Effective Location Of Shear Wall In Torsionally Imbalanced Reinforced Concrete Tall Building Under Lateral Loading:A Review

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Abstract- *There in forced concrete buildings are subjected to lateral loads due to wind and earthquake and these forces are predominant especially in tall and slender buildings. In order to resist these lateral loads, shear wall share provided in the building as alter allowed resisting element which inherently possesses sufficient strength and stiffness. The importance of shear wall in mitigating the damage to reinforced concrete structures is well documented in the literature. The shear walls are generally classified into three categories on the basis of aspect ratio of the shear wall (height/width ratio) viz., short, squat and slender shear walls. The short shear wall, though not very common, has the aspect ratio less than unity. The shear walls with aspect ratio between one and threeare generally considered to be of squat type and shear walls with aspect ratio greater than 3are considered to be of slender type. Due to functional as well as the architectural requirements, sometimes the shear walls are penetrated with openings to accommodate door sand windows. In general the structural response of shear wall strongly depends on the type of loading, aspect ratio of shear wall, size and location of the openings in the shear wall and ductile detailing(strengthening)around the opening so shear walls.Although it is implied that the behavior of shear wall is strongly influenced by these verity of loading, it is essential to understand the response characteristics of shear wall under different type of loading conditions, viz. static and dynamic, as well as at different regimes, i.e. linear as well as non-linear.*

Keywords- lateral loads, Shear wall, Reinforced Concrete.

I. INTRODUCTION

Shear wall systems are one of the most commonly used lateral load resisting systems in high-rise buildings. Shear walls in buildings must be symmetrically located in plan to reduce ill- effects of twist in buildings. When shear walls are situated in advantageous positions in the building, they can form an efficient lateral force resisting system by reducing lateral displacements under earthquake loads. Recent codes have defined torsional irregularity as the condition where the maximum story drift, including accidental torsion, at one end of the structure transverse to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure. This means that if one end of a rectangular structure drifts in excess of 2.33 times the other end, extreme torsional irregularity is said to exist.Recent codes have defined torsional irregularity as the condition where the maximum story drift, including accidental torsion, at one end of the structure transverse to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure. A little pencil work will show this means that if one end of a rectangular structure drifts more than 1.5 times the other end, torsional irregularity is said to exist.

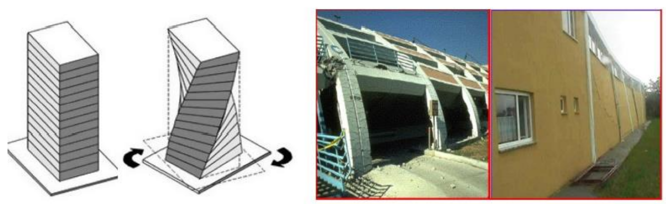

Figure 1. Generation of torsional moment in asymmetric structures

For the newer category of extreme torsional irregularity, the calculation steps are fundamentally the same, but this designation is assigned to structures where the maximum story drift, including accidental torsion, at one end of the structure transverse to an axis is more than 1.4 times the average of the story drifts at the two ends of the structure. Again, in simple terms, this means that if one end of a rectangular structure drifts in excess of 2.33 times the other end, extreme torsional irregularity is said to exist.

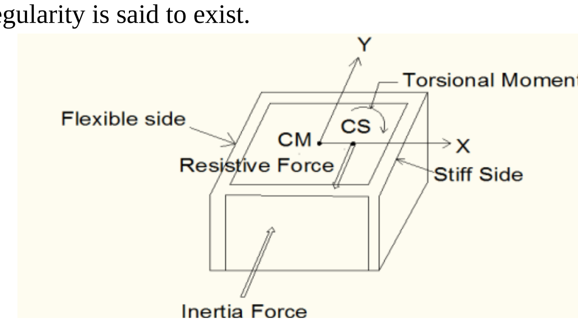

Figure 2 Generation of torsional moment in asymmetric structures

The torsion will be developed at Re-entrant corners in L-shape and T- shape Building .the Re-entrant corner, lack of continuity corner is the common characteristic of overall building configuration that in plan .L-shape and T-shape occurs due to lack of tensile capacity and force concentration. According to IS-1893(Part1)-2002, Plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction. In fig 3 shows differential motion between different parts of building, resulting in local stress concentration at the notch of the re-entrant corners.

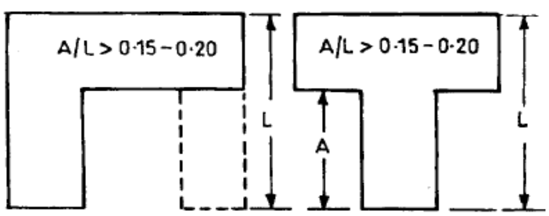

Figure 3. Examples of building with plan irregularities

Shear Wall

Shear wall is a structural member used to resist lateral forces i.e. parallel to the plane of the wall. For slender walls where the bending deformation is more, Shear wall resists the loads due to Cantilever Action. In other words, Shear walls are vertical elements of the horizontal force resisting system.In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants, create powerful twisting (torsional) forces. This leads to the failure of the structures by shear. Shear walls are especially important in high-rise buildings subject to lateral wind and seismic forces. Generally, shear walls are either plane or flanged in section, while core walls consist of channel sections. They also provide adequate strength and stiffness to control lateral displacements. The shape and plan position of the shear wall influences the behaviour of the structure considerably. Structurally, the best position for the shear walls is in the center of each half of the building. This is rarely practical, since it also utilizes the space a lot, so they are positioned at the ends. It is better to use walls with no openings in them. So, usually, the walls around lift shafts and stairwells are used. In addition, walls on the sides of buildings that have no windows can be used

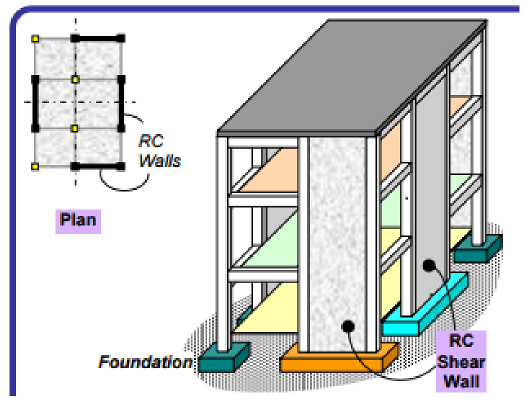

Figure 4.Reinforced concrete shear wall in building

Base isolation on soft soil

Although the concept of base isolation is gaining widespread acceptance in different parts of the world, a question is being raised over performance of base isolated building located at soft soil sites as to the effect of a low site natural frequency on isolated structures. To address these concerns carried out an experimental study on shake table at EERC, University of California at Berkeley (Figure 3.5). Two different isolation systems were used in the shake table tests. One isolation system was designed to provide the model with a natural period that corresponds to the period of a proposed nuclear facility. The second system made use of newly developed high damping rubber with low shear modulus, which provides a frequency of about 25% lower than that given by the first system. This allowed the assessment of (i) the benefits of lengthening the period of isolation system where the site is particularly soft and (ii) the practicality of long-period isolation systems based on elastomeric components. The test series has shown that the base isolation systems can be used at soft-soil sites under circumstances where load on the isolation system and, consequently, sizes of the isolation systems are sufficiently large to accommodate the resulting large displacement.

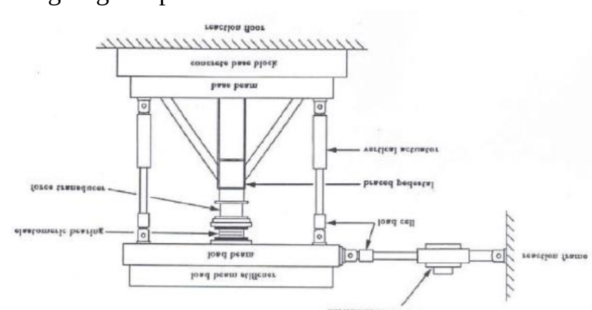

Figure5. Typical set up for shear test of laminated rubber bearing

Base isolation design

In general, base isolated buildings are designed such that the superstructure remains elastic and nonlinearities are localized at the isolation level. Hence, the superstructure is modelled by a linear elastic system and nonlinear behaviour is confined in base isolation bearings. The base and floors are assumed to be infinitely rigid in plane. The superstructure and the base are modelled using 3 degrees of freedom (DOF) per floor at the center of mass. Each nonlinear isolation bearing is modelled using Book-Wen model. Recently, active or semi-active devices are also used in place of passive damper for limiting excessive deformations in the isolated system. The equations of motion for superstructure and base of the isolated system are as follows:

The finite element analysis is a numerical technique. In this method all the complexities of the problems, like varying shape, boundary conditions and loads are maintained as they are but the solutions obtained are approximate. Because of its diversity and flexibility as an analysis tool, it is receiving much attention in engineering. The fast improvements in computer hardware technology and slashing of cost of computers have boosted this method, since the computer is the basic need for the application of this method. A number of popular brand of finite element analysis packages are now available commercially. Some of the popular packages are STAAD-PRO, GT-STRUDEL, NASTRAN, NISA and ANSYS. Using these packages one can analyze several complex structures. The finite element analysis originated as a method of stressanalysis in the design of aircrafts. It started as an extension of matrix method of structural analysis. Civil engineers use this method extensively for the analysis of beams, space frames, plates, shells, folded plates, foundations, rock mechanics problems and seepage analysis of fluid through porous media. Both static and dynamic problems can be handled by finite element analysis.

1.3 Problem statement

"A comparative study of effective location of shear wall in torsion ally imbalanced reinforced concrete tall building under lateral loading"

1.4Objectives of the study

The objectives of the study is as listed below,

To study effective location of shear wall in torsion ally imbalance in a concrete tall structure. To study lateral loading on the concrete tall structure.
To study effect of irregularities in low rise, medium rise and tall building in accordance with IS 1893:2002.
To analyze the stresses and failure occurred at re-entrant corner for L- shape and T-shape building.
To identifying the effective solution for irregularities with base isolators, architectural relief and shear wall.

1.5 Scope of the study

In order to reduce these effects shear walls can be added on the outer North and West sides of the Main Block building. Through the study lateral loading on the concrete tall structure. Selective weakening of the reinforced concrete coupling beams (to the perimeter concrete frames) could be carried out to minimize the likelihood of localized damage to the coupling beams during a significant earthquake. Through study effect of irregularities in low rise, medium rise and tall building in accordance with IS 1893:2002.Modifications could be made to the stairs and their supporting elements allowing the stairs to slide during a seismic event. To analyze the stresses and failure occurred at re-entrant corner for L- shape and T-shape building.

II. LITERATURE REVIVE

2.1ZeshanAlam1,Chunwei Zhang, and BijanSamali (2020)
Asymmetric structures have detrimental effects on the seismic performance because such structures create abrupt changes in the stiff ness or strength that may lead to undesirable stress concentrations at weak locations. Structural control devices are one of the effective ways to reduce seismic impacts, particularly in asymmetric structures. For passive vibration control of structures, VE dampers are considered among the most preferred devices for energy dissipation. Therefore, in this research, VE dampers are implemented at strategic locations in a realistic case study structure to increase the level of distributed damping without occupying significant architectural space and reducing earthquake vibrations in terms of story displacements (drifts) and other design forces. It has been concluded that the seismic response of the considered structure retrofitted with supplemental VE dampers corresponded well in controlling the displacement demands. Moreover, it has been demonstrated that seismic response in terms of understory drifts was effectively mitigated with supplemental damping when added up to a certain level. Exceeding the supplemental damping from this level did not contribute to additional mitigation of the seismic response of the considered structure. In addition, it was found that the supplemental damping increased the total acceleration of the considered structure at all floor levels, which indicates that for irregular tall structures of this type, VE dampers were only a good retrofitting measure for earthquake induced understory

deformations and their use may not be suitable for acceleration sensitive structures.

2.2 J. Abdullah et.al. (2017)T-shaped buildings are classified as buildings with plan irregularity and vulnerable to damages under seismic loading. This study investigates the sensitivity of lift core positions by comparing the percentage difference of the maximum torsional moment and building deformation for T-shaped reinforced concrete buildings. Building models having 6-storey and 12-storey were generated and analysed with the aid of SAP2000 software package. The results showed that the locations of the lift core significantly influenced the magnitude of the torsional moment and particularly true for all building heights. It is highly recommended that the position of the lift core must be carefully determined in order to reduce or arrest the failure associated to torsional moment.

2.3 ShaikhTabassumSayyad et.al (2016) The most significant aspect of seismic design and retrofitting a structure is estimating earthquake movements at the structure's location. The motion at the foundation level of a structure is supposed to be equivalent to bottom different ground motion in conventional structural analysis techniques. This assumption is accurate only for constructions supported by rock or even very stiff soils. For buildings built on soft soils, foundational motion differs from free field motion, and a rocking component induced by support flex on horizontally foundational motion has been incorporated. The term "soil-structure interaction" refers to the effect of the behaviour of the soil immediately under and surrounding the foundation on the reaction of the soil-structure when exposed to static or dynamic stresses. A foundation is a structure that connects the superstructure to the surrounding soil or rock. Under static circumstances, only vertical loads from the structure must be transferred to the supporting rock. In a seismic atmosphere, the loads exerted on a foundation by a structure undergoing seismic excitation may substantially exceed static vertical loads and potentially cause uplift; there will also be horizontally forces and even movement at the foundation level. The soil and rock at the location have unique properties that may dramatically enhance incoming earthquake movements travelling from the earthquake source.

2.4 H. Gokdemir ., H. Ozbasaran, M. Dogan, E. Unluoglu, U. Albayrak Eskisehir Osmangazi University, Department of Civil Engineering, 26480, Eskisehir,(July 2013) Turkey explains Seismic design Failure analysis Structures experience lateral defections under earthquake loads. Magnitude of these lateral defections is related to many variables such as structural system, mass of the structure and mechanical properties of the structural materials. Buildings should be designed so that they can resist earthquake induced defections and internal forces. Structural irregularities are important factors, which decrease the seismic performance of the structures. Buildings, which have structural irregularities, may experience different drifts of adjacent stories, excessive torsion, etc. according to irregularity type and fail during an earthquake. In this paper, effects of torsional irregularity on structures are studied. A computer program generates building models, which have different number of floors and floor areas, and calculations are made. Results are compared and precautions are given to prevent damages caused by torsional irregularity under earthquake loads. Also, statements in different earthquake codes about torsional irregularity are compared. Calculations show that separating big building sections from each other with proper separation distances and increasing lateral rigidity on the weak direction of the structures decrease the effect of torsion.

2.5 Miranda Novare Design, Wellington G.A. MacRae& T.Z. Yeow Department of Civil Engineering, University of Canterbury, Christchurch K. Beyer Department of Civil Engineering, Écolepolytechniquefédérale de Lausanne, Switzerland [1](2012) Stated that, all buildings are subjected to some degree of torsion which in turn changes the member demands from that of translation only. Torsional effects on buildings subjected to earthquakes are not found directly in structural analysis unless full three-dimensional inelastic dynamic time history analysis is conducted. Since design is often conducted using two-dimensional analysis, these effects are not directly considered. There is currently an understanding of how different parameters may influence torsion, however, the degree to which these factors influence torsion is relatively unknown. Currently there are two simple design recommendations by Beyer/Priestley and MacRae; however, these need to be verified to be used in design. To do this, earthquake ground motions are applied in one direction to single storey structures with different in plane wall strength and stiffness, rotational inertia and torsional restraint to obtain the inelastic dynamic response considering torsion. A single multi-storey analysis is performed to verify the response compared to that of the single storey. It is found that an increase in strength on an element does not increase the demand on any critical element. An increase in rotational mass or a decrease in stiffness eccentricity decrease critical wall displacement. Increasing torsional restraint reduces the critical wall displacement. Beyer/Priestley’s prediction is generally non-conservative while McRae’s is conservative. The multi-storey analysis was well approximated by the single-storey response. Both single and multi-storey structures are recommended to be designed by McRae’s method.

2.6 J. Yang, J.B. Li, G. Lin[3] (2006) indicate that direct integration of the ground acceleration data provided for seismic soil–structure interaction analysis often causes unrealistic drifts in the derived displacement. The drifts may have a significant effect on large-scale interaction analysis in which the displacement excitation is required as an input. This paper proposes a simple approach to integration of the acceleration to acquire a realistic displacement–time series. In this approach, the acceleration data is firstly baseline-corrected in the time domain using the least-square curve fitting technique, and then processed in the frequency domain using a windowed filter to further remove the components that cause long-period oscillations in the derived displacement. The feasibility of the proposed approach is assessed using several examples and comparisons are made between the results obtained using the proposed scheme and those using other complicated procedures.

2.7 LIU Jingbo, GU Yin, WANG Yan and LI Bin[4] (2006) propose a simplified and efficient procedure, based on the viscous-spring artificial boundary and the modal superposition method, and is developed to analyse the dynamic soil-structure interaction system in the time domain. The viscous-spring artificial boundary introduced in this procedure transforms the infinite soil-structure interaction system to an approximately finite system. A seismic wave input method is used to transform the wave scattering problem into the wave source problem. The modal superposition method is then applied to this approximate finite system. The results show that this method with only a few modes can significantly reduce the computational time with almost the same precision as the traditional direct integration method. Comparison of results from different loading times demonstrates that the advantages of this method are evident in computing with long loading time

2.8 J.L. Humar and S. Yavar(2002), : Observation of damage after earthquakes has shown that torsional vibration of buildings, induced by lateral seismic ground motion, may cause serious distress in a structure, sometimes leading to its collapse. Most seismic codes include provisions for design against seismic torsion. The code provisions are specified in terms of design eccentricities that depend on the relative stiffnesses of the lateral load-resisting elements. Also, the allocation of strength among the lateral load-resisting elements is related to the stiffness of such elements. The current practice is to determine the stiffness of an element from its given geometry. Recent studies have, however, shown that in reinforced concrete structures, the stiffness does not depend on geometry alone, but is strongly related to the strength of the element. Consequently, the conventional method of design of concrete structures for seismic torsion in which the stiffness of an element is considered as being independent of strength needs to be reviewed.

III. CONCLUSION

This chapter discussed briefly the literatures related to the topic, “Effective Location of Shear Wall in Torsionally Imbalanced Reinforced Concrete Tall Building under Lateral Loading:A Review”. From the review papers studied we can summarized that, It is found that an increase in strength on an element does not increase the demand on any critical element. An increase in rotational mass or a decrease in stiffness eccentricity decrease critical wall displacement. Increasing torsional restraint reduces the critical wall displacement. Observations of damage after earthquakes has shown that torsional vibration of buildings, induced by lateral seismic ground motion, may cause serious distress in a structure, sometimes leading to its collapse. effects of torsional irregularity on structures are studied. Building models, which have different number of floors and floor areas, are generated by a computer program and calculations are made. Results are compared and precautions are given to prevent damages caused by torsional irregularity under earthquake loads.

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