

Advanced Spare Wheel Carrier

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Abstract— In the conventional mechanism spare tires in buses are often stored in a spare tire well – a roof carrier area above the roof of a vehicle, usually in the center, where the spare tire is stored while not in use. In most buses, the spare tire is not secured with a bolt and wing-nut style fastener. While this is still the most commonly used method for storing the spare wheel in a commercial vehicle such as bus, trucks etc. There are many disadvantages of this method. In order to overcome the disadvantages of this conventional mechanism we have designed and developed an ‘Advanced spare wheel carrier’ which can be used to store the spare wheel(s) in a vehicle. This mechanism uses electrically powered motor to lift and lower the spare wheel and has a suitable locking mechanism to lock up the spare wheel in the spare wheel bracket after the change of tire; it is also strategically located at the bottom of the bus to facilitate easy and safer tire changing. Proper selection of the Stepney bracket results in the lowest overall tyre changing cycle, reduced waiting time for travelers, No hard work for driver and reduces stress, & strategically located spare wheel bracket which facilitates easy and safer tire changing. Further, we have also developed CAD drawing and full scale working model to illustrate design features, feasibility and working of this model. We were also able to reduce the overall tire changing time from approximately 90 minutes to 30 minutes.

Index Terms— Automobile, Spare Wheel, Tyre, Stepney, Bracket, Carrier.

1 INTRODUCTION

A spare tire or spare tyre stepney is an additional tire carried in a motor vehicle as a replacement for one that goes flat, a blowout, or other emergency. Spare tires in buses are often stored in a spare tire well – a roof carrier area above the roof of a vehicle, usually in the center, where the spare tire is stored while not in use. In most buses, the spare tire is not secured with a bolt and wing-nut style fastener. Usually it is unorthodox method and cause headache at the time of tire changing. It is not easy to lower the 100 kg tire by single person without any mechanism. This system of storing the spare wheel on the roof of the vehicle has some major disadvantages in the form of fatigue to the driver, large cycle time, large physical stresses to the driver and decreased productivity.

So, this process is quite cumbersome, time consuming and at times unreliable. Therefore, there is need for a spare wheel bracket which makes this whole process of tire changing much easier, safer, and faster whilst avoiding any additional fatigue to the driver. The main aim of this project is to reduce the overall tyre changing cycle and stresses to the driver during the cycle. In accordance to the objectives set up by our project we have designed and fabricated an advanced spare wheel bracket for buses, which uses electrically powered motor to lift and lower the spare wheel and has a suitable locking mechanism to lock up the spare wheel in the spare wheel bracket after the change of tire, it is also strategically located at the bottom of the bus to facilitate easy and safer tire changing. This mechanism has been designed mainly for buses but can also be extended to trucks and other vehicles of the same class, which have tire weight of around 100 to 200 kg. The advantages of this new mechanism being lowest overall tyre changing cycle, reduced waiting time for travelers, No hard work for driver and reduces stress, & strategically located spare wheel bracket which facilitates easy and safer tire changing. We have also developed CAD drawing and full scale working model to illustrate design features and working of this model.

2 PROBLEM DEFINITION

Spare tires in current buses are often stored in a spare tire well – a luggage carrier area above the roof of vehicle, usually in the center, where the spare tire is stored while not in use. In most buses, the spare tire is not secured with a bolt and wing-nut style fastener. Usually it is unorthodox method and cause headache at the time of tyre changing. It is not easy to lower the 100 kg tyre by single person without any mechanism. This tedious process increases the drive time towards the destination as well as cause to lose driving efficiency of driver [1].

3 WORK OBJECTIVE

- Tyre changing average time reduced from 60-120 minutes to 30-60 minutes.
- To increase accuracy level from 60 % to >80%
- To ensure a smooth & a system dependent process, for ensuring timely execution of tyre changing process.

4 LITERATURE REVIEW

A spare tire or spare tyre stepney is an additional tire carried in a motor vehicle as a replacement for one that goes flat, a blowout, or other emergency. Spare tire is generally a misnomer, as almost all vehicles actually carry an entire wheel with a tire mounted on it as a spare, as fitting a tire to a wheel would require a motorist to carry additional specialized equipment. The early days of motor travel took place on primitive roads that were littered with stray horseshoe nails. Punctures (flat tires) were all too common, and required the motorist to remove the wheel from the car, demount the tire, patch

the inner tube, re-mount the tire, inflate the tire, and re-mount the wheel. Walter and Tom Davies of Llanelli, Wales, invented the spare tire in 1904. At the time, motor cars were made without spare wheels. Their company, Stepney Iron Mongers, had agents distributing the United States, Belgium, France, and Italy. The word "stepney" is sometimes used interchangeably in countries that were once part of the British Empire such as Bangladesh, India, and Malta. The first to equip cars with an inflated spare wheel-and tire assembly were the Ramblers made by Thomas B. Jeffery Company. The Rambler's interchangeable wheel with a mounted and inflated spare tire meant the motorist could exchange it quickly for the punctured tire that could then be repaired at a more convenient time and place. Automakers often equipped cars with one or dual side mounts. The spares were mounted behind the front fenders as they blended into the running boards (a narrow footboard serving as a step beneath the doors).

5 CURRENT STORAGE SYSTEM

Spare tires in buses are often stored in a spare tire well – a roof carrier area above the roof a vehicle, usually in the center, where the spare tire is stored while not in use. In most buses, the spare tire is not secured with a bolt and wing-nut style fastener. Usually it is unorthodox method and cause headache at the time of tire changing. It is not easy to lower the 100 kg tire by single person without any mechanism. The storage solutions include storing the spare in a cradle underneath the rear of the vehicle. This cradle is usually secured by a bolt that is accessible from outside of the body, for security. This arrangement has advantages over storing the tire inside the trunk, including not having to empty the contents of the trunk to access the wheel and this arrangement may also save space in some applications. However it has disadvantages because that tire gets dirty, making the act of changing the tire more unpleasant and the mechanism may also rust on older cars, making it difficult to free the spare. The cradle arrangement is usually only practical on front wheel drive cars, as the cradle would get in the way of the rear axle on most rear or four wheel drive cars. A similar arrangement is also often found on trucks where the spare is often stored beneath the truck bed. Current location of spare wheel is shown in the following view:-

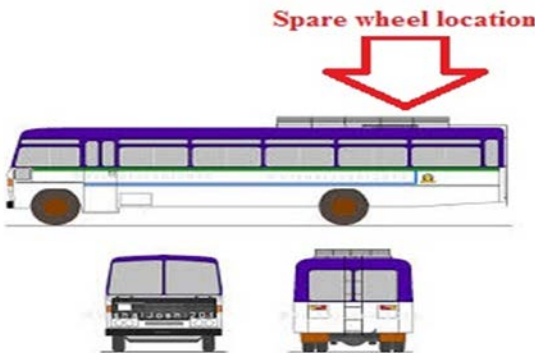


Fig. 1, Spare wheel location in current buses.

6 PROJECT MEASURE PHASE

Process flow chart –

Flowcharts are used in designing and documenting complex processes or programs. Like other types of diagrams, they help visualize what is going on and thereby help the viewer to understand a process, and perhaps also find flaws, bottlenecks, and other lessobvious features within it. There are many different types of flowcharts, and each type has its own repertoire of boxes and notational conventions. The two most common types of boxes in a flowchart are:

- a processing step, usually called activity, and denoted as a rectangular box
- A decision usually denoted as a diamond.

A flowchart is described as "cross-functional" when the page is divided into different swim lanes describing the control of different organizational units. A symbol appearing in a particular "lane" is within the control of that organizational unit. This technique allows the author to locate the responsibility for performing an action or making a decision correctly, showing the responsibility of each organizational unit for different parts of a single process.

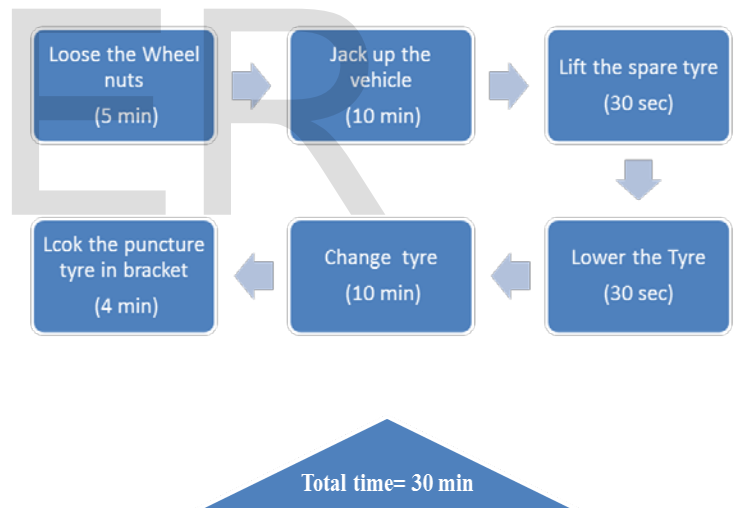


Fig. 2, Optimized Process cycle

6 DATA MEASUREMENT

The following graph indicates the time required for tyre change in different days conditions at different locations.

As we can see above, we have achieved a significant reduction in terms of time in the tire changing cycle irrespective of the time of the day when the test was carried out. In the morning with no to light traffic scenario it took us around 25 minutes to change the tire. In the afternoon it took 55 minutes, and 70 minutes in the evening. And at the night the time taken for the whole tire change cycle was the highest due to poor weather

and light conditions which resulted in time of 100 minutes.

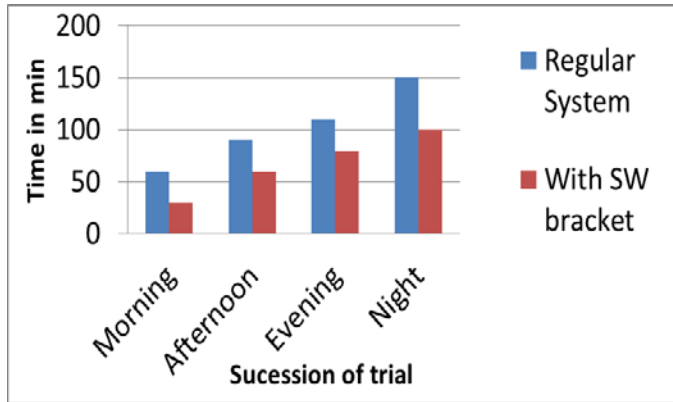


Fig 3, Bar Chart for Data measurement during successive Intervals

7 PROJECT MODELLING PHASE

The main phase of project was after modeling, for modeling the best option was CREO 2.0. In CREO 2.0 separate part is designed and finally all parts are assembled with full constraint. The components are designed as one by one as follows

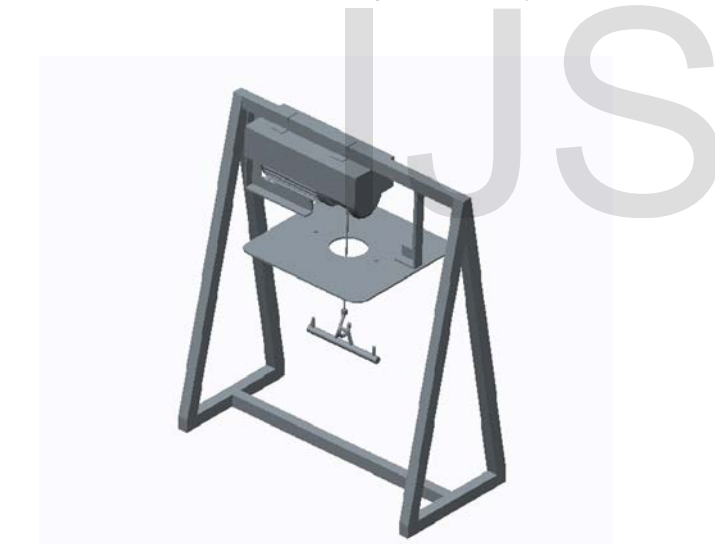


Fig 4, Intial Design 1

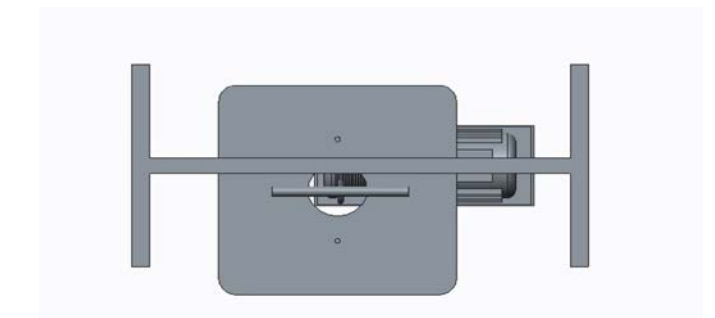
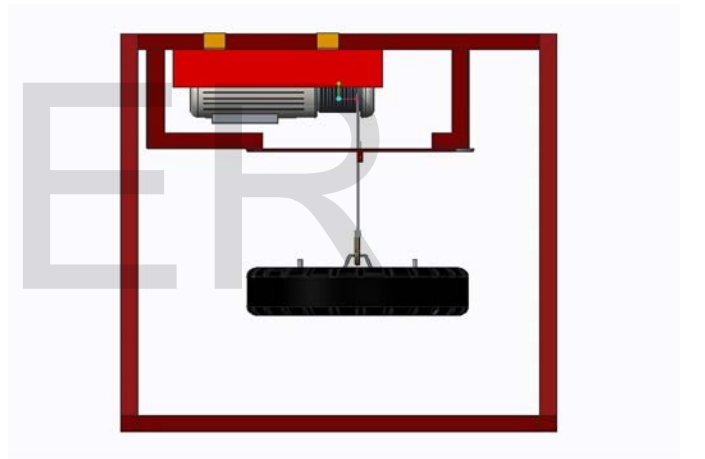


Fig 5, Intial Design 2



Fig, 6 Final Design 1 (3-D view)



Fig, 7 Final Design 2

The tyre which we have used in this analysis is of Eicher Sky-line Bus (India). The detailed specifications of the bus tyre are as follows-

Tyre Width is the width of the tyre measured in millimeters from sidewall to sidewall. This tyre is 215 millimeters.

Aspect Ratio is the ratio of the height of the tire's cross-section to its width. 65 means that the height is equal to 65% of the tire's width.

Construction tells you how the tyre was put together. The "R" stands for radial, which means that the body ply cords, which are layers of fabric that make up the body of the tyre, run radially across the tyre from bead to bead. "B" indicates the tyre is of bias construction, meaning that the body ply cords run diagonally across the tyre from bead to bead, with the ply layers alternating in direction to reinforce one another. This tyre

is of radial construction.

Wheel Diameter is the width of the wheel from one end to the other. The diameter of this wheel is 15 inches.

Load Index is a number that corresponds to the maximum load in kilograms that a tyre can support when properly inflated. You will also find the maximum load in pounds and in kilograms molded elsewhere on the tyre sidewall. Load index of the above tyre is 346.

Speed Rating is a number that corresponds to the maximum service speed for a tyre. "H" means that the tyre has a maximum service speed of 150 km/h. Please note that this rating relates only to tyre speed capability, and is NOT a recommendation to exceed legally posted speed limits; always drive within the legal speed limits.

The details of the electric motor used to lift and lower the spare wheel tyre is as follows-

- Motor Weight- 4.5kg
- Weight Capacity- 250-300 kg.
- Current rating- 220/230V, 50 Hz
- Power rating- 450 W

8 RESULTS

8.1.1. From the modal analysis of base structure results are tabulated as follows

TABLE 1
Modal analysis of base structure

Mode	Frequency
1	17.833
2	19.328
3	72.457
4	96.178
5	97.04
6	99.376

After compilation compares the bus vibration natural frequency and base structure natural frequency of vibration. It results in resonance of structure, so isolation of bracket from bus chassis is required.

7.1.2. From the modal analysis of hanger plate results are tabulated as follows

TABLE 2

Modal analysis of Hanger plate

Mode No.	Frequency (Hz)
1	246.31
2	468.17
3	476.56
4	494.21
5	512.65
6	567.69

After compilation compares the bus vibration natural frequency and Hanger plate natural frequency of vibration. It clearly results in safe structure, so no isolation of hanger plate is required.

3. The Total deformation of hanger plate is 0.12797mm which is acceptable at the initial design level.
4. Factor of safety for hanger plate ranges between 10 to 15 which is quite good and satisfy that the material selection is good for the whole structure.
5. Factor of safety for Base structure with tommy bar assembly ranges from 0.029816 to 15, minimum FOS at tommy bar because as torque applied at this portion will vary due small cross section and to increase safety during working we need locking mechanism.
6. Total deformation for tommy bar is 880mm while base structure has 0.0914mm, cross section of tommy bar at body end cannot be varied for lowering the deformation it will cost more and made structure heavy.

9 CONCLUSION

Proper selection of the Stepney bracket will result in the lowest overall tyre changing cycle. This requires finding the optimum time between tyre removal and installation of tyre and energy associated with the heavy work.

It should further be noted that the tedious design created by designer can require larger force, Tommy bar, and power supplies to overcome the losses than if larger human power were used.

Driver stress will also be greater when heavy work is excessive. Proper design and fabrication will ensure that the equipment will be reliable and will not fail due to the effects of the vibration, tyre load, corrosion.

Future scope in this work is to have remaining analysis and use of light weight material standardization to include 100 % of customer order.

5 REFERENCES

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