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Analysis and design of multistory (G+10) building using Tekla structural designer

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**Abstract -*The most difficult duty for any structural engineer in today's world is to build earthquake-resistant constructions. Because its mass and rigidity are evenly distributed across its height, a regular building operates consistently. Many reinforced concrete buildings in metropolitan centers in active seismic zones may sustain moderate to severe damage during ground vibrations. The study and modelling for the entire structure in India's seismic zone 4 is done using a popular FEM integrated programme named TEKLA STRUCTURAL DESIGENER, as prescribed by IS 1893 (Part-1) 2016 and for concrete design we prefer IS 456:2000. In this project, a response spectrum analysis is performed on a regular structure in plan in zone 4 as required, and it is concluded that the construction is of type II (Medium soil).Here we perform analysis on software and discuss about the different parameters of Tekla structural Designer we use in our study*

***Key Words*: Multi-storey, Tekla structural designer, Sesmic Analysis, IS code 1893:2017

1. INTRODUCTION

Structural are designed to withstand earthquakes, wind loads, and to keep the structure stable. Damage to the structure can result in the death of people, and high-rise structures must be checked for strength. Stiffness and resists the displacement of the building by correct designs and the ductility of the building and can design the proper gravity loads and depend on the design of the building, the article deals with the analysis and design is done by using the software package called TSD.

TEKLA Structural designer is a 3D structural design program. As a result, adjustments are made in accordance with the provisions of the code and the findings of the analysis. Steel reinforcing is always in higher demand when standing. TSD's credibility was also established by manual computations. Once the materials have been accurately defined in TSD, the relevant steps in the modeling process will be detailed below.

2. Literature Review

1. **Hong Fana, Q.S. Li, et.al (2008)**

In this paper they do a seismic analysis on the one of the tallest building in world Taipei 101. The great height of the building, the special geographic and environmental conditions, not surprisingly, presented one of the greatest challenges for structural engineers. A detailed study on the dynamic characteristics and seismic responses of Taipei 101, was presented in this paper. The seismic analysis results of the super-tall building indicated that the structural system, with belt trusses at every eighth or tenth story, provides equal stiffness along the height of the building, which can decrease the lateral deformation efficiently. Meanwhile, for such a mega-frame structural system with a central braced core connected to perimeter columns on each building face, the total dead and live loads at every floor are transferred to the sloping exterior columns.

2. **Khushbu Jania, Paresh V. Patel (2013)**

In this paper they were studied about Design and analysis of Diagrid Structural System for High Rise Steel Buildings. They analyze 36 storey diagrid steel building is presented. With a regular floor plan of 36 m × 36 m size is considered. ETABS software is used for modeling and analysis of structural members. All structural members are designed as per IS 800:2007 considering all load combinations.

From the study it is observed that most of the lateral load is resisted by diagrid columns on the periphery, while gravity load is resisted by both the internal columns and peripheral diagonal columns. So, internal columns need to be designed for vertical load only. Due to increase in lever arm of peripheral diagonal columns, diagrid structural system is more effective in lateral load resistance

3. P. Nagasri Anjaneyulu, Dr. Dumpa Venkateswarlu (2021)

In this paper they studied about Analysis and Design of Reinforced Concrete Multi-Stored Building (G+5) by using Tekla Software. The design of column, beam, footing and slabs are done in limit state method which is safe at control of deflection and in all aspects using Tekla software, the design considerations has been taken as per IS Codes. Tekla has the capability to calculate the reinforcement needed for any concrete section. The program contains a number of parameters which are designed asper IS456:2000. Beams are designed for flexure, shear & torsion. From the Tekla result required different types size and number of bars are found. And final evaluation and valuation is confirmed by estimation and costing software.

Objective

To complete the structure's study and design without any failures.
1. To comprehend the fundamental principles of buildings through the use of I.S. Codes
2. To comprehend the design parameters for beams, columns, slabs, and other structural elements.
3. Create a 3D model of the structure for further analysis and design using TSD Software.
4. Learn about the Tekla Structural designer

Loads and Combination

As per the limit state design of reinforced concrete structures and pre-stressed concrete structures, the following load combination has been taken.

Parameters

Member		Dimensions	Grade
Slab		125mm	M25
Column		400*350	M30
Beam	B1	400*350	M30
	B2	350*350	M30
Foundation			M25

Load Calculation

S.no.	Type of load	Calculation
1	Dead Load	1Kn
2	Imposed Load/Live load	1.5Kn
3	Wall Load 230mm (outer)	13.6Kn
4	Wall load (115 mm) Inner wall	6.8Kn
5	Seismic Load	As per IS 1893:20016

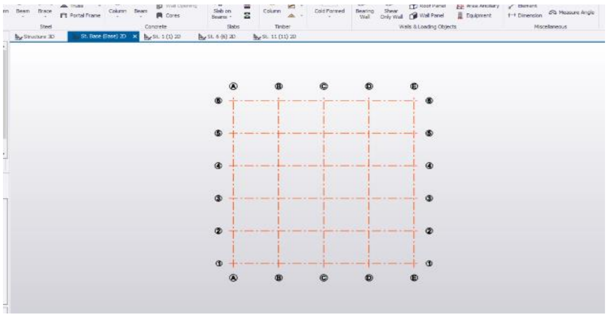
Methodology / Procedure:

Step - 1: Initial setup of Standard Codes and Country codes

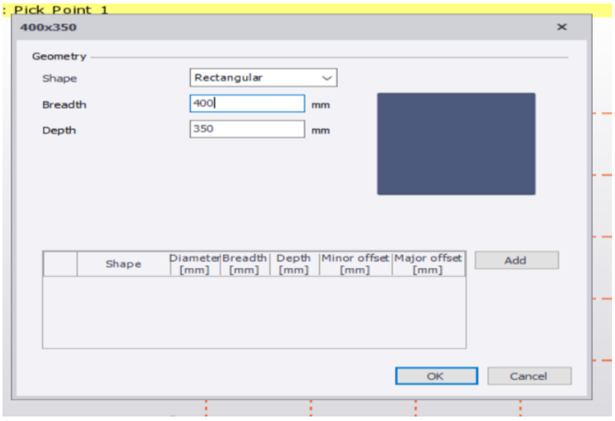
	Dir1	Dir2	
Response Modification Factor, R	3.000	3.000	IS1893 (Part 1): 2016 Table 9
Approximate fundamental period, T_a [sec]	1.061	1.061	IS1893 (Part 1): 2016 Cl. 7.6.2
Structure fundamental period, T [sec]	2.466	2.550	
Average response spectrum coefficient, S_a/g	0.552	0.533	IS1893 (Part 1): 2016 Cl. 6.4.2
Design horizontal seismic coefficient, A_h	0.033	0.032	IS1893 (Part 1): 2016 Cl. 6.4.2
Base Shear (using T_a), $\bar{V}_b$ [kN]	3544.26	3544.26	IS1893 (Part 1): 2016 Cl. 7.6.1
Base Shear (using T), V_B [kN]	1524.70	1474.12	
Modal Base Shear (from RSA), V_t [kN]	-	-	
Scaling Factor for Forces	1.000	1.000	IS1893 (Part 1): 2016 Cl. 7.7.3
Scaling Factor for Drifts	1.000	1.000	IS1893 (Part 1): 2016 Cl. 7.11.1.2
Structure Plan Irregularities - User Defined			IS1893 (Part 1): 2016 Table 5

Step - 2: Creation of Grid points & Generation of structure

After getting opened with TSD we select a new model and a window appears where we had entered the grid dimensions and story dimensions of our building.

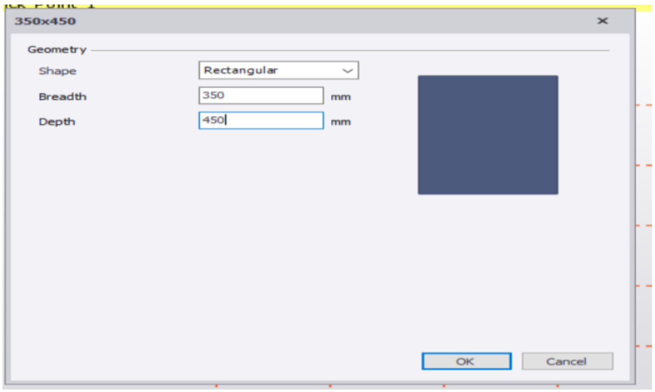


Step - 3: Assigning and defining columns property



Here first we had to assign size of Coolum and property of concrete M30 with Bars using 500HYSD

Step - 4: Assigning and defining Property of beams



After assign the and define Column we draw the beam for two different set.

a. For up to 5th floor we use 350*450 beam
b. From 6th to last floor we use 350*350 beams
And then use HYSD500 steel M30 Concrete

Step - 5: Assigning and defining the properties of slab

We use 125mm slab on each floor

Step -6: Assigning different types of loads

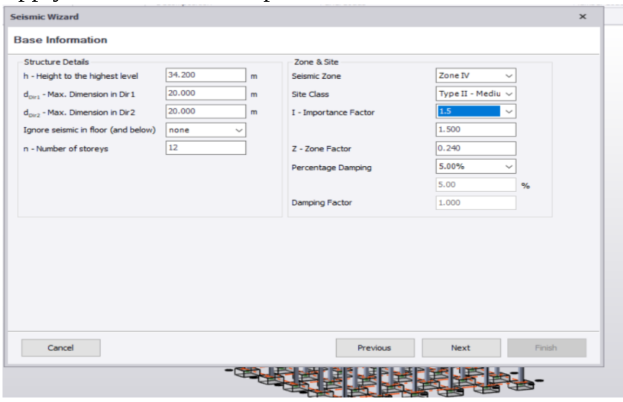
a. Assign dead load

For dead load we apply 13.6kn Full UDL on outer Wall (bricks of 230mm used) And for inner wall we apply 6.8Kn (for 115mm bricks)

For boundary of roof we use 5Kn dead loads

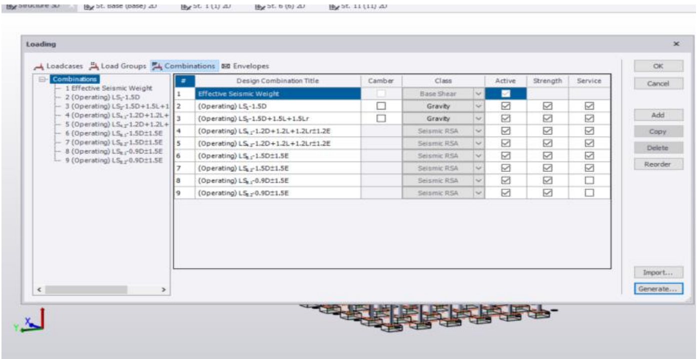
b. Assign Imposed load on slabs of 1.5kn on each floor and 1kn on roof top.

c. Apply Seismic loads As per IS code 1893:2016



Step -7: Load combinations

After assigning Seismic load we generate different load combination according to Limit state methods



Combinations

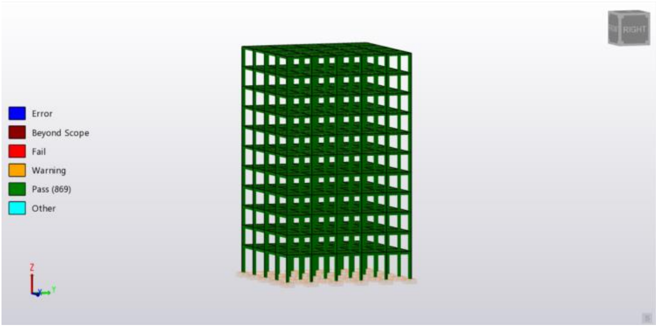
Name	Class	Active	Strength	Service
1 Effective Seismic Weight	Modal Mass	•	•	
2 (Operating) LS_1-1.5D	Gravity	•	•	•
3 (Operating) LS_2-1.5D+1.5L+1.5Lr	Gravity	•	•	•
4 (Operating) $LS_{4,1}$-1.2D+1.2L+1.2Lr ±1.2E	Seismic RSA	•	•	•
5 (Operating) $LS_{4,2}$-1.2D+1.2L+1.2Lr ±1.2E	Seismic RSA	•	•	•
6 (Operating) $LS_{6,1}$-1.5D±1.5E	Seismic RSA	•	•	•
7 (Operating) $LS_{6,2}$-1.5D±1.5E	Seismic RSA	•	•	•
8 (Operating) $LS_{8,1}$-0.9D±1.5E	Seismic RSA	•	•	
9 (Operating) $LS_{8,2}$-0.9D±1.5E	Seismic RSA	•	•	

Step -8:

After assigning the combination we analysis the model and get different results like Member torsion, moment and axial forces. Discussed in results.

Step - 9: Design

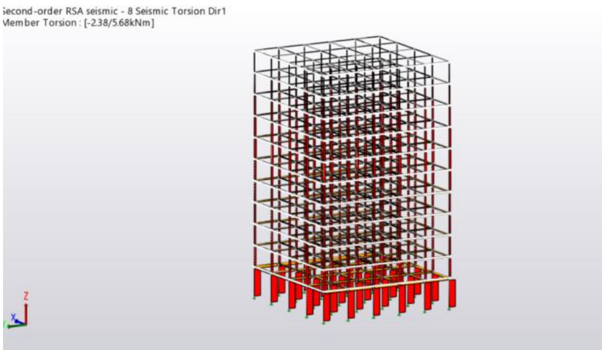
The design of after completion of analysis of structure deforms the shape of a model.



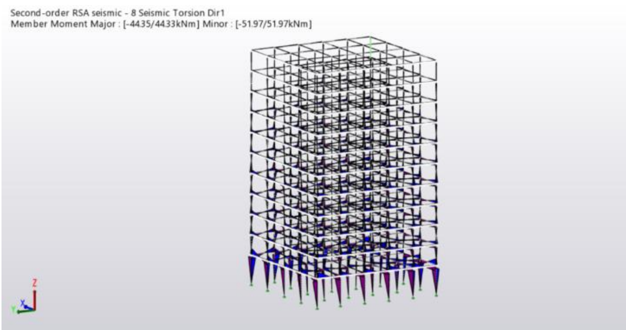
Result of analysis

Here ae the images show different results

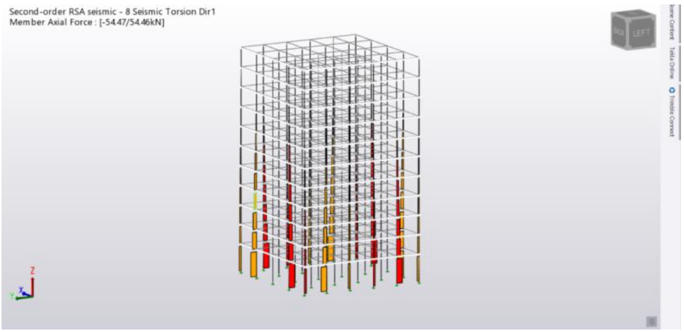
1. **Member torsion**



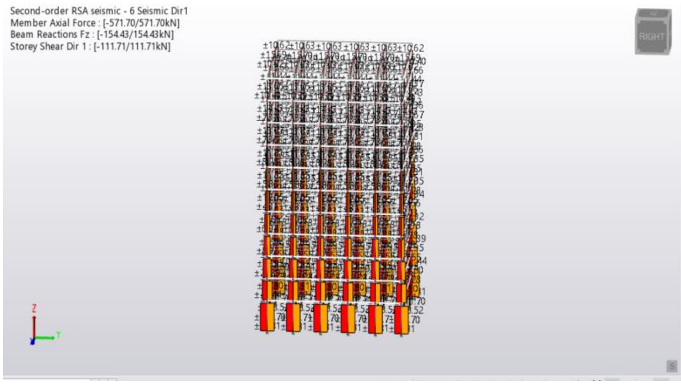
2. **Moment force**



3. **Axial Force**

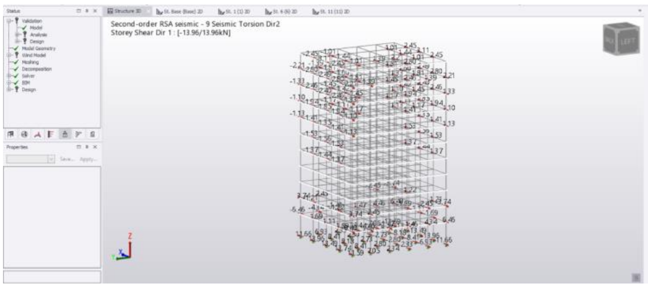


1. **Beam reaction**

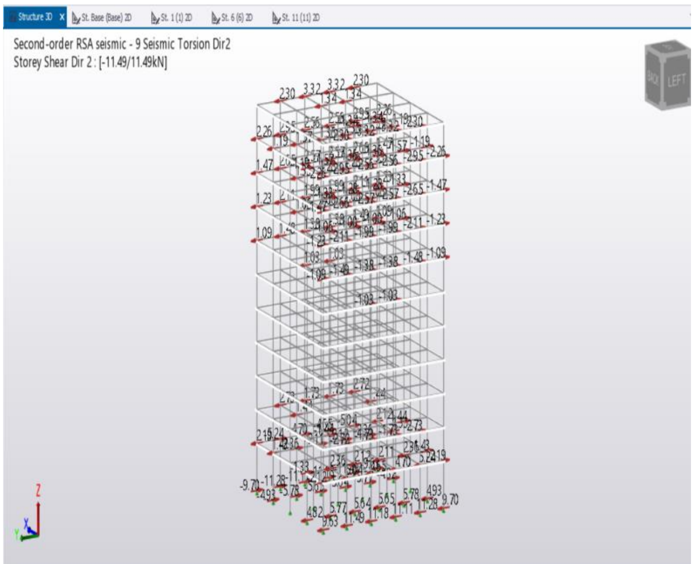


2. **Storey Shear**

i. **Dir 1**



i. **Dir 2**



Seismic report

Vert irreg ii –Mass Irregularity	No
Vert irreg iii –Vertical Geometric Irregularity	No
Vert irreg iv –In-Plane Discontinuity in Vertical Elements Resisting Lateral Force	No
Vert irreg v–Strength Irregularity – Weak Storey	No
Vert irreg vi – Floating or Stub Columns	No

Modal Response Spectrum Analysis is permitted(IS1893-Part 1 : 2016 Cl. 7.7.5)

Reference	Level [m]	Weight [kN]	Dir1			Dir2		
			Factor	Q [kN]	Ecc [m]	Factor	Q [kN]	Ecc [m]
St. 11 (11)	33.000	2423.22	0.340	518.80	1.000	0.352	518.80	1.000
St. 10 (10)	30.000	4221.42	0.493	752.18	1.000	0.510	752.18	1.000
St. 9 (9)	27.000	4221.42	0.403	614.48	1.000	0.417	614.48	1.000
St. 8 (8)	24.000	4221.42	0.322	490.70	1.000	0.333	490.70	1.000
St. 7 (7)	21.000	4221.42	0.250	380.82	1.000	0.258	380.82	1.000
St. 6 (6)	18.000	4221.42	0.187	284.85	1.000	0.193	284.85	1.000
St. 5 (5)	15.000	4499.49	0.142	216.15	1.000	0.147	216.15	1.000
St. 4 (4)	12.000	4494.24	0.094	143.34	1.000	0.097	143.34	1.000
St. 3 (3)	9.000	4494.24	0.056	85.59	1.000	0.058	85.59	1.000
St. 2 (2)	6.000	4494.24	0.028	42.65	1.000	0.029	42.65	1.000
St. 1 (1)	3.000	4557.24	0.010	14.71	1.000	0.010	14.71	1.000

Analysis procedure to be used:

Modal Response Spectrum Analysis

Conclusion

3. CONCLUSIONS

- The construction is based on the TSD and the LIMIT STATE METHOD theories.
- It provide enough strength, serviceability, and durability while still being cost effective
- If a beam fails, the beam and column proportions should be altered, and reinforcement details can be constructed
- Variation in displacement, torsion, shear force, storey shear, beam reaction and axial force, moment force has been demonstrated

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