REPORT

OF

ENQUIRY COMMITTEE

ON

GOVERNMENT HOUSING FACTORY

PRINTED IN INDIA BY THE MANAGER
GOVT. OF INDIA PRESS, NEW DELHI 1951

TABLE OF CONTENTS

APPENDICES

APPENDIX I	Report dated 8-7-1948 submitted to the Hon'ble the Finance Minister, Government of India, by Dr. O.H. Koenigsberger.
APPENDIX II	Agreement with M/s. Structural and Mechanical Development Engineers Ltd., and the original estimates furnished by the company.
APPENDIX III	Charts showing the existing set up of the organisation at Govt. Housing Factory.
APPENDIX IV	Statement showing the various posts and their sanctioned strength and the rates of pay sanctioned for respective appointments.

Enquiry Committee

Chairman

Shri S. Moolgaokar, Director, Tata Industries Limited, Bombay House, Bruce Street, Bombay.

Member

Shri Kanwar Sain, I.S.E., Member, Central Water Power, Irrigation and Navigation Commission, New Delhi.

Member/Secretary

Shri S. V. Ayyar, Chief Cost Accounts Officer, Ministry of Finance (I. & C. Division), Government of India, New Delhi.

CHAPTER I

Introductory

Appointment of Committee and Terms of Reference: A Committee, to advise the Government of India on certain matters connected with the Government Housing Factory at Delhi, was set up by the Government of India in their Ministry of Health letter No. 4304-LSG/50, dated the 2nd November 1950 which reads as follows:

> "The Government of India are pleased to set up a Committee with the following composition to advise them on certain matters connected with the Government Housing Factory at Delhi.
>
> *Composition of the Committee*:
>
> Shri S. Mookgaokar, Director, Tata Industries Ltd., Bombay House, Bruce St., Fort, Bombay—*Chairman*.
>
> Shri Kanwar Sain, I.S.E., Member, Central Water Power, Irrigation and Navigation Commission, New Delhi—*Member*.
>
> Shri S. V. Ayyar, Chief Cost Accounts Officer, Ministry of Finance (Industry & Commerce Divn.), New Delhi—*Member/Secretary*.

The terms of reference to the Committee are as follows:—

(1) To examine the organisation of the factory that has been set up for the manufacture of Alcrete Housing building materials, and to make recommendations regarding its adequacy, or otherwise, for the purpose in view;

(2) To examine the house building material produced in the Alcrete factory and the design of the house, and to pronounce on their suitability from a structural and qualitative point of view;

(3) To examine the operation of the Alcrete factory from the commercial (including financial) point of view, and to advise on the fixation of the sale price of the house in the initial period."

The Committee was requested to submit its report as early as possible.

2. *Programme of Enquiry*:

(1) The Chairman and the Member/Secretary had discussions on the 31st October 1950. Shri Kanwar Sain, Member, was out of station and was therefore unable to attend.

(2) The Chairman and Member Shri Kanwar Sain had discussions on the 8th November 1950.

(3) The Chairman, Member Shri Kanwar Sain and the Member/Secretary, each visited the factory on several days, as and when they deemed necessary, made observations and collected necessary information.

(4) The Chairman arranged with the Concrete Association of India at New Delhi to make varied and extensive tests of the material produced in the factory.

(5) Member Shri Kanwar Sain arranged to have various tests conducted independently both at the CWINC Laboratories, Hirakund and at the Punjab Irrigation Research Institute, Amritsar.

(6) Arrangements were made with the factory to make certain specified tests.

(7) The Chairman and Members of the Committee, having thus made their individual studies, met at New Delhi for further enquiry and discussions with the following programme:

6*th December* 1950:

(i) Discussion amongst the Members;

(ii) Fixation of the future programme of enquiry;

(iii) Discussions with Mr. C. V. Nazareth of Messrs. Concrete Association of India, in regard to the special tests that were being conducted.

7*th December* 1950:

Discussions with Mr. G. H. Thosar, Construction Engineer, Government Housing Factory, Delhi.

8*th December* 1950:

(i) Discussions with Mr. B. D. Sahi, Works Engineer, Government Housing Factory, Delhi.

(ii) Discussions with Mr. K. K. Nasta, General Manager, Government Housing Factory, Delhi.

9*th December* 1950:

(i) Discussions with the representatives of Messrs. S. M. D. Engineers Ltd., Technical Consultants to the Government Housing Factory, Delhi. The representatives who attended the discussions were:

Mr. L. R. Archibald, Technical Adviser.
Mr. E. G. Kitching.
Mr. F. W. Ward.

(ii) Discussions with Dr. Koenigsberger, Director of Housing.

(iii) Final discussion between the Chairman and Members.

On the 8th December 1950, the Chairman and the Members paid a visit

(a) to the factory and its stock yard, and

(b) to the houses erected both at the factory colony and at Jungpura, with a view to obtain first hand experience of the various problems involved.

3. *Report*: After careful consideration, the Committee came to the conclusion that the second term of reference relating to the design of the house, with special emphasis on the suitability of the material produced, from a structural and qualitative point of view, should be considered first, as the two other terms of reference depended, to a great extent, on their findings thereon. The Committee's programme of work was accordingly regulated on that basis. In the Report also, the same sequence is followed.

4. The Director of Housing had arranged to carry out wind pressure tests and loading and water proofing tests on the roof of FR-1 type. Certain additional tests were suggested by the Engineer Member of the Committee. These tests, as well as tests carried out by the National Physical Laboratory were watched by the Engineer Member personally or through his representative.

A detailed report on the results of all the tests will be made subsequently on the completion of the tests.

CHAPTER II

History of the Housing Project

From information submitted to the Committee, the history of this housing project is as follows:

1. At a meeting of the Committee of the Cabinet held on the 27th May 1948, it was decided that steps be taken to establish in India factories for the mass fabrication of houses rapidly and at low cost.

2. The Government of India accordingly deputed Dr. O. Koenigsberger, who was then the architect to the Government of Mysore, to proceed to the U.K. in order to

(1) Investigate the possibility of adapting to Indian conditions the methods used in the U.K. for building prefabricated houses;

(2) Explore the possibilities of setting up house building factories in India;

(3) Obtain sample houses and proto types so that they could be tried and tested under Indian conditions;

(4) Investigate availability and procurement of plant for producing prefabricated buildings.

3. Dr. O. Koenigsberger proceeded to the U.K. in June 1948 and spent 25 days in studying and in making the necessary investigations.

4. In the meantime, the then Hon'ble the Finance Minister was on a visit to the United Kingdom and the Cabinet had asked him to utilise his visit to investigate into the possibility of acquiring a factory for the mass fabrication of houses in India. Dr. Koenigsberger, who was already in the U.K. as stated above, assisted the Hon'ble the Finance Minister in this connection. He furnished a report dated the 8th July 1948 to the Hon'ble the Finance Minister which is attached as Appendix I to this report.

5. The Hon'ble the Finance Minister, on the advice of the relevant officers of the U.K. Government and after discussion with the Chancellor of Exchequer in England, consulted the firm of Messrs. Structural & Mechanical Development Engineers Ltd., Slough, Bucks, who had been responsible for the design and manufacture of a large number of aluminium prefabricated houses in England and Scotland. The Hon'ble the Finance Minister visited one of their factories in Scotland, where aluminium houses were being produced at the rate of 40 a day.

6. The Hon'ble the Finance Minister asked the firm to prepare a detailed scheme for the establishment of a plant in India for the manufacture of 100 houses per week or 5,500 houses per annum. The firm of Consultants thereupon submitted a scheme for the rapid production of low cost houses at an estimated cost of Rs. 2,500 per

house. The salient features of the scheme according to the Hon'ble the Finance Minister were as follows:—

"(i) The house to be manufactured at the Indian plant will consist of prefabricated foamed concrete panels of about 5" thickness, 3'—2" width and 10' height. These panels can be used for the composition of houses of various types and designs as well as for schools, small hospitals, middle class bungalows and other structures. Foamed concrete is a material with excellent heat insulation qualities, which can be manufactured from indigenous raw materials. As the material is very light (specific weight 0·65), the panels can be transported and handled without difficulty.

(ii) For the present, foamed concrete panels will be used for the manufacture of small houses consisting of two rooms, two verandahs, a small kitchen, a bath room and court-yard enclosures and a latrine.

Including doors and windows but without electrical fittings, the complete houses are estimated to cost Rs. 2,500 each, including the cost of the plinth. They will be of permanent construction.

(iii) All the materials required for this type of construction are available in India with the exception of a small quantity of aluminium alloy necessary for the protection of the panels during transport and as roof-covering. The total annual consumption of the factory of such aluminium alloy for the construction of 5,500 houses will not exceed 1,500 tons which, I am advised, can be secured without difficulty.

(iv) The capital expenditure for the plant necessary for the manufacture of these houses (inclusive of buildings) is estimated at Rs. 25 lakhs. If this amount is written off within 10 years, the cost per house will be about Rs. 38-8-0. The cost of a house as estimated includes this amount.

(v) A good proportion of the plant and machinery required can be procured in India and the rest is available in the United Kingdom.

(vi) The scheme includes arrangements for the transport of the foamed concrete panels from the factory to various housing sites."

7. It was also arranged to order from this firm, six pairs of prototype houses at a ceiling price of £1700 per pair, C.I.F. Bombay, in order to acquaint the local authorities, housing societies and others concerned, with the type of house to be manufactured in the proposed plant. These prototypes were thus not only to serve for demonstration purposes, but were also to facilitate the finalising of many structural details of the design before mass production could be taken up.

8. Under instructions from the Hon'ble the Finance Minister, a draft agreement was drawn up with Messrs. Structural & Mechanical Development Engineers Ltd., in Slough, in consultation with the

Director General, Indian Stores Department, Mr. P. G. Bhagat, and with Dr. Koenigsberger. This agreement embodied the following principal terms:—

(a) for licenses of the specialised form of construction consisting essentially of patented light weight foam concrete panels developed by Messrs. Structural & Mechanical Development Engineers Ltd.;

(b) for technical assistance for purchase of plant, equipment and aluminium and light alloy products in England;

(c) for the preparation and supply of detailed working drawings and specifications for Alcrete houses as well as for the factory;

(d) for technical experts to be sent to India to erect and start the factory;

(e) for a royalty payable to Messrs. Structural & Mechanical Development Engineers Ltd., on the production of their patented wall panels. Other services to be charged to Government at cost and reasonable overheads.

9. A copy of this Agreement together with a copy of the estimates furnished by them will be found in Appendix II.

10. The Consultants decided the flow sheet and lay out of the entire plant. Accordingly, equipment and machinery as per the Consultants' wishes and specifications, were ordered from the U.K. Construction work on the Delhi factory proceeded apace and by March 1950, the factory was practically completed.

11. From April to August 1950, i.e., about five months were spent by the Consultants in tuning up the factory to achieve production on a reasonable scale. These efforts continued till the end of November 1950, by which time the Consultants had not suceeded in establishing regular production on an economic basis.

12. During the extended tuning up period of the factory, certain problems and difficulties were brought to the forefront which necessitated a detailed and systematic examination of the entire problem. This resulted in the appointment of this Committee.

13. The Committee feels that it is desirable to draw the attention of the Government in regard to their agreement with the Consultants. The implementation in practice of the terms of the agreement reveals that it is rather one sided. The Consultants have not been tied down to definite guarantees in regard to specific performances, such as guaranteed output of the factory, costs of production, durability and consistency of the wall panels produced with the Delhi raw materials.

CHAPTER III

Capital Expenditure of the Project

The original estimate for the capital expenditure on the factory was Rs. 25 lakhs. It was based on the detailed estimate given by the technical consultants in June 1948. Their estimate for the plant and equipment, exclusive of buildings, but inclusive of erection and supervision upto the stage of manufacture of the first batch of house parts, was £ 1,20,000 round or Rs. 16 lakhs.

2. The actual expenditure upto 30th September 1950 together with further anticipated expenditure to complete the factory will be as shown below:—

		Expenditure upto 30-9-50 including known liabilities	Anticipated Future expenditure	Total
		Rs.	Rs.	Rs
I.	Site	2,49,000	5,000	2,54,000
II.	Buildings	5,00,000	50,000	5,50,000
III.	Butler Hangers	3,17,000	nil.	3,17,000
IV.	Staff Colony	1,18,000	2,00,000	3,18,000
		11,84,000	2,55,000	14,39,000
V.	Water, Power, Light and Drainage	2,41,000	..	2,41,000
VI.	Transport	3,51,000	5,00,000	8,51,000
VII.	Plant and Machinery	15,69,000	..	15,69,000
VIII.	Design and Establishment	5,23,000	1,00,000	7,23,000
IX.	Erection, Transport & Misc.	7,78,000	..	7,78,000
X.	Moulds & Jigs.	2,00,000	..	2,00,000
XI.	Plant for manufacture of precast plant	25,000	1,50,000	1,75,000
XII.	Miscellaneous	50,000	..	50,000
		38,37,000	7,50,000	45,87,000
XIII.	Prototypes	2,13,000	..	2,13,000

SUMMARY

Site & Bldg., including Staff Colony.	11,84,000	2,55,000	14,39,000
Plant & Equipment including Erection.	38,37,000	7,50,000	45,87,000
Prototypes	2,13,000	nil	2,13,000
	52,34,000	10,05,000	62,39,000

or say, Rs. 63 lakhs, roundly.

3. The estimate of the technical consultants was made in June 1948 and the erection of the factory was practically completed by March 1950, *i.e.* in about 20 months. It will be noted that the capital expenditure has worked out to as high as 250 per cent of the consultants' estimates.

CHAPTER IV

Proposed Design of low cost house suitable for mass prefabrication

The original design of the house produced by the technical consultants was for an attractive type with aluminium roof known as type MZ-2. The major portion of this house was built with prefabricated components but some portions were built with ordinary, traditional building materials such as bricks and concrete mortar. According to the consultants' estimate, the total cost per house was to be in the neighbourhood of Rs. 2,470. This could be divided into the following groups:—

	Rs.
(a) Cost of imported materials including aluminium alloy product	1,083
(b) Cost of materials locally manufactured in the factory at Delhi.	593
	1,676
(c) Cost of portion built in ordinary brick construction	722
(d) Other overheads	72
Grand Total Rs.	2,470

This break up reveals that the total estimated cost of the prefabricated portion of the MZ-2 house was Rs. 1,676. Out of this amount, parts worth as much as Rs. 1,083 were proposed to be imported from abroad; and only a small portion worth Rs. 593/- were to be produced in a factory, then estimated to cost Rs. 25 lakhs but which will actually cost Rs. 63 lakhs.

The Committee can only surmise that the economics of the proposition could not have been studied in any detail, for, otherwise there can be no explanation for incurring a large capital expenditure on a factory which was constructed to produce only 35% of the value of prefabricated parts required per house.

2. These estimates were prepared in June 1948 by the technical consultants. This was a time when, as a result of cessation of the Second World War, there was presumably considerable surplus aluminium sheeting available in the U.K. at a low price. The question whether this low price level could have continued for long might have been considered, before deciding on the MZ-2 type house. The Committee has been informed by Dr. Koenigsberger that he was given to understand that there would be no difficulty in obtaining indigenous supplies of aluminium in due course. The actual position is, of course, that no indigenous supplies of aluminium components are available and the imported components have increased in price to such an extent that the MZ-2 type has now become a completely uneconomic proposition. The MZ-2 type house has had to be abandoned

and an alternative design is now being evolved in such a manner as to necessitate the minimum amount of imported materials.

3. This new design known as the FR-1 type has been produced with a flat roof in place of the original aluminium roof and two houses of this type have been put up as prototypes to assist the evolution of the final design. As at present designed, this type still requires about Rs. 1,000 worth of imported materials—aluminium components—for each house, which is roughly 50% of the cost of material involved. It is understood that investigations are being made to replace these by locally produced substitutes; until the whole design has taken final shape, it is not possible to make any comments thereon.

It is obvious, however, that the production of the new FR-1 type house will entail a serious reduction in the output of the factory for the simple reason that additional foam concrete panels will be required for the FR-1 roof to replace the originally proposed aluminium roof of the MZ-2 design.

It is worth mentioning that the change over from the MZ-2 type to the FR-1 type will result in some dead loss to the Government, as the existing equipment for processing aluminium components and a portion of the building used for this purpose will be no longer required. It will also result in a substantial increase in the factory production costs, in view of the reduction in capacity that will result.

CHAPTER V

Comparison of Original Specifications of Wall Panels and Specifications of Wall Panels as now produced in the Factory

A copy of the specification for the MZ-2 type Alcrete houses which were originally designed by the consultants will be found at Appendix II. It will be seen therefrom that the original specifications for all the external load bearing and internal wall panels were as follows:—

> "The external panels would be finished with a hard concrete face 5/8" thick, backed by 3-1/2" of foamed cement, suitably reinforced and having light alloy edge protection members. The internal face of these panels would be sprayed with a finishing surface of aerated cement rendering. The internal panels would be of foamed cement, suitably reinforced and sprayed both sides with an aerated cement rendering."

2. It will be seen from the above, that in accordance with these specifications, the patented panels produced should have had

(1) a hard concrete face 5/8" backed by
(2) 3-1/2" foamed concrete;
(3) suitable reinforcement; and
(4) light alloy edge protection members.

The Committee was, however, surprised to find that in the actual production of panels in the factory, these patented specifications have been given up and only a plain 4" thick unreinforced foamed concrete panel is being produced. The three important patented specification details, namely, (1) a hard concrete face 5/8" thick, (2) suitable reinforcement and (3) light alloy edge protection members have been omitted.

3. The representatives of the technical consultants, who were questioned on the subject, had no satisfactory explanation to give for this omission. They considered that it was adequate and cheaper to produce in the manner now being done and that a hard concrete face and reinforcement etc., were unnecessary. They further stated that these changes were made in consultation with the local management.

The equipment required for the production of this hard skinned wall panel has already been supplied. According to the Director of Housing, the suggestion to eliminate this feature was made to him by the consultants in June 1949.

4. The original specification did provide for suitable reinforcement in the load bearing wall panels. The facts that the reinforcement proposed was of the wire mesh type, is established from the statement of principal materials required, furnished by the technical

consultants along with their estimates. They qualified this with a note which read as follows:—

> "This reinforcement has primarily been included to ensure the satisfactory handling of the panels by untrained labour. It is not necessary to provide structural strength to the house when the panels are erected.
>
> We consider it likely that the use of steel reinforcement in the panels could be totally dispensed with, after practical trials have ensured the capacity of the work people to handle the panels without damage."

Accordingly, and on the advise of the technical consultants, a good quantity of wire mesh was purchased by the factory for being used in production. But no use whatever was made of this; not even to make certain that, at the outset the factory people could handle the panels without undue damage. The Director of Housing has stated that when the casting of panels started in April 1950, the technicians of the consultants informed him that their head office recommended the omission of this wire mesh. An examination of the panels incorporated in the prototypes installed in Delhi revealed sometime in August 1950 that there was a dangerous tendency for the wire mesh embedded in foam concrete panels to rust, resulting in cracks which closely followed the pattern of the embedded wire mesh.

5. Regarding the elimination of the light alloy edge protection members, we understand the following from the Director of Housing. When he saw the first panels with such beading, he felt that the protection afforded was negligible. The provision of beading was expected to increase the difficulty of making proper joints between the panels. The Director of Housing therefore agreed to the suggestion of the consultants to eliminate these items. The consultants, at that time, claimed that the beading had become redundant, because of the improvement in the quality of the foamed concrete, which, according to them, was sufficiently strong to withstand the necessary degree of handling, without this protection. It may be noted here that the edge protection beadings required for as many as 1,000 houses had already arrived by this time. It is therefore clear that the extent of protection afforded by these beadings could not have been studied when the designs were drawn up and when the prototypes were supplied.

6. In furnishing their estimates for the prototypes, the consultants stated as follows:

> "It would be possible, by producing these prototypes to ensure that any slight modifications considered necessary after inspection, were incorporated in the design, prior to commencement of production, thus enabling the Indian plants to commence full scale production from the outset."

It will be seen that the original plan was to make only *slight modifications considered necessary after inspection*. The changes referred to above could, by no stretch of imagination, be called slight modifications. The drastic changes proposed by the consultants should only have been accepted after clear proof was made available by the

consultants that there was no impairment whatsoever in the quality and strength of the building panels.

7. The Committee regrets to record that in a project like the Government Housing Factory, Delhi, the object of which was mass production of low cost houses, after the design of the house was planned and the factory erected for producing such houses, both the Director of Housing and the technical consultants should have changed their minds and diverted their plans to producing panels—the most important part of a prefabricated house—which bear no semblance to the original patented specifications, and about the characteristics of which neither of them had sufficient experience, either in the United Kingdom or in this country.

8. It is admitted by the representatives of the technical consultants that their experience in the United Kingdom, in the building of houses even according to their original specifications, was restricted to only two double-storied houses and no more. Their actual experience has been largely confined to building prefab houses, designed around the use of aluminium sheeting and such other light alloys. If the consultants had sufficient experience in the practical working and exploitation of their patented wall panels, they would assuredly have had ample opportunities to decide in good time whether a hard surface was necessary, whether the light alloy beadings were essential, and what the effects of steel reinforcement would be in foam concrete panels. It is quite clear that at the time they entered into this agreement with the Government of India, they did not possess any such experience. The exploitation of their patented wall panel was very much in the experimental stage and what is perhaps worse, it is doubtful if they even had commercial experience of producing plain foam concrete load bearing wall panels in the sizes adopted.

9. It is the Committee's opinion that the plain foam concrete wall panels which are now produced in the Government Housing Factory bear no semblance whatever to the patented wall panels of the consultants. Under the circumstances, there can be no justification for paying the consultants any royalty on their production.

CHAPTER VI

House building Material Produced in the Factory and its Suitability from a Structural and Qualitative Point of View

The principal item of the house building material produced in the factory is the foam concrete precast wall panels. In discussing the suitability of the house building material, attention has to be focussed on these wall panels. At this stage, a brief description of light weight concrete may not be out of place. In the process adopted in the Delhi factory, ground sand, cement and a stable foaming agent are mixed mechanically. The foam is firm enough so that it resists the pressure of the mortar until the cement takes its initial set and a strong skeleton of concrete is built up around the voids filled with air.

To gain rapid strength and to reduce the adverse property of this material of excessive shrinkage, the wall panels are steam cured in steel vessels known as Autoclaves. In this form of light weight concrete, air particles replace the normal aggregates of the ordinary concrete.

2. Another form of light weight concrete can be produced by using light weight aggregate. Thus, wood shavings, foamed slags or even cork particles can produce light weight concrete; in each case the 'light weight' being a result of the characteristics of the aggregates used. The density of concrete produced by using light weight aggregates is determined by the density of the light weight aggregates employed. This is a straightforward method, not in any way complex.

3. In the case of foam or cellular concrete, the density of the resultant concrete can be varied within a wide range but the resultant product is complex in nature. The consensus of opinion is that the industry is still seeking for the ideal process of manufacturing commercial light weight concrete and that perfected foam or aerated concrete for commercial production is not yet out of the laboratory stage.

4. It has been pointed out in the preceding chapter that the panels produced in this factory are not to the specifications originally laid down. Nevertheless, it has been the object of the Committee to ascertain whether this material, in the form and size it is now produced, is suitable for house-building purposes from the different points of view, namely, from the structural, qualitative and the cost point. In this chapter, the first point of view is only dealt with. The cost point of view has been dealt with later in great detail.

5. Apart from the question of the panels, the position relating to the composition of the concrete mix itself is not entirely satisfactory. The original specification laid down that the mix will be of one part of cement and two of sand. The technical consultants have established the technical data for this mix and it is presumed that the panels for the proto-type buildings were produced from an identical mix. In the factory in Delhi, however, experiments and production have been largely confined to the much richer 1 : 1 mix. Little attention

has been paid so far to the originally specified 1 : 2 mix. In this connection, the local Technical Adviser representing the technical consultants has stated as follows:—

"When this 1 : 1 mix is in use, the materials required for 100 c. ft. of foamed mortar are as follows:

Cement	2903 lbs
Sand	2903 lbs
Neat foam liquid	0·52 gallons
Water	209 gallons

This has been considered the most convenient mixture with which to commence production, as it was the one on which the most experience was available. Also the results of the tests, under Indian conditions of the 1 : 2 mix (which is the basis of the plant's design) were not available when the demand 'production at any cost' was made. However, test panels have now been cast and tested and it is reasonable to assume, given three months in which to eliminate the troubles likely to be experienced on full scale production, that the 1 : 2 cement-sand ratio at one specific gravity will be in use by February 1951."

He further said:

"There is, no doubt, an economy in cement in producing 1 : 2 mix, if the same densities are adhered to. If, however, the densities were reduced to 0·75 specific gravity, it may be that there would be very little difference in cost between 1 : 1 at 0·75 and 1 : 2 at 1 specific gravity. However, whilst a great deal of data is available on this point, experimental blocks have been made and tested in U.K.—the only material which has been made successfully so far under Indian conditions is the 1 : 1 at 1 specific gravity and 1 : 2 at 1 specific gravity.

There is still a certain amount of data to be collected on 1 : 2 mix under Indian conditions, but from what is known at present, it should be possible to switch over to this production early in 1951. This assumes that time is allowed for completing the task of collecting the necessary data by deliberately slowing production."

These would clearly indicate that though the consultants planned the factory for the 1: 2 mix, they had not yet established on this ratio. Further, it is noticed from the Finance Minister's note dated 16th July 1948 that the specific gravity proposed was 0·65, obviously with 1 : 2 mix. Now the technical consultants are discussing of a specific gravity of 0·75 with a 1 : 1 mix or of a specific gravity of 1 with 1 : 2 mix. It must be noted that any increase in the specific gravity over the initially proposed 0·65 will adversely affect the insulation property of the wall panels. In the opinion of the Committee, these are factors which should have been decided before the house itself was designed and before the factory was laid out. Such basic experiments should have been done in the laboratory and should not have been left over to be carried out on the factory scale.

6. The technical consultants have produced technical data to establish the satisfactory nature of this material. The Committee, however, apart from looking into the question from this angle, has to consider the many practical and commercial aspects of this problem.

7. In the study of this question, the Committee's attention was focussed on the breakages occurring in the process of manufacture. Careful statistics maintained by the factory for the months of October and November 1950 showed that in October, the breakages were of the order of about 29% and in November of the order of 39% of the total number of panels produced. This rate of breakages is, of course, abnormally high and until it is brought down to reasonable proportions, the factory output and costs are bound to be adversely affected.

8. The technical consultants observed that the high rate of breakages in October 1950 was largely due to inefficient handling by untrained labour employed in producing these panels. This position, they accept, was corrected by the third week of November 1950. The breakages, however, continued at a high rate. This time they attributed the high rate of breakages to the bad quality of cement. No satisfactory or convincing explanation has been forthcoming so far. In respect of the period April to September 1950, authoritative records to indicate the position in this respect are not available. It would appear that from the 15th August upto the middle of September 1950, the breakages were not quite as high as in October and November 1950. It has been observed by the technical consultants, in the course of their evidence, that the breakages only amounted to about 8%. Mr. B. D. Sahi, Works Engineer in the Government Housing Factory, who was examined by the Committee in this connection, stated that adequate records were not kept between the 15th August and the 2nd of September. In his opinion, the records of breakages related only to those noticed in the stock yards. The breakages in the casting shop (Infill shop) were not recorded at all. He, however, confirmed his experience that during the time the technical consultants were making experiments, i.e., upto the end of September 1950, the breakages varied from 10% to 60%.

9. In spite of the Committee's specific attempts with the technical consultants, to ascertain whether it would be possible for them to bring down the breakages to reasonable figures so as to result in economic costs, it has not been possible to obtain any substantial information or assurance from them. The Committee considers that the technical consultants have not been able so far to ascertain the specific reasons for such a high rate of breakages. In the course of their evidence, it was accepted by them that they have no practical experience of producing foam concrete panels on a commercial scale by the process being followed in the factory. The factory tuning up process which began 8 months ago still continues at heavy cost to the Government. In the course of their evidence, Mr. Archibald, Technical Adviser, stated as follows:—

> "I think I should point out at this stage that the process was a new one and we were engaged because we had more experience of this than any one else. At no time had any one pretended that this was a ready made process like making ASPRIN or anything like that. We were

asked to act as Consultants, because we knew more about the process than any one else."

The consultants indicated that they might be able to solve the problem and complete the tuning up of the factory in another two to three months, but they were not prepared to give any assurance on this point. Nor were they willing to carry out further experiments at their own cost, in case they did not succeed in tuning up the factory in two or three months.

It should also be borne in mind at this juncture that all the attempts made by the consultants are in relation to 1 : 1 mix. If and vhen 1 : 2 mix is put into use, for which the plant is designed, it is not possible to say what further difficulties may face them.

10. It is obvious to the Committee that the present situation is an extremely unsatisfactory one. The consultants cannot be given an indefinite length of time to set the factory right.

The Committee feel that the consultants should be given a time limit in which to set matters right and put the factory on a satisfactory basis.

11. Assuming for the moment, that at a later stage, the defect of excessive breakages in the manufacturing process is eliminated, the next question for the Committee to consider is whether the house building material after erection will continue to function satisfactorily. In dealing with this aspect, the Committee has been largely guided by the actual experience gained up-to-date, in the erection of some 102 houses so far erected. In a number of cases, in these houses, the wall panels developed cracks after erection. Such cracks appeared in about a week after erection in some cases, and even after three to four weeks in others. The technical consultants have argued that in some of these cases, the panels must have already cracked before erection and they should, therefore, not have been used at all in erecting the houses. In other cases, they have other reasons to offer.

12. The construction engineer Mr. Thosar, who gave evidence before the Committee, was specifically questioned on this and he assured the Committee that in no case was a cracked panel erected. He has made the very obvious point that it is physically impossible to erect a panel weighing some 800 lbs if there is an existing crack in it. During the course of erection, such a panel would ordinarily give way.

13. At the time the Committee visited the site, where the houses have been erected, it was reported that out of the 102 houses erected, there were cracks in 20 houses. It was also explaind that in the case of houses where cracked panels had already been replaced, at later stages, further cracks have resulted in other panels. It has further been reported that after the Committee's inspection of the houses, 17 subsequent cracks were noticed in the panels upto 19th December 1950. The Committee noticed that in a majority of cases, horizontal cracks occurred in the corner wall panels. In most cases, the cracks developed on the external faces which are more exposed to weather conditions, as compared with the internal faces.

14. The Committee is not prepared to accept that panels with cracks could have been used in the erection. A possible explanation

is that certain internal locked up shrinkage stresses in the wall panels are released, which, in due course, appear as cracks.

15. The Committee feels that the technical consultants could have ensured at least in the initial stage of erection of these houses, that only panels which, in their opinion, were considered sound, were sent out for erection. The Committee is not prepared to concede that the technical consultants would have permitted a development of the nature which has now taken place, had they any suspicion that unsound panels were being used in the erection.

16. In this connection, it may be observed that cracks have appeared also in the prototypes which were manufactured in England and sent out to India. The material of the wall panels is therefore inherently prone to the development of cracks. It may be that at the present juncture, the percentage of cracks is excessive and with greater experience in due course such cracks may be reduced. The fact must be stressed, however, that so far, it has been extremely difficult to obtain from the factory sound and durable wall panels.

17. In the opinion of the Committee, it would be inadvisable to sell to the public houses constructed with wall panels as now produced in the factory. Before such houses can be put up for sale, it has to be definitely established that the climatic conditions in and around Delhi do not have adverse effects on the panels produced, and that the type of cracks which appear in the panels of the erected houses are eliminated entirely.

18. An important point that needs consideration when dealing with the suitability of this material is the difficulty of repairs to any wall panels after a house has been erected. The panels, as made at present, are quite large and heavy. If a panel cracks, it cannot be repaired like an ordinary brick wall. Repairs can only be effected by replacing the entire panel with the help of a mobile crane. Neither will it be a simple matter to replace a wall panel. In the case of the FR-1 house, if a wall panel has to be replaced, most of the roof will have to be dismantled.

19. A very large number of tests have been conducted by the Committee to test the physical and engineering properties of this foam concrete load bearing wall panel as now produced in the factory. The panels in the density and sizes produced at present possess the following disadvantages:—

(i) The foam concrete does not develop a solid bond with any steel reinforcement which is thus liable to rust and corrode.

(ii) The material develops high shrinkage stresses and is therefore prone to develop dangerous cracks. For the same reason, it is impossible to repair or to achieve a completely impermeable rendering.

(iii) The transverse strength of foam concrete is low and occasional flaws may reduce this strength dangerously. Since it is not feasible to reinforce the slabs, they can only be used for roof slabs with extremely short spans.

20. Taking into account all these factors as well as the results of the large number of tests made recently, the Committee has come to the unanimous conclusion that from a qualitative and structural point of view, the load bearing unreinforced foam concrete panels, as produced in the factory, cannot be considered suitable for house building in our country. The Committee feels that it cannot, with any degree of confidence and safety, recommend to the Government to put up for sale houses erected with such wall panels.

Costs permitting, such panels may be used for partitions and similar non-load bearing walls and as roof panels, provided their individual spans are kept very short.

Panels or blocks produced in very low density will make good insulation material, if laid over ordinary dense concrete capable of withstanding the stresses.

CHAPTER VII

Factory Production Capacity

In order to estimate the costs of production with the requisite degree of accuracy and also to determine the requirements of staff, labour and transport equipment etc. for the normal operation of the factory, it is necessary to ascertain the actual production capacity of the factory.

2. This factory was laid out and equipped to produce 5000 MZ-2 type of houses per year. For reasons mentioned previously, the original MZ-2 type has been abandoned and therefore it becomes necessary to determine the capacity of the factory in terms of the FR-1 type house which is now being evolved.

3. Mr. Archibald, of the technical consultants, has, in answer to the questions asked by the Committee, stated that a previous estimate of 350 FR-1 houses per month is to be considered as rather over optimistic. In his opinion a rate of 10 FR-1 houses per day may be considered as the normal output of the factory.

4. According to Mr. Archibald, the plant as adjusted at present can produce 5000 c.ft. foamed mortar per day of 24 hours. One FR-1 type house requires 411·1 c.ft. of foamed mortar, and on this basis, in 24 hours, 12·16 FR-1 type houses could be produced, assuming that all the equipment works continuously for 24 hours a day, and that all the 5000 c.ft. of wall panels come out in tact.

5. In actual practice, it is not possible to run such a factory continuously for 24 hours each day and a suitable allowance has to be made for production hold ups. For this, a minimum allowance of 5% is considered reasonable.

6. The consultants have estimated a 5% loss of unautoclaved material due to screeding. At present, due to lack of experience, the loss due to screeding is about 10% but there is no reason why it should not be reduced to 5% in due course.

7. In regard to wastage on account of mishandling, breakages etc., after autoclaving, the technical consultants feel that a wastage of 6% only need be provided. Irrespective of whether it is possible to achieve such a low rate of wastage or otherwise, the Committee has estimated costs based on a wastage rate of 6% as well as a rate of 25% which appears to be sufficiently near the present day actuals.

8. Taking these wastages into account and assuming 3 shift production, the output of 12·16 FR-1 type houses referred to in para 4 above will stand reduced to 10·3 houses as follows:

	12·16	
Less 5%	0·61	for production hold up etc.
	11·55	
Less 5%	0·58	on account of 5%wastage in screeding.
	10 97 **	
Less 6%	0·66	on account of wastage in mishandling, autoclaving etc.
	10·31	
Or Say	10.3	houses a day.

If the rate of wastage in mishandling, autoclaving etc. is taken at 25%, as against 6% noted above, the position will be as follows :—

	10·97 **	(as above)
Less 25 %	2·74	on a/c of wastage in mishandling autoclaving etc.
	8·23	or, Say 2.8 hours per day.

9. A further problem to be considered is for how many days in the year can regular production be maintained. There are various factors to be taken into account in this connection, viz., the time to be given for overhaul of the plant and equipment, general maintenance of the factory, the period of boiler inspection, the holidays to be granted to the workmen etc. It is not possible to accept that production can be had on all the 365 days in a year. In such factories, 25 days in the month is taken as the number of actual working days and an output is assessed based on 300 working days in a year. In continuous process industries, increased labour force has to be maintained so as to provide the time offs, weekly holidays etc., necessitated by the provisions of the Factories Act. At any rate, an allowance for major repairs, overhauls, breakdowns etc., has to be made, and it would be reasonable to assume a minimum of 15% for this purpose. Having regard to these considerations, the factory can be expected to produce only for 365 minus 55=310 days in the year. The actual production per year then would amount to $310 \times 10 \cdot 3 = 3,193$ or 3,000 houses per year. The normal output of FR-1 type houses can thus be only of the order of 250 houses per month, if the wastages are kept at the level estimated by the technical consultants.

If, however, the wastages amount to 25%, the yearly production will be reduced still further to $310 \times 8 \cdot 2 = 2,542$ houses or 2,500 houses roundly.

10. On the same basis, the equivalent output of the obsolete MZ-2 type houses has been calculated just as a matter of interest.

11. In the circumstances explained in the preceding paragraphs, the normal output may be assessed at

(1) 250 houses per month for FR-1 type, if the wastages are at the same level as estimated by the technical consultants, or 210 houses per month for FR-1 type houses, if the wastages amount to 25%,

and

(2) 460 houses MZ-2 type per month, if the wastages are of the level assessed by the technical consultants, and 400 MZ-2 type houses per month if the wastages are of the level assessed by the Committee.

CHAPTER VIII

SECTION I

Estimated Cost of Production of MZ-2 Type Houses

It has been pointed out in the preceding chapters that the original design was for the MZ-2 type house. In Chapter IV, it was observed that this design had to be given up on account of its cost being excessive, as it contained an extremely high proportion of imported items.

2. Although no regular production of MZ-2 house was established, the Committee has endeavoured to estimate the cost of producing a house of this type assuming normal conditions, with the factory running three shifts. A full load factor has been taken into account, since any price fixation should be based on the cost of production under such conditions.

3. It has already been pointed out in Chapter VII that the normal output of the factory can be considered to be 460 MZ-2 type houses a month, if breakages in manufacture are controlled at a maximum of 6% as estimated by the technical consultants. If the breakages increase to 25%, the monthly output will be only 400 houses. In order to give a full picture of the financial effects involved, the cost of production has been estimated separately under both these conditions. When the breakages are at the lower level, the daily output will be of the order of about 18 houses as against about 15 houses per day when the breakages are at the higher level. These rates of output have been used in determining the costs.

4. The estimated costs have been shown in the exhibit attached to this Section under certain detailed heads so as to give an idea of their makeup. Information regarding the value of materials imported, the value of indigenous materials used, expenditure on wages and overheads, cost of depreciation, royalty etc., are readily available from this exhibit.

5. In respect of imported materials, prices have been calculated from the available invoices. It should be noted that the materials supplied for 1000 houses were not on the basis of a fixed rate, but were on a 'cost plus' basis. The invoices show only provisional prices, and final bills are yet to be received. It is therefore quite possible that the actual final values may be different from those included in estimated costs. It may, however, be taken that they will be near enough to the final prices. Charges on account of customs duty have been provided for in the calculations.

6. In the Chapter dealing with the organisation of the factory, it has been pointed out that in the opinion of the Committee, the present strength of officers and staff is excessive and requires considerable reduction. In estimating costs, only a reduced strength as is considered reasonable has been taken into account. If the strength is retained either at the present level or as sanctioned, the costs will be appreciably higher than those estimated.

7. In assessing the value of labour and staff salaries, an addition of 15% has been made to provide for leave salaries, provident fund contributions etc. In the case of labour, this addition is intended also to provide for extra expenditure that would result by observing all the requirements of the Factories Act, which, incidentally, is not the case at present.

8. Depreciation on capital assets has been assessed as considered reasonable, and as far as possible, consistent with the Incometax Act. Moulds, jigs etc., have been adjusted on the basis of a life of five years.

9. Detailed statements showing how the values against the various heads have been arrived at are separately available, but have not been included in this report, as they will be too voluminous.

10. It will be seen from the cost statement that the cost per prefabricated house ex-factory varies as follows :—

	1:1 mix. Rs.	*1:2 mix.* Rs.
When daily output is 18 houses	4,775	4,682
When daily output is 15 houses	4,938	4,875

The least cost is Rs. 4,682 with 1 : 2 mix and at full load of 18 houses a day and the maximum is Rs. 4,938 per house with 1 : 1 mix at 15 houses per day.

11. The erection cost, inclusive of the traditional portion, has been estimated at Rs. 1,000 per house. A very careful study has been made of the estimates made by the factory management in this respect, and the field experience of the Construction Engineer has also been taken into account. It was noticed that the management's estimate was not complete and that the Construction Engineer's actual experience could be improved upon. The estimate of Rs. 1,000 per house, which is higher than the management's estimate, but lower than that of the Construction Engineer, is considered reasonable and attainable.

12. Thus, for fabrication and erection, the cost per house, after charging cost of sales and designs, will be a minimum of Rs. 5,710 or Rs. 5,700 roundly, and a maximum of Rs. 5,971 or Rs. 6,000 roundly, without making any provision for interest on fixed and working capital.

13. The working capital will represent at least 3 months' cost of production which will be about Rs. 72 lakhs. This, together with the fixed capital, would amount to an investment of Rs. 135 lakhs. If the price is fixed at Rs. 6,000 per house, it will leave either no margin or a maximum margin of Rs. 300 per house, to provide for interest on capital. At the maximum margin, this would amount to about 12% on capital investment. Thus, on the whole, a price of Rs. 6,000 per house will be a very reasonable minimum on the basis of cost of production.

14. A price of Rs. 6,000 for one type MZ-2 house is very much on the high side. Houses of a similar type and size are being regularly constructed in Delhi with traditional building materials at a much lower cost.

15. The MZ-2 type of prefabricated houses do not possess any special advantages over similar types of houses built in brick and cement mortar as to justify the higher price.

Exhibit showing Estimated Cost of Production and Erection of MZ-2 Type houses.

Vide Para 4, Section 1, of Chapter VIII.

	Cement/Sand Ratio 1:1				Cement/Sand ratio 1:2			
	On the basis of 18 houses per day		On the basis of 15 houses per day		On the basis of 18 houses per day		On the basis of 15 houses per day	
Quantitative Data :	Per pair of Houses				Per pair of Houses			
Cement	15,632 lbs.		18,982 lbs.		10,671 lbs.		12,957 lbs.	
Sand	15,632 lbs.		18,982 lbs.		21,342 lbs.		25,914 lbs.	
Neat foam liquid	3 gals.		3,680 gals.		2,900 gals.		3,500 gals.	
Water	1,125 gals.		1,367 gals.		1,120 gals.		1,360 gals.	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Material								
Imported	7,646		7,659		7,644		7,656	
Indian	894		1,021		710		899	
		8,540		8,680		8,354		8,555
Wages	268		322		268		322	
Factoy salaries	52		62		52		62	
Transport Service	48		58		48		58	
Power & Fuel Repairs & Maintenance	64		78		64		78	
	54		64		54		64	
Stores service & Inspection	18		20		18		20	
Management	112		134		112		134	
Fire & Security	10		12		10		12	
Welfare Expenses	34	660	40	790	34	660	40	790
		9,200		9,470		9,014		9,345
Depreciation	280	280	336	336	280	280	336	336
		9,480		9,806		9,294		9,681
Royalty	70	70	70	70	70	70	70	70
		9,550		9,876		9,364		9,751
Erection, including traditional portion	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
		11,550		11,876		11,364		11,751
ADD Cost of Sale & Design	56	56	66	66	56	56	66	66
		11,606		11,942		11,420		11,817
For One MZ-2 Type House		5,803		5,971		5,710		5,908

SECTION 2

Estimated Cost of Production of FR-1 Type Houses

16. It will be seen from Section 1 that the cost of production and erection of one MZ-2 house is estimated at Rs. 6,000 per house. Since this type is more expensive than houses of similar dimensions constructed and completed traditionally and since for the construction and erection of such houses, materials and components worth about Rs. 3,800 have to be imported, the alternative FR-1 type house had to be designed. In order to examine the economic aspect of this type of house, it is necessary to examine the cost of production and erection of this type of house.

17. As in the case of the MZ-2 type house, costs have been ascertained under the four different conditions namely:—

(1) 1:1 mix—with breakages as estimated by the technical consultants;

(2) 1:1 mix—with breakages as estimated by the Committee;

(3) 1:2 mix—with breakages as estimated by the technical consultants;

(4) 1:2 mix—with breakages as estimated by the Committee.

It has already been pointed out that with breakages as estimated by the technical consultants, the monthly output will be about 250 houses per month or 3000 houses per year. At the rate of breakages as assessed by the Committee, the output will be about 210 houses per month or 2520 houses per year.

18. If maximum economy of labour is achieved in the factory, some savings are possible in the factory production costs. In estimating these costs, we have assumed such savings. With these adjustments, the cost has been estimated as shown in the exhibit attached to this section. It will be seen that the minimum cost is Rs. 3,800 roundly and the maximum is Rs. 4,300 roundly, the former with 1:2 mix with breakages as estimated by the technical consultants and the latter with 1:1 mix with breakages as estimated by the Committee.

19. It will be evident that if the price is fixed at somewhere about Rs. 4,300, the organisation may just cover itself against its expenditure without much of a margin for interest on capital invested. Assuming the cost works to Rs. 4,000 on the average and the price is Rs. 4,300 per house, the margin will be only Rs. 300 per house. At this rate, on 2,500 houses per year, the gross earnings will be Rs. 7,50,000 which will be equal to a rate of about 5·5 per cent on a capital investment of Rs. 135 lakhs, provided, of course, that the full quantity of houses produced can be sold to the public year after year.

20. Taking all factors into account, it can be safely stated that the cost per house cannot be anywhere below Rs. 4,000 for the FR-1 type house.

Exhibit showing Estimated Cost of Production and Erection of FR-1 Type houses.

Vide Para 18, Section 2, of Chapter VIII

	Cement/Sand Ratio 1:1		Cement/Sand Ratio 1:2	
	Breakages as estimated by the Technical Consultants. Output : 3000 houses per year	Breakages as estimated by the Committee. Output : 2500 houses per year	Breakages as estimated by the Technical Consultants. Output : 3000 houses per year	Breakages as estimated by the Committee. Output :2500 houses per year
Quantitative Data :	*Per each House*		*Per each House*	
Cement	14,042 lbs.	17,050 lbs.	9,585 lbs.	11,639 lbs.
Sand	14,042 lbs.	17,050 lbs.	19,170 lbs.	23,278 lbs.
Neat Foam liquid	2·720 gals.	3·300 gals.	2·600 gals.	3·160 gals.
Water	1,012 gals.	1,229 gals.	1,006 gals.	1,222 gals.
	Rs. Rs.	Rs. Rs.	Rs. Rs.	Rs. Rs.
Material :				
Imported	978	989	975	986
Indian	894	1,009	730	810
	1,872	1,998	1,705	1,796
Wages	214	255	214	255
Factory salaries	48	57	48	57
Transport Service	36	43	36	43
Power and Fuel	59	70	59	70
Repairs and Maintenance	49	59	49	59
Stores service and Inspection	14	17	14	17
Management	103	123	103	123
Fire and Security	10	11	10	11
Welfare Expenses	30 563	36 671	30 563	36 671
	2,435	2,669	2,268	2,467
Depreciation	222	264	222	264
	13 235	16 280	13 235	16 280
	2,670	2,949	2,503	2,747
Royalty	55	55	55	55
	2,725	3,004	2,558	2,802
Erection including traditional portion	1000	1000	1000	1000
Including precast material	200 1,200	200 1,200	200 1,200	200 1,200
	3,925	4,204	3,758	4,002
ADD Sales & Design	51	61	51	61
For One House	3,976	4,265	3,809	4,063
Or Say Roundly Rs.	4,000	4,300	3,800	4,100

CHAPTER IX

Comparative Study of Costs: Traditional type Versus Prefabricated House MZ-2 and FR-1

A visit to the Jungpura site affords an opportunity to study both methods of construction, the traditional and pre-cast, both types having been erected side by side.

2. Building construction basically resolves itself into the handling of weight and placing it in its final position. Precast construction reduces this weight considerably. But a practical usage of any precast method must take into account the soundness of design, construction procedures as well as the invested capital, and all three must be served to advantage. This is the final test which determines whether a method or system of construction is to survive. In the previous chapter, detailed costs have been established for the precast houses.

3. The C.P.W.D. has constructed, on behalf of the Rehabilitation Ministry, traditional dwellings in bricks and mortar more or less of the same size as the prefabricated types.

Dwellings put up in the traditional manner appear to be pucca, sound, durable and well liked by the occupants and cheaper than the prefabricated types. It is understood that the Rehabilitation Ministry are selling these houses at Rs. 5,000 each, and this includes the cost of compound walls also.

As compared to this price, the MZ-2 type will cost about Rs. 6,000 and the FR-1 type about Rs. 4,300, in both cases, *without* the compound walls.

4. At the present stage of production, the precast design has a number of serious limitations, and although its design has not yet been finalised, it can be stated at this stage that the prefabricated house does not convey to most people a sense of its being a permanent dwelling. It strikes one as being essentially a temporary structure. Having regard to all the factors involved, the Committee feels that even when the production snags are overcome, it would be unwise to expect a persistent demand for such houses, unless they can be constructed at a cost of Rs. 3,000 or thereabouts. Unfortunately, it is not possible to see, in the foreseeable future, any possibilities of such a drastic reduction in the production costs, when using the wall panels advocated by the consultants.

CHAPTER X

Organisation of the Factory

The existing set up and organisation of the housing factory is as follows:

There is a Committee of Management consisting of

(1) The Joint Secretary, Ministry of Health, Government of India, as Chairman,

(2) The Director of Housing, Ministry of Health, Government of India, as Member/Secretary,

(3) A representative of the Ministry of Finance,

(4) A representative of the Ministry of Works, Mines and Power,

(5) A representative of the Ministry of Labour,

(6) A representative of the Ministry of Industry and Supply.

This Committee has full powers for giving financial sanctions and directing the affairs of the Housing Factory. The actual execution of the work is directed by the Director of Housing, who is also the Managing Director of the Factory. The technical consultants advise on technical matters.

2. At Appendix III will be found a Chart showing the existing set up of the organisation at the factory proper. Appendix IV shows the various posts and their strength as sanctioned at present. The rates of pay sanctioned for the respective appointments are alsc indicated therein.

3. With the knowledge which the Members of the Committee have about the organisation of similar commercial concerns, the inevitable conclusion is that the present set up is extremely top heavy. An undertaking of this type and size simply cannot afford to employ the ranks and the numbers that have been sanctioned. The organisation for such a factory must commence by employing the absolutely minimum number of people required to run the show. It can then be developed and built up to suit the volume of business being conducted The actual position is that an estimate was made of the requirements for the factory at full load, sanction for all the posts was obtained and recruitment was made without too much regard being paid to the progress of production. Little attempt appears to have been made to weed out staff who were employed during the construction period and who were surplus to requirement on completion of the factory.

4. The Committee has carefully considered the necessity for the various posts now sanctioned for this factory. In their view, the following changes can be effected.

5. For a small factory of this size whose policies are decided by a Board of Management, it is scarcely necessary to have a Managing

Director, a General Manager as well as a Works Manager. It is suggested that a first class and experienced works manager be appointed who would work directly under the Board of Management. His principal assistants would be:

(a) A Production Engineer, who would look after production and equipment at the factory,

(b) A Chemist, who would attend to the problems of chemical and quality controls,

(c) A Construction Engineer, who would attend to the field construction work.

This is all the Senior Staff that is needed at a factory of such a size. The Committee accordingly recommends the following:

(i) The position of Managing Director and General Manager be abolished, and a first class Works Manager, with adequate experience, be appointed in sole charge of the entire factory. He would carry out the policies laid down by the Board of Management.

(ii) From the existing staff, suitable appointments be made for the position of Production Engineer, Chemist and Construction Engineer.

(iii) The present appointment of a Liaison Officer and Town Planner should be converted into that of an Assistant Works Manager.

(iv) The position of Chief Purchase Officer should be abolished. His function should be carried out by a Chief Store Keeper.

(v) The post of one Chief Designer, one Senior Designer, 3 Junior Designers Grade I, and 7 Junior Designers Grade II, are not considered necessary. There should be one good Designer, assisted by three able Draughtsmen. Additional drawing office staff can be recruited according to the volume of work.

(vi) The position of Transport and Despatch Officer can be done away with. Corresponding responsibilities can be shouldered by an Assistant Construction Engineer.

(vii) Against the three sanctioned posts of head clerks, only one is considered necessary.

(viii) The 6 posts of Junior Engineers are not necessary, in view of the fact that there will be overseers in charge of the erection. So, only two Junior Engineers should do.

(ix) The post of Surveyor is not considered necessary.

(x) The post of Fire and Security Supervisor should be combined with that of a Welfare Officer.

(xi) All the posts of Personal Assistants should be done away with.

(xii) The Administrative Officer can be the Personal Assistant to the Works Manager.

(xiii) Six Store Keepers are not considered necessary; only 2 are needed. It may be necessary, in due course, to appoint a few godown keepers.

(xiv) The sanctioned strength of Chargehands is, at the moment, 15, out of which 9 are employed in the Metal Assembly Shops. After the present stock of imported aluminium components are over, there will hardly be any work in the Metal Assembly Shops. It is therefore suggested that there should be a final strength of 9 Chargehands, which would include 6 for the casting section.

(xv) The three positions of Assistant Surveyors, sanctioned at present, are not necessary.

(xvi) At present, there are 2 Overseers; as and when construction centres increase, it will be necessary to employ more overseers.

(xvii) As against 15 Examiners sanctioned at present, 9 would meet the requirements.

(xviii) The 2 posts of Progress Assistants and 2 posts of Technical Assistants, which have been sanctioned, are not considered necessary.

(xix) At present, there are three Fire Security Inspectors; only one is considered necessary.

(xx) There are, at the moment 11 Issures; only 6 are considered adequate.

(xxi) At the moment, there are 6 posts sanctioned of Assistant Time Keepers; only 4 are considered necessary.

(xxii) The position of a Librarian for drawings is not considered necessary.

(xxiii) As against 9 posts of Security Men sanctioned, 3 should be adequate.

(xxiv) At present, there are 27 Security Chowkidars; this is considered very high. About a dozen Chowkidars should suffice.

(xxv) There are 14 Messengers at present; only 10 are considered necessary.

(xxvi) There are a total of 61 Clerks Grades I, II and III and Typists. It is felt that only 40 are necessary.

As has been stated before, unless staff expenses of the factory are brought down to a reasonable proportion, they will be a permanent burden on the production costs.

CHAPTER XI

Fixation of the Selling Price for FR-1 Type House during the initial period

The Committee's findings reveal that the present type of house building material produced in the factory in the form of plain, foam concrete wall panels is unsuitable for the purpose. The extended tuning-up period and the past record of the Consultants do not inspire confidence. The Committee cannot help but feel that if conditions are permitted to stagnate as at present, the chances of the Consultants overcoming the snags experienced in the day to day production are very remote indeed. Under such circumstances, it is scarcely possible to determine the true production cost, with a view to ascertain a selling price in the initial period.

2. The MZ-2 type house is ruled out. It employs an unduly large proportion of imported materials and its cost is excessive.

It is true that Government have in stock very substantial quantities of imported aluminium parts. Whilst there will be no difficulty in disposing of the aluminium roofing material at a good price, it is feared that the balance of the aluminium components may have to be disposed of at considerably below cost.

3. At the present stage, the selling price can only be suggested for FR-1 type of flat roof house whose final design has yet to be evolved and in the case of which the factory production snags have to be put right.

4. As at present designed, this type of house utilises imported components valued as high as Rs. 1,000 per house. Substitute items will have to be produced. It may be stated that at the moment this question is being actively studied and followed up by the local management.

5. The maximum cost of this type of house, as explained in Chapter VIII, is Rs. 4,300. Apart from the substitution of imported components by locally produced ones, the Committee does not envisage any further reduction in the production costs of such houses. It estimates this saving at about Rs. 500 per house, bringing down the cost to Rs. 3,800. A margin of Rs. 200 will have to be provided for interest on the investments. This makes a total cost of Rs. 4,000 per house.

6. The Committee accordingly recommends that the selling price of a FR-1 type house be fixed in the initial period at Rs. 4,000 per house. Before such houses can be sold to the public, all the defects experienced in the house building material as well as the production snags in the factory will have to be overcome. The Committee repeats that unless this is done, it cannot recommend the sale to the public of such houses.

CHAPTER XII

Summary of Conclusions and Recommendations

Terms of Reference 1: To examine the organisation of the factory that has been set up for the manufacture of Alcrete Housing Building materials, and to make recommendations regarding its adequacy or otherwise for the purpose in view.

(1) For the maintenance of production, a fairly satisfactory organisation has been built up, but the factory has been staffed on a very generous scale. It is recommended that the economies suggested in Chapter X be carried out.

Terms of Reference 2: To examine the house building material produced in the Alcrete factory and the design of the house, and to pronounce on their suitability from a structural and qualitative point of view.

(2) The house building material produced in the factory at the moment comprise foam concrete wall panels which bear no relation whatsoever to the type of patented wall panels previously specified by the Consultants. The present type of plain foam concrete load bearing panels bear all traces of a complex product, the commercial production of which does not appear to be a straightforward job. Production of a uniform product with the desired properties would appear to require considerable experience and close control of the manufacturing process. The Consultants' lack of experience in the production, on a commercial scale, of this complex product has been abundantly revealed. The performance of the factory product in actual practice has so far turned out to be unsatisfactory. Even with large scale production, the cost per unit volume of foam concrete will not be comparable with that of ordinary dense concrete.

(3) *Design of the House.*—The original design known as the MZ-2 type with an aluminium roof and other expensive aluminium alloy parts may have been suitable from the point of view of quick production and erection, and also from the point of view of the consultants, whose function it is to promote the use of aluminium products, but from the point of even reasonably low cost, the design has failed badly. Its production can no longer be considered in view of its high cost.

(4) Another design is being evolved which substitutes the aluminium roof with a flat roof, composed of a large number of foam concrete panels. At present, even this house employs a fairly large proportion of expensive aluminium components. The factory has yet to be equipped to produce concrete parts which will substitute such aluminium parts. The design is yet to be finalised in certain details.

(5) As far as the general design of the flat roof house is concerned, there can be no complaints. The design would appear to be generally to the taste of the buying public.

(6) The choice of foam concrete wall panels as a principal ingredient of a low cost house is not justified, because it is definitely more expensive than the traditional type of construction. The application of foam concrete wall panels results in a house which is, in no way, superior to a house built in the traditional manner.

(7) Although the Committee has stated that the design of the flat roof type house is suitable, it cannot recommend the sale to the public of a house constructed with the foam concrete panels, as now produced; the reasons being that the consultants have not yet succeeded in producing in the factory a consistent and safe panel, which can be guaranteed not to develop cracks after erection.

(8) The Committee recommends that Government should obtain from the consultants a definite indication of the time required by them to complete the tuning up of the factory, which has been laid out at such heavy cost, strictly in accordance with the consultants' designs and specifications.

(9) The consultants have been carrying out their experiments during the past 6 to 8 months exclusively at Government expense. At the most, a further 3 to 4 months may be given to the consultants to set right the production problems at the factory. If the consultants do not guarantee results, Government should not hesitate to take such action as is indicated.

(10) Even if the production problems relating to the manufacture of load bearing foam concrete wall panels are solved within a reasonable period, it is certain that the production costs at the factory, in view of its very high initial capital cost and the low level of its rated capacity, cannot be brought down to an extent that would stand comparison with costs of traditional building materials. The Committee has accordingly given a great deal of attention and thought to the problem of utilising the factory and the existing organisation in the most effective manner.

(11) The Committee recommends that future production at the factory should not be confined to the manufacture of the complex foam concrete load bearing panels but should be extended so as to cover the vastly greater field of ordinary concrete products, such as hollow building blocks and various other types of precast products, which are in great demand for all types of building activities. It is felt that the future bread and butter line for this factory should be the production of hollow concrete building blocks, used in place of ordinary bricks.

(12) The siting of the Government Housing Factory at Delhi is such that the only cheap raw material it can secure is Jumna sand. This sand, which is normally extremely fine, is not considered suitable for making concrete hollow blocks. This sand, however, can be screened at the factory, the very fine portion being used for the production of insulation blocks, as mentioned later, and the coarse portion for the economic manufacture of hollow blocks. Experiments conducted have shown promising results, and there is reason to believe that hollow blocks, made with Jumna sand, can produce walling at lower cost than bricks and mortar at Delhi prices.

(13) The existing factory process should be used to produce very low density insulation blocks and panels for which there should be a good demand. A precasting section should be set up for manufacturing concrete products of various types, so largely used by the C.P.W.D. and other house builders.

(14) This Committee has been requested to submit its report as early as possible. In the short time at its disposal, it has not been possible to study, in very great detail, the economics of the proposals made above. It is, therefore, suggested that Government should appoint immediately a small committee of people with experience of house building and concrete products industry to study the above recommendations and make final proposals.

Terms of Reference 3: To examine the operation of the Alcrete Factory from the commercial (including financial) point of view and to advise on the fixation of the sale price of the house in the initial period.

(15) The commercial side of the operation of this factory has been discussed in the relevant preceding chapters. From para. 7, it will be seen that the Committee cannot recommend the sales to the public of a house constructed with the building panels as now produced, the reasons being that the Consultants have not yet succeeded in producing in the factory consistent and safe panels which can be guaranteed not to develop cracks after erection. In view of this finding of the Committee, there would seem to be no necessity for fixing a price to be charged for the house in the initial period. In spite of this position, if the Government feel that there is any chance of the material proving suitable, and if they, for any reason, decide to sell such houses to the public, the Committee would recommend that the MZ-2 type houses should be sold at not less than Rs. 6,000 per house and the FR-1 type houses at not less than Rs. 4,000 per house.

CHAPTER XIII

Acknowledgments

This report will not be complete without the Committee's acknowledgments of the assistance it has received from the various parties, in completing this enquiry.

2. Messrs. Structural & Mechanical Development Engineers Ltd.,— the technical consultants to Government—, the Director of Housing, the Officers and staff of the Government Housing Factory, were all very helpful to us and placed promptly at the disposal of the Committee all the information that was called for. Our thanks are due to them.

3. Our thanks are particularly due to the Concrete Association of India at New Delhi, who kindly agreed to place the services of their Engineer Mr. C. V. Nazareth to carry out numerous experiments and tests as indicated by the Committee.

4. Dr. R. C. Hoon, Deputy Director, Central Waterpower Irrigation & Navigation Commission, carried out certain tests at the Hirakud Laboratory at the request of the Committee. Similarly, certain tests were carried out by Shri C. L. Handa, Director, Irrigation Research Institute, Punjab (India). Shri N. K. Aggarwal and Shri N. M. Gidwani of the Central Designs Organisation of Central Waterpower Irrigation and Navigation Commission, New Delhi, supervised the structural tests carried out by the Director of Housing. Thanks of the Committee are due to all of them.

S. MOOLGAOKAR,
Chairman.

KANWAR SAIN,
Member.

S. V. AIYAR,
Member/Secretary.

APPENDIX I

MEMORANDUM

SUBJECT:—*The Establishment of a Factory for Prefabricated Houses in India.*

I was asked by the Cabinet to utilise my visit to the United Kingdom to investigate the possibility of acquiring a factory for the mass fabrication of houses in India. Dr. Koenigsberger subsequently visited the United Kingdom to assist me in these investigations.

2. On the advice of the relevant officers of the United Kingdom Government and after consultation with the Chancellor of the Exchequer, I consulted firm of Messrs. Structural and Mechanical Development Engineers Ltd. Slough, Bucks who had been responsible for the design and manufacture of a large number of houses in England and Scotland. I also visited one of the factories in Scotland where aluminium houses are being produced at the rate of 40 houses per day.

3. I asked the firm to prepare a detailed scheme for the establishment of a plant in India for the manufacture of 100 houses per week or 5,500 houses per annum.

4. The salient features of this scheme are

(i) The house to be manufactured at the Indian plant will consist of prefabricated foamed concrete panels of about 5" thickness, 3'-2" width and 10' height. These panels can be used for the composition of houses of varying types and designs as well as for schools, small hospitals, middle class bungalows and other structures. Foamed concrete is a material with excellent heat insulation qualities which can be manufactured from indigenous raw materials. As the material is very light (specific weight ·65) the panels can be transported and handled without difficulty.

(ii) For the present, foamed concrete panels will be used for the manufacture of small houses consisting of two rooms, two verandahs, a small kitchen, a bath room and courtyard enclosure and a latrine.

Including doors and windows but without electrical fittings the complete houses are estimated to cost Rs. 2,500 each including the cost of the plinth. They will be of permanent construction.

(iii) All the materials required for this type of construction are available in India with the exception of a small quantity of aluminium alloy necessary for the protection of the panels during transport and as roof-covering. The total annual consumption of the factory of such aluminium alloy for the construction of 5,500 houses will not exceed 1,500 tons which I am advised, can be secured without difficulty.

(iv) The capital expenditure for the plant necessary for the manufacture of these houses (inclusive of buildings) is estimated at Rs. 25 lakhs. If this amount is written off within 10 years the cost per house will be about Rs. 38/8/-. The cost of house as estimated includes this amount.

(v) A good proportion of the plant and machinery required can be procured in India the rest is available in the United Kingdom.

(vi) The scheme includes arrangements for the transport of the foamed concrete panels from the factory to various housing sites.

5. In order to acquaint local authorities, housing societies and other concerned with the type of house to be manufactured in the proposed plant it is suggested to order for the manufacture of a small number of prototypes (six pairs of houses). These prototypes will be manufactured in England and shifted to India. As they are produced individually and as they have to be packed and sent to this country their cost is expected to be about four times that of the houses that will eventually be manufactured at the Indian plant. An agreement was reached that the cost of prototypes would be paid according to actual expenditure incurred subject to costing by the costing organisation attached to His Majesty's Government's the Ministry of Supply up to a maximum ceiling of £1,700 per pair inclusive of packing, insurance and freight to Bombay. The prototypes will not only serve for demonstration purposes but will also facilitate the finalising of many structural details of the design before mass production is taken up.

6. Under my instructions a draft agreement was drawn up with Messrs. Structural and Mechanical Development Engineers Ltd. in Slough in consultation with the Director General, India Store Department—Mr. P. G. Bhagat—and with Dr. Koenigsberger. This agreement is now ready to be finalised and provides for the following terms:

(a) for licences on the patent rights of the methods of construction developed by Messrs. Structural & Mechanical Development Engineers, Ltd.;

(b) for technical assistance for purchase of machinery and materials in England;

(c) for the preparation and supply of detailed working drawings for the plant as well as for the houses;

(d) for technical experts to be sent to India to help with the establishment and the initial working of the plant;

(e) for a royalty payable to Messrs. Structural and Mechanical Development Engineers Ltd. in return for these services.

7. Details of designs, estimates agreements etc. are contained in a report submitted by Dr. Koenigsberger.

8. I recommend that the first factory should be set up in the neighbourhood of Delhi for the supply of houses to the Delhi area, to the Southern parts of the Punjab and the Northern parts of United

Provinces; that three or four other factories be erected in other parts of India after the first plant has proved a success.

9. As this is a new venture by the State, it is necessary to locate it in some appropriate Ministry for administrative purposes. I suggest that a new subject of "Housing" should be created and placed under the direction of my colleague, the Minister for Health. In England also housing is under the Health Ministry.

R. K. SHANMUKHAM CHETTY.

The 16th July 1948.

Report submitted to the Hon. the Finance Minister, Government of India

SUBJECT:—*Transfer of Housing Factories from the U. K. to India.*

At the meeting of the Committee of the Cabinet, held on Thursday, the 27th May, 1948, it was decided that steps should be taken to establish house building factories in India at an early date and that Dr. Koenigsberger should proceed to the United Kingdom as soon as possible to investigate the possibility of adapting to Indian conditions the methods used in the United Kingdom for building prefabricated houses, and to explore the possibilities of setting up house building factories in India. Sample houses and prototypes should be obtained from the United Kingdom so that they could be tried and tested under Indian conditions.

In addition, the Directorate General of Industries and Supplies desired Dr. Koenigsberger to investigate the establishment and procurement of plant for making prefabricated factory buildings and roofing.

In accordance with these instructions, I have spent 25 days in England and have inspected a large number of housing estates in England and Scotland, studied plants for the mass manufacture of houses and housing components, interviewed tenants and discussed production problems with manufacturers, exporters and organisers. As the housing problem in the United Kingdom is almost entirely sponsored and directed by the Government, I made a point of obtaining the views of the authorities concerned on the different types of construction considered for India.

Help and advice were obtained from several Government Departments, in particular from Mr. H. Symon, Under Secretary to the Ministry of Health; Sir George Turner, Joint Secretary to the Ministry of Supply; Professor F. Webster, Chief Scientific Adviser to the Ministry of Works; Mr. R. B. White, R.I.B.A. and A. E. Duck, both of the C. S. A.'s Department of the Ministry of Works; Mr. Cyril H. Walker, Director of Housing to the London County Council, Mr. S. Howard, R.I.B.A., Housing Architect to the London County Council, Mr. Romanes, Chairman of the Edinburgh Housing Board, and with Messrs. Blanfoy and Ellicot, Directorate of Technical Planning in the Ministry of Town and Country Planning. Questions of contracts

and procurement were discussed with Mr. P. G. Bhagat, India Stores Department, and Mr. M. L. Bhargava, of the India Supply Commission.

Methods of construction used in the housing programme in England and Scotland are usually grouped under the headings 'traditional construction' and 'non-traditional construction'. The term 'Non-traditional construction' covers all methods which are based on the mass manufacture of whole houses or component parts, irrespective of whether the results are considered as temporary or permanent houses. The number of houses built by various firms on behalf of the local authorities in the United Kingdom with 'non-traditional' methods of construction during the past two years exceed 100,000.

After a careful study of several hundred proposals for construction methods, the Scientific Adviser's Department of the Ministry of Works selected about 35 major types for actual execution. Out of these 35 only about 8 or 10 have been used for large scale mass manufacture, while the other approved methods were applied to small groups of houses, according to local requirements and locally available materials.

Non-traditional houses in England can be grouped according to their construction in 9 major groups:

1. Steel houses.
2. Houses with steel frames covered with factory-made slabs or boards of light weight concrete or other filling materials.
3. Timber houses.
4. Timber houses covered with insulating slabs of fire-resisting material.
5. Houses built of pre-cast solid or hollow concrete blocks.
6. Houses built of pre-cast light concrete units, including no-fines concrete, foamed slag, aerated concrete, etc.
7. Houses cast *in situ* in prefabricated moulds, including both heavy and light concretes with or without re-inforcement.
8. Aluminium houses.
9. Constructions using wood wool, cement, asbestos sheets and other permanent or semi-permanent wall materials.

The degree of prefabrication varies from the concrete house, cast at the site with the help of factory made shuttering to aluminium houses which are factory completed with all fittings and require the least amount of site work. The method most frequently used lies between these two extremes and consists of the factory assembly of large load-bearing wall panels (each about 3 ft. wide and 10 ft. high) which can be assembled very quickly by unskilled labour. This method has the advantage of the greatest ease of transport.

Many of the construction methods listed above are not adaptable to our present requirements in India. Methods 1 and 2 require too much steel (about 4½ tons per unit in the case of the B.I.S.F. houses). Methods 3 and 4 require a large supply of timber and are not sufficiently fire-proof. The construction of timber houses in hard wood

would be too expensive, while soft woods would require elaborate treatment for protection against termites.

Method 5 involves a large consumption of cement and is bound to cause transport difficulties, as the pre-cast concrete members are heavy and bulky.

Method 6, *i.e.*, the use of light concrete, is by far the most interesting for India. The light concretes have better insulating qualities than brick, stone or heavy concretes, and are usually strong enough to take the structural stresses which occur in one and two-storeyed buildings. In the case of the mass manufacture of housing panels of light weight concretes the main problem will be to give them sufficient strength and rigidity to withstand transport.

Method 7, the casting *in situ* in moulds which can be re-used for 20 or 30 houses may well be adaptable to India. Unfortunately, the experiments with no-fines concrete conducted in the United Kingdom are not conclusive and, so far, have not provided a solution to the roofing problem.

Method 8, the Aluminium House, was used in Great Britain not so much with the idea of providing a cheap house, but for the purpose of utilising the production capacity of the many aluminium plants and aircraft factories which were in existence at the end of the war. Although such conditions do not apply in India, the use of small quantities of aluminium in house construction may well be worth considering because it is one of the few materials—if not the only one—which has gone down in price since 1938 and is fairly freely available. It has the advantage of being non-corrosive, and of being light and easy to transport.

Method 9 covers a large variety of materials. The one most widely used in the mass fabrication of houses is cement asbestos in the form of sheets. Its inclusion as a material of major importance to the Indian housing programme deserves serious consideration. Unfortunately, there is a world shortage of asbestos fibre. As the two main producer countries of this raw material are South Africa and Canada, it does not appear likely that we shall be able to increase our production of cement asbestos sheet in the near future sufficiently to make this material a major component for large-scale manufacture.

Wood wool, wood fibre boards, straw boards, plaster and gypsum boards would all be useful for the mass production of dwelling houses. While the establishment of plants for the manufacture of such boards should be encouraged, the housing programme cannot afford to wait until such factories have come into being.

Investigations were therefore concentrated on methods using light concrete and small quantities of aluminium and subsidiary materials procurable in India.

The mass manufacture of houses involves the use of a large variety of materials. For this purpose, several groups of factories in the United Kingdom got together to pool their resources and to manufacture in each plant those parts for which the best equipment was available. In order to co-ordinate manufacture as well as procurement of raw materials and preparation of sites, and also in order to

have one agency as contract partner for the local authority under whose order the houses were to be constructed, various industrialists got together in groups and selected one of their group as a firm of managing agents or managing contractors. The role of managing agents usually fell to a firm of designers rather than to one of the manufacturers. Government authorities in the United Kingdom who were consulted, advised us that for the procurement of plants for India it will be best to deal with managing contractors rather than with individual manufacturing firms. The task of the managing contractors will be that of designers of building and plant for Indian conditions and of technical consultants of the India Stores Department in the procurement of the necessary machinery and of those raw materials and fittings which may have to be imported into India from other countries.

The investigations for a light weight concrete house in India were carried out in consultation with Messrs. Structural & Mechanical Development Engineers Ltd., in Slough, Bucks, England and with their architects Messrs. A. F. Hare and Partners who had been the designers and managing contractors for some of the aluminium houses, of which over 70,000 units were ordered and completed for local authorities in England and Scotland. These investigations resulted in the design of a house for mass manufacture in India. It will be composed of moulder panels using foamed concrete and light aluminium frames. A note describing this method of construction together with preliminary estimates for the houses and for the plant and machinery for their production is attached to this Report.

A draft agreement with Messrs. S. & M. D. Ltd., drawn up in consultation with Mr. P. G. Bhagat, India Stores Department, London is also enclosed.

In addition to the foam concrete house a scheme for the use of petrified wood wool in combination with cement asbestos sheeting was discussed and prepared in collaboration with Messrs. Uni-Seco Ltd. and their Architect, Mr. R. G. Booth, managing contractors for a large number of temporary houses built for the Government authorities in England. The design and proposals which resulted from the discussions with this firm are also attached. While the scheme for the foamed concrete houses is fairly complete, the Uni-Seco house for India will require a good deal of modification, discussion and supplementation before a decision can be taken in the matter. Although the shortage of cement asbestos fibre is likely to exclude any large scale adaptation of this system, the use of the "sandwich boards" of wood wool and cement asbestos as developed by Uni-Seco may well prove useful for roofing purposes, provided that the danger of cracking of the asbestos sheets can be overcome by suitable packing methods.

Plans for the mass manufacture of component parts, and particularly of standard roofing and standard doors and windows for factories, schools, small hospitals and dwelling houses, were discussed with the Arcon Group of designers and with Messrs. Taylor Woodrow Construction Ltd., who were the managing contractors for a group of firms producing the so-called Arcon House on behalf of the Government. Although the Arcon House was based on a light

steel frame and is therefore unsuited to Indian conditions, the experience of this firm in the organisation of mass manufacture of building components makes them valuable advisers for the development of standard component parts for Indian housing. A report containing their suggestions is attached.

Several other firms and groups of firms volunteered to work out schemes for the mass manufacture of building components. They were provided with the necessary information about Indian conditions and materials and told to submit their proposals through the India Stores Department.

Schemes discussed in England included, in every case, the manufacture and shipment to India of prototypes. Although such prototypes are expensive and give little indication of the cost of the ultimate product, it was agreed by all concerned that it would be well worth to have them, both for the Government of India and for the management of the proposed new housing factories. Prototypes will help to manufacturer in finalising the details of his production line and will help to give a clearer idea of our housing programme to authorities and to the general public. It is therefore suggested that prototypes be ordered of the Foamed Concrete House for India ("ALCRETE HOUSE") and of the Uni-Seco house for India: the former with a view to starting manufacture as soon as possible, and the latter for purposes of study and modification according to materials which can be locally obtained in sufficient quantity.

Investigations in the United Kingdom have on the whole confirmed my view that the provision of accommodation for refugees in particular and for labour and lower middle classes in general can be accelerated by the setting-up of plants for the manufacture of houses and their components.

My recommendation is to begin with a plant for about 100 houses a week. This plant will serve an area of about 500 miles diameter, other plants may follow in the neighbourhood of all important centres of consumption.

These plants will not replace the need for continuing our efforts to construct the largest possible number of houses by traditional methods. They will supplement the traditional housing programme, but not supersede it. It is also necessary to bear in mind that the consideration of factory assembly lines for houses and housing components will be effective only when manufacture starts working at full speed. In other words, the help to be expected from the proposed plants in the first year will be very small, it will be moderate in the second year and will give us all we want in the third.

DR. O. H. KOENIGSBERGER.

INDIA HOUSE,

Aldwych, London, W.C. 2.

8th July 1948.


सत्यमेव जयते

APPENDIX II

STRUCTURAL & MECHANICAL

DEVELOPMENT ENGINEERS LTD.

SLOUGH - BUCKS - ENGLAND

ALCRETE HOUSING FOR INDIA

JUNE 1948


सत्यमेव जयते

INTRODUCTION

Following the production of the Report on Prefabrication for the Mysore Government, the Indian Government deputed Dr. O. H. Koenigsberger to visit the United Kingdom to report on the possibilities of producing prefabricated houses in various parts of India.

Structural and Mechanical Development Engineers Limited, whose technicians were responsible for the design and development of the Aluminium House for the British Government, with their Consulting Architects, A. F. Hare and Partners, discussed in detail with Dr. Koenigsberger the most suitable type of house for general use in various parts of India and produced the ensuing estimates and drawings, showing the prices and arrangements of the MZ/2 Alcrete House.

Whilst presenting these estimates of the production and capital costs involved in the production of the type MZ/2 Alcrete House in India, we would emphasize the desirability of producing prototypes in England.

The price of these prototypes would be £1,500 each pair for 12 pairs, or £1,250 each for quantities between 50 and 100 pairs, delivered F.O.B. London.

The cost of producing prototypes in England would be amply justified by the fact that work on these could be proceeding parallel with the purchase and assembly of the plant, and the first 2 pairs would be available 6 months after the establishment of the necessary credit in London. Production in England would thereafter be at the rate of 2 pairs of houses per week.

It would be possible, by producing these prototypes, to ensure that any slight detail modifications considered necessary after inspection, were incorporated in the designs prior to commencement of production, thus enabling the Indian Plant to commence full scale production from the outset.


सत्यमेव जयते

Cost of producing six pairs of prototype MZ/2 houses in England.

	Per pair
	£
1. Production, materials, labour and overheads	866
2. Cost of special autoclave grids (£ 1,200)	200
3. Cost of foundations for trial erection (£ 250)	42
4. Cost of trial erection, labour and overheads (£ 200)	33
5. Drawings and Architectural service (£ 1,000)	166
6. Packing and F. O. B. Charges	300
7. Carriage, Insurance and Freight to Bombay at the rate of 30 Shipping tons/pair at the rate of £ 5-10-0 per ton	165
	1,772
Add 12½ per cent. Contingency	217
	1,989

It will be appreciated that a number of the items, in particular No. 5, would, if charge on the prototype, come out of the service cost incurred under the agreement when signed Alternatively, if it were considered preferable, we could manufacture prototypes on th cost basis as provided for other services in the agreement.

Although it would appear that the cost of these prototypes is high, we would like t point out that prototypes must be made for any mass-produced job and expenditur incurred at this stage will enable the production plant to develop its full effective outpu much sooner than if it were necessary to manufacture prototypes in India from the ne plant when it was available.

ALCRETE HOUSE FOR INDIA

Estimated cost of producing type MZ/2 Houses

NOTE.—Costs of production are based on the use of an Alcrete Housing Plant, capable of producing 5,500 single houses per year (2,750 pairs of MZ/2 Houses). as detailed in Part II of this estimate, and are based on the assumption that the Light Alloy parts are cut to length and drilled in the United Kingdom, for assembly in India.

Composite estimates of complete costs for type MZ/2 Houses.

	Cost per house. Rs. A. P.
1. CAPITAL COST—	
(As detailed on page 62) £. 119,881 Life Plant taken at 10 years Production over 10 years period—55,000 houses . .	29 0 0
2. COST OF FACTORY PRODUCED COMPONENTS—	
(As detailed on page 50)	1,676 0 0
3. COST OF TRADITIONALLY CONSTRUCTED COMPONENTS—	
(As detailed on page 51)	721 12 0
4. ROYALTY PAYMENTS—	
Based on Rs. 5 per 100 sq. ft. of Alcrete filled panel area . .	34 10 0
5. COST OF 75,000 sq. ft. FACTORY SPACE—	
At the rate of 10 per sq. ft.—£37,500 divide by 55,000 houses	9 2 0
TOTAL OVERALL COST PER HOUSE . .	2,470 8 0

Cost of factory made components (including erection)

Item No.	Description	Quantity	Cost
			Rs
1.	ALCRETE WALL PANELS—		
	including external heavy mortar face, internal sprayed cement face, light alloy, edge protection and reinforcement.		
	10′ 0″ high × 38″ External plain . . .	10 off	
	10′ 0″ high × 38″ External window . . .	3	
	10′ 0″ high × 38″ External door . . .	2	
	8′ 0″ high × 38″ External plain . . .	4	
	8′ 0″ high × 38″ External door . . .	1	
	10′ 0″ high × 38″ Internal plain . . .	5	
	10′ 0″ high × 38″ Internal door . . .	2	
	8′ 0″ high × 38″ Internal door . . .	1½	593
2.	ALCRETE WALL FILLER PANELS—		
	Fable end 13′ 4″ × 2′ 0″ (External) . .	1	
	9′ 6″ × 1′ 0″ (kitchen) . . .	1	
	Verandah 9′ 6″ × 1′ 0″	1	
	3′ 2″ × 6″	1	
	Party wall 13′ 4″ × 2′ 0″ (front room) . .	½	
	9′ 6″ × 1′ 0″ (kitchen) . . .	½	
3.	Providing and Fixing ALUMINIUM ALLOY FRAMED DOORS, faced aluminium alloy sheet externally, and with plywood internally, including door furniture and painting . .	3	174
4.	Providing and Fixing ALUMINIUM ALLOY FRAMES AND SHUTTERS, with ¾″ diameter mild steel rods at 5″ centres, including plywood lining, all furniture and cost of painting .	3	88
5.	Supplying and Fixing ALUMINIUM ALLOY VENTILATORS, complete	6	41
6.	ALUMINIUM ALLOY ROOFING, complete, including insulation and plywood lining and cost of painting to plywood, all framing brackets, fixing bolts etc., comprising mainly the following :—		
	Trussed Girder 2′ 0″ deep × 19′ 4″ long (9′ 6″ span)	1	55
	Eaves Beam 1′ 0″ deep × 19′ 4″ long . .	½	34
	Brackets 1′ 3″ deep × 3′ 2″ long . . .	3	7
	Roof Panels 1′ 7″ deep × 8′ 0″ long . .	22	528
	(including 2′ 2″ deep × 8′ 0″ long . .	2	
	window 1′ 7″ deep × 11′ 0″ long . .	6	
	canopies) 1′ 7″ deep × 4′ 0″ long . .	6	
	Ridge, 19′ 4″ run	19′ 4″ run	31
	Column Support	1	25
7.	ALUMINIUM ALLOY FRAMED PLY SHELVES AND BACK		100
	TOTAL COST . .		1,676

Cost of components of traditional manufacture (including erection.)

These costs are taken from the Mysore Report estimate and do not take into account any alterations in building costs since July 1947.

Item No.	Description	Quantity	Total cost
			Rs. A. P.
1.	EARTHWORK EXCAVATION FOR FOUNDATION and filling in basement with watering and tamping etc. complete	13·5 c. yds.	5 0 0
2.	LAYING LIME MORTAR AND GRANITE JELLY CONCRETE for foundations	55 c. ft.	24 0 0
3.	SIZED STONE IN CLAY FOR FOUNDATION and basement with bond stones etc.	216 c. ft.	82 0 0
4.	LAYING (1 : 2 : 4) CEMENT CONCRETE OVER basement	42 c. ft.	42 0 0
5.	BURNT BRICK IN CLAY TO COMPOUND WALL, BATH AND LATRINE	332 c. ft.	133 6 0
6.	CONSTRUCTING R. C. RACK IN KITCHEN over masonry superstructure		14 0 0
7.	CONSTRUCTING B. B. in cement and B. S. slab wash stones		10 0 0
8.	CONSTRUCTING SINKS IN KITCHEN		5 0 0
9.	CONSTRUCTING OVEN AND CHIMNEY IN KITCHEN		25 0 0
10.	FLOORING WITH 3″ (1 : 4 : 8) cement concrete and cement plastering etc., complete, to Compound Yard	3·89 sqs.	117 0 0
11.	COPING OVER COMPOUND WALL with B. B. in lime mortar and lime mortar plastering etc., complete	86 ft. run	64 8 0
12.	DADO IN CEMENT CONCRETE to compound wall, 2 ft. height	190 ft. super	20 0 0
13.	LIME MORTAR PLASTERING to compound wall	7·5 sqs.	40 4 0
14.	WHITE AND COLOUR TO ALCRETE PANELS		
	2 coats Externally	6·0 sqs.	2 4 0
	2 coats Internally	9·0 sqs.	3 6 0
	2 coats Compound wall	7·5 sqs.	3 0 0
15.	FLOORING with cement concrete (1 : 2 : 4) over a bed of 3″ lime concrete ½″ thick cement plastering, etc.	399 ft. super	96 0 0
16.	WHITE AND COLOUR WASHING, 2 coats as per area of lime plastering		10 0 0
17.	CLEARING APPROACHES etc.		25 0 0
	TOTAL COST		721 12 0

Principal materials required

Item No.	Description	Quantity for one house	Quantity for 1 year's supply	Source of supply
1.	ALUMINIUM ALLOY EXTRUSIONS, SHEET AND STRIP .	600 lbs.	1480 tons	U. K.
2.	REINFORCING WIRE MESH* .	200 lbs.	490 tons	U. K.
3.	CEMENT	1·5 tons	8250 tons	Local.
4.	SAND	3·625 tons	20,000 tons	Local.
5.	PLYWOOD	700 sq. ft.	3,850,000 sq. ft.	Local.

*NOTE.—This reinforcement has primarily been included to ensure the satisfactory handling of the panels by untrained labour. It is not necessary to provide structural strength to the house when the panels are erected.

We consider it likely that the use of steel reinforcement in the panels could be totally dispensed with after practical trials have ensured the capacity of the workpeople to handle the panels without damage.

Fuel and power requirements.

If the boiler plant is coal-fired, the quantity of coal required per day would be	6 tons.
If oil-fired, the quantity of fuel oil required per day would be . .	800 gallons.
The electrical power required would be	250 K. V. A. approx.

ASSEMBLY PLANT FOR INDIA

Equipment for prefabrication plant

NOTE—.(1) The attached list and description gives a close approximation of the cost of the plant necessary to manufacture 16 single houses (8 pairs) per day, to be despatched from the United Kingdom.

(2) Delivery in all cases is dependent on the date at which the material will be made available to the manufacturers.

Generally speak ing, despatch can be affected in 6—7 weeks from date of receipt of materials.

Receipt of materials in turn is dependent upon the type of priority which we get from the Export Promotion Department.

Specification of Factory Produced Parts and Description of Prefabrication Plant for the Production of type MZ/2 Alcrete Houses as Shown on Drawing PB. A2193/1

Since the issue of our report to the Mysore Government, very considerable advances have been made at Slough on the technique of cellular concrete production, which were hinted at in our conversations in Bangalore. The main advance has been made in the development of a cellular concrete utilising only 33% cement and 66% sand. This cellular concrete is actually stronger than the 100% cement foamed-concrete originally put forward, and in addition, has the advantage of being more stable as far as expansion and contraction are concerned.

The foamed-concrete now put forward is an excellent building material and enables us to dispense with the vapour barriers which were originally envisaged. There is an appreciable reduction in the price of the concrete products of the house and also there is a reduction in cement content.

The following parts would be produced in the factory as finished parts ready for immediate erection on site on prepared foundations.

(i) All the external and internal wall panels.

The external panels would be finished with a hard concrete face 5/8″ thick, backed by 3½″ of foamed-cement, suitably reinforced and having light alloy edge protection members. The internal face of these panels would be sprayed with a finishing surface of aerated cement rendering. The internal panels would be of foamed-cement, suitably reinforced and sprayed both sides with an aerated cement rendering.

The three window panels for each house would be supplied complete with aluminium alloy frames and shutters, including ¾″ diameter mild steel rods at 5″ centres instead of glazing.

The wall panels would be supplied with three doors for each house, suitably arranged, each having aluminium alloy frames and aluminium sheet covering externally, with plywood or hard-board internal finish.

All furniture would be provided to doors and windows. Six light alloy ventilators would be provided over doors and windows, where shown on arrangement drawing, for each house.

(ii) All necessary jointing materials and internal and external cover strips, keel plate etc., for walls, would be provided.

(iii) Filler panels would be provided above wall panels where necessary, to fill between wall and roof panel units.

(iv) A flue would be provided for the kitchen constructed of pre-formed blocks, suitably arranged to form a chimney unit.

(v) A shelf unit would be provided in each bungalow, where shown on arrangement drawing, having aluminium alloy framework and ply or hardboard shelves and back.

(vi) The whole of the roof structure would be provided including all necessary bolts and cleats required for erection purposes. The roof structure would comprise mainly the following parts :—

1. All necesary roof panels, including 28 each approximately 7′ 6″ × 1′ 7″, 2 gable panels approximately 7′ 6″ × 2′ 2″, 12 verandah panels approx. 3′ 9″ × 1′ 7″.
2. Two canopies would be provided for each house, for fitting over windows where shown on arrangement drawing.
3. One centre column support, together with a bracket each and would be provided in the centre of front verandah to support the roof.
4. All necessary column and eaves supports would be provided for rear verandah as shown on drawing.
5. A centre support for the roof, consisting of a trussed girder approximately 2′ 0″ × 19′ 4″ would be provided for each house arranged to be carried on walls at approximately 9′ 6″ centres.
6. An eaves beam would be provided as shown on arrangement drawing, suitably arranged to carry verandah roof panels.
7. The roof structure would be inclusive of all necessary aluminium alloy riding, finials, flashings, cover strips etc., as required.

General Description of Plant

We are proposing a plant in accordance with the flow sheet No.PB.2191/1 and drawing No. PB.2191/2. The plant consists of sand and cement stores, from which conveyors feed to hoppers and weighers.

The cement is handled by means of an enclosed elevator and screw conveyor to the mixing station. The sand is handled on an open conveyor to the grinding mills and is then handled by means of an air conveyor to the mixing station. Both the sand and cement conveyor deliver to surge hoppers supported on the mixing station structure. The surge hoppers each discharge through feeders into automatic weighers, thus proportioning the sand and cement into the foam concrete mixers.

An additional mixing station is provided for the casting of the heavy outer skin.

Sand and cement are transported to this station by means of hand trolleys and are elevated by monorail hoists into the mixer

The grid with panel moulds is brought to the mortar mixing station and the mortar is applied by means of a portable container. The grid is then vibrated in order to form a dense, thin layer of mortar. The panels are then moved to the foam concrete mixing station and are filled with a wet mix. The wet mix is levelled off after ½ hour's air set. After levelling, the panels are elevated by a four-point crane and crosstraverse trolley, to either of the two autoclave lines.

After 6 hours minimum air cure, the train of six trolleys is winched into the autoclaves, the autoclave is sealed and brought up to pressure. Pressure is applied for 11 hours and the charge is then allowed to cool off for 3 hours inside the autoclave.

The train is then discharged and the panels are taken off the grids. They are stored on racks for one to three days and the inner surface is afterwards coated with a spray-applied cement finish.

General

The accompanying plant list gives the estimated price for the equipment. These prices have been obtained from suppliers and are subject to variations, and suppliers will not at present give a firm quotation until they are certain of the order being placed. In view of this a substantial contingency has been added.

The items of local supply should be available without difficulty in India.

Item No.	Description	Source of supply	Total price
			£
1.	Cement Store, in bags	Local	
2.	Cement Feed Hopper, cast in concrete with adjustable steel chutes to control flow of sand. Size of hopper at top 8′ × 4′.	U. K.	150
3.	Motor driven belt feeder, from hopper to elevator, consisting of 12″ belt, 1 t.p.h., capacity, with a variable speed drive for adjusting quantity of feed.	U. K.	212
4.	Belt and Bucket Elevator, approx. 20′ centres, for taking cement from belt feeder to horizontal worm conveyor. Motor drive, totally enclosed, 1 t. p.h.	U. K.	20
5.	Worm Conveyor from elevator to mixing stations, 100 ft. long, totally enclosed, motor driven with outlet chutes and inspection doors.	U. K.	350
6.	Four Surge Hoppers, capacity of each hopper ½ cub. yards. The hoppers to be complete with steel columns to raise them to the correct height. The hoppers will also carry the worm feeders and weighers.	U. K.	240
7.	Four motor-driven Form Feeders for supplying cement from hoppers to weighers. These consist of a cast iron worm running in a mild steel chute and a capacity of 5 t. p. h.	U. K.	192
8.	Four Automatic Weighers, each having capacity of 300 lbs. and consisting of tilting buckets which release when the correct weight is in them. In releasing the worm feeder is shut off.	U. K.	1,000
9.	One Safety Hopper, placed at end of worm feeder, consisting of a 1 cub. yard hopper, with a pressure operated cut off switch which will shut off elevator No. 4 and feeder No. 3, when cement spills over into hopper No. 9, after surge hoppers No. 6 are filled	U. K.	70
			£2,422

Sand Handling for the Foamed Concrete

Item No.	Description	Source of supply	Total price
			£
1.	Sand Store, consisting of 4" thick reinforced concrete slab approximately 1,000 sq. ft. in area.	Local	
2.	Charging hopper, cast in concrete with adjustable steel chutes to control flow of sand. Size of hopper at top 8' × 4'.	U. K.	150
3.	Motor driven belt feeder, from hopper to elevator, consisting of 12" belt, 3 t.p.h., capacity with a variable speed drive for adjusting quantity of feed.	U. K.	12
4.	Inclined belt conveyor, 100 ft. long, complete with supporting structure, 15° slope, 3 t. p. h., capacity, electrically-driven.	U. K.	700
5.	Sand holding hopper, capacity 6 tons, sand; mounted on steel columns, complete with ore gate.	U. K.	250
6.	Ball Mill unit, Hardinge, complete with electric feeder of the worm type, air separator, necessary deducting.		
7.	Ball Mill, and	U.K.	2,600
8.	Ball Charge, suitable for grinding 2 t. p. h. of fine sand down to minus 150 mesh.		
9.	Air Conveying equipment, consisting of paddle fan, electrically driven for conveying air, and		
10.	Two Cyclones for discharging sand from air stream With the necessary shut-off valves, rubber lined corner pieces and flap, operated discharge valves.	U.K.	600
11.	Four Worm Feeders, motor driven, for supplying sand from hoppers to weighers. These consist of a cast iron worm running in a mild steel chute and having a capacity of 5 t. p. h.	U. K.	192
12.	Four Automatic Weighers, each having capacity of 500 lbs. and consisting of tilting buckets which release when the correct weight is in them. In releasing the worm feeder is shut off.	U. K.	1,000
13.	Electric Interlock Switches between sand holding hoppers (Item 5), Feed Hopper (Item 2), Discharge cyclones (Item 10), and Ball Mill (Item 6).	U. K.	120
14.	Portable Belt Loader for conveying sand from sand store tip, into charging hopper.	U. K.	350
			£6,174

Foamed Cement Mixing and Casting

Item No.	Description	Source of supply	Total price
			£
1.	Casting Structure.		
	Structure for carrying casting hopper mixer sand automatic weighers consisting of fabricated steel work, supplied drilled and work gusseted, ready for erection.	U. K.	1,500
2.	Four Foamed Concrete Mixers, each 10 cub. ft. capacity, complete with electric motor drive.	U. K.	800
3.	Four Zero-ising type water meters . . .	U. K.	36
4.	Four Foam-mixing Valves for metering foaming liquid and water.	U. K.	120
5.	Two Casting Hoppers of 20 cub. ft. capacity, complete with traversing arrangement to enable two discharges to be used to either panel grid.	U. K.	500
6.	Water Piping and Valves inter-connecting foam machines, water meters and mixers.	U. K.	100
			£3,056

Mortar Mixing and Casting

Item No.	Description	Source of Supply	Total price
			£
1.	Two Bin Trucks for Sand Handling ¼ cub. yd. capacity.	Local	20
2.	Two Sack Trucks for cement, 6 cwt. capacity	Local	30
3.	Two Platform Scales, 500 lbs. capacity . .	Local	36
4.	Two electrically-driven Monorail hoists, 5 cwt. capacity.	U. K.	160
5.	Two electrically-driven Mortar Mixers, 10 cub. ft. capacity.	U. K.	500
6.	Two Water Meters, zero-ising type . . .	U. K.	18
7.	Two Casting Buckets	Local	10
8.	Two Vibrating tables for vibrating the panel grids.	U. K.	400
			£1,174

Cements S

Item No.		Description	Source of Supply	Total Price
				£
1.		Two Bin Trucks for sand, ¼ cub. yd. capacity	Local .	20
2.		Two-Bin Trucks for cement, 6 cwt. capacity .	Local .	30
3.		Four " Aerocem " spraying units . . .	U. K. .	820
				870

Curing Plant and Equipment

Item No.		Description	Source of Supply	Total Price
				£
1.	420	Panel Support Grids	U. K. .	8,400
2.	60	Trolleys for supporting panel grids, with ball bearing wheels and the necessary buffers and couplings.	U. K. .	2,750
3.	4	Autoclaves, 8′ 6″ i/d × 70′ long, with bolted-on doors.	U. K. .	12,000
4.	4	½-ton Jib Cranes, hand-operated for lifting autoclave doors.	U. K. .	160
5.	1	Steam-boiler, 4,000 lbs/cub. ft. of water evaporation per hour, from and at 212°F, operated at 140 lbs./sq. in. pressure, to use coal fuel. (For fuel oil it would be necessary to add £1,500 to cover the cost of extra feed pumps, storage tanks, etc.).	U. K. .	3,500
6.	4	Two-point recorders for recording pressure and temperature of autoclaves.	U. K.	720
				27,530

Grid and Panel Handling

Item No.	Description	Source of Supply	Total Price
			£
1.	Two Roller Conveyors for casting lines, consisting of double track, 130 ft. long.	U. K.	220
2.	Two 4-point Lifting Hoists, with crab traverse, 2-ton capacity.	U. K.	800
3.	Two Monorail Hoists for de-stacking panels from trolleys after curing, 2-ton capacity.	U. K.	500
4.	Two Roller Conveyors for empty grid handling and cleaning.	U. K.	220
5.	One Cross Traverse Track and Bogey connecting roller conveyor lines.	U. K.	100
6.	Monorail tracks, handling panels from grids to drying out racks 4 sets, each 300 ft. long, ½-ton capacity.	Local	350
7.	12 Electric Lifting Hoist Blcosk for running on tracks (Item 6) complete with panel lifting slings ½ ton capacity.	U. K.	720
8.	Four sets Drying-out Racks, consisting of posts let in to the floor to support panels vertically.	Local	100
			3,010

Trolley Handling

Item No.	Description	Source of Supply	Total Price
			£
1.	1,260 ft. run of 20 lb. Rail Track	U. K.	3,000
2.	8 Cross traverse bogies		
3.	6 Electric hoisting winches, 3 ton capacity		

Metal Assembly Plant

Item No.	Description	Source of Supply	Total Price
	. . . . .		£
1.	5 Wall Panel Jigs	U. K.	2,500
2.	3 Partition Panel Jigs		
3.	1 Centre Beam Jig		
4.	1 Eaves Beam Jig		
5.	1 Verandah Support Jig		
6.	5 Roof Panel Jigs		
7.	Storage Racks for parts bought cut to length and part drilled.	U. K.	1,600
8	Air Compressor, capable of producing 300 cu. ft. of free air per minute, complete with air lines, valves, and fittings, air receiver, motor and starter etc.	U. K.	790
9.	20 Pneumatic drills	U. K.	240
10.	20 Pneumatic revetters	U. K.	400
11.	6 Pneumatic Chobert Revetters	U. K.	195
			5,725

Paint Spray Plant

Item No.	Description	Source of Supply	Total Price
			£
1.	4 Pressure Pot Containers for paint, complete stirring air mechanisms	U.K.	480
2.	10 Air spray guns		
3.	4 Main air filters and oil traps		
4.	Necessary rubber hose and gauges . .		
5.	Paint spray booth with exhaust fans etc. . .	U. K.	450
			930

Total Capital Expenditure

		£
Plant	The total capital outlay for the plant and equipment as detailed in the foregoing list, exclusive of factory space	53,891
	Contingencies	5,390
		59,281
Installation and Shipment.	The total capital outlay to cover the cost of Installation and Shipment of the plant, including the provision of a suitable maintenance workshops, would be	20,000
Transport . .	The total capital outlay to provide 100 loading bogies and a fleet of 20 lorries and trailers, would be .	30,000
S. & M. D. Fees .	We estimate that the cost of providing the services of our technical staff to produce the detailed drawings of the house components, complete the detailed designs and purchase of plant, provide all necessary architectural services and send an Engineer to India for 6—8 months, to supervise the erection of the plant and a cement technologist to supervise the manufacture of the first batch of house parts would cost	10,000

We would point out that this is an estimated figure only, based on past experience, and we should charge a sume based on the actual cost of the services provided, plus an amount for overheads based on the figure for similar work in the United Kingdom for the British Government.

An Agreement made at the day of One thousand nine hundred and forty-eight between the Structural and Mechanical Development Engineers Ltd., whose registered office is situated at 2 Buckingham Avenue, Slough, in the Country of Buckingham, England (hereinafter referred to as "the Licensor" which expression shall where the context so admits or requires include its successors and permitted assigns) of the one part and the Governor General of India (hereinafter referred to as "Government" which expression shall include his successors for the time being) of the other part.

WHEREAS Government is desirous of arranging for the construction as soon as possible of Factory or Factories to be designed and erected on site or sites to be decided by Government capable of producing prefabricated houses on a mass scale.

AND WHEREAS the Licensor have knowledge of the specialised form of construction, consisting essentially of light-weight panels generally as described by Indian Patent 36001/46 or improvements to this Patent which may hereafter be notified to Government.

AND WHEREAS the Licensor agree upon the terms and for the consideration hereinafter appearing to grant Government a licence to manufacture under the said applications or Letters Patent in India and to render technical assistance in connection with the manufacture of prefabricated houses and structures to Licensor's specialised form of construction (such houses and structures being hereinafter referred to as "Alcrete" Houses).

Now it is hereby agreed by and between the Licensor and Government as follows :—

1. The Licensor shall in consideration of the fees and payments hereinafter stated :—

(a) Supply drawings and specifications of Alcrete houses to the requirements of Government.

(b) Supply layouts and schedules of the plant required for the manufacture of Alcrete Houses.

(c) Advise Government on the purchase of such plant and equipment for the manufacture of Alcrete Houses as Government may require to be purchased from the United Kingdom.

(d) Provide all information to Government in regard to the purchase by Government of aluminium and light alloy products.

(e) Provide the services of an Engineer and Cement technologist to visit India to supervise the erection of the first Factory and the manufacture therein of the first batch of house parts.

(f) Provide technical personnel to visit India to act in an advisory or technical capacity as and when required by Government.

(g) To give adequate facilities for the practical training of a reasonable number of technicians chosen by Government for Managerial and supervisory duties in connection with the processes involved in the manufacture of prefabricated houses on a mass scale.

(h) Provide all information and help at its disposal and within its powers to further the manufacture by Government of Alcrete houses.

2. In consideration of the services hereinafter mentioned Government shall :—

(a) Pay to the Licensor the actual cost including overhead charges of all design work and preparation of drawings, schedules and specifications carried on behalf of Government. Such cost to be ascertained by the same procedure and on the same basis as similar work already carried out by the Licensor for His Majesty's Government (Ministry of Supply).

(b) Pay to the Licensor the full cost of the services of all the personnel sent to India either to supervise the erection and manufacture of houses parts in the first Factory or subsequently to advise Government on technical and other matters as required by them. Such personnel will be entitled to First Class travel and receive all the benefits granted to Class I Officers of Government engaged on short term contracts. Payments made by the Licensor towards the pensionary and other rights of such personnel will be payable by Government.

3. On commencement of manufacture of Alcrete houses by Government or on their behalf or instructions Government will within the months of January, April, July and October of each year during the life of this Agreement and promptly upon the termination thereof furnish to the Licensor a written statement that shall show the area in sq. ft. of the panels manufactured during the preceding three calendar months (but as to the first and last such statements during the preceding period unaccounted for) and at the time of rendering such statements shall pay the Licensor a Royalty on the basis as hereinafter stated :—

(a) Rs. 5 per square (of 100 sq. ft.) for the first 100,000 squares.

(b) Rs. 4 per square (of 100 sq. ft.) over 100,000 squares up to 400,000 squares.

(c) Rs. 3 per square (of 100 sq. ft.) over 400,000 squares up to 800,000 squares.

(d) Rs. 2 per square (of 100 sq. ft.) over 800,000 squares.

4. Government shall keep or arrange to keep separate and proper records relating to the manufacture of panels required for the Alcrete houses under this agreement and shall permit the Licensor or their duly authorised Agents at all reasonable times to inspect, take extract from, any books and papers and documents in possession or under the control of Government.

5. (a) Government shall give preference to the Licensor while ordering all aluminium and light alloy products required by Government for the production of Alcrete houses under this Agreement provided the prices quoted by the Licensor are competitive and the Licensor is in a position to supply such products within the time required by Government.

(b) All such orders shall be subject to the standard conditions of Contract adopted by Government or as mutually agreed between the Licensor and Government.

6. Government agree not to dispute the validity of the Indian patents held by the Licensor and shall not during the continuance of this Agreement without the previous written consent of the Licensor—

(a) Sell or knowingly permit to be sold outside India any Alcrete houses manufactured under this Agreement.

(b) Disclose (except to its own employees to the extent necessary for operating the processes subject of this Agreement) any technical or Commercial information supplied to Government as "Confidential" by the Licensor.

(c) Introduce any technical modifications in the design and specification without the prior agreement of the Licensor.

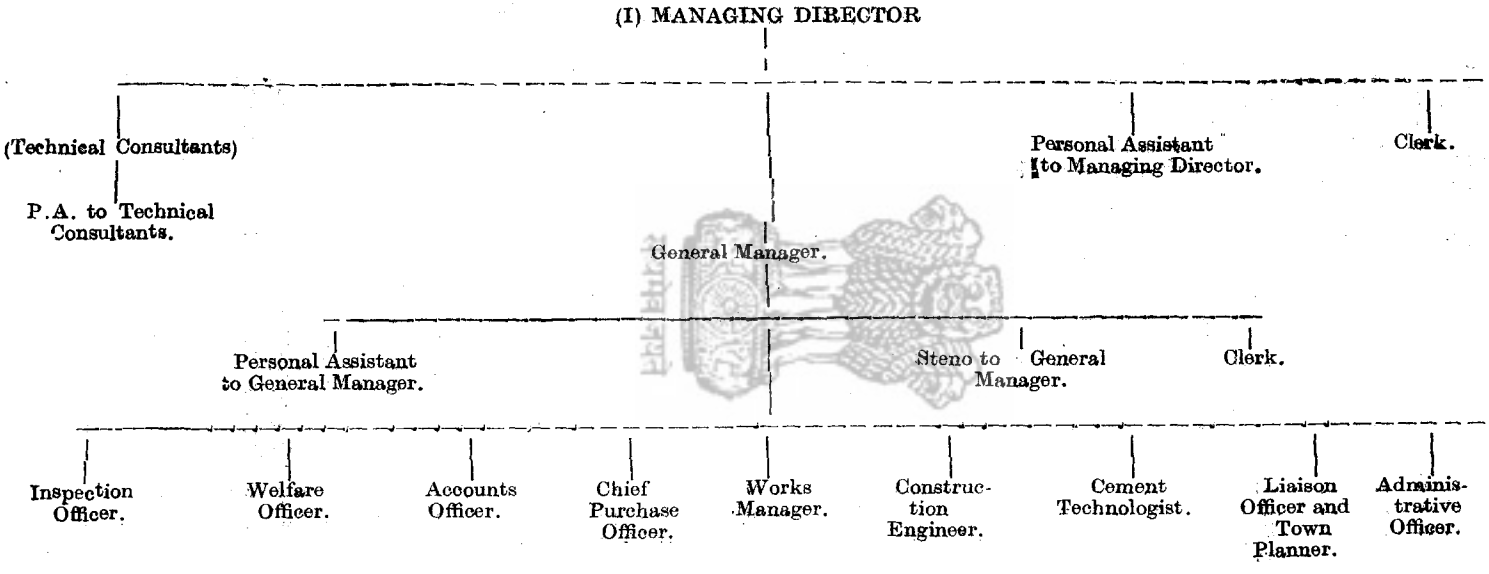
7. If any dispute, question or controversy the settlement of which is not herein specifically provided for, shall at any time arise between the Licensor and Government touching this Agreement or any clause or thing herein contained, or the construction thereof or any matter connected with this Agreement or the operation of the same or the rights or duties or liabilities of either party, then and in every such case the matter in difference shall be referred to two arbitrators one to be nominated by Government and the other by the Licensor, or, in case of disagreement between the arbitrators, to an umpire appointed by the arbitrators in writing under their hands before proceeding further with the arbitration and the decision of such arbitrators or umpire shall be final and binding on both parties. Any such reference shall in all respects be subject to the English Arbitration Acts, 1889 to 1934 or any statutory modification thereof for the time being in force. Upon any and every such reference the assessment of the costs incidental to the reference and award respectively shall be in the discretion of the arbitrators or in the event of their not agreeing the umpire appointed by them. Services under this agreement shall notwithstanding the existence of any such dispute, question or controversy continue during the arbitration proceedings and no payments due or payable by Government to the Licensor or *vice versa* shall be withheld on account of such proceedings unless they are the subject of the arbitration.

This Agreement shall continue for 14 years from the date thereof.

IN WITNESS whereof The Structural and Mechanical Development Engineers Ltd., has caused its Common Seal to be hereunto affixed and the High Commissioner for India in the United Kingdom has hereto set his hand and seal on behalf and with the authority of the Governor-General of India the day and year first above written.

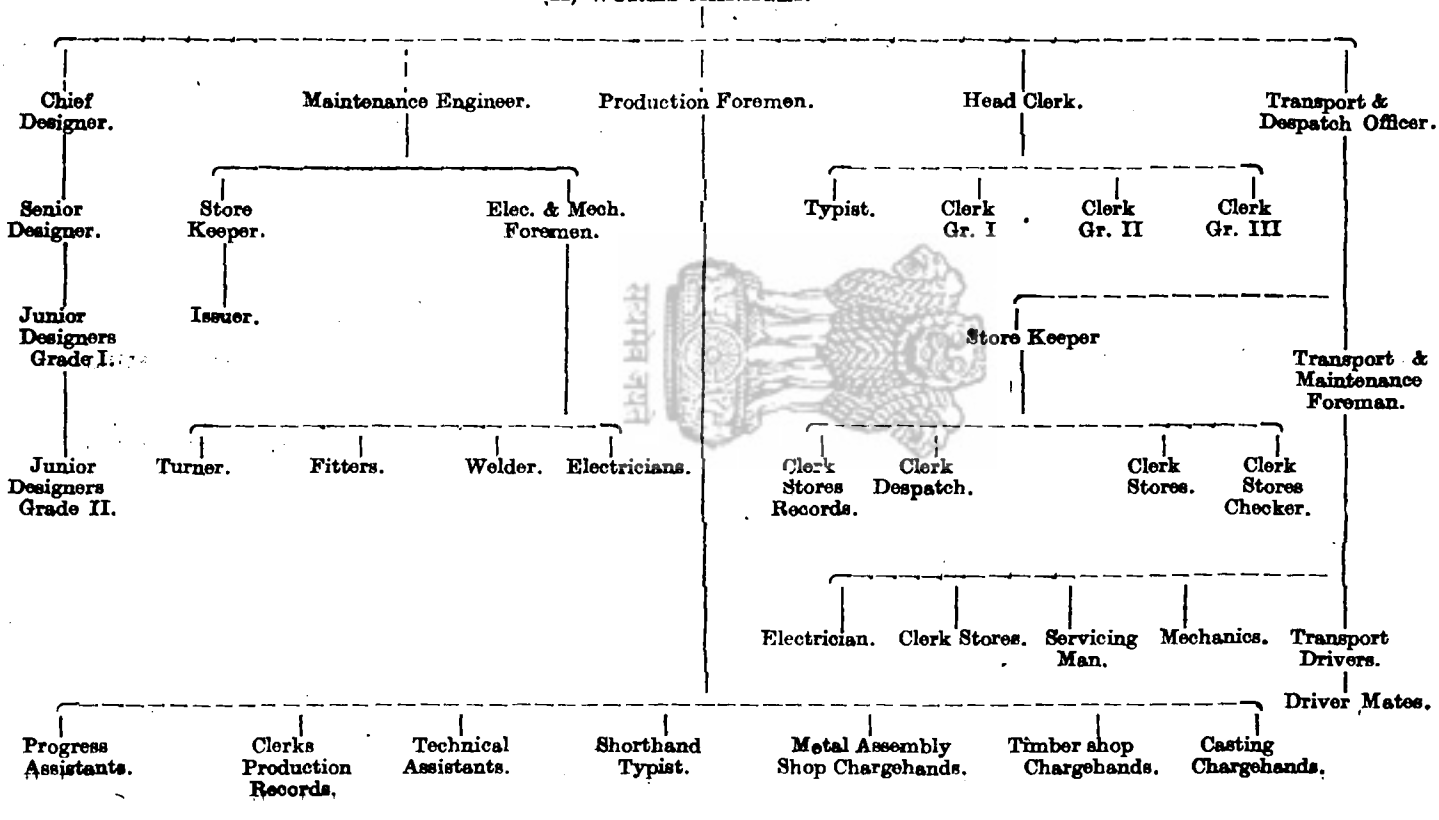
APPENDIX III

Government Housing Factory Organisation.



APPENDIX III—*contd.*

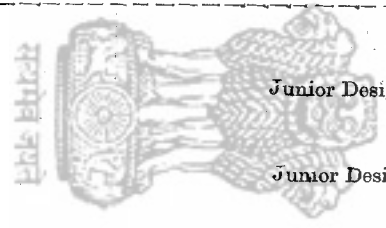
Government Housing Factory Organisation, Delhi.



APPENDIX III—*contd.*

overnment Housing Factory Organisation.

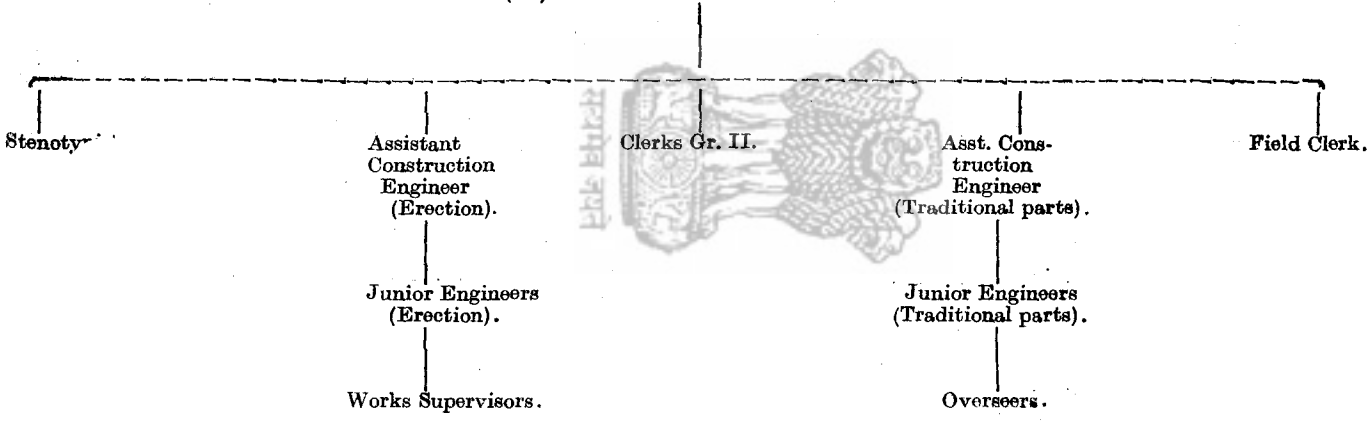
(III) LIAISON OFFICER & TOWN PLANNER



- Head Clerk.
  - Clerks Grade II
    - Clerks Gr. III
- Surveyor
  - Assistant Surveyors.
- Junior Designer Grade I.
  - Junior Designers Grade II.
    - Draftsmen.
- Stenotypist.
  - Typist.

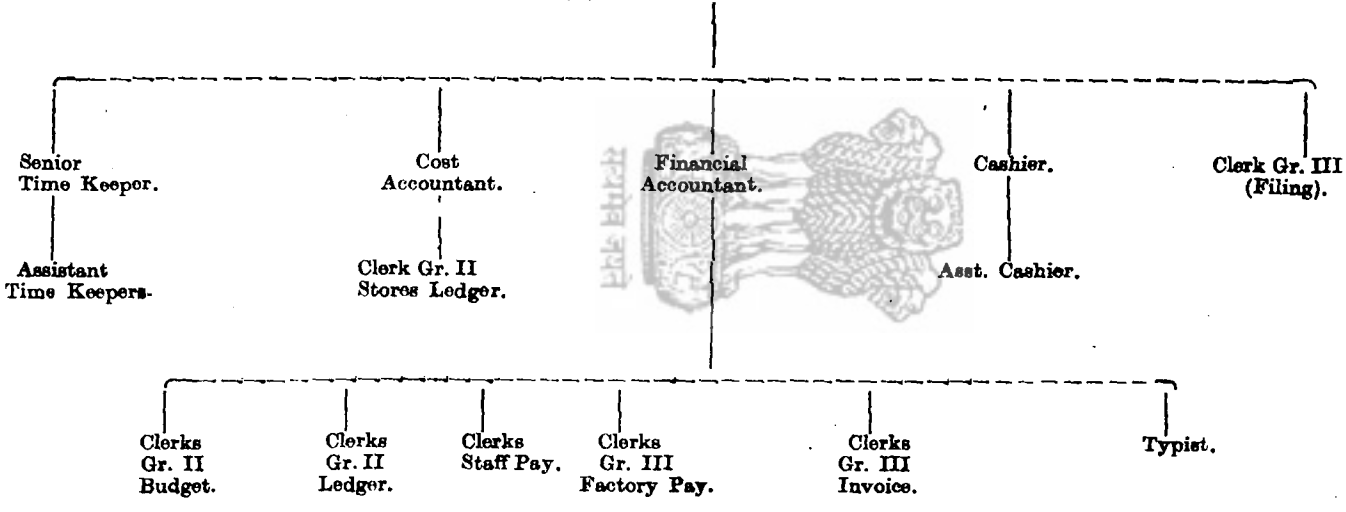
APPENDIX III—*contd.*

Government Housing Factory Organisation.



APPENDIX III—*contd.*

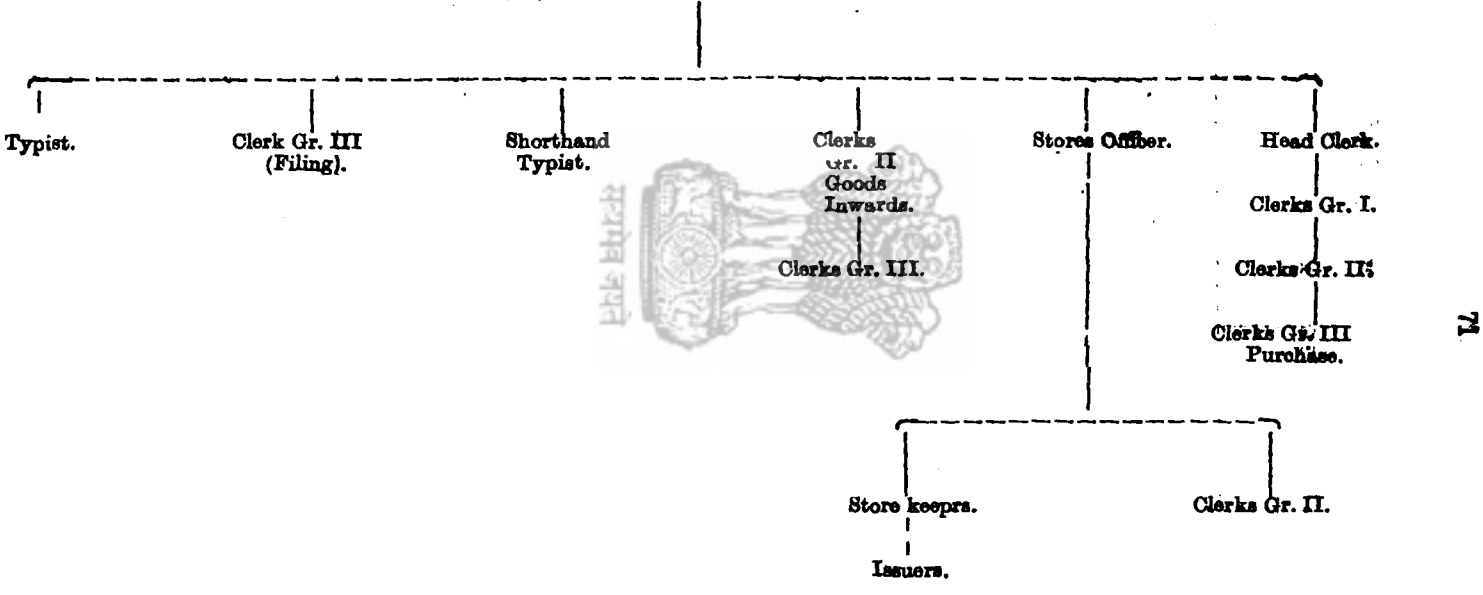
Government Housing Factory Organisation.



APPENDIX III—*contd.*

Government Housing Factory Organisation.

(VI) CHIEF PURCHASE OFFICER.



APPENDIX III—*contd.*

Government Housing Factory Organisation.

(VII) INSPECTON OFFICER.

- Metal Assembly Shop Examiners.
- Casting Shop Examiners.
- Clerk Gr. III.
- Typist

APPENDIX III—*contd.*

Government Housing Factory Organisation.

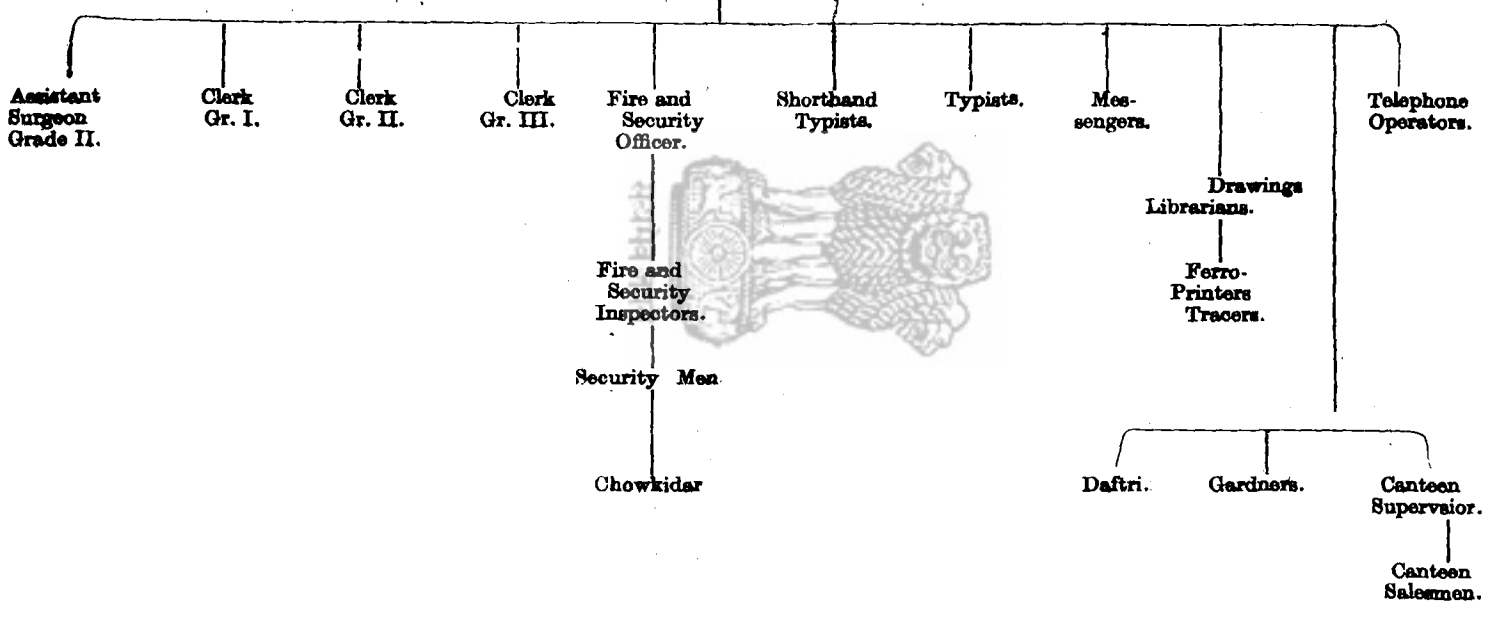
(VIII) CEMENT TECHNOLOGIST

- Sand & Cement Testers.
- Laboratory Assistant.

APPENDIX III—*contd.*

Government Housing Factory Organisation.

(IX) ADMINISTRATIVE OFFICER.



APPENDIX IV

GOVERNMENT HOUSING FACTORY, DELHI

Statement showig the sanctioned strength of the Officers and Staff

Serial No.	Designation of Post	Sanctioned strength	Sanctioned Scale of Pay
1	2	3	4
			Rs.
1.	General Manager	1	1,300—100—1,600
2.	Works Manager	1	1,000—50—1,400
3.	Liaison Officer and Town Planner	1	600—40—1,000—50—1,150
4.	Chief Purchase Officer	1	Do
5.	Construction Engineer	1	Do.
6.	Cement Technologist	1	Do.
7.	Accounts Officer	1	Do.
8.	Chief Designer	1	Do.
9.	Administrative Officer	1	400—25—500—30—620
10.	Transport and Despatch Officer	1	Do.
11.	Inspection Officer	1	350—30—650
12.	Senior Designer	1	Do.
13.	Maintenance Engineer	1	Do.
14.	Assistant Construction Engineers	2	Do.
15.	Stores Officer	1	Do.
16.	Production Foremen	3	Do.
17.	Financial Accountant	1	260—15—380—E.B.—20—500
18.	Transport Maintenance Foreman	1	250—20—450
19.	Electrical and Mechanical Foreman	1	Do.
20.	Head Clerks	3	200—15—380—E.B.—20—500
21.	Junior Designers Gr. I	3	Do.
22.	Junior Engineers	6	Do.
23.	Surveyor	1	Do.

1	2	3	4
24.	Cost Accountant	1	Rs. 200—15—380—E.B.—20—500
25.	Fire and Security Supervisor	1	Do.
26.	Personal Assistants	3	Do.
27.	Cashier	1	Do.
28.	Welfare Officer	1	Do.
29.	Clerks Grade I	5	160—10—300—E.B.—15—450
30.	Senior Time Keeper	1	Do.
31.	Boiler Attendants	3	150—15—300
32.	Junior Designers Grade II	7	Do.
33.	Storekeepers	6	Do.
34.	Chargehands	15	Do.
35.	Assistant Surveyors	3	Do.
36.	Field Clerk	1	Do.
37.	Overseers	2	Do.
38.	Sand and Cement Testers	6	Do.
39.	Examiners	15	Do.
40.	Progress Assistants	2	Do.
41.	Technical Assistants	2	Do.
42.	Canteen Supervisor	1	100—8—140—10—330+S.P. of Rs. 20
43.	Fire and Security Inspectors	3	Do.
44.	Shorthand Typists	3	100—8—140—10—330
45.	Clerks Grade II	28	Do.
46.	Transport Servicingmen	2	Do.
47.	Motor Mechanics	3	Do.
48.	Electricians	4	Do.
49.	Issuers	11	Do.
50.	Fitters	3	Do.
51.	Welder	1	Do.
52.	Assistant Cashier	1	Do.
53.	Assistant Time Keepers	6	Do.

1	2	3	4
			Rs.
54.	Turner	1	100—8—140—10—330
55.	Assistant Surgeon Grade II	1	100—8—140—10—170—10—300
56.	Draftsman	1	100—5—125—6—155—E.B.—6—185
57.	Male Nurse	1	Do.
58.	Works Supervisors	8	Do.
59.	Clerks Grade III	20	80—5—120—E.B.—8—200—10/2—220
60.	Telephone Operators	2	Do.
61.	Drawings Librarian	1	Do.
62.	Laboratory Assistant	1	60—4—120—E.B.—5—150
63.	Canteen Salesmen	2	80—5—120—E.B.—8—200—10/2—220
64.	Securitymen	9	60—4—120—E.B.—5—150
65.	Ferroprinters/Tracers	2	Do.
66.	Transport Drivers	54	60—5/2—75
67.	Typists	8	55—3—85—4—125—5—130
68.	Dressers/Compounders	3	Do.
69.	Sanitary Inspector	1	Do.
70.	Daftri	1	35—1—50
71.	Security Chowkidars	27	Do.
72.	Malis	2	Do.
73.	Drivers Mates	33	30—1/2—35
74.	Messengers	14	Do.
75.	Sweepers	11	Do.

GIPD—28—184 MofHealth—3-2-51—150


सत्यमेव जयते