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The Construction of Church of the Taksiyarhis in Ayvalik: Structurally Problems and Intervention Techniques

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Abstract: In the present paper, the construction of the Church of Taksiyarhis in Ayvalık is investigated. The Taksiyarhis Church is one of the most important ancient buildings of Ayvalık. It is understood from an inscription in the wall that of the church was made in 1844. TaksiyarhisChurch is the largest church of Ayvalık and is treasured for its interior decoration, portraits of Saints and ancient reliefs picturing the life of Jesus Christ. Due to take place on a sloping hill road, was built on an area of slightly higher than that. Basilica-shaped church has a long rectangular plan. Western and eastern fronts are larger than the other fronts. Upper and lower walls of the church were built with cut stone masonry technique. On the outer walls of the church in the region was often used garlic stone obtained from Ayvalık region. Compared with other churches' exterior facades, church is very simple and modest. The exterior facade of church has been completely lost its originality. In 1924, the church became Monopoly Store and the icons on the walls were erased. The lack of maintenance for many years has determined causing serious damage to the structural elements and interior decoration. The damage is both on the main structure and interior space. Despite the damage, the church still retains some of the mural icons, such as Hz. Jesus, sacred meal, the crucifixion of Prophet, baptism and resurrection after death. Destruction has maintained despite the presence of iconostasis. The building, which is high as the other churches in the historical structure of Ayvalık, has got a city-crown quality, does play a significant role in the present structure silhouette, has played an effective role in forming the historical landscape of the town, shaping the structure around itself. The purpose of this study is to discuss the historical transformation the restoration proposals made for the building, which has been damaged since the exchange of population in 1925, the function has been changed but survived by itself until today, having an important place in our national cultural heritage. The current state of the construction has been documented by photographs, a 1/50 scale (surveying) and restoration projects have been prepared and restoration criteria are set with the data on hand. Thus, the repair recommendations to building construction have been proposed for sustainability of cultural heritage and its integration with restoration has been planned with our modern life to deliver it to posterity.

Key words: Ayvalık · Intervention Techniques · Restoration Protection · TaksiyarhisChurch

INTRODUCTION

Historical buildings are the most important aspects of city life and a major element affecting the general appearance of cities. For that reason, the study of the structure and material of the different architectural elements that form the main building integrity of a building is tackled from the perspective of a material scientific study, using intervention techniques.

In addition, in the case of structural intervention of historical buildings, we put special emphasis on the superimposition of materials in order to associate them with integrity together. The sequence of these layers and the kind of the materials contribute to the historical documentation of the building.

Now, the need of a new intervention on the building, to tidy up the structural system and protect the architectural elements which have deteriorated has been considered. The building is now is currently being restored and was originally the TaksiyarhisChurch of this city. Therefore, the Asmira Architectural Firm has requested a scientific report about the structural systems and architectural elements used in previous interventions for having a reference document and for taking the

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decisions in this new intervention. The methodology used for determining the systems and architectural elements used throughout its history, is shown in this article.

Intervention means that a concept that involves standards/norms regarding consolidation, repair and reshaping of structural and /or non-structural elements [1]. Recently, the restoration of ancient buildings has become a topic of interest within the wide-ranging debate on historical heritage as well as for the issues relating to their actual preservation.

Today, the reasons for this debate can be considered as the sum up of different issues:

Floors are structures and, in a restoration project they are often relegated to a secondary role;, floors are supports of "forms" and "decorations" that are considered of greater historical importance. Floors are made of wood, a material neglected in the 20th century and only vocationally thought as a substitute; by consequence, their use, enjoyment and visibility become limited.

However, in the past years, a renewed interest, especially in Italy has arisen confirmed by an increase of studies and research in the sector (historical, technologic, structural etc.) as well as by a considerable number of technical intervention proposals introducing the use of new materials and innovative technologies. The intervention techniques can been proposed with some justification such as the preservation of the original function, to that of "safeguard", preservation of the object image deprived of its supporting functions, by an increase of the working loads, or for security reasons (true or presumed), static adjustments (necessary or presumed) [2].

With this preamble, the aim of this paper is to evaluate historical structure of Taksiyarhis Church and after, in a real case, is to offer an alternative techniques to the restoration currently in use, whose durability and efficiency in the sense of historical heritage are still the object of debate and to contribute to its durability and efficiency in the sustainability meaning of historical heritage.

METARIALS and METHODS

The methodology developed for studying this building can be outlined in the following stages:

- Characteristics of the building intended use (architectural constrains, original occupancy of the building, building structure, technical equipment's within the building, etc.).
- Building safety as a response to daily activities, mainly related to structural vulnerability, vulnerability of non-structural elements, appliances or /and equipment).

Intervention Solutions and Criteria for Repair and Strengthened & Rehabilitation of Construction: Traditional techniques and materials are preferred of old building aggregates. However, modern techniques and materials, which offer substantial conservation benefits, may sometimes be also appropriate. Restoration and reconstruction should reveal significant cultural aspects of the place. Restoration is appropriate if there is sufficient of an earlier state of the fabric.

Demolition of significant fabric of a place is generally not acceptable. In some cases minor demolition may be appropriate as part of conservation. Removed significant fabric should be reinstated when circumstances permit [3]. Intervention efforts are responsible to ensure acceptable structural safety conditions. This effort requires theoretically and experimental studies.

The Repair and Strengthening Design Process: Even though the main aim of this work package is the reviewing of intervention strategies, some basic principles on current approaches to damage assessment and definition of vulnerabilities of structural types will be cited for completeness.

Criteria of Repair and Strengthening: Each country or governmental area should establish its own criteria and regulations as the minimum standard for repair and strengthening projects. For selected projects such as historical structures the designer may have to use criteria in excess of the established ones, based on the particular circumstances regarding the Project. The designer may also have established criteria or method to assign strength values to traditional materials.

Structural Investigations: During the preliminary investigation, the information about design, drawings, specifications, construction details, data on construction, material strengths, foundation and soil condition data, previous repairs and alterations must be gathered.

Documents regarding to original construction that this includes the design, drawings, construction details, data on original construction material strength, foundation and soil condition data, previous repairs and alterations are prepared. The information gathered should be compared with the actual structure to confirm that it was built in conformance with that information. Deviations should be noted and recorded.

Completion of the detailed site inspection is an essential and important phase in the process of designing repair and strengthening measures. Damage due to seismic forces most often appear in structural elements as columns, shear and infill walls, beams, beam-column joints, floor slabs and the connection between floors and walls and foundations.

Each structural member must be inspected and the damage must be recorded, sketched and photographed.

Damage Evaluation and Selection of Repair and Strengthening Solution: The designer must typically evaluate the damage; to develop alternative schemes to repair and/or strength structure. These alternative schemes must be evaluated and the most appropriate solution should be selected.

The engineer must first search the damaged structure and thoroughly understand the causes of damage occurrence. Calculations must be performed in order to evaluate the existing strength and stiffness of the damaged structure. The decision of the need to strengthen the structure will generally follow these analyses.

Conclusively, in order to select one solution for implementation, the feasibility evaluation of alternative solutions must include the following aspects:

- Compatibility of with the functional requirements of the structure,
- Feasibility of construction, including availability of materials, construction equipment and personnel with specialized training and the ability of implement the solution
- Economical consideration
- Sociological consideration
- Aesthetic

Restoration of Historic Buildings: Restoration was in the past reserved to monumental buildings. Restorers were few experienced professionals who took care for years and sometime for their professional life of the same monument or group of monuments.

In the recent years, the analytical models have been developed. For this reason, stone was protected as well as steel and wood.

Protectionist approach must contain responsible behavior to “conservative” design criteria to ensure acceptable structural safety conditions of existing historic constructions. For this, it is necessary to analyze as theoretically and experimentally studies. These studies contain structural robustness of building and interventions that were made prior and after, in order to avoid over-designing approaches. Intervention criteria are durability, compatibility and repair/strengthening.

Each intervention should, as far as possible, respect the original concept and construction techniques.
Structural intervention, conservation and structural restoration of architectural heritage were recommended for Taksiyarhis Church.

Case Study: the Proposal to Structural Intervention for Taksiyarhis Church: The Taksiyarhis Church constitutes an historical heritage of considerable historical as well as artistic interest. Its primordial nucleus dates from the XVII century. In this case study, the construction of the timber structures is particularly significant both for the great number of timber column realized.

Although the total area of the church is 1200 m2, the church was built on an area of 500 m2.

The purpose of the study is to discuss the repairing proposals of Taksiyarhis Church's that is used as Monopoly warehouse after cross-country exchange between 1923-1924 years. Church is one of the best-preserved examples of countries. In this regard, prepared on-site survey and comprehensive review of the structure's current situation was photographed the data obtained with the restoration criteria have been determined. With this study, it is aimed contemporary structure will integrate to future generations and will contribute to people in the region.

Taksiyarhis Church where is in İsmet Pasha Neighborhood is located in the center of Ayvalık. Church is 16 meters in height; the bell tower is 30.00 meters in heights. Church is 22.00 meters in length, is 12.75 meters in width.

It is entered to church courtyard by an arched doorway supported by two columns with seven digits. The bell tower on the door that is the original structure of building does not available today. The garlic stones have been used in columns and stairs constructions. Entrance gates and iron works are the original workmanship.

Entrance doors to the church were changed later. Exterior facade is very simple and modest character compared to other churches. Upper and lower walls of the church were built with cut stone masonry technique. Vaults, domes and arches are made of lath and plaster technique. Stairs and window arches and stucco is the cornerstone of the traditional garlic.

Bell tower that collapsed is made of brick material. The use of brick material is observed partly in vaults, domes and arches. On the outer walls of the church, garlic stone that is regional material is often used [4]. The church's roof is sloping roof to four sides. Taksiyarhis used as Monopoly storage after exchange of populations between Turks and Greek between the years of 1923-1925, then it was emptied and the church has been protected by the decision of the High Council of Monuments. The purpose of the study; is to discuss the historical transformation and of the repair recommendations of Taksiyarhis Church, to integrate with contemporary life and to contribute to future generations.

All repair and strengthening suggestions was made considering 1964 "Venice Charter". According to Venedik Charter, restoration should be contain archaeological and historical researches, it must should be contributions belonging to different periods, missing parts and sections should be merged that in way it will not cause misunderstandings [5].

Construction System: Taksiyarhis Church shown in Figure 1 is masonry structure with stone and timber frame system, approximately 11:40 X 20.65 m.It is 3.84 m in height and a total height is 11.65 meters 2-storeybuilding. Outer wall thicknesses is 65 to 75 cm. Wood column diameter is 42 cm, height is 4.7 meters.

Structure of the roof section has been formed on wood columns; wood columns vault and wrought iron are secured together with tie rods.

In original structure, in the outer part of the building, it is seen that vertical column is formed by connecting with each other via belts. However, in present case, as shown in Figure 3, outer wall is formed as masonry wall with the filling between vertical columns and arches.

Present Situation of Structural System and Repair Recommendations

Building Foundation: As shown in Figure 2, the stone walls were examined by opening the observations pits at various points.

As a result of ground surveys, it is observed that andesite material around the area. It is stated that floor safety tension = 2.0 kg/cm2, characteristic spectrum periods TA = 0.15 sec. TB = 0.40 sec. In light of this information, the floor group B1 - Z2 is defined as local ground class.

In the survey, the obvious damage was not observed in depth of 1.1 meters of classic stone wall footings. Considering that wear out over time of the

Fig. 1: Masonry walls in the lower floor formed later

Fig. 2: Foundation of Stone Wall

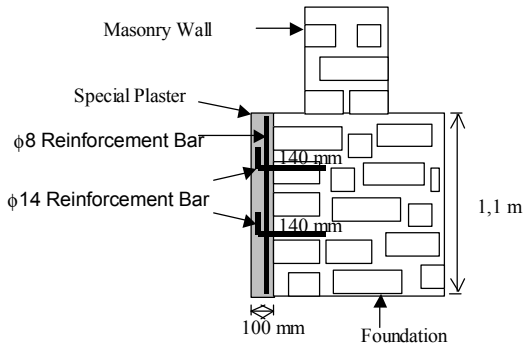

Fig. 3: Special Plaster Mesh Steel Reinforced that is proposed for building foundation implementation

binding mortar, it is thought that reinforcedwith wire mesh -reinforced plaster of stone foundation will contribute to earthquake behaviors of the top structure.As shown in Figure 3, special plaster wire mesh reinforcement is recommended for administration

- Opening up building foundation in width of 1.1m. along the perimeter of the structure

- Basically, in both directions (horizontal and vertical) with intervals of 30 cm to the holes of the anchor rod 14 epoxy embedding to a depth of at least 14 cm,
- Basic depth and an for steel reinforcement mesh, placed on the thickness of at least 100 mm, while the share of rust is recommended to be at least 30 mm of plaster. Recommended 4 volumes of special plaster sand, 1 volume and 1 volume of cement will be made with a mixture of lime.

Masonry Walls: In original structure, the outer section on the vertical columns to each other masonry wall is constructed by connecting with belts.In present case, as shown in Figure 4, vertical columns and filling the spaces between the arches of the outer wall is formed as masonry wall altogether.

Cracks depending on the time were detected in the outer parts of stone walls. As seen Figure 5, in entrance of the building, on the top floor of the church roof, or during the repair, medium-grade a crack was detected.

Original slurry-like material under reduced pressure is recommended for cracks occurred in the outer parts of building. In the building entrance, the cause of the formation of cracks should be removed, before moderate cracks repair. Roof load on Cracks at the point of the junction of two perpendicular walls should be mitigated by using lower density materials such as with tile. Then, cracks must be repaired under reduced pressure with injection method.At the point of that the cracks width is 4 cm. periphery of the bearing wall elements should be expanded with rebuttal method. Texture, original stone-brick and mortar should be recreated with original manner.

Wooden Columns: In time, infestation and yeast occurred in wooden columns and in some parts of the timber frame.

As a result of roof damage, moisture, humidity and decay have occurred.As shown in Figure 6, it is seen that this damage was seen in advanced level especially in the embellished wood column.First of all, it is proposed to be replaced with new ones if timber ornamental plasters stucco decorations suffered particularly to insect damage. In addition, local repair is recommended for wood column that is located in sub-base parts of column.This join part that will be formed by the combination of local repair should be exhibit the desired behavior statically.

When exposed to large forces of wooden buildings, in the, the use of steel plate is generally recommended as traditional strengthening techniques. It is inevitable that the steel plates require maintenance and brings extra load to building in historical texture [6].For these reasons, carbon fiber is recommended to ensure continuity of wood fibers in the end region of the wood column. Thus, the pressure and the tensile strength increase.

Fig. 4: Gaps made filling with masonry walls between Vertical Columns and Arches

Fig. 5: Cracks on masonry wall

Fig. 6: Damaged Wood Columns

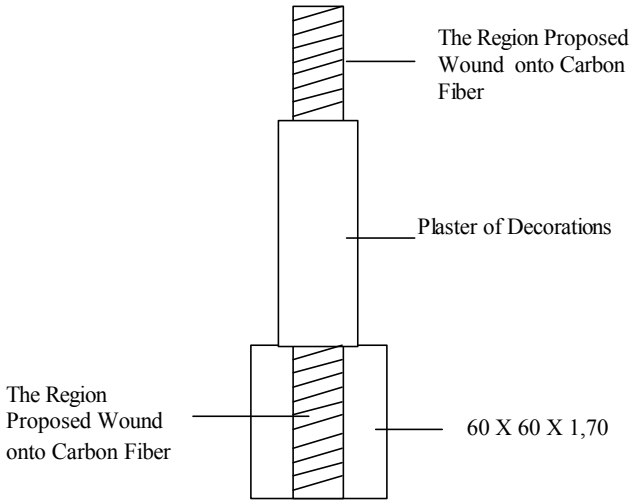

Fig. 7: Carbon Fiber Winding onto Wood Column with epoxy

In recent years, carbon fiber that was used in different sector such as aerospace and aviation industry and high-performance and high-speed aerodynamic loads exposed to racing cars, speed boats are used frequently in the structure of the elements in the rehabilitation.Carbon fiber strands are recommended due to their advantageous material structure, such as, mechanical strength of carbon fiber is very high, is resistance to corrosion, many years of maintenance-free, has the complex geometry, their shapes can easily be produced, their repair is simple, is light weight material. The biggest advantages of carbon fiber that one of the areas of their use are restoration and strengthening of wooden structures is resistance strength that can be obtained over strength that will be obtained with conventional methods [7].

During the repair, primarily, it is recommended that plaster base in the lower part of the colon should be open and colon end zone should be exposed. After spraying for mushrooms infestation, maintenance will be made the carbon fiber winding by epoxy method as shown in Figure 7. This method is similar to fret winding of vertical rebar of circular sectioned reinforced concrete columns.The burr-like particles will be cleared with surface cleaning powder in the section that carbon fiber will apply.The surface must be dry that application will be made to this surface.The epoxy resin should be saturated with brush after the preparation area that application will be made.Preformed carbon wood fiber is wound onto the column as shown in Figure 7. Epoxy resin will be applied again.The surface will be roughened before epoxy resin drying and will be ready for plaster restitution. In the central area of the column, the region that is completely covered with plaster is protected. Carbon fiber continuity will be ensured with repair between column ends and central region.

Carbon fiber in the end region of the column with the suggested repair, in the junction point of wooden columns and iron tie, the damage (corrosion and rot) will be prevented.

Wooden Beams: The worm infestation is observed on wooden beams. It is recommended that these beams are replaced with oven dried fibers without twigs. The wood beams should be prepared as to cut parallel to the wooden fiber direction.

Iron Braces: The iron braces in inner part of building among wooden columns, as shown in Figure 8, were exposed to corrosion due to moisture and humidity. The stained with a dye doped of iron braces is recommended after surface cleaning.

External Stairs: The wrought iron reinforcement, as shown in Figure 9, is exposed to severe corrosion in the external environment in the bottom of the stairs that was built as an arch.It is recommend that this arch-shaped staircase should be suspended and iron fittings replaced with wrought irons based on the same properties of wrought.

Roof: As shown in Figure 10, the damage on the roof structure has occurred. Over time, a portion of the roof was reconstructed, by ignoring the principles of restoration. Thus, the much more serious damage was prevented.

Fig. 8: Corroded Iron Braces

Fig. 9: Iron Reinforcement Heavy Corroded

Fig. 11: Status of the damaged roof

Fig. 10: Roof repair by ignoring restoration principles

However, the roof is unavailable before the restoration. (Figure 11). Removals of all roof tiles unoriginal, removal of renovated wood are necessary. In repair of removal parts, the wood in accordance with the original should be selected. Taking the necessary drainage precautions, roof tiles should be changed which is lighter than the current roof tile.In building elements not being able to be replaced, such as vaults, etc, carbon fiber is recommended that was recommended for the repair of wooden columns.

Taksiyarhis Church after Restoration: According to intervention method consisting structural system and building elements and ornaments that was proposed, the restoration of Taksiyarhis Church has been completed on site on December 2013. The preservation and restoration adapted methodology includes specifications for documentations, architectural drawings, material analyses, deterioration evaluation and finally proposed intervention technologies.

Assessing alternatives for strengthening of structure (traditional methods, new technology and intervention). Special features in historical studies are been evaluated, these include as bonding of structural materials, statically system, load-bearing walls, stone arches and ties.

With this framework, completed restoration of Taksiyarhis Church has been photographed in below.

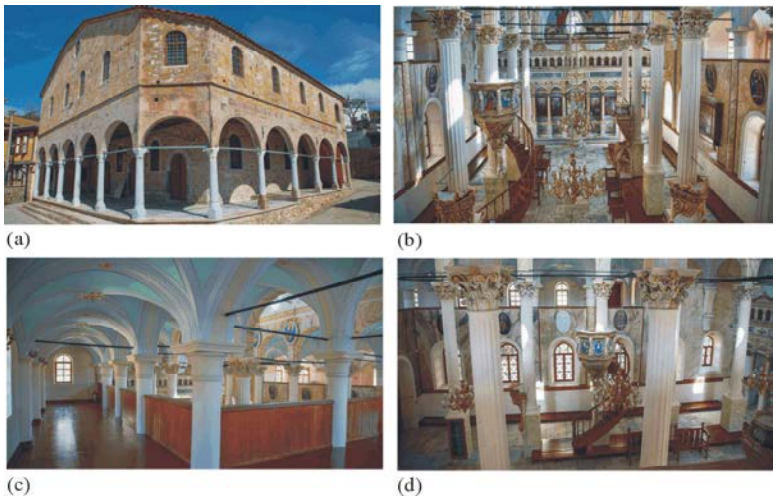

Fig. 12: Completed Restoration of Taksiyarhis Church

RESULTS AND DISCUSSION

As a result of the review and evaluation made in Taksiyarhis Church showed a successful performance under vertical loads from the date of construction. It was observed that there wasn't a significant crack and damage in structure. Although the historic building showed successful performance that was nearly 150-year period in earthquakes, building materials was deformed over time. For this reason, it is considered that the building wasn't providing constructive rules of today's.It is at risk under current horizontal loads.

The various structural defects were observed in the original construction of the church, such as, soft fold formation, interrupting of wooden vertical beams among stone walls at the height of the window level. According to DBYBHY (2007) the soft floor irregularities is strictly prohibited in the masonry building. The restoration decision belonging to these defects are thought to be extremely important that will be taken into account.

It is recommended that all of the wooden plaster ornaments under the stucco decorations should be removed by looking insect damage and to be replaced with the new ones.According to Restoration Board, the local repairs have been proposed if is not suitable for replacement of the entire timber element. For this reason, only the ornamental plaster should be removed.

It is recommended that all wood material used to build the church (columns, beams, roof and mezzanine floor elements, etc.) should be replaced with new ones having same features.

In the light of the restoration application in Taksiyarhis Church,it is expected that the building will behave much more successful against the forces that may affect structure compared the previous status of structure by the repair method recommended. However, it should be remembered that will be under a certain risk in the case of exposure of the load on the loads (high-magnitude earthquakes, extreme snow loads, etc).

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