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Design and Development of 4 Level Car Parking Systems

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ABSTRACT: The main aim of this project is toreduce the traffic in the parking place. Normally we can see in the multiplexes, cinema halls, large industries, and function halls there is problem they have to go and search which line is empty and which line having place to park the vehicle, for parking then they need workers for parking in correct position it is the money consumed process. So, to avoid this problem Car Parking System project is implemented. In this project 4 level Car Parking System is considered to show the use of control system in parking system. The control system will play a major role in organizing the entry and exit from the parking lots. It also presents the design of multi-level parking lots which occupies less need on the ground and contains the large number of cars. In the modern world, where parking space has become a very big problem, it has become very important to avoid the wastage of space in modern big 4 level car parking system helps to minimize the car parking are companies and apartments.

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I. INTRODUCTION

From reference of L. Wenghong, X.Fanghua et al. it seen that industrial growth of the world is reflected by the increase in the number of automobiles on the streets throughout the world [1], which has caused lot of parking related problems. C. Wenzhi, L. Bai et al. identified slow-paced city planning has increased the problem even more [2].

Li et al. shows the parking space is a time-consuming process which not only affects the economic activities efficiency, but also the social interactions and cost [3]. Network companies cannot provide updated information of the parking facilities on the internet as the parking facilities do not cooperate with the companies. Certain big carfare not able to fit into the normally available parking spaces. Hence there is a need for a system; which can take all relevant information into consideration, for finding the parking vacancy. Human errors are the major source of traffic accidents, therefore building in-car technologies for checking the parking lot, avoiding accidents and guidance to the parking facility is turning out to be an integral area for research. The objective of such technologies is the reduction of the burden on driver, improvement of the traffic capacity, and provision of reliable and secure car functions.

Indian real estate developers must emphasize parking as a USP of upcoming projects by adopting world-class systems. The Society of India Automobile Manufacturers forecasts that the passenger car segment will grow 12 to 13 per cent in 2013-14 over the previous year. In real terms, that translates into the addition of no less than 250,000 cars to Indian roads this year. This gives rise to significant concerns for motorists and non-motorists alike. Experts opine that most passenger vehicles remain stationary for anywhere between 80 to 95 percent of their life-making safe parking a necessity. Many of these cars, however, are parked in lanes outside office or residential buildings, sometimes even blocking entrances, making building access a veritable nightmare. India has yet to develop on-street pay parking and meter parking, which is only compounding the problem. Even if these parking methods are introduced, streets would not offer enough space for the growing number of cars. A car parking system is a mechanical device that multiplies parking capacity inside a Parking system are generally powered by electric motors or hydraulic motors that move vehicles into a storage position.

There are two types of car parking systems: traditional and automated. In the long term, automated car parking systems are likely to be more cost effective when compared to traditional parking garages. Automatic multi- storey automated car park systems are less expensive per parking slot since they tend to require less building volume and less ground area than a conventional facility with the same capacity. Both automated car parking systems and automated parking garage systems reduce

Problem statement

To develop and validate a 4-level pit car park with optimized design so as to use a double hydraulic cylinder to lift and to lower the platform. To use some safety mechanism to prevent the destruction caused due to faulty situation like leakage of oil from the cylinder and to use some mechanism to keep the platform straight during its fully loaded condition.

Objectives

Literature Survey: To generate new ideas for developing the new model of 4 level pit car park based on study of existing stack par. To finalize the conceptual design. Detail lay outing and part design with calculations and analysis. Prototype Trials

Bene ts

There are several advantages of employing a car park system for urban planners, business owners and vehicle drivers. They offer convenience for vehicle users and ef cient usage of space for urban-based companies. Automated car park systems save time, money, space and simplify the often-tedious task of parking. Auto car lifts move vehicles into safe and secure storage areas until they are needed.

Maintenance and Service

Service intervals vary for automated car parking systems, depending on the type of machines used and their usage. Parking systems should be serviced at least once a year, and up to four times a year for high traf c areas or for valet parking. In addition, regular cleaning is mandatory to keep the car parking system in good working order, especially with the problems posed by weather (salt on the road can spread to lifter platforms and cause severe damage if not removed. A reputable car parking company will regularly clean all critical elements of its automated parking system, including the car lifters top and bottom, all concrete pits, all posts resting on the concrete, and the entire concrete oor in the parking area.

II. METHODOLOGY OF DESIGN

1. Design and analysis - Catia and Ansys.
2. Fabrication - At vendors place.
3. pollution cars are not running or circling around while drivers look for parking system.
4. Assembly of prototype at vendors place.
5. Trials at vendors place.
6. Manufacturing of model.

III. DESIGN

Platform

Present model of PIT PARK has two main columns made up of mild steel rolled channel section of ISMC 200. The platform is made up of three basic components i) Z profile on both sides ii) Corrugated GI sheet of 1.6 mm thickness and iii) Cross members joining both Z profiles and supporting corrugated GI profiles. Cross members are made up of mild steel rolled square tubes of 50 mm size. At the entry of the platform GI sheet is given slope so that car can climb easily on the platform. The total height of the platform top when resting on ground is about 80 mm. The platform of standard model is of the size 2.1 m wide x 3.8 m long. It is suitable for most of the passenger car models in India. The pay load capacity of this platform is 2000 kg. This platform is joined on both sides by the vertical slides called as vertical carriage. these vertical carriages are made up of bend plates. The bend plate accommodates four number of guide pieces which provide smooth vertical movement of platform on the columns mounted on the both sides of the platform.

Cylinder

The platform is moved up and down by using a hydraulic cylinder attached to the LHS and RHS vertical carriage. The cylinder is mounted near LH side and RH side column. This cylinder is of double acting, telescopic type and has two stages. The maximum stroke is 2.05 m.

Telescopic Cylinder

Cylinders are designed with a series of steel or aluminum tubes of progressively smaller diameters nested within each other. The largest diameter sleeve is called the main or barrel. The smaller inner sleeves are called the stages. The smallest stage is often called the plunger or piston rod. The cylinders are usually mounted in machinery by pivot mounts welded to the end or outer body of the barrel as well as on the end of the plunger. Telescopic cylinders are commonly re- stricted to a maximum of 6 stages. 6 stages are commonly thought to be the practical design limit as stability problems become more dif-ficult with larger numbers of stages. There are exceptions however, with one pneumatic cylinder manufacturer successfully incorporating up to 9 stages in their cylinder designs. Telescopic cylinders require careful design as they are subjected to large side forces especially at full extension. The weight of the steel bodies and the hydraulic oil contained within the actuator create moment loads on the bearing sur- faces between stages. These forces, combined with the load being pushed, threaten to bind or even buckle the telescopic assembly. Suffi- cient bearing surfaces must therefore be incorporated in the design of the actuator to prevent failure in service due to side forces. Telescopic cylinders must only be used in machinery as a device for providing force and travel. Side forces and moment loads must be minimized.

Telescopic cylinders should not be used to stabilize a structural com- ponent. Hydraulic telescopic cylinders are often limited to a maxi- mum hydraulic pressure of 2000-3000 psi. This is because the out- ward forces produced by internal hydraulic pressure tends to expand the steel sleeve sections. Too much pressure will cause the nested sleeves to balloon outward, bind the mechanism and stop moving. The danger exists that a permanent deformation of the outer diameter of a sleeve could occur, thus ruining a telescopic actuator. For this reason, care must be taken to avoid shock pressures in a hydraulic system us- ing telescopic cylinders. Often such hydraulic systems are equipped with shock suppressing components, such as hydraulic accumulators, to absorb pressure spikes.

Double acting cylinder

Double acting rod style cylinder, the Double acting telescopic cylinder is extended using hydraulic or pneumatic pressure but retracts using external forces when the fluid medium is removed and relieved to the reservoir. This external retraction force is usually gravity act- ing on the weight of the load. This external weight must obviously be sufficient to overcome the friction and mechanical losses within the machine design even after the work portion of the machine cycle has been accomplished. In the example above of the dump truck, the weight of the dump body, now raised at an angle of 60 degrees but empty of the load, must be enough to force the pressurized hydraulic fluid out of the cylinder and cause it to retract to the fully collapsed position.

Chain Mechanism

Balance the load of platform and to keep it in horizontal position dur- ing functioning, a leaf chain has been used crosswise such that LH side end of it is fixed to the base of LH column and the other end is fixed to the top side of the RH column. This chain passes over the rollers mounted on the Z profiles and below the platform across. Thus there is no need of two cylinders for lifting the loaded platform.

The lifting of the platform is achieved through hydraulic power while the lowering of the platform is by gravity. There is a solenoid operated valve fitted at oil port of the cylinder. During upward stroke pressurised hydraulic oil is pumped in the cylinder at about 160 bar. During lowering the valve is simply opened electrically and oil is drained to the tank. As the hydraulic oil acts as buffer there is no jerk or impact or banging during lowering the platform.

The platform is positioned along its length with respect to columns such that position of CG of the platform as well as that of loaded plat- form are close to column vertical axis. This helps to avoid more num-ber of columns and also the wear of guide pieces. Both the columns have a base which can be grouted to the concrete floor using hammer drive expansion type foundation bolts.

Safety Mechanism

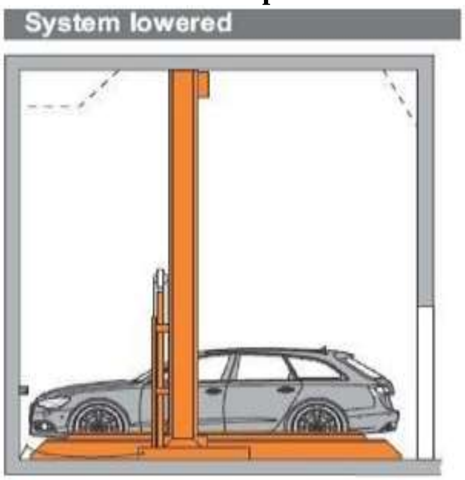
Avoid the falling of the platform in case of any kind of leakage of oil through cylinder or otherwise, there is an electromagnetically operated device called as 'fall protector' is fitted on the LH column. It acts as a safety device. The dog of the fall protector gets attracted towards the electromagnet during required downward stroke. Its function is very much similar to door latch.

Safety features of multi-parking syaytem

1. Magnet lever for mechanical safety front side. Avoids unintentional lowering of platform. Chain Sprocket Safety. Safety for chain sprocket during operation.
2. Safety limit switches for mechanical safety at rear side. Safety against unintentional lowering of platform.
3. Chain slack safety switch. Safety against platform tilting during operation.
4. IVCar entry sensor for safety. Safety for people at the entry position against accidents.
5. Rear Limit Switch. High quality limit switch for vertical limit sensing.Read switch. Magnetic Imported Read Switches for non-contact sensing of end positions for horizontal movement platform.
6. Control Panel. Mitsubishi PLC, Siemens Switchgear, continuous ferruling system for ease of identifications for Maintenance.

IV. WORKING

Step 1



Step 2

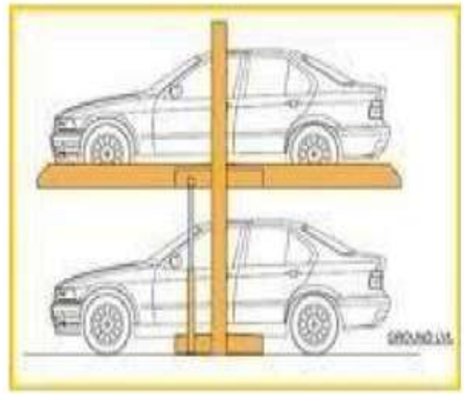


Figure 4.1: System-Lower

Step 3

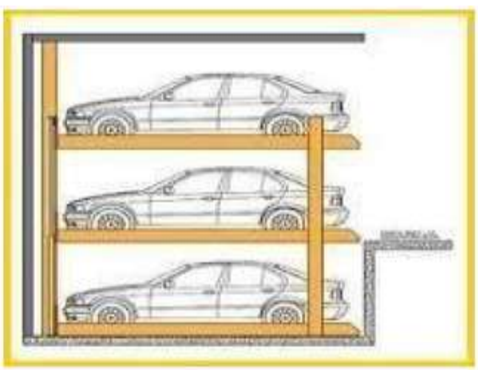


Figure 4.3: System-Middle-Position

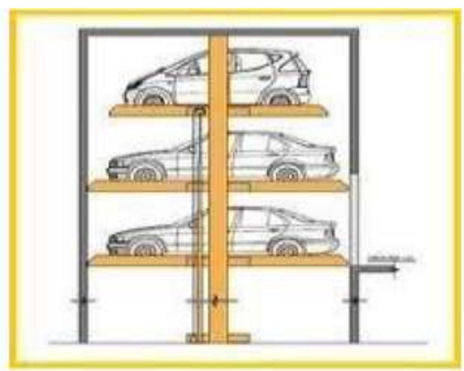


Figure 4.4: System-Lifted

V. DESIGN INPUTS

1. Platform Size :

Suitable for mounting of various vehicles, 4 wheel- ers weighing up to max. 2500 kgs. Size to be minimum possible considering safety.

Length 3800 mm x Width (min. 1900 mm Max. 2400 mm)

2. Pay Load Capacity : Pay Load Max. 2500 Kgs(Benchmarked Specifications)

FAW : 60

RAW : 40

3. Max. Safe Pay Load : 2500 x 1.1 = 2750 KgsFAW : 60

RAW : 40

4. Test Pay Load : 2700 x 1.1 = 2970 Kgs

FAW : 60

RAW : 40

5. Loading Location :

Min. Distance between Front / Rear Tyres is 1180 mm (Wagon R) Tyre Width is 120 mm.

Hence Load is to applied in area 120 mm x 50 mm and centrally width wise at 1300 mm

6. GI Profile :

Load : Vertical, 726 Kgs

Loading Points :Min. 650 mm from centre on both sides on area 120 mm x 50 mm

Max. 900 mm from centre on both sides on area 120 mm x 50 mm

Boundary Conditions : Profiles supported on Z-Profiles at both ends.

Analysis to be done for GI Profile widths 2050.

7. Cross Members :

Load : Vertical, 726 Kgs

Loading Points: Min. 650 mm from centre on both

sides on area 120 mm x 50 mm
Max. 900 mm from centre on both sides on area 120 mm x 50 mm Boundary Conditions : Cross Member supported at both ends.
Analysis to be done for Cross Members of Length 2100.

8. **Rod End Bracket :**
Load : Vertical, 2420 Kgs + Weight of All Moving Parts (Width 2100.)
Loading Points : Cylinder mounting location Boundary Conditions : Column supported at one end.

9. Z-Profiles + Cross Members :
Load : Vertical, 726 Kgs on Cross Members below wheels + Weight of Cross members
Loading Points : Min. 650 mm from centre on both sides on area 120 mm x 50 mm
Max. 900 mm from centre on both sides on area 120 mm x 50 mm Boundary Conditions : Cross Member supported on and bolted to Z-Profiles at both ends. Z-Profiles are fixed.

10. Z-Profiles + Cross Members + GI Profiles:
Load : Vertical, 726 Kgs on Cross Members below wheels Loading Points : Min. 650 mm from centre on both sides on area 120 mm x 50 mm
Max. 900 mm from centre on both sides on area 120 mm x 50 mm Boundary Conditions : Cross Member supported on and bolted to Z-Profiles at both ends.
All GI Profiles supported on and bolted to Z-Profiles at both ends. Z-Profiles are fixed.

11. Rod End Bracket :
Load : Vertical, 2420 Kgs + Weight of All Moving Parts (Width 2100.)
Loading Points : Cylinder mounting location Boundary Conditions : Column supported at one end.

12. Z-Profiles + Cross Members :
Load : Vertical, 726 Kgs on Cross Members below wheels + Weight of Cross members
Loading Points : Min. 650 mm from centre on both sides on area 120 mm x 50 mm
Max. 900 mm from centre on both sides on area 120 mm x 50 mm Boundary Conditions : Cross Member supported on and bolted to Z-Profiles at both ends. Z-Profiles are fixed.

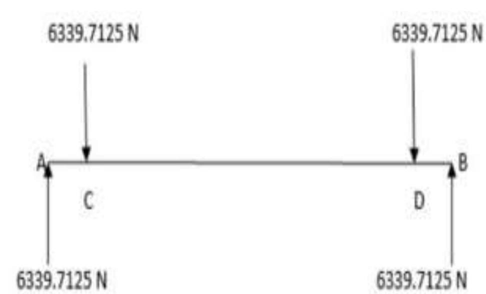
13. Z-Profiles + Cross Members + GI Profiles :
Load : Vertical, 726 Kgs on Cross Members below wheels Loading Points : Min. 650 mm from centre on both sides on area 120 mm x 50 mm
Max. 900 mm from centre on both sides on area 120 mm x 50 mm Boundary Conditions : Cross Member supported on and bolted to Z-Profiles at both ends.
All GI Profiles supported on and bolted to Z-Profiles at both ends. Z-Profiles are fixed.

VI. SYSTEM DESIGN CALCULATION

1. Calculation FBD, SFD & BMD
Fy=0
RA + RB = 12679
MA = 0-608.6124 - 14606.6976 + RB 2.4 = 0 RB=6339.7125N
RA = 6339.7125N
Mmax = 608.6124
Section modulus (Z) = $(bd^2)=6 = 0:12(0:05)^2=6$
$= 0:00005mm^3$
=
Mmax=z=608:6124=0:00005
$== 121N=mm^2$
FOS = (Yieldstrength)/(Allowablestrength) = 380/121:72 = 3:1218
Therefore factor Of safety for platform = 3:1218

2. Calculations for guide pins
Eccentricity = 273mm Couple produced due to eccentricity
= 6922.96/2
= 3461.48 Nm

1.1 m Distance between guide pins = 1.1m



Reaction produced at guide pin = F
Couple = F x 1.1
F=3146.8
F = 3146.8 N

3. Calculations of Cylinder
Calculations for bore and capacity of hydraulic cylinderAvailable Data:

Total no of vehicle to be accommodated= 3 Weight of each vehicle=2000kg
Size of platform = 2.1m x 3.8m
Size of vehicle = 5m x 1.65m x 1.95m

3. Calculation Parameter

Sr.	Parts	Diameter
1.	Single cylinder	73.87mm
2.	Double cylinder	52.2mm

Calculation:
Weight of platform to be lifted =500kg Max weight of vehicle = 2000kg
Total weight to be lifted for 1 platform = 2500kg
For design safety considering additional 500kg so total weight to be lifted = 3000kg
Max hydraulic pressure for power pack = 160 kg/cm2
Std operating pressure intencity140kg/cm2
Case 1: If two cylinders are used Capacity of each cylinder
=3000 kg /(4) x d2 x 140 = 3000 kg d = 5.22 cm = 52.2mm
Case 2: If one cylinder is used
Capacity of cylinder = 6000 kg /4 x d2 x 140 = 6000
d = 7.387 cm = 73.87mm

VII. CAD DRAWING

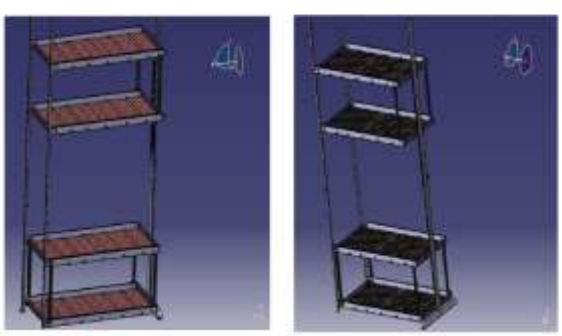


Figure 6.1: Final Modal Assembly (a)
Figure 6.2: Final Modal Assembly (b)

VIII. ANALYSIS OF PARTS

Analysis of Top Joining Member

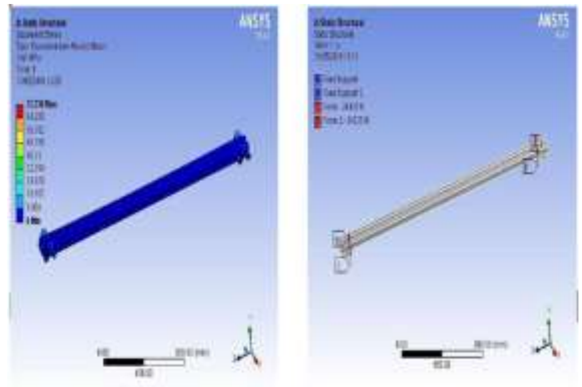


Figure 7.1: Loading on Top joining member
Figure7.2: Stress on Top joining member

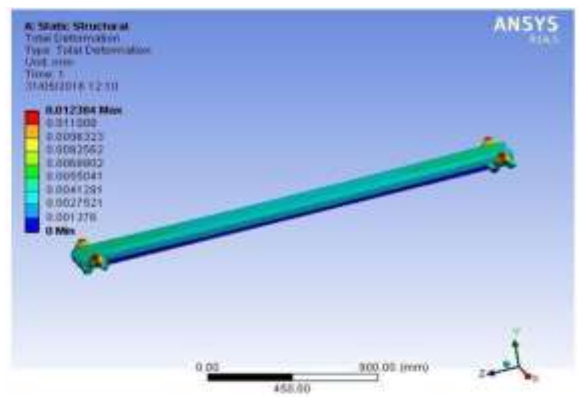


Figure 7.3: Deformation of Top joining member

Analysis of Base Frame:

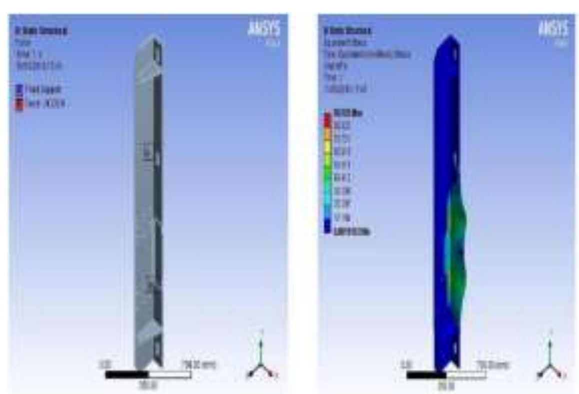


Figure 7.5: Loading on Base Frame
Figure 7.6: Stress on Base Frame

Top Joining Member:
Material = MS -EN8
Syt = 465 N/mm2
FOS = 2
Max Equivalent Stress = 72.234 N/mm2

Permissible Stress = 232.5 N/mm2

Base Frame

Sr.	**Parts**	**Syt (N/mm2)**	**FOS**	**Per=Syt/FOS (N/mm2)**	**max (N/mm2)**	**Defrm.**	**Remark**
1.	Top Joining Member	465	2	232.5	72.234	0.0124	Safe
2.	Base frame	465	3	155	90.926	0.37	Safe

Table 8.1: Verification

IX. CONCLUSION

1. Stress Analysis shows that the design is found satisfactory and safe.
2. Equivalent Stress is been found below the permissible stresses, hence the design and analysis is fine and in safe condition.
3. To overcome the space problems in metro cities different customized solutions for car parking are possible. 4 DP car park is one of them.
4. DP car parking is possible using two cylinder.

X. FUTURE SCOPE

1. There is a scope for development of different solutions for creating space for parking of maximum number of cars as per need.
2. Also there is a scope to develop a simple user friendly solution for multilevel parking systems for 2 Wheeler.
3. This automated car parking system can be installed with safety installations such as,whenever there is any human movement in the system, the rotation of the platform should be immediately stopped.
4. The platform can also be equipped with safety sensors guiding the movement of the vehicles in the platforms.
5. As it not completely possible to design the whole parking system with the structure containing the column in actually we'll try to make the best of the replica of the model.

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