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Study of Scale and Proportion in Government Housings of Chandigarh

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Abstract: The city of Chandigarh was planned based on Le Modulor which is one of the most extensive measurement systems invented in 20th century by Le Corbusier. The spirit of the city lies in Le Modulor itself. Apart from the monumental buildings of Chandigarh the government housings also used Le Modulor in its sections and elevations in the initial phase.

The study focuses on the government housings of the city which were based on this system of scale and proportions but with time and need for more housings the spirit of Le Modulor is lost. The need for more space led to the removal of Le Modulor from the housings which is shown in the study. Thus, the hypothesis argues on the aspects which can be used to revive the spirit of Le Modulor in these government housings keeping in mind the need of the inhabitants in the contemporary scenario. There will be a set of guidelines proposed after an extensive study of the current government housings in Chandigarh based on Le Modulor.

Index Terms - Le Modulor, Government Housings, Chandigarh.

I. INTRODUCTION

In the 1940s Le Corbusier made an effort toward standardization. The architect said that he found a solution for harmonious standardization of mass production that is based on mathematical foundations and human scale. (Rozhkovskaya, 2020) In 1950 Le Corbusier surprised the architecture world by his publication that he has been working on since 1942 based on the subject of proportion. The subject of proportion always concerned Le Corbusier as his training was largely governed by proportions derived from nature. Thus, a ratio was called upon that was extraordinary and extremely important to Le Corbusier 'The Golden Ratio'. The valid aspects of this proportion led as a base to a relation of systems derived from it. He used the concepts of "Modul(e)" and "Nombre d'or" (the golden number) to generate a title for his book, "Modulor". The book was acclaimed all over the world and the system of proportional measurements he described widely acclaimed. (Gast, 2000)

In 1950, Le Corbusier was given the opportunity to bring his answer from the drawing board to reality, the opportunity to design and construct a new capital for Punjab at the foothills of the Himalayas. The new capital, named Chandigarh, was meant to be an administrative city for the state of Punjab and was designed to eventually house up to 500,000 inhabitants. (Ramesh, 2016)

Le Corbusier and his team of architects Jane Drew, Maxwell Fry, and Pierre Jeanneret, as well as a large number of Indian architects, collaborated to build Chandigarh's urban structure as a 'framework'. The city was originally made for a population of 1,50,000 which was later increased to 5,00,000. Le Corbusier created the fundamental framework of the city through sectors and the Capitol Complex on the northern outskirts. While the neighborhoods with planning of individual blocks were assigned to Pierre Jeanneret along with Maxwell Fry and Jane Drew to be designed.

Le Modulor is clearly visible at a monumental scale in the the Capitol Complex or the buildings designed by Le Corbusier but is not so much focused upon in the designs produced by Pierre Jeanneret for Chandigarh.

Pierre Jeanneret worked on the internal planning of the main city such as Government Housings, Townhall, State Library, etc. Government housing in the city was initially divided into 13 categories ranging from house for the Chief Minister to the lowest paid class-IV employee. These government houses were single or double storeyed. A lot of attention was given to making the design of these houses suitable for local climate keeping the economic constraints in mind. These were constructed using the local building materials. (Administration, 2021; Fry & Walden, 2021).

II. LE MODULOR

(The Modulor: A Harmonious Measure to the Human Scale Universally Applicable to Architecture and Mechanics)

Modular is the most comprehensive proportional system of the 20th century which ended decades of discourse on proportions. The modular is formed by the amalgamation of the concept of 'Module' with the concept of the 'Golden Section'.

Le Corbusier created The Modulor as a six-foot (about 183- cm) man with his arm upraised (to a height of 226 cm; 7'5") and was inserted into a square. The ratio of the height of the man (feet to head 183 cm; 6') to the height of his navel (at the mid-point

of 113 cm; 3'8.5") was taken precisely in a Golden Ratio. He further divided the height of the man (from feet to the raised arm) in golden ratio (140 cm and 86 cm) at the level of wrist of downward –hanging arm. These two ratios (113 /70) and (140/86) were further divided into smaller dimensions according to Fibonacci series. According to the quantities of 113 and 226, Le Corbusier developed two vertical measurements, the red series and the blue series, which are descending scales related to the height of the human figure. The basic plot of human figure is 113 (feet to naval), 70 (naval to head) and 43 (head to raised arm) have been shown on left side of human figure. The whole anthropometrics of human activities could be worked out by the Modulor man.(Gangwar, 2017)

The grid is made up of three measures: 113, 70, 43 (in centimetres) in a relationship with the golden section; the fibonacci series gives $43+70=113$ while added together they give $43+70+113=226$. These three units (70-113-226) defines the space occupied by 6 feet man.

The measure 113 furnishes the golden mean 70 which gives the red series: 4-6-10-16-27-43-70-113-183-296, etc. While the measure 226 (the double unit) with the golden mean 140-86 gives the blue series: 13-20-33-53-86-140-226-366, etc. (Corbusier, The Modulor, 1954)

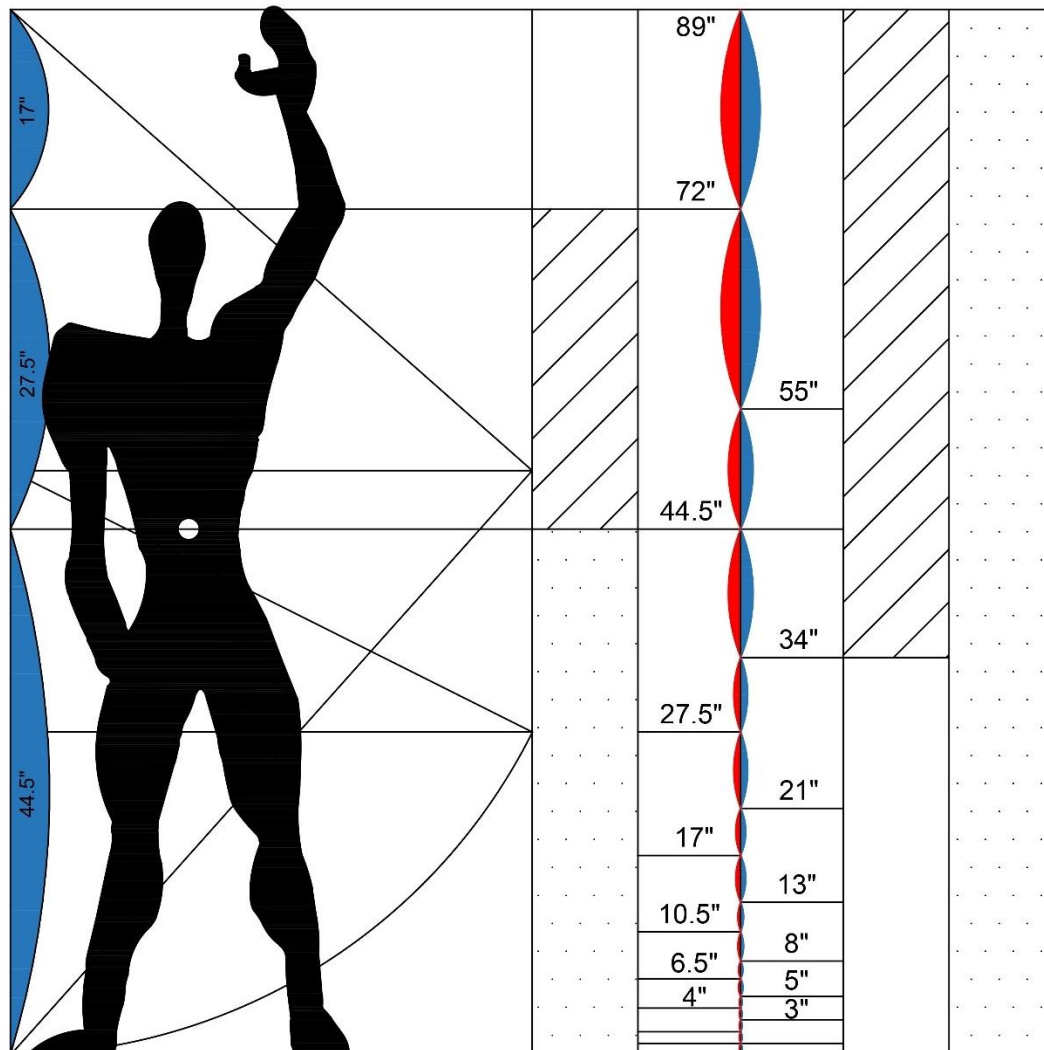


Fig. 1: Le Modulor

III. EVOLUTION OF CHANDIGARH

The city of Chandigarh has seen a significant amount of boost in the population of inhabitants living in and around the city. A major setback in the use of Le Modulor was for the government to provide sufficient accommodations for government employees to live in. To fulfill the demand the city expanded. The expansion happened in three phases at different time intervals. The first phase was in 1950s when the city was being constructed. The second expansion happened post 1966 when the city saw a significant boost in the population due to political reasons. While the third happened in the early 2000s to satisfy the increasing demand of government housings.

Each phase was accompanied by the expansion of the city itself. Sector 1-30 came under Phase 1 (29 sectors as Sector 13 is missing), Sector 31-47 came under Phase 2 (17 sectors) and Sector 48-56 in Phase 3 (8 sectors) which comes partially in Chandigarh and partially in Mohali, Punjab.

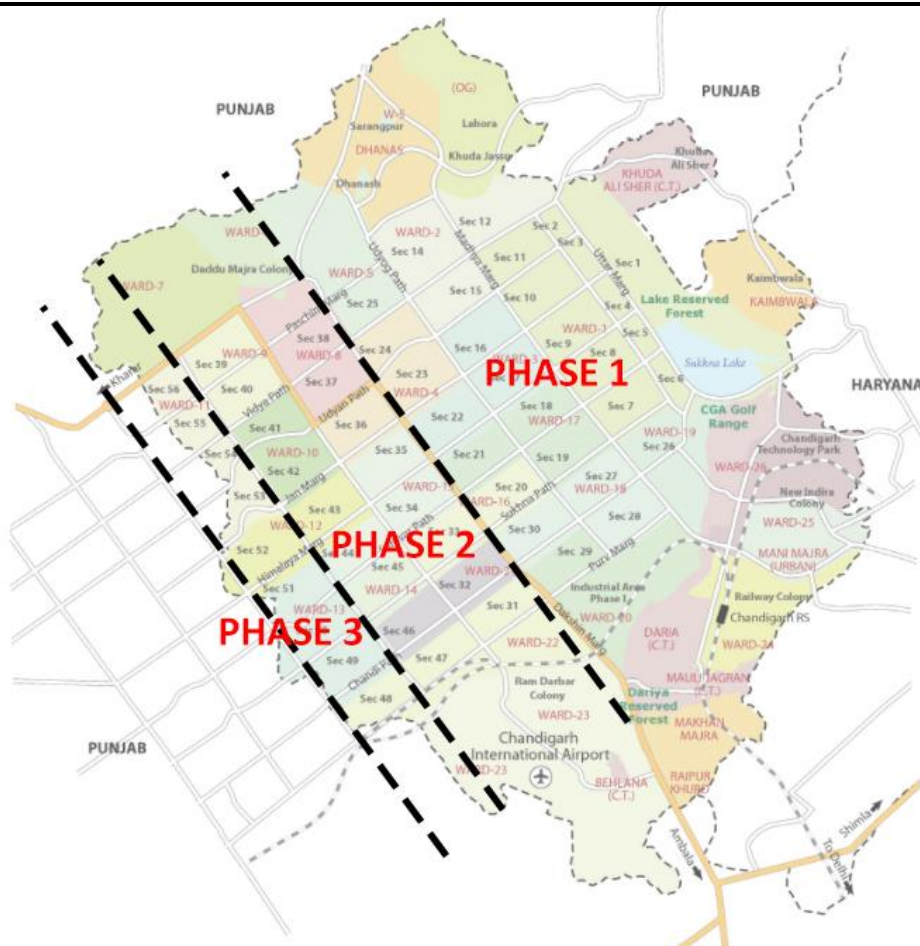
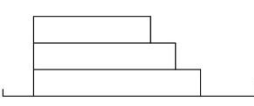
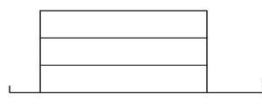
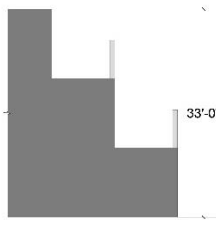
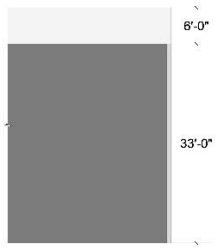
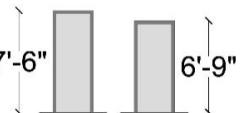
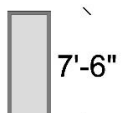


Fig. 2: Map of Chandigarh showing the 3 Phases.

	PHASE 1	PHASE 2	PHASE 3
BUILT FORM			
BUILDING HEIGHT	19'-6" (233") 	33'-0" (377") 	33'-0" (377") + additional 6'-0" (72") for services. 
DOOR AND WINDOW SIZES	Specified in frame control and restricted to rectangular or square shapes only.	Specified in frame control and different shapes permitted.	No restrictions on the shapes and sizes.
LINTEL LEVEL	7'-6" (89") or 6'-9" (81") 	7'-6" (89") 	Not specified.

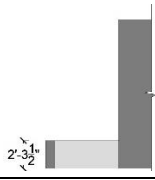
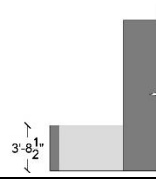
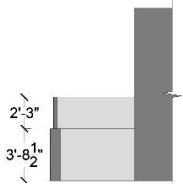
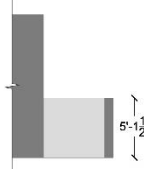
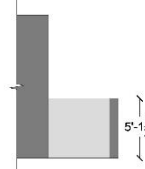
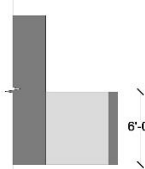
MATERIALS	Only bricks with white washed cement plastered bands and raw concrete surfaces permitted.	Bricks with white washed plastered bands and raw concrete surfaces permitted. Stone and tiles were also permitted.	No restrictions on the use of materials.
TOP COURSE AND PARTY WALL	Both mandatory.	Party wall mandatory. Top course not mandatory anymore.	Party wall mandatory shared among adjoining units.
FRONT BOUNDARY WALL	2'-3.5" (27.5") 	3'-8.5" (44.5") 	3'-8.5" (44.5") + 2'-3" (27") 
REAR BOUNDARY WALL	5'-1.5" (61.5") 	5'-1.5" (61.5") 	6'-0" (72") 

Table 1: Comparative Analysis of Government Policies.

A significant change is seen in the density of the houses from 1 plot for each family in phase 1 to a floor for each family that is 3 families on one plot of land. The building form evolved in each phase resulting at last into a simple cuboidal planning, while phase 2 sectors mandated compulsory stepped rear terraces, each provided with brick screen walls for outdoor sleeping. The building height was subsequently increased to 33' to meet the increasing population needs. Also, additional height was allowed on terraces for water tanks and other services in phase 3. The lintels of the doors were fixed to 7'-6" or 6'-9" which was shifted to just 7'-6" in phase 2, while with the implementation of phase 3 norms these doors had no fixed sizes anymore thus no specified lintel levels. Restrictions on the materials and top course were also removed in phase 3 while the party walls are still mandatory and to be shared among adjoining units. The height of the boundary walls was also subsequently increased to 6' in phase 3.

IV. IMPLEMENTATION OF LE MODULOR IN GOVERNMENT HOUSINGS

Studies were conducted to analyze the use of Le Modulor in the government housings of Chandigarh thus one house was selected from each phase.

- Government House in Phase 1, Sector 22.
- Government House in Phase 2, Sector 20.
- Government House in Phase 3, Sector 43.
- Unite'd Habitation, Marseille, France.

In order to create a basic understanding of the principle of Le Modulor Unite'd Habitation is also studied.

4.1 Government House in Phase 1, Sector 22

Completed in 1956 it follows strict frame control and have great impact of Le Modulor on it inspite of being designed by Pierre Jeanneret which can be seen through the sections and elevation of the house.



Fig. 3: View of Government House of Phase 1.

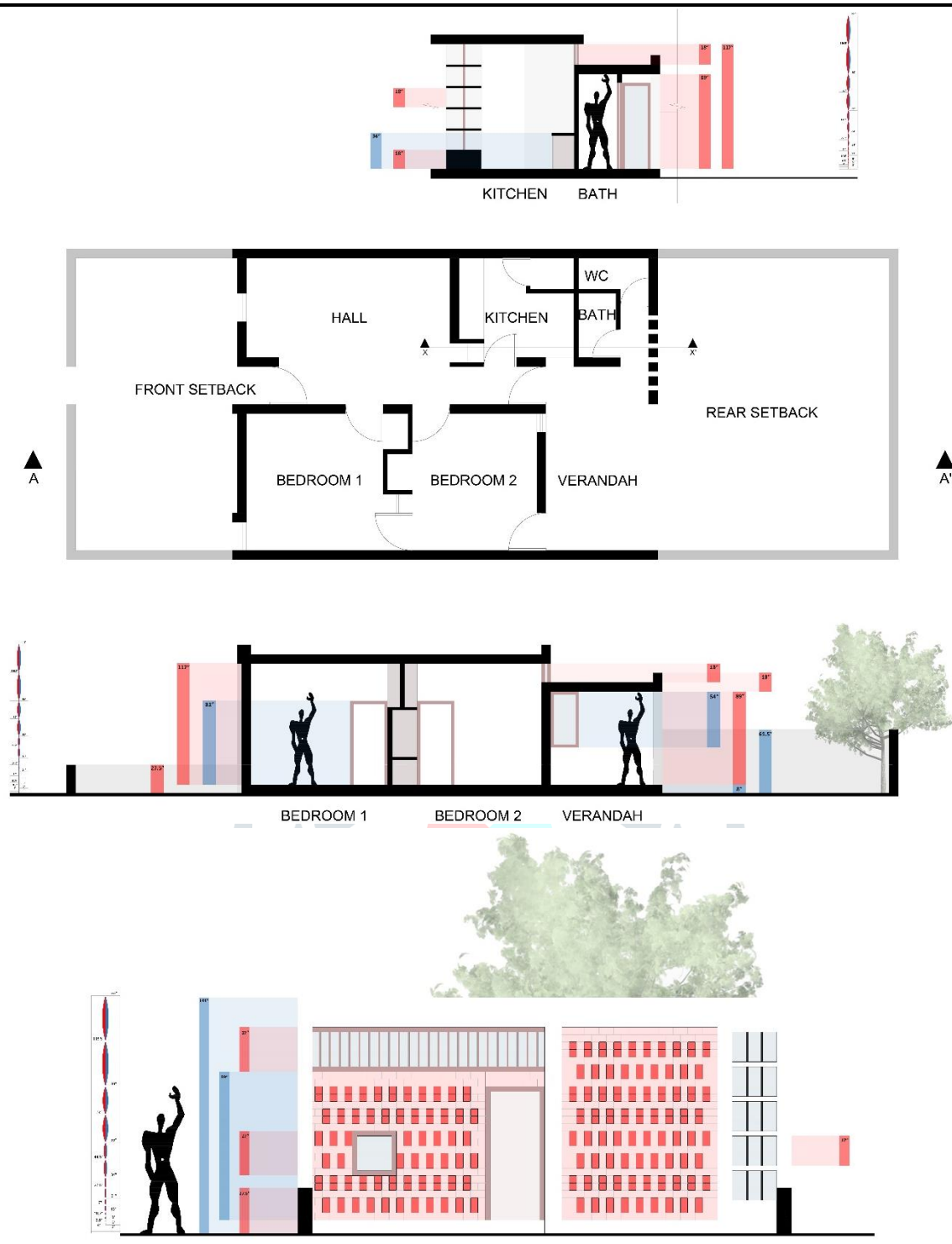


Fig. 4: Plan, Sections and Elevations of Government House of Phase 1 showing the use of Le Modulor.

4.2 Government House of Phase 2. Sector 20

Completed post 1966 it follows the restrictions of frame control. The frame control in this phase had limited use of Le Modulor in its sections and facades. The houses have rear terraces on each floor for proper ventilation and light. There are mandatory top course and party walls that act as a dominating feature in the façade of these houses. The plans were functionally optimized to fulfil the increasing requirements of housings in Chandigarh.



Fig. 5: Front and rear view of Government House of Phase 2.



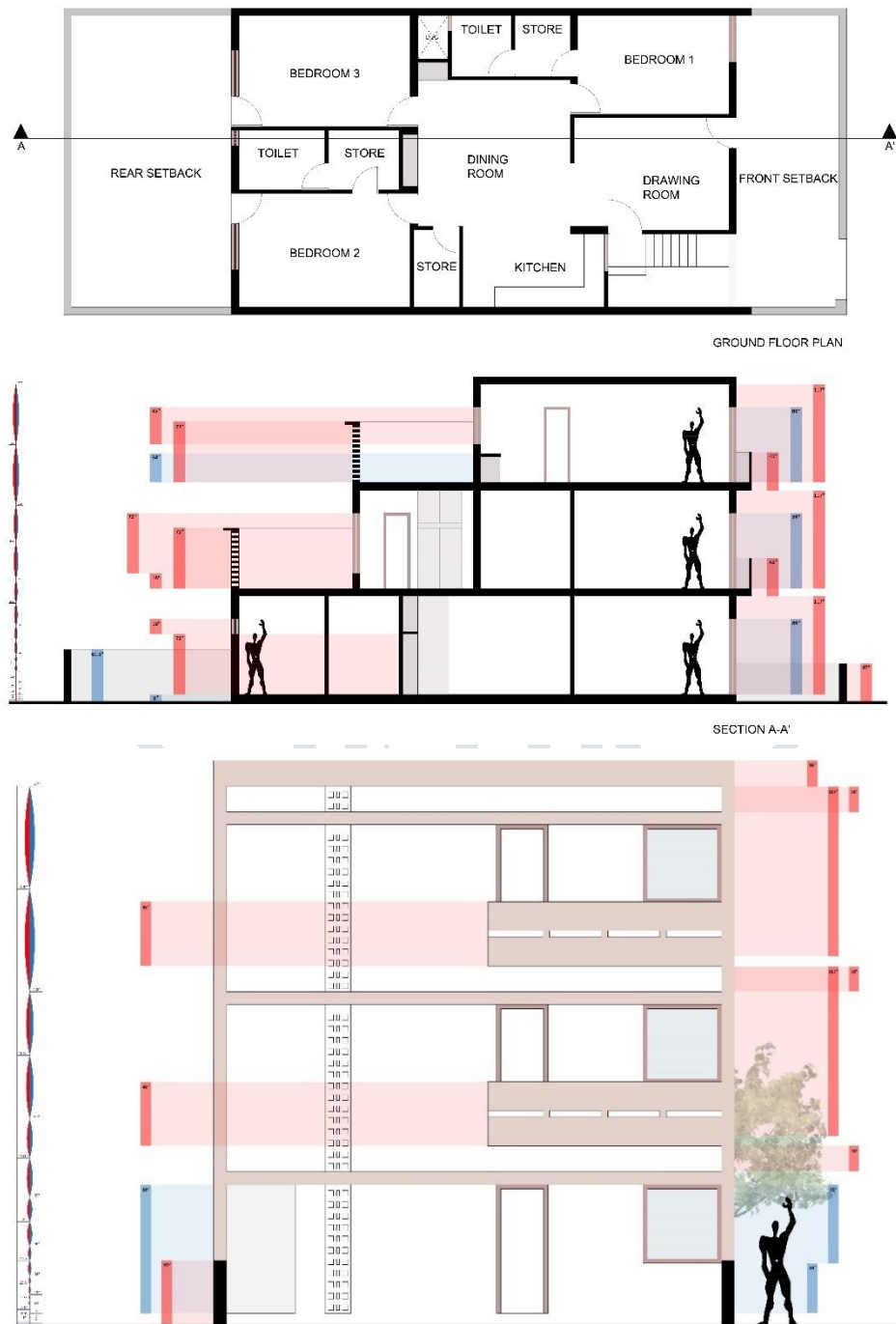


Fig. 6: Plan, Section and Elevation of Government House of Phase 2

4.3 Government House of Phase 3, Sector 43

Completed post 2010 it follows the norms provided by government with no frame control. The use of Le Modulor that was seen through the frame control is almost lost in this phase.



Fig. 7: Front view of the Government House of Phase 3.

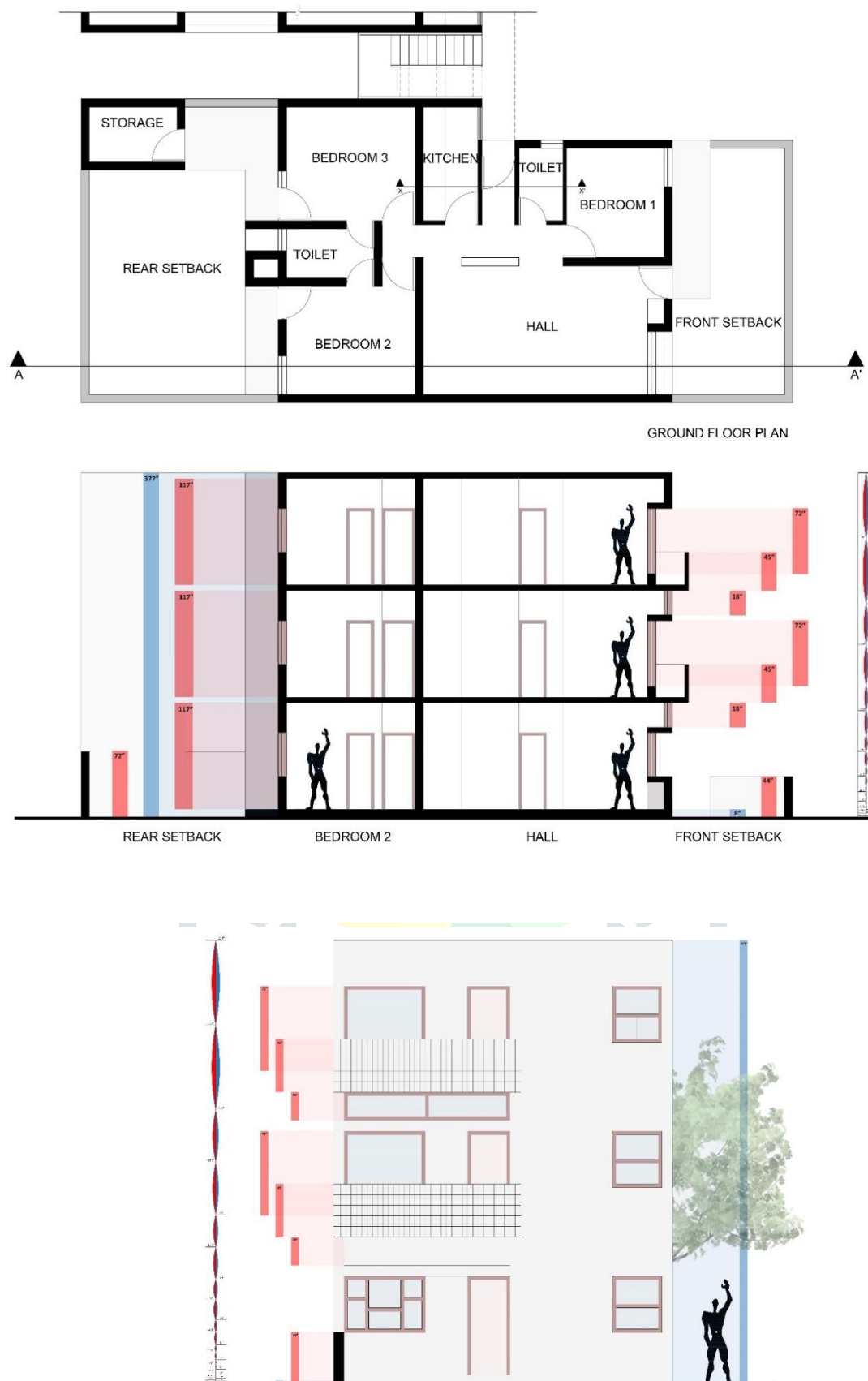


Fig. 8: Typical Floor Plan, Section and Elevation showing total height of the house.

4.4 Unite'd Habitation, Marseille, France

Completed in 1952 it was the first of the series of the new housing project series of Le Corbusier based on communal living for the inhabitants to shop, play and live in a vertical garden city. Nearly 1600 inhabitants were divided among 18 storeys. The innovative approach was to bring together living as well as public and communal spaces together.



Fig. 9: Views of Unite'd Habitation



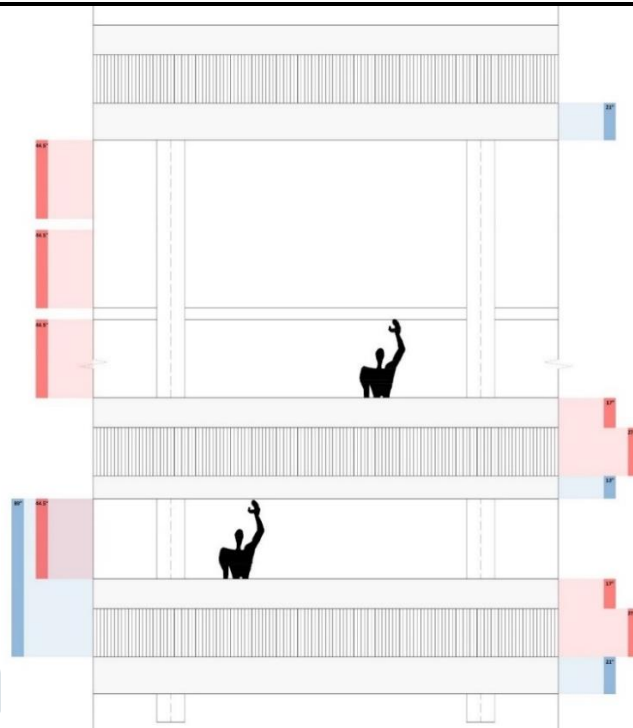


Fig. 10: Plans, Section and Partial Facade of Unite'd Habitation.

V. INFERENCES

- There is no proper ventilation and light provided in the houses anymore with the allowance of typical floor plans.
- From one family living on each plot, due to increase in population each family was permitted to live on one floor, that is, three families on each plot.
- Frame control have been removed and replaced by simple norms defined by the concerned authorities and there is no significance of Le Modulor in the facades.
- The top course and party wall that previously defined the building line were removed in phase 3.
- The fenestrations were defined in Frame control in Phase 1 and Phase 2 but there are no restrictions of shapes, sizes and lintel levels of the fenestrations anymore.
- The sizes of windows are seen to have gradually increased for aesthetic purposes.
- The heights of the boundary walls in the front setbacks gradually increased but always in accordance to Le Modulor with slight variations while for the rear boundary walls they are not in accordance to it.
- The rear setbacks have gradually reduced and permitted to constructed storage spaces that are connected to the main structure.
- Earlier there were restrictions on the use of materials which were totally removed with the implementation of Phase 3.
- There was a significant amount of use of Le Modulor in the sections of houses in Phase 1 which was also somewhat visible in Phase 2 but in Phase 3 the sections do not illustrate the use of Le Modulor anymore.

VI. RECOMMENDATIONS

- Total of height of the building to be kept in accordance with Le Modulor.
- Individual floor heights should depict the dimensions of Le Modulor preferably 117".
- The height of brise-soleils and parapets should be in accordance to Le Modulor preferably 44.5".
- Private terraces should be made mandatory for proper ventilation and lighting for the upper two storeys such that the living spaces remain the same on all three floors.
- Brick jaalis to be provided on terraces for privacy.
- Verandahs where provided should be 89" high where provided.
- Projections of the cantilevers should be up to the building line not beyond that.
- Water pipes and other services should not be visible on the facades.
- There should be no symbolic representations on the facades.
- Plinth level should be fixed.

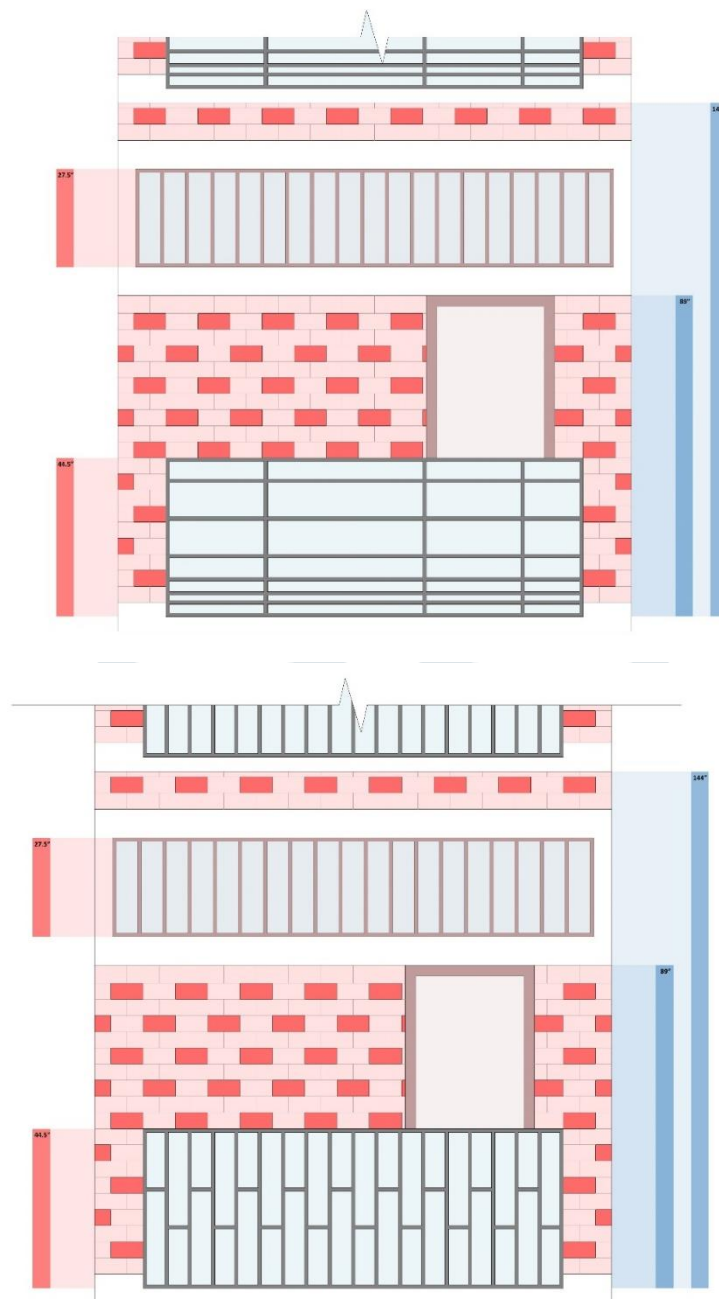


Fig. 11: Conceptual Elevations

These conceptual elevations are showing the proposed use of Le Modulor in various elements of facade along with the examples of designs of railings all designed in accordance with Le Modulor. There are also proposed floor height and lintel levels and the use of bricks in facade with white bands running across.

- The lintel level should be fixed to 89" for doors.
- Materials other than wood for doors and windows should be permitted.
- The size of the fenestrations can be flexible but the ratio of windows to walls should be fixed.
- For large windows divisions can be further made based on golden section or Le Modulor.
- Ribbon windows can be provided running across the facades of houses.
- Materials should be fixed to exposed bricks, stone, white washed cement plastered surfaces and raw concrete showing the marks of shuttering.
- The height of both front and rear boundary walls should be in accordance to Le Modulor.
- There should be no symbolic representations on the boundary walls just the name and address shall be permitted.

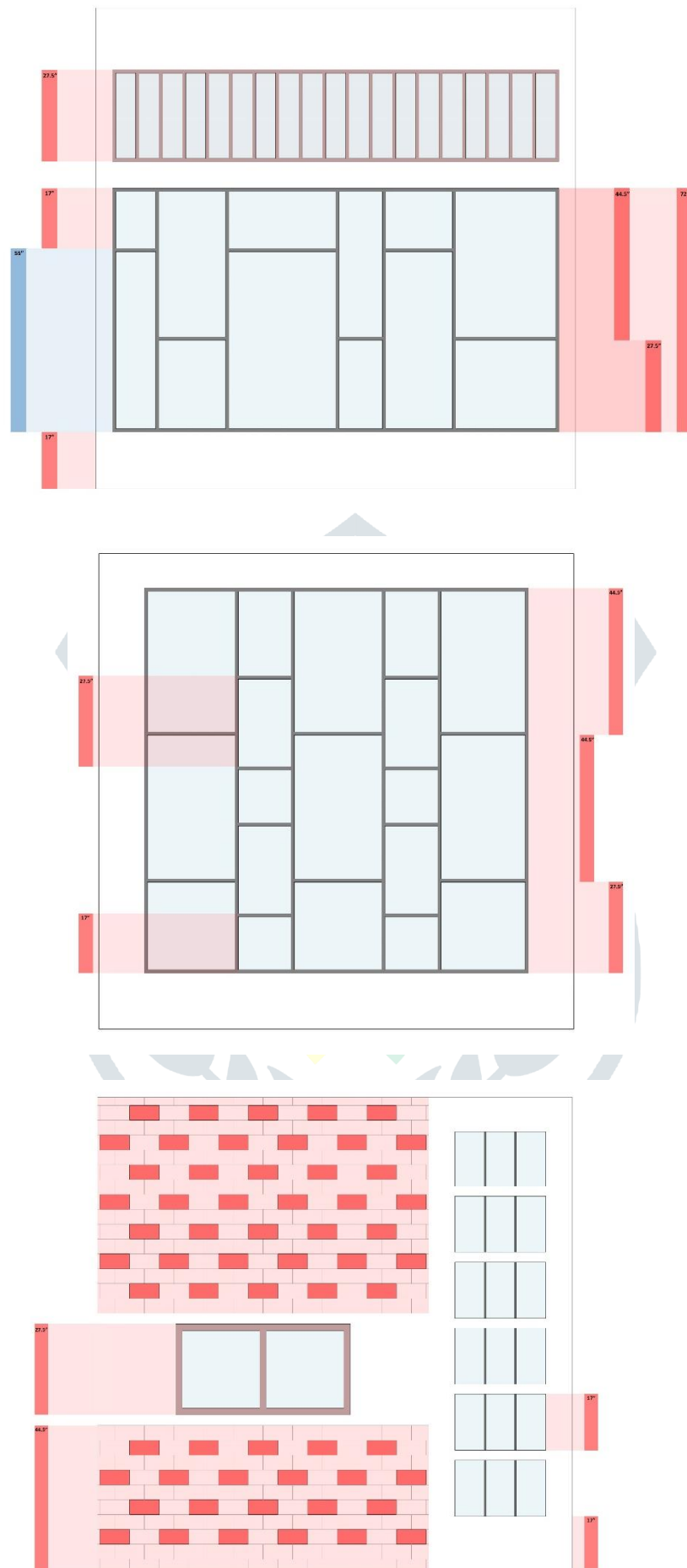


Fig. 12: Conceptual drawing of fenestrations along the façade showing use of Le Modulor.

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