

**ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE**

**THE UNBEARABLE LIGHTNESS OF GLASS: TRANSPARENT ARCHITECTURE**

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***ABSTRACT***

The heaviness or lightness effect of a building that left to the user changes according to some different features such as its form, relation to topography, structure, fullness-emptiness rate of mass, organization and etc. The organization which gives the best lightness effect is transparency that is provided both with fullness-emptiness and material. The most valid material of transparency that provides lightness effect on the perception of façade is glass. Glass which made progress parallel to the development of technology in modern period turns into the skin of building now. In this study firstly, the development process of building façades on the basis of material from past to present –from heavy to light- is discussed. Then, the glass buildings that built in both new and historical environments are evaluated in terms of the heavy-light effect.

**Keywords:** Architecture, Glass, Transparency, Perception, Lightness.

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***ÖZ***

Bir yapının kullanıcı üzerinde bıraktığı ağırlık ya da hafiflik etkisi; yapının formu, topografya ile ilişkisi, strüktürü, kütlelerin doluluk-boşluk oranı, yapı yüzeyinin organizasyonu gibi farklı bir takım özelliklere bağlı olarak değişmektedir. Tüm bu özellikler içinde hafiflik etkisini en iyi veren organizasyon, gerek doluluk-boşlukla gerekse malzeme ile sağlanan saydamlıktır. Cephe algısında hafiflik etkisi sağlayan saydamlığın en geçerli malzemesi ise camdır. Modern dönemde teknolojinin gelişmesine paralel olarak aşama kaydeden cam, günümüzde yapı kabuğuna dönüşmüş durumdadır. Bu çalışmada öncelikle geçmişten günümüze yapı cephelerinin malzemeye dayalı olarak -ağırdan hafifenasıl bir süreç geçirdiği ele alınmıştır. Daha sonra camın, gerek yeni gerekse tarihi çevrelerdeki uygulamaları algı üzerindeki hafiflik-ağırlık etkisi açısından değerlendirilmiştir.

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## 1. INTRODUCTION

In the dictionary of Turkish Language Association the word of heavy is defined as overbalanced, the opposite of light; dense and large in diameter and sizes. It is also defined as having great value, imposing; draggy and depressing in metaphorical sense. On the contrary the word of light is defined as underweight, opposite of heavy; easier, non-strenuous; thin or low density; the opposite of rough. It is also defined as fretless, spacious and comfortable in metaphorical sense (<http://www.tdk.gov.tr>, 2011).

The heaviness or lightness effect of a building that left to the user changes according to some different features such as its form, relation to topography, structure, fullness-emptiness rate of mass, organization, colour, texture and material of building surface. For example, solid geometric-formed masses leave the impression that they are heavier when the organic-formed masses leave the impression that they are lighter. Similarly, dark-coloured surfaces are perceived as heavy when the light-coloured surfaces are perceived as light. Masses with low-span, filled and opaque surfaces are described as heavy and the masses which has opposite features are described as lightweight structures. It is possible to increase the samples. The organization which gives the best lightness effect in all of these examples is transparency that is provided both with fullness-emptiness and material.

In a thesis on the concepts of transparency and opacity, the academicians that were working in the departments of architecture in Turkey were asked what connotes the light concept to they. Light concept connotes structural words such as structure and construction and adjectives such as permeable and transparent to them. And also wood and glass are the materials which have been coming to mind first (Elmalı Şen 2009).

The most valid material of transparency that provides lightness effect on the perception of façade is glass. Gothic period is a historic moment both for using glass and for lightening the building by using large openings. In

following periods which formed a basis for the Modernism, glass was one of the materials that came into prominence with iron and steel in all manifests that aimed to lighten the building. Glass which made progress parallel to the development of technology in modern period turns into the skin of building now. Glass which found a large place in all building types from offices to houses –from public to private- is not only used in modern building environments but also in historical environments.

In this study firstly, the development process of building façades on the basis of material from past to present –from heavy to light- is discussed. The relationship between the lightness and transparency is explained in the context of manifests of architecture. Then, the glass buildings that built in both new and historical environments are evaluated in terms of the heavy-light effect on perception. 10 samples of glass buildings are selected -5 in historic, 5 in modern texture- dated after 1980s and are evaluated in terms of the heavy-light effect which they have according to material of façades.

### 1.1 The Evolution of Façade from Heavy to Light

In the first and subsequent periods of architecture the buildings were built for protection and defence motions for a long time. Therefore all the buildings including shelters were massive and heavy. For example, the Romans (BC 509-AD 476), used the glass first in the structure, even built strong, rough and heavy-looking buildings (Turani 1995). A very small number of windows opened on the walls. So the walls would be strong enough during the invasions which realised in precarious periods. Buildings were made of massive masses and windows were small in this period (Mutlu 1996, Roth 2000). Walls were brick in Roman and Late Antiquity periods, then built up with stone or broken stone in Romanesque Era. Due to the material the walls were built very thick and had heavy-looking in the mentioned eras (Figure 1) (Mutlu 1996).

Gothic period is the first period in which the glass entered to the building in an effective androuter position and reached the ideal of unity with light so the building was lightened. Vaults thrust which was directed to the four corners with a masterful construction system made possible both to defy gravity and to open large windows on walls (Hasol 1995). The thrust of heavy stone roof cover got carried by outer props instead of thick stone walls same as before in Romanesque. Large windows, opened between props, were enlightened the inside (Mutlu 1996). Props were taken the place of massive walls in churches and side walls of the chapels had completely vanished. Translucent glass surface which almost replaced the wall and is a very important character of Gothic churches lightened the effect of space (Figure 1) (Türkseven 1999; Elmalı 2005).

In Renaissance the walls were lighter and more open; the columns were thinner and more suitable for human sizes (Mutlu 1996). Nevertheless, the palaces of this period were massive buildings and their façades were in a symmetrical order that did not give any information about the interior of them (Figure 2) (Elmalı Şen 2009).

Building, lightened by the structural innovations in the Gothic period, became heavier again with Baroque architecture which was emerged as a reaction to the strict rules of Renaissance in Italy in 17th century. Heinrich Wolfflin summarized the features of Baroque as following: heavy, massive and free forms, compositions of light and shadow, to use light as an element of psychological effect, strange, unusual behaviours, capricious, dynamic and exhilarated approach (Kortan 1986). The architects of Baroque and subsequent Rococo almost completely left aside to express the basic structure of architecture in time and created an architecture that focused on shaping the space. By this way, literal sense of the architecture word returned to a nice and colorful varnish that was spreaded on another thing. So it is inevitable that the façade to be heavy and bulky with intensive ornamentation (Figure 2).

In 18th century Enlightenment Period (1720-1800) began and extensive cultural

changes took place in this period. European architects, in the effect of this period, rejected the visual extremeness of Rococo art and tended to an arhitecture that was free of unnecessary ornamentation and highlighted the structural features. They tried to create a pure basic forms architecture that based on the use of Greek orders with a lightness of Gothic in other words based on to get carry the maximum load with the minimum sized columns. Windows, doors and arch spans were completely cleaned from ornamented frames during this period (Mutlu 1996, Roth 2000, Elmalı 2005). Later, this understanding was supported and sustained with the slogans as 'Ornament is crime' (Adolf Loos/1908) and 'Less is more' (Mies van der Rohe/1944) (Elmalı Şen 2009).

In 20th century Industrial Revolution signed undeniable developments in architecture by the technological developments as in all areas. During this period developments in structural construction systems and improvements in the technics of glass manufacturing and applying began to offer new opportunities to architecture and to influence the outer forming of the building. Evolution of glass production and structural (skeletal string) evolution were realized in the same period and they even conditioned eachother. The said developments also guided architectural identity (İzgi 1999).

Metals as construction materials, especially lightness of steel and aluminium and suitability for the industry technology as the ease of formation also led to be defined as the material of era with the plastics and glass (İzgi 1999). Light and bright building structures that gave a significant feature to this period were used quiet in the buildings that were built during and after the Industrial Revolution by showing parallel with technologic developments (Figure 3, 4) (Elmalı Şen et al. 2009a).

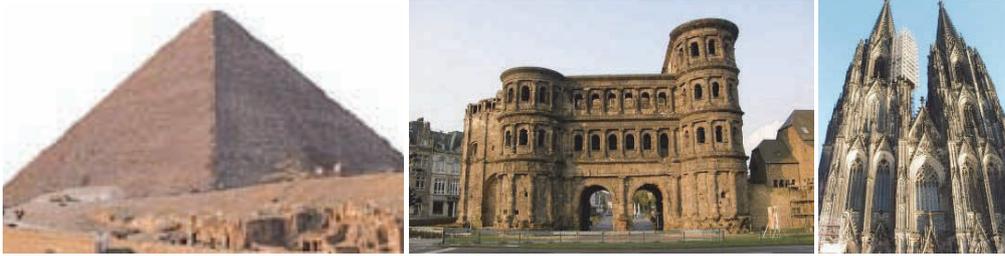


Figure 1. Keops Pyramid, Egypt; Porta Nigra, Trier/Germany, 186-200; Köln Cathedral, Köln/Germany, 1248-1880



Figure 2. Farnese Palace, Rome/Italy, 1530-46; San Carlo Alle Quatro Fontane, Rome/Italy, 1665-67; Santa Maria Della Pace Church, Rome/Italy, 1656; Karlskirche, Vienna/Austria, 1716

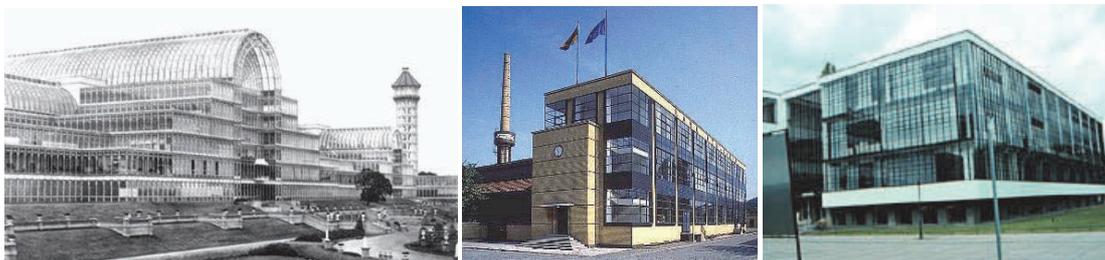


Figure 3. Crystal Palace, London/England, 1851, Joseph Paxton; Fagus Shoe Factory, Alfeld-an-der-Leine/Germany, 1911, Walter Gropius; Bauhaus, Dessau/Germany, 1926, Walter Gropius



Figure 4. Farnsworth House, Illinois/USA, 1946-51, Mies van der Rohe; Glass House, Connecticut/USA, 1949, Philip Johnson

## 2. METHODS

In this part of the study 10 samples of glass buildings are selected that built in both new and historical environments and dated after 1980s. Selected samples -5 in historic, 5 in modern texture- are firstly investigated in terms of their functions and the reasons of glass material choice. Then they are evaluated in terms of the heavy-light effect which they have according to material of façades.

### 2.1 The Glass Building Samples in Historic Texture

**S1. The Entrance of Louvre Museum, Paris/France, 1980, I.M. Pei:** The most recent addition to the Louvre was the construction of the glass pyramid, which functions as the museum's main entrance. The glass pyramid, connecting elegantly to expanded galleries below the courtyards, allows the sunlight to come in on the underground floor. The modern addition originally received mixed reviews, as it contrasts sharply with the classical design of the surrounding buildings. But today it is generally accepted as a clever solution which has given the museum a spacious central entrance without the need to touch the historic patrimony (Figure 5) (<http://www.aviewoncities.com/louvre.htm>, 2011).

**S2. The Museum of Art, Lille/France, 1997, Jean Marc Ibos, Myrto Vitart:** The site is dominated by the existing historic building, the old palace, which is formed in a symmetrical, classical 'C' plan. Ibos and Vitart's response to the dominant Beaux Arts palace is to create the missing fourth elevation as a largely transparent wing set to one side of, but adjacent to the central courtyard, in the form of a full-height glass-clad elevation. According to the architects, "The building is a mirror of reality. It is a reflector that explores the meaning of presence, materiality, absence and tests our sense of place". The net effect is that the wall appears as an incredibly minimal surface, a unified sheet of translucency, rather than simply

being the elevation to the extension (Figure 6) (Richards 2006).

**S3. The Dome of Reichstag Parliament Building, Berlin/Germany, 1999, Norman Foster:** The current Reichstag dome is a glass dome constructed on top of the rebuilt Reichstag building in Berlin. It was built to symbolize the reunification of Germany. The distinctive appearance of the dome has made it a prominent landmark in Berlin. Foster's dome is a gleaming metal and glass structure with a ramp that spirals up to a roof terrace with 360-degree views of central Berlin. The dome overlooks the debating chamber for the Bundestag and a central mirrored cone draws light into the plenary chamber (<http://www.galinsky.com/reichstag>, 2011). The dome is integrated very well with the old building functional and physical as well as semantic. Although it was built with material and construction system in contrast to the historic building, it is highly compatible with it in terms of proportion and size (Figure 7).

**S4. Nelson Atkins Museum of Art, Kansas/USA, 2007, Steven Holl:** The expansion of the museum fuses architecture with landscape to create an experiential architecture. The new addition engages the existing sculpture garden, transforming the entire Museum site into the precinct of the visitor's experience. As visitors move through the new addition, they will experience a flow between light, art, architecture and landscape, with views from one level to another, from inside to outside. Rather than an addition of a mass, the new elements exist in complementary contrast with the original 1933 classical 'Temple to Art': New building is defined as transparent/opaque, light/heavy, meshing/hermetic, unbounded/bounded, views to landscape/inward views, open circulation/directed circulation and transparent lenses/single mass (Figure 8) (<http://www.archdaily.com/4369/the-nelson-atkins-museum-of-art-steven-holl-architects>, 2011).

**S5. The History Museum, Bern/Switzerland, 2009, MLZD:** The expansion creates a multileveled dialogue between old and new architecture. New annex includes two main elements: an exhibition hall and a monolithic six-story structure. The massive concrete walls of the new wing give the south, east, and west elevations a fortified appearance in keeping with the older museum. On the north elevation, a flat, fully glazed curtain wall helps frame the public plaza and spectacularly reflect its surroundings. The fully glazed curtain wall wrapping the north elevation seems to reveal the cut surface of the massive rock as if it were a gemstone. On sunny days, it reflects the museum facade opposite, and from a point of view parallel to the glass panels, it even completes the older building's design by turning it into a symmetrical composition. The architects have succeeded in creating an extension that both responds to the late 19th -century museum and competes with it (Figure 9) (<http://archrecord.construction.com>, 2011).

## 2.2 The Glass Building Samples in Modern Texture

**S6. Kunsthaus, Bregenz/Austria, 1991, Peter Zumthor:** The art museum is a mysterious translucent monolith, was conceived as a 'museum of daylight'. According to Zumthor, 'It is made of glass and steel and a cast concrete stone mass which endows the interior of the building with texture and spatial composition. From the outside, the building looks like a lamp. It absorbs the changing light of the sky, the haze of the lake, it reflects light and colour and gives an intimation of its inner life according to the angle of vision, the daylight and the weather'. The facade consists of etched glass shingles with several functions: they lend the building's main body lightness with their transparency, insulate against cold and heat and form an essential part of the lighting arrangement for the building. The facade was designed as a self-supporting construction, completely independent from the actual building

(Figure 10) ([http://www.kunsthausebregenz.at/ehhtml/k\\_arch.htm](http://www.kunsthausebregenz.at/ehhtml/k_arch.htm), 2011).

**S7. Rose Center of Earth and Space, NY/ABD, 2000, Polshek Partnership:** The center is the new premiere high-tech museum and planetarium facility of the American Museum of Natural History. It housed in a glass cube containing the spherical Space Theater, which incorporates high-resolution fulldome video to create space shows. It consists of a six-story high glass cube enclosing a 27m illuminated sphere that appears to float—although it is actually supported by truss work. James Polshek has referred to this work as a "cosmic cathedral" (<http://mimoa.eu/projects>, 2011). It is highly effective with its entirely glass façades due to its sizes and sense of absence (Figure 11).

**S8. Sendai Mediatheque, Sendai/Japan, 2001, Toyo Ito & Associates:** With the intentions of designing a transparent cultural media center that is supported by a unique system to allow complete visibility and transparency to the surrounding community, the Mediatheque is revolutionary in it's engineering and aesthetic. This striking visual quality that is one of the most identifiable characteristics of the project is comparable to large trees in a forest, and function as light shafts as well as storage for all of the utilities, networks and systems. Each plan is free form, as the structural column lattices are independent of the facade and fluctuate in diameter as they stretch from floor to floor. The tree-like nature of the metal columns of the Mediatheque are continuous with the natural surroundings of the area, as the design is found on a street lined with trees. The building changes along with the seasons, its openness reflective of the summer green and also the streets during winter (Figure 12) (<http://toyo-ito.mr926.me/2011/sendai-mediatheque-toyo-ito>, 2011).



Figure 5. The Entrance of Louvre Museum, Paris/France, 1980, I.M. Pei



Figure 6. The Museum of Art, Lille/France, 1997, Jean Marc Ibos, Myrto Vitart



Figure 7. The Dome of Reichstag Parliament Building, Berlin/Germany, 1999, Norman Foster



Figure 8. Nelson Atkins Museum of Art, Kansas/USA, 2007, Steven Holl



Figure 9. The History Museum, Bern/Switzerland, 2009, MLZD

**S9. Kanagawa Institute of Technology Glass Building, Kanagawa/Japan, 2007, Junya Ishigami:** A white forest in a grey field, Kanagawa Institute of Technology is a building designed to almost disappear. The lines between indoors and out are blurred in the crystalline building studio and workspace. With floor-to-ceiling glass, the building is totally transparent, giving students an incredibly bright space in which to work during the day, and turning it into a veritable art installation at night. The structure presents another round in the architect's ongoing contest with gravity. The forest comprises 305 slender steel 5m-high columns, irregularly orientated and distributed throughout the space, while the field from which they rise is a distorted square bed of concrete, 47m by 46m, slightly raised above the surrounding bitumen. Inside, supportive columns are arranged to subtly define 'zones' of the building without walling them in and cutting them off from the rest of the space and all of that natural light (Figure 13) (<http://weburbanist.com>, 2011).

**S10. Basque Health Department Headquarters, Bilbao/Spain, 2008, Coll-Barreu Arquitectos:** The formerly building was in need of an energy-efficient update, but rather than tearing down the whole building and starting anew. Architects gave the existing building a faceted glass façade that not only insulates the building, brightens it up and enables ventilation, but also makes a dramatic street-side statement. The unusual shape of the facade was partially the result of strict city zoning rules. A double facade solves not only zoning rules requirements but also energetic, fire-resistant and acoustic insulation ones. This element allows breathing the building. In the other hand, that folded element produces multiple views of the city, and changing its appearance depending on the point of view, the hour and the season. The objective of this element is introducing the mutability (Figure 14) (<http://weburbanist.com>, 2011).

### 3. FINDINGS

Heaviness-lightness effects of façades of the samples given above (Figure 7-16) are evaluated in terms of their façade surfaces, material surfaces and transparency-opacity status (Table 1). According to the evaluation,

- Buildings which are permeable and transparent because of their flat and pure façade surfaces and colourless glass façades are perceived as lighter than the others (S1, S3, S7, S8 and S9).
- Buildings that are translucent and semi-transparent because of their coloured glass surfaces are perceived as neither heavy nor light although their façade surfaces are flat (S4, S6).
- It is expected that the buildings will be perceived as heavy because of they are opaque due to their glass surfaces are coloured. Nevertheless they reflect the opposite buildings because of their flat and glass façades. So they are perceived as neither heavy nor light (S2, S5).

Although their façades are covered with glass if the façades of buildings are vaulted or movable and the glass surfaces are coloured then they are perceived as heavy (S10).

### 4. CONCLUSION

Heavy-light contrast in architecture is more related with material and structure. The lightness tendency that emerges as a result of new searches in architecture is realized through the technologic developments and architecture is put forward which is much lighter than the old one.

A result like following arises when the examples are evaluated in the content of this study in terms of glass and lightness. If a building's surface has more faulted and movable structure, it displays a heavy appearance, although its all façades are entirely glass. At the same time opacity is dominated instead of transparency in some buildings depending on the character of used glass such as reflective glass, mirror glass and etc., although the façade is built with glass.



Figure 10. Kunsthhaus, Bregenz/Austria, 1991, Peter Zumthor



Figure 11. Rose Center of Earth and Space, NY/ABD, 2000, Polshek Partnership



Figure 12. Sendai Mediatheque, Sendai/Japan, 2001, Toyo Ito & Associates



Figure 13. Kanagawa Institute of Technology Glass Building, Kanagawa/Japan, 2007, Junya Ishigami



Figure 14. Basque Health Department Headquarters, Bilbao/Spain, 2008, Coll-Barreu Arquitectos

Table 1. Heaviness-lightness effect of façades of samples that located both in historic and modern texture

	Located environment	Façade surface		Material (glass) surface		Transparency-opacity status			Heaviness-lightness effect				
		historic	modern	movable	flat	coloured	colourless	opaque & reflective	translucent	transparent & permeable	heavy	neither heavy nor light	light
S1		○			○					○			●
S2		○			○			○					●
S3		○			○					○			●
S4		○			○				○				●
S5		○			○			○					●
S6			○		○				○				●
S7			○		○					○			●
S8			○		○					○			●
S9			○		○					○			●
S10			○	○		○		○				●	

The said buildings become transparent and light only at night when they are illuminated from interior. Colour and translucency even mostly give weight to buildings rather than lightness. However the coloured glass is permeant, it is very effective on a building with glass façade

that loses its lightness due to its character of translucent. For this reason it is not enough only to cover the façade with glass for providing the visual lightness. To organize the façade as flat/pure as possible, to use colourless glass and to increase the permeability are the ways that

will contribute to increase the lightness effect of glass. Because glass reaches the lightness effect in real terms when it meets with light –natural or artificial-. It reaches the top level of both materialistic and metaphoric lightness when the permeability in other words integrity of interior-exterior is provided by making the feel of absence. Therefore, it can be said that the key of lightness of a building is the meeting of glass and light in other words transparency in the building.

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