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INVESTIGATION OF LINEAR DYNAMIC ANALYSIS AND DUCTILE DE SIGN OF HIGH RISE STRUCTURE AS PER REVISED INDIAN CODE: A REVIEW

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Abstract— This paper compares the New IS 13920-2016 with the Old IS 13920-1993 standards for ductile column design and construction. Recent Indian earthquakes shown that traditional structure design and construction approaches fail to fulfill basic seismic protection criteria. Conventional building must consider ductile design and detailing procedures. The overall ductility of reinforced concrete buildings is a tricky subject. It is possible to prevent seismic damage and life-threatening collapse by using precise design variables and reinforcing details in important structural areas. This is a simple, cost-effective method that is specified in the Indian Bureau of Standard Code of Practice (IS13920). The Equivalent Static approach should be used to compare multi-story framed structures, including column c/s aspect ratio and minimum column requirements. It is also advised to examine time period, base shear, storey drift, and storey displacement while analyzing and designing multi-story structures. An earthquake-proof structure must follow IS 13920 for strengthening details. This moment-resisting frame is created via ductile detailing on an RCC frame. This study examines the IS code recommendations for beam column joints and their design. The new ductile detailing requirements constitute a major structural change. As a result, a structure built before the IS 13920 regulations were revised will be less detailed for strong seismic forces. Good design choices need understanding joint behavior. On the consequences of earthquakes on joints, the thesis focuses on bond and shear transmission, which are fundamental to joint function. We'll compare deflections. This research uses ETABS connect software to conduct seismic analysis on a G+20 storey building using IS 13920:1993 (old version) and IS 13920:2016 (new version) (new version). Story & era in comparison to old code data, fresh code data reduces drift. With new IS criterion, the displacement decreases.

Keywords — Linear analysis, ductile design, high rise building.

INTRODUCTION

Earthquakes occur, a building undergoes dynamic motion. This is because the building is subjected to inertia forces that act in opposite direction to the ac celeration of earthquake excitations. These inertia forces, called seismic loads, are usually dealt with by assuming forces external to the building. So, apart from gravity loads, the structure will experience dom inant lateral forces of considerable magnitude during earthquake shaking. It is essential to estimate and specify these lateral forces on the structure in order to design the structure to resist an earthquake. The duc tility of a structure is the most important factor affect ing its seismic performance and it has been clearly observed that the well designed and detailed rein forced structures behave well during earthquakes and the gap between the actual and design lateral force is Structure..

The national building code of India (NBC) 2015 is likely to be released by bureau of Indian standards during December 2016/January 2017. Various sec tions of this NBC have undergone changes as per lat est technologies and user requirements. The docu ment CED 39 (and corresponding IS.1893) on "crite ria for earthquake resistant design of structures" (part-1–general provisions for all structures and spe cific provisions for buildings) has undergone tremendous changes for structural design requirements. The process of designing high-rise buildings have changed over the past years. In the most recent years it is not unusual to model full three-dimensional fi nite element models of the buildings. This due to the increased computational power and more advanced software. However, these models produce huge amount of data and results where possible errors are easily overlooked, especially if the model is big and complex. If the engineer is not careful and have a lack of knowledge of structural behaviour and finite element modelling, it is easy to just accept the results without critical thoughts. Furthermore, different ways of modelling have a big influence on the force and stress distribution. This can lead to time consuming discussion and disagreements between engineers as they often have different results from calculations on the same building.

Instead of designing structures elastically to with stand lateral forces from severe and infrequent earth quakes, designing structures for lower force levels and higher ductility is a widely accepted practice in performance-based design.

1.1 STUDY OBJECTIVES:

Based on the problem statements discussed earlier, the objectives of this study are:

1. Investigation of dynamic behavior of high rise structure by response spectrum method as per IS 1893 Part1-2016
2. Study of parameters such as diaphragm mass displacement, base shear and story drift.
3. Establish the impact of new revised codal provisions on the seismic behavior of high rise structures as compared to old code provi sions.
4. Ductile design of high rise structure as per new codal provisions given in IS 13920- 2016.

II. REVIEW OF LITERATURE

Farinha, M. D. F., Bezelga, A. A., & Azevedo, A. V. (2006)

This paper is intended to present a model that is be ing developed for use in the design of buildings with a reinforced concrete reticulate structure. First a brief reference is made to the applicability of the model, next the main requirements to be fulfilled by the sys tem are mentioned, and lastly the main developments carried out are presented. The general use of integrat ed design systems is introducing several changes in the different phases of the design of building struc tures. Designers can free themselves of arduous and repetitive work and have more time available for conception and optimization of solutions. Then the necessary conditions are created for increasing design quality, which will certainly contribute to a better quality of the buildings.

Rama Raju, K., Shereef, M. I., Iyer, N. R., & Go palakrishnan, S. (2013)

This paper states that, consideration of site specific lateral loading due to wind or earthquake loads along with vertical gravity loads is important for finding the behavior of the tall buildings. As the height of a building becomes taller, the amount of structural ma terial required to resist lateral loads increases drasti cally. The design of tall buildings essentially involves a conceptual design, approximate analysis, prelimi nary design and optimization, to safely carry gravity and lateral loads. The design criteria are strength, serviceability and human comfort. The aim of the structural engineer is to arrive at suitable structural schemes, to satisfy these criteria. In the present study, the limit state method of analysis and design of a 3B+G+40-storey reinforced concrete high rise build ing under wind and seismic loads as per IS codes of practice is described. Safety of the structure is checked against allowable limits prescribed for base shear, roof displacements, inter-storey drifts, acceler ations prescribed in codes of practice and other rele vant references in literature on effects of earthquake and wind loads on buildings.

Svetlana Brzev IS:13920-2016. (2016) This paper states that , the Parliament of India has set out to pro vide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached pub lication of the Bureau of Indian Standards is of par ticular interest to the public, particularly disadvan taged communities and those engaged in the pursuit of education and knowledge, the attached public safe ty standard is made available to promote the timely dissemination of this information in an accurate man ner to the public.

Hosseini, M., & Rao, N. V. R. (2017)

This paper states that, the shear walls are located on each level of the structure, to form an effective box structure, equal length shear walls are placed sym metrically on opposite sides of exterior walls of the building. Shear walls are added to the building interi or to provide extra strength and stiffness to the build ing when the exterior walls cannot provide sufficient strength and stiffness or when the allowable span width ratio for the floor or roof diaphragm is exceed ed. Shear walls are analyzed to resist two types of forces: shear forces and uplift forces. Shear forces are created throughout the height of the wall between the top and bottom shear wall connections. Uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Shear walls are analyzed to the provide necessary lateral strength to resist horizontal forces. Shear walls are strong enough, to transfer these horizontal forces to the next element in the load path below them. The seismic motion that reaches a structure on the surface of the earth is influenced by local soil conditions.

Hosseini, M., & Rao, N. V. R. (2017)

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Gautam, K., & Gupta, M. (2020)

This study reviewed the recent developments in find ing the response reduction factor for RC framed building and the influence of soil-structure interaction (SSI) effects in the various responses of the building. For Response Reduction Factor, the nonlinear analy sis was done in order to capture all the hysteretic En ergy beyond the elastic limit. Various approaches to pushover analysis and time history analysis have been mentioned in this review paper.

Cavdar, O. (2021)

In this paper, the seismic behavior of existing rein forced concrete tall building is investigated by the linear and nonlinear dynamic analysis. The selected reinforced concrete structure was designed according to "Turkey Seismic Code-2007" (TEC-2007). A typi cal 41 story reinforced concrete building is designed. Turkey Building Earthquake Code-2018 (TBEC 2018) is utilized for evaluating the seismic perfor mance of the selected building. Natural earthquake acceleration record selected and adjusted for compat ibility with the adopted design spectrum, is used.

Ferraioli, M. (2021)

This paper states that, the current generation of seis mic design codes is based on a linear elastic force based approach that includes the nonlinear response of the structure implicitly through a response modifi cation factor (named reduction factor R in American codes or behaviour factor q in European codes). However, the use of a prescribed behaviour factor that is constant for a given structural system may fail in providing structures with the same risk level. In this paper, the behaviour factor of reinforced concrete frame structures is estimated by means of nonlinear static (pushover) and nonlinear incremental dynamic analyses. For this purpose, regular reinforced con crete frames of three, five, seven, and nine storeys designed for high ductility class according to the Eu ropean and Italian seismic codes are investigated, and realistic input ground motions are selected based on the design spectra. Verified analysis tools and refined structural models are used for nonlinear analysis.

Sudhir K Jain (2003)

This paper states that Indian seismic code IS 1893 has now been split into a number of parts and the first part containing general provisions and those pertain ing to buildings has been released in 2002. There has been a gap of 18 years since the previous edition in 1984. Considering the advancements in understanding of earthquake-resistant design during these years, the new edition is a major upgradation of the previ ous version. This paper reviews the new code; it con tains a discussion on Clauses that are confusing or vague and need clarifications immediately. The typo graphical and editorial errors are pointed out. Sugges tions are also included for next revision of the code.

S.K. Ahirwar, S.K. Jain and M. M. Pande (2008)

In this research "earthquake loads on multi-storeys buildings as per is: 1893-1984 and is: 1893-2002: a comparative study": As a result, Indian seismic code IS: 1893 has also been revised in year 2002.This pa
per presents the seismic load estimation for multi storey buildings as per IS: 1893-1984 and IS: 1893- 2002 recommendations. Four multi-storeys RC framed buildings ranging from three storied to nine storied are considered and

analyzed. The process gives a set of five individual analysis sequences for each building and the results are used to compare the seismic response viz. storey shear and base shear computed asper the two versions of seismic code. The seismic forces, computed by IS: 1893-2002 are found to be significantly higher, the difference varies with structure properties. It is concluded that such study needs to be carried out for individual structure to predict seismic vulnerability of RC framed build ings that were designed using earlier code and due to revisions in the codal provisions may have rendered unsafe.

CONCLUSION

The displacement is also decrease with new IS re quirements. Using the new code requirements of shear design of beam column joint, they are effective for high rise building. The revision of codes is a pe riodic process which results from continuous and systemic research in the related field. IS: 13920- 2016 is the first revision of the code on ductile de tailing of RC structures subject to seismic forces. The first revision has added some design aspects also along with detailing. The provisions of earlier code have been suitably modified keeping in view more strength and stiffness and enhanced energy dissipa tion in the event of an earthquake along with ductili ty for seismic resistance of structures. The revision of codes is a periodic process which results from continuous and systemic research in the related field. IS: 13920-2016 is the first revision of the code on ductile detailing of RC structures subject to seismic forces. The first revision has added some design aspects also along with detailing.

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