BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER
PN-AAJ-372

2. SUBJECT CLASSIFICATION (695)
LL00-0000-G302

3. TITLE AND SUBTITLE (240)
Housing survey for disaster relief and preparedness: Latin America

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101)
Evaluation Technologies, Inc.

6. DOCUMENT DATE (110)
1981

7. NUMBER OF PAGES (120)
152p.

8. ARC NUMBER (170)
LAT363.5.E92

9. REFERENCE ORGANIZATION (130)
ETI

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

12. DESCRIPTORS (920)
Disaster assistance
Wind resistance
Latin America
Housing
Earthquake resistance
Regional planning
Low-cost
Surveys

13. PROJECT NUMBER (150)

14. CONTRACT NO.(140)
AID/SOD-PDC-C-0283

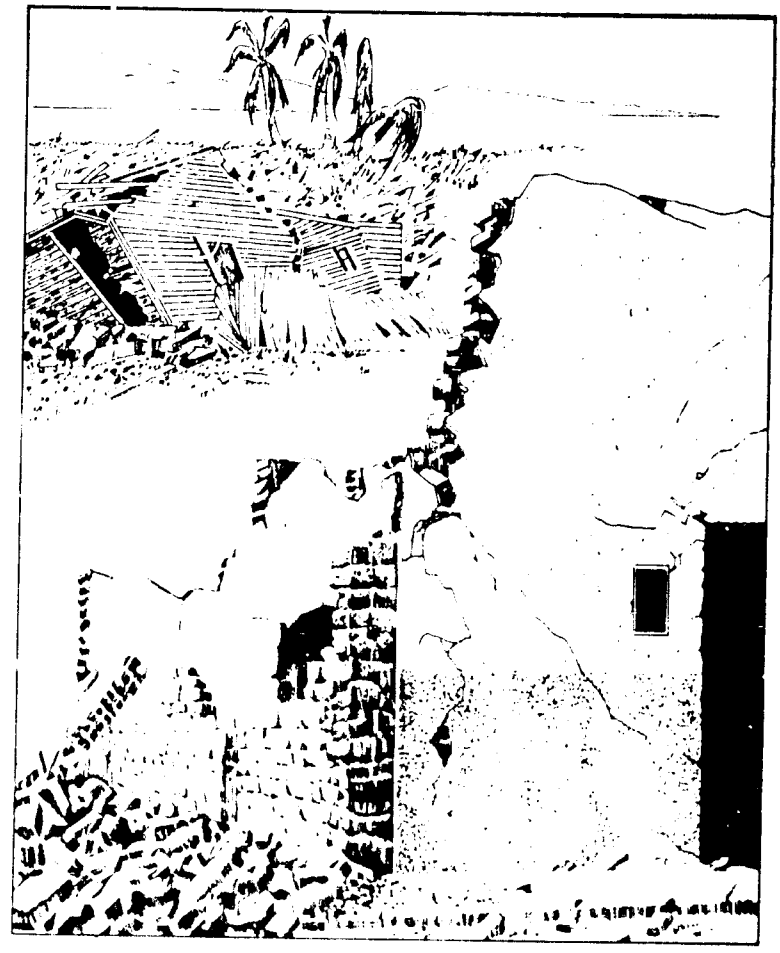
15. CONTRACT TYPE (140)

16. TYPE OF DOCUMENT (160)

AID 590-7 (10-79)

LAT
363.5
E92

PN-AAJ-372



LATIN AMERICA Housing Survey for Disaster Relief and Preparedness

March 1981

Office of U.S. Foreign Disaster Assistance
Agency for International Development
Washington, D.C. 20523 U.S.A.

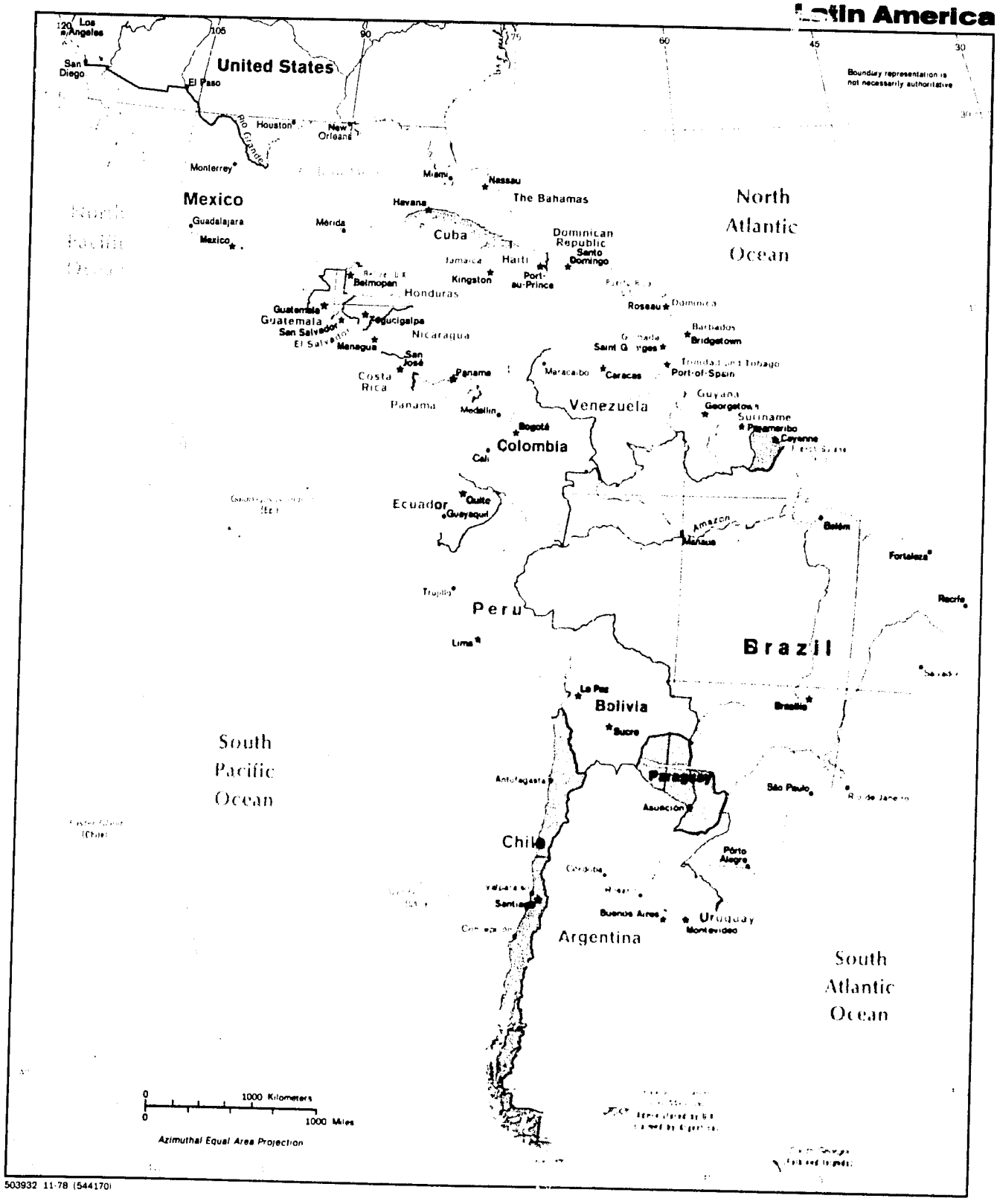
Housing Survey for Disaster Relief and Preparedness:

LATIN AMERICA

March 1981

Office of U.S. Foreign Disaster Assistance
Agency for International Development
Washington, D.C. 20523 U.S.A.

Latin America



503932 11-78 (544170)

HOUSING SURVEY FOR DISASTER RELIEF AND PREPAREDNESS: LATIN AMERICA

TABLE OF CONTENTS

Table of Contents i
Introduction iii
Acknowledgements iv
Abbreviations and Acronyms v
Measures and Equivalents vii
Housing Survey by Country 1
- Bolivia 2-10
  - Overview 2
  - Housing Policy and Institutions 4
  - Disaster/Low-cost Housing 4
  - Housing Types, Materials, Construction and Services 5
  - Bibliography 10
- Chile 11-16
  - Overview 11
  - Housing Policy and Institutions 12
  - Disaster/Low-cost Housing 12
  - Housing Types, Materials, Construction and Services 14
  - Bibliography 16
- Dominican Republic 17-29
  - Overview 17
  - Housing Policy and Institutions 18
  - Disaster/Low-cost Housing 19
  - Housing Types, Materials, Construction and Services 24
  - Bibliography 29
- Ecuador 30-44
  - Overview 30
  - Housing Policy and Institutions 32
  - Disaster/Low-cost Housing 34
  - Housing Types, Materials, Construction and Services 34
  - Bibliography 44
- El Salvador 45-54
  - Overview 45
  - Housing Policy and Institutions 45
  - Disaster/Low-cost Housing 48
  - Housing Types, Materials, Construction and Services 48
  - Bibliography 54
- Guatemala 55-64
  - Overview 55
  - Housing Policy and Institutions 55
  - Disaster/Low-cost Housing 57
  - Housing Types, Materials, Construction and Services 60
  - Bibliography 64
- Haiti 65-73
  - Overview 65
  - Housing Policy and Institutions 65
  - Disaster/Low-cost Housing 67
  - Housing Types, Materials, Construction and Services 67
  - Bibliography 73

Honduras..... 74-84
Overview..... 74
Housing Policy and Institutions..... 74
Disaster/Low-cost Housing..... 76
Housing Types, Materials, Construction and Services..... 78
Bibliography..... 84
Nicaragua..... 85-93
Overview..... 85
Housing Policy and Institutions..... 86
Disaster/Low-cost Housing..... 87
Housing Types, Materials, Construction and Services..... 88
Bibliography..... 92
Peru..... 94-105
Overview..... 94
Housing Policy and Institutions..... 95
Disaster/Low-cost Housing..... 96
Housing Types, Materials, Construction and Services..... 97
Bibliography..... 105
Disaster Mitigation for Low-cost Housing..... 106-141
Earthquakes..... 107-125
Introduction..... 107
Causes of Earthquake Damage..... 107
Effects of Earthquakes on Structures..... 108
Building to Resist Earthquake Forces: Siting..... 110
Building to Resist Earthquake Forces: Design..... 111
Building to Resist Earthquake Forces: Components and Critical Connections..... 113
Building to Resist Earthquake Forces: Materials..... 118
Building to Resist Earthquake Forces: Building Codes..... 120
Bibliography..... 124
Windstorms..... 126-141
Introduction..... 126
Causes of Wind Damage..... 126
Effects of Wind on Structures..... 127
Building to Resist Wind Forces: Siting..... 132
Building to Resist Wind Forces: Design..... 132
Building to Resist Wind Forces: Components and Critical Connections..... 133
Building to Resist Wind Forces: Materials..... 135
Building to Resist Wind Forces: Building Codes..... 138
Bibliography..... 140

Introduction

This regional housing profile of Latin America was designed to provide a concise yet comprehensive picture of housing in that region to assist the US Office of Foreign Disaster Assistance in the planning of shelter relief operations. The countries chosen for inclusion--Bolivia, Chile, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Nicaragua and Peru--are particularly prone to natural disasters and have received US relief assistance in the past. The focus is on the housing of the poor--the economic group most likely to be affected when disaster strikes and least able to recover quickly without assistance.

The report is in two parts. The first describes settlement patterns and housing types; methods and materials commonly used in housing construction in each country; the institutions involved in the financing and building of low-cost housing; and, when information was available, the kinds of emergency shelter provided in the past and their acceptability. The second part covers disaster mitigation techniques in earthquake- and wind-resistant housing.

It is hoped that the information provided will also be useful to others in the disaster assistance and development communities in their planning, mitigation and relief operations, as well as in future efforts to coordinate relief and permanent housing assistance programs.

Every effort was made to obtain current and reliable data; however, in some instances very recent statistics were not available. The reader who wishes a more detailed and technical description of housing construction methods and disaster mitigation techniques than this summary provides is referred to the bibliography for sources.

We invite your comments and corrections. Address these and other queries to Office of U.S. Foreign Disaster Assistance, Agency for International Development, Washington, D.C. 20523.

March 1981

Acknowledgements

The authors, Deborah Webb, Faye Henderson and Cecily Mango, wish to acknowledge their indebtedness to those agencies and individuals who assisted their research by suggesting sources and providing material. In particular, they wish to express their gratitude to the following: Office of Housing, Agency for International Development, for making its Shelter Sector Assessments and other publications available and for reviewing the final drafts; INTERTECT, for the use of its publications on disaster mitigation; and Mr. Charles Mathews, Engineering Division Chief, LAC/DR, for reviewing photographs used in the section on earthquake damage mitigation and for assisting with captions.

Thanks also go to our ETI colleagues who assisted with style and copy editing, and with typing.

Abbreviations and Acronyms

BANDESA -	National Agricultural Development Bank (Guatemala)
BANVI -	Banco de la Vivienda (Housing Bank) (Bolivia)
BANVI -	Banco Nacional de la Vivienda (National Housing Bank) (Guatemala)
BAVINIC -	Banco de la Vivienda de Nicaragua (National Housing Bank) (Nicaragua)
BEV -	Banco Ecuatoriano de la Vivienda (Ecuadorian Housing Bank) (Ecuador)
BDL -	Banque du Logement (Housing Bank) (Haiti)
BIAPE -	International Savings and Loan Bank
BNV -	Banco Nacional de la Vivienda (National Housing Bank) (Dominican Republic)
BVP -	Banco de la Vivienda del Peru (Peru)
CABEI -	Central American Bank for Economic Integration
CICV -	Comision Inter-Institutional para la Coordinacion de Programas de Viviendas (Inter-Institutional Commission for the Coordination of Housing Programs) (Dominican Republic)
CONADE -	Consejo Nacional de Desarrollo (National Planning Board) (Ecuador)
CONAVI -	Consejo Nacional de Vivienda (National Housing Council) (Bolivia)
DIDECO -	Direccion de Desarrollo Comunal (Community Development Department (El Salvador)
EMADIPERU -	Peruvian Real Estate Management Enterprise (Peru)
FEHCOVIL -	Honduran Cooperative Housing Federation (Honduras)
FHA -	Instituto de Fomento de Hipotecas Aseguradas (Institute of Insured Mortgages) (Guatemala)
FNV -	Financiera Nacional de la Vivienda (El Salvador)
FUNDASAL - (FSDVM)	Fundacion Salvadorena de Desarrollo y Vivienda Minima (El Salvador)
IBRD -	International Bank for Reconstruction and Development (World Bank)
IDB -	Inter-American Development Bank
INIAVI -	Instituto de Investigaciones para la Accion en Vivienda (Institute for Investigation of Housing Action (Peru)
INVA -	National Housing Institute (Honduras)
INVI -	Instituto de la Vivienda (National Housing Institute) (Dominican Republic)
INVU -	Instituto Nicaraguense de la Vivienda (Nicaraguan Housing Institute) (Nicaragua)
IVU -	Instituto de Vivienda Urbana (Urban Housing Institute (El Salvador)
JNV -	Junta Nacional de la Vivienda (National Housing Board) (Ecuador)
MINVU -	Ministry of Housing and Urbanism (Chile)
MOHC -	Ministry of Housing and Construction (Peru)
MUV -	Ministry of Urban Development and Housing (Bolivia)
ONL -	Office National du Logement (National Housing Office) (Haiti)

PRIDECO - (formally ONCOM - Oficina de Mejoramiento de Communidades Marginales) (El Salvador)
SINAP - Savings and Loan System (Chile)
SPU - Service de Planification Urbain (Town Planning Service) (Haiti)

Measures and Equivalents

mm	=	millimeter (0.03937 inches)
cm	=	centimeter (0.3937 inches)
1 meter (m)	=	3.28 feet
1 kilometer (km)	=	0.62 mile
cm^2	=	square centimeter (0.1550 square inches)
m^2	=	square meter (10.764 square feet)
m^3	=	cubic meter (35.314 cubic feet or 1.308 cubic yards)
ha	=	hectare (2.471 acres)
km^2	=	square kilometer (0.386 square miles)
l	=	liter (0.264 U.S. gallons)

Housing Survey by Country

1. Overview

The census of 1976 recorded a national population of 4,647,816; World Bank estimated 5,290,000 in 1978. Growing urbanization in recent years is evidenced by the rise in percentage of people living in cities of over 2000 inhabitants from 30.5% in 1965 to 34% in 1975. An urban growth rate of 4% per year during the same period compares with a rural rate of 2.1% and an overall growth rate of 2.9%. Between 1950 and 1976 Santa Cruz recorded the fastest growth rate at 7.3% per year; the main cities of La Paz and Cochabamba grew at 3.5% and 3.9% respectively. About 80% of the rural population lives in the highlands (30%) or valleys (50%). Lowlands are sparsely populated.

Provision of housing and services has not kept pace with urban growth. Despite government efforts of recent years, including expropriation of large urban holdings and redistribution of land (Urban Reform Law of 1963), creation of a housing council (1964) and housing bank (1974) to accelerate construction of low-cost units, much housing of urban poor is makeshift, self-built, and lacking in basic services. 83% of the housing stock in the cities of La Paz, Cochabamba, Oruro, Potosi, Sucre, and Tarija was considered marginal by the Ministry of Planning in 1972. Overcrowding is a common problem; 60% of dwellings in Trinidad, 40% in Sucre, have 3 or more persons per room. 1966-1972 census data showed that more than half of the urban units were rented while 98% of rural dwellings were owner-occupied.

The rural population consists mainly of subsistence farmers who work small plots. In general there is little buying and selling of homes, and self-construction is the usual method. The typically small rural home is built of adobe brick in the highlands and of natural plant materials in the lowlands.

An estimated annual housing demand of 40,000 units is equally divided between urban and rural; production through housing institutions, however, does not exceed 5,000 units.

Estimates of National Housing Deficit
(CONAVI)*

Cities	Population	Housing Demand	# of Existing Houses	Housing Deficit
La Paz	805,448	161,289	49,500	111,789
Cochabamba	173,779	34,755	15,900	18,855
Santa Cruz	159,410	31,882	17,040	14,842

* Consejo Nacional de Vivienda

Cities	Population	Housing Demand	# of Existing Houses	Housing Deficit
Oruro	138,768	27,753	10,556	17,197
Potosi	114,969	22,993	6,850	16,143

Cities	Population	Housing Demand	# of Existing Houses	Housing Deficit
Sucre	100,836	20,167	6,300	13,867
Tarija	42,401	8,480	3,700	4,700
Trinidad	27,080	5,416	3,545	1,871
Cobija	5,609	1,121	405	716
Total	1,569,300	313,856	113,876	199,980

Source: AID, Bolivia Shelter Sector Assessment, 1976.

Household and Family Size

	Persons per Household	Family Members per Household*	Labor Force Participation Rate
Bolivia	5.11	5.00	39%
City of La Paz	4.72	4.51	38%
Other Urban Areas	5.32	5.10	34%
Rural Areas	5.12	5.07	41%
Provinces:			
Chuquisaca	5.21	5.11	34%
La Paz	4.76	4.67	44%
Cochabamba	5.10	4.95	40%
Oruro	5.04	4.97	32%
Potosi	5.19	5.15	33%
Tarija	5.67	5.48	36%
Santa Cruz	5.85	5.56	36%
Beni	6.84	6.67	36%

* excludes non-relatives living in the household

Source: AID, Bolivia Shelter Sector Assessment, 1976.

2. Housing Policy and Institutions

Ministry of Urban Development and Housing (MUV), established in 1970, was given the central role by the 1973 Housing Law to give single source direction to housing and urban development activities. The Housing Division of MUV has three principal sections: Housing, Community Development, and Technology. As the community development arm, Direccion General de Promocion Communal (DGPC) has low-income community development plans as its main function.

Banco de la Vivienda (BANVI)--financial entity created by Housing Law. Solution to financing low-income shelter expected to be its primary objectiv .

The Bolivian Savings and Loan System--consisting of central bank and regulatory agency, Caja Central de Ahorro y Prestamo (CACEN), and 11 member associations, is the only institutional source of long-term financing in the private sector. Since change in AID Housing Guaranty policy, savings and loan institutions h ve been involved in low-cost shelter programs. CACEN is principal contact with government and international lending institutions.

Banco Hipotecario and other commercial banks lend for housing on short-term basis only.

The Consejo Nacional de Vivienda (CONAVI), founded in 1964 as largest housing council, is semi-autonomous under MUV and an effective implementing agency in the housing sector.

3. Disaster/Low-cost Housing

Several recent housing "solutions" have received external financing.

1. IBRD - 1977 Urban Development Project included 5,525 serviced plots in El Alto section of La Paz, about 85% with core dwelling options; upgrading of 4,500 units with basic infrastructure and construction material credits based on mutual aid.

2. IDE - $21 million loan to CACEN for emergency shelter for Trinidad flood victims in 1976 that provided 800 core units and services on high land on city outskirts.

3. Interamerican Savings and Loan Bank (BIAPE) - negotiated $15 million in June 1978. CACEN presented solicitation for $3 million loan for construction of low-cost urban units to begin mid-1979.

4. AID - proposed two $4 million housing guarantees in 1979: one to BANVI to finance 2,090 shelters in Plan Socio Urbano projects, about 25% of them completed core units; one to savings and loan system for 2,870 shelters in rural areas, about 20% completed core units.

4. Housing Types, Materials, Construction and Services

4.1 Housing Types

Urban

The near absence of lean-tos and shacks in urban low-cost housing of the Altiplano is attributed to Bolivians' skill in constructing with adobe block. Thus, dwelling walls in La Paz or Sucre, for example, appear solid, though floors may be earthen, roofs of a variety of materials, and windows few. Slum housing in the lowlands, where sun-baked bricks are the common building material, is less durable.

About 62% of the population of La Paz lives in marginal housing on city outskirts, chiefly on steep, landslide-prone slopes; poor site selection, overcrowded conditions, and an absence of services are greater problems than structure durability.

In the lowland city of Trinidad, a recent survey found 80% of the housing to be substandard and in need of repair. Over 50% of units were built in the traditional manner: mud and cane walls, tile or palm roofs. 78% of the dwellings lacked sanitary facilities; 50% depended on a public spigot for water supply.

Rural

Rural homes are usually small and rectangular in shape. In the highlands they are typically of adobe brick construction with steeply gabled roofs of thatch (scrub). The kitchen may be a separate structure but cooking is usually done in the main house. Houses may be grouped or in compounds.

Low-cost housing in the lowlands is less permanent, with plant materials, such as reeds, palm fronds or thatch, extensively used. Mud, cane, and palm are traditional building materials in the eastern parts of the country. Roofs of palm fronds are steeply gabled.

Basic sanitary facilities are usually lacking; electric service is available only in, or near, major cities or towns. Manure or wood are used as fuel for cooking, kerosene lamps or candles for lighting.

4.2 Materials and Construction

Usual low-cost housing materials are adobe walls, cyclopean footings, and tin or clay tile roofing. 90% of traditional materials are domestically produced. Cement, brick, block, cement tiles, adobe, and wood for windows and doors are locally available; reinforcing steel, aluminum, sanitary fixtures, electrical conduit, pipes, glass, and hardware must be imported. Cement also is increasingly imported since annual production of about 266,000 tons does not meet demand. An inadequate transportation network and general inflation add to cost of materials.

Roofing: clay tiles common in La Paz; imported asbestos, aluminum, and zinc sheets have become popular.

Flooring: dirt floors common; otherwise, concrete slab is easiest, if not least expensive, material to use. Wood is preferred in higher altitudes; cement tiles set in mortar or compacted earth are often used in lowlands.

Walls: adobe brick in the Altiplano; clay brick or cement block in lowland urban areas.

Windows: increasingly seen (doors only openings in traditional homes); iron or wood frames most common in low-cost housing.

There were 176 construction companies in 1977: La Paz (104), Cochabamba (25), Santa Cruz (22). Technicians and unskilled workers are in adequate supply but shortage of skilled labor exists.

Self-construction and improvement of homes is a Bolivian cultural tradition. The basic shell which most low income families are capable of constructing can often be brought up to adequate standards with modest investments in improvements and addition of infrastructure.

Classification of Housing: According to Quality of Construction in 1972

Cities	# Inhabitants	Type I	Type II	Type III	Type IV	Total
La Paz	582,000	2,802 5.81%	6,965 14.45%	12,403 25.73%	26,032 54.01%	48,202 100%
Cochabamba	163,940	1,359 7.99%	2,985 17.55%	5,697 33.51%	7,861 46.23%	17,002 100%
Oruro	103,740	88 0.65%	1,055 7.85%	5,372 40.0%	6,928 51.54%	13,443 100%
Potosi	72,070	22 0.32%	313 4.51%	2,407 34.71%	4,193 60.46%	6,935 100%
Sucre	52,890	80 1.1%	488 6.57%	2,837 38.86%	3,903 53.46%	7,308 100%
Tarija	29,110	127 3.19%	350 8.80%	1,239 31.18%	2,258 56.82%	3,974 100%
Total	1,003,750	4,478 4.62%	11,248 11.61%	29,955 30.93%	51,175 52.84%	96,856 100%

Type I: good quality construction with a full endowment of public facilities and amenities.

Type II: less luxurious than Type I but of good construction and access to public utilities. Includes most of the public sector housing.

Type III: marginal units, built of simple materials with no amenities, poor access to public utilities, and inhabited often by more than one family. This class includes deteriorating tenement buildings and boarding houses.

Type IV: slums or squatter units. The least stable construction, combined with an absence of all or most utilities and comforts.

Source: Ministerio de Planeamiento y Coordinacion. "Diagnostico de Vivienda" as cited in AID Bolivia Shelter Sector Assessment, 1976.

4.3 Services

Forty percent of urban housing units lack water service, 63% lack sewer facilities. Only 1% of rural population has access to piped water and 11.2% to adequate sewage disposal. Not more than 5% of rural households had electricity in the early 1970's.

A water treatment plant and related trunk lines were expected to be in operation by 1978, facilitating development of the Altiplano. There were no sewer treatment plants in Bolivia in 1976, though construction of one in La Paz was being negotiated that year.

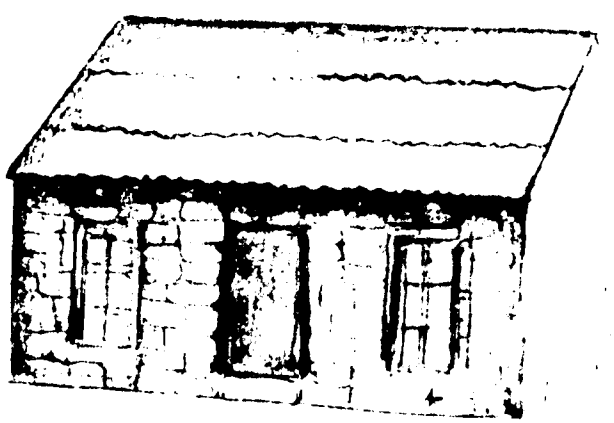
Percent of Housing Units with Service

City	Year of Census	Water	Electricity	Sewer
Potosi	1972	43%	65%	32%
Tarija	1970	*	82%	*
Cochabamba	1967	61%	72%	41%
Oruro	1972	58%	83%	27%
Sucre	1972	71%	78%	46%

* No data available

Source: Ministerio de Planeamiento y Coordinacion as cited in AID Bolvia Shelter Sector Assessment, 1976.

Rural house in Altiplano: walls of adobe brick, roof of thatch.



Marginal urban dwelling: walls of adobe brick or block, roof of corrugated metal.

5. Bibliography

Agency for International Development. Bolivia: Country Development Strategy Statement, FY 82. United States International Development Cooperation Agency. Washington, D.C.: AID, January 1980.

_____. Bolivia Project Paper: Shelter Program for Low-Income Families. Washington, D.C.: AID, 1979.

_____. Office of Housing. Bolivia: Shelter Sector Assessment. Washington, D.C.: AID, December 1976.

U.S. Department of Commerce. Bureau of the Census. International Population Dynamics 1950-79. Demographic Estimates for Countries With a Population of 5 Million or More. Washington, D.C.: GPO, 1980.

Weil, Thomas E., et. al. Area Handbook for Bolivia. Washington, D.C.: GPO, 1974.

World Bank. Bolivia Urban Development Project. Washington, D.C.: IBRD, September 8, 1977.

1. Overview

Though Chile's national population growth rate of 1.6% in 1977 is one of the lowest in Latin America, the urban growth rate, especially that of the capital city of Santiago (4.4% per year between 1960-1970), has been considerably higher in recent decades due to a steady rural to urban migration. The percentage of population described as urban rose from 37% in 1940 to 60% in 1970 with a growing proportion of the urban population concentrated in Santiago: 51% in 1940 and 54% in 1970. The rural population made up only 27% of the national total in 1978 (projected estimate for national total in 1979: 10,848,00).*

Rapid urban population growth, combined with normal deterioration of housing stock and destruction of homes by natural disasters (an estimated 11,700 units are destroyed or become marginally habitable each year), has created a massive housing shortage. The 1978 deficit was estimated at 484,000 units of which 200,034 were needed for very low income families. Except for the luxury market, the housing supply has been severely depressed in recent years. The public sector's withdrawal from participation in construction has encouraged greater participation by private enterprise. The rising cost of housing and mortgage interest rates and shortage of long-term financing have excluded even middle-income families from the market.

Housing Terms

Poblacion - usually a government-built housing project in discrete neighborhood; often of one housing type.

Campamento - government-built housing project considered temporary and substandard by government's own definition.

Callampa - squatter or ad hoc housing.

Meddiagua - a basic 3 X 6 m shelter of wood frame and siding provided by the government as emergency housing. Floors may be of dirt, wood, concrete slab; roofs are of corrugated asphalt impregnated organic material, zinc, or cement asbestos.

Source: Charlotte Thompson and Paul Thompson. Preliminary Report on Post Disaster Housing in Chile. August 5, 1976.

* International Population Dynamics 1950-79. U.S. Department of Commerce, Bureau of the Census.

2. Housing Policy and Institutions*

The Ministry of Housing and Urbanism (MINVU) was created in 1965 to provide a central organization for housing and related urban affairs. Among the agencies integrated into MINVU were four semi-autonomous corporations in charge of various aspects of housing programs until 1976: the Urban Renewal Corporation (CORMU), the Housing Corporation (CORVI), the Corporation of Housing Services (CORHABIT), and the Urban Works Corporation (COU). The eventual overlapping of functions and competition among these agencies led to the decision to restructure MINVU and to consolidate activities under one agency while also decentralizing away from Santiago. (A national policy of regionalization was being implemented by the early 1970's.)

The Caja Central de Ahorros y Prestamos (Central Savings and Loan Bank), also under MINVU, regulated the private system of savings and loan associations (21 in 1974) and served as the central credit facility. The Savings and Loan System (SINAP) was given the task of allocating a large part of its resources to financing "social interest" housing. In addition, the establishment of a National Housing Bank to promote construction of medium-and low-cost housing within the public sector was being planned in 1974.

3. Disaster/Low-cost Housing

3.1 Post-Disaster Housing **

An earthquake and tidal wave (tsunami) in the south of Chile destroyed more than 50,000 homes in 1960; the 1965 earthquake in central Chile destoyed 23,000 homes and damaged over 31,000 others; another in about the same area in 1971 destroyed the same number of homes. The extensive use of wood in home construction in recent years and anti-seismic building codes in effect since the disastrous earthquake of 1939 are credited with keeping losses at this level.

* Data for this section are drawn from the AID Chile Shelter Sector Analysis, written in 1974 when housing policy and institutions were in a stage of active transition. Little information is available on subsequent developments.

** Major data source for this section is Preliminary Report on Post Disaster Housing in Chile (August 5, 1976) by Charlotte Thompson and Paul Thompson.

There was only limited use of tents and makeshift shelters following these recent disasters; survivors found refuge mostly in public buildings--schools, military barracks--or with relatives until government emergency housing became available.

The government's approach to emergency housing in each disaster followed the general housing policy then in effect. After the 1960 earthquake, the GOC established large areas as sites on which to erect simple wood duplex or row shelters (each project had 200-600 units). Though generally in a state of disrepair, the majority of units were still occupied in 1976.

Due to the high cost of providing infrastructure to these sites, this method was abandoned in the 1965 disaster. Instead, mediaguas (basic 3X6 m units with wood frame and siding) were provided to families on pre-existing or pre-serviced sites. There was a return to designated special zones (campamentos) for emergency housing in 1971, with mediaguas again provided.

In the opinion of Charlotte and Paul Thompson, the likely GOC approach to providing emergency shelter in a future disaster would again be the building of 3X6 m mediaguas on small lots in campamentos with basic infrastructure. They also saw evidence in the success of Plan BID (a loan program of Banco Interamericano de Desarrollo diverted to building completed homes in the disaster area in 1960) that, for little additional money, permanent housing could be built in the typical three-month span required for emergency housing.

3.2 Low-cost Programs

The cultural tradition that the head of a household must provide at least minimal family shelter has sanctioned the formation of callampas and even land invasions. A wave of illegal seizures of new housing units in the early 1970's prompted the GOC to institute an emergency housing plan which resulted in the completion of 28,000 36m^2 units. A current program is directed at families living in extreme poverty in slum areas. Under the guidance and direction of Community Housing Committees (given legal status as autonomous public agencies), families are moved out of callampas into homes of minimal standard which are considered transitory solutions until permanent housing is available. Another GOC program provides subsidies to qualified low-income families to make up the difference between the cost of a house and the amount of a mortgage loan obtainable from a banking institution.

4. Housing Types, Materials, Construction and Services

4.1 Housing Types

Urban

A result of rapid urban growth has been the proliferation of marginal callampa (mushroom) villages on the outskirts of major cities. The makeshift shanties of these densely populated squatter communities house the overflow from the traditional dwelling of the urban poor, the conventillo (tenement). An estimated 140,000 families lived in slums and shanty towns in 1974.

Rural

Homes of rural poor are typically one-or two-room dwellings, built of rough board or wattles and chinked with clay. Floors may be earthen or brick; roofs are of thatch or turf. Kitchen and dining room may be in a separate lean-to or veranda. The dwellings of those in slightly better economic circumstances often have adobe walls and tile roofs.

4.2 Materials and Construction

In the south, wood has been increasingly used as building material in recent decades, although in 1974 there was still a preference for the more expensive masonry or reinforced concrete construction. Despite widespread recognition among Chileans of the superior seismic-resistant qualities of wood over traditional adobe construction, adobe is still used in rural areas of the north, where termites are a serious problem and wood is more expensive, with little improvement in construction technology. Likewise, adobe structures still occupied in areas recently hit by earthquakes are often cracked and damaged, and highly vulnerable to collapse during a severe quake. The serious housing shortage makes eradication of these dwellings impossible.

The use of new techniques to improve efficiency of construction (e.g., prefabrication) was being encouraged in the mid-1970's. Chile has several housing factories capable of producing a variety of prefabricated components.

In 1974, the GOC originated about 80% of all construction investment. There appeared to be no shortage of skilled or unskilled labor in the industry nor any lack of critical materials such as lumber or cement. Builders in Chile, described as sophisticated and numerous emough to produce a

large volume of housing units, were under-utilized in 1974.

4.3 Services

The more extensively developed areas of Santiago have sewage collectors, though there are no treatment plants. Collectors discharge into the Mapocho River which eventually empties into the Pacific. The potable water system in the capital city consists of a central system and at least 10 others. Treatment is generally limited to chlorination and, in some systems, filtration.

72% of urban homes and 20% of rural ones have running water, though piped water is no guarantee of purity. Recent studies covering 80% of the country's water systems reveal that 43% of those tested, reaching 20% of the people with potable water, are supplying contaminated water.

Only 56% of urban homes (housing 49% of the urban population) and 12% of rural homes are equipped with waste disposal systems.

5. Bibliography

Agency for International Development. Office of Housing. Housing Guaranty Program. Chile Shelter Sector Analysis. Washington, D.C.: AID, 1974.

_____. Country Development Statement: Chile. FY 1981. Washington, D.C.: AID, January 1979.

Thompson, Charlotte and Paul. Preliminary Report on Post Disaster Housing in Chile. August 5, 1976.

U.S. Department of Commerce. Bureau of the Census. International Population Dynamics 1950-79. Demographic Estimates for Countries with a Population of 5 Million or More. Washington, D.C.: GPO, 1980.

Weil, Thomas E., et al. Area Handbook for Chile. Washington, D.C.: GPO, 1969.

1. Overview

High rural-urban migration and urban population growth rates have resulted in concentrations of population in urban areas, especially Santo Domingo and Santiago. The average annual national population growth rate is 2.5%; however, in urban areas it averages between 5 and 6%. The damage caused by Hurricane David and Tropical Storm Frederic (September 1979) has exacerbated this situation, increasing immigration dramatically to urban areas. Because of these pressures, housing is clearly inadequate to meet the needs of the population. Urban deficits are estimated at 13-23%, while rural are as high as 64%. In order to satisfy the housing demand incurred because of population growth, an annual average of 32,900 units of new housing must be constructed: 29,300 urban units and 3,600 rural units.

2. Housing Policy and Institutions

Until recently, housing policy was characterized by a lack of any comprehensive policy or plan, and by neglect of the needs of low income households, which constitute the majority of the population. The government had established priority areas for urban/rural integration and development in an attempt to correct socio-economic imbalance, and to prevent any further polarization of growth (which might result from Hurricane David and Tropical Storm Frederick).

Shortly after Hurricane David, INVI (Instituto de la Vivienda - National Housing Institute) initiated a permanent consultative commission representing the principal public and private low-income housing institutions. The Comision Inter-Institutional para la Coordinacion de Programas de Viviendas (CICV) will have a permanent status and seek to plan and implement programs with both national and international financing. Members include: INVI, ODC, FDD, Caritas, SEOPC, CODIA, the Fundacion San Jose, the Asociacion para el Desarrollo de San Jose de Ocoa, Catholic Relief Services, Servicios Social de los Iglesias Dominicanos, IAD, INADA. The overall purpose will be to organize housing programs oriented toward low income households, and to coordinate financing. (See Disaster/Low-cost Housing for more information on this commission).

Housing Institutions

Entity	Legal Base Nature	Geographic Scope	Stated Objectives	Sources of Finance
Instituto Nacional de la Vivienda (INVI)	Autonomous 1962	National urban/ rural	Planning, implementation and management of housing programs for low income households.	• subsidies • loans • payments by households • issuing of cedulas
Savica (IAV)	(1961)	National	Serve public employees; serve autonomous institutions	• own resources • loans from private international bank • loans from D.R. Reserve Bank
Presidencia	---	National (± 60% of actual programs in Santo Domingo)	---	• own resources • general fund • authorized funds of other entities
Banco Nacional de la Vivienda (BNV)	(1962) As official credit institution -- autonomous and decentralized	National	To facilitate through savings and loan associations the acquisition and maintenance of houses for the maximum number of middle income and low income households. Among its other functions, the BNV is able to provide financial assistance to the SAAPs and supervise and control them and guarantee mortgages.	• loans • payments by borrowers • issuing of cedulas
Savings and Loan Associations (SAAPs)	(1962) Private credit entities	National (84% of actual loans concentrated in Santo Domingo and Santiago)	To provide loans for the construction, acquisition, conservation, repair or improvement of housing. The SAAPs are also able to finance the urbanization of land for the construction of housing. They are regulated by norms established by the BNV.	• savings deposits • loans • payments by borrowers
Banco Hipotecario (BH)	An official credit institution -- autonomous and decentralized (1971)	National (86% of loans concentrated in Santo Domingo and 14% in Santiago)	To undertake loans with real property mortgage guarantees, including loans for the construction and acquisition of housing. For middle income and high income households, particularly for the latter.	• loans • payments by borrowers • issuing of cedulas

Source: AID Office of Housing. Dominican Republic Shelter Sector Assessment. April 1980.

Basic urban services are provided by the following institutions:

Corporacion del Acueducto y ALcantarillado de Santo Domingo (Santo Domingo Aqueduct and Sewage Company) CAASD

Instituto Nacional de Aguas Potables y Alcantarillado (National Institute of Potable Water and Sanitation) INAPA

Corporacion Dominicana de Electricidad (Dominican Electric Corporation) CDE

Secretario del Estado de Obras Publicas y Comunicaciones (Secretary of State for Public Works and Communications) SEOPC

Liga Municipal Dominicana (Dominican Municipal League) DML

28% of all arable lands are the property of the government agency Bienes Nacionales as a result of the transfer of the vast Trujillo holdings to the government. The two major holders of public lands are the Instituto de Agrario Dominicano (Dominican Agrarian Institute) IAD, and the Consejo Estadal del Azucar (state sugar board) CEA.

Many of the lands occupied by low income squatter settlements are part of government holdings. Thus, the relatively monolithic nature of the landholding pattern would expedite any contemplated land use policy change (such as transfer of title to the residents of squatter settlements located on public land).

3. Disaster/Land-cost Housing

The most widespread effect of Hurricane David and Tropical Storm Frederic was the destruction of an estimated 105,000 houses (80 million pesos), located primarily in the National District and Provinces of San Cristobal, Peravia, San Jose de Ocoa, Padre Las Casas, San Juan de la Maguana, Santiago, La Vega. Loss of roof structure was the most common type of damage sustained.

Immediately after the disasters, the GODR designated the Instituto Nacional de la Vivienda (INVI) as the responsible agency for coordinating emergency relief and assistance efforts of local, national and international agencies. INVI adopted the following policy guidelines: private and public sector organizations would participate in the relief/recon-

struction effort; relief/reconstruction programs would complement ongoing production activities and should be carried out as part of development objectives.

The "Post Hurricane Housing Repair and Reconstruction" table at the end of this section provides a summary description of the relief/reconstruction program:

With regard to Program 1, Repair of Roofs and Minor Damage, INVI performed minimum rehabilitation necessary to make each affected house habitable, provided employment for those individuals whose economic activities were paralyzed because of the disaster and made use of materials from damaged or destroyed housing. Program 2, Reconstruction and Repair of Major Damage, was directed at refugees still located in temporary housing solutions (schools, hospitals, etc.). The program involved structural repairs of housing in precarious and dangerous condition, reconstruction of walls, roofs and partitions and construction of new housing. Program 3, Row Housing, relocated non-property owner refugees to barrack housing. Program 4, Reconstruction and Development, directed the efforts and contributions of national and foreign private non-profit institutions. The principal objective of this program was the construction or reconstruction of population centers on an integrated basis.

During the execution of the programs, an inter-institutional group of public and private sectors was initiated under the leadership of INVI. This group, the Comision Interinstitucional de las Viviendas (CII-Viviendas), has attained permanent status and functions to respond to low-income housing needs, integrate the provision of housing with community development activities, and serve as a technology information and transfer center. The following organizations are members of CII-Viviendas: INVI, Public Works and Communications (SEOP); the Community Development Office (ODC); the Central Bank; the Dominican Agrarian Institute (IAD); the Dominican College of Architects and Engineers; the Dominican Development Foundation (DDF); Social Services of Dominican Churches (SSID); the San Jose Foundation; CARE; Catholic Relief Service (CRS); the Association for the Development of San Jose de Ocoa; the Office of Construction for North Bani; and Caritas of the Dominican Republic.

The USAID Emergency Housing Program was implemented through coordination with six PVO's to repair and rebuild destroyed or badly damaged rural homes. The program consists of three components: the AID/PVO Materials Package, the AID/INVI Zinc and Nails in Kind Donation and Housing Repair and the AID/INVI Basic Core Housing Construction.

The AID/PVO Materials Package subprogram channelled grant funds to six PVO's to finance home repair activities. The distribution of a building materials package was realized through a subsidized sale delivery mechanism. Each PVO was given an advance by AID to purchase a certain quantity of building materials (including wood, corrugated zinc roofing sheets, nails, cement, concrete blocks and hand tools), which the PVO then distributed through its network of affiliated service agencies. Actual repair/construction was the responsibility of the individual beneficiary, although technical assistance was provided in many cases.

The AID/INVI Zinc and Nails In-Kind Donation and Housing Repair program donated 20,000 sheets of galvanized and zinc roofing, 7,000 feet of ridgepoles and 50,000 pounds of nails to INVI to assist in the repair of the houses of the neediest families in the affected rural areas. INVI and PVO's supervised the distribution of building materials and the technical assistance support.

The AID/INVI Basic Core House Construction Program will provide core shelter for 930 families who are still residing in sub-standard housing. The program objectives include making maximum use of self-help participation in planning and construction activities to promote community support and to reduce costs.

The institutional response to the post-disaster housing need was criticized as inadequate. However, as a result of the experience, the abilities of the participating groups and agencies grew considerably. Over the year following the disaster, the technical and management capability of the institutions was significantly enhanced. Based on the experience of the Dominican Republic, the following recommendations were made:

1. Post-disaster surveys to determine need should be pre-planned, diagnostic, and directed to the specific needs of individuals.

2. Post-disaster plans and actions should be oriented to promote the effective recovery of the affected zones and to complement the economic development goals of the zones or sectors.

3. Beneficiary participation should be encouraged as an essential part of all housing relief/reconstruction efforts.

4. Housing solutions should be identified as to whether they are permanent or temporary and appropriately phased follow-up and modification activities should be implemented.

5. Effective mechanisms and criteria for making use of disaster assistance should be in place to take full advantage of aid.

INVI Post Hurricane Housing Repair and Reconstruction Program

Province	GENERAL TOTALS		STAGE I: EMERGENCY	STAGE II: RECONSTRUCTION		
	Investment (thous.RD$)	No. of Houses Reconstructed	Program I: Repair of Roof & Minor Damage	Program II: Reconstruction & Repair of Major Damage	Program III: Barracks Housing	Program IV: New Housing Development
Distrito Nacional	2,226	5,089	3,000	289	1,800	
San Cristobal	1,534	18,019	4,500	12,889	294	336
Peravia	2,116	17,275	5,000	10,469	220	1,586
Azua	10	64			64	
San Juan de la Maguana	92	100			100	
La Vega	37	65		65		
Sanchez Ramirez	21	82		82		
COUNTRY TOTAL	6,101	40,694	12,500	23,794	2,478	1,922

Source: AID Office of Housing. The Disaster Relief Response in the Dominican Republic following Hurricane David and Tropical Storm Frederick with particular emphasis on the USAID Housing Program. December 1980.

USAID Emergency Housing
Disaster Relief Funds

Agency	Budgeted Amount ('000) US$	Disbursed Amount ('000) US $	Houses to be Repaired/ Reconstructed	Houses Repaired/ Reconstructed
CARE	130	130	595	595
Servicio Social de Iglesias Dominicanos (SGID)	129	129	355	355
Southern Baptist Mission of the Dominican Republic	3	3	22	22
American Institute For Free Labor Development (AIFLD)	50	50	430	430
Dominican Development Foundation (DDF)	150	135	477	438
Catholic Relief Service (CRS)	76	50	84	20
Instituto Nacional de la Vivienda (INVI)	1,485.5	144.5	180.3	151
TOTAL	2,284.5	641.5	376.6	2,011

Source: AID, Office of Housing, The Disaster Relief Response in the Dominican Republic Following Hurricane David and Tropical Storm Frederick. December 1980.

4. Housing Types, Materials, Construction and Services

4.1 Housing Types

Seven major housing types have been identified in the Dominican Republic. The standard single family house is the most common type of dwelling, housing 51% of the households. 65% of urban units and 40% of rural units are single family. Rustic houses, 42% of all households, predominate in rural areas, and represent 56% of the rural housing stock. Provisional housing, which accounts for 1% of the households, is generally located on the outskirts of cities. Apartments and occupied buildings constructed for purposes other than housing contain about 4% of the households. Generally these types are located in urban areas. Bateys, located on sugar plantations, represent .07% of the housing stock. A residual category, other collective housing, consists of mainly urban dwellings such as barracks, jails, etc.

Formal residential construction, utilized for standard single family and apartments, is typified by concrete block walls and reinforced concrete slab or concrete block roofs. Informal residential construction, characteristic of rustic and provisional housing, is sided with either wooden boards or indigenous materials (especially palm and tejamil). Zinc panels or native materials are the most common roofing materials. Bateys are barrack-like structures constructed of wood with zinc or asbestos roofs and floors of "caliche" (a type of stone). A shift in materials used in informal construction is occurring as the depletion of native resources forces increased dependence on concrete. The majority of building materials used for residential construction are produced domestically using a high labor component.

Because three-fourths of Santo Domingo's families are low-income, an additional classification of marginal housing became necessary. 34% of the capital's poor families live in cuarterias and traspatios. Cuarterias are rows of attached units consisting of one or two rooms. Traspatios are small dwelling units constructed in the back of other houses. Block walls and zinc roofs are standard. Both these housing types are generally located near the center of the city. Water is obtained from public faucets or bought from neighbors or water vendors; sanitary waste disposal and trash collection systems are lacking in the majority of cases. Electricity is generally available, although blackouts are common.

Housing Characteristics: Dominican Republic

ASPECT	TYPE OF HOUSING	"STANDARD" SINGLE FAMILY			RUSTIC			PROVISIONAL			OCCUPIED BUILDINGS CONSTRUCTED FOR OTHER THAN HOUSING PURPOSES			BATEY		
		TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL
NUMBER OF HOUSEHOLDS (000's)		493.4	278.1	215.3	406.4	105.2	300.2	7.9	5.1	2.8	2.1	1.2	0.9	7.2	0.2	7.0
PERCENTAGE OF TOTAL HOUSEHOLDS' (%)		51.2	28.9	22.3	42.2	11.0	31.2	0.8	0.5	0.3	0.2	0.1	0.1	0.7	0.0	0.7
WATER SUPPLY (HOUSEHOLDS OBTAINING WATER FROM TANK, WELL, RIVER OR OTHER NON-PIPED SOURCE)	HOUSEHOLDS (000's)	140.4	23.9	116.5	269.1	38.5	230.6	2.4	0.5	1.9	0.6	0.1	0.5	4.1	0.0	4.1
	% OF HOUSEHOLDS BY URBAN/RURAL	100	17.0	83.0	100	14.3	85.7	100	20.8	79.2	100	16.7	83.3	100	0.0	100.0
	% OF HOUSEHOLDS BY TYPE	28.5	8.6	54.1	66.2	36.3	76.6	30.4	9.8	67.9	28.6	8.3	55.5	56.9	0.0	58.6
SANITARY FACILITIES (HOUSEHOLDS NOT HAVING "FORMAL" TOILET FACILITIES AS PART OF DWELLING UNIT)	HOUSEHOLDS (000's)	208.7	70.0	138.7	328.9	70.6	258.1	3.6	1.8	1.6	0.9	0.2	0.7	5.6	0.0	5.6
	% OF HOUSEHOLDS BY URBAN/RURAL	100	33.5	66.5	100	21.6	78.4	100	50.0	50.0	100	22.2	77.8	100	0.0	100.0
	% OF HOUSEHOLDS BY TYPE	42.3	25.2	64.4	80.4	66.7	85.3	45.6	35.3	64.3	42.9	16.7	77.8	77.8	0.0	80.3
ELECTRICITY (HOUSEHOLDS NOT SERVED BY ELECTRICITY)	HOUSEHOLDS (000's)	171.3	29.6	141.5	337.3	54.0	281.3	4.5	1.7	2.8	0.6	0.1	0.7	N.A.		
	% OF HOUSEHOLDS BY URBAN/RURAL	100	17.4	82.6	100	16.0	84.0	100	37.8	62.2	100	12.5	87.5			
	% OF HOUSEHOLDS BY TYPE	34.7	10.7	65.7	83.0	50.6	94.4	57.0	33.3	100.0	38.1	8.3	77.8			
DWELLING UNIT BUILDING MATERIALS: FLOORS (HOUSEHOLDS WITH EARTH FLOORS)	HOUSEHOLDS (000's)	34.5	3.6	30.9	215.2	28.6	186.6	4.1	2.0	2.1	0.2	0.0	0.2	0.4	0.0	0.4
	% OF HOUSEHOLDS BY URBAN/RURAL	100	10.4	89.6	100	13.3	86.7	100	48.8	51.2	100	0.0	100.0	100	0.0	100.0
	% OF HOUSEHOLDS BY TYPE	7.0	1.3	14.4	53.0	26.9	62.5	51.9	39.2	75.0	8.5	0.0	22.2	5.6	0.0	5.7
EXTERIOR WALLS (HOUSEHOLDS WITH EXTERIOR WALLS OF PALM, TEJAMANIL OR OTHER NON-FORMAL MATERIAL)	HOUSEHOLDS (000's)	104.7	27.9	76.8	260.2	51.4	208.8	2.1	0.5	1.6	0.6	0.0	0.6	0.2	0.0	0.2
	% OF HOUSEHOLDS BY URBAN/RURAL	100	26.6	73.4	100	19.8	80.2	100	23.8	76.2	100	0.0	100.0	100	0.0	100.0
	% OF HOUSEHOLDS BY TYPE	21.2	10.0	35.7	64.0	46.4	69.8	28.6	9.6	57.1	28.6	0.0	66.7	2.6	0.0	2.9
ROOF (HOUSEHOLDS WITH ROOFS OF CANE, YAGUA OR OTHER NON-FORMAL MATERIAL)	HOUSEHOLDS (000's)	49.6	13.1	36.5	248.4	53.3	195.1	3.3	1.1	2.2	0.4	0.0	0.4	0.2	0.0	0.2
	% OF HOUSEHOLDS BY URBAN/RURAL	100	26.4	73.6	100	21.5	78.5	100	33.3	66.7	100	0.0	100.0	100	0.0	100.0
	% OF HOUSEHOLDS BY TYPE	10.1	4.7	17.0	61.1	50.2	65.0	41.8	21.6	78.6	19.0	0.0	44.4	2.8	0.0	2.9

Source: AID Housing Office. Dominican Republic Shelter Sector Assessment. April 1980.

Typical Rural House in the Dominican Republic. (Photo by Aaron Benjamin, USAID Urban Development Officer, Santo Domingo.)

Typical Rural House in the Dominican Republic. (Photo by Aaron Benjamin, USAID Urban Development Officer, Santo Domingo.)

Settlements with access are large areas of spontaneously developed illegally or legally occupied land, located in the urban periphery between the city and settlements without access. Zinc roofs, wood walls and c ent floors are most common, although some walls are of concrete block. er is bought or obtained from a public faucet and there is no sanitary waste disposal or trash collection. About 50% have electrical connections.

Settlements without access, located on the outskirts of Sarto Domingo between the river and the marginal settlements with access, are difficult to reach by vehicle. The houses are constructed of wood or less durable materials, and water is transported from distant sources. Sanitary waste disposal systems are non-existent.

Isolated settlements, lcoated in an urban area used for some other purpose than housing, are generally occupied illegally. Provisional-type houses are constructed from waste materials, often on steeply sloping land. These settlements have access to water from surrounding serviced areas. Electrical connections are informal (through neighbors) and sanitary waste disposal is not provided.

Settlements with minimum services are government instituted sites and services schemes where tenure has been formalized. The most common building materials are wood, zinc roofing and floors of mosaic tiles or blocks.

The following table estimates the cost of various materials likely to be used to improve or repair housing.

Materials to Improve Physical Structure	Estimated Cost RD$ *
Concrete floor (cement, gravel, sand)	75
Cement blocks for exterior walls (blocks, cement, sand)	225
Roof trusses (lumber, nails, wood screws)	300
Zinc roofing panels (including nails)	175
Doors and windows (5 windows & 2 doors, w/hinges, nails and frames	110
$15m^2$ kitchen/dining room addition (including cement blocks, door, window, concrete floor)	400
Pit latrine	50
Utility connections:	
water connection with meter	90
sewerage connection (including excavation, installation and backfill)	80
electrical connection with meter	n.a.

* Dominican Republic Dollars (1RD$ = 1 US$)

Materials to Improve Physical Structure	Estimated Cost RD$ *
A hypothetical home improvment including the following:	
Materials to cement an earthen floor	75
Replace an existing roof of native materials (cane, yagua, etc. w/one of zinc panels)	175
Connect plot into existing municipal water distribution system	90
TOTAL	$340

Source: AID, Dominican Republic Shelter Sector Assessement, April 1980.

5. Bibliography

Agency for International Development, Office of Housing. Dominican Republic Shelter Sector Assessment (Volume I and II). Washington, D.C.: USAID, April 1980.

_____. The Disaster Relief Response in the Dominican Republic Following Hurricane David and Tropical Storm Frederick with Particular Emphasis on the USAID Emergency Housing Program. Washington, D.C.: USAID, December 1980.

Inter-American Development Bank. Estudio Sobre el Desarrollo Urbano de San Domingo. Santo Domingo: IDB, 1978.

_____. Project Report: Dominican Republic Recovery Program for Basic Infrastructure Damaged by Hurricane David and Frederick. Washington, D.C., IDB, October 23, 1979.

United Nation's Economic Commission for Latin America. Republica Dominicana: Repercusiones de los Huracanes David y Federico Sobre la Economia y las Condiciones Sociales. Santiago, Chile: ECLA, October 1979.

World Bank. Dominican Republic. Urgent Import Requirements Financing for Hurricane Reconstruction. (# 2640-DO). Washington, D.C.: World Bank, November 29, 1979.

1. Overview

Urbanization has progressed rapidly in Ecuador. In 1950 only 28.5% of the population lived in the cities; by 1975 that proportion had grown to 41.6%. The strong urbanization has relied on the acceleration of internal emigration from rural areas. In Quito as much as 43% of the population was not born in the city; in Guayaquil this share is 33%. Of 2.8 million urban dwellers in 1975, as many as 1.1 million or 38% were rural-born. This process of rapid urbanization has created a precarious life-style, known as "marginalidad", for many people. In Guayaquil almost one-half of the population (400,000) live in substandard housing and are deprived of sanitary services. The same is true for Machala, Santo Domingo de Los Colorados, Quevedo, and some sections of Quito. It should be noted that a substantial effort has been made to construct new dwelling units. About 175,000 new units were built between 1974-79. Of these, 101,000 were constructed through public sector programs with about one million people benefiting. However, 98% of this construction has taken place in urban areas, of which Quito and Guayaquil accounted for 75%.

1.1 Settlement by Region

The Costa

During the 1970's, the Costa was the most urbanized region, although the city of Guayaquil alone accounted for two-thirds of the area's urban population. In 1974 the region had 49% of the total Ecuadorian population; Guayas Province with Guayaquil as its hub accounted for 23%. The other urban centers are smaller and of recent origin. A majority are located on or close to the coastline; Esmeraldas and Manta, in particular, have grown with the development of the fishing industry. Away from the coast, most villages are located along or near streams that served as the main arteries of communication before the installation of a highway system. The rural population of the Costa is not crowded. In the rain forest of the north, the settlement pattern follows the system of slash-and-burn agriculture practiced by semi-nomadic farmers who move to new lands as the soil is exhausted. There are also some permanent settlements concentrated around banana plantations. Farther to the south where rainfall is lighter, farming is sedentary. Inland, along the western base of the Andes, the population is dispersed in cattle ranches and plantations of sugarcane and other export crops. Close to the Peruvian border, settlement is limited by the scanty rainfall.

The Sierra

In 1974, 48% of the population lived in the Sierra. The Pichincha area, with Quito in its center, accounted for 15% of the total population. From the town of Tulcan on the Colombian border to Macara on the border with Peru, the provincial capitals and nearly all of the larger Sierra towns are situated at the bottom of basins and are on or close to the Pan American Highway. The rural majority of the Sierra population lives for the most part clustered in farm villages scattered around the slopes of the basins, at elevations of 7,500 to 10,000 feet.

The Oriente

Settlement of virgin lands in the Oriente has been an important facet of recent Ecuadorian development. The government plan called for the establishment of directed and semi-directed settlement schemes where the government would provide basic infrastructure and housing for new settlers. However, in practice, colonization has been mostly spontaneous and, except for land titling, it has received little government support.

The population of the Oriente can be divided into two groups: "old" settlers and "new" settlers. "Old" settlers are located mostly on the Andean slopes (along the Baeza/Tena/Puyo/Macas line) where permanent settlements began to be established in the late 19th century, with another influx in the 1930's and 40's. "Old" settlers' farms are either concentrated in small villages or scattered throughout the territory in irregular fashion. A few are found in the lowlands, almost always spread along the banks of the major rivers. These populations consist primarily of indigenous Indian groups.

Nearly all of the "new" settlers have established themselves in a regular pattern along both sides of the new roads in the region. They stake out a claim to a plot along the road which is 200-250 meters wide and 2,000 m deep (providing 40-50 ha). As locations immediately alongside the road fill up, newcomers stake their claim 2,000 m back where the earlier settlers' property ends. Along the Lago Agrio-Coca road as well as on several others in Napo and Morona provinces, these settlement lines (respaldos) are now four to six deep, putting those in the last line at least 6 to 10 km away from all-weather roads, access to services, and even to local markets.

1.2 Housing Deficit

The most serious problem facing Ecuadorian housing authorities is the severe shortage of housing units. Production of new housing has been unable to keep up with population increases, causing many families to move into dwellings that are already occupied. This overcrowding is made worse by the fact that most of these houses are already in deteriorating condition and lack adequate services. A recent tendency on the part of developers has been to use vacant land on the periphery of the cities where land prices are lower. This policy favors continued and often uncontrolled expansion of the urban area, and results in the increased deficit of urban services as well as higher public utility costs due to increased distances involved. While urban renewal (which includes housing) is costly, such an effort would have a favorable impact on the urban core, halting deterioration and outmigration, and assuring maximum use of existing infrastructure. JNV/BEV housing programs should also be directed at urban centers of medium size (40,000 to 100,000 population). Although the housing deficit is greater in Quito and Guayaquil, the problems of congestion and higher costs for urban services will become increasingly severe if these areas are the only ones which offer new and better housing.

The demand for housing is expected to increase by about 54,000 units annually over the next five years.

2. Housing Policy and Institutions

The major goal of the national housing policy is to reduce the housing deficit, with special programs directed at sectors of the population with the least economic resources. Emphasis has also been placed on the provision of essential public services in an attempt to create more healthy and stable living environments. Housing is seen as a social investment as well as an economic investment.

Consejo Nacional de Desarrollo--CONADE (National Planning Board)--prepares economic and social development plans and coordinates the development activities of all bilateral and multilateral donors in Ecuador.

Instituto Ecuatoriano de Obras Sanitarias--IEOS (Ecuadorean Institute of Sanitary Works)--plans and executes sanitation programs at the national level.

Instituto Ecuatoriano de Seguridad Social (Ecuadorean Institute of Social Security)--provides financial assistance and social services, and housing to affiliates of the system who are middle-income, mostly urban.

Junta Nacional de la Vivienda--JNV (National Housing Board)--has directed the development and implementation of the nation's housing policy since 1973. The JNV has responsibility for planning, site preparation, and construction; it also has authority to import building materials. JNV controls and supervises the operations of the Banco Ecuatoriano de la Vivienda (BEV) and requires BEV to finance housing programs of "social significance." To assure that the JNV and BEV follow identical policies, the president of the JNV is also the president of the BEV.

Banco Ecuatoriano de la Vivienda--BEV (Ecuadorean Housing Bank)--is the financial arm of JNV in charge of loans, collections, and contracts. The responsibility of financing new construction and providing loans to lower economic groups is in the hands of JNV/BEV.

Mutualista system - consists of 11 member associations organized along the same lines as U.S. savings and loan institutions. The system was created to offer more flexible financing for the purchase of housing than was available in the private banking system. The Mutualistas are chartered as private business organizations but have received some aid from and are regulated by BEV. Occasionally the Mutualistas act as developers, planning the acquisition and development of the site and contracting out the actual construction of the housing unit.

2.1 Urban Zoning and Planning

Zoning in Ecuador is very flexible. The implementation of regulations rests with the municipal government, which often does not have the ability to carry out the task. At the same time, the flexibility permits the establishment of mixed-use zones, principally mixes of commercial and residential use, which reduce the reliance on vehicles for simple shopping activities. The majority of sites used by the JNV have not had any zoning regulations for use or density. Of Ecuador's 119 municipalities only three, Cuenca, Guayaquil, and Quito, have complied with the requirements of the Municipal Management Law (Ley de Regimen Municipal), which requires that municipalities plan their development. This means that JNV projects in the remaining urban areas are developed without local guidance.

After the earthquake in Ambato in 1949, a building code, with standards adapted from the California Uniform Building Code, was developed for areas prone to seismic activity. The BEV also developed the "Minimal Technical Specifications for Housing Construction" for the Guaranteed Housing Program, which details the specifications for building materials and design standards. In 1976, the municipal government of Quito was re-

viewing standards for high-rise construction and the Instituto Ecuatoriano de Normalizacion was consolidating existing standards in order to draw up a national code. The final stage, dealing with project execution, was expected to be most difficult because of an inadequate inspection process. Greater interest in quality control of building materials and project execution was needed.

3. Disaster/Low-cost Housing

The housing units constructed during the 1974-79 period fell far short of meeting the growing housing demand, and little effort has been made otherwise in the formal housing sector to provide affordable housing for low-income groups. The new management of BEV-JNV has announced a shift in the orientation of those institutions, however, more toward the needs of the poor. At the same time, an ambitious BEV-JNV shelter program for low-income families of Guayaquil was outlined which included an IBRD-financed project as well as the construction of 10,000 units at a cost of about US$4,000 each.

The IBRD's first Guayaquil Urban Development Project, to be carried out between 1980 and 1985, includes two components which relate to low-cost housing: 1) Services to low-income areas --upgrading (landfill and infrastructure) in two squatter settlements, Lotizacion Mapasingue and Guasmo North, and development of 3,700 serviced plots in two new areas, Alegria and Floresta Pilot; 2) Housing loans --small loans for home improvements and/or construction of new units will be provided through BEV to about 9,700 residents of the project sites and in other low-income areas.

4. Housing Types, Materials, Construction and Services

4.1 Housing Types

Urban

Both Quito and Guayaquil have undergone tremendous growth in their housing stocks. In 1974 the combined totals for the two cities equaled 58% of the national urban housing stock. In Quito colonial homes of volcanic stone are numerous in the inner city. The newer buildings are of modern design and are constructed of earthquake-resistant materials. A majority of working-class dwellings are of simple adobe construction with tiled roofs. Quito also has squalid suburban slums; some of the units are shacks made of scrap materials; others are dilapidated houses with ten rooms which

may house as many as ten families. Their working class occupants are usually slum dwellers, less because of poverty than because of the severity of the housing shortage.

New housing in Guayaquil is of fire-/and earthquake-resistant design, constructed under a strict code. Most of the modern apartment buildings in Ecuador are in Guayaquil. A majority of the houses are of impermanent materials, a large proportion of them built by migrants from rural areas. Many of the poorer houses are built in swampy sites on the outskirts of the city. Although suburban slums are less common in the provincial cities and towns, they can be found in some of the faster growing urban centers of the Costa.

The second national housing census completed in 1974 (concurrently with the third population census) showed a stock of 1.2 million units. The census classified the different types of housing units as follows:

Casa or Villa -	permanent construction of resistant materials such as concrete, wood, brick, adobe, or stone with wood; tile or brick floor; exclusive use of sanitary facilities
Apartment -	a group of rooms for residence, forming part of a building of one or more floors, with independent entry and exclusive use of water supply and sanitary facilities
Rooms in a boarding house -	belonging to a building with a common entrance. Access to water and sanitary facilities is usually shared, these services being available to the building as a whole
Mediagua -	one story construction with walls of adobe, mud, or wood and with a roof of tile or metal
Rancho or Covacha -	a unit covered with straw, palm leaves or other vegetation, with walls of cane or bajareque and floors of wood, cane or earth
Choza -	a unit with walls of adobe or straw, earth floor, and straw roof
Other -	this category includes huts, caves, kiosks, boats, wagons, tents, etc.

Distribution by Types of Housing Units, 1974

Types	No. of Units
Casa or Villa	329,388
Apartment	93,396
Rooms in a boarding house	164,897
Mediagua	196,106
Rancho or Covacha	302,400
Choza	111,833
Other	2,146
Areas not designated for housing	1,844
National Stock	1,202,010

Source: AID, Ecuador Shelter Sector Analysis and Recommendations, 1976.

Rural

Approximately 59% of the nation's housing stock is located in rural areas. Of this total more than 80% lack electricity, exclusive use of sanitary facilities, drainage, and drinking water. At least 30% of the rural housing units consist of one room inhabited by three or more persons. Nearly all rural housing is made of adobe, adobe brick, reed or cane, or wattle and daub. Cane or reed is most frequently used in the Costa where units are often constructed on stilts to avoid flooding. Thatch is the most common roofing material, although many units in the rural Sierra and most of the two-story adobe houses lining the main streets of provincial towns have tile roofs. The typical house in the Indian villages of the Sierra consists of a single room with a dirt floor, mud walls, and a thatch roof. There are no windows, and the walls are coated with soot from cooking and heating fires. The home serves as a storage place for produce, and during the rainy season domestic animals are often sheltered inside.

4.2 Construction Methods

The traditional house covers 20 to 30 sq m and consists of two rooms. The first is a bedroom which also serves as the living room. The second room is the kitchen with a hearth. Any remaining area is used for storage. Ventilation is achieved by an opening in the roof because the walls have few or no windows for security reasons. Construction methods and the use of building materials vary with the climatic region. In the Sierra, where cold weather is common, the following construction characteristics describe the average house:

Floor: earth, bricks, or boards, sometimes covered with a mat of fiber

Walls: adobe, brick, wood

Ceiling: fiber matting

Roof: wood, clay tile

Windows: wood

Doors: wood

Along the coast and in the central valley, where the climate is hot and humid, lighter building materials are used. Usually the house is constructed on pilings due to marshy conditions and the need for ventilation.

Floor: earth, cane, wood, fiber matting

Walls: cane, wood, whitewashed clay

Ceiling: cane

Roof: cane, palm or paramo straw

Windows: wood

Doors: wood

Settler housing in the Oriente is generally a one-room (6 m x 4 m) hut with a slightly elevated rough wood floor, wall, and roof supports. The walls are made of hollow cane; the roof often consists of a leaf cover, but metal is preferred and is installed as soon as the settler can afford it. A small part of the house is partitioned off for sleeping quarters. Stoves are primitively fashioned of clay and metal, and most households use wood for cooking fuel. Furniture is usually no more than a table and some stools or benches. By contrast indigenous people build larger and more solidly constructed houses, usually measuring 7 x 12 m. Living quarters are always separated from the kitchen, and floors are raised well above the ground to protect against humidity as well as animals.

Modern construction methods are heavily dependent on imported materials (steel, concrete) as Ecuadorean production capacity has been insufficient to deal with the dramatic increase in construction activity.

Although the JNV has begun to experiment with the substitution of local materials for imported products, most of the materials used in new construction still come from outside the country. The JNV also attempted to introduce pre-fabricated materials; however, they met with unfavorable reaction from potential consumers. The reduction in the use of local labor and the problems of assuring a supply of consistently high quality materials were also seen as major disadvantages of pre-fabrication.

Materials Used by Dwelling Unit and Price
(in Feb. 76)

Materials	Unit	Average Estimate/D.U.	Average Price Sucres
Aggregates			
Sand	M^3	16.0	70.00
Gravel	M^3	10.0	105.00
Crushed stone	M^3	4.0	100.00
Pebbles	M^3	3.0	50.00
Cement			
Portland cement	Bag (50 kg)	96.0	66.00
White cement	Bag (50 kg)	0.3	265.00
Limestone	pounds	2,200.0	0.60
Masonry Units			
Bricks small	U (100)	302.0	120.00
Bricks regular	U (100)	40.0	160.00
Concrete blocks - 10 cm	U	203.0	3.50
Concrete blocks - 15 cm	U	34.0	4.30
Flooring			
Cement tiles	M^2	25.0	73.00
Pipes and Cement Products			
Pipes - 15 cm	M.L.	2.0	25.20
Pipes - 10 cm	M.L.	18.0	17.20
Pipes - 8 cm	M.L.	2.0	n.a.
Metals - Iron and Steel			
Steel - 6 mm	qq.	3.0	595.00
Steel - 9 mm	qq.	5.0	470.00
Steel - 12 mm	qq.	2.0	460.00
Wire No. 18	qq.	0.1	1,118.00

Materials	Unit	Average Estimate/D.U.	Average Price Sucres
Wood			
Forms	U	56.0	17.00
Mouldings	M	65.0	7.00
Wooden Floors			
Industrial type	M^2	68.0	50.00
Finishing Materials			
Ceramic tiles	M^2	9.0	82.20
Roofing			
Asbestos cement panels	U	28.0	406.70
Roof hips	U	6.0	88.40
Plumbing Fixtures			
Lavatories	U	1.0	370.00
Toilets	U	2.0	1,365.00
Sinks	U	1.0	638.00
Glass			
Glass panels - 2 cm	M^2	7.0	85.00

Source: AID, Ecuador Shelter Sector Analysis and Recommendations, 1976.

4.3 Services

Water Supply

Of the 1.2 million occupied units in 1974, approximately 42% had public water supply and of this total only 19% had service within the unit itself. In rural areas only 14% of the houses had public water supply, and of those 2.4% had supply within the unit. Both regularity of service and water quality are major problems. Although responsibility for water supply lies with the municipalities, the scarce financial resources of these authorities makes it difficult for them to expand or improve their systems.

The principal water treatment plant in Quito is located in the El Tajar section of the city and provides about 60% of the city's water. The remainder of the supply is provided by small auxiliary plants and by wells. Distribution is handled by 25 networks of uniform pressure.

However, due to the inadequate water supply, the municipal government has applied a program of density control through limitations on building height. The inefficiency of the supply systems in both Quito and Guayaquil has forced the municipalities to establish systems of distribution via tank trucks. This is often supplemented by distribution in steel drums set up in central locations to which area residents go with pails. Such techniques greatly increase the risk of contamination. Rural areas do not have even minimal levels of service.

Sanitary Facilities

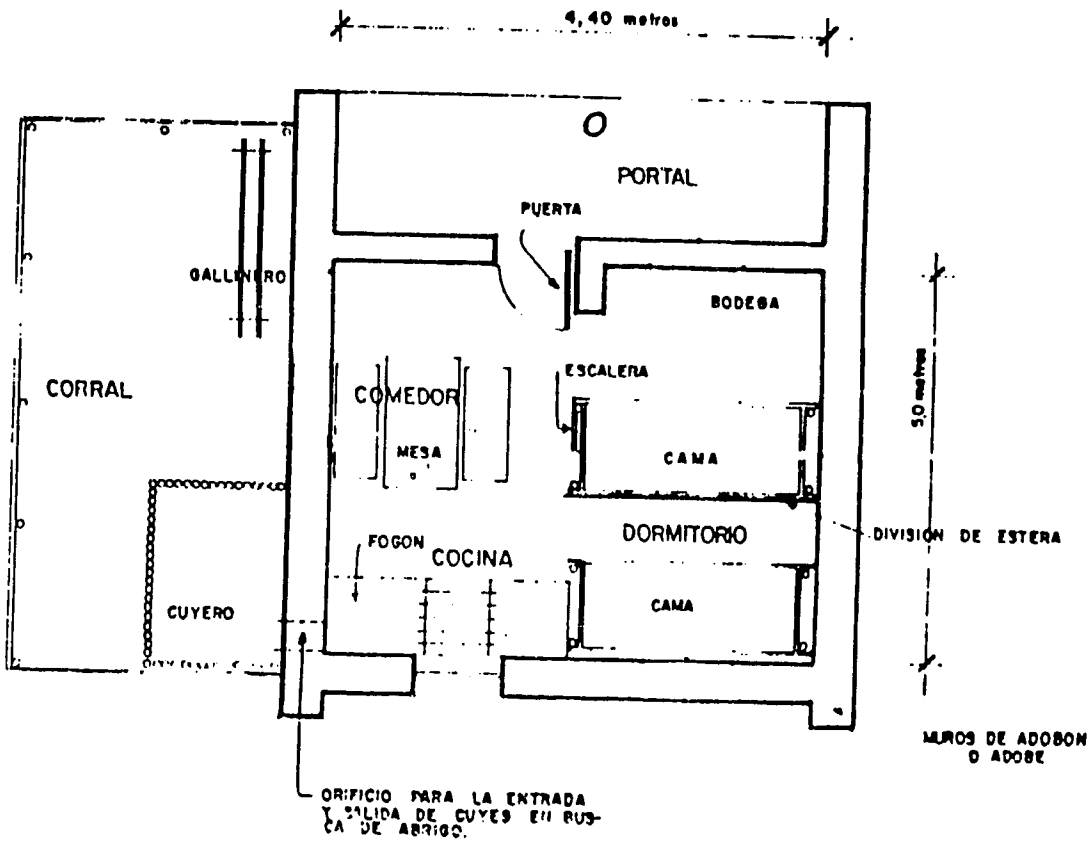
Forty percent of urban housing units have exclusive access to sanitary facilities, while only 33% of rural units do. 15% of urban units have no access to facilities, 87% of rural units. Sewer treatment by public network is available to 64% of urban houses, with 17% having no service. Only 2.4% of rural houses are served by a public system, with 89% having no service of any kind.

Garbage and trash collection in the principal urban centers is generally satisfactory except in urban slum areas where sanitary services are virtually nonexistent. In rural areas sanitation is left up to the local municipalities which organize voluntary cleanup groups when needed. The Institute of Sanitary Works, part of the Ministry of Public Health, has a program of well-digging and latrine construction in rural areas with populations of 3,000-5,000. However, there are no plans for bringing sanitary services to smaller rural settlements. The government also conducts spraying and fumigation programs in Indian villages to rid them of disease-carrying rats and insects.

Electric Power Service

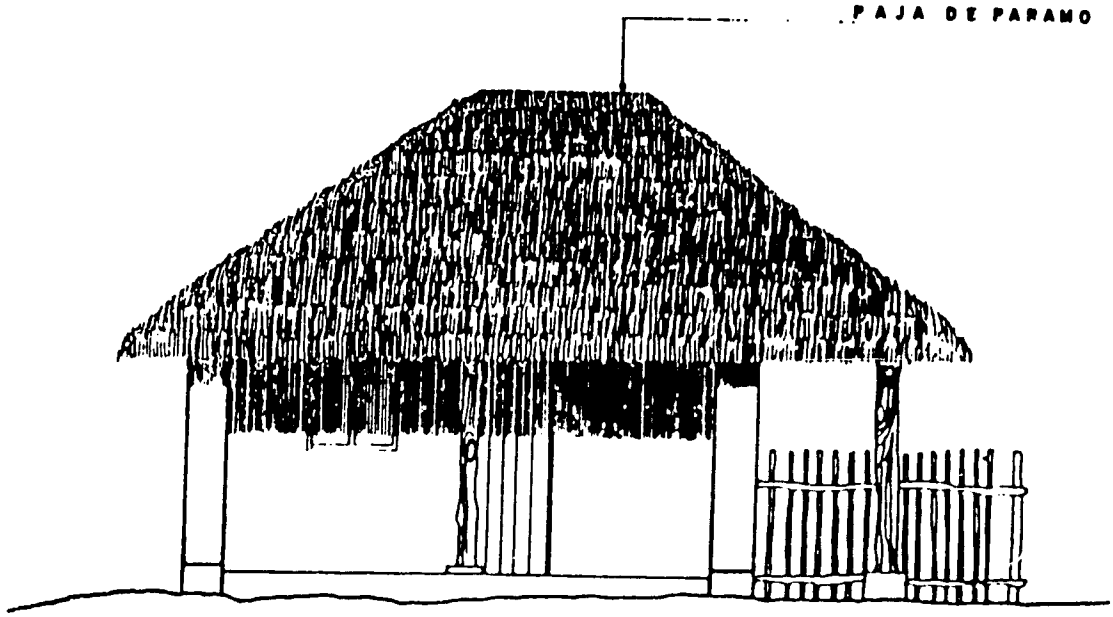
Almost 60% of all occupied units are without power service. In urban areas 82% have service, but in rural areas 88% are without. Because electric power is transmitted by overhead cables, it can easily adjust to spontaneous urban development and, as a consequence, reaches many areas that cannot expect provision of other essential services for some time. The extension of electric power to spontaneously developed neighborhoods is often the first step toward recognition of the area as a formal part of the city.

CASA TRADICIONAL - TRADITIONAL HOUSE
PLANTA - FLOOR PLAN



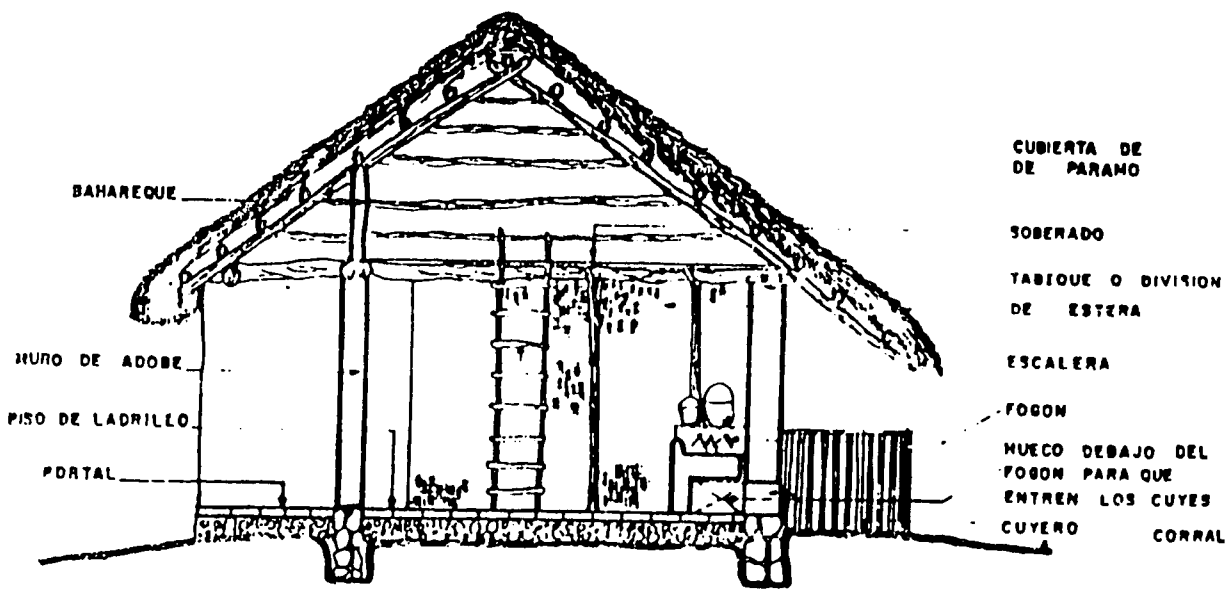
Source: AID, Shelter Sector Analysis and Recommendations, July 1976.

CASA TRADICIONAL - TRADITIONAL HOUSE
ELEVACION - ELEVATION



Source: AID, Shelter Sector Analysis and Recommendations, July 1976.

CASA TRADICIONAL - TRADITIONAL HOUSE
SECCION - SECTION



ecoforum

Source: AID, Shelter Sector Analysis and Recommendations, July 1976.

Services in Dwelling Units

	Urban		Rural		Total	
	No.	%	No.	%	No.	%
No. of Housing Units	489,151	40.7%	712,856	59.3%	1,202,007	100.00%
Electricity	400,309	81.84%	79,415	11.14%	479,724	39.91%
None	86,023	17.59%	627,615	88.04%	713,638	59.37%
Water						
Inside	209,435	42.81%	16,747	2.35%	226,182	18.82%
Outside	52,861	10.80%	60,907	8.54%	113,768	9.46%
Toilet	197,038	40.28%	23,836	3.34%	220,874	18.37%
None	76,303	15.60%	621,470	87.18%	697,773	58.05%
Sewer	313,421	64.07%	16,896	2.37%	330,317	27.48%
None	81,732	16.70%	634,584	89.02%	716,316	59.59%

Source: JNV, Dept. de Programacion, 1976

5. Bibliography

Agency for International Development, Office of Housing. Ecuador Shelter Sector Analysis and Recommendations. Washington, D.C.: USAID, July 1976.

Library of Congress, Science and Technology Division. Draft Environmental Report on Ecuador. Washington, D.C.: Library of Congress, Sept. 1979.

World Bank. Development Problems and Prospects of Ecuador Special Report. (Vol. I: The Main Report, Vol. II: Sectors and Regions, Vol. III: Technical Annexes and Statistical Appendix). Washington, D.C.: IBRD, June 1978.

_____. Ecuador: Guayaquil Urban Development Project. (Report No. 2415-EC). November 9, 1979.

1. Overview

Because ethnic and cultural diversity is minimal, Salvadorean settlement patterns vary only with urban or rural location and economic status. Highly skewed income distribution is reflected in Salvadorean settlement patterns. Majority of urban and rural population is unable to purchase land or housing, resulting in a proliferation of high density informal settlements with substandard housing.

Total Urban Population in Informal Settlements by Urban Area, 1975

Urban Area	Total Urban Population	Informal Settlements Population	Percent Informal Settlements
Metropolitan Area of San Salvador	564,967	351,899	62.3
Santa Ana	98,433	65,831	66.9
San Miguel	61,940	37,763	61.0
Usulutan	19,783	14,912	75.4
Sonsonate	33,302	18,539	55.7
TOTAL	778,425	488,944	63.0

Source: AID, El Salvador: Shelter Section Assessment (Draft 1980)

2. Housing Policy and Institutions

Housing institutions have traditionally concentrated resources on middle-income housing, with the exception of the private institution, Fundacion Salvadorrena de Desarrollo y Vivienda Minima (FSDVM). Housing investments have proceeded in a largely uncoordinated fashion and without reference to urban development plans. Recent change in political atmosphere, along with a major World Bank/UNDP urban study and resulting recommendations, have brought about a new focus on the upgrading of low income housing. The following institutions are expected to play a major role in home financing and technical assistance for low-income groups and have been used in the past by international organizations to channel housing assistance to El Salvador.

Public

Instituto de Vivienda Urbana (IVU)--public corporation created in 1950 to construct housing for low- and middle-income urban families. Until recently, IVU tended to build units significantly beyond the reach of lower income groups and focused on San Salvador. However, since 1977, emphasis

has shifted to secondary cities--Santa Ana, San Miguel, and Sonsonate, and low-income families. Recent IVU loan terms have been 7% for 20 years, with a 10% mortgage downpayment for families with an average annual income of $160 to $240.

Direccion de Desarrollo Comunal (DIDECO)--located in the Ministry of the Interior. DIDECO normally provides technical assistance for construction and upgrading of access roads, streets, bridges, water systems, secondary electric distribution systems, school buildings, health facilities, homes, latrines, etc., in which the target community supplies labor. DIDECO maintains four regional offices in San Miguel, Santa Ana, San Salvador, and San Vincente and anticipates frequently used construction materials at DIDECO regional office and/or regional MOP warehouses. DIDECO is the only major GOES organization capable of carrying out several small scale infrastructure projects outside of San Salvador and the major secondary cities.

Fondo Social Para La Vivienda (FSV)--a semi-autonomous entity of the GOES with regional offices in San Miguel and Santa Ana created to administer a fund consisting of employee and employer contributions. Mortgage financing is limited to workers who contribute to the FSV. FSV purchases housing from private developers and resells to its contributors.

Financiera Nacional de la Vivienda (FNV)--a regulatory agency of the savings and loan associations. Financed 4,000 units per year at an average cost of over $15,000, but recent loss of resources has reduced system's liquidity.

Federacion de Cajas de Credito (FEDECREDITO) and Federacion de Asociaciones Cooperatives de Ahorro y Credito de El Salvador (FEDECACES) have network of 84 credit unions in very small communities. FEDECREDITO extends small loans to "grupos solidarios", composed of 5-9 people, in marginal SSMA settlements (for small enterprise "micro-empresa").

Direccion General de Urbanismo y Arquitectura (DUA)--controls the physical development of urban centers and potential urban centers by setting standards, plans and installing storm drainage systems. Has not addressed problems associated with illegal settlements or coordinated its project specific approach with other shelter-service institutions.

Municipal Governments--have no authority or tax base at present to implement urban planning or shelter activities. These functions remain the responsibility of a highly centralized national government.

Salvadorean Institute for Agrarian Transformation (ISTA)--provides rural housing as part of integrated rural development projects. Scope of activities includes socio-economic studies of project areas, organi-

zation of agricultural cooperatives, small agro-industries, the promotion of productive activities by women's associations and youth groups, and promotion of small community infrastructure projects such as street improvements, school construction and structural repairs to buildings.

PRIDECO (formally ONCOM - Oficina de Mejoramiento de Comunidades Marginales)--operates under the Ministry of the Presidency, implementing projects similar to those of DIDECO; in the San Salvador metropolitan area supplies technical assistance, materials and finacial assistance. Lacks focus and employs highly centralized decision making.

Ayuda-Mutua (Mutual Assistance - Ministry of Public Works)--provides materials, supervision and occasionally funds to help community groups in marginal areas carry out physical projects with community labor. Works only with groups which already are organized and request assistance and primarily in "colonias ilegales" to provide basic urban services.

Private

Fundacion Salvadorena de Desarrollo y Vivienda Minima (FUNDASAL)--private non-profit entity created in 1970 to improve the living conditions of the lowest income groups, especially their squatter settlements. Internationally recognized model for low-income shelter projects.

Basic concept is to use housing as an incentive for community development, rather than an end in itself. FUNDASAL project involvement consists of three stages, spanning five years total:

(1) basic technical infrastructure and foundations built by a contractor. Cooperative action plan prepared by community and social workers.

(2) mutual-help phase for construction lasts 6-8 months. Individual houses are then assigned by lottery.

(3) communities encouraged to resolve their own problems and establish community services and etnerprises. FUNDASAL monitors this several-year phase.

FUNDASAL employs about 80-90 social workers who live in the project area.

Informal

Since it is difficult for low-income families to obtain access to credit in formal capital markets, they frequently pay high rates of interest (60%) to moneylenders in the informal sector.

Policy

The 5-year National Development Plan (1978-1982) proposes an urban growth policy guided by development plans for the major urban areas and by yet-to-be-adopted zoning regulations. No mention is made of the illegal settlements.

Two key laws, the Ley de Urbanismo y Construccion (1951) and the Ley de Planos Reguladores (1955) legislate urban development in El Salvador. The first promulgates urban subdivision standards and regulations. The second sets forth urban planning procedures and norms. Some of the major cities have adopted urban plans, but do not use them, and secondary cities generally have no plans at all. Ineffective enforcement of the existing legislation is also a problem.

3. Disaster/Low-cost Housing

Rehabilitation and upgrading of marginal urban area to be carried out in 10 marginal settlements in San Salvador Standard Statistical Metropolitan Area (SSMA) with World Bank funding utilizing FUNDASAL, FEDECCREDITO and IVU.

4. Housing Types, Materials, Construction and Services

Urban

Marginal settlements dominate urban landscape. An estimated 47% of the 1976 San Salvador metropolitan area (SSMA) population lived in marginal settlements. The total is projected to reach 54% in 1987 based on current migration and home construction rates.

In Santa Ana, El Salvador's second largest city, an estimated 70% of the population live in marginal housing. Five types of marginal settlements exist: tugurios, campamentos, mesones, casas viejas, and colonias ilegales.

Urban Housing Types, Services and Building Materials

Settlement Type	Builder	Materials	Water/ Sanitary Facilities	Electricity
Tugurios	Household/or informal contractor	Debris (cardboard, plastic, wood), bajareque or adobe	Potable water (standpipe or trucked in)/ pit latrines	Generally available
Campamentos	Government	Wooden structure and walls, cement floor, asphalted cardboard or aluminum roof	Piped water/ Shared toilet	Generally available
Mesones	Private contractor	Floors: cement or mud and cement bricks. Walls: bajareque, wood, metal sheets or debris. Roof: tile, metal sheets, or debris	Piped water/ Shared toilet	Generally available
Casa Viejas	Private contractor	Floors: cement or mud and cement bricks. Walls: bajareque, metal sheets or wood. Roof: aluminum sheets or tile	Piped water/ Shared toilet	Generally available
Colonias ilegales	Private contractor or household	Same as materials in tugurios: cement and bricks with asbestos cement roofs	Potable water (standpipe or trucked in)/ Pit latrines	Generally available

Characteristics of San Salvador Marginal Settlements
(representative of urban marginal settlements)

Housing Type & Locale	# of Houses	Average Household Size	Total Population	Total Area	% Metro Population
Apartments; tenements; located along ravines, steambeds, public lands and easements	8,060[1]	4.7[1]	38,000[1]	72.46[1]	5.4[1]
Provisional post 1965 earthquake housing on public land throughout city	4,320[2]	4.7[2]	20,300[2]	12.00[2]	2.9[2]
Apartments; tenements located in central city area	34,130[3]	3.8[3]	129,700[3]	95.00[3]	17.8[3]
Old, central city houses converted to multi-family units	5,230[4]	4.0[4]	20,900[4]	26.00[4]	2.9[4]
Single family units on periphery of city on steep terrain	23,360[5]	5.8[5]	135,500[5]	1,533[5]	18.7[5]

1/ Tugurios; 2/ Campamentos; 3/ Mesones; 4/ Casas Viejas; 5/ Colonias Ilegales

Source: World Bank, EDURES, 1978.

Rural

Overcrowding is symptomatic of rapid population growth; 63.5% of one room homes are occupied by 5 or more people. Mean family size is 5.9 individuals, although more than one family generally resides within one household. 57% of rural population own homes, 5% rent and 38% either borrow homes, live in houses as caretakers or are squatters. Colonias chorizos, a rural counterpart to urban marginal settlements, are long, high density rows of crude housing. Colonias chorizos are located along highway rights of way.

Locally available hand-made housing materials are typical; a one room adobe structure with a dirt floor and tile roof most common, followed by bajareque (mud supported by a framework of small tree branches, split bamboo, adobe, straw or grasses). Roofs are thatched with sugarcane leaves or jarajua grass. Since barareque cottages are not durable, adobe dwellings are preferred by rural residents. Rural kitchens are generally separated from the rest of the house.

Principal fuels for cooking are wood, corn cobs, husks and stalks, bagazo (sugar cane); tobacco stems are also used. Kerosene lanterns are most common source of light; 10% of the homes have electrical connections. Latrines are rare. Rivers or springs supply water for half of the population while community wells or public standpipes are other sources. Pilas (open basins to collect rainwater from roofs) supply water for washing. Water is distributed either by filling metal containers, if the water source is close, or by collecting water from a public tap or stream in 50 gallon barrels set on carts.

Construction Costs Per Square Meter of Covered Space
(colones)

	Informal	Bajareque	Wood	Adobe	Mixed
Structure:					
Wooden poles		9.00		11.00	
Cardboard			19.50		
Reinforced concrete					30.50
Bamboo, twigs, etc.	6.25				
Baked bricks					34.00

	Informal	Bajareque	Wood	Adobe	Mixed
Walls:					
Mud and mixed materials		14.00			
Wood boards			31.50		
Adobe				28.00	
Cardboard, plastic, etc.	4.17				
Roof:					
Tiles		34.50		34.50	
Galvanized iron			18.00		
Asbestos sheets					22.00
Cardboard, plastic, etc.	2.50				
Floor:					
Earth					
Cement tiles					9.50
Cement		6.50	6.50	6.50	
Cost per m^2	12.50	64.00	75.67	79.33	96.23
Total cost for $12m^2$ house (C)	150.05	768.00	908.00	952.00	1,154.80

Source: World Bank, EDURES, 1978.

Services and Facilities for Houses in El Salvador

Characteristics	Urban	Rural	National Total
Electricity	83.8	14.4	49.1
Cooking material			
Firewood	46.5	96.5	71.5
Propane gas	26.5	0.7	13.6
Water source-private	38.9	3.5	21.2
Domestic connection-public	27.3	2.0	14.7
Standpipe outside house	20.2	9.9	15.1
Well	1.5	11.0	6.3
Private	2.2	24.8	13.5
River	9.8	48.8	29.3

Characteristics	Urban	Rural	National Total
Bathing areas			
Private	38.8	4.4	21.4
Public	29.9	3.1	16.5
Sanitary facility			
None	12.5	79.0	45.8
Private toilet	29.0	0.0	14.5
Shared toilet	10.0	0.0	5.0
Septic tank	20.8	5.8	13.3
Latrines	27.7	15.2	21.4

Source: World Bank, Economic Memorandum on El Salvador, 1979.

5. Bibliography

Agency for International Development. El Salvador: Shelter Sector Assessment. Washington, D.C.: USAID, 1980.

_____. Health Sector Assessment El Salvador. San Salvador: USAID, May 1978.

_____. Housing Guaranty Program Draft Project Paper. Washington, D.C.: USAID, February 26, 1980.

_____. Housing Guaranty Program Project. Washington, D.C.: USAID, January 8, 1980.

Blutstein, Howard I., et al. Area Handbook for El Salvador. Washington, D.C.: GPO, 1971.

Fundacion Salvadorena de Desarrollo y Vivienda Minima, Proyecto Experimental Rehabilitation del Meson El Progresso (Estudio Monografico), Washington, D.C.: Inter American Foundation, September 1979.

World Bank. Demographic Issues and Prospects of El Salvador: A Special Report. Washington, D.C.: IBRD, June 1979.

_____. Economic Memorandum on El Salvador. Washington, D.C.: IBRD, May 1979.

_____. Final Report: A Program for the Integrated Improvement of Critical Metropolitan Areas in El Salvador (EDURES). (Vol. I: Principal Findings and Recommendation, Vol. II: Appendices Executive Summary). Washington, D.C.: IBRD, May 1978.

1. Overview

Because a large percentage of the country's rural population is forced to migrate to urban centers to secure jobs, Guatemala City and other cities are growing faster than the nation as a whole. Urban population has grown from 25% of the total population in 1950 to about 40% in 1980.

The production of minimum standard shelter has lagged far behind this rapid urban population growth. Despite large national and internationally assisted efforts to build housing for victims of the 1976 earthquake, current production reaches 1/4 of the housing goal set forth in the current National Development Plan. As a result of this gap, the population has resorted to informal solutions, with an average housing production of over 18,000 units a year. The geography of Guatemala City, public policy and the skyrocketing cost of land around Guatemala City have severely constrained even the informal housing solution possibilities.

2. Housing Policy and Institutions

In November 1975, a document, "Development Policy of the Housing Sector," was prepared as part of the National Plan for 1975-79. The document proposed a national savings and loan system backed by BANVI (Banco Nacional de la Vivienda), an existing institution which engages in operations similar to those of commercial banks. BANVI would serve as the central institution and would create a National Housing and Urban Development Committee, which in turn would produce a National Housing Plan and a National Social Housing Plan.

At present the GOG has two major housing or housing-related agencies: the FHA (Instituto de Fomento de Hipotecas Aseguradas-Institute of Insured Mortgages) and BANVI (Banco Nacional de la Vivienda-National Housing Bank). The FHA, created in 1962, issues insured home mortgages representing up to 95% of the value of the house, and attempts to attract private capital to the housing market. BANVI was founded in 1973 and, as a federally owned development and finance institution, is responsible for formulating national housing policy.

The attention of these two agencies is focused primarily upon housing need in urban areas, especially Guatemala City. Although other institutions indirectly affect rural housing, no agency has been specifically designated to respond to rural housing needs.

Private commercial banks are the primary source of credit for housing in Guatemala, along with private insurance and finance companies. When these institutions are associated with FHA, risk free investment with high rates of return is guaranteed. However, there is a strong indication of a significant informal financing system operating outside the formal housing finance system. Short-term expensive credit serves middle and lower income groups and small entrepreneurs.

BANDESA, the National Agricultural Development Bank, is mandated to provide assistance for agricultural activities and rural housing. 34 agencies which authorize and administer loans, located throughout 7 regions, operate as field offices for BANDESA.

The cooperative movement also contributes to filling the housing need in rural Guatemala. The federations of cooperatives that represent credit unions and agricultural cooperatives, the National Federation of Credit Unions (FENACOAC) and the Federation of Regional Agricultural Cooperatives (FECOAR) constitute 85% of all legalized cooperatives.

FENACOAC, with regional offices and storage facilities in three urban centers outside Guatemala City, provides its members with credit, savings, insurance, administrative and accounting assistance, education, fertilizer supply and marketing services. In contrast, very few of the loans made by FECOAR cooperatives are for shelter needs. However, two FECOAR cooperatives have undertaken housing programs financed by BANDESA with Inter-American Development Bank funds.

There are about 90 construction firms registered with the Guatemalan Chamber of Commerce, the majority of which have the capability to work in housing construction. The firms are concentrated in the Guatemala City metropolitan area but only about 10 of them have experience with large scale housing projects. (The Guatemalan Chamber of Commerce should be contacted for current information on construction firms. See also Disaster Resources.)

Engineering analysis indicates a dangerous lack of construction industry standards, especially building codes and specifications. Among them: widespread failure to use non-structural masonry walls in reinforced-concrete framed structures (vulnerable to lateral loads and displacement); lack of reinforced-concrete columns (framing masonry vulnerable to collapse); preference for buildings with heavy parapets (extremely dangerous to people at street level). The recommendation from the US Geological Survey on 2/76 quake is adamant: adopt and enforce minimum standards for structural reinforcement, regardless of the material used.

Note: In rural highland areas, most families traditionally constructed homes of materials produced (adobe) or gathered (wood) by family members. Only roofing was likely to be purchased.

3. Disaster/Low Cost Housing

Most damage from the 1976 earthquake and previous earthquakes was due to the collapse of massive adobe brick walls and heavy tile roofs. Also, deaths resulted when squatter homes, built on ravine slopes, slid down following earthquake-induced landslides. The earthquake was characterized as "class conscious" in two respects:

- the poor lived in the most vulnerable areas, and therefore were most adversely affected;

- low-income individuals were the least able to afford the quality of construction which would ensure survival of their dwellings.

As a result of the earthquake of February 4, 1976, 258,000 housing units were damaged seriously or destroyed, 58,000 in Guatemala City alone of which 80%, about 46,000, are estimated to have belonged to the urban poor. Many of these units were already included in the housing deficit, but it is clear that the housing problem has been seriously aggravated by the earthquake. Since the earthquake, several large housing reconstruction loans have been made to Guatemala, as shown below.

Institution	No. of Units	House Sales Price $	Time Frame
*1. BANVI-WORLD BANK Sites-Services	10,000	1,400 to 3,600	77-79
*2. BANVI-International Agencies, e.g. Church World Services	3,700	2,500	76-78
*3. BANVI-GOG Self-Help	555	1,000	76-78
*4. BANVI-GOG	5,000	1,800	76-78

Institution	No. of Units	House Sales Price $	Time Frame
*5. BANVI-GOG Various Projects Outside City	1,100	1,600 to 3,000	76-78
*6. BANVI-CABEI	2,000	3,000	76-78
7. BANVI - Justo Rufino Barrios	200	5,500	77-78
*8. BANVI Bello Horizonte	880	6,500	77-78
9. BANVI El Tesoro	220	9,500	77-78
10. BANVI Individual Credits	800	2,000-6,000	76-78
11. Banco Granai & Townson			
Project 1)	355	16,000 to 32,000	
Project 2)	60	28,000 to 59,000	77-78
Project 3)	280	29,000 to 59,000	77-79
12. Banco Inmobiliario			
Project 1)	2,000	13,000 to 40,000	76-78
Project 2)	1,200	20,000	79-80
13. Banco International			
Project 1)	216	19,500	77-78
Project 2)	60	60,000	77-78
Project 3)	800	42,000	78-80
Project 4)	400	40,000	78-79

* Reconstruction Loans

Project 5)	120	65,000	78-80

Source: USAID, Office of Housing. Project Paper ROCAP--Urban Shelter Improvement 1978

For the reconstruction effort, the GOG decided to use the institutional framework already in place. BANVI and BANDESA took primary responsibility for the execution of the reconstruction program in housing. A substantial role was also planned for FHA and private banks. FENACOAC requested assistance from BANVI and BANDESA and purchased construction materials (roofing, concrete blocks and lumber). FECOAR purchased sheets of roofing for its members. The World Bank and Inter-American Bank channelled their loans through BANVI and BANDESA. In addition, the Penny Foundation (Fundacion del Centavo), a non-profit foundation whose objective is to assist in rural and urban development in Guatemala, sought donations for a home improvement program in rural areas.

The GOG adopted the following policy with regard to shelter reconstruction:

- The effort should be labor intensive and directed toward the reestablishment of small dwellings or enterprises destroyed or made inoperative by the earthquake.
- Provision of potable water, health services, electric power (especially for small establishments and domestic lighting), communication, and public transportation in low-income settlements should take priority.
- Low cost shelter should be within the financial reach of the poor.

Problems encountered in the shelter reconstruction effort were as follows:

- Earthquake occurred in the middle of the harvest season. As a result, many farmers were more concerned with gathering and marketing crops than with rebuilding or repairing their houses;
- Campsites did not permit people to be near their houses and livestock and many individuals did not want to leave what remained of their property unprotected. Therefore, many camps were not occupied;

- There was a failure to match casualty and damage statistics with relief supplies;
- Timber and adobe dust swept aside as rubbish should have been used as rebuilding materials, especially in lower income areas;
- Land tenure patterns and general settlement patterns were not observed in reconstruction projects.

However, several positive aspects emerged to balance the problems. Co-ops were utilized successfully to distribute relief supplies, especially to lower income individuals and families. The self help approach and sale of materials at subsidized prices (to prevent "handout" dependency) encouraged full participation of the population in the reconstruction effort.

In additon to the reconstruction projects mentioned, a $40 million urban reconstruction project was considered, utilizing a $2 million contribution from each of the other Central American countries, $3 million from CABEI's resources, $10 million from the IDB Social Progress Trust Fund and a $19 million HG loan from AID. After prolonged negotiation, it was determined that the IDB funds were not available.

However, a housing guaranty loan to the Central American Bank for Economic Integration (CABEI), augmented by funds from other Central American countries, was utilized by BANVI (National Housing Bank of Guatemala) for several construction projects: apartment units in Guatemala City; cooperative projects in the capital and secondary cities; and individual units on property already individually owned by families in the capital and secondary cities.

The basic concrete frame design of these units incorporated seismic resistant features and the project was not located over any known faults. All proposed designs were evaluated for their seismic resistant features.

4. Housing Types, Materials, Construction and Services

In rural areas, housing typically consists of one room, covered by thatching. The floors are generally earthen, and the walls are built of cane and mud plaster or adobe. Services are lacking, with only 9% of rural housing having access to piped water, 40% to electricity, 10% to latrines.

Urban housing is characterized by concrete slab or corrugated asbestos cement-sheet roofing (although the second material is not accepted by the FHA). Walls are fabricated of clay blocks with "mochetas" or light columns

of steel rods and concrete filling the clay block cavities. The wall is capped by a reinforced concrete tie beam. Floors are concrete slabs covered with cement floor tiles in the living areas and with ceramic tile in the bathrooms. Concrete is utilized for footings, while typical windows are iron framed glass; doors and door frames are wood. Squatter settlements and lower income housing are constructed typically of adobe, which is especially vulnerable to earthquake damage.

TYPICAL MATERIALS FOR RURAL AND URBAN HOUSING COMPONENTS

	Rural	Urban
Roof	- thatched with paja (straw) in highlands or palma (palm leaves) in eastern region; used by minority of population	- concrete slabs
		- duralite (corrugated asbestos-cement panels); not accepted by FHA
	- tile (1000-3000 tiles at a cost of Q20 - Q30 per 1000 tiles)	- tile cardboard or lamina for squatter settlements
	- lamina - corrugated steel sheeting galvanized with zinc	
Walls	- adobe bricks (mud, straw, pine needles)	- clay blocks with "mochetas" (light columns of steel)
	- cane; walls made of cornstalks, lined up and bound together (considered low prestige and used only by people who could not afford more expensive material)	- unreinforced adobe for squatter settlements; also, cardboard and wood
	- bajareque; walls made with rows of cane or wood filled with mud	
	- cement block (high prestige: very few houses)	
	- no corner posts with exception of cement	

	Rural	Urban
Floor -	earthen	- concrete slabs covered with cement floor tiles in living areas and with ceramic tile in the bathroom - earthen for squatter settlements.
Window -	open air, may be barred or shuttered; highland Indian houses often windowless	- iron framed glass - open air for squatter settlements.

In 1976, the overall material supply was about equal to the total construction demand. Total installed cement production capacity was more than adequate; however, sand and stone production were pressed. Precast concrete supply was less than the demand, and lumber has been scarce.

INSTALLED CAPACITY AND INDUSTRIAL PRODUCTION
OF THE PRINCIPAL CONSTRUCTION MATERIALS
1974

Materials	Production Volume	Production Value	Installed Capacity	Use of Capacity (%)
Dimension lumber	85,648 B_2F.	11,309	100,000	85.6
Plywood	550,500 m^2	900	847,000	65.0
Boards of various widths	230,800 m^2	532	355,000	65.0
Cement	319,879 tons	10,914	460,000	69.5
Lime	36,480 tons	1,322	40,000	91.2
Aggregate	596,000 m^3	1,814	800,000	74.5
Common brick	6,669,000 units	121	8,500	78.5
Hollow bricks or clay tile	22,264,000 units	976	32,000	69.6
Clay tile	932,000 units	14	1,200	77.7
Cement flooring	421,000 m^2	755	525,000	80.2
Ceramic tile for walls and floors	282,500 m^2	765	480,000	58.9
Concrete blocks	7,534,000 units	965	11,000	68.5
Asbestos cement sheet	1,590,800 m^2	1,973	2,200,000	72.3
Asbestos cement pipe	277,300 m^2	614	465,000	59.6
Cement pipes	365,700 units	527	450,000	81.3
Cement laundry trays	3,342 units	26	4,600	72.7
Reinforcing rods	17,149 MT	7,030	35,000	49.0

Materials	Production Volume	Production Value	Installed Capacity	Use of Capacity (%)
Galvanized sheets for roofing	20,500 MT	6,455	28,000	73.2
Iron or steel pipes	8,400 "	5,149	11,800	71.2
Steel joists and trusses	7,500 "	5,600	12,000	62.5
Iron frames for doors and windows	675 "	565	1,050	64.3
Aluminum frames for doors and windows	1,600 "	1,680	2,200	72.7
PVC piping	1,080 "	1,210	1,600	67.5
Paint	4,400,000 liter	5,058	7,000,000	64.0

Source: AID, Office of Housing, Shelter and Related Development in Guatemala: Analysis and Recommendation for AID Support, May 1976.

5. Bibliography

Agency for International Development. Disaster Relief Program Reports on Post-Earthquake Distribution of Building Materials. Washington, D.C.: AID, December, 1977.

_____. Office of Housing. Guatemala: Shelter Sector Analysis. Washington, D.C.: AID, July, 1974.

_____. Office of Housing. Shelter and Related Development in Guatemala: Analysis and Recommendation for AID Support. Washington, D.C.: AID, May 1976.

_____. Office of Housing. Urban Poverty in Guatemala. Washington, D.C.: AID, March 1980.

_____. Office of Housing. Urban Shelter Improvement (Project Paper). Washington, D.C.: AID, April 1978.

Davis, Ian. Housing and Shelter Provision Following the Earthquakes of February 4 and 6, 1976. Oxford, England: Oxford Polytechnic, Department of Architecture, June 1976.

FCH Services, Inc. Low Cost Housing Prospects in Guatemala. Washington, D.C.: FCH, 1972.

McKay, Mary. The OXFAM/World Neighbors Housing Education Program in Guatemala Following the February 4, 1976 Earthquake. Oxford, England: Oxford Polytechnic, April 1978.

Thompson, Charlotte and Paul. Post-Disaster Housing in Latin America. Washington, D.C.: Organization of American States, 1977.

_____. Reconstruction of Housing in Guatemala. Washington, D.C.: Organization of American States, May 1, 1976.

World Bank. Latin America and the Caribbean Regional Office. Guatemala: Earthquake Reconstruction Project Technical Annex (A) Housing Component. Washington, D.C.: World Bank, June 24, 1976. (Report # 1220-GU)

1. Overview

With an average of 393 persons per square kilometer, Haiti is one of the most densely populated countries in Central America. A strong rural-urban migratory trend and socio-economic imbalances have resulted in a concentration of population in urban areas, especially Port-au-Prince. Sixty percent of the urban population live in the Port-au-Prince metropolitan area and, with an annual population increase of 5-6%, the predominance of the capital continues to grow.

The housing situation in Port-au-Prince is one of the worst in the world. Sixty-four percent of the housing stock is built of scrap, wattle, straw and wood, and is collectively considered slum-level. 43.7% of the population live in densities of 800 people per hectare. In some areas of the city, the density reaches 2,000 people per hectare. More than 80% of the housing stock is not connected to the water supply system, and 61% of dwelling units offer less than 3 sq m per resident.

Although shelter conditions in provincial towns and rural areas are better by comparison, construction activity in these areas is inadequate and shortages of housing are felt at all income levels.

2. Housing Policy and Institutions

At present, a coherent material housing strategy does not exist. The housing section of the five-year development plan consists of several projects, but offers no guiding policy. However, the government has adopted a policy of decentralization of economic activity to rural areas which, once implemented, will affect the housing situation.

The basic legislation for control of shelter development is an Executive Order, (Decret-Loi Etablissant des Regles Speciales Relatives a l'Habitacion et a l'Amenagement des Villes et des Campagnes, Le Moniteur 92 no. 63, 5 August, 1937), which contains rules pertaining to town planning and the supply of services. However, this legislation is deficient since there is no provision to ensure basic infrastructure, nor is there any mechanism to determine the appropriateness of a subdivision or building. Instead, the procedures for obtaining a permit focus on design and structural characteristics. In addition, the regulations are not followed by the authorities.

Expropriation of land for public purposes can occur quickly, once a declaration of public interest has been made. A lack of cadastres, inventories of public land, and zoning regulations aggravates the shelter problem.

Although there is no large-scale formal production of housing by either the public or private sector, the following institutions play a significant role in the shelter sector.

Ministry of Planning (Division de l'Amenagement du Territorie et de la Protection de l'Environment -- DATPE, formerly National Development Planning Council -- Conseil National de Developpement et de Planification--CONADEP). Created in November 1978, the Ministry of Planning is expected to define regions in the country, undertake studies, and formulate strategies concerning regional decentralization and development. Since there is no provision for linking its activities with sectoral departments and financial divisions of the planning ministry, DATPE's plans bear little relevance to actual investments. Substantial foreign assistance has been the sole reason for DATPE's continued existence.

Town Planning Service (Service de Planification Urbaine - SPU, formerly Service d'Urbanisme). Established within the Department of Public Works, Transport and Communications (Departement des Travaux Publics, Transports et Communications DTPTC) the service is charged with the physical and economic planning of urban and rural centers, including formulating plans for reconstruction following a natural disaster. Detailed control of urban development is the responsibility of the Urban Engineering Service (Service de Genie Urbain), while the SPU has the more general responsibility of planning and standardization. The absence of a zoning plan and building code severely constrains the control of private construction activities and the SPU is forced to rely on the general prescriptions of the 1937 Town Planning Law.

Programming Unit (Unit de Programmation--UP). As part of the DTPTC, the UP prepares 5-year and annual plans in the areas of public works, urbanization, transport, energy, drinking water, and communications. There is some confusion as to the functional overlap between UP and SPU; however, the coordinating mandate of UP is of great potential importance.

The Municipalities. Poor financial status, lack of technical expertise, and limits on local authority render the planning activities of municipalities of little significance.

The National Housing Office (Office National du Logement - ONL) ONL's activities have been confined to the maintenance and management of housing projects planned, built, and financed by other state agencies, and its staff is not directly involved in planning, programming finance, or construction of shelter. The ONL is charged with executing low-income housing policy.

Housing Bank (Banque du Logement - BDL). BDL was created to promote private property access for middle income groups in the population and to improve the housing conditions of low income families. Specific duties include: creation of savings and loan mechanisms, preparation of loan guarantees, and the supervision of private home savings and loan associations. The ONL and BDL functions overlap in the areas of constructing low-income housing, setting physical and financial standards for low income housing, maintaining and managing buildings built by BDL, and determining property acquisition and transfer methods.

Service related institutions include:

Centrale Autonome Metropolitaine d'Eau Potable (CAMEP). CAMEP is responsible for water supply, management of distribution facilities, and planning extensions and improvements to the system.

Service National d'Eau Potable (SNEP). SNEP has the same responsibilities as CAMEP only for provincial towns.

3. Disaster/Low-cost Housing

Since one of the major Caribbean hurricane tracks crosses Haiti, heavy damage is often suffered by the low-lying coastal settlements. Sections of Port-au-Prince which house the majority of the low income population may be subject to up to two meters of flood waters.

Two low-income housing projets are currently being financed in St. Martin and the Brooklyn section of Cite Simone. The St. Martin project is being developed with support from the UN and the Brooklyn project with funding from the Belgian government. The monthly payment ranges from US$2-10. The Office National dun Logement (ONL) has designed a middle-class housing project, which has not yet been funded.

Since there is no savings and loan system in Haiti, housing has been heavily subsidized by international and national donor organizations, with no recoupment of investment.

4. Housing Types, Materials, Construction and Services

Shelter production is customarily the result of individual efforts, whether for low-, medium-, or high-income families. The following table summarizes the urban housing types and their characteristics:

Type of Settlement	Materials	Avg. Dwelling Unit Size	Cost US $	Avg. Monthly Rent US $
High density, low-income, uncontrolled, spontaneously settled access ways. No infrastructure.	Scrap or concrete block masonry and sheet metal roof.	10 m^2	100-300	40
High density, low-income, planned road layout.	Concrete masonry and sheet metal roof or wood walls and sheet metal roof	15 m^2	100-2,000	40
Medium and low density, low income on peripheral unserviced land.	Wattle and straw roof or wattle and sheet metal roof or concrete block and sheet metal roof	11 m^2	300	25
Medium density, low-income. Internal road networks, minimal infrastructure.	Concrete block and sheet metal roof or concrete block and reinforced concrete roof	40 m^2	1,000-4,000	70
Mixed commercial and residential. Residences of upper-income business owners and low-income spontaneous settlers.	Concrete block, reinforced concrete roofs	60 m^2		

Source: USAID, Housing Office Shelter Section Assessment: Haiti. June 1980.

The following tables indicate the costs of materials and labor associated with housing construction and repair:

Housing Construction Costs
(US $ per sq m)

Builder	Walls and Structure	Roof	Materials $/sq. m	Labor $/sq. m	Total
Low-Income	scrap	scrap or straw	5-10	2-3	7-13
	wattle	straw	15-20	5-7	20-27
	wood	sheet metal	20-30	5-8	25-38
	blocks	sheet metal	25-35	10-13	35-48
Middle-Income	blocks	sheet metal	50-80	25-40	75-120
	blocks	concrete	90-140	45-70	135-210

Cost of Construction Materials in Port-Au-Prince (US$1976)

Item	Unit	Price ($)	Price Increase 1970-1976
Small tree trunks (5 cm. dia)	dozen	2.00-7.00	--
Quarry stone	m^3	2.50	50%
Rocks	m^3	5.00	50%
Wattle	m^2	6.00	--
Blocks, 10 cm			
vibrated	each	0.12	--
nonvibrated	each	0.12	--
Blocks, 15 cm			
vibrated	each	0.14)	55%
nonvibrated	each	0.13)	
Blocks, 20 cm			
vibrated	each	0.16)	45%
nonvibrated	each	0.16)	
Wood planks, scrap	m^2	3.00-5.00	--

Item	Unit	Price ($)	Price Increase 1970-1976
Wood planks,			
local-wholesale	m^2	2.50)	105%
retail	m^2	3.60)	
Wood planks,			
local-wholesale	m^2	3.50)	65%
retail	m^2	5.00)	
Sheet metal, scrap	each = m^2	0.90	--
Corrugated sheets, inferior	each = m^2	2.00)	30%
Corrugated sheets, inferior	hundred	140.00)	
Corrugated sheets, superior	each = m^2	3.00)	20%
Corrugated sheets, superior	hundred	175.00)	
Asphalt panels	each = m^2	4.90	30%
Sand			
delivered by wheelbarrow	m^3	8.50)	65%
delivered by truck	m^3	5.00)	
Cement	sack	2.40	60%
Reinforcing steel	pound	0.21)	130%
Reinforcing steel	1,000 lbs.	190.00)	

Source: World Bank, Haiti: Urban Sector Survey, 1979.

Shelter conditions in provincial towns and rural areas are somewhat better than in major urban centers. Most units are independent structures with more space than urban ones. Interior space is used primarily for sleeping and storing goods, while external space is used for cooking, washing, eating, and social gathering. Most families rent a bare plot and build their own houses. Housing construction costs are lower than in urban areas. Low-income families tend to build with wattle and mud with straw roofs.

Higher income groups invest in corrugated metal roofs and corrugated metal supporting structures. Sand, rocks, and labor costs are lower, while cement, wood, and metal sheets are higher than those in urban areas.

Haiti's urban areas have a serious lack of adequate service provision. For example, the existing water supply systems in Port-au-Prince and Cap Haitien serve about one third of the populaton. On a per unit basis, the prices paid by the low income population are at least ten times the average paid by those connected to the water distribution. Consumption by low income families averages 12-15 liters per capita per day compared to more than 130 liters per day for high income families.

Structure of Port-Au-Prince Residential Water Distribution, From The CAMEP System, 1976

Supply Source	No. of Consumers	% of Consumers	Daily per Caput Consumption (liters)
Private connections (legal and illegal)	150,000	23%	156
Public fountains (free)	55,000	9%	15
From another's private collection (free)	95,000	15%	32
From leaks and breaks	40,000	6%	18
Purchase from intermediaries	300,000	47%	11
Total (Average)	640,000	100%	49

Source: World Bank, Haiti: Urban Sector Survey, 1979.

There is no sanitary sewer system in operation in any of Haiti's urban areas. Septic tanks are utilized by higher income households, while pit latrines are the most common form of sanitary facility used in low income neighborhoods. In many cases, the households do not have any form of sanitary facility.

Haitian Wattle and Daub House with Thatched Roof. (Photo by Aaron Benjamin, USAID Urban Development Officer, Santo Domingo.)

5. Bibliography

Agency for International Development. Country Development Strategy Statement, FY 1982. January 1980.

_____. Housing Office. Sector Survey Assessment: Haiti. June 1980.

_____. Office of Urban Development. The Economics of Survival: A Study of Poverty and Planning in Haiti. November 1980.

World Bank. Haiti Urban Sector Survey (Report #2152-HA). April 19, 1979.

1. Overview

In the past rural to urban migration in Honduras has been relatively limited compared to other Central American countries. In 1980 only 36% of the Honduran population (estimated at 3,702,000) was urban, in contrast to 53% in Nicaragua, 43% in Costa Rica, 41% in El Salvador, and 39% in Guatemala. However, in recent years the annual urban growth rate has been increasing (average of 5.5% p.a. during 1970-80). The general pattern of migration is south to north with San Pedro Sula the fastest growing urban area. Over the years the northern coastal and lowland areas have experienced the most population growth due to employment opportunities offered by two fruit companies. As both companies expanded, they could offer services such as housing, education, and medical facilities which were unavailable in the rest of the country.

Highland settlements range from large urban centers (Tegucigalpa, Compayagua, Copan) to small villages which have grown up around local agricultural, lumber, and mining enterprises, to isolated subsistence farms which are scattered throughout the mountainous areas in the west and southwest. Also characteristic of this area are large agricultural estates where workers' housing is provided by the landowner. Overall, the population of Honduras is distributed very unevenly. While rapid growth is occurring in a corridor which includes La Ceiba, Tela, Puerto Cortes, San Pedro Sula, Siguatepegue, Comayagua, Tegucigalpa, and Choluteca, other areas (particularly in the east) are under-settled or even devoid of population.

2. Housing Policy and Institutions

The National Housing Plan clearly distinguishes between rural and urban housing with greater emphasis placed on the former. The rural housing program is being coordinated with the development of new rural settlements through the agrarian reform program. Use of local construction materials and aided self-help housing methods are stressed. However, to date little progress has occurred in the rural sector. In urban areas the trend is toward decentralization and the development of secondary cities. Greater participation by the public sector in urban areas is encouraged. The National Housing Agency (INVA) is the main implementing agency for both urban and rural housing in the public sector. The National Board for Social Welfare is responsible for rural housing improvement programs.

Role of the Government of Honduras

- Provides financial support to INVA
- Creates public bodies related to housing as well as semi-autonomous banks and other financial and technical institutions
- Supports the creation and development of private organizations such as the Honduran Cooperative Housing Federation (FEHCOVIL) and savings and loan associations
- Sets housing policy and makes regulations for the housing industry as a whole

Honduran National Housing Institute (INVA) - autonomous public agency charged with carrying out the national housing plan. It is responsible for the development of housing for low to moderate income families throughout the country, though most projects have been located in Tegucigalpa and San Pedro Sula; no rural projects have been built by INVA. Principal funding sources have been the government and the InterAmerican Development Bank. USAID has provided Honduras with $27.9 million through four HG loans since 1963 when the first HG loan was authorized.

National Agrarian Institute (INA) is the principal agency for land reform and agricultural development. It collaborates with INVA by designating sites eligible for housing programs and providing non-technical assistance.

Asociacion Por Desarrollo Humano is a private institution involved in low-cost housing. Usual construction technique is a primitive wooden frame modular which has found wide local acceptance. Funding comes from overseas grants and locally raised capital.

Federation of Credit Unions of Honduras (FACACH) is a private group involved in two low-cost semi-urban housing projects.

Three private groups have been involved in middle-income housing: the savings and loan association system; Banco Hipotecario, a commercial bank; and the Honduran Cooperative Housing Federation (FEHCOVIL). FEHCOVIL has been assisted by A.I.D. since its inception in 1963. Two unions, the Federacion de Sindicatos de Trabajadores del Norte de Honduras (FESITRANH) and the Sindicato de Trabajadores de la Tela Railroad Company (SITRATERCO) have sponsored housing in the San Pedro Sula area for lower middle-income families.

City Planning

City planning and zoning regulations are the responsibility of municipal governments. However, financial constraints and a lack of trained personnel in the municipalities have prompted the national

government to organize a Department of Urban Planning (Direccion General de Urbanismo) to assist local governments in preparing master plans.

3. Disaster/Low-cost Housing

3.1 Effects of Natural Disasters on Housing

The lack of adequate housing affects roughly one million Hondurans (over one-third of the population), most with very low incomes. Besides the general deficit of housing stock which accumulates year after year, the housing situation has worsened since 1974 due to a series of natural disasters. Disaster vulnerability in Honduras is overwhelmingly related to floods like those that accompanied Hurricane Fifi in September 1974. An estimated 15,000 housing units were destroyed. Most of those destroyed were rural huts of cane and thatch, though some 2,500-3,000 houses of permanent construction were also destroyed. The majority of victims lived either in the flood plains or on steep slopes which are vulnerable to mudslides. In most cases, the housing destroyed or damaged was of the poorest quality and belonged to those least able to afford repairs or replacement. Floods and mudslides in the middle of 1976 also caused substantial damage to the housing sector and contributed to a greater degree of overcrowding and the growth of uncontrolled settlements. A major lesson learned from these experiences was that the site of a unit is more crucial than the materials or construction method used. If appropriately sited, even houses made of bajareque or wood are able to withstand heavy rains.

HONDURAS: Estimate of Destruction of and Damage to Housing[a/]

Location	Before the Hurricane[b/]	Affected by the Hurricane Destroyed	Affected by the Hurricane Damaged	Percent Affected
Total		2,898	12,500	
Tegucigalpa-Comayaguela	50,950	3	25	
San Pedro Sula & La Lima	31,820 c/	500	4,000	14
Santa Rita	1,620	200	500	43
Choloma	1,680	500	500	60
Puerto Cortes	5,480	400	500	16
Omoa	312	150	300	d/
Progreso	5,625	500	3,000	62
San Manuel	405	50	150	49
Villanueva	940	100	400	53
Pimienta	404	50	150	49
Potrerillos	1,334	50	500	41

Location	Before the Hurricane b/	Affected by the Hurricane Destroyed	Damage	Percent Affected
Tela	3,975	n.a.	80	2
La Masica	360	20	50	19
Tocoa	542	100	1,200	d/
Sonaguera	390	n.a.	300	77
Saba	395	n.a.	150	25
La Ceiba	7,615	150	500	9
Utila	310	5	50	18
Santos Guardiola	290	10	20	10
Roatan	490	10	25	7
Guanaja	474	100	100	42

a/ Not including an as yet undetermined number of rural dwellings.
b/ In the municipal district, according to the 1974 Population and Housing Census.
c/ Includes 3,070 dwellings in La Lima.
d/ The figures for houses affected also include dwellings in neighboring villages and hamlets and thus exceed the figure given for the number of houses in the municipal district.

Source: Technical Secretariat of the Higher Council for Economic Planning.

3.2 Government-sponsored Housing

In urban low-cost housing the basic house, as built by INVA, consists of reinforced concrete footing, clay brick or block walls, concrete floors, asbestos cement roof, wood-framed glass windows, and wood doors. Interior and exterior walls are left bare and no ceilings are put in. These houses have electricity and indoor plumbing. The kitchen is equipped with a concrete sink with cold water only, while electrical wiring is left exposed. Pipes are concrete and galvanized iron. A typical lot is 72 sq. meters and the building area 30 to 35 sq. meters.

Construction materials for urban middle-income housing are the same as in low-cost housing, but with improvements and larger spaces. The bathroom is complete with lavatory and probably a ceramic tile wainscot. A dropped ceiling is included and electric conduits are concealed in the walls. Lots are larger, 150 to 200 sq m and the constructed area is 70 to 80 sq m.

Physical Design of Two Urban Housing Projects

	INVA	FEHCOVIL
Lot	6 x 12 meters (72)	5 x 13 meters (65)
Dwelling	3 x 6 meters (18)	5 x 5 meters (25)
Materials		
Floors	Concrete	Concrete
Walls	Concrete panels	Concrete block & wood
Roof	Galvanized sheets	Galvanized sheets
Expansion Area	9 x 6 meters (54) w/o preparation or retaining walls	6.5 x 5 (32.5) meters leveled, with retaining walls
Utilities	Water, sewer, electricity	Water, sewer, electricity

Source: Lindsay Elmendorf, Housing Project in Honduras, 1980.

4. Housing Types, Materials, Construction and Services

4.1 Housing Types

Urban

The traditional owner-built house in urban areas has exterior walls of adobe or bajareque except in the northern coastal area where wood is predominant. Brick and cement walls are used by upper-income families and in government-sponsored projects. In the major cities clay and cement tiled floors are usual, though earth floors are still found in marginal areas and in smaller cities. Wood floors are common in the low coastal areas and off-shore islands where houses are often constructed on wood pilings. Because of the increasing cost of ceramic tile, zinc sheeting and corrugated asbestos are replacing tile as the most common roofing materials.

Rural

A typical rural house has a packed earthen floor, an unsawed timber frame, walls of bajareque (packed mud and straw) on a woven "manaca" (palm leaf), no interior partitions, one door, no windows, and a manaca roof. Cooking facilities are minimal and are often in a corridor outside the living quarters. There is no electricity, indoor water supply or plumbing. Most of these houses are built by their owners and are small (one room) and overcrowded. Most rural families are homeowners in contrast to being renters (only 2% rent), though they probably do not have title to their lot. Incomes in rural areas are so low that nearly all rural families are unable to purchase a home. Based on this situation, the government has not found it feasible to develop housing programs in rural areas. To date there have been only a handful of rural projects, generally after a disaster.

4.2 Construction Materials

Approximately 90% of all building materials are produced locally, although they are not always readily available. Overall quality of domestic materials is acceptable but orders must be placed well in advance to assure prompt delivery.

Cement - one plant in San Pedro Sula has capacity to fill domestic needs and produce a surplus for export. 5,542,000 sacks were produced in 1973.

Concrete blocks and clay bricks - generally sufficient supply. To ensure availability order should be placed in advance.

Sand and gravel - abundant in northern coastal areas; shortages in highlands near Tegucigalpa. A rock crushing plant in the North Coast area was being relocated near Tegucigalpa in 1974 and other plants were being planned.

Wood - although Honduras has the largest forest reserves in Central America, most of the lumber produced has been exported. High domestic demand has caused scarcities and high prices. Honduras is industrializing its forest reserves with the assistance of international agencies. Five zones have been designated as potential forestry development areas with projects presently being carried out in two: Olancha and Comayagua. Timber production has shown an upward trend since 1975: 203 million board feet that year compared with 260 million board feet in 1979. The proportion of exports has been declining: 95% in 1975 and 54% in 1979. Common

grade lumber is generally left to meet domestic demand for construction; standing timber is sold to sawmills for primary transformation.

There were 118 sawmills in 1977 and 58 secondary wood processing plants, including 2 companies producing 13,000 m^3 of plywood.

Roofing - asbestos cement planks are most widely used; local plants maintain adequate supplies. Traditionally clay tiles were used, but due to increased costs only upper income families can afford them. Corrugated galvanized iron sheets are imported.

Construction Costs

Item	Unit	1974
Layout	M^2	$ 0.05
Excavation	M^3	1.50
Footings (cyclopean concrete)	M^3	68.49
Drainage (concrete pipe 4")	M^1	4.36
Compacted fill	M^3	2.50
Brick walls	M^2	5.90
Roof (wood purlins covered with asbestos-cement pants)	M^2	3.90
Water supply lines	M^2	3.55
Cement floor tile	M^2	6.00
Wood doors	U	30.00
Electricity	U	15.61

Source: AID, Honduras Housing Sector Analysis, 1974.

4.3 Services

Water Supply

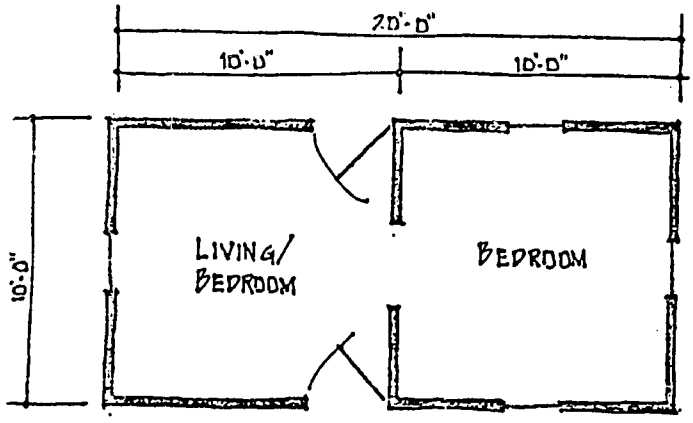
Of the approximately 7,500 villages in Honduras, only 389 have some type of water system. The majority of these systems are inadequate and/or in need of repairs. Only 60% of the systems provide water all day during the dry season and in only 20% is the bacteria level of the water satisfactory. Servicio Autonomc Nacional de Acueductos y Alcantarillado (SANAA) is the government agency in charge of the water supply in the larger urban areas. Smaller cities and towns generally operate local plants and systems. Approximately 70% of urban families have piped water, while only 4.2% of rural families have direct access; 89% of urban and 15% of rural families have general (communal) access to safe water.

Sanitary Facilities

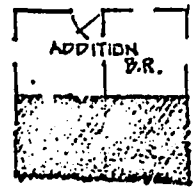
Approximately 80% of the population have no access to sanitary facilities and there are no sewage treatment plants in the country. Throughout the country, about 45% of the homes in urban areas and 90% of those in rural areas are without sanitation facilities. Septic tanks are used in 50% of the homes with facilities. In Tegucigalpa there is a main underground collector running along the Rio Choluteca which collects most of the sewage and discharges it into the river outside the city limits.

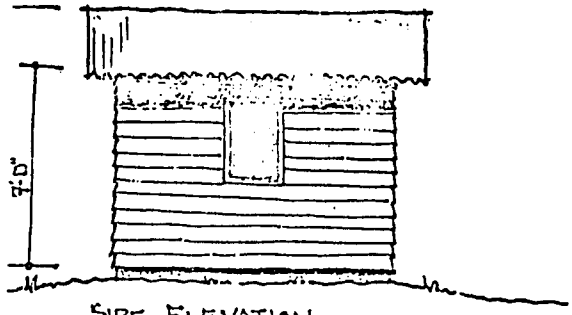
Electricity

Electric power is supplied to about 15% of the population, primarily urban, by municipal or community owned systems. Electricity is generally used for lighting only; heating is done by kerosene, wood or charcoal. Empresa Nacional de Energia Electrica (ENEE) is responsible for the provision of electric energy. This agency operates in most of the municipal capitals and larger cities. In some of the smaller cities on the north coast, electricity is purchased from banana companies. Power is available an average of 5 hours daily. The sources of electric energy are 61% hydraulic and 39% diesel or gas turbine.



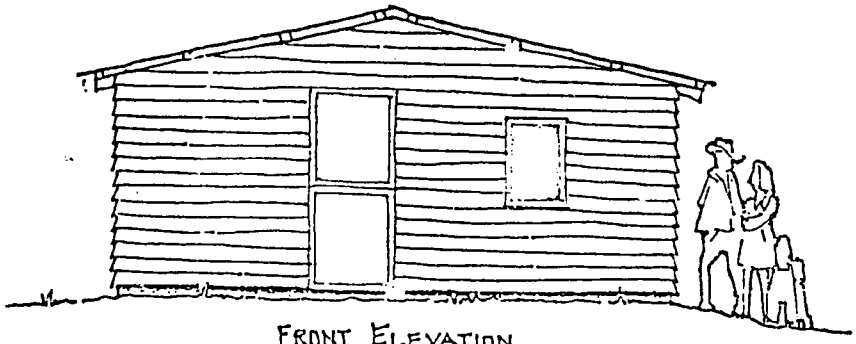
FLOOR PLAN





SIDE ELEVATION

Area	200 ~~400~~ sq.ft.
Estimated cost	$350
Roof	Zinc
Walls	Wood
Floor	Concrete
Structure	Wood
Foundation	Concrete

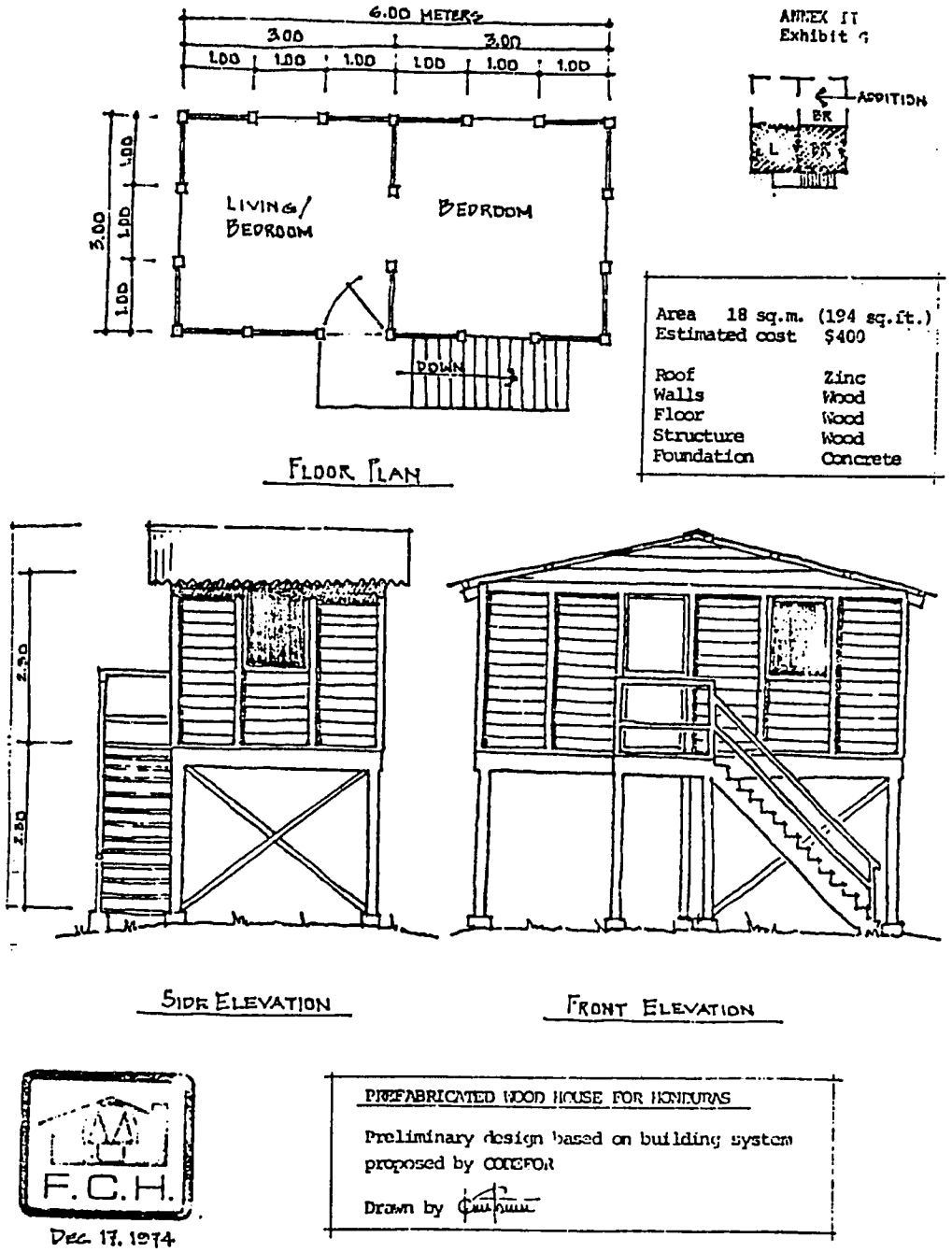


FRONT ELEVATION

PREFABRICATED WOOD HOUSE FOR HONDURAS

Preliminary design based on existing APNU housing unit and proposed FESITRANH building system

Source: AID, Capital Assistance Paper. Honduras - Hurricane Rural Reconstruction and Recovery, December 1974.



Source: AID, Capital Assistance Paper. Honduras - Hurricane Rural Reconstruction and Recovery, December 1974.

5. Bibliography

Agency for International Development. Capital Assistance Paper. Honduras - Hurricane Rural Reconstruction and Recovery. Washington, D.C.: USAID, December 1974.

_____. Office of Housing. Honduras Housing Sector Analysis. Washington, D.C.: USAID, August 1974.

Blutstein, Howard I., et al. Area Handbook for Honduras. Washington, D.C.: GPO, 1971.

Elmendorf, Lindsay. Housing Project in Tegucigalpa, Honduras: Final Report. Washington, D.C.: Foundation for Cooperative Housing, May 1980.

Inter-American Development Bank. Honduras: Loan Proposal for Comayagua Forestry Development Program. PR-1047. Washington, D.C.: IDB, September 1980.

Snarr, Neil D. and Brown, Leonard E. "Permanent Post-Disaster Housing in Honduras: Aspects of Vulnerability to Future Disasters," Disasters, Vol. 3, No. (3) 287-292.

U.S. Central Intelligence Agency. National Basic Intelligence Factbook. Washington, D.C.: GPO, January 1980.

World Bank. Staff Appraisal Report. Second Agricultural Credit Project. Report No. 2691-HO. Washington, D.C.: IBRD, March 1980.

United Nations Economic and Social Council. Economic Commission for Latin America. Report on the Damage Inflicted on the Honduran Economy by Hurricane Fifi and its Repercussions. October 11, 1974.

1. Overview

In a pattern of rapid urbanization, more than 48% of Nicaragua's 1.9 million people were urban dwellers at the time of the 1971 census. The population had grown to an estimated 2.2 million by 1975; 50% were urban in 1974, projected to rise to 54% by 1990. Managua's population, growing at an annual rate of 7% (compared to a 1% rural growth rate and 2.8% for other cities and the country as a whole), had reached about 430,000 in 1972--nearly 50% of the urban population. The country's population is unevenly distributed: 60% live on 15% of the land area (the Pacific zone where 20 of the 36 cities of over 4,000 people are located); 32% live in the central zone which represents 35% of total area; 8% inhabit the remaining 50% of the country.

The earthquake which devastated Managua on December 23, 1972, killing more than 11,000 people, destroyed about 45% of the housing stock or 32,000 to 35,000 units*, damaged another 22-28%, and forced the evacuation of 160,000 to 250,000 people. The heavy structural losses, combined with a large existing housing deficit, created massive shelter needs over a wide income range in the post-earthquake period. As housing problems continue, the projected new housing requirements for the country as a whole for the period 1976-1986 are 361,594 units.

Two government decisions made in the aftermath of the earthquake were to affect future housing construction and settlement patterns: 1) new building codes taking the seismic characteristics of the region into account were developed because none had been established with design and structural requirements appropriate to the risk, despite the disastrous earthquake of 1931 which destroyed the city; 2) decentralized development was encouraged in order to minimize loss of life and property from future quakes and to promote the growth of secondary cities. The cost of extending infrastructure over a wider area and building with improved standards made strict implementation of the new regulations difficult. As a result, considerable unauthorized and unorganized building occurred, creating problems in the provision of services as well as potential hazards of unknown dimensions during future quakes.

The urban poor are generally housed in inner city rental units in cuarterias or, as city populations swell as a result of rural to urban migration, in improvised dwellings on the periphery. Varied self-help construction techniques and styles of houses are found throughout the countryside. The small, square rancho type, built largely of local materials, is typical of low-cost housing in the Pacific region.

* Initial estimate of about 53,000 units was later revised downward.

Projected Requirements for Number of Housing Units
July 1976-December 1986

Managua

Income Group	New Families	Replacements	Existing Need	Required Total
Less than:				
400	6,010	1,450	6,250	13,710
401-675	16,490	4,000	13,360	33,850
676-1,350	22,660	5,530	9,180	37,370
1,351-2,025	5,720	1,380	660	7,760
2,026-2,700	2,260	3,540	n.a.	2,800
2,701-3,375	960	280	n.a.	1,190
3,376-4,050	850	210	n.a.	1,060
4,051 and more	1,700	410	n.a.	2,110
Total	56,650	13,750	29,440	99,850

Other Urban Areas

Income Group	New Families	Replacements	Existing Need	Required Total
Less than:				
400	7,265	2,350	10,070	19,685
401-675	12,970	4,190	13,980	31,140
676-1,350	19,060	6,170	10,270	35,500
1,351-2,025	5,975	1,930	920	8,825
2,026-2,700	3,550	1,150	n.a.	4,700
2,701-3,375	1,235	400	n.a.	1,635
3,376-4,050	1,560	500	n.a.	2,060
4,051 and more	2,205	710	n.a.	2,915
Total	53,820	17,400	35,240	106,460

Source: AVINIC-Delcanda Politica Nacional de la Vivienda-Analisis

2. Housing Policy and Institutions *

The National Housing Bank (Banco de la Vivenda de Nicaragua-BAVINIC) is an autonomous agency established by the government in 1966 to construct

* Structure and Functions as of 1973

and finance housing units in both public and private sectors. It incorporates three departments: Instituto Nicaraguense de la Vivienda (INVU) with responsibility for low-cost housing development and financing; Savings and Loan Department with Caja Central de Ahorro y Prestamo (CACE) having supervision over a system of private savings and loan societies; Mortgage Insurance Department (Fomento de Hipotecas-FHA). BAVINIC was experiencing financial difficulties in 1978 when over $9 million in funds lent by the bank was in arrears.

In actual practice, most low-income families have lacked access to credit in the past, and "spontaneous construction" using family labor has been a common home building method.

3. Disaster/Low-cost Housing

75 to 80% of the people left homeless by the 1972 earthquake found shelter (in some cases for an extended period) with relatives on the outskirts of Managua or in more distant towns. Others took refuge in schools or other public buildings.

Perhaps because of these alternative solutions, the emergency housing provided was not fully used, including the tent cities erected in several locations with tents donated by the USG and other nations. One source suggests that the lack of receptivity was due to the layout of the camps along military lines (with the exception of that in Masaya) and the regimentation of family activities. The 500 spun polyurethane foam igloos provided by the West German Red Cross were slow in arriving and never fully occupied.

A $3 million USAID grant helped finance the building of 11,000 low-cost temporary housing units on the outskirts of Managua (las Americas project). The 15' x 15' huts with no electricity and shared water and sanitary facilities had rough wood siding, corrugated metal roofs and dirt floors. The low initial occupancy (30-50% in the first six months) was believed by officials to be due to the reluctance of the earthquake victims to leave the homes of relatives for the uncertainty of a new housing project and possible unemployment. Though initial poor grading and drainage problems slowed the conversion of the huts to permanent shelters, they were eventually upgraded through an AID loan and fully occupied by late 1974.

4. Housing Types, Materials, Construction and Services

4.1 Housing Types

Urban

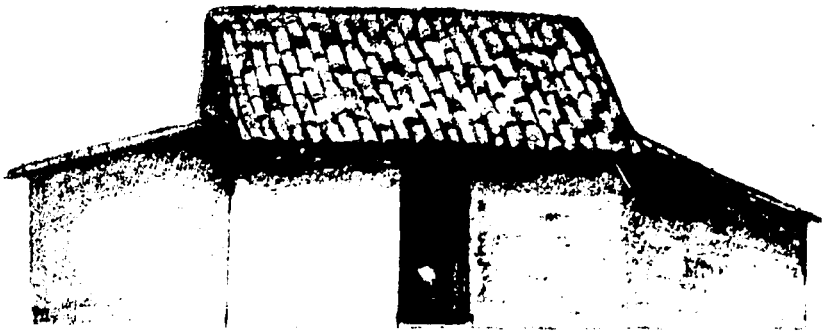
According to the 1971 census, over one-quarter of the housing units in Managua were makeshift shelters or rooms in cuarterias--old houses subdivided into single rental units with shared water and sanitary facilities. The typical migrant settlement pattern is to find shelter with friends or relatives in cuarterias, then move to makeshift housing on the city fringes (barrios). Unlike many Latin American cities, Managua has no tradition of illegal squatting by large, well-organized groups. 1971 census data also showed that 40% of Managua's families lived in a single room; 42% lacked sewerage service, 39% water service, 9% electricity; 48% were renters. Although there was a considerable mix of housing by income level in Managua at the time of the earthquake and losses at all levels, about 50% of those losses were lower middle-income housing in the city core.

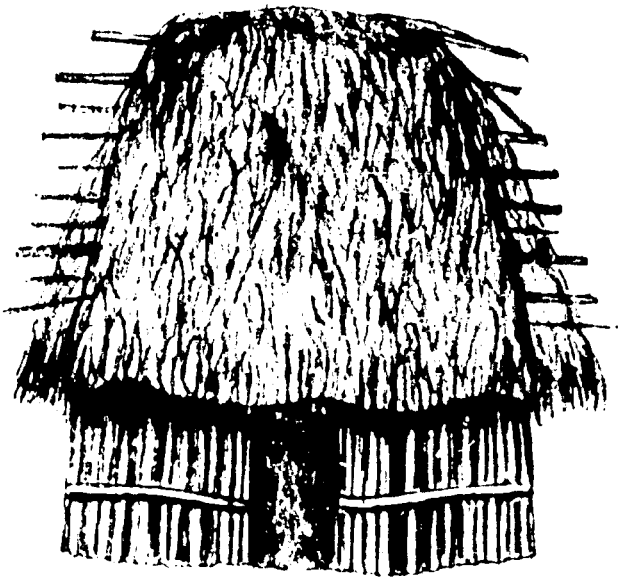
Rural

The simply constructed traditional housing of the rural poor is mainly of two types. The small rancho, common in the Pacific lowlands, has walls of poles (sometimes mud-covered) or cane, and often a straw roof distinguished by its four sides. There are usually two rooms: a dormitorio for sleeping and a salita (living room) which may also include a kitchen area.

The rectangular canoi-type house is the common dwelling of poor people in the highlands. Additions (barjareque) with single shed roofs are attached to the short sides of the house and sometimes to the back. Walls may be of poles, cane or board, or of poles or cane covered with mud-straw mix; roofs are frequently of tile. The main house consists of one or two rooms; the kitchen and possibly the sleeping areas are in the barjareque additions.

Adobe construction is sometimes seen in large houses in coastal towns but is rare in the countryside and among homes of the poorer classes.





Traditional Rural Dwellings

Drawings after photographs in Nicaragua by Rene Moser (Paris: Editions Delroisse)

4.2 Materials and Construction

Building materials used in Managua in 1972 included hollow clay tile, concrete and concrete block, brick, structural steel and, to a limited extent, wood. Materials used in traditional construction were presumably produced locally; structural steel and possibly some other modern materials were imported.

Dwellings of Managua's very poor were at best crude shelters constructed with concrete floors and foundations, wood siding, tile or zinc roofs; most were shacks made of scrap materials. About half of lower middle-income housing was of wood, concrete block, or wood and block combination. The other half, mostly in the city center, was of a traditional construction called "taquezal" in which timber frame walls of widely spaced posts connected by double lathing were filled with stone and mud balls and plastered with stucco when dry. Floors and roofs were also wood framed, the latter overlaid with clay tile, cement asbestos sheeting, or corrugated metal. The outwardly substantial appearance of these houses belies their inherent weakness. With poor lateral force resisting strength and framing often weakened by termites, the structures collapsed in the earthquake, causing most of the deaths.

The extensive use of hollow clay tile as partitions and wall infills in frame buildings (reducing flexibility) also accounted for much structural damage. Many buildings of modern materials (concrete, reinforced concrete, masonry, etc.) also failed to withstand the shock, often because of inadequate attachment of roofs to walls. On the other hand, houses built to resist earthquakes generally suffered little damage.

With international agencies playing a major role in relief and reconstruction, 9,000 homes had been repaired, 27,000 new homes constructed by February 1976. Seismic-resistant stock was expected to be brought up from the 15% pre-earthquake level to 40% within four years. Most new buildings were in outlying areas of Managua and in the nearby cities of Leon, Granada, and Masaya.

4.3 Services

The Managua Water Co. (EAM), with World Bank assistance, was expected to carry out a project between 1978 and 1981 to improve and expand water and sewerage service, especially to low-income families.

The second stage of the "74 communities joint program," which would provide water and sewerage service to 10 major cities and increase water availability in 64 others, was to have been undertaken by the National Office of Water and Sewerage (DENECAL) in 1978. DENECAL also planned to improve the sewerage system in Managua and the pollution control of Lake Managua.

Indicators of Potable Water and Sewerage Services in the 20 Principal Cities of Nicaragua

	Potable Water (1976)		Sewerage Service (1975)	
Cities	% Population Served	# of Connections	% Population Served	# of Connections
Granada	100	7,619		
San Marcos	100	939		
Masaya	91	5,573	22.5	1,508
Estell	82	4,000		
Ocotal	78	1,440	28.8	420
Jinotepe	75	1,880		
Somoto	73	838	28.8	315
Boaco	70	925		
Managua	68	54,360	66.0	46,473
Juigalpa	66	1,212		
Leon	60	6,232		
Rivas	60	1,186	32.3	770
Matagalpa	60	2,526		
Corinto	58	1,643		
Chinandega	57	3,405	16.6	1,029
San Carlos	49	274		
Jinotega	45	968		
Chichigalpa	42	1,321		
Diriamba	40	955		
Bluefields	30	878		

Source: Departamento Nacional de Acueductos / Alcantarillado (DENACAL) as cited in A Study of Housing and Urban Development in Nicaragua. PADCO, 1978.

Indicators of Electric Service in the 20 Principal Municipalities of Nicaragua in 1975

Municipalities	Average Consumption in Kwh per household	Total Consumption 1,000's of Kwh	# of Clients
Chichigalpa	11,579	17,206	1,486
Managua	7,028	379,359	53,976
Granada	4,112	26,671	6,486
Leon	3,720	38,014	10,220
Rivas	3,327	7,546	2,268
Diriamba	2,602	5,950	2,287
Corinto	2,505	6,465	2,581
Chinandega	2,485	13,546	5,450
Boaco	2,392	3,136	1,311
Jinotepe	1,998	4,228	2,116
Masaya	1,192	6,675	5,061
Bluefields	1,145	2,205	1,925
Juigalpa	1,105	1,557	1,410
Somoto	1,068	682	639
San Carlos	817	189	231

Source: Empresa Nacional de Luz y Fuerza (ENALUF) e Instituto de Energia Electrica as cited in A Study of Housing and Urban Development in Nicaragua. PADCO, 1978.

5. Bibliography

Agency for International Development. Nicaragua - Housing Investment Guaranty. Proposal and Recommendations for the Review of the Development Loan Committee. August 2, 1973.

_____. Office of U.S. Foreign Disaster Assistance. Case Report: Nicaragua - Earthquake, December 1972. Washington, D.C.: AID.

Davis, Ian. "Disaster Housing: A Case Study of Managua." Architectural Disaster Information System. Carnegie-Mellon University.

Earthquake Engineering Research Institute Conference Proceedings, Volume I (November 29 and 30, 1973). "Performance of Native Construction, Masonry Structures and Special Structures in the Managua Nicaragua Earthquake of December 23, 1972." San Francisco, Calif.: Earthquake Engineering Research Institute.

Haas, J. Eugene. et.al. Reconstruction Following Disaster. Cambridge, Mass.: MIT Press, 1977.

Moser, Rene. Nicaragua. Paris: Editions Delroisse.

Planning and Development Collaborative International. A Study of Housing and Urban Development in Nicaragua. Washington, D.C.: PADCO, 1978.

Ryan, John Morris, et. al. Area Handbook for Nicaragua. Washington, D.C.: GPO, July 1970.

U.S. Comptroller General. Nicaragua - An Assessment of Earthquake Relief and Reconstruction Assistance. Washington, D.C.: GAO, March 17, 1977.

U.S. Department of Commerce. National Bureau of Standards. Building Performance in 1972 the Managua Earthquake. Washington, D.C.: U.S. Dept. of Commerce, November 1973.

World Bank. Appraisal of Earthquake Reconstruction Project: Nicaragua. Report No. 134a - NI. Washington, D.C.: IBRD, April 20, 1973.

_____. Economic Memorandum on Nicaragua. Report No. 914-NI. Washington, D.C.: IBRD, November 5, 1975.

_____. Memorandum on Recent Economic Development and Prospects on Nicaragua. Report No. 2061-NI. Washington, D.C.: IBRD, June 30, 1978.

1. Overview

Several major waves of rural to urban migration since the 1940's have changed Peru's population from predominantly rural to 55% urban by 1975, and put a great strain on urban resources. Metropolitan Lima, the destination of 58% of migrants to coastal areas, quadrupled its population between 1940 and 1970 (4,290,735 in 1977). Of the estimated 3.1 million housing units in Peru in 1977, 62% were in urban areas but only 51% of dwellings in Lima were considered of standard quality. The Metropolitan (Lima) Development Plan (PLANDEMET) estimates an additional 910,549 units will be needed in that city by 1990 to accommodate the projected population.

About 65% of all families own their own homes, though not necessarily the land; a single-family detached home is the predominant type (80%). The present high rate of inflation has priced all but a tiny minority out of the housing market. Self-help or "auto-construccion" is the only means for poor people to build permanent shelters, though such structures tend to be "under-built" or "over-built".

1977 Urban and Rural Housing Needs by Region

Regions	Total Units 1977	Housing Needs: New Units 1972-77	Housing Needs: Replacement Units 1972	Total
National	3,147,903	473,539	2,195,890	2,669,429
Urban	1,960,341	429,803	1,057,202	1,487,005
Rural	1,187,562	43,736	1,138,688	1,182,424
Coastal	1,812,813	345,263	1,020,149	1,365,412
Urban	1,468,461	342,525	680,404	1,022,929
Rural	344,352	2,738	339,745	342,483
Sierra	1,054,171	86,397	947,476	1,033,873
Urban	373,366	63,439	292,013	355,452
Rural	680,805	22,958	655,463	678,421
Selva	280,919	41,879	228,265	270,144
Urban	118,514	23,839	84,785	108,624
Rural	162,405	18,040	143,480	161,520

Source: Banco de la Vivienda del Peru, based on National Housing Census, 1972, as cited in AID Peru Shelter Sector Assessment, February 1979.

Urban Households

Department	Average Number of People per Household	Department	Average Number of People per Household
Amazonas	5.5	La Libertad	5.2
Ancash	5.1	Lambayeque	5.3
Apurimac	4.6	Lima	5.1
Arequipa	5.1	Loreto	6.5
Ayachucho	4.6	Madre de Dios	5.0
Cajamarca	5.9	Moquegua	5.0
Callao	5.2	Pasco	4.8
Cuzco	4.0	Piura	5.6
Huancavelica	4.7	Puno	4.4
Huanuco	5.7	San Martin	5.7
Ica	5.5	Tacna	5.0
Junin	5.1	Tumbes	5.8

Source: Compania Peruana de Investigacion de Mercados, S.A., Censo Muestra de Provincias, 1978, p. 13 as cited in AID Peru Shelter Assessment, February 1979.

2. Housing Policy and Institutions *

Ministry of Housing and Construction (MOHC) has overall direction of the housing sector. The Banco de la Vivienda del Peru (BVP) is its financial arm; EMADIPERU (Peruvian Real Estate Management Enterprise) administers MOHC housing portfolio. Several quasi-independent entities (e.g., Direccion General de Obras Sanitarias (DGOS) and ELECTROPERU) have responsibility for infrastructure.

The state-owned, semi-autonomous BVP is the principal source of finance for low-income housing and has had extensive experience in contracting foreign loans, including USAID loans for housing reconstruction after the 1970 earthquake.

17 savings and loan associations (7 in Lima), regulated by BVP, are authorized to lend for housing and infrastructure.

Banco Central Hipotecario (BCH), Central Mortgage Bank, finances higher-income housing.

* Structure and functions of institutions as of November 1979, when the country was in a transitional phase prior to the election of a civilian government in May 1980.

All banking institutions have been seriously decapitalized during the past few years by rapid inflation, necessitating government support, in part through subsidies, for BVP and S and L's.

Numerous other public and private institutions have responsibilities and programs related to housing. The Institute for Investigation of Housing Action (Instituto de Investigaciones para la Accion en Vivienda, INIAVI), a private voluntary organization, has potential for making an important contribution to self-help housing through its program of technical assistance using professional construction engineers, "master" supervisors, and teaching materials.

3. Disaster/Low-cost Housing

Following the disastrous May 1970 earthquake several types of emergency housing were provided by the GOP and international donors, some more readily accepted than others.

500 hemispherical, inflatable "igloos" of spun polyurethane were supplied by the German Red Cross for use in Caraz, Callejon de Huayles. A 1976 survey found 272 still standing and only a few not occupied. In many instances the original units had been regrouped, enlarged by the addition of separate or abutting adobe structures, or otherwise modified. Though earthquake resistant and well insulated, the domes were not popular, their long-term occupancy apparently dictated by necessity rather than choice.

Several hundred multi-family units with corrugated cement asbestos roofing were built by the GOP in mountainous urban areas. The communal living arrangement, dirt floors, and lack of windows have been cited as reasons for their generally negative reception. In addition, the time required for building (3 to 6 months) limited their effectiveness as emergency housing. Some units were still occupied in 1976; others were being used for commercial or governmental purposes; still others had been disassembled and moved to other sites. The 662 AID-funded wood frame four-family modulars, built in rural communities of Callejon de Huayles, met with many of the same objections as the GOP units. The plan to reuse materials in permanent structures proved unfeasible due to deterioration of the wood frames and cracking of the cement asbestos roofing.

More than one thousand 3x4.5 m windowless shelters of corrugated zinc sheets over wood frames provided by the OAS were built in rural areas of Yungay and Huaylos. Their thermal characteristics (too hot during the day and too cold at night) were the chief drawbacks.

The USG also supplied tents which were still in use long after the initial emergency period. Since they could not provide adequate protection in rain and cold weather, the purchase and delivery of corrugated metal and aluminum roofing to cover temporary structures erected by earthquake victims became a high GOP priority.

The USG responded to Peru's need for temporary housing after the October 1974 earthquake near Lima by financing the purchase of locally obtainable "esteras" (woven cane mats) to be used in building shelters rather than investing in the far more expensive tents. The warm, dry weather of the region at the time of the emergency permitted that solution. Obtaining esteras proved difficult, however, because they had to be purchased from several small manufacturers along the entire coast.

4. Housing Types, Materials, Construction and Services

4.1 Housing Types

Urban

Two types of settlements house the majority of urban poor: tugurios (inner city tenements) and pueblos jovenes (squatter communities). Firm statistics are lacking, but a 1976 study reports more than 2.3 million people living in pueblos jovenes in 28 cities. Other studies suggest that at least 75% of Lima's population live in tugurios or pueblos jovenes.

Tugurios may be multi-story, multi-family houses; small, one- or two-room units off alleyways (callejones); or tenement-like structures built as rental accommodations. They are typically over-crowded, in deteriorating condition, and often with communal water and sanitary facilities.

By invading public and private land, migrants have built pueblos jovenes on the outskirts of cities. In contrast to tugurios, progressive improvement of living conditions has characterized these settlements. Largely through self-help development, temporary shelters lacking public services are often replaced by permanent dwellings with them. Population densities are low relative to inner city ones though increasing ("tugurization") in older settlements in the 1970's. Approved pueblos jovenes are eventually legitimized and the residents given title to their lots.

Rural

Rural houses are typically small with one or two rooms. Roofs are flat in dry Costa, gabled in Sierra; windows are often lacking. Kitchen may be separate low-roofed structure; cooking is often done over an open fire. Houses in rainforests of Selva are built of local materials and on stilts for protection from animals and flooding. Steeply pitched roofs of palm fronds allow run-off in heavy rains.

4.2 Materials and Construction

Five general kinds of traditional (non-engineered) structures are found throughout the country: adobe (sun-dried earthen bricks), quincha (wood frame with walls of mud-covered cane infill), tapial (rammed earth), unreinforced masonry (brick or block without proper reinforcing systems), and wooden houses (wood frame and timber, built by owner).

Despite the heavy structural and human losses in the 1970 earthquake, due to the primitive technology of traditional adobe construction, the low cost and climatic suitability of adobe accounts for its continued widespread use.* Although found in nearly every region except the jungle, adobe structures are concentrated in parts of the Sierra and along coastal river valleys where necessary adobe soils and bonding grasses are found. In coastal regions where the climate is dry and wood scarce, roofs of adobe houses may be flat (formed by laying a mesh of cane, bamboo mats, and mud over bamboo poles) or in southern coastal areas made of quincha (A-frame of mud plastered over a lattice work of bamboo and cane). Heavy rains in mountain areas make pitched roofs (usually 30° necessary; they may be 2-sided or 4-sided, tile or sod. In larger cities of the Sierra, corrugated metal and asbestos roofing are growing in popularity. In addition to tapial and adobe block structures in mountain regions, adobe with small stone coursing and, in the high Andes, stone wall houses are also seen. "Self-help" in adobe construction is usually limited to assisting a hired mason (albanil), though skilled albanils are decreasing in number. Adobe occupies a middle position in the housing hierarchy: more desirable than quincha in the coastal region or tapial in the Sierra but lower in value than brick or concrete block.

* An earthquake (6.6 on the Mercalli scale) in the area of Arequipa on February 16, 1979, caused slight damage to pueblos jovenes in Arequipa and extensive structural damage in the provinces of Condesuyos, Castilla, and Camana. In the town of Chuquibamba, for example, virtually all adobe buildings were damaged and in need of reconstruction with stronger materials. The towns of Aplao, Pompacolca, and Viraco reported similar damage.

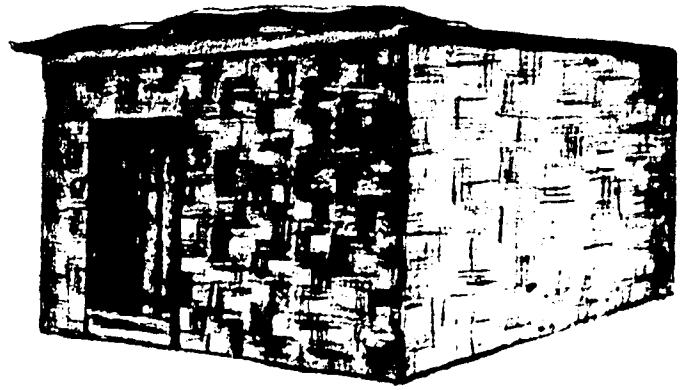
The vulnerability of adobe structures to earthquake damage in Peru is due to the country's generally inferior adobe (only a few regions have good adobe soils) and to dangerous building features such as high and heavy walls, heavy roofs, improper building configuration and balance, lack of reinforcement. Poor soil composition (high content of rock, clay, sand or, in coastal regions, salt), combined with inadequate stabilization and improper drying and curing of adobe accounts for its characteristic weaknesses: brittleness and susceptibility to erosion. Through research initiated by the GOP in 1971 some new techniques to reduce vulnerability of traditional structures have been developed but are not widely implemented. Among the developments is the promising use of asphalt as an effective adobe stabilizing agent, suitable for most regions. The introduction of stabilized adobe is expected to meet with resistance because of tradition, added cost, and problems of supply.

Peru produces nearly 95% of its own construction materials although difficult access to rainforests limits availability of lumber west of the Andes. An expensive though preferred technology for permanent buildings in coastal and mountain areas where seismic design criteria are needed is reinforced concrete skeleton frame (1979 A.I.D., Shelter Sector Assessment). Walls are of concrete block, fired tile or brick; reinforced fired tile is used for roofs and floors.

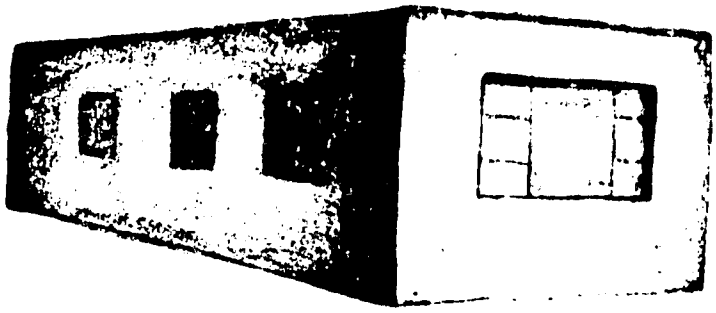
Temporary shelters in coastal regions made of cane mats ("esteras") stretched over wood poles are inexpensive and relatively long lasting in a dry climate but offer inadequate protection in winter.

Materials and technology standards are described as generally higher than income and climate justify. Several projects to test low-cost techniques for seismic zone construction have had mixed results. Taste and tradition are obstacles to innovation. The desired goal of many residents of pueblos jovenes is to acquire enough bricks, blocks ("materiales noble"), and steel to make a permanent room with concrete columns and beams regardless of cost.

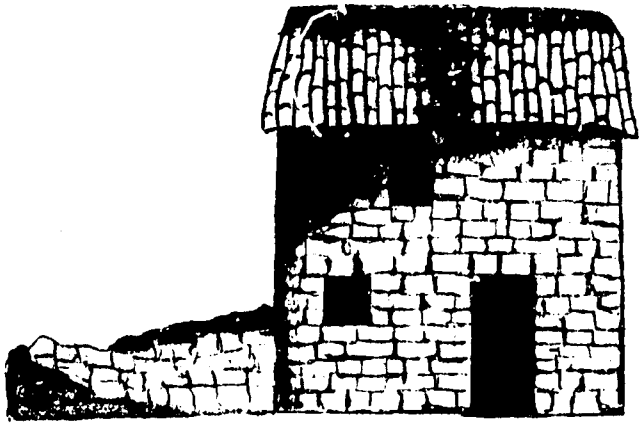
1972 census data: 56% of houses in Peru have roofs of permanent materials (14% concrete); 71% of urban houses have permanent roofs (25% concrete); 23% of houses countrywide, 38% of urban have walls of brick, concrete blocks, stone or reinforced concrete, with totals rising to 72% country-wide and 81% urban when adobe is included.



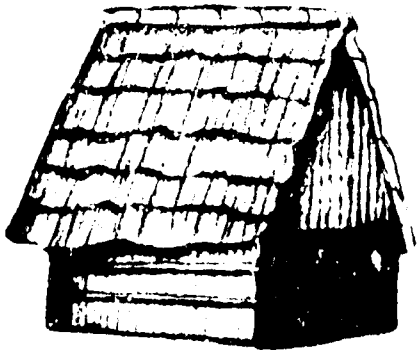
Temporary squatter shelter made of woven mats stretched over wooden poles.



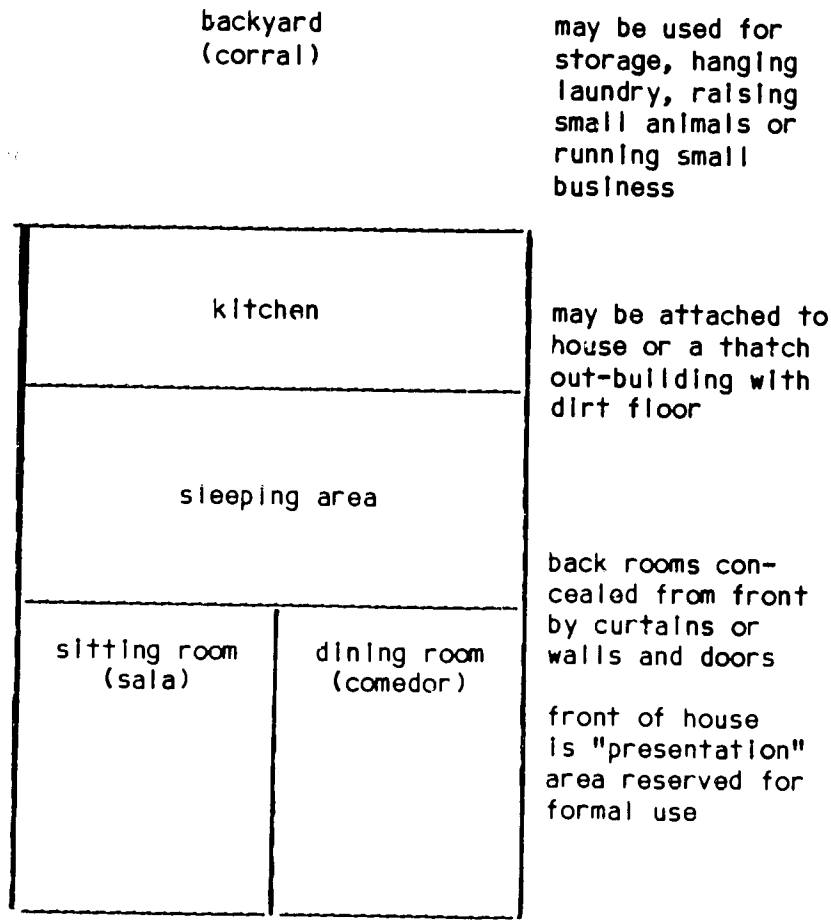
Flat roofed permanent dwelling in coastal pubelo joven.



House of adobe block or stone wall construction with burned tile roof found in mountain areas.



Jungle house of thatch.



Layout of self-built permanent dwelling in a pueblo joven shows division of front and back areas and reflects aspirations of settlers to better their living conditions and make improvements visible to neighbors and visitors. Front areas are finished first and furnished more elaborately than the private, informal family space in rear of house.

Suggested by description in AID Peru Shelter Sector Assessment, 1979, pp. 30-31.

4.3 Services

Urban and Rural Housing Without Basic Services by Region, 1977

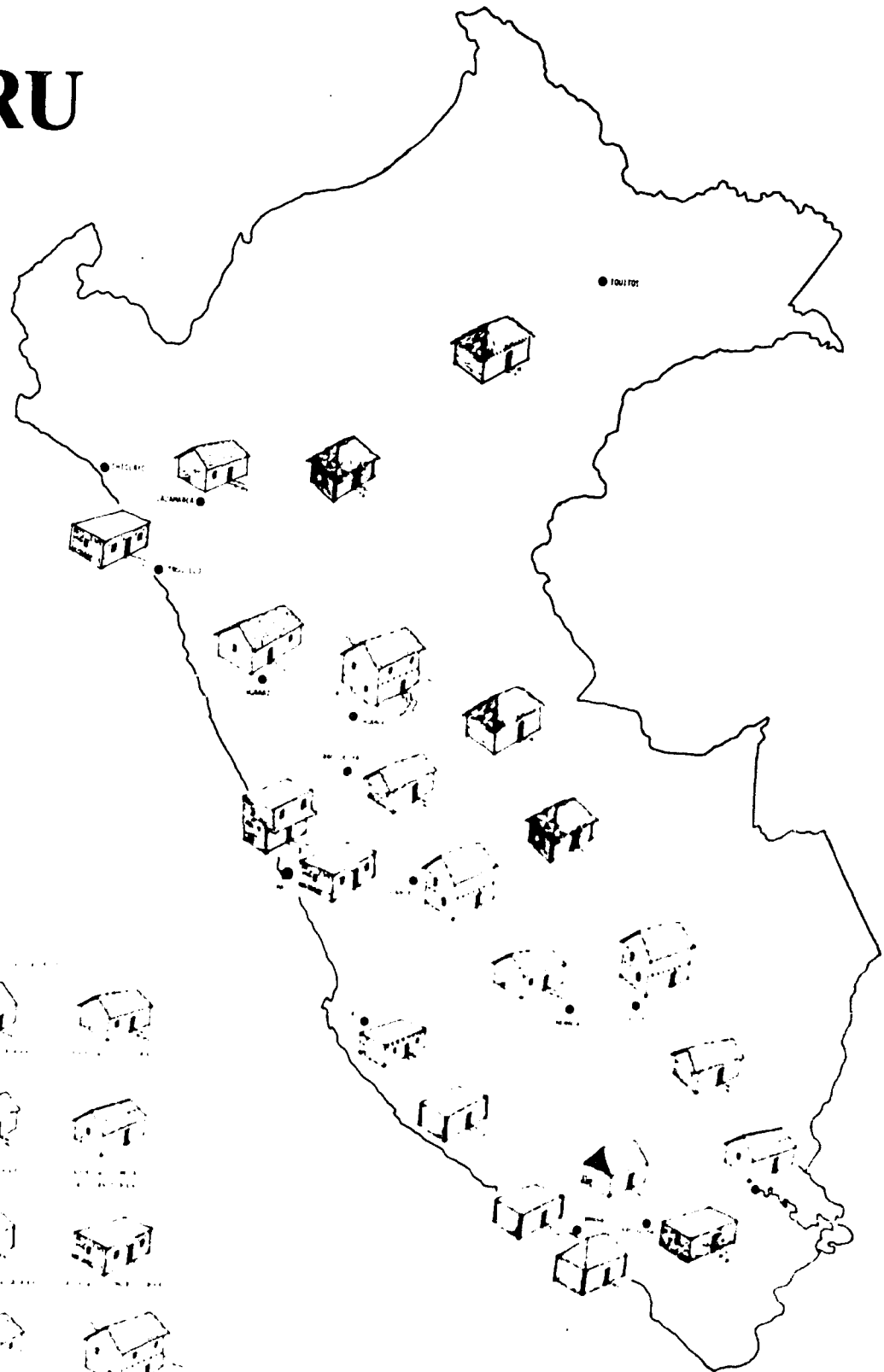
Regions	Total Housing Units 1977	Lacking Services		
		Water	Sewerage	Electricity
National	3,147,903	2,268,003	2,470,905	2,043,613
Urban	1,960,341	1,099,197	1,291,712	886,584
Rural	1,187,562	1,168,806	1,179,193	1,157,029
Coastal	1,812,813	1,064,753	1,200,012	896,627
Urban	1,468,461	729,776	860,141	571,352
Rural	344,352	334,977	339,872	325,275
Sierra	1,054,171	952,379	1,009,499	907,565
Urban	373,366	280,106	331,885	236,179
Rural	680,805	672,273	677,614	671,386
Selva	280,919	250,871	261,393	239,421
Urban	118,514	89,315	99,686	79,553
Rural	162,405	161,556	161,707	160,368

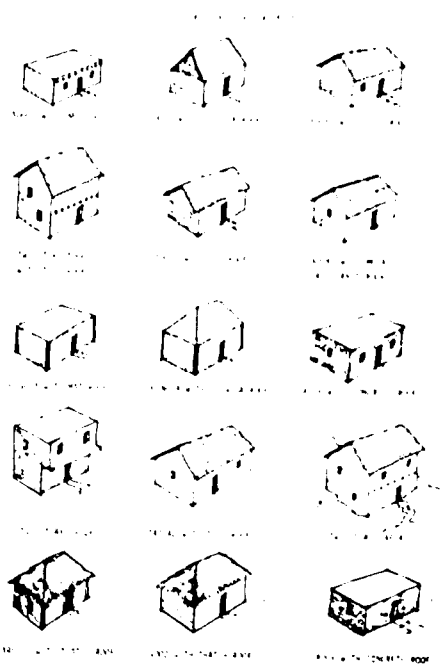
Source: BVP calculations based on 1972 National Housing Census as cited in AID, Peru Shelter Sector Assessment, February 1979.

Services are more likely to be available in urban areas than in rural, in urban areas as a whole than in squatter communities. In the latter, until infrastructure is provided, water of doubtful quality is delivered to each home by tank truck (often at exploitative rates) and stored in cisterns or barrels; kerosene lanterns and candles are used for lighting, kerosene stoves for cooking. Pit latrines provided in more crowded areas are the only sanitary service.

The water supply in Lima is from a central source, dependent on electricity for pumping. In the event of a major earthquake, the city water supply could be entirely cut off.

PERU





Prepared by: James Viets

INTERTECT

5. Bibliography

Agency for International Development. Office of Housing. Peru Shelter Sector Assessment. Washington, D.C.: AID, February 1979.

_____. Report on Peruvian "Pueblos Jovenes" and Possibilities for USAID IIPUP Technical Assistance. Washington, D.C.: AID, November 1979.

Cuny, Frederick C. Analysis of Potential for Housing Improvement in High Risk, Vulnerable Areas of Peru. Dallas: INTERTECT, April 1979.

_____. Analysis of the Potential for Housing Introduction of Stabilized Adobe in Peru. Dallas: INTERTECT. April 1979.

_____. Improvement of Adobe Houses in Peru: A Guide to Technical Considerations for Agencies. Dallas: INTERTECT. April 1979.

Foundation for Cooperative Housing International Inc. Final Report. Contract for Housing and Urban Development. Washington, D.C.: FCH, May 1979.

Thompson, Charlotte Louise. Reconstruction After A Natural Disaster in Latin America. Master's Degree Thesis. University of California, Los Angeles, 1974. (INTERTECT).

Thompson, Paul and Thompson, Charlotte. Preliminary Report on Post Disaster Housing in Peru. October 12, 1976.

U.S. Department of Housing and Urban Development, Office of International Affairs. Study of Alternative Housing Technologies for Seismic Areas of Peru. Washington, D.C.: HUD, January 1972.

World Bank. Appraisal of the Urban Sites and Services Development Project: Peru. Report No. 1065 a-PE. Washington, D.C.: IBRD, May 24, 1976.

_____. Peru: Long-term Development Issues. Vol. I: Postscript - Summary and Conclusion. Washington, D.C.: IBRD, April 1979.

_____. Peru: Long-term Development Issues. Vol. II: the Main Report. Washington, D.C.: IBRD, April 1979.

_____. Peru: Long-term Development Issues. Vol. III: Statistical Appendix. Washington, D.C.: IBRD, April 1979.

Disaster Mitigation for Low-cost Housing

1. Introduction

> Given the potential magnitude of seismic forces and general level of construction practices, it is not surprising that when an earthquake occurs, people are often safer in an open field than they are in buildings that are supposed to shelter them. Earthquakes rarely kill people, but buildings do--unless specific precautions are taken.[1]

Earthquake disasters throughout the world have taken more than one million lives in this century (not including the high toll in the China earthquake of July 1976). By far, the greatest number of victims were low-income people in developing countries. More than 80% of the deaths resulted from the collapse of small unreinforced adobe and masonry structures.[2] The heavy loss of life and property can be significantly reduced through improved building design and construction methods and by proper siting. Any attempt to establish guidelines, however, must take into consideration the cultural patterns and socio-economic conditions in developing countries as well as technical capabilities.

The need for a low-cost technology to reduce earthquake damage to structures is particularly great in many of the countries included in this housing profile, located as they are along major plate boundaries where seismic activity is frequent. While general principles in seismic design will be discussed in this paper, the focus will be on low-cost, earthquake-resistant construction.

2. Causes of Earthquake Damage

Four basic phenomena account for earthquake-induced damage: ground shaking, ground rupture in fault zones, ground failure, and tsunamis. A structure located astride a ground rupture in a fault zone would almost certainly be damaged by the resulting vertical or horizontal offset. Likewise, buildings may be destroyed as a result of ground failure which can take the form of landslides, earth lurch, settlement or liquefaction. In the latter condition, silty or sandy soils saturated with water lose their shear strength when subjected to vibration. Support systems such as water lines, sewers, transportation and communication lines are particularly liable to damage in ground failures. Tsunamis, high velocity seismic seawaves, can cause devastation in coastal communities.

[1] Architects and Earthquakes (Washington, D.C.), p.x, Introduction.

[2] Resa Razani, "Seismic Protection of Unreinforced Masonry and Adobe Low-Cost Housing in Less Developed Countries: Policy Issues and Design Criteria," p.1.

Most earthquake damage is caused by ground shaking, and it is the principal consideration in earthquake-resistant design. When the earth moves suddenly, seismic waves (body and surface waves) emanate from the source of disturbance, with surface objects responding to the resulting vibration. Such factors as earthquake location and depth of focus (most damaging earthquakes are at a shallow depth of less than 20 miles), length of fault break (major determinant in duration and magnitude of the earthquake), and local soil conditions (firm soils amplify ground vibrations less than soft soils, for example) have an effect on the extent of ground shaking.

Due to its geologic environment, Peru can serve as an example of a country in which all four earthquake-related phenomena are potential hazards. There was no observed surface faulting in the disastrous 1970 earthquake when the epicenter was located offshore; however, recent faults are widespread and there was surface faulting in the 1946 Ancash and the 1969 Pariahuanca earthquakes. Nor was there a tsunami in 1970, though tsunamis have accompanied previous earthquakes in Peru. The great destruction in 1970 was due principally to the poor performance of buildings (mainly poorly constructed adobe dwellings) in ground shaking and to the unstable terrain, which accounted for the massive loss of life in the Huascaran debris avalanche and for widespread damage from failure of geologic foundations in river valleys and coastal regions.

3. Effect of Earthquake on Structures

The characteristics of ground motion which particularly interest the architect or structural engineer are duration, amplitude of ground shaking, frequency and its division into vertical or horizontal components of motion. Buildings should be able to withstand extended periods of large amplitude ground motion without collapse.

Ground motion from seismic waves is transmitted to buildings through their foundations. The inertia of a building's mass resists motion applied to its base, thus creating inertial forces [F(force)=M(mass) times A (acceleration)]. The inertial forces, which exist in every component of the building, act in the direction opposite to that of ground motion. Vertical loads are normally provided for in building construction and are thus not considered in earthquake design; horizontal inertial forces must be provided for, however, in order to give a structure adequate lateral resistance.

The elastic properties and mass of structures cause them to develop vibratory motion when activated by dynamic stresses. In general, less deformable, rigid structures have shorter periods of vibration than flexible structures. It is important in seismic design to determine the

probable frequency of ground motion as well as the natural period (rate of oscillaiion) of the structure in order to avoid resonance which can occur, particularly in tall buildings with complex deflections, when ground motion coincides with the building's natural period.

The ability of a structure to withstand seismic stresses depends on its capacity to absorb or transfer the energy released in an earthquake. When a building is able to recover its original shape after deformation, it has remained within its elastic range of deformation. Beyond this range, in the inelastic or plastic range, fracturing can occur. Materials with a limited plastic range are "brittle;" those which can withstand considerable inelastic strain (absorb energy) are "ductile." Ductility depends on design as well as on materials.

The Earthquake Insurance Classification of the Pacific Fire Rating Bureau, USA, types buildings according to anticipated damage as summarized below:

Class	Relative Damage-ability	Structure
A I	1.0	Small wood-framed structures as dwellings, not over 300 sq m and three stories.
A II	1.5	One story, all steel. Single or multi-storied steel frame, fireproof concrete, exterior concrete panel walls, concrete floors and roof, moderate wall openings; otherwise Class A V.
A III	2.0	Single or multi-storied concrete frames, concrete floors, walls, and roofs, moderate wall openings, otherwise Class V.
A IV	4.0	Large wood frames and other wood frames not included in Class I.
A V	4.0	Single or multi-storied steel frames, unreinforced masonry exterior panel walls, concrete floors and roofs.

Class	Relative Damage-ability	Structure
A VI	5.0	As Class V but with reinforced concrete frames.
A VII reduced basic rate	5.0	Walls cast in place or precast reinforced concrete, reinforced blocks, or reinforced bricks with floors and/or roofs other than reinforced concrete (reinforcement must be adequate).
A VII	7.0	Buildings with unreinforced bearing walls with lime mortar and certain multi-storied steel or concrete structures with wood floors or unusually poor design features.
A VIII	Collapse hazards in moderate shocks	Bearing walls unreinforced above, hollow clay tiles or unreinforced hollow concrete blocks.
B Special rate	0.5 to 2.0	Buildings which can resist earthquake of 1906 type with minimum to slight property damage.

Note: 1) Category A buildings are generally without specific lateral force bracing systems.

2) Unfavorable foundation conditions and/or hazardous roof tanks can increase earthquake hazards considerably.

Source: "Building in Earthquake Areas." Overseas Building Notes. No. 143, April 1972.

4. Building to Resist Earthquake Forces: Siting

Assessing the seismic risk of a location for safe siting of structures involves consideration of many factors: e.g., presence of faults, history

of earthquake activity; geological conditions (record of landslides, ground settlement and warping, inundation by flooding or tsunami); physical properties of foundation soils (density, water content, shear strength, attenuation values). While generalizations concerning siting may be misleading, some comments can be made. Sites where there is a possibility of surface faulting, landslides, flooding or other hazards or where weak foundation conditions exist should be avoided if possible, or provision made in the design and construction of buildings for the mitigation of potential hazards. Structures sited in a seismic region must be constructed to withstand effects of strongest anticipated ground motion. When siting large structures, the failure of which could affect large numbers of people (dams, nuclear reactors, etc.), detailed geological-engineering studies of the area would be required.[1]

5. Building to Resist Earthquake Forces: Design

Lateral forces which are concentrated at roof and floor levels are transferred to other levels through vertical elements such as columns, producing critical shear and bending forces in these elements. Gravity load changes, caused by lateral drifting of the roof, add to bending. The use of lateral stiffening agents such as cross beams or walls acting in plane shear (those parallel to direction of ground motion) reduce drift, alter force distribution patterns.

In a shear wall system, a diaphragm (roof or floor acting as a horizontal beam) must be able to resist the inertia forces generated within it as well as a portion of those generated within the walls perpendicular to ground motion. A sheer wall must be able to resist its own inertia forces and those transferred to it. Proper connections between the two components are a third indispensable element.[2] Structures must be tied together so that components act as a single unit.

The choice of building shape is of critical importance in seismic design. The strongest configuration is a square, with rectangular shape acceptable if the proportion of long wall to short is 2.5:1. For uniform stress distribution, the structure should be balanced: parallel walls

1/ See Bolt, Geological Hazards, pp. 46-49.

2/ See A Methodology for Seismic Design and Construction of Single-Family Dwellings for a further discussion of how these components function.

approximately equal in weight, strength and height. Ideally, wall openings should match in parallel walls. The wings of buildings of irregular shape ("L", "T", or "U") may experience different movements, thus creating torsion (twisting around an axis). Failures are most common at points where wings connect. Torsion may also occur in a flexible section of a rectangular house with a stiff off-center. If a house must be built in an irregular configuration, a lightweight "crush" section between wings is recommended.

The observance of calculated separation distance between buildings is probably more important in high-rise than in low structures because of greater deformation in the former. The required distance between any two structures is determined by a formula based on calculated drift values. Even smaller structures should be far enough apart that people evacuating their homes in an earthquake would not be hit by debris from collapsing houses once they are outside.

The relationship between structural and nonstructural components must also be considered. While the effect of nonstructural elements on structural portions is most significant in cases where the former provide unexpected stiffness (e.g., non-bearing masonry walls, stair-framing), the horizontal displacement and shearing and racking action in structural elements due to drift may have a critical effect on nonstructural components and must be compensated for.[1] Such nonstructural additions as cantilevered balconies, cornices, parapets, railings create potential hazards unless properly anchored. Chimneys require special attention so that combustible material will not be near an earthquake-damaged flue.

Low-cost housing should be limited to one or two stories (preferably one in adobe construction) with floor and roof weight kept to a minimum. Low walls have the advantage of lighter weight and a lower center of gravity.

A building concept growing in acceptance in the United States, which may have applicability for developing countries, is earth-sheltered construction. Houses built partly underground are significantly more energy efficient than are those of conventional construction. While research to test the disaster resistant potential of such housing is limited, the advantages in such hazards as windstorms and fires appear obvious. Developers of earth-sheltered construction believe seismic performance would also be improved since underground structures would tend to move with ground motion rather than resisting it and creating inertial forces. As in other types of seismic construction, roofs would need firm anchoring,

1 Architects and Earthquakes, pp. 55-67.

and areas with unstable terrain or subject to flooding would be unsuitable building sites.

6. Building to Resist Earthquake Forces: Components and Critical Connections

While it is essential that the various parts of a building be adequately connected in order to provide structural integrity, each component requires attention in planning and construction to ensure satisfactory performance during an earthquake. The use of proper construction techniques is very important; poor building practices can undermine good design.

6.1 Foundations

A strong foundation can dampen earthquake effects. The following guidelines are suggested:

- Base of foundation should be below top soil and frost level (at least 45 cm).
- Foundations should not span both soft and hard ground.
- Foundations of separate wings should also be separate.
- Resisting walls of adobe buildings should rest on wall foundations extending above ground level to protect against moisture.
- Wall footings should be continuous with building tied into footings.
- Footing width should be 1.5 times wall thickness or at least 35 cm for single-story house.
- Water pipes and drains require special attention to avoid escape of water into foundation soil during an earthquake.
- Care must be taken in backfilling building and sewer excavations to prevent earth settlement adjacent to building.

6.2 Walls and Openings

Unreinforced bearing walls of masonry and adobe, in such common use in many developing countries, are particularly susceptible to earthquake damage, the failure being due to racking shear (initiated by cracks at points of high stress such as corners of openings), out-of-plane bending from transverse forces, or a combination of both. Faulty connection between roof and walls and walls and foundations is another cause of failure. Filler walls within load-bearing frames have the same structural weakness.

The use of stabilized adobe and locally available reinforcing materials (e.g., split cane, bamboo, wire mesh) can significantly improve seismic resistance of adobe walls. The extension of reinforcement into adjacent walls and foundations provides structural unity.[1]

Walls can be strengthened, too, by the use of a ring beam to tie walls together, thus preventing tensile cracking at upper corners.

Wall openings, which require effective reinforcement to prevent failure of adjacent piers, should be kept small and a minimum of one meter away from corners and from each other. (See illustration.) Ideally, doors should open to outside to allow quick evacuation of buildings in an earthquake.

Care must be taken to avoid damaging structural members (columns, walls, slabs) in the installation of piping.

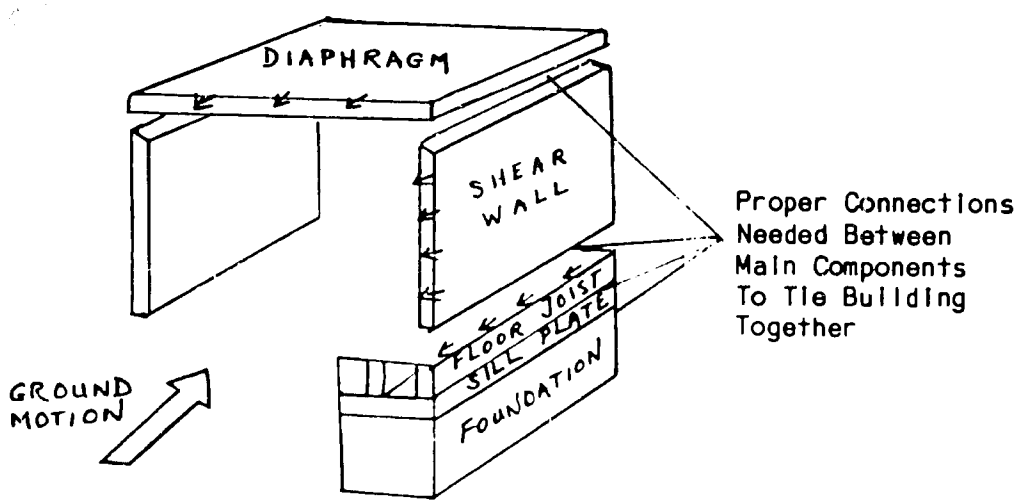
6.3 Roofs and Upper Floors

The collapse of heavy roof systems in earthquake-damaged houses is a major cause of death and injury. Failure may be due to insufficient strength, inadequate connections, or rupture of supporting walls or columns. The system's configuration determines the type of failure. The rupture of the bottom chord in a roof truss, for example, may cause walls to fall outward. On the other hand, the separation of abutting walls can result from the failure of a roof to act an a unit and to transfer loads to lateral (shear) walls. (See illustration.) The roof or floor elements must be provided with sufficient in-plane stiffness to enable them to act with diaphragm action in transferring lateral forces.

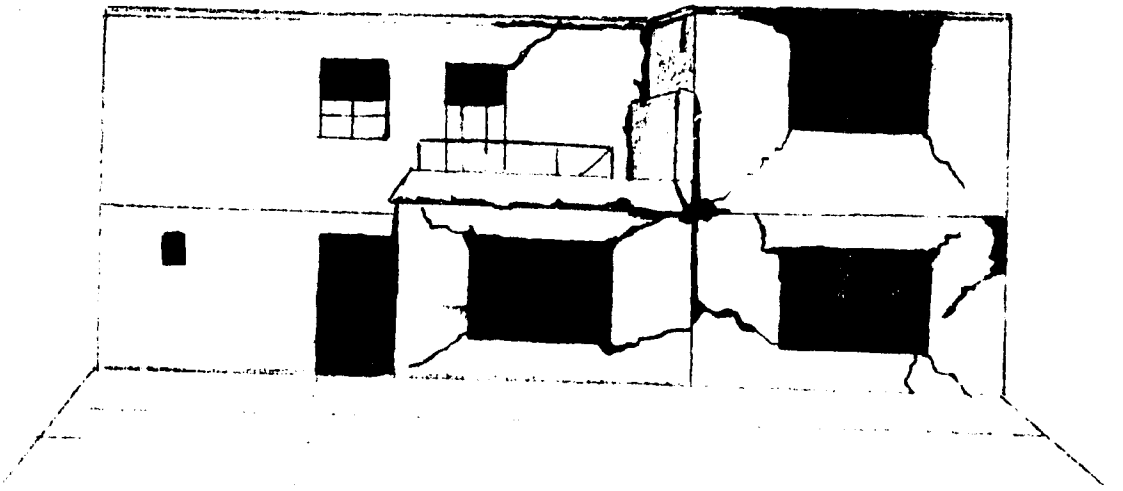
The substitution of lightweight roofing material (e.g., lightweight panel systems, corrugated asbestos sheeting, corrugated metal, grass or palm leaves) in low-cost housing for the commonly used tile or mud can greatly improve a building's seismic performance. A four-sided roof also offers advantages: the trusses more evenly distribute the weight of roof and earthquake forces; it requires less reinforcing and thus can be lighter; it eliminates need for a gable, which is a dangerous feature if not built of lightweight material. All trusses should rest on the ring beam (not on the walls themselves) and be properly bolted.[2]

[1] Three methods of reinforcing adobe walls (a reinforced concrete system, the Modern Adobe System, and a cross-brace system) are discussed in detail by Frederick C. Cuny in Improvement of Adobe Houses in Peru.

[2] Cuny, pp. 23-24.

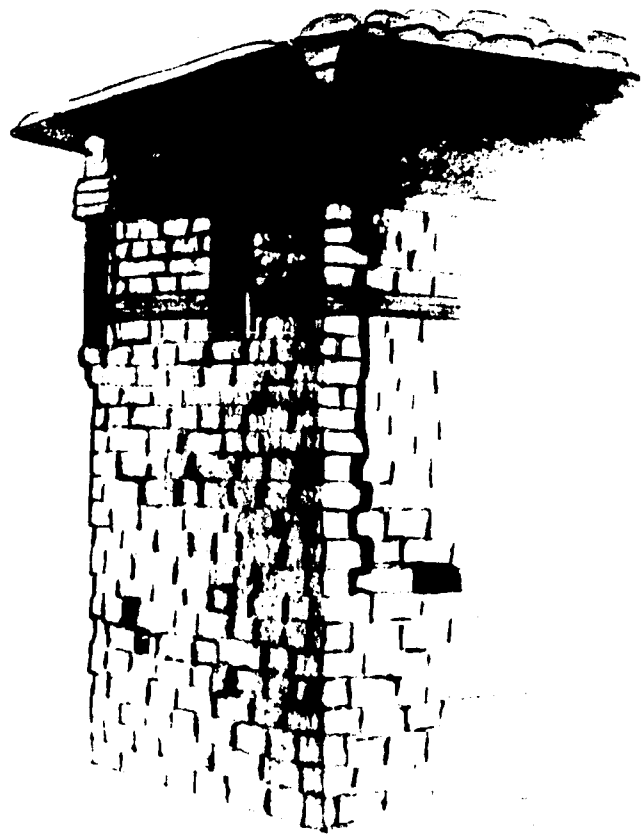


It is necessary in a lateral load-resisting system to use proper connections in order to transfer load through diaphragm, from the diaphragm to the wall, down through the wall by means of proper nailing of shear-resisting materials, proper connections of sill plates at the base and, when required, installation of hold-down anchors and proper reinforcing in footings. (A Methodology for Seismic Design and Construction of Single-Family Dwellings.)



To prevent this type of damage, wall openings should be smaller, better reinforced at corners; adequate tie-beams and sufficiently long lintels are required; connections between roof, wall, and floor levels must be stronger.

Source: Design, Siting, and Construction of Low-Cost Housing and Community Buildings to Better Withstand Earthquakes and Windstorms, p. 16.
(Drawing after photograph)



During an earthquake, roof fails to act as a unit and does not transfer loads to lateral (shear) walls. Instead, the frontal wall (with openings) receives roof thrust, separating it from lateral walls.

Source: Design, Siting, and Construction of Low-Cost Housing and Community Buildings to Better Withstand Earthquakes and Windstorms, p. 19.
(Drawing after photograph)

7. Building to Resist Earthquake Forces: Materials

As indicated above, different materials behave differently in the inelastic range. Ductile materials such as steel can undergo considerable permanent deformation without breaking. Such brittle materials as brick, glass and unreinforced concrete, on the other hand, experience sudden failure at or near the elastic limit. Seismic performance is improved by reinforcement of brittle materials and the use of ductile connections.

A lack of quality control in the manufacture of building materials (much of which is done on site) is often a problem in developing countries.

7.1 Concrete

Concrete is versatile, durable and fire-resistant, but it is weak in tension and therefore requires reinforcement with such materials as steel, fiberglass or bamboo. Steel rods, which are capable of absorbing tensile stresses, function particularly well with concrete. Care must be taken to see that reinforcements are properly positioned and anchored. Concrete should be thoroughly mixed in a special mixer, never on a soil face, and properly dried and cured. A main cause of failure of reinforced concrete members in an earthquake is the poor execution of concrete joints. Concrete joints should be located as specified (based on stress analysis) and kept clean during construction.

7.2 Masonry

Because of its low tensile strength, masonry (brick, stone) needs reinforcement. Mortars must be durable, especially in structures subject to extreme cold or structural stresses. Masonry walls should be securely tied to the reinforced concrete confining frames. A better anchorage is formed if the masonry wall is built before the columns and tie beam are concreted. Some common causes of masonry failure:[1]

- Excessive sagging (more than one thirtieth of thickness).
- Poor quality of mortar; carelessness in curing.

[1] Low-Cost Construction Resistant to Earthquakes and Hurricanes, pp. 104-105.

- Unsuitable bricklaying techniques.
- Incomplete filling between bricks.
- Use of fragile, poorly baked bricks.
- Improper arrangement of bond and placement of bricks.
- Failure to meet specifications for fastenings and separations between masonry and main structure.

7.3 Soil

The low cost and ready availability of natural earth account for its widespread use in many developing countries. A major weakness of adobe, its lack of moisture resistance, can be at least partly overcome by the use of high foundations, eaves, stucco covering and stabilization, the latter an important breakthrough in improving the durability of adobe blocks and bricks. The kind of asphalt used in stabilization is determined by the type of soil. Generally, those with sand and/or silt content of more than 45% are not suitable for reinforcement. Main construction faults affecting stability of adobe houses:[1]

- Poor adobe-making technique.
- Use of insufficiently dried adobe.
- Incomplete covering in horizontal layer and incomplete fill of vertical joints between blocks.
- Poor geometrical quality of the walls.
- Poor interlocking at wall intersections and lack of proper fastening.
- Walls built too rapidly (the maximum vertical rate should be one meter per day).
- Failure to lay courses along the whole contour of the walls (instead of in isolated panels), thus causing possible differential settlement.
- Lack of continuity in timber tie beams.
- Poor execution of wall coverings.

7.4 Wood

Wood has good strength in both tension and compression, making it especially suitable for construction of bending-resisting elements. Among its many uses: wood joists and plywood panels for roofs and floors, sand-

[1] Ibid., p. 110.

wich panels for exterior walls. It is not readily available, however, in all areas (e.g., coastal Peru) and, thus may be costly. Alternatives such as raw timber, cane, bamboo, palm or thatch may be substituted for some purposes. Protection is needed against moisture, fire and insects.

7.5 Metals

With high strength, stiffness and ductility, steel is widely used, as bars and wire mesh, for reinforcing concrete and masonry. Other uses of metals in low-cost construction include corrugated sheet metal of galvanized steel or aluminum for lightweight roofing and siding; steel connectors for bolting and anchoring; rods and cables for bracing.

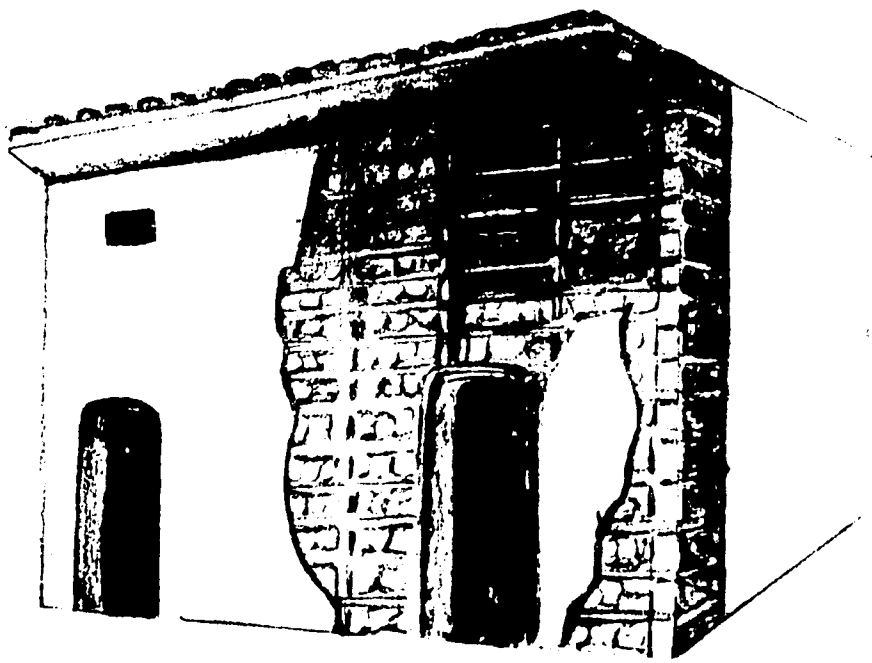
8. Building Codes

Progress in the development and implementation of low-cost, earthquake-resistant housing requires continued action in the areas of finance, design and construction, and education. Needed, too, is improvement and better enforcement of building codes in many earthquake-prone countries. The lack of feasible codes can often be attributed to the following problems:[1]

- Technical design limits are not known due to lack of study of local materials and construction systems.
- Geological and soil conditions have not have been adequately studied.
- Seismic records may not be available.
- A reliable system of inspection and enforcement may be lacking.

Building codes must be compatible with local conditions (which may vary from region to region within a country) and with local capabilities if widespread evasion is to be avoided.

[1] Design, Siting, and Construction of Low-Cost Housing and Community Buildings to Better Withstand Earthquakes and Windstorms, pp. 89-93.



Building facade showing traditional taquezal construction. The severe damage suffered by this type of construction in the 1972 Managua earthquake resulted in great loss of life.

Multistory building under construction in Bogota, Colombia. This appears to be of a type of construction, common in many countries of Latin America, in which non-structural masonry walls and partitions are enclosed within a reinforced concrete structural frame. Although the integrity of this particular building cannot be assessed from a photo alone, the type of construction described is vulnerable to earthquake damage. (Photo by Oliver Davidson, Regional Preparedness Officer - Latin America and the Caribbean, US Office of Foreign Disaster Assistance.)

Street and buildings in Quito, Ecuador. The building with balcony cantilever slabs (second from right side of photo) appears to be of a common construction type in which a reinforced concrete structural frame confines non-structural masonry walls and partitions. The building on the left appears to be of another type of construction common in Latin America, characterized by a wood frame covered with adobe for walls and partitions and wood-framed second floor and roof structure. Both types of construction have suffered severe earthquake damage in the past. (The integrity of these buildings, which depends on many factors, cannot be assessed from the photo alone.) (Photo by Oliver Davidson, Regional Preparedness Officer - Latin America and the Caribbean, US Office of Foreign Disaster Assistance.)

9. Bibliography

Bolt, B.A. et al. Geological Hazards. Revised 2nd. edition. New York: Springer-Verlag, 1977.

"Building in Earthquake Areas." Overseas Building Notes. No. 143, April 1972. (INTERTECT).

Center for Planning and Development Research. Earthquake Advisory Services: A Prototype Development Project. Final Report. Berkeley: University of California, 1980.

Cuny, Frederick C. Improvement of Adobe Houses in Peru: A Guide to Technical Considerations for Agencies. Dallas: INTERTECT, April 1979.

Fattal, S.G. "Use of Stabilized Adobe Blocks and Cane in Contstruction of Low-cost Housing in Peru." Washington, D.C.: National Bureau of Standards. Structure Section Center for Building Technology, IAT. May 1979. (INTERTECT).

INTERTECT. Earthquake Design Criteria. Dallas: INTERTECT.

National Science Foundation. AIA Research Corporation. Architects and Earthquakes. Washington, D.C.: GPO, 1975.

_____. Designing for Earthquakes. Proceedings from the 1978 Summer Seismic Institute for Architectural Faculty, September 1979.

Razani, Reza. "Seismic Protection of Unreinforced Masonry and Adobe Low-Cost Housing in Less Developed Countries: Policy Issues and Design Criteria." Paper Submitted at International Conference on Disasters and Small Dwellings, Oxford U.K., April 19-21, 1978. Oxford: Oxford Polytechnic Institute. (INTERTECT).

United Nations. Department of Economic and Social Affairs. Low-Cost Construction Resistant to Earthquakes and Hurricanes. New York: UN, 1975.

U.S. Department of Commerce. National Bureau of Standards. Design, Siting, and Construction of Low-Cost Housing and Community Buildings to Better Withstand Earthquakes and Windstorms. Building Science Series 48. Washington, D.C.: GPO, January 1974.

U.S. Department of Housing and Urban Development. Office of Development and Research. A Methodology for Seismic Design and Construction of Single-Family Dwellings. Washington, D.C.: HUD, September 1976.

1. Introduction

Tropical cyclone damage to low income housing has been especially severe in the Caribbean and Central America. In the Dominican Republic alone, after 1979's Hurricane David and Tropical Storm Frederic, housing losses were estimated at over 80 million pesos, with 100,000 houses affected. Such losses can be significantly reduced through the application of wind resistant building technology. The effect of high winds on common housing types and methods to increase wind resistance are considered in this section.

2. Causes of Wind Damage

Winds damage or destroy houses in two ways: roof uplift and forces on the walls. Most of the damage is due to the roof lifting off from the walls. Structural damage occurs when the connection between the roof and walls is strong, but not strong enough to keep the roof from separating. In cases when the connection between roof and walls is weak, no more structural damage occurs. Three types of forces cause roof uplift:

1) A lift force occurs when the wind strikes the house and separates to flow around and over the house. The air moving over the roof moves faster than the air moving around the structure, creating suction. This suction pulls the roof upward. At the same time, the inside of the house remains relatively airtight, resulting in a constant air pressure inside the house. This inside pressure is considered positive compared to the negative air pressure of the flowing air outside. The pull of the negative pressure and the push of the positive pressure causes roof uplift.

2) A lift force also occurs when the wind strikes a wall and is deflected upward. If there is a roof overhang, pressure is placed on the edge of the roof, prying the roof away from the wall.

3) A lift force can occur if wind enters the house through open doors or windows and pushes up from the inside. This force may add to the forces already created by positive pressure within the structure, or to the forces pushing upward on the edges of the roof.

Wall failure in a house can be caused by three types of forces:

1) Differential pressure, created by winds rushing around the structure (negative) and the pressure (positive) on the inside of the house. Eventually the pressure differential will cause the collapse of the walls.

2) Horizontal displacement, caused by winds pushing on the windward side and pulling from the leeward side, moves the building relative to its position on the foundation. Wooden houses are most likely to be damaged under these conditions.

3) Failure of the wall on the windward side due to extreme wind forces often occurs. Unreinforced block or rock structures are most vulnerable to this type of damage.

3. Effect of Wind on Structures

The ability of a structure to withstand wind stress depends more on the manner of construction than the materials used. Concrete block houses are not automatically more wind resistant than those of wood or wattle-and-daub. The factors that determine how well a house will withstand wind are as follows:

Configuration of the Roof

Gabled roofs allow the wind to pass evenly over the surface, creating undisturbed lift, which pulls the roof off the walls.

Pitch or Angle of the Roof

Houses with low pitched roofs (0°-30°) create lift on top of the roof, which lifts the roof off the house. At an angle of over 45° the windward face of the roof is exposed to excessive pressure, which cannot be borne without extensive reinforcement.

Configuration of the House

L-shaped houses are most vulnerable, because wind is channelled into the juncture between the two wings and also because winds striking the house from the other sides can create a racking effect, which causes the structure to collapse inward. When houses have open or half open porches, high winds can be deflected upward and lift the roof off.

Siting of a House

The vulnerability of a structure is determined to a large extent by its siting. Houses built on stilts on hillsides close to the coastline and those situated in long narrow valleys are especially vulnerable. Also, houses built in long straight lines close together in a grid layout (as is much government housing) are subject to the "funnel effect" during hurricanes.

Strength of Critical Connections

The strength of the following critical points of a house will also determine the extent of damage caused by high winds:

- Roof Material-Roof Frame Connection. Roof material which is not securely fastened is likely to be pried off by high winds. If the material is corrugated metal sheeting, then an additional threat is posed by the flying debris.

- Roof-Wall Connection. Two factors influence the vulnerability of this connection. An unsealed roof overhang of 46 cm. or more invites roof uplift forces. Also, if the roof frame is not attached securely to the walls, high winds can easily remove the roof.

- Wall-Wall Connection. Because of the differential pressure exerted on a house during a hurricane, the walls are often pulled apart at unbraced corners.

- House-Ground Connection. When vertical columns or posts are not anchored to the ground or not set deeply enough, high winds can completely destroy a house. Untreated posts or foundations are vulnerable to insects and fungi; this deterioration decreases wind resistance.

Strength of Components

Roof - unreinforced roof frames cannot support pressure from high winds.

Wall -Improperly bonded and reinforced walls often collapse in high winds.

Air Vents, Doors and Windows

Air vents - transoms (air vents at the tops of doors or windows, used in tropical climates to increase interior circulation) allow the entry of wind during a hurricane. The wind adds to the interior pressure, causing the house to collapse.

Doors and windows - louvered or unprotected glass doors and windows allow wind to enter the house during a hurricane, increasing the outward pressure on the walls and roof.

Although the material used in construction of a house is not the main determinant of wind resistance, certain failures during hurricanes can be attributed to material characteristics. The performance of wattle and daub, wood frame with palm board siding, wood frame with sawn board siding, slip form concrete and concrete block houses with corrugated metal roofs under extreme wind conditions is summarized in the following section.

Wattle and daub

A wood frame is erected, and bamboo or cane is woven between the vertical columns to use as a base for the application of a mud plaster to both sides of the walls. Occasionally, the wall is finished with an exterior application of a cement-sand plaster or lime wash. Roofs are prepared from grass, or, more recently, corrugated iron sheeting.

Hurricane damage results from the collapse of walls due to lack of reinforcement and deterioration of wood at the ground level. The primary damage sustained is separation of roof from walls, caused by uplift on the roof's surface as well as uplift under the eaves.

Wood Frame with Palm Board Siding

Side framing made from the outer surfaces of palm trees is nailed to a wood frame. Gable roofs predominate, although a truss system is sometimes used. Transoms are common.

These buildings tend to be weakest at the connections between:

- the roof sheeting and the roof truss,
- the roof system and the walls,
- the siding material and the walls, and
- the vertical posts and the ground.

Wood Frame with Sawn Board Siding

Board siding is nailed onto a wooden frame. A gabled roof is generally used. There are many variations in the configuration of these houses.

Roof separation, roof sheeting separation and displacements caused by lack of wall reinforcement are common hurricane-induced failures. Louvered windows, associated with this type of construction, increase the differential pressure pushing out on the walls until portions of the walls separate at the corners. Insufficient anchorage may result in the building's being lifted off the ground and toppled over. (Many wood frame houses rest on concrete slabs and are anchored only by the extension of the corner posts into the soil.)

Slip-Form Concrete

Slip-form concrete houses are constructed on a wooden frame with columns placed approximately 1 1/2 meters apart. Wide boards are attached to each side of two parallel columns and concrete is poured between the two boards. As soon as the concrete begins to set, the boards are moved upwards and another layer of concrete is poured. This continues until the entire wall is completed.

The lateral resistance and strength of the walls is often increased by barbed wire cross brace reinforcement. Gabled corrugated iron roofs are usual, although grass or palm leaf roofs are occasionally used.

Hurricane damage includes: separation of the roof from the walls (because of weak roof frame-wall connection); failure of the gables and failure of the walls (due to separation of the concrete from the wooden columns). Post-hurricane studies show a high percentage of explosive damage (due partially to the presence of louvered windows and transoms).

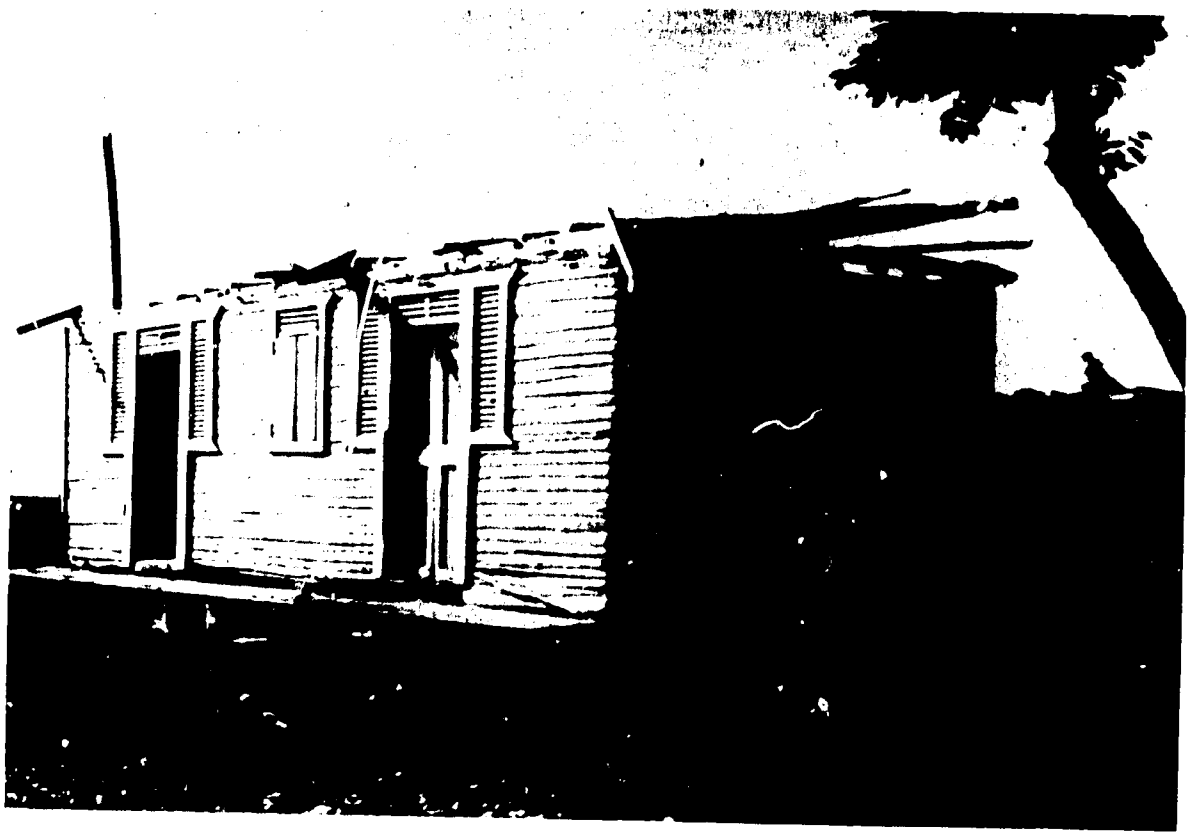
Concrete Block with Corrugated Metal Roofs

When properly reinforced, concrete block is one of the most resistant materials.

Roofing is generally made of corrugated iron sheeting placed on a wood frame, attached to a wood frame system and tied to the walls by bending a portion of the iron used in reinforcing the concrete column or ring beam around the base of the truss. Roofs are almost always gabled.

Separation of the roof from the wall (due to poor connection of the roof truss to the wall) and collapse of walls (due to unreinforced or poorly reinforced walls) are the principal types of hurricane damage to

concrete block houses. The porches characteristic of this housing style permit excessive amounts of wind to create uplift under the gable end of the house, lifting the roof off the structure. False facades, also typical of concrete block housing, are susceptible to high wind damage. In extreme cases, end walls can be pulled away, precipitating the collapse of the entire structure.



Roof Damage Sustained by Rural House in the Dominican Republic. (Photo by Aaron Benjamin, USAID Urban Development Officer, Santo Domingo.)

4. Building to Resist Wind Forces: Siting

Good site location or orientation in terms of local topography and natural cover can be determined to some degree from historical wind data that give the frequency, velocity, and direction of the prevailing or predominant wind. This information can be utilized to locate building sites and position individual dwelling units to minimize the hazard from wind. Wind damage may be minimized by staggering houses (to avoid the "funnel effect" created by grid layouts) and taking advantage of natural windbreaks (such as landforms or stands of trees). Houses should not be sited on hillsides near the coast (especially if they are on stilts), as high winds can be deflected up the side of the hill.

5. Building to Resist Wind Forces: Design

Configuration of the Roof

A hip roof configuration reduces the uplift force caused by extreme winds. Gabled roof designs should be avoided. (See photo at end of "Building to Resist Wind Forces" for illustration of a hip roof.)

Pitch or Angle of the Roof

Roofs should be built with a pitch of 30°-45° to most effectively resist wind.

Configuration of House

When expected wind loads are high, the selection of a housing configuration which permits as direct a stress path as possible is recommended. The preferred length-to-width ratio is 3:1 or less. Long rectangular and L-shaped house plans should be avoided, since they are especially vulnerable to high wind damage. Porches or elaborate facades should not be constructed. If cultural preferences dictate the addition of a porch, one that can blow off without damaging the rest of the house should be designed.

6. Building to Resist Wind Forces: Components and Critical Connections

Roof

Framing for the roof involves the use of either trusses or a rafter and joist system. Trusses are fabricated with metal plate connectors or bolted joints. In some larger structures, split-ring connectors are used. Trusses generally are made from an engineered design and under controlled conditions, so they have less potential for failure than the conventional rafter-and-joist system.

Where rafters are used, some type of collar tie is important to keep the roof from dividing at the peak. Ceiling joists, well nailed or bolted to rafters, prevent the roof from spreading outward. Purlins are connected to rafters or trusses in several ways. Nailed joints are among the most vulnerable because in this application the nail is loaded in direct withdrawal. Short boards nailed to the purlin and the rafter provide a stronger joint by loading the nails laterally.

Walls

A properly bonded and reinforced wall can best resist high winds. For wooden walls, siding must be securely nailed to the frame and vertical columns must be closely spread to reinforce it. In constructing concrete block walls, vertical columns, ring beams and binding mortar should be incorporated. In order to reduce collapse of the walls, diagonal bracing (X-bracing) should be utilized at the corners, especially in houses constructed of wood, wattle and daub or slip form concrete.

Air Vents, Doors and Windows

Sheltered or battened air vents, doors and windows can prevent damage caused by wind penetration.

Foundations

The damaging effects of storm surges or floods on the foundation itself may be avoided by providing adequate foundation materials whose properties do not deteriorate under the prolonged action of water. If the foundation is constructed of soil, mortar, and stone, a stabilizing ingredient can be added which will improve its resistance to water damage.

Inexpensive protective banks or pole-type foundations may serve to protect the building from severe storm surges.

Roof Material - Roof Frame Connection

Metal sheet roofing should be of appropriate thicknesses. The quality of fasteners should be adequate. For example, by simply doubling the number of nails used to hold roofing in place, the probability of sheets blowing off in high winds can be reduced substantially. In general, nails resist or transmit smaller loads than screws, and screws resist or transmit smaller loads than bolts or lug screws. One method of tying roofing to purlins is the use of sheet metal straps. One end of a strap is bent at a 90° angle, and the bent portion is riveted to the roofing. The strap is nailed to the side of the purlin and bent under the purlin. The attachment of the strap to only one side of the purlin results in an unsymmetrical load so the strap can be twisted off by wind forces. Two straps riveted to the roofing on both sides of the purlin and lapped under the purlin would resist forces due to movement in the connector.

If roofing has not been anchored, and a storm is predicted, wind storm anchorage kits (consisting of fiber nets thrown over the building and anchored to the ground or anchorage cables) can be utilized.

Roof - Wall Connection

Since, in present tropical construction, the most frequent failure caused by high winds is the loss of roofs, this juncture is particularly important. A roof overhang of less than 46 cm. (18") with a barrier that prevents air from being trapped under the eave of the roof substantially reduces the uplift forces on the edge of the roof. Anchors for the ring beam and metal straps should be used to reinforce the connection. It should be recognized that improved design which holds the roof securely will ultimately result in the concentration of greater loads in other parts of the building. Details of wall construction and anchorage to the foundation which were adequate when roof failure relieved the total load on the building, may not be adequate when the roof remains intact. The building will be subjected to a large overturning movement as well as to uplift load on walls.

Wall - Wall Connection

A diagonal brace at the tops of corners can counter the effect of the differential pressure.

House - Ground Connection

For wooden houses or structures that use wooden vertical columns, the posts should be set deeply into the ground and should have some form of anchoring device at the base. The wood should be pre-treated to resist insects and moisture. Concrete block houses should have a strong moisture proof foundation. The vertical column iron rods should be securely anchored in the foundation.

7. Building to Resist Wind Forces: Materials

The guidelines set forth in this section are derived from the INTERTECT publication, Introduction to Wind Resistant Housing.

Wattle and daub

In order to improve the structural performance of this type of house, the following actions are recommended:

- All wooden parts of the house in contact with the ground should be treated.
- The primary columns (corners and columns in the middle of each wall) should be buried a minimum of 18" (46 cm) and should use some form of anchoring device.
- Diagonal or cross-braces should be added between all the primary columns of the building, especially in the corners.
- The roof-wall connection should be strengthened by using metal straps to help bind the roof to the wall, especially at the vertical columns.

The hurricane resistant potential of this type of structure, if properly built and reinforced, would be moderate. Structural performance can be improved, although, due to the type of construction, the building cannot be made airtight or sufficiently strong to withstand extremely

high winds (over 100 mph), and structural damage can still be expected. If all the basic rules are followed, however, a substantial improvement in the performance in high winds will be attainable.

Wood Frame with Palm Board or Sawn Board Siding

- Use a hip roof configuration, rather than a gable roof.
- Use more nails to secure the iron sheeting to the roof frame.
- Use metal straps to help secure the roof frame or truss to the walls.
- Keep all overhangs to 18" (46 cm) or less.
- Close in the overhang with a wooden eave.
- Add diagonal or cross-braces to the wall frame, especially in the corners.
- Place additional stiffeners vertically to help reinforce the siding.
- Build shutters to close off the transom in high winds.
- Treat all wood that is placed in or on the ground with preservative to reduce deterioration.
- Anchor the vertical columns and place them in a minimum of 18" (46 cm) into the ground.

If the above recommendations are carried out, the potential for this type of structure to resist high winds will be substantially increased. If properly built, this type of structure will provide moderate safety in hurricanes.

Slip Form Concrete

The following actions are recommended to improve structural performance in high winds:

- Use a hip configuration for the roof.
- Use a truss system for the roof, rather than a frame system.

- Use more nails to secure the metal sheets to the roof trusses.
- Tie the roof trusses to the ring beam by use of metal straps, giving special attention to the corners.
- Seal the eaves of the structure to reduce uplift under the overhang.
- In structures that do not use barbed wire cross-bracing, it is recommended that, at a minimum, barbed wire be used. If possible, it is recommended that chicken wire be used for additional strength between the wooden columns.
- Use shutters to help close off louvered windows during periods of high winds.
- Treat wooden posts before placing them into the ground.
- Use anchors at the base of all posts in the ground, and bury the posts to a minimum of 18" (46 cm).

If the above recommendations are carried out, the wind resistant potential of slip-form concrete structures will be substantially increased. If properly reinforced, this type of building can offer good wind resistance.

Concrete Block

In order to improve the structural performance of concrete block housing in high winds, the following actions are recommended:

- Use a hip configuration for the roof.
- Use a roof pitch between 30°-45°.
- Increase the number of nails used to attach the metal sheets to the roof frame.
- Seal off the eave of the roof and reduce the overhang to less than 18" (46 cm).
- Fasten the wooden roof truss more securely to the ring beam of the walls by using special anchors, and double the number of anchors on each connection.

- Use one horizontal ring beam in the middle of the wall.
- Use vertical reinforced concrete columns at an interval no greater than 2 1/2 meters between columns.
- Use shutters on the outside of all louvered windows.
- Design front porches on structures such as "A" and "B" above so that they are structurally independent of the roof, thereby reducing the chance of uplift under the porch removing the entire roof.
- Use porches such as those illustrated in "C" and "D" above only on concrete block houses that use concrete slab for the entire roof.

If the recommendations outlined above are incorporated into the design of concrete block houses, the wind resistant potential of the structures will be excellent and only minor damage should occur in wind storms.

8. Building to Resist Wind Forces: Building Codes

Some of the building codes in use that take into account hurricane force winds for buildings and structures are listed below. These codes range from "specification" type codes which specify and detail every operation, to "performance" type codes which give the desired end product or loading the structure should withstand, but do not tell how it is to be accomplished. None of the Latin American countries considered have adopted building codes which incorporate wind resistance standards.

The Uniform Building Code of the International Conference of Building Officials, USA

The National Building Code of the American Insurance Association, USA.

The South Florida Building Code

The Bahamas Building Code

The Japanese Building Code

Southern Standard Building Code of the Southern Building Code Congress, USA

A building code is a legal document for the public safety and well being, generally stating minimum standards. (Thus it does not cover every eventuality.) Without enforcement, the adoption of a code is of no value.

Secondary materials used for the "cladding" of the building (windows, composition board, etc.) are not standardized in building codes.

Wind Resistance of a Rural House in the Dominican Republic Increased by Use of Hip Roof and Combination of Concrete Block/Board Siding. (Photo by Aaron Benjamin, USAID Urban Development Officer, Santo Domingo.)

9. Bibliography

INTERTECT. Bibliography on Wind Resistant Construction. Dallas, Texas: INTERTECT.

_____. Como Construir Una Casa Segura de "Concreto Armado". Dallas, Texas: INTERTECT. March, 1980.

_____. Como Construir Una Casa Segura de Madera. Dallas, Texas: INTERTECT, March 1980.

_____. Como Hacer Una Casa Segura de Bloques. Dallas, Texas: INTERTECT. March 1980.

_____. Introduction to Wind Resistant Housing Construction: A Guide for Agencies in the Caribbean. Dallas, Texas: INTERTECT, 1979.

_____. Vulnerability Analysis of Traditional Housing in the Dominican Republic. Dallas, Texas: INTERTECT, 1979.

_____. Wind Induced Failures in Traditional Housing: Dominica, Dominican Republic. Dallas, Texas: INTERTECT, 1979.

_____. Wind Resistant Block Houses: Basic Rules. Dallas, Texas: INTERTECT, 1979.

James Cook University of North Queensland, Department of Civil and Systems Engineering: The James Cook Cyclone Structural Testing Station. Design for Tropical Cyclones (2 volumes). Queensland, Townsville, Australia: James Cook University, 1978.

United Nations. Department of Economic and Social Affairs. Low-Cost Construction Resistant to Earthquakes and Hurricanes. New York, New York: United Nations, 1975.

U.S. Defense Civil Preparedness Agency. Wind Resistant Design Concepts for Residences. Washington, D.C.: Government Printing Office, July 1975.

U.S. Department of Commerce, National Bureau of Standards. Building to Resist the Effect of Wind. (NBS Building Science Series 100). Washington, D.C.: Government Printing Office, 1977.

U.S. Department of Commerce, National Bureau of Standards. Design, Siting, and Construction of Low Cost Housing and Community Buildings to Better Withstand Earthquakes and Windstorms. (NBS Building Science Series 48). Washington, D.C.: Government Printing Office, 1974.