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ANALYSIS OF EFFECT OF EARTHQUAKE LOADS ON G+7 MULTI STOREY BUILDING USING REINFORCED CONCRETE SHEAR WALL AND REINFORCED MASONRY SHEAR WALL

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ABSTRACT

The present project deals with the analysis of G + 7 multi storied building subjected to effect of earthquake loads. The application of earthquake load effect was considered using IS : 1893 (Part 1) : 2002 and a nominal wind load of 33m/s was also included in the analysis. The paper presents the comparison of effect of earthquake load in ZONE II, III, IV and V for rocky and medium soil conditions. The use of reinforced concrete shear wall and reinforced masonry shear wall was considered. The parameters like seismic drift, seismic moment, base shear, lateral load distribution on each floor was also discussed in this project. The comparison for reinforced concrete shear wall and reinforced masonry shear wall was made using a soft ware named RESIST which was developed by NICEE government of India organization for the development of understanding capacity of effect of earthquake on multi storied buildings in Indian condition with application of wind effects also. ordina
ry foundation condition which can be effect with earthquake load was assumed in the complete analysis of building.

KEYWORDS: *Shear wall, RC shear, Reinforced masonry shear wall, base shear, and base moment.*

INTRODUCTION

Shear walls are specially designed structural walls incorporated in building to resist lateral forces that are produced in the plane of the wall due to wind, earthquake and other forces. The term 'shear wall' denotes that the walls behave more like flexural members. They are usually provided in tall buildings and have been found to be of immense use to avoid total collapse of building under seismic forces. Seismic force consideration is to be done for buildings in regions likely to experience earthquake of large intensity or high winds. Shear walls for wind are designed as simple concrete walls. The design of these walls for seismic forces requires special considerations as they should be safe under repeated loads. Shear walls are generally made of concrete or masonry. They are usually provided between in walls stair cases, external wall systems etc. Tall buildings with flat slabs should invariably have shear walls. Such systems as compared to slabs with beams have very little resistance even to moderate lateral loads. Initially shear walls were used in reinforced concrete buildings to resist wind forces. These came into general practice only as late as 1940. With the introduction of shear walls, concrete construction can be used for tall buildings also. Earlier , tall buildings were made only of steel, as bracing to take lateral wind loads could be easily provided in steel construction. However, since recent observations have consistently shown the excellent performance of buildings with shear walls even under seismic forces, such walls are now extensively used for all earthquake resistant designs. Surveys of buildings after earthquakes have consistently shown that the loss of life due to complete collapse was minimal in buildings with some sort of reinforced concrete shear wall.

LITERATURE REVIEW

Sudhir K.Jain reviewed the new code of IS 1893 (Part-1): 2002, contains a discussion on clauses that are confusing and need classifications. The topographical and editorial errors are pointed out. Suggestions are also included for next revision of the code.

The following observations are made from this paper

1. The seismic zone map now contains only four zones as compared to the five zones earlier, and relative values of zone factors are different.
2. The design spectrum shape depends on the type of soil and foundation soil factor has

been dripped.

3. The minimum design force based in empirical fundamental period of the building even if the dynamic analysis gives a very high value of natural period and thus low seismic force.
4. Most India buildings are soft storey buildings as per codal definitions simply because the ground storey height is usually different from that in the upper storeys.
5. In the load combination the load factor 0.90 for gravity load, 1.5 for earthquake loads is used the in RC structures.

Comments and suggestions on earthquake intensity, risk level, service life of structure, response spectrums etc are given.

The author suggests that there is need to simplify provisions on torsion in buildings, treatment of soft storey buildings, treatment of building, treatment of building with masonry infill walls etc.

M.S.Alpha Sheath discussed a case for a simplified methodology of detailing for ordinary buildings in Zones with moderate seismic hazard which will greatly ease the application of earthquake engineering for buildings in zone III. The author argues that the simplification of ductile detailing in zone III would greatly encourage its wide spread implementation. IS 13920:1993 covers the requirements for design and detailing of monolithic special reinforced concrete, moment resisting frames (SMRF) so as to give them adequate toughness and ductile to resist severe earthquake shaking without collapse and moderate shaking with some non-structural damage. Code suggests same ductile detailing required for zones III, IV and V. The intensity of shaking in zone III towns and cities was much lower. To compensate for the reduction in the toughness due to a relaxation of the ductile criteria, the response reduction factor R be less than the value of 5 for special RC moment resistance frame but may be mote than 3.0 for RC moment resisting frames. Some of provisions are explained for flexural members, columns and structural walls etc. The author suggests that concluded that, in zones II and III, buildings may be designed with less stringent ductility detailing but with an increase in design seismic force.

Sudhir K.Jain., et.al describes the context of the push-over analysis and illustrates its utility with the results of analysis on a hypothetical example building. Author observed that, a large number of buildings in our country need seismic retrofitting. These buildings are to be provided with additional strength, stiffness and ductility to ensure acceptable performance in a future earthquake. This paper discusses the concept of "push over analysis", that is becoming a popular tool in the profession for,

i) Design of new building
ii) Seismic evaluation of existing buildings, and
iii) Developing appropriate strategy for seismic retrofitting of building.

It is clear that the earthquake resistant building is expected to perform satisfactorily even when subjected to earthquake loads much higher than the code – specified design force. A typical example of push-over analysis results by using computer programmed SNAP-2DX is given. Lateral loads are applied at different floors in an inverted distribution. The retrofitting options being considered are

i) Jacketing of column only,
ii) Providing additional beams and
iii) Providing both column jacketing and additional beams.

Author observed that the structural engineering profession is fast moving towards static – linear analysis (push-over analysis) for seismic design of new buildings, and for development of retrofitting evaluation of existing and for development of retrofitting methodology of deficient building.

Joseph M. Bracci, Sashi K.Kunnath et.al have given , a procedure for evaluating the seismic performance and retrofit of existing low to mid rise reinforced concrete (RC) buildings . The procedure is derived from the well-known capacity spectrum method and is intended to practicing engineers with a methodology for estimating the margin of against structural failure. A series of seismic story demand curves are established from modal superposition analysis where in changes in the dynamic characteristics at various response phases ranging from elastic to full failure mechanism are considered. These demands ate compared to the lateral storey capacities as determined from independent inelastic pushover analysis. The proposed technique is applied to a one- third scale modal; three- storey reinforced concrete frame building this was subjected to repeated shaking table excitations and that was later reinforced and tested again at the same intensities.

BUILDING DATA FOR ANALYSIS

The proposed building considered for the project is of G + 7. The considered building data is furnished below:

Building information:

Building importance category : All other buildings = 1.0

Number of storeys : G +7, 8 Storey building.
Length of the building in X direction : 15.0m
Length of the building in Y direction : 15.0m
Inter storey height of the building : 3.5m (storey height to storey height)
Floor load : Dead load considered for the building is 6.5kPa.
Live load considered for the building is 5.0kpa.
Interior wall : dead load of 4.75kpa.
External wall : dead load of 2.40kpa.
Roof is at the level of 1.5m above with dead load of 7.71kpa and live load of 0.25kpa.
Structure in both X direction and in Y direction the resisting systems are considered and are then subjected to earthquake load and identification of safety conditions are made.
Structure in X direction : Reinforced concrete shear wall / reinforced masonry shear wall.
Structure in Y direction : Reinforced concrete shear wall / reinforced masonry shear wall.
The structure was analysed for all the cases of zones II, III, IV and V and for soil conditions of rocky and medium soils. It was not safe to use the masonry shear wall systems in soft soil conditions and hence the project was restricted for medium and rocky soils.
Wind load data considered for the analysis of building:
Wind region considered for the building is zone I.
Basic wind speed of the wind in zone I is of 33.0m/s.
Terrain category of the building is built up towns.
Site shape is flat in conditions and not hill slopes.
The analysis is of the structure was made using resist software used for the analysis of multi storied building in Indian conditions for application of earthquake intensities for all zones and also for application of wind effects also.
The results obtained for the analysis of the building are given in the next section.

RESULTS

BASE SHEAR RESULTS

T.4.1.1.Details of base shear for reinforced concrete shear wall in zone II for rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	5
7.0	2	20.1
10.5	3	45.2
14.0	4	80.3
17.5	5	125.4
21.0	6	180.6
24.5	7	245.9
28.75	Roof level	284.9
FOR TOTAL BUILDING BASE SHEAR IS :987 kN.		

T.4.1.2.Details of base shear for reinforced masonry shear wall in zone II for rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	3.7
7.0	2	14.7
10.5	3	33.0
14.0	4	58.8
17.5	5	91.8
21.0	6	132.2
24.5	7	179.9
28.75	Roof level	201.1
FOR TOTAL BUILDING BASE SHEAR IS :715kN.		

T.4.1.3.Details of base shear for reinforced concrete shear wall in zone II for medium soil condition:

Height of building	Floor level	Base shear kN
3.5	1	6.9
7.0	2	27.6
10.5	3	62.0
14.0	4	110.3
17.5	5	172.3
21.0	6	248.1
24.5	7	337.7
28.75	Roof level	389.8
FOR TOTAL BUILDING BASE SHEAR IS :1355 kN		

T.4.1.4.Details of base shear for reinforced masonry shear wall in zone II for medium soil condition:

Height of building	Floor level	Base shear kN
3.5	1	5.1
7.0	2	20.4
10.5	3	45.9
14.0	4	81.6
17.5	5	127.6
21.0	6	183.7
24.5	7	250.0
28.75	Roof level	277.1
FOR TOTAL BUILDING BASE SHEAR IS :991 kN		

T.4.1.5.Details of base shear for reinforced concrete shear wall in zone III for rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	8.1
7.0	2	32.5
10.5	3	73.2
14.0	4	130.2
17.5	5	203.4
21.0	6	292.9
24.5	7	398.7
28.75	Roof level	459.5
FOR TOTAL BUILDING BASE SHEAR IS :1599		

T.4.1.6.Details of base shear for reinforced masonry shear wall in zone III for rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	6.1
7.0	2	24.4
10.5	3	54.9
14.0	4	97.6
17.5	5	152.5
21.0	6	219.6
24.5	7	298.9
28.75	Roof level	329.4
FOR TOTAL BUILDING BASE SHEAR IS :1183		

T.4.1.7.Details of base shear for reinforced concrete shear wall in zone III medium soil:

Height of building	Floor level	Base shear kN
3.5	1	11.2
7.0	2	44.6
10.5	3	100.4
14.0	4	178.5
17.5	5	278.9
21.0	6	401.7
24.5	7	546.7
28.75	Roof level	628.0
FOR TOTAL BUILDING BASE SHEAR IS :2190		

T.4.1.8.Details of base shear for reinforced masonry shear wall in zone III medium soil:

Height of building	Floor level	Base shear kN
3.5	1	8.3
7.0	2	33.2
10.5	3	74.7
14.0	4	132.7
17.5	5	207.4
21.0	6	298.7
24.5	7	406.5
28.75	Roof level	448.0
FOR TOTAL BUILDING BASE SHEAR IS :1610		

T.4.1.9.Details of base shear for reinforced concrete shear wall in zone IV rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	11.8
7.0	2	47.1
10.5	3	106.0
14.0	4	188.4
17.5	5	294.4
21.0	6	424.0
24.5	7	577.1
28.75	Roof level	710.1
FOR TOTAL BUILDING BASE SHEAR IS :2359		

T.4.1.10.Details of base shear for reinforced masonry shear wall in zone IV rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	8.4
7.0	2	33.7
10.5	3	75.8
14.0	4	134.8
17.5	5	210.6
21.0	6	303.3
24.5	7	412.8
28.75	Roof level	498.4
FOR TOTAL BUILDING BASE SHEAR IS :1678		

T.4.1.11.Details of base shear for reinforced concrete shear wall in zone IV medium soil condition:

Height of building	Floor level	Base shear kN
3.5	1	16.2
7.0	2	64.8
10.5	3	145.7
14.0	4	259.0
17.5	5	404.7
21.0	6	582.8
24.5	7	793.3
28.75	Roof level	971.7
FOR TOTAL BUILDING BASE SHEAR IS :3238		

T.4.1.12.Details of base shear for reinforced masonry shear wall in zone IV medium soil condition:

Height of building	Floor level	Base shear kN
3.5	1	11.5
7.0	2	45.8
10.5	3	103.1

14.0	4	183.3
17.5	5	286.4
21.0	6	412.5
24.5	7	561.4
28.75	Roof level	677.8
FOR TOTAL BUILDING BASE SHEAR IS :2282		

T.4.1.13.Details of base shear for reinforced concrete shear wall in zone V rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	17.9
7.0	2	71.7
10.5	3	161.4
14.0	4	286.9
17.5	5	448.3
21.0	6	645.5
24.5	7	878.7
28.75	Roof level	1074.3
FOR TOTAL BUILDING BASE SHEAR IS :3585		

T.4.1.14.Details of base shear for reinforced masonry shear wall in zone V rocky soil condition:

Height of building	Floor level	Base shear kN
3.5	1	12.6
7.0	2	50.5
10.5	3	113.7
14.0	4	202.2
17.5	5	315.9
21.0	6	454.9
24.5	7	619.2
28.75	Roof level	747.5
FOR TOTAL BUILDING BASE SHEAR IS :2517		

T.4.1.15.Details of base shear for reinforced concrete shear wall in zone V medium soil condition:

Height of building	Floor level	Base shear kN
3.5	1	24.9
7.0	2	99.6
10.5	3	224.1
14.0	4	398.5
17.5	5	622.6
21.0	6	896.5
24.5	7	1220.3
28.75	Roof level	1479.0
FOR TOTAL BUILDING BASE SHEAR IS :4965		

T.4.1.16.Details of base shear for reinforced masonry shear wall in zone V medium soil condition:

Height of building	Floor level	Base shear kN
3.5	1	17.2
7.0	2	68.7
10.5	3	154.7
14.0	4	275.0
17.5	5	429.7
21.0	6	618.7
24.5	7	842.1
28.75	Roof level	1016.7
FOR TOTAL BUILDING BASE SHEAR IS :3423		

4.2. SEISMIC WEIGHT DISTRIBUTION

T.4.2.1.Details of seismic weight for reinforced concrete shear wall in zone II for rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2993	675
3.5	1	3988	675
7.0	2	3988	675
10.5	3	3988	675
14.0	4	3988	675
17.5	5	3988	675
21.0	6	3988	675
24.5	7	3988	675
28.75	Roof level	3355	0

T.4.2.2.Details of seismic weight for reinforced masonry shear wall in zone II for rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	3089	675
3.5	1	4370	675
7.0	2	4370	675
10.5	3	4370	675
14.0	4	4370	675
17.5	5	4370	675
21.0	6	4370	675
24.5	7	4370	675
28.75	Roof level	3546	0
FOR TOTAL BUILDING SEISMIC WEIGHT IS :715kN.			

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T.4.2.3.Details of seismic weight for reinforced concrete shear wall in zone II for medium soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	3003	675
3.5	1	4027	675
7.0	2	4027	675
10.5	3	4027	675
14.0	4	4027	675
17.5	5	4027	675
21.0	6	4027	675
24.5	7	4027	675
28.75	Roof level	4027	0

T.4.2.4.Details of seismic weight for reinforced masonry shear wall in zone II for medium soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	3112	675
3.5	1	4463	675
7.0	2	4463	675
10.5	3	4463	675
14.0	4	4463	675
17.5	5	4463	675
21.0	6	4463	675
24.5	7	4463	675
28.75	Roof level	3593	0

T.4.2.5.Details of seismic weight for reinforced concrete shear wall in zone III for rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	3007	675
3.5	1	4040	675
7.0	2	4040	675
10.5	3	4040	675
14.0	4	4040	675
17.5	5	4040	675
21.0	6	4040	675
24.5	7	4040	675
28.75	Roof level	3381	0

T.4.2.6.Details of seismic weight for reinforced masonry shear wall in zone III for rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	3130	675
3.5	1	4535	675
7.0	2	4535	675
10.5	3	4535	675
14.0	4	4535	675
17.5	5	4535	675
21.0	6	4535	675
24.5	7	4535	675
28.75	Roof level	3629	0

T.4.2.7.Details of seismic weight for reinforced concrete shear wall in zone III medium soil:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	3015	675
3.5	1	4073	675
7.0	2	4073	675
10.5	3	4073	675
14.0	4	4073	675
17.5	5	4073	675
21.0	6	4073	675
24.5	7	4073	675
28.75	Roof level	3398	0

T.4.2.8.Details of seismic weight for reinforced masonry shear wall in zone III medium soil:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	3130	675
3.5	1	4535	675
7.0	2	4535	675
10.5	3	4535	675
14.0	4	4535	675
17.5	5	4535	675
21.0	6	4535	675
24.5	7	4535	675
28.75	Roof level	3629	0

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T.4.2.9.Details of seismic weight for reinforced concrete shear wall in zone IV rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2744	270
3.5	1	3973	270
7.0	2	3973	270
10.5	3	3973	270
14.0	4	3973	270
17.5	5	3973	270
21.0	6	3973	270
24.5	7	3973	270
28.75	Roof level	3550	0

T.4.2.10.Details of seismic weight for reinforced masonry shear wall in zone IV rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2751	180
3.5	1	4271	180
7.0	2	4271	180
10.5	3	4271	180
14.0	4	4271	180
17.5	5	4271	180
21.0	6	4271	180
24.5	7	4271	180
28.75	Roof level	3744	0

T.4.2.11.Details of seismic weight for reinforced concrete shear wall in zone IV medium soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2754	270
3.5	1	4015	270
7.0	2	4015	270
10.5	3	4015	270
14.0	4	4015	270
17.5	5	4015	270
21.0	6	4015	270
24.5	7	4015	270
28.75	Roof level	3571	0

T.4.2.12.Details of seismic weight for reinforced masonry shear wall in zone IV medium soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2751	180
3.5	1	4271	180
7.0	2	4271	180
10.5	3	4271	180
14.0	4	4271	180
17.5	5	4271	180
21.0	6	4271	180
24.5	7	4271	180
28.75	Roof level	3744	0

T.4.2.13.Details of seismic weight for reinforced concrete shear wall in zone V rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2758	270
3.5	1	4031	270
7.0	2	4031	270
10.5	3	4031	270
14.0	4	4031	270
17.5	5	4031	270
21.0	6	4031	270
24.5	7	4031	270
28.75	Roof level	3579	0

T.4.2.14.Details of seismic weight for reinforced masonry shear wall in zone V rocky soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2751	180
3.5	1	4271	180
7.0	2	4271	180
10.5	3	4271	180
14.0	4	4271	180
17.5	5	4271	180
21.0	6	4271	180
24.5	7	4271	180
28.75	Roof level	3744	0

T.4.2.15.Details of seismic weight for reinforced concrete shear wall in zone V medium soil condition:

Height of building	Floor level	Seismic weight kN	Reduced live load kN
0	0	2779	270
3.5	1	4114	270
7.0	2	4114	270
10.5	3	4114	270
14.0	4	4114	270
17.5	5	4114	270
21.0	6	4114	270
24.5	7	4114	270
28.75	Roof level	3621	0

CONCLUSIONS

1. When compared with G + 7 multi storey building for zones II, III, IV and V for rocky and medium soil, the reinforced concrete structural shear wall has seen economical.
2. In all cases of analysis the comparison of shear wall is economical in reinforced concrete shear wall than in reinforced masonry shear wall.
3. The highest base shear was observed in reinforced concrete shear wall constructed building in zone V region.
4. When compared with reinforced concrete shear wall to reinforced masonry shear wall in zone V medium soil, base shear is 30% less than the obtained base shear by reinforced concrete shear wall.
5. In all the cases of analysis the base shear for reinforced masonry shear wall is less of 30% than reinforced concrete shear wall.
6. The wall length and wall thickness used for the safety conditions of the structure in all the cases of the structure is 3 time more in reinforced masonry shear wall than the reinforced concrete shear wall.
7. As the thickness and length of shear wall in all cases of reinforced masonry shear wall is high than the reinforced concrete shear wall the drift effect less.
8. For all the cases or reinforced masonry shear wall the strength of masonry was considered as 40MPa, which is very high for obtaining in normal site conditions.
9. Reinforcement provisions are also helped for creating web reinforcement in reinforced masonry shear wall than reinforced concrete shear wall which will help in stability of shear wall.
10. The diameter of the reinforcement of masonry shear wall was kept constant for 16mm diameter bars and 200mm spacing.

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