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SEISMIC ANALYSIS OF RC OPEN GROUND STORY BUILDINGS IN ZONE-V

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Abstract: Open ground floors (also known as soft storey) buildings are commonly used in the urban environment today, as they provide parking which is most needed. This type of building shows a relatively greater tendency to collapse during earthquakes because of the soft ground floor effect. The great lateral movement is induced in the first level of these buildings producing large curvatures in the columns of a floor of the ground floor Indian Standard IS 1893: 2002 allows the analysis of open ground floor building structures without taking into account infill stiffness but with a factor of multiplication 2.5 in compensation for the discontinuity of the stiffness. As per the code the columns and beams of the open aground storey are to be designed for 2.5 times the storey shears and moments assessed under aseismic loads of bare frames (i.e., without considering the infill stiffness). However, as experienced by the engineers at design offices, the multiplication factor of 2.5 is not accurate for low rise buildings designs these days.

Infill walls can be modelled in commercially available software ETABS using two-dimensional area element with appropriate material properties for linear elastic analysis. But this type of modelling may not work for non-linear analysis since the anon-linear material properties for a two-dimensional orthotropic element is not very well understood. Seismic evaluation of an assumed reinforced concrete (RC) framed building would invariably require a non-linear analysis and is performed in this thesis in detail to capture the behaviour of such building structures..

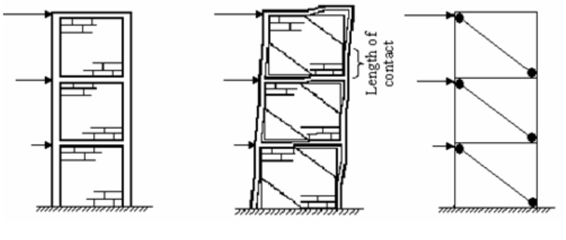
KEYWORDS: *open ground storey, response spectrum analysis, RC building, infill wall*

1. OVERVIEW

Car parking space for residential apartment'sinpopulated cities is a matter of significant concern due to the growing population over the past few decades. Therefore the practice has been to a use the building's own ground storey for parking. These types of buildings (Fig. 1.1) having no infill masonry walls in ground storey, but infilledain all upper stores, are calledaOpen Ground Storey (OGS) buildings. They area also known as 'open first storey building' (whenathe storey numbering starts with one from the ground storey itself), 'pilotis', or 'stiltedbuildings'.

Fig. 1: Typical example of OGS building

Support condition has a great impact in the global stiffness of the structure. Therefore the building models were analysed in the current study for two usually used support conditions: (a) fixed and (b) pinned end support conditions. The hinged end support conditions are considered in instance of isolated footing. From literature it is understandable that a hinge is to be provided at column end at the bottom of the foundation. Nevertheless, when it is established on hard rock, the column end may be demonstrated as fixed, with the level of fixity at the top of the footing.



(a)Infilled Frame (b)Deformed Frame (c)Equivalent Strutmodel

Fig. 2: Behaviour of Infilled frames (ref. Asokan 2006)

2. SEISMIC BEHAVIOUR OF OPEN GROUND STOREYBUILDING

Initially the frame and infill wall remain intact under lateral packing. When the lateral load rises, the infill wall at the unloaded (tension) corner gets removed from the surrounding frame, but the infill walls are still intact at the compression corners. The length over which the wall and the frame of the infill are intact is called contact length. Load transfer takes place across an imaginary diagonal that serves as a compression strut. Because of this infill wall behaviour, they can be modelled as an equivalent diagonal strut that diagonally connects the two compressive corners. The property of stiffness should be such that the strut is only active when undergoing compression. This concept was first put forward by Holmes (1961).

Elastic Analysis Approach

The modelling of infill wall asaan equivalent diagonal compression memberawas introduced by Holmes (1961). The thickness of the equivalent diagonal strut was recommended as the thickness of the infill wall itself, and the width recommended as one-third of the diagonal length of infill panel.

The width of the strut using Airy's stress function was found to vary from d/4 to d/11 depending onathe panel proportions. Later, a number of tests conducted bismuth (1966) proved that the equivalent strut width (w) is a function of relative stiffness (λh) of the frame and infill wall, strength of equivalent corner crushing mode of failure (Rc) and instantaneous diagonal compression in the infill wall (Ri).

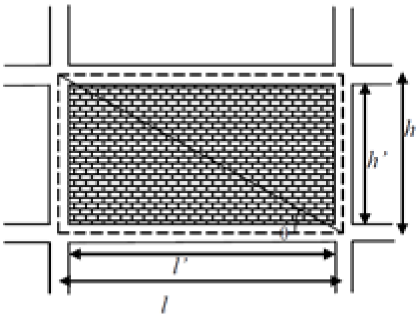


Fig. 3: A typical panel of the infilled frame

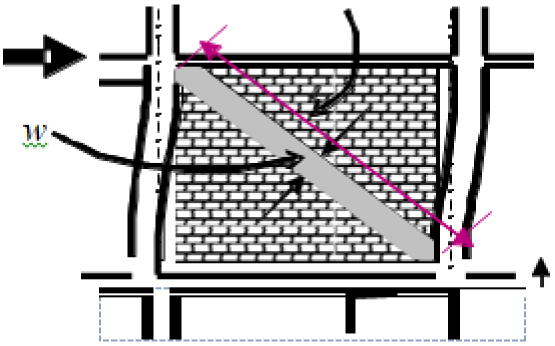


Fig. 4: Behaviour of typical panel subjected to lateral load

3. BUILDING DESCRIPTION

An ideal OGS framed building located in Seismic Zone V is selected for the present study. The building is fairly symmetric in plan and in elevation. This building is a G+3 storey building (12m high) and is made of Reinforced Concrete (RC) OrdinaryaMoment Resisting Frames (OMRF). The concrete slab is 150mm thick at each floor level. The brick wall a thicknesses are 230 mm for external wall sand 120 mm for internal walls. Imposed load is taken as 2.5 kN/ m2 for all floors. Fig. 3.1 presents typical floor plans showing different column and beam locations. The crossasections of the structural members (columns and beams 300 mm×600 mm) are equal in all frames and all stories. Storey masses to 295 and 237 tonnes in the bottom stories and at the roof level, respectively. The design base shear was equal to 0.15 times the total weight.

4. RESULTS

Seismic analysis is a sub-set of structural analysis and is the calculation of the earthquake response of the building structure, and is a relevant part of the structural design in which earthquakes are common. Seismic analysis of a structure involves evaluating the earthquake forces acting at different levels of the structure during an earthquake and the effect of such forces on the overall structure's behaviour. Analysis in approach may be static or dynamic as provided for in the code provisions.

Thus broadly we can say that linear analysis of structures to compute the earthquake forces is commonly based on one of the following three approaches.

1. An equivalent lateral procedure in which dynamic effects are approximated by horizontal static forces applied to the structure. This method isaquasi-dynamic in nature and is termed as the Seismic Coefficient Methodain the IScode.
2. The Response Spectrum Approachain which the effects on the structure are related to the response of simple, single degreeaof freedom oscillators of varying natural periods to earthquake shaking.
3. Response History Method or Time History Methodain which direct input of the time history of a designed earthquake into a mathematical model of the structure using computer analyses.

Two of the above three methods of analysis, i.e. Seismic Coefficient Method and Response Spectrum Method, area considered for the analysis of buildings studied here. Details of these methods are described in the following section.

5. CONCLUSIONS

Followings are the salient conclusions obtained from the present study:

Shear capacity base of a bare chassis 10 S6B designed with MF 3.0 and 2.5 is about 28% more than the one designed with MF 1.0 while turning varies by a score of more than 15 mm between them -based Shear capacity of a strict framework 10S6B designed with MF 3.0 and 2.5 is about 28% more than the one designed with MF 1,0 while turning varies by rating more than 10 mm between them. -Strong Frame filling 10s with fixed support 3 may take longer charge times than that with a low filling while the steering is nearly identical to about 66 mm for both cases. - For 10S also part fixed frame of the behavior and articulated supported in full filling is almost the same as the difference being in the base shear. For the fixed support strength is articulated almost 29% of the deformation and the fixed frame supported up to 31 mm then hinged up to 22 mm. - OGS-frame 10S with 2.5 fixed support has a resistance 3 times higher than with articulated support then the point of view articulated deviation has a higher deformation capacity as determined by 10 mm. 10S6B curves Conclusions easy prey with all variants • shear basic capacity OGS framework designed to MF = 3 is about 1.5 times more than that of MF = 2.5, • shear basic capacity OGS framework designed to MF = 2.5 is about 2.5 times that of MF = 1.0, • The base shear capacity of full frame infilled designed to MF = 1.0 is about 1.1 times more than the bare frame, • The base shear capacity of full frame infilled designed to MF = 1.0 is about 9.5 times more than that of OGS framework designed with MF = 2.5, • The shear capacity at the base raw frame is the lowe st • The highest deformation can be seen in the case of a frame designed with MF 2.5 which is about 90 mm, while for others it is Max just 75 mm.

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