IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 57-59

Parametric Study by Using Various Methods of Seismic Retrofitting Analysis for RCC Structure

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Abstract: *This paper consist of various parametric study of seismic retrofitting technique for Reinforce cement concrete(RCC) structure. The building performance is reduces in terms of safety level, strength or capacity due to the variety of causes or situations such as alteration of building units, deterioration of concrete, unskilled work, heavy loads due to extension of structure etc. This is a more difficult scenario for a structural engineer than designing and constructing a new building. Enhancement of the performance of such a deficient buildings can be done by increasing the strength and the strength of building can be increased by the process of retrofitting. The output of a retrofitted structure is aimed higher than that of original structure. Among some retrofitting techniques for strengthening the structure jacketing is applied for strengthening proposed existing structure which is located at low seismicity region. The work deals with some aspects such as Non-destructive testing(NDT) on existing structural elements, determination of load and moment carrying capacity of structural elements before and after considering extension, method used for strengthening of structure and design of the existing structural elements such as RCC beams and columns as per to the load carrying capacity requirements. For modeling and analysis of building software STAAD PRO 2008 is used.*
Keywords: *Non destructive testing (NDT), Seismic retrofitting technique, STAAD Pro.*

I. Introduction

A R.C.C structure is designed to have a capacity to carry combined loads (dead, live and seismic loads) at certain safety level and at certain degree of reliability. When this design is finally executed in construction process, the expected performance of the structural building should come into satisfaction. However, this ideal condition is not always realized. Almost all the structures are constructed of R.C.C and even though it is a wonderful construction material, but once set it is very difficult to increase its strength. The performance of building reduces in terms of safety level, strength or capacity due to the variety of causes or situations such as deterioration of concrete, unskilled work, alteration of building units, larger loads due to extension of structure etc. These structures behaves or performs normally during their entire life span but at the end of design period of structure, the structure may not be capable to take the existing loads and obviously it will not be possible to take the extra loads on it. This pose a more difficult scenario for a structural engineer than designing and constructing a new building. Enhancement of the performance of such a deficient buildings can be done by increasing the strength and the strength of building can be increased by the process of retrofitting.

R.C.C Buildings can be made to undergo three different R's namely Repair, Rehabilitation and Retrofitting. Repair is partial improvement of the degraded strength of a building after an earthquake. Rehabilitation is a functional improvement, wherein the aim is to achieve the original strength of a building after an earthquake. Retrofitting means structural strengthening and enhancement of performance of deficient structural elements of a building to a pre-defined performance level whether or not an earthquake has occurred. The performance of a retrofitted structure is aimed higher than that of original structure. The structural elements are strengthened according to the load carrying capacity required. Retrofitting of deficient existing building to improve the performance will be a pathway to assure the future safety of the structure. There are several retrofit techniques for strengthening the structure and one of the retrofit techniques named as jacketing is applied for strengthening proposed existing structure in this project. In recent years, RCC jacketing is commonly used to increase the seismic strength of a R.C framed structure, for rehabilitation of structures damaged by an earthquake or for strengthening of an undamaged structure made necessary by revision on structural design or for taking additional loads.

1.1. Objectives:

The primary objectives of this project can be summarized as follows:
1. To analyze an earthquake resistant structure.

2. Performance of non-destructive tests on the existing structure for assessing the condition of old structure. (Using rebound hammer and ultrasonic pulse velocity test).
3. Determination of strength of the existing structure.
4. Structural analysis of existing structure.
5. Seismic structural analysis of existing structure with extra floors to be constructed.
6. Determination of the actual strength required for existing structural elements.
7. Strengthening of the structural elements accordingly.

II. Literature Review

Mahdi shariati, Nor Hafizahramli-sulong, Mohammad Mehdi Arabnejadk.h, Payamshafighand Hamid sinaei, "Assessing the strength of reinforced concrete structures through ultrasonic pulse velocity and Schmidt rebound hammer tests", Scientific research and essays vol.6 (1)-2011. Experimental studies using ultrasonic pulse velocity and Schmidt rebound hammer as NDT tests were presented in the paper to establish a correlation between the compressive strength of compressive tests and NDT values. These two tests have been used to determine the concrete quality. The main members of an existing building including column, beam, and slab were included in the study. The test results show that the rebound no. method was more efficient in predicting the strength of concrete under certain conditions.

Pravin S Waghmare, In this paper, different jacketing methods are mentioned. Jacketing methods described for strengthening of column to improve the performance of R.C.C building. Jacketing is the most popularly used method for strengthening of building columns. The most common types of jackets are steel jacket, reinforced concrete jacket, fiber reinforced polymer, composite jacket, jacket with high tension materials carbon fibre, glass fiber. Construction technique for steel jacketing, R.C.C jacketing, FRP jacketing are studied. Construction technique detail for each jacketing is shown in the paper.

Sudhir k. Jain(2002), In this paper the Concept of pushover analysis that is becoming a famous tool in the profession for design of new structure, seismic evaluation of existing buildings and developing appropriate strategy for seismic retrofitting of structure. It is shown how this Analytical technique can be useful in deciding seismic retrofitting strategy and techniques.

Abdullah and Takiguchi (2003), Investigated the square columns using both square and circular ferrocement simultaneously under compressive and cyclic loading. For the study three types of columns were considered Three columns, designated as CJ-AL10-6L, CJAL15- 6L, and CJ-AL20-6L were tested under different axial loads after being strengthened 13 with circular ferrocement jackets containing six layers of wire mesh. Specimen CJAL15- 6/3L, strengthened with reduced number of layers of wire mesh for the centre portion, was tested to investigate the behavior and strength of the important practical aspect of strengthening RC column with ferrocement. Two reference columns, SJ-AL15-4L and SJAL15-6L, were strengthened with square ferrocement jackets, with four and six layers of wire mesh, respectively, before tested to their failure to study the effects of different shapes of jacketing on lateral load–displacement response. Each of the reference columns was reinforced with 12 deformed D-6 bars distributed evenly around the perimeter of the column cross-section. Smooth R-2 (diameter¼2mm) bars were used as transverse reinforcement spaced at 50 mm.

Shailesh Agrawal and Ajay Chourasia (2003), performed the nonlinear static analysis of RC building using pushover approach before and after retrofitting. The comparison of strength parameters and pushover curve indicated that there was increase in ductility. As regards to stiffness of the building, it was seen that it remains more or less same up to linear stage, while in nonlinear stage every point increased both in capacity and the deformation after retrofitting. The strength of the building was correlated with base shear, the net enhancement in strength after retrofitting.

Sengupta Amlan K., Reddy ChemuruSrinivasulu, Badri Narayanan V.T., Ashokan ASeismic Analysis and Retrofit of ExistingMulti-Storeyed Buildings in India- An Overview with Case study. Authors are discussing about local and globule retrofit strategies. They observed deficiencies which were common in the region, are inadequate design, detailing, soft storey, wrong construction practices. They analyzed the structure by using the finite element analysis software SAP 2000. They observed that though the building had larger strength it failed before reaching target displacement due to lack of required ductility. They conclude the paper with stress on need of participation of owners, real estate promoters, architects, engineers, and contractors to allay the fear of residents of multi-storeyed buildings.

III. Research Methodology

The proposed work is planned to be carried out in the following manner.

- Performance of non-destructive tests on the existing structure for assessing the condition of old structure. (Using rebound hammer and ultrasonic pulse velocity test)
- Determination of strength of the existing structure.

- Structural analysis of existing structure.
- Seismic structural analysis of existing structure with extra floors to be constructed.
- Determination of the actual strength required for existing structural elements.
- Strengthening of the structural elements accordingly

IV. Conclusion

Based on the NDT results, Analysis and design following conclusions are derived: Load carrying capacity of the columns is not sufficient to take the additional load of extension of the structure that i.e. L.C.C of existing column is found less than actual load on column. After analysis it has also been observed that moment of resistance of existing beam is more than actual bending moment, so it is not required to strengthen the beams. Rebound hammer, ultrasonic pulse velocity tests are carried out for testing the concrete condition of existing R.C.C structure. As per the Non destructive Tests carried out on existing structure, it is observed that the Ultrasonic Pulse Velocity Results with direct, semi direct and indirect methods indicates the maximum readings are below 3km/sec and between 3.0 km/sec to 3.5km/sec. As per the Ultrasonic pulse velocity test (refer to IS 13311 (Part I) 1992 "Non –Destructive Testing of concrete methods of test, Ultrasonic Pulse Velocity").It is observed that quality of concrete is medium and doubtful. As per Rebound Hammer test (refer to IS 13311 (Part II) 1992 "Non- Destructive Testing of concrete - methods of test, Rebound Hammer") the readings of Rebound Hammer indicates the probable compressive strength of CONCRETE IS M18 TO M22. On performing analysis it has been observed that Loads on the existing structure increased due to the extension of the structure which is due to the additional floors. Strengthening of the existing columns by using R.C.C jacketing to increase their load carrying capacity and to enhance the performance of structure to withstand the seismic effects and additional loads. Strengthening of existing footings according to the actual load required to be carried after extension of the structure.

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