



A STRATEGY FOR LOW INCOME HOUSING FOR TUNISIA

by

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June 17, 1967

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Dear Dean Anderson:

In partial fulfillment of the requirements for the degree
of Master of Architecture I hereby submit this thesis
entitled "A Strategy for Low Income Housing for Tunisia. "

Respectfully,

Stanley Ira Hallet

Note

The author of this thesis served two years in the American Peace Corps in Tunisia. There he worked with the government agency for tourism and traveled extensively throughout the country. During his spare time he completed with the collaboration of Pere Andre Louis, anthropologist - ecologist, a documentary color film entitled Primitive Villages in Southern Tunisia showing various examples of troglodyte Berber villages found in the Matmata Mountain Range.

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Introduction

In the past, man constructed his own shelters from materials at hand. Over the generations his work became perfected and beautifully attuned to his physical environment and expertly tailored to the needs and activities of those who used it. However, the juxtaposition of a more advanced western industrialized economy on a traditionally agricultural one has resulted in economic turmoil. Today the developing country is forced to compete with the western economy, but it can not.

In the process the agricultural lands are no longer managed as they traditionally were, and those indigenous to the land have been forced to find work elsewhere. Thus, the exodus to a city in search began. Those torn from their native land with its ancient customs and traditions are helpless in the city. Tradition has been broken and man appears defenseless against the new order. Slums grow as evidence of man's new natural environment. The squatter problem has now been created.

The squatters are many and the government is poor. So, then when housing projects are built, they effect few families and due to their own limitations often become slums of the future. There is no money to spend and even less costly housing remains still too expensive.

And yet has man forgotten how to build? After constructing elaborate and sophisticated dwellings in the past, can he no longer construct an adequate shelter? Can the situation be altered so that he can once again construct his own habitations in the manner worthy of his accomplishments?

The object of this master's thesis is to propose a strategy to do just this for the Arab state of Tunisia.

Tunisia - Its Geography and Climate

The describe Tunisia we will start from the south and work our way north. First there is the desert. The average rainfall is hardly 100 millimeters and only the xerophyte plants dot the south. In the Mamata mountain range palm, fig and olive trees add to the meager resources of cattle breeding. Along the shore where the large plain begins, water is more abundant and certain cereals are cultivated. North of the Gafsa Mountains the Steppes begin. Average rainfall increases to 200 to 400 millimeters but this can vary drastically year to year. In the east the Low Steppes are the home of the semi-nomadic families. The cultivation of olive trees on the old roman system of spacing them each 25 meters apart is found around Sfax. As we move up along the shore, the country profits still from more rainfall. The olive is king along the eastern coast. The sea begins to yield her riches in the ports of Souse and Mahdia. Beyond the Great Dorsal the Tell starts. The soil is more fertile and the rainfall is heavier and more regular. To the east the Lower Tell is cultivated with cereal, olive groves and citrus fruits.

In September the storms come. The air is fresher, and the weather remains mild (ave. temp. for Tunis is $15\frac{1}{2}^{\circ}$ C. with extremes of 25.1° to 6.8°). With winter the temperature drops (Tunis is now an average of 11.6° C. with extremes of 18.1° to 6.4°). Spring comes and the weather is again milder (spring average in Tunis is 19.2° C. with extremes of 29.0° C. to 10.3° C). Summer comes and it grows hotter. The sirocco or hot winds that carry burning sand from the Tell sweep the country (the average Tunis temperature is 25.6° C. with extremes of 32.6° C. to 19.7° C).

For additional information pertaining to the population and size see the appendix.

History

The indigenous people of North Africa are the Berbers. They spoke similar Libyan dialects, led a pastoral life, living in mobile dwellings called mapalia and called themselves imazighen or free men. They grouped into tribes so that their reserves were easily protected while they roamed the country during pastoral seasons.

In 814 B.C. Carthage was founded by the Pheonicians on the eastern Berber coast and soon crushing the Berbers in the process due to its strategic position, it soon became the capital of the Pheonician Empire. Punic religion and language spread across the land and the semitization of the Berbers continued until the conquest of Carthage by the Romans in 146 B.C. Thus under the command of Augustus, Carthage became Capital of the Roman proconsul. Agriculture was encouraged, and land and road systems were developed. Dougga, El Djem, Thuburbo Majus still honor today the remains of the sophisticated town structure of this period. But the Berber's poverty was in contrast to the wealthy aristocracy, and in 439 A.D., the Vandals conquered a country weak from within. They destroyed very little and actually continued the Roman civilization up until the Byzantine rule in 533 A.D.

With the Byzantines, Berber states divided the country. In 570 the Prophet Mohammed was born and Islam started to spread. Calips from Damascuc and Bagdad ruled. Egypt was conquered, the seat was moved to Cairo and rebellion in Tunisia broke out. To quelch this, fierce Arab tribes from the delta were set loose on the Berbers.

This was the beginning of the Arab invasion of 1050 and a flourishing of the art occurred in the Arab world. The great mosques of Kairouan, Tunis, and Mahdia were built. But defeat came by the Spanish who occupied Tunisia for fifty years until the Turks invaded in 1574 and Tunisia became another province of the Ottoman Empire.

It is during this period that the lands began to go to waste. Land was held by either the sovereign or great families or religious foundations -

habous - the people who worked the land were practically slaves. With little incentive the land was left to waste and the desert grew where the Roman 'bread basket' once was. A stagnant economy developed, and the industrial revolution left Tunisia untouched.

Collapse was immanent and France, under the pretext of protecting the Turks from the Khrojmar Invasions of 1881, moved in and was there to stay. Under French Colonization certain advantages were felt. Administrative cadres were formed; roads were built; health and hygiene were administered, and money was invested. Work was created, but it was the French who benefited, and this could not last for long. National movements grew, and Habib Bourguiba became the popular leader. Finally, in 1956, Tunisia gained her independence and President Bourguiba and the Neo Destour Party was left with the problems of building up a poorly endowed country with one foot in the past and the other in the future, a future that appeared both bleak and threatening.

The Berber Migration

. . . ce dualism entre l'economie traditionnelle et l'economie moderne qui partage et dechire la vie meme du pays. ¹

The Berber migration began as early as 1936, with thousands of migrants leaving their rural homes to search for work in the capital city. Often just the men came, but soon they were followed by their families. There seems to be three reasons for this massive exodus to the city:

- (1) the disruption of the traditional equilibrium between man and the agricultural areas;
- (2) the demographic explosion; and
- (3) the famines

Fredj Stambouli notes in his study "Urbanism et Developpment en Tunisie" that the greatest portion of the migrants were from the rich agricultural areas of the north. Here French colonization and seizure of the best lands and the introduction of modern farming methods and equipment, forced many workers off the land. ² These men were forced to seek work elsewhere and the capital city was their only hope.

Perhaps even more significant was the demographic explosion. With the introduction of relatively more modern medicine, Tunisia experienced a drastic reduction in mortality rates. With this, the demographic phenomenon began in 1930. In thirty-five years the population of Tunisia doubled. It grew at the rate of twenty-five per cent every fifteen years. In 1936 it stood at 2,608,000; in 1956 it passed 3,783,000 and during this time the proportion of urban population increased from seventeen to thirty per cent. ³

Finally the famine of 1936 and of 1945 to 1948, perhaps in part a result of the other two factors, sent hordes of people from the dry south and central areas to the cities to find food and work.

Le grande Marasm et la famine des anness 1936, 1945-1948 provoquerent un afflux considerable de compagnards ruines et deracines qui pour eviter le naufrage, s'accrochaient a la planche de salut d'une ville deja saturee de main d'oeuvre.⁴

As Tunis comprised almost half of the urban population and was the capital city, she alone received the brunt of this urban migration. In 1921 she held inside her metropolitan areas 257,000 population; in 1936, 332,000; in 1946, 454,000; and in 1956 she reached 747,967.⁵

Population Characteristics of the Squatter Area

In 1946, the total population of Tunis' goubivilles stood at 50,500; in ten years it increased to 105,000; and between 1956 and 1960 the population grew at a minimum annual rate of fifteen per cent.⁶ Of this fifteen per cent only two and one-half was due to the natural growth of the population, while the other twelve and one-half represented the continuing inflow of migrants.

During the first years of settlement, the squatters usually group themselves by their ethnic and regional affinities so that the traditional social and family structure will remain intact. The size of the family was also determined by several surveys. In comparing this average family size to the average for the whole of Tunisia, the results were smaller than would be expected. For Djebel Lahmar and Djebel Djelloud the average family size varied for the districts studied, from 4.6 to 5.7.⁷ Examining a typical age distribution chart for Saida Manoubia, one finds, first, a higher percentage than normal of younger people, and, second, that the children under ten years of age make up almost fifty per cent of the population of the studied area. This is understandable as it was the younger men who were the first to leave the rural areas, attracted both by the glitter of the city and always eager to do better than was possible by staying on the land. In fact, many of the squatters still had land in the rural areas.

In the suatter areas the family begins. The young marry and the family is soon started. It would be interesting to compare the family size for the same squatter settlement varying with time, but to the best of the writer's knowledge, no such information is available. It could be predicted that the family would never take on the giant proportions of the traditional Arab family. As previously mentioned, the tribal traditions are kept up, though with time the families are intergrated into a more modern and urban life. Second, birth control is highly publicized and made available by a government seriously

involved with the population explosion. Their program is one of the most advanced for any underdeveloped country and it is possible that the demographic problem will be controlled by such measures.

Employment and Income Levels in the Squatter Areas

The results of the Sebag studies in Saida Manoubia⁸ show first that the majority of family heads were not steadily employed, and second that when employed the principal work was selling newspapers. Making up almost two-thirds of the employed squatters, they earned only 3,600 francs or \$7.00 a month and this was not enough for subsistence. In addition the men worked odd jobs, unofficially selling tickets for the train or bus, watching parked cars, shining shoes, or being guardians of one sort or another. In most cases the family was expected to help. The wife performed domestic work, taking in laundry, etc. The sons collected waste paper and cigarette butts, or sold gum or cigarettes. Sometimes, when possible, a spare room was rented or perhaps a better-off cousin would help out a little. If the family was lucky enough to have a few chickens then there would be eggs.

Ici es sont des series de pustules qui sortent de sol agileux qui abrite ainsi dans sec ex-croissances ces populations . . . Dans ces damilles ou le pere un jour est debardeur au port, le lendemain "fait" les poubelles, le surlendemain commet quelque larcins, ou la mere rammasse des cartons at ou la fille est prostitues, ou les enfants mendient . . . une ville ou les poubelles sont riches.⁹

The Role of the Government and Present Squatter Policy

In 1960, the Tunisian government, after a short period of reconstruction following independence, began to seriously and conscientiously attack the growing squatter problem. Since the gourbivilles were the direct result of the hordes of migrants coming from the rural areas in search of work, the first efforts made by the government were to control this urban movement. Simply enough, the governor was made responsible for stopping all those unemployed people in his district from leaving and migrating to the city. If any slipped by, they would be stopped in Tunis by the governor and sent back to their districts of origin. According to Stambouli, this immediate treatment of the problem was greater than that and as long as there was a disparity between the agricultural and urban areas, the migration continued.

The government also attacked the squatters already in Tunis in two ways. First, those squatters who were presently unemployed or who had arrived in the last ten years, would be sent back to the region of their origin. Again here, the governor would be responsible for keeping them there, finding them employment and finally providing housing. Unfortunately, all this was not realistic; there was no employment to be found nor money to build housing. The governors were almost obliged to let them escape back to the city in the constant search for work.

Second, the government would deal in another way with those squatters who had been in Tunis for at least ten years and were presently employed. These people would be allowed to stay. Eventually, all the gourbivilles would be destroyed and those permitted to stay would be housed in the better "improved" housing built by the government. This had been started, but enough housing can never be built and the money spent on housing could be better used in other areas of the Tunisian economy.

Meanwhile, the gourbivilles would all be destroyed. Until that time those left would be ameliorated. By 1958 the pressure for the destruction of the most "unsightly" squatter areas had mounted and the first gourbiville, Borgel, was totally demolished. However, because it was so difficult to resettle these people, the destruction of the squatter areas continued at a slower rate. The more "obvious" places went first. For example, the main road connecting Tunis to the airport was a prime area for cleaning, clearly conspicuous to visiting dignitaries. This "clean the front yard" approach removed only the borders of the slum areas, soon to be replaced by other projects which would hide the blighted remains.

In 1965, the governor of Tunis bulldozed the popular gourbiville of Bourg Alli Rais, bordering, as usual, one of the major entry routes. He believed the inhabitants to be elsewhere, but unfortunately he was wrong. The result was a minor battle and bloodshed.

The government concentrated on the following goals:

- (1) to prevent the construction or extension of new gourbivilles;
- (2) to send the new squatters back to their rural origins;
- (3) to give decent housing to those squatters already well integrated and employed;
- (4) to improve, if not replace, the existing gourbivilles.¹⁰

Meanwhile, at the national level, efforts were made to decrease the disparity between the rich and poor areas; to create employment in the rural areas and to fix the people on the farmlands. With respect to improving the existing squatter areas, the following proposals were made by Dr. Martin of UNICEF which are summarized as follows:

, A. Sanitary facilities

1. Drinking water - the extension of individual pipelines where possible and the placement of public water outlets within 150 meter radius

2. Streets to be resurfaced, or atleast kept up
3. Open spaces - to be created and kept up, anti-dust surfacing where possible, planting and greenplaces in the future
4. Drains - the extension of individual drains and the upkeep and control of open sewage
5. Lighting - extension
6. Cleaning - improvement in the quality and control of street cleaning, waste and garbage collection

B. Housing

1. Relocation where housing occurs in an uninhabitable or unhealthy industrial zone
2. Improvement of unfit housing

In addition, the proposals asked for the provision of collective sanitary equipment, maternal and child welfare centers, better schooling, extra-curricular activities, a school for the advancement of women and social centers.¹¹

Part One Land Allocation

To the very low income levels land tenure gives a family security that cannot be underestimated. It is upon this security that the family will invest the little money it has and by providing its own labor it will build, over a period of time, a habitation well suited to its particular needs. In the initial stages of growth, the family does not need or expect an elaborate shelter equipped with electricity and water such as were provided by the few existing government projects. But in the course of less than a generation it will want and expect more than even the government's standards of today offer.

The concept of phasing is vital. In the initial stages the security of place is all important. Minimum shelter becomes the next problem, and, at this time, the family will be content with minimum space and crowding as long as it is just a temporary situation and the means are available to assure that this is not the permanent situation as in the now existing squatter areas. Depending upon the family's unique socio-economic structure, needs will vary and the order that they will be satisfied will differ. Building additional space could be sacrificed to the installation of utilities. In each case the evolution of the habitation will be dictated by the unique needs of every family. Unfortunately it has always been these needs that have been ignored by the standardized projects offered by the government now in existence today.

Close examination of the goubivilles around Tunis, the capital of Tunisia, reveals structures of mud and sunbaked blocks. For the average squatter family, life is limited to a crowded single room with no space for expansion. Outside the streets are torturous open sewage systems, becoming rivers of mud in the rainy season, and the home for insects and disease during the long hot months. The squatters do build but it is limited. The crude mud and clay blocks evolve into larger more elaborate structures. But in the urban areas building is discouraged for who wants to invest the little money they have in a habitation that could be bulldozed down by tomorrow by

the government.

Our strategy is simply this. Give to the squatters tenure, the right to a small lot of land, and they will, with the scanty means available, develop it better than the government could ever possibly do. Our proposal will be presented in three parts: each part dealing with aspects of the total problem but each at a different scale. Part one will allocate land to the squatters, to be either completely or partially subsidized. Often the government has access to large tracts of land outside the urban centers. Street and lot layouts of the size of a small neighborhood will be proposed to the government. Part two will cover the multitude of plans that best guide both the government as well as the squatters in the best utilization of the lots in a future expanding building program. Part three will propose a structural system. This will concentrate on only the spanning problem of roofs and floors making it quite possible to reduce material and labor, thus being more economical.

All three parts are intended to work either together or independently. For example, land could be allocated and the family would be left entirely on its own. Other plans could possibly be substituted for the plans of Part two. If the family decides to follow the plans offered for the development of the lot he is not restricted to using the structural system of part three. Still popular are the traditional vault and adobe block systems as described in the appendix.

In conclusion we have proposed a search for a flexible strategy that would not be obsoleted by the particular geographic, economic or political situations that could arise.

Part one, represented by models 1, 1a to 1d and models numbers 2, 2a to 2d, has attempted to present to the Tunisian authorities a plan neighborhood type (two variation) which the public works ministry could employ where needed - much as it presently employs the already existing plan types for popular housing. The difference is that government's expense would be concerned with only the actual construction. The installation of elaborate utilities would be left to the individual occupants. These land allocation plans do no more than establish the individual lots, indicate the streets and future utilities, and establish the minimum standards for public services as indicated by the Agency for International Development (see appendix) : water outlet, waste disposal, a few toilets, the wash area, etc. However, this barest of skeleton will evolve into and support the more developed environment of the future.

Arab Urban Patterns

So important are the barest of beginnings, as described in the previous section, that certain tenants of arabic urban activities and patterns must be reflected upon in their design. Arabic life appears divided into two parts: that which happens inside the family unit and that which happens outside. The private world is well separated from the public one. This division continues into the urban sphere where the woman and her activities are considered private and the man and his activities less so. Thus develops a very definite man's versus woman's area. The man's "world" consists of the busy street, the cafes and the baths. Here he gathers to spend entire evenings together with his friends sipping tea or coffee, playing cards, or just staring into the ever moving crowd. The woman tries to avoid this street environment but when shopping necessitates a visit she is always veiled and very aloof. Even in the smallest of villages or in the tiniest remote corners of the city, usually the corner cafe, (the man's hangout) is always found. The home is the woman's kingdom. In the cafe the man finds his throne.

Still there is one place where the women gather and the men passing slip by without intruding into their secret world. This occurs at the source of water where the women bring their heavy jars to fill and rest a few minutes. Water is fetched as many as three times a day. Washing is also done here and this becomes one of the rare times the women can gossip informally with others of the village. Unlike their husbands it is not over coffee but over the wash that the women exchange the latest of news. Children are numerous. A few shops that service to the woman's most frequent needs are located close to the water source.

The streets are connectors. The private ones are narrow and offer shade. Some are very quiet and used simply for getting from one place to another. And yet others with a slight widening of the street provides places for women to stop and talk and for children to play. Those more central contain the commercial areas, the cafes, and the crowds begin.

The Urban Proposal

The thesis proposes two alternatives: model 1 and 2 (see Urban Model). Although they are structured similarly with respect to phase development and the basic breakdown in arabic urban activities, there are certain advantages and disadvantages that accompany these differences.

First it is best to describe those features that the two share in common. In either case the government can decide where to begin. Land could be simply allocated and certain provisions for common water and waste could be provided. Again what is important is that the builders or families are not impeded in building what is necessary and the lot is of ample enough size. If enough land is not provided then new slums will be encouraged.

In both schemes utilities can be expanded with alternative 2 being a little more expensive in the final stage but more flexible and economical in the initial stages. In both cases the services will be extended as the need arises. Cost to the government, in this initial stages, is kept to a minimum and in this way organizing land allocation can effect many instead of just a few.

Quickly the families will be organized into small cadres. In the men's area a small shelter will offer to those constructing, instruction. Health, hygiene and literacy programs will be available to the women and children.

Soon walls will rise as each family quickly closes off what belongs to them and the villages take on the shape as shown in the models A-D, 1 & 2 examples of the building growth.

Alternative 1 (see Urban Models #1)

Alternative one is characterized by two secondary streets off the main access street. These secondary streets are kept pedestrian in scale and

use, but emergency traffic can enter. Where car access to the dwelling unit is required the street must be widened but here possible cars would be kept at the main access node as indicated. The problem of providing for the car is still not important. This housing is intended for the lowest of income classes and even if cars will someday be built in Tunisia the number that will reach this income class will remain small. Still provision is made at the main access nodes and at the density of the proposals as to where might be the best place to always keep them - keeping the back streets always for the pedestrian.

Where these two secondary streets reach the major access street commercial facilities concentrate. Water will first reach this point and the cafe will quickly locate itself here. Commercial facilities and open markets are located here and the community will connect to the larger community at this point. Men will sit out in the cafes and here the traffic of mules and carts will converge. Stables are provided for the mules and with a little imagination these could be turned into garages for parking in the future.

The pedestrian streets first access the individual lots that are at times pulled back to give a little room for the children to play or the pedestrians to rest. Finally they meet a smaller pedestrian path that wiggles its way horizontally to the major access street. This sub corner, when compared to the major access node, ties the secondary streets together, and holds the more private intimate women's sphere. Water for drinking and facilities for washing clothes are provided. A few shops that wish to locate themselves near the women spring up. Waste is provided. This small nucleus is found in each grouping of 70 to 100 families.

Alternate #1 (70 Families)

Total Area	12,900 sq. met.
Density	54 Families/Hectare
Residential Area	9,000 sq. met. or 70.7% of Total Area
Commercial, Recreational, Public	2,300 sq. met. or 18.1% of Total Area
Circulation, Parking	3,100 sq. met. or 11.2% of Total Area

Alternative 2 (see Urban Model #2)

The major difference between alternative one and two is that in alternative two the two secondary streets merge to become a single spine that in turn feeds small courts of 13 lots. The major access node remains relatively the same, with cafes, shops and markets. The stables are to the left and right and buses and taxi service the node between. The secondary spine holds water outlets, wash areas, play spaces and certain shops that service groups of two and four courts. Since the distance from furthest lot to water source is limited by the AID standards (see appendix) this alternative is more flexible in terms of expansion since groups of two or four courts can be added at will carrying its own water supply. Thus the utility is extended and new lots are allocated.

The courts provide intimate places for children and women and when the units are fully expanded as shown in Model 2d the court streets will twist back and forth across the secondary spine. Models a to d show the evolution of a typical court. Again cars are kept at the major access node and the spine remains pedestrian. For vehicle access the spine can be widened but it will lose its pedestrian character.

Alternative #2 (78 Families)

Total Area	16,200 sq. met.
Density	48 Families/Hectare
Residential Area	10,900 sq. met. or 68% of Total Area
Commercial, Recreational, Public	2,400 sq. met. or 13.2% of Total Area
Circulation, Parking	3,100 sq. met. or 18.8% of Total Area

Part Two Unit Plans

Expansion:

The difference between fixed and flexible plan types is that in the fixed situation the problem can be solved only once for a given situation where as a flexible solution is one that is planned to adapt and respond to a changing situation. Since the land allocation of part one is to be accompanied by a set of plans that the families can follow or that the government authorities can build and let the families expand on, flexibility is most important. Plans presented in sheets 1 to 4 are examples of the plan proposal.

The development of these plan types insisted upon solving the following problems:

1. division between the men and their guests and the women and children of the house
2. separation of any room that will hold the guests and the rest of the house
3. private entrance for the women
4. controlled entrance for guests so that the host room may be emptied in preparation
5. court use for traditional families, for example, cooking, washing, etc.
6. stable if needed connected directly to the street
7. stairs from the court that lead to the roof
8. roof used as a work space and sleeping for the children in the hot summer
9. extra rooms built on the roof
10. apartment for member of the family built on the roof
11. exterior stairs to access rented apartment
12. interior stairs to access rooms on the second story

In all cases the plans evolve from the simple lot 8 meters by 16 meters in Part 1 by the Tunisian government. In sheet one the initial unit is described

The roof system covers 22.0 . . . sq. m. As soon as possible walls surrounding the lot, to insure privacy, are built either by the government or the inhabitants. Partitions of concrete block or brick go up.

Types 1, 2 and 3 show the three types of evolution planned for, differing mainly by the ethnic needs of those occupying the initial unit. The second stage or semi-expanded state occurs when the area between the initial unit and the neighboring wall is covered. As soon as two separate rooms exist, living or entertaining occurs in the larger, the initial unit, and sleeping occurs in the smaller. Work, cooking, etc. always occur outside. Also sheet one shows how the stable can be built in this inbetween space. In most cases the private court is protected and isolated from the public streets by the animals and storage areas. The difference between the needs of each family begins to become physically apparent with the following stages. Those families following type one are the most traditional. The court is all important and cooking always occurs in it. Several rooms will go up in the back of the court for the women and children. Since the arab traditional family consists of many brothers and their wives, rooms completely surround the court and several are built on top.

Type two is much like the unit for the traditional family but the utilities, both cooking and sanitary, move inside. Access to most of the rooms are now in the inside. Interior stairs can lead up to additional rooms. In both cases the guest or entertaining room may be completely shut off from the rest of the house and still the rest of the house will function.

Finally, in type three the rooms cluster more compactly, cooking and utilities are inside and the unit adopts the form of a more conventional house in Tunis.

The ability to cross types during the building is still possible so that with the phasing the family moves from left to right on the type plans but with change in economic and social status it is possible to move from type one to type two and perhaps even to type three, though it is the authors contention that type three is least suited to the climate, habits and temperments of the arab people.

Part One described the general problems of land allocation, proposing several alternate plans emphasizing the importance of land tenure and a flexible economic completion of the urban settlements. Part Two proposes various plan types of growth upon which the habitants can build. The family, beginning with only a lot of land or minimum shelter, follows one of three plan types that reflect, in both manner of growth and in actual layout, the economic and unique ethnic structure of the individual family. Finally, within this new context, Part Three presents several structural systems that will form alternates to the existing popular methods of construction as described in the Appendix: A Description of Existing Materials and Methods of Construction in Tunisia.

The intent of this section is to explore and propose alternate systems of construction that will hopefully be more tailored to the particular building needs of the conclusions of Part One and Two, more efficient in terms of the amount of material used and the amount of material imported, and last, more efficient in the use of labor.

The existing methods of construction:

Having completed a program of two years with the Peace Corps in Tunisia, the author would like to summarize the following observations made concerning the presently popular systems of construction. In the rural areas the construction is characterized by heavy rock wall. The rock is usually quarried in the vicinity of the actual site. These walls, sometimes as thick as three feet, are pierced by small openings for light and ventilation. The walls depend primarily on their mass and their protective plaster and white-wash covering to keep out the terrible long summer months heat. Only in the inner courts of the traditional Arab houses is the white wash tinted blue to reduce the unbearable glare of the reflected sun.

Interestingly the Arabs are unconscious of this factor, and paint their doors and window frames blue to ward off the evil spirits.

The heavy walls are in turn spanned by brick vaults constructed of one or two layers. Without complicated scaffolding, simple round vaults, flat vaults and the more complex cross vaults are all easily erected by the village masons. These methods are primitive but very effective. The bricks are produced locally, dried in the sun or baked in a small oven. Due to the geometry of the vault shape, all live and dead loads are resolved into components working in the direction of the vault thus eliminating the need of expensive imported reinforcing steel. The bricks are thrown into compression and these forces are in turn resolved at the outer heavy exterior walls where buttresses are sometimes added if needed, to further counteract the outward thrust. Upon approaching the urban areas the transport of rock (the availability of quarrying the rock becomes rarer and rarer) becomes in turn more and more expensive. With this increased cost of transportation, we note the following change in new construction: the heavy walls are replaced by thinner walls made of a poor quality concrete block. More like stabilized soil, these concrete blocks are made by hand since they are also unreliable in compression, constructive columns of twenty by twenty centimeters are included along the wall every several meters to assure that the wall will stand under simple bearing. The brick masons, and in more particular, the vault makers, are rare to be found in the urban areas. In new structure the brick vault is therefore completely replaced by a composite roof slab made up of poured concrete and hollow clay tiles called "hourdis". This more contemporary method of construction in the cities is less expensive and consequently more popular. (A more complete description of the system with necessary drawings is included in the Appendix.) The clay tiles used are produced domestically with local materials but the nature of the system requires the extensive use of reinforcing steel placed between the rows of "hourdis" blocks to provide the necessary tensile strength. In most cases, the roof is always needed as an additional work or "use space", thus being one more advantage to the flat slab system. Even in the primitive villages of the south where vaults are made of clay, shale and plaster, the

"void spaces" between the major vaults are always spanned by smaller vaults so that a relatively flat surface can be made with the addition of little fill.

To summarize, for the squatters who normally build for themselves, the roof system still remains the most expensive part of the structure and the most difficult part of the habitation to build. Since the "hourdis" system of construction is the most prevalent building method in the urban areas, and since the squatter areas generally locate themselves around such urban centers any alternate system of construction proposed by this thesis must compete with the hollow clay "tile" or hourdis" roofing system.

Disadvantages of the Hourdis Construction

Although the "hourdis" system is both high in insulation values, due to the air space in the hollow clay tiles, and relatively inexpensive to build, most of the materials are domestic, the following disadvantages are listed so that any proposed alternate will concentrate upon reducing some of these problems.

1. Extensive scaffolding is needed to support the many rows of blocks. The scaffolding is expensive in terms of the wood that is used and the labor needed to assemble and disassemble it.
2. Though the blocks are small to facilitate handling, a great deal of time is needed to place each one. This limitation is posed by the properties of the material and the extrusion method of production. An immediate solution could be to extrude longer blocks but improvements of this type can only be properly studied in the "field" in Tunisia.
3. Expensive imported reinforcing steel is required between the rows of clay tiles. Such reinforcing is expensive in terms of material and in terms of a great deal of skilled labor output to tie the rod-bottoms and tops together with the necessary stirrups. If the web-members could be concentrated, making them fewer in number, certain savings would be made.

Goals of an Alternate System

The goals for any alternate structural proposal are set as the following:

1. Decrease the amount of overall material cost, where possible, by reducing the amount of material and by favoring domestic materials over imported materials which are usually more expensive and require an exchange of currency.
2. Decrease the overall amount of labor, where possible, always favoring a simplification of structural methods, so that the squatters can take an active part in the actual building of their habitation.
3. Simplify and speed up the erection time since those waiting for the completed habitation will be often living outside of the construction site.
4. Determine the size and weight of the basic elements of construction so that they may be handled easily by two men and simple equipment.
5. Determine the actual construction and distribution of the elements of construction so that they may be produced and handled by a very small contractor either on the work site or from some central located factory site.
6. The roof will be flat and constructed so that it can be immediately used as an addition work surface.
7. Construction must be designed so that building of at least two stories is possible, with the second story being added on for future expansion.

The Proposal

The wall components will be conventionally built out of concrete block or stabilized earth block. It will rather, be in the construction of the roof that certain alternates will be introduced to reduce labor and cost of material.

The basic unit of the proposed structural system will consist of a square, repetitive, modular unit of an overall dimension. "A" plus ten centimeters on each side. The dimension "A" will vary, depending on the dimensions of local materials, but in all cases will not be smaller than 80 centimeters, nor larger than 110 centimeters. The dimension "A" has been chosen because of its approximation to a reasonable dimension used in the planning of housing, i.e., the width of the door, the bed, the minimum circulation of space.

The second limitation of size of the modular unit will depend upon weight since it will be desirable that the unit be handled by two men. Therefore, the unit will be limited to a maximum of 200 pounds. Because the structural unit is unable to span by itself the common distance needed for normal housing construction, it was decided that the unit would only be a form, but, allowed to stay in place after the composite slab is cured.

The shape of the structural unit or coffer is in the shape of the dome so that live and dead loads will be easily transmitted, with minimum tensile stresses, to the sides of the coffer where the steel will be concentrated to transmit the collecting stresses. The dome also flattens out at the top so that the minimum amount of concrete infill is necessary, thus reducing the dead loads and the consequential reinforcing steel required. The final form of the coffer is the compromise between these two needs; the need to reduce infill by flattening the dome, and the need to retain the dome shape to minimize the tensile forces in the area of the dome. The final shape is presented in the Appendix.

The Plastic Form for the Coffin

The first laboratory investigations took place at the Laboratory of Plastic Turning in Leominster, Massachusetts. Since form work for the final coffin would be both expensive and difficult to make if made of imported steel, other techniques were proposed. The possibility of plastic molds, simply made, relatively inexpensive and easily handled, shipped and maintained, was proposed. The use of plastic material for the mold element was first attempted with the small plastic domes of plexiglass, now commercially sold. A wooden form was built around the sides and a concrete mix of the consistency of mortar was applied without steel reinforcing. After curing, this separated easily from the plastic mold without even the use of a mold release. After these ~~successes~~ ~~the problem of forming a~~ particular plastic mold shape to the desired dimensional properties needed, necessitated the investigation of several plastic molding techniques and their respective original molds. Finally the blowing technique was utilized and a square sheet of plexiglass is mounted at table height, after being properly heated. Usually compressed air is blown from a hole in the table in the center of the square and the heated plastic is blown upwards, until the normal dome shape is attained. Our first attempt was only to fix a plywood piece at a certain height over the table, parallel to the surface of the table. When the dome met the plywood and started to flatten out the pressure was too great and therefore the plywood unit was replaced in the second experiment with a more complete wooden mold, as illustrated in the Appendix. In this fashion, several plastic forms were blown to be used in the stages that followed.

In summary, the following advantages of the plastic dome for a form were observed:

1. Obvious light weight, facilitating transportation, handling, etc.
2. Low cost of production, acrylic sheet cost approximately \$8.00.
3. Low labor is involved in the production, time averaged fifteen minutes for each dome with an organized production line cutting this down to even less.

4. Durability, proved by later use, the plastic showed little deterioration and could be probably used much longer than most materials.
5. Stacking quality of domes facilitated storage and shipping.
6. Combination of size and weight enables on the job employance by one or two men.
7. The forms could be used on site in the actual construction, by placing the plastic form in the structure, placing the reinforcing steel, pouring the concrete and then removing the domes after curing, but this would require many plastic forms, thus presently out of the present Tunisian economic scale.

As in previous experiments with the first plastic dome, a wooden frame consisting of no more than a ridge 6 centimeters thick is built to hold and surround the plastic dome. This edge must control the exterior dimension for the repeatable units. The plastic dome is placed on the simple frame where it is then coated with a thin coat of motor oil that acts as a release agent. A small reinforcing bar of one quarter inch in diameter is laid around the dome to give the finished product a certain amount of rigidity and ability to cope with the tensile stresses that occur during transportation and handling. This reinforcing rod could be reduced to several winds of wire which would then save more by limiting the amount of imported steel. Between the bordering steel rod perimeter, common chicken wire is stretched, from side to side, thus reinforcing a later applied concrete finally forming a thin concrete shell. Total cost of both the reinforcing steel and the chicken wire is approximately \$1.60 in the United States. Afterwards, a "one to two to four" concrete batch is evenly as possible trowelled on, making sure that the concrete completely surrounds the chicken wire and reinforcing perimeter steel. Working from top down, alternating with the bottom up, the steep sides are the last to be covered. Curing time averages one day; though with the proper addition of accelerators and assembly line techniques, this can be shortened to four or five hours curing for each concrete coffer.

Finally, after curing, the concrete unit, with the plastic inner form, is tilted on its side and the plastic form now on the outside is easily pulled out. The concrete coffers weight is approximately 180 pounds and is easily lifted by two men. It is believed that with a concrete mix composed on even a smaller aggregate than was originally used a thinner shell could be made - the result being more of a mortar like concrete mixture. In this manner the concrete shell coffer could be probably reduced in weight to approximately 130 to 150 pounds; thus, making it even more handable by two men.

The finished shell is adequately strong to withstand the stresses incurred in transport and handling, and sufficiently able to support men walking on the top surface.

Our concrete experiments clearly showed us that the limitations of the concrete system is inherent by the enormous weight of the material used. Weight determined the maximum size unit and continues to raise many problems involving transport and handling. Its greatest advantage is the readability of most of the materials involved. This factor alone, is the best argument for its present use, but with time, the ridiculous low rates of labor, sixty cents (60¢) per day, will hopefully rise and with it new materials that lend themselves to greater savings in terms of labor, will be promoted. One of these is plastic and it was the intention of a second structural alternate to explore the possibilities of using more sophisticated materials to come to terms with the same problems solved by Alternate "One".

Our first investigations into the fields of plastics led us to the following hypothesis: urathene foam could be utilized in the same way as the concrete of Alternate "One". Structural steel reinforcing would remain the same, thus, perhaps offering high enough strength characteristics to the combined unit to be considered as a suitable enough structural coffer. Other plastics were investigated but their methods and equipment were, but unlike the urethane spray gun application, remained far outside the scale and scope of both our laboratories and the existing Tunisian industrial context.

Our experiment was executed in the following manner.

First, the same plastic inner form that was used to form the concrete coffers was prepared with a different release agent. Bowling wax was first utilized but results were poor and the urethane foam did not readily separate from the plastic form leaving a very poor surface to the inner side of the finished dome. This releasing agent was replaced by Contour No. 1711 Release Agent - presently available at Contour Chemical Company in Allston, Massachusetts - which was prepared especially

for the separation of urethane spray and plexiglass. Unfortunately, not enough time was available to repeat the experiment with this new spray but we were assured by the inventors of the new release agent that there would be no problem in separation of foam and its mold.

Following the preparation of the plastic dome surface, the plastic mold was placed in the same wooden frame described in the concrete section and reinforced with steel and chicken wire as in the preceding concrete experiments. The foam was in liquid form, sprayed by the same apparatus that mixes the two chemical components involved. This simple gun was handled by one man and assisted by one other man. The spray was passed over the dome's surface and the speed of the passing gun regulated the thickness of the foam. With certain adjustments in the gun, one can change the density of the foam. After completely covering the plastic form and waiting fifteen minutes to be sure that the urethane foam had reached a certain rigidity, the unit was easily turned over and the plastic inner form was pried out.

Reinforced in the same way as the concrete coffer, the urethane foam copy, weighing approximately fifteen pounds or, less than one-twelfth of the concrete unit, behaved impressively well under load. It easily supported several men lying over the surface of the dome, but was believed unable to cope with direct and concentrated loads that occur when a man is walking along the tops. The sides are strong since their geometry throws most loads into compression but in the direct forces created from concentrated loads in the center, however, boards placed across the tops of several urethane coffers will satisfactorily distribute the concentrated loads of a man walking. Eventually, these tests will be made in more properly equipped laboratories. Total laboratory cost for the materials was three dollars (\$3.00) for the chemicals, and one dollar and thirty cents (\$1.30) for the steel rod and mesh. This was less expensive than the concrete dome but all the materials in concrete, were the aggregate probably more expensive than their counterparts in Tunisia.

In conclusion, the observed advantage of the urethane foam system are the following.

1. The obvious lighter weight greatly facilitates handling, and in addition, allows composite domes of "two domes by two" and "three by three" to be fabricated in one piece and installed in one piece. No longer limited by weight, entire roof forms can be made in one piece.
2. Insulation qualities are much lighter than the equivalent dimension of concrete, therefore they reduce the finished dead load, by no longer needing the extra thickness of fill which is added to the finished structure to insulate the interior from the heat of the sun. In turn, with the lighter coffer of urethane replacing the heavy one of concrete, the total dead load is reduced, meaning a savings both in material as well as a reduction of the imported tensile steel required for the resolution of bending forces in the web-members poured between the coffers.
3. Installation of the foam spray is not expensive, the total cost for the necessary equipment being approximately Three Thousand Dollars (\$3,000.00). The equipment is small and can be employed either on the site or in a more central location for future distribution. The equipment is easily handled by two men and the skills involved are easily taught.
4. Chemical materials involved are shipped in liquid form to be expanded on location. This compactness in shipping means saving in cost of transportation. Eventually, the chemicals necessary would be fabricated in Tunisia, since plastics in many forms are already being utilized in North Africa.
5. A great deal of labor is saved in the production of coffers. A man can now produce as many as one hundred a day, instead

of ten a day in the case of concrete forms. In the future when labor costs start to rise this will become an extremely important factor.

6. In the fabrication of the urethan coffers, the plastic form is used many more times a day and the deterioration of the form is naturally smaller. This savings of the form, in terms of wear, and the greater utilization of the form, in terms of frequency of use, will reduce the total cost of fabrication.

Finally, it is hoped that certain sophistications of the material's properties, unfortunately beyond the scope of this thesis, will lead to a more efficient use of foam plastics in the construction of the habitation. If the necessity of the roof use is removed then it is very possible that the roof unite can presently be made in one piece of urethane form, lifted and placed by two men, and with the addition of a lightweight fill and the proper coating to assure protection of the material from weather, corrosion, etc., a complete roof unit prefabricated, easily installed and less costly can be proposed.

Conclusion

It has been the intent of this Architectural thesis to propose a new and practical alternative to the Tunisian Government for the solution of the housing problem most characterized by the squatter habitations thriving around Tunisia's principle cities. Existing practices to control these urban problems are presently ineffective.

The government's first attempts to stop the rural exodus by sending back those already encamped around the major cities did not work. Today the migration has slowed down but the problem continues to exist. The urban blight continues to grow as the demographic expansion, resulting from the poverty of the squatters, reaches new heights. The government also tried to destroy the squatter areas and attempted to resettle the inhabitants in government built projects, but the money available for housing was and is too small to be of any subsequential effect. Even if the money were available, it is questionable that a developing country could afford to invest limited capital in an area that offers so little return.

Only after most avenues were explored, did the government acknowledge the fact that the squatters are here to stay and that little could be done to rebuild their camps. Concentration was then placed on improving the existing squatter environments but utilities are hard to install in the twisting muddy streets and the problem of crowding, 4.6 persons to a room, is only relieved by expansion. Financing has not and in the near future will probably continue not to reach these very low-income families. Thus, they are forced to remain crowded in their meager shelters and seem to have little chance to improve their situation. In this way the slums of despair are created.

The strategy, as proposed by this thesis, recognizes the important need these families have for land. Land tenure and the security that accompanies it is enough to change the slums of despair into slums of hope. With enough land for future expansion, the traditional methods of building occurs once more. The family, safe from eviction, builds, with the meager materials at hand, his own habitation. Satisfied with very little in the first stages, he slowly improves upon the barest of shelter until a more adequate home for both his family and the families of his sons can be made.

This thesis proposal is planned within the context of government land allocation. The subsidy can be stopped here. From this point of departure, the thesis proposals are planned in three parts. The first occurs two alternatives as to how the allocated land can be planned to form the sub-structure of tomorrow's village. The second part offers a collection of plan types tailored to the distinct changing needs (both economic as well as social) of the squatter families. With land allocation is the accompanying principle of building over a long period of time, and therefore, plans must be adopted to anticipate these changes. Simple economic changes reflected by the increasing need for space and utilities, and changing social values resulting from the urbanizing of these once rural squatters all must be reflected in the plan types intended to be followed. In the third part, structural alternatives and recommendations are both studied and made, with specific structural alternatives to the existing methods of construction made in concrete and urethane foam.

Finally it is the intention of this proposal to outline a particular strategy of land allocation followed by self-help in conjunction with technical assistance in the form of plans for building and structural proposals. It is hopeful that this "dossier" conveys the conception that a strategy of land allocation accompanied with technical assistance is more realistic than the present policy which will always be limited by funds to the very few. Although the initial stages of self-help will never compete with the government project in terms of high standard housing, it will reach many more people. By giving them the initial investment in land, they will in the future build far more than could be offered by even the richest of governments.

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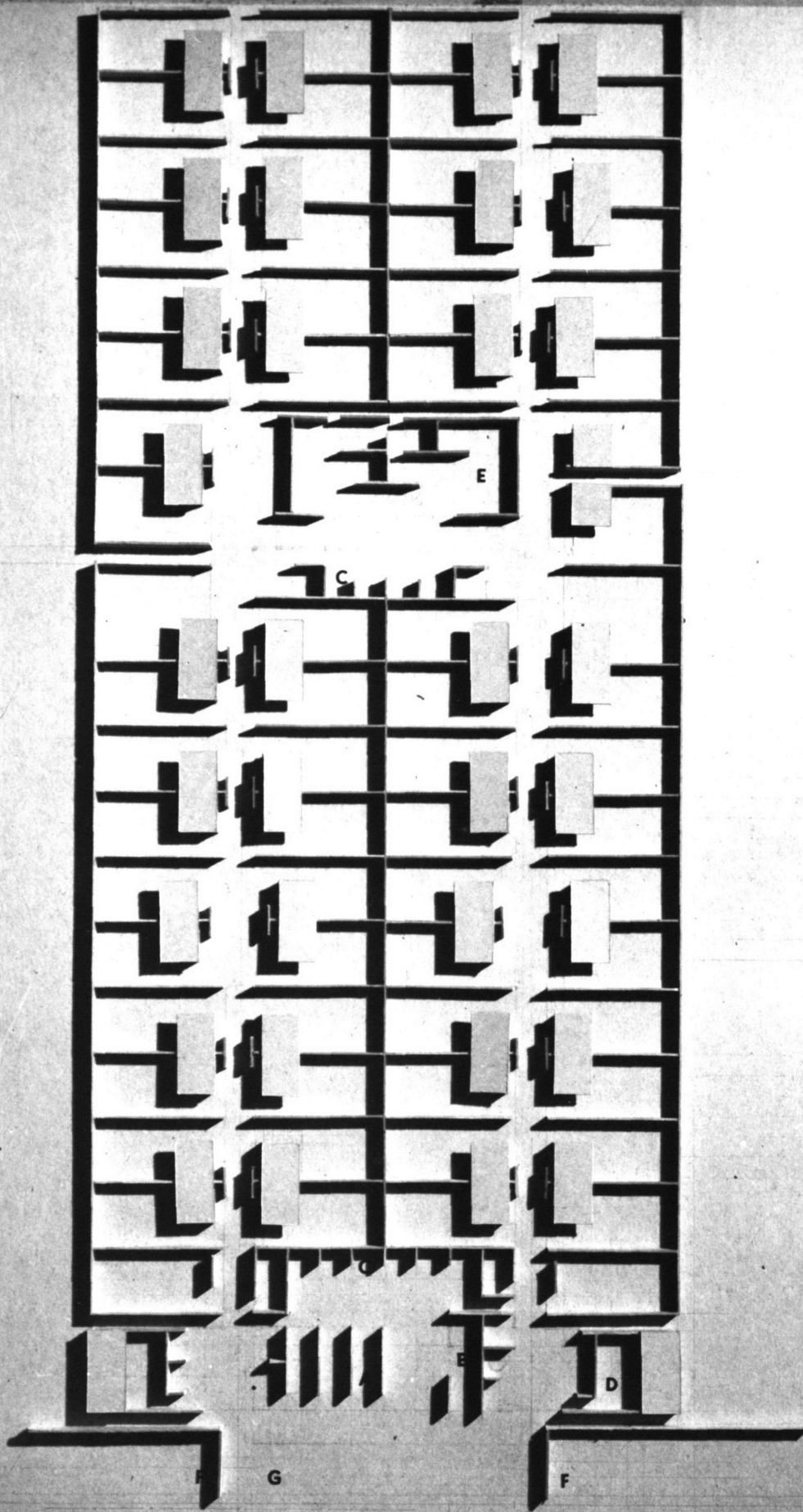
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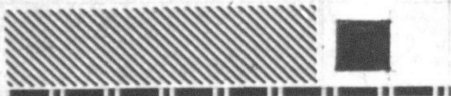
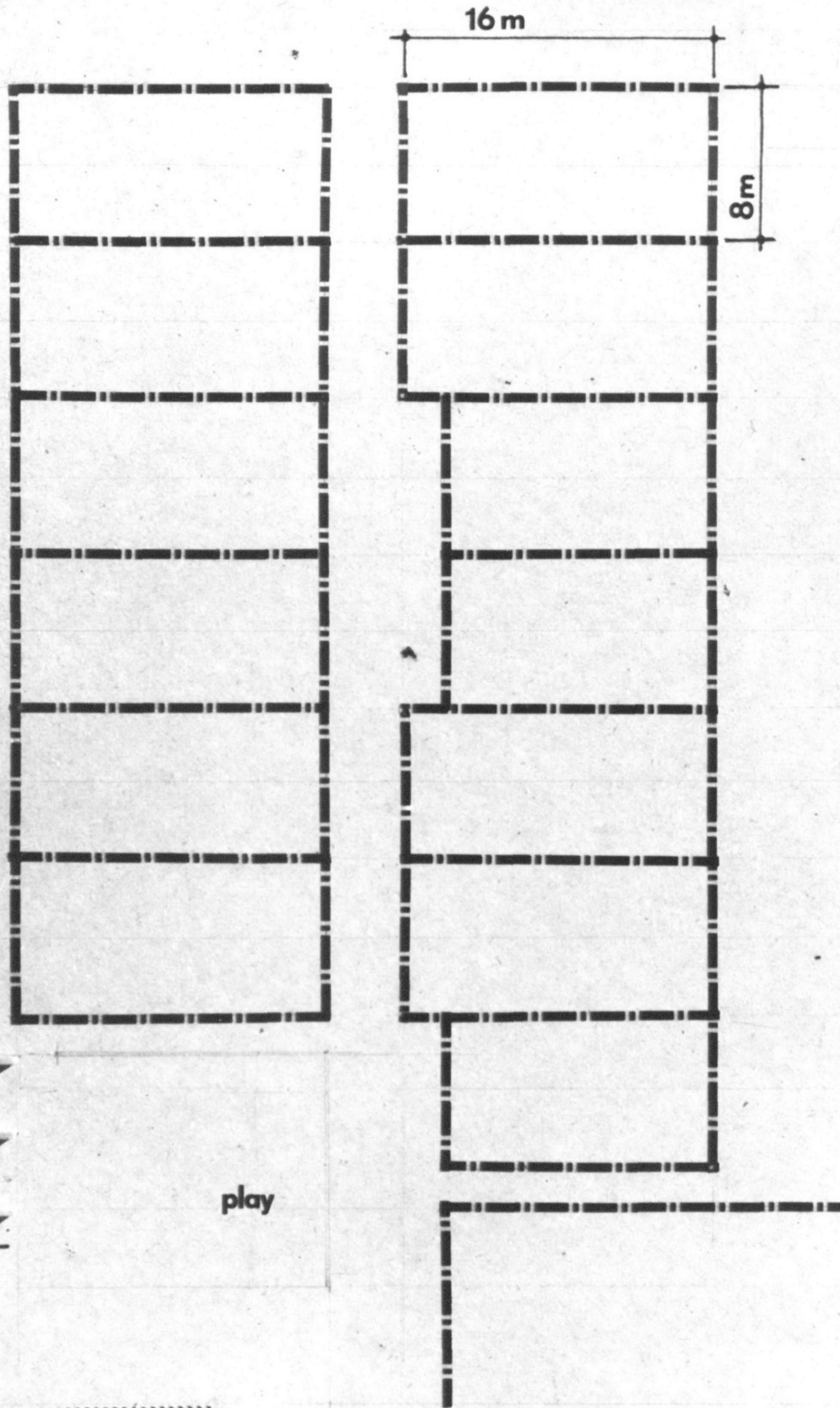
Appendix

Urban Models

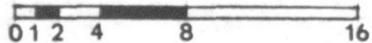








- A cafe
- B commercial
- C market(open)
- D stable
- E nursery
- F parking
- G bus stop

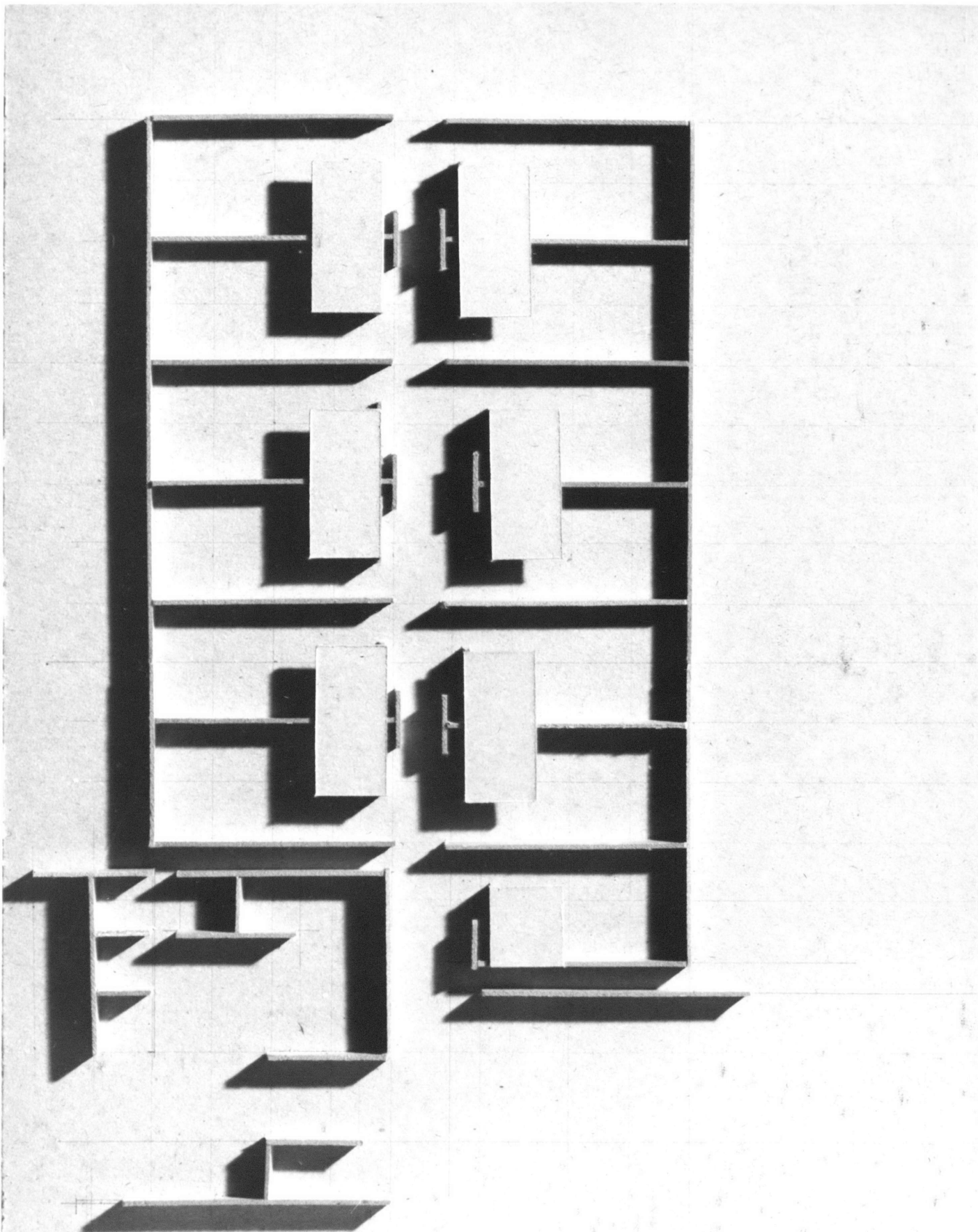
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- ⊕ wash
- toilets
- waste
- storage



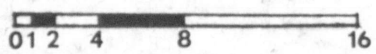
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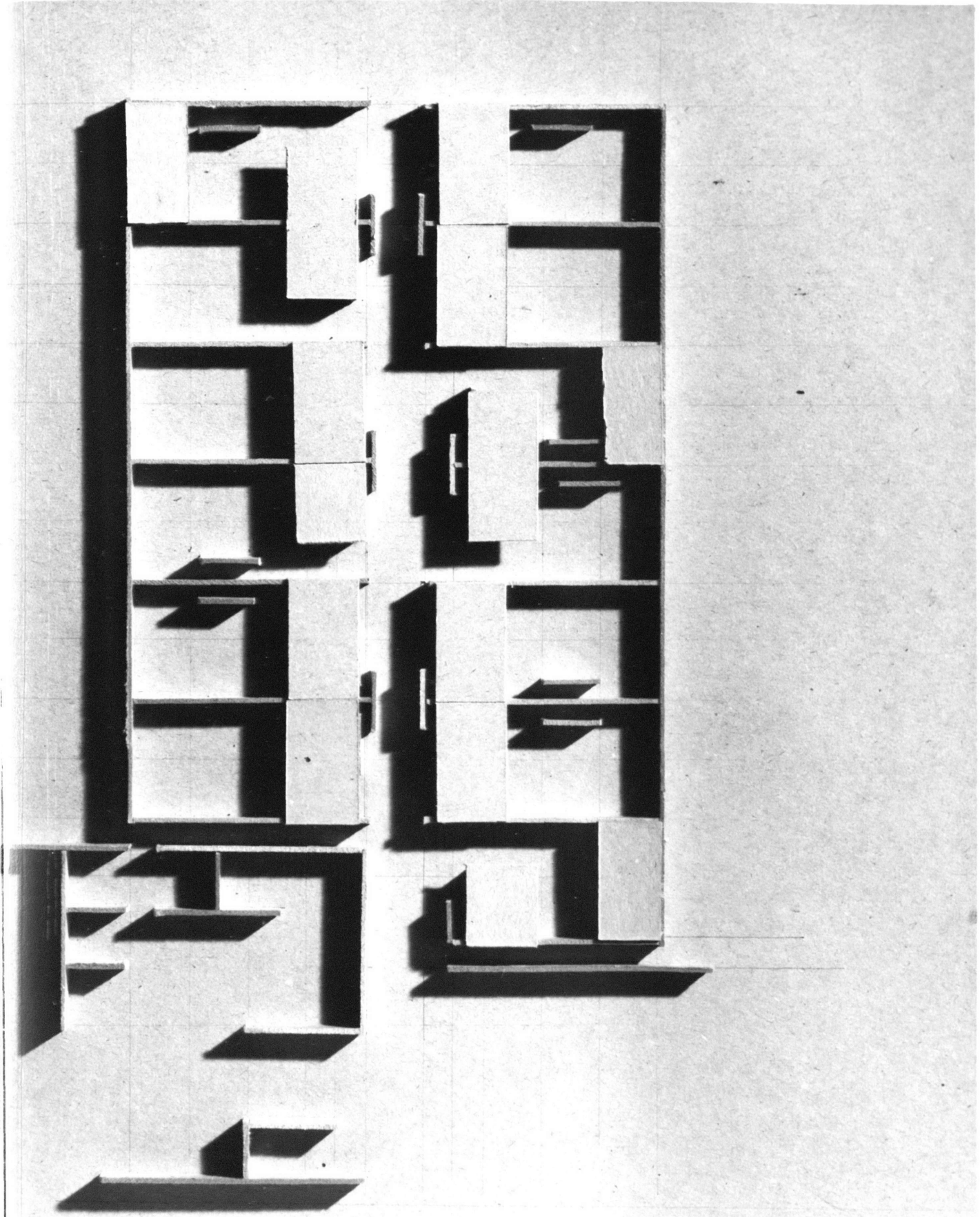


-  water
-  wash
-  toilets
-  waste
-  storage
-  commercial

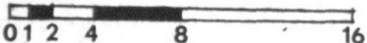


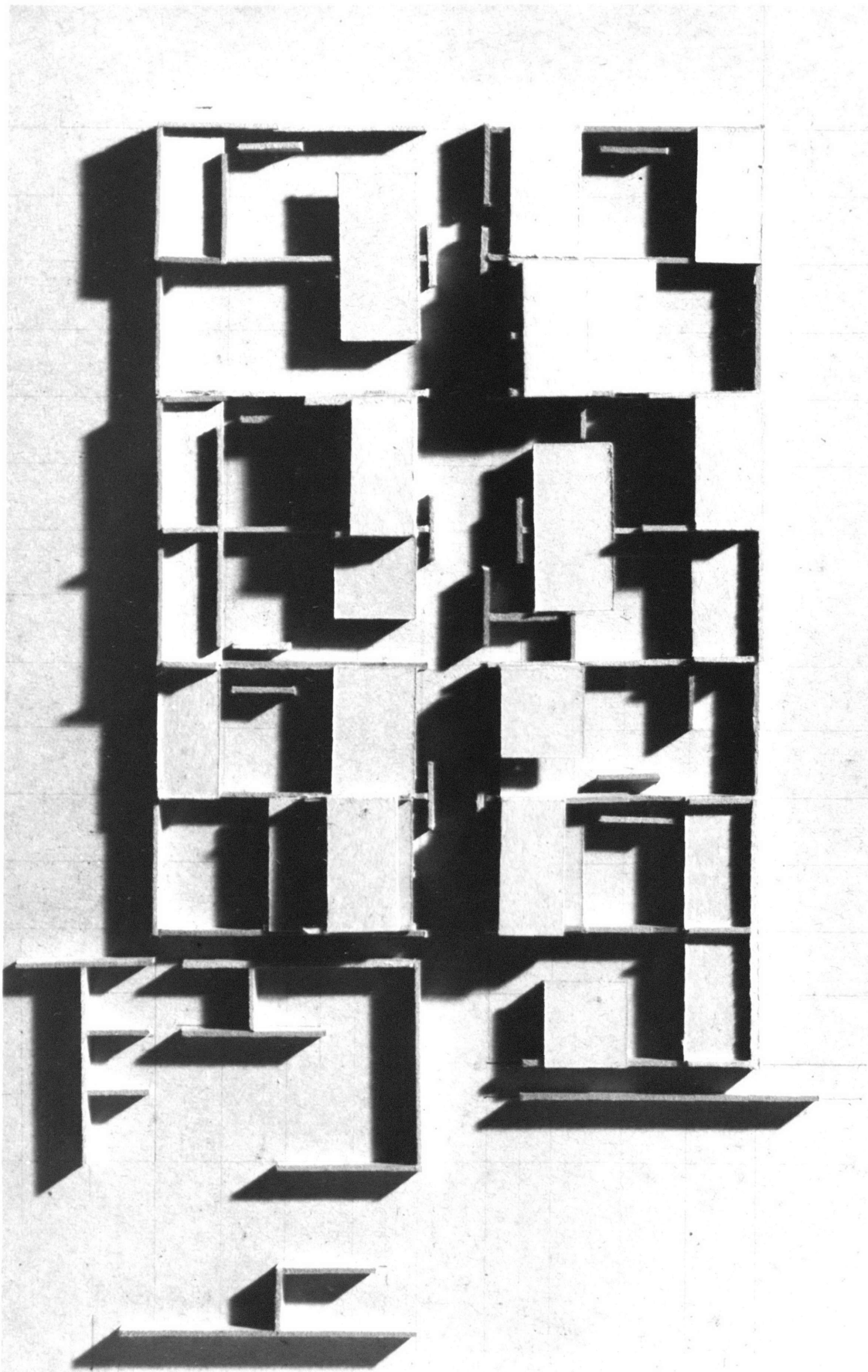
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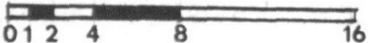


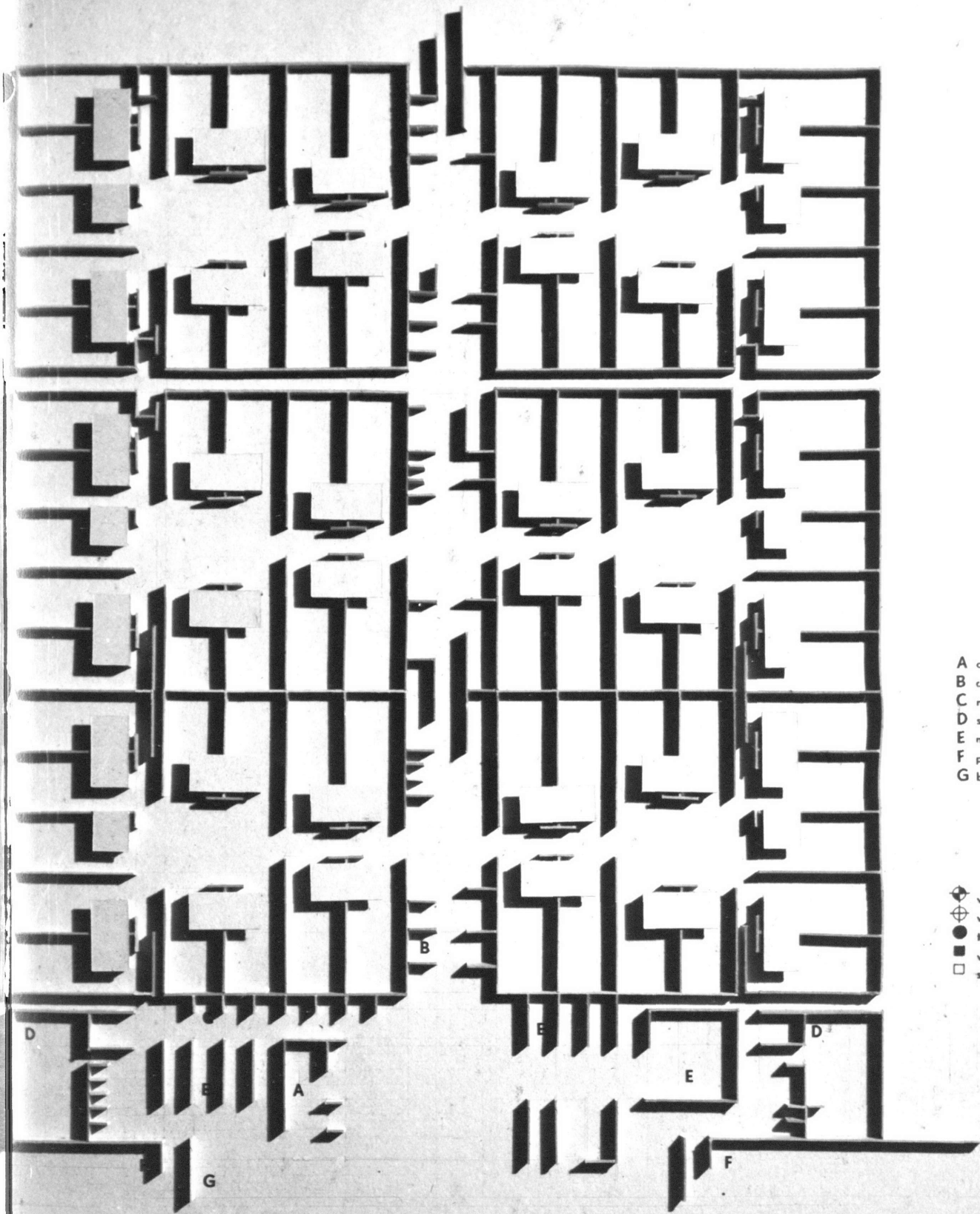
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1 EXPANDED





- A cafe
- B commercial
- C market (outdoor)
- D stable
- E nursery
- F parking
- G bus stop

-  water
-  wash
-  toilets
-  waste
-  storage

2






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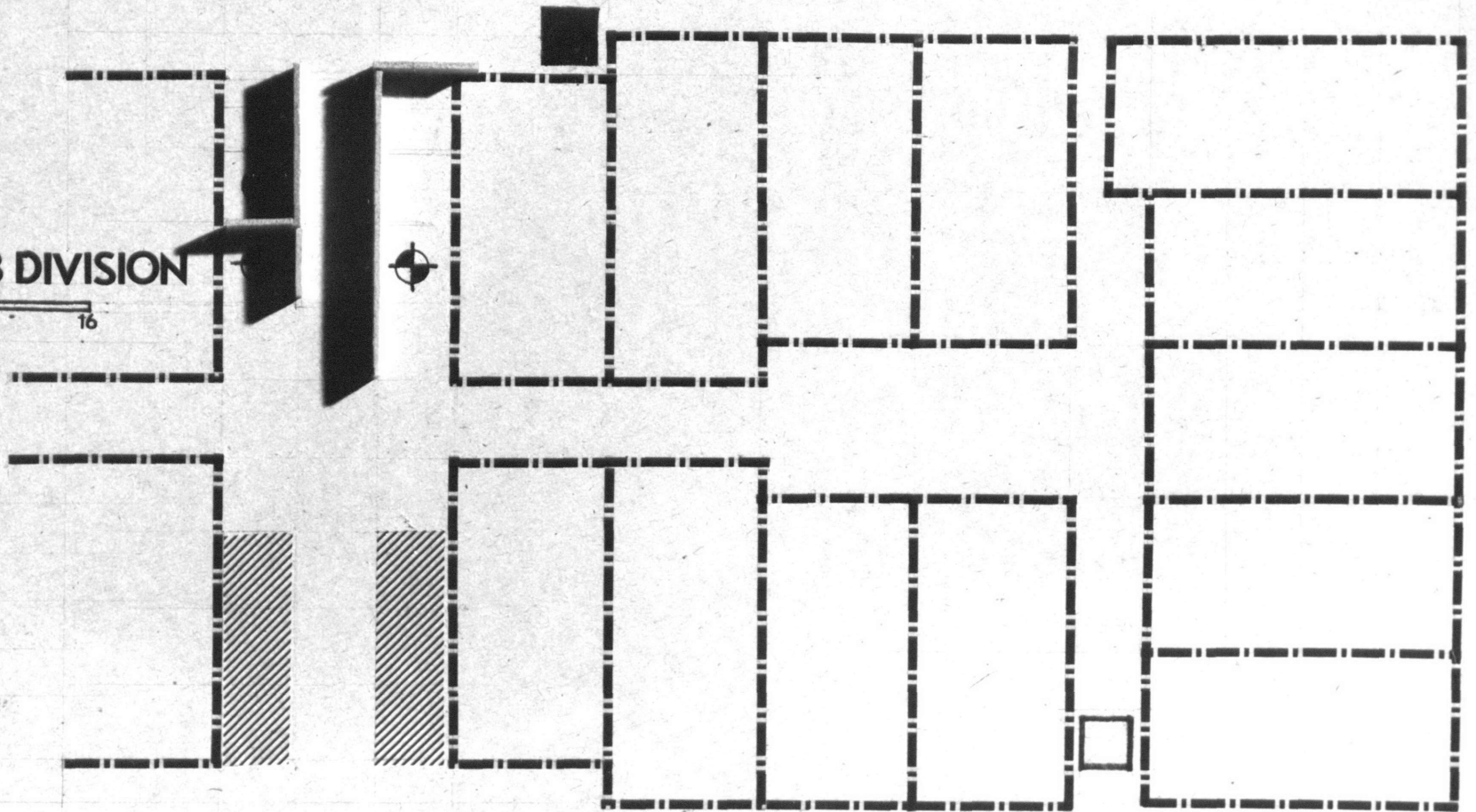
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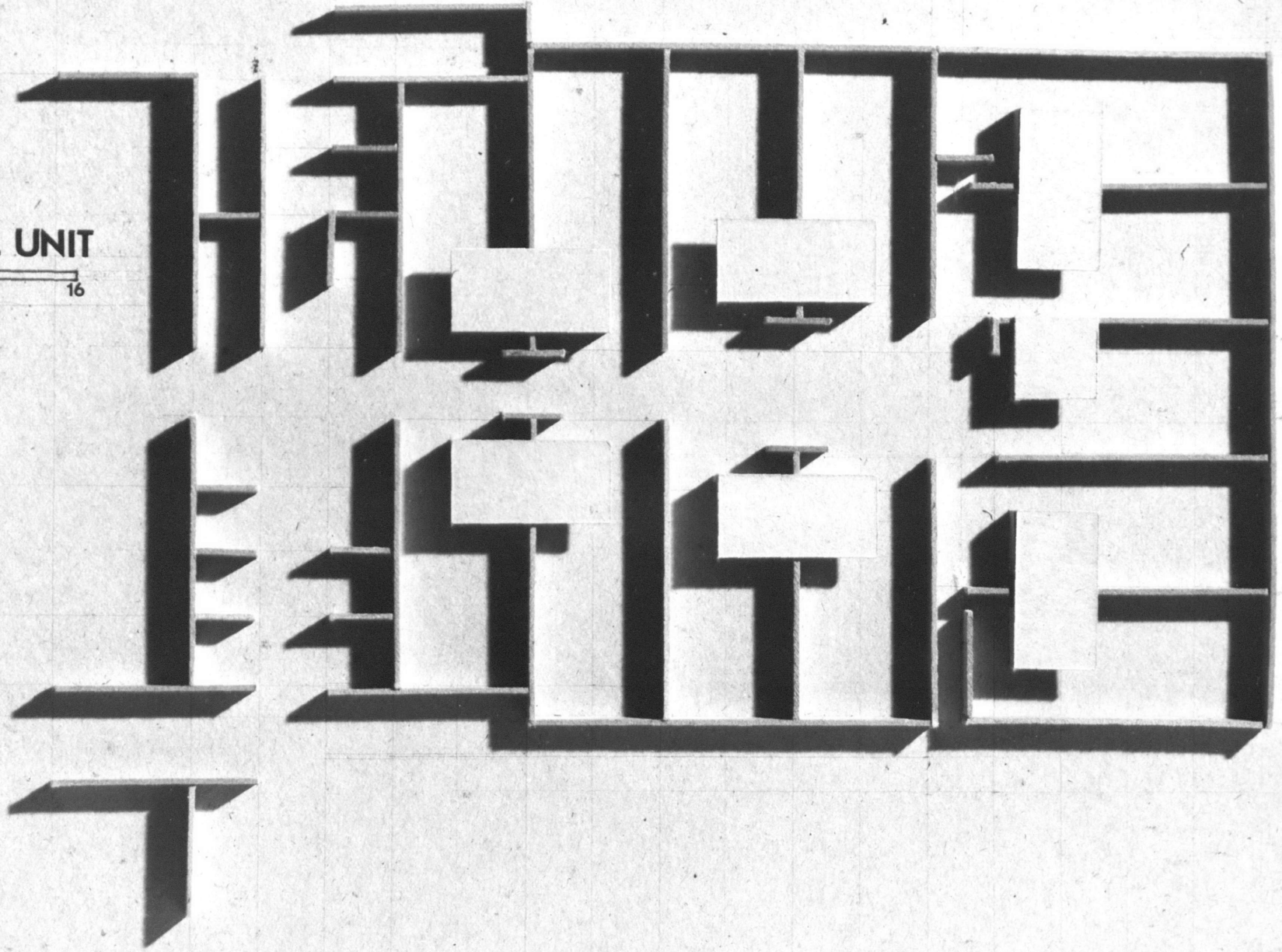
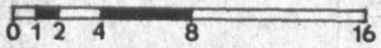
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-  water
-  wash
-  toilet
-  waste
-  storage

 commercial

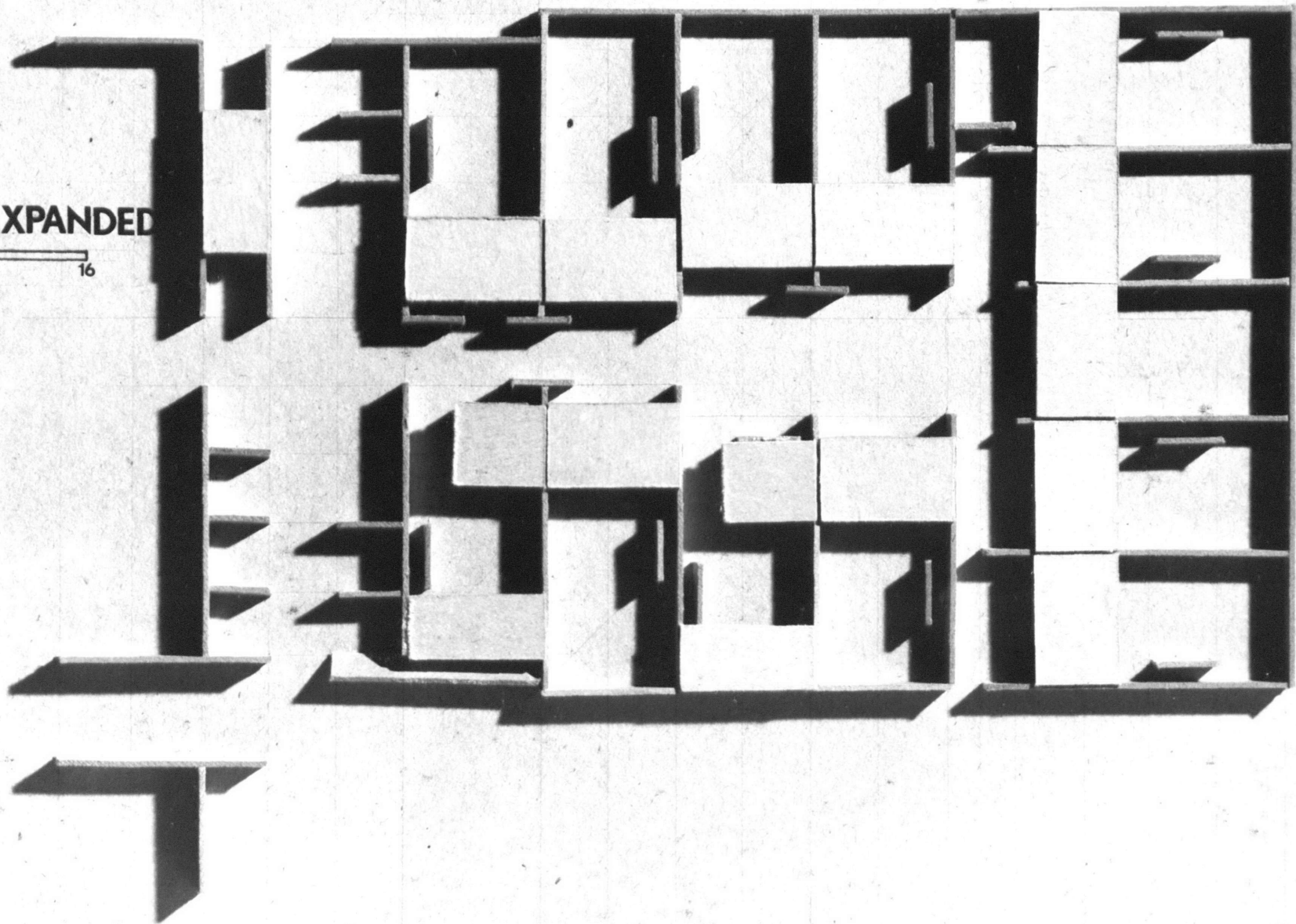


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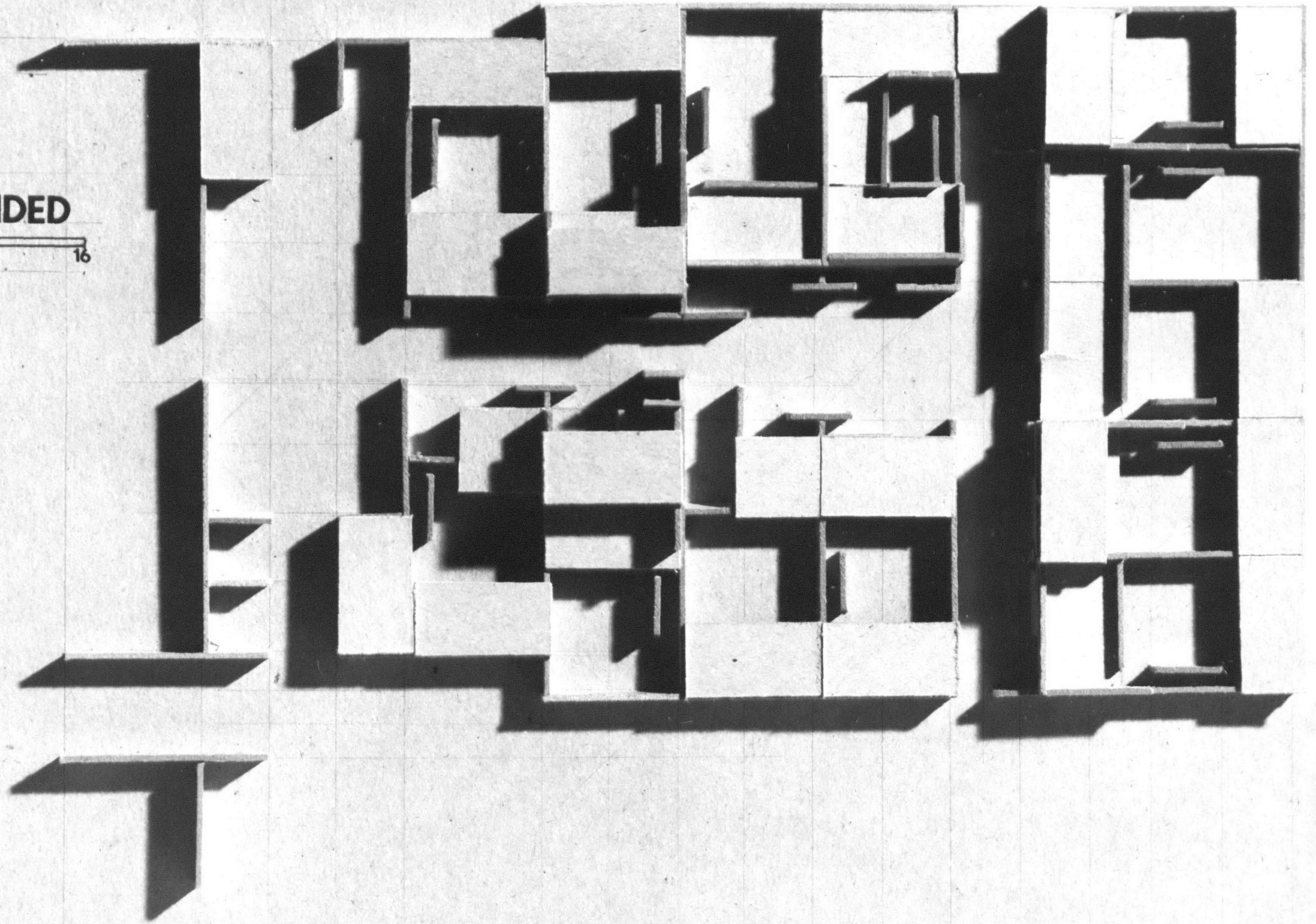
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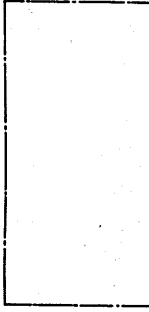
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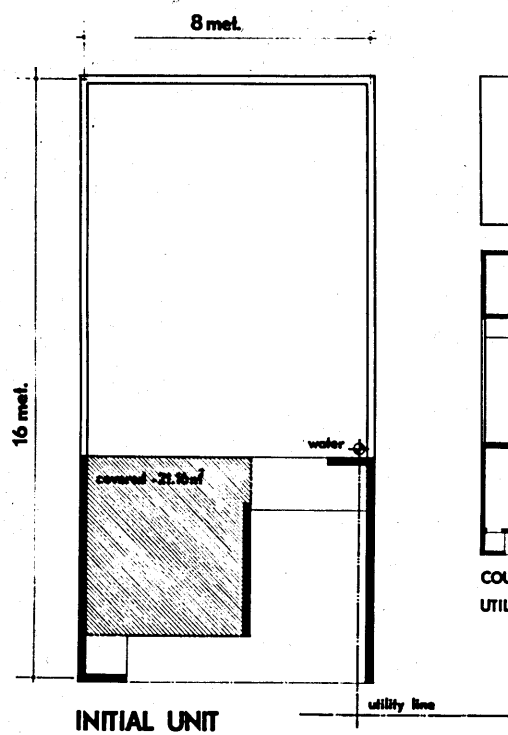


Drawings

GROWTH TYPES

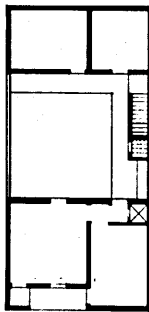


LOT - 128 sq. met.



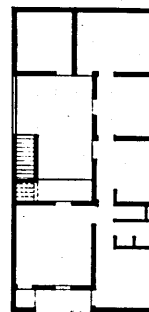
INITIAL UNIT

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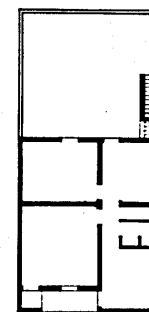
COURT PLAN
UTILITIES OUTSIDE

2
TYPE



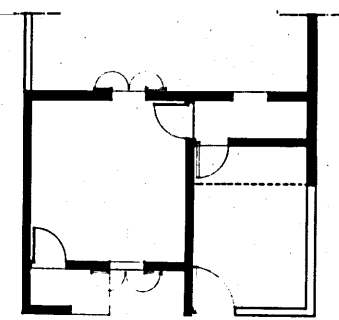
COURT PLAN
UTILITIES INSIDE

3
TYPE

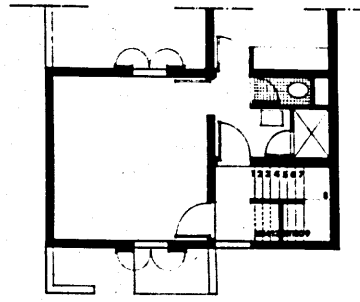


COMPACT PLAN

VARIATIONS



STABLE

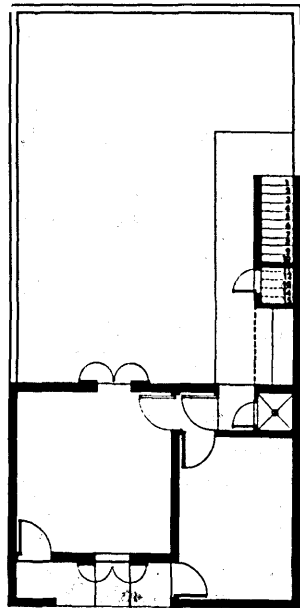
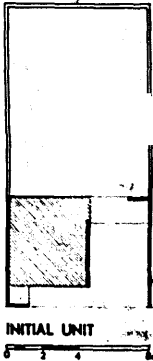


EXTERIOR STAIRS

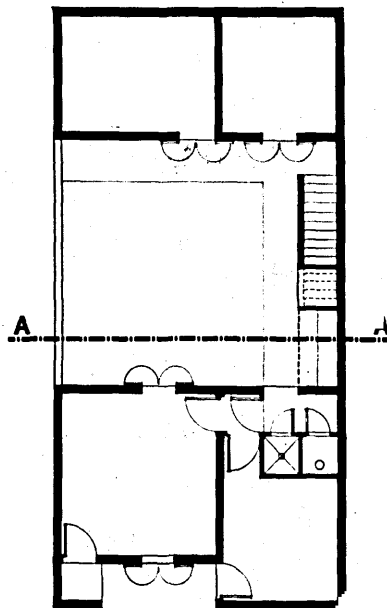
Submitted by
STANLEY IRA HALLET
In Partial Fulfillment
of the Requirements for the
Degree of Master of Architecture
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June, 1967

1
TYPE

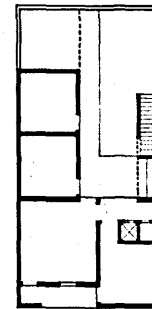
COURT PLAN
UTILITIES OUTSIDE



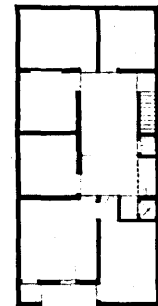
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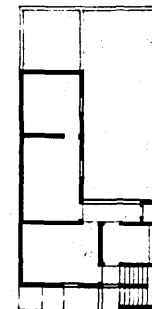
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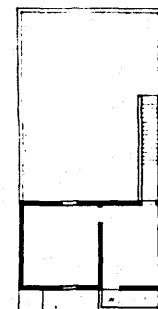
SIDE COURT



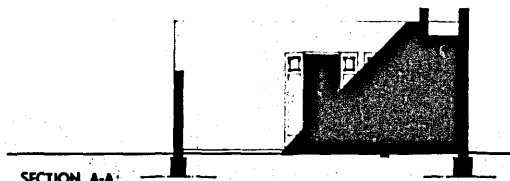
FULL COURT



APARTMENT exterior access



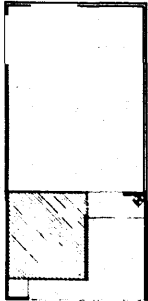
2nd STORY court access



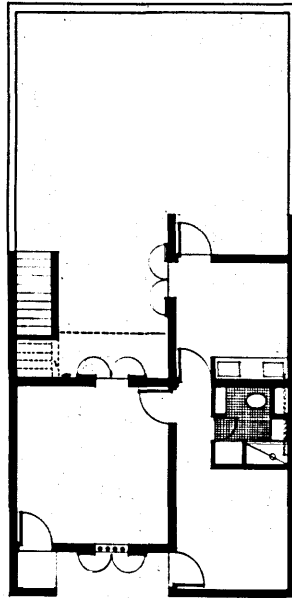
SECTION A-A

TYPE **2**

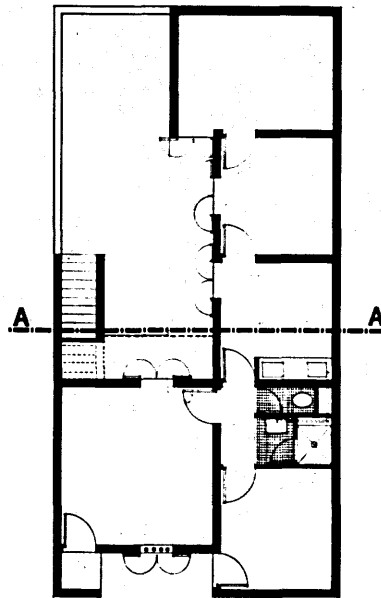
COURT PLAN
UTILITIES INSIDE



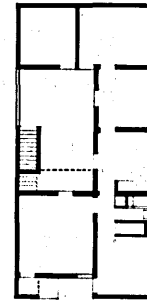
INITIAL UNIT
0 1 2 3 4 m



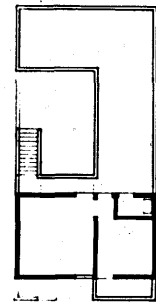
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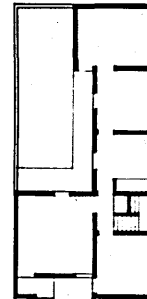
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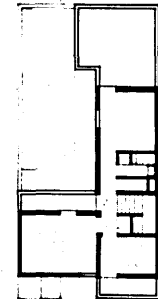
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ALL COURT



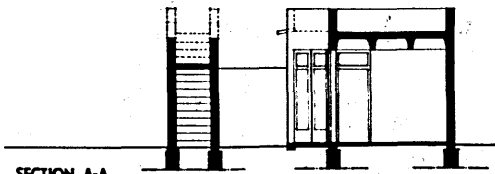
2nd STORY
court access



1st STORY



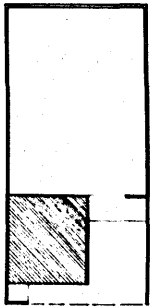
2nd STORY
interior access



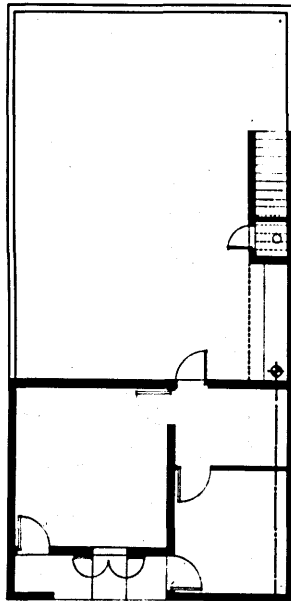
SECTION A-A

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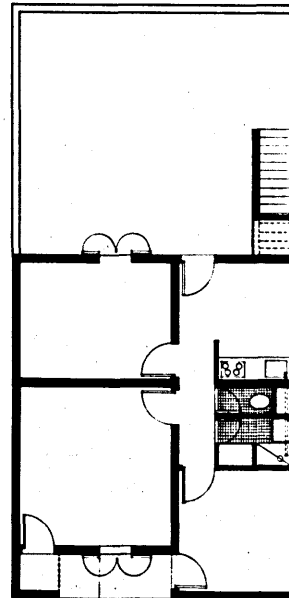
COMPACT PLAN



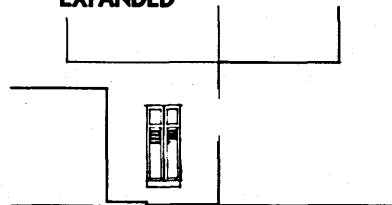
INITIAL UNIT



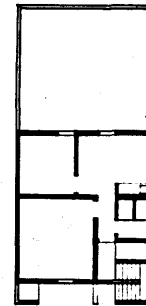
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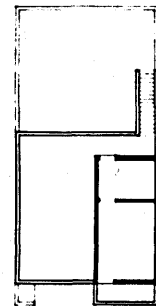
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ENTRANCE



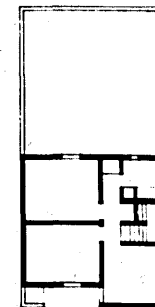
APARTMENT exterior access



2nd STORY court access

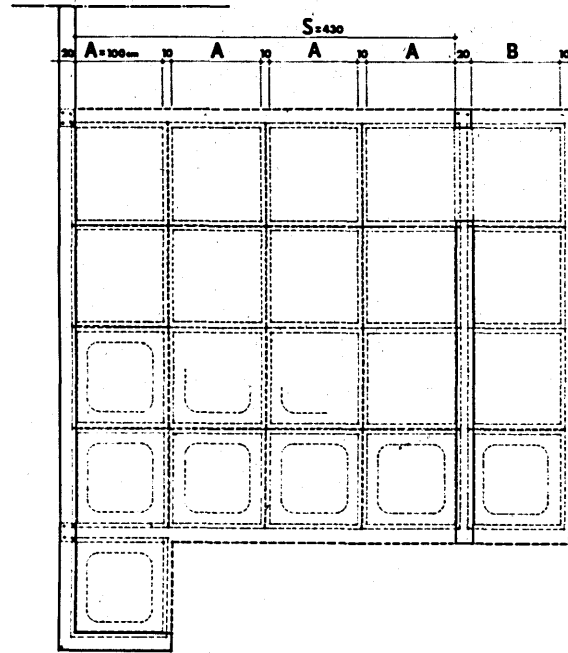
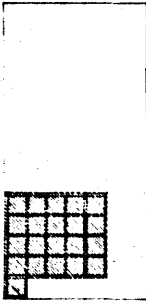


1st STORY

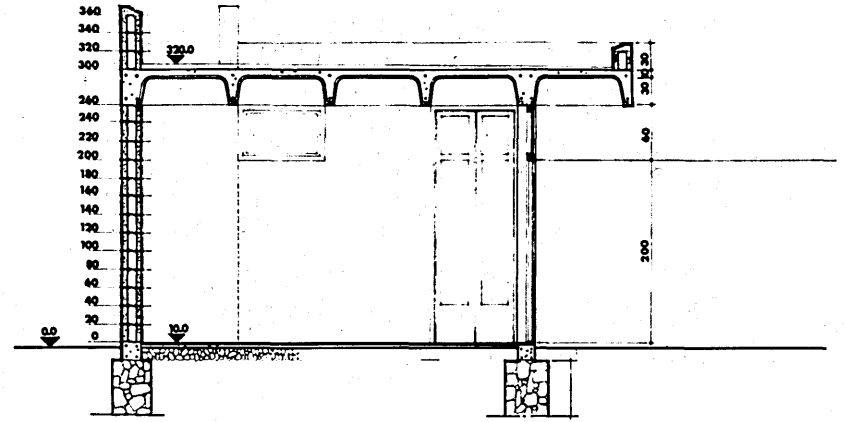


2nd STORY interior access

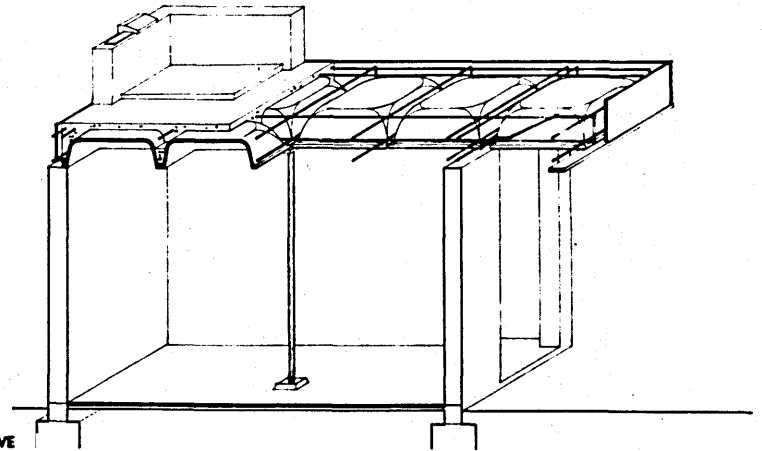
THE BAY



PLAN
 Design Limitations
 Smax = 4A + 30mm
 A = 60mm, 90mm, 100mm, 110mm
 B = A mm, max floor



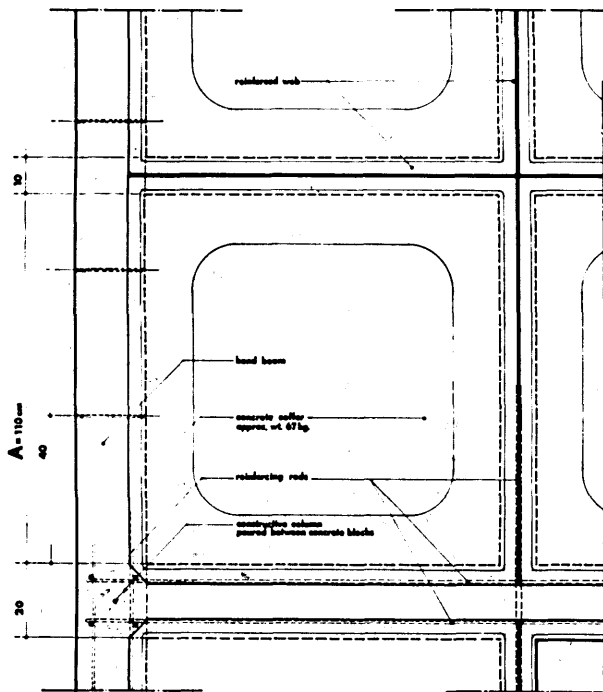
TYPICAL SECTION



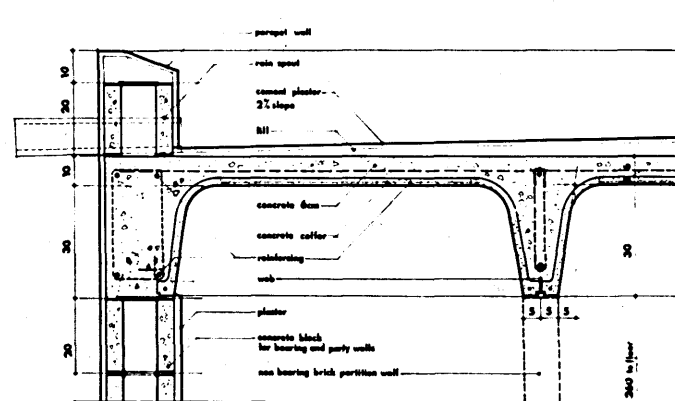
BAY PERSPECTIVE



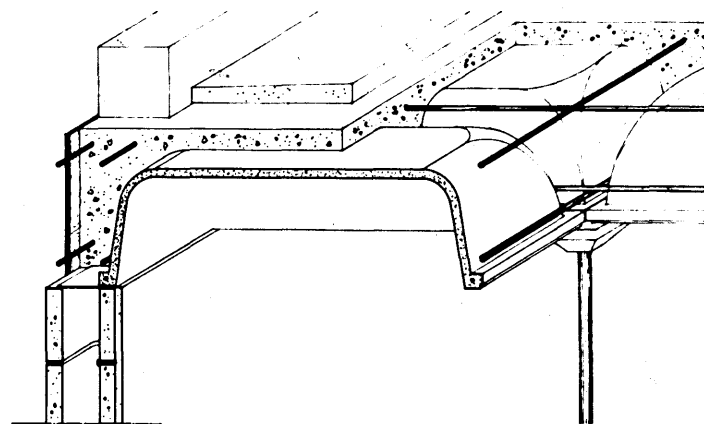
DETAILS



PLAN



TYPICAL DETAIL



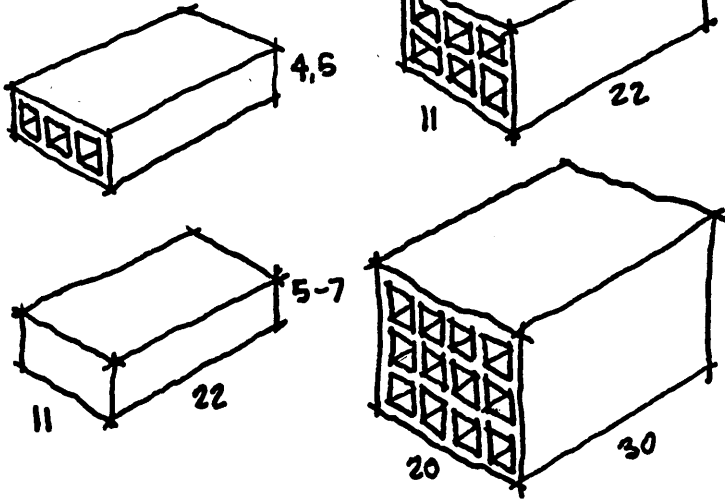
DETAIL PERSPECTIVE

Models of Structural Studies

Materials

page 1.

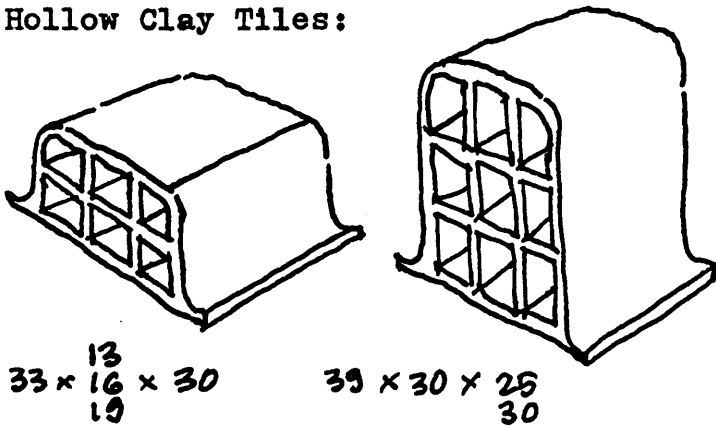
Bricks:



Notes:

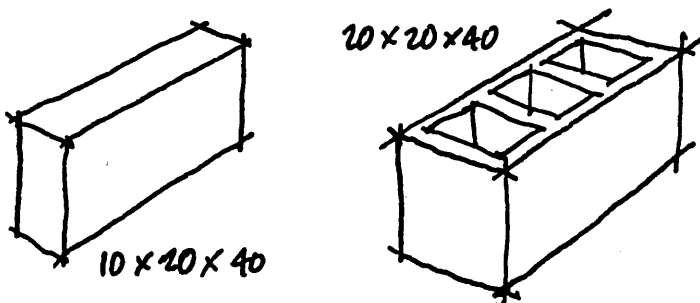
1. Locally produced
2. In bearing walls used with 'constructive' columns
3. Bearing wall construction of single 12 hole brick or in combinations of hollow and solid brick with or without uninsulated cavity

Hollow Clay Tiles:



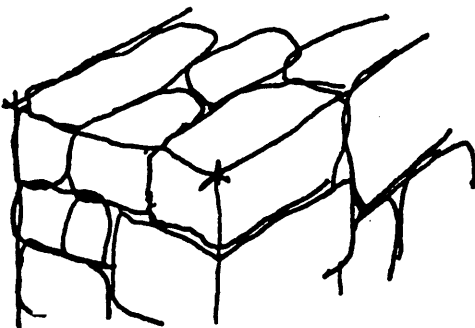
1. Locally produced
2. Inexpensive
3. Used in roof construction
4. Excellent thermal insulation

Concrete Block:



1. Locally produced
2. Poor quality requires use of 'constructive' columns in compression walls
3. Very inexpensive wall

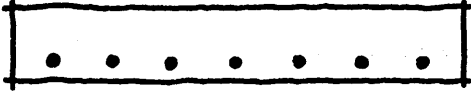
Stone:



1. Often, near site, only cost is quarrying and transportation
2. More expensive in urban areas
3. Locally produced lime for lime mortar
4. Bond beams at grade and floor levels
5. Rarely supports more than two stories
6. Labor is inexpensive

Type 1:

Flat Slab



Notes:

1. Slightly cheaper than hollow clay tile construction (type 2) for less than 4-meter spans
2. Poor thermal insulation
3. Normally used for exterior and non-habited spaces
4. Reinforcing steel imported from France

Type 2:

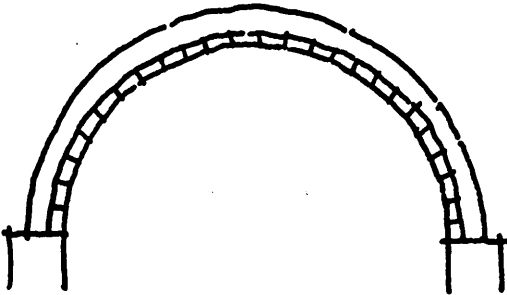
Hollow Clay Tile Construction



1. Good thermal insulation
2. Presently the most popular roofing system
3. Spans easily up to 6 meters
4. Stiffeners in opposite direction for spans up to 8 or 9 meters
5. Hollow clay blocks are produced locally

Type 3:

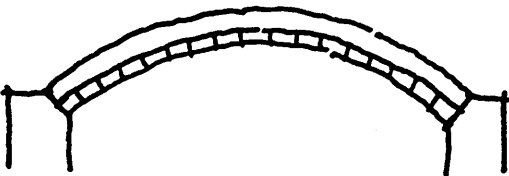
Semi-circular vault



1. Traditional roof construction
2. Still popular in rural areas
3. In the form of semi-circular vaults, groin vaults and domes
4. Bricks are put into compression
5. Round vault is more expensive than flat vault (fig. 4) but theoretically minimizes horizontal thrust at exterior walls and also gives a higher ceiling for a more thermally comfortable room

Type 4:

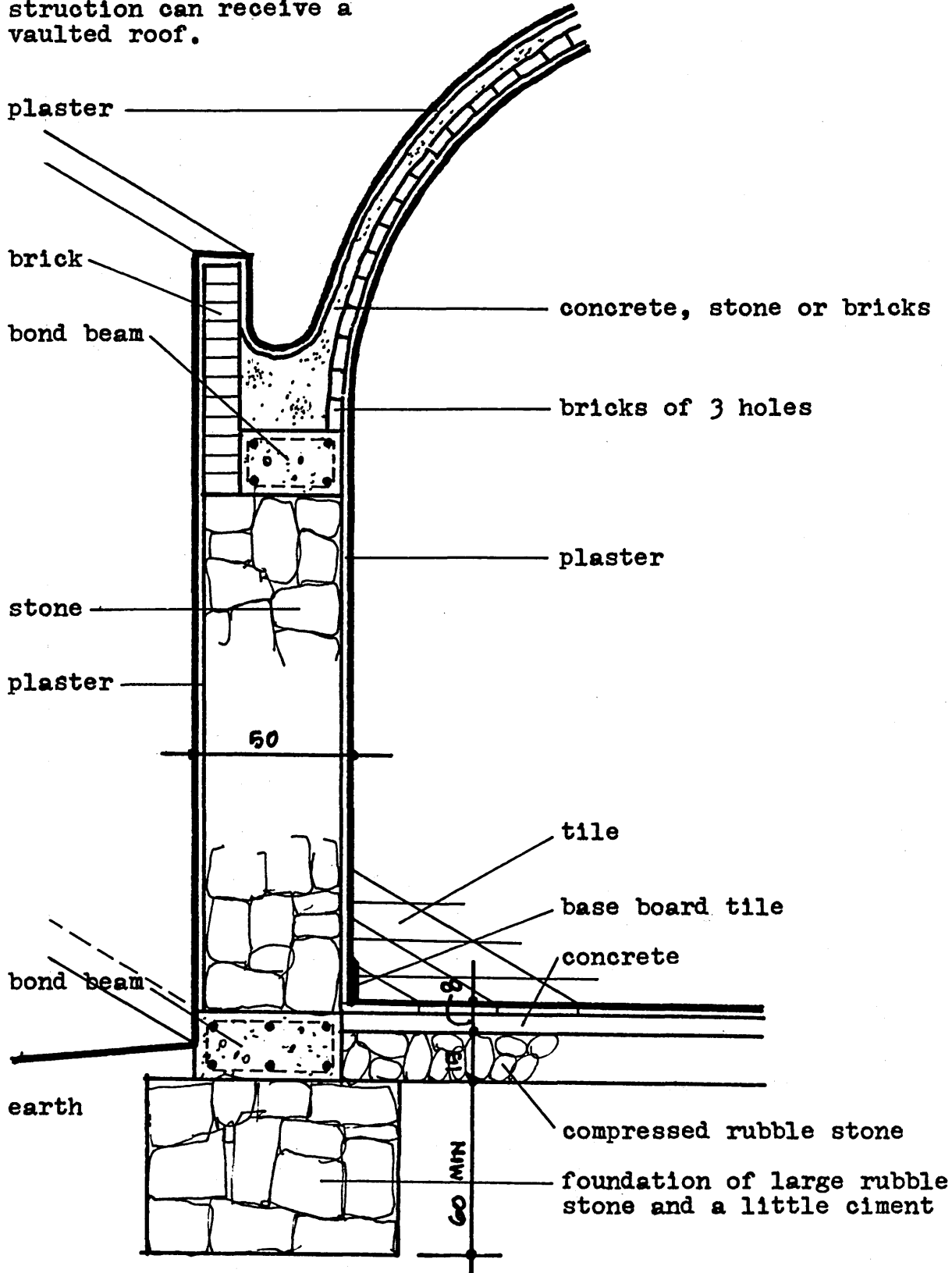
Flat Vault



1. More economical structure than semi-circular vault as it uses less material
2. Horizontal thrust carried by heavy exterior end walls, by tie rods, or by buttresses

scale 1:20

Note: The vault shown here can be substituted by a flat roof construction. Conversely the concrete frame type of construction can receive a vaulted roof.



Typical Frame Construction:

scale 1:20

rain spout

bond beam

plaster

'constructive' column

plaster

earth

parapet wall

cement plaster
2% slope

fill

hollow tile

plaster

lintel

window frame

glass

shutter

window sill

wall in brick or
concrete block

bond beam
floor base
floor tiles

setting bed

stone base

wall foundation

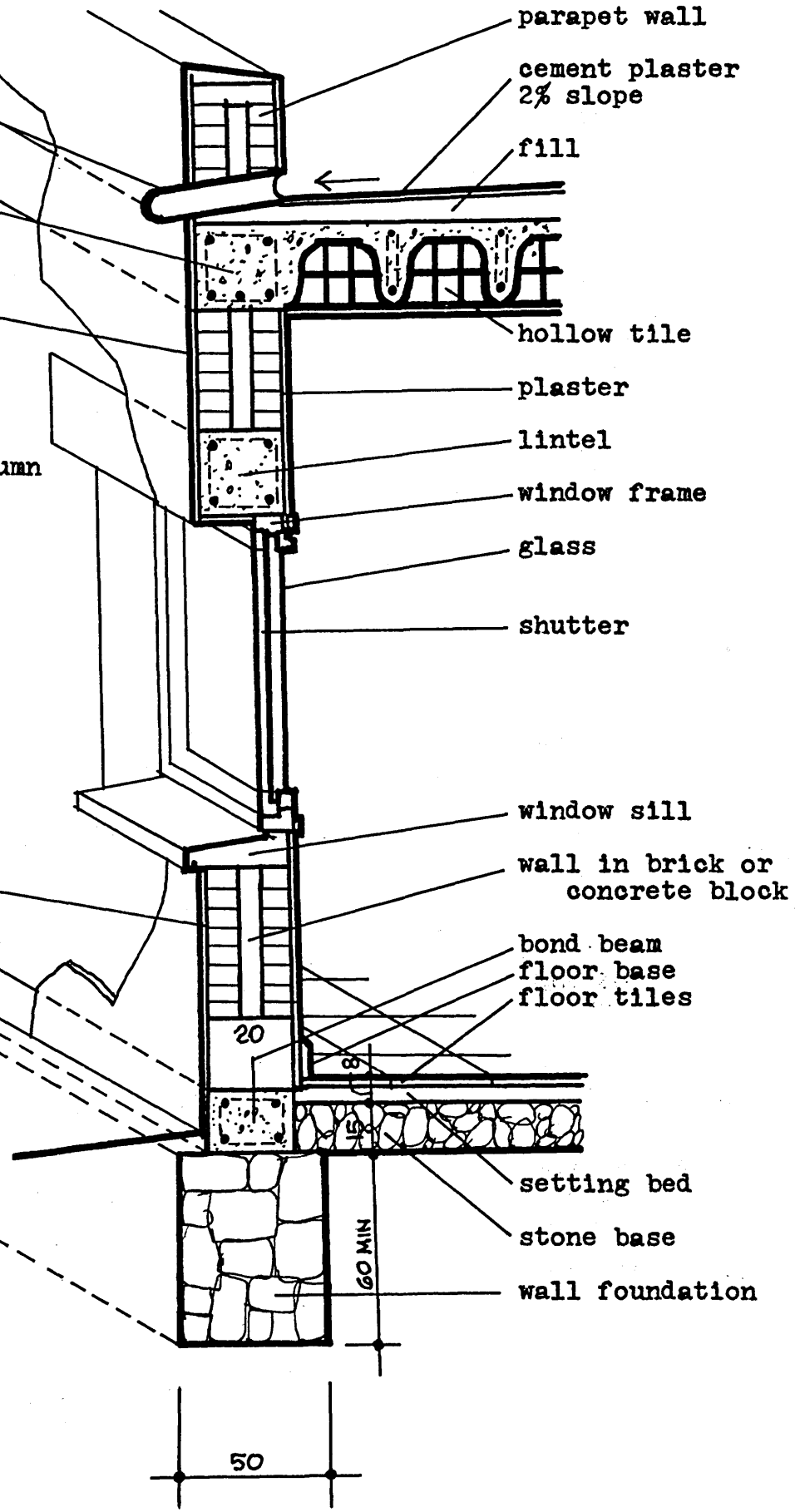
20

8

15

60 MIN

50



A Description of Existing Materials and
Methods of Construction in Tunisia



