IJITE INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN ENGINEERING (IJITE) ISSN: 2395-2946
VOLUME 17, NUMBER 01, 2016

Estimation and designing of Earthquake Resistant Building

Amrish Kumar[1], Adarsh Sharma[2]

[1]Graduate student, [2]Graduate student, Buddha Institute of Technology, Gorakhpur, U.P, India

Abstract - Disasters are unexpected events which have adversely affected humans since the dawn of our existence. In response to such events, there have been attempts to mitigate devastating effects of these disasters. Results of such attempts are very encouraging in developed countries but unfortunately and miserably poor in developing countries including ours. Earthquakes are one of the nature's greatest hazards on our planet which have taken heavy toll on human life and property since ancient times. The sudden and unexpected nature of the earthquake event makes it even worse on psychological level and shakes the moral of the people. Man looks upon the mother earth for safety and stability under his feet and when it itself trembles, the shock he receives is indeed unnerving. Mitigation of the devastating damage caused by earthquakes is of prime requirements in many parts of the world. Since earthquakes are so far unpreventable and unpredictable, the only option with us is to design and build the structures which are earthquake resistant. Keeping in view the huge loss of life and property in recent earthquakes, it has become a hot topic worldwide and lot of research is going on to understand the reasons of such failures and learning useful lessons to mitigate the repetition of such devastation. If buildings are built earthquake resistant at its first place (as is being done in developed countries like USA, Japan etc.) the devastation caused by earthquakes will be mitigated most effectively. The professionals involved in the design/construction of such structures are structural/civil engineers, who are responsible for building earthquake resistant structures and keep the society at large in a safe environment. In this project we design an EQRB for zone-4 (especially for GIDA CL-1, Sector-7, Gorakhpur).

Keywords- Shear wall, Dampers, Raft Foundation.

1. INTRODUCTION

An earthquake is sudden shaking of the earth surface caused by a disturbance inside the earth." Vibration induced in the earth's crust due to internal or external causes that shake up virtually shake up a part of the crust and all the structures and living and non-living things existing on it". It deals with the design & construction of the structure that the earthquake. The various structural components are design to withstand various earthquake forces.

2. TYPE OF EARTHQUAKE

1-Based on the depth of focus

Table no.-1

S.No	Types	Focal length
1	Shallow earthquake	Up to 60 km
2	Intermediate earthquake	60 to 300 km
3	Deep earthquake	300 to 700 km

2-Based on the magnitude

Table no.-2

Class	Magnitude
A	7.8 and above
B	7.0 – 7.7
C	6.0 – 7.0
D	5.3 – 6.0
E	Less than 5.3

3-Based on the origin

A-Tectonic earthquakes

B-Non tectonic earthquakes

3. SITE LOCATION

Built up area=24m*20m, located in GIDA CL-1, Sector-7 Gorakhpur (zone-IV).

4. TYPICAL PLAN OF OUR BUILDING

There are 4 main columns & 16 intermediate columns with shear wall.

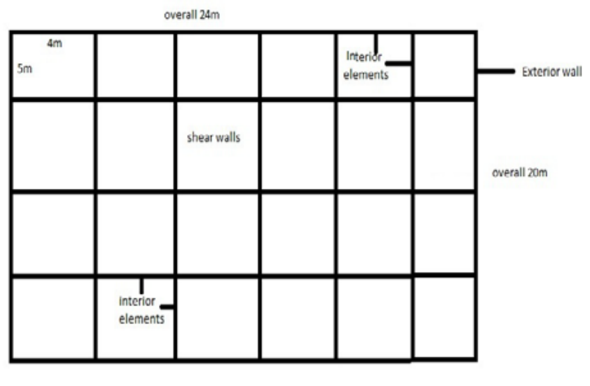

Fig-1: Typical plan of site

4. SOIL TESTING REPORT

Table no.-3

S.No	Tests performed	Results
1	Liquid limit	39%
2	Plastic limit	30%
3	Plasticity index	9%
4	Type of soil	"CI"
5	Safe bearing capacity	350 KN/mm2 (adopted)

5. PROPOSED METHODOLOGY

A-Shear wall* **B-**Foundation* **C-**Dampers*

D-Base isolation **E-**Diaphragms **F-**Bearing

G-Bracing **H-**Trussing **I-**Moment resisting frames

*---is used in our research paper

6. DESIGNING OF VARIOUS STRUCTURAL ELEMENTS

1- Designing of column

Table no.-4

Column size=500*500 mm2	Ac=248391 mm2 (16mm dia.)
Leff=3000 mm	Pu=2450 mm2
use M20/Fe415	Ties=6 mm@256mm spacing
Provided short column	
Ag=250000 mm2	
Asc=1608 mm2	

2-Designing of footing

Table no.-5

Size of column=500*500 mm2	Area provided= 3*3=9 m2
S.B.C=350 KN/m2	Net upward pressure= 473 KN/m2
use M20/Fe415	Overall depth= 980 mm
Column load= 2450 KN	Effective cover= 84 mm
Footing load= 245 KN	Effective depth= 894 mm
Factored load= 4263 KN	Ast= 3531 mm2
Area of footing= 7.7m2	Providing 8 bars of 16mm dia.@176.46 mm c/c spacing

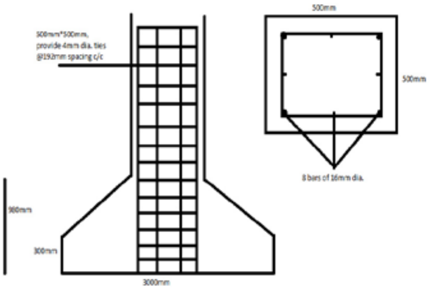

Fig-2: Reinforcement detail of column

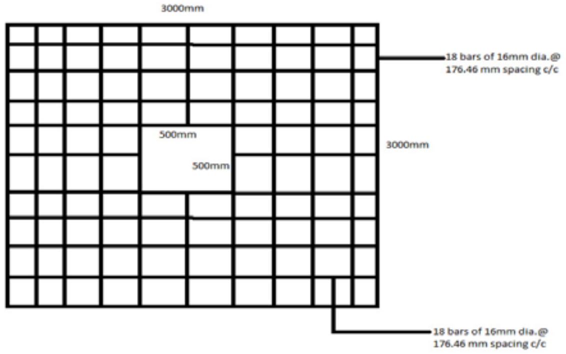

Fig-3: Reinforcement detail of footing

3-Design of shear wall

We provide 3m length & 250mm thickness of shear wall

Use M25/Fe415 & EBCS-2, 1995 CODE provision

Load considered for design of shear wall

Table no.-6

Loading (KN)	Axial load (KN)	Moment (KN-m)	Shear force (KN)
D.L.+ L.L	2500	1000	80
E.Q	400	6000	900

Design strength of material

Table no.-7

S.No	For concrete	For steel
1	fcd= 14.17 MPa	fyd= 360.87 N/m2
2	f= 1.197 MPa	
3	Em= 29 GPa	

Designing of load combination

Table no.-8

Nsd= 2500 KN	Md= 6750 KN	Vd= 960 KN

Design eccentricity

Table no.-9

In A direction	In B direction
ea= 20 mm	ea= 20 mm
e0= 2700 mm	e0= 0 mm
e2= 104.53 mm	e2= 104.53 mm
etot=2824.53 mm	etot= 124.53 mm
er= 0.56	er= 0.415

Table no.-10

Load combinations	Axial load (KN)	Moment (KN-m)	Shear force (KN)
1	2500	1000	80
2	2275	6750	960
3	1475	-5250	-840
4	2275	6750	960
5	1475	-5250	-840

Table no.-11

Equivalent eccentricity (eq)= etot *(1+K*0.7176)= 4312.26mm
Design moment calculation (msd)=eeq*Nsd =403122*2500=10780.65 KN
Design of vertical reinforcement (Amin)= 6000 mm2
Design of shear reinforcement (Vrd)= 5048.06 KN

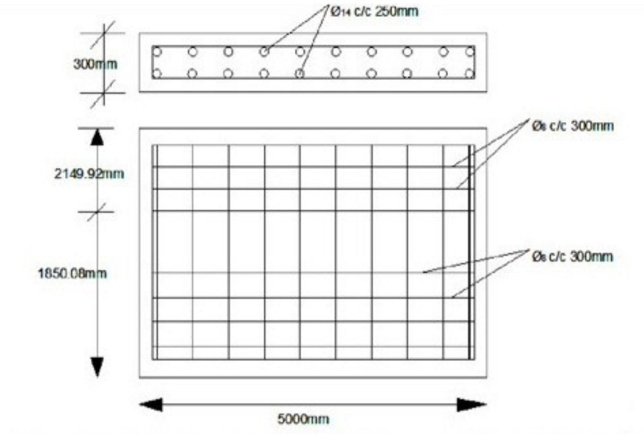

Fig-4: Reinforcement detail of shear-wall

4-Designing of Raft foundation

Table no.-12

Total no. of column=20	**Total load on soil= 53900 KN**
Factored load on each column= 2450 KN	Area of raft foundation= 154m2
S.B.C= 350 KN/m2	Width of slab provided= 1.75m

Design of Raft slab

Table no.-13

B.M(factored)= 64.14 KN-m	% of steel= 0.99%= 1%
effective depth= 160mm	A.s.t= 1600 mm2
Overall depth= 160+40= 200mm	Provide 16mm bars@140mm c/c

Design of Continuous Raft slab

Table no.-14

Max. B.M= 890.88 KN-m	% of steel= 1.05%
Effective depth= 787 mm	A.s.t= 3500 mm2
Overall depth= 787+63= 850mm	Provide 12mm bars ,20 mm dia.

Design for shear

Table no.-15

Max. shear force= 1336.32 KN	Net shear force= 1009715 N
Nominal shear stress= 3.4 N/mm2	Provide 4 legged , 10mm dia. stirrups@250mm c/c spacing
Max. shear stress= 0.83 N/mm2	

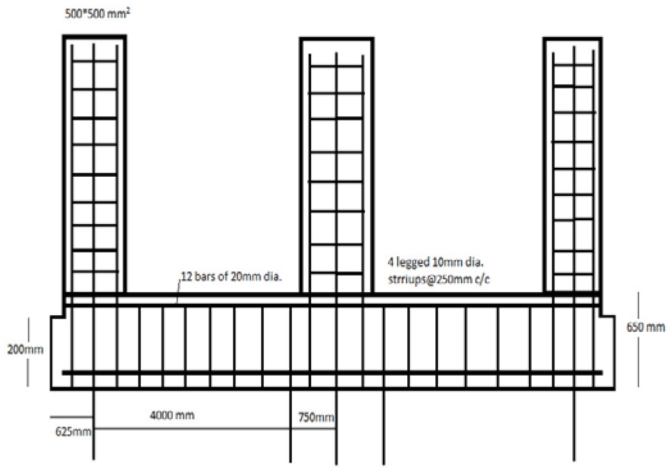

Fig no-5: Reinforcement detail of foundation

7. ESTIMATION

In this research work, we have estimated the various structural elements like column, foundation, footing & shear-wall which are shown below;

1- Cost estimation for first floor

Table no.-16

S. No	**Material**	**Footing**	**Foundation**	**Column**	**Shear-wall**	**Addition**	**Rate in rupees**	**Total amount in rupees**
1	Steel	11256 kg	48984 kg	4144 kg	2404 kg	66788 kg	34 of 1 kg	2270792
2	Cement	924 bags	2535 bags	196 bags	350 bags	4005 bags	355 of 1 bag	1421775
3	Sand	60 ft.2	4677 ft.2	336 ft.2	428 ft.2	5501 ft.2	55 of 1 ft.2	320555
4	**Aggregate**	**119 ft.2**	**9355 ft.2**	**644 ft.2**	**850 ft.2**	**10968 ft.2**	**80 of 1 ft.2**	**877440**
								4890562

2-Equipment cost for first floor

Equipment's cost= 10% of total cost

= 10% 4890562

= Rs. 489056.2

Total cost required for 1 floor = Rs. 5379618.

3-Cost estimation for upper floor

Table no.-17

S.No	Material	Column	Shear-wall	Addition	Rate in rupees	Total amount in rupees
1	Steel	4144 kg	2404 kg	6548 kg	34 of 1 kg	222632
2	Cement	196 bags	350 bags	546 bags	355 of 1 bag	193830
3	Sand	336 ft.2	428 ft.2	726 ft.2	55 of 1 ft.2	42020
4	Aggregate	644 ft.2	850 ft.2	11612 ft.2	80 of 1 ft.2	928960
						1387442

4-Equipment cost for upper floors

Equipment's cost= 10% of total cost

= 10% 1387442

= Rs. 138744.2

Total cost required for one floor = Rs. 1526186.2

Total cost required for G+3 EQRB = Rs. 1526186.2*3 + 5379618.2*1

= 4578558.6 + 5379618.2

= 9958176.8

= Rs. 99,60,000

8. CONCLUSION

According to Geological survey of India, Gorakhpur comes in zone-IV, i.e. moderate destructive zone. It is prone to EQ of magnitude 7 to 8.5 (approx.) on Richter scale. Thus this zone is in great requirement for EQRB. This work focuses on designing EQRB, according to the recommendation given in IS codes.

In the present scenario shear wall are mostly used in mid & high rise building which helpful to resist lateral/side-ways forces (Inertia Forces) of about 30-40%, and it also moderate in cost. The cost of casting one shear wall of length 4m & 250mm thickness, the cost is Rs.34,902 (excluding the labour cost & water).

The damper is the second choice of a civil engineer to make a EQRB, this is used as shock absorber in the building which absorb seismic load of about 30-40%. It is very easy in installation & operating and also available at moderate cost with long life.

In this research work shear walls, viscous fluid dampers, raft foundation is designed to resist EQ of high magnitude. Above techniques are used to design a building, which can resist EQ magnitude prone to occur in this zone, with maximum resistant within an optimum cost utilization.

REFERENCES

[1] A text book of Engineering & General Geology by Prof.Parbin Singh, published by S.K Kateria& Sons.
[2] Basic & applied Soil Mechanics by Gopal Ranjan.
[3] Earthquake resistant design by Manish Shrikhande& Pankaj Agarwal.
[4] IS 1893 (Part I), 2002, Indian Standard Criteria for Earthquake Resistant Design of Structures (5th Revision)
[5] IS 456, 1978 & IS 4326, 1976, Indian Standard Guidelines for shear wall
[6] IS 456, 2000, Indian Standard Guidelines for concrete structures
[7] IS EBCS 2, 1995-Structural use of Concrete code.
[8] Reinforcement concrete structures by B.C Punamia, Ashok Jain &Arun Jain published by Laxmi Publications.
[9] Reinforcement concrete structures by S. Ramamrutham, published by Dhanphat Rai.
[10] Soil Mechanics & Foundation Engineering by K.R Arora published by Standard distributors.
[11] Soil Mechanics & Foundation Engineering by B.C Punamia,Ashok Jain &Arun Jain published by Laxmi Publications.
[12] Design of shear wall by using EBCS, American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p- ISSN: 2320-0936 voulme-4, issue-3, pp-31-43.

AUTHOR'S PROFILE

Amrish Kumar pursuing Bachelor of Technology from Buddha Institute of Technology, Gorakhpur, Affiliated to AKTU LUCKNOW.

Adarsh Sharma pursuing Bachelor of Technology from Buddha Institute of Technology, Gorakhpur, Affiliated to AKTU LUCKNOW.