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Seismic Analysis of Multi storey Framed Structure

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Abstract: *Multi-Storey Frames are generally the basis of construction of multi-storey and high rise buildings. This researchconcisely discusses the analysis and methodology of irregular and regular buildings with and without the incorporation of Fluid Viscous Dampers subjected to seismic loads in accordance with IS 1893: Part1 2016. The type of method adopted is Static Analysis with reference and accordance to IS 456:2000 and IS 1893:2016. The objective of this study is to demonstrate and conclusively prove the efficiency of Fluid Viscous Dampers with the help of ETABS by considering various aspects of Structural Analysis like storeydisplacement.The height of each storey is taken as 3.25 m for regular building and 3m for, making total height of the structure 45m. Loads considered are taken in accordance with the IS-875 (Part1, Part2), IS-1893(2016) code and combinations are according to IS-875(Part5). Post analysis of the structure, the maximum storey displacement of the buildings for the considered load combinations in accordance with IS 456:2000 for both buildings with and without dampers is compared.*

Key Word: *Muti-Storey Frames, Dampers, ETABS, Analysis,IS 456:2000,IS 456:2000,IS 1893(Part-1):2016.*

I. INTRODUCTION

There are various meanings associated with the word "seismic engineering." The World Conferences on Earthquake Engineering, for instance, cover a range of issues that fall under various disciplines outside engineering. The practice of applying engineering, primarily civil engineering, to the challenges posed by earthquakes is known as earthquake engineering.Buildings that are outdated and fragile combined with seismic risks increase the risk of destruction, loss of life, and damage to property. Risks have the potential to seriously harm infrastructure, including buildings. The majority of insured property loss worldwide due to natural disasters is due to earthquakes. The likelihood of exposure to various risks has significantly increased due to the rapid population growth and economic development, even though one hazard may be more substantial than another. The heightened danger to structures in regions is not taken into consideration by the way that current design rules and hazard mitigation measures approach earthquake. The number of tall buildings, both residential and commercial, has significantly increased recently, and the current trend is toward taller structures. As a result, the relevance of lateral loads like seismic forces is growing, and practically every designer must deal with the challenge of supplying adequate strength and stability against lateral loads. For this reason, to estimate earthquake loading on high-rise building design.Today's technology allows for the construction of extremely large structures, but in India, we have not yet developed the same level of proficiency with it as other regions of the world. It has been discovered that the development of tall buildings' structural systems and their technological underpinnings is what drives their growth. Ali and Moon introduce a novel division of the primary structural systems into interior structures and outer structures. The lateral force-resisting system, sloping outer concrete columns, long span post-tensioned beams, and structural design considerations transfer girder and other design challenges are faced in the tall building design. Moving forward, every nation has created its own standards for building safe homes, buildings, and structures based on its own experiences with building materials, construction methods, and the natural world.

1.1 Brief Methodology of the Project

In the present work dynamic analysis and comparison of different shapes of building is carried out using ETABS 2016 software. The ETABS software is used to develop 3D models and to carry out the analysis. Critically understand the comparison between the Regular and Irregular shapes of multi storey buildings. Two types of structures are to be analyzed: Regular and Irregular shaped. To model the buildings according to IS Codal provisions. The loads acting on any tall buildings are Gravity load and Lateral load. The Gravity load comprises Dead Load, Live Load, and the Lateral load comprises Seismic Load and Wind Load. It's essential to spot the seismic response of the structure even in high seismic zones to cut back the seismic damages in buildings. A study involving dynamic effect of wind load on RC buildings and study the behavior of the buildings. To determine a seismic load effect on different shapes of building using Indian standard, spread sheets are prepared. In order to withstand the lateral loads acting on the structure there is a need to provide the lateral load resisting system. These structural systems transfer the lateral loads through the components which are interconnected among them. Comparative study

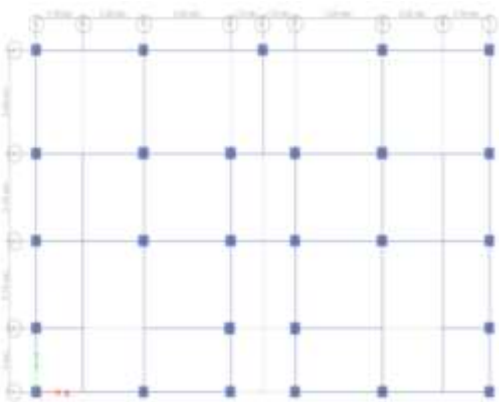
on the result obtained from the above analysis. As a part of research the international standards and their provisions were critically studied. For this purpose, following codes were considered:
a) Indian Standard - IS 456:2000 - Code of practice for plain and reinforced concrete.
b) Indian Standard - IS 800:2007 - Code of practice for general construction in steel.
c) Indian Standard- IS 1893(Part-1):2016 - Criteria for earthquake-resistant design of structures:
Part 1 General Provisions and buildings.

II. LITERATURE SURVEY

Jianguo Dinget al[1] argues that the results from MS-TMM and ANSYS analysis are one and the same. But it is noted that MS-TMM is more time efficient than the ANSYS analysis i.e. ANSYS takes 20 times more time than the MS-TMM method. And in addition to this MS-TMM has greater calculation efficiency too without hampering the calculation efficiency. L.M. Meggett et al [2] built a reinforced concrete portal frame and tested to study the seismic behavior of multi-storey frames which are resisting appreciable gravity loads. In the test two constant point loads were applied to the beam while cyclic lateral loads were applied to the frame to represent earthquake loading. Alia O. M. Ahmedet al[3] aimed to assist the development of performance based recommendations for both thin-walled and cold-framed steel portal frames.JaafarDheyaa et al [4] presents an experimental and numerical investigations for three reinforced self-compacting concrete portal frames tested under uniform load. Tadatoshi Furukawa1 et al [5] proved that the strength of R/C frames is highly improved by using Portal-Grid method. And the strength and rigidity of the reinforced frames can be calculated to sum up strength and rigidity of portal frames and of R/C frames. Yuanqi Li et al [6] focuses on a series of monotonous loading and hysteresis loading tests on cold-formed steel portal frames conducted. JaafarDheyaa et al [7] proposes an analytical model to estimate the seismic displacement capacity, at serviceability and ultimate limit states, of timber portal frame structures with dowelled joints. The predictions from the simplified formula are compared with the results of numerical analyses carried out on a sample of representative cases. Aria Ghabussi et al [8] focuses on using steel curved dampers (SCD) systems in studying the structural behavior of steel portal frames. Five dampers with the same length and thickness, yet with different angles and eccentricities, had been used in the pitched roof symmetric and mono-pitch portal frames. Series of cyclic loading were imposed on the frames equipped with various curved dampers to assess their impacts on steel portal frames. Giuseppe Muscolino et al [9] proposes a consistent model to evaluate, in both frequency and time domain, the seismic response of steel frames with viscoelastic semi-rigid joints and validates with numerical examples.TamásBalogh et al [10] deals with the complex structural optimization of steel structures subjected to seismic loading. The developed algorithm adopts state-of-the-art design and analysis tools with respect to the seismic performance assessment and to the optimization methods. The performance assessment is based on complex and comprehensive reliability analysis directly incorporating the uncertainties of the seismic effects and the response of the structure.

III.DESIGN AND IMPLEMENTATION

The building design and load calculations are designed as per Indian Standard codes.Dead and superimposed dead loads calculations are done as per IS 875 Part 1:1987 and live load calculations are done from part 2 of the same code.Seismic load parameters and important terms in seismic loading are derived from IS 1893 Part 1:2016.The plans of the G+3 regular building and G+11 irregular building is shown in Fig 3.1 and Fig 3.2 .The regular building consists of columns of size 350X350 mm and 375X375 mm with clear cover of 40 mm and rebars of 16 mm diameter with lateral ties of 8 mm.Primary beams are of size 240X375 mm and secondary beams are size 240X250 mm with 12 mm diameter rebars and 25 mm clear cover. Two way slabs are used with torsional reinforcement of size 10 mm diameter with clear cover 20 mm.The residential building has a floor height of 3.25 m with the plinth area of 16.5 X m.sq.The regular building is located in mumbai with zone factor of 0.16 and IF=1.



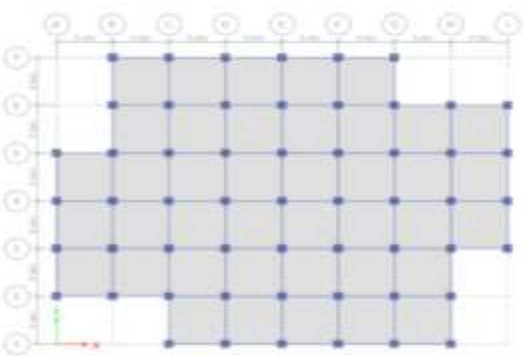


Fig 3.1 Plan of regular building **Fig 3.2 Plan of irregular building**

The G+11 irregular building is constructed from M30 grade concrete with steel reinforcement grade of Fe500.It consists of columns of size 500mmX500 mm with beams of size 350mmX500 mm.It consists two way slabs of thickness

150m. The building is located in zone 4 with the zone factor as 0.36 and IF+1 for resting loads.The plot area for the irregular building is 27x27 m.sq.

The load combinations considered for the regular and irregular building are shown in the table 3.1 and table 3.2. All the load combinations are applied in accordance with IS 456:2000.To study and demonstrate the effect of dampers in absorbing seismic loads was done by considering the two buildings with and without dampers with the exact same loading conditions.The type of damper used was Fluid Viscous Dampers with capacity of 500 kN and weight 98 kgs as suggested by ASCE code 7-16.The dampers is so selected as to provide optimum results keeping in mind cost efficiency and handling,they have been strategically placed on all the corners of the building so as to minimize the story displacement and preserving the aesthetics of the building with minimum spatial obstruction to the people residing in the building.

Sl. No.	Load combinations in E tabs	Definition of Combination
1.	DCon 15	1.2(DL+LL+EQ x)
2.	DCon 16	1.2(DL+LL-EQ x)
3.	DCon 17	1.2(DL+LL-EQ y)
4.	DCon 18	1.2(DL+LL+EQ y)

Table 3.1 Load Combinations definition for Irregular building

Sl. No.	Load Combinations in Etabs	Definition of Load Combination
1.	A 23	1.2(DL+SIDL+LL+El x)
2.	A 24	1.2(DL+SIDL+LL-El x)
3.	A 29	1.2(DL+SIDL+LL+El y)
4.	A 30	1.2(DL+SIDL+LL-El y)

Table 3.2 Load Combinations definition for Regular building

4.1 Results and Discussıon

The following results were obtained and tabulated after analysis of the two structures under the considered loading conditions and the percentage reduction in maximum storey displacement was calculated.

4.2 Result comparison for G+11 Irregular building

Load Combinations	Maximum Storey Displacement with Dampers(mm)	Maximum Storey Displacement without Dampers(mm)	Percent Reduction in max. Storey Displacement
1.2(DL+LL+EQ x)	46.45	54.67	15.04 %
1.2(DL+LL-EQ x)	27.68	47.07	41.19%
1.2(DL+LL-EQ y)	46.50	`57.28	18.82%
1.2(DL+LL+EQ y)	31.60	49.83	36.58%

4.3 Result comparison for G+3 Regular building

Load Combinations	Maximum Storey Displacement with Dampers(mm)	Maximum Storey Displacement with Dampers(mm)	Percent Reduction in max. Storey Displacement
1.2(DL+SIDL+LL+El x)	11.60	13.58	14.58%
1.2(DL+SIDL+LL-El x)	13.04	14.80	11.89%
1.2(DL+SIDL+LL+El y)	06.31	13.18	52.12%
1.2(DL+SIDL+LL-El y)	07.33	12.28	40.31%

As inferred from the above result comparison the incorporation of Fluid Viscous Dampers in both regular and irregular building that there is a significant reduction in **Maximum Storey Displacement** for all the load combination significant for the comparison**.**

IV.CONCLUSION

The top levels of the respective regular and irregular structures, G+3 and G+11, are where the highest displacement may be seen. Since the maximum storey displacement is reduced when dampers are applied to structures under similar load conditions, the stability of the structure is increased. The percentage reduction in maximum storey displacement for G+3 regular building varies between 15 % to 40% with average being 27.9% for different load combinations considered whereas for the G+11 Irregular building the same value varied between 14% to 50 % with the average being 29.73%. This is obtained by examining the structure behavior using the structure model in ETABS. So, by following the IS guidelines and ASCE codal provisions, we can easily achieve around 50% reduction in maximum storey displacement when subjected to seismic loads.

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