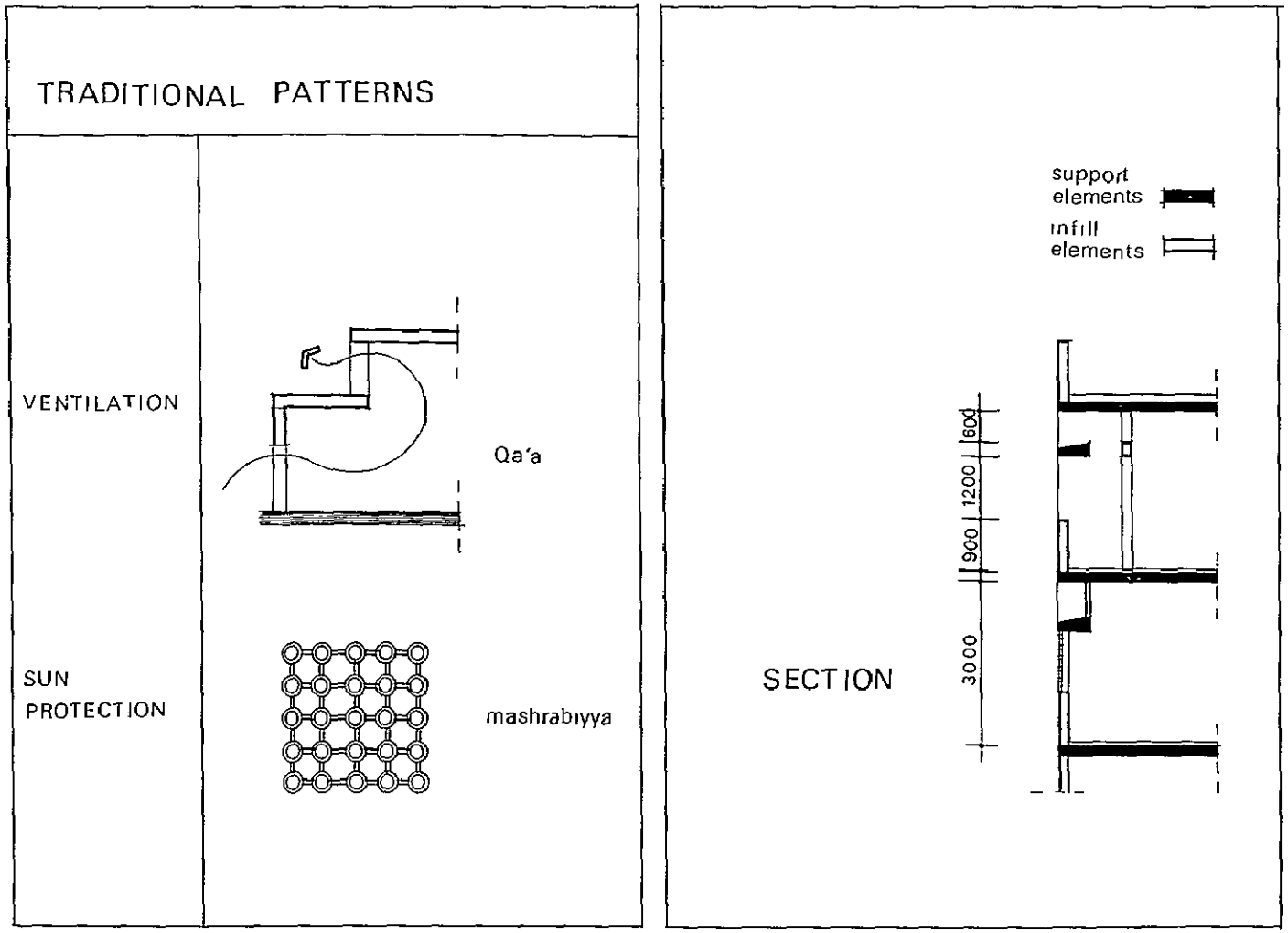


Illustration 7.4

Traditional Elements: Qa'a, Mashrabiyya, and Recessed Shading

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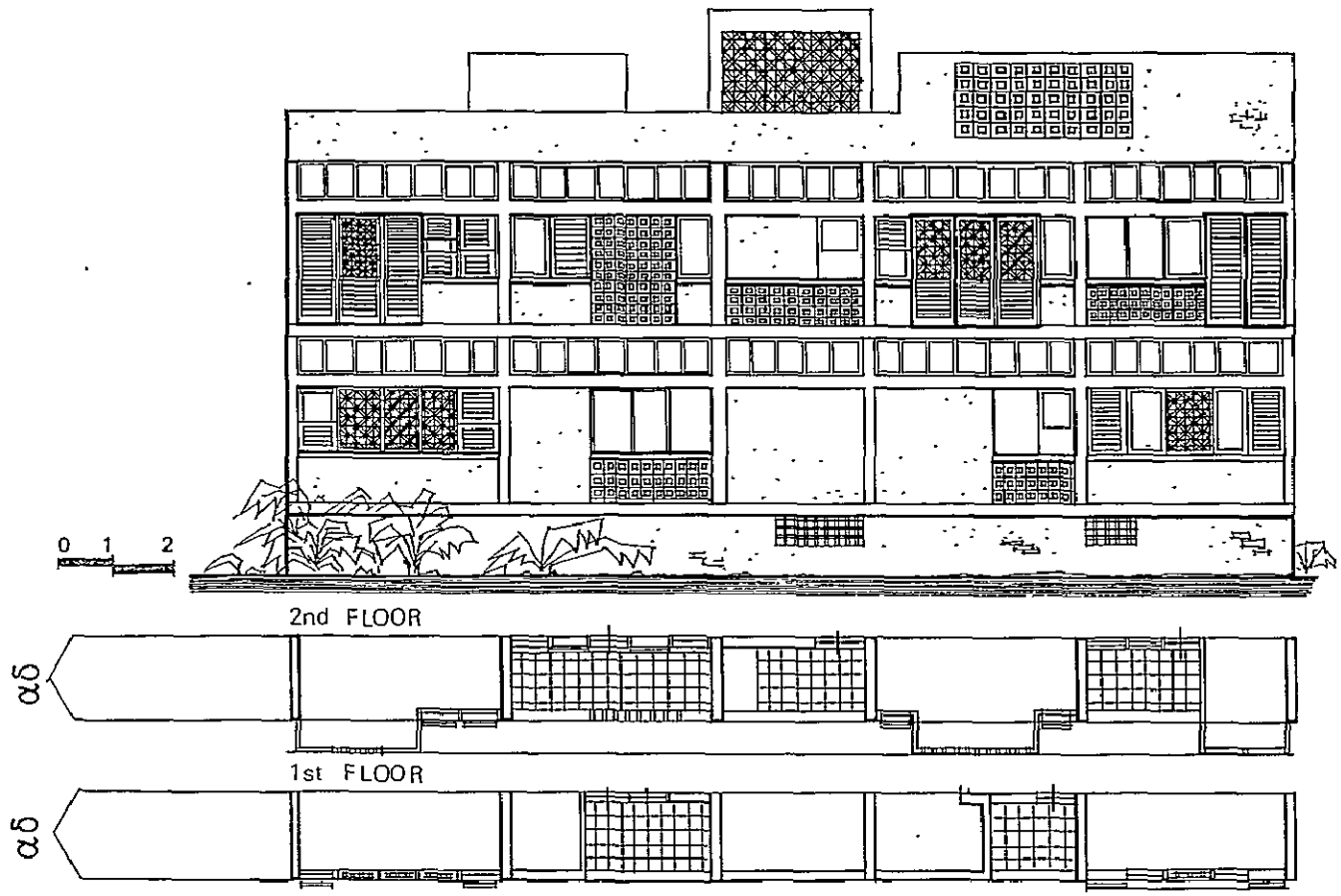

Illustration 7.5

Example of "Support" with Basic Modular Facade Element Variations.

8. Concluding Remarks

The Performance Concept, as an analytical tool for generating design proposals, is characterized by both the advantages and problems that occur whenever systematic approaches are used in architectural design.

There is no question that the performance concept is a powerful tool, when used in large scale (industrialized) building projects. It allows a more flexible and adaptable approach to the establishment of criteria for the translation of user needs (which are becoming ever more complex in contemporary society) into technical performance standards, without fixing results, while at the same time establishing the possibility of new directions for innovation in building production. In addition, and related to the above issues, variety and compatibility in buildings has become a universal requirement for any program in mass housing, to avoid mindless repetition, visual monotony, and lack of opportunity for plan variation, equipment upgrading, and adaptation to improved or changing lifestyles.

Obviously, it cannot be considered as the sole determinant of the complete design process, since the establishment of performance criteria is limited to providing an impetus, rather than a prescription for the elaboration of alternative design solutions and/or element options. Consequently, designers need other, related conceptual tools to integrate performance specifications into the overall design process (e.g., for the previous example, the SAR methodology was used to generate the overall "support" elements for accommodating alternative facade solutions).

One of the problems in applying the performance approach is that the architect may become completely bogged down in exhaustive analytical procedures, and thus lose sight of the need to creatively collate and synthesize the information by judicious choice of only those factors relevant to a particular use or situation.

Another important point is that the objectivity of the preliminary analysis does not necessarily insure an "objective" overall solution (namely, there is no iron-clad guarantee that the user needs will always be satisfied). Thus, the quality of the solutions still depends to a large degree on choice of values and subjective interpretation by the various participants involved in the design process.

Furthermore, the concept itself is not value free. It assumes the existence of an industrialized society organized in certain ways and accepting certain formal and/or informal relationships among the people involved in the design process, (i.e., specialists, users, contractors, manufacturers) which may function well in one society, but may function less well, or not at all, in another. Only testing the concept in prototype or experimental situations in Egypt can provide an answer to these questions.

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A SAR APPROACH TO THE SITE

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Summary

This work briefly presents one possible approach for a rationale for site plans generation in residential areas, comprising some physical and selected non-physical factors, while at the same time combining order and modularity required by contemporary approaches to industrialization and advanced construction techniques in the housing industry.

Selected physical determinants, affecting the site planning are discussed and the proposed generation process reviewed. A theoretical site provides the setting for the presentation and demonstration of the suggested approach to site plans generation.

Examples of three housing projects demonstrating the practicality and applicability of the rationale and the design criterial for residential areas with special reference to Egypt are also included.

1. Introduction

Egypt is suffering, as most developing countries, from the chain of interrelated problems caused by the population explosion and rapid urbanization. Topmost among these problems are: an acute housing shortage and a continuous deterioration of urban environmental quality.

Great efforts and positive steps have been undertaken by the government of Egypt to provide practical solutions to these problems and to effectively implement some of these solutions. The manifestations of these efforts are evident in the Egyptian new towns movement, the reconstruction projects, the revitalization of urban areas throughout the country, the number of large-scale housing developments for various income groups that were completed during the last decade, and the newly planned ambitious housing programmes currently in progress.

The scale and magnitude of the construction activities in the housing sector is unprecedented in the country's modern history. This boom in the housing construction industry is characterized by adaptation of modern construction techniques, introduction of new materials, industrialization of products and prefabrication.

In spite of the unprecedented activities in the housing sector and the number and scale of housing projects, design of the house units and planning of the space between houses (housing layouts and site plans) has remained very much the same; intuitive, casual and far from attempting to incorporate the complexity of new factors and aspects affecting the form of the contemporary house and its immediate external environment.

Site-planning of residential areas is, in most cases an afterthought, and a casual exercise often neglecting the physical, environmental, technical and socio-economic factors affecting the site-planning process.

This work is an attempt to coordinate and compile some of the more important factors and criteria affecting the design of new housing layouts and to formulate a possible rationale for the generation of site plans. This rationale also includes order and modularity, as required by industrialization and the introduciton of advanced industrial techniques in the housing industry.

This is not to be interpreted as a call for dogmatic and rigid approach to exterior space organization in housing areas, it is rather a reaction against casuality and indifference in the generation of site plans.

The suggested rationale is presented in a simple and straightforward manner; highlighting the chosen physical determinants and important design criteria affecting the site-

planning generation process.

The rationale is based on a flexible sequence of actions, comprising:

- definition of objectives,
- formulation of briefs and programmes,
- definition of the design context: physical and non-physical
- definition of the design criteria,
- development of design alternatives,
- comparative analysis and evaluation of the design alternatives,
- reviewing design objectives and criteria,
- selecting final design.

Emphasis in the present work is on the physical aspects of the rationale evolved and a methodical approach to site plan generation.

The work falls into two sections:

1. Physical Determinants and
2. Generated Siteplans.

The two sections briefly definte the structure of the rationale and how it may be used for siteplan generation.

The design criteria for residential areas, which is the backbone of the rationale for siteplans generation, is briefly introduced in the main text. In Appendix 2 is an extended review of the multi-faceted nature of the design criteria, highlighting the complexity and variety of factors involved, detailed discussion of which is outside the scope of this work.

2. Physical Determinants

In this section a brief account of the physical determinants affecting the site plans generation will be briefly reviewed. These are:

- setting, the physical context, i.e. the (theoretical site),
- modular grid,
- house types used, and
- design criteria.

The physical determinants define the frame-work for the generation process of the site plans and together with the design criteria provide the basis for the design/planning rationale.

2.1 The Setting: the theoretical site

The question of choosing a site(s) to use as a setting for the grouping and external organization of the house types selected represents the first problem encountered in this work. Two options were available; to choose a real site with its boundaries, relations, ecology and complexities and to use it as the setting for accommodating a given house type. Alternatively a theoretical superblock may be used to provide the setting.

A real site may add a sense of realism to the study and may suggest the practicality and applicability of the approach. It was felt that this, albeit important, is subordinate to the objectives of this work: to outline the structure and components of a rationale for site plans generation taking into consideration the contraints of industrialization and recent developments in modern construction techniques, which call for some degree of standardization and modular coordination.

A theoretical site will make comparison between alternative solutions earlier; its abstract nature will provide a better chance to make comparisons. It will avoid complications in the process of comparison which an existing site feasture may impose, and finally it will not assume the

form of a psuedo-realistic exercise, that may eventually turn out to be detrimental to the initial objectives of the study, i.e., to establish generically valid site planning guidelines, rather than an exclusive and idiosyncratic case study.

The applicability and practicality of the rationale is presented and highlighted in Appendix 1, showing selected projects and applications.

A square city block, 108 x 108 m, (i.e., 1.116 hectare = 2.78 acres) in area and surrounded by roads on all sides (Fig. 1) has been chosen as the theoretical site.

The area and dimensions are justified on the following grounds:

- It provides a reasonable social unit, a residential group "HETTAH" *, society of approximately 200 families or so and is big enough to contain a nursery school.
- It coincides and agrees with the superblock dimensions suggested in new towns and community studies planned for Egypt (see, for example, 6th October City, Second Report; and the New Ameriyah city First Stage Report; MODANC, Egypt).
- The 108 meter dimension accommodates many modular series and respects the basic design and structural grids dimensions based on the 300 m^2 basic module.

$$108m = 3 \times 36m = 3 \times 10 \times 3.6m$$
$$= 2 \times 54m = 2 \times 15 \times 3.6m$$
$$= (1 \times 72m) + (1 \times 36m)$$

*Hettah: an Egyptian word refering to a coherent urban social unit characterized by its coherence and bondage with clearly defined territory.

2.2 Modular basis: The Tartan Grid

The house types used in the site plans were developed on a modular basis; a tartan grid (1.2m - 2.4m x 1.2m - 2.4m), i.e., a 3.60m square grid provided the modular basis for the design of the housetypes and their details.

The same grid was used to provide the dimensional basis for site plans generation and groupings of the house blocks as well as for layouts details.

The modular grid provided the behicle for the creation of a variety of form and configuration of external spaces. It guided, but never impeded the generation process. The modular grid is a direct reflection of the modularity and order inherent in industrialized products and construction techniques, and hence a cornerstone in the suggested rationale for site plan generation.

2.3 The House Types

Four house types were used in the site plans. Two five story walk-ups, a cross shaped 10 story tower and three story row-type maisonettes ("villas"). The house types were developed by Dr. Nasamat Abdel-Kader, to demonstrate the use of a modular pattern."*

A brief description of the major features of those house types is presented below.

2.3.1 House Type A:

- direct access type
- staircase serving two apartments
- 5 stories high
- dual aspect apartments

*A modular pattern for the design of Mass Housing Projects Cairo Univ. & M.I.T., Cairo, Cambridge, 1980.

- apartment areas vary considerably ($43m^2$--$120m^2$ or more.
- ground floor may provide accommodation for public uses; a corner shop, parking, nursery--if needed.
- distance between the vertical circulation cores may vary to control the area of apartments.
- split levels may result in this type as a result of access on each landing.
- linear.

2.3.2. House Type B:

- direct access type--5 stories high
- staircase serving four apartments
- dual aspect apartments
- apartment areas vary according to the distance between vertical cores, and units are of fixed areas.
- apartments may be grouped to contain an internal court, thus restricting the aspects to one external and one internal, each.
- linear.

2.3.3. House Type C:

- direct access
- 10 stories high or more
- 2, 3, and 4 aspects for each flat according to its location and the grouping adopted.
- point plan
- linear grouping in two directions is possible

2.3.4. House Type D:

- terrace houses (row Houses) maisonettes
- three stories high
- each two houses occupy three modular bays
- linear

2.4 The Design Criteria

In site planning the design criteria serve two functions:

1 Translate the design objectives into qualitative and quantitative criteria which can be incorporated in the design and more generally provide the basis for the form generation process.
2. Provide the means of evaluating alternative forms: i.e., the generated environments and site plans.

The design criteria for planning Residential Sites are multi-faceted and comprise numerous factors, both qualitative and quantitative as well as those of environmental and psychological nature.

The quantitative aspects of the design criteria involve the contraversial question of standards and norms, their real value, and touch upon the problems of cultural variability, not to mention the importance of cost effectiveness. Similarly, the qualitative aspects of the criteria are open-ended and undefined, e.g., it is difficult to put a quantitative value judgment on the visual character of a given site development, on visual privacy, views, amenities or safety in a proposed design for a residential site. The precise definition of these factors is, however, beyond the scope of this work, but has not been ignored in that a thorough review of design criteria for housing areas applicable to the Egyptian context was undertaken. A selected list of the literature review is included in Appendix II. The format highlights problems and facts on the subject of design criteria for residential areas and lends itself well to the purpose of this work and can be used to re-evaluate the layouts generated and assessed in this work.

The design criteria used comprise the following factors:

A. Environmental Criteria:
- sunlighting in and around house blocks
- daylighting in and around house blocks
- provisions of shadows in the spaces between houses; e.g. in walkways and play areas
- provisions for shelter from wind and sand storms
- air movement and penetration of breezes
- noise

B. Privacy
- visual privacy; freedom from visual intrusion
- acoustic privacy; freedom from outside noise and the need for acoustic privacy

C. Views from the house units outward and from spaces in-between

D. Amenities and the provision of open spaces

E. Accessibility and circulation:
- vehicular access
- service access
- parking provisions
- pedestrian access
- safety.

F. Security (the defensibility of the site), Newman (14)
- territoriality: the question of identity and belonging
- surveillance: house blocks--open spaces and their inter-relation

G. Visual Form and Aesthetics:
- structure
- components
- proportions
- scale
- details
- intricacy and complexity
- character and identity
- rhythm and sequence

Some of these aspects are further discussed in the following section and in Appendix II.

3. The Generated Site-Plans

3.1 Introduction

In this section, a selection of the housing layouts that were developed for each of the four house types (reviewed in Section 2.3) is presented and evaluated.

The site layouts are presented as a set of alternatives; each alternative comprises a site plan, a cross section followed by two tables: site data and site evaluation.

The site plan shows the arrangement of the blocks, the hierarchy of spaces, public and private (if any), the limited access roads and services and mews courts, where cars and pedestrians may safely mix. The cross-sections illustrate the space configuration, highlighting the merits and drawbacks of the spatial organization.

3.2 Site Data

The site data comprise:
- The house type: e.g., walk-ups, towers, villas. A letter (A,B,C,D) is given for each type and a serial number indicating the order of the alternative.
- number of floors
- site area in square meters and hectares (10,000 sq. m)
- number of units; i.e., number of apartments or housing units
- number of persons; e.g. an average family number of 4.5 persons was used throughout, i.e., number of units times average family number
- ground coverage: the area occupied by buildings in square meters
- floor area ratio = $\frac{\text{total built area}}{\text{site area}}$
- density: number of persons/site area
- open spaces: (a) area of public open spaces (sq. m); (b) area of private and semi-private open spaces in sq. meters; (c) area of incidental open spaces in sq. meters.
- roads: area in square meters
- parking: area of parking and services in square meters

3.3 Site Evaluation

Each site is evaluated qualitatively and quantitatively when possible. A three-graded scale was used (good, fair, poor) together with a fourth grade, indicating problem areas. The site evaluation is based on the design criteria for residential areas presented in Section 1 and highlighted in Appendices 2 and 3. It includes the following aspects:

3.3.1 Density:

No comment on density was indicated. However, in practice the success or failure of a given layout to achieve a target density may be commented on.

3.3.2 Daylighting and Sunlighting

The spacing between blocks in relation to height, the angle between the ground floor flats and the top eduge of the facing block and the orientation of the blocks and their interrelations.

As a general rule no major problems of daylighting will be encountered if $H/D \leq 1.5$, where H is the height of the facing block and D is the spacing between the two blocks.

3.3.3 Provision of Shade

This is related to the external spaces around the blocks; it depends on the orientation of blocks, spacing versus height, landscaping and sun angles (i.e., time of day and season). It can be calculated for a given period. It should be kept in mind that this criterion clashes with the provision of sun-light and day-light indoors.

3.3.4 Wind Shelter

The protection of exterior spaces against sand storms and windy weather; this depends on the height of the blocks, their spacing and orientation in respect to the prevailing unwanted wind. The golden rule here is: the smaller the spacing between blocks the greater the shelter ($H/D \leq 1/4$ where D is the spacing between blocks and H is the height).

3.3.5 Air Circulation

The freedom of air streams to penetrate and reach the various house blocks. This may clash with the provision of shelter and shadows externally.

3.3.6 Orientation

The preferred orientation in Egypt is north/south (i.e., the long axis of the block runs east/west), see also Evans (6) and Koenigsberger (8).

3.3.7 Privacy (Visual)

By means of distance: the greater the distance between parallel blocks (18 meters and more) the better the chance of visual privacy (given opposite openings).
By means of design (e.g., perpendicular parallel blocks)

3.3.8 Noise

A multi-faceted criterion comprising:

- exposure of the long side facades to major roads
- distance between blocks
- house type characteristics
- number of the house units overlooking external spaces (courts)
- density (physical and activities)
- relation between car parks, roads and dwellings

3.3.9 Views

Open versus restricted views; variety and contrast

3.3. Amenities, Open Spaces

Efficiency, adequacy, hierarchy, territoriality, relation between blocks and spaces, safety, etc.

3.3.11 Accessibility and Circulation

Provisions of car parks, access for garbage collection,

services and emergencies; pedestrian safety, pedestrian routes, efficiency of road network, length and area of roads.

3.3.12 Flexibility and Adaptability
House type grouping and exterior organization. Spatial characteristics, possibilities of future growth and modifications.

3.3.13 Defensibility and Security
A. Territoriality:
Relation between blocks and their immediate environments; the question of a space not belonging to anyone (no man's land), and the clear functional and territorial identification of spaces.
B. Surveillance:
Spaces overlooked by blocks, distance between windows and spaces, routes unrelated to blocks. . . etc.

3.3.14 Visual Form
Identity, character, proportions, building line, silhouette, details, complexity, enclosure variety and contrast, structure, etc.

Each site has been separately evaluated in the light of the above criteria. It should be kept in mind that the site evaluation procedure was simplified because of time limitations and the nature of the present study. It is only presented to highlight and illustrate the structure and sequence of the suggested approach to site plans generation.

4. Epilogue

The structure of the rationale appears simple enough in that it comprises a flexible sequence of steps leading to siteplans generation. However, the simplicity is only skin deep; the complexity of the interrelated components will always call for a more thorough detailed investigation, in-depth critical analysis and hard follow-up work. The flexible sequence of actions suggested is the following:

- definition of objectives
- formulation of a programme,
- definition of the design context (physical and non-physical)
- developing design alternatives
- evaluation of the alternatives using elaborate criteria
- seeking fitness between context and form and selection of final design

The sequence of actions is not rigid or linear. Alternating between steps, the review of earlier actions, and feed-back are inherent in the nature of any design process and hence an important feature of the rationale.

The rationale for siteplans generation presented here is not a guarantee for sequring good design nor will it automatically produce successful siteplans. It merely attempts to define a course of action and set out the rules of a game in which scoring and winning is another story.

APPENDICES

I. SELECTED APPLICATIONS
II. REFERENCES
III. GENERATED SITE PLANS

APPENDIX I

Selected Applications

The rationale for siteplans generations, presented in this study, provided the basis for the creation and development of a number of housing layouts, designed by the author together with Dr. Nassamat Abdel Kader for different clients in Egypt.

Three examples of these layouts are presented here to highlight the suitability and applicability of the rationale. The selected examples are:

- a residential community, Maasara, Cairo Egypt
- Cairo University staff apartments, Phase 2, Giza, Egypt
- residential community, Phase 1, Heliopolis, Cairo, Egypt

Each project is briefly introduced, together with the site-plan and synopsis of the site data.

HELIOPOLIS: A RESIDENTIAL COMMUNITY

Client: Arab Contractors

Designers

Dr. Nassamat Abdel Kader

Dr. Sayed M. Ettouney April 1980

This was a pilot project, to demonstrate the efficiency of the designers'approach to create a livable housing environment that respects the requirements of sophisticated construction techniques calling for modularity and order (fig. A.1.6).

SITE DATA

SITE AREA:	27,625 sq.m = 6.6 acres or 2.76 h.
HOUSE TYPES USED:	direct access 5 story walk-ups, one stair serves two flats or one stair serves four flats
NUMBER OF UNITS:	440 apartments
NUMBER OF PERSONS:	1,980
DENSITY:	330 ppa or 750 ppha
FLOOR AREA RATIO:	1.9

MASARA, CAIRO, EGYPT

A residential community for 5400 persons

Client: Arab Contractors

Designers

Dr. Nassamat Abdel Kader

Dr. Sayed Mohamed Ettourney

(for Sabbour Associates) April 1979

The site is located to the sourth of Cairo in MAASARA District by the River Nile. It is envisaged to provide housing accommodation for ownership (upper middle income group). The project was developed under a number of constraints, namely:

- limited time for the preparation of tender documents and execusion.
- the use of sophisticated construction techniques, prefabrication and industrialized components.
- the site is to contain a shopping center, a primary school, two kindergartends.
- service and parking facilities should be provided (a separate study was to be conducted to examine the possibilities of underground parking). Figures A.1.1, A.1.2, A.1.3 and A.1.4 show the site plan and some analytical studies.

SITE DATA

SITE AREA:	59,200 sq. m; 14 acres or 5.92 hect.
HOUSE TYPES USED:	direct access, 5 story, slab blocks; cross-shaped, 10 story towers
NUMBER OF UNITS:	1,200; density: 385 ppa or 912ppha
NUMBER OF PERSONS	5,400; floor area ratio: 2.4

CAIRO UNIVERSITY STAFF APARTMENTS

(Second Stage)

Client: Cairo University, Staff Housing Society (limited competition)

Designers

Dr. Nassamat Abdel Kader

Dr. Sayed M. Ettouney

Structural Engineer

Dr. Aly Abdel Rahman November 1979

The brief for this project called for the provision of about 220 housing units to be accommodated in the Northern part of the site; respect for the almost completed first stage, comprising direct access slab and T-blocks was a prime factor in the proposals. The brief also asked the designers to allocate some public facilities: e.g., shopping centre, kindergarten, administrative offices as well as parking (fig. A.1.5).

SITE DATA

SITE AREA:	1,700 sq. m = 4 acres or 1.72 h
HOUSE TYPES USED:	direct access, 6 story walk-ups and cross-sahped 11 story towers
TOTAL NUMBER OF UNITS:	220 apartments
NUMBER OF PERSONS:	1000 persons (approx.)
DENSITY:	250 ppa or 625 ppha
FLOOR AREA RATIO:	1.53

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APPENDIX III: GENERATED SITE PLANS

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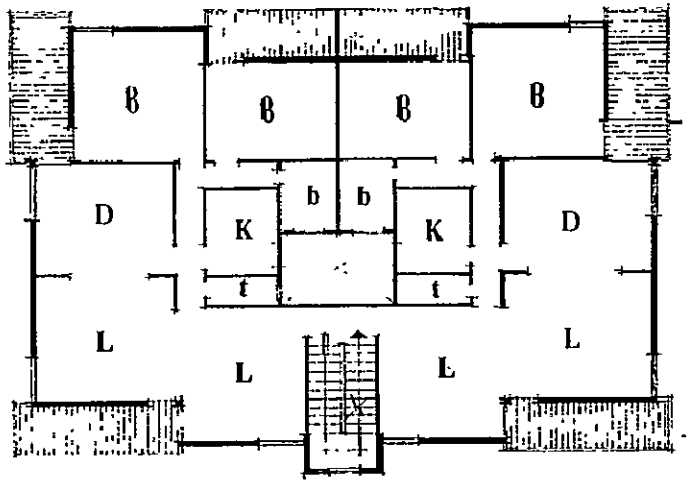
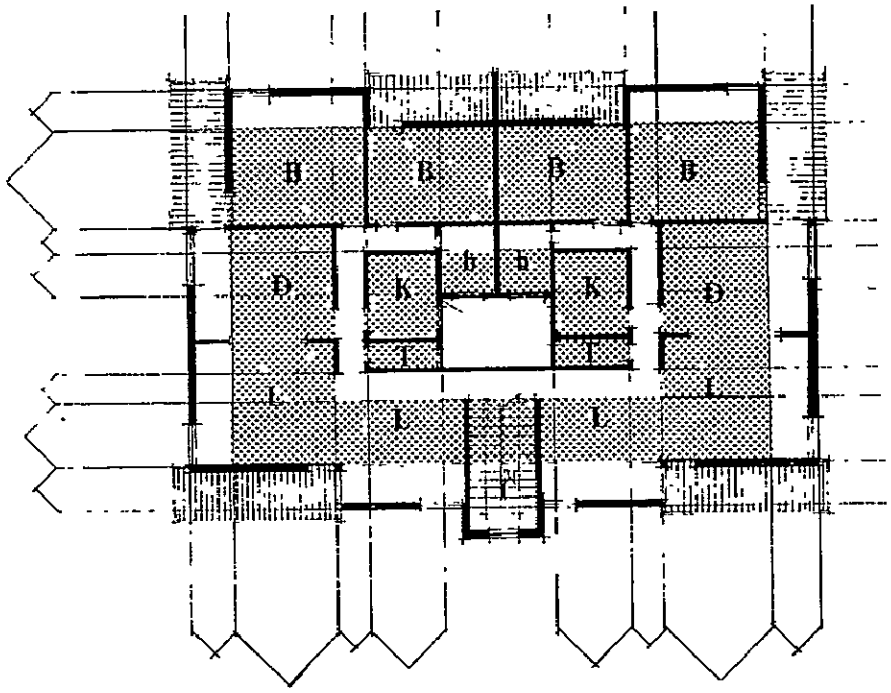
HOUSE TYPE A

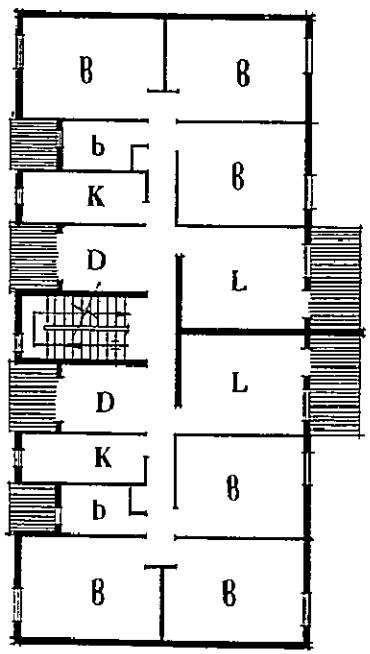


ORIGINAL PLAN



ZONES AND MARGINS

HOUSE TYPE A



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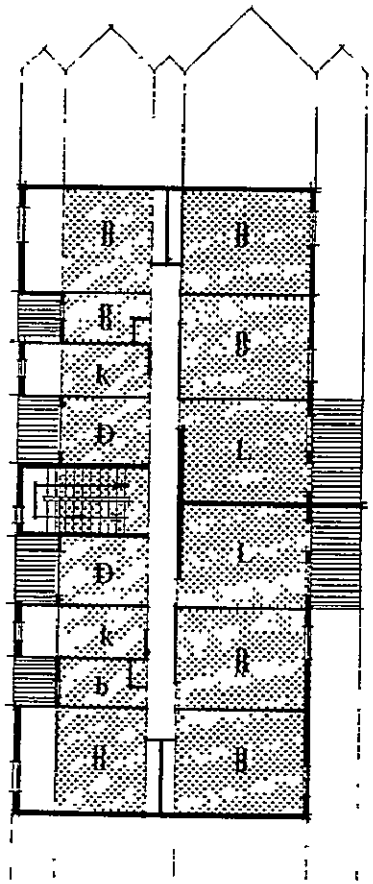

ZONES AND MARGINS

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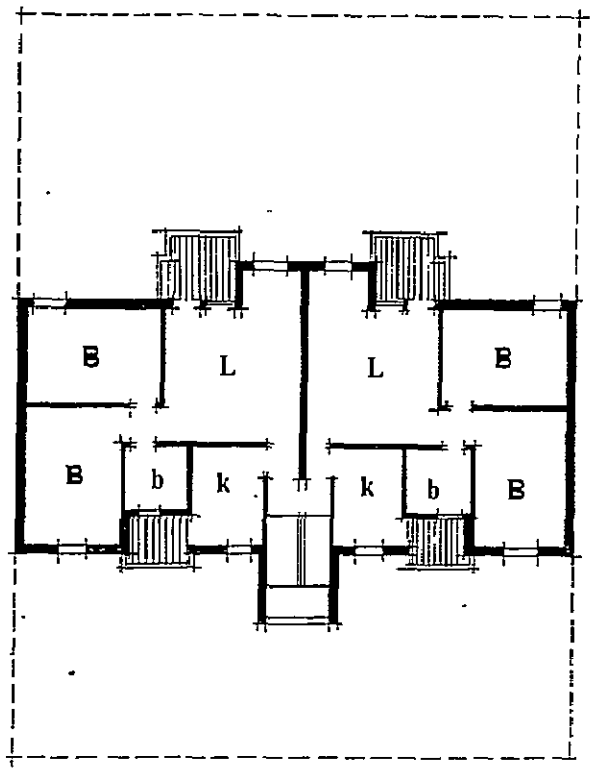
HOUSE TYPE A



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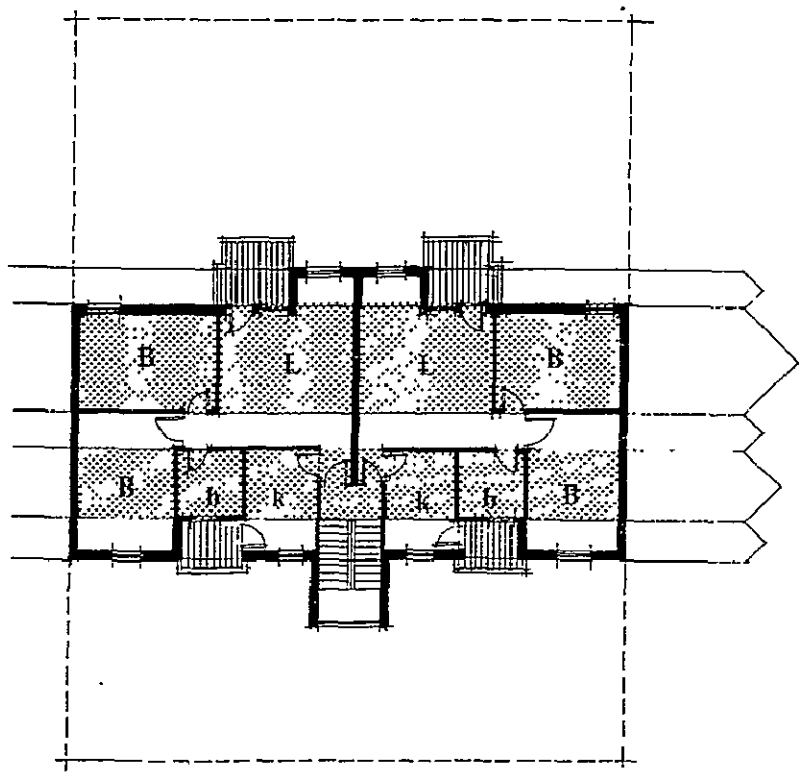
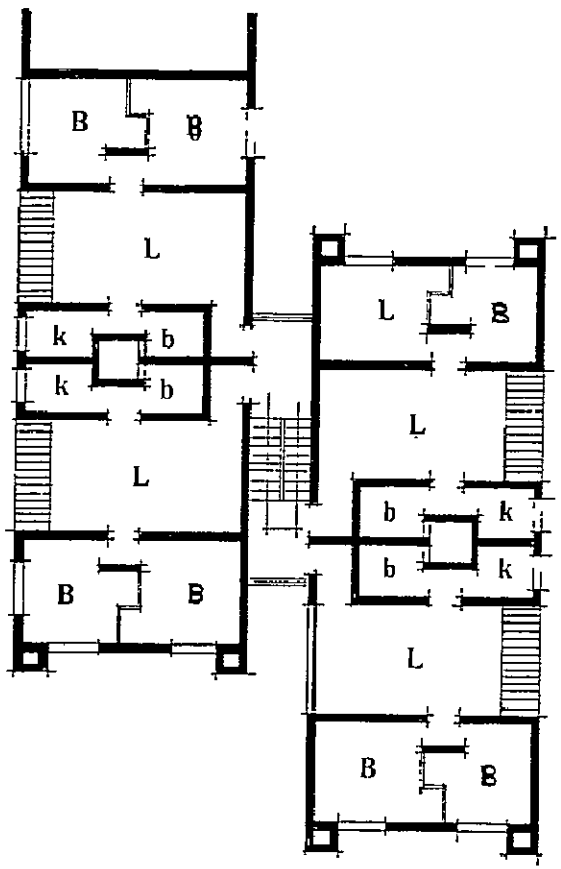


ZONES AND MARGINS

HOUSE TYPE A



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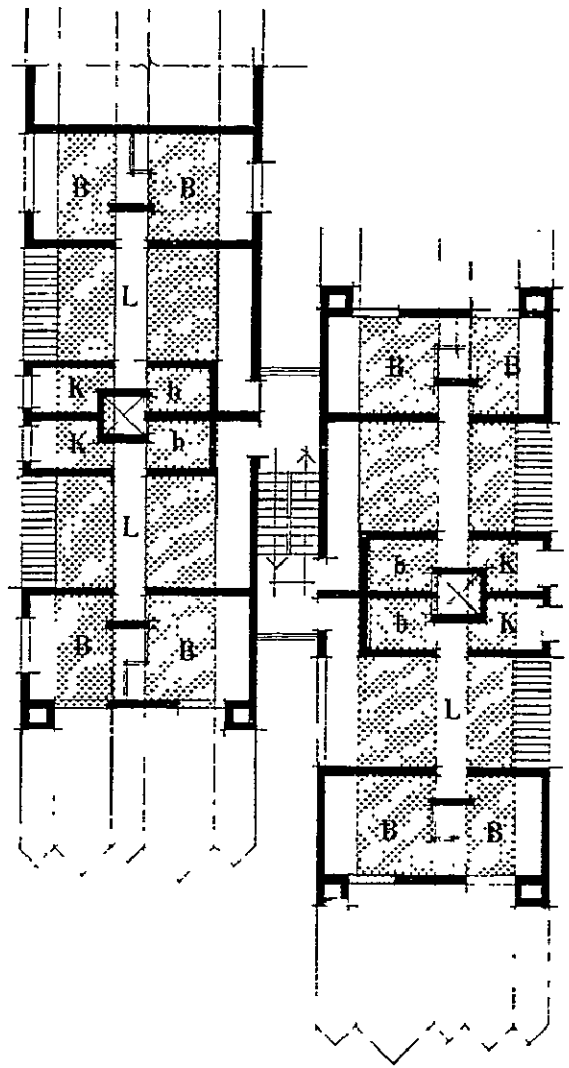

ZONES AND MARGINS

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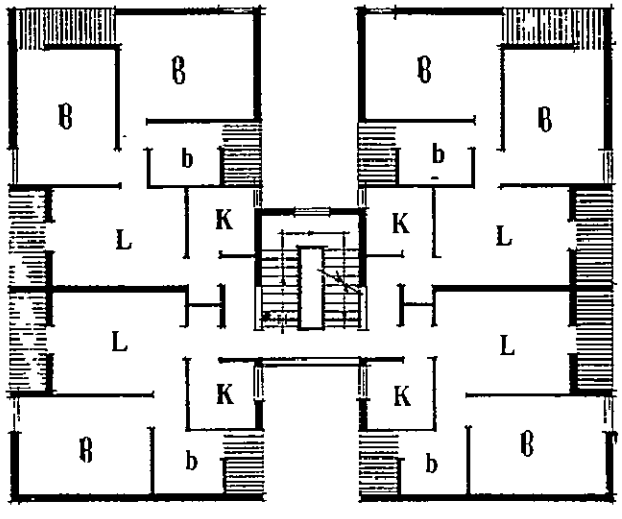
HOUSE TYPE B



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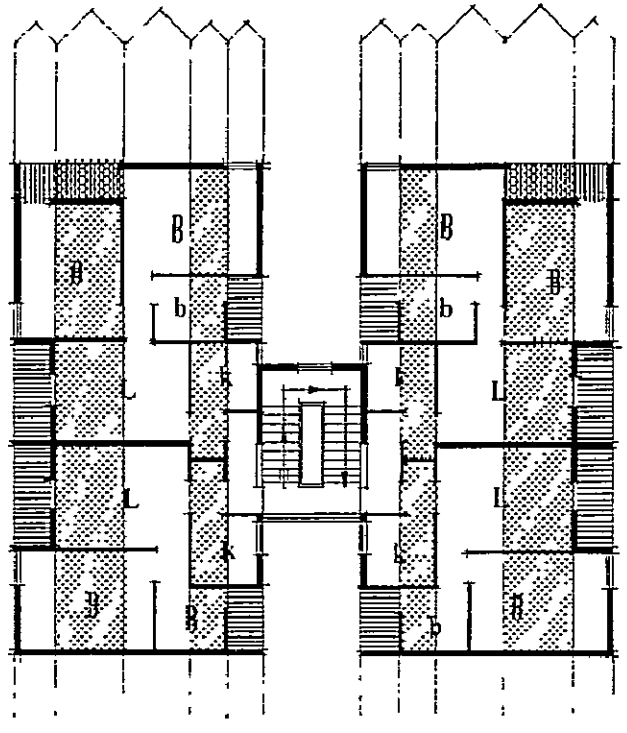
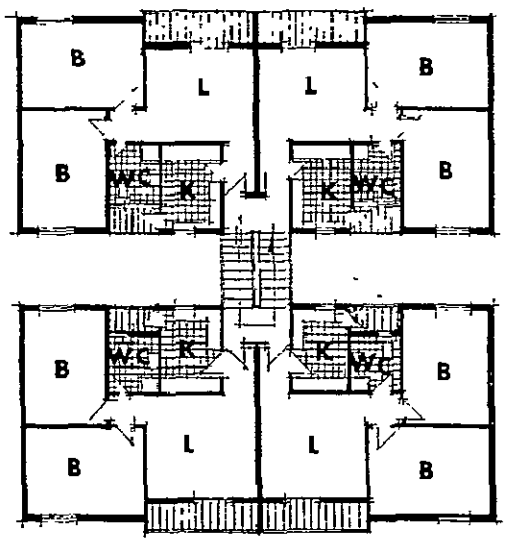


ZONES AND MARGINS

HOUSE TYPE B



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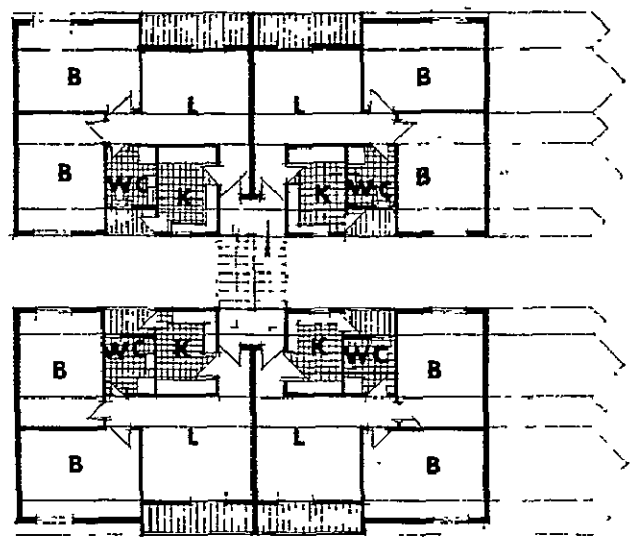

ZONES AND MARGIN

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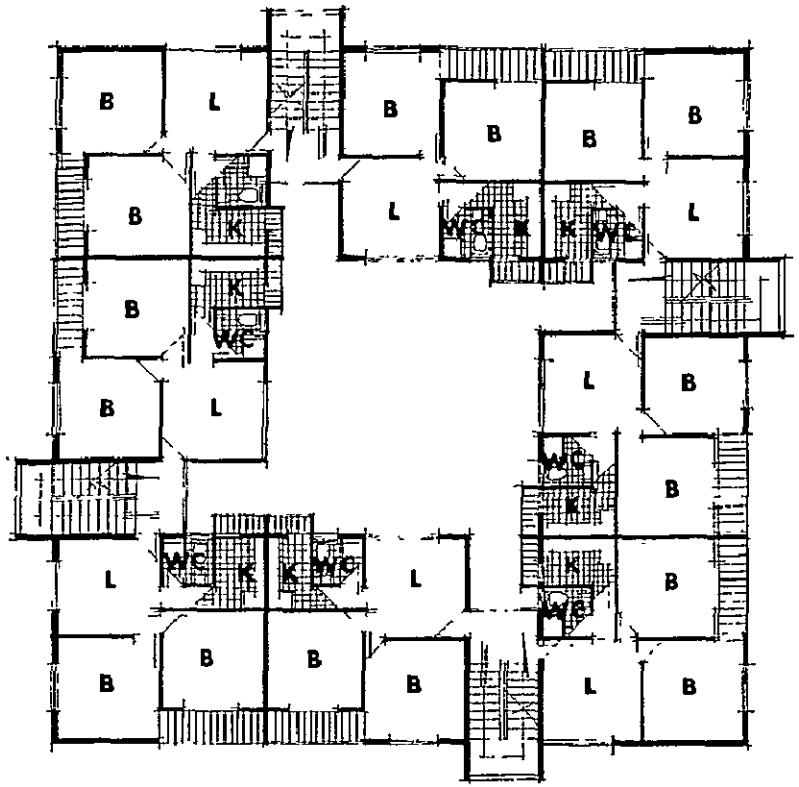
HOUSE TYPE B



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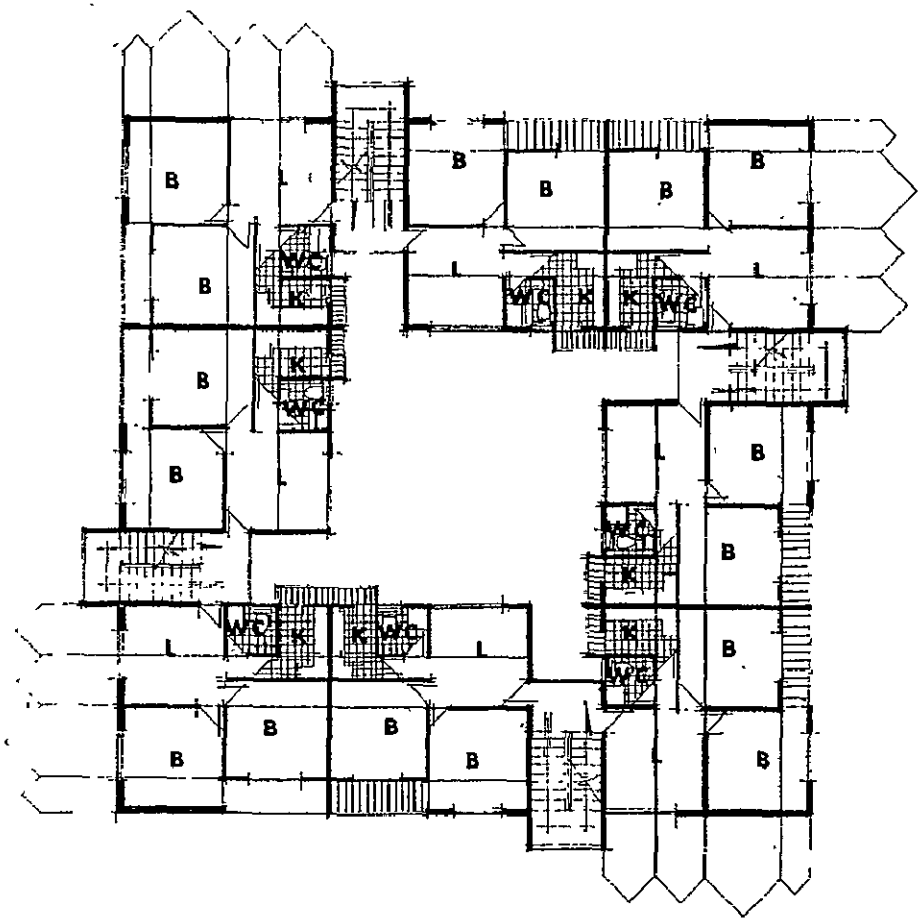
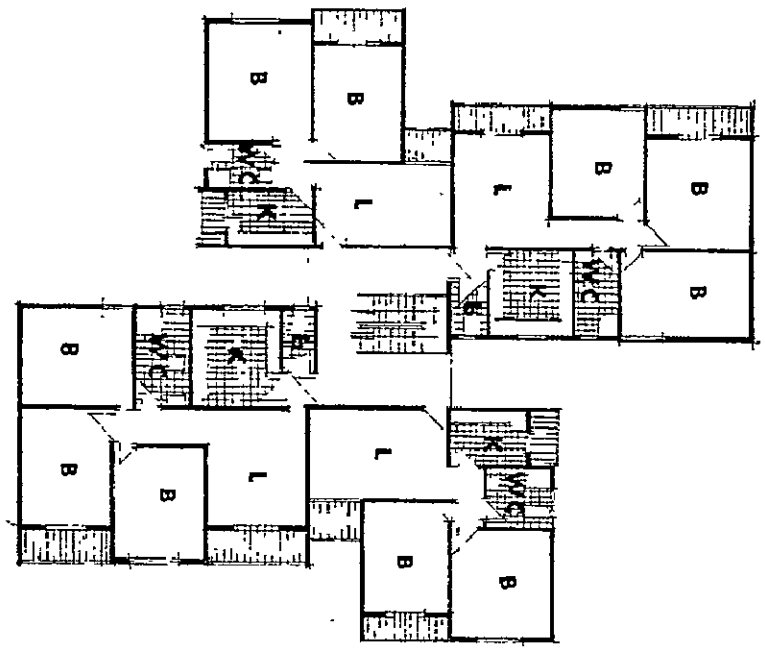


ZONES AND MARGINS

HOUSE TYPE C



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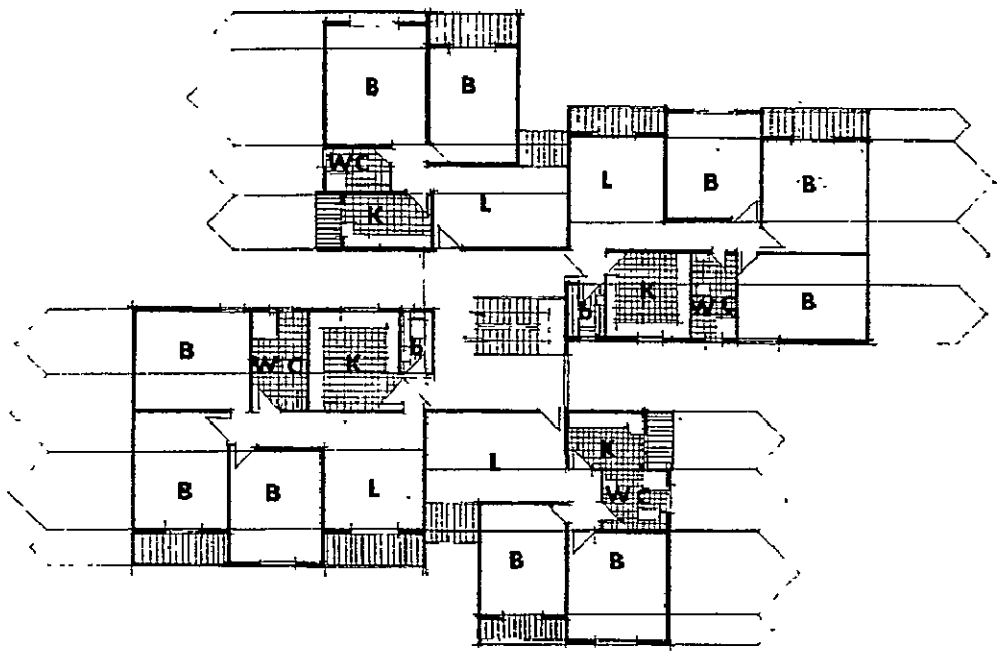
ORIGINAL PLAN



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ZONES AND MARGINS

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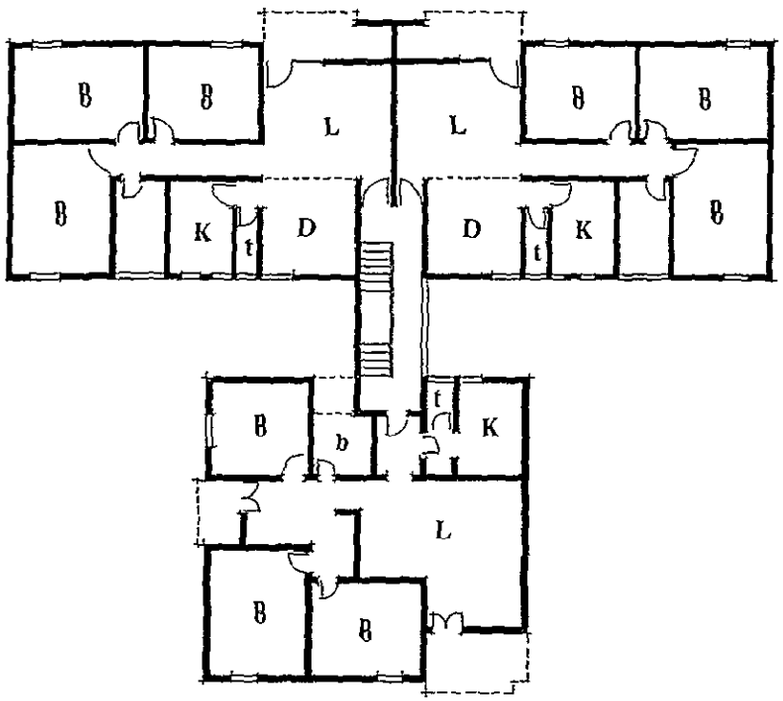
HOUSE TYPE C



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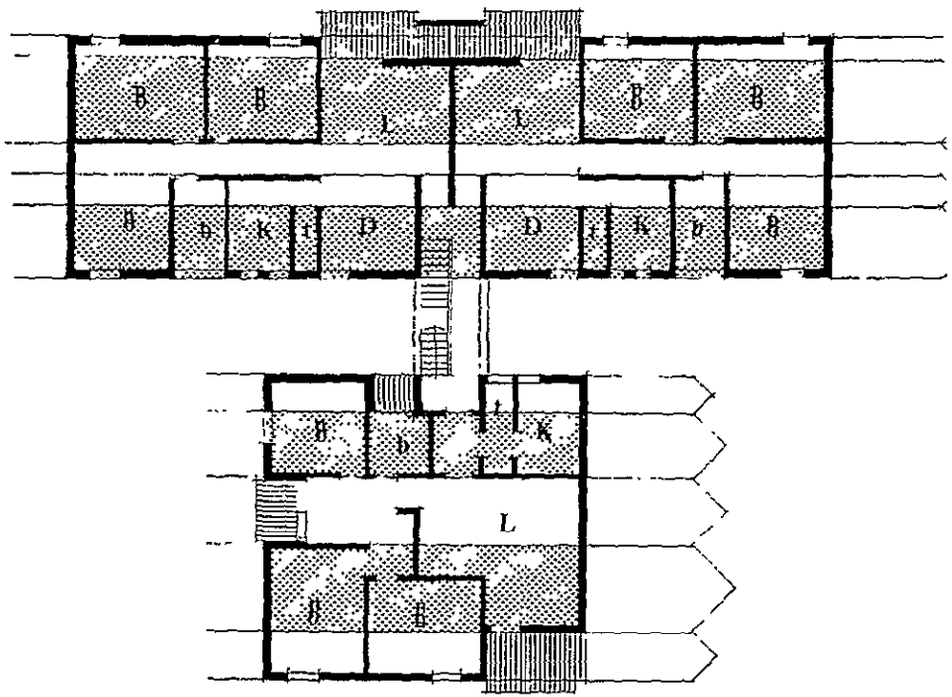
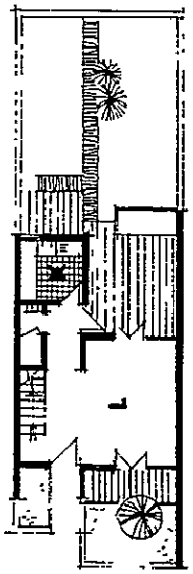
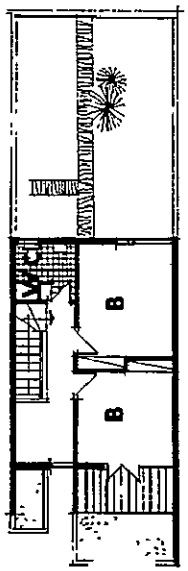


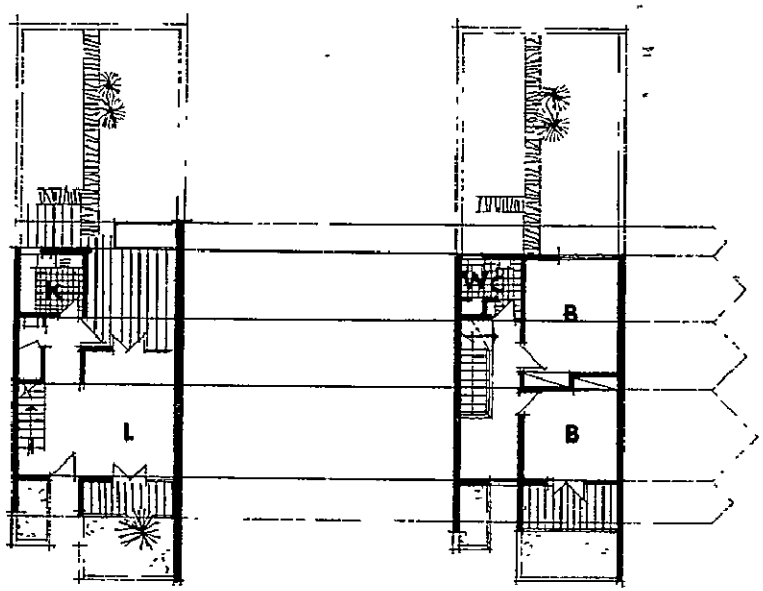
ZONES AND MARGINS

HOUSE TYPE D





ORIGINAL PLAN



ZONES AND MARGINS

242

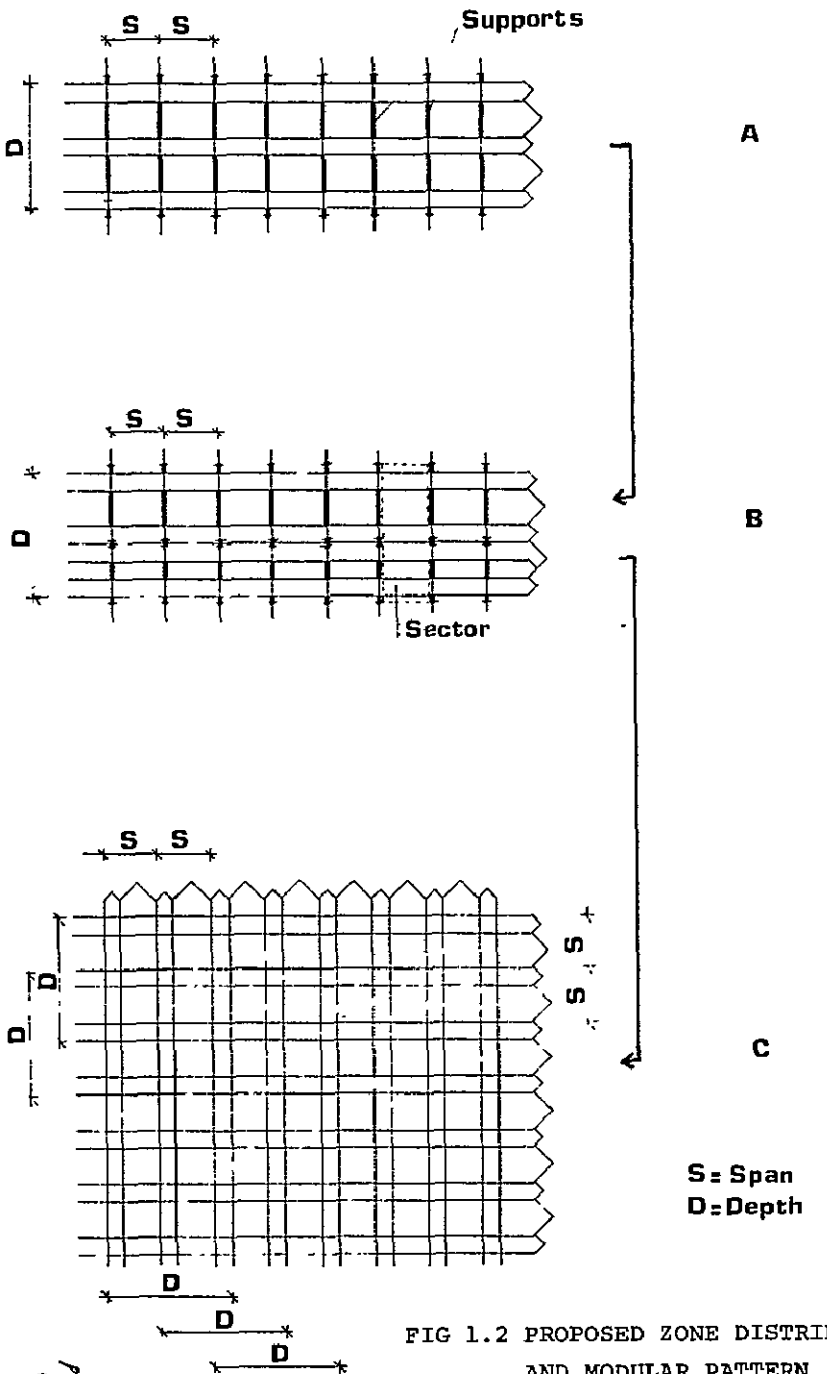


FIG 1.2 PROPOSED ZONE DISTRIBUTION AND MODULAR PATTERN

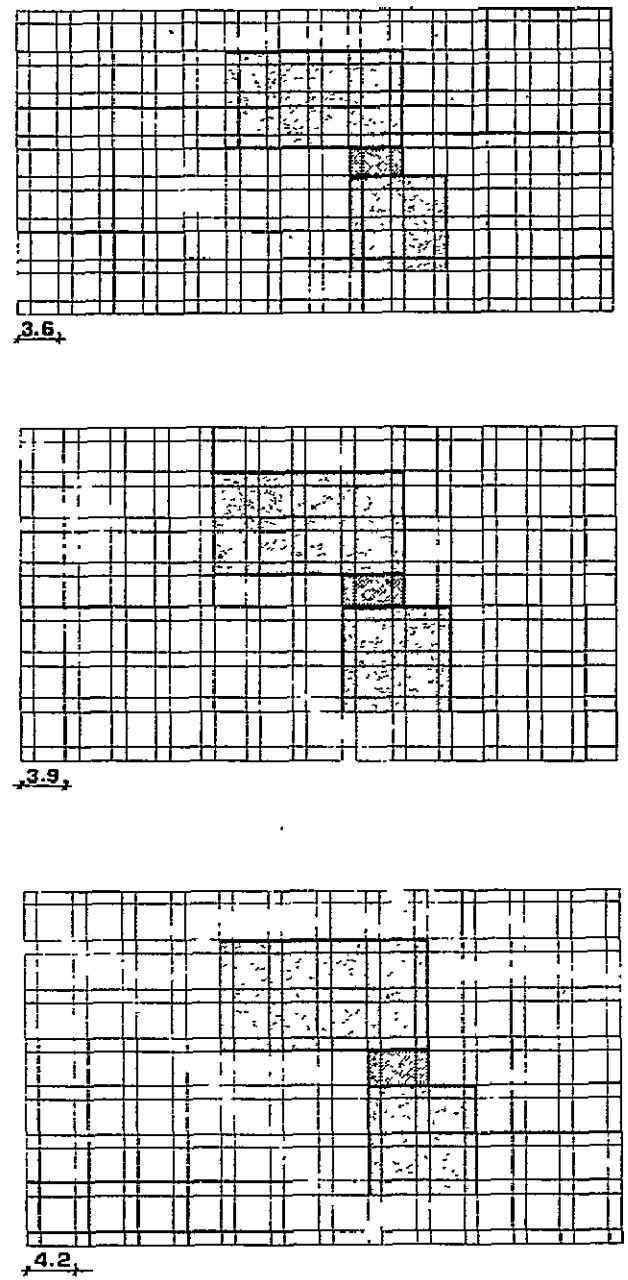


FIG 1.3 POSSIBLE DIMENSIONS FOR THE MODULAR PATTERN

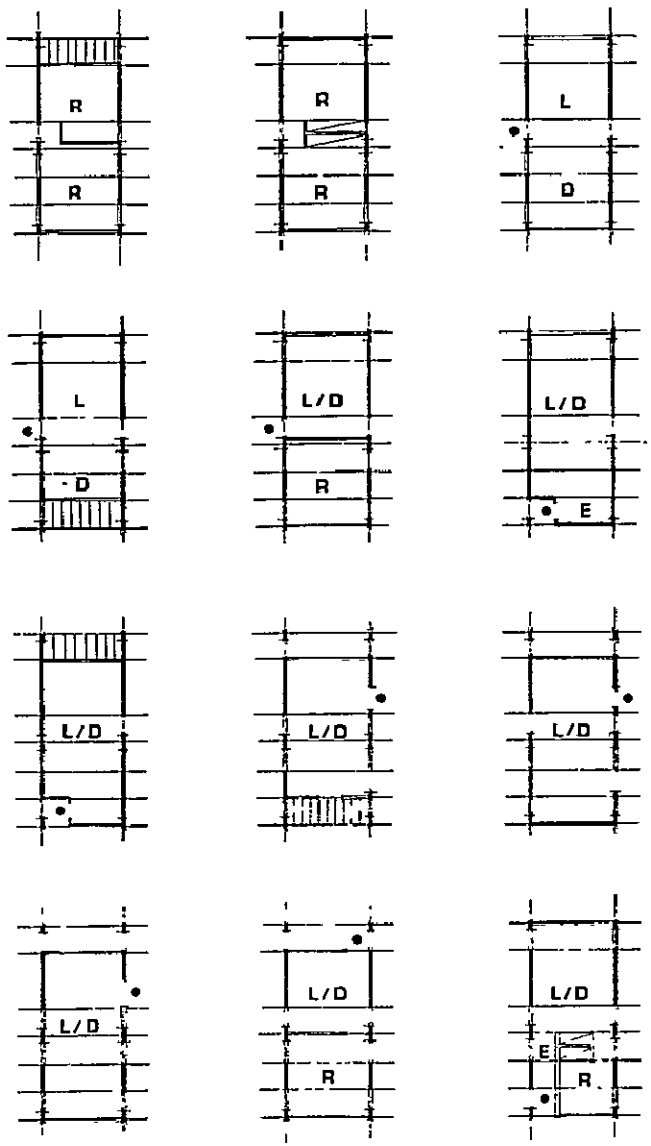


FIG 1.4 OPTIONAL DESIGN FOR THE SECTORS

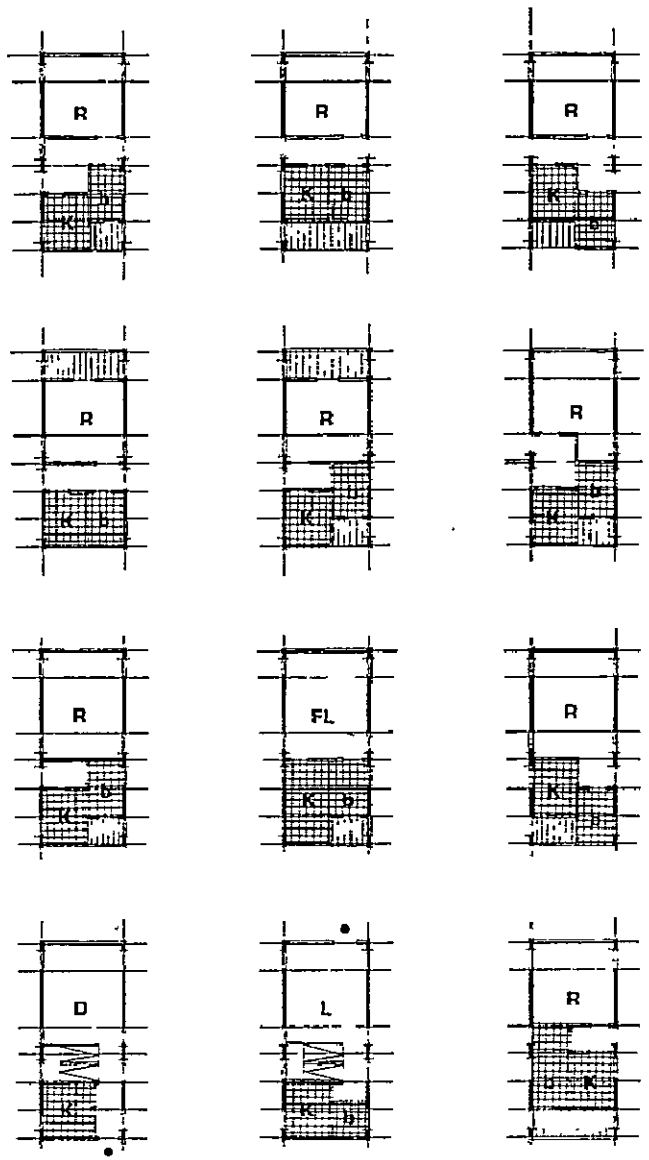


FIG 1.5 OPTIONAL DESIGNS FOR THE SECTORS

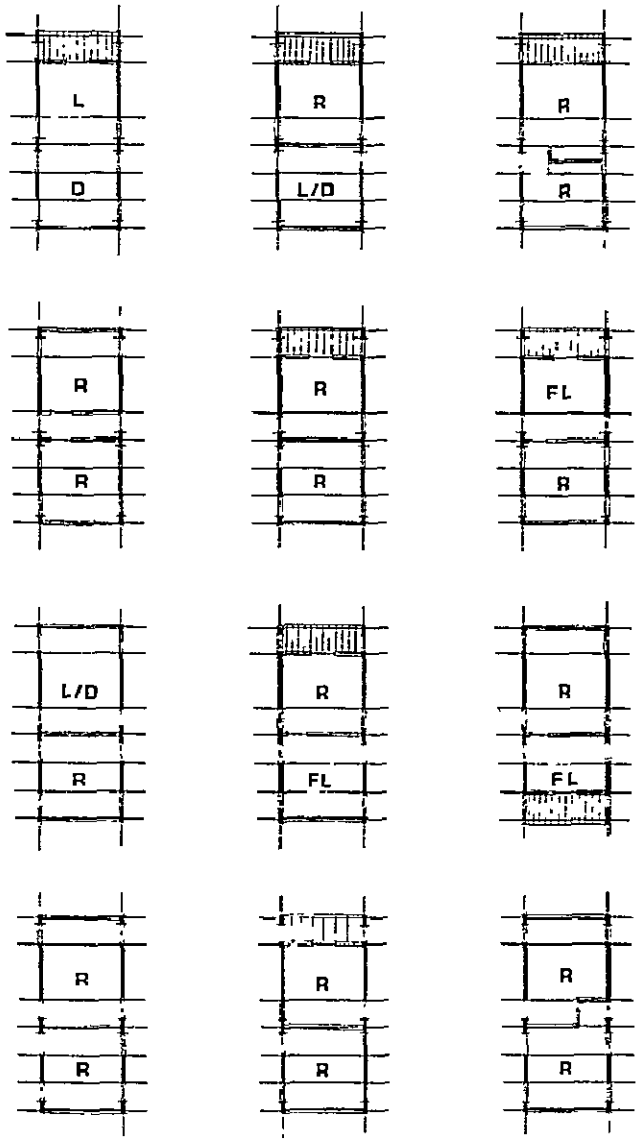


FIG 1.6 OPTIONAL DESIGNS FOR THE SECTORS

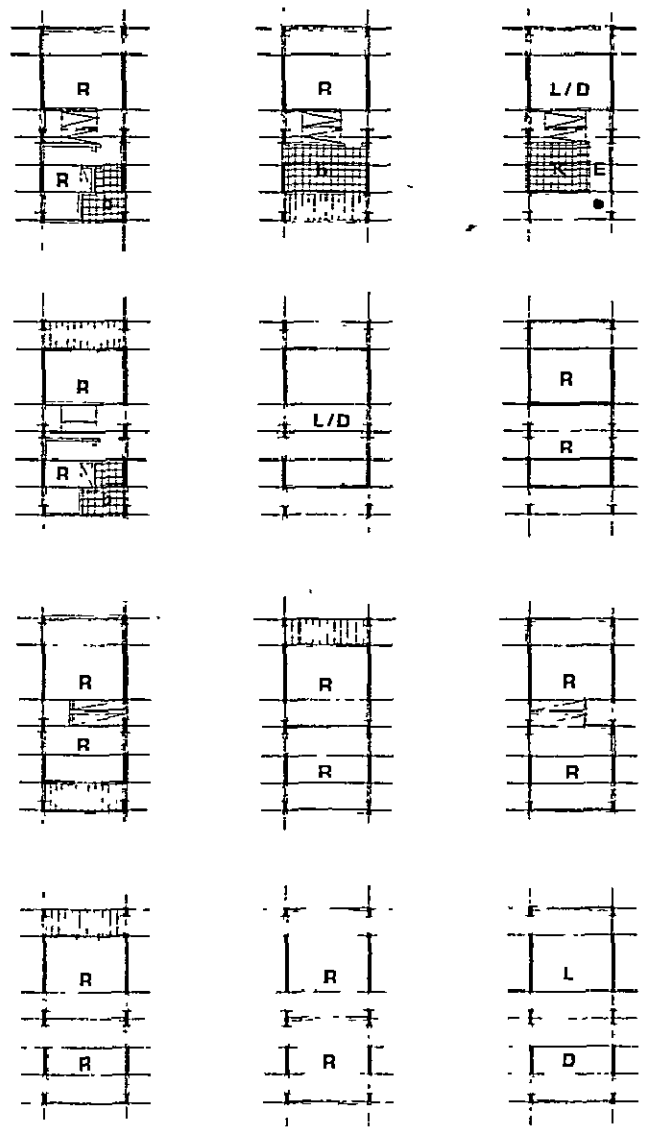


FIG 1.7 OPTIONAL DESIGNS FOR THE SECTORS

245

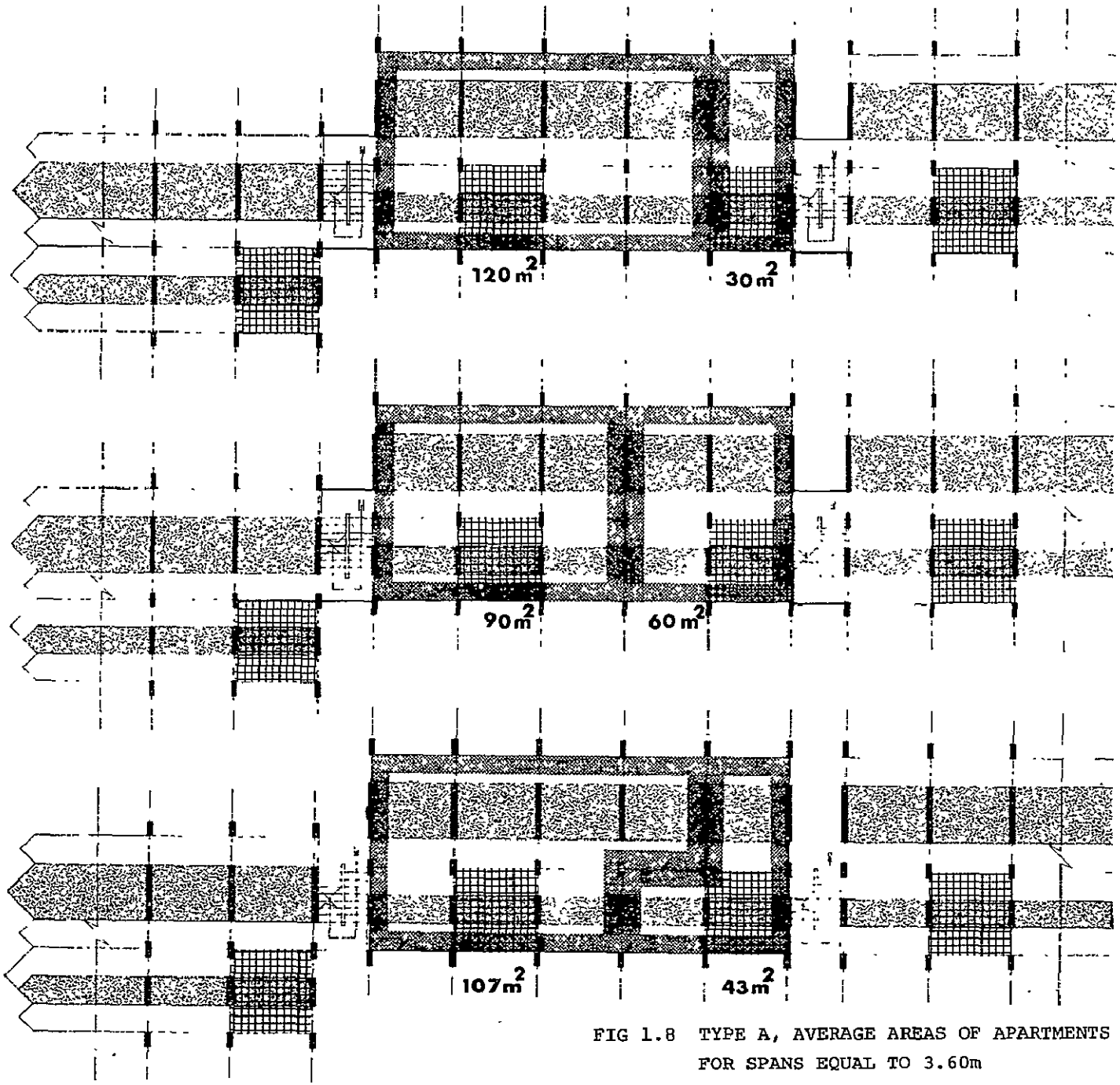


FIG 1.8 TYPE A, AVERAGE AREAS OF APARTMENTS FOR SPANS EQUAL TO 3.60m

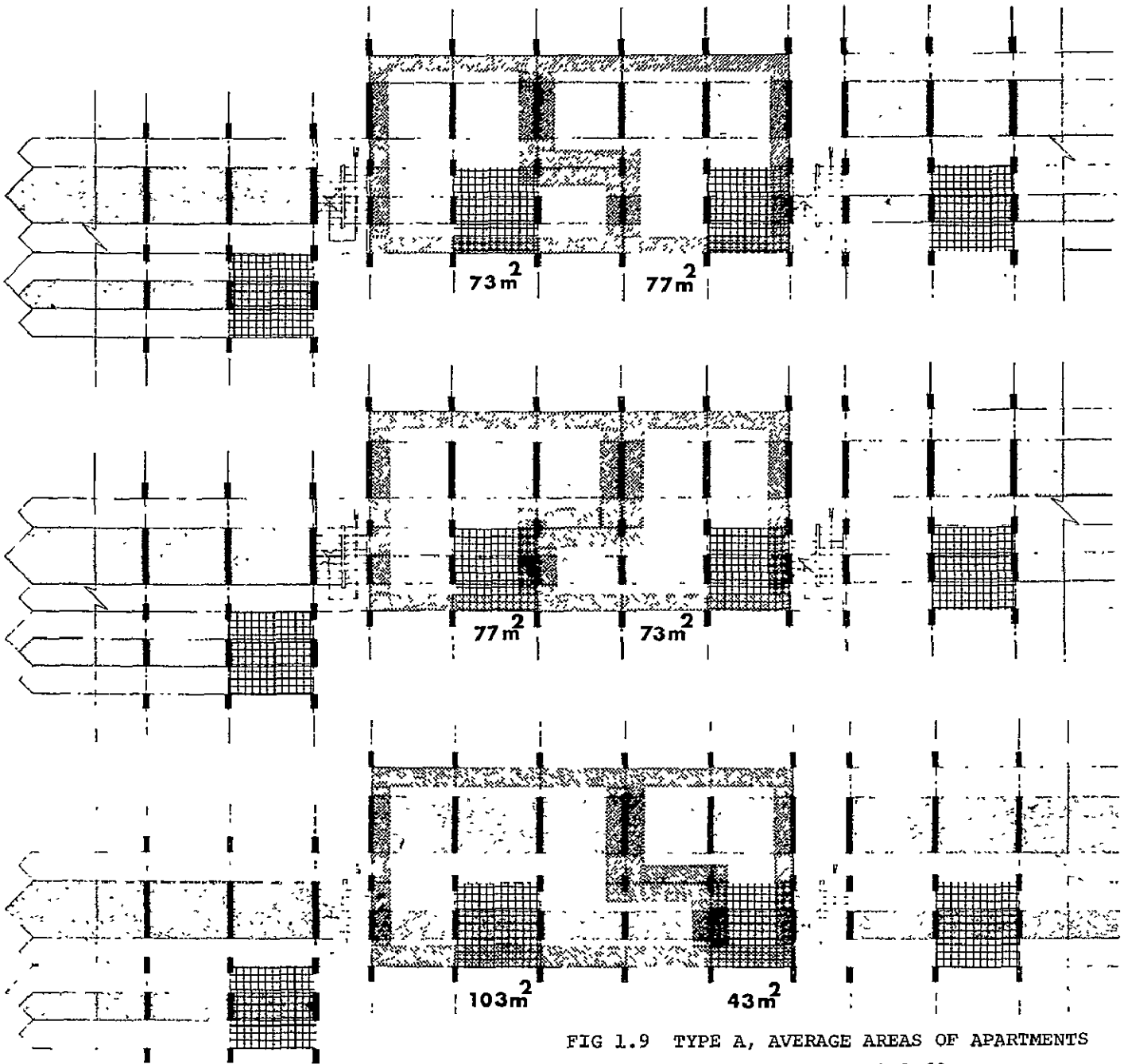
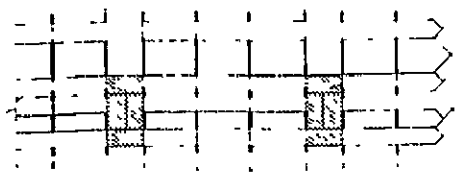
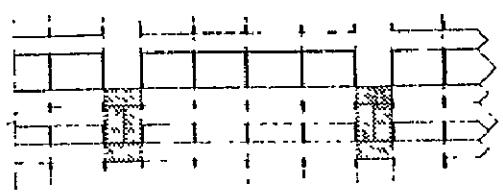


FIG 1.9 TYPE A, AVERAGE AREAS OF APARTMENTS FOR SPANS EQUAL TO 3.60m

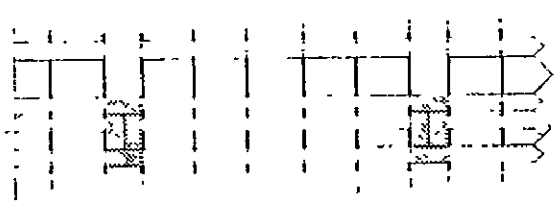
247



size of apartments range between 30m^2 and 60m^2 (for 3.60).

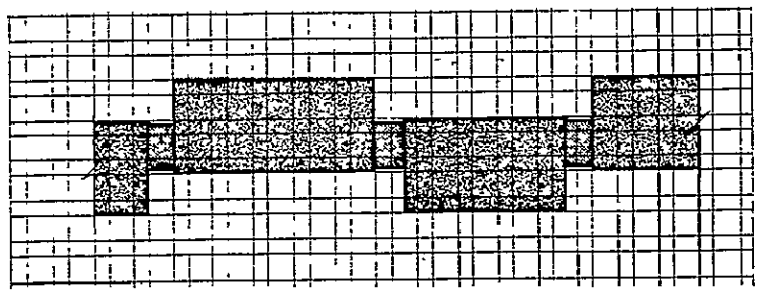


size of apartments range between 30m^2 and 90m^2 (for 3.60)

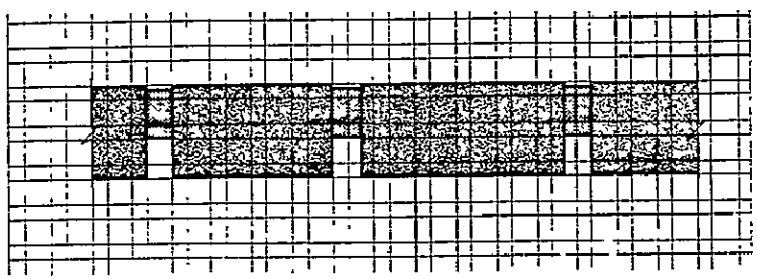


size of apartments range between 30 m^2 and 120 m^2 (for 3.60)

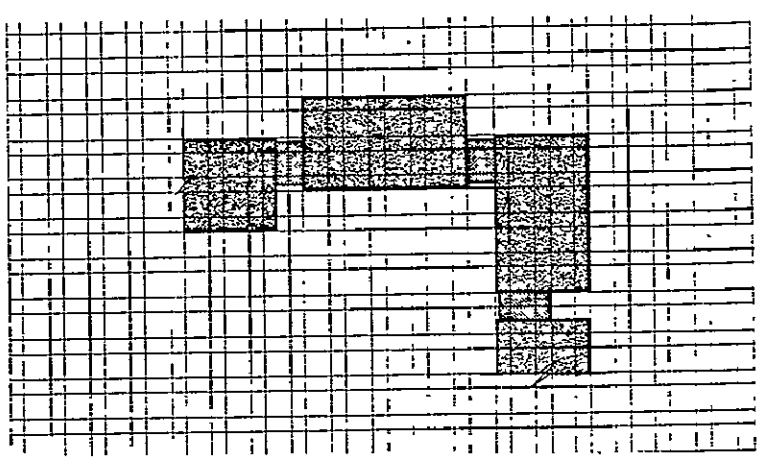
FIG 1.10 TYPE A, AVERAGE SIZES OF APARTMENTS COULD CHANGE BY VARYING THE DISTANCE BETWEEN THE STAIRS



CONFIGURATION 1



CONFIGURATION 2



CONFIGURATION 3

FIG 1.11 TYPE A, POSSIBLE CONFIGURATIONS FOR THIS HOUSING TYPE

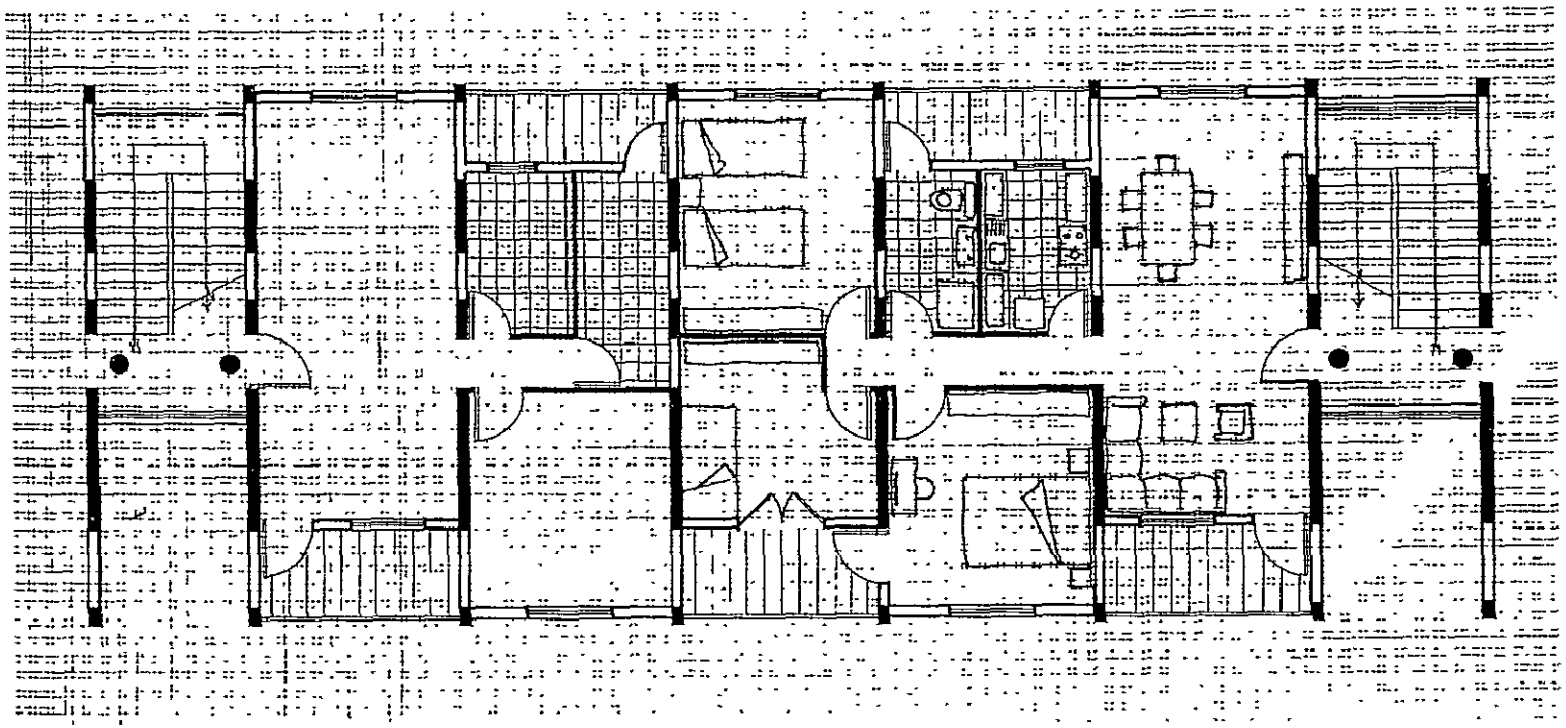


FIG 1.12 TYPE A, AN OPTIONAL DESIGN

249

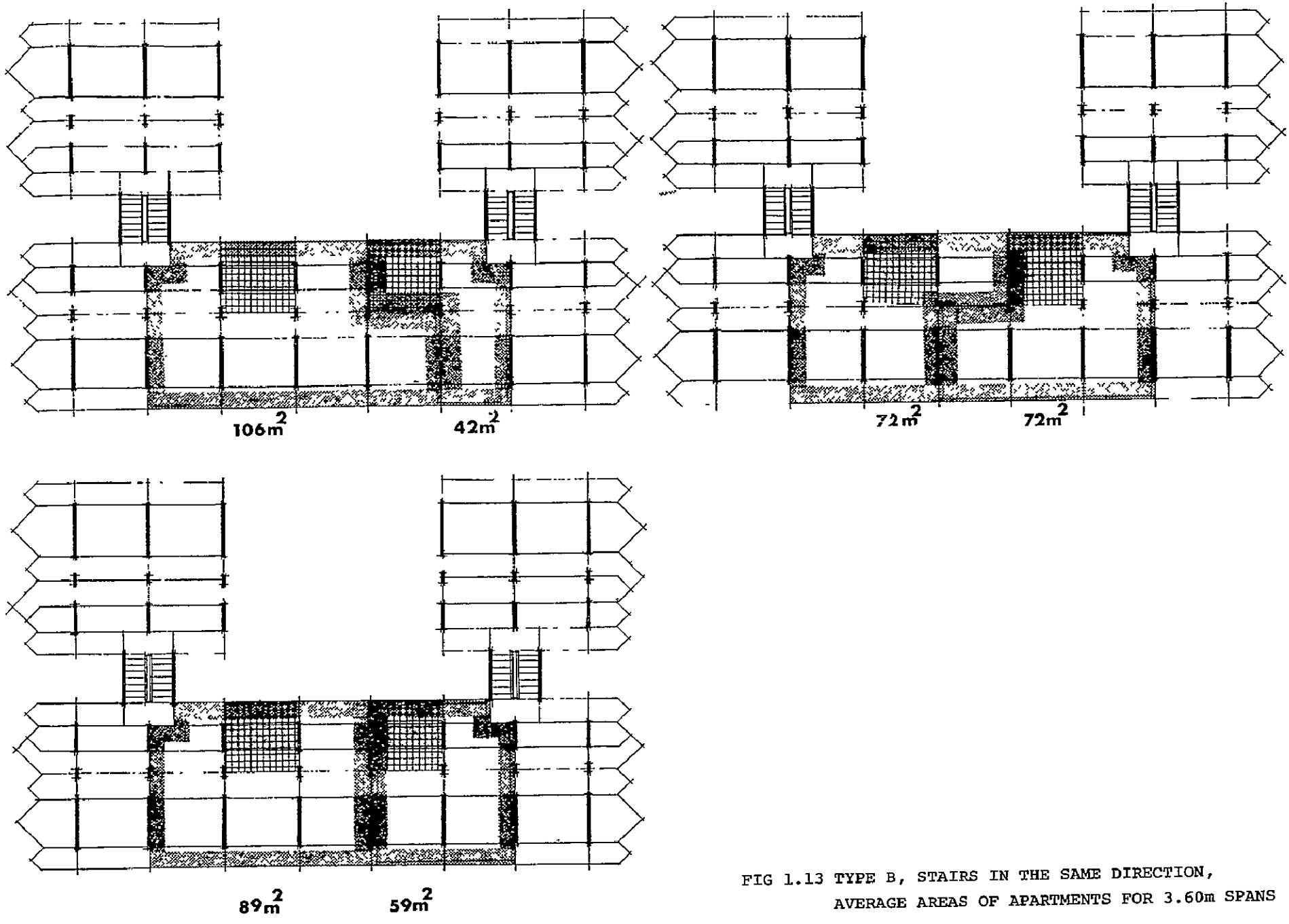


FIG 1.13 TYPE B, STAIRS IN THE SAME DIRECTION, AVERAGE AREAS OF APARTMENTS FOR 3.60m SPANS

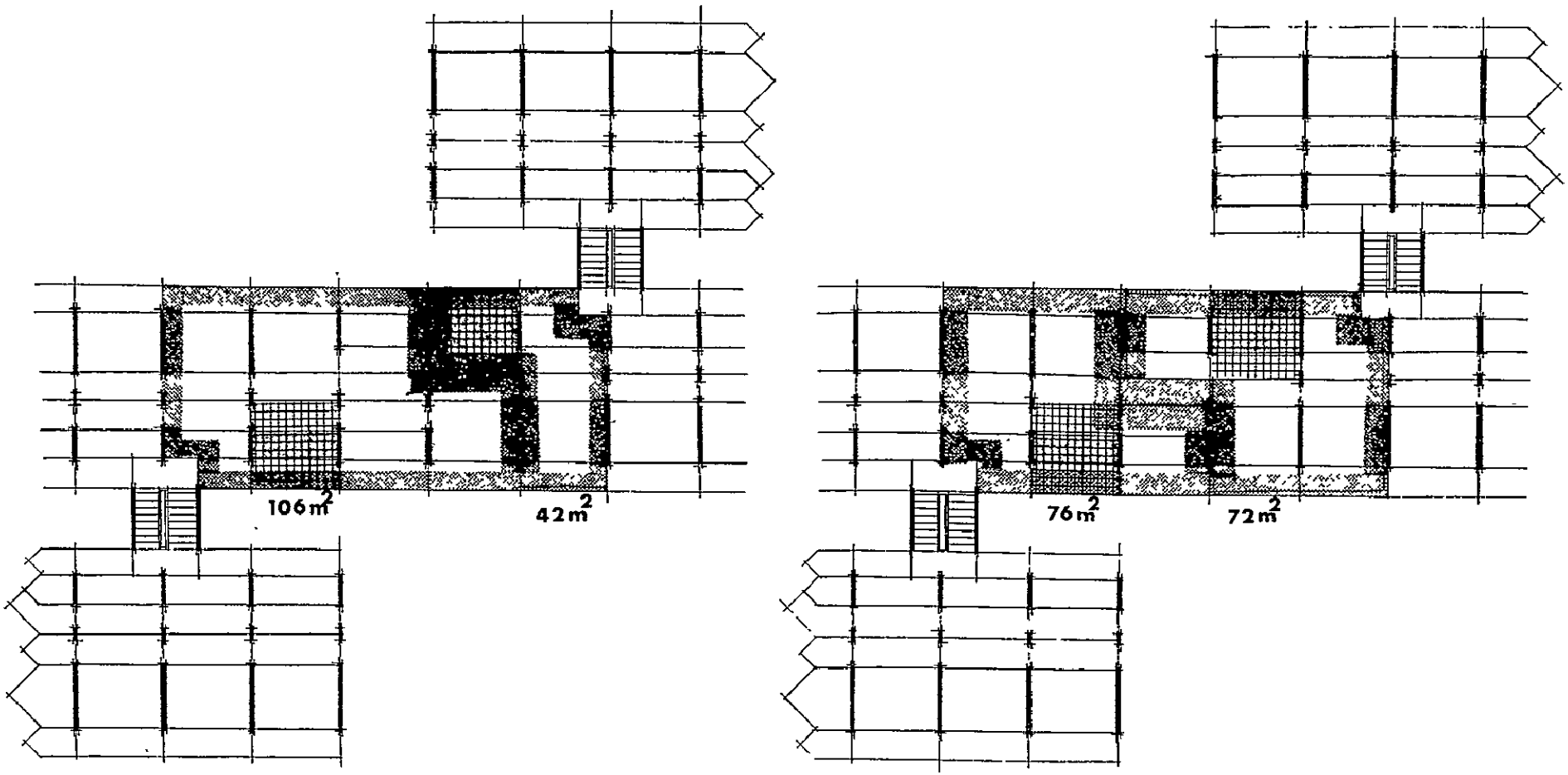
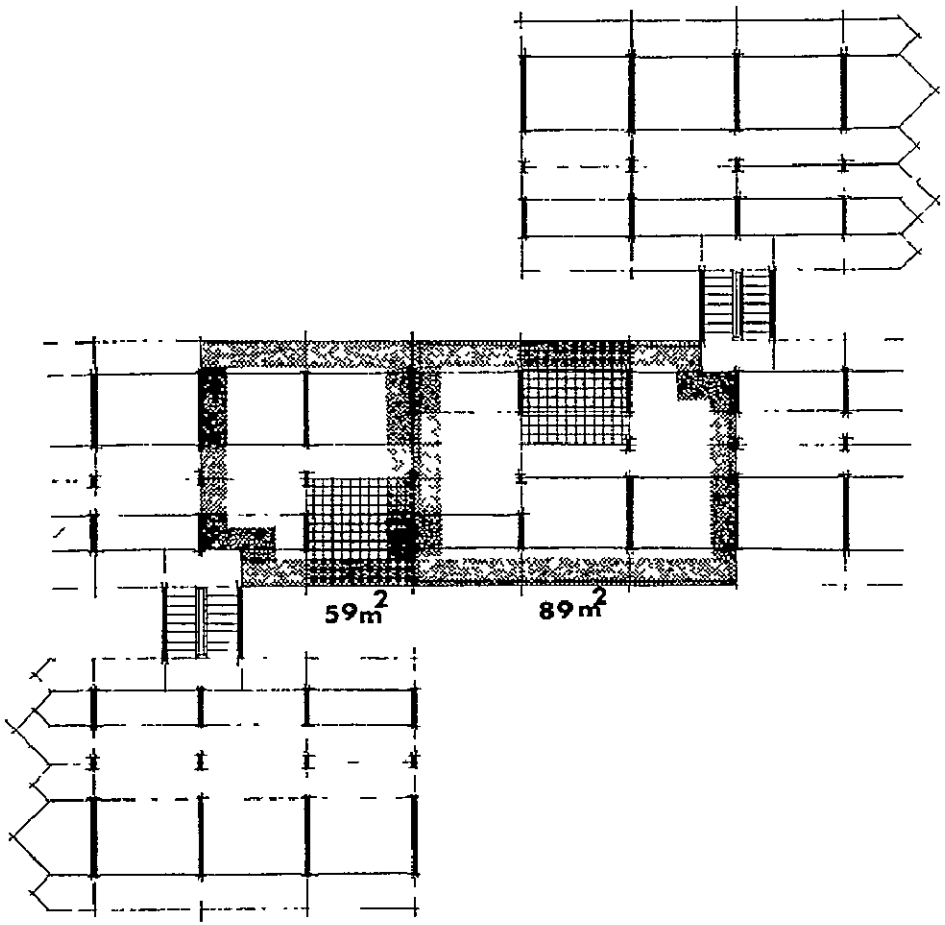
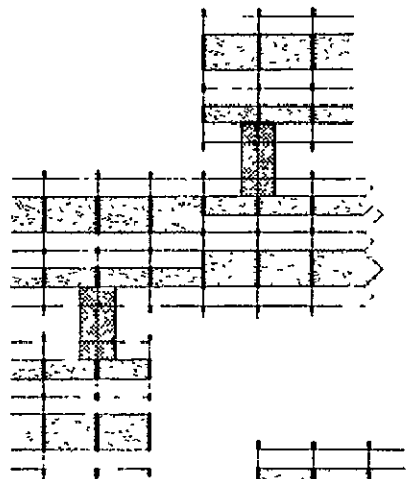


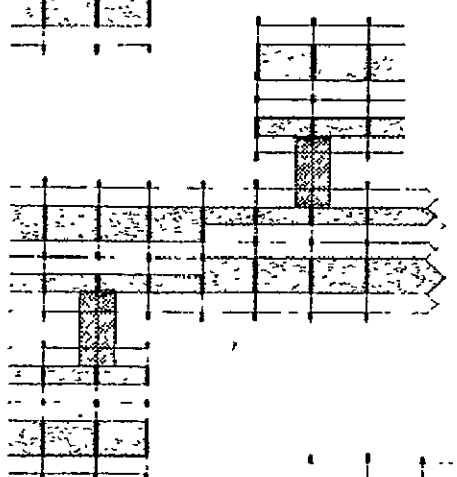
FIG 1.14 TYPE B, STAIRS IN OPPOSITE DIRECTIONS,
AVERAGE AREAS OF APARTMENTS FOR 3.60m SPANS

251

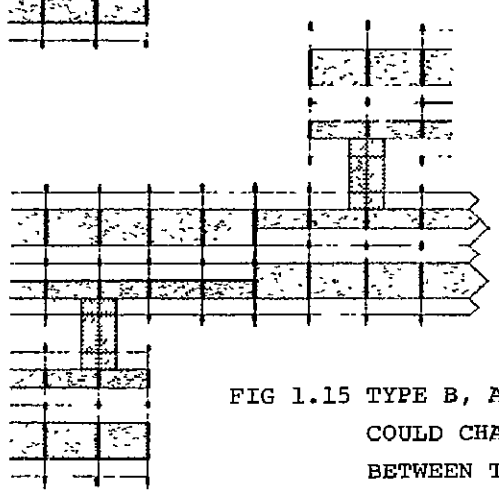




size of apartments range between 30m2 and 90m2



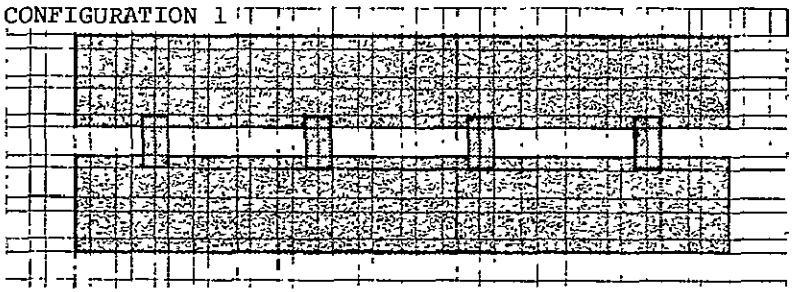
size of apartments range between 30m2 and 90m2



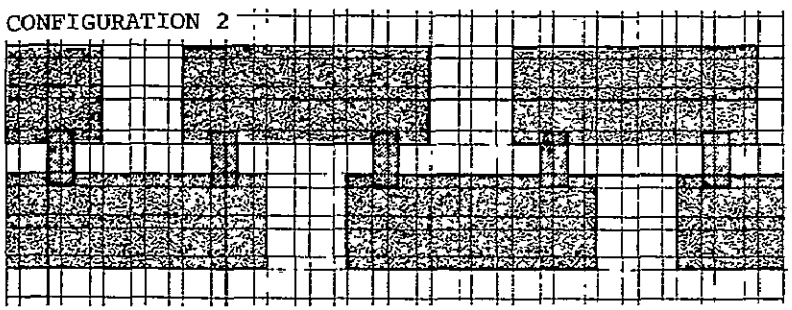
size of apartments range between 30m2 and 120m2

FIG 1.15 TYPE B, AVERAGE SIZES OF APARTMENTS COULD CHANGE BY VARYING THE DISTANCE BETWEEN THE STAIRS

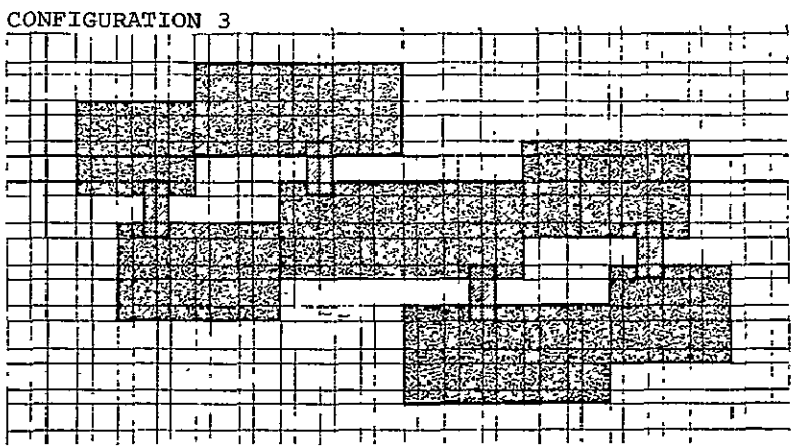
CONFIGURATION 1



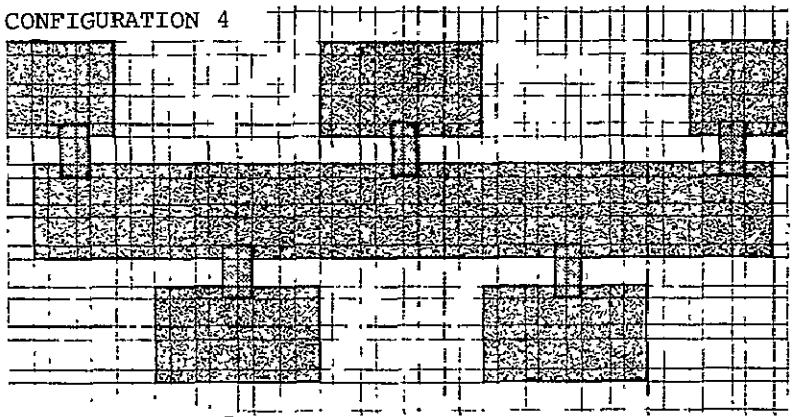
CONFIGURATION 2



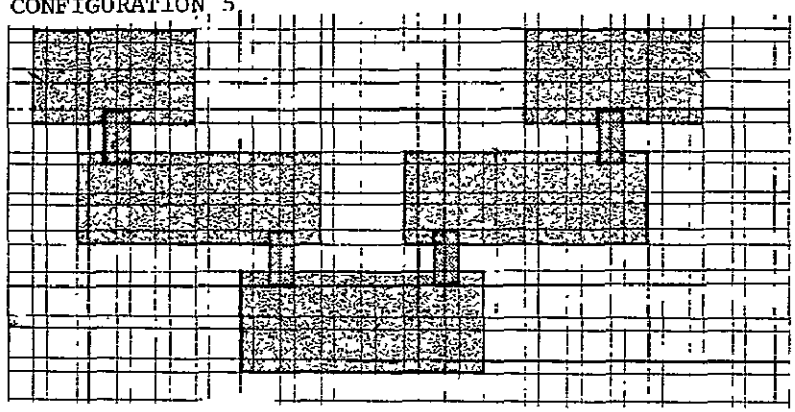
CONFIGURATION 3



CONFIGURATION 4



CONFIGURATION 5



CONFIGURATION 6

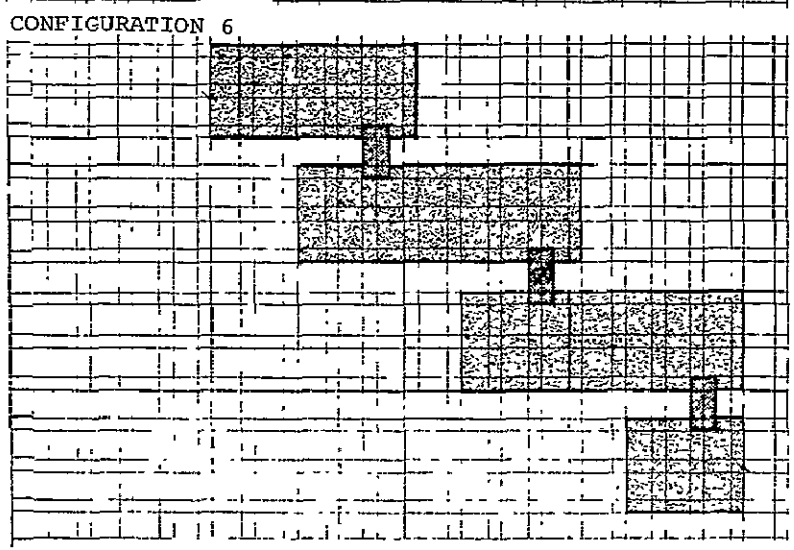


FIG 1.16 TYPE B, POSSIBLE CONFIGURATIONS FOR THIS HOUSING TYPE

253

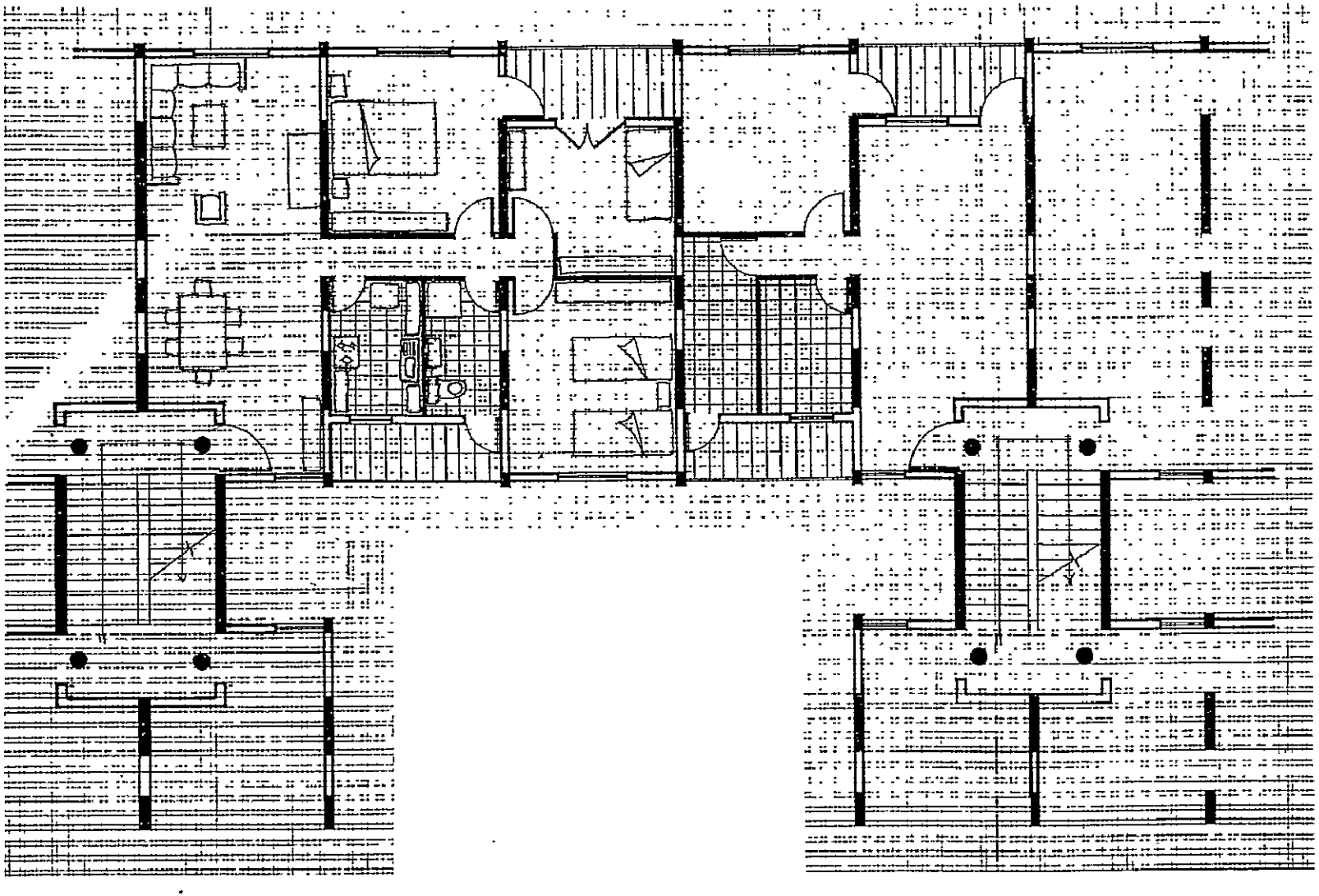
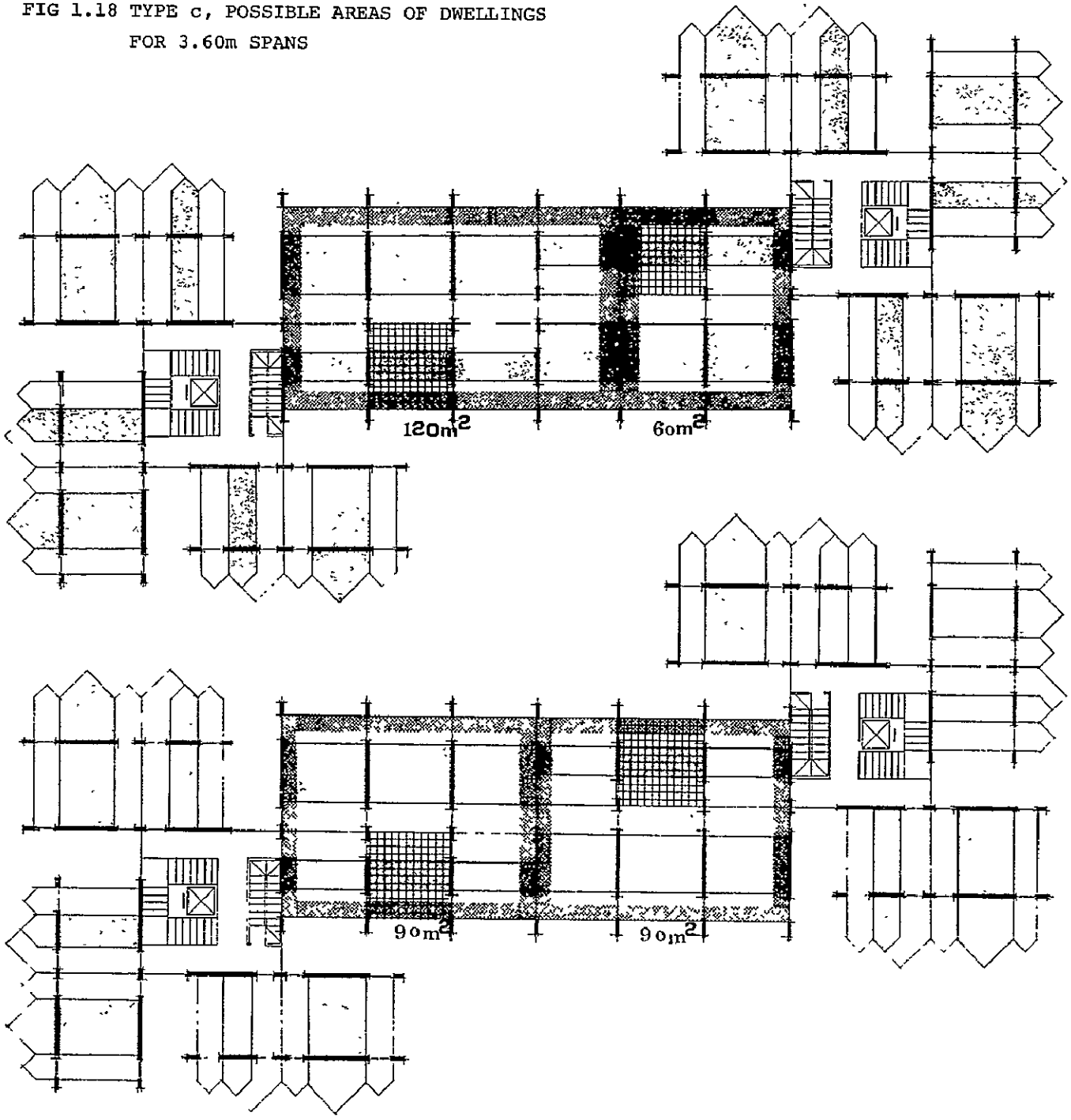


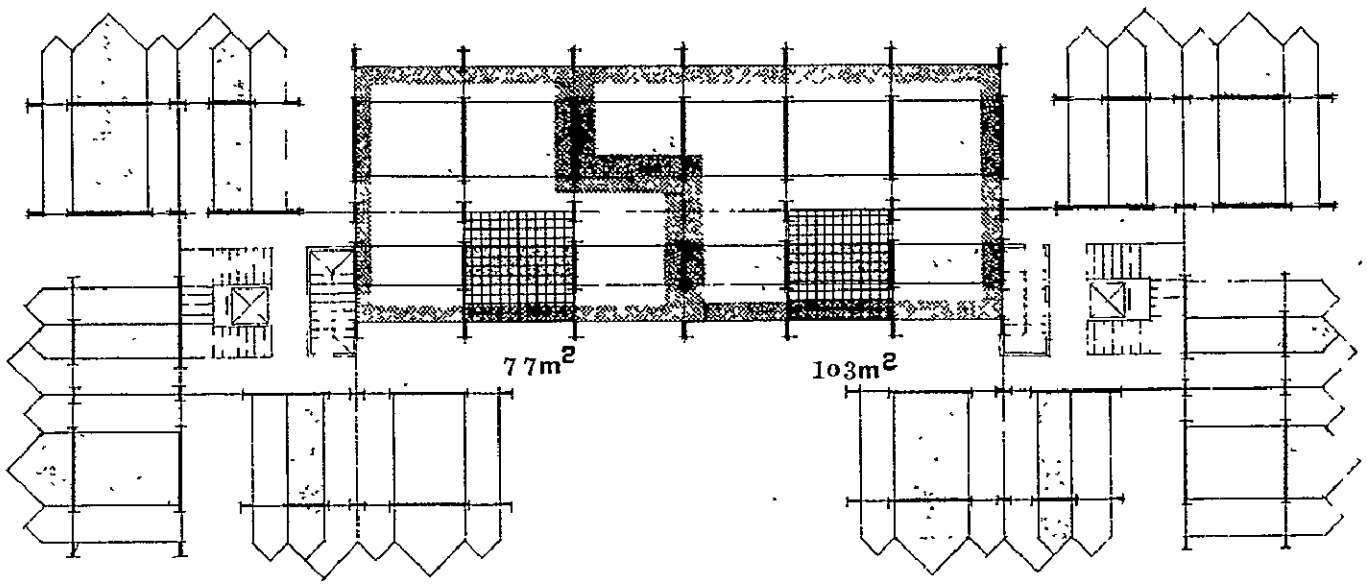
FIG 1.17 TYPE B, AN OPTIOANL DESIGN

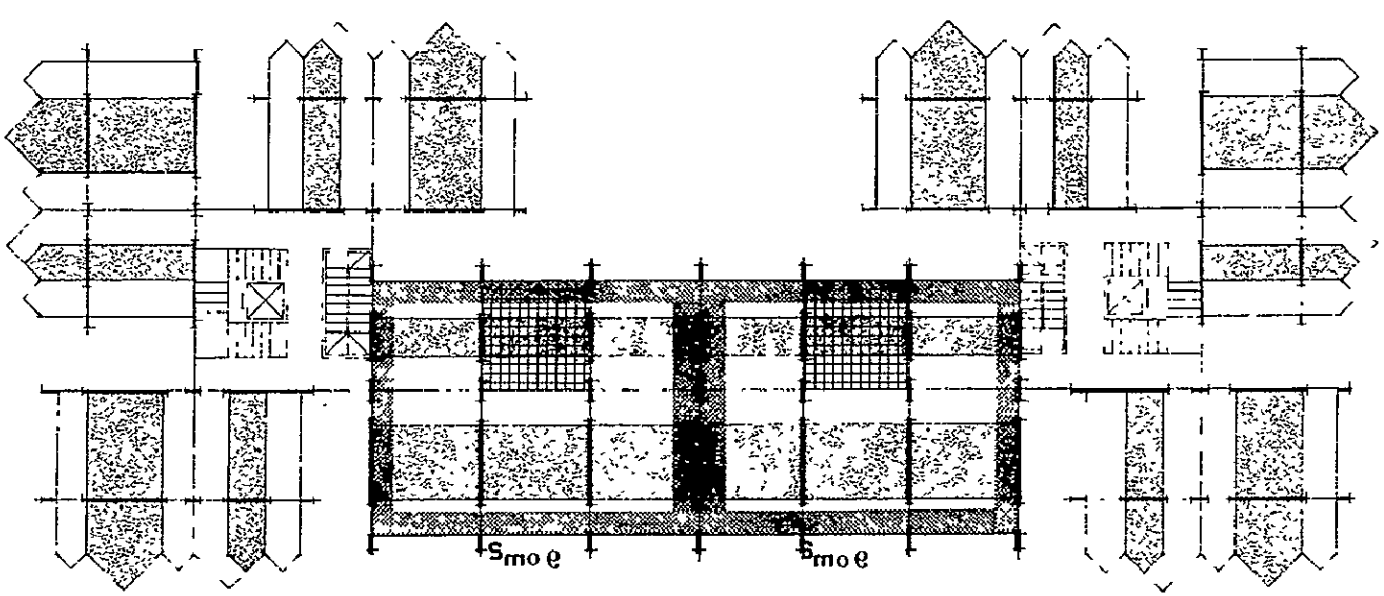
FIG 1.18 TYPE c, POSSIBLE AREAS OF DWELLINGS FOR 3.60m SPANS



255

256





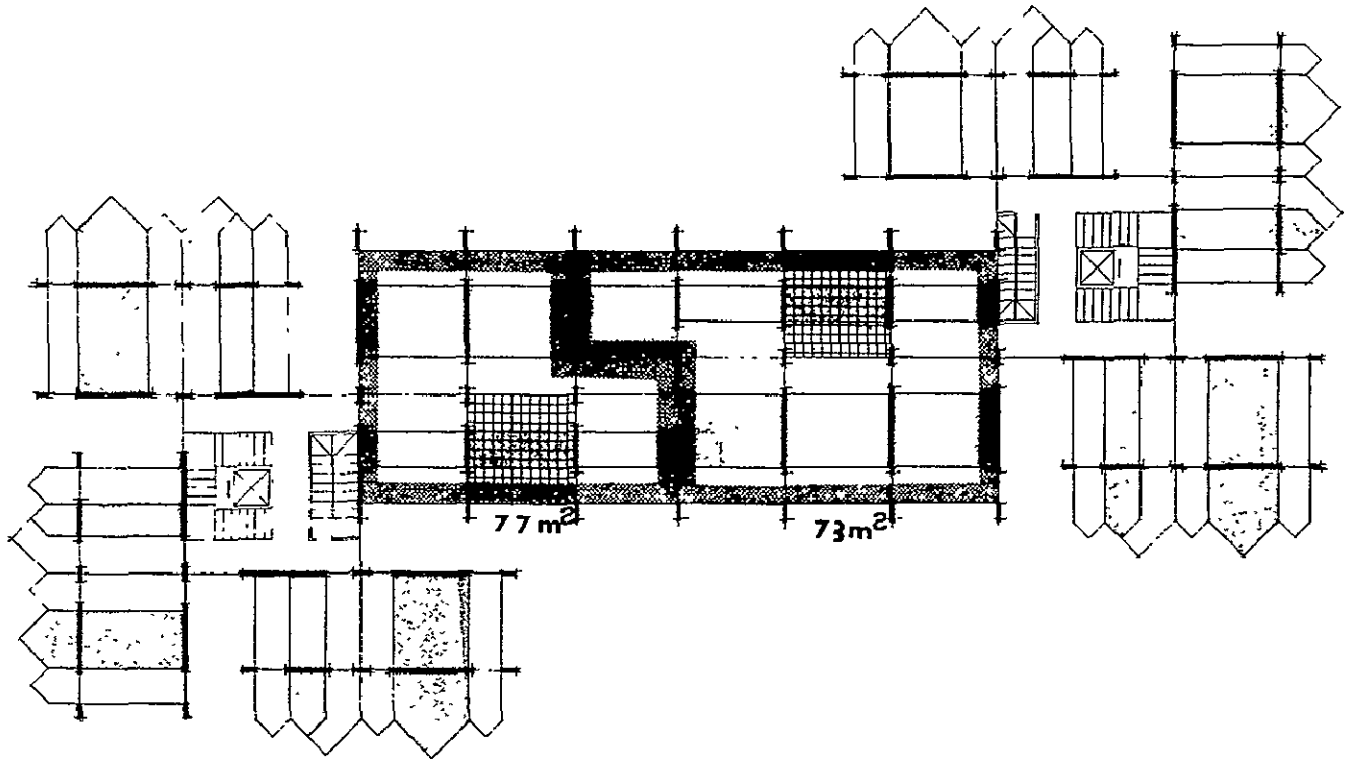
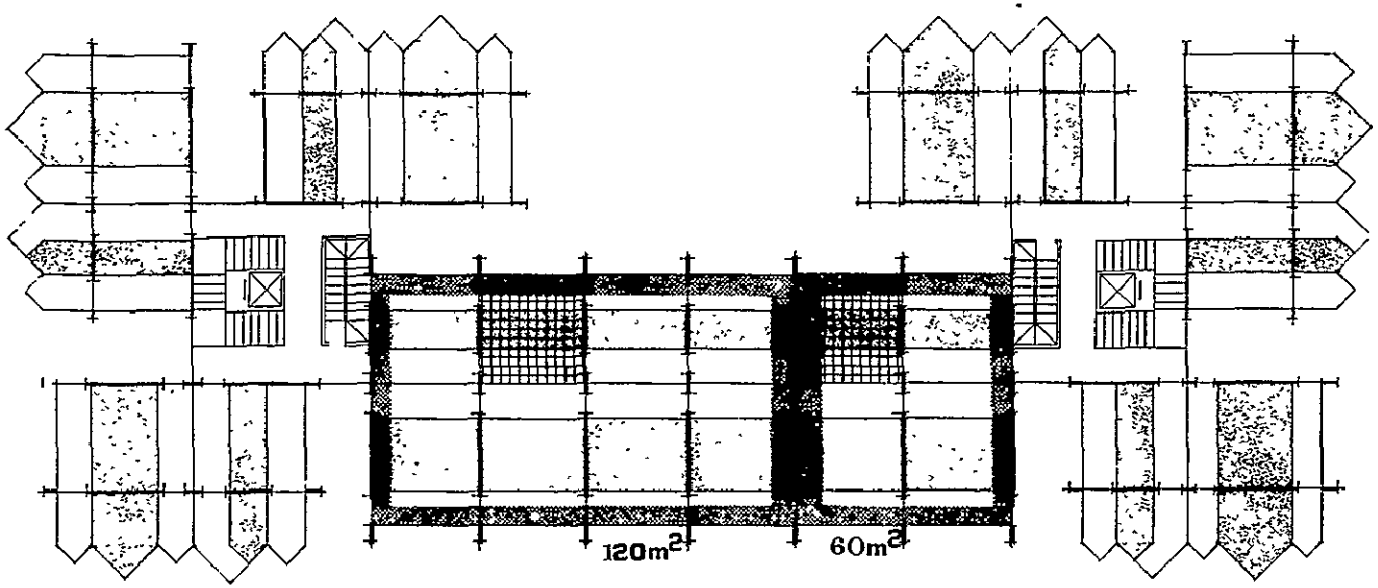
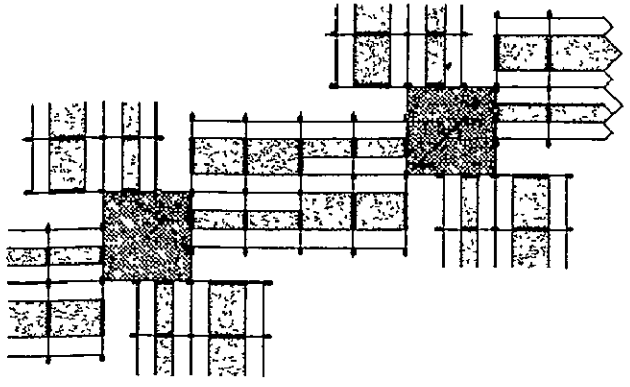


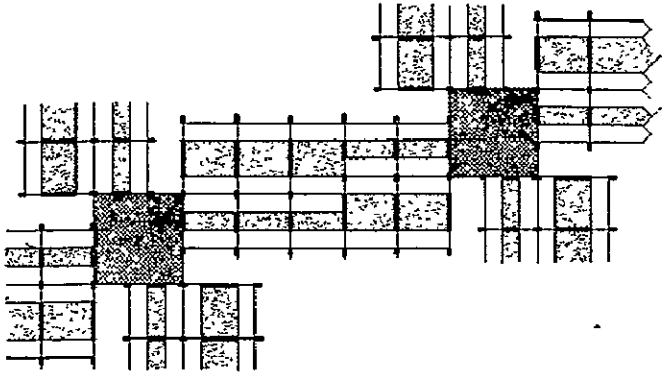
FIG 1.19 TYPE C, POSSIBLE AREAS OF DWELLINGS FOR 3.60m SPANS



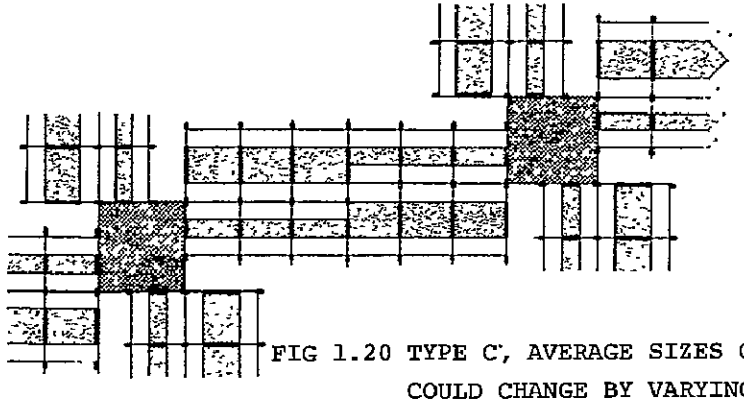
257



size of apartments range between 30m² and 90m²



size of apartments range between 30m² and 120m²



size of apartments range between 60m² and 120m²

FIG 1.20 TYPE C', AVERAGE SIZES OF APARTMENTS COULD CHANGE BY VARYING THE DISTANCE BETWEEN THE STAIRS

CONFIGURATION 1

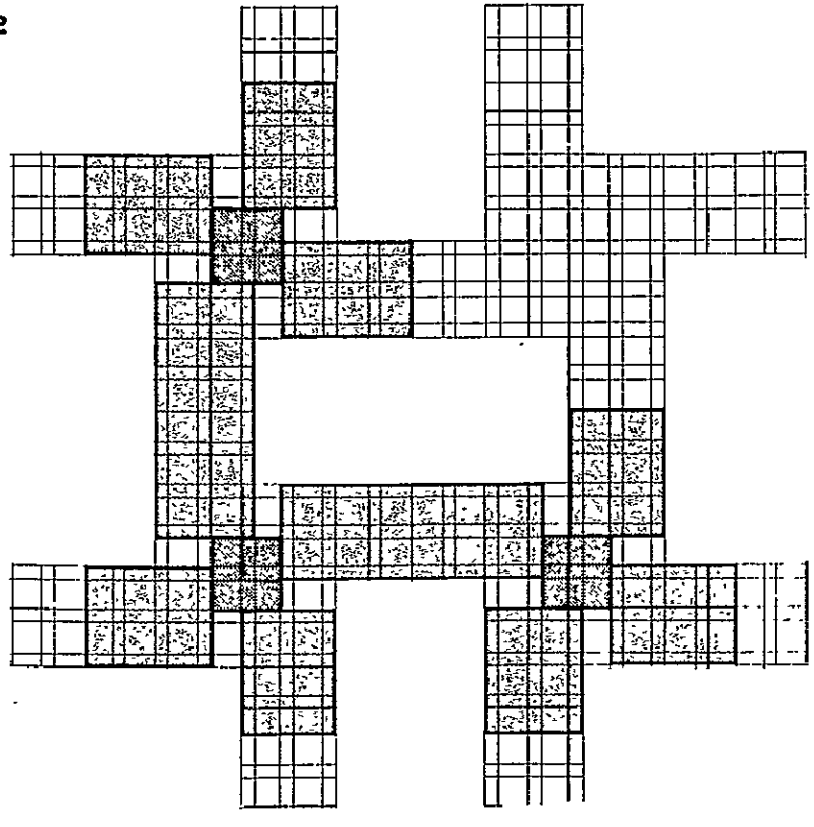
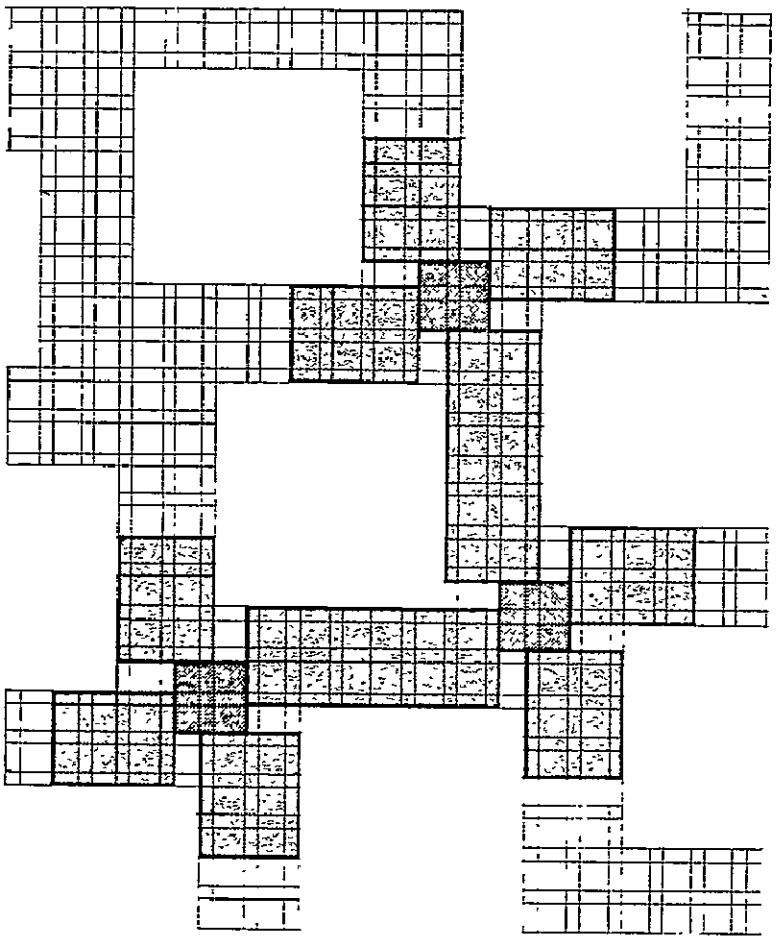
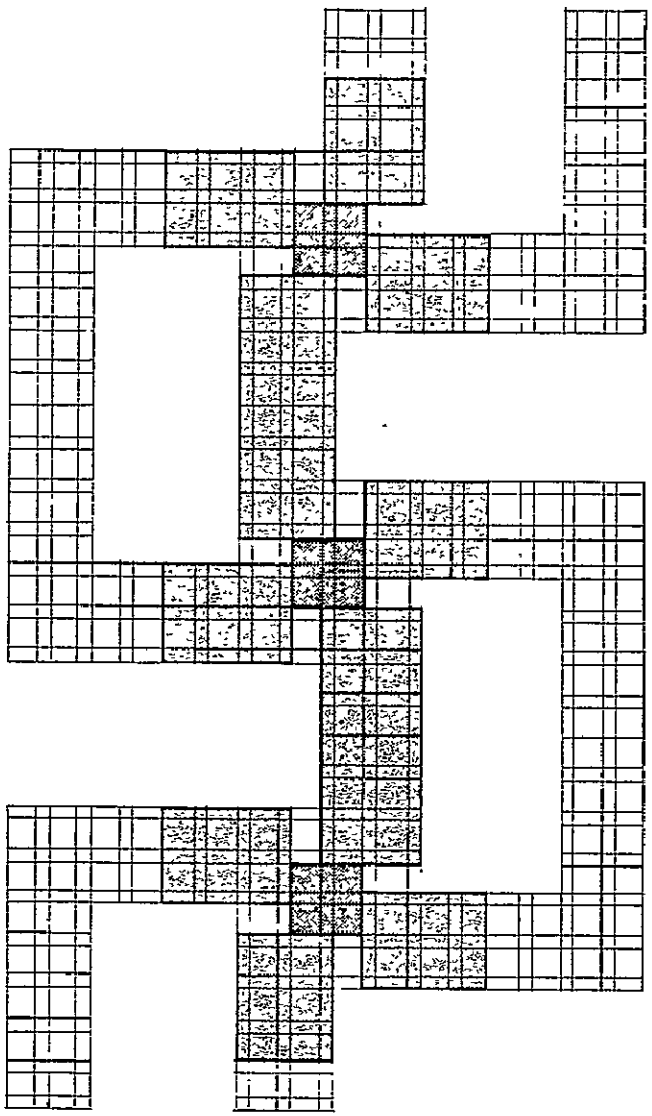


FIG 1.21 TYPE C, POSSIBLE CONFIGURATIONS FOR THIS HOUSING TYPE

CONFIGURATION 2

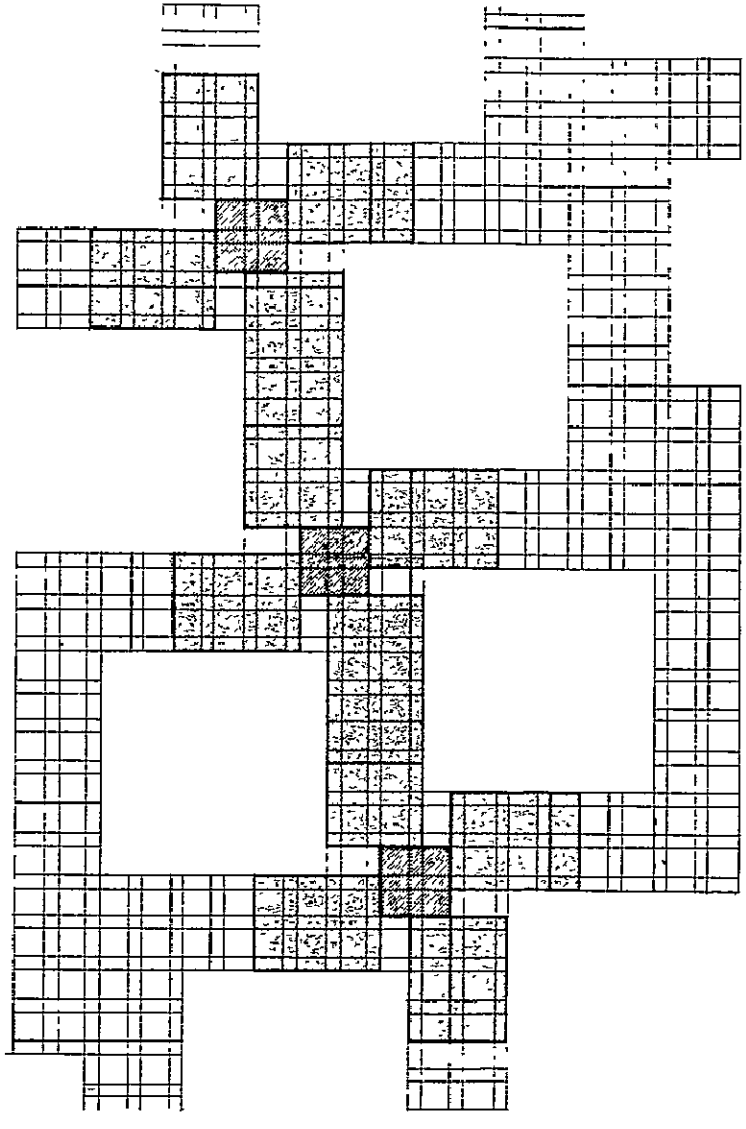


CONFIGURATION 3



259

CONFIGURATION 4



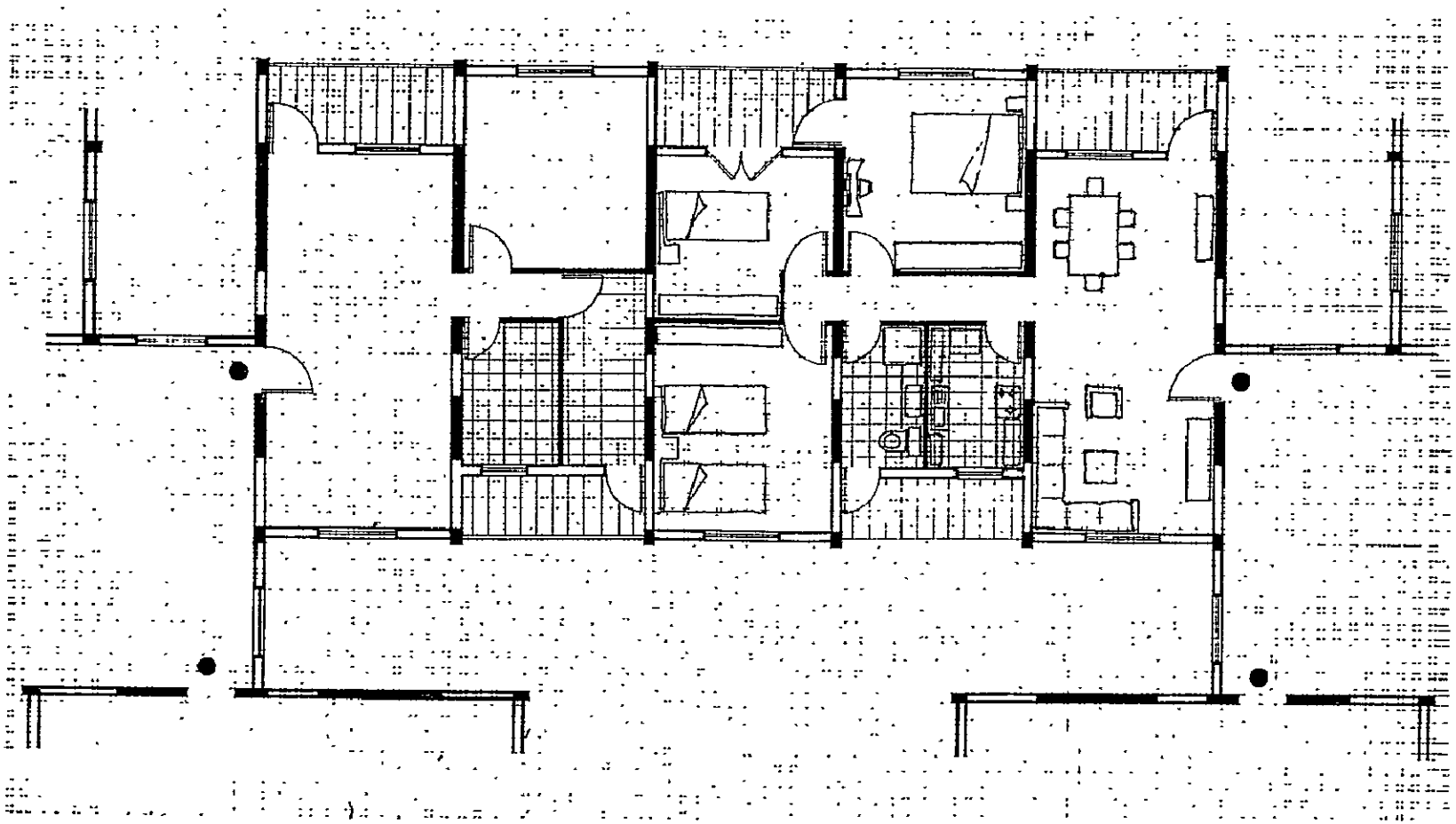


FIG 1.22 TYPE C, AN OPTIONAL DESIGN

FIG 1.23.1

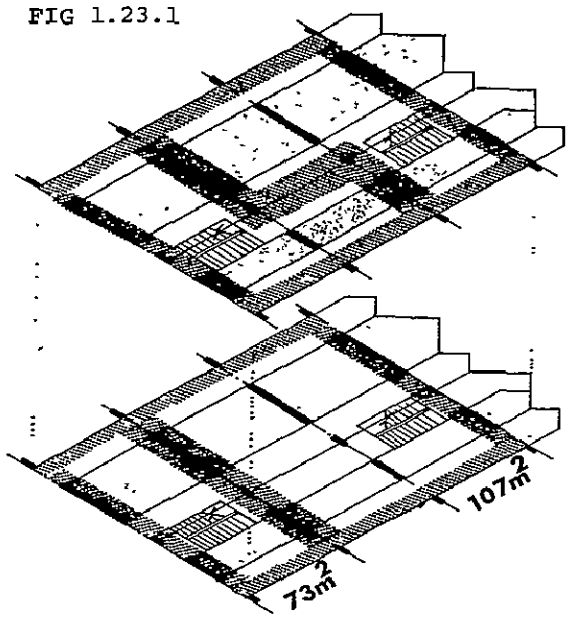


FIG 1.23.2

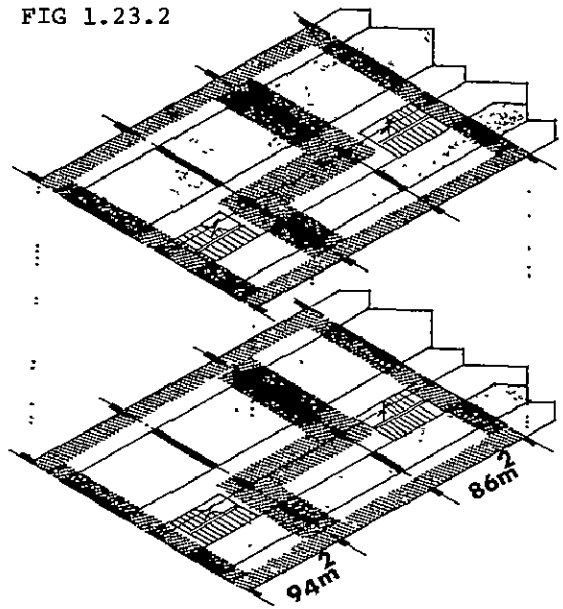


FIG 1.23.3

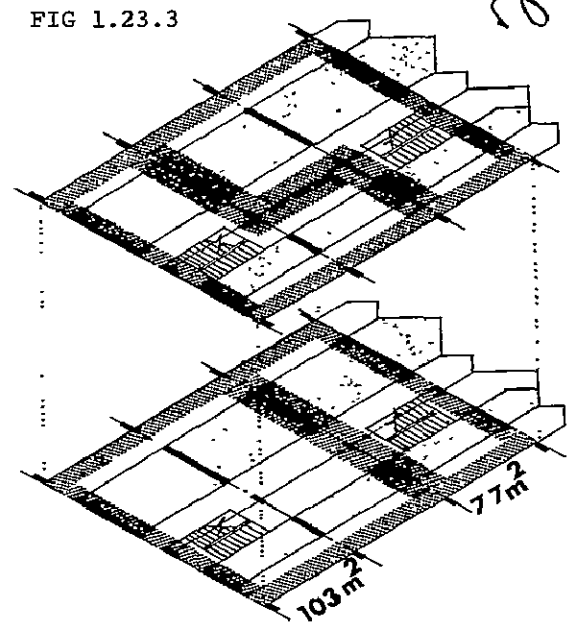


FIG 1.23.4

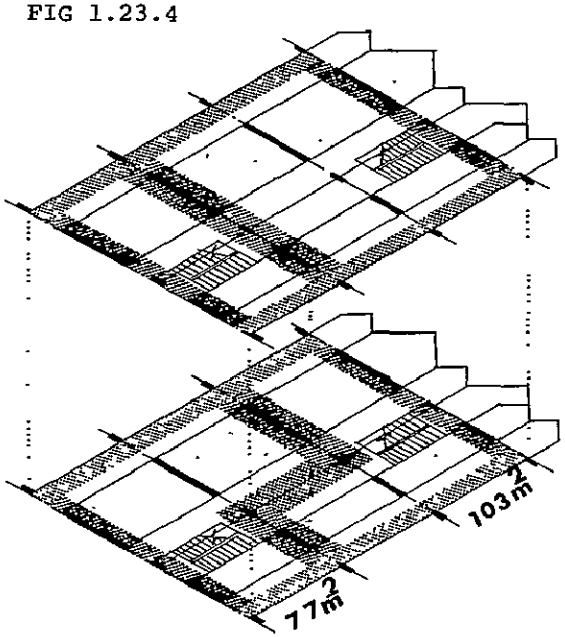


FIG 1.23.5

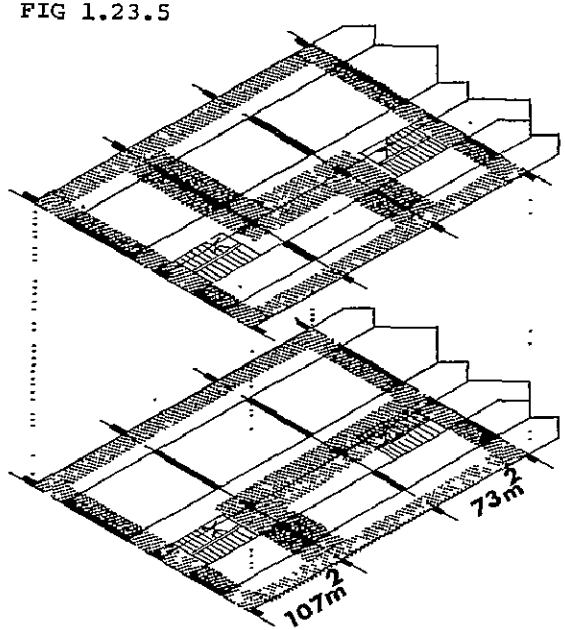


FIG 1.23.6

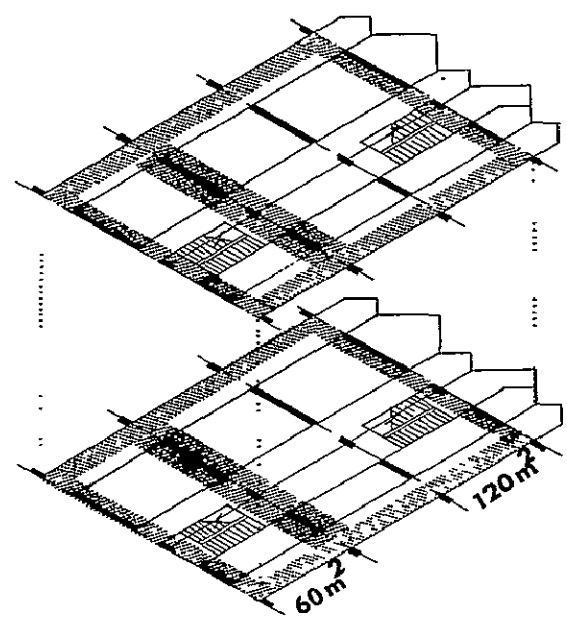


FIG 1.23 TYPE D, POSSIBLE AREAS OF DWELLINGS FOR 3.60m SPANS
(2 LEVLES)

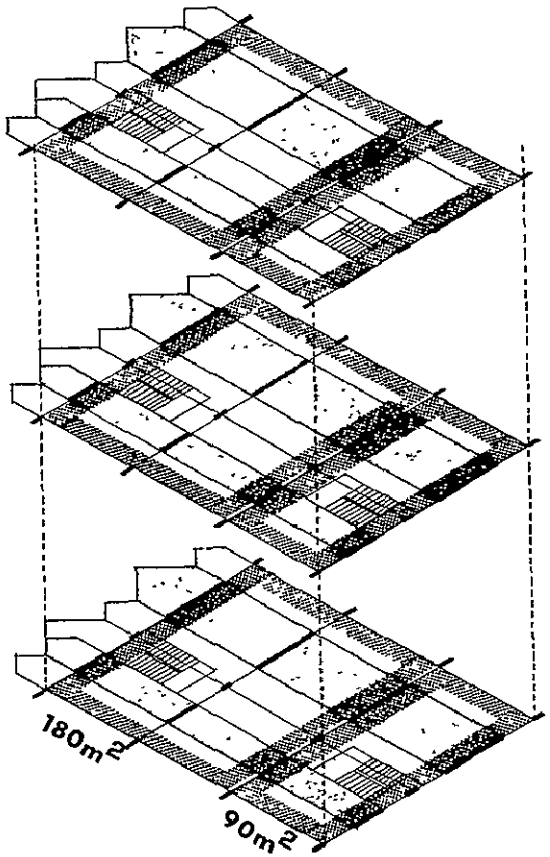


FIG 1.24.1

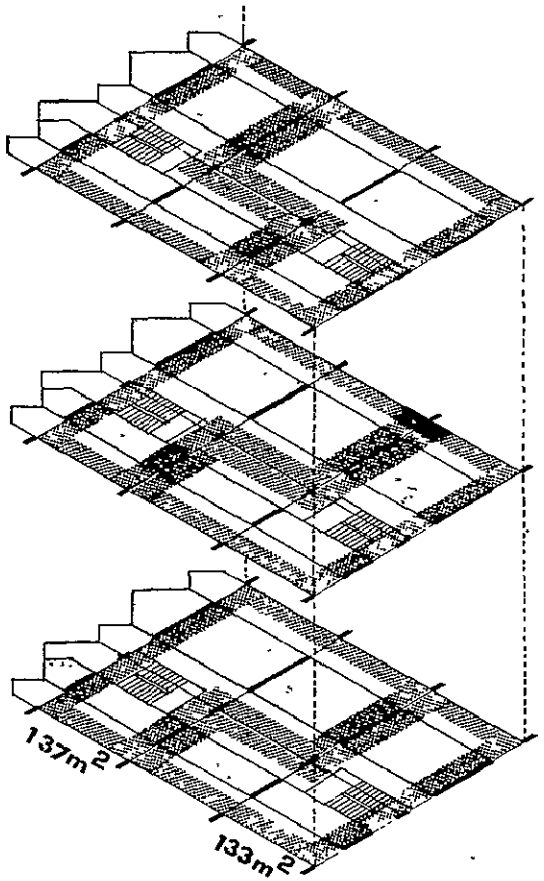


FIG 1.24.2

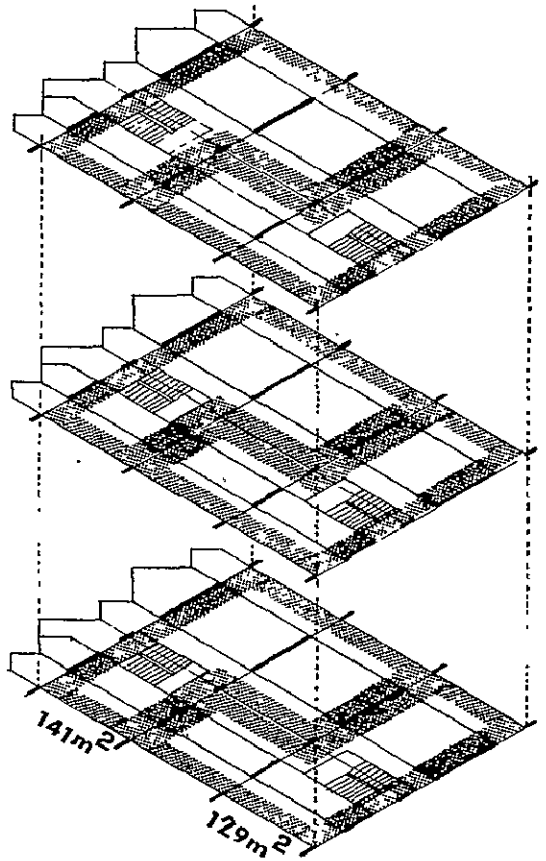


FIG 1.24.3

FIG 1.24 TYPE D, POSSIBLE AREAS OF DWELLINGS FOR 3.60m SPANS
(3 LEVELS)

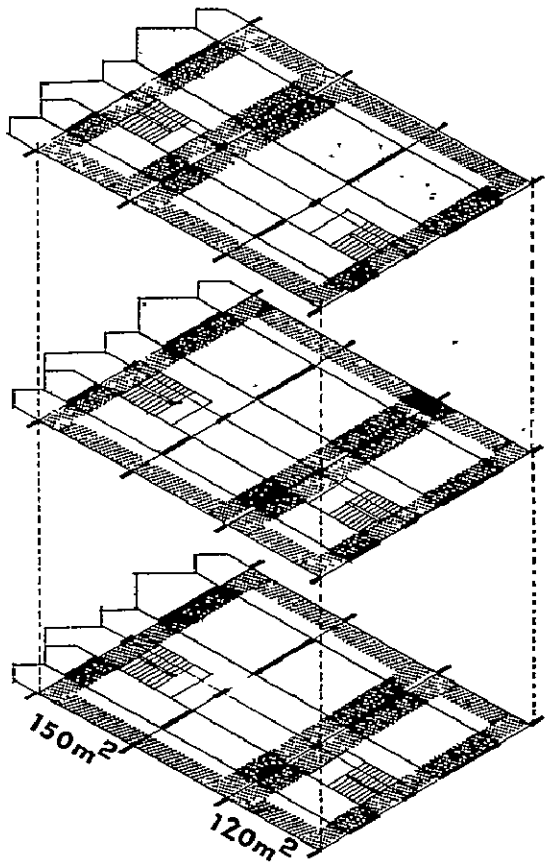


FIG 1.24.4

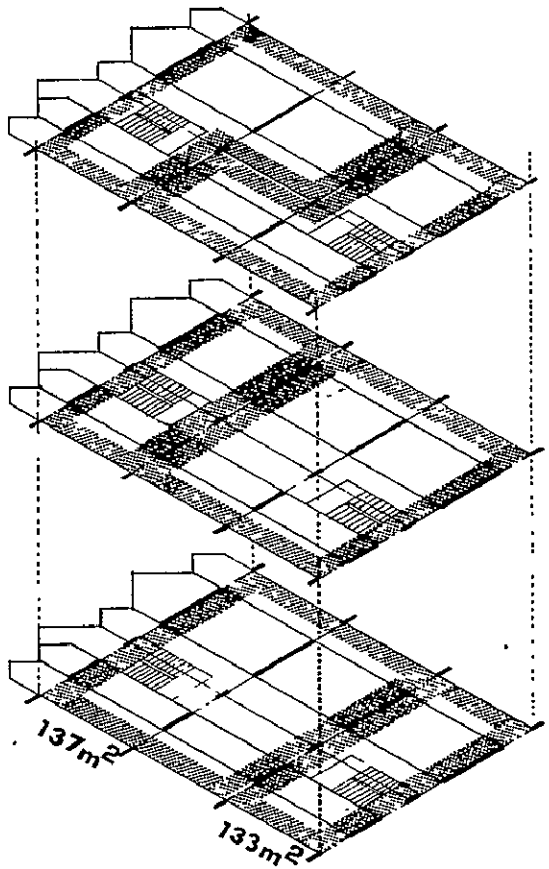


FIG 1.24.5

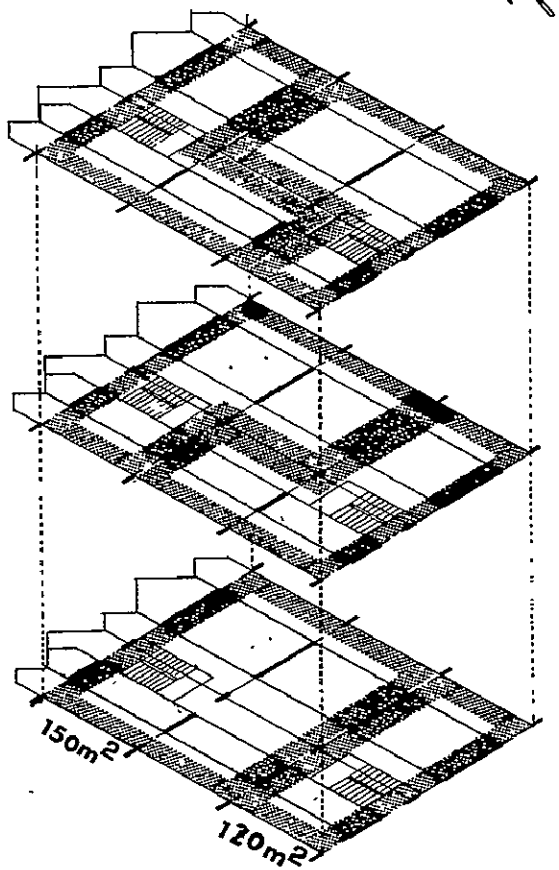


FIG 1.24.6

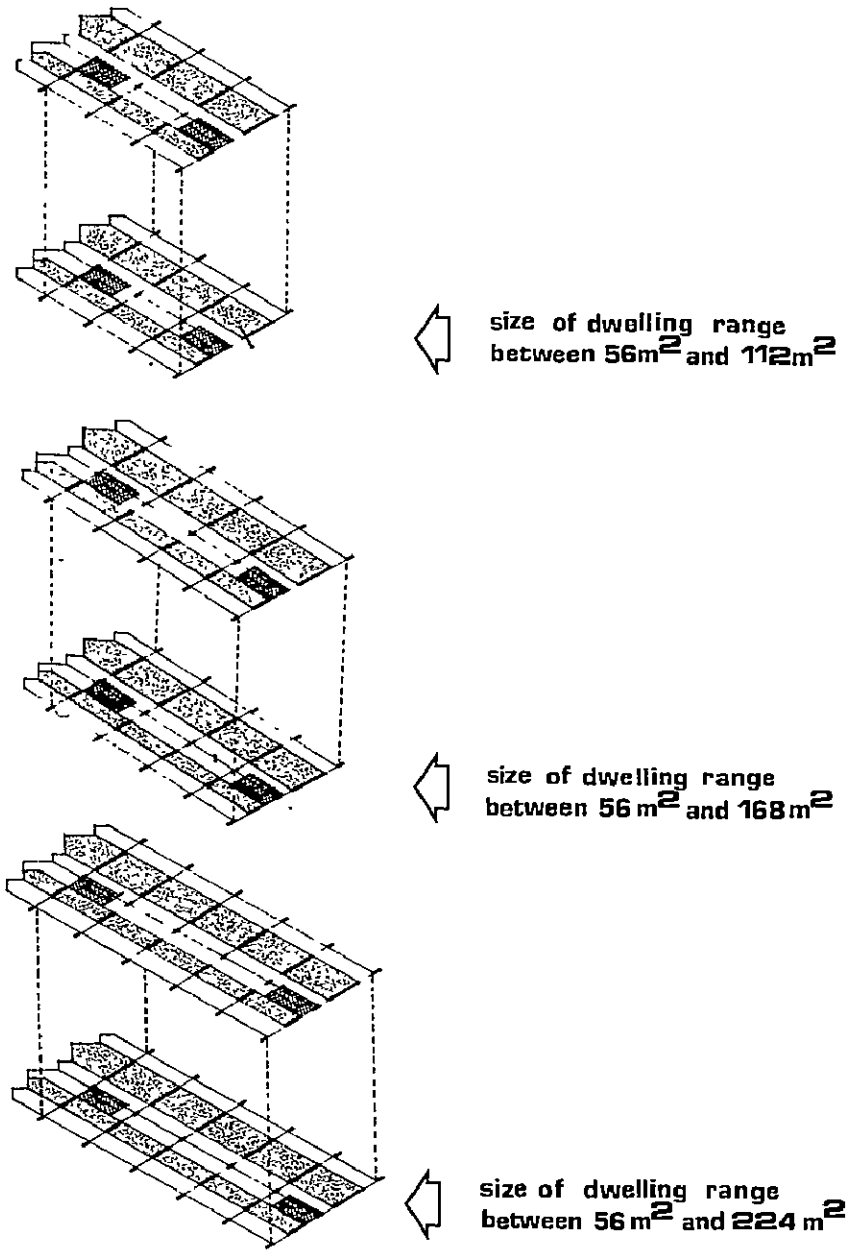


FIG 1.25 TYPE D, AVERAGE SIZES OF DWELLINGS COULD CHANGE BY VARYING THE DISTANCE BETWEEN STAIRS (2 LEVELS)

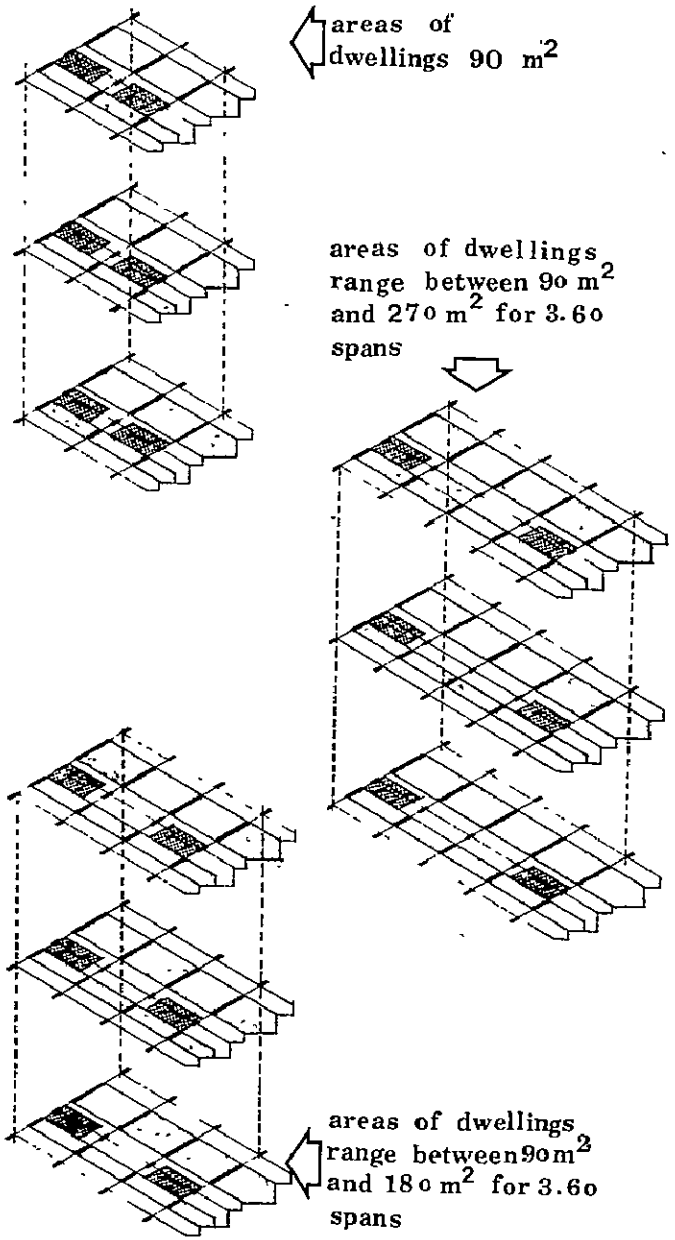


FIG 1.26 TYPE D, AVERAGE SIZES OF DWELLINGS COULD CHANGE BY VARYING THE DISTANCE BETWEEN STAIRS (3 LEVELS)

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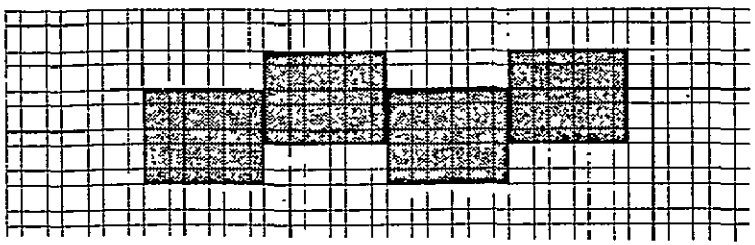
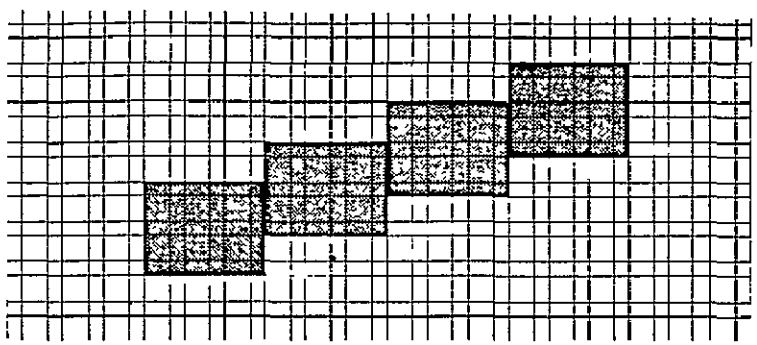
CONFIGURATION 1



CONFIGURATION 2



CONFIGURATION 3

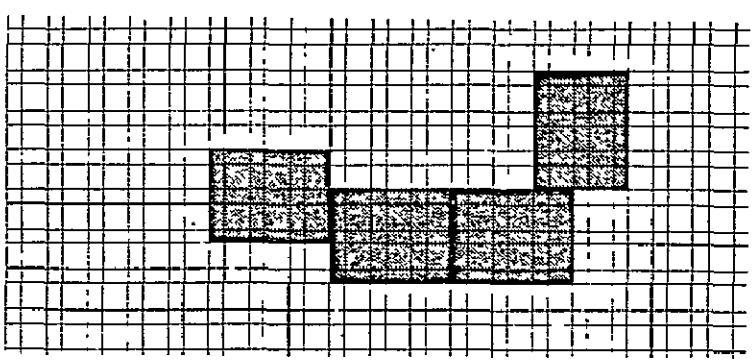
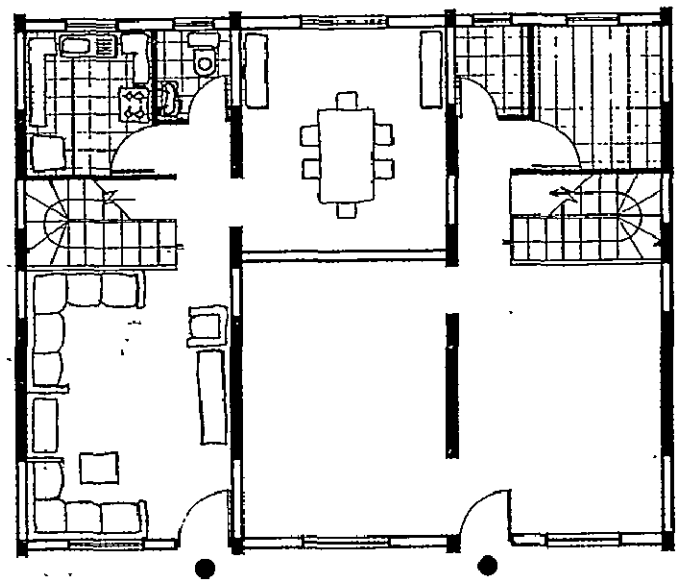


FIG 1.27 TYPE D, POSSIBLE CONFIGURATIONS FOR THIS HOUSING TYPE

GROUND FLOOR PLAN



FIRST FLOOR PLAN

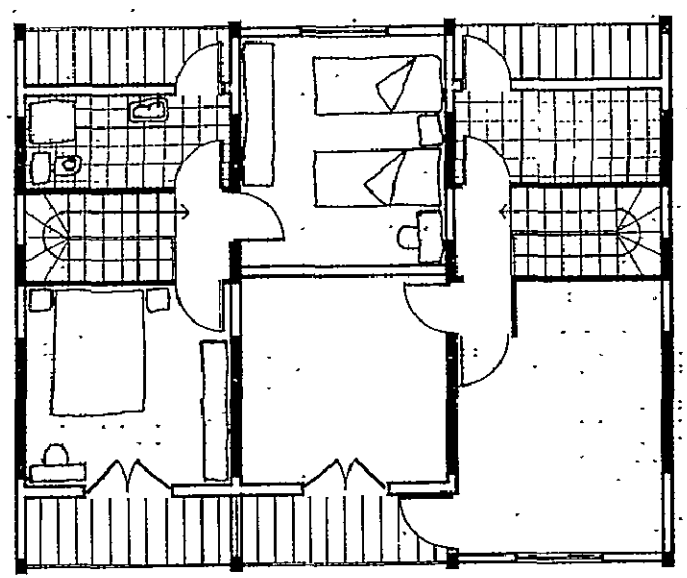


FIG 1.28 TYPE D, AN OPTIONAL DESIGN

GENERATING ALTERNATIVE STRATEGIES FOR THE PREFABRICATION INDUSTRY IN EGYPT

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GENERATING ALTERNATIVE STRATEGIES FOR THE PREFABRICATION INDUSTRY IN EGYPT

This chapter is an attempt to assess the position of the industrialized (prefabrication) sector in relation to the industrial sector as an agent of modernization in so-called developing countries, using the case of Egypt as an example. Structural and generic differences between the operational and organizational characteristics of the conventional and industrialized sectors are noted, including the need to account for "phasing-in" and "phasing out" of new techniques and methods, in the assessment of the efficiency of the industrialized sector.

It is the main hypothesis of the paper that the industrialization and mechanization of the construction industry can only be fully assessed, if viewed as an integral part of modernization goals on the national level. One-to-one cost comparisons with conventional construction methods are of little value, since there is no objective way of assessing global effects over long period of development time.

As a corollary of the above, choice of technology should be made in the context of overall industrialization, and should be based on multiple-choice policy options, rather than simple choice ones (e.g., "open" vs. "closed" systems).

In conclusion, the notion that industrialized building has "failed" should be set aside until a more comprehensive evaluation of the efficacy of industrialized building can be made, based on overall development and modernization, not only in Egypt but in many other developing countries all over the world.

Currently, it has become not only fashionable, but apparently "objectively" proven by many critics of industrialized building and prefabrication, that conventional construction techniques and methods are more economical and of better overall quality than industrialized systems.[1] While much of the criticism is justified in detail, and while conventional construction methods no doubt are superior to industrialized techniques for certain building tasks,[2] the tendency to dismiss industrialization, prefabrication, mechanization and rationalization in construction as a "failure" is not only disguising the true nature of industrialization, but does not hold up logically and methodologically. The following discourse is an attempt to correct some of the conceptual and methodological errors which have contaminated much of current thinking on industrialized building as part of the overall modernization process in developing countries, especially Egypt.

One of the major problem areas of current research concern is to eliminate bottlenecks for the utilization of the 12 prefabrication facilities which have been established in Egypt[3] and to overcome difficulties encountered in "phasing in" this new technique of housing production, along with a technology assessment concerning its relationship to (a) the general economy and (b) the construction industry at large.

The former (a) represents a formidable task of economic, resource and policy analysis, and can only be resolved after a rigorous and thorough investigation of all factors determining the economic modernization of Egypt and their social, technical and economic interrelationships.

The latter (b) is not a question of a simplistic and static comparison between conventional techniques of house building and industrialized techniques of building produc-

tion, but a question of assessing the development of industrialization in housing as an integral component of the declared policy of overall modernization and industrialization in Egypt, whose purpose it is to provide a higher living standard and greater productivity for its economy and for its people.

Consequently, the construction industry must be considered as only one among many sectors of the overall economy, where the prefabrication industry represents a subsection of the building industry.

Flow Chart 1 demonstrates a number of important features:

--the structure of the organization of the industrialization sector is generically different from that of the craft-based conventional method, in terms of activities, work flow, and technique.

--The industrialization sector contains elements which are not only structurally but also technically an extension of industrialized process at large, rather than representing a transfer of conventional craft processes into the factory (even though this may initially happen).

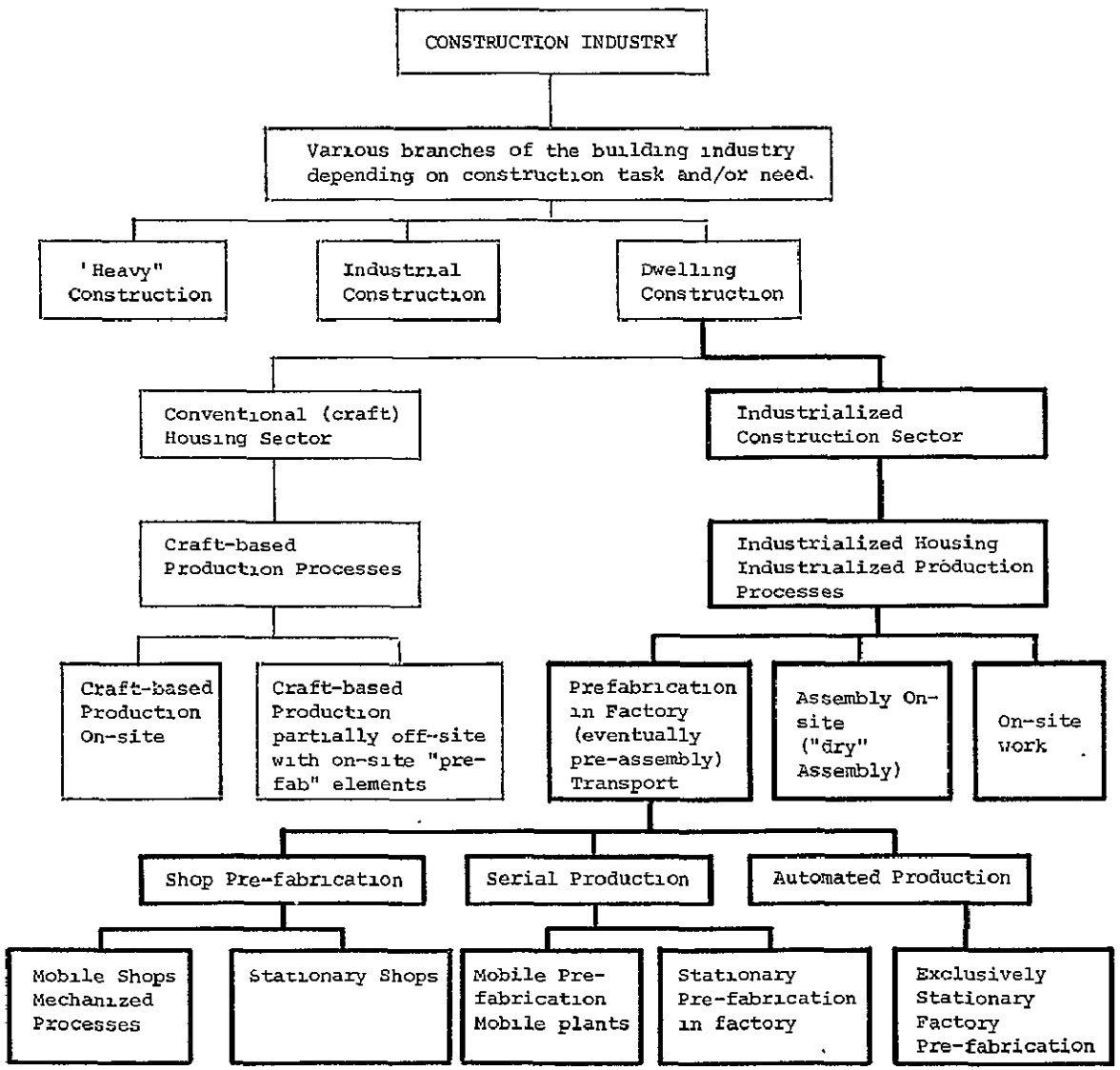
--the organization of the industrialized sector requires generically different production and assembly processes than craft-based construction. This means that a direct comparison between craft-based activities and industrialized processes is not very appropriate, since each obeys different requirements for quality standards, quality determination (i.e., minimum, optimum, maximum output per unit, etc.) and substantially different time and motion rythms.

--the craft-based, conventional sector is essentially an agglomeration of discrete and diversified production units, forming temporary and multi-faceted alliances for each given construction project, while the industrialized process requires long-term management and control of all the phases of planning, programming, production, assembly, etc., by pre-determined flow frequencies. This means that each sector operates on the basis of different criteria of evaluation and that an optimization of their respective inate efficiencies must obey separate criteria of efficiency and performance.

--the main issue of industrialization is not a one-to-one comparison of conventionally conceived discrete tasks broken down by either building function or material elements, but their respective overall capacity to satisfy the demand for quantity production at controlled levels of quality and performance (which need not necessarily be minimum levels).

--the industrialization of the building sector is not only developed by quantitative considerations, but represents qualitative re-orientation of all aspects of the economy of which prefabrication is an integral part.

Thus, any evaluation of the prefabrication sector will make sense if it is related to the overall development level of the industrial sector as a whole. Another reason why direct comparison is suspect is that craft-oriented, conventional construction and industrialized prefabricated production occupy different levels of the development cycle, with craft-oriented production representing a "mature" technique, with built-in and historically developed "efficiencies," which are being "phased out" as the new techniques and technologies of modernization (e.g., mechanization, prefabrication, etc.), are being "phased in"; the former obeying efficiency factors which are determined by habit and craft-oriented behavior while the latter are subject to accelerated "learning curves" of scientific management and pre-engineered production organization. See Figure 2



Flow Chart 1

Schematic Flowchart of Construction Industry With Industrialized Sector in Housing Added (European Model)

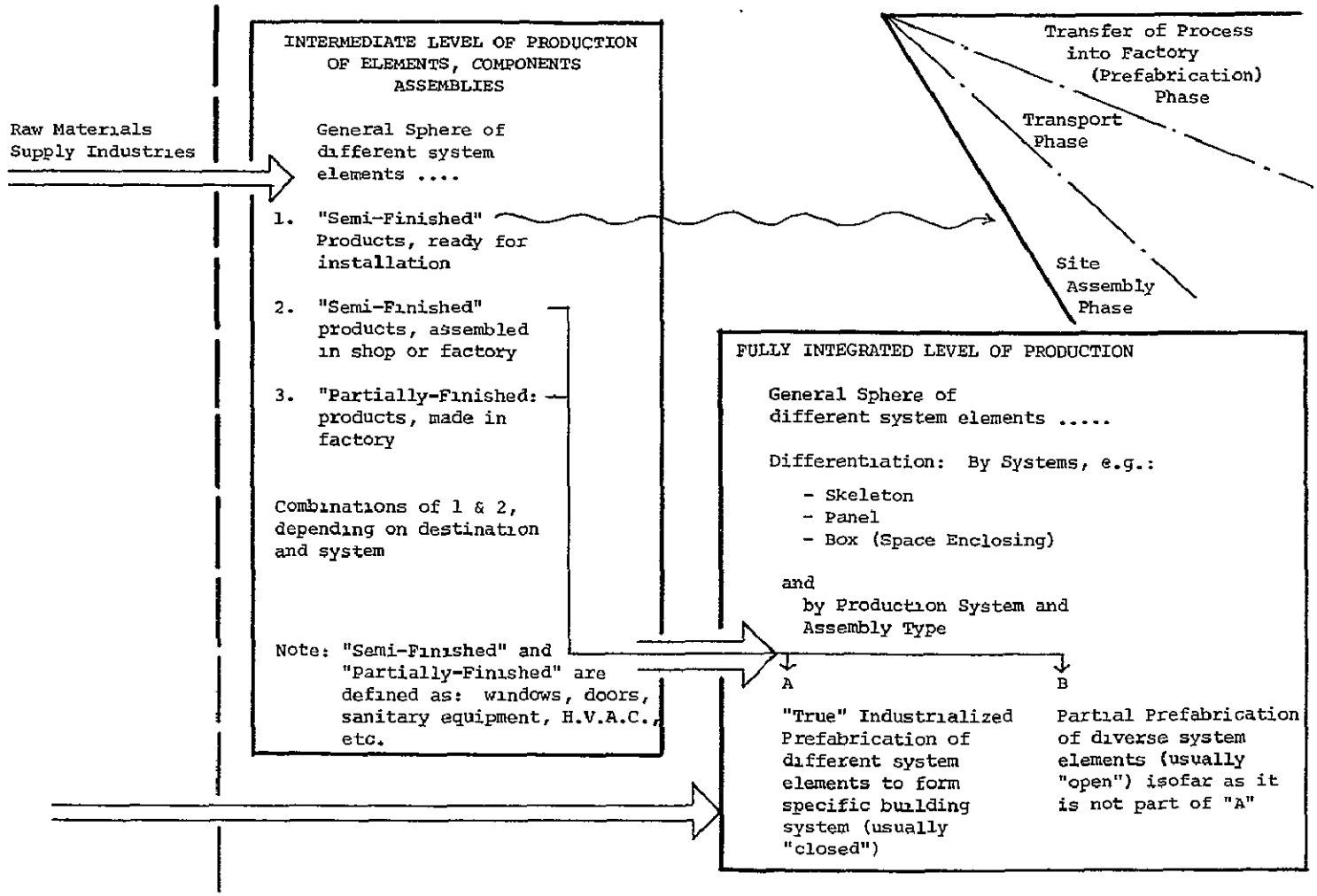


Figure 2

Schematic Flow of Production Processes and Levels of Production
in the Development of Industrialized Construction

Thus, any comparison of craft-oriented, conventional construction methods with industrialized methods of prefabrication does not yield very useful results, since the criterion of comparison is primarily focused on the image of a conventionally conceived product, rather than concentrating on mass production criteria of process.

There is another reason for cautioning against direct comparisons, using conventional building techniques as a base: Such comparisons are more a matter of convenience than the result of rigorous methodological determinations, since known and easily understood (also relatively simple) factors of the conventional construction processes are easier to account for than the more complex determinants of industrialized building. It is evident that any radical change in materials, methods, processes and production flow, which are inherent features of industrialization, will call for a complementary re-definition of most, if not all of these factors. In other words, a change in technique (and/or technology) causes radical problem-shifts, and cannot be conceived as a one-to-one comparative cost-accounting exercise without explicitly stating its inherent limitations. Problem shifts, generated by any new technique and/or technology generate as a matter of necessity dislocations, insecurity and sometimes temporary chaos, especially in the early phases of change, and thus are difficult to assess on the basis of conventional categories of quantity surveying and cost accounting.

The causes for these changes are in themselves radical and "non-conventional," i.e.:

1. Short-term, cyclical and excessive demand for quantity production of finished dwellings to "catch-up" with amenity levels set by the "developed" countries and perceived as desirable "standards" by the rest of the world. This leads to choosing housing industrialization as the most promising candidate to achieve these goals.
2. Parallel development of overall economic growth, seen as a pre-requisite for improving living standards, which means higher wages, higher demands on services, etc., and thus a "natural" increase in the cost of construction. The result is, that the increase in wages etc,. must be offset by increasing productivity, by mechanization and industrialization in all sectors of the economy, i.e., by transforming the whole production base of the economy.
3. Population increase and urbanization, requiring rapid methods of production to provide housing in quantity, i.e., by industrial methods. (N.B., this does not specify type of industrialization but involves techniques of mass-production, which may or may not include the house as such. Thus the provision of sewers, water, electricity, roads, etc., is merely another facet of industrialization with another "technology.")
4. Overall organizational patterns and management of large complex social, economic, and technical entities require "learning period," which took centuries to develop for the so-called "developed" countries, but which now must be compressed to decades or even years in the so-called "developing" world.

The concentration of the above factors leads to social and economic distortions and dislocations or so-called "bottlenecks," which occur during the process of industrialization; both on the macro-economic and subsequently at the sectorial levels. The recognition of these "bottlenecks" is central for the analysis of the progress of industrialization and cannot be predicated on a comparison of che essentially different problem areas

represented on the one hand by the conventional craft-oriented sector of the building industry and the newly emerging industrialized mass-production sector on the other hand.

The preceding discussion leads to the following tentative conclusions:

Only by making explicit the course, nature and functional locus of a given bottleneck, a valid statements or statements about the future development of the industrialized housing sector can be made with any degree of probability, including the question, whether industrialization represents a necessary development or stage in modernization (industrialization) as a whole or by segment, and if so, to what extent it can be "managed" to "pass through" certain bottlenecks with least difficulty. This requires the application of conditional and gradated categories to the problem, leading to multiple-choice strategies, rather than categorical conclusions based on an inherently unstable situation which by its very nature does not and cannot conform to a conservative and static perception of development. Thus, the only possible conclusion or set of conclusions from a point by point comparison of conventional with prefabrication techniques is the identification of bottlenecks and not categorical single-option policy statements, especially since the overall explicit objective of industrialization is the conscious pursuit of a policy of modernization as a national goal. The pursuit of this goal is only partially a matter of economic concern, and therefore cannot be stated in purely economic terms. On the constrary, it is the function of economic analysis to provide alternative strategy options leading to this goal, which may or may not include the recommendation for the abandonment of a discrete subsector of the economy to strengthen overall economic performance, but only if the elimination of one element can be compensated by a more efficient replacement at a higher level of (industrial) performance of the economy as a whole or other sectors in the long run. So far, there is no evidence that this state has been reached in the prefabrication sector, based on the data currently available.

As a matter of internal policy, based on cooperative teamwork, the most fruitful strategy to be followed may be best served by defining and analyzing the systemic rather than the particularistic causes of the bottlenecks which prevent the optimal utilization of the prefabrication factories, in order to determine options for their mitigation or correction. The fact that steel and concrete presently represent a serious bottleneck for currently cost-effective development of housing prefabrication is an insufficient reason to condemn the technique in its entirety and to counsel the abandonment or conversion of production to other uses without the most careful and broad-based consideration of all other factors, such as the technical and organizational ability of the industry to convert their production to other uses, the existence of a real market for these new products, and the cost of a possible conversion (piled on top of capital expenditures already expended to set up the factories for the purpose they were designed for i.e., the production of flat, large reinforced concrete panels in rectangular molds).

Only by defining the precise nature, origin and relationships of the existing bottlenecks, a tentative prognosis can be made about the markets to be served by the prefabrication industry and the new types to be produced within the overall production capacity of building industry as a whole and by carefully considering short, medium and long-term needs of the housing market.

To abandon or drastically change the output of this sector

even before it has commenced production on the basis of a one-dimensional single cost comparison, based on incomplete and admittedly inaccurate data of as yet unconfirmed production costs of a single factory is an extremely dangerous position to take and must be considered scientifically as well as methodologically suspect.

Aside from the above, the "discovery" of bottlenecks as problems of "appropriate technology" and their contribution to the problem of housing must be seen in the context of long-term "snap-sho ts" of possibly only temporary difficulties and marginal dislocations.

It may also be argued that industrialization in the construction sector is already inevitable, since it has occurred in all developed countries and even in other branches of the Egyptian construction industry, (viz., widening of the Suez Canal, industrial projects, hotels, road construction, etc., etc.). Given this hypothesis, it may be possible to extract different conclusions from the comparison than those conventionally arrived at, e.g.:

--Manipulate the economy to supply cheapter and more plentiful quantities of cement and steel (by increasing production in that sector, or re-allocation of resources, or other options to be tested by appropriate economic modeling).

--Accelerate the "learning curve" of the industry by providing sites and large projects to absorb full production of carefully monitored prototypes of differentiated characteristics for different income groups.

--Provide training and other incentives to labor to become "skilled" as factory workers with prospects of steady employment and increased status.

--Test alternative industrialized elements and components during periods of decreased activity or slack production periods.

--Reduce content of steel and cement by decreasing area of panels by masonry or gypsum "inserts".

--Study alternative inventory and distribution strategies.

Aside from the necessity of recognizing the existence of the factories in Egypt not only as a given economic fact, but more so as a new institutional element and as an instrument of modernization, there is an inherent assumption in the recommendations of conventional technology proponents that it is in the power of a single individual (technical advisor or policy-maker) or a small academic team of advisors to state categorically whether a country should or should not industrialize any sector of its economy. It seems a more productive course to proceed on the assumption that industrialization has been accepted as an imperative of national policy and that only by a careful integration of social, political, technical, psychological and economic complexities of the situation can any suggestions be made (cautiously) on policy, and only as a matter of presenting multiple choice alternatives to the course already taken, with the understanding that the existing situation is--in fact--determined to some extent by other factors than "pure" economics (which by itself is not entirely without "extra" economic bias), not only in terms of how much and where capital should be invested, where man-power should be committed, and what organizational structures should be developed, and so forth. In other words, the abandonment of any sector or even its radical transformation will create not only economic consequences which are difficult to predict, but equally--if not more so--may lead to devastating political and social side-effects which may or may not transcent purely economic considerations. To abandon or transform a whole sector of the economy, simply because of its initial "phasing-in" difficulties, without exploring first every possible feasible alternative is irresponsible and dangerous.

Thus, the "discovery" of bottlenecks in the prefabricated sector by means of single option comparisons merely reinforces and justifies resistance to change (i.e., by focusing on conventional construction techniques as the only alternative). A better strategy may be to contrast the industrialized sector with conventional craft-based building and consequently evaluate the advantages and disadvantages of each within the context of the total demand of housing, allocating to each only those tasks which can be managed best by either in the short, medium and long-term, i.e., anticipating change, rather than responding to an existing situation. This would require a dynamic model of economic analysis, with a network of alternatives rather than single option yes-no recommendations. Such a strategy would consist of two elements:

1. Distillation of those limiting factors (bottlenecks) which may be considered as generic to industrialization and modernization as such (i.e., macro-economic analysis).
2. Determination of those limiting factors (bottlenecks) which are specific to industrialized prefabrication, on its own terms.

This may provide a better model than the comparison of two sub-sectors of the construction industry, as part of the larger economy. Such a strategy should lead to the development of multi-options, based on the refinement of the argument by establishment of the base of assumption by integrattive strategies rather than exclusionary ones.

This does not mean that the building sector does actually behave like any other consumer industry or that certain options will have to be eventually exlcuded. However, this should happen if and only if the discarded option does not contribute even marginally to overall industrialization, and only after careful assessment of the magnitude of this margin, including social, political and technical considerations.

METHOD

The argument concerning alternative or appropriate technologies is not a fruitful base upon which to deal with assessing the efficiency of industrialization, since it takes existing difficulties as a point of departure by either comparing them with "successes" in mature industrialized countries, or with conventional craft-based production (which has demonstrably failed to provide quantity production of acceptable quality housing). The first strategy--i.e., comparison with mature industrialized countries--is preferable to the latter, although the element of maturation over time presents great methodological difficulties. Since planning for industrialization is both long-term and dynamic, the determination of difficulties (bottlenecks) at time A does not necessarily have a direct bearing on the behavior of a developing industrialized context at time B. Aside from that, the assessment of the difficulties in the building industry is too limited a criterion to make reliable statements about long-term development, let alone long-term trends in one of its sub-sectors.

For example, it is quite conceivable that a given technique of industrialization, e.g., large prefabricated concrete housing may prove less effective than anticipated during the early phases in the industrialization of a "developing" country, but that during later periods, under different circumstances parts or wholes of the industry may perform at very high levels of productivity--or vice versa. It should be remembered that the use of mechanized and automated machinery represents not only a change of technology, but will affect the whole process of construction over long periods of time, and thus cannot be "tested" on the basis of currently prevailing notions of

efficiency.

Both methods of comparison have a common feature, i.e., due to the complex nature of maturization of industrialization, it is difficult to assign "efficiency criteria" in an unbiased and scientifically "value-free" manner. Intrusions of unpredictable and/or unanticipated factors make a truly "scientific" forecasting of trends difficult and thus must be viewed with great caution if not outright skepticism. Economic analysis provides tentative indicators of probable trends, not necessarily a trend as such. The only approximation possible is to assume that the development of the industrialized construction sector can be expected to follow in a more or less orderly way the industrialization (modernization) of the whole economy, and thus it can be safely assumed that it will fail if the economy as a whole fails, while success will inevitably offer not one but many options for its survival. It is on the latter assumption that one must proceed, the former being unacceptable as a basic premise ipso facto. Since there is no "scientific" way to assure that events will proceed according to either path, policy advice based on the projection of present trends in the conventional sector is actually not very useful, except as an indicator of the existing gap between supply and demand. This creates a difficult situation, since there is really no firm methodological basis to use the existing situation in the conventional building sector as a basis for comparison for policy statements concerning the future of industrialization, and to assign to the present condition of the prefabrication industry in Egypt bottlenecks or difficulties which are--in effect--inherent in the processes of overall economic development as such.

A better methodology may be to construct a desirable model for industrialization, taking into account the development in the other sectors of the economy, while at the same time testing the experience of other industrialized sectors against the peculiarities and constraints of the building sector. In other words, difficulties and bottlenecks in one sector can only be overcome by a systematic and detailed analysis of its relationship with other sectors (i.e., the whole economy). To analyze or compare a single case as a sub-sector of a larger system seems ill-suited to gain an insight into either the whole or its parts. After all, it is the explicit aim of any serious research project to create the conditions for generating knowledge which hitherto has been inaccessible by conventional methods. Thus, it seems that economic analysis needs to create a certain "distance" when confronting difficulties in a given sector or sub-sector, which focuses beyond the narrow concerns of intuitive "conventional wisdom" of those already too close to the problem (and who are empirically quite aware of the difficulties and bottlenecks encountered). By creating this "distance" it may be possible to effect a "problem shift" which avoids the trap of a myopic assessment on the basis of conventional "empirical givens" and which allows for bold but affirmative conjecture as a mechanism for generating alternative additional options, rather than capitulation in the face of the existing status quo.

To predicate a model of industrialized housing on conventional craft-oriented techniques and processes is erroneous and does not provide us with any useful statements about the future development or direction of industrialization in housing, or in the construction sector at large.

NOTES:

--It is important to include in the concept of "building system" all those elements and components required for transport (i.e., determining the optimal radius of market accessibility).

--Size and configuration of factory-produced elements is determined by:

a. transport limitations
b. maximum level of pre-assembly, based on functional considerations.

Both in combination, determine the level of prefabrication possible at a given level of (industrial) infrastructure.

--Unlike in conventional construction, systems building requires the co-ordination of elements, components, assemblies, etc., already in the factory. Only minor adjustments are expected to be necessary on the site during assembly. Thus, coordination by drawing, becomes coordination of production.

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Housing for the Low Income and Informal Sector

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This summary is a part of the Housing and Construction Industry Research Program carried out under the Technological Planning Program, a joint research project by Cairo University and the Massachusetts Institute of Technology. The views and opinions expressed in this report are those of the authors and do not necessarily reflect those of AID, MIT, or Cairo University.

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INTRODUCTION/CONTEXT

We would like to acknowledge the General Organization for Physical Planning for their continued support and assistance throughout the conduct of the research. Particularly, we would like to acknowledge Mr. Michel Fouad, Chairman, and Mr. Tag El Sahly, Vice Chairman, for their generous time and efforts on our behalf, and also their staff members Miss Nahed Ali Hassan and Mr. Adel Fawzy for their patience and assistance in the everyday tedium of the work.

1. The low income majority of the population comprise and cause severe problems which require immediate direct action.

2. The larger cities act like magnets drawing people from rural agricultural areas. The level of education, medical centers, entertainment, and - of prime importance - the availability of jobs and employment, is the lure.

3. The central areas in Cairo are already very crowded, new housing developments, if built after demolishing slum areas, would need to be middle income or even high middle income people, due to the present high prices of building sites.

4. Public housing built by the government can barely house the low income people from slum clearance areas. The cost of new construction has nearly tripled over the past few years.

5. Low income people move to the peripheries of Cairo; the agricultural land is subdivided into small plots and sold cheaply to individuals. They build a minimum shelter, move to the new area, and gradually they complete the building, first the ground floor and eventually 2 or 3 more floors, which are rented out.

6. The owners have neither applied for a building permit, as they are building on agricultural land outside the city's building cordon, nor are they building according to by-laws and regulations. These newly developed areas have been called "informal housing".

7. Over the past 25 years the informal housing has increased and spread all around Cairo, spreading quicker in the least resistance areas, west and north of Cairo; the Giza governorate taking most of the population overspill of Cairo.

8. It is apparent that the Informal Sector is capable of building and does build houses suited to their needs and within their income capacity, not withstanding the shortage of labor or the scarcity of building materials during the past 15 years. (See: Interim Report Working Papers 1978, page 71.)

9. Rapid, undirected urbanization is having deteriorating effects on Cairo. The city's infrastructure facilities have been overloaded. The size and rate of growth of these informal urban peripheral housing areas encroaching on agricultural land has been studied, and the magnitude of the problem is apparent. Accordingly, practical planning policies to direct, control, and upgrade these growth areas are more realistic.

10. In an exploratory study of satellite images for 1973 and 1978 of the Greater Cairo urban area, some sense of the rapid expansion can be seen. Approximate results indicate a growth rate of 5.68% per year, with agriculture land being developed at a rate of 4:1 over desert land. (See: Exploratory Studies with LANDSAT IMAGES Of Cairo.)

11. The rapid growth is particularly apparent in the informal sectors. Some studies have indicated that the built-up area in these sectors doubles every 10 years. (See: Growth of an Informal Area over a Thirty Year Period: Imbaba.)

12. The economic drive of the Informal Sector clearly points to a shift in emphasis that could be applied to housing policies for the low income. Instead of erecting fully finished dwellings, infrastructure facilities and a minimum of shelter could be sold to individuals, giving the owner the responsibility of future development, minimizing public authorities' expenses and maximizing individual participation by money and effort in the urbanization process, still within necessary planning guidelines.

13. Core houses or apartment types, depending on the location of area to be developed, are the implementation of a new policy for public housing where the responsibility of building or completing the dwelling is shared by the low income owner and the public authority.

14. Small plot, or small core house areas do not necessarily mean cheaper building. Certain layout or design characteristics influence the cost, especially when considering a long term economical appraisal of a developed area. The detailed study of the layout and dwelling characteristics of 16 core house examples and 2 apartment examples, built or proposed in urban areas in areas in several localities in Egypt, outlines the trend in core house designs from which future government policies concerning this type of development could be referenced. (See: "Comparison of Core House Designs Proposed in Egypt.")

COMPARISON OF CORE HOUSE DESIGNS PROPOSED IN EGYPT

Prepared by:

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and Teaching Assistants Ahmed H. Sherif and Tolba Ragab Tolba

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INTRODUCTION: CORE HOUSING

In the master plans of many of the new desert cities, sections of the residential areas were allocated to core houses, i.e. in Sadat City, Ameriyah New Town and 10th of Ramadan. Also, in the initial stages of rebuilding the canal zone cities after the 1973 war, i.e. Suez, Ismailia; sites and services projects with or without core houses were outlined in their planning proposals. In addition the Agency for International Development (AID) is financing a housing development in Helwan for low income inhabitants, and core houses of different sizes are proposed. The World Bank also is financing several core houses projects for very low income inhabitants; two sites were chosen, one in Alexandria and the other in Assiut. In the CU/MIT research team, the members dealing with housing for the low income and informal sector outlined proposals for core house designs (see: "Interim Report Working Papers 1978") which were based on the study of the informal housing areas around Cairo, (see: "Interim Report Working Papers 1977" which includes a survey of 6 low income areas in Cairo). This wide range of designs - usually with the participation of outside expertise - provides a unique opportunity to study the use of the core house for the low income.

This paper compares and evaluates the core house design proposals in their context as a proper building type for low income people. A detailed assessment of their characteristics and an analytical review of their potentialities is undertaken. From each of the proposed core houses in Egypt two examples were selected from the forementioned planning, design, or research groups; one small lot situation and one large lot situation.

The 16 examples selected do not, by any means, represent all the types proposed but rather provide a similar or analogus sample in order to facilitate comparisons, while at the same time covering a wide range of the different design aspects. The ground floor and first or typical floor plans of the 16 core houses selected are included in Appendix A.

Economy plays a great role in core house design. It is the goal of the planner and designer.

Views may differ on methods of application whether it is for economy in the initial cost or the long term. But all should offer the most appropriate dwelling for low income inhabitants. The range for minimum expenses of low income may vary from one situation to another; from the lowest low income to middle low income. This may account for the wide range of differences that was apparent in some of the analysis results. But it also displays the potentialities of the core house, and points out that this dwelling type could be appropriate for a wide range of low income inhabitants.

CONCLUSIONS

1. Small plots do not necessarily mean cheaper infrastructure costs per built-up m^2, unless there is the possibility for future vertical expansion. Accordingly, there is a wide range of plot areas. The width is usually 6m; this is more consistent as it is one of the governing economical factors for infrastructure cost. Small plot areas average $54m^2$ and large ones $130m^2$.

2. Not withstanding the plot size, there is a marked trend to allocate about 30% of the initially built core unit.

3. The number of habitable rooms in the initial core is usually one room plus bath and cooking area, or kitchen. Usually, the core area in small plots is 15 or $20m^2$ but in larger plots it might go up to 30 or $40m^2$. This means that the initial cost paid by the public authorities covers a minimum of built area.

4. The location of the core unit at the front of the plot is the most logical solution for economic reasons. The cost of connecting pipe lines is minimized. Also from the urban point of view, a more unified facade is maintained, which also makes it more acceptable to politicians.

5. It is much more economical if the designer takes into consideration the importance of future growth of the core house, whether horizontal or vertical. The core house with its minimum habitable facilities is only "Phase I" in the process of urbanizing a residential area. Thus, the easier is the process of expansion, the quicker the owner would build in the future, and the quicker would be the growth of the area thus making full benefit of the costly initial infrastructure. In the long run it might be more economical to have larger plots than smaller ones, for the cost of infrastructure per family when the maximum contemplated built-up area is reached would be less for larger plots.

6. Flexibility of growth is closely tied with the construction. In skeleton construction if columns are placed shifted from the sides the building process for vertical expansion would be facilitated. Load bearing walls should not run parallel to the facade. This is in the case of the core occupying the full width of the plot. If the core is adjacent to one long side of the plot the duplication of bearing walls running the whole long length of the plot is avoided.

7. It is not enough to reduce the area of core unit for economy, the geometric shape of the core itself has a strong bearing on the wall surface necessary to enclose that space. One compact rectangular area is more economical than several combined rectangles.

8. The design of core unit which takes into consideration the possibility of vertical expansion of the habitable area as a separate entity (i.e., separate dwelling per foot floor) is much more economical in the future. This is assured by the proper placing of the staircase outside the dwelling unit on the ground floor, but not occupying the facade which is more appropriate for habitable rooms (see: "Interim Report Working Papers 1978").

9. For economic reasons, the kitchen and bath are sometimes placed at the front of the plot. This is not advisable as habitable rooms fronting on a street have far more value to the inhabitants. Not only should the kitchen and bath be placed adjacent to each other in the core, but also cores should be built as mirror images so that an economy in street man-holes could be maintaned.

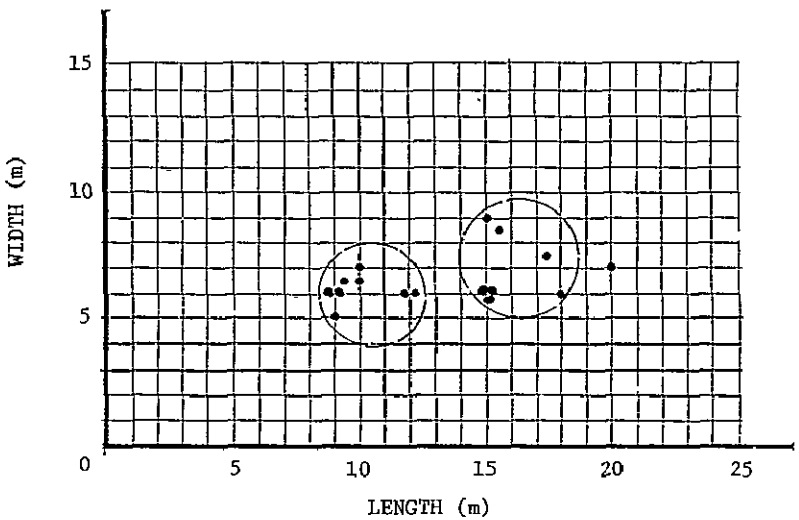


Figure 1: WIDTH/DEPTH RELATIONSHIP OF PLOT

It is evident that in all of the types proposed, plot lengths do not exceed 20 meters and width is not less than 9 meters. The range in width dimensions of the various plots of the 16 types are more limited (5 meters minimum - 9 meters maximum). Fifty percent of the plots are 6 meters in width, and eighty percent are between 6-7.50 m.

Plots proposed vary in area; while plot areas suggested by the World Bank in Assuit and MOH-AID in Helwan are quite small, those designed for the New Towns and the redevelopment areas in the Canal zone cities are much larger in contrast.

The small areas are approximately between 55 and 70 m^2, while the larger ones are between 90 and 130 m^2.

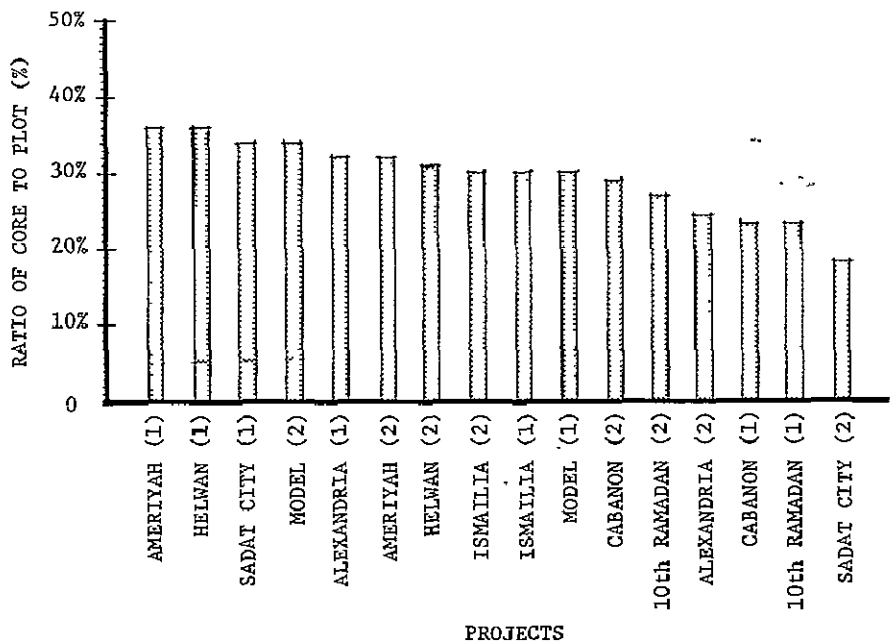


Figure 2: CORE AREA/TOTAL PLOT AREA RATIO

The design of the core itself - although composed of a few simple functional units - has many alternatives, except that in all of the 16 types the kitchen and bath are planned adjacent to each other.

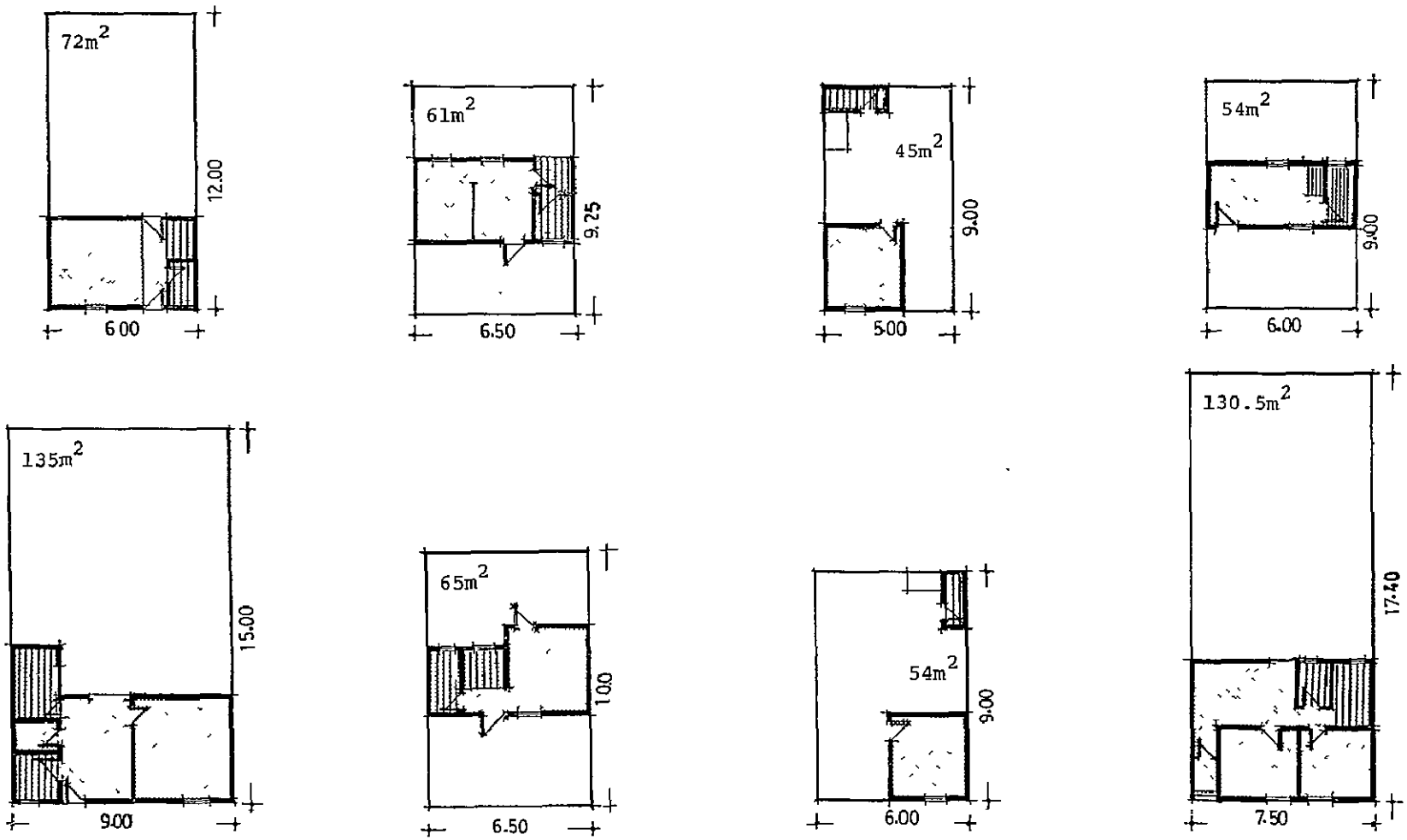
Notwithstanding the variety in plot dimensions and plot area, or the location of the core within the plot, the ratio of core area to total area of is 30% (ranging from 272-322), and in 75% of the types the ratio ranges from 27% to 36%.

Figure 3: LOCATION OF THE CORE ON THE PLOT AND NUMBER OF INITIALLY BUILT ROOMS

KEY: Habitable Room Kitchen + Bath

The 16 core house examples are drawn at the same scale, each with the plot. The habitable area is shown dotted, while the core service area (kitchen + bath) is shown hatched. The area of each plot is indicated and also the width and depth of the plot.

There is a large variation in the location of the



ISMAILIA DEMONSTRATION PROJECT

HELWAN NEW COMMUNITY (MOH-AID)

ASSUIT PROJECT (MOH-WORLD BANK)

PROPOSED MODEL

core on the plot, although in 50% of the cases the core is located at the front. The other locations are: slightly shifted from the front (Suez), in the middle (MOH-AID, Proposed Model), at the back (Sadat City), at the side (10th of Ramadan, Ameriyah) or even split having the room on the front and the core service at the back (Alexandria).

In all of the small plots only one habitable room serves all purposes. In the larger plots, a hall and one or two rooms are provided.

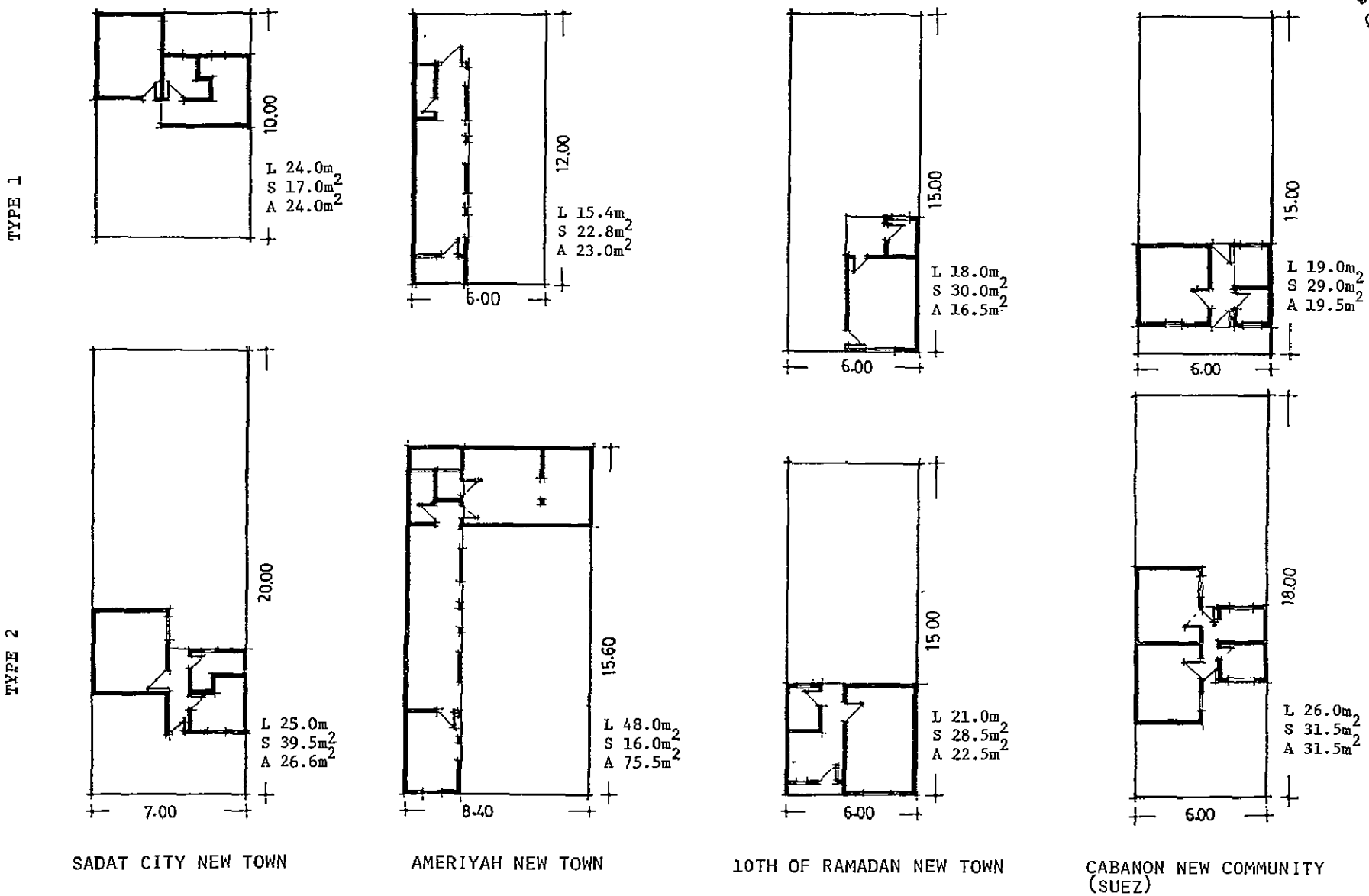
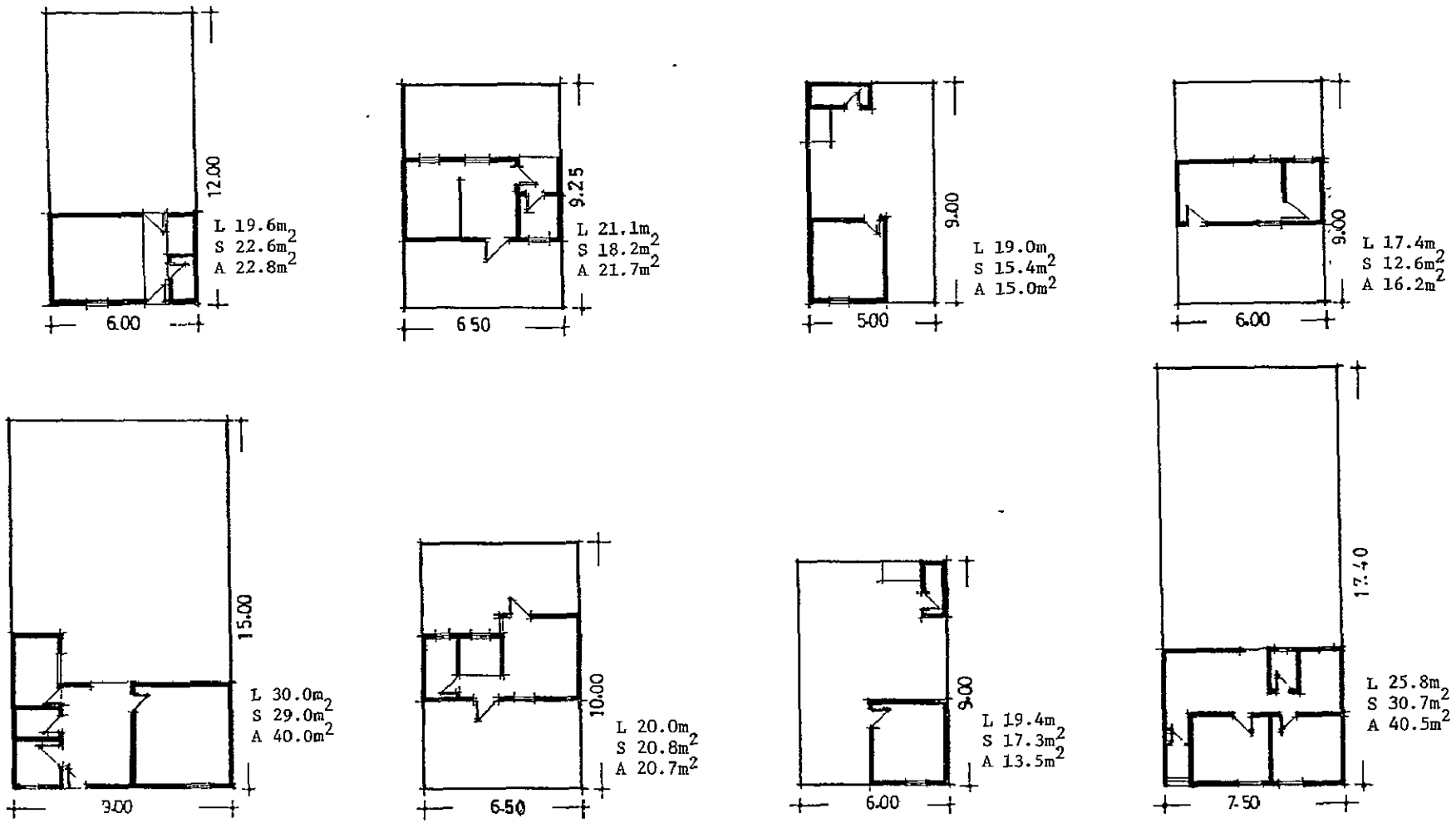


Figure 4: WALL AREA OF CORE

KEY:
L = outer wall length
S = outer wall surface area
A = core area

It is clear that the shape of the core affects the relationship between the surface area of its enclosing walls and the area of the enclosed space itself. Thus, for areas nearly equal but different in their geometric shapes, we find a difference in the surface areas of their outer walls. Also, for the same surface area of walls, we find



ISMAILIA DEMONSTRATION PROJECT

HELWAN NEW COMMUNITY (MOH-AID)

ASSUIT PROJECT (MOH-WORLD BANK)

PROPOSED MODEL

that it can enclose functional spaces of unequal area.

To illustrate, compare most World Bank Type 1 with the Proposed Model Type 1, having nearly the same core area of 15 m^2 and 16.2 m^2. We find that the first with a smaller area needs more enclosing outer surface walls (19 m x 3 m height = 57 m^2), while the second requires less (17.4 m x 3 m height = 52 m^2).

Also, comparing Sadat City Type 2 with the Proposed Model Type 2 both with the same outer wall length of 25 m, and an outer wall surface area of 75 m^2, we find the enclosed core area of the first 26.6 m^2, while the second has 40.5 m^2.

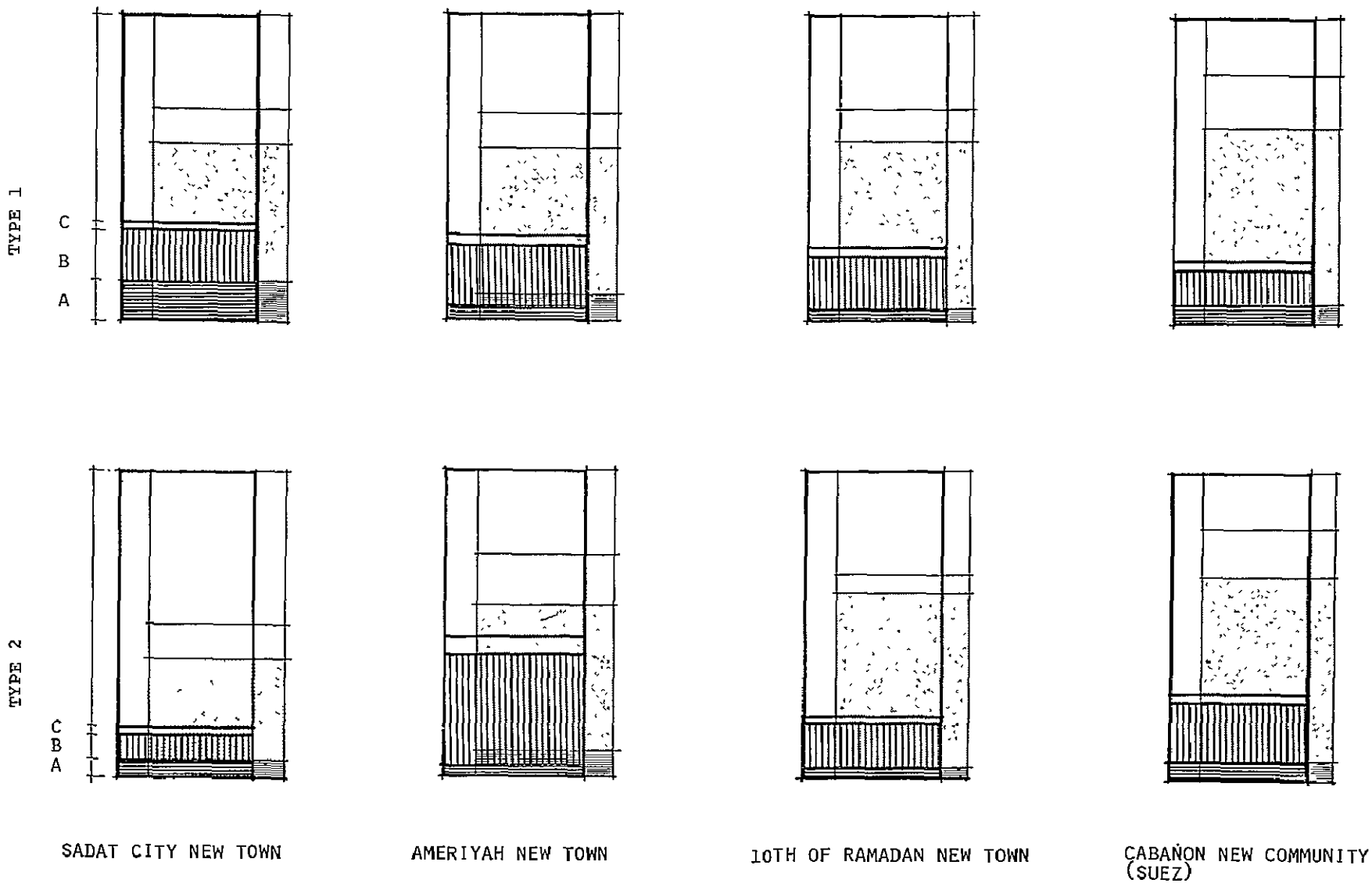
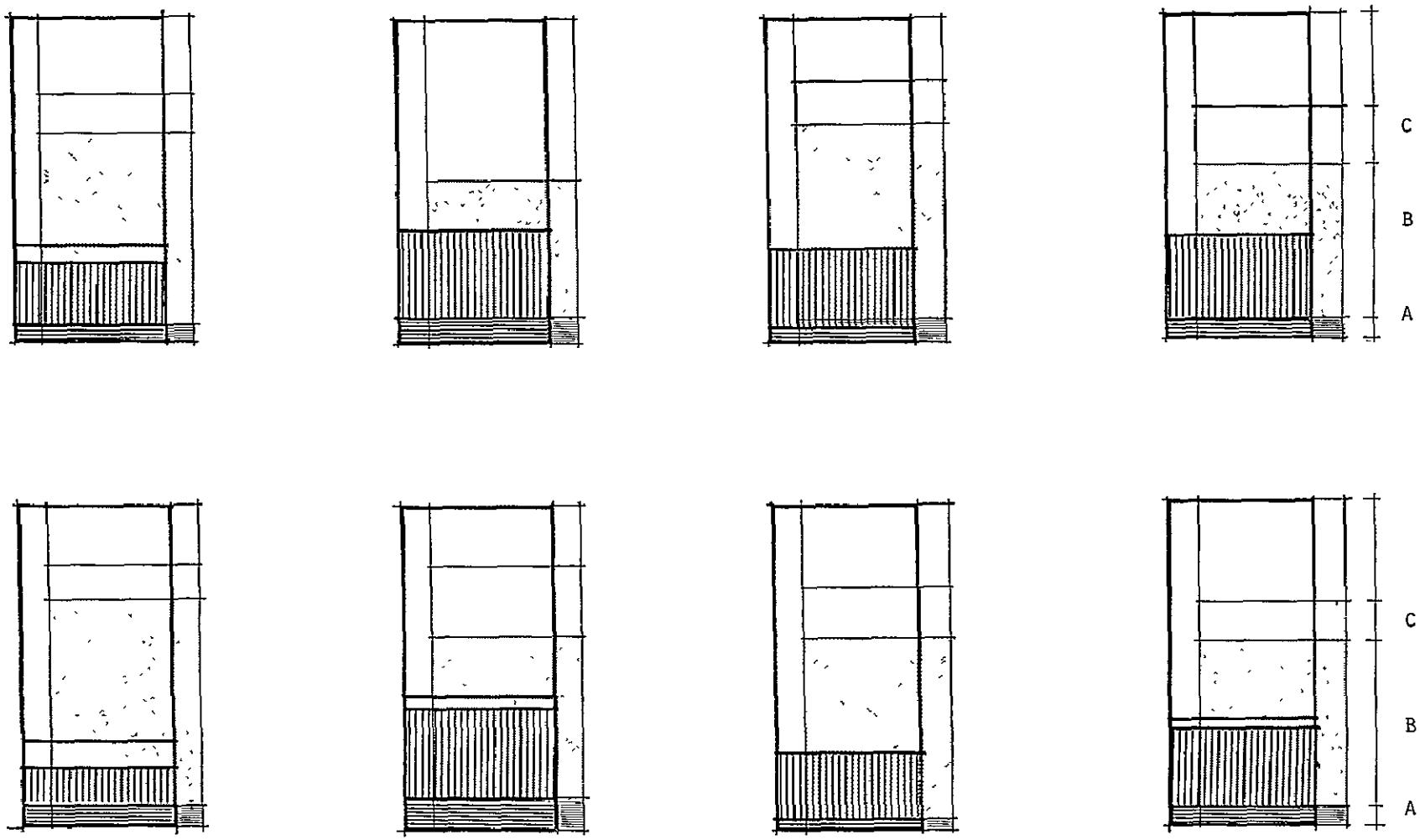


Figure 5: FUNCTIONAL RELATIONSHIP OF PLOT

The 16 examples are drawn in a uniform rectangle, representing 100% of the area, with their specific functions of core service A (hatched horizontally), habitable rooms B (hatched vertically), and circulation C (not hatched) drawn as a ratio to the total plot area in order to facilitate comparison. The offset rectangle illustrates the same functions (core service hatched horizontally, habitable rooms dotted) when full horizontal expansion is realized, i.e., when the ground floor is totally built.

In Type 1 the circulation area in the initial core



ISMAILIA DEMONSTRATION PROJECT

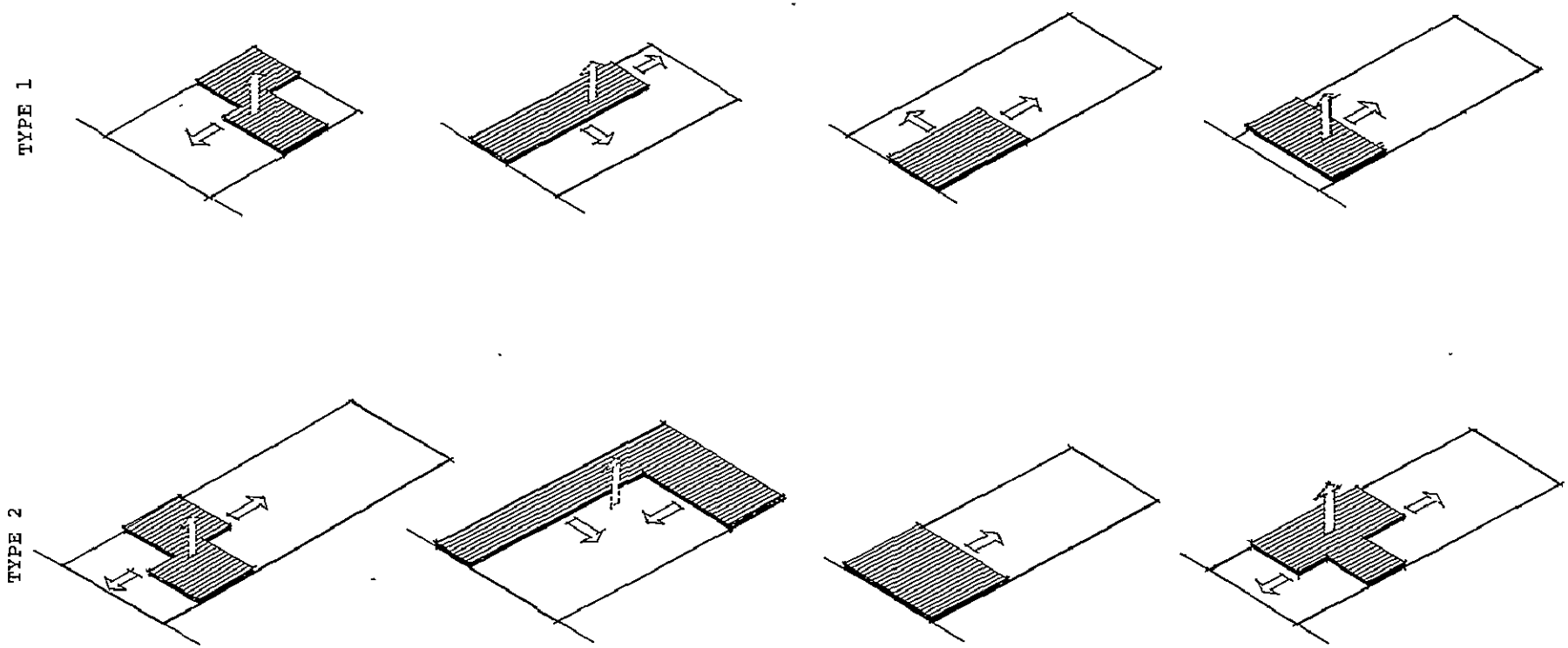
HELWAN NEW COMMUNITY (MOH-AID)

ASSUIT PROJECT (MOH-WORLD BANK)

PROPOSED MODEL

unit is negligible, and in 40% of the cases the circulation is either through the court of through the habitable room itself. There is a uniform pattern for allocation of functions within the plot except in Sadat City Type 1 which has a very large core area in comparison to habitable room. In Type 2 it shows the lowest intensity of use of the site which does not reflect the low income economy, which is quite in contrast to Ameriyah Type 2.

The area allocated to circulation for the ground floor in the finished phase is larger in some types than in others because of the space allocated for staircase access to the upper floors.

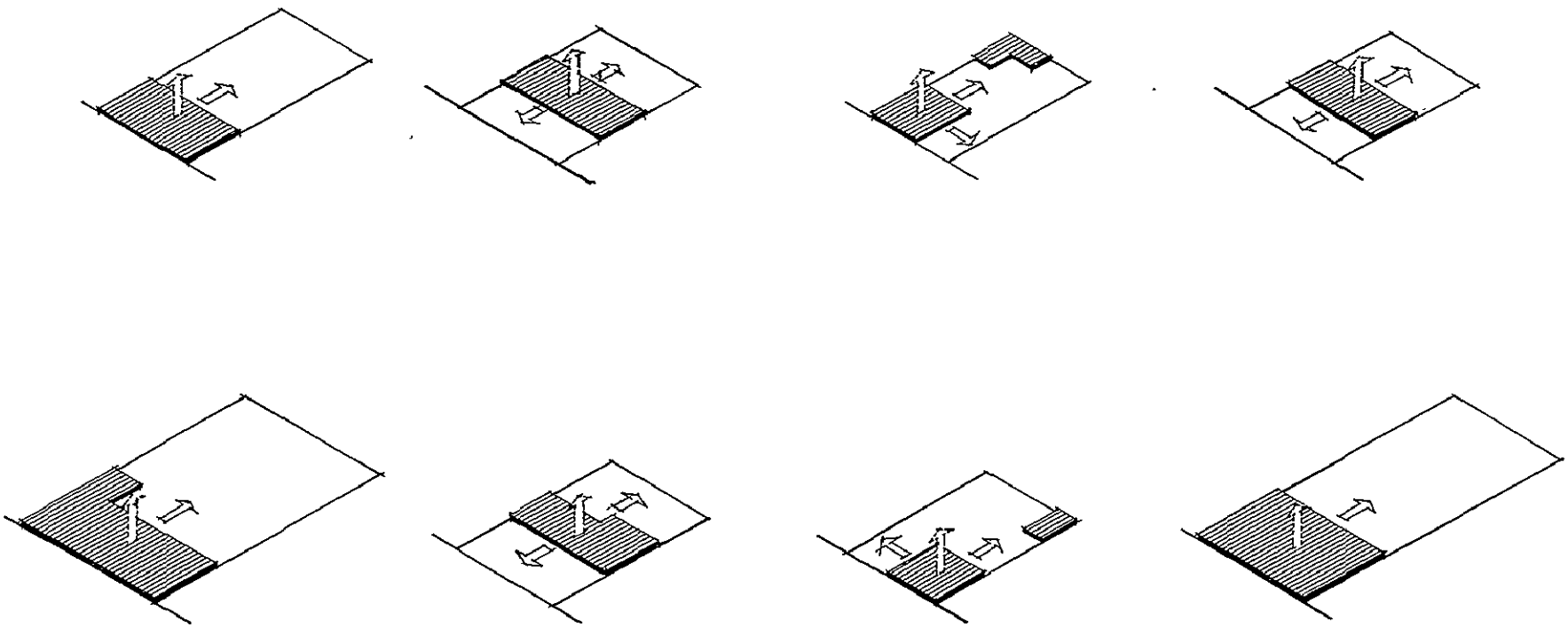


SADAT CITY NEW TOWN | AMERIYAH NEW TOWN | 10TH OF RAMADAN NEW TOWN | CABANON NEW COMMUNITY (SUEZ)

Figure 6: GROWTH FLEXIBILITY

The 16 examples are drawn in isometric form with continuous arrows indicating horizontal expansion and dotted arrows indicating vertical expansion.

The location of the core unit in the middle of the site offers several options and possibilities of expansion, while the location of the core at the front or at the back



ISMAILIA DEMONSTRATION PROJECT

HELWAN NEW COMMUNITY (MOH-AID)

ASSUIT PROJECT (MOH-WORLD BANK)

PROPOSED MODEL

offers one direction only for expansion.

The larger the width of the site the more flexible is future expansion. It offers many options and several varieties for expansion (see Proposed Model Type 2, Appendix A).

The more compact the core unit, the easier it is for future vertical expansion. In the MOH-World Bank Type 1 and 2 with a split core, vertical expansion is not a typical plan of the ground floor, it is on the front with a different location of core service (see Appendix A).

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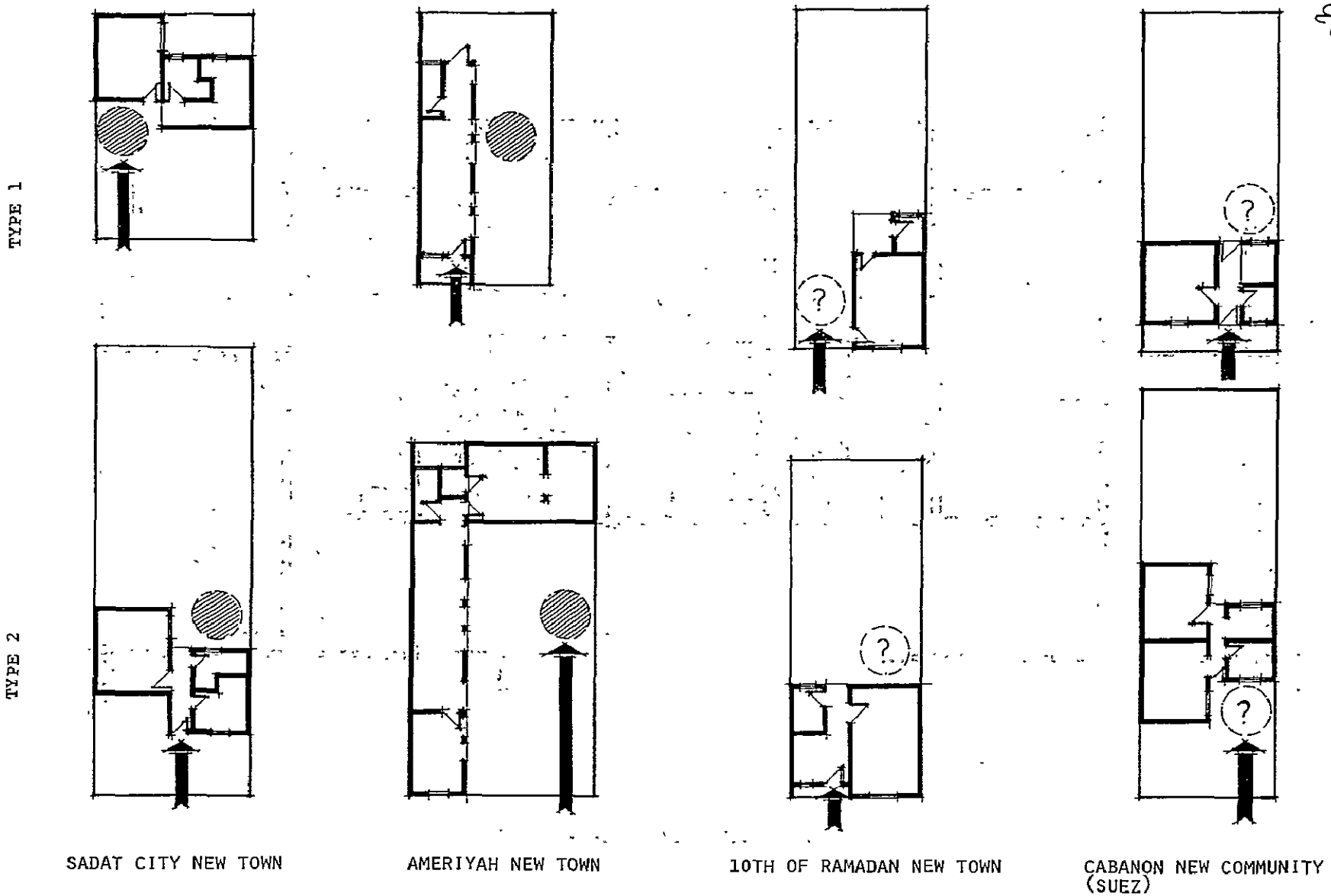
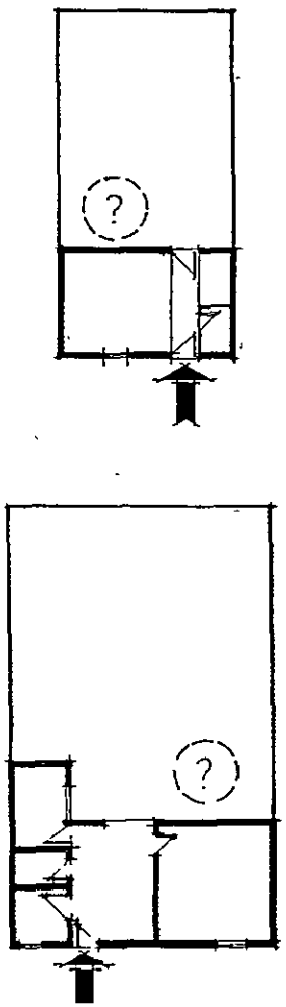


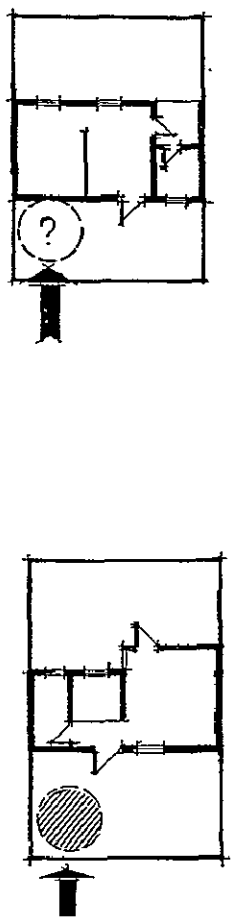
Figure 7: STAIR ACCESS TO UPPER FLOORS

The 16 examples are drawn with an indication of contemplated or possible staircase location (a hatched circle is drawn).

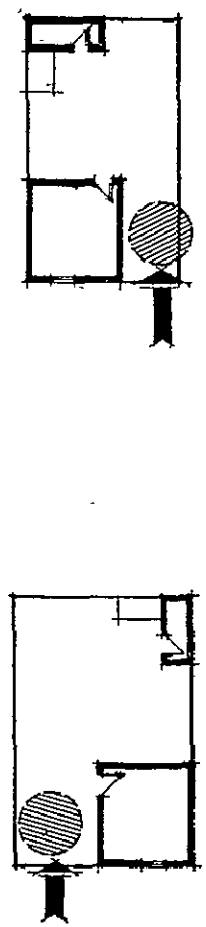
For possible (but not planned) staircase location a question mark within a circle is drawn. The black arrow indicates the entrance from the street.



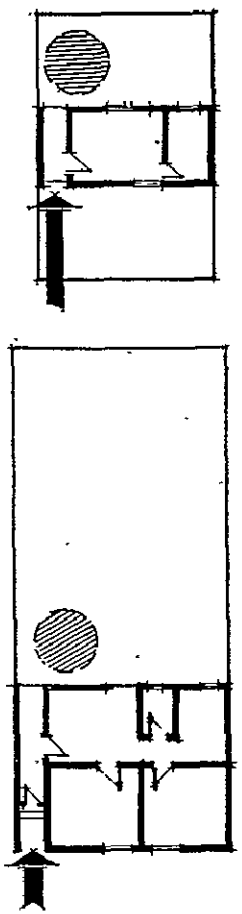
ISMAILIA DEMONSTRATION PROJECT



HELWAN NEW COMMUNITY
(MOH-AID)



ASSUIT PROJECT
(MOH-WORLD BANK)



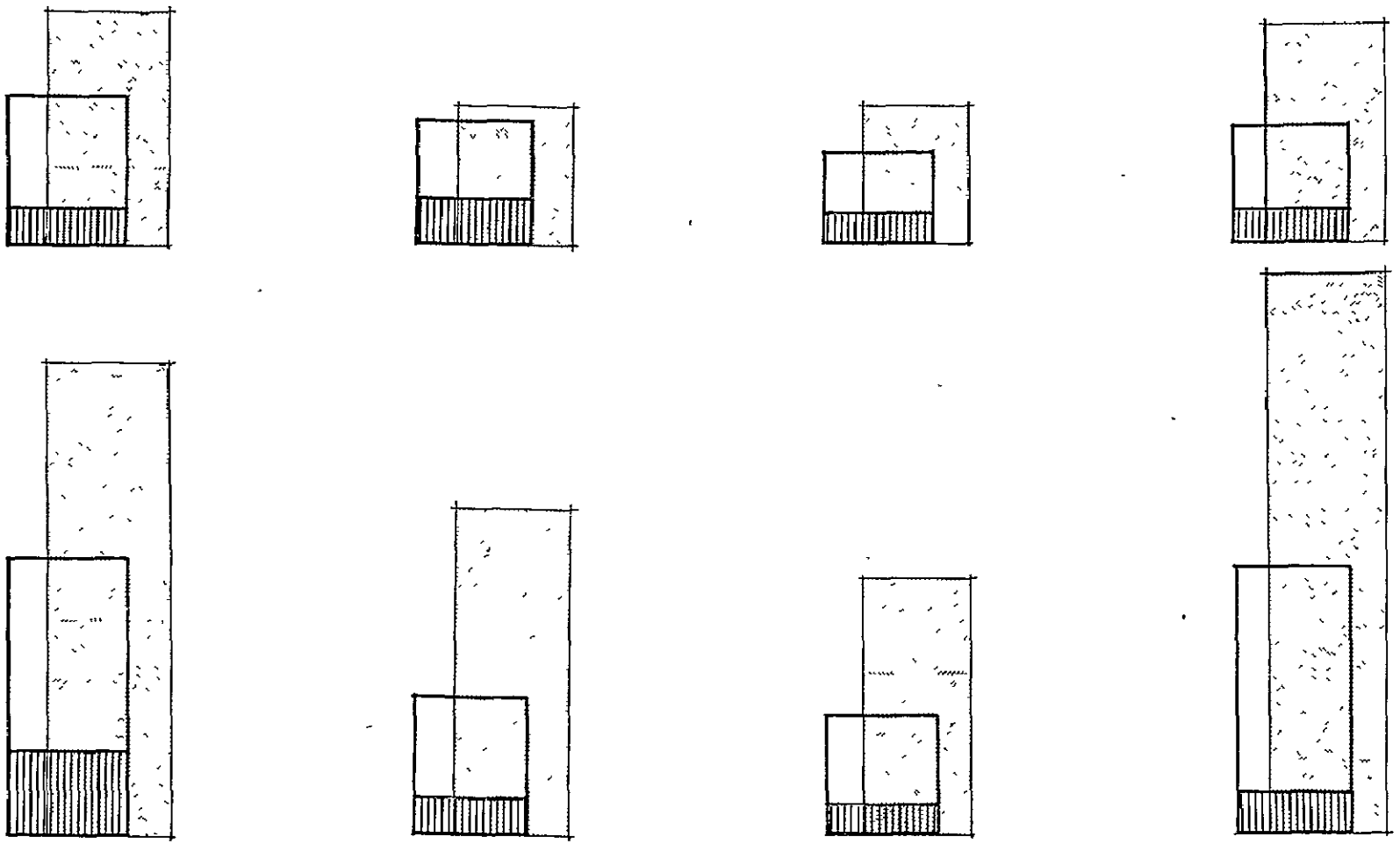
PROPOSED MODEL

It is obvious from the examples that some of the designs take into account the location of the staircase for future vertical expansion as a separate dwelling having a direct access from the street, while in others one crosses the core unit in order to reach the staircase. Thus privacy can not be maintained and vertical expansion would be a continuation of the same dwelling on the ground floor and not a separate dwelling, which would be used for rental purposes.

Figure 8: MAXIMUM DEVELOPMENT/INITIAL DEVELOPMENT RELATIONSHIP

The 16 examples are drawn in rectangles at a constant width while maintaining their true area for easier comparison. The initial core area is striped A, while the maximum contemplated built area is shown dotted B. The number of floors is written beside each rectangle.

It is evident that in Type 1, which has a small plot,



ISMAILIA DEMONSTRATION PROJECT

HELWAN NEW COMMUNITY (MOH-AID)

ASSUIT PROJECT (MOH-WORLD BANK)

PROPOSED MODEL

the finished area is rather small as it has a limited possibility of expanding vertically.

In 10th of Ramadan New Town, no vertical expansion is apparently contemplated.

In Type 2 there is a marked variety in the expected intensity of use of the site while in Ameriyah and in the Proposed Model maximum built-up is a ground floor + 3 floors, while the others only expect vertical expansion for one or two floors.

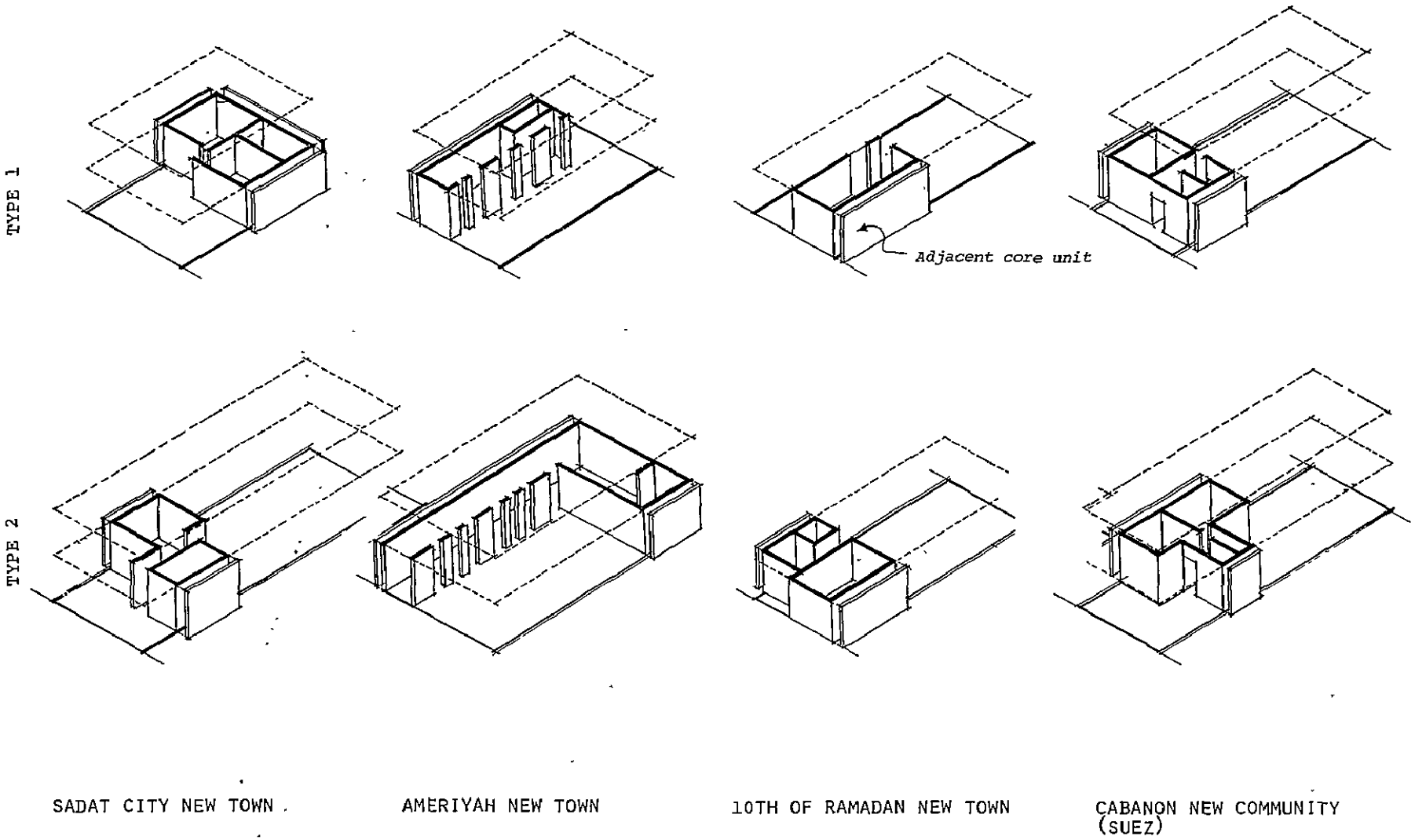
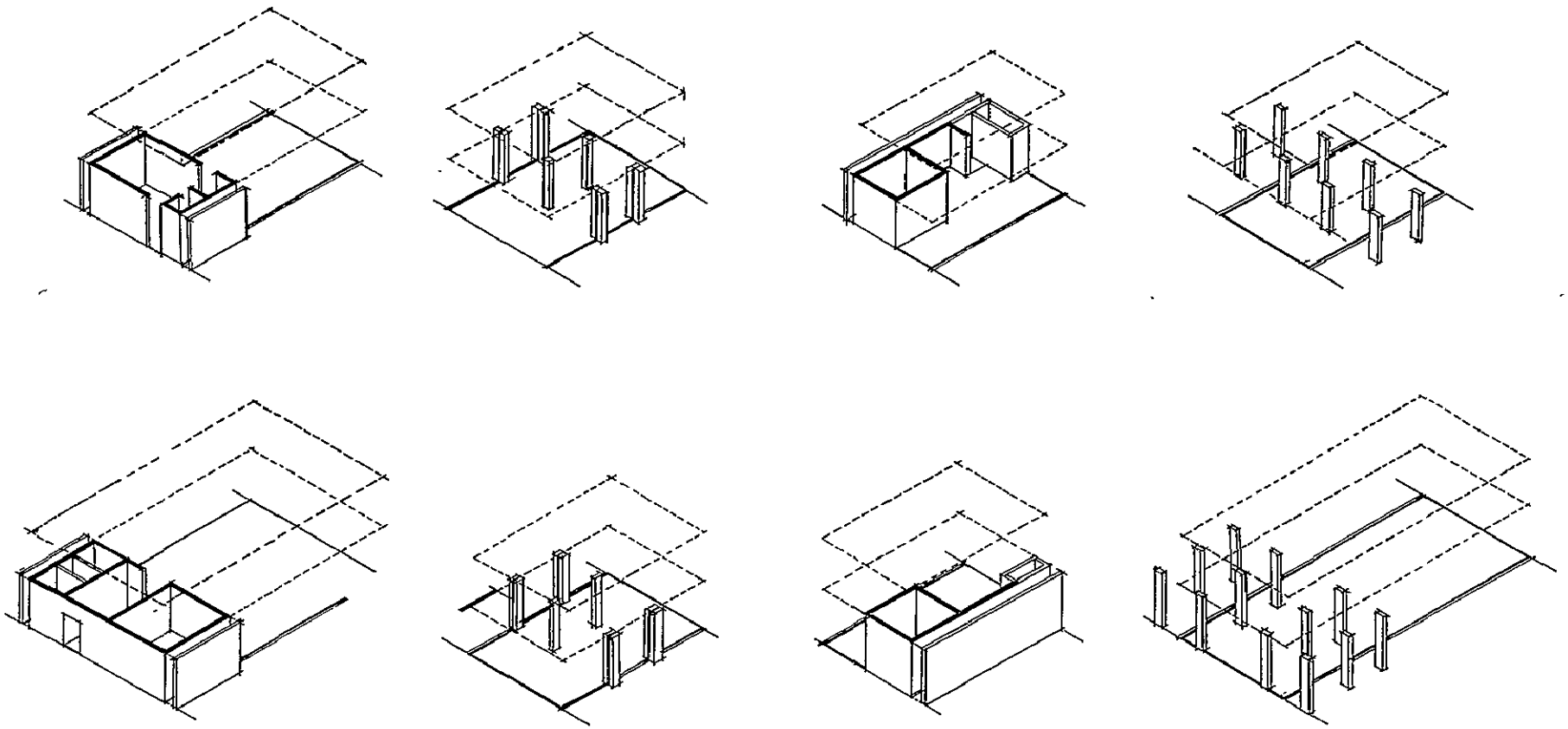


Figure 9: CONSTRUCTION

The 16 examples are drawn isometrically showing their construction.

1. Load bearing walls, which are found in the majority.
2. Skeleton construction, MOH-AID, and in the Proposed Model
3. Prefabricated load bearing walls, in Ameriyah New Town.



ISMAILIA DEMONSTRATION PROJECT

HELWAN NEW COMMUNITY (MOH-AID)

ASSUIT PROJECT (MOH-WORLD BANK)

PROPOSED MODEL

It is inherent in the idea of core house that the owner will eventually expand his dwelling horizontally, and also vertically as proposed in many of the types.

If the columns are slightly shifted inside the site in the skeleton type, the owner can easily expand vertically and the number of columns are reduced from 3 in a row to 2 in a row. Thus, reducing the total number from 9 to 6 reinforced concrete columns (see Proposed Model Type 1 and 2). This, of course, is dependent on the structural requirements of the width of the lot. Moreover, the width is critical to ensure that columns do not penetrate rooms, or in other awkward positions.

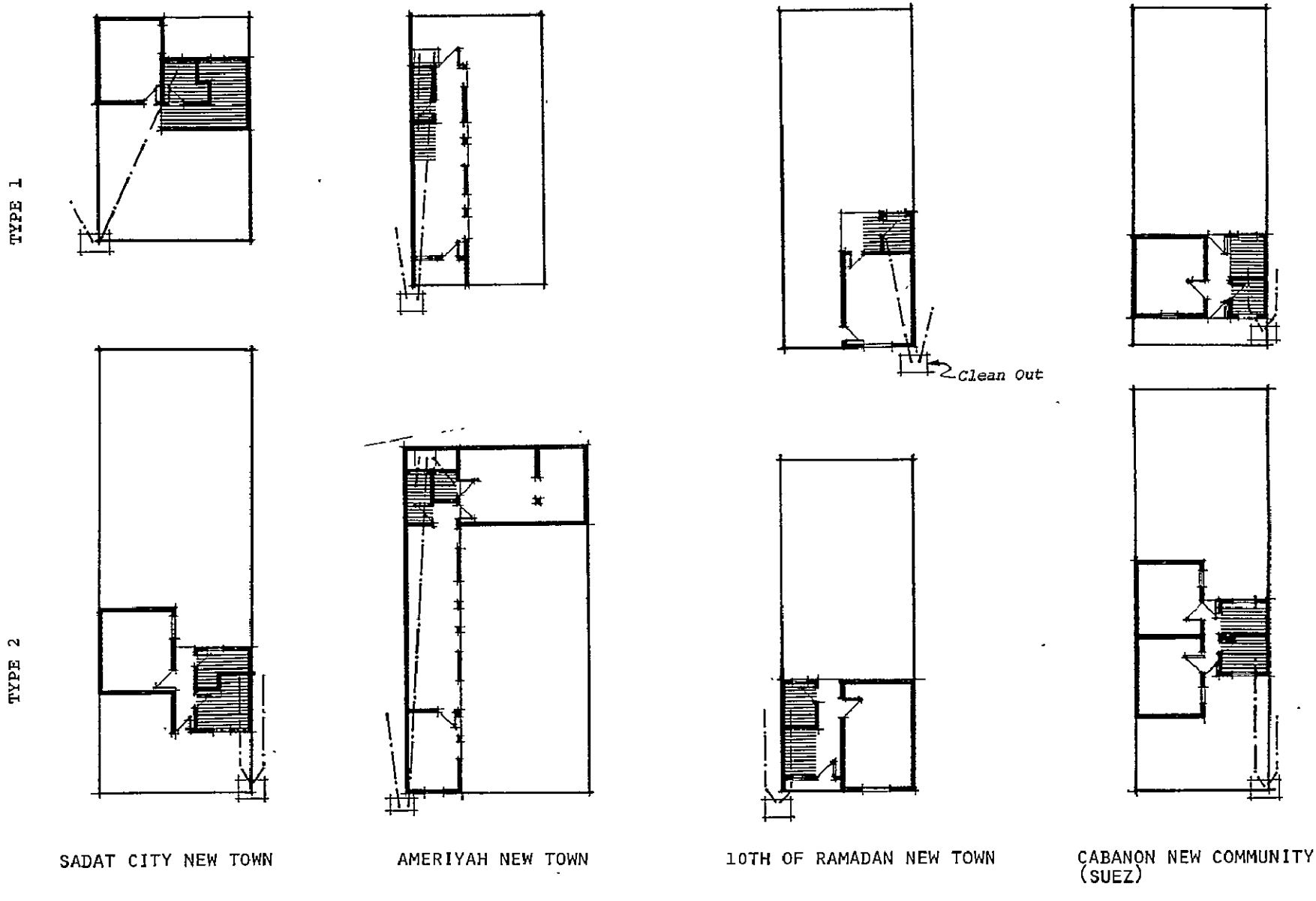
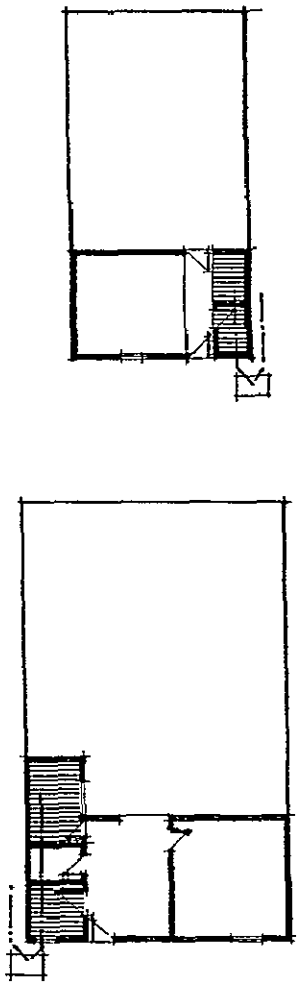


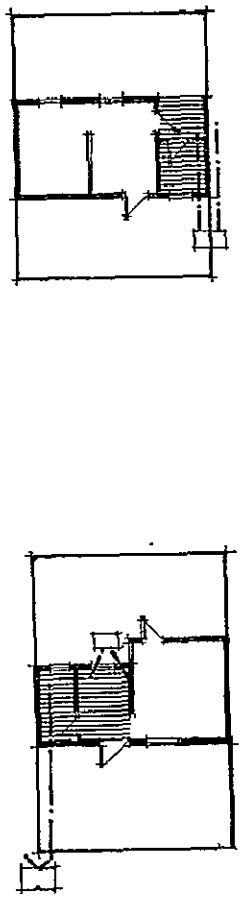
Figure 10: UTILITIES/SEWAGE

The 16 examples are drawn with their core service (bath + kitchen or cooking space) hatched horizontally. Note that the location of the core service within the plot has a direct bearing on the construction length of plumbing lines.

- Core service at the front of plot: piping is minimum

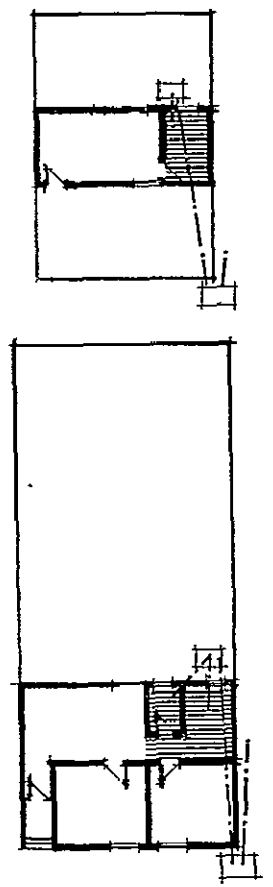


ISMAILIA DEMONSTRATION PROJECT



HELWAN NEW COMMUNITY (MOH-AID)

ASSUIT PROJECT (MOH-WORLD BANK)



PROPOSED MODEL

and simple. It is connected directly to the main pipes in the street.
- Core service within the middle part of the site: piping is longer; they are laid through courts or entrances (MOH-AID Type 2, Sadat City Type 1, Suez Type 2), or they are laid under the already built habitable room (10th of Ramadan Type 2, Proposed Model Type 1,2). This is to avoid the area anticipated for future construction.
- Core service at the back: Long pipe lines pass under habitable areas and connect to the main street system (Ameriyah Type 1,2), or connect to pipes in easements running along the back of the plots (MOH-AID Type 1,2).

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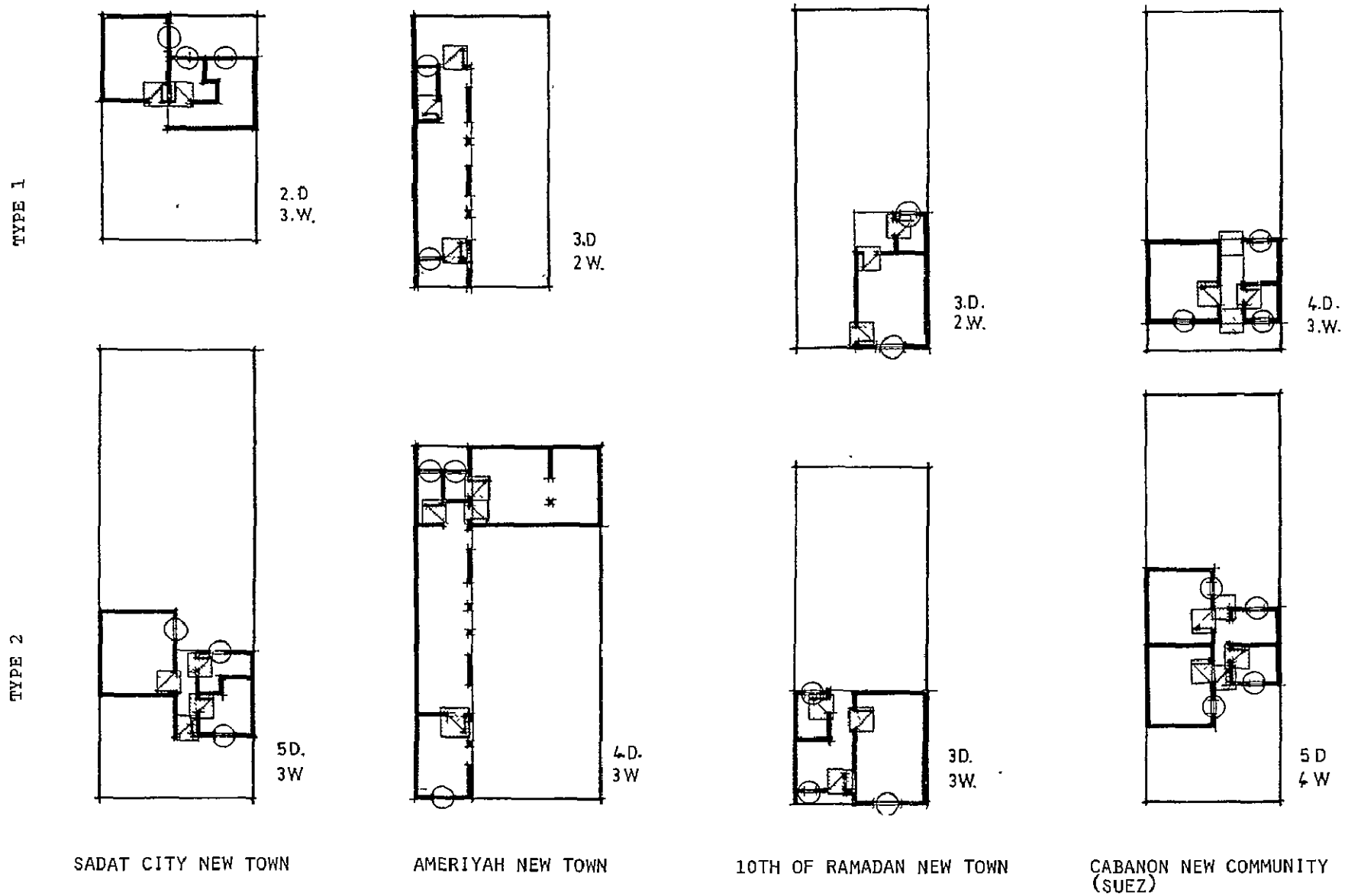
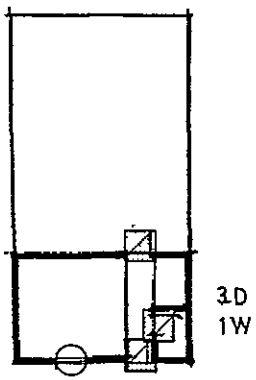
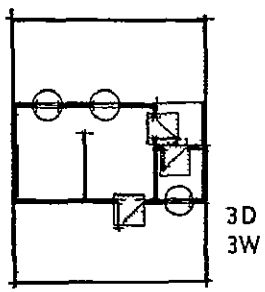


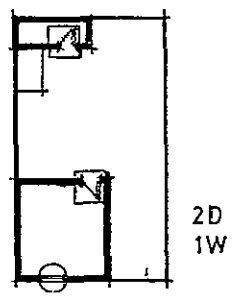
Figure 11: NUMBER OF DOORS AND WINDOWS

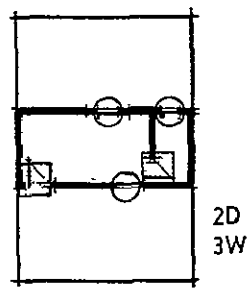
The 16 examples are drawn with the doors indicated by squares and the windows by circles.

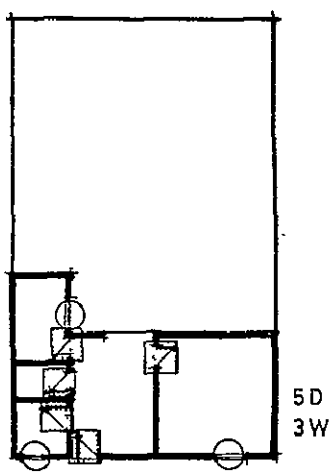
There is a wide variety in the number of doors and windows allocated within each type. MOH-WB Type 1,2 are the most economical but the bathrooms do not have a window, relying on ventilation through the door. Sometimes cooking



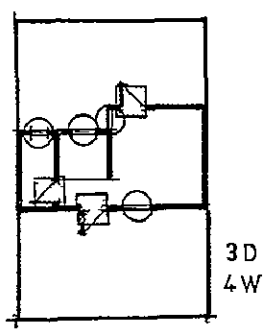




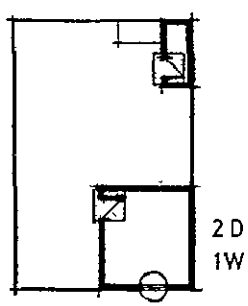




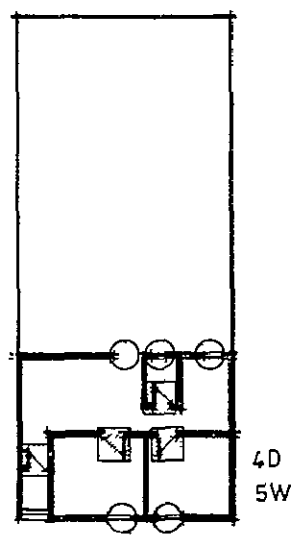
ISMAILIA DEMONSTRATION PROJECT



HELWAN NEW COMMUNITY
(MOH-AID)



ASSUIT PROJECT
(MOH-WORLD BANK)



PROPOSED MODEL

is done under shelter in the open court, i.e., no walls, doors aor windows are necessary as in MOH-WB Type 1,2, 10th of Ramadan Type 1, MOH-AID Type 1.

Sometimes cooking is undertaken within the habitable area or adjacent to it as in Ismailia Type 1, Proposed Model Type 1, Ameriyah Type 1. Mostly the kitchen occupies a special space and is not closed by a door.

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INTRODUCTION: VERTICAL CORE HOUSING

In the planning for rebuilding Port Said after the 1973 war limited sites appropriate for low income housing projects were available. In addition, soil conditions were generally poor and required expensive foundations. A site adjacent to surrounding lake was finally chosen. For lowering expenses, a core house "apartment type" was designed instead of the core house "plot-type". Essentially, this type is a semi-finished structure: Floor slabs and a central stairway and utility core are completed, but further internal divisions and the outside walls are built by the users as desired.

Previous research (see"Interim Report Working Papers 1978") has also proposed core house apartment type which has a flexible plan and could eventually accommodate apartments of different sizes, expanding from a central service core (Appendix B). This model is also included to show another variation of the same approach with a more generous (higher cost) design.

A detailed assessment of the characteristics and an analytical review of the potentialities of the vertical core house follows, in order to point out the differences between core house "apartment type" and core house "plot type".

CHARACTERISTICS OF VERTICAL CORE HOUSING

1. The economic argument against using core houses is the alleged high initial cost of infrastructure compared to the low density of inhabitants of the initial phase in the development. "Core House" apartments could be the answer. The core unit is the only finished area in the 4 story building, and the users expand as needed, within the floor area limitations.

2. Unkept waste land between blocks in the usual public dwelling types is avoided.

3. Horizontal flexibility of expansion is maintained for each owner.

4. Contemplated non-built area could vary in the same building, thus giving a variety of different dwelling sizes.

5. The design pattern of the apartment buildings could generate variable layout designs, these could create more individual identifiable communal spaces. They also could be planned in sites of different areas and proportions. Their flexibility to adapt to many patterns of layout is contrary to the usually rigid pattern applied in public housing layouts of paralleled and perpendicular thin, slab blocks.

6. Construction could be by any structural methods, traditional = skeleton or load bearing, or prefabricated columns or walls and ceilings in factories or on site, i.e., tunnel form, etc.

7. Cost per dwelling is more reduced than in the core house by the increased sharing of the users, i.e. stairs, walls, and water and sewage networks.

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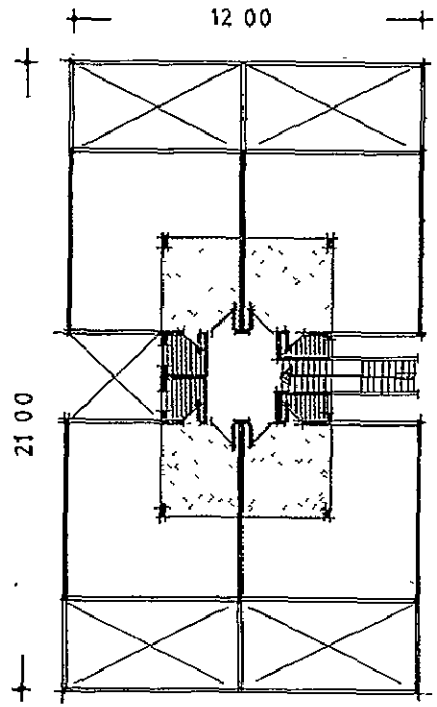
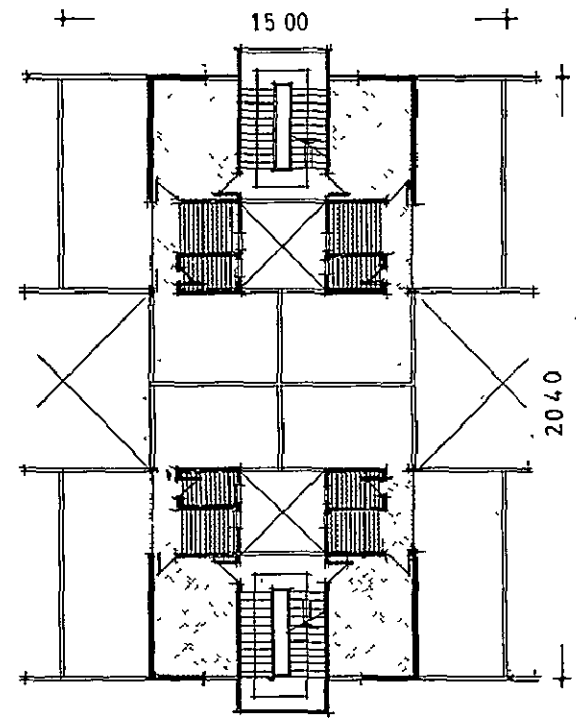


PORT SAID PROJECT



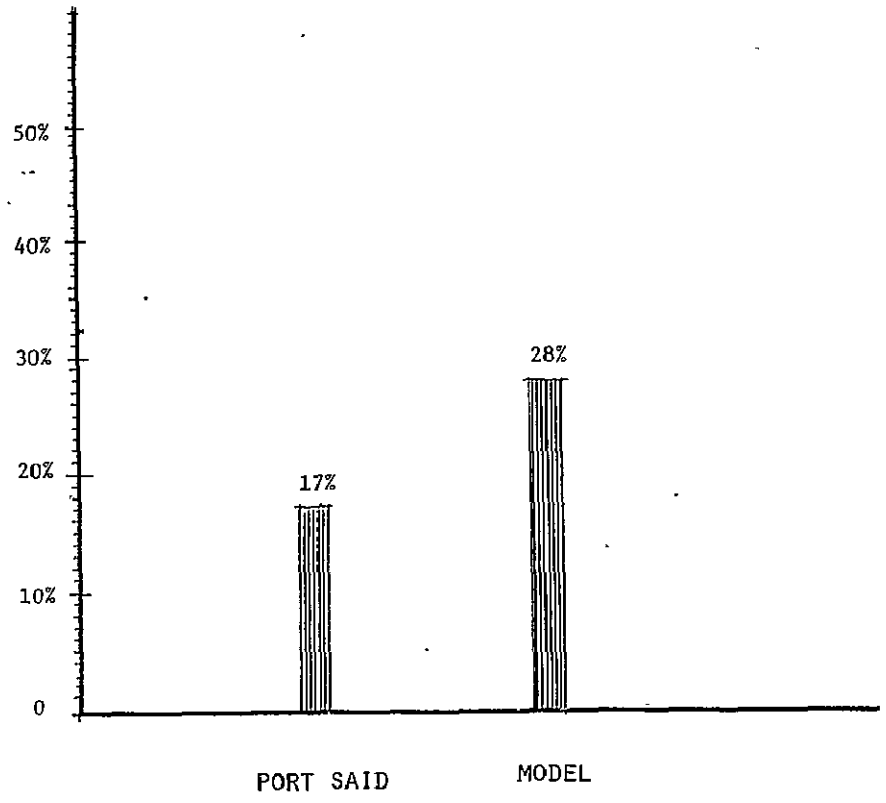
PROPOSED

Figure 1: CHARACTERISTICS

The two types are drawn the location of the core within the built-up area. Both cores are located near the stair entrance.

The number of habitable rooms are one in both cases. The Port Said design has just a roof shelter over a room. The Proposed Model has an enclosed space with 2 doors and a window.

The area of core for the Port Said design in 11.25 m^2 and in the Proposed Model it is 21.6 m^2. The Port Said design does not include a kitchen, cooking could be done under the shetlered roof within the habitable area or on the open roof. Outer walls are 24 x 3 = 72 m^2 for the Proposed Model while in the Port Said design it is only 15 m^2. This is due to the habitable room having two open sides without walls.



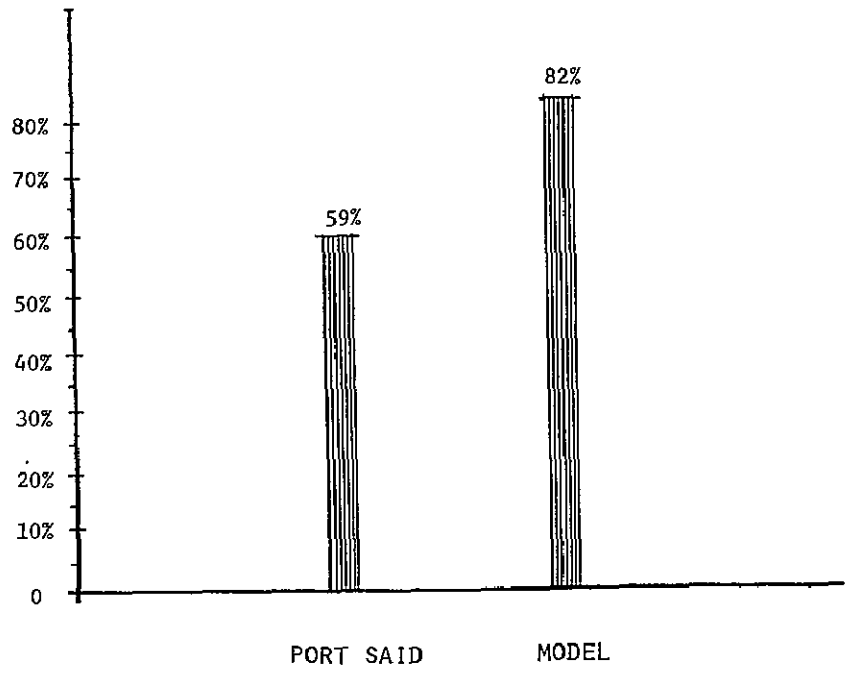


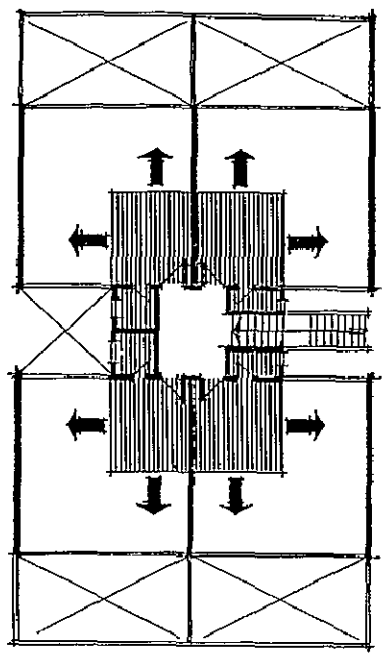
Figure 2: CORE AREA/TOTAL AREA RATIO

The area of the core is drawn as a ratio to the area of the plot; i.e., Port Said 12 x 21 = 252 m^2 divided by 4 = 63 m^2. Area of core = 11.25 m^2

Ratio = $\frac{11.25}{63}$ x 100 = nearly 18%, and in the Proposed Model, 28%.

The latter is more in accordance with the core house plot type.

305



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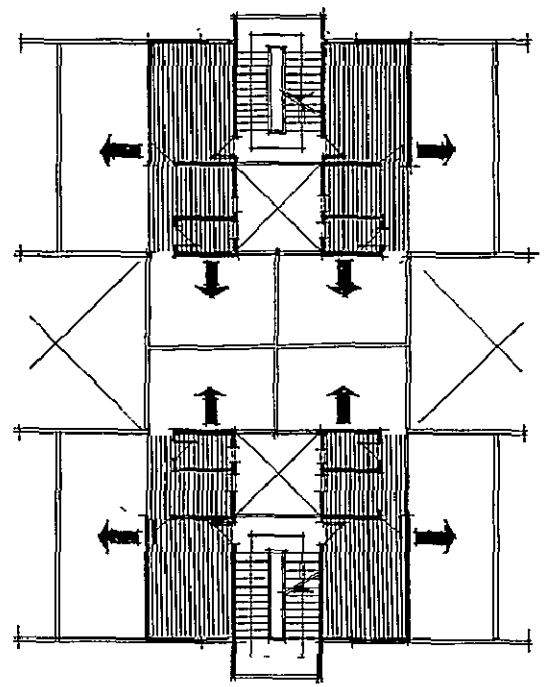
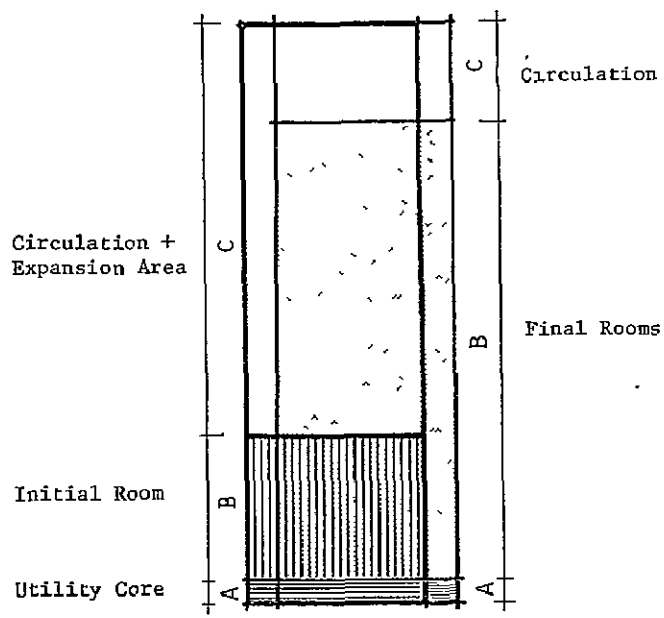


PROPOSED MODEL

Figure 3: FLEXIBILITY OF GROWTH

The two types are drawn indicating the possibilities of horizontal expansion as shown by the arrows.

Both can expand in two directions, but the amount of expansion is limited in the Port Said design and quite variable in the Proposed Model. (See Appendix B)



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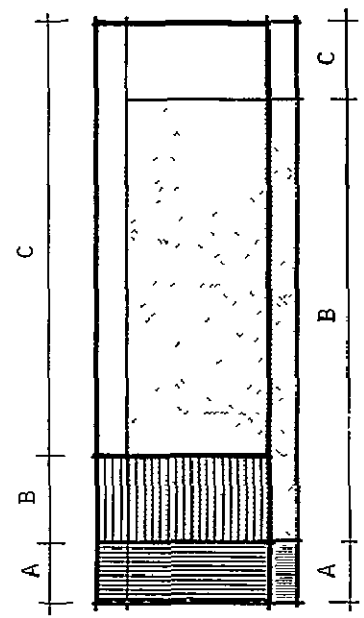
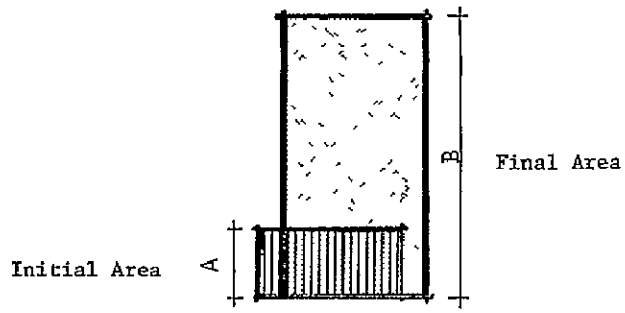


PROPOSED MODEL

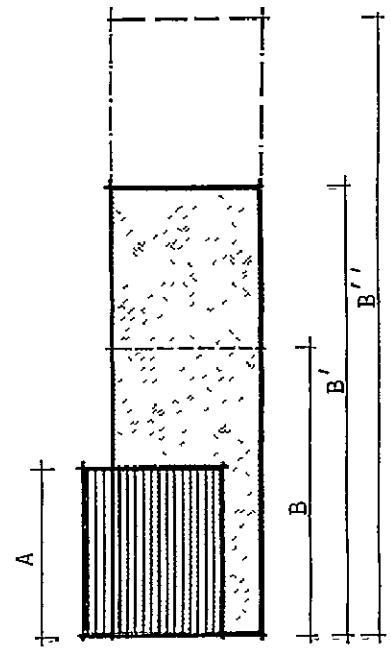
Figure 4: ALLOCATION OF AREAS TO SPECIFIC FUNCTIONS

The total built-up area is drawn as a rectangle representing 100%, indicating core service (hatched horizontally), habitable room (hatched vertically when representing core, and dotted when representing the final dwelling in the shifted rectangle), and circulation.

The area of core service is larger in the Proposed Design than in the Port Said design as the latter does not include a separate space for a kitchen. The ratio of core service area when compared to the finished dwelling is more reasonable in the former proposal.



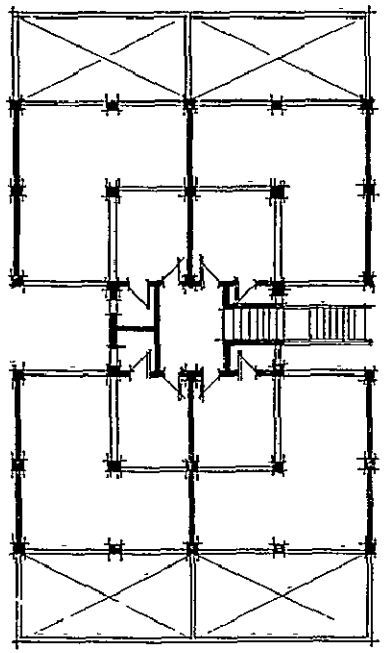
PORT SAID PROJECT



PROPOSED MODEL

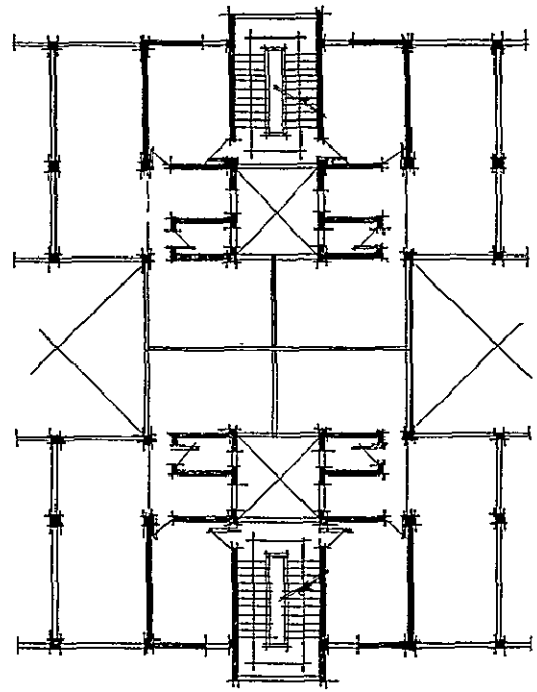
Figure 5: MAXIMUM BUILT AREA

The area of the core, in both of the two types, is drawn as a rectangle hatched vertically, having the same width for easy comparison, while the finished core is drawn in a shifted dotted rectangle. In the Proposed Model the maximum built area at completion shows three different areas. This is because flexibility is inherent in the design concept, thus offering different possibilities of expansion.



O 18
P 21
A 11.25

PORT SAID PROJECT



O 24
P 20.85
A 21.6

PROPOSED MODEL

Figure 6: CONSTRUCTION

The two types are drawn showing their construction. Both are of skeleton type construction. The regular grid with 3 meter spans of the Proposed Model could easily be adopted to load bearing walls, in which case the flexibility of different design alternatives for expansion would be limited. Prefabricated wall panels could also be used or even the tunnel form type of construction system.

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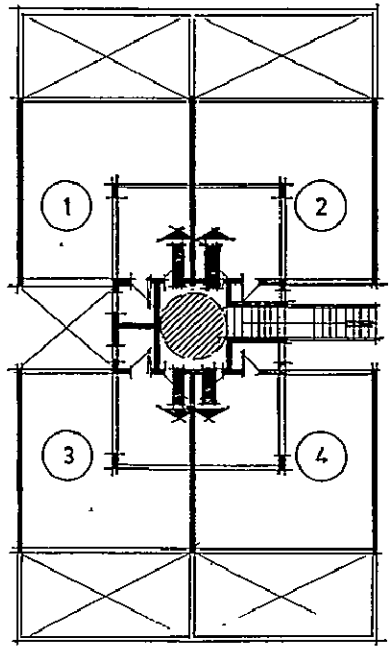

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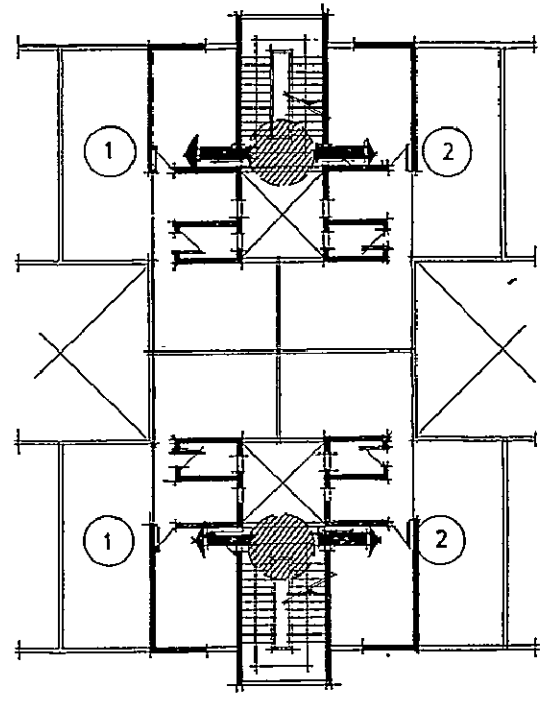
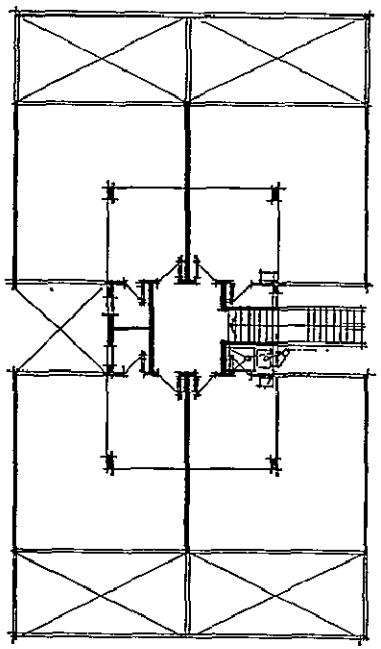


PROPOSED MODEL

Figure 7: STAIRCASE ACCESS

The plans are drawn showing the stairs with their access to the flats. In the Port Said design, the staircase gives access to 4 separate dwelling units. In the Proposed Model each staircase gives access to 2 dwelling units only, but in the first example the staircase can only reach one floor so each stair case serves only one level or 4 individual dwellings while in the Proposed Model it can serve 3 or 4 floors.



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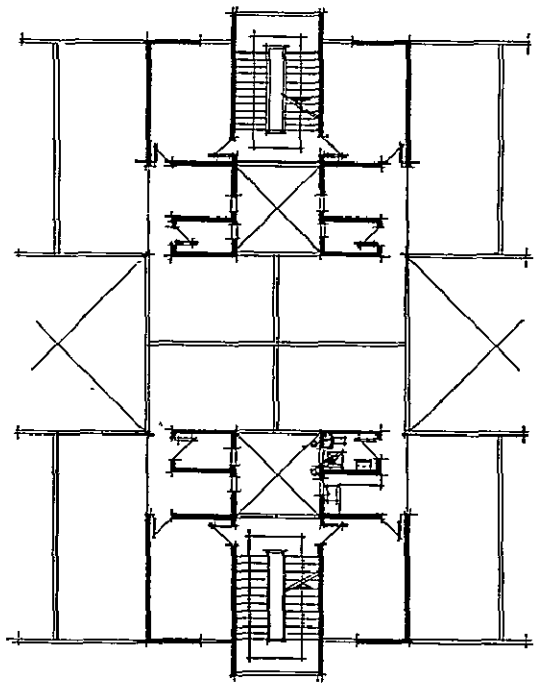
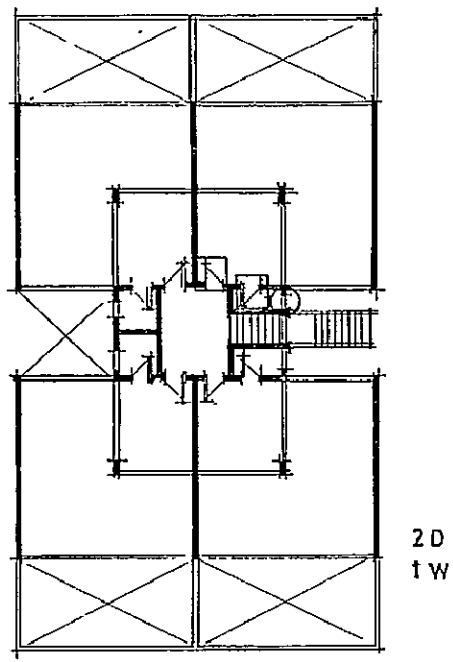


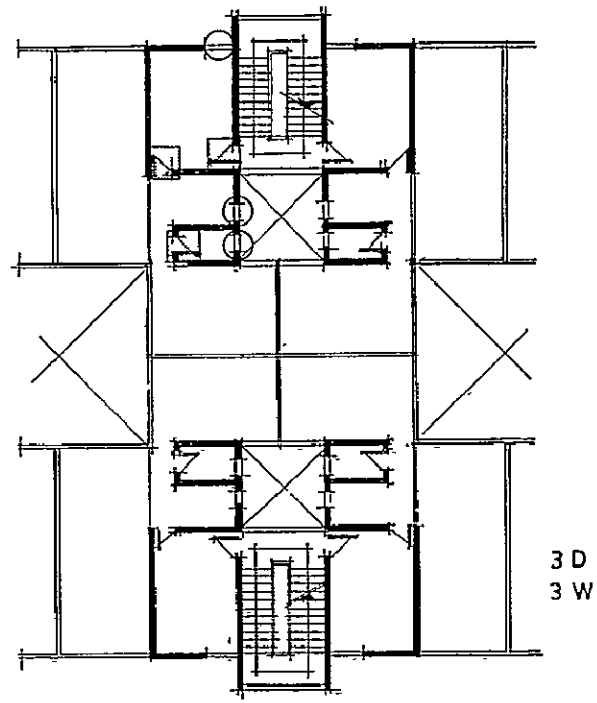
PROPOSED MODEL

Figure 8: UTILITIES

The two types are drawn showing their sanitary fixtures and plumbing within the flat and the main pipe lines for waste. The distance to the manhole in the street is essentially the same for both cases.



PORT SAID PROJECT



PROPOSED MODEL

Figure 9: DOORS AND WINDOWS

The two types are drawn showing their doors by squares and the windows by circles. In the Port Said design the number of doors and windows are less than the Proposed Model as the habitable room has no walls but just a roof. Only the bath room is closed by a door and window.

APPENDIX A

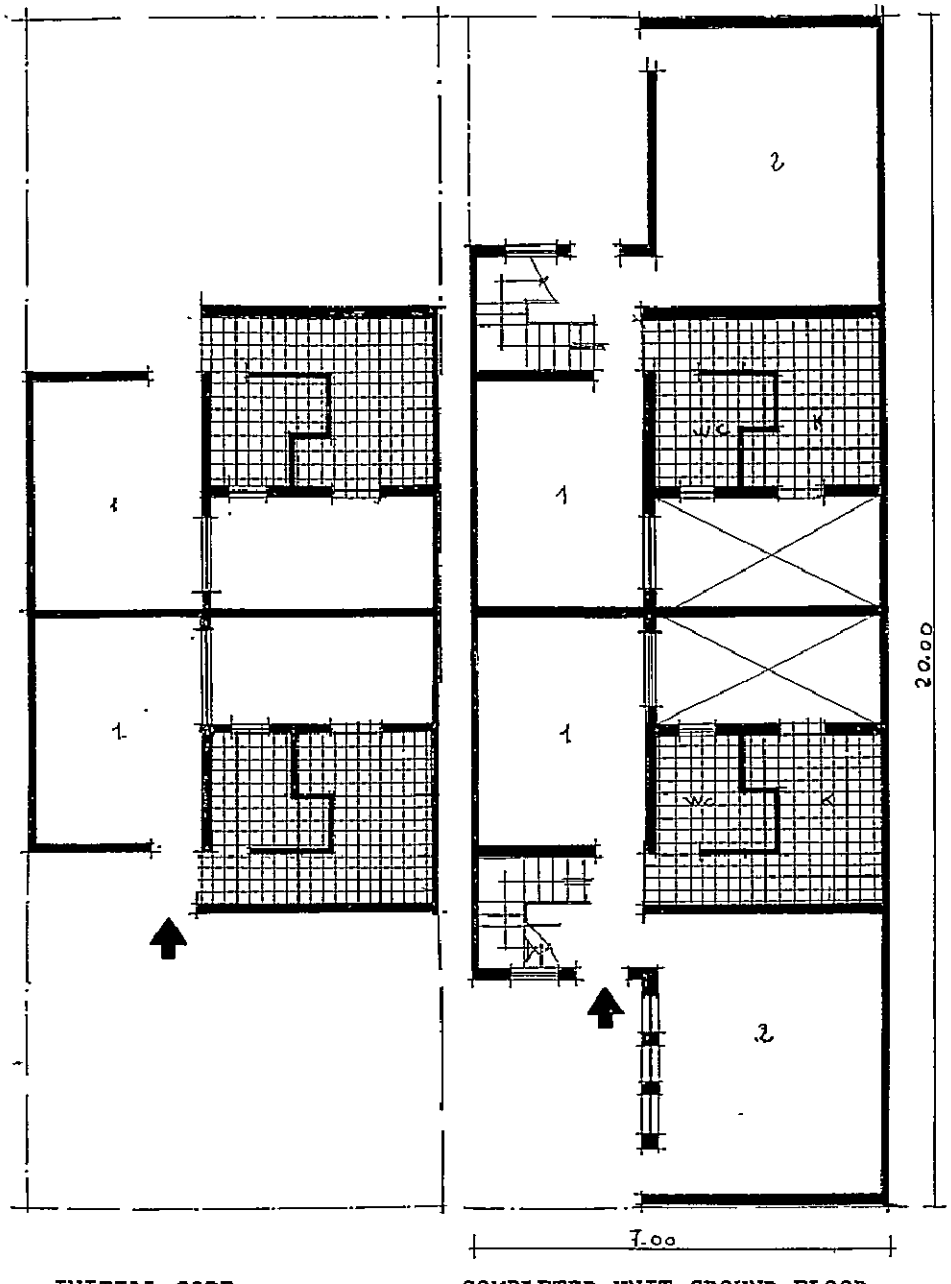
Core House Units:

Sadat City New Town
Ameriyah New Town
10th of Ramadan New Town
Cabanon New Community (Suez)
Ismailia Demonstration Project
Helwan New Community (MOH-AID)
Assuit Project (MOH-World Bank)
Proposed Model

Vertical Core House Units:

Port Said Demonstration Project
Proposed Model

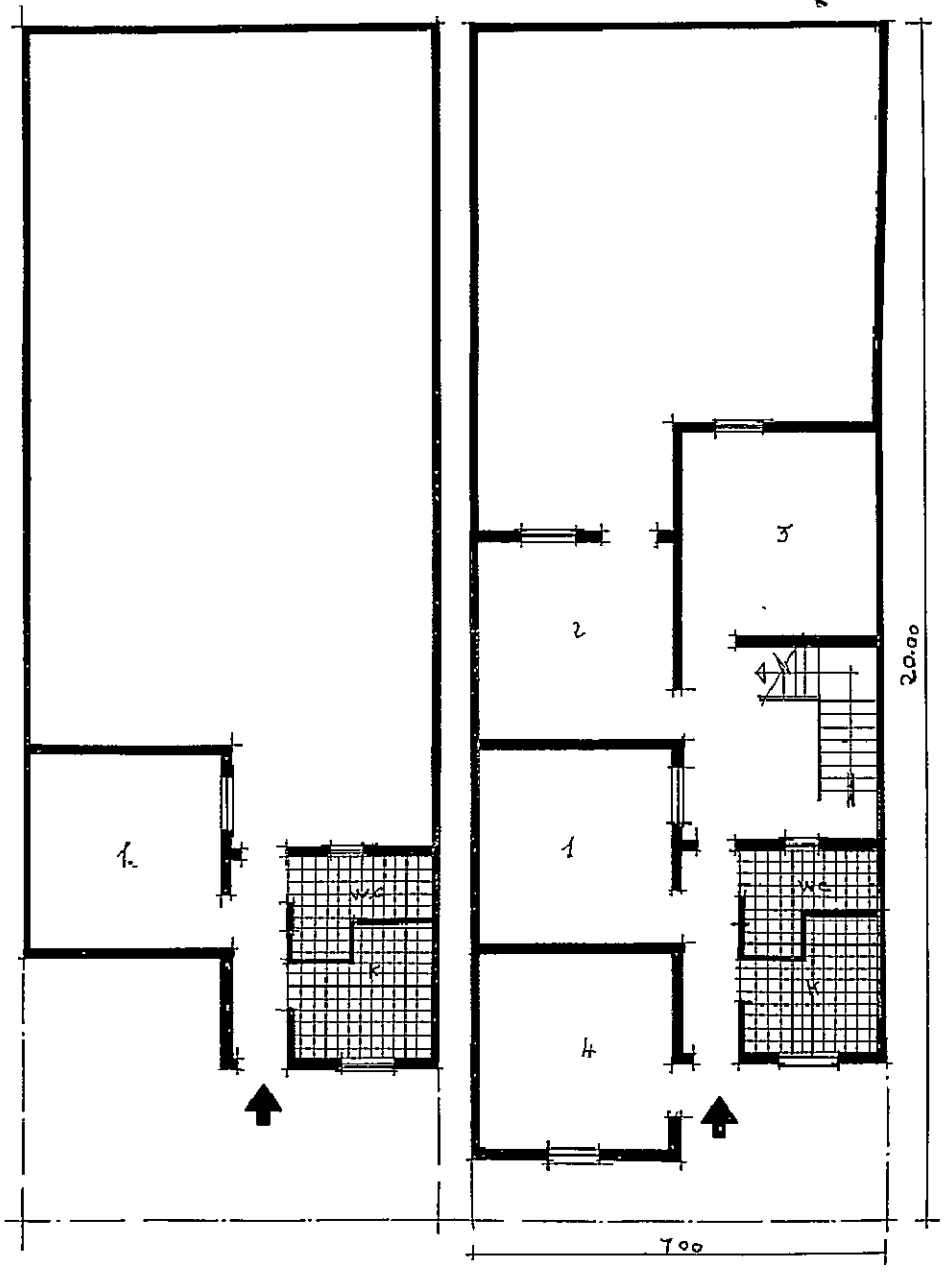
TYPE 1



INITIAL CORE

COMPLETED UNIT-GROUND FLOOR
(anticipated by designers)

TYPE 2



INITIAL CORE

COMPLETED UNIT-GROUND FLOOR
(anticipated by designers)

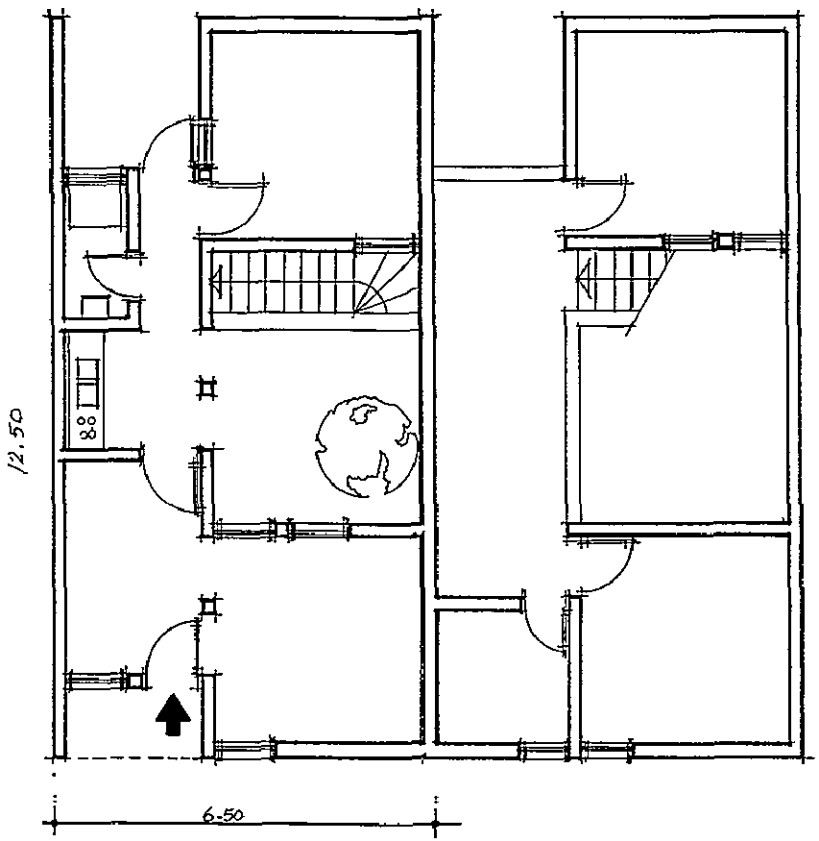
SADAT CITY NEW TOWN CORE HOUSE UNITS

Source: Working Drawings, Sadat City Development Group, January 1979, Scale 1:50.

TYPE 1

Ground Floor

Upper Floor

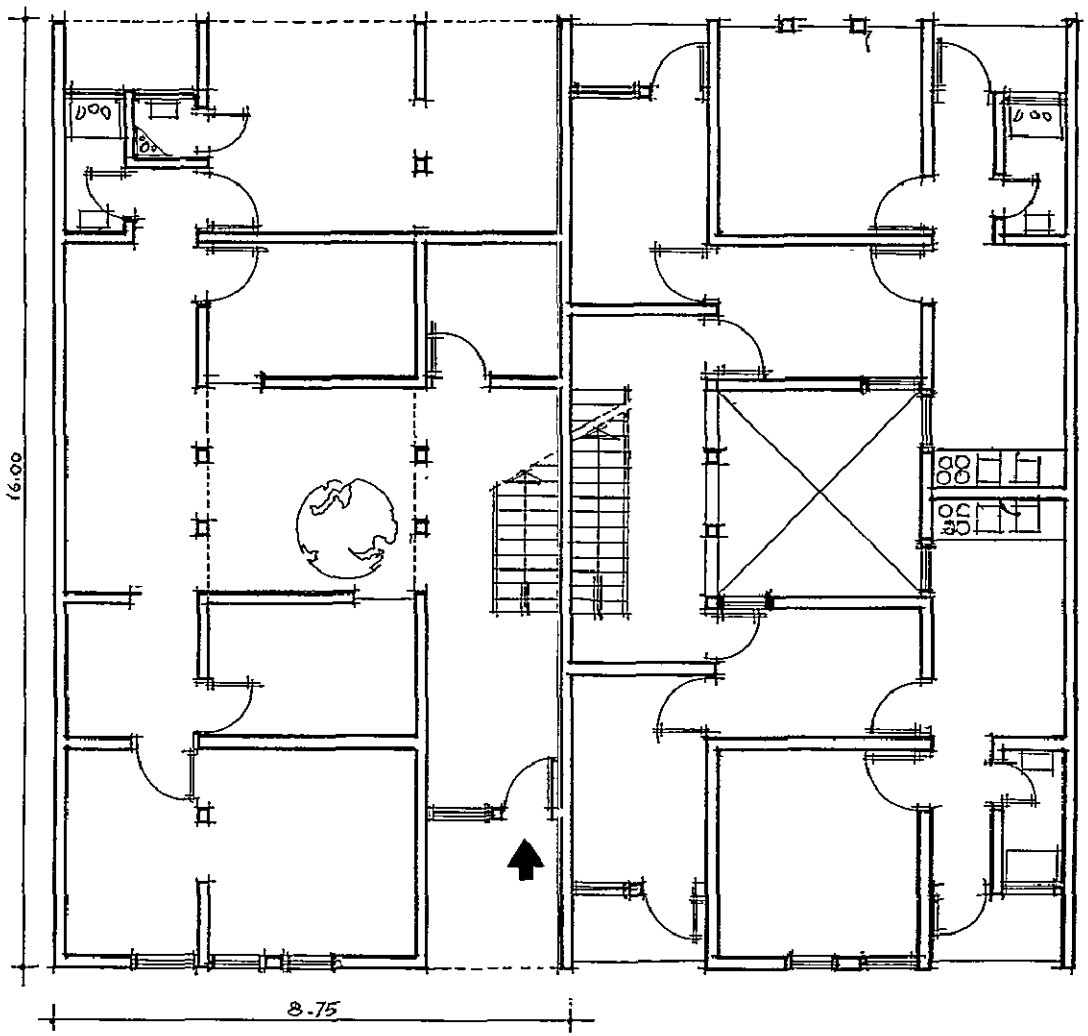


COMPLETED UNIT
(anticipated by designers)

TYPE 2

Ground Floor

Upper Floor



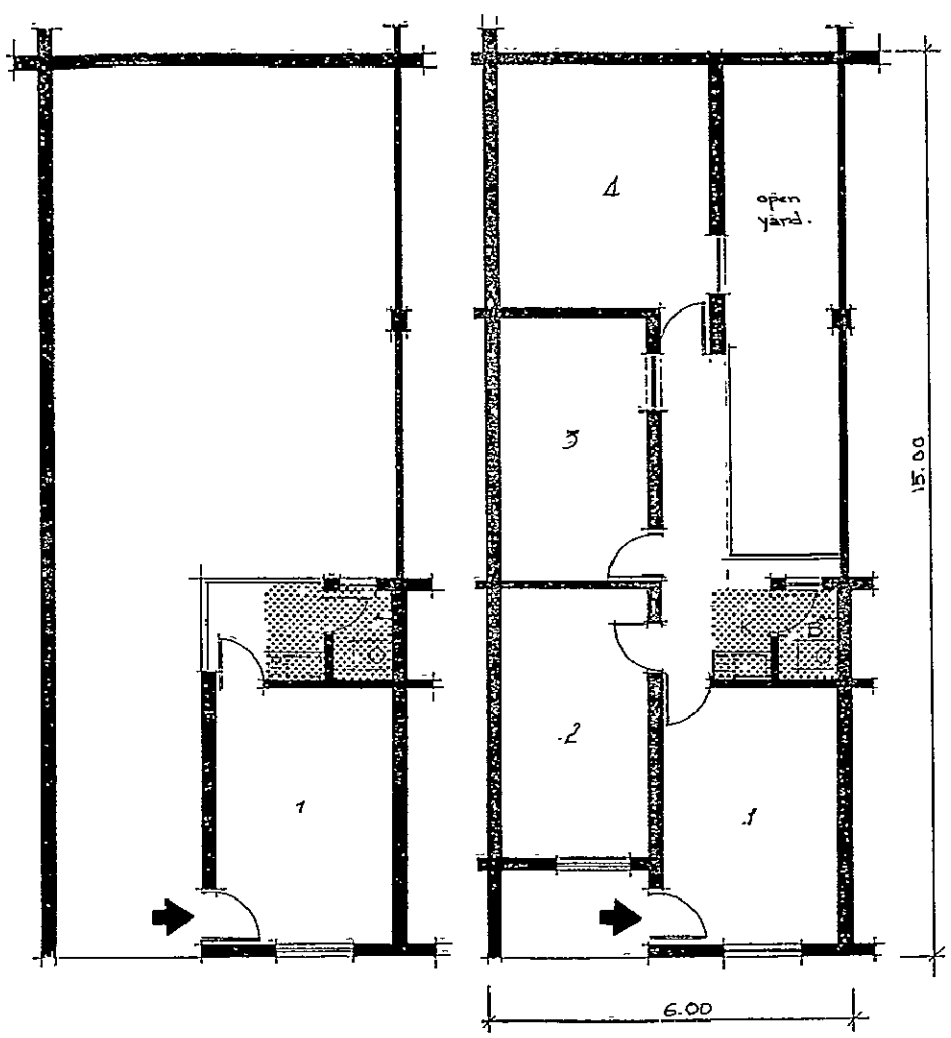
COMPLETED UNIT
(anticipated by designers)

AMERIYAH NEW TOWN CORE HOUSE UNITS

Source: Expandable Minimum Ameriyah Dwelling, EMAD, Pacer/ILACO, 1980 (date not indicated).

3/5

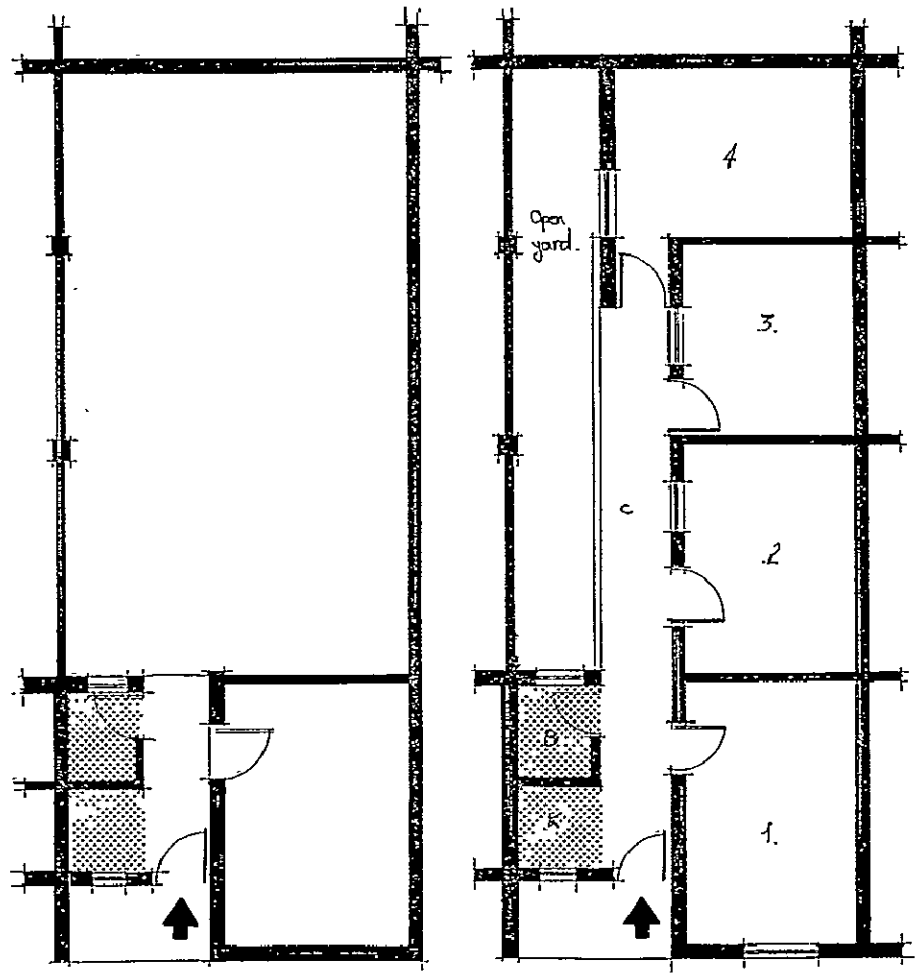
TYPE 1



INITIAL CORE

COMPLETED UNIT
(anticipated by designers)

TYPE 2



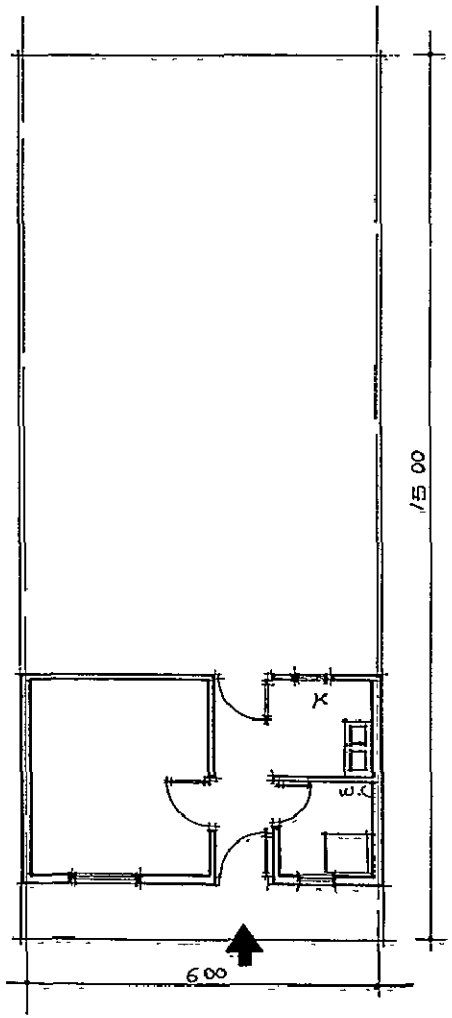
INITIAL CORE

COMPLETED UNIT
(anticipated by designers)

10TH OF RAMADAN NEW TOWN CORE HOUSE UNITS

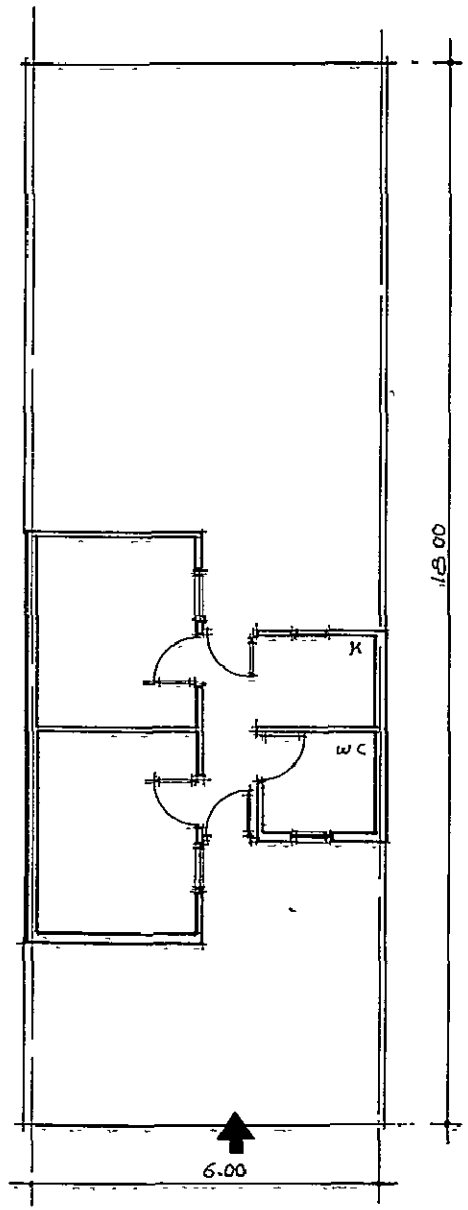
Source: Working Drawings; Tenram Group, COPA EGYPT, SWECO SWEDEN, June 1978, Scale 1:50.

TYPE 1



INITIAL CORE

TYPE 2



INITIAL CORE

CABANON NEW COMMUNITY CORE HOUSE UNITS
(SUEZ)

Source: Cabanon New Community, Demonstration Projects Draft Kayat Report, Vol. 2, February 1978.

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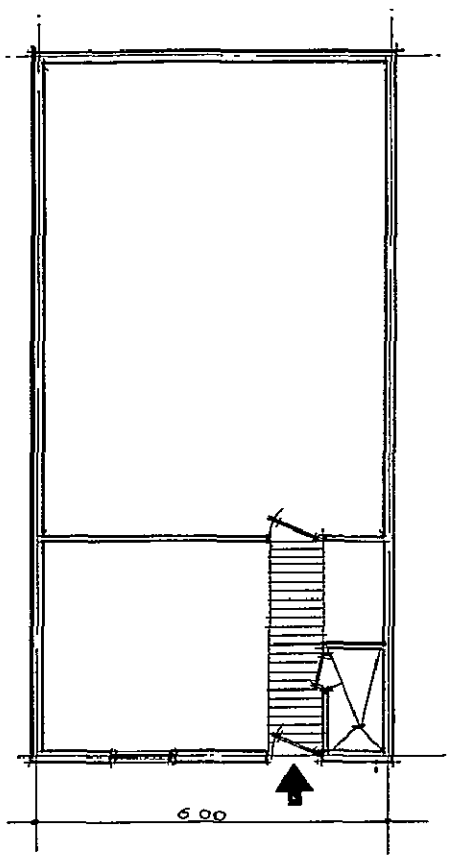
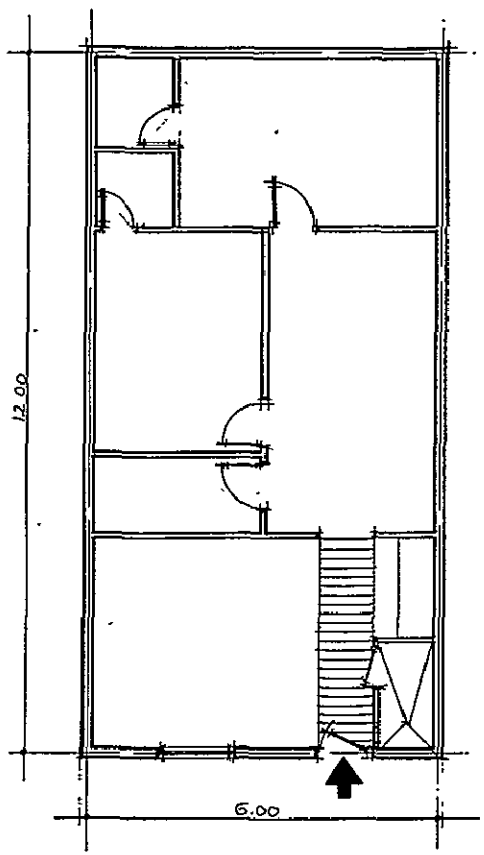
TYPE 1

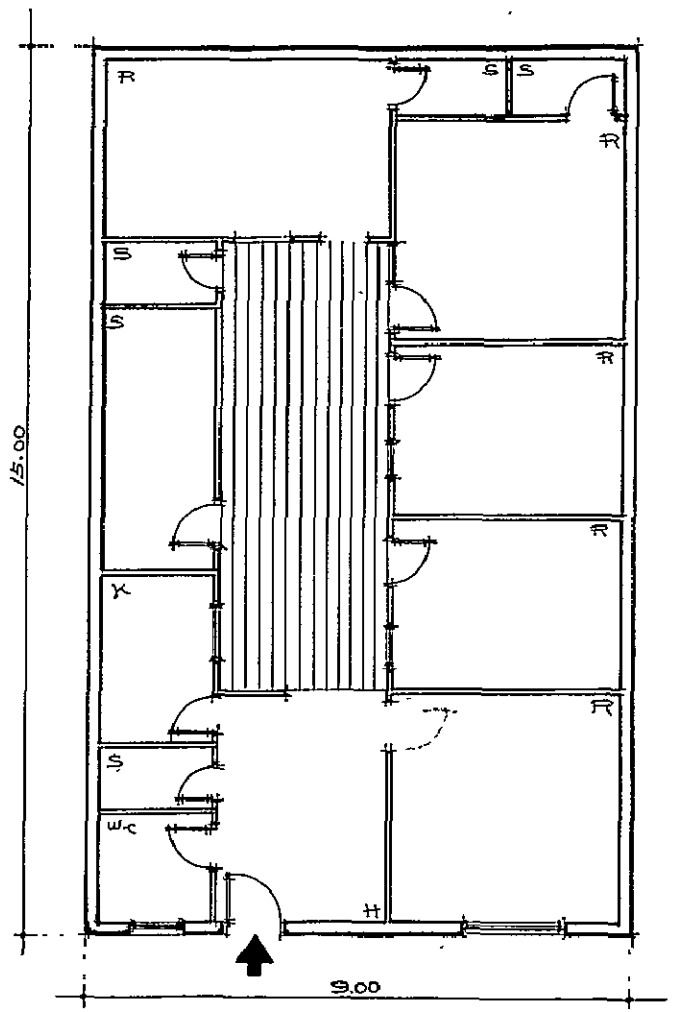


INITIAL CORE



COMPLETED UNIT
(anticipated by designers)

TYPE 2

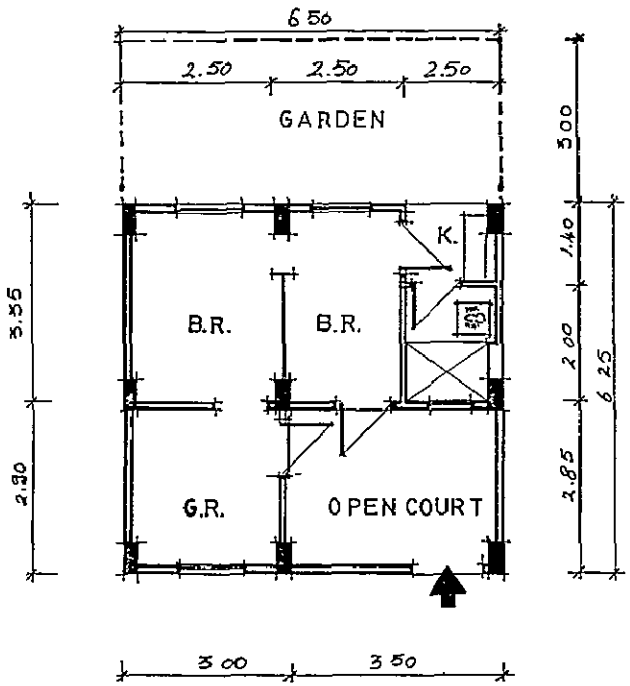


COMPLETED UNIT
(anticipated by designers)

ISMAILIA DEMONSTRATION PROJECT CORE HOUSE UNITS

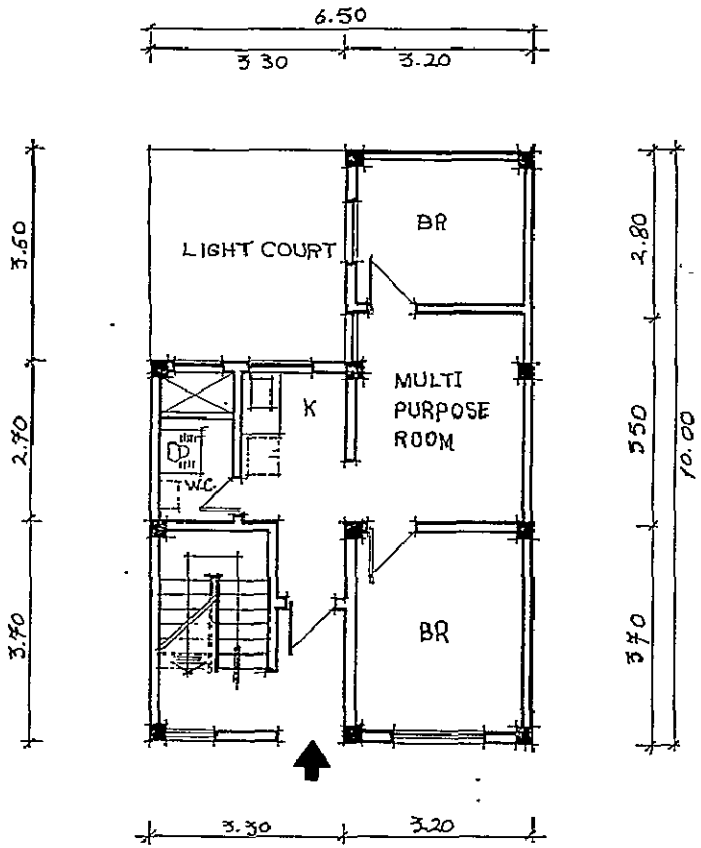
Source: Final Report, Volume 2: Technical, April 1978.

TYPE 1



COMPLETED UNIT
(anticipated by designers)

TYPE 2

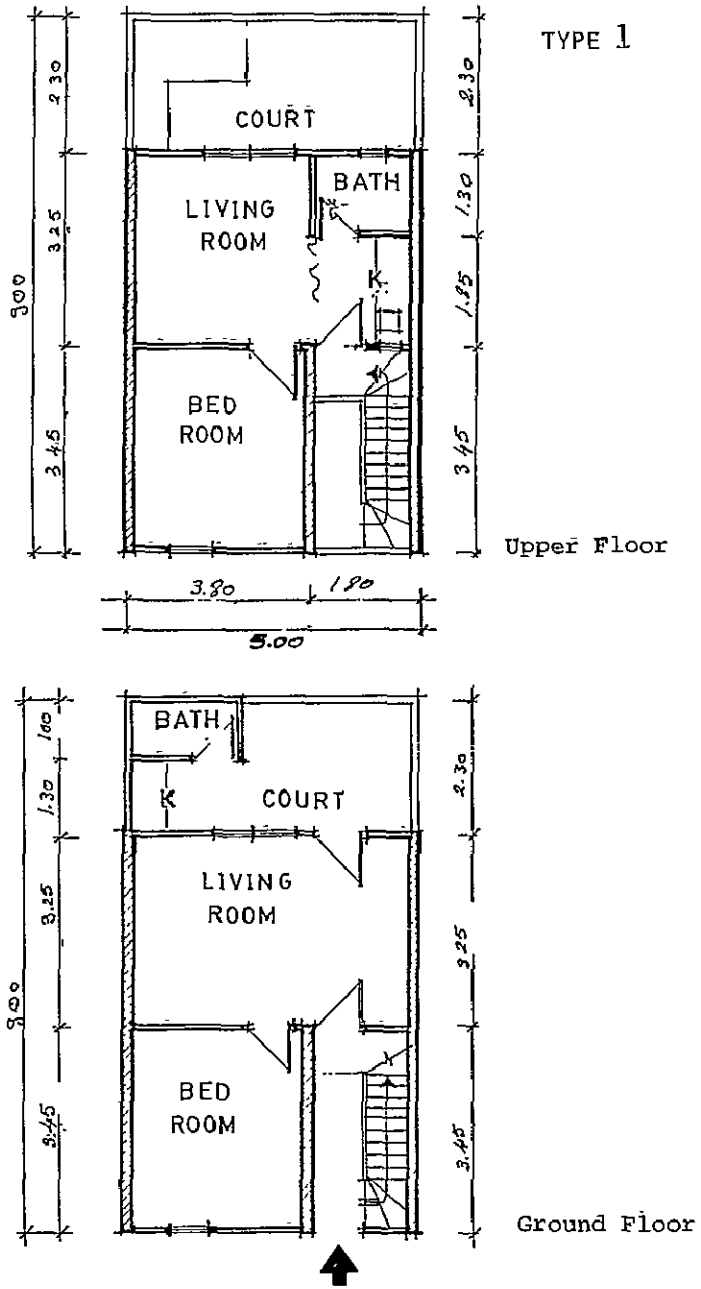


COMPLETED UNIT
(anticipated by designers)

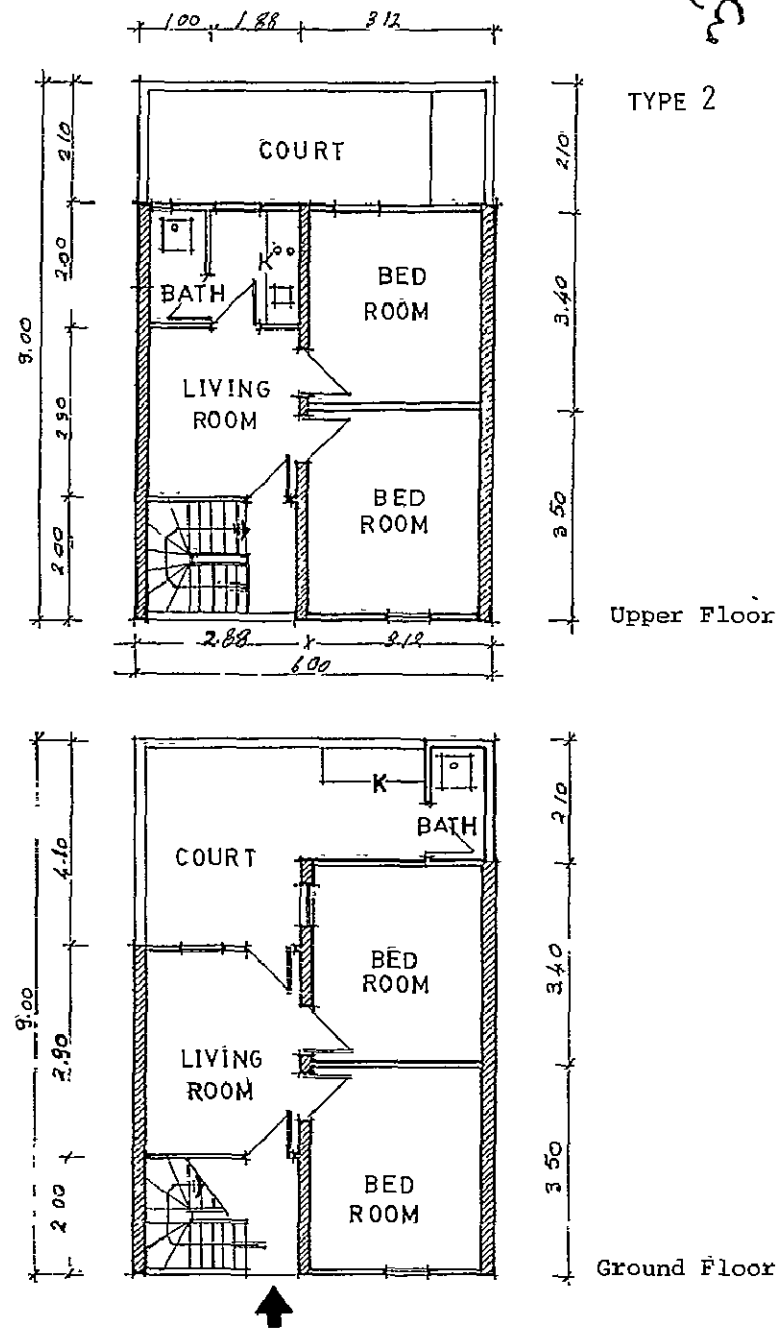
HELWAN NEW COMMUNITY CORE HOUSE UNITS
(MOH-AID)

Source: "Final Engineering Feasibility Report", September 1978, and "Project Paper: Housing and Community Upgrading for Low Income Egyptians", July 3, 1978, Scale 1:100.

10/3

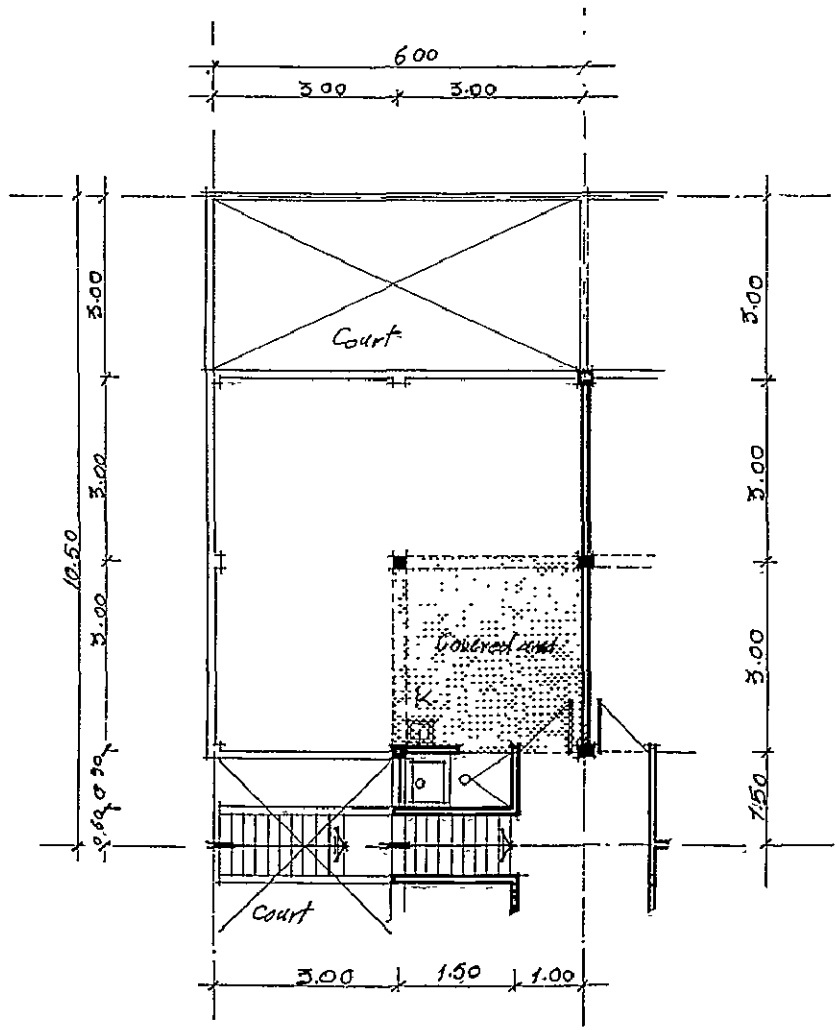


ASSUIT PROJECT CORE HOUSE UNITS
(MOH-WORLD BANK)



COMPLETED UNIT
(anticipated by designers)

Source: Preliminary Drawings, GOPP 1977, Scale 1:200 and 1: 100.



INITIAL CORE UNIT (1/4 section of floor)

PORT SAID DEMONSTRATION PROJECT VERTICAL CORE HOUSING

Source: "Task 1: New Community Project, Final Report", Port Said Demonstration Project Study, May 1978.

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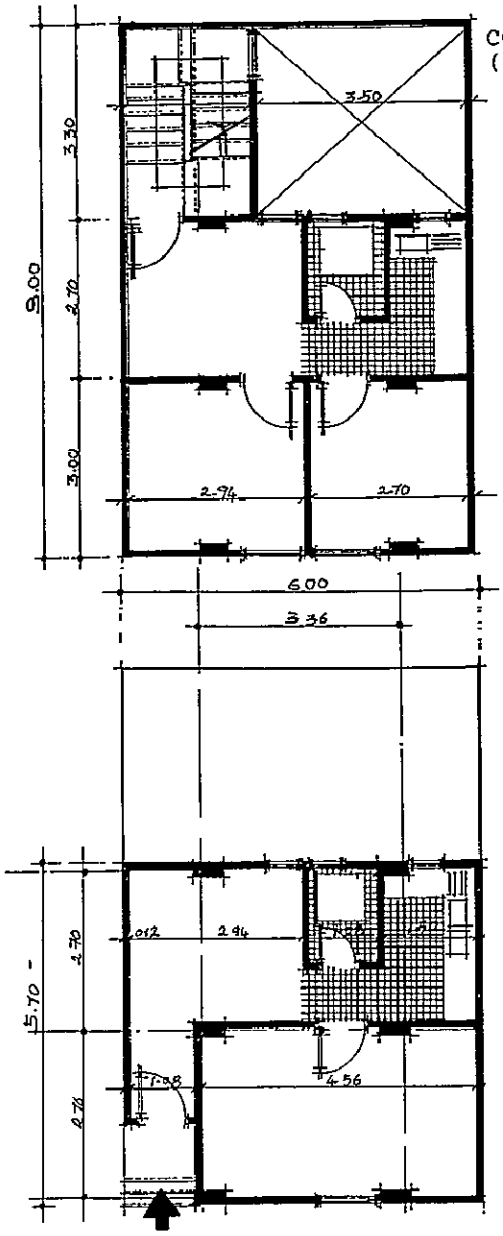
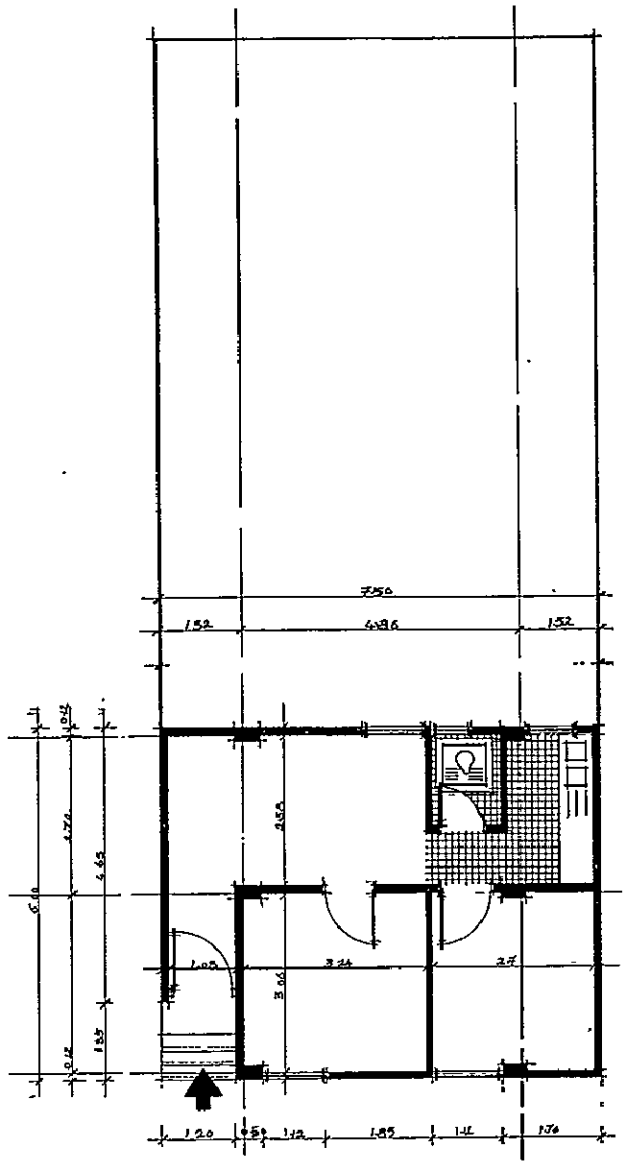
TYPE 1



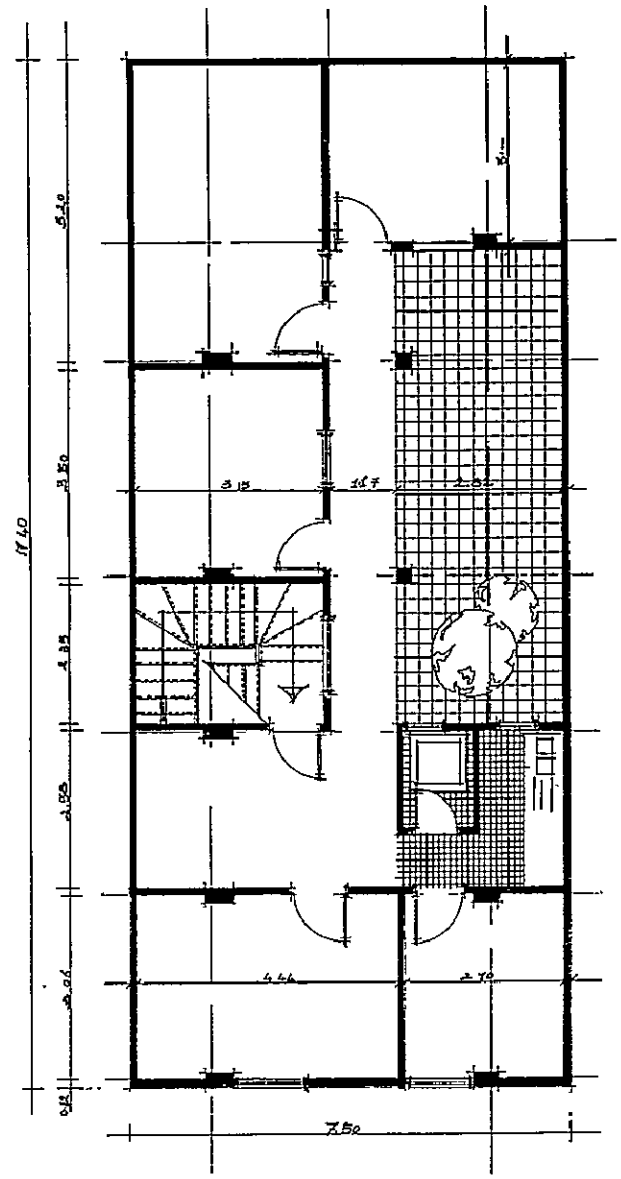
COMPLETED UNIT-UPPER FLOOR
(anticipated by designers)

INITIAL CORE

TYPE 2



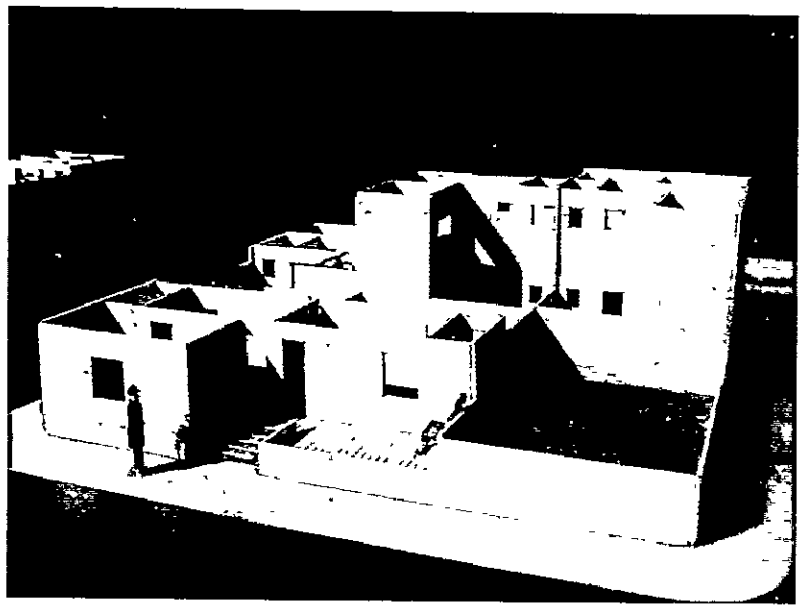
INITIAL CORE



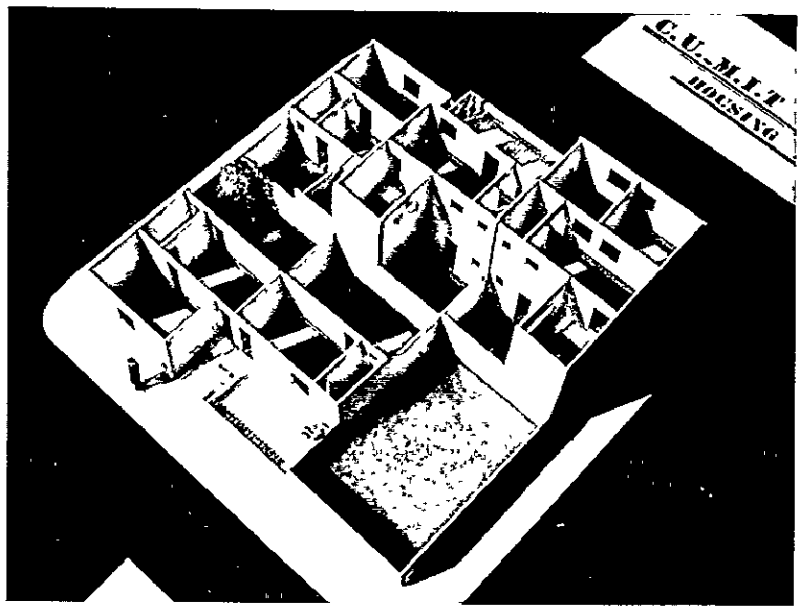
COMPLETED UNIT-UPPER FLOOR
(anticipated by designers)

PROPOSED MODEL CORE HOUSE UNITS

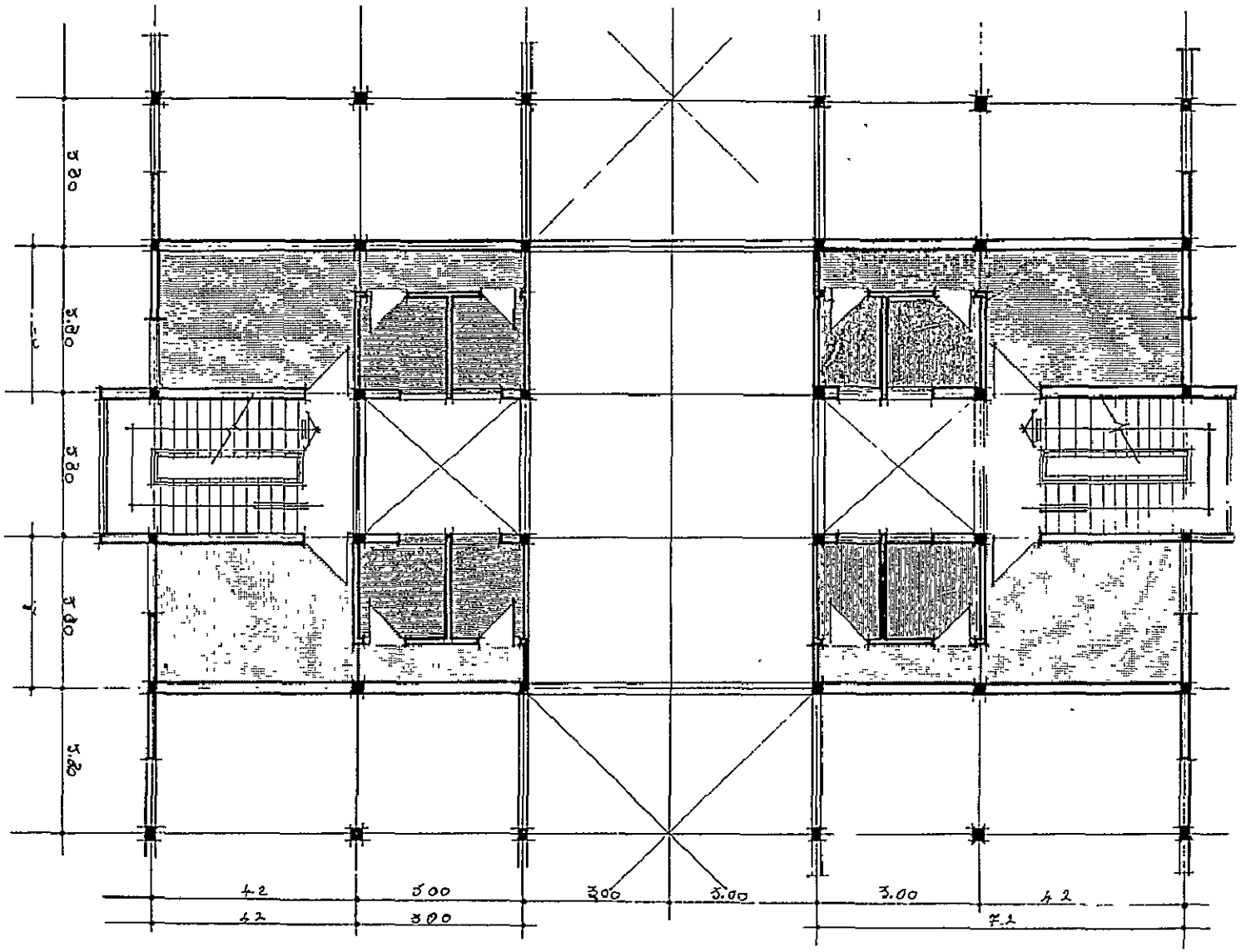
Source: (See also "Interim Report Working Papers 1978" The Housing and Construction Industry in Egypt, TAP Report 79-5, Spring 1979)



FRONT ELEVATION: GROUP OF UNITS AT VARIOUS STAGES
Proposed Model Core House Units



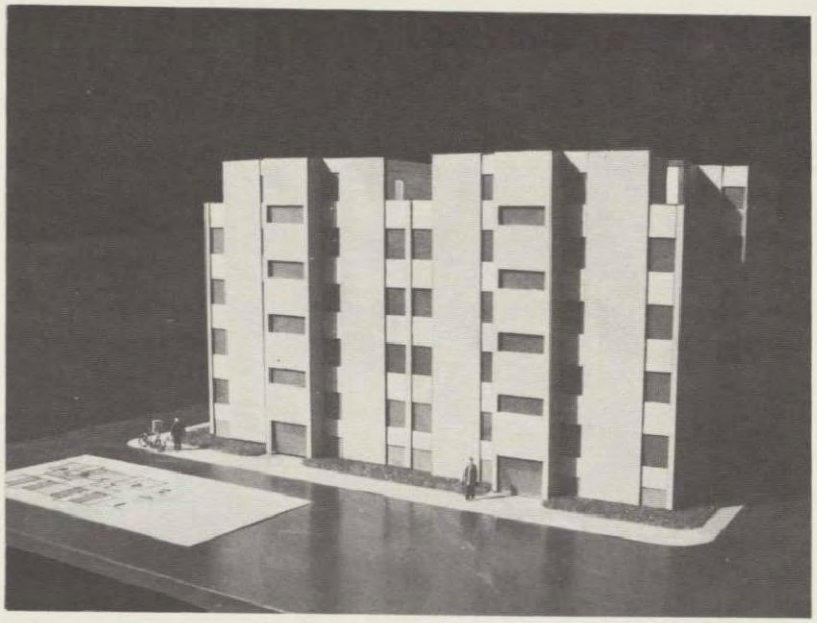
CUT-AWAY VIEW SHOWING ROOM ARRANGEMENT
Proposed Model Core House Units



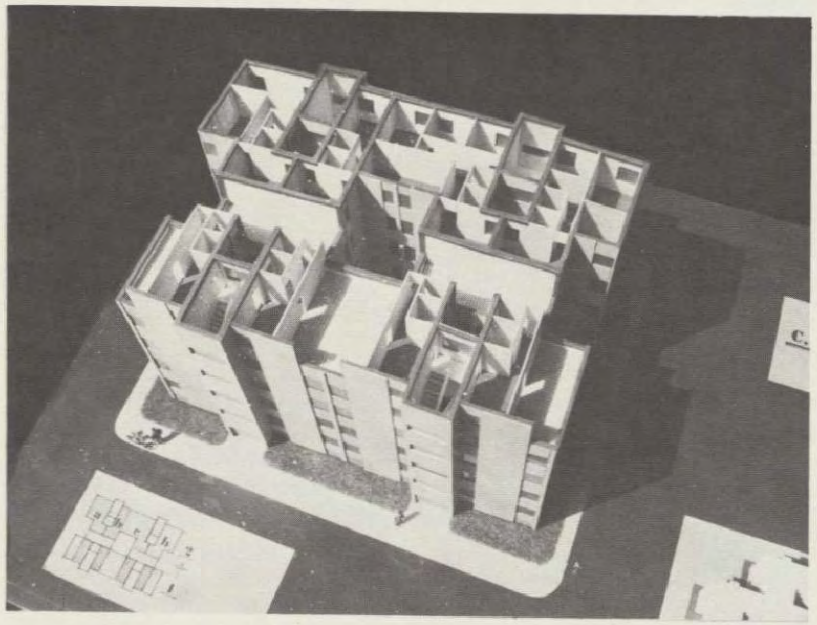
INITIAL CORE UNITS

PROPOSED MODEL VERTICAL CORE HOUSING

(For design details, see: "Support System Proposal", INTERIM REPORT WORKING PAPERS 1978, pages 31-34.)



FRONT ELEVATION
Proposed Model Vertical Core House



CUT-AWAY VIEW SHOWING ROOM ARRANGEMENT
Proposed Model Vertical Core House

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COMPARISON OF LAYOUTS IN SITE AND SERVICES/CORE HOUSING PROJECTS

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Reference Layouts (64)
Land Utilization (66)
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Reinhard Goethert
Massachusetts Institute of Technology
Assisted by: Nezar El-Sayyad, Research Assistant

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INTRODUCTION

This study deals with the comparison and evaluation of the basic land subdivision element - the block. This evaluation is a part of a larger study of site and services/core housing projects in the process of being designed and constructed in Egypt. (See also "Seminar Proceedings: Core Housing and Site and Services Projects for Low Income Groups" for detailed information on each project). This study takes advantage of the unique opportunity which exists in Egypt to study and to learn from the examples of the several prjects designed by experts throughout the world.

The goals are: 1) to increase awareness of the cost implications of physical layouts, 2) to determine key elements and factors that disproportionately influence a layout through obvious cost penalties or advantages, 3) to point out indeces for evaluating projects in order to improve performance, i.e., lower costs without sacrificing design parameters. In this regard, three indeces are proposed to be included into the basic design procedure.

Eight projects are compared: Sadat City New Town, Ameriyah New Town, 10th of Ramadan New Town (core house sector), Cabanon New Community, El Hekr Demonstration Project (Ismailia), Helwan New Community, Alexandria Project, and Port Said New Community. Three patterns from the spectrum of low income housing areas in Cairo are also included as a reference with real situations: Medieval Ciaro, public housing (Ain El Sira), and informal housing (Imbaba sector). A block or a basic block pattern is selected for each.

Three basic indeces are determined for each of the blocks: land utilization percentages (public or private revenue producing), length/area ratio, and expected densities. These indeces are simple enough to be readily calculated for any layout, yet they provide a basic reliable tool of evaluation and assist in cost prediction.

The block, or patterns of blocks, determines the essential street/lot relationships and effectively fixes the basic capital costs of urbanization: water supply, sewage disposal, electricity networks, and street paving, as well as effecting the continuing costs of operations and maintenance. An inefficient block width/length relationship can never be improved through a clever arrangement of other land subdivision elements (open spaces, school areas, etc.). Conversely, however, the cost effectiveness of an efficient block is only partially mitigated through wasteful practices in allocation of other land areas.

Focus is on the geometric considerations of the block for two reasons: 1) only two of the 8 projects have progressed to the construction phase, and making assumptions as to more detailed construction, social and economic aspects has no merit, and 2) the land subdivision pattern and utility networks will remain, long after financing, construction, and allocation issues have been forgotten. The geometry determined costs of operation and maintenance will always continue.

The indeces discussed in this section have limited validity for comparison with larger segments of a layout. They only relate to the basic "building block" which generates the overall layout. Public spaces - parks, playgrounds, etc. - are not considered, and consequently all of the values are higher than one might find in other sources. The values determined here are only valid for comparison among each other, unless a similar methodology is used for other projects.

The report is presented in three sections: the first presents a summary and basic data, the second discusses each of the three indices in turn, and the third - the appendix - provides supporting information including hypothetical lot/block layouts with their corresponding values as another reference.

DIAGRAMATIC SUMMARY OF INDECES

The eight projects and the three reference layouts are arranged in ascending order according to percentage of private land - land that is for sale in a project. The 3 basic indeces for each project are included in both diagrammatic and numerical form. The scale of the sketches is the same for comparative purposes.

LAND UTILIZATION PERCENTAGES

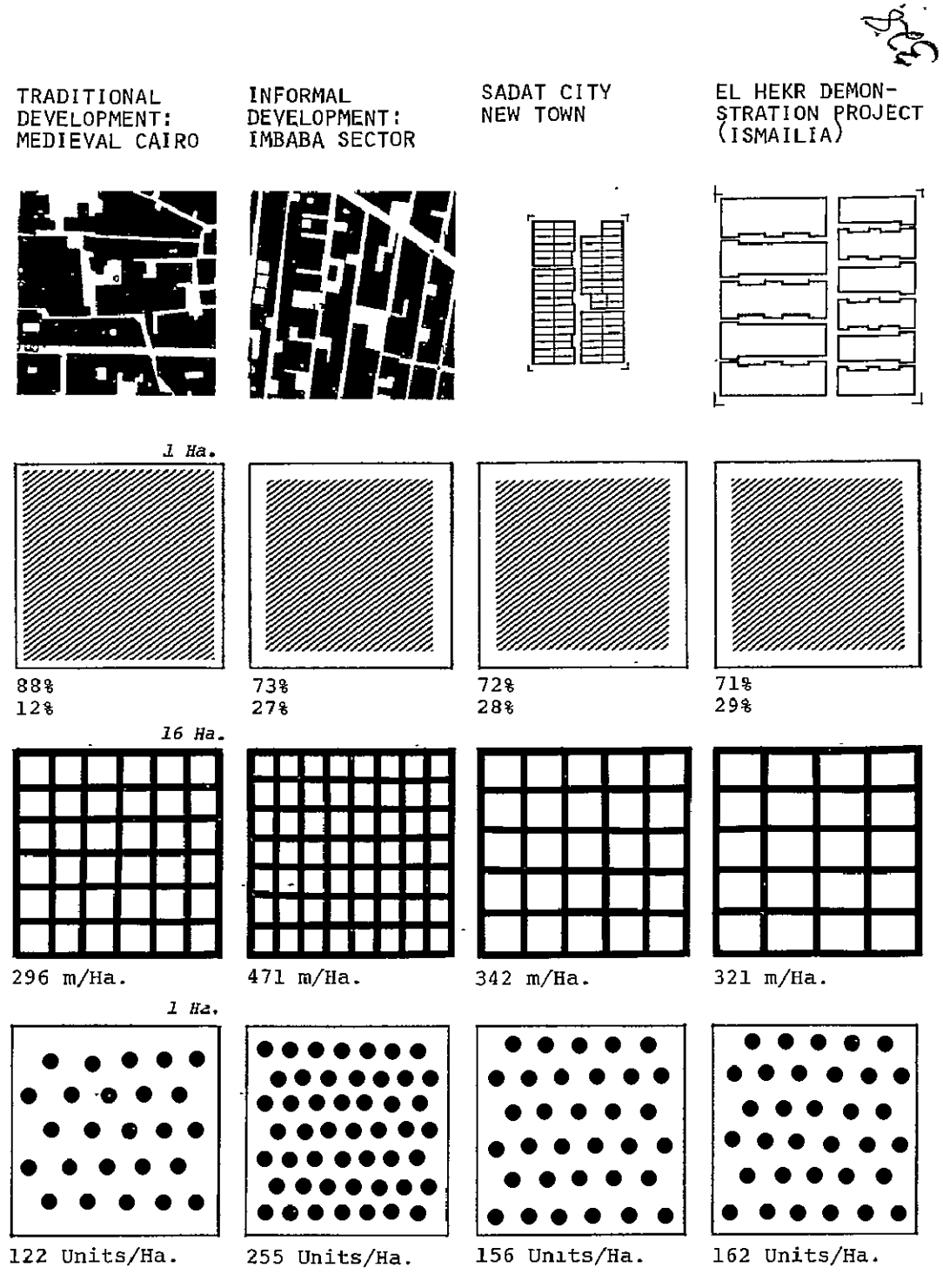
Percentages are given for private land: land which is usually for sale and direct responsiblity of the user, the lots; and public land: land which is the responsibility of the government for maintenance and control;. usually streets and open spaces.
The diagram represents 1 hectare; hatched is private, white is public.

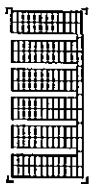
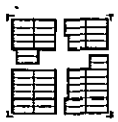
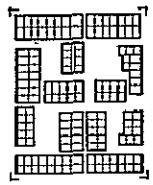
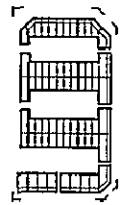
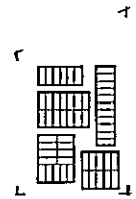
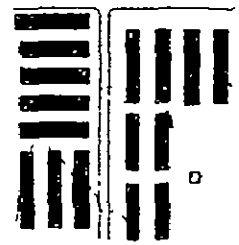
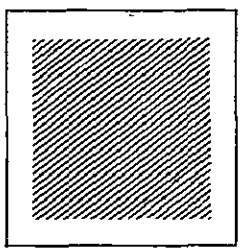
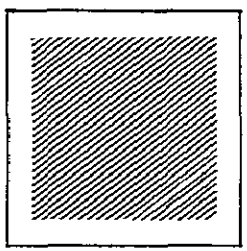
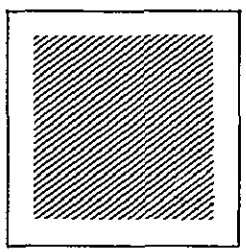
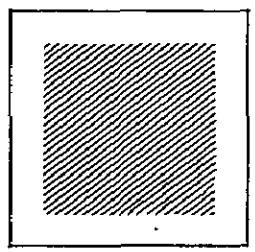
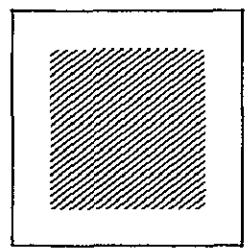
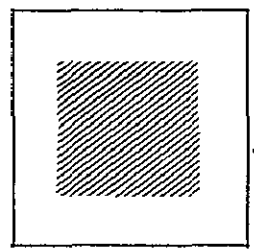
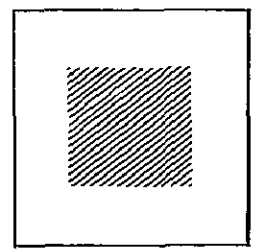
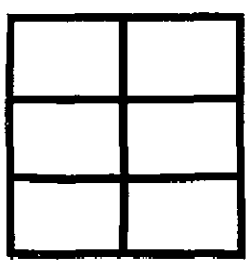
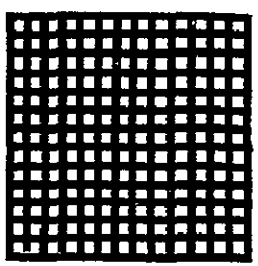
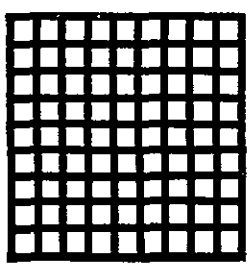
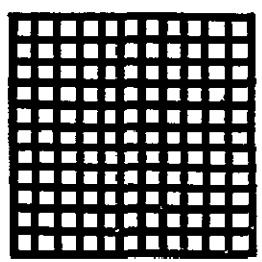
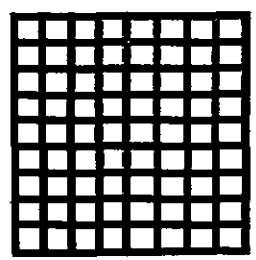
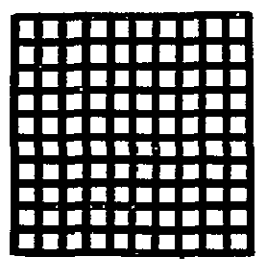
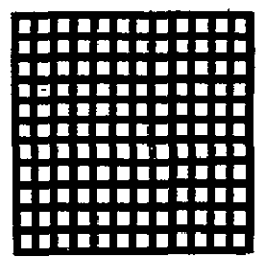
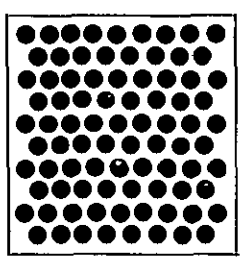
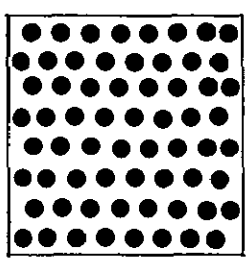
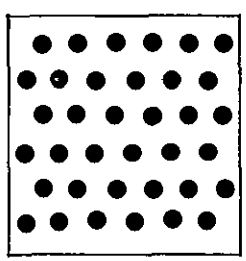
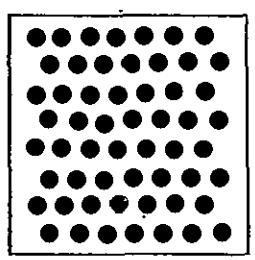
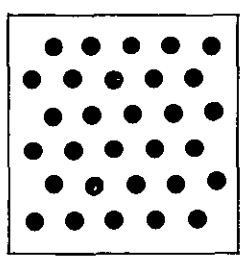
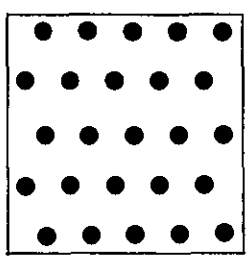
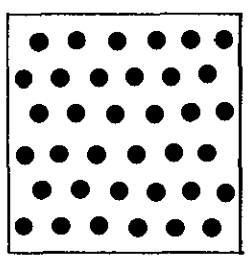
CIRCULATION LENGTH/AREA RATIO

Indeces are determined for meters per hectare of land. The indeces parallel the amount of streets, walkways, and in most cases the utility network. It represents initial capital costs as well as recurring costs.
The diagram represents 16 hectares, with the resultant regular grid derived from each project.

NET DENSITY (3 FLOORS)

Indeces are given for an expected average saturated denisty for 3 floors, irregardless of initial design of the project. Denisty is an indicator for required communal services: schools, clinics as well as utilities. Very high densities overload services, very low densities are wasteful.
The diagram represents 1 hectare, with each dot equal to 5 units.



ALEXANDRIA PROJECT (MOH-WORLD BANK)	PORT SAID NEW COMMUNITY	CABANON NEW COMMUNITY (SUEZ)	HELWAN NEW COMMUNITY (MOH-AID)	AMERIYAH NEW TOWN	10TH OF RAMADAN NEW TOWN (CORE HOUSING SECTOR)	PUBLIC DEVELOPMENT: AIN EL SIRA
						
						
65% 35%	65% 35	63% 37%	54% 46%	48% 52%	31% 69%	27% 73%
						
217 m/Ha.	757 m/Ha.	554 m/Ha.	656 m/Ha.	533 m/Ha.	609 m/Ha.	675 m/Ha.
						
441 Units/Ha.	318 Units/Ha.	180 Units/Ha.	276 Units/Ha.	150 Units/Ha.	129 Units/Ha.	183 Units/Ha.

COMMENTS AND OBSERVATIONS

The comments are directed with a bias toward minimization of public (government or institutional) responsibility and control. In the context of limited resources - both in capital and administrative and technical personnel - this becomes a major issue in land development. Regardless of the type of housing, an efficient layout which minimizes the costs to the government is desired. In site and services types of projects, however, this becomes more critical in that the "first costs" should ba as low as possible in order to reach a wider range of the low income sector, and operation and maintenance costs also be minimized, since low income neighborhoods tend to be overlooked in these aspects.

It is clear from the comparisons that land subdivisions make a difference, and an appreciable difference, in the eventual cost of a project, assuming that the indeces are a fair indicator. Keeping in mind that all of the projects including the reference layouts, are intended for a similar low income sector, land utilization and circulation length/area ratios vary by approximately 2½ times from the highest to the lowest groups, and density varies by 3 times. Average lot sizes vary from 139m^2 to 44m^2.

No consistent approach is noticed. Even when the new towns on desert lands are looked at separately, no pattern emerges.

It is suggested that land utilization, circulation length/area ratio and density be calculated for all projects during the design process to assist in decision-making in the design. Obviously these indeces should not be the only criteria, but deviations should be carefully analyzed.

At the minimum, a lyout should match the indeces of the typical, regular patterns found throughout Cairo. (See Reference Indeces in Appendix.) In all of the indeces, the traditional and informal layouts exceeded the minimums suggested; conversely, again in all cases, the planned public housing layout was worst than most of the other cases. If planned areas result in a larger cost burden to the city and to the user, it is best to let the "informal" development process take place and not interfere.

Combining two of the basic indeces - length per area and unit density - the average length of infrastructure per unit may be approximated, keeping in mind the assumption that the utility networks and services parallel circulation. Obviously, the less length per unit the more cost effective.

TABLE OF CIRCULATION LENGTH PER UNIT *(assuming 3 floors)*

	m/unit	
10th of Ramadan	4.72	(would be 7.08 if 2 floors as designed)
Ain El Sira	3.69	(would be 2.21 if 5 floors, 2.77 if 4 floors)
Ameriyah	3.55	
Cabanon	3.08	
Port Said	2.38	
Helwan	2.38	
Medieval Cairo	2.40	(would be much lower if tenements considered)
Sadat City	2.19	
El Hekr	1.98	
Imbaba	1.85	(would be 1.38 if 4 floor average)
Reference models	*1.2-1.8*	
Alexandria	0.50	(would be 1.15 if cul-de-sacs public)

Clearly the argument of public housing defenders that 4-5 floors are necessary to justify the costs of infrastructure has little merit. However, at 5 floors, the designs of hte site and services projects cannot compete and are more expensive except for the large lot situation of Sadat City and El Hekr. The informal sector again builds more advantageously considering infrastructure costs.

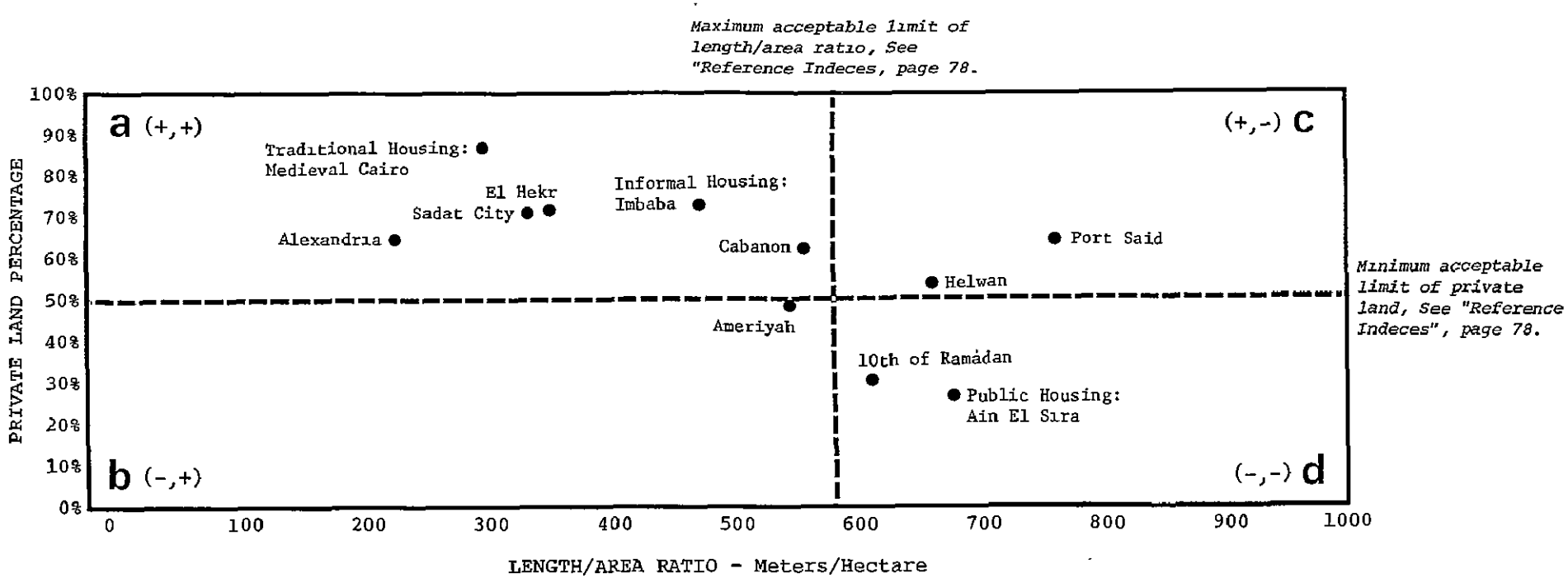
From studies with the reference models, enlarging the block length from 75m to 125m, a 16% drop in length per unit occurs; changing the street width from 6m to 10m, a 3% increase occurs. Adding another floor is the most beneficial, with a 25% drop in length per unit.

SPECIFIC DESIGN RECOMMENDATIONS: It is clearly seen from the comparisons that blocks with large lots, narrow streets, and a long length result in lower indeces (Note Sadat City). However, in the context of housing for the low income - particularly core housing - the smaller the lot, the more affordable it will be, but the more extensive (and expensive) is the required utility network, and less (proportionally) is the amount of private land available to be sold (Note Cabanon). This basic dilemma is difficult to overcome, but grouping small lots into cooperative clusters has the geometric effect of duplicating a large lot, large block situation with its lower costs. This approach can be seen in the case of the traditional city pattern (Medieval Cairo) as well as in the Alexandria Project. A variation in the scheme to overcome initial high inflation costs, is not to provide individual utilities initially, moreover, it can be argued, that the resultant shared services would be superior to what is now provided in most cases, which is none!

Specific recommendations for more cost effective layouts are as follows. (In all cases it is assumed tht there would be a suitable lot proportion at least 1:2 with the lesser dimension fronting the street.)

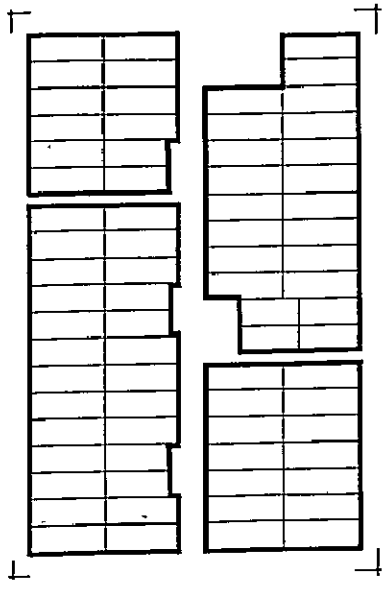
1) Maintain narrow streets, perhaps 6 meters, with wider streets only at clear vehicular circulation streets and at large intervals, minimum 200 meters.
2) Keep block lengths a minimum of 75 meters, with 100-125 meters desirable.
3) Avoid undefined, smaller open spaces; combine open spaces into larger useful sports fields, preferably in combination with other facilities (schools, etc.) which can assume a minimum responsibility. Block layouts intersperced with many small open spaces (of ambiguous use) tend to lower any advantage which a layout may otherwise have.
4) Use cluster lot layouts to lower public streets and utility network lengths; this layout readily allows staged provision of services, which parallels the progressive nature of core housing, both in physical and economic terms.

GRAPH OF LAND UTILIZATION VS CIRCULATION LENGTH/AREA RATIO

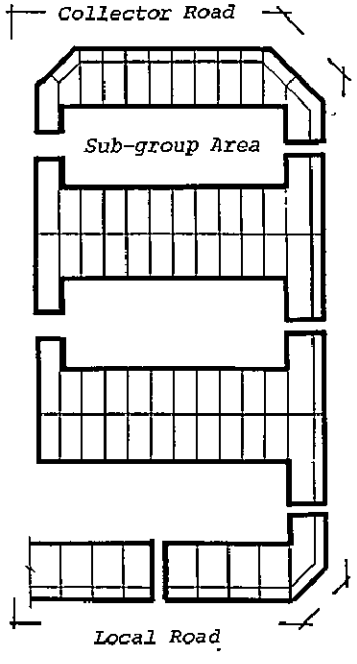


SELECTED BLOCKS USED AS MEASUREMENT BASE

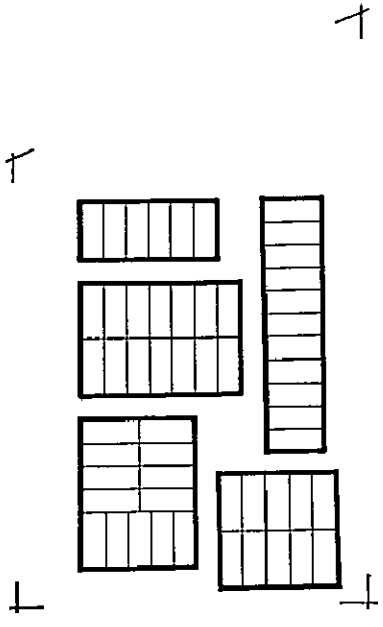
Note: All blocks are drawn to the same scale.



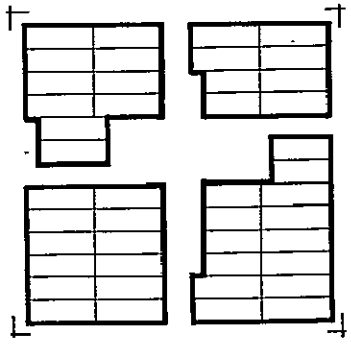
SADAT CITY NEW TOWN



AMERIYAH NEW TOWN



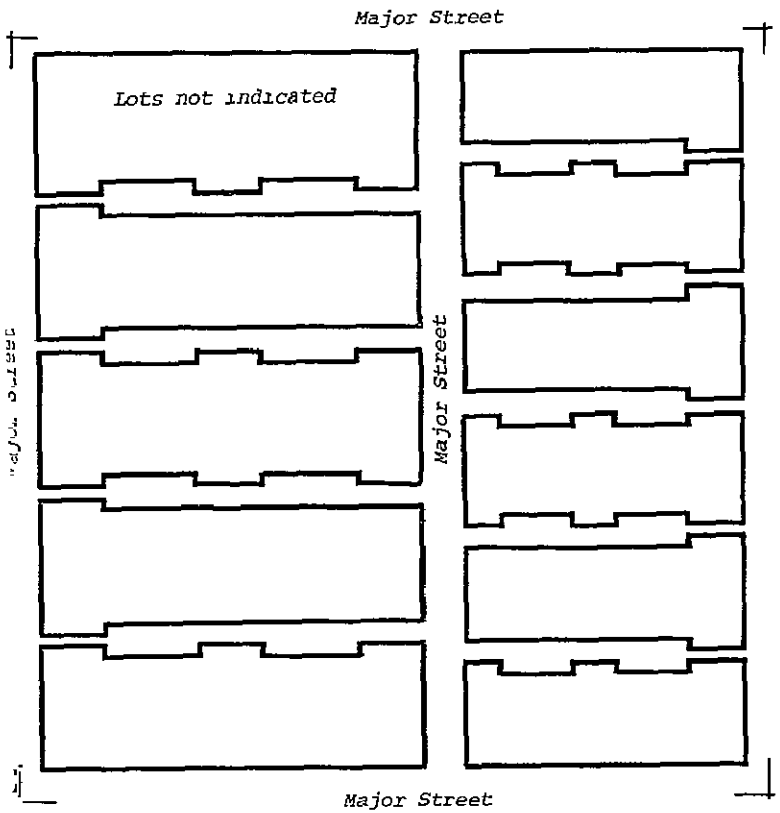
10TH OF RAMADAN NEW TOWN (CORE HOUSING SECTOR)



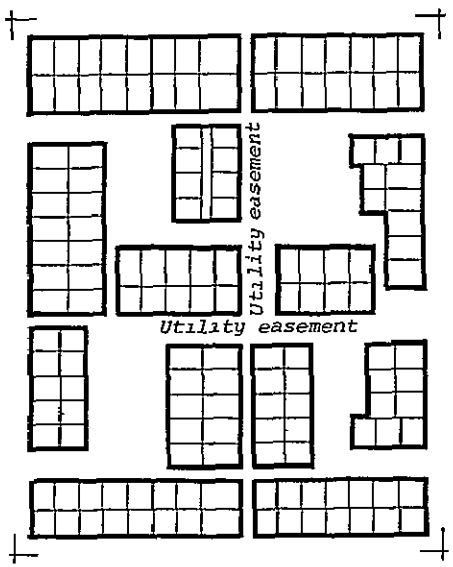
CABANON NEW COMMUNITY (SUEZ)

SYNOPSIS OF PROJECTS

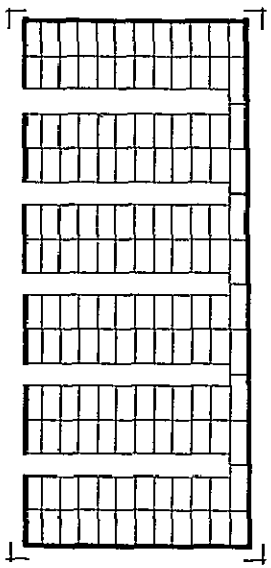
- SADAT CITY NEW TOWN: The City is located 95 kilometers north of Cairo on the Alexandria desert road. Of the 30,000 Ha. site, only 5000 will be used for the eventual population of 500,000. The goal is to draw off excess population from the major cities and to attract rural migrants. Various house types and sizes would be provided, emphasizing lowrise construction and dense ground coverage to provide shade and minimize unirrigated open space. Progressive expansion through self-help methods is anticipated.
- AMERIYAH NEW TOWN: The proposed new town is located approximately 25 kilometers southwest of Alexandria. At full development, the population is expected to reach 500,000. The city is a part of the government's strategy of decentralization and desert development, and it will be complete and self-contained. Housing will be developed according to the socio-cultural factors and to supply factors, which is contrary to others.
- 10TH OF RAMADAN NEW TOWN: This new town is part of an overall strategy of stressing new urban centers, decentralization and rural development. The site is approximately 5,600 hectares, located 50km east of Cairo entirely in the desert. By the year 2000, it is expected to reach 500,000 people at a density of 180 people/hectare. The housing policy is oriented to providing a large supply quickly, to utilizing conventional and prefabricated methods, to allowing all forms of investment while providing housing at five cost levels.
- CABANON NEW COMMUNITY: The expansion area is part of a regional program to reduce population pressures in Cairo and Alexandria. The 200 Ha. area is located to the north of Cabanon Beach in the Western Sector of Suez. 40,000 people at a gross residential density of 67 dwellings/Ha. are expected. Individual services are provided through four core options. The units are intended to facilitate the traditional pattern of continuous expansion and improvement through owner initiative.



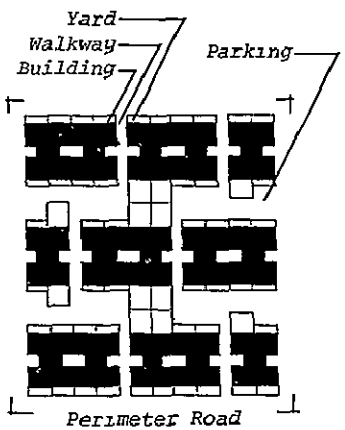
EL HEKR DEMONSTRATION PROJECT
(ISMAILIA)



HELWAN NEW COMMUNITY
(MOH-AID)



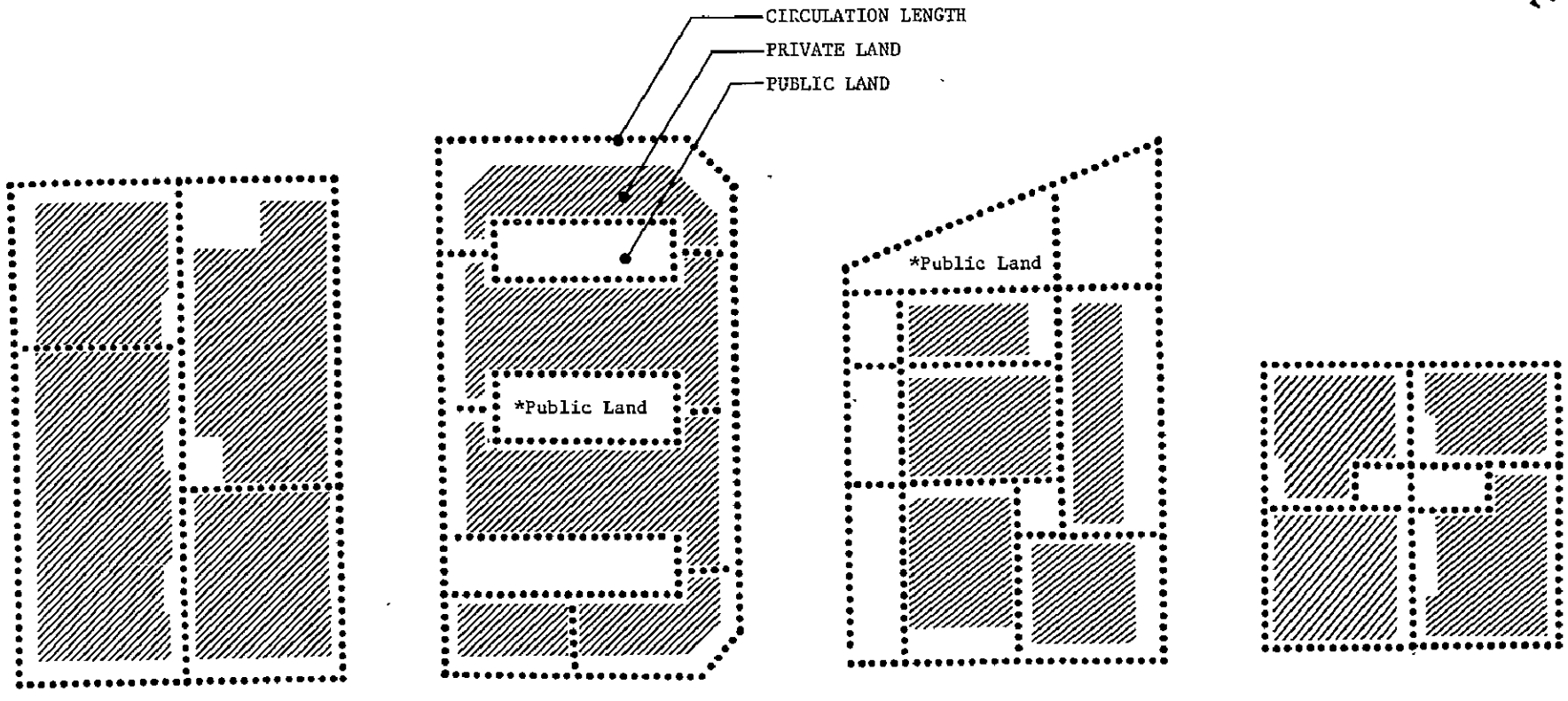
ALEXANDRIA PROJECT
(MOH-WORLD BANK)



PORT SAID NEW COMMUNITY

- EL HEKR DEMONSTRATION PROJECT: The project was set up to demonstrate policies and proposals of the Ismailia Master Plan. It is an upgrading and expansion area on the northern outskirts of the city. It is relatively flat, with uncompacted sand cover, with an area of 226 ha. The primary goal is to strengthen and improve the area's functions of providing low cost lots for owner builder construction and low and moderate cost rental accommodations. Plots with various utility service levels would be provided.
- HELWAN NEW COMMUNITY: The 150 hectare site is adjacent to the southeast corner of Helwan City. The site is planned for 6,500-6,800 dwellings to accommodate an ultimate population of 100,000 at a net density of 1,770 persons/hectare. A standard utility core of 4.2m^2 is proposed for all of the lots. Six to seven options will be offered to buyers according to their mortgage payment capacity. Contruction will be by "self-help" or by small contractor selected from a prequalified list. A standard level of services has been provided.
- ALEXANDRIA PROJECT: The "South Metras" site covers 15.3 hectares, with a design population of 9,000. It is part of a swamp and requires several meters of fill before use. A standard level of service would be provided. Two house options are offered: a basic perimeter wall and ablution unit with toilet and faucet, and the wall, ablution unit and 9m^2 room. Construction of the dwelling unit would be through self-help.
- PORT SAID NEW COMMUNITY: The site area is 63.55 hectares, located in a reclamation area of Lake Manzala, approximately 3 kilometers to the city center. Final population is expected to be 35,000. A site and services solution is provided with "apartment type" core housing based on an unfinished framed dwelling with minimum sanitary facilities on more than one level.

LAND UTILIZATION AND LENGTH/AREA RATIO

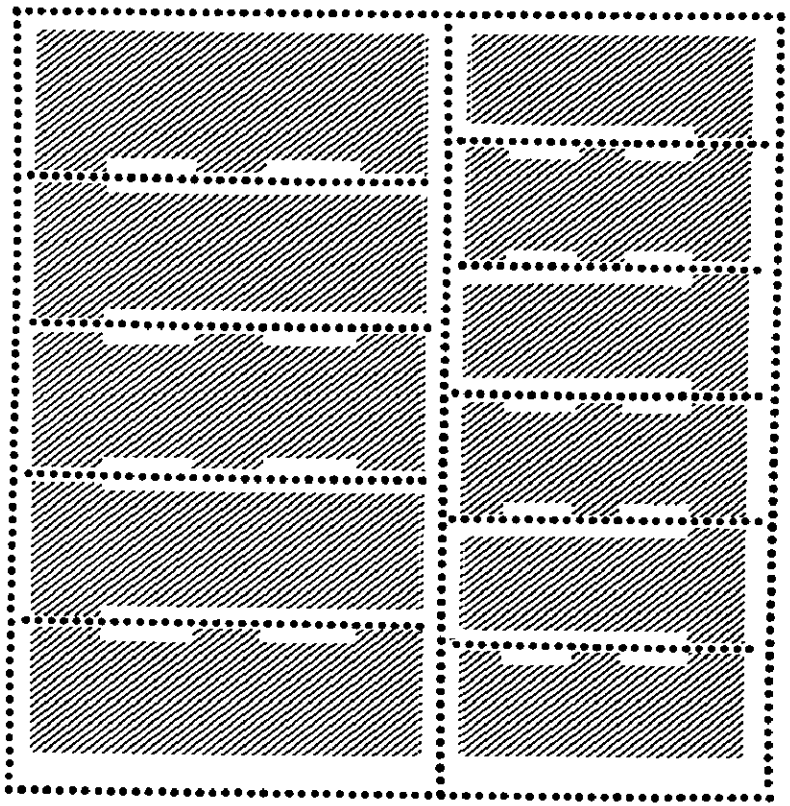


BASIC DATA	SADAT CITY NEW TOWN	AMERIYAH NEW TOWN	10TH OF RAMADAN NEW TOWN (CORE HOUSING SECTOR)	CABANON NEW COMMUNITY (SUEZ)
Area(m^2):	14,259	13,920	12,466	7,353
Private Land(%):	72	48	31	63
Public Land(%):	28	52*	69*	37
Circulation Length(m):	488	742	759	407
Length/Area Ratio(m/Ha):	342	533	609	554
Total Lots (No.):	74	69	54	44
Av. Lot Area(m^2):	139	97	72	105
Density-1 floor(Lots/Ha):	52	50	43	60
Density-3 floors(Lots/Ha):	156	150	129	180
Quality of Data:	ACCURATE	ACCURATE	ACCURATE	APPROXIMATE

Notes:

*Difficult to determine, easy access to interior common space encourages through passage, although design restricts passage.

*Clearly public land; uncontrolled access encourages through passage; circulation design dictates through traffic.

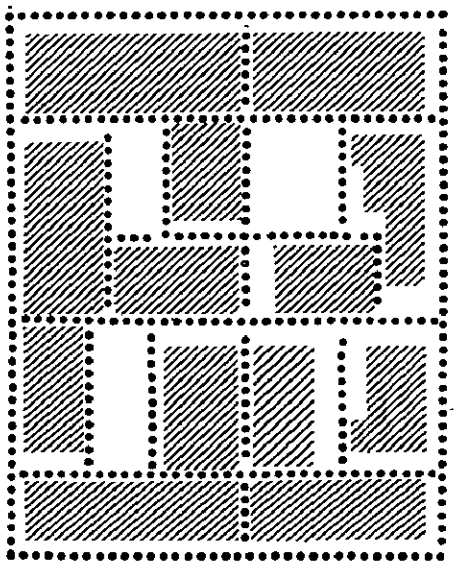


EL HEKR DEMONSTRATION PROJECT
(ISMAILIA)

39,798
71
29
1,276
321
216*
131
54
162

TENTATIVE

*Number of lots estimated.

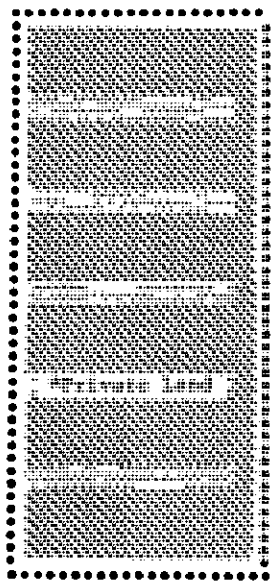


HELWAN NEW COMMUNITY
(MOH-AID)

16,160
54
46
1,060
656
149
59
92
276

ACCURATE

Design very tentative; it is assumed to substantially change when constructed.

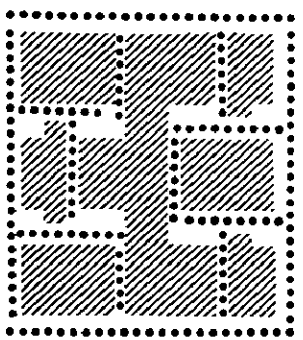


ALEXANDRIA PROJECT
(MOH-WORLD BANK)

9,788
65*
35
212 (498)
217 (508)
144
44
147
441

ACCURATE

*Because of court size, limited families, dead-end, and clear potential for control, area considered private.



PORT SAID NEW COMMUNITY

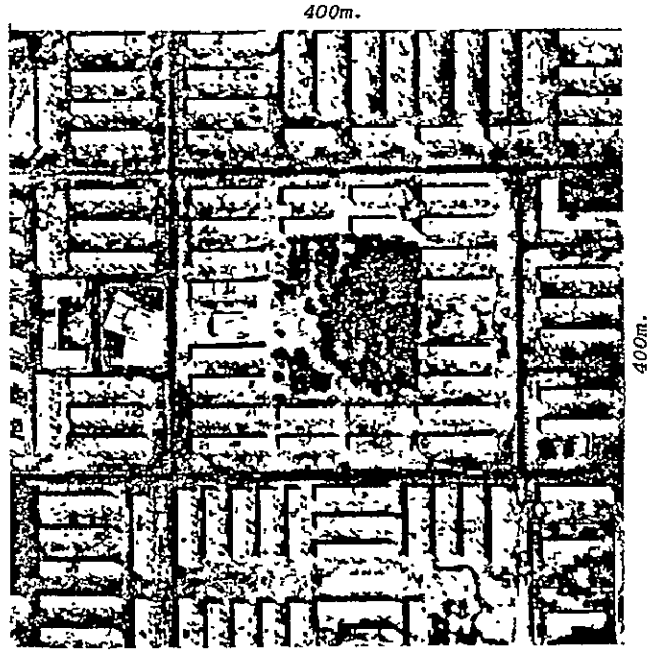
5,625
65
35
426
757
60
61
106
318

APPROXIMATE

335

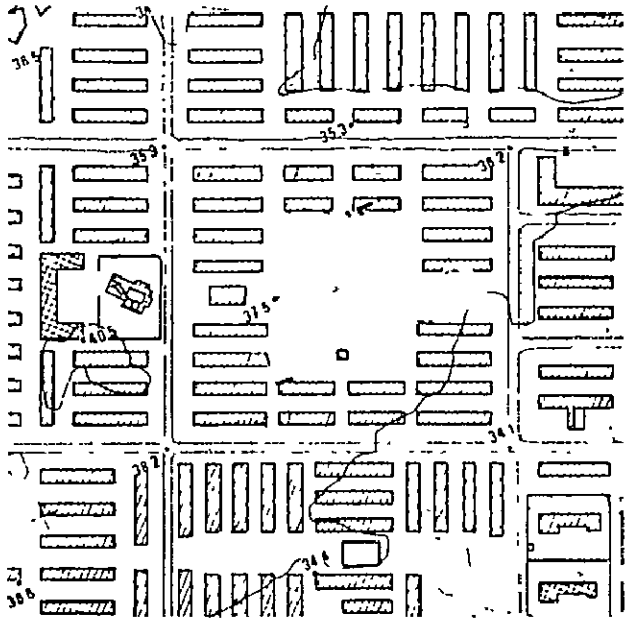
REFERENCE LAYOUTS

Each of the three reference layouts are represented by a 400m x 400m segment (16 Ha.). Both plans and aerial photographs are at a scale of 1/5000, from 1976.



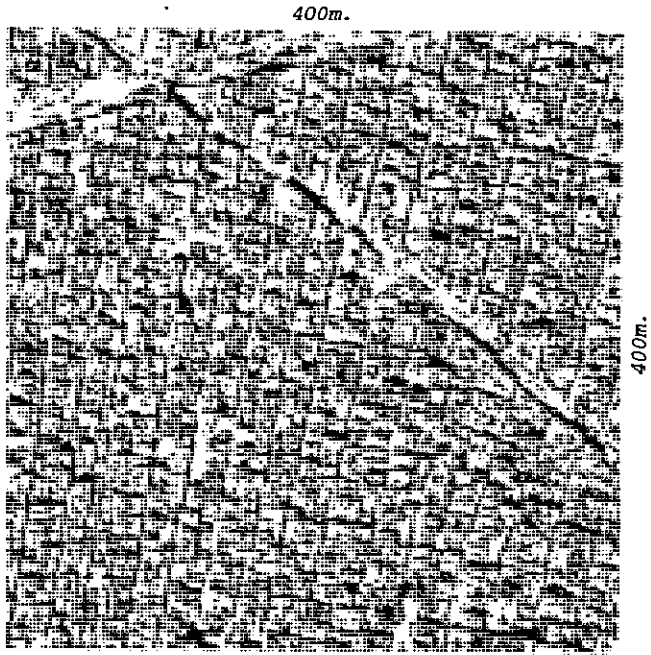
CURRENT PUBLIC DEVELOPMENT: AIN EL SIRA PROJECT

CURRENT PUBLIC DEVELOPMENTS: This type of "economic" housing is the standard product of government housing efforts for the low income, but represents only 7% of new construction in 1966-1976*. The basic form and design is repeated throughout Egypt. Basis of the design is the "Garden City" approach, but the costly plantings are gone and the high maintenance necessary for success is non-existent. Ain El Sira is one of the earliest projects built in 1951 south of Cairo on a reclaimed garbage dump. The blackened blocks were used in the calculations. Original plans were used.
PRIVATE AREA: 27% PUBLIC AREA: 73%
CIRCULATION LENGTH/AREA RATIO: 675 m/Ha.
UNIT DENSITY: 61 units/Ha. (1 floor), 183 units/Ha. (3 floors) (actually 4-5 floors)
AVERAGE UNIT SIZE: 45m^2

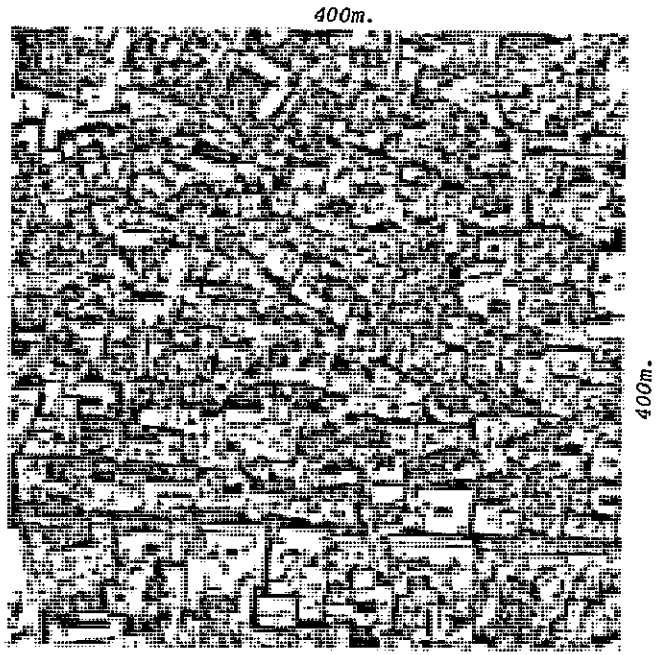


INFORMAL DEVELOPMENT: This type represents the vast sections of housing built around the outskirts of Cairo, outside of the formal legal housing market. In 1966-76 it represented 77%* of all new housing construction. Small agriculture plots surrounding Cairo are sold and subsequent housing development is in progressive stages, from a single story unit to 4-5 stories which provide rental units for extra income. The Imbaba sector to the northwest of Cairo is typical of these areas. Detailed 1/500 field survey plans were used as the base for calculations.
PRIVATE LAND: 73% PUBLIC LAND: 27%
CIRCULATION LENGTH/AREA RATIO: 471 m/Ha.
UNIT DENSITY: 85 units/Ha. (1 floor), 225 units/Ha. (3 floors)
AVERAGE LOT AREA: 86m^2

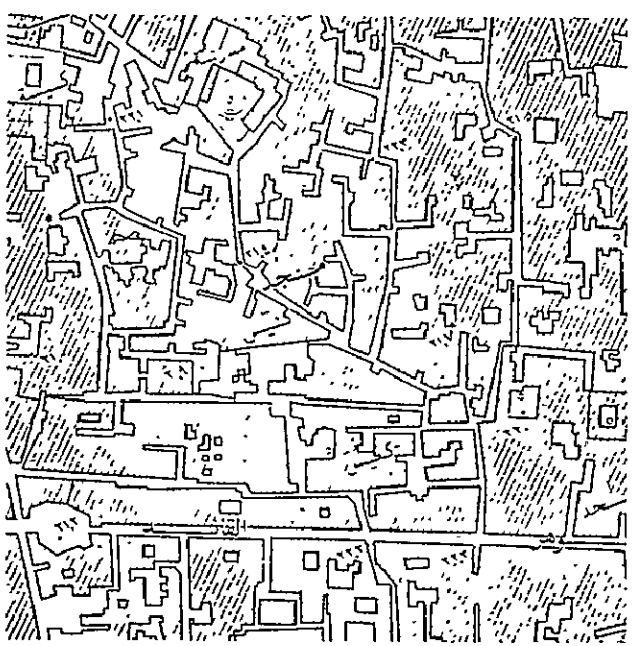
TRADITIONAL DEVELOPMENT: The Gamalyia section of Cairo is used as the example of this type. Although much of hte area is in disrepair, and data is very tentative, sufficient plans exist from which to approximate the basic indeces. 1952 plans at scale 1/500 were a base for the calculations.
PRIVATE LAND: 88% PUBLIC LAND: 12%
CIRCULATION LENGTH/AREA RATIO: 296 m/Ha.
UNIT DENSITY: 41 units/Ha. (1 floor); 123 units/Ha. (3 floors)
AVERAGE LOT AREA: 216m^2



INFORMAL DEVELOPMENT:
IMBABA SECTOR



TRADITIONAL DEVELOPMENT:
MEDIEVAL CAIRO



LAND UTILIZATION

The index of land utilization is a qualification of the land in relation to user, physical controls, and responsibility. The index here considered is different from "land use", which considers the function of a parcel of land (commercial, residential, industrial, etc.). Land utilization looks at how land is actually used, irregardless of legal tenure considerations. Two types of utilization are considered: 1)public: that land which is essentially used for circulation - streets, walkways, paths, and left over open spaces. The user here is anybody, an unlimited number, with minimum controls (mostly legal) and clear responsibility of a public agency. 2)private: that land which is used for residential, commercial, industrial purposes; land which is sold, usually through freehold tenure. The users are very limited, usually owners or tenants with maximum controls,physically, legally and socially, and clear responsibility of the individual or user. (See URBANIZATION PRIMER, by Caminos, Goethert; MIT Press 1978; pages 92-95 for further discussion).

A coherent relationship among users, responsibility and physical controls is necessary in any project. Proper controls should define the extent of a territory, facilitate its specific function, and allow and encourage users to assume their responsibility in terms of maintenance and operation.

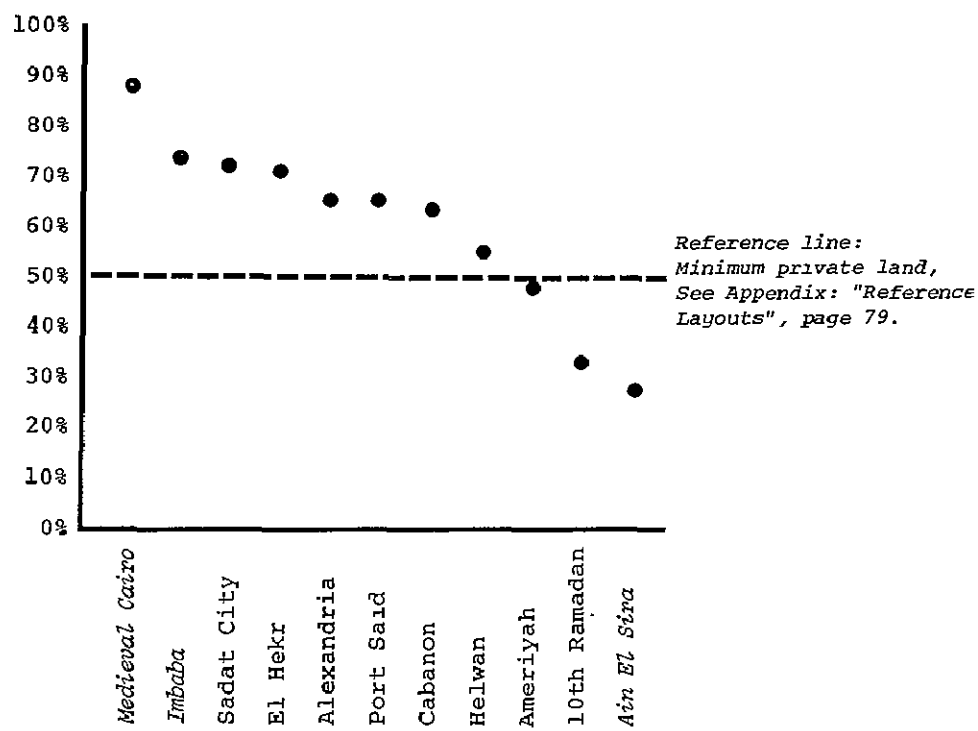
TABLE OF LAND UTILIZATION

Project	*Private Land*	*Public Land*	
Medieval Cairo	*88%*	*12%*	
Imbaba	*73%*	*27%*	
Sadat City	72%	28%	
El Hekr	71%	29%	Group 1
Alexandria**	65%	35%	
Port Said	65%	35%	
Cabanon	63%	37%	
Helwan	54%	46%	Group 2
Ameriyah	48%	52%	
10th of Ramadan	31%	69%	
Ain El Sira	*27%*	*73%*	

* Projects in italics are included for reference.

** Alexandria has lots grouped around a circulation area/court which is considered private.

GRAPH OF PERCENTAGE OF PRIVATE LAND



Excessive public land places an undue burden on the limited government resources for both initial capital costs and continuing maintenance costs, which could better be directed elsewhere.

Calculation of private and public land is very simple by inspection: in most cases, the lots are private and the remainder is public. In public housing the buildings become the only private areas. Block areas are considered to extend to the centerline of the bounding streets.

OBSERVATIONS

There is a 2.3 times difference between the highest and lowest values. Disregarding both extremes (Medieval Cairo and Ain El Sira), the difference drops to 1 1/2 times.

The layouts with the higher percentages of private land tend to be those with large lots, relatively narrow streets, long blocks, and a minimum of ambiguous, unspecified open areas. (Note Sadat City and El Hekr, compared to 10th of Ramadan.) Imbabe has a high percentage because of very narrow streets, and inconsiderate long blocks (difficult for pedestrians, which is the common mode of movement). Medieval Cairo uses cul-de-sacs to achieve the high amount of private land.

The bias in the index penalizes two situations: 1) blocks with "mini-parks" and ambiguous open spaces. It is felt that parks, playgrounds, etc., should be combined in function and location to focus the limited maintenance efforts of the public authorities. Small, dispersed open areas ("parks") invite neglect by their overwhelming number and limit their useful recreational function by inviting unwanted activities (car parking, garbage dump, etc.). 2) blocks with redundant circulation: blocks that are very short with superfluous cross-streets. The extra streets make channeling of movement difficult and they generally do not enhance movement either. Many cases have been seen where these areas were blocked with refuse and resulted in a complete waste of land and in addition to being health hazard.

CIRCULATION LENGTH/AREA RATIO

Circulation length is the total of streets, walkways, and paths in a project. For comparative purposes, the unit circulation length is derived in terms of meters per hectare. The lengths are determined for both formal, paved areas, as well as the informal, non-planned areas which in actual fact are also pure circulation elements.

The length of circulation is directly related to costs in a project. Paving and maintenance of streets, etc. are direct costs, as well as the utility networks which invariably follow the above ground circulation. Although a precise 1:1 relation does does not exist, both parallel sufficiently to allow this assumption. Indirect costs that result from the street network are mail delivery, fire protection, police protection, garbage collection, etc. (Many of the services, however, are not actually provided in most of the existing neighborhoods.)

Too many streets are redundant and wasteful, but allow enhanced pedestrian access; few streets lower utility network costs, but make pedestrian access less convenient.

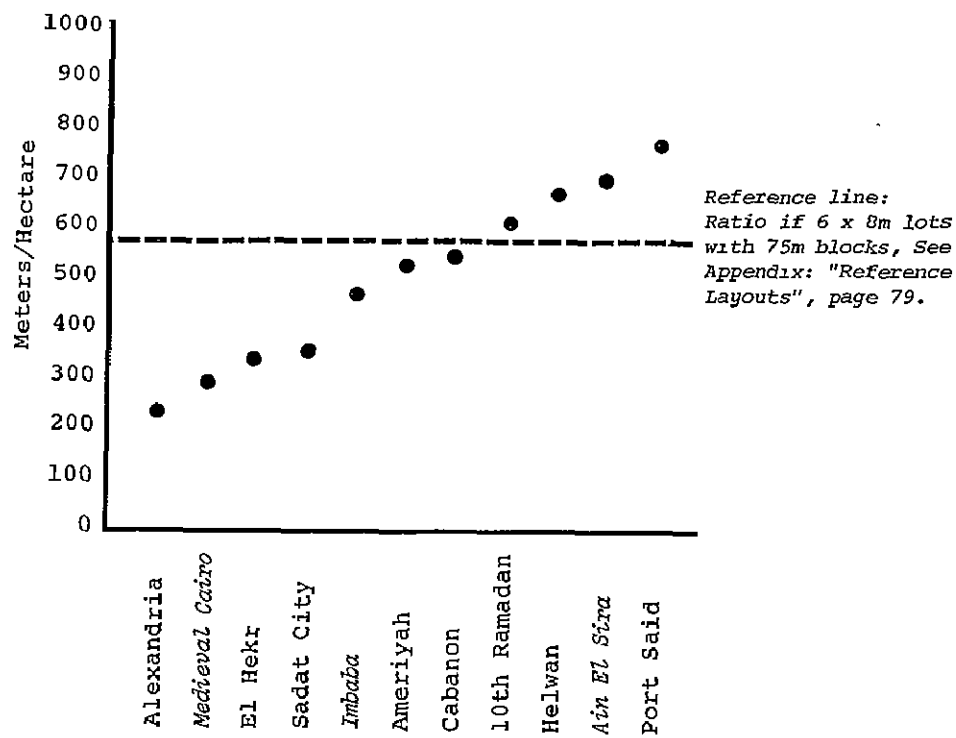
Calculation of the index is through measurement of the actual lengths. Perimeter streets count as one-half since they are properly shared with the adjacent property. All circulation avenues are counted, whether paved or

TABLE OF LENGTH/AREA RATIOS

Project	*m/Ha.*		
Alexandria	217**		
Medieval Cairo	*296*	Group 1:	Average 294 *60% less than Group 3* *48% less than Group 2*
El Hekr	321		
Sadat City	342		
Imbaba	*471*		
Ameriyah	533		
Cabanon	554	Group 2:	Average 565 *24% less than Group 2*
10th Ramadan	609		
Helwan	656		
Ain El Sira	*675*	Group 3:	Average 696
Port Said	757		

*Projects in italics are included for reference.
**Alexandria would be 508 m/Ha. and rank between Imbaba and Ameriyah if shared cluster courts are considered public domain. Alexandria would shift to Group 2.

GRAPH OF LENGTH/AREA RATIOS



not, whether formally decreed or not.

Ways to improve the length/area index is through extending of the blocks to a minimum length, perhaps 75 m (note Cabanon) and avoidance of blocks with only a single row of lots (note 10th of Ramadan).

OBSERVATIONS

The layouts readily divide into three groups: Group 1 with an average of 294 m/Ha.; Group 2 with an average of 565 m/Ha.; and Group 3 with an average of 696 m/Ha. Group 1 is two and one half times less than Group 3.

In Group 1, the low ratio is characteristic of very large lots and long blocks (Note Sadat City and El Hekr) or because of a "clustered" arrangement of lots, as in Medieval Cairo, and the similar recent use in Alexandria.

The use of large lots is a luxury, and is probably an atypical situation which cannot be followed in future projects. Arranging small lots in a clustered fashion around a shared court as in Alexandria is a device which should perhaps be adapted more extensively. (See also "1978 Interim Housing Report, page 71.)

In Group 2, lot sizes tend to be similar in all of the examples, but blocks are either short (Note 10th of Ramadan and Cabanon) or spaced widely apart requiring extra infrastructure lines (Note Ameriyah). Improvements could readily be made by combining lots into longer blocks and adjusting their arrangment.

In Group 3, clearly excessive ratios follow the use of walkup apartments (Note Ain El Sira and Port Said) or excessive ambiguous open spaces, requiring extra infrastructure lines (Note Helwan).

UNIT DENSITY

Density is the ratio of the total number of units in a given area and the area. Density is used as an index for determining the amount of utilities and services to be required. Services include schools, health clinics, parks, and utilities include water supply, sewage disposal, electricity, and streets. Low densities imply a larger amount of land for a given population and result in a higher per capita cost for land and infrastructure. Very high densities however can put an excessive load on services but at the same time can create negative social conditions. Limits which cause negative social situations are difficult to determine.

Density also provides an index on how much land is required in housing a given population. For example, low density neighborhoods (generally for higher incomes) require more land than housing an equal number of people at a higher density.

In Cairo, the tendency is for all types of dwellings to eventually expand vertically into multi-story dwellings, in wealthy and poor districts, for houses originally designed as villas to those which were one-room informal dwellings. Most of the expansions occur many years after their initial construction, and it is unclear if the founda-

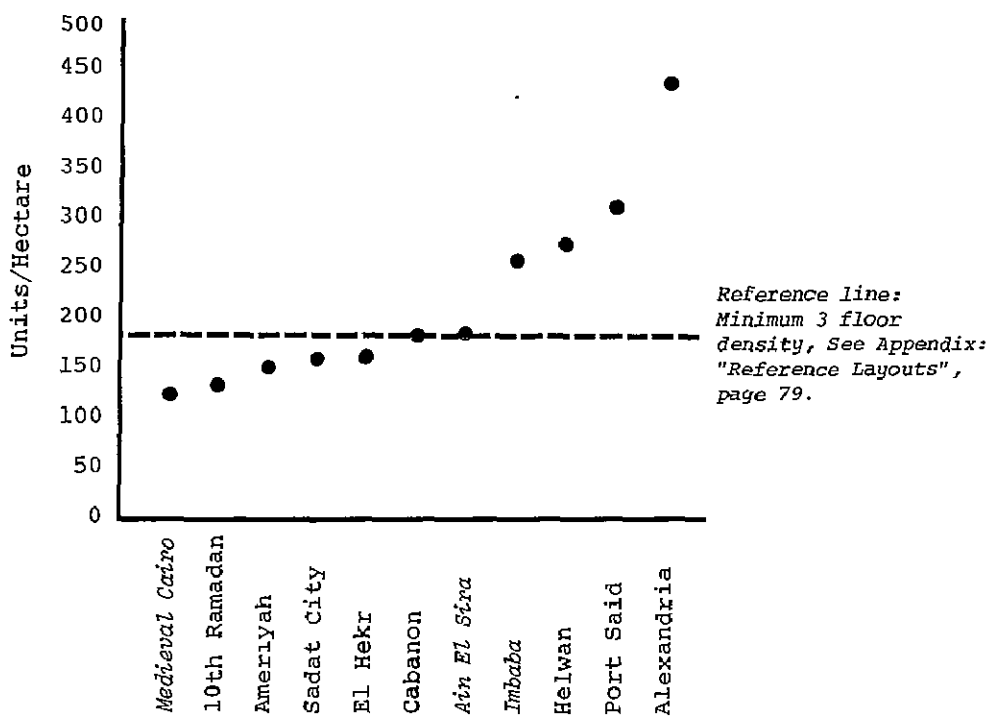
TABLE OF NET UNIT DENSITIES

Project	*1 Floor Units/Ha.*	*3 Floors Units/Ha.*	*Av. Lot m^2*	
Medieval Cairo	*41*	*123***	*216*	
10th Ramadan	43	129	72	
Ameriyah	50	150	97	Group 3: Average 155 *(3 floors)*
Sadat City	52	156	139	
El Hekr	54	162	131	
Cabanon	60	180	105	
Ain El Sira	*61*	*183*	*45*	
Imbaba	*85*	*255*	*86*	
Helwan	92	276	59	Group 2: Average 283 *(3 floors)*
Port Said	106	318	61	
Alexandria	147	441	44	Group 1: Average 441 *(3 floors)*

*Projects in italics are included for reference.

**Misleading unit density because of very large average lots (many mosques) and many tenements which result in very high population density.

GRAPH OF NET UNIT DENSITIES (THREE FLOORS)



tion were originally designed to accommodate the extra floors. Utilities and public services also would be affected, since an additional unplanned fast load is added.

Because of the variance in the number of floors among the projects, and since invariably all of the progressively built dwellings will expand - despite restrictions and designs to the contrary - a uniform 1 story density is used for comparison. A 3 story density is also included as the saturated average density of an area.

Calculation of density was made by simply counting the number of lots and dividing by the total area of the block from the centerlines of the bounding streets.

OBSERVATONS

Group one follows the expected pattern in that the smallest average lot size results in the highest density. It is interesting to note that Ain El Sira with a lot size almost the same has a denisty 2 1/2 times smaller. This is because Ain El Sira has only 27% of the land for dwellings, as opposed to 65% for Alexandria.

The lowest density found in Medieval Cairo is misleading. The very large average lot size($216m^2$) results in each lot being further subdivided into multi-unit tenements. Sadat City, El Hekr, and Cabanon may also face a ruther subdividing of the lots. The 10th of Ramadan design with an average lot size more appropriate to Group 2 remains in Group 1 because of the extensive open areas.

The very high densities of Group 2 and 3 are balanced with large open areas which do not show up in the block calculations. Imbaba, however, does not have any larger open spaces and little relief from the high density is available.

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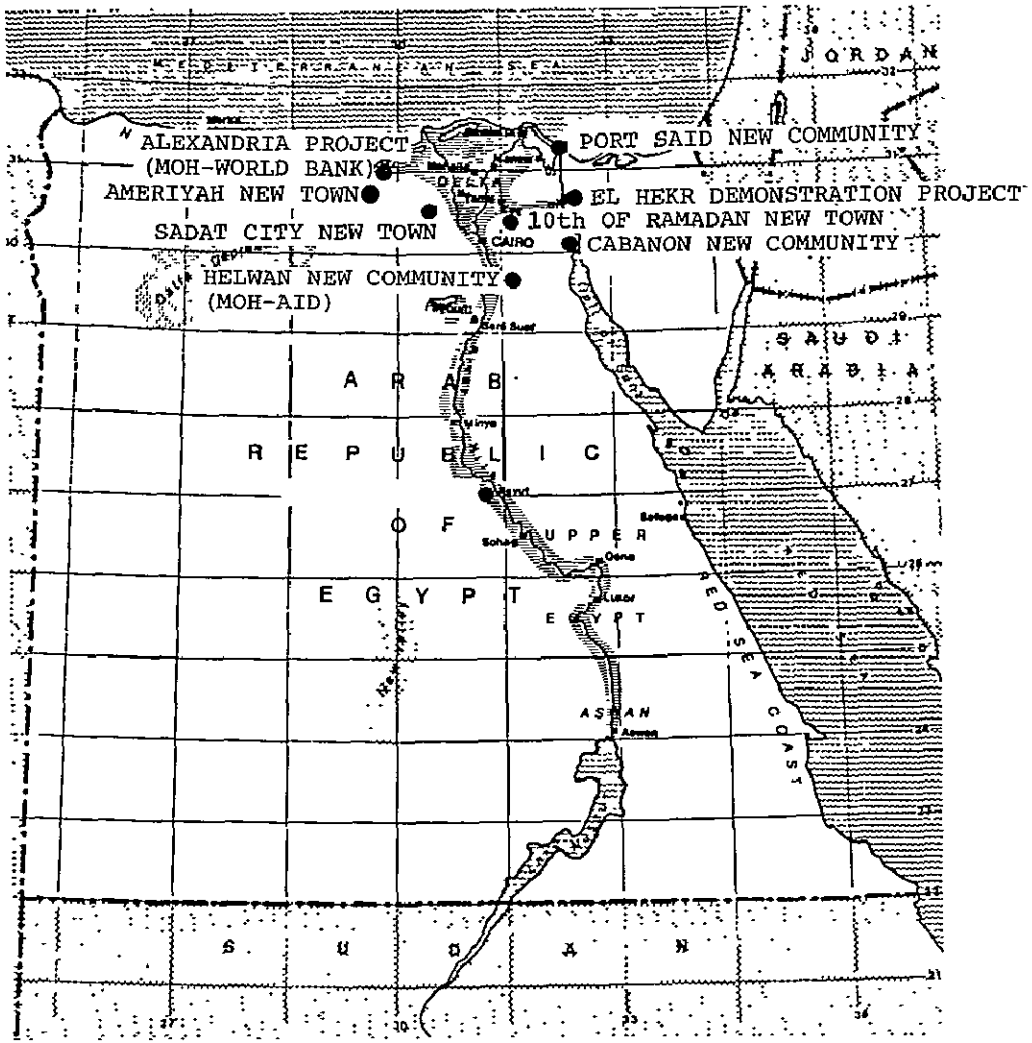
APPENDIX

Location of Projects in Egypt
Location of Selected Blocks
Reference Indeces

LOCATION OF PROJECTS IN EGYPT



MAP OF EGYPT

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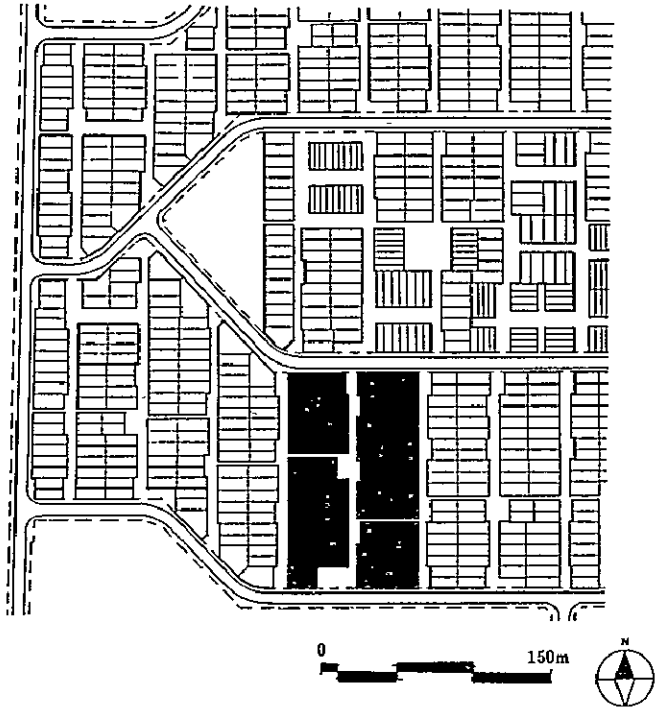
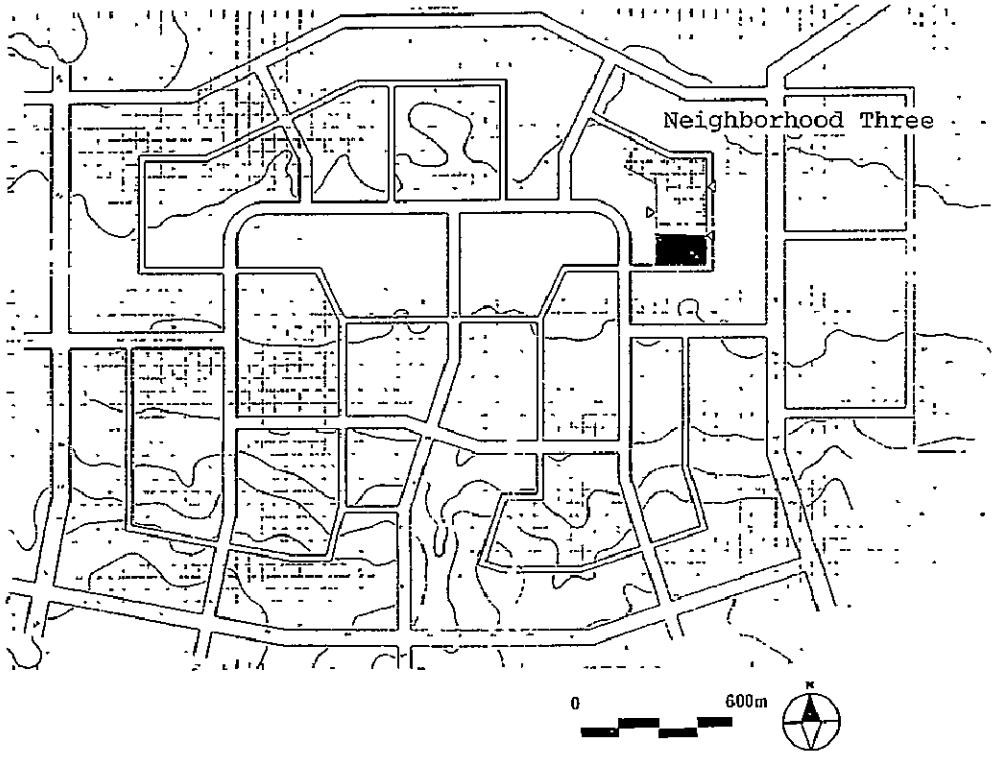
LOCATION OF SELECTED BLOCKS



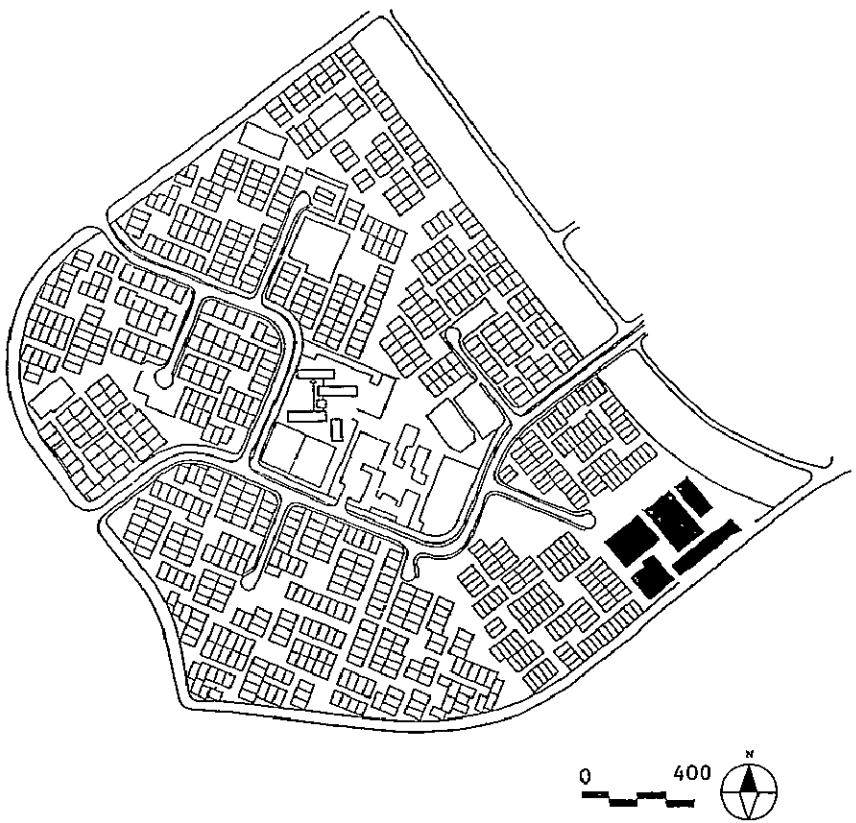
SADAT CITY NEW TOWN



AMERIYAH NEW TOWN

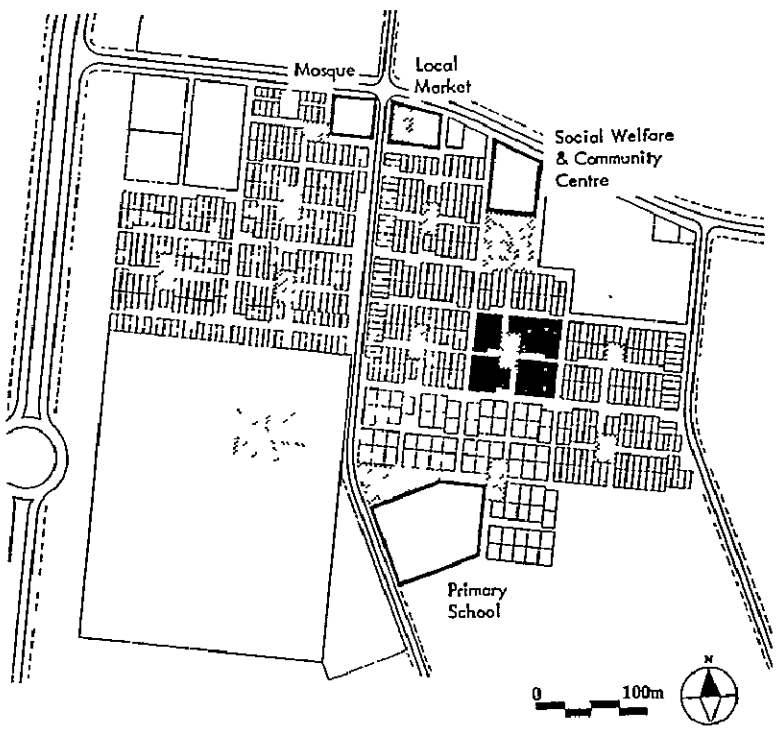
SOURCE OF INFORMATION: "The Planning of Sadat City", Final report: Elements of the Plan, September 1977, working drawings, summer 1980.

SOURCE OF INFORMATION: "Expandable Minimum Ameriyah Dwelling", New Ameriyah City, Summer 1979.



10TH OF RAMADAN NEW TOWN
(CORE HOUSING SECTOR)

SOURCE OF INFORMATION: "First State Final Report", 1978. "Draft Master Plan Report", January 1976. Working drawings of the core house area, 1979.



CABANON NEW COMMUNITY
(SUEZ)

SOURCE OF INFORMATION: "Cabanon New Community, Suez Demonstration Projects, Volume 2," Draft final report, February 1978.

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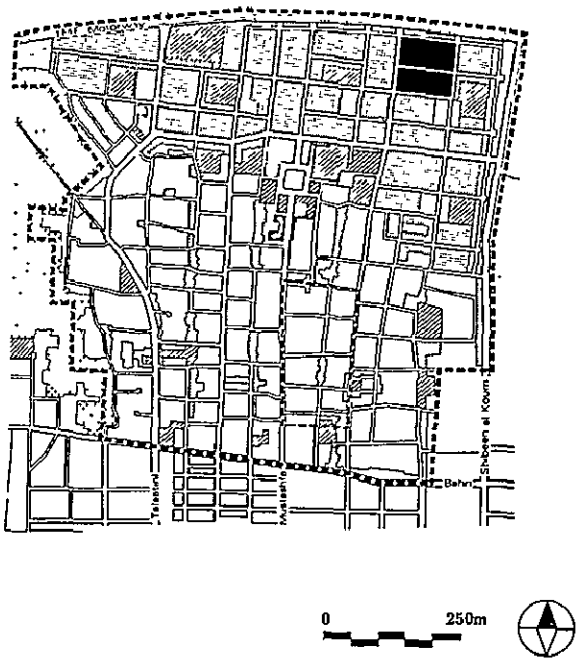
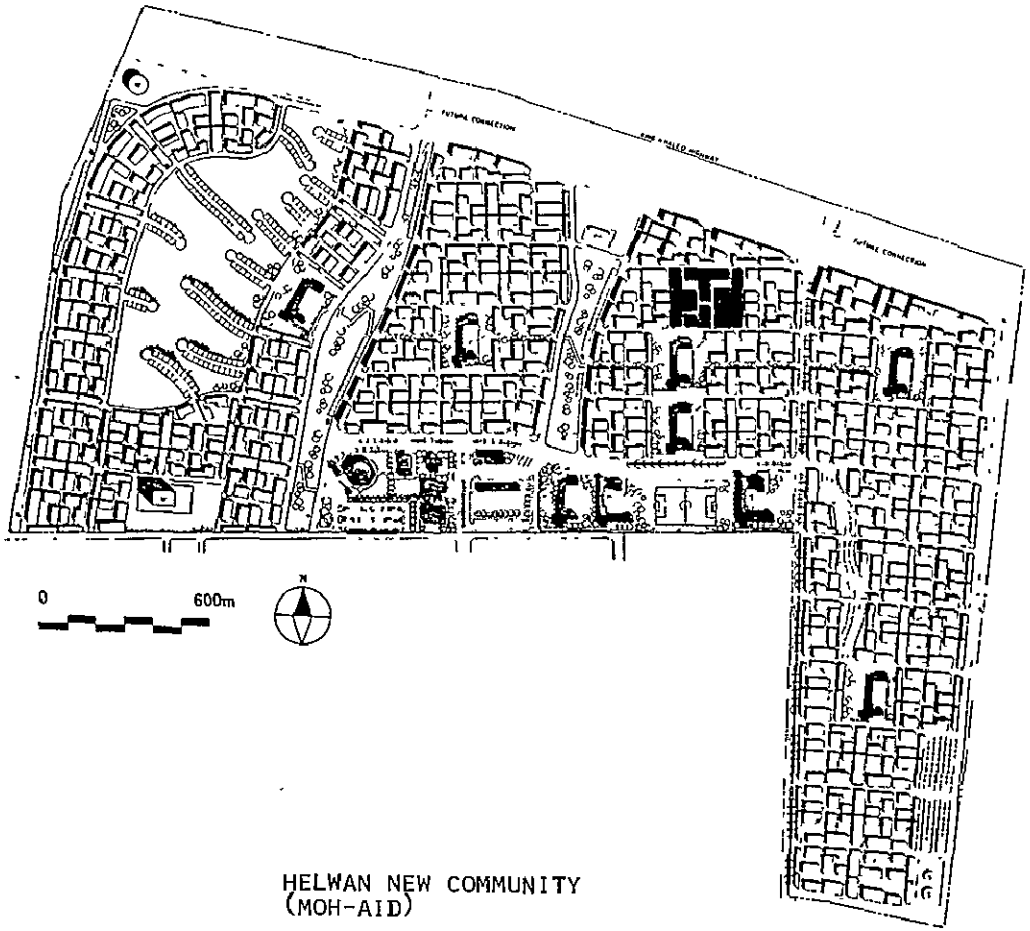


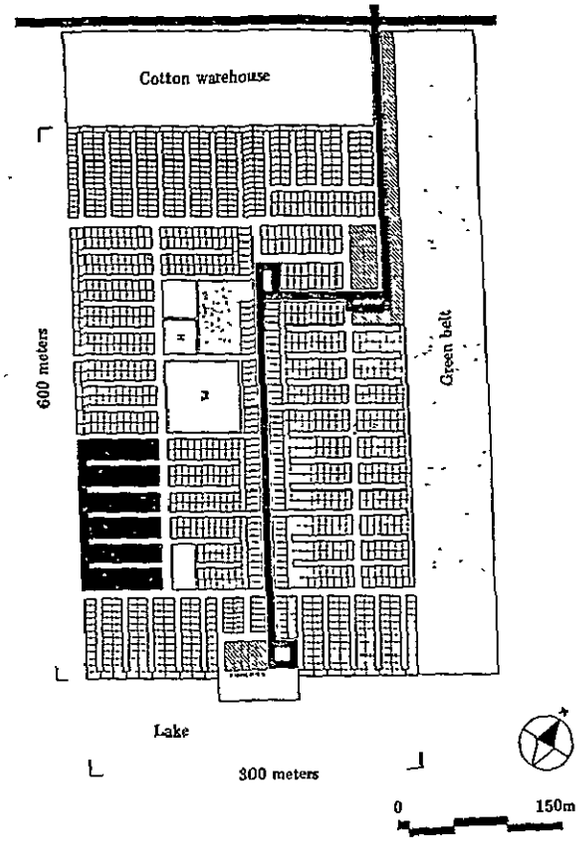
EL HEKR DEMONSTRATION PROJECT
(ISMAILIA)

SOURCE OF INFORMATION: "Ismailia Demonstration Projects, Final Report", Volumes I, II, III, April, 1978.



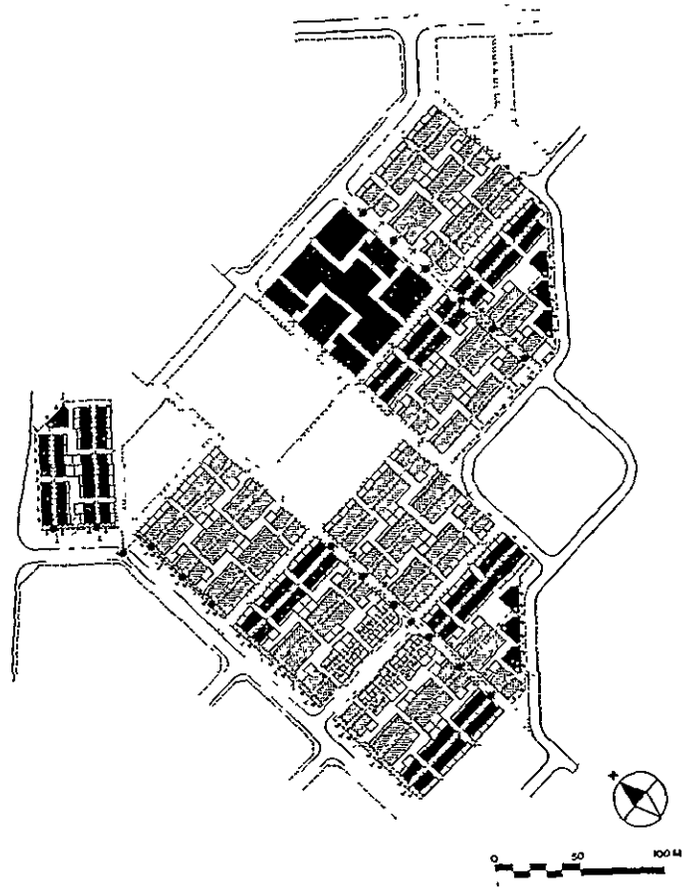
HELWAN NEW COMMUNITY
(MOH-AID)

SOURCE OF INFORMATION: "Final Engineering Feasibility Report," the Joint MOHR-USAID Housing and Community Upgrading Program for Low Income Egyptians, September 1978.



ALEXANDRIA PROJECT
(MOH-WORLD BANK)

SOURCE OF INFORMATION: "Appraisal Report-Egypt Urban Project," June 6, 1978.



PORT SAID NEW COMMUNITY

SOURCE OF INFORMATION: "Port Said Demonstration Project, Summary Brochure," May, 1978.

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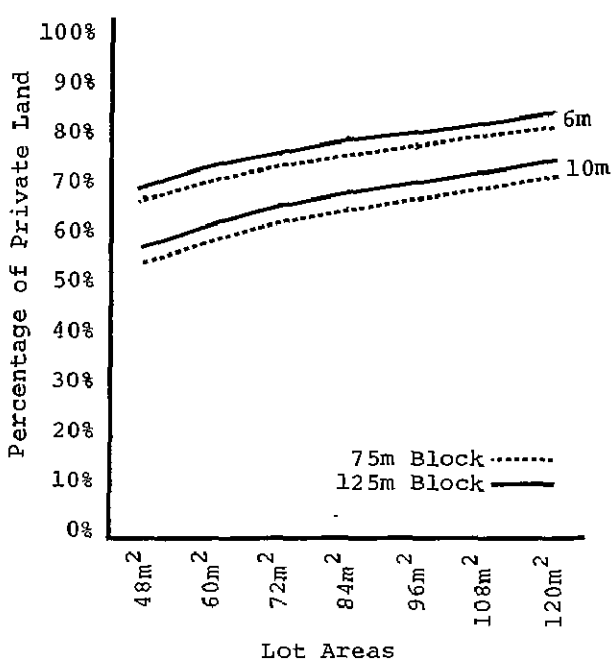
REFERENCE INDECES

Length/Area Ratio
Land Utilization Percentages
Net Densities

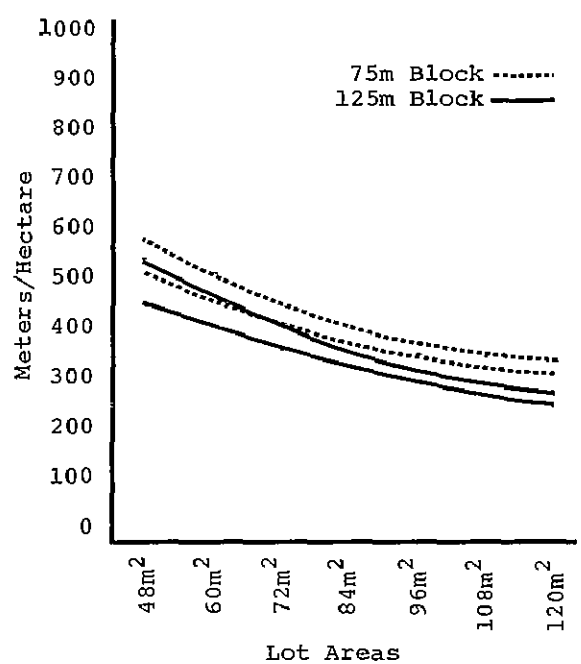
The reference indeces are developed from the sketches on the right. They represent typical configurations found in Cairo. Each of the blocks/lot layout sketches are shown to the same scale as those of the projects compared.

Parameters for the layouts are as follows:
LOT SIZES: A width of 6m was selected as an average dimension used in Egypt, as well as being a "standard" frontage for a lot determined by a two room width. The depth varies from 8m (a 48m^2 lot) to 20m (a 120m^2 lot), which encompasses the range of lot sizes used in the site and services projects. The larger the lot areas, the more efficient is the layout. With larger lots, private land increases from 20-30%; circulation length ratio drops approximately 40%; and densities decrease approximately 50%, but this is not a completely reliable indicator in that the larger lots would probably contain several units per floor.
STREET WIDTHS: Two widths are assumed, a 6m width for a minimum situation allowed by code, and a 10m width for more major streets, with clearly vehicular circulation. Widths are generous in that 3-4m width are not uncommon in the informal areas (note Imbaba). The larger width results in a 10% drop in private area, a 10% decrease in the circulation length ratio, and a decrease of 10-20% in density.
BLOCK LENGTHS: 75m and 125m lengths are chosen as being "desirable" from a utility line length standpoint and still appropriate for pedestrian circulation. (see URBANIZATION PRIMER, Caminos and Goethert, MIT Press 1978, for further discussion on block lengths). The block length increase results in a negligible 2% decrease in private land, a 8-14% decrease in the circulation length index (hence more economical) and a negligible increase in density.
DENSITIES: Net unit density for both 1 floor and 3 floor situations are derived as in the cases compared. (See discussion under "Net Densities".)

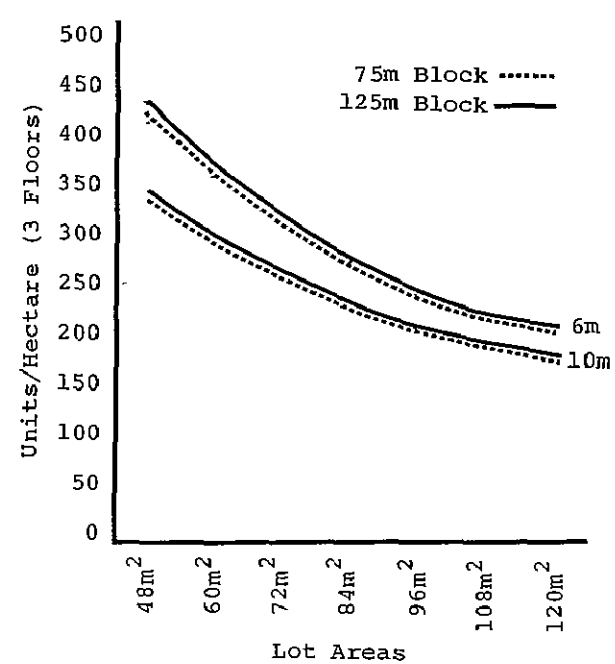
PERCENTAGE OF PRIVATE LAND



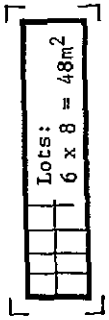
LENGTH/AREA RATIOS

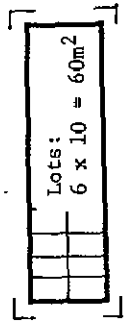


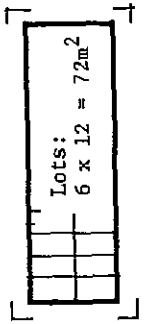
NET UNIT DENSITY (THREE FLOORS)

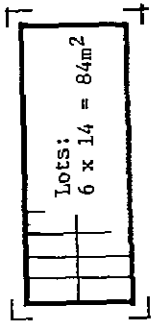


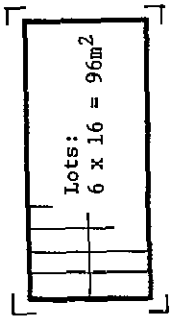
75 METER BLOCKS

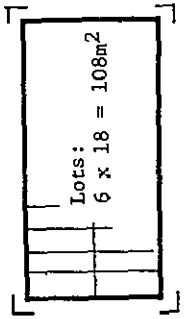


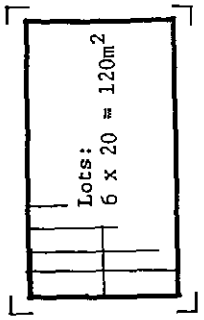






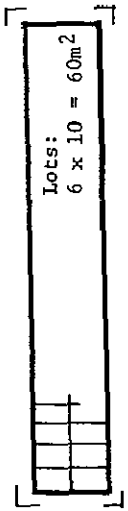


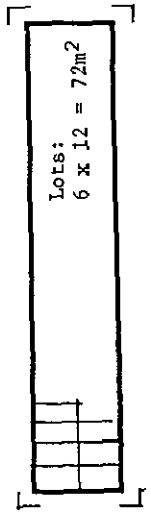


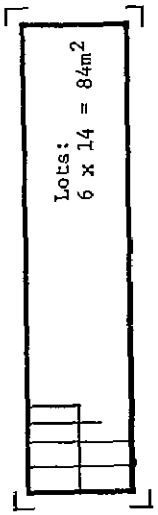


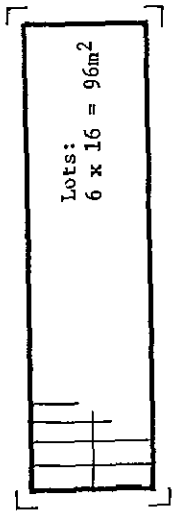
Street width (m):	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m
Length (m):	103	111	107	115	111	119	115	123	119	127	123	131	127	135
Area (m^2):	1782	2210	2106	2550	2430	2890	2754	3230	3078	3570	3402	3910	3726	4250
Length/Area (m/Ha):	578	502	508	450	457	411	418	380	387	355	362	335	341	318
Private land:	67%	54%	71%	59%	74%	62%	76%	65%	78%	67%	79%	69%	81%	71%
Public land:	33%	46%	29%	41%	26%	38%	24%	35%	22%	33%	21%	31%	19%	29%
Lot Den.1Fl.(N/Ha.):	140	113	119	98	103	87	91	77	81	70	73	64	67	59
Lot Den.3Fl.(N/Ha.):	420	339	357	294	309	261	272	231	243	210	219	192	201	177

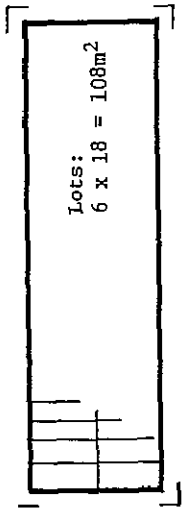
125 METER BLOCKS

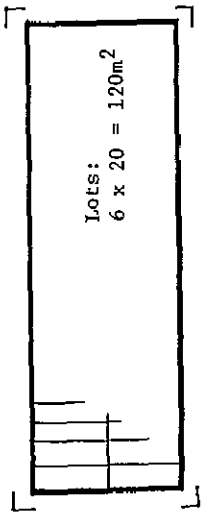












Street width (m):	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m	@6m	@10m
Length (m):	153	161	157	165	161	169	165	173	169	177	173	181	177	185
Area (m^2):	2882	3510	3406	4050	3930	4590	4454	5130	4978	5670	5502	6210	6026	6750
ength/Area (m/Ha):	531	445	461	407	410	368	370	337	340	312	314	291	294	274
Private land:	69%	57%	73%	62%	76%	65%	79%	68%	80%	70%	82%	72%	83%	74%
Public land:	31%	43%	27%	38%	24%	35%	21%	32%	20%	30%	18%	28%	17%	26%
ot Den.1Fl.(N/Ha.):	145	119	122	103	106	91	94	81	84	73	76	67	69	62
ot Den.3Fl.(N/Ha.):	435	357	366	309	318	273	282	243	252	219	228	201	207	186

EXPLORATORY GROWTH STUDIES OF CAIRO WITH 'LANDSAT' SATELLITE IMAGES

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Massachusetts Institute of Technology

with

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and

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Remote Sensing Center

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Academy of Scientific Research and Technology
Cairo, Egypt

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INTRODUCTION

Experiments were undertaken with imagery recorded by satellites in order to explore their use in determining the size of urbanized Greater Cairo and in monitoring its growth. Specifically the images were used for exploratory studies in three ways: 1) to calculate the aggregate size of the urbanized area, 2) to determine the growth of the built-up area over a 5-year period, and 3) to determine if specific housing types or sectors - particularly informal and formal - could be identified and monitored. The underlying goal throughout was to identify problem areas and to establish a base from which a definitive approach could be developed.

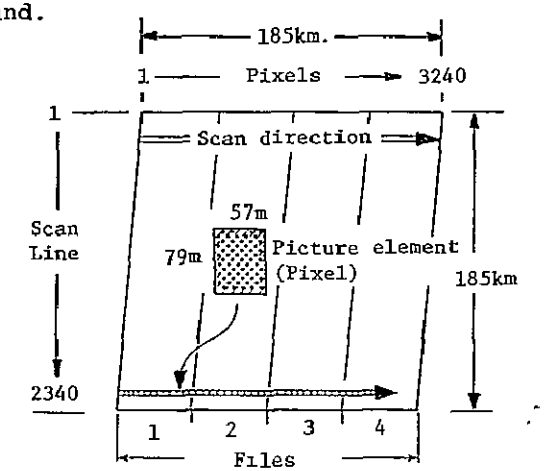
Landsat imagery provides a readily accessible and comparatively inexpensive tool for updating census information and monitoring the growth of a city. Yearly monitoring is feasible. The repetitious, uniform and consistent data provides a ready resource for easy use. Trends are readily identified, and an up-to-date inventory would be easy to maintain.

LANDSAT IMAGES: The first satellite designed for public use in exploring the resources of the earth was launched July 23, 1972, and called "Earth Resources Technology Satellite 1", abbreviated to ERTS-1. (Later the name was changed to "LANDSAT 1" to distinguish it from a similar satellite designed for oceanigraphic resource called "SEASAT"). A second satellite was launched January 22, 1975 (ERTS-2 or LANDSAT-2) and a third March 5, 1978. Each experimental satellite improved upon the other, with the eventual goal of developing a public worldwide operational system.

Images generated are in two forms: 1) Return beam vidicom (RBV), an image similar to a video "TV" image; and 2) Multi-spectral scanner image (MSS) available in digitized form on magnetic tape for computer manipulation or in image form, either black and white or color.

Four spectral bands are used, labeled 4, 5, 6, 7; with band 8 added in LANDSAT 3 for thermal data. Bands 1, 2, and 3 are for bookkeeping purposes. Bands 4 and 5 are from the visual spectrum (0.5-0.6, and 0.6-0.7 micrometers, the green and red) with Band 5 emphasizing cultural features as metropolitan areas. Bands 6 and 7 are in the near-infrared spectrum (0.7-0.8, and 0.8-1.1 micrometers). Various combinations of single bands are used to identify specific categories of interest.

The standard image frame contains an area 185 km x 185 km, composed of 3240 picture cells or "pixels" horizontally and 2340 scan lines vertically. Each pixel approximates 79 m x 56 m on the ground.



The satellite repeats its rotation of the earth each 18 days; about 20 times a year, at the same time of day. It is a sun synchronous orbit, allowing clear morning light for the images.

(For detailed additional information, see the following two sources: "Remote Sensing and Image Interpretation", by Thomas Lillesand and Ralph Kiefer, John Wiley & Sons, 1979, and "The EROS Data Center", Allen H. Watkins, U.S. Department of the Interior, Geological Survey, 1978.

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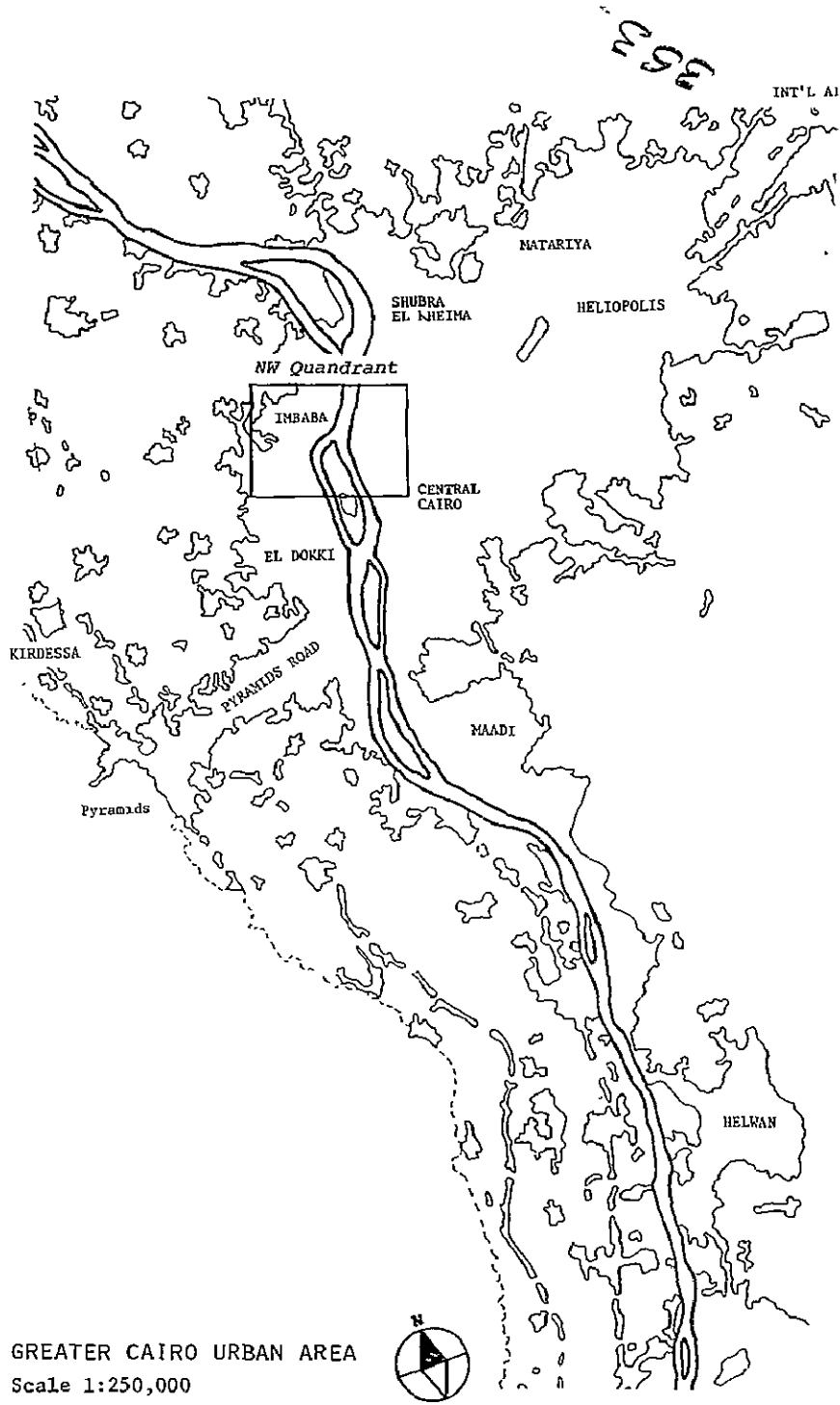
BOUNDARIES: It was impossible with present equipment and techniques to match the boundaries of the semi-official Greater Cairo Urban Area with the Landsat image. Therefore, a rectangular section (sector 11) of 510 pixel width and 585 scan line depth was selected as the base for comparison to minimize extraneous areas. The upper limit was placed above the village of Qalyub, the lower limit below Helwan (the image is abbreviated but Helwan is still included in the calculations) The left and right edges were then visually adjusted to minimize the amount of agriculture area. The resultant values of built-up areas include the surrounding villages; therefore, growth is a combination of village expansion and urban development on the fringe of Cairo.

There is not a precise match between the 1973 and 1978 images. The 1978 is shifted slightly to the west.

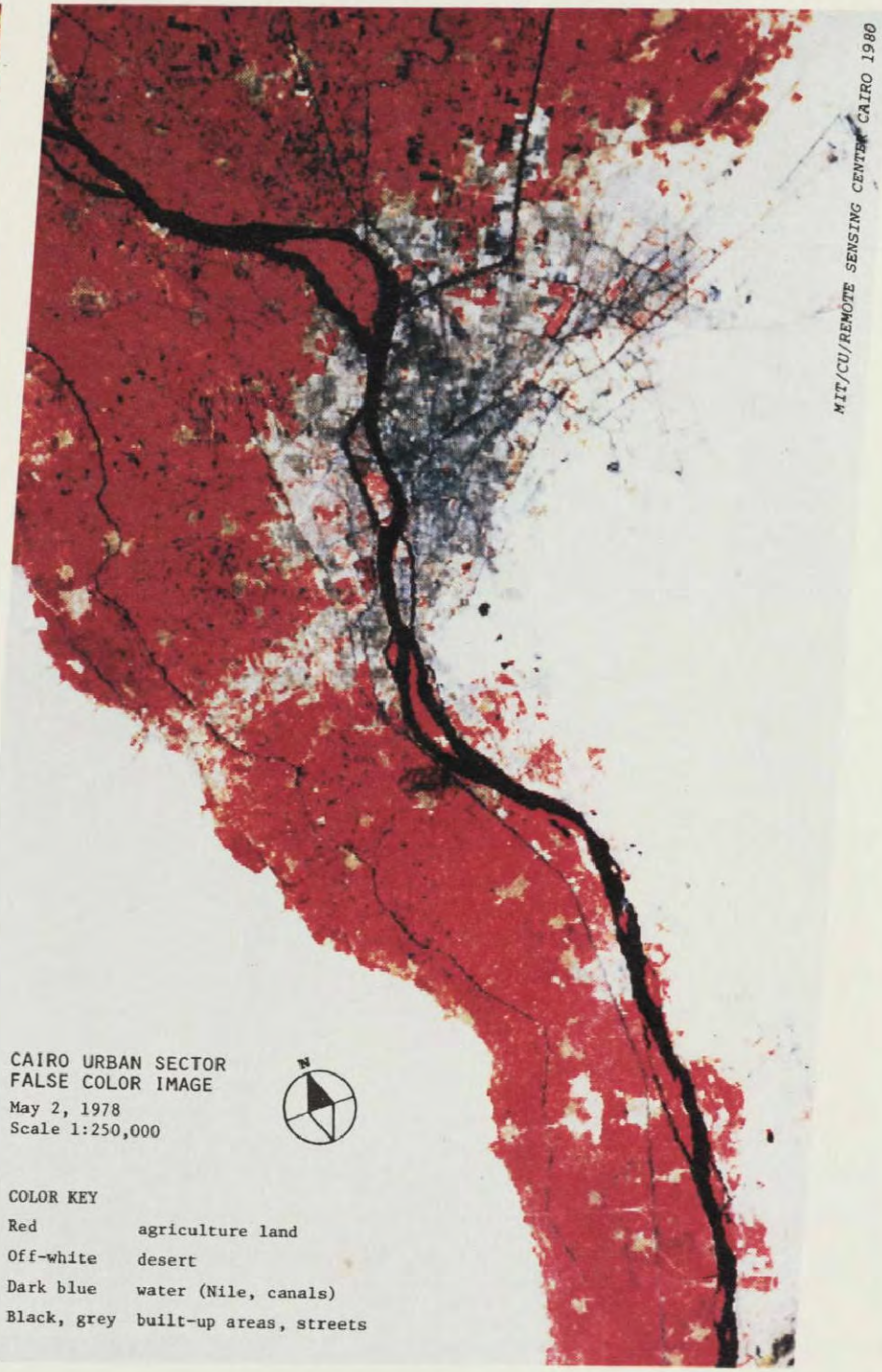
EQUIPMENT: All of the technical work was carried out at the Remote Sensing Center, Academy of Scientific Research and Technology, Cairo. Technical assistance was provided by personnel at the Center. The categorizations were done during two periods: 1 week in March and 2 weeks in June.

The equipment available was a Bendix Multi-Spectral Data Analysis System (M-DAS), with a CONRAC CRT screen and a Digital Equipment Corporation PDP 11/35 central processing unit with DEC magnetic tape input, 9 channels. Output was through keyboard or through an Optronics system P-1700 digitizer and photo-writer for negatives.



GREATER CAIRO URBAN AREA
Scale 1:250,000

EGYPTIAN DELTA
FALSE COLOR IMAGE
May 2, 1978
Scale 1:1,000,000



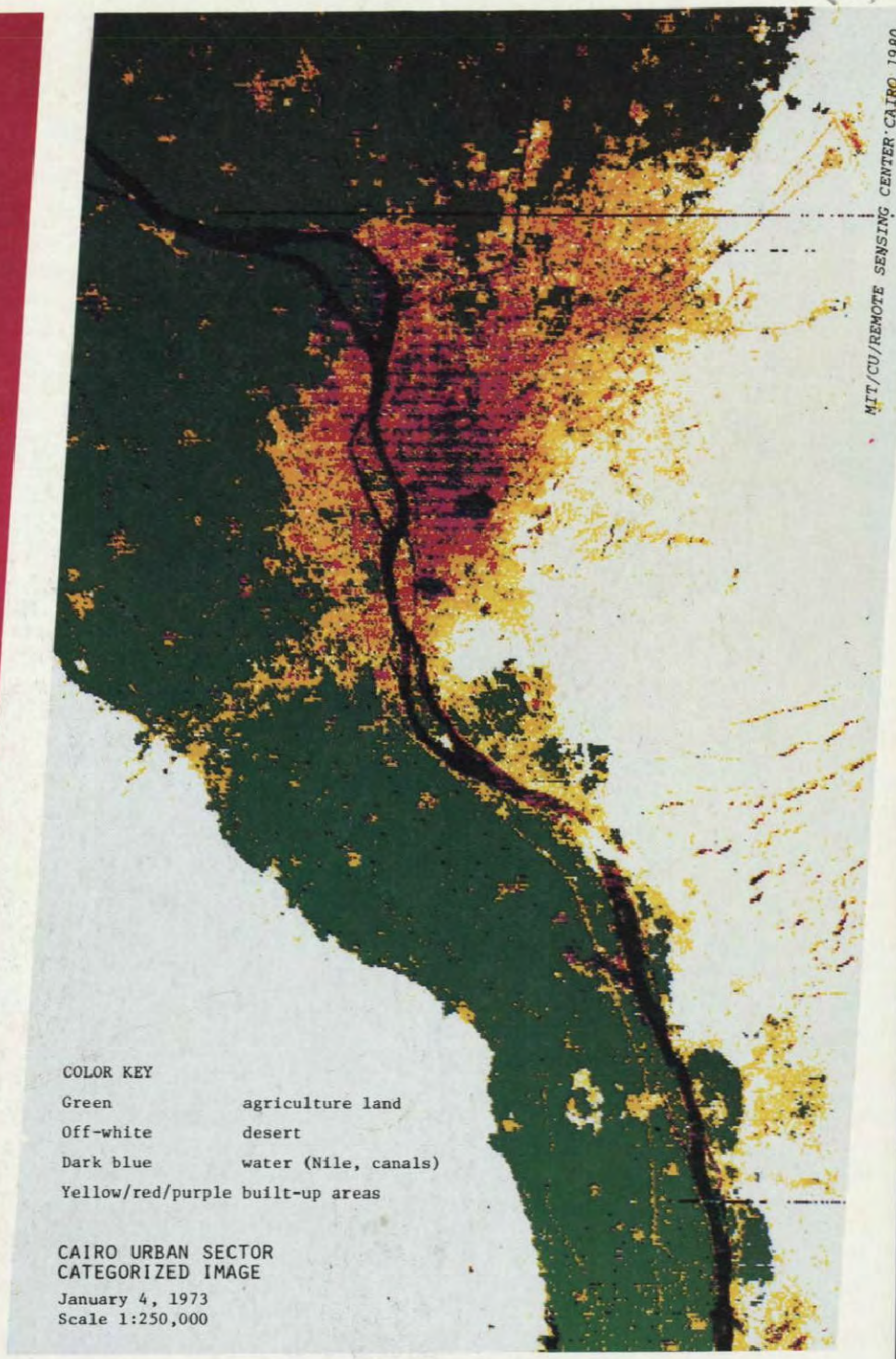
CAIRO URBAN SECTOR
FALSE COLOR IMAGE
May 2, 1978
Scale 1:250,000

COLOR KEY

Red	agriculture land
Off-white	desert
Dark blue	water (Nile, canals)
Black, grey	built-up areas, streets

MIT/CU/REMOTE SENSING CENTER CAIRO 1980

CAIRO URBAN SECTOR
PRELIMINARY COLOR SLICED IMAGE
January 4, 1973
Scale 1:250,000

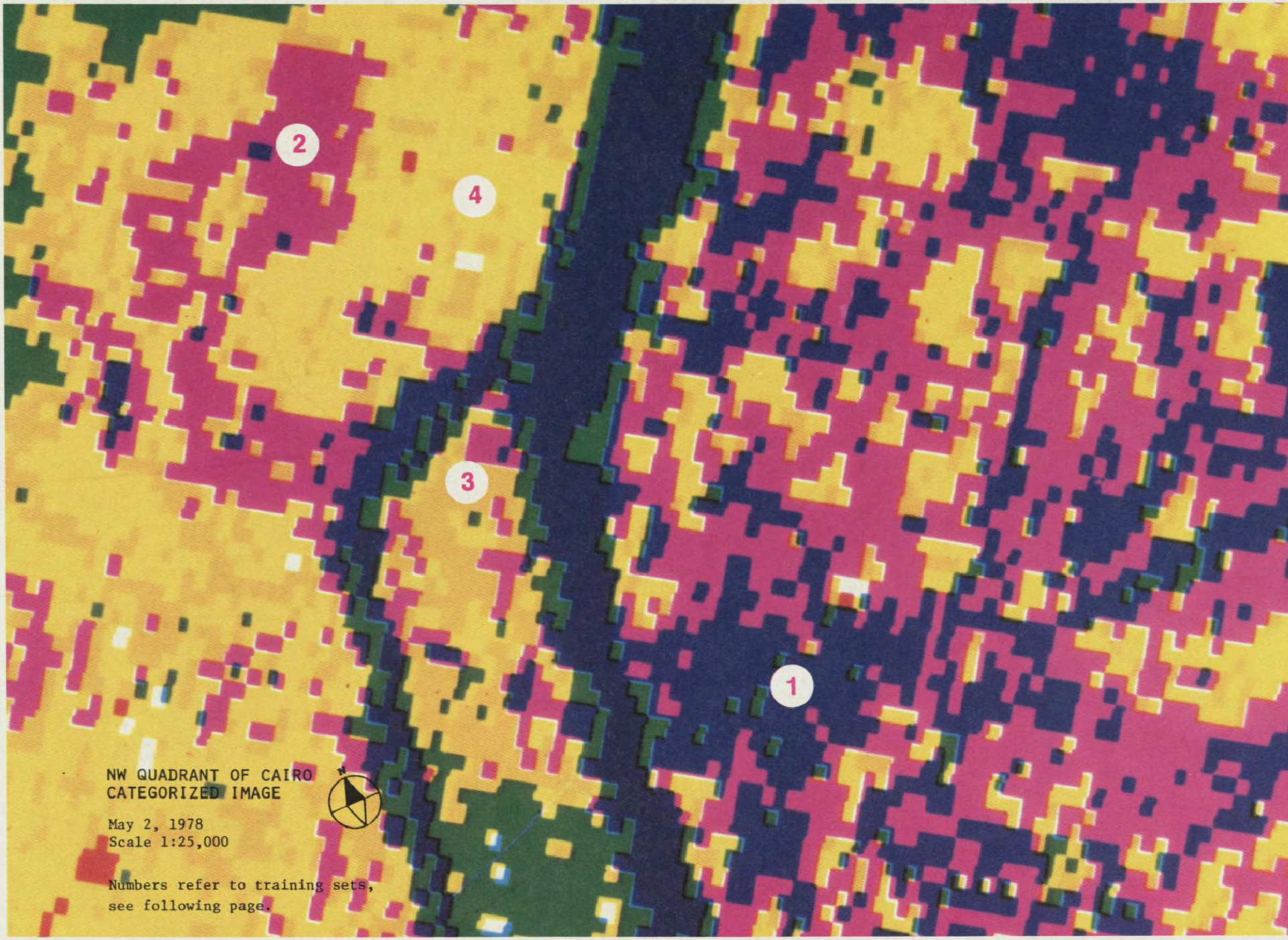


COLOR KEY

Green	agriculture land
Off-white	desert
Dark blue	water (Nile, canals)
Yellow/red/purple	built-up areas

CAIRO URBAN SECTOR
CATEGORIZED IMAGE
January 4, 1973
Scale 1:250,000

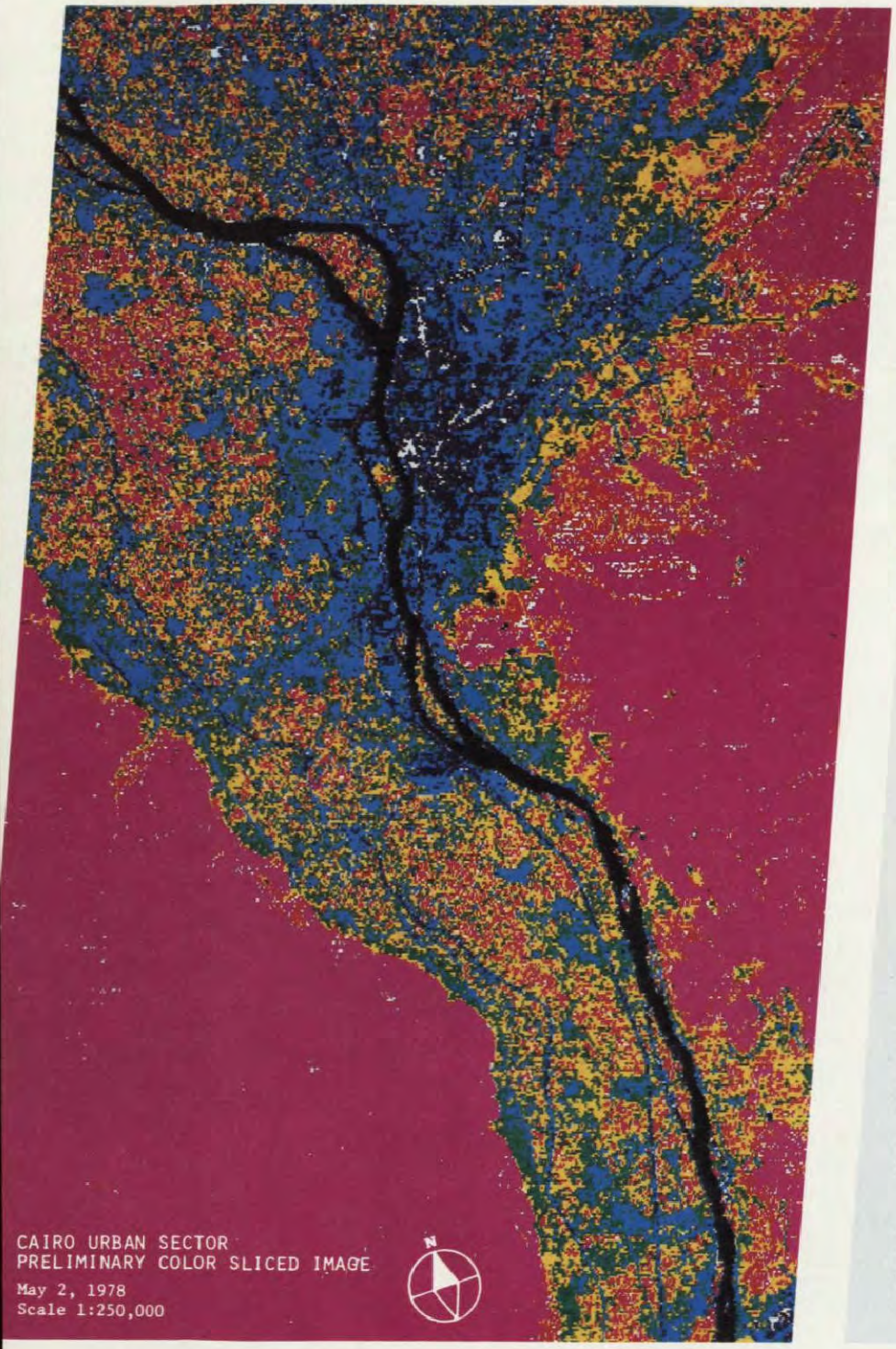
MIT/CU/REMOTE SENSING CENTER CAIRO 1980



NW QUADRANT OF CAIRO
CATEGORIZED IMAGE

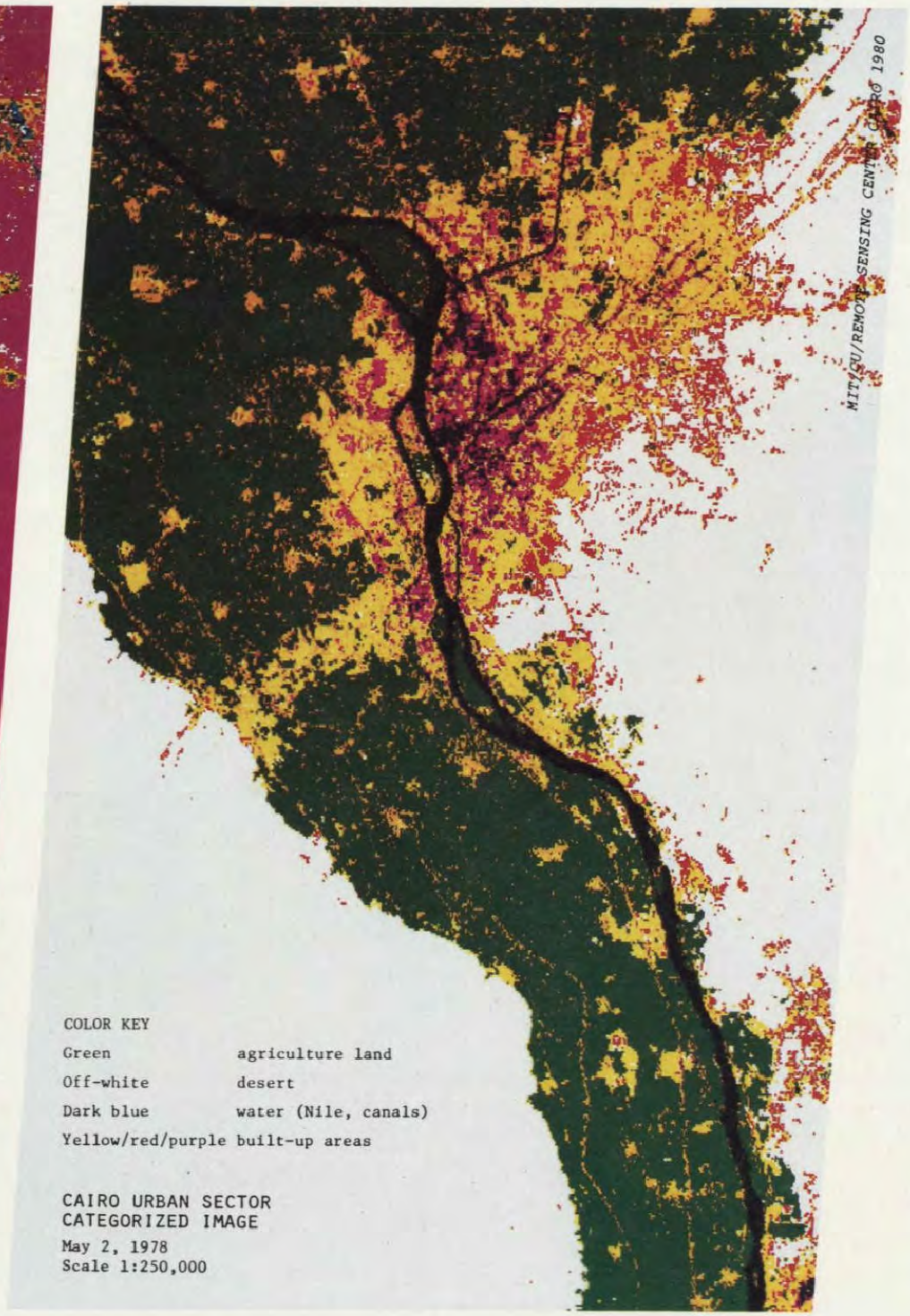
May 2, 1978
Scale 1:25,000

Numbers refer to training sets,
see following page.



CAIRO URBAN SECTOR
PRELIMINARY COLOR SLICED IMAGE

May 2, 1978
Scale 1:250,000

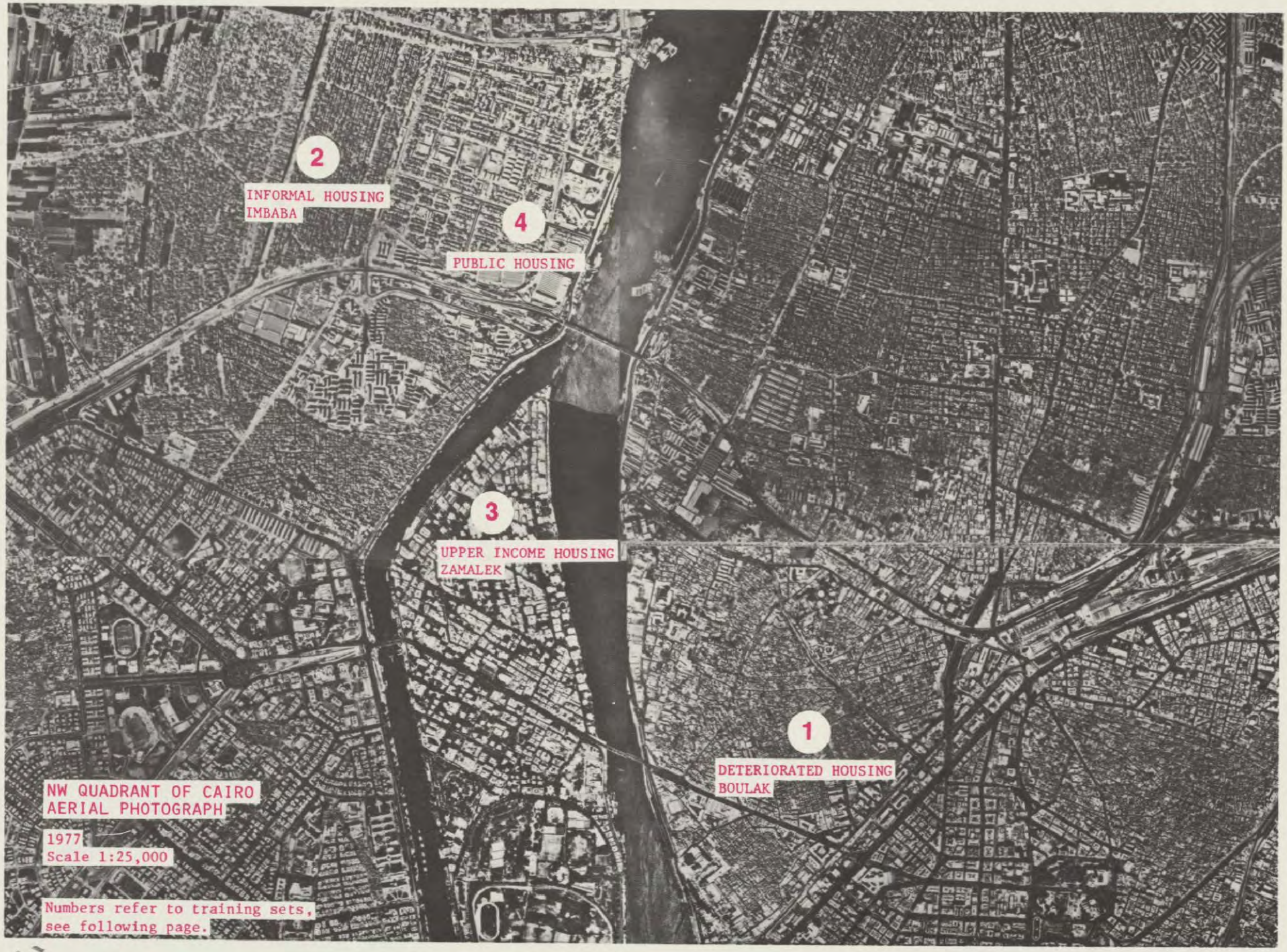


COLOR KEY

Green	agriculture land
Off-white	desert
Dark blue	water (Nile, canals)
Yellow/red/purple	built-up areas

CAIRO URBAN SECTOR
CATEGORIZED IMAGE

May 2, 1978
Scale 1:250,000


2
INFORMAL HOUSING
IMBABA
4
PUBLIC HOUSING
3
UPPER INCOME HOUSING
ZAMALEK
1
DETERIORATED HOUSING
BOULAK
NW QUADRANT OF CAIRO
AERIAL PHOTOGRAPH
1977
Scale 1:25,000
Numbers refer to training sets,
see following page.

CATEGORIZATION OF IMAGES

Two dates, five years apart, were selected as the base with which to experiment: January 4, 1973 (LANDSAT-1) and May 2, 1978 (LANDSAT-3). The period was considered sufficient to indicate growth in the urban area. Both dates were somewhat arbitrarily selected: the 1973 digital data tape was already available at the Center in Cairo, and the 1978 data tape was then selected because it was five years later and of high quality.

An unsupervised classification of the 1973 data was first carried out to determine 1) built-up, agriculture, desert and water areas, and 2) types of housing sectors which could be identified. Band 7 was used for the categorization, with reduced color to facilitate pattern recognition. 1977 aerial photographs (scale 1/5000) and 1966 aerial photographs (scale 1/10,000) were used as ground data controls to assist in identifying housing, built-up areas, agriculture land, and desert edges.

Based on the unsupervised categorization, "training sets" were established for five types of housing. An area (the "training set") with distinct spectral characteristics(determined visually) was identified to the computer and assigned a name and color. All other areas matching these spectral characteristics were then similarly designated by the computer, and the total area of this type calculated. The more unique the spectral characteristic, the greater the accuracy of a given category.

A similar procedure was undertaken for the 1978 data. Band 7, color slice 4-4-7 were used as the initial base. From the experience gained from the 1973 data, the housing categories were changed.

Table A: HOUSING CATEGORIES - CAIRO URBAN SECTOR 1978
(Category definition very tentative; trial values only.)

Key	Area		Training Set	Color(color slice key)
	km^2	%		
1	14.29	5.4%	DETERIORATED, OLDER HOUSING (BOULAK) very dense, narrow streets, run-down housing	Bright blue (007)
2	28.89	10.8%	INFORMAL HOUSING (IMBABA) very dense, narrow streets, total lot coverage, 3-6 stories, well-built dwellings	Purple (707)
3	80.60	30.3%	FORMAL HOUSING (ZAMALEK) Streets lined with trees, 3-6 story detached villas, generous lots	Orange (730)
4	106.94	40.2%	PUBLIC HOUSING (IMBABA) Garden city type of layout, much open space, some trees, 3-5 story apartment slabs	Yellow (770)
5	35.60	13.4%	CEMETERIES (CITY OF THE DEAD) Varied streets, single story units with partial roofs, no vegetation (Training set outside of plan shown on facing page)	Red (700)
	$266.32km^2$	100.1%		

1

2

3

57 meters

TRAINING SETS

1 DETERIORATED OLDER HOUSING
(Boulak)
very dense, narrow streets, run-down

2 INFORMAL HOUSING
(Imbaba)
very dense, narrow streets, 3-6 stories, well built dwellings

3 FORMAL HOUSING
(Zamalek)
streets lined with trees, 3-6 stories, detached villas, generous lots

4 PUBLIC HOUSING
(Imbaba)
Garden city layout, much open space, some trees, 3-5 story apartment slabs

5 CEMETERIES
(City of the Dead)
varied streets, single story, partial roofs, no vegetation

4

5

79 meters

1 Pixel

360

VILLAGE CASE STUDY

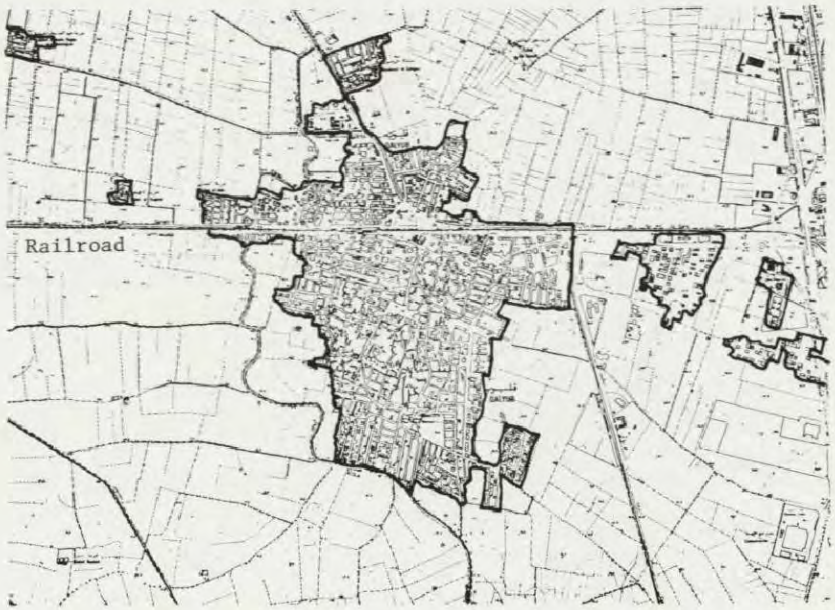
Two of the surrounding villages were further studied because of their small size and their clearly defined boundaries. Their growth was determined and their degree of congruence with ground controls was further investigated. Kirdasah to the west and Qalyub to the north were selected, essentially arbitrarily, but both stand alone and are easy to identify.

Kirdasah is a rapidly growing village west of Cairo and north of the pyramids. It has the traditional agricultural functions but also serves as a repair station and terminal for transit of workers to Libya (although this is noticeably declining because of tensions between the countries) and also a rising textile and tourish handicraft market.

Qalyub is well north of Cairo, on the Cairo-Tanta-Alexandria railroad line. It is a traditional agriculture village, and now rapidly growing.

The relative change in area was easy to determine between 1973 and 1978. The areas were simply measured and the differnce noted. There is not a one to one relation between the two because of their inconsistent spectral resolution and perhaps because of the difference in their dates, one in January, the other in May during the growing season.

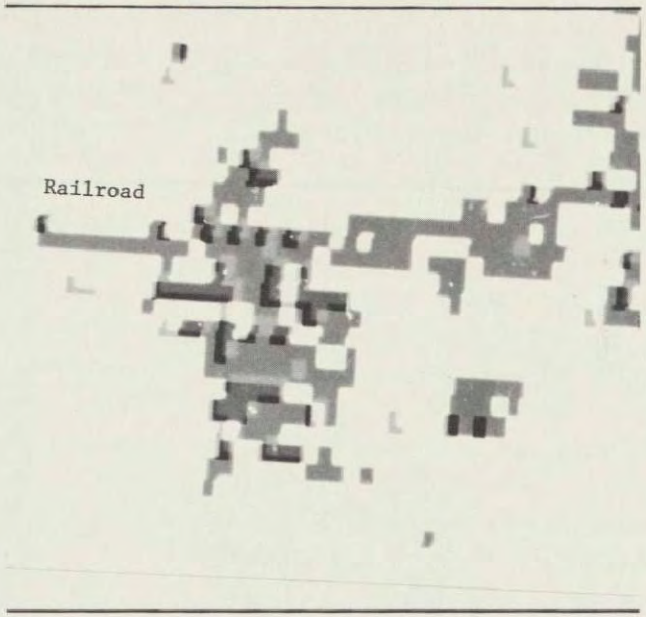
Coincidence with the ground control (plans prepared from 1977 aerial photographs) was more difficult.



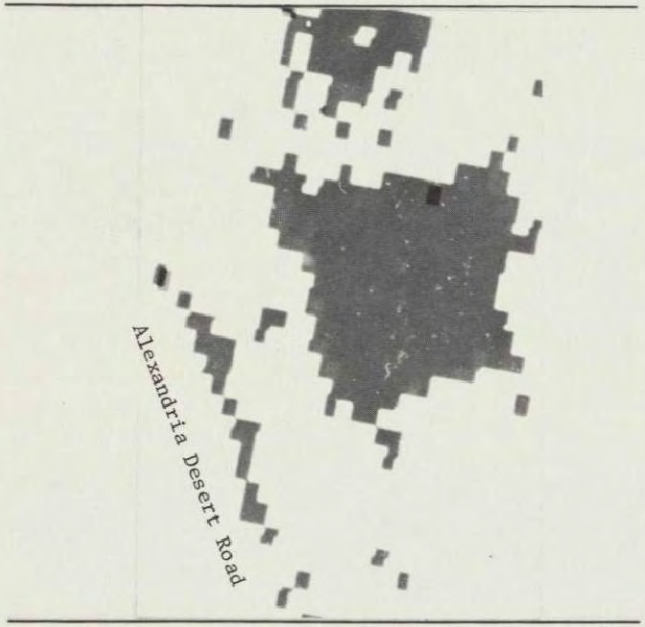
QALYUB 1977 Scale 1:25,000

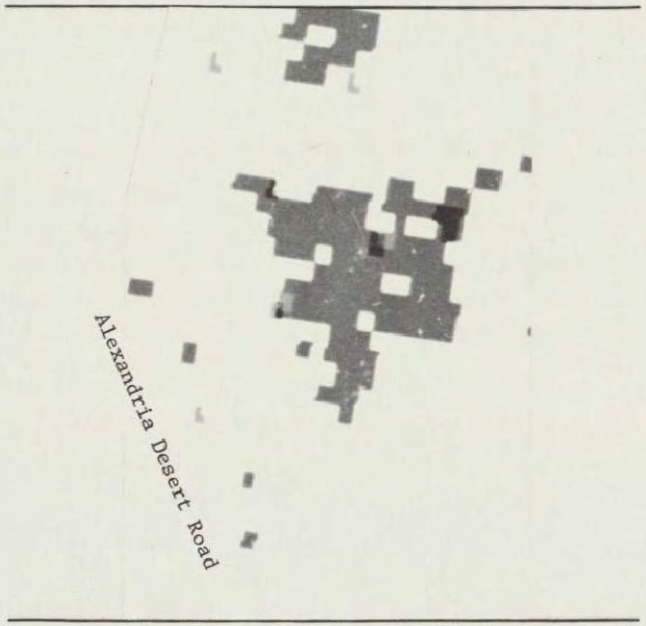
KIRDASAH 1977 Scale 1:25,000

May 2, 1978



January 4, 1973





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OBSERVATIONS

1) LANDSAT is a feasible and very attractive method for monitoring urban growth on an aggregate basis. Quick relatively inexpensive images and area calculations can readily be generated;

2) There was limited success in determining various housing categories. Although some types were readily identifiable, (for example, old, very dense areas like Boulak), it is still unclear if the types can be consistently differentiated throughout the urban area and from other types. It appears - very tentatively - that the the spectral responses of the built-up areas are determined by only three variables: a) Building surface area; b) Building coverage in proportion to open area, which is a function of street widths, open spaces, lot coverage; and c) Building height (shadows).

Color, in the case of Cairo, is believed to be less of a factor in that all construction tends to be of similar materials, dust coats everything because of the absence of rain, and streets tend to have a coat of sand if paved, and are of sand if not paved, the prevalent situation. In short, everything has a "dust" coat which homogenizes the spectral responses.

Differentiation between informal and formal areas is difficult, if not impossible, because the areas tend to be political/administrative labels and not physical categories.

3) Change could readily be ascertained, in terms of urbanized land, agriculture land, and desert land. Saturation of housing areas was not readily apparent, only change in built-up areas could be seen.

Problems and suggestions for further use of LANDSAT include the following:

1) Because various computer tape augmentation techniques were not available in Cairo, several necessary steps were not possible to carry out; for example, the relative reflectance of the tapes should be made consistent to facilitate comparsion between different years. (radiometric correction)

2) The equipment available in Cairo dates from 1975, and many desirable routines now commonly carried out in the United States are not yet available in Cairo. These include, for example, lack of etablishing training sets (used in categorization) on the larger 4x scale, and difficulty in assigning non-rectangular boundaries as in the Greater Cairo Urban Area. It is understood, however, that hardware changes expected to be completed within 8-15 months would eliminate most of the difficulties.

3) Because the 1973 tape proved to be unclear, no definitive conclusions could be made in the growth of the urban area. Indications of "water", particularly in the central section of the Cairo urban area made the results inconclusive. It was speculated that the "water" indications could be due to a heavy dew or to a rare rainfall since it was in January that the image was taken. However, with very limited confidence, it was found that the built-up area increased over the five year period by 28% (an annual growth rate of 5.6%) with expansion into the agricultural land four times greater than expansion into the desert areas. (At the larger scale, "water" was less of a factor in the calculations.)

Table B: AGGREGATE LAND USES - CAIRO URBAN SECTOR

	1973		1978		% change	
	km^2	%		%	1973-78	of total
BUILT-UP	207.4	15%	266.32	19%	(+28.4%)	(+4.3%)
AGRICULTURE	510.532	37%	463.93	34%	(-9.1%)	(-3.4%)
DESERT	626.49	46%	614.8	45%	(-2.3%)	(-1.0%)
WATER	25.58	2%	24.952	2%	(-2.5%)	(-0.04%)
	1370.002km^2	100%	1370.002km^2	100%		

4) Coincidence with ground planes could be solved by relating the data to some universal geo-coding system. Several systems exist, and examples are available at different scale of mapping. Computer routines also exist which straighten the skewed rhomboid pixels into a map-true rectangular format. Both of these techniques should be further investigated in future research.

5) Research is suggested in establishing the sensitivity of the Landsat images. At what point does a pixel indicate "built-up" when the area is in early stages of development. Do large open spaces (parks, playgrounds, and open spaces common to "garden city" type of layouts favored by planners) shift the spectral response to indicate "agriculture"?

6) A clear handicap emerged through the limited hands-on time with the computer in Cairo. Ready, frequent access is necessary in experimenting with different techniques.

GROWTH OF AN INFORMAL HOUSING AREA OVER A THIRTY YEAR PERIOD

CASE STUDY: IMBABA SECTOR

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Massachusetts Institute of Technology

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INTRODUCTION

This section looks in detail at the growth of an informal area - El Mounirah - which is located on the outskirts of Cairo. It is in the Imbaba section, and is just one example of the vast low-income housing areas surrounding Cairo. Although it cannot be claimed that all or even most of the informal areas are similar it is believed that the growth pattern is essentially the same. (See previous studies of informal sector which included Matarayah and El Haram.)

This study attempts to monitor the physical growth of a specific informal area over a 30 year period. The purpose is to develop a better understanding in order to control and direct informal development into - perhaps - more desirable modes and locations. It was not possible to include other informal areas because of the lack of sufficient aerial photograph coverage.

Despite the rapid growth of the so-called "informal" areas, little definitive information is known about their size, growth and development, although it has been estimated that 77% of all new construction in the period 1966-1976 was the result of this "informal" process. (1)

"Informal" is considered here as the developments on the outskirts of Cairo without full legal authorization, generally because of their location on agriculture land, their absence of a building permit, improper land subdivision (too narrow streets, total lot coverage, lack of land reserved for schools, parks, etc.) and absence of public utilities. They are clearly outside of the "formal" (western oriented, generally higher income) market structure. Apparently the land is purchased and construction is by small contractors, generally of a very high quality (in a study now being carried out it was found better than even that of the largest contractors.(2))

The Imbaba area is assumed to be "informal" since it meets the above criteria in all aspects. However, law 29 of 1966 - legalizing previously unauthorized development on agriculture land - is considered to include the earlier sections of Imbaba. But, from the pattern of development, and from the responses of people interviewed in a sample field survey, legalization had no real effect and was of little concern to the people.

The large migrations into Cairo started in the mid 1940's. Some development was already apparent in the Imbaba section (based on field interviews) but most of the early informal development is believed to have taken place in areas closer to Cairo. In 1957, twenty-nine hectares of land were already settled in Imbaba representing - approximately - a ten year growth. In the next 10 years ninety additional hectares were developed, a threefold increase, and in 1977, seventy-one hectares, for a total of 190 hectares per year - 3.3% per year, varying from 4.72% (1957-1966) to approximately 1.5% (1947-1957). These figures represent the total urbanized areas and include vacant lots as part of the urbanized area.

METHODOLOGY

Growth was primarily determined through aerial photographs taken in 1957, 1966, and 1977 (3). These were supplemented by sample field surveys of families from each of the three time periods. Twenty families were interviewed, for the intent was not statistical relevancy but only as indications of basic issues.

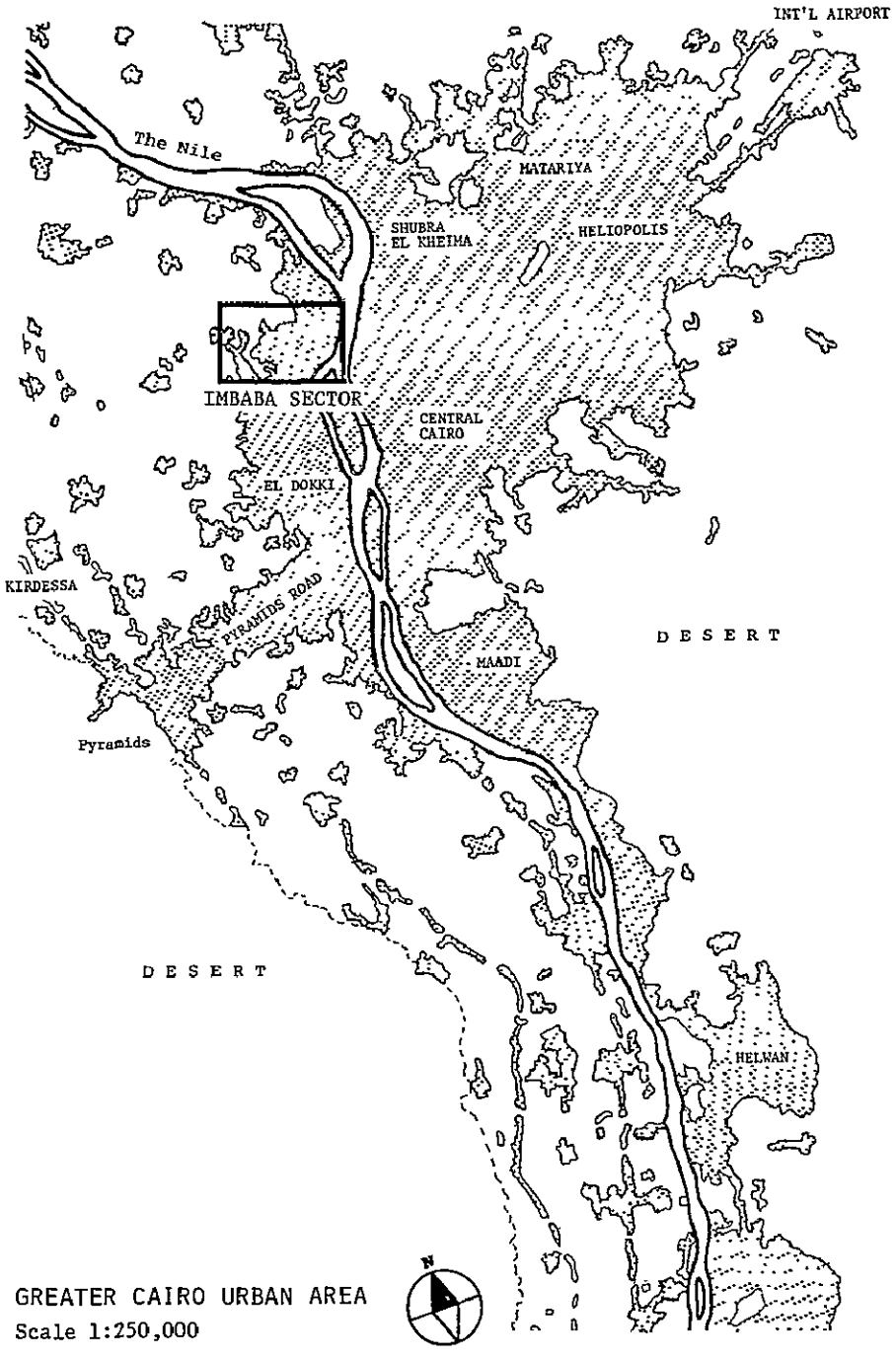
The report first shows the development in the three time periods through aerial photographs. A narrative interview of a hypothetical family is abstracted from the interviews and is included with each aerial view to provide a sense of reality to the abstraction. The three types of growth are then identified and a general hypothesis of growth is proposed. An Appendix includes the field survey forms and an item by item summary of the interviews.

Imbaba is an informal development located in the northwest of Cairo, on the west side of the Nile. It is well located, adjacent to several industries, but poorly served by public transportation. Many small artisans and small scale industrial activities are found in the area, as well as many small shops and cafes. The mean income is 49 LE per month, with the primary occupations of laborers, craftsman, and production workers representing approximately 40% of the employment (4).

There are few schools in the area. Children reportedly walk 3 kilometers to the nearest school. There is no clinic, post office or telephone office.

The area has some utilities, mostly along the main "roads" and adjacent to the older sections of the development. As a rule the newer the settlement the less supplied with utilities and services, and Imbaba follows this pattern. Some standpipes have been installed by the government but limited to areas parallel to the canals. Only very few dwellings have individual piped water connections. Electricity is available throughout, however (84% of the households). Sewers do not exist. Sewage disposal is generally through holding tanks (72%) located in the streets and periodically emptied. 99% of households have private toilets of some kind. Both water and sewage networks are in the process of being installed in the area by the General Organization Greater Cairo Water Supply through a U.S. AID grant.

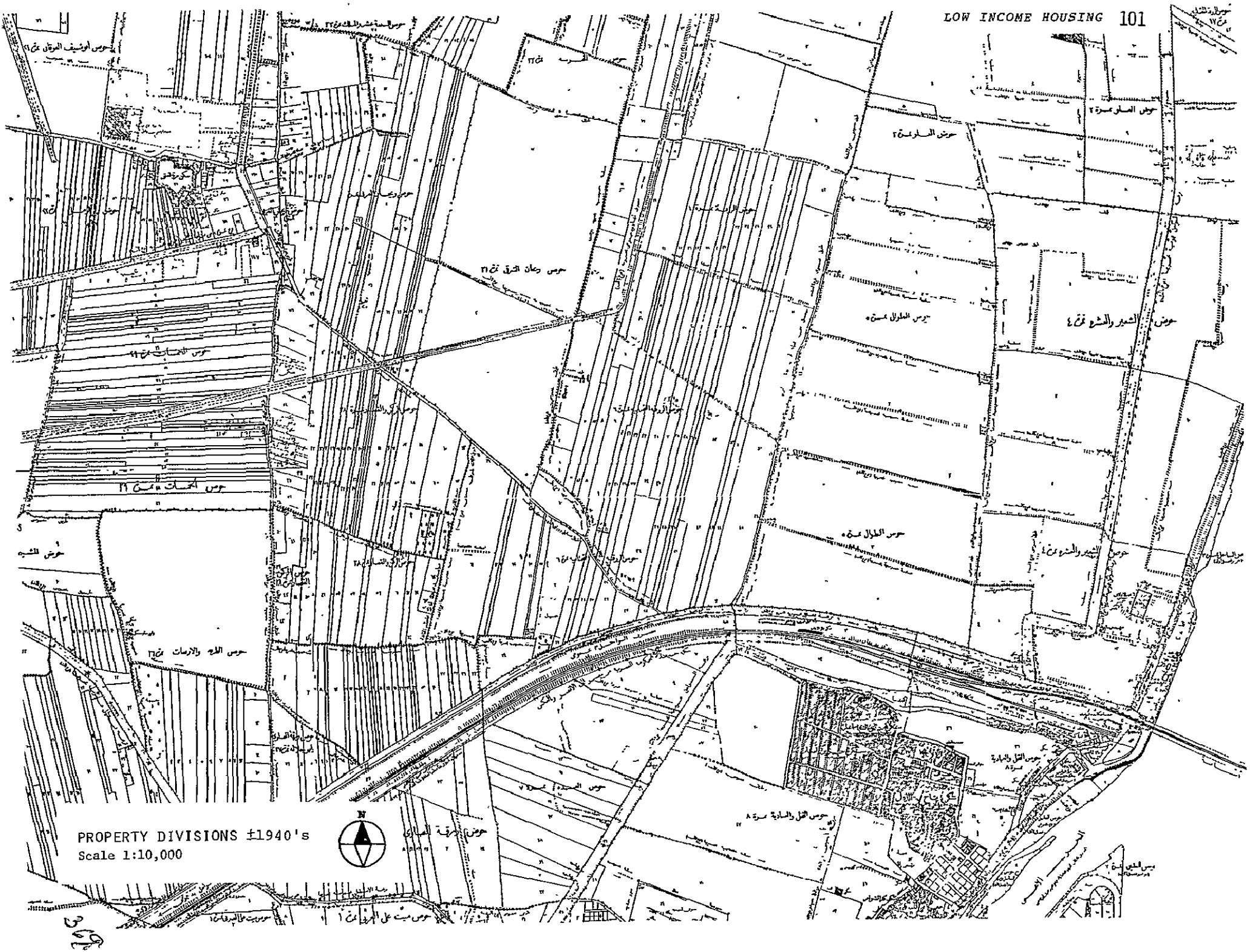
The land has been purchased from farmers but the dwellings have been illegally constructed in contradiction to subdivision and agriculture land use law.



GREATER CAIRO URBAN AREA
Scale 1:250,000

367

Shaira El Wehdah
Sharia Sekkah Guedidah
Sharia El Bouhi
Sharia Abdel Meneim Ismail
EL MOUNIRAH
MADINAT EL'OMAL
(Housing Project)
Sawahel Canal
Cairo-Aswan Railroad
GUEZIRET IMBABAH
Airport Road
ZAMALEK
IMBABA SECTOR 1977
Scale 1:10,000
N


PROPERTY DIVISIONS ±1940's
Scale 1:10,000
N

IMBABA 1957

The area is believed to have started to develop after 1947 (probably by 1950) when the first housing project for government employees was initiated. By 1952 1,100 units of the project were completed - approximately 2/3 of the intended area - and it was planned to be later further expanded.(5)

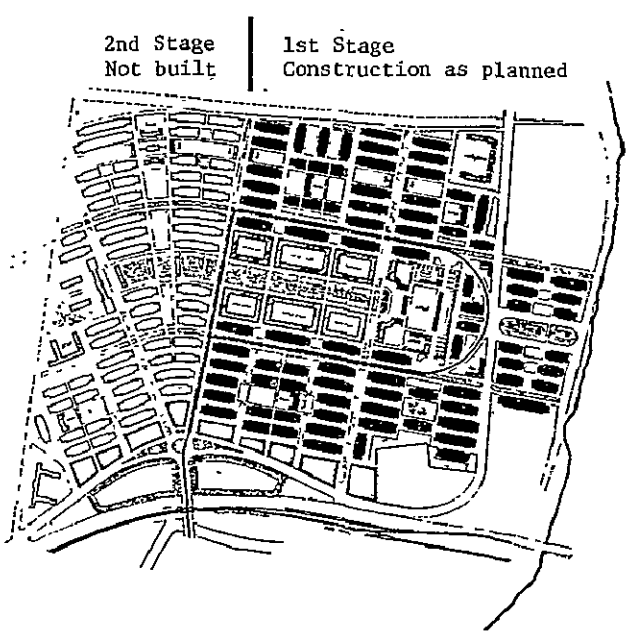
It is speculated that at this time the first informal dwellings were built by the construction workers from the nearby housing project, occupying areas intended for expansion. (It is customery in Egypt for laborers to live near the construction in crude self-built "temporary" shelters.)

The initial stage of the project was on land composed of large properties. (See property plan.) The area intended for expansion was composed of many small holdings, making expropriation for expansion more difficult. In addition, since this was the beginning of the Nassar period, politically it would have been difficult to evict them.

Essentially then, it is speculated that the informal development started in Imbaba as a result of a "spill-over" from the government housing project.

IMBABA WORKERS' HOUSING PROJECT

Scale 1:20,000



HYPOTHETICAL FAMILY NARRATIVE
(based on interviews, see Appendix)

EARLY PERIOD
UP TO 1957

"I am 60 years old and I have lived here since 1955. I am among the first to settle in this area. I am married and have 5 children. My younger children still go to school, for I want them to read and write like I can. My wife never had the chance to learn. I used to work for the government as a driver, but now I am retired. My eldest sons are working, and I receive some money from renting one of the floors. We make about 105LE a month.

"When I first came to Cairo I rented a small 2 room apartment in Shoubra for about 1.5LE a month. It had water, electricity and sewage. I was lucky because some of my friends could only find one room and paid about the same and then without water or sewage, although some had electricity. We finally moved when the flat became too small as my family grew.

"Most of my relatives also live close by. The land was very cheap, and I only paid 2 LE a square meter. I like it here because all of the utilities are available and there is good transportation. However, I am glad I am retired because my job was too far away! My neighbors complain that the water pressure is weak and the electricity always goes out, but they should be thankful for much of the area has nothing. They are right however about the unpaved roads and the garbage dumped in the streets which attracts enormous numbers of flies.

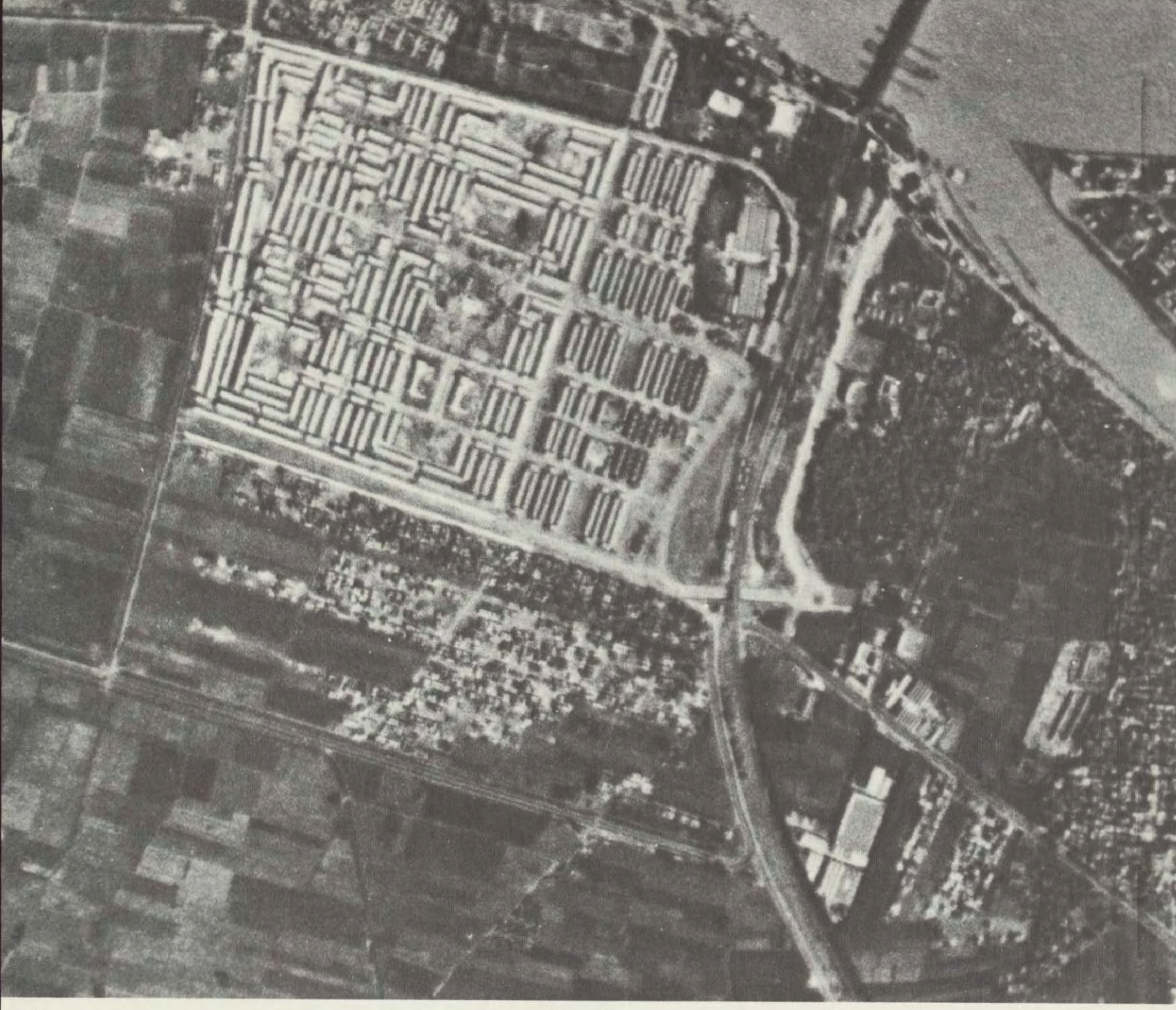
"I am proud to say my house is 4 stories high with concrete floors, plastered brick walls, and cement floor tiles. My family moved in after only one room was finished so I didn't have to pay rent any longer. I got the money to finish the house from savings and selling my wife's jewelry, but my neighbor claims he got a loan from the cooperative.

"I kept expanding the house as my sons got married. They live on two of the floors and the other is rented.

"My neighbor helped me to find a contractor to build my house. I watched him all the time to make sure he did a good job. I planned the house after the others around me. Just the other day I was surprised to learn that I had to have a building permit, but I really don't care.

"I wish the government would pave the roads and repair the water, sewage and electricity, and arrange for street cleaning. It gives our neighborhood a bad image, and we can't do much about it."

(right) AERIAL PHOTOGRAPH of Imbaba sector in 1957.
Scale 1:10,000; North is up.



IMBABA 1966

HYPOTHETICAL FAMILY NARRATIVE
(based on interviews, see Appendix)

MIDDLE PERIOD
1958-1966

"My age is 37, and my family and I lived here since 1962. I am married and have 4 children. All my children attend school and I would like them to attend the university if their grades are good enough. I work for the government and make about 30LE a month. My neighbor is a shopkeeper and he makes twice as much money as I do.

"I used to rent a 2 room flat for 2.5LE a month before moving here. The flat had water, sewage and electricity but I wanted to own my house so I moved. Besides, my family was growing and I needed the room! My brother lived with my father, so he didn't have to pay any rent.

"I moved to Imbaba because I have relatives here, and the land is very cheap. I bought a good piece for 4LE a square meter but bad lots were available for 2 LE and some people were asking 7 LE for lots not much better located than mine! The area is not the best to move to because of the deteriorating utilities and the many flies from the garbage thrown everywhere.

"I own my house together with my brother. We built it 4 stories high with the same concrete frame and brick walls as we see in Cairo. My neighbor can't finish his house until he evicts the family living on his roof! Most of my other neighbors are also finished with their houses but some are waiting till they get more money to add the last floors.

"I bought all the materials for the house, and brought them to the lot. I hired a bricklayer to do the walls of my house and a concrete contractor to prepare the floors and columns. Both of the people live in Imbaba so it was easy to work with them. I didn't bother to get a building permit since none of my neighbors did. It is usual to break the law in this respect here.

"I paid for the house through my savings and from selling some old furniture which I had.

"I wish the government would put in the pipes and sewer lines and fix the electricity to every house. I also think that the school is too far away and we need a good medical center in this area."

(right) AERIAL PHOTOGRAPH of Imbaba sector in 1966.
Scale 1:10,000; North is up.

عزبة الشيخ محمد
الغني الشامي
شارع عبد الله سليمان
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IMBABA 1977

HYPOTHETICAL FAMILY NARRATIVE
(based on interviews, see Appendix)

RECENT PERIOD
1967-1979

"I am 48 years old and we have just recently moved into this area. I have four children who all go to school in this area. I am illiterate, but my neighbor has his university degree and is a lawyer. My wife and I both work; she is on the cleaning staff in a building downtown and I am a guard in one of the large companies. I want my children to finish school quickly so they can help with the family expenses, but if one makes very good grades, I would like him to go to school longer.

"Before I moved here I lived in Boulak. The house where I rented 2 rooms for 4.5LE a month was going to be demolished for rebuilding of the area. It didn't matter though, many of the surrounding houses were collapsing anyway. My flat had electricity, but my wife had to get water from a public tap. Many of my friends also came from Boulak, but also several from Gamalyia.

"At first, I didn't like Imbaba because of the bad health conditions because it has no sewage or garbage pickup. However, the land still cheap and I could pay in installments. Furthermore, I have many relatives and friends in the area.

"I still live in a one story house but I will add more floors when my son gets married and I have more money. Many of my friends are getting money from their sons working in other Arabic countries, and they are already 3-4 stories high.

"We expect electricity soon in our street, but we have to get water from a tap installed by the government. The man on the corner is lucky because he can get it from his neighbor who is already connected.

"My wife and I both helped in the construction of our house but we really only were helpers. We lived already on the lot in a mud brick shack and we helped in the brick laying, carrying bricks, and concrete mixing. Our friend who is a bricklayer actually did the real work. We didn't really care about the building regulations, because no one else was following them.

"We had to sell our silverware and copper bed as well as my wife's jewelry in order to pay for the land and the first floor of our house. It is a rumor that land is now being sold for 50LE a square meter but I didn't believe it.

"We really need help from the government in getting utilities, paved roads, and schools. We would be willing to assist in helping to build the networks. Some of the people who are fortunate to live near a water main have organized and put in their own water pipes to their houses."

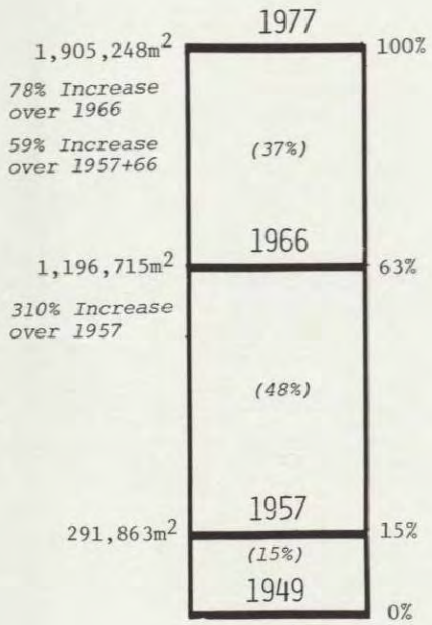
(right) AERIAL PHOTOGRAPH of Imbaba sector in 1977.
Scale 1:10,000; North is up.

1. INITIAL SETTLEMENT: HORIZONTAL GROWTH

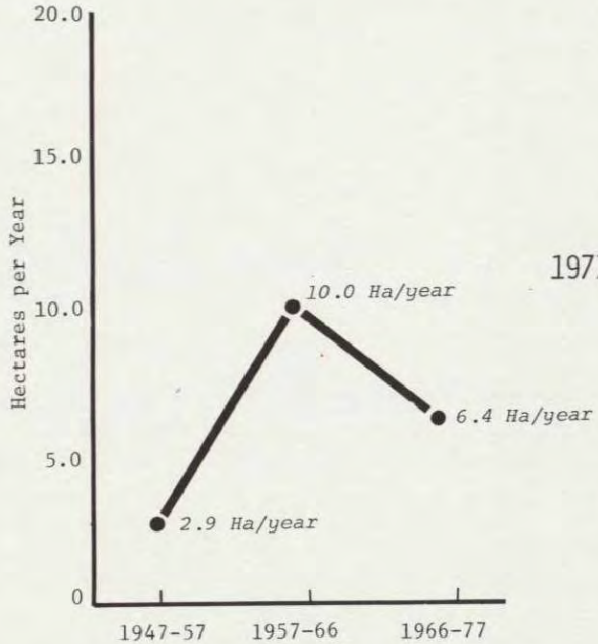
Basic urbanization of land (gross area development, includes vacant lots)

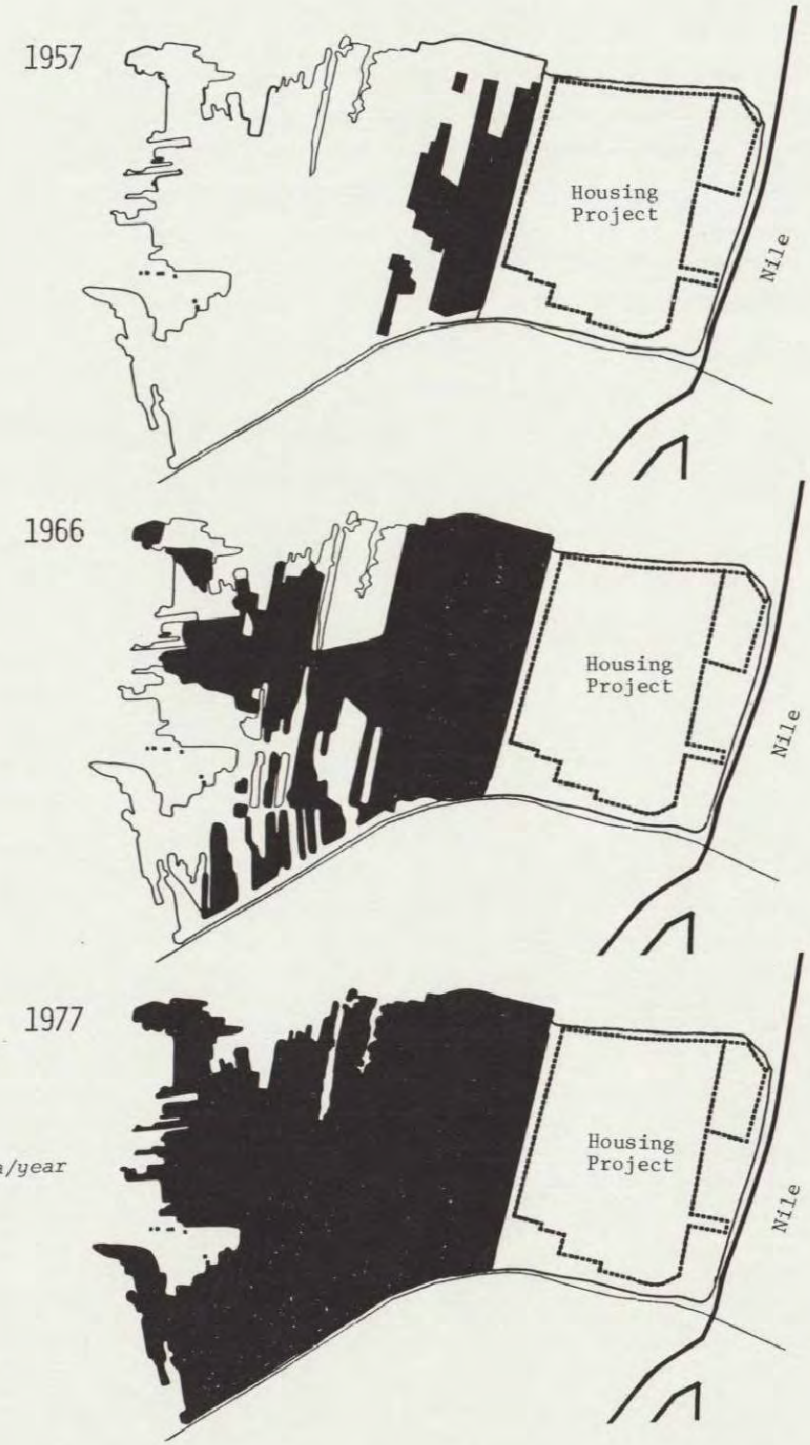
The first type of development may be classified as a horizontal activity. Although this horizontal area index is crude, it is a sufficient (and relatively easy to determine) measure for future demands on urban utilities and services. Periodic monitoring allows determination of the rate of growth, providing an indication of where and when future demands may occur.

AMOUNT OF LAND DEVELOPED



RATE OF DEVELOPMENT





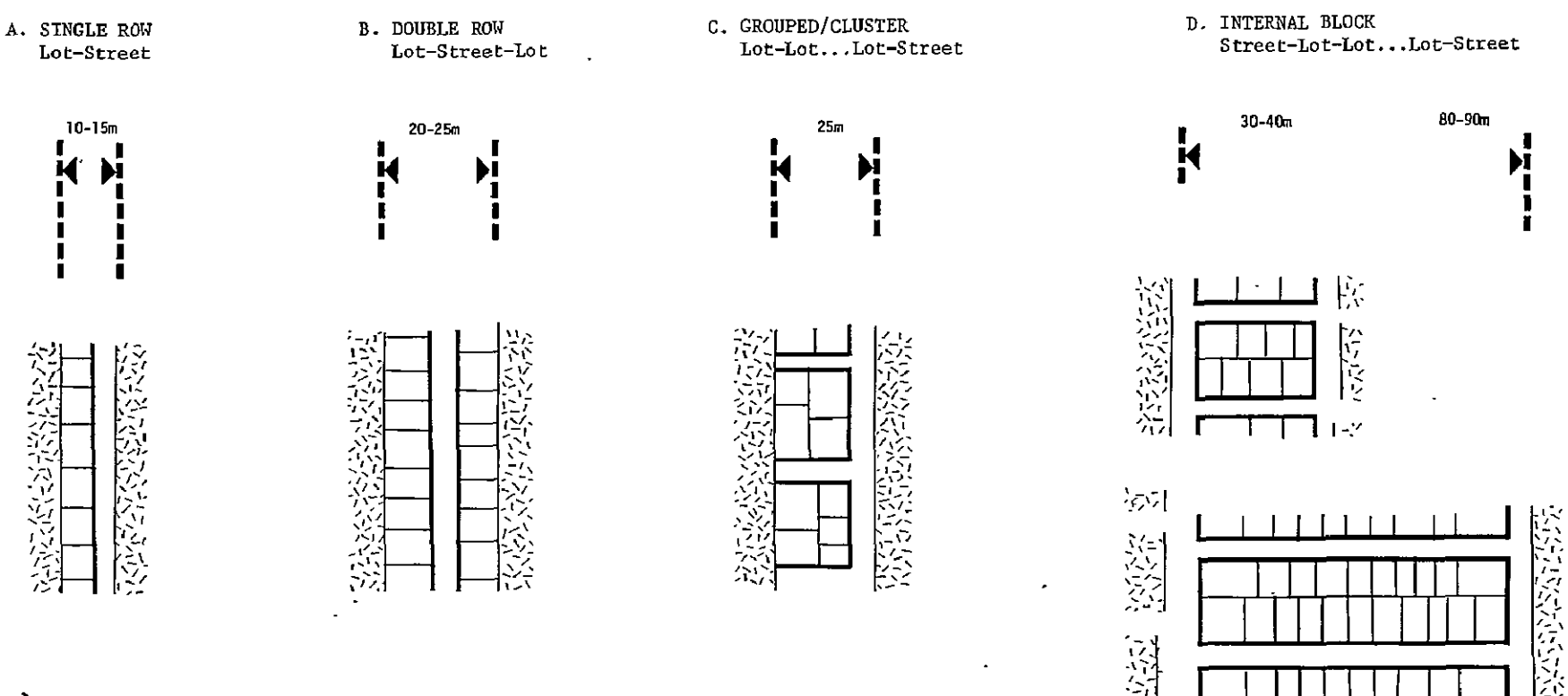
In the Imbaba example, the time intervals of the study are somewhat large and unfortunately do not coincide with presummed increases in growth; for example, in the period after 1973 when a new confidence surged through the country. (It would be interesting to determine if and what correlation exists between surges in the economy and surges in informal development, particularly in determining if a time lag exists).

No attempt has been made to correlate growth and choice of location with the installation of the few utilities which already are available.

PATTERN

The subdivision pattern is a function of the width of the agriculture land parcel. The diagrams indicate the variety of widths and their resultant layout pattern.

PATTERN



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2. INFILL: HORIZONTAL GROWTH

The second type of development is primarily a horizontal activity, characterized by an initial rapid but scattered settlement pattern and the subsequent infilling of the area. This development mode is a function of land prices, crop prices, demand for housing, and boundary constraints.

An initial scattered development indicates that only a few lots are sold in each of the agriculture parcels offered for sale. It is speculated that once several lots are developed in one parcel, a price increase in adjacent lots encourages prospective buyers to shift to other parcels still undergoing the transition from agriculture use to housing use. Prime lot locations probably sell first - prime being defined as adjacent to streets, water sources, proximity to relatives, or lowest cost, dependent on the buyer's viewpoint.

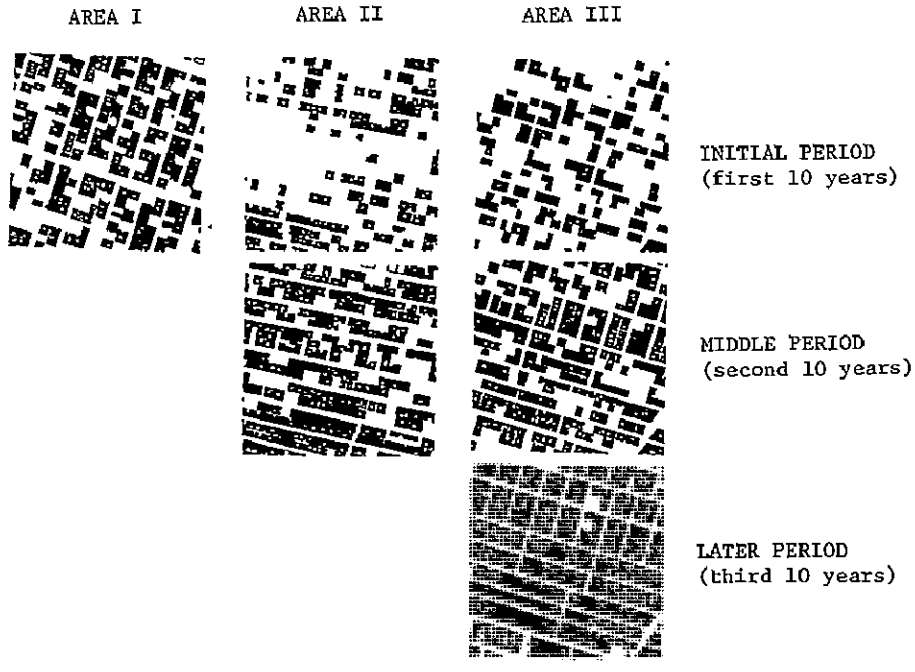
At some unknown point, the vacant lots gradually are sold. Again, it is speculated that this occurs for the following reasons, dependent on viewpoint: proximity to relatives, lowering of prices in adjacent parcels to attract buyers, perceived distance to employment opportunities, or a relatively higher income group which desires a more developed community into which to move.

In order to monitor the infill process, a 200m x 200m sector from each of the 10 year time periods was selected and traced through its stages. For each, basic indeces (for the most recent stage) and the lot distribution according to area and size are developed.

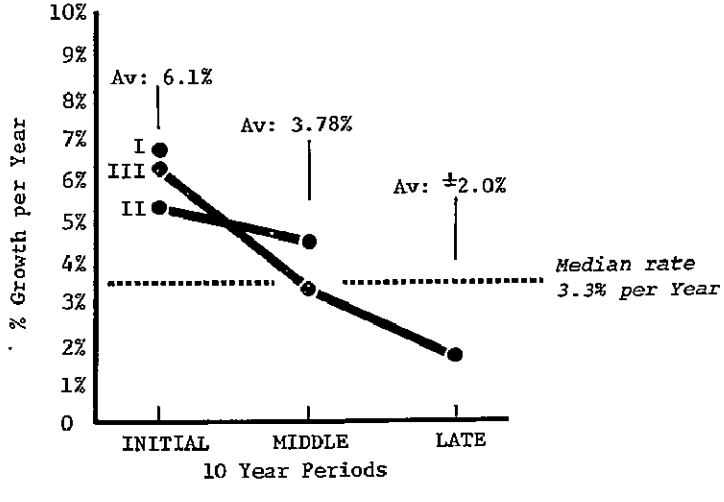
PATTERN:

The infill is essentially similar for each of the three time periods, irregardless of when the development was initiated. Only in Area III, the most recent case, is the pattern broken, since it more closely approximates the middle period of development. Perhaps because of distance the infill process is more accelerated than expected.

PATTERN OF INFILL

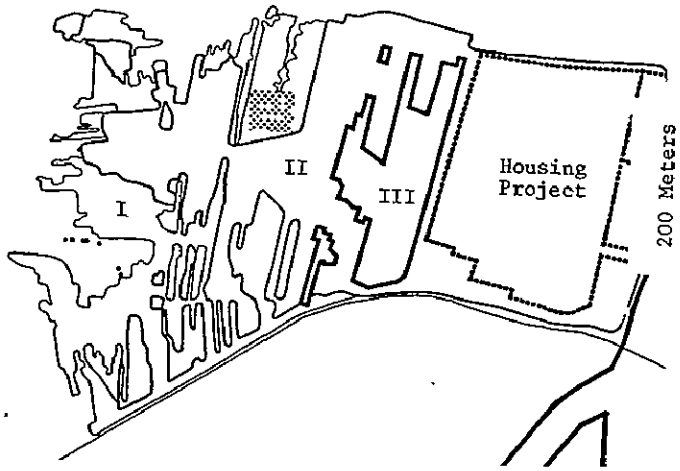


RATE OF INFILL

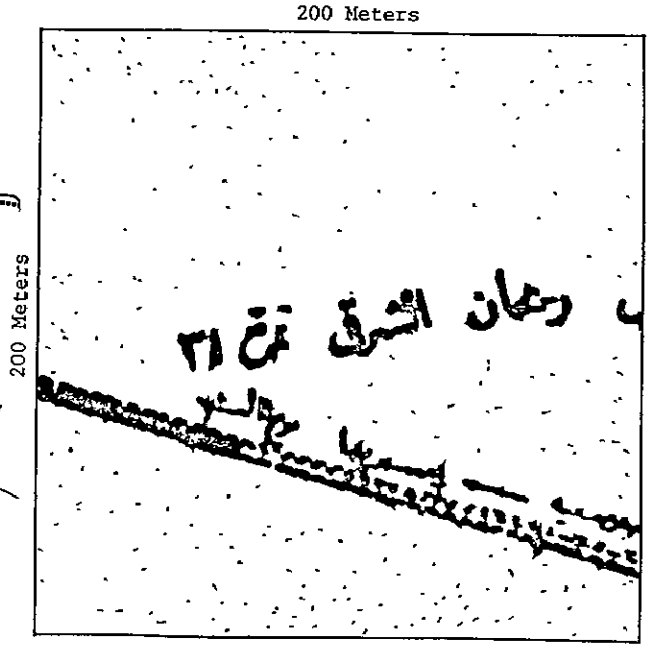


Example of Infill:

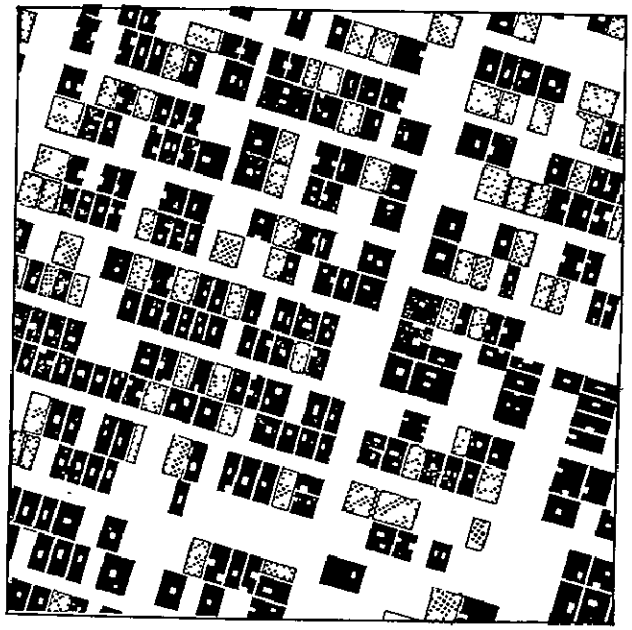
AREA I



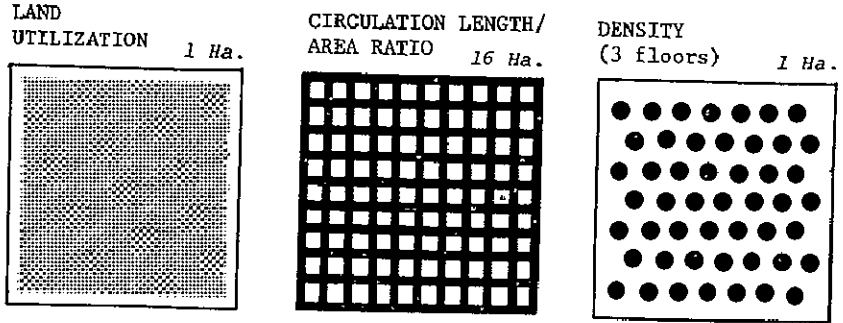
LOCATION PLAN - AREA I



PROPERTY LINES 1940's
AGRICULTURE LAND



1977

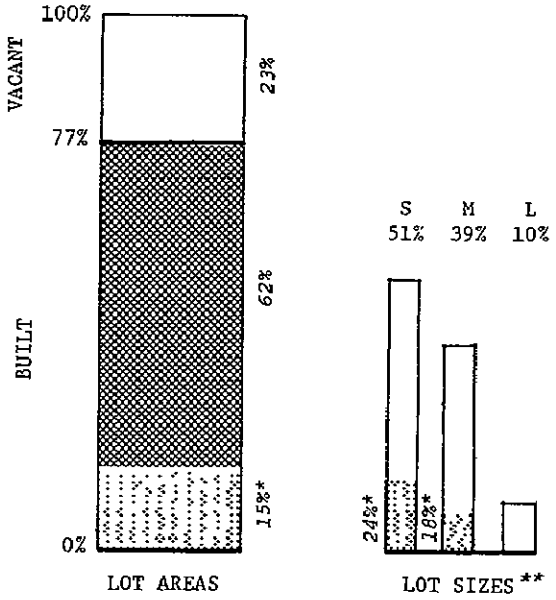


82% Private land
18% Public land

500 Meters/hectare

238 Units/hectare

BASIC DATA
(For latest stage)



LOT DISTRIBUTION

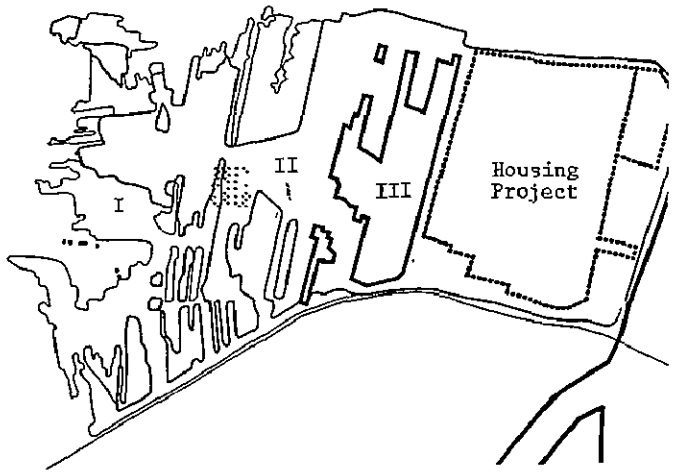
*Under construction: expanding or new.

**S: below 60m^2; M: 60-100m^2; L: above 100m^2.

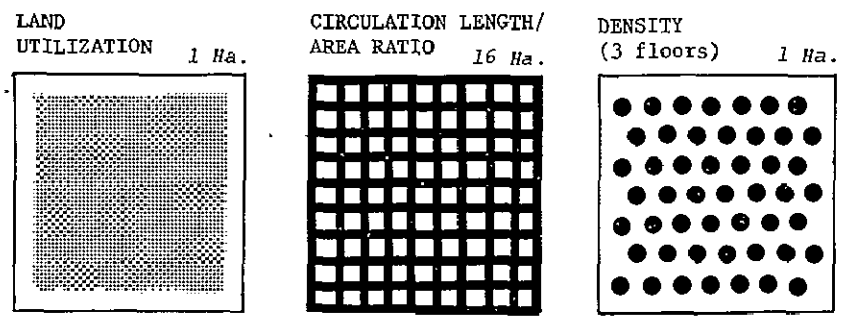
Example of Infill:

AREA II

This area experienced the largest total expansion in 10 years, and the quickest rate of growth of the three example areas. In comparison to Area I and III, it parallels the pattern of III in the first period of development (49% vs 47%), but more closely parallels the saturated, mature stage of Area III instead of the middle 10 years.



LOCATION PLAN - AREA II

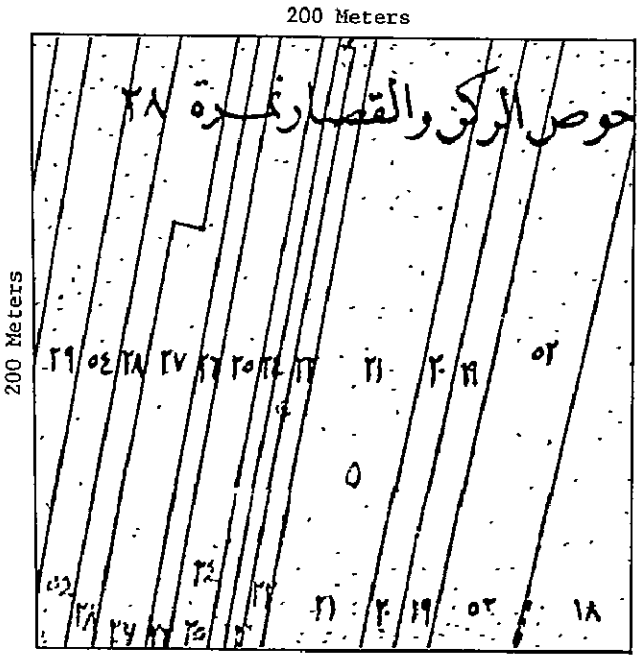


73% Private land
27% Public land

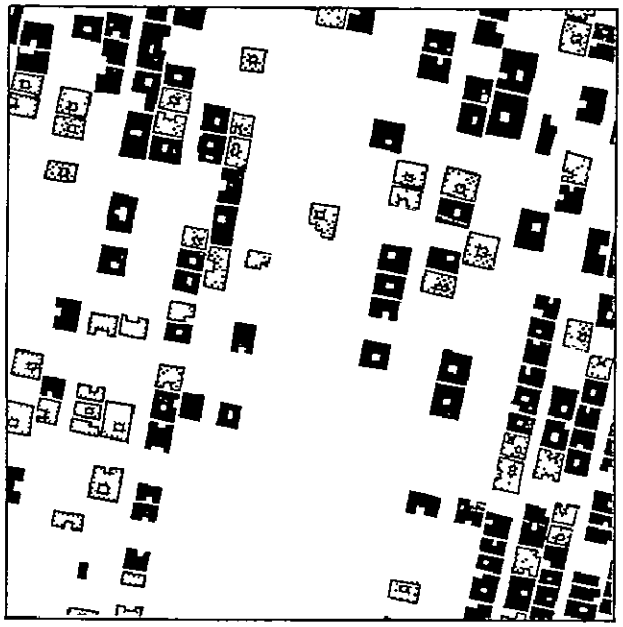
471 Meters/hectare

255 Units/hectare
5 Units ●

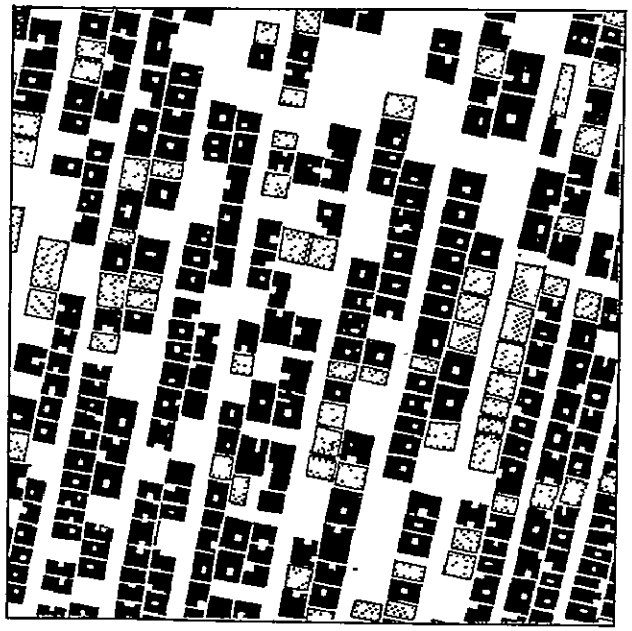
BASIC DATA
(For latest stage)



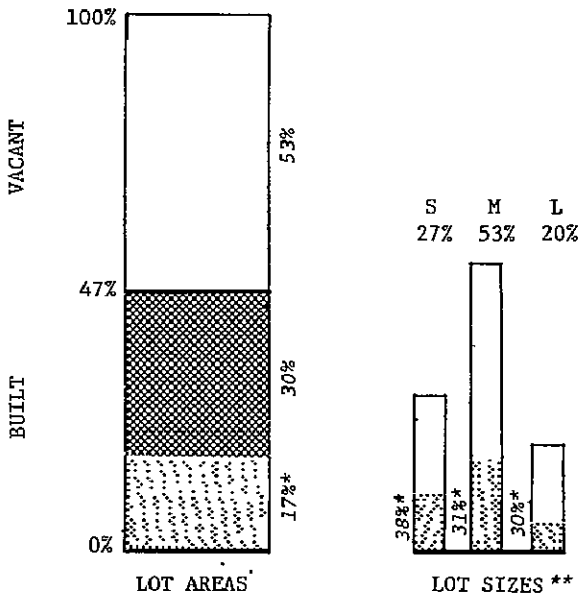
PROPERTY LINES 1940's
AGRICULTURE LAND

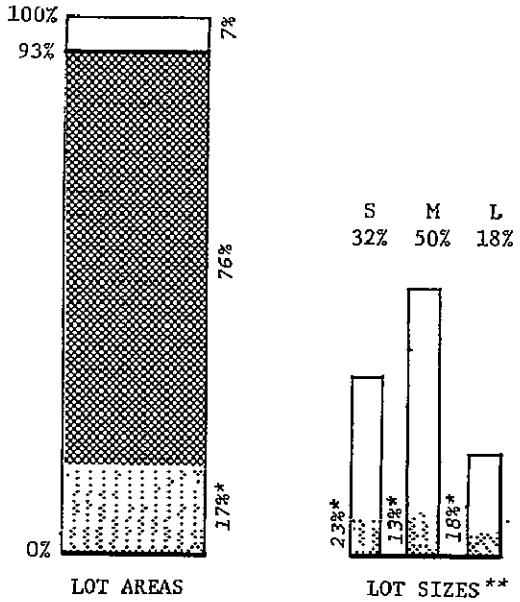


1966



1977





LOT DISTRIBUTION

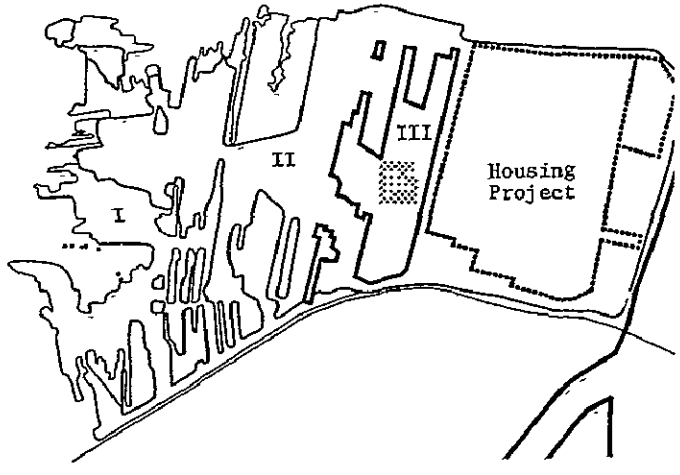
LOT DISTRIBUTION

*Under construction: expanding or new.
**S: below 60m^2; M· 60-100m^2; L: above 100m^2.

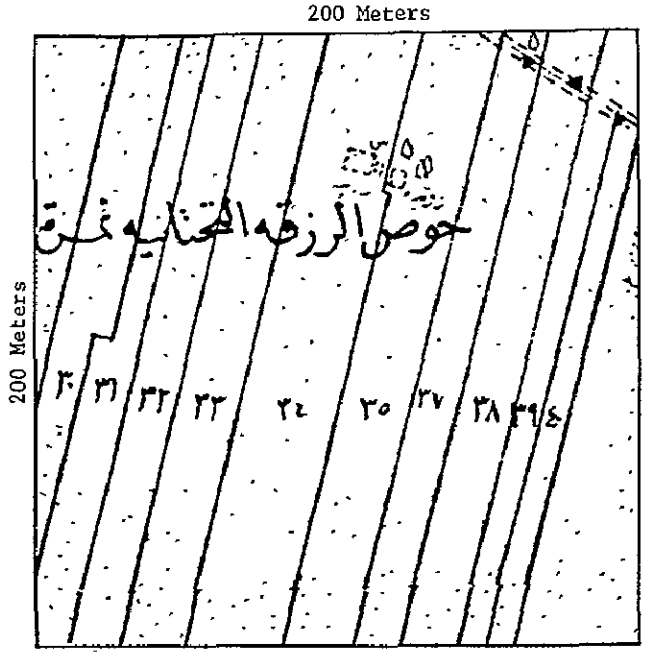
Example of Infill:

AREA III

This is the oldest settlement area of the three examples. Today, it represents an informal settlement at maturity - maturity in development but stil severely limited in basic utilties and services.

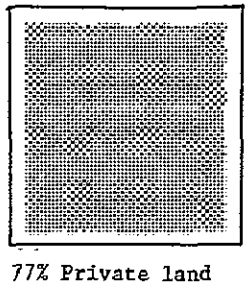


LOCATION PLAN - AREA III



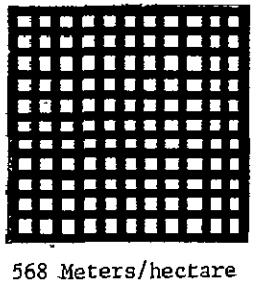
PROPERTY LINES 1940's
AGRICULTURE LAND

LAND UTILIZATION *1 Ha.*



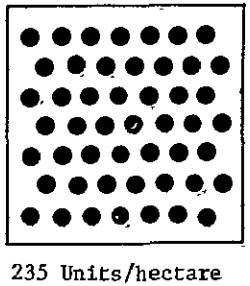
77% Private land
23% Public land

CIRCULATION LENGTH/ AREA RATIO *16 Ha.*



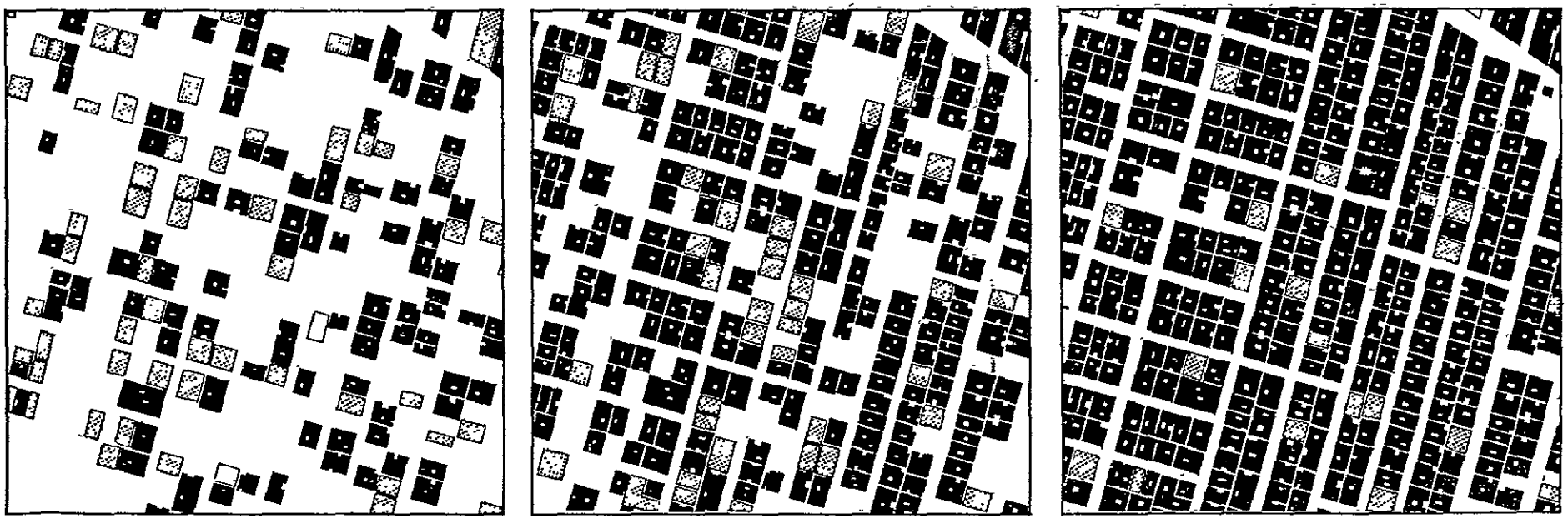
568 Meters/hectare

DENSITY (3 floors) *1 Ha.*

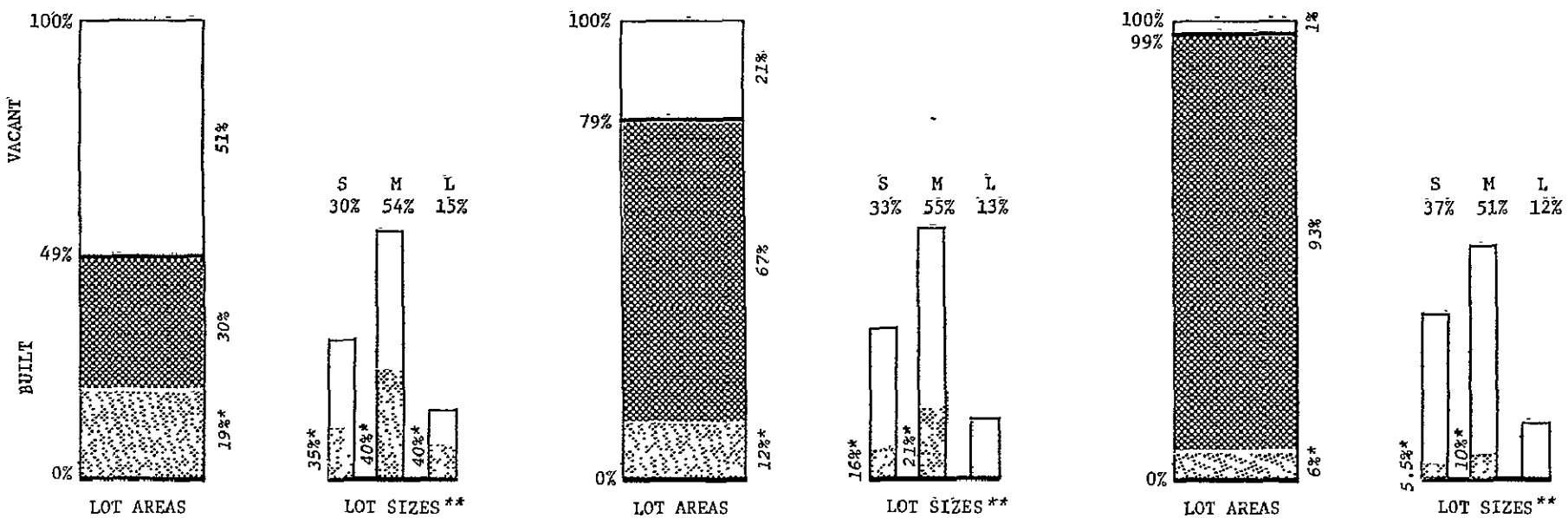


235 Units/hectare
5 Units ●

BASIC DATA
(For latest stage)



1957 1966 1977



*Under construction: expanding or new.
**S: below 60m²; M: 60-100m²; L: above 100m².

3. SATURATION: VERTICAL GROWTH

The last type of development may be considered as a "vertical" activity. Once an area has been rapidly but sparsely settled, and subsequently vacant lots have been largely filled, owners expand vertically for additional housing space.

Housing is built by essentially two groups: the owner/builder and the small contractor/entrepreneur. Each group builts in different periods of development and at different rates and modes.

OWNER/BUILDER: The majority of structures are believed to be built by this group, with the primary purpose being for family shelter.

The initial construction tends to be a single story, with subsequent addition of floors as the family expands and perhaps in order to supplement their income by renting rooms or floors.

SMALL CONTRACTOR/ENTREPRENEUR: This group is believed to construct a significant proportion of units, but figures are not available.

Generally the building is constructed in one stage of several floors with the intention of renting units for income generating purposes. The lots tend to be purchased during the initial stages of development when the land is cheap. Only when a sufficient population exists to allow quick and higher rental opportunities, the dwelling is constructed.

The location of the lots tend to be in choice positions: fronting major streets, and on corners.

In both cases, construction is the same: reinforced concrete frame, brick infill, and concrete floor and roof slab. Various brick types are used, dependent on availability and cost. In some cases brick bearing walls are used, particularly by owners to lower costs. All buildings achieve 4-6 stories in height.

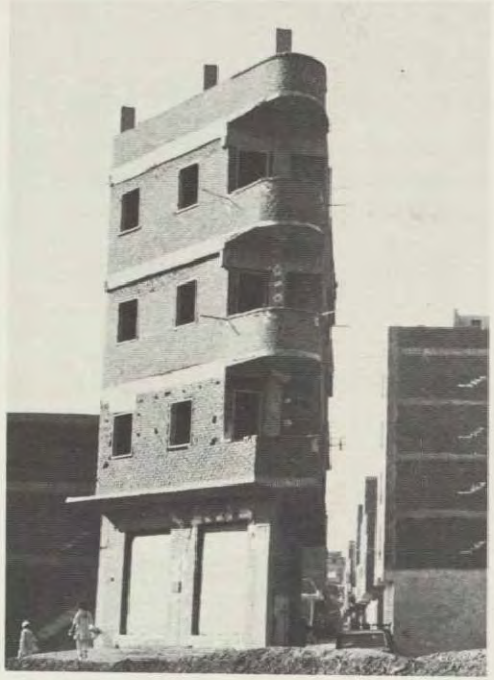
Measurement of the rate of vertical growth was not undertaken since data is not available and it would be difficult to determine. However, it may have been possible to use shadows as indicators of the height, but the quality of the earlier aerial photographs precluded this option. Also, the sample family interviews unfortunately omitted the time aspect of dwelling expansion.

PATTERN:

It may be speculated that dwellings built on prime locations - corners, fronting larger streets - tend to develop quicker, since the owner is more likely to have extra income from shops or cafes and therefore can invest quicker. This has not been quantified, and only supported by personal observations.

(Top right) SMALL CONTRACTOR/ENTREPRENEUR DEVELOPMENT. Note the complete multi-story construction. A space for shops is included in the ground floors. The surrounding areas are already well developed.

(Bottom) OWNER/BUILDER DEVELOPMENT. The far left photograph shows a later stage of development; note the erosion from drainage and the garbage in the street. The dwelling itself looks worn, its value now lowered because of the lack of utility services and therefore the initial optimism has been lost. The far right photograph shows the initial stage; note the relatively elegant facade, exhibiting obvious pride and investment. Note the newly installed electrical connection in the photograph second from the right.



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OBSERVATIONS

1. Informal land development appears to follows the agriculture land patterns. Because of the extensive irrigation systems, a relatively regular, rectangular land subdivision exists, guiding development in a simple grid pattern, facilitating future infrastructure installation.

2. The physical layout apparently follows the similar pattern as in the villages: a minimum area for streets, little public open space (if any), and a very dense development.

3. The initial horizontal growth apparently starts relatively slow, surges after the initial occupation stage, and then slows when distance (accessibility) advantages are less. Outlying land prices may be elevated also, in anticipation of the expansion, further slowing the late stages of horizontal growth.

4. The high initial infill rate indicates that if nothing is done quickly to prevent informal development in a specific area, the number of people involved will be too great to take any positive action. After the initial rapid settlement, the rate of infill steadily declines, approximately by one-half in each of the sugsequent 10 year periods (6.1% to 3.8% to 2.0%). It may also be noted that the lots tend to become smaller in the latter time periods, perhaps because of the increase of land values, or the rise in prices from inflation in the economy in general.

5. In any given area, there would obviously be considerable overlap of the three development modes. The factors influencing their congruence are housing demand, land values, size of agriculture parcels, and boundary constraints.

6. Using Imbaba as a model, the primary attraction for recently settled areas would be the proximity to relatives, initially available cheap land and easy access to work opportunitites. The bridge across the Nile by Imbaba and the large road paralleling the Nile with direct access to the south are perhaps the main factors for location of the Imbaba settlement.

7. In the future, the Imbaba area will probably continue to grow, and to grow much more rapidly, since: a) a new international airport for Cairo has been planned in the vicinity, although admittedly this may be far in the future, if then; b) The proposed outer ring road is planned to pass west of the area with a major intersection at Imbaba; and c) a wholesale market is considered as a possible use for the land around the intersection. In all cases, the land values will most probably rise very quickly, and attract other types of development. The settlement itself would change, and informal developments would spread further out, most probably to the north where the Imbaba airport does not block development.

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APPENDIX

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SUMMARY OF SURVEY RESPONSES

Survey Questionnaire	Summary of Responses
1.0 FAMILY CHARACTERISTICS 1.1 How many are in the family? 1.2 What is the age of the family members? 1.3 What is the education level of the family members? 1.4 What is the employment of members working? 1.5 Where are the members employed? 1.6 What is the total family income? 1.7 What are the expectations for the children?	Families were large 5-9 member, particularly those who lived there longest, with head of family in early 60's. More recent families generally younger, with head in mid 30's. Occupants varied: government drivers, guards, military, shop keepers, etc. Generally father could read and write, mother illiterate. Children expected to attend school. Incomes ranged from 30-105 LE/month, with most near 30 LE. Children were expected to finish school quickly so they could contribute to family income, however, if grades very good, expected to go for further schooling.
2.0 PRESENT DWELLING CHARACTERISTICS 2.1 What is the tenure of land and dwelling? 2.2 How long have you lived there? 2.3 What utilities are available? 2.4 How many stories will dwelling be at completion? 2.5 When will dwelling be completed?	Building land is held in freehold. Few utilities, if any, are available in newer areas; generally, electricity is provided. Height is usually 3-4 stories, sometimes higher. Completion time dependent on money available, and necessity of providing home for son and family.
3.0 PREVIOUS DWELLING CHARACTERISTICS 3.1 What was the tenure? 3.2 What was the size? 3.3 How much did you pay? 3.4 What utilities were available?	Rental units, 1-2 rooms, with payments from .80 to 4.5 LE, with 2.5 LE usual. Half have all utilities, half have none. In general, a higher level of utilities than in present dwelling.
4.0 LOCATION AND CHOICE OF AREA 4.1 What factor led to choice of area? 4.2 How was location found? 4.3 Where is location in relation to employment? 4.4 Did you have job before moving? 4.5 How much did you pay for land? 4.6 Whom did you pay? 4.7 What is liked about area? 4.8 What is not liked about area?	Cheap land was primary reason, followed by proximity to relatives. Relatives invariably guided choice of location. Payments of land were from 2-10 LE/m^2 over a 30 year period, with payment generally by installments. The lack of utilities, services, and no garbage cleaning were biggest drawbacks of area. For many, it was far from their employment.

5.0 STAGE IN FAMILY TRAJECTORY *5.1 Where did you live before?* *5.2 How long did you live there?* *5.3 Why did you move?* *5.4 What size was your family when you moved?*	Families came from central Cairo areas: Gamalia, Shoubra, Boulak. Their stay in the previous area was usually over 10 years. An increase in family size (need for more space) and desire for ownership were main reasons for moving. Families generally were small, young.
6.0 DWELLING DEVELOPMENT PROCESS *6.1 How much of dwelling was completed when moved in?* *6.2 Did you own land before building dwelling?* *6.3 Where did you live while dwelling was being built?* *6.4 At what stage did you move in?*	Families moved into the dwelling after the first floor was completed; sometimes when only a room was finished. Sometimes lived in temporary room on site during construction.
▷ *construction:*	
6.5 How was building constructed? *6.6 What was built in first stage?* *6.7 Did you contribute in construction? How?* *6.8 How did you find contractor?* *6.9 Where does constractor live? In area?*	Dwelling usually constructed by small local contractor referred by friends. Owner usually contributed by material purchase with occasional assistance on site.
▷ *financing:*	
6.10 Where did you get money for first stage? *6.11 Where did you get money for subsequent stages?* *6.12 Will you rent rooms to help pay?*	Generally savings, selling of wife's jewelry, and sometimes "cooperatives". As further savings accumulated, building was continued. One floor usually rented, the rest reserved for family members. A third of income usually from rental units.
▷ *expansion:*	
6.13 How will you decide when to expand dwelling? *6.14 When do you expect to expand?*	Expansion generally determined by finances and need for providing home for newly married son.
▷ *building regulations:*	
6.15 Did you follow building regulations? *6.16 If not, does this worry you?*	Regulations always ignored, not a source of worry since no one in area follows them.
▷ *utilities:*	
6.17 When do you expect to get utilities? *6.18 How do you expect to get utilities?*	Unclear when utilities will come although all were hopeful that the government will eventually provide them.
▷ *assistance:*	
6.19 What assistance would be most desired?	Utilities, payed roads, schools and health center by almost all respondents (no mention of dwelling assistance).

IMBABA SURVEY FORM

بحث ميدانى للعينة المختارة

1.0 FAMILY CHARACTERISTICS	١ ـ خصائص السكان :
1.1 How many are in the family?	١٠١ ماهو عدد الافراد فى العائلة الواحدة وماهى علاقتهم (اب ، ام ، ابن ، الخ ..)
1.2 What is the age of the family members?	٢٠١ ماهى أعمار اعضاء الاسرة الواحدة ؟
1.3 What is the education level of the family members?	٣٠١ ماهى الحالة التعليمية لاعضاء الاسرة ؟ (أمى ، متعلم ، الخ ...) .
1.4 What is the employment of members working?	٤٠١ ماهو نوع النشاط الاقتصادى للافراد العاملين ؟ (الوظيفة) .
1.5 Where are the members employed?	٥٠١ اين يقع مكان العمل للافراد العاملين ؟ (مكان الوظيفة) .
1.6 What is the total family income?	٦٠١ ماهو الهدف من تعليم الابناء ؟ (لماذا هذا النوع من التعليم ؟) .
1.7 What are the expectations for the children?	
2.0 PRESENT DWELLING CHARACTERISTICS	٢ ـ خصائص المسكن الحالى
2.1 What is the tenure of land and dwelling?	١٠٢ هل تمتلك الارض أو المسكن أو أنت مستأجر ؟
2.2 How long have you lived there?	٢٠٢ منذ متى تعيش هنا ؟
2.3 What utilities are available?	٣٠٢ ماهى الخدمات الموفرة لك ؟ (مياه ، مجارى ، كهرباء) واذا لم تكن متوفرة لك فمن اين تحصل عليها ؟ .
2.4 How many stories will dwelling be at completion?	٤٠٢ هل تعتزم بناء ادوار اخرى ؟
2.5 When will dwelling be completed?	٥٠٢ متى تعتزم اكمال الوحدة نهائيا ؟
3.0 PREVIOUS DWELLING CHARACTERISTICS	٣ ـ خصائص الوحدة السابقة :
3.1 What was the tenure?	١٠٣ هل كنت تمتلك ام تستأجر ؟
3.2 What was the size?	٢٠٣ ماهو حجم السكن القديم ؟ (عدد الغرف ، مسطح)
3.3 How much did you pay?	٣٠٣ ماذا كنت تدفع فيه ؟ (كملك أو كأيجار)
3.4 What utilities were available?	٤٠٣ ماهى الخدمات التى كانت متوفرة ؟ (مياه ، مجارى ، كهرباء ، الخ) .
4.0 LOCATION AND CHOICE OF AREA	٤ ـ موقع السكن واختيار المنطقة :
4.1 What factor led to choice of area?	١٠٤ لماذا اخترت هذه المنطقة ؟
4.2 How was location found?	٢٠٤ لماذا اخترت قطعة الارض هذه ؟
4.3 Where is location in relation to employment?	٣٠٤ ماهى علاقة الموقع بمكان عملك ؟
4.4 Did you have job before moving?	٤٠٤ ماذا كنت تعمل قبل ان تنتقل هنا ؟
4.5 How much did you pay for land?	٥٠٤ كم دفعت ثمنا للارض ؟
4.6 Whom did you pay?	٦٠٤ كيف تم الدفع ؟ (نقدا ، بالمبادلة ، بالتقسيط الخ ..)
4.7 What is liked about area?	٧٠٤ ماذا يعجبك فى المنطقة ؟
4.8 What is not liked about area?	٨٠٤ ماذا يضايقك فى المنطقة ؟

5.0 STAGE IN FAMILY TRAJECTORY	٥ — مراحل تطـــور الاســـــرة :
5.1 Where did you live before?	١٠٥ اين كنتتعيش من قبل ؟
5.2 How long did you live there?	٢٠٥ ماهى المدة التى قضيتها هناك ؟
5.3 Why did you move?	٣٠٥ لماذا فكرت فى الانتقال ؟
5.4 What size was your family when you moved?	٤٠٥ ماذا كان حجم اسرتك عندما قررت الانتقال ؟
6.0 DWELLING DEVELOPMENT PROCESS	٦ — مراحل تطور المسكـــــن :
6.1 How much of dwelling was completed when moved in?	١٠٦ ماهى حالة المسكن فور انتقالك اليه ؟ (غرفة واحدة ، كاملة التشطيب)
6.2 Did you own land before building dwelling?	٢٠٦ هل امتلكت الارض قبل البناء عليها ؟
6.3 Where did you live while dwelling was being built?	٣٠٦ اين كنت تقيم اثناء عملية بناء المسكن ؟
6.4 At what stage did you move in?	٤٠٦ فى اى مرحلة انتقلت للسكن فى الوحـــدة ؟
construction:	
6.5 How was building constructed?	٥٠٦ كيف تمت عملية البناء ؟ (مقاول) مهندس ، جهـود ذاتية)
6.6 What was built in first stage?	٦٠٦ ماذا تم بناءه فى البدايه ؟
6.7 Did you contribute in construction? How?	٧٠٦ هل ساهمت شخصيا فى عملية البناء (اشراف ، مساعدة)
6.8 How did you find contractor?	٨٠٦ كيف وجدت المقاول واتصلت به ؟
6.9 Where does constractor live? In area?	٩٠٦ اين يسكن المقاول ؟
financing:	
6.10 Where did you get money for first stage?	١٠٠٦ كيف دبرت المال اللازم لعملية البناء فى البداية ؟
6.11 Where did you get money for subsequent stages?	١١٠٦ كيف دبرت المال لاى عملية بعد ذلك ؟
6.12 Will you rent rooms to help pay?	١٢٠٦ هل تنوى تأجير اى حجرات فى المسكن ؟
expansion:	
6.13 How will you decide when to expand dwelling?	١٣٠٦ متى تقرر وكيف انك تريد تعلية المسكن ؟
6.14 When do you expect to expand?	١٤٠٦ متى تتوقع ان يتم ذلك ؟
building regulations:	
6.15 Did you follow building regulations?	١٥٠٦ هل احترمت قوانين المبانى فى البناء ؟
6.16 If not, does this worry you?	١٦٠٦ هل يضايقك انك لم تحترمها ؟
utilities:	
6.17 When do you expect to get utilities?	١٧٠٦ متى تتوقع توصيل المرافق لمسكنك ؟
6.18 How do you expect to get utilities?	١٨٠٦ كيف تتوقع ان يتم ذلك ؟
assistance:	
6.19 What assistance would be most desired?	١٩٠٦ ماهى نوع المساعدة التى ترغب فيها من الحكومة ؟ (مالية ، فنية الخ ..)