DOCUMENTATION OF THE STRUCTURAL CHARACTERISTICS OF A HISTORICAL HOUSE

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Abstract:

The sustainability of historic structure systems are of primary importance for the conservation of architectural heritage. This paper focuses on the documentation of structural characteristics of a historical house so that necessary conservation work can be planned prosperously. This late 19th century historical house is located in Karatas, Izmır, Turkey.

The techniques combined for documentation are conventional and tacheometric survey techniques, visual analysis, mapping and 3D-modelling. The tools used for measurement are Topcon 7003i total station, Leica DISTO laser meter, steel tapes and range rods. The programs used for processing of measured data are Autocad 2010, Archicad 12, Artlantis.studio.2.0 and Topcon Link 7 2.

The structural characteristics and problems are visualized in the form of scaled maps with appropriate legends. 3D-modelling technique is preferred for illustrating the details of the structural system and the possible sequence of construction. These visual documents will facilitate understanding of the structural system of the building with all its details and guide conservation interventions aright.

1. INTRODUCTION

The recording, investigation and visualization of structural systems are important for deciding on appropriate conservation interventions. The aim of this paper is the documentation of a historical house [1], with particular emphasis on the structural characteristics so that necessary conservation work can be planned prosperously. The methodology includes measured survey by combining conventional and tacheometric techniques, visual analysis, mapping and 3D modelling. The tools used for measurements are Topcon 7003i total station, Leica DISTO laser meter, steel tapes and range rods. The programs used for processing of measured data are Autocad 2010, Archicad 12, Artlantis.studio.2.0 and Topcon Link 7 2. The details of the methodology are explained under two headings: Data collection and data evaluation.

1.1 Collecting the Data

The techniques used in the documentation of the historic structure were visual analysis, photographic documentation, conventional and tacheometric measuring techniques. Conventional techniques were used for the measurement of plan and sections. Steel tapes and survey rods were the conventional instruments used. Besides, a laser based device; Leica Disto Laser meter was also used for the hand measurements. The facades were measured with tacheometric techniques. Topcon 7003i total station was used for this purpose. To decipher structural system details, the walls and floors were visually analyzed; and the structural elements which could be reached were measured in detail.

1.2 Evaluating the Data

The data gathered in the field survey was used for producing 2D drawings of the case study house, the maps and 3D model regarding the structural characteristics. Subsequent to 2D drawings, an analysis table was developed for evaluating the structural characteristics of the house. Defining the concepts of the analysis table took several issues into consideration: First, the building elements were labeled as wall, floor and roof covering, etc. Then the role of each element was considered and three different types were identified: structural, finishing and architectural elements. Finally, sub-groups of each type were identified according to their construction technique and material usage*. Each structural concept was illustrated with a different color on the scaled drawings is shown with a different color (Figure 1). AutoCAD 2007 was used to produce 2D conventional drawings and maps.

Figure 1: Map illustrating the structural characteristics

3D-modelling technique was preferred to illustrate the details of the structural system and the possible sequence of construction. The parts whose finishing material was missing were thoroughly observed and the data gathered from different locations in the building was combined to produce the system detail (Figure 5). In turn, this detail drawing does not illustrate a specific part of the building, but it gives analytic information about characteristics of the primary structural and finishing elements. This information was further emphasized with the production of the analytic 3D Model. The sequence of the construction was illustrated with four views from the 3D model. The software used for modelling is Archicad 12 and Artlantis.studio.2.0. First, the structural and finishing elements were modelled as 3D elements in Archicad 12. Then, these elements were brought together differently in four models to present the possible sequence of the construction. Each phase was transferred to Artlantis.studio.2.0. In Artlantis, the appropriate textures and colors which were selected similar to the original features of the materials are added. Lastly, a photo was captured with the same camera viewpoint in each model (Figure 6).

*The illustration column providing a view from the 3D Model or a photo of the historic structure for each line was omitted here due to lack of space.

Table 1: Analysis of the building elements

Element Name	Element Type	Construction Technique and Materials	Map Color
Roof	Structural	Wood plank and beam roof system, details unobserved	
	Structural	Iron roof framing, additional, inconsiderate	
Floor	Structural	Wood joist floor system, original, only wood beams	
		Wood joist floor system, original, wood joist floor system supported with iron brackets	
	Structural	Reinforced concrete floor system , additional, inconsiderate	
Wall	Structural	Masonry, original, rubble stones bonded together with lime mortar, reinforced with cut stone at the corners (42 cm in the basement, 36 cm in the ground floor)	
		Masonry, altered, solid bricks bonded together with cement (36 cm)	
	Structural	Composite, original Masonry exterior: Rubble stones bonded together with lime mortar, reinforced with cut stone at the corners (20 cm in the ground, 15 cm in the first floor) Wood post and beam framing interior: Rubble stone and brick infill bonded together with lime mortar (12 cm in the ground, 10 cm in the first floor)	
	Structural	Wood post and beam framing, original, no infill, finishing with lath technique (13-15 cm)	
		Wood post and beam framing, original, rubble stone and brick infill bonded together with lime mortar (13-15 cm)	
Column	Structural	Reinforced concrete ,additional, inconsiderate	
	Structural	Steel, additional	
Roof covering	Finishing	Marseille roof tile, original (23x1.5x 41)*	
Ceiling covering	Finishing	Wood lath technique, original, (3x1x various), finished with double layer plaster: Lime plaster reinforced with straw underlayer (3.5), lime plaster finishing layer (0.5)	
		Wood, original (17.5x1x various)	
		Wood paneling, oil painted, additional, inconsiderate quality (35x30x various, 83x170x various, 125x125x various)	
		Cement plaster + white washed, additional, inconsiderate quality	
Wall covering	Finishing	Wood lath technique, original (3x1x various)	
		Lime plaster reinforced with straw (underlayer) (3.5)	
		Lime plaster reinforced with straw (underlayer) + lime plaster (finishing layer) (3.5 + 0.5)	
		Lime plaster reinforced with straw (under layer) + lime plaster (finishing layer)+beige washed (3.5 + 0.5)	
		Cement plaster + white washed, additional, inconsiderate quality	
		Faience tiles (15x0.5x15)	

Floor covering	Finishing	Wood, original (20x1x various)	
		Wood, original (10x1x various)	
		Marble, original (64 x unobserved x 64)	
		Mosaic tile, original (20x unobserved x 20)	
		Mosaic tile, original (21x unobserved x 21)	
		In situ mosaic, additional, inconsiderate quality	
		Leveling concrete, additional	
Ceiling embellishment	Architectural	Gypsum plaster + beige washed, original	
Cornice	Architectural	Gypsum plaster + beige washed, original	
		Stone, original	
Window	Architectural	Wood, original	
Door	Architectural	Wood, original	
		Iron joinery, original	
		Glass panel, original	
Casing	Architectural	Stone, original (as wide as the opening x2x as long as the opening)	
Pilaster	Architectural	Wood, original	
Stair	Architectural	Wood, original	
		Concrete, additional	
Joinery	Architectural	Iron joinery, additional	
		Glass panel, additional	
Balustrade	Architectural	Iron, original	
Threshold	Architectural	Marble, original (20x4x as wide as the door)	
		In situ mosaic, additional (9x5x as wide as the door)	
Baseboard	Architectural	Marble, original	
		Mosaic tile, original	

*In the order of width, thickness and length; in centimeters.

2. IDENTIFICATION OF THE CASE STUDY

This late 19th century historical house, which is a listed building expropriated by its Municipality [2], is located on 169 Street, no: 12, in Karatas (Figure 3), Izmir, Turkey (Figure 2). Izmir has been an active trade center that grew rapidly since the beginning of 17th century due to its harbor [3]. The historical district of Karatas, which developed in the 19th century as a Jewish inhabitation area, neighbours the downtown at its

west [4]. As the name ‘Karatas’ indicates, the inhabitation ground is rocky. The buildings in the inclined topography were erected partially on rocks and on filled land.

The case study house is located on a street composed of stairs (Figure 3). It is a modest structure with an annex and a small courtyard at the back of the main mass. It has two main stories; ground floor and first floor; and two partial stories, basement floor and mezzanine floor. The main mass is approximately 6.8 m in width, 14 m in length and 9.7 m in height. When plan organisation is evaluated according to location of the hall, an asymmetrical plan type is observed on the ground floor and a symmetrical plan type is observed on the first floor. The partial basement at the northeast gained as a result of inclined topography ventilates the floor of the room at its above. Nevertheless, the other room at the ground level has a subfloor ventilation space (h:.42 cm) [5]. The partial mezzanine above the kitchen is reached from the landing of the staircase and used together with the first floor of the service mass.

The entrance and courtyard facades of the main mass are enriched with the projection and rhytmic openings (Figure 4), where as the two long facades have massive character with a single top window at the south and two windows at the north facades. The neighbouring building at the northern lot was demolished and the southern neighbours are entered from the narrow deadend street (100-150 cm) juxtaposing the studied house. Today, the building is subject to major structural failures and needs emergency interventions.

Figure 2: Location of the Izmir

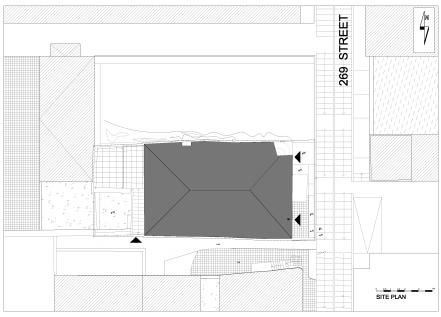

Figure 3: Site Plan

Figure 4: Photo of the Entrance Façade

3. STRUCTURAL CHARACTERISTICS OF THE HOUSE

The characteristics of structural, finishing and architectural elements are discussed below.

3.1 Structural Elements

Structural elements are roof, floors, walls, and columns (Table 1).

The roof is in wood plank and beam system. An iron roof framing system is added to the terrace. Floors in the main mass are in wood joist floor system in general, where as those in the service mass were renewed in reinforced concrete system. The wood projection in the entrance facade is not constructed as a part of the first floor system, but attached to the related wall with iron brackets just after the completion of the construction. The substructure underneath the entrance hall, stairwell and the kitchen on the ground floor can not be observed. There are three different types of structural systems in the walls; masonry, composite and wood post and beam framing system. The exterior masonry walls in the basement floor and southern exterior masonry wall in the ground floor are out of rubble stone. Brick masonry walls are only observed in the altered service mass. All exterior walls except the mentioned basement floor and the southern wall in the ground floor are in composite system. On the other hand, all interior walls are in wood post and beam framing system with no infill and finishing in lath technique at the first floor; and with rubble stone and brick infill at the ground floor. Both reinforced concrete and steel columns are additional. Reinforced concrete columns are in the service mass. Steel columns were added as a precaution to prevent collapse.

3.2 Finishing Elements

The finishing elements are roof, ceiling, wall and floor coverings (Table 1).

The wood roof system is finished with Marseille Roof tiles at the exterior, where as wood is used in the ceilings of the main mass. Nevertheless, this original ceiling covering is greatly lost and oil painted wood panelling is seen at present. Under the wood panels, original wood laths can still be observed.

The wood joist floor system at the first floor level is finished with original wood in the rooms and embellished mosaic tiles (21x unobserved x 21) in the terrace, while double layered lime plaster is observed as the ceiling covering of the ground floor's rooms and halls. The floor system at the ground level is finished with original marble in the entrance hall, original wood (20x1x various, 10x1x various), and original mosaic tiles (20x unobserved x 20) in the staircase hall, and additional in situ mosaic in the kitchen. The ceilings of the basement floor are also finished with wood. The finishing element of the floor system at the basement floor is not observed due to the debris layer.

The wall covering both at the exterior and interior surfaces of the exterior walls is double layered lime plaster reinforced with straw and beige wash. The finishing layer of plaster and the beige wash are partially lost. The wall covering at the interior walls of the first and the mezzanine floors is double layered lime plaster and beige wash. The wall covering at the interior walls of the ground floor is double layered lime plaster and blue wash. The wall covering at the interior walls of the basement floor is double layered lime plaster. Partial repair with cement plaster can be observed at the mezzanine floor.

In the service mass; floors, ceilings and all walls except for eastern exterior wall are finished with white washed cement plaster. At the mezzanine floor, faience tiles with inconsiderate workmanship are observed at walls.

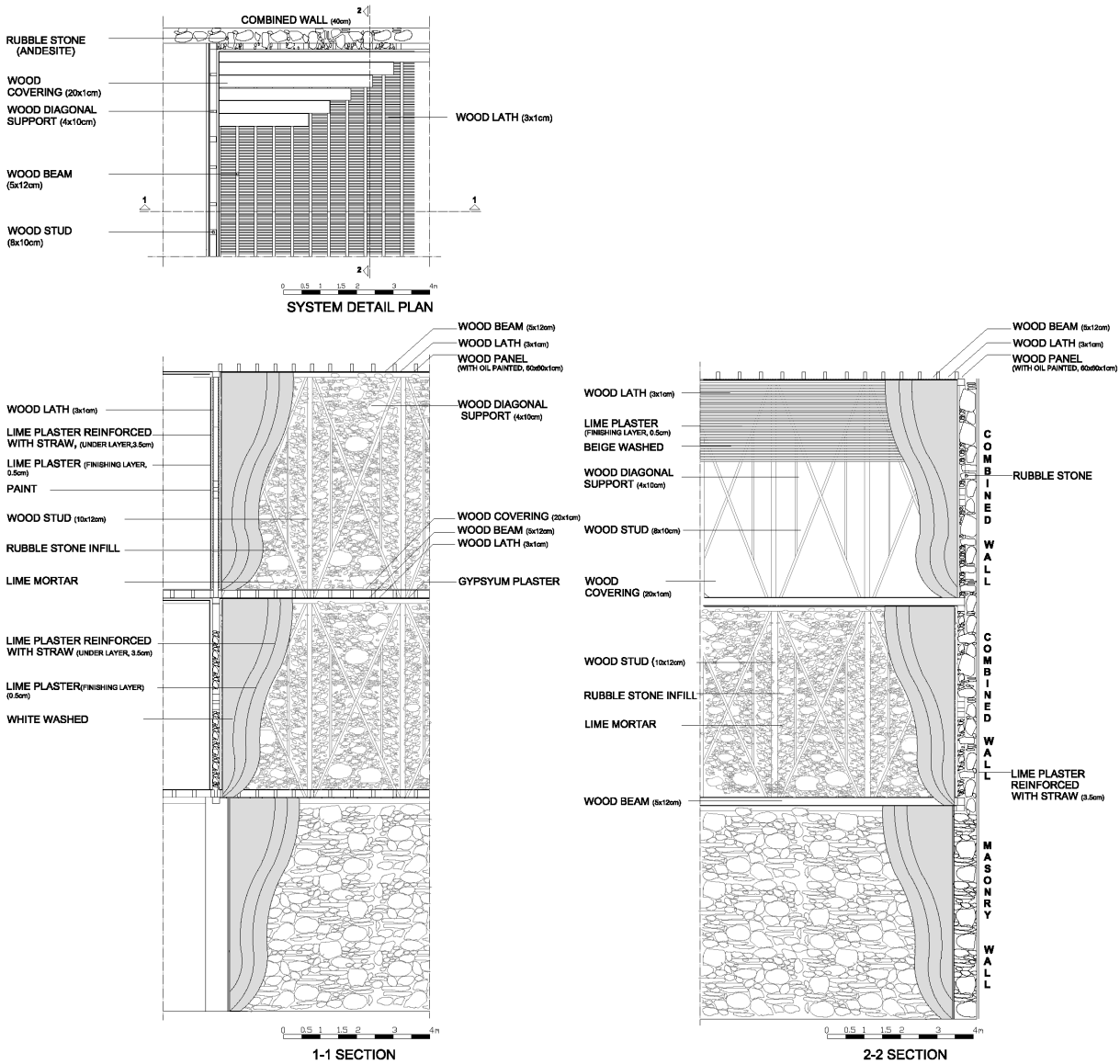

Figure 5: Structural system detail

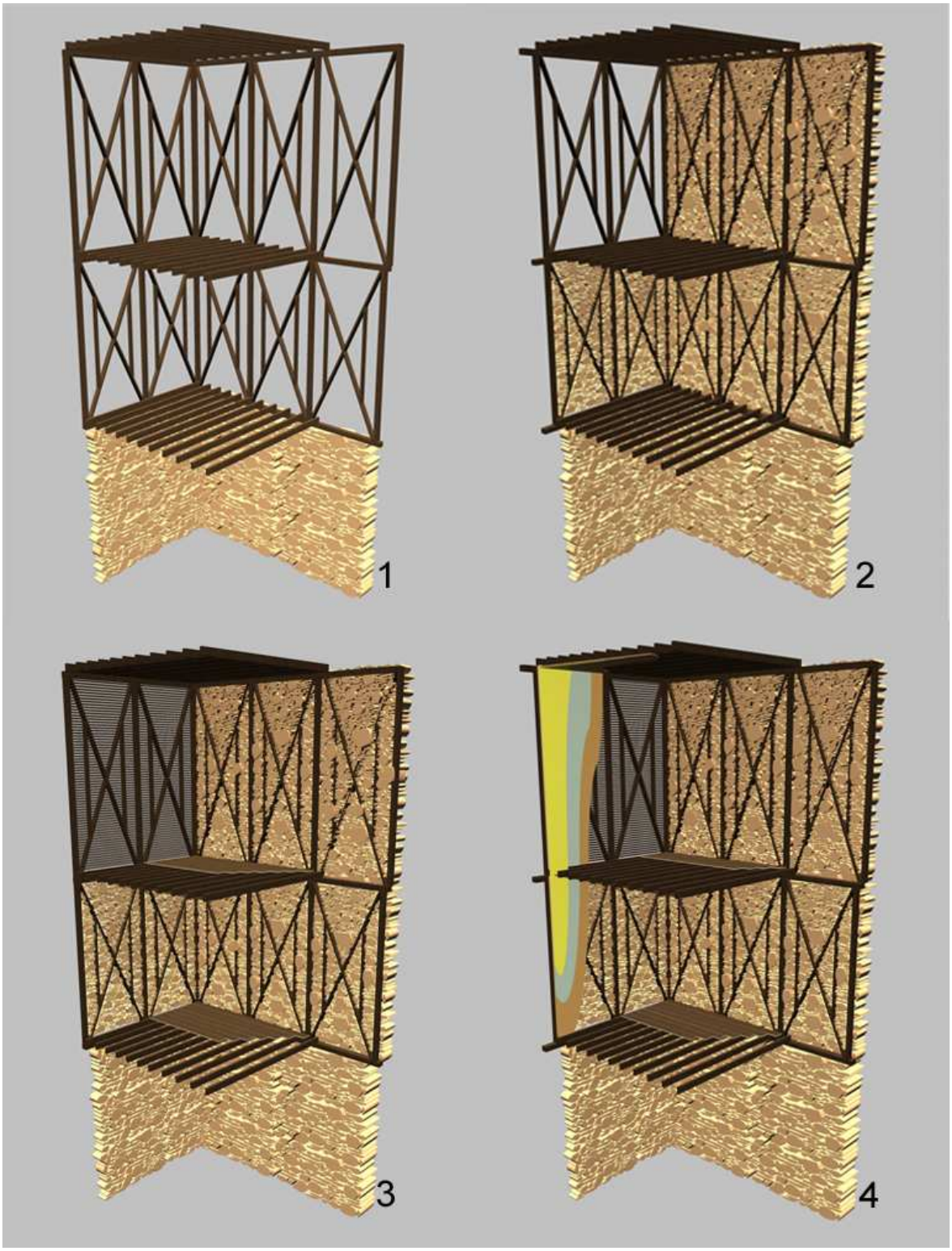

Figure 6: 3D Model views illustrating the possible sequence of construction

3.3 Architectural Elements

The architectural elements are ceiling embellishments, cornices, windows, doors, casings, pilasters, staircases, joineries, balustrades and thresholds (Table 1).

Ceiling embellishments at the ground floor are out of gypsum. The cornices in the facades are out of stone, while the cornices in the interior walls are out of gypsum and beige wash. Only the joineries of the windows are observed as wood since all the leaves and shutters are lost. In the façades, there are original stone casings surrounding the windows. Interior doors are out of wood and the main entrance has iron joineries and glass

panels. There are beige washed, original pilasters out of wood in the ground floor hall. The main staircase is out of wood and the additional staircase at the courtyard is out of reinforced concrete. In the terrace at the first floor, there are additional iron joineries with glass panels and iron balustrades. At the ground floor, there are original marble thresholds in the interior doors, an additional threshold out of in situ mosaic is observed in the main entrance door. Original marble and mosaic baseboards are also observed in the entrance hall.

3.4 Evaluation of the Structural Characteristics

The building reflects the construction technique of residential architecture of 19th century Izmir. Both traditional and new techniques of its period are observed in the historic structure. Composite system, which consists of masonry and wood post and beam framing, is a synthesis of traditional techniques (Figure 5-6). Since wood post and beam framing is not fire resistant and masonry is not durable to earthquakes, a combined structural system making use of the advantages of the two techniques are developed. This system which is a typical characteristic of 19th century Izmir houses is different from the traditional Ottoman houses in Anatolia, in which ground floor and basement floor are masonry and upper floors are wood post and beam framing [6]. However, the tradition of wood frame system with lath technique or wood frame system with brick and stone infill used in the Ottoman Houses is sustained in the late 19th century Izmir houses' interior walls. Another new technique is observed in the construction of wood projection. While iron brackets support projection in the late 19th century in Izmir houses, projection is constructed as a part of the floor system in the traditional Ottoman houses.

Some import materials such as pilasters, iron doors, iron brackets, black and white marbles, embellished mosaic tiles and wood stairs and Marseille roof tiles are used in the house. The usage of these import materials is typical for the period [7].

4. CONCLUSION

The structural characteristics of a late 19th century Izmir house are presented on an analysis table. The factors considered in the design of the analysis table are the types of building elements, their roles in the building system and their construction qualities. 3D-modelling technique is preferred for illustrating the details of the structural system and the possible sequence of construction. The conventional analysis maps together with the views from the 3D model have provided ease in the conception of the structural concepts that shape the building.

The combination of wood post and beam framing and masonry in the exterior walls, and usage of both traditional and new materials of its period are the distinctive characteristics of the historic structure. This documentary information will guide conservation interventions aright.

5. REFERENCES

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