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Design and Analysis of G+5 Residential Building and Reduction of Time Period Using ETABS and SAFE

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ABSTRACT

Current earthquake engineering procedures only apply a single earthquake to a building structure during modelling and analysis. However, in a true earthquake, tremors always occur again (or three times) after the first tremor. This phenomena can have an impact on the structural system's stiffness and strength. Any rehabilitation effort is impracticable due to a lack of time. As a result of the frequent shocks, the building may sustain more damage. This project provides a brief overview of the nonlinear behavior of a conventional reinforced concrete building under single and recurrent seismic stimulation.

The incremental dynamic analysis curve was used to depict the non-linear behavior of the structure in terms of inter-storey drift ratio. The analytical results show that the recurrent earthquake occurrence necessitates a bigger inter-storey drift demand than a single earthquake. This is an earthquake's nature, and it is known as the repeated earthquake phenomena in technical terms. As a result, during an earthquake event, the earthquake load may strike the structure more than once. The current project aims to lower the time period of the residential G+5 building, which in turn reduces the modal value, allowing the building's sudden collapse to be avoided. Non-linear analysis should be performed using dynamic load situations that incorporate both wind and seismic loads.

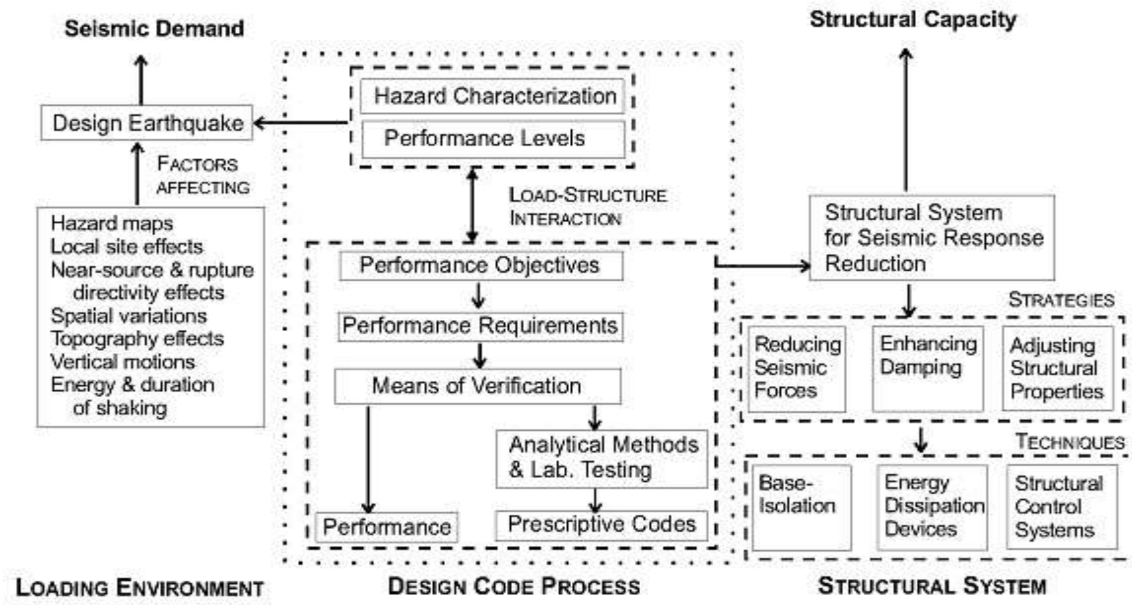
KEY WORDS: ETABS, LOADS, ANALYSIS, DESIGN, COLUMN REDUCTION

1. INTRODUCTION

Earthquakes occur as a result of fault movement caused by geologic and tectonic processes. They frequently occur without warning and are hence unexpected. Earthquakes are the most destructive natural disasters because their affects can cover broad areas, resulting in massive deaths, injuries, and destruction. The magnitude, location, and time of occurrence of an earthquake all influence its magnitude. A considerable portion of India is vulnerable to a wide range of potential maximum seismic intensities, with shallow earthquakes of magnitude 5.0 or greater on the Richter scale known to have happened in the past or documented in the recent century or so. The India Meteorological Department (IMD) has compiled a list of approximately 1200 known earthquakes. According to this catalogue, there are 8 M 8.00 earthquakes, 43 M 7.0 -7.9 earthquakes, 312 M 6.0 -6.9 earthquakes, and the rest are M 5.00 - 5.9 earthquakes. Table 1 lists earthquakes of various magnitudes that have killed thousands of people in India. The strongest earthquake in India, with a magnitude of 8.7, happened in 1897 on the Shillong Plateau. This and the 1950 M 8.6 earthquake in Sadiya region were so powerful that rivers changed course, ground heights were permanently altered, and stones were flung upward with an acceleration reaching 1 g.

1.2 PREPARATION OF SEISMIC TECTONIC ATLAS OF INDIA

The GSI has included the creation of an Indian seism tectonic atlas in its agenda, which will consist of 43 sheets of maps covering 3° longitude 4° latitude on each sheet to a scale of 1:1 m. The maps will be derived, including earthquake data, gravity data, magnetic data, stress field data, geological faults, main and minor lineaments, and geodetic data included. Seismic tectonic maps created in this manner could be utilized for seismic hazard risk assessment and the creation of a valid seismic zoning map for India.



1.3 SCOPE OF THE PRESENT INVESTIGATION:

The most common causes of construction-related accidents are carelessness, technical flaws, inadequate tool use, incorrect worker behavior, alcohol misuse, and, most importantly, a lack of understanding about potential sources of accidents. A construction site is a gathering area for individuals to come together to work, primarily to generate money to support their families. No economic consideration justifies an accident in a place where people join together to make a life. What a terrible tragedy for a family if no more income is available due to a preventable workplace accident. Knowing the causes of probable and predictable accidents allows us to avoid them. A construction supervisor's responsibility is to be aware of potential sources of accidents and to prevent them as far as possible.

2. REVIEW OF LITERATURE:

Hussain Imran K.M and Sowjanya G.V (2014):

The influence of seismic and wind stresses on the stability of rigid steel frames with and without bracing systems was investigated. For this experiment, they took five models, one without bracing and four with different bracing systems, and used ETABS to analyze the behavior of buildings with and without bracing systems subjected to seismic and wind loads. The model is subjected to equivalent static analysis in accordance with IS 1893:2002. Wind stresses on structural systems are studied and compared in accordance with IS 875 (part 3): 1987. Finally, they concluded that for significantly damaged seismic zones and varied wind speeds, an X-type construction is required. Bracings are a highly effective bracing method.

Dr. Okay. R. C. Reddy, Sandip A. Tupat Et., AI. (2014):

According to his research, the wind hundreds and seismic masses for a twelve-story RC-framed structure are estimated. The following conclusions are drawn based on the results obtained. The number of earthquakes and windstorms increases with the height of the constitution. Wind loads are more valuable than earthquake loads for tall structures. Constructions must be planned for the loads determined in each recommendation independently for significant wind or earthquake forces.

3. MODELLING OF A STRUCTURE

3.1 CREATION OF CENTRELINE IN AUTO CADD

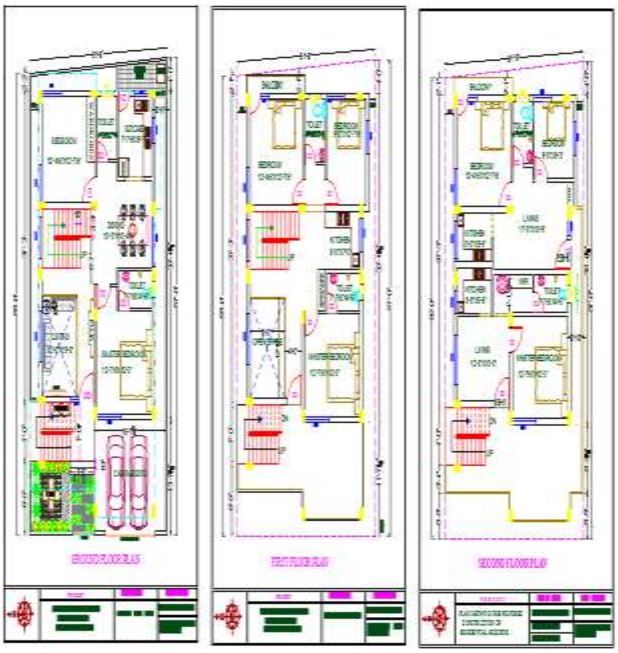


Fig 3.1 Architectural Ground Floor Plan

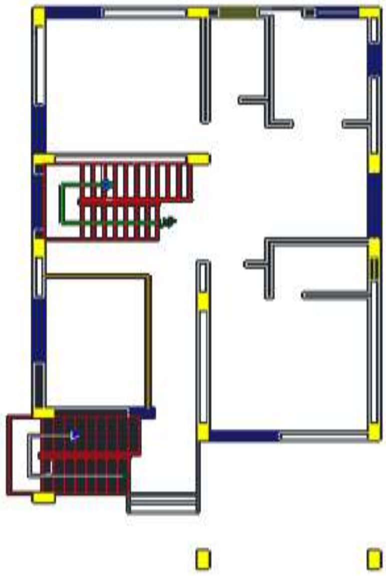


Fig 3.2 Column, Staircase and Wall Layout Plan

Above plan is created by erasing the objects except column, stair- case, Walls (Including internal and external) windows, and ventilators. Utilising auto cad commands such as Select erase.

3.2 EXPORT FROM AUTO CADD

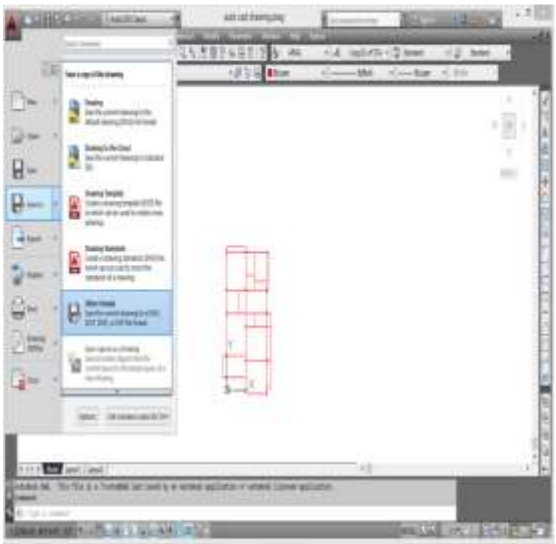
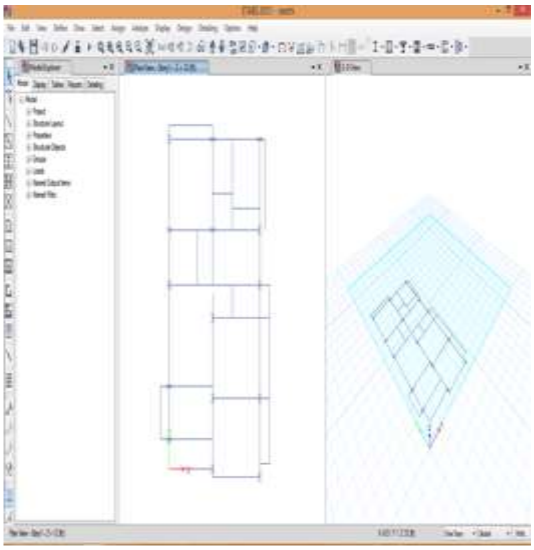


Fig 3.3 Auto CADD Interface



3.4 Centreline in Etabs

3.3 DEFINE MATERIAL PROPERITIES

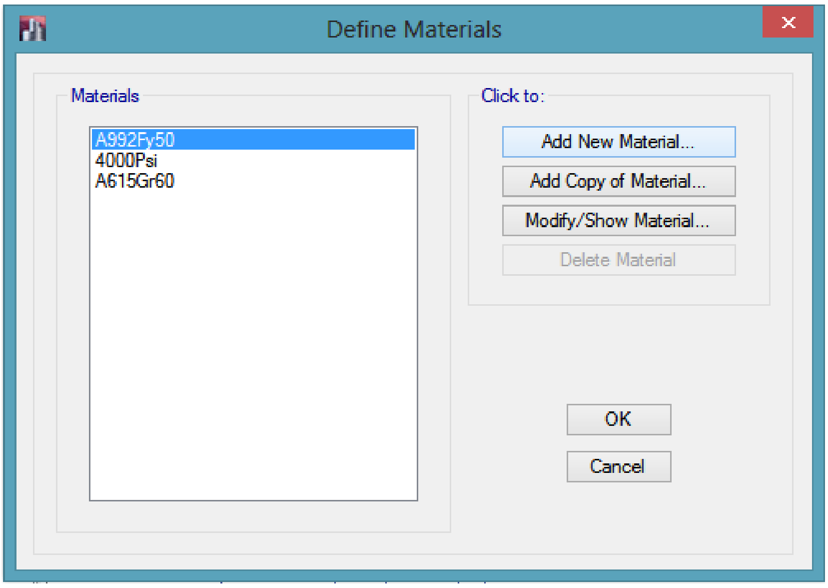


Fig 3.5 Defining Material Properities

- ➢ A992Fy50, 4000psi, A615Gr60 are default materials in the software.
- ➢ Add copy of material… is used; define already existing material with another name.
- ➢ Modify /show material….is used; change the existing material properties.
- ➢ Hit add new material property icon, change all properties as shown below.

Edit replicate story select all story in the replication hit apply and then ok.

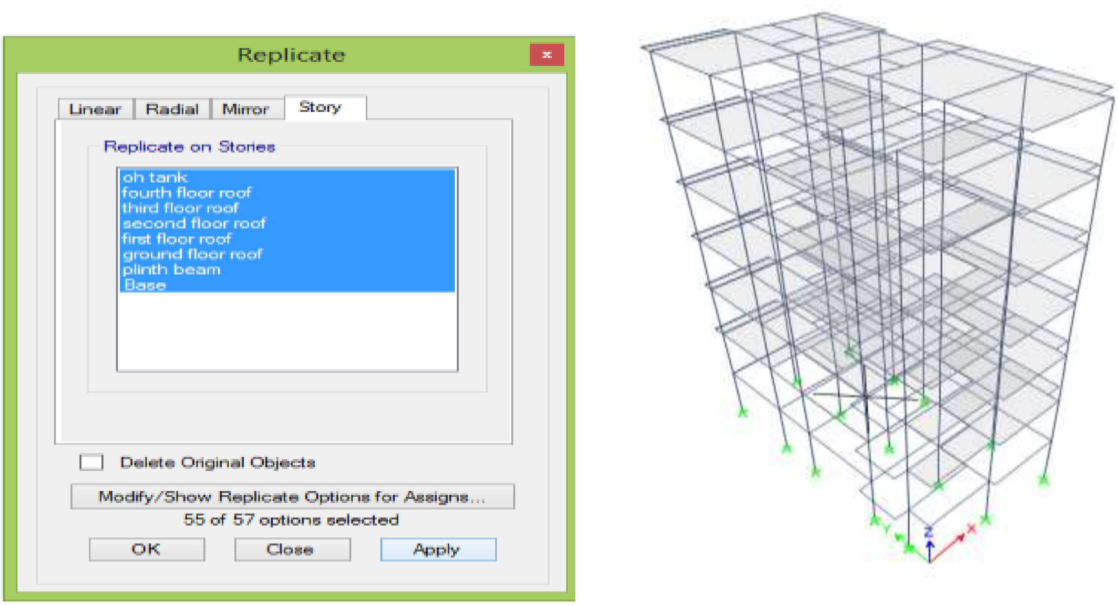


Fig 3.6 Replication of Story Data

3.4 ASSIGN LOADS TO FRAME AND SLAB ELEMENTS

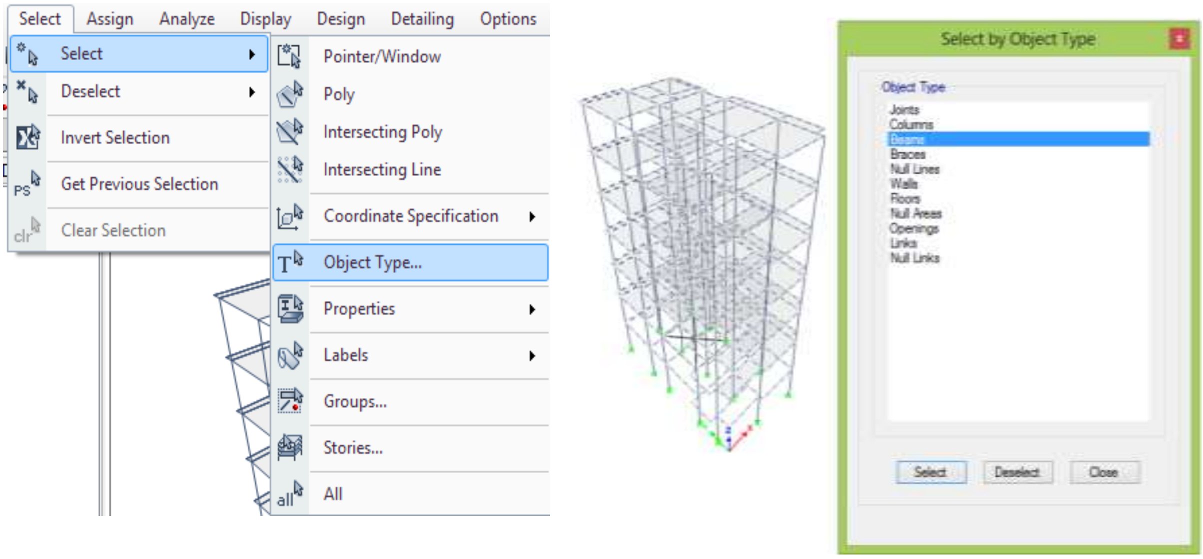


Fig 3.7 Beam Selection

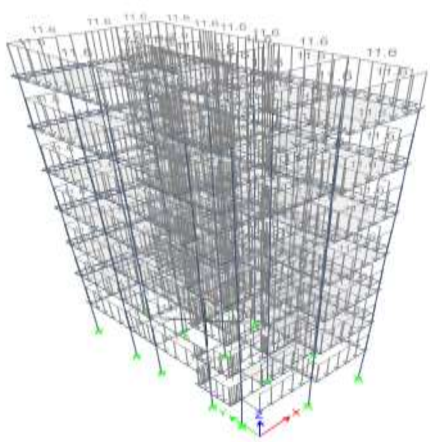


Fig 3.8 Assigning of Wall Loads

4. ADVANCED ANALYSIS AND DESIGN

4.1 DEFINING EARTHQUAKE LOAD PATTERN

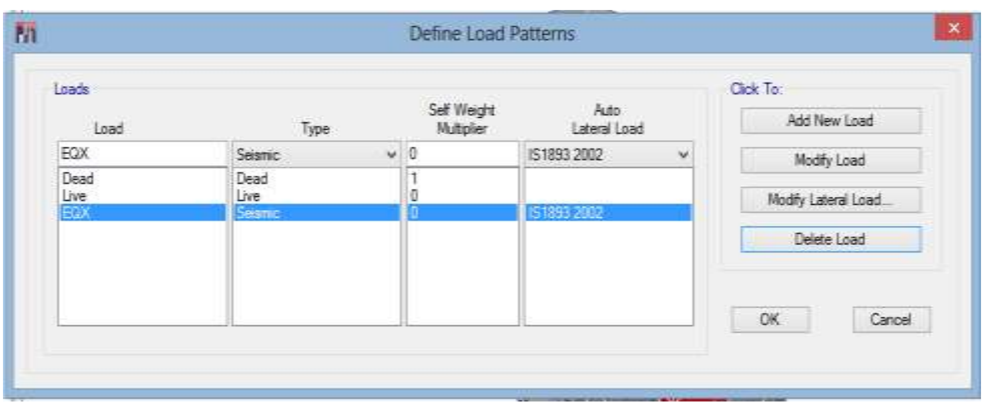


Fig 4.1 Defining Load Patterns

Fig 4.2 Seismic Load Patterns

4.3 STORY RESPONSE PLOTS

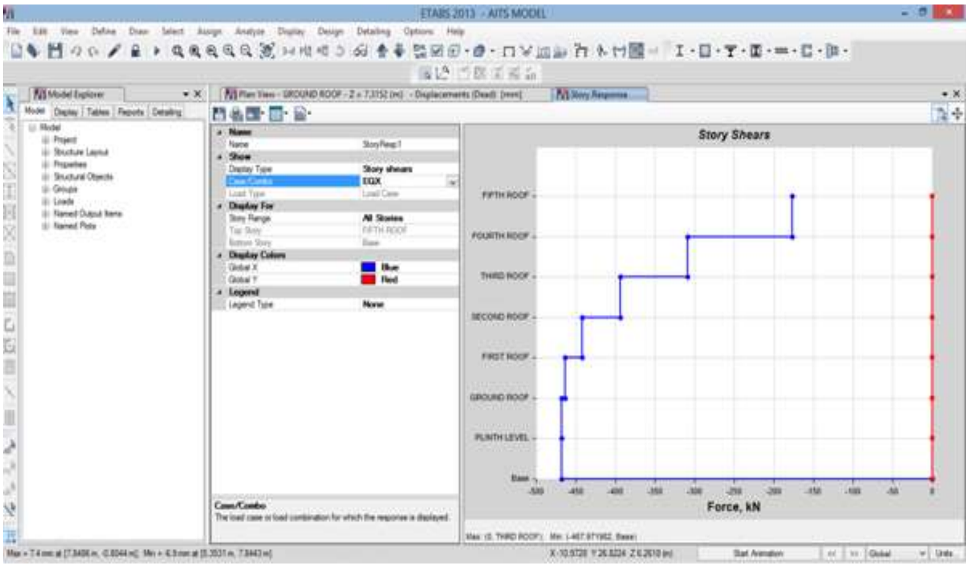


Fig 4.3 Story Response Plot

4.4 CONCRETE FRAME DESIGN AND CHECK

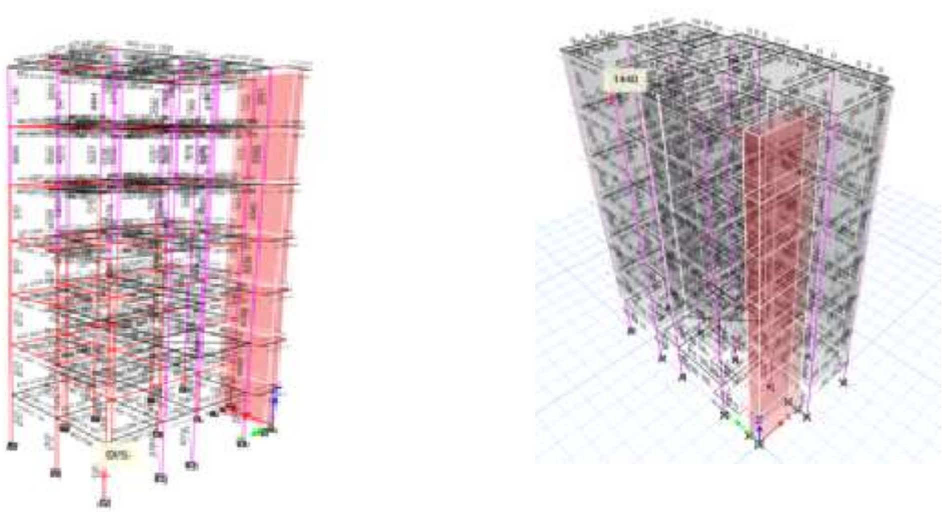


Fig 4.4 Concrete Design Results

4.7 Column Reinforcement details

4.1. Reinforcement details of columns in ETABS

Story	Column Line	Section ID	PMMCombo	Ast	b	d	Reinforcement %
1	C1	C300X1500	UDWPY	8654	450	1500	3.8
1	C2	C300X1500	UDL	16967	450	1500	4.5
1	C3	C300X1500	UDL	17607	450	1500	4.6
1	C4	C300X1500	UDSPEC	7022	450	1500	2.5
1	C5	C300X1500	UDL	19422	450	1500	5.9
1	C6	C300X1500	UDWNY	7981	450	1500	3.5
1	C7	C300X1500	URDSPEC	4500	450	1500	0.5
1	C8	C300X1500	UDL	22415	450	1500	6.2
1	C9	C300X1500	UDL	16260	450	1500	4.4
1	C10	C300X1500	URDSPEC	4500	450	1500	0.7
1	C11	C300X1500	URDSPEC	4500	450	1500	0.6
1	C12	C300X1500	URDSPEC	4500	450	1500	0.6
1	C13	C300X1500	URDSPEC	4500	450	1500	0.6
1	C14	C300X1500	UDWNX	14373	450	1500	3.7
1	C15	C300X1500	UDL	23230	450	1500	6.5
1	C16	C300X1500	URDSPEC	4500	450	1500	0.6
1	C17	C300X1500	UDWPY	10119	450	1500	4.2
1	C18	C300X1500	UDSPEC	20810	450	1500	6.2
1	C19	C300X1500	UDSPEC	11159	450	1500	2.2
1	C20	C300X1500	UDWNY	10293	450	1500	4.1
1	C21	C300X1500	UDL	19707	450	1500	6.0
1	C22	C300X1500	UDL	26812	450	1500	6.7
1	C23	C300X1500	UDSPEC	17362	450	1500	6.4
1	C24	C300X1500	UDL	20509	450	1500	6.3
1	C25	C300X1500	UDL	16435	450	1500	5.4

The column percentage reinforcement data in the above table range from more than 6% to less than 0.8%.According to the IS code, these are not acceptable for design, thus we must minimize the reinforcement and verify in SAFE.

5. COLUMN REDUCTION DESIGN

Table 5.1 Column Reduction

Story	Column Line	Section ID	PMMCombo	Ast	b	d	Reinforcement %
1	C1	C300X1500	UDWPY	7646	450	1500	1.7
1	C2	C300X1500	UDL	16567	450	1500	3.7
1	C3	C300X1500	UDL	16667	450	1500	3.7
1	C4	C300X1500	UDSPEC	6032	450	1500	1.3
1	C5	C300X1500	UDL	17422	450	1500	3.9
1	C6	C300X1500	UDWNY	6881	450	1500	1.5
1	C7	C300X1500	URDSPEC	3600	450	1500	0.8
1	C8	C300X1500	UDL	21615	450	1500	4.8
1	C9	C300X1500	UDL	15160	450	1500	3.4
1	C10	C300X1500	URDSPEC	3600	450	1500	0.8
1	C11	C300X1500	URDSPEC	3600	450	1500	0.8
1	C12	C300X1500	URDSPEC	3600	450	1500	0.8
1	C13	C300X1500	URDSPEC	3600	450	1500	0.8
1	C14	C300X1500	UDWNX	12273	450	1500	2.7
1	C15	C300X1500	UDL	22230	450	1500	4.9

1	C16	C300X1500	URDSPEC	3600	450	1500	0.8
1	C17	C300X1500	UDWPY	9719	450	1500	2.2
1	C18	C300X1500	UDSPEC	18810	450	1500	4.2
1	C19	C300X1500	UDSPEC	10059	450	1500	2.2
1	C20	C300X1500	UDWNY	9293	450	1500	2.1
1	C21	C300X1500	UDL	17807	450	1500	4.0
1	C22	C300X1500	UDL	25722	450	1500	5.7
1	C23	C300X1500	UDSPEC	15362	450	1500	3.4
1	C24	C300X1500	UDL	19409	450	1500	4.3
1	C25	C300X1500	UDL	15335	450	1500	3.4

The cross-sectional area of the longitudinal reinforcement in columns shall neither be less than 0.8% nor greater than 6% of the gross cross-sectional area of the column, according to IS: 456-2000. According to the preceding table, the percentage of reinforcement varies between 0.8 and 6% depending on the loading conditions. As a result, as compared to ETABS, we can reduce column reinforcement by adopting SAFE.

5.2 Column reinforcement details

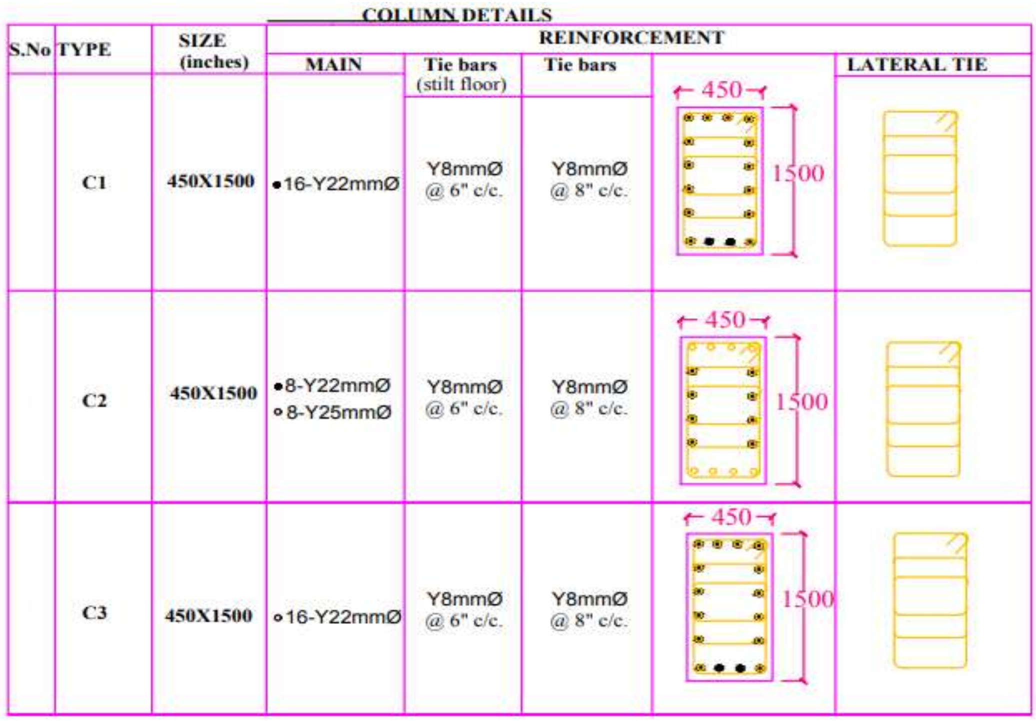


Fig.5.1 Reinforcement Details drawings

6. CONCLUSIONS

1) The structure is a design based on the E-Tabs, which provides adequate serviceability, strength and also the work is economical.

2) With the usage of ETABS software working time is saved and it also helps us in the designing of structure accurately.

3) While designing a members observed that in etabs gives comparatively higher area of steel whereas safe gives lesser areas. I have made the model in etabs and directly exported the story in safe to design the members.

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