iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VI **Month of publication:** June 2022

DOI: https://doi.org/10.22214/ijraset.2022.45042

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

A Seismic Vulnerability and Fragility of RC Conventional and Monolithic Building

Vaishnavi Nitin Wankhade[1], Prof. Vishal Sapate[2]
[1]*Department of Civil Engineering, G. H. Raisoni University ,Amaravti*

Abstract: This thesis aim is to study the modeling and analysis of monolithic building by STAAD PRO modeling of normal framed building and regular monolithic building have to be conducted and analysis and modeling of different plan irregular building, using equivalent static analysis, modal analysis, response spectrum analysis. The earthquake response of the building and damage assessment and are found out by comparing the analysis result. The earthquake parameters of building is comparing in X-direction. In this study the vulnerability assessment is analyzed by DCR method. In this study we compared the RC building and monolithic buildings analysis with two types of seismic zones
Keywords: Vulnerability, STAAD PRO., Fragility

I. INTRODUCTION

In this project we discuss about the importance of use of monolithic building construction work for high rise building. In accordance with the importance of time, modern work methods, safety of the structure it is feasible method for construction of the tedious work as compared to conventionally applied method of construction. Monolithic structure that means the overall structure slab and walls are constructed together. It has been used in development of schools, stadium, light houses, silos, and roof of industries, nuclear reactors, pressure vessels, and auditoriums. In monolithic structure we used formwork which provides proper alignment, smooth surface and good quality work. Cost and time are the two important parameters which plays vital role in any construction activity. For construction of mass building works, it's far important to have progressive technology that are capable of fast construction and are able to construct best quality and durable construction in cost intended manner. Seismic Vulnerability Assessment is one of the main initial step in any disaster alleviation in a seismic active region. Reports of Indian past earthquakes have highlighted huge casualties, economic losses and sufferings of people due to collapse number of buildings. The resulting huge stock of buildings is highly vulnerable to earthquake. This makes the task of seismic risk assessment for Indian cities very challenging. So, there is urgent need to develop efficient tools and procedures for estimation of seismic risk in order to plan short term and long term mitigation measures to reduce risk from future earthquakes.

.

A. Monolithic Building

Monolithic construction in a method by which walls and slabs are constructed together. In this method, fresh cement concrete is poured in light weight aluminum formwork system having required reinforcement bars for needed strength. As the walls and slabs are cast in one go, the operation is very fast. High-storey buildings and skyscrapers are erected using on this technology. In active monolithic erection was in seismic zones as the monolithic construction can withstand high loads without being destroyed. It promises accelerated construction at optimized cost and time. It is a highly efficient technology which facilitates concreting of all the components like walls, roof, etc. Monolithic reinforced concrete construction system uses a formwork system that allows casting walls and slabs according to a pre-defined cycle. It combines the speed; quality and accuracy in production in production with the flexibility and economy of in-situ construction.

B. Advantages of Monolithic Building

1) Allow speedy construction.
2) This technology helps to optimize the cost and time of project.
3) The structure was constructed by optimal use of time, money, and building material.
4) No need for any type of bricks, blocks, and plastering work
5) In this structure we get an excellent finished structure that avoids expansive plastering costs.
6) The durability and quality of monolithic construction are very high compared to normal construction.

C. Seismic Vulnerability Assessment

Damage to structures cause deaths, injuries, economic losses. Earthquake risk is associated with seismic hazard, vulnerability of building, exposure. Seismic risk measures the likely ground movement that can happen at site. Tools specifically defined for crisis administration and seismic danger moderation arrangements must be defined. Vulnerability assessment reveals the damageability of a structure under varying ground motion intensities. The aim of a vulnerability assessment is to obtain the probability of a given level of damage for a given building type due to scenario earthquake. Vulnerability of structures to ground motion effects is usually expressed in terms of fragility curves or damage functions that take into account the uncertainties in the seismic demand and structures capacity. Fragility curve is a statistical tool developed for the vulnerability assessment in different field. The seismic vulnerability assessment is an essential tool for seismic risk management and for prioritizing pre-earthquake strengthening of the built environment.

D. Objectives

1) To find out the effectiveness of monolithic building construction techniques in various types of buildings.
2) Comparison of monolithic building with normal framed building.
3) Comparison of various monolithic buildings and RC building response and damage assessment in different zones.
a) Base Shear
b) Story Displacement
c) Story Drift
d) Story Shear
4) Evaluate the seismic vulnerability of various monolithic building with RC building in different zones.

II. METHODOLOGY

A. Methods Of Seismic Vulnerability Assessment

Vulnerability assessment methods are grouped into two categories:

1) Demand capacity ratio method
2) Rapid screening procedure

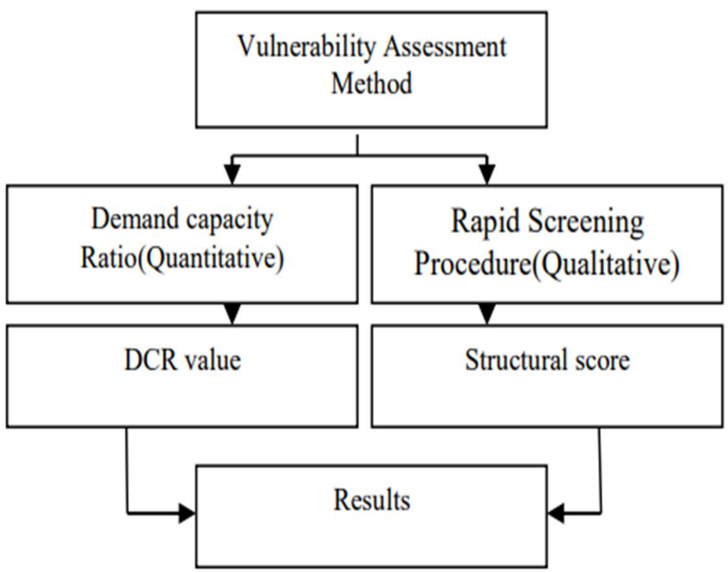


Figure 1:Methods Of Calculation Of Seismic Vulnerability Assessment

Demand Capacity Method

The demand and capacity of the building is calculated. When the ratio of the demand and the capacity of the building s less than 1, then the building is said to be safe otherwise the building is said to be vulnerable. DCR exceeding 1, indicates that building is vulnerable to earthquake loads as defined in IS: 1893-2002.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

The design seismic lateral forces is given by

$$Fi = Ah \times W$$

Where, W= seismic weight of all floors of buildings.
Ah = design horizontal seismic coefficient.

The design horizontal seismic coefficient
Can be evaluated by the procedure given by clause 6.4.2 in IS 1893-2002.

$$Ah = (Z\ I\ Sa / 2\ R\ g)$$

Where Z= zone factor (Z=0.16, (Zone III))
I= Importance factor (depends upon the types of building)
R= Response reduction factor depending on the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations
Sa/g= Average response acceleration coefficient, it depends upon the natural fundamental time period and type of soil.

Natural fundamental time period

$$T= (0.009h/\sqrt{d})$$

where d= dimension of building at plinth level.

Over turning moment calculation
Over turning moment is different for the different floors of the building. It depends upon the height of the buildings. The over turning moment at different floors can be calculated by following method
Over turning Moment = $\{(FiHi2 / \sum FiHi2) \times Fix\ Hi\}$

Calculation of capacity of the Building
The capacity of the building depends upon the dead load of the building. The resisting moment of the building can be calculated with the help of the dead load of the building. Factor of safety (f)= (Resisting moment/overturning moment)

Demand Capacity Ratio
DCR of the Building = 1.5/ (f)
when the DCR of any building is less than 1 then building is said to be safe or less vulnerable(in case of close 1to) otherwise vulnerable

B. Analysis

There are three types of analysis is done on building:-

1) *Equivalent Static Analysis:* The natural period of building is calculated by the empirical expression prescribed in the code. The total design seismic base shear calculation and its distribution along the height are done as per IS 1893(part-I)-2002. The seismic weight is calculated using full dead load plus 25% of live load.
2) *Model Analysis:* Modal analysis or mode super position method is a linear dynamic response procedure which evaluates and super imposes free vibration mode shapes to characterize displacement patterns .mode shapes describes the configuration into which a structure will naturally displace.
3) *Response Spectrum Analysis:* For response spectrum analyses, earthquake ground acceleration in each direction is given as a digitized response spectrum curve of pseudo spectral acceleration response versus period of the structure. On comparing the normal framed building with monolithic building construction on conducting several analysis methods it is clear that the monolithic building offers much more rigid or offers less vibration.

C. Design Specifications Of Buildings

Table 1 represents the design specification of G+10 Building.

Table 1: Design specification of G+10 Building

SR NO.	COMPONENT	VALUES
1	Model	G+10
2	Storey Height	3.3m
3	Beam	300mm x 450mm 300mm x 530mm
4	Column	380mm x 900mm
5	Wall Thickness	230mm
6	Material	M25
7	Grade Of Steel	Fe415
8	Slab Thickness	150mm
9	Seismic Zone	VI and V
10	Important Factor	1
11	Type of Soil	Medium soil
12	Type of structure	RC structure
13	Response reduction factor	5
14	Live load	3 KN/m²
15	Floor finish	1 KN/m²

Table 2 represents the design specification of G+20 Building.

Table 2: Design specification of G+20 Building

SR NO.	COMPONENT	VALUES
1	Model	G+20
2	Storey Height	3.3m
3	Beam	320mm x 700mm
4	Column	400mm x 1800mm
5	Wall Thickness	230mm
6	Material	M25
7	Grade Of Steel	Fe415
8	Slab Thickness	150mm
9	Seismic Zone	VI and V
10	Important Factor	1
11	Type of Soil	Medium soil
12	Type of structure	RC structure
13	Response reduction factor	5
14	Live load	3 KN/m²
15	Floor finish	1 KN/m²

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

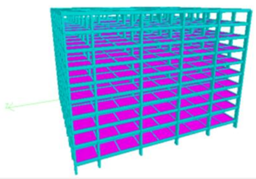


Figure 3 RC Building

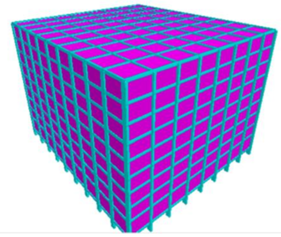


Figure 4 Monolithic Building

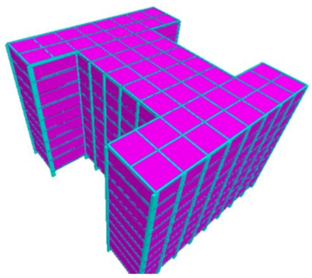


Figure 5 I-Shape Building Design

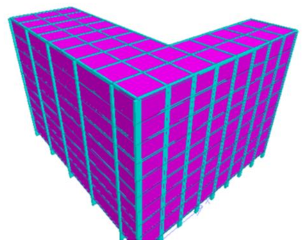


Figure 6 L shape Building Design

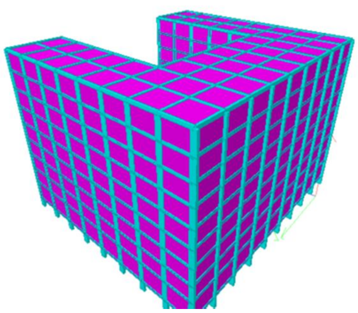


Figure 7 C Shape Building Design

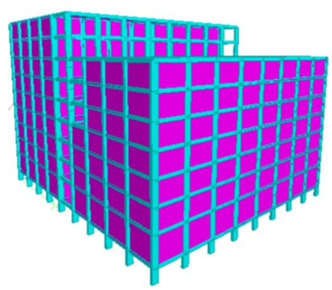


Figure 8 Step Shape Building **Design**

D. Load Calculations

As per IS 1893.2002 clause no. 6.3.1.2
1) 1.5(DL + IL)
2) 1.2(DL +IL +EL)
3) 1.5(DL+EL)
4) 0.9D ± 1.5EL

III. RESULT AND DISCUSSION

The results obtained are as discussed below :-

A. Time period

In this case we can take the time period for all shapes of buildings, RC building and monolithic building will be same.
[1] For G+10 Building:-
Time period in X-Direction = 0.46sec
Time period in Z-Direction = 0.43sec
[2] For G+20 Building :-

Time period in X-direction = 0.93sec
Time period in Z-direction = 0.88sec

B. Modeling

Table 3 Model Names

M1 – Rectangular RC Building
M2 – Rectangular Monolithic Building
M2 – Rectangular Monolithic Building
M3 – L shape Monolithic Building
M4 – I shape Monolithic Building
M5 – C shape Monolithic Building
M6 – Step Shape of Monolithic building

C. Results

1) Lateral forces or seismic base shear of G+10 Building

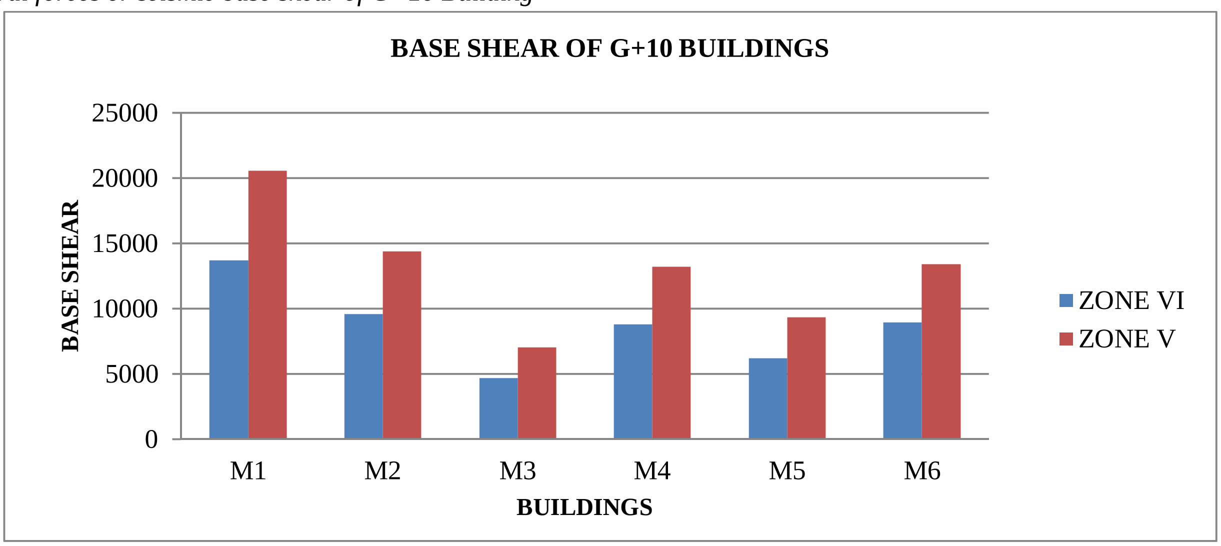


Figure no. 2.3.1 Lateral forces or Base shear of G+10 Building

2) Lateral Forces or Base shear of G+20 Buildings:

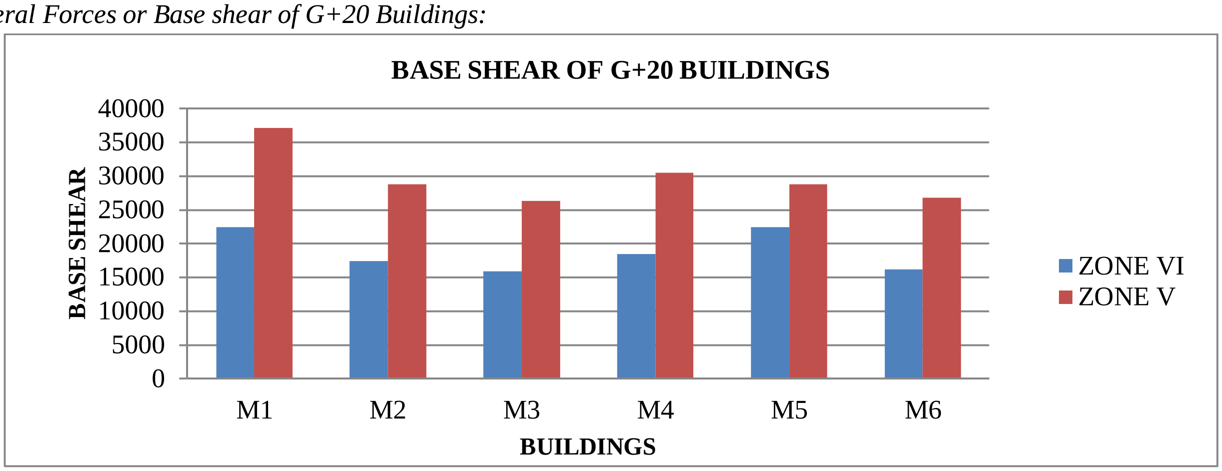


Figure no. 2.3.2 Lateral forces or Base shear of G+20 Building

3) Story Displacement In X-Direction of G+10 Building For zone VI

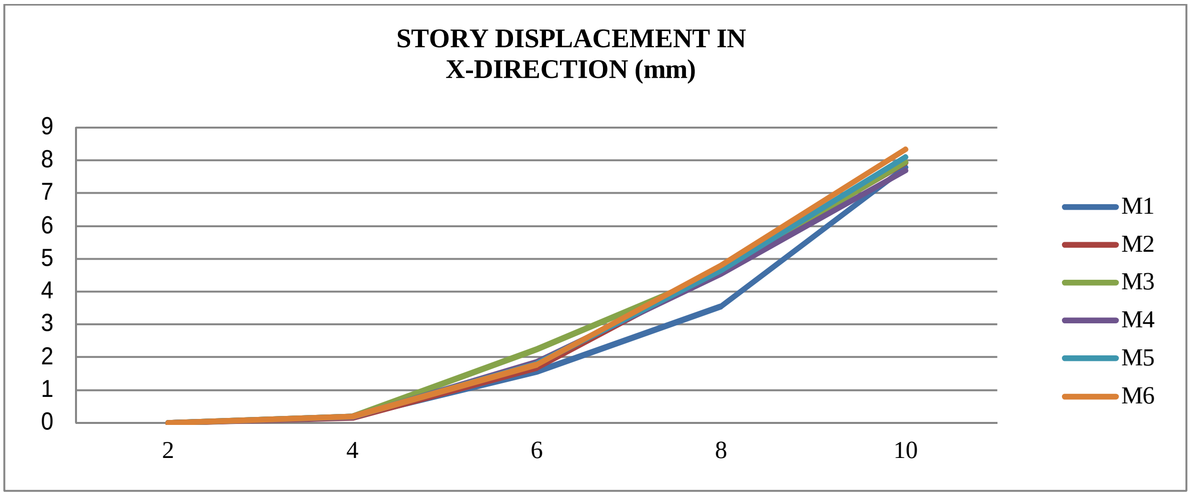


Figure 2.3.3 Story Displacement In X-Direction of G+10 Building for Zone VI

4) Story Displacement In X-Direction of G+10 Building

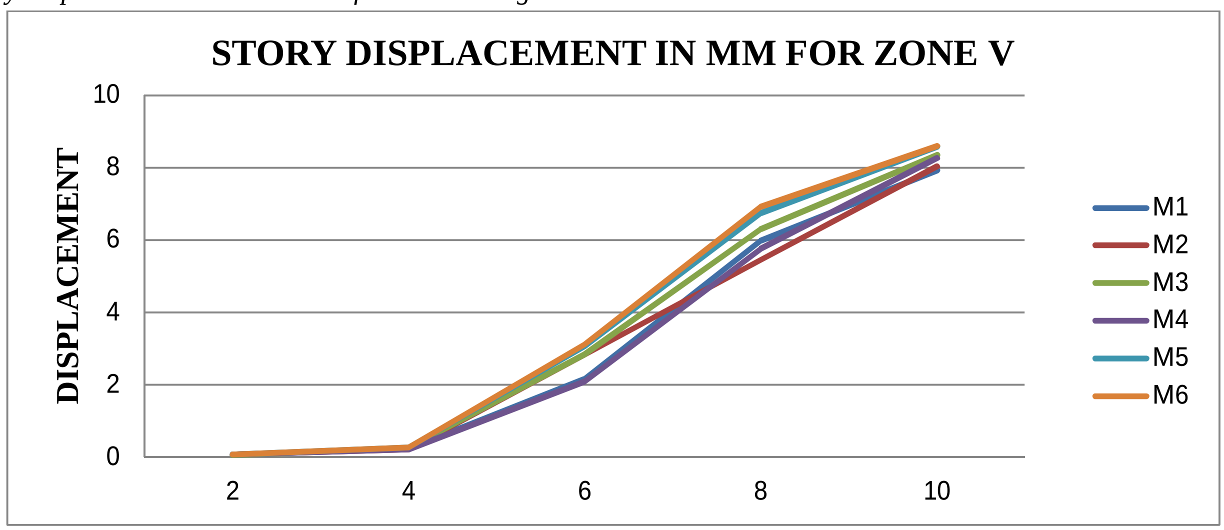


Figure no. 2.3.4 Story Displacement In X-Direction of G+10 Building for zone V

5) Story Displacement In X- Direction of G+20 Building for Zone VI

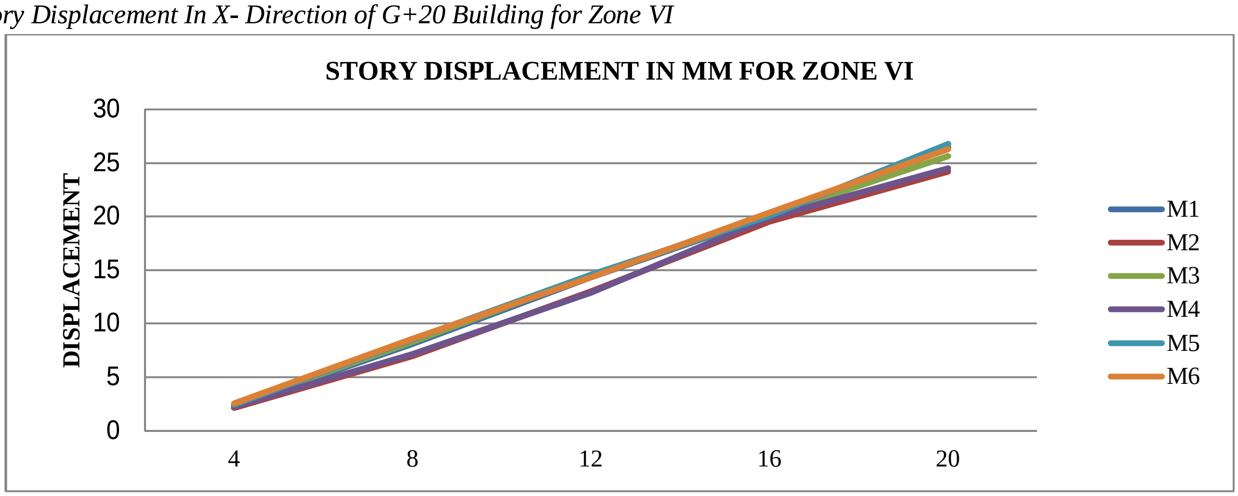


Figure no. 2.3.5 Story Displacement In X-Direction of G+20 Building for Zone VI

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

6) Story Displacement In X-Direction of G+20 Building for Zone V

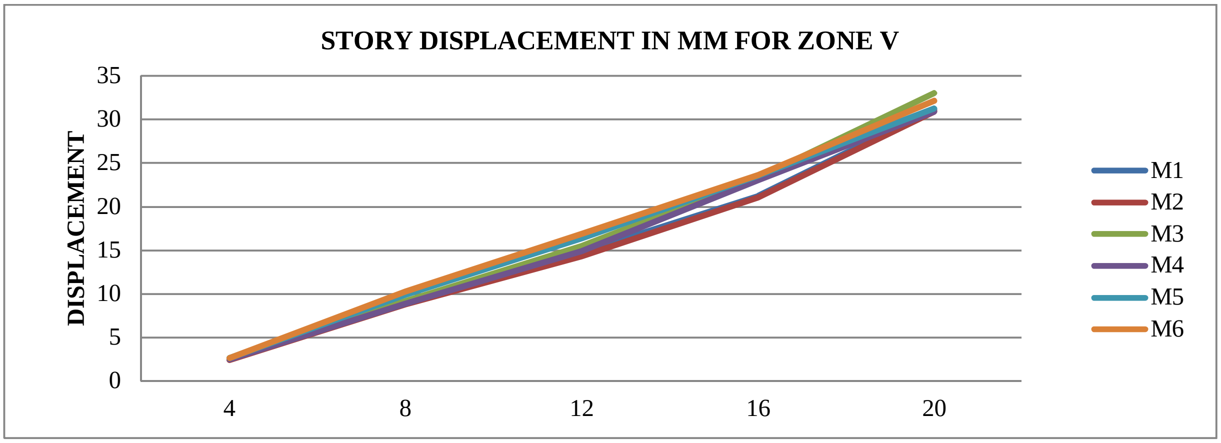


Figure no. 2.3.6 Story Displacement In X-Direction of G+20 Building for Zone V

7) Story Drift In X-Direction of G+10 Building for Zone VI

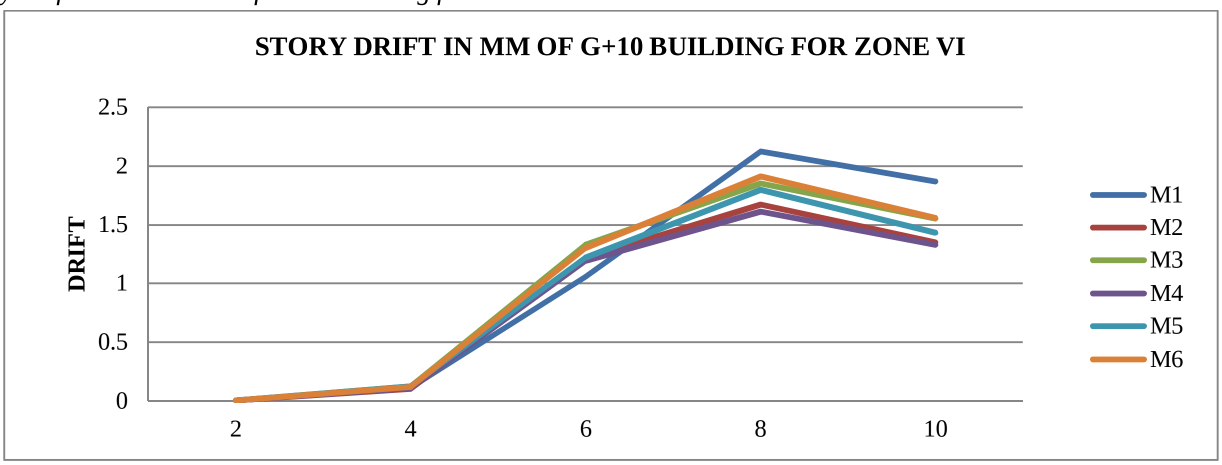
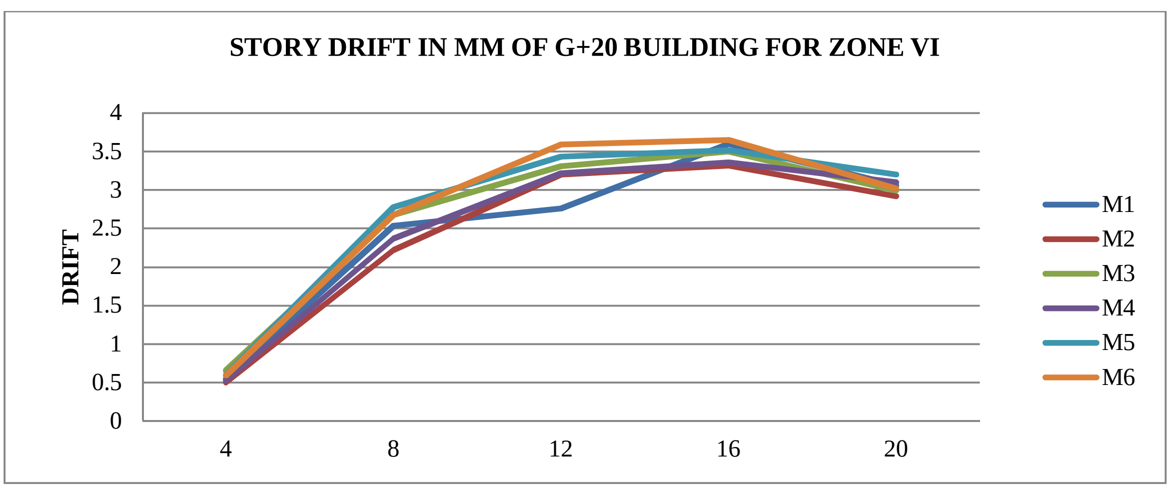


Figure 2.3.7 Story Drift In X-Direction of G+10 Building for Zone VI

8) Story Drift In X- Direction of G+20 Building for Zone VI



2.3.9 Figure Story Drift In X-Direction of G+20 Building for Zone VI

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

9) Story Drift In X-Direction of G+20 Building for Zone V

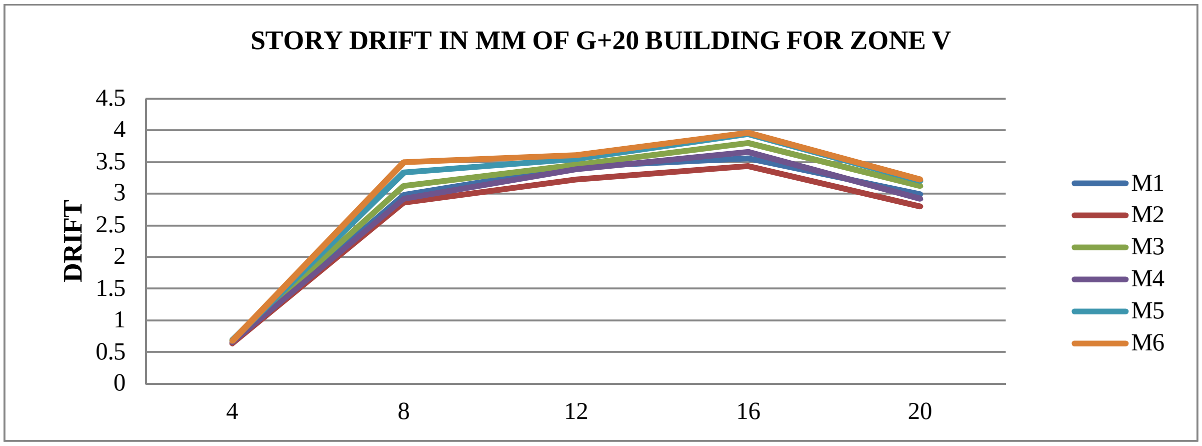
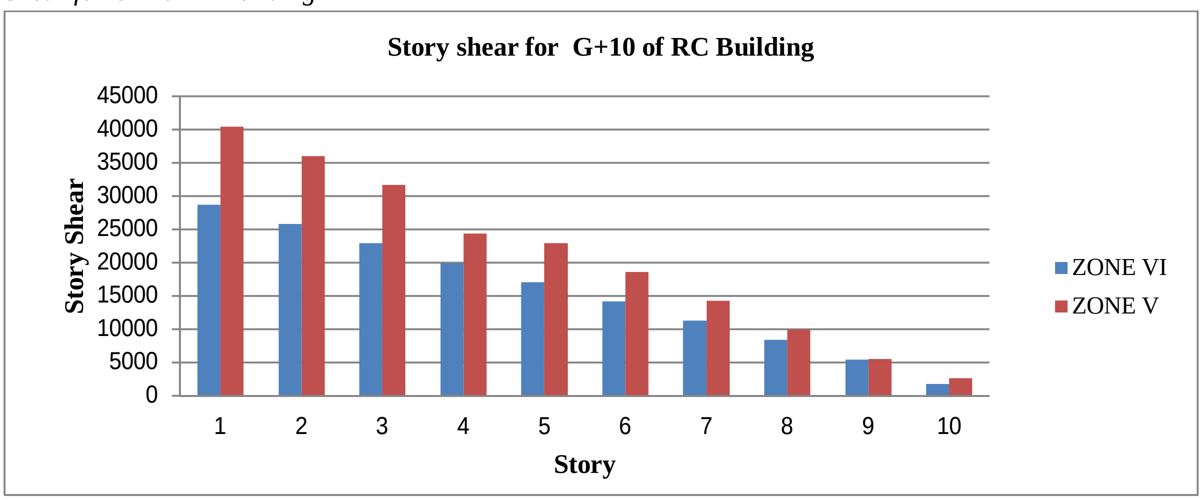
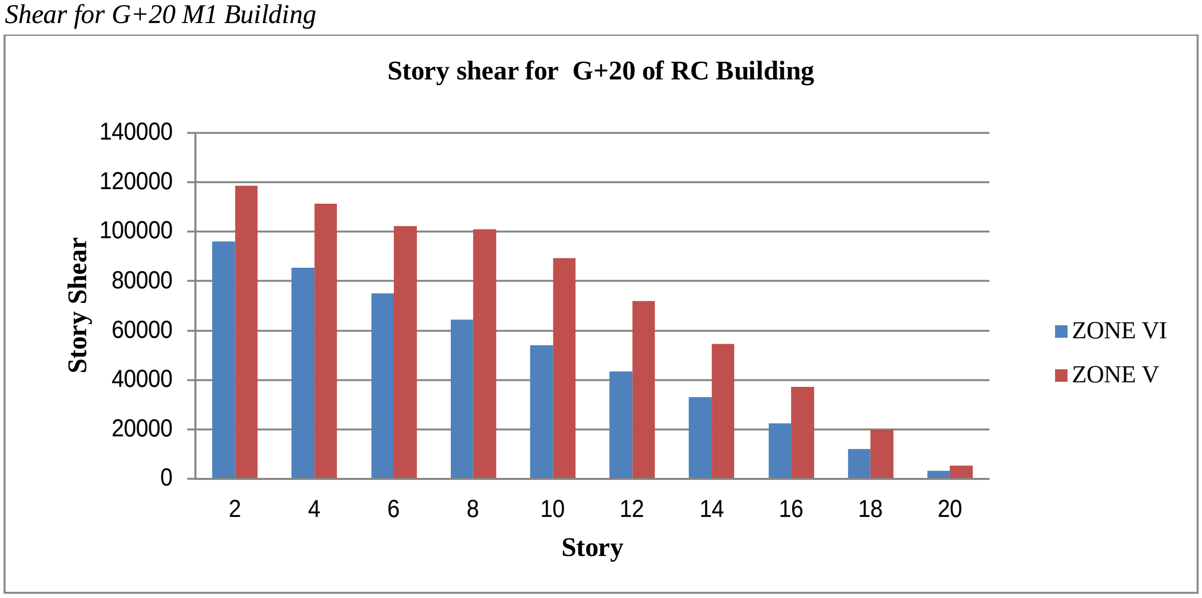


Figure 2.3.10 Story Drift In X-Direction of G+20 Building for Zone V

10) Story Shear for G+10 M1 Building

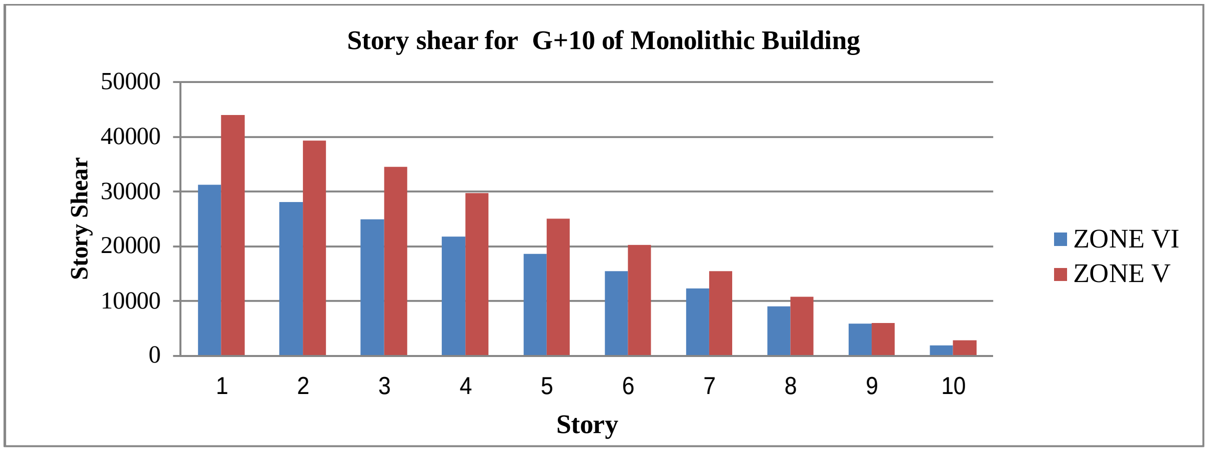


11) Story Shear for G+20 M1 Building

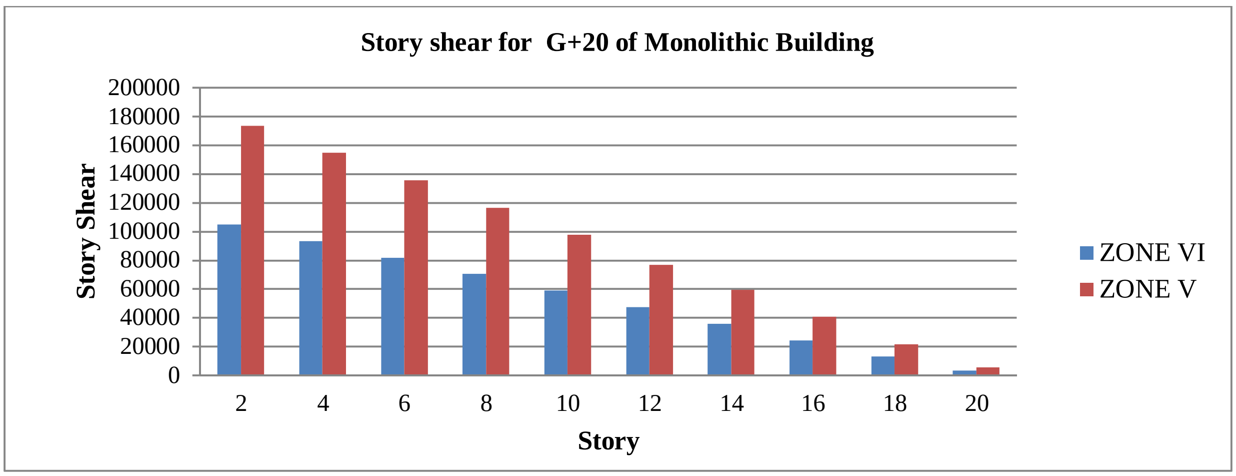


International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

12) Story Shear for G+10 M2 Building



13) Story Shear For G+20 M2 Building



14) Final DCR of G+10 Buildings

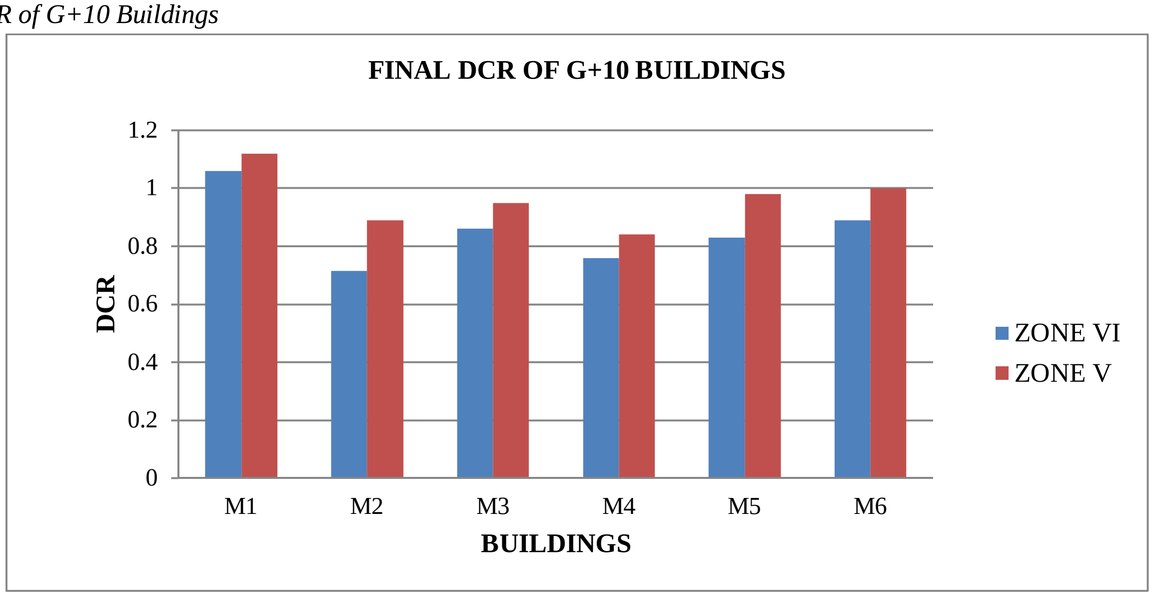


Figure 2.3.15 Final DCR of G+10 Buildings

15) Final DCR of G+20 Buildings

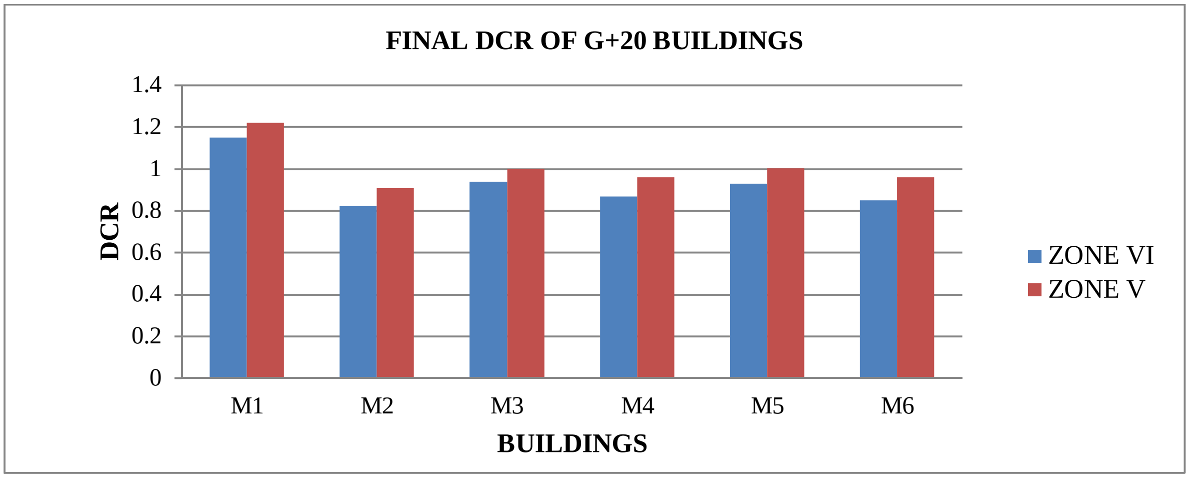


Figure 4.2.25 Final DCR of G+20 Buildings

IV. CONCLUSION

From the above results it is concluded that,

1) The base shear of Rectangular shape Monolithic Buildings of G+10 in zone V is 33% greater than the zone V, and in Monolithic Buildings have 30% and 23% lesser than RC Building in zone IV and V.
2) The base shear of Rectangular shape Monolithic Building of G+20 in zone V is 35% greater than the Monolithic Building of G+20 in zone IV.
3) The Shear Displacement of Monolithic Buildings of G+10 in zone V is 15% greater than zone IV and in RC Building of G+10 in zone V shear displacement is 19% greater than zone IV.
4) The shear Displacement of Monolithic Building of G+20 in zone V is 12.2% Greater than in zone IV and in RC Building of G+20 in zone V shear displacement is 15% greater than zone V .
5) The Shear Drift of Monolithic Buildings of G+10 in zone V is 2.76% greater than zone IV and in RC Building of G+10 in zone V shear drift is 3.3% greater than zone IV.
6) The Shear Drift of Monolithic Buildings of G+20 in zone V is 3.27% greater than zone IV and in RC Building of G+10 in zone V shear drift is 3.5% greater than zone IV.
7) Top story has a less story shear than the basement of the building. It is also that the structure has less stiff.
8) The story shear is 33% more in zone V than the zone IV of monolithic buildings and in RC Building 35% more than zone V than the Zone IV.
9) Final DCR of Monolithic Building of G+10 in zone V is 2.02% greater than zone IV, and in RC building DCR is 1.2% more than the monolithic building in both zones.
10) Final DCR of Monolithic Building of G+20 in zone V is 2.1% greater than zone IV, and in RC building DCR is 1.685% and 1.75% more than the monolithic building in zone IV and V.

REFERENCES

[1] Alok Goyal A National Policy for Seismic Vulnerability Assessment of Buildings and Procedure for Rapid Visual Screening of Buildings for Potential Seismic Vulnerability. Prof. Ravi Sinha and Department of Civil Engineering Indian Institute of Technology Bombay.

[2] Ali Kadhim Sallal (2018) Design and analysis ten storied building using ETABS software-2016International Journal of Research in Advanced Engineering and Technology ISSN: 2455-0876 Volume 4; Issue 2

[3] B Kranthi and Dr J.S.R. Prasad (2018) SEISMIC VULNERABILITY ASSESSMENT OF RC PRECAST BUILDINGS ,International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 8, August 2018, pp. 217–225, Article ID: IJCIET_09_08_023.

[4] Baylon, Michael B and Cecilia M,(2018) seismic vulnerability assessment of Adamson university building as built using fragility curves. Global journal of researchers in engineering volume 18 issue 1 version 1.0

[5] Devang Gohel1, Dr. Jayeshkumar Pitroda(2017) A CRITICAL LITERATURE REVIEW ON COMPARATIVE STUDY OF CONVENTIONAL STRUCTURE WITH MONOLITHIC STRUCTURE Volume 5, Issue 4 December 2017 | ISSN: 2320- 2882 IJCRT1704284 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org 2220.

[6] Dhanalakshmi P, Ramesh B M (2017) Seismic vulnerability of plan irregular RC building with soil structure interaction , International Research Journal of Engineering and Technology (IRJET)

[7] Herrick Caldeira, Sonia Vasco Da Gama, Godwin Fernandes, Yash Dessai, Ray Cortez Department of Civil Engineering, Don Bosco College of Engineering, Fatorda-Margao, Case study on Evaluation of Vulnerability to Earthquake of High Rise Buildings in Goa Goa, India, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181.

[8] IS 1893: Part 1: 2002 (2007). Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings, Bureau of Indian Standards, New Delhi.

[9] IS 4326: 1993 (2008) Code of practice for earthquake resistant design and construction of buildings, Bureau of Indian Standards, New Delhi

[10] Pawan M. Walvekar1, et,all(2017) Seismic Performance Evaluation of Mivan Structural System v/s Conventional Structural System with Effect of SSI by Pushover Analysis ,International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 06 | June -2017

[11] Prasad Kolekar, et.all (2020) Analysis and Comparison of Mivan Formwork System with Conventional Formwork System International Research Journal of Engineering and Technology (IRJET) Volume: 07 Issue: 06 | June 2020 www.irjet.net

[12] Prof. R. B. Bajare, Shubham Deshmukh1, Ashwin Mahajan, Roohi Karnataki, Indrayani V. Patil.(2017) Page Remedies to the Common Deficiencies Faced in Mivan Technology at Malin Rehabilitation IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).

[13] Sopna S Nair, Dr. G Hemalatha ,Dr. P Muthupriya (2017) Vulnerability Assessment Using Fragility Curves, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 9 (2017) pp.

[14] Utkarsh Verma, Rehan Ahmad, Arun Bhatt, Prashant Mishra Seismic Vulnerability Assessment of Buildings in Lucknow International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV6IS060005 Vol. 6 Issue 06, June - 2017