Architecture
Image Studies
AIS Scientific Journal

Vol.4 , Issue 1, Turkey Architecture Studies, 2023

Industrıal Steel Structures in Hadımköy Regıon for the Perıod 2018-2023: Systemıc Solutıons For Changıng Needs

Ezgi YILMAZ [1,*]
[1] Interior Architect, 34515, Turkey; E-Mail:ezgiyilmaz10@gmail.com
* Corresponding author

Sezgi YILMAZ [2,*]
[2] Architect 34515, Turkey; E-Mail:sezgiiiyilmaz@gmail.com
* Corresponding author

Abstract

In line with the building needs arising with the increase in industrialization in Hadımköy district, the tendency towards steel construction has increased significantly. The aim of this study is to reveal the necessity of building industrial buildings with steel construction in order to prevent disaster and soil problems in Hadımköy region. For this purpose, three factory examples from the Hadımköy region, which were partially or completely built with steel construction, were discussed. The evaluations made on these examples aim to qualitatively examine the hardware features of the construction in line with the changing needs of the industry. In this context, two buildings with different functions were evaluated and analyzed in terms of structural quality, flexibility, sustainability, durability and resistance to disasters. In line with the findings, it has been determined that the construction of industrial buildings in accordance with the changing needs of industrial buildings is provided by the use of steel construction system. The result of this study is an important reference in terms of preventing disasters and soil problems in the region by increasing the use of steel construction structures in regions with dense industrial buildings such as Hadımköy district.

Keywords: Industry, steel structures, sustainability, structure, Hadımköy

1.Introductıon

As a result of the First and Second World Wars in the 1900s, there was a huge loss of life, property and structures, and countries have rapidly moved towards the creation of new systems in order to rebuild themselves. In this direction, the steel material obtained as a result of the industrial revolution and the development of steel through various processes has rapidly gained importance in the construction sector. Due to the increase in building density in the development process of cities, the use of steel as a building material has started to be seen as an ideal system. Initially used in applications that meet the need for large housing in a short time, such as low-rise buildings and worker shelters, steel has started to be used in building types such as factories and aircraft hangars that require large spans in metropolitan areas, as it is seen that it can meet the need for high strength due to its structure.

When we think of light steel structures, the first thing that comes to mind is reliable and earthquake-resistant assembled structures, as well as structures that use environmental elements (landscaping) and are adapted to the design context. Today, light steel structures can be found in many places such as residential and industrial buildings, bridges, roof systems, large spans, and space completion. Since the raw material of the product we call

light steel is steel, it appears in many areas in the building sector (Köse I., 1996.).

Light steel building system is a form of structure in which the structural elements are load-bearing (wall-flooring) and produced from galvanized light steel by cold forming management. Due to the fact that it has a structure in which the desired form can be obtained systematically, production up to 6 floors height in buildings is determined by SAP2000 program.

Hadımköy region Hadımköy, which did not show much development until the 1980s and was known as a military settlement in the west of Istanbul, has continued its development with buildings of different qualities. When we look at its proximity to the E-5 and TEM highway, physical and human geography features, it is a flat land with a wide plan, 18 km away from the city center and 8 km away from the TEM highway connection is seen in the road maps (1/25000 Ölçekli İstanbul Nazım İmar Planı Raporu, 2007).
The first elements that stand out in industrialization are that the large openings should be closed in the desired direction and the vibration etc. in the space should be of a quality that will respond to the elements. Since Turkey is an earthquake country and after August 17, 1999, the biggest earthquake in the history of Istanbul, it is observed that the people of the society living after the August 17, 1999, the biggest earthquake in the history of Istanbul, the state of building on the land is maximum. In this direction, it is known that public awareness changes with earthquakes and natural disaster events (Taşdemir, M.A., Özkul, H.,1999).

After 2018, when light steel structures are examined in line with the change in construction, it is seen that they cause a move away from reinforced concrete construction according to the first findings. First of all, transportation, transportation and ground slope models should be determined and the structural structure of industrial buildings should be determined in line with suitable land conditions. In line with the needs and primarily in earthquake countries, the need for reinforcement of buildings in order to survive brings along important measures. In order to ensure that the buildings are sustainable and long-lasting, it is seen that industrial constructions have reached today's models with light steel and heavy steel structural structures (Tümertekin, E., 1969).

It is seen that the constructions have also greatly affected holiday tourism in regions such as Antalya and Bodrum. As a result of short-storey constructions, the society looks at prefabricated structures at a more exceptional level, but it is seen that there is a transition from reinforced concrete to light steel construction in short-storey buildings. In industrial buildings, it is seen that reinforced concrete platform is needed when steel connections are established with anchors. In this direction, a minimum 50 cm platform is built on the floor of the building with a minimum C35 concrete class and the upper part of the building is completely or partially formed in the form of steel construction (Özkan, Ö., 2004)

In addition, the concrete class starting with minimum C35 and the materials used in industrial buildings vary depending on the function. For example, some seismic fluctuation-reducing materials are used in the impact-applying parts of press machines because they cause vibration in press printing factories. Since seismic effects are a term that is heard a lot due to earthquakes, the force power given to buildings varies according to the calculation data. Another important point is that the wide openings required in industrial buildings can be achieved with the steel system (Köse I., 1996.).

Due to the favorable topographic structure of the Hadımköy region, industrial structures have developed in the region, while the settlement rates of the region have increased day by day in this direction. Since this rapid, uncontrolled and unplanned development has started to adversely affect the infrastructure and environment of Hadımköy, necessary planning measures should be taken and the relationship between settlements and industrial buildings should be designed correctly in terms of the health of the people living in the region.

As the name suggests, the effective location of the establishment of the industry constitutes the basis of socioeconomic development. The use of incentives and opportunities provided by the state, the right choice of land and the use of light steel materials in the structure of industrial buildings built in line with the urban population make these buildings more durable

and sustainable, and it is seen that these buildings become more advantageous compared to other types of functional buildings (Tümertekin, E., 1969).

Since there have been some relocations in industrial settlements in the Hadımköy region, old industrial stations are still seen in some districts today. The use of steel construction, which started with the hope of passing large openings in industrial buildings, clearly reveals the reason why it is largely preferred when the relocations in industrial residential areas are taken into consideration. The biggest reason is that the design, installation and realization phases of the structures are realized quite quickly compared to reinforced concrete structures, and the steel structure can be dismantled in the processes after the use of the structures is abandoned and the structure can be moved quickly over the land (Özkan, Ö., 2004.)

When today's industrial buildings are examined, it is seen that partial or the entire structure is composed of steel materials and reinforcements, and when the selected buildings in the Hadımköy industrial zone are examined, it is seen that steel is used in the building structure in this direction. In line with the researches conducted, the necessity of frequent inspections should be brought to the agenda in order to try to reduce the damage caused by the industry to the environment to a great extent.

In the study, the advantages of steel construction structures in terms of flexibility, sustainability, durability, and resistance to disasters are discussed in terms of evaluation criteria, and it is thought that it is necessary to ensure the sustainability of the structures formed around these structures.

2. Use of Steel Materıals in Structures

Steel is an alloy of carbon and iron that can be mechanically processed (forged, pressed and shaped after rolling), contains less than 2% carbon and has high mechanical resistance. Steel can be quenched to harden it or combined with other materials. Since steel is much lighter and harder than iron, it can be processed better and contains a certain amount of carbon and manganese (Hasol, D., 1993.)

Steel used in buildings is a very reliable material because it is isotropic, homogeneous and produced under continuous control. Its self-weight is low compared to the load it carries due to its high strength, and it has the ability to carry full load after the assembly of the skeleton system is completed. Thanks to these advantages of steel frame systems, their use has accelerated in industrial buildings, large span bridges or prefabricated and portable structures that need to be built quickly, such as sports facilities. In addition, it offers a wide range of architectural and engineering uses in multi-storey buildings resistant to horizontal loads such as earthquakes and wind, and located on weak foundations.

As the use of structural steel has reached high rates in developed countries such as Japan and the United States, which are constantly exposed to factors such as wind and earthquake loads whose direction and intensity cannot be determined in advance, the production, application, limits of usage possibilities and necessity of steel material have a very important place. The standards and regulations established for the use of steel materials in the construction sector are as follows; German Standard (DIN), Turkish Standard (TS), American Institute of Steel Construction (AISC), American Iron and Steel Institute (AISI) and Society of Automotive Engineers (SAE).

2.1 Advantages of Steel Materials in Structures

The use of steel as a material in buildings can be examined in three groups compared to other materials.

Architectural Advantages of Steel: The structural systems of multi-storey, high occupancy or large span buildings must be made of a material with high strength. It is known that the bearing strength of a column made of steel is approximately 6-15 times higher than that of a reinforced concrete column with the same cross-sectional dimensions and conditions. In a building constructed with a steel system, economic advantages are obtained with the floor usage area provided at the maximum rate. For example, a reinforced concrete column with a section of 100x100 cm is equivalent to a column with a steel section of 40x40 cm **(**https://www.tucsa.org/tr/).

- Reinforcement of a building with a steel structural system depending on the need and changes in the system can be made within certain limits. Examples of these applications are increasing the load capacity of the structural or slab system or adding stairs by opening a gap in the slab (Özgen, A., Bayramoğlu, G., 2002).

- While steel structures provide infinite flexibility thanks to various joining techniques, they can be formed in any desired form and geometry. So much so that steel structures can be completely dismantled and rebuilt in the same form in another place, while this feature is not possible in traditional systems.

- Since it is possible to pass mechanical and electrical installation ducts through the gaps created in the beams, there is no loss of floor height. The use of steel in multi-storey buildings such as hotels, residences and parking lots is very advantageous in terms of this feature.

- With the urgent need for buildings such as hospitals due to the effects of pandemics and natural disasters experienced today, buildings have started to be built rapidly using steel structures. As an example of these buildings, Figure 2.1 shows a building completed in a very short time such as 28 hours and 45 minutes.

Figure **2.1:** Chinese Construction Company Broad Group Builds a 10-story Building in 28 Hours 45 Minutes in Changsha, China (Anonim,.2021)

Engineering Advantages of Steel: Since the strength of structural steel is high, the share of the steel's own weight in the load carried by the system is very small. Due to this feature, it is the most suitable material for crossing large openings.

- Thanks to the homogeneous and isotropic properties of structural steel, it is possible to obtain maximum benefit from the material by taking the safety coefficient value (μ) taken for dimensioning problems much smaller compared to other materials.

- Due to the high modulus of elasticity of structural steel, it provides less use of steel material in sizing problems where deflection, vibration, stability problems and bending stiffness play an important role.

- Due to the low ratio of the self-weight of the high strength steel material to the load it carries, the structural core is 30-40% lighter compared to conventional systems.

- The reduction of the earthquake force on the structure is related to the reduction of the weight of the structure. Since steel structures are about 50% lighter than reinforced concrete structures, the earthquake force that will affect the structure will also decrease at the same rate.

- Due to the fact that steel structures give less load to the foundation compared to traditional reinforced concrete structures, steel material becomes much more advantageous for buildings to be constructed in earthquake zones.

- In addition to the superiority of steel structures in terms of ease of inspection and reliability of construction quality, the carrier system can be opened and controlled if desired. Thanks to the control of the carrier system, any desired area can be opened and controlled.

Advantages of Steel in terms of Application: It is a building material that is under industrial quality assurance due to the fact that a large part of the steel workmanship is carried out in factories with high equipment features under the supervision of experts and by qualified people (https://www.tucsa.org/tr/). Steel structures are constructed in dry construction form without the use of materials such as plaster and mortar and only by assembling the finished parts together in the construction site.

- The system components within the structure that make up steel structures start to fulfill their load-bearing duties simultaneously with their assembly to each other. Thanks to this advantage, applications such as flooring, walls, installations, facades, etc., which are started by waiting for a certain period of time in traditional systems, can be started quickly.

- It is understood that structural steel is recyclable since steel is the most recycled material in the world. When steel system carrier elements are partially or completely removed from the steel structure, they can be used in a different structure without loss and can be recycled 100%.

- It is a building material that does not harm health for building users. Building users need to be able to meet their shelter needs in order to protect their health and continue their vital activities. In this respect, housing structures where they will meet their shelter needs should be built using materials that will not harm health.

- Steel structures do not have a cheap application labor, but they are economically advantageous due to the speed of construction and the fact that some items used in traditional buildings are not used in the construction of the structures. While the share of the structural system cost in the total cost of the building varies between 5-30%, when steel is preferred, there will be an increase of 20-30% and an increase of 1-9% in the total project cost. However, considering the time element in the construction process and the economic rate of return, the net present value (NPV) of steel structures is 5-10% more economical compared to traditional construction techniques (https://www.tucsa.org/tr/).

2.2 Disadvantages of Steel Materials in Structures

Since steel loses its strength at high temperatures ($\sigma \approx 0$ at 600˚C), the strength of structural steel will weaken under high temperatures. For this reason, if the temperature rises above 500˚C, steel structural elements should be protected as in closed volumes. In multi-storey buildings, fire protection can be provided by using methods such as coating the columns and beams by spraying a protective material, painting with fire-resistant paint, coating drywall and insulation plates by choosing fire-resistant ones or enclosing them in concrete. The choice between protection methods depends on criteria such as intended use, aesthetic appearance and cost.

- Structural steel that is exposed to the harmful effects of the atmosphere, i.e. unprotected, is susceptible to corrosion and must be protected. Corrosion is defined by the 'German Committee for Mine Protection' as "the destruction of a solid material from the surface to the interior by unintentional and unexpected

chemical and electrochemical effects" shown (Öztürk V., (2010).There are two methods to protect stainless steel building materials from harmful electro-chemical effects. First of all, it is to eliminate the effects such as water and humidity that it may be exposed to due to climatic factors and then to eliminate the internal structural irregularities that will create a potential difference.

- While the superiority of steel structures compared to reinforced concrete structures in earthquake zones is indisputable, the dynamic effect of wind gains importance in buildings above 50 floors. This is a problem since steel structures are lighter and more deformable than reinforced concrete structures.
- Within the scope of Turkey, the number of experienced companies with a certain history, experience and facilities dealing with steel structure construction is quite small. In this respect, the development of steel structure construction is also restricted.
- Since the most important factor affecting the quality of steel structures is manufacturing and application, the project of the whole system must be prepared in advance. All materials to be used in the structure should be defined, details of the application should be given and connection details to the steel carrier system should be shown (Öztürk V., (2010).

Figure 3.1: Hadımköy Posta Dağıtım Merkezi

3.1 Evaluation of Selected Steel Structures

In the study, two different steel industrial structures located in Hadımköy region, Postal Distribution Center and Yapı-Sel Engineering Steel Factory, were evaluated in terms of structural quality, flexibility, sustainability, durability and resistance to disasters.

3.1.1 Mail Distribution Center (Hadımköy, 2010-2012)

During the construction process of the Postal Distribution Center in Hadımköy, Istanbul, the main employer TOKİ, the contractor Siyah Kalem Mühendislik and the subcontractor Örtaş Çelik San. Tic. A. Ş. as the subcontractor.

Structural Quality: It was constructed with a steel construction system using steel material weighing approximately 1500 tons. The entire building, including the roof system, is constructed with the use of steel material, and the steel column system seen in the interior is covered with drywall material. On the exterior façade, the building envelope is formed using a glass cladding system and composite coating on bordex plate, while on the interior façade, the steel construction on the walls can be seen because it is not clad with drywall. In the light steel industrial building, which was created by utilizing the advantages of steel structure's wide span and the ability to use the desired floor height, a flat roof system was used, covered with trapezoidal sheet metal and a roof skylight system was created using glass material.

Flexibility: The flexibility criterion is valid for all large span steel structures since steel system structures can be disassembled and reassembled, and additions, changes or subtractions can be made to the form of the structure.

Sustainability: Thanks to the steel roof structure system, the building benefits from natural lighting and contributes to sustainability as less artificial lighting is used. Since the building benefits from natural lighting with the windows on the façade and the roof skylight, it also benefits economically with less use of electrical energy.

The fact that the steel material that forms the building structure is recyclable and suitable for health, that it causes little damage to the environment and that long-lasting structures can be created with this material should be taken into consideration.
Strength: It is known that the strength of the steel material is quite high in cases other than fire and that it is obtained at maximum quality is due to the fact that it is produced using fabricated construction techniques. In this respect, the strength criterion is considerably higher in steel structures than in traditional structures due to the fact that it can be measured and limit values can be determined for fabricated productions.

Due to the use of steel material in the structural structure of the Postal Distribution Center, the strength ratio of the structure is high and therefore it has a long-lasting structure feature.
Strength Against Disasters: Since the Postal Distribution Center Hadımköy, which was built by using the wide span advantage of the steel system, is located in the earthquake zone, the structural structure of the building was formed from the steel system and a system with high structural strength, long life and resistance against disasters was obtained. The façade was covered with transparent component and composite cladding in terms of climatic factors, and the steel roof system was covered with sheet trapezium to protect the interior of the building.

3.1.2 Yapı-Sel Engineering Steel Plant (Hadımköy, 1999) Yapı-Sel Engineering, located in Istanbul Hadımköy Industrial Zone, serves as 1500 m² closed area Production Facility, Head Office and Logistics Warehouse Building on 3000 m² land. The building was constructed in 1999 and took its place in the industrial sector with steel construction system building construction services.

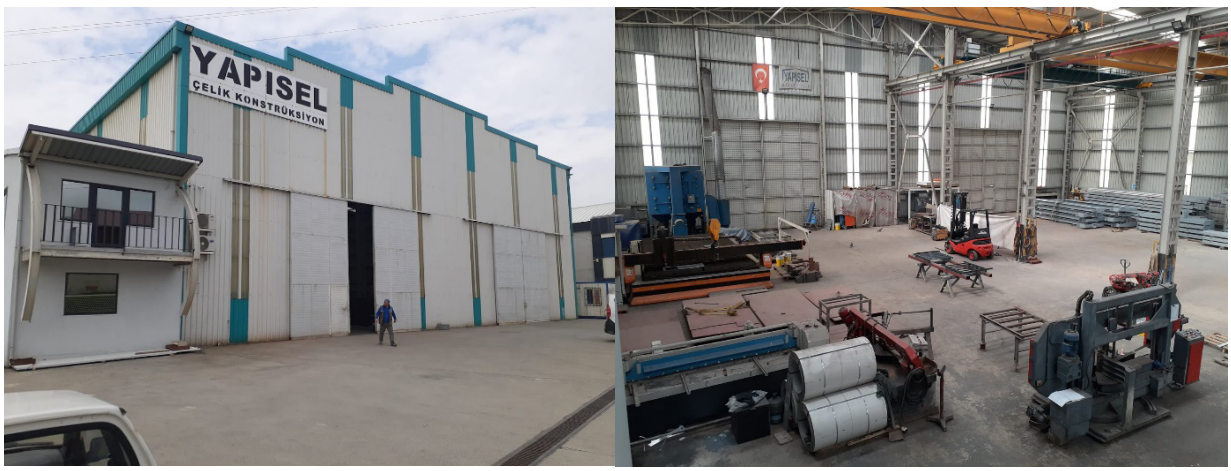

Figure **3.2:** Yapı-Sel Mühendislik Çelik Fabrikası

Structural Quality: The building was constructed using a steel construction system, including the roof system, all of which was formed with the use of steel materials. The steel column system seen in the interior space is not covered with any material and it can be easily perceived that a wide opening is created in the interior space. On the exterior façade, the building envelope is formed using composite plates, while on the interior façade, it can be easily seen that sheet metal plates are clad between the steel construction on the walls. In this steel structure, which was created by utilizing the advantages of the steel structure's wide span and the ability to use the desired floor height, a flat roof system was used and covered with trapezoidal sheet metal. It can be seen in the interior visual that transparent components are used in the building envelope.

Flexibility: Since the flexibility criterion is valid for steel system structures because they can be dismantled, installed and added, the advantage of flexibility is valid for this industrial steel structure. It has been observed that there has not been any addition, subtraction or change in the structural design of the building since its construction.

Sustainability: The building benefits from natural lighting thanks to the transparent components placed in a staggered arrangement on the building envelope and thus provides sufficient natural lighting to the interior workspace. In this respect, it is seen that sustainable development is benefited by obtaining sufficient natural lighting during working hours. The building is also economically advantageous and therefore sustainable.

Durability Due to the use of steel material in the structural structure of the Yapı-Sel Engineering Steel Factory, the structure has a high strength ratio and therefore has a long-lasting structure feature. However, it is seen that the structure has remained unchanged since 1999 and the deformation rate is low due to the high strength of steel.

Strength Against Disasters: Since Yapı-Sel Engineering Steel Factory Hadımköy, which was built using the wide span advantage of the steel system, is located in the earthquake zone, the structure of the building was formed from the steel system and a system with high structural strength, long life and resistance against disasters was obtained. In terms of climatic factors, the facade is covered with a transparent component and trapezoidal sheet metal cladding, and the steel roof system is covered with trapezoidal sheet metal to protect the interior of the building. When viewed from the exterior, the building shell is covered with light color composite on trapeze.

4. CONCLUSION

Within the scope of the study, two different light steel industrial structures located in Hadımköy region, Postal Distribution Center and Yapı-Sel Engineering Steel Factory, were evaluated in terms of structural quality, flexibility, sustainability, durability and resistance to disasters, and the advantages of the structures were mentioned. In this respect, a review that will guide the structural systems to be built in earthquake zones has been made and the criteria to be considered before system design have also been put forward.

The superior properties of steel material have been revealed, and it has been determined that both buildings are recyclable in terms of use, long-lasting and created using materials that do not harm the health of the users. In line with the building examinations, it was seen that the Postal Distribution Center building, where natural lighting is used to the maximum extent, is suitable for sustainability criteria compared to other industrial buildings. In addition, since the building was built in an earlier period, it is superior in terms of design and aesthetics.

It has been revealed that the study will be a guide for the light steel industrial buildings to be built in the Hadımköy region and that natural lighting is very important in terms of sustainability.

REFERENCES

Anonim., (2021). 28 saatte 10 katlı bina inşa edildi! Dünya bunu konuşuyor. Erişim Tarihi: 20.05.2023. https://beyazgazete.com/haber/2021/6/21/28 -saatte-10-katli-bina-insa-edildi-dunyabunu-konusuyor-6106597.html

Hasol, D., 1993. "Ansiklopedik Mimarlık Sözlüğü", Yapı Endüstri Merkezi Yayınları, İstanbul.

Köse I., 1996. "Çelik yapıların sismik dizaynı" M.S. Tez, Boğaziçi Üniversitesi.

Özgen, A., Bayramoğlu, G., 2002. "Çok Katlı Çelik Yapılar", TMMOB İnşaat Mühendisleri Odası Gebze Temsilciliği, Çelik Yapılar Semineri, Kocaeli.
Özkan, Ö., 2004. "Çesitli beton sınıflarının yapı maliyetine etkisi", *Ulusal Hazır Beton 2004 Kongresi*, Istanbul, 160-171.

Öztürk V., (2010). Çelik prefabrik yapı sistemlerinin imalatı, montajı, yalıtım usulleri ve maliyet analizi ile uygun kaplamanın belirlenmesi. Gazi Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Ankara.

Taşdemir, M.A., Özkul, H., 1999. "Marmara depremi beton arastırması", Hazır Beton, 35.

Tümertekin, E., 1969. Sanayi Coğrafyası, istanbul: İstanbul Üniversitesi Yayınları, No: 751, s. 42.

1/25000 Ölçekli İstanbul Nazım İmar Planı Raporu, 2007.

https://www.tucsa.org/tr/, Erişim Tarihi 02.05.2023