PD-AAS-765
ISN 1349

912 0007/52

February 12, 1982

Jeffery A. Malick - PD

HUDCO Shelter Design & Analysis Project - AID Grant No.912-0007

Mr. Al Votaw - RHUDO, USAID/Bangkok

Enclosed please find a copy of the semi-annual progress report covering the period from the date of the Grant Agreement to October 31, 1981 for the subject project.

att: a/s

PD:GPVarshneya:trr:2/12/82

No.17029/19/80-Ps(I)
Government of India
Ministry of Works and Housing
Nirman Aur Awas Mantralaya
...

New Delhi, dated the 3rd Feb.,1982

To

The Director,
US AID,
American Embassy,
Chanakya Puri,
New Delhi-21.

Subject:- HUDCO Shelter Design & Analysis Project
AID Grant-No.912-0007.

Dear Sir,

As per the Implementation Letter No.I, I am to send herewith a copy of the semi-annual implementation report covering the period from the date of the Project Grant Agreement to 31st December,1981. It is presumed that the Housing & Urban Development Corporation Limited, New Delhi, has already sent to you a copy each of the task list and the work programme.

Encl: as above.

Yours faithfully,

(M.K. Moitra)
Director (Housing)

RECEIVED
9 FEB 1982

Copy to:-

1. Ministry of Finance, Department of Economic Affairs, New Delhi. Their No.2/8/AID/80, dt.11.12.1981 refer.

2. HUDCO Ltd.,(Shri B.K. Chakrabarty, Chief-Projects-I) with reference to his letter No.HUDCO/Ministry/US-AID/82/27578, dt.29/30.1.1982. It is requested that a copy of each of the task list, the work programme and the semi-annual implementation report may be sent to the Ministry of Finance, Department of Economic Affairs, if not already done.

(M.K. Moitra)
Director (Housing)

Semiannual implementation report on HUDCO Shelter Design and Analysis Project AID Grant - Project No. 912-0007 covering the period from the date of the Project Grant Agreement to December 31, 1981.

The Task 1, 2, 4, 5, 6, 7, 8, 9, 10 & 11 have been completed and discussed with AID/U.S. counterpart and further works have also been taken up as required.

The work of project design studies has been entrusted to HUDCO Consultancy Wing as provided in the Agreement executed by the Government of India with the US-AID and this work is in progress. Release of rupee equivalent of 30,000 US $ for the project design studies has been asked for from the Government of India, which is awaited. As the HUDCO Consultancy Wing has to meet its own expenses from its earnings itself, it has asked for advance payment. HUDCO has also completed a part of housing study such as, optimization of housing element (wall of room).

Task 12 - Collection of information and refinement

The various aspects of model building for shelter design and analysis have been discussed with Mr. Edward S. Popko, U.S. counterpart who visited Delhi in November 1981 and HUDCO has also developed number of m-odels for typical layouts and further refinements are being done in conjunction with the project design studies taken up by the HUDCO Consultancy Wing. A copy of paper prepared by HUDCO in this regard is enclosed.

Task 13 - Visit of HUDCO staff to USA for pilot test of model and finalization of arrangement for medium term training

HUDCO has already sent the specifications of medium term training and the matter has also been discussed with Mr. Votaw, Asst. Director for Asia Office of Housing to take up with US-AID Washington D.C. Office and communicate the requisite information about the Universities which can take up this type of training programme.

Mr. Edward S. Popko, U.S. counterpart, has suggested that HUDCO representative should visit USA to evaluate the computer system first hand before final selection. In order to finalise the selection of equipment and the arrangement for medium term training, the Government of India is being requested to permit deputation of HUDCO team to USA for this purpose.

The concerned Department of the Government of India has clarified that the import licence could be processed only on the basis of specific details of the computer system proposed to be imported are furnished to them, which will be furnished after selection of the computer system by the above team.

Incl: as above

Systems Approach - Land Subdivision, Utility Networks and Affordability*

In one in the year 1970 HUDCO raised the issue that not much attention is being given by professionals in India (a) to achieve economies in use of land by adoption of efficient layouts and (b) through that to achieve further economies in laying utility networks. HUDCO also called attention to the fact that land and land development constitutes over half of the cost of a housing project and sizeable economies can be achieved by optimising use of land and economising infrastructure costs[1]. Simultaneously it mounted various project design and evaluation studies to identify critical variables which contribute to economies or diseconomies in land sub-division and utility network.

This was a significant development in view of the fact that though number of professionals and research organisations have made significant contributions in the area of reducing cost of construction, the research in the area of cost reduction in respect of land and land development continued to be neglected. Many basic decisions continue to be taken on the basis of minimum recommended standards that are often too prodigal. Few techniques/models are available to help professionals designers to assess the impact of their basic premises in terms of cost. Because of above HUDCO has consistently raised the issue of optimising use of land and economising in cost of land development with its borrowing agencies and at diverse national and international gatherings of experts[2].

Previous Studies

A few scientific models which link physical planning and its cost implications to the affordability are available. However, the development of such models is of recent origin

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* This study has been undertaken by a group of HUDCO professionals and is financed jointly by US AID Washington D.C. and HUDCO

and a vast majority of professionals are still unaware of its existence. Even if they are aware they are not used at field level. Prominent studies in this area include Bernaud-Padoa[3] Model which takes affordability, density and plot size as determining criteria and arithmetically evaluates the prodigality or otherwise of different cost components of housing projects. The model helps arrive at solutions at expected, desirable or affordable plot size, density goals etc. and allows the planners to work backafarth. The second study is by Cortinas-Goethert[4]. The model while addressing itself to the question of urbanisation, specifically, land sub-division and the provision of services for the most needy sections of the population, presents two approaches to minimise costs. In the first, levels of services are analysed to provide range for policy decisions. In the second indicators are proposed to provide jurisdiction for design decisions i.e. provision of utilities, water supply service disposal, circulation and storm drainage, electricity and street lighting etc. The study primarily provides matrix and indicators for optimum land utilisation and infrastructure utilities for normal site conditions at minimum and standard level of services.

Besides these, studies by Allan Turner[5] and others are available as guide to physical planners. In addition there are number of national[6] and local codes which help determine standards in physical planning. Recently Gloria Popko[7] of HIT Karachi while working with HDUCO has emphasised the need of further work in having another look at these models in view of indigenous requirements and has emphasised the need of further work in this regard. It is also heartening that an association has been created to explore this margin area of affordable cost reductions in high value and major cost elements of housing projects.

Despite these developments the professionals in HUDCO feel that the existing knowledge wherewithal does not

(i) accommodate the local limiting factors i.e. local standards and building regulations.

(ii) cater to layout patterns other than rectangular blocks.

(iii) prevent encroaches of impractical conditions.

Considering that, it became necessary for HUDCO to develop a systems approach to project planning suitable for Indian conditions.

HUDCO Feedback

HUDCO has extensive feedback of atleast 1600 projects spread over 370 towns and hundreds of rural human settlements. Its projects are worth Rs.1200[d] crores and involve construction of over 1 million houses. During the last few years it has become still more urgent to quicken research work in this regard and develop guidelines to help housing planners in view of the fact that (i) cost of land is increasing (ii) resources available for housing continue to be limited (iii) adhesion in land subdivision planning continues to be rampant and (iv) awareness has been created that unless shelter solutions are provided at affordable levels for the people at large the housing problem will become still worse.

In land subdivision for housing purposes, the basic decisions taken by a planner relate to plot area, plot width and depth, the pattern of grouping plots/houses and densities to be followed. Most professional planners take decision on the basis of experience or minimum recommended standards. Very rarely a physical planner evaluates the

trade offs available by changing the ratios of plot sizes, clusters, etc. In the absence of any appropriate technique available to suits the local conditions, the only way such trade offs can be analysed is to prepare alternative layouts and estimate these. Such tasks will consume considerable amount of time and will rarely enable us to evaluate implications of change in number of variables such as plot ratios, plot sizes, circulation length, circulation area, cluster ratios, etc. If such exercises are to be of any fruitful use, it will be desirable if a physical planner can evaluate in advance all such alternatives even before drawing a single layout.

Objectives.

HUDCO aims to develop the requisite technical aids in the form of a Reference Matrix, Graphs/Charts, Handbook of Guidelines and a computerised programme which will enable a physical planner to evaluate cost and design implications of various alternatives available to him.

Evaluation of research done in this regard made it obvious to us that the task is far from easy. The difficulties encountered emanate from numerous physical planning variables, cost variables and multiplicity of financial terms available for project implementation. Feedback from studies already done and which visualise physical planning module in terms of a rectangular block provided only partial solution. This is so because in the family of layout plans the simple grid iron block is only one of the numerous grouping patterns available. Consequently, the models developed on this basis are not applicable to numerous other forms of grouping patterns. HUDCO has, therefore, identified from the schemes mentioned by us, the basic forms of layouts in terms of row or clusters. These are indicated in Fig.1. In order to develop a model, the land use efficiencies and the cost implications are first being tested on cluster level. The

cost implications will be analysed with reference to the various standards of land development and options in terms of circulation network width. In the second stage, this study will be extended to cover the implications of provision of residential support facilities in the total layout based on a unit grouping pattern. These implications will be studied in terms of land use efficiencies and per plot cost available by changing the residential support facility standards and the standards for utility network in terms of sources and disposal etc. Final models will establish the relationship between the cost implications of total layout to the desired total cost of a dwelling unit.

Results

HUDCO has already initiated studies and has come out with the results of analysis of the first typical cluster - Fig.2. In order to pre-judge the implications of changing different parameters before drawing cluster layout, formulae were developed to derive the total number of plots, the density, the area under circulation and the length of circulation. All these formulae are basically in terms of plot area, plot ratio, different road widths, cluster ratio and per capita social facility area. By operating these relationship formulae the implications of changing the plot ratio or cluster ratio or any other variable can be studied in advance. Formulae developed are as follows:

FORMULAS

1. N = NUMBER OF PLOTS $= \dfrac{\sqrt{ax}\left[6r\left(6\sqrt{ax}+2S_1+S_3\right)-4S_1-3\left(S_2+S_3\right)\right]}{a+5p}$

2. D = DENSITY $= \dfrac{\sqrt{ax}\left[6r\left(6\sqrt{ax}+2S_1+S_3\right)-4S_1-3\left(S_2+S_3\right)\right]\times 5\times 10^4}{(a+5p)\,r\left(6\sqrt{ax}+2S_1+S_3\right)^2}$

3. $P\%$ = AREA UNDER CIRCULATION $= \dfrac{100}{\left(6\sqrt{ax}+2S_1+S_3\right)}\left[2S_1+S_3+\dfrac{\sqrt{ax}\left(4S_1+3S_2+3S_3\right)}{r\left(6\sqrt{ax}+2S_1+S_3\right)}\right]$

4. L_{cl} = TOTAL CIRCULATION LENGTH PER SQ. M $= \dfrac{1}{r\left(6\sqrt{ax}+2S_1+S_3\right)}\left[1+3r-\dfrac{S_2+S_3-1\sqrt{ax}}{6\sqrt{ax}+2S_1+S_3}\right]$

WHERE

a = AREA OF PLOT.
x = RATIO OF PLOT DEPTH TO WIDTH.
r = CLUSTER RATIO.
S_1, S_2, S_3 = WIDTH FOR DIFFERENT CLUSTER ROADS.
P = OPEN SPACE OR SOCIAL FACILITY SPACE PER CAPITA.

The formulae evolved are already tested for the cluster ratios of 1, 1.5 and 2 for various options available in terms of width of the network. The graphs indicating the relationship of depth factor to percentage of area under circulation, the length of circulation per sq. m., density factor and total number of unit factor are prepared for various options of network width for the cluster ratior indicated earlier. For a given depth of plot, these graphs can directly indicate the area under roads, the length of roads, etc. for a given cluster ratio. The cluster level studies indicating the options available in terms of land use are further extended to relate these to two levels of cost standards. The different cost standards are derived by changing the specifications for roads and utility network. The formula to arrive at cost factor has been developed in terms of cluster ratio and plot depth factor, cost-efficients and different options of road widths. These formulae are as follows:-

Cp = COST PER PLOT

$$= \frac{a + 5P\left[(6\sqrt{ax}+2S_1+S_3)\left\{C_L + r(6\sqrt{ax}+2S_1+S_3)+r(2C_i+C_{ps})+0.5(C_{pn}+C_{ps})\right\} - C_i(S_2+S_3-4\sqrt{ax})+8C_{mh}\right]}{\sqrt{ax}\left\{6r(6\sqrt{ax}+2S_1+S_3)-3S_2-4S_1-3S_3\right\}} + \frac{C_{mh}}{0.25}$$

WHERE

C_L = COST OF LAND/SQ M. INCLUDING LEVELLING, DRESSING, EXTERNAL ELECTRIFICATION AND ARBORICULTURE.

C_i = COST PER METER LENGTH OF INTERNAL CIRCULATION & NETWORK.

C_{pn} = COST PER METER LENGTH OF MAJOR PERIPHERIAL CIRCULATION AND NETWORK.

C_{ps} = COST PER METER LENGTH OF SUBSIDIARY PERIPHERIAL CIRCULATION AND NETWORK.

C_{mh} = AVERAGE COST OF SINGLE STANDARD MANHOLE

A graph has been developed where the depth factor expressed in terms of area and plot ratio for different cluster ratios is related to cost factor Fig. 3. Horizontal axis of this graph indicates the depth factor while the vertical axis indicates the cost factor. For any given plot area and cluster ratio, corresponding cost factor can be identified to give the cost per plot. It will, therefore, be seen that even before a planner prepares the layout plan this graph can enable him to choose the most economic solution.

Fig. 2 will indicate a typical study where three alternative layouts are illustrated. Variables indicated for different layouts in terms of circulation area per plot, circulation length per plot and cost per plot were determined before drawing the cluster layout and were verified subsequently. The original cluster in the comparative study had a cluster ratio of 1.5 and the plot ratio of 1.48. This cluster was resulting in per plot cost of Rs.1619. The second cluster layout indicates that the cost per plot has been reduced to Rs.1505 by merely changing the cluster ratio. The third layout indicates that the per plot cost can be further reduced if the plot ratio is also varied. However, a note of caution needs to be added to indicate that the limiting factors in terms of minimum plot width suitable for dwelling unit design as well as minimum and maximum cluster dimensions to suit the socio-economic needs will be operating. For example, the width of a plot cannot be lesser than 3 m. if a habitable dwelling unit is to be provided in the selected plot width or the length of a cluster cannot be more than a given length (120 to 150 m.) without adversely affecting the efficient functioning of utility networks in terms of connections, head losses, etc. for the water supply grid. The use of systems approach does not necessarily impose a rigid discipline. The system co-relates number of plots and open spaces for a given plot/cluster ratio. Within this framework an architect is free to arrange the available open spaces in number of

alternate ways. This is also demonstrated in the Fig. 2 layouts.

Future Perspective

These cluster level studies are now being expanded to cover different forms of grouping patterns and the total layout efficiencies. In the coming weeks and months we propose to bring out as aforesaid a comprehensive reference material to help physical planners achieve economics in utility networks and optimize use of land. In this context, the objective of above write-up is to provide a review of the possibilities available to us through systems approach to strengthen land subdivision planning for obtaining the most desired solutions even before carrying out new planning exercises.

R E F E R E N C E S

1. S.C. Bijlani, The Hindu (Madras) 30th October 1970

2. S.C. Bijlani Government Sponsored Low Income Shelter Housing Finance in India, 23 ATH Regional Seminar February 1981 Bangkok

   HUDCO/IIPA Workshop on Project Formulation New Delhi 1981

   HUDCO - Management Development Institute (MDI), New Delhi. Training Programme on Housing Management, 1980, New Delhi.

   Guidelines for Achieving Optimum Density (Economy in Housing Projects 1981 - A HUDCO Publication).

   Research and Development Series No. 3 - A HUDCO Publication.

3. Urban Demand Index Model (Mimeographed) Planning and Development Consultancy Organization Washington D.C.

4. Constantinos-Doxiadis. Urbanization Policy FIT Harvard U.S.A.

5. Allan Turner - Cities of the Urban Poor.

6. National Building Code. Special Chapter on Low Cost Housing ISI 3000 New Delhi etc.

7. Edward Popko. Computer Based Project Analysis and Design Housing and Urban Development Corporation(HUDCO) New Delhi Harvard University U.S.A December 1981

8. HUDCO Programme, Procedures and Guidelines (2nd Edition) 1980. A HUDCO Publication.

TYPOLOGY FOR DWELLING GROUPING PATTERNS

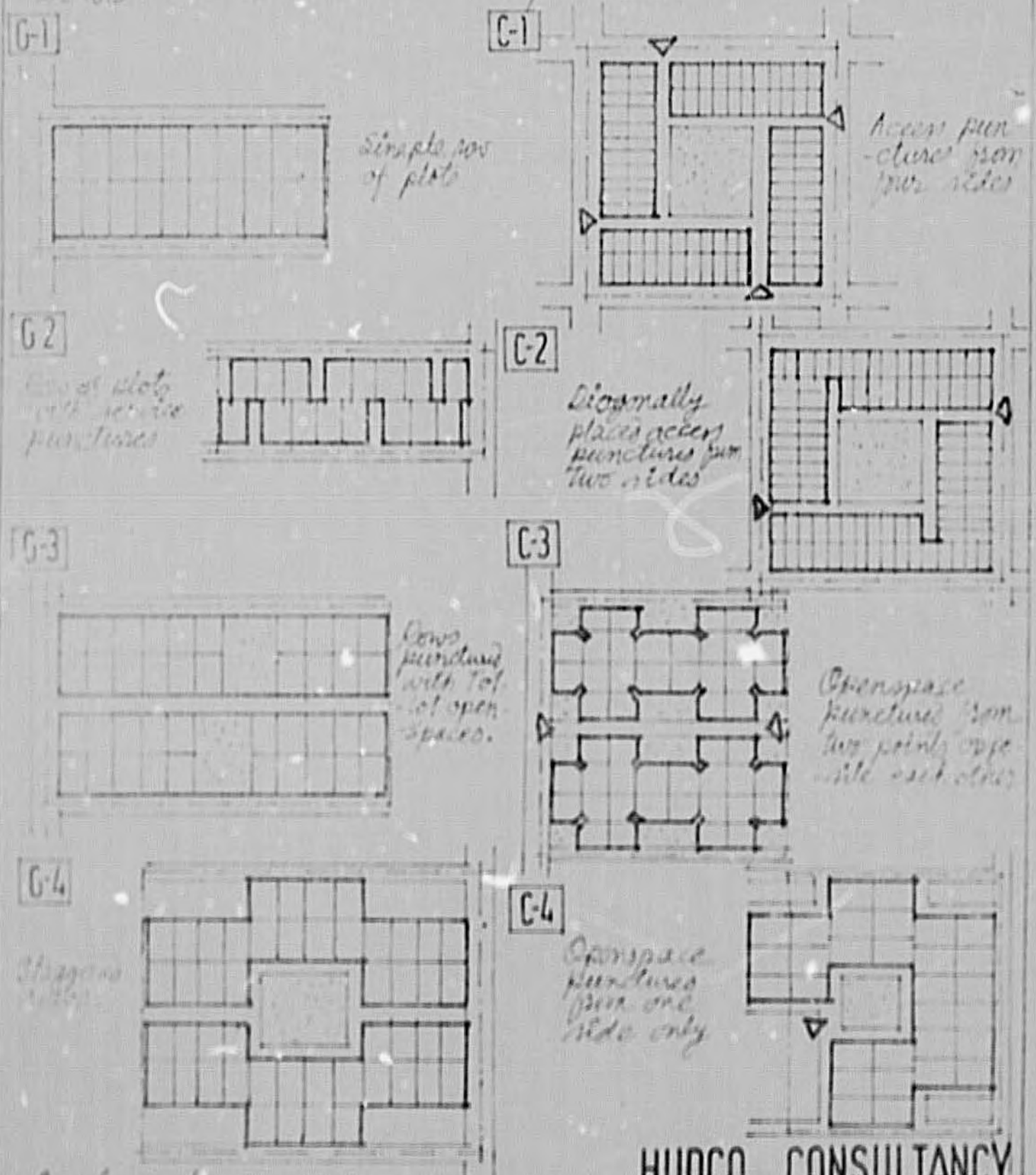
TWO BASIC TYPES - GRIDIRON (ROW PATTERN), CLUSTERS

GRIDIRON (G)

formed by plots in parallel arrangement of roads. Subgroups are identified by the way plot rows relate to the needs of services and tot lots

CLUSTERS (C)

Forms by enclosing an openspace by dwelling units locate around it, having more than two orientations. Subgroups are indicated by the way enclosed spaces are punctured.

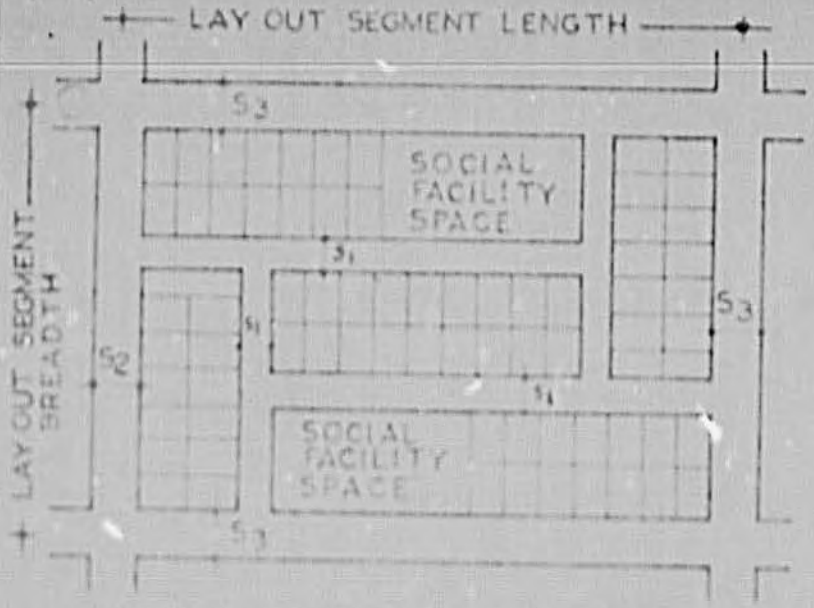


NOT TO SCALE

HUDCO CONSULTANCY

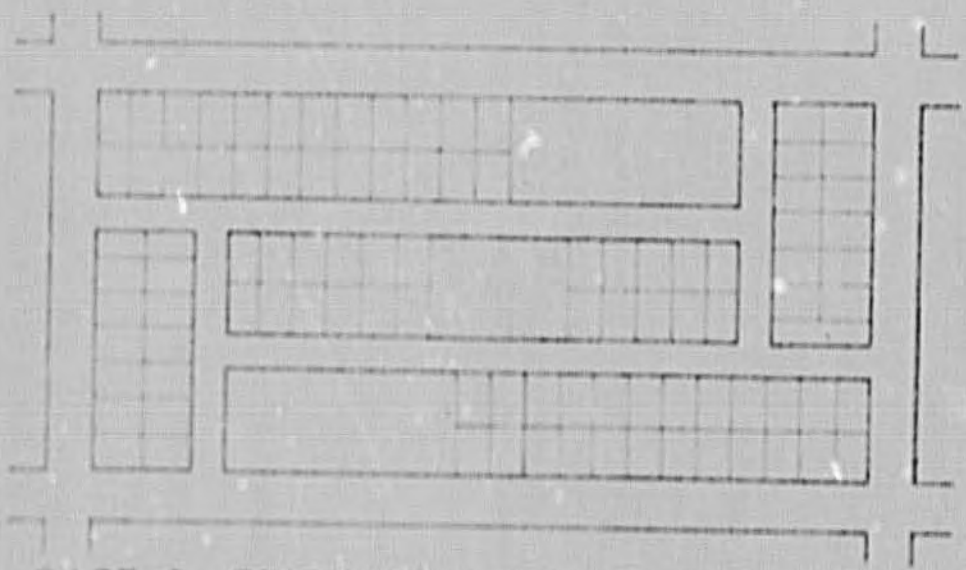
HUDCO SHELTER DESIGN & ANALYSIS

FIGURE ONE



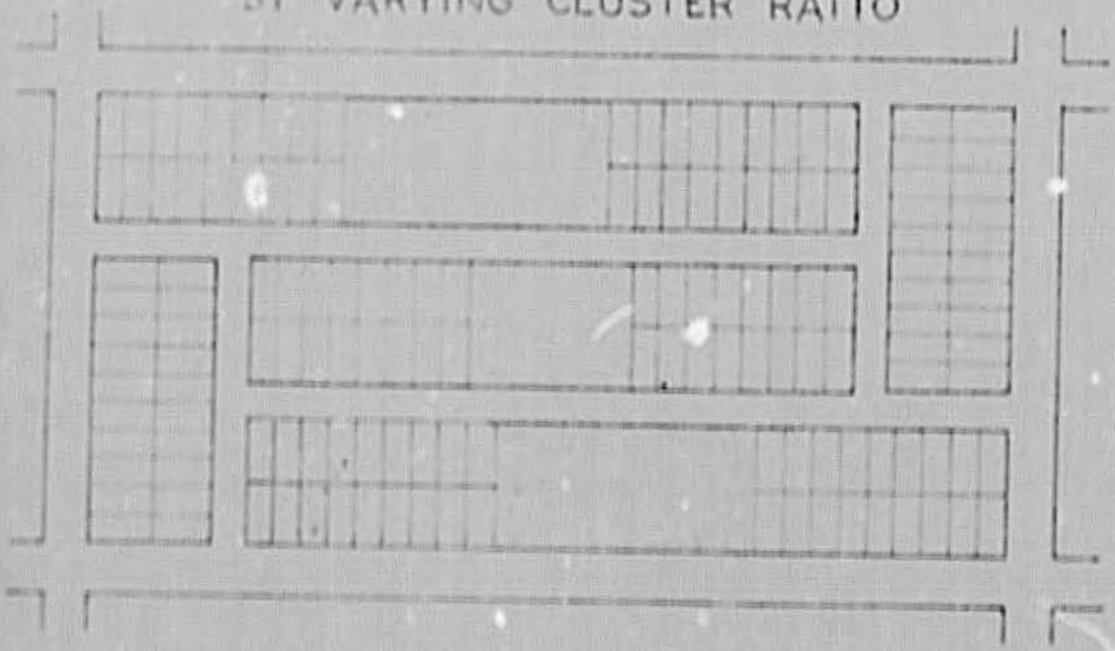
PLOT SIZE: 4·5×6·67 m.
PLOT AREA: 30 Sq.m.
PLOT RATIO: 1·482
CLUSTER RATIO: 1·5
DENSITY: 164 Dus/ha.
CIRCULATION LENGTH PER PLOT: 5·05 m
CIRCULATION AREA PER PLOT: 20·55 Sq. m.
COST PER PLOT: Rs 1619.00

CASE 1 ORIGINAL LAYOUT



PLOT SIZE: 4·5m×6·67m.
PLOT AREA: 30 Sq.m.
PLOT RATIO: 1·482
CLUSTER RATIO: 2
DENSITY: 164 Dus/ha.
CIRCULATION LENGTH PER PLOT: 4·09 m.
CIRCULATION AREA PER PLOT: 19·35 Sq.m.
COST PER PLOT: Rs. 1565·00

CASE 2 ORIGINAL LAYOUT IMPROVED BY VARYING CLUSTER RATIO



PLOT SIZE 3.6×8.197 m.
PLOT AREA 30 Sq.m.
PLOT RATIO 2.28
CLUSTER RATIO 2.0
DENSITY 164 Dus/ha
CIRCULATION LENGTH PER PLOT 3·21 m
CIRCULATION AREA PER PLOT 15·23 Sq.m.
COST PER PLOT Rs. 1217·50

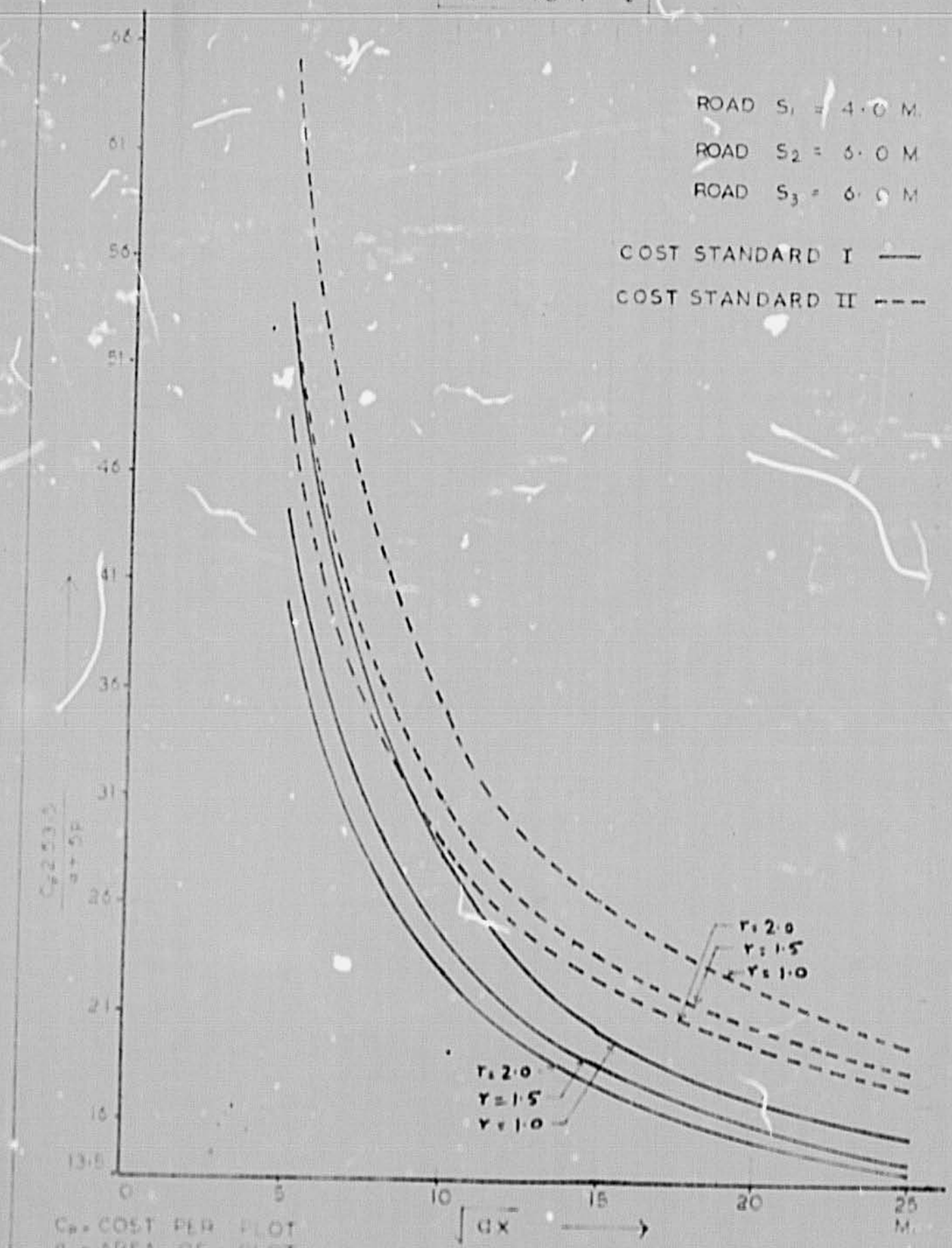
CASE 3 ORIGINAL LAYOUT IMPROVED BY VARYING CLUSTER RATIO AND PLOT RATIO.

HUDCO CONSULTANCY
HUDCO SHELTER DESIGN & ANALYSIS

FIGURE TWO

COST FACTOR $\frac{C_p \cdot 253 \cdot 5}{a + 5p}$ VS $\sqrt{ax}$

OPTION I



C_p = COST PER PLOT
a = AREA OF PLOT
p = OPEN SPACE PROVISION PER CAPITA
x = PLOT DEPTH/WIDTH RATIO
r = CLUSTER RATIO

HUDCO CONSULTANCY

HUDCO SHELTER DESIGN AND ANALYSIS

FIGURE THREE

9120007

March 11, 1982

Jeffery A. Malick - PD, USAID/India

Ed Popco's Draft Report

Mr. Al Votaw - RHUDO, USAID/Bangkok

Attached for your information and appropriate action is HUDCO's comments on Ed Popco's draft report.

att: a/s

cc: Mr. E. Popco (with copy of HUDCO comments)

PRE/H, AID/W (" ")

PD:GPVarshneya:trr:3/11/82

B. K. Chakraborty
Chief (Project)

hudco
Housing and Urban Development Corporation Limited
HUDCO HOUSE, LODHI ROAD, NEW DELHI-110003
Off. 699534 res. 653927
grams : housecorp

No.HUDCO/US-AID/82/ 29713

3.3.1982

VED
5 MAR 1982

Mr. Jeffery A. Melick,
Deputy Chief,
Office of Project Development
US-AID,
American Embassy, West Building,
Chanakyapuri,
New Delhi -110021.

Sub: US Counter Part Consultancy Report Oct.30-Nov.25, 1981.

Dear Sir,

Please refer to Mr. Varshneya's letter of February 17, 1982. By and large we agree with the draft report of Mr. Edward S.Popko, US-AID Consultant, on the HUDCO Shelter Design and Analysis Project as forwarded by the US-AID. However, we would like to say the following:-

Group A : Systems Analysis in Land Sub-division, Utility Network.

1. We agree with the recommendation of Mr. Edward Popko that HUDCO undertake "a review of client applications and competition submissions showed that there are two broad sub-division approaches, gridiron and clusters, and that a typology could be created which compares the efficiency of different lot layouts within them". In line with this thinking "range of sub-division design and on-plot housing types"(P.5) were selected and analysed by HUDCO and first output in this regard has already been sent to Director, US AID Washington D.C. Taking off from the discussions we had with US Counterpart on the analysis of work already done in HUDCO, it is proposed to utilise HUDCO model to evaluate the set of client projects.

2. It has been suggested that HUDCO should analyse support land uses with increasing densities and size of the projects. It is proposed to undertake the above study jointly by the HUDCO Consultancy Wing and Design Development Group under the item 'Studies' in the Agreement. Further action is being taken accordingly.

3. It may be difficult to integrate entirely the matrix or table of co-efficients of support facilities into the geometric model which will be a deterministic model based on a specific layout. However, HUDCO is attempting to take into account the social facilities space in the model as far as possible and first model sent to the US-AID incorporates this.

4. It is felt that the inclusion of cost escalation in the residential support matrix may not be necessary as the relative merit of various layouts could be assessed by the relative cost of each option using the model already developed by HUDCO and sent to the US-AID.

Contd..2...

Group B : Equipment

5. US Counterpart consultancy Draft Report makes inter-alia the following three observations and to which we agree:

i) "total lack of vendor support" (p.6) for suggested micro-processors.

ii) It would be "more convenient to retain a US Counterpart to assist in equipment procurement, testing etc." (p.9).

iii) Final selection of equipment should be based on the ability to inter face peripherals from "Other Equipment Manufactures" (p.43 Appendix 6). This to be done during discussions with US Counterpart.

Further during discussions with Mr. Sean P. Walsh, Office of Housing US AID Bangkok, HUDCO took into consideration the on-going computer based loan accounting system in HUDCO and the need to integrate US AID-HUDCO sponsored Shelter Design and Analysis Project with the computer-based loan accounting system on considerations of cost and in-house availability of micro-computer facilities. With this background $50,000 were tentatively provided in the Loan Agreement.

Hence we feel that the micro-processor based configuration will be of limited solution to overall objective of US AID grant to enable HUDCO "promote and expand the supply of low-income Shelter in HUDCO".

As desired in the report this will be discussed further with US Counterpart during HUDCO Team's visit to USA.

Group C: Visit of HUDCO team as laid down in US AID Checklist and US Counterpart Consultancy Report

6. As suggested by Mr. Edward S.Popko, HUDCO is considering to depute a Team to the USA for first hand evaluation of the computer equipment systems before placing firm orders. Accordingly, approval from the Govt. of India has been sought. In the meantime, the recommendation of Mr. Edward S.Popko on the computer system keeping in view the point mentioned in para 5 above may please be sent along with the short list and technical details of various US computer systems fulfilling the above requirement with cost of each system and indicating the availability of facilities for maintenance in India. Depending on the cost of the computer system fulfilling the requirement enumerated, it is proposed to adjust the requirement of hand held calculators and also other line items, if required as per the Agreement in consultation with US-AID/Govt. of India.

7. The training may be a general multi-disciplinary type of short duration where use of computer for shelter design analysis may be covered. The number of trainees will depend on the cost of training and the fund available for training as per the Agreement. The details of training will be decided

Contd...3..

by HUDCO in consultation with US-AID during the proposed visit of the HUDCO team to USA.

Group D: Miscellaneous

8. At page-3 of the report, the word 'HUDCO's consultancy group' should be replaced by only 'HUDCO' and similarly at page-10, the word 'project appraisal' should be replaced by 'project design, analysis and appraisal'.

Yours faithfully,

(B.K. Chakraborty)
Chief (Projects).