MODERNIZATION OF MODERN BUILDINGS – CASE STUDY ON THE MAIN BUILDING OF SZÉCHENYI ISTVÁN UNIVERSITY IN GYŐR

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Received 13 May 2009; accepted 4 September 2009

Abstract: This paper presents a case study on a building, which was designed in the influence of the New Brutalism in the 1970s. At first the origin, the concept and the values of the building are revealed, then several experts’ opinion are summarized about its problems emphasizing the necessity of the frontal modernization. From the description of the designed modernization it is visible how the house will be able to fulfill the recent functional and energetic requirements.

Keywords: Façade modernization, Building analysis, New Brutalism

1. Old and new tasks for tomorrow

In the twentieth century a lot of trends of modernism emerged. After the turn of the century a completely new direction seems to advance on non-aesthetic basis, which is called as sustainable design. In the last decades the world’s attitude greatly changed about the energy efficiency of buildings causing this new approach of design. Sustainability is a very complex concept, which came from economics, but nowadays it has got also a social and environmental meaning. According to the usual definition sustainability aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but in the indefinite future, too [1].

In the architectural practice new houses are usually built based on much stricter energy aware aspect having a high level of comfort and low maintenance costs. These features are also welcomed at older buildings. Because of these strong requirements building modernization is getting to be more and more important and frequent task today. In order to increase the energy efficiency of existing buildings difficult
conversions are needed with a lot of trouble. Such problems can be solved only by means of good architectural and structural designing. The physical survival of the buildings can be ensured with their precise renovations besides the spiritual worth, hidden and coded in materials, in spaces, in masses, in forms [2]. This is especially true in the cases of great existing buildings, because the strong architectural works do not allow to be modified them. The main question of modernization is: How is it possible to save the spirit of a great building after conversion [3]?

In the field of sustainable architecture there are two types of works: new design or redesign of existing buildings. Designing a new building architects have to satisfy indispensable strict demands according to the actual standards. Usually an existing building cannot fulfill these actual standards so the designers also have the task to determine which features of the building should be improved in which rate. In this view the protected old, historical monuments have moderated demands also in laws and in standards. For modernizing a not protected building the requirements of energy and cost efficiency are quite as strong as at a new building.

There are a lot of great masterpieces among the not protected buildings waiting for modernization. The products of modernism are in a special situation. They were made in an architectural age in which structural knowledge increased as never before. The static exploitation of bearing structures reached the extremity. Bearing and dividing structures started to be separated. More and more layers were built in structures having different functions. These changes caused that some modern buildings don’t have so good energy efficiency than the former built ones. The modernization of these buildings will be a very important and interesting object for the architects.

2. Subject of this case study

The examined building is the former Technical College for Communications and Telecommunications, which was designed in 1969-74 and built in 1971-77. In 2001 the college became the Széchenyi István University in the same building (Fig. 1).

This building complex was the biggest educational investment of the decade in the country. In 1968 the Hungarian socialist government decided to establish a new college in Győr to centralize the education of communications. The appointed large and empty site beside the river Mosoni-Danube, near to the downtown had exceptionally good features for this complex. One of the major Hungarian architectural and engineering consulting companies, KÖZTI (Public Building Designer Company) was commissioned to design this project (leading architect: Miklós Hofer, co-architect: Ildikó Halmányi, structural engineer: Kálmán Z. Horváth, mechanical engineers: Antal Solymosi, András Hámori, Jánosné Pénz, Tibor Fröhlich, Csaba Lehoczky). The complex was built in a six-year long project by GYÁÉV, the regional state building company [4].

The building has a very strong concept and order expressing strictly the spirit of the architectural and historical age in which it was made. It was designed originally for 4 faculties, for about 1800 students and for about 280 instructors. Miklós Hofer preparing the design process made a scholarly program analysis in which he considered the communications and telecommunications as the most intensive developing technical sciences. Therefore the possibility of the expansion and the flexibility became his main
goals, as he considered the college as a permanently developing and changing organization where buildings were the spatial frames of the changing function [5]. In addition to this elevated aim the designs had to fit the building-trade of the socialist period, which preferred prefabricated large-sized elements in construction.

According to these principles Miklós Hofer created a functional and (mega)structural composition in which high dual towers were made for non variable, vertical functions and 18 m spread slabs were made as bridges between the towers for variable spaces: seminar rooms and offices. The house was formed with four similar units, because it was originally made for four faculties. In each unit the different functions are separated into different levels resulting a terraced cross-section where auditoriums are on the first floor, seminar rooms are on the second and third floors and offices on the other ones.

The construction of this composition was easy using a three dimensional modular system in which the floor plan modules, the width of a vertical block (6.00 m) and the width of a floor-panel (2.40 m), were complemented with a vertical module, the height of a step (0.17 m). This system was also favorable for the application of prefabricated concrete panels, modular steel windows and aluminum curtain walls. Structures are strongly emphasized in the visual image of the house. Movements of masses and structural units give a deep plasticity of the façades on which the concrete elements appeared with several different surfaces: plain, demolished-ribbed and graveled concrete surfaces can be also found [4].

Understanding the principles of the building composition it is acceptable that this building is important in the Hungarian architecture history. It is classifiable as a masterpiece of the movement of New Brutalism. This style emerged mainly based on Le Corbusier’s life-work in England in the years of 1950s and 1960s. He liked using crudely shuttered, monolithic concrete structures outside of his buildings. Sometimes he used this material as a sculptor created interesting forms as he did in Chandigarh or on
the terrace floor of the Unité d’Habitation in Marseille. Later Le Corbusier’s principles returned in England, where Alison and Peter Smithson became the leading advocates of the new movement [6]. In 1966 the architectural critic Reyner Banham described the purposes of the new style as follows [7]:

- the building was a unified, clear and memorable visual image;
- the building exhibited its structures clearly;
- raw, untreated materials got high valuation at the design.

Other architects can also be associated with Brutalism as Ernő Goldfinger, Denys Lasdun, Louis Kahn, John Andrews, Ralph Rapson and Paul Rudolph. The last one designed the Yale University Art and Architecture Building in 1958, which was a pioneer work of a special branch of Brutalism called Campus Brutalism (Fig. 2). In the late 1960s many architect designed university buildings in this style in the world, especially in North America [8]. The campus of the Széchenyi István University is one of these interesting works.

![Fig. 2. Paul Rudolph: Yale Art and Architecture Building, New Haven, Connecticut, USA (1958-63) [9]](image1)

![Fig. 3. Ernő Goldfinger: Trellick Tower, a 31-storey block of flats, London, England (1966-72) [10]](image2)

Miklós Hofer could get first hand experiences about the principles of New Brutalism in 1962-63 working in London in the architect studio of Ernő Goldfinger who was an important creator of the movement as mentioned before (Fig. 3) [11]. Hofer formed the college buildings with this kind of thinking. His most important architectural design intent for the educational building was to introduce the enormous structure openly, almost brutally [4]. The intent became truth and the concrete structures expressed this brutal aesthetics well. Therefore people usually find the university buildings unfriendly but the profession acknowledged the worth of this design and Miklós Hofer was awarded with the most significant Hungarian architectural tribute, Ybl Prize in 1978 [12].
3. Necessity of modernization

The possibility of the expansion and the flexibility were the main elements of the concept from the beginning so changing of the building was an accepted necessity by designers. They thought about the college building as a complex of structures ordered in a hierarchy, which had three levels according to the moral lifetime of elements. The bearing structures give the primer level. They should work all over the whole lifetime. The separation walls, windows and doors, some mechanical systems belong to the second category. Their estimated lifetime is about 40 or 50 years. Some other elements like coverings, mechanical equipments and furniture are ranged in the third category, because their lifetime is often only about 10 or 20 years [13].

By now the university building is almost 40 years old so the revision of the structures and the modernization is surely needed at least related to the secondary and the tertiary categories. Seeing this situation the Management of the University decided to take the preliminary steps to modernization.

Management commissioned a preparing study, which examined the condition of the building and its service systems. The team including some members of many consulting companies not only evaluated the building and suggested some way of the conversation, which can improve the cost efficiency of the building [14]. According to the study the service systems are considerably outdated and they are not able to satisfy the changed demands properly. Therefore the study suggested changing almost all service networks, planting a gas engine to generate heat and electricity and an oil engine as an emergency energy source. But to reduce the maintenance cost the modernization of mechanical equipments is not enough, the energy wasting structures of the house should be also converted because the way of energy saving is dual: the new service systems will use less primary energy with better efficiency and the produced fewer secondary energy will be saved by the improved thermal shell of the building. This also means that building conversion should be performed before the modernization of the services.

Based on the recommendations of the comprehensive study including chapters about functionality, building constructions [15], [16], [17], mechanical and electrical engineering [14] and fire protection [18] University Management ordered the architectural plans of frontal modernization. This design process is in the phase of permission at the writing of this article.

4. Practical aspects of modernization

In the near future architectural design should react to several different practical problems caused by the radically changed requirements and degradation. The designed solutions of the building structures are equal to the standard of the 1970s and the quality of the execution was almost average. These circumstances and the destructive impact of decades resulted to the actual problematic condition of the building [15]. The following description shortly summarizes all the most important aspects revealed by the preparing studies of needed modernization of the whole educational building.
Frontal concrete structures: By now several damages of the uncovered concrete structures are noticeable on the façades. Usually these have two kinds of origin. First one is a structural feature: cracks are occurred between the panels due to the diverse movements of the long-span floor panels. The other one is an executing feature, because of some reasons, for example the poor quality of concrete, the thin concrete cover on steels or the planned demolition of the ribbed concrete surfaces, the reinforcements could start corroding and threw the concrete cover helping further rusting and so endangering the load-bearing structures. Therefore it would be important to make a revision of concrete panels and their joints to prepare the resurface [15].

Flat roofs waterproofing: Originally the flat roofs were waterproofed with bituminous felts; the terrace roofs were designed with artificial stone covering. The latter one has been never carried out in such a way, so the terrace roofs are not walkable, even until now. Because of the unprofessional execution of waterproofing the flat roofs often leaked therefore some roofs had to be renewed. That time PVC felts were used. The concerning study reported several problems about roofs: some membranes were hurt, some drain-traps were narrow, some of them were plugged up, some roofs had only one drain-trap, some conduit-pipes were leaded outside of the façade, at the terraces the doorsills were low, evidences of leaks were visible in several places in the building [15].

Heat insulation: According to the thermo-graphic examination the temperature of the external surfaces are high [16] and the whole façade shows almost homogeneously, significant heat losing [15] (Fig. 4). This observation is easily understandable, because the monolith concrete walls, the prefabricated parapet panels and the flat roofs have only 3-5 cm polystyrene foam heat insulation. Moreover the heat insulation of the walls is in the internal side of the structures because of the high valuation of clearly visible materials on the fronts. Naturally the internal heat insulation can’t create a continuous thermal shell, so the building structures have strong thermal bridges. If the buildings bounding structures were insulated in compliance with the current standard, approximately the 40% of the actual heat using would be saved [14]. Therefore the complete external heat insulation of the building is strongly recommended. This means
a consequent packing of the whole building, when the original concrete surfaces should be unfortunately covered. The very articulated façades have a lot of problematic details, where the covering won’t be easy. Such critic places are the attics, the slots between the building units, the arched artificial stone footing panels and the window mountings.

Windows and doors: The brutal aesthetic of this building is based on the harmony of the concrete, steel and glass, so glassing is an important architectural instrument of the house. The 53% part of the whole frontal surfaces is glassed [17]. On the fronts of the building there are four types of window. The assembly hall has glass walls with extreme big glassing. The elevator halls have aluminum curtain walls. The staircases and the toilets in the vertical blocks have profile glass walls in steel frames. The seminar rooms and the offices have steel framed windows. The heat insulation of these window structures is poor, as proved by the thermo-graphic photos [16], because their framing is not insulated. Due to some errors in the gaskets the double glassing often lost the gas load so vapor and dirt could get between the glasses resulting opacification of the windows. The steel windows cannot be closed well, because they have not sealing between the window frame and the casement. In order to reduce the so occurred filtrating heat loss a part of the windows were fixed. Unfortunately other maintenance tasks, for example repainting and ordinary cleaning were not performed so the steel frames started corroding and the sloped glass surfaces got to be dirty. The windows of the seminar rooms and offices are designed with a special vertical section. The vertically pivoted windows above the parapet panels are continued with sloped glass roofs, which are criticized a lot. The always dirty and often leaking glass roofs have only aesthetical function - they give plasticity to the façade. Moreover by the mounting of the window structures thermal bridges are produced. Two different studies examined the possibilities of frontal modernization. The first one was made in 2002 by Attila Somfai and Gergely Molnárho [17]. They suggested only the replacement of windows in the original form without eliminating the thermal bridges and not heat insulating the concrete structures (Fig. 5a). The later study, made in 2008 by Oszkár Zádor thought in a complex façade modernization described two possible solutions [15]. The first one suggested supplying the concrete panels with heat insulation and insertion new flat windows in the newly generated surfaces (Fig. 5b). The other solution can be the
installation of a curtain wall in front of the existing fronts (Fig. 5c). But both study agreed in the following: the windows should have steel or aluminum structure, tilt and turn windows are welcome, it isn’t necessary to may open all windows, but the glasses should be able to be cleaned easily, southern windows should be shaded outside, designed solution should consider acoustic and fire-protecting aspects as well.

Shading: The main façade of the educational building faces exactly to south, this orientation occurs significant heat load in the rooms behind these fronts in the months of the summer. Currently the rooms can be shaded by using curtains and internal blinds and some offices are equipped with individual air-conditioning devices. The internal shading is not efficient and it makes darkness so the lights should be turned on for working. Air-conditioning and lighting increase the energy consumption of the house. Considering these aspects the southern windows should be designed with external shadowing [17].

Fig. 6. Modeled lights and shadows on the southern façade in three different days of the year and the most favorable fronts for energy producing, signed in the photo

Energy producing façade: First time Attila Somfai and Gergely Molnárka recommended installing equipments on the southern front to collect the energy of the sun. According to their paper photovoltaic panels can be used also to shade the windows fixed up above them nearly horizontally [17]. In this position solar cells are optimized to generate electricity in summer, when the energy using of the educational building isn’t intensive. Moreover the quasi-horizontal panels would be completely new and strong elements on the front. If vertical panels were used for example installed on the south front of the vertical blocks they would be optimized to the months of winter and would be fit in the facades (Fig. 6). Although the efficiency of the solar collectors is usually better then that of solar cells, using of this kind of equipments is not advisable, because the educational building isn’t a significant heat water user [14]. Unfortunately the suggestion for the frontal energy producing hasn’t been welcome by the University Management yet because the returns of this investment are quite unsure.

Acoustics: The building has acoustic problems making difficult the study in the seminar rooms and the work in the offices. Internal noises can be heard through the walls because the separation walls are not able to insulate sounds enough good and the long-
span floor panels even worsen this condition leading the voices over the walls. Nowadays external noises mean seasonal problems for example at the time of open-air programs, but in the front of the university a new road is planed, which will increase constantly the level of noise in the future. So the design of the frontal modernization should select such window structures, which have good acoustic parameters especially on the southern fronts, and can joint to the separation walls ensuring the sound proofing of the rooms.

*Fire protection:* The building is a busy, middle high public building suitable for staying a mass of people. In case of this kind of buildings the fire protecting requirements were always strict, but they became even stricter from the time of the building design so the existing building is not able to totally fulfill them without modernization. The needed arrangements, which can be listed into four categories described in details by an expert [18].

- Building structures should be made of fire-resistant materials. In this view partition walls, internal coverings, frontal structures including heat insulations, façade coverings and curtain walls as well and the installations of the building engineering are in the most critic position;
- The building has to be divided into four fire-sections. On the border of them the propagation of the fire should be inhibited with special structural design;
- The conditions of the safe escape at an emergency should be improved by installing alarm systems, transforming the exits and rebuilding the staircases to be smokeless;
- Operation area and emergency windows should be specified for fire-fighting and life-saving.

5. Architectural aspects of frontal modernization

The recently completed architectural design job focused on the frontal modernization of the educational building reacting all aforementioned practical aspects which were related to this part of the conversion (leading architect: Attila Bodrossy, Tamás Czigány, co-architect: Tamás Horváth, structural engineer: Péter Szabó, mechanical engineers: István Kovács, Attila Galambos, Pál Hornung). Architectural design had to find out solutions of the existing problems so that the architectural quality of the building would not be changed significantly. Therefore the main goal of the architectural redesign was to save the spirit of the building, which was possible if the way of the conversion had emphasized the original concept of the house. Keeping the following conceptual elements was the most important objects to reach this goal in the case of this building:

- to keep the contrast between vertical and horizontal functions, which appeared in the building as double towers and floors between them;
- to keep the visibility of the heaviness of elements, which are originally made of concrete, but they will be covered with the needed external heat insulation;

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• to keep the character of a building made of prefabricated panels having gaps between the elements;
• to keep the deep plasticity of the façade, which is given from the movements of masses, from the formation of the towers and from the double breaking of the windows vertical section.

This redesign of the house planed an exterior continuous thermal shell around the building. Different materials are used to insulate the structures considering the actual requirements of the situations. So the fronts are insulated with 10 cm mineral wool, because a fireproof material should be used there. On the terrace roofs 10 cm polyisocyanurate foam is used, because its thermal conductivity is better than that of the conventional heat insulating materials so it has the same heat insulation capacity with a less structural thickness. And the non-utilized flat roofs are insulated with 20 cm polystyrene foam. The bounding structures of the house are redesigned to fulfill the current requirements of the Hungarian decree with a big allowance. The over-fulfillment is about 120-140%. The heat insulation is uniform on each structure, so thermal bridges are eliminated.

Naturally the external heat insulation has to be covered. On the flat roofs this covering is given only by the new polyvinylchloride waterproofing, which has to be changed as complete system on all roofs, but the terrace roofs are also covered with concrete tiles to realize the original architectural intention: the walkable terrace.

Unfortunately the task doesn't allow preserving the concrete of the frontal structures as visible material so such covering should be selected which can give a similar impression as the fair-face concrete. The manufacture of new prefabricated concrete covering would be an ideal, but very expensive, solution of this problem so designers have to select a kind of light, thin frontal panel system. In the concerning expert’s opinion [15] two systems are suggested. In the first one the panels are made of resin bonded wood fiber-board and in the other one they are made of fiber-cement board. The latter one is a more brittle material than former one, but it has a better fire-resistance than the former one, so the application of it seems to be the favorable. According to the architectural goals of the facelift the panels are used in two different tones of grey to keep the contrast between the vertical and horizontal functions. The tones can intensify the visibility of the heaviness of the elements as well. Fiber-cement face work is mountable with smaller panels, so the gap image of the fronts will be denser than the original was. Therefore the fronts are designed using two types of gap: a normal thin gap and a stronger one to sign the levels of the floors (Fig. 7 and Fig. 8).

In the designed frontal modernization the window structures are completely renewed with aluminum framed windows and curtain wall structures. These up-to-date products will be able to radically reduce the heat loss of the building. The double breaking seminar room and office windows are removed in the plans, but to keep the plasticity of the façade the new window structures are mounted in a deep position over the around heat insulated parapet panels (Fig. 5d). The building has more fix windows than before because of some reasons of heat insulation and fire-protection. On the southern fronts the windows get external blinds as shading devices to protect the rooms from the heat of the summer sun. The acoustic parameters of the windows have not given yet. The detailed working out of these problems should be a part of the executing design.
6. Conclusion

The original buildings of the Széchenyi István University are almost 40 years old. The university is ready to develop: new buildings and the modernization of the existing buildings are also designed to satisfy the new functional demands. One of the most important demands is to improve the energy efficiency. Therefore the service systems of the building have to be quite completely reinstalled. But this step would be void of sense unless the modernization of the energy prodigal façades and roofs. The main question of the design of the frontal modernization, which could be based on several experts’ opinion, was: how it is possible to save the spirit of the building. Designers hope they could save the original character of the house after the frontal modernization.

As this case study shows nowadays the architects stand before a new and interesting job in which the buildings of the near past have to be modernized according to the recent requirements [19]. Some of these houses are obviously valued masterpieces but some others are criticized a lot. The buildings of the 60s and 70s, even seeing them ugly, are the cultural-social-technical products of their age, and they hide important information and lessons for the posterity [20]. Therefore it would be important to discuss the problems of this kind of modern buildings with wide publicity to find the right compromises in their modernizations.
Acknowledgements

The Author wants to give thanks to the Interdisciplinary Doctoral School of Engineering of the Széchenyi István University for supporting this research and to Anikó Müller for her unselfish assistance in the paper writing.

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