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METHOD FOR CONSERVATION OF LATE 19TH CENTURY TIMBER FRAMED BUILDINGS IN ISTANBUL: POST-EARTHQUAKE HOUSE OF KEMALEDDIN EFENDI IN DOLMABAHCE PALACE

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Abstract

After Sultan Abdulhamid II settled in Yildiz Palace in 1878 and started the construction of his residence buildings, he preferred the cheapest and fastest building technology: Timber framed construction. Timber framed construction technique was predominantly used in the neighborhoods nearby the Palace inhabited by the members of imperial family or high bureaucracy in the last quarter of the 19th century. Ottoman archival records reveal the construction of many timber framed post disaster houses constructed in the precincts of damaged masonry palaces and mansions after the 1894 Istanbul earthquake. One of those post-earthquake timber framed buildings is Kemaleddin Efendi's house constructed in the courtyard of Dolmabahce Palace. Starting with the examples in Yildiz Palace, the timber framed building systems of the late 19th century differ from the traditional timber framed constructions: The factory / workshop shaped timber posts, beams and ornaments and the industrial products of the 19th century such as cement and galvanized wire used for plastering the timber walls or corrugated galvanized sheets used as roof covering brought the standardization and rationalization of traditional timber constructions. However, the industrial products of the 19th century are often considered as inappropriate interventions and are replaced with traditional materials during the conservations. This study discusses the conservation method of Kemaleddin Efendi timber framed house, based on chemical/ physical analyses of industrial building materials and the cost estimates prepared by building contractor Serkiz Balyan in 1894.

Keywords: Conservation of Timber Framed Constructions, Industrialization, Late 19th Century

1. Introduction

The Istanbul earthquake of 10 July 1894 resulted in severe destruction of about 20.000 houses and 1.500 public buildings in the city (Kucukalioglu Ozkilic, 2009). According to official reports, high and medium damage occurred in masonry palaces, mansions, and public buildings such as the Grand Bazaar, the Supreme Court, Dolmabahce Palace, Mercan Palace etc. One of those reports was prepared for Prince Resad and Prince Kemaleddin's masonry mansion within the boundaries of Dolmabahce Palace (BOA, 1894b and 1894d). The essential repair of the masonry residence became a challenging issue since almost all of the masonry palaces and mansions inhabited by the members of the imperial family had similar damages and a temporary residence for princes could not be provided. The solution to the problem of temporary shelters after the 1894 earthquake was solved by constructing small timber framed houses that could be quickly built, given the industrial achievements of the period. Those houses were built in the courtyards of all damaged masonry residences of imperial family or high bureaucracy. Two of those houses that survived till today almost in their authentic state were those built for Resad and Kemaleddin Efendi within the boundaries of Dolmabahce Palace (Figure 1). Based on archival evidence of Kemaleddin Efendi house, this paper focuses on the usage of industrial materials in the 19th century timber houses together with traditional techniques and discusses the restoration and conservation method for those rationalized traditional structures.

Figure 1. Prince Kemaleddin timber house (Dolmabahce)
Source: Tezdogan (2010)

2. Construction Technique of Kemaleddin Efendi Timber House

Kemaleddin Efendi's timber house has two floors and a masonry bath (*hamam)* on its Northern side. The house is connected to the *hamam* with a corridor (*camekan*) from the upper floor. On the ground floor, there is veranda, salon, dining room (*yemek odasi*), housekeeper's room (*kalfa odasi*), *taslik* and a toilet, on the upper floor there is salon, writing/reading room (*yazi odasi*), bedroom (*yatak odasi*), a toilet and *camekan*. The house has *chalet* style[1] sloppy roof with wide eaves (Figure 1 and 2).

2.1. Timber Structure

Kemaleddin Efendi post-earthquake timber house's first cost estimate was prepared by building contractor Serkiz (Balyan) on 28 July 1894, only 18 days after the earthquake (BOA, 1894c) (Figure 3). According to the cost estimate, the construction of the house started with the excavation for the foundations. After the excavation, oak beams (9-11 x 13-14 x 450-460 cm) were placed to form a grid under the stone foundation. This grid beam structure separates the earth and the foundations and acts as a seismic isolator during earthquakes. The timber structure of the house started with the oak base beam (9-11 x 13-14 x 450-460 cm) placed horizontally over the foundation wall. All timber posts, braces and floor beams are erected on that base beam (Figure 4 and 5). The main oak posts have headings on which the oak base beam of the upper

[1] Characteristic style of timber mountain houses constructed in Swiss or French Alps.

floor rests (Figure 6). According to the cost estimate, timber posts and braces were recorded to be the same in size and type with the oak base beam. However, during the survey, it was seen that the timber frame elements are not in a standard shape and were hand cut on site. Similar to the other cost estimates and cost journals of late 19th century timber constructions, Serkiz's cost estimate points out the usage of standardized timber elements (Acar and Mazlum, 2016) (Figure 7). In the preliminary cost estimate prepared before the construction started, Serkiz did not take into account the shortage of factory produced timber elements in Istanbul, which were extensively used after the earthquake. Thus, the wooden posts, beams, diagonals and covering timber floor and ceiling planks of Kemaleddin Efendi's house were roughly hand shaped on site and all had different sizes. Obviously, the factory shaped and standardized posts and braces of the wall on Figure 7 ensured an unhazardous and less vulnerable construction in Mehmed Selim Efendi's house at Yildiz Palace, whereas the irregularity of handmade timber bearing elements of Kemaleddin Efendi timber house made the building more vulnerable and unsafe. Probably aware of this disadvantage Serkiz positioned crossed diagonals wherever possible in order to strengthen the timber frame (Figure 8).

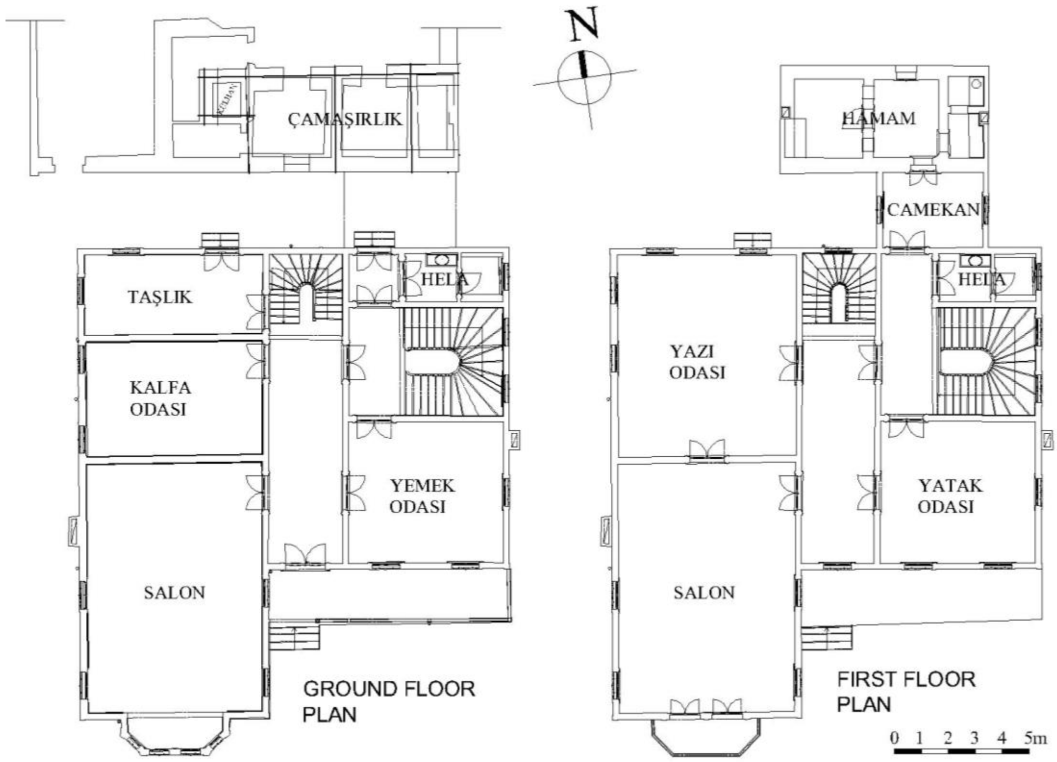


Figure 2. Ground and upper floor plan of Kemaleddin Efendi house
Source: Acar (2012a)

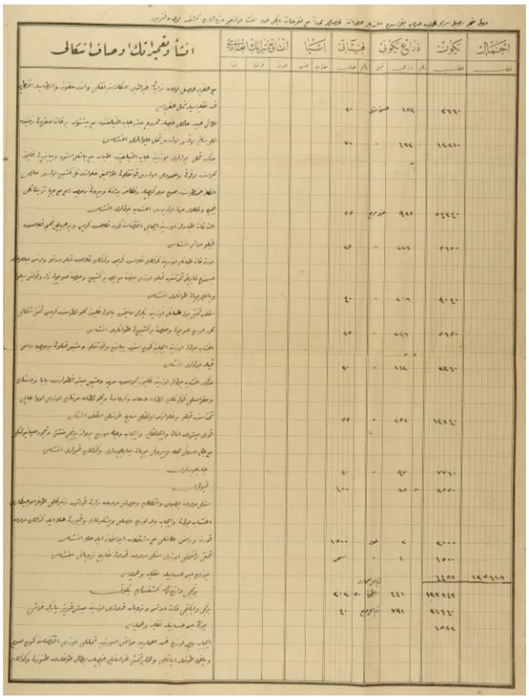


Figure 3. First page of Kemaleddin and Reşad Efendi houses cost estimate
Source: BOA (1894c)

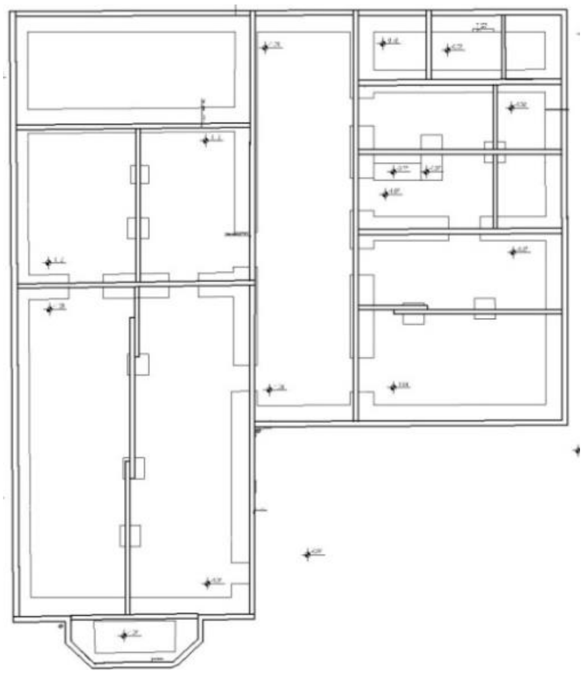


Figure 4. Plan of Kemaleddin Efendi house foundation wall and the base beam
Source: Acar (2013a)

Figure 5. Foundation wall and posts, diagonals and floor beams standing on the base beam
Source: Acar (2013b)

Figure 6. The heading over the main post and the base beam of the upper floor
Source: Acar (2013c)

Figure 7. Timber wall of Mehmed Selim Efendi's post-earthquake house in Yıldız Palace constructed with standardized factory shaped posts, diagonals and beams built simultaneously with Kemaleddin Efendi timber house

Source: Acar (2012b)

Figure 8. Timber frame of the Northern wall

Source: Acar (2014a)

2.2. Plasters and Wall Decoration

The wooden wall structure is covered with galvanized wire both inside and outside. Serkiz's cost estimate reveal that *English cement* plaster was applied on the galvanized wire of the façade, which was very common for the timber buildings constructed during Sultan Abdulhamid II's period (Acar and Mazlum, 2016). After Abdulhamid II settled in Yildiz Palace in 1878 and started the construction of his residence buildings, he preferred timber construction as the cheapest and fastest building technology. However, he was aware that timber construction was not resistant to fire. Due to the industrial developments and new materials of the 19th century, cheaper and faster technique for fire protection of timber buildings was adopted. The outer façades of the timber buildings constructed within the boundaries of Yildiz Palace were finished with thick *English (Johnson) cement* plaster. Galvanized wire was nailed to the timber construction and 2-3 cm thick cement plaster was applied over the wire (Figure 9). Ottoman cost estimates reveal that especially after 1880s, timber constructions with *English (Johnson) cement* plaster were predominantly applied for building, repairing or enlarging residential buildings of imperial family or high bureaucracy. Almost all of the timber houses constructed after 1894 Istanbul earthquake had the same *English cement* plaster on the façade (Acar and Mazlum, 2016).

The laboratory analyses report of the 2-3 cm thick façade plaster of Kemaleddin Efendi house concludes that this plaster which binder is *Portland cement* with 350-400 cement factor has 20-25% areal binder ratio. The façade plaster contains only sand as aggregate and very few amounts of brick ballast and black slag (Istanbul Metropolitan Municipality, KUDEB, 2011) (Figure 9). The cement factor of the façade plaster shows that it was prepared as strong as artificial stone. The laboratory analyses of façade cement plaster interpret the binder as *Portland cement*, which is probably "*English (Johnson) cement*" mentioned in the cost estimate. *Portland cement* plaster was also used in the 19th century Istanbul buildings, and if so, it was clearly stated in the cost estimates and recorded as *Portlan(d) cement* (BOA, 1894a).

There are two different plasters on galvanized wire of the inner walls, *English cement* plaster covers ground floor walls and "*local fine gypsum*" *(ince yerli alci)* plaster covers the upper floor inner walls of the house. "*Local fine gypsum*" plaster applied 2 cm thick on the galvanized wire was recorded in the second cost estimate prepared by Serkiz Balyan on 18 September 1894 (BOA, 1894e). The SEM-EDS analyses reveal the composition of that plaster (Figure 10b-11a and 11b). The analyses report states that inner wall plaster has 2 units of gypsum and 1 unit of "*19th century cement"* as a binder (Istanbul Metropolitan Municipality, KUDEB, 2011). The sample also includes approximately 3-5% quartz sand as aggregate and 5-10% limestone powder. The "*local fine gypsum*" plaster recorded in the cost estimate is the 19th century gypsum based cement. Gypsum based cement is known to be used in late 19th -early 20th century Ottoman masonry buildings. Baturayoglu Yoney and Ersen (2009) reported the use of gypsum based cement in the relief panel in early 20th century masonry building in Balat district.

The inner wall gypsum cement and *English cement* plasters of Kemaleddin Efendi house differ in appearance. *English cement* plaster has a rough surface; whereas gypsum based cement plaster is very smooth (Figure 10a). It was surprising that the decorative painting was detected on the rough *English cement* and not on the smooth gypsum plaster (Figure 12). The reason for that was a great mystery until handmade wallpaper pieces were discovered inside the timber roof of the veranda (Figure 13). The wallpaper was probably covering the smooth gypsum based cement walls of the upper floor.

Figure 9. Galvanized wire and 2-3 cm thick *English cement* plaster on the outer façade of Kemaleddin Efendi timber house
Source: Acar (2013d)

Figure 10a. Photograph of the gypsum based cement plaster

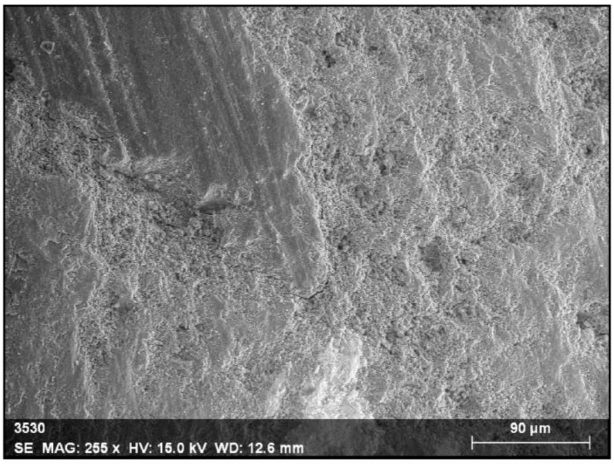


Figure 10b.SEM image of the gypsum based cement plaster

Source: Istanbul Metropolitan Municipality, KUDEB (2013)

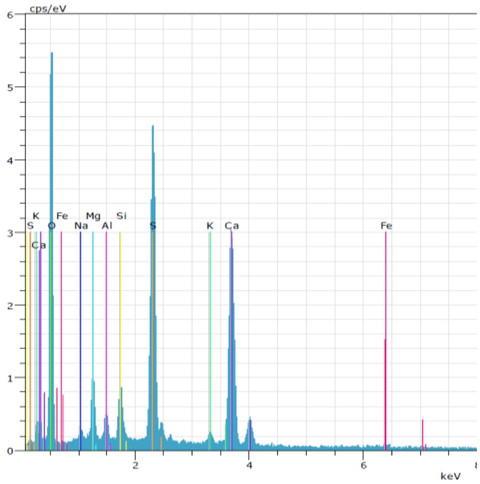


Figure 11a. XRD pattern of gypsum based cement plaster

Spectrum

Element	norm. C [wt.%]	Atom. C [at.%]	Compound	norm. Comp. C [wt.%]
Oxygen	44.62	63.79		0.00
Sodium	0.64	0.64	Na2O	0.87
Magnesium	2.78	2.61	MgO	4.61
Aluminium	1.08	0.92	Al2O3	2.04
Silicon	2.50	2.03	SiO2	5.35
Sulfur	17.99	12.83	SO3	44.91
Potassium	0.88	0.51	K2O	1.06
Calcium	28.42	16.22	CaO	39.76
Iron	1.09	0.45	FeO	1.40
Total:	100.00	100.00		

Figure 11b. Elemental composition of gypsum based cement plaster

Source: Istanbul Metropolitan Municipality, KUDEB (2013)

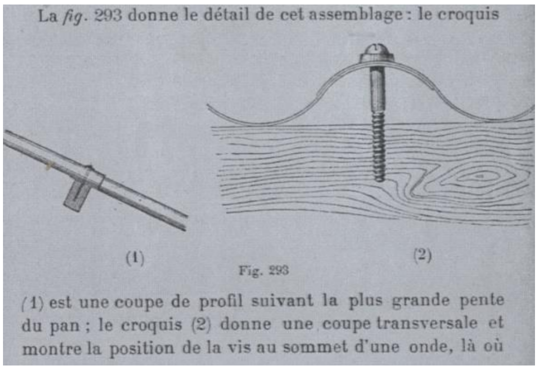
Figure 12. Water based decorative paint on the *English cement* plaster of the inner wall of Kemaleddin Efendi house
Source: Tekinmirza (2014)

Figure 13. Piece of handmade wall paper
Source: Acar (2014b)

2.3. Roof

Timber frame elements of the house’s roof (trusses, posts, purlins, ridgepole and diagonals) are all original (Figure 14). The posts and trusses are oak, while the purlins and ridgepole are pine from Filyoz Region (Southern Black Sea) (BOA, 1894c). Over the timber covering planks tar-impregnated felt was laid out and corrugated galvanized sheets were put over that felt and screwed to the timber planks (BOA, 1894c) (Figure 15). This roof covering technique was often used in the last decades of the 19th century, and could be traced through many cost estimates of the period. One of those cost estimates prepared in 1890 concerning the roof repair of masonry Maslak Kiosk, mentions the replacement of tile roof coverings with corrugated galvanized sheets (BOA, 1890). Similar to Kemaleddin Efendi's house, almost all of the 19th century post-earthquake timber houses were covered with corrugated galvanized sheets, which were 1.5 mm thick and weighting 11.78 kg/m². Whereas, Marseille tiles used in the 19th century weight 42.5 kg/m² and 1.5 mm thick lead sheets weight 17.10 kg/m². Thus, the industrial products of the 19th century made possible the lightening of roof, which enabled earthquake safe constructions.

Figure 14. Timber roof structure
Source: Acar (2012c)



La *fig*. 293 donne le détail de cet assemblage : le croquis

(1) (2)
Fig. 293

(1) est une coupe de profil suivant la plus grande pente du pan ; le croquis (2) donne une coupe transversale et montre la position de la vis au sommet d'une onde, là où

Figure 15. Page from the book in Ottoman Engineering School library showing the application of corrugated galvanized sheets
Source: Denfer (1893)

2.4. Ceiling Decoration

Ceilings of the ground floor were covered with timber planks, painted with oil based paint. Upper floor ceilings were decorated with oil painted canvases and timber laths (Figure 16). Detailed research at Ottoman and Republican archives, analytical and detailed photographic survey of the architectural decoration and SEM-EDS, XRD and FT-IR analyses were carried out. The results of the research enlighten the 19th century Ottoman painting technique of interior decoration and provide required information for treatment. The materials and techniques of ceiling decoration are the topic of another research and are left outside the scope of this paper.

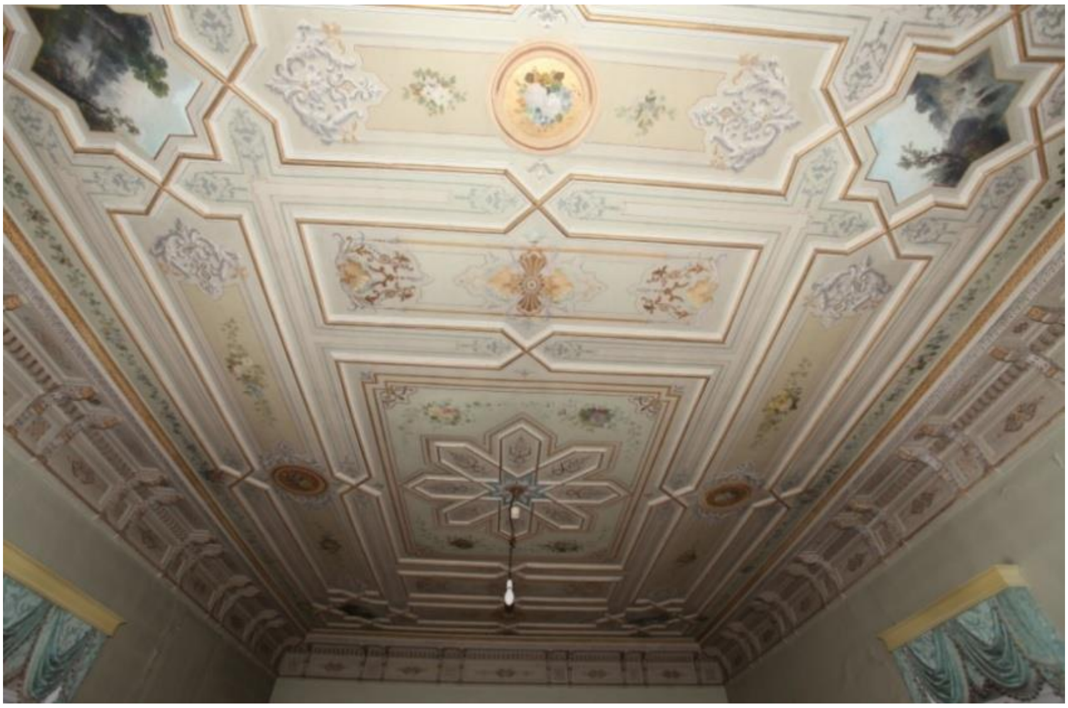


Figure 16. Painted canvas ceiling of the salon – upper floor
Source: Tezdogan (2011a)

3. State of Preservation and Method for Conservation

Kemaleddin Efendi post-earthquake house had witnessed three major repairs. Cost estimate of 1904 repair (Ottoman period) points out the decay due to humidity of the floor beams, covering timber planks and parquet of the ground floor. In order to solve the humidity problem, the soil ground left in between the foundation walls was digged out up to 80 cm bellow the ground floor level and ventilation windows were opened in the foundation wall (BOA, 1904). The rush after 1894 earthquake and the urgent need for shelter was probably the reason for ignoring the ventilation windows of the foundation wall. Second major repair was in 1966, but unfortunately there is not any record of the interventions done. Only several photographs from the outside of the house show that two chimneys attached to the Western and Eastern façade walls were built, window frames were changed and the façades were re-painted. There was not any record about 1985 repair as well. The interventions traced through photographs convey very limited information.

3.1. Roof

The roof covered with corrugated galvanized sheets was leaking water and caused damage to some of the painted ceiling canvases. The leakage originated from the inappropriate detailing of galvanized sheets during the 1985 intervention. Instead of using screws, as shown in Figure 13, nails were used to fix the covering sheets. Moreover, galvanized sheet has an average life of 15-20 years, but it was used for 26 years without any maintenance (Figure 17). The ventilation funnels (Figure 18) helped the drying of the timber roof structure, except the very end parts of the beams that were boxed in the eaves.

The roof structure was designed to bear the weight of the galvanized sheets, which were the original covering materials. However, the difficulty in their application and short average life brings forward the consideration of modern roof covering materials (i.e. titanium zinc sheets), which should be as light as galvanized sheets, but with longer average life.

Figure 17. The condition of the corrugated galvanized sheets
Source: Tezdogan (2011b)

Figure 18. Ventilation funnels inside the roof
Source: Acar (2012d)

3.2. Timber Structure

The decay of the timber structural elements was mostly observed above the masonry foundation wall. Almost the entire base beam decayed and the end parts of ground floor beams, posts and diagonals resting on the base beam were affected as well. The reason for this decay was the rubble fill inserted over the foundation wall between the floor beams, which prevented the ventilation of the base beam and floor beams (Figure 19 and 20).

The thick *English cement* plaster of the façade has protected the timber construction for 116 years. Except some posts and diagonals of the Northern wall, there was no decay in the timber elements that constitute the wall frame. The decay in the timber elements of the Northern wall was mainly due to the application of cement flooring in *taslik* space in 1966, which pushed the timber posts of the ground floor and caused out of plane behavior of Northern timber wall and deformation of the façade plaster. The rain entered the wall through the edges and micro cracks of the deformed plaster and caused the decay of timber elements.

Figure 19. Floor beams embedded into the rubble fill
Source: Acar (2013e)

Figure 20. The decay in the floor beams observed after the removal of the rubble fill
Source: Acar (2013f)

3.3. Façade Plaster

The damaged Northern façade plaster was repaired in 1966 and 1985 using modern Portland cement applied directly on the original *English cement* layer (Figure 21). This inappropriate intervention fastened the deterioration of the façade plaster and the timber structure behind the plaster. The modern Portland cement plaster should be cleaned out from the Northern façade and the damaged parts of *English cement plaster* should be restored with compatible plaster prepared in accordance with 19th century cement.

Figure 21. Modern Portland cement applied on the 19th century cement plaster
Source: Acar (2014c)

Figure 22. *Bagdadi* wooden laths nailed on the timber posts during 1966 or 1985 repair
Source: Acar (2014d)

4. Conclusion

Istanbul timber houses of the 19th century have been depicted as buildings with traditionally (hand) shaped timber frame with *bağdadi* wall plaster (wooden laths nailed on the timber construction and *horasan* mortar applied) on the inside and timber planks as façade covering. That was the prevailing building technique in many neighborhoods in the city throughout 19th century. However, industrial products that dominated the Ottoman market in the late 19th century affected timber construction technique as well. Cement façade plasters were seen as solution for fire protection, while corrugated galvanized sheets were preferred as lighter, cheaper and faster applied covering materials. The Ottoman contracts and cost estimates prepared in the last decades of the 19th century refer to the use of mainly six cement types; English Johnson cement, English Hollich cement, Grenoble cement, Capa cement, Roquefort cement and Portlan (d) cement (BOA, 1894a and 1893). It is difficult to identify these cements only by chemical analyses, since there is no databank for 19th century cement plasters and mortars in material laboratories. These materials are simply classified according to their color or sometimes even named as Portland cement, which brought the danger of considering them as inappropriate interventions. Thus, mostly cement plasters have been removed and replaced with *horasan* mortar during restorations. One way to detect the authenticity of cement plasters and mortars are Ottoman cost estimates. These cost estimates can also be used as reference data while creating a databank for cement types used in the 19th century Istanbul. The presence of galvanized wire in traditional timber buildings is also considered as modern intervention and it is easily replaced with *bagdadi* laths. That was the case in partial repairs done in the Northern wall of Kemaleddin Efendi house during 1966 or 1985 restorations (Figure 22).

The literature on the late 19th century construction techniques in Ottoman Empire emphasize that masonry construction techniques evolved and standardized with the production of artificial stone and cement plasters (Baturayoglu Yoney and Ersen, 2009). Whereas, timber buildings are not discussed as rationalized constructions and it is even accepted that they were neglected or even forbidden with the 1848, 1863 and 1875 Building Regulations. However, archival sources reveal that timber framed residences were preferred by the imperial family members or bureaucrats especially after 1880s and those were characterized with the presence of factory produced timber elements. The timber decorative elements of the veranda (Figure 23) and wooden laths on the ceilings were factory produced (machine shaped) elements of Kemaleddin Efendi house that survived until today. It could be concluded from the cost estimates that the intention of Serkiz Balyan was to build the entire timber frame of the house with standardized factory shaped elements, but the material shortage after the earthquake forced him to build the timber frame in traditional technique. Whereas, the post-earthquake houses within the boundaries of Yildiz Palace were built with standardized factory shaped timber elements (Acar and Mazlum, 2016) (Figure 7). Moreover, after the establishment of Ahirkapi Timber Factory in 1893, Victorian or *chalet* type fully prefabricated timber houses became fashionable as summer residences of bureaucrats or tradesmen (Ahmed Ihsan, 1899) (Figure 24). Thus, the restorations of 19th century timber houses do not necessarily mean dealing with the traditional building techniques, details and materials.

Figure 23. Wooden moulding shaped with saw machine in 1894
Source: Acar (2014e)

Figure 24. Ali Şefik Paşa prefabricated timber house in Kızıltoprak (Istanbul) constructed in the very beginning of the 20th century
Source: Kalafatoglu (2009)

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Acar, D., 2012c. *Timber roof structure of Kemaleddin Efendi house*. [photograph] (Damla Acar's own private collection)

Acar, D., 2012d. *Ventilation funnels inside the roof of Kemaleddin Efendi house*. [photograph] (Damla Acar's own private collection)

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