SEISMIC EVALUATION OF EXISTING STRUCTURE

MOHAMMED MUDASSIR ATHER
M.Tech student, structural Engineering, Department of Civil Engineering, Global Institute of Engineering and technology, Hyderabad.

G.SANDHYA RANI
Assistant Professor, structural Engineering, Department of Civil Engineering, Global Institute of Engineering and technology, Hyderabad.

P. SAI LEELA VISHNAVI
Assistant Professor, structural Engineering, H.O.D, Department of Civil Engineering, Global Institute of Engineering and technology, Hyderabad

ABSTRACT: *Buildings are planned following code standards, satisfying all of the code's particular criteria and assuming that structural parts would behave in a linear elastic manner. Furthermore, it is vital to understand the behaviour of buildings built to earlier regulations or that were not meant to withstand earthquake pressures. Natural disasters are known to strike the world from time to time, posing a major hazard. The repercussions of earthquake reoccurrence, in particular, include the loss of human lives and the damage of property, both of which impact the natural economy. Because earthquakes cannot be foreseen or avoided, the ability of buildings to withstand seismic forces becomes more crucial. This thesis attempts to examine the performance of a typical chosen R.C. building regarding seismic vulnerability, keeping in mind the ongoing revision of the seismic zones in India and the lack of suitable design and detailing of buildings against earthquakes. For this seismic evaluation, a linear static has been performed by software ETABS considering material modification factor (Knowledge factor, K) FEMA 154. The analysis results showed the performance levels, the components' behaviour, and the building's failure mechanism. It also showed the failure concerning the concrete deterioration of the existing buildings. Based on the analysis retrofitting is done by considering shear walls at different positions of the building, and the result has been compared with a term of story displacement, story drift, time periods, base shear and area of steel, and several columns failure with Knowledge factor.*

***Keywords**: Seismic vulnerability, Knowledge factor, Existing building, FEMA 154.*

1.0 INTRODUCTION

India's rapidly urbanizing population has fueled a housing boom, notably in seismic Zones IV and V. Because most of these constructions are not earthquake-resistant, these areas are categorized as seismically susceptible. Indian towns feature a vast diversity of building styles, some badly designed and maintained, making seismic safety problematic. Seismic vulnerability is considered the most significant component of an earthquake risk assessment. Not all structures can benefit from extensive seismic risk assessments, which are time-consuming and costly. To focus on the most important buildings, it is necessary to use simplified processes that can swiftly analyze the risk profile of different building types. High-rise structures are inevitable in rapidly growing cities and towns where land is limited. Earthquakes, tornadoes, hurricanes, tsunamis, and other natural catastrophes constitute a continual danger to certain parts of our world.

Seismic vulnerability evaluation

An earthquake's danger relies on both the structures and the seismic hazard. Every city considers the likelihood of a specific magnitude or intensity earthquake striking a spot. Local construction methods and stock quality are connected to seismic risk. Local construction techniques also influence seismic risk since natural building materials result in larger buildings. Every deadly quake emphasizes the necessity for earthquake risk and risk assessments. It is potentially dangerous within a particular time period and geographic region. An area's "risk" is the projected damage (of lives, injuries, property damage, etc.). Risk is the sum of vulnerability and risk. Despite advances in seismic forecasting, earthquake timing, magnitude, and location are unpredictable. Even a detailed prognosis could not prevent an earthquake and its damage. We can reduce earthquake risk by merging regional geology and geographic data with cutting-edge technology. The key component in seismic hazard assessment is a structure's seismic strength.

Aims and objectives of the present study

The following were the goals of this research:

- This research aims to compare and analyze the seismic response of structures with standard reinforced concrete frames as the concrete deteriorates over time.
- To explore the seismic behavior of a 14-story R.C.-framed structure in zone 4 using the Knowledge Factor, K. (1.0 to 0.5).
- According to the I.S. 2016-2002 seismic code, typical 14-story reinforced frames have been developed for seismicity. Fifteen models were constructed by progressively lowering the concrete strength from M30 to M15 (3 for each structure).
- To investigate a variety of reactions, including maximum deflection, time period, Storey Shears, bending moment, and building steel area, among others.
- To investigate the influence of three alternative shearwall locations on R.C. framed buildings using the Knowledge Factor, K (1.0 to 0.5).

Scope of the present study

The linear static approach and ETABS 2019 are used to investigate models of a fourteen-story structure with a regular plan in the IV seismically active region with medium soil. This study aims to assess R.C. structures (designed according to IS456:2000). It comprises calculating displacement, drift, Base Shear, and Time period for a certain structure based on the research findings while considering the Knowledge factor, K, (1.0 to 0.5). And to observe how the Comparative Results vary without the shear wall and at different places with the shear wall.

2.0 LITERATURE REVIEW

SUPRADIP SAHA and SUBHARAJIT DAS (2019): The performance of shear walls in reducing structural response in an existing asymmetrical building exposed to seismic loadings was studied. The efficiency of the shear wall was determined by conducting a seismic analysis on the building with and without a shear wall. Linear Static Study, Response Spectral Analysis, and Time History Evaluation have all been performed using STAAD Pro V8i. These methodologies have been used to comprehensively investigate the impact of both static and live loads on the dynamic response.

Mohamed Sobaih1 and Ahmed Al Ghazali (2016): As part of this study, researchers compared base shear and deformation at different stages of earthquake loading to determine the seismic response of conventional reinforced concrete frame structures. Reinforced concrete frames of 5, 15, 20, and 30 stories have been built using the newly accepted Abu Dhabi seismic code ACI 318-08/I.B.C. 2009

Research by Munshi Md Rasel & Co (2016): Many Bangladeshi structures do not meet current seismic regulations and might be badly destroyed in an earthquake. To remodel older structures, particularly those erected without adequate seismic consideration. Corrective procedures based on seismic assessment may limit the degree of damage. This study's goal is to examine the present building's seismic performance.

Mangulkar Madhuri N.2 (2012): Recent earthquakes have shown the need to avoid rapid lateral stiffness and strength changes. Weak flooring can cause structural problems. The lower-level concrete columns behaved as a soft tale during the earthquake because they lacked shear strength. Adding shear walls to soft floors is typically the most cost-effective way to avoid such disasters. Shear walls are an excellent lateral force-resisting element in high-rise structures.

Anuj Chandiwala et al. (2012): In India's earthquake zone III, researchers tried to calculate the moment at a certain column even while factoring the seismic load. Shear walls may help buildings withstand earthquakes. 14 For this investigation, a 10-story R.C. residence in India's seismic zone III was used.

Ozmen 1 and Intel 2 (2008): Many existing, structurally vulnerable buildings in earthquake-prone areas need to be examined for seismic activity. The problem is that most engineers in the area aren't acquainted with nonlinear techniques. Shortly, linear approaches should be utilized to examine many faulty existing structures.

3.0 METHODOLOGY

The static analysis using ETABS 2019 software is shown. An ETABS static linear analysis is performed on the proposed structure. Among the parameters examined by the program are the displacement of the roof and the period, story drift, foundation shear, and so on.

Methodological Approach

Using this method, the seismic performance of RCC Shear walls may be assessed.

Data gathering, analysis, and interpretation are all steps in the research process. The last step is concluding and making suggestions for the future.

Civil engineers use concrete frame systems and concrete frame-wall systems to withstand external vertical and horizontal loads on concrete constructions. In concrete frame-wall systems, shear walls provide lateral resistance and may carry specified localized vertical loads, according to A.T.C. 40 (1996), which states that concrete frames bear both horizontal and vertical loads. In terms of seismic performance and resistance, concrete frame-wall constructions outperformed concrete frame buildings. Seismic performance is determined by the building's structural strength, stiffness, and ability to deform.

Reinforced Concrete Shear Walls

Shear walls resist lateral forces vertically. Side-force transmission from the diaphragm to the foundation. The wall is a cantilever plate girder with the floor diaphragms as web stiffeners and the vertical boundary reinforcement (columns) as flanges. The shear force distribution depends on the cross-sectional moment of inertia. Wall flexure causes floor or level displacement.

Forces vertical (gravity) and horizontal (wind or earthquake). They enter and exit the aircraft. Eccentric loads and overturning forces must be addressed in-wall design.

A wall is only non-structural if isolated on three sides (both ends and top). Non-isolated walls tend to bend under load when the underlying structure deforms. Plan geometry, orientation, and position affect overturning moment, shear force, and story torsion resistance. The reinforced concrete shear walls design considers torsional stability, wall location, and flexural and torsional stiffness. They must also be ductile in design. The ductile detailing of reinforced concrete shear walls is required in many nations. Reinforced concrete shear walls need steel reinforcing bars in grids.

Using reinforced concrete shear walls reduces lateral sway. This reduces structural and non-structural component damage. In seismic zones, reinforced concrete needs special attention. The seismic analysis measures a building's reactivity to earthquakes. Seismic analysis of a system involves evaluating the forces operating on it at different levels. The analysis might be static or dynamic.

Structural analysis methods can be divided into the following categories-

- Equivalent static Analysis or Linear Static Analysis
- Response spectrum analysis or Linear dynamic Analysis
- Pushover Analysis of Nonlinear Static Analysis
- Time history analysis or Nonlinear dynamic Analysis

STATIC ANALYSIS EQUIVALENT

Since forces are based on code-based introduction periods of structures with empirical modifiers, the static analysis approach is the most convenient. Using a regular mass and stiffness distribution, various simple formulas may be used to disperse the design base shear across the building's height. Lateral load resisting components receive the lateral design force from the diaphragm movement at each level and distribute it accordingly. Seismic force determination involves the steps listed below.

THE CONFIGURATION OF THE BUILDING

Table 3.1 Without a shear wall, the parameters of a 14-story structure

S. No.	Specifications	14 story
1	Slab Thickness	125mm
2	Beam dimensions	230x450mm
3	Column dimensions	350x650mm
4	Grade of concrete	M30 to M15
5	Grade of steel	Fe-500
6	Unit weight of concrete	25kN/m^3
7	Live loads (a) Floor load (b) Floor finishes	3kN/m^2 1kN/m^2
10	Importance factor	1.0
11	Seismic zone factor	0.36
12	Response reduction factor	5

Table 3.2 Essential collection of data

S. No.	Description	Information	Remarks
1	Plan size	42mx42m	-------
2	Building heights	40.8m	-------
3	Number of story's above ground level	14	-------
4	Number of basements below ground	0	-------
5	Type of structure	RC frame	-------
6	Open ground story	Yes	-------
7	Special hazards	None	-------
8	Type of building	Regular frame without shear wall	IS-1893:2016 Clause 7.1
9	Horizontal floor system	Beams & Slabs	-------
10	Software used	Etabs 2019	-------

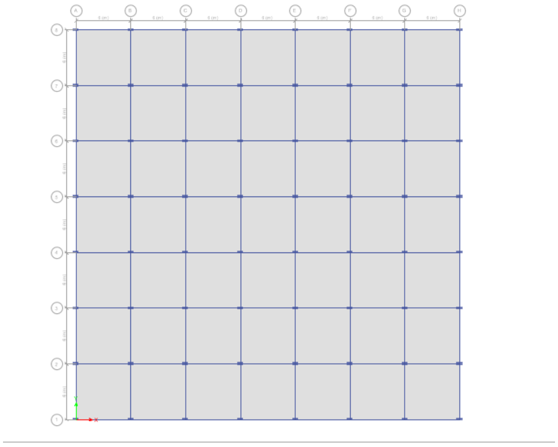

Figure 3.1: Building Model Plan View

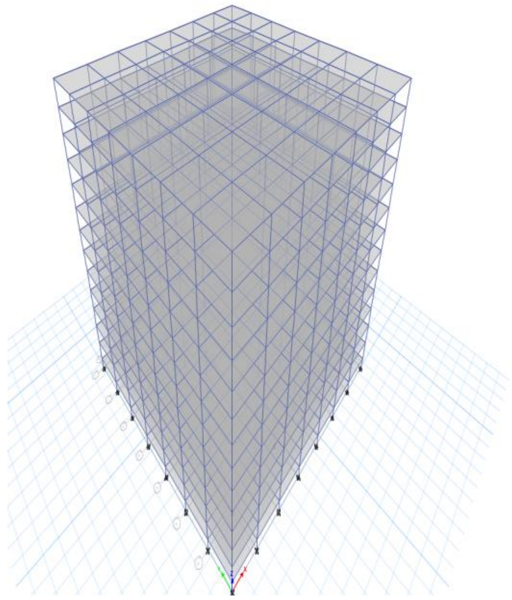

Figure 3.2: Isometric Views of Models

Model 2 In zone IV explores a 14-story RC framed skyscraper. The structure has a 42 x 42 m layout with a 3 m average story height. There are seven X-bays and seven Y-bays in all. The constructions had a total length of 40.8 meters.

THE CONFIGURATION OF THE BUILDING

Table 3.3 Structural dimensions of 14 storied building with shear wall at corner

S. No.	Specifications	14 story
1	Slab Thickness	125mm
2	Beam dimensions	230x450mm
3	Column dimensions	350x650mm
4	Grade of concrete	M30 to M15
5	Grade of steel	Fe-500
6	Unit weight of concrete	25kN/m^3
7	Live loads (a) Floor load (c) Floor finishes	3kN/m^2 1kN/m^2
10	Importance factor	1.0
11	Seismic zone factor	0.36
12	Response reduction factor	5
13	Shear wall position	SW on Corners

Table: 3.4 Essential Collection of Data

S. No.	Description	Information	Remarks
1	Plan size	42mx42m	-------
2	Building heights	40.8m	-------
3	Number of story's above ground level	14	-------
4	Number of basements below ground	0	-------
5	Type of structure	RC frame	-------
6	Open ground story	Yes	-------
7	Special hazards	None	-------
8	Type of building	Regular frame with shear wall	IS-1893:2016 Clause 7.1
9	Horizontal floor system	Beams & Slabs	-------
10	Software used	Etabs 2019	-------

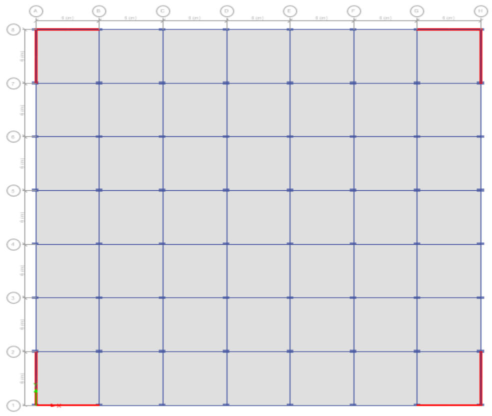

Figure 3.3: Model Plan View of Buildings

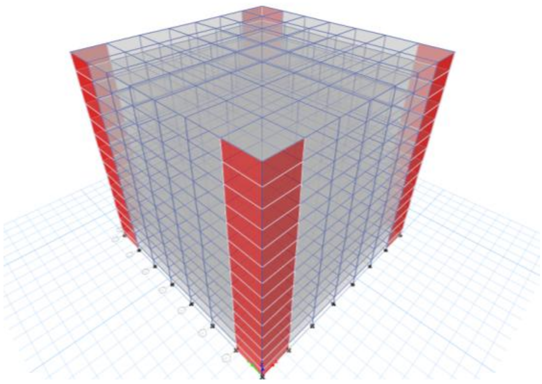

Figure 3.4: Isometric Views of Models

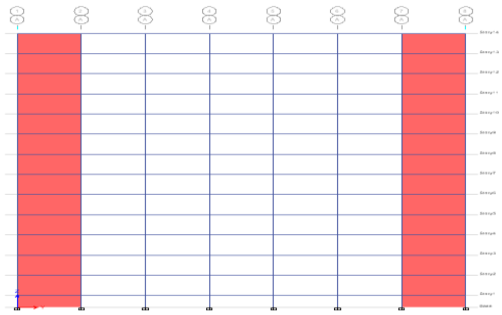

Figure 3.5: Elevation view of the model

The third model uses a 14-story RC framed skyscraper in Zone IV for research. On the plan, the building has an area of 42 42 m2 and a typical floor height of three meters. There are 7 berths in the X direction and 7 bays in the Y direction. There was a total of 40.8 meters of height in the constructions.

4.0 RESULTS AND DISCUSSIONS

Story displacement, Storey drift, Base shear, Modal Periods, and other findings are gathered. A linear static assessment of fourteen-story structures is presented below.

Model 1: RCC without shear wall

Model 2: R.C.C. shear wall corners

Model 3: R.C.C. structure with shear wall in the middle.

Model 4: R.C.C. building shear wall

Then the findings for symmetric buildings are discussed individually and the Story impact of symmetric buildings by examining the Framework Response for fourteen storied buildings.

MODEL WITHOUT SHEARWALL

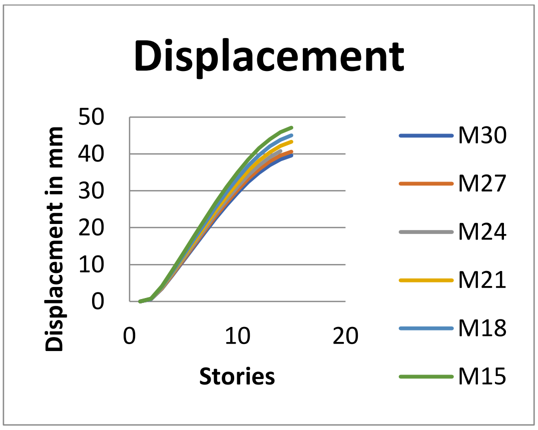

Figure 4.1: Displacements of buildings with knowledge factors

Displacement of structures rises with deterioration of concrete strength, as seen in Figure 4.1. If you compare it to other concrete grades, M 30's the least displacement is at its lowest level.

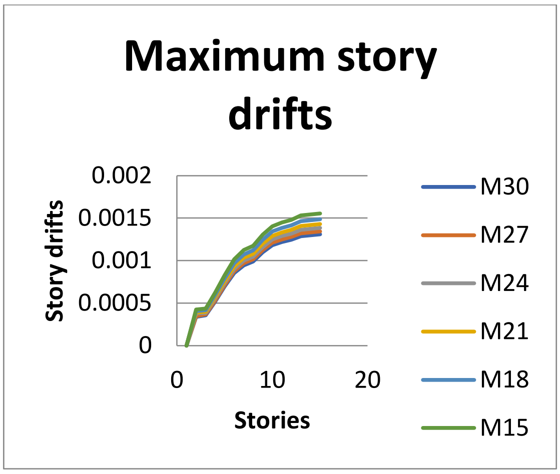

Figure 4.2: Drift of buildings with knowledge factors

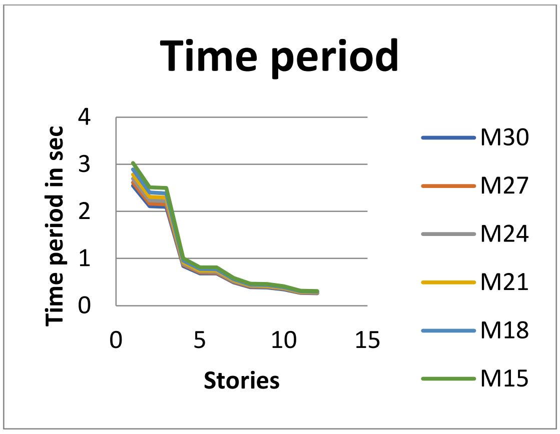

Figure 4.3: time period of buildings with knowledge factors

Model with Shear wall for (M30) Grade of Concrete

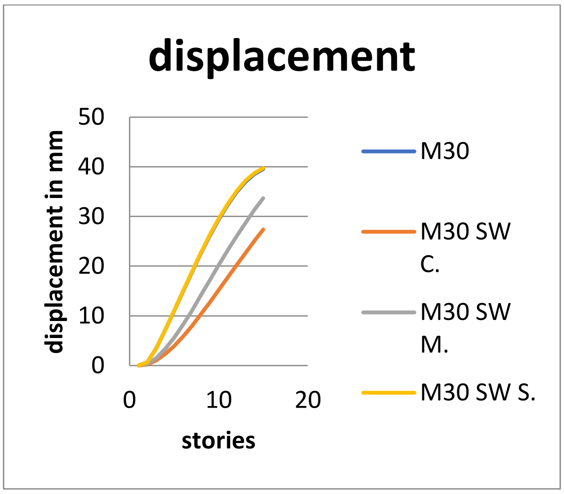

Figure 4.4: Displacements of buildings with shear wall at different positions for M 30 grade of concrete

As per the observation from the above figure 4.4, the displacement of the buildings increases as the strength of the concrete decreases. It is found that the shear wall at the corner for M 30 has the least displacement compared to another grade of concrete

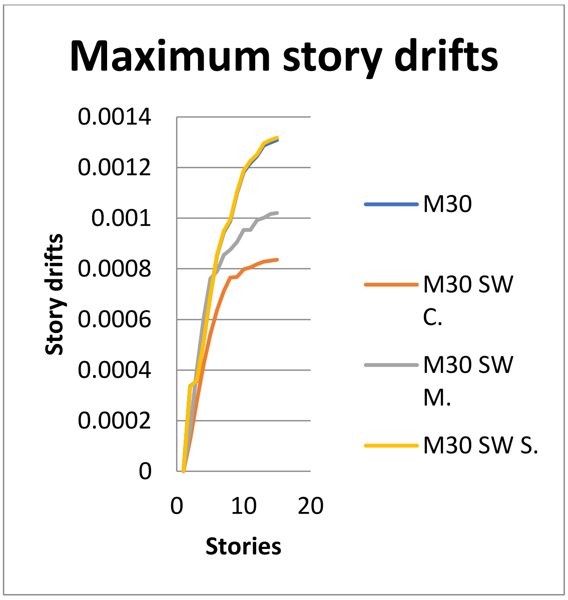

Figure 4.5 Drift of buildings with shear wall at different positions for M30 grade of concrete

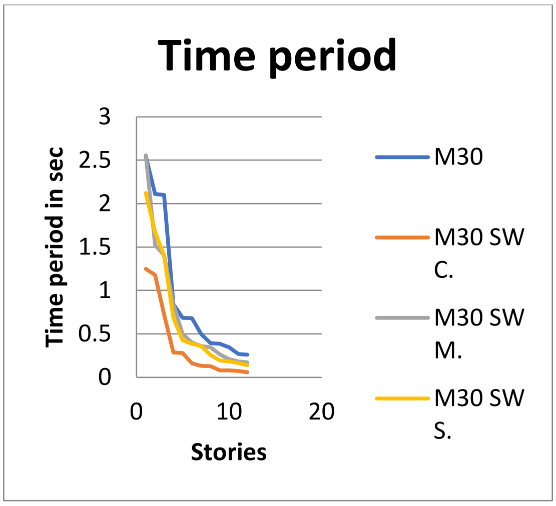

FIGURE 4.6: time period of buildings with shear wall at different positions for M 30 grade of concrete

MODEL WITH SHEARWALL FOR (M27) GRADE OF CONCRETE

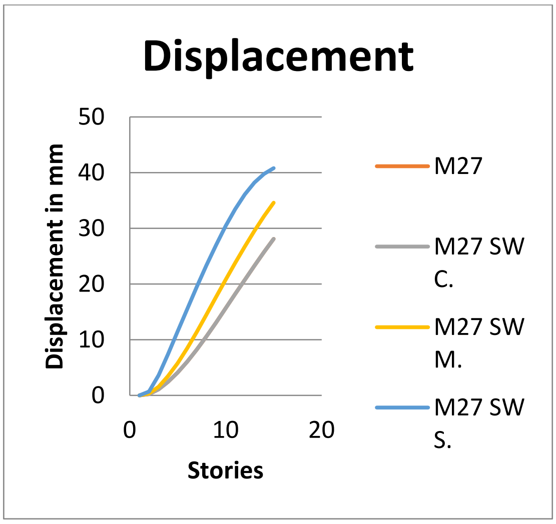

Figure 4.7: Displacements of buildings with shear wall at different positions for M 27 grade of concrete

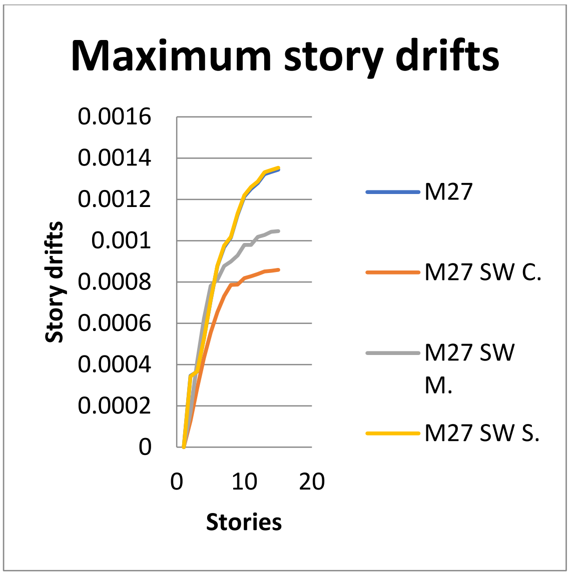

Figure 4.8: Drift of buildings with shear wall at different positions for M 27 grade of concrete

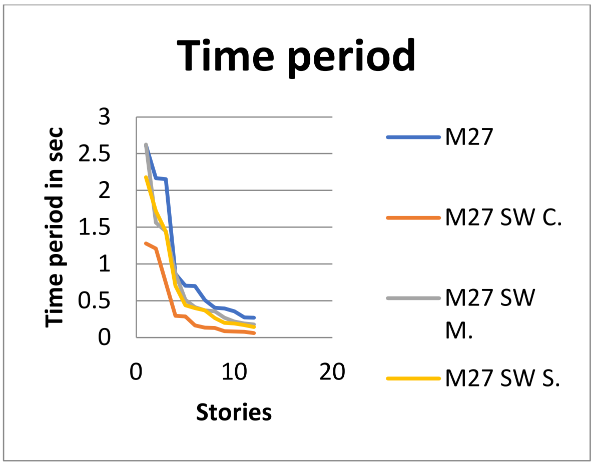

Figure 4.9: time period of buildings with shear wall at different positions for M 27 grade of concrete

CONCLUSIONS

This research highlights the entire project for R.C.C buildings with and without Shear walls for construction. The impact of seismic stress on a building with various shear___wall placements has been investigated. The following conclusions have been formed based on the findings:

• For all cases, such as M30, M27, M24, M21, M18, and M15, displacement and drift rise as concrete strength diminishes. From M 30 to M15, the displacement and drift of buildings without shear wall have risen by 16 percent.

- For all cases, such as M30, M27, M24, M21, M18, and M15, the base shear reduces as the concrete strength falls. In both the x and y directions, base shear was decreased by 15.8% for structures without shear wall.
- The rigidity of a structure is inversely proportional to its time period. As the strength of concrete lowers, the structure's lifespan lengthens. As a result, as a structure's stiffness grows, its time period reduces, and vice versa. From M 30 to M 15, the time period rises are roughly 15.9%.
- As the concrete strength declines from M30 to M15 grade of concrete without shear wall, the number of columns fails from 0 to 216. And when the strength of the concrete falls, the proportion of steel rises.
- For M 15 concrete grade, there are 216 column failures without shear wall, but when shear wall at corners is used, the total number of column failures is decreased by 136. It seems that corner shear walls are more effective than the center and side shear walls.
- The displacement of the building decreases by providing shear wall at the corner compared to other buildings where shear wall is provided at the middle and sides. The percentage reduction is 31.1% for shear wall at the corner to shear wall at sides for M 30 grade of concrete.

- The displacement of the building decreases by providing shear wall at the corner compared to other buildings where shear wall is provided at the middle and sides and without shear wall, for all grades of concrete, i.e., From M 30 to M 15.
- The time period of buildings with shear wall at the corner is less than other buildings without and with shear wall at middle and sides for all grades of concrete.

Future scope:

Different building heights and eccentric placements of shear wall openings may be used in future projects. Nonlinear analytical methods and cracking of the shear wall may be used to investigate smaller and bigger apertures further. The structure's performance in various seismic zones may be investigated. Various kinds of shear walls may be placed in various building parts to study the structure. Shear walls may also be compared in terms of their cost and efficiency. For an existing building, the adjusted load factor may be used to account for reduced lateral force and other aspects such as the building's remaining useful life.

BIBLIOGRAPHY

1. *Subhrajit Das ,Supradip Saha , (2017) " Performance Evaluation of Shear-Wall on Existing Irregular Building under Seismic Loadings " , International Journal of Management and Applied Science (IJMAS) , pp. 60-65, Volume-4,Issue-2*
2. *Mohamed Sobaih1, Ahmed Al Ghazali2 "Seismic Evaluation of Reinforced Concrete Frames in the Harsh Environment Using Pushover Analysis". Open Journal of Civil Engineering, 2016, 6, 685-696*
3. *Federal Emergency Management Agency FEMA 356 (2000) Pre-Standard and Commentary for the Seismic Rehabilitation of Buildings.*
4. *Sobaih, M.E and Alghazali, A. (2013) Seismic Evaluation of Reinforced Concrete Frames in the Harsh Environment Using Pushover Analysis. MSc. Thesis, Faculty of Engineering & Applied Sciences, ALHOSN University, Abu Dhabi*
5. *O. Esmaili 1 S. Epackachi 2 M. Samadzad 3 and S.R. Mirghaderi "Study of Structural RC Shear Wall System in a 56-Story R.C. Tall Building "The 14 th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China*
6. *Munshi Md Rasel1, Md Asif Rahman2, Ayesha Binta Ali3, Md Moinul Islam3, Dr. Md Mahmudur Rahman3 "Retrofitting Process of an Existing Building With Respect To Seismic Consideration in Bangladesh "International Journal of Scientific & Engineering Research, Volume 6, Issue 5, May-2015 1051*
7. ***Yousuf Dinar, Md. Imam Hossain, Rajib Kumar Biswas, Md. Masud Rana**, "Descriptive study of Pushover analysis in R.C. structures of Rigid joint", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 11, Issue 1 Ver. II (Jan. 2014), P.P. 60-68*