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"Seismic Strengthening Of Structures with Exterior Retrofitting"

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Abstract

Seismic engineering provides design and construction techniques so that buildings and other structures can survive the tremendous forces of earthquakes. While codes and design practices have resulted in greatly improved designs of new buildings, the main danger lies in the nation's inventory of existing vulnerable buildings. This study examines the seismic retrofitting project for a 7-storied building designed only for gravity load situated in seismic zone III as defined in Indian Seismic Code IS 1893 (Part I): 2002.

Different solutions for increasing the lateral rigidity of the buildings are presented in the study, based on the idea that the disturbance to the residents of the buildings, noise, vibrations, and dust has to be minimized. For performance evaluation of commonly used methods of retrofitting, few retrofitting methods such as external shear walls, jacketing are selected. These methods are applied in the FEM model of the existing building analyzed earlier. For performance evaluation, important structural aspects such as base shear, displacement and lateral resistance provided were considered.

INTRODUCTION

Many existing structures located in seismic regions are inadequate based on current seismic design codes. In addition, a number of major earthquakes during recent years have underscored the importance of mitigation to reduce seismic risk. These types of buildings were found to be very vulnerable to unexpected earthquakes. It was observed that some modifications to structural configurations and material properties showed improvement in seismic performance of such buildings. Therefore, seismic retrofitting was suggested and practitioners applied various seismic intervention techniques to structural systems found to be deficient.

Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes. A seismic retrofit provides existing structures with more resistance to seismic activity due to earthquakes. In buildings, this process typically includes strengthening weak connections found in roof to wall connections, continuity ties, shear walls and the roof diaphragms.

Seismic retrofitting of existing structures is one of the most effective methods of reducing this risk. In recent years, a significant amount of research has been devoted to the study of various strengthening techniques to enhance the seismic performance of RC structures. However, the seismic performance of the structure may not be improved by retrofitting or rehabilitation unless the engineer selects an appropriate intervention technique based on seismic evaluation of the structure. Therefore, the basic requirements of rehabilitation and investigations of various retrofit techniques should be considered before selecting retrofit schemes. In this report, the characteristics of various intervention techniques are discussed and the relationship between retrofit and structural characteristics is also described. In addition, several case study structures for which retrofit techniques have been applied are presented.

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Objective of the study

The present study investigates possible seismic retrofiting techniques for use in the seismic up gradation of RC frame building. A comparison of different techniques is made based on seismic performance and cost involved.

ANALYSIS AND DESIGN

In the present work a 7-storied, building subjected to gravity load only is modelled.The selected building is a typical RCC multistory structure with beams and columns as gravity force resisting system. The building is situated in seismic zone III as defined in Indian Seismic Code IS 1893 (Part I): 2002. The grade of concrete used is M20 and steel for main and transverse reinforcement is Fe 415, Structure analysis (Linear structural analysis) and design are carried out as BIS Codes

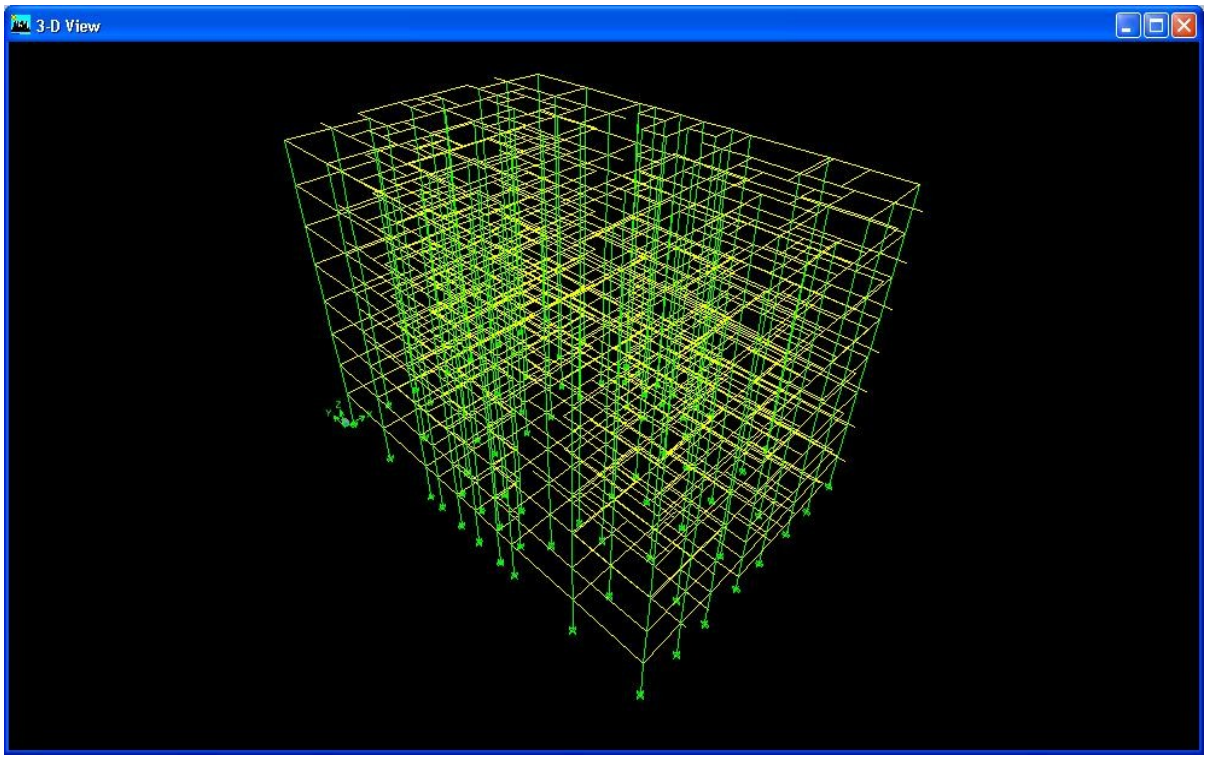

Figure 1.1 Model of the building for gravity loads only.

RESULTS AND CONCLUSION

Comparison Between different methods

Regardless of architectural and site constraints, we can conclude that all the options, the concrete shear walls and jacketing could be chosen. In fact, all of them provide satisfactory deflection control. On the other hand, the results have demonstrated that the all three options provide dissimilar stiffness to the building. The concrete shear wall option is about twice stiffer than Jacketing (Table 5.4 and 5.5). The reduction in moments is about 80 to 85 percent (Table 5.1) at lower stories and 75-to 80 percent

(Table 5.2 and 5.3) on upper stories in case of shear wall. For the actual case, the difference was not significant, but in a region of higher seismic activity, the other option specially jacketing would probably not be selected. Also cost calculation shows that shear wall as the most economic method amongst all in Table 5.6.

Table 5.4 Comparison of displacement in X direction.

Level (m)	Eq. (mm)	Shear wall (mm)	Jacketing (mm)
24	-65.89	-28.94	-43.56
21	-62.38	-25.02	-41.16
18	-55.47	-20.82	-36.87
15	-45.85	-16.39	-30.96
12	-34.61	-11.92	-24.02
9	-24.77	-7.73	-17.26
6	-14.81	-4.06	-10.36
3	-6.32	-1.54	-4.02

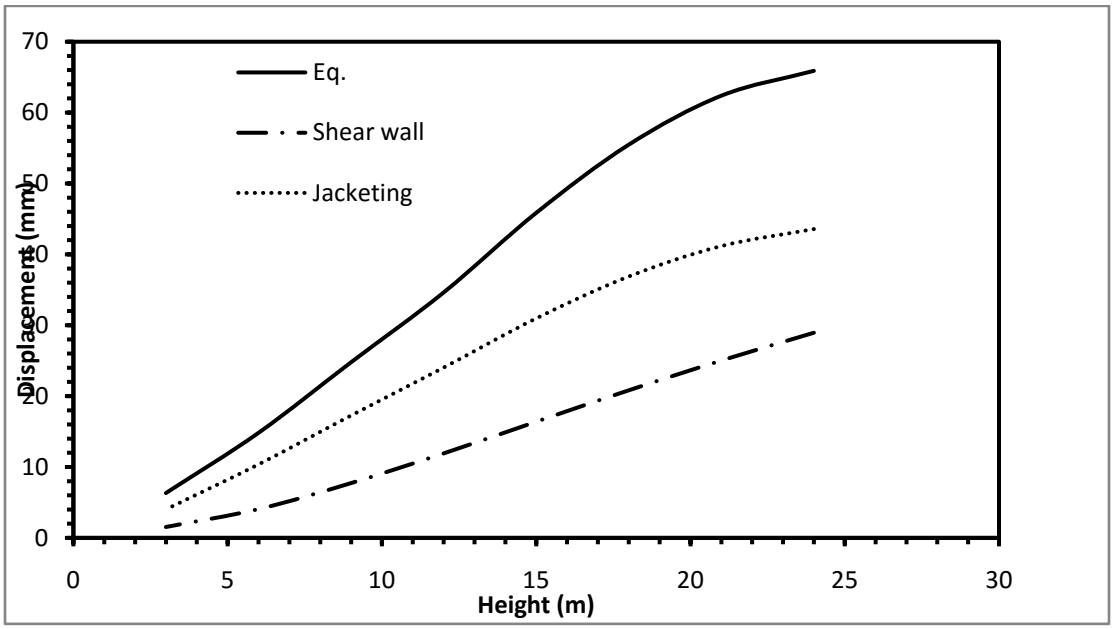

Figure 5.1 Displacement comparisons in X direction

Table 5.6 Cost comparison of different methods.

S.No.	Method	Steel		Concrete		Labour	Total(Rs)
		Quantity	Cost(Rs)	Quantity	Cost(Rs)	Cost(Rs)	
1	Shear Wall	13,440 Kg.	6,72,000	168 Cum.	8,40,000	2,10,000	17,22,000
2	Jacketing	7,000 Kg.	3,50,000	225 Cum.	11,25,000	2,75,000	17,50,000

Although, each of these methods satisfactorily increased the strength and stiffness, all of them with the exception of jacketing require construction work outside the building, which means no disturbance to users and results in the buildings being in service at the time of retrofitting. Also the external strengthening techniques offer advantages with respect to cost and ease of construction. While in case of jacketing construction works inside the building, which means disturbance of users and results in the buildings being out of service.

Conclusion

- RCC buildings which were constructed before 2000 and designed only for gravity loads were found seismically deficient as the lateral loads are not considered and also the codes available at that time are not that modernized according to the existing scenario.
- On the basis of seismic evaluation of the existing structure selection of rehabilitation program should be made.
- Cost analysis of all the methods shows that shear wall retrofitting can be use efficiently for retrofitting which also provide sufficient seismic resistance.

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