International Journal of Research in Engineering, Science and Management
Volume-1, Issue-11, November-2018
www.ijresm.com | ISSN (Online): 2581-5792

Design and Analysis of Earthquake Resistant Building for Zone III

Suail Khan
Student, Department of Civil Engineering, Millennium Institute of Technology and Science, Bhopal, India

***Abstract*: Earthquake being a natural and frequent phenomena all over the world need proper addressal during the design of any structure. Effect of earthquake detrimental to the structural design to a point that could lead to the collapse. In this academic work a thorough study has been done on the effects that an earthquake can have. Different earthquake resistance have been studied and comparisons are made throughout the work and a new theory has been proposed, analysis of structure's design has been done by ETAB software and Extended three dimensional building analysis software. Entirely new technique of interlock mechanism has been put forward in this thesis by combining by combining number of principal of interlock which already exists. The technique position of stirrups and ties joints and alignment of joints has been explained and method of ideal stirrups and ties joints has been proposed. The use of ancient architecture has also been implemented with effect to make buildings and structures earthquake resistance.**

***Keywords*: earthquake resistance structure, interlock mechanism, principal of interlock, structural design, analysis of structure's design**

1. Introduction

Earthquake: Earthquake may be defined as shaking of earth surface due to movement in faults, result sudden release of energy which cause earthquake. Earthquake come anywhere result he destruction (destruction depend on the type of earthquake and magnitude). Tremors are measured by richest scale. Every country has their own rules to overcome with the earthquake problems. Earthquake also effect the material environment kind of dead list of natural hazards example – anywhere deep down earth surface where fault is active then there is huge possibility of her move. With above example we can clearly understand the relationship between earthquake and fault. Earthquake intensity directly depends upon on movement in fault when the fault length increases earthquake magnitude increases.

Scientist made various instruments to detect tremors. With the help of those instruments they can predict the long term probability of earthquakes for specific location. Now we understand about earthquake and we know earthquake or Tremors depend on faults let's discuss about classification of fault. There are three types of fault

A. Normal fault
B. Reverse fault
C. Strike slip fault

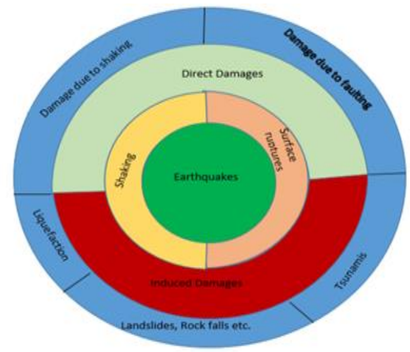

Fig. 1. Earthquakes

A. *Normal fault*

The normal faulting, the hanging wall blocks shifts down relatively to the footwall brick. Normal faults are generally associated with crustal tension.

B. *Reverse fault*

The reverse faulting, the hanging wall blocks shifts up relatively to the footwall block. Reverse faults are generally associated with crustal compression and thrust faults is another term used for reverse fault.

C. *Strike slip fault*

The strike-slip faulting, two of the blocks moves away either towards left or to the right relatively from one another. Strike-slip faults are associated with crustal shear. Wrench faults is term also used for strike slip fault.

Tremor produces seismic waves which are captured by a recorder known as seismograph and table 1.1 we see how the value of earthquake is converted into magnitude scale with the help of Richter numerical 1.0

Richter scale is one and only method to easily calculate the earthquake in the form of magnitude. Amplitude of seismic waves recorded on seismograph. In 1930(s) Charles Richter developed the scale to measure shallow earthquakes. This scale is logarithmic. Each division represent an increase in the ground motion associated with the earthquake for example, a magnitude tremors has nine times as much ground motion.

$$M10 = \log_{10} (A/T) + Q$$

A = Amplitude of ground motion

International Journal of Research in Engineering, Science and Management
Volume-1, Issue-11, November-2018
www.ijresm.com | ISSN (Online): 2581-5792

T = Time taken for motion (seconds)
Mb = Determine magnitude from body waves.
From depth the epicenter and local (kilometers)

D. Type of wave in earthquake

Tremors wave or seismic waves are divide into two types.

1. Surface Waves
2. Body waves

There are four different type earthquake zones in India. As per Indian standard code –1893 part – 1, 2002.

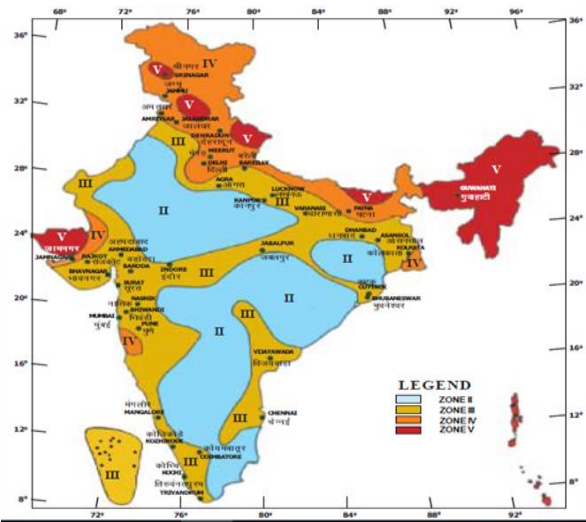

Fig. 2. Different zones in India

Zone II: In this zone low intensity earthquake is occurring. When earthquake or tremor occurs that can be felt by all and chance of people enough to cum outdoors. Some damage to building may also be observed. Heavy stuff gets moved like furniture books fall down. 0.10 zone factor assigns by Indian standard code Maximum lateral acceleration that can be felt by structure in this zone is 10% of gravitational

Zone III: In this zone high intensity earthquake occur. Tremors that scale everyone. When earthquake occur in this zone, it makes people too difficult to stand properly. Buildings structure with proper design with bands) suffer slight damage, while building without band or improper design suffer considerable damages 0.16 zone factor is assign by Indian standard code.

Zone IV: This zone is susceptible to strong tremor, which create panic all over moving even heavy fun it we this area cause moderate damage in well-designed building. While poorly bull structure we suffer great damage, different effects could be landslide on steer few centimeters. The Indian standard code assigns zone factor of 0.24 for zone 4.

Zone V: Earthquake with 7-0 or 8.0 (Magnitude) are come in this zone (v) is High risk zone in all over the country.

Tremor in this area can cause total panic and considerable damage to life and properly. Railways tacks bend and rood ways get damaged. Indian standard code assigns zone factor of 0.36. Structural designers use this factor for earthquake resistant design of structure. In zone 5.

2. Methodology

There are three methods of analysis and design of building

1. Static coefficient method
2. Response spectrum analysis
3. Time history analysis

Static coefficient method:

The equivalent static method analysis the lateral seismic base shear. Simple regular configuration H<40m.

Dynamic response spectrum analysis

Asymmetrical building in layout and elevation. Building having immediate change in strength and rigidness in layout and elevation.

Time history

Actual response of earthquake is difficult to analyze. Inelastic time-history analysis can help in finding closest estimate.

In this research work we use static coefficient method because of the height of building and location of building (earthquake zoneIII).

A. Experimental work

Interlock System: In the column above the plinth level when new casting is put up and that after the mounding process when this casting is removed a very this space is left because of Collins of concrete. This left over space through minute affects adversely the lateral force capability of the column.


Fig. 3. Collins of concrete in column

As it is evident from the day to day examples that design is the weakest from its joints side. To mitigate the weakness in the design we have proposed the interlocked system. The bar being used in this interlock system of 10mm. diameter, 4" x 12" is the dimension. HySD 415 bars are being used here.


Fig. 4. Interlock system

Ties are to be provided one both at the top and bottom and one in the middle. It is known that concrete has a much superior strength against compression but its strength against tension is not much Reinforcement are provided so that strength remain intaeed even during tension. This interlock key which also by reinforced gives strength and uphold the integrity of the bean during by lateral durss that is faced during an earthquake. The weather is the joint B rat taken care of with the interlock system.

Fig. 5. Placing of interlock system

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQ X+ according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = X

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2]	Z = 0.24
Response Reduction Factor, R [IS Table 7]	R = 3
Importance Factor, I [IS Table 6]	I = 1
Site Type [IS Table 1] = III	

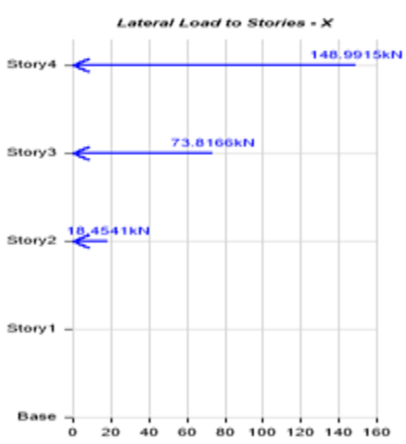

Fig. 6. Applied story forces

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.5]

$$\frac{S_a}{g} = \frac{1.67}{T}$$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2], $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Table 1
Calculated base shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	0.76	2744.7137	241.2622

3. Results and discussion

A. Experimental investigation

A through investigate study has been undertaken in this work. ETAB "extended three dimensional analysis building software" has been intensively used throughout the study. Results obtained in the work are being presented in this section and comparison is drawn.

1) Story displacement results

The building while facing tremors has undergone global displacement in X and Y direction in X direction displacement is 14.05m.m and 17.25m.m in Y direction. Clearly from above mention data the building has more prepensely for displacement in the Y direction.

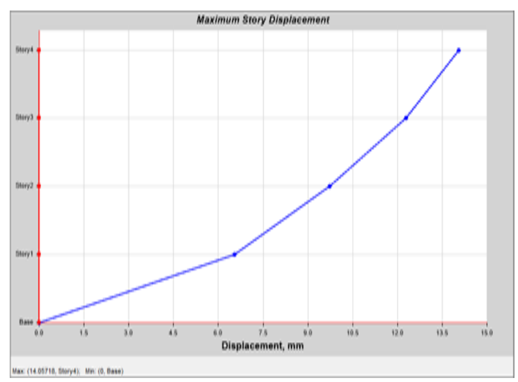

Fig. 7. Displacement of building in X direction

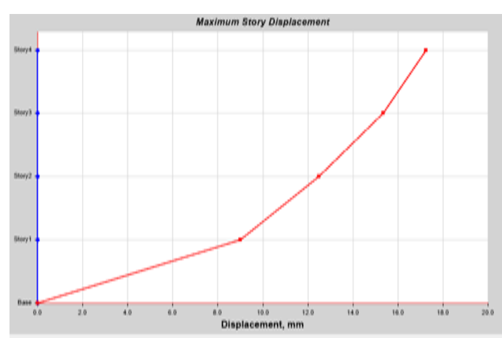

Fig. 8. Displacement of building in Y direction

Also has been observed in the difference in displacement between two consecutive story divided by their height is story

$$\frac{S_a}{g} = 2.197517$$

Table 2
Story and displacement

Story	Elevation M	Location	X-Dir. mm	Y-Dir. mm
Story 4	14	Top	14.057	0.001
Story 3	10.5	Top	12.291	0.001
Story 2	7	Top	9.732	0.0017
Story 1	3.5	Top	6.545	0.0004
Base	0	Top	0	0

drift. It is the absolute value of displacement under the top most floor has undergo the maximum displacement in both X and Y direction.

4. Conclusion and future scope of work

A. Conclusion

It has been experimenter concluded in the work that the structure is more resist to earthquake damage than mainly designed structure.

Because of the optional use of steel in the beams and columns the structure designed although strong and of economical in nature

Interlock mechanism a given it's this there is a perfectible and efficient result of providing strength between the two cons quite columns which is the weakest point in either column and because of the result of the amount of steel requires drastically reduced for achieving the save strength.

B. Future scope of work

In order to optimize the designed building composite high strength plastic grade material can be explored instead of steel bars this will also be useful in mitigating the rusting problems that is currently faced with steel structures.

Analysis can be done using more invasive design software, where it can be accessed that even the smallest change in the ties and stirrups or in interlock result in much stronger and earthquake resistant design.

Study of AAC blocks can be performed systematically as it does not increase any dead weight to the building structure.

References

[1] Chopra, A.K., (2012), Dynamics of Structures – Theory and Application to Earthquake Engineering, Fourth Edition, Prentice Hall Inc, USA
[2] Dowrick,D.J., (1987), Earthquake Resistant Design for Engineers and Architects, 2nd Ed., John Willey & Sons, NY, USA
[3] FIB, (2003), Displacement-based Seismic Design of Reinforced Concrete Buildings, State-of-the-Art Report Prepared by Task Group 7.2, International Federation for Structural Concrete (fib), Switzerland
[4] Housner, G.W., and Jennings,P.C., (1982), Earthquake Design Criteria, Earthquake Engineering Research Institute, Oakland, California, USA
[5] IS: 13920, (1993), Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi
[6] IS:1893 (Part 1), (2007), Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
[7] IS: 456, (2000), Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
[8] Dasgupta K., (2009), "Improvement in Geometric Design of Reinforced Concrete Structural Walls to Resist Earthquake Effects," Ph.D. Thesis, Department of Civil Engineering, Indian Institute of Technology, Kanpur, India.
[9] Murty C. V. R., (2005), IITK-BMTPC Earthquake Tips - Learning Earthquake Design and Construction, National Information Center of Earthquake Engineering, IIT Kanpur, India
[10] Murty C. V. R., Chrleson A. W., and Sanyal S. A., (2006), Earthquake Design Concepts, Teaching Resource Material for Teachers of Architecture Colleges, National Information Center of Earthquake Engineering, IIT Kanpur, India
[11] Naeim F. (Ed.), (2001), The Seismic Design Handbook, Kluwer Academic Publishers, Boston, USA
[12] Newmark N. M., and Hall,W.J., (1982), Earthquake Spectra and Design, Earthquake Engineering Research.