

Effect of Different Types of Infills on The Static and Dynamic Behaviour of Rc Frame Structures with and Without Retrofitting

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Abstract- This study investigates the effect of different types of infill walls on the static and dynamic behavior of reinforced concrete (RC) framed structures with and without retrofitting. Masonry infill walls significantly influence the stiffness, strength, and seismic performance of RC frames, although they are often neglected during structural analysis. In this work, bare frames and infilled frames using conventional brick masonry and AAC blocks are analyzed under seismic loading using equivalent static and time history methods according to IS 1893:2016 provisions. Numerical modeling and finite element analysis are carried out using ABAQUS software. The study also evaluates the effect of soft stories at different floor levels and the efficiency of CFRP retrofitting techniques. Results indicate that infilled frames show considerable reduction in displacement and improved stiffness compared to bare frames. AAC infill walls provide better seismic performance than conventional masonry. Retrofitting using CFRP further enhances structural resistance and reduces seismic displacement significantly.

Keywords: RC framed structures, masonry infill, seismic analysis, ABAQUS, AAC blocks, retrofitting, CFRP, time history analysis, soft storey, earthquake resistant structures.

I. INTRODUCTION

An earthquake is usually explained as-a wave-like movement produced-by focus in constant-turbulence (disturbance) beneath-the surface area of the earth (lithosphere) travelling along-the crust in the interior of the earth. The earthquake phenomenon can also be defined as the vibrations (sometimes catastrophic or violent) of the surface of the earth occurring because of the release of the energy from the crust in the interior of the earth.

From past few years the earthquake attacks have been raised. The ones having lower intensity are less harmful and cause less damage to the structure. The ones that have higher intensity if occurred in a densely populated area will cause more damage and loss of life. So due to these effects we need to focus more on the seismic study and construct a building

that will be able to stand various intensities of the ground motion when earthquake occurs.

A large number of reinforced concrete and steel buildings are constructed with masonry infills. Masonry infills are often used to fill the voids between the vertical and horizontal resisting elements of the building frames with the assumption that these infills will not take part in resisting any kind of load either axial or lateral; hence its significance in the analysis of frame is generally neglected.

Moreover, non-availability of realistic and simple analytical models of infill becomes another hurdle for its consideration in analysis. The presence of the infill panels has an important effect on the behavior of the bare frame, because the infill panels alter the mechanical characteristics of the portico under seismic loading, and their presence can influence the strength, stress, stiffness and ductility of the

structure. In fact, an infill wall enhances considerably the strength and rigidity of the structure. It has been recognized that frames with infills have more strength and rigidity in comparison to the bare frames and their ignorance has become the cause of failure of many of the multi-storied buildings.

In seismic zones, the interaction between the infill panels and bare frames influence the seismic response of the structure. The collapse of infilled reinforced concrete frames exposed to earthquake loading is caused in the most of the cases by the presence of infill panels and by the insufficiency of shear resisting capacity due to the lack of ductility and resistance of reinforced concrete bares. Finite element analysis can simulate the non-linear comportment of reinforced concrete elements of the model even if the non-linear response of each material has a complicated behavior.

Masonry infill walls are a common building element found throughout the world. Infill walls constructed of various masonry materials are often used in both concrete and steel structures to infill the frame openings are,[a]. This type of construction is particularly common in developing countries where masonry materials such as clay bricks, concrete masonry units, and hollow clay tiles are readily available [b]. In many cases, infill walls are treated as architectural elements and their influence on the behavior of the structure is not considered. This design philosophy can lead to uneconomical design as well as unexpected behavior and even catastrophic collapse.

The opposition of the lateral load and gravity load that is dead load and live load which can contributed by the combined action of slab, beams and columns. Satisfactorily ductile property shall be provided for the R.C. structures which are contributed at the earthquake zones or they ought to at least possess the capacity with support specific deformity under that movement for overwhelming staking states. In vertical plane the walls are constructed with beams and columns at the required locations in structures. The most commonly used brick infill is conventional burnt clay brick masonry. Along with this or combination of light weight bricks such as

autoclaved aerated concrete bricks, hollow concrete blocks are also used.

Guideline For Earthquake Resistant Structures

- The selection of cross section will have adequate strength. Then you can justify a desire possibility so can achieved desire strength.
- The structure layout should be simple and regular avoiding offset of beams to column, or offsets of column from floor to floor.
- The amount of tensile reinforcement in beam should be restricted and more compression reinforcement should be provided. The letter should be enclosed by stirrups to prevent it from buckling.
- Closed stirrups or spiral should be used to confine the concrete at section of maximum moment to increase the ductility of member.
- Design of building should be based on seismic code IS: 1893 (part-1) 2002 and other this code IS: 13920-1993.
- Integral action of soil foundation and superstructure system.
- Structure should not have large height & width ratio.
- Column and wall should be continuous without offset from the roof to the foundation.
- Beams & column should be equal width.
- The structure should have uniform floor height.
- The structure should be designed on strong column weak beam concept.
- Load should be uniformly distributed.
- To ensure this sum of moment capacity of the column for the design axial loads at a beam & column joint should be greater than the moment capacity of the beam along each principle plane.
- The structure should have balanced lateral resistant.
- Shear wall should be provided for increasing stiffness.
- The structure should have low center of mass relative to the ground.
- Avoid ground floor soft story.
- The design shear force for column will be maximum.

Analysis Method

As per, the Indian Standard code for Earthquake IS: 1893-2002, seismic analysis can be performed by following methods.

Static Method

a. Equivalent Static Linear Method

Dynamic Methods

b. Time history method

Static analysis

Equivalent static linear method

The equivalent static analysis performed to obtain the design lateral forces at each floor level along the height of the building and its distribution to individual lateral load-resisting elements. The equivalent static analysis procedure is essentially an elastic design technique. The equivalent static analysis by using finite element method is the only method that cannot be applied for dynamic analysis of soil structure interaction. In this method the structure and soil are analyzed in single step. The structure is discretized using finite beam elements and solid with finite elements.

Dynamic analysis

Dynamic analysis is performed to calculate the design seismic force, and its distribution to different levels along the height of the building and to the various lateral load resisting elements, for the following Buildings:

Regular buildings - Those greater than 40 m in height in Zones IV and V and those Greater than 90 m in height in Zones II and III.

Irregular buildings - All framed buildings higher than 12m in Zones IV and V and those greater than 40m in height in Zones II and III

Strengthening Techniques (Retrofitting)

It is a process of increasing the strength of the existing structures of the structural components due to the increased loads, aging of the construction materials (corrosion of the steel), modification of the structural systems (removal of walls/columns) which is not taken care during the design. This process can be achieved by various techniques which can be decided based on the crack pattern and crack length observed in the control specimen. For example strengthening of wall can be in flexure zone when

leads to shear failure finally. Or In case of the building if the wall is strengthened by any techniques the wall next to it may be the critical point in the structure this may be due to change in stiffness in a undetermined structural systems.

Scope Of The Work

- Static and Dynamic analysis of the infilled frame and the bare-frame has been carried out using ABAQUS software.
- The manual calculations are compared with the software analysis result.
- In this study the behavior of the infilled frames using equivalent static method and time history method is explained in detail.
- The response curves of the base shear and story displacement calculated manually and then is compared with that of the results from ETABS and ABAQUS software's.

II. LITERATURE REVIEW

General Review

From the past few decades the influence of the infills on structures and the respective studies with respect to different parameters such as load carrying capacity, modes of failure and stiffness have been done.

In the past researches several attempts have successfully been made to check on the behavior of both bare and infill walls and soft story considerations on alternative floors for different buildings and check their seismic performance resulting a better in a better performer and to finally develop different methods encouraging behavior of the structures since past few decades (60 years). The very first and ancient studies using an infill in the structure was observed in the empire state building at New York city.

It was lately observed that there were diagonal cracks seen in the infill walls when the wind speed was more than that of 90m/hr. Initially steel frames were used which did not dominantly show much of the strain that led to cracking of masonry excluding the wind action. But by including the above structure with an infill substantially reduced the effect that

took place for steel frames (provided stresses were in the limits of furious capability) of infill.

Most of all the previous works focused mainly on the stiffness-parameter of the infilled-frames. Some of the studies also gave a detailed report of the interaction between frame and infill. Previous works on infills can be divided into few categories namely experimental investigations and few different types of analytical investigations such as micro-modeling and macro-modeling techniques/approaches.

Objectives

The aim of this project is to achieve the following goals

- To study the behavior of the RC frames with brick infills by modeling infill.
- Comparative study regarding the better performance between the bare frame model and infilled frame model.
- To identify the Maximum stress, strain and displacement of bare frame and bare frame with infills.
- To examine the influence of infill panels on the seismic response of the structure.
- To study the effect of soft story on the performance of masonry infilled RC framed structure.
- To evaluate the response of bare frame model and infilled frame model subjected to seismic loads as per IS 1893-2016 Codal provisions.
- To Strengthening the failure masonry wall by retrofitting using ABAQUS software.
- To compare the results between manual calculations and the software outputs.

III. RESULT AND DISCUSSION

Introduction

In this section we discuss the end a results or consequences procured in the present-work. This outcomes and applications are most suitable for the universal-engineering practices.

Behavior of the masonry-infill frames and bare-frames a under lateral load sand dynamic load is studied. Effects and significance of different parameters are studied-in detail. The following a characteristics are discussed.

1. Comparison between infilled frame and bare frame model.
2. Performance level of alternate story opening in infilled frames.
3. Retrofitting of failure infill wall

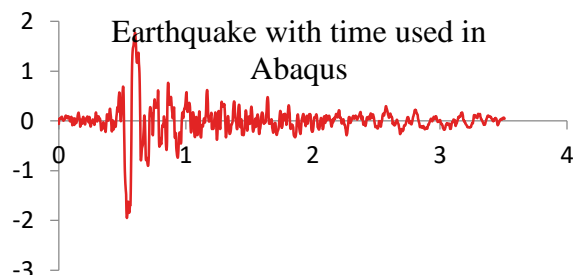
Model description

In order to understand the behavior of bare-frame and infill frame, a three story-frame with two bays width of 3m each is considered in one direction and one bay width of 3m in the other direction for the present study. In the first part of the study that is comparison between the bare frame and infill frame both in static and dynamic analysis, we consider two models one bare frame model and another infilled frame model and study the seismic performance of the two models.

The second part of the study we prepare three different models fully infilled with soft story consideration at alternate floors (for example consideration of soft story at ground floor for the first model and for the next considering the soft story at first floor) and study the seismic performance of all the four models and then comparing the results.

Dynamicbehavior Of Rc Framed Structure

The dynamic analysis is done by using time history method and the earthquake data taken from journal paper that is the accelerograms are implemented, separately, to the fixed support, i.e. the North-South acceleration component of the Vrancea 1977 Earthquake magnitude of 7.8. The North-South component is the one chosen because it has the highest peak accelerations of the earthquakes, as it can be observed in Figure 6.6. The data for Vrancea Earthquake is provided by URBAN INCERC, i.e. Romania's National Institute of Research in Construction.



Ground motion of Vrancea earthquake, Europe

Analysis done with different cases, they are

- a. Bare frame
- b. Bare frame with infill wall (both conventional and AAC type of infill)
- c. Soft story at ground floor
- d. Soft story at first floor
- e. Soft story at second floor
- f. Retrofitting using CFRP

ABAQUS 3D FEA

- A building with the specification is created in ABAQUS as a solid 3D deformable body and then meshed with Hex 8 nodes elements.
- The earthquake motion direction is defined as the z direction in ABAQUS.
- The boundary conditions are zero displacement of the base on x and y and zero rotation around all the axes. For analysis of structures subjected to earthquakes, it is important that the material
- Density and gravity load are carefully defined, since they play an important role in the equation of motion.
- First, the boundary conditions are set as fixed base, so all the displacements and rotations are restricted at the base, and a frequency analysis is performed.

IV. CONCLUSION

GENERAL

The aim of the present study is towards the seismic performance of the infilled frame and bare frame. The equivalent static method and time history method was acknowledged out in order to recognize the seismic behavior of infill frame and bare frame. Also the displacement curve was developed with respect to the results obtained. Base shear was manually calculated and the results were compared with that obtained from the software. The values of main parameters namely displacement and base shear, were obtained and then were compared between the cases of models considered. Some of

the important conclusions of the present study have been listed in here.

The conclusions that are obtained from the results discussed in the present study are shown below:

- The infill walls predominantly deflects the behavior of the frame structure and it is required to consider the infill walls to always be a part of the structure and necessarily examine the infill walls for seismic analysis of the structure.
- Including infills in the RC-frames condenses the dislocation of the bare frames and also improves the ability of the structure against stiffness. A fully infilled frame has the lowest story drift value and uppermost base shear value.
- From the results, it has been found that 18% displacement of structure with AAC block in all cases is found less than conventional brick masonry.
- In the Equivalent static method, bare frame model is considered the maximum displacement is very high in the range of 8.9 mm but after providing an infill to the bare frame it was seen that the maximum displacement is very less in the range of 1.26mm. Therefore with the infills there is 76% of reduction in the displacement.
- In the Dynamic method (Time history method), bare frame model is considered the maximum displacement is very high in the range of 7.05 mm but after providing an infill to the bare frame it was seen that the maximum displacement is very less in the range of 1.63mm. Therefore with the infills there is reduction 70% in the displacement.
- This study accentuates the poor seismic performance of the building with soft story consideration especially when the soft story is given at ground floor and highlights a better performance when soft story is given at top floor. Therefore the displacement is reduced when the soft story is provided at higher levels.
- From the results, it has been found that Retrofitting by using CFRP 84% the displacement is reduced.
- Infill increases the initial stiffness of the structure and also increases the base shear carrying capacity of the structure.

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