JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ANALYSIS OF MULTILEVEL PARKING SYSTEM AT COLLEGE CAMPUS

[1]Anagha Dinesh, [2]Faizal Muhammed, [3]Sanjay S,[4]Preetha Prabhakaran

[1,2,3]B.Tech Student, [4]Assistant Professor
[1,2,3,4]Department of Civil Engineering
[1,2,3,4]Toc H Institute of Science and Technology, Arakkunnam, Kerala, India

Abstract: Structural design is aimed to design a structure that fulfill its intended purposes during its lifespan and safe in terms of stability, strength, durability, stiffness etc. and is economically viable. This project deals with the planning and analysis of a Multilevel parking structure which is proposed to be constructed at Toc H Institute of Science and Technology, Arakkunnam. The over dependence of concrete which is releasing higher amount of carbon dioxide into the atmosphere, to look for the possibility of steel structure which provides better replacement and rapid construction. Analysis and design of the proposed structure is carried out using ANSYS software. ANSYS is a building information modelling software to model structures that incorporate different kinds of building materials. This software enables to design and manage 3D structures in concrete or steel. This project deals with planning, analysis of parking structure to be constructed using steel at Toc H Institute of Science and Technology.

Index Terms **- ANSYS, Multilevel Parking structure**

I. INTRODUCTION

The number of vehicles on the campus ground of Toc H Institute of Science and Technology has been increasing at an alarming rate. Due to this, there is a strong demand for developing parking on campus. Notably, the campus needs adequate parking due to the rising number of vehicles area. In order to guarantee that drivers park their vehicles properly and without overlapping, the existing parking yard should also be clearly marked. Some car owners have a serious issue with parking their vehicles in two spaces. They consist of college employees and students. Finding parking spots on campus has been a challenge for faculty, employees, and students. There are clearly more cars on campus now than there were a few years ago. Because employees and students drive their own cars and bikes to campus, there needs to be efficient parking and traffic management. A better parking situation on campus will also improve the campus's reputation. The campus's parking will operate more efficiently due to a parking enhancement. The proposed parking structure is analyzed using the commercial software ANSYS Workbench, which is a highly efficient software that can be used for modelling and detailing of steel structure.

II. ANALYSIS OF THE PARKING SYSTEM

2.1. Planning of the parking structure

Parking structure includes basement, ground floor and first floor in which basement and ground floor is utilized for parking of 4 - wheelers. First floor is used for parking of 2- wheelers. A 2-way line ramp has been provided for passage of 4- wheelers to basement and ground floor. It is a steel structure with a composite deck. Composite deck consists of both concrete and steel. There are 3 buildings in the college campus namely, Aryabhata block, Einstein block and Visveswaraya block where area behind Aryabhata block has been selected for the site for parking structure. Fig No. 3 and 4 shows location for the proposed parking structure. The suggested location is chosen based on vehicle owners' convenience and accessibility. Considering the distance between the other two blocks in the institution, Aryabhata Block will be the prime spot for the parking structure to be built. The chosen location for the proposed project is a sloping area. The ground is uneven and undulating. A sloping part of the site is removed and made vertically straight so that soil may be utilized to level the ground. There are no obstacles made to the surrounding buildings. AutoCAD Drawing of the site is shown in Figure 2.1.

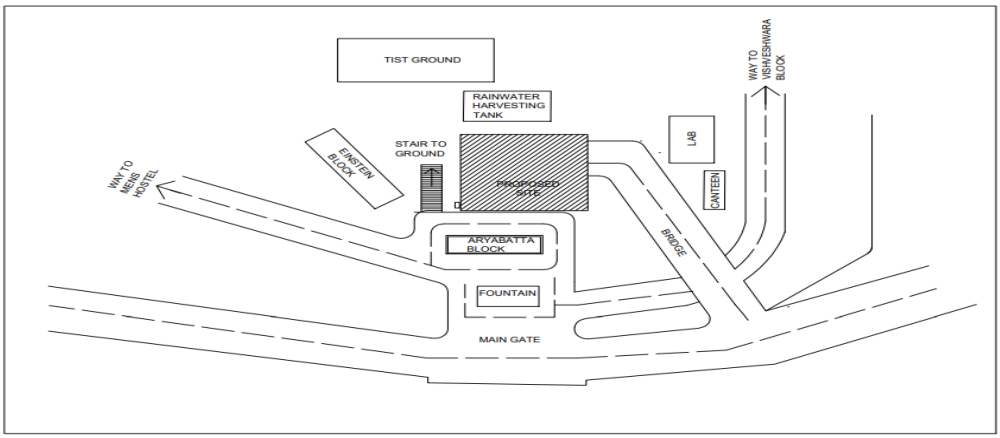

Fig 2.1: AutoCAD Drawing of the site

An overbridge has been provided from entrance of the college gate to top floor of the pa*rk*ing system for the convenient transportation of vehicles. Number of vehicles of students are greater than of faculties. Students depend upon the area outside main gate of college for parking. Students require parking facility which is necessary in the campus. From survey, it has been concluded that 80 numbers of four-wheelers and 300 numbers of two-wheelers has to be parked in the parking facility. Future increase in number of vehicles is also considered.

2.2. Modelling of the Parking structure

Modelling of the proposed parking structure has been done using ANSYS Workbench. This is the initial phase of modelling, during which we acquire the basic aspect of the parking structure where structural frame has been shown in figure 2.2.

- Type of support provided is fixed where it is the most rigid type of support or connection. Fixed supports can resist vertical and horizontal forces.
- Slab has been placed where the structure is composed of composite deck. Both steel and concrete are used where concrete is placed over steel that is, overlapping is done but there is no connection provided between them.
- A 2-way line ramp has been provided for the movement of vehicles from: first floor to ground floor and from ground floor to basement.

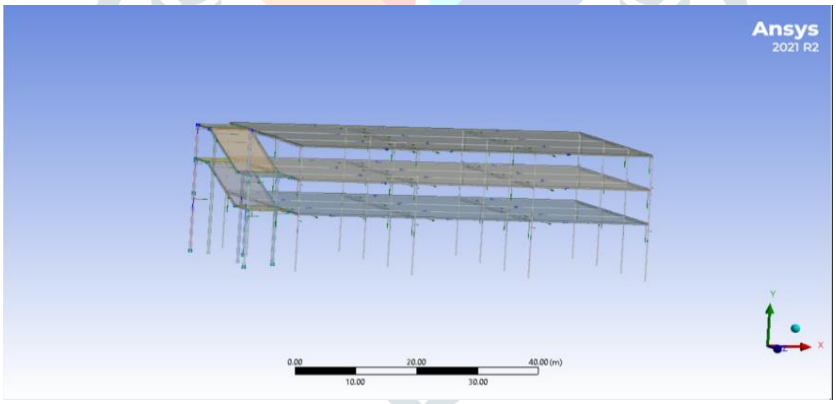

Fig 2.2: Modelled structure of parking system using ANSYS

2.3. Load Calculation

a) Load calculated for 4-wheelers to be parked has been shown in table 2.1

Table 2.1: Load calculated of 4-wheelers

No. of 4-wheelers	Total weight in Kilogram and Newton
1 car	1300kg , 12753N
40 cars (first floor)	52000kg , 510120N
40 cars (ground floor)	52000kg , 510120N

b) Load calculated for 2-wheelers to be parked has been shown in table 2.2

Table 2.2: Load calculated for 2-wheelers

No. of 2-wheelers	Weight of 2-wheeler in Kilogram and Newton
1 bike	125kg, 1226.25N
300 bikes(basement)	37500kg, 367875N

c) Dead load and Live load acting on the structure is obtained :Dead Loads are permanent loads due to the weight of the building components themselves, such as the weight of the walls, floors, roof, and other fixed elements. Live Loads are temporary loads caused by occupancy, people, furniture, and other movable items within the building.

Load calculation :

i) For 4-wheelers:

Dead load = Unit weight of concrete x Thickness of slab

= 25 x 0.25

= 6.25 kN/m^2

$$\text{Live Load} = \frac{\text{no.of 4-wheelerto be parked in a floor} \times \text{Average weight of a 4-wheeler}}{\text{Area of the floor}}$$

$$= \frac{40 \times 1300 \times 0.0098}{60 \times 42} = 0.202 \text{ kN/m}^2$$

Total load= 6.25 + 0.202 = 6.45 kN/m^2

ii) For 2-Wheelers:

Dead Load = 6.25 kN/m^2

$$\text{Live Load} = \frac{\text{no.of 2-wheelerto be parked in a floor} \times \text{Average weight of a 2-wheeler}}{\text{Area of the floor}}$$

$$= \frac{300 \times 125 \times 0.0098}{60 \times 42} = 0.145 \text{ kN/m}^2$$

Total load = 6.25 + 0.195

= 6.395kN/m^2

3.4 Static Structural Analysis

Static structural simulation determines the effect of steady or static loading on a structure. Stress, strain, and deformation of a structure can be studied under a range of loading. This helps to identify weak areas with low strength and durability at conditions the design stage and avoid expensive failures. The parking system has three floors which is to be used for parking of 4-wheelers on top floor and ground floor and 2-wheelers on basement. Calculated load has been applied to each floor for conducting Static Structural Analysis of parking structure using ANSYS Workbench Software. Axial force, Total deformation and Total bending moment acting om parking structure when subjected to dead load, live load and both have been found out by analysis.

a) Axial load: Axial forces in buildings are primarily caused by vertical loads, such as the weight of the building itself (dead load) and live loads imposed by occupants, furniture, and other movable objects. Additionally, lateral loads, such as wind or earthquake forces, can induce axial forces in structural members. Axial load obtained from analysis of structure using ANSYS has been shown in Figure 2.3.

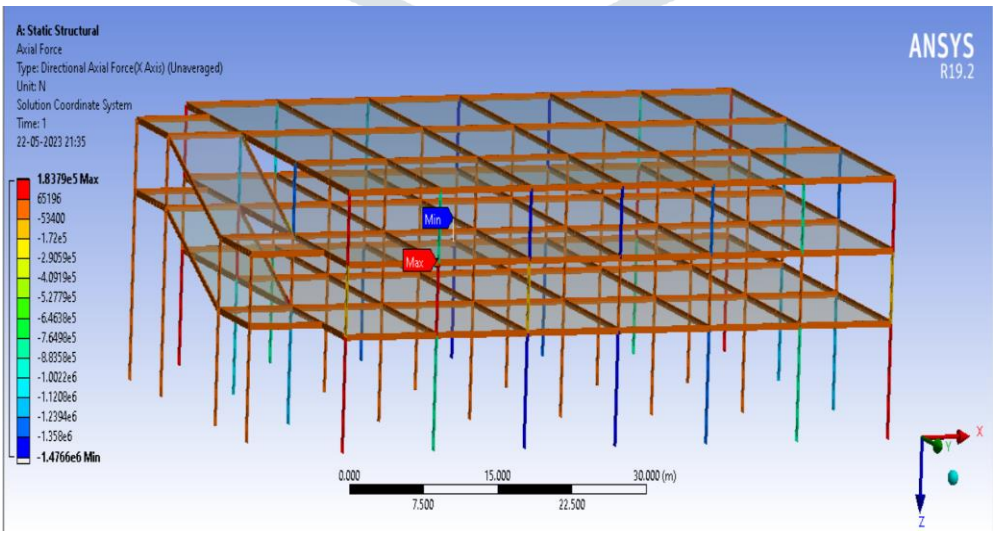

Fig.2.3: Axial force obtained from analysis of the structure

b) Total Bending Moment :It refers to the internal force or moment that is generated within a structural element, such as a beam or column, when it is subjected to external loads or forces. When a beam or column is loaded, it tends to bend or deform, and the bending moment is responsible for this deformation. The bending moment is the result of the distribution of forces acting on the

beam. It is the algebraic sum of the moments of all the forces to one side of a specific section along the beam.Total bending moment obtained from analysis of the structure has been given in figure 2.4.

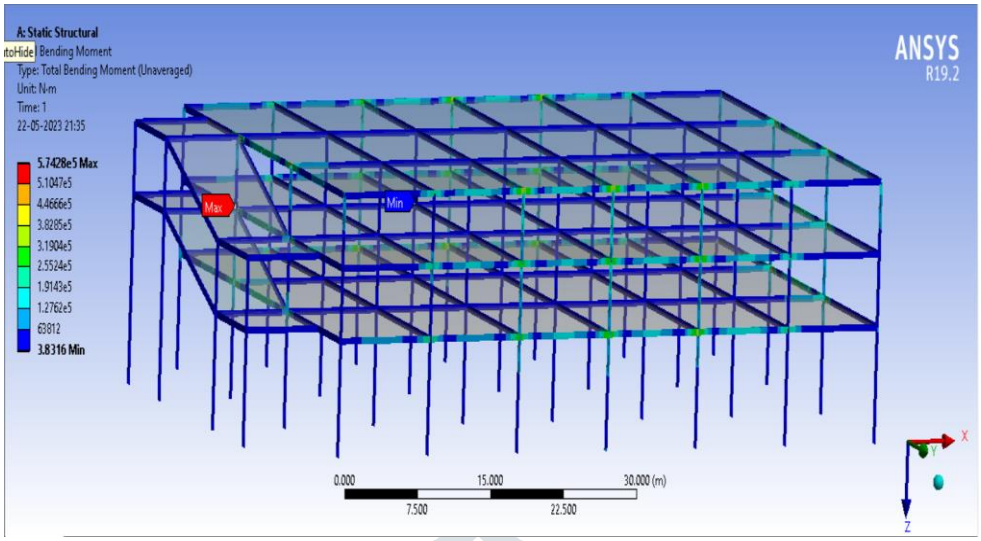

Fig 2.4: Total bending moment obtained from analysis of the structure

c) Total Deformation: Total deformation in a structural member refers to the overall displacement or change in shape experienced by the member when subjected to external loads or forces. When a structural member is loaded, it undergoes deformation due to the stress induced in the material. The total deformation of a structural member is the sum of the elastic deformation and the plastic deformation. Total deformation obtained from analysis of the modelled structure has been given in Figure 2.5.

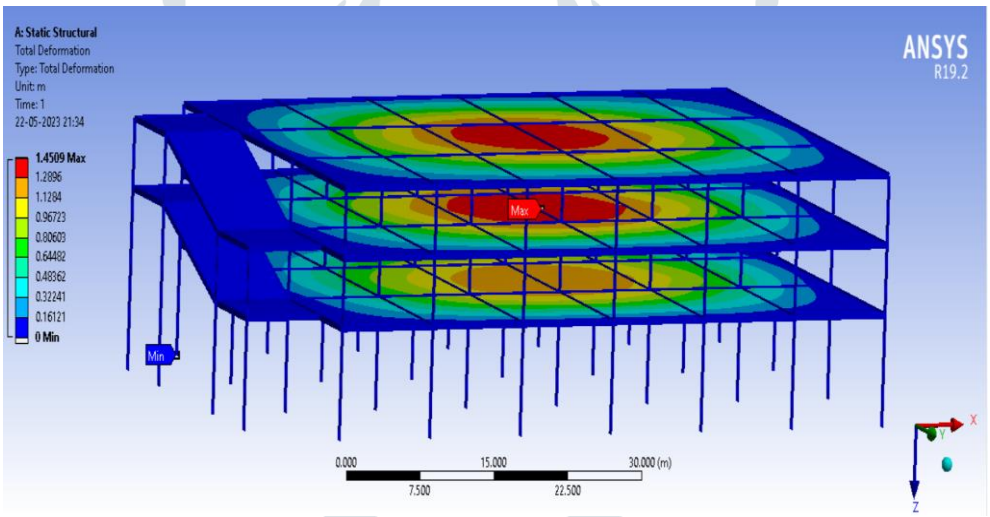

Fig 2.5: Total deformation obtained from analysis of the structure

III. RESULTS

Results from ANSYS Workbench has been obtained and given in the table below.

Table 3.1: Results from ANSYS Workbench

	Axial force(N)	Total Bending Moment (Nm)	Total deformation(m)
Dead load	1.78×10^5	5.56×10^5	1.405
Live load	5657.2	18060	0.0455
Dead load+Live load	1.837×10^5	5.742×10^5	1.4509

IV.CONCLUSION

- A Multi-storeyed parking structure is planned to park total number of vehicles inside the campus which includes vehicles owned by both students and faculties. Construction of the same is done using steel considering its strength. Parking structure designing at the selected site does not cause any kind of disturbances to nearby buildings.

- Modelling has been completed to provide the basic structural view of the proposed parking system which has been carried out using ANSYS Workbench.
- Static Structural Analysis of the structure has been completed and thus axial force, total deformation and total bending moment has been obtained.

Future Scope

- Efficient space utilization: Optimize layout and design of parking structure to maximize the number of parking spaces within available area.
- Electric Vehicle Infrastructure: Providing Electric vehicle charging infrastructure within parking structure can be a significant advantage.

REFERENCES

[1] Ashok Kumar Jain, Dr.B.C.Punmia , Arun kumar , (2005): Comprehensive Design Of Steel Structures, second edition, Laxmi Publications.
[2] Conway, A.J, Thuillier , Dornhelm E, Lownes N.E. (2013): Commercial vehicle- bicycle conflicts: a growing urban challenge, Transportation Research Board 92nd Annual Meeting (No. 13-4299).
[3] Herdis Herdiansych (2017) Capacity analysis of parking structure and volume of vehicles towards parking convenience.
[4] Leroy Gardner, Nuno Silvestre, Kwok Fai Chung,(2019), " Analysis and Design of Steel Structures", Structures , Volume 17,pp (1-102).
[5] Mehdi Nourinejad , Matthew J. Roorda (2017) : Parking enforcement policies for commercial vehicles , Transportation Research Part A 102 (2017), pp 33-50.
[6] S.R. Mirghaderi, M. Dehghani Renani (2015) : The rigid seismic connection of continuous beams to column, Journal of Constructional Steel Research 64 (2008) 1516–1529.
[7] Xiang Siyu (2021): Behaviour and failure modes of steel parking structure column under transverse impact, Thin-Walled Structures, Volume 167.
[8] IRC: SP: 12- 2015: Guideline for parking facilities in Urban Areas.
[9] IS 800: 2007: Indian Standard General Construction in Steel (Third Revision)
[10] SP:6 (1)- 1964 : Handbook for Structural Engineers,1, Structural steel sections.