OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

D03377

Distr.
LIMITED

ID/WG.122/8
25 February 1972

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Seminar on Prefabrication in
Africa and the Middle East

17 - 29 April 1972

Bucharest, Romania and Budapest, Hungary

STATUS AND PROBLEMS OF PREFABRICATION IN AFRICA

presented by

The United Nations
Economic Commission for Africa

id.72-1688

TABLE OF CONTENTS

Traditional Building

1. Traditional building in Africa and elsewhere have had the following characteristics:-

1. Each head of family was his own builder; he has built by the use of methods and techniques which he learned by apprenticeship from his ancestors. The whole society knew the same techniques and where needed, members of the Society came to the aid of the owner to construct the required building. Thus traditional building was executed by self-help and co-operative methods.

2. Local materials were extensively used. Most of the buildings were put up in materials assembled in the immediate locality with minimum processing.

3. Most of the buildings in any locality were put up by the use of the same or similar structural systems: these systems might be supposed to have been the ones found most suitable in practice over the years.

4. Examination of the environment showed a remarkable degree of standardization of architectural forms, sizes, and openings within the same geographical or tribal region. In spite of this neither drabness nor monotony was in evidence.

5. The evolution of the built-up environment traditionally has not been spear-headed by specialists. This evolution developed spontaneously from the experience in the use of forms and structures.

6. The built-up traditional environment fulfilled the basic functions of shelter security and privacy without monotony and the so-called unpleasant effects of the standardised construction of the environment.

Rationalised methods of housing

2. Increasing urbanization as well as the growth of specialised professions has resulted in the growth of a large number of specialized builders who satisfy the demand for housing and building generally. The traditional systems have broken down and been replaced by systems developed by these specialist builders. Thus it is common in many modern societies to notice as many building systems as there are specialist builders. This situation has created a very fragmented building industry in which there is such a large number of products, components, and producers that it has proved difficult to meet the growing demand for buildings without rationalisation. The first steps at rationalization has been to support manual effort by means of mechanization. Within the systems operating in the building industry

mechanization could achieve only a limited increase in efficiency. The next step in this process of mechanization would naturally be industrialization. The justification for increasing productivity by means of mechanization and industrialization are clearly seen in the graphs shown in Figure A. In order to industrialize building the following conditions would be necessary:-

1. The establishment of building regulations which should establish uniformity in structure and function across the territory as appropriate.

2. The formulation of regulations which while emphasizing standardization, have functional adequacy as the primary purpose.

3. The promotion of industrialized production of building components.

4. The use of dimensional and modular co-ordination in the design of buildings.

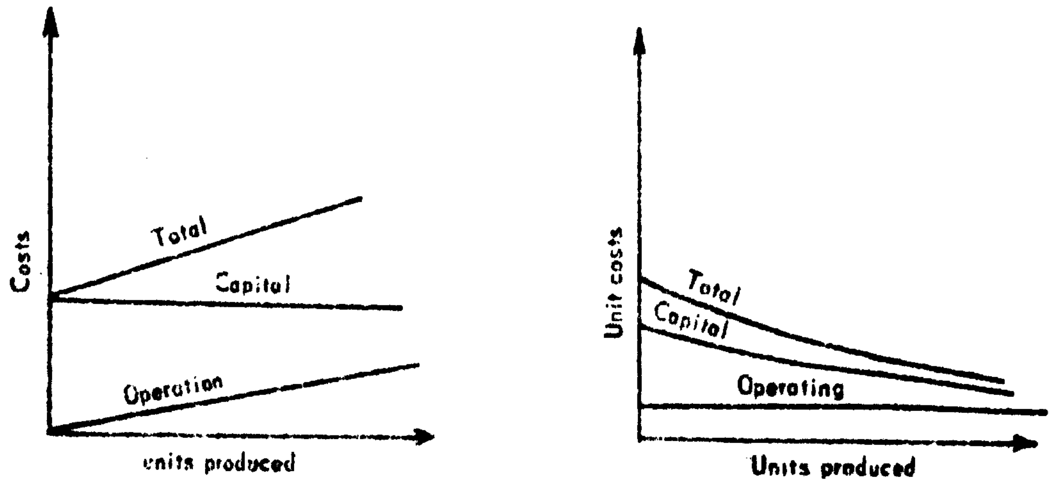
5. The drawing up of long-term plans which would create the appropriate markets which would justify the necessarily heavy investments in machinery for prefabrication.

Prefabrication in Africa

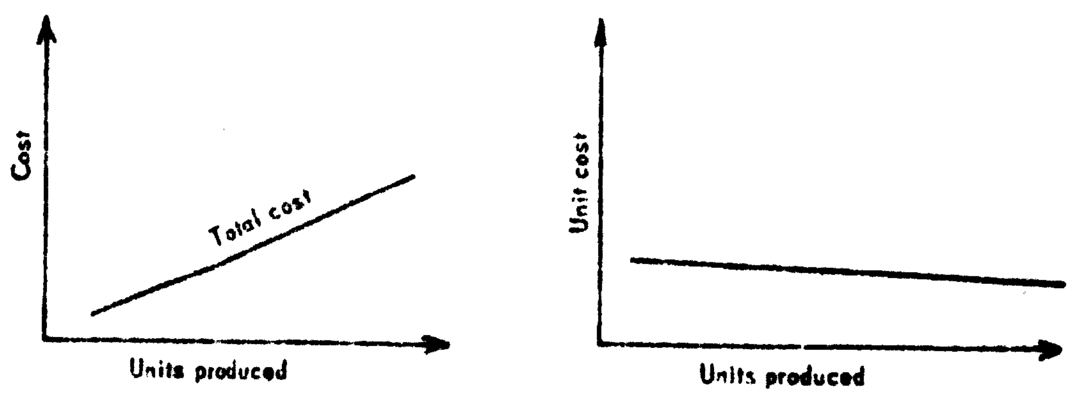
3. As seen above the demand for housing and building has increased with urbanization and industrialization. In an attempt to satisfy these demands, certain African countries have started to set up prefabricated housing/building plants which have not proved successful mainly because the investments in prefabrication plant have not been matched by the appropriate advance planning which would create a steady demand for the buildings from the prefabricating plants. The second reason for the partial failure of prefabrication in Africa is the current prejudice against prefabricated systems. Some of these prejudices are justified on the grounds that the standard of construction of prefabricated building has been lower than traditional building while the reverse should have been true since the quality of prefabricated building is expected to be higher because it is easier to control quality in the factory than on site. The third reason for the failure of prefabricated housing has been the use of machinery and technology which was unjustified given the conditions of manpower, materials, and know-how in Africa. The fourth reason is that in many cases, there was insufficient examination of the feasibility of the system adopted.

4. In order to create the appropriate technology for a given environment it would be necessary to examine the components of the prefabricating technology as shown in Figure B.

Fig. A THE RATIONALE FOR MECHANISED BUILDING



(i) Machine Cost Function



(ii) Manpower cost functions

(a) Machine cost and Manpower cost functions

(b) Comparison of Machine and Manpower cost functions

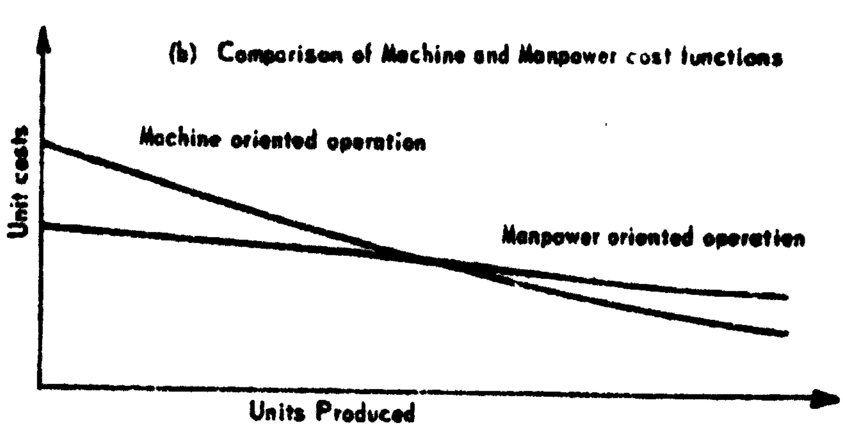
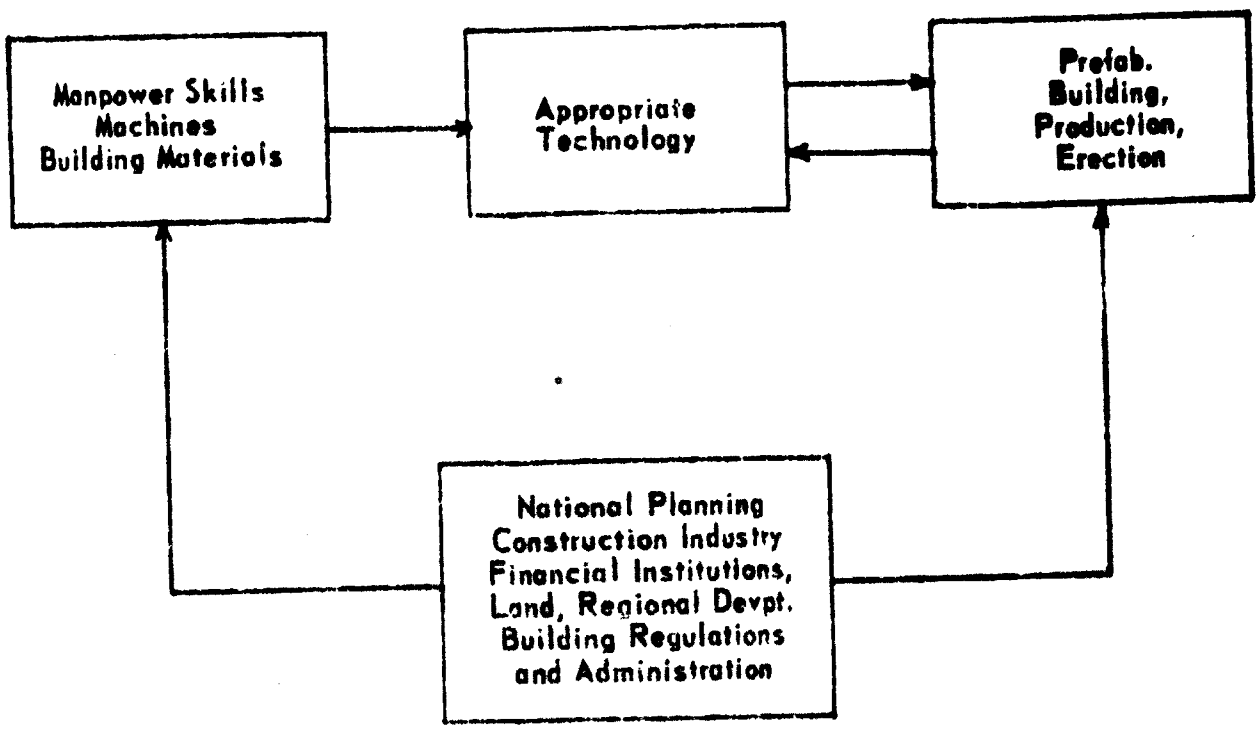


Figure B. THE PREFABRICATION CYCLE



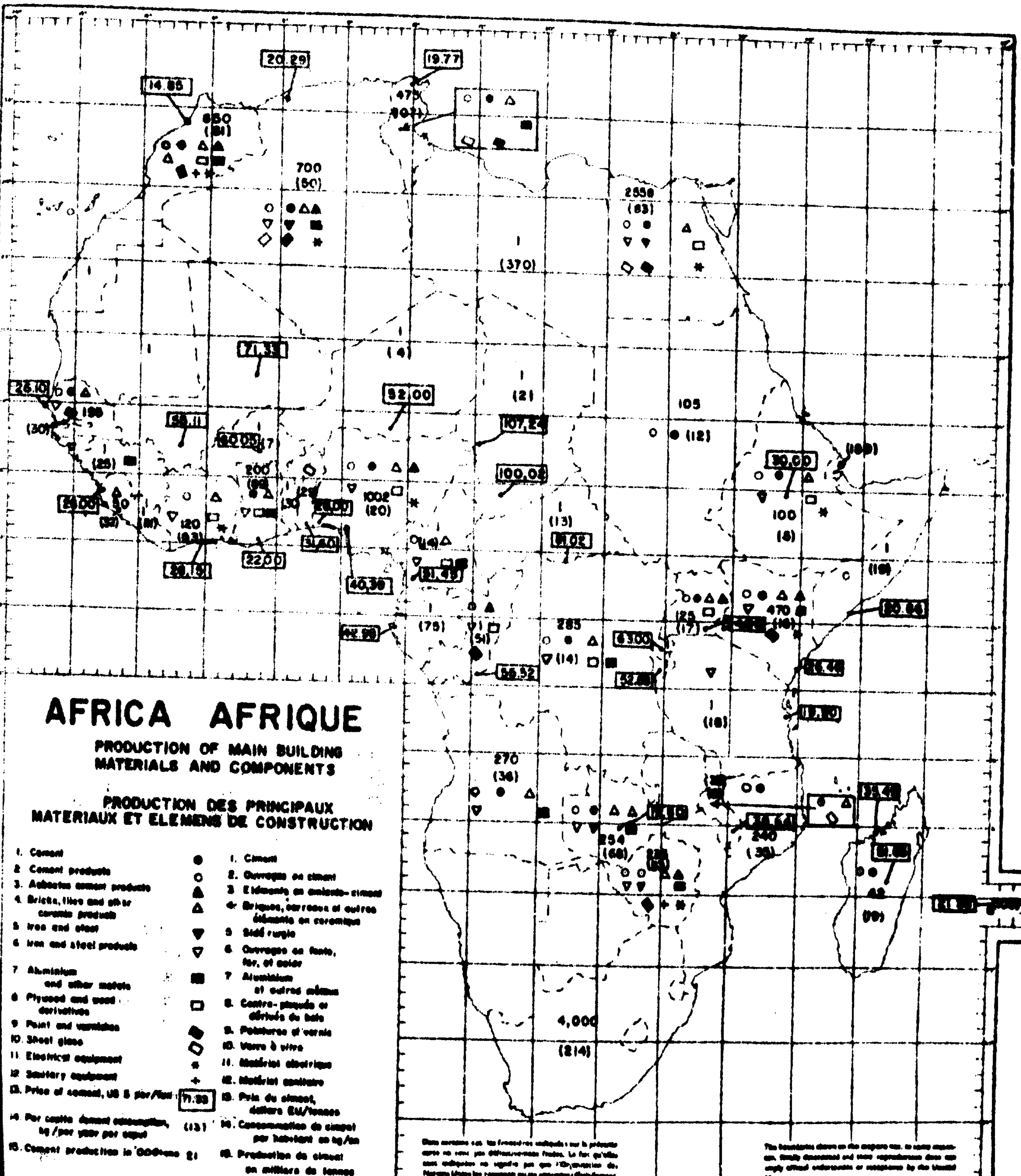

AFRICA AFRIQUE
PRODUCTION OF MAIN BUILDING MATERIALS AND COMPONENTS
PRODUCTION DES PRINCIPAUX MATERIAUX ET ELEMENS DE CONSTRUCTION
1. Cement
2. Cement products
3. Asbestos cement products
4. Bricks, tiles and other ceramic products
5. Iron and steel
6. Iron and steel products
7. Aluminium and other metals
8. Plywood and wood derivatives
9. Paint and varnishes
10. Sheet glass
11. Electrical equipment
12. Sanitary equipment
13. Price of cement, US $ per/ton
14. Per capita cement consumption, kg/per year per caput
15. Cement production in '000 tons
1. Ciment
2. Ouvrages en ciment
4. Briques, carreaux et autres éléments en ceramique
9. Peintures et vernis
10. Verre à vitre
13. Prix du ciment, dollars EU/tonnes
14. Consommation de ciment par habitant en kg/an
15. Production de ciment en milliers de tonnes

FIG. 6

5. For the African environment the development of the appropriate technology should take account of the following:-

(i) An abundance of manpower which is relatively expensive;
(ii) The lack of skills;
(iii The availability of simple machines;
(iv) The relative scarcity of capital associated with the lack of appropriate financial institutions for long-term capital finance and mortgage;
(v) A development planning machinery which does not take full account of the economic importance of the building industry;
(vi) National building regulations which at the moment do not take account of prefabrication in formulating regulations;
(vii) The existence of prejudices against prefabrication;
(viii) The general lack of process industries for improving local building materials.

6. When all these factors are taken into account it would appear that, for the time being, the first steps towards prefabrication in Africa would have the following characteristics:

1. The basic prefabricating elements should either be craft-fabricated or fabricated with the help of simple machines.
2. These elements should be light enough to be handled by a minimum of two but no more than four workers.
3. The assembly of the elements should be done by the help of simple machinery such as pulleys or non-mechanized cranes.
4. The first designs for all prefabricated houses should be such as to acquaint householders with the new methods. This would create an atmosphere in which there is no shock rejection of prefabricated systems thus the initial steps for prefabrication should be half traditional, half mechanized. This would also give the industry the opportunity to adjust itself to the new methods and the market.

7. Certain countries which have adopted prefabrication do insist on a minimum planning cycle of five years for the factory. A transition cycle of at least the same order in Africa would be recommended, since it would take a long time to get the new production method fully established, and sufficiently proved to be regulated upon. The agencies which administer building and housing should realise that for the benefit of the society, 'test buildings' should be permitted. The results of these tests go into the final building regulations.

8. In the development of this type of technology it may be necessary to incorporate in local building regulations the structural systems and sizes of prefabricated components that would be suitable in any given place at any time; these regulations should be subject to regular assessment and review as conditions change. So far no such organized system has evolved in Africa.

Standardization and modular co-ordination

9. The current view that prefabricated housing is uninteresting because it is based on the standardized use of components and space is not true. The classical architecture of ancient Greece and Rome were based on standard modules, components, and structural systems; this architecture is very interesting. The insistence on standardization and modular co-ordination in building would create manufacturing industries for building components which would produce in large quantities to reduce costs. The advantages of modular co-ordination in building are two well-known to be repeated here: if components were assembled in mass and of standard dimensions consistent with function then it is easy to increase the housing stock by use of self-help and co-operative methods. The optimal use of local building materials resources would naturally demand the use of standardization and modular co-ordination in such a way that components are easily assembled without any specialised training, as happens in the motorcar and aircraft industries. Thus the quality of the end-product would be less dependent on the skills employed on site but more on the process used in the factory. Given the broad basis of standardization and modular co-ordination, systems could be developed which correspond with geographic and climatic zones. The following paragraphs are brief summaries of the situation of prefabricated housing/building in Africa. This broad survey of selected countries contains examples to illustrate what is happening in various countries. The countries have been selected to highlight the progress of development.

10. The prefabricated housing system developed by the Nairobi City Council is reported on in detail as one which could be developed and used on a larger scale, not only in Kenya but also in other countries. The system is recommended for its low-cost, flexibility and appropriate technology.

The role of Government

11. In support of the government agencies which formulate building regulations and control the execution of the built-up environment, governments should play a direct role in setting up the conditions which make the demand for prefabricated housing of such a magnitude that would justify not only continued investments in facilities for prefabricated housing but also in research and development which would produce more efficient prefabricated systems for housing and building. These conditions must be supported by appropriate financial arrangements whereby banks are encouraged to give loans for investment in building machinery as well as for mortgage on prefabricated buildings.

12. A central issue which arises when one considers prefabricated housing is the fact that when prefabrication is accepted as standard means of constructing the built up environment, the building industry would have to be reorganized in order to make the prefabrication system efficient. This reorganization would involve considerable initiative on the part of governments; thus a precondition for the initiation of prefabricated housing on any scale is the direct involvement of the central planning process which should have long-term plans for the use of the building elements from the prefabricating

plants. Experience in other places has shown that in some cases five years have been too short to make an impact on the building industry. The important thing, however, is that the length of the planning cycle for building and construction must adequately reflect the level of investment and the type of technology used in the system of prefabrication; thus the demand, investment, and the type of technology must be closely studied together and with these the policy issues for the housing and construction industry should be settled.

The role of institutions and individuals

13. Prefabricated building is particularly suitable for use by institutions which require large numbers of similar public buildings like offices, schools and hospitals. When the decision is taken to industrialise institutional buildings the reorganisation of the construction industries which these demands should not be lost site of. With increasing costs and the difficulty of an individual client co-ordinating the various professions which come together to build, the use of prefabrication to make standard elements which could be easily assembled by the individual using unskilled labour must seriously be considered. The only condition for this is that the material used is acceptable to the individuals concerned. The advantages of such a method of building are quite obvious since all services could easily be incorporated into the prefabricating system and all the builder had to do would be to assemble the house using the kit from the factory.

Materials available

14. The accompanying map - Figure C - shows the distribution of the production facilities of the main building materials in Africa; of these cement is the most prominent and its use is concentrated mainly in the urban areas which house about 15 per cent of the population of the continent. The rest of building on the continent is in vegetable materials or a combination of vegetable materials and clay. It is conceivable that with the economic organization of rural societies the techniques of rural construction could be rationalized either by a certain degree of mechanization or even by the use of simple systems which depend on light prefabricated elements. Experience in Africa over the past decade has shown that neither the local production of building materials such as cement, asbestos, brick, tiles, iron and steel, aluminium, etc. nor prefabrication has had any significant effects on the cost of building. This situation is due to poor organisation, inappropriate marketing arrangements for building materials, inadequate background study before the establishment of the industries, etc. The materials and techniques available thus lie beyond the means of those who most need them. There is thus a clear need to reorganise the building industry to take into account the basic needs of the local people before the technology is decided upon. For, clearly, unless this is done, the present deteriorating condition of the building and construction industry is bound to aggravate.

15. One basic building material which has not been exploited the way it might have been is lime. The use of lime or lime derived products for building has not been given the attention it deserves. Since lime is cheaper than cement it could be used as a basis for developing simple systems for use in the rural areas. These systems could be based on traditional techniques like the timber-frame-clay-infill building, stabilized interlocking lime clay products, lime stabilized clay products for lining canals, etc. It is clear from the above that prefabrication should not be in cement-based materials only: there is as yet a broad field which is unexplored. This field should cover timber, clay, and lime if the products of prefabrication should meet the basic needs of the majority of the African population. In this respect research agencies and building centres are invited to explore the possibilities of using these traditional building materials as basis for prefabricating building elements.

Review of prefabrication in selected countries

GABON

16. The main medium of prefabrication in Gabon is timber. Prefabrication is done for housing, classrooms and other meeting halls. Before 1966 the buildings were completely in timber. After 1966 however the buildings have been of composite construction being in concrete and timber. The prefabricated housing construction is done mainly by a subsidiary of the French Railway Company in Libreville. The statistics of production are as follows:

Year	Built up area (meter square)	Total turn-over
Before 1968	4,000	
1968	4,000	100 million CFA francs
1969	5,000	150 ——"——
1970	6,000	200 ——"——

In 1970 out of a total of 6,000 meter sq. of prefabricated timber construction 3,000 m.sq. were in housing alone.

17. The prefabricated timber housing in Gabon is designed to last about twenty years and so the treatment of the timber is carried out with this in mind. Experience shows, however, that the houses do last longer than twenty years.

18. The cost of construction of composite prefabricated housing is about 30,000 CFA francs per meter square. Outside Libreville, however, the costs are higher and the prices of prefabricated timber housing are no more competitive with those in bricks blocks erected by traditional methods.

19. The floor of prefabricated timber housing is generally in concrete but often in hard wood 'bilingo'. The external walls are generally (80 per cent) in "bibingo" (guibourti sp), iroko (chlorophora excelsa) is also used. The interior walls are adequately constructed in marine plywood which is grooved or slotted as appropriate.

20. The rest of the interior construction is done in less durable wood.

21. The main elements used in prefabrication is a standard panel measuring 0.92 meters wide and 2.56 meters high.

22. These panels are grooved for ease of attachment. When the buildings are demolished almost all the panels are recovered intact. Construction of a house by the use of prefabricated panels starts with the preparation of the foundation and floor slab in concrete and the erection of columns either in reinforced concrete or in timber. This usually takes three weeks. This is followed by the assembly of the prefabricated panels which for a house with 100 m.sq. covered area takes about three weeks. Finishing also takes fifteen days. Thus the minimum time one would require for the construction of prefabricated timber house is about two months.

23. The timber used in this construction is usually treated under pressure in a solution of xylophene for a period of twelve hours. Treatment against termite, and other vermin is usually not necessary since the hard woods are pre-selected and those used are the ones known to be resistant to termite and vermin attack. Exterior walls are protected by the use of appropriate paints and varnishes. The bathrooms, kitchens and all areas where water is used frequently are constructed either in stone or brick by traditional methods.

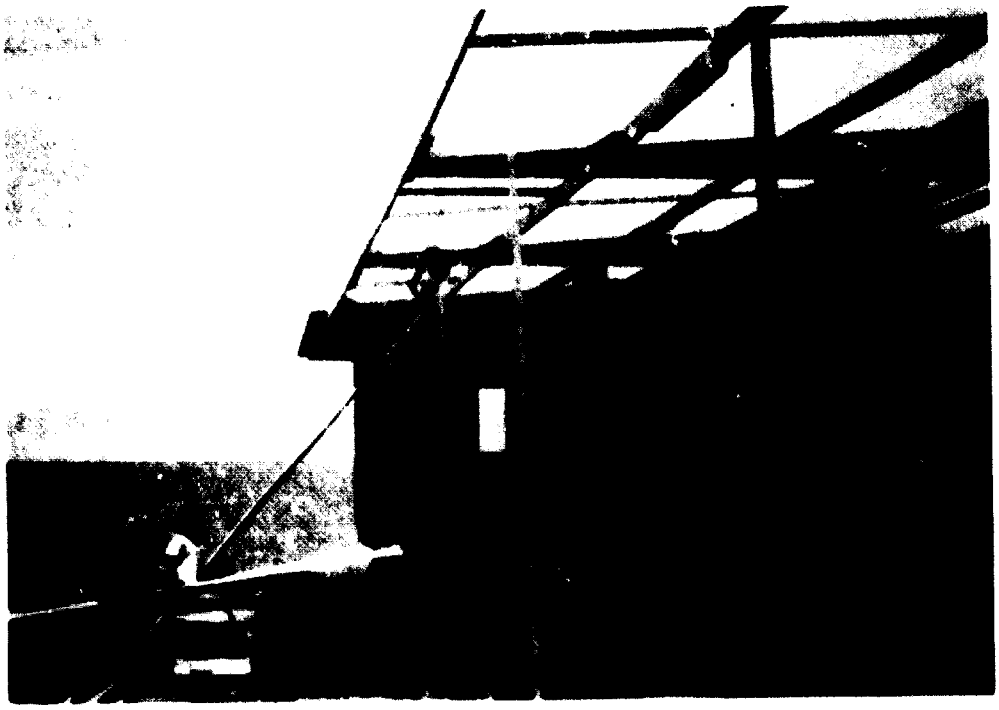
24. It is significant to note that most construction in Gabon before the colonial period was in timber. In the colonial period, however, certain prejudices have been built against timber in favour of cement block houses. The prejudice against timber housing is slowly diminishing with the use of composite construction methods employing both cement and timber elements according to their functions in place.

25. Because of the high humidity in Gabon household fires are infrequent; in addition, the timber used for housing is not flammable. Thus there is no need for treating the timber against fire.

26. The illustrations G1 to G6 show the various stages in the erection of a prefabricated timber house; from foundation platform to finished product. The plan of a typical prefabricated timber house in Gabon is shown in Fig.G6.

G1

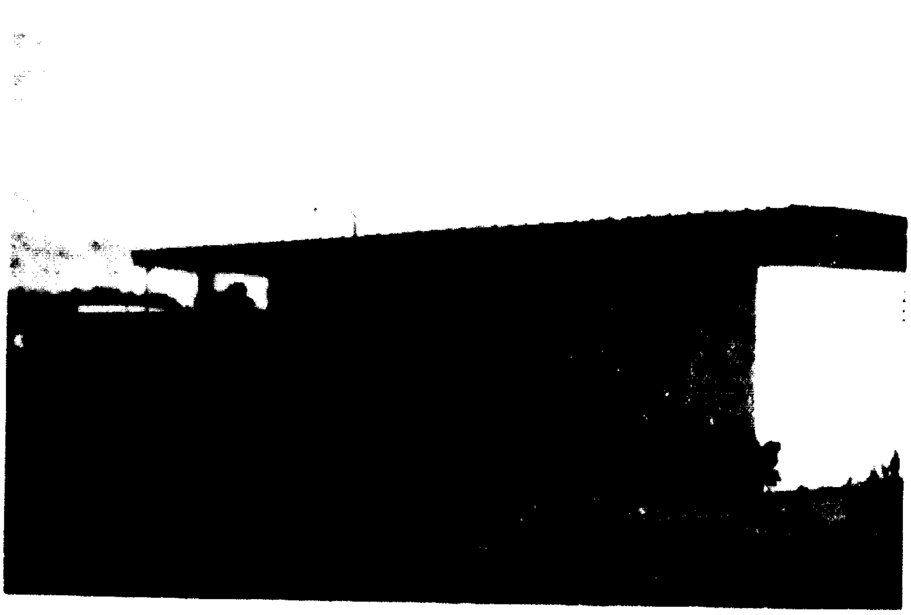
G2



G3

G4

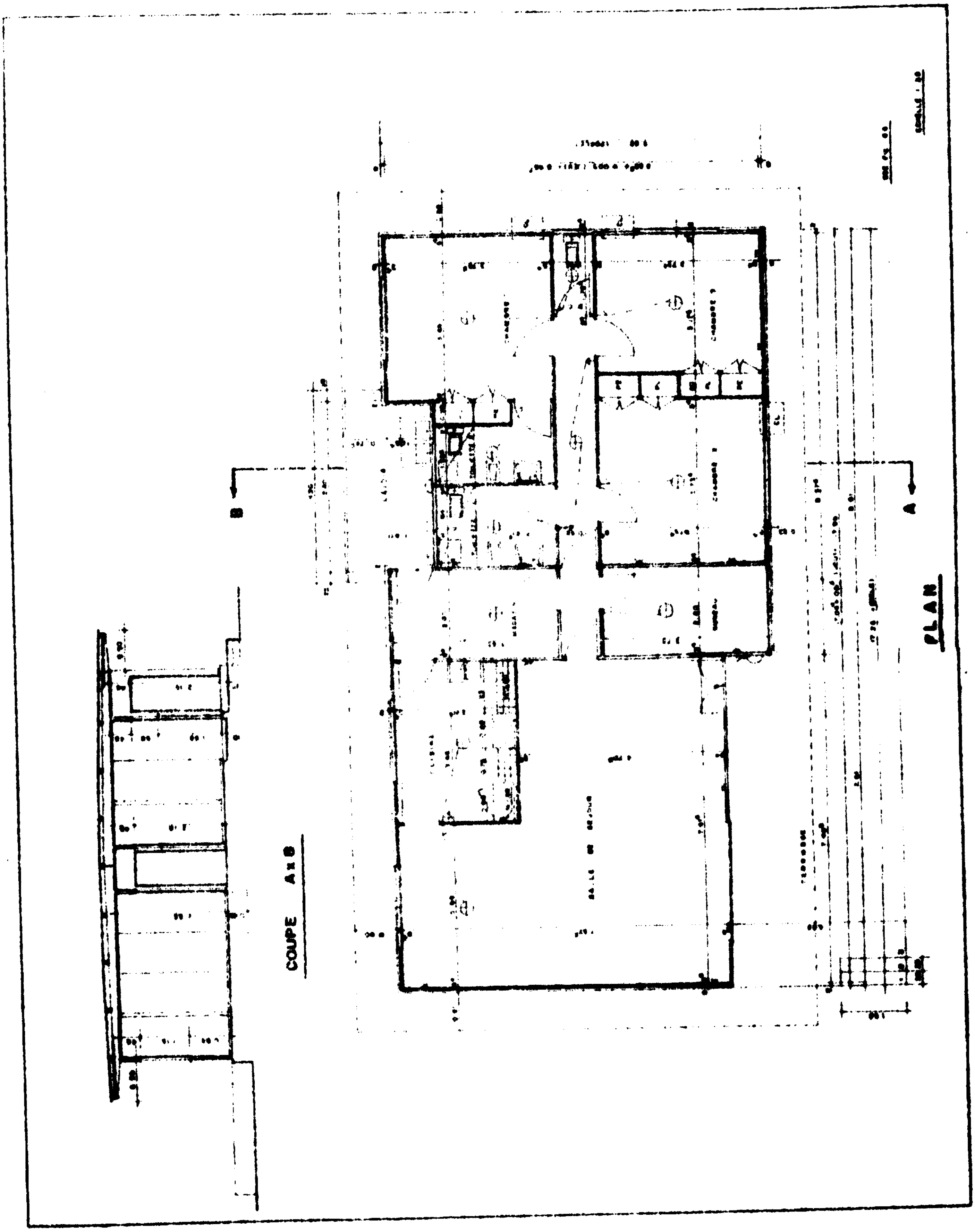
G5



G6

SEE PLAN AND ELEVATION (next page)

071-793


PLAN
COUPE A x B
A
B

GHANA

Cement and concrete products

27. In Ghana the predominant system of prefabrication is the system used by a construction company called African Concrete Products Ltd. This Company prefabricates elements, the maximum weight of which is 250 pounds (100 kgs.) such that any element could be carried and installed by two workers. The shapes and forms of these prefabricated element are also governed by this condition. This Company is able to install low-to- medium cost housing within two weeks. Their annual output in terms of housing, office or class-room units is about 200 a year. They also manufacture decorative concrete elements.

28. The other companies which operate in the prefabricating field manufacture heavy prefabricated prestressed elements for bigger structures. These are either floor beams for housing, main and secondary beams for bridges and other heavy prefabricated elements which are usually installed by the use of cranes.

29. In 1964-65 a factory for prefabricated housing using heavy elements was installed. This factory has a capacity of 2400 housing units a year. Each housing unit is about 80 sq.m. of three bedrooms, living/dining room, and the usual kitchen and toilet facilities.

30. The elements are designed in such a way that the walls and the ceilings for a single house are accommodated in 8 panels. Each of which weighs about 5 tons. For the transportation and assembly of these elements, cranes and motorized trolies are available. The cranes have a capacity of 12 tons and motorized trolies have a capacity of 30 tons. The range of the factory for such heavy elements is about 32 km. The continued production of the factory would depend on an established market of at least 2000/year units in the Accra/Tema area; given a total demand of about 4000, there is thus a ready market for the factory provided a policy decision is taken to use the factory.

Timber

31. There is an active market in prefabricated timber elements such as roof trusses, doors and windows. One notices a disappearance of carpenters sheds on building sites. There is, however, the need for standardisation of doors and windows as well as the control of the quality of timber used in their manufacture, by the use of proper seasoning techniques, etc.

32. There is a certain amount of prefabricated timber housing using ply-wood panels. This type of construction, though very suitable, has not yet gained public acceptance and the production of housing by use of plywood panels is still at the development stage.

Aluminium

33. The Flag Aluminium Company now fabricates arched aluminium elements for use as roofing in factories, these have a maximum span of 13 m. Since their use eliminates the need for roof trusses, these arched elements are becoming very popular in the construction of factories, classrooms, markets, and other structures of large spans.

KENYA

34. The use of prefabricated concrete in Kenya is mainly in the field of light weight concrete elements for housing. The Kenya example will be used in this paper for illustration purposes. The precast concrete housing system in Kenya is therefore reported in detail below:

35. Pre-fabricated construction was started on experimental basis in 1969. The intention was to develop a system of precast concrete elements which could be handled by manpower only, and by which it would be possible to construct various house types mainly in view of low cost housing. Figs. 1A to 1D show various possibilities for one and two storey houses.

Prefabrication

36. All the prefabrication of various elements is done in a precasting yard with a capacity of 50 elements per day. The layout of the yard is designed in a such a way that all the operations are carried out with minimum delay.

37. The main task in construction of moulds has been to build a mould, which can be produced without the need of special skill or equipment. This has been achieved by building the mould on a framework of cedar stiffened with angle irons (where the accuracy is of great importance). The top of the mould is line with galvanized iron sheets to facilitate easy removal of the mould and also to give the mould a longer lifespan.

38. Details of the moulds for wall, gable, cill and ridge elements are shown in Figs. 2A to 2D.

39. The mould, with reinforcement in position, is placed on the vibration table and then filled with concrete. When sufficient compaction has been achieved, the concrete is leveled-off and the mould is carried on a hand trolley to the store for green elements.

40. After two days the mould is removed and the element transfered to the curing yards. The hollow side of the element is filled with water to obtain good curing. Normally the elements take two to three weeks to cure.

Size and functional use of precast components

41. The prefabrication system consists of seven different element types: a wall element; a ventilation element, a cill element, a lintel element a gable element; a ridge element; and a floor slab element.

42. The dimensions of the element are determined by the following criteria:-

1. Each element has to weigh less than 250kg. The weight limit makes it possible for erection, casting and stacking to be done manually.
2. The element must fit a planning module. It therefore follows that all room dimensions should be a multiple of the planning module.

Wall and ventilation elements

43. The wall element is 90 x 230 cm. and weighs 245 kg. On each side of the element there is a groove designed with toothing to help the joint withstand shear forces. The element is reinforced with nominal reinforcement in both directions. The projecting ½" dia m.s. bars in the grove take up tensile stress and also provide fixing for frames.

44. The ventilation element replaces the wall element in w.cs. shower rooms and stores. It is more difficult to cast and therefore more expensive than the wall element. However it is an alternative to a window and it still means a saving.

45. The precast concrete louvreblades are fixed with grout after the element has been erected.

46. Both elements have two ½" dia.holes at the top which provide:

1. fixing for staybars during erection.
2. fixing for shuttering when casting ring beams.

Cill element and lintel element

47. The cill element weighs 108 kg. and its height is made to suit an eight blade TACAM loure window. Together with the lintel element they make the same height as the wall element.

48. The cill element has the same reinforcement and fixing facilities as the wall element.

49. The lintel element has 3 pieces of 2" asbestos pipe with mosquito net cast into it to provide through ventilation. It is used in external walls as well as internal walls over both windows and doors.

Gable element

50. The gable element is not really a standard element but should be designed individually for the house it has to fit.

51. Unlike other elements, the gable element is made solid. This results in a simpler and cheaper mould. Hoop irons are cast into the element to provide fixing for purlins'.

Ridge element

52. A ridge element, 270 cm. long, could be produced within the weight limit, but due to the fact that conduits have to be provided in walls without gable elements, it is found more convenient to work with small elements.

53. When placed on top of the wall element, the ridge element brings to the height of the partition wall to ridge level.

Floor slab element (used in two storey construction).

54. Floor slab elements are hollow reinforced concrete units, 278 cm. long each weighing 223kg.

55. The $\frac{1}{2}$ dia. bars in the slab are bent outside the end of the slab to provide fixing for the hand operated crane hooks and for obtaining a firmer joint. The sides of the slab are provided with toothing to make the joint withstand shear forces.

Erection

56. Special equipment is needed for holding the lements in position while the mortar sets, and for lifting the elements when they are to be placed above ground level.

57. The stay bar shown on Fig.4 is used where it is possible to drive a steel peg about 2.5m from the element. The staybar is bolted onto the element by means of the $\frac{1}{2}$" holes. A sliding joint is provided on the say bar to enable it to be adjusted when necessary.

58. Where it is not possible to fix a stay bar, angle iron beams are used to keep the elements in line.

59. On Fig.3 is shown a small crane used for erection of gables, ridges, floor slabs and wall elements on the first floor. The crane has a 6m. lift chain and can take loads up to 300 kg.

60. The erection gang collect the elements by hand and places in position for erection. If the element is to be erected on the foundation, a damp proof course is laid first and then the element is placed on $\frac{1}{2}$" dia. pipe pieces. The pipes facilitate positioning of the element. When the element has been correctly positioned, the pipe pieces are removed and the stay bar is fixed onto the element. If the element is for the first floor or it is a ridge or gable element it is brought to the final position by means of the crane.

61. The elements are joined by grouting the cavity between them. This cavity serves as room for services and therefore all pipes and plugs should be arranged to go where two elements meet.

62. The last operation is the casting of in situ columns. One of the basic ideas in the system is that a column is cast in situ where two (at corners) or more elements meet. Minor inaccuracies are taken up by the columns which also adds to the bracing of walls. When building multi-storey houses, the height of the rooms is adjusted to conform with the by-laws by casting a ring beam on top of the elements.

Capital costs

63. The capital cost of setting up the production facilities amount to approximately £7000. This covers the cost of:-

1. Approximately 2000m^2 of roofing.
2. A mixer and a vibration table.
3. Carpenters and bar bending workshops.
4. Power supply to the precasting yard.

Production costs

64. The production costs of individual elements can be estimated using unit volume costs of concrete, casting mould, plant and transport.

65. From cost analysis, the total cost of elements in walls is 7.9 Shs/Cu.ft. while the cost of floor slab elements comes to 7.40 Shs/Cu.ft. The floor slab elements are cheaper because they do not require any trowelling.

66. The cost of the elements works out as follows:-

Wall element	34.30	Shs.
Ventilation element	40.10	
Cill element	15.20	
Lintel element	7.90	
Gable element	31.30	
Ridge element	31.50	
Floor slab element	37.70	

Plus an allowance for breakages.

Erection costs

67. The following gangs are required to assemble all the elements in one unit per day.

			Shs. 1/
Erection gang	1 mason + 7 labourers	at	101.15 / day
Jointing gang	1 mason + 1 labourer	at	29.75 / day
Column gang	1 mason + 1 labourer	at	29.75 / day
1 Foreman		at	15.00 / day
Total daily wages			175.65 Shs.

68. The above gangs consisting of 3 masons and 10 labourers can erect 25 elements per day independent of element type involved. The cost of erecting on element would therefore be 7 Shs.

1/ Rate of exchange 1 K.shilling = 0.1428 US$.

Cost analysis of a completed test house (single storey)

Foundation	6,000 Shs.	(black cotton soils)
Superstructure	15,000	
Total cost (2 units)	21,000	
Cost per unit	10,500	
Cost of honeycomb walling per unit	500	

69. Total cost including honeycomb walling 11,000/- = £550. For a two storey house the cost per unit would amount to £730.

LIBYA

70. The general situation in Libya in the field of prefabrication may be presented as below:

> The first investigation into prefabrication in Libya started in 1966 when it became evident that the traditional building industry could not cope with increasing demands on housing in Libya. Under the sponsorship of the Ministry of Housing and Public Utilities both Government and private organisations studied prefabrication systems suitable for local conditions. These studies have so far resulted in the establishment of a privately sponsored system building factory in Tripoli.

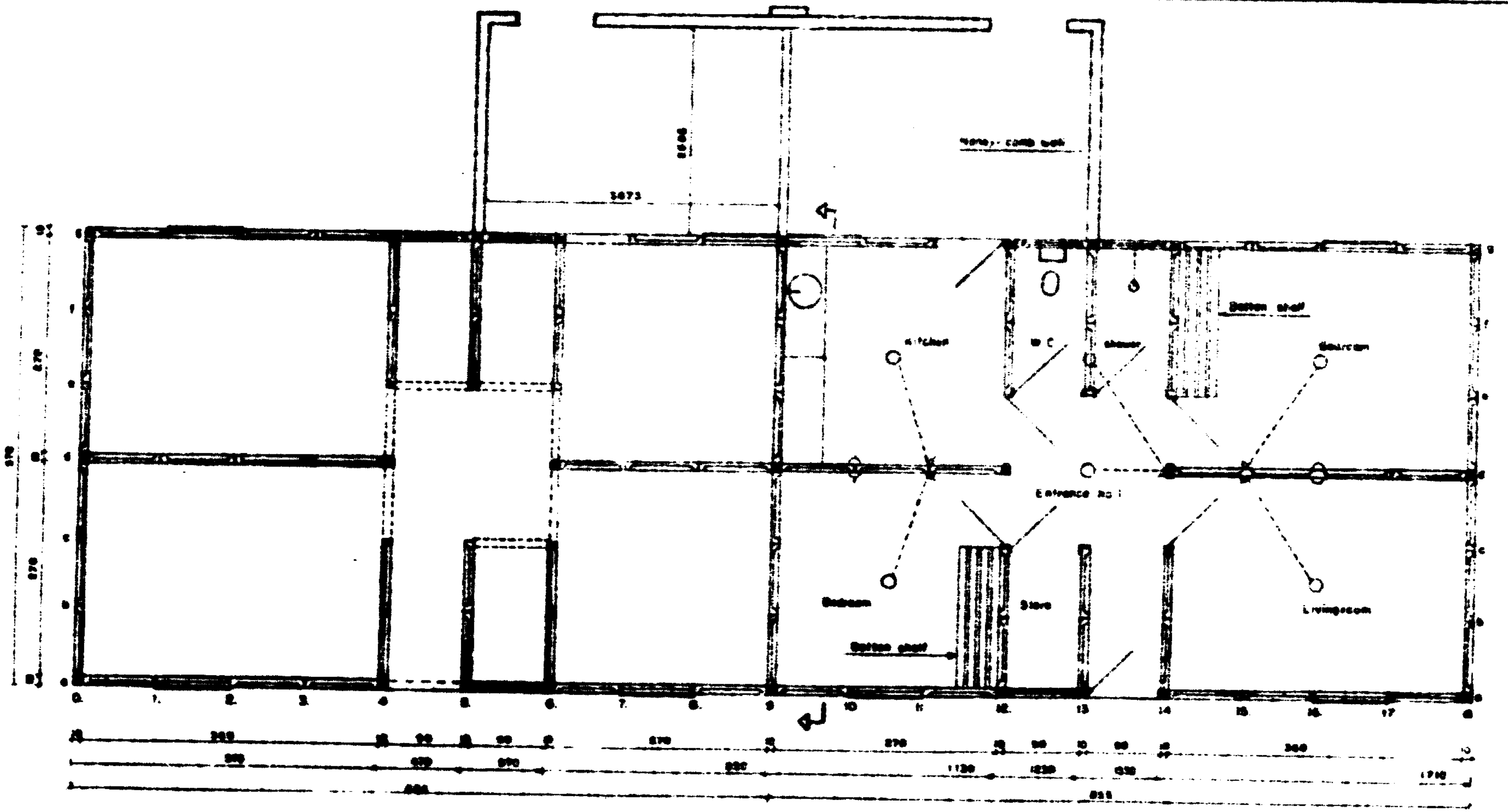
71. The increasing demands on housing have made the Government increase the tempo of industrialized building in Libya. In accordance with this new tendency the Ministry of Housing and Public Utilities has granted a contract for three hundred houses to be erected by the existing system building factory in order to test the cost efficiency and the general acceptability of the system. This system is based mainly on large precast panels of composite construction. The elements of which are made as follows:-

(a) Walls: each panel consists of a light weight concrete core surrounded by a heavy reinforced concrete frame and both surfaces are covered by a thin layer of reinforced concrete for protection; the light weight concrete gives the insulation and the reinforced concrete frame gives the required structural strength.

(b) Floors are made of heavy reinforced concrete panels.

(c) Roofs are made of precast, prestressed concrete T beams with cellular concrete infill blocks.

72. A number of large scale projects are planned at present to be built three well proved and up-to-date industrialized building systems. Each project will consist of about 5,000 housing units. The systems will be selected during this year. A number of smaller scale projects will also be introduced to test the value of some rationalized building systems in Libya. The programming of these projects will start within a short time.

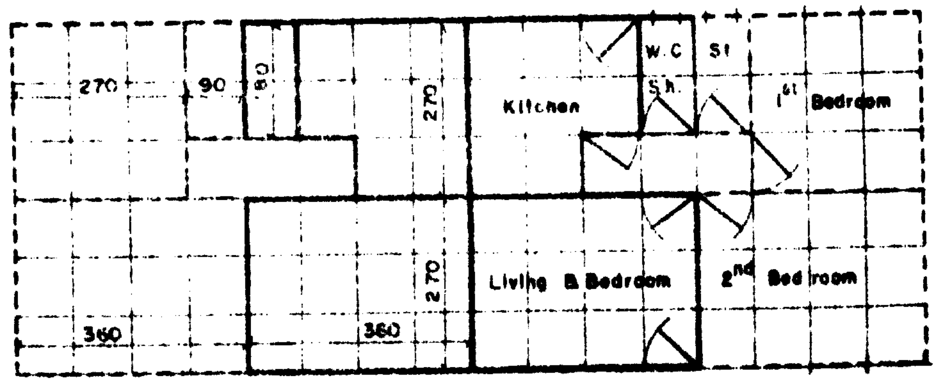


■ Cast in situ

All measurements are in cm.

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

Fig. 1 A



—— BASIC CONSTRUCTION: KITCHEN, LIVING & BEDROOM, W.C. & SHOWER.

- - - - FIRST EXTENSION : 1 BEDROOM, STORE.

- - - - SECOND EXTENSION : 2 BEDROOM,

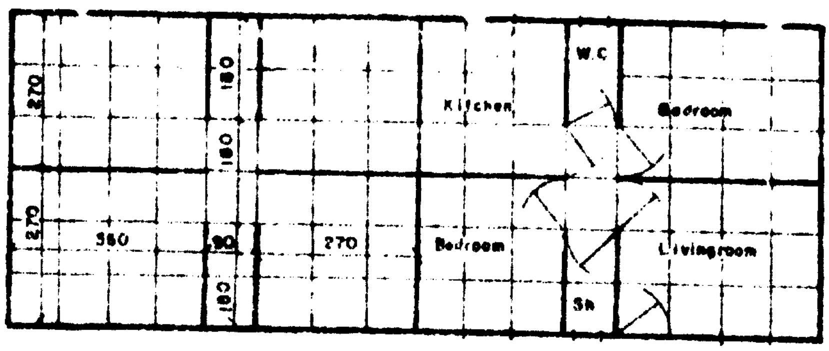
All measurements are in cm.

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

SCALE. 1:100

Fig. 1B

TYPE PLAN FOR SEMI-DETACHED HOUSE



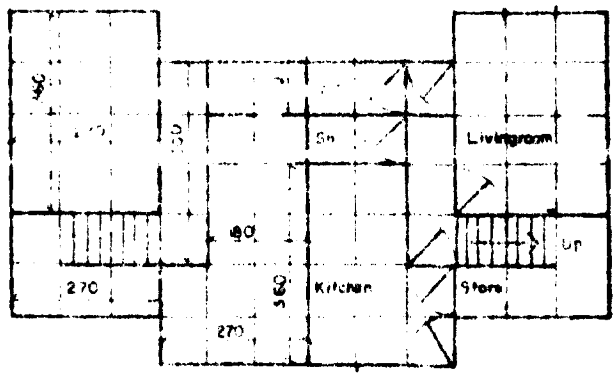
All measurements are in cm.

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

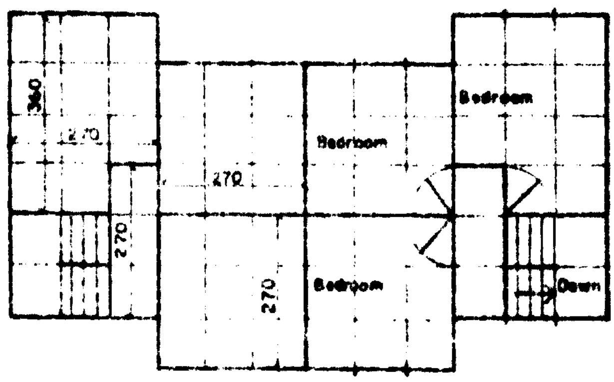
SCALE 1:100

Fig. 1 C

TYPE PLAN FOR SEMI-DETACHED HOUSE



FIRST FLOOR



GROUND FLOOR

EACH DWELLING OCCUPIES BOTH GROUND FLOOR AND FIRST FLOOR
FLOOR AREA PER DWELLING 82 m (889 sq.ft)

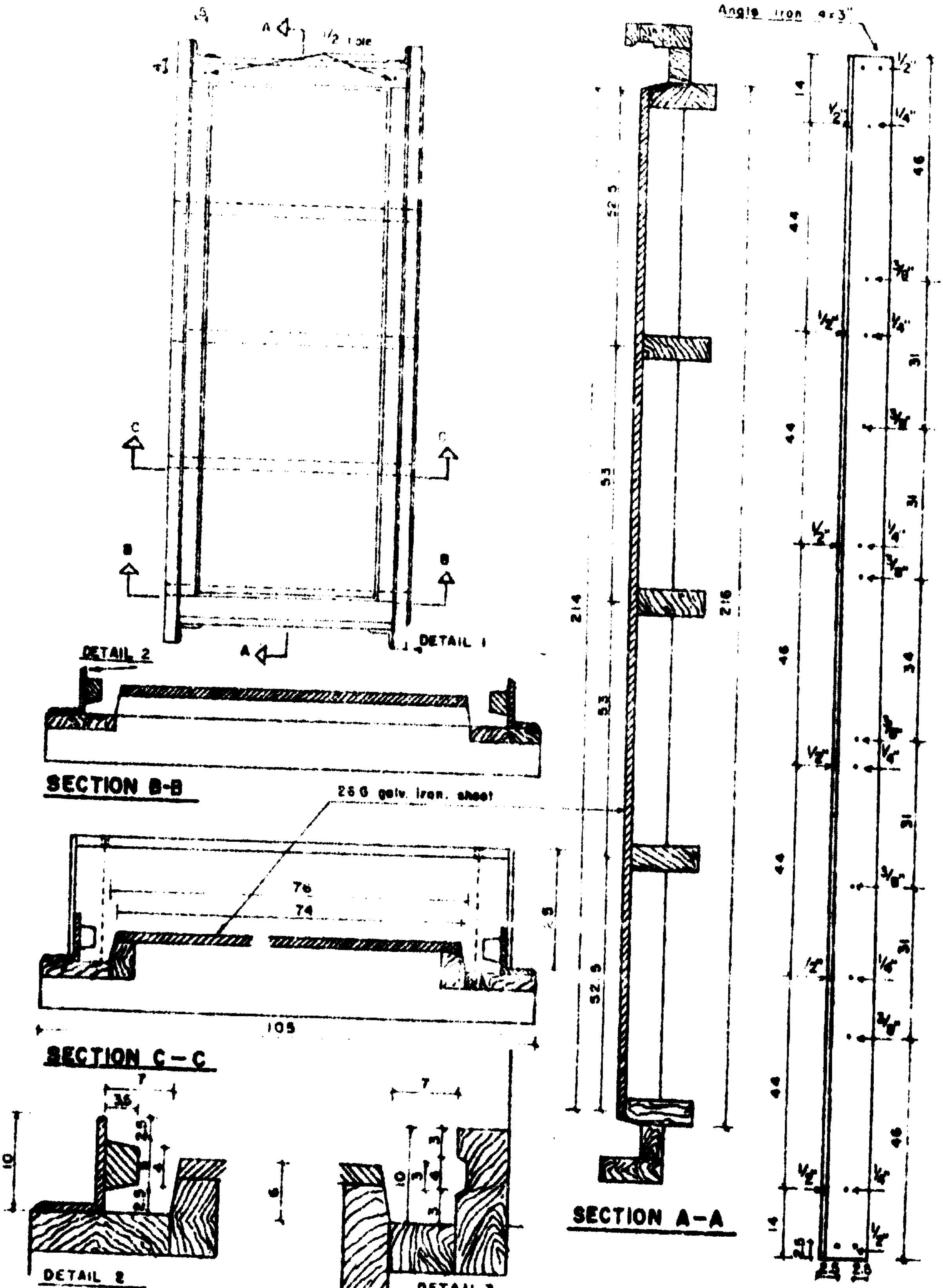
All measurements are in cm.

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

SCALE 1:100

Fig. 1 D

TYPE PLANS FOR STOREY BUILDING



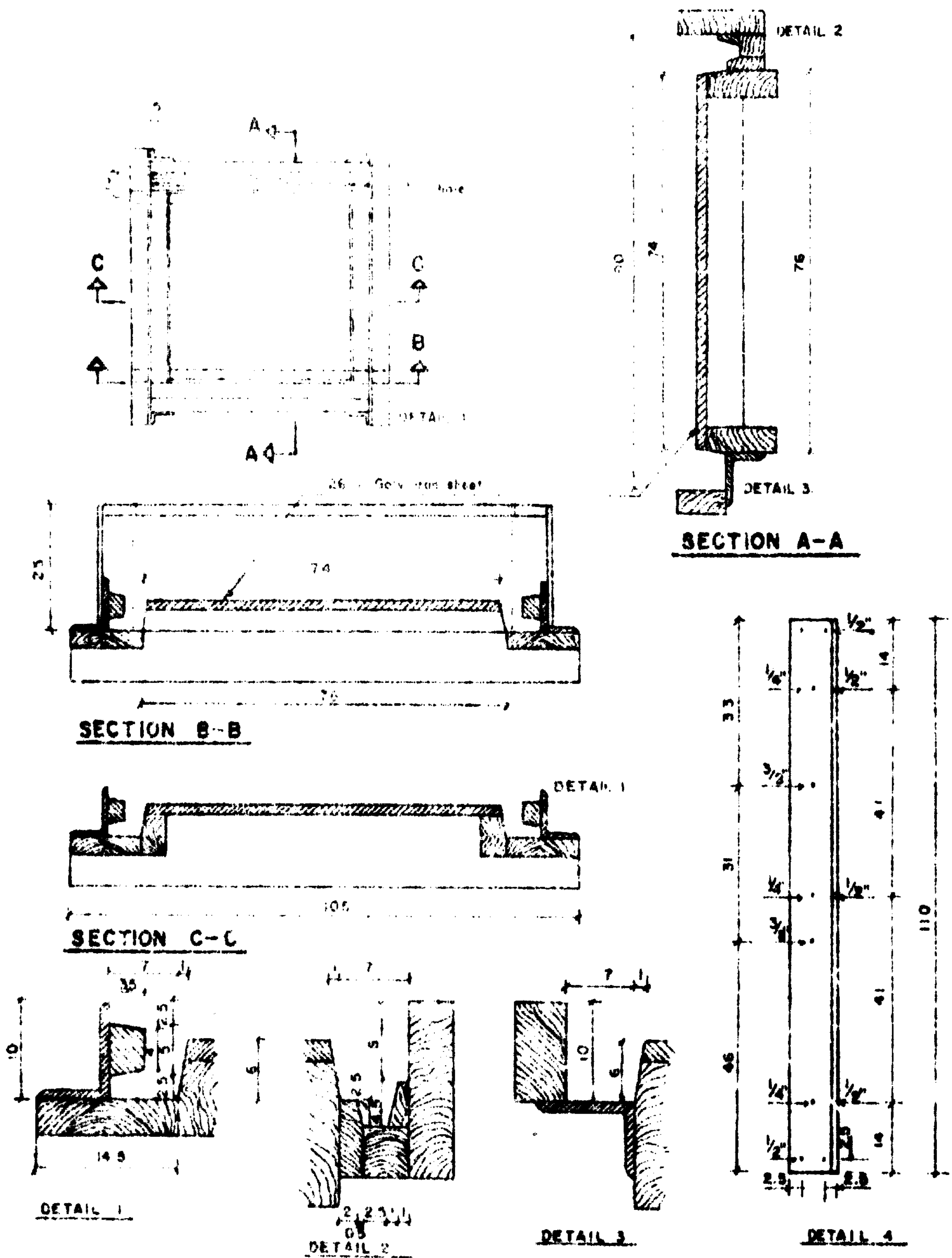
All measurements are in cm

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

SCALES 1:20 – 1:10

Fig. 2 A

MOULD DETAIL



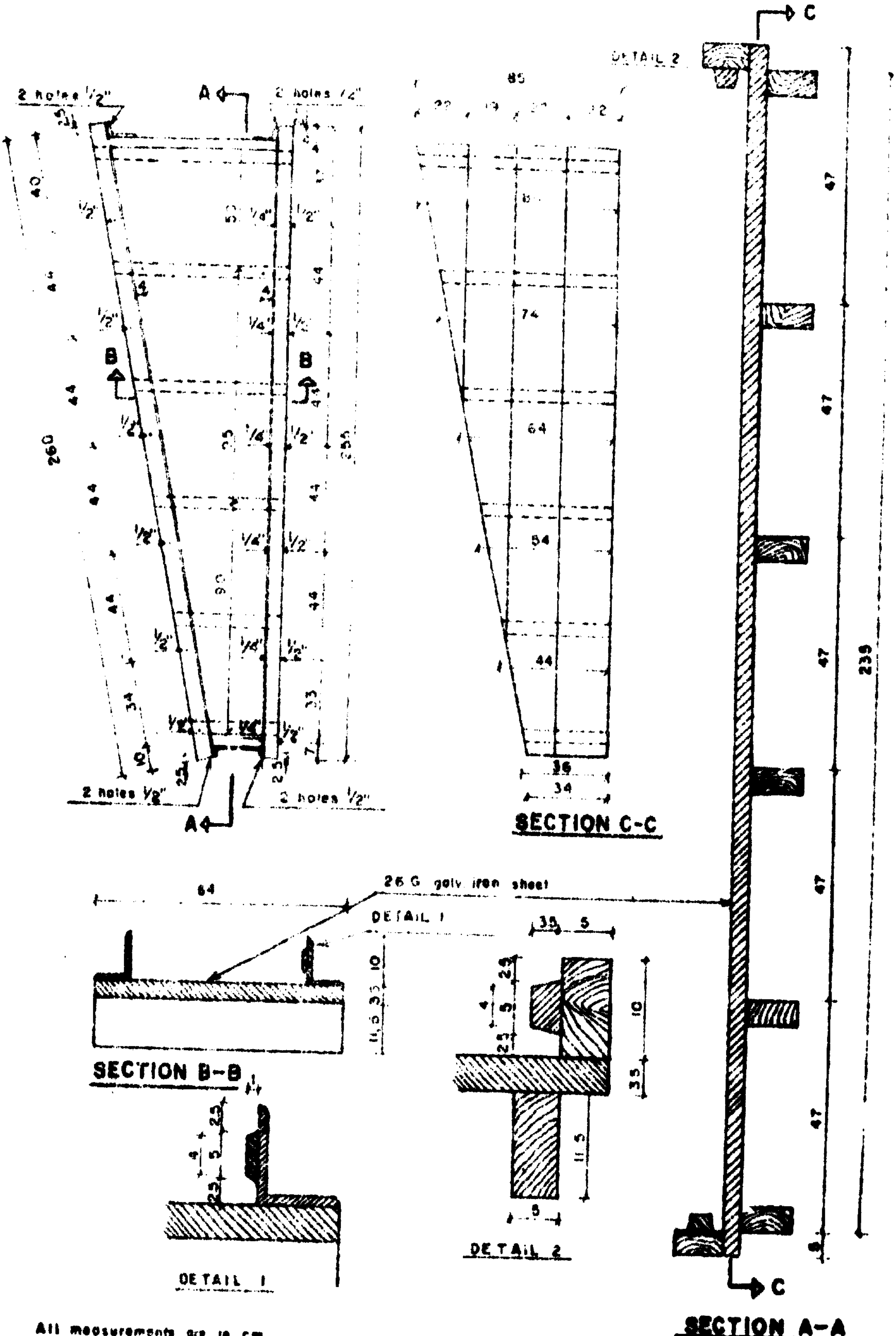
All measurements are in cm.

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

Fig. 2B

MOULD DETAILS

SCALES 1:20 1:10 1:5

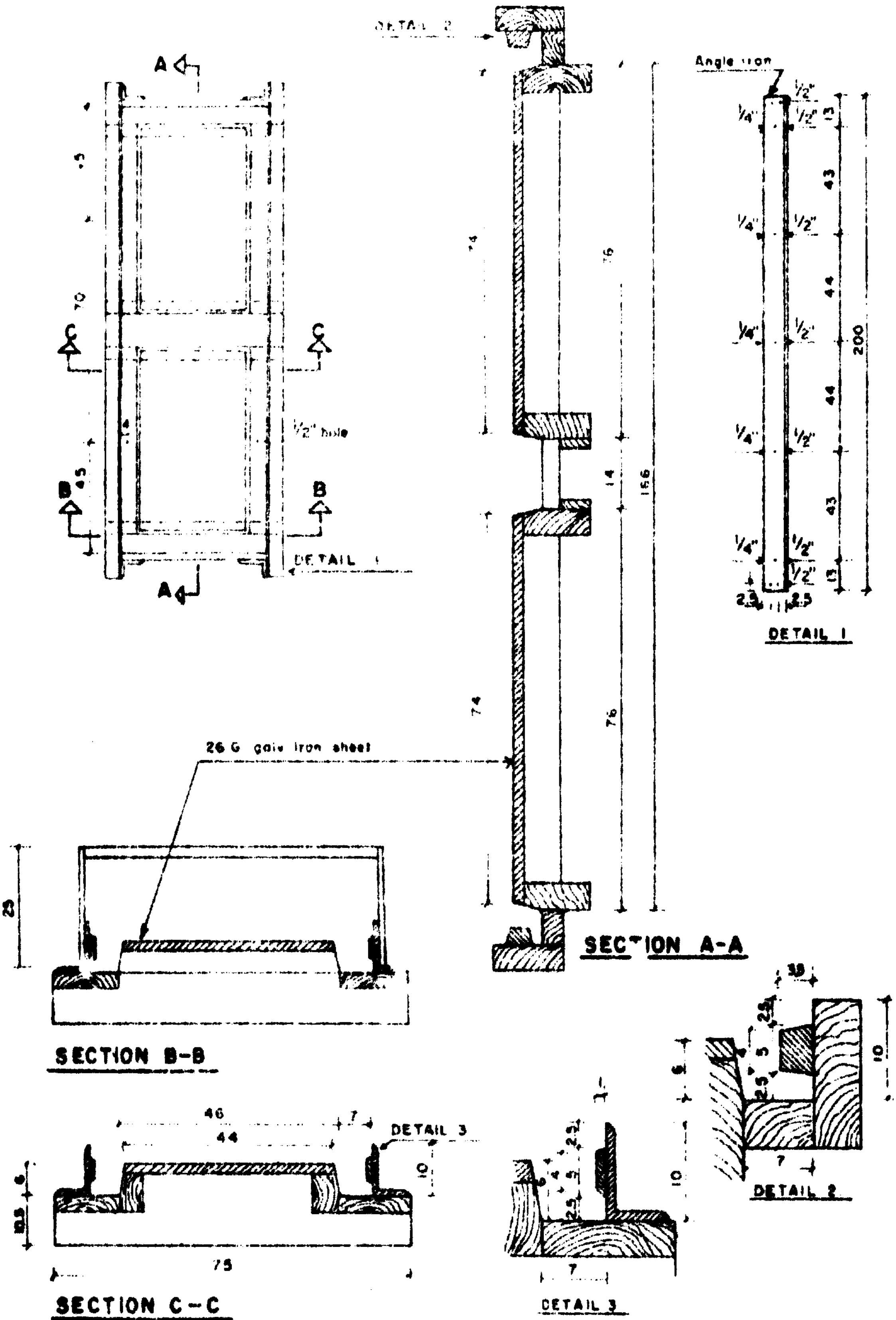


All measurements are in cm

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

Fig. 2C
MOULD DETAILS

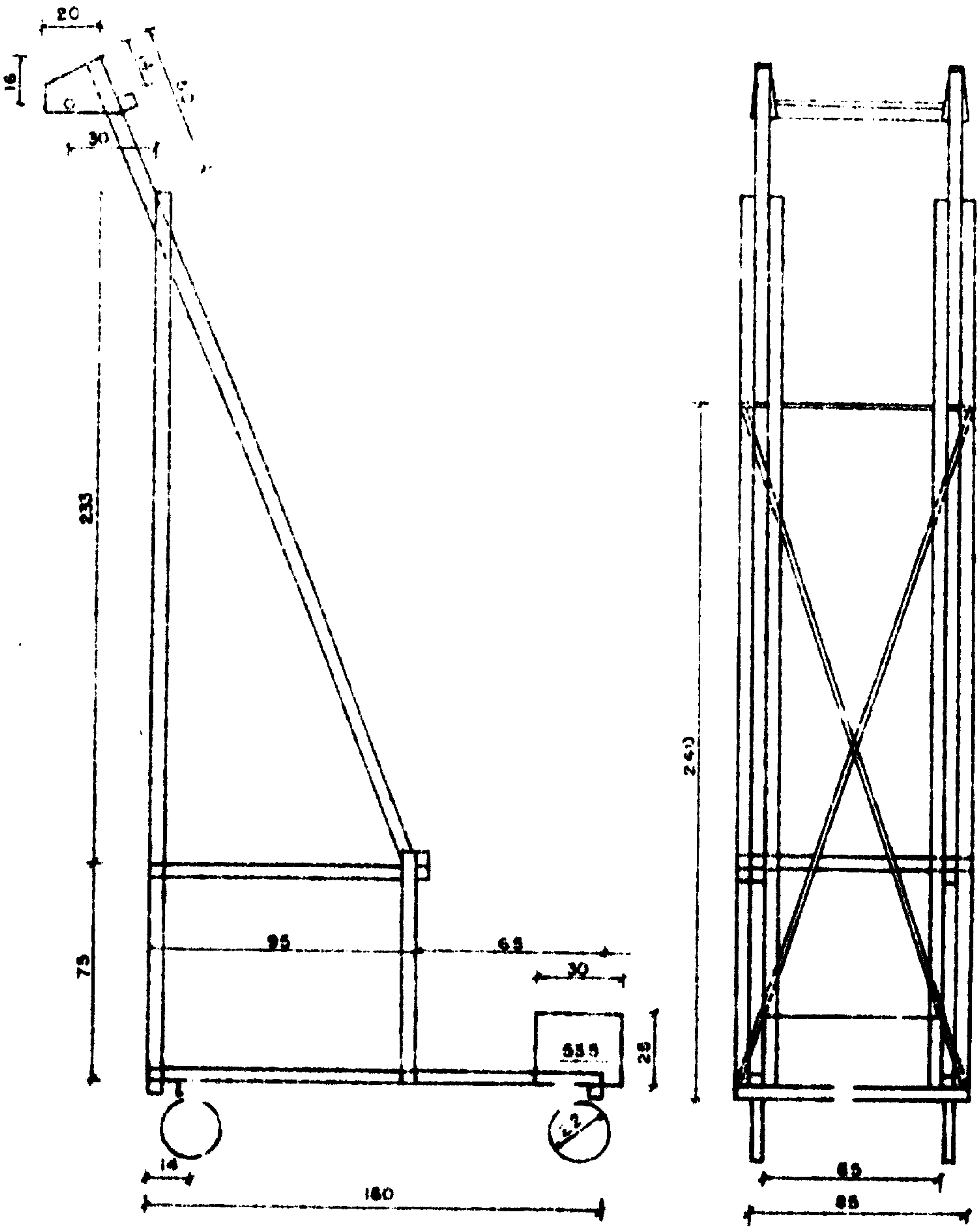
SCALES 1:20 – 1:10 – 1:5



All measurements are in cm

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING	Fig 2 D MOULD DETAILS

SCALES 1:20 - 1:10



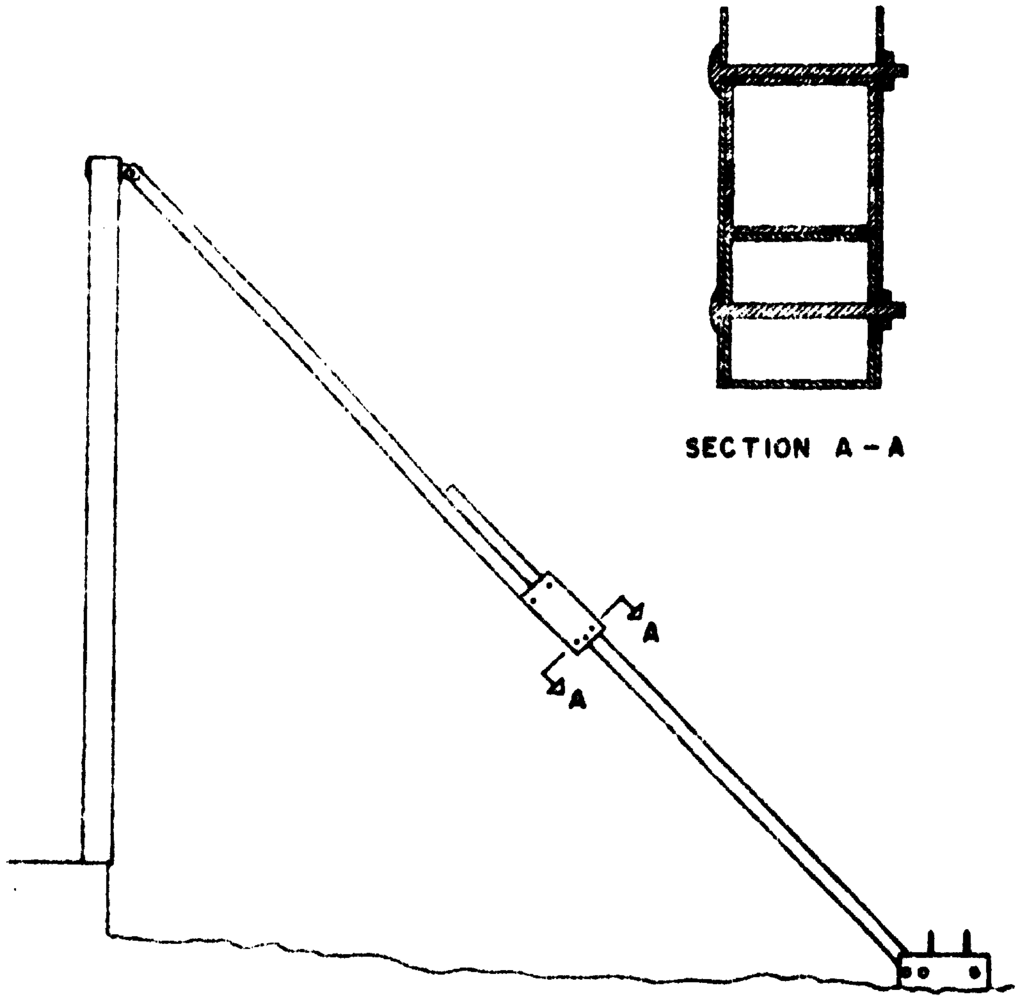
CRANE

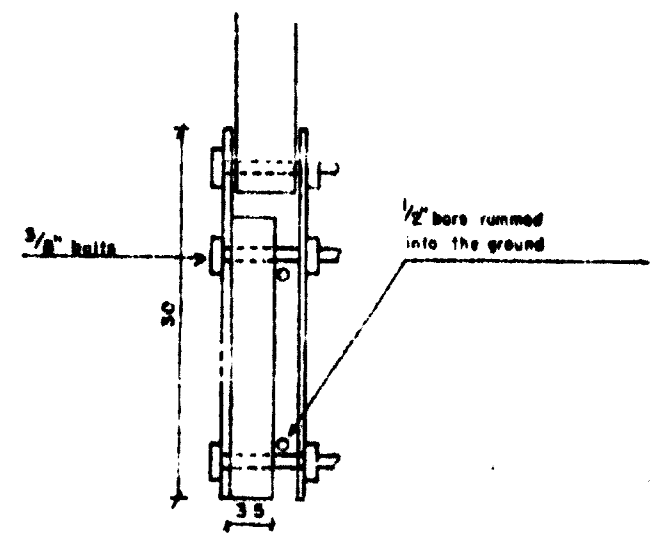
All measurements are in Cm.

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSE

Fig. 3

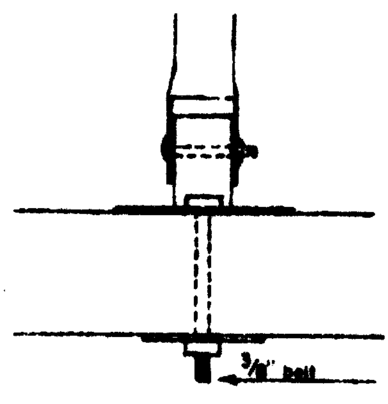
SCALE 1:20





Fixing of staybar to the ground

All measurements are in cm.



Fixing of staybar to the panel.

NAIROBI CITY COUNCIL	PRECAST CONCRETE HOUSING

Fig 4

ERECTION JACK

SCALES 1:20 - 1:5 - 1:2

NIGERIA

73. The predominant system of prefabricated housing in Nigeria is the system based on prefabricated plywood panels. This system is called the "African Timber Plywood System". It is used to build houses, classrooms, offices and workshops. The ATP system uses timber panels consisting of external tongue and grooved boards internal plywood. The panels are usually 8 ft. (2.43m) high and 3.3 ft. (1 m) wide. There are usually several types of panels according to their function, viz. door panels, window panels, structural panels and partitions, etc.

74. Roof trusses are made in appropriate timber members joined with marine plywood. Roof overhangs are such as to ensure the adequate protection of the walls throughout the year.

75. ATP also has special prefabricated timber structural members such as portal frames, etc. which could be used for buildings other than housing.

76. All the timber used is pressure treated against termite, wood worm attack, and fungus decay; painting of the exterior walls gives further protection.

EGYPT

77. In the UAR the use of industrialized building is at the development stage. Studies are in hand to develop suitable techniques as well as to decide the level of investment that should be appropriate to local conditions in the UAR. It is expected that the results of this study would be put into effedt within a short time.

78. The Misr Concrete Company already manufactures reinforced concrete panels and slabs of various sizes and thicknesses but not exceeding 2 tons in weight each. These are used for the erection of one storey buildings.

79. The Technical Committee of the Ministry of Housing is actually studying the possibility of the establishment of the proper method for erecting factories for the production of prefabricated building units, taking in consideration the following:

(a) Available building raw materials, mainly gravel, sand, lime stone, cement, lime, gypsum and steel.

(b) The economical programmes for the development in the field of industry and agriculture.

(c) The possibility of employing unskilled labour by absorbing the greatest number of untrained workers.

(d) The production of light-weight elements and units to reduce the cost of transportation, and erection while at the same time ensuring that light weight does not affect their heat and sound insulation properties.

80. The Committee shall take in account the preference for the installation of mobile units as well as the practicability of the production of the required elements, without the need for complicated automatic machinery requiring skilled labour.

19.6.74