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Response of RCC Structure under Influence of Earthquake using Etabs

Mr. Tushar saxena[1], Ghanshyam sahu[2], Shubham[3], Hemukta Nand[4], Akshat Dubey[5], Yuwan Singh[6]

[1] Assistant Professor & Bhilai Institute Of Technology, Durg c.g. India, [2]Student & Bhilai Institute Of Technology, Durg c.g India

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Abstract

Seismic evaluation of strengthened Concrete (RCC) homes are one of the studies pastimes in recent times and it's far due to the fact of, earthquake reasons plenty of harm and losses with appreciate to existence and harm of structures. The gift observe is constrained to strengthened concrete multi-storied residential constructing beneath have an impact on of earthquake floor motions. In this observe, a nonlinear time records evaluation is carried out on G+8 storey RCC constructing body thinking about time records the use of ETABS software. Analysis additionally carried out to observe the conduct of constructing beneath the seismic and gravity hundreds as in step with the IS:1893-2016. All evaluation are as compared for results inclusive of storey displacements and base shears. From the observe it's far encouraged that evaluation of multistoried RCC constructing the use of Time History approach turns into essential to make certain protection towards earthquake force.

***Key Words*: Time History Analysis, Story Drift, Base Shear, Earthquake Load.**

1. INTRODUCTION

Now a day's Earthquake has multiplied because of excavation and different sources. Earthquake is the biggest supply of casualties and reasons damages in inhabited areas. Great efforts have been made in latest years for fixing the hassle of constructing layout in seismic areas; no shape can absolutely dispose of harm from earthquakes. The important motive of earthquake-resistant creation is to construct systems that carry out higher at some point of seismic interest than traditional creation. According to constructing codes, earthquake-resistant systems are supposed to face up to the biggest earthquake of a positive chance this is in all likelihood to arise at their location. This manner that systems ought to be capable of face up to minor stage earthquakes with none damages, mild stage earthquakes with a few non-structural harm in an effort to be repairable and fundamental stage earthquake with out collapse.

1.1 Objectives of Study

The main objective of the present study is to carry out the seismic response of 8 storey RCC frame structure using time history analysis methods. The specific objectives are as given below

- To study the comparison of performance of Fixed Base Building using published work as a reference and understands the behavioral aspects.
- To develop a simplified model of a multi story building with identical parameters and simultaneously providing it with base isolation and viscous damper.
- To carry out dynamic seismic analysis on the modeled buildings using scaled records of acceleration time histories and comparing their results.
- Seismic non-linear time history analysis of multi-storied RCC building under influence of different earthquakes using Etabs.
- To study the behavior of multi-storied RCC building under the action of load combination (seismic loads and gravity loads).
- The time history analysis is performed for the RCC building firstly and then the seismic analysis is performed for load combination (DL, LL, and EQL).
- Analysis of base shear and displacement on different storey.
- To compare seismic behavior of multistoried RCC framed building for different earthquakes in terms of various responses such as, base shear and displacements.

The entire process of modeling and analysis of all the primary elements for all the models are carried by using ETABS 2020 nonlinear version software

2. INTRODUCTION TO ETABS:

ETAB is software program evolved with the aid of using maintaining targeted on evaluation and layout of the constructing structure. Its person interface is likewise pleasant and smooth to use. It has functionality to address each easy in addition to maximum complicated constructing model, which incorporates a giant sort of linear and non-linear behaviors, which turns into a device for structural engineers with inside the industry. Using a not unusual place database, it may combine modeling, analytical and layout procedures; it additionally capabilities an intuitive and effective graphical interface

.Method of Analysis

The analysis procedures are further classified as given below:

1. Linear static analysis
   1.1. Equivalent static method
2. Linear dynamic analysis
   2.1. Response spectrum method
   2.2. Elastic time history method
3. Nonlinear static analysis
   3.1. Push over analysis
4. Nonlinear dynamic analysis
   4.1. Inelastic time history method

Time History Method

This technique offers us the maximum correct solution and is maximum state-of-the-art technique for dynamic evaluation of buildings. Time records evaluation is a grade by grade system of the dynamic reaction of the shape to a specific loading which could range with time. This technique solves the equation of movement through grade by grade direct integration over a time c language with displacements, velocities and accelerations of preceding step serving as preliminary function.

$M\ddot{U} + C\dot{U} + KU = F\ (t)$

There are many cases which can be performed using Time History Analysis, which is as:

1. Linear vs. Non-Linear
2. Modal vs. Direct Integration
3. Transient vs. Periodic

Load Combinations for Analysis:

As per IS 1893 (Part I):2002 the following load combinations are considered in limit state design of reinforced cement concrete structure during the analysis of the model:

a) 1.5 (DL + LL)

b) 1.2 (DL + LL $\pm$EL)

c) 1.5 (DL $\pm$ EL)

d) 0.9 DL $\pm$ 1.5 EL

The above equation can be further expressed for EL in x and y directions are as follows:

i) 1.5 (DL + LL)

ii) 1.2 (DL + LL $\pm$ EX)

iii) 1.5(DL + EX)

iv) 0.9 DL $\pm$ 1.5 EX

v) 1.2 (DL + LL $\pm$ EY)

vi)1.5 (DL + EY)

vii) 0.9 DL $\pm$ 1.5 EY

2.2 Design steps for Fixed Base Building:

G+8 storied constructing is modeled the use of concrete beams, columns, slabs, infill wall and stairs. It has given a geometry form of rectangle with plan dimensions of 30mX24m. It is loaded with Dead, Live and Seismic Forces [according to IS: 1893 (Part I): 2002]. It is then analyzed the use of Time History Method for earthquake region V of India (Zone Factor = 0.36). The info of the modeled homes are as follows: Modal damping of 5% is taken into consideration with SMRF (Response Reduction Factor, R = 5) and Importance Factor (I) = 1. ETABS is used to document the overall performance of fashions to give a quick concept approximately the position of base isolation and fluid viscous damper in shielding the shape in opposition to earthquake hazards. The following assumptions had been made earlier than the begin of the modeling technique in an effort to keep comparable situations for all of the fashions:

a) Only the principle block of the constructing is taken into consideration. The staircases aren't taken into consideration with inside the layout technique.

b) The important cognizance is at the reaction of the body configuration, because the constructing is for use for residential purposes.

c) The ground is resting at once at the floor, so slabs aren't supplied on the floor ground.

d) The beams are resting centrally at the columns in an effort to keep away from the situations of eccentricity. This is carried out routinely in ETABS.

e) For all structural elements, M 25 & Fe 415 is used.

f) The footings aren't designed. Supports are assigned with inside the shape of constant supports.

g) Seismic hundreds are taken into consideration with inside the horizontal path only (X & Y) and the hundreds in vertical path (Z) are assumed to be insignificant.

h) Unit weight of concrete and brick are 25 KN/m3 and 18 KN /m3 respectively.

Table : Member Properties & Specifications for the Models Sizes of the member are as follows:

1	Plan Dimensions (X × Y)		30 m × 24 m
2	Floor to Floor Height (Z)		3 m
3	Total Height of Building (G+ 8)		27 m
4	Type of Structure		SMRF
5	Soil Type (as per IS: 1893 (Part-1) – 2002)		Medium
6	Response Reduction Factor		5
7	Importance Factor		1
8	Seismic Zone Factor		0.36 (Zone V)
9	Grade of Concrete & Steel		M 25 & Fe 415
10	Beam Size		0.30 m × 0.50 m
11	Column Size		0.30 m × 0.60 m
12	Slab Thickness		0.150 m
13	Wall Thickness		0.200 m
14	Staircase	Rise	0.120 m
		Thread	0.350 m
		Width	1.5 m
		Stringer	0.160 m
15	Load Combination		According to IS : 1893 (Part 1) :2002
16	Loads Applied	Dead Load	Calculated as per Self Weight
		Floor Finish	1 KN/m²
		Live Load	3 KN/m²
		Seismic Load	Calculated as per IS: 1893 (Part-1) – 2002

2.3 Steps involved in design of fixed base building are as follows:

STEP 1: Lumped mass calculation of various floor levels

At roof level: (M_9)

Weight of structure at roof level (W_9) = weight of slab + weight of beam + weight of column + weight of wall

+ imposed load

= 2700 + 1417.5 + 330.75 + 2041.2 + 0 = 6489.45 KN

Mass of structure at floor level (M_9) = $\frac{W_9}{9.81}$ = 661.5 tone

For other stories: ($M_1 = M_2 = M_3 = M_4 = M_5 = M_6 = M_7 = M_8$)

Weight of slab = 25×0.15×24×30 = 2700 KN

Weight of beam = 25×0.3×0.5[30×7+24×7] = 1417.5 KN

Weight of column = 49(25×0.3×0.6× 3) = 661.5 KN

Weight of wall = 18 ×0.2(30×7+24×7) × 3 = 4082.4 KN

Weight of floor finish = 1×24×30 = 720 KN

Live load = 3×30×24×3×0.25 = 540 KN

Weight of structure for other stories (W_1) = weight of slab + weight of beam + weight of column + weight of wall

+ Live load + floor finish

= 2700 + 1417.5 + 661.5 + 4082.4 + 540 + 720 = 10121.4 KN

Mass of structure for other stories (M_1) = $\frac{W_1}{9.81}$ = 1031.74 tone

Note: The earthquake forces shall be calculated for the full dead load plus the percentage of imposed load as given in Table 8 of IS 1893 (Part 1): 2002. The imposed load on Roof is assumed to be zero. 25 % of imposed load, if imposed load is upto 3 KN/m².

Seismic Weight of the building = 8 × 10121.4 + 6489.45 = 87460.65 KN

Mass of the building = 8915.45 tone

STEP 2: Determination of fundamental natural period

$$T_a = 0.09 \times \frac{h}{\sqrt{d}}$$

Where, h = height of building in meter and

d =base dimension of the building at the plinth/ground level in meter along the

considered direction of the lateral force.

$T_{ax} = 0.09 \times \frac{27}{\sqrt{30}}$ = 0.44 second, $T_{ay} = 0.09 \times \frac{27}{\sqrt{24}}$ = 0.49 second

STEP 3: Determination of Design Base Shear

Design seismic base shear, $V_B = A_h \times W$

$$A_h = \frac{Z}{2}\frac{I}{R}\frac{S_a}{g} = \frac{0.36}{2} \times \frac{1}{5} \times 2.5 = 0.09$$

$\frac{S_a}{g}$ = 2.5, according to IS 1893 (Part I): 2002

$V_B = 0.09 \times 87460.65 = 7871.45$ KN

STEP 4: Vertical Distribution of Base Shear

The design base shear (V_B) computed shall be distributed along the height of the building as per the expression,

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$$

Where, Q_i = Design lateral forces at floor i,

W_i = Seismic weights of the floor i,

h_i = Height of the floor i, measured from base, and

n = Number of stories

Q_1 = 27.62 KN, Q_2 = 110.48 KN, Q_3 = 248.57 KN, Q_4 = 441.90 KN, Q_5 = 690.48 KN, Q_6 = 994.29 KN,Q_7 = 1353.34 KN, Q_8 = 1767.62 KN, Q_9 = 2237.15 KN

STEP 5: Total Lateral Stiffness of each story

$k_1 = k_2 = k_3 = k_4 = k_5 = k_6 = k_7 = k_8 = k_9 = 49 \times (\frac{12\ E}{L^3})\ I = k$

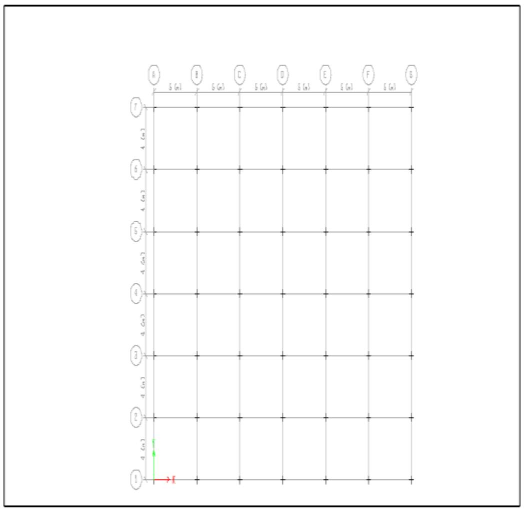
$E = 5000\sqrt{f_{ck}} = 5000\sqrt{25} = 25000$ N/ mm²,

$I = \frac{0.3 \times 0.6^3}{12} = 0.0054$ m⁴, L = 3 m

$k = 2.94 \times 10^6$ KN/m.

3. MODELLING IN ETABS

Fig: Plan view of G+ 8 Residential building model



3.1 Description of Models :

Model = Time History Analysis of Fixed Base Building

3.1.1 Building Details :

a) Plan Dimension = 30 m $\times$ 24 m
b) Height of Building = 27 m (G+ 8)
c) Height of each Story = 3 m
d) Building Type = Residential

3.1.2 Material Properties :

a) Grade of concrete = M 25
b) Grade of steel = Fe 415 and Fe 250
c) Density of concrete = 25 KN/ m³
d) Density of brick infill wall = 18 KN/m³

3.1.3 Section Properties

a) Beam size = 300 mm $\times$ 500 mm
b) Column size = 300 mm $\times$ 600 mm
c) Slab Thickness = 150 mm
d) Wall Thickness = 200 mm

3.2 Load Consideration:

3.2.1 Gravity Load:

a) Dead Load = Beam, Column, Wall, Stair, Slab
b) Live Load = 3 KN/m²
c) Floor Finish = 1 KN/m²

3.2.2 Various terms used in Time History Analysis:

a) Seismic Zone = Zone 5
b) Soil Profile type = Medium
c) Response Reduction Factor = 5.0
d) Importance Factor = 1.0
e) Damping = 0.15
f) Zone factor = 0.36

4. CONCLUSIONS

Seismic non-linear time history analysis of a multistoried RC building earthquakes is carried out. From the present study the following conclusions can be drawn out.

- In Time History Analysis, The Base Shear of the Structure by manual method is more than the value given by Etabs The maximum lateral forces is 7871.45 KN & 7820.3408 KN respectively.
- Base Shear of Structure as per Etabs result is 99.35% manual method. This Reduction decreases the ground motion, which makes the structure more stable.

- In Time History Analysis, Time Period of the structure the value given by Etabs is more than manual method, which gives more time for the structure to react during earthquake.

- From this study, it has been found that displacement increases on higher floors, which make higher floor more critical as compare to lower story.

- Stiffness of the building is found to be more near the ground and its value decreases as the distance increases from ground. This make it more stable near the ground and result in less displacement in lower stories.

- From results it is observed that the storey shear is decreased as height of the building increased and reduced at top floor in all the building models subjected to seismic loads considered. The storey shear is maximum at the base.

- As time history is realistic method, used for seismic analysis, it provides a better check to the safety of structures analyzed and designed by method specified by IS code Results from various time histories can be efficiently presented and utilized for future building design problems. Standards can be established for same.

- For important structures time history analysis should be performed as it predicts the structural response more accurately in comparison with other methods.

- The results should be the same but as software calculations tends to require less effort once they are set up they usually calculate more load cases . where as an engineer that does his work by hand will try to work smarter and identify the key sections and load cases and so limit the amount of the work required.

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