ANALYTICAL REVIEW OF SOFT STOREY

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Abstract - Soft storeys in a high rise building play an important role on its seismic performance. At the soft storey level, there is a discontinuity in the rigidity of the structure due to lack of infill walls or due to variation in floor height. It is this continuity which is the cause of structural failure of multi stored buildings under earthquake loads. Severe structural damage suffered by several modern buildings during recent earthquakes illustrates the importance of avoiding sudden changes in lateral stiffness and strength. Recent earthquakes that occurred have shown that a large number of existing reinforced concrete buildings are vulnerable to damage or even collapse during a strong Earthquake. While damage and collapse due to soft story are most often observed in buildings, they can also be developed in other types of structures. The lower level containing the Concrete columns behaved as a soft story in that the columns were unable to provide adequate shear resistance during the earthquake. The buildings with soft storey are very susceptible under earthquake load which create disasters. In this paper study of difference between soft storey and weak storey and also IS code provision related to soft storey is discussed out.

Key Words: *soft storey, weak storey, strength and stiffness Criteria etc…*

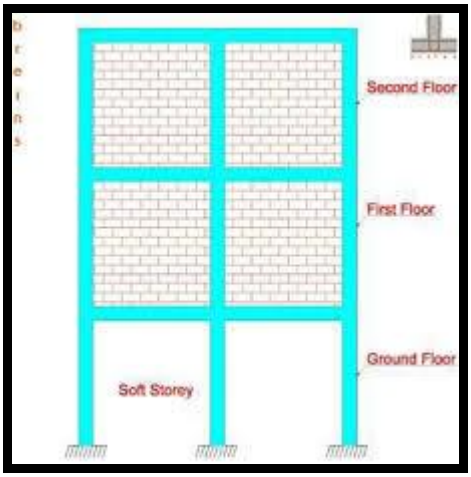

Fig no:-1

Fig no:-2

1. Soft storey and Weak storey

Soft storey

Definition-

It is the one which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above.

Following images showing soft storey.

Weak storey-

Definition-

It is one in which the storey lateral strength is less than 80 percent of that in the storey above. The storey lateral strength is the total strength of all seismic forces resisting elements sharing the storey shear in the considered direction.

1.1 Soft Storey Failure

Multi-storey buildings in metropolitan cities require open taller first storey for parking of vehicle and/or for retail shopping, large space for meeting room or a banking hall owing to lack of horizontal space and high cost. Due to this functional requirement, the first storey has lesser strength and stiffness as compared to upper stories, which are stiffened by masonry infill walls. This characherics of building construction creates weak or soft storey problems in multi storey buildings. Increased flexibility of first storey results in extreme deflections, which in turn, leads to concentration of forces at the second storey connections accompanied by large plastic deformation. In addition, most of the energy developed during the earthquake is dissipated by the column of the soft stories. In this process the plastic hinges are formed at the ends of column, which transform the soft stories into a mechanism. In such cases the collapse is unavoidable.therefoere, the soft stories deserve a special consideration in analysis and design.

It has been observed from the survey that the damages are due to collapse and buckling of columns especially where parking places are not covered appropriately. On the contrary, the damage is reduced considerably where the parking places are covered adequately. It is recognized that this type of failure results from the combination of several other unfavorable reasons, such as torsion,exceesive mass on upper floors, P-Δ effects and lack of ductility in the bottom storey. Figure shows some of the examples of soft storey.

The soft storey concept has technical and functional advantages over the conventional construction. First, is the reduction in spectral acceleration and base shear due to increase of natural period of vibration of structure as in a base isolated structure. However, the price of this force reduction is paid in the form of an increase in structural displacement and inter-storey drift, thus entailing a significant P-Δ effect, which is threat to the stability of the structure.

Secondly taller first storey is sometimes necessitated for parking of vehicles and /or retail shopping, large space for meeting room or banking hall. Due to this, functional requirement, the first storey has lesser stiffness of columns as compared to stiff upper floor rooms, which are generally constructed with masonry infill walls.

There some images showing soft storey failure in different earthquakes shown below.

Fig no-3

Fig no:-4

Fig no:-5

1.2 Causes of soft storey

There are many practical reasons for having fewer walls at the ground level of a building. A building may have larger public spaces at this entry level, such as lobbies, large meeting rooms or open-plan retail space. In urban locations, residential buildings sometimes have fewer walls at the ground level to allow for parking underneath the building which is shown in figure below.

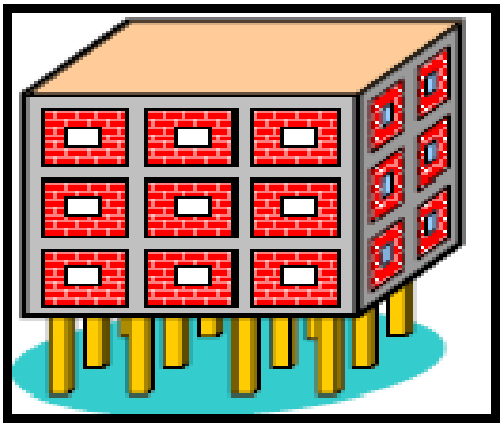

Fig no: -4

2. *Irregularity in strength and stiffness of weak and soft storey-*

A weak storey is defined as one in which the storey's lateral strength is less than 80 percent of that in the storey above. The storey's lateral strength is the total strength of all seismic resisting elements sharing the storey shear for the direction under consideration i.e. the shear capacity of column or the shear wall or the horizontal component of the axial capacity of the diagonal braces. The deficiency that usually makes a storey weak is inadequate strength of frame columns. A soft storey is one in which late al stiffness is less than 70% of that in the storey immediately above, or less than 80% of the combined stiffness of the three stories above.
The essential characherics of a weak or soft storey consist of a discontinuity of strength or stiffness, which occurs at the second storey connections. This discontinuity is caused by lesser strength, or increased flexibility, the structure results in extreme deflections in the first storey of the structure, which in turn results in concentration of forces at the second storey connection. The result is a concentration of inelastic action.

3 Building With Soft Storey-

In case building with a flexible storey, such as the ground storey consisting of open spaces for parking that is stilt buildings. A special arrangement needs to be made to increase the lateral strength and stiffness of the soft/open storey.
Dynamics analysis of building is carried out including the strength and stiffness effects of infills and inelastic deformations in the members' .particularly, those in the soft storey, and the members designed accordingly.

3.1 IS Code Provisions-

Alternatively, the following design criteria are to be adopted after carrying out the earthquake analysis. Neglecting the effect of infill walls in other storeys:

1. The column and beams of the soft storey are to be designed for 2.5 times the storey shears and moments calculated under seismic loads specified.
2. Besides the columns designed and detailed for the calculated storey shears and moments, shear wall placed symmetrically in both directions of the building as far away from the centers of the building as feasible: to be designed exclusively for 1.5 times the lateral storey shear force calculated as before.

4 Conclusions

RC frame buildings with open bottom storey are known to perform poorly during in strong earthquake shaking. Thus, it is clear that such buildings will exhibit poor performance during a strong shaking. This hazardous feature of Indian RC frame buildings needs to be recognized immediately and necessary measures taken to improve the performance of the buildings.
The phenomena of soft story may arise due to many Different reasons such as change in load carrying and slab system between stories. The abrupt changes which take place in the amount of the infill walls between stories is also one of the frequent reasons of the soft storey behavior. Since infill walls are not regarded as a part of load carrying system, generally civil engineers do not consider its effects on the structural behavior.

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