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/AN ALTERNATIVE APPROACH TO LOW-COST
HOUSING CONSTRUCTION, DESIGN AND PLANNING/

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INTRODUCTION

There is acute housing shortage in Nigeria. The problem is worsened by the continuous rural-urban influx of citizens for economic reasons.

This dwelling deficit has gotten the attention of both the federal and state governments. Acknowledging this as social dilemma, the governments instituted different programmes and policies. The programmes ranged from establishing Housing Corporations/Authorities to enacting Rent Control Boards. The Housing Authorities were charged with the responsibility of constructing houses. The Federal Mortgage Bank of Nigeria was charged to provide low interest loans to potential home owners.

Despite all of these efforts, the housing supply continues to fall short of demand. Where available, the cost is exorbitant. The goal of this paper then is to study ways and means housing could be supplied in the country at affordable cost. The study is to be done through comparative analysis and evaluative research. The areas of study are as follows:

Chapter 1 will discuss existing housing conditions.

Chapter 2 will discuss, describe, and evaluate housing policies and programmes.

Chapter 3 will describe the different types of housing markets and the construction industry.

Chapter 4 evaluates alternative methodologies.

Chapters 5 and 6 discuss material analysis and suitability for adobe and other construction methodologies.

Chapter 7 describes the considerations to be given attention in house design.

Chapter 8 discusses the criteria and guidelines for physical and environmental planning.

From this study, conclusions and recommendations are made. These recommendations are intended to make housing in Nigeria affordable.

CHAPTER 1

EXISTING HOUSING SITUATIONS

Urban Housing Needs and Demands

The provision of adequate social amenities has continuously been a major problem confronting many developing countries. Among them, urban housing has presented a tremendous task to the governments. In Nigeria, for instance, this case was highlighted when the Federal Government noted that housing,

is essentially an urban problem. Rapid urban growth associated with accelerated tempo of socio-economic development has seriously aggravated the shortage of dwelling units in Nigeria resulting in overcrowding, high rent, slum and squatter settlements which are visible features of the urban scene throughout the country (Third National Development Plan, 1975-80).

The acute shortage of adequate and affordable housing in the urban centers has caught the attention of each successive administration in the country. This shortage has been aggravated by the mass exodus of citizens from the rural areas to the cities. The teeming urban population and "higher" standard of living has drastically worsened the existing housing stock both quantitatively and qualitatively. As would be expected, the high demand for living quarters resulted in overcrowding and high rents. Cities such as Lagos has an average 3.8 persons/room, and Enugu with about 3.0 persons/room (Table 1). While urban population in most of the cities experience growth rates of 5 per cent per annum on the average, the urban housing stock grows at a negligible 2 percent per annum in most of the cities (Okpala, 1978).

With this opportunity provided, private estate developers have largely contributed to this widespread inflation. Developers are able to rent their houses as high as 30 per cent of tenants' income. According to Wahab (1974), Nigeria needs about 200,000 dwelling units annually to cope with the demand for accommodation.

Social and Economic Conditions

The residential land use pattern of the cities reflects the socio-economic characteristics of the urban dwellers. Four distinct residential growth zones could be classified, viz, the core region or the Central Business District (CBD), the newer urban zone, and the city fringe. At times, in some cities, Government Reserved Areas (GRA) are identified.

The Core Region/CBD

This is usually the heartland of the city and the site for the majority of the city's commercial and administrative activity. As the oldest and centre of the city, the houses are usually old. Most of them even show signs of wear and tear, especially those that have received little or no maintenance. The typical design of the houses is a variation of the traditional u-shaped open courtyard or compound houses---referred to as Brazilian style (figure 1). Typically, these have corridors running down the length of the houses with rooms spinning off the corridors. Facilities such as the kitchen and bathroom are communally used. These houses reflect the commercial zones they are located in because storefronts are dominant features. In essence, these

houses perform dual functions, i.e. both for residential and commercial uses. The occupancy ratio is high and the dominant tenants are low wage owners. Although it is not surprising to find middle and upper dwellers in these areas also, many cities have embarked upon programmes of upgrading the toilet system but there still exists a lot of houses that are served by the pail-system. For example, Izeogy noted (1977) that in Port-Harcourt "about 85.4 per cent of the households are served by the pail-system, 11.5 per cent has water closet system, while 3.1 per cent had no toilet facilities at all."

Newer Urban Zone

This is simply an extension of the central business district. Such extensions are usually prompted by the desire for proximity to the commercial centre. Usually, this area shows evidence of new houses and infrastructure. The houses exhibit different architectural character from the traditional u-shaped courtyard to the bungalows and duplexes. It is not uncommon to find some two storey buildings too (figure 2). Because of its newness, there is evidence of some planning features from the road layout to the house facilities. Most of the houses are equipped with water closets, private kitchens, private "modern" baths or showers.

The residents of this region are generally considered middle and high income earners, mostly professionals such as lawyers, doctors, architects, and teachers, etc. Again, this zone is not exclusive to this class of people as low income people inhabit this zone too. The occupancy ratio is relatively lower than in the core region, about 2.4 persons per room.

One notable feature of these houses is the inclusion of car ports or garages. While this area is strictly residential in character, commercial activities also occur in the residences. Many of the residents even convert their garages into commercial stores. In terms of functionality, these houses are functionally the same as those of the core region--both for residential and petty commercial activities. Provisions are also provided in some of the houses for private gardening in the backyards.

City Fringe

At the outskirts of the city, depending on the pattern of growth, this area is likely to develop into a high residential area or slum. The closer it is to the city the more likely it will be a slum, conversely, the more likelihood of high density residential area developing.

If the latter develops, the type of houses are mostly the compact bungalow types. All the facilities are self-contained within the house. The kitchen, toilet, baths and others are all within the house. Car ports and garages are common features also. These houses are well landscaped with manicured green lawns and generous backyards. This area has the advantage of being provided with functional public utilities, such as regular water supply, electricity, water closets, and good motorable roads.

As would be expected, these residents are people on the higher end of the economic scale. The occupancy ratio is low relative to the others.

If slum develops, all the facilities enjoyed in the above area will not exist here. Instead, the slum will be made up of run-down structures, make-shift structures, congested roads, and lack of functional infrastructures. It will have a high occupancy ratio.

It is very common for both of these sub-zones to grow into adjacent villages. When this occurs, the so called high residential area would blend with people of other socio-economic background.

Government Residential Areas (GRA)

The government has always been in the habit of providing residential quarters for their senior staff. Just as the high residential area of the city fringe, the GRA is endowed with all functional utilities and services. Aesthetically and otherwise, GRA houses are exactly identical to the high residential area (low density) of the city fringe, except that the GRA is more homogenous. This is attributed to the holistic approach to the physical planning. Unlike the city fringe, the GRA does not experience sporadic growth.

Environmental and Health Conditions

The inadequacy of and the unaffordability of dwelling units, and the continuous urban population explosion, has resulted in "primary urban environmental health factors such as slum housing, inadequate water supply, inadequate disposal of refuse and faces" (Hunponu-Wusu, 1977).

Hunponu-Wusu (1977) divided the environmental health issues in Nigeria into primary and secondary environmental problems. The primary health problem is associated with residential conditions such as inade-

quate water supply, inadequate disposal of feces and refuse. The secondary environmental problems are not directly linked to housing conditions but does impact on it. This problem is road traffic, and the impact of industries on the ecosystem.

Sewage Disposal

Efforts are being made to upgrade the sewage system by requiring water closets in all new buildings and the gradual inclusion of water closets in the older houses. but there still exists the traditional 'salga' and the pail or bucket latrine. The wastes are usually buried at city's dump site or simply dumped into lagoons or rivers. The lack of central sewage treatment plants requires that buildings with water closets have septic tanks. As complimentary and noteworthy as it is to convert to water closet system, it does possess its own setbacks. One of these being the infrequent supply of water to flush the feces creates potential health hazards. And this condition is worsened where the toilet is within the building. The other setback is the danger the septic tanks present to children. It has been recorded on numerous occasions of children falling into them. Also, septic tanks are noted to be breeding grounds for mice and rats.

Refuse Disposal

The disposal of refuse in most Nigerian cities will at best be described as bad, if in existence. The cities provide public refuse dumps at the corner of every neighborhood block. Residential refuse is expected to be dumped in these receptacles that are subsequently picked

up by the city's garbage collection agency. Instances have been noted where the city does not make the rounds. This results, in places like Calabar and Lagos, where large refuse heaps are overflowing and blocking the roads, thus adding to the problem of traffic congestion and the attendant health hazards.

Drainage

Open trenches and concrete gutters are primarily the water drainage systems available in the cities. Because of the concrete pavements and asphalt road surface volume of runoff water is enormous, and occasional flooding occurs. Also, this runoff water carries with it the uncollected disposed garbage. The contents are discharged into rivers and lagoons.

Urbanization and Residential Pattern---Land Use

The physical layout of modern or new towns has been a transplanting of the western grid-iron plan to a different geo-cultural setting. This plan has little relationship to or respect for the different lifestyle of the city. The city plan has evolved not from within but from outside, and neglect the individual family, neighborhood and the village fabric.

The concentric zone theory stipulates that land cost is higher at the city's centre and progressively declines outward. And the center of the city becomes both the commercial and transportation hub. The major determinant of city structure hinges then primarily on the industrial growth. This approach to city planning has continuously been removing land that was once community property to individual ownership. With the weakening of the traditional form of land ownership, and with the

inception of the "practice of individual land ownership ... alienation started." As a result of this, land acquisition no longer meets the needs of the community; but is based on capital ability of the potential buyers, land now has an economic value placed on it, and "the price of land varies with the distance from the city centre, the type of use, the availability of social facilities, and the associations related to it" (Sada, 1972). Spatial distribution of residential land use had to and continues to follow the economic dictates of the land.

Another aspect of the new town planning is the subtle but nonetheless present differentiation of the residents by socio-economic class. This socio-economic stratification could be translated into residential classification as high-grade, medium-grade, and low-grade residential zones. These zones correspond accordingly to the provision and availability of social facilities and infrastructures.

High-Grade Residential Zone

This is primarily a low housing density area. The total acreage of land occupied by this residential type is inversely proportional to the number of residents. A study conducted by Sada (1972) found that the low density housing carried only 9 percent of the population of Lagos, and covered an area 33 per cent of the residential land available. This residential zone is markedly different from the others because of a high percentage of functional amenities such as portable water, electricity, water closet, good roads and storm drainage. Also noticeable is the appreciable landscaping. The cost of housing in this area screens out a great percentage of potential landlords limiting choices which Sada

(1972) sees as working against the "basic assumptions in traditional land-development model."

Medium-Grade Residential Zone

This is an area of higher density housing than the high-grade residential zone. Housing density could range from twelve to sixteen units per acre and the average occupancy ratio is about three. In most cases, amenities are always provided after residential structures are already in place. But on the average, this zone is of better quality than the low-grade zone.

Low-Grade Residential Zone

This zone could occur at any location in the city, either at the core or at the city fringe. Those at the city's core are properties that have declined in physical quality. And the closeness to the centre of the city provides an advantageous location for low income people. Although the quality of the houses have depreciated, the properties occupy high land values. The inner city in Lagos, for example, enjoy the advantage of being planned, but this is masked because of population congestion, crowding, traffic "go-slow" and the construction of unauthorized structures. Once workable amenities now suffer from over usage, lack of maintenance and the need for up-grading.

The low-grade residential zone at the outskirts of the city lacks all amenities. It is not planned and the growth is chaotic. The conditions at this area are such that they are called slums or shanty towns.

Both the low-grade residential zones characteristically have the highest population and housing density. A significant feature of the residential growth pattern of most Nigerian cities is that the above residential classifications are not finely defined. None of these zones are totally homogenous and exclusive to a particular socio-economic class. Some of the reasons for this range from cultural bondage to economic independence. In essence, the residential pattern could be said to develop into overlapping sectors (figure 3). According to Sada (1972), "except for isolated density spots, the population density reduces with distance from the central districts in the city, rises at the boundary, and falls off again from the boundary."

The lack of amenities at the outskirts has contributed to restrictions or to slow down the exodus of the wealthy to the suburbs or the city fringe. Another factor is security. Isolated living in the suburbs does not provide the security and psychological attachment to family groups. The extended family network and tribal affiliations definitely plays a determining role in residential location within the city. Therefore, it is not uncommon to find in one neighborhood residents sharing common socio-cultural characteristics, yet be economically different. The growth pattern than could not be described as concentric, but instead as multiple nuclei (see figure 3).

TABLE I
URBAN HOUSING CONDITIONS IN SELECTED NIGERIAN TOWNS

TOWN				% of Households occupying one room	Average No. of persons per room	% of Houses with tap water	% of Houses with flush Toilet	% of Houses with elec- tricity
Lagos	..	..	..	72.5	3.8	71.7	43.5	93.2
Port Harcourt	..	..	.	51.5	2.4	75.0	18.0	81.4
Benin	..	..	..	48.0	2.2	24.9	4.0	59.3
Warri	..	..	..	59.9	2.6	62.4	10.9	89.7
Kaduna	..	..	..	63.9	2.1	40.3	14.1	53.3
Kano	..	..	..	69.1	2.4	26.1	1.8	69.1
Ilorin	..	..	..	23.9	1.6	30.7	10.3	28.4
Ibadan	..	..	..	47.3	2.1	33.4	25.2	56.1

Source, *Third National Development Plan, 1975-80*, Federal Ministry of Economic Development,
Lagos

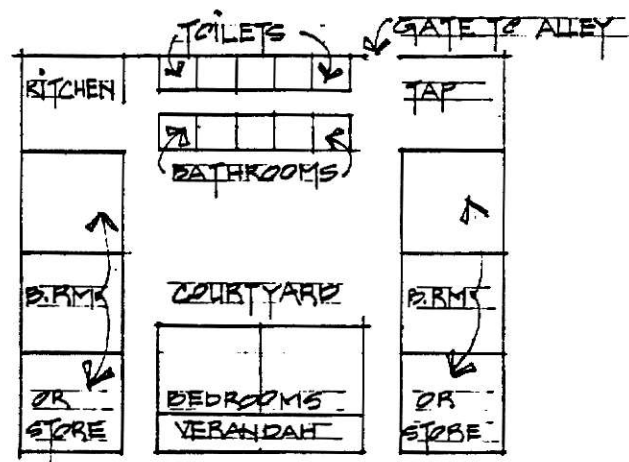


Fig. 1: Typical variation of the traditional u-shaped house plan.

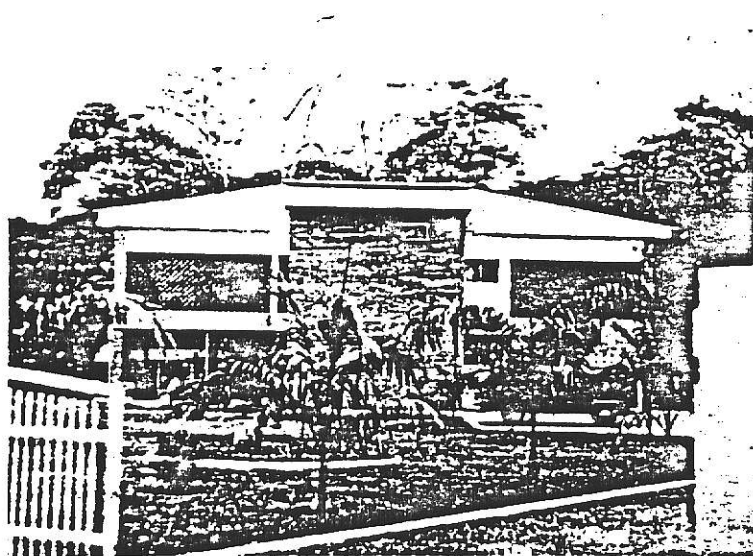


Fig. 2: Example of houses found in the newer urban zones.

Source: Ono Kerhoraye. Ekistics, Vol. 242, 1976.

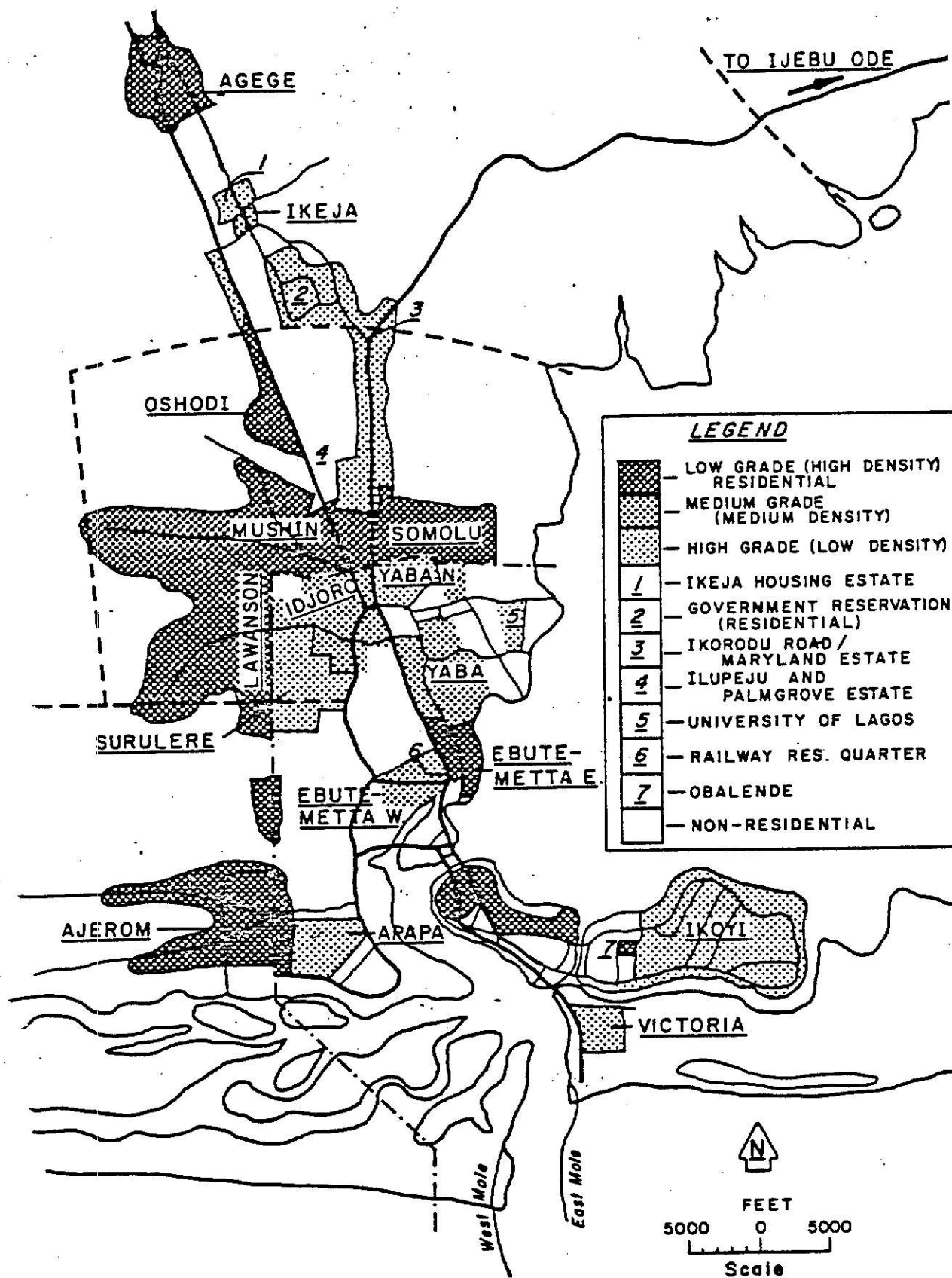


Fig. 3: Classification of residential districts in Lagos.

Source: Sada African Urban Notes, VII, No. 1 (1972).

CHAPTER 2

HOUSING POLICIES AND PROGRAMMES

Policy Evaluation and Description

The Nigerian government provision for housing for the public can be traced back to the colonial days. The goal then was not in housing the less fortunate but instead it was a means of establishing racial and class segregation. As noted by Sada (1972), housing during this era was more of "a basic psychological weapon in the exercise of political authority," and the "need to invoke and perpetuate a mythical image around the expatriate administrator, ... through residential exclusiveness." This exclusory zoning resulted in what is popularly called European Quarters or the Government Reservation Area (GRA). Among the earliest public housing schemes was by the Lagos Executive Development board (LEDBD) to house residents in Metropolitan Lagos following the outbreak of bubonic plague in 1925 and 1928 (Megbolugbe, 1983). During the slum clearance in Surulere, Lagos, temporary housing was provided for the displaced households. While these houses were primarily built to alleviate the problems encountered by the affected residents, the Western Nigeria Housing Corporation (WNHC) established in 1958 was primarily concerned with high income housing. For example, the Bodiya Estate in Ibadan was for this economic class, contrary to its policy of providing subsidized housing for the poor.

The creation of nineteen states resulted in subsequent increases in population growth in the urban centers. This population explosion did not help the housing situation in any way, qualitatively or otherwise.

In the light of this both the Federal and State governments established housing corporations. In October 1973, the Federal Government by decree, established the Federal Housing Authority as a statutory corporation. The expressed concern of these housing corporations was to arrest and alleviate the acute shortage of modest housing through housing subsidies. One of the principal means of addressing the issue was the provisions of low-cost/low income housing at affordable cost. The expected target were the low income earners. The house package was not to cost more than 20 per cent of the prospective buyers annual income.

In the Third National Development Plan (1975-80) the Federal Government saw the provision of low cost housing as part of its social responsibility. During this development plan a sum of #1.84 billion was earmarked by the federal government for the construction of public housing throughout the federation. An estimated 60,000 dwelling units were to be provided during this plan. A combined total of 202,000 residential units were expected to be constructed by both federal and state governments. Each state's share were 8,000 units except for Kaduna with 12,000 units and Lagos with 46,000 units, see Table 2 (Anusionwu, 1982; Mabogunje, 1977; Megbolugbe, 1983). The most common delivery system used by all the housing corporations is the direct construction and selling of finished units. The construction is normally performed through government contractors. The Federal Housing Authority was to handle the planning and implementation of all federal low cost housing. It is also charged with the responsibility of ensuring that the states

counterparts that receive federal assistance abide by its rules and regulations.

In order to diversify the delivery system, the Federal Government by decree, changed the Nigerian Building Society to the Federal Mortgage Bank of Nigeria (FMBN). It was established solely for financing housing development to both private and state housing corporations. The Central Bank of Nigeria permitted the commercial banks and insurance companies to increase their sectoral allocation for residential development (Anusionwu, 1982).

To slow down skyrocketing house rents the governments formulated rent control policies. Also the governments provided housing allowances or rent subsidies to their workers especially the senior civil servants.

Policy Evaluation

Despite the good intentions of the housing programmes, the policies have been plagued by a wide range of problems such as undefined policy terms and construction methodologies. The government's participation in the provision of urban housing while it is a laudable venture, proved to be ineffective and counter-productive because of the expensive and almost unrealistic delivery system approach.

At best the housing policies can be described as exclusionary both in principles and practice. While the expressed goal has been to deliver modest housing at affordable cost to the low-income earners, the implementation of these policies are far from realistic. Even the policy guidelines defining eligibility for the beneficiaries omit the intended

participants. For example, the low-cost housing project at Ikpoba in Benin City funded by the Federal Government requires:

"that the gross income of applicant be related to the housing units i.e., 1 bedroom unit requires an annual income of not less than N720.00, for the 2 bedroom unit annual income must not be below N1,500; 3 bedroom for N2,500 and for 4 bedroom unit annual income must not be lower than N5,000" (Ministry of Lands and Housing, Bendel State of Nigeria).

From the above figures it becomes apparent that restricting the eligibility of applicants systematically excludes those that should be the beneficiaries of the projects. According to Sule (1981), this is an elitist approach to providing low-cost housing. The government by eliminating those below grade level 06 (below N720.00) subsidizes those who are able to provide private housing leaving the "unables" still without shelter.

The market price of the finished housing units definitely makes the term "low cost" meaningless. The construction techniques coupled with the high building standards have lead to unexpected high prices for the dwelling units. The price factor has actually eliminated most potential buyers. As pointed out by Sule (1981), 59 per cent of his respondents gave 'expensive cost' as the major element for not purchasing the "subsidized" housing (Table 3). The high cost then becomes an obvious elimination factor for the low income. This elimination mechanism coupled with extremely low effective demand by a majority of the urban population has resulted in retargeting of the public housing units to the middle- and high-income minorities. Where targeted as intended the implementation has required high government subsidies, benefiting not more than 5-6 percent of the urban low-income population. The case of

Kulende Estate, Ilorin, Kwana State is a vivid example. The dwelling units were intended to be leased out for not more than 20 percent of annual income, but when it was completed the final cost to the average low-income households was between 30-45 per cent of their income. The low-income households were eliminated. This leaves the housing stocks to the middle- and high-income brackets who could afford the private housing in the first place. Not only does about 70 per cent of the urban poor become eliminated from the programme, but the medium- and upper-income classes only have to spend between 8-15 per cent of their income on housing (Megbolugbe, 1983; Sule, 1981).

Another contributory factor to the high cost of the dwelling units is the use of locally non-available building materials. This aspect of the programme will be addressed to in details in chapter 3. For now, it will suffice to say that no concerted effort has been demonstrated by the federal and state government to encourage the use of locally available building resources and skills.

The management of public housing also has proved to be exorbitant and suffers from many bureaucratic hurdles. This has partly resulted from poor management. The poor management and maintenance is a factor where both recipients and respective governments or housing corporations must share the blame. For the government, the management and maintenance of these units is no longer cost effective. A larger operating budget is required for effective and efficient provision of workable infrastructures, such as garbage clearance, sewage disposal and drainage system. To the owners, there is the nonchalant attitude towards public housing as

it is looked upon as government's property. This could be attributed to the non-participatory role of the tenants in the planning of such projects. Public apathy, coupled with the government's lack of maintenance has resulted into faster depreciation of the public housing. Overall, the longevity of these buildings are in no way comparable to the high cost of construction. Apparently, most of the state governments are withdrawing from the maintenance aspect of the programme. One of such steps taken is to hand over such projects to private developers. Ikenegbu Housing Estate, formerly owned by the Imo State Housing Authority, was handed over to a private developer. Without proper deeds and regulations the private developers, being driven by a profit motive usually embark on a policy of converting any foreseeable open spaces for addition residential structures. The estate ends up being crowded, not in terms of persons per dwelling units but in terms of dwelling units per acre/hectare. The original aesthetic qualities and the intended functional purpose is lost.

From the point of view of socio-psycho-cultural satisfaction, the owners of public houses are viewed as transients. Again the non-participatory role of the tenants is a legitimate excuse. A sense of alienation is ensured, indifference is established, and cultural indignation is present. Cultural respect is accorded a landlord if his house is built by himself instead of handed out to him by a "benevolent" government. Just as in the study done in Calabar, Cross River State by Sule (1981), those who prefer to build their houses ranked first among other respondents (see Table 3).

The goal of constructing 202,000 dwelling units during the Third National Development Plan was to say the least, a total failure. Of these, only 24,397 dwelling units have been completed by 1979 (Anusionwu, 1982). To begin to make an appreciable impact on the housing crisis the federal and state governments need an average of about 725,000 dwelling units annually. The continuous backlog of housing supply has also been due to the lack of comprehensive study to ascertain the exact housing needs. The policy has therefore not been based on needs. Rather it has been based upon "guess-stimation" of housing needs.

To actually provide modest accommodation by 1985 the government needs to construct a total of 4.4 million dwelling units (Anusionwu, 1982). Even though the Third National Development Plan, 1975-1980, was a proper acknowledgement of the housing crisis, still the steps taken were either not enough, or it is a misplaced and misdirected approach. The housing investment is low in the country because the government devotes a meager percentage of the GNP to housing (Wahab, 1974; Anusionwu, 1982).

While the Federal Mortgage Bank is instructed to provide loans to both private and state Housing Authorities for residential construction, they have only been accessible to those in the high-income bracket. The eligibility requirements for applicants has continuously eliminated the low-income households. Even the rental subsidy programme for the government staff has benefited only the senior civil servants. Without the needed rent subsidy and inability to get into the public housing the poor ends up spending up to 40 per cent of their annual income on housing (Sule, 1981; Hunponu-Wusu, 1977). In as much as the governments

are interested in providing completed finished dwelling units to the citizens, there is also the need to investigate other cost effective delivery approaches.

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CHAPTER 3

HOUSING MARKET AND CONSTRUCTION INDUSTRY

Housing Markets Comparison

Although the government is now directly involved in the construction and selling of houses, it is not the only way housing demands are met. In addition to the government's intervention in the market there is still other market approaches to housing. Principally, there are three types of housing markets in the country: private, commercial and government. Each market occasionally is comprised of sub-markets. The differences between these markets are the financing, production/construction techniques, provision of infrastructural services, and even the programming and design phases.

Private or Popular Sector

This sector as its name suggests is the private ownership of a residential unit. The advantages of the private or popular sector is the fact that it allows incremental development; complete control by the builder family; self financing of the housing construction (Agrawal, 1978). The private sector could further be divided into squatters and non-squatters.

Squatter settlement is usually the illegal occupation of a plot of land with subsequent erection of illegal and usually "sub-standard" residential structures. The structure could be temporary or permanent. The occupation and construction of such structures occur concurrently. Usually the construction is staged or incremental depending on the needs

of the builder family. The construction is self executed with occasional employment of semi-skilled artisans. The building materials are always recycled materials ranging from scrap boards to even cement blocks. Because of the illegal occupation of the land many of households hesitate in erecting permanent structures. Yet it is not uncommon to see others making the effort to construct permanent structures with concrete blocks; etc. One disadvantage of this settlement is the unplanned layout of the structures and the unavailability of city services. Still, people are seen providing themselves with such services as electricity, and pipe borne water, by illegally tapping into the city's supply. The growth rate of the urban centres and the unavailability of housing have made landlords out of these squatter settlers. Some owners of squatter settlements are known to be in the business of renting out rooms. Principally the financing of these structures are through personal savings or esusu* (Vernez, 1976; Agrawal, 1978; Schwerdtfezer, 1982).

Non-Squatter. The major differences between non-squatter and squatter settlements is that the former is legal and enjoys the city's infrastructure where it is available. The structures are built in planned sections of the town but must be approved by the appropriate building authority before construction commences. The satisfaction derived from this is the assured security of ownership. The fear of destruction by government authorities is absent. Even though these are to be constructed for private occupation, some landlords still rent out

*private saving society.

rooms. Mostly these are to next of kin. The rent may be used for the upkeep of the house. The finance of this type of market is mostly private. Even though the Federal Mortgage Bank is authorized to make loans available to these builders, it is not a fairly distributed loan. To avoid the bureaucratic red-tape and administrative bottleneck most owner-builders avoid the process. The design and construction in this category involves the use of skilled labour. At times the construction is also incremental in nature.

Commercial Sector

Estate developers in the business of providing dwelling units for sale are strictly in it for profit. The source of financing is through the financial institutions. And the skill and management involved in estate development requires the services of skilled manpower. The building materials are always concrete, metal and other materials, commonly not produced on large scale in the country. The high price of these materials coupled with the technical expertise required for the construction escalates the construction cost (Vernez, 1976). The houses are either rented out in rooms/apartments or bungalows and duplexes. Recently the trend has been in the construction of bungalows and duplexes. This approach reduces maintenance costs on the developers and increases the margins of profitability. The construction of bungalows and duplexes further aggravates the housing shortages as most low-income households would prefer renting rooms rather than renting a house. Evidently the high cost of construction, the interest on loan repayment, and the high demand for accommodation has resulted in developers renting

out their houses or rooms for as high as 30-40 per cent of the tenants annual income (Hunponu-Wusu, 1977; Sule, 1981).

Government or Public Sector

As noted in Chapter 1, government has always provided accommodation for the senior staff dating back to the colonial era. The approach has always been a delivery of a complete package. The houses come with complete amenities including in-house flush toilets and kitchens. for the purpose of this paper the public sector will be divided into government subsidized houses and corporate-employees housing sub-sectors.

Government Subsidized Housing Sector. There is evidence of planning involved in this sector. The land is developed and provided with necessary infrastructural amenities. The government handles all the stages of the development in the construction and sells it to prospective tenants. The units are either allotted to the government staff by seniority or through balloting or drawing of lots. According to the programme these units are expected to be leased out for about 20 per cent of households' income. As mentioned earlier, the targeted cost programme has yet to materialize. Most of these units, when completed have been leased out for about 30-45 per cent of the tenants' annual income (Magbolugbe, 1983). Except recently, these houses have always been the bungalow types satisfying the high income market or demand. But states such as Lagos have started constructing high rise apartment complexes to alleviate the low-income market (Figure 4). Because of the standards set by the sponsoring government there is a lot of technical expertise needed for the construction. Also it consumes many foreign produced building

materials. A noticeable feature of the government housing is the undue construction delays and high cost of materials frequent scarcity of building materials. Caught by inflation, the contractors seize the opportunity to escalate their prices (Anusionwu, 1982). Hence, the high percentage of income needed to own one of these homes.

Corporate or Employees Housing Sector. Exactly the same approach has been taken by most corporations to house their employees. For large corporations like the Shell Oil Company, large hectares of land are acquired and developed with all of the necessary site amenities provided. Again these units are allotted to senior staff while the junior staff is left to fend for themselves. In order to attract essential staff to remote areas, corporations tend to construct modest housing as an enticement for such staff. And it is not unusual for such dwelling units to be rent/lease free to such employees. The government has always used this approach to keep their staff in most rural plantations. While physical accommodations are provided to the senior staff, some corporations do subsidize junior staff housing by the provision of housing/rent allowances or subsidies. Where corporations can not house their senior staff on site; housing is provided for them across the city. Each makes his living arrangement with private developers. The cost is then borne by the corporation but must be within his salary bracket. Also government functionaries and corporations customarily house their senior staff in hotels until "reasonable" accommodations are made available to them.

These three types of housing markets—private, commercial, and government—exhibit different market characteristics and philosophical approaches. The private housing is designed according to owners specifications. Financing the construction is either through loans or personal savings. The private houses are user motivated. The commercial sector of the housing market is strictly profit motivated. With no particular users in mind, such units are designed to ensure maximum utilization of space, and maximum returns on investment. The government sponsored housing is intended to be subsidized for the low-income earners but is yet to be achieved. It could safely be assumed that the public dwellings were intended to meet tenants' needs, the delivery system used for achieving this has made the goal unrealistic. The government housing programme is centrally administered which requires skilled manpower and resources to effectively run the management and maintenance aspect of the programme.

Construction Methodologies and Materials

A thorough analysis of construction methodologies of houses in the urban areas will reveal a technological progression. From the use of locally available building materials and skills to the use of modern but scarce building materials and technical expertise. In older cities like Ibadan, Benin City, and Lagos, the older homes at the central areas are mostly constructed of native building materials. Burnt or sun dried bricks are used for the walls, timber, galvanized corrugated steel/-aluminum roofing sheets for the roof (Figure 5).

A combination of both the basic and modern building materials are even used in constructing two-story buildings. Figure 6 shows such combinations where the structural members are concrete and the envelope is brick or adobe. The construction of these houses normally involve the use of local labour who are skilled in such construction. Because of the readily available materials and not much expertise needed the pace of construction is always quick.

As the country develops technologically the emphasis on using local building materials has unfortunately been abandoned. The increasing use of modern building materials also meant the increasing need for technical know-how to handle the construction. The lack of this technical ability meant two things to the construction industry. One is the transfer of such projects to expatriate firms or given to indigenous firms that are likely to do shoddy works because of inadequate training in handling such works (Diejomaoh, 1974). The increasing use of modern building materials entails a corresponding increase in the capital cost of housing, which should the owner overrate his financial resources, results in prolonging the period of construction for several years (Schwerdtfezer, 1982).

The switch to and adoption of modern building techniques and materials has adversely affected the indigenous construction industries. Because of the management expertise and technical skills possessed by the expatriate firms, they control a larger share of the construction industry. A reference to Figure 4 illustrates the construction of a high-rise apartment which is being built by Cappa and Dalberto Ltd., which is a foreign construction firm. For such construction indigenous

contractors are only used at the lower levels of operations—the non-technical aspect of management. This total contrast of technical and management skills gives the expatriate firms a complete monopoly of the construction industry.

The study carried out by the United Nations (1965) indicated that building materials accounted for 50-60 per cent of total construction cost. The implication of this in residential construction is the increased competition for materials such as cement, steel, etc. for use in the construction for both public (roads, bridges, etc.) and private (residential) projects. This increased demand has an enormous strain on the local production of these building materials. To ensure adequate supply of these materials, the government expanded the production capacity of existing cement industries and established new ones at Ewekoro and Calabar. Clinker industries were also established to help out in this respect. The government took further steps in eliminating excise duties on cement and roofing sheets, while drastically reducing the ad valorem taxes on other building materials such as paint, steel and tiles. In addition to all these measures, the Nigerian National Supply Company, established primarily by the Federal Government as the sole importer of essential commodities, was authorized to increase its percentage of cement and other building materials importation (Diejomaoh, 1974).

All of the measures taken by the government has been to ease scarcity and cut cost of construction. But from all indications this has not been the case because demand has continued to outweigh supply. The

construction and building material cost continues to represent more than 60 percent of total construction costs. With this high cost of building materials, appropriate building methodologies that will capitalize on existing technologies and readily available local resources need to be investigated and researched.

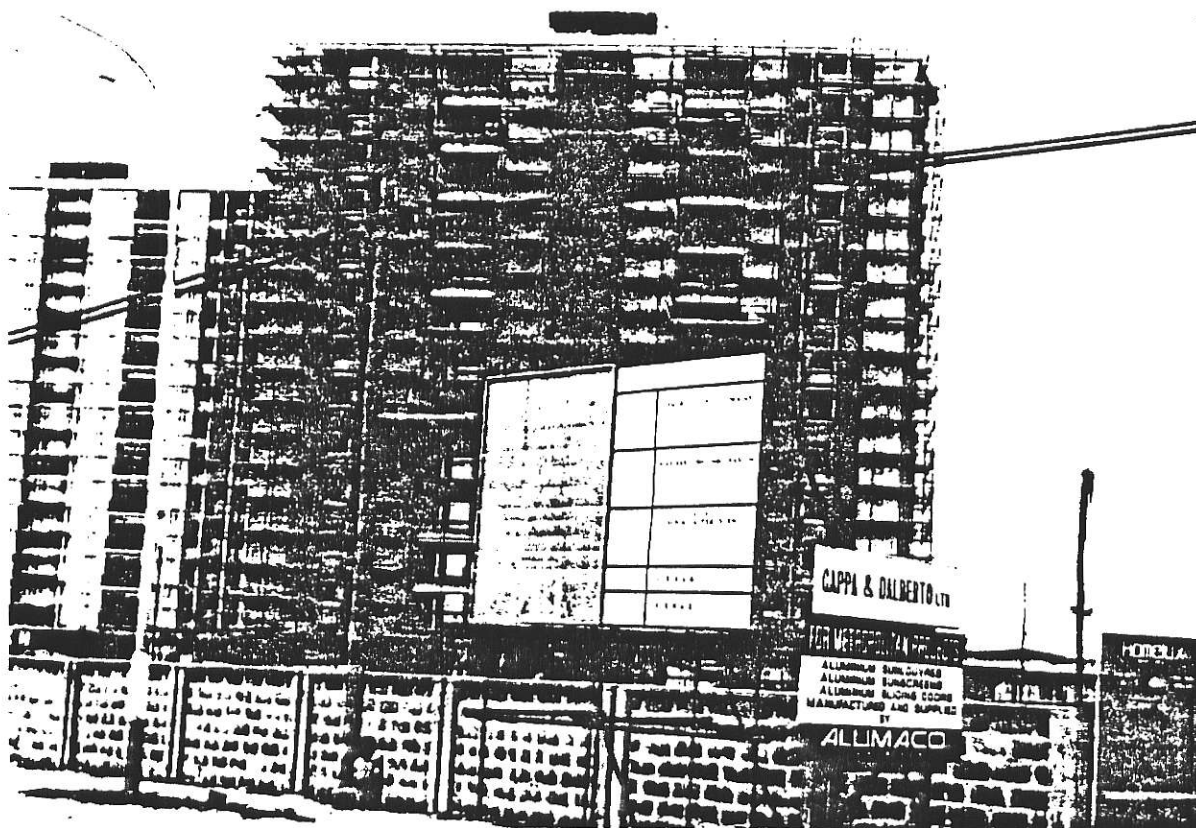


Fig. 4: High rise apartments being constructed by a foreign firm in Lagos.

Source: Awatona. Financing Appropriate Housing in Nigeria. Ekistic s, Vol. 261 (1977).



Fig. 5: Houses in the older parts of the cities are constructed of local materials such as burnt or sun dried bricks.

Source: Awotona. Financing Appropriate Housing in Nigeria. Ekistic s, Vol. 261 (1977).



Fig. 6: A two-storey house built of concrete structures and burnt brick envelope with decorative balustrade in Ibadan.

Source: Schwerdtfezer. Traditional Housing in African Cities (1982).

CHAPTER 4

EVALUATION OF ALTERNATIVE METHODOLOGIES

The housing shortage is acute in urban centres of developing countries, including Nigeria, and the trend will most likely continue unless drastic measures are taken to arrest the problem. With the urban population in Nigeria growing at a geometric rate while the housing supply is at best growing at below arithematic progression, as noted in the previous chapters, there is a need then to search for alternative innovative approach to providing the basic human necessities of cloth, food, and shelter, at a level that is affordable and appropriate.

As admitted by the Federal Government of Nigeria in its Third National Development Plan, the major problem confronting the urban poor, and even the rich to a certain degree, is the scarcity of living accommodations and the high rents of the available units. In accepting the task of providing adequate and affordable housing units as their social responsibility the federal and state governments embarked on different programmes ranging from financial assistance to direct construction of dwelling units. Yet the governments have not been able to experience appreciable success in the provision of this good. While it is not the only reason for the apparent failure, Awotonia (1977), Anusionwu (1982), Megbolugbe (1983) and others have pointed to the high construction cost as the major reason for not realizing 202,000 dwelling units targeted for 1980. This cost is attributed to the high reliance of imported building materials, lack of technical expertise and management skills to handle such huge government projects.

Because of the goal to industrialize, a high price is being paid in human and material terms. Construction skills and building materials determine the construction techniques. Therefore, the dependence upon imported building materials automatically means a reliance on imported technology. This has invariably left most building projects in the hands of the expatriate construction firms creating total monopoly and price escalation (Diejomaoh, 1974). In addition, such enterprises are capital intensive, with enormous under utilization of available manpower.

Appropriate or Intermediate Technology

For the eventual realization of meeting and satisfying housing needs there is the need to re-evaluate the present delivery system and to investigate and propose alternative delivery approaches. Such an alternative system should be cognizant of the fact that efforts to adequately provide housing were thwarted by scarcity of resources and dearth of needed technical skills. These alternative systems will require a mobilization of available local resources and manpower and training.

In view of the inadequate housing supply, a challenge is presented to the planning and design professions to assist in the development of alternative and innovative processes for residential construction. Also, these processes must be cost-effective and appropriate for use in the areas to which it will be applied. Therefore, a promising system for alleviating the acute housing shortage and high construction cost will be "appropriate technology." Appropriate Technology, as defined by the

Canadian Hunger Foundation and Brace Research Institute (1977) is that "which is most suitably adapted to the conditions of a given situation. It is compatible with the human, financial and material resources which surround its application." Disagreements have often surfaced against the term appropriate technology because of the ambiguity that surrounds the term. Alternatively, a term such as "intermediate technology" has been used instead. And according to Parry (1984),

"intermediate technology describes the level of capital investment and associated labour requirement which seems to best meet the people's needs of many areas of the developing world with their rising aspirations but scarce capital resources."

Intermediate technology is viewed as bridging the void between industrialized/modern and traditional approaches to solving a problem. For this paper, the author intends to use both words interchangeably.

Both intermediate and appropriate technology share common denominators such as being labor intensive; simple, easy and inexpensive, small scale, and low cost. The Canadian Hunger Foundation and Brace Research Institute (1977) also stipulated that in addition to the above factors, such technology should meet the following criteria:

- (1) The technology should benefit as many people as possible.
- (2) It should be flexible-adaptable to the changing needs of the community and to regional, national and even international considerations.
- (3) It should not conflict with the local ecology.
- (4) The choice of an appropriate technology must consider that in every culture, there is a complex interweaving of many diff-

erent aspects of life, and any particular change will affect the whole.

- (4) Finally, it should be acceptable to the people who are growing to use it.

Primarily, the intention of the intermediate technology approach will be the utilization of readily available local building materials to the full benefit and advantage of the beneficiaries. Such intentions are expected to be achieved through the adoptions of programmes as defined below.

Use of Local Building Materials

History reveals that the most widespread building materials in countries as Nigeria have been soil and (native) timber, primarily a result of their availability, ease of use and low cost. The appropriate use of locally available building materials will take residential construction away from the competition for concrete and other high-tech building materials that are now imported. Competition for these materials has created both real and artificial scarcity, hence the exaggerated prices. Its potential for residential construction, makes soil (adobe or rammed earth) an effective substitute for concrete blocks, and will definitely provide a method for reducing or eliminating import costs. The same argument holds true for timber rather than iron and steel. Using timber for roof trusses, doors and window jambs, sills and heads not only utilizes local skills but also provides better thermal properties than steel or iron. If local building materials are used for residential construction, concrete, steel and other high-tech building

materials will be left for execution of such capital projects as dams, bridges and other projects embarked upon by the government.

Use of Local Skilled Labor

There already exists traditional indigenous technology. This technology is mostly labor intensive, and there is no scarcity of manpower to support such a technology. The use of locally available materials will create the desire to revive a known technology. At the same time, this could be blended with modern technology without making it capital intensive. For example, while 'Brepak Block' and 'Cinva-Ram' machines (Stevens, 1983) are not traditional equipment, their operation does not require much technical expertise and would fit and be appropriate to local conditions (see Figures 7-8). Another advantage of such equipment is that it allows product manufacturing operation to occur on site.

Aided Self-Help Construction

The application of local building materials and local skilled labor creates enormous opportunity for a self-help approach. Because of their ease of operation (Cinva-Ram and Brepak Press) owner built houses are possible. No technical expertise is required, and only semi-skilled labor to assist in carpentry works is needed. Most of all, this approach is an effective means of reducing construction cost. Where there is need for assistance the government could set up a delivery system to provide such services at a miniscule cost of service. Here the government could act as consultants; a conduit for disseminating necessary information and

rendering needed help. In addition to providing housing at minimum cost, there is a sense of belonging, pride and attachment to their houses. It is also worth mentioning that the people are educated in and learn the trade of housing construction. It provides the lesson of "How To Build It Yourself." Such a policy or programme will provide the needed avenues also for local contractors to master their trade.

Vernacular Architecture. Essentially, by using the incremental and flexible nature of vernacular or traditional home construction, initial building cost could be reduced. This operates on the principle that construction of the house proceeds according to family space needs and financial capability to meet the cost. The addition of needed spaces to the initial block does not disrupt the cultural needs of the architecture or the overall planning. This "open-ended" (author's terminology) design philosophy reduces initial front-end cost. And allows for changes and adaptation without extended difficulties (Figure 9). By vernacular architecture it does not imply only the use of local building materials and design forms but it also means the definition of spaces to meet socio-cultural factors of any particular region of the country. This will be discussed further in the next chapter.

Selection of Appropriate Methodology

The above building concepts as a means of reducing construction cost is not new, but simply reviving an old known technology that will be modified, adapted and improved to meet the present situation. In Nigeria, four types of traditional or indigenous construction techniques could be identified. These are namely: (1) cob, (2) wattle and daub, (3) rammed earth, and (4) adobe brick construction techniques.

Cob Construction Method. On the site of construction, earth is excavated from a borrow pit. The earth is wetted and cut grass is added and mashed into a consistent mortar mixture. Gravel and sand could also be added. The mortar is molded into oval shapes about the size of footballs (not soccer). These are left in the sun to cure. Construction begins with the foundation dug about one foot deep. The dried earthen molds are laid on each other in courses with mud mortar as the bond. The use of cut grass or chopped straw minimizes shrinkage and cracks. The irregularity of the wall could be smoothed out with the use of mud plaster to render the surface. The advantages of this method are its ease of construction and the fact that no formwork is required (Little, 1983).

Wattle and Daub Construction Method. This construction method combines timber and earth. The timber serves as structural support for the earth. Bamboo, poles, canes, reeds, and withes are the most common timber used. The bamboo and poles are woven into a framework of lattices while the reeds are used to tie the framework into place. Clay soil dug out from the site is mashed into a colloid mass. Cut grass or chopped

straw could be added to the clay to prevent cracking and shrinkage. The mortar is then applied to the wattle from both sides. When completely dried wetter mixture of clay and sand is used to daub the walls. Just like the cob construction, it is a fast and easy construction method. The foundation is about six inches (6") deep. A major drawback to this method is the vulnerability to termite attack, and its durability depends on preventing the wattles from termite attack.

Rammed Earth Construction Method. This is a variation of the cob construction method. Instead of molding the mortar into oval shaped bricks while wet, it is simply pressed in lumps horizontally and vertically. Conspicuously absent is the use of mortar between courses. Each course is allowed to dry before subsequent ones are applied. The walls are load-bearing and could be as thick as 16". The rough surfaces are rendered smooth with the thinner consistency of clay plaster. In terms of labor time the rammed earth construction compares favorably with adobe brick construction.

Adobe Construction Method. The process of mixing the earth is exactly the same, however the wet mud is placed into bottomless boxes to form adobe (rectangular) bricks. The bricks are allowed to cure in the sun. And construction commences after the foundation has been dug. The adobe unit courses are laid with mud mortar. The same principle of masonry wall construction is applicable here. The walls could be plastered or left unrendered.

A common attribute of the traditional or indigenous construction methodologies is their ease of use, availability of materials and the

non-requirement of technical expertise. However, all of these share some common drawbacks, namely, the lack of durability, vulnerability to termite attacks, and they are prone to the deterioration by rain and wind blown sand. It is on this ground that the use of appropriate or intermediate technology could improve the product without making the solution capital intensive. It will be taking the traditional technology into a new dimension and exploring its potentials.

Therefore, the selection of the appropriate construction methodology for low-cost housing has to be flexible, cheap, easy to use, and adaptable. The four named traditional construction methods above could be categorized into two major types, namely, rammed earth and adobe construction methods. Adobe bricks could be produced in addition to manual production by using Cinva-Ram and Brepak Press block making machines. Rammed earth construction will require the use of formwork.

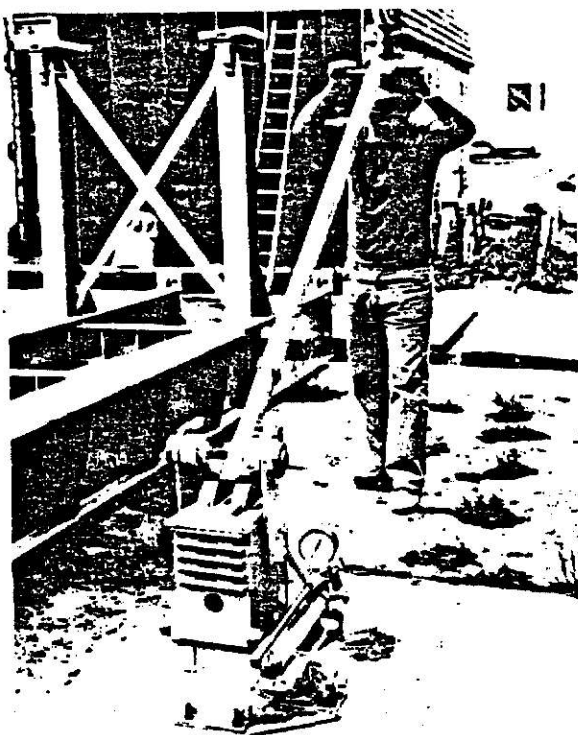


Fig. 7: The Brepak block making machine.

Source: Stevens. International Journal for Development Technology, Vol. 1 (1983).

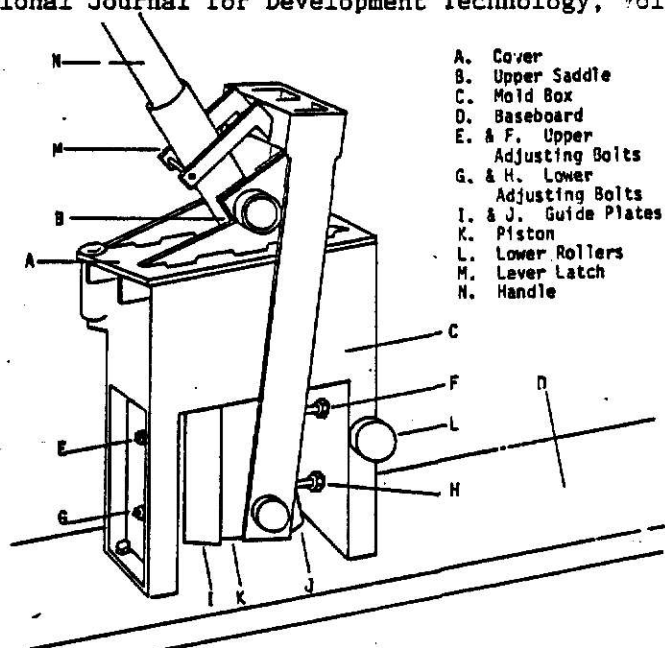


Fig. 8: The CINVA-RAM Block making machine.

Source: Volunteers in Technical Assistance (VITA) (1977).



Fig. 10: Production of adobe block for cob construction.

Source: Schwerdtfezer. Traditional houses in African cities.

Fig. 11: House in Northern Nigeria constructed by the cob construction method.

Source: Schwerdtfezer. Traditional houses in African cities.



CHAPTER 5

MATERIALS ANALYSIS AND DISCUSSION

This chapter discusses the different methods of making adobe bricks by using the earth. Because of soil durability, investigation will deal with cost-effective ways of making the brick of a higher quality through stabilization methods. Various methods of preparing the blocks range from wholly manual production to intermediate technology methods such as Cinva-Ram and Brepak block making machines (see Figures 7-8).

Suitability of Soils

The suitability of soil for adobe construction is of importance in ensuring a successful building. While there are some variations in the soil of particle percentages, generally the Nigerian soil is suitable for adobe and rammed earth construction. This is demonstrated by the vernacular architecture existing in villages and older parts of the cities. The goal of this portion of the paper is to identify and characterize soils and their suitability for adobe construction.

To reduce construction cost and eliminate transportation cost, it is best to carry out soil tests on the site of the expected construction. Simple field tests, while not scientific, can give a good approximation of soil characteristics. In order to increase efficiency and minimize disturbance of the site, a prudent approach would be to use the soil from the foundation excavations for making adobe bricks.

Generally the soil for making adobe should contain coarse sand, fine sand, silt, and clay. The clay and silt acts as a binder. In addition,

the clay adds elasticity and strength to the soil. Almost any soil of proper proportion is adequate for adobe as long as it contains the above particles. The top soil should not be used for construction. A higher proportion of sandy soil than clay and silt is about the best. The best approximate percentage ratio should range from a minimum of 55 per cent sand and 45 per cent clay to a maximum of 80 per cent of sand and 20 per cent of clay.

While there are other more accurate laboratory tests for soil quality the following field or site tests will suffice:

Visual Examination, i.e. visually evaluating the proportion and particle size of the grains from very coarse, coarse, medium, to fine sands. The very finest particles are clay and silt.

Touch or Feel Examination, a highly accurate field test. A sample of soil is rubbed between fingers or the palm to approximate the particle sizes. With sand, there is a rough feeling to it and total lack of cohesion. It is the smallest particle visible to the sight (0.074 mm) (United Nations, 1964).

The silt is rough when dry, just like the sand. In a dry clay it is difficult to achieve pulverization and the grains are coarse. But the wet clay is a very adhesive, cohesive and has strong plasticity. It exhibits volume change when moist (Table 4).

Screen or Particle Size Test, which is essentially a combination of both the visual tech and touch tech above. Over a 200-mesh screen, a known weight sample of dried and pulverized soil is sifted. This method segregates the particles by their sizes. Both the clay and silt will go

through the screen leaving the larger particles which are the sand (very fine and ocarse) on the screen (Figure 12). The sand is then reweighed. A good adobe soil should have from 50 per cent to 80 per cent sand, and 20 per cent to 50 per cent clay and silt.

Sedimentation Test. This test is probably the best in determining the physical composition of the soil. In a transparent jar or bottle with wide mouth a sample of soil is placed in the bottle to about one quarter to one half of its depth. Then clear water is poured into it. About two teaspoons full of salt may be added to help the clay and silt particles settle faster. This mixture is thoroughly shook and placed on a flat surface. After a couple of hours the mixture separates and settles according to the particle density. At the bottom of the bottle is the sand, followed by the silt. Above these is the clay particles (Figure 13). These layers are measured to determine the sand, silt and clay percentage ratio. From this ratio, the best soil for adobe construction will be that containing up to 20 per cent clay/silt and 80 per cent sand. If the soil does not meet this standard it could be improved by the addition of clay or sand, whichever is absent. It could further be improved by several stabilization methods which are discussed below:

Stabilization Materials and Methods

Earth in its natural form has been used traditionally for residential construction as noted earlier. One disadvantage of this material has been its durability. Its longevity is shortened because of its vulnerability to erosion. This shortcoming of adobe could be improved

by various methods of stabilization is the process of improving the structural strength, durability, and water repellent qualities by the addition of stabilizing agents. These stabilizing agents range from organic (vegetal) materials such as hays and straws to inorganic substances as lime, portland cement, and asphalt emulsion. While cost effectiveness is needed in determining the stabilization method, its use must be in direct relation to the type of soil as determined by the soil suitability and field tests. Soil stabilization methods are:

Compaction or Consolidation. This method compacts the soil particles closer together thereby increasing the cohesion and internal friction. When a soil is compacted and dried the adobe brick is strengthened by the reduction of the voids or air spaces between particles. A heavy soil, i.e. one with a greater clay content, could be treated before compaction. A certain quantity of coarse sand should be added to a high clay content soil to help reduce the likely volumetric changes resulting in cracking when dry. Similarly, clay should be added to soil which has a high sand content. Because of the smooth rounded form of beach sand, it does not adhere well and should not be used to treat a high clay soil.

The addition of vegetal matter such as straw and hay functions equally well in acting as a binding agent. The straw or hay, while not a strengthening material, does allow the adobe brick to dry with less cracking. The vegetal matter should be chopped into smaller pieces and thoroughly mixed with the mud paste. Historically, this method is a

standard technique in the design and construction of either rammed earth or adobe buildings in rural Nigeria.

Chemical Treatment. This method involves the addition of chemical materials to further fortify the brick. This treatment could be subdivided into waterproofing, and/or the addition of a binding agent such as portland cement.

Waterproofing. By the addition of asphalt emulsion, the resultant adobe brick is more water resistant. In addition, the emulsified asphalt adds cohesiveness to the adobe bricks. It should be noted that emulsified asphalt is not a strengthening agent but just waterproofing. The amount of emulsified asphalt depends on the physical composition and the quantity of the soil (Table 5). A high clay or silt soil will require more emulsified asphalt than one with high sand content. Emulsified asphalt added to adobe brick eliminates or reduces cracking because it reduces the absorption of water by capillary action.

Emulsified asphalt is mixed with water and poured evenly over already spread raw mud and thoroughly mixed together until uniform paste is formed. This may require a mechanical mixer to ensure uniformity. But this cost could be eliminated by manually mixing the mixture more vigorously. As a petroleum by-product, emulsified asphalt could be made available at low cost, as Nigeria produces and refines petroleum.

Lime Treatment. Limestone in its natural form is abundant in Nigeria. Local technology has been used in converting it to quicklime and it is also produced industrially in the country. Stabilization by lime treatment changes the chemical composition of the mud and also

increases the compressive strength and binds the soil together. As McHenry, Jr. (1984) noted, the addition of lime could have some disadvantages because of its hygroscopic nature. This property of lime allows the adobe brick to constantly expand and shrink in the presence of moisture.

Portland Cement Treatment. Stabilizing adobe units with Portland cement is very similar to making concrete blocks. Adding Portland cement to raw earth creates a strong cementous effect, and produces durable adobe bricks. The Portland cement as stabilizer has advantages over the other methods because of greater compressive strength and as a waterproofing agent. To achieve this relative advantage the Portland cement need not be added in large quantity and is again determined by the nature of the soil. In practice, a clay soil needs more Portland cement than a sandy soil.

Among all the stabilization methods mentioned the one with the least construction utility is the compaction/consolidation method. It is the most vulnerable to climatic action such as erosion by rain or wind. All the same, the advantage of all of these methods is that they could be combined together. A combination of these methods is surely to produce adobe bricks that are devoid of any of the disadvantages of a single method. And this combination does not call for any technical skill than that already available locally.

Adobe Brick Preparation Methods

The practice of making bricks for adobe construction ranges from the traditional methods of soaking-mixing pit and surface mixing to the low-keyed mechanical processes of plaster mixer, Cinva-Ram and Brepak machines. The essential equipments for this job are shovel, pick-axe, moulds, plastic covers or raffia roofing mats, and the necessary mud and stabilizing agents. In view of transportation cost, it is advisable to have all the bricks made at the site. This will also reduce the possibility of the bricks cracking and breaking in transit.

Soaking-Mixing Pit.

On the site, away from the actual construction zone and circulation path, a pit is dug. Inside the pit the mud is hydrated with water and thoroughly mixed by either feet or shovels until a homogenous paste is formed. Inside this pit all the stabilization methods could be carried out. At the end of the day's job the pit should be flooded to keep the pit's surface fresh for the next day's job.

Surface Mixing

This is a variation of the soak pit method. While mixing is done in a pit in the above method, the surface mixing allows mixing to be done on grade.

Mechanical Mixer

For the short-term use it is needed for, it may not be cost-effective to purchase a mixer. It should rather be rented or leased for

the work. Among the mixers the plaster mixer is better than the concrete mixer (Newcomb, 1980).

In the mixer, add water first and shovel in the soil. The mixer is turned on and water added again, enough to allow the soil to form a thick paste. Then Portland cement is added, sparingly, followed slowly by adding emulsified asphalt. If desired by the owner, chopped straw could be added. The final soil paste should be thick enough not to run off the shovel when it is shoveled.

The production of adobe blocks proceeds after the mud is stabilized and thoroughly mixed to a uniform consistency. The blocks could be used by any of the following methods: moulds, Cinva-Ram and Brepak Block press machines.

Moulds

The mould could be constructed to contain as many brick units as possible. However, the major determinant is the availability of labor. A one man labor force would need a mould that can easily be lifted alone. If more than one person, then a multiple mould would be appropriate.

The first step in this process is to clear a flat portion of the site, where the adobe brick mould would be laid down horizontally instead of on an inclined or rugged surface. Then a thin sheet of plastic or wooden planks are laid down upon which the bricks are formed. Fine sand could be sprinkled on the ground, to keep the bricks from sticking to the ground.

Next, put the moulds on any of these surfaces and place the already mixed mud into it. The mud is trampled, pressed and raked evenly into the mould to fill the corners. With a trowel or straight edge board the excess mud is scrapped off. The mould is lifted off and readied for the next moulding. At the end of each moulding, the mould must be cleaned by immersing it in water so the bricks will slip out easily.

"Cinva-Ram" Block Press. The machine is made of steel and hand operated for the making of stabilized blocks. Thoroughly mixed and stabilized mud is placed into the box and evenly pressed to fill in the corners. The box is then covered. The lever is moved into a vertical position and the lever latch disengaged. The cover is opened and the lever depressed to eject the block. This is removed and left to cure.

Figure 17 is a diagrammatic explanation of Cinva-Ram mechanism.

The advantages of Cinva-Ram press over concrete blocks are:

1. They are easier to make than concrete blocks. They can be removed immediately from the press and stacked for curing without the use of a pallet.
2. The cost of the building material is greatly reduced since most of the raw material comes from your own land.
3. Transportation costs are avoided since the machine is portable and the blocks are made near or on the construction site.
4. The blocks are easily handled.
5. The blocks need no baking since the curing process is completely natural.

6. The press makes variations of the block adapted to the various phases of construction (Volunteers in Technical Assistance).

Cinva-Ram block press is essentially a one block at a time mechanical press. On the average, the press, manned by two people, could produce about 300-500 blocks per day.

"Brepak Block" Press Machine. This machine developed by the Housing Research and Development Unit (HRDU) of the University of Nairobi, in collaboration with the Building Research Establishment is being used in Kenya to produce high quality building blocks using stabilized soil (Stevens, 1983). In the research carried out in Kenya the machine was found to have potentials such as:

1. It has offered opportunities for the HRDU staff and village people to produce, on a self-help basis and with minimum assistance, stabilized blocks, and to construct a low-cost building on site.
2. The Brepak machine produces high quality soil blocks which contain a large proportion of a locally available clay soil with a suitable stabilizer. The choice of the stabilizer to be used is determined by its cost relative to those of the others; for example, in Kenya the choice is between 4 per cent cement and 6 per cent hydrated lime.

3. The entire operation of preparing the soil, mixing and producing the blocks is simple to implement; it is therefore possible to use Brepak machine to produce blocks on any site without mechanical power or fuel.
4. When blocks are produced on a large scale for major projects, the use of human power is maximized and employment created for unsilled labor (Stevens, 1983).

Drying and Curing

The bricks are left in the flat position for about 3-4 days for an initial drying or until they are sufficiently hardened to be carried. After initial drying the bricks they are transferred to a permanent location for continued curing. They must be stacked vertically standing them on edge/end. The top of the bricks must be covered with a waterproof material to avoid excessive sunshine. While direct sunshine will hasten the drying process it could cause some cracking too. A slow drying process is advisable, especially during the first couple of days. Daily watering of the brick will slow down the curing process but is recommended. On stacking the bricks they should be raised off the grade to avoid absorbing ground water and must be off the drainage path. They must be stacked on end to prevent breaking. After about three to four weeks the adobes are ready for construction.

Building Materials and Accessories

Small-scale local iron foundries using local skills have been producing cast iron products using scrap metals. Such foundries should

be encouraged into producing construction materials such as anchor bolts, steel plates, nails, etc. Because of the use of scrap and local materials and local skills, the cost of such construction tools will be comparatively cheaper when compared with the industrially manufactured counterparts.

Being situated in the tropical rain forest, Nigeria is enriched with large quantities, qualities and varieties of timber. Nigeria has a "total forest area roughly 313,380 sq. km. which is about 36 per cent of the land surface" (Awotana, 1977). Such endowment of timber resources should be fully integrated into residential construction, mostly for trusses, ceiling joists, door and window frames.

Not only is the Cinva-Ram and the Brepak Block Pressing machines quite useful to owner-builder approach, they do provide enormous opportunity for commercial adobe block making. An encouragement in this direction by the government will be a boost to the small business adventures, creating employment opportunities and through a performance standards established by the government will ensure a higher grade of adobe blocks and other building accessories.

Table 4. Field Test for Soil Suitability.

Soil Texture	Visual Detection of Particle Size and General Appearance of the Soil	Squeezed in Hand and Pressure Released		Soil Ribboned Between Thumb and Finger when Moist
		When Air Dry	When Moist	
Sand	Soil has a granular appearance in which the individual grain sizes can be detected. It is free-flowing when in a dry condition.	Will not form a cast and will fall apart when pressure is released.	Forms a cast which will crumble when lightly touched.	Cannot be ribboned.
Sandy Loam	Essentially a granular with sufficient silt and clay to make it somewhat coherent. Sand characteristics predominate.	Forms a cast which readily falls apart when lightly touched.	Forms a cast which will bear careful handling without breaking	Cannot be ribboned.
Loam	A uniform mixture of sand, silt and clay. Grading of sand fraction quite uniform from coarse to fine. It is mellow, has somewhat gritty feel, yet is fairly smooth and slightly plastic.	Forms a cast which will bear careful handling without breaking.	Forms a cast which can be handled freely without breaking.	Cannot be ribboned.
Silt Loam	Contains a moderate amount of the finer grades of sand and only a small amount of clay - over half of the particles are silt. When dry it may appear quite cloddy; can readily be broken and pulverized to a powder.	Forms a cast which can be freely handled. Pulverized it has a soft flour-like feel.	Forms a cast which can be freely handled. When wet, soil runs together and puddles.	Will not ribbon but has a broken appearance, feels smooth, and may be slightly plastic.
Silt	Contains over 80 per cent of silt particles with very little fine sand and clay. When dry, it may be cloddy; readily pulverizes to powder with a soft flour-like feel.	Forms a cast which can be handled without breaking.	Forms a cast which can be handled. When wet, it readily puddles.	It has a tendency to ribbon with a broken appearance, feels smooth.
Clay Loam	Fine textured soil breaks into hard lumps when dry. Contains more clay than silt loam. Resembles clay in a dry condition. Identification is made on physical behaviour of moist-soil.	Forms a cast which can be handled without breaking.	Forms a cast which can be handled freely without breaking. It can be worked into a dense mass.	Forms a thin which readily breaks, barely sustaining its own weight.
Clay	Fine textured soil breaks into very hard lumps when dry. Difficult to pulverize into a soft flour-like powder when dry. Identification based on cohesive properties of the moist soil.	Forms a cast which can be handled freely without breaking.	Forms a cast which can be handled freely without breaking	Forms long thin flexible ribbons. Can be worked into a dense compact mass. Considerable plasticity.
Organic Soils	Identification based on the high organic content. Muck consists of thoroughly decomposed organic material with considerable amount of mineral soil finely divided with some fibrous remains. When considerable fibrous material is present, it may be classified as peat. The plant remains or sometimes the woody structure can easily be recognized. Soil colour ranges from brown to black. They occur in lowlands in swamps or swale. They have high shrinkage upon drying.			

Source: United Nations. Soil-Cement, Its Use in Building (1964).

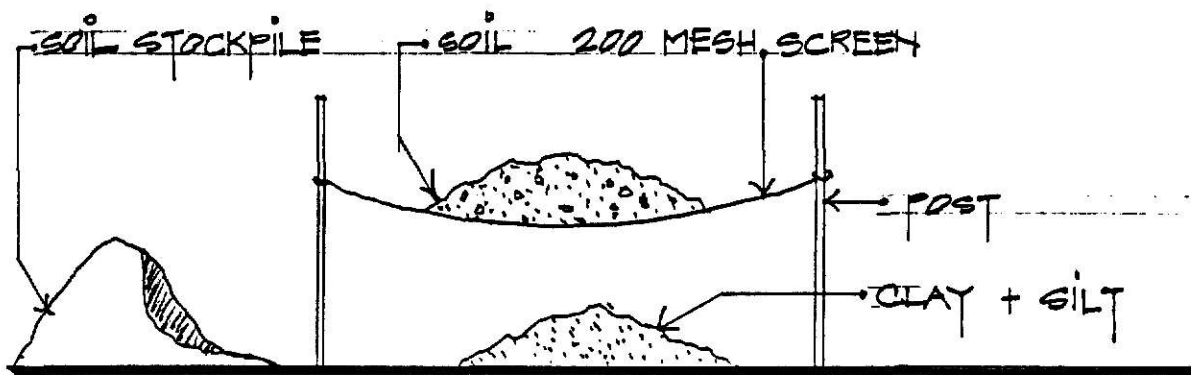


Fig. 12: Screen Test Diagram.

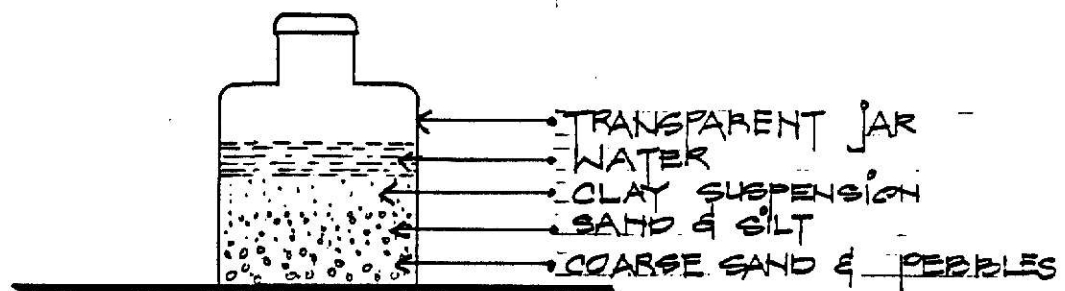


Fig. 13: Sedimentation Test Diagram.

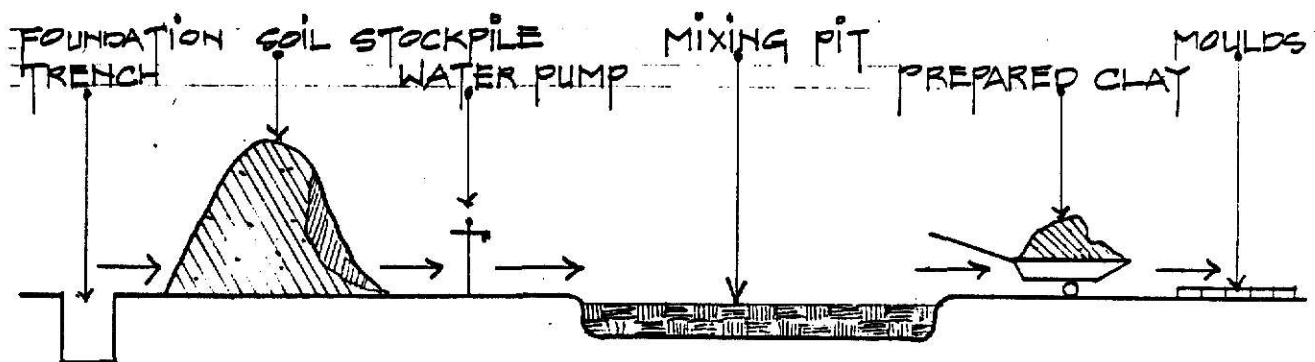


Fig. 14: Soaking-Mixing Pit.

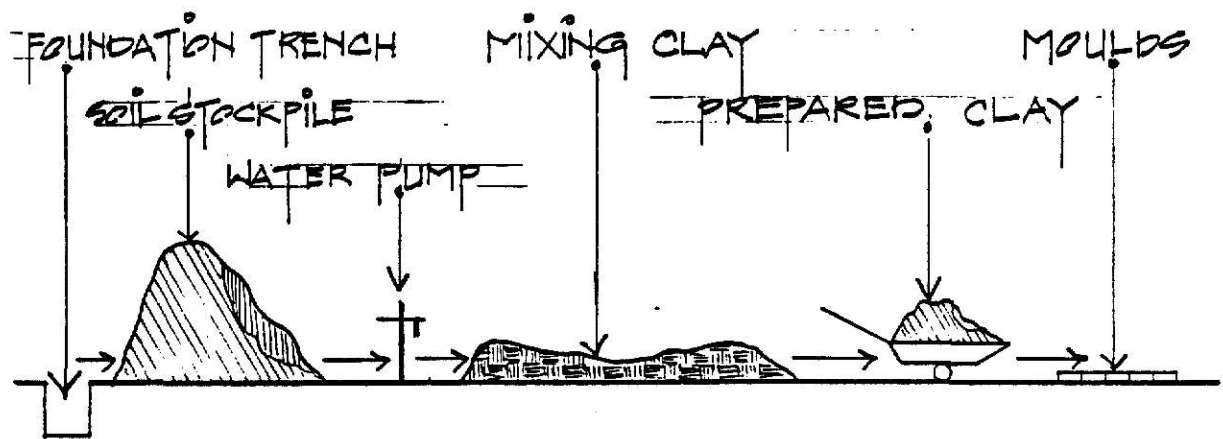


Fig. 15: Surface Mixing.

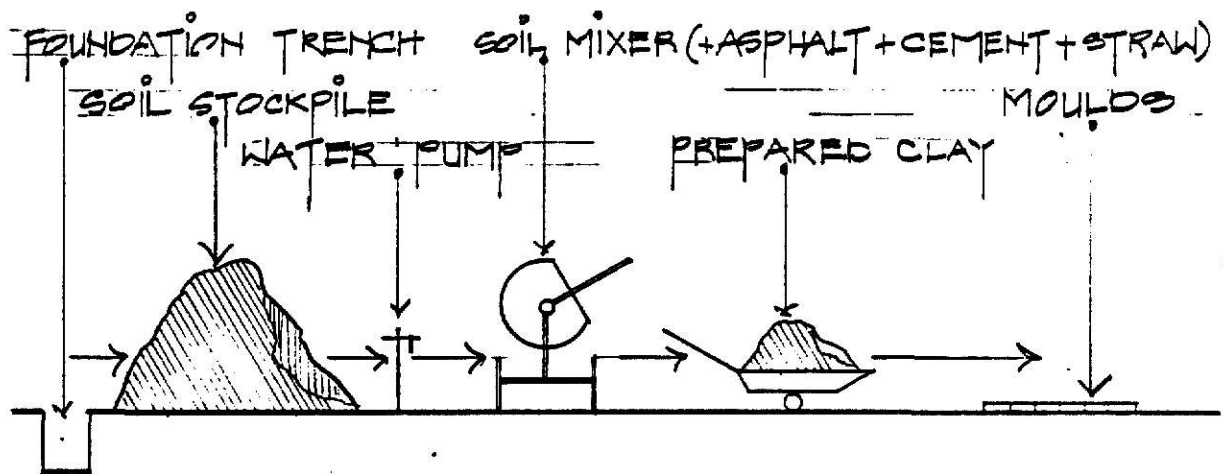


Fig. 16: Mechanical (Plaster) Mixer.

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rollers, since this end receives the greatest pressure. The washers help to keep the bolt head from pulling through the board. If the heads do start to pull through, install larger washers immediately; the great strain put on a loosely mounted press can easily throw it out of adjustment and eventually break it.

45. Pressing.

- (1) Open the cover.
- (2) Make sure the piston is all the way down. If it is part way up it will not be possible to get the correct amount of mixture into the box.
- (3) Dump the proper amount of soil-cement mixture into the box (see Fig. 8). The supervisor should determine the correct amount of mixture for each block - a measuring box can be used to make sure that the same amount is used each time. Uniformity in loading is absolutely necessary for producing uniform blocks.
- (4) Fill the corners of the box to the top so that the corners of the finished block will be well pressed.
- (5) Press a bit in the corners with your fingers.
- (6) Replace the cover.
- (7) Move the lever to a vertical position, letting the lower rollers fall into place (see Fig. 9).
- (8) Disengage the lever latch.
- (9) Move the lever to a horizontal position on the side opposite the lower rollers (compression cycle) (see Fig. 10). If the right amount of mixture is used, one man of average weight should be able to move the lever down alone with only two or three pushes. The lever must be

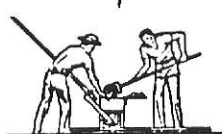


Fig. 8 - Filling the Box.



Fig. 9 - Raising the Lever.

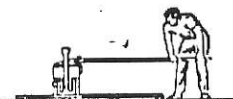


Fig. 10 - Lowering the Lever.

lowered completely; otherwise the block will be too thick, wasting material and producing a block which may be too thick to use.

- (10) Move the lever to a vertical position, engage the lever latch and return the lever to its rest position on the lower rollers.
- (11) Open the cover (see Fig. 11).

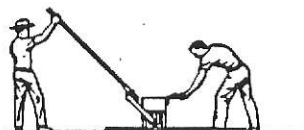


Fig. 11 - Returning the Lever to Rest Position and Opening the Mold Box.

- (12) Depress the lever steadily to eject the block (see Fig. 12). If the block is cracked or deformed, it should not be used. Read the instructions in paragraphs 52-61, Adjustments.



Fig. 12 - Ejecting the Block.

- (13) If the blocks are lifted from the machine and carried properly and carefully, and if the mixture is correct and the machine is in good adjustment, the blocks will not break easily.

(a) Press in on opposite ends of the block with the fingers closed, the thumbs in close to the fingers, and using part of the palms (see Fig. 13).

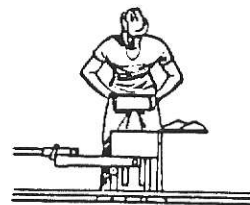


Fig. 13 - Removing the Block.

- (b) To set the brick down, tip it into place on its side.

Fig. 17: CINVA-RAM Operation.

Amount of Emulsified Asphalt Needed per Brick Utilizing a $\frac{1}{8}$ Cubic Foot Test Box		
Measuring Cup oz of Asphalt per $\frac{1}{8}$ cu ft Box	Gal per cu ft of Soil	Measuring Cup oz Needed per Brick
4	$\frac{1}{4}$	9.1
6	$\frac{3}{8}$	13.7
8	$\frac{1}{2}$	18.2
10	$\frac{5}{8}$	22.9
12	$\frac{3}{4}$	28.0
14	$\frac{7}{8}$	32.0

Source: Newcomb. The Owner-built Adobe House.

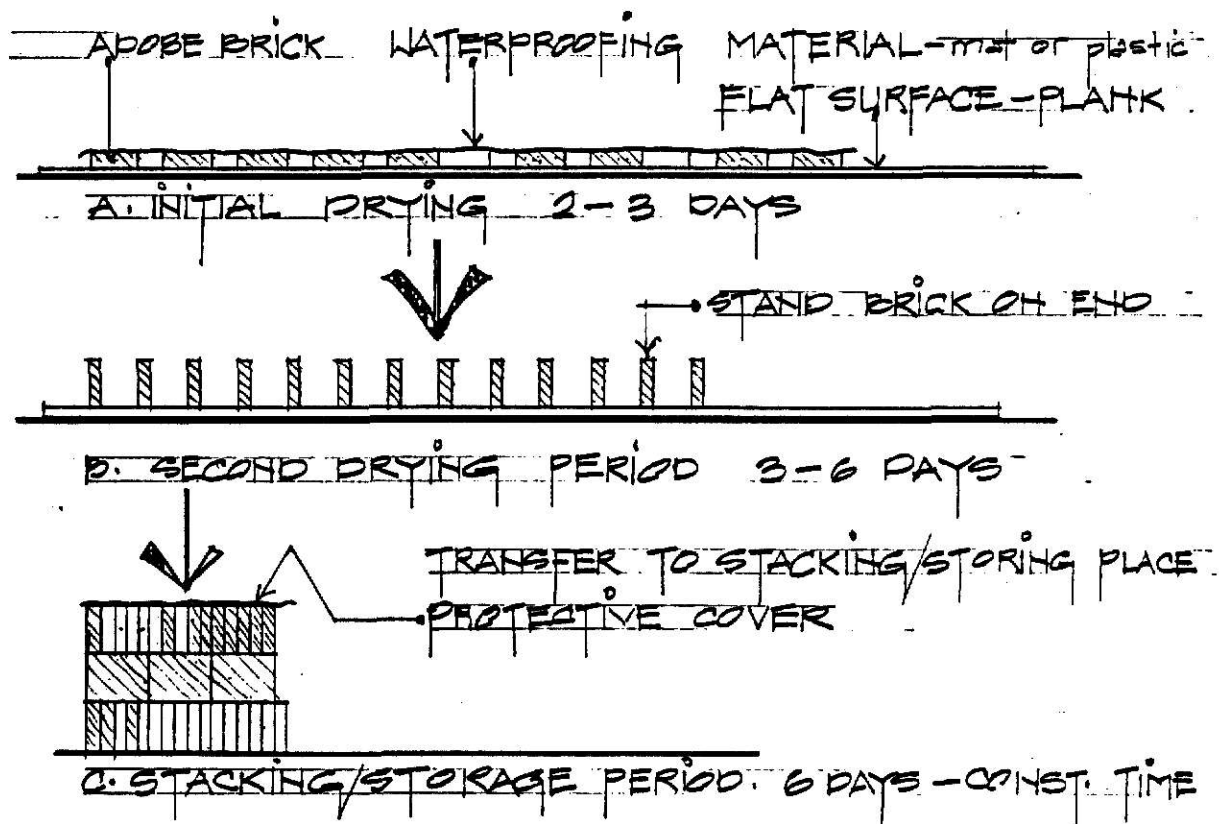


Fig. 18: Drying, Curing, and Storage of Adobe Bricks.

CHAPTER 6

ADOBE CONSTRUCTION TECHNIQUES

To effectively carry the load exerted by the building materials, the soil should be structurally sound to withstand such pressure. In the adobe construction one of the major determinants in the construction will be the height to thickness ratio. Because of low tensile strength, the structure is best made to be load bearing.

Foundation

Foundations for adobe construction must be capable of bearing the structural load. The soil must be stable for this, and the foundation type adjusted or adapted accordingly. But the rule of thumb is that the more unsuitable the soil (e.g. sandy) the wider the foundation footing. In general terms, soils good for foundation should be firm and less liable to volume changes. Among such soils should be "stones, gravel, consolidated dry sand, and compacted clay not subjected to appreciable moisture changes" (United Nations, 1964).

A continuous concrete foundation footing is probably the best foundation type for this type of construction. The footing by rule of thumb should be twice the width of the foundation wall. This will help for proper distribution of the vertical load.

For undisturbed soil the trench for the foundation need not be more than 2 foot deep. The bottom of the excavation should be levelled with shovel, or the trench compacted with gravel or stone. Concrete is then poured to about 4 inches high with roughened surface. The first course

of blocks are laid on top of this. To avoid the damage to the bricks through the absorption of ground water it is advisable that the blocks for the foundation be of cement. As a prevention against undercutting of the walls at grade level, the foundation wall should be at least 6" above grade. Among contributors to structural failures undercutting is a notable factor. The use of cement for the foundation guards against the destructive attack of subterranean termites. Another foundation method could be the spread type. Piles of concrete or wood are driven into the ground and floor slab poured over it. Timber could be used in place of the concrete piles but they must have to be treated against termite attack. This type of foundation is best suited for poor soils such as muddy or filled sites (i.e., soils that are unstable).

Wall Systems

Walling

As the skin of the building the wall acts as protective cover against the environment. Also the wall transfers structural loads from the roof down to the foundation.

Construction guidelines should be established both vertically and horizontally. A carpenter's level, plumb-line, and string are used for this. The placing of the blocks would be facilitated by the use of "block-fitters." And the corners should be laid first. The bricks' joints should be alternated so that mortar joints of a course of block should coincide with the centre seam of the block above and below. Such an arrangement will allow the proper load transfer to the foundation.

The mortar for binding the blocks together could be from raw mud to soil-cement mixed with lime. In order not to exert undue structural load on the blocks, thereby causing sheer stress, the raw mud as mortar should not be used. The mortar should be made of equal strength as the adobe block but thinner. Before setting any block in place, its surface must be moistened very lightly.

The types of mortar commonly used are:

Mud Mortar: This is clay of the same mixture as adobe blocks made into mortar. Any pebble should be removed either when the mortar is being made or used. The mud mortar is not as strong as the ones mentioned below, but nevertheless is a good mortar. It could be used for interior walls that are not load-bearing.

Cement Mortar: The cement mixed with water and sand will give a better mortar. The cement to sand proportion should be 1:7 to 1:10 by volume. It will set faster than mud mortar (United Nations, 1964).

Cement and Lime Mortar: Lime and cement mixed in right proportion of 1:2:8 (lime, cement, sand) will be another variation of mortar.

The above two methods will need to be justified because of its cost. These mortars call for the use of cement that may be unnecessary. Their use could be limited to the outside load-bearing walls.

Soil-Cement Mortar: This is the exact composition used in the adobe production. The strength of this mortar will be the same as that of adobe brick.

Preferably, a combination of all the above methods could be used. The soil-cement mortar could be used for the external walls while the mud mortar is used for the internal non-load bearing walls.

Lintels: Wood or concrete are commonly used for lintels. The timber should be heavier and about 8" wide. For proper anchor to the blocks, the lintel should be provided with adhesive anchors like 6" nail, guaze or metal straps. Also, the lintel should be treated with emulsified asphalt to make it water repellent and termite retardant. Both ends of the lintel should extend for at least 12" into the wall. The wooden lintel could be incorporated into the bond beam above or isolated as shown below.

The concrete lintel, though an additional cost, could be used where it is affordable. Similarly, it could be incorporated into the bond beam.

Bond Beam: The bond beam is used to cap the wall. It functions as an anchoring device for the walls, preventing spreading and cracking. To be effective it will be desirable to use concrete, but stabilized soil could suffice. But this should have a high content of cement. It should be about 4" minimum thickness and reinforced with one or two #2 reinforcing bars. Where the beam runs over window or door lintels, both should be anchored together. Provisions for metal strap anchors or anchor bolts must be available for the roof to be held in place (Figure 20).

Frame: The door and the window frames are best secured to the wall with wooden blocks called "GRINGO" blocks or nailing blocks. These are

placed between courses and a rough buck, or rough frame will then be nailed to the gringo blocks. The rough frame or buck provides anchoring surface for nailing door and window frames. The gringo/nailing blocks should be of the same size as the adobe brick. For protection against moisture and termite it is best to treat the gringo/nailing blocks with bituminous paint. One advantage of gringo block over metal anchors such as nails, screws, and metal strap is that they are not prone to expansion and contraction due to temperature changes. And with time, the metal strap rust and loose their grip.

Flooring

The floor could be laid down using either of the following:

Soil-Cement Floor: Before laying on the floor the ground must be levelled and compacted. It must be adequately moistened before compaction. Small stones and gravel could be added. The proportion of the soil-cement mortar should be about 1:6 or 1:8 of cement to sandy soil. The mortar should be laid to a depth of about 6". When the floor sets, it is moistened and sprinkled with dry cement before being smoothened out with a finishing trowel. At every 3'-0" intervals small grooves may be made to act as expansion and shrinkage joints. This device will prevent the cracks and fissures likely to occur (Figure 22).

Earth Floor: As noted above, the earth must be solidly compacted. The soil is moistened with water to form a workable mortar. The soil for the earth floor should contain more clay. After mixing into a troweable consistency, the mortar is laid in layers. The layers are laid to a depth of 2" at a time. Each layer must be allowed to dry before applying

the next layers. As cracks develop they are filled with water and smoothened out with a trowel. The surface is finished with a thin layer of cement mortar. This could be made more waterproof by the addition of emulsified asphalt (Figure 22.1). This is a common practice in vernacular architecture.

Concrete Floors: Among the different floor types the concrete floor has greater strength. Also, it is the costliest. The concrete floor could be made as a monolithic part of the foundation. If done in this fashion it should be structurally supported. The concrete should be of structural grade of 2500–3000 psi and reinforced accordingly with wire mesh and reinforcing bars. The earth must be compacted before pouring the concrete. The slab may not require additional treatment to resist water penetration unless where and when necessary. Unless determined for engineering reasons, this type of floor may serve the low-cost goal because it lasts longest and requires little or no maintenance (Figure 22.2).

Finishing

While natural mud surfaces as adobe brick have beauty, care must be taken to prevent such surfaces from wind and rain erosion. A well stabilized adobe will not present much problem. A 10–20 percent of clay content in adobe brick will be of sufficient strength to resist erosion caused by rainfall. The joints must be filled properly with mortar to avoid the creation of water pockets. The availability of water pockets will set off capillary reactions, which will subsequently erode the wall. The wall could be struck finish or raked mortar finish. In struck

finish, the mortar joints are trimmed with a trowel. In raked mortar joints, individual block is defined and the mortar flushed (McHenry, 1984).

Both of these approaches expose the gringo blocks, the frames, and the lintels of the doors and windows. Additional attention is called for to protect such junctures. Such juncture must be anchored to the wall as illustrated in Figure 21.2.

Plastering is another step further in protecting the wall surfaces. Traditionally, mud with some organic matter has been used as plaster. The mud properly moistened to troweable paste is applied on the brick surfaces in thin coats. The adobe surface should be moistened to provide plasticity for the mud plaster to adhere to. As the plaster dries, cracks and shrinkages are likely to occur. The surface should be wetted again and retroweled. Each additional layer should be applied by this method. The mud plaster when set is hard but is not waterproof.

The addition of emulsified asphalt will give it the waterproofing character. Soil-cement (stabilised soil) will definitely be a better plaster than the mud plaster. The mud plaster could be stabilised with only emulsified asphalt without the cement. Stabilised plaster is not hygroscopic and not liable to volume changes.

Roofing

Due to the lack of vertical reinforcement anchoring the roof to the foundation, there is need to secure the roof properly to the wall. The provision of a bond beam presents a suitable anchorage for the roof to the building. A wooden plate anchored to the bond beam acts in turn as

anchoring surface for the roof trusses and joists. Alternatively, a metal strap embedded into the bond beam holds the roof structure in place. Where an overhang is desired, it should be as is the case in Nigeria, additional anchoring is needed as shown in Figure 23. The eave joists are tied back to the wall. This will present a resistance force against moment effect of the wind (Figure 23).

Roofing panels is among the major construction components that affect implementation of low-cost housing. Corrugated galvanized iron and aluminum roofing sheets are primarily used. Also, asbestos cement roofing panels are used. But the drawback to these materials is the cost. When new, the galvanised iron and aluminum roofing sheets, present enormous glare, high reflectance, and poor heat insulation. On the other hand, when old, they present unaesthetic quality of a cityscape because of their rustic appearance. Also, asbestos material is proven to be carcinogenous in loose form. Therefore, asbestos roofing panels are potential health hazards.

Bryant (1978) has successfully used agricultural products to produce roofing panels called corrugated oriented roof board (CORD). The materials were sugar cane bagasse or rice straw subjected to from hammermilling to post treatment using aluminized asphalt. Pilot projects have been carried out in Ghana, Jamaica, and the Philippines. The sheets are about 17" x 7.5' x 1/8" in size and could cost between one-quarter to one-half the cost of corrugated galvanized iron roofing sheets. According to Bryant,

"The potential benefits to Third World communities resulting from the manufacture of the product include the creation of employment, savings of foreign exchange and strengthening of agricultural based economies while providing low-cost construction materials for local building (Bryant, 1978).

Another intermediate technology of using organic fibres such as sisal, coconut oil, and date palm fibre, etc. have been developed by the IT Building Materials Workshop in Cradley Heath, Britain. The fibres are used to reinforce cement and sand inside a steel frame and supported by a polyethene sheet. The end product is a fibre-reinforced concrete (FRC). Fibre-reinforced concrete roofing sheets have been shown to have longer durability and suffer not from discolouration (rust) that corrugated galvanised iron roofing sheets are known to experience. It is a labour intensive technology and "from the viewpoint of self-builders, the greatest advantage of the new FRC Technologies is portability of the plant and its independence of normal services. These features make it possible to undertake production on the building site, reducing both transport costs and breaking" (Parry, 1984).

Additional information on the mechanisms of corrugated oriented roof board (CORD) and fibre-reinforced concrete (FRC) is available on Corrugated Roofing Panels from Agricultural Residues by Bryant, Ben S. in Intermediate Technology and Building Materials and Construction Systems by Parry, John P.M. in Low-Income Housing in the Developing World respectively.

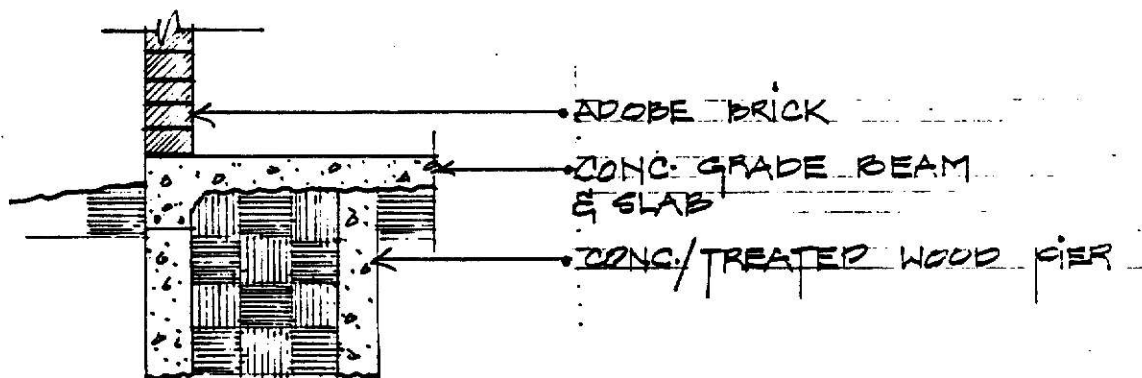
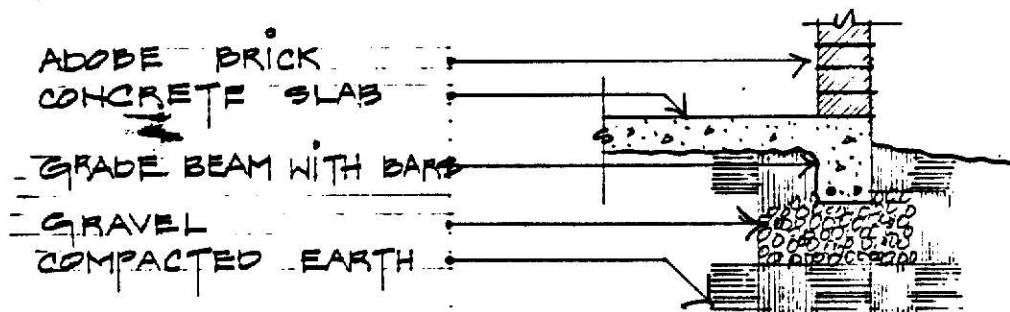
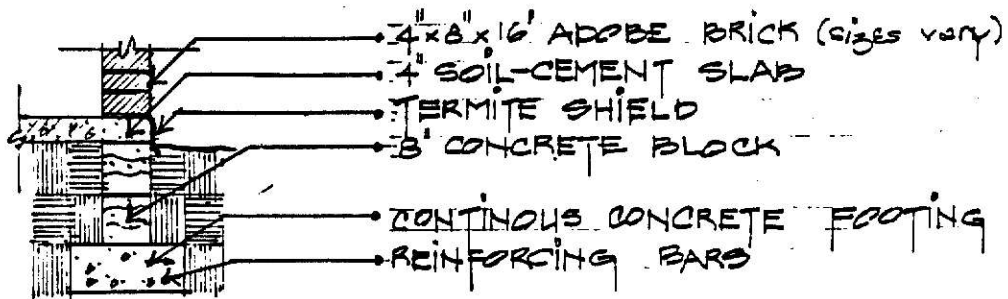
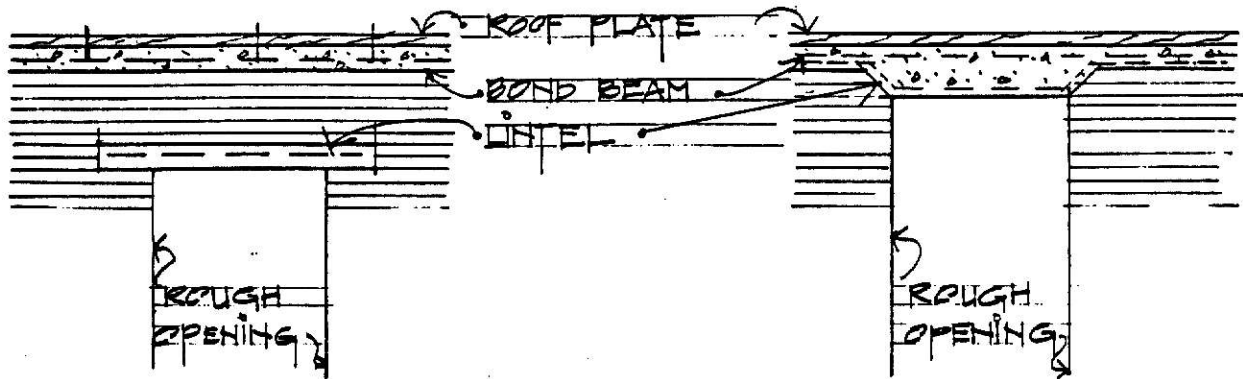
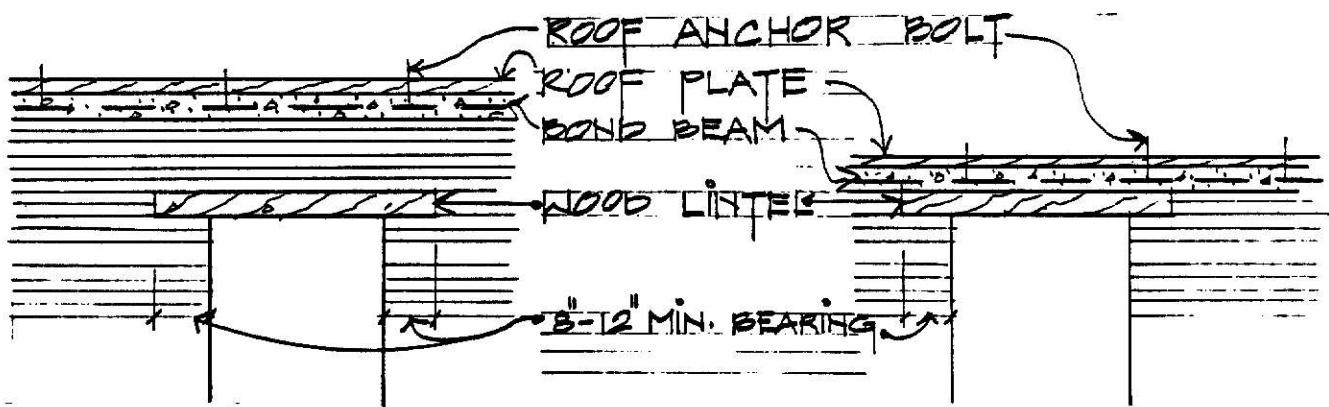


Fig. 19: Types of Foundation.



1. INDEPENDENT BEAM-LINTEL 2. COMBINED BEAM-LINTEL
 CONCRETE BEAM AND LINTEL



3. INDEPENDENT BEAM-LINTEL 4. COMBINED BEAM-LINTEL
 CONCRETE BOND BEAM AND WOOD LINTEL

Fig. 20: Types of Bond Beams and Lintels.

**THIS BOOK
CONTAINS
NUMEROUS PAGES
WITH DIAGRAMS
THAT ARE CROOKED
COMPARED TO THE
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THE PAGE.**

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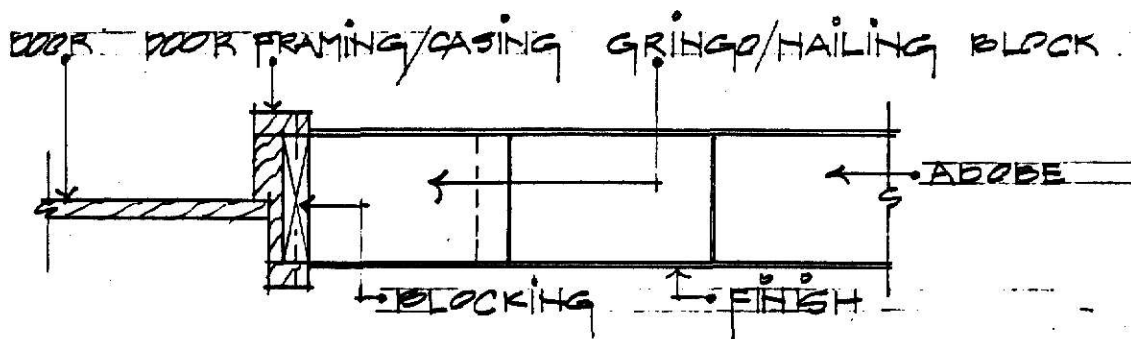
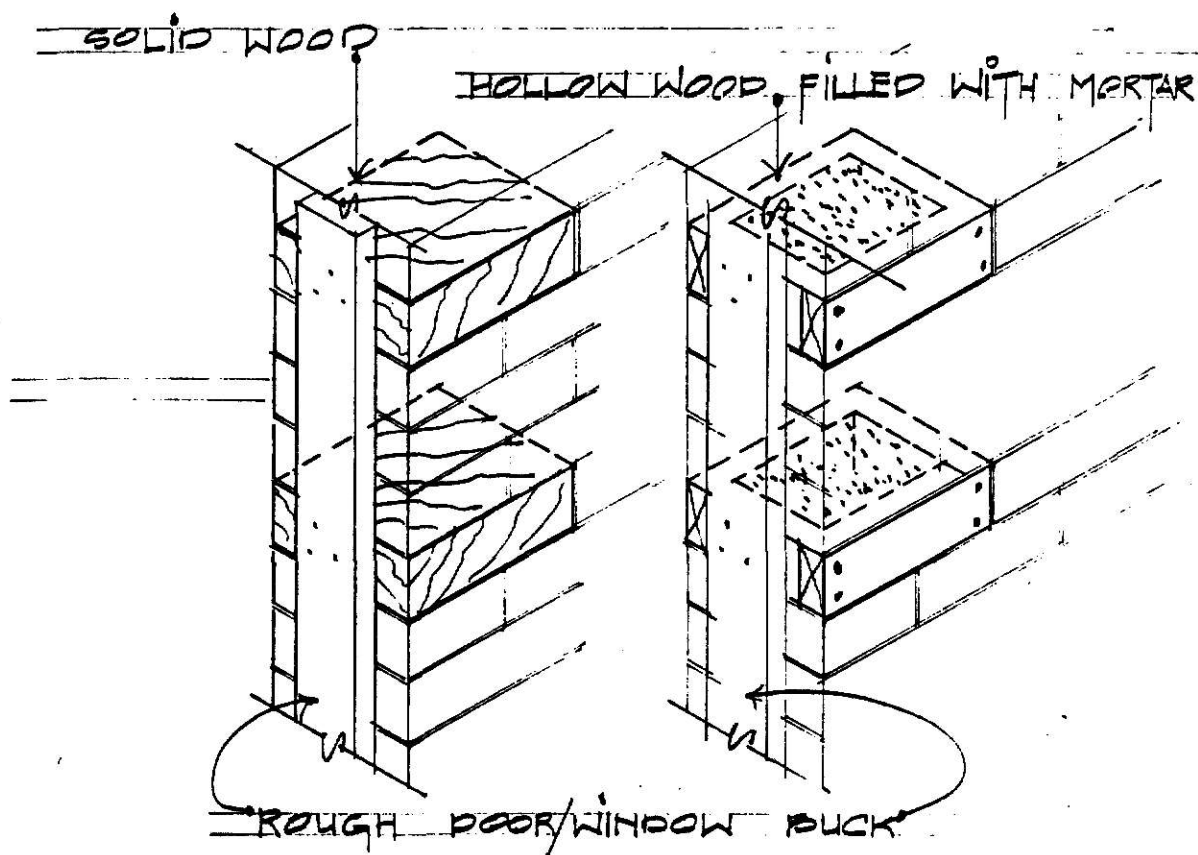


Fig. 21.2: Door or Window Casing Detail.



THE NAILING BLOCK SHOULD BE
MADE THE SAME SIZE AS THE
ADOBE BRICK. IT MUST BE
TREATED WITH EMULSIFIED
ASPHALT TO PROTECT
AGAINST TERMITE ATTACK.
MINIMUM OF 3-BLOCKS PER JAMB.

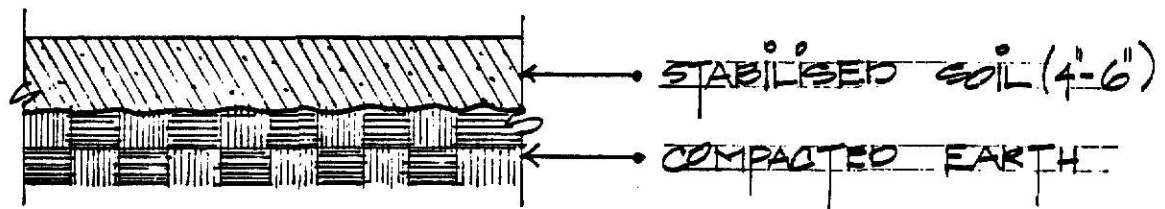


Fig. 22.0: Soil-Cement Floor.

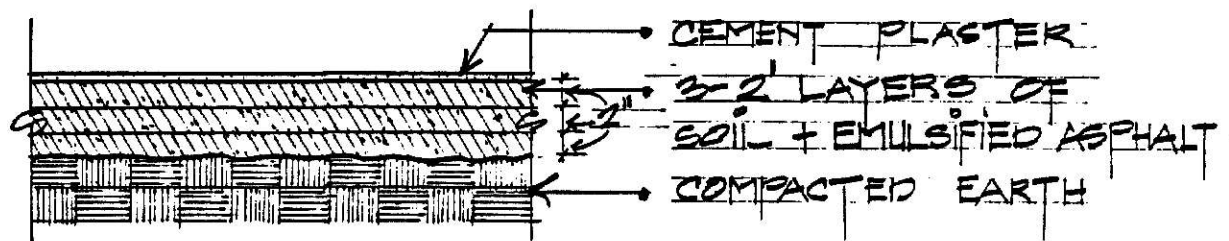


Fig. 22.1: Earth Floor.

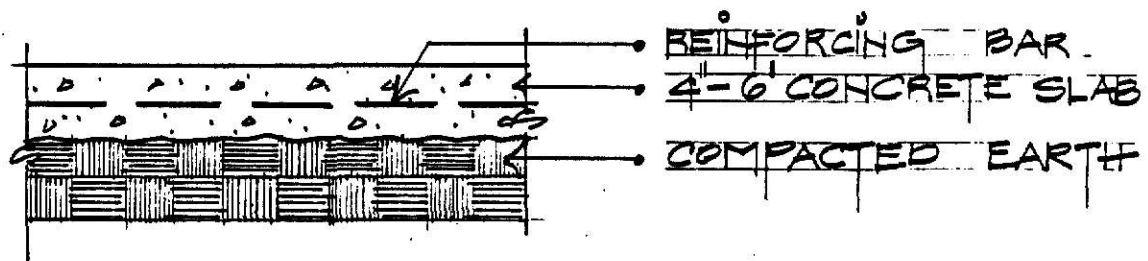


Fig. 22.2: Concrete Floor.

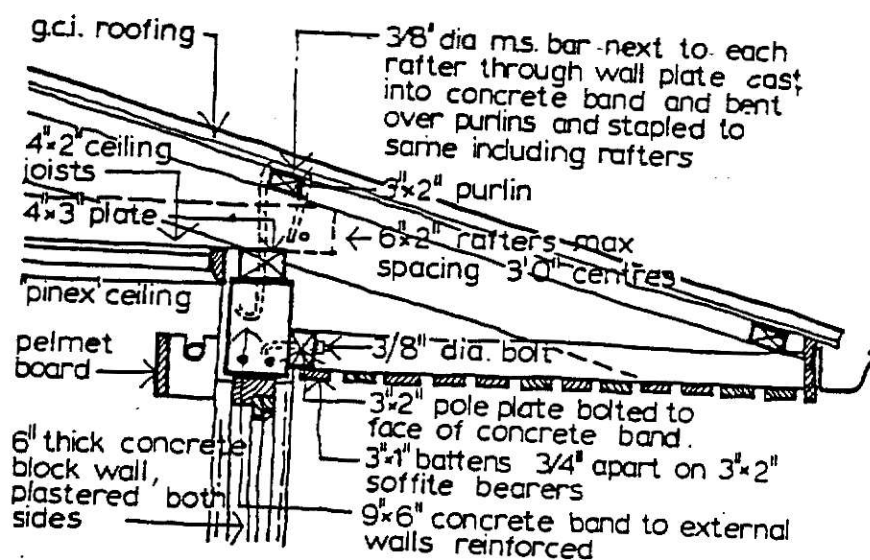
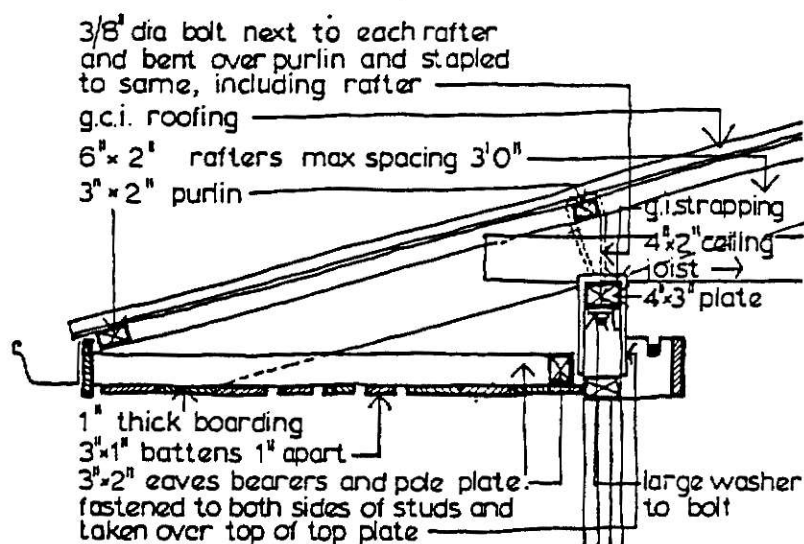


Fig. 23.0: Roofing Systems.

Source: Fry, Tropical Architecture.

CHAPTER 7

DESIGN CONSIDERATIONS FOR HOUSE DESIGN

To be properly considered a place for habitation, a house must satisfy certain minimum requirements ranging from socio-cultural factors to architectural and infrastructural needs. While there may be various trade-offs in achieving a desirable goal, none should be relegated to the background. A functional design stems not only from the physical distribution of spaces or functions but also the cultural implications that it has to the ultimate users. In addition to architectonic and climatic considerations for house design, socio-cultural elements affecting building design and physical planning must be considered.

Socio-Cultural Significance of a House

A grievous mistake that has consistently been repeated in almost all public housing designs, even in private houses, is the erroneous assumption by architects and planners of the existence of mono-culture. On this premise, the designs have been a transplant of western architecture to the country without efforts for regional adaptation. The craze for the so called "modern" architecture has resulted in the misuse of spaces in the houses. The misconception of what "modern" architecture is all about has lead to misinterpretation of traditional/ vernacular architecture. Traditional architecture is being viewed as mud architecture instead of in terms of cultural determination of functional spaces.

The issue of private and public spaces has lost its meaning in modern architecture in Nigeria. The single-space (compact) concept of the modern architecture allows for concentration of functional spaces. As Figure 24.0 shows, the room layout creates functional conflict. The bedrooms that are meant to be private open directly into the living room. Such room relationship does not allow for private activities (e.g. discussion) to take place in the bedrooms without being overheard by guests in the living room and vice versa. The guest and the host are constantly distracted by activities in either the bedrooms or living room. The entrance to the house is through the living room. This is totally absurd. The egress or ingress through the living room with a guest around is not viewed as a mark of respect. Another total disregard to cultural dimension of design is the integration of dining and living rooms into a single-space (Figure 24.0). In the western culture such a concept is right where visitation is limited or by appointment. In Nigeria this is not true, visitations are usually unnoticed and occur any time of the day. Therefore, it is absurd to intergate such divergent spaces because family dinner would be interrupted by unexpected guests. Whenever this happens the guest is welcome to join the family dinner. As rightly put by Aradeon (1981) with the same circumstance occurring in the western society, "the guest is given a magazine, and perhaps a drink, while he waits for his host to finish eating." Figure 24.0, on the other hand, allows for dining space to be allocated in either spaces noted. One alternative is designing the dining to occur as shown with kitchen, toilet, and bathroom around it. This approach is not only a blatant

ignorance to cultural norms but also a total disrespect to culture. It is not a welcome scene to be having dinner and have someone easing oneself (passing faeces) across the room.

Thoughtful understanding and with appreciation of socio-cultural norms is enough to realize that the physical proximity of such spaces as dining, kitchen and toilet is a cultural "no-no." The process of easing oneself is considered a ritual. And as such, the ritual is supposed to be performed in seclusion. The toilets in Figures 24.0 and 24.1 are designed to be flush systems, hence their location. But the fundamental issue overlooked in this solution is the necessary supply of urban water. Unwarranted water shortage has become a daily expectation of urban life in Nigeria. With the non-availability of water the flush toilet ceases to function. This becomes a potential health hazard to the tenants in particular and the public in general. And the issue is aggravated when you have the toilets located as shown.

The kitchen is the other space that has been wrongly interpreted in the "modern" architecture. Traditionally, the kitchen is primarily considered the "woman's" domain, but at the same time does serve as informal conservation area for the family and intimate guests. Therefore, the kitchen design calls for openness. The positioning of the kitchen in Figures 24.0 and 24.1 does not allow for openness. The two designs are close-knit and their rigidity does not permit flexibility for their use. The kitchens for these houses are designed on the assumptions that gas/electric cookers, or kerosene stoves will be the cooking appliances. Again, these assumptions have been proven wrong. Fire wood

is still the primary cooking fuel. Even for those that use gas or kerosene stoves, fire wood stoves are used as back-up alternatives in the event of gas or kerosene shortages or power outage. Wood stoves as the primary cooking appliances require proper ventilation because smoke and soot formation present a major aesthetic and functional problem. Even the kerosene stove is not free from this problem. In addition, it produces gaseous odor and carbon monoxide, which is dangerous to health. The location of the ktichens in the two designs illustrated definitely does not help solve these problems. In Figure 24.1 the kitchen faces the road while the bedrooms are placed at the back of the house. The kitchen, which is supposed to be private domain, is rather treated as public by its location. In none of these plans shown is there any provision for storage. This is an essential part of the house.

There is only one entrance/exit serving the house in Figure 24.1. In essence, the passage is used as both formal and informal egress and ingress. This is not right. There should be provision for entrance into the courtyard. While the house in Figure 24.0 has no courtyard it does have two entrances. The front entrance is treated as formal ingress and egress. And the back entrance is regarded as informal. The issues raised in this section are considered to be shared by most cultures in the country, but each particular design should be tailored to its geo-cultural location. The negligence of functional interrelationships of spaces and socio-cultural spatial determinism has caused visible apathy in public housing.

Climatic Elements Affecting Design

A greater portion of Nigeria is situated in the Warm-Wet sub-region of the tropics, the northern most half being in the sub-humid region. These two climatic zones are noticeably different because of their seasonal characteristics. These differences call for architectural and planning approaches responding to each geographical conditions.

Warm Wet Climate

As the name depicts, this area experiences heavy rainfall for greater part of the year as much as nine months in a year. The rains are mostly conventional rainfalls, often stormy and torrential, occurring usually in the afternoons. The relative humidity could be as high as 90 per cent. The temperature could be as high as 27°C (80°F) with diurnal range of temperature about 8°C (15°F). There are two principal wind systems, namely the southwest and the northeast trade winds. The southwest trade winds are moistened laden winds, delivering heavy rainfall to the coastal regions and diminishing progressively as it moves inland. The northeast trade winds are cool and dry and usher in the harmattan season. Also, there are land and sea breezes. These occur because of the constant heating and cooling patterns of land and sea/rivers. The sea breezes occur at night, and the land breeze at noon. The effect of these breezes are felt mostly along coastal and river areas. The primary design consideration for this region will be the assurance of continuous natural ventilation. This singular factor

will affect the orientation, sun control, roof design, landscaping, room alignment/configuration and other socio-cultural issues.

Sub-Humid Climate

The rainfall in this region is less than that experienced in the warm-wet region. The diurnal range of temperature is as high as 20°C (36°F). That means that the mean temperature is as high as 70°C or 158°F. While the night temperature dips as low as 15°C (59°F). The relative humidity fluctuates with the temperature, 20 per cent in the afternoon and about 40 per cent at night. Both southwest and northeast trade winds are experienced here but the most dominant is the cool, dry northeast wind. By the time the southwest wind makes it inland it has lost most of its moisture. The major architectonic consideration for this region will be cooling through natural ventilation.

Housing--Design Approach

For the purpose of this report, a great deal of emphasis will be placed on socio-cultural and climatic factors to be considered while designing residences in the Warm Wet region of the country. Relevant comments will be made in passing as it affects the sub-humid region. For illustration purposes, the author intends using his design competition for low cost housing as a reference.

The design (Figures 25.0 and 25.1) is an attempt to "modernise" vernacular architecture without losing the essential socio-cultural context that shaped traditional architecture.

The design strategies employed for this competition were to orient the long axis of the building on an east-west direction. The intent was to minimise the building's exposure to solar radiation. Invariably, this plan form affected the distribution of spaces. Most usable spaces have to be concentrated on the north or south sides of the building. On the south and east sides of the house are usable patios/vernandas.

The rooms are single-banked on the east-west axis and form L-shape on the east side. The private wing of the house, i.e. the bedrooms, are markedly separated from the public and semi-public areas--the parlour and the dining. This distinct separation by the corridor and the location of the door leading to the parlour help solve the problem encountered in Figure 24.0. This approach resolves the abrupt entry into the living room. The living room should not be used as a passage way as shown in Figure 25.0.

The dining and the living room, while almost a single space is still divided into two distinct spaces allowing for the two activities--entertainment/conversation in the parlour and eating in the dining room, and can take place simultaneously without interruption. Adjoining the dining room is the kitchen and the pantry. The location of the kitchen allows for the ventilation of smoke (if wood stove is used). The ventilation is further enhanced by the provision of a chimney to vent out the smoke. Through this technique, the build-up of smoke and soot is prevented. None of these techniques are applied in the modern house plans of Figures 24.0 and 24.1. Traditional architecture has solved this problem of smoke and soot accumulation by either detaching the kitchen

from the main house or using thatch roof. The spaces in the thatch act as pores and allow the smoke to vent out easily. In front of the kitchen is a covered porch. This is an extension of the kitchen and at the same time, a place where family members could meet for informal family gatherings. Therefore, the porch becomes a zone of both private or semi-public activities. This area provides the lady/mother of the house an area where she could entertain her guests if the living room is occupied or if too busy in the kitchen to entertain a guest in the parlour.

As shown in the design (Figure 24.0), the toilet, bathroom, storage, and domestic animal shed occupy a different wing in the house. By so doing the rituals of easing oneself is carried on without notice. Also, the toilet occupies a space that maintains a distance both physically and visually from either the dining room or the kitchen. This cultural issue is not addressed by either the Ikenezbu Housing (Figure 24.0) or Kulende Housing (Figure 24.1). Providing an animal shed in residential design is worth encouraging. Urban dwellers in Nigeria are still in the habit of rearing domestic animals mostly chickens. In the traditional architecture, this space is as essential as any other space in the house. And that is what the author was trying to achieve in the design. By providing such a space it does allow the occupants the choice of keeping poultry, sheep and goats, etc.

Courtyard

The courtyard, either explicit or implied, has been a dominant feature in the traditional architecture in Nigeria. It has both cultural

and climatic rationale. First of all, the courtyard is an extension of the functional spaces in the house. It provides for both passive and active functions. For passive uses, the courtyard serves as a meeting place, mostly at night for family get togethers. It is also a place for afternoon naps, when the indoor areas are not comfortable. Even in the urban centres, an extended family system is a fact, and there still exists monthly family meetings/get-togethers. Such family meetings are regularly rotated from house to house to ensure equal participation. The courtyard in this instance becomes an appropriate place in the house to hold such a meeting, as the participants may number above twenty. At this number the parlour will be too small to hold such a large audience.

In addition to its passive purpose, the courtyard provides for active engagement. It is a logical extension of the kitchen. And it is not uncommon to see outside cooking in the tropics. The grinding and pounding of foodstuff is still mostly done manually. Therefore, the location of the kitchen in relation to the courtyard allows for such chores to occur conveniently either in the kitchen or in the courtyard. In either case, there is likely to be minimal acoustic disturbance (echo, and vibration) than when compared to the same situation occurring in Ikenegbu Housing (Figure 24.0). Located in the courtyard is a laundry platform and a tap. Laundry then can be done outside.

As a climatic moderator, the courtyard acts as a cooling well (Konya, 1980). To be very effective for this purpose, the smaller it is the better. But occasionally there is need for bigger courtyards. In the rural areas, where vernacular architecture is still very apparent,

miniature gardening does occur in the courtyards. These "walk-in" (author's terminology) gardens in addition to providing immediate vegetables and the likes do assist in creating a conducive microclimate. Plants commonly used toward this end range from vegetables like pumpkin, bitterleaf, waterleaf to small trees such as oranges, paw-paw, etc. These help in preventing the penetration of solar radiation, create constant shadows, and cool by evapo-transpiration, consequently turning the courtyard into a cooling well.

Security-wise, it provides a total sense of enclosure visually and physically. It allows all the activities mentioned above to take place outside the public's view. The kids play in the courtyard under total surveillance by adults. Because of these factors, the courtyard is considered spatially the focal point of the house, and is a design response to social, psychological, cultural and climatic demands.

Ventilation

To ensure a sense of comfort to the inhabitants, the architecture of this region calls for cooling through proper and effective ventilation device(s). That calls for openness in the design encouraging cooling through natural movement of air by cross-or through ventilation. Two of the ways to do this is by stack effect and pressure differential. Because of temperature difference between the outside and inside of the house, the inside air being warmer tends to rise by displacement (Kukreja, 1978). The exhaustion of warm air allows for suction of cooler air indoors. To facilitate this movement the roof is provided with a lot of air passages. For example, the venting slates of the roof acts as an

air passage. The fascia are covered with wire gauze thereby allowing air to filter through. Alternatively, the fascia could have been louvred (Figure 26). The roof eaves were also open. Timber slates were equally spaced over the wire gauze. This approach of opening the eaves the full length of the house will allow for maximum air circulation rather than the common practice of equally spacing the vent slots. Internally, the ceilings are also opened up with the provision of vent slots too. The ultimate intention of all these design techniques will prevent the double roof, or the attic space to become a holding pool of warm air. If this happens there would be no displacement of spent air. But by providing as much openings as possible on the roof, the combined effect of such is that they function in unity as a ventilating shaft.

Therefore, the warmer, indoor air rises to the roof top, where it immediately escaped and permits cooler and denser air to enter at the floor. Although not specifically designed for such, the chimney at the kitchen also helps in exhausting the lighter, warmer air.

In addition to the roof design, achieving maximum ventilation will dictate the orientation of the building, the exterior material, window sizes and placement, etc. As noted earlier, there are two dominant air masses in this region, viz the northwestern (cool and dry) wind and the southwest (moisture-laden) wind. The southwestern wind is experienced for about eight to nine months of the year, and the northwestern for about three to four months annually. For design decisions it is logical that the southwestern wind has precedence over the northwest wind. By principles of aerodynamics it is proper to place bigger openings on the

leeward side, and the smaller openings on the windward side (Kukreja, 1978; Fathy, 1973). In the above design, the author achieved this by locating a regular sized window on the south. Then on the leeward side the door is louvred at the lower end. Additionally, above the door running the whole length of the wall are louvred openings. The entire length of the gallery or corridor is walled with vent walls. For design principles it is a reasonable approach to having "a larger ratio of outlets to inlets in terms of size will facilitate the speediest, and hence the most cooling air flow within a building (Kukreja, 1978). Further north, where the effect of the southwest wind diminishes, and the northwest wind felt more, the overall design approach would be different.

In effect, that cooling could not be achieved through cross-ventilation, a low-keyed mechanical devices could be incorporated. This was done in the design by the use of ceiling fans. As long as there is air movement the above device would suffice in cooling the house. But where air circulation is impaired, ceiling fans become handy mechanical devices to encourage such circulation. According to Saini (1970), ceiling fans are preferred to desk fans or other mechanical devices (e.g., air conditioners) because of their low power consumption to air handling capacity. The other advantage of ceiling fan is its ability to produce both vertical and horizontal air flow (Figure 27). Although it is not incorporated in the design, the use of attic fan is worth mentioning. Installing an attic fan in the attic space induces cooling by drawing cool air into the building and exhausting warm air accumulated in the attic space. Again, the use of this should not be on a regular

basis, instead determined by the prevailing air situation. The ultimate effect of encouraging air movement through the building mostly by natural-or cross-ventilation, or when necessary, mechanical means (e.g., fans) is to dissipate body heat either by convective heat loss or accelerated evaporation.

Shading from the Weather

Characteristically, the tropical region in addition to having heavy rainfall, experiences intense solar radiation, bright but often cloudy sky. A major design concern for an architect will be to minimise the glare and the solar radiation striking the building. In his book, Tropical Architecture, Kukreja (1978) listed factors that should guide such selection as follows:

1. Minimisation of glare and reduction of eye strain.
2. Maximisation of solar heat entering rooms in winter.
3. Protection against rain and wind.
4. Provision of adequate ventilaton at all times.
5. Control of insects, dirt and dust.
6. Providing privacy when needed.
7. Adequate exterior vision.
8. Maintenance costs versus original costs of sun control devices.
9. Exterior appearance, i.e., the architectural or aesthetic factor.

Further, he noted that shading devices will be designed and selected by such factors like natural, internal, and external devices.

The external device method employed in the design is the use of the roof overhang. The roof overhang is extended for 3'-0" beyond the wall. This extension of the roof allows for complete blockage of direct sunlight into the rooms. Also, the entire wall, especially on the west is shaded from the late intense afternoon. Therefore, the wall is not allowed to build up heat. This overhang is also very effective in protecting the building from being weathered by the rain. The horizontal overhang being independent of the window, shades the building and controls interior illumination but does not obstruct the operation of the window (such as being opened when it is raining) or the view from it. Other shading devices would include vertical shades, free standing screens, or a combination of vertical and horizontal devices such as eggcrate types. A major disadvantage of these devices is that they call for frequent adjustments to be effective. Where they are fixed, a lot of compromise will be required in the design. Shading devices have to be used according to direction and intensity of the sun. For example, no shading device is required on the north facade, vertical fins may be appropriate on the west and east facades, and longer horizontal roof overhang will be quite effective on the south facade, etc. The interior shading could be accomplished by the use of curtains, venetian blinds, etc.

Landscaping

The third sun control device is by natural shading. And this includes building orientation, but mostly through landscaping. Essentially, the use of vegetation in this architecture, in addition to

achieving other things, is to modify the micro-climate. And in this region, it is to block off the solar radiation and provide an air cooling device at the same time. The trees when carefully selected and placed provide an air cooling effect by its biological process of photosynthesis and evapo-transpiration, and through reflectivity of their foilage. As a shading device, solar radiation striking hard surfaces, such as the earth, concrete pavement, the wall, etc. are blocked off. Therefore, the heat absorbing capacity of these surfaces is reduced, the heat load cut down, and the heat transmittance into the living environment is minimised. In his book, Buildings in Hot Dry Climates, Saini (1980), illustrated the findings of Kelly and Ittner in which they found temperature difference of as much as 40°C (22.2°C) in 5 minutes between unshaded and shaded areas. The shaded area reduced solar radiation as much as 63 per cent under solid shade, and 55 per cent under dappled shade. While being effective as a shading device, the trees should not be used as windbreak. The trees should allow enough fenestration for air circulation. This caution will require the use of mostly tall deciduous trees with unobstructed stems. For classification sake, the trees in this region are grouped into rounded, oval-shaped, and columnar trees (Saini, 1980), and are used for shading differently because of the foilage formation and shadow characteristics (Figure 28). Just as the sun behavior determined the types of shading devices (see Shading from the Weather), the same limiting principle will guide the selection of tree types and their positioning. For example, because of the low angle of the sun in the mornings and late afternoons, the oval-shaped trees are

better positioned on the east and west. Their long shadows shade the building from the intense late afternoon sun rays. The round shaped trees on the other hand provide a better shading if positioned on the southeast, south and southwest. They also shade the roof very well. The trees because of their long stems, as much as 15' high before branching off, are preferred because they do not prevent the through air movement (Figure 29). The structural condition of the building has to be given due consideration before the placement of the trees. Because of their root structure, they pose structural hazard to the building's foundations. Shrubbery trees, because they are mostly evergreen and their relative shortness could invariably function as a wind break, hence their use calls for judicious planning. The same reasoning applies to the use of annuals and perennials in creating hedges. The aesthetics these create could be maintained without blocking the cool breeze. One of such remedial approaches will be to keep the height of the hedge low, to approximately 2'-0". At this height, the cool breeze will actually be flowing at the same height as the window sill (Figure 30). The annuals, such as the grasses, further contribute in modifying the micro-climate. According to Kukreja (1978) grassy surfaces will reflect about 10-15 per cent of the incident sun rays while hard surfaces such as concrete pavement will reflect between 25-35 per cent of incident light and has low temperature capacity (table 6). By reducing the amount of reflected light, landscape cuts down on glare and reflection. The integration of vines and trellises into the architecture will provide similar climatic modifier, even if minute.

In commenting on the work of Robert B. Deering, Kukreja (1978) outlined the former's recommendations in modifying the climate through landscaping.

1. In areas where the sun's warmth in winter is needed, deciduous trees should be used.
2. If planted near a house, trees and grass allow the heavier cool air to flow inside, provided the house has low openings. High strip windows are, therefore, not desirable in this situation.
3. The greater the number and size of trees and the larger the lawn, the more cooling there is.
4. Shrubs may even increase heat levels if air circulation is cut off. Very low shrubs are therefore recommended.
5. Wind breaks may be necessary in order to keep out hot, dry winds in summer and cold winds in winter.
6. Deciduous vines, trained over trellises and covering windows, can be used to keep the sun out.

Recommendation #5 may only be necessary in the northern most portions of the sub-humid region.

Summary

The design above not only tried to satisfy climatic conditions, but incorporated vernacular interpretation of landscape design. Traditional use of landscape has weighed heavily on the economic aspect than on the aesthetic. In the rural areas, where farming is still the main life sustenance, landscape design is farming at a smaller scale. Because of the farming orientation of the rural communities, the family is still

considered a production/economic unit. In the rural communities there are two levels of farming activities. There are the community farms located at the outskirts of the village or town. By virtue of their location, they are usually big and their harvests are for both consumption and commerce. More or less, they could be considered commercial farms on a micro-scale. The second type of farming is what the author calls "recreative farming/garden." Such farms are located on the house site and could incorporate both the front and back yards of the house. These gardens are maintained on a convenience basis and only for subsistence needs. For convenience purposes these provide immediate satisfaction by the ready availability of food stuffs, i.e., vegetables as pumpkin, bitterleaf, okra, pepper, etc. Trees such as orange, mango, pea, etc. are also a source of economic savings. Therefore, landscape architecture at the rural level is not only for climatic modification but also to provide edible landscape. The design referenced was an attempt to do that.

This farming instinct has been carried into the urban centres. Commonly, vegetable gardens (however small) are found around the squatters' homes. Even in the built-up areas of the urban centres, tenants have been known to carve out small nooks and corners in their houses where they could carry out "recreative gardening." And the realization of this has permitted the addition gardening grounds in some of the recent public housing.

It will be worth mentioning that the side benefits of edible landscape are noise reduction, soil stabilization, moisture retention,

and prevention of soil erosion. Also, there is atmospheric purification through the process of photosynthesis as well as providing therapeutic values and verdure refreshment.

Ancillary Services

As mentioned in Chapter 1 (Environmental and Health Conditions), the environmental problems confronting urban housing are inadequate water supply, improper disposal of refuse and sewage. Attempts to resolve these health hazards were applied in the design of low-cost housing competition (Figures 25.0 and 25.1).

The tropical rain forest is bestowed with abundance of precipitation, as high as 1500 mm rainfall per annum. The problem then is not scarcity of water, but the conservation and utilization of available water. Again, the rural citizens have had answers to collecting and storing the pure rain water. The solution has been simple and straight forward. Gutters made of corrugated metal or split bamboo stems are simply attached to the roof. This collects and channels the rain into storage equipment such as clay pots, and other such devices. The stored water serves the users as long as it lasts. Once the supply is depleted they start fetching water from the streams and rivers.

In the above design the same approach is employed. Gutters and downpipes are attached to the roof, acting as a catchment basin. The collected water is sent through the downpipes to the underground storage tank or the cistern. Instead of the single process of collection and usage of the rural approach, the approach suggested goes through further

steps to ensure purification of the water. First of the steps is the initial collection of the water in the collection tank. Next, the water is passed down into the Filtering Tank. In the filtering tank or the purification chamber are layers of sand, charcoal, gravel, and chlorine tablet. The purified water is then passed on into the holding tank for storage and subsequent use (Figure 31). The adequacy, safety and proper functioning of the tank depends on certain specifications and safety needs. Therefore, the type of such a tank will depend on standards that will/may vary from site to site. This technique of making each dwelling unit water self sufficient will help in relieving the city in their ability to ensure a constant supply of water. A precautionary step is taken in the design, because total self sufficiency of water supply is not possible. It is still connected to the city supply, for emergency or when the need arises. For instance, during the dry season, when there is little or no rainfall, the household could rely on the city supply by merely switching on the goose neck swivel connection (Figure 25.0).

The design handled the sanitation aspect by dividing it into sewage disposal, greywater treatment and garbage clearance. If the present situation of requiring flush toilets is to be functional, there should be a constant supply of water and sewage treatment plants to process and treat the wastes. But it is known that this is not true in the urban centres (see Chapter 1). Also, even if treated, the end product is not always reusable. The proposed solution to this in the design is the installation of waterless/sewerless system that is pollution free, disease free, waste recycling, and zero discharge. At present, there are

various types fulfilling these functions. These are aerobic tanks, biological toilets, oil-flushed toilets, chemical toilets, incinerating toilets, pressure or vacuum toilets, and composting toilets. The one selected for the design is the composting toilet type called Clivus Multrum (Figure 25.0). The advantages of Clivus Multrum over the others are that it is owner built, and saves up to 40-50 per cent of total water usage in the home. For every flush, five gallons of water is expended and about 13,000 gallons of fresh water is contaminated. But the use of Clivus Multrum not only eliminates water waste but could save from 25-60 gallons of water per person per day (see Goodbye to the Flush Toilet by Carol Störner and The Toilet Papers by Sim Van Der Ryn, etc. for complete description).

The greywater treatment is simply collecting the spent water and reuse if and when possible. The greywater is held up in the holding tank after pretreatment in the septic tank. During the dry season when rain is not frequent, the water from the holding tank could be used for irrigating the lawn and the garden.

The household waste is divided into biodegradable and non-biodegradable types. All biodegradables are added to the Clivus Multrum through the garbage chute (Figure 25). Or they are dumped into the ditch from which soil was dug out for making adobe bricks. It does act as an incinerator and provides necessary manure for fertilizing the garden. The non-biodegradables are handled separately. They are dumped into city dumpsters that are strategically located. The locations of

such is highly desirable. The streets will be rid of flies infestation and unpleasant odors.

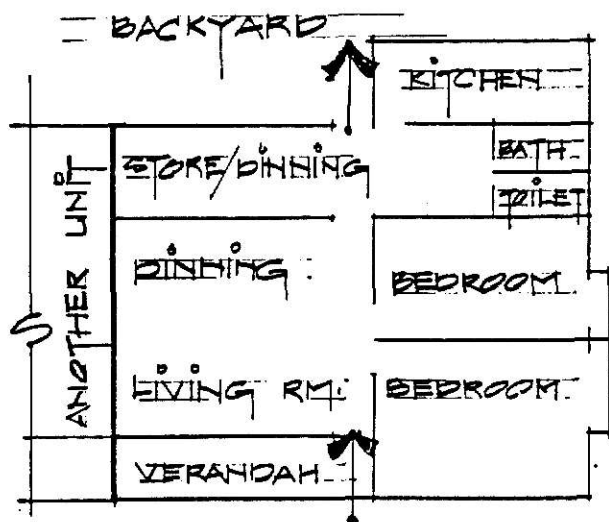


Fig. 24.0: 2-Bedroom House at Ikenegbu Estate, Owerri.

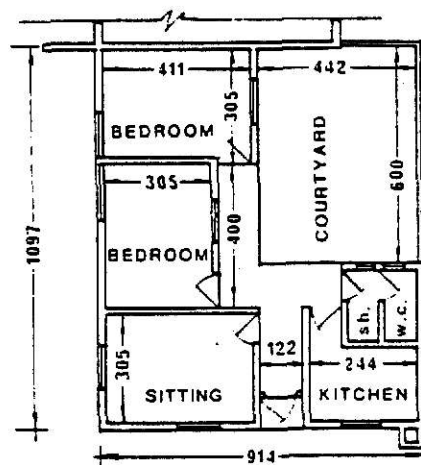


Fig. 24.1: 2-Bedroom House at Kulende Estate, Ilorin.

Source: Megbodugbe. Third World Planning Review, Vol. 5, No. 4, November 1983.

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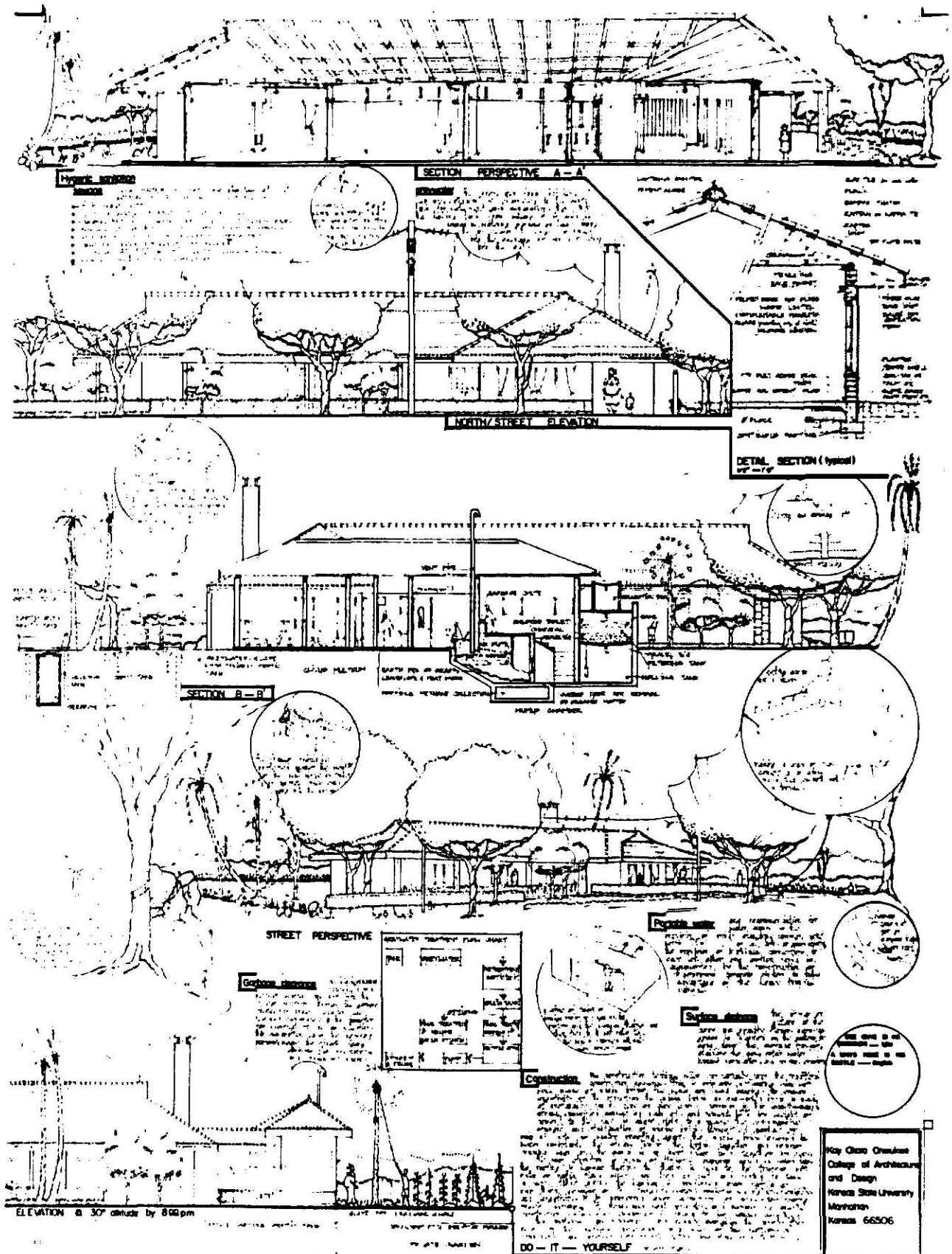


Fig. 25.1: Elevations, Sections and Perspective.

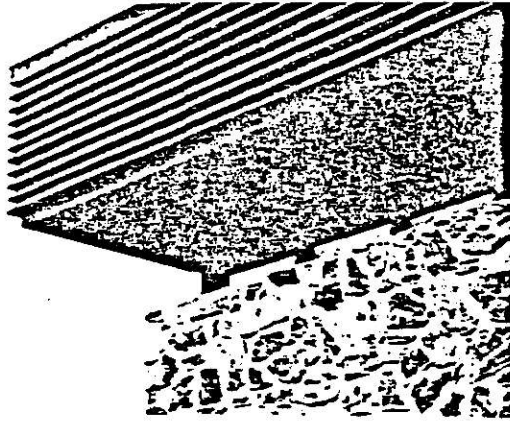
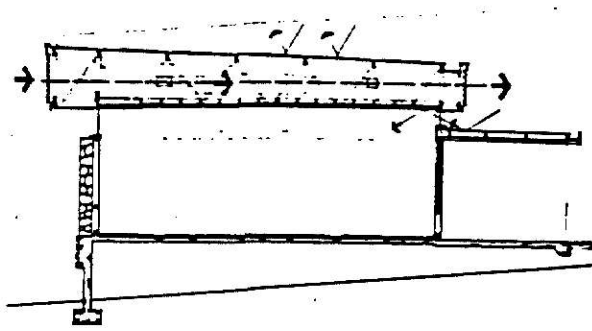
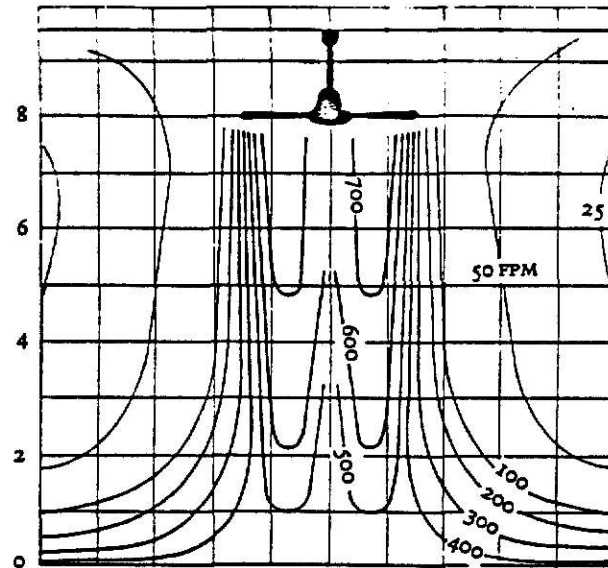
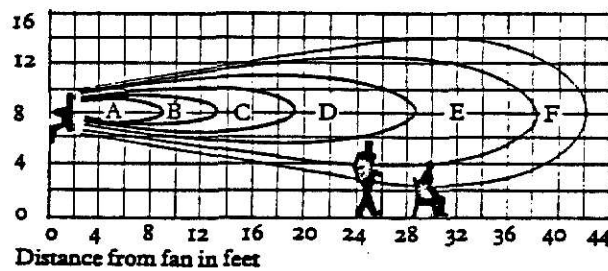


Fig. 26.0 and 26.1: Louvred Fascia with a double roof

Source: Saini. Architecture in Tropical Australia.



AIR VELOCITY DISTRIBUTION
For 36" Ceiling Fan



A	B	C	D	E	F
1000	750	500	250	100	50
FPM	FPM	FPM	FPM	FPM	FPM

AIR VELOCITY DISTRIBUTION
For 24" Air Circulator

Fig. 27: Ceiling and Wall Mounted Fans.

Source: Saini. Architecture in Tropical
Australia.

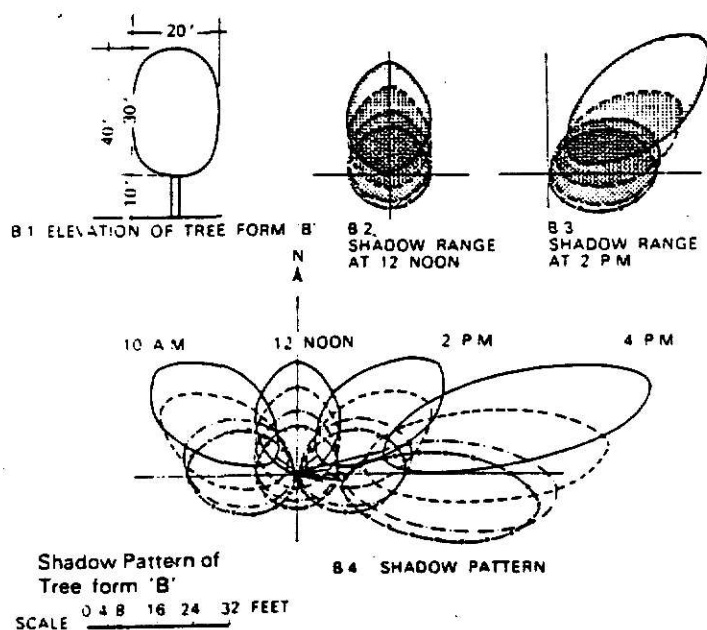
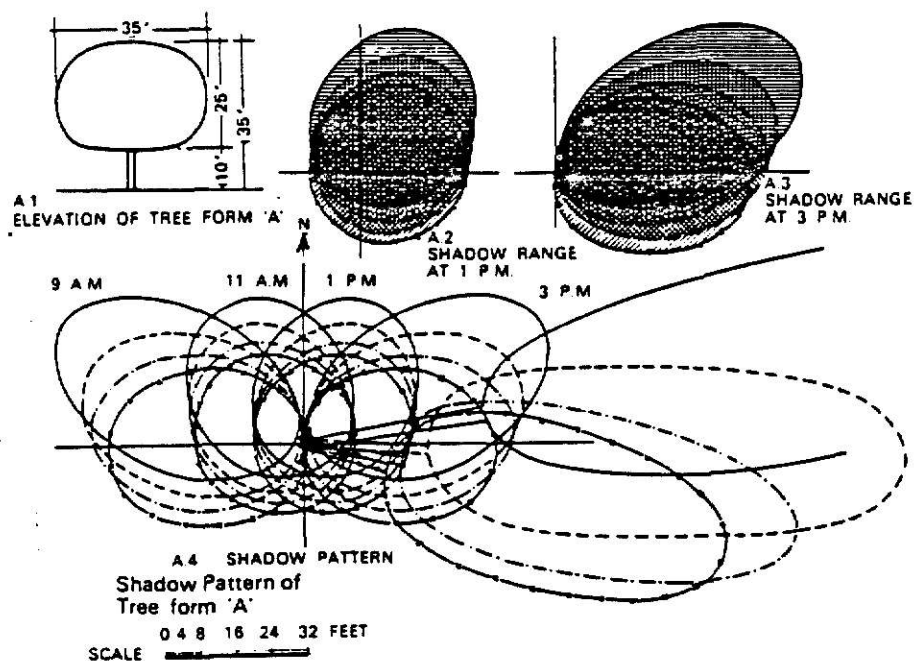


Fig. 28: Shading Characteristics of Different Tree Types.

Source: Saini. Building in Hot Dry Climates.

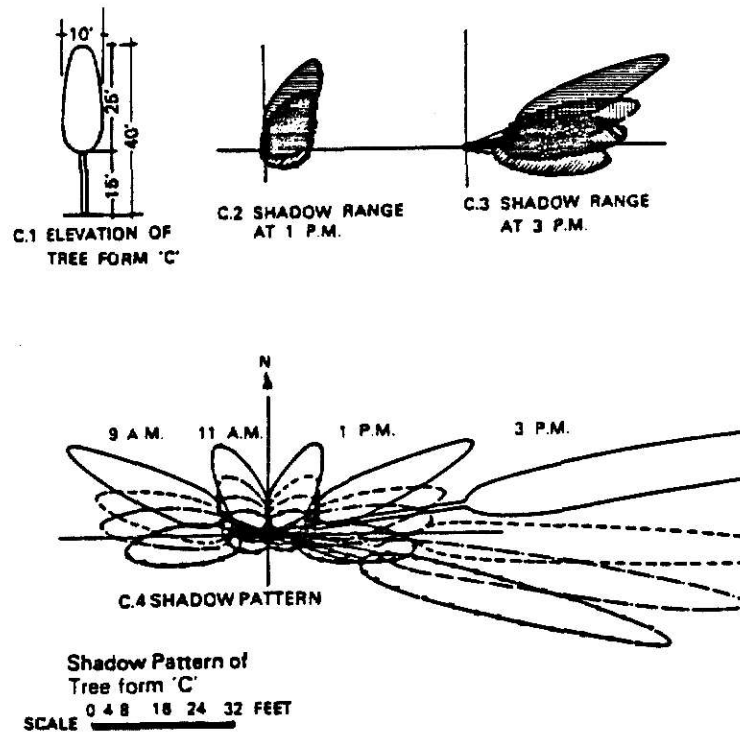


Fig. 28: Shading Characteristics of Different Tree Types.

Source: Saini. Building in Hot Dry Climates.

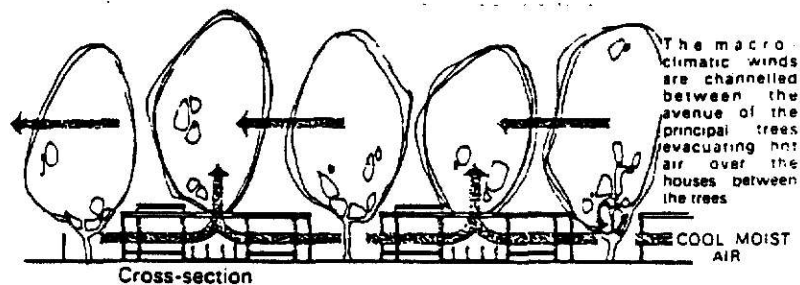


Fig. 29: Effects of Trees in Controlling the Micro-climate.

Source: Saini. Building in Hot Dry Climates.

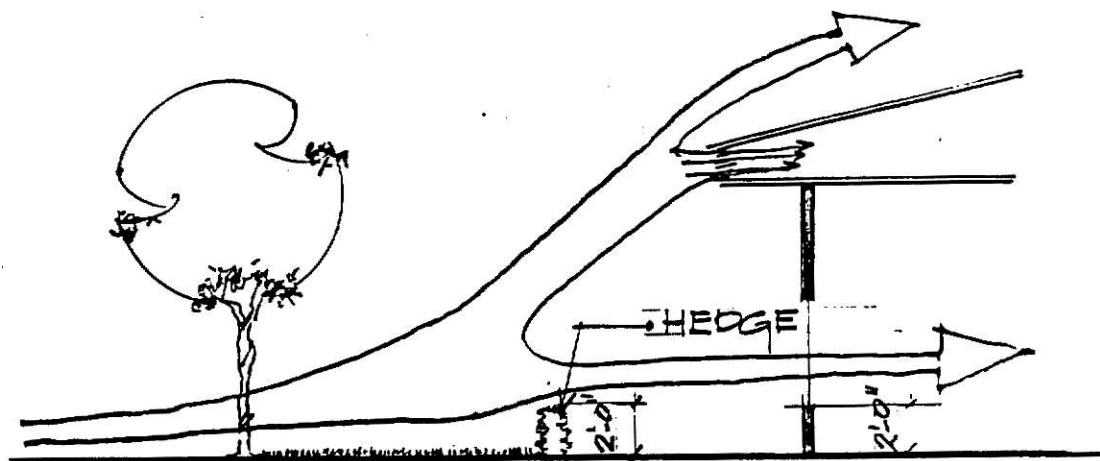


Fig. 30: Hedge Height Being Used to Deflect Breeze into House.

TABLE 6. Range of Temperature Variation Over Different Surfaces.

<i>Material</i>	<i>Temperature (°C)</i>
Tar Macadam	32.6
Sand	25.9
Earth	25.0
Gravel	21.1
Grassy ground	16.0
Clay soil	11.2

Source: Kukreya.

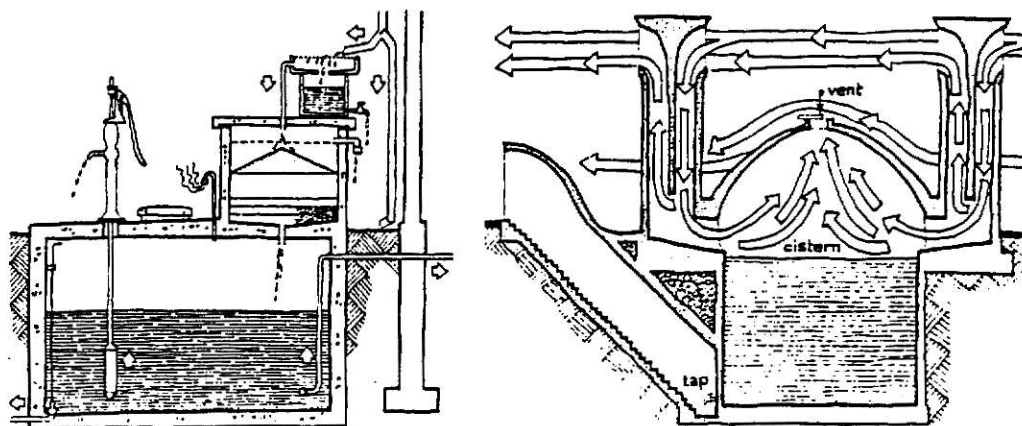


Fig. 31: Two Types of Underground Cistern Used for Collecting Water from the Roof.

Source: Konya. Design Primer for Hot Climates.

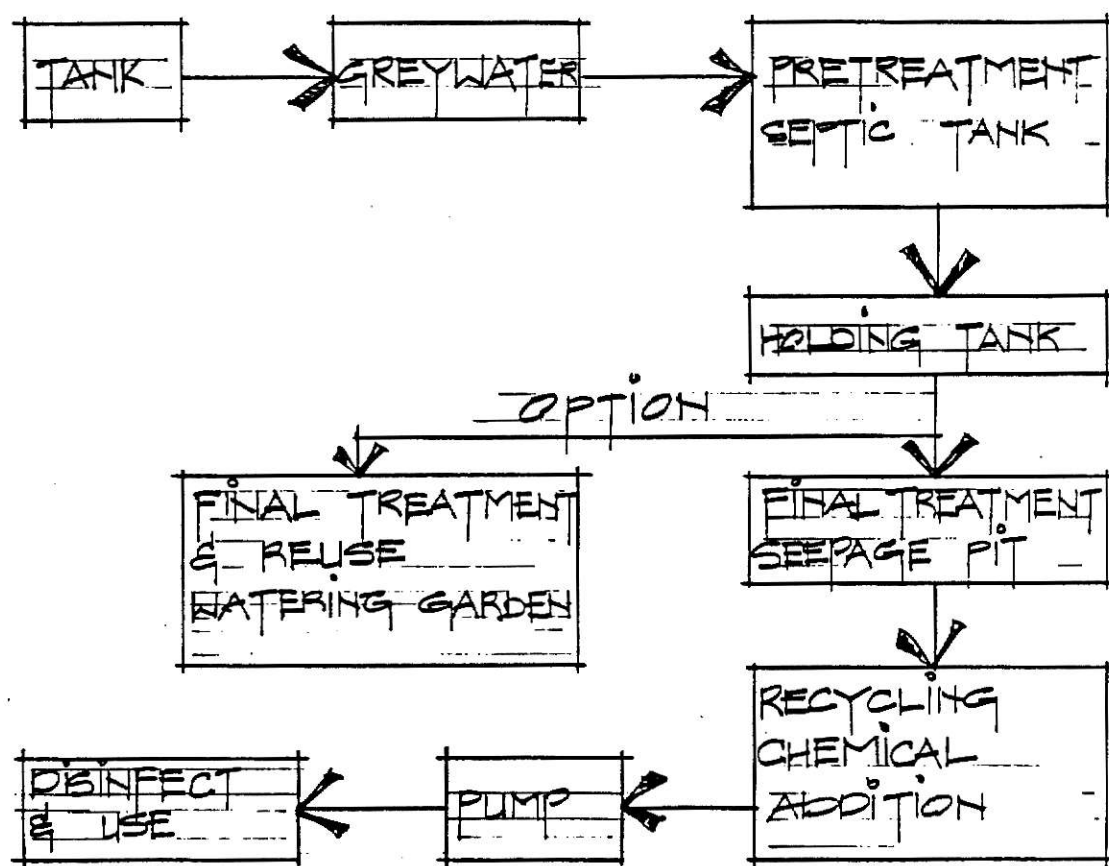


Fig. 32: Grey Water Treatment Flow Chart.

CHAPTER 8

PHYSICAL AND ENVIRONMENTAL PLANNING

The provision of affordable low-cost/low-income housing does not stop with the provision of basic/core shelter. Instead, other infrastructural amenities are needed to complement the success of low-cost housing projects/programmes. A successful approach to the planning of a neighborhood will be to establish the goal of the residential planning effort. Although the implementation approach may differ from community to community, in general the goal of any residential planning is to ensure safety, economics, efficiency, aesthetics, socio- and ethno-cultural objectives.

Safety. The safety of the community from both natural and man-made dangers should be a goal to be pursued by such planning. This factor should guide the establishment of minimum building codes, street design, and the handling and disposal of wastes.

Economics. The provision of essential community utilities to the public at affordable costs could not be over emphasized. Such affordability should include ability to build one's own house at no cut-throat cost and still afford all the essential amenities of life.

Efficiency. This calls for the prudent and judicious use of resources. The planning goal should aim at encouraging efficient use of scarce and renewable energy resources. A policy that encourages appropriate or intermediate technology in the overall design and planning of the houses, circulation pattern and waste handling.

Aesthetics. To add pomp and beauty to a community calls on the need to excite the different sensory organs by creating reasonable varieties. There is a need then to provide a variety of items to complement the housing stock. Such should range from safe street design, landscape, parks, etc.

Ethno-Cultural. The need to have identity for itself must be the intended goal of any community. Such an identity will be a strong factor in fostering a sense of belonging and pride to the citizens. Also, it will be a good approach in nurturing social integration.

The implementation of these goals will have to vary according to physical and other environmental factors that will influence the site. These factors will surely be a limiting factor in establishing performance or specification standards for the community planning. Building codes establishing minimum design standards must be formulated and administered with a certain degree of flexibility without jeopardising the overall intended goal. Such performance standards should require reasonable minimum codes for the handling and discharge of sewage and garbage wastes, land use planning, street design and other community facilities and physical aspects of the community design and planning. These essential services should be provided in conformity with the overall goal of making it low cost.

Figure 33 is the general plan of the Kulende Estate, in Ilorin which is one of the low-cost housing projects executed by the Kwara State Government. The author intends to propose alternative physical plans and develop standards (Figure 34) for essential urban facilities by using the

plan of Kulende Estate as a reference site. Four major categories should guide the land use planning, namely housing, education, open-space and industry. A fifth category called residual uses should include transportation and traffic, commercial, public or cultural buildings, government establishments, public utilities, and community farms.

The major guiding principle in the proposed general plan for Kulende Estate is to employ the village concept. In essence, in an attempt to provide residential units, other amenities will be introduced to complement housing. The community is planned as a self-contained unit with its own market and commerce, i.e., house stores, cottage and light industrial activities and other residual uses that are deemed necessary (Table 7).

Housing Density and Lot Sizes

There is no absolute lot size for any residential planning. Lot sizes should be based on among other factors the type of community that is being planned for, the topography and terrain of the site, cultural and social needs, availability of land, affordability and the ability to provide essential public amenities at affordable costs. By the rule of thumb, lot sizes decrease with density and the need for open spaces increase with density. Also the location of the community is a factor. The closer the community is to the Central Business District (CBD) the higher the housing density, and vice versa if located further away from the CBD because of land availability. Tables 8-10 show densities as they occur in different parts of the world. For example, 50-foot-square house units (Figures 35.0 and 35.1) linked in groups were proposed for the

Birnawa low-cost housing in Kaduna State. By Tables 8-10 it could be seen that there are no set standards for lot sizes.

Accessibility--Street Design

Streets are designed and classified into local, collector and major streets depending on their particular uses. Particularly the local (residential) streets should be designed to be pedestrian oriented by narrowing the width of the streets and designing for sidewalks and planting strips (Figure 36). The locating of necessary amenities within walking distances will discourage driving. Efforts should be made to discourage on-street parking. Alleys will encourage pedestrian use and act as service routes for garbage clearance. A narrow street will use less land, cost less, reduce water run-off and save life by discouraging speeding. The width of a fire truck should be a guide for designing the narrow street. By narrowing the width and winding the residential streets would reduce traffic hazards because the street configuration will deter reckless driving which is a common occurrence in the country because the residential streets are too wide, too long and straight just like highways. The pathway shading advantage of planting strips are enumerated in traditional planning theory. Additionally, the shaded streets control the micro-climate while the winding streets deter the adverse effects of wind turbulence.

Community Farm

In line with the concept of village design and the goal to make the community self-contained, there is the need to design for the community

farm as well as the individual house gardens. The farm could be subdivided into individual small farm plots and made available to the residents of the community. These could be rented/leased out on an annual basis to ensure equal participation and discourage monopoly. These farms, though likely to be small, would suffice in providing essential vegetables on a subsistence basis and be in the spirit of Operation Feed the Nation (OFN) and the Green Revolution embarked upon by the previous regimes in an attempt to make the country feed itself once more. Such gardens will not only add to the landscape of the community, but could provide visual breaks, and even become educational (experimental) farms, in addition to forming greenbelts between communities (Figure 34).

Village Plaza

Traditionally, the village plaza has functioned as the hearth of each village where cultural, ceremonial and commercial activities occur. It is a public space that is used for community activities, and does provide nodes for each village. The same approach could be used in designing the urban community in the spirit of achieving a self-contained neighborhood. But the standard should be upgraded by providing essential present day facilities like clinic, fire and police departments, etc. turning it into a small civic centre (Figure 37).

Park and Recreational Space

Such a space is needed to beautify the community by breaking the monotony of the solid structures (e.g. houses). A green or open space is the breathing lung of a community because of its natural

setting. It also serves the recreational needs of the community for all age groups. Its location should be such that it will allow for full and equal participation by the members of the community. The size of the parks are determined by "(a) a minimum of one acre of public park or recreation land for every hundred persons, (b) a minimum of 10 percent of the total land area of a municipality devoted to recreation, and (c) one-half of any municipality's park and recreation area reserved for active recreation and the other half for larger parks" (Claire, 1973). It should be mentioned that these standards are guidelines and must be adapted to fit any particular site and need (Table 11).

Utility Systems--Infrastructures

The well being of a community depends on how efficient the infrastructures work. Among those to be addressed here are water supply, sewage and garbage disposal.

Water Supply. As a site and service design approach, it would be necessary for the government to provide community standpipes to the site. The standpipes should be located at locations not farther than 78 yards (approximately 75 m) from the farthest house. Individual units could tap into the city's main. While individual house tap will increase water consumption, this could be reduced by employing the underground cistern for collecting and storing rain water as discussed under Ancillary Services in Chapter 7. According to Turner (1980), the following figures (Table 12) are often used to determine residential water consumption.

Sewage Disposal. Among the sewage disposal systems commonly proposed for new low-cost housing has been the water closet systems, however this system has been plagued by infrequent water supply and treatment. Because this requires large capital and technology to operate a central sewage plant, an interim approach is advisable. Instead of individual septic tanks for each dwelling unit, cost could be reduced and efficiency increased by constructing a single septic tank for each block and discharged regularly. Alternatively, such systems as Clivus Multrum and others mentioned (anaerobic digesters or compost privies) under ancillary services in Chapter 7 are worth investigating. These options in addition to being low-cost technology, they are also water resource savers. Another device to easing and improving sewage disposal is in the separation of dark and grey water from storm water. To ease the choking and clogging of drainage channels, grey water should not be discharged into the drainage channels because they carry debris and impurities. Grey water should be collected into septic tanks and discharged accordingly by appropriate authorities. This measure allows only storm water without grey water impurities to be discharged into the streams and rivers with little pollution. Such solution is proposed for the housing design competition in chapter 7.

Garbage Disposal. Garbage clearance and sewage disposal have presented the most environmental problems to environmental planners and designers in Nigeria. The lack of appropriate garbage clearing procedures have resulted in dumping wastes at open dump sites, such as open gutters, open/green spaces, vacant lots, and at street

intersections. This practice of indiscriminate disposal of refuse presents health hazards and causes inconveniences such as blocking gutters and drainage channels resulting in flooding and traffic flow hinderance for both pedestrian and vehicular access. This practice also is a potential water contaminant and environmental pollutant.

To ease the problem of blocking traffic flow, dumping sites or depots should be sited on the alleys of each block. This will allow for clearance without interfering with movement (vehicular or pedestrian) and unsightly appearance of garbage spillovers and pest infestation. For health reasons the block's dump site should be cleared frequently. The refuse from the block dumping site could finally be disposed of either in the city's sanitary land fill, by combustion or composting.

The sanitary land fill is the method employed in Nigeria for disposing of solid wastes. The wastes are deposited in excavated land forms, compacted, and covered with soil. The compaction increases the rate of decomposition while the soil hides the unsightly appearance, seals the odors and eliminates pest infestation. Sanitary land fills need sufficient land to be operative and stringent regulatory controls for health reasons, and should be located at the outskirts of the city.

Combustion involves the burning of wastes. The problem this method may face is the public's acceptance of its location. The siting of the combustion site should be away from residential areas, perhaps the community farm site. The burnt wastes could be used as manure for the community's farms.

Composting is the degradation of bio-degradable wastes. Thus there should be a complete separation between biodegradable and non-biodegradable wastes. The biodegradables are decomposed into organic or soil manure or conditioner. The compost could appropriately be situated in the community farm where the use of the organic fertilizer and manure will be needed most. This method falls into place with the Clivus Multrum System proposed in Chapter 7, which calls for distinct separation between organic and inorganic waste materials.

Among the three disposal methods, a sanitary land fill requires financial resources, technology and suitable land. The other two--combustion and composting are both economical, appropriate and require low-skilled technology. These two methods allow for recycling and an efficient reuse of resources, and would produce enough organic manure to satisfy the community farm. On a large scale this could be a revenue saver as it will cut down the need for imported fertilizers. In addition, these methods are hygienic since the bodies of water do not become a body of contaminants as a resultant of waste dumping practice, as is the case in Lagos and other urban centres.

Drainage. The safe discharge of storm and grey water is a major handicap in the cities. A separation of the storm and grey water will be a solution that will be environmentally safe. Only the storm water should be discharged into the open drain. The grey water should be discharged and collected in the septic tanks. These then should be periodically emptied by the appropriate authorities and properly disposed of. The advantage of this separation is that the open drain is saved

from the continuous blocking by debris contained in the grey water. The open drains, then, do not become breeding grounds for mosquitoes with the inherent offensive smells released to the atmosphere, and are no longer health hazards. The open drains are then left to storm water which discharges with minimum contaminations to the streams and rivers. The grey water can be treated before it is discharged to the rivers. A cost cutting approach to the design of the drainage will be planned for instead of running two parallel open drains or ditches in the street, one could function just as well as two (Figure 36). For safety purposes the ditches should be covered and where possible, they should be placed at the alleys.

Alternative Policy and Programme Approach

The preceding chapters in this report have dealt with the analysis and evaluation of existing low-cost housing programmes to the investigation of possible alternative approaches to the planning, design and the construction of such projects. The overall arrangement of the report (i.e. construction, design, and planning) does not indicate the order of importance. Rather, it is indicative that a holistic approach should be employed in addressing low-cost housing programmes and policies. As such, each chapter in this report is interdependent to the others and any one of the chapters could be a complete study by itself.

All of the previous studies carried out to determine the cause(s) for the failure of public housing in Nigeria have pointed in the direction of high cost of construction/building materials and the

technology/ techniques of construction. High cost of building materials, as noted earlier, dictate construction techniques which lead to high construction cost (Figure 38). The ultimate result is unattainable housing costs by the poor. Under such an exclusionary housing market, coupled with the high building standards, there is extremely low effective demand by the majority of the urban poor.

Other studies have indicated that the government's roles in the provision of public housing, with all the good intentions, are hindering forces in the effective execution and implementation of the programmes and policies. Since the inception of public housing programmes in Nigeria, the governments have taken the supply side approach in the provision of this essential public good. Throughout the history of the low-cost housing programme, the governments (federal and state) have been involved directly in the design, construction and selling of completed dwelling units. This approach has been plagued by large administrative structures that are typically bureaucratic bottlenecks, administrative red tape, and low accountability.

Within the framework of providing modest housing at affordable costs, a careful analytical assessment and planning is required. All areas affecting the successful implementation of low-cost housing, either directly or indirectly, need to be given considerable attention. Such will require considerable changes in the existing policies, strengthening some aspects of present programmes, and potentially new approaches.

Recommendations

The problems of low-cost housing are multi-dimensional and interwoven. Successful and feasible solution(s) should be varied, comprehensive and complementary. As noted in Chapter 2, Sule (1981) found that the majority of the people preferred to build their own houses given favourable conditions. The following are recommendations the author feels are conditions that will assist in the successful implementation of low-cost/low-income housing programmes in Nigeria.

Slum Upgrading. This approach is a reversal to the popular approach of complete demolition of the squatter settlements, and potential relocation of the affected citizens. Slum upgrading deals with upgrading the infrastructures, ranging from road layout, waste disposal systems, and regularizing the plots. Because of the haphazard growth pattern of the slums, the performance standards for such areas should be flexible enough to accommodate the tenants. The advantage of slum upgrading over outright demolition is that there is little or no displacement of tenants, minimum demolition or displacement of houses, and the area is generally upgraded in aesthetic quality with the provision of all essential infrastructures. It should also be mentioned that this practice will likely be more cost effective to the government, and the least expensive.

Sites-and-Services Concept. This is an approach which involves the platting of plots with the provision of essential public utilities such as paved roads, pipe borne water, sanitation systems, etc. By taking the initiative, the sponsoring housing authority is able to control growth

and allow for staged development. There is proper land use planning because other services are provided to complement the housing units. It becomes easier to establish functional performance specifications. What must be remembered is that the housing agencies or the governments do not assist in the erection of the buildings. They provide the services and the citizens build their housing within prescribed building codes. The advantages of the sites-and-services concept are numerous. Families are given considerable choice in the design and construction of their housing, and the sponsoring housing agency would reduce costs by not being involved in the housing construction. Sites-and-Services approach calls upon the government's technical expertise in the area where the citizens do not possess the necessary skills or the money to foot the construction cost (public utilities and other infrastructures). As would be expected, the provision of different lot sizes would be a good tool for class integration and potentially eliminate the polarization of economic classes, the poor and the government. Generally, the government plays the consultant and is seen as caring for the welfare of the people.

Aided Self-Help/Sweat Equity. The self-help approach emphasises the helping of oneself in the provision of housing, while the government provides the necessary assistance. This approach allows for tenant-ownership development whereby the tenant becomes the eventual owner of the property. Government assistance takes the form of "granting of land tenure, low interest finance, roof loan schemes, core house, provision of 'wet wall' on each lot (containing toilet, plumbing, and power connection) around which the rest of the house can be built and

making available the low-cost building materials and equipments" (Saini, 1980). Self-Help encourages the use of local building materials and skills because it is mostly labour intensive. "Sweat-equity" is the provision of the skeletal (exterior) structure and the recipient is allowed to finish it at a reasonable pace with the assurance of eventual ownership. The other self-help approaches are mutual help and cooperative methods. The Aided Self-Help housing scheme allows for participation of the tenant-owner, encourages community development, and most of all, it is an avenue that affords local contractors the needed experience in their trade.

Education. There is definitely a need for restructuring educational policy in the country. A great deal of government policies are always short lived and ineffective. A contributing factor for this is that such programmes/policies are never carried across to the public. All design, planning and environmental curriculums in the universities should be tailored to emphasize the need for low-cost housing and the best approaches to achieving it. Researchers are needed in the use of local materials and techniques in providing affordable housing. In conjunction with the federal and state ministries of housing, planning, education, universities, and the private sector, a strong and effective research programme should be developed. A similar change should be effected in the secondary school levels, making the needs of the country the cornerstone of the educational programmes. Rural development programme should also be a part of such educational policy as a means of arresting

the rural-urban migration. Without such a thrust, the much publicized low-cost housing programme will continue to be a failure.

Extension Services. Findings and new developments in the housing sector will not do any good if the information is not disseminated to the public. The extension services of the Ministries of Agriculture inform the farming community of the improved and newest techniques of farming, and introduces improved or hybrid seeds to the farmers. Their main function is on the transmittal of information relating to farming. A building extension service affiliated with the ministries of housing, planning, and environment should serve the public in the same capacity. Comprehensive extension programmes should cover other environmental issues such as landscaping, sanitation, and conservation and renewal of available and scarce resources, along with appropriate building technologies. Extension services should carry out regular pilot projects as a demonstration to the public. In this capacity, the extension service will act as a conduit (clearing house) between institutions (the government included) who develop appropriate technology and the public.

Local Government Participation. The three tier systems of government (federal, state, and local government authorities) are yet to be felt in the housing sector. So far the housing sector has been the exclusive domain of both the federal and state governments. For efficiency and effective operation the creation of housing departments at the local government levels will surely ease the perennial confrontation that is always evident between either the federal or state governments and the local citizens when the former(s) intend to acquire land for

projects. Local governments, by virtue of their positions, have a better working understanding of the socio-cultural factors of the locality.

This could be used advantageously in establishing partnerships between subjects rather than in opposition to the government. The involvement of the local government could invoke mutual trust. The 1976 local government authority reform placed town planning under the jurisdiction of the local governments. Such a decree should be expanded to include housing since it is an integral part of town planning. The ambiguity between the Local Government Act and the Local Government Reform Act should be cleared. At present, there exists a lot of disagreements between the state and local governments over who has jurisdiction over housing and town planning. To be effective as a professional unit, the proposed housing department at the local government level should be manned by professionals in the field of architecture, urban design, landscape architecture, civil and sanitary engineering and other environmental training. At present, not all local governments have these professionals or professional expertise available for assistance. A step in this direction will create ample opportunity for retaining professionals in the rural areas and be along the goals of the National Youth Service Corps (NYSC).

Long Range Planning. A guided land development policy is a must if slums are to be avoided. The government (all three levels) should have the ability to anticipate urban growth and be able to plan towards it. Therefore, a policy of land management is inevitable. It could either be Land Banking or Guided Land Development (GLD). Land Banking is the

acquisition of agricultural land, at its present value, for future development. Guided Land Development is the platting of land and provision of infrastructure. It is very similar to sites-and-services approach, but in GLD the land is privately owned. A growth management approach of this type allows for controlled growth and eliminates haphazard sprawling because the planning is comprehensive. Only the local authorities are in a better position to understand the growth pattern, as well as plan for it because the federal and state governments are too remote from the scene of reality. Again, this is another reason for having trained professionals at the local levels. Long Range Planning is essential.

Housing Inventory. Currently, there is no efficient way of estimating the housing needs in the country. Housing quantification has been strictly a game of 'guess-timation' because the government does not have an accurate and scientific method of determining the housing needs of the country. A body charged with the regular study of the housing needs in Nigeria would be helpful in recommending an equitable distribution of the Gross National Product (GNP) for enhancement of housing programs. The study could be a part of the research institute, the ministries of housing in both the federal and state governments, and the local government housing departments. The ability to understand the housing needs in Nigeria would be of great assistance for effective long range planning and the development of acceptable programs for implementation of the plans.

Inclusive Housing Policy. Housing policies in the country are nothing but elitist and exclusionary in nature. The criteria for eligibility for housing has been cut off at salary grade level 06 and above. Ironically, those below grade level 06, who need the assistance, are prohibited from participation in the various programmes. The Federal Mortgage Bank of Nigeria (FMBN) should liberalise their loan policy and extend it to all salary levels. Different below market interest rates and repayment plans should be devised to suit the different salary scales. The housing beneficiaries should not be restricted to only civil servants. Corporations and other private sectors should be urged to devise a housing programme for their staff along the government line. Similarly, the government should establish and encourage housing cooperatives and associations to provide credits, subsidies, and technical assistance.

Building Specification Requirements. The performance standards in use across the country are those passed down by the colonial planners. Disappointedly, these have been adhered to rather fanatically. Efforts have not been made to change and adapt building standards to the changing needs of the society. The rigidity and high standards called for by these codes have affected the ability of the poor to build their houses. The various housing authorities should liberalise their building codes to allow for innovations such as the use of local building materials, i.e., adobe, and the substitution of flush toilets for clivus multrum or other compost toilets. Unless there is a move in this direction, the poor will

continuously be unable to adequately house themselves at the level dictated by the current housing standards.

Decentralizing Job Centres. Arresting the rural-urban influx through decentralization of employment centers or opportunities will surely be an effective way of decongesting the urban centres and ultimately ease the housing crisis. Rural development policy should be pursued and encouraged by creating job opportunities in these rural centres. Coupled with the location of these industries in the rural areas should be other pull factors such as rural electrification, pipe borne water, good roads, recreational facilities and much of the good and affordable housing.

The above listed recommendations are by no means in order of importance and no one recommendation is considered more important than the others. By the nature of the housing crisis in Nigeria a combination of these recommendations could be applied. Housing problems in the country are multi-faceted and therefore require a comprehensive solution. The major recommendation that emerges from this report is aimed at government. Their continued involvement in the construction and selling of houses must cease. Studies have repeatedly shown that the government housing approach, or supply side economics to tackling the housing crisis has not been in the best interest of the Nigerian people. Therefore, a demand side approach which will stimulate housing needs should be given a trial. All of the above recommendations are geared toward achieving this.

Conclusion and Summary

This report has dealt with the problems inhibiting low-cost housing programmes in Nigeria. Through literature research the study found that for a successful low-cost/low-income housing programme there must be a drastic change in the existing policies. Such changes will include improving the qualitative and quantitative aspects of housing. There is need for adequate housing in Nigeria as the report shows. Essential amenities such as sewage disposal, refuse clearance, electricity and portable water needs to be upgraded.

The housing policies and programmes call for comprehensive study dealing and addressing the issue proper, and proposals that involve citizens' participation should be pursued and encouraged. Programmes encouraging corporations and companies to provide housing for their staff, both senior and junior, are laudable efforts to be advocated.

A need for appropriate construction that will cut construction costs should be a prime target for solving the acute housing shortage. Cutting construction costs will then allow low income earners into the housing market. This study reveals that the utilization of intermediate/appropriate technology will amount to prudent utilization of resources (both natural and manpower). In addition, it will foster the "privitization" of the building industry. Such steps will create needed jobs, provide avenues for expertise in appropriate construction techniques, and would surely be a saver in foreign reserve. Early participation of potential tenants in the planning and design stages will create and insure the sense of security and belonging to their homes.

The absence of this has been partly responsible for the apathy in public housing. Early involvement will ensure design and planning solutions that would relate well to geo-cultural and climatic factors.

The study showed that the supply side approach to housing has not been successful. Instead, the solution to low-cost housing should be as varied as the problem and must cover all of the areas that make housing a beneficial habitable environmental unit. This involves more than the construction and selling of dwelling units, but calls for a comprehensive housing programme ranging from socio-economic, architecture through alternative technology. A strong conclusion drawn from this study is that a major step in the fulfillment of low-cost housing will be in the area of adapting alternative/intermediate technology. And what this involves is the appropriate use of available technology and building materials. The future of low-cost housing policies/programmes relies heavily on the use of adobe brick and other locally available materials. Contrary to popular belief, adobe brick does last as long as any other contemporary building material when properly cared for and maintained. Adobe brick as a successful building material is evident in contemporary architecture of Arizona and New Mexico in the United States, or in the traditional architecture of the older urban centres or the villages. Therefore, the ingenuity of creative planners and innovative architects and builders with reference to and adaptation of traditional architecture will surely make adobe brick the building block of the future in Nigeria.

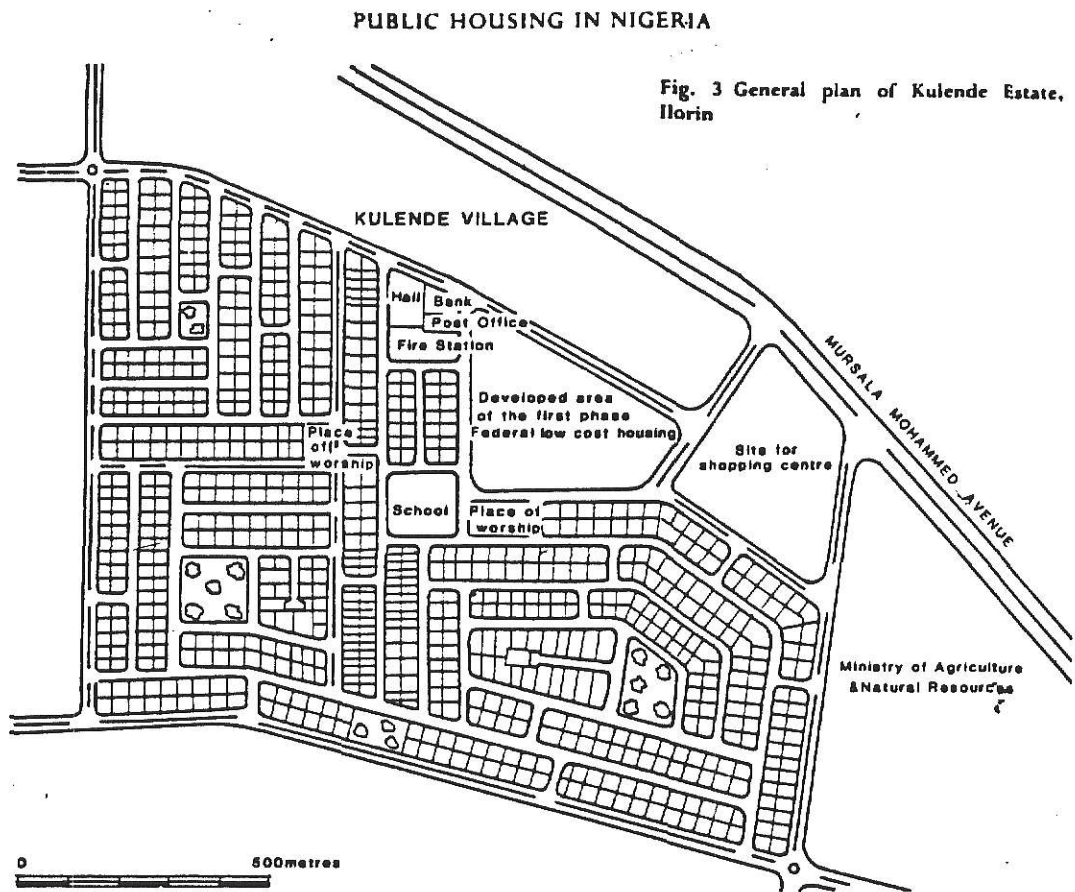
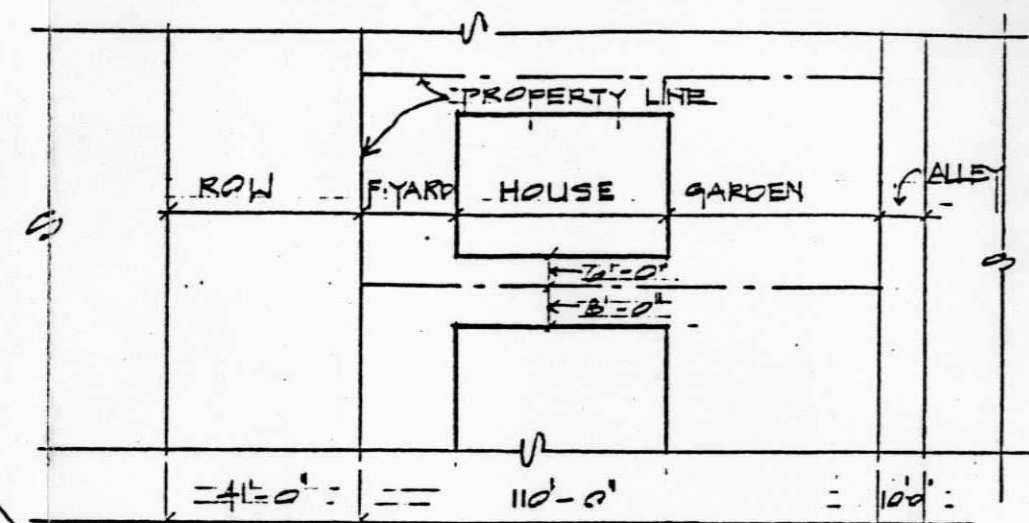


Fig. 33: General Plan of Kulende Estate, Ilorin, Kwara State.

Source: Megbolugbe.



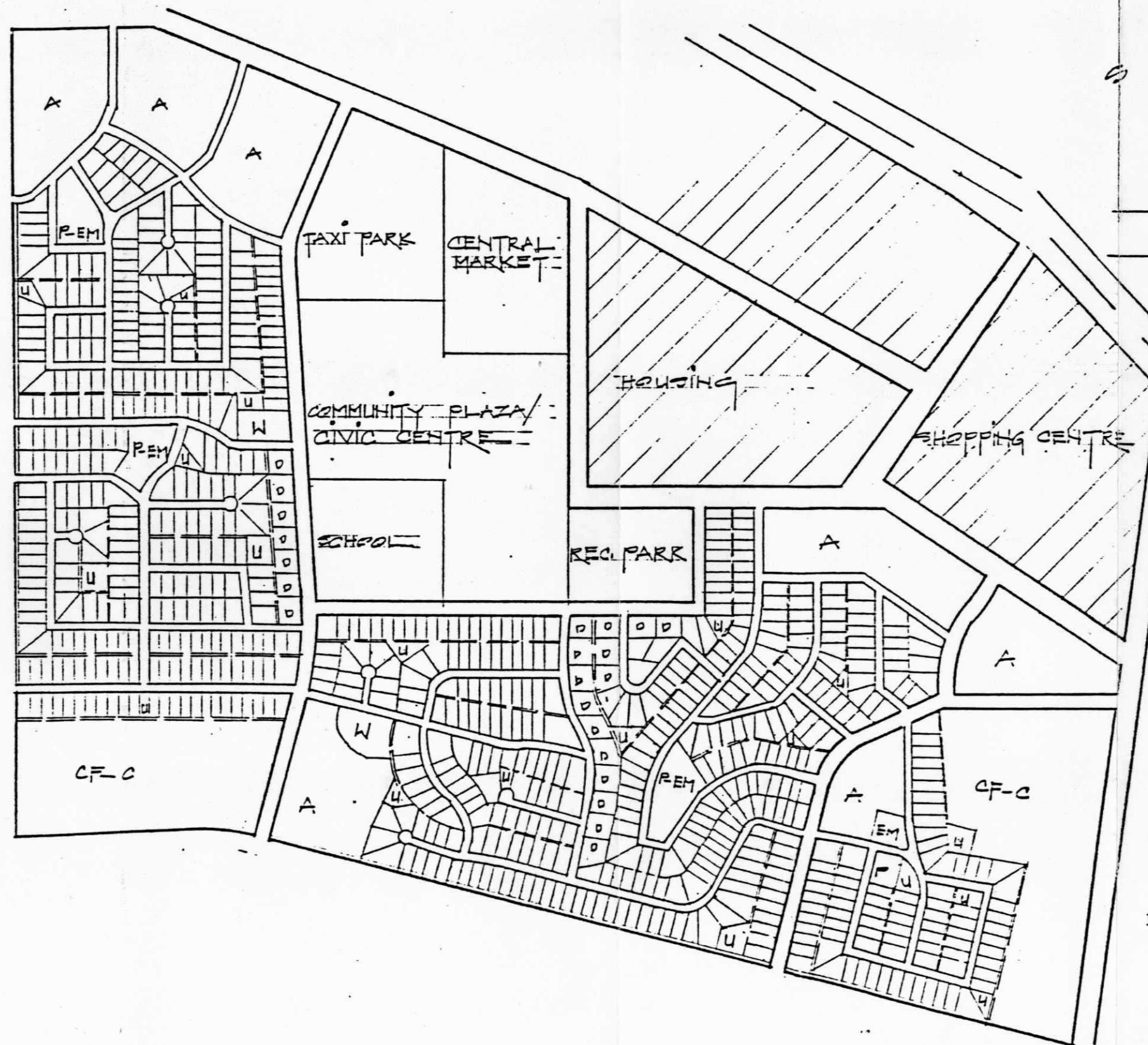
TYPICAL LOT LAYOUT 41'-0" x 110'-0"

LEGEND

- MAJOR STREET
- COLLECTOR STREET
- LOCAL/RESIDENTIAL STREET
- ALLEY WAY
- SCREEN PLANTING
- LOT (TYP.)
- DUPLEX
- APARTMENT COMPLEX
- UTILITY LOT
- PUBLIC TAP
- REFUSE DUMP
- SEPTIC TANK, ETC.
- W WORSHIP
- P-EM PLAY SPACE AND EVENING MARKET
- CF-C COMMUNITY FARM AND COMPOST SITE
- EXISTING DEVELOPMENT

Fig. 34 PRELIMINARY SKETCH

SCALE: 1" = 500'-0"



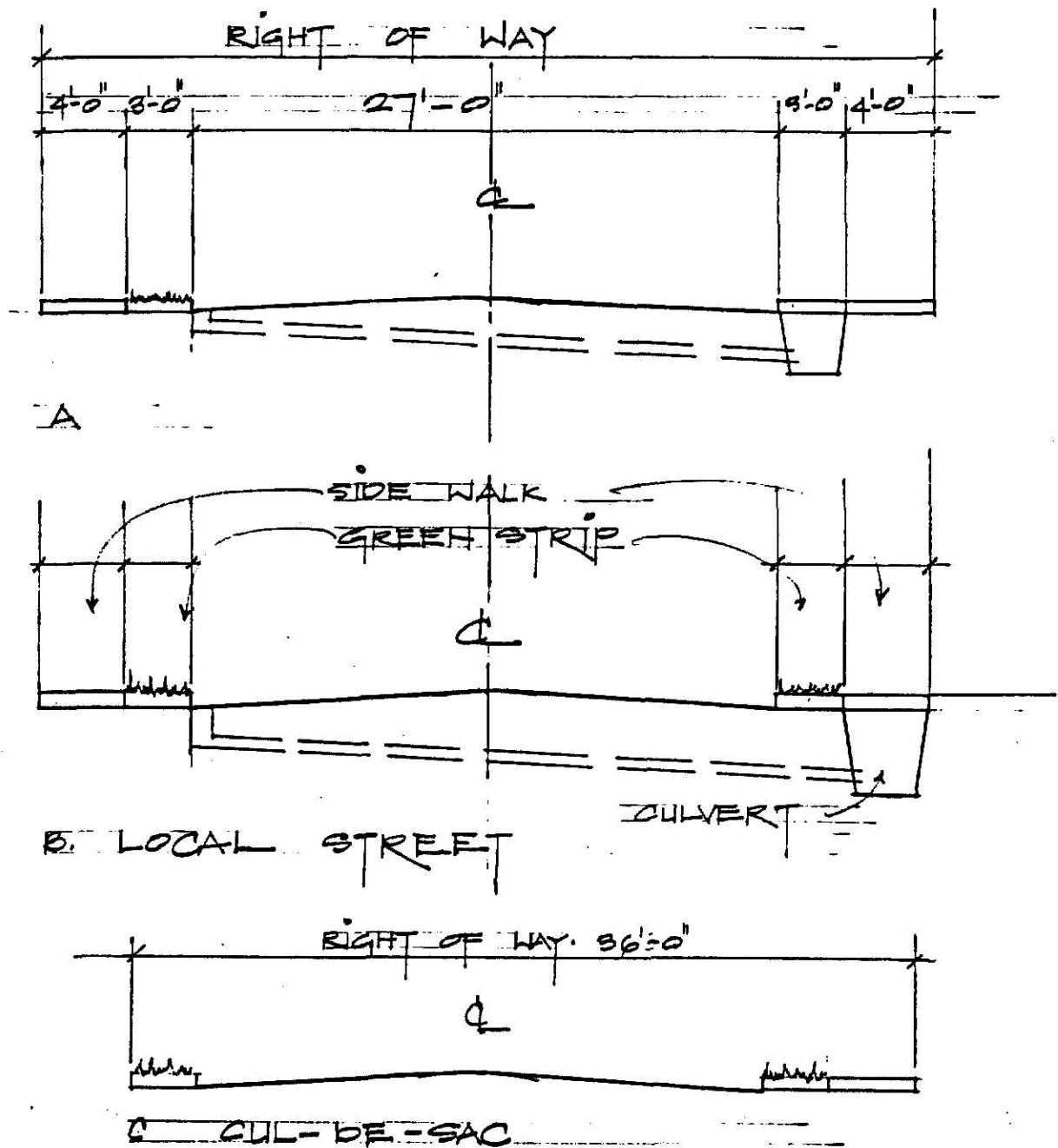


Fig. 34.1

TYPICAL RESIDENTIAL STREET PROFILE

Table 7. Land Use Areas: Angola

Use	Area per person m ²
Housing lot	19.00
Open space	10.00
Schools	2.00
Commercial	0.50
Social, cultural, religious	0.80
Administration	0.50
Circulation	11.00

Source: Turner.

Table 8. Some Recorded Examples of Existing Lot Sizes and Densities from a Number of Countries

Place	Source	Sizes m ²		Occupancy	Built area per person m ²	Density dw. per ha.	Notes
		House	Lot				
1 Angola	Sampaya, ³ p. 180	50-60	279	5-11	4.6-7.4	30	
2 Luanda, Angola (musseques) (a)	aerial photos high	—	114	—	—	70	Urban, developing squatter areas, filling in gradually
(b)	medium	—	217	—	—	36.8	
(c)	low	—	444	—	—	18	
3 Jamaica	SCP Report ⁴ Tower Hill (Sites & Services Project)	92	167	2 persons per habitable room 8	11.5	23.4	Original figures — since then open space has been 'captured'
4 Cuevas, Lima, Peru	Camino ¹⁰ , p. 138	87	128	6	14.5	30.5	Includes 30m ² for walls
5 El Ermitano Lima, Peru	Camino ¹⁰ , p. 145	110	160	10	11.0	26.06	Includes 27m ² for walls
6 El Agustino Lima, Peru	Camino ¹⁰ , p. 159	43	61.8	6	10.3	68.05	Includes 5m ² for walls
7 El Gallo Ciudad Guayana, Venezuela	Camino ¹⁰ , p. 215	65	300	6	10.83	10.56	
8 Villa Socorro Colombia	Camino ¹⁰ , p. 229	43	96	6	7.16	38.25	
9 Davao Philippines (Piapi)	Social survey of area	24	48	9	2.6	176.00	high-density urban slum — all houses on ground — no multi-storey

Source: Turner.

Table 9 : Some Recorded Examples of Proposed New Housing from a Number of Countries

Place	Source	Sizes m ²		Occupancy	Built area per person m ²	Density ^a per ha. net	Notes
		House	Lot				
10 Kaduna, Nigeria	Max Lock ¹¹	84.5	232	7-8	10.5-12	34.4	
11 Luanda, Angola (Ilha do Cabo)	OTAM ¹²	60	95	4	15	)	Semi-urban
		84	145	6	14	)24	
		88	150	8	11)	
12 Luanda, Angola Bairro do Cazenga	Observation	60	162	6	10	43	Urban
13 Huambo, Angola Bairro do Cacilhas	Observation	64	375	6	10.6	21	Rural
14 Alto Liro, Angola	Lobito ¹³	36	144	6	6	55	Urban self-help project. Houses to be extended
15 Angola	Sampaya ³ p. 184	50-60	130	6	8-10	60	
16 Jamaica	Shankland Cox ⁴	45.5	93.6	6	7.5	69	
		36.2	93.6	4	9.05	69	

Note: a. Where not specifically indicated, 20 per cent of the area has been deducted for roads and footpaths.

Source: Turner.

Table 10. Percentages of Public and Private Use in Some Typical Sites-and-Services Layouts

Project	Lot size m ²	Net density lots/ha.	Percentages of land use			Source
			Lots	Social facilities	Roads and footpaths	
17 Nicaragua	110	50	55	25	20	IBRD, Sites and Services Projects
18 Senegal	150	44	61	15	24	Annex A, p. 10
19 Indonesia	64 ^a	95	61	21	18	"
20 Jamaica	77 ^a	77	60	20	20	"
21 Botswana	330	20	66	14	20	"
22 Zambia	210	21	50	15	35	"
23 Tanzania	130 ^a	38	50	34	16	"
24 Kenya	150 ^a	40	60	20	20	"
25 Korea	105 ^a	72	76	5	19	"
26 Philippines	68 ^a	100	68	17	15	Alan Turner
27 Curacao	320	18	59	25	16	Alan Turner

Note: a. Average lot size in projects where a range of lot sizes is used to provide greater choice.

Source: Turner.

Birnawa Housing Area.
Family groupings: Based on the assumption that more than two families in each house plot would be the rule rather than the exception, the house plan A (12) enables each family to have one or two rooms together. The two corner courts can be private to each of two families. In these cases the whole house plot might be owned by one person and rooms sublet to individual families or single occupants. The open court in the centre of each house, being common to all occupants, makes the dwelling function ideally for one large family with a number of growing children. It also meets the demand for varying degrees of privacy within the house.

Growth and change: A concept such as this not only manages to meet present demands and living patterns, but is capable of further growth and change. A group of houses may be taken as a whole by persons intending to live together as a large community: the various social and economic patterns of different ethnic groups could be served without major changes in design. The system is flexible because it allows for a high degree of social and economic integration and at the same time gives considerable freedom of choice of accommodation.

Each of the 50-foot-square house units can take a total of seven habitable rooms of sizes varying between 14 by 10 feet and 12 by 10 feet. They add up to a total area of 910 sq. ft. The design is adaptable to the changing fortunes of a family, who might start building the basic habitable rooms in sandcrete of mud stabilized with cement and later add the remaining rooms in concrete block or other more durable building materials. The service core of the plans comprises kitchen, shower-room, water closet, and storeroom.

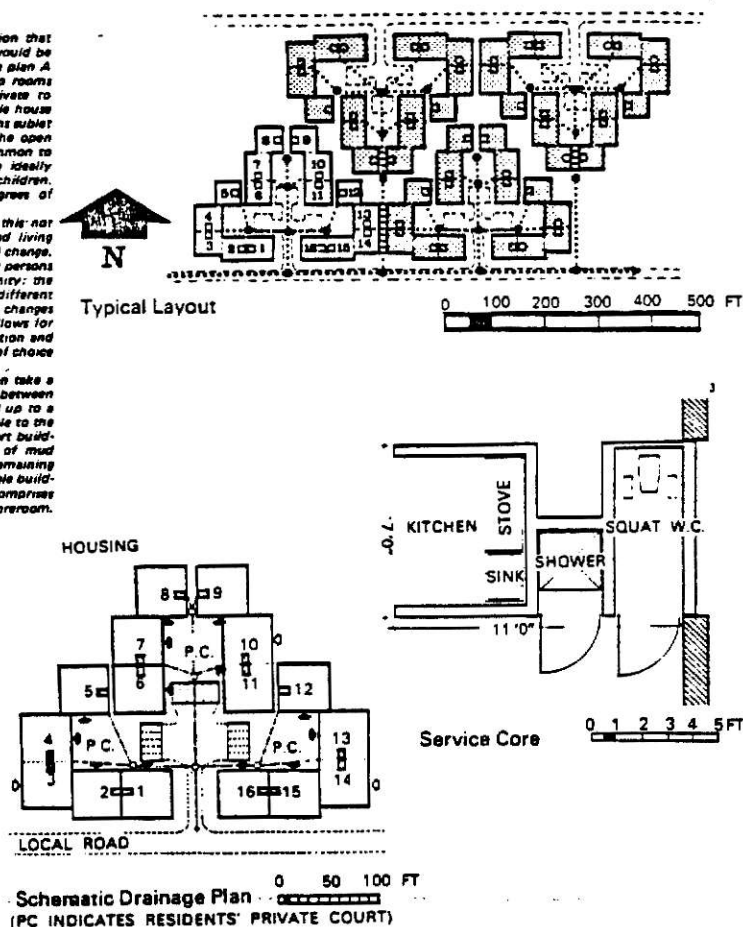
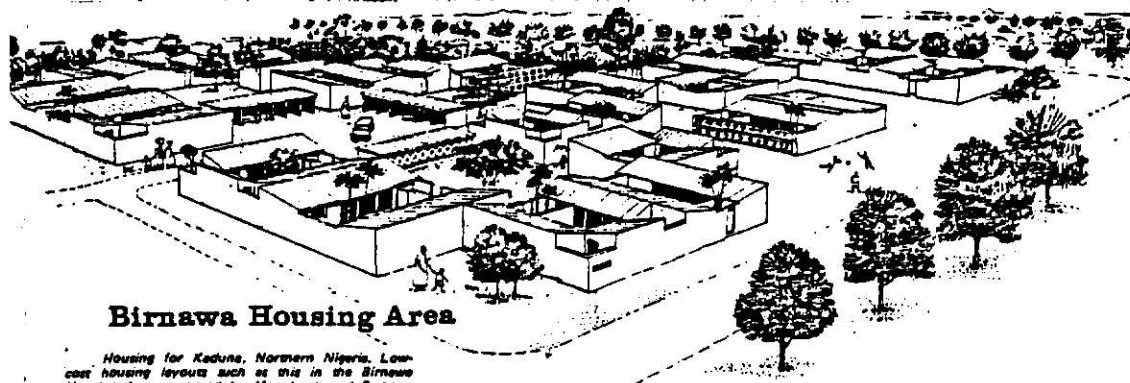


Fig. 35.0: House Plan at Birnawa Low Cost Housing Kaduna State.

Source: Saini.



Birnawa Housing Area

Housing for Kaduna, Northern Nigeria. Low-cost housing layouts such as this in the Birnawa Housing Area proposed by Max Lock and Partners point to the kind of approach suitable for communities in hot dry lands. Typical local enclave courts consist of sixteen 50-foot-square plots which can be adapted to produce a variety of combinations or subdivisions of house types and plots (continued overleaf).

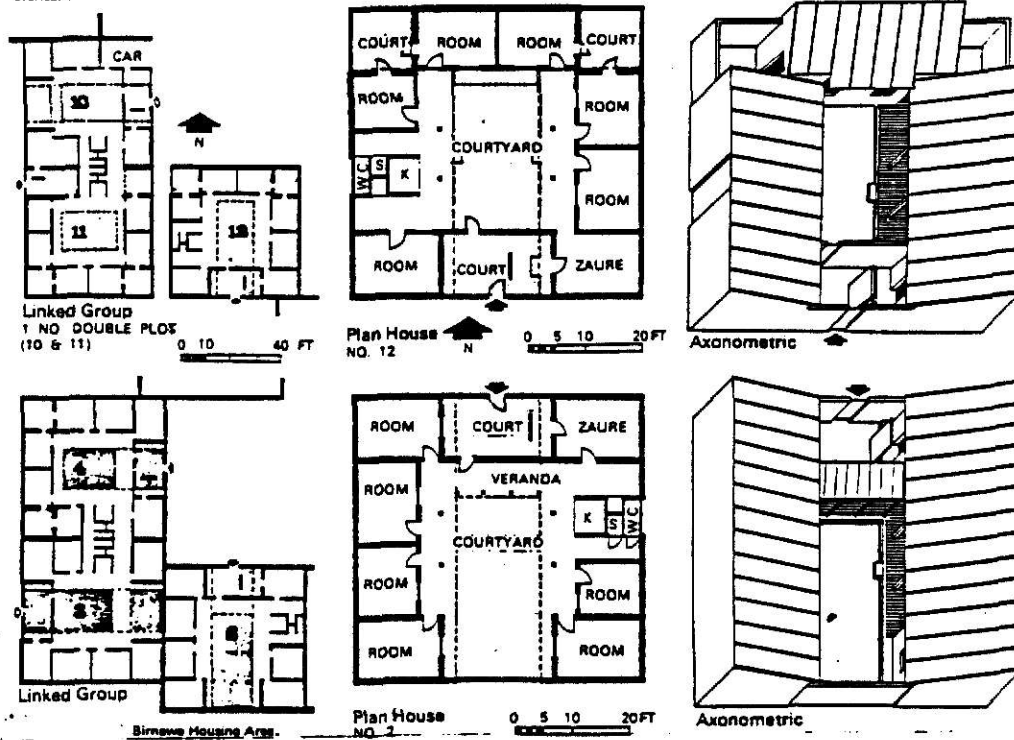


Fig. 35.1: Floor Plan and 3-D Drawings of Birnawa Housing.

Source: Saini.

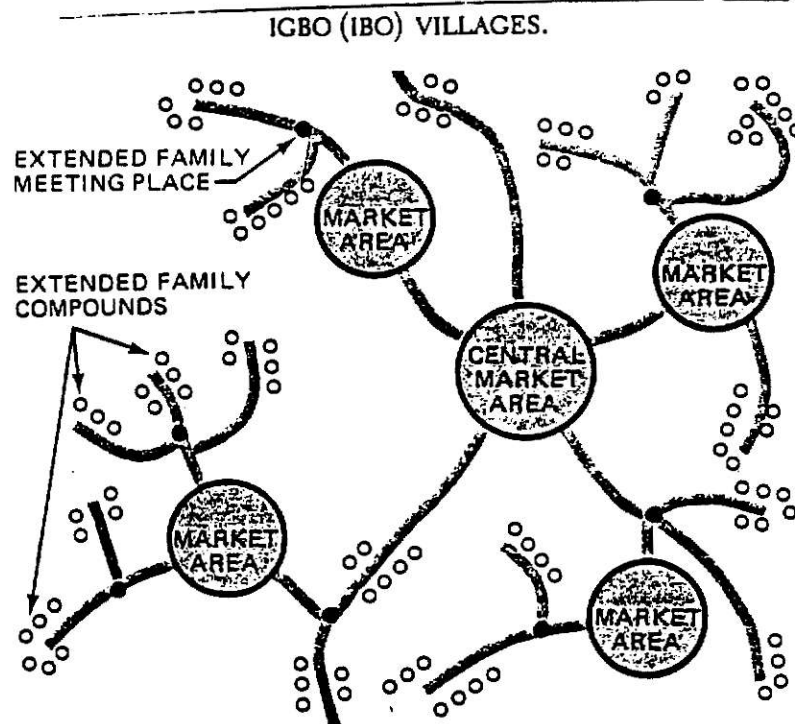


Fig. 37.0: Igbo Village Layout.

Source: Hull.

Table 11. *Recreational Open Space*

<i>Category</i>	<i>Provision</i>
Play lot	0.5m ² -2m ² per lot depending on density and land cost. Minimum area per play lot of 20-30m ²
Playing field	1 m ² per person for general purposes, including use by schools
Small park	About 1-2m ² per lot for 'vest-pocket' parks. Minimum size 100m ²
Community park	About 1-2m ² per lot with minimum size of 400m ²
Large park	To serve community of at least 5,000, 1 m ² per person

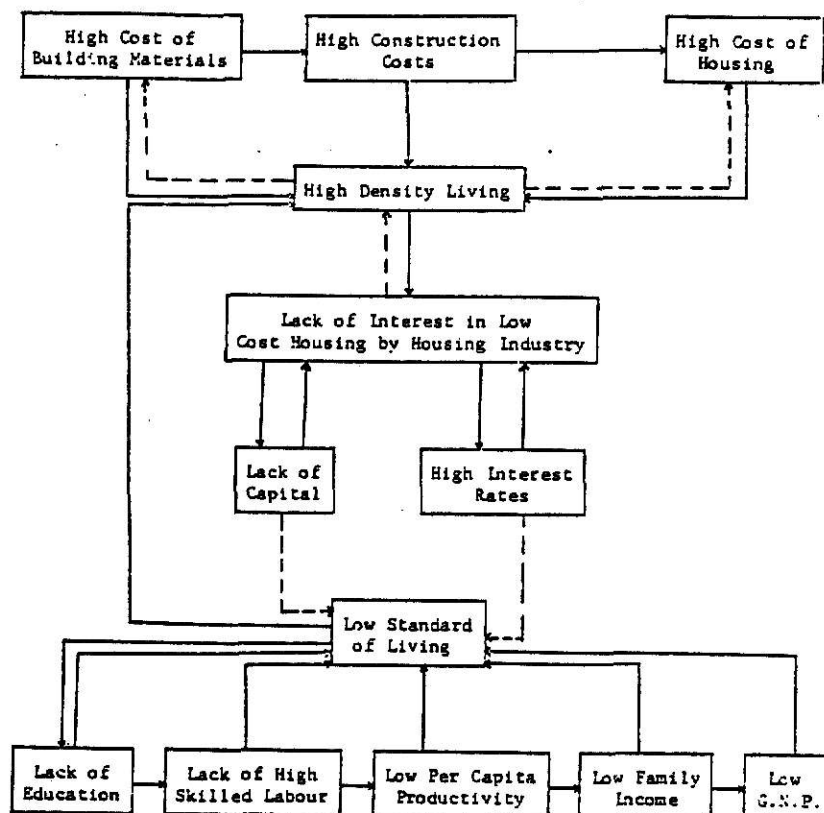
Source: Turner.

Table 12. *Infrastructure*

Water Supply. Water for industrial use cannot be quantified without a knowledge of the specific industry. For residential uses the following figures are often used as a guide:

- 80 litres *per capita* per day with pit latrines;
- 100 litres *per capita* per day with water-borne sewerage;
- 40 litres per minute per tap for community stand-pipes;
- 400 litres per minute per fire hydrant.

Source: Turner.



Note: Solid arrows indicate direct causal relationship. Dashed or broken arrows indicate indirect relationship.

Fig. 38: The Basic Identification of Casual Factors in the Housing Problem of an Emerging Nation.

Source: Mazdiya.

BIBLIOGRAPHY

Books

Aller, Paul, Build Your Own Adobe, Stanford University Press, California, 1947.

Alexander, Christopher et. al., The Production of Houses. Hatch, Richard (Ed.), The Scope of Social Architecture, Van Nostrand Reinhold Company, New York, 1984.

Ayeni, B., Lagos, M. Pacione, Problems and Planning in Third World Cities, Croom Helm Ltd., London, 1981.

Bainbridge, Bunting, Taos Adobe, Fort Burgwin Research Center Museum of New Mexico Press, Santa Fe, 1981.

Benedick, Kenneth A., Guide to the Use of Native Plant Materials in a Landscape, MLA thesis, Kansas State University (unpublished 1979).

Boudreau, Eugene H., Making the Adobe Brick Brick, Fifth Street Press, 1982.

Center for Renewable Resources, Renewable Energy in Cities, Van Nostrand Reinhold Company, New York, 1984.

Claire, William H., Handbook on Urban Planning, Van Nostrand Reinhold Company, New York, 1973.

Dakhil, Fahd H. et. al. (Editors), Housing Problems in Developing Countries. Proceedings of IAHS International Conference 1978, Vol. 1, John Wiley & Sons, New York, 1978.

_____, (Editors), Housing Problems in Developing Countries. Proceedings of IAHS International Conference 1978, Vol. 2, John Wiley & Sons, New York, 1978.

De Chiara, Joseph and Lee Koppelman, Urban Planning and Design Criteria, Van Nostrand Reinhold Company, New York, 1975.

_____, Site Planning Standards, McGraw-Hill Book Company, New York, 1978.

De Chiara, Joseph and John Callender, Time-Saver Standards for Building Types, 2nd Edition, McGraw-Hill Book Company, New York, 1980.

Dethier, Jean, (translated by Ruth Eaton), Down to Earth, Mud Architecture, An Old Idea A New Future, Thames and Hudson, London, 1981.

- Dwyer, D.J. (Editor), The City in the Third World, Harper and Row, Inc., 1974.
- El-Shakhs, Salah and Robert Obudho (Editors), Urbanization, National Development, and Regional Planning in Africa, Praeger Publishers, New York, 1974.
- Fareed, Adeh, Aided Self-Help Housing. Iktay Ural (Editor), Construction of Low-Cost Housing, John Wiley and Sons, New York, 1980.
- Fathy, Hassan, Architecture for the Poor, University of Chicago Press, Chicago, 1973.
- Ferguson, Francis, Architecture Cities and the Systems Approach, George Brazillier, New York, 1975.
- French, J.S., The Design of Urban Space. A.B. Grove et. al. (Editors), City Landscape, Butterworths, Boston, 1983.
- Fry, Maxwell and Jane Drew, Tropical Architecture in the Dry and Humid Zones, Reinhold PUBLISHING Corporation, New York, 1964.
- Fullerton, R.L., Construction in Warm Climates, Vol. III, Oxford University Press, London, 1968.
- Givoni, B., Man, Climate and Architecture, Van Nostrand Reinhold Company, New York, 1981.
- Gray, Virginia and Alan macrae, Mud, Space and Spirit. Handmade Adobes, Capra Press, Santa Barbara, 1976.
- Golany, Gideon, Housing in Arid Lands. Design and Planning, John Wiley and Sons, New York, 1980.
- _____, (Editor), Desert Planning, Nichols Publishing Company, New York, 1982.
- _____, (Editor), Design for Arid Regions, Van Nostrand Reinhold Company, New York, 1983.
- Hull, Richard W., African Cities and Towns before the European Conquest, W.W. Norton and Company, New York, 1976.
- Jacob, Jane, The Death and Life of Great American Cities, Vintage Book, New York, 1961.
- Koenigsberger, Otto and Robert Lynn, Rofs in the Warm Humid Tropics, Lund Humphries for the Architecture Association, London, 1965.

- Koenigsberger, Otto et. al., Manual of Tropical Housing and Building, Part 1. Climate and Design, Longman, London, 1978.
- Konya, Allan, Design Primer for Hot Climates, Architecture Press, London, 1980.
- Kukreja, C.P., Tropical Architecture, McGraw-Hill Book Company, New York, 1978.
- McHenry, Jr., Paul G., Adobe Build It Yourself, The University of Arizona Press, Tucson, 1973.
- _____, Adobe Comes Full Circle, Kenneth Clark and Patricia Paylore (Editors), Desert Housing, The University of Arizona Press, Tucson, 1980.
- _____, Adobe and Rammed Earth Buildings, Design and Construction, John Wiley & Sons, New York, 1984.
- Newcomb, Duane, The Owner-Built Adobe House, Charles Scribner's Son, New York, 1980.
- Ojo, G.J.A., Yoruba Palaces, University of London Press, Ltd., London, 1966.
- Olgyay, Victor, Design with Climate, Bioclimatic Approach to Architecture Regionalism, Princeton University Press, Princeton, 1973.
- Pama, R.P. et. al. (Editors), Low-Income Housing--Technology and Policy, Vol. I, Pergamon Press, New York, 1977.
- _____, Low-Income Housing--Technology and Policy, Vol. II, Pergamon Press, New York, 1977.
- _____, Low-Income Housing--Technology and Policy, Vol. III, Pergamon Press, New York, 1977.
- Payne, Geoffrey K., (Editor), Low-Income Housing in the Developing World: The Role of Sites and Services and Settlement Upgrading, John Wiley & Sons, New York, 1984.
- Ridgeway, James, Energy-Efficient Community Planning, The JG Press, Inc./The Elements, 1936.
- Rubenstein, Harvey M., Central City Malls, John Wiley & Sons, New York, 1978.
- Saini, Balwant S., Architecture in Tropical Australia, Architectural Association, George Wittenborn, Inc., New York, 1970.

Saini, Balwant S., Building in Hot Dry Climates, John Wiley & Sons, New York, 1980.

Seelig, Michael Y., The Architecture of Self-Help Communities, Architectural Record Book, New York, 1978.

Sprerger, Paul D., Urban Design. The Architecture of Towns and Cities, McGraw-Hill Book Company, New York, 1965.

Sterkenburg, J. and J. Hinderink, Anatomy of an African Town, Dept. of Geography of Developing Countries, Geographic Institute, State University of Utrecht, The Netherlands, 1975.

Turner, Alan (Editor), The Cities of the Poor, Croom Helm, London, 1980.

Turner, John F.C., Housing by People, Marion Boyars, London, 1976.

Weitz, Raanon (Editor), Urbanization and the Developing Countries--Report on the Sixth Rehovot Conference, Praeger Publishers, New York, 1973.

Westmacott, Richard and Christopher Blanford, Environmental Evaluation and Design. Alan Turner (Editor), The Cities of the Poor, Croom Helm, London, 1980.

Journals, Professional Magazines and Government Gazettes

Abiodun, Joseph O., "Housing Problems in Nigerian Cities," Nigerian Geographical Journal, May 1975.

Adedibu, Afolabi A., "The Impact of Government Policy on Indigenous Housing in Ilorin, Nigeria," Ekistics, Vol. 48, No. 287, March-April 1981.

Adeyemo, Michael A., "Financing the Construction Industry: Problems and Prospects," The Nigerian Economic Society, 1974.

Adobe Today's Earthbuilder, Adobe News Inc., Albuquerque, New Mexico, Issue 42, 1984.

_____, Adobe News Inc., Albuquerque, New Mexico, Issue 43, 1974.

Adobe Today, Issue 31, Albuquerque, New Mexico, 1981.

_____, Issue 34, Albuquerque, New Mexico, 1981.

_____, Issue 35, Albuquerque, New Mexico, 1982.

_____, Issue 37, Albuquerque, New Mexico, 1982.

- Agency for International Development, Sewage Lagoons for Developing Countries, Deppt. of Housing and Urban Development, Washington, 1966.
- Anusionwu, E. Chukwuma, "Low-Cost Housing in Nigeria: Problems and New Perspective," *The Nigerian Journal of Economic and Social Studies*, Vol. 24, No. 3, Nov. 1982.
- Aradeon, David, "Space and House Form: Teaching Cultural Significance to Nigerian Students," *Journal of Architectural Education*, Vol. XXXV, No. 1, Fall 1981.
- Awotona, Adenrele A., "Financing Appropriate Housing in Nigeria," *Ekistics*, Vol. 43, August 1977.
- Ayeni, M.A.O., "Living Conditions of the Poor in Lagoos," *Ekistics*, Vol. 43, No. 255, Feb. 1977.
- Barnes, Susan, "Ablobe," *Fine Homebuilding*, No. 21, June/July 1984.
- Bryant, Ben S., "COrrugated Roofing Panels from Agricultural Residues," *Appropriate Technology*, Vol. 4, No. 4, Feb. 1978.
- Cain, Allan et. al., "Indigenous Housing and the Third World," *Ekistics*, Vol. 41, No. 242, Jan. 1976.
- Canadian Hunger Foundation and Brace Institute, "Appropriate Technology Primer," *Ekistics*, Vol. 43, No. 259, June 1977.
- Clark, Z. and Steve Tibbetts, *Composting Toilets and Grey Water Disposal, Build Your Own Alternative Waste Treatment Association*, Bath, Maine, 1977.
- Clivus Multrum, Qs and As, *Organic Waste Treatment System*, Stalens Bakteriologiska, Laboratorium, Stockholm.
- Correa, Charles M., "Third World Housing: Space as a Resource," *Ekistics*, Vol. 41, No. 242, Jan. 1976.
- Devas, Nick, "Financing Urban Land Development for Low-income Housing," *Third World Planning Review*, Vol. 5, No. 3, August 1983.
- Diejomah, V.P., "Government and the Construction Industry in Nigeria," *The Nigerian Economic Society*, 1974.
- Ebong, Maurice O., "The Perception of Residential Quality. A Case Study of Calabar, Nigeria," *Third World Planning Review*, Vol. 5, No. 3, August 1983.

- Gupta, V.K. et. al., "Construction of Rural Houses through Aided Self-Help--An Experience in India," *International Journal for Development Technology*, Vol. 2, 1984.
- Hunponu-Wusu, O.O., "Environmental Health Issues in Nigeria: Lagos Observations," *The Nigerian Economic Society*, 1977.
- Igeogu, C.V. et. al., "Housing Conditions and Needs in Port Harcourt," *The Nigerian Economic Society*, 1977.
- Johnstone, Michael, "Housing Policy and the Urban Poor in Penninsular Malaysia," *Third World Planning Review*, Vol. 5, No. 3, August 1983.
- Kabagambe, Dennis and Cliff Moughtin, "Housing the Poor: A Case Study in Nairobi," *Third World Planning Review*, Vol. 5, No. 3, August 1983.
- Kendall, Stephen H., "An Intermediate Housing Technology for the USA," *Eristics*, Vol. 43, No. 259, June 1977.
- Little, J.A. et. al., "Traditional and Improved Methods of Low-Cost Housing in the Sudan," *International Journal for Development Technology*, Vol. 1, 1983.
- Mabogunje, Akin L., "Towards an Urban Policy in Nigeria," *The Nigerian Journal of Economic and Social Studies*, Vol. 16, No. 1, March 1974.
- _____, "Issues in Nigerian Urbanization," *The Nigerian Economic Society*, 1977.
- Mansell, R.S., "Building Regulations and codes for the Less Developed Countries," *International Journal for Development Technology*, Vol. 2, 1984.
- Megbolugbe, Isaac F., "The Hopes and Failures of Public Housing in Nigeria," *Third World Planning Review*, Vol. 5, No. 4, Nov. 1983.
- Murie, Alan, "Estimating Housing Needs: Techniques or Mystic," *Housing Review*, May-June 1976.
- Murie, Alan and Philip Leather, "Developments in Housing Strategies," *The Planner; Journal of the Royal Town Planning Institute*, Nov. 1977.
- National Center for Appropriate Technology, *Compost Toilets, A Guide for Owner-Builder*, Butte, Montana.
- Ojo, A.T., "Financing Urban Housing in Nigeria," *The Nigerian Economic Society*, 1977.
- Okpala, Donatius C.L., "Housing Standards: A Constraint on Urban Housing Production in Nigeria," *Eristics*, Vol. 45, No. 269, 1978.

- _____, "Strengthening Urban Local Governments for Development Planning: The Critical need for urban Chief Executives," Nigerian Economic Society, 1977.
- Onibokun, Gale A., "Socio-Cultural Constraints on Urban Renewal Policies in Emerging Nations: The Ibadan Case," Nigerian Journal of Economic and Social Studies, Vol. II, No. 3, Nov. 1969.
- Onokerhoraye, Andrew G., "The Pattern of Housing, Benin, Nigeria," Ekistics, Vol. 41, No. 242, Jan. 1976.
- Sada, P.O., "Residential Land Use in Lagos: The Relevance of Traditional Models," African Urban Notes, VII, No. 1, 1972.
- _____, "The Rural-Urban Fringe of Lagos: Population and Land Use," The Nigerian Journal of Economic and Social Studies, Vol. 12, No. 2, July 1970.
- Stedman, Myrtle, "Agless Adobe," Fine Home Building, No. 5, Oct-Nov 1981.
- Stepick, Alan and Arthur Murphy, "Housing and Government Intervention Among Urban Poor," Ekistics, Nov-Dec 1979.
- Stevens, R.F., "Improved Uses of Local Building Materials in the Less Developed Countries," International Journal for Developed Technology, Vol. 1, 1983.
- Sule, R.A. Olu, "Environmental Pollution in an Urban Centre: Waste Disposal in Calabar," Third World Planning Review, Vol. 3, No. 4, Nov. 1984.
- _____, "The Future of the Nigerian Housing Subsidy: The Unanswered Questions," The Nigerian Journal of Economic and Social Studies, Vol. 23, No. 1, March 1981.
- Third National Development Plan (1975-80), Federal Government of Nigeria, Lagos, 1975.
- Ugo, S.U., "The Cement Industry," The Nigerian Journal of Economic and Social Studies, Vol. 8, No. 1, march 1960.
- United Nations, Soil-Cement, Its Use in Building, United Nations Publications, 1964.
- _____, Housing in Africa, United Nations Publication, 1965.
- _____, Design of Low-Cost Housing and Community Facilities, Climate and House Design, Vol. 1, United Nations Publications, New York, 1971.

_____, Basic Housing Case Studies, Design of Low-Cost Housing and Community Facilities, Vol. II, United Nations Publications, New York, 1976.

_____, Housing Policy Guidelines for Developing countries, New York, 1976.

Vernez, Georges, "A Housing Services Policy for Low-Income Urban Families in Developing Countries," Ekistics, Vol. 41, No. 242, Jan. 1976.

Vielrose, Egon, "Needs for Residential Construction in Urban Areas of Nigeria: 1975-84," The Nigerian Economic Society, 1974.

Vogale, L.R., "People and Planning: Focus on Africa," Ekistics, Vol. 46, No. 279, Nov-Dec 1979.

Volunteers in Technical Assistance (VITA), Making building Blocks with the CINVA-RAM Block Press, Mt. Rainer, Maryland, 1977.

AN ALTERNATIVE APPROACH TO LOW-COST
HOUSING CONSTRUCTION, DESIGN AND PLANNING

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B.S., B. Arch., Kansas State University, 1983

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree of

MASTER OF REGIONAL AND COMMUNITY PLANNING

Department of Regional and Community Planning

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1986

ABSTRACT

Housing as a social need ranks among the three major necessities of life, including food and clothing. And the provision of decent shelter is the goal of every man. 20-25 percent of income is generally considered to be an optimum ratio for providing adequate shelter. But as noted in the report, it has been recorded that up to 35-40 percent is being spent by an average household on housing, even for the so-called low-income/low-cost public housing.

The strategies employed by the government has failed to adequately provide housing at affordable cost. Therefore, while the approach could not be totally be disregarded and ignored, there is a need for a new innovative approach. And this hinges on redirection from the capital intensive and imported building materials to labour intensive and the use of available local resources. The untapped human labour should be usefully utilised in achieving the housing goal of the country. And appropriate/intermediate technology will be the tool for cutting construction cost which is being blamed for the escalation of the housing cost, hence the inability to fulfill the housing policy.

This report, therefore provides some guidelines for making low-cost/low-income housing policy/programme a wholly issue addressed from the construction, design, and planning aspects. The report, while not intended as a panacae for the chronic housing problem in Nigeria, but given the social, cultural, economic and political will and acceptance could easily be one.