A REVIEW PAPER ON SEISMIC DESIGN EVALUATION OF EXISTING UNREINFORCED MASONRY STRUCTURES USING IS CODE RECOMMENDATIONS

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Abstract - The earthquake-resistant design of structures as indicated by the existing design philosophy aims to ensure that the structures withstand the extreme vibration during their lifetime without collapsing. This philosophy ignores the fact that for the permissible damage at the end of the design lifespan it is important to show the seismicity of the area in an extensive way, that is, in terms of size with suitable spatial distributions around the location. Interest in structural brickwork has expanded considerably in recent years. That is why, in many countries further advanced practical codes for structuring structures in masonry have been presented. The threat of seismic tremors have underlined the need for a comprehensive monitoring and safety assessment of architectural heritage. This paper is written for studying the current technology pertaining to the seismic analysis of ancient building and based on investigation and technological details, the seismic vulnerability of a particular monumental masonry building: RANI MAHAL, Islam Nagar in Bhopal, M.P India is checked. The various codes for seismic behavior assessment were consulted while working on seismic analysis.

Keywords: Old Masonry Structures, Earthquake damages, Seismic design, Base shear, IS code provisions.

1. INTRODUCTION

Heritage structures are the essential part of the culture of any country. The reason behind their importance is that they represent masterpieces of the human creation, bearing testimony to cultural traditions of previous civilizations and illustrating prominent stages in human history with artistic works of outstanding universal significance. Thus, they require protection from the effects of all hazards because of their importance in mankind cultural heritage and evolution -a legacy from the past which definitely should be preserved for future generations as they are irreplaceable sources of inspiration and points of reference to human identity, intelligence and civilization. These world heritage sites represent resources of outstanding universal value, which belong to all the people of the world, regardless of the territory on which they are located and national sovereignty or ownership. In Western and European countries, the awareness for preserving and defending the Heritage structures is in move forward put on at what time compared to in Asian countries. India is notorious for its sculpture and urbanity all along with the variety of one of its style heritage Structures. Countless of these structures in our country are in a territory of ruins or on the brink of ruins for the reason that of crude personal property and neglect.

1.1 NECESSITY FOR THE USE OF SEISMIC DESIGN EVALUATION

India has experienced six moderate-intensity earthquakes, even if these were moderately intensive, these earthquakes have caused massive losses of property to large extent, highlighting the exposure of the infrastructure to earthquakes. The last vibration of 1993 and the Buhl earthquake of 2001, which caused major damage to property, emphasized the need to focus on long-term seismic improvement and vigilance in series to mitigate the money-consuming losses caused by earthquakes. Buhl shaking on January 26 was the biggest devastating one that cleaned up at a high level in a situation of shortage of property. This shaking is the first major upheaval to seize a city area of India in the last 50 years. Various heritage structures in Ahmedabad, Kutch, Buhl, Ajar and Bacau and surrounding villages were severely damaged during this earthquake. A 600 years old Junta Mineral monument in Ahmedabad was one of the dozens of ancient monuments that partially collapsed or dented during the quake. In Buhl the Raolakha Chhatri was built in the 18th century and survived the vast earthquake of 1819 Kachchh, but succumbed to the earthquake of 2001. It was the oldest, largest and mostly extensive of these assets land monuments for precedent Maharajas.

However, the September 1993 upheaval that struck Maharashtra in central West India that claimed about 12,000 lives, was not a remarkably tough event, but caused such damage for the reason that of other factors. The Marathwada region has an extended history stretching from antediluvian times'As a result; the province is calorific in copious heritage structures such as forts, temples, tanks, caves, parapet etc., which are extant evidences of assorted time period. However, the important part of the heritage are accepted settlements with 'vernacular housing' as a principal component. This has traditionally built using materials that are certainly available locally, typically, the walls completed of stone masonry, even upto 600 mm thick, with mud mortar. Cement used for sealing the uncluttered joints. All of

Kashmir's ancient temples (constructed 750-950AD) have also resisted some damage. Although largely not recognized, it is probable that generally of this damage initiated by earthquakes. An ordinary story is the damage of the monolithic capstone roofs of temples, whereas the walls in spite of everything post without the gain of mortar. Examples of tossed capstones are set up at Naranag. A number of temples cover subsequently been quarried for stone used in later on re-construction (Parihansapura). Few have partly re-assembled by the Archaeological survey of India (Shiva and Naranag). An exceptional few stay evidently in the state they left following earthquake shaking (Sugandhesa, Payar).

Thus, the study of design criteria for any structure and the computed damage helps in getting a proper understanding about the current state of the structure, depending on which we will come to its preservation. The main objective is to check the seismic design criteria of Rani Mahal, Bhopal, M.P and check whether it is safe as per I.S code so as to assure its safety against earthquakes in future.

2. REVIEW OF LITERATURE

Kapil Sharma, Prof. Praveen Sing Tomar, et al, 2016 [1] carried out micro zonation of the city, as it is obvious that damage due to an earthquake may differ even within a few meters, because of difference in local site circumstances such as thickness and variety of soil. The objective of micro zonation was to model the rupture mechanism at the source of a tremor, estimate the proliferation of waves through the ground to the top of bedrock, regulate the effect of local soil profile and therefore develop a hazard map signifying the susceptibility of the area to potential seismic hazard.

Mulyani R, Ahmadi R, Pilakoutas k, et al, 2015 [2] has studied the multi-hazard assessment of buildings in Padang city. The foremost purpose of an earthquake risk assessment is to assess the potential loss of structures in earthquake prone areas and to offer enough data to employ appropriate mitigation strategies. They have emphasized the significance of multi-hazard risk assessment framework that comprises of the effects of earthquakes and its related hazards such as tsunami. They have then used the developed risk assessment framework for the city of Padang that has a noticeably high earthquake hazards with excessive exposure to population as well as infrastructures.

Asteris P, Chronopoulos M, Chronopoulos M, et al, 2014[3] presented a procedure for earthquake resistant design or assessment of masonry structural systems. They illustrated the whole process using case studies from historical masonry structures in the European area. In particular, the application of the proposed method has been checked through analysis of existing masonry buildings in three countries namely Greece, Portugal and Cyprus, with different seismicity levels, influencing the hazard affected the masonry buildings.

Debranjan, 2014 [4] studied the procedure available in literature to assess the seismic vulnerability of un-reinforced masonry building with the use of linear/non-linear static and dynamic analysis and to check the applicability of these measures for seismic estimation of un-reinforced masonry building through investigational studies. To attain such objectives, an experimental program had taken out as part of this research. Sixteen wall panels of different dimensions verified for in-plane monotonic lateral loads. For every specimen, a fixed axial compressive load kept during testing procedure. A window opening at recommended location of the test sample provided for eight of the sixteen samples and its in-plane monotonic lateral load behaviour was calculated. Four additional specimens with a door opening in addition to a window opening tested for in-plane monotonic lateral load behaviour. Four solid walls with no opening tested as well and linked with the behaviour of alike panels with openings.

C.V.R Murty, Rupen Goswami et. al, 2013 [5] presented that the mass of the building being designed controls seismic design and also the building stiffness, for the reason that earthquake induces inertia forces which are proportional to the building mass. Designing buildings to behave elastically for the period of earthquakes devoid of damage may reduce the project economically unviable. Thus, it may be compulsory for the structure to undergo damage and thus disperse the energy input to it throughout the earthquake. Consequently, the traditional earthquake-resistant design philosophy needs that normal buildings must resist

(a) Minor (and frequent) trembling with no destruction to structural and non-structural elements;

(b) Moderate trembling with slight damage to structural elements, and certain destruction to non-structural elements; and

(c) Severe (and infrequent) trembling with destruction to structural elements, but without collapse (to save life and property inside/touching the building).

Buildings have designed only for a fraction (~8-14%) of the force that they would go through, if they designed to stay elastic all through the predictable strong ground trembling and thus allowing damage. though adequate initial stiffness is essential for guaranteed to avoid structural damage under minor shaking. Therefore, seismic design equilibriums reduced cost and satisfactory damage, to make the project feasible.

N.G. Maldonado, P.E.Martín, 2012 [6] analyzed that the Structural rehabilitation in public buildings belonging to the heritage in earthquake zone must obey with safety necessities. The behaviour of such type of building studied using finite element modelling, which includes standardized testing physical and mechanical characterization of materials used and the use of non-

traditional techniques such as measuring soil waves and environmental vibrations. The investigation of the improved building must consider the numerous substitutes available for the site. The criteria for rehabilitation have agreed with heritage specialists, finding out a balance between new and prevailing technologies for the rehabilitation of the structure with steel and reinforced concrete.

Paulo B. Lourenço, 2011 [7] Studied that the preservation of architectural heritage is considered a fundamental matter in the cultural life of modern cultures. This heritage is accumulating damage due to deterioration of materials, repetitive loading and exceptional events. This means that conservation, repair and strengthening are frequently necessary. In this procedure, monitoring and non-destructive testing play a major part, providing data on the building state and existing damage, and allowing to define satisfactory remedial methods. Dynamic based methods are an eye-catching tool for the reason that they are non-destructive and are able to capture the global structural behaviour. This paper focuses on three main features related to dynamic identification and monitoring: (a) exploring damage in masonry structures at an initial phase by vibration measurements, with the use of one arch model constructed in the laboratory. Progressive destruction induced in the arch and consecutive modal identification examination performed at every damage step, directing at finding suitable correspondence between dynamic behaviour and internal crack growth. The dynamic based methods permitted noticing and tracing the damage; (b) two complex case studies of modal and structural identification of monuments using conventional sensors. Operational modal analysis used to evaluate the modal parameters, followed by statistical analysis to assess the environmental effects on the dynamic response. The purpose is to discover destruction valuation in masonry structures at an initial phase by vibration signatures, as a part of a health monitoring process; (c) finally, a contrast between profitable wirelesses based platforms and conventional wired based systems presented for a laboratory specimen.

Srikanth T, Kumar R, Singh A et al, 2010 [8] studied about the earthquake vulnerability assessment of existing buildings in Gandhidham and Adipur cities Kachchh, Gujarat (India),after 14000 casualties were caused because of Bhuj earthquake of 26 January 2001. Soon after the massive destruction caused, some new sections were added to IS 1893(criteria for earthquake resistant design of structures) in 2002 after a long gap of nearly 18 years. In this respect, a comprehensive study of seismic risk assessment on 16000 buildings of Gujarat found to be of utmost importance.

Robert Reitherman, Sue C. Perry, 2009 [9] observed that many concerns must be taken into account when emerging a program to diminish the seismic risks of unreinforced masonry buildings. Each consideration includes key individuals and groups, which should become involved at a premature phase in the development process. The principal means of plummeting the seismic risks of unreinforced masonry buildings is retrofitting, even though changing a building's use in order to lesser its occupant load (number of occupants) also decreases risk. Retrofitting is the process of adding earthquake resistance to a prevailing building. It is normally identical with the terms 'seismic strengthening' or 'seismic rehabilitation'.

Rajshree Kamat, Dr. Ashutosh, 2008 [10] inspected that the Objective of the study is to develop earthquake damage situation by using building and infrastructure records, topographical information, Demographical Data and other related facts and figures to recommend right urban planning approaches to lower the threat of damages being confronted by the town, being an Earthquake susceptible town.

Edoardo Fusco, Andrea Penna et al., 2008 [11] visualized the results of the experimental investigations and non-linear analysis on a historical building. Analysis were done using laboratory tests and in-situ investigations; they emphasize critical matters linked to the seismic response of historical buildings, such as the changeability of traditional material properties, the different construction techniques, the limited knowledge on earlier destruction or the restrictions in examinations and tests due to conservation matters for buildings of historical value. Finally, several interesting contemplations about numerous strengthening outlines stated, to evaluate the effects of certain common interventions on historical masonry buildings, considering the global response as well as the local collapse modes.

V-H. kwok and A. H-S. ang 1987 [12] investigated a model for assessing the structural damage to masonry buildings exposed to earthquake ground motion. Damage articulated as a combination of the effects of extreme deformation and repeated loadings. The model parameters for unreinforced brick masonry attained from cyclic load tests of masonry wall samples. A random vibration method using a nonlinear hysteretic restoring force model to define the load-deformation behaviour of masonry accepted to assess the response statistics mandatory for damage calculation. The proposed destruction model is regulated masonry buildings damaged during previous earthquakes. A simplified method for destruction assessment also proposed, in which seismic damage is conveyed as a function of seismic loading to the structural resistance. The validity of the simplified systematically inspected relative to the random vibration method. A damage-limiting design based fundamentally on the equivalent lateral load process, in which the developed shear coefficient is expressed openly as a function of a tolerable damage level design examples specify the value of the design technique.

3. CONCLUSIONS

A lot of research has been done by the civil engineers in the field of Earthquake engineering to address the losses faced by the catastrophic tremors around the world.
From the study of several articles referred and listed in the Referral section, it appears that nowadays several researchers are indulged in bringing innovations in their building materials, technology etc., to make their existing infrastructure elegant in every aspect and make them withstand shakes during seismic event. It has been observed that the safety of ancient buildings are the prime agenda for the researchers and they have planned the assessment in two major categories:-

- Since the buildings which have not been constructed by considering the standard design code, hence using the visual inspection and NDT, collective information is assessed for the investigation of building for seismic event.
- Based on the information received from previous point, Numerical modeling or manual technology proposed by various researchers pertaining to seismic analysis like equivalent static load method may be utilized for seismic check.

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