International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

Modern Houses on the 'International Exhibition of Low-Cost Housing in 1954' as a Dissemination of Modern Architecture

Takashi ONO

Professor, Chitkara School of Planning and Architecture, Chitkara University, Punjab, India

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Abstract - *The purpose of this research paper is to discuss modern houses witnessed in the international exhibition of 1954 organized by the Ministry of Works, Housing and Supply, Government of India, to illustrate that the exhibition was a crucial disseminations of modern architecture that used modern materials and techniques while ensuring representations of modern life exemplified the ideas of privacy, hygienics, and social welfare, along with remaining traditional Indian elements such as the verandah.*

The exhibit showed 62 types of housing, and the houses constructed used methods (rather than local/regional materials and techniques and conventional ideas) that were achieved at a low cost. Thus, constructing equally and massively affordable houses is possible wherever that may be. Indeed, by shifting from iconicity to architecture for the citizen, modern architecture was sensibly executed using reasonable technology and materials, which were also ideas of the time. It is through this that modern housing was achieved.

Key Words: Modern house, Affordable house, Construction materials and techniques, PWD

1. INTRODUCTION

Prime Minister Nehru's statement that "a house is not merely a place to take shelter" for the "international exhibition on low-cost housing" in 1954 demonstrates that the government was increasingly conscious of the role that a modern welfare state was obliged to play in planning the orderly development of its rapidly growing towns and cities and in addressing the associated demand for affordable "new housing" [6]. Although, since that time the exhibition was not well known, the author has reconsidered the exhibition of respective housing types based on drawings in the publication because the precedence research was limited to explanations of the exhibition. Through analysis, this study seeks to discuss new (modern) houses that were demanded by the government. The exhibition was the one of the crucial disseminations of modern architecture.

Looking back on the history of Indian architecture, modern Indian architecture appeared after the independence of India [4]. This includes, for example, the presence of Le Corbusier, who designed the modern city of Chandigarh from 1951-65. Native Indian architects also got an architectural education from abroad. For instance, Habib Rahman (1915–1995) was the senior architect of the central Public Works Department (PWD) under the Ministry of Works, Housing and Supply at the time.

In addition, innovated construction techniques and materials were introduced in India so that mass products could be constructed with the same quality and cost. Furthermore, many simple housing products of modern housing without excessive ornamentation came into existence in the housing field in India. The exhibition was held in the early 1950s as an experimental opportunity and led to the opening of the modern era of propaganda from the government. It is thus that the exhibition should be positioned as the door to modern architecture.

The main research material was a publication called "Designs for low cost housing" published in 1956 as a reproduction of the exhibition souvenir [5].

The methodology of this study is as follows: The first step was to understand the historical context, which can be seen in the precedence research conducted before the analysis of the exhibition. Then, the analysis focused on the government's intention to promote modern housing proposals based on 62 types of low-cost housing posted in the publication from viewpoints that not only consider architectural features with modern concepts but also specific architects, housing types, construction materials, and cost. Thus, this exhibition is indeed intended to seek new houses of modernism, meaning sensible buildings constructed of standardized construction materials (wherever they are easily and reasonably obtained and wherever they can be used) based on modern life.

2. Historical context of Indian architecture as the exhibition was held

In seeking out the historical context, the following four books were available; *Architecture & Independence – The Search for Identity – India 1880 to 1980, India: Modern Architectures in History, A Concise History of Modern Architecture in India, and Architecture in India Since 1990*. As Rahul Mehrotra mentioned in his book, it is indeed true that the Golconde Ashram designed by Antonin Raymond (1888–1976) at Pondicherry in 1936 would open the door for modern architecture (Fig.1). Needless to say, it was a concrete step of the first attempt in India. Also realized was the idea of "pristine forms, new paradigms in space conceptualisation and organisation, and the use of new technologies," based on his concept [4]. This, however, was limited.

Fig -1: Golconde Ashram at Pondicherry in 1936 (Source: Author)

In the 1940s, Indian architecture was rooted in the "Art Deco." Due to representations of the image of symbolized and authorized government promoted by the revivalists, the style could be used in public. Hence, it is difficult to say that Indian architecture steered toward modernization. With the next decade, in the 1950s, some instances leading toward modernism (like the idea of the Golconde Ashram) were raised by young architects who came to study from abroad, as well as foreign architects.

In other words, it is Indian modernism from the approach of architecture that, through shifting from iconicity to architecture for the citizen, allowed modern architecture to be sensibly executed using reasonable technology and materials of the time.

The following projects that joined this exhibition were used as examples of modernism:

1) Chandigarh project by Le Corbusier
2) The Housing Factory LTD
3) Indian architects who had belonged to Central PWD, etc.

The following are details of the three examples mentioned above:

1) First, the Chandigarh project was designed by Le Corbusier (1987–1965) from 1951 to 1964, which led to modern architecture (Fig.2). Additionally, a founder of Chandigarh, Jawaharlal Nehru (1889–1964), stated, "Let this be a new town symbolic of the freedom of India, unfettered by the traditions of the past. [2]" That is, the creation of modern architecture and urbanism was pursued. Through Le Corbusier, with the help of Pierre Jeanneret (1896–1967) and collaborators, countless buildings were constructed in Chandigarh. Furthermore, Ahmedabad had a large influence on modernism.

Fig -2: Interaction between Nehru and Le Corbusier (Source: Fondation Le Corbusier, Doc. L4-3-6)

2) Several institutes implemented through government initiatives were established, including, for example, the Central Building Research Institute, the Roorkee, and the Hindustan Housing Company (now the Hindustan Prefab Limited). The Hindustan Housing Company, which was established by Otto Koenigsberger (1908–1999), was intended to serve as the capital city, supplementing rather than replacing the traditional construction of houses and targeting refugee housing needs. He recommended prefabricated housing as a viable solution due to the chronic housing shortage in India.
3) In the West, where modern architecture had already spread, some Indian architects learned modern architecture and then returned to India and played an active role in its development. For instance, G.B. Deolalikar, who trained at the Full Royal Institute of British Architects (RIBA) Association, was a chief architect from 1947 to 1952. Habib Rahman trained at MIT in the United States and worked under Lawrence Anderson (1906–1994), William Wurster (1895–1973), and Walter Gropius (1883–1969) as an architect in the mid-1940s and became a senior

architect in 1953. His interest was "low-cost housing projects," which he had studied as a thesis project.

Although these points are a component of introducing modernism in India, the abovementioned participants showed their works in this exhibition.

3. The detail of the "the international exhibition on low-cost housing"

In 1954, the exhibition with the initiative of the Ministry of Works, Housing, and Supply (now the Ministry of Housing and Urban Affairs) of the Low-Income Group Housing Scheme was held. The exhibition was deemed "international" due to the participation of the government of Burma.

3.1 Compiled documents, including drawings and photos (published in January 1956)

Looking at the contents of the publication, some drawings of exhibited housing with the details are included. It comprised four components of each housing type: (a) a brief introduction of the house; (b) architectural data (1. Floor area, 2. Plinth area, 3. Cost at Delhi 4. Plinth area rate, Floor area rate and note mentioned whether including cost of service or not); (c) specifications（Foundation and Plinth, Superstructure, Doors and windows, Roof, Finishing, Flooring, Services）; and (d) special features.

It is noteworthy that construction cost per floor and plinth area is indicated in it for having been constructed in the local area as well as in Delhi. As can be seen by the title of the exhibition, it focused on 'low-cost' and comparing the cost, regardless of the size or housing type. Moreover, it can be implied that emphasis was placed anywhere, not at a specific place. The general solution of the site is in Delhi.

3.2 The conception of Nehru

At the inauguration of the exhibition (Fig.3), Nehru stated, "the minimum accommodation that any family should have is two rooms, a kitchen, a lavatory and a small verandah. If possible, a little open space also. If the open space is difficult, a group of small houses should have a common open space. [5]"

Discussing Nehru's words further, although he did not mentioned the usages of "two rooms" for a family, it could be appropriate to include the idea of privacy in the modern house while denying that a single family had only a single room, according to his idea that "the idea of one room for a family is bad."

Regarding "a kitchen, a lavatory and a small verandah," as Nehru repeated, his idea was that "the old idea of so-called servants' or workers' quarters with one small and dark room without proper ventilation or anything and with no sanitary or other facilities, was an abomination and should be condemned out of hand. [5]" Thus, he required the house to be hygienic. As mentioned, the securing of privacy and the improvement of hygienic environments were part of modernization.

The verandah is, however, a traditional feature Nehru also recognized. Even as the modern living environment was developing, he believed that the verandah had to remain to support the traditional life of the past.

Regarding open space, as Nehru mentioned, "that is planned, should include good housing for all its workers. Also, amenities, social welfare centers, children's education, children's playgrounds, etc. In the older factories, it would be a good thing if a certain sum was set aside from the profits every year for housing and amenities. [5]" Although open spaces can be considered a factor for acquiring ventilation and sunshine and for creating a hygienic environment, it seems that the effort focused on social welfare centers, children's playgrounds, children's education, etc., rather than on hygienic environments.

In other words, Nehru's words about privacy, hygienics, and social welfare were ideas to ensure modern life and his will to shift to modernization, with the aim of all citizens escaping the feudal society and obtaining a minimum and good living environment as part of modern life.

Fig -3: Nehru at the inauguration of the exhibition in 1954
(Source: Reference 5)

3.3 62 exhibited housing types

There are 67 housing types included in the publication, which can be divided into urban and rural housing. Sixty-two housing types were urban, and the remaining five were in rural areas. This research paper covers the urban houses that were susceptible to modernization.

Table -1: List of participated Institutes (Source: Author)

House No.	Name of Participants
1(a), 2, 3, 13, 14, 34	Central P.W.D.
1	Indian Plywood Co.
4	Competition Drawing for hot and humid region (Designed by V.J. Mistry)
5	Uttar Pradesh Government
6, 7, 8, 9,	Central Building research institute – Roorkee
10–11	Growing house
12	Government of Hyderabad
15	Government of Uttar Pradesh
16	Government of West Bengal – Calcutta
17–18	Bengal Engineering College
19, 45,	Military Engineering Services
20, 44	Asbestos Cement Company, LTD.
21, 29, 30	Northern Railway
22	Hot and dry competition house (Shri S. P. Caprihan – Nagpur)
23, 24	Punjab Government – Chandigarh
25	Government of Saurashtra
26	Hyderabad City Improvement Board
27	Bikaner Gypsum
28	Government of Madhya Bharat – Sanitary Engineer
31	Government of Assam
32	Military Engineering service
33	Associated cement companies
35	Andamans P.W.D
36, 65–66	Foreset Research Institute, Dehra Dun
37	Delhi Land and Finance (D.L.F.)
38	Government of Bhopal
39	Indian Aluminum Co. LTD.
40	Hindustan Block Manufacturing Co. LTD., West Bengal
41, 41(a)	Government of Bombay – Housing Board
42	Government of Bihar – P.W.D.
43	Government of PEPSU – Patiala
46	Delhi Improvement Trust
47, 48	The Rational Planning Corporation Hollow walls
49–50	`Mehta's` `Minimum house` – Saharanpur
51	Government of Rajasthan
52	Sindri Fertilizer Factory
53	Millars Machinery – Bird & Co., Vacuum Concrete house
54	The Hindustan Housing Factory LTD., Jangpura
55	Pitamber Dosabhai Patel – Bhavnagar
56, 57,	All India Housing Association
58	Shri Gore – Portable house
59	Government of Madhya Pradesh
60	Mrs Jardine Hendrson Ltd., Aerocem
63	Government of Burma
68	The Rational Planning

3.3.1 Participated Institutes

Table 1 shows a list of participated institutes (see Table 1). The 62 housing types were designed by 45 groups, which were local PWDs from states of India, private firms, the government of Burma (Myanmar), etc. Most were, however, government-based.

Many companies included modern construction materials and technology in their company names, and, besides the government, there is no doubt about seeing such companies.

3.3.2 Architectural features

Table 2 shows not only architectural information (area, construction cost, etc.) but also whether the house has an open space, W.C. and bath, verandah, at least two rooms or not (see Table 2). Table 3 shows the planar composition (organization) of 62 cases in total (besides houses without drawings) (see Table 3). This is simplified in Figure.4, with the room names used in the original drawing.

As can be seen in Table 2, most of cases covered all four conditions: open space, W.C. and bath, verandah, and two rooms, so participants followed the modern ideas mentioned

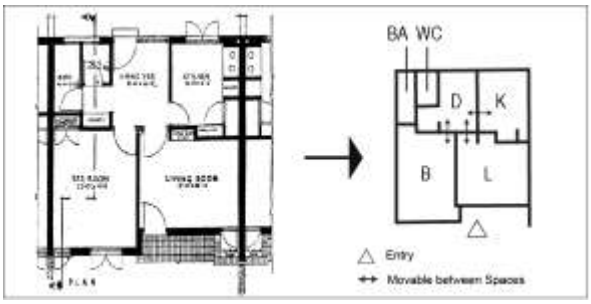

Fig -4: Diagram simplified from respective drawings (Source: Author)

by Nehru. In addition, in the case of the two rooms of the exhibited housing types, there are two ways of using the living room and bedroom or two bed rooms. This is true whether separating rooms for usage or to secure privacy.

As seen in Table 3, although the size of all the houses seems to be different at first glance, the composition and size of each room are almost the same, and the scale differs according to the placement and size of the courtyard. Hence, private rooms partitioned by walls and doors were composed and connected toward the verandah and courtyard beyond which is the inherited traditional lifestyle.

Table -2: Architectural information of all exhibited houses (Source: Author)

Housing No.	Name	Floor Area (sft.)	Open Space	WC & Bath	Veranda	Min.2 Room	Area Rate (Plinth)	Area Rate (Floor)
1(a)	Central P.W.D. model house 7	434	O	O	O	O	8/4	10/12
1	Indian Plywood Co.	298	×	O	O	O	Delhi: 9/-/- Mumbai:11/3/-	Delhi: 11/9/- Mumbai: 14/8/-
2	Central P.W.D. model house (3)	420	O	O	O	O	7/12/-	10/7/-
3	Central P.W.D. model house, Hollow Blocks	576	×	O	O	O	7/4/-	8/6/-
4	Competition Drawing for hot and humid region (Designed by V.J. Mistry)	572	O	O	O	O	8/3/-	9/13/-
5	Uttar Pradesh Government	606	O	O	O	O	6/14	8/7
6	Central Building research institute -Roorkee	915	—	—	—	—	4/10/-	4/15/-
7	Central Building research institute -Roorkee	864	—	—	—	—	4/8/-	4/12/-
8	Central Building research institute –Roorkee	584	—	—	—	—	4/9/-	5/2/-
9	Central Building research institute -Roorkee	513	—	—	—	—	2/13/-	3/1/1
10-11	Growing house	357 to 452	O	—	—	—	—	—
12	Government of Hyderabad	432	O	O	O	O	Delhi: 6/7/- Hyderabad: 9/8/-	Delhi: 6/7/- Hyderabad: 8/4/-
13	Central P.W.D. model house (2)	539	??	O	O	O	7/4/6	8/8/-
14	Central P.W.D. model house (1)	416	??	O	O	O	9/2/-	11/4/-
15	Government of Uttar Pradesh	486	O	O	O	O	Delhi: 7/5/- Uttar Pradesh: 9/2/-	Delhi: 5/12/- Uttar Pradesh: 7/4/-
16	Government of West Bengal - Calcutta	469	O	O	O	O	Delhi: 8/2/- Calcutta: 9/11/-	Delhi: 8/10/8 Calcutta: 10/5/-
17-18	Bengal Engineering College	595	O	O	O	O	Delhi: 4/15/- Bengal: 6/5/-	Delhi: 5/10/- Bengal: 7/2/-
19	Military Engineering Services	471	O	O	O	O	8/1/-	10/10/-
20	Asbestos Cement Company, LTD.	393	O	O	O	O	Delhi:6/13/- Bombay: 7/2/3	Delhi: 8/5/6 Bombay: 8/13/-
21	Northern Railway	601	O	O	O	O	Delhi: 7/14/- Railway: 6/11/-	Delhi: 9/-/- Railway: 8/4/-
22	Hot and dry competition house (Shri S. P. Caprihan - Nagpur)	683	O	O	O	O	7/4/-	8/8/-
23	Punjab Government - Chandigarh	433	O	O	O	O	Delhi: 7/2/- Chandigarh: 7/2/-	Delhi: 9/3/- Chandigarh: 9/3/-
24	Punjab Government - Chandigarh	218	O	×	O	O	Delhi: 8/- Chandigarh: 10/-	Delhi: 8/- Chandigarh: 10/-
25	Government of Saurashtra	482	O	O	O	O	Delhi: 7/2/- Saurashtra: 5/3/6	Delhi: 10/- Saurashtra: 7/5
26	Hyderabad City Improvement Board	310	O	O	O	×	Delhi: 6/15/- Hyderabad: 6/4/-	Delhi: 10/2/- Hyderabad: 9/1/-
27	Bikaner Gypsum	378	O	O	O	O	Delhi: 5/15/- Bikaner: 5/15/-	Delhi: 7/5/- Bikaner: 7/5/-
28	Government of Madhya Bharat – Sanitary Engineer	537	×	O	O	O	Delhi: 7/14/- Gwalior: 7/2/-	Delhi: 9/14/- Gwalior: 8/14/-
29	Northern Railway	224	O	O	O	O	Delhi: 9/7/- Railway: 8/12/-	Delhi: 13/7/- Railway: 12/8/-
30	Northern Railway	313	O	O	O	×	Delhi: 7/11/- Railway: 6/14/-	Delhi: 9/9/- Railway: 8/9/-
31	Government of Assam	250	O	O	O	×	Delhi: 12/9/- Assam: 12/1/-	Delhi: 14/3/- Assam: 13/1/-
32	Military Engineering service	251	O	O	O	×	10/2/11	13/-/-
33	Associated cement companies	384	O	O	O	×	Delhi: 8/6/- Association: 9/7/-	Delhi: 10/8/- Association: 11/13/-
34	Central P.W.D. – Assam Model – 5	382	O	O	O	O	10/7/-	13/-/-
35	Andamans P.W.D	542	×	O	O	O	8/-/-	9/-/-
36	Foreset Research Institute, Dehra Dun	386	O	O	O	O	Delhi: 8/-/- Dehara Dun: 5/4/-	Delhi: 6/15/- Dehara Dun: 5/11/-
37	Delhi Land and Finance (D.L.F.)	535	O	O	O	O	7/10/-	9/-/-
38	Government of Bhopal	424	O	O	O	O	Delhi: 9/4/- Bhopal: 8/4/-	Delhi: 12/13/- Bhopal: 11/12/-
39	Indian Aluminum Co. LTD.	450	O	O	O	O	10/8/-	10/8/-
40	Hindustan Block Manufacturing Co. LTD., West Bengal	492	×	O	O	×	Delhi: 6/7/- Bengal: 8/3/-	Delhi: 8/10/- Bengal: 10/0/-
41	Government of Bombay – Housing Board	293	O	O	O	×	Delhi: 6/6/0 Bombay: 8/10/7	Delhi 8/6/0 Bombay: 10/7/0
41(a)	Government of Bombay – Housing Board	319	O	O	O	O	Delhi: 8/-/- Bombay: 10/-/-	Delhi: 10/-/- Bombay: 12/10/-
42	Government of Bihar – P.W.D.	367	O	O	O	O	Delhi: 10/6/- Bihar: 10/8/-	Delhi: 13/7/- Bihar: 13/9/-
43	Government of PEPSU - Patiala	472	O	O	O	O	Delhi: 8/10/4 Patiala: 7/3/0	Delhi: 11/1/0 Patiala: 9/2/0
44	Asbestos Cement Company, LTD.	354	O	O	O	O	8/8/-	11/2/10
45	Military Engineering Service	446	O	O	O	O	8/7/-	11/3/0
46	Delhi Improvement Trust	430	O	O	O	O	Delhi: 8/10/- Trust rate: 8/6/-	Delhi: 10/13/- Trust rate: 10/9/-
47	The Rational Planning Corporation Hollow walls	271	×	O	O	×	Delhi: 10/9/- Bombay: 11/5/-	Delhi: 13/1/- Bombay: 14/-/-
48	The Rational Planning Corporation –Kotah Stone	224	O	O	O	×	Delhi: 10/6/- Kotah: 9/4/-	Delhi:14/5/- Kotah: 12/11/-
49-50	'Mehta's' 'Minimum house' - Saharanpur	321	×	O	O	×	Delhi: 7/1/- Saharanpur: 5/13/-	Delhi: 9/7/- Saharanpur: 7/13/-
51	Government of Rajasthan	509	O	O	O	O	Delhi: 11/3/4 Jaipur: 7/4/-	Delhi: 15/2/8 Jaipur: 9/12/6
52	Sindri Fertilizer Factory	426	O	O	O	O	6/1/-	7/10/-
53	Millars Machinery – Bird & Co., Vacuum Concrete house	465	×	O	O	O	7/13/-	8/5/-
54	The Hindustan Housing Factory LTD., Jangpura	738	O	O	O	O	4/13/-	5/13/-
55	Pitamber Dosabhai Patel - Bhavnagar	220	×	O	O	×	Delhi: 6/4/- Bhavnagar: 6/3/6	Delhi: 7/7/- Bhavnagar: 7/3/6
56	All India Housing Association	542	×	O	O	O	7/9/-	9/-/-
57	All India Housing Association	580	O	O	O	O	6/13/-	8/10/-
58	Shri Gore – Portable house	256	×	O	×	O	Delhi: 7/8/- Bombay: 7/8/-	Delhi: 7/13/- Bombay: 7/13/-
59	Government of Madhya Pradesh	555	×	O	O	O	Delhi: 5/13/- Bombay: 6/4/-	Delhi: 8/6/- Bombay: 9/10/-
60	Mrs Jardine Hendrson Ltd., Aerocem	418	×	O	O	O	Delhi: 5/8/- Tea estate: 4/-/-	Delhi: 6/5/- Tea estate: 4/11/11
64	Government of Burma	648	×	×	O	O	3/6/-	3/6/-
65-66	Forest research Institute, Dehra Dun.	475	×	×	—	—	7/11/-	8/6/1
68	The Rational Planning	367	×	×	O	O	5/10/-	6/-/-

O=Confirm, × =Not confirm, — = Not Applicable

Table -3: Simplified diagrams from respective drawings (Source: Author)

3.3.3 Detail analysis in terms of modern construction materials, techniques, and construction costs

The following 12 cases are detailed further:

A) No.54 The Hindustan Housing Factory LTD, Jangpura

The modern construction method of concrete was used, including prestressed concrete for the beam and foam concrete for the panels in the roof (Fig.5).

1) Architectural features

The housing designed by the Hindustan Housing Factory Limited, as mentioned before, was employed using modern construction methods: prestressed concrete and foam concrete was used in order to downsize the section of them and to reduce the construction cost. In addition, the doors and windows were all factory-made according to the standard.

2) Analysis

Originally, the Hindustan Housing Factory Limited was established by the government initiative so as to promote prefabrication by modern construction materials, namely, concrete. The purpose of the exhibited house, as mentioned in the architecture features, was prefabricated and standard.

The low-cost construction of this house was successfully achieved using the modern method of prefabrication in comparison to other houses.

B) No.31 Government of Assam – Bamboo, No.48 The Rational Planning Corporation – Kotah Stone, No.51 Government of Rajasthan

These houses were built with local materials and were easily constructed in specific areas but were costly to build in Delhi. This means that these housing types could not be highly evaluated.

1) Architectural features

No.51 was built of stone and included famous construction materials in the past of the state of Rajasthan (Fig.8). The utilization of the stone makes the house well protected from moisture.

No.48 was built using the Kotah Stone, which was a high-class construction material. However, the house, according to the purpose of the exhibition, was built at a low cost due to a difference in the thickness of the stone as per the application (Fig.7).

No.31 was proposed using bamboo and cement for walls and galvanized iron sheets for the roof to be suitable for the area with very heavy rainfall (Fig.6).

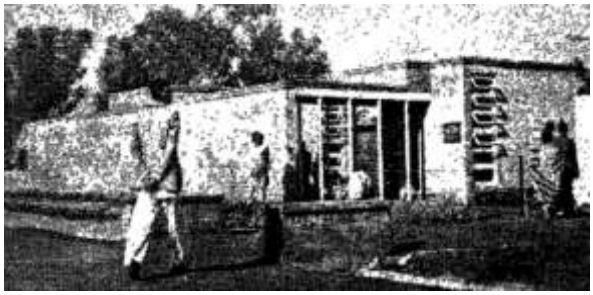

Fig -5: No.54 house by The Hindustan Housing Factory LTD (Source: Reference 5)

Fig -6: No.31 house by Government of Assam (Source: Reference 5)

Fig -7: No.48 house by The Rational Planning Corporation (Source: Reference 5)

Fig -8: No.51 house by Government of Rajasthan (Source: Reference 5)

2) Analysis

These houses used local materials, such as stone or bamboo, and, as a result, were constructed at comparatively higher costs, unlike the No.54 house. Moreover, the No.31 house, as mentioned, had walling that consisted of single wattle/split bamboo crete walling plaster on both sides, with cement mortar to support 24 British Wire Gauge (BWG) iron sheets. Thus, this house was not constructed at a low cost.

Regarding both houses No. 48 and No. 51, there is large difference between the local construction cost and that of Delhi. This was true because local techniques and materials were easily available locally due to transport costs.

In other words, local materials and techniques rooted in a specific place would be difficult to use and maintain standards everywhere and could also not be achieved at a low cost in terms of standard houses built everywhere.

C) No.17–18 Bengal Engineering College, No.39 Indian Aluminum Co LTD, No.44 Asbestos Company, LTD

They used modern material, including asbestos and aluminum so as to reduce construction costs.

1) Architectural features

No.17–18, No.39, and No.44 were built by a company that dealt with aluminium and asbestos (Fig. 9-11). In the case of the No.39 house, as mentioned in the brief introduction of the house, "if bricks and other ordinary materials cannot be easily obtained, but a house has to be put up very quickly, this Aluminum house is the solution. It is extremely light and portable. [5]" Although it is not a sensible material, the house is made of a modern material.

As with the asbestos of house No.44, although it is also not cheap, it would be considered a modern material. In the case of house No.17–18, the small house was made lighter with the help of an asbestos roof and pillar and panel construction with a light foundation to stand on the loose, soft soils.

2) Analysis
These two materials, aluminum and asbestos, were not inexpensive. However, it should be noted that the houses using these modern materials were more sensible than those using local materials, as with No.51, No.48, and No.31.

D) No.6-7-8-9 Central Building Research Institute – Roorkee, No.60 Mrs. Jardine Henderson LTD., Aerocem

These were built using a non-traditional type of material and construction technique to achieve low-cost construction.

Fig -9: No.17-18 house by Bengal Engineering College (Source: Reference 5)

Fig -10: No.39 house by Indian Aluminium Co LTD (Source: Reference 5)

Fig -11: No.44 house by Asbestos Company, LTD (Source: Reference 5)

Fig -12: No.7 house by Central Building Research Institute – Roorkee (Source: Reference 5)

1) Architectural features

These four houses, No.6-7-8-9, used a shell structure without any pillars or walls and were the cheapest ones exhibited (Fig.12). There might be problems with the quality of the living environment in them, but they were the ultimate low-cost housing type aimed to shelter from the rain and wind. Additionally, house No. 60, with its pre-cast hollow blocks for walls, was an attempt at low-cost construction through the use of a foaming agent, which expanded the cement concrete to the extent of 70 % over its original volume (Fig.13). Furthermore, hollow blocks have greater insulation capacity and are better protected against moisture.

1) Analysis
As with the No.6-7-8-9 houses, the No.60 house using asbestos sheets for roofs also achieved a low cost and surpassed functionality in comparison with others. As can be seen in the analysis table (see Table 3), this indicated that the houses, with help of modern techniques and materials, could be constructed at a comparatively low cost.

E) No.13 and 14 Habib Rahman of Central PWD

Lastly, the Central PWD, which was part of the organizer, should be discussed. Habib Rahman, as mentioned before, became a senior architect in 1953, when the exhibition was held, and he designed some of the exhibited houses.

The No.13 and 14 houses (which are paired according to the drawings) were designed by him (Fig.14, 15). In addition, his house called the "Habib model" has been spread all over India [1].

1) Architectural features

Although the floor plan of the No.13 and 14 houses seems to be similar at first glance, the structure and concepts were different.

The No.13 house, as mentioned, "thought of reducing construction costs by simplifying floor plan. [5]" The house with two rooms was compact, and a verandah penetrated the house itself so that ventilation could be obtained sufficiently in case of high temperature and humidity. In addition, the roof was semi-precast.

The No.14 house is a more compact plan. A column (of which the material was not mentioned) was located at the center if the floor plan could support the 4.5-inch thick concreate slab covering the entire house. Thus, the wall separating each room was not a structure. By changing the height of the partition wall, ventilation holes were created in the upper part of the wall. The No.14 house, instead of having a verandah as in house No.13, was further compacted with the mechanism of the ventilation.

2) Analysis
The cost of the innovative houses combined with the cost of services was not low in comparison with the No.6-7-8-9 houses, which had keen low costs, even though the living environment of these houses could be better.
As shown with the Central PWD proposal, the proposed housing was a sensible building in which decorations were eliminated and which used modern materials.

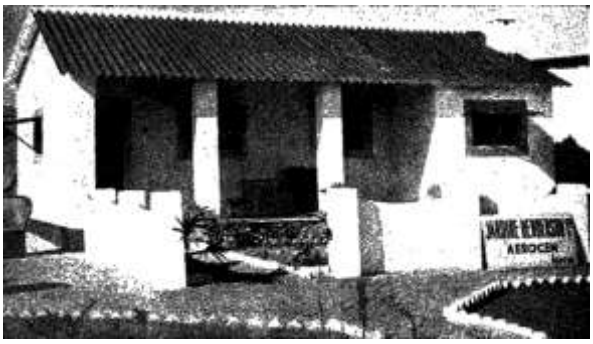

Fig -13: No.60 house by Mrs. Jardine Henderson LTD. (Source: Reference 5)

Fig -14: No.13 house by Habib Rahman of Central PWD (Source: Reference 5)

Fig -15: No.14 house by Habib Rahman of Central PWD (Source: Reference 5)

This was the intention of the organizer (which may be the same with Prime Minister Nehru). Even with architects Habib Rahman or GB Deolalikar, their modernized houses by

the central PWD had been a trend of the whole of India in the time of a housing shortage and then spread to the domestic market.

4. CONCLUSIONS

Looking back at Section 2, low-cost housing was achieved by introducing modern materials, such as concrete, aluminum, asbestos, etc., and modern construction methods, such as prefabrication and hollow concreate blocks. As for stone, bamboo, and other local materials that have been used for specific areas, they would not be suitable for standardized houses when attempting to achieve low costs.

Not only the abovementioned ideas but also modern ideas, such as privacy, hygienics, and social welfare, had been installed as state-of-the-art requirements.

Both are thus being introduced and are important as the intention of the organizer to steer toward modernization through the exhibition. Additionally, the houses, with the help of modern materials and techniques that ensure modern life, are modern as indicated by the government.

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