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# Static and Dynamic Analysis of Elevated Parking Structure

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**ABSTRACT:** With the rapid advancement of Science and Technology, the global proliferation of cars and vehicles has escalated, leading to congested roads in cities worldwide. Furthermore, existing urban areas lack adequate parking facilities, forcing vehicles to occupy roadside areas, residential streets, and other non-designated spaces, exacerbating traffic congestion and frequent jams. To mitigate this challenge, an innovative solution is proposed, the implementation of Elevated Parking Structures. This system offers a dynamic approach to alleviate traffic congestion in residential and commercial areas by utilizing terrace spaces for vehicle parking, facilitated by lifts. The Elevated Parking Structure comprises steel columns supporting an operational platform, which is adaptable and convertible. Vehicles are lifted to the terrace level via lifts and parked, thus reducing reliance on roadside parking and easing traffic congestion. The study has shown the behaviour of structures under various loading conditions, ensuring structural integrity, stability, and safety in static and dynamic analysis carried in E-Tabs software. The static analysis allowing us to assess its strength and stability under steady-state conditions. This analysis aids in optimizing member sizes, ensuring code compliance, and predicting structural performance under typical service loads. The dynamic analysis particularly using Response Spectrum Analysis (RSA), enables us to evaluate the structure's response to dynamic forces, such as seismic events. By this we can minimize the traffic congestions in the cities and ensure smooth flow of pedestrian traffic.

**KEYWORDS:** Elevated Parking Structures; E-Tabs; static analysis; dynamic analysis

## I. INTRODUCTION

It is an advancement of Science and Technology, the number of cars and other vehicles have increased on roads of all cities of the world. The rural roads construction in the past in old way have proved competent to accommodate increases number of vehicles. The existing towns are also lacking the facility of parking, due to which the vehicles are being parked along the highway sides, residential roadway, pathway, and green points of the roads which causes frequent traffic jams. The precious time of workers is wasted due to traffic jams and if this problem is not solved at this stage, then it would become a serious and complicated problem in future.

The problem is required to be solved urgently by elevated parking structure, this system consist of new type of parking the vehicles on terrace with the help of lifts to reduce the traffic congestions on the residential & commercial areas. It is an innovative idea designed to minimize the area and volume required for parking cars. An operational platform is attached to the steel columns which are convertible also. The cars can be lifted through the lift and parked over the terrace which reduces the traffic congestion by roadside parking.

## II. OBJECTIVE

- Exploring the suitable materials through examination of their sizes and types.
- Analyzing in Static analysis methods for calculated live load.
- Analyzing in Dynamic analysis techniques for optimizing the structural design of columns and beams.

### III. METHODOLOGY

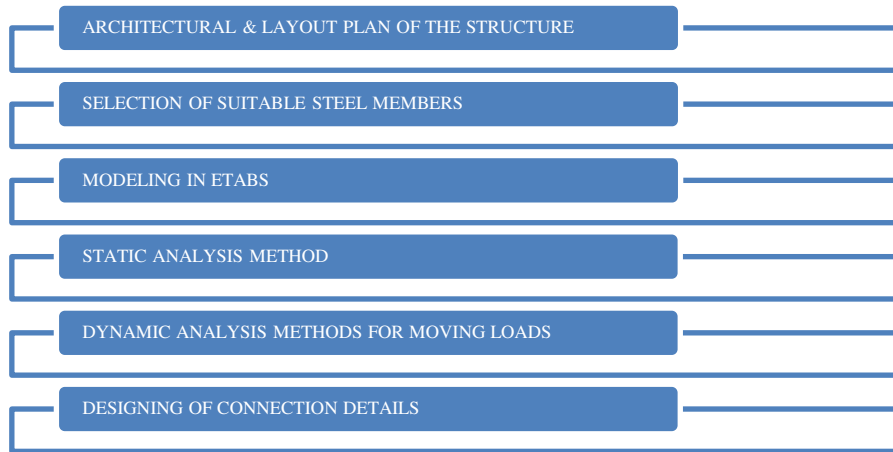


Fig 1: Flowchart of methodology

#### 1. ARCHITECTURAL PLAN IN AUTO CAD

The architectural plan shown below is a G+3 story building of 30 feet width and 45 feet length which does not have a proper parking facility due to excessive land rate. The ground floor and typical floor consists of 3BHK with 3 bike parking, there are 4 houses in the building but the plan is lacking with car parking facilities. The bike parking size is 5’10” x 12’11” by this size only 3 numbers of bikes can be parked, hence the elevated parking structure is designed for the plan. The layout of the structure is shown in the plan which lies between the site and does not disturb any government properties. The footpath for the pedestrian walking is 6 feet width and the road width is 20 feet.

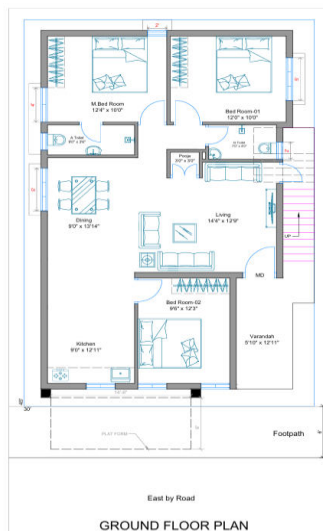


Fig 2: Architectural plan for Ground Floor

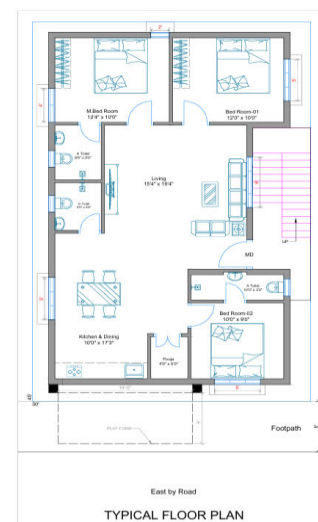


Fig 3: Architectural plan for Typical Floor

#### 2. MATERIALS

Member	Section	Material
Column	ISWB-450	FE-250
Beam	ISMB-200	FE-250
Bracing	200 x 200 x 10mm	FE-250
Slab	200mm	FE-250

Table 1: Section property data

### 3. MODEL IN ETABS

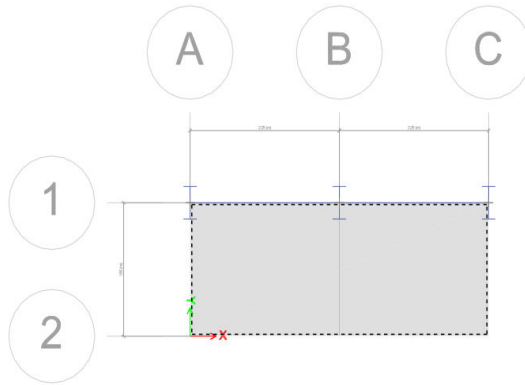


Fig 4: Plan view of Structure in E-TABS

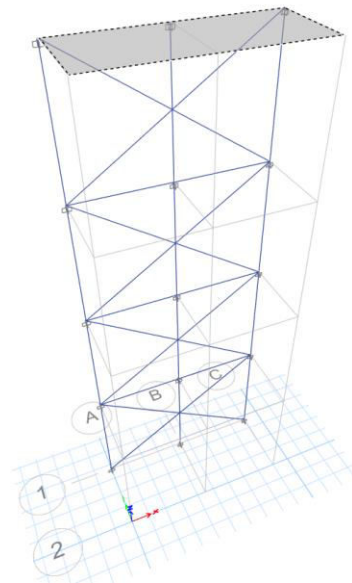


Fig 5: 3D view of Structure in E-TABS

### IV. EXPERIMENTAL RESULTS

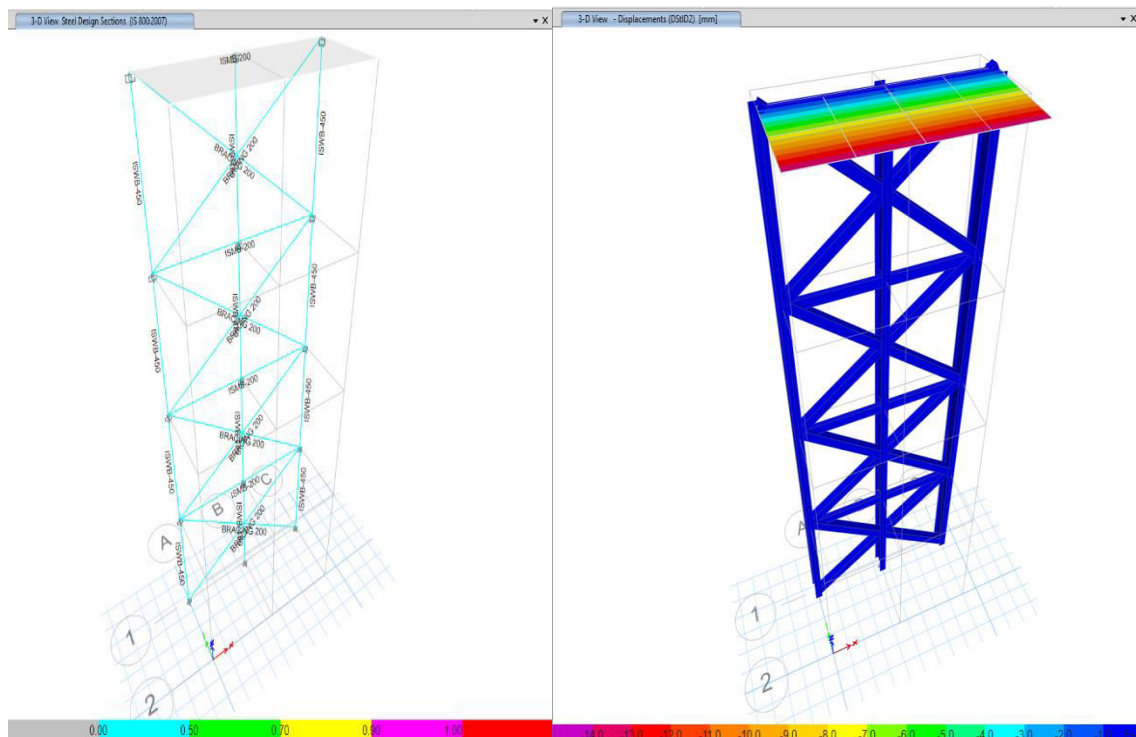


Fig 6: Members passing the Analysis in E-TABS

Fig 7: Displacement for DStID2 combination in E-TABS



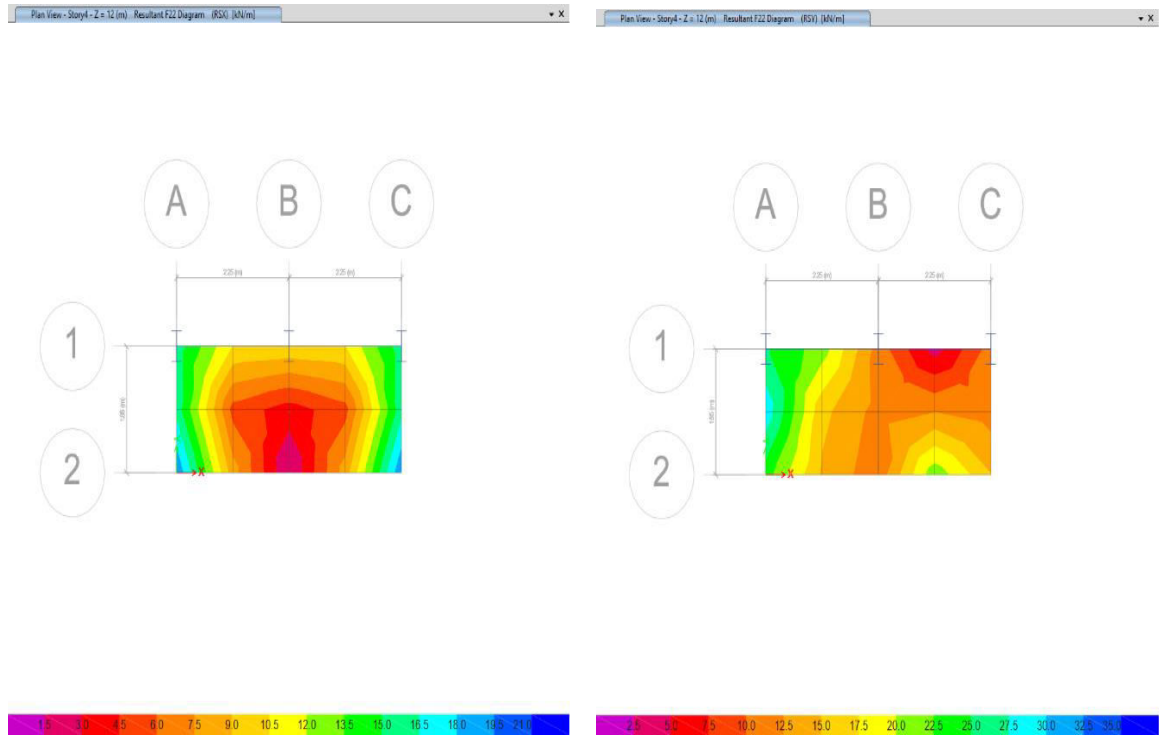


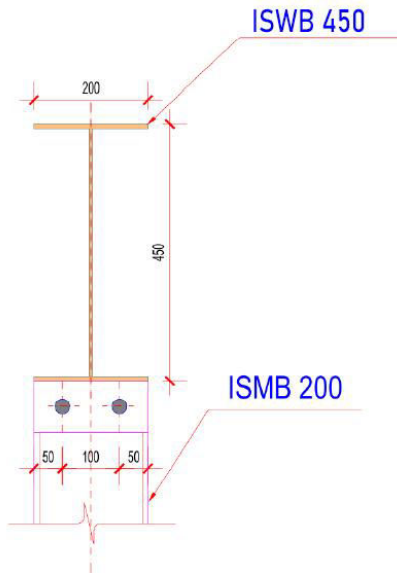
Fig 8: Resultant of Platform in X-Direction

Fig 9: Resultant of Platform in X-Direction

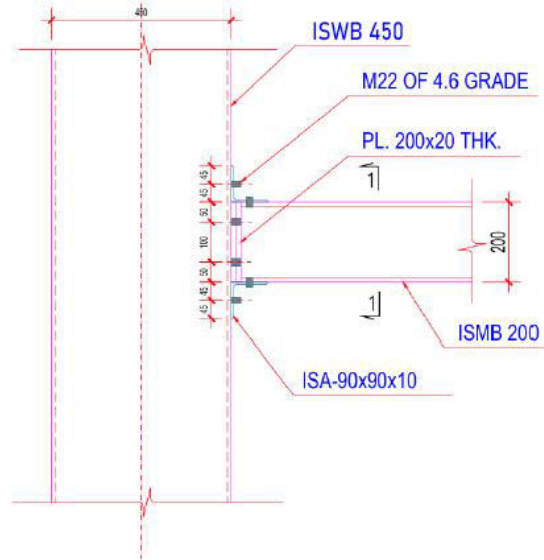
TABLE: Joint Reactions											
Story	Label	Unique Name	Output Case	Case Type	Step Type	FX	FY	FZ	MX	MY	MZ
						kN	kN	kN	kN-m	kN-m	kN-m
Base	1	5	RSX	LinRespSpec	Max	66.64	38.48	335.65	0	0	0
Base	1	5	RSY	LinRespSpec	Max	12.03	6.56	63.98	0	0	0
Base	2	10	RSX	LinRespSpec	Max	0.22	18.13	0.00	0	0	0
Base	2	10	RSY	LinRespSpec	Max	0.05	8.04	0.07	0	0	0
Base	3	15	RSX	LinRespSpec	Max	66.64	20.41	335.65	0	0	0
Base	3	15	RSY	LinRespSpec	Max	12.06	8.43	64.14	0	0	0

Table 2: Joint reactions obtained from ETABS

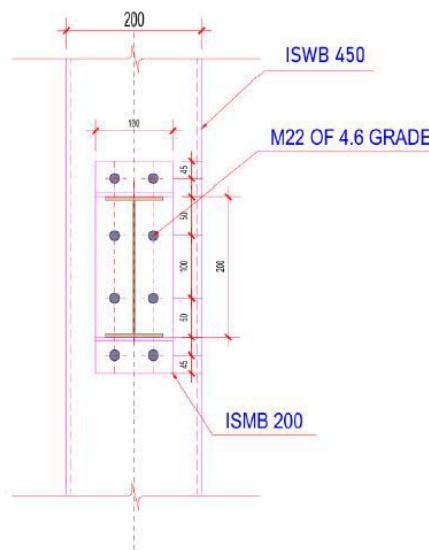
**CONNECTION DETAILS**



**Fig 10: Plan view**



**Fig 11: Elevation**



**Fig 12: Sec 1'-1'**

**V. CONCLUSION**

1. In conclusion, conducting both static and dynamic analyses on elevated parking structure using ETABS provides comprehensive insights into their behavior under various loading conditions, ensuring structural integrity, stability, and safety.
2. Through static analysis, the distribution of loads, stresses, and deformations within the structure can be accurately determined, allowing us to assess its strength and stability under steady-state conditions. This analysis aids in optimizing member sizes, ensuring code compliance, and predicting structural performance under typical service loads.
3. Dynamic analysis, particularly using methods such as Response Spectrum Analysis (RSA), enables us to evaluate the structure's response to dynamic forces, such as seismic events. By considering the time-varying nature of these loads

and the structure's inherent dynamic characteristics, we can assess the potential for resonance, identify critical modes of vibration, and design robust structural systems capable of withstanding seismic forces.

4. The column members A1 and C1 at the base story was found to be critical members in the analysis, hence the design was carried and the connection details for these members are done taking the maximum reaction value of 335.65 kN. The static analysis results are found only 5.54 % with comparison to dynamic analysis results.

5. In summary, the combination of static and dynamic analyses in ETABS provides a powerful toolkit for us to design, analyze, and evaluate steel structures with confidence, ultimately contributing to the creation of safer and more resilient built environments

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