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A Study on Design of Earthquake Resistant Building for Zone-III

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***Abstract*: In this work a thorough study has been done on the effects that an earthquake can have. Earthquake being a natural and frequent phenomena all over the world need proper addressable during the design of any structure. 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. Effect of earthquake detrimental to the structural design to a point that could lead to the collapse. 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. The standard provides that the steel in columns must not exceed 8% and also it should not be less than 0.8% the maximum steel that would be needed in our proposed structure will only be 3.70% and minimum is 0.8%**

***Keywords*: earthquake resistance structure, stirrups and ties joints, alignment of joints, structural design, analysis of structure's design, rebar percentage**

1. Introduction

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

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. Since earthquake give rises to the inertia forces these inertia forces are proportional to the mass of M as building, if can be said that the mass of designed building plays an important role in seismic design along with the building stiffness. Ideally an elastic building design would go through in earthquake unharmed, but even design is not always economically possible due to the proportional Constraints so pragmatically what done is this building are designed with such specification that the building undergo some days during the tremors Such that the every of the quake can be dissipated. This is done as by relay a building that can with stand.

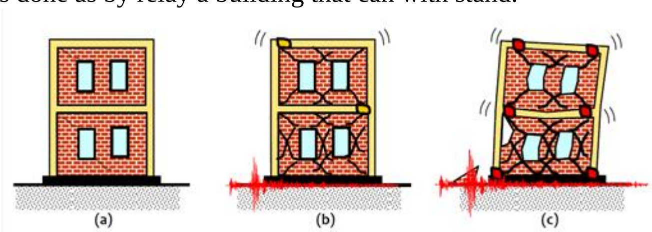

Fig. 1. Earthquake resistant design philosophy for building

- Minor and frequent shaking with no damage to structural and non – structural elements.
- Moderate shaking with minor damage to structural elements and some damage to non-structural element;
- sever and non-shaking with damage to structural

elements, but the building should not collapse

Hence building are designed to with stand only a small part of force they are to experience day a severe earthquake sufficient initial stiffness so that there is no days the low intensity tremors. The design strategy is hence optional cost wise and the day that is being incurred is acceptable. Designing of the building of appropriate elasticity that can with stand a certain lend of tremor intensity is possible only when the building has certain level of durability that is building remains stable during the time of large displacement demand done by the structural damage but without collapse and structural Strength remaining intact. By appropriately proportioning the size and material of the member it is possible to design with required initial stiffness and the lateral strength.

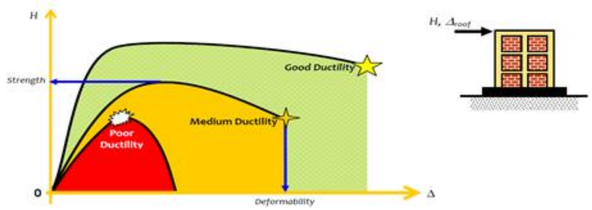

Fig. 2. Ductility of building are design and detailed to develop favorable failure mechanism that possess specified lateral strength

Acquiring suitable ductility require more laborious test on full scale specimen in order to test suitable method of detailing shaking phenomenon due to the occurrence of earthquake require the building design to withstand a relative displacement within it due to the displacement its bare which is imposed by the tremor. Wind and other disturbances needs the design to resist a certain level of force on it Hence, the loading due to earthquake is displacement type and due to wind etc. is of force type.

2. Methodology

There are three methods of analysis and design of building

- Static coefficient method
- Response spectrum analysis
- 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 analyses. 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 zone III)

A. *Experimental work*

Placement of bars in stirrups and ties

In the process of making ties and stirrups, they should be prepared to from the same diameter of bars. Since resting the ties and stirrups one prepared using some premade using a standard diameter bars and are used with all types of bars such practice leave some space at the corner of ties and stirrups. This problem occurs due to their permanent instrument for making stirrups and ties as shown in the figure.

Fig. 3. Permanent instrument for making stirrups and ties

The disadvantage of the non-optional use & material also the structural integrity of the beam or column is compromised.
Also the use of binding wire can be considered as a receded of this problem, as the binding wire only use is until the casting process, after which it erodes due to reaction of the wire and concrete

Joints of ties and stirrups

In a column or beams, to hold the bar ties and stirrups are used. Generally in the construction works these ties and stirrups are joined symmetrically i.e. to say joints are the weakest part of stirrups and ties, when these joints are aligned in a line what we get to each other. Whenever a force is applied, this series of weak links due to the presence of joints of ties and stirrups in a column and beam respectively results in the breaking and compression failure. In any earthquake, the presence of lateral force makes this problem of grand concern as the bears. With such joints are valuable to breaking a compression failure.

Fig. 4. Joints of stirrups in same symmetry

The re ready to this problem is the placement of joints, in stirrups and ties in column and beam respectively, is to provide these joints an unsymmetrical way as shown in the figure below. Such an arrangement provided strength to the structure and easily resists lateral loads.

Fig. 5. Joints of ties in alternative position

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

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	2744.713 7	241.2622

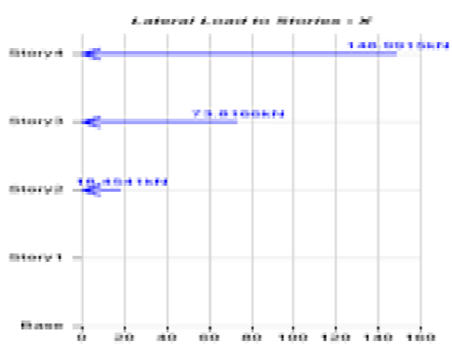

Fig. 5. Applied Story Forces

3. Result 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.

B. *Rebar percentage result*

Even through the structure has been designed as earthquake resisting it is highly economical according to the Indian standard. The standard provides that the steel in columns must not exceed 8% and also it should not be less than 0.8%. The maximum steel that would be needed in our proposed structure will only be 3.70% and minimum is 0.8%

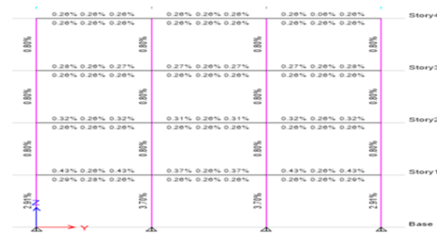

Fig. 6. Rebar's percentage of structure

4. Conclusion

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. It is also been concluded that is joints of ties and stirrups should not be in a symmetrical fashion when alternative scheme of joints of ties and stirrups is use resulted in compression failure in the columns. In this paper, we have also shown that the bar used in making of stirrups and ties are going to hold the new scheme solves the problem of bar displacement. It has been experimentally 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

$$\frac{S_a}{g} = 2.197917$$

$$A_h = \frac{ZI\frac{S_a}{g}}{2R}$$

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

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