SEISMIC ANALYSIS OF SOFT STOREYS STRENGTHENED USING EQUIVALENT DIAGONAL STRUTS- A REVIEW

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Abstract

Earthquake in different parts of the world demonstrated the hazardous consequences and vulnerability of inadequate structures. Soft storey is a storey in which the stiffness is less than 70% of the storey above or less than 80% of the combined stiffness of the storey's above. In a multi-storied building, soft storey is adopted to accommodate parking which is an unavoidable feature. With the advancement in field of high rise construction, various types of frame arrangements have been emerged. Le Corbuiser popularly known as LC was one of the pioneers of, what is now called five points of modern architecture. Hence, he deviced the concept of soft storey, in which stiffness is altered, along with storey height to achieve an asthetic view. The present study is an attempt to analyse soft storeys strengthened using equivalent diagonal struts. The equivalent diagonal struts method was proposed by Stafford Smith and Hendry, in which the concept of equivalent width was formulated mathematically. The total cases studied are 14 (7 with struts and 7 without struts). Seismic zone II is considered in the analysis. Results are analysed in terms of bending moments, shear forces, nodal displacements and storey displacements. Graphical outputs are also generated

Keywords— Struts, diagonal, soft, storey, strength, seismic, static.

I. INTRODUCTION

Soft storey is a common building weakness. The term soft storey explains one level of a building that is appreciably more flexible than the stories above it and the floors or the foundation below it.

Buildings are classified as having a soft storey if that level is less than 70% as stiff as the floor instantly above it or less than 80% as stiff as the average stiffness of the three floors above it. Open ground storey buildings are called soft storey building, whereas their ground storey may be soft or weak. The soft or weak storey commonly exists at the ground storey level, but it might be at any other storey level. Soft storey buildings are characterized by having a floor which has a lot of open spaces for example; Parking garages are often soft stories, as are restaurants or floors with lots of windows.

The behaviour of soft storey building in earthquake is very crucial because soft storey building is more flexible in seismic condition, vibration is happen in soft storey building so we provide shear wall in soft storey building (shear wall resist the effect of earthquake).

Reinforced concrete frame structures have become common form of construction with masonry infill in urban and semi urban areas in the world. The infilled frame term denotes a composite structure formed by the combination of a moment resisting plane frame and infill walls. The infill masonry may be of brick, concrete blocks, or stones. Ideally in present time the reinforced concrete frame is filled with bricks as non-structural wall for partition of rooms because of its advantages such as, thermal insulation, durability, cost and simple construction technique.

An Earthquake is a sudden slipping or movement of a portion of the earth's crust or plates, caused by a sudden

release of stresses .Earthquake epicenter are usually less than 25 miles below the ear surface and are accompanied
and followed by a series of vibrations. The earth has four major layers: The inner core, outer core, mantle and crust.
The crust and the top of the mantle make up a thin layer on the surface of earth. But this layer is not a single cover, it
is made up of many pieces like jigsaw covering the surface of the earth. These keep slowly moving around each other, slide past one another and bump into each other. These puzzle pieces are called tectonic plates, and the edges
of the plates are called the plate boundaries. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults. Since the edges of the plates are rough, they get stuck while the
rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstick on one of the faults
and there is an earthquake

Fig. 1.1: Building with opening at base.

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II. OVERVIEW OF WORK

Present research work deals with comparative study of behaviour of soft storey building frames considering geometrical configurations under earthquake loading. The framed buildings are subjected to lateral load and vibrations because of earthquake and therefore lateral load analysis is necessary for these frame structures. The fixed base system are analyzed by employing different equivalent diagonal struts frame structures in seismic loading by means of STAAD.Pro software. The responses of the same building frames are studied and evaluate the best geometry which satisfy lateral loading.

Equivalent Static method of analysis is a linear static procedure, in which the response of building is assumed as linear static manner. The analysis is carried out as per IS: 1893-2002 (Part 1).
A comparison analysis of results by moments, displacements, shear force, storey displacement and axial force has been done. Following steps are considered

Step-1 Selection of building geometry and Seismic zone: The behaviour of all the models is studied for Zone III of Seismic zones of India
Step-2 Selecting a geometry of 6 storey (G+5) of plan area 15m x 15m
Step-3 Modelling of soft storey floor wise and each soft storey floor is strengthen by providing equivalent diagonal struts
Step-4 Selection of Equivalent diagonal struts (200 mm x 200 mm)
Step-5 Formation of load combination

III. LITERATURE REVIEW

Literature based on the modelling of multi-storey building using floating column and transfer beam under seismic behaviour. From the detailed literature review, inference is studied.

Dhiraj D Ahiwale , Rushikesh R Khartod (2020) Open ground construction is quite prevalent from last 25 years in metropolitan India. Buildings with open ground stories are to be particularly exposed to collapse, and severe damage under earthquake excitation. Although, many buildings constructed in recent times have been observed adverse effect during Bhuj earthquake. In present work, twelve storied building are taken into account and the performance of structure evaluated by using pushover analysis in SAP 2000 software. The analytical results discussed in the nature of capacity curve, structure performance point and plastic hinge development pattern. Result indicated that, there are formations of plastic hinges at ground storey column level. To counteract the total collapse of soft storey structures, there is need to retrofit the open storey. Therefore, the alternative measures are recommended to get better the reaction of soft storey like RC shear wall, steel bracing, and infill wall**.**

Mr. Raghavendra S. Deshpande (2018) Open first storey is now a days unavoidable feature for most of the multistory buildings in urban areas for vehicle parking, shops etc. Many earthquakes in the past, have demonstrated the potential hazard associated with soft first storey buildings. The first storey become soft and weak relative to the upper stories, since the first storey is composed of only columns while the upper stories are divided by unreinforced masonry infills. Structurally those unbalances are unhealthy and the soft first storey buildings are well known for being susceptible to collapse through past big earthquakes. In the present paper, an investigation has been performed to examine the behavior of various alternative models of same reinforced concrete moment resisting frame building with an open first storey & unreinforced masonry infills in the upper stories. The structural action of masonry infill panels of upper stories has been taken into account by modeling them as equivalent diagonal struts. The parameters discussed include fundamental natural periods, stiffness of open first storey in relation to the upper storey, lateral displacements, inter-storey drift by linear elastic analysis using ETABS analysis package. It is noticed that significant change in stiffness between the soft storey and upper storey is responsible for increasing the strength demand on first storey columns. The objective of this paper is to promote safety without too much changing the constructional practice of reinforced concrete structures

Akhildev KS , Bhagyaraj (2018) This paper consists of seismic analysis of a multistoried building with soft storey using ETABS and comparison of effectiveness of various methods to mitigate soft storey effects. A soft storey is a regular feature of multi storey structures for parking and auditoriums. The behavior of a building during earthquake highly depends on the effects of soft storey due to its inherent vulnerability to seismic forces

Mohammed Irfan Hussain (2017) In this study, an industrial building is selected for the study, to study the seismic performance of soft storey buildings, there are six 3D mathematical models have been developed using ETABS. The various parameters have been studied, storey drift, storey displacement, forces and time period, storey shear, modes shapes. Subsequently adopting the control measures to reduce the effect of soft storey in terms

Shobha. L et. al. (2016) Since long Masonry Infills (MI) are being used to fill the voids between the horizontal and the vertical structural elements such as beams and columns. But, when Laterally loaded, the masonry infill

tends to interact with the RC frame, changing the structural behavior. In this work masonry infill is replace by Equivalent Diagonal Strut (EDS), whose width is calculated using the various relations proposed by the researchers. Variation in the Deflection and the Stiffness in the frame by modeling the masonry infill as equivalent diagonal struts and performing the linear analysis. The software technique is being used for the analysis.

Vikunj K. Tilva at. al. (2016) In the present era we are spotting that the load bearing structures are substituted by the RC frame structures because of its sustainability against the earthquake, durability, long life span and also high strength. Structural fall down implies that the structural system is unable to withstand its own gravity loads. In this paper, symmetrical frame of commercial building (G+5) located in different seismic zones and different soil condition is considered by modeling of initial frame. Which contain the requirements of computation of stiffness of infill masonry wall frames by modeling infill as a "Equivalent diagonal strut method" and IS 1893-2002. In which it shows that infill panels increase the stiffness of the structure. Different parameters like displacement, storey drift, and base shear are calculated for the different storey height.

Ho CHOI et. al. (2014) In this study, RCC frames institutional buildings in Korea are experimentally investigated to evaluate their seismic capacity. In this work, the diagonal strut system of concrete block wall is discussed using principal compressive strains on concrete block wall. The transverse force is counter by both concrete block wall and RC frame are also explained based on the compressive stress acting on concrete block wall and the curvature distribution along both columns during the test.

IV. NEED FOR THE PROPOSED WORK

Now a day's multi-storey building construction for residential, industrial or commercial purpose has become a common feature. These multi-storey building need plentiful of parking or open spaces below.

In multi-storey inhabited building to provide accommodations for the number of parking places and the turning radius, some of the columns from the floors above create a problem. In such cases, these columns are designed as floating columns. Even in commercial building there might be a need for conference hall or banquet hall on the lower floors. For these purposes, we have a preference to have a clear open space rather than having columns in between. This is where floating columns come into the picture. Floating columns gives the liberty to alter the floor plans above.

V. OBJECTIVE OF THE WORK

In this work G+5 storey (six storey) building is taken in which floor wise (changing soft storey position form first to six storey) soft storey is analysed and its contribution in the behaviour of the structure is examined. Soft storey is very flexible so our purpose is to strengthen it by proving equivalent diagonal struts at centre and corner and find out the effective equivalent diagonal struts pattern which stands against wind and earthquake loading. The investigation is to be carried out by conducting-

(a)Modelling of building frames with different patterns of equivalent diagonal struts

(b)Analysis of frames considering wind and earthquake parameters

(c)Critical study of results in term of moments, forces and displacement

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