Retrofit of Residential Building For Increased Floor Height

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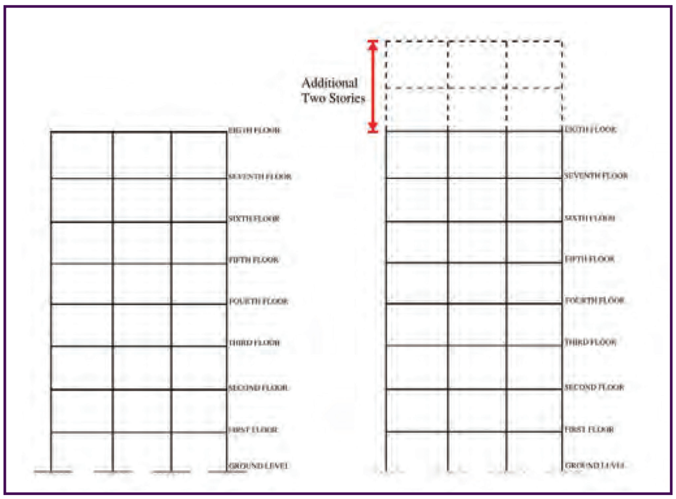
Abstract

In recent times, many builders have received an increased floor space index (FSI) from the government. As a result, there is a tremendous demand from builders to architects and structural engineers to increase the floor height of the already constructed buildings to max permissible floor levels. This paper presents a case study of retrofitting a residential building in Pune whose floor height was increased from G+8 to G+10 floors.

Introduction

Vertical extension of existing buildings is required in the development of urban construction as with the increase of population, cities are bound to expand but the actual area of the individual city is limited. It is, therefore, necessary to confine the development within the scope of the city properly. As the new regulations have allowed the admissible FSI, raising the height of buildings has become more popular in metropolitan areas.



(a) (b)

(a) Existing G+8 Storey Building (b) Proposed G+10 Storey Building

***Fig.1.1:* Elevations of Building**

Building Analysis Of Revised Floor Height

For the revised floor height of the building, and analysis model was prepared to calculate revised loads on the columns and foundation. As the floors were revised from G+8 to G+10, there was a 25% increase in gravity loads in the building. The seismic weight of the building was also increased, thereby increasing the earthquake load on the building. After modelling and analysis, the foundations and superstructure were rechecked for revised loads. It was found that the isolated foundation provided was sufficient for the revised loading condition. There were few columns and shear walls on the ground floor which were deficient due to increased load demand. It was concluded that the retrofit of these columns would render the building fit for the intended purpose.

Retrofit options for vertical members

Three types of retrofitting techniques were considered to strengthen the existing structural members for providing these additional floors to the existing buildings;

- **R.C.C. Jacketing**

R.C.C. Jacketing is the technique of retrofitting that involves section enlargement by adding a concrete jacket with reinforcement. Due to the section enlargement the cross-sectional area of a column increases which reduces the usable carpet area and adds the load on the substructure. For this case, a minimum 100 mm concrete jacket with reinforcement (as per IS 15988:2013) is required, which costs 90% of the reconstruction of the column and a 122% increase in weight.

- **Externally Bonded Steel Jacketing**

Steel jacketing is a technique of encasing the columns with steel plates or steel angles and filling the gap with non-shrink grout. This provides passive confinement to core concrete. High young's modulus of steel causes the steel to take a large portion of axial load. A major drawback of this method is that steel is vulnerable to corrosion. For this case, the column is to be encased with 12 mm thick steel jacketing, anchored with 16 mm bolts at 300 mm c/c, which costs 70% of the reconstruction of the column and a 30% increase in weight.

- **Jacketing with Carbon Fibre Reinforced Polymer (CFRP)**

This technique of retrofitting involves wrapping of RCC column with Carbon Fibre Reinforced Polymer CFRP and carbon fibre anchors are used for anchorage. R&M carbon fibre sheets are a lightweight, non-corrosive material, that provides passive confinement to core concrete. which costs 50% of the reconstruction of the column and a 0.1% increase in weight. It provides minimal disturbance to the existing structure. After reviewing the merits and demerits of the three retrofitting options and working on the project economics, jacketing with carbon fibre reinforced polymer (CFRP) was finalised for retrofitting. R&M carbon fibre sheets were used for the required retrofitting.

1. Typical Strengthening Sketch For Column

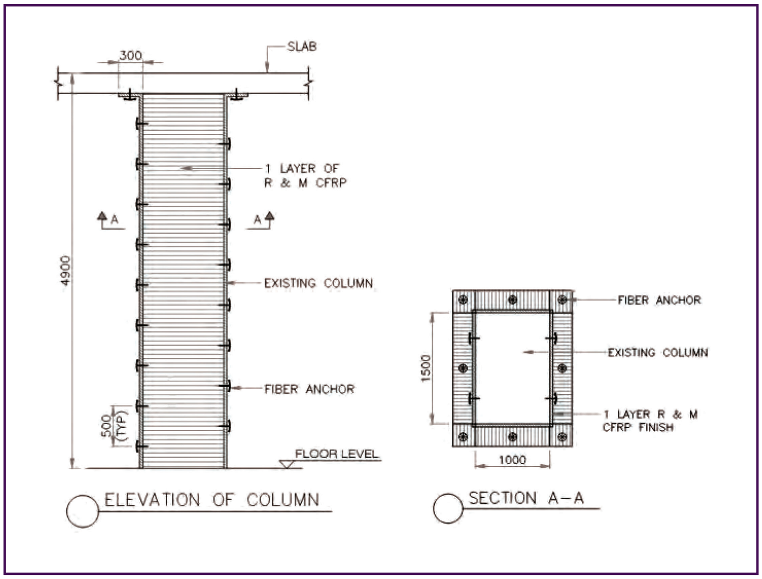


Fig. 3.1: Typical column strengthening Details

Fig. 4.1: surface preparation for CFRP strengthening

Fig. 4.2: Forming Radius at corners of the column

Fig. 4.4: beam-column junction confining with CFRP

Fig. 4.5: Execution of the column strengthening with CFRP

Fig. 4.6: Finished Column after the top coating sand sprinkling

Summary

This paper presented a retrofit of a multistoreyed building in Pune to a vertical extension of 2 floors. After carefully studying and analysing the building, it was affirmed that only the shear walls and columns require strengthening. Three retrofit options were considered i.e. RCC jacketing, external bonding with steel plate and jacketing with CFRP. Owing to the loss of usable area in the case of RCC jacketing and the high cost of steel plates, the CFRP technique was utilised for retrofitting. This scheme turned out to be an economic option and provided satisfactory performance.

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