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Researches on Historical Constructions Built in Several Stages

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ABSTRACT: Many buildings belonging to the architectural heritage are built in several stages. Constructions are transformed or/and completed in accordence with the changing functional necessities required by the developing social environment. Representative residential and public buildings of historical value in the Middle- and Middle-East European area built between the 18th and the beginning of the 20th century are the objects of our study. A methodology of identifying the different parts of the construction built at different times is presented and applied. Architectural and structural characteristics are put into evidence.

1 INTRODUCTION

The architecture can be considered as an interface between art and technique. The job of the architect is a very special one. The talent and imagination in creating new forms of constructions responding to a social command has to be validated not quite free, but in a strict correspondence with a certain material object. The fantasy is restricted by functional, structural and economical demands as well. Thus the theme is more fascinating in comparison with that of the art generally. The creative activity earns a scientific character and the engineer inter12venes in the process.

For a long time in the course of the history the architecture and engineering joining each other have constituted one single profession being practiced by different categories of professionals: scientists (in Antiquity), craftsmen (in Middle Age), artists (in Renaissance).

The science of structural engineering as a result of the great progress of science and technique during the 18th and 19th century (new mechanical theories, new materials and technologies) has gradually separated from the architecture beginning with the middle of the 19th century. From this time, depending on the character of the building, the role of the architect or engineer can be more or less important. At any rate, in a building created for a certain function the relation structure and form can be decisive for its quality, for the impression it induces. A building can give a good impression and inspires confidence and assurance as well when in the structure organized material appears sincerely. At other times, special effects can be reached by hiding the structure or wrapping it with older or newer clothes of a soberer or more frivolous elegance depending on the epoch and place. Consequently, any intervention on historical buildings has to be made very carefully respecting the original conception and assuring the actual safety requirements. Both the architect and structural engineer have to be involved in this process.

There are many examples of interventions on representative buildings during the history. The central part covered by cross vaults of Caracalla's thermal bath built in 216 was transformed in church (Sta. Maria degli Angeli) by Michelangelo in the 16th century. This is a classical example of functional change and retrofitting of an old construction. Generally it is not easy to make a just judgement on transformations of buildings happened in the past. The interiors of the Gothic Cathedrals were destroyed and replaced by another one during the Baroque era in the

name of the "great taste". We are inclined to say it is pity of them. But at the same time we are accustomed with this feature today. The Pfalzkapelle in Aachen built in 798 looks like a jewel between the other church naves built around in the following times, every with its specific style. Thus, it can be considered as a successful and beautiful monumental ensemble.

The evolution in the domain of buildings, urban planning, built environment and the modality of intervention on them as well, is influenced by many factors. Besides the evidence of social determination that reflects both the exigencies and the means, some other considerations matter too, like geographical place, environmental conditions, spirituality and tradition, scientific level and technological development as well as many other factors.

2 PRINCIPLES OF INTERVENTION ON HISTORICAL BUILDINGS

The research on a construction built in different stages is inevitable during the study of its maintenance and retrofitting. The base of this research shall be a careful study of the successive interventions performed in the past. During this research we have to answer a lot of questions. What make an intervention to be necessary? Which are the modalities of intervention? How can we judge an intervention when it is right?

At first, a building or built environment may suffer different changes imposed by functional or other necessities. That can be the enlargement of an activity, total change of a function, urban modernization e.g. Otherwise, the modification can be provoked by the dominating new tendencies in the art of building or/and the challenge represented by discoveries and innovations in the field of science and technique. At last by not least intervention can appear as necessary because of the continuous degradation of the buildings.

In general, there are two main ways of intervention: (i) transformation of the building in correspondence with the new necessities and (ii) keeping the old building almost unchanged operating the minimum necessary transformations and adding new units to the construction. We practically meet both of them.

As concern the correctness of an intervention it is not easy to make a right judgement. There are so many criteria to be taken into account like functionality, structural conformation, the quality of materials put in work, details of architectural appearing, harmonizing with the surrounding environment etc., that every case has to be studied separately. However, there exist some principles regarding interventions on buildings and built areas that can be considered as quasi-available like:

- to establish the different stages of the construction;
- to determine the technical state (Bucur-Horváth 2001b) for every part of the building to be transformed;
- to maintain as much as possible the original structural form performing the necessary reparations;
- the material and technique for reparations has to be compatible with the original one;
- to maintain as much as possible the original architectural signs as concern proportions; interior organization of the space, facades, interior and exterior decorations;
- to make interior transformation when the change in use or the precarious technical state requires it, taking into account the reliability requirements related to structural safety and serviceability;
- the added structures and structural elements have to be with appropriate degrees of reliability.

3 CHARACTERISTICS OF THE STUDIED EPOCH

The representative historical buildings we have studied belong to a historical period embracing 18th until the beginning of the 20th century. In Middle and Middle-Eastern Europe the first period of it (1700-1800) is the time of Baroque that appeared sometimes earlier (1600-1650) in South and Western Europe. This new style was used at first in church constructions as a mean of the Catholic Church for counter-reformation. On the other side, the opening scientific world of the 17th century (marked by names like Kepler and Galilei, Descartes and Spinoza, Leibnitz and Newton) required something new, changeable and dynamic in all the fields of activity, so also in

constructions. The Baroque composition appears as an organic unity of composing elements each with its own well defined role. The idea of movement and decoration binds in an inseparable union the structural, sculptural and painting elements. As concern the baroque buildings in Transylvania (Romania) there are: palaces and small palaces of the aristocracy and the big bourgeoisie, churches of the Catholic counter-reformation and that of the Unitarian Church, buildings of civil interest of the communities and houses of the middle-class and petty bourgeoisie. While the churches and palaces were only repaired and rehabilitated during the time without major modifications, the public and residential buildings have suffered a lot of transformations in according with the changing functional necessities. We refer to these buildings.

The Baroque era was followed by a much multicolored epoch in the domain of the constructions (1800-1900) characterized by a turning back to the past, to the classical antique and generally to historical epochs. This tendency could be a result of the researching spirit of the 19th century, time of historical and archeological researches. The time of neo-classicism and many other neo-styles, i.e. the Eclectic era has come. At the same time, the new materials and technologies put in practice during the 19th century (iron, steel and reinforced concrete) developed the Eclectic architecture also to a structural branch having regard for the material and sincerity in expression. The cavalcade of the Eclectic was interrupted by the Secession at the beginning of the 20th century.

4 METHODOLOGY OF IDENTIFYING THE BUILDING STAGES

In order to identify the parts of a construction built at different times two main things are required. At first, a careful examination of the structure identifying functional changes, added parts, former repairs, materials, structural subassemblies, decorations, architectural details. This examination has to be seconded by a study of documents (original project, old technical books) if they exist. Secondly, one has to know the dominant characteristics of the historical periods passed by the examined building through.

Studies on the history of architecture (Bucur-Horváth 1995), the examination of many historical civil constructions belonging to the mentioned period (Bucur-Horváth et al. 2000a,b, 2001a,b, 2004, Bucur-Horváth and György 2003) and studies on old technical literature (Wanderley 1885) permitted us to establish those structural and architectural characteristics that may constitute a grid for identification of the different stages of intervention on a building.

Concerning the buildings of the Baroque and of the Eclectic the conclusions of these researches are contained and illustrated in the Table 1 and Table 2 respectively.

Table 1: Building characteristics for Baroque (1650-1800)

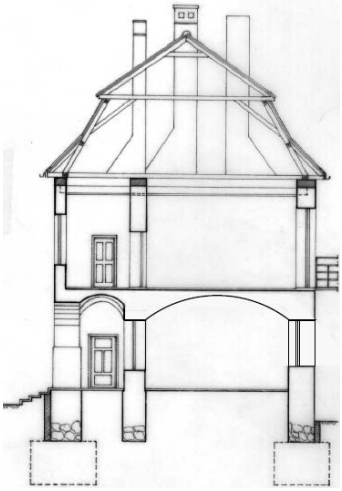
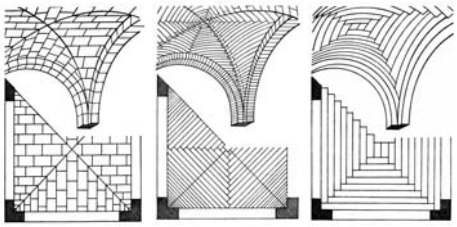
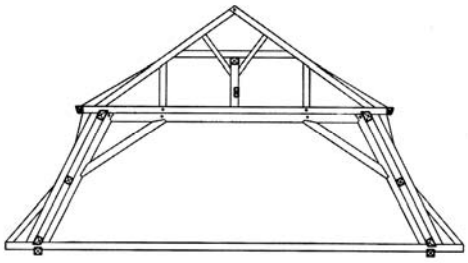
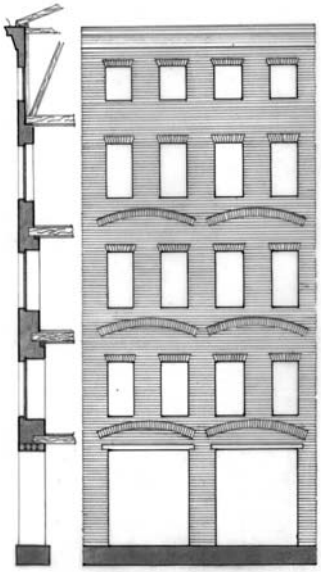
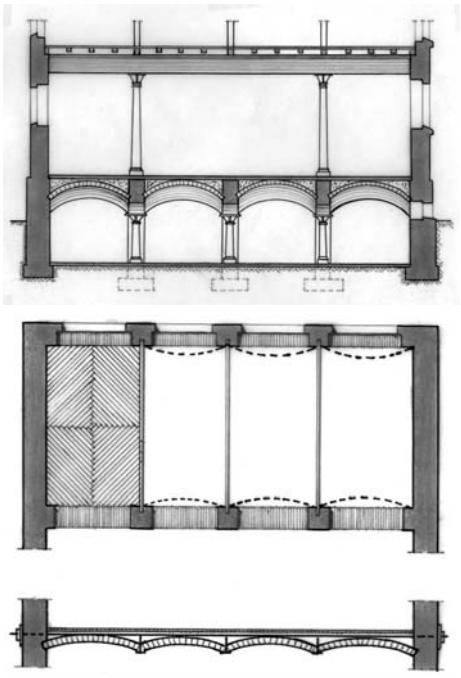
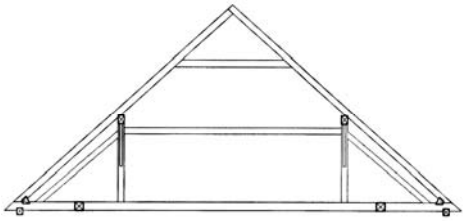
Structural element	Material	Illustration
Foundation made of stones	Cobble and rubble stone without mortar (dry masonry)or with low-resistant mortar of lime or/and clay	 School building – cross-section
Vertical supporting structure: masonry walls and pillars	Full bricks of various dimensions (150 x 80 x 50, 200 x 100 x 55, 300 x 150 x 65 etc.); Stone of various dimensions; Lime based structural mortar	 Bohemian masonry vault – Banffy palace
Horizontal structure: - masonry vaults of different forms (cylindrical-, cross-, cloister-, elliptical or Bohemian vault) - wooden floor	Full bricks of various dimensions (150 x 80 x 50, 200 x 100 x 55, 250 x 130 x 60 etc.) in different mode of weaving (cooper's mode, in circular layers or in swallow-tail); Lime based structural mortar eventually with additives like pozzolana, trass or brick powder; Sawn timber: timber beams, ceiling battens, ceiling boards	 Weaving techniques of cross-vaults
Roof structure: Specific two-sloped mansard-type roof	Carpenter work consisting in transversal main and secondary timber trusses and longitudinal bracing frames	 Baroque main truss for roof

Table 2 : Building characteristics for Eclectic

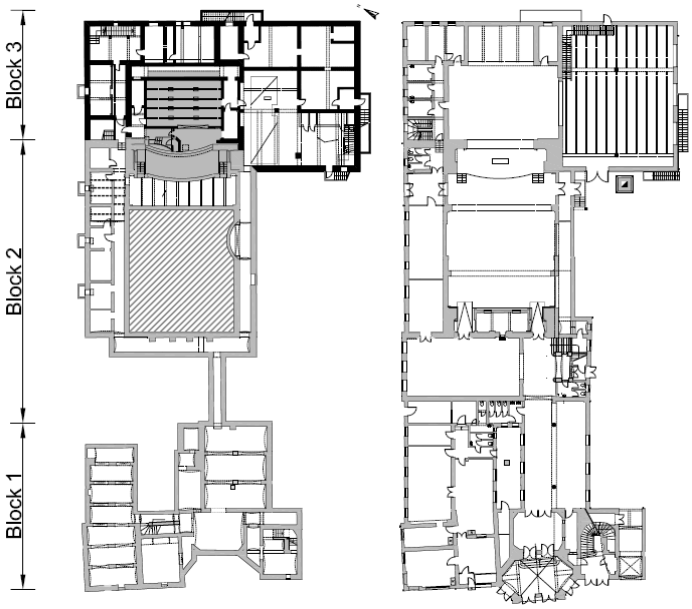
Structural element	Material	Illustration
Foundations of stone and concrete	Cobble and rubble stone with mortar of cement and lime or cement, structural concrete	 Multi-storied building with discharging arches in façade
Vertical supporting structure: - masonry walls, - discharging arch systems, - pillars	Full bricks of various dimensions (150 x 80 x 50, 200 x 100 x 55, 250 x 130 x 60, 300 x 150 x 65 etc.); Cement based structural mortar; Cast iron and wrought iron Forged steel and rolled steel	
Horizontal structure: - masonry vaults at the level of the basement or cellar, - slabs of small brick vaults for upper stories with iron or steel beams for the upper levels - coved (or mirror) vault with marginal half-barrels and plane or cloister vault panel - wooden floor	Full bricks of various dimensions (150 x 80 x 50, 200 x 100 x 55, 250 x 130 x 60, 300 x 150 x 65 etc.) in different mode of weaving (cooper's mode, in circular layers or in swallow-tail); Cement based structural mortar; Cast iron and wrought iron; Forged steel and rolled steel; Swallow-tailed full bricks for flattened cloister vault of the panel Reinforced mortar Timber beams, ceiling battens and ceiling boards;	 Bohemian vaults and small brick vaults supported by iron pillars
Roof structure: - Specific eclectic roof structure structures - Iron or steel roof - Cupola	Carpenter work consisting in transversal main and secondary timber trusses and longitudinal bracing frames; Iron and steel Reinforced concrete	 Eclectic main truss for roof

5 EXAMPLES OF REPRESENTATIVE CASES

5.1 Theater of Turda (Romania)

The building of the actual theater (Fig. 1) was built in several stages (Fig. 2). The first part, built as an inn, was erected on the basement of another older house at the end of the 18th century. This fact is proved by the obvious reconstruction of the masonry vaults of the basement. The original style identified by the constructive elements is the Baroque. Afterwards, between 1902 and 1910 was added the second part consisting in a joining part to the first one and a great hall. The building became a casino, namely a multifunctional space for cultural, entertainment and commercial activities. In this part of the building the elements of Eclectic architecture can be identified.

Figure 1: Façade of the Theater of Turda



(a) (b)

Figure 2 : (a) Basement floor and (b) Ground floor plan

The foundations are of stone and concrete. The vertical supporting structure consists in masonry walls. The great hall of the height of ground and first floor is covered by a mirror vault (Fig. 3) on a rectangular plan of 14 x 18 m, consisting in half-barrels on perimeter joined by a central plane panel. This vault is built of reinforced mortar with a thickness of 20 cm and is supported by the peripheral walls. At the same time the central panel of the vault is hanged on the roof

structure by means of metallic bars embedded in the shell. The structure of the roof is a characteristic

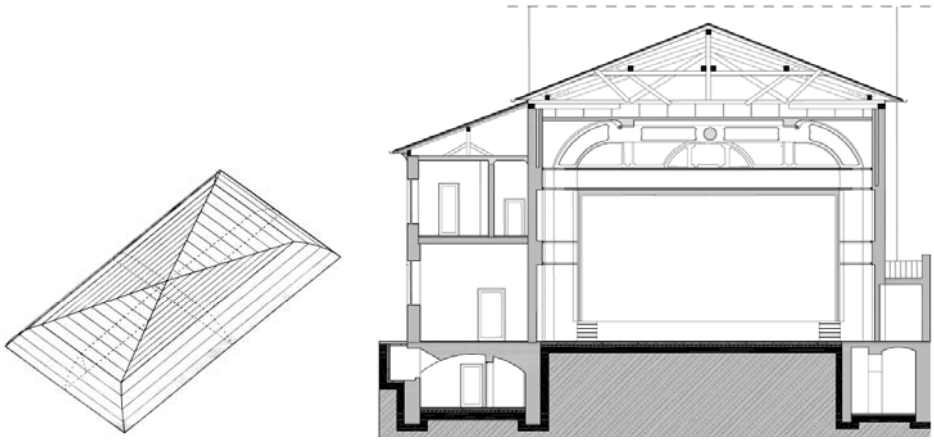


Figure 3 : Mirror vault over the public hall – 3D sketch and cross-section

one for the Eclectic. It is to be mentioned that when the electricity was introduced in the building, in the twenties the public hall was provided with two great candelabra. They were hanged on the roof structure and modifications and strengthening of the roof structure were made at that time. After the second war the public hall has served as cinema until the fifties. In 1956 began the third stage of the construction and the third block consisting in the stage building and a wring for storage and workrooms was added. The structure of this part is of reinforced concrete and metallic frame and slab systems.

The technical state was separately determined for each block. The very bad technical state of the first block led to the proposition of demolishing it, but maintaining the original façade. Behind it a proper functional organization of the space in a new structure was proposed. The most valuable part of the structure of the public hall shall be rehabilitated. General repairing is needed for the third block.

5.2 The Summer Playhouse of Cluj

Today it is used as the Hungarian Theater and Opera House. It was built in 1909-1910 as a nice neo-classical ensemble (Fig. 4) destined for operetta, comedy performances as well as for social events. The building is composed of several blocks corresponding to the classical organization of the space for the required function at that time (Fig. 5). The main block is that of the public hall on a circular plan covered with a spherical cupola of reinforced concrete, surrounded by a circular corridor under the dress circle also covered by a reinforced concrete thin shell. The stage building arises behind the public hall, followed by the block for storage and cloakrooms. The most interesting part of the structure is the reinforced concrete cupola. It seems to be the very first reinforced concrete dome in the world, a large, 28.50 m spanned cupola with a peripheral ring supported by vertical walls. An original cross section (Fig. 6) put into evidence the double-layered cupola and the another thin shell of tore surface as well. Drawings of the original project were found in the Széchenyi Library in Budapest.

In 1959 from functional reasons the old staircases and the entrance hall were demolished and a larger entrance hall with large interior staircases was added. The two lateral pavilions were also demolished. A timber structure supporting the new covering was placed over the dome and the central tambour was built in (Fig. 7).

A study on the structural safety and serviceability of the building put into evidence the good quality of the old structural elements. The ensemble was initially very well conceived from both, structural and architectural point of view. But it was also emphasized, that the external look of the ensemble was badly influenced by the false raising of the profile of the dome. At the same time, the architecture of the front side has suffered essentially. The study proposed improvement measures for these problems.

Figure 4 : The Playhouse in its original form

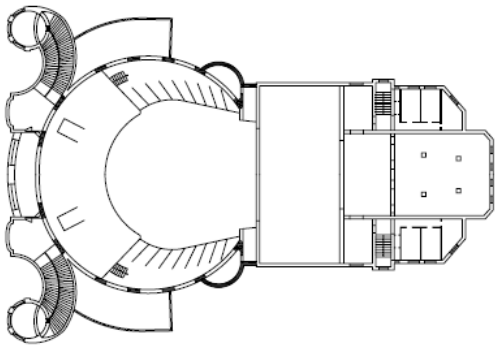


Figure 5 : Plan of the theater – original project

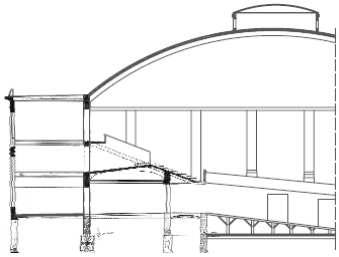


Figure 6 : Partial cross-section – original project

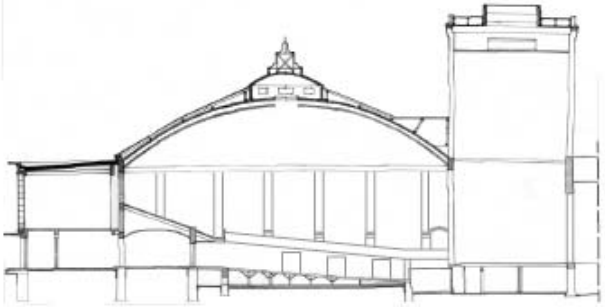


Figure 7 : Cross section by the transformed building

6 CONCLUSIONS

Theoretical and practical researches led to principles to be followed and recommendations on the mode of treating the problem of historical constructions built in several stages. It seems to be very important to identify these stages in order to perform a correct research on the structural safety and serviceability of the building.

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