International Journal of Scientific Research in Civil Engineering
© 2021 | IJSRCE | Volume 5 | Issue 5 | ISSN : 2456-6667

Health Monitoring of an Existing RC Structure Considering Seismic Analysis Using Analysis Tools Staad

Abhishek Sharma[1*], Pradeep Kumar Nirmal[2], Lokesh Singh[3]
P.G. Scholar[1], Professor[2], Associate Professor[3]
Department of Civil Engineering, RSR Rungta College of Engineering and Technology, Bhilai, Chhattisgarh, India

ABSTRACT

Article Info
Volume 5, Issue 5
Page Number : 01-08

Publication Issue :
September-October-2021

Article History
Accepted : 01 Sep 2021
Published : 03 Sep 2021

Seismic retrofitting is mainly done to meet the seismic safety requirements. The planning of alterations to existing buildings differs from new planning through an important condition; the existing construction must be taken as the basis of all planning and building actions. India is one of the most earthquake prone countries in the world and has experienced several major or moderate earthquakes during the last 15 years. About 50-60 % of the total area of the country is vulnerable to seismic activity of varying intensities. Many existing buildings do not meet the seismic strength requirement. In this study we are performing health monitoring on existing old structure G+2, using rebound hammer to evaluate its present strength and analyze the structure using analysis tool staad.pro. In this study we are performing time history analysis (el-centrino) with retrofitting over weak members.

Keywords : Time history, staad.pro, Non destructive test, rebound hammer, existing structure, retrofitting, analysis.

I. INTRODUCTION

Retrofitting of constructions susceptible to earthquakes is a problem of great political and social significance. Prevention of disasters due to earthquake has become more and more important in recent years. There has been much research on the topic of retrofitting of structures in modern years. Considerations has been focused on both building and bridge structures and with the extensive damage to older structures, owners are increasingly taking action to avert similar damage to existing structures in future earthquakes. Disaster avoidance includes the reduction of seismic risk through retrofitting present buildings in order to meet seismic safety necessities. Though, no such thing as fully earthquake proof structure can exist in real, proper retrofitting method can remarkably improve the seismic performance of a structure. Mostly column failures, which include shear failure and shear cracking, have been detected in a RC structure during the recent earthquakes.

This study shows comparative study of high-rise G+02 building R.C. frame considering seismic zone II with medium soil type Under the seismic effect (TIME HISTORY ELCENTRO) as per IS 1893(part I) - 2016analysis. A comparison of analysis of results in terms of forces, moment, displacement and cost is presented in this study.

A. Retrofitting of the Structure

The need for seismic retrofitting of an existing building can arise due to several reasons like: building not designed to code, subsequent updating of code and design practice, subsequent upgrading of seismic zone, deterioration of strength and aging, modification of existing structure, change in use of the building, etc. Seismic retrofit is primarily applied to achieve public safety, with various levels of structure and material survivability determined by economic considerations. In recent years, an increased urgency has been felt to strengthen the deficient buildings, as part of active disaster mitigation, and to work out the modifications that may be made to an existing structure to improve the structural performance during an earthquake.

B. The need for retrofitting in existing building can arise due to any of the following reasons:

- Building not designed to code
- Subsequent updating of code and design practice
- Subsequent upgrading of seismic zone
- Deterioration of strength and aging
- Modification of existing structure
- Additional loads
- Change in use of the building, etc.

Rebound Hammer test is a Non-destructive testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. The rebound hammer is also called as Schmidt hammer that consist of a spring controlled mass that slides on a plunger within a tubular housing. As per the Indian code IS: 13311(2)-1992, the rebound hammer determine the compressive strength of the concrete by relating the rebound index and the compressive strength with a principle that the hardness of concrete and rebound hammer reading can be correlated with compressive strength of concrete.

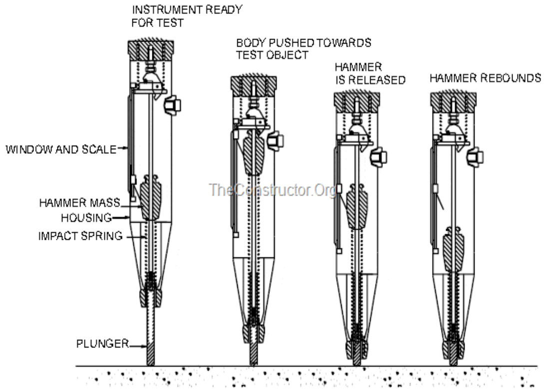

Fig 1: Rebound Hammer

II. LITERATURE REVIEW

Premalatha et.al. (2018) An analytical study on seismic retrofitting of a reinforced concrete Beam-column joint was performed using FEM modeling. The main objective of this study is to increase the shear capacity and load carrying capacity of the structures using retrofitting techniques. In this study, the retrofitting was done by jacketing methods like carbon fibre reinforced polymer sheets (CFRP), Glass fibre reinforced polymer mesh, Sisalfibres along with crossed bars are carried out using the ANSYS Workbench. The wrapping of beam column joint was done by single, double, triple layer of CFRP, GFRP and Sisal fibres with different thickness. During the analysis one end of the column were fixed. Cyclic loading was applied at the free end of the cantilever beam in Beam-column joint and Fixed load was applied at the top of the column. The load is applied up to the ultimate load to obtain the fatigue failure. This report discusses about the performance of the retrofitted beam column joint; and was compared with the conventional specimen.

Tsige and Zekaria (2018) analyzed a office medium rise building for earthquake force by considering three type of structural system. i.e. Bare Frame system, partially-infilled and fully- Infilled frame system. Effectiveness of masonry wall has been was studied with the help of five different models. Infills were modeled using the equivalent strut approach. Nonlinear static analyses for lateral loads were performed by using standard package ETABS, 2015 software. The comparison of these models for different earthquake response parameters like base shear vs roof displacement, Story displacement, Story shear and member forces are carried out, found that the seismic demand in the bare frame is considerably more when infill stiffness is not taken with larger displacements. It has been concluded that fully infilled frame is around 15% more compared to bare frame model; frame with 25% masonry wall decreased is nearly 10% more compared to the bare frame; frame with 50% of the masonry wall decreased is nearly 8% more compared to the bare frame and frame with 75% of the masonry wall decreased is about 5% more compared to the bare frame. This is because the bare frame models do not account the stiffness rendered by the infill panel, it gives significantly longer time period.

Tareket. al. (2017) have strengthened and tested the 3 beams with GFRP and two with CFRP composites using epoxy resins and results were compared with a control beam. 1 and 2 layers of 1mm CFRP and 1, 2 and 4 numbers of layers of 1.3mm GFRP were used for strengthening beams externally. All beams were reinforced with 3-10mm diameter bars at tension zone and 1-6mm diameter bar at compression zone and 2 legged 8mm diameter stirrups at 100mm c/c. The equations developed are based on ACI code for moment capacity of strengthened beams, thickness of FRP is theoretically verified with experimental values. Two point loads with spacing 200mm were applied for the test. All beams failed by concrete crushing at compression zone. It was determined that the flexural strength of strengthened beams using FRP laminates at tension zone, more than that of control beam.

III. PROBLEM IDENTIFICATION

Authors in past perform analysis of a old RCC structure but none of them describe its present strength and after retrofitting strength using analysis tool. The numerous analyses were done on experimental setup but here we are going to perform analysis of a case study which is approx. 35 year old RCC structure.

For modelling and designing we are considering staad.pro analysis tool also considering seismic load as per I.S. 1893-I: 2016.

A. Aim of the study

The primary aim of the study is to perform health monitoring of an old structure and increase its design life using retrofitting technique.

Structural and their connections shall be demonstrated by analysis or by a combination of analysis and testing to provide a reliability not less than that expected for similar components designed in accordance with the Strength Procedures when subject to the influence of dead, live, environmental and other loads. Consideration shall be given to uncertainties in loading and resistance.

B. Objectives

These following are the primary objective of our research work:

- To determine the strength of an existing old structure using NDT (rebound hammer).
- To determine the effect of composite member on an old structure strengthening.
- To perform Non-linear (Time history analysis) over a strengthened old structure.
- To determine the cost of retrofitting as per SOR (CPWD).

IV. METHODOLOGY

Analysis of building with given dimensions has been considered for the parametric analysis of critical load position as per superimposed loading standard which are analyses with the help of staad pro software. Proposed steps are as followings:

Step 1: Selection of the geometry of superstructure by using coordinate system in STAAD Pro or plot over the AUTO CAD, which can be import in Staad-Pro as per dimension of beams, c/c distance of columns, expansion to expansion distance and no. of diaphragm etc. Schematic sketch of the superstructure.

Step 2: Building as per existing strength is modelled and one model with retrofitting is prepared of same dimension and same loadings as per Indian standards. Finite element modeling of the model considering the above parameters.

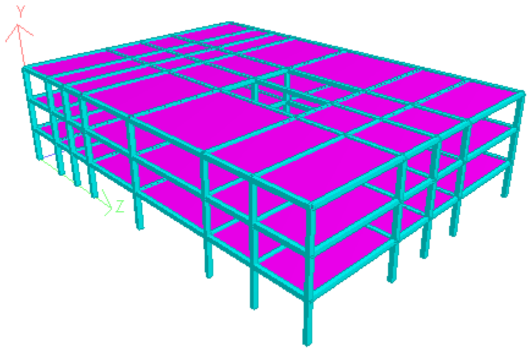

Fig 2: Existing Structure

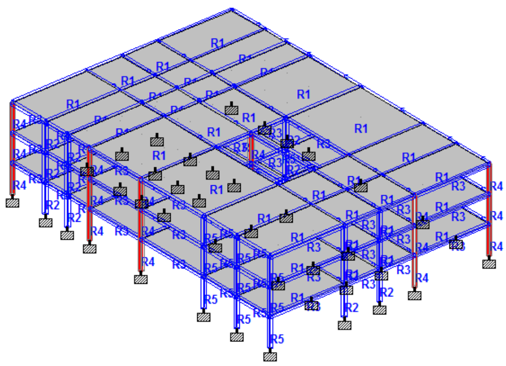

Fig 3: Building after Retrofitting (Steel Casing)

Step 3: Computation of existing culvert strength by N.D.T. rebound hammer method to determine its present condition.

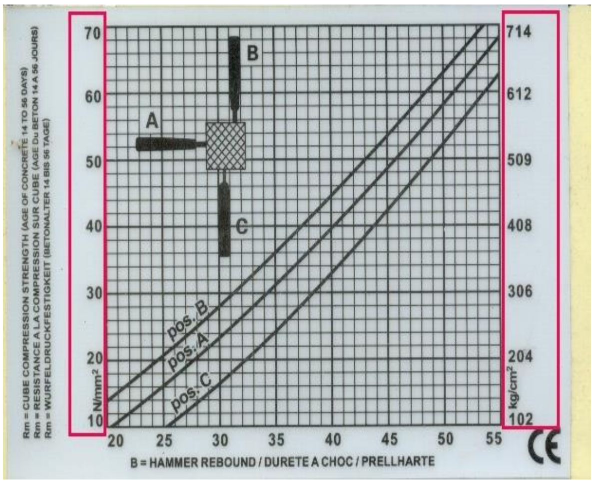

Fig 4 : NDT Strength Graph

Step 5: After apply the support condition, now the next step to be considered for the Dead Load of the superstructure i.e. "self weight".

Step 6: After apply the Dead Load, now the next step to be considered for the **Superimposed load**.

Step-7 Selection of Seismic zones (Zone II) and medium type soil as per IS- 1893(part I) -2016.

Step-8 load combination as per 875-part-V

Step-9 Analysis of building frames considering Time history Analysis (ELCENTRO CASE) method for seismic forces in X & Z direction and gravity load as shown in figure below.

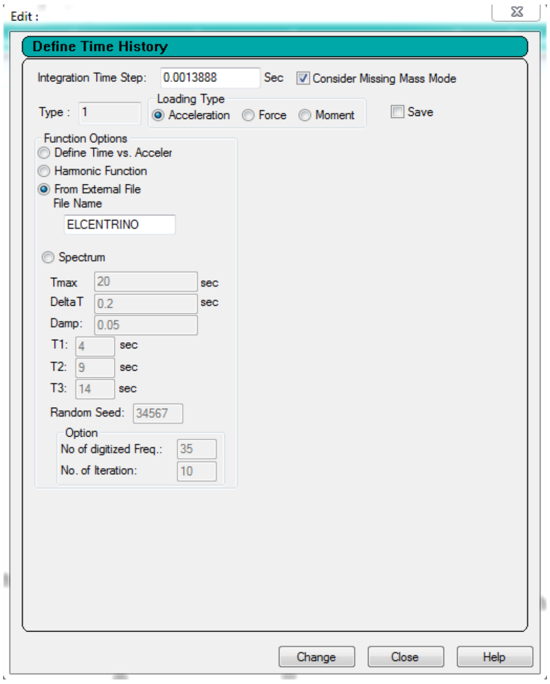

Fig 5 : Assigning El-centrino (time history)

Step-10 Designing structures as per I.S.456:2000 to determine the amount of reinforcement required in both the cases.

Step-11 Cost analysis of material quantity i.e. concrete in cubic meter and reinforcement in kilo Newton using S.O.R. M.P.P.W.D. 2014.

Step 12: After applied all the boundary condition and forces, now the model has to be "Analyze" for getting the results i.e. axial force, shear force, deflection and support reactions etc.

Table 1 : Description of existing structure

S. No.	Description	Value
1	Area of building	
2	Length	24 m
3	Breadth	17 m
4	Storey height	3.5 m
5	Height of the column below plinth level	1.5 m
6	Size of the column	300 mm x 300 mm
7 (a)	Size of beam for 5m span	200 mm x 500 mm
7 (b)	Size of beam for 4m span	200 mm x 500 mm
8	Thickness of slab	150 mm
9	Thickness of outer walls	200 mm
10	Thickness of inner walls	100 mm
11	Support condition	Fixed

V. Result Analysis

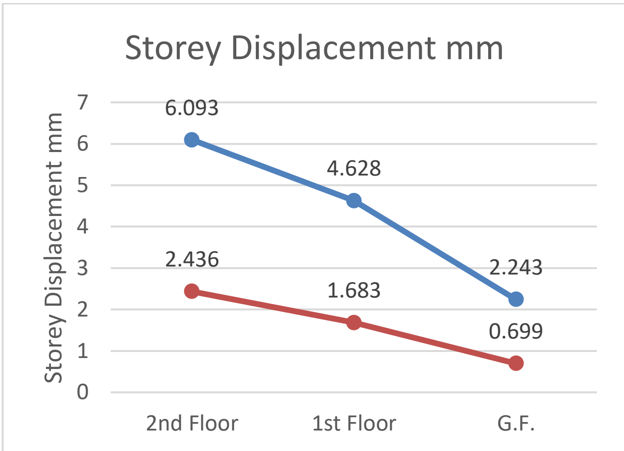

Fig 6 : Displacement (mm)

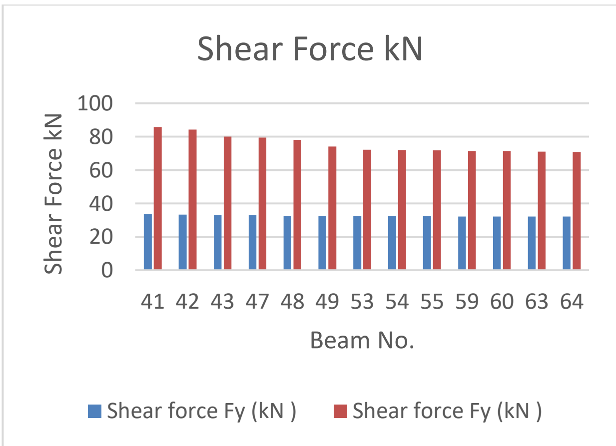

Fig 7 : Shear Force (kN)

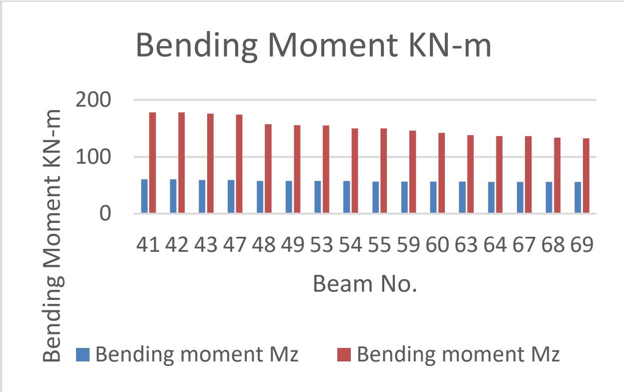

Fig 8 : Bending Moment kN-m

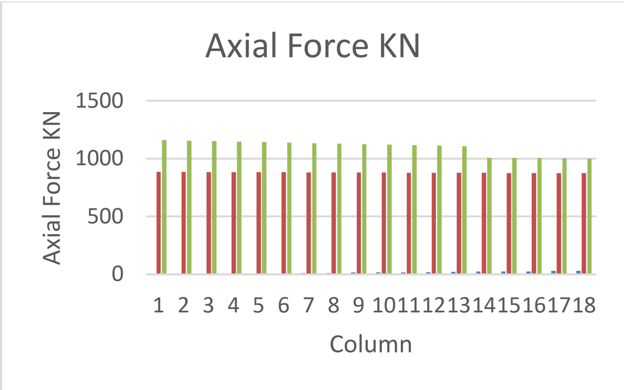

Fig 9 : Axial Force kN

Material	S.O.R. Rate	Quantity	Total Rate
Steel Casing	40/ kg	35953	14,38,120/-
Concrete	5091 / cu. M.	5.0208	25560/-

Table 2 : Cost Analysis

VI. CONCLUSION

Following are the ends according to the examination

- In this investigation, it is seen that with the procedure of retrofitting, the soundness of a structure can be recovered without disassembling the structure utilizing fortifying steady individuals.
- It is seen that the retrofitting method can be 88.64% cost effective than destroying and developing another structure.
- It can be reasoned that product examination and site test work can be joined for the advancement of the framework, as we did in this investigation where we decided the quality of the structure utilizing NDT (Non-destructive testing) though displaying and checking quality improvement should be possible utilizing investigation apparatus staad.pro.

Maximum bending moment

It is seen in section 5 that with retrofitting method bending moment in bar and segments are increased by 33.9%.

Maximum shear force.

It is seen in chapter 5 that with retrofitting method shear force in bar and segments are increased by 39.186%.

Maximum axial force

An axial force constrain is any power that explicitly follows up on the centre turn of an inquiry. These powers are regularly expanding power or weight compel, dependent upon heading. Additionally, when the power stack is even over the edge's geometric centre, it is concentric, and when it is uneven, it is strange. Here outcomes demonstrate that pivotal powers are dispersing equitably.

Maximum Storey displacement.

It is observed that after retrofitting of the sectional members with steel casing, storey displacemet has been reduced to 39.98 % which is in its permissible limit. Hence structure is now stable and stiff to bear and distribute load.

VII.REFERENCES

[1]. Agarwal A. (2012): Seismic Evaluation of Institute Building, Bachelor of Technology Thesis, National Institute of Technology Rourkela.

[2]. Agarwal P., Shrikhande M. (2004): Earthquake Resistant Design of Structures, PHI Publication.

[3]. Bodige N., Ramancharla P. K. (2012): Pushover Analysis of RC Bare Frame: Performance Comparison between Ductile and Non-ductile Detailing, Report No: IIIT/TR/2012/-1, Urban Safety of Mega Cities in Asia (USMCA)

[4]. Faella C., Martinelli E., Nigro E. (2002): Steel and concrete composite beams with flexible shear connection: “exact” analytical expression of the stiffness matrix and applications, Computers & Structures - COMPUT STRUCT, vol. 80, no. 11, pp. 1001- 1009, 2002

[5]. Fardis M. N. (2009): Seismic Design, Assessment and Retrofitting of Concrete Buildings, Springer Publication.

[6]. Griffith M. C., Pinto A. V. (2000):“Seismic Retrofit of RC Buildings - A Review and Case Study”, University of Adelaide, Adelaide, Australia and European Commission, Joint Research Centre, Ispra Italy.

[7]. Goel R. K. (2008): Evaluation of Current Nonlinear Static Procedures for Reinforced Concrete Buildings, The 14th World Conference on Earthquake Engineering October 12- 17, 2008, Beijing, China.

[8]. Kadid A., Boumrkik A. (2008): Pushover Analysis of Reinforced Concrete Frame Structures, Asian Journal of Civil Engineering (Building and Housing) Vol. 9, No. 1 (2008) Pages 75-83

[9]. Krawinkler H., Seneviratna G.D.P.K. (1998): Pros and Cons of a Pushover Analysis of Seismic Performance Evaluation, Engineering Structures, Vol.20, 452-464.

[10]. Lawson R.S., Reinhorn A.M., Lobo R.F. (1994): Nonlinear Static Pushover Analysis - Why, When and How? Proceedings of the 5th US National Conference on Earthquake Engineering, Chicago, Vol. 1, 283-292.

[11]. Monavari B., Massumi A., Kazem, A (2012): Estimation of Displacement Demand in RC Frames and Comparing with Target Displacement Provided by FEMA-356, 15th World Conference on Earthquake Engineering, 24th to 28th September, 2012, Lisbon, Portugal.

[12]. Mouzzoun M., Moustachi O., Taleb A. (2013): Seismic Damage Prediction of Reinforced Concrete Buildings Using Pushover Analysis, International Journal of Computational Engineering Research (ijceronline.com) Vol. 3 Issue. 1, January 2013.

[13]. Mouzzoun M., Moustachi O., Taleb A., Jalal S. (2013): Seismic performance assessment of reinforced concrete buildings using pushover analysis, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE); ISSN: 2278-1684 Volume 5, Issue 1 (Jan. - Feb. 2013), PP 44-49.

[14]. Mwafy A. M., Elnashai A. S. (2001): Static Pushover versus Dynamic Analysis of RC Buildings, Engineering Structures, Vol. 23, 407-424.

[15]. Otani S. (2000): Seismic Vulnerability Assessment of Reinforced Concrete Buildings, Faculty of Engineering, University of Tokyo, Series B, Vol., XLVII, October 2000, pp. 5 - 28.

[16]. Pillai S. U., Menon D. (2009): Reinforced Concrete Design, TMH Publication.

[17]. Poluraju P., Nageswara Rao P. V. S. (2011): Pushover analysis of reinforced concrete frame structure using SAP 2000, International Journal of Earth Sciences and Engineering, ISSN 0974-5904, Volume 04, No 06 SPL, pp. 684-690.

[18]. Rai, Durgesh C. (2005): “Seismic Evaluation and Strengthening of Existing Buildings” IIT

Kanpur and Gujarat State Disaster Mitigation Authority.

[19]. Amlan K. Sengupta, ChemuruSrinivasulu Reddy, Badari Narayanan V T and Asokan A, (2004)—seismic analysis and retrofit of existing multistoried buildings in India – an overview with a case‖

[20]. S. Anbarasu, K.Tamilvanan, "Seismic Retrofitting of Reinforced Concrete Frame Building with Soft Storey", International Journal of Innovative Research in Science, Engineering and Technology, vol. 5, issue 3, March 2016.

[21]. Kritika Gupta, Abhishek Kumar, MohdAfaque khan, "Review paper on seismic retrofitting of structures" Volume:04/April-2017.

Cite this article as :

Abhishek Sharma, Pradeep Kumar Nirmal, Lokesh Singh, "Health Monitoring of an Existing RC Structure Considering Seismic Analysis Using Analysis Tools Staad", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 5 Issue 5, pp. 01-08, September-October 2021.
URL : https://ijsrce.com/IJSRCE21551