RELATION BETWEEN THE INCREASING TRANSPARENCY IN ARCHITECTURE, TECHNICAL KNOWLEDGE AND THE CHANGES IN DESIGN PROCESS

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ABSTRACT: The main aim is to discuss the relation between the structural characteristics of two different suspended glass systems with pre-stress cable trusses (SGSPCT) in relation to their design processes. The graphical illustrations help both in understanding the space characteristics and the elements, which exist in the structure. The methods of gathering the necessary information to produce these graphical illustrations were: 1)evaluations of special reports, 2)reference books and, 3)information gathered from producers. Two cases which represent different types of uses of SGSPCT, are examined in order to relate their spatial and structural characteristics to their design processes. Design processes of these cases are studied in order to find out the leading figure in design. Is it the architect, or the engineer, or the manufacturer, or the contractor? The paper presents a comparative research that is based on the comparison of the two cases by considering their structural principles and the leading figures in the design processes.

Keywords: Suspended glass systems, Cable truss, Design process.

1.INTRODUCTION

The transparency of buildings is increasing parallel to the recent developments in building technology. Together with the new developments in building technology, glass started to be used in such away that is uninterrupted by the framing. A different type of truss system with pre-tensioned cables which is called *`cable truss system`*, (Figure 1) is being used in many different organizations in order to form vertical, inclined and curved transparent surfaces. Previously cable trusses were only being used in order to form circular horizontal surfaces that are known as *`bicycle wheel structures`* (Figure 2). However, if these surfaces are compared with the 2D transparent surfaces of ordinary curtain wall systems, it can be stated that the transparent surfaces that are formed by the cable trusses, are able to form 3D spaces. (Figure 3)

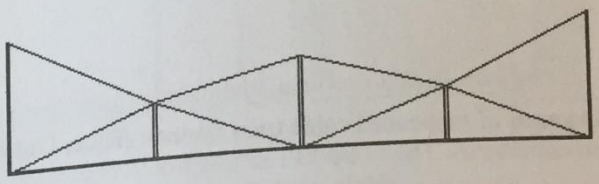


Fig. 1.Cable truss. (Atakara, 2002)

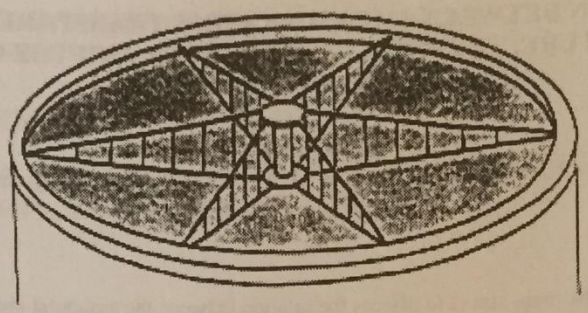
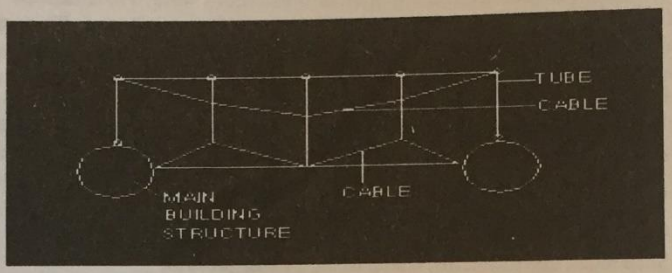


Fig. 2.Bicycle-wheel structure. (Salvadori, Heller, 1975)



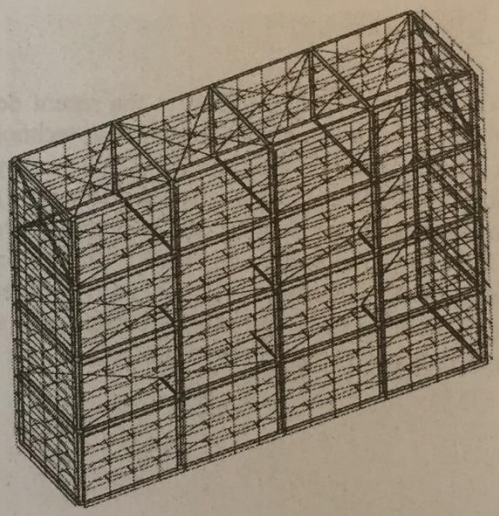


Fig. 3.An example of suspended cable truss system. (Rice, Dutton, 1995).

Because they have to be supported by another structure which is usually the main building structure. Still, SGSPCT is totally structural, including the structural role of the glass surface and the fittings. The geometry of such structures is determined by considering the the perpendicular wind loads on the glazed plane and to the requirements of the main building structure to which these loads are transferred. The allowable limit of deformation of

these systems is much more than the limit of deformation of other building structures. (Martini,1996)

SGSPCT forms a new category between structural systems and curtain wall systems. Each joint, each bearing, reflects the way in which glass behaves, plays role in the idea of transparency and creates an immaterial space. Thus, the structural space understanding changes besides the changes in the value system of structural design.

Architectural and structural engineering design processes of such transparent spaces in the buildings differ radically from the processes of other types of buildings. Design of these 3D compositions of transparent surfaces, requires the support of innovative engineers, manufacturer and contractor firms.

Banque Populaire de l'Ouest et de l' Armorique in Montgermont (Figure 4) and Avenue Montaigne in Paris (Figure 5) are selected as examples of two different uses of SGSPCT related to the main building, in order to relate the type of use of SGSPCT to the changes in the design processes of them. This paper presents a comparative research depending on these two examples in order to show the relation between;

a. The relation between the SGSPCT and the main building structure,
b. The level of standardization of SGSPCT,
c. The changing amount of required technical knowledge,
d. The role of architectural, engineering, manufacturer and contractor firms of SGSPCT in the design processes of these buildings.

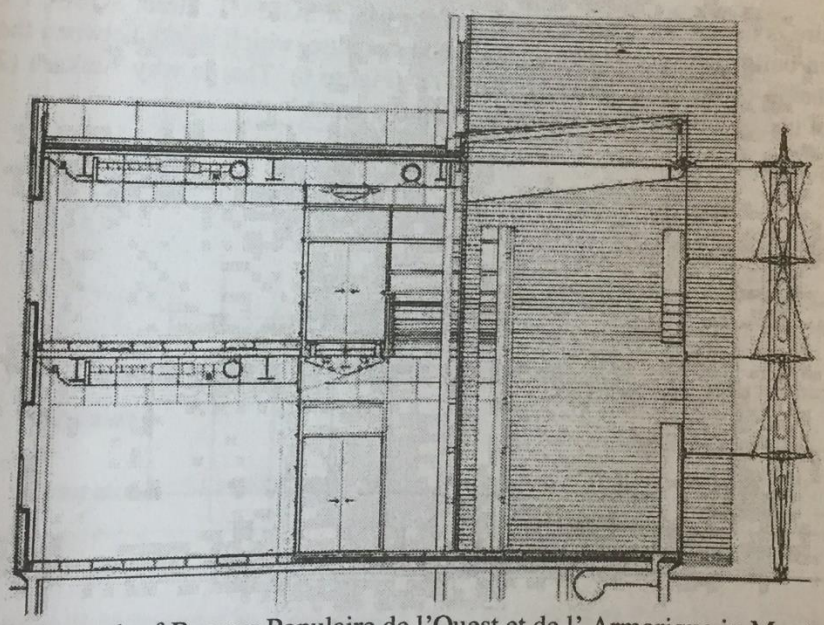


Fig. 4.Photograph of Banque Populaire de l'Ouest et de l' Armorique in Montgermont (Rice, Dutton, 1995)

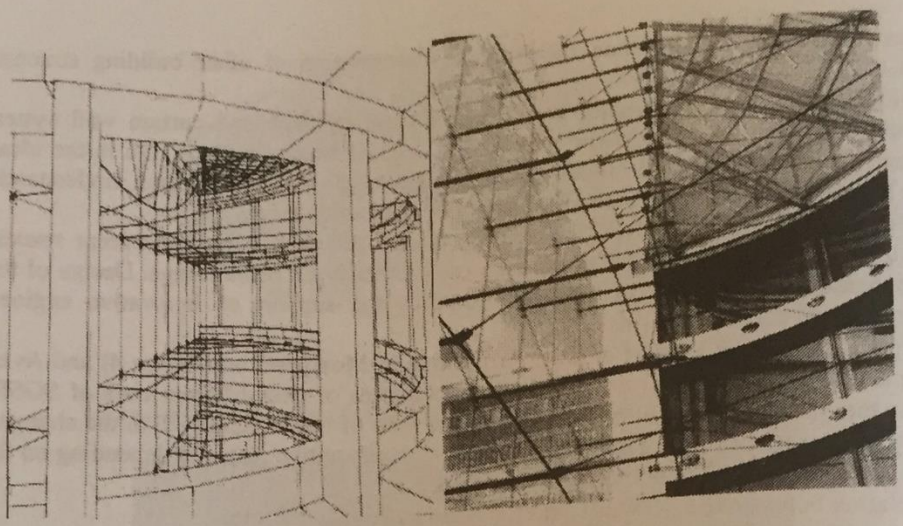


Fig. 5.Photograph of Avenue Montaigne in Paris (Rice, Dutton, 1995)

2. SGSPCT IN BANQUE POPULAIRE DE L'OUEST ET DE L' ARMORIQUE IN MONTGERMONT

Banque Populaire is one of the early examples of the use of SGSPCT. Here, SGSPCT exists besides the main building structure and another tube structure, which works between the first two as an extension of the main building structure. (Figure 6). That is why Atakara (2002) calls this type of use of SGSPCT as *'distance bridging system.'*

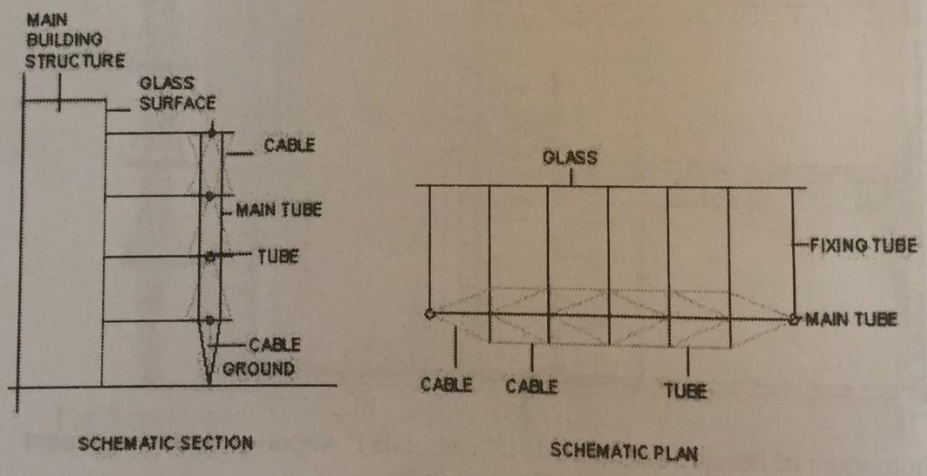


Fig. 6. Banque Populaire de l'Ouest et de l' Armorique and the types of structures it contains. (Atakara, 2002).

In this building the system forms a smooth and transparent surface as all of the fixing details are on the exterior. Since only the SGSPCT is allowed to have perceivable deflection, it is much lighter than the main building structure and the tube. It is easy to differentiate SGSPCT from the rest of the building.

The level of standardization of the elements in SGSPCT is always very high. This is valid for all uses of the system. However, in Banque Populaire the relation between SGSPCT and the main building structure is also highly standardized. This means that this type of SGSPCT can be used in any other building, which contains the necessary basis for the connection of SGSPCT.

3. SGSPCT IN AVENUE MONTAIGNE IN PARIS

In Avenue Montaigne two different systems of structure co-exist. There exist a main building structure, and a SGSPCT. Here, SGSPCT is inside the main building structure. Since the main building structure is not allowed to have any perceivable deflection, it is heavier than the SGSPCT, which is allowed to have perceivable deflection. However, although the main building structure is heavier than the SGSPCT, it is not very easy to differentiate the two structures, because of the high level of integration between them. (Figure 7) Visual presence of the structure as a whole is stronger than the other systems, and the span of the suspended pre-stress cable structure is the largest. (Rice, Dutton, 1995)

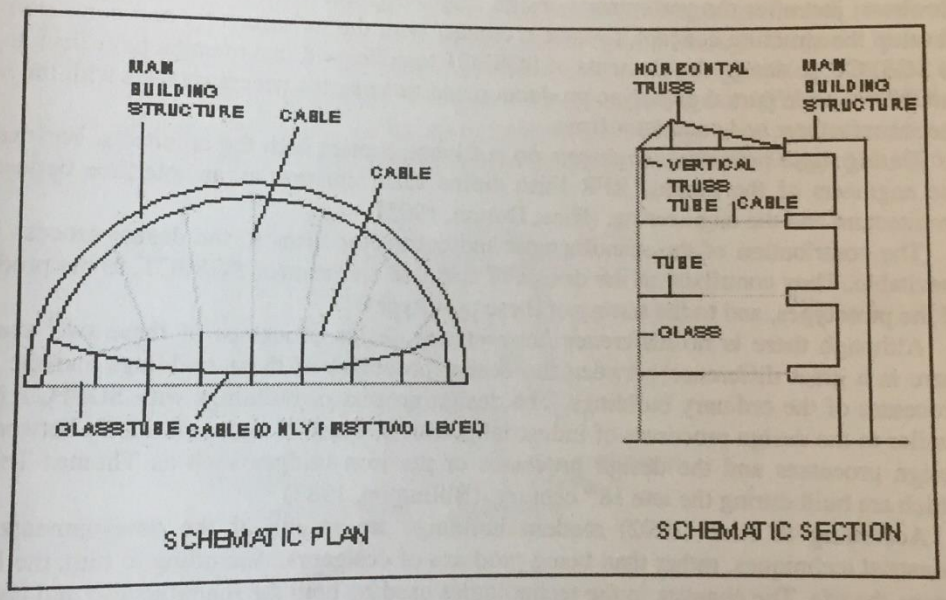


Fig. 7. Avenue Montaigne in Paris and the types of structures it contains. (Atakara, 2002)

This type of use of SGSPCT is called *'independent body'* by Atakara (2002). Such a use of SGSPCT maximizes transparency and the continuity between the outside and the inside. One can even talk about a dematerialization because of the minimization of the material and the structure.

The design of the SGSPCT in Avenue Montaigne is a response to the overall geometry of the main building. Here, there is not any standardized relation between the main building

structure and the SGSPCT. Although all members in SGSPCT are standardized, the relation between SGSPCT and the main building structure is unique. This SGSPCT is designed only for this building.

The level of standardization in Banque Populaire can serve for the purposes of repetitive production. However, the standardization that exists in Avenue Montaigne can only be defined as a fine modular coordination. Thus, the repetition of the structural idea of SGSPCT of Avenue Montaigne is more difficult than the repetition of the idea of the same system in Banque Populaire. The required level of technical knowledge for the repetition of the structural design principles of SCSPCT in Avenue Montaigne is higher than the level of knowledge required to repeat the design principles of the same system in Banque Populaire.

It can be stated that the relation between main building structure and the SGSPCT is a highly concentrated to certain points in case of Banque Populaire. The SGSPCT is connected to the main building structure by a limited number of joints. However, the touch of SGSPCT is very much distributed to the circular surfaces of the main building structure of Avenue Montaigne.

4. DESIGN PROCESS OF BUILDINGS WITH SGSPCT

The design processes of both Banque Populaire and Avenue Montaigne are the same, although the structural design principles are very different. (Rice, Dutton, 1995) Architects determine the space quality and geometric characteristics of these transparent spaces. However, just after the preliminary design stage, engineers enter into the design process to develop the structure concept, to have a contact with the manufacturer and contractor firms of SGSPCT, to design the elements of SGSPCT together with the manufacturer firm, to carry out the 1/1 scale partial prototype production and to make the necessary tests with the help of the manufacturer and contractor firms.

During these processes, engineers do not loose contact with the architects. For example, the engineers of the famous RFR Firm define their situation as an interface between the architecture and the engineering. (Rice, Dutton, 1995)

The contribution of the manufacturer and contractor firms to the design process is also inevitable. They contribute to the design of standard elements of SGSPCT, to the production of the prototypes, and to the testing of these prototypes.

Although there is no difference between the design processes of these two examples, there is a great difference between the design processes of these buildings and the design processes of the ordinary buildings. The design process of buildings with SGSPCT is more similar to the design processes of industrial products. There is also a similarity between their design processes and the design processes of the iron bridges such as Thomas Telford's, which are built during the late 18^{th} century. (Billington, 1983)

According to Rice (1992) modern buildings are results of the developments in the industrial techniques, rather than being products of designers. According to him, the industry means the life. The changes in the technologies used by both the manufacturer and contractor firms have to be followed. And, the most fundamental characteristic of building construction is the political nature of it. Getting permission for building is a political aspect. Thus, both the manufacturers of the elements of SGSPCT, and the contractor firms, which are responsible from the on-site work, play a specific role in the design of SGSPCT systems.

Design of SGSPCT needs having a close relation with the industry. Consultation of the manufacturer and contractor firms is the basis of achieving the major information. (Rice, 1992)

However, it is also mentioned that to transfer information between the departments of these firms is a problem, because they are defensive about information. People working in these firms are given very little information about the possible details. (Rice, 1992)

This means that the major role in design of the SGSPCT systems neither belongs to the architect, nor to the manufacturer and contractor firms.

5. CONCLUSION

The aim of the use of suspended glass system with pre-stressed cable truss (SGSPCT) is to minimize the bracing structure of transparent surfaces and to create a space where one is neither inside nor outside the building. SGSPCT is always used together with another structural system that is the main structural system of the building.

If the structure of the transparent spaces can be differentiated from the main building structure, the technical knowledge requirement to repeat the same principles in some other buildings is not to high for architects, because the relation between the SGSPCT and the main building structure is highly standardized.

However, if the structure of these transparent spaces is integrated with the main building structure, the relation between the SGSPCT and the main building structure becomes unique, and type of standardization changes to be modular coordination, thus, the required level of technical knowledge for the repetition of the same structural design principles increases besides a need for experience.

The main figure in the design of SGSPCT is the engineer who is able to form an interface between the knowledge systems of engineering and architecture. Although the main idea of having large transparent surfaces, is an architectural idea, it is also an engineering idea which considers 1/1 details, such as articulated bolt and V brackets. (Figure 8) (Pilkington,2001; 2002.a,b,c) It is clear that there is a need for more technological design ideas, and these ideas deserve 1/1 scale design ideas. (Alpha,2000; Dalumur,2002; Sweet's,2001; Wigginton,1996; Wintek,2000)

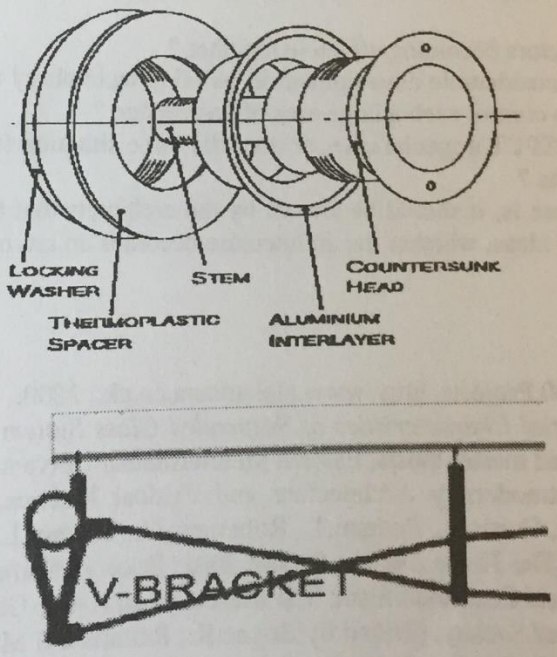


Figure 8. Articulated bolt and V bracket. (Inkan,2001, Rice, Dutton, 1995)

The producer firms are also effective on the design process because this is a design process that is similar to the design process of industrial products. The engineer also plays the role of an activator for these firms, because without the existence of these innovative engineers, the manufacturer and contractor firms are usually static and slow.

RFR Firm containing P.Rice designed SGSPCT's of both Banque Populaire and Avenue Montaigne as unique cases. SGSPCT of Banque Populaire is designed as a unique system, which can also be repeated in some other buildings, whilst SGSPCT of Avenue Montaigne was designed as a unique case that cannot be repeated in any other building.

Was this situation a result of the demands of the architects, the clients, the manufacturers, or the contractors? Is it only related to the increase of knowledge and experience about the system? Is it a political decision? We do not know.

In any case, the architects do not design SGSPCT systems. They can only repeat certain types of them in their designs. We do not also know how widely these SGSPCT systems are being repeated by the architects.

Whether the system is standardized or not, the role of the architect is usually related only to the aesthetics of the building including such transparent parts. This is also valid for the architects such as Pei, Tschumi and Rogers who worked with Rice in order to design SGSPCT systems for their buildings. (Rice, Dutton, 1995)

This means that the professional power of architecture is changing hands specificly when the design processes of some new systems such as SGSPCT are considered. The material power of architecture is now being transferred to engineering, manufacturer and contractor firms. This situation which becomes clear in the design process of SGSPCT, brings forward some questions to be answered, in order to be aware of the area of the profession of architecture, and to understand the needs of the building market and architectural education. Is this change in the design process which decreases the effect of architecture on building market, a result of increasing corporatization in architecture ? (Gutman,1991; King,1993)

Is it a result of recent artistic tendencies both in architecture and architectural education which neglects the importance of technical knowledge ? (Bandini,1993; Caygill,1991; Gleichmann,1992)

Are these two factors becoming effective together ?

Or, is it only a considerable development in building technology that requires team work in order to be able to control such a large area of knowledge ?

Is the case of SGSPCT a special case, or does the same situation take place also in the use of some other systems ?

What ever the case is, it should be known by the architects that there is still demand for technological design ideas, whether the architecture becomes an art, or not.

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