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CASE STUDY OF CYCLE RICKSHAW ON ERGONOMIC BASIS

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Abstract: *The cycle rickshaw is a modified tricycle, which is used extensively as a mode of transport for carrying passengers and luggage. All over India, about 10 lakh persons earn their livelihood by pulling cycle rickshaw. The cycle rickshaw pullers undergo heavy physical work during carrying passengers. Besides, the pullers have to work in hot summer and rainy season.*

The objectives of the present study were to develop a new design of cycle rickshaw, which would be more comfortable for the driver to pull with lesser effort as well for the passengers to board and travel.

In India, Rickshaws are one of the most important means of transportation. In the past years, the changes that took place in the design of the vehicle have not been very prominent. The initial framing structure is still being followed where the seats are at a higher level creating ingress and egress problem, no head cover for the rickshaw puller and no place to keep the luggage. The faults or disadvantages of this design made it necessary for it to be re-designed, keeping in mind the elderly along with the needs of the rickshaw puller who may also be aging.

The basic purpose of this re-design was to develop some easy mode of transportation for the elderly. Taking into consideration the infirmity of old age, the first alternative proposed was a low floor and a low seating with proper framing structure to hold. This solved the ingress and egress problem. The next proposal was a head cover for the rickshaw puller for which the cover for the change required to safeguard against extreme climatic changes. To reduce the effort of the puller a small helping electric motor was installed in the wheel axle.

Keywords: *Ergonomics, Anthropometry, Factor of Safety, Speed controller*

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I. INTRODUCTION

Cycle rickshaws are commonly used mode of transportation in India. The basic rickshaw is a three wheeled tricycle design, pedalled by a human driver in the front, and with a back seat in the rear for passengers or for conveying luggage. As for taxis, passengers are required to pay for travelling in a rickshaw from one place to another. There are estimated ten million cycle rickshaw pullers in India. As such, rickshaws serve as a mean of employment for poor rural citizens who have migrated to cities in search of work. Without proper training and skills needed to get a desired job, those unable to find a better livelihood rent a rickshaw instead, in an effort of making a living.

Cycle rickshaws reduce pollution, eliminate fuel consumption, are low cost, road safe, increase employment and promote small scale industries. For example in Delhi, there are more than 500,000 passenger cycle rickshaws. Each travels 25-30 km/day and makes 6-8 passenger trips/day or about 1.5 million trips every day; directly and indirectly supporting nearly 2 million people. They occupy less than half of the road space per passenger in a car and produce no pollution at all. Imagine what an environmental and social disaster it would be if all these rickshaw trips changed into motorized trips. Governments of developing countries are doing away cycle rickshaws in the false belief that rickshaws portray the image of being under developed. Cycle rickshaws are fast loosing patronage as inefficient and unsafe.

There is a demand to make rickshaws comfortable and safer to promote their usage. To garner support from local governments and public groups, changing their image through media and public awareness campaigns are necessary. This will help in the creation of an infrastructure for safe plying of cycle rickshaws. The promotion of local small scale industry utilizing appropriate technology to manufacture technically sound and safe cycle rickshaws is the need of the day.

The private sector does not innovate on its own when the profit margin is too low. The producers are risk-averse small businesses and consumers are risk-averse low income people. But underwriting the risks of new product development, marketing and dissemination can overcome these barriers to modernization.

Driving rickshaw is often the only available job for the poor who migrate to urban areas. Modernizing the cycle rickshaws not only reduces the stress on the drivers but also

improves their income earning capacity. Adding a non-polluting electric motor to the cycle rickshaw would only further increase the daily rental cost beyond the reach of the current cycle rickshaw driver. The increase in income would have only been marginally higher.

II. MARKET SURVEY

Even though cycle rickshaws are one of the most popular modes of Transportation, the cycle rickshaw industry remains a highly unorganized Sector; almost 95% of the cycle rickshaws in any given city are run on a daily rent basis and are not owned by the cycle rickshaw drivers.

- The cycle Rickshaw-pullers are usually exploited by the owners, who otherwise claim to be charging a nominal rent for their cycle rickshaw.
- Several studies and surveys have been conducted to find out the income and spending habits of rickshaw pullers in Delhi. Most studies have found that, on average, a rickshaw puller earns between 150 to 300 rupees per day
- The average monthly income of a rickshaw puller is between 1200 to 4500 rupees. But the earnings vary from day to day and season to season.
- Almost 90 percent of the rickshaw pullers rent rickshaws from large rickshaw owners on a daily basis. On average, a rickshaw puller spends about 50 rupees per day on rickshaw rent. The rest of his earnings go towards food and medicine, and in some cases, a big portion of the earnings goes towards alcohol and tobacco. Any remaining money is sent home to be saved.
- Most rickshaw pullers cannot afford an accommodation as the rents are quite high. Many rickshaw pullers sleep on the pavements and the footpaths, under flyovers and bridges. Those who live in rented accommodation spend a considerable amount of their earning on paying rent.
- 'Eco cabs' is the name given to the traditional Indian cycle rickshaw operations after adding to its facilities like "dial-a-rickshaw." These are cycle rickshaw services made available on phone call at one's door step through a network of call centers, similar to dial-a-cab/taxi service. Introduced in a town, Fazilka located in the state of Punjab, India, the scheme is a first of its kind in the country as well as in the world. Aimed at improving the unorganized cycle rickshaw transport system in the town and providing affordable means of mobility to the city residents, the scheme has been a success in the city and earned accolades, both nationally and internationally.

- In India, Rickshaws are one of the most important means of transportation. In the past years, the changes that took place in the design of the vehicle have not been very prominent. The initial framing structure is still being followed where the seats are at a higher level creating ingress and egress problem, no head cover for the rickshaw puller and no place to keep the luggage.

With the improved technology in the modern world making every aspect of life faster, easier and more accessible, the development of the most primary form of transportation for the passenger was only to be expected. Hence, it is to be hoped that it actualizes all the uses that were envisaged during its invention.

III. ISSUES IDENTIFIED

The concept also developed taking into consideration the previously designed rickshaw. The positive points are taken into consideration and are kept constant. The negative points are being studied and provision is made to convert them into positive points by changing the design.

The ergonomics issues that are identified are mentioned below:

1. The pullers are forced to sit a highly inclined trunk position due to the large distance between the seat and the handle. This trunk position is causing back pain and severe discomfort.
2. The absence of a back rest makes long distance rides uncomfortable.
3. The pressure on the toe is high because of the short foot pedal.
4. The positioning of the hands is not at the optimum levels for all rickshaw pullers because of the non-customizable design of the existing cycle rickshaws.
5. No roof cover for the pullers (rainy season is a nightmare)
6. Ingress and egress problem for elderly passengers due to high positioning of foot rest and seating.
7. Uncomfortable seating space for passengers

IV. PROPOSED SOLUTION

For making something for the elderly, one had to consider their movement, their psychology, their behaviour, their mentality, their likes and dislikes and many more things. So studying the elderly was the first step taken. For a rickshaw, we have to consider two groups or categories of elderly people- one who is a passenger and the other- a rickshaw

puller. So, the rickshaw to be designed should consider both the groups and provide facilities for both of them. Considering the first group as the passengers, the things that are needed to be considered are their ingress and egress problem which includes the seating height and the floor height of the rickshaw, their holding position, etc. For these things the design considerations that are made are:

- The seating height to be kept low along with the floor height so that the passenger can climb up and move down easily
- A proper frame to hold and support.
- Certain provisions are being made that can reduce their effort. This led to the provision of providing a power assistance which will help reduce their effort. For power assistance, a 350W electric motor is to be employed in the wheel axle with a throttle control. The Throttle control will provide an added advantage that the rickshaw can be driven by motor on roads with slopes or when to give an initial motion to rickshaw. When the rickshaw would have gained a momentum, the throttle can be released to drive it by pedals. When the rickshaw is being driven on 10-15 km/hr., the efforts required to pedal it are going to be very less.
- Also, a study is being carried out to reduce the efforts by adjusting the mechanical linkages. For that, we have shifted our focus towards the sprockets. The conventional drive mechanism of tricycle is provided with one set of sprocket, which gives speed ratio of two between input and output. This speed ratio is fixed for all loading conditions. More effort is required to the puller in starting from the rest or going up. Hence it is necessary to analyze various factors responsible to increase the mechanical efficiency. The most important factor is the optimal speed ratio between front and rear sprocket.
- Other than this some consideration is to be made to provide a top covering for them which can prevent them from the scorching sun and unpleasant weather. Hence for this the covering provided for the passengers could be extended till the puller.
- The new design would have a proper designed handle and seat of the rickshaw according to anthropometric analysis explained above.
- There is also a provision to increase the stability of the rickshaw by providing wheels with smaller diameter and increased thickness so that they could take up the torque

loads of the electric motor drive.

V. SOLUTIONS

- **ADJUSTABLE SEAT**

In the vast diversity of the human race there are people of different heights and it is not possible that a single non customizable design would satisfy all the ergonomic requirements of everyone. Hence to solve the problem of high trunk inclination and improper hand posture an adjustable seat has been proposed.

It was identified that that the most comfortable elbow position of the puller is between 150degrees – 165degrees. So in order to maintain this angle for the puller the need of the adjustable seat is felt. The seat has different modes of adjustment from which the puller can choose according to his/ her height.

- **DESIGN OF FOOT PEDAL**

The design of the pedal is important as it is the part which the driver has to put the force in order to drive the cycle rickshaw. When the force is applied on the pedal there is an equal and opposite force which is acts on the foot. In the standard cycle rickshaw the pedal is designed in such a way that the total force is exerted at the toe of the foot. If the cycle rickshaw is pedalled for a long time then the stress concentration on the toe would cause pain to the puller. In order to solve this problem the pedal has to be designed in such a way that the force is evenly distributed on the foot. The proposed design of the pedal is like a foot rest so that it more convenient for the puller to ride the cycle rickshaw. The foot rest is also designed using acupuncture data to ensure good blood circulation.

The most desired angle between the calf and thigh of the puller for comfortable sitting position is 150 degrees. It was observed that the angle between the thigh and the calf is 150 degrees of more number of positions than the regular pedal of the normal cycle rickshaw.

- **INTRODUCTION OF BACK REST**

One of the most common muscle pains is the back pain. In a cycle rickshaw the back is subjected to different positions which cause pain in the pullers' back. The general trunk angle of the rider while riding a cycle rickshaw is 10 degrees- 15 degrees and due to the absence of a support for the back there is high stress is a high stress concentration on the back which leads to back pain in the riders. This problem is eliminated by the introduction of a back rest.

- **INTRODUCTION OF LOW FOOT REST**

Considering the group as the elderly passengers, the things that needed to be considered are their ingress and egress problem which included the seating height and the floor height of the rickshaw, their holding position. For these things the design considerations that are made are- the seating height to be kept low along with the foot rest height so that the passenger can climb up and move down easily, a proper frame to hold and support.

- **INTRODUCTION OF ROOF COVER FOR PULLER**

The top cover is to be made in such a way that it covers both the passengers and the rickshaw puller. The design is made taking into consideration the direction of wind flow. The front covering is kept at such an angle that it saves the puller from the sun and rain. Though it does not completely save him from the rain (depends on the intensity and angle of rain) but his head and face do get covered or saved due to the cover.

The cover is kept at such height that it is at a good distance above the passengers head and also the rickshaw pullers head. Even if the puller stands up while riding the rickshaw it does not touches his head.

The roof cover is also to be given a hinged joint so that it could become foldable. The need for the foldable roof cover is that, every day is not rainy and on bright sunny winter days, there is no need of roof cover.

- **INTRODUCTION OF DC MOTOR**

On the basis of survey conducted and interviewing rickshaw pullers, a number of hardships that they face came into our limelight. Of all, the major problem for the pullers is to give an initial momentum to the rickshaw and to pull it on inclined terrains. Therefore, to solve this problem, we are introducing a DC motor in the wheel axle ran by a battery that would help to reduce considerable amount of load of the rickshaw puller.

- **SPEED CONTROLLER**

Now we attach controller with motor. An electronic speed control or ESC is an electronic circuit with the purpose to vary an electric motor's speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on electrically powered radio controlled models, with the variety most often used for brushless motors essentially providing an electronically-generated three phase electric power low voltage source of energy for the motor.

An ESC can be a stand-alone unit which plugs into the receiver's throttle control channel or incorporated into the receiver itself, as is the case in most toy-grade R/C vehicles. Some R/C manufacturers that install proprietary hobby-grade electronics in their entry-level vehicles, vessels or aircraft use on board electronics that combine the two on a single circuit board.

VI. CALCULATIONS

Maximum rpm = 3000

No of teeth on motor shaft (t1) = 12

No of teeth on reduction gear (t2) =136

We know,

N1/N2 = T2/T1

N2= (3000*12)/136

= 264.7 = 265 KM

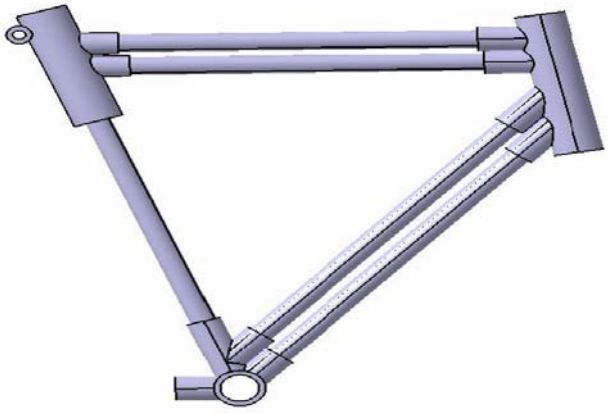
Linear velocity of rickshaw (no load condition) = 2πRN2/60

= 2π*(0.36)*(265)/60

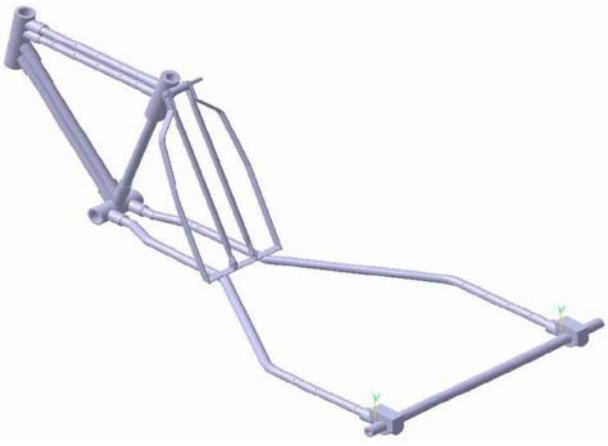
=9.98 ~ 10m/s = 36Km/hr.

VII. DESIGN & ANALYSIS

DESIGN OF FRONT FRAME



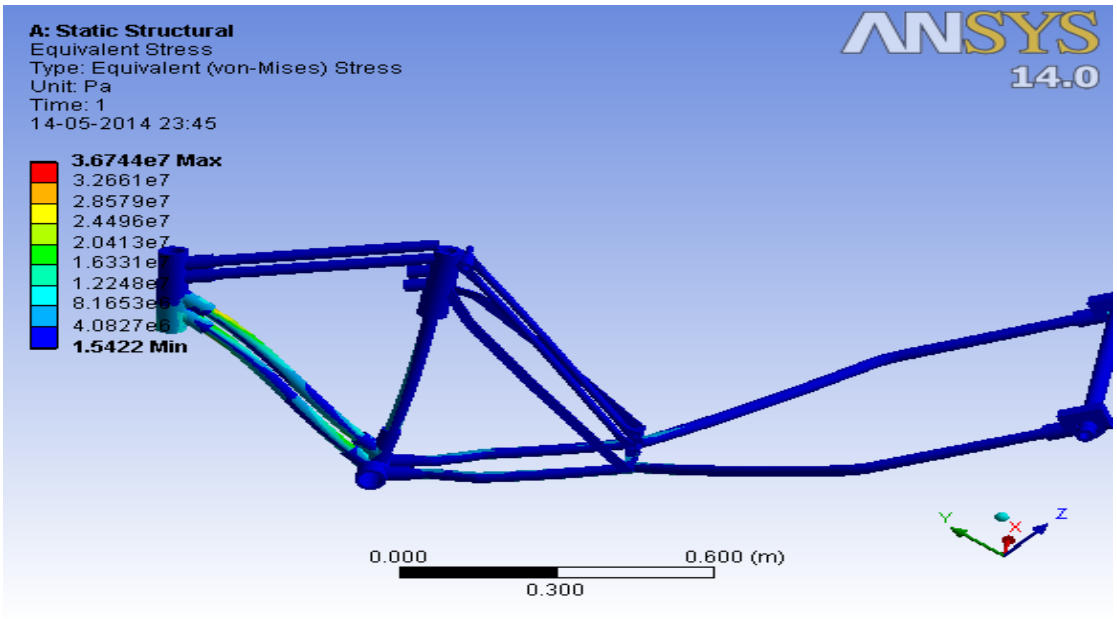
3D DESIGN (frame assembly)



VIII. STRESS ANALYSIS

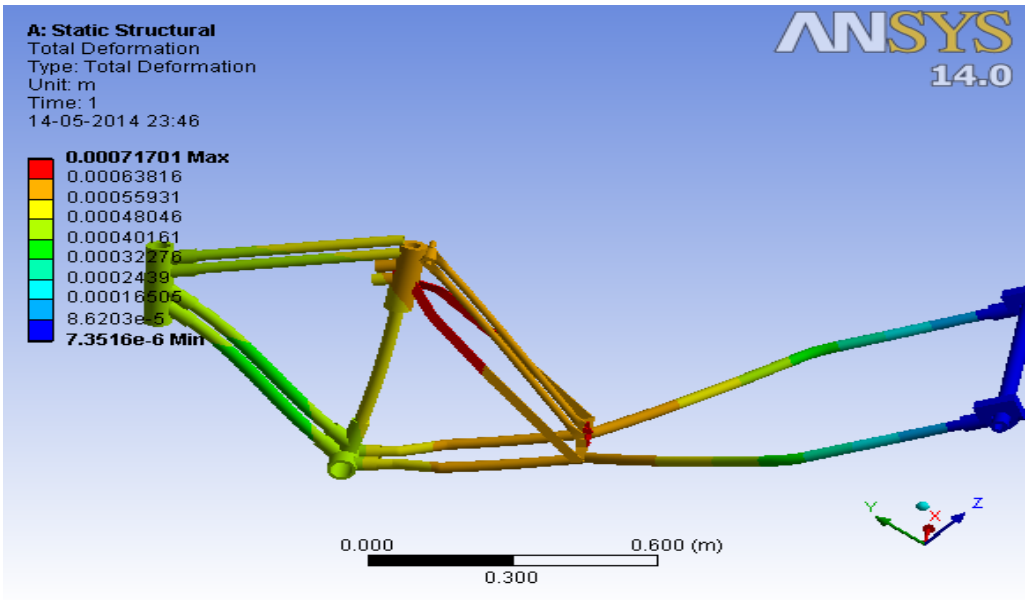
In this analysis, 700N load is delivered to rickshaw puller seat which is situated at upper end of front frame & 2000N of load is given to back frame where passengers load is seated.

In equivalent stress diagram generated by ANSYS 14.0 we get stress resolved in frame parts. And also we get maximum & minimum stress generated in the frame.



- **TOTAL DEFORMATION**

In this diagram, we get the spots in frame where deformation may be occurred when yield point stress is generated



- **F.O.S**

In this diagram, we get the factor of safety (F.O.S) in different parts of frame. In our frame minimum F.O.S is6.8.

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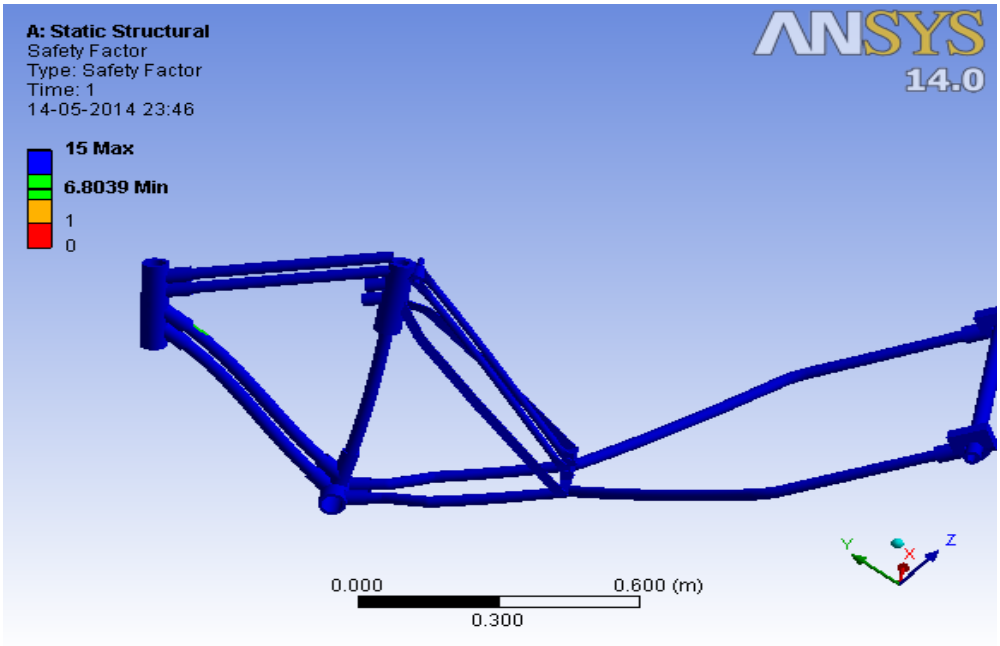

IX. FABRICATION PROCESS

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X. TESTING

Testing consists of two phases:

Phase one: - In this phase we used the battery of 12V AND 7 ah. It drives the rickshaw under unloaded condition but during loading condition, it failed to drive the rickshaw.

Phase two: - In this phase we used the battery of 12 V and 35ah. It successfully drove the rickshaw during loaded condition.

XI. CONCLUSIONS

- Low foot rest. It reduces the ingress and egress problems mostly occur for elderly people
- Introductionof motor. It reduces the efforts to drive the rickshaw for pullers

- Proper shed for passenger and rickshaw puller. It protect puller from scorching heat of sun and even in rainy season
- Reduction in the weight of rickshaw by eliminating the extra linkages.

XII. SCOPE FOR FUTURE WORK

- Charging of battery through pedaling
- Better design for shed
- Ergonomically, rickshaw can be designed in many ways
- Introduction of multiple gear system

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