Design & Analysis of Multi-storied Building under Static and Dynamic Loading Conditions

Mohammed Misaquddin Hussain[1], Mohammed Ehsaan Ullah Shareef [2], Mohammed Abdul Razaq[3], Touseeq Anwar Wasif [4]

[1, 2, 3] UG Student, Department of Civil Engineering
[4] Asst Professor of Civil Engineering
ISL Engineering College, Hyderabad, Telangana.

---***---

Abstract - - *With the rise in population, evolution & advancement in civilization, the demand for housing has been at maximum rate . Mainly in cities due to high speed industrialization, the demand is very high . Switching on to the construction of multi-storey buildings meets the demand as well as reduces the price of a single house. In the last few years , engineering has engaged in noteworthy development. The construction is designed for gravity loads only. An Engineer has to be expert in analysing , planning and designing such multi-storey buildings. The leading development of computers has given tools to the designer in the direction of carrying in their work with ease and precision*

Key Words: Advancement , Civilization , Advancement, Industrialisation, Gravity Loads , Development

1. INTRODUCTION

The procedure for analysis and design of any building depends on the type of building, its complexity, the number of storeys etc. Firstly, the architectural drawings of the building are studied, the structural systems are taken into consideration, sizes of structural members are decided and carried on to the knowledge of the architect . The procedure for structural design involves a few steps which depend on the type of building, its complexity and the time obtained for structural design. Most of the time , the work is required to start soon, so the steps in design have to be put together in such a way that the foundation drawings can be initiated within a specific period of time. Before starting the structural design, the details of data are required as follow : (i) A set of architectural drawings (ii) Soil Investigation report (SIR) of soil data (iii) Location of the place or type of building in order to determine loadings and (iv) Input for lifts, water tank position on top, specific roof features of loadings, etc .

2. TYPES

There are mainly two types of building systems (1) Load Bearing Masonry; (2) Framed Buildings .

2.1) Load Bearing Masonry Buildings - These include compact buildings like houses with small spans of beams, slabs overall constructed as load bearing brick walls with reinforced concrete slab beams. This system is fit for building up to four or lesser storeys. (As shown in fig. below). The crushing strength of the bricks shall be 100 kg/cm2 minimum for four storeys . For vertical loads , this system is preferable as it also serves to resist horizontal loads like wind & earthquake by box action. In addition to icing its action against earthquakes, it is mandatory to give RCC Bands in horizontal & vertical reinforcement in brick walls as per IS: 4326-1967 (Indian Standards Code of Practice for Earthquake Resistant

Construction of Buildings.). In some Buildings, 115mm thick Brick walls are prepared since these walls are incapable of supporting vertical loads, beams have to be handed along their lengths to support adjoining slab & the weight of 115mm thick brick wall of the upper storeyed. These beams are to rest on 230 mm thick brick walls or reinforced concrete columns if needed . The design of Load Bearing Masonry Buildings are done as per IS 1905-1980.

2.2) Framed Buildings - These include reinforced concrete framed buildings which give principal directions to resist vertical loads which are transmitted to the vertical framing system i.e., Columns and Foundations. This type of system is effective in resisting both vertical & horizontal loads. The brick walls are to be regarded as non-load bearing filler walls only. This system is preferred for multi-storied buildings which is also effective in resisting horizontal loads due to the earthquake. In this system the floor slabs, generally 100-150 mm thick with spans ranging from 3.0 m to 7.0 m. In certain earthquake prone areas, even single or double storeyed buildings are made framed structures for safety reasons.

3. STATIC ANALYSIS

Static analysis is really a simpler interpretation of dynamic analysis, for the reason that earthquake forces are dynamic in nature. Yet we can make this analysis in a lot of similar cases such as when the building is regular and not tall enough . Static and dynamic analysis are grouped into linear and nonlinear analysis. Static Analysis means that loads are applied so slowly that they can't be compared to the natural vibration frequency of the structure considering the loads are static. When the loads are static , the effect of inertia and damping is not taken into considered in the equation of motion , which is;

inertia force + damping force + spring (stiffness) force = time dependent external force

3.1) Methods : After grouping the analysis methods , the 4 major methods are as follow :

- Linear Static (i.e. Equivalent Lateral Force Method) - Least Complicated
- Linear Dynamic (i.e. Response Spectrum Method)
- Nonlinear Static (i.e. Push-Over Method)
- Nonlinear Dynamic (i.e. Time-History Method) - Most Complicated
- Note: The last one, Time History Method can also be linear.

3.1) (i) Linear analysis considers that no yield or any instability of structure happens and analyses everything for the non yielded . That in other words means an elastic and stable state. The lateral force then demands on the building which can be high, concluding no yielding passing so as when no yielding happens, it means you keep pushing and pushing with further force, like an elastic spring, and when you remove the load, you assume everything will go back to original (elastic).

3.1) (ii) Non Linear analysis considers yielding of materials, cracking and foundation rocking and structural instability issues, etc analysing the structure based on deformed shape too. Non linear analyses are more complicated than linear ones as the necessity to consider all nonlinear effects to construct the structural model is more time consuming and furthermore interpreting the results as well . Mainly, the non linear dynamic is the most complex one and mostly done at an academic level. If you do not clarify the results of nonlinear analysis precisely , it will do more harm than good .

Table - 1 : Building Description

Name	Size
Concrete Grade	M 40
Reinforcement Grade	FE 500
Beam	500 X 500 MM
Column	450 X 230 MM
Slab	150 MM
Soil type	II Medium
Zone	IV
Importance factor	1
Response reduction factor	5 SMRF
Plan Area	20 x 20 (m)

Table - 2 : Loading Data

Live load on roof	1.5 KN /M2
Super imposed load on roof	4 KN/M2
Live load on floor	3 KN/M2
Super imposed load on floor	4 KN/M2
Wall load on top floor	13 KN/M
Wall load on story	4 KN/M

Figure 1 - Plan View

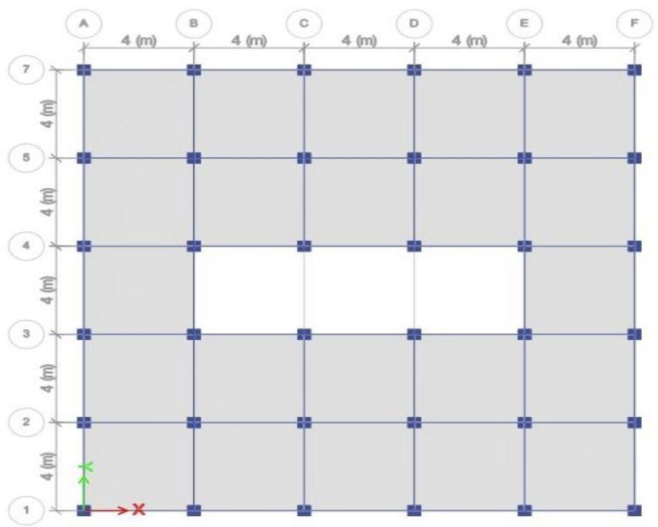


Figure 2 - 3D View

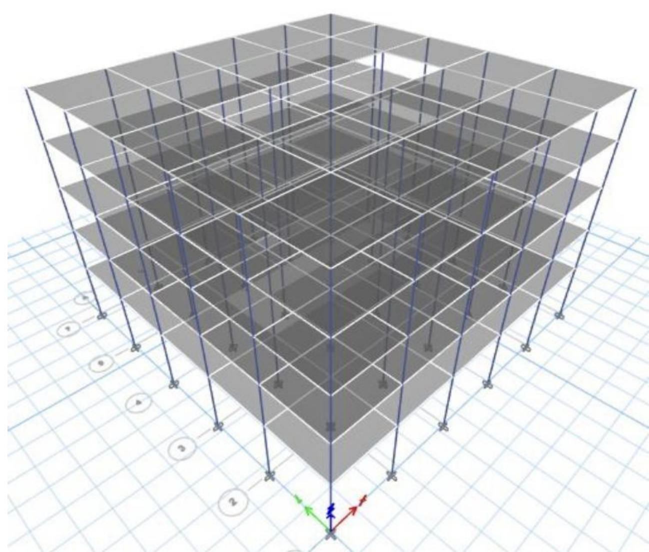
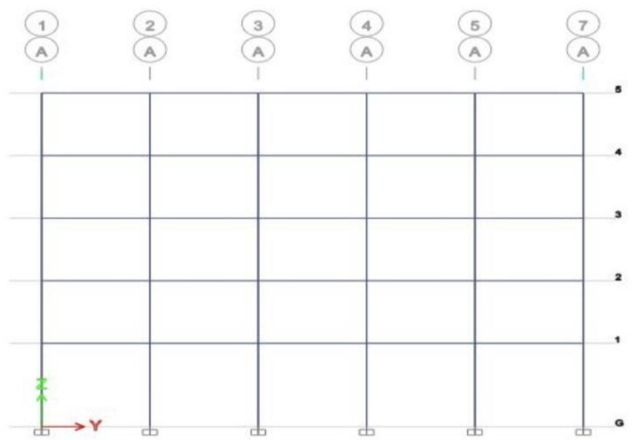


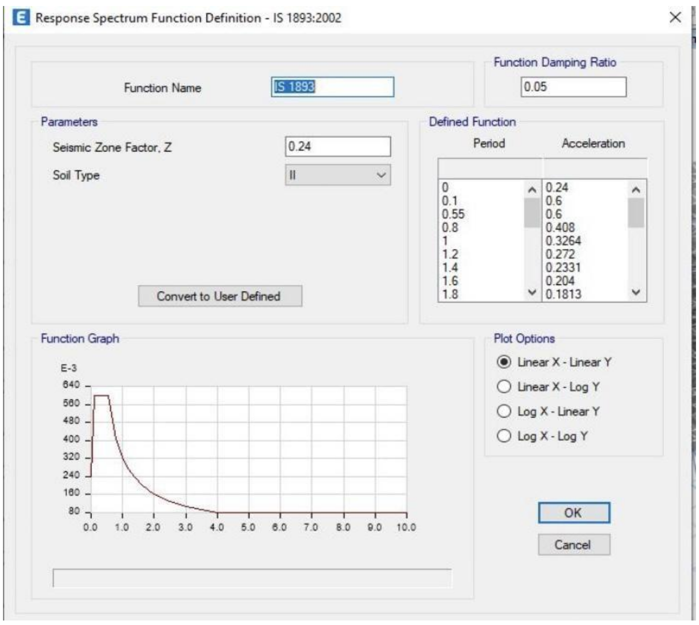
Figure 3 - Elevation View



4) Earthquake Zone Data

India has been divided into 4 seismic zones :zone II, zone III, zone IV, zone V. Earlier there were 5 zones. But after the bhuj earthquake in 2001, zone I was eliminated. Zone V: The areas which have the highest risk of an earthquake are categorised as Zone V. Rann of Kutch, Eastern regions etc. fall under zone V. Zone IV: Areas under zone IV have a lesser risk by an earthquake compared to Zone V. Some of the regions which fall under this zone are Northern regions, North Eastern regions, Delhi etc. Zone III: Areas under zone III have a lesser risk by an earthquake compared to Zone IV. Some parts of Gujarat & Maharashtra, Andaman Nicobar Islands etc. fall under this category. Zone II: Areas under Zone II have the least risk of an earthquake. A large part of India comes under this zone. **Present building is considered in zone IV .**

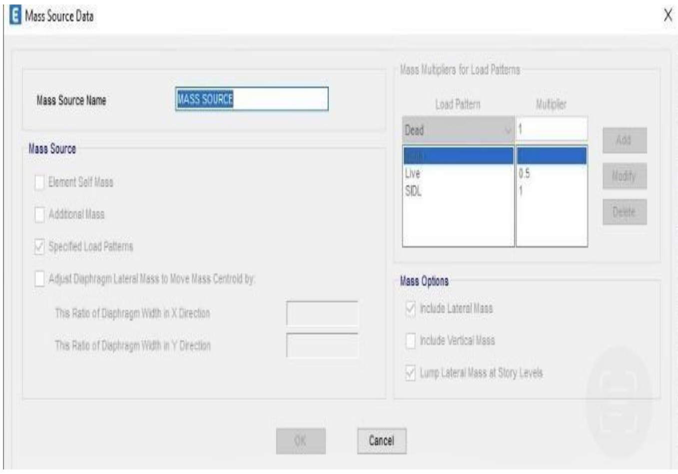
Figure 4 - Zone IV Data



5) Mass Source

Mass source is the mass of the structure i.e. self weight as well as additional mass due to surface loads line loads usually DL +LL. It's required to calculate base shear of the structure.

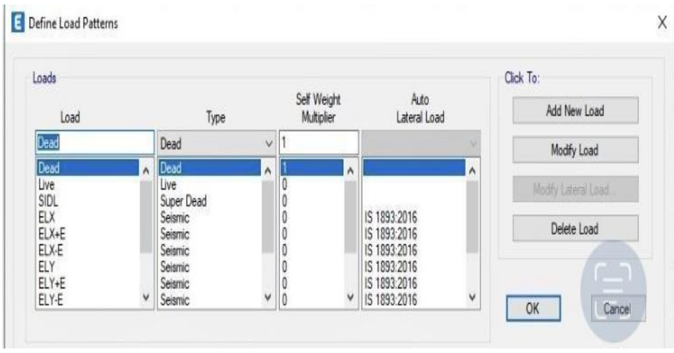
Figure 5 - Mass Source Data



6) i. Load Pattern

A load pattern is the spatial distribution of a specific set of forces, displacements, temperatures, and other effects which act on a structure. Any combination of joints and elements may be subjected to loading and kinematic conditions. Each load pattern is assigned a design type (DEAD, WIND, QUAKE, etc.) which classifies the load and initiates the associated computational process. Users may define an unlimited number of load patterns Load patterns are then applied through load cases to generate analysis results.

Figure 6 - Load Pattern

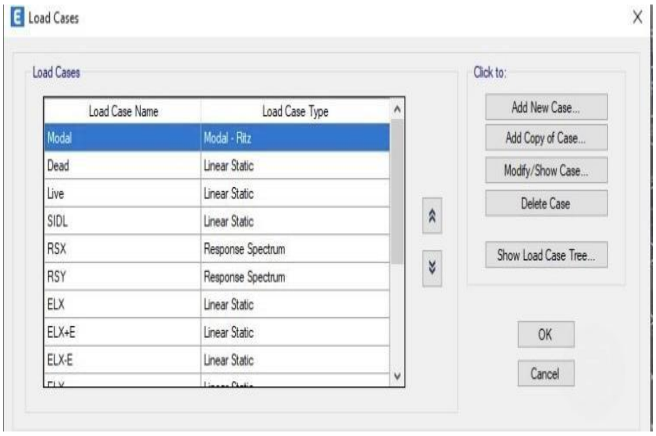


6) ii. Load Case

A load case defines how load patterns are applied (statically or dynamically), how the structure responds

(linearly Or nonlinearly), and how analysis is performed (through modal analysis, direct integration, etc.). For each analysis to be performed, a load case is defined

Figure 7 - Load Case



6) iii. Load combination considered according to IS 1893 2016

Figure 8 - Load Combination

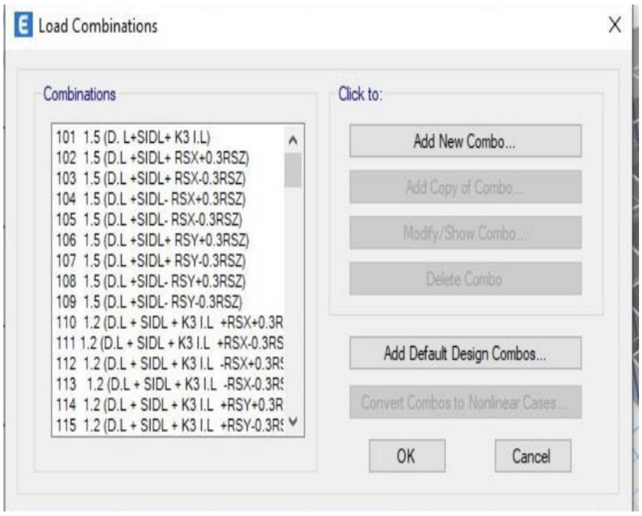
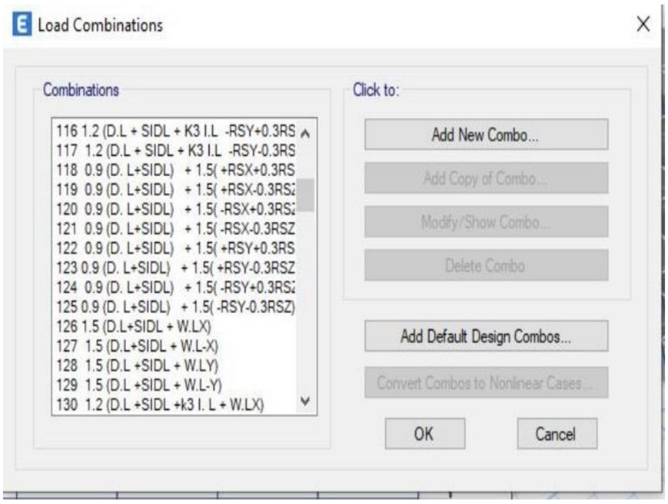


Figure 9 – Load Combination



7. Base Share

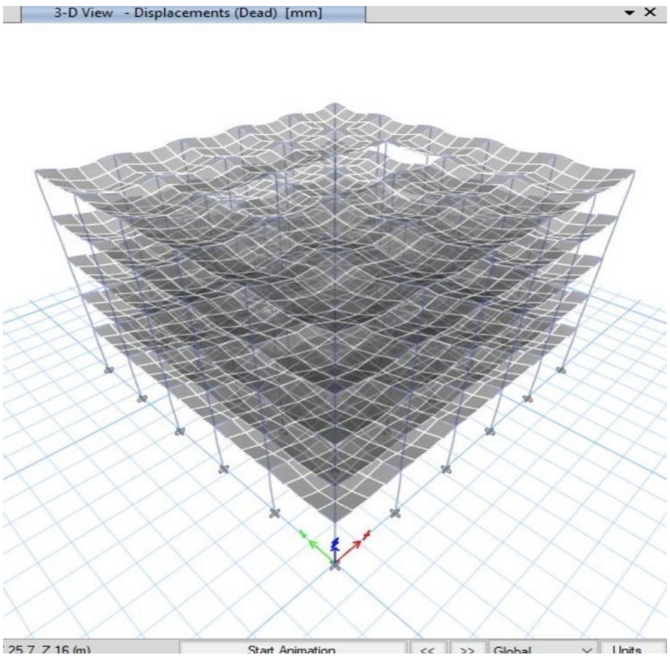
Whenever seismic activity (earthquake) occurs then the base of structure experiences a lateral force, whose maximum value is termed as base shear and its mathematical value is given as product of net vertical force at that base and a factor called horizontal seismic coefficient, whose value depend upon factors like seismic zone etc

Table Base Shear

	Modal Base Shear		Kn
RSX	LinRespSpec	MA X	1396.521
ELX	LinStatic		1371.439
RSY	LinRespSpec	MA X	1366.884
ELY	LinStatic		1429.583

8) Analysis and result:

Figure 10 - Deflected Shape After Analysis



9. CONCLUSIONS

The maximum displacements of building in different stories in both X and Y direction for all methods of analysis have been compared and shown in figures. Also, the maximum displacement of center of mass is considered to indicate the difference between all methods; the results obtained have been shown in figures. From the diagrams below, it is observed that, in first five stories, the difference between the results obtained with different methods is insignificant. It is observed that, the maximum displacement is increasing from first storey to last one.

However, the maximum displacement of center of mass, obtained by time history analysis for both earthquakes.

10. REFERENCES

[1] IS 456:2000, "Plain and Reinforced concrete" – Code of practice.

[2] P.C.Varghese, "Limit state design of reinforced concrete"

[3] N.Krishnaraju.," Reinforced concrete design"

[4] Non –linear static analysis of multi storeyed building, Srinivasau.A , Dr.Panduranga Rao.B.

[5] Non –linear seismic response of EC-8 designed RC building structures Dolce.M & Ponzo.F.c.

[6] Static & dynamic analysis of multi sotrey building using composite structures Mahesh suresh kumawat & kalurkar.L.G.

11. BIOGRAPHIES:

Mohammed Misaq Uddin Hussain (UG STUDENT, DEPARTMENT OF CIVIL ENGINEERING, ISL ENGINEERING COLLEGE, HYDERABAD, TELANGANA.)

Mohammed Ehsaan Ullah Shareef
(UG STUDENT, DEPARTMENT OF CIVIL ENGINEERING, ISL ENGINEERING COLLEGE, HYDERABAD, TELANGANA.)

Mohammed Abdul Razzaq
(UG STUDENT,DEPARTMENT OF CIVIL ENGINEERING, ISL ENGINEERING COLLEGE, HYDERABAD, TELANGANA.)

Touseeq Anwar Wasif (Assistant Professor, DEPARTMENT OF CIVIL ENGINEERING,
ISL ENGINEERING COLLEGE, HYDERABAD, TELANGANA.)