International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 02
February 2017

An Inspection of Seismic behavior of Heritage Masonry structures

[1]Banothu Venkati, [2] Chilaka Nagaraju
[1,2]Assistant professor, Dept. of Civil Engineering, Madhira institute of Technology and science,Telangana, India

Abstract: The conduct of masonry partitions subjected to both axial and cyclic lateral loading has been investigated appreciably via distinct researchers global. Such investigations are very vital because of the want to preserve the historic structures subjected to seismic actives. The dynamic conduct of block masonry minaret of a historic mosque in Cairo is analyzed, and a seismic evaluation is proposed. Under seismicity of the Cairo region and Egyptian loading code, a 3-D finite element version is used to determine lateral displacements and failure modes below seismic load. The analyses show that the highest damage commonly takes place at the bottom and the decrease a part of the minaret. Wall-Hungarian eyes which can be some other a heritage structure is analyzed. The dynamic houses have evaluated the usage of ambient vibration field measurements.

Keywords- Historic masonry structure, Minaret, Masonry building seismic assessment

I. INTRODUCTION

The Italian earthquakes of Umbria and Marche in 1997 [1] and Abruzzo in 2009 [2], have highlighted the need for an intensive monitoring and safety assessment of ancient Italian production background. Following the talk developed inside the medical community, new Italian Technical Recommendations for homes have been drawn up: first after 2003 [3,4] and later, after 2008 [5,6]. As is known, historic masonry buildings, even though perfectly able to bear vertical hundreds, normally are not good enough to sustain the horizontal forces produced by earthquakes. So, they're especially vulnerable to intense damage beneath seismic loading. In addition, historic built background represents a monetary issue especially in contexts in which tourism has ended up one of the foremost assets of wealth. Therefore, retaining historical buildings is a cultural requirement and a monetary and developmental demand [7].

The structural analysis of a brand new masonry building is a fantastically easy task, while the evaluation of the seismic vulnerability of a historic masonry building is a difficult undertaking, due to the fact of several uncertainties affecting the geometrical and the mechanical characteristics of the structural factors [8]. Each masonry building is characterized by its own records and the actual configuration is the end result of fusions, additions, and replacements of many structural factors. Thus, an accurate structural evaluation of an ancient building calls for a deep expertise of (a) the constructing history and its evolution; (b) the geometry; (c) the structural info; (d) the cracking pattern and the harm map; and (e) the masonry creation strategies [9,10].

The characterization of the material houses is required to broaden a proper structural analysis. This information may be done combining in-situ and laboratory experimental checks. Due to the difficulties in obtaining all data for use for a proper definition of a numerical model, in some instances its miles vital to carry out simplified, frequently iterative, strategies for assessment of the static and the seismic reliability. Hence, the structural engineers should be capable of dealing with the relevant elements of the hassle and offer guidance in analyses and experiments [11].

Maintenance of historic homes has to turn out to be an applicable clinical trouble that has attracted the hobby of researchers all over the globe as confirmed by using the growing number of researchers provided in latest a long time. These studies represent a huge trendy of the engineering approach for evaluation of the safety of historical buildings. Among the numerous researchers in this area, there are the paintings of Lourenço et al. [12]. The authors discuss the case of the Monastery of Jerónimos in Lisbon (Portugal) and show that it is feasible to apprehend the conduct and the damage of a complex historical construction offering valuable data in designing in-

e-ISSN: 2348-6848
p-ISSN: 2348-795X
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situ exams and tracking. The relevance of proper numerical strategies has been talked about by Cardoso et al. [13,14]. These authors discuss the aseismic provisions included in vintage masonry buildings in downtown Lisbon, after the Lisbon earthquake in 1755. They suggest an iterative technique for the seismic assessment wherein the damage to the structural elements or connections is diagnosed and the stiffness of the structural model is modified as a result. Each iteration comprises a linear elastic evaluation, so the method is beneficial for contemporary design exercise. Betti and Vignoli [15] mentioned the seismic vulnerability of the Basilica of Santa Maria of Impruneta (Italy) and proposed the aggregate of a finite element version of the building with a simplified approach based totally on the kinematic theorem of restriction analysis. The outcomes endorse that the comparison between different techniques of evaluation is obligatory to cover the unknowns affecting the mechanic properties of the substances. The relevance of a tremendous analysis technique has been pointed out also via Gallardo et al. [16]. The authors discuss the seismic behavior of a Renaissance Palace in Ferrara (Italy). Firstly, a 3D nonlinear model of the Palace is taken into consideration in order to understand the massive-scale structural performance. Next, an in-depth examination of the main façade of the Palace is supplied, by three decreased 2D nonlinear models.

II. RELATED WORKS

Significant results have been achieved in the study of mechanical behavior of historic (masonry) structures (Doherty et al., 2002; Laurent et al., 2008; Sezen et al., 2008; Lourenco, 2006; Lourenco et al., 2005; Turk and Cosgun, 2010), Dogangun et al., 2008). These studies are crucial not only from the point of view of protection, but also for analysis of ground motion that occurred during past earthquakes. Within this framework, dynamic properties of old masonry structure, which usually exhibit vulnerable behavior under seismic load, are investigated.

A contribution to dynamic characterization and seismic assessment of medieval masonry structures is provided in a representative single case study (Pineda et al., 2011), the Árchez tower, located in the active seismic area of Málaga, Spain. This study follows a multidisciplinary approach, in order to identify architectural, historical and structural features. The tower exhibits high vulnerability under seismic action, mainly due to its slenderness, low shear strength, low ductility and its possible lack of effective connections among structural elements. To assess its safety, transient and incremental static analyses are performed, aimed at predicting the seismic demand as well as obtaining the expected plastic mechanisms, the distribution of damage and the performance of the building under future earthquakes. A number of three-dimensional linear and non-linear finite element models with different levels of complexity and simplifications are developed, using 3-D solid elements, 3-D beams and macro-elements. All the models assume that the masonry structure is homogeneous, and the material non-linear behavior- including crushing and cracking is simulated by means of different constitutive models. Comparison among the different models are discussed, in particular as predicted local and global collapse mechanisms is concerned, to evaluate the suitability, accuracy and limitations of each analysis.

The static behavior and the seismic vulnerability of the Basilica of Santa Maria allImpruneta near Florence (Italy) have been evaluated using the finite element modeling technique (Michele and Andrea, 2011), where the nonlinear behavior of masonry has been taken into account by proper constitutive assumptions. Complete 3D models of Un-Reinforced Masonry (URM) structures have been obtained assembling 2-nodes macro-elements (Alessandro et al., 2004), representing the non-linear behavior of masonry panels and piers.

A finite element methodology for the static and dynamic nonlinear analysis of historical masonry structures is described and applied to the case study of a Romanesque masonry church (Michele and Andrea, 2008). A quasistatic approach (the seismic coefficient method) for the evaluation of the seismic loads has been used (as indeed is common in many analyses of the seismic behavior of masonry structures). The comparison demand vs. capacity confirms the susceptibility of this type of building to extensive damage and possibly to collapse, as frequently observed.

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III. THE SUGGESTED APPROACH

In the present study, two structures build with masonry in Cairo are presented in Figure 1 and Figure 2. The first is a wall – Hungarian eyes built by Sultan Al-Ghouri 800 years ago and was the target of the wall is to extend Citadel of Salah al-Din water by raising the waters of the Nile Balsoaki to the course of the fence, so that the water running to be up to the castle, because the castle was the seat of power in Egypt since the Ayyoub period and then moved the headquarters after to Abdeen Palace.

Figure 1: View of Wall-Hungarian Eyes (from 1798-2012)

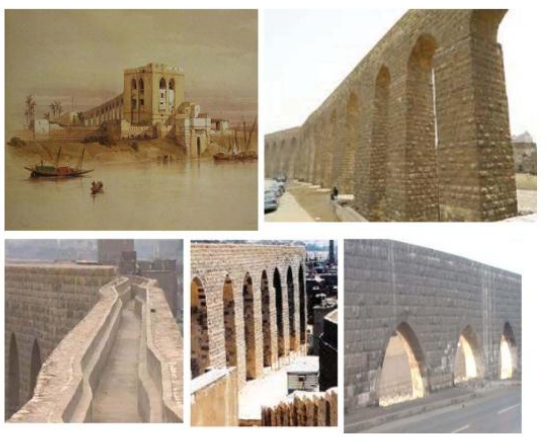
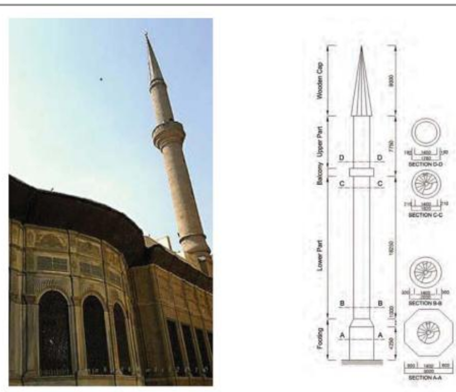


Figure 2: View of Solomon AGA Jagan Mosque Minarets with Their Main Features (dimensions in mm)



The length of the remaining portion of the Aqueduct of water about three kilometers away, and this is the Aqueduct water from the barrages of the most beautiful examples of water not only in Egypt but also in the whole Islamic world.

The second on is a minaret of Prince Suleiman AGA mosque Jagan which was constructed from the year 1250 Hijri, completed in the year 1255 Hijri and is one of the finest and rarest ancient mosques architecture make it the pearl of the region with Islamic antiquities, and is divided into three halls and a standpipe and a book to teach the Koran. The mosque is Locate left stepper towards Bab Al-futuh and minaret shape as other Ottoman cylindrical minarets and have one session and ending with the conical obelisk.

Experimental field dynamic measurements of these two structures are present. Results of the eigenvalue analysis of numerical models were compared to the natural frequencies extracted from the in situ measurements. The field measurements were used to update the finite element model analysis. Numerous material tests were performed on limestone specimens taken from residue of old historical structures. Typical mechanical properties of the limestone are given in Table 1. Mechanical properties of limestone are: modulus of elasticity of un-cracked stone section E = 8856 MPa, Poisson ratio n = 0,24, and unit weight g =22 kN/m3. While calculating the elastic modulus of the limestone material it was assumed that the elastic modulus to compressive strength ratio is E/fc=720, where Fc=12.30 MPa (minimum compressive strength of the tested lime stone)

Table 1: Mechanical Properties of Limestone

Physical Properties	Max.	Min.	Average
Density (dry,kN/m³)	25.0	22.8	23.9
Density (fullysaturated,kN/m3)	25.3	23.7	24.5
Uniaxial Compressive Strength (MPa)	19.2	12.3	16.7
Uniaxial Tensile Strength (MPa)	0.95	0.88	0.9
Modulus of Elasticity (GPa)	7.36	4.30	5.84

Descriptions of the Structure: The height of wall-Hungarian eyes ranging from 4.0 m to 22 m above adjacent road level next to the River Nile and then gradually to less than 4.0 m when intersect to Salah

Salem Street. The wall was built of stone columns up through decades of stones. The column dimensions are approximately 2.5 x (2.5-3.0 m). The Foundation layer is weak soil due to the nature of the region and it's close to adjacent waterways. Due to clear difference in wall height, in different regions, leading to different stiffness and therefore the stability of the stone itself. Given the great wall length with more than 8 km, the highest wall part it is taken for study and evaluates field dynamic measurement as this part has less stiffness compared with the remaining parts of the wall.

Ambient Vibration Testing: Ambient vibration tests were conducted on the Wall-Hungarian eyes at the beginning of July 2010 to measure the dynamic response in 6 different points, with the excitation being associated to environmental loads and traffic load from adjacent roads.

V. CONCLUSION

This paper presents feasible failure modes for normal historical systems placed in Cairo. The effects obtained from ambient vibrations, and previous material exams cited within the paper, display that the conduct beneath the seismic movement can be predicted pretty correctly, and that the stated measurements may be used within the assessment of those systems.

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e-ISSN: 2348-6848
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February 2017

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