Structural Analysis of Multi-Storied Building For Different Plan Configuration For Different Types of Soil Considering Equivalent Strut Approach- Review Paper

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Abstract*:*

In India, soil conditions are different in different regions which plays important role during earthquake shaking. Soil having number of layers at various depths at different locations doesn't show same response on structure during earthquake. Infill walls are referred as non-structural element during design in general but effect of infill walls on structure during earthquake is also considered which called as equivalent strut method. Regularity in plan is also affect structure during earthquake. Irregular building does not show same response in all directions during earthquake.

In current study, analysis of plan irregularity of building and consideration of soil structure interaction under seismic loading. Aimed with purpose, the plan irregular building (G+20) is analyzed by using SAP 2000 subjected to the combination of gravity load and seismic load under specific zone. Compare the same building with equivalent strut approach and without equivalent strut approach consideration of different soil condition structure interaction; it is analyzed by using the SAP2000 software. Results are compared structural building with and without equivalent strut approach with different soil conditions i.e. soft, medium, hard soil structural interaction.

***IndexTerms - Irregular buildings in plan; Equivalent strut approach; Different soil* conditions**

I. INTRODUCTION

1.1 General

Multi-storied buildings causes structural irregularity with respect to stiffness. Unfortunately, lots of buildings in India leads to collapse under lateral forces due to structural irregularity. In current study analysis of plan irregularity of building and consideration of soil structure interaction under seismic loading is considered with equivalent strut approach.

1.2 Analysis of multistorey building with different soil conditions

Soil has different properties at various locations as well as at different depths. Testing of soil samples of various locations in laboratory does not shows same properties. This changes in properties cause serious effect on stability of multistoried building

1.3 Analysis of multistorey building with different plan configurations

Irregularities are of different types such as stiffness irregularities, vertical geometric irregularities, Weight (mass) irregularities, Discontinuity in capacity etc. A structure irregular in plan causes structural irregularity in terms of stiffness. Unfortunately, many buildings in India leads to collapse under lateral forces due to structural irregularity. In this study, various buildings of different plan configurations are considered for analysis.

1.4 Analysis of multistorey building with consideration of infill walls by equivalent strut method.

A building without infill walls cause serious structural problems during earthquake, infill walls doesn't have any type of loading except its own weight but it helps columns to be stand against lateral loads i. e. earthquake forces. In current study A building with infill walls and without infill walls are to be tested.

Literature Review

ThupdenTashiLachenpaBhutia, Dr. Rajendra. S., Vijay. K. (July 2016), have carried out a study on the seismic analysis of RC frame structure by taking different soil types and considering soil structure interaction with fixed and spring base in different zones of India. Soil structure interaction greatly affect the response of a structure during earthquake. For the analysis of a RC structure, soil structure interaction are considered in two modes, in first mode, soil is replaced by springs and in second mode, whole soil mass is considered. In this study, SAP 2000 were used by the researchers for the analysis purpose. Different soils types are considered for soil structure interaction study such as hard soil, medium soil and soft soil. In this study they concluded that the

Deflection, Shear Force Bending Moment, Beam End Forces, Displacement, Beam Stresses, Sectional Force and Bending Moment were noticed maximum in Zone V for all cases considered for this study. (1)

AnkitPurohit, LovishPamecha (June 2017) have carried out the study on Seismic Analysis of G+12 Multistory Building with Varying Zone and Soil type. For analysis, the building which is subjected to various seismic zones and variation in soil type was selected for analysis. This study is based on four cases. 1-Soft soil subjected to zone V, 2-Medium soil subjected to zone V, 3-soft soil subjected to zone II and medium soil subjected to zone II. Researchers was performed this study to understand and check the behavior, performance and response of multi-storied G+12 building with varying parameters. In this study, various models were selected and they were evaluate for deflection, stresses, bending moment and shear force and results were compared for various cases. Results of all selected parameters were traced in tabular format and observed against selected zones such as zone II and zone V with varying soil type. In this study they concluded that the Deflection, Shear Force Bending Moment, Beam End Forces, Displacement, Beam Stresses, Sectional Force and Bending Moment are maximum in Zone V for all cases. Soil strength analysis in medium and soft soil are examined in both Zone V and Zone II. Results of above mentioned cases shows that the displacement in soft soil was greater than medium soil case. Results of Shear force values are also greater in soft soil. Bending moment is noticed lesser in soft soil than medium soil for all cases.(2)

Suman, Dr.Sunil, Kumar Tengali (July 2017) have investigated the Soil structure interaction of RC building with different foundations and soil types. In this study they reported that the ignorance of SSI proved dangerous for structures of heavy weight resting on soft soils such as clay silt. They examined that the designers and techniciansare generally neglect the soil structure interaction i.e. Soil layers and its effect on multi-storied building during earthquake shaking. When a multi-storied RC building is subjected to earthquake motion, vibrations takes place at the foundation and it tries to overturn the structure, and thus changes the motion of the ground connected to the structure. By comparing a structure with and without consideration of soil-structure interaction, the structure with soil-structure interaction has been strengthened with increase in natural period of the structure. In this study, a G+7 storied building having vertical irregularities located in zone IV was structurally analyzed by using softwareSAP2000 by considering various soil properties and different types of foundations. In this result they concluded that the time period was increases and also it gives the more stability for the building and frequency was decreases. (3)

Mr. Rahul Sawant, Dr. M. N. Bajad (Jan-Feb 2016) have studied the effect of Soil-Structure Interaction on High Rise RC Building. In this research, they studied the interaction between the super-structure and sub-structure by modelling the soil to understand the overall response of the system. A non-linear frame model of multi-storied residential building of G+42 storeys located at MUMBAI and time history of ELCENTRO was used to study the response of the model in ETABS. Then a simple soil model with pile and raft foundation was considered in MIDAS GTX NX to this nonlinear models of frames to check the effect of SSI on the overall response of actual structures. In this study they concluded that the use of flexible base can cause the reduction in the structural response and damage in joints and infills during the analysis. (4)

Ranu R. Akulwar (2015) have reported Seismic Analysis of Structures under Different Soil Conditions. In this study, seismic design analysis of asymmetrical plan building was carried out. They have modelled a building as a 3D frame using SAP2000v14 which was thenanalyzed by Response Spectrum method. They have concluded following points, the percentage of the modal mass participation are 0.63% and 0.006465% along X and Y directions of corresponding building, respectively. This was because of low torsional rigidity of the building. By manual design of a typical beam and column, they have found that the reinforcement required for flexure and shear as obtained from SAP2000 was in acceptable results with manual calculations. They have also concluded by considering soil-structure interaction effect on multi-storied buildings that buildings behave differently with more stiffness on loose soil. Base shears have shown significant variation with high values for structures resting on loose soils and low values for structures resting on hard rock. This attributes mainly due to more absorbing energy capacity of soils when compared to rock materials. (5)

Akhil R, Aswathy S Kumar (June 2017) have carried out study on Response spectrum analysis (RSA) of vertically irregular RC building. In this study they modelled regular and H-shape plan irregular buildings having same area of 25X25m and height of 3.5 m from each G+10 storey.The performance of framed building during steady earthquake motion depends on the stiffness, strength, and mass of the building in both the horizontal and vertical planes of the building. This research study includes the stiffness of the structure for different vertical irregular structures with consideration of three models in Regular Structure and three models in Plan irregular structure for different soil conditions. All models were analyzed for zone V with dynamic earthquake loading pattern. In this research, they concluded that from the response spectrum analysis of irregular shaped building displacements are more than that of regular shaped building. In this study, they reported that the overall performance of regular building is more strengthen than irregular building Software. They also reported that the time period require for H-shaped plan configuration is more as compared to other considerations. Average Frequency was more for Irregular Buildings. In this study, they concluded that maximum displacement for regular shapes and minimum for irregular shapes.(6)

Mamathashree K. S., Sanjay S. J. (November 2016) have studied the effect of seismic evaluation of RC framed irregular buildings with soil structure interaction. In this research, they studied the RC special moment resisting frame buildings for seismic response of 4,8,12 stories regular and irregular structure with consideration of different types of soil by using linear response spectrum analysis with and without soil structure interaction effect. They have studied the seismic behavior of mass, stiffness, diaphragm and reentrant corner irregular buildings with the addition of soil structure interaction. They found seismic response of these buildings in terms of base shear, maximum displacement, natural period and variations of these with building height, type of

soil, inclusion of soil interaction by Winkler method are found. They also examined the regular and irregular buildings for the effect of soil structure interaction with different soil types. (7)

Veena S Ravi, SreedeviLekshmi (2015) have studied effect of Shape and Plan Configuration on Seismic Response of Structure (ZONE II & V). They have carried out studied seven models of G+11 storey building for one regular plan and also for irregular plan (C, E, H, L, T, PLUS shapes). They kept the plan area of every building same but consideration of geometry was different.Selected elevation of all building models for study was same. By using STADD-Pro software, the static and dynamic both analysis has done on computer and the parameters considered for design are as per the IS1893-2002-Part-1. They have studied the seismic performance of different shape of building models or structures which are located in severe earthquake zone (V) and minor earthquake zones (II) and they compare the design lateral shear, time period, joint displacement etc for respective parameters. For analysis, Response spectrum analysis was used. In this study, they concluded that the response spectrum method gives a clear understanding of different modes of vibration. They also concluded that the building with regular square plan have the maximum base shear value as compared with other irregular plan shapes and "L" shaped plan configuration have least base shear value in IInd and Vth zone. Stiffness of structure hence the structure becomes more flexible due to this natural period increase. (8)

Milind V. Mohod (2015)have reported the effect of shape and plan configuration on seismic response of structure. In this research they studiedthe effects of different plan and different shape configuration on irregular shaped structures with consideration of earthquake motion. Buildings with irregular geometry respond differently against earthquake motion. Plan geometry was the parameter which decides its performance for different loading conditions. STAAD Pro. V8i was used to check the effect of irregularity (plan and shape) of buildings orstructure by using structural analysis software. There were other factors also, which affect the behavior of building from which storey drift and lateral displacement play an important role in understanding the response of the structure. They have reported that, different shapes like Plus, L, H, E, T, C building have more displacement in both direction (X and Y) as compared to other remaining simple shaped building (Core-rectangle, Core-square, Regular building). (9)

L. Landi, P.P. Diotallevi& A. Tardini have considered the equivalent strut model for analysis of multi-storied building structure. This study was started from the model for monotonic loading proposed by Al-Chaar. This model was checked for the case of cyclic loading by calibrating the degradation of strength and stiffness, the remaining strength and the loading and unloading branches. This calibration was performed by comparing the results obtained by analysis with the ones of available experimental tests on infilled building model. The model was then applied and tested for investigating the seismic response of infilled RC frames: pushover and nonlinear dynamic analyses were carried out to obtain the response of structure for base shear-top displacement and to check the possibility of collapse. (10)

G.Prasanna Lakshmi, Dr. M.HelenSanthi (May 2016) have done research on the evaluation of G+3 storeyed residential Reinforced Concrete (RC) building with infill brick masonry wall subjected to earthquake load. In this research the effect of masonry on the seismic resistance of RC building structure was studied. They have carried out a analysis for the strut action with different percentage of opening for doors and windows. For this study they assume the building located in seismic zone III. This study was carried out with nonlinear parameters using pushover analysis in ETABS. The infill walls in multi-storied RC framed building under study was modeled as brick masonry wall with openings and as diagonal strut. The frames were studied for seismic resistance by push over analysis. In this study, they reported that the responses of the frames for stiffness, base shear, displacement and acceleration from both the cases are nearly same. In this research paper the investigation clearly shows that the diagonal strut approach is very effective in testing the seismic response of RC frame with masonry infill. (11)

Mohammad H. Jinya, V. R. Patel (June 2014) have studied the analysis of RC frame with and without masonry infill wall with consideration of different stiffness with outer central opening. In this study they observed two remarkable structural damages caused by masonry infill walls during seismic motion i.e. soft stories and short columns. Outer side central opening were used for office or residential buildings. In this case, central opening were provided in periphery wall with different percentage i.e. 15% and 25% and brick compressive strength were considered as per IS : 1905-1987 i.e. 5.0 and 12.5 N/mm2 and Brick Masonry strength considered as per IS is 0.50 and 1.06N/mm2. In ETABS software G+9 R.C.C framed building models has been prepared, Seismic coefficient method(SCM) and time-history(TH) has been performed for analysis of same building models as per IS 1893:2002. In this study, they studied various parameters such as story displacement, base shear, storey drift, axial force with and without consideration of soft story effect and also considering effect of infill walls with various percentage of opening. For Macro model, Equivalent diagonal strut (EDS) method was use to find out width of strut using FEMA approach method. (12)

NasratullahZahir, Dr. VivekGarg (July 2017) have examined the static and dynamic analysis of multi-storied R.C building frame with infill. In this paper G+9, 6-bay by 3-bay RC building frame was selected which was situated in seismic zone V as per IS: 1893(part 1)-2002 was analyzed with and without infill masonry wall using STADD pro software. The masonry infill was modelled as an equivalent diagonal strut element and infill panel. The width of equivalent diagonal strut element was obtained by various approaches given by Smith, Holmes and Paulay. In this research static and response spectrum analysis was carried out on bare and infill frame models. The results obtained from the analysis for infill frame were compared in terms of story shear, floor displacement, story drift, time period and vertical support reaction with bare frame. It was found that the results obtain from this study shows that story shear and vertical support reaction increase and floor displacement, story drift, time period was decreases for models with infill wallsas compared to bare frame models by equivalent static method and response spectrum method. (13)

HaroonRasheedTamboli, Umesh.N.Karadi (October 2012) have performed the seismic analysis using Equivalent Lateral Force Method for different multi-storied reinforced concrete(RC) frame building models. This study include various frames such as bare frame, infilled frame and open first storey frame. The results of bare frame, infilled frame and open first storey frame were discussed. In modelling the masonry infill panels the Equivalent diagonal Strut method was used and the models were performed using software ETABS was used for the analysis of all the frame models. (14)

EhsanDehghaniSanij, Dr.RezaAlaghebandian (2015) have studied a reinforced concrete frames with masonry infill walls for comparison between three models which includes diagonal strut model, three strut model, and horizontal spring model for nonlinear analysis.In this study, a brick masonry panel was replaced by single diagonal compression strut of same properties between the corners in diagonal strut model. A masonry panel was replaced by one diagonal and two non-diagonal struts of same properties with force-deformation characteristics based on the orthotropic behavior of the masonry infill in three strut model. A masonry panel was replace by a horizontal shear spring between two nearby stories in horizontal spring model. (15)

3. Concluding Remarks

Extensive literature survey by referring books, technical papers is carried out to understand basic concept of topic, selection of type of structures, modeling of the selected structures, analytical work is to be carried out, interpretation of result and conclusion.
A review of existing literature indicates that most of existing studies are based on effect of different soil conditions on seismic response of building. However very little literature is available in the published works regarding the effect of vertical irregularity on the seismic response of building.
Not even one literature is available in the published works regarding structural analysis of building for different plan configuration for different types of soil considering equivalent strut approach.

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