

Steel Frame Construction Technology in Ottoman Architecture and “Metro Khan”

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Abstract From the first quarter of the 18th century, an expansion to European civilization was beginning in Ottoman Empire and with Tanzimat period, this westernization fact had transformed to a fundamental innovation act in the structure of the state and society. European capital image gained by İstanbul created a symbolic view of change. However, a contradiction of traditional urban tissue, consisted by the timber buildings, necessitated a fundamental change in the urban and architectural structure. According to this aim, new building types which were necessary for the Tanzimat reforms (a period of time of political reforms during the Ottoman sultanate of Abdulmecid (r.1839-61) began to be constructed by the European architectural design models, with modern building materials and production technologies.

In this context, construction technologies like jack arches, steel framework, fer-concrete and reinforced concrete, which are formed with structural materials like modern brick, iron beam, and concrete, are the factors of formation of the historical development process of the Ottoman architecture after the first years of the 19th century.

From the middle of 19th century, use of the “steel beam” was beginning in the building product technology, depending on the evolution of the industrial metal technology in European countries. Technological level of the steel construction after “Jack Arch”, which is formed with the iron beam, has brought new expansions to the building production. As from the first years of the 20th century, buildings constructed by steel construction technology began to take place in Ottoman architecture.

In this paper, the place of the steel-framed building technology in Ottoman architecture, especially the steel frame construction in the Tanzimat period buildings and their architectural design criteria will be presented. Besides, the conclusions based on the comparisons of structural and architectural design with the European architecture buildings will be indicated.

“Metro Khan”, dated 1914, is the first building that was erected with this construction technology. This building is constructed as an administration and station building of the under ground train, named “Tünel”, which connects Pera and İstanbul Seaport. This paper traces the importance of the building in terms of conservation and cultural values, while benefiting from its characteristic architecture and static projects.

Keywords: Istanbul, steel-framed, station building, Eugène Henry Gavand

Introduction

Until the 19th century, materials used for building construction had displayed few changes. After the technical evolution of Industrial Revolution, fundamental changes occurred in the field of building construction and modern construction materials. The effect of this change in Ottoman Empire during the period of Tanzimat, which is the turning point of the Westernization, was seen with the reflection of state and society changes in architecture. A new building program, necessitated by the innovation movements, began to be constructed using European architectural design principles as well as modern building materials and building production technologies by European architects. It was aimed to bring İstanbul a European capital view by the modern masonry buildings resistant to fire.

‘Modern’ brick that began to be produced at important European production centers like Livorno and Marseille, is used in Ottoman Empire for the first time by a Swiss architect, Gaspare Fossati, in the

construction of Bab-ı Seraskeri Hospital in 1841. In European countries, from the middle of the 19th century, “i-beam” began to be used in the building construction with the development of steel production. Buildings were resistant to fire by a new building construction technology that was constructed by brick barrel vaults. From the third quarter of 19th century, buildings with modern brick walls and “jack arches” began to take place in Ottoman architecture. Technological level of steel industry brought a new expansion to building production.

Steel Building Structure Technology

As a construction material, steel allows constructing large-span and multi storey buildings and has important characteristics like soundness, durability, flexibility, lightness and workability. Since 1880s, steel building constructions in U.S and European countries influenced modern architecture and were constructed until the beginning of the 20th century (Benevolo 1981).

Steel structure bases on the principle that the building weight is transferred to the ground by bearings. Therefore beams, which form horizontal and vertical bearings, are designed in the form of framework. The structural steel frame emerged as an alternative to the traditional load-bearing masonry construction.

Steel Building Structure Technology in Ottoman Architecture

Steel structures began to take place in Ottoman architecture since the first years of 20th century. This construction technology is preferred to be used usually in transportation and trade buildings because of their large-span and multi-storey characteristics. Static and architectural projects of these steel buildings were designed and even constructed by European companies that are experienced in this field. However, in contrast to European architectural practices, the steel structure was hidden within the masonry wall. In Ottoman architecture, Haydarpaşa Station (1906) and Metro Khan (1914) are the first buildings constructed in steel construction system.

Metro Khan's History

French architect Eugène Henry Gavand, who came to Istanbul in 1867, had noticed that pedestrians walked across the ramp which connects Galata and Pera and he had thought that a metro with a lift system would be useful. With a credit loan from the British Empire, he imposed his project to the Ottoman Government with 42 years of concession privilege. Gavand founded a limited company named “The Metropolitan Railway of Constantinople from Galata to Pera”. He began to work in 1871 and completed the construction of the metro (with 556m length, 6.70m diameter, 4.90m height) in 1874 December (Gavand 1876) (Fig.1).

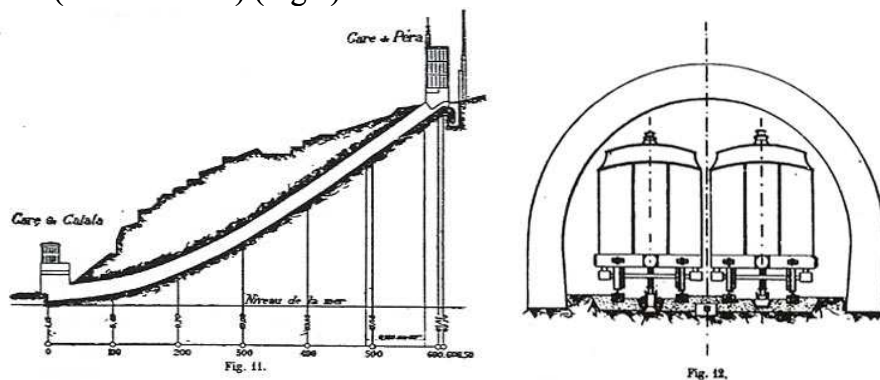


Figure 1: Gavand's railway project

The world's oldest metro, after London (1863) and New York (1868), was opened on 18 January 1875. A single-storey station building was constructed instead of Gavand's Pera station with a four-storey hotel (Gavand 1876). English company sold his concession privilege to a Belgian

company named Sofina in 1911. The new company with a necessity of a modern enterprise building destroyed the old station building in Pera and constructed the Metro Khan with a station in ground level (Cezar 1991). Tünel and Metro Khan, which were bought by Turkish Government in 1939, were held by IETT (Istanbul Municipality Bus Enterprise) in the same year. Currently, the ground level is used as a station and the other levels are IETT Headquarters (Fig.2, Fig.3).



Figures 2, 3: Metro Khan façades

Architectural Description

Metro Khan was a six-storey structure, about 37 m long and 24m wide. The original architectural project, named “Métropolitain de Constantinople Station de Péra”, that was designed between 15 November 1912 and 12 March 1913 in Charleroi, Belgium, without the name of the architect and company and the static projects that were made by a company named “Vereingte Kammerich’und Belter and Schneevolgl’sche Werke Aktiengesellschaft” in 17 March 1914 at Berlin, Germany are in the archive of IETT. Barrel vaulted roof design seen in the architectural project was not applied (Fig.4) and 7th floor was added. It was designed according to the design principles of European styled commercial buildings seen in Ottoman architecture at the last period of 19th century. Ground level is arranged as a station with offices facing the street. The staircase and elevator core are situated at the left part of the building, by the west entrance axis. Guard rails of the staircase are of iron with art nouveau ornamentation. Façade arrangements reflect a historical eclectic style of the European architecture.

Construction System Analysis

In the original projects, horizontal and vertical beams are designed in steel-framed construction system. The west and east sides of the building are divided in 7 sections by the bearings, the initial two sections are 5m wide, the others are 5.20 m; north and south sides are divided in 5 sections, the initial two are 5.15 m, and the others are 4.15 m wide (Fig.5).

Vertical bearings are located at the intersections of the axes. Those vertical bearings (38x38 cm) are formed by a combination of 4 “U” (22x8x0.95x1.25 cm) and 4 “L” (8x8x0.8 cm) steel beams. Only at the corner of the buildings, vertical bearings (33x33 cm) are formed by a combination of 4 “U” (22x5x1.1x1cm) and 4 “L” (5.5x5.5 x0.7 cm) steel beams. Those vertical beams are anchored by “L” formed metal plates in a concrete base with 40 cm height and 130 x 130 cm dimensions. The main horizontal beams are formed by 2 “I” beams (25x25 cm). Junction of the horizontal and vertical beams is composed by anchoring the horizontal beam (38x38 cm) with “L” formed metal plates at the four sides. Sheet iron (50x45x1.6 cm) at the junction of the beams enlarges the surface between horizontal and vertical bearings and provides the anchoring of two bearings all over and all around. Steel construction of the building is also supported by diagonal metal beams located at the last

horizontal and vertical axis of each storey. “T” beams carried by the main horizontal bearings are used at the floors with ~35 cm thickness and the gaps between the beams are filled with concrete. According to the size of the spaces, dimensions of the beams alter between 18x6 and 20x7 cm, distance of the axes alters between ~85 and 92 cm. Besides, they are supported by beams in the opposite direction. Nut-bolt and rivet are used at all the metal junctions of the building. Exterior walls are 45 cm thick, constructed by bricks that are not load-bearing (Yergun 2002).

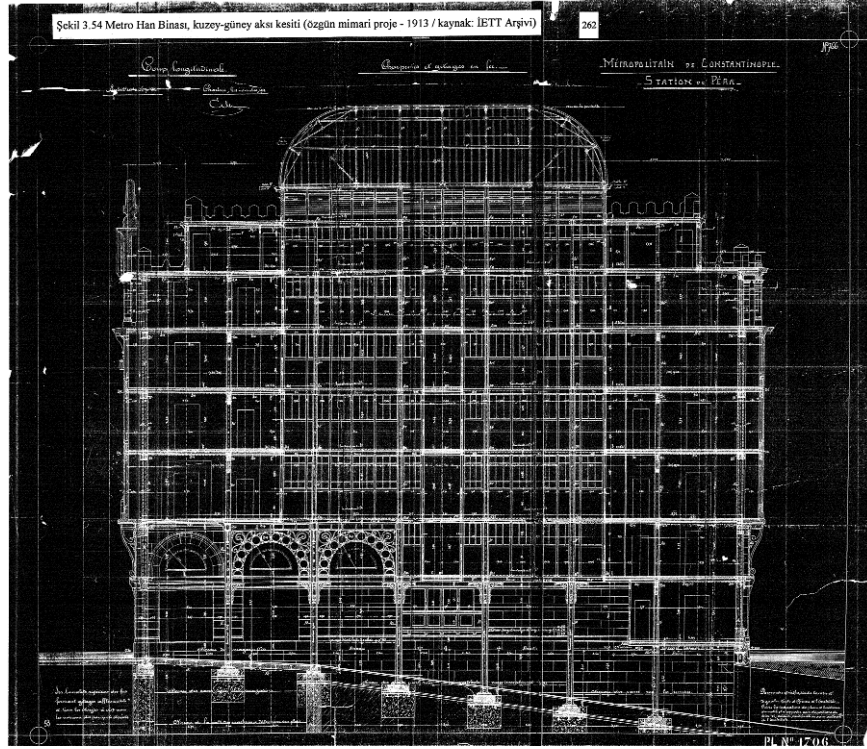


Figure 4: Metro Khan Section

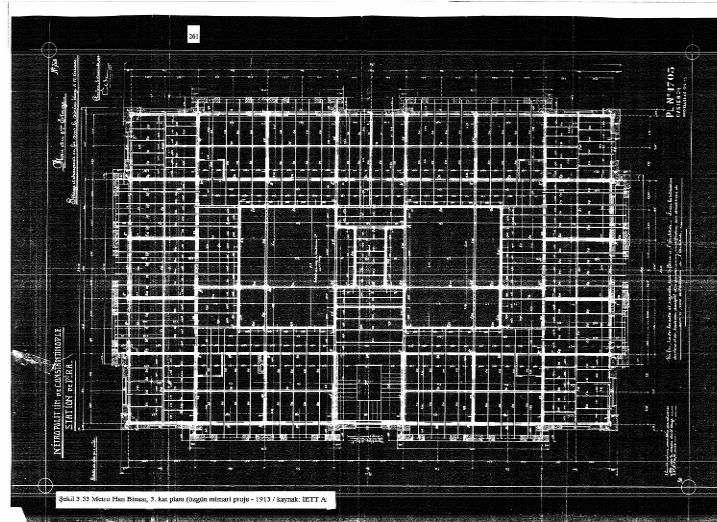
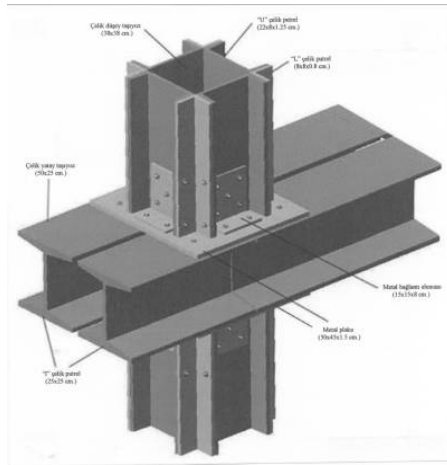


Figure 5: Metro Khan plan



Figures 6: Metro Khan beams junctions

Conclusion

Starting from the middle of 19th century, an important change was realized in terms of design concepts, building materials and technologies. At the first years of 20th century, metal building structures were used in this process. The number of the buildings which are constructed with this technology is few in Ottoman architecture. One of these, Metro Khan is the unique example that we can examine, search and survey the metal structure technology of this period from the documents. However, like Metro Khan, many buildings of this period are exposed to a change of original construction technology during restoration practices. A great importance and consideration must be given to protect original construction materials and technology, as well as cultural values of those buildings which reflect industrial environment and technological level of the period, as much as in terms of Ottoman architectural history.

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