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Meeting on Prefabrication in Africa and the Middle East

17 - 29 April 1972

Budapest, Hungary and Bucharest, Romania

MONOGRAPH ON BUILDING ACTIVITIES IN KENYA 1/

by

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CONTENTS

A. HOUSING AND BUILDING STATISTICS

I-0 HOUSING GENERAL - KENYA

I-1 The Importance of Housing

The quality of houses and neighbourhoods in which people live in any country is a significant factor which determines their health and well-being. Housing supply is, therefore, a major asset in any urban community and as a matter of fact the primary cause for municipal improvements and services.

A careful study of urban areas in Kenya would reveal that over 50% of the developed areas are residential. It has been clearly established universally that planning is very closely related to housing and, therefore, it follows that poor location of housing does not only affect the welfare of the people but also virtually intensifies overall municipal problems. For instance, the general adoption of extremely low density in Nairobi has made it impracticable to operate an adequate public transport system. The residents have, therefore, to depend on private cars and as a consequence the road system leading to the centre of the town becomes congested at peak hours and there is not enough parking in business and shopping areas.

I-2 Government Policy on Housing

Housing pronlems are of great concern to Government of Kenya because they affect the welfare of individual citizens and all local communities in the country. In Kenya housing functions are carried out through the Ministry of Housing The Ministry of Works, however, is the body responsible for design, construction and administration of all Government buildings including housing elements which go along with them particularly in the rural areas where new administrative centres are established.

The Ministry of Housing is responsible for Housing Policy of the country and has powers over National Housing Corporation through which Government stimulates house-building through loans made by the Corporation to individuals or the local Councils. There are about forty Councils in the country. Nairobi being the largest. The loans are usually charges ½% above the rate at which the Board borrows from Development Fund of Government or Commonwealth Corporation.

Ministry of Works has developed its own standard type plans for the purpose of Government Housing. These plans are usually executed in traditional methods of concrete blocks or Kiln-burned bricks wallings with pitched tile asbestos or corrugated iron sheets roofing. The degree of prefabrication, if it occurs at all, is minimum and may be applied only to doors and windows.

It is my strong belief that ideas evolved from this important seminar might contribute towards application of prefabrication methods in Government housing with a view to reducing costs.

The Nairobi City Council has powers to negotiate external loans. The Council builds houses either for rent or tenant purchase, mainly for the low income groups, and has for this purpose attempted experiments in prefabrication some of which will be described later in this paper.

Generally, where housing has been implemented 'standards' cover a wide area. They include poor projects of earlier days to better arrangements which capital permits and prefabrication methods can be applied where feasibility satisfies workability.

I-3 Needs and Demand

All the urban areas in Kenya have been undergoing a transitional period for the last few years because of rapid immigration to towns. The estimated size of household (Africans) is six in the city of Nairobi and this may be taken as standard for housing all over the country. Where low cost housing plans are implemented the minimum house size should able to accommodate a family of six. There has been a degree of population tending to form permanent homes in towns plus the job seekers. This has greatly contributed towards population growths in towns.

There is a problem in estimating demand based on expense-income proportions because of lack of comprehensive data and wide differences in family habits. People come to urban areas with their mind 'screwed backwards' and usually do not establish complete permanence. Farms and rural homes continue to be their daily focus. The idea 'go-back-to-the-land' as it is locally termed is, however, encouraged by Government not only as a means of minimizing unemployment and housing problems, but also to enforce Government policy and commitment of developing rural areas as far as possible.

I-4 Distinctive Nature of Housing Problems

The points raised above, relate to a young country Kenya, but they form only a very minute part of world-wide distinctive nature of housing problems of which solution by PREFABRICATION methods is the theme of this seminar. With special reference to the underdeveloped country of Africa, Asia and Latin America, whichever policy is adopted which seems on the face value, suitable for solving housing problems, it is vital to bear in mind there are pillars of development which no country can afford to do without if any form of development is to take place.

In the underdeveloped countries land is considerably cheap but cannot be easily serviced because of limited finance, technology, or otherwise. A house being the most durable consumer goods cannot be moved and for a family to buy it means the largest single expenditure or indebtness in mortgage transactions. This means that for a developer full advantage cannot easily be taken of the highly mechanized cost-reducing methods such as for cars, television, etc. It explains why one would find television aerials on slum roofs.

Housing problems are closely related to the long life and cost of dwelling units. Vast expenditures are required to solve them, thus placing a limited choice of policy It is within this scope that possibiliti s of PREFABRICATION hav to be viewed.

I-5 Why Prefabrication In Kenya

The net-works of transport and communi-ation which are developing in Kenya (or Africa as any other part of the world), need equally balancing networks of towns and villages in which people can live and work. The rate at which urbanisation is taking place needs methods of construction quick enough to cope with growth of communities in towns.

The communities need accommodation within the scope of social limitations. The limitations are usually difficult to incorporate within the pillars of development as mentioned earlier.

This is where a modern scientific technique as PREFABRICATION, amoung others, is of great significance to architects. If population explosion has resulted in application of modern scientific techniques in other fields of science like medicine why not to equal extent in building technology. The discovery of low-cost drugs, and their convenience of application in medicine, has greatly eased world problems for the welfare of human beings whether rich or poor all over the world. It is high time, therefore, architects and other professions involved in building process came out with an idea of making it relatively possible to suggest whether the world communities whether now rich or poor can afford their accommodation if medicine has helped them to survive; or we are going to watch the situation get out hand and people will be forced to sleep in streets let alone living in dangerous, overcrowded slums. The discussion now already initiated in this second seminar on PREFABRICATION through the office of the United Nations Industrial Development Organisation should continue at least for the benefit of developing countries where technology has serious limitations.

Simplicity is very important if PREFABRICATION has to be adopted in a developing country because of the lack of skilled labour. Any system in PREFABRICATION would achieve good results if panel fixing and joining means is simple enough to reduce construction time. Better still, in massive housing the building components can be standardised to increase efficiency. Panels may be dismantled and reused as required

Setbacks over PREFABRICATION in a developing country like Kenya are numerous. One of the most serious and which impedes any progress in design alternatives is the use of costly and yet non-tropicalised imported building materials which may present problems in combination with local materials. Technology involving meaningful research in the use of natural resources has not yet been fully exploited. Some local materials like timber, for instance are easy to work and require unsophisticated machinery for production. However, the performance of Kenya woods generally presents problems. Warping, twisting and splitting as a result of poor preparation in an equipped industry are very common features.

In Kenya, timber with its good bearing/weight ratio has economic design possibilities in prefabrication particularly in the realm of low cost housing. However, timber has to be expensively treated in order to overcome building by-laws governing fire hazards and the risk which may be caused by tropical termites. An amount of insulation on timber walls is therefore needed not only to meet the above requirements but also to secure any degree of human comfort zone, in a dwelling, necessitated by extreme climatic conditions.

II-0 BUILDING MATERIALS AND TOOLS

II-1 Timber

There is a variety of building materials in Kenya for housing and other building activities. Great percentage of the commonly used materials depends on the local availability. Wattle is commonly used in the rural areas while in towns it is used in form of timber. Timber construction employs over 10,000 workers and with its design opportunities it is only the industrial potential and erection methods which need to be fully exploited. The demand for low cost housing is so massive that the economics of scale would obviously justify efficient plants for curing and intensive research to assess structural capability of timber at all stages of growth. Decentralisation of manufacture should, therefore, follow with a view to offering rural employment where timber is in plenty.

Please see attached Paragraphs II-2, II-3, and II-4 for official statistics (Kenya) for Forestry and Timber Production, Building Construction and Costs and Mining.

II-2 FORESTRY [illegible]

Notes and Definitions

The table on timber production covers timber and other forest produce from forests controlled by the Forest Department. Timber cut on private farms and estates is excluded, as also is a very small amount of timber issued free by the Forest Department. The amounts excluded in this way form only a small proportion of total production.

FOREST LAND*

Area, 1960-1969

(as at 31st December)

Table 87 '000 Hectares

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Type of Forest										
Closed										
Central Government	718	718	702	705	815	721	728	616	610	610
County Council	207	210	200	207	99	190	221	319	318	318
Total	925	928	902	912	914	911	949	935	928	928
Woodland										
Central Government	284	284	291	293	356	273	308	124	100	100
County Council	110	106	68	68	47	117	59	241	241	241
Total	394	390	359	361	403	390	367	365	341	341
Bamboo										
Central Government	139	136	142	142	161	136	149	135	129	129
County Council	47	47	45	45	26	46	23	27	27	27
Total	186	183	187	187	187	182	172	162	156	156
Grassland										
Central Government	183	180	180	179	236	171	173	115	106	106
County Council	59	61	52	51	9	50	48	105	105	105
Total	242	241	232	230	245	221	221	220	211	211
Mangroves										
Central Government	54	54	54	54	45	45	45	45	45	45
Forest Department Total ..	1,801	1,796	1,734*	1,741*	1,794	1,749	1,754	1,727	1,681	1,681
Ownership										
Central Government										
Gazetted	1,373	1,366	1,369	1,374	1,614	1,364	1,403	1,034	990	990
Other	6	7	5	29	24	—1	5	—2	—	6
Total	1,379	1,373	1,374	1,403	1,638	1,363	1,408	1,032	990	996
County Council										
Gazetted	351	363	366	370	180	364	351	692	691	691
Other	73	61	51	23	22	37	56	52	57	60
Total	424	424	417	393	202	401	407	744	748	751
Forest Department Total ..	1,803	1,797	1,791	1,796	1,840	1,764	1,815	1,775	1,738	1,747
Private Forest	114	128	188	206	173	117	119	118	126	124

Sources: Forest Department and Statistics Division.

*Includes gazetted forest areas only.

FORESTRY

FOREST LAND

Plantation Area (1), 1960-1969

(as at 31st December)

'000 Hectares

Table 88

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Indigenous Softwoods	5	5	5	5	5	5	4	4	4	5
Indigenous Hardwoods	3	4	4	4	4	4	4	4	4	4
Exotic Softwoods										
Cypress	25	26	28	29	31	33	35	37	40	43
Pines	26	31	34	36	36	38	40	42	47	50
Total	51	57	62	65	67	71	75	79	87	93
Exotic Hardwoods										
Timber	3	3	3	3	3	3	3	3	2	3
Fuel	9	9	7	7	6	6	6	6	7	7
Total	12	12	10	10	9	9	9	9	9	10
Total Afforestation	71	78	81	84	85	89	92	96	104	112

Sources: Forest Department and Statistics Division.

(1) Total area of Forest Dept. Plantation; this takes account of planting and felling during the year.

FOREST PRODUCTION, 1960-1969

Table 89 (*a*) (a) Timber

Thousand cu.m

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Soft Wood										
Podo	94	47	50	46	50	56	38	35	38	37
Cedar	31	20	21	15	22	18	12	18	25	26
Cypress	44	30	47	54	47	116	98	160	122	180
Other	4	0	3	5	7	6	7	5	4	13
Total	173	97	121	120	126	196	156	218	189	256
Hard Wood										
Musharagi	3	2	1	1	1	2	1	0	0	1
Mueri	5	1	1	1	2	1	1	2	0	0
Camphor	10	6	6	5	4	3	3	5	3	6
Other	24	9	9	7	10	11	9	11	12	16
Total	42	18	17	14	17	17	14	18	15	23
Total	215	115	138	134	143	213	170	286	204	279

Table 89 (*b*) (*b*) Fuel Sales

Thousand Stacked cu. m.

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Railway	7	5	—	—	—	—	—	—	—	—
Public	197	177	216	140	166	190	254	174	214	216
Firewood	*136*	*118*	*127*	*66*	*81*	*101*	*89*	*80*	*82*	89
Charcoal	*44*	*41*	*73*	*57*	*71*	*73*	*147*	*72*	*106*	*107*
Fuel ticket	*17*	*18*	*16*	*17*	*14*	*16*	*18*	*23*	*26*	*20*
Total	204	182	216	140	166	190	254	174	214	216

Table 89 (*c*) (c) Other Forest Produce

Item	Unit	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Mangrove poles	'000	685	462	504	445	851	759	649	687	297	544*
Power and telegraph poles	'000	12	20	9	6	9	10	7	—	..	7
Other poles	'000" r.m	1,636	1,428	2,037	983	1,404	1,013	1,579	12.95	1,157	1,999
Bamboos	"	4,029	3,416	2,135	1,313	1,945	1,243	1,855	994	914	1,363
Fence posts	'000 cu. m	11	5	4	3	2	6	1	3	26	13
Withies	'000 *head loads*	81	54	53	45	49	189	75	71	93	202
Mangrove bark	'000 *kg.*	323	382	810	888	577	691	327	347	—	—
Plants	'000	1,422	1,248	642	616	425	733	745	460	503	498

Sources: Forest Department and Statistics Division.

*Provisional

II-3 BUILDING AND CONSTRUCTION

Notes and Definitions

The definition of items in Table 95 are the same as on page 90. The figures cover only private firms with fifty or more wo engaged.

Statistics of private buildings are compiled from returns of private buildings and extensions completed in the Municipalities.

The term "extensions" includes all major alterations and additions to buildings.

Buildings which are partly residential and partly non-residential have been allocated according to their main purpose. It sh.. be noted that floor area can be allocated more accurately than cost.

A block of flats is counted as a single building.

Floor area is defined as plinth area together with the floor area of any external ancillaries such as garages, servants' quarters, st rooms, lavatories etc.

SURVEY OF INDUSTRIAL PRODUCTION—BUILDING AND CONSTRUCTION, *1963–1968

Summary of Results

Table 95

Industry	Number of Firms						Numbers Engaged					
	1963	1964	1965	1966	1967	1968	1963	1964	1965	1966	1967	1968
Building and Construction												
Building and Construction	16	23	23	39	201	43	5,094	4,356	5,618	9,305	16,313	8,858
Electrical Contracting	2	3	2	4	27	4	227	283	229	294	764	467
Total	18	26	25	43	228	47	5,231	4,639	5,847	9,599	17,077	9,325

Table 95 (*Contd.*)

Industry	Labour Costs (K£'000)						Gross Product (K£'000)					
	1963	1964	1965	1966	1967	1968	1963	1964	1965	1956	1967	1968
Building and Construction												
Building and Construction	1,165·8	1,088·1	1,129·1	1,981·9	4,168·1	3,269·1	1,611·1	1,229·1	1,450·4	2,593·6	6,022·8	6,220·7
Electrical Contracting ..	105·7	55·5	50·2	79·5	248·8	142·7	115·7	65·2	47·3	124·0	390·2	212·6
Total	1,271·5	1,143·6	1,179·3	2,061·4	4,416·9	3,411·8	1,726·8	1,294·3	1,497·7	2,717·6	6,413·0	6,433·3

Table 95 (*Contd.*)

Industry	Input (K£'000)						Output (K£'000)					
	1963	1964	1965	1966	1967	1968	1963	1964	1965	1966	1967	1968
Building and Construction												
Building and Construction	2,471·8	2,371·8	3,120·2	5,211·4	11,111·5	8,095·7	4,082·7	3,600·9	4,570·6	7,505·1	17,126·8	14,316·4
Electrical Contracting ..	221·5	125·9	81·8	128·7	537·2	381·2	337·1	191·1	129·1	252·7	927·6	593·9
Total	2,693·3	2,497·7	3,202·0	5,340·1	11,648·7	8,476·9	4,419·8	3,792·0	4,699·7	8,057·8	18,054·2	14,910·3

Source: Statistics Division.

*Covers private sector only.

REPORTED COMPLETION OF BUILDINGS FOR PRIVATE OWNERSHIP IN MAIN TOWNS

By Type of Building and Town 1960–1969

Table 96

	1960	1961	1962	1963	1964†	1965	1966	1967	1968	1969*
Number of New Buildings										
Residential	562	123	57	86	98	44	129	245	305	282
Non-Residential	154	93	100	102	98	77	72	107	160	137
Total	716	216	157	188	196	121	201	352	465	419
Floor Area of New Buildings ('000 sq. m.)										
Residential	185·2	43·4	17·5	22·1	31·6	13·0	28·7	59·9	74	119
Servants' quarters	10·0	1·8	1·4	0·9	3·1	0·8	6·9	4·5	—	—
Total Residential	195·2	45·2	18·9	23·0	34·7	13·8	35·6	64·4	74	119
Offices	21·6	17·1	15·3	1·8	17·3	4·9	8·8	13·2	5	10
Shops	26·4	20·3	3·6	3·5	5·7	1·3	3·9	5·7	6	5
Godowns, Stores etc.	14·4	12·6	6·0	6·9	2·8	5·4	17·5	17·7	38	10
Factories	12·7	9·0	7·2	11·0	6·0	21·8	15·1	21·6	41	45
Other	30·6	20·5	23·2	29·3	31·9	37·9	8·8	25·3	27	101
Total Non-Residential	105·7	79·5	55·3	52·5	63·7	71·3	54·1	83·5	117	173
Total Floor Area	300·9	124·7	74·2	75·5	98·4	85·1	89·7	147·9	191	292
Cost (K£'000)										
New Buildings: residential	3,290	798	328	405	482	262	663	1,440	1,811	2,014
New Buildings: non-residential	2,339	1,644	1,476	868	2,248	1,076	1,157	1,630	2,630	5,358
Extensions: residential	264	102	119	154	186	104	159	287	257	309
Extensions: non-residential	424	337	358	201	476	376	366	660	870	619
Total Cost	6,317	2,881	2,281	1,628	3,392	1,818	2,345	4,017	5,568	8,300
Analysis of Cost by Town (K£'000)										
Nairobi	5,186	2,236	1,655	1,091	2,950	1,432	1,700	3,145	3,631	7,251
Mombasa	623	496	468	420	316	160	515	590	1,305	922
Other main Towns	507	149	158	117	126	226	78	282	632	127

Source: Statistics Division.

*Provisional.

†The figures from 1964 onward, include Thika which became a municipality at the beginning of that year.

NUMBER OF UNITS AND VALUE OF BUILDINGS COMPLETED IN NAIROBI, 1969

(By Cost Category)

Table 97

Cost Category	Residential				Non-Residential			
	Number of Units		Value K£		Number of Units		Value K£	
	Public	Private	Public	Private	Public	Private	Public	Private
£ 0— 500	21	5	2,919	2,115	13	6	568	1,865
£ 501— 1,000	33	8	25,749	5,429	7	7	5,301	5,223
£ 1,001— 1,500	40	3	52,750	3,862	9	1	11,987	1,200
£ 1,501— 2,000	40	7	65,833	12,850	7	2	12,835	3,875
£ 2,001— 2,500	31	6	68,581	13,947	6	2	13,672	4,900
£ 2,501— 3,000	14	6	37,351	17,200	5	5	14,247	14,691
£ 3,001— 3,500	5	13	15,857	41,850	4	8	13,260	26,325
£ 3,501— 4,000	12	19	45,888	75,108	1	1	3,838	4,000
£ 4,001— 4,500	5	5	21,633	13,500	3	3	12,531	13,000
£ 4,501— 6,000	—	9	—	44,650	3	5	14,150	24,200
£ 5,001— 6,000	—	34	—	191,407	5	5	26,664	28,645
£ 6,001— 8,000	13	49	90,666	360,842	3	7	34,533	47,535
£ 8,001—10,000	7	27	63,321	257,486	4	4	35,344	37,500
£10,001—12,000	—	16	—	179,379	—	4	—	46,650
£12,001—and above	6	24	169,504	591,397	20	35	662,729	4,463,343
	227	229	660,052	1,811,022		95	861,639	4,725,152

Source: Statistics Division

REPORTED COMPLETION OF BUILDINGS FOR PRIVATE OWNERSHIP

Table 98 (*a*)

(a) Analysis by Town, 1968

Details	Nairobi	Mombasa	Nakuru	Kisumu	Kitale	Eldoret	Thika	Total
Number of New Buildings								
Residential	223	46	12	17	1	2	4	305
Non-Residential	99	42	5	12	—	—	2	160
Total	322	88	17	29	1	2	6	465
Floor Area of New Buildings ('000 sq. metres)								
Residential	56	12	1	4	—	—	1	74
Servants' quarters	—	—	—	—	—	—	—	—
Total Residential	56	12	1	4	—	—	1	74
Offices	4	1	—	—	—	—	—	5
Shops	3	2	—	1	—	—	—	6
Godowns, Stores, etc.	14	23	—	1	—	—	—	38
Factories	28	10	—	3	—	—	—	41
Other	14	3	1	4	—	—	5	27
Total Non-Residential	63	39	1	9	—	—	5	117
Total Floor Area	119	59	2	13	—	—	6	191
Cost (K£'000)								
New buildings, residential	1,485	242	15	61	1	1	6	1,811
New buildings, non-residential	1,522	933	8	96	—	—	71	2,630
Extensions, residential	200	45	1	3	—	3	5	257
Extensions, non-residential	424	85	3	—	329	—	29	870
Total Cost	3,631	1,305	27	160	330	4	111	5,568

REPORTED COMPLETION OF BUILDINGS FOR PRIVATE OWNERSHIP

Table 98 (*b*)

(b) Analysis by Town 1969*

Details	Nairobi	Mombasa	Nakuru	Kisumu	Kitale	Eldoret	Thika	Total
Number of New Buildings								
Residential	229	34	10	8	—	1	—	282
Non-Residential	95	33	6	3	—	—	—	137
Total	324	67	16	11	—	1	—	419
Floor Area in '000 sq. metres								
Residential	108	8	1	2	—	—	—	119
Servants quarters								
Total	108	8	1	2	—	—	—	119
Offices	9	2	—	—	—	—	—	11
Shops	4	1	—	—	—	—	—	5
Godowns, Stores, etc.	4	6	—	—	—	—	—	10
Factories	43	3	—	—	—	—	—	46
Other	85	14	1	1	—	—	—	100
Total Non-Residential	145	26	1	1	—	—	—	173
Total Floor Area	253	34	2	3	—	—	—	292
Cost (K£'000)								
New buildings, residential	1,811	162	10	30	—	1	—	2,014
New buildings, non-residential	4,723	604	15	16	—	—	—	5,358
Extensions, residential	274	24	2	3	—	6	—	309
Extensions, non-residential	443	132	10	4	24	—	6	619
Total Cost	7,251	922	53	37	24	7	6	8,300

Source: Statistics Division.
*Provisional.

REPORTED COMPLETION OF NEW NON-RESIDENTIAL BUILDINGS FOR PRIVATE OWNERSHIP

Analysis of Cost by Town and Type of Ownership, 1965-1969

Table 99

Cost K£'000

Type of Ownership	Nairobi	Mombasa	Nakuru	Kisumu	Kitale	Eldoret	Thika	Total
Agriculture								
1965	9	—	—	—	—	—	—	9
1966	—	—	—	—	—	—	—	—
1967	—	—	—	—	20	—	—	20
1968	—	—	—	—	—	—	—	—
1969*	—	—	—	—	—	—	—	—
Mining and Quarrying								
1965	—	—	—	—	—	—	—	—
1966	—	—	—	—	—	—	—	—
1967	—	—	—	—	—	—	—	—
1968	—	—	—	—	—	—	—	—
1969*	—	—	—	—	—	—	3	3
Manufacturing								
1965	257	42	—	13	—	5	153	470
1966	534	143	—	9	—	—	—	686
1967	209	41	3	—	—	—	43	299
1968	452	139	—	51	—	—	71	713
1969*	970	91	4	—	—	—	—	1,065
Building and Construction								
1965	—	—	—	—	—	—	—	—
1966	3	—	—	—	—	—	—	3
1967	29	—	—	—	—	—	—	29
1968	15	—	—	17	—	—	—	32
1969*	30	5	—	—	—	—	—	35
Electricity and Water								
1965	6	—	—	—	—	—	—	6
1966	—	—	—	—	—	—	—	—
1967	12	—	—	—	—	—	—	12
1968	22	—	—	—	—	—	—	22
1969*	—	1	—	—	—	—	—	1
Transport, Storage and Communications								
1965	302	2	—	—	—	—	—	304
1966	61	5	—	—	—	—	—	66
1967	138	—	—	—	—	—	—	138
1968	43	66	—	—	—	—	—	109
1969*	8	—	—	—	—	—	—	8
Wholesale and Retail Trade								
1965	39	25	5	3	—	4	—	76
1966	99	24	—	—	—	—	—	123
1967	139	20	16	—	5	—	—	180
1968	264	545	—	11	—	—	—	810
1969*	260	31	4	—	—	—	—	275
Services								
1965	110	10	3	8	—	—	—	131
1966	223	37	3	—	—	—	16	279
1967	590	160	14	—	—	25	—	789
1968	570	123	8	17	—	—	—	717
1969*	3,475	475	7	16	—	—	—	3,973
Financial Institutions								
1965	76	—	—	—	—	—	—	76
1966	—	—	—	—	—	—	—	—
1967	163	—	—	—	—	—	—	163
1968	166	61	—	—	—	—	—	227
1969*	—	2	—	—	—	—	—	2
Total								
1965	799	79	8	23	—	10	153	1,073
1966	970	209	3	9	—	—	16	1,157
1967	1,230	224	33	—	25	25	43	1,630
1968	1,552	933	8	96	—	—	71	2,633
1969*	4,773	604	15	16	—	—	—	5,358

Source: Statistics Division.

*Figures provisional.

BUILDING

PRIVATE BUILDING PLANS APPROVED BY NAIROBI CITY COUNCIL

Table 100 (*a*)

1960–1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	196
Number of Plans										
Residential	1,042	311	386	357	321	266	610	774	887	9
Non-Residential	488	379	312	328	367	420	486	520	590	5
Total	1,530	690	698	685	688	686	1,096	1,294	1,477	1,5
Estimated Cost (K£'000)										
Residential	2,272	306	184	465	542	504	1,714	2,408	4,430	4,0
Non-Residential	3,021	1,689	1,208	1,381	1,397	1,600	2450	6,366	3,550	6,6
Total	5,293	1,995	1,392	1,846	1,939	2,103	4,164	8,774	7,980	10,9

*Provisional

PUBLIC BUILDING PLANS APPROVED BY NAIROBI CITY COUNCIL

Table 100 (*b*)

1962–1969

	1962	1963	1964	1965	1966	1967	1968	1969*
Number of Plans								
Residential								
Government and E.A.C.	6	13	10	6	11	58	6	8
Nairobi City Council	3	1	1	4	2	8	5	1
Total	9	14	11	10	13	66	11	9
Non-Residential								
Government and E.A.C.	23	23	17	16	26	24	34	74
Nairobi City Council	6	2	15	16	6	48	40	21
Total	29	25	32	32	32	72	74	95
Total Plans Approved	38	39	43	42	45	138	85	104
Estimated Cost (K£'000)								
Residential								
Government and E.A.C.	13	66	37	68	78	254	137	305
Nairobi City Council	251	250	1	299	2	1,357	848	350
Total	264	316	38	367	80	1,611	985	655
Non-Residential								
Government and E.A.C.	317	60	483	1,078	206	221	242	1,113
Nairobi City Council	40	24	35	125	348	284	277	830
Total	357	84	518	1,203	554	505	519	1,943
Total Estimated Cost	621	400	556	1,570	634	2,116	1,504	2,598

Source: Statistics Division.

*Provisional

CEMENT*

Table 101

Production and Consumption, 1960–1969

Metric Tons

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1959
Production (Kenya)	341,138	329,474	343,516	343,657	422,073	483,840	470,340	493,613	543,194	642,381
Domestic Exports	43,096	95,111	105,541	110,602	174,117	199,407	169,528	221,180	239,027	309,025
Inter-State Trade										
From Uganda	7	1	—	1		2	48	100	70	8
From Tanzania	8	8	5	14	4	18	15	80	—	157
To Uganda	7,869	6,605	11,294	17,072	13,405	7,185	9,142	12,444	5,516	29,843
To Tanzania	106,357	108,186	102,419	98,560	150,927	179,037	145,784	74,852	118,319	80,965
Net Estimated Consumption of E.A. Produced Cement	183,832	119,581	124,267	117,438	83,628	98,231	145,949	185,317	180,402	222,713
Retained Imports	1,157	696	901	765	1,114	171	611	675	1,260	1,200
Total Estimated Consumption†	184,989	120,277	125,168	118,203	84,742	98,200	140,172	195,296	234,675	269,655

Source: Cement Companies and E.A. Customs and Excise.

*Excluding cement clinker

†Up to 1961 local cement consumption was estimated using production and External Trade figures. This method has been discontinued from 1965 onwards and actual sales figures from the cement companies are used instead.

Notes and Definitions

The definition of items in Table 102 are the same as on page 90. The figures cover only private firms with fifty or more workers engaged.

Kenya statistics of mineral production are compiled from returns made by mining concerns. For salt and lime, commercial output only is covered; consequently some unknown quantities of these items which are mined and used on farms, etc., are not recorded. The values given for gold, lime, sulphuric acid and carbonate are the gross amounts realized by the producers. The production of limestone and gypsum excludes that used in the production of local cement.

SURVEY OF INDUSTRIAL PRODUCTION—MINING AND QUARRYING, 1963-1968

Summary of Results

Table 102

Industry	Number of Firms						Number Engaged					
	1963	1964	1965	1966	1967	1968	1963	1964	1965	1966	1967	1968
Mining and Quarrying—												
Metallic minerals, crude petroleum and natural gas	2	1	1	2	6	3	1,210	850	877	575	715	572
Quarrying, non-metallic and chemical mining	4	6	6	10	61	16	787	894	790	1,000	2,437	1,658
Total	6	7	7	12	67	19	2,037	1,744	1,667	1,575	3,152	2,230

Table 102—(*Contd.*)

Industry	Labour Costs (K£'000)						Gross Product (K£'000)					
	1963	1964	1965	1966	1967	1968	1963	1964	1965	1966	1967	1968
Mining and Quarrying—												
Metallic minerals, crude petroleum and natural gas	581·2	138·1	199·9	304·4	468·2	500·0	27·8	402·8	541·1	564·6	759·4	769·0
Quarrying, non-metallic and chemical mining	358·4	281·1	254·6	302·8	528·9	477·8	656·7	615·8	585·4	690·7	1,173·5	1,197·5
Total	939·6	419·2	454·5	607·2	997·1	977·8	684·5	1,018·6	1,126·5	1,255·3	1,932·9	1,966·5

Table 102—(*Contd.*)

Industry	Input						Output (K£'000)					
	1963	1964	1965	1966	1967	1968	1963	1964	1965	1966	1967	1968
Mining and Quarrying—												
Metallic minerals, crude petroleum and natural gas	1,751·2	455·3	646·9	913·9	1,551·3	1,423·3	1,779·0	838·1	1,032·0	1,476·5	1,610·8	2,192·3
Quarrying, non-metallic and chemical mining	474·5	479·8	326·1	677·0	1,092·4	1,078·7	1,131·0	995·6	911·5	1,367·7	2,266·7	2,276·2
Total	2,225·8	935·1	973·0	1,588·9	2,643·7	2,502·0	2,910·0	1,833·7	1,943·5	2,844·2	3,877·5	4,468·5

Source: Statistics Division.

MINING

MINERAL PRODUCTION 1960–1969

(a) Quantity

Table 103 (*a*)

Mineral	Unit	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Soda	*Metric tons*	2,511	2,295	2,924	2,342	2,220	2,548	2,463	3,224	2,283	2,[illegible]
Soda Ash	,,	265,021	14,471	124,074	103,350	81,665	83,193	112,394	104,750	117,244	103,[illegible]
Copper	,,	1,784	2,564	2,225	2,247	2,077	1,969	792	11	38	77
Salt	,,	22,267	23,012	18,865	16,397	16,350	26,149	25,154	27,339	28,799	42,2[illegible]
Gold	*Grams*	245,081	34,867	264,416	288,966	353,802	340,563	337,302	945,909	994,954	556,8[illegible]
Lime and Limestone	*Metric tons*	25,291	19,783	18,283	16,447	13,860	14,407	16,733	19,040	18,566	24,9[illegible]
Diatomite	,,	3,439	3,209	2,909	3,336	3,055	2,218	1,772	1,886	2,055	2,2[illegible]
Carbon dioxide	,,	840	648	465	517	746	762	817	817	819	76[illegible]
Silver	*Grams*	1,014,827	1,154,703	142,201	1,486,137	1,352,328	759,341	538,726	86,126	86,186	51,[illegible]
Gypsum†	*Metric tons*	439	72	183	—	—			246	501	48[illegible]
Kaolin	,,	1,053	741	1,173	6,663	1,288	1,714	893	1,456	1,332	1,472
Asbestos	,,	106	137	192	71	185	123	66	51	—	—
Meerschaum	,,	22	1	—	6	—	2	1	—	82	1,851
Magnesite	,,	30	1,751	—	261	170	67	576	422	68	583
Mica	,,	1	—	1	1	—	—	—	—	371	—
Quartz	,,	—	10	—	259	—	—	—	—	11	—
Vermiculite	,,	257	—	20	92	34	22	76	251	279	776
Pumice	,,	2,459	707	1,128	284	1,438	1,039	792	122	—	—
Beryl	,,	1	1	—	—	1	—	—	17	11	3
Columbite	,,	1	—	—	—	—	—	—	—	—	—
Coral (for stone)	,,	—	15,841	6,108	2,154	—	—	—	—	—	—
Felspar	,,	—	1	—	—	—	—	164	402	535	1,560
Graphite	,,	1,010	—	—	—	—	—	—	—	—	—
Mullite	,,	1,285	—	—	—	—	—	—	—	—	—
Sand	,,	146	—	—	—	—	—	—	—	—	—
Sandstone	,,	35,404	4,355	49,174	—	—	—	—	—	—	—
Wollastonite	,,	—	—	—	—	—	—	—	—	1,382	691

*Provisional.

†Excluding gypsum used for cement.

(b) Value

Table 103 (*b*)

£'000

Mineral	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969*
Soda	17·1	16·7	18·1	19·3	19·3	22·7	21·9	28·7	21·8	25·0
Soda ash	1,410·3	1,584·9	1,346·5	1,283·6	887·9	895·8	1,183·7	1,093·5	1,203·6	1,111·0
Copper	412·7	583·0	505·0	504·7	654·7	868·3	426·3	5·5	14·7	40·4
Salt	166·8	183·5	150·5	139·5	142·2	210·5	208·6	241·0	281·6	392·9
Gold	108·2	154·0	116·2	128·9	168·6	150·1	149·5	420·1	448·0	273·8
Lime and limestone	147·5	106·1	109·6	97·4	94·4	109·9	127·0	128·4	125·6	180·7
Diatomite	51·7	47·6	41·1	71·0	71·9	49·2	33·8	27·8	30·3	32·2
Carbon dioxide	47·7	44·2	30·6	54·2	59·2	60·5	68·8	70·1	76·2	71·6
Silver	11·8	14·1	20·3	25·2	22·3	12·1	8·5	1·8	2·1	1·7
Gypsum†	2·6	0·4	1·1	—	—	—	—	1·0	1·7	2·0
Kaolin	3·5	2·4	2·4	5·2	2·9	5·3	16·1	22·5	24·1	36·2
Asbestos	3·5	4·5	6·1	1·9	6·5	3·3	1·8	1·7	—	—
Meerschaum	3·3	0·2	—	0·7	0·9	0·9	0·3	—	—	0·5
Magnesite	0·1	4·3	—	0·5	0·7	0·3	5·3	3·7	0·6	4·6
Mica	0·5	0·1	0·6	0·4	—	—	—	—	—	—
Quartz	—	—	—	0·3	—	—	—	—	0·1	—
Vermiculite	2·5	—	0·1	0·1	0·7	0·3	0·2	0·7	0·8	2·7
Pumice	1·7	1·2	0·3	—	0·4	0·3	0·2	—	—	—
Beryl	0·1	0·1	—	—	0·1	—	—	2·2	2·4	0·4
Columbite	0·1	—	0·1	—	—	—	—	—	—	—
Coral (for stone)	2·3	0·9	0·2	—	—	—	—	—	—	—
Felspar	—	—	—	—	—	—	5·2	1·9	8·4	25·0
Graphite	28·0	—	—	—	—	—	—	—	—	—
Mullite‡	30·2	—	—	—	—	—	—	—	—	—
Sand	0·1	—	—	—	—	—	—	—	—	—
Sandstone	12·1	1·4	14·5	—	—	—	—	—	—	—
Wollastonite	—	—	—	—	—	—	—	—	21·6	6·[illegible]
Total	2,463·4	2,749·7	2,373·2	2,471·5	2,286·4	2,528·2	2,411·8	2,091·7	2,139·7	2,[illegible]

Source: Mines and Geological Department

‡Including kyanite

†Excluding gypsum used for cement

*Provisional

QUANTITY INDEX OF MINING AND QUARRYING PRODUCTION, 1962–1969

(1961 = 100)

Table 104

Industry Group	1962	1963	1964	1965	1966	1967	1968	1969
Metal Mining	100·6	103·0	100·0	94·1	49·6	54·3	52·8	31.6
Non-Metallic Mining	119·9	102·8	100·0	98·0	123·0	112·6	129·4	127.1
Quarrying	122·2	114·3	100·0	103·3	132·7	168·8	157·0	206.9
Total Mining and Quarrying	**115.3**	**108.4**	100·0	99.3	**106.1**	**117.3**	**120.3**	**137.7**

Source: Statistics Division.

Note.—The weights have been changed to take into account the growing importance of quarrying, and therefore the overall index differs from the figures in the last Abstract.

B. PREFABRICATION IN KENYA

III-0 EXPERIMENTAL TIMBER HOUSING NAIROBI (4 ORGANISATIONS PARTICIPATING)

III-1 Introduction

The main theme of this seminar is aimed at evaluating merits, if any, of using local building materials in any particular place with a view to lowering costs by using better building techniques. Perhaps I should mention that the experiment described here was first of its kind in Kenya where four Organisations involved in low cost housing put their activities together on one site. The four Organisations, namely, Nairobi City Council, Ministry of Housing, Housing Research Unit - Nairobi University and the National Housing Corporation. There was a common cause for all. The main reasons were to use national material (timber) which is considerably flexible and to experiement on ease and speed of construction. For the purpose of this seminar I wish to describe one group of prototype designs of the four groups ++ of proposals which were experimented.

III-2 The Project General Requirements

(a) Metric units were to be used throughout (Costing has been done in Sh/sq.ft. as readily convenient).

(b) Each dwelling unit was to have Kitchen, W.C. ablution, store and habitable rooms of variable sizes.

(c) Design to be executed as convenient but not essentially on prefabrication principles.

(d) Timber structural members to be of treated pine and cypres.

(e) Use of plates and hangers permissible.

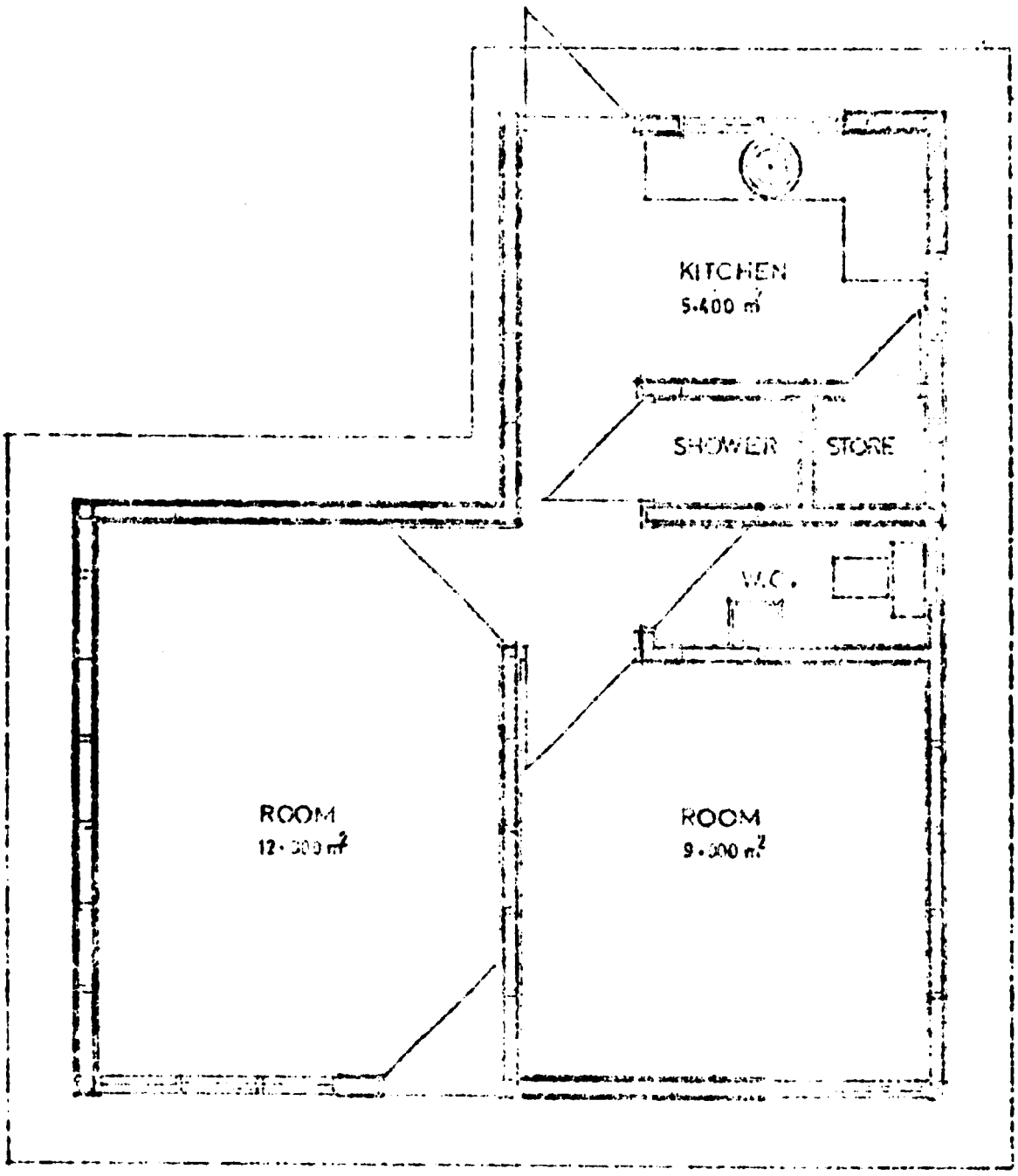
(f) Some designs to explore the possibility of flexible rafts on black-cotton soil.

(g) To provide store with external access (for bicycles and charcoal etc.,)

(h) Windows to be steel or wood glazed or shutters.

(i) Doors to be in wood.

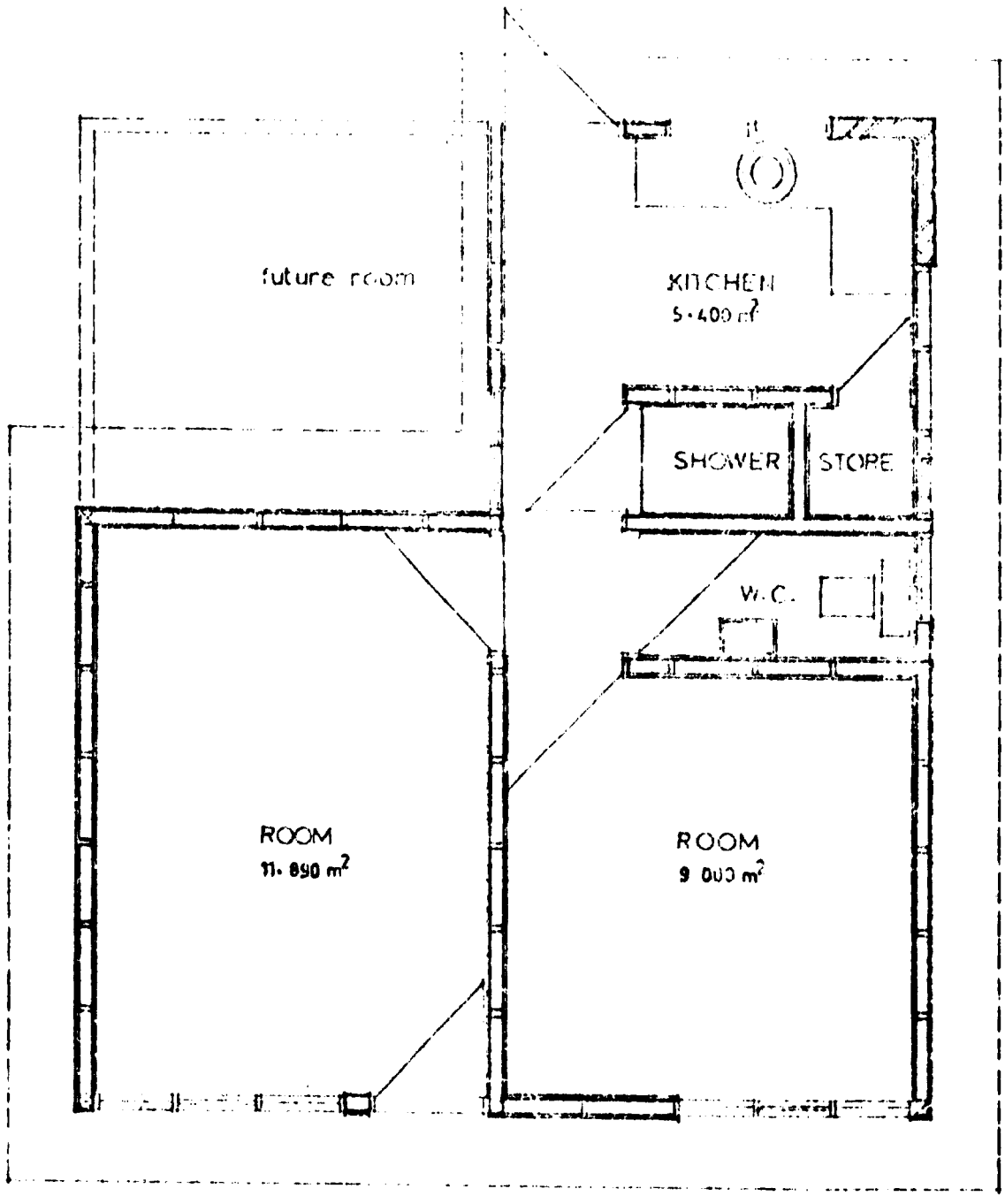
++ Out of 27 different type plans, I will discuss only 10 house plans which are specified as type A1, A2, B1, B3, B4, C1, C2, C3, and C4 on the drawings.



[illegible] TRADER HOUSING - KENYA

Type A.1

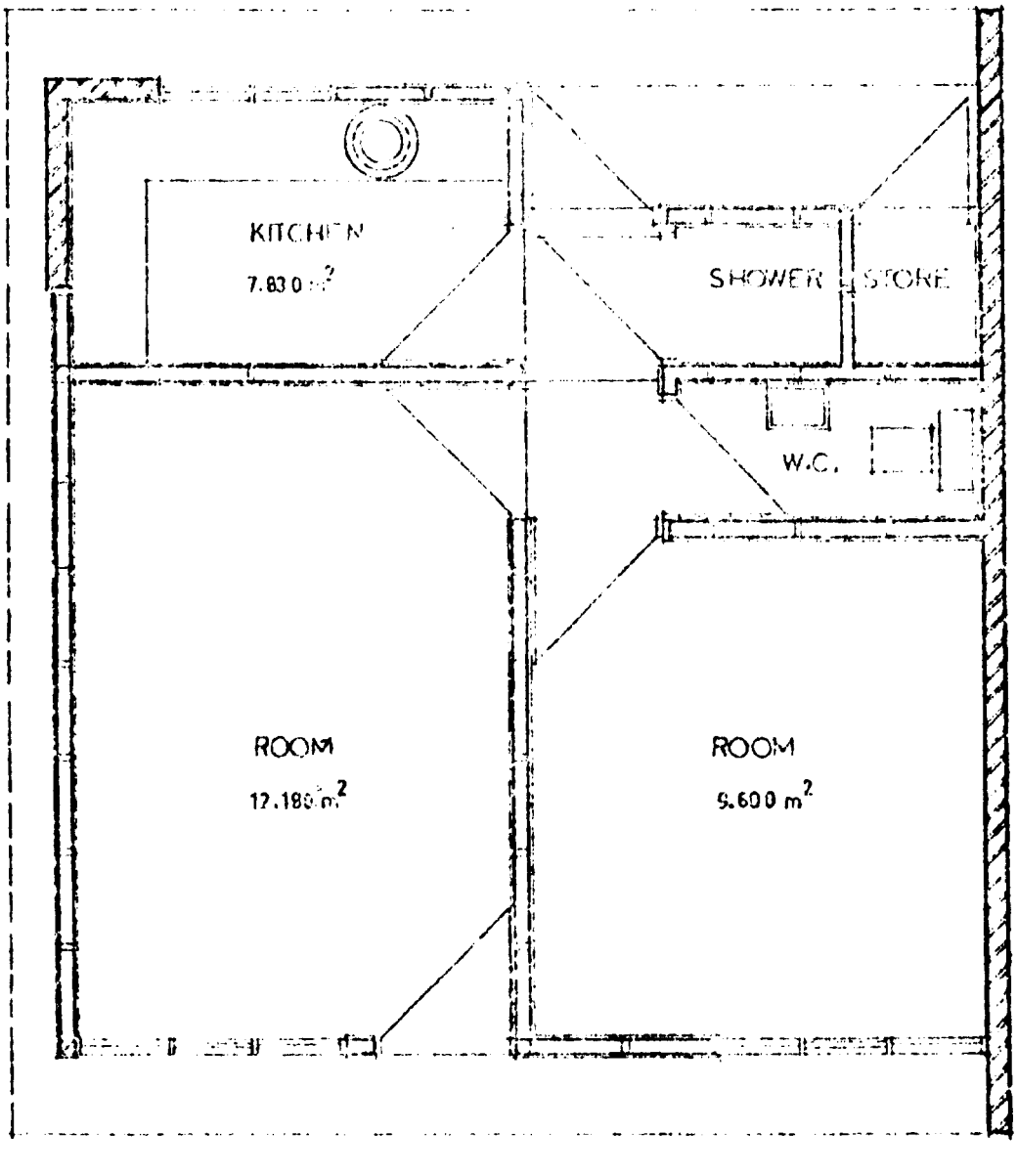
scale 1:50



EXPERIMENTAL TIMBER HOUSING — KENYA

Type A 2

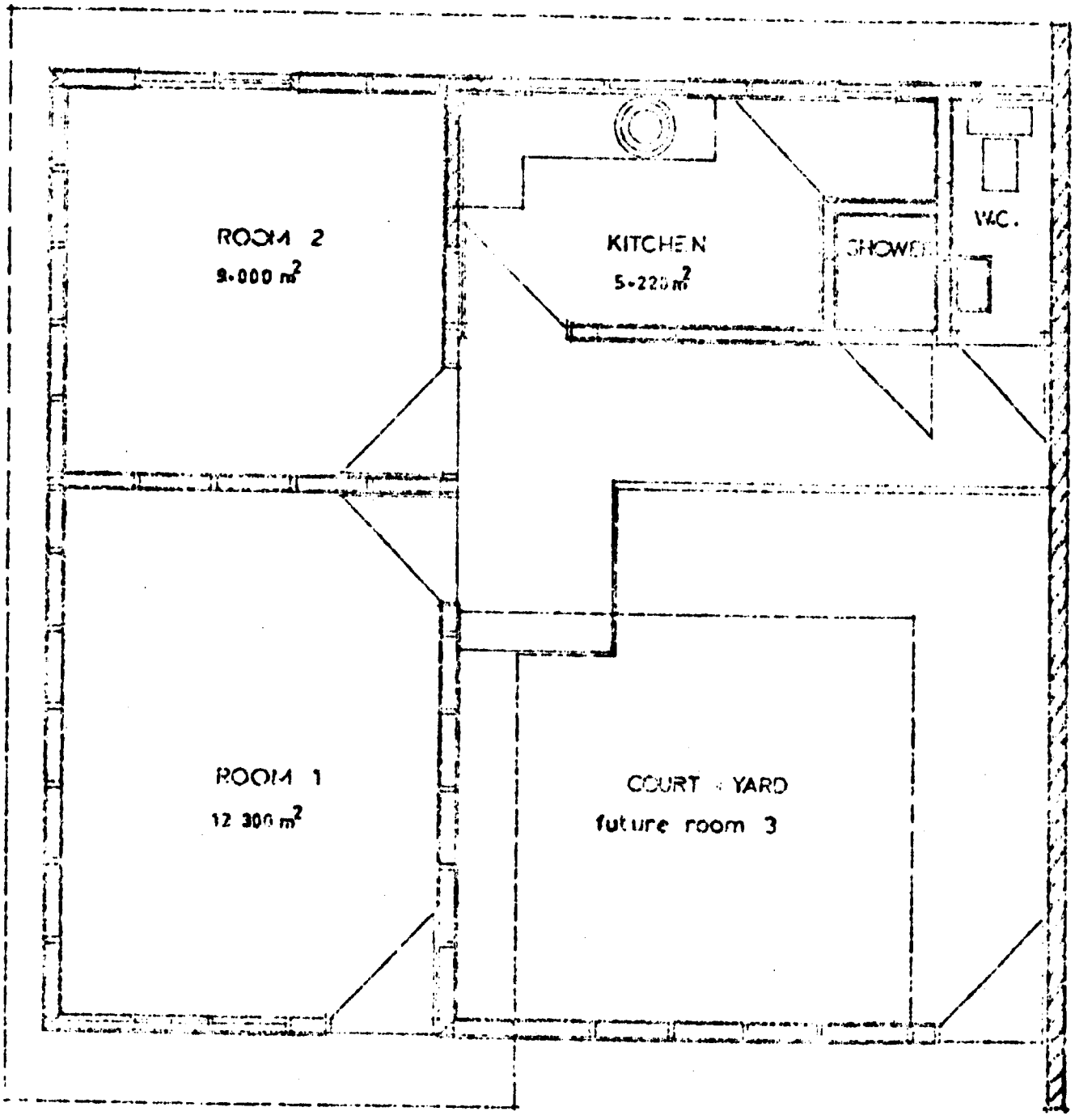
scale 1 : 50



EXPERIMENTAL TIMBER HOUSING – KENYA

Types B1 & B2

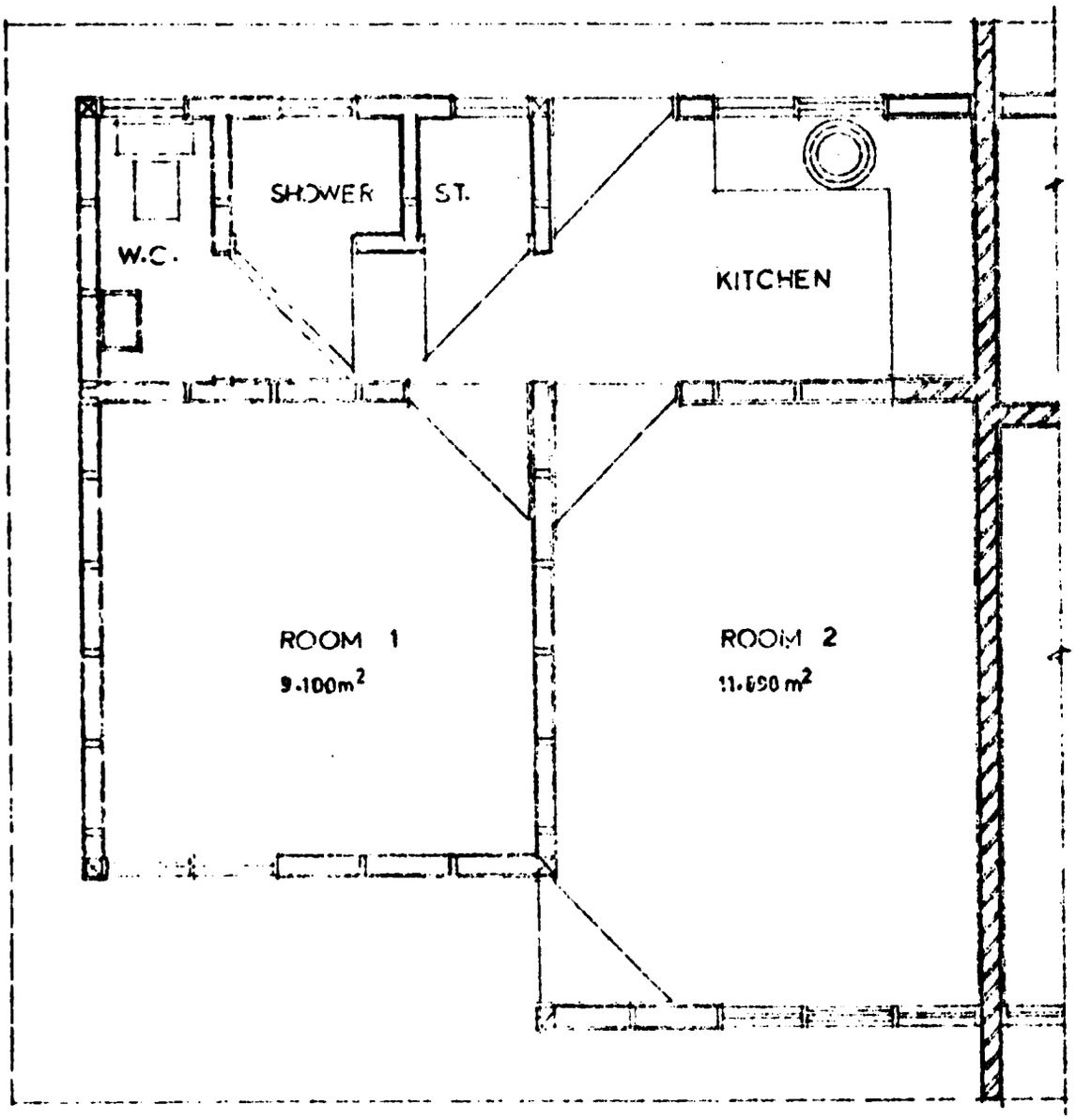
scale 1:50



EXPERIMENTAL TIMBER HOUSING - KENYA

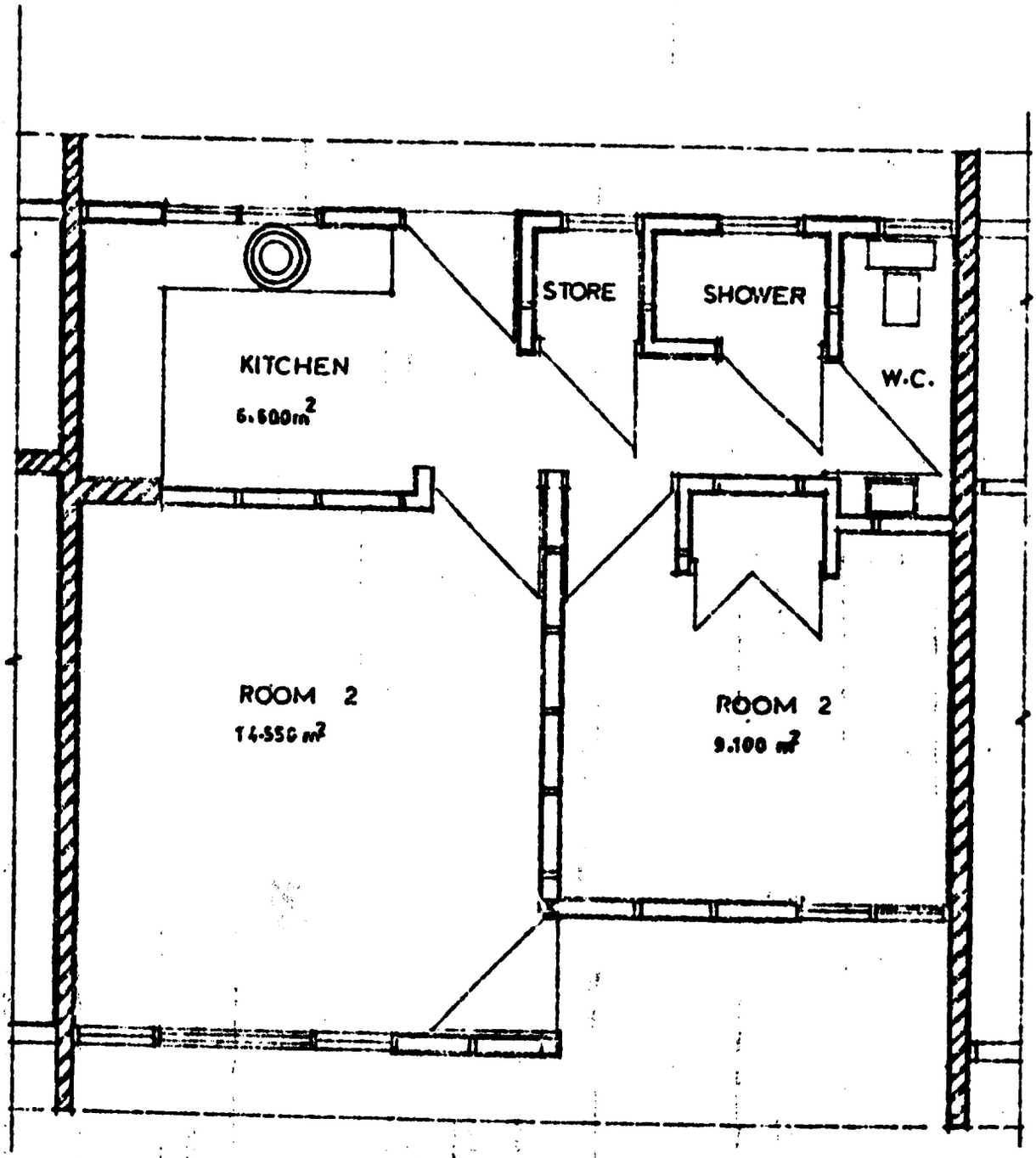
Types B3 & B4

scale 1:50



EXPERIMENTAL TIMBER HOUSING – KENYA

Typos C1, C2, C3 & C4 scale 1:50



EXPERIMENTAL TIMBER HOUSING — KENYA

Types C1, C2, C3 & C4

scale 1:50

III - 3 House Types

Plan No.	Joinery	No. of Habitable Rooms	Design Concept	Ceilings	Fire Retardant	Floors	Modular	Treated Timber
A1	Cypress	2	detached	-	-	Cone	-	PP
A2	ditto	2	ditto	Yes	-	Cone	-	DD
B1	ditto	2	semi-detached	-	-	Wood	Yes	PP
B2	ditto	2	ditto	-	-	Wood	Yes	DD
B3	ditto	2	ditto	Yes	-	Cone	-	DD
B4	ditto	2	terrace	Yes	-	Cone	-	PP
C1	Ceder	2	ditto	Yes	-	Cone	-	
C2	Cypress	2	ditto	-	-	Cone	-	DD
C3	ditto	2		-	-	Cone	-	PP
C4	ditto	2	ditto	Yes	-	Cone	-	DD

Notes : PP - Pressure processed. DD - Dip Diffused. Only C2 has thermal insulation.

Calculation for comfort zone nil.
Climate fairly good.
All houses single storey.

III - 4 Cost Analysis

(a) Building Works

Plan No.	Estimated Cost £	Labour Rs	Materials	Plants	Actual Cost £	Floor Area sq.ft.	Cost per sq.ft. £	Imported Materials %
A1	800	9,523/20	10,192/99	996/00	1,035	388	2.05	17.9
A2	800	10,381/75	10,819/40	833/00	1,101	388	2.8	28.8
B1	850	8,016/10	9,383/09	885/00	914	420	2.0	18.5
B2	"	7,348/50	9,271/88	945/00	878	420	2.0	14.9
B3	"	8,151/85	11,761/29	2,340/00	1,112	366	3.0	18.8
B4	"	6,709/10	9,899/64	2,048/00	932	366	2.0	27.0
C1	"	8,479/14	9,733/36	1,569/75	989	441	2.0	12.7
C2	"	7,251/13	8,149/28	1,563/25	849	409	2.0	9.92
C3	"	6,970/31	7,963/17	1,728/75	833	409	2.0	12.80
C4	"	7,063/68	9,260/37	1,420/25	887	409	2.0	19.56

(b) Site Works overall total costs £11,756/06

III-5 Example of typical walling approximate cost per sq ft for a type unit

(a) External Walls

	Sw/Sq.Ft.
Cost of 75mm x 40mm studding frame into panels plus labour	0/80
Cost of 500 gauge polythene sheeting and labour	0/15
Spacers of ¼" chipboard 1" sq. in size plus labour	0/10
½" chicken wire mesh on spacers -do-	0/60
2 coat work plaster 1:1:6, 1:2:6 cem:lime:sand -do-	0/50
1 coat Rough Casting -do-	0/25
½" Budongo Chipboard -do-	1/60
Total per sq.ft. of typical wall	5/00

(b) Internal Walls

	Sw/Sq.Ft.
Cost of 75mm x 40mm studding and labour	0/80
Cost of ½" thick Budongo Chipboard both sides and labour	3/30
Total per sq.ft. of wall	4/00

III-6 Example of typical dwelling unit overall amount of import/Export materials and their costs

Local Material by name	Cost Rs Cts	Imported Material By name	Cost Rs Cts
Treated timber cypress and pine	2,809.33	Cistern Tank	89.80
Plywood	4,261.00	Gauge Wire	1.06
Nails	106.13	1½" Bends G.I.	14.37
Asbestos Sheets	1,864.13	Evomastic	6.00
Cement	443.20	½" Elbows	36.40
But hinges	170.03	Stop cocks	8.42
Tee hinges	9.00	½" Copper nuts	62.20
Flush Doors	232.00	Hacksaw blades	.50
Wood Screws	21.20	Hacksaw blades	.50
Paint Super velvet	1,163.05	Tees G.I.	56.98
Bituminous paint	18.25	Plugs G.I.	2.38
Cooking hood	75.00	Clear glasses	107.10
Cooking slab	139.50	Glaved piping	18.30
Agregate	25.55	Circular Stainless sinks	69.00
Sand	50.44	Cylinder night latches	18.00
Chipboard	98.37	Cylinder night latches	18.00
Mild steelbars	86.12	Formica Sheet	83.75
Ling Chromate	3.60	Pattase glue	14.00
C.P. Screws	3.25	Stock die set	30.15
Nipples	4.30	Bushes G.I.	.71
Block Board	155.00	Back nuts	.65
Gully grating	12.50	Bib taps	18.00
Solid Concrete blocks	145.82	Saddles electrical	21.64
Gully trap	52.00	P.C. 3	4.12
Lime	35.20	Twisted flexible wire	4.61
Turpentine	9.12	Conduit socket	4.29
		Bib taps	18.00
Coat hooks	6.75	Brass Knob handles	44.00
Pollyfiller	6.05	Rim latches	27,00
Galved steel mesh	1.68	Cable flexible 23/0076	4.50
		Cable T.& E. 7229	71.40
Pull handles	4.00	Cable single load	8.70
Pinotex wood preservative	100.50	Cable single load black	18.50
		Cable T. & E.3/029	122.85
		Glass Louvres	414.00
	13,112.11		1400.58

Percentage 90.35%

Percentage 9.65%

III-7 Brief notes on experimental timber housing

(a) Duration of the project

The project was started in January 1970 and was completed in December 1971. Difficulties experienced resulting in slow progress will be outlined below.

(b) Execution

The project was to be executed by direct labour. Therefore, arrangements were made in advance, to recruit Technicians, labourers and clerks, for the purchase of relevant materials and for setting up workshops, stores, offices, timber gantries and purchase of machinery.

(c) Quality Control and Proper Use of Materials

This was necessary in order to minimise wastage of expensive materials available. Periodic tests were carried out by Ministry of Works, Materials Branch to ensure economic use of good quality materials.

(d) Training

Although the scheme served an experimental purpose it should also be a training ground for carpenters and joiners recruited without basic training. As a result there was a considerable loss of materials and man-hour output. School leavers without much knowledge of book-keeping and the know-how to shoulder responsibility in keeping proper stores' records were employed. Most of them left after having secured better jobs somewhere else and new learners were constantly employed to replace them. This reflected on the slow-going of the job.

(e) Designers

These as was mentioned earlier was comprised of Nairobi City Council, Ministry of Housing, Housing Research Unit,-University of Nairobi and the National Housing Corporation. It was essential for the D.R. to maintain and entertain the interests of individual designers of various house units if the experiment was to be successful.

(f) Personnel (total 59 men)

Office Staff

1 Departmental Representative
1 Site Clerk - replaced after a month or so
2 Costing Clerks - replaced after 9 months
1 Storesman - replaced after 11 months
2 Stores Labourers
2 Watchmen
1 Workshop Foreman - removed after 4 months owing to inefficiency in his trade

Workshop team

4 Carpenters later increased to 8 - 10
4 Labourers later increased as required.

Site Team

15 Carpenters
20 Labourers
1 Mason Foreman
4 Masons
2 Plumbers - later added to 3 after 9 months
4 Painters - recruited at decoration stage

(g) Plant and Machinery

Workshop

1 No. 12" arbour tilting saw
1 No. 12" x 7" thickness planner
1 No. 6" Joiner
1 No. 12" Radial tilting saw
1 No 8" Wolf Bench Grinder
1 No, ¼" electrical drill - light duty
1 No. ½" electrical hand drill - heavy duty
6 No. T bars Cramps - 4' long
7 No. T. bars Cramps - 6' long
6 No. Work bench vices
3 No. Clamps

(h) Materials

A few products about 40% were used on trial basis and rejected. Twisting of timber was very difficult to detect at very early stage of Dip diffused Cypruss or pine. It was, however, discovered that twisting was cuased mainly by timber being cut from young trees. When these were replaced by timber from mature trees there was minimum difficulty. Pressure impregnated timber presented minimum difficulty. It was concluded that seasoned timber was more satisfacty for use in panels and frame work with negligable amount of wastage. It is, therefore, my contention that maximum prefabrication can be achieved. However, as I implied earlier (see I-5) simplicity is very important bearing in mind the unskilled labour and to overcome the setbacks involved.

(i) Suppliers

Due to the nature of small quantities required for this experiment the suppliers were reluctant to co-operate. The suppliers were not used to metric system which was being introduced in the country and in which drawings and bills of quantities were presented. This presented problems in meeting time schedules for outstanding materials.

(j) Prefabrication and erection of Panels

Large scale and more informative details were to be supplied from architects to avoid redrawing on site for the benefit of semi-skilled carpenters.

Strict supervision was found necessary in transporting of large panels to the site from near workshop. Tractors or vans had to be used. As there were 27 different house types ~~by~~ the degree of wastage in timber was obvious as this necessitated cutting different sizes of pieces in the frame work or panels The only remedy was to preserve the cut away pieces and try to reuse them as far as possible

IV-0 EFFORTS CONTEMPLATED BY INDIVIDUAL FIRMS OF PREFABRICATION IN KENYA

IV-1 Gordhandas Daramshi & Bros. Ltd., Limuru

This is a saw miller organisation which make houses from their own timber based on prefabrication system at customers request and specification. Their aims are not necessarily geared to low-cost housing but the operation is on commercial basis. Further details of plans and costs are unavailable.

IV-2 Timsales Ltd., Nairobi

(i) Introduction

The firm has so far made efforts towards PREFABRICATION as far as timber housing section are concerned only.

Further to this they manufacture doors, door frames, windows, floor tiles and blocks, mouldings, packing cases and glue lam beams.

(ii) Mode

Timber walls and roof all in panels.
Wall linings in chipboard.
Sizes of panels manufactured 8'-0" x 3'-4" with T and G on vertical panels.

(iii) Use of manufactured elements

A few houses are built in rural areas on customers request. The urban building by-laws have tremendously limited building in the city. Treatment to overcome fire hazards and termites as governed by the by-laws put the costs high than practicable.

(iv) Prefabricated elements

Panels sizes 8'-0" x 3'-4" and 8'-0" x 6'-8" possibly to take windows and doors.

Assembly is done by means of 3" screws.

Floors are usually cement screed.

The internal partitions are afterwards faced with chipboard.

Roofing is corrugated iron sheets on pitched timber prefabricated truss.

(v) Costs

There have not been high demand in Kenya for say 200 houses to enable standardisation of possible cost. However, for a building of 2000 sq.ft (office) built on concrete foundations and cement floors elemental breakdown of cost is as follows.

Prefabricated component plus roof	26%
Wall linings and ceiling	15%
Roof covering	7%
Concrete foundation and erection	31%
Painting	7%
Electric Installation	5%
Plumbing	9%
	100%

Cost per sq.ft. of such a building would vary from Kshs.48/- to Kshs.52/-.

IV-3 Prefab Systems Ltd., Nairobi

(i) Introduction

This firm is in the process of setting up a factory for the manufacture of prefabricated panels for housing, office partitions, and coldrooms. The panels are insulating core of expanded polystrene manufactured from imported grain material.

(ii) Mode

Foundations and floors are in concrete and the firm does not undertake their construction

Walls are prefabricated structural panels 4" to 10" in thickness.

(iii) Use of the Elements

In principle the panels are for office partitions at owners request.

(iv) Costs

With most of the materials imported and experiments not tried in housing it is not possible to predict the possibility of the use of this system in low cost housing.

IV-4 Ministry of Natural Resources

(i) Forest Department Training Centre

Mostly the buildings are for the rural areas and are outside the City Building By-Laws.

(ii) Mode

Materials used are cypress timber for wall framework and cedar timber for window frames. The woood is treated with preservatives by dipping or pressure impregnated.

Sizes of external walls and partitions are not necessarily standardised.

(iii) Use of the elements

For single storey and double storey houses based on prefabricated timber framing and sheathing. The degree of total prefabrication is not advanced. Usually construction is carried out for departmental use.

(iv) There have not been proper analysis of building costs to include concrete foundations and floors. However, it is estimated that an overall labour cost of Khs.10,000/- per month (excluding machinery) would turn out about 30 dwelling units.

IV-5 Nairobi City Council
(Experimental pre-cast concrete housing)

(i) Introduction

As was stated earlier Nairobi City Council is the largest local authority concerned with low-cost housing in Kenya. Together with Timber Housing Experiment the idea of pcc elements was tried to see whether this would be an improvement to traditional methods of using cement only in form of concrete blocks. A standard plan was developed and built in traditional methods of concrete but did not prove very popular. An experiment was, therefore, initiated by the Council to comprise the following stages, each one to be proceeded with after the previous one is successful.

(a) developing of elements, moulds and erection equipment, and building of a test house

(b) erection of single-storey dwelling house based on improvement of earlier unpopular plan built in concrete blocks.

(c) erection of a two-storey of four dwelling units.

The intention was to develop a system of Precast concrete elements handy for unskilled manpower and to be used for construction of various dwelling units within the low-cost housing brackets.

(ii) Seven different types of elements are prefabricated These are, wall, window, ventilation, lintol, cill, gable, ridge, and floor element in case of double-storey design.

Dimensions for each element is determined by following criteria on 90cm. module.

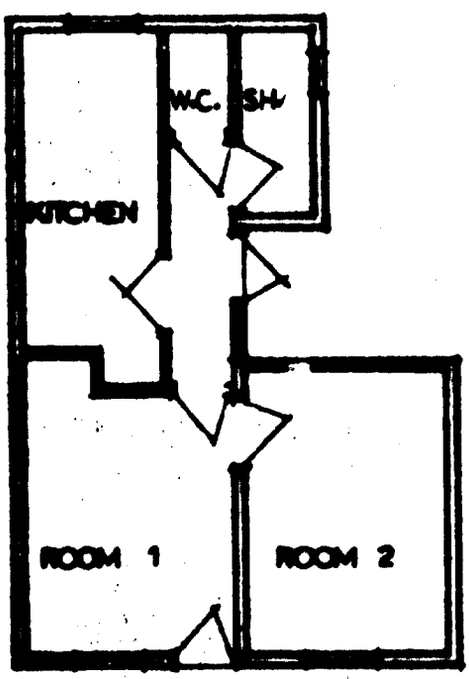
(a) Each element to weigh 250 kg to enable it to be handled manually and without using cranes etc.

(b) All elements to fit in planning module

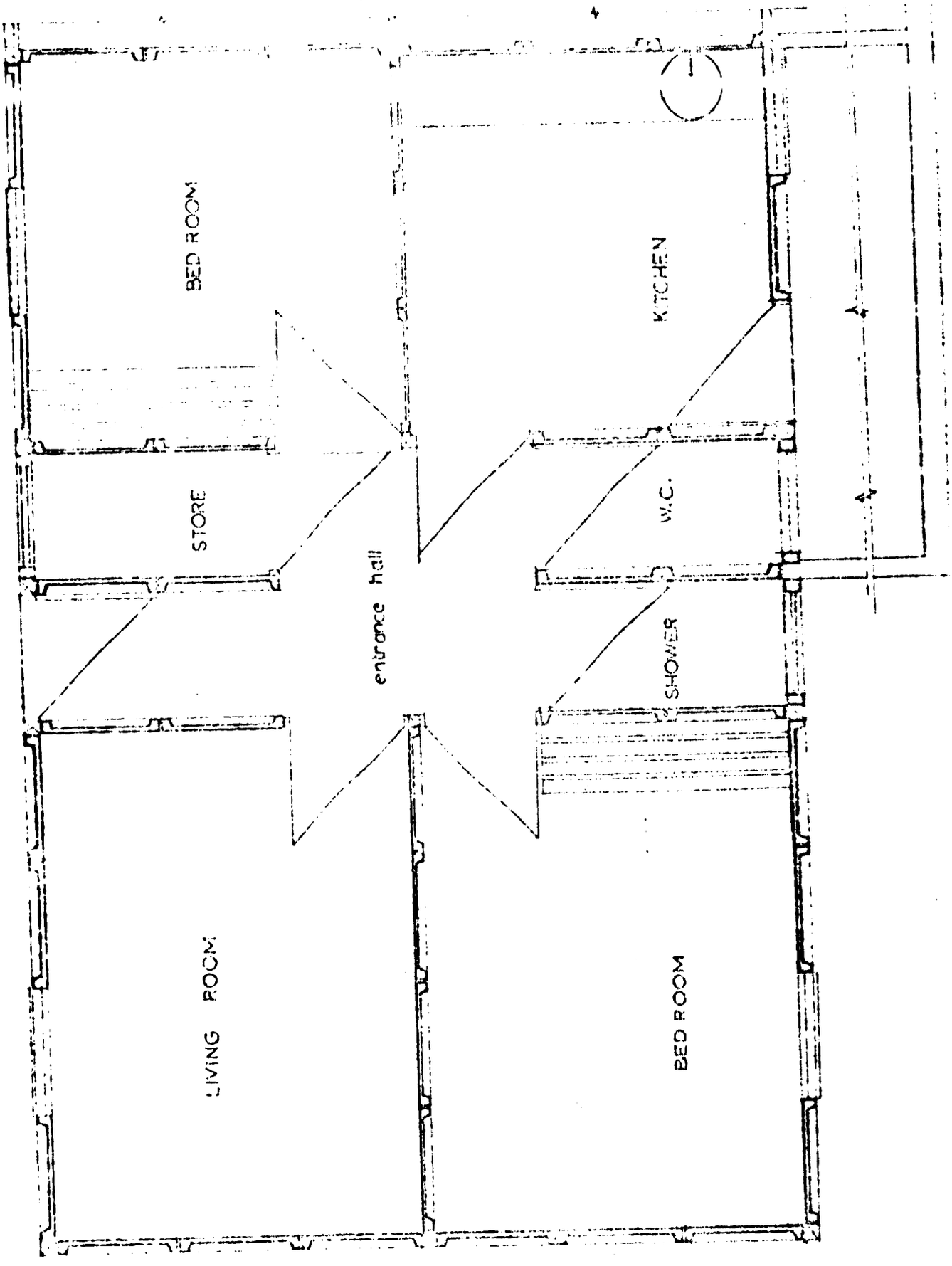
(c) In case of double-storey house the height of the rooms to be brought to agree with Building By-Laws by casting a ring beam on top of the ground floor elements.

(d) The system to have columns where two walls meet and elements to be joined together by grouting the cavity which can also take service pipes.

(e) Weather proofing treatment to be incorporated to the external surface when casting an element. Alternatively snowlem and cemwash to be used for weather proofing and decorative purposes externally.



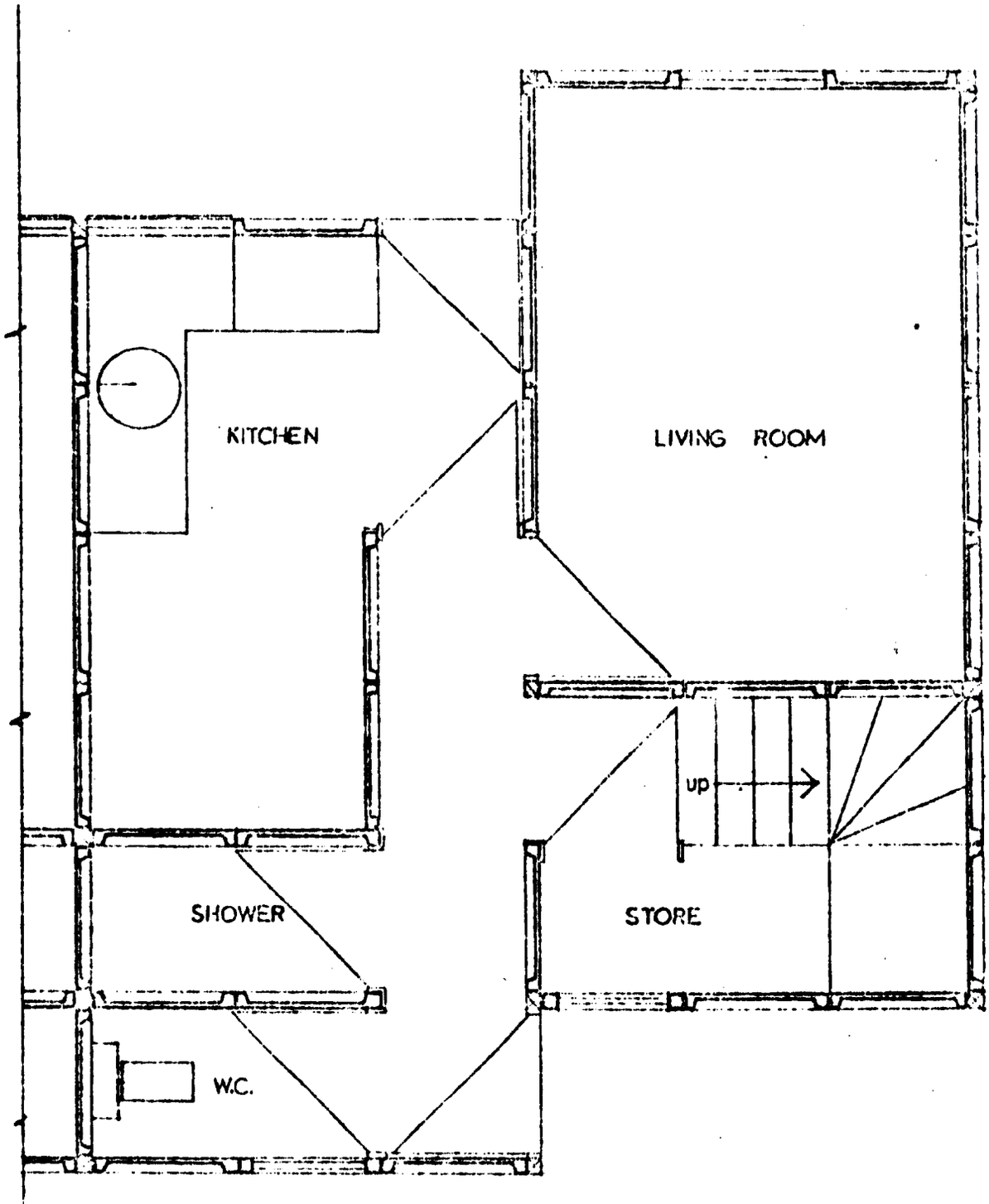
OUSE PLAN BASED ON TRADITIONAL BUIDING MATERIALS &
ETHODS – 9' & 6' Concrete block walls & timber trusses



SINGLE STOREY FLOOR PLAN

EXPERIMENTAL PRECAST CONC. HOUSING - KENYA

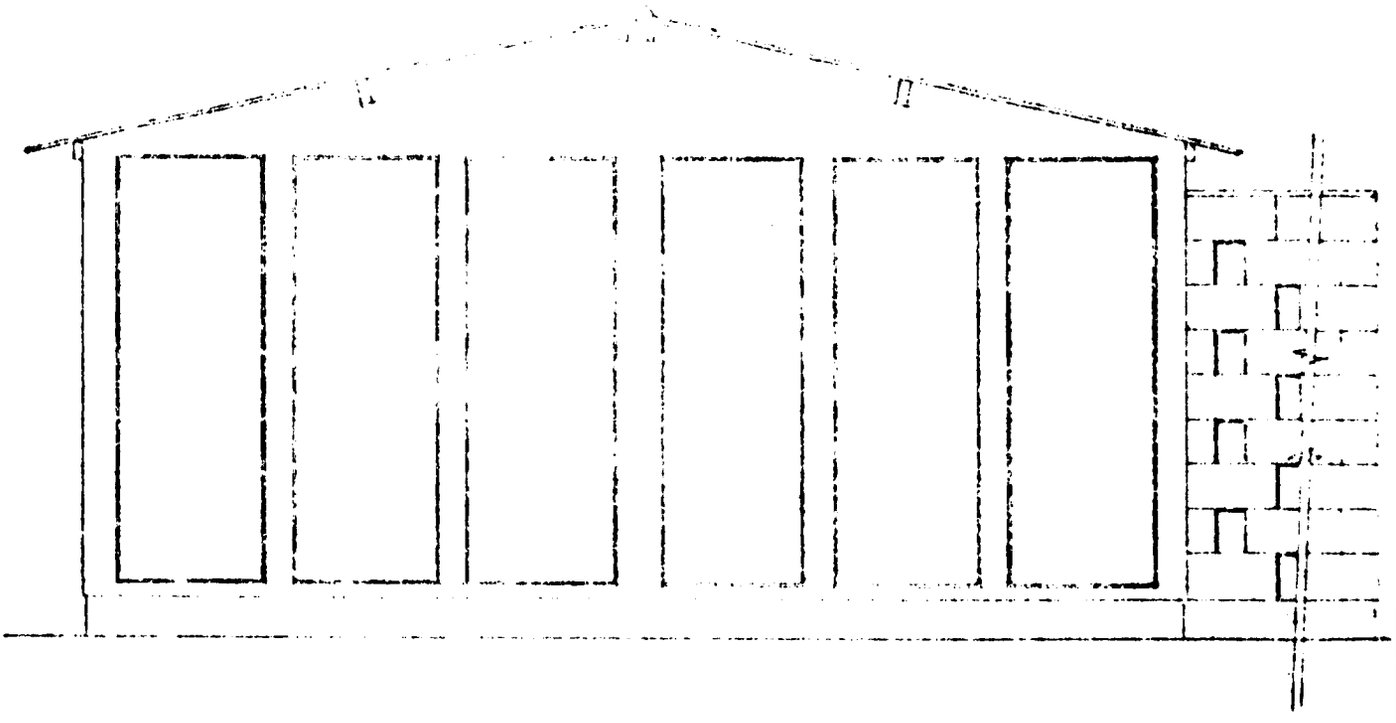
scale 1 : 40

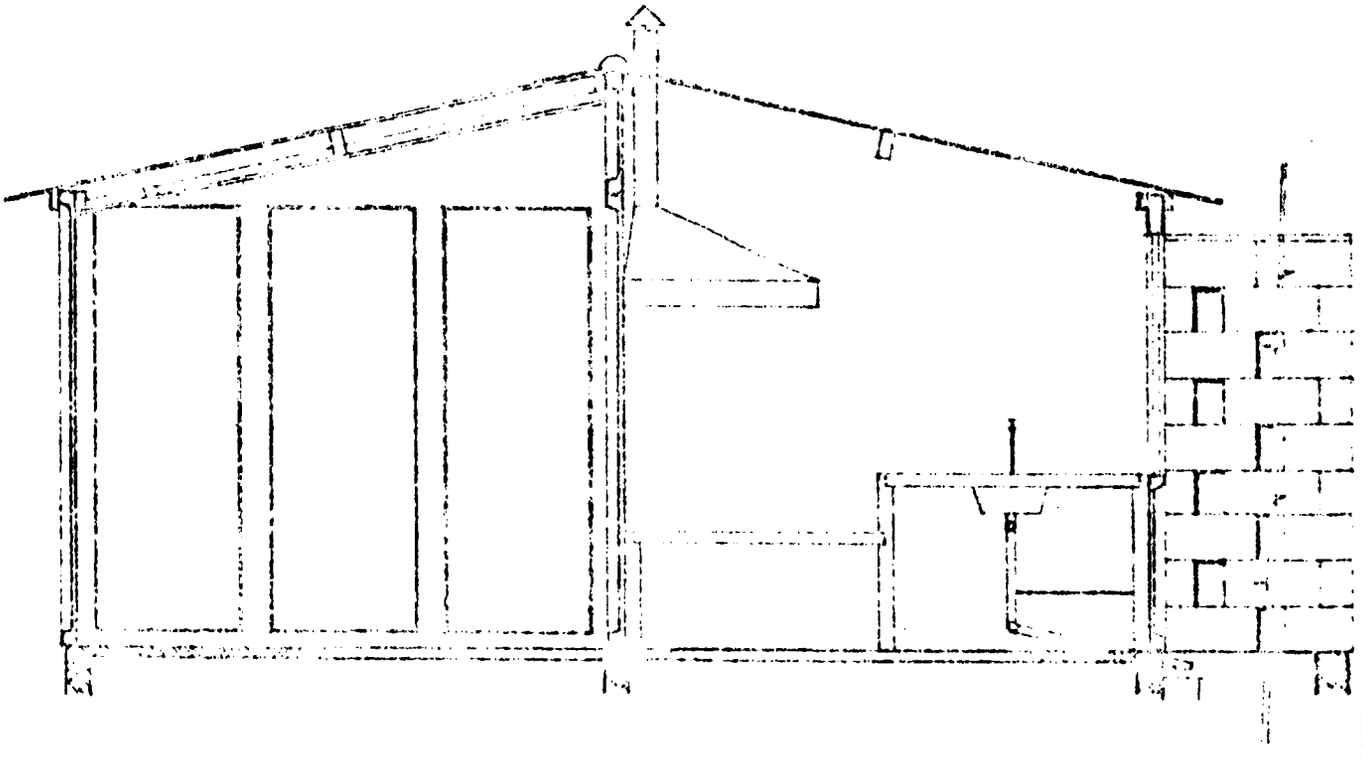


DOUBLE STOREY TYPE GROUND FLOOR PLAN

EXPERIMENTAL PRECAST CONC. HOUSING – KENYA

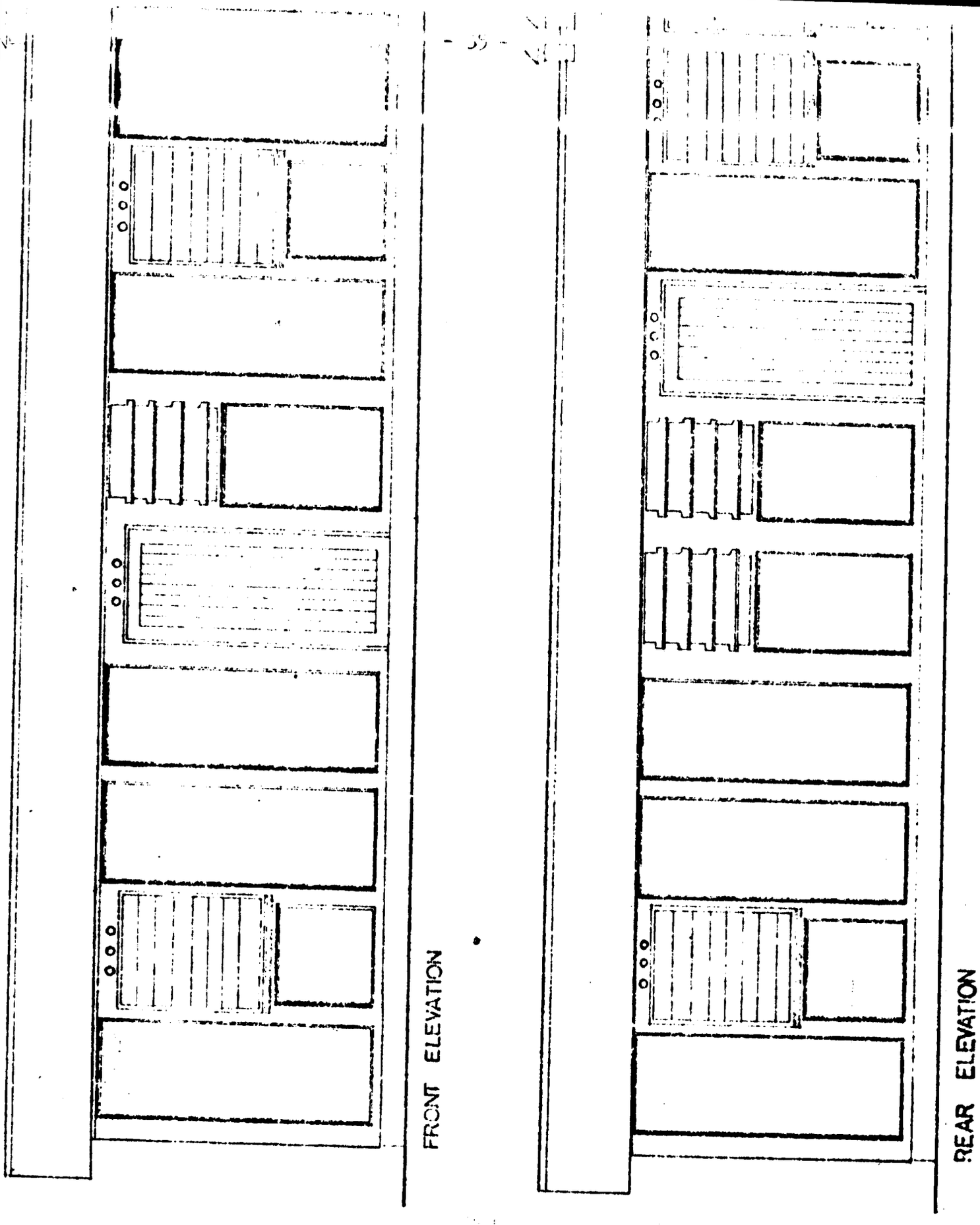
scale 1:40





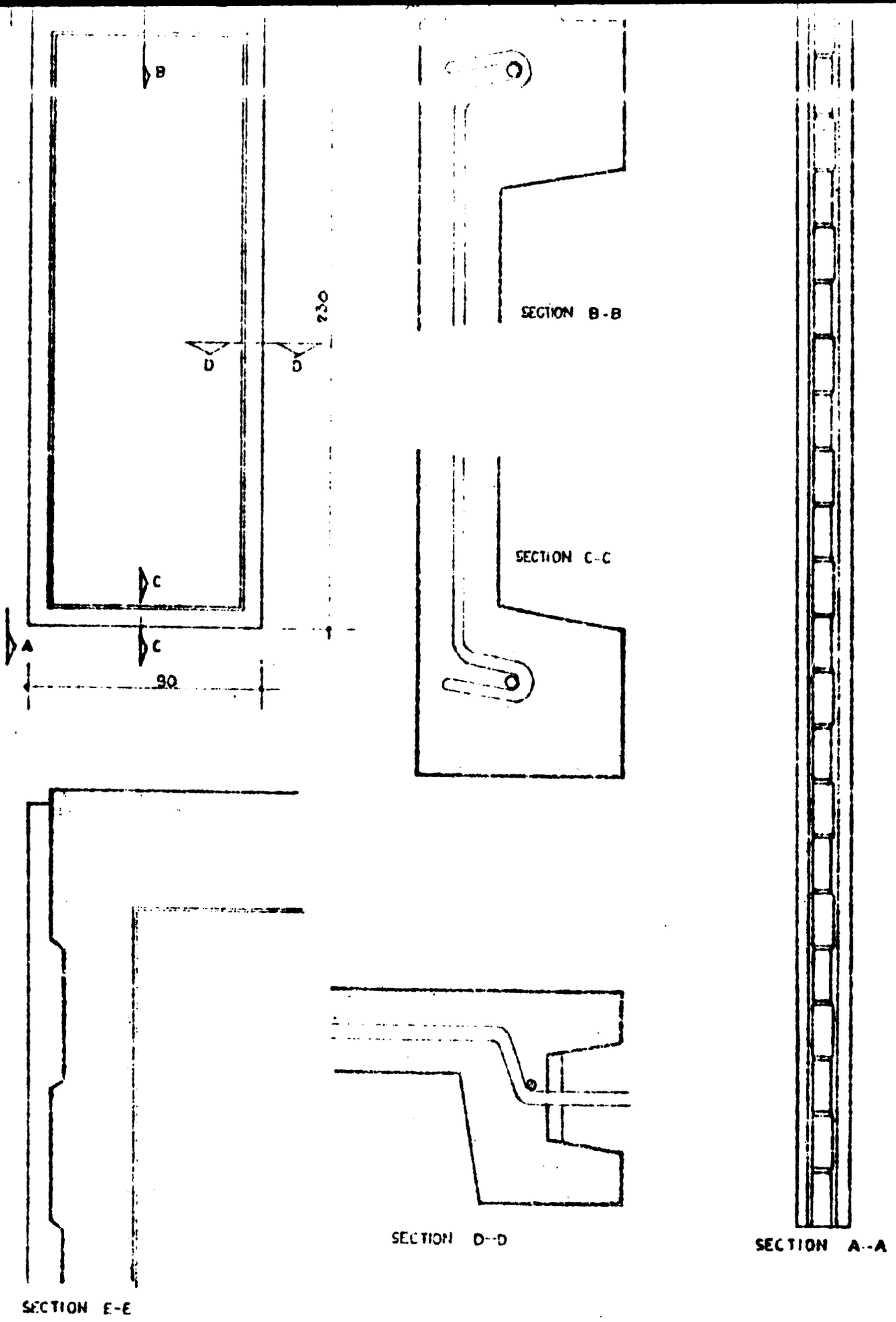
EXPERIMENTAL PRECAST CONC. HOUSING - KENYA

scale 1:40



EXPERIMENTAL PRECAST CONC. HOUSING — KENYA

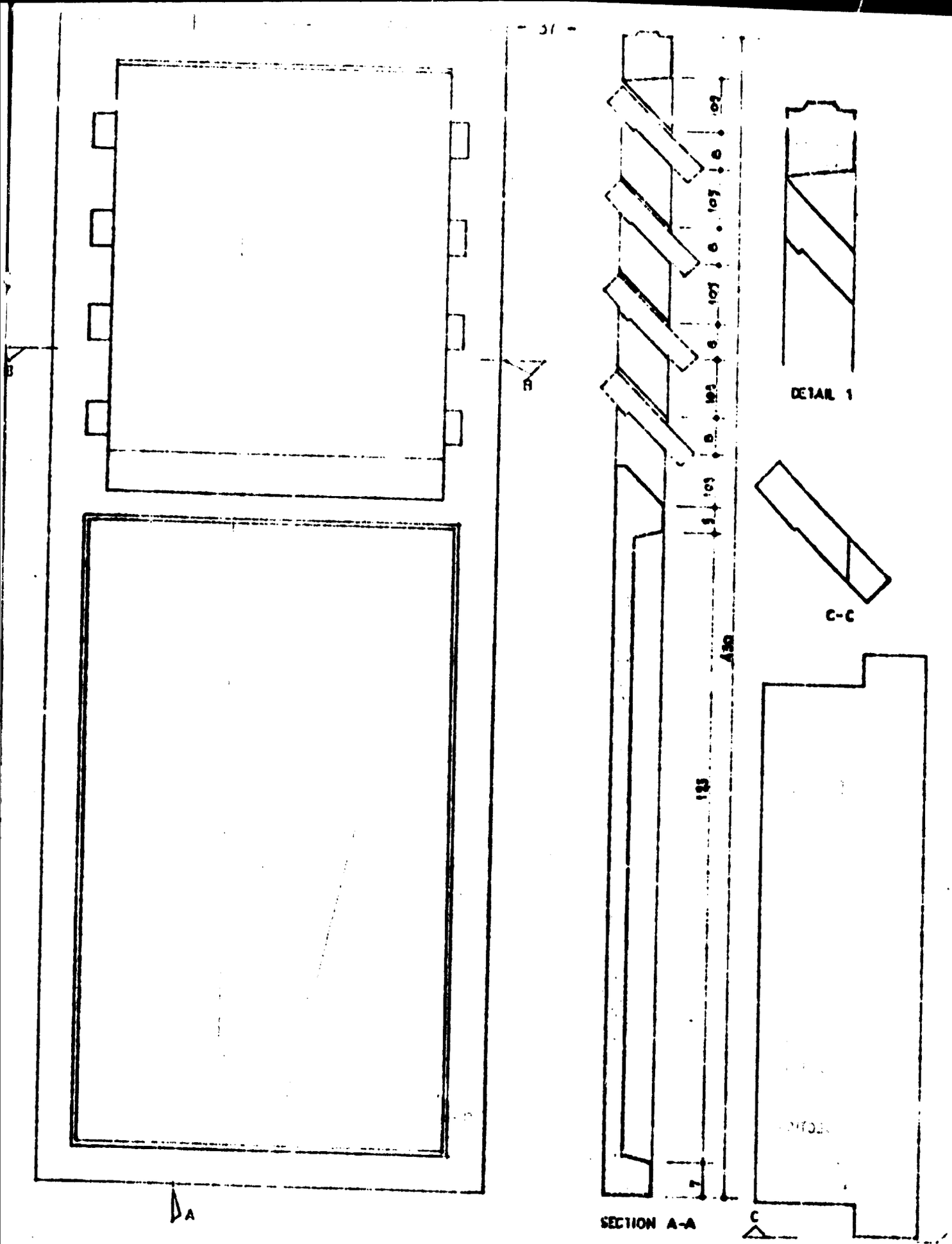
scale 1 : 40



EXPERIMENTAL PRECAST CONC. HOUSING – KENYA

Details of joints

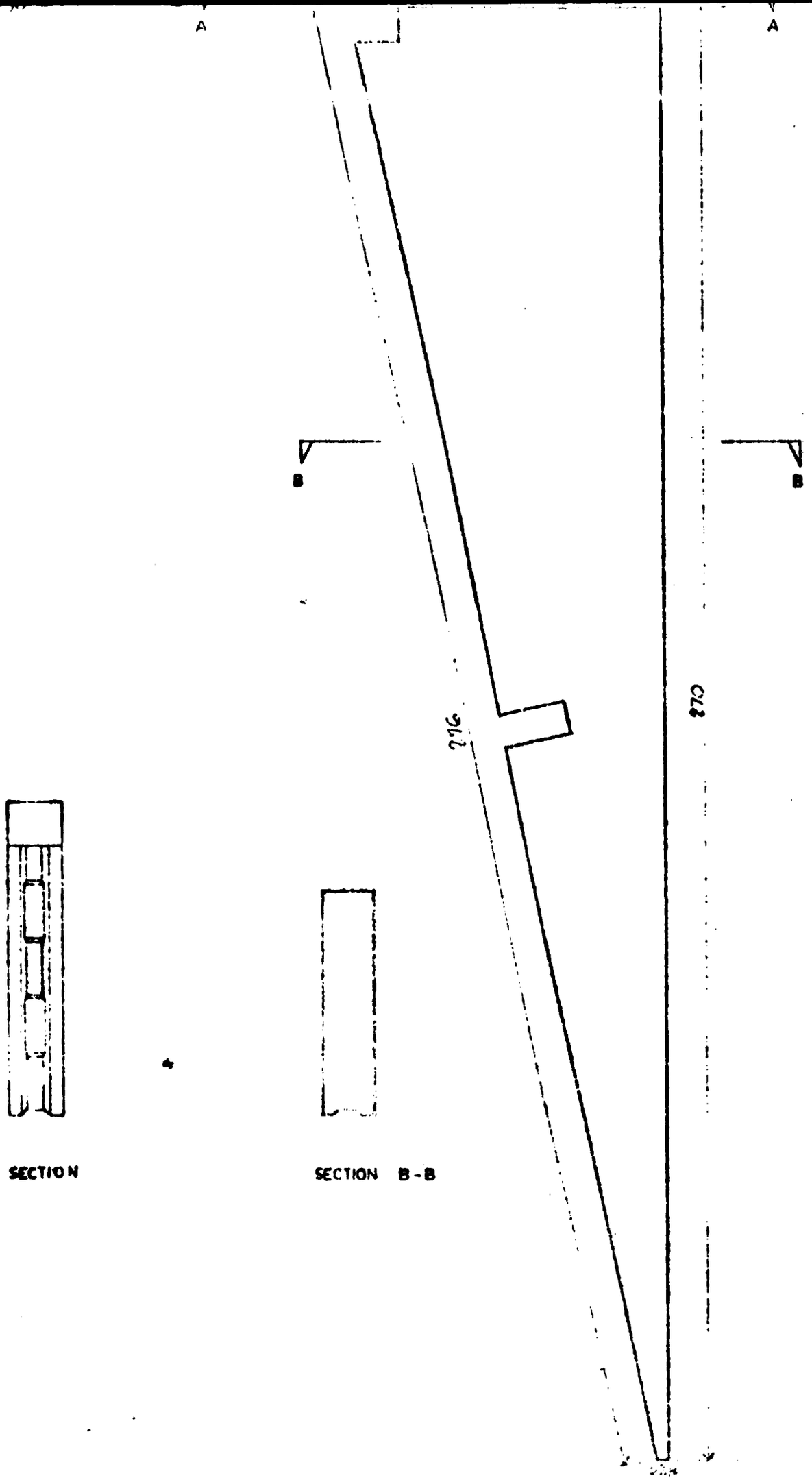
scale 1:20 1:10 1:25 & 1:4



EXPERIMENTAL PRECAST CONC. HOUSING – KENYA

Ventilation Element

scale 1:10 & 1:25

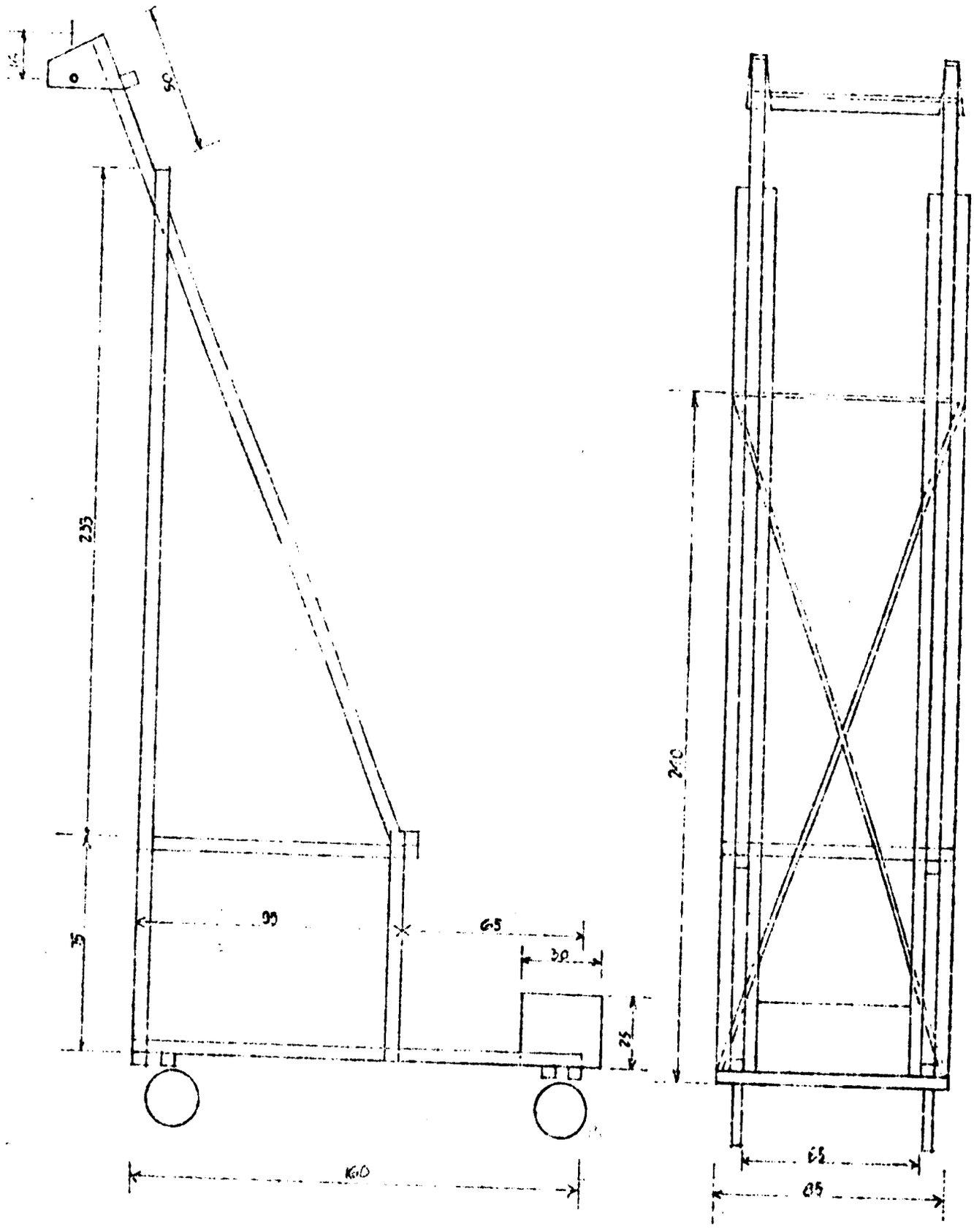


SECTION

SECTION B-B

EXPERIMENTAL PRECAST CONC. HOUSING – KENYA

Scale 1:10



CRANE

EXPERIMENTAL PRECAST CONC. HOUSING – KENYA

Erection equipment

scale 1:20

(iii) Use of the elements

(a) Wall element

Size 90 x 230 cm and weighs 245kg.

Designed with toothing in a groove to help joint withstand shear force and projecting bars to take tensile stress.

(b) Ventilation element

This is an alternative to a window and will replace wall element in W.C.'s, shower and store. It is more difficult to cast but yet has a saving as compared to a window. The louvre blades are cast separately.

(c) Cill element and lintol

Size 90 x 90cm and weighs 108kg. Cill together with lintol will be made to suit height of wall element and standard louvre windows.

(d) Ridge element

Dimensions 180 x 60 cm and weighs 144kg or 90 x 60cm weighing 72kg.

This is not a standard unit and unlike other elements is solid to make a simpler mould. Hoop iron is cast into the element to provide fixing for timber purlins to receive corrugated iron sheet roofing or asbestos.

(e) Erection

Special equipment is needed for holding the elements in position as the mortar sets and for lifting.

(g) Costs

Element Works

	Khs
Wall element	34.30
Ventilation element	40.10
Cill element	15.20
Lintol element	7.90
Gable element	31.30
Ridge element	31.50
Floor slab element	37.70

Note: Allow for breakages.

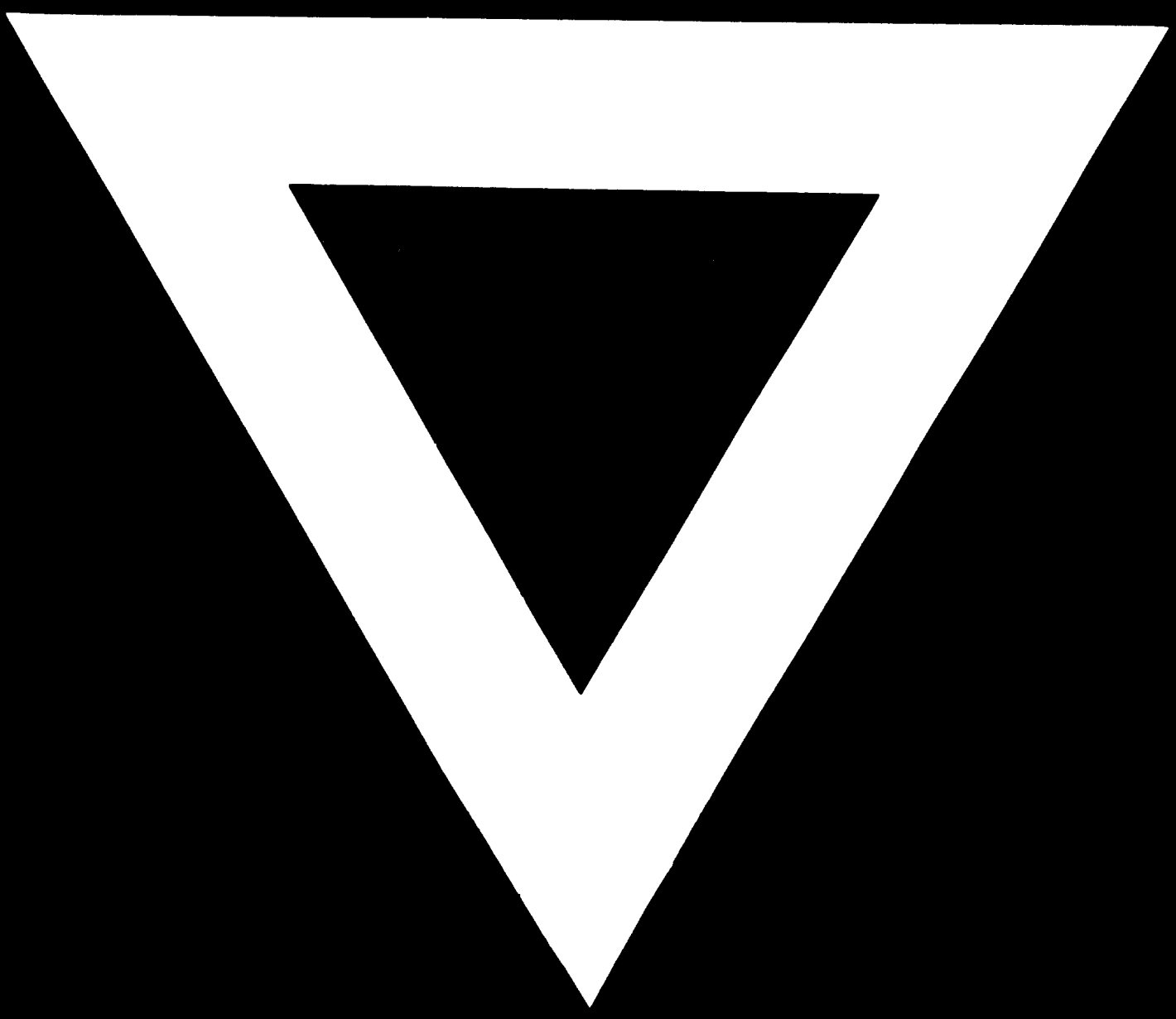
Total labour wages for erecting one unit per day Khs175/65.

Cost Analysis Of A completed test house single-storey

Foundation (Black Cotton Soil)		6,000.00
Superstructure		15,000.00
Total Cost (2 units)	Khs.	21,000.00
Cost per unit	Khs.	10,500.00
Cost of honeycomb walling to courtyards	Khs.	500.00
Total Cost	Khs.	11,000.00

KC550

Two storey house cost per unit £730.



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