Assessment of A Historical Stone Masonary Stucture Using Analysis Tool Etabs

Shubhanshu Gupta[1], Hitesh Kodwani[2]
[1]Dept of Civil Engineering
[2] Assistant Professor, Dept of Civil Engineering
[1, 2] Sam College of Engineering and Technology, Bhopal-462021, Madhya Pradesh, India

Abstract- *Masonry is the oldest building material that still finds wide use in today's building industries. The most important characteristic of masonry construction is its simplicity. Laying pieces of stone, bricks, or blocks on top of each other, either with or without cohesion via mortar, is a simple, though adequate, technique that has been successfully used ever since remote ages.*

In this paper we are presenting a case study of an historical structure (bhojpur temple) made up of stone masonry, where we are modelling the same structure in etabs and assigning seismic case as per I.S. 1893-I.

In this paper we concluded that assessment of historical structures are important to justify their present conditions and requirement of repairing type. In this structure we observed that some parts are at the verge of failure and need retrofitting.

Keywords- Assessment, seismic, analysis, etabs, structure, historical monument.

I. INTRODUCTION

To reduce loss of life and property from future earthquake hazards, comprehensive risk based-preparedness programs of mitigation must be developed. Experience has shown that lives can be saved, damage to property can be reduced and economic recovery can be accelerated significantly by promoting initiatives that incorporate effective screening, prevention and mitigation measures. Such measures include, consistently building safer and stronger buildings, enforcing building codes and making sound choices in community planning. The success of these initiatives can be made possible by taking preventive measures to reduce catastrophic losses from natural disasters through structural and nonstructural actions at the local levels.

In India, masonry constructions are generally made by using locally available materials like stone, brick, timber, adobe, mud etc., and are constructed in a traditional manner with or without the earthquake resistant features mentioned in IS: 4326 and 13927. Therefore, this type of construction is treated as non-engineered construction and most of the casualties are due to collapse of these constructions in earthquakes. Moreover, the plight is that even after gaining knowledge of earthquake engineering since the last three decades, neither a proper method has been developed for the seismic analysis and design of masonry buildings nor the topic is fairly covered in current Indian curriculum in spite of the fact that about 90% population of India lives in masonry buildings.

Noteworthy structures and landmarks are the most vital piece of the social legacy and human progress and it is the human basic to secure those structures for the who and what is to come. Other than their masterful esteem those structures are available to the general population and to the vast amass of individuals. Most noteworthy stupendous structures that constitute the enormous piece of memorable legacy made of workmanship materials, for example, blocks, stones, adobe and mortar are extremely mind boggling. Typology, development and association of the structure, component/square size, sort of development materials shift contingent upon the development time frame.
Seismic Assessment:

Assessing of seismic behaviour of existing building can be faced according to main focuses, namely in terms of either maximum strength against the horizontal seismic actions and maximum ductility, consisting in the capability for plastic displacements. According with the most modern seismic codes and guidelines seismic behaviour of structures must be analysed in terms of performance both under service and destructive earthquakes.
Seismic response of masonary structures under seismic shaking should be analyzed by means of complex nonlinear dynamic procedures requiring a large number of accelerograms for describing the possible seismic input and great computational efforts. However, Capacity Spectrum Method (CSM) provides a solution very easy-to-obtain and reliable enough. In the present paper, such a method has been

widely adopted for evaluating the performance point of the structures considered in the analyses.

II. LITERATURE REVIEW

Maria Basdeki, ArgyroDrakakaki (2018) here the author introduced a test method, concerning an RC segment before and after corrosion. An estimation concerning the drop of its mechanical execution has occurred, showing the significance of the consumption factor. Also, a current brickwork tower building was exposed to seismic assessment. Both OASP and EC2 examination techniques were utilized. The outcomes called attention to that, for medium– force seismic tremors, both logical and rough techniques are good and dependable.

Gabriele Milani, Paulo Lourenc(2007) here the author went for an increasingly broad system, a micromechanical model grew already by the writers for the point of confinement investigation of secluded all through plane stacked stonework dividers is stretched out here and used within the sight of coupled layer and flexural impacts.

In the model, the rudimentary cell is subdivided alongside its thickness in a few layers, where completely equilibrated pressure fields embracing a polynomial extension are expected. The coherence of the pressure vector on the interfaces between contiguous sub-spaces and hostile to periodicity conditions on the limit surface are additionally forced. Linearized homogenized surfaces for brick work in six measurements are gotten and executed in a FE limit investigation code, and two 3D contextual investigations are broke down utilizing the kinematic hypothesis of utmost examination. From the outcomes, the methodology proposed is approved and its value for taking care of designing issues is illustrated.

Arifulislam et. al. (2011) here the essential goal behind the author's investigation was to assess the tremor safe conduct and evaluate the seismic helplessness of brickwork frameworks. A real brick work building was chosen for the basic examinations and plan. The investigation incorporates the examination of the structure essentially for quality of in-plane dividers just as the security of out-of-plane dividers and furthermore watches the impacts of openings (entryways/windows) in changing the conduct of in-plane dividers. The code-determined seismic plan arrangements of stone work structures were additionally checked with the structures under examination.

Outcome of the literature review:

No detailed study on non linear analysis of stone masonary structure and related technique such as analysis tools has been done in past researches were conducted on different existing structures (R.C) or monumental buildings built up of steel, rc and brick masonary materials.

III. OBJECTIVES OF THE STUDY

1. To determine the architectural design of the temple.
2. To perform non-linear seismic force as per regional zone and site condition using analysis tool ETABS.
3. To Study the history of the structure and attaining metric data of structural elements,
4. Provide visual review of the structure by aiming on the existing decay and damage state of structural elements.

IV. METHODOLOGY

Step-1: Modelling of the temple:

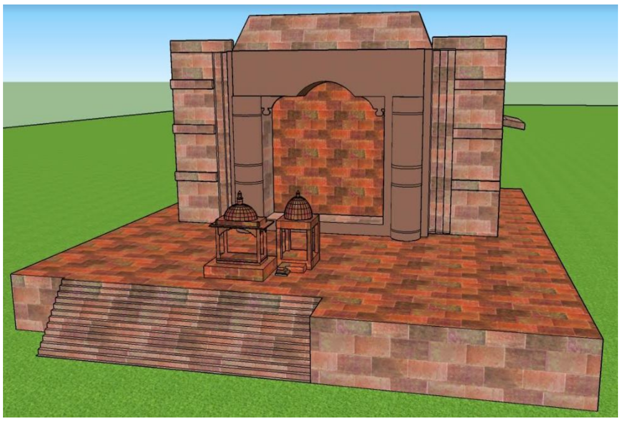

Figure 1: Bhojpur temple model

Step-2:Generating Stone masonry material in ETAB

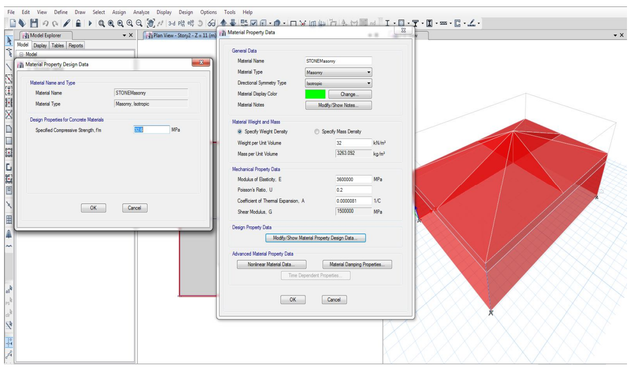

Figure 2: Generating material properties

Step-3: Assigning end conditions

Step-4: Assigning Loading conditions

Step-5: Load combinations
Step-6: Analyzing

Table 1: Geometrical Properties

Bhojpur Temple	Dimensions (m)
Plan dimension	35x25
Length (m)	35 m
Width (m)	25 m
Height (m)	9.2 m
Dome Height (m)	1.8 m
Open Area (m)	25 x 15 (m)
Stone masonary pillars	1.4 x 1.4 (m)
Stone masonary Density	35 kN/m^3

V. ANALYSIS RESULT

Bending Moment kN-m:

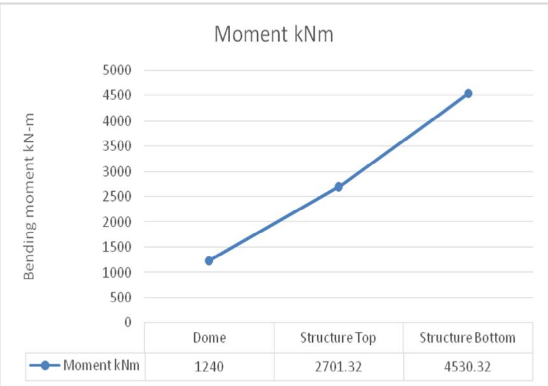

Figure 3: Bending moment

Base shear:

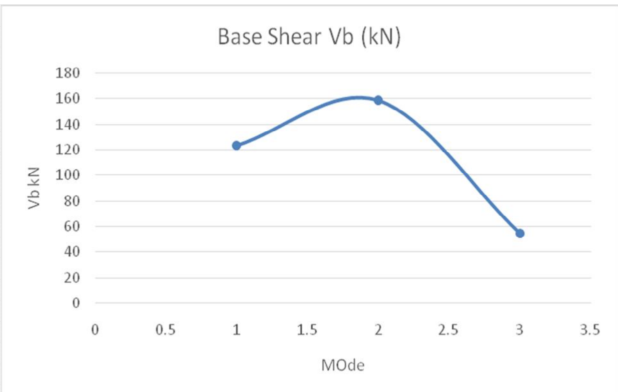

Figure 4: Seismic effect at base

Seismic Interaction:

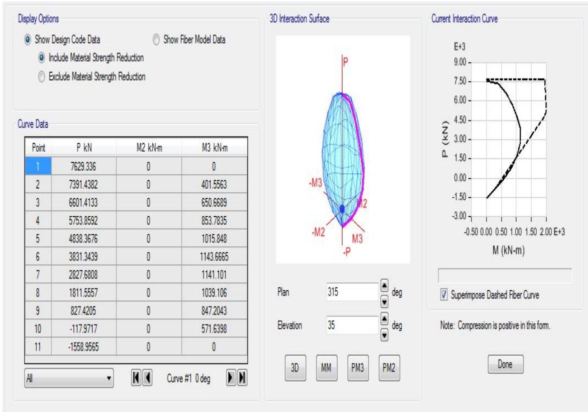

Figure 5: Seismic Interaction

Natural Frequency:

Table 2: Natural frequency

Period (sec.)	Frequency cyc/sec.	Circular frequency	Eigen value rad^2/sec^2
0.532	1.913	12.032	144.513
0.437	2.317	14.58	211.54
0.404	2.475	15.54	241.556
0.146	6.89	43.02	188.23
0.118	8.4711	53.225	317.65

VI. CONCLUSION

Technology is accessible to considerably improve the earthquake associated disasters. This is confirmed by nominal destruction usually without any loss of life when moderate to severe earthquake strikes developed countries, however even a moderate earthquake cause’s enormous destruction in developing countries as has been perceived in recent earthquakes. The cause being that quake resistant methods are rigorously followed in these countries where as such recommendations are despondently violated in developing countries. The supervision system is well-organized and operative in developed countries, and it is not similar in developing countries – so the government should ensure the implementation of earthquake resistant design guiding principles. Thus, it is here that civil engineers in general and structural engineers in particular have a great role to play in modifying the anguishes, affected by earthquake related destructions. Hence different inferences based on the research are summarized below: -

The fact that there are numerous historic structures and a few specialists on this field it is very significant to make condition survey based on visual inspection as a prior stage of safety evaluation method.

Masonry structures belong to the most vulnerable class of structures which have experienced substantial destruction or even complete demolition in earthquakes. Non–linear seismic analysis is beneficial for evaluating inelastic strength and deformation of the building.

Grade of mortar must be according to codes listed for diverse earthquake zones.

Horizontal bands must be provided at plinth, lintel and roof levels as per code.

The equivalent frame method which is to be developed for capably simulating the service and ultimate response of structural system of masonry load bearing wall. The non – linear response is noted by the use of biaxial equations. This process supports the prediction of whole response of the masonry constructions and their failure circumstances.

Masonry unveils different directional properties due to the mortar joints, which act as planes of weakness, resulting in stone masonry structures viewing complex and non-linear mechanical behavior.

REFERENCES

[1] MeltemVatan, "*Condition Survey of Historic Buildings by Visual Inspection - Case Study: Murat Pasha Mosque", International*Journal of Electronics, Mechanical and Mechatronics Engineering Vol.2 Num.1 Pp. (147-156).

[2] Neethu Gopal, et al. (2017), "Behavior of Masonry Buildings Under Seismic Action"
International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395 -0056, Volume: 04 Issue: 04, p-ISSN: 2395-0072.

[3] Sourabh Bhargava, et al. (2017), "A Study on the Earthquake Resistant Low Cost Construction Techniques", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 5 Issue IV, April 2017 IC Value: 45.98 ISSN: 2321-9653.

[4] Kamran, Shakeel Ahmad et al. (2016), "Seismic Performance of a heritage school building",11th International symposium on Plasticity and impact mechanics, implast.

[5] Mahmud Sami Donduren(2016), "Calculation of Loads and Stresses Acting on Masonry Walls, International Journal of Applied Mathematics, Electronics and Computers, ISSN: 2147-82282147.

[6] ZeljkaRadovanovic, et al. (2015) "The Mechanical Properties of Masonry Walls-Analysis of the Test Results, Procedia Engineering 117 (2015) 865 – 873.

[7] Narayanan S P, Sirajuddin M (2013) "Properties of Brick Masonry for FE modeling", American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-1 pp-06-11

[8] Mohammad Adil Dar, et al. (2013), "A Study on Earthquake Resistant Construction Techniques" American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-02, Issue-12, pp-258-264.

[9] Michele Betti and Luciano Galano (2012), "Seismic Analysis of Historic Masonry Buildings: The Vicarious Palace in Pescia (Italy)" Buildings 2012, 2, 63-82; doi:10.3390/buildings2020063.

[10] J.Snoj,M.Osterreicher and M.Dolsek (2012), "Experimentally supported modeling of an existing masonry building by measuring ambient and forced vibrations", Proceeding of15th World Conference of Earthquake Engineering,LISBOA2012.

[11] Nataliya Y. Vorontsova (2012), "Strengthening of Historical Monuments in Seismic Regions" 15 WCEE, LISBOA 2012.

[12] Pere Roca et al. (2005), "Strength Capacity of Masonry Wall Structures by the Equivalent Frame Method", Journal of Structural Engineering, Vol. 131, pp 1601-1610.

[13] K S Jagadish et al. (2003), "Behavior of masonry structures during the Bhuj earthquake of January 2001", Proc. Indian Acad. Sci. (Earth Planet. Sci.), 112, No. 3, September 2003, pp. 431–440.

[14] Durgesh C. Rai (2000), "Future trends in earthquake-resistant design of structures", SEISMOLOGY 2000.