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Concept design and proto build of Roto parker for two wheeler

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Abstract

In metropolitan cities, vehicle parking has become a major concern in all busy areas. Thus arises a need for a parking system that can park more number of vehicles in a limited or available space. As there is a gradual increase in number of two wheelers day by day there also increases the need for parking space. The parking space can be utilized to the maximum if a multilevel parking system is designed. There exists a multilevel parking system for cars such as puzzle parking, tower parking, multi-circulation type, rotary type parking system. Our project is concerned with rotary type parking system for two wheelers. The present project work is aimed to designing of a two wheeler parking system to park 20 two wheelers in a parking space of 30m².The chain and sprocket mechanism may be used for driving the parking platform and a suitable powered brake motor is implemented for powering and indexing the platform. The prototype of a platform assembly is fabricated to suit the working model. This model is further useful for different branches of engineering in order to develop different type of automations microcontrollers and computerization etc.

1. INTRODUCTION

The first question that we may encounter while explaining our project is "What is the need of multilevel parking system?"So we would like to introduce our project by answering the above question. The answer for above question would be, parking more vehicles in limited available space and space constraint is the major objective of this project. One more advantage of this project would be a mobile parking system if this entire parking system assembly is anchored on a truck or a carrier. We are using the same type of mechanism found for rotary parking system for cars and that is modified to the parking of two wheelers. Below are some of the parking systems available for cars and reasons are quoted why they can't use for parking two wheelers.

2. LITERATURE REVIEW

There are no parking systems available for two wheelers. Based on the parking systems that are used for four wheelers, a parking system for two wheelers may be designed and fabricated.

2.1 GROUND PARKING

This is the parking situation found in metropolitan cities. There is a great demand for parking space. We even find parking full board on weekends everywhere in the growing cities. Hence to get rid of the specified problem a multilevel parking system needs to be developed where more number of vehicles are parking in a limited or available space. One such type of parking system found for two wheelers are linear hydraulic parking system.

Fig.1

2.2 VERTICAL HYDRAULIC PARKING SYSTEMS

Using the hydraulics a parking system is developed for bikes in Pune. It has the capability of parking two bikes in a space used for parking one bike.

Fig.2

2.3 INTEGRATED PARKING SYSTEMS (REF NO.1 & 2)

This Provides total consulting such as demand forecasts, recommendation of a desirable parking system and design of safety measurements. Customized application suitable for various types of landscapes and buildings, Structure available below and above ground. Reducing management cost through precise control and low power consumption. User's easy control by soft touch on the operation panel screen Simultaneous vertical and horizontal movement for short waiting periods. When a vehicle stops in front of the entrance, automatically door opens, trolley transfers the vehicle to parking cell. Very safe for the driver with no need to stay in the vehicle.

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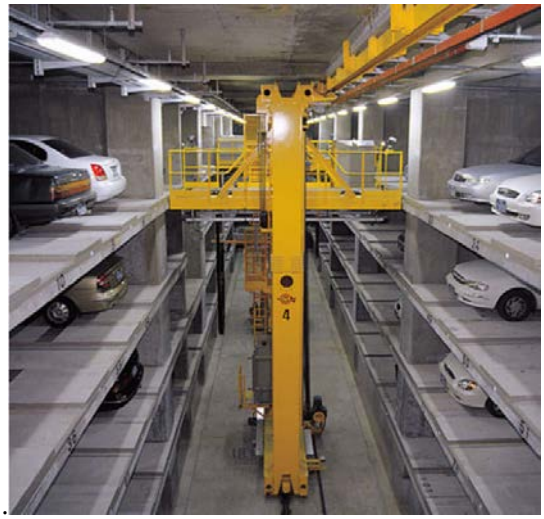
Fig.3



2.4 ROTARY PARKING SYSTEM (REF NO. 3)

It is simple to operate with the driver parking and leaving the vehicle in the system at the ground level. Once the driver leaves the incorporated safety zone the vehicle is automatically parked by the system rotating to lift the parked car away from the bottom central position. This leaves an empty parking space available at the ground level for the next car to be parked on. The parked car is easily retrieved by pushing the button for the relevant position number the car is parked on. This causes the required car to rotate down to ground level ready for the driver to enter the safety zone and reverse the car out of the system. Except Rotary Parking System all other systems use a large ground area, Rotary Parking System is developed to utilize maximum vertical area in the available minimum ground area. It is quite successful when installed in busy areas which are well established and are suffering with shortage of area for parking. Although the construction of this system seems to be easy, it will be par from understanding without the knowledge of materials, chains, sprockets, bearings, and machining operations, kinematic and dynamic mechanism

3. MECHANICAL COMPONENT

3.1 BEARING

Ball bearings used to take radial load and allow the rotary element to rotate about the support of stationary elements

3.2 CHAIN DRIVE MECHANISM **(Ref no. 4)**

Chain drive to transfer the torque from drive motor to main shaft of the Roto parker with the appropriate rpm

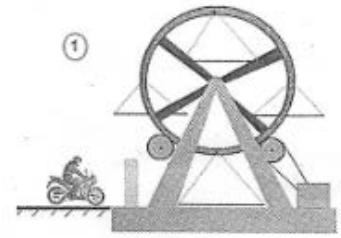
4. PROBLEM STATEMENT

4.1 WORKING MECHANISM

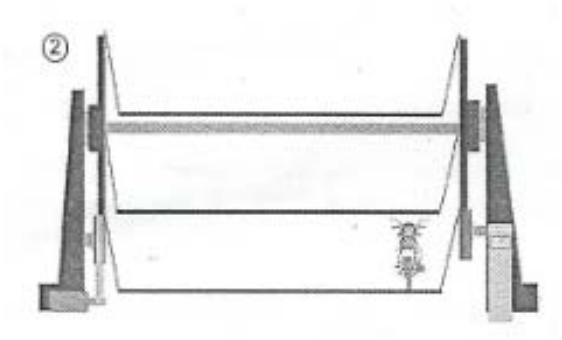
When a two wheeler arrives for parking, the driver can park his vehicle in the empty slot and when the entire platform is filled with specified number of bikes the platform is carried.

The computer then activates the motor so that the vehicle rack is stacked up and the next vacant space is ready for next customer. When the person wants to retrieve the vehicle he must come to the opposite side of the Roto-Parker and the fare for the parking time is collected and the respective bike holding platform is retrieved.

1) Driver arrives for parking, see below fig



2) Parks the bike in empty slot, see below fig



3) The motor is activated and the bike is stacked up in the Roto-parker, see below fig

4) Empty slot is kept ready for next driver, see below fig

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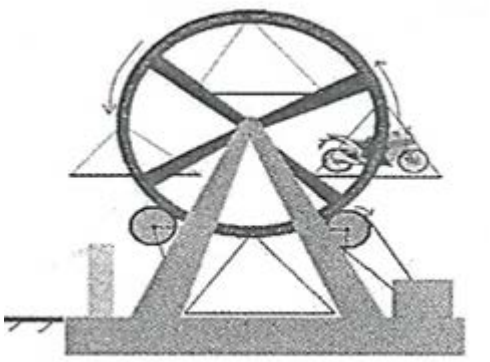
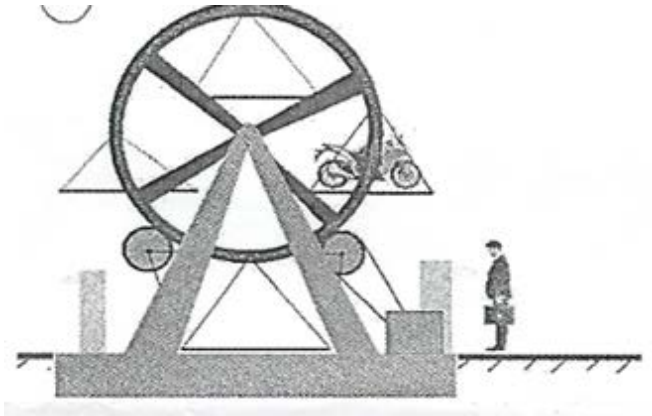
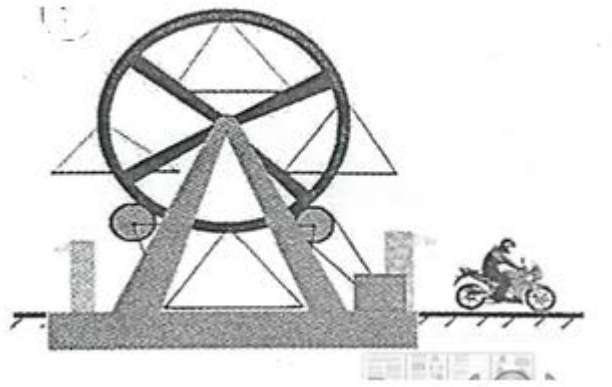


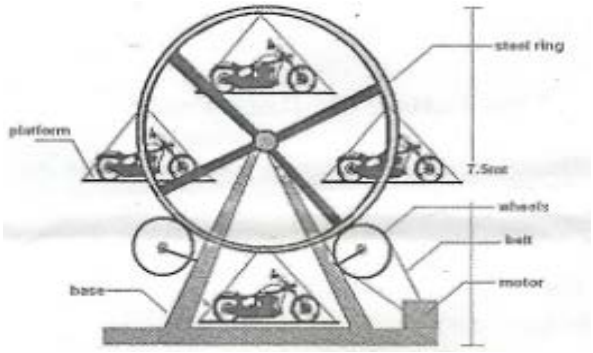
5) When retrieving the vehicle, platform is identified and is brought down, see below fig



6) The driver takes the bike and rides off, see below fig

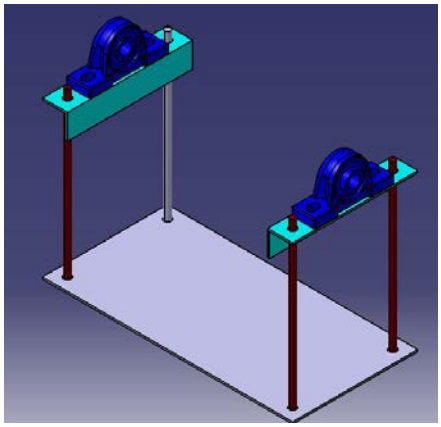


The Roto-Parker with full parking looks similar to a giant wheel where the platforms are hanged to the steel beams.



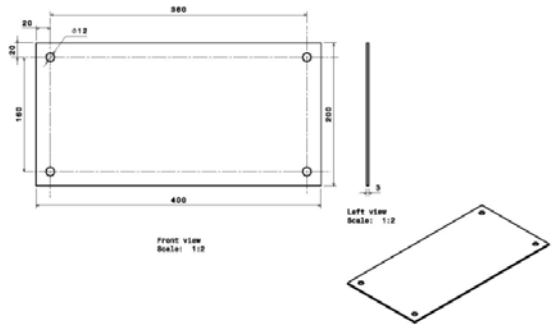
6. MODELING

6.1 PLATFORM ASSEMBLY



The above platform is designed for parking five bikes and the various parts in the above assembly are Platform, Hanging rods, Bearing blocks and L-Shaped blocks

6.1.1 PLATFORM, Fig 4



The platform is made from mild steel and has a length of 4500mm and a width of 2250mm.Based on the weight considerations for the platform, the thickness of the platform is selected as 11mm.

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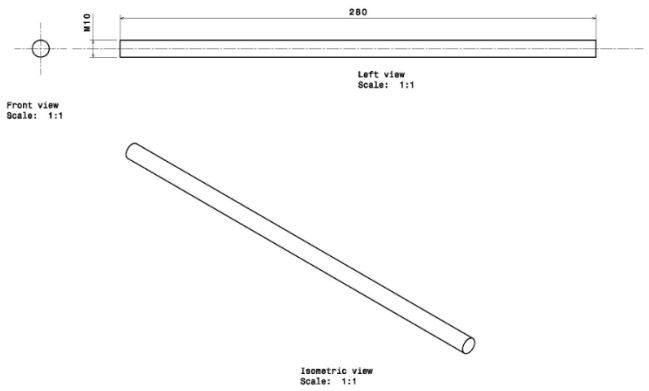
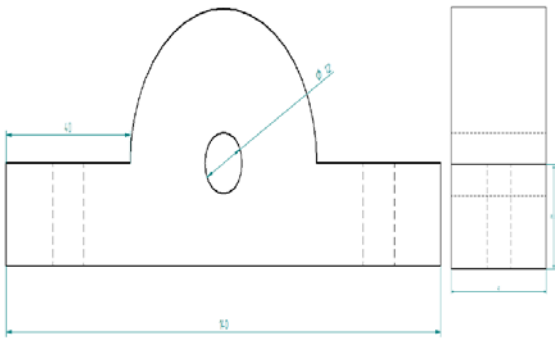
6.1.2 HANGING RODS, Fig 5



The height of the platform assembly is based on the height of the bikes and a person who comes to park the bike. A height of 2m is sufficient for this purpose. Hence the height of this hanging rods on the four corners of the platform is selected as 2m.

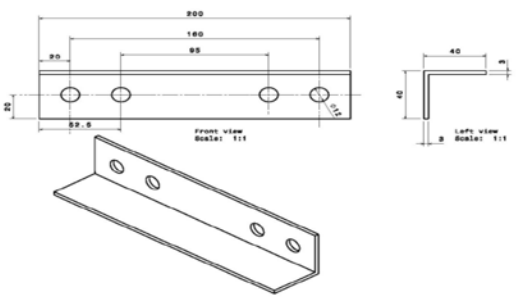
6.1.3 BEARING BLOCK, Fig 6



The bearing block is the housing for the accommodation of ball bearing. The bearings are used in this model in order to keep the platform always parallel to the ground. In general, maximum load on a ball bearing is proportional to outer diameter of the bearing times width of bearing. The total weight is shared by two ball bearings to keep the platform parallel to ground.

From design data hand book for the total weight of the platform considering the full load conditions two bearings of 25mm each can be used.

6.1.4 L-SHAPED BLOCKS, Fig 7



L-shaped rods are used in the model to accommodate the hanging rods and a bearing block. There are four hanging rods that hanged to carry load and each L-shaped rod can have two hanging rods. Hence there is a requirement of two rods. L-shaped rods are taken as square cross section and the dimension of this is 55mm*55mm as calculated.

7. CALCULATIONS(Ref 10)

The following specified dimensions are used for the platform for parking five bikes

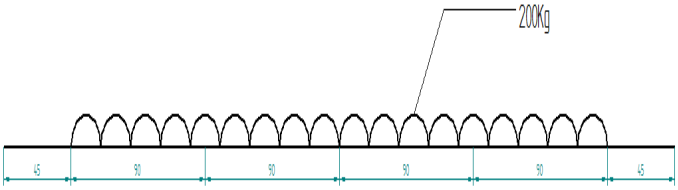
Length =4500mm, Width=2250mm

The load applied on steel sheet is maximum when the platform is completely filled with bikes that is 5 bikes

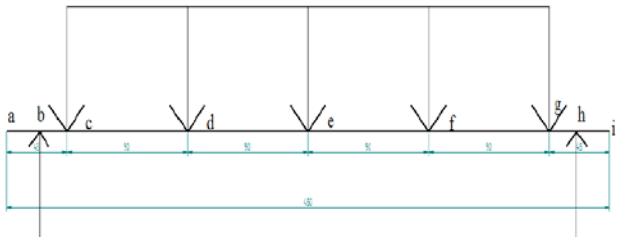
The load may be considered as uniformly distributed load (UDL) under full parking

Total load imposed on full parking

Considering the weight of each bike to be 200Kg



7.1 FREE BODY DIAGRAM



Weight=Mass*Gravity

=200kg*9.81 =1962N

7.2 SUPPORT REACTIONS

Rh=4905N

Rb+Rh=5*200*9.81 =9810N

Rb=9810-Rh =9810-4905 =4905N

7.3 BENDING MOMENTS

mA =0, mB=0, mC=981000N-mm

mD=3629700N-mm,mE=4512600N-mm

mF =3629700N-mm,mG=98100N-mm

BENDING MOMENT DIAGRAM

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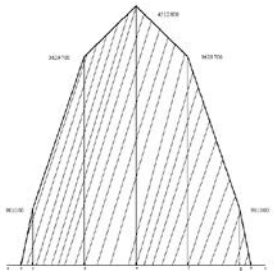


Considering maximum bending moment that occurs at point "e" due to the applied load (mb/I=σ/C)

Where σ=230Mpa and considering FOS of 2

C=h/2, mb=4512600N-mm ,I=(bh³/12)

=(2250*h³/12)

h=10.229mm

Self wt=795Kg

Total weight=1000+795==1795Kg

Total weight due to four platforms

=1795*4=7180Kg

This total weight is to be carried by four hanging rods. On full load conditions the total weight that is shared and tension in each rod is as calculated below.

7.4 TENSIONS IN RODS

Total number of rods =4

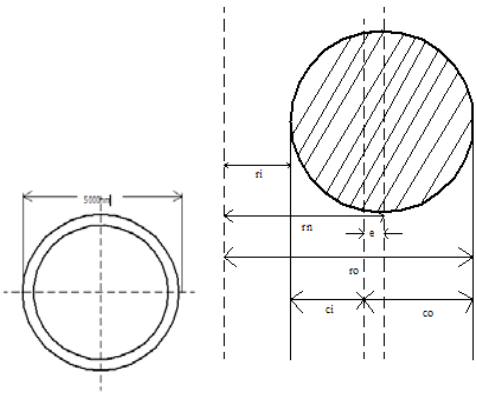
Total weight=1795Kg

w=44022N

$$\frac{\frac{w}{4}}{\sigma} = A$$

d=7mm

7.5 DESIGN OF CIRCULAR RING



One circular ring on each side of the rotor arms are required in order to prevent the platform carrying arms from bending due to the weight. The total weight due the loading of platforms is equally shared between two rings.

Therefore weight on each ring=$\frac{w}{2}$=7180/2

=3590Kg

A=$\frac{F}{\sigma}$

d=19.74mm=20mm

The diameter of the ring is 5m

Therefore Circumference=2πr=2π*5000=15700mm

Inner radius=4980/2=2490mm

Outer radius=5000/2=2500mm

Radius of centroidal arms=Rc=Ri+($\frac{d}{2}$)

=2490+(17/2) =2498.5mm

Radius of neutral axis=Rn

$$=\frac{(\sqrt{Ro}+\sqrt{Ri})^2}{4}$$

=2495mm

Distance from centroidal axis to neutral axis=e

=Rc-Ro=2500-2495
=5mm

Distance from inner radius to neutral axis =Ci

=Rn-Ri=2495-2490
=5mm

Distance of outer radius from neutral axis=Co

=Ro-Rn =2500-2496 =5mm

Bending moment=Mb=0.318F*Rc

=0.318*7180*9.81*2498.5

=55962.86N-mm

$$\text{Bending stress}=\frac{Mb*Co}{A*e*Ro}$$

=71.25Mpa

7.6 TORQUE ON RING:-

Considering factor of safety 2

$$Mf=\frac{Wt*g*L}{FOS}$$

= 88044.75 Nm

7.7 DESIGN FOR ASSEMBLY:-

A=Major axis, B=minor axis=0.5 A

N= no. of arms=8

Max bending moment at the lug which is assumed as cantilever and is given by

$$M=\frac{T(R-r)}{R*N} = \frac{T(D-d)}{D*N}$$

M=44 Nm,

Section modular of C/S of arm

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$Z=\frac{\pi}{32}*b*a^2$

$=\frac{\pi}{32}*0.5a*a^2$

$Z=0.05a^3$

Bending stress

$\frac{M}{Z}$ = 71.25 N/mm^2

a =23.11mm,b =11.55mm

7.8WEIGHT OF ARMS:-

Weight = length*breadth*height*density

=23*11.5*2.4*7850 =5.03Kg

N=no. of arms=8

Total wt =8*5.03=40.24 Kg

TOTAL WEIGHT:-

Wt of arm +Wt of Platform=7180+40=7220Kg

7.9 DESIGN OF SHAFT:-

Torque on ring mf=88044.75Nm

Bending moment=$\frac{w*l}{4}$=88535.25Nm

For simply supported beam, assume Kb=1.5 and Kf =1

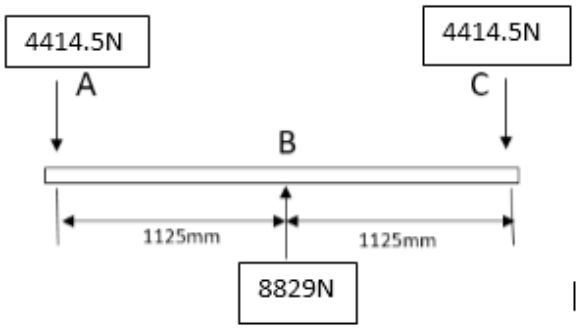
Max tensile strength of Fe 250(σ)=310 Mpa

Dia of shaft:-

$D= (\frac{16}{\pi*\sigma}(Kb*Mb+((Kb*Mb)^2+(Kb*Mb)^2z)^{1/2})^{1/3}$

D=166.28 mm

7.10 DESIGN OF BEAM:-



Total length of cross beam=2250mm

Weight on each side=(800+1000)/2

= 900 Kg

Weight on each rod side=450Kg

450*9.81=4414.5N

900*9.81 =8829 N

mbA =0

mbB =4414.5*1125

=496631Nm

mbC =0

Maximum bending moment

$\frac{mb}{I}=\frac{\sigma}{C}$

h=63.75mm

Weight of cross beam=b*h*l*ρ

= 138Kg

7.11 TOTAL WEIGHT OF PLAT FORM:-

=Platform wt+ bike wt+ rod wt+ connecting rod+ cross beam wt+ accessories

=800+1000+2.5+130+110+20=2062.5Kg

Total 4 platforms in the roto parker

=4*wt of each plat form=8250Kg

7.12 MOTOR DESIGN:-

Torque required to rotate the shaft is =189750Nm

Assuming 1 rotation of parker per min, N=1RPM

P=19.87KW

So the Power of motor required to run the Roto parker is approximately 20KW

8. ADVANTAGES

- Quick Automated Parking and retrieval of vehicles.
- 20 bikes can be easily and safely parked.
- Surface space required equivalent to just 12 ground space parking.
- Most suitable for Staff or dedicated user parking.
- Engineered to ensure driver safety.
- Low maintenance levels required by the system.
- Does not require a parking attendant.
- Easily constructed in a small area, just requiring a simple concrete base and 3 phase electricity.

9. SCOPE FOR FUTURE WORK

This Roto-Parker system can be installed with safety installations such as, whenever there is human movement in the system, the rotation of the platforms should be immediately stopped. The platforms can also be equipped with safety sensors guiding the movement of vehicles in the platforms. It can be fully automated by integrating it with a panel board, such that whenever a particular number is called on the panel board, the respective platform should appear at the ground level. This calling can also be made more secured by providing each platform a specific password, so that only whenever a particular password is typed the platform is retrieved. It can also be programmed, so that the platforms travel the minimum distance in the retrieval of the vehicle.

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10. CONCLUSIONS

Our Roto-Parker model has been designed; all the parts in it are manufactured and we are under assembly which will be completed soon. Analysis of the model has to be done when developing a life size model. As the life cycle model involves huge money, proper design and advanced methods are to be used to meet the requirements of the customers. Although we developed working model of the original one, we tried maximum to develop a replica of original and we were compromised only in those stage where the work cannot be completed by assuming or neglecting few factors.

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