SPACE UTILIZATION AND COST REDUCTION MEASURES IN MIDDLE INCOME GROUP HOUSING AT BHOPAL

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CERTIFICATE

Certified that the dissertation entitled "SPACE UTILIZATION AND COST REDUCTION MEASURES IN MIDDLE INCOME GROUP HOUSING AT BHOPAL" being submitted by Shri Ghanashyam Vishnu Kulkarni in partial fulfilment for the award of degree of MASTER OF ARCHITECTURE, Department of Architecture and Planning, University of Roorkee, Reorkee, India, is a record of student's own work carried out by him under my supervision and guidance. The matter embodied in this dissertation has not been submitted for the award of any other degree or diploma.

This is further to certify that he has worked from January 1979 to July 1979 for preparing this dissertation at this University.

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PREFACE

Housing has become a perennial problem of our urban areas especially of large cities. The problem has become more aggravated because of the limited resources of both the Government and the individual. To ameliorate the housing conditions various social housing schemes have been introduced and are being implemented through public sector agencies such as Housing Boards etc. Efforts although laudable suffer from erroneous approach. It is common knowledge that the cost of dwelling units under hire purchase scheme is much beyond the capacity of each group ; Middle Income Group (MIG) is no excaption to it. The experience of State Housing Boards and also of HUDCO is that dwelling units for a particular category are occupied by the families in the next higher income group. This defeats the very purpose of directing the housing efforts based on income category. High cost of dwelling units has created a paradoxical situation in Bhopal that although there is demand for houses yet 40 to 50% of them remain vacant. The relevance of this to planning is that families' ability to pay constitutes the demand and type of dwelling units. In present circumstances, substantial economy can be achieved through space reduction with maximum utilization of space with increased use efficiency and rationalisation of construction techniques and use of materials i.e. specification.

An effort has been made to evolve rational space standards and specification to effect economy in unit cost for MIG housing at Bhopal.

CONTENTS

CHAPTER - I INTRODUCTION

Housing in general is the most graphic portrayal of the crisis of our urban and rural areas and most serious manifestation of mass poverty and reflection of economy of the country. Housing shortage is a perennial problem of urban areas and can be measured in astounding figures. The backlog and the current needs have assumed alarming proportions and funds made available are insignificant to the need and can hardly touch the fringe of the problem. The problem becomes more aggravated as the paying capacity of the overwhelming majority for the accomodation has also declinded because of the rising price index.

1.1 URBAN HOUSING SITUATION

With every successive Five Year Plan the shortage of housing has been increasing progressively. The urban housing shortage was estimated at 2.8 millions units in 1951, 5 million units in 1956, 9.3 million units in 1961 and 11.8 million units in 1969*. The Fifth Plan (1974-79) started with a backlog of of 15.3 million units in urban areas. Reasons for the regressive movement are not far to seek. Housing sector is not getting enough priority in different Five Year Plans. Outlays

*Report of the expert committee on methods for achieving low cost large scale housing construction in the major cities-NBO Publication 1970.

on social housing schemes during the first four plans have been 1.6%, 1.8%, 1.6% and 0.96% respectively*. In Fifth Plan it has been 1.2% (Rs.456 crores) of the total outlay. Rate of urban growth (3.1 to 3.8% per annum in last 2 decades) has been faster than the rate of construction of dwelling units which is 3.5 dwelling units per 1000 of the population compared to 8-10 units per 1000 annually recommended by U.N. for balanced development.**

National Building Organization has estimated that the requirement of cement and steel in country will increase from 17.04 and 4.6 million tons in 1975 to 75.54 and 20.60 tons by 1990. Building cost index has inflated by 3 times in last two decades.

The factors that have been cumulatively responsible for housing shortage are :

i) Population growth
ii) Influx of large masses in urban areas
iii) Low economic capacity of majority of households
iv) Inadequacy of public resources
v) Increasing cost of building
vi) Absence of major technological break-through
vii) Low rate of construction.

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* Report of the expert committee on methods for achieving Low Cost Large Scale Housing Construction in the Major Cities - NBO Publication 1970.

**Mukhopadhay, B.K, "The Take of Roof over the Head", ITPI Journal December 1978.

1.1.1 Considering the magnitude of the problem it has been thought desirable to limit the scope of the studies at city level. Bhopal has been chosen for the purpose.

1.2 URBAN HOUSING SITUATION IN MADHYA PRADESH & BHOPAL

The situation of housing shortages is no substantially different in the urban areas of Madhya Pradesh State. Urban housing shortage as estimated in second, third and fourth plan was 1.4, 2.5 and 4.1 lakh units respectively. As per Fifth plan, total housing shortage is 3.3 million units out of which urban housing shortage is 0.66 million units. Based on 1971 census data and the survey conducted by Madhya Pradesh Town and Country Planning Department (MPTCPD), the backlog of housing shortage in Bhopal, capital of the State, is 33000 dwelling units and the projected figures for housing requirement for 1981 and 1991 are 98000 and 1,78,000 dwelling units respectively.* With modest estimation of Rs.12,000 for urban dwelling unit it would require Rs.39.6 crores to cover the backlog of Bhopal whereas Fifth Plan allocations for housing have been only 32.4 crores for the whole state. Plan allocations for housing sector were also meagre compared to the need. In second plan, outlay for housing sector was 1.97%, in 3rd plan 1%, 4th plan 2% and in 5th plan 4.5%.

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* "Bhopal Development Plan - 1971", MPTCPD.

1.3 EFFORTS IN THE HOUSING FIELD

Urban housing as a part of core infrastructure in city growth has been assigned a higher priority for institutional finance and is on its way to gain an appropriate place in a well conceived and integrated approach in urban planning. The problem of housing is being tackled by various public sector agencies such as Government Departments, Local bodies, Autonomous Bodies, Housing Boards etc. as well as private sector Industrial and Institutional Organisations and are devoting, in an organised way, considerable efforts towards mitigating the housing problem by promoting and constructing large number of dwelling units. Of all the public sector agencies, Housing Board caters to the need of social housing in urban areas.

Private investors are not interested in entering into housing construction as the entrepreneurship is based upon speculation and huge profit making motives. Such an housing activity benefits only few 'haves' in the society. Private participation in Bhopal has been negligible and can be gauged from the fact that after 1956 only 5% of the total housing area has been developed by private colonizers*.

Although the public also contributes towards solving the housing problem, it is becoming increasingly difficult for an individual to construct house because of i) sky rocketing land prices ii) exhorbitant experts' fees iii) bureaucratic

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* "Bhopal Development Plan - 1991" by MPTCPD.

procedure for sanction iv) scarcity of conventional building materials and their rising prices v) the high interest rates on loan and stringent conditions attached to them limit the numbers.

Co-operative Housing system could not gain ground in Bhopal mainly because Housing Board, Apex Co-operative Bank etc. used to advance the loans even to individuals. Although the practice has been discontinued, yet very few co-operative housing societies have been formed.

People in general then seemingly depend upon the Housing Board which construct the houses and make them available at no loss no profit basis. In order to ameliorate the unsatisfactory conditions various social housing schemes have been introduced for which the whole population has been categorised in different income groups for fixing the space standards, repayment period, rate of interest amount of subsidies etc. The following table indicates these details along with paying capacity of each group.

TABLE

Category	Monthly income	Average monthly paying capacity	Cost of house with repayment capacity and period
EWS	below Rs.350	Rs.20 (10% of Rs.200)	Rs.2490-20 years at 5% interest.
LIG	351-600	Rs.62 (13% of Rs.475)	Rs.6600-15 years at 7% interest
MIG	601-1500	Rs.168 (16% of Rs.1050)	Rs.13750-12 years at 9.5% interest
HIG	above Rs.1500	Rs.400 (20% of Rs.2000)	Rs.26900-10 years at 11.5% interest

Source : Compiled from HUDCO Folder - 1

Housing Board constructs the houses and sells them on 'Hire purchase' system. In fact, it is this main consideration which attracts the clientele to the Housing Board dwelling unit. Rental housing construction has been stopped as a policy matter and the houses are made available on ownership basis as the increased house ownership has many distinct advantages 1) It offers greater security to families 2) investment creates appreciating assets 3) Owner occupiors are more likely than tenants to invest in the maintenance of their own houses which results in maintaining the housing stock and 4) Expenditure by the agency for estate management is less.

Each category with different Socio-economic conditions poses different problems. In view of the complexities involved, it has been thought desirable to study the problem of MIG housing within the frame-work of M.P.Housing Board.

1.4 POLICIES AND IMPLICATIONS

Housing Board is faced with the difficult task of reconciling rising costs with limited paying capacity of target group. The task is made further difficult because of unrealistic policies adopted.

The bureaucratic approach to the housing problem can be termed as the arithmatical approach which starts by establishing an unrealistic minimum standard (plinth area of 80 M^2) for housing. This standard creates severe housing shortage because

within the resources only few dwelling units can be constructed. Setting standards is a difficult task for uptill now there is no definition as to what constitutes an ideal house which becomes then a relative term. The issue of setting standards and then finding resources to achieve them appears to be seperate steps in overall policy formulation and implementation process. Experts set the standard (should be commonly believed) and the decision makers determine if the funds are available to meet the standard. This approach can hold good when resources are enough. Then the sequential approach : standard setting → need estimating → policy and programme is appropriate or atleast is reasonable. But in the wake of paucity of resources the sequence should be reversed. The availability of resources leads to calculations of appropriate expenditure which leads to setting standards that can be met from pre determined budget. i.e. resource estimate → budget allocation → standard setting. The necessary linkage between standards and costs is frequently ignored in setting the standard. Then the cost tends to be unrealistic making it beyond the reach of target group.

It is a prosaic fact that the cost of dwelling unit of Housing Board is much beyond the paying capacity of the people. Cost of dwelling unit constructed in last 2-3 years and the corresponding monthly instalment etc. have been shown in the following table.

TABLE

Type	Area M2	Outright purchase cost Rs.	Monthly instal-ment Rs.	Initial deposit* (% to outright purchase cost)
1. MIG HOUSE	80.80	62000	483	17250 (27.80%)
2. Sr. MIG House	135.66	82000	696	25000 (30.48%)
3. MIG FLAT	84.81	60670	467	16550 (27.27%)
4. MIG FLAT M1	90.12	72000	795	19000 (26.38%)
5. MIG FLAT Jr.	60.92	48000	435	9872 (20.56%)
6. MIG Flat Sr.	97.88	70000	540	20000 (28.57%)

Source: Compiled from the information as given by MPHB - Construction Division.

Notes:- 12 years repayment period
- Interest rate 9.5% (M1), 10.5% (M2)
* Full land cost + 20% of construction cost.

The table is self explanatory and clearly indicates that the high instalment of Rs.435 P.M. (minimum within the lot) forming 41.42% against 16% of the average income (Rs.1050) preclude the substantial number of MIG to purchase the dwelling unit. As a result 40 to 50 MIG dwelling units remain vacant* It is a paradox of the situation that although there is demand for houses yet 50% of them remain vacant. The experience of State Housing Board and that of HUDCO has also revealed that houses for particular category are largly occupied by families in the next higher income group**.

* 'Urban Housing in Madhya Pradesh'. Report published by Institute of Regional Analysis (IRA) in Jan. 1978.
** 'Bulletin of the National Institute of Urban Affairs'. Vol.2 No.1 January, 1979.

If house cost is to be within the resources of the owner occupier, it has been suggested that the repayment on house loans over reasonable period (12 years) should not exceed 20-25% of the income*. Income multipliers for determining house cost related to the income of MIG owner - occupier i.e. the amount he is capable to set aside from his income for loan repayment for different repayment periods for interest rate of 9.50% have been worked out and shown in the Table on Page No.10. From the table it can be noted that the cost of house should not exceed Rs.19261 or Rs.24076 if the monthly instalment is 20% or 25% of the average MIG income respectively for repayment period of 12 years. Reduction in the construction cost to the above level will not only bring it within the paying capacity of MIG but will also enable creation of much higher number of dwelling per unit of investment. Thus, larger number of people can be given benefit of housing within the limited resources available.

1.5 NEED FOR FAIR DEAL TO MIG HOUSING

Although it cannot be disputed that the Government committed to social welfare should divert its resources and efforts to solve the problem of majority which comes under EWS category, yet it cannot overlook the problems of other

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* "House Ownership"; EKISTICS August 1977 - Incidently the surgey carried out by the author revealed that the people are prepared to pay maximum 20 to 25% of the income as monthly instalment towards the ownership house.

TABLE : MONTHLY INSTALMENT & HOUSE COST RELATIONSHIP

Income range	Average income Rs.	Average monthly instalment		Cost of Dwelling Unit Repayment period in years			
		%	Rs.	10	12	15	20
600-900	750	10%	75	6801	6878	7885	9230
		15%	112.5	9152	10318	11828	13846
		20%	150	12203	13757	15771	18461
		25%	187.5	19254	17197	19713	23076
901-1200	1050	10%	105	8542	9630	11039	12923
		15%	157.5	12813	14445	16559	19384
		20%	210	17084	19261	22079	25864
		25%	262.5	213.55	24076	27599	32307
1201-1500	1350	10%	135	10963	12382	14093	16615
		15%	202.5	16474	18573	21290	24923
		20%	270	21966	24764	28387	25476
		25%	337.5	27457	30955	35484	41538
			INCOME MULTIPLIER	1.475	1.57	1.712	1.95

Note:- Cost of dwelling unit has been calculated by the following formula.

$$C + \frac{C \times I \times Y/2}{100} = M$$

where C = cost of dwelling unit
I = rate of interest (9.5% per annum)
M = Total money over the years
= Y x 12 x R
R = Monthly instalment

sections of the society. There seems to be undue emphasis on the provision of housing for EWS category. Whilst it is no doubt true that in urban areas nearly 70-75% of the population constitutes EWS, it is not the unsatisfied demand of this section but of middle, lower middle and low income group which inflates the prices of land and rent. Even though these groups constitute only 25-30% of the population, their effect in absolute number is substantial in the urban market.

Our Major objective should, therefore, be to substantially increase housing stock for these sections. Such public housing policy should aim at providing sufficient housing for MIG (and LIG also) so that at least these sections do not exert pressure on the housing stock available for the poor. In the absence of such housing policy, there is danger of those who can afford better housing perforce resorting to lower levels of housing and pricing it out of the market for the poor. Once the housing situation in MIG section is stabilised it shall be possible to stop the chain process which pushes the weaker section from slums to worst slums.

Furthermore, the housing programmes for EWS are associated with heavy subsides. Regarding the questin of subsidy serious doubts have been expressed about its ability to resolve the housing problem. Any scheme of subsidy not only dries up resources for plough back in housing but also leads to number of mal practices like reselling etc. and the problem

remains where it was. Improportionate diversion of resources (90% for EWS/LIG) neither solves the problem of EWS nor MIG. Traditional ambition to own a house in the life time and relative paying and saving capacity of MIG section should be exploited as a fount of resources to mitigate the housing problem of MIG section atleast.

1.6 IDENTIFICATION OF THE PROBLEM

1.6.1 The crux of the problem is to reduce the cost of dwelling unit substantially so that MIG (for that matter each category) is able to afford satisfactory housing. In order to bring down the cost of dwelling unit within the affordable limits i.e. to make it economical, an all sided attack on all components that constitute the cost of 'house' is imperative. There are two primary components of the cost of house i) the cost of developed land and ii) the cost of building construction. Studies carried out by HUDCO has revealed that the cost of developed land accounts for 15 to 30% of the total cost of building and is primarilly determined by the cost of land itself and cost of development. The construction cost accounts for 70 to 85% and depends upon the material and construction technique i.e. the specification adopted. It intrinsically depends upon the space standards vis a vis space allocation. From the percentage break up as mentioned above it is clear that substantial economy can be achieved mainly through construction cost and hence it has been chosen as a main theme of dissertation.

1.6.2 SPACE

The important aspect which determines the limits of cost of dwelling unit is adoption of space standards which become all the more important because it will be ultimately converted into the finances required. Standards by themselves are necessary to provide a minimum level of quality in terms of social life, aesthetics, satisfaction and protection from hazards like fire, disease and functional useability. But it would not be sensible to set higher unrealistic standards (80 M^2) which increases the unit cost beyond the capacities of potential owners. In view of the limited resources of both the state and the individual, it is necessary to go in for housing programme with austere standards. In order to achieve economy, space reduction can be effected taking into consideration, the family composition, nature of belongings, the activity pattern, social attitudes and habits. Thus, if the space standards are evolved through rational space utilisation with increased use effeciency, the overall reduced size of dwelling unit will bring down the cost of unit considerably if not totally and will incur the following advantages.

1. There can be more the number of dwellings on smaller land holdings.
2. The increased density to a certain extent may solve the land acquisition problem and thereby lessen the pressure on costly urban land.

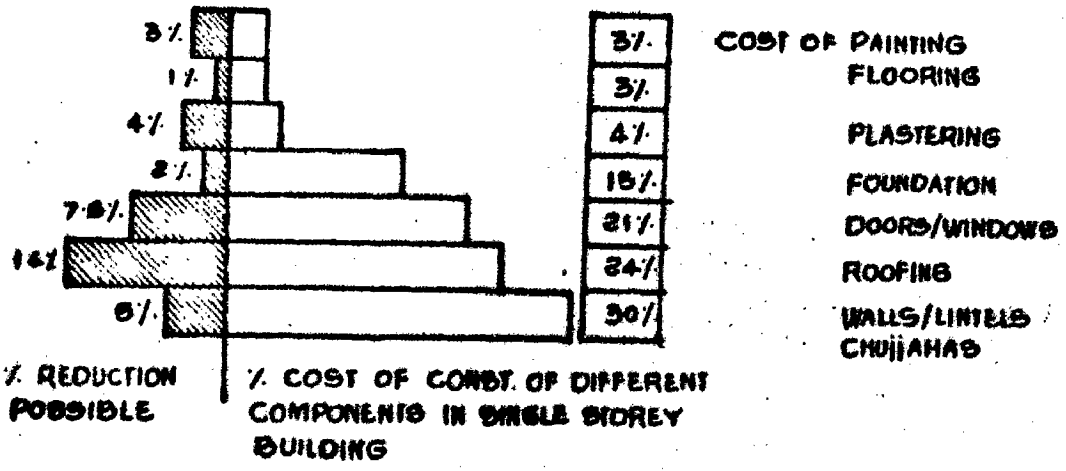
3. This will further help in optimising land as resource.
4. It would conserve the building materials.
5. Smaller dwellings with reduced cost would allow more number of units in allocated budget.

It must be made clear here that advocating the reduction in spaces does not mean sacrificing the basic requirements of family. These must be provided with no compromise what so ever. It simply means the judicious and rational utilization of the space - both horizontal and vertical.

1.6.3 SPECIFICATION

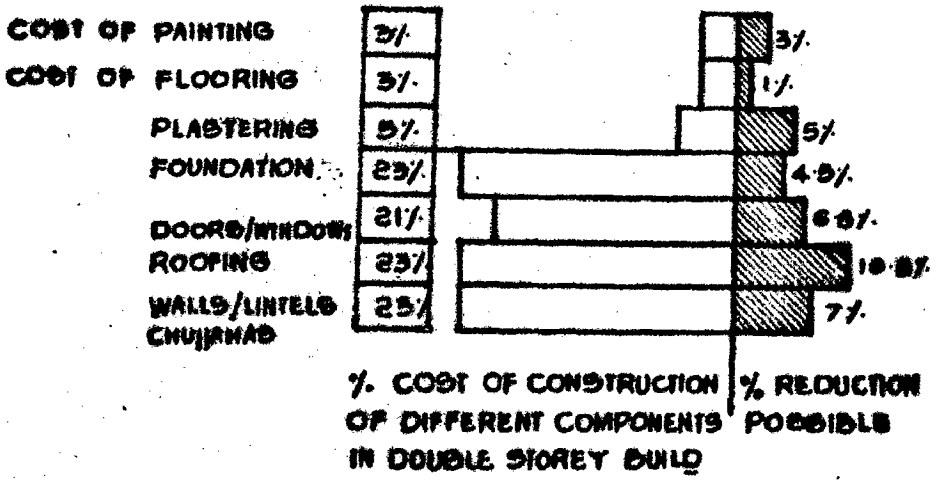
Research and development in the field of building has made available more exact data and knowledge regarding the quality, behaviour and performance of building materials and structures. Based on these the traditional and conventional specifications and techniques can be substituted without impairing the structural safety and functional useability and at the same time achieve economy and speed in building work. There is a scope for cost reduction by rationalisation of specification of various items and components of construction work. Studies carried out by HUDCO (Ref.Page 14 A) indicate that the construction cost can be reduced by 14% to 22% and inspite of escalation in the building cost it has been possible for HUDCO to reduce the construction cost (Ref. Table on Page 14 A).

BREAK UP OF COST OF COMPONENTS AND PER CENT REDUCTION POSSIBLE



OBSERVATION

THE GRAPHS SHOW THAT ABOUT 90% OF THE COST OF CONST GOES IN ROOFS, WALLS DOORS/WINDOWS & FOUNDATION IT IS POSSIBLE TO REDUCE ABOUT 29·57% - 28% OF COST THROUGH SPECIFICATION



SOURCE : MATERIALS' WING OF HUDCO

TABLE : AVERAGE COST PER DWELLING IN HUDCO SANCTIONED SCHEMES

1971-72	17795	LIG HOUSING SCHEMES.
1972-73	17020	
1973-74	19278	
1974-75	21783	
1975-76	15756	
1976-77	16422	
1977-78	15622	

SOURCE : URBAN NEWS BULLETIN, VOL 8, JANUARY 1979

OBSERVATION.

INSPITE OF ESCALATION IN COST OF CONSTRUCTION, IT IS POSSIBLE TO REDUCE THE COST THROUGH SPECIFICATION

It is often thought that cost reduction can be effected by adopting prefabrication technique. In western countiries it helped to solve their problem which was one of the scarce and costly labour. Industrialised building process is highly capital intensive and employment generated for production of materials and labour employed at site is hardly 40%*. It requires more of scarce resources & would leave surplus manpower unemployed. Adoption of prefabrication technique would create more problems than solve it.

However, there is no denying fact there is a pressing need to make the building operations more efficient and less wasteful. This can be done by going in for partial prefabrication of certain components.

1.7 THE NEED

While formulating the standards whether space or specification families' ability to pay must be the governing factor. There ought to be corelation between these two. Then only it would be possible to make any significant dent on demand. There is a difference between demand and need. Needs refer to inadequacy of existing provision when compared with socially acceptable norms. It takes no account of price. Demand on the other hand gives pride of place in equation.

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* Gokhale, R.G., " Appropriate Low Cost Technology for Housing Break-through", Seminar on Low cost housing & fire research, March 1975, N.Delhi.

With limited resources and increasing demand, the only way to produce more housing would be by making optimum use of the available resources and stretch them to maximum possible extent. There is imperative need to recognise and understand that housing of bare minimum requirement and environment is an immediate necessity and as the economic capacities of an household are increased, fittings, furnishings and equipments can be added by the owner to improve the quality. At present, the solution lies only in production of more dwelling units by skilful and balanced manipulation of the standards that control the production of housing. It would be an act of folly to insist upon idealised housing in the wake of paucity of resources. The distinction between the ideals of planners/ architects/policy makers and the physical reality of housing shortage refers to a real opposition between artistic aspirations and immediate needs.

1.8 SCOPE AND OBJECTIVES

The cost of dwelling unit is a complex phenomenon and encompasses many diversified fields. It is too difficult if not impossible within limited time and resources to consider all aspects of cost in detail in this dissertation. As such the scope of the study has been limited to effect an economy in the cost of dwelling unit for MIG category at Bhopal throggh i) space reduction - its maximum utilization with increased use efficiency ii) cost reduction measures in terms of specification appropriate in the region. More specifically the

objectives are -

1) To evolve space standards for a MIG dwelling unit in consonance with the activity pattern, the life style, family composition and nature of belongings.

2) To rationalise and evolve specification of various items and components which constitute construction work.

3) To ascertain the effectiveness of devised space standards and specification on the cost of dwelling unit through cost analysis of conceptual designs.

1.9 METHODOLOGY

While evolving space standards, great care will have to be exercised in order to account for living habits, requirements, etc. of the occupiers. These facts can be ascertained by undertaking a comprehensive sample survey of MIG dwelling units. Although the findings cannot be conclusive but can be fairly representative for space formulation.

The second objective shall be accomplished through the studies of various findings of Research Organisations such as CBRI, NBO etc.

The third objective shall be met by working out the cost estimates.

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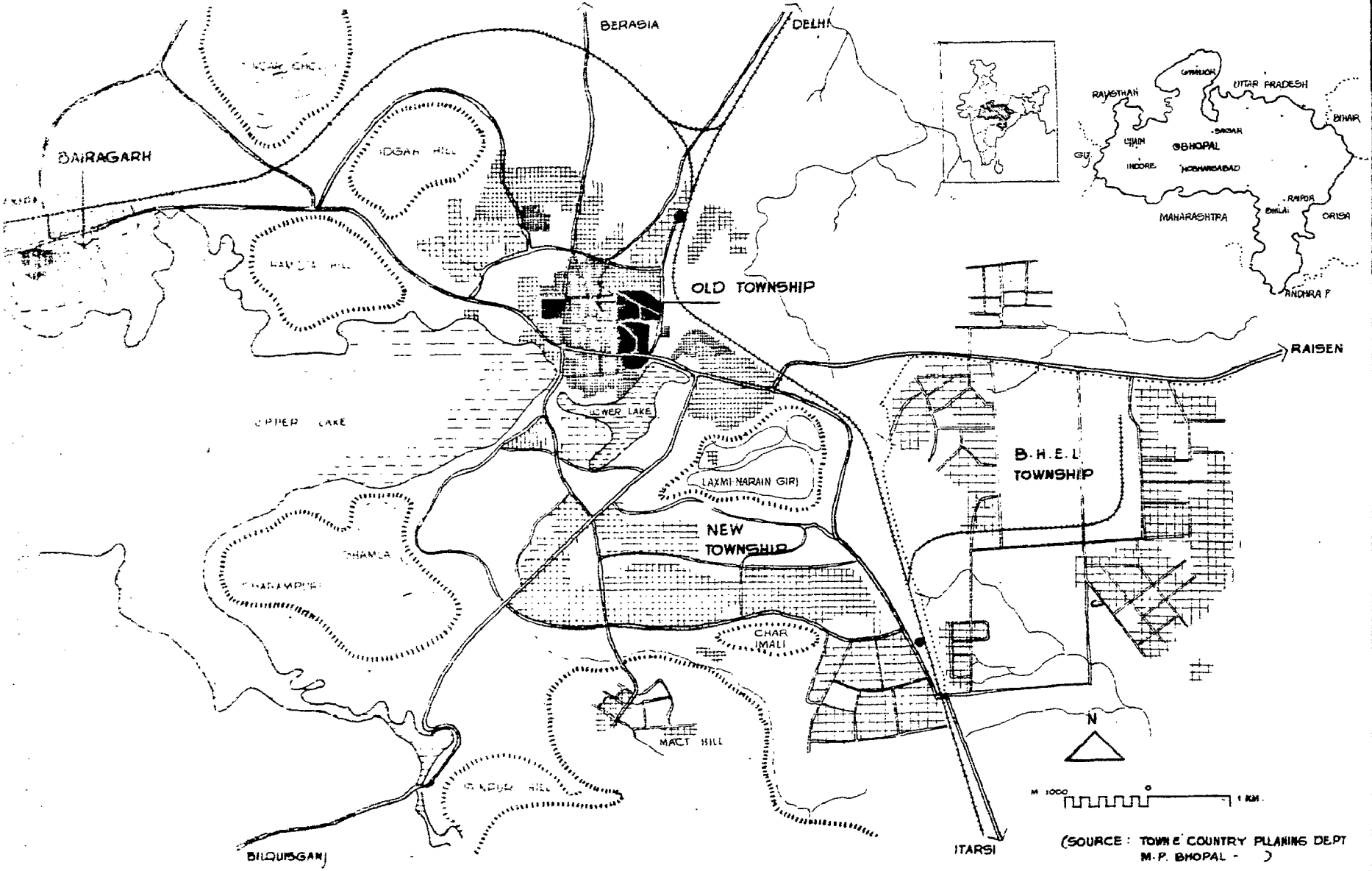
CHAPTER - 2 FOCUS ON STUDY AREA

Housing conditions obtaining in any city largly depends upon the factors such as population - its growth and trend, economic standard of dwellers, geo-climatic conditions etc. Any study dealing with housing problem of any type and nature must take a note of such factors in order to understand the interrelationship and the effect on housing situation. The population and its content has a relationship with type and cost of structure and their integration with economic activities, while living patterns emerge largely due to geo-climatic and functional factors. Study of major factors and prevailing housing conditions themselves will indicate adequacy or otherwise, the gap that exists and the measures (within the scope of the study) that are necessary to cover this gap.

2.1 LOCATION, PHYSICAL FEATURES

Bhopal, the Capital of Madhya-Pradesh, is the best example of manmade squalor thriving in most beautiful natural surroundings provided by low hills and expansive lakes. It is situated along 77°-3' E longitude and 23°-25' N. latitude. The city is well connected to all important cities/metropolices in the country by road, railway and air. The present city stands segregated distinctly in four parts i) Old city ii) New township iii) BHEL township iv) Bairagarh (refer map No.1).



(SOURCE : TOWN & COUNTRY PLANING DEPT M.P. BHOPAL -)

BHOPAL

PHYSIOGRAPHY & OTHER CHARACTERISTICS

REFERANCES

HILLS
RIVULATES
MAIN LINKAGES
RAILWAY
LAKE
RESIDENTIAL DENSITY : PERS
751 & ABOVE
501 TO 750
251 TO 500
121 TO 250
120 & BELOW

MAP No. 1.

18-A

Bhopal stands on red sand stone strata of Malwa plateau. Black cotton soil is, however observed in various depths from 1 to 2½ metres on the east where most of the development is taking place.

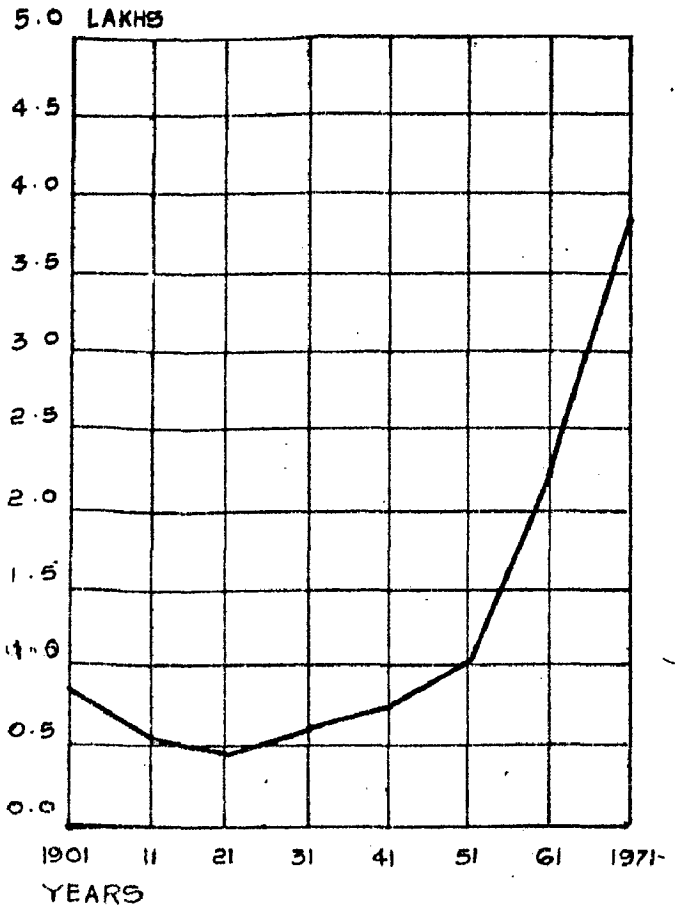
2.2 CLIMATE

The presence of two vast lakes and hillocks in the city has helped in modifying the micro climate of the city to large extent, giving it a moderate nature. Normally mean maximum temperature ranges between 30°C and 34°C while the mean minimum temperature ranges between 16°C to 19°C. In such a moderate climate residential areas can be developed at higher densities as three or four storeyed buildings can be constructed without causing discomfort to the occupants. The average rainfall is around 11000 mm. Westerly and south westerly winds are more predominent.

2.3 POPULATION

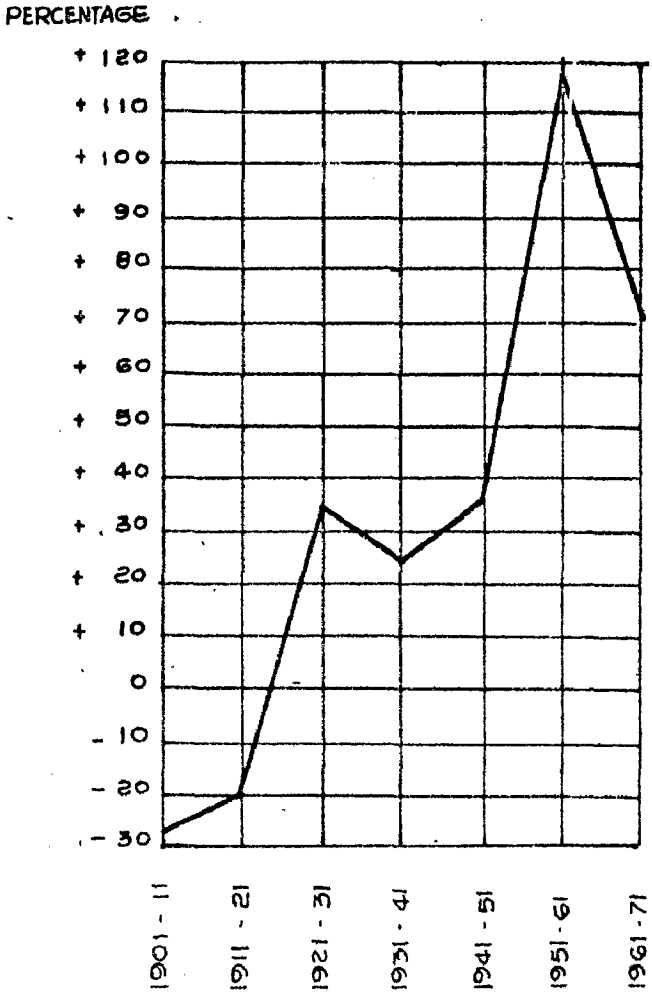
2.3.1 During the last 7 decades the population of Bhopal has gone up by 382.45%. The growth between 1901 to 1971 has been given in the table No.1 (Page 19-A). The phenomenal growth during the decade 1951 & 1961 can be attributed to two main facts :- i) The city was made capital of the State in 1956 in the wake of State re-organisation ii) Concurently Heavy Electrical Plant (now BHEL) was located on the fringe of the city. Consequently population of the city

POPULATION TRENDS
1901 - 1971



SOURCE : CENSUS REPORT

POPULATION VARIATION
DECENNIAL GROTH RATE
1901 - 1971



SOURCE : CENSUS REPORT

BHOPAL : POPULATION CHANGES

TABLE - 1

YEAR	POP. IN LAKHS	% DECADE VARIATION
1901	0.77	-
1911	0.56	-27.03
1921	0.45	-19.77
1931	0.61	+35.36
1941	0.75	+23.25
1951	1.02	+36.03
1961	2.23	+117.87
1971	3.85	+72.63

SOURCE : CENSUS OF INDIA, 1961 & 1971

BHOPAL : POPULATION ESTIMATES

TABLE - 2

METHOD	PRESENT 1971	FUTURE 1981	ESTIMATES 1991	2001
1 DECENNIAL GROWTH	3.85	6.6	12.5	18.7
2 FITTING CURVE METHOD	3.85	6.8	10.6	15.1
3 RATIO METHOD	3.85	6.7	11.8	19.5
4 COMPARATIVE GRAPH METHOD	3.85	6.7	9.5	14.0
FIGURES ADOPTED	3.85	6.5	10.0	15.0

(SOURCE : BHOPAL - DEVELOPMENT PLAN M.P.T.& C.P. DEPT)

swelled from 1 lakh to 2.23 lakhs in 1961 an increase of of 118%. The increase was too sudden to accomodate or provide urban services. Slums and juggies sprang up particularly in BHEL and new townships. The city is yet to recover from these effects because the growth rate is nearly 7.5% per annum which is the highest among the cities of the state. During the last two decades the city has grown nearly four times in population.

2.3.2 Population estimates for 1981 & 1991 worked out by M.P. Town and Country Planning (MPTCP) Department by different methods are given in Table 2 (Page No. A.) Strategic location of Bhopal, its climate and its unique landscape value will give impetus to growth and make it potential metropolitan city of the State by 1991.

2.4 MIGRATION

Migration figures for Bhopal city are rather significant. According to 1971 Census 53% of the total population were migrants (23.14% from other states). Migration trends would continue in future because of shifting of offices to the capital.

2.5 FAMILY SIZE

1961 census gave 4.5 as the average household size while in 1971 the household size have swelled upto 5. Larger household size may be owing to sharing of the accomodation. In general, number of persons per family is reducing for many socio-economic reasons.

2.6 OCCUPATIONAL PATTERN

The capacity of a city to provide variety of jobs and absorb its working population in various sectors of economy is an indicator of the economic viability of the city. In 1971, the percentage of economically active population was 28.12% and the participation of females in the gainful occupation was very low (4.75%). The distribution of workers in three broad sectors as per 1971 census report is as follows:-

Primary sector	-	3.2%
Secondary sector	-	32.8%
Tertiary sector	-	64.0%
Total		100%

Of the total workers (1,10,318) about two fifths are service class people engaged in Government jobs, 29% in manufacturing and the rest (31%) in other activities.

On comparison of 1961 data with that of 1971 data revealed phenomenal increase by 64.7% in tertiary sector indicating administrative character and growing trade and commercial activity whereas increase in the workers in 'manufacturing' by 12% is not indicative of the strengthening of the industrial base of the city.

Percentage of households classified by the income is shown in the following table.

TABLE :

Monthly income Rs.	% of Households	Category	%
less than 50	0.18		
51 -99	1.72		
100-199	22.65	EWS	67.5
200-349	42.95		
350-499	10.75	LIG	16.91
500-599	3.34		
600-749	5.34		
750-999	7.25	MIG	14.59
1000-1499	2.00		
1500 & above	2.00	HIG	2.00
Total	100.00		100.00

SOURCE : Socio-Economic Survey, M.P. Town & Country Planning Department.

HUDCO norms that for every 100 houses to be constructed 75% should be for EWS, 15% for LIG, 8% for MIG and 2% for HIG have been tailored to reflect the income pattern of society. However, the table clearly indivates that MIG category in Bhopal is almost double than the average normal pattern. The imperative indication is that the housing efforts by housing agency should be revised to the actual proportion.

2.7 HOUSING

Normally the word housing and the problems related to it are taken to mean dwelling units in terms of quality and quantity

alone. It is often forgotten that the quality of life is even more dependent on other elements such as tenure status, occupancy rate, housing shortages etc. It is in this context that the problem of housing, being experienced in Bhopal, have been studied.

2.7.1 Housing activities in Bhopal, unlike other cities, are dominated by Government and semi Government organisations. Quantum of housing areas developed by Government and other agencies after 1956 is reflected in the Table 2.71 - T.1 . It clearly reveals the prodigious amount of development done by corporate sector. Out of nearly 884.8 hectares of housing area nearly 838.8 hect. i.e. 95% has been developed under corporate sector, while only 48 hectares i.e. nearly 5% have been developed by private colonisers.

2.7.2 TENURE STATUS

Nearly 70% houses were recorded as rented in 1971. Even in old city, owing to economic disparity, the quantum of rented houses is more. There has been some marginal improvement in situation as the percentage of rented houses in 1971 decreased to 70% from 73% in 1961. The tendency of the workers to settle down in the city is likely to create more demand for owned houses in future.

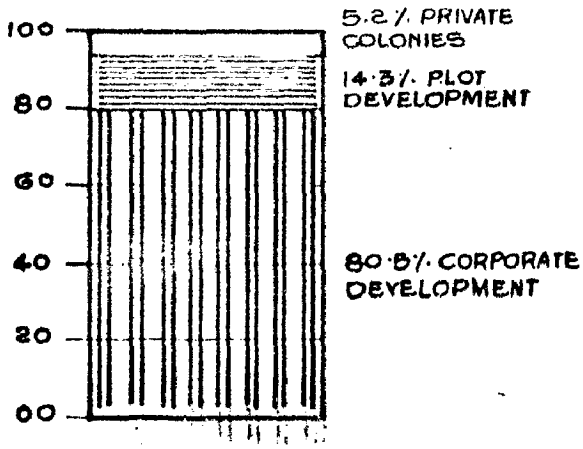
CHARACTER OF HOUSING AREA

TABLE : 2.7.1 – T 1

	AGENCY	DECRIPTION	HOUSING AREA DEVELOPMENT AFTER 1956 AREA IN HECTARES	%	% OF TOTAL HOUSING AREA
A	CORPORATE DEVELOPMENT	T.T.NAGAR, B.H.E.L. ETC.	712.7	80.5	46.5
B	PLOT-WISE GOVT. LOCAL BODY	ARERA COLONEY, MALVIYA NAGAR	126.1	14.3	8.2
C	PRIVATE COLONIES	RAISEN, SEHORE & BERASIA ROAD	46.0	5.2	3.0
	TOTAL		848.8	100.0	57.7
D	MAIN CITY/BAIRAGARH/ OUTGROWTH	OLD DEVELOPMENT	649.2		42.3
	TOTAL		1534.0	100.0	100.0

SOURCE : FIELD SURVEYS, TOWN AND COUNTRY PLANNING DEPARTMENT.

HOUSING AREA DEVELOPMENT AFTER 1956



2.7.3 OCCUPANCY RATE AND DWELLING UNIT SIZE

In spite of efforts of the Government and Housing Board in construction of more houses the situation in overcrowding has not improved. Only 20% of the Govt. employees (total No.38400) are provided with Government accomodation. Housing activity in private sector has also not kept pace with the demand. The change in the situation in overcrowding in various types of dwelling units is indicated by figures compiled from census data for last two decades in the Table T-1 (Page 24-A).

A close perusal of the table reveals that the average occupancy rate (i.e. persons per room) has almost remained the same during 1961-71, although changes in various sizes of dwelling unit have taken place. The proportion of households living at an occupancy rate of more than two persons per room has reduced only insignificantly from 94.2% in 1961 to 92.7% in 1971. Even the large scale housing activity undertaken particularly in the Government sector has failed to make any impact. The rate of house construction will have to be intensified to reduce the overcrowding as nearly 79.4% of the households are still living at an occupancy rate of more than 2.8 persons per room* Overcrowding in one room and two room dwelling units has increased during 1961.71 by 10.3% and 8.8%

* In U.K. Permissible rate of occupancy is 0.89 persons per room. A Higher occupancy is liable for prosecution for overcrowding but in India a rate of 1.5 PPR is considered acceptable.

BHOPAL : DWELLING UNIT SIZE & OCCUPANCY RATE

TABLE T-1

YEAR	HOUSEHOLDS TOTAL		OCCUPANCY RATE	DWELLING UNIT SIZE 1 RM	2 RM	3 RM	4 RM	5 RM
1961	39947	HHD %		58.4	29.4	6.4	3.8	2.0
		OCCUPANCY RATE PPR	2.89	4.06	2.60	2.24	1.89	1.56
1971	58673	HHD %		50.7	28.7	13.3	4.4	2.9
		OCCUPANCY RATE PPR	2.87	4.48	2.83	2.08	1.79	1.68
1961-1971	-	RATE OF CHANGE OF OCCUPANCY RATE %	-0.7	10.3	8.3	-7.1	-5.3	23.5

SOURCE : COMPILED FROM CENSUS REPORT 1961, 1971

HOUSING SHORTAGE (SECTOR WISE)

TABLE - 2

	EMPLOYEES /WORKERS	D. UNITS NEEDED	AVAILABLE	SHORTAGE D. UNITS
1 STATE, CENTRAL GOVT, AUTONOMOUS BODIES, EX. SAF/DEF.	36400	23700	11500	12200
2 B.H.E.L.	19400	15500	12000	3500
		39200	23500	15700
3 SHORTAGES NOT COVERED BY 1 & 2		37100	20150	16950
DWELLING UNITS		76300	43650	32650

SOURCE : 'BHOPAL DEVELOPMENT PLAN - 1991', M.P. TOWN & COUNTRY PLG DEPT.

respectively. This indicates deteriorating living condition among household living in such units. It is also revealed that only about 3% households are enjoying adequate housing space.

2.7.4 STRUCTURAL CONDITIONS

As per 1971 census increase in the content of katcha units by 4.5% and decrease in the content of pacca houses by 13.6% indicates deterioration of housing stock. This also indicates formation of more slums in the city.

2.7.5 HOUSING SHORTAGE AND REQUIREMENTS

Unprecedented influx of migrants eventually resulted in chronic housing shortage, particularly in the formative stage of capital city. Housing shortage could not be wiped out inspite of large scale construction under Government sector. On the basis of 1971 census data and survey conducted by MPTCP Department, the housing backlog has been estimated as 32750 dwelling units inclusive of shortage of quarters (16950). Ref.Table-2 (Page 24-A).

Considering future growth of population, change in socio-economic conditions, family size, replacement of housing stock in dilapidation etc., MPTCP Department have estimated the future requirements as follows:-

1981 - 92500 dwelling units

1991 - 178100 dwelling units.

Further break up of housing requirement as per income category by 1991 is shown in table below.

TABLE: DWELLING UNIT - REQUIREMENT BY TYPE

Category	Dwelling unit Number	%
EWS	71,200	40
LIG	53,400	30
MIG	44,500	25
HIG	8,900	5

Source : Bhopal Development Plan - 1991 by MPTCPD

With the modest estimate of average Rs.12,000 per dwelling unit it would require 39.6 crores to clear backlog. As against this Rs.31.2 crores have been allotted for the housing in Sixth Plan period (1978-83) for the whole of Madhya Pradesh. At the state level the housing requirement in 5th plan period has been estimated as 3.3 million units (23 lakh rural - 10 lakh urban), HUDCO assistance, debenture fund and L.I.C. assistance would marginally supplement the financial requirement.

2.8 BUILDING MATERIALS

The black cotton soil which is found in and around city areas is not at all suitable for brick manufacturing as it contains calcium. The bricks available are of poor quality having a crushing strength of 35 kg/cm2. Of late some manufacturers have started production of GHOL bricks (crushing

strength 70 to 80 kg/cm^2). But the demand far exceeds the supply.

The red sand stone suitable for building purposes is abundant almost along all the hillocks and near about areas. However, black basalt trap stone useful for aggregate in R.C.C. work is available in limited quantity and is required to be imported from areas 20 to 25 km away.

The local sand available in the beds of various nallahas is not of good quality as it contains clay. Narbada sand is commonly used for almost all the building purposes which is brought from Hoshangabad - a distance of 55/65 km.

Cost of sand and B.T. metal is rather high because of transportation cost involved.

Teak-wood from central province (C.P.Teak-wood) is considered as one of the best and is available in plenty. Timber from secondary spices such as Bija, Mokha etc. are also available. Seasoning plant established by M.P. Industries Department should give impetus for the use of secondary spices.

Supply position of cement keeps on fluctuating. Pozolana cement and dry hydrated lime are now available.

Locally available steel is sub-standard steel which is rerolled steel. However steel as per IS:432 grade (mild steel) or I.S : 1986 (Ribbed Tor steel) is now available in plenty.

The labour wages for skilled workers are high and are not readily available. Unskilled workers are available readily. Building industry faces no special problem on account of either materials or labour.

The prices of various building materials and wages of labour have been given in Appendix-II.

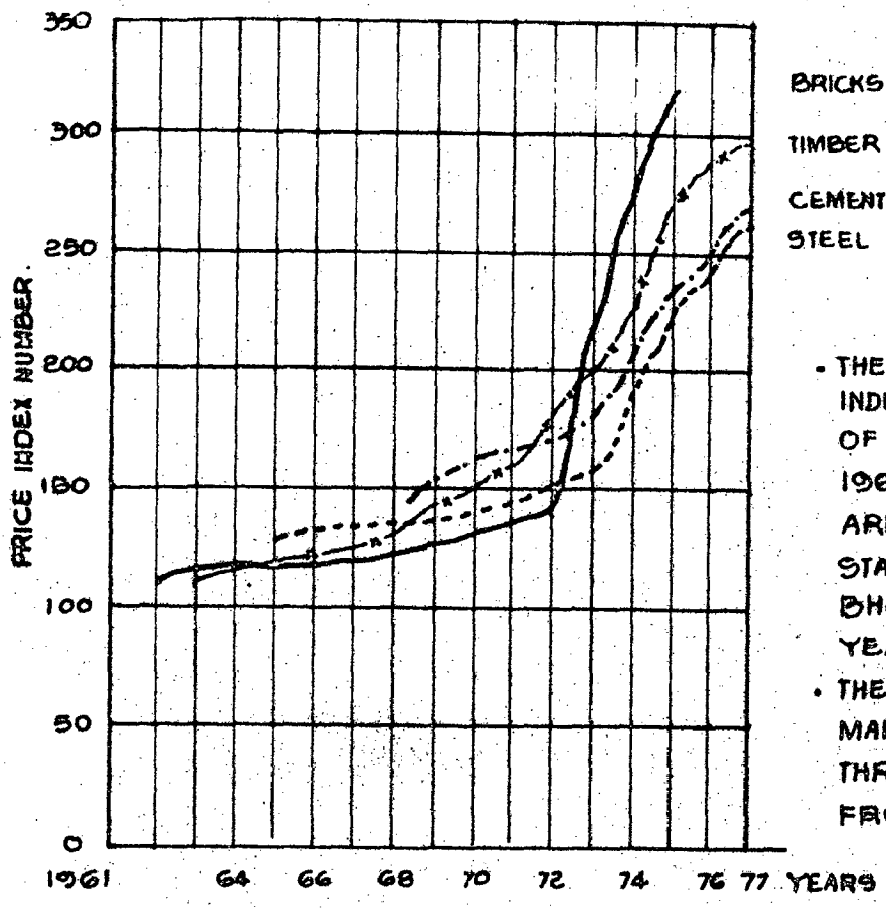
2.9 TRENDS IN BUILDING COST

Building costs have been steadily rising especially during last 15-17 years. This is due to the fact that the building cost is directly related to the living cost which itself is progressively increasing. The trends in building cost indices are depicted in graph on page 28-A. It can be observed that building cost has increased nearly 3 times in the last 17 years.

Building cost indices are related to the increasing cost of building materials. The trends in the increase in the cost of building materials is shown in graph on page 28.A.

2.10 OBSERVATIONS

1. In last two decades, Bhopal has grown nearly 4 times in population. Projected population for 1991 is 10 lakhs.
2. Migration trends are significant and would continue because of the shifting of many offices at Bhopal.
3. Average family size of Bhopal is 5.

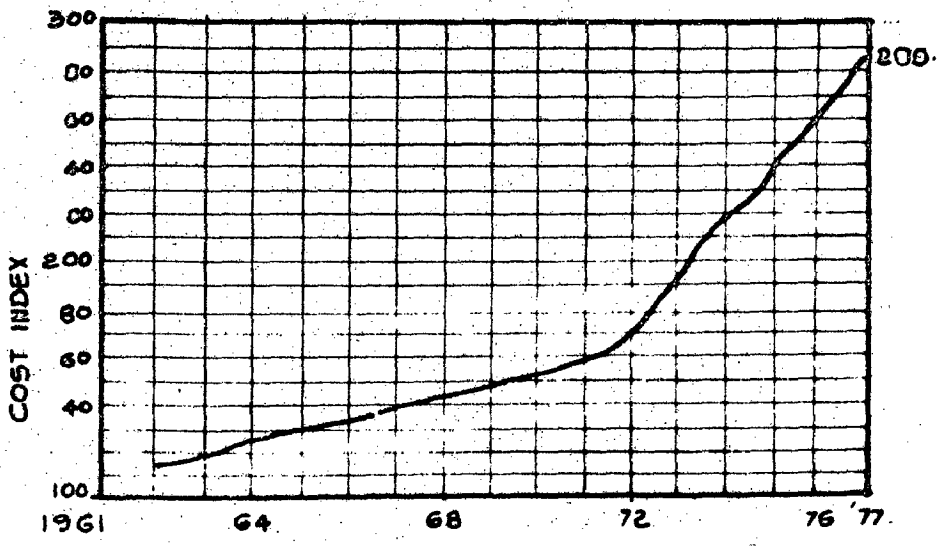


- THE GRAPH DEPICTS THE TRENDS IN INDEX NUMBER OF WHOLESALE PRICES OF VARIOUS BUILDING MATERIALS FROM 1962 TO 1975. THE INDEX NUMBERS ARE AS COMPILED BY ECONOMIC & STATISTICS DEPT. GOVT. OF M.P FOR BHOPAL TAKING 1961-62 AS BASE YEAR.
- THE PRICES OF THE MATERIALS HAVE MAINTAINED AN INCREASING TREND ALL THROUGH BUT IT IS MORE PROMINENT FROM THE YEAR 1972.

TRENDS OF MATERIAL PRICES

SOURCE : ECONOMICS AND STATISTICS DEPT. GOVT OF MADHYA PRADESH.
THE GRAPH WAS COPIED FROM M.P. P.W.D. S'E'S OFFICE, BHOPAL CIRCLE

RESIDENTIAL BUILDING COST INDICES OF BHOPAL - BASE: 1961 = 100



- THE BUILDING COST INDICES SHOW A SUBDUED INCREASE UPTO YEAR 1972 & THERE AFTER THE INCREASE IS STEEP.
- THE INDEX IS COMPILED ON THE BASIS OF THE WEIGHTED AVERAGE (ARITHMETIC) FOR MATERIALS & LABOUR INDICES COMPUTED BY ECONOMICS & STATISTICS DEPT. BHOPAL.

4. Of the total working population, 60% are engaged in administrative services and are Govt. servants.

5. MIG section is approx. 15% of the total population.

6. Housing activity is predominantly in corporate sector and private investment is insignificant.

7. 70% of the households live in rented accomodation.

8. About 80% of the population live in less than two room accomodation.

9. The requirement of dwelling units by 1991 is in the order of 1,78000 out of which the requirement for MIG section would be 44000.

10. Building industry faces no special problem because of material or labour.

11. Building cost and cost of materials have escalated 3 times during last 15-17 years.

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CHAPTER - 3 AN APPARAISAL OF MPHB's WORKS

Madhya Pradesh Housing Board (MPHB), Government sponsored public housing agency is functioning in the city and the State since 1960. But the real momentum in housing efforts could be geared only by 1972 when it was reconstituted with expectedly wider functions to perform, till 1971 it had been functioning mainly as a financing institution providing loans for house construction but later this facility was withdrawn and the Board is mainly concentrating on construction of houses for ownership under hire-purchase/ outright purchase scheme for EWS, LIG, MIG section of the population. Construction of rental housing has been stopped as a matter of policy.

To develop land and undertake housing construction in residential zones is the responsibility entrusted to the Housing Board. In Bhopal particularly all the housing development is earmarked to be developed by the MPHB alone because of the "land freeze" at the time of formation of capital. Because of the enforcement of stringent conditions on the colonizers, the private enterpreneurship in the housing activity has been practically eliminated. Apart from the willingness to invest on development there might be other reasons such as extension of essential urban infrastructure i.e. water supply, sewerage, accesibility by roads etc. But the fact remains that it has retarded housing activities to a great extent and has also

shifted the housing activity to only those areas where the Government provided developed plots. Consequently the development has been lop sided. Thus the contribution from private sector being negligible, it is only the Housing Board which caters to the needs of housing in Bhopal. Secondly, the very purpose of forming the Housing Boards under public sector is to provide economic housing. It is, therefore, all the more important to review and evaluate the works of MPHB at Bhopal. With this view, five MIG completed schemes of MPHB have been chosen as case studies (Ref.Drg.No. D 1 to D 5) and examined critically in general with special emphasis on space standards and the specification.

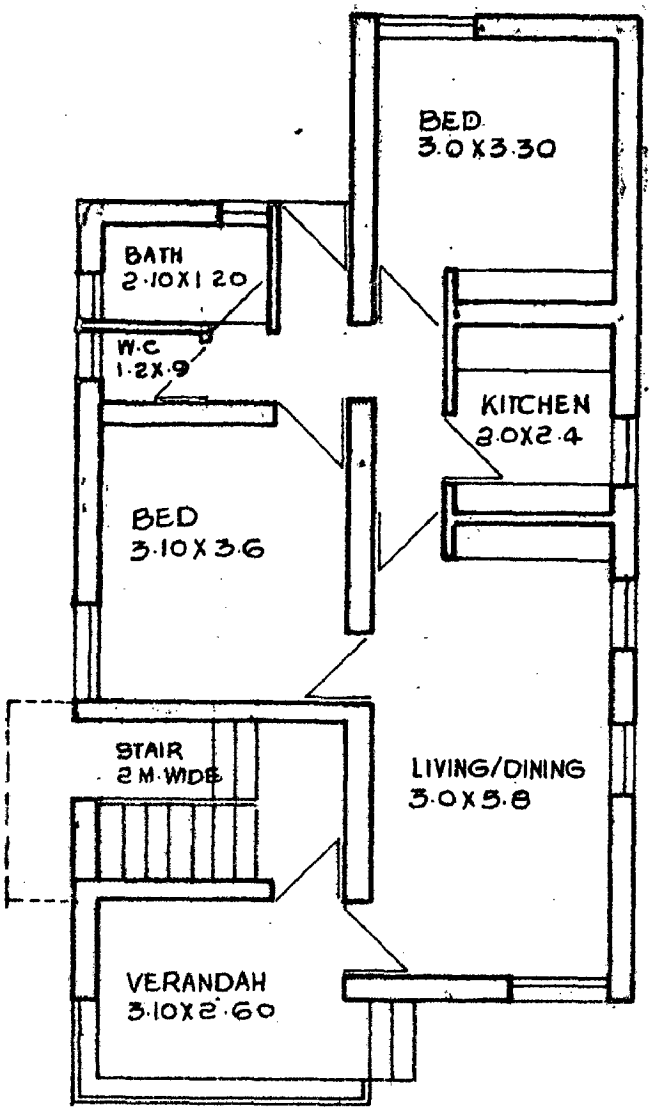
3.1 ACHIEVEMENTS OF MPHB

In Bhopal, total number of dwelling units constructed upto 31.3.1978 is 5222 under hire purchase schemes. Distribution of dwelling units under each category and percentage to the total have been shown in the Table below.

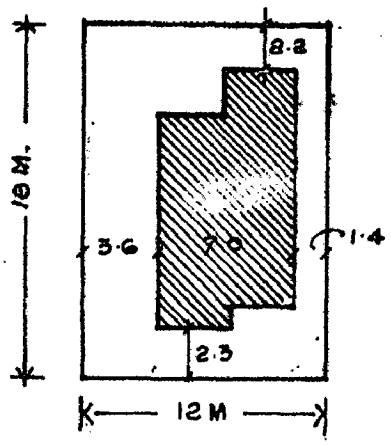
TABLE

Category	No. of Dwelling units	% to the total
EWS	2835	54.31
LIG	1189	22.76
MIG	900	17.23
HIG	298	5.70
Total	5222	100

Source : compiled from the Booklet published by MPHB.



GROUND FLOOR PLAN



SITE PLAN

OUTRIGHT PURCHASE COST
RS. 62000/-

MONTHLY INSTALMENT
RS. 483/-

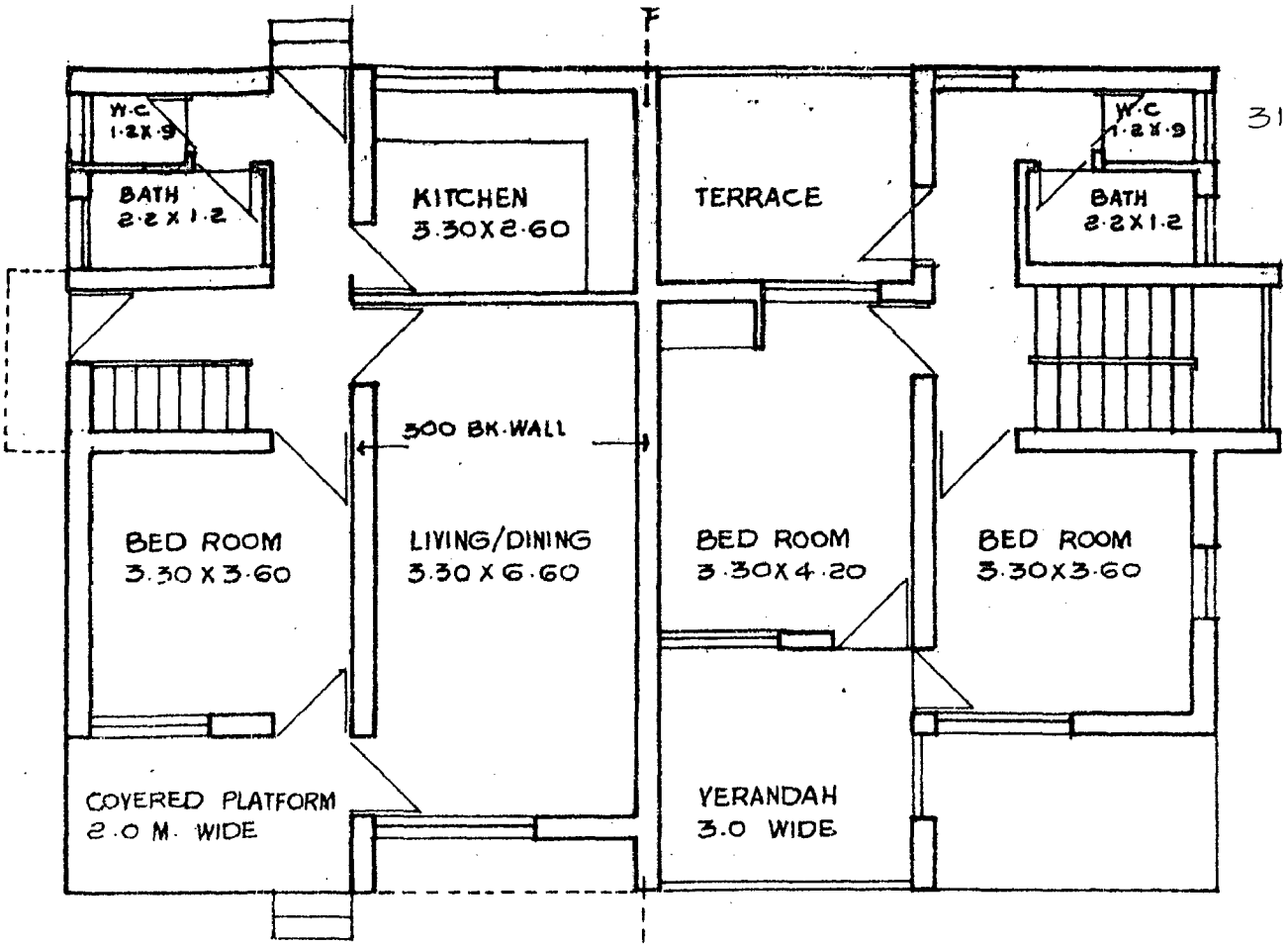
PLOT AREA : 216
PLINTH AREA : 80.80
FLOOR AREA : 62.68
EFFECIENCY : 76.67 %

AREA OF DOORS : 19.40 M^2
AREA OF WINDOWS : 11.52 M^2 18.37 %

SPECIFICATION

WALLS : 300 th.
FLOOR : IPS/MOSAIC
PLASTER : CEMENT
D/W FRAMES & SHUTTER T.W.
FLOOR HEIGHT : 3 M.

MIG HOUSE SOURCE : MPHB DRG Nº 84/703 FIG. -D1



31·B

GROUND FLOOR PLAN

FIRST FLOOR PLAN

OUTRIGHT PURCHASE COST
Rs 82000/-

MONTHLY INSTALMENT
Rs. 696/-

GROUND FLOOR AREA	70.36	M^2
FIRST FLOOR AREA	58.00	M^2
TOTAL	128.36	M^2
PLOT AREA	216.00	M^2

EFFECIENCY 76 %.

SPECIFICATION

MOSAIC FLOOR

CEMENT PLASTER

DOOR/WINDOW FRAME : T.W.

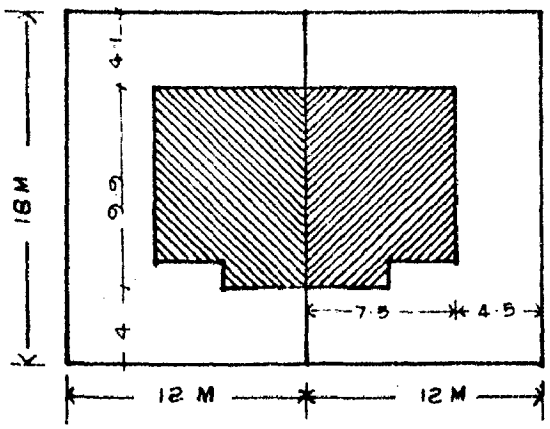
DOOR/ WINDOW SHUTTER : T.W.

LOAD BEARING WALLS : 300 th

FLOOR HEIGHT : 3M.

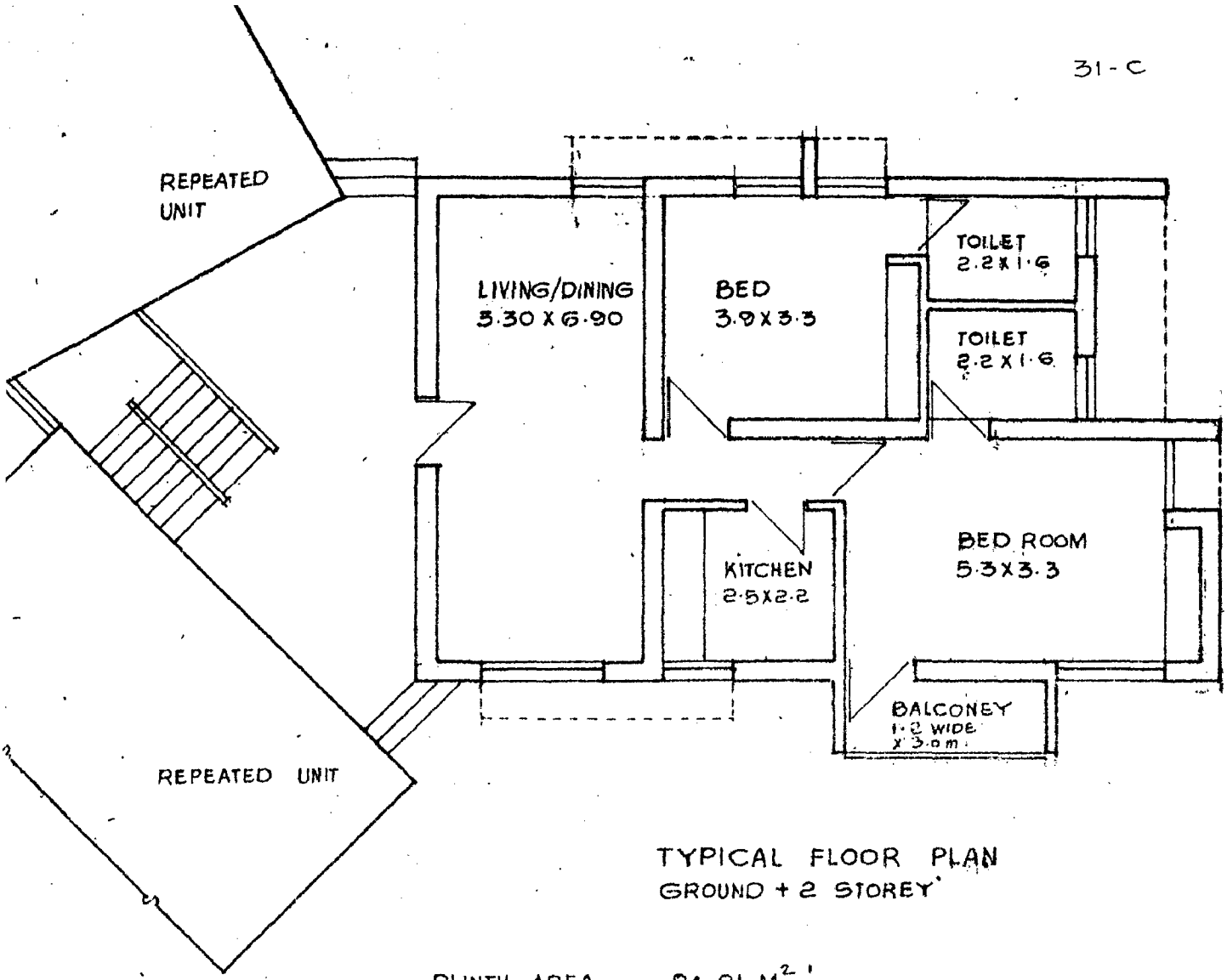
DOOR AREA : 28.4 M^2

WINDOW AREA : 16.32 M^2 · 16 % OF FLOOR AREA



SITE PLAN

Sr. MIG SOURCE : MPHB DRG Nº M/241 Dt. 13.9.76 FIG - D·2



TYPICAL FLOOR PLAN
GROUND + 2 STOREY

PLINTH AREA	84.81 M^2		
FLOOR AREA	68.57 M^2	EFFECIENCY	: 76.23 %
STAIR + PASSAGE	7.5 M^2		

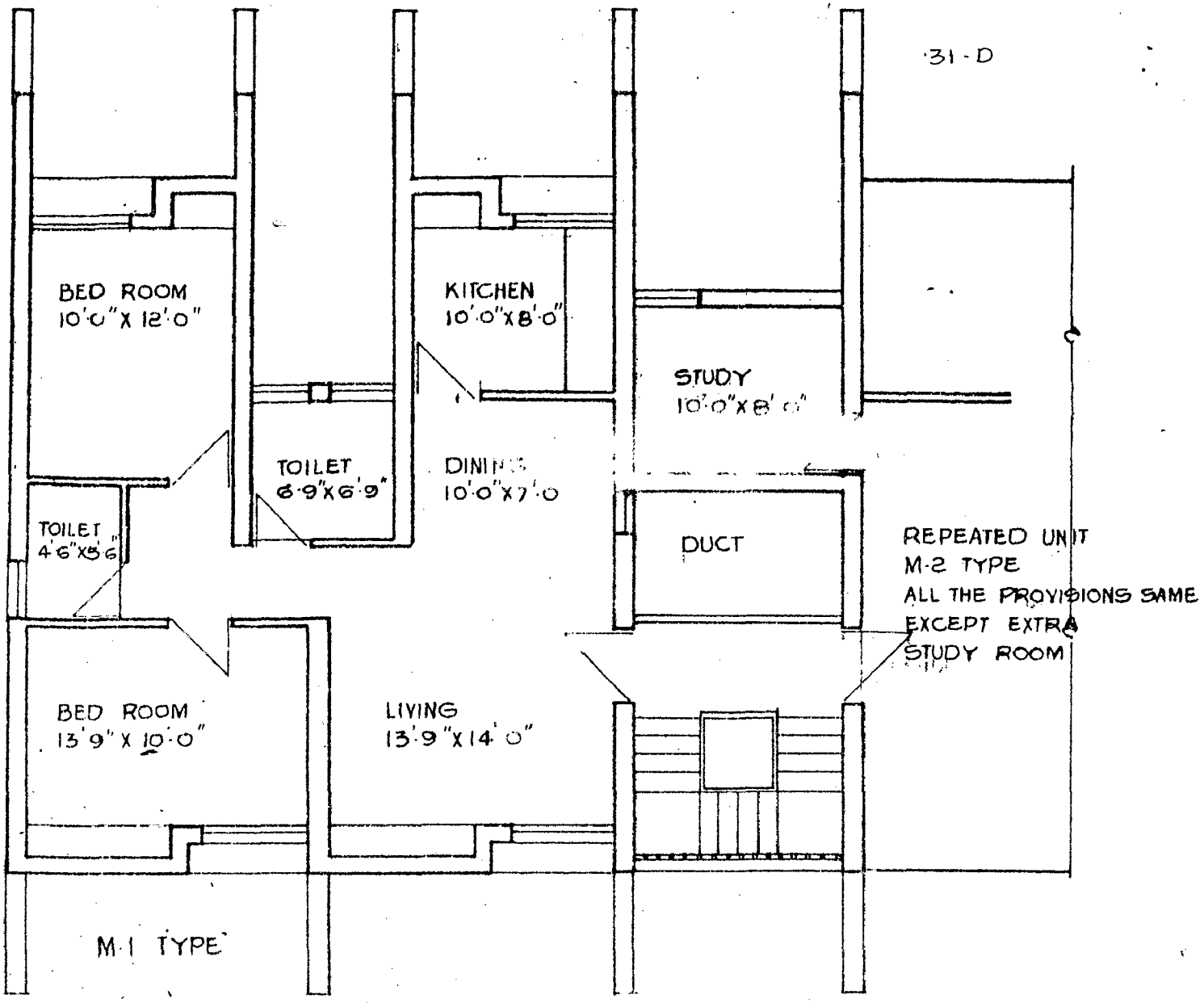
O.P. COST : Rs 60,670/-
M. INSTALT : Rs 467/P.M.

SPECIFICATION

FLOOR : IPS/MOSAIC
WALLS : 300 FOR ALL THE FLOORS
D/W : TEAK WOOD
FLOOR HEIGHT : 3.0 M
R.C.C. SLAB

DOOR AREA : 12 M^2
FLOOR AREA : 11.2 M^2 16.1 % OF FLOOR AREA

MIG FLATS SOURCE: MPHB ORG Nº 76/0824 FIG 10.1 - D.3



TYPICAL FLOOR PLAN

GROUND + 2 STOREY

PLINTH AREA : 84.4 M^2
FLOOR AREA : 66.63 M^2 EFFECIENCY 78.12 /.

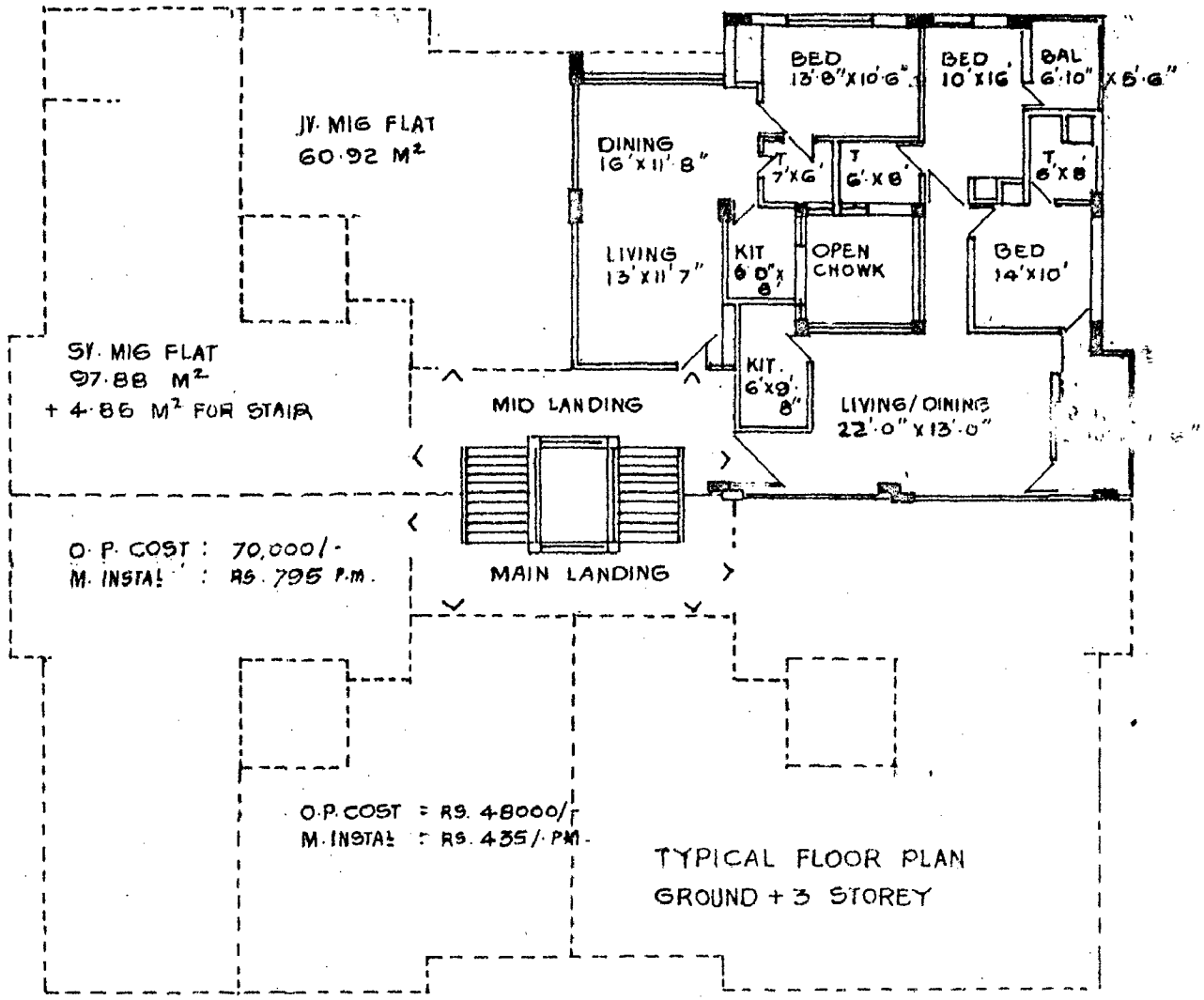
SPECIFICATION

WALLS : 300 FOR ALL FLOORS (LOAD BEARING)
FLOOR : MOSAIC
DOORS : FLUSH TYPE
D/W FRAMES & SHUTTERS : TEAK WOOD
PLASTER : C. SAND FACED OUTSIDE
C. NEEROO FINISHED INSIDE
R C C SLAB

O.P. COST : Rs. 72000 /-
M. INSTALMENT : Rs 795 / P.M.

FIG [illegible] - D4

MIG FLATS M-1 & M-2 TYPE SOURCE : MPHB DRG NO MISC/180 (M)



SY. MIG
PLINTH AREA : 97.88 M²
FLOOR AREA : 80.26 M²
EFFECIENCY : 81.97 /.

JY. MIG
PLINTH AREA : 60.92 M²
FLOOR AREA : 49.95 M²
EFFECIENCY : 82 /

SPECIFICATION
R.C.C. FRAME STRUCTURE, D/W. FRAMES & SHUTTERS : T.W., FLOOR HEIGHT 3.2 M.
FLOOR : MOSAIC, C. PLASTER INSIDE & OUTSIDE.

FIG - D5

MIG FLATS Jr. & Sr. TYPE SOURCE : VIDE DRG Nº M/308

By and large the housing efforts by the Board are in accordance with the income pattern of the population in Bhopal.

3.2 HOUSING FORM

Dwelling units for MIG have been constructed in almost all the housing forms such as multi family housing, single family houses (detached, semi detached maisonette) and duplex except row housing which is considered as most economical. Of the 900 MIG dwelling units, 440 are in multi-family housing (48.8%) and 460 (51.2%) in single family houses. Time and again, through various seminars and reports, it has been emphasised that the public agencies which construct the houses through public exchequer should resort to group housing rather than plotted development. Group housing is not only economical as the cost of dwelling units but also checks the urban sprawl encroching on nearabout agricultural land. Maisonette form is economical by 40% provided it is used in groups of 5 or more* whereas MPHB has adopted twin unit form. Secondly maisonettes with sloping R.C.C. roof do not allow any possibility of future expansion. It appears that different housing forms have been used as an architectural exercise rather than for the economic advantages offered by each housing form.

3.3 SPACE STANDARDS AND SPACE ALLOCATION

As per MPHB norms, the space provision for MIG housing is 80 M^2 (plinth area) which is only in intents and not in

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* Cleeve Brar. 'Counsil Authority Housihgg'

contents. Space provision (plinth area, floor area and other space areas) as obtained from case studies have been comiled in Table No.3.3 - T 1. It can be observed that there is wide variation in space provision (in terms of plinth area) from 60.92 M2 to 128.36 M^2 for the same economic group. The Housing Board ought to have adopted at the most 3 standards to cater to the needs of sub group in MIG: one akin to LIG standard for lower MIG, second for middle MIG and third akin to HIG standard for higher MIG. Area variation would have been justified provided the cost of dwelling unit achieved is within the imposed ceiling cost of Rs.42,000/- (vide HUDCO's FOLDER-1). It can be observed from table No.2 that the cost of dwelling unit (at S.No.5) having a plinth area of 60.92 M^2 (lowest in the lot) is 14% more than the ceiling cost.

The stipulated area standard should be followed in all design solutions. The argument that at times the design considerations necessiate an upward shift has no sound footing. For example, in the designs of Govt. quarters stipulated area standards are strictly adhered. It means, different design solutions with fixed space norms can be achieved. Schemes at S.No.6 and 2 exceed plinth area ceiling of 95 M^2 (as imposed by HUDCO vide folder No.1) by 35.11% & 3.15% respectively.

Wide variation in the space provision of different spaces (living, dining, bed, kitchen, toilet etc) is ofcourse due to variation in plinth areas. However, the designs (S.No.1, 3 & 4 - Table 3.1 T). which have more or less identical

TABLE 3.3- T 1

S. No.	Type	Plinth area	Floor area	Efficiency F.A/P.A	Living/ Dining	Bed 1	Bed 2	Bed 3	Kitchen	W.C	Bath	Passage Ver/ Bal.	Door Area (M^2)	Window % to Floor area
1.	MIG House Plot Area	80.80 216.00	62.68	75.67%	13.4	11.16	9.9	-	4.8	1.08	2.52	7.29 8.06	19.40	18.37%
2.	Sr.MIG House Plot Area	128.36 216.00	97.55	76.0%	21.78	11.88	11.88	13.86	8.58	1.08*	2.64*	10.4 16.2	28.4	16%
3.	MIG Flat (Load Bearing St.)	84.81	68.57	75.73%	22.77	17.49	12.87	-	5.5	3.52 (Toilet*)		2.9 3.6	12	16.1%
4.	MIG Flat-M 1 (L.B.Structure)	84.4	66.63	78.12	17.90 6.51	12.79	11.16	-	7.44	4.23(Toilet) 1.97(Toilet)		4.51	12	17.3%
5.	MIG Flat Jr. (Frame structure)	60.92	49.95	82%	31.35	13.34	-	-	4.95	3.90(Toilet)		-	8	17.56%
6.	MIG Flat Sr. (Frame structure)	97.88	80.26	81.97%	26.60	13.02	14.88	-	5.39	4.46(Toilet)*		5.20 10.79	24.0	16.97%

*Two Numbers

TABLE No.2

S.No.	Type	Outright purchase cost	% variation from the ceiling cost*
1.	MIG House	Rs.62000/-	+ 47.61%
2.	Sr.MIG House	Rs.82000/-	+ 95.23%
3.	MIG Flat	Rs.60670/-	+ 44.45%
4.	MIG Flat M-1	Rs.72000/-	+ 71.42%
5.	MIG Flat Jr.	Rs.48000/-	+ 14.28%
6.	MIG Flat Sr.	Rs.70000/-	+ 66.66%

* Ceiling cost of Rs.42000/- for MIG dwelling unit has been imposed by HUDCO (Vide Folder No.1).

floor areas (considering 5% variation due to design concept) also indicate wide variation in different spaces as indicated in the Table below:-

TABLE

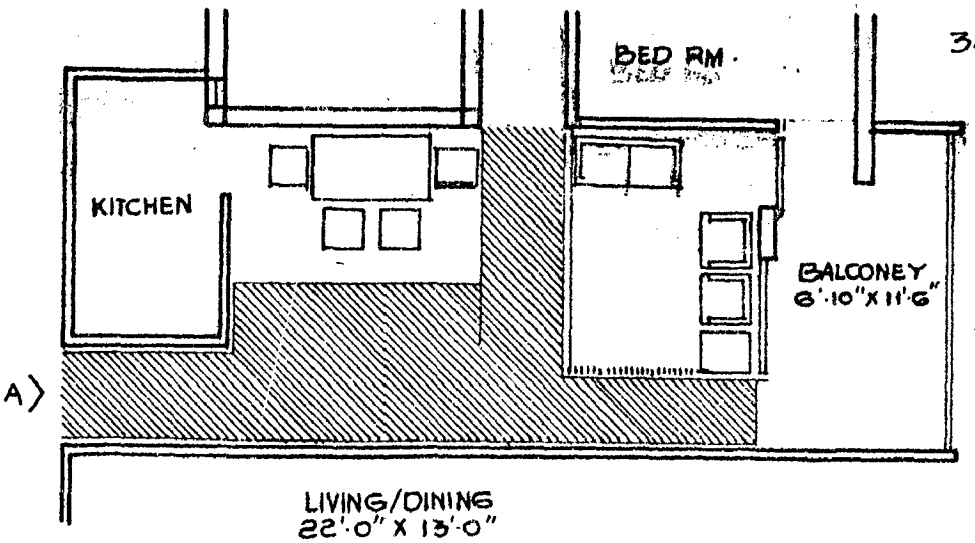
Space	Range in Area	Variation %
Living-Dining	17.4 M^2 to 22.77 M^2	30.56
First Bed	11.6 M^2 to 17.49 M^2	33.67
Second Bed	9.9 M^2 to 12.87 M^2	30.00
Kitchen	4.8 M^2 to 7.7 M^2	60.41
Toilet	3.52 M^2 to 3.6 M^2	-

Variation in areas to the extent of 30% can be observed in all the spaces except that of Toilet. It clearly indicates that there is no rationale and the design solutions are based on the intuition of the designer. Such an intutional approach not only leads to user's dissatisfaction but often results in wasteful spaces which increases the cost. A typical case of living-dining has been shown on page 34-A indicating the proportion of 'wasteful' space.

CEILING HEIGHT:

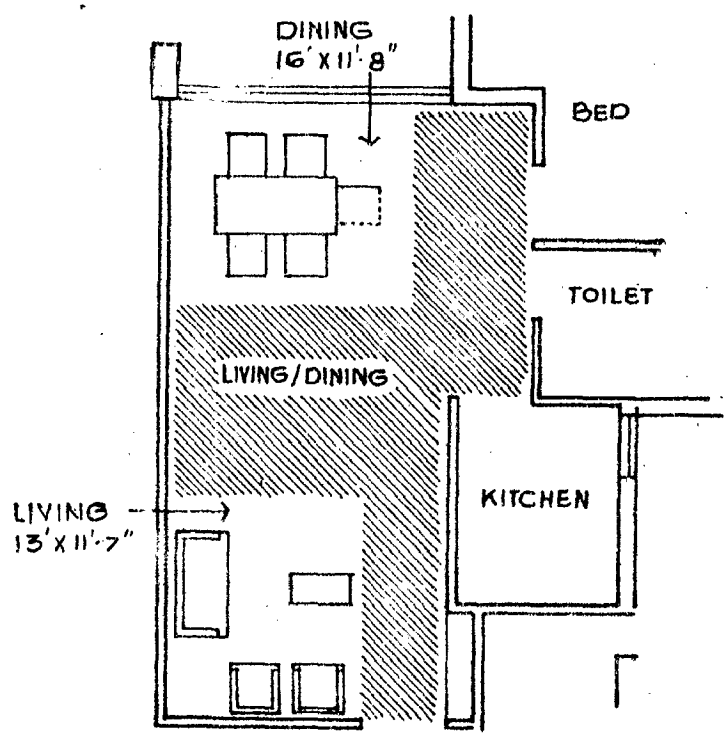
CBRI has already established that the ceiling height more than 2.7 M* has no marked effect on the thermal comfort and yet the floor height of 3.1 M to 3.5 M height has been provided in the designs.

*National Buildings Code 1970 also stipulates minimum height 2.7 M for residential buildings.



Sr. MIG FLAT VIDE DRG Nº

IF THE SPACE PROVISION IS NOT 'NEED' BASED OR BASED ON NATURE OF BELONGINGS, IT RESULTS NOT ONLY IN EXCESSIVE SPACE BUT ALSO ULTIMATELY INCREASES THE COST



Jr. MIG FLAT: DRG Nº

VIEW FROM 'A'

TYPICAL EXAMPLES SHOWING WASTAGE OF SPACE IN MIG DWELLINGS

STORING UNITS:

It can be observed from the drawings D.1 to D.5 that the provision of cupboards (storing unit) has not been standardised. The floor area provision for such units vary from 0.54 M^2 to 1.44 M^2 i.e. width varies from 0.9 to 2.4 M.

3.4 EFFICIENCY OF PLAN

The utility of the accomodation depends on not only what is given but how it is planned. The measure of efficiency (floor to plinth area ratio) as suggested by the "Committee on Plan Projects" has been used to check the efficiency of the designs (Ref.Appendix III). It can be observed from the Table No.3.3 T.1 that the recommended efficiency of 83% in case of load bearing structures and 87% in case of frame structures has not been achieved in any of the designs. It indicates that more area has gone in wall area. It was also observed that break up of spaces into different categories such as living, service, circulation and walls has not been indicated on any plans leave alone giving the justification of any variation from the limits.

WINDOW AREAS:

Cost of windows/doors is 5 times more than the cost of wall. As such the need to economise on such provisions does not require any comment here. It can be observed from Table No.1 that window areas range between 16 to 18% of floor area against normal provision of 10 to 12% in hot-arid climate. In absolute terms window areas are 60 to 80% more than the normal provision of 10 to 12% in hot-arid climate.

3.5 SPECIFICATION AND CONSTRUCTION TECHNIQUE

With the advancement in structural designs and availability of Ghol bricks, it was possible for MPHB to design 3 storeyed structures in one brick load bearing walls for all the floors and yet 300 thick load bearing walls have been deployed even for G + 1 structures. Secondly, 300 thick load bearing wall all along the periphery could have been avoided by using 200 th. brick wall where it does not support the structure. This would have resulted in saving in foundation cost as well as in material.

Although only metric size bricks are available in Bhopal yet drawings are prepared in inch foot system wherein the openings etc are provided in 3" module which if used with metric bricks results in wastage in cutting of bricks upto 10 to 15% *

SPECIFICATION:

The specification adopted in the said designs were studied from the respective tender documents. The following is the brief of specification.

Foundation	: strip foundation/RCC col.foundation/ pile foundation
Foundation concrete	: 300th 1:4:8 cement concrete
Walls	: 300th in 1:6 cement mortor

*'Economy in the Construction of Housing Projects' - Vidharbha Housing Board, Nagpur.

D.P.C.	: 50 thick 1:2:4 cement concrete
Intermediate Floor/Roof	: R.C.C. slab (cast in situ)
Plaster (Ext.)	: 1:4 cement plaster(sand face)
Plaster (INT.)	: 1:6 cement plaster
Windows/Doors (Frames & shutters)	: Teak-wood
Finish on walls (INT)	: distemper
Finish on walls (Ext)	: Snowcem

The above brief speaks volume for itself and shows inaptness in adopting technological and material innovations by different R & D and other organisations. Different research organisations have already come out with alternative materials and specification to economise in the cost of construction but not a single one has been adopted. It indicates that there is a scope for rationalising the specification to reduce down the cost.

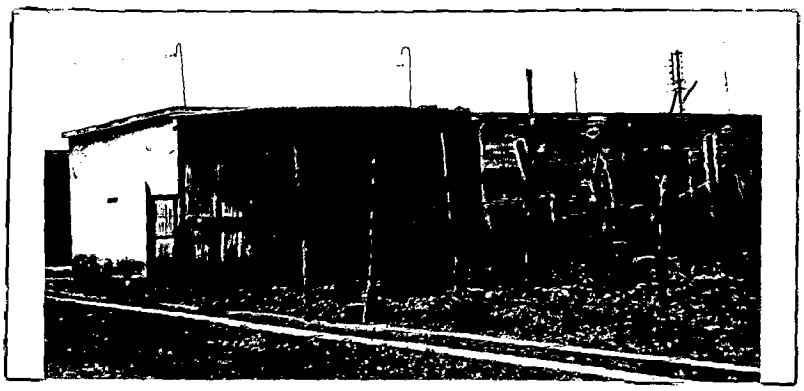
3.6 COST

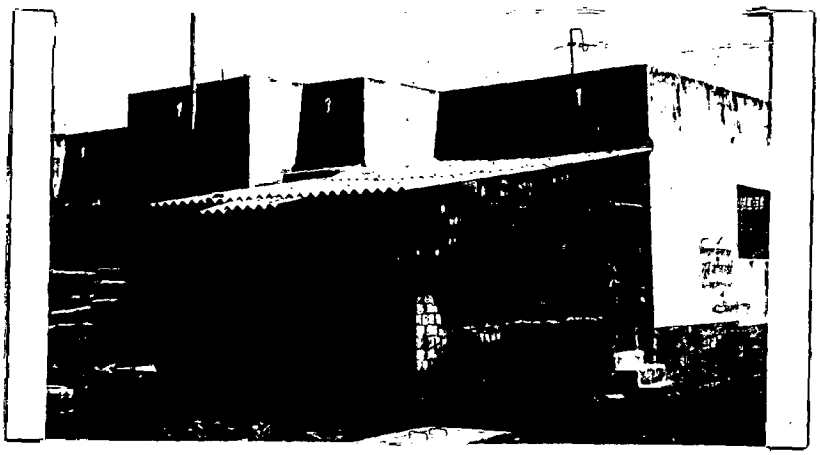
Ostentitious concepts about MIG housing in terms of space provision and specification have resulted in exhorbitant cost of MIG dwelling unit much beyond the paying capacity of MIG. Cost of dwelling units and corresponding monthly instalment has been already discussed in Chapter 1 (Page..8..). Monthly instalment of Rs.430 (lowest among the lot) forms

43.5% of the average MIG income. This has adversly affected the occupancy i.e. the ownership. The failure of MPHB can be gauged from the Survey Report 'Urban Housing in Madhya Pradesh' published by Institute of Regional Analysis, Bhopal in 1978. It has reported that 40 to 50% MIG dwelling units remained vacant, 47% out of the occupied were by HIG, 96% of LIG dwellings costing Rs.24000/- were occupied by MIG, 3 out of 4 EWS houses built at the cost of Rs.15000/- were owned by the families in the next higher income group. Non-affordability, the report further points out was evident from the fast that 6 out of 10 MIG houses have been sublet either partly or wholly. In order to compensate the monthly instalment, the owners construct temporary shabby constructions and let out at high rents. (Ref. photograph on Page 38 A). Occupants per force increase the number of tenantry portions in such circumstances. This not only creates visual disorder but results in theoretical slums and the purpose of providing reasonably adequate space for occupants is totally lost.

Construction of multi storied apartments (Betwa, Tapti) originally meant for MIG costing Rs.96000/- with monthly investment of Rs.950/- is an example of maniacal approach rather than realistic approach. (Ref. Photograph on Page 38 A). The land cost is not that exhorbitant so as to warrant construction of multi storeyed apartments. Most of these apartments have been rented out to executives and managers whose house rent is paid by their companies*.

* This information was given to the author by Estate Manager of MPHB.

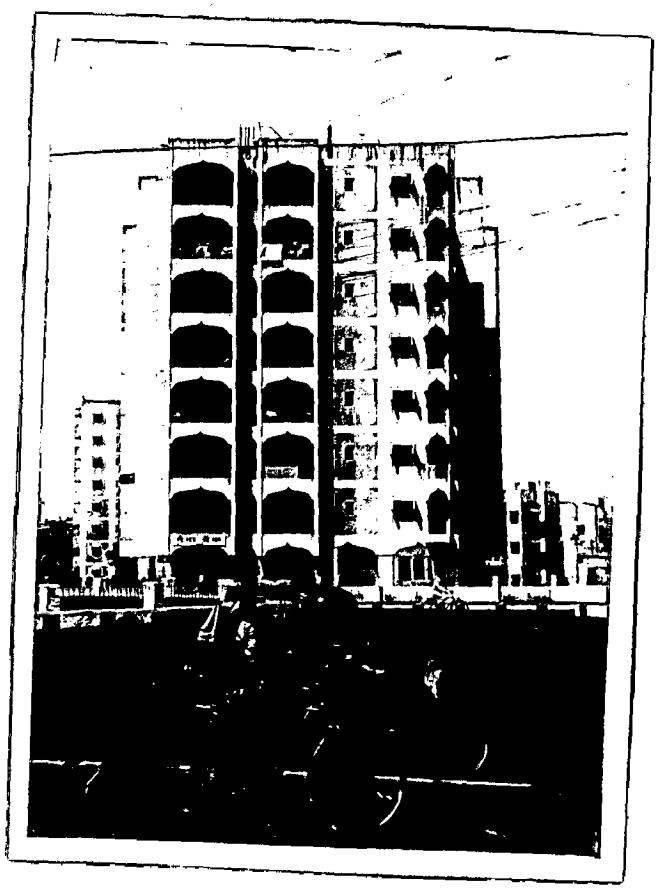




Owners per force construct shanty constructions which fetch rents approx. Rs.100 to 150 per month to compensate high monthly instalment.

Is the monthly instalment of Rs.950/- p.m.(90.47% of average MIG income)afford-able by MIG?

- In the words of John F.C. Turner "Probably these are meant for invisible MIG".



Confronted with unique situation of inability to dispose of MIG dwelling units and unable to attract hire purchasers because of high cost, the Housing Board has rented out the dwellings to offices(Ref.PhotographP.39A) and/or have been converted into Government quarters in order to recoup the money invested. Unrealistic policies have created a paradoxical situation where there is demand for houses and yet houses remain vacant or are let out to offices. It is worth mentioning here that MPHB has temporarity suspended the registration for ownership houses because of heavy pending demand.

3.7 GENERAL

Although MPHB is an autonomous body but still adopts the PWD system of 'percentage tendering'. Studies carried out by CBRI has proved that lump-sum contract system or item rate contract system is economical by 13 % & 11 % over percentage contract system respectively.*

It takes about 3 to 4 years to get an house from MPHB after the registration. People often back out from the enrolment because of upward revision (at times 15 to 20%) in the cost of dwelling unit.

Housing Board spends crores of rupees in the housing and yet the basic statistical information so vital for review/analysis/feed-back has not been maintained. Author experinced a great difficulty in getting the basic information such as housing shortages and requirements in Bhopal, cost break up, housing targets, etc.

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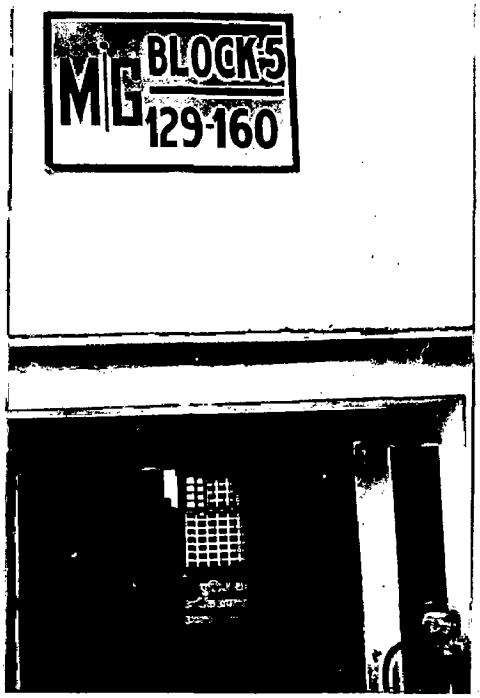
* CBRI B.Digest No.



Is Madhya Pradesh Housing Board (MPHB) solving the problem of offices or MIG housing ?

Majority of the schemes are designed by the architects through selected invitation rather than open competition. The greatest drawback in selected invitation system is that architect indulges in architectural extravagancy with disregard to economic, social and physical reality of the time and tends to be individualistic.

SUMMARY OF OBSERVATIONS:

1. In Bhopal, it is mainly the Housing Board which caters the needs of urban housing.
2. More than 50% of the dwelling units are in single house,
3. Space provision is not based on any rationale as such there is wide variation in total space as well as in other spaces such as living/dining, bed, kitchen etc.
4. Ceiling height of 3 to 3.5 M have been adopted.
5. Provision of storing has not been standardised.
6. Wall area exceeds than the recommended norms affecting the efficiency.
7. Window areas far exceed than the stipulated norms for economic housing.
8. No attempt has been made to lower down the cost by rationalising the specifications.
9. Obsentitious concept of MIG housing in terms of specification and space has resulted in exhorbitant cost of MIG dwelling unit which in turn has affected the occupancy.

...

CHAPTER - 4 SURVEY REPORT AND ANALYSIS.

It has been already pointed out in the previous chapter that MPHB, the only public housing agency in Bhopal, adopts different space standards for the same economic group (i.e. MIG) under same socio-climatic conditions. It means there are no precise guidlines or rationale and the designer is eventually guided by his own assumptions and intuitions. In the absence of such guidelines, the dwelling design solution often leads to users' dissatisfaction either utilitywise or costwise. In order to evolve rational space standards exploring the possibility of space reduction and get the guidelines for the design of MIG dwelling unit which would give maximum satisfaction and meet reasonable aspiratious of the people within the economic limitations, it is important to thoroughly understand among other things the activity patterp,the life style, socio-cultural needs and the economic capabilities of the dwellers. Socio-economic characteristics mainly influence the space norms and are not static. Hence, dwelling design should be viewed as an evolutionary process with users' needs and expectatiqns forming one link of chain. This approach will ultimately help in finalising the users' requirements. With these considerations in view systematic comprehensive survey of 100 MIG households in MPHB dwelling units was carried out with the objective to get planning guidelines in consonance with both - the paying capacity and pattern of living.

The results of such a small survey are normally regarded as indicative but can be taken as conclusive so far as generalization about living pattern is concerned.

4.1 SAMPLE DESIGN AND SCHEDULE

Since the purpose was to obtain a representative sample of MIG housholds, random sampling method was adopted for selection of samples. Preference was given to storeyed flats as only such housing form is likely to be constructed in future. Only those dwellings which were constructed in last 2-3 years and occupied by the owners themselves and were neither shared by a sub-tenant nor sublet were only subjected to detailed investigations, using predetermined schedule (Ref. Appendix IV). While open end questions were put for suggestions of the owners to elicit unbiased opinions, check list of probable responses was canvassed with the respondants. Mainly those aspects which are crucial in the design of dwelling units from the point of view of rational space provision and their sufficient use were covered.

4.2. COLLECTION OF DATA:

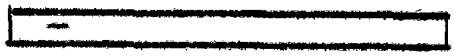
The technique for collection of data was personal interview with the responsible mambers (house owner/housewife) at their residences either in the evening/morning or on holidays.

4.3 OWNERSHIP PATTERN AND OCCUPATION

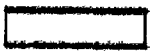
The owner's occupation has been taken into account for identifying the household occupation. As a matter of fact

ownership distribution by occupation as also the mode of purchase i.e. on outright or hire purchase basis is important for the purpose of future planning - the type as well as the cost.

The main categories of the employeds could be identified from the surveyed households - the service and the self employeds. The service households claimed 82% whereas the self employeds were only 18%. Amongst the service class 68.29% were state Goverment employees (n = 54), semi Govt. employees claimed 21.95% (n = 18) and 9.76% (n=8) were mainly the employees of private agencies. The Central Govt. employees (n=2) were negligible contributors to the purchase of dwelling units. Distribution of households by occupation is shown below:-



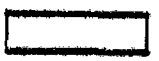
54 State Govt.



18 Semi Govt

8 Private agencies

2 Central Govt.



18 Self employeds

N =100

From among service class category only 15 owners puchased the dwelling units on outright basis theoretically because the owners who were permanent Govt. servants met the purchase

obligation through Govt. loans at 6½% interest rate against MPHB's interest rate of 9½%. Factually these owners pay instalments to the Govt. instead of MPHB. As such outright purchasers in service class were none. Amongst the self employeds outright purchasers claimed only 11.11% (n=2) owners.

4.4 INCOME GROUP AND OWNERSHIP PATTERN

The pattern that emerges is quite an eye opener. Maj ority of the owners (84%) came in higher middle income group bracket and the rest 16% in middle income group bracket. The owners under lower middle income group bracket were none. This clearly indicates that the cost of the dwelling unit is unaffordable by the lower and middle strata in MIG. The following table indicates the distribution of owners by income group.

TABLE:

Group	Income Range Rs.	Number of Owners	%
Lower MIG	601 - 900	Nil	Nil
Middle MIG	901 - 1000	2	
	1001 - 1100	4	16%
	1101 - 1200	10	
Higher MIG	1201 - 1300	15	
	1301 - 1400	24	84%
	1401 - 1500	25	
	Total	100	100

4.5. HOUSEHOLD CHARACTERISTICS

4.5.1 SIZE & TYPE :

Compared with the state average household size of 5.3 persons and Bhopal city average household size of 5 persons the survey revealed few of larger households and more of smaller households giving average household size of 3.91. Seventy four per cent of the households reported a family size of 4 members and less, 22% of 5 members and only 4% households reported to have six or more members. The household size ranged from 2 to 7 members. The Table below shows the distribution of households by size.

TABLE : Distribution of Households by size

H.H. Size	No. or % of owners	
Single	Nil	
2	9	
3	12	Average H.H. size 3.91.
4	53	
5	22	
6 +	4	
Total N =	100	

Out of the total households surveyed 3% were nuclear type, 12% conjugal type and 5% extended type. The large household size (5+) predominently occurs in conjugal type. The relevance of this to planning is, therefore, that the dwelling unit should be designed for a primary nuclear unit of 4 members.

4.5.2 - 4.) AGE COMPOSITION

Seventy nine per cent of the owners were in the age group of 35-45 years. The average of all the sample owners was 38.7 years which indicates that the people think of owning the house when they are in their middle ages.

4.5.3 ACTIVITY STATUS

Besides owners, very few members of household were gainfully employed. Seventy six households out of 83 nuclear households reported to have sole earning member. The joint income of husband and wife in the remaining 7 nuclear households did not exceed the maximum limit of MIG income. Working by women seem to be taboo in this class of society. The incidence of earners was higher in conjugal families.

4.6 SOURCES OF FINANCE

In order to meet the purchase obligation of paying the first instalment (20% of the construction cost and full land cost) the majority (78%) had to borrow the money from more than one source (Govt. loan, G.P.Fund, LIC, CTD, friends, relatives etc). Contribution through personal savings amounted to 20 to 25% share to the first instalment.

4.6.1 INSTALMENT & PAYING CAPACITY

The table below indicates the distribution of owners according to the instalment paid in terms of % to their income.

TABLE

Monthly instalment (% of monthly income	No. of owners
30%	25
31 to 33%	27
33 to 35%	22
36 to 40%	10
40 to 43%	6
38.87% average	100 = N

It can be observed from the table that the surveyed households pay 30 to 43% of their monthly income towards the ownership accomodation. On an average the household pay 38.87% of the income towards the instalment.

(It would be wrong to conclude that the MIG households can pay 39% of their income towards the instalment, because from the monthly expenditure break up on other items of living it was found that the expenditure exceeded remaining 61% income. It is, therefore, obivious that the households must be having other sources of income (legal or illegal) which the owners did not disclose).

Ability to pay mainly depends upon the household size i.e. number of dependents, monthly income and standard of living. All the owners unequivocally expressed that the monthly instalment should not exceed 20 to 25% of the income.

4.7 OPINION ON DWELLING UNIT COST

76% of the households considered the cost of dwelling unit as very high, 15% opinioned as high, 6% considered as reasonable and 3% could not solicit their opinion. The reactions for lowering down the cost is quite interesting-47% reacted favourably to reduce the cost by space reduction above, 22% by lowering the specification, 19% by space reduction as well as specification and 12% by increasing the ~~~~repayment period and/or lowering down the rate of interest.

4.8 PURCHASE PREFERANCES

The main factor which drew owners for MPHB dwelling units relates to the 'Hire Purchase system', 68% owners gave first preference to this significant consideration, 27% owners prefered for location and only 5% owners gave the design factor pride of place in the preference order. Quality of work in terms of materials and worksmanship etc. was considered secondary.

4.9 SPACE UTILIZATION

The users' way of life at house provides insight into the needs in terms of space. The text below describes the pattern of activity which is one of the determinals of room occupancy and how some of the activities are carried out within the spatial arrangement. The contrast between the facts presented and the assumptions of the policy makers indicate the wide differences between intuition and reality. Need for any extra

space is corelated to the cost of the dwelling unit. This point was explained to the respondants while canvasing the schedule with them and opinion was sought on bigger or smaller rooms.

4.9.1 LIVING ROOM:

Living room is predominently used for formal activities i.e. to entertain visitors. Occasionally it is used for quiet reading and to accomodate the guests. However, the majority 94% reported that the incidence of entertaining the visitors is very occasional i.e. once in a fortnight and the duration of visitors' stay varies from 15 minutes to maximum 45 minutes. Diminishing enthusiasm in social visits can be attributed to i) long working hours including time involved in travelling, overtime and partime jobs. ii) effects of urbanisation and industrialisation on social attitudes and values iii) families are yet to settle in new colonies. A few households (6% of the total) of self employeds expressed the need for bigger living room to act as business centre rather than social centre. It was observed that the living room is mostly furnished with sofa set (4 or 5 seats) and the central table. To the subsequent querry whether the living room is furnished with minimum furniture because it is unaffordable or whether it is sufficient to satisfy the need, the overwhelming majority affirmed the second question. It was also observed that the entrance verandah in single family houses was inveriably converted into a living room, actual living room is used either

as family room or bed room. In spite of the infrequent use of the living room, the housholds are reluctant to put it for multiple uses for the following reasons -

i) The desire for furnished and imaculate living undisturbed by the untidyness is associated with the status symbol.

ii) The daily chores of arranging the furniture is tiresome. This may be even attributed to the lacuna in uni-functional furniture.

iii) Fixed and predetermined spaces for individuals are prefered in the dwelling unit.

94% of the households reacted favourably for reduced space provision for living area.

4.9.2 DINING AREA

Dining space has become the central area or nucleas of the family and is used for various activities such as teaching, reading, chit-chating besides eating for which it is meant. Informal family sessions invariably take place across the dining table. Information about the normal practice of taking meals in the space was collected. The 100 families were equally divided in their opinions of eating in the kitchen or dining. All of them, however, appreciated the fact that they could have meals in greater comfort and more pleasant surroundings in the dining room than in the kitchen. However, 10 families

were persistant in taking the meals in the kitchen. Even when the size and design of the kitchen appears to preclude its use, these families make all manner of improvised arrangement to eat in kitchen. Except for the dinner when all the members are usually at home for it, the schedule for lunch/ tiffin/morning tea is followed in relays.

The dining table of size 750 x 1200 to accomodate four diners was commonly found irrespective of the family size.

4.9.3 KITCHEN

Looking after the family, child care and cooking are normally the prerogatives of the housewife and the evening leisure activities and hobbies of the whole family. Kitchen to an Indian wife even today remains the focal point in a house as a lot of her time* is spent there. As such satisfaction over arrangement, storing space, platform etc. is of great significance. Large proportion of housewives (89%) were dissatisfied with the kitchen detailing and not the space (area of kitchen varied from 4.4 M^2 to 7.6 M^2). Specific objection was that kitchen space does not allow even occasional dining. Secondly, the need for some open/semi open space along with the kitchen to carry activities like winnowing, churning etc was strongly expressed. This was the specific complaint from the housewives living in multi-family dwelling units.

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* Dr(Mrs) Saldhama in her book 'Indian Housewives' have concluded after compiling the survey of 10 cities that on an average housewife spends 4 hours in the preparation of meals, 2½ hours in house work, 2 hours in child care and education and 1 hour in miscellaneous work.

As far as storing is concerned there was no complaint as most of the households have resorted to purchase the provisions sufficient for month's requirement. Storing below and above cooking platform (1.8 M. length) and in side racks (900x300x1800) was considered adequate for storing utensils and other necessities in the kitchen. Now a days people, depending upon the availability and taste, prefer to use those fuels which are non smoky, reduce time and save energy in cooking. Nearly three fourths of the surveyed households were using gas for cooking. The rest of using kerosene oil (29%) and soft coke (6%) because of scarcity in gas connection.

4.9.4 BED ROOM(s)

The transition to a discussion of bed room space utilization was not easy to accomplish in an interview geared to the collection of factual data. In addition the owners were unaccoustoured to discuss such matters. Dwelling units covered in the survey work were of two types : i) dwelling units with one bed room (n = 25) and ii) dwelling units with two b ed rooms (n = 75).

The residents of dwelling unit having one bed room expressed to have smaller but seperate bed rooms for parents and children. Two persons sleeping on the same cot is not prefered in these households. However, children upto the age of say 7 to 9 years sleep in parent's room as an implicitly recognised emotional need. Thereafter the need for seperate

bed room is increasingly felt. Grownup children sleep either in living or dining on floors because of insufficient space for storing the cots when not in use. All the families advocated that the area of living/dining be curtailed to give a second bed room, even if small, so as to have furnished independent space for each member in the house. Insufficient storing space was observed in the bed rooms. Unplanned storing items such as boxes almirahas etc. not only affect the use efficiency but also increase overall cost.

Functional usages of seperate bed rooms for parents and children are well defined and it was expected that the households living in such dwellings should not have any complaining note. But the survey revealed that the households complained about the insufficiency of space in childrens' bed room to accomodate two cots and two study tables. On close scrutiny it was found that the difficulty in arranging the required furniture is not due to space but because of relative positions of doors, windows, wardrobe etc. 84% of the master bed rooms were furnished with two beds and the remaining 16% with double beds and a side table.

Except for 12 households. The families did not have a dressing table. Lobby area near toilet with a mirror above wash basin is commonly used as a dressing area by all the members.

Use of double decked bunks in children's bed room to economise the space was explained. Likewise,the idea of smaller master bed-room accomplishing all the functional requirements with just sufficient circulation space around the furniture was also explained. 83% of the households reacted favourably for such space saving concepts if these are going to effect the economy in the cost of dwelling unit.

4.9.5 BATH & W.C.

In general, the people are satisfied with the space provision and arrangements of toilet. The households having combined unit of bath and w.c. did not express any objection to such an arrangement because the timings to use the toilet are staggered i.e. it is used in relays. In the absence of wash basin people use kitchen sink for preliminary morning ablution. Surprisingly enough toilet each for the bed room is considered as luxury.

The economics of combined toilet unit was explained to the respondants. 67% gave concurence to the concept, 25% rejected outrightly and 8% were neutral.

Rubbing and cleaning of utensils is done in the kitchen and bath-room is used for washing the clothes. In 74% households the job is done by housewives themselves and the remaining 26% households reported that it is done by maid servants. A servantless class of society is gradually emerging obviously for economic reasons.

4.9.6 BALCONEY

Provision of balconey is redundant in a sense it is not used for the purpose for which it is meant. Smaller width (1.2 M) does not allow group seating. Secondly in group housing or even on smaller plot holdings it does not give any privacy. An ubiquitous function of using balconey for drying clothes and sundry storing was commonly observed. About 80% of the families reported that they sleep inside in summer months as nights are comparatively cool and balconey space is insufficient to accomodate all the members of the families. The fact that even in single family houses or flats with terraces/verandahas where the occupants have a choice to sleep on the lawns or terraces, 61% occupants prefer to sleep inside the room points to some change in the living habits of people as regards sleeping during summer.

The majority expressed that the balconey area be merged with any other space to increase the useability or should be atleast attached with kitchen so that it can be used more fruitfully.

4.10 MODE OF TRANSPORT

Undulating terrain of Bhopal forbid the people from using common mode of transport i.e. bicycle. Bus, a public conveyance, is used as it is subsidised for Govt. servants. Only 2 out of 10 households have either mopeds or scooters.

People commute 3 to 10 km to reach their respective work places. This gives an average of 8.5 Km. Commuting distance.

4.11 CHOICE OF DWELLING UNIT

Housing form becomes an important issue once it is accepted that diverse living and behavioural patterns, attitudes and reactions are closely related to the type of dwelliings they occupy. The survey revealed that the people are becoming more possitively disposed to living in flats in 2/3 storey walkup blocks. Their willingness to co-operate with neighbours on selected issues is on increasing. However, given the choice, the people naturally prefer single family house even away from city core.

4.12 FURNITURE TYPE AND INCIDENCE

In addition to other considerations the type of furniture greatly influences spatial requirement. The incidence of various furniture items commonly found in the surveyed sample households is compiled in the Table 4.12-T1. Sizes of various furniture items were measured and their dimensions critical from space determination point of view were worked out. Their design dimensions have been suggested on the basis of statistical average of different items found.

4.13 NATURE OF BELONGINGS

Details of belongings particularly in kitchen and Bed room could not be collected as the people were reluctant to give the

TYPICAL HOUSEHOLD BELONGINGS (FURNITURE)

TABLE : 4.12-T1

	INCIDENCE %								DESIGN SIZE	DESIGN BASIS
	81-100	61-80	51-60	41-50	31-40	21-30	11-20	1-10		
SOFA 4 SEATS (2+1+1)		○							600 x 600 x 375 (1000)	LIVING ROOM
SOFA 5 SEATS (3+1+1)					○				1500	5 SEATS
CENTRAL TABLE	○								375 x 750 x 375	CENTRAL TABLE
FOLDING CHAIR							○		450 x 450 x 450	
STOOL / MUDHAS							○			
DIWAN								○		
SHOW/BOOK CASE								○		
DINING TABLE (FOR 4)					○				750 x 1200 x 750	DINING
DINING TABLE (FOR 6)					○				800 x 1400 x 750	DINING TABLE FOR
CROCKERY CUPBOARD							○			FOUR DINERS
FR								○		
SIDE BOARD								○		
DOUBLE BED			○						1475 x 1800 x 450	M. BED
SINGLE BED			○						900 x 1800 x 450	2 BEDS
STEEL ALMIRAH					○					1 SIDE TABLE
DRESSING TABLE								○	375 x 700	WARD-ROBE CUPBOARD
SIDE TABLE			○						400 x 300 x 400	DESIRABLE —
EASY CHAIR/CHAIR									450 x 450 x 450	SEWING MASHINE
TRUNKS/ATTECHE	○									
BEDDING BOXES								○		
SINGLE BED - 1 Nº	○								900 x 1800 x 450	C. BED
2 Nº								○		2 BEDS
STUDY TABLE/DESK - 1 Nº	○								600 x 900 x 675	2 STUDY TABLES
2 Nº								○		WARDROBE
CHAIR	○								450 x 450 x 450	
SIDE TABLE								○		
MISCLANEOUS									-	
CYCLE								○	-	
SCOOTER / MOPED								○	-	
RADIO	○									
SEWEING MACHINE							○		300 x 550	

information. This information would have helped in standerdising the storing units in kitchen and Bed-room.

4.14 LIVING ACTIVITIES

In the course of survey 21 living activities could be identified to be of major significance and are generally performed in a average MIG household. These activities can be grouped under i) personal care ii) food preparation iii) Serving and eating iv) Leisure and living v) Resting and sleeping and vi) Ancillary and miscellancy. Activities and their places of performance have been compiled in Table 4.14.T2 PAGE 59 for proper choice of grouping and combinations. With due consideration to the preferences of the people and grouping of compatible activities it could be concluded that MIG dwelling unit should have Living, Dining, sleeping (two No), kitchen, toilet and utility spaces to provide for all essential activities.

4.15 INFERENCES

From the survey analysis the following inferences have been drawn.

- Occupants mostly belong to the service class
- Ownership of dwelling units is due to Hire Purchase system
- On an average the families can pay 20 to 25% of the monthly income.
- Considering the average monthly income (;.1050) and families ability to pay (25% of average income i.e. Rs.260/-), the house cost should not exceed Rs. 24076

- Dwelling unit should be designed for a family composition of four
- MIG family needs seperate and stipulated spaces for each major activity.
- The dwelling unit should constitute a living dining, sleeping (two enclosures), kitchen, combined toilet unit and utility spaces.
- Preference is for more number of smaller rooms than less number of big rooms.
- Balconey/verandah/Terraces etc. should not be provided.
- An open plan to meet the diversified requirements is preferable.
- A servantless class of society in MIG section is gradually emerging.
- People have no apprehension to live in multi-family housing.

TABLE 4.12 - T2

Activity	Place of performance	Seperate enclosure		Privacy	
		essential	optional	essential	optional
1. Exereting	W.C/T	*	-	*	-
2. Bathing	T	*	-	*	-
3. Using wash basin	T, LY	-	*	-	*
4. Using cupboard	B	-	*	-	*
5. Washing cloths	T	-	*	-	*
6. Drying of clothes	LY,CY, BY	--	*	-	*
7. Ironing of clothes	D,B	-	*	-	-
8. Pre cooling preparation	K,D, LY.	-	*	*	-
9. Cooking	K	*	-	*	-
10. Eating	D,K,B,L	-	*	-	*
11. Cleaning utensils	K, CY	*	-	*	-
12. Recreation (chit-chating playing, listening radio)	L,D,B	-	*	-	*
13. Reading	L,D,B	-	*	-	*
14. Relaxing	L,B	-	*	*	
15. Entertaining	L, D	-	*	*	*
16. Sleeping	B	*	-	*	-
17. Studying	B,D	*	-	*	-
18. Sick care	B	*	-	*	-
19. Worshping	D,K,B	-	-	*	-
20. Maintaining	B,D	-	-	-	-
21. Administering	L,B,D	-	-	-	-

Index : L - Living. D - Dining, K - Kitchen, B - Bed, T - toilet
Ly- Lobby, CY - Courtyard.

CHAPTER - 5 SPCACE DETERMINATION

The space formulation must aim at maximum utilization of space with due regards to anthropometric needs and nature of belongings necessary for the performance of different living (domestic) activities. In view of the high construction cost and limited paying capacity, it is essential to set out realistic space standards. These space provisions which cater to the household needs without detrimental effect to the basic living activities most determine space norms. The standards should be such that within the socio-economic framework they meet functional needs reasonably well. Besides other considerations enumerated in the paras below, the spatial requirements in the dwelling depend on the degree of convenience required to perform household activities. At times, the change in the modes of performance is the outcome of the space restrictions leading, ultimately, to the accepted level of convenience. The space standards will be minimum when minimum acceptable level of convenience is adopted but in actual practice it is desirable that they are always slightly higher. The expression of minimum is as valid and exciting as that of optimum. The quality of a coupe in a railway carriage compartment, for example, can be very exciting and is in part a function of limited space. There should be no opportunity for other than casual movements between the

furniture and other elements. Economical formulation of space requires elimination of any extra space and use of same space for different activities when they do not have to be performed simultaneously.

5.1 APPROACH

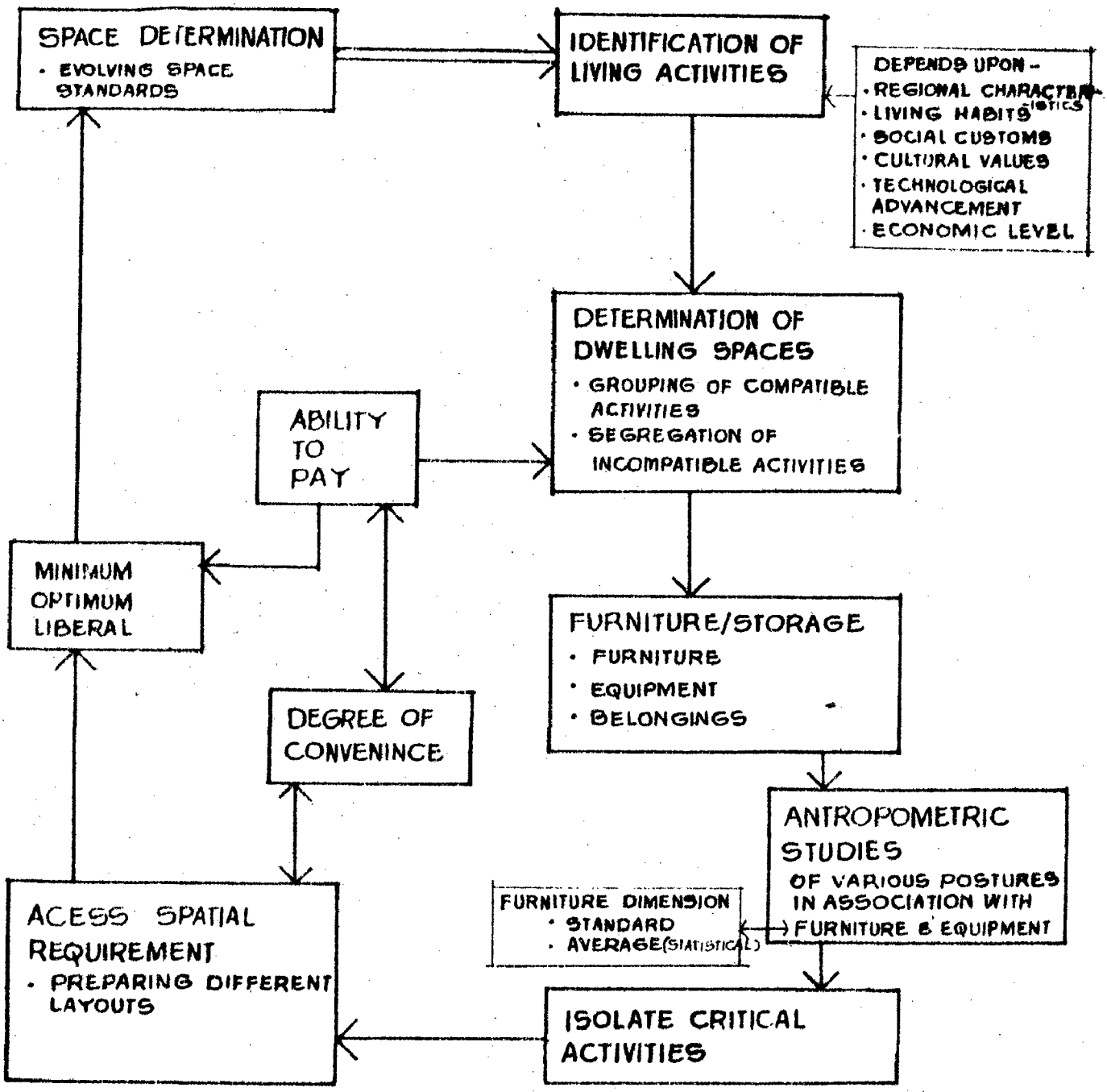
5.1.1 For the functionally effective formulation of spaces understanding of living activities, their anthropometirc data and critical dimensions of the furniture associated therewith is explicit. The approach adopted in determining spatial requirement for the spaces is described below.

5.1.2 LIVING ACTIVITIES:

In determining dwelling spaces various living activities (as identified in the survey. Refer 4.12 - T 2) were grouped together considering segregation of conflicting activities, combinability of related activities and users' preferences. The grouping of activities automatically lead to translation into physically distinct spaces - living, dining, sleeping (two enclosures) kitchen, toilet and utility area - which are considered necessary to cater to various household activities of average MIG household.

5.1.3 FURNITURE AND STORAGE

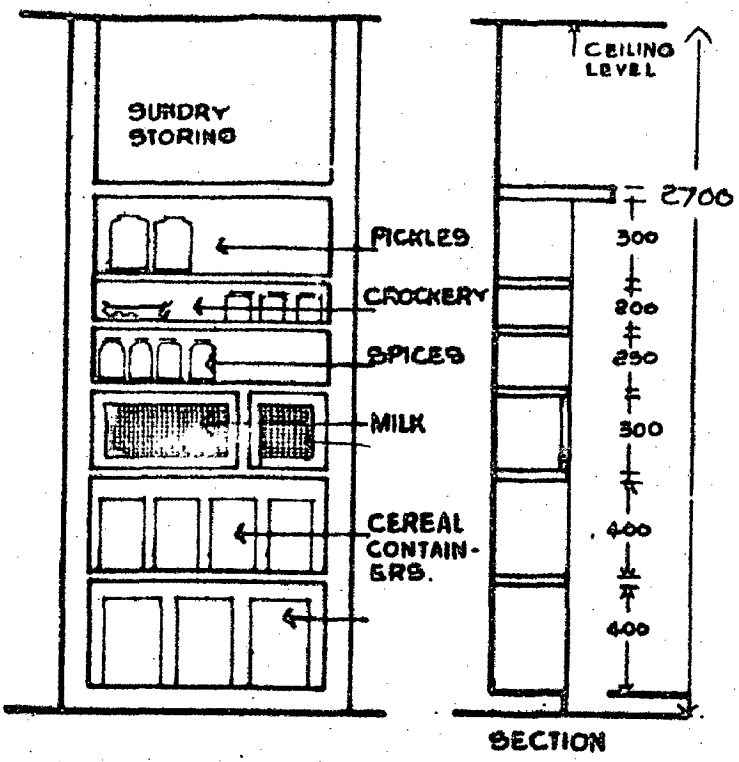
Type of furniture and storage facilities greatly influence spatial requirement. Furniture of inconsistant



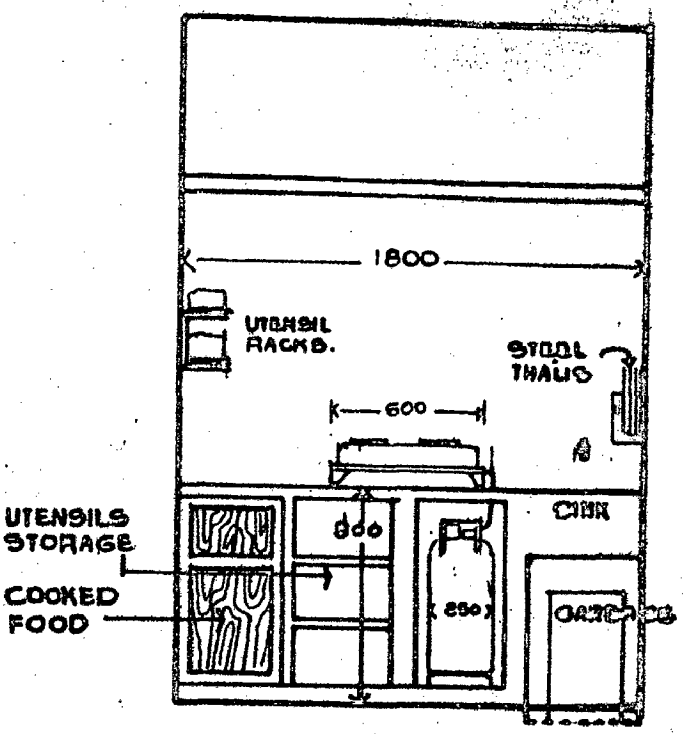
SPACE DETERMINATON : AN APPROACH MODEL

size and unplanned storage adds to inconvenience besides occupying useful space thereby affecting the use efficiency. Provision of proper built in storage facility in the dwelling avoids purchase of costly items such as racks, boxes, almirahas etc. Hence it is necessary to rationalise and/or standardise their provision for convenience and overall cost reduction. On the basis of general observation the storage facility for sleeping spaces and kitchen have been worked out for various household belongings considering use frequency nature of articles and mode of placement. Maximum use of space in height has been done to reduce requirements of floor space.to the ~~minimum~~. A wardrobe cum storing unit of 90 cm. width, 55 cm depth and 200 cm height is necessary in the sleeping spaces. A loft space of 55 cm width and 200 cm length is considered adequate for storage of winter beddings during off season, steel trunks and for other items of rare use. (Ref Drg.No.D 1).

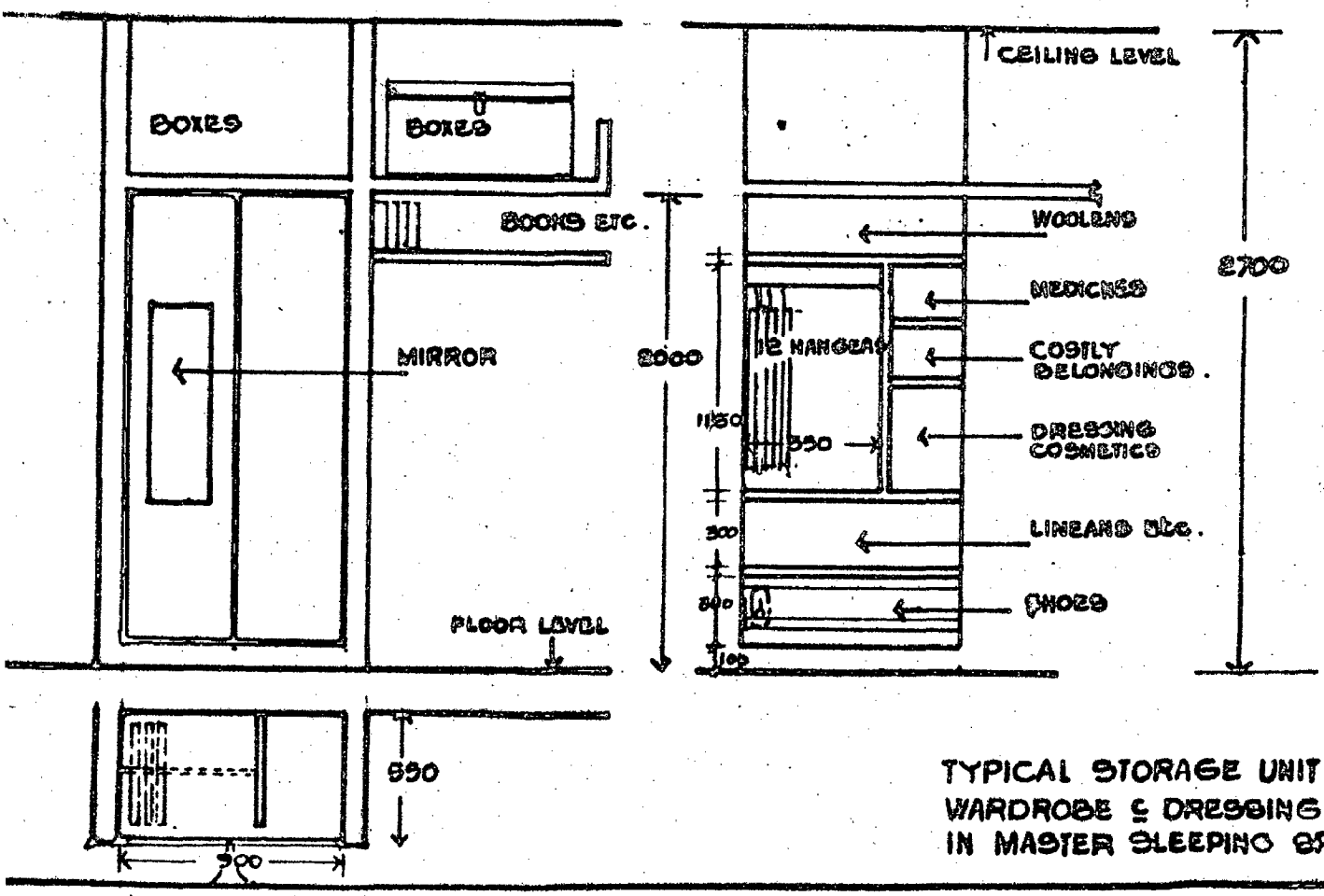
Similarly, for kitchen space storing unit integrating storage of cereals, milk, grocery and other items has been worked out. A storage unit of 30 cm depth, 90 cm width and 200 cm height is found sufficient. The exercise in calculating the length of cooking platform revealed that platform of 60 cm width and 180 cm length (including sink - 45 cm x 45 cm) is adequate. The space below the platform with suitable division accomodates gas cylinder, utensils and a cupboard for prepared food. loft above the cooking platform can be suitably used for storing things of rare use.



TYPICAL KITCHEN STORAGE UNIT



TYPICAL COOKING PLATFORM.



TYPICAL STORAGE UNIT
WARDROBE & DRESSING
IN MASTER SLEEPING SPACE

STANDARDIZATION OF STORAGE UNITS DRG NO D1

Sizes of furniture items associated with the activities are based on the results of the actual survey or these are as generally adopted standards. Number of furniture items or necessary for each space have been determined as per survey findings.

5.1.4 ANTHROPOMETRIC STUDIES

The role of anthropometric studies for scientific determination of space requirement for achieving effective planning is universally recognised. Design of furniture and equipment is also related to the anthropometric dimensions for greater working efficiency and comfort. Undue waste of space can be avoided if the enclosure sizes are governed by the dimensions based on anthropometric studies, requirements of the equipment associated therewith, desired clearances and movement spaces.

CBRI data* on anthropometric studies have been used extensively. However, anthropometric measurements of postures for various activities such as squatting eating, using storage facilities etc. and clearances for movements through confined spaces such as between two pieces of furniture, between wall and furniture were determined. (For anthropometric dimensions Refer drg. No. 5.1.4 - D1 to D5

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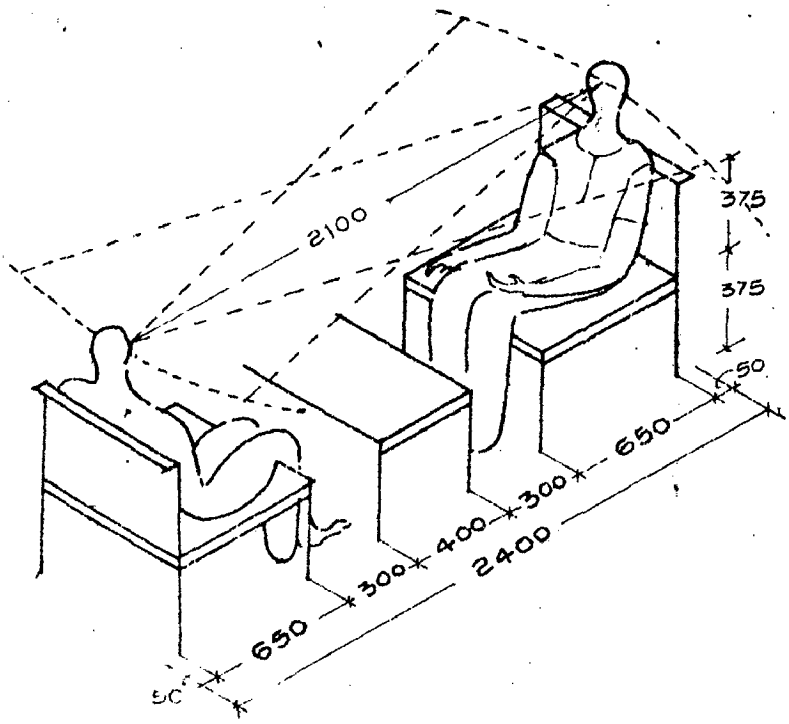
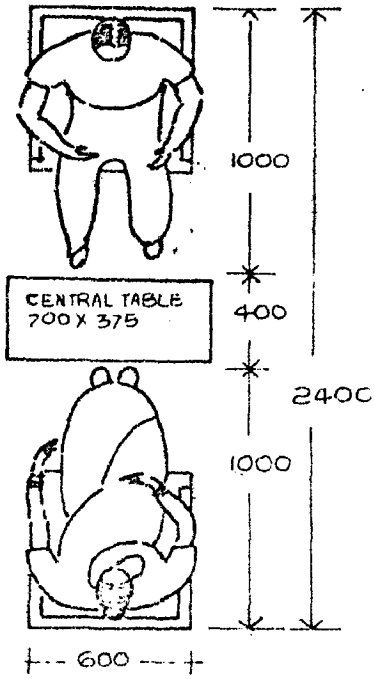
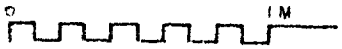
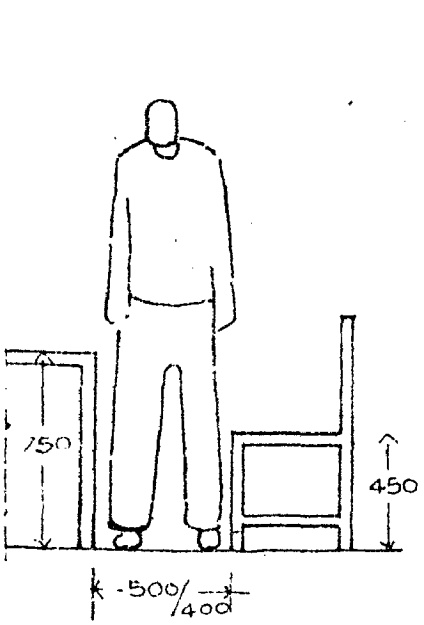
* Datta, K.L. & Gupta, T.N., "Anthropometrics and Residential Space", IIA Journal, December 1966.

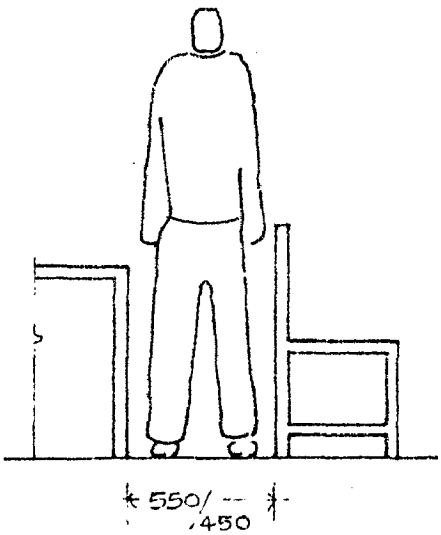


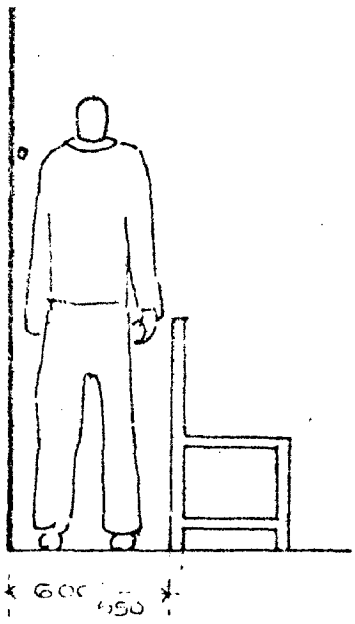


"THE ARC OF CONVERSATION"
AFTER FRANCIS DE N SCHROEDAR
SOURCE - 'THE HOUSE' by R.W KENNEDY



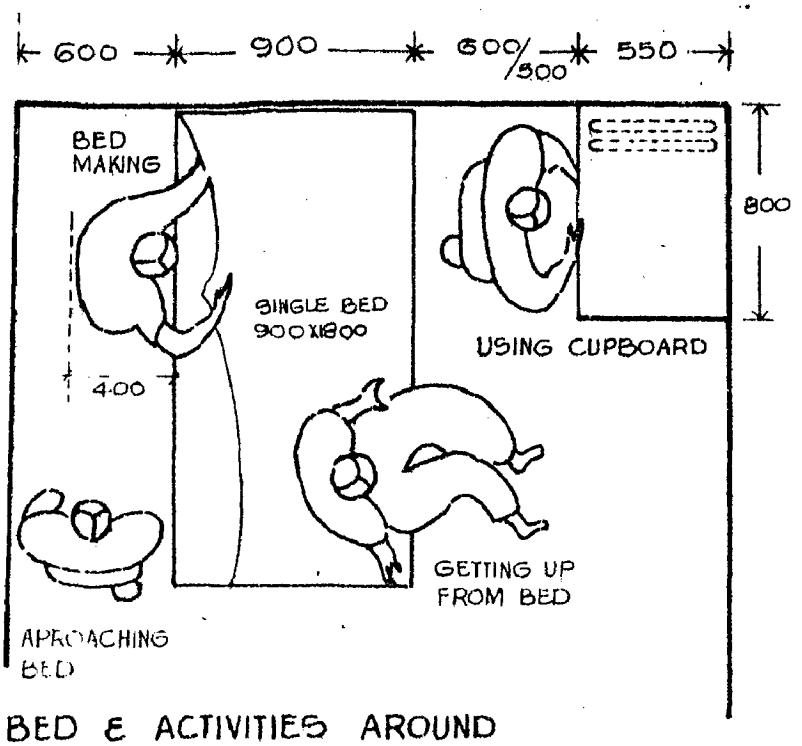


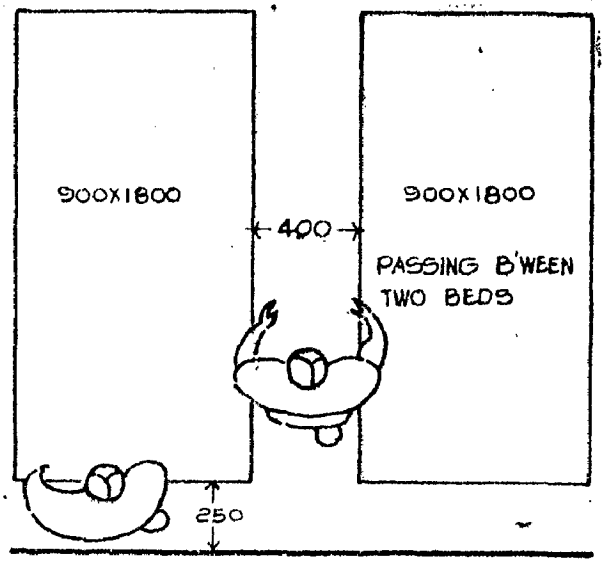




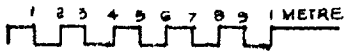
DRG No. 5.1.4-D1

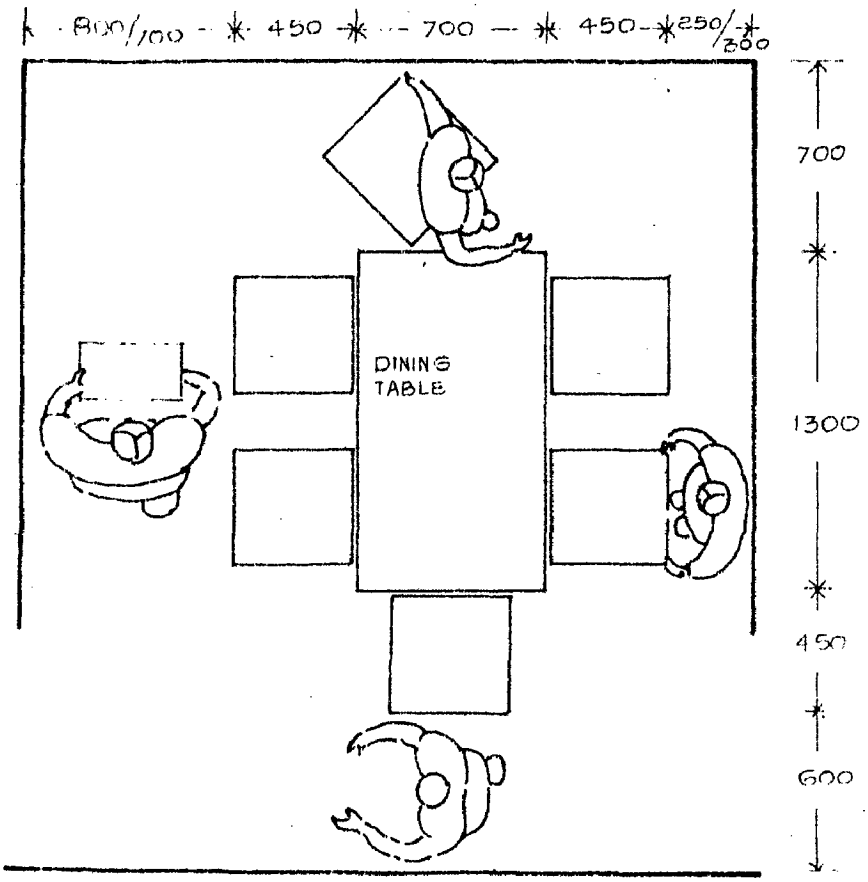
ANTHROPOMETRIC DIMENSIONS OF VARIOUS ACTIVITY POSTURES

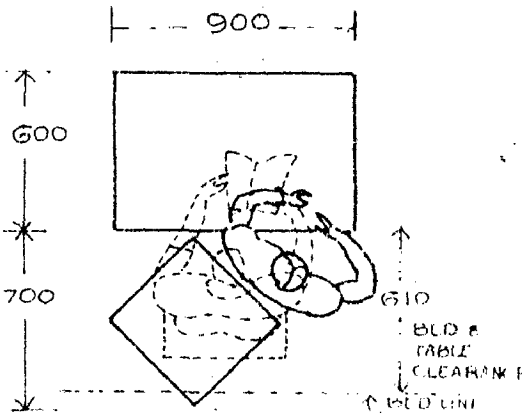


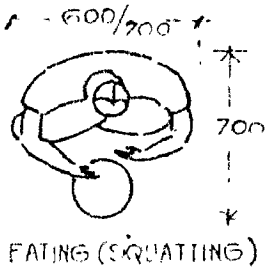


BED & ACTIVITIES AROUND









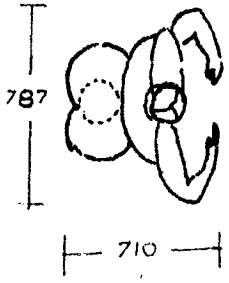
DINING TABLE & ACTIVITIES AROUND

SOURCE : I.I.A. JOURNAL DEC'1966

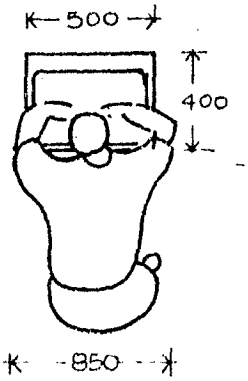
DRG No. 5.1.4.-D 2.

ANTHROPOMETRIC DIMENSIONS OF VARIOUS ACTIVITY POSTURES

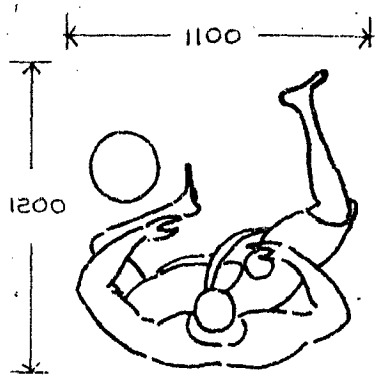
63-C



USING INDIAN PAN

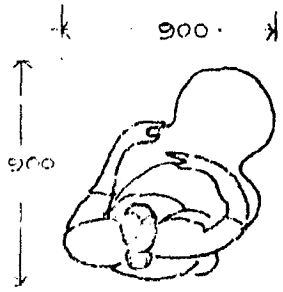


USING BASIN

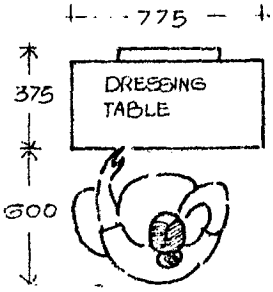


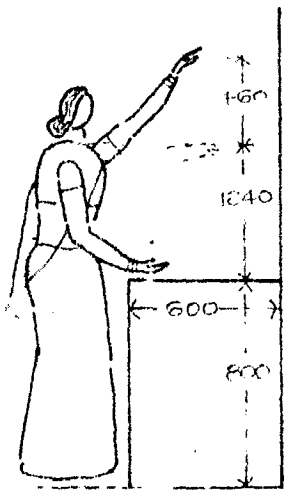
BATH - SQUATTING

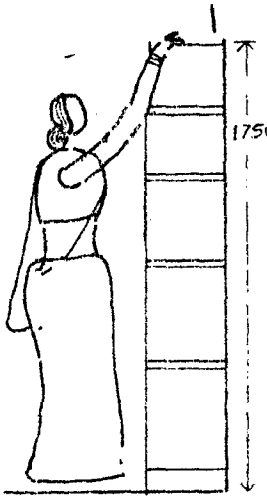
SOURCE:
I.I.A. JOURNAL DEC'1966

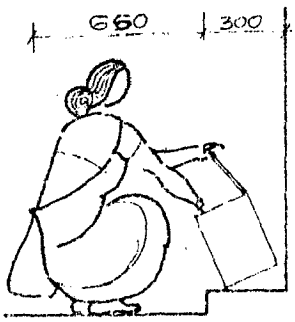


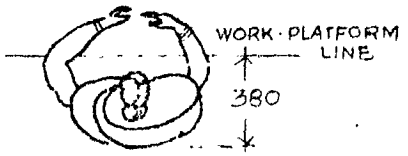
WEARING SARI

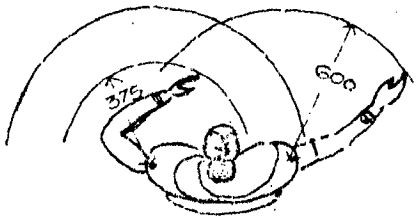






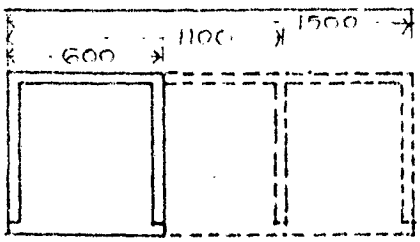


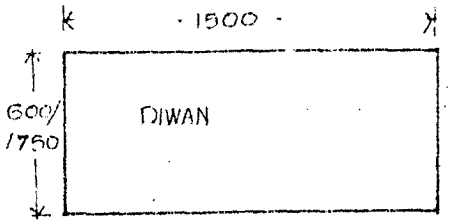


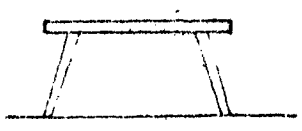


RANGE OF HAND MOVEMENTS

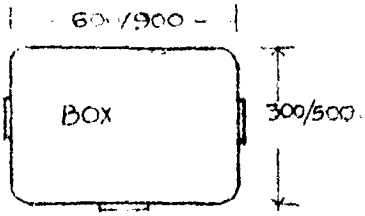
SOURCE I I A JOURNAL MARCH 1966

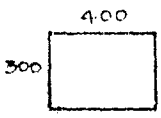


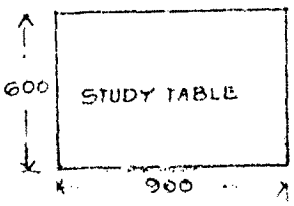




CENTRAL TABLE







DRG No: 5.1.4/-D-3

5.2 DETERMINATION OF SPATIAL REQUIREMENTS

5.2.1 For determining spatial requirements, out of various activities corresponding to each space, critical activities were isolated from generally assigned functions and alternative enclosure sizes were worked out considering furniture, equipment and storage requirements and clearances. The furniture pattern is fixed in the spaces when assigned with specific functions i.e. functions do not change often. The information regarding the dwelling spaces, their assigned functions, critical functions, furniture and storage associated with each space and their respective dimensions have been compiled in Table No. 5.2 - T1 for ready reference. By superimposing the pattern of various individual and group activities a few typical arrangements of the internal furniture layout in conjunction with door positions and storage have been developed. These arrangements cover for minimum and optimum provision.

Windows are assumed to be opening outwards in all the arrangements to avoid obstructions in the use of internal spaces. For entrance door(s) and toilet, single leaf shutters have been assumed. Between living and dining, dining and lobby, and lobby and kitchen only openings have been considered.

TABLE 5.2 - T1

SPACE	LIVING ACTIVITIES OR FUNCTIONS			FURNITURE/STORAGE	
	BROAD GROUPING	ACTIVITIES	CRITICAL ACTIVITIES	ITEM	SIZES
TOILET	PERSONAL CARE	• USE OF W.C & BATH • WASHING CLOTHES	• USE OF W.C. • BATH		
COOKING	FOOD PREPARATION	• PRE COOKING • COOKING • STORAGE • CLEANING UTENSILS	• COOKING	• COOKING PLATFORM • STORAGE	600X1800 300X900 X1800
DINING	SERVING	• SERVING • EATING • INTERNAL CIRCULATION • CONJUGAL LIFE	• SERVING • EATING • INTERNAL CIRCUATION	• DINING TABLE • CHAIR	750X1350 450X450
LIVING	LEISURE AND LIVING	• ENTERTAINING VISITORS • CONVERSATION • LIGHT READING • RECREATION • PLAYING CARDS • CHILDREN' PLAYING • INTERNAL CIRCULATION	• ENTERTAINING VISITORS • INTERNAL CIRCULATION	• SOFA SEATS • CENTRAL TABLE • SHOW/BOOK CASE	600X600 375X750 300X600
SLEEPING	SLEEPING	• RESTING • SLEEPING • RELAXING • DRESSING • STUDYING • USING CUPBOARD SEWING	SLEEPING USING CUPBOARD	• COTS (2 Nº) • CUPBOARD COTS CUPBOARD STUDY TABLES	900X1800 560X900 X2000 900X1800 560X900X2000 600X900
UTILITY	ANCILLARY AND MISCLANY	• DRYING CLOTHES • USING WASH BASIN • PRE-COOKING CHORES • INFORMAL DRESSING	—	—	—

64-A

5.2.2 LIVING SPACE

Several functions like conversation, entertaining guests, quiet reading, recreation, children playing etc. can be assigned to the living space and most of the functions can be performed in the same space and do not require any additional space. The living space is principal area of contact with visitors. The households want it in order all the times. Occasionally it serves as a guest room. This is inevitable because of lack of space elsewhere in a house. Primarily it must have 5 seats (to accomodate 75% of family members i.e. 3 + 2 visitors and a show case for magazines/ books/show pieces etc. and radio (or T.V. in future) which are permanent part or decor. Although passage through the living space to reach bed rooms is generally inconvenient it is not too objectionable in economic house when an occupancy of two persons per bed room is assumed and overnight guests are likely to be infrequent. Moreover, the aggregate of additional area required to provide privacy of access makes financially impossible to do so.

The question as to what should be the distance between opposite seats was resolved by using an ideal minimum conversation diameter (an arc of conversation) of 2.1 M* Refer drg.no. 5.14-D1).

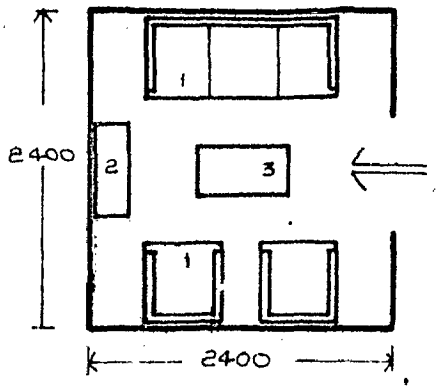
* Maximum conversation diameter is 4.5 M. The model has been evolved by Francis De N Schroedar through scientific studies considering several factors such as audibility psychology, hygene etc.

Incidentely this (the dimension & the arrangement) matches perfectly well with the coupe of a first class railway compartment. The furniture is grouped along the wall so that these can be easily approached with a minimum space going in circulation.

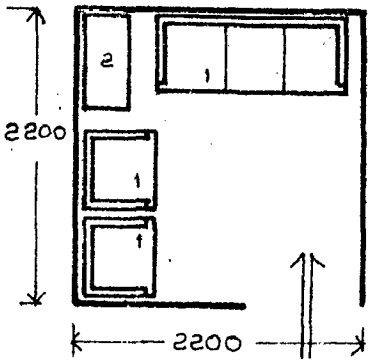
With these considerations nine alternative arrangements have been worked out. (Refer Fig.5.2.2 - D1). Floor area of these arrangements range from 5.76 M^2 to 8.64 M^2 although majority of them are less than 9.3 M^2. Minimum width is 2.4 M for one two or three door arrangements. An area of 7.2 M^2 with minimum width of 2.4 M is considered as optimum.

5.2.3 DINING

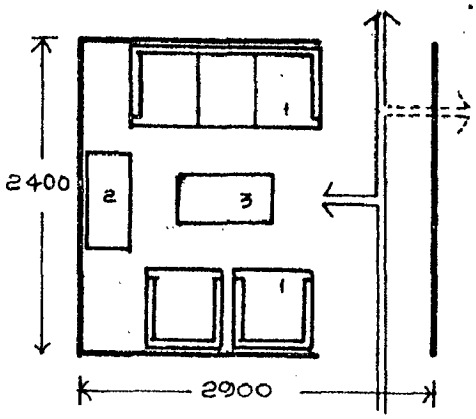
Primarily by the dining space, it means as area seperated or seperable from the living and cooking areas. Dining space also serves a second ppurpose in affording an additional social centre for the family. It is this function which seeks to emphasize adequacy rather than minim . Although in survey it was found the majority of the households have a dining table for 4 diners, dining space has been worked out for 6 diners. If the dining area is 2.25 M. square the table can be set in either way and for occasional additional seating can be extended in the passage. The clearance required to reach the chair can be easily integrated with the



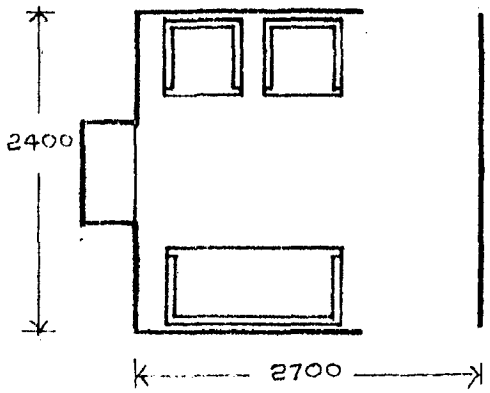
AREA : 5·76 M²



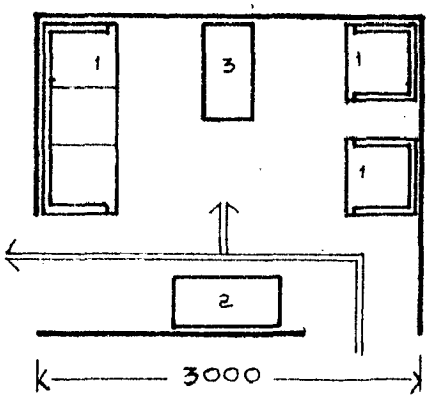
4·84 M²
MINIMUM



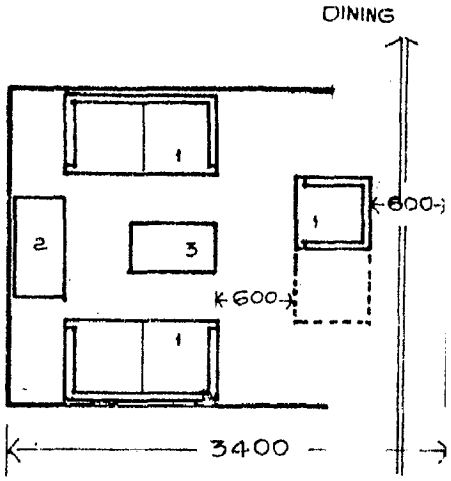
6·96 M²



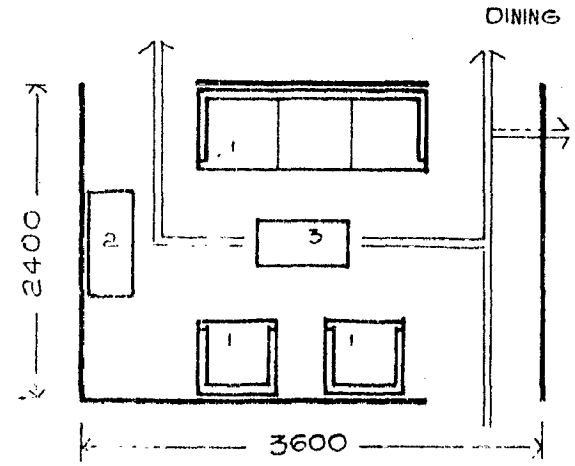
6·8 M²



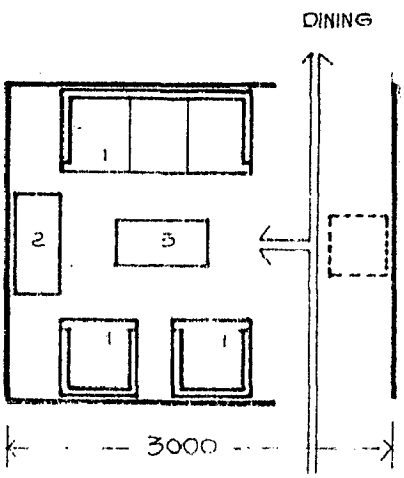
7·2 M²



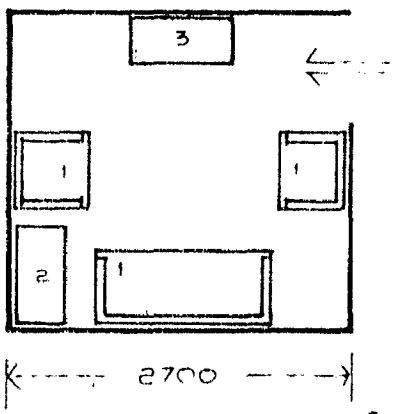
8·16 M²



8·64 M²



7·2 M²
OPTIMUM



6·48 M²

REFERANCES

1 SOFA SEAT (1 2 3)
2 SHOW/BOOK CASE
3 CENTRAL TABLE
4 MAIN ENTRY 900x2000

SPACE ASSESSMENT - LIVING SPACE

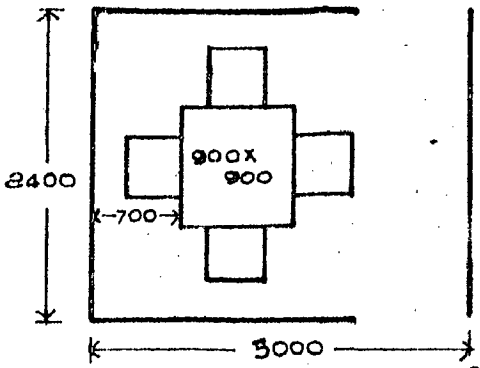
FIG 5.2.2 - D1

space meant for the service. Dining space also includes the area for internal circulation. A total of seven arrangements have been worked out and shown on drawing No. . Floor area ranges from 6.16 M^2 to 7.2 M^2. Most commonly occuring other dimensions are 2.2. M and 2.4 M.

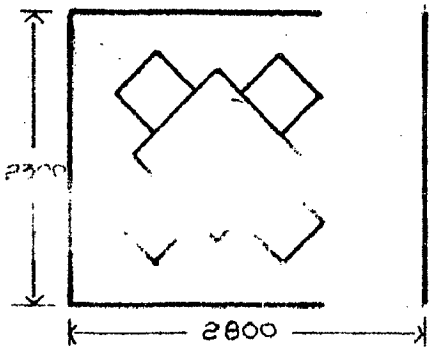
The tendency of combining living and dining is increasingly accepted. The idea of combining living and dining has found the roots mainly because i) the combination effects in saving in the space and ii) free flowing areas give an effect of spaciousness. Combination of the two spaces would result in saving in the space provided the areas are liberal. With minimum areas devised for each space, the combinatiom does not result in any saving (Ref. Fig.No. 1 & 2 drg.No. 5.2.3-D1).

5.2.4 SLEEPING SPACE(s)

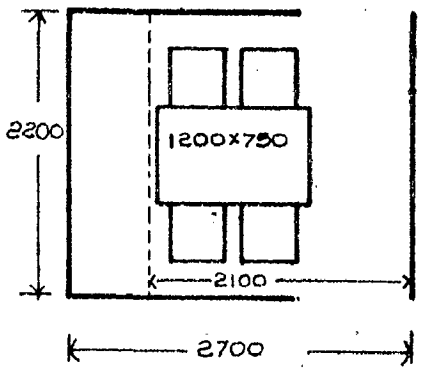
As with other spaces, sleeping spaces have been evolved with consideration for furniture, operational area and placement and mode of operation for storing unit (wardrobe). Where space and cost is limited the sleeping spaces should be just sufficiently large to accomodate furniture and passage such spaces can be termed as 'passage plus furniture'. These are not objectionable in themselves but if all the sleeping spaces in a dwelling are of this type, the living room is likely to be used for many purposes. In view of economising



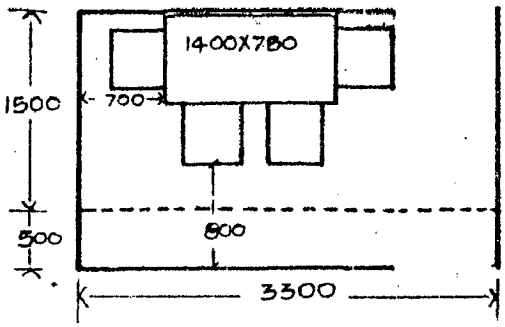
AREA : 7.2 M²



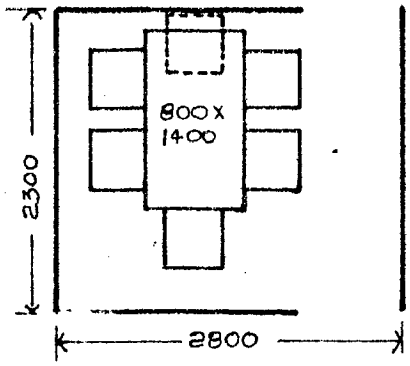
6.44 M²



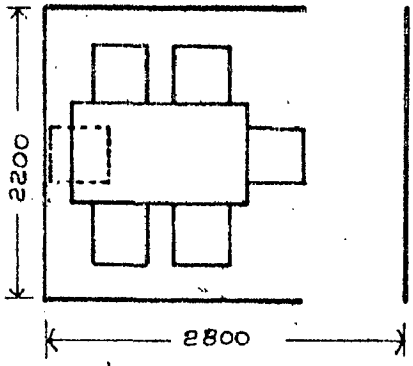
5.94 M²



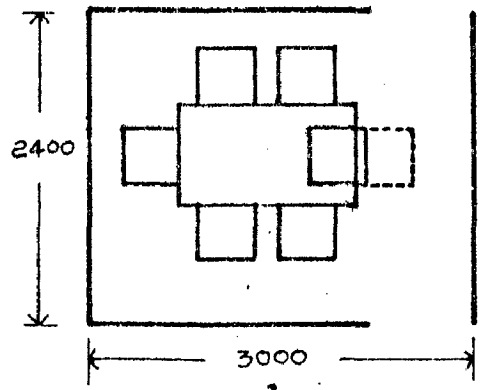
6.6 M²



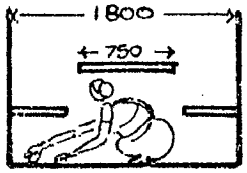
6.44 M²



6.16 M²



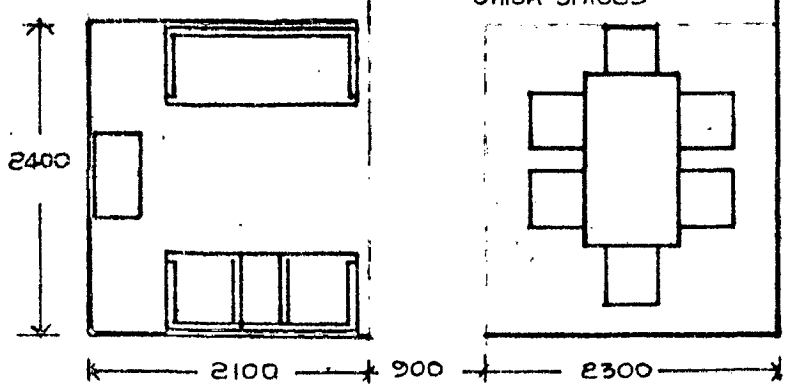
AREA 7.2 M²



BUILT IN DINING ALCOVE SETS ARE SPACE SAVERS. BUT THOSE INSIDE CANNOT LEAVE WITHOUT DISTURBING OTHERS. SWEEPING CRUMBS REQUIRES CRAWLING. NO ROOM FOR OCCASIONAL GUESTS

DINING

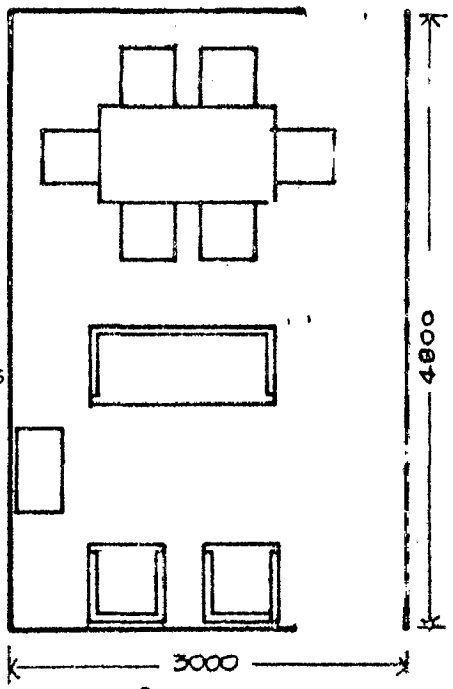
D.TABLE FOR FOUR 700X1200
D. TABLE FOR SIX 800X1400
CHAIR 450X450



AREA : 14.88 M²

COMBINED LIVING DINING DOES NOT RESULT ANY SAVING IN THE TOTAL SPACE AS THE INDIVIDUAL SPACES ARE OPTIMUM

FIG 1 a



14.88 M²

DRG 5.2.3 - D1

the space, access to beds from shorter side is considered as reasonable. Standard adult size cots have been considered for furniture layout. Sleeping space have been assumed with only one door arrangement.

Different area arrangements for master's sleeping space have been worked out accomodating two cots, a side table and wardrobe cum storage unit. The provision of sewing area has also been considered. The floor area ranges from 7.2 M^2 to 8.64 M^2 with minimum width of 2.4 M (Ref.Fig.No. 5.2.4 - D1).

Children's sleeping space has been worked out to accomodate two study tables, two cots and wardrobe. An area of 9 M^2 is necessary to accomodate all these functions. However, if the sleeping space for children is conceived on railway compartment model i.e. using double decked bunks, the saving of 20% is achieved in floor space. Such an arrangement requires an area of 7.2 M^2 with minimum width of 2.4 M (Ref.Fig. No.5.2.4 - D2).

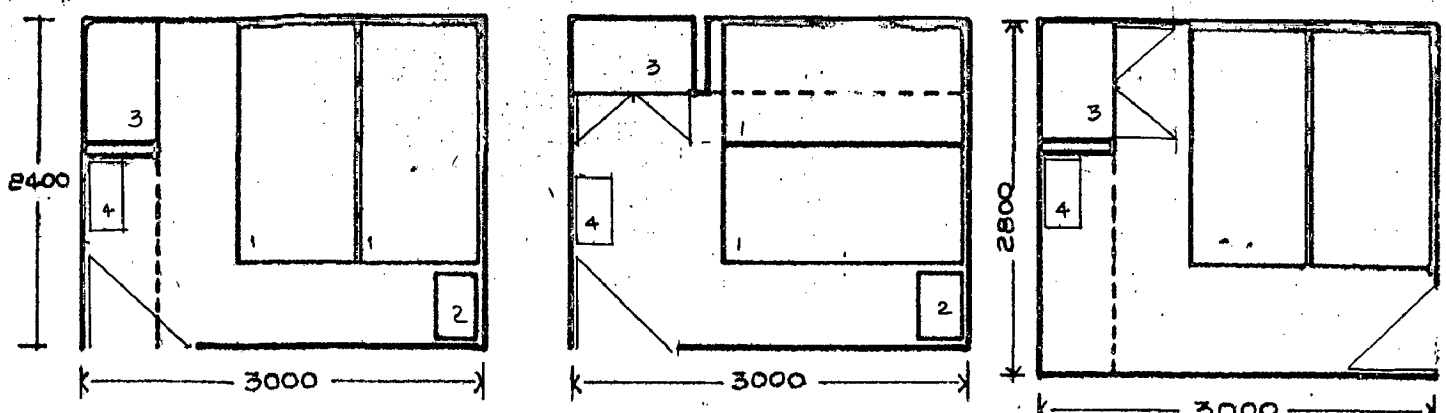
5.2.5 KITCHEN

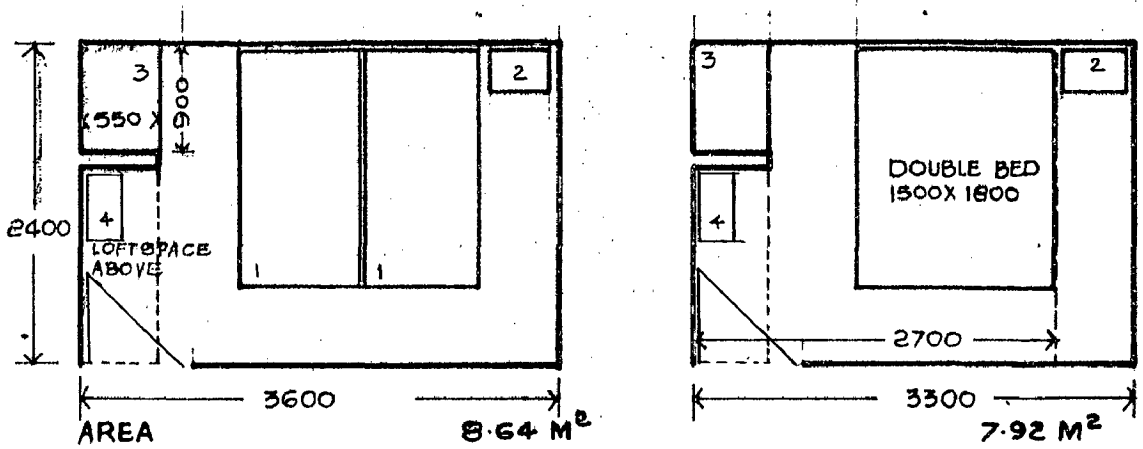
Many analytical studies* of kitchen operation have been made with the objective of saving steps and arm motions and consequently reducing fatigue. Most of these studies are based on thoroughly logical sequence of storage and operation

* Gupta, T.N., "Household Kitchen Planning - Part I & II, IIA Journal March/April 1966.

SPACE ASSESSMENT MASTER BED

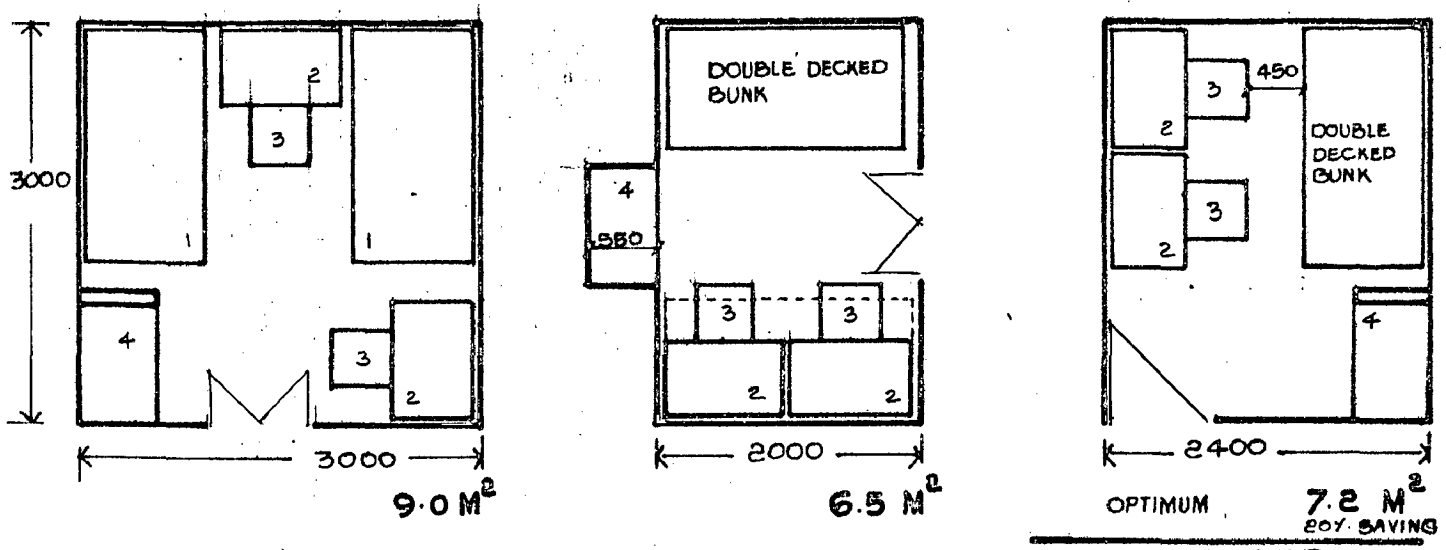
G8·A



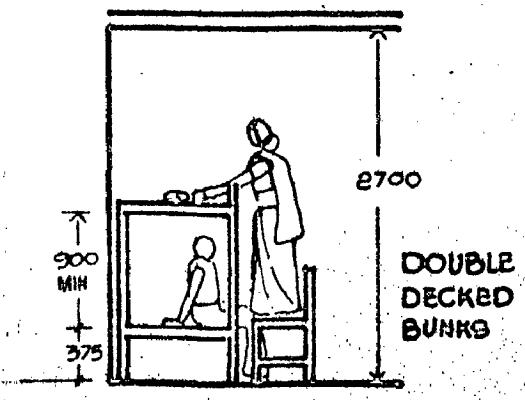


1 SINGLE BED : 900X1800
2 SIDE TABLE : 300X400
3 CUPBOARD : 550X900
4 SEWING MACHINE : 500X 250

FIG 5.2.4 - D1



CHILDREN BED



1 SINGLE BED : 900X1800
2 STUDY TABLE : 600 X 900
3 CHAIR : 450 X 450
4 WARDROBE : 900 X 580

FIG 5.2.4 - D2

so that food preparation follows assembly line course along a counter top at the end of which is is ready to serve. It is difficult to predict any operational sequence for cooking is an art and not a mechanical process. What is important is that operational area be reasonably small with everything not more than one or two steps from a work counter. The following activities were considered to determine spatial requirement.

1. 1.8 M length of cooking platform with a width of 55 cm with minimum movement space of 80 cm.
2. Provision of draining board and sink (45 cm x 45 cm) as utencils are cleaned in the kitchen.
3. Storage unit for kitchen supplies, cereal conhainers etc.with minimum floor space of 30 cm x 90 cm.

The area of minimum kitchen comes out to be 3.75 M^2. However if the occasional dining (squatting type at the rate of 70 cm x 70 cm floor space per person) for 3 persons is to be included then the floor area comes out to be 5 M^2 with minimum width of 2 M.

Different layouts for cooking area, cooking + occasional dining and cooking + table dining have been shown in Fig. 5.2.5-D1

It was also observed that detailing rather than space governs the efficient planning of the kitchen.

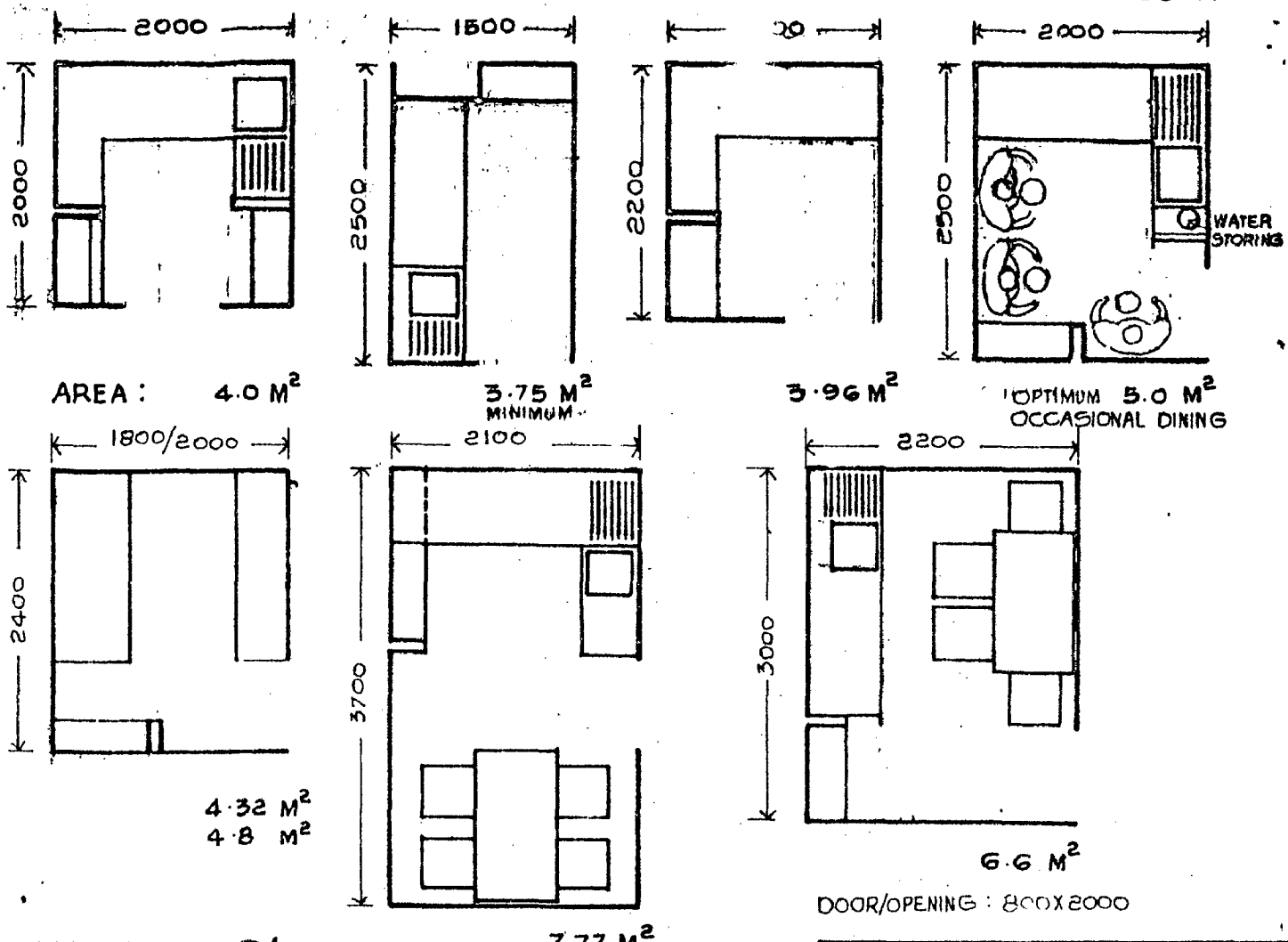
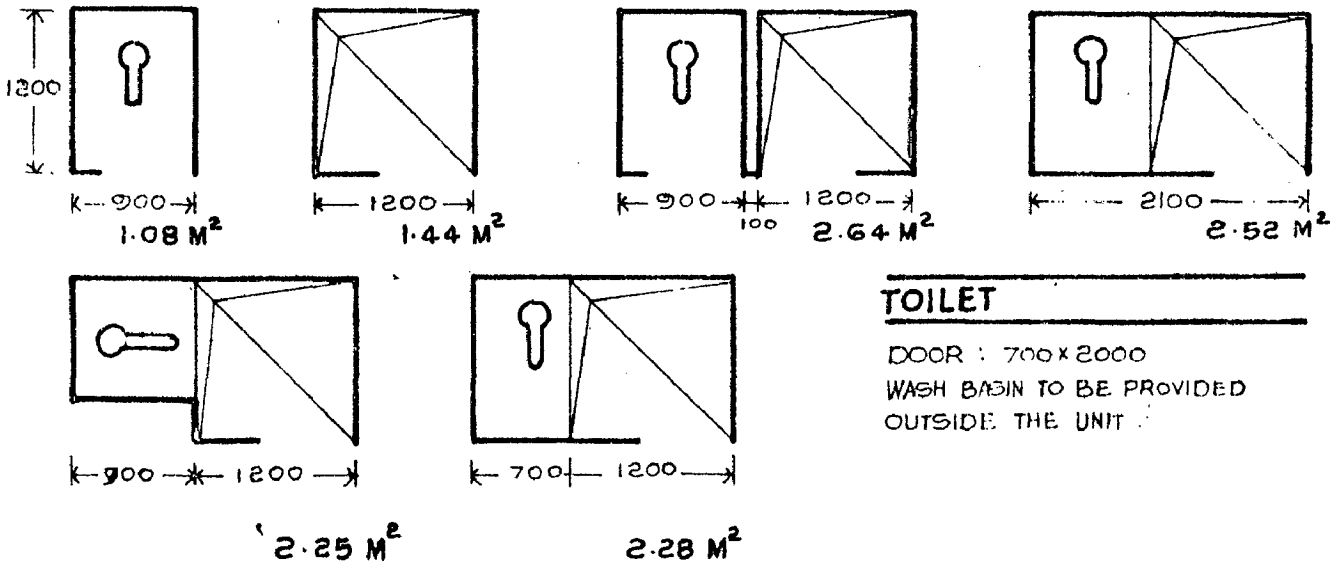


FIG 5.2.5 - D1

KITCHEN: SPACE ASSESSMENT



TOILET

DOOR : 700 x 2000
WASH BASIN TO BE PROVIDED OUTSIDE THE UNIT

FIG 5.2.5 - D-1

5..6 TOILET/UTILITY AREA

The survey has revealed that the owners have no objection to the provision of combined bath and W.C. The combined provision not only saves the floor/area space but also one door and partition wall. Minimum floor of 1.44 M^2 for bath (width 1.2 M) and 1.08 M^2 for w.c. (width 0.9 M^2) is required for seperate bath and w.c. facility.

With the minimum dimensions required for bath and W.C., enclosure sizes for combined unit have been worked out. It can be observed that further saving in space is possible w.c. and bath are partly alcoved in the same enclosure. Floor area range of 2.25 M^2, 2.28 M^2 and 2.52 M^2 have been worked out for a combined unit. (Ref.Fig.5.2.6 - D1)

A utility area accomodating wash basin or for carrying out certain pre-cooling chores such as winnowing, picking etc, drying clothes, ironing etc is considered.necessary particularly for a flatted dwelling unit. An area of 2 M^2 with minimum width of 1 M is sufficient to eater the assigned functions.

5.3 INTERCHANGEABILITY

For the performance of various activities several furniture arrangements are possible. These require different sizes of enclosure. In case all the variations and the optimum sizes of enclosure provide for interchangeability

is to be arrived at these arrangements should be superimposed. An enclosure with extreme dimensions shall afford the desired flexibility. Although such a size is little more than the minimum required for a particular space, it can cater for increased usage. Interchangeability is possible only for living spaces i.e. living, dining and sleeping.

5.4 DWELLING AREA AND SPACE STANDARDS

5.4.1 While evolving space norms the major consideration was to effect an economy through space reduction with increased use effeciency. A dwelling constituting of living dining, sleeping (two enclosures), kitchen, toilet and utility spaces give a floor area range of 34.1 M^2 to 43 M^2.(Refer Table No. . Many combinations are possible depending upon the choice of spaces. Thus, it is obivious that the evolved dwelling spaces can meet sufficiently wide range of MIG household requirements.

5.4.2 SPACE STANDARDS

Since space standards are a function of socio-economic characteristics of the uses group, rational choice of space norms is extremely important. Primarily the choice of space norms is governed by the economic capabilities, however efforts were made to keep ballanced compromise between diverse and conflicting demands within the overall framework of living pattern, users' preferances and their capacity to adopt.

The following are the recommended space norms:

Living Space	: Floor area not less than 7.2 M^2 with minimum dimension of 2.4 M.
Dining Space	: Floor area not less than 6.5 M^2. However if an interchangeability is to be achieved then area should be 7.2 M^2 with minimum dimension of 2.4 M.
Sleeping Space(s):	An area of 7.2 M^2 and width 2.4 M.
Kitchen Space	: Floor area not less than 5 M^2. Minimum width of 1.8 M is essential.
Toilet Space	: Combined toilet unit of minimum 2.25 M^2 with minimum dimension of 1.2 M.
Utility Space	: An enclosure of 2.00 M^2 with minimum width of 0.9 M.
Passage/Lobby	: Minimum width 0.9 M (as far as possible should be avoided).

Recommended space standards and minimum and maximum range of areas for the spaces have been tabulated in table for ready reference.

5.5 COMPARISON

With the above recommended space standards the total floor area comes out to be 38.9 M^2. With 20% wall area added gives a plinth area of 45.66 M^2 which in turn decides the plot area of 130.45 M^2 considering the built up area as 35% of

the plot. If these standards are compared to present MPHB norms (80 M^2 plinth area and 216 M^2 plot area) a saving of 51.37% in built up area and 39.60% in plot area is achieved.

With the recommended space norms, a living space of 7.2 M^2 per person for a family size of 4 persons is achieved.

5.6 PLANNING GUIDELINES

The important considerations which should be borne in mind to achieve not only planning efficienty but also economy are listed below.

1. The recommended space standards should be considered as absolute values and be adhered to in all plan possibilities. Should the modifications be necessary because of furniture layout, circulation, inter-relationship of various spaces, the shift should be minimum.
2. The ratio of the useful space to the plinth area is a good index of planning efficiency, endaevour should, therefore, be made to obtain as high a ratio by reducing to the minimum the circulation space and the area under walls. In group housing scheme, staircase should serve at least two dwellings on each floor. The circulation area including staircase external corridors should not exceed 3 M^2/unit where 4 dwelling units are grouped around a staircase and 5.5 M^2/unit when two units are grouped

around a staircase. The width of staircase shall conform to those stipulated in NBC for fire safety.

3. The basic principle of cost dynamics is that the length of wall, other things being equal, affects the cost. As such the plinth area which has the minimum wall length should be selected. The sensitivity analysis must be done for each solution. Repetition of same plan on all the floors results in economy in construction cost. Therefore every possible effort should be made to achieve it.

4. Fig. 5.6-D1 shows two different configurations with same built up areas which call for different land coverages for the layout. The building having similar profiles (in plan) as the plot, will call for minimum coverage of land. The plan(shape) of the building therefore, should follow the configuration of the project site. This will result in economy with respect to land and development cost of services.

5. In Bhopal, metric bricks are now being used extensively. Yet the plans are prepared in inch-foot system and the sizes of various components are based on old module of 3". If this module is adopted with metric bricks it results in wastage which can be avoided by adopting 10 cm (1M) module. It is observed that against the estimated normal provision of

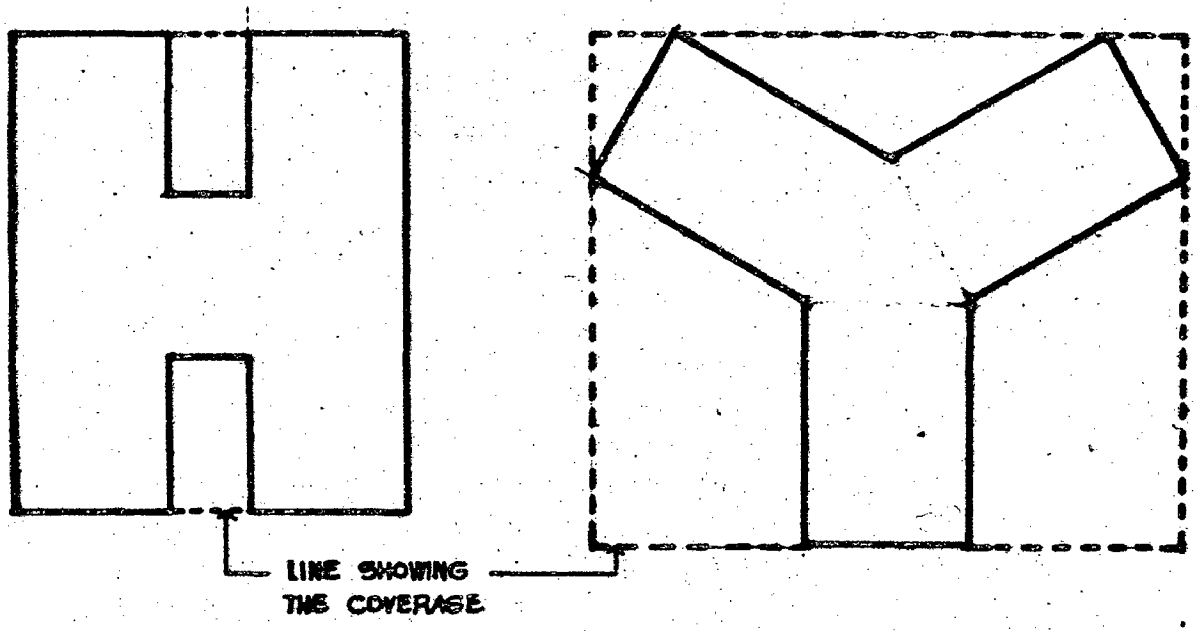


FIG.5.6.1.8-D1

DIFFERENT CONFIGURATIONS WITH SAME BUILT-UP AREA REQUIRE DIFFERENT LAND COVERAGE

480 bricks per cu.M, the requirement can be cut down to 430 bricks per Cu.M. of masonary i.e. saving of 15 to 20% can be achieved in bricks.

Secondly, the modular co-ordination leads to standardization which in turn leads to mass production wherein economy can be achieved. It can be also introduced in traditionel building methods of construction thereby simplifying the design procedure and raising the efficiency right from start to the end.

6. The cost of doors and windows per sq.m. is nearly 5 times the cost of wall. It is, therefore, necessary to minimise the area of doors and windows. The area of windows should not exceed 10-12% of the floor area as Bhopal is in hot-arid climate. Windows shall open outwards. These shall be located to give sufficient light and cross ventilation. The following window sizes are suggested.

- Living, dining, sleeping spaces	- 700 x 100
Kitchen	- 500 x 1000
Toilet, Utility space	- 400 x 600

Doors of 90 cm, 80 cm and 70 cm width 2.0 M. height are adequate for living space/main entry, sleeping and kitchen space and toilet/rear entry respectively. Number of doors and windows should be minimum.

In many existing dwelling units, fanlights are provided above the doors and windows and ventilators below the roof level. Observations made in the houses (during survey) show that most of the users never operate the fanlights. The ventilators are source of nuisance and subsequantly they are closed. These conventional provisions which increase the cost construction should be avoided.

7. Furniture layout including the storage, door opening directions must be shown on every dwelling plans.
8. Wet core units (toilet and kitchen) should be grouped together to achieve economy of plumbing and services.
9. Consistancy and simplicity in dimensional requirements must be aimed at for achieving overall economy.
10. Normally new sites are developed with proper drainage etc. which should be taken advantage of in restricting the plinth height to 20 cm. above the level of surrounding ground.
11. The minimum height of floor upto ceiling should be 2.7 M as recommended b y National Building Code - 1970. The studies conducted by CBRI have revealed that any ceiling height beyond 2.7 M has little impact on the thermal comfort of a room.

5.7 CONCEPTUAL DESIGNS

In order to ascertain the results of evolved space norms, conceptual designs for multi-family housing and single family house with above guide lines have been prepared (Refer drg.No.5.7-D1 to D4). Achieved overall efficiency and space(s) efficiency have been compared with the standards as recommended by'Committee on Plan Projects' and is indicated on the respective drawings. It can be observed that an efficiency of 84% (floor to built up area ratio) has been achieved.

Several configurations are possible depending upon the shape of the plot. However, conceptual designs have been prepared assuming rectangular divisions.

The following table indicates the percentage of saving achieved in plot area and built up area by comparing MPHB design and conceptual design.

TABLE

Type	Area Type	MPHB Design	Conceptual design	% saving
House	Built upp	80.80 M^2	46.6 M^2	42.33%
	Plot	216.0 M^2 vide Drg.No 3.10.4-D1	135 M^2 Vide drg No. 5.2- 3.	37.5%
	Built up	84.81 M^2 3.10.4-D3	4 9.07 M^2 5.2-D.2	42.15

It can be noted that on an average 42% saving in built up area (plinth area) has been achieved by adopting evolved space norms.

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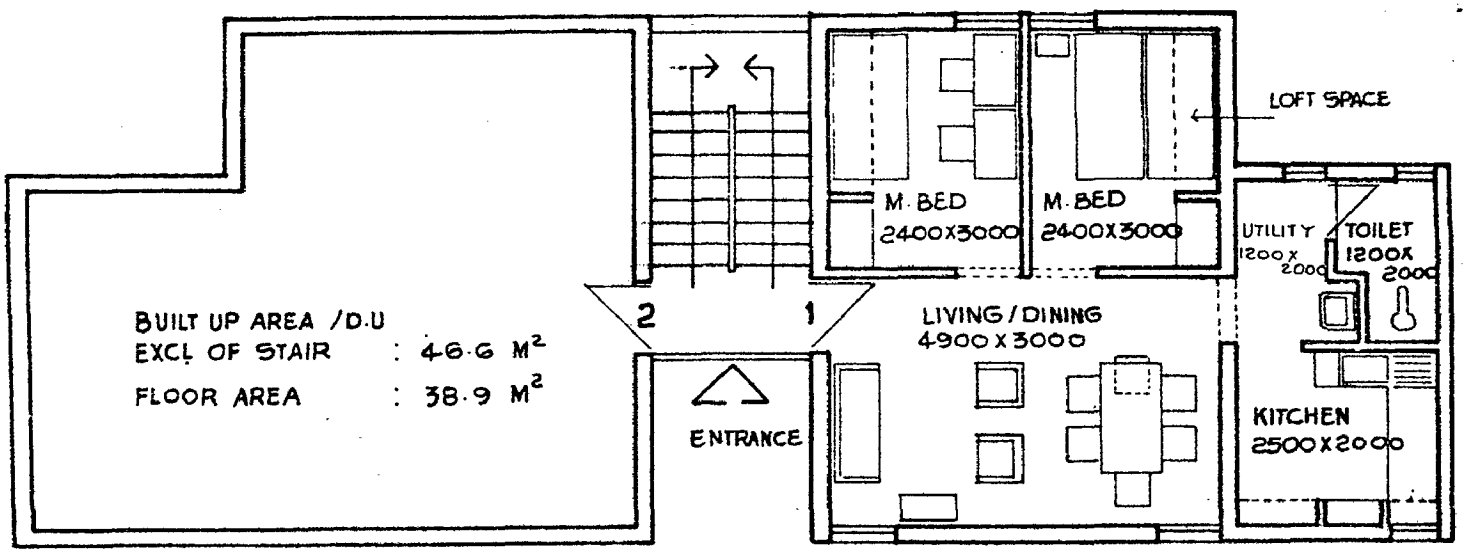


TYPICAL FLOOR PLAN
GROUND + 1/2/3 STOREY STRUCTURE

SPACE STANDARDS : ANALYSIS

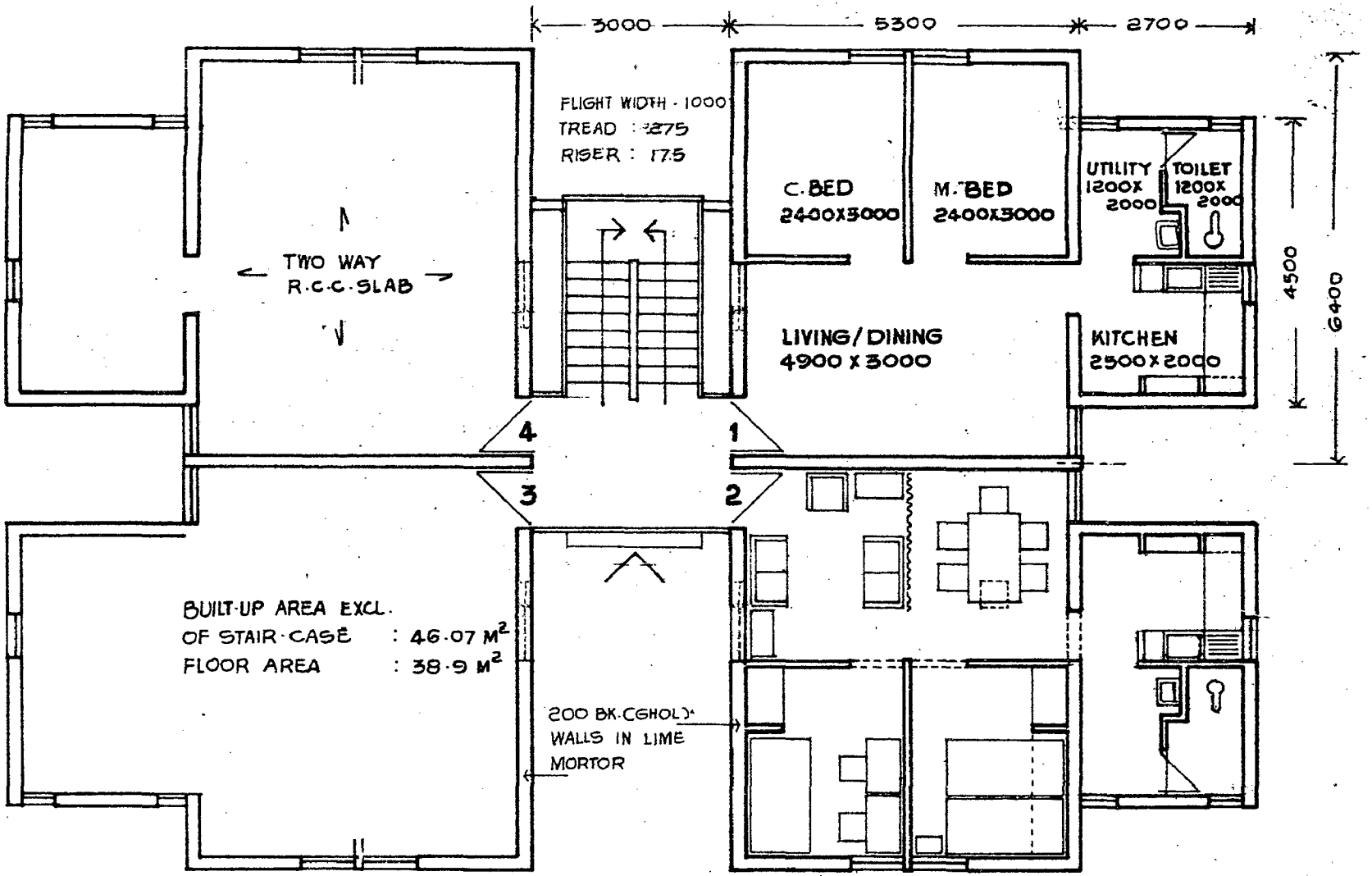
		% TO TOTAL AREA M²	% TO TOTAL ACHIEVED	RECOMMENDED
A	LIVING SPACE	29.1	57.73 %	47 - 50 %
B	SERVICE SPACE	7.4	14.68 %	15 - 20 %
C	HORIZONTAL CIRCU/SPACE	2.4	4.76 %	10 - 12 %
D	VERTICAL CIRCU. SPACE	3.8	7.53 %	4 - 7 %
E	WALLS SPACE	7.7	15.30 %	15 - 17 %
	TOTAL	50.4	100.0 %	

TOTAL PLINTH AREA
/D.U. INCLU OF STAIR : 50.4 M²
FLOOR AREA : 42.7 M²
EFFECIENCY : 84.72 %

CONCEPTUAL DESIGN : MIG FLATS

FIG 5.7 - D1

77-A



TYPICAL FLOOR PLAN
GROUND + 3 STOREY STRUCTURE

	AREA M²	ACHIEVED	RECOMMENDED
A LIVING SPACE	29.1	59.39 %	47 - 50 %
B SERVICE SPACE	7.4	15.08 %	15 - 20 %
C HORIZONTAL CIRCU/S	2.4	4.89 %	10 - 12 %
D VERTICAL CIRCU/S	3.0	6.1 %	4 - 7 %
E WALLS SPACE	7.17	14.62 %	15 - 17 %
	49.07	100 %	

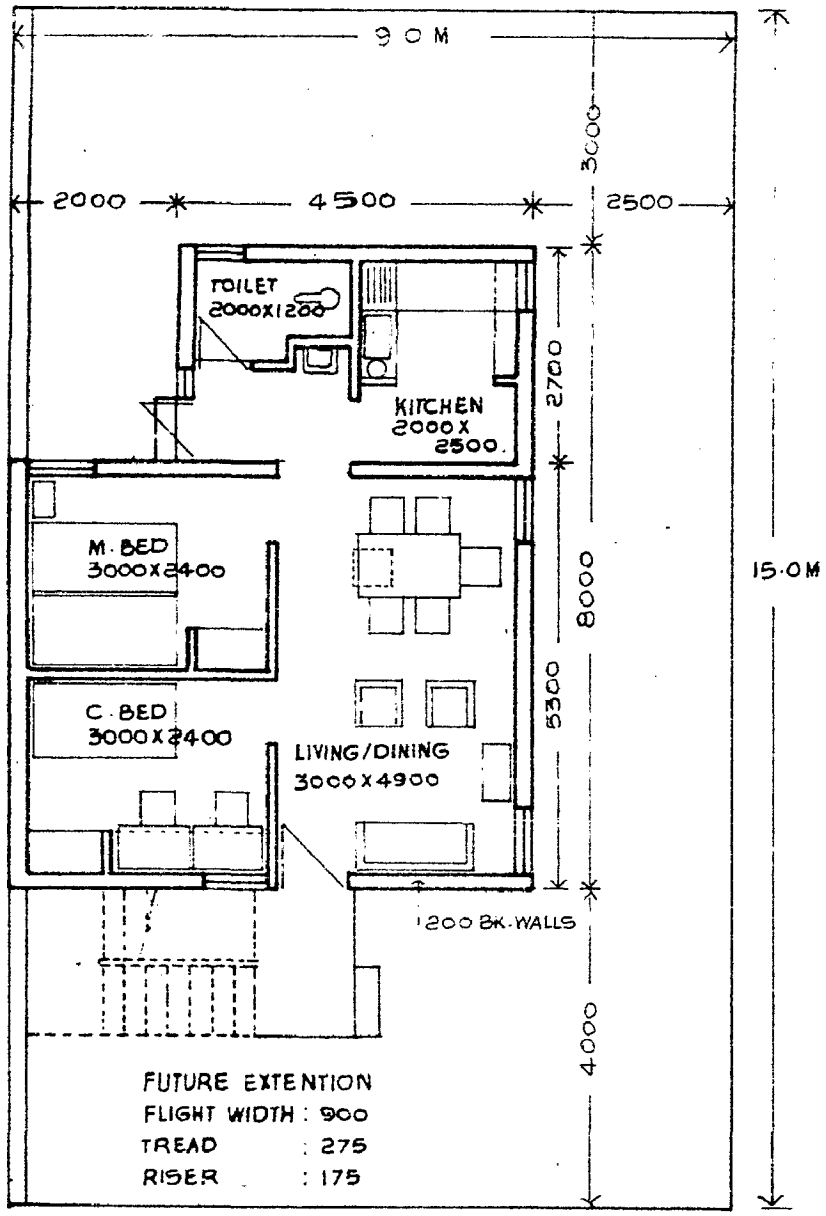
TOTAL PLINTH AREA
INCL. OF STAIR-CASE/D.U : 49.07 M²
FLOOR AREA / D.U. : 41.9 M²
EFFECIENCY : 85.38 %

CONCEPTUAL DESIGN : MIG FLATS

FIG 5.7-D2

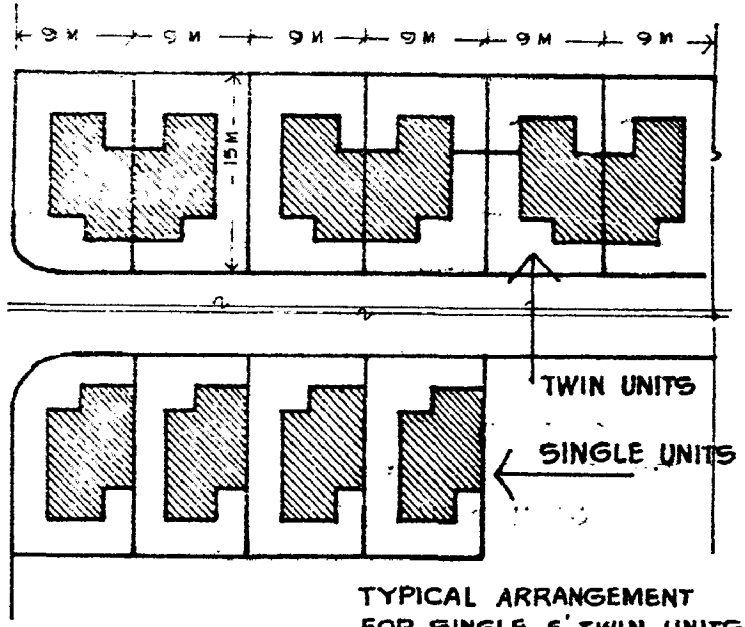
77-B

CONCEPTUAL DESIGN : MIG HOUSE (SINGLE & TWIN TYPE) FIG 5.7-D3



SCHEDULE OF DOORS / WINDOWS

D-1	900 x 2000	L FRAME,	F. PANELLED	(IN SEASONED BIJA)
D-2	700 X 2000	L FRAME,	F. PANELLED	— DO —
W-1	800 X 1100	L FRAME,	F. GLAZED	L SHUTTER FRAME
W-2	600 X 1000	L FRAME,	F. GLAZED	— DO —
W-3	400 X 600	L FRAME	F GLAZED	— DO —



TYPICAL ARRANGEMENT
FOR SINGLE & TWIN UNITS

SPACE STANDARDS : ANALYSIS

		AREA M^2	% TO TOTAL ACHIEVED	RECOMMENDED
A	LIVING SPACE	29.1	62.44	47 - 50 %
B	SERVICE SPACE	7.4	15.87	15 - 20 %
C	HORIZONTAL CIRCU/S	2.4	5.15	10 - 12 %
D	WALLS SPACE	7.7	16.54	15 - 17 %
	TOTAL	46.6	100.0 %	

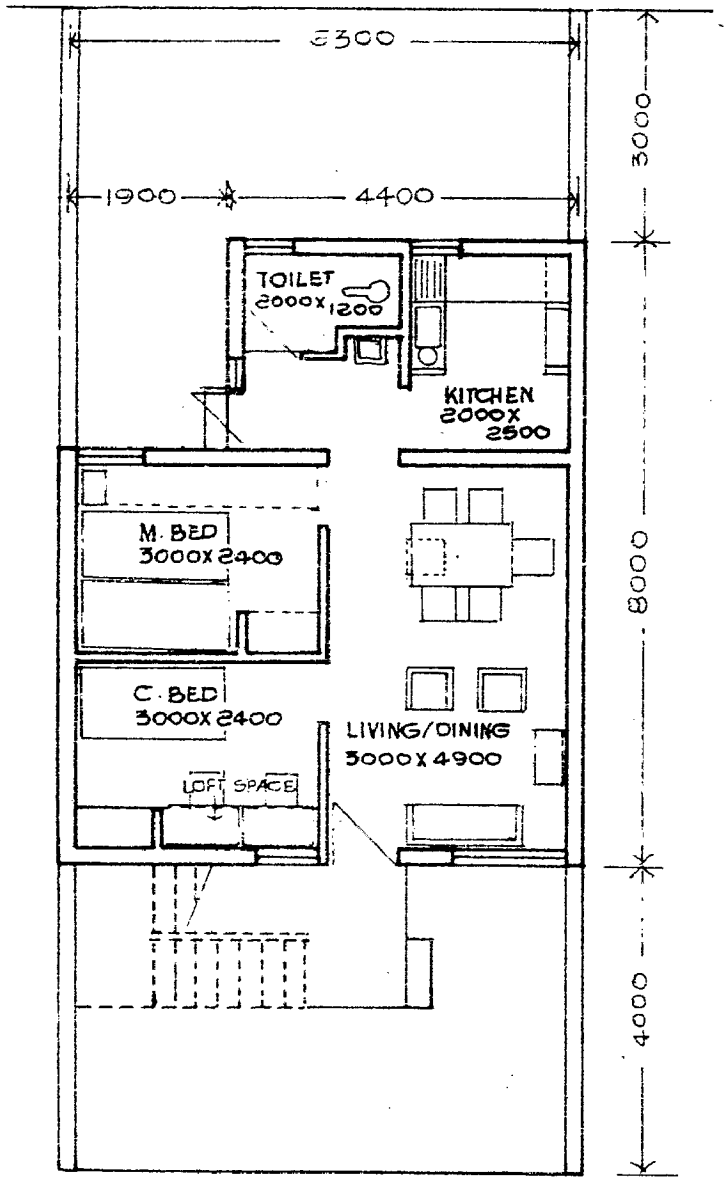
BUILT UP AREA : 46.6 M^2 (34.51 % of PLOT AREA : 135 M^2)
EXL STAIR CASE
FLOOR AREA : 38.9 M^2
EFFECIENCY : 83.47 %

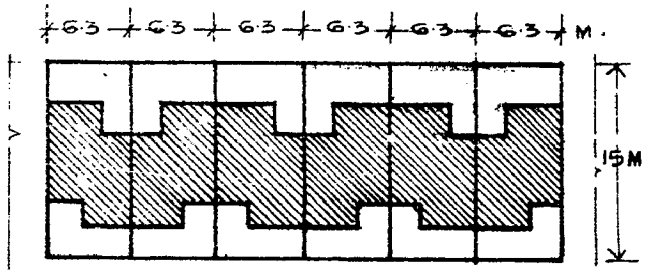
77-C

CHAPTER - 6 COST REDUCTION MEASURES

Research and development in the field of building has made available more exact data and knowledge regarding the quality, behaviour and performance of building materials and structures. Based on these the traditional and conventional specifications and techniques so far being adopted could be rationalised to result in economy and speed in building work. There is a scope for cost reduction by rationalisation of specification of various items and components. It is not proposed to recommend cheap specification because ultimately the building is expected to be structually safe, functionally effecient and durable. These aspects become all the more important when public agency sells the dwelling units on outright or hire-purchase system. While suggesting the measures the factors relating to economy in cost of construction as well as reduction in the use of costly and scarce materials has been given due consideration. The main emphasis is on the increased use of local materials and such specifications and construction techniques that have been proved to be technically acceptable for mass construction. Climatic conditions obtaining in the region (Bhopal) have been also taken into consideration.

CONCEPTUAL DESIGN :- MIG ROW HOUSE FIG 5.7 D-4





TYPICAL ARRANGEMENT
FOR ROW HOUSING

SPACE STANDARDS : ANALYSIS

		AREA M^2	% TO TOTAL ACHIEVED	RECOMMENDED
A	LIVING SPACE	29·1	64·28	47-50 %
B	SERVICE SPACE	7·4	16·34	15-20 %
C	HORIZONTAL CIRCU/S	2·4	5·3	10 - 12 %
D	WALLS SPACE	6·37	14·08	15 - 17 %
	TOTAL	45·27	100 %	

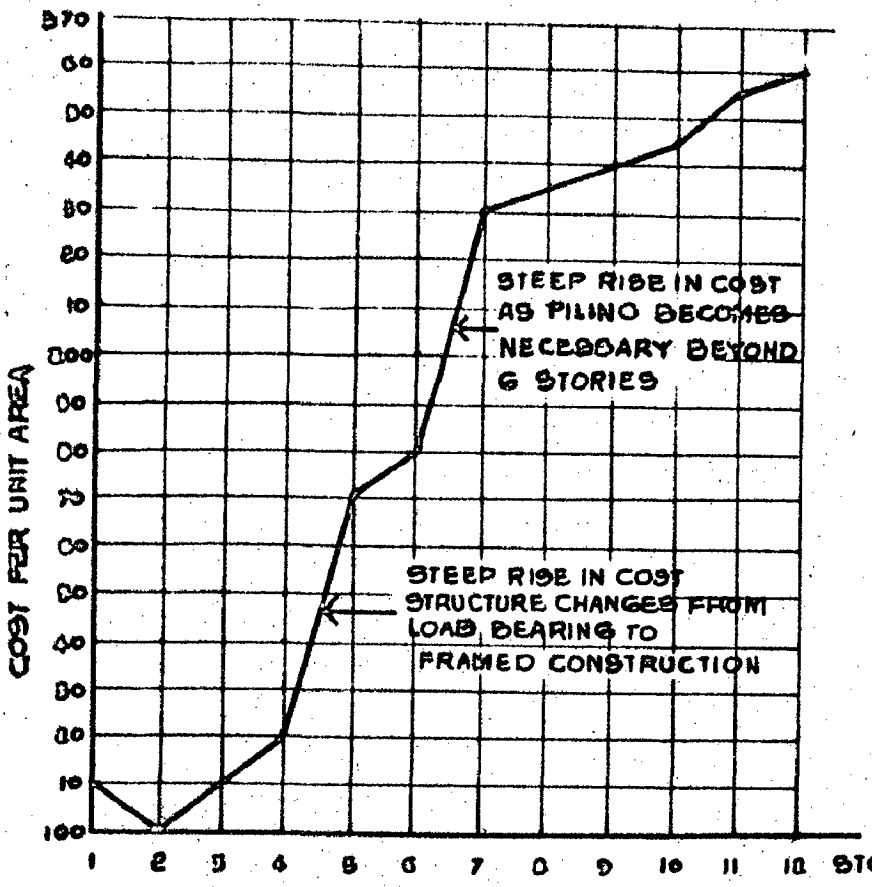
BUILT-UP AREA
EXL STAIRCASE : 45.27 M^2 (47.90 % OF PLOT AREA : 94·5 M^2)
FLOOR AREA : 38.9
EFFECIENCY : 85.98 %

77-D

6.1 TYPE OF STRUCTURE

The specification and construction technique to be adopted shall mainly depend upon the type of structure i.e. load bearing or frame structure. Cost of construction is generally proportional to the number of stories as the cost of foundation, services and lead & lift cost increases. Number of studies have been done to study the nature of the relationship. According to the study done by Economic Commission for Asia it was found that the cost per square metre of a 2 storeyed buildings is the least (100%) while single storey and three storey buildings 10% more and a 4 storied building 20% more (Ref. table No. & graph on page 79-A).

Two steep rises in the cost of construction were observed, one after 4 stories, and second, after six storeys. These are due to the change of the system from load bearing to the framed construction, lift installation and foundation cost. The study has concluded that load bearing construction upto 4 stories (walk up type) is economical and for structures with 5 and more storeys R.C.C. frame construction is economical. It also points out that load bearing structures upto 4 storey results in saving of 25% of cost, 50% saving in steel and 30% saving in cement as compared to R.C.C. frame structures.



FROM THE CURVE IT IS SEEN THAT BUILDING COST PER SQUARE UNIT OF PLINTH AREA IS LOWEST FOR TWO STOREY BUILDING. ACTUALLY A SINGLE STOREY BUILDING WOULD BE EVEN CHEAPER BUT THE RATIO OF COST OF SERVICES TO THE COST OF STRUCTURE IS HIGH.

COST OF CONSTRUCTION PER UNIT AREA (BASIS 1960 PRICES)

SOURCE : ECONOMY FACTORS IN MULTISTORIED BUILDING : A CASE STUDY BY ECONOMIC COMMISION OF INDIA

TABLE 1 RELATIONSHIP BETWEEN COST OF CONSTRUCTION & LAND AND NO OF STORIES

NO OF STORIES	PERMISSIBLE COVERAGE	UNIT COST OF CONSTRUCTION	% COST OF CONSTRUCTION	% COST OF DEVELOPMENT	
ONE	60	30	45	55	
2	60	28	60	40	
3	50	28	68	32	IMPACT OF THE COST OF LAND AND ITS DEVELOPMENT GETS CONSIDERABLY REDUCED BEYOND FIVE STOREY CONSTRUCTION.
4	35	32	67	33	
5	35	45	78	22	
6	25	40	73	27	
7	25	40	76	24	
8	25	40	76	24	

SOURCE :

In R.C.C. buildings the component of appearent employment at site is about 25% of the total construction cost whereas it rises upto 35% in case of housing built with local materials. Further in the second case the employment for production of local materials can be as much as 45% of the cost of building whereas in R.C.C. construction the component of employment in production of materials goes down to 25% of the cost of house.

The studies* in physical planning i.e. layout of blocks indicate that two to four storied walk up tenements offer optimum density and development cost.

From all the considerations discussed above, it is clear that load bearing structures are economical over R.C.C. frame construction. As such the specifications and construction techniques which are appropriate for load bearing structures have been evolved.

6.2 FOUNDATION

6.2.1 The design of foundation depends upon the nature of supporting soil, its depth and intensity of wall loads. To avoid excess depths and over designing of foundations, detail investigations on the bearing capacity of soil is necessary using the plate bearing tests or dynamic cone penetration method at every construction site. Width of foundations is designed by Rankine's formula. Since very

*Garg B.B., "Optimisation of Nature of Housing Developments in relation to Land use and Economics", CBRI Roorkee, 1971.

limited methods of foundation are possible, it is not difficult to adopt economical methods of foundation. Open type of foundations are economical upto 1.5 m. depth. Even on rocky sites which are commonly found in Bhopal, a minimum anchorage of 30 cms. below the exposed rock is necessary to ensure lateral stability.

SAVING: There is saving of 15 to 20% in the cost of foundation or a saving of 1 to 1½% in the building cost if designed on rational basis in accordance with I.S:1892-1962 in place of conventional design of foundation.

6.2.2 BED CONCRETE

A bed of lean concrete (1:2:6 lime concrete or 1:5:10 cement concrete) is usually provided under the wall footings to distribute evenly the load of walls on supporting soil and to keep settlement within reasonable limits. On an average thickness of 15 cm for this block has been recommended by N.B.O. for average conditions.

Saving: If compared with MPHB practice of providing 30 cm thick 1:4:8 cement concrete saving of 54% and 50% can be achieved by using lime concrete (1:2:8) or cement concrete (1:5:10) respectively in this item.

6.2.3 MASONARY IN FOUNDATION

Since good masonry stones are available at reasonable cost in Bhopal, C.R. stone masonry in foundation and plinth is recommended. Under average conditions cement mortor 1:6, cement lime mortor 1:1:8 or lime mortor 1:2-3 is adequate for masonary in foundation. The width of stone masonary provided at present is 60 cm for first footing and 45 cm for second footing, and have been found excessive from design point of view. Maharastra P.W.D. specification of providing 40 cm and 30 cm widths for footing can be well adopted.

SAVING: This would result an economy of 13% in this item.

6.2.4 UNDER REAMED PILES*

In Bhopal large areas are covered by black cotton soil and therefore use of under reamed pile foundation is economical over conventional foundations. These are nothing but short bored concrete piles having one or more bulbs at the base. Single reamed pile foundations are suitable for buildings upto two storey while double or multi-reamed piles can be used for heavier loads. Additional bulbs increase the bearing capacity of the pile. The construction of under-reamed pile foundation does not require any special skill or costly machinery. The plinth beams are designed to support

* 'Processes ready and suggested for implementation', CBRI, Roorkee 1975.

the super structure using the formuly M = WL/50. These piles have a depth upto 5 metres and spacing depends on the plan and loading and may very from 1.5 to 3 M. The diameter of pile may very from 20 to 30 cm.

SAVING : Under reamed pile foundation effect and economy of the order of 20 to 30% compared to traditional foundations.

6.3 DAMP PROOF COURSE (D.P.C)

Function of this item which is provided at plinth level, is to check the rise of moisture from ground to superstructure. When C.R. stone masonry in cement or lime mortor is used in foundation and plinth either D.P.C. can be omitted or relatively lighter specification could be adopted. In place of conventional 4 cm thick 1:2:4 cement concrete with layes of bitumen, some alternative specifications for this item in the ascending order of cost are given below.

1) 2 cm. thick cement lime plater (1:1:5) with one or two coats of bitumen (Saving : 57%).
2) Black polythene sheets (400 gauge) laid over 12 mm thick gauged plaster (Saving: 45%).
3) 2 cm. thick coat of cement concrete (1:2:4) with two coats of bitumen (Saving : 40%).

6.4 WALLS : SUPER STRUCTURE

6.4.1 BRICK WALLS:

The bricks available in Bhopal are of second class quality having a crushing strength of 35 Kg/cm^2. Of late some manufacturers have started production of Ghol bricks having a crushing strength of 70 Kg/cm^2.

With the advancement of structural design and production of moderate strength bricks it is possible to build 4 storeyed structures with one brick load bearing walls for all the floors. National Building Code - 1970 has given a rational method of calculating thickness of walls based on strength of masonary units grade of mortor, % of opening in walls etc. Thickness determined this way being much less results in economy. By using the nomogram for finding out the thickness of walls it is found that structures upto 3-4 storey can be constructed in single brick in Ghol bricks (70 Kg/cm^2). Mortors of the following strength should be used for various floors

- Walls upto second floor level - cement mortor 4:3 or cement lime mortor 1:1:6
- Walls above second floor level- cement mortor 1:6 or cement lime mortor 1:2:9.

Ground + 1 structures in one brick wall can be constructed using second class bricks (35 kg/cm^2) in cement mortor 1:6 or cement lime mortor (1:2:9). A wall, apart from being structural member, has to provide thermal comfort. In Bhopal the dirunal variation in temperature is less than 15°C and hence 20 cm. thick external wall is sufficient to achieve desired level of comfort in summer and winter.

While using the Nomogran it was experienced that the procedure is cumbersome to find out the group of mortor and bricks for various % of openings. Through several exercises a ready recknor in the form of table (Page No. 85-A) has been prepared keeping wall thickness constant 20 cm and 30 cm. From the tables one can easily find the type of mortor and bricks for any number of storeys (max. upto 4) for the particular % of openings in the wall.

6.4.2 STONE WALLS

Although in Bhopal, good masonry stone is available, it is not recommended for the following reasons.

1) Even for G+1 storey structures minimum thickness of 37.5 cm. is required.
2) Increased wall thickness affects floor/plinth area ratio, as 30 to 35% of plinth area is covered by walls only.
3.) It consumes more mortor for joinery (33% of the wall) and plaster (minimum thickness for plaster - 2.5 cm).

TABLE

Specifications of Bricks and mortars for different number of storeys, keeping wall thickness constant(20)cm. as obtained from NBC Nomogram.

Number of Storeys		Percentage of Openings				
		10	20	30	40	50
ONE	Internal and External	Group VI mortar Group I bricks	Group VI mortar Group I bricks	Group V mortar Group I bricks	Group V mortar Group II bricks	Group V Mortar Group II bricks
TWO	Internal	Group V Mortar Group II bricks or Group III mortar Group I bricks	Group V mortar Group II bricks or Group III mortar Group I bricks	GroupIV mortar Group II bricks	Group III mortar Group II bricks	Group III mortar Group II bricks
	External	Group V mortar Group I bricks	Group V mortar Group I bricks	Group V mortar Group I bricks	Group V mortar Group II bricks	Group V mortar Group II bricks
THREE	Internal	Group IV mortar Grou p II bricks	Group IV mortar Group I bricks	Group III mortar Group I bricks	Group III mortar Group III bricks	Group III mortar Group III bricks
	External	Group V mortar Group II bricks	Group B mortar Group I bricks	Group IV mortar Group I bricks	Group III mortar Group II bricks	Group III mortar Group II bricks
FOUR	Internal	Group III mortor Group III bricks	Group III mortor Group III bricks	Group III mortor Group III bricks	Group II mortor Group III bricks	Group I mortor Group III bricks
	External	Group IV mortar Group II bricks	Group IV mortar Group II bricks	Group III mortar Group II bricks	Group III mortar Group III bricks	Group III mortar Group III bricks

TABLE

Basic compressive stresses for masonary walls

Mortar group	Equivalent mortar Mixes: Lime:sand Lime:surkhi	Cement: Lime sand	Cement: sand	Cement:sand with plasticizer	Basic stress of masonary in Kg/cm^2 corresponding to brick strength in kg/cm^2: 70	105	210
i	-	1:½:3	1:3	-	7.0	10.5	16.5
ii	-	1:½:4–4½	1:4	-	7.0	10.5	14.5
iii	-	1:1:5–6	1:4½	1:5:6	7	10	13.5
iv	1–2½	1:2½:8–9	1.6	1:7.8	5.5	8.5	12.0
v	1–3	1:310–12	1:7	1:8	5	7	10
vi	1:4	-	1:8–10	-	4.0	5.5	7.0

Table shows, the stresses of masonary obtained with different combinations of bricks and mortars. This also shows equivalent strength mortars for proper choice in selection of mortar.

4) Lack of skill can have serious consequences. The method of finishing the joints is equally important.
5) From external sides neat cement pointing is necessary otherwise rain water penetrates.
6) Superior dressing at jambs, pillars or other projections are also necessary.
7) Adoption of dense mortor leads to shrinkage cracks which lessens the resistance against moisture/rain penetration. On the other hand a weak mortor restrict the height to which the masonary can be built in a day.

With these considerations it is infered that in no way stone masonary can substitute the brick masonry not only from economic considerations but also from performance point of view.

6.4.3 STONE BLOCK MASONARY*

The normal stone masonary requires a wall thickness of not less than 37.5 cm and requires more labour, more mortor and more consumption of materials on account of greater thickness. A technique has been evolved by CBRI by which stone masonry blocks are cast by semiskilled labour reducing the thickness to 15 to 20 cm. For making these blocks, first

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* Source : CBRI Data Sheet No.8.

12cm size stones are laid inside steel moulds with concrete 1:5:8 upto a height of about 5 cm. The remaining portion of the mould is then filled with stones of 60 mm to 75 mm size and the gaps again filled up with concrete 1:5:8. The blocks thus precast are of size 30 cm x 20 cm x 15 cm and have an average compressive strength of 75 to 90 Kg/cm^2 depending upon the concrete mix. used. The advantages are:-

1) The productivity in laying is increased on account of blocks being of proper shape and size.
2) The block masonry presents a regular appearance.
3) A thin layer of plaster is required to be applied on the interior side (1 cm against 2.5 to 3 cm required for normal stone masonry), while on the outside the natural stone texture can be retained.

The system has been successfully used by Rajastan and Andra Pradesh Housing Boards. The stone block masonary is economical by 20% & 30% over brick (23 cm) and stone masonary respectively.

6.4.5 THIN CAVITY WALLS*

The system consists of two independent 75 cm walls with an air gap 50 mm. The walls are tied together by means of metal ties or concrete bricks. The system effects saving in bricks by 27%, in cement by 30% and overall saving of 15%

* CBRI Data Sheet No.8.

as compared to 23 cm brick walls. The cavity walls offer better thermal insulation and prevents ingress of moisture, reduces the consumption of mortor as thickness is reduced. However, the system requires high degree of construction skill and is suitable for structures upto two storey only. Moreover, the system cannot be adopted in Bhopal as only bricks in metric module are available.

6.5 MORTORS FOR MASONARY AND PLASTER

The N.B.O. and CBRI have suggested several measures for effecting economy in the consumption of Mortors. These include use of lime mortors, pozzolana cement mortors and composite mortors.

Lime has better workability and plasticity, better adherance to masonary units, greater freedom from cracking and is more resistant to water percolation. Lime is not used in the mortors mainly because of the time consuming and cumbersome procedure and non availability of standard quality of lime. The lime industry has already started manufacturing dry hydrated lime as per I.S.I. Specification (IS-712-1964) and the greater use of lime will put pressure on the lime industry to produce lime of standard quality in large quantities. Lime mortors can be used in masonry walls upto two storeys and results in 20% saving.

Flyash is a waste product and the investigations carried out by CBRI and other institutes have shown that cement can be replaced by 20% in cement mortors by fly ash without any detrimental effect. Banmore and Kymore factories in Madhya Pradesh have now started production of pozolana cement (cement with fly-ash). This cement is ideally suited for masonary mortors and plasters. Pozzolana cement starts gaining strength after three days of its laying. It is, therefore, necessary to water the surface thoroughly during first three days after which normal curing process may be adopted. Where pozolans cement is specified bricks should be immersed in water for a period of minimum ½ hour before being used.

The research in the field by N.B.O. has established that composite cement lime sand mortor are superior and more economical than the straight cement sand mortors in their use in masonary work and plastering. These mortors have the advantage of both the ingrediants i.e. cement and lime has quicker setting, earlier development of strength, good workability, plasticity, adherance to masonary units and greater freedom from cracking. The use of composite morters results in 6 to 10% saving in the cost of mortors over cement sand mortor. The following proportions have been recommended for masonry and plastering -

MASONRY : 1:1:6-9 / 1:2:-12 / 1:3: 12-15

EXTERNAL RENDERING : 1:1:6-8.

INTERNAL RENDERING : 1:1:6

For external rendering a mix of 1:1:6-8 has been found effective against rain penetration in area with moderate rainfall. Internal plastering is meant to provide a smooth and dust free base for finishing treatment i.e. white wash or colour wash.

Good quality of sand (fineness modulus - 1 to 1.5) and lime are necessary for composite mortors. There would be no marked economy in using either composite mortor or pozolana cement mortor but the shrinkage resistance and water tightness quality of gauged mortor will minimise leakages and cracks in the wall.

SAVING : Composite mortors are economical by 15 to 18% over straight cement mortors.

6.6 R.C.C. LINTELS

CBRI has evolved precast lintels (Building data sheet No.1) 7.5 thick with 3 bars of 10 mm placed in the centre of slab thickness. This lintel can be used upto 1.8 M. span provided the height of masonary above the lintel is at least 49 cm. Its design is based on arch action and panel wall theory or adopting the empirical relation of

bending moment equal to WL/50. Such lintels act as composite members, tension being taken by the lintel and compression by the brick work above. The precast lintels result in a saving of 50% in overall cost and speed up the construction of walls as the time involved in centering etc. is eliminated.

Stone lintels although economical poss difficulty in providing plaster finish at door frame (head). Secondly when chujjahas are to be provided over the openings, heavy lintels are required as the lintel thickness regulates the chujjah thickness.

Brick flat arches as lintels can be provided over the openings in one brick wall thickness and where chujjahas are not required.

6.7 STRUCTURAL FLOORS AND ROOF

6.7.1 Usually R.C.C. slabs (cast in situ) are designed on elastic theory and are normally 10 to 15 cm thick. If the shalbs are designed using 'ultimate load theory' which has been accepted and introduced by ISI Codes (1970), a thickness of 8 to 10 cm is possible and results in saving of about 15%.

Experts committee on low cost housing for large cities have recommended two-way slab.*

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* Report of the Expert Committee on methods for achieving 'Low Cost Large Scale Housing Construction in the Major Cities' - Page 34.

The report points out that

> "There is misconception that two-way slabs are uneconomical, but if designed as two-way contineous slab, the design is economical. The designing of R.C.C. two way slab takes more time and number of details have to be worked out. The time and effort spent in designing is worth the trouble in view economy and better performance. The ISI:456 : 1964 gives design tables for different and conditions. This coupled with the use of ultimate strength design will result in savings in steel upto 20% ".

6.7.2 DESIGN MIX OF CONCRETE

Generally, 1:2:4 (M:150) concrete mix is adopted for R.C.C. work. However with proper controls such as weigh batching, correct water cement ratio, use of mixers and vibrators for compacting it is possible to get a concrete mix of M:200 even with 1:3:6 proportion. Designed concrete mixes for specific usages are allowed by codes and in the latest revision of IS:456 volume mix concrete is almost banned.

6.7.3 USE OF DEFORMED BARS

The use of high-strength deformed bars in place of mild steel bars for reinforcement results in reduction in

the consumption of steel from 20 to 40% and therefore leads to economy in construction cost.

METAL:

The common belief that B.T. metal alone is suitable for R.C.C. work is not established by laboratory tests. The B.T. metal in and around Bhopal is a vessicular basalt having small pores. It is flaky and not quite suitable for concrete. The sand stone (strength 500 to 600 kg/cm^2 against the strength of 200 to 300 Kg/cm^2 of B.T. metal) available in Bhopal is quite strong. A firmr insistance on the use of red sand stone metal is necessary. Although crushing efforts may increase, the lead cost will be reduced. An economy of 2% can be achieved with the use of sand stone metal in R.C.C. work.

6.7.4 USE OF FLY-ASH

Replacement of cement with flyash upto 20% of cement improves workable quality of concrete without adversaly affecting the strength of concrete.* It has also been established that addition of flyash does not increase the risk of corrosion in the reinforcement and on the contrary improves the water tightness of concrete.

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* Report of the Technical Committee on Economy in the use of Cement and Steel in Building Constructions - Ministry of Works and Housing.

6.7.5 R.B. SLAB

Although R.B. slab is economical and saves the cement by 60% requires good quality bricks having a minimum strength of 150 kg/cm^2 and since such bricks are not available, the system cannot be adopted in Bhopal. Moreover, the experience of U.P. P.W.D. reveals that the reinforcement gets corroded in course of time because of lime contents in brick. As such use of R.B. slab is not advocated.

6.7.6 R.C.C. PRECAST UNITS

6.7.6.1 CBRI has brought out different pre-cast roofing units which have gone through all the stages of experiment in place of cast in situ R.C.C. slab. Besides saving in cost to the extent of 15 to 25%, it provides considerable saving in time as the time involved in the preparation of form work, casting and curing is completely eliminated. The units can be cast either at the work sites or mass produced in factory where better quality control can be effected.

6.7.6.2 CORED UNITS*

These units are concrete hollow box type units having two or more circular hollow cores with nominal width

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* CBRI Data Sheet No.3

of 30 cm (width of 60 cm & 90 cm are also possible) and thickness of 13 cm. Any span between 2.5 and 4.2 metres can effectively be covered by these units. The units are placed one adjacent to the other and the joints between the units are filled with concrete by placing reinforcement for negetive moments if necessary. No insitu structural deck concrete above the units is needed in the system and it provides a flush ceiling.

6.7.6.3 CHANNEL UNITS*

The unit is in the form of trough - 30 or 60 cm wide and 13 cm deep. These are suitable for spans 2.5 to 4.5 metres. The sides have corrugations and grooves at the ends to provide shear key action between adjacent units. No structural deck concrete is necessary above the units. The scheme results in a saving of 40% in cement and 6% in steel as compared to one way slab construction.

6.7.6.4 DOUBLY CURVED TILES**

The system uses single roofing units comprising of 70 cm square doubly curved tiles and are placed on partially precast concrete beams at 75 cm c/c and the haunches filled with in situ concrete to act as 'T' beams. Props for each

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* CBRI Data Sheet No.5
** CBRI data sheet No.4

partially precast beams is necessary. The casting of the tiles can be done with hessian cloth placed over timber frame.

Use of these units result in 20% saving in cement and 40% in steel when compared to traditional in situ R.C. slabs. The overall cost is about 20% less than in situ R.C. slab.

6.7.6.5 CELLULAR UNITS**

Cellular units are unreinforced hollow precast concrete units of size 120 x 60 x 7.5 cms. having 4 hollow spaces or the unit of 100 x 50 x 10 cm with 3 hollows. These units are placed over partially or fully precast beams. Deck concrete of 35 mm thick of 1:2:4 alongwith temperature reinforcement of 6 mm dia at 300 mm c/c is provided over the units. These can be used for normal roof/floor loads. The scheme results in saving of 22% in cement and 54% in steel against R.C. slabs.

6.7.6.6 PRECAST R.C. PLANKS***

The scheme consists of R.C. plank (120 x 45 cm or 130 x 40 cm, and partly 5 cm thick and partly 2.5 cm thick) supported over partially precast R.C. beams. The flooring is laid directly over the planks after the insitu concrete

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** CBRI Data Sheet No.4
*** CBRI Data Sheet No.7

in haunches has been laid and cured. Props for each partially precast beams is necessary. The system gives a saving of 47% in cement and 20% in steel and gives an economy of 26% in overall cost.

The table below gives a comparison between various precast roofing/flooring systems in terms of % saving of steel cement and cost over the 11.25 thick R.C.C. slab for a span of 3.5 M.

Table

Type of Roof	% Saving		
	Cement	Steel	Cost
1 Cored Unit	25%	4%	15%
2 Channel unit	20%	5%	36%
3 D.C.Tiles	24%	19%	45%
4 Cellular units	22%	54%	35%
5 Precast R.C.Planks	26%	20%	47%

Source: CBRI Data Sheets.

6.8 PARTITIONS

Partitions are provided to function as space dividers and cut off noise. The desired value of noise reduction is 40 decibles between two rooms which can be achieved with the use of 10 cm thick brick wall with 1.5 cm rendering on both sides respectively. At present, brick partitions are

the cheapest as compared to any other partitions giving similar acoustical privacy. Hence no change is possible in this item.

6.9 DOORS AND WINDOWS

6.9.1 The rate of teak-wood in last 5 years has more than doubled. First class timber is a comodity for luxury houses. Even the cost of secondary spices such as Bija, Mokha etc. inclusive of the cost of seasoning and chemical treatment necessary for secondary spices preclude the use of timber on economical grounds.

The use of M.S. Tee or angle iron frames which gives an economy of 28% over the cost of T.W. frames and 40% over frames made out of secondary spices is adviced. The following sizes as suggested by N.B.O. should be adopted -

- 40 x 40 x 5 mm M.S.Tee or 45 x 30 x 5 mm angle iron for door frames and 35 x 35 x 5 m.s.tee or 40 x 30 x 5 mm angle for window frames.

Suitability for mass production, durability and comparatively good bond with wall are the adgantages of these frames. Steel frames are economical by 15% over the frames in secondary spices.

R.C.C. FRAMES: R.C.C. frames are 40% cheapter against Teak or Bija wood frames. But these need care in handling, proper

planning of various fixtures at the time of casting and difficulty in fixing shutters. Bad finish and difficulty in case of repairs are other disadvantages due to which R.C.C. frames are loosing its popularity. Experience of R.C.C, frames is not very encouraging. It's use is therefore not recommended.

6.9.2 MAGNESIUM OXYCHLORIDE CEMENT AND SAW DUST FRAMES:

CBRI has brought out door and window frames from magnesium oxychloride cement and saw dust. These frames possess adequate strength, screw holding property. The frames can be easily cast and errected on construction site. They are economical by 33% and 25% over T.W. and secondary timber frames respectively.

6.9.3 DOOR/WINDOW SHUTTERS:

Panelled (15 mm thick panels) or battened and framed door shutters of 35mm thickness for door width of 900 mm or more and 30 mm thickness for shutters of width 800 mm and less made out of well seasoned and treated secondary spices have prooved to be satisfactory from considerations of durability and liability from wraping. Thickness of 30 mm for window shutters are suitable for general sizes of window.

Shutters in secondary spices give an economy of 35% over shutters in teak wood.

6.10 FLOORING

The quality and utility of a flooring which is non structural item is manifest in the house. This item is required to provide a smooth and dust free surface capable of taking loads expected on floors and resisting wear and tear under use. Freedom from water leakage is important in case of floors of kitchen, bathroom and W.C. An additional requirement on the ground floor is that it should not get damp. In case of ground floor minimum specification which gives satisfactory service under normal conditions is 10 cm sand filling, 10 cm lime concrete and 3.0 cm IPS floor (1:2:4 cement concrete) finish. Sand under the floor serves to check dampness and movement of termites.

Noise reduction is important consideration for intermediate floors. For airbone noise, a reduction value of 45 decibles can be achieved by a cement concrete slab floor of 10 cm thickness with IPS floor topping of 3.0 cm.

Flooring is a non-structural item as such, the owners can change the floor as per their choice as and when necessary.

IPS floor finish is quite strong, durable and can resist wear and tear. Terrazzo/mosaic flooring (6 mm terrazzo/mosaic finish over 4.0 mm thick & 1:2:4 concrete sub-floor) is 5½ times costly than IPS flooring.

6.11 DADOS/SKIRTING

Dado finish in a toilet unit should be finished with neat cement rendering integrated water proofing compound (Accoproof, Impermo etc). Likewise ~~instead--~~ ~~terrazzo/mosaic~~ skirting should be provided with same specification as that of dado.

6.12 WATER-PROOFING OF ROOFS

Effective water-proofing of roofs in residential buildings is important. The specification normally adopted is the traditional method of providing brick breeze concrete or lime coba. It, however, costs more, the process is cumbersome and is not truely water-proof because of several drawbacks. The main defect lies in the method of hand temped terracing.

A float of cement slurry integrated with water-proofing compound on the roof slab when it is green gives an absolute leak-proof slab besides being economical by 85%. Cement slurry should be spread with broom and need not be rendered smooth. A nominal slope can be given in the centering of roof slab itself. In case of further extention the surface can be levelled by brick-bat lime coba.

6.13 FINISH ON WALLS

The main requirement for this item are hygiene and good appearance, the minimum specification for this item being white wash or colour wash.

6.14 FINISH ON WOOD-WORK & IRON WORK

Purpose of this item is to provide protective layer and improve appearance. Minimum specification for this item is one coat of primer and two coats of good quality paint.

6.15 INTERNAL SERVICES

6.15.1 WATER SUPPLY AND SANITARY FITTINGS:

Internal water supply, sanitary fittings and drainage arrangement account for nearly 7 to 10% of the total building cost. The single stack system of drainage atleast upto 4 stories without any disadvantage is now accepted as economical and efficient alternative. The use of asbestos cement pipes and fittings is economical over cast-iron pipes. Concealed piping and fittings are costlier and careless work may invite future troubles. External water supply pipe fittings are recommended on the grounds of economy and ease in carrying repair work.

6.15.2 Plastic is a new material which is now being extensively used in buildings. A number of plastic products are being manufactured in India which include P.V.C. pipes and conduits, plumbing fittings and fixtures, sanitary appliances, tapes, wash basins, cisterns, W.C. seats etc. The use of plastic products in place of conventional materials results in saving of not only costly materials but offers other advantages. The use of plastics in plumbing instead of G.I.pipes and C.I. pipes results in saving of about 25%. The conventional properties such as resistance to corrosion of these pipes is also reported to to be better.

6.16 ELECTRICAL INSTALLATIONS

The method of providing electrical wiring on open teak wood battens with CTS wiring remains to be most economical method of wiring. Due to prohibitive cost of conduits concealed wiring in conduits is uncalled for. The cost of installing individual meters can be reduced by adopting the sub meter system where a main meter is provided on ground floor and sub meter in each dwelling unit. This saves on wiring cost. Providing a common earthing strips and distributing it to the smaller units can save the cost.

6.17 SUMMERY OF COST REDUCTION MEASURES

Various alternative economical specifications have been enumerated. The choice of particular system will mainly

depend upon the prevailing prices and availability of the material. In present circumstances, the following specification for various items is recommended.

1.	FOUNDATION	: Strip foundations / pile foundation.
	BASE CONCRETE	: 100 or 150 mm thick a) lime concrete (1:2:6) b) Cement concrete (1:5:10)
	MASONRY	: C.R.Masonary 30 & 40 cm thick for first and second footings in cement lime mortor 1:1:8.
2.	D.P.C.	: 2 cm. thick cement lime plaster.
3.	WALLS (Super structure)	: a) Brick masonry in cement lime mortor 1:1:6/1:2:9-12/1:3:12-15 b) Stone block masonry in cement lime mortor 1:1:6/1:2:9-12/1:3:12-15.
4.	LINTELS	: Precast thin R.C.C. lintels.
5.	STRUCTURAL FLOOR/ROOF	: a) R.C.C. slab b) Precast units
6.	DOORS/WINDOWS	: a) Frames - Angle iron frames b) Shutters - Secondary spices : door Shutter - 3.5 cm thick. Window shutter - 3 cm thick
7.	FLOORING	: i) Rammed earth followed by 10 to 15 cm of sand filling & 10 cm lean lime concrete (1:2:6). ii) 2.5 cm thick IPS floor finish (1:2:4 cement concrete).

8. FINISHING

a)	External rendering	: Cement lime mortor 1:2:6-8
b)	Internal rendering	: Cement lime mortor 1:1:8
c)	Finish on wall	: White wash inside, colour wash outside.
d)	Finish on wood work and iron work	: One coat of primer plus two coats of paining

9. WATER PROOFING : Cement slury coat integrated with w.p. compound or Lime concrete coba.

10. PLUMBING & DRAINAGE : a) External plumbing : G.I.Pipe.

b) Internal plumbing : Plastic pipe.

DRAINAGE : Single stack system

11. ELECTRICAL INSTALLATION : Wiring on wood battens with C.T.S. wiring.

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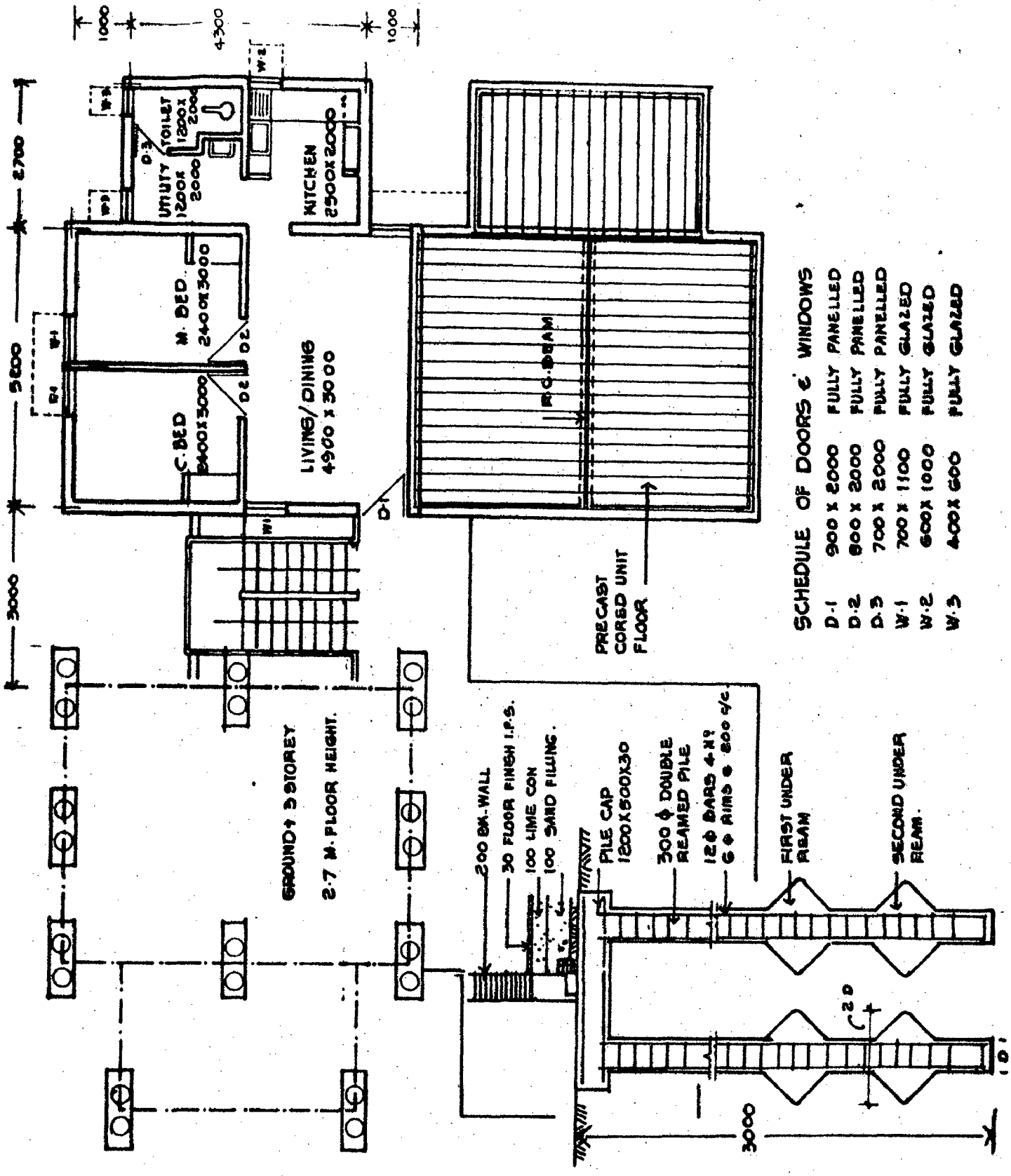
CHAPTER - 7 COST ANALYTICAL STUDIES

In order to ascertain the effectiveness of evolved space norms and specification on the overall cost of MIG dwelling unit, detail estimates were prepared of two housing forms namely the multi-family housing i.e. flats (vide conceptual design Fig.No.5.7-D2) and singhe family house (vide conceptual design Fig.No.5.7-D3). The estimates were prepared on the basis of 1978 schedule of rates so as to have easy comparison with MPHB schemes started and completed in 1978. The rates of non scheduled items such as M.S. angle frame for doors and windows, precast lintels and chujjahas and R.C.C. precast cored units for floor/roof were taken from CBRI cell in Bhopal.

7.1 Two seperate estimates of MIG house (Ref. Appendix V &VI) were prepared 1) on the basis of evolved specification and 2) on the basis of specification as adopted by MPHB The estimated costs have been grouped under major heads and have been tabulated in Table 7-T 1 for easy comparison. It can be observed from the comparative statement that as a result of revised specification, the construction cost of MIG house can be reduced by 27-45% without lowering the standards of safety and acceptibility. The percentage saving may be different for



SCHEDULE OF DOORS & WINDOWS

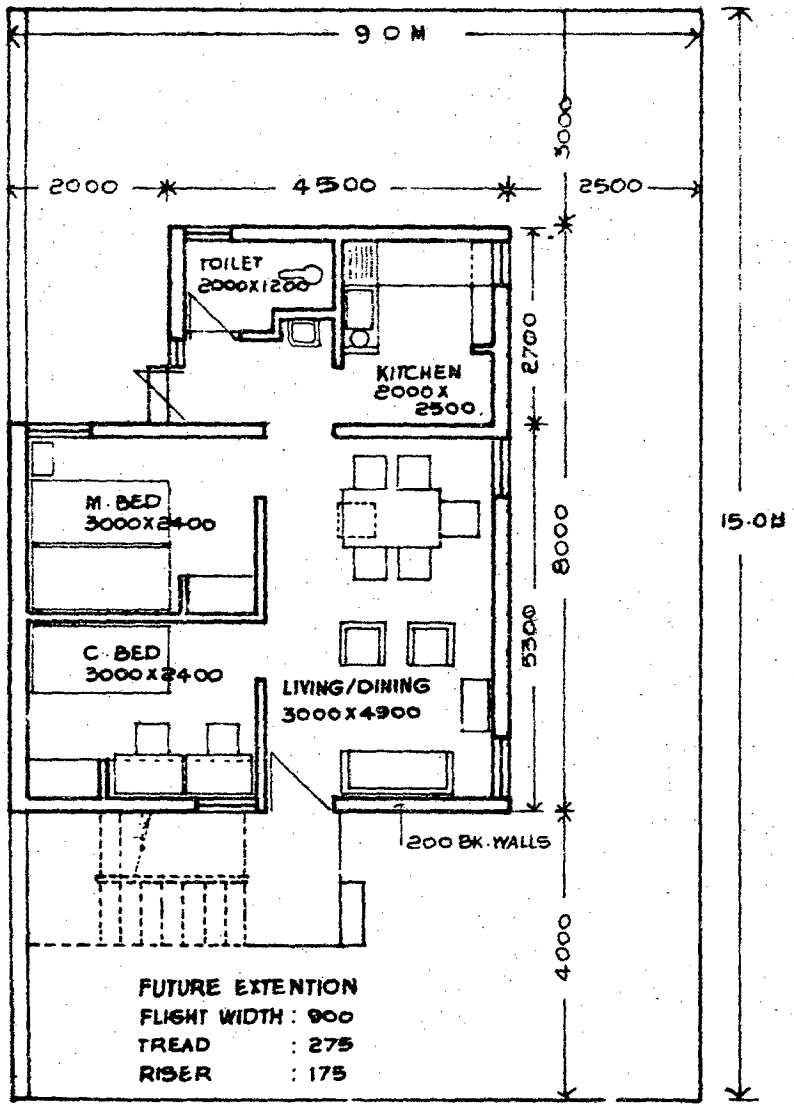
D-1	900 X 2000	FULLY PANELLED
D-2	800 X 2000	FULLY PANELLED
D-3	700 X 2000	FULLY PANELLED
W-1	700 X 1100	FULLY GLAZED
W-2	600X 1000	FULLY GLAZED
W-3	400X 600	FULLY GLAZED

CONCEPTUAL DESIGN : MIG FLATS D FIG 5.7 D2

TABLE 7 - T1 : COST COMPARISON

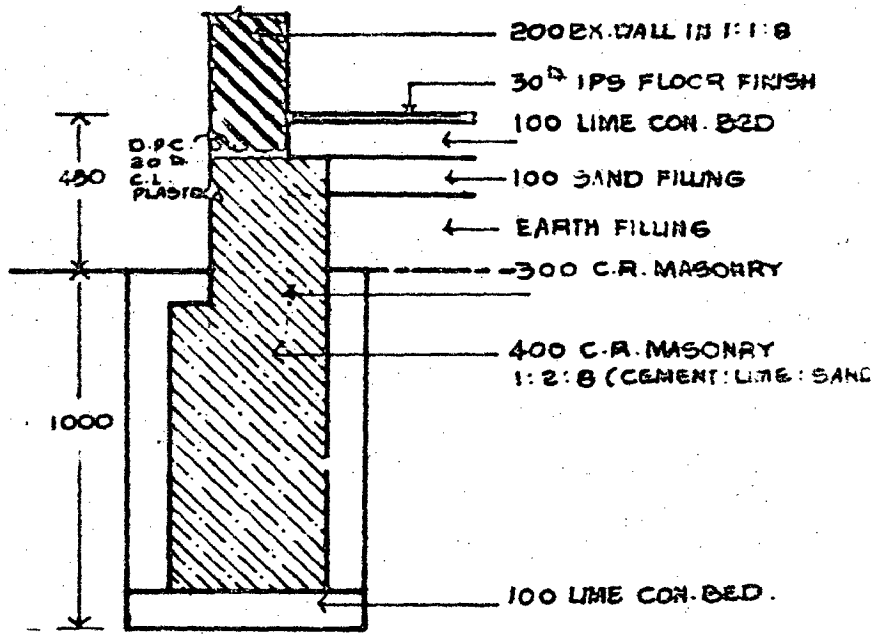
Item : Group	% cost as per MPHB Specification	% cost as per evolved specification	Net saving % to total	Absolute saving (% saving in respective items/groups)
1. Foundation & plinth	16.95	11.61	5.34	31.50
2. D.P.C.	0.59	0.29	0.39	66.10
3. Walls (super structure)	17.37	14.90	2.47	14.21
4. R.C.C.(lintels, chajjahs, lofts beams etc).	7.31	3.84	3.47	47.46
5. R.C.C. roof slab	16.21	13.49	2.62	16.16
6. Doors & windows	17.12	12.06	5.36	30.76
7. Plaster	15.15	10.00	5.15	33.99
8. Flooring	4.14	2.25	1.89	45.65
9. Grille work	1.56	0.70	0.86	55.12
10. W.P. treatment	2.17	2.17	-	-
11. Finishing	1.13	1.13	-	-
Total %	100%	72.54	27.45	
Construction cost	23,494	17,044		
Sanitary, water supply/ Electrical fittings @ 15%	3,376	2,556		
A Total construction cost	Rs. 25886	19600		
Plinth area rate in Rs. A/46.6(Plinth area)	555.49	420.60	/M2	

CONCEPTUAL DESIGN : MIG HOUSE (SINGLE & TWIN TYPE) FIG 5.7-D3



SCHEDULE OF DOORS / WINDOWS

D-1	900 x 2000	L FRAME,	F. PANELLED (IN SEASONED BIJA)	
D-2	700 x 2000	L FRAME,	F. PANELLED	— DO —
W-1	800 x 1100	L FRAME,	F. GLAZED	L SHUTTER FRAME
W-2	600 x 1000	L FRAME,	F. GLAZED	— DO —
W-3	400 x 600	L FRAME,	F GLAZED	— DO —



DETAIL OF FOUNDATION.

. FLOOR HEIGHT - 2700 CLEAR.
LOAD BEARING 200 BK. WALLS IN 1:1:8 CEMENT:LIME:SAN
INTERNAL & EXTERNAL RENDERING IN COMPOSITE MORTOR
I.P.S. FLOOR FINISH
LIME CONCRETE. W.P. TREATMENT OVER ROOF
M.S. ANGLE FRAME
SHUTTERS OF DOORS & WINDOWS IN BIJA.

alternative designs and also in different housing forms. Neverthless, there would be substantial saving. if the evolved specification is adopted.

7.2 Comparison between the construction cost of MIG house (conceptual design) and MPHB house (Vide Drg.No.3-D1) has been shown in the following table.

TABLE

	MIG House		% saving
	MPHB design	Conceptual design	
Plinth area	80.80 M^2	46.6 M^2	42.33%
Construction Cost	Rs.42608.69*	Rs.19,600	54%

* Source : MPHB Construction Division.

It can be seen from the table that the construction cost is reduced by 54% in conceptual design, obviously because of space and specification. It has already been pointed out that specification results an economy of 27.45%. It means that the remaining 26.55% (55% - 27.45%) is due to space. It is worth pointing out here that although the space reduction is by 42.33%, saving due to space is only 27.45% i.e. for every 10% reduction in the space, cost reduction is by 6.27%. Similar results have been found out by N.B.O*

* Patel, C.B., "Ability of Households to Pay for Housing", selected papers from Symposium on Housing Finance, N.B.O. Publication, 1965.

7.3 Outright purchase cost for a flatted dwelling (for estimates Ref. Appendix VII) and the single family house has been computed and shown in Table 7.3 -T1. The outright purchase cost includes:

A.	Construction cost :	As per estimates worked out.
B.	Land cost :	Sale price of the plot has been taken into account instead of gross land price. As per MPHB the sale price varies from Rs.45/M^2 to Rs.65/M^2(in central areas).
C.	Management charges :	Ten per cent of construction cost
D.	Capitalized interest: i.e. interest on capital during construction period.	Construction cycle of 8 months for multi family housing and 3 months for single family house have been considered for computing the average interest.

MPHB rule of initial payment (first instalment) of 20% of outright purchase cost has been followed while calculating montly instalment. It can be seen from the table that the monthly instalment of Rs.237.46 for flatted dwelling unit and Rs.243.00 for single family house forms 22.63% and 23.14% of the average monthly income (Rs.1050/- P.M.) of MIG. In both the case the monthly instalment is less than 25% of average MIG income which is the maximum paying capacity of MIG.

TABLE 7.3 - T.1 COST OF DWELLING UNIT AND MONTHLY INSTALMENT.

ITEM	Cost in Rs. Flat (4 storied walk up.)	Single family house (Ground floor only) inclusive of staircase).
A. Construction cost/ dwelling unit	22,344	19,600
B. Land cost/D.U.	1974	6075
C. Management charges (10% of 'A')	2234	1960
D. Capitalized interest	672	230
(1) Outright purchase cost	27,224	27,865
(2) Innitial payment 20% of (1)	5444	5573
Total cost for Repayment (1) - (2)	21,780	22,292
Monthly instalment . 12 years repayment period . @ 9½% interest p.a.	237.46	243.00
% of average MIG monthly income	22.63%	23.14%

Formula for calculating monthly instalment

$$C + \frac{C \times I \times Y/2}{100} = Y \times 12 \times R.$$

where C = Total cost for repayment
I = Rate of interest
Y = Repayment period
R = Monthly instalment.

Since the rates of p.v.c. pipes for internal plumbing, fixtures etc. are not available (in schedule of rates) detail estimates for sanitary services could not be worked out. Use of single pipe system, p.v.c. pipes for internal plumbing and fixtures etc. will further reduce down the cost.

Secondly, if the repayment period is made 15 years instead of 12 years, monthly instalment for flatted dwelling unit and single family house will be, 19.74% and 20.05% respectively.

7.4 On the basis of cost analytical studies it can be safely inferred that cost ceiling of Rs.28890 (Rs.24076 (Ref. Table on page 10) + 20% of Rs.24076 towards first instalment) should be imposed for MIG dwelling units, so that cost of MIG dwelling unit will be within the paying capacity (25% of average income) of MIG.

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CHAPTER - 8 CONCLUSIONS AND RECOMMENDATIONS

Conclusions in the form of observations have been given at the end of each chapter. Broad conclusions and recommendations drawn from the study and analysis within the scope of study are as follows:

CONCLUSIONS

1. Families' ability to pay constitutes the demand of housing by type and design and must be the governing factor in determining the standards of space and specification.
2. Maximum paying capacity of an average MIG household is 25 of the income.
3. While formulating the spaces it is extremely important to take into account the family size, nature of belongings, the activity pattern & the life style and to a certain extent users' preferences. Rational space formulation depends upon the degree of convenience imagined.
4. Requirements of an average MIG family can be accomodated in a floor area of 40 M^2.
5. Author's concept of space reduction is far from the general trend. Its main focus is on the maximum utilization of space - both horizontal and vertical by increasing the use efficiency without compromising the users' requirement.

6. An economy to the extent of 23% can be achieved by adopted rationalised specification without impairing the structural safety and functional usability.

7. To achieve economy use of alternate materials with proven performance in place of scarce materials, use of local materials and new construction technique is imperative.

RECOMMENDATIONS

1. MPHB should undertake large scale construction with austere standards and specification. This may lead to the aceptance of new concepts in space saving and new techniques and materials and create psychological atmosphere in favour of modest living.

2. Housing is an evolutionary process which depends upon dynamic socio-economic conditions. Periodic survey for feedback information should be undertaken to form the basis for modifications and revisions in the standards.

3. Inspite of authoritative recommendations and researches carried out by national institutions and organizations, the resistance to the general adoption of new techniques and use of substitute materials on the part of construction agencies continues. What is important is that these should be put into practice by self-imposed ban on the use of rich specification.

4. Ceiling cost of Rs.29000/- and ceiling on built up area of 47 M^2 should be imposed for MIG capacity.

5. The survey has revealed that most of the owners belong to service class. An 'Housing Fund' on the lines of G.P.Fund should be introduced by the authorities. It should be made compulsory for each employee to contribute say 5% of his income towards the fund. This will provide the 'Seed Capital' for housing development and in a way can be self sustaining basis. The contributor should be allowed to withdraw the amount for house purchase only. The scheme will also create an awareness about the housing problem.

6. In view of rising living index, the rules regarding repayment period and rate of interest should be those which are applicable to LIG section i.e. 15 years repayment period and 7% rate of interest.

7. Densities (dwelling units/hectare) in Bhopal Development plan have been stipulated assuming probable area of dwelling for each category. Densities should be revised to higher standards in view of the reduced space provision for MIG dwellings. The incidence of land cost per dwelling unit will be less due to higher densities.

EPILOGUE

Cost of housing cuts across many diversified fields and encompasses many parameters. The present work unveils the solution to the problem of reducing the cost through only two parameters i) space & ii) specification. Further cost reduction is possible by rationalising other parameters. Such a multidimensional approach will further reduce down the cost and it would be possible to provide better housing.

The spaces evolved are not ultimate. The studies form a basis to explore further the possibilities of economising the space requirements. The spaces can be curtailed further by maximization of the space usage by multi-functional furniture, interchangeability and by adjusting the time schedule. An architect can decide and even dictate the course of activities through design. Like other experts he will have to accept the role of reformer. In view of acute conditions people will have also to co-operate by changing their living habits. Social education and awareness can be imparted through mass medias.

Even though the vision is limited to Bhopal and MIG category, its focus is also on other cities of M.P.State and country. Bhopal and MIG category has been taken as symbolic example. It would be advisable for the MPHB to undertake construction of a few houses adopting evolved space standards and specification and evaluate it from emperical evidences. It remains to be seen as to how MPHB is going to set an example.

APPENDICES

APPENDIX- I

HOUSING SHORTAGES AND OUTLAYS IN FIVE YEAR PLANS

TABLE:

Plan	Urban Housing shortage in millions	Rs. Crores	% To Total Public Sector outlay
First Plan* 1951-56	2.8	37.50	1.6
Second Plan* 1956-61	5.0	101.14	1.8
Third Plan* 1961-66	9.3	182.00	1.6
Fourth Plan* 1969-74	11.8	176.00	0.96
Fifth Plan** 1974-79	15.3	456.00	1.2
Sixth Plan** (Draft) 1978-83	-	595.00	0.9

Source: *Report of the Expert Committee on Methods for Achieving Low Cost Large Scale Housing Construction in the Major Cities.

**Mukhopadhyay, B.K., "The Tale of Roof Over the Head", ITPI Journal, December, 1978.

APPENDIX-II

PRICES OF BUILDING MATERIALS (AS ON 1st APRIL 1979)

S.No.	Description	Unit	Rates Rs.
1.	Bricks (35 kg/cm^2)	1000	225
	Bricks (70 kg/cm^2)	1000	240
2.	Sand	M^3	54
3.	Stone Aggregate(40mm)	M^3	25
4.	Stone Aggregate (12mm)	M^3	50
5.	Boulder	M^3	17
6.	Murrum	M^3	20
7.	Cement	Bag(50 Kg)	29.30
8.	Cement Poszolana	Bag(50 Kg)	22.45
9.	Dry Hydrated lime	Bag(50 Kg)	16.50
10.	Masonary stone (Approx. 20 x 20 x 20 cm size)	100 No.	210
11.	Steel (M.S.Bars)	Ton	3100
12.	Timber (Teak-wood)	Cu.ft.	160
13.	Timber (Bija)	Cu.ft	100

WAGES OF BUILDING LABOUR

1.	Mason	each	19
2.	Carpentar	"	16
3.	Painter	"	15
4.	Plumber	"	12
5.	Coolie	"	8
6.	Reja	"	5
7.	Boy coolie	"	4
8.	Bhisti	"	6

Source: On the basis of Data supplied by Circle offfice of M.P. PWD.

APPENDIX - III

STANDARDS IN PLANNING THE DIFFERENT SPACES IN RESIDENTIAL BUILDING - A GUIDE LINE*

	Lead Bearing construction	Framed construction
a) Living space i.e. floor areas of Living, Dining and Bed rooms	47-50%	49-54%
b) Service space covered by Kitchen, bath, w.c. etc.	15-20%	14-19%
c) Horizontal circulation space passage and verandahas.	10-12%	9-11%
d) Vertical circulation space staircase and lifts.	4-7%	3-6%
e) Walls and column space	15-17%	12-14%

The circulation area including staircase and external corridor should not exceed 3 sq.m/unit where 4 dwelling units are grouped around a staircase and 5.5 sq.m/unit when two units are grouped around a staircase.

* Report of the expert panel constituted by the Ministry of State for Works and Housing for evolving guidelines for reduction in the cost of buildings - N.B.O. Publication 1977.

APPENDIX : IV
QUESTIONNAIRE

All information collected on this questionnaire is confidential and shall not be presented as individual opinion. Computation in various forms will be used for evaluation of the problems.

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1. IDENTIFICATION OF DWELLING UNIT

1.1 Type : MIG-1/MIG-2/Jr.MIG/Sr.MIG/Any other.

1.2 Locality :

1.3 House No :

1.4 Tenurial Status : Owner/Owner c tenant.

1.5 Year of construction :

2. HOUSEHOLD CHARACTERISTICS

2.1 Owner's Name :

2.2 Occupation : State Govt/Central Govt/Semi Govt/ Private/Business.

2.3 Household income :

a) Owner's earnings : Rs.
b) Other sources : Rs.
c) Rents i) same house : Rs.
ii) other house: Rs.
d) Pension/Remittences : Rs

Total : Rs.

3. HOUSEHOLD PARTICULARS

Name	Reelation with owner	Sex M	Sex F	Age	Marital status	Education level	If earner write occupation
1. Owner							
2. A							
3. B							
4. C							
5. D							
6. E							
7. F							
8. G							

4. COST AND FINANCE OF DWELLINGS

a) Date of purchase :

b) Purchase price at the time of booking :

c) Purchase price at the time of possession. :

d) Mode of purchase : Outright/Hire purchase

e) Sources of finance for first instalment

Source	Amount	Rate of interest	Periodicity of loan
i) Personal saving.			
ii) LIC/CTD			
iii) Govt/State/ Central			
iv) G.P.Fund			
v) Banks			
vi) Other resources.			
Total			

4.1 Total instalment for dwelling

a) Housing Board instalment Rs.

b) Loan instalment (if any) Rs. _____

Total Rs. _____

4.2 Whether the instalment is convenient ? Yes/No
If 'No' give suggestions. :

4.3 Break of household expenditure in terms of %

i)	Food :	%	v)	Entertainment :	%
ii)	Clothing :	%	vi)	Miscellaneous :	%
iii)	Education :	%	vii)	House rent :	%
iv)	Transport :	%			
				Total	100%

4.4 How much maximum you can afford towards house rent ? Rs.....

4.5 What do you think of cost : Very high/high/acceptable/low/do not know.

4.6 If high how could it be lowered down. _____

_____

_____

_____

_____

5. REGARDING DWELLING UNIT.

5.1 Why do you prefer MPEB House (mention order of preference).

i) Location
ii) Cost
iii) Design
iv) Instalment facility
v) Loan facility
vi) Quality of work.

5.2 When you opted to purchase a house were any alternatives available. Yes/No

5.3 Are you residing : Wholly/Partly

6. SPACE AND UTILIZATION

6.1 Are you satisfied with the spaces in terms of area arrangement.

Room	Yes/No	If 'No' give suggestions.
Living		
Dining		
Bed. 1		
Bed. 2		
Kitchen		
Toilet - w.c. Bath		
Balconey		
any other.		

* If no what should have bean done within the total space and money available.

6.2 SPACE UTILIZATION

Living Room

6.2.1 Living room is primarily used for : meet visitors/conversation/ entertain guest/reading/mosie games/children play/any other (specify) .....

6.2.2 Do you make any alternative uses of living room ? Yes/No

If yes specify the use : family room/Bed room/ guest bed/study room/ any other use (specify)

6.2.3 Do you have to entertain visitors/guests : daily/twice in a week/ weekly/occasionally/very occasionally.

6.2.4 What is the duration (approx) of visitors stay

6.2.5 List out the furniture in your Living room _____
_____
_____

(Does the furniture satisfy the need or is unaffordable)

6.3 DINING ROOM

6.3.1 Do you like to dine in a) kitchen b) dining which is the normal place of dining _____
_____

6.3.2 For what other activities dining room/space is used ? specify _____

6.3.3 List out furniture in dining room _____
_____

6.4 BED ROOMS

6.4.1 Do you prefer a) Single Bed room b) seperate bed room

6.4.2 Specify other activities in bed room.

6.4.3 If storing (ward robe/cupboard) sufficient ? Yes/No.
List o ut the belongings for storing : _____
_____
_____

6.4.4 List out the furniture in Bed rooms : _____
_____
_____

6.5 KITCHEN

6.5.1 Is the housewife satisfied with space : Yes/No
arrangement : Yes/No
fittings : Yes/No

6.5.2 If 'no' why _____
_____

6.5.2 Is storing space sufficient Yes/No.

List out the storing items _____

_____

_____

6.5.3 Type of fuel used for cooling : Gas/Kerosene/Soft coal/ Electric/timber

6.5.4 Have you employed any servant Yes/No

6.5 BALCONEY/VERANDAH.

6.5 It is used for : Sitting/sleeping in summer months/ any other use (specify).

6.6 Any other space(s)

6.6.1 Write the uses of these spaces if any.

7. GENERAL

7.1 a)workspace b) Distance

c) Mode of transport used : Bus/Auto/Motor cycle/ Moped

7.2 Do you prefer dwelling unit as

i) on independent plot
ii) single storey in groups of 2/4/8/16 blocks
iii) Two/Three/Four storied
iv) Multi storied.

7.3 Do you feel sure that you would have constructed the house better, if you had done the work yourself ? Justify _____

_____

_____

7.4 Any suggestion to lower down the cost of dwelling unit.

- space reduction
- lowering down the specification
- Amortisation period
- Rate of interest
- Any other.

_____

Investigators Observation :
Note down the dimensions of furniture.

APPENDIX.V

ABSTRACT OF ESTIMATED COST.

AS PER EVOLVED SPECIFICATION. FOR MIG house (Conceptual design 5.7-D3)

Item No.	Description	Quantity	Rate Rs./unit	Amount Rs.
(1)	(2)	(3)	(4)	(5)
	FOUNDATION & PLINTH			
1.	Excavation for foundation in ordinary soil	20 M^3	3.45/M^3	60.00
2.	Earthwork in filling in plinth and around foundation.	5 M^3	2.10/M^3	10.50
3.	Coursed rubble masonry in composite mortor (1:1:8) in foundation.	15.74 M^3	131.2/M^3	2065.00
4.	Sand filling (10 cm) in plinth-	3.11 M^3	20/M^3	62.2
5.	Lime concrete (1:2:6) (10 cm) under wall foundations & sub floor	3.30 M^3	98.75/M^3	325.87
				2730.00
	D.P.C.			
6.	D.P.C. 2 cm cement lime (1:1:5) plaster	10.28 M^2	7.00/M^2	70.00
	WALLS (SUPER STRUCTURE)			
7.	20 cm brick (Ghol) wall in composite mortor(1:2:9)	25.00 M^3	122.56/M^3	3064.00
8.	10 cm brick wall -do-	3.6 M^3	122.56/M^3	441.20
			Say	3505.00

(1)	(2)	(3)	(4)	(5)
	R.C.C.			
9.	R.C.C. work 1:2:4 excluding reinforcement & centering for beam, loft, kitchen, plat form, shelfs etc.	0.43 M^3	510/M^3	229.5
10.	Steel reinforcement including bending, cutting, ninding & placing in position.	108 kg	3/kg	584.00
11.	Centering	6 sq.M.	15/M^2	90.00
			Say	904.00
12.	R.C.C. ROOF SLABS			
12.	R.C.C. Precast cored units including filling in joints & negetice reinforcement etc.	43.51	73.93/M^2	3217.00
	DOORS & WINDOWS			
13.	M.S. angle frame for doors and windows.	93.30 kg	3.9 kg/M^2	363.87
14.	35 mm thick panelled shutters in Bija.	13.9 M^2	139.6/M^2	1940.00
15.	30 mm thick glazed shutters in Bija.	4.6 M^2	176.4/M^2	535.40
			Say	2839.00
	PLASTER			
16.	12 mm plaster in composite mortor (1:1:8)	268 M^2	8.7/M^2	2063.6
17.	-do- but with W.P.compound for dado/skirting.	29 M^2	9.9/M^2	287.0
			Say	2351.00

(1)	(2)	(3)	(4)	(5)
	FLOORING			
18.	I.P.S. flooring (30 cm thick) in 1:2:4 concrete with neat cement finish.	38.8M^2	13.70/M^2	Say 532
19.	Grille work in 12ø M.S. bars welded to M.S. angle frame.	4.16	40.18/M^2	167.00
20.	Lime concrete (average thickness 100) terracing over the roof.	42.18 M^2	11.55/M^2	487
21.	Painting two coats of oil paint over one coat of priming.	20.23 M^2	3.10/M^2	62.71
22.	White washing three coats (inside)	158.76	0.6/M^2	92.25
23.	Colour washing 2 coats over one coat of white washing.	109.00 M^2	0.8/M^2	87.20
			Say	242.00

Total	17044
Sanitary & water supply @ 6% ⎫ Electric fitting @ 9% ⎭	2556
Total construction cost of MIG house (vide conceptual design 5.7-D3)	19600

APPENDIX. VI

ABSTRACT OF ESTIMATED COST

AS PER MPHB SPECIFICATION FOR MIG HOUSE (conceptual design 5.7- D3).

Item	Description	Quantity	Rate Rs./Unit	Amount Rs.
(1)	(2)	(3)	(4)	(5)
	FOUNDATION & PLINTH			
1.	Excavation for foundaion in ordinary soil.	20 M^3	345/M^3	60.00
2.	Earthwork in filling in plinth and around foundation.	5 M^3	2.10/M^3	10.50
3.	C.R. masonry in cement morter 1:4	15.74 M^3	144/M^3	144.00
4.	20 cm boulder & murrum filling in plinth.	3.11 M^3	32/M^3	99.52
5.	Cement concrete (1:4:8) in foundation & sub floor.	3.30 M^3	175/M^3	577.5
			Say	3983.00
	D.P.C.			
6.	4 cm thick 1:2:4 concrete with two bitumen coats.	10.00 M^2	13.92/M^2	139.00
	WALLS (SUPER STRUCTURE)			
7.	20 cm brick wall in cement mortor 1:6	25.00 M^3	147.20/M^3	3680.00
8.	10 cm brick wall in C.M. 1:4	3.6 M^3	155.00/M^3	558.00
				4238.00

(1)	(2)	(3)	(4)	(5)
	R.C.C.			
9.	R.C.C. work 1:2:4 in beam, lintels & chajjahs, lofts, kitchen offer excluding reinforcement & centering.	0.65 M^3	510/M^3	331.50
10.	M.S. reinforcement	397 Kg.	3 Kg	1191.00
11.	Centering for R.C.C. work	11.60 M^2	15/M^2	174.00
				1696.00
	R.C.C. ROOF SLAB			
12.	R.C.C. work 1:2:4 in slab including reinforcement & centering.	43.51 M^2	87/M^2	3785.00
	DOORS & WINDOWS			
13.	T.W frames for doors & windos.	.43.51 M^2	27.12/M^3	1139.00
14.	40 mm thick T.W. panelled shutters for doors	13.9 M^2	167.12	2323.00
15.	35 mm T.W. fully glased shutters for windows.	4.6 M^2	132.16	608.00
				4070.00
	PLASTER			
16.	Ext. plaster in cement mortor 1:4 inclusive of plaster for ceiling	152 M^2	10.12/M^2	1538.29
17.	Int. plaster in C.M. 1:6.	158.76M^2	8.2/M^2	1301.83
18.	6 mm mosiac dado/skirting.	29.00 M^2	24/M^2	696.00
			Say	3536.00

(1)	(2)	(3)	(4)	(5)
	FLOORING			
19.	I.P.S. flooring (40 mm thick)	241 M^2	15.04/M^2	362.46
20.	Mosaic/terrazzo flooring	14.7M^2	40.00/M^2	588.00
			Say	950.00
21.	Decorative grille work for windows.	4.16	88.55/M^2	368.00
22.	W.P. treatment (lime concrete)	42.18	11.55/M^2	487.00
23.	Finishing (same as in appendix V)			242.00
			Total	23494.00
	Sanitary & water supply @ 6%			
	Electric fitting @ 9%			
			15%	3376.00
	Total construction cost			25886.00

APPENDIX.VII

ABSTRACT OF ESTIMATED

For Flatted dwellings (G+3 storied) vide conceptual design

Item No.	Description	Quantity	Rate Rs/unit	Amount Rs.
(1)	(2)	(3)	(4)	(5)
	FOUNDATION AND PLINTH			
1.	Boring holes with Auger for under reamed piles (30 cm dia 3.M depth)	68 No.	24 each	1632.00
2.	R.C.C. 1:2:4 for piles, pile cap, col. studs and beam.	26 M^3	510/M^3	13260
3.	M.S. reinforcement including bending cutting, binding & placing in position.	20.41Q	300/Q	6125.00
4.	Centering for pile caps col. stude, beams	50 M^2	15/M^2	750.00
5.	Sand filling in plinth	12.44 M^3	20/M^3	249.00
6.	Lime concrete in sub floor.	15.12 M^3	98.75/M^3	1493.00
				23507
	SUPER STRUCTURE (GROUND FLOOR)			
	WALLS.			
7.	Brick walls in composite mortar.	78.4 M^3	160.00/M^3	12544
	R.C.C.			
8.	R.C.C. 1:2:4 work in beams staircase, lintels, chajjahas, lofts, kit. otta, shelves etc.	2.4M^3	510/M^3	1224.00
9.	M.S. reinforcement in R.C.C. work for item No.8.	856 Kg	3/kg	2568.00
10.	Centering	36 M^2	15/M^2	540.00
				4332.00

(1)	(2)	(3)	(4)	(5)
	R.C.C. (INTERMEDIATE FLOOR)			
11.	R.C.C. precast cored units including pracing in position filling in joints and negetive reinforcement etc.	174.04M^2	73.93/M^2	12,867
	Doors and Windows			
12.	M.S.Angle frames for doors and windows	373.2 Kg	3.9/kg	1455.46
13.	35 mm thick fully panalled shutters in Bija.	55.6M^2	130.6/M^2	7761.17
14.	30 mm thick fully glazed shutters in Bija.	18.4 M^2	116.4/M^2	2141.76
				11,358
	PLASTER			
15.	12 mm plaster in composite mortar (1:2:8)	1037 M^2	7.7/M^2	7984.9
16.	-do- but with w.p. compound for dado/skirting	116 M^2	9.9/M^2	1048.4
				9039.00
	FLOORING			
17.	IPS flooring 30 mm thick in 1:2:4 cement concrete	155.2M^2	13.70/M^2	2125.00
18.	Grille work in 12ø M.S. bars welded to M.S.angle frame.	16.64 M^2	40.18/M^2	669.00
	FINISHING			
19.	Painint two coats of oil paint over one coat of priming	80.92M^2	3.10/M^2	316.00
20.	White washing 3 coats	635.04	0.6/M^2	381.00
21.	Colour washing 2 coats over one coat of white washing.	402.0	0.8/M^2	322.00
				1019.00
			(Ground floor) total cost	63,953.00

(1)	(2)	(3)	(4)	(5)
	TERRACE FLOOR			
1.	Brick wall in composite mortar ( ) for parapet and staircase block	26.2 M^2	167/M^2	4375.4
2.	Plaster (12th) the composite mortar	262 M^2	10.10/M^2	2646.20
3.	Flooring(staircase landing)	6 M^2	18.80/M^2	112.80
4.	Lime concrete (10 cm average thickness) as w.p. treatpent.	19.6 M^3	108/M^2	2116.00
5.	Doors			
	M.S. angle frame	14.1 Kg	3.9/kg	54.99
	35 mm panelled shutter	3.15 M^2	146.58/M^2	461.72
6.	Finishing			
	i) Painting	2.8 M^2	3.10/M^2	8.68
	ii) White washing	132 M^2	.6/M^2	79.20
	iii) Colour washing	132 M^2	1.40/M^2	184.80
				10040.59

Construction cost		3,10,874.00
Add 15% for sanitation, water supply and electrical fittings		46,630.00
		3,57,504.00
∴ Cost of one dwelling unit	=	3,57,504/16
	=	22,344.

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BIBLIOGRAPHY

1. Beyer, G.H: Housing - A Factual Analysis.
2. Bhopal - Development Plan, 1991, M.P. Town and Country Planning Department.
3. Booth, R.G: Living Space.
4. Bose, Ashish : Studies in India's Urbanization 1901-1971, Institute of Economic Growth.
5. Calderwood, D.M : Principles of Mass Housing.
6. Cleeve Barr, A.W : Public Authority Housing, B-7, Batsford Ltd, London.
7. Ekestics, August 1976.
8. Ekestics, July, 1974.
9. Fuerst, J.S : Public Housing in Europe and America.
10. Hole, W.V.& Attnburrow, J.J : Houses and People - A review of user studies at the Building Research Station, Ministry of Technology and Building Research Station, London.
11. Kennedy, R.H : House Design.
12. Klaber, E.H : Housing Design, Reinhold Publishing Corporation, New-York.
13. Malhotra, P.C : Socio Economic Survey of Bhopal City and Bairagarh, Asia Publishing House, 1961.
14. National Building Code - 1970.
15. Obst, F.M : Art and Design in House Living.
16. Sovani, N.K : Urbanisation and Urban India, Asia Publishing House, 1977.
17. Van der brock, J.H : Habitation - Programme Design Production, International Series 1, 2, & 3, I.U.A. Publication.

REPORTS

18. Report of the Expert Panel on Works and Housing for Evolving Guidelines for reduction in the cost of Building - N.B.O. Publication, 1977.

19. Report of the Technical Committee on Economy in the use of Cement and Steel in Building Construction - November 1974 - Ministry of Works and Housing.

20. Report of the Expert Committee on methods for achieving Low Cost Large Scale Housing Construction in the Major Cities - May 1970.

21. Report on Economics in Construction Cost - Planning Commission (Construction Division) - March, 1968.

22. Report of The Development Group on Low Cost Housing including Minimum Economic Specification - N.B.O.Publication.

23. Report on Residential Buildings - Committee on Plan Projects (Building Projects Team) - July 1961.

SEMINAR PROCEEDINGS

24. International Seminar on Low Cost Housing - Madras, January, 1972.

25. Seminar on Low Cost Housing & Fire Research, March 1975, New Delhi.

26. Fourth Afro Asian Housing Congress - 24 to 30th November, 1975, New Delhi.

27. Housing Convention organised by NBO and IIA, December, 1969, New Delhi.

28. Selected Papers from Symposium on Housing Finance : New Delhi, 1965 - N.B.O. Publication.

TECHNICAL PAPERS

29. Datta, K.L. & Gupta, T.N. : Internal Planning of Dwelling Units, C.B.R.I.

30. Datta, K.L. & Gupta, T.N. : Anthropometries and Residential Spaces, I.I.A. Journal, December 1966.

31. De, P.L, Gurdeep Singh : Building Technique for Cost Reduction - C.B.R.I., Roorkee.

32. Garg, B.B. : Optimization of Nature of Housing Developments in relation to Land use and Economics, CBRI, Roorkee, 1971.

33. Gupta, T.N. : Household Kitchen Planning, I.I.A. Journal, March/April 1966.

34. Rao, B.Bhaskar : Housing - 2000 A.D. A long range perspective for India, ITPI, Journal No.88 & 89.

35. Swamy, M.C.K : Housing for the Poor, ITPI Hournal No.88 & 89.

CBRI DATA SHEET

36. Thin Precast R.C.C. Lintels in Brickwalls - No.1

37. Thin Cavity Walls - No.2

38. Cored Unit for Roof/Floor - No.3

39. Cellular Unit Rpof/Floor - No.4

40. Channel Unit Floor/Roof - No.5

41. Precast R.C. Plank Flooring/Roofing Scheme - No.7

42. Precast Stone Masonary BBlock Walling - No.8

43. Waffle Unit Floor/Roof - No.98

44. Bored Compaction Piles - No. 116.