STRUCTURAL STRATEGY AND CONSTRUCTION SYSTEM IN THE CASE OF TRADITIONAL BERI-CHETTIAR DWELLINGS IN CHENNAI (1850–1950)

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Abstract: The Beri-Chettiar dwellings in Chennai are a unique example of traditional residential architecture. This research paper studies the Structural Strategy employed in the making of the Beri-Chettiar dwelling and analyses the constituent parts of the building along with the construction system employed in the bringing together of these various components. The selected case-studies are documented in detail through photographs and measure drawings. Analysis was done by first understanding the building as an existing artefact. The load-bearing members were identified and subsequent structural hierarchies were established. The materials used were traced and elements were observed using non-destructive methods. The availability and sizing of elements predominantly dictates the way the structure is organized. Based on the above study the strategy used for the structure of the building was understood and elaborated. From this understanding, the system of construction was conjectured. Due to the non-availability of traditional building materials and the change in building crafts these construction and structural innovations are non-existent in contemporary practices. The remaining few examples of such buildings are being demolished at a rapid rate due to the rise in land-prices and change in family structure which makes these structures obsolete in today’s context. Through this paper we seek to illustrate the innovations used in these buildings, provide an understanding of the strategies and systems used in their making which can aid future conservation efforts and to encourage the conservation of these buildings which form an important link in the historic evolution of structure and architecture of the region.
1 INTRODUCTION

Architecture or the built environment is the ‘envelopment’ of various processes in society. It is not a fossilized record of what happened, but it is a containment of all kinds of forces which have already occurred and are probably likely to occur.

Tradition is generally defined as an inherited pattern of thought or action. Traditional architecture is often a good record of the contextual forces of a particular time-period in which it was constructed. They show a tendency to be ‘rooted’ in the place, its traditions and to assimilate the forces and factors which were at play. Thus they become unique to that place and time-period. Construction is one of the primary activities in the making of a traditional architecture. The methods and processes of construction were developed over several hundreds of years with regards to the materials available locally and the skills of the craftsmen involved in the making of these buildings. Also it had acquired a particular richness over time which is directly reflected in the architectonic quality of these buildings.

1.1 The Context : Chennai

Chennai (Madras) was one of the important colonial centers of power before Independence in 1947. It was founded by the British in 1639. Areas surrounding Fort St George, which is the nucleus of the city, was where the native Indian population settled. This settlement mainly consisted of these settlers residences. These houses were made using a unique mixture of traditional methods which were brought by the native settlers influenced by those introduced by the colonial rulers.

1.2 The People : Beri-Chettiars

One of the several communities which settled in this native area was the Beri-Chettiar community. Their predominant occupation was trade with the British East India Company. They quickly established themselves as wealthy merchants whose trade extended to other British occupied territories like Burma. Though this community had extensive outside contact, it maintained and preserved its traditional roots. The houses of this merchant community built in Madras old city are a good example for studying the unique methods of this place and time period. The Beri Chettis are principal merchants like most other Chettis and belong to the ‘Vaisya’ stock. [1]. The Beri-Chettiar Community was also closely associated with a class of artisans called ‘Kammalars’. This association was also one of the reasons for the architectural richness of these houses. [2].

2 THE BERI-CHETTIAR HOUSE

What primarily defines the Beri-Chettiar house as a type is the ‘Making’ of the building. The urban contexts of Chennai due to the nature of its development lead to the creation of these houses in isolation with each other. Despite these factors the Beri-Chetti dwelling is uniquely identifiable. The material usage, the building components, their assembly and the exquisite craftsmanship applied in these dwellings is what gives them their unique identity. As part of this research paper two of the houses which were most representative of this type of buildings are presented as case-studies. They were constructed in the time-period between 1850 to 1950. The first case study (Veera Vilas) represents a typical case-study and the second case-study (Nainiappa House) represents an atypical one with modifications to the typical plan type. Yet the similarities in the structural strategy are remarkable.
2.1 Case Study 1: Veera Vilas

This Beri-Chettiar house representing the Typical Case is located in Mangapathy Street in Chintadripet area of Chennai. The house was added to in many phases starting with the ground floor in 1880’s and then the second court and first floor in 1930’s. An additional timber framed structure was added in 1950’s as the family profile and economic prowess increased. The ground floor follows the traditional house plan with two courtyards organized in two linear bays. The ground floor is made from a part load-bearing and part frame structure. The masonry is brick and lime mortar and the frame structure consists of wooden members. The floor system is Bengal terrace (brick supported on timber rafters with wooden planks). Some wooden members which are re-used from the older construction have carvings and motifs on them. The newer constructions are comparatively bare. The second courtyard was made later with a higher ceiling height (refer Figure 4). The whole of the second ‘kattu’ (a construction / spatial module consisting of a courtyard and its ancillary spaces) reads as one single volume due to the usage of steel ‘I-sections’ to span the entire courtyard space without the use of columns. The floor rafters are placed on these beams. The first floor is completely a load bearing construction. Even the courtyards vertical support structures are walls placed on top of the columns on the ground. Both the stairs are made very differently, the front one being made from wooden members supporting the flight with ornate wooden railings and the back one being made from masonry with a parapet wall. The second floor is made completely from a timber structure except for the staircase enclosure and toilet. This was a much mater addition to the building. The documentation of this case-study is provided below. (Figure 1-8).

Figure 1: Front Facade.  Figure 2: First Courtyard.  Figure 3: Timber Joinery  Figure 4: Second Courtyard.

Figure 5: Long Section.
Figure 6: Floor Plans (Ground, First and Second).

Figure 7: Transverse Section.

Figure 8: Conjectured Detail at Courtyard Edge.
2.2 Case Study 2: Nainiappa House

This Beri-Chettiar house representing the Atypical Case is located in Nainiappa Naicken Street in Park-town Area of Chennai. The construction of this house was completed in 1936. Hence a lot of the material and ornamentative features of this building also represent the latter part of this time period. Owing to the peculiar plot shape, the house does not exactly confirm with the traditional house plan. But similar principles of organization are used here. The first ‘Kattu’ or courtyard bay is made perfectly rectangular in shape whereas the second ‘kattu’ is fitted into the odd shaped part of the plot. The ground floor is made as a part load-bearing and part frame structure. The ornamentations of the elements can be called colonial. The front stairs is made very ornate and in wood. The second ‘kattu’ is ‘Z’-shaped with a lot of rooms being incorporated into the peripheries. The courtyard is roughly in the centre. A well is located within this court. Elements salvaged from the previous construction like columns and rafters are used in the making of this part. The front kattu is devoid of these members. The second stairs are made in masonry. The first floor is completely made from a load bearing structure. The courtyards and terraces are covered by a metal grille for reasons of security. The documentation of this case-study has been provided below. (Refer Figure 9 – 16).

Figure 9: Front Facade.  Figure 10: First Courtyard.  Figure 11: Timber Joinery  Figure 12: Second Courtyard.

Figure 13: Long Section.
Figure 14: Floor Plans (Ground and First).

Figure 15: Transverse Section.

Figure 16: Conjectured Detail at Courtyard Edge.
3 STRUCTURAL STRATEGY

The Structural Strategy employed in the making of these Beri-Chettiar dwellings is analyzed as follows. For each case-study the construction modules were identified. The horizontal spanning system is understood from them. Following this the vertical supports which transfer the loads are studied. The materials and systems used in these supports are classified as either ‘heavy’ (load-bearing masonry), or ‘light’ (timber frame-work). The type of structural system used in each segment of the building is identified and analyzed.

3.1 Construction Bay Widths

The construction bay widths of the house have been decided based on the spanning capacity of the wooden rafters which support the floor. In Case-study 1 (Veera Vilas), the Bengal terrace floor is constructed on top of these rafters. These rafters take the tensile loads generated in the floor. Brick courses are laid on top of the rafters which form the bulk of the floor and provide a firm surface. These brick courses take the compressive stresses generated in the floor. This part is constructed by first laying wooden planks (25mm / 1” thick) on the rafter on top of which diagonal courses of a special type of brick called ‘kandi-kal’ which has a thickness of 25-40mm / 1-1.5” are laid. The bricks are laid vertically on edge and rich lime mortar is used as a binding agent. Generally two layers of brick tiles are laid. The typical cross section of Burma-teak rafter observed in this house is 125mm / 5 inches deep and 63.5mm / 2.5” wide. The typical floor spans are between 2.4-3m / 8’-10’. The span to depth ratio is roughly between 20:1 to 24:1. (Refer Figure 17). In Case-study 2 (Nainiappa House) the Madras terrace system is used, in which the bricks are laid directly over the rafters, without the use of wooden boards like the former. On the first floor of the house a rare type of rafter was observed which has a depth of 200mm / 8”. This is used to span large spaces with a clear span of 4.5m / 15’0”. The span to depth ratio is maintained the same. (Refer Figure 18)

Figure 17: Construction Bay Width analysis of Case Study 1- Veera Vilas. The value of ‘x’ is between 2.4 and 3m. The figure on the right shows the reflected ceiling plan with horizontal spans.
Figure 18: Construction Bay Width analysis of Case Study 2- Nainiappa House. The value of ‘x’ is between 2.4 and 3m. The figure on the right shows the reflected ceiling plan with horizontal spans

3.2 Massing

The diagrams below (refer Figure 19 and 20) explain the massing of these houses. The volumes shaded in yellow (translucent) are semi-enclosed areas. They use a mixed structural system. The peripheries are brick walls but the internal supports are wooden columns on the ground floor and brick piers on the first floor. Thus there is a use of both planar load-bearing elements and point-load bearing elements. The areas shaded in grey (opaque) are enclosed areas which use only the masonry walls to support the floor. They form masonry boxes which are placed in alternate bays with regard to the yellow volumes.

Figure 19: Analysis of Massing in Case Study 1
Figure 20: Analysis of Massing in Case Study 2
3.3 Structural Strategy

The primary materials used in the construction of the Beri-Chettiar house are Brick and Timber. The structural system is designed to take optimum advantage of the constituent material’s properties. The spatial planning of the house is directly related to and a resultant of the structural system. The house is organized in a series of alternating bays (along the transverse direction) with every alternate bay as a heavy enclosed brick box-structure and in-between bays as a lighter timber-frame in-fill structure enclosed by peripheral walls. This creates a composite structure, with the brick boxes providing rigidity to the structure and the timber providing flexibility to the same. This dichotomy is what defines this structural strategy as remarkable. (Refer Figure 21).

The structural strategy is a clever adaptation to existing constraints of space and material. The Peripheral walls are shared with the neighbour as in many wall-to-wall constructions. The Heavy masonry boxes which form alternate bays tie the peripheries and provide a rigid support holding the peripheral walls in place (serves as bracing during earthquakes). It also forms the intimate private spaces of the home. The in-between bays are made using timber frames which are inserted within the masonry boxes. These provide flexibility to the structure and create lightness to the space. The more public functions of the home are hosted here. These are then spanned over by wooden rafters on which the floor is constructed.

Figure 21: Stage 1 to 4 illustrates the Structural Strategy used in the making of the Houses.
4 CONSTRUCTION SYSTEM

Following the understanding from the previous analysis, the construction system of these houses was elucidated. The constituent parts of the house were clearly de-lineated and studied in an exploded format showing the various main components. Once the components were understood the sequence in which they were put together was conjectured.

4.1 Constituent Parts

The individual components of the building were identified. Then the hierarchy of elements was understood. The construction of an independent floor was examined as kit of parts being put together. Next the entire building was understood as an articulation of this system. The below exploded views represent the learning from the study of the buildings. (Refer Figures 22 - 23)

Figure 22 & 23: Exploded axonometric showing the components of a floor (on left) and the entire building showing various levels (on right).
4.2 Sequence of Construction

The sequence of construction is explained through the following set of diagrams which highlights each individual phase in the construction of these buildings. (Fig-24)

Phase 1 - Foundation
Phase 2 - Plinth
Phase 3 - Entry Doorway
Phase 4 - Walls up to Lintel
Phase 5 - Timber Columns
Phase 6 - Beams + Walls
Phase 7 - Floor Spans (Rafters)
Phase 8 - Madras Terrace Floor Slab
Phase 9 - Wall marking
Phase 10 - First Floor Walls
Phase 11 - Staircase
Phase 12 - Wall above lintel
5 CONCLUSIONS

The Beri-Chettiar dwelling offers a unique case-study into the makings of a building type as a response to the needs of the context. The structural strategy has evolved as a direct response to available material technologies and functional needs. This is evident in the way each primary material manifests itself in the building as a mutually complimentary ‘Hybrid’ system. The spatial planning of the house is a direct resultant of the structural system and together they form an Architecture which is cohesive and integrates the various systems in a seamless and multi-dimensional manner. Through this paper we seek to illustrate the innovations used in these buildings, provide an understanding of the strategies and systems used in their making which can aid future conservation efforts and to encourage the conservation of these buildings which form an important link in the historic evolution of structure and architecture of the region and its time-period.

REFERENCES


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