To Study The Seismic Analysis Of An Existing RC Structure By Using STAAD PRO

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Abstract

India is one of the most earthquake inclined nations on the planet and has encountered a few significant or moderate earthquakes during the most recent 15 years. Around 50-60 % of the absolute zone of the nation is defenseless against seismic movement of shifting forces. A live project of G+2 existing old structure, structure is modeled and analyzed in Staad.Pro with existing strength determine from NDT and then providing extra columns, thickness and struts at places where strength is at failure. Comparative analysis is done in between the existing structure and the proposed structure which can easily overcome the failures seen by existing structure proven in the results of NDT.

Keyword: Retrofitting, NDT, Staad.Pro, Axial Force, Storey Displacement, Shear Force, Bending Moment

Introduction

The primary reason for seismic retrofitting is to ensure the building's safety in the event of a seismic event. In contrast to new planning, the planning of changes to existing buildings requires that the existing development be regarded as the starting point for all planning and construction operations. In the last 15 years, India, one of the world's most earthquake-prone countries, has seen a few large or moderate quakes. Around 50-60% of the country's absolute zone is vulnerable to seismic power shifts. Existing structures often fail to fulfil seismic quality requirements. Seismic retrofitting an existing building might arise for a variety of reasons, including the building not being designed to meet current building codes, a change in the building's intended use, or other structural changes that need retrofitting. There are many levels of structural and material survivability imposed by budgetary considerations in seismic retrofitting. As a part of dynamic disaster assistance, it has become more urgent to strengthen weak structures and find out how to increase their auxiliary performance in the event of an earthquake.

In this proposed work we are considering a live project of G+2 existing old structure, structure is modeled in staad with existing strength determine from NDT and then providing extra columns, thickness and struts at places where strength is at failure.

Strength and Stiffness

Buildings and different structures, and all parts thereof, will be planned and built with sufficient quality and solidness to give basic dependability, shield nonstructural segments and frameworks from unsuitable harm and meet the workableness prerequisites Acceptable quality will be shown utilizing at least one of the accompanying systems:

- The Strength Procedures
- The Allowable Stress Procedures of Section.

Subject to the approval of the person's guardian. Activities, Section's procedures depending on presentation

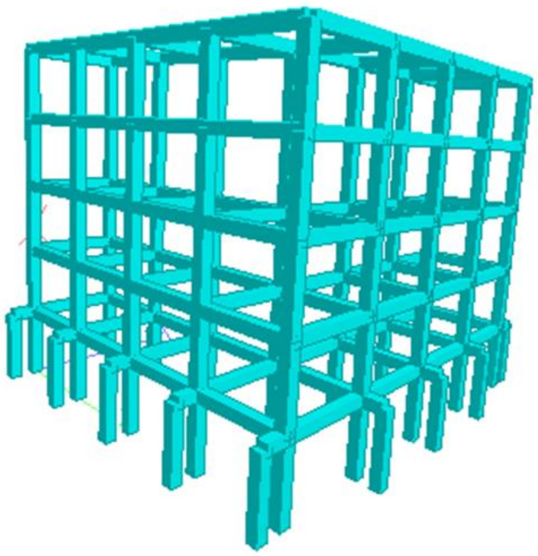

Figure 1: Retrofitting technique in staad

Scope of the Study

The design recommendations contained herein are applicable to the seismic design of structures that generally have the unique seismic response characteristics associated with tall buildings, including:

- A fundamental translational period of vibration considerably in excess of 1 second.
- Significant mass participation as well as lateral response in higher modes of vibration.

To counteract the sidelong float caused by hub twisted dividers and sections as opposed to shearing failure of the casings or dividers, a seismic-power opposing framework with a small angle proportion is used. Because of the high frequency of earthquakes in the western United States, the Pacific Earthquake Engineering Research Center developed these guidelines as an optional means of adhering to I.S. 1893 section 1's quality requirements for seismic load prevention for Risk Category II buildings. Because of the inelastic response of their fundamental segments, these structures are projected to resist massive seismic displacements. For buildings that don't display significant inelastic reactivity or that are located in places with seismicity to a degree that is not nearly the same as the Western United States, these recommendations may be of interest. In spite of this, it may be necessary to make a few changes.

NDT (Non-Destructive Testing)

The non-hazardous Rebound Hammer test is a method for evaluating a solid's compressive strength that provides an immediate and useful result. It is also known as a Schmidt hammer, which is a spring-loaded tool that glides along an unclogging in a circular chamber.

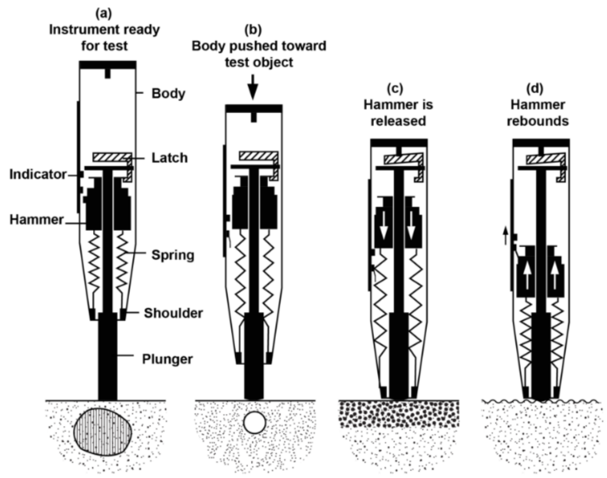

Figure 2: Operation of the rebound hammer

Objectives of the Study

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)

Literature Review

Tsige and Zekaria (2018) An office building with a modest ascension was demolished for seismic power by considering three different types of fundamental framework. Exposed Frame structure, for example, or partially filled and totally filled outline framework. With the help of five different models, the viability of the work divider has been examined. The equal swagger approach was used to depict the infills. ETABS, 2015 programming was used to conduct nonlinear static evaluations of sidelong loads. Correlation of these models for numerous earthquake reaction parameters like the seismic interest in the exposed casing when infill firmness is not taken into account with larger removals is found to be significantly greater than that found when infill firmness is taken into account with smaller removals.

MAYORCA et. al. (2004) Seen that Masonry structures are generally utilized because of its minimal effort and development effortlessness particularly in creating nations. Regardless of the endeavors to give rules to the development of sound earthquake safe houses, each year setbacks due to falling stone work houses during earthquakes are accounted for. Despite the fact that plainly retrofitting the existing lodging stock is pressing, effective crusades situated toward this path are rare or inexistent. To defeat this circumstance, retrofitting strategies including modest development materials accessible in remote locales and low-expertise work just as forceful instructive crusades are required. This paper displays an imaginative retrofitting technique for brick work houses, which comprises of utilizing polypropylene groups masterminded in a work style and implanted in a mortar overlay.

U.Akguzelet. al. studied that three-dimensional (3D) beam-column junctions with and without floor slabs have been studied for their seismic performance under multiaxial stress in both their as-built and FRP retrofitted forms. Four 2/3 scale, inadequate RC beam-column junctions were tested for this purpose, with the findings being reported and inferences being taken based on the observed global and local performance. With the use of GFRP composites, the feasibility and efficiency of a retrofitting intervention are highlighted. A retrofit method based on performance is used, and the desired particular limit states or design goals are taken into account. There's also a computational research that compares the response of the 3D corner as-built joint under bidirectional loading with concurrently variable axial load to experimental data, in order to calibrate and build adaptable finite element (FE) models using micro plane concrete.

Amlan K. Sen Gupta et. al. all of these worldwide retrofitting procedures, including shear walls, infill bracings, etc., are shown to increase the structural integrity of a three-storey building.

Since the 1960s, experimental testing has been used to examine the behaviour of beam-column joints in plane frames subjected to seismic pressure. There has been far less experimental investigation into the behaviour of under-designed (e.g. following an older code of practise when compared to the current one and prior to the introduction of capacity design principles) beam column joints in space frames in as-built or retrofitted configurations than there has been for the majority of these studies to verify the design of new space frame joints.

(Hertanto, 2006; Chen, 2006; Akguzel et al., 2010b; Engindeniz, 2008) To investigate the behaviour of deficient full-scale RC buildings strengthened with FRPs using uni-directional and bi-directional pseudodynamic (Ludovico et al., 2008) or quasistatic lateral load tests, several experimental studies have been carried out in the past (Balsamo et al., 2005; Ludovico et al., 2008). (Della et al., 2006) Unidirectional shaking table tests on a full-scale, RC frame with insufficient detailing in the beam-column joints in the as-built and CFRP retrofitted configurations were also reported by Garcia et al. (2010)

A non-ductile 3-story 2/5 scale RC frame model structure was recently tested on the shake table of the University of Canterbury to evaluate the effectiveness of the proposed FRP retrofit technique and to validate the adopted design procedures (Akguzel et al., 2011a; Quintana-Gallo et al. 2011, 2012).

Methodology

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.

Two cases has been considered for comparative analysis

- First Existing “Building structure”
- Second Existing “building with retrofitting technique”

To accomplish this purpose, the following three steps must be taken:

- Modeling the frame using STAAD Pro.
- Calculations to determine the explanatory findings
- The framework's graphical interface provides all of the tools needed to verify results.

For the parametric analysis of critical load positions as per the superimposed loading standard, a building of specified size has been taken into consideration. The following are some possible next steps:

Step 1: In STAAD Pro or in the AUTO CAD, which can be imported into Staad-Pro as per the dimensions of beams, c/c distance of columns, expansion to expansion distance, and no. of diaphragm etc., the geometry of the superstructure may be selected.

Step 2: The building is modeled using the present strength, and a model with retrofitting is created using the same dimensions and loadings as per Indian norms. Modeling is done using finite elements in consideration of these factors.

1.1. Different types of cases considered

A. Existing Building:

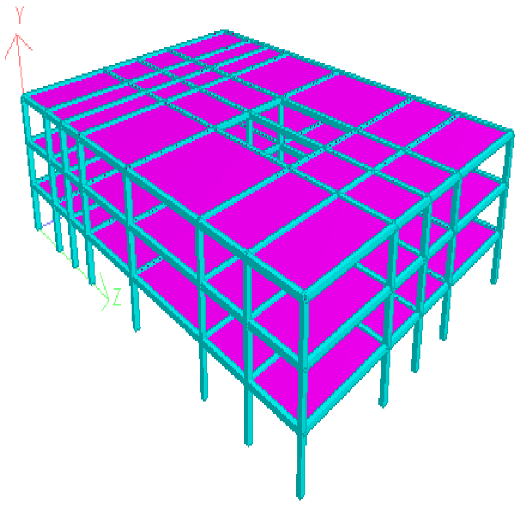

Figure 3: Existing building

B. Retrofitted Building:

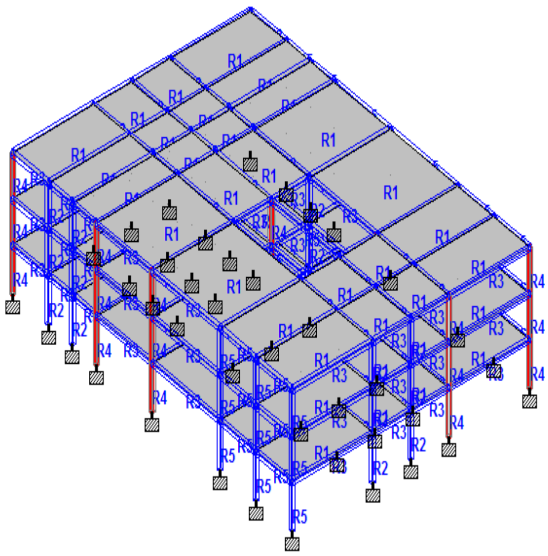

Figure 4: Retrofitted Building structure

In retrofitting technique we are assigning composite steel tubular sections for strengthening the existing weak structure.

Step 3: To establish the current state of the culvert, the NDT rebound hammer technique was used to calculate its actual reality.

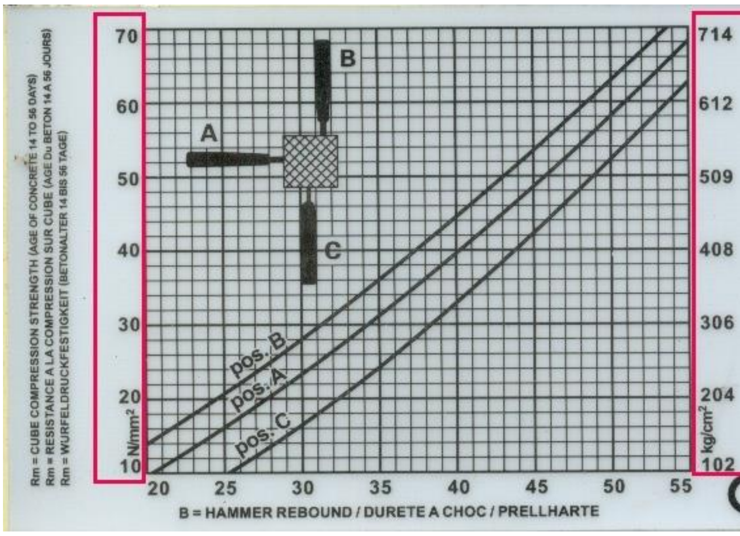

Figure 5: Rebound Hammer Graph

Step 4: After taking into account the support conditions at the pinned/hinged superstructure's bearing points and modelling for the same strength, the modeler next applies the material's properties.

Step 5: Once you've applied the support condition, the following step is to take into account the "self-weight" of the superstructure.

Step 6: Dead load applied, now the Super imposed load must be taken into account.

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.

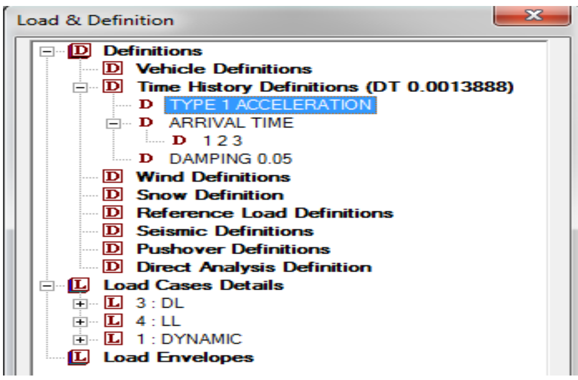

Figure 6: Schedule of Rates as per M.P.P.W.D. 2019

Step-10 Cost analysis of material quantity i.e. concrete in cubic meter and Steel casing in Kg using S.O.R. M.P.P.W.D. 2014.

Material	S.O.R. Rate	Quantity	Total Rate
Steel Casing	68 / kg	2200 kg	1,49,600/-
Concrete	5091 / cu. M.	56/ cu. M.	2,85,096/-

Step 11: In order to achieve results such as axial force, shear force, deflection and support responses, the model must be "Analyzed" after all the boundary conditions and forces have been applied to the model.

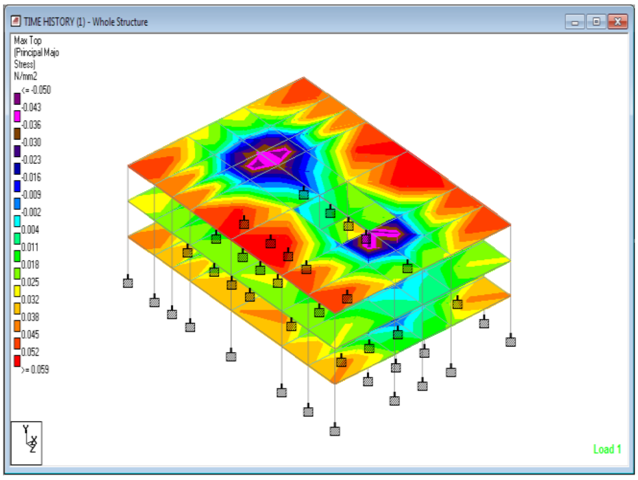

Figure 7: Stress Distribution

Step 12: After the optimization procedure, a graph utilising M.S. Excel is used to find the best outcomes in all circumstances.

Result And Discussion

Forces in Beams

Maximum Bending Moment kN-m

Table 1: Bending Moment KN-m

Beam No.	Bending moment Mz (KN-m) Case 1 (Existing Structure)	Case 2 (Proposed Structure)	Increase
41	60.567	178.293	117.726
42	60.567	177.954	117.387
43	59.481	175.619	116.138
47	59.481	174.038	114.557
48	57.8	157.366	99.566
49	57.8	155.381	97.581
53	57.348	154.918	97.57
54	57.348	149.755	92.407
55	56.391	149.752	93.361
59	56.391	146.266	89.875
60	56.327	141.877	85.55
63	56.327	137.989	81.662
64	56.125	136.598	80.473
67	56.125	136.316	80.191
68	55.946	133.821	77.875
69	55.945	132.503	76.558

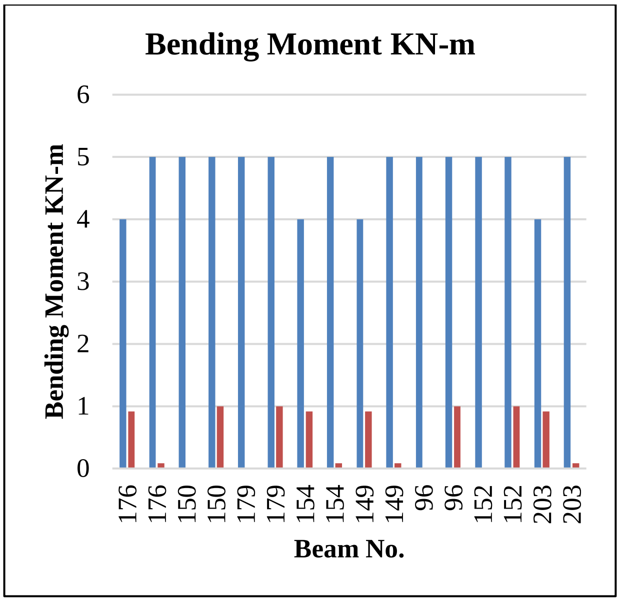

Figure 8: Bending Moment kN-m

Maximum Shear Force KN

Table 2: Shear Force kN

Beam No.	Shear force Fy (kN) Case 1 (Existing Structure)	Case 2 (Proposed Structure)	Increase
41	33.639	85.844	52.205
42	33.329	84.234	50.905
43	32.893	80.173	47.28
47	32.871	79.602	46.731
48	32.658	78.167	45.509
49	32.624	74.229	41.605
53	32.564	72.297	39.733
54	32.491	72.083	39.592
55	32.343	71.785	39.442
59	32.238	71.563	39.325
60	32.226	71.38	39.154
63	32.189	71.101	38.912
64	32.182	70.989	38.807

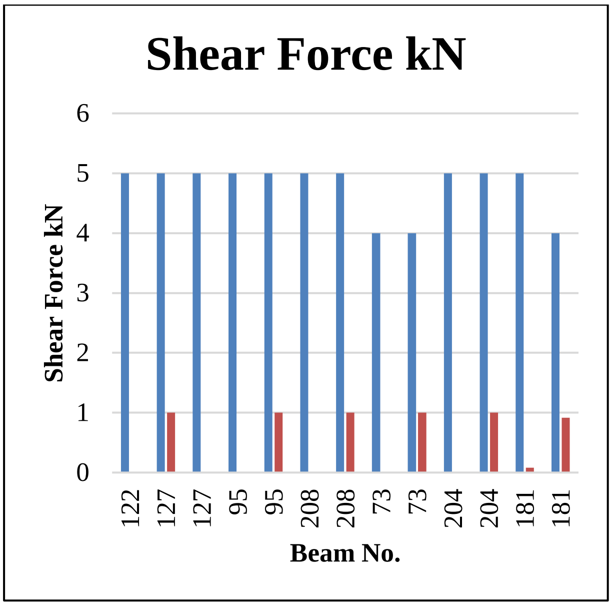

Figure 9: Shear Force KN

Forces in Columns

Analysis results of axial force Fx in columns obtained from Staad Pro

Table 3: Axial Force KN

Column No.	Axial force Fx (kN) Case 1 (Existing Structure)	Case 2 (Proposed Structure)	Increase
1	884.941	1159.076	274.135
2	884.939	1154.774	269.835
3	883.621	1150.472	266.851
4	883.62	1146.17	262.55
8	882.302	1141.869	259.567
9	882.3	1137.567	255.267
10	880.982	1133.265	252.283
11	880.981	1128.963	247.982
15	879.663	1124.661	244.998
16	879.661	1120.359	240.698
17	878.344	1116.057	237.713
18	878.342	1111.755	233.413
22	877.024	1107.453	230.429
23	877.023	1008.184	131.161
24	875.705	1005.219	129.514
25	875.703	1003.882	128.179
30	874.385	1000.918	126.533
31	874.384	999.58	125.196

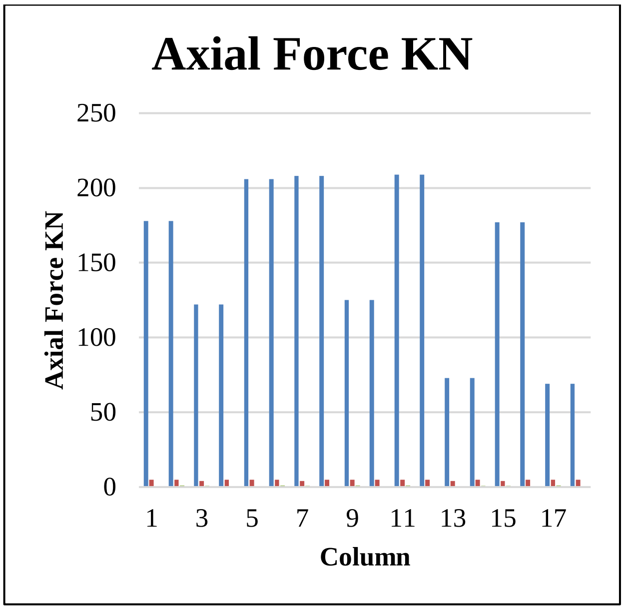

Figure 10: Axial Force KN

Storey Displacement mm

Table 4: Storey Displacement

Storey	(Existing Structure)	(Proposed Structure)
2nd Floor	6.093	2.436
1st Floor	4.628	1.683
G.F.	2.243	0.699

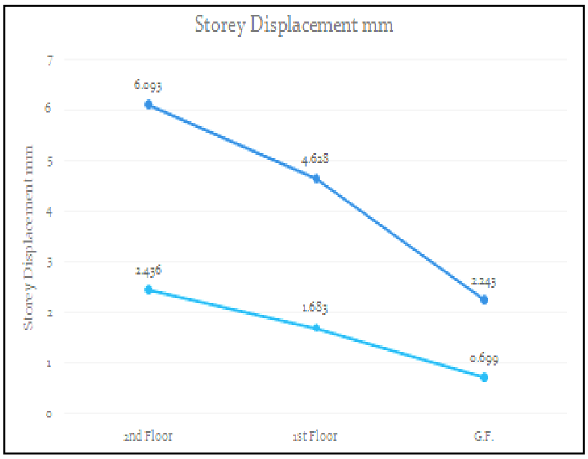

Figure 11: Storey Displacement mm

Cost Analysis

Table 5: Cost Analysis

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

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.

References

1. TanjaKalmanŠipoš, Hugo Rodriguesb , Marin Grubišića. “Simple design of masonry infilled reinforced concrete frames for earthquake resistance”. “ELSEVIER”. ISSN 0141-0296, 2018, pp 1-22.

2. R. Soto, ch. H. Wu and a. M. Bubela. “development of infill drilling recovery models for carbonate reservoirs using neural networks and multivariate statistical as a novel method”. “Ciencia, Tecnología y Futuro”. Vol. 1, ISSN 5, 1999, pp 5-23.

3. Santiago Pujol, AmadeoBenavent-Climent, Mario E Rodriguez and J. Paul Smith-Pardo. “Masonry infill walls: an effective alternative for seismic strengthening of low-rise reinforced concrete building structures”. “14 th World Conference on Earthquake Engineering”. October 12-17, 2008.

4. SachinSurendran and Hemant B. Kaushik “Masonry Infill RC Frames with Openings: Review of In-plane Lateral Load Behaviour and Modeling Approaches”, “The Open Construction and Building Technology Journal”, ISSN 1874-8368, Vol 6, 2012, pp126-154.

5. H. Ozkaynak , E. Yuksel, C. Yalcin , A. A. Dindar and O. Buyukozturk, “Masonry infill walls in reinforced concrete frames as a source of structural damping”, “EARTHQUAKE ENGINEERING & STRUCTURAL DYNAMICS, ISSN 949–968, 2013, pp949-968.

6. Andrew Kauffman 1 and Ali M. Memari. “Performance Evaluation of Different Masonry Infill Walls with Structural Fuse Elements Based on In-Plane Cyclic Load Testing, mdpi, ISSN 2075-5309, vol 4, 2014, pp605-634.

7. Prakash Paudel, “Effect of Infill Walls in Performance of Reinforced Concrete Building Structures,” International Journal of Engineering Research and General Science” ISSN 2091-2730, Vol. 5, Issue 4, 2017, pp24-27.

8. Mohammad Aliaari and Ali M. Memari, “Development of a Seismic Design Approach for Infill Walls Equipped with Structural Fuse,” The Open Civil Engineering Journal, ISSN 1874-1495, 2012, Vol. 6,pp 249-263.

9. Haroon Rasheed Tamboli and Umesh.N.Karadi, “Seismic Analysis of RC Frame Structure with and without Masonry Infill Walls”, Indian Journal Of Natural Sciences, ISSN: 0976 – 0997, Vol.3, Issue 14, 2012, pp 1137-1194.

10. Mohammad MohibulHasan , Mohammed KarimulAbsar Chowdhury, RashidulMamurRafid, “Seismic Analysis of Infill Reinforced Concrete Building Frames”, American Journal of Engineering Research, e-ISSN: 2320-0847, p-ISSN : 2320-0936, Vol 6, Issue-9, 2017, pp-263-268.

11. GirmaZewdieTsige ,AdilZekaria. “Seismic Performance of Reinforced Concrete Buildings with Masonry Infill”, American Journal of Civil

Engineering, ISSN: 2330-8729, Vol. 6, 2018, pp. 24-33.

12. MehrzadMohabbiYadollahi ,AhmetBenli , SadıkVarolgüneş “Masonry Infill Walls Effect in Short Column Formation in Rc Buildings: A Case Study”, Journal of Engineering Sciences, ISSN 19, vol. 2, 2016, pp78-83.