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Comparitive Studies on Seismic Load and Wind Load for a Multistorey Building with Shear Wall

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Abstract : Tall buildings are prone to heavy damage due to lateral loads namely seismic and wind load .This damage causes a heavy loss of life .In order to improvise the standards of the building by introducing shear walls .A study was made using STAAD Pro V8i to study the deflection, Bending moment, Shear force caused due the Earthquake and wind load and on comparison with the buildings with shear wall subjected to same loading conditions. Indian Wind Code IS 875 (Part 3) 1987' [4]has been prepared by IIT Kanpur gives recommendations to obtain across wind response of tall buildings as per procedure. A 15 storey building considered to be located at zone III subjected to wind loads and seismic loads is analyzed with and without shear walls. Deflection study was made and the amount of deflection reduced when application of shear wall on two sides of a building was carried over.

1.0 Introduction

1.1 General

Some of the largest earthquakes of the world have occurred in India and the non-Engineered buildings from the fury of the earthquakes is a subject of highest priority in view of fact that in the moderate to severe seismic zones of the world more than 90%of the population is still living and working in such buildings, and that most loses of lives during earthquakes have occurred due to their collapse[6,7]. The threat to life is further increasing due to rising population particularly in developing countries, poverty of the people, scarcity of the modern building materials, viz., cement and steel, lack of awareness and necessary skills. The gradual increase in the no. of populated places subjected to earthquakes. Every year more than 3lakhs earthquakes occur most of which, fortunately are not of greater intensity or strike unpopulated areas. However some centres of severe earthquakes are located near cities and populated areas. An earthquake occurring in this centres results in the death of many people and the collapse of structures that have not been designed to resist earthquakes.

1.2 Earthquake

Earthquake doesn't kill people; it is the unsafe buildings, which do. The Bhuj earthquake is a living example. Earthquakes of much greater intensity have beenexperienced elsewhere in the world, but the death tools have been much lower than in Bhuj. Buildings can be made quake – resistant, if not quakeproof, by following building codes defined by seismic history of a particular region. In case California, which falls ina highly seismic region in the west coast of the U.S.? In October 1989, a high magnitudequake rocked the Santa Cruz Mountains in central California. The impact was felt indowntown San Francisco – 100kilometers away- where occupants of the Trans America were unnerved[7]. The 49 – storey office building shook for more than a minute. The U.S.Geological survey (USGS) instruments, installed years earlier, showed that the top floorswayed more than one foot from side to side! However, no one was seriously injured,and the Transamerica Pyramid was not damaged. This famous San Francisco landmarkhad been designed to withstand even greater earthquakes stresses, and design worked asplanned during the quake.

Based on the occurrence of earthquakes in the past in and around India, thecountry is divided into four seismic zones, namely zones II, III, IV, V, where II is theleast severe and V is the most severe. Based on this zoning, about 60% of India's landarea is under moderate seismic threat or more, i.e., under seismic zone III or above infact, the 1993 Killari earthquake in which over 10,000 persons died, occurred in an area that was considered to be non- seismic. Even now amongst our four mega-cities, Delhi is in seismic zone IV, which Mumbai, Calcutta and Chennai are in seismic zone III. Despite this level of seismic hazard, little is being done, particularly in these cities, to make the development akin to earthquake shaking. The quality of both design engineering and construction is way behind the expected seismic standards.

The experience of severe earthquake has shown that when structures were built in accordance with seismic codes, the consequences of earthquakes were least severe.

1.3 Seismic Load

Seismic force depends on mass of structure and the distribution of mass. The loadacts at the centre of mass of the structure[7]. The seismic force will be distributed along interior and exterior frames and columns in a structure. i.e., acts at location of centre ofmass[8.] A structure having lesser mass will perform well during seismic events since it attracts lesser load and the exposed area has got no influence on the performance during seismic events. The stiffness of the structure influences the seismic force developed. The base shear value is more at bottom and it decreases as height increases due to reduction in cumulative weight. The damping will be considered in the calculation of seismic forces. The inertia of the structure is the main factor which causes seismic force $m\ddot{u} + c\dot{u} + ku = 0$. These ismic force is mainly generated at the base of a structure. When a structure is subjected to seismic load, torsion will develop if the centre of mass and the centre of stiffness doesn't coincide. The soil type in which the structure stands will also affect its performance during seismic force. The performance of a structure during seismic events can be improved by providing base isolators which will retard the transfer of seismic load from ground to structure. The suction effects will not develop during seismic events. The deflection of the structure will be to and fro about the centre of mass and it causes stress reversal in members. The storey displacement will be large at upper floors during seismic events and the displacement will be parabolic. The maximum deflection of the structure will be around 0.4%.The IS codal provision deals with the seismic load IS31893-2002[2] and IS 13920-1993[3]. Non-structural elements inside the building such as furniture's, storage racks etc. can cause damage when a structure is subjected to seismic load, since it has mass and less stiffness. The seismic force can be artificially generate dusing a shake table. The seismic force will depend on the focus of earthquake and ground conditions through which the wave travels. The duration of seismic force varies from afew seconds to minutes and we will not get any warning the area affected by seismic force is large. The prediction of seismic event is only probabilistic. The design bases hear is computed and it is distributed along the vertical height of the building. This shear and force distribution is shown in fig. 1.a as per IS 1893 – 2002[4].

1.4 Wind Load

Wind force depends on the exposed area of the structure. The wind force will act mainly on exterior (i.e., exposed) frames and it may reduce to interior frames based on the type of structure (Shielding effect)[8]. A structure having higher mass will resist the wind load effectively and the structure having lesser surface area will perform better since it attracts lesser wind force. The stiffness of the structure has no influence on the wind force developed .The wind force increases as height increases if the exposed area remains sameThe damping will not be considered in the calculation of wind forces in normal conditions (i.e., for static analysis) Inertia has less impact in the.

Calculation

Calculation for wind and seismic load is calculated as further

Wind load for respective heights

Table 1.1. Tis tables shows the intensity of winds at different level

38.22	m/s	upto10
39.78	m/s	10 to 15
40.95	m/s	15 to 20
42.9	m/s	20 to 30
44.85	m/s	30 to 40
47.58	m/s	40 to 50

Seismic load for respective heights

Table 1.2.This table shows the seismic load distribution for different heights

Seismic Load	Q_b	Qi	Height
Q1	3.574247581	1411.44	3.5
Q2	14.29699032	1411.44	7
Q3	32.16822823	1411.44	10.5
Q4	57.18796129	1411.44	14
Q5	89.35618952	1411.44	17.5
Q6	128.6729129	1411.44	21
Q7	175.1381315	1411.44	24.5
Q8	228.7518452	1411.44	28
Q9	289.514054	1411.44	31.5
Q10	357.4247581	1411.44	35
Q11	432.4839573	1411.44	38.5
Q12	514.6916516	1411.44	42
Q13	604.0478411	1411.44	45.5
Q14	700.5525258	1411.44	49
Q15	804.2057056	1411.44	52.5

1.5 Shear wall

Shear wall is a structural system composed of braced panels to counter the effects of lateral load acting on a structure. Wind and seismic loads are the most common loads that shear walls are designed to carry. Under several building .Plywood is the convectional material

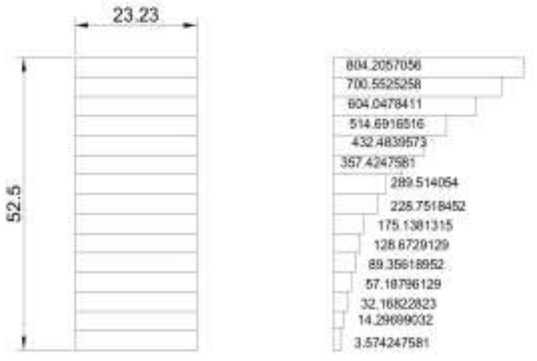


Fig 1 Seismic load distribution

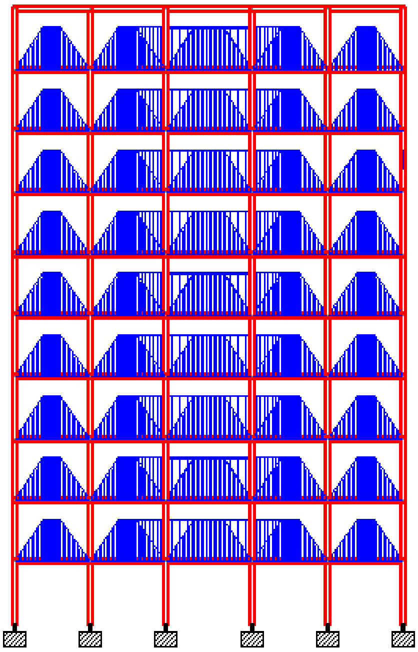


Fig 2 Distribution of load throughout the building

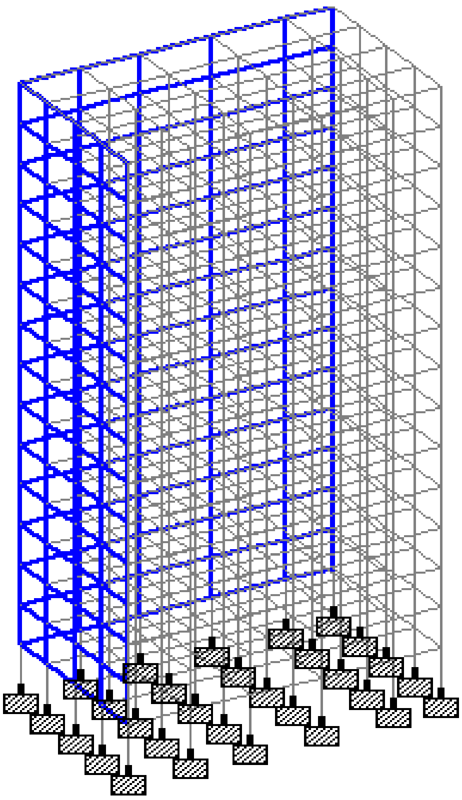


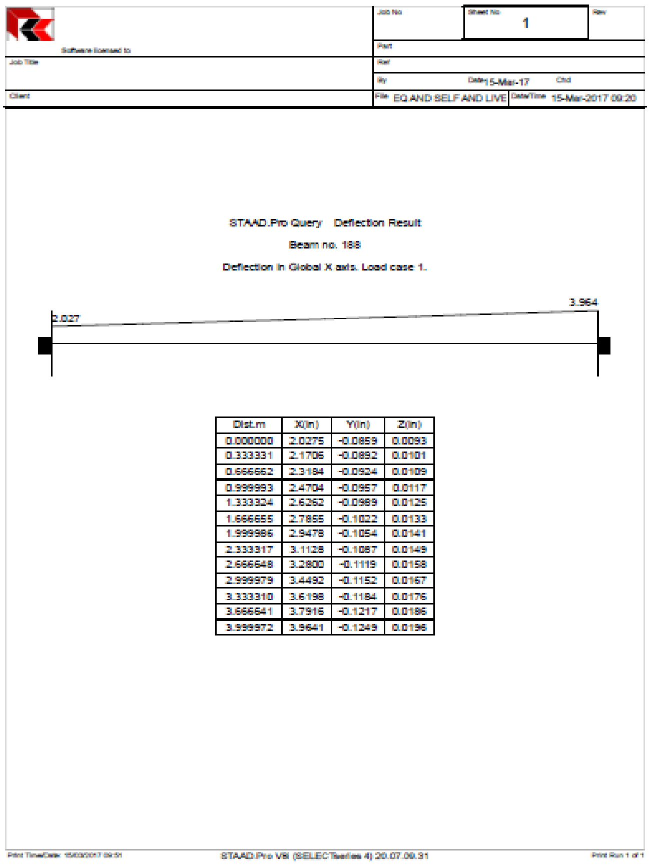
Fig 3 Shear wall distribution throughout the structure

2.0 Results

Table 1.3 This tables shows the comparison of results

Beam	With shear wall Mx kip-in	Without shear wall Mx kip-in
58	4597.348	8389.37
57	5702.309	5964.534
176	4.226	8.347
177	8.894	11.048
58	4597.348	8389.37

Deflection of beam without shear wall



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STAAD.Pro Query Deflection Result

Beam no. 188

Deflection in Global X axis. Load case 1.

Dist.m	X(in)	Y(in)	Z(in)
0.000000	2.0275	-0.0859	0.0093
0.333331	2.1706	-0.0892	0.0101
0.666662	2.3184	-0.0924	0.0109
0.999993	2.4704	-0.0957	0.0117
1.333324	2.6262	-0.0989	0.0125
1.666655	2.7855	-0.1022	0.0133
1.999986	2.9478	-0.1054	0.0141
2.333317	3.1128	-0.1087	0.0149
2.666648	3.2800	-0.1119	0.0158
2.999979	3.4492	-0.1152	0.0167
3.333310	3.6198	-0.1184	0.0176
3.666641	3.7916	-0.1217	0.0186
3.999972	3.9641	-0.1249	0.0196

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Fig 4 Deflection of beam without shear wall

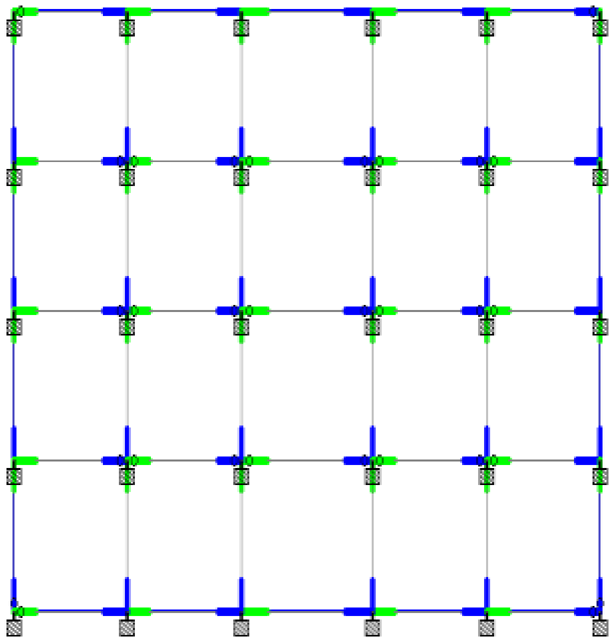
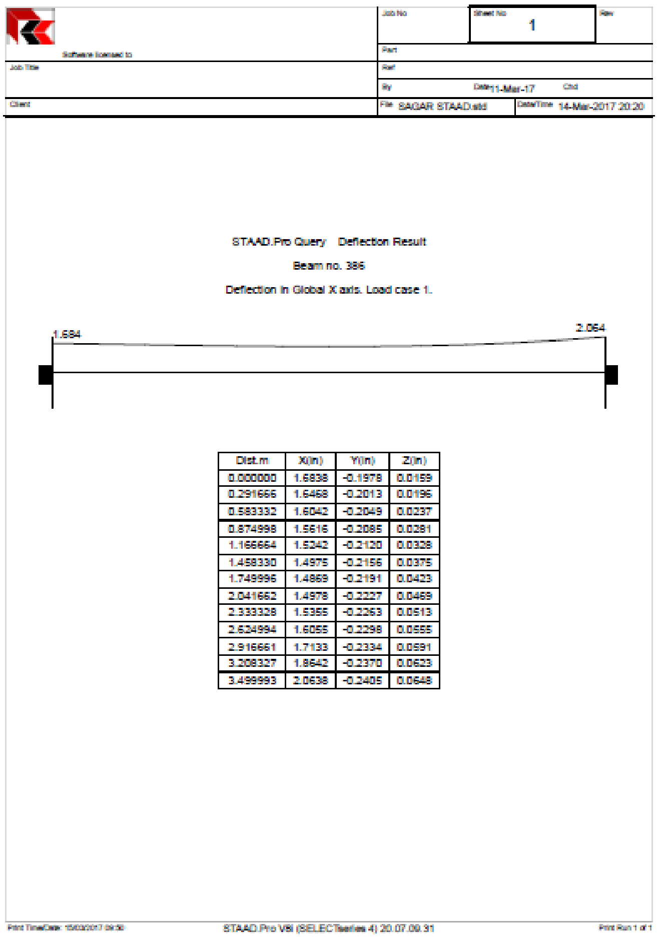


Fig 5 Start end configuration for the building

Deflection of beam with shear wall



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Beam no. 386

Deflection in Global X axis. Load case 1.

1.684

2.064

Dist.m	X(in)	Y(in)	Z(in)
0.000000	1.6838	-0.1978	0.0159
0.291666	1.6468	-0.2013	0.0196
0.583332	1.6042	-0.2049	0.0237
0.874998	1.5616	-0.2085	0.0281
1.166664	1.5242	-0.2120	0.0328
1.458330	1.4975	-0.2156	0.0375
1.749996	1.4869	-0.2191	0.0423
2.041662	1.4978	-0.2227	0.0469
2.333328	1.5355	-0.2263	0.0513
2.624994	1.6055	-0.2298	0.0555
2.916661	1.7133	-0.2334	0.0591
3.208327	1.8642	-0.2370	0.0623
3.499993	2.0638	-0.2405	0.0648

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Fig 5 Deflection of beam with shear wall

3.0 Conclusion

By comparing the results of two frames subjected to wind and seismic force, the behavior of structure is varied accordingly.

- The Storey displacement is large at upper floors during seismic events.
- The Storey displacement is small at upper floors for wind forces.
- The displacement is parabolic under seismic force.
- The displacement is linear under wind force.
- Deflection of the columns is more under wind forces than under seismic forces.
- Deflection and shear bending for beams will increase when height increases under wind load case.
- Deflection, Bending moment, Shear force got reduced gradually when shear walls were provided

4.0 References

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