

# STRUCTURAL ENGINEERING PERSPECTIVE ON HISTORIC BUILDING RESTORATION

BURCU BALABAN OKTEN<sup>1</sup>, MEHMET SELIM OKTEN<sup>2</sup>, CEM HAYDAROGLU<sup>3</sup>, and  
GIANMARIO BENZONI<sup>4</sup>

<sup>1</sup> Faculty of Architecture, Fatih Sultan Mehmet Waqf University, Istanbul, Turkey

<sup>2</sup> Faculty of Architecture, Mimar Sinan Fine Arts University, Istanbul, Turkey

<sup>3</sup> Arup, Istanbul, Turkey

<sup>4</sup> Dept of Structural Engineering, University of California San Diego, La Jolla,

The restoration of historic buildings requires a comprehensive approach through a collaborative effort, as well as multi-disciplinary professionals. According to the general conservative guidelines of the Venice Charter of 1964 and the ICOMOS/ISCARSAH Recommendations for the Analysis and Restoration of Structures of Architectural Heritage of 2003, structural engineers are responsible for repair and strengthening of these structures on the basis of principles of authenticity, reliability, compatibility, durability, reversibility, and monitorability. In restoration projects, engineers often face significant issues due to the intrinsic challenges of the projects themselves, as well as the complex level of interaction with other professionals involved. The main goal of this research project is the identification and evaluation of the most significant challenges encountered by structural engineers in restoration applications in Turkey. Data were obtained from semi-structured interviews with six professionals involved in restoration projects in Turkey. The sample group was chosen based on specific competences and involvement in different phases of restoration projects in order to gain different professional perspectives. The results revealed several issues from the early stages of the projects, such as a lack of records about previous interventions, a lack of standards and guidelines with respect to historic structures. The identification and evaluation of these issues is intended to raise awareness by the community as well as by the legislative authorities. In the future, dedicated legislative tools could facilitate the execution as well as the efficiency of these interventions, thus limiting subjective approaches.

*Keywords:* Historic heritage, Conservation, Project management, Repair and strengthening, Survey, Codes.

## 1 INTRODUCTION

Restoration projects have increasingly come to take part in building projects in Turkey. According to the T.R. Prime Ministry Directorate General of Foundations, 19,825 cultural properties of various foundations were digitally recorded in archives. Although the number of completed restoration projects was only 46 between 1998 and 2002, 3,363 projects were completed between 2002 and 2008.

Numerous applications of restoration projects reveal significant issues for professionals, generally composed of architects, art historians, restoration technicians,

material chemists and engineers. Although all professionals contribute to these projects, structural engineers are the only group who are responsible for repair and strengthening applications of historical structures in view of structural sufficiency and safety guidelines as determined by the legislative authorities.

Lourenço (2006) stresses that “conservation engineering requires a different approach and different skills from those employed in designing new construction” (p. KP05-2). According to Giannopoulos and Asteris (2011), “For an engineer, taking part in the restoration process of a historical structure, through the analysis of its structural system, means mainly to face the demanding task of equipping the historical structure with the capability to withstand future actions with the minimum possible amount of damage, while bearing in mind the characteristics and values which make this structure unique and worthy of special attention” (p. 82). As with many participants in restoration projects, structural engineers need to take into account general conservative guidelines such as the Venice Charter of 1964 and the ICOMOS/ISCARSAH Recommendations for the Analysis and Restoration of Structures of Architectural Heritage of 2003 as related to the principles of authenticity, reliability, compatibility, durability, reversibility and monitorability (D’Ayala 2014). Therefore, structural engineers need to perceive all these aspects, and it therefore appears critical to understand the challenges encountered by structural engineers in restoration applications.

The purpose of our paper is to identify and evaluate the common problems in restoration applications in Turkey from the perspective of structural engineers. The paper is organized as the following three sections. In Section 2, the methodology and characteristics of the interviewees are presented. More specifically, six professionals involved in restoration projects in Turkey were interviewed to obtain data. Then, the findings are identified and a brief discussion is reviewed in Section 3. Finally, the conclusion is summarized.

## **2 METHODOLOGY**

A qualitative research method has been chosen for this study. The interview method provides a closer look into subjects and allows the interviewers to interact with professionals deeply to understand and define research problem.

The professionals selected for the study include five civil engineers specializing in the structural engineering field and one architect working on a conservation committee. The architect was chosen because of his performance duty on a conservation committee. In Turkey, conservation committees do not appoint civil engineers as committee members. Convenience sampling was identified as a suitable sampling method for reaching professionals in different stages of restoration projects. The professionals were recruited through the researchers’ informal and formal contacts. Semi-structured interviews were conducted with civil engineers in different stages of restoration projects. The interviews were conducted by telephone between May and August 2015, in accordance with the professionals’ busy schedule. The interviews lasted between thirty minutes and one hour. All interviews were recorded and later transcribed. All data was kept in QSR NVivo 10 for collaborative study. Data were coded several times to determine common problems and solution recommendations. The characteristics of the interviewees are summarized in Table 1.

Table 1. Characteristics of the interviewees.

Interviewee	Position	Occupation	Int. Date
I-1	Professor at Faculty of Architecture Structural and Earthquake Engineering	Ph.D. Civil Engineer	21.05.2015
I-2	Founder and Director of a structural engineering firm	M.S. Civil Engineer	28.05.2015
I-3	Assistant Prof. Faculty of Architecture	Ph.D. Architect	17.06.2015
I-4	President of Center for Protecting Cultural Heritages, Application and Research	M.S. Civil Engineer and Architect	18.06.2015
I-5	Site manager	Civil Engineer	30.07.2015
I-6	Site manager	M.S. Civil Engineer	28.08.2015

### 3 FINDINGS AND DISCUSSION

Interviews were conducted with six selected professionals in different stages of restoration projects to understand the major problems encountered by structural engineers in restoration projects in Turkey. According to the interviews, four significant problems were outlined; they include inadequate restoration courses in civil engineering education, absence of records of previous interventions on historic buildings, lack of standards and guidelines with respect to historic structures, and finally, ineffective participation of civil engineers. The major problems encountered by interviewees are listed on Table 2.

Table 2. Major problems defined from interviews.

Major Problems	I-1	I-2	I-3	I-4	I-5	I-6
Inadequate restoration courses in civil engineering education	YES	NO	YES	YES	YES	YES
Absence of records about previous interventions	YES	YES	YES	NO	YES	YES
Lack of standards and guidelines	NO	NO	NO	YES	NO	YES
Ineffective participation to projects	YES	YES	NO	NO	YES	NO

Almost all interviewees stated that restoration principles and concepts are taught in too limited a manner in civil engineering schools. Dewoolkar *et al.* (2011) emphasizes the importance of integration between the field of historic preservation and civil engineering on the undergraduate level. Although the assistance of structural engineers is of great importance to historical heritage conservation in the way of giving critical structural decisions, there is no course given about conservation and restoration processes in undergraduate civil engineering education in Turkey. This situation causes

a lack in the understanding of conservation principles among numerous structural engineering graduates. Graduate architecture programs do offer courses about restoration and conservation, but most of the time enrollment for these courses is limited to architecture students, not engineers. I-6 mentioned that, as a result of absence of education in this field, structural engineers perceive conservation projects like new buildings and this approach causes incorrect implementations in historical structures that include intrinsic problems. According to I-4, civil engineering education related to restoration field should be given in undergraduate programs. I-4 also underlined that lectures in undergraduate civil engineering programs would help to construct an understanding of conservation concepts among civil engineers. Similarly, I-1 pointed out that the studies and theses researched for the strengthening of historical buildings are becoming popular in graduate programs but that there is still a need for courses at the undergraduate level. More specifically, I-3 emphasized that strengthening methods of historical buildings required experimental studies and that more research should be done in civil engineering departments.

Another problem defined by the interviews is the lack of information about past interventions applied in historical buildings. I-1 mentioned that if they had the resources to research information about the history of construction or intervention in historical buildings, they could have started projects with more accurate knowledge, which in turn would provide the option of more efficient, better and applicable restoration projects. Moreover, past interventions might be critical for the structural system, and lack of information could easily cause bad decisions in the design process. According to I-5, half of the restoration projects on site were not useful or applicable because of the uncertainties related to the structure. After construction starts on site, many revisions are revealed within a project due to the discovery of past interventions. Also, I-2 and I-1 mentioned that it was very hard to make appropriate decisions without enough information, and this lack of information caused several unexpected changes in construction steps. In addition, I-3 said that the contractors did not welcome changes in projects and applications because new information causes delays and extra costs during the process. I-3 suggested a governmental institution be established to keep renovation, restoration and conservation information of the historical buildings in an archive. I-6 claimed that it is very difficult for project owners to understand the current condition of historical structures and participate in the restoration projects without knowing these structures' historical background.

Lack of standards and guidelines with respect to historic structures affects all restoration processes from the beginnings of the projects. I-4 suggested that well-designed procedures should be prepared specifically for the field of historic building restoration to prevent unnecessary and redundant applications, such as repetitive material experiments and analyses.

Three interviewees also mentioned ineffective participation in projects. I-1 emphasized that civil engineers ought to join projects during the early stages. Thus, they could have an opportunity to affect structural decisions from the very beginning. This participation could also provide efficient schedules and accurate budgets in restoration projects.

#### 4 CONCLUSION

This paper presented an identification and evaluation of the significant challenges encountered by structural engineers in restoration applications in Turkey. This qualitative study was conducted with six interviewees in order to obtain data. Four major problems were determined, including inadequate restoration courses in civil engineering education, absence of records of previous interventions in historic buildings, lack of standards and guidelines with respect to historic structures, and finally, ineffective participation of structural engineers in restoration projects.

The limitation of the present study is the small number of interviews, and the reliability of our findings is therefore limited. However, it appears also to make an important contribution to the literature for future studies.

#### References

- D'Ayala, D., Perspectives on European Earthquake Engineering and Seismology. In A. Ansal, ed. *Geotechnical, Geological and Earthquake Engineering* 34. pp. 489–513, 2014.
- Dewoolkar, M.M., Porter, D. & Hayden, N.J., Service-Learning in Engineering Education and Heritage Preservation. *International Journal of Architectural Heritage*, 5(6), pp.613–628, 2011.
- Giannopoulos, I. P. and Asteris, P. G., Earthquake Resistant Design of Structures. In M. Papadrakakis, M. Fragiadakis, & V. Plevris, eds. *III ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering* M. Greece, pp. 1–12, 2011.
- Lourenço, P. B., Structural restoration of monuments: recommendations and advances in research and practice. In *1st International Conference on Restoration of Heritage Masonry Structures*. Cairo, Egypt, pp. 1–16, 2011.