

Seismic Assessment of a Stone Masonry Structure (Bhojpur Temple) using Analysis Tool: A Review

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Abstract— In heritage Structures there is necessity to determine the effect of seismic risk in prevailing historic buildings for hazard moderation, prediction of disaster which may occur due to lateral forces. Seismic risk can be consider as the main force on safety assessment which necessitates qualitative and computable data. This data is necessary to determine the futurestic hazards over the historical structures. In this paper we are presenting the past researches done related to seismic assessment of historical building.

Keywords: Seismic Assessment, Historical Structures, Masonry, Analysis, Strength, Stability

I. INTRODUCTION

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. Naturally, innumerable variations of masonry materials, techniques, and applications occurred during the course of time. The influence factors were mainly the local culture and wealth, the knowledge of materials and tools, the availability of material, and architectural reasons. The subjective information is visual review of degenerations, auxiliary harms and deteriorations; and the calculable information requires lab tests, basic investigation and so forth. Getting the processable information is careful technique, which requests pros and takes additional time and cash. The way that there are various noteworthy buildings and a constrained proficient on this field, it is exceptionally critical to make condition review dependent on visual examination as an initial step of security appraisal method.

The thorough review of literatures associated to seismic analysis of masonry buildings is very vast area. This literature review emphasizes the brief assessment of the seismic analysis of masonry structures.

Doğangün, A. Uralz (2008) here the author abridged the different brickwork structures which were commonly utilized in Turkey. Furthermore, a point by point report of the seismic tremors which occurred as of late. Indeed, even the discourses were made in regards to the prerequisite of seismic codes. The author featured different basic insufficiencies because of seismic tremor harm which incorporated a substantial opening in burden-bearing dividers, absence of particularly vertical limiting components, low-quality mortar, overwhelming overhangs and unconfined peak dividers.

Empty clay tiles utilized as block units were seen to be the real reason for the halfway or all-out breakdown of the structure. A considerable lot of breakdown and harms were ascribed to following things arranged by significance: Inadequate brickwork units, poor mortar, absence of vertical

restricting components, abnormalities in the plane and in the vertical course, the deficient association of burden bearing dividers, and lacking length of burden bearing dividers, unconfined peak dividers and substantial cantilever components. Just constrained kept stonework structures were watched. Regardless of these kept stonework structures couldn't fulfil prerequisites according to the Turkish Earthquake Code, they carried on superior to the unreinforced workmanship structures. Particularly the Kocaeli quake calls attention to the way that the fortified solid edge framework ought not to be viewed as the main option for contemporary development frameworks. On the off chance that the workmanship structures could be intended to be quake-safe and built so as to endure.

Matthew J. DeJong (2009) here's the author essential spotlight was on notable curved or vaulted structures, yet increasingly current unreinforced stonework structures are additionally considered. Evaluation methodologies which utilize improved semi static stacking to reenact seismic impacts are at first tended to. New investigation techniques which Centre around solidness or quality are introduced, and the benefits of these systems are cleared up. Initial, another parametric graphical harmony technique was created which permitted constant investigation and lights up the mind boggling solidness of vaulted brick work structures. Second, a limited component technique for anticipating weak crack of workmanship structures was reached out to fuse non-relative stacking and shell components. These expansions empower expectation of harm and breakdown components all in all however were explicitly used to anticipate the reaction of a full-scale brick work structure to semi static cyclic stacking. Improved utilization of discrete component demonstrating: The assessment of DEM through correlation with exploratory and investigative outcomes gives trust in, and a point of view of, displaying capacities. A strategy for characterizing discrete component displaying parameters was proposed, permitting an increasingly educated application regarding this device.

A S Patil and P D Kumbhar (2013) here the author's paper depended on the investigation of nonlinear powerful examination of Ten storied RCC building considering distinctive seismic powers were completed and seismic reactions of such structure. The structure under thought was displayed with the assistance of SAP2000-15 programming. Five diverse time accounts were utilized thinking about seismic forces V, VI, VII, VIII, IX and X on Modified Mercalli's Intensity scale (MMI) for the foundation of the connection between seismic powers and seismic reactions. The consequences of the examination introduced comparable varieties design in Seismic reactions, for example, base shear and story relocations with powers V to X. From the investigation it was prescribed that examination of multistoried RCC building utilizing Time History technique

winds up importance to guarantee wellbeing against quake powers.

Here the outcomes introduced that the seismic reactions specifically base shear, story removals and story floats in both the headings were found to differ in a comparative example with powers (V to X) for all the Time Histories and both the models considered for the examination. The estimations of seismic reactions to be specific base shear, story removal and story floats for all the Time Histories and both the models were observed to be of the expanded request for seismic forces shifting from V to X. The estimations of base shear, story relocations and story floats (X and Y bearings) for seismic powers of VI, VII, VIII, IX and X are observed to be more by 1.85, 3.56, 7.86, 15.1, and 17.15 occasions, individually when contrasted with seismic force of V for both the models (i.e., with and without delicate story) and for all the time accounts. As Time History was the practical technique, utilized for seismic investigation, it gave a superior check to the security of structures examined and planned by the strategy indicated by IS code.

Ahmed Ghobarah (2000) here the author exhibited the cutting edge, ideas, rationality and methodologies for the seismic evaluation of existing fortified solid structures. The condition of training in the assessment of the execution of structures, strategies for investigation, and confinements was talked about.

The assessment of the seismic opposition of structures by review might be proper for a class of structures so as to recognize structures and segments that visualize to a real existence security danger. The versatile time-history examination was not suitable for the assurance of the conduct of existing RC structures which relied upon inelastic dislodging and distortion up to fall. The pushover analysis was a promising basic and productive methodology for the assessment of the inelastic horizontal burden obstruction of an expansive class of existing structures gave that its confinements were completely perceived. It gave a sensible tradeoff between errors of the basic methodologies and multifaceted nature of the nonlinear unique time-history examination. The nonlinear time-history investigation had the potential for giving an amazing asset to the seismic evaluation of existing RC structures if the conduct of the auxiliary parts was appropriately displayed. Be that as it may, the consequences of the examination were reliant on the attributes of the particular ground movement utilized. At present, the nonlinear time history technique was possible for the investigation of significant and unique structures and for research applications. Despite the fact that there were different methodologies for the seismic appraisal of existing structures, the exactness and unwavering quality of these assessment techniques was to a great extent obscure and stay to be built up. The accumulation of real information sufficiently detailed or statistically complete enough to allow calibration of models and to set up the dependability of the examination was troublesome and amazingly tedious.

Michele Betti(2015) here the author introduced an examination between two numerical demonstrating approaches utilized to explore the seismic conduct of unreinforced brickwork structures with adaptable stomachs. The correlation was performed breaking down a two-story model tried on a shaking table at the CNR-ENEA inquire

about the focal point of Casaccia (Italy). The main numerical model was worked by utilizing the limited component (FE) strategy, while the second one was worked by an improved large scale component (ME) approach. The two models were utilized to perform non-straight powerful examinations, coordinating the conditions of movement by well-ordered techniques. The shaking table tests were mimicked to break down the conduct of the model from the underlying flexible state until the improvement of broad harm. The fundamental aftereffects of the examinations were talked about and basically analyzed as far as designing parameters, for example, increasing speeds, relocations and base shears. The viability of the two models inside the examined typology of structures was then assessed top to bottom.

Here the examinations result featured that the FE model was equipped for repeating with great certainty the exploratory harms, while the large scale component model, because of the inborn speculation of unbending floors, was fit for anticipating the breakdown load, however not giving a palatable remaking of the genuine breakdown instrument. Blunders on removals and increasing speeds are adequate in the reproductions with low-to-direct PGA forces, i.e., in the most straight scope of the dynamic reaction. In the majority of the recreations, the ME model thinks little of the shear powers, since it furnishes increasingly articulated firmness rotas for the FE model. As the accessibility of a successful non-straight device for the seismic evaluation of stonework basic components was as yet an urgent necessity, the paper proposed that the seismic investigation of customary brickwork structures (with adaptable floors and poor associations between the dividers) ought to be analyzed through a cross-numerical methodology.

Ana Maria (2003) the essential goal of the paper was to depict the ordered advancement of the conventional kinds of structure establishment utilized in structure s built inside the outskirts of the previous European areas of the Roman Empire, amid the timeframe crossing from the presence of the first of these sorts of establishments up to the beginning of the main Industrial Revolution. In view of this point, archaeological, to measuring and building forms utilized in the development of establishments, both shallow and profound, over the period contemplated, has been basically assembled and requested.

Notwithstanding, that in this equivalent period saw an improvement in the structure methods utilized for establishments, connected main]y to the need to determine issues emerging from the development of structures of certain significance on poor ground.

Murat Saatcioglu and JagMohanHumar (2005)here the author gave a diagram of dynamic examination methods for use in seismic plan, with statements on scientific displaying of structures, auxiliary components, and hysteretic reaction. A discourse of the assurance of the auxiliary time frame to be utilized in relationship with the proportional static power strategy was displayed.

This was particularly valid for flexure-prevailing structures where the hysteretic reaction was commanded by balanced stable hysteresis circles, a component that was tended to by most of the accessible PC programming. As a rule, it was adequate to examine these structures with the utilization of an elastoplastic model for steel structures and a

solidness debasing model for strengthened solid structures. Extraordinary consideration ought to be worked out, be that as it may, to ensure that the registered reaction could be accomplished with the plan and enumerating rehearses utilized.

P. Gülkan and S. T. Wasti (2009) here the author's paper exhibited examined the difficulties presented by, and arrangements required, to guarantee the basic life span of notable structures. Contextual analyses were portrayed where standards expressed with regards to accomplishing life span for antiquated landmarks had been actualized.

Here the author presumed that the danger of future tremors and different catastrophes will guarantee that in each nation and locale consideration will be given in the coming a long time to the retrofitting of noteworthy structures. Such great structures are a solid notice of the wonders of the human past in a world that is contracting as far as reality. National pride will, gradually however unavoidably, be deciphered as a piece of all worldwide accomplishment.

Regular fortifying strategies, particularly those including 'imperceptible' intercession, will keep on having a significant impact in the seismic security of notable [as well as more conventional] structures. Be that as it may, the advancement of base separation innovation for more extensive application at lower cost will result in more noteworthy utilization of contact pendulum interfaces between the superstructure and establishments of notable structures, and the practicality of such arrangements will be limited just if the extent of the structure is extremely vast.

Ariful Islam 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.

The fundamental ends got from the investigation of the general auxiliary conduct of stonework incorporated that Masonry dividers ought to be looked at for-of-plane criteria dependent on their (h/t) proportion. This was constantly the weakest connection in their seismic opposition, due to precariousness caused because of the vast upsetting minutes from parallel burdens like a tremor. Divider openings definitely diminished the firmness and sidelong burden conveying capacity of unreinforced workmanship structures. Actually, extremely expansive dividers that were required to convey critical horizontal burdens are rendered exceptionally feeble and powerless because of the substantial window and entryway openings and Closely-separated divider openings and the ones excessively near divider limit are entirely helpless against seismic tremor harm.

Abraham Christopher Lynn (2001) [Seismic Evaluation of Existing Reinforced Concrete Building Columns] here the author's examination explored the horizontal and vertical burden opposing conduct of fortified solid segments run of the mill of pre-1970s development.

Eight full-scale examples were developed and were stacked with steady hub load and expanding cyclic sidelong removal increases until disappointment. Test information was given and thought about conduct assessed by utilizing different assessment strategies.

Utilizing guideline stress investigation and a free body examination of the cross-area, a proposed strategy for assessing the shear quality of a fortified solid section was touched base at. The shear quality included commitments because of the solid and the transverse fortification.

The current structure model utilized proportionate swaggers to estimate the commitment of various infill dividers put in the base story of the structure as directed by FEMA 273. In any case, examinations of the deliberate story floats and those anticipated by the FEMA 273 investigations demonstrate that the displayed infill dividers are excessively firm. One of the proposed retrofits investigated was the expulsion of the infill dividers and it was discovered that the story floats of this "retrofitted" model all the more intently approximated those deliberate in the structure amid the 1994 Northridge tremor. Furthermore, on the grounds that the DRAIN-2DX program comes up short on a component with corrupting solidness and quality, when a component achieves its pinnacle quality the program enables it to keep up that quality, without redistributing the powers to different individuals. The absence of power redistribution may not permit DRAIN-2DX to precisely foresee the kind of framework disappointment that really happened in the structure amid the 1994 Northridge seismic tremor.

Investigations of the proposed retrofits of the structure met with shifting degrees of accomplishment. Despite the fact that the shear divider retrofit wiped out numerous issues with the structure segments, new ones emerged with establishment issues and shear basic shafts. The proposed propped outline retrofit gave the best-determined dimension of security to the structure, disposing of all issues with the segments, sections and shafts.

Maria Basdeki, Argyro Drakakaki (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.

The author composition exhibits the significance of rough techniques for evaluation of both RC structures and structures made of brickwork. Logically, the mechanical execution of a strengthened solid section when consumption has been assessed, affected by expanding even dislodging and the concurrent burden of a steady hub load. Moreover, an estimated technique for the evaluation of the seismic limit of existing structures has occurred. The rough strategy for OASP has been followed so as to survey a workmanship building and a correlation has been made with an authentic circumstance of it and limited component examination.

The ends expressed that Reinforced solid segments are unfit to adapt to the high uncertainties requests, owed to loading, coming about in the debasement of circles as well as

in serious corruption of every individual twisting; specifically, the versatile and the plastic distortion. The rough technique for OASP expectations of story float removals for medium quakes had all the earmarks of being progressively steady with the genuine circumstance in the result of the tremor. All the more explicitly, the outcomes demonstrated that the harms recorded because of seismic activity were observed to be in acceptable consistency with the proposed by OASP technique, rather than the outcomes dependent on EC2, where the harms were discovered obviously minor.

The technique for OASP does not consider the genuine mechanical properties of the stonework, because of the absence of exploratory testings. Consequently, Young's modulus of versatility significantly affects the technique, while a conceivable decrease of it prompts a noteworthy increment of the deficiency list of the structure as indicated by EC8. In this way, deficiency record as indicated by EC8 are moderate in contrast with those as per OASP and Greater intermingling of the two techniques could be seen for qualities bigger than 1.5 of the conduct factor.

Gabriele Milaniet. al. (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.

In the author's paper, a kinematic FE limit investigation approach for the 3D examination of brickwork structures exposed to even activities was introduced where both all through plane disappointments are considered in the assessment of the all-out interior power dispersed.

The primary ends got from the examination was that that: (a) the proposed methodology enables us to acquire disappointment components and breakdown loads, gives comparable outcomes to increasingly complex methodologies dependent on nonlinear additions and iterative limited component recreations. The outcomes are acquired for a little part of the exertion when contrasted with nonlinear reproductions. The most extreme handling time of the proposed methodology for the models appeared in the present paper does not surpass 150 s; (b) the affectability examination completed demonstrates that diverse overwhelming disappointment instruments can be gotten in the investigation after a moderate change in the material parameters. In this manner, the noteworthy alert is prescribed when endeavouring to repeat existing harm designs in existing stonework structures utilizing progressed nonlinear reproductions.

II. CONCLUSION

No detailed study on non linear analysis of stone masonry 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 masonry materials.

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