ABSTRACT

This research work aims at providing a scientific basis for the development of behavioral as well as theoretical guidelines for the ground storey of soft storey framed structures of steel and concrete with bracing and partial infill of cement mortar and concrete up to collapse and shear walls with fully infilled frames. In general such soft storeys which are provided for free circulation at bottom storeys have less lateral load capacity in comparison to storeys above it and are worst affected at the time of earthquakes.

Accounting for the contribution of bracing and infill walls (even partial infills), in resisting the lateral loads to more efficient use of materials and simple connections. Evaluating the strength of partial infill and bracing also leads to reduce the risk of damage to the bounding frames and finishes. Such provisions can lead to significant reductions in maintenance and rehabilitation cost. Even epoxy repaired frames were tested in order to know if such frames are repaired after collapse, how much strength can be recovered. The aim of this study is to determine the information about the behavior, ultimate loads, deformations and failure patterns of the single storey single bay, braced steel and R.C. infilled frames. Mainly, it is experimental study with plastic analysis of frames by equivalent strut approach.

The work has been divided in seven chapters, each chapter has particular aspect. Chapter 4 and 5 dealt with important contribution of the work.

The chapter 1 of introduction highlights the primary significance of this work, related to lateral stability of building structures. It defines the terms infill, soft storey, braced frames, partial infill and epoxy repaired frames. The objective, methodology, scope are indicated and the outline of this thesis is given. The organization of this research thesis is summarized in the flow chart. The limitations of the investigation have been mentioned. The next chapter deals with the literature survey.

In the chapter 2, the general behavior of infilled frames, as found in the literature, is described. This chapter provides an overview of findings from experimental and analytical research in infilled frames during the last half century.

This research, therefore, represents a new application for a relatively new but considerably prevalent method for soft storey and shear wall construction. The evolution of analysis of infilled frames is delineated. Herein, the key factors that affect the behavior of infilled frames are discussed. The studies are classified as
methods based on (1) concept of equivalent strut (2) finite element analysis (3) results on experiential investigations (4) plasticity and collapse approach (5) general studies.

The next chapter contains experimental set-up for the steel and R.C. frames.

Information regarding experimental investigations is given in the chapter 3. This experimental study reported herein consisted of a number of tests on models of bare, braced, partial infilled steel and R.C. frames, subjected only to lateral loads. The details of frames, bracings, partial infills, experimental set up and test procedure are discussed. The testing of materials with relevant IS codes are mentioned. All the experiments were performed on models with single bay, single storey frames. Two models of each category were tested. The observation and results of experimental work are dealt in next chapter.

The chapter 4 presents an evaluation of results of the experimental investigation into the structural response of steel and R.C. frames infilled with cement mortar and concrete. Observations and results from these experiments are evaluated in this chapter and related tables, graphs, figures and photographs are presented. The global responses, together with the detailed observation and study of crack patterns for partial and fully infilled frames provided data for calculating the ultimate loads by using plastic analysis of the following chapter.

Details of the developed analytical model, simplified equations for prediction of the ultimate loads of the different frames are proposed and evaluated are given in the chapter 5. The model was validated by a comparison of numerical and experimentally determined the ultimate loads of all the specimens of the partial and full infills. These simplified equations form a basis of the design guidelines for predicting the behavior of infilled steel and R.C. frames. In the following chapter the ultimate loads from the numerical results are compared with calculated results from the simplified equations and results are discussed.

Chapter 6 contains discussions and analysis on the present work. In this chapter observations and problems arising during the experiments and reason for the failure pattern has been discussed. Theoretical results have been compared with the experimental results. Conclusions based on results are concluded in the next chapter.

The chapter 7 summarizes the contents of this work in terms of the experimental and proposed theoretical methods engaged and the main findings. Recommendations of a possible sequence in future continuation of this research are given.
At the end, a list of references, followed by appendices with their details and a list of technical papers published is given.

**Appendix-A: Calculation of the Ultimate Load for Bare Steel frame and design of the connections**

**Appendix-B: Material properties for the Steel frames**

**Appendix-C: Material properties for the R.C. frames**

**Appendix-D: Calculation of the Ultimate Load for the infilled Steel Frames**

**Appendix-E: Calculation of the Ultimate Load for the infilled R.C. frames**

**Patent and Publications**

This study leads to the following-

All braced and infilled frames have significantly less deflection in comparison to the bare frames for the similar loads. Practically, central bracing system is more effective than that of the corner and full corner bracing system as it may hinder the free movement. Moreover, with bracings the R.C.C. infilled steel frame is composite in nature; hence it is an added advantage. If the structures are moderately damaged due to the seismic forces, it can be repaired by epoxy resin and utilized again. The experimental ultimate load of the braced frame increases in comparison with the bare frame. The contribution of partial infills is noteworthy than that of the similar braced frames. This may be significant in developing a construction technique for industrial application of the infilled frames. While designing the columns with braced partially infilled frames, modified load factor is suggested, thus saving considerable cost of the construction. For horizontal braced frames, brick masonry, concrete and cement mortar partial infills are used. As the contribution of brick masonry, as a partial infill is not significant in comparison to the cement mortar and concrete partial infills. So, for further research only cement mortar and concrete partial infills are considered. Further to avoid excessive drift and stiffness between the two consecutive floors, it is suggested that as per the requirement, the corner, top corner or diagonal bracings can be used for a particular storey in a shear wall. With appropriate material and safety factors, the simplified equations can be used as a basis of design guidelines. Theoretical results obtained using these simplified equations have been compared with results from the experiment and are fairly close. These simplified equations form the basis of design guidelines for predicting the behavior of infilled steel and R.C. frames.