# Static & Dynamic Analysis on Automated Car Parking Towers & Study Behaviour of the Building

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**Abstract -** *Over the decades our country has been developed drastically, now we are in this state that we have a lot of well contacted roads, commercial building and increasing number of automobiles. As we are advancing with time, the manual car parking system in commercial spaces is creating hurdle which is causing wastage of time and some economic losses as well. Therefore we need a solution which can overcome these problems. Hence, the Automated Parking Systems are the solution of these problems. This system not only saves time and money, it can also earn money by charging for parking spaces.*

*In this project a parametric study of Automated car parking tower is prepared, subjected to static load (self-weight of structure, weight of car, weight of pallet etc.) & Dynamic load (wind load, seismic load) for different zones of earthquake and wind in INDIA. The effects of load & behavior of building will be evaluated on the basis of following parameters –Storey deflection, quantity of structural steel. In this work, analysis of work is carried out using STAAD.Pro software.*

***Key Words***: Staad.Pro, Static load, Dynamic load, storey deflection

## 1. INTRODUCTION

Automated car parking system is typically consists of a vehicle elevator with a parking space either side of the elevator shaft. To have an overlook of parking tower, this configuration is repeated over a number of levels. The vehicle elevator rises to one of the parking levels of the tower and deposits the vehicles sideways into a parking spot. A vehicle is taken back in a same way. System redundancy is an issue with tower system as there is single mechanism to park and retrieve cars.

An automated parking system (APS) is a mechanical system designed to minimize the area and/or volume required for parking cars. Like a multi-level parking garage, an APS provides parking for cars on multiple levels stacked vertically to maximize the number of parking spaces while minimizing land usage. The APS, however, uses a mechanical system to transport cars to and from parking spaces (rather than the driver) in order to eliminate much of the space wasted in a multi-story parking garage. While a multi-story parking garage is similar to multiple parking lots stacked vertically, an APS is more similar to an automated storage and retrieval system for cars.

### 1.1 literature review:

A Automatic Car Parking System-Prototype: A Review by Prathmesh. K. Bhadane1, Prashant Gosavi2, Ravikumar Dongarraje3, SohamGeet4 Mrs. Shalaka.H. Joshi5 [Journal of Automotive Engineering & Technology] [1] Paper states about the Unique Characteristics the space for parking 3 motorcar can hold more than 9 motorcar. Flexible managing system, no caretaker is required, key pressing function, High safeness, whole investigate device Stable and safe it is simple to manage with the driver parking and leaving the vehicle in the system at the ground level.

It is completely successful when installed in engaged areas which are well established and are suffering with shortage of area for parking. Although the building of this system seems to be comfortable, it will be with from knowing without the knowledge of materials, chains, sprockets, bearings, and machining operations, kinematic and dynamic mechanisms imagine the period that automatic smart parking systems would preserve us.

Analysis and Strengthening of Soft Storey Building with Equivalent Diagonal Strut at Center under Earthquake and Wind Load by Abdul Juned Siddiqui1 , Prabhat Soni1 , Aslam Hussain2 [International Journal of Engineering Research] [2] From this paper it is observed that value of moments of earthquake moments is higher than the value of wind load moments. It is also seen that soft storey at 4th storey is critical in both direction for all cases of buildings. So it can be concluded that soft storey at fourth floor shall be avoided. From above observation it can be concluded that considering all the parameters, 4th storey is critical in all load cases. CASE-1 (bare frame without equivalent diagonal struts) is most critical frame between them and CASE-2 (equivalent diagonal struts at centre) is efficient one. Means while providing equivalent diagonal struts at corner will reduces moment, shear force, displacement and storey displacement. Equivalent diagonal struts provide better stiffness to the soft storey.

## 2. OBJECTIVES

1. To study the factor that will affect the behavior of parking tower through a series of analysis. Effect of static load (self-weight of structure, weight of car, weight of pallet etc.) & Dynamic load (wind load, seismic load) will consider as the load acting to the parking tower.

2. To determine the force and moment value on parking tower when the static load is applied.

3. To determine the deflection and stress value on parking tower when the static load is applied using Staad.Pro software

4. To determine the force and moment value on parking tower when the dynamic load (earthquake & wind) is applied.

5. To determine the deflection and stress value on parking tower when the static load is applied using Staad.Pro software.

6. To determine comparative statement of horizontal displacement, vertical displacement, support reactions and steel takeoff for parking tower.

7. To determine comparative statement of steel quantity variation of same tower in different wind zones & earthquake zones of INDIA.

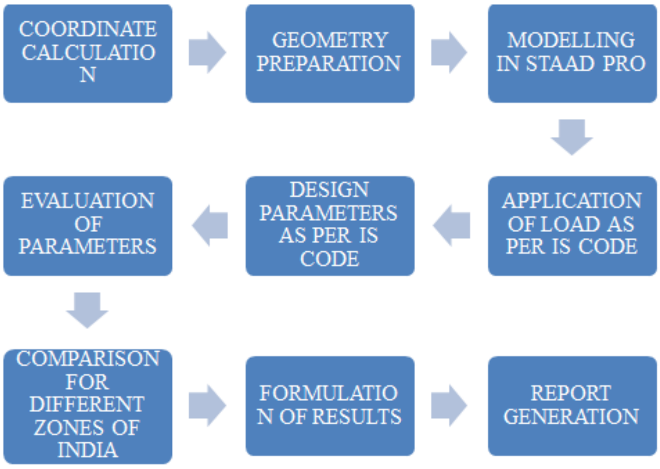


**Fig -1**: Methodology

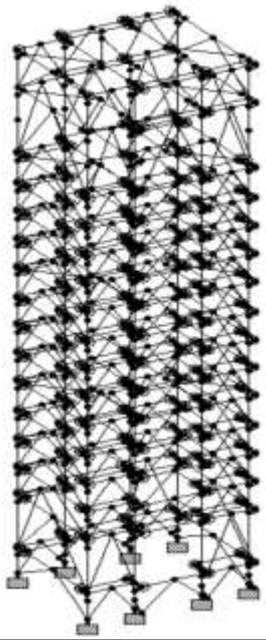

**Fig -2**: Isometric view of tower staad frame

Sample papragraphDefine abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

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## 3. RESULTS AND ANALYSIS

Analysis of automated car parking system is carried out using STAAD.Pro software. Following are the load data & parameters considered for analysis.

+ Dead load:
Includes self-weight of the structure with metal sheeting. Weight of metal sheet assumed as 30 kg/m2 by considering Class I - Galvanized Steel Sheet of thickness 1.6mm as per IS Code 875 part-I.
Load of pallet – 800kg
Load of car – 3000kg
Load of lift – 10000kg
Load of counterweight – 9000kg

+ Live load:
Due to automation, labor is not required at site for daily working. Although, for maintenance it requires labor. Assuming following loads as per IS 875 part-III
Load at machine room level – 200kg/sq. m.
Load at roof level – 75kg/sq. m.

Wind load:

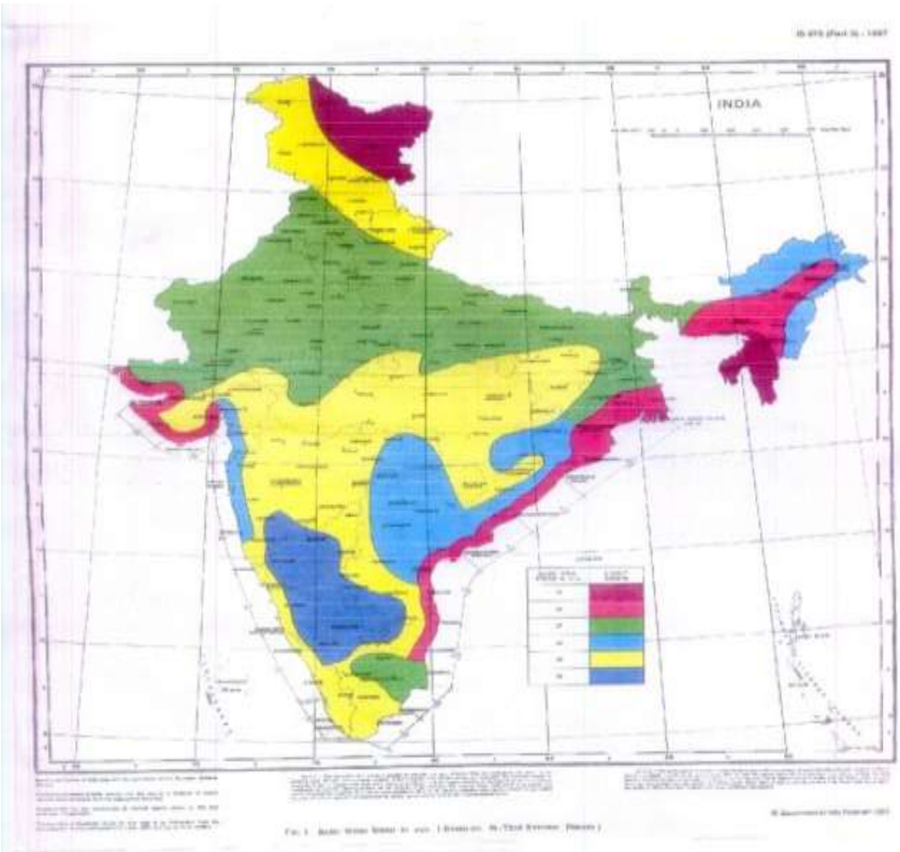


**Fig -3**: Map of Wind zones in India

Design Wind Speed (Vz) - The basic wind speed (Vb ) for any site shall be obtained from Fig. 8 and shall be modified to include the following effects to get design wind velocity at any height ( Vz ) for the chosen structure:

a) Risk level
b) Terrain roughness, height and size of structure and
c) Local topography

It can be mathematically expressed as follows:
Vz = Vb .k1 .k2 . k3

Where,
Vz= Design wind speed at any height Z in m / s
Vb= Design wind speed
k1= Probability factor (Risk coefficient IS 875 clause 5.3.1)
k2 = Terrain, height and structure size factor (IS 875 clause 5.3.2)
k3 = Topography factor (IS 875 clause 5.3.3)
+ Seismic load:
Seismic zone = V
Seismic coefficient = 0.36
Response reduction factor = 3
Importance factor = 1.0
Damping percent = 5
Damping factor = 1
Soil factor = II
Height of tower = 30m

Design criteria:
For the purpose of determining the design seismic forces, the country (India) is classified into four seismic zones (II, III, IV, and V). Previously, there were five zones, of which Zone I and II are merged into Zone II in fifth revision of code. The design horizontal seismic forces coefficient Ah for a structure shall be determined by following expression.
Ah = ( Sa Z I ) / ( 2Rg )
Z = zone factor for the maximum considerable earthquake.
I = importance factor, depending on the functional purpose of the building, characterized by hazardous consequences of its failure, post-earthquake functional needs, historical value or economic importance.
R = response reduction factor, depending upon the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations however the ratio I/R shall not be greater than 1.
Sa /g = average response acceleration coefficient

### 3.1 Load combination:

+ Load combinations
( Reference IS: 800 2007)

| Combination | Limit State of Strength | | | | | Limit State of Serviceability | | | |
|---|---|---|---|---|---|---|---|---|---|
| | DL | LL[1] | | WL/EL | AL | DL | LL[1] | | WL/EL |
| | | Leading | Accompanying | | | | Leading | Accompanying | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| DL+LL+CL | 1.5 | 1.5 | 1.05 | — | — | 1.0 | 1.0 | 1.0 | — |
| DL+LL+CL+ | 1.2 | 1.2 | 1.05 | 0.6 | — | 1.0 | 0.8 | 0.8 | 0.8 |
| WL/EL | 1.2 | 1.2 | 0.53 | 1.2 | | | | | |
| DL+WL/EL | 1.5 (0.9)[2] | — | — | 1.5 | — | 1.0 | — | — | 1.0 |
| DL+ER | 1.2 (0.9)[2] | 1.2 | — | — | — | — | — | — | — |
| DL+LL+AL | 1.0 | 0.35 | 0.35 | — | 1.0 | — | — | — | — |

**Fig -4**: Load combinations from IS-800-2007

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### 3.2 Deflection check:

This facility allows the user to consider deflection as criteria in the CODE CHECK and MEMBER SELECTION processes. The deflection check may be controlled using three parameters. Deflection is used in addition to other strength and stability related criteria. The local deflection calculation is based on the latest analysis results.

### 3.3 Code Checking:

The purpose of code checking is to verify whether the specified section is capable of satisfying applicable design code requirements. The code checking is based on the IS: 800 (2007) requirements. Forces and moments at specified sections of the members are utilized for the code checking calculations. Sections may be specified using the BEAM parameter or the SECTION command. If no sections are specified, the code checking is based on forces and moments at the member ends.

### 3. CONCLUSIONS

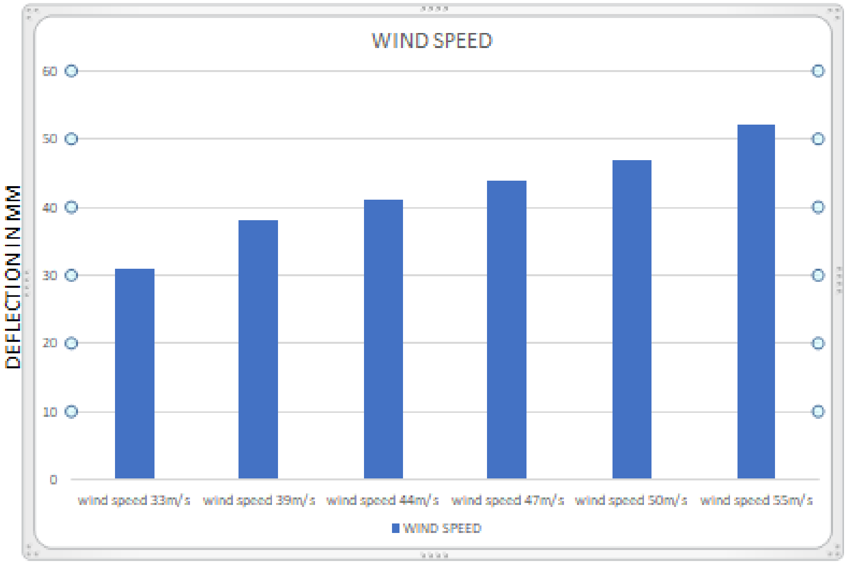


**Fig -5**: comparative graph for deflection of tower for various wind zones

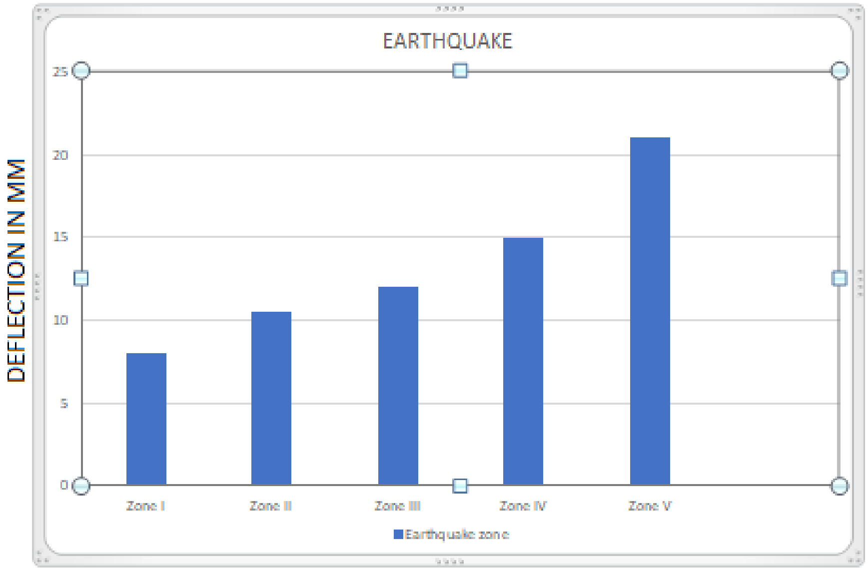


**Fig -6**: comparative graph for deflection of tower for various earth quake zones

## REFERENCES

[1] Patrascu, Daniel (2010), "How Automated Parking Systems Work", Auto evolution, retrieved 2012-11-16

[2] Design and Fabrication of an Automated Multi-level Car Parking System A. ALBAGUL, K. ALSHAREF, M. SAAD, Y. ABUJEELA

[3] IS800:2007. General Construction in Steel - Code of Practice Bureau of Indian Standards.

[4] IS875:1987. “Code of Practice for design load (other than earthquake) for Building and structures” Bureau of Indian Standards, (part-II) Imposed load.

[5] IS 875 (Part 3) 1987- Code of Practice for design Loads (Other than Earthquake) for Building and Structures

[6] Design and Fabrication of an Automated Multi-level

[7] Car Parking System