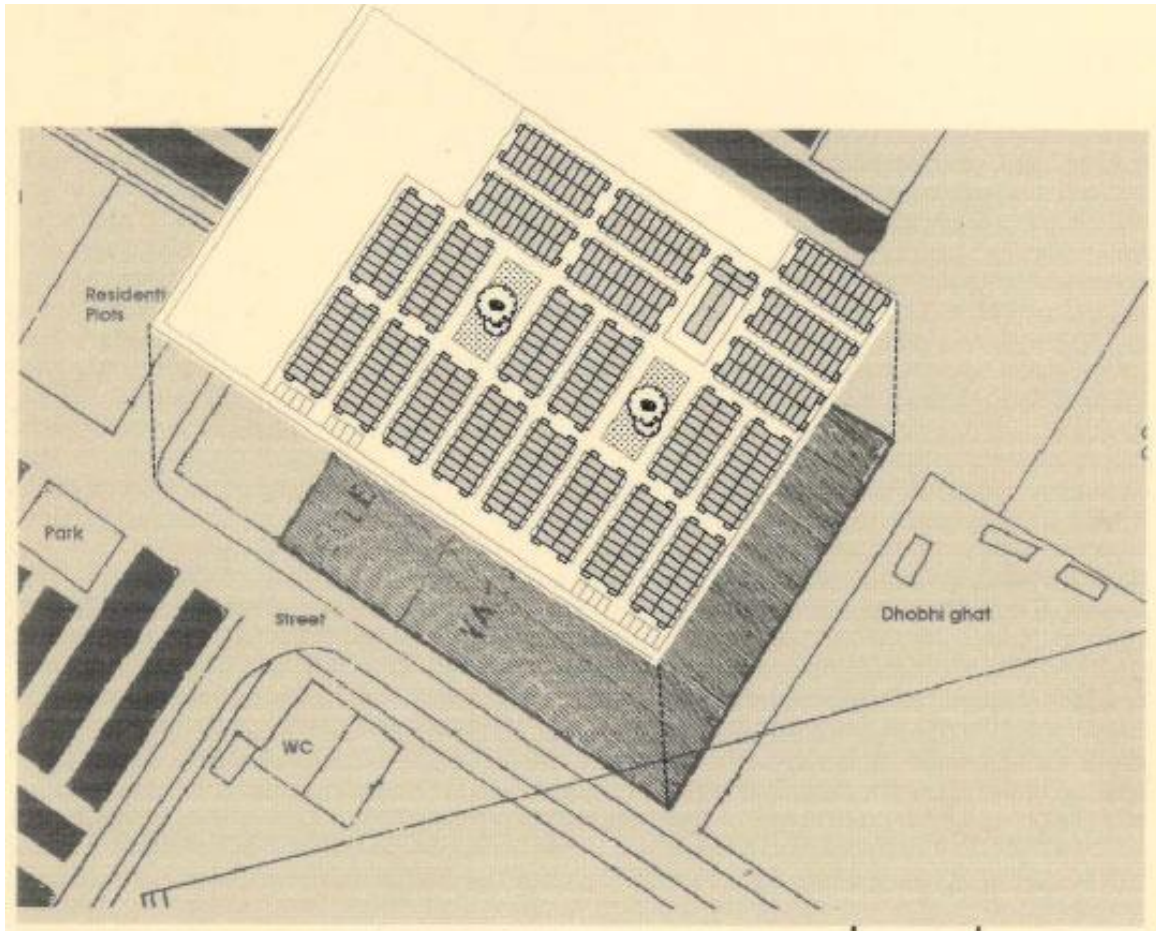


MSc/Diploma in Development Practices
Diploma project

Improving Housing Trough Community Self-Sufficiency



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Oxford, March 1994

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Executive Summary

Building community self-sufficiency through training centre, local micro enterprises bank of materials and self-help co-operatives aimed at economic improvement.

The key thrust of this study is to identify the problems of the area. We understand that the implications of dense urban population is evidently one of the explicit catastrophe of urban slums. Planners face the enormous task of managing the phenomenal growth and have failed to meet the challenge. The slum area 'Sanjay camp' can be perceived as people living in an area are without adequate shelter, and without access to safe water or sanitation. The economic inefficiency, environmental degradation and poverty are a result of the haphazard housing and urban growth.

To address this problem our approach is towards planning and management through appropriate affordable construction technology. This package consists of elements for training provision at professional level, produce competent building components in the micro enterprises workshops under a semi public private initiative, and to form a self-help co-operative for storage of materials and to assemble the housing units.

The proposal is to enable the community to improve their quality of life by rebuilding their homes and creating self-sufficiency for themselves.

All the elements of this package are interlinked and interdependent, although they function independently e.g. the training centre has potential to provide other types of training facilities, and the micro enterprises to produce different products for income generation at project completion.

The interdependency of all these centres is based on cross subsidy. The income generated through the training centre is used to pay for labour and for training provision. The sizes of the prefabricated components for construction produced in the workshops are selected to the sizes of materials available in the local market. The cost saving measure here is by reducing wastage, obtaining access from the sources of materials and supervision by the professional trainers from the training centre.

The implementation of the project is phased out into eight stages. Each stage consists of 3 blocks, each block has 40 houses, 20 on each floor and the floor area of one house is 18 sq. mts., where as the existing floor area of a house is approximately 12.5 sq. mts. The effectiveness of the implementation is dependant upon community participation. The responsibility lies on the community to make land available, manage the project and execute the project. Incentives of income generation with skills training and

construction are interlinked with facilitating and mobilising themselves to take advantage to improve their standard of living. Camps are proposed in the open area outside the slum as temporary accommodation until the completion of each stage of construction using the proposed system.

Using the proposed system the cost of each house is Rs. 22, 950,- i.e. £510. This is expected to fall within the affordable criteria of an urban slum dweller in India. 30% of one adult income of the family is required for payment, i.e. Rs 250 per month over a period of 15 years for total repayment at an interest rate of 10%. This includes cost of construction and infrastructure. However this does not take into consideration land values and inflation.

The proposal is addressing at a level of provision which can be compared to private housing standards. Although this is aimed at the low income groups, it is known to reach middle income groups or other beneficiaries. In order that it reaches the beneficiaries efforts by the community, other organisations who can influence the system, the Delhi Municipal Corporation (DMC) and the housing finance or other finance organisations should ensure that loans are made available to the beneficiaries, infrastructure provision and land tenure is made available to the beneficiaries etc.

An effective cost recovery system can be adopted to allow flexibility of payments to different income levels within the community.

SUMMARY OF RECOMMENDATIONS

To address the high housing densities and lack of space in the slum areas.

To address the lack of building skills within the community.

Building Community self-sufficiency through Training centre, Micro enterprises and self-help Co-operatives.

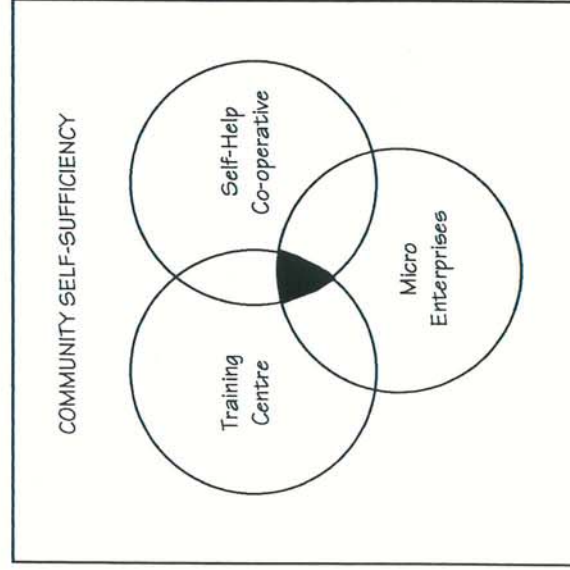
IMMEDIATE ACTIONS:

1. Develop a package to improve housing conditions through appropriate affordable construction technology.

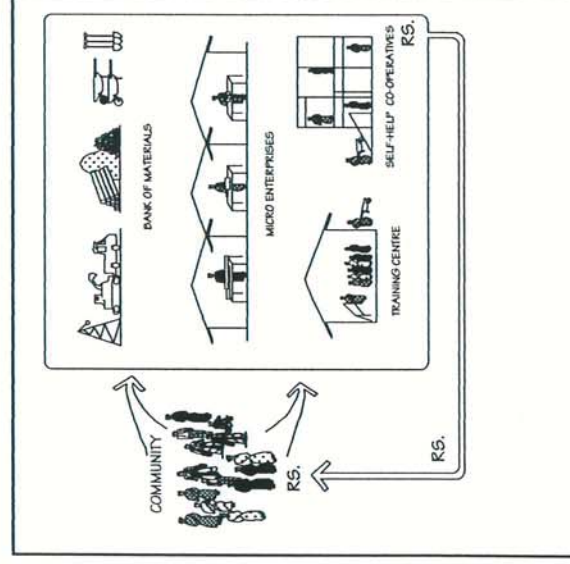
- Identify land ownership's
- Identify land availability
- Build camps to move people.
- Build community building.
- Start project implementation.

2. Set up a training programme for skills generation in plumbing, electrical installation, carpentry and masonry.

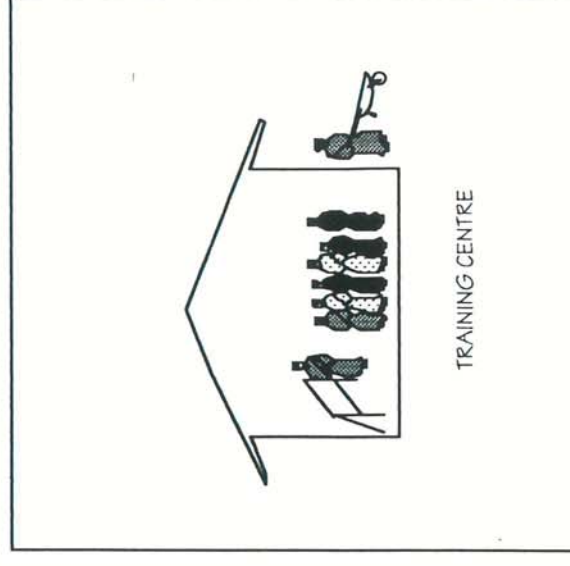
- Mobilise community interests to organise and start skills training programme.
- Build a training centre.
- Start training sessions in plumbing, electrical installations, carpentry and masonry.



SHORT-TERM ACTIONS:

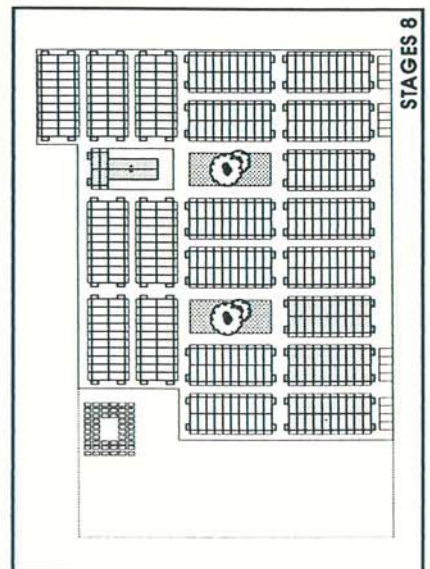
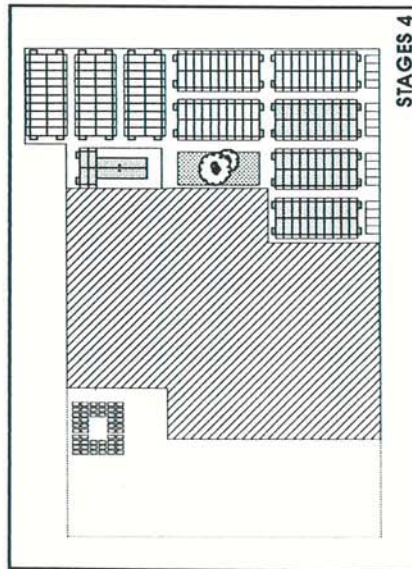
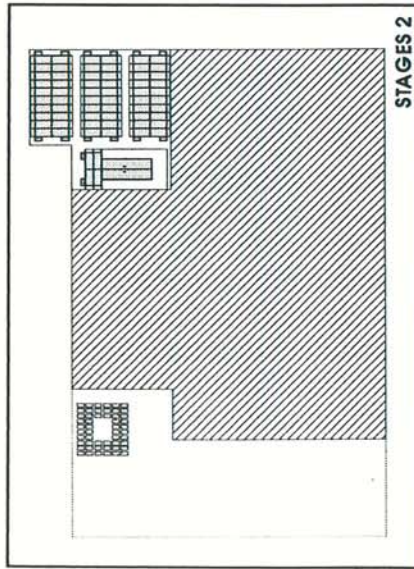


- Build stages (building and construction).
- Create communal open spaces.
- Improve access to the area.



- Provide professional training to the people.
- Improve employment prospects with skills training.

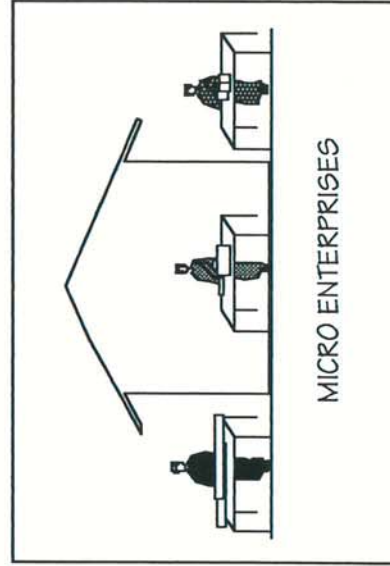
INCREMENTAL STAGES



To address lack of income generation through production of prefabricated building components.

3. Establishing an enterprise in the production of prefabricated building components for construction

- Identify entrepreneurs within the community to install the micro enterprise system and ownership.
- Organise people for producing the components for construction.
- Workshops owned and run as a business by the community. Production is based on semi public-private initiative, 50% products sold at real value to self-help co-operative and 50% in the commercial market at its price.

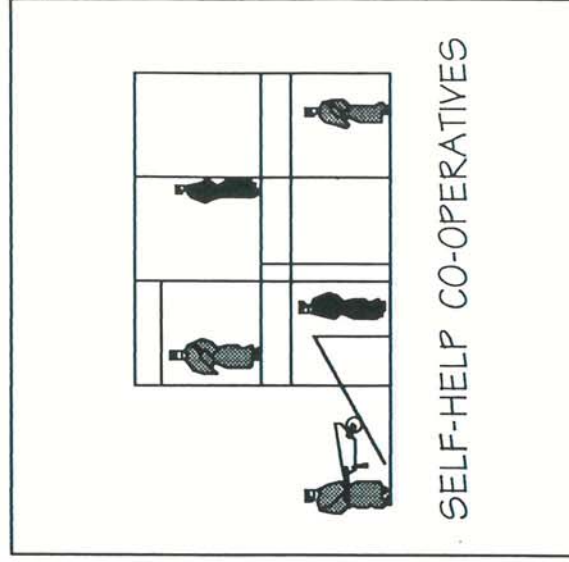


- Production of building materials in plumbing, carpentry and masonry.
- Achieve professional standards.
- Improve income generation capacity.

To address the lack of community organisation for incremental improvement through housing construction and dedensification of the urban areas to create communal spaces and better environment.

4. Provide a basis to form an organisation based on self-help for house building.

- Mobilise community to build Co-operative Building.
- Organise work teams for storage and distribution of materials.



- Organise people for assembling the housing units.
- Assemble housing units.
- Mobilising people in phases.

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Chapter 1 : Introduction

Dakshinpuri development project is a partly self-financing urban settlement upgrading proposal to implement in Delhi. It proposes to enable 15,000 people to gain access to land with secure tenure and basic affordable levels of housing and infrastructure provision.

It is complimentary in its approach to basic housing principles, on the one hand it is aiming to provide healthy built environment to bring healthy people and on the other hand calls for a change in the institutions to bring change. The approach chosen for this project is not minimal upgrading but rebuilding, because after considering the existing circumstances of the squatter settlement, it was evident that an effective measure aimed at socio-economic improvement was required.

The technical solution applied is to use appropriate affordable construction technology through planning and management for income generation, skills training and building community self sufficiency.

This package has components for training provision through professional trainers, gain experience in producing the prefabricated building components to professional standards and also in assembling the housing units on the site. The community organisation and other non governmental organisations are responsible for execution and management of the project during and after implementation.

Through this package house building is introduced as a business, where with the element of self-financing and cross subsidy using the enterprise workshops and training and supervision in assembling, the community workers acquire a level of skill which has a good market value for employment opportunity, this system further introduces potential for expansion to other areas for similar project application in Delhi or the rest of India.

City of Delhi is known for being a national capital for centuries. It has continued to be an important centre for ruling the nation passed on to the Mughal Dynasty and then the British Raj. All these influences have developed different forms of architecture forming 'Old Delhi' and 'New Delhi', both are distinctly different in structure and form. Delhi continues to attract migrants, one of the effects of this century is the growth of slums and squatter settlements. The migrating population from the rural areas bringing the poverty over to the urban areas. This is distinguished in character and form as poor physical conditions of living and visibly depressing in contrast and adjacent to high rise or planned buildings. The term often used is informal sector an unplanned spontaneous growth of populations and settlements.

Chapter 2: Background information

The site is set in the outer suburbs of the city of Delhi. The area comes under the jurisdiction of the Delhi Development Corporation (DDC). The corporation is responsible for policy making and its implementation. The resettlement areas and the squatter settlement areas have influence of the Housing Urban Development Corporation of India (HUDCO), who is responsible for housing in the urban areas. HUDCO is a national organization, which implements projects addressing issues of urban growth as a result of rural-urban migration. India has a Land Ceiling Act, which allows the authorities to declare land urban or rural on a given criteria based on land acquisition or occupation. DDC is responsible for the development of the land. After development the Municipal Corporation of Delhi (MCD) undertakes the provision and maintenance of the services for the site.

The policies of Sites and Services have been implemented in the city boundaries and also urban upgrading programmes. Land is scarce in Delhi, the corporation is unable to provide adequate infrastructure for the fast growing urban population. The rate of growth of urban population is highest in Delhi, mainly by attracting migrants from rural areas and not natural increase. The urban population is estimated to increase to 2.8 million by the year 2000 (UN 1989, Table 7). The urban growth rate in Delhi is 4.06% per year, which is the highest in India, higher than Bombay, which is 3.25% per year, which is alarming compared to international standards. This addresses an important policy issue for the institutions on control of migrating population to the cities. The squatter settlers are in a state of transition until development takes place, they have gained a legal right over the land 'Sanjay Camp' as settlers over undeveloped land.

Non Governmental Organizations are involved in many sectors of the economy. Providing health services, training in enterprises and other activities. They are linked with other Community Based Organizations all working for the upliftment of the area.

Chapter 3: Survey, Data collection and analysis

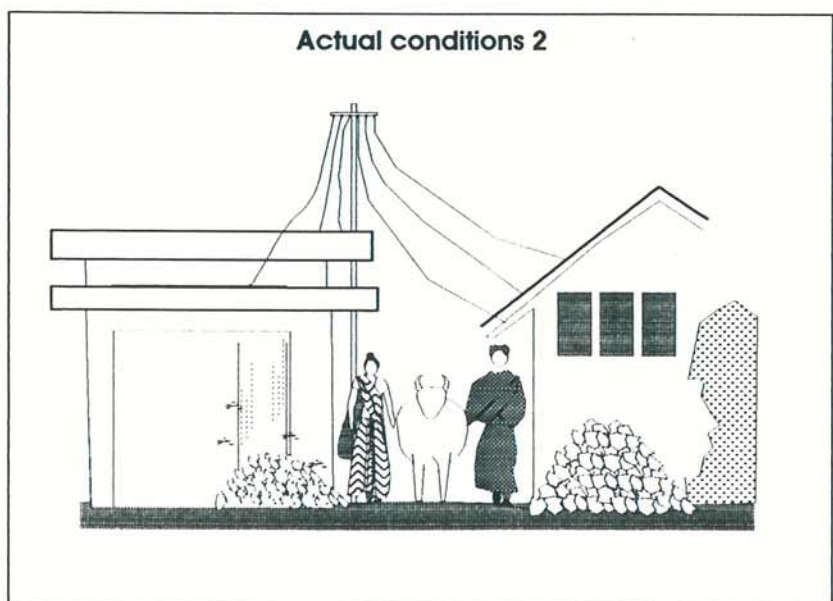
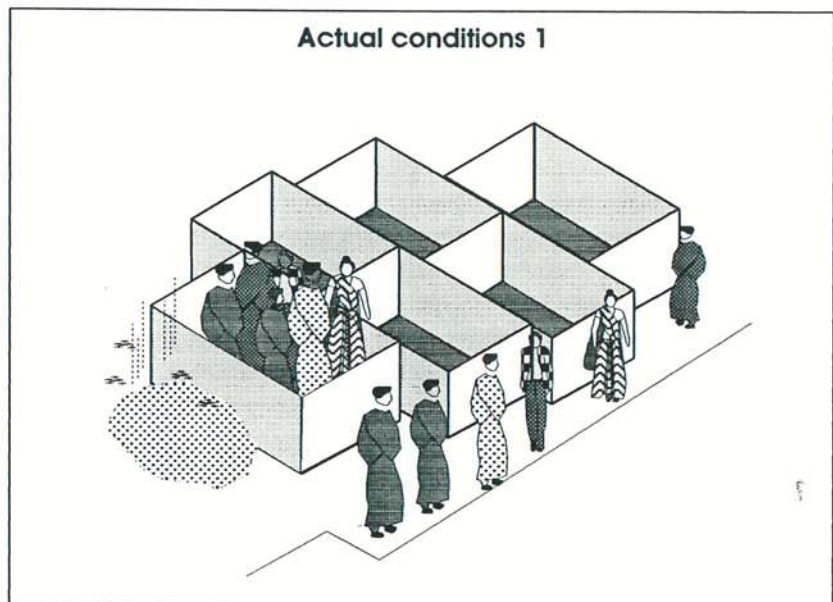
On making an initial survey of the squatter settlements of Delhi and developing an understanding the general pattern of urbanization. About 30 kms. from the centre, in the outer suburbs the squatter settlement at Dakshinpuri was chosen as a area for work as it is adjacent to the resettlement programme undertaken by the Delhi Development Corporation and Housing Urban Development Corporation of India (HUDCO). This squatter is evidence of urban growth. Policies and programmes are being addressed to provide shelter for the slum dwellers, such as the resettlement area, although shelter is provided the problem of inability to improve socio-economic conditions still persists.

The importance is to address issues at the root of resettlement programmes, although this does not address the problem of urbanization, it is looking at providing an alternative to use the existing resources efficiently with appropriate technology and micro enterprises, self-help cooperatives and training centre.

Presentations were made by the authorities on the programmes and policies to give us a basic understanding of the pattern of development. The data was collected by interviewing people who were available on site, information was gathered on income levels, standard of living, physical conditions, accessibility to public services, employment opportunities, transportation facilities, modes of transportation and affordability. Analysis was carried out based on the given information by the interviewees and observation. The secondary sources of information were the Delhi Development Corporation, HUDCO and an organization based on appropriate technology called 'Development Alternatives' (DA), who provided information on the cost of construction by different methods. This indicator has been used in calculation for the proposed design.

Chapter 4 Existing conditions

The actual conditions of the settlements in the squatter area can be described as, those with high densities, a ratio of less than 1 sq. mt. per person. The plot sizes are small, with no vertical expansion and the construction of houses is dependant upon the availability of materials. The houses are all crammed very tightly not allowing any houses adequate ventilation, sunlight or accessibility to the streets, open spaces, communal areas, other facilities etc. The conditions are severe in terms of the constraints it imposes on the community to develop an ability to self sufficiency to improve its socio economic condition and improve their quality of life and standard of living. (See Appendix for the analysis of the conditions and proposal to build community self sufficiency)



Chapter 5 Site area / analysis

Total site area: 14,687 sq. mts.

Infrastructure 29% of total area (infrastructure includes roads, water supply, sanitation, electricity and open spaces for community recreation)

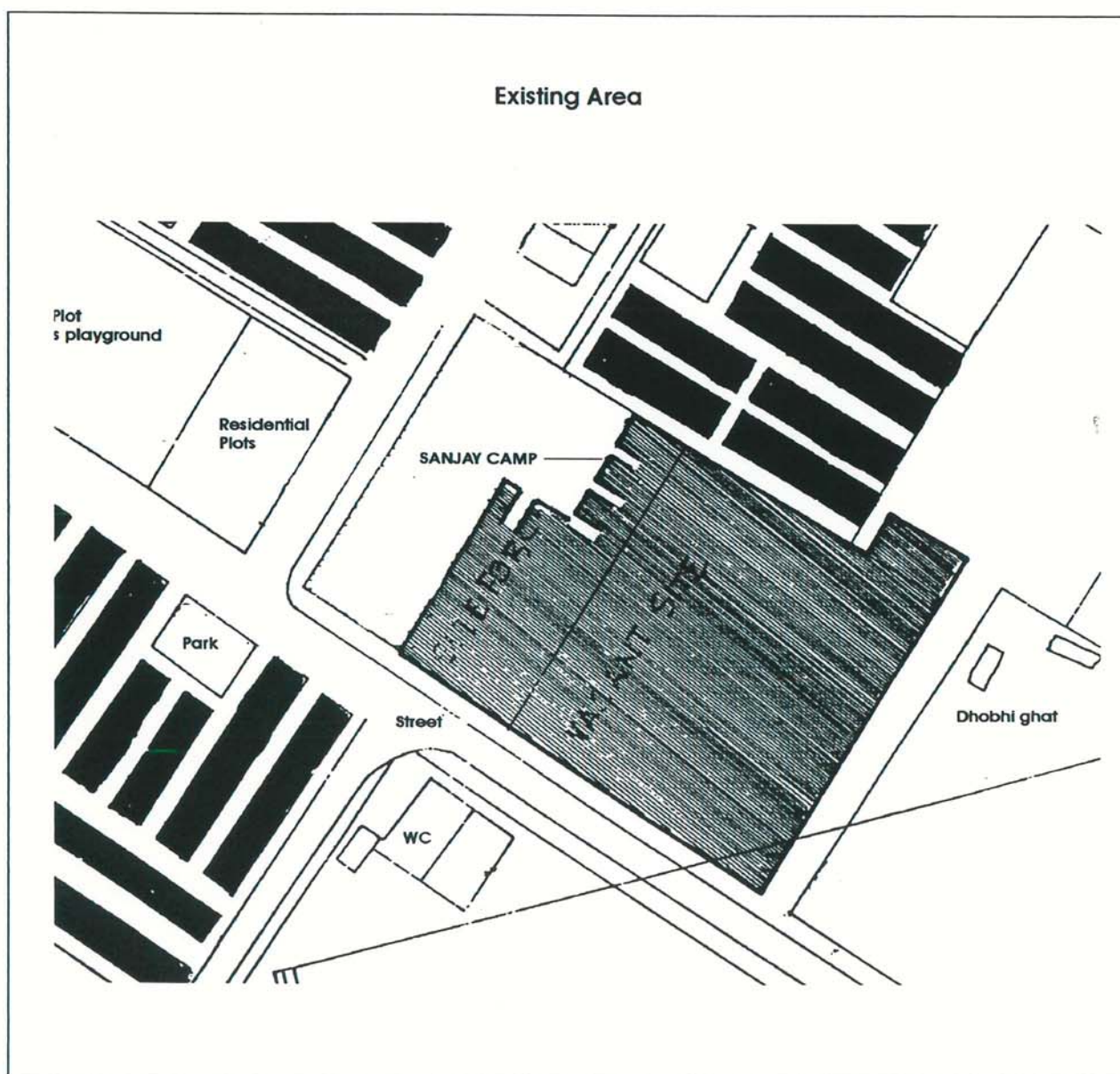
therefore total area after infrastructure is 10,650 sq. mts.

Average area per household is 12.5 sq. mts, i.e. 2.5 sq. mts per person.

Therefore total inhabitants in the area is approximately 4260 persons.

Average size of the family is 5 persons.

No:of Houses to build is 852 units approximately

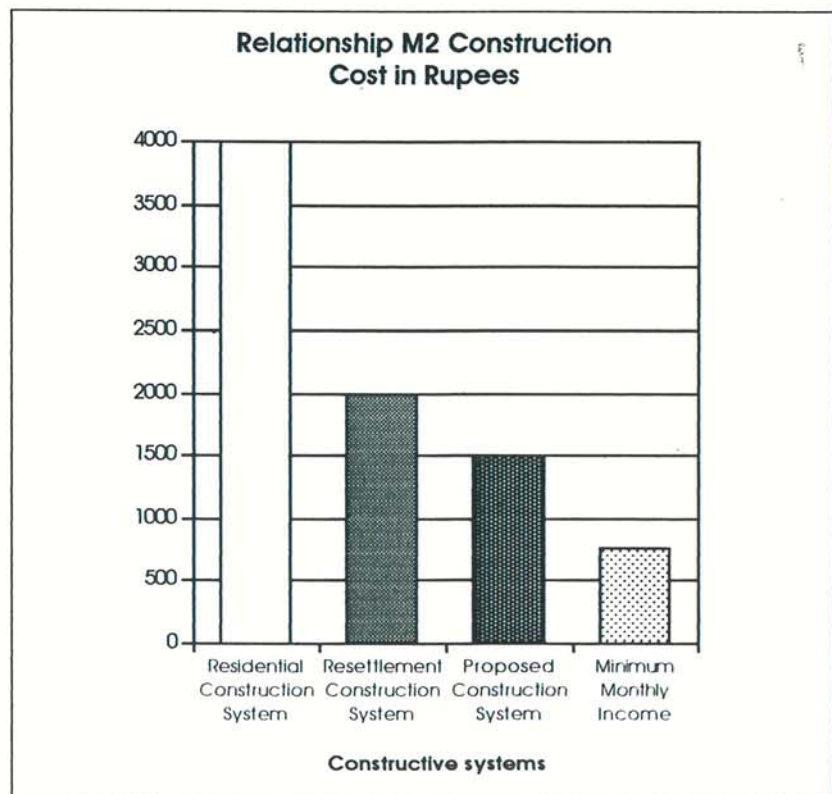


Chapter 6 Proposal

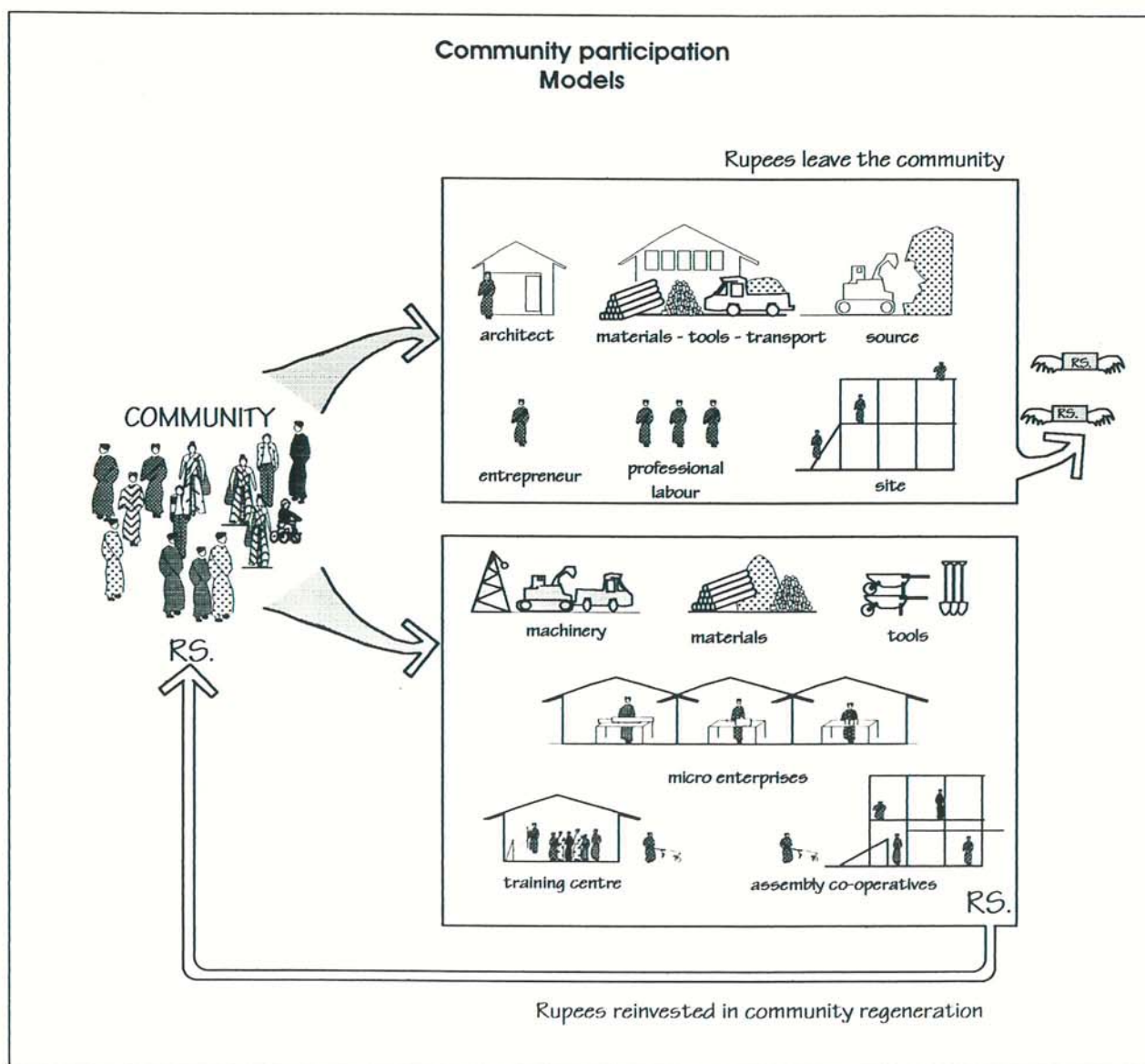
In the conventional system money leaves the community, for e.g. considering the resettlement area around the squatter settlement area, the construction and development method used is to employ professionals to carry out the tasks for e.g. entrepreneurs, architects etc. (see graph), and these are paid professional fees and thus the money leaves the community. In the proposed system income is generated with employment opportunities and training (skills generation) and the investment is used in regenerating the economy of the community and develop further.

The task taken was to redesign the squatter settlements with an incentive for income generation with micro enterprises and forming assembly co-operatives with self-help methods of construction.

This proposal is designed linking house building activity with providing some employment opportunity to divert the resources to building the basic structure of the dwelling. Under this system the cost of construction is Rs. 1,500 per sq. mt, and the resettlement is Rs 2,000 per sq. mt. The economic argument is to adopt a method which will use the investment from the community concerned in terms of labour, management of cooperatives and enterprises, and the communities taking part in decision the making at every level of implementation.



In this system the community undertakes the operation of the training centre, micro-enterprises, and self-help cooperative as a business. The micro enterprise workshops will run on public private initiatives, they will be privately owned, ownership can be individually or shared, the responsibility in making this decision lies with the community. Profits made are used to pay for the running costs of the business, the professional trainers at the training centre and these are linked with the self help cooperative who will take responsibility for making decisions. The principle used here is of self-help, with micro enterprises, the system will provide training, some employment and helping themselves to provide better standard of living. The whole system is run as a community organization with their own ownership, initiative and participation. The Important indicators used here for analysis are income and expenditure.



Basic assumptions

The general assumption used here is that up to 80% of the income is used up on all expenses on the household. The survey has identified the monthly income of one adult to be Rs 750 per month. The investment required is Rs 250 per household which is only 30% of one adult income.

Based on this assumption and other indicators such as

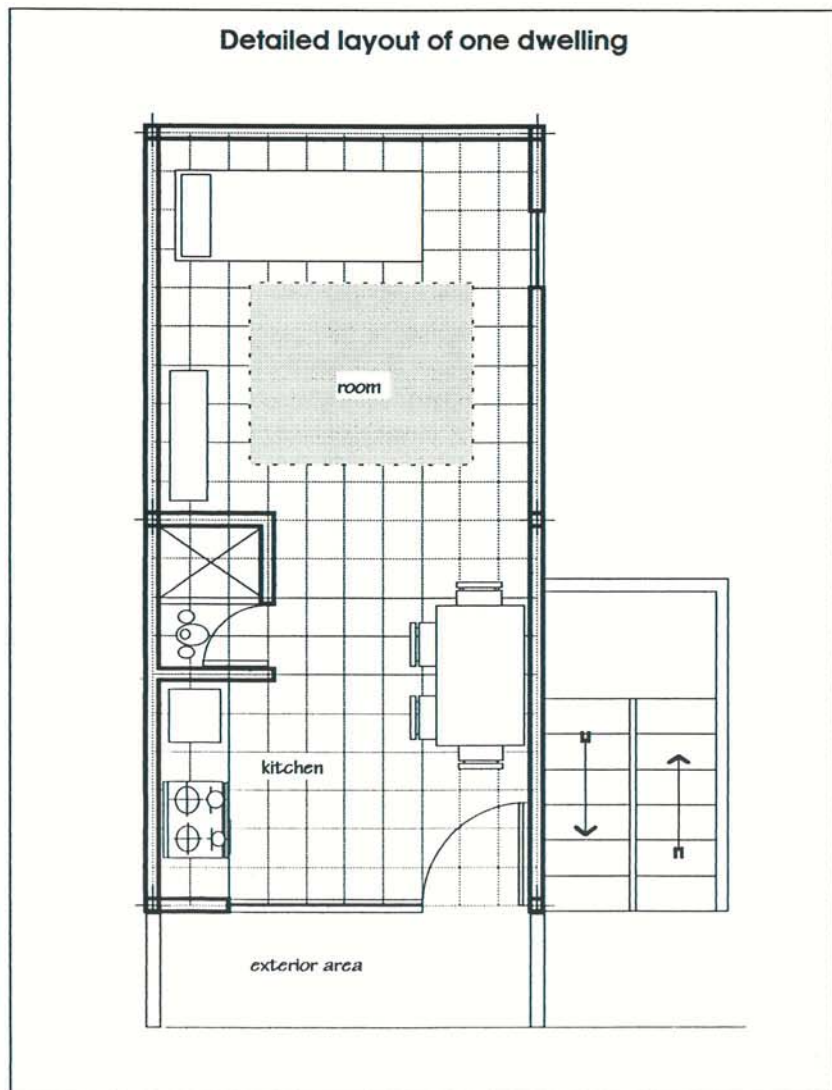
- assurance of land tenure on a freehold basis as a result of the habilitation programme by the Delhi Development Corporation, the term soft loan are to be made flexible for repayment over 15 years with necessary conditions for land tenure and repayment and longer if possible.

Labour is one of the highest cost factor on the list. Some materials for construction are locally made within the community using the enterprises, plumbing, electrical appliances, masonry and carpentry.

The proposal is to provide one large room with kitchen and toilet attached giving the household flexibility to expand out into the street on the ground floor and the terrace alternatively for the first floor.

Chapter 7 : Criteria for development

- * The density standards are based on the existing density of the squatter settlement .
- * To resettle 4260 people in the given site using appropriate technologies.
- * Appropriate construction techniques are based on using wood, bricks, minimum RCC concrete and other basic materials.
- * Open spaces are allocated at two locations on the site.
- * Each dwelling is designed to provide a floor area of 18 sq mts without including the balcony on the first floor. The staircase is provided externally. Each block consists of 40 units 20 units on each floor with access via external staircases on each side of the building to the first floor and the terrace.



* The streets are 6 mts wide, allowing the households to encroach upon the streets and build or use the space as they require.

* The buildings are designed back to back to eliminate any use of space as a garbage dump.

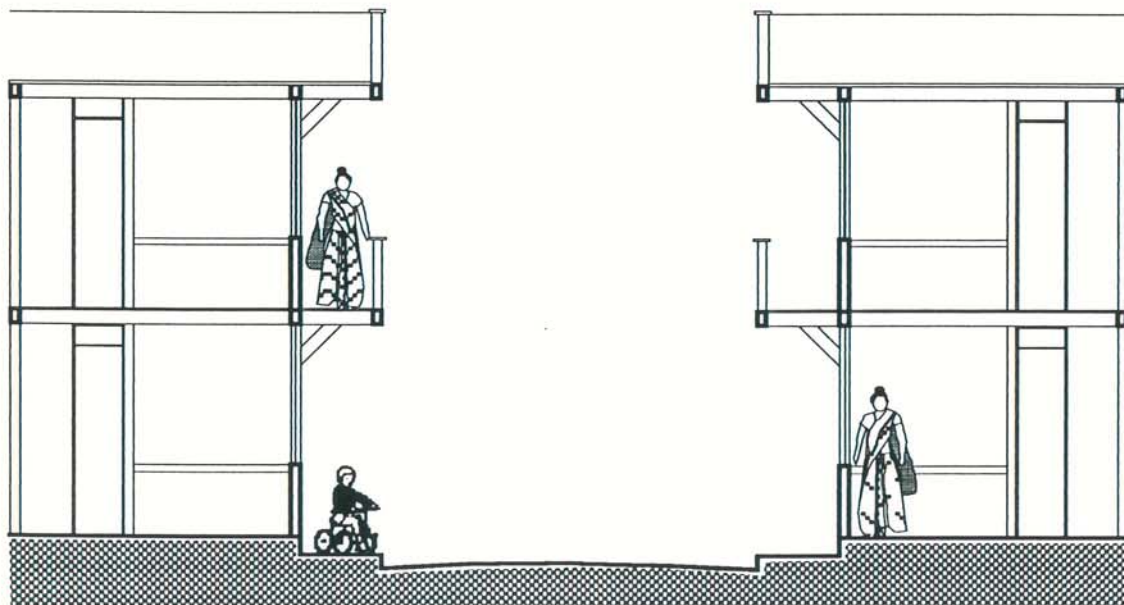
* Each dwelling provides a shower/bathroom, toilet, kitchen/dining and bedroom/living area.

* The general understanding is that one bed is provided which is piled up with mattresses. These mattresses are used to lay on the floors of the living and dining areas for sleeping as the floor area is limited it is used for different purposes as necessary.

* The front of the building faces the other and the roads in between them, with the balconies protruding from the first floor.

* Every building is given a terrace, these terraces are used for recreational purposes and communal activities such as parties, games, drying foods, garden terraces, drying clothes etc.

Street cross section



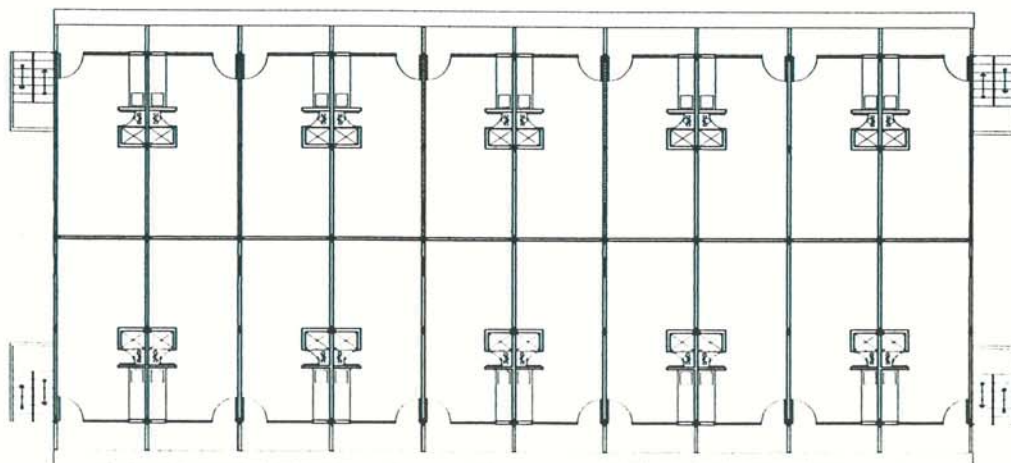
Design

The area consists of a mixture of houses with very poor living conditions and inadequate facilities. It has a very disorganised layout of buildings, street space and open spaces. The physical conditions are very poor, its a concoction of living areas, communal areas, with residential and commercial activities all interacting at the same time. Supported by infrastructure, such as, water supply, drainage system, electricity. The communities living within carry a large amount of personal risk due to the exposure to such inadequacies in shelter, support systems, access to education, employment and credit institutions.

The proposal is to organise the existing system by creating defined spaces for residential and communal areas, with access to available credit institutions such as HUDCO, Housing Finance Development Corporation and Delhi Development Corporation for financial, institutional and administrative support to allocate the designated areas with forms of tenancy agreements as applied to the resettlement areas. Land occupied by the settlements gives them a right over the occupied land. the process of regularisation will be enhanced by the resettlement programme.

The site is divided into twenty one equal blocks, each block consists of 40 dwelling units, 20 on each floor. Each house is a large rectangular room of 6m x 3m on the ground floor and on the first floor but with the balcony measuring 0.9m. The balcony forms a space for individual family use as well as providing an access for the adjacent houses from the staircases at both ends of the building. This complements the existing character of the area.

Typical block



Chapter 8: Policy considerations

In policy terms formal sector policies since 1968 have contributed both directly and indirectly to an increase in squatter settlements, due to a range of factors that spring from the misconception about nature of the housing problem and the reason adopted to deal with it. (Geoffery Payne).

These policies address the authorities directly to take a responsibility to provide "minimum" standard housing to lower income groups, irrespective of the growing evidence that people of all income levels are capable of providing their own housing and they need access to resources and infrastructural supports.

However provision of infrastructure and services is one of the key issues to be addressed. Plan of action recommended at the Habitat conference in 1986 is to make shelter, infrastructure and services available to those who need them and at a monetary and social cost they can afford. How shelter strategies are to be evolved if negative trends are to be reversed and everyone allowed the basic right to a decent place to live in requires a state of thinking and action addressing all levels of implementation, like the housing and city authorities, national and international policies, local non governmental organizations and community based organizations and the community itself.

The Housing Finance Development Corporation (HFDC) was founded in 1977, with the support of the International Finance Corporation, Aga Khan Foundation and Industrial Credit and Investment Corporation of India. Their objective being to mobilize resources for financing acquisition or construction of dwelling units in India. Along with HUDCO, HFDC has been successful in its provision of finance and mobilising resources.

The HFDC has developed a housing finance system capable of financing shelter for the majority of the population. Its function is to mobilize resources at national as well as beneficiary level. It creates financial intermediaries with ability to channel funds into the human settlement sector and to the households most in need. It has also developed a loan and saving scheme which adapts to the needs and financial capabilities of low-income groups. These institutions are supported by international funds, and can be an important resource for the income generation activity for the low income communities. The interest rates in 1992 were 10% for low income groups for housing.

Chapter 9 : Affordability/Cost recovery

Our aim is to achieve affordability with appropriate construction technology, cross subsidy and partial self-financing of the components of the package. The proposed system makes a saving of Rs 500 per sq.mt of developed land in comparison to the re-settlement site, and provides a much superior standard of construction with enabling the community with construction skills and opportunities for income generation and self-sufficiency.

The cost of each house is Rs 22,950; £ 510.

Interest rate for housing loan is calculated using the HFDC figures for 1992 at 10%.

The repayments include infrastructure at 29% = Rs 250.

Repayment period at Rs 250 is 15 years; 6 months.

Cost recovery for individual household is calculated on a optimum payment of Rs 250 by the household to recover over a period of 15 years and 6 months. The calculation is shown in the adjacent table 'cost recovery for one household'. The payments if reduced will require a longer period for recovery. The flexibility for reduction of payments is limited, if reduced to more than Rs 220 per month, there is no scope for cost recovery unless the interest rate is reduced, otherwise the interest rates will be higher than the payments resulting in negative growth. A flexible cost recovery system can be adopted after negotiations among the community and the housing finance about the communities willingness to pay and the period of payment. The possibilities for subsidies for the very low income families is an important consideration for cost recovery.

Chapter 10 Implementation

Community centre

The Community centre forms the central focus of this proposal. It aims to enable the community to improve their socio-economic conditions via income generation and skills generation whilst providing opportunity for taking responsibility in planning and managing the components of the package independently and as a community project. It is important to recognise that in the implementation of this project, although the size of the units, materials and design has been provided. It is only in an effort to demonstrate that the given high densities can be rehoused within the existing site with larger houses, better standard of living, better accessibility to services, land tenure, affordable cost of housing and very low maintenance costs due acquired skills, better income levels and taking responsibility for the project. The onus lies on the community to make changes in the design and allocation of houses. The proposal provides sufficient flexibility for changes. Land availability for construction is voluntary. The community leaders (NGO's, CBO's etc.) organise themselves to start the process of implementation.

The components of this package work on cross subsidy and partial self-financing, but the package allows flexibility to be redesigned for total self-financing, cross subsidies can be run as business contracts, and there are possibilities of expansion of each component. For the purpose of this exercise it is recommended that expansion of the components proceed after completion of the project. Under the given consideration, as obtained from this study the limitations are set and flexibilities are provided in the proposal. The changes in the proposal is dependant upon any other added considerations that can be obtained to improve the proposal.

Training Centre

The training centre provides professional training by trained professionals in masonry, carpentry, plumbing and electrical installations. The instructors can play a multiple role by allowing themselves to be involved in the sectors of the proposals, they can be from the self help cooperatives (NGO, CBO, etc.), alternatively they can also take ownership of the workshops at the micro enterprises to produce the components.

The system works accordingly: at the training centre people to be trained are 3 in plumbing, 8 in carpentry and 5 in masonry. This is sufficient to carry out the building activity in each phase, i.e. 120 units; 3 blocks. This calculation is based on project "comunidades" 1992-3, Brazil (Yves Cabannes). After receiving training they can find employment in the micro-enterprises workshops to produce the components. The training centre can provide training for other skills that are needed for the community after completion of the project.

Micro enterprises workshops

Micro enterprises work directly in relationship with the training centre and self help cooperatives.

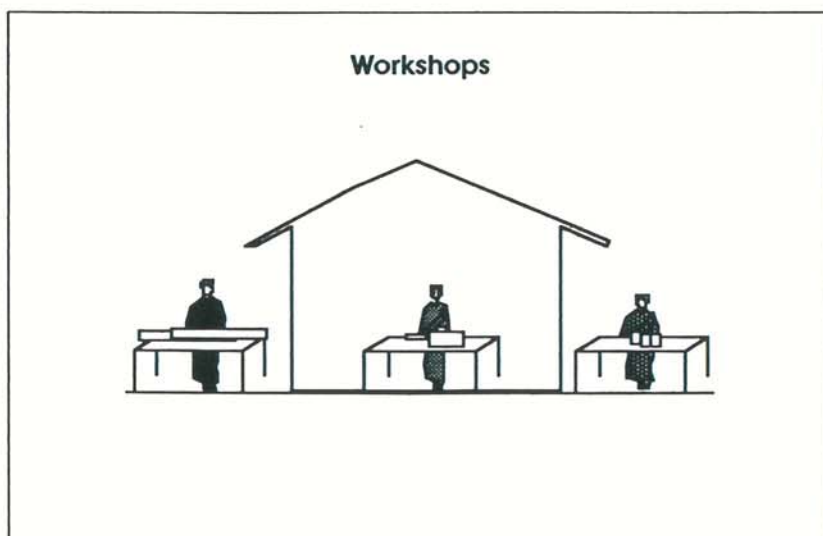
The micro enterprises will run as a normal business based on public private ownership, with accurate accounting for materials, labour and all other costs, with administration support. The supervisors and employees are paid appropriate wage for their work. The components produced are all of the same dimensions. And an arrangement is made is that as it is in community ownership and organisation, 50% of the components produced are sold to the self help cooperatives at the real cost and the other 50% of the components produced are sold commercially as a business, out of which a profit is made. This profit is used to pay the instructors and the pupils who make the components.

The system of micro enterprises in association with the self help cooperatives and the training centre works as shown. The process of the workings of micro enterprises is introduced to the community 'slum dwellers' leaders as an incentive for income generation. People living in urban slums generally come from rural areas looking for work. Providing opportunities for work is the key aspect of this scheme. The micro enterprises will work as workshops which will provide prefabricated components for foundation and other parts. The components produced in the workshop are:

In masonry; foundation elements such as blocks, prefabricated plinth, prefabricated wall foundations, prefabricated staircases.

In carpentry; structures such as doors, windows and kitchen cabinets.

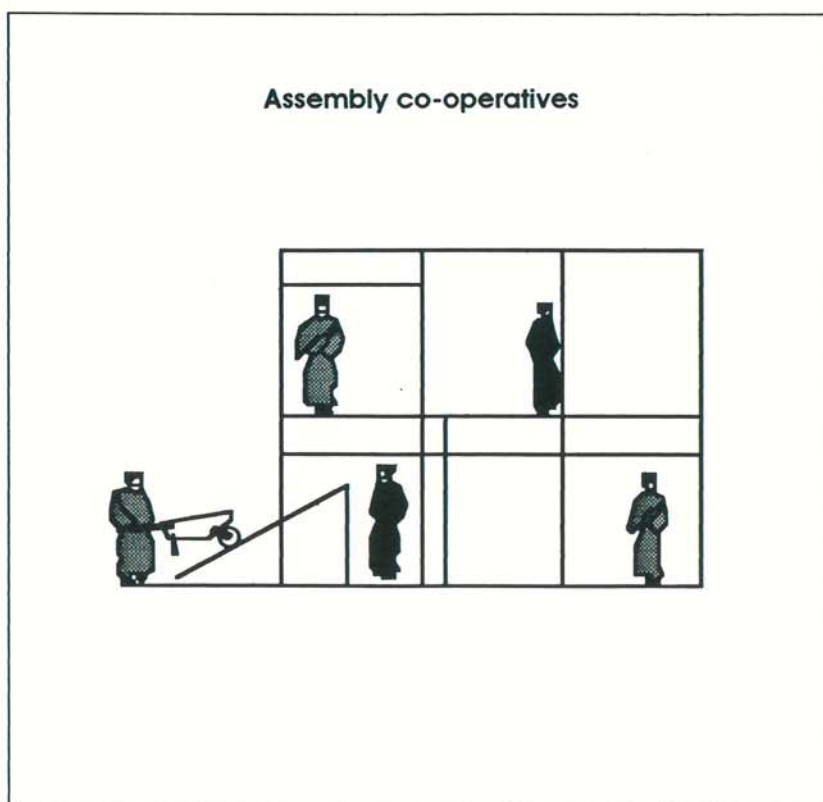
In plumbing; electrical installation components, plumbing components, sanitation and drainage components.



Self-Help Co-operatives

The next stage after preparation of the components leads to the building activity. This co-operative also performs a function for storage of materials obtained from the source and the construction components bought from the enterprise workshops.

Pupils from training centre along with volunteers from the community form a team for assembling the housing units. All the labour input by community is credited and accounted with the co-operative. The instructor, can play a role of the supervisor here as well, however these decisions will depend on the community themselves, and availability of masons with in the community. 10 assistants are required under the masons to complete a minimum number of team for one stage of construction, help from the community will be added and all the hours of work will be logged by the administrator for credit. In each stage 3 blocks; 120 units will be constructed. This process can be continued moving to the next stage of construction. The limitations are for the proposed micro enterprise, it has a capacity to build only one stage at a time and the production of materials is sufficient for each stage of construction, some of the materials are stored with the self help cooperative, but sufficient to start next stage. The people who are trained after gaining knowledge and experience of working on the site are in a better position to find employment in the market. The training centre continues recruiting new pupils at each stage to keep the movement going.



Mobilisation of inhabitants

The proposal is to mobilise in eight stages, (see plan).

Stage 1 is to move people from the area 1 to the vacant open space where temporary structures will be built called camps, they will live in these camps for one and a half month while the cooperative building is being built.

Stage 2 will accommodate the people from area 2 making the camp bigger and live in the camps for 4 months until the houses are built which will house all the families in the camp and the same procedure is expected to follow in all the eight stages.

The stages have been created for showing the possibility of expansion using the micro enterprises with skills training, production, construction and good management and administration all built on mutual trust and joint ownership.

Project Responsibilities

This project will be implemented by CENDEP (Centre for Development and Environmental Planning).

For the execution of this project an agreement needs to be signed by the following institutions.

- DA (Development Alternatives) Local NGO in New Delhi working in appropriate technology for low cost construction. Their responsibility lies in carrying out construction of the housing project in partnership with CENDEP.
- DMC (Delhi Municipal Corporation) is responsible for land ownership and service provision for the project area.
- CBO (Community based Organisation) to take responsibility in initiation, implementation and maintenance of the project.

Structure of the team work

The team consists of five professionals and two administration support. The principal co-ordinator works part time based in UK, where as the rest of the team carry out the work in India after initial preparation in UK. The support of technical and professional staff from TVB (School of Architecture), DA and the local NGO's and CBO's are included for the implementation of the project.

Structure of Work Team			
	Title	Name	Time
1	Principal Co-ordinator	Nabeel HAMDI	30 Months/Part Time
2	Project Co-ordinator	Carlos GUERRERO	30 Months/Full Time
3	Assistant Co-ordinator	Sunita CHIRMALLA	30 Months/Full Time
4	Technical Manager	François PAVI	30 Months/Full Time
5	Logistics Manager	Belinda COWDEN	30 Months/Full Time
6	Secretary	To be appointed	30 Months/Full Time
7	Administration assistant	To be appointed	30 Months/Full Time

Time table

The implementation of the scheme will proceed after the consultations of the community leaders with the non-governmental organizations, community based organisations and the authorities involved. The decisions made on the responsibilities and the roles they will take in the management of the project. The time table for the execution of the project will be as follows.

Time Table																																							
Activities	Year 1												Year 2												Year 3														
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12			
Project preparation UK	■																																						
Project preparation India		■	■																																				
Construct Community building (prototype)			■	■	■	■																																	
Construct First Stage				■	■	■	■	■	■	■	■	■																											
Construct Second Stage								■	■	■	■	■	■	■	■																								
Construct Third Stage													■	■	■	■	■	■	■	■																			
Construct Fourth Stage																	■	■	■	■	■	■	■																
Construct Fifth Stage																									■	■	■	■	■	■	■								
Construct Sixth Stage																																	■	■	■	■	■	■	
Construct Seventh Stage																																			■	■	■	■	
Construct Eighth Stage																																				■	■	■	
Evaluation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

Costing

The implementation of the project follows a simple pattern of executing the initiatives of economic improvement and community self sufficiency by means of the prototype and developing a methodology.

The phasing is divided in to simple capacities dependant upon the design of the micro enterprises. Initially the setting up of the micro enterprises for training, workshops and self help cooperatives is needed. To initiate the project the micro enterprises have to become functional, the start of this enterprise will require an investment of Rs 843,030.00, £18,734.00 and the self help cooperatives approximately requires Rs 275,850.00 , £6,130.00. The cost of one stage of house building (3 blocks, 120 houses including infrastructure) is Rs 3,552,660.00, £78,948.00. (See Appendix). Each stage consists of the same number of units for construction, progressively moving to the next stage after the completion of the previous stage. The cost of the total project is estimated to Rs 24,868,620.00, £552,636.00 to provide housing for the entire population of the site. Appropriate technologies are used in the construction system and the costs of both internal and external fixtures are calculated for one block and shown in the appendix (see cost sheets).

Appendix

ACTUAL CONDITIONS

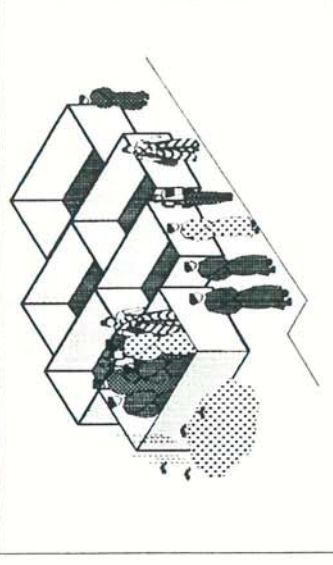
WHAT

WHY

GRAPH

DENSITY

- Small plots
- No vertical expansion
- Construction is a function of materials available



LACK OF VENTILATION

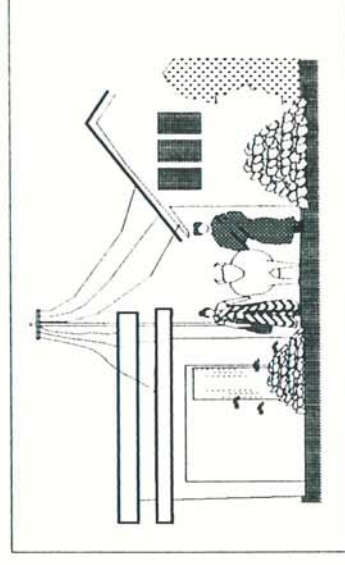
- Back to back, side to side arrangement of houses

RAIN

- Poor construction of roof
- Poor mix of mud mortar

POOR CIRCULATION AND ACCESSIBILITY

- Haphazard development
- No Street layout



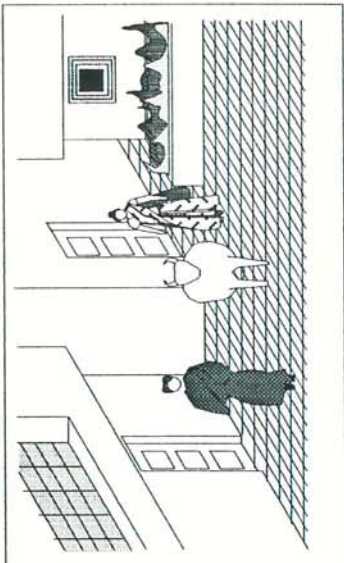
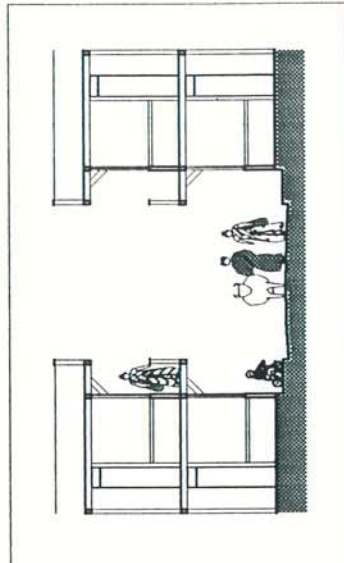
LACK OF OPEN COMMUNITY SPACE

- Haphazard development
- No street layout

CRITICAL ECONOMICAL CONDITIONS (POVERTY)

- Lack of employment opportunities, education and community organisation

PROPOSALS

WHAT	HOW	FOR WHOM	WHO	GRAPH
LESS DENSITY: OF PEOPLE/FLOOR AREA SPACE	- Vertical expansion, adding more floor area	Family	Planners + Builders	
VENTILATION	- Vertical construction providing more openings - Alteration at settlement level to reduce present configuration	Family + Community	Planners + Builders	
WATER PROOF ROOF	- Introduce new materials - Improve construction techniques	Family	Builders + Designers	
REGULARISE AND FORMALISE THE SETTLEMENT	- Plan the allocation of land	Community	Planners + Authorities	
PLAN COMMUNITY SPACES	- Incorporate community spaces in settlement layout when land is allocated	Community	Planners + Authorities	
IMPROVE ECONOMIC CONDITIONS	- Develop new opportunities for employment and strategies for strengthening the community organisation	Community	Community	

ACTUAL CONDITIONS

COMPONENT	WHAT	PROBLEM
FOUNDATION	- Cement concrete and 1st. class brick work	- Expensive - Poor construction - Non existent (in some cases)
WALLS	- Brick work in mud mortar - Brick work in cement mortar	- Weak mortar mix - Expensive
ROOF	- Thatch - ACC sheet with wooden understructure - Stone slab with steel understructure	- Yearly maintenance required - Not water resistance - Fire prone - Very brittle - Poor thermal properties - Expensive
FLOOR	- Cement concrete - Mud paved	- Expensive - Manintenance problem

PROPOSALS

COMPONENT	WHAT	ADVANTAGE	HOW	GRAPH												
FOUNDATION	- Lime concrete (prefabricated Plinths and wall foundations) - random rubble	- Strong - Relatively cheap - faster assembling - possibilities of prefabrication	APPROPRIATE AFFODABLE CONSTRUCTION TECHNOLOGY	<table><caption>M2 construction Cost Data (Estimated from Graph)</caption><tr><th>System</th><th>Cost (Rupees)</th></tr><tr><td>Residential Construction System</td><td>~1000</td></tr><tr><td>Resettlement System</td><td>~1500</td></tr><tr><td>Proposed System</td><td>~2000</td></tr><tr><td>Construction System</td><td>~2500</td></tr><tr><td>Minimum Monthly Income</td><td>~3000</td></tr></table>	System	Cost (Rupees)	Residential Construction System	~1000	Resettlement System	~1500	Proposed System	~2000	Construction System	~2500	Minimum Monthly Income	~3000
System	Cost (Rupees)															
Residential Construction System	~1000															
Resettlement System	~1500															
Proposed System	~2000															
Construction System	~2500															
Minimum Monthly Income	~3000															
WALLS	- 2nd. Class brick - Prefabricated timber (roof trusses)	- Relatively cheap - easy to manufacture locally (prefabricated) - faster assembling														
ROOF	- Improved thatch with bitumen - Timber structure	- Improved life - Water proof - faster assembling - possibilities of prefabrication - Provides thermal inertia - cheap														
FLOOR	- Lime concrete	- Relatively cheap														

PROPOSALS

WHAT

WHY

HOW

APPROPRIATE
AFFORDABLE
CONSTRUCTION
TECHNOLOGY

- Easy access to local materials at low prices

- To generate processes to initiate and strengthen the local economy

- Eliminate dependency on normal providers of materials, and expensive qualified labour

° BANK OF MATERIALS
Tools and Machinery

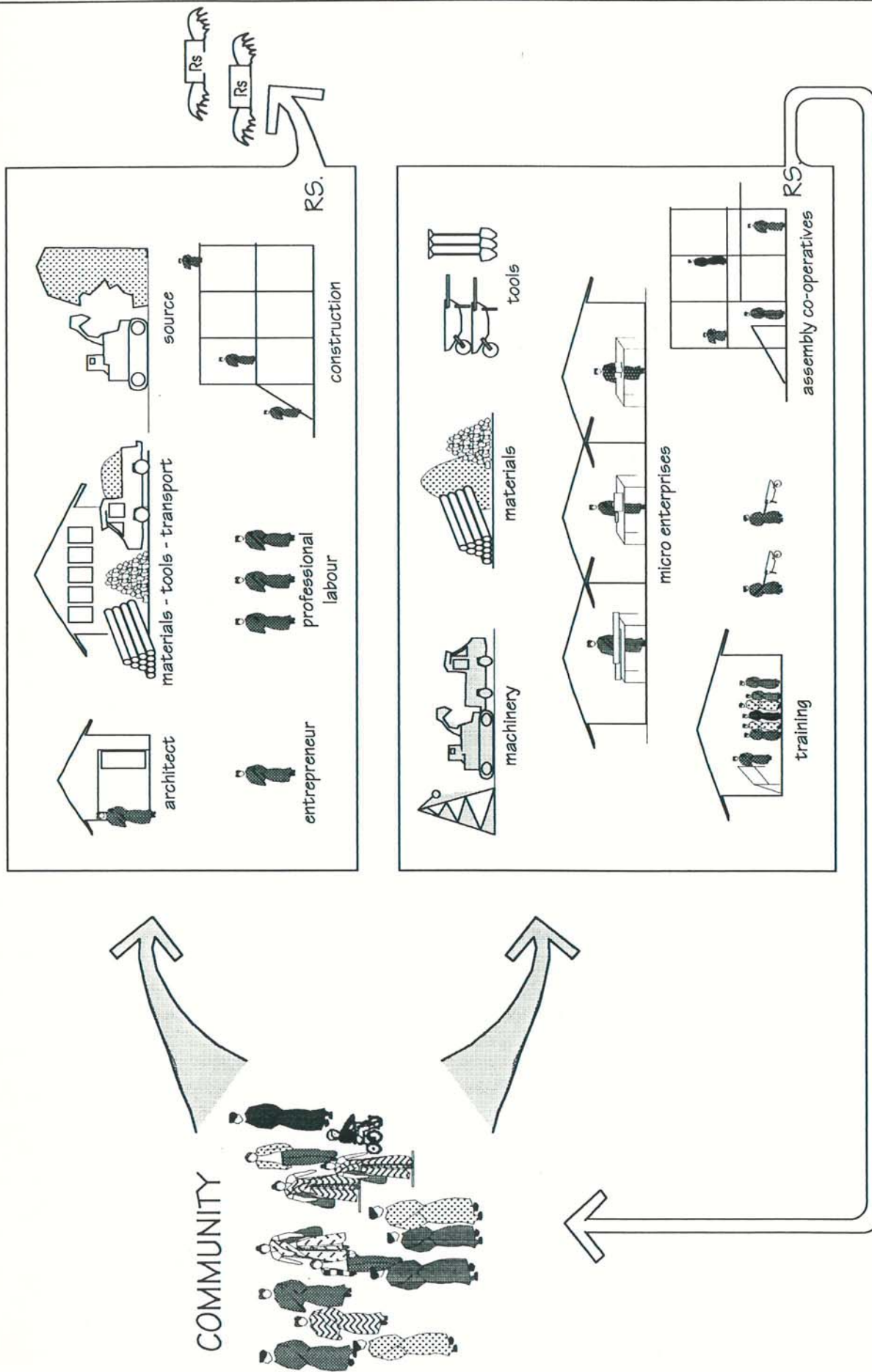
° MICRO - ENTERPRISES
Fabrication of components

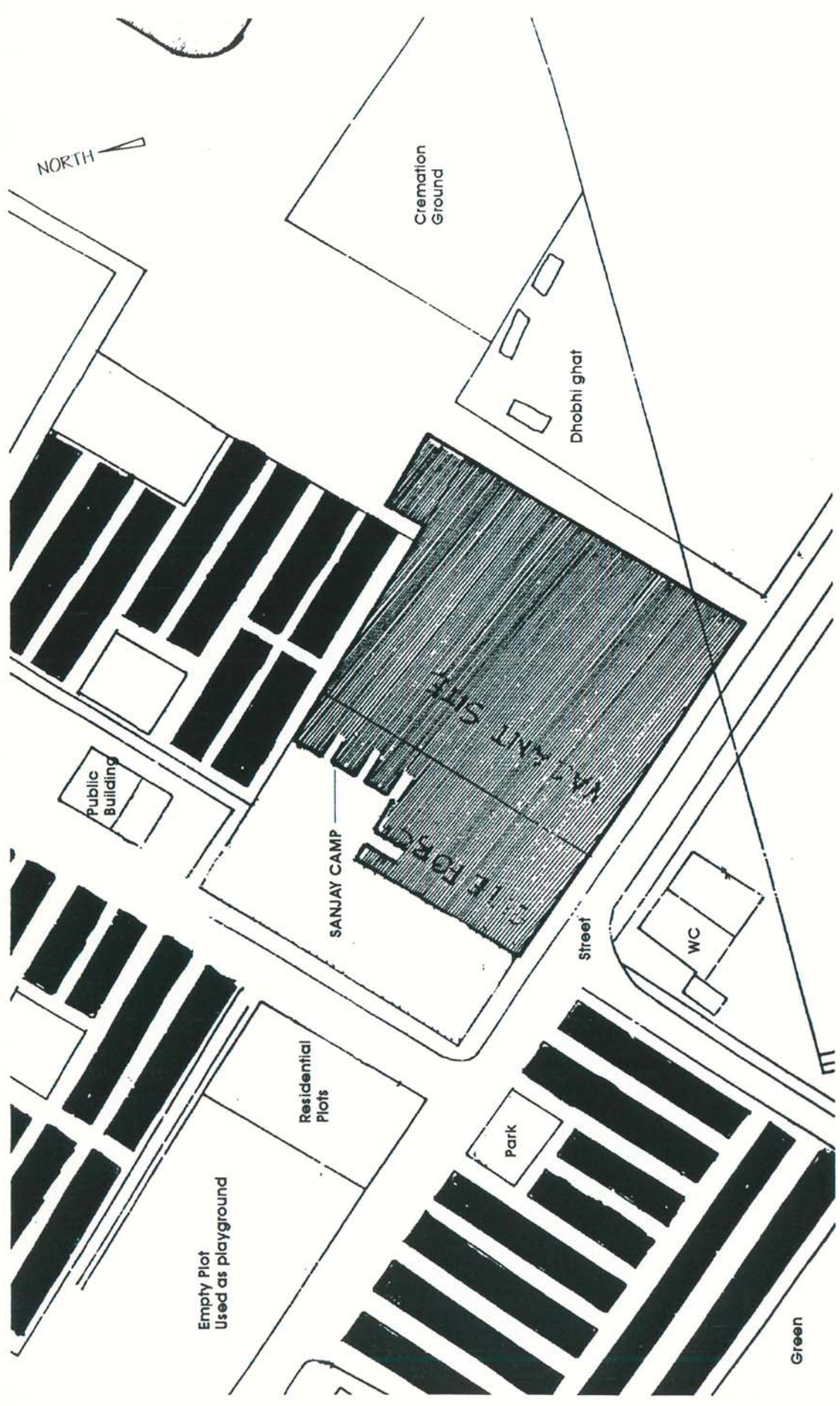
° ASSEMBLY CO-OPERATIVES
Self-help methods for construction

° TRAINING CENTRE
For management and building skills

PROPOSALS

WHAT	WHY	HOW	ACTORS
BANK OF MATERIALS	- Exclude the formal provider sector - Save money	- Purchase materials in large quantities directly at source - Storage and distribution of materials - Credits system (for materials) Rentals (for tools + machinery)	- International agencies (World Bank) - NGO's - Local Govt.
COMMUNITY MICRO - ENTERPRISES	- To generate income and employment	- Pre-fabrication of components for the construction system - Infrastructural system (drainage, pavements)	- Local NGO's - CBO's - Local Govt.
SELF HELP COOPERATIVE	- Speed of construction - Income generation - Improve construction process	- Organise brigades for assembling houses + general installations - Coordination between trained labour + available community labour	- Local CBO's - Local NGO's - Local Public Institution - Community
TRAINING CENTRE	- Avoid costly dependency on professionals - Education	- Workshops in: - Management - Plumbing - Electricity - Masonry - Carpentry - Assembly	- Local NGO's - DA - Community - Local University



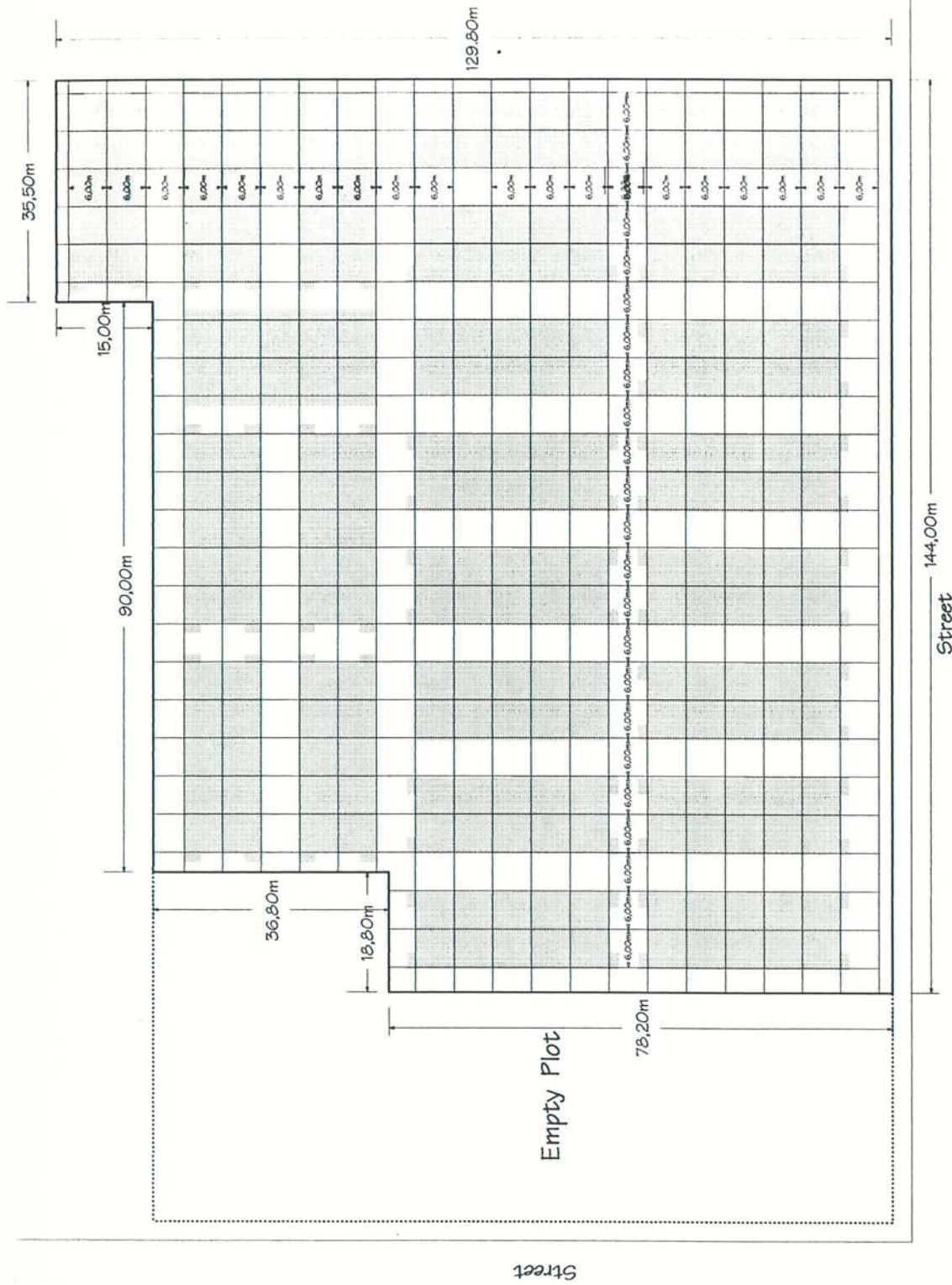


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EXISTING AREA

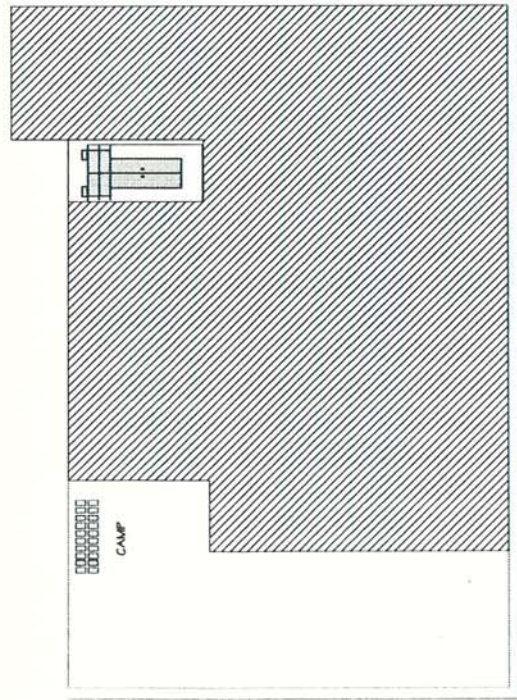
Improving Housing Through Community Self-Sufficiency
DAKSHINPURI - DELHI - INDIA

NORTH

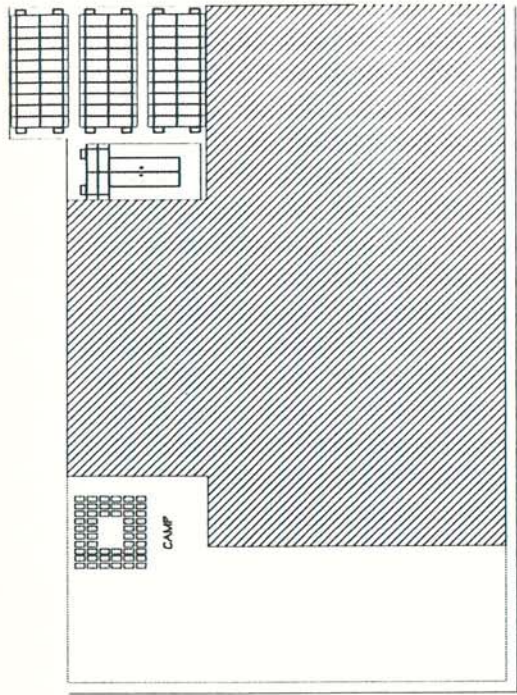


PLOT & GRID

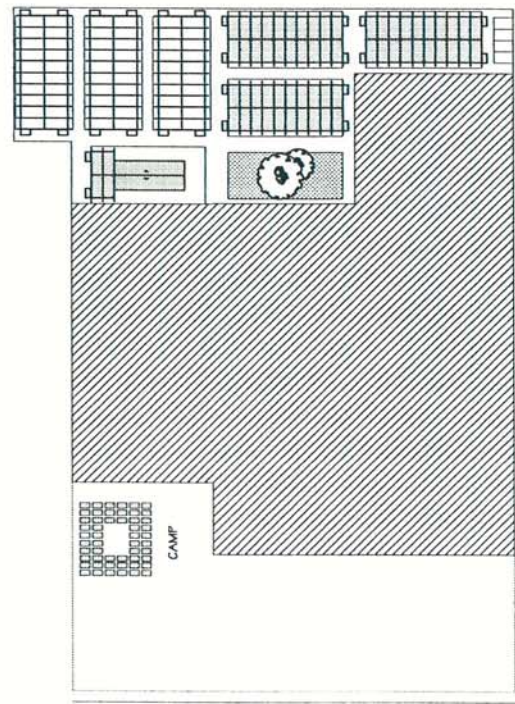
Improving Housing Through Community Self-Sufficiency
DAKSHINPURI - DELHI - INDIA



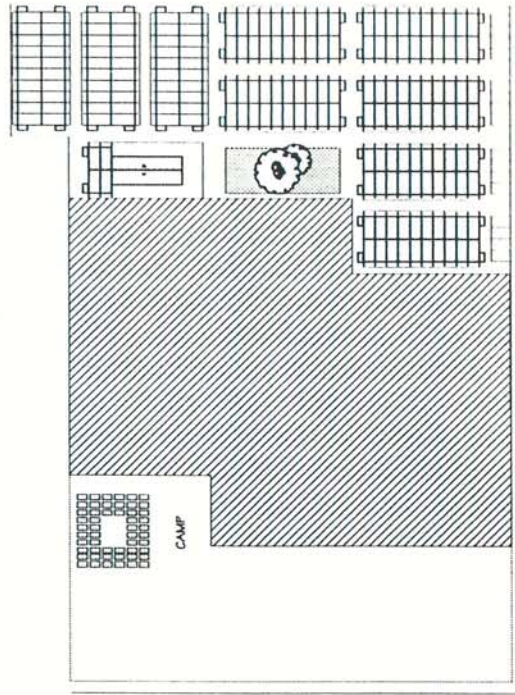
STAGE 1



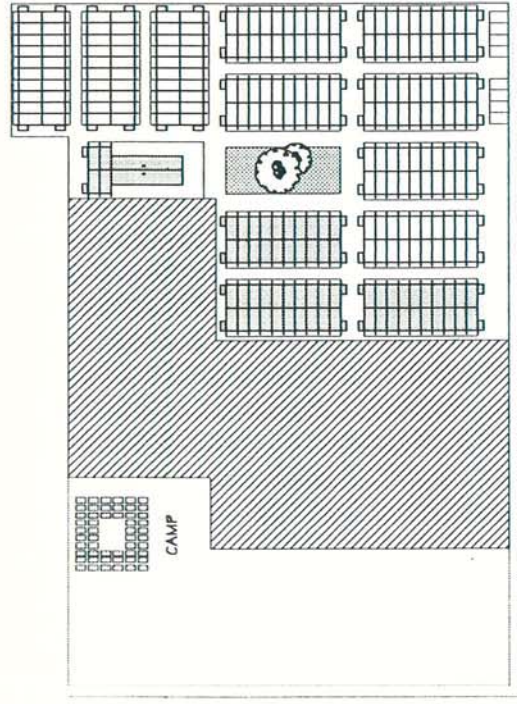
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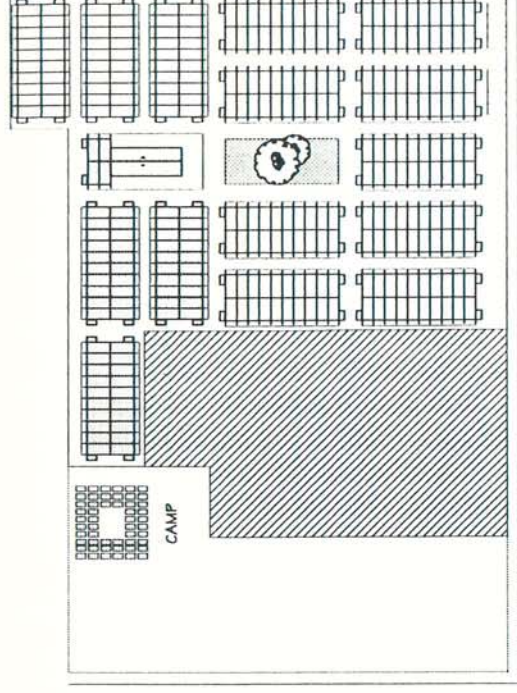
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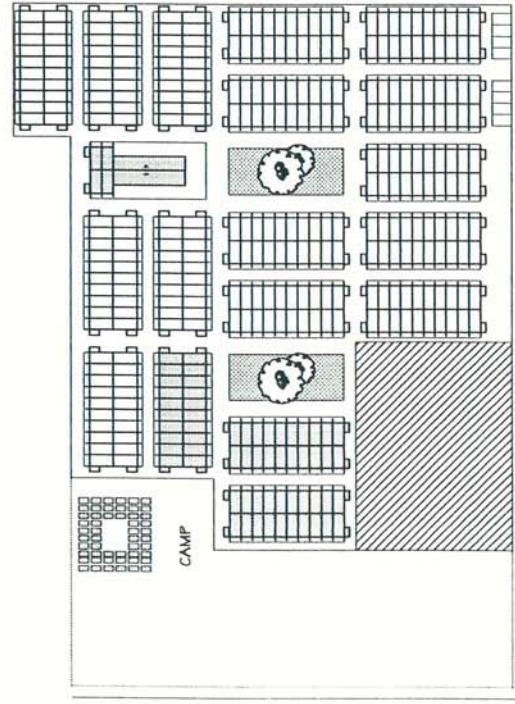
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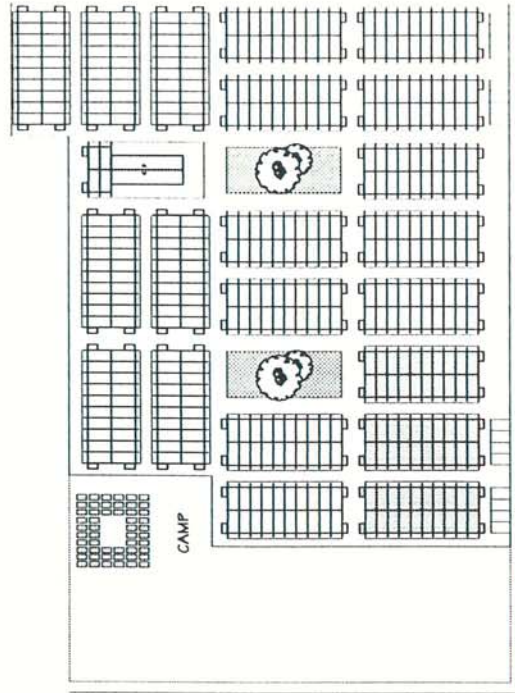
STAGE 5



STAGE 6



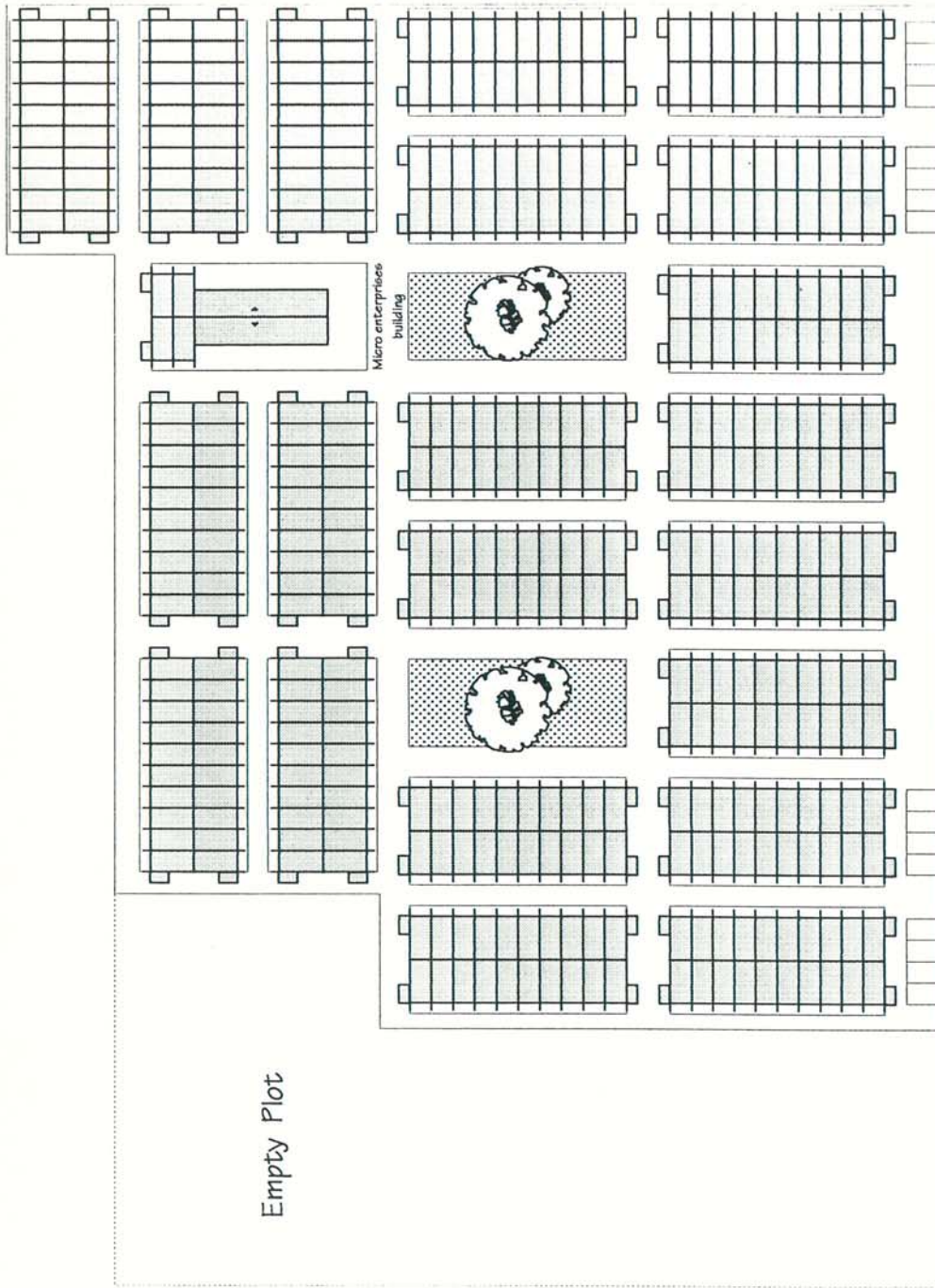
STAGE 7



STAGE 8

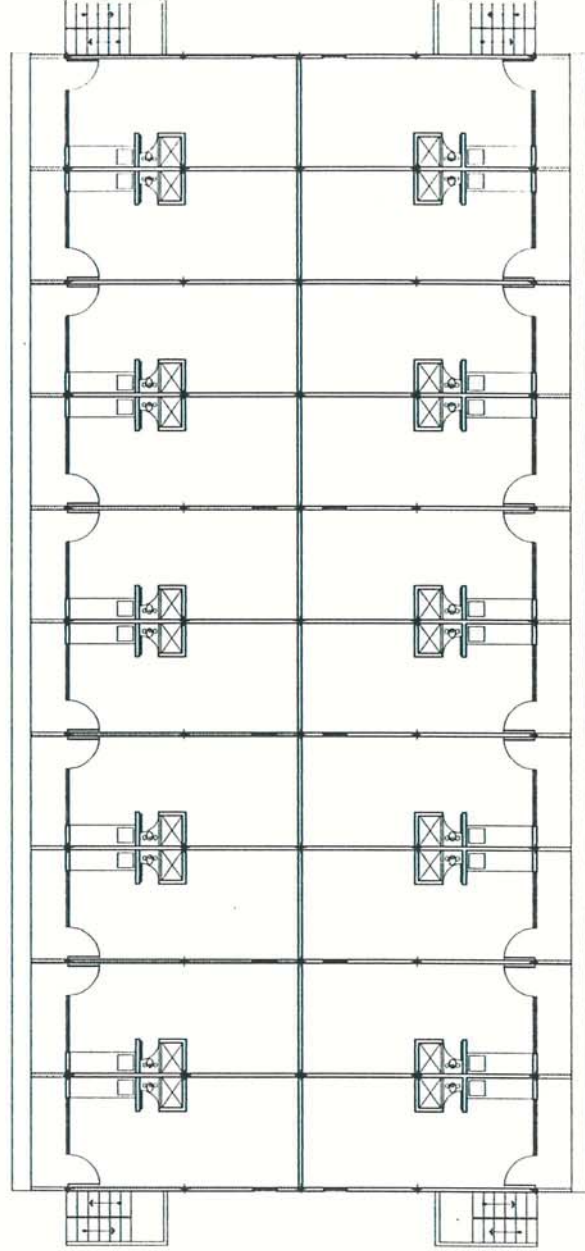


NORTH

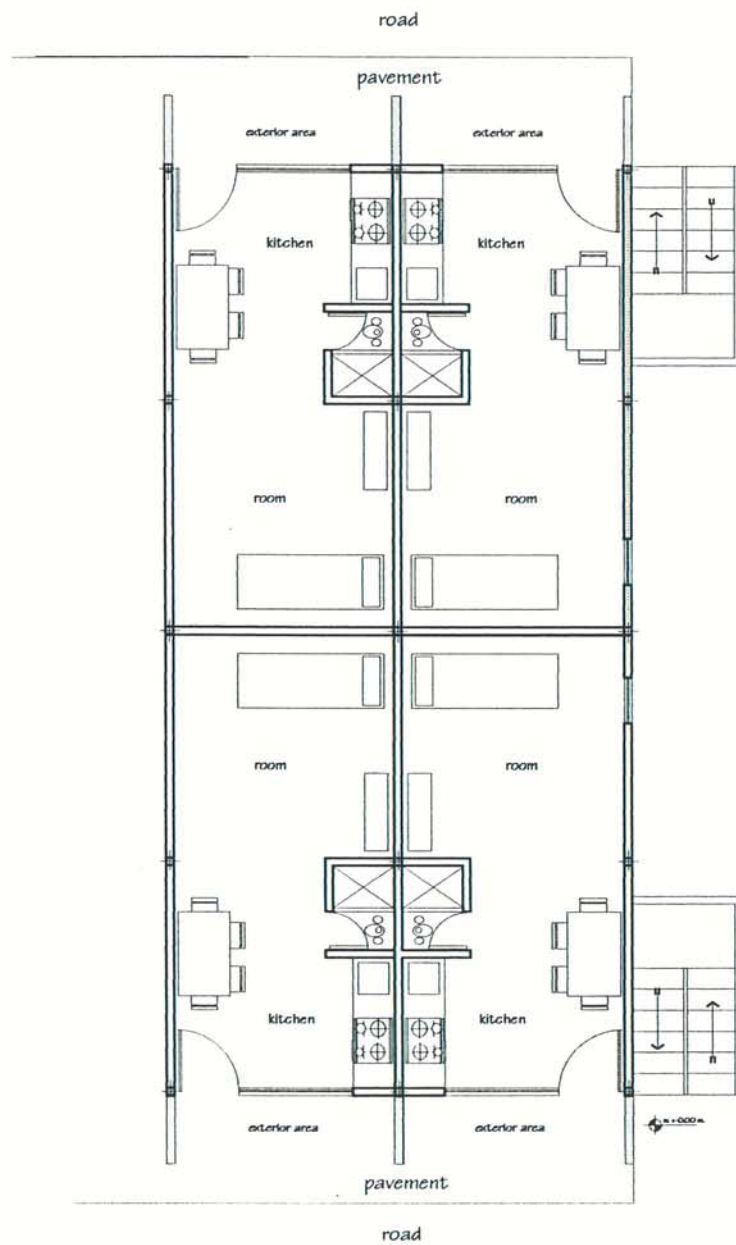


LOCATION PLAN

Improving Housing Through Community Self-Sufficiency
DAKSHINPURI - DELHI - INDIA

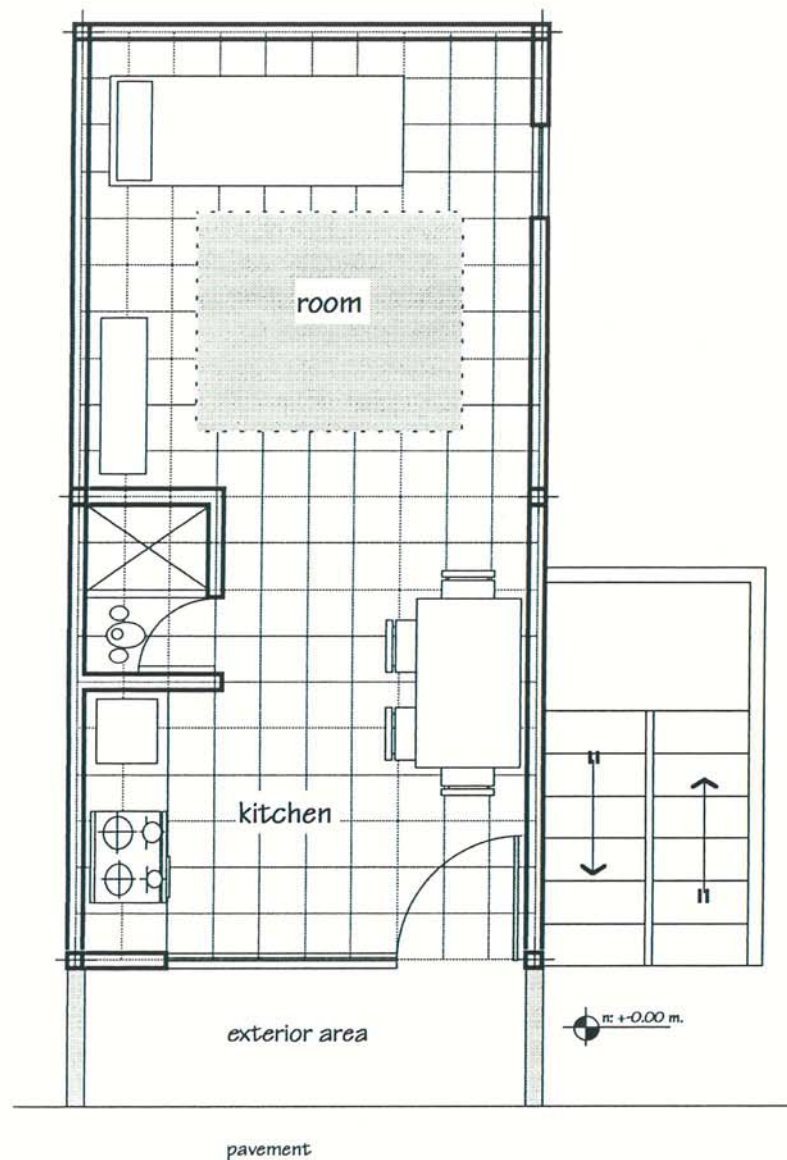


TYPICAL BLOCK



GROUND FLOOR PLAN

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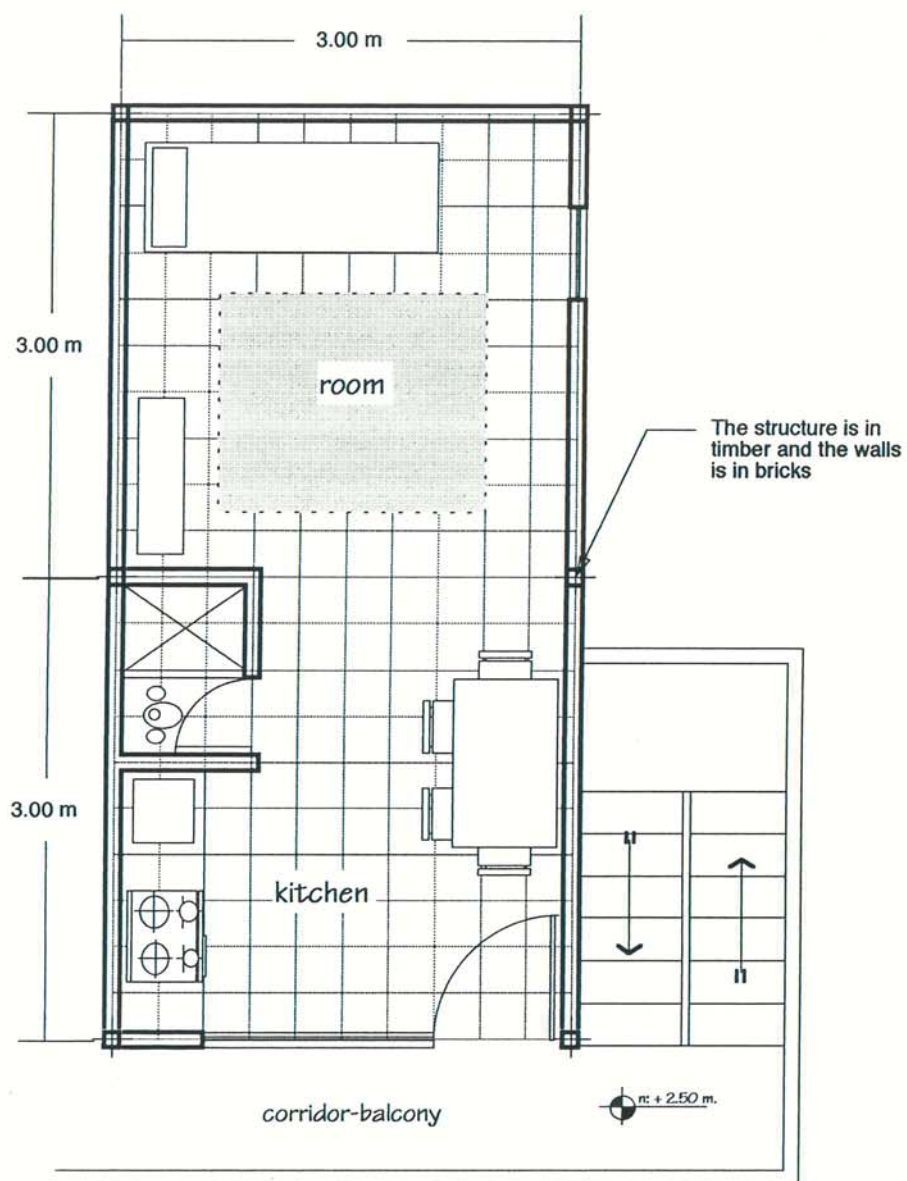
Detailed layout of one dwelling

Area house : 18.00 m²

Exterior ar. : 2,70 m²

TOTAL : 20.70 m²

**Improving Housing Through Community Self-Sufficiency
DAKSHINPURI - DELHI - INDIA**



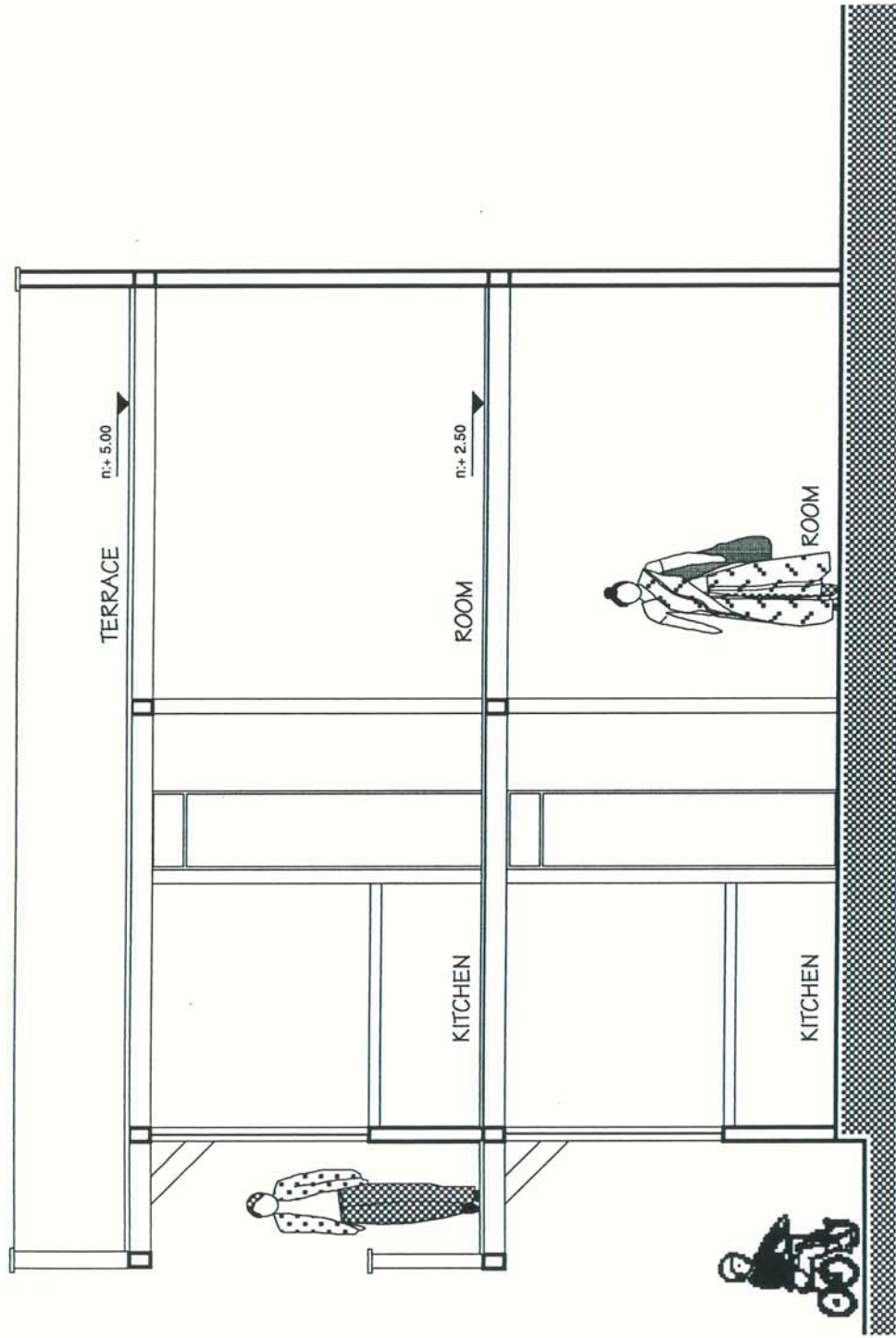
FIRST FLOOR PLAN

Area house : 18.00 m²

Balcony : 2.70 m²

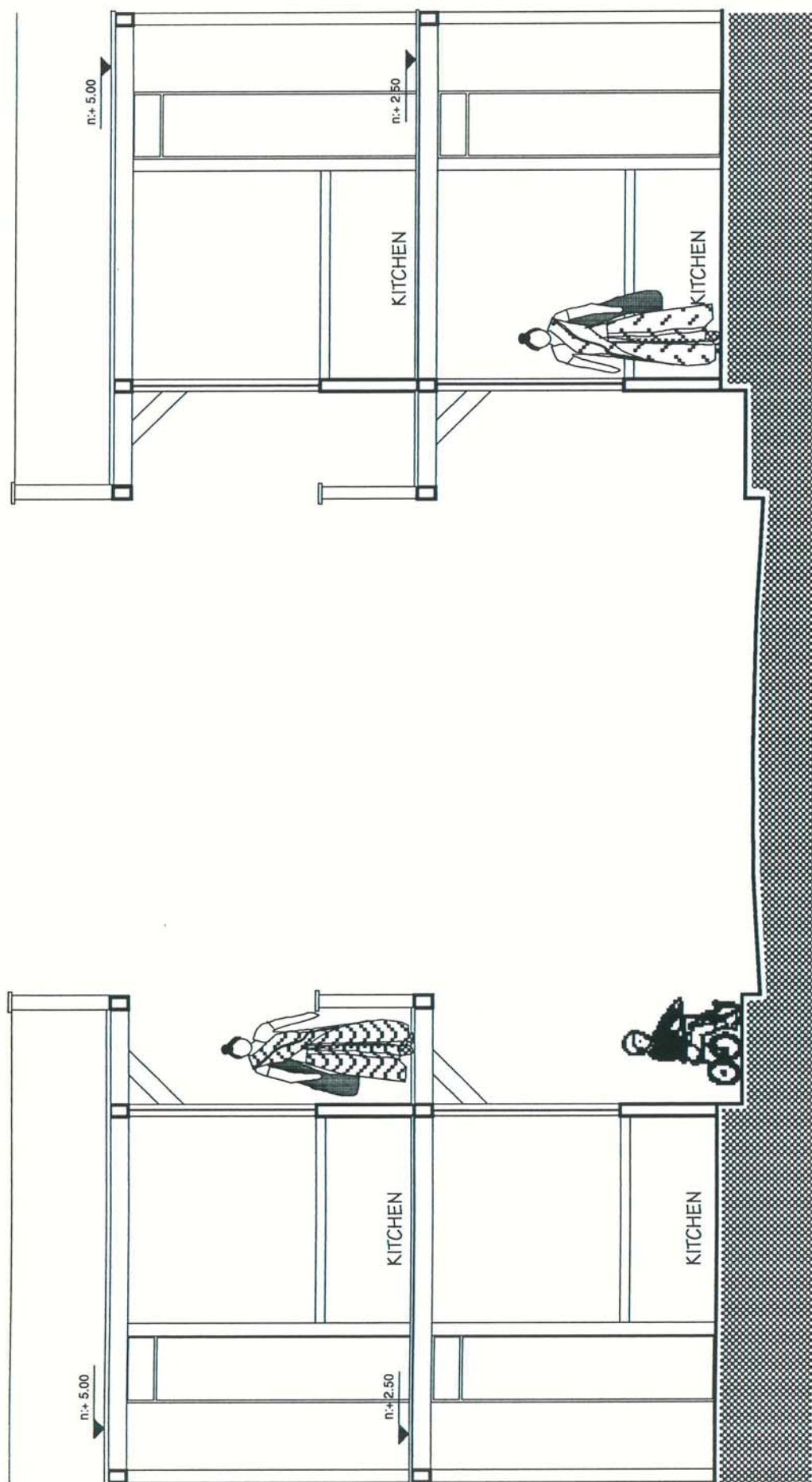
TOTAL : 20.70 m²

Improving Housing Through Community Self-Sufficiency
DAKSHINPURI - DELHI - INDIA



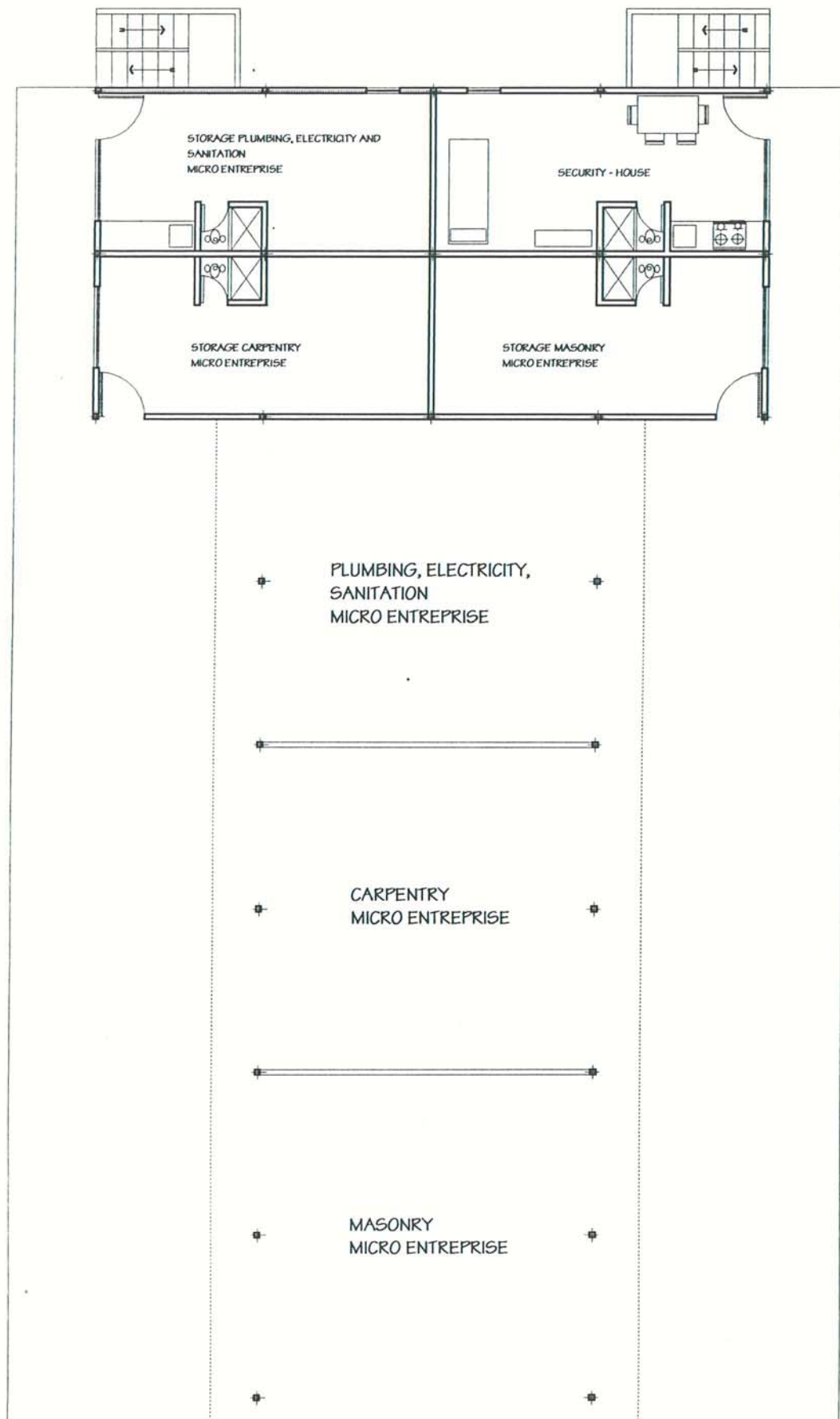
CROSS SECTION

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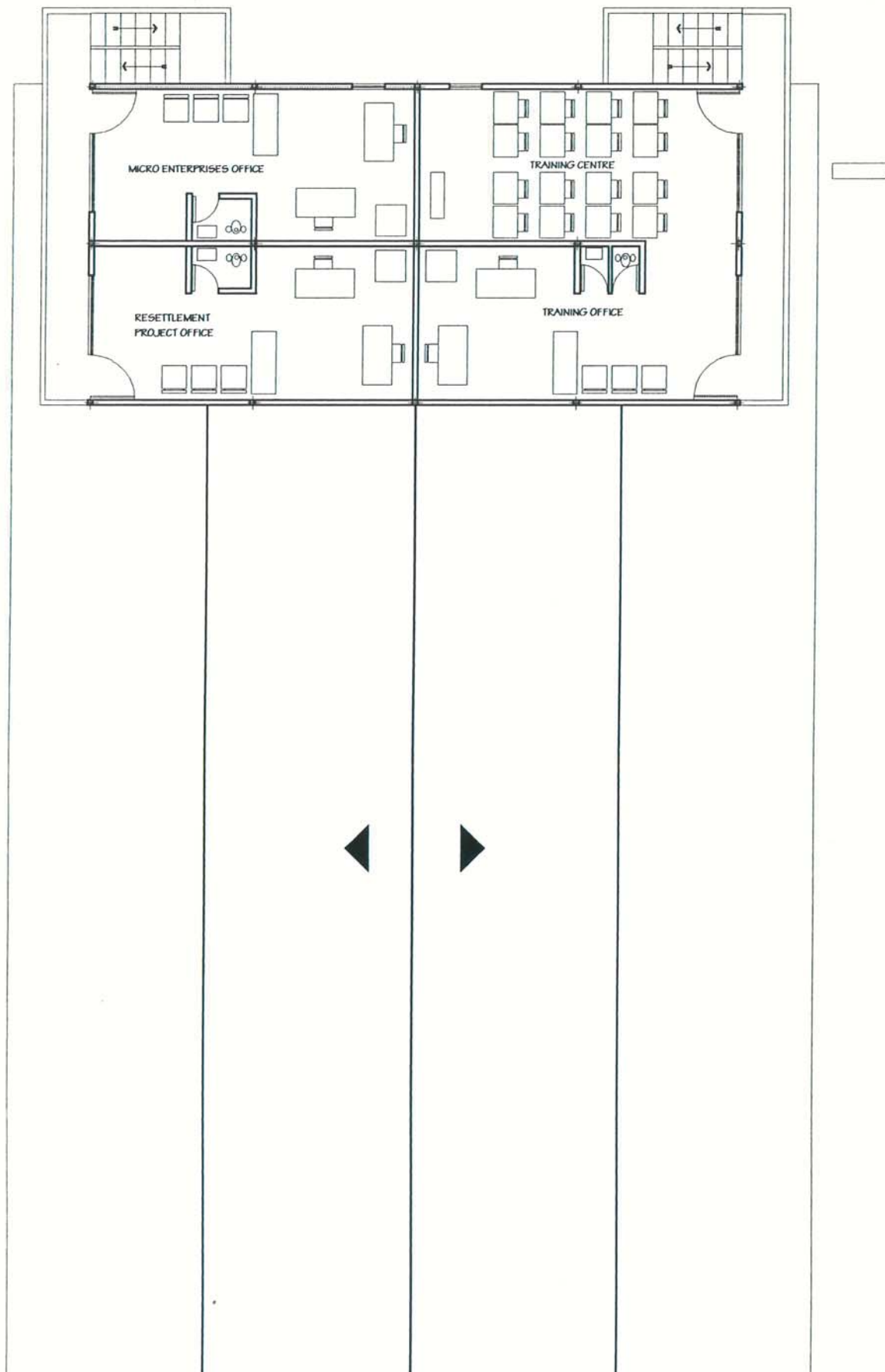


STREET CROSS SECTION

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MICRO ENTERPRISES BUILDING
GROUND FLOOR PLAN



MICRO ENTERPRISES BUILDING
FIRST FLOOR PLAN

**Improving Housing Through Community Self-Sufficiency
DAKSHINPURI - DELHI- INDIA**

Improving Housing	Technology Timber - Brick	Building: Typical - House
Dakshinpuri - Delhi - India	Date: February - 94	Pound = Rs. 45.00

Items/Description		Shell		Finishes		Totals	
		Rupees	Pounds	Rupees	Pounds	Rupees	Pounds
01	Foundations	925.00	20.56	0.00	0.00	925.00	20.56
02	Structure	4,589.00	101.98	0.00	0.00	4,589.00	101.98
03	Walls	2,237.00	49.71	1,204.00	26.76	3,441.00	76.47
04	Floors	2,581.00	57.36	860.00	19.11	3,441.00	76.47
05	Roofs	3,213.00	71.40	0.00	0.00	3,213.00	71.40
06	Doors & Windows	0.00	0.00	2,754.00	61.20	2,754.00	61.20
07	Basin, latches	0.00	0.00	918.00	20.40	918.00	20.40
08	Fixed units	0.00	0.00	688.00	15.29	688.00	15.29
09	Sanitary Installations	206.00	4.58	481.00	10.69	687.00	15.27
10	Plumbing Installations	296.00	6.58	392.00	8.71	688.00	15.29
11	Electrical Installations	305.00	6.78	1,301.00	28.91	1,606.00	35.69
Total		14,352.00	318.93	8,598.00	191.07	22,950.00	510.00

TOTAL GENERAL	22,950.00 510.00

Improving Housing Through Community Self-Sufficiency

Pound = Rs. 45.00

DAKSHINPURI - DELHI - INDIA

	Costs		Totals	
	Rupees	Pounds	Rupees	Pounds
COSTS FOR ONE STAGE				
Costs for one House	22,950.00	510.00		
Costs for one Block (40 Houses)	918,000.00	20,400.00		
Costs for one Stage (3 Blocks, 120 Houses)	2,754,000.00	61,200.00		
Costs for infrastructure (Streets, Water and Sanitation, Electricity, 29%)	798,660.00	17,748.00	3,552,660.00	78,948.00
COSTS FOR TOTAL BLOCKS (21)				
Costs for one Block	918,000.00	20,400.00		
Costs for 21 Blocks	19,278,000.00	428,400.00		
Costs for infrastructure (29%)	5,590,620.00	124,236.00	24,868,620.00	552,636.00
COSTS FOR MICRO ENTERPRISES (production for one Stage at a time)				
Costs for building	263,565.00	5,857.00		
Costs for equipment	547,470.00	12,166.00		
Costs for Labour (one month)	31,995.00	711.00	843,030.00	18,734.00
COSTS FOR SELF-HELP CO-OPERATIVE (production for one Stage at a time)				
Costs for tools (2.5 % costs of one stage)	68,850.00	1,530.00		
Costs for Skilled Labour (four months)	207,000.00	4,600.00	275,850.00	6,130.00
Total for one Stage			4,671,540.00	103,812.00
Cost of the total project			25,987,500.00	577,500.00

Improving Housing Through Community Self-Sufficiency

DAKSHINPURI-DELHI-INDIA

Cost recovery for one household (Rupees)

Year	Month	Cost of dwelling	interest 10%	Cost after interest	Payments	Closing balance
1	1	22,950.00	191.17	23,141.17	250.00	22,891.17
	2	22,891.17	190.68	23,081.86	250.00	22,831.86
	3	22,831.86	190.19	23,022.05	250.00	22,772.05
	4	22,772.05	189.69	22,961.74	250.00	22,711.74
	5	22,711.74	189.19	22,900.93	250.00	22,650.93
	6	22,650.93	188.68	22,839.61	250.00	22,589.61
	7	22,589.61	188.17	22,777.78	250.00	22,527.78
	8	22,527.78	187.66	22,715.44	250.00	22,465.44
	9	22,465.44	187.14	22,652.57	250.00	22,402.57
	10	22,402.57	186.61	22,589.19	250.00	22,339.19
	11	22,339.19	186.09	22,525.27	250.00	22,275.27
	12	22,275.27	185.55	22,460.83	250.00	22,210.83
2	13	22,210.83	185.02	22,395.84	250.00	22,145.84
	14	22,145.84	184.47	22,330.32	250.00	22,080.32
	15	22,080.32	183.93	22,264.25	250.00	22,014.25
	16	22,014.25	183.38	22,197.62	250.00	21,947.62
	17	21,947.62	182.82	22,130.45	250.00	21,880.45
	18	21,880.45	182.26	22,062.71	250.00	21,812.71
	19	21,812.71	181.70	21,994.41	250.00	21,744.41
	20	21,744.41	181.13	21,925.54	250.00	21,675.54
	21	21,675.54	180.56	21,856.10	250.00	21,606.10
	22	21,606.10	179.98	21,786.08	250.00	21,536.08
	23	21,536.08	179.40	21,715.47	250.00	21,465.47
	24	21,465.47	178.81	21,644.28	250.00	21,394.28
3	25	21,394.28	178.21	21,572.50	250.00	21,322.50
	26	21,322.50	177.62	21,500.11	250.00	21,250.11
	27	21,250.11	177.01	21,427.13	250.00	21,177.13
	28	21,177.13	176.41	21,353.53	250.00	21,103.53
	29	21,103.53	175.79	21,279.32	250.00	21,029.32
	30	21,029.32	175.17	21,204.50	250.00	20,954.50
	31	20,954.50	174.55	21,129.05	250.00	20,879.05
	32	20,879.05	173.92	21,052.97	250.00	20,802.97
	33	20,802.97	173.29	20,976.26	250.00	20,726.26
	34	20,726.26	172.65	20,898.91	250.00	20,648.91
	35	20,648.91	172.01	20,820.92	250.00	20,570.92
	36	20,570.92	171.36	20,742.27	250.00	20,492.27
4	37	20,492.27	170.70	20,662.97	250.00	20,412.97
	38	20,412.97	170.04	20,583.01	250.00	20,333.01
	39	20,333.01	169.37	20,502.39	250.00	20,252.39
	40	20,252.39	168.70	20,421.09	250.00	20,171.09
	41	20,171.09	168.03	20,339.11	250.00	20,089.11
	42	20,089.11	167.34	20,256.46	250.00	20,006.46
	43	20,006.46	166.65	20,173.11	250.00	19,923.11
	44	19,923.11	165.96	20,089.07	250.00	19,839.07
	45	19,839.07	165.26	20,004.33	250.00	19,754.33
	46	19,754.33	164.55	19,918.88	250.00	19,668.88
	47	19,668.88	163.84	19,832.72	250.00	19,582.72
	48	19,582.72	163.12	19,745.85	250.00	19,495.85
5	49	19,495.85	162.40	19,658.25	250.00	19,408.25
	50	19,408.25	161.67	19,569.92	250.00	19,319.92
	51	19,319.92	160.93	19,480.85	250.00	19,230.85
	52	19,230.85	160.19	19,391.05	250.00	19,141.05
	53	19,141.05	159.44	19,300.49	250.00	19,050.49

	54	19,050.49	158.69	19,209.18	250.00	18,959.18
	55	18,959.18	157.93	19,117.11	250.00	18,867.11
	56	18,867.11	157.16	19,024.28	250.00	18,774.28
	57	18,774.28	156.39	18,930.67	250.00	18,680.67
	58	18,680.67	155.61	18,836.28	250.00	18,586.28
	59	18,586.28	154.82	18,741.10	250.00	18,491.10
	60	18,491.10	154.03	18,645.13	250.00	18,395.13
6	61	18,395.13	153.23	18,548.36	250.00	18,298.36
	62	18,298.36	152.43	18,450.79	250.00	18,200.79
	63	18,200.79	151.61	18,352.40	250.00	18,102.40
	64	18,102.40	150.79	18,253.19	250.00	18,003.19
	65	18,003.19	149.97	18,153.16	250.00	17,903.16
	66	17,903.16	149.13	18,052.29	250.00	17,802.29
	67	17,802.29	148.29	17,950.58	250.00	17,700.58
	68	17,700.58	147.45	17,848.03	250.00	17,598.03
	69	17,598.03	146.59	17,744.62	250.00	17,494.62
	70	17,494.62	145.73	17,640.35	250.00	17,390.35
	71	17,390.35	144.86	17,535.21	250.00	17,285.21
	72	17,285.21	143.99	17,429.20	250.00	17,179.20
7	73	17,179.20	143.10	17,322.30	250.00	17,072.30
	74	17,072.30	142.21	17,214.52	250.00	16,964.52
	75	16,964.52	141.31	17,105.83	250.00	16,855.83
	76	16,855.83	140.41	16,996.24	250.00	16,746.24
	77	16,746.24	139.50	16,885.73	250.00	16,635.73
	78	16,635.73	138.58	16,774.31	250.00	16,524.31
	79	16,524.31	137.65	16,661.96	250.00	16,411.96
	80	16,411.96	136.71	16,548.67	250.00	16,298.67
	81	16,298.67	135.77	16,434.44	250.00	16,184.44
	82	16,184.44	134.82	16,319.25	250.00	16,069.25
	83	16,069.25	133.86	16,203.11	250.00	15,953.11
	84	15,953.11	132.89	16,086.00	250.00	15,836.00
8	85	15,836.00	131.91	15,967.91	250.00	15,717.91
	86	15,717.91	130.93	15,848.84	250.00	15,598.84
	87	15,598.84	129.94	15,728.78	250.00	15,478.78
	88	15,478.78	128.94	15,607.72	250.00	15,357.72
	89	15,357.72	127.93	15,485.65	250.00	15,235.65
	90	15,235.65	126.91	15,362.56	250.00	15,112.56
	91	15,112.56	125.89	15,238.45	250.00	14,988.45
	92	14,988.45	124.85	15,113.31	250.00	14,863.31
	93	14,863.31	123.81	14,987.12	250.00	14,737.12
	94	14,737.12	122.76	14,859.88	250.00	14,609.88
	95	14,609.88	121.70	14,731.58	250.00	14,481.58
	96	14,481.58	120.63	14,602.21	250.00	14,352.21
9	97	14,352.21	119.55	14,471.76	250.00	14,221.76
	98	14,221.76	118.47	14,340.23	250.00	14,090.23
	99	14,090.23	117.37	14,207.60	250.00	13,957.60
	100	13,957.60	116.27	14,073.87	250.00	13,823.87
	101	13,823.87	115.15	13,939.02	250.00	13,689.02
	102	13,689.02	114.03	13,803.05	250.00	13,553.05
	103	13,553.05	112.90	13,665.95	250.00	13,415.95
	104	13,415.95	111.75	13,527.70	250.00	13,277.70
	105	13,277.70	110.60	13,388.31	250.00	13,138.31
	106	13,138.31	109.44	13,247.75	250.00	12,997.75
	107	12,997.75	108.27	13,106.02	250.00	12,856.02
	108	12,856.02	107.09	12,963.11	250.00	12,713.11
10	109	12,713.11	105.90	12,819.01	250.00	12,569.01
	110	12,569.01	104.70	12,673.71	250.00	12,423.71
	111	12,423.71	103.49	12,527.20	250.00	12,277.20
	112	12,277.20	102.27	12,379.47	250.00	12,129.47
	113	12,129.47	101.04	12,230.51	250.00	11,980.51
	114	11,980.51	99.80	12,080.30	250.00	11,830.30
	115	11,830.30	98.55	11,928.85	250.00	11,678.85
	116	11,678.85	97.28	11,776.14	250.00	11,526.14
	117	11,526.14	96.01	11,622.15	250.00	11,372.15

	118	11,372.15	94.73	11,466.88	250.00	11,216.88
	119	11,216.88	93.44	11,310.31	250.00	11,060.31
	120	11,060.31	92.13	11,152.45	250.00	10,902.45
11	121	10,902.45	90.82	10,993.26	250.00	10,743.26
	122	10,743.26	89.49	10,832.76	250.00	10,582.76
	123	10,582.76	88.15	10,670.91	250.00	10,420.91
	124	10,420.91	86.81	10,507.72	250.00	10,257.72
	125	10,257.72	85.45	10,343.16	250.00	10,093.16
	126	10,093.16	84.08	10,177.24	250.00	9,927.24
	127	9,927.24	82.69	10,009.93	250.00	9,759.93
	128	9,759.93	81.30	9,841.23	250.00	9,591.23
	129	9,591.23	79.89	9,671.13	250.00	9,421.13
	130	9,421.13	78.48	9,499.61	250.00	9,249.61
	131	9,249.61	77.05	9,326.66	250.00	9,076.66
	132	9,076.66	75.61	9,152.26	250.00	8,902.26
12	133	8,902.26	74.16	8,976.42	250.00	8,726.42
	134	8,726.42	72.69	8,799.11	250.00	8,549.11
	135	8,549.11	71.21	8,620.33	250.00	8,370.33
	136	8,370.33	69.72	8,440.05	250.00	8,190.05
	137	8,190.05	68.22	8,258.27	250.00	8,008.27
	138	8,008.27	66.71	8,074.98	250.00	7,824.98
	139	7,824.98	65.18	7,890.16	250.00	7,640.16
	140	7,640.16	63.64	7,703.81	250.00	7,453.81
	141	7,453.81	62.09	7,515.90	250.00	7,265.90
	142	7,265.90	60.52	7,326.42	250.00	7,076.42
	143	7,076.42	58.95	7,135.37	250.00	6,885.37
	144	6,885.37	57.36	6,942.72	250.00	6,692.72
13	145	6,692.72	55.75	6,748.47	250.00	6,498.47
	146	6,498.47	54.13	6,552.61	250.00	6,302.61
	147	6,302.61	52.50	6,355.11	250.00	6,105.11
	148	6,105.11	50.86	6,155.96	250.00	5,905.96
	149	5,905.96	49.20	5,955.16	250.00	5,705.16
	150	5,705.16	47.52	5,752.68	250.00	5,502.68
	151	5,502.68	45.84	5,548.52	250.00	5,298.52
	152	5,298.52	44.14	5,342.66	250.00	5,092.66
	153	5,092.66	42.42	5,135.08	250.00	4,885.08
	154	4,885.08	40.69	4,925.77	250.00	4,675.77
	155	4,675.77	38.95	4,714.72	250.00	4,464.72
	156	4,464.72	37.19	4,501.91	250.00	4,251.91
14	157	4,251.91	35.42	4,287.33	250.00	4,037.33
	158	4,037.33	33.63	4,070.96	250.00	3,820.96
	159	3,820.96	31.83	3,852.79	250.00	3,602.79
	160	3,602.79	30.01	3,632.80	250.00	3,382.80
	161	3,382.80	28.18	3,410.98	250.00	3,160.98
	162	3,160.98	26.33	3,187.31	250.00	2,937.31
	163	2,937.31	24.47	2,961.78	250.00	2,711.78
	164	2,711.78	22.59	2,734.37	250.00	2,484.37
	165	2,484.37	20.69	2,505.06	250.00	2,255.06
	166	2,255.06	18.78	2,273.85	250.00	2,023.85
	167	2,023.85	16.86	2,040.71	250.00	1,790.71
	168	1,790.71	14.92	1,805.62	250.00	1,555.62
15	169	1,555.62	12.96	1,568.58	250.00	1,318.58
	170	1,318.58	10.98	1,329.56	250.00	1,079.56
	171	1,079.56	8.99	1,088.56	250.00	838.56
	172	838.56	6.99	845.54	250.00	595.54
	173	595.54	4.96	600.50	250.00	350.50
	174	350.50	2.92	353.42	250.00	103.42
	175	103.42	0.86	104.28	104.28	0.00

A GENERAL GUIDE TO THE MANUFACTURE AND USAGE OF BUILDING MATERIALS IN THE DEVELOPING WORLD

As an integral part of the Dakshinpuri Redevelopment Housing project, much emphasis has been placed on the establishment of micro-enterprises within the redevelopment area.

The production of building materials accounts for nearly two thirds of the total cost of building and is therefore a significant factor.

In this, a basic guide, some of the more important constructional elements have been examined, with respect to each of the following aspects :

Raw materials - local materials should be used to maximum extent possible.

Equipment - should be as inexpensive as possible.

Technique - should be simple but effective.

The advantages and disadvantages of each element have also been considered, concentrating on performance characteristics, availability and cost comparisons. In some areas attention has been made to design, in the hope to tie in some or all of the structural elements. As an old saying clearly demonstrates "All cob (soil) wants is a good hat and a good pair of shoes", that is to say, it is no good having structurally sound walls, if your roof or foundations are insufficient.

The ultimate aim of the guide is to bring about an awareness as to what options are available, when considering materials and techniques, to developing countries, on an appropriate scale.

BRICK TECHNOLOGIES

Alternative forms of building materials

Most third world housing needs are met by a mixture of

- plastered soil
- water
- wooden laths for reinforcement
- acquired man-made materials

These methods of construction are most appropriate due to the availability of excess labour and widespread variety of suitable soils. However they have a low durability and require frequent maintenance and rebuilding. They are also structurally weak and unable to support heavy roofs or multistories.

Consequently a number of other materials have come to dominate construction in developing countries.

These include - bricks

- cement
- cement blocks
- soil-cement blocks
- stone blocks
- acquired man-made materials

Generally well produced bricks are more durable than traditional materials and are an inherently cheaper form of construction than cement blocks. Given their regular shape they are also readily transportable and attractive to the eye.

BRICK-MAKING TECHNOLOGIES

five major stages.

1. THE WINNING AND TRANSPORTING OF CLAY TO SITE

Winning - clay dug from ground.

- soil harder at lower depths therefore process likely to be extensive rather than deep.
- labourers use tools such as spades or heavy earth moving equipment.

Transporting - Extent dependent on locale of the brickwork's.

- Modes include wheelbarrows, oxcarts or motorised vehicles.

2. THE MIXING OF CLAY

The mixing technology is dependent on the - hardness of clay.

- scale of output.

In general damp surface clay soils with a good amount of natural silts and sand require no crushing. It is therefore a relatively easy task for labourers to mix clay and water with simple tools. However, mechanised forming technologies require a homogeneous clay input, since they operate with significantly drier mixtures, and crushing is necessary.

3. THE FORMING OF BRICKS

Three distinct methods.

Slop Moulding

- mixture ladelled into wooden moulds.
- excess clay removed.
- moulds unpended on a smooth floor.
- mixture must have high water content (25%-35%) to prevent clay sticking to moulds.
- duration of drying 10-30 days.

Wastage high : susceptible to - cracking during drying.
- deformation & damage during transfer.

Pressing

- mixture placed in mould on horizontal work surface.
- then through a leveraged action pressed into required shape.
- manually operated - moulding two bricks per pressing.
 - up to 200-300 bricks / hour.
- semi-automatic - up to 2000 bricks / hour.
- water content approximately 10%.
- duration of drying 2-3 days.

Advantages over Slop Moulding : lower rate of cracking
reduction in energy for firing.
regular in shape (appearance) less cement used.
shorter duration of drying.

Disadvantages : requires fixed capital - press.
- clay homogenisation.

Extrusion

- mixture forced through a die which dictates the final shape of the brick.
- extruded clay cut by sharp wire.
- bricks treated analogously to procedure involved in pressing.
- up to 8000 bricks / hour.
- capital extensive.

preferred where labour costs are high.

4. THEIR TRANSFER AND DRYING

Transfer - manually brick by brick or with the use of pallets.

- moving lines not viable due to fragility of bricks.

Drying - left to stand in large, covered areas. (protection from wind and sun to prevent cracking).

5. AND THEIR FIRING

To strengthen the brick and give a red colour.

Three types of kiln.

Clamp Construction

- bricks stacked in the open into a largish cube shape approximately 2m high.
- between 5000- 40000 bricks.
- clamp plastered on outside with clay or spoilt bricks to maintain high temperature and minimise fuel usage.
- tunnels left for fuel. (wood or coal)
- 2-5 days firing.
- 14 days cooling.
- regular shape - acceptable structural quality.
- each batch inherently uneven in nature - bricks in centre over fired.
 - bricks at rim under fired.
- requires considerable degree of skill.

Purpose Built Stationary Kiln

Rectangular kiln - has at least two parallel chambers.

- whilst one firing other reloaded.

Hoffman kiln - ellipse or circle.

- fired continuously.
- fire moving slowly around the kiln.
- loading taking place in front of the fire and unloading in its wake.

Scotch kiln - containing wall on at least three sides with arches for the fuel to be inserted.

All three types of kiln produce high quality bricks and can be fuelled by oil, coal, wood or coffee husks.

Tunnel Kiln

- bricks move through kiln on purpose built trolleys.
- requires most carefully controlled firing system.
- gas, oil, coal.
- large scale , continuous & high quality.

NB - Not for developing countries.

ROOFING TECHNOLOGIES

GALVANISED CORRUGATED IRON (GVI)

- zinc coating
- can rust through in 2-3 yrs.
- poor insulation against heat and noise
- under sun very hot
- under rain very noisy
- bulk cost in the making and thickening of the sheet steel.
- largely imported.

'RE MANUFACTURED OR RECLAIMED MATERIALS'

Great ingenuity is applied to turning waste products into roof cladding surfaces.

- motor tyres.
- kerosene cans.
- packaging materials (plastic , etc.)
- cloth.

LOCALLY PRODUCED CLAY TILES

The same five stage process adopted in brick manufacture is taken for tile production. Obviously the method of moulding is slightly different but essentially the process does not change.

- clay winning and transportation.
- clay mixing.
- clay forming.
- transfer and drying.
- firing.

However the tiles are fired using different types of kiln:

- side-fired kiln - all fuels (mainly wood)
850-900 degrees.
- top-fired kiln - more energy efficient
fuel - coal, briquettes, sawdust.
850-900 degrees.

The advantage of these kilns is that they may be used to fire bricks as well as tiles which could prove to be highly flexible and cost efficient in production.

FIBRE CONCRETE TILES

The manufacture process does not require any special buildings or infrastructure : therefore the equipment can be installed on an ordinary floor slab in an existing building.

operator skills - simple and quickly learned

- maintenance can be carried out by operators themselves or by anyone with experience equivalent to that of a motor mechanic

raw materials - widely available.

- mainly local.
- cement being the only manufactured ingredient.
- one bag can produce 10m² of roof.

Installation and commission - extremely rapid (no delay in realisation due to capital investment).

manufacturing costs - less than half those of other permanent roofing materials.

technical requirements - familiar to building workers.

weight - roof cladding with fibre concrete tiles is lighter than with any other concrete or clay tiling system.

- 20-30 kg/m² compared with 50-90 kg/m² with normal tiles.
- this enables roof to be built with relatively light structure (as for sheeted roofs)

How a fibre concrete tile is made

raw materials : cement - binder.

sand - aggregate.

fibre - cohesive (easy to spread and mould).

water - provides workability.

- special mortar mixed by hand in batches to make 10 tiles at a time.
- the vibrating screeding table is set up, and a sheet of industrial polythene is placed upon the table top and clamped under the screeding frame.
- quantity of mortar (measured with a special scoop) spread into a steel frame using a towel.
- vibration speeds up trowelling and compacts the mortar- operation time 1 minute.
- when screed has become level, tile drawn off table on to a setting mould to give a curved shape.
- stays on mould overnight, removed next day.
- cured for two weeks.

SOIL BLOCKS

building with earth

advantages

- availability in large quantities in most regions.
- hence low cost for excavation and transportation.
- easy workability, usually without special equipment.
- suitability both as wall and roof construction material.
- fire resistance.
- favourable climatic performance in most regions, due to high thermal conductivity and porosity.
- low energy input in processing and handling unstabilised soil.
- unlimited reusability of unstabilised soil (recycling demolished buildings).
- environmental appropriateness - use of an unlimited resource in its natural state, no pollution, negligible energy consumption, no wastage.

disadvantages

- poor durability
- excessive water absorption, causing - cracks and deterioration by frequent wetting and drying (swelling and shrinkage)
 - weakening and disintegration by rain and floods.
- low resistance to abrasion and impact, thus rapid deterioration through climatic elements, human usage and penetration by rodents and insects.
- low tensile strength, making earth constructions susceptible to destruction during earth quakes.

MANUFACTURE PROCEDURE

The technology is not simple and the mere fact that natives of many countries have been building their houses with earth for thousands of years does not mean that the technology is sufficiently developed and known to every one. Often longevity is of little importance.

Each of the following stages of production must be carefully considered:

Soil Selection

Not all soils are suitable for building. They differ in chemical composition and grain size distribution, factors which determine their performance. Soil selection is based on experience and tests.

Soil Testing

field - sight, smell, touch, behaviour in fingers.

lab. - particle size analysis, shrinkage, plasticity, dry strength, compressionibility, optimum moisture content and cohesion.

Soil Preparation

- depending on type of construction, the soil mixture must satisfy certain requirements.
- these may call for : addition of sand or clay
 - crushing
 - sieving
 - dry and wet mixing

Soil Stabilisation

- to improve the quality of the soil mixture, a large variety of stabilisers can be added. The main ones are :
 - Fibres (such as straw, agricultural wastes, animal and synthetic fibres) to improve the tensile strength.
 - Cement, to improve the compressive and tensile strength, dimensional stability, erosion resistance.
 - Lime, dependent on the clay content of the soil, to achieve a similar improvement as with cement.
 - Bitumen, mainly to reduce water absorption.
 - Natural and synthetic resins, for increased load-bearing capacity, elasticity and impermeability.
 - Animal (cow dung, blood, hair, casein) and vegetable products (oils and fats, ashes, sap).
 - Commercial products, mainly for impermeability.

Soil Compaction

- All soil constructions require some form of compaction, either by throwing, vibrating, ramming or mechanical compression. Some of the soil block presses available are highlighted on the attached information sheet.

Drying and Curing

- All soil constructions have to dry for several days to gain strength, the time needed depending mainly on the weather conditions. Hence, controlled drying and protection from rain are essential.
- When cement or lime is used for stabilisation, the material must be kept moist for the first 4-5 days (for curing).
- Depending on the degree of compaction, compressed soil blocks can be stacked (up to 5 layers) immediately or on the next day.

ALTERNATIVE CEMENTS AND BINDERS

The following materials all play an important role in methods of construction. They may be added to other materials to provide bond and strength, applied as a rendering or mortar to masonry, or simply used to form a low strength concrete. Those which require firing are done so in a kiln. The choice of kiln varies widely from region to region and some are obviously more energy efficient than others. In recent years much work has been focused on the development of such kilns.

Portland Cement

Advantages - reliable.
- consistent.
- easy to use.

Disadvantages - expensive.
- in short supply.
- consumes much energy in manufacture - calcination temperature approx. 1450 degrees.
- fine grinding.

Gypsum and Anhydrite

- capital cost of plant very much less than portland cement.
- energy requirement 1/5 of that required to make cement clinker.

Dolomite

- possible to half burn dolomite to produce the magnesium oxide required for Sorel cement.
- also found naturally in Salem, Madras.
- must not be wetted for any length of time.

Limestone's

	clay impurities
high calcium lime	0 - 15%
semi-hydraulic limes	10 - 15%
hydraulic limes	20 - 30%

Pozzolans

A pozzolan is a material which, when mixed with lime and a little water, sets to a solid. The following groups of materials are regarded as having useful pozzolanic properties:

- Calcined clays - widespread availability.
- Bauxite - found in tropical regions such as Kerala.

Surkhi

- strictly a pozzolanic material.
- by-product of small-scale brick and tile manufacture.
- generally 'underfired' pulverised fire clay or brick-earth.
- widespread availability and simplicity of manufacture.
- less liable to shrinkage.
- more impermeable.
- better accommodates internal stresses.

Latent Cement

- produced from slag, a by-product of the iron industries.
- molten slag poured into water to cool and then ground.
- mixed with portland cement, producing a reaction which forms a cementitious material.
- slag enables portland cement to be extended by a factor of over three.

A GUIDE TO HAND OPERATED SOIL BLOCK PRESSES

PRODUCT	MOULD TYPE	WEIGHT OF MACHINE (KG)	STANDARD BLOCK SIZE (CM)	OUTPUT RATE (BLOCKS PER/HOUR)	LABOUR FORCE REQD. (MEN)	PRICE (U.S.\$)
CINVA - Ram	SINGLE	58	29x14x9 29x14x3.8	37 60	4	230
CETA - Ram	SINGLE	86	32.3x15.7x11.5	60	4	500
CTA Triple - Block Press	TRIPLE	121	24x11.5x11.3	130 - 170	4 to 6	500
CRA Terre AMERICA	SINGLE	280	28x28x8	120	5 to 7	not for sale (project use)
LATINA Press	DOUBLE		28x12.8x8	240		
DSM	SINGLE	85	29x14.5x10.5	90-110	5 to 7	860
MARO DC Press	SINGLE	105	30x15x10	150	3	980
			30x15x5			
Geo 50	SINGLE	125	29.5x14x9	90-110	5 to 7	1050
UNATA 1003	SINGLE	78	29x14x9	70	5	500
UNATA 1004	SINGLE	86	29x14x9	100	5	550
ELLSON Blockmaster	SINGLE	190-222	29x14x9 29x19x9 30.5x14.6x10 30.5x22.8x10 22.8x10.8x7.6	90 80 90 70 100	8 to 12	750
TEK - Block Press	SINGLE	85	29x21.5x14	50	10	173
ASTRAM	SINGLE	138-145	30.5x14.4x10 23x19x10 23x10x7.5	56 56 112	5	400 400 540
TARA BALRAM	DOUBLE	160	23x10.8x7.5 23x10.8x6	124	5	550
IIT Madras Cam Block Press	SINGLE	158	30x20x10	54	5	400
VS Cinva Ram	SINGLE	71	30x14x12	40	6	300-400
TERSTARAM	SINGLE	380	29.5x14x9 40x20x10 22.5x10.5x6	90 70 180	5 to 7	1445 1485 1470
Multibloc BREPAK Block Press	DOUBLE					
	SINGLE	163	29x14x10	30-40	6	2213

(prices valid 1988)

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