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Behaviour of Steel and R.C.C Structures during Earthquake

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ASBTRACT: A earthquake is an most dangerous, destructive, unpredictable naturally occurring phenomenon which is caused due to the movement of tectonic plates present below the surface of the ground which causes shaking and production of seismic waves. An earthquake can destroy many properties within a fraction of seconds thus this research mainly focuses on the behaviour of the steel and RCC structures when an earthquake hits to them.

So it is very necessary to know how the structures are going to behave under the seismic conditions what will be there various parameters to be considered while designing, there advantages, comparison with non earthquake resistant structures and how we can make an steel and RCC structures earthquake resistant.

KEYWORDS: Earthquake, Advantages, Comparison.

I. INTRODUCTION

1.1 General

Earthquake is a natural calamity and a unpredictable phenomenon and can cause a very severe damage to the steel and RCC structures by collapsing them. Such natural occurring calamities challenges the development of the steel and RCC structures in various manners however a civil engineer as a structural designer has to play a very major vital role in the design of the such earthquake resistant structures. To minimize the effects of the earthquake on the steel and as well as on the RCC structures though we have various Indian standard codes for the seismic loading such as IS 1893 – 2002 (Part – I) but this codes does not have any provisions for the other effects caused by the earthquake.

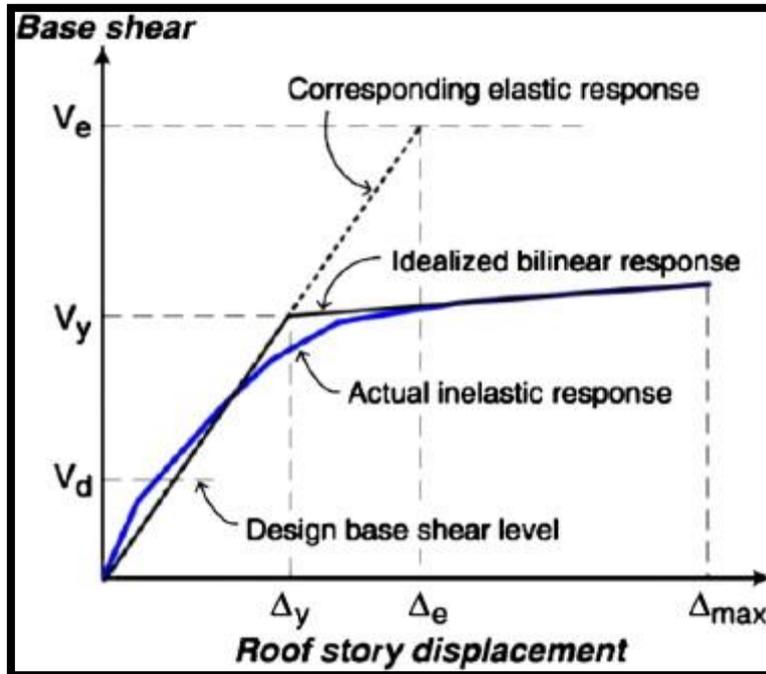
The earthquake can have its effects on the structure in direct and in indirect manners some of the direct effects such as ground shaking, surface faulting, liquefaction in which soil loses its stability due to seismic waves, sliding of foundation and structural vibrations and as the indirect effects are considered they may be due to floods, tsunamis etc caused by the earthquake. As far as this research is concern we are going to deal and study with the behaviour of the steel and RCC structures during the earthquake, Advantages of steel and RCC as a earthquake resistant structure and there comparison.

II. METHODOLOGY

2.1 Behaviour of Steel Structure During Earthquake:-

Experience and analysis study shows that the steel structures performs well at the time of an earthquake phenomenon as compared to the other structures such as RCC structures which are made from different materials. The possibility of the steel structures to resist such earthquake may be due to the implementation of the heavy steel sections which are only subjected to the elastic stresses or on the other hand the probability is implementation of the small steel sections which are used to form many small plastic zones. The steel structures designed by the first possibility may not be a good idea as we are using heavy steel sections on large scale in the structure which will make the structure heavier and the failure at the time of earthquake will be in the form of an brittle failure.

Where as the second case is concerned it is much more effective as compared to the first case because in this case the selected parts of the steel structures are intentionally designed to undergo an plastic deformation without any failures and the steel structure as a whole is designed in such a manner that only the selected steel section zones will be plastically deformed. Thus the steel structure can transfer the significant amount of energy in this plastic zones and the failure type of the steel structure will be observed as the ductile failure.



(Figure 2.1 Relation Between Base Shear and Roof Story Displacement)

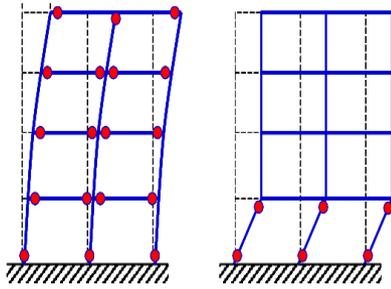
The above graph (Fig. 2.1) shows the relation between base shear and roof story displacement for the steel structure. However the amount of roof story displacement may be less in case of the ductile type of failure as compared to the brittle failure.

2.2 Behaviour of R.C.C Structure During Earthquake:-

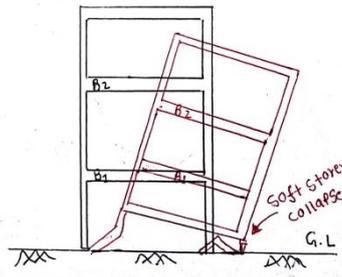
The most common behaviour observed during the earthquake in every structure is the shaking effect which is caused due to the seismic wave production. This shaking effect can be minimized by proper provision of the foundation for the RCC structures. The biggest disadvantage found in the RCC structure is that it lacks in the elastic property due to the use of the composite materials in it. However when an earthquake hits on the RCC structure the structural members such as slab, beam, column and foundation of the RCC structure play an very important role the general failure and behaviour of the RCC structure during an earthquake may be due to the following reasons. The very first reason is the strong column and weak beam concept we know that the failure of the column can affect on the whole stability of the RCC structure and it is very essential to maintain the connection between all the structural members during an earthquake hence in the method the beams are kept to be in a ductile manner so they can make a free movement during an earthquake the method of designing such RCC structures is called as a Strong column and weak beam concept.

The Second behaviour observed in the RCC structures during an earthquake is due to the soft story effect in which the bottom most storey of the building lacks in the lateral force carrying capacity produced by the earthquake as compared to the upper storey of the RCC structure this type of behaviour is commonly observed in the RCC structure during an earthquake.

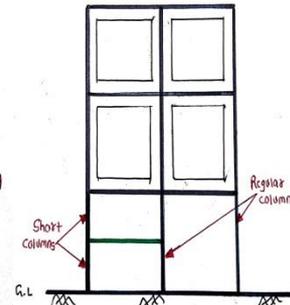
The very last and third type of behaviour given by the RCC structure during an earthquake is due to the short column effect the short column effect is generally observed at the staircase section of the RCC structure we know that the short columns are more stiffer as compared to the long columns thus the short columns are likely attract more effects of the earthquake as the short column are more stiffer they resist more deformation during an earthquake for which they are not designed hence they fail.



(Figure 2.2 Strong Column – Weak Beam Concept)



(Figure 2.3 Soft Storey Effect)



(Figure 2.4 Short Column)

2.3 Advantages of Steel Structure over R.C.C Structure as a Earthquake Resistant Structure:-

- Steel Structure has properties like ductility, High Density, good tensile strength which helps to resist the seismic forces.
- Steel Structures resistance to earthquake is quiet good as compared to the R.C.C structures.
- Steel structure generally fails in the ductile type of failure where as R.C.C structures fails in Brittle type hence loss of structural element is more in the R.C.C structures.
- Generally effects like soft story, short column does not develop in the steel structure due to the use of uniform sections.

2.4 Advantages of R.C.C Structures over Steel Structures as a Earthquake Resistant Structure:-

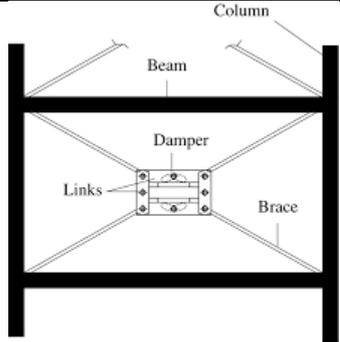
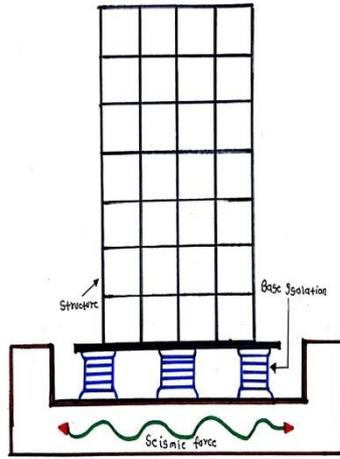
- As RCC stands for Reinforced Cement Concrete this structure has concrete material which have some characteristic such as high compressive strength which helps to resist the intensity of the seismic forces.
- Strong column – weak beam concept can be implemented in R.C.C structures which helps during the earthquake.
- R.C.C structures does not get corroded at an early stage as compared to the steel structures.
- R.C.C structures are more resistant to the environment changes as compared to the steel structures which helps a lot during the earthquake phenomenon.

2.5 Comparison Between Steel and R.C.C Structure as a Earthquake Resistant infrastructure:-

Though both Steel and RCC structures have their own structural properties such as strength, durability, life span etc. But according to the analysis and experience of many structural engineers the steel structures are likely to resist more seismic forces as compared to the RCC structures. The load transfer system of both the structure remains the same the difference is of the material only from which the structural member is made up of or casted i.e in RCC structures both the material steel and concrete are required where as compared to the steel structures only there is requirement of the uniform steel section such as I, T, L or C Sections as far as the strength to weight ratio is concern the steel has the highest strength to weight ratio as compared to any other construction material.

And as RCC structures are concern the structure have their own properties such as one of the important property i.e workability in which the concrete structural member can be moulded into any shape and size in which the steel structure lacks hence the aesthetic looks of the RCC structure are much more better as compared to the steel structures.

2.6 Earthquake Resisting Devices:-

Sr. No.	Name of the Device.	Location of the Device in the Structure.	Function of the Device.	Photograph of the Device.
1	Friction Dampers.	The friction dampers are located in the Intermediate Stories of the Structures.	The main function of the friction dampers is to allow the structure to move in a elastic manner during an severe earthquake so as to dissipate the seismic energy.	
2	Base Isolation.	The base isolation is provided at the base of the superstructure above the foundation of the structure.	The main function of the base isolation is to act as a suspension member between the base of the superstructure and the top surface of the structures foundation so as to minimize the effect of the seismic forces.	

2.7 Example of Earthquake Resisting Structures Worldwide:-

- Taipei 101 (Skyscraper) – Taiwan.
- Petronas Towers (Building Complex) – Malaysia.
- U.S Bank Tower – United States of America.
- Yokohama Landmark Tower – Japan.
- Transamerica Pyramid – United States of America.
- Torre Reforma– Mexico.



III. CONCLUSION

As in the present scenario there are much more requirement of the earthquake resistant structures worldwide especially in the earthquake regions so it is very essential to know the behaviour of this structures and there various advantages.

As in this study we have deal with the behaviour of the Steel and R.C.C structures also discussed there advantages over each other we have also done a comparative study between both the structures and found that the steel structure are more resistant to the earthquake as compared to the R.C.C structures however while doing the study and research we thought that the resistant property of the R.C.C structures to the earthquake can be improved by doing some important changes in the properties of the materials such as variation in the Carbon content property of the steel can help a lot during the earthquake phenomenon.

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