

DESIGN AND FABRICATION OF COMPACT BICYCLE TROLLEY

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Abstract - A Bicycle trolley is a motor less wheeled frame with a hitch system for transporting cargo for bicycle. It can greatly increase a bicycle cargo capacity. The trolley may be required for a specific use, such as the transport of passengers or the movement of a particular type of cargo, or it may be needed as a general-purpose goods carrier. The trolley has been in existence since a very long time and has been providing human with ease of carriage of loads rather than carrying it by themselves.

Key Words: Bicycle Trailer, Material and Method, Design, Hinge, Frame, Guide pins, Wheels.

1. Introduction

In many developing countries people live in regions away from the main transport infrastructure. This means transport services are expensive. Many villages in the South are not part of road networks and the lack of transport is a constraint on income generating activities such as taking produce to markets and acquiring equipment and materials needed for a small enterprise[1].



The bicycle is the most common wheeled vehicle in the world. Till today it's been excessively used in rural as well as suburban areas. Because of its efficiency, low-cost and versatility, the bicycle is extensively used by people for personal transport and for the movement of goods.

A variety of different methods are used in rural and urban areas to carry loads on bicycles, but the weight and volume that can be carried in safety is limited by the strength of the machine, and by problems of stability and control. Some carry load by attaching it on carrier with a rope or any attachment.

The problem while carrying load was unbalance, due to which people weren't able to carry load, labors used to carry loads in their heads and bicycle was just limited to transportation. On observing the problem faced by people in rural as well as urban, our project got an idea of working. A project which reduces human effort to an extent and reduction in unbalancing while carrying, also maintaining human comfort[1].

An approach to this practical action is to promote a view on carrying goods while maintaining its stability.

The bicycle trolley enables user an easy drive while carrying loads so even a kid can ride it easily without the risk of unbalance. Apart from household purpose even labors can use the trolley for carrying load through places. Another important feature is it is detachable so the user can not only use while driving the bicycle but also can be used as a trolley while detaching it.

The bicycle trolley has considerable potential for meeting many local transport needs in because of the following characteristics:

- It offers considerable flexibility because it is easily detachable from the bicycle
- It aims heavy loads to be transported safely by bicycle
- It can be manufactured locally and purchased by bicycle owners to increase the utility of their vehicles.

1.2 BRIEF HISTORY OF PROJECT

1.2.1 INTRODUCTION

Bicycle is the most common wheeled vehicle in the world. Because of its efficiency, low-cost and versatility, the bicycle is extensively used in developing countries for personal transport and for the movement of goods. A variety of different methods are used in rural and urban areas to carry loads on bicycles, but the weight and volume that can be carried in safety is limited by the strength of the machine, and by problems of stability and control. So to overcome this type of problem, bicycle trolleys were introduced.

The trolley is attached to the bicycle and is used as medium for transporting the goods. The bicycle trolley has considerable potential for meeting many local transport needs in various aspects. Trolleys are common in certain parts of Europe but are rarely used in the developing world. The evidence indicates that this is not because the technology is inappropriate, but because it is unknown. As transporting goods through bicycle is the cheapest mode and does not require any external source for operations, so it has potential in the market[1,2].

Trolleys are, by definition, attached but not rigidly connected to the towing vehicle. So because of its detachable property they can be used when required. This property has enabled the use trolley in bicycle to meet different needs.

Bicycle trolleys enable a standard bicycle to move substantial loads, but can be easily and quickly detached when the cycle is required for personal transport. The trolley can also be used as a hand cart. Bicycle trolleys are usually two wheeled devices and they are versatile, can carry

reasonably heavy and/or bulky loads and are very easy to use.

Different design was carried out to meet different applications. The choice of a suitable design of cycle trolley for a particular application depends upon the conditions under which the trolley is to be used. The starting point for any bicycle trolley is the cycle with which it is to be used. If a 'one off' trolley is to be made to fit a specific bicycle, this does not cause any significant design problems. However, if trolleys are to be manufactured according to applications, differences in the design and size of the bicycles which will be used with the trolleys needs to be considered.[2,3]

1.2.2 TYPES

Different types of trolley are designed for various purposes:

1) Single-wheel: a single rear-mounted wheel. Though of limited towing capacity, this design tends to be more stable (when moving) than trolleys with two or more wheels. The single wheel can tilt from side to side when cornering (as the bicycle itself does,) allowing for coordinated turns at relatively high speed. The connection to the bicycle is



Fig. 1 Single Wheel Trolley.

2) Two-wheel: A two-wheel design makes possible much greater load carrying capacity and a wider cargo bed. Though not suitable for high speed, they are ideal for everyday cycling (very much like towing a trolley behind a car). Two-wheel trolleys tend to be as wide or wider than the handlebars of the bicycle, therefore care needs to be taken when riding through narrow spaces



Fig. 2 Rigid and non-detachable.

3) General cargo: for transporting cargo of all kinds. The load capacity of commercially available cargo trolleys ranges

simpler than a two-wheeled trolley since only two degrees of freedom are required- the trolley tilts with the towing bicycle.

With time as the automobiles were introduced in the market, the use of the cycle decrease. But still it kept its share in rural areas for satisfying their daily needs. Bicycle is used by the majority for transporting goods from one place to another.

from 30 to 300 pounds (14 to 140 kg), but much larger loads have been transported by custom-built trolleys or by multi-trolley "trains" attached to a single bicycle.

In 1900's, Based on the application point of view, bicycle for transportation of goods is being used by the people of all categories. Weather the movement of goods is at short or at distant places, bicycle were used.



Fig. 3 Trolley without Rear Wheel.

To meet the requirements various method or adjustments were done in the cycle so that the desired output can be achieved. As the system does not require any primary source, its usage was very beneficial.

4) COCA-COLA bicycle trolley: In earlier times, many big companies used cycle trolley for selling their products or to provide service to the customers. As Coca-Cola used to sell the cokes through cycle trolley especially designed for its purpose and IBM used the cycle trolley as to provide door to door service to customers.



Fig. 4 COCA-COLA Bicycle trolley.

2 LITERATURE CONSIDERATIONS

Bicycle trolley is generally an unpowered vehicle towed by a powered vehicle. It is commonly used for the transport of goods and materials.

Sometimes recreational vehicles, travel trolleys, or mobile homes with limited living facilities, where people can camp or stay have been referred to as trolleys.

While designing a trolley there are certain considerations to look after so that to obtain a detail knowledge about the attachments and mechanism used. Before that there are consideration to look after in its characteristics and performance[3].

2.1 CHARACTERISTICS

They enable the bicycle to carry loads for personal use and also can be detached when not in use.

- Can also be used as a without bicycle.
- A simple mechanism for its attachment and detachment.
- Should have a durable frame to withstand load.
- Wheels should be used such that it can carry load at uneven roads.

-The trolley should be designed such that they don't affect the handling of a bicycle.

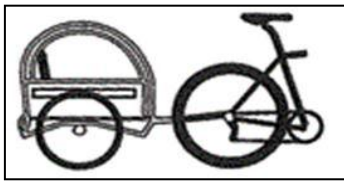


Fig. 5 Rear Trolley.

The above considerations should be maintained for a well-designed trolley[4].

2.2 PERFORMANCE

Its performance can be affected by a number of factors such as road conditions, load to be carried, rider etc. Apart from that there are also additional features which should be considered

- They should be move with ease with imparting on its own wheels and not creating a pull on driver.
- They shouldn't be fed with load above the given limit or else there might be chances of failure while carrying.
- They shouldn't affect the handling of the bicycle.
- They should be manoeuvrable.
- The base should be kept rigid so as to keep the trolley stable during bumps and lows while carrying vehicle.

From the above given considerations, its frame, wheel, frame material, joint etc. was all designed accordingly.

3 DESIGN CONSIDERATIONS

3.1 INTRODUCTION

The choice of designing a trolley depends upon its application, i.e load carrying. Hence designing the trolley plays a crucial part as the designing is to be done keeping in mind all the factors such as:

- Its load carrying capacity
- Mechanism used
- Wheel mounting
- Space for putting load
- Attachment with bicycle

The trolley is used for general purpose load carrying, the below sections give information about its design and various design considerations to be used while designing the bicycle trolley[5,6].

3.2 ABOUT BICYCLE

Before going on with the design considerations we need to know about the bicycle in which the trolley is designed to be mounted. Not every bicycle has the same configuration, they might look alike but still differ in wheel size, height of carriage. They are also different in frame construction, saddle, etc. And all these factors play an important role for trolley and the kind of mechanism to be used.

The trolley is designed keeping in mind the bicycles which are mostly used in rural areas, so the hitch joint used in trolley attachment is also used looking after the factors mentioned above. Designing was an important part of construction of trolley, since cycles used in rural areas are of a standard type and basically wheels have a larger radius. Apart from it the connection which connects the trolley to cycle plays an important factor so going on with hitch mechanism for improved suitability considering all factors is important.

3.3 CONSIDERATION FACTORS

A suitable design of cycle trolley for a particular application depends on a number of factors, including:

1. Fabrication skills and equipment which are available,
2. The materials and components which can easily be obtained,
3. The conditions under which the trolley will be used,
4. The type of load which it is expected to carry.

The trolley is required for a specific use, such as the transport of commodities or the movement of a particular type of cargo, or it may be needed as a general-purpose goods carrier.

3.4 TYPES OF STEEL

1. Lightweight mild steel tube, which is usually referred to as Electric Resistance Welded (ERW) or 'furniture' tube;
2. Mild steel angle iron;
3. Mild steel round bar;
4. Mild steel strip and
5. Mild steel sheet.

In general, steel is a very suitable material for bicycle trolley construction because

- It has a very good strength to weight ratio.
- Available in a wide range of forms and sizes:
- Easy to work with.

It is important to select the correct specification, in terms of strength, for the intended use, and examine carefully the quality of material to be used. This is particularly important for tubular steel, as quality, and hence strength, can vary widely.

3.5 ALTERNATIVES

1. Wood is a useful material for load containers, and in many countries, an inexpensive solution. Wood framed bicycle lack strength and durability and also affected by environmental conditions.
2. Glass Reinforced Plastic (GRP), is another material which can be used for trolley construction
3. Commonly known as 'Fiberglass' is suitable for load containers But it is difficult to obtain in many countries, and expensive. It is difficult to repair without suitable facilities.

3.6 MATERIAL REQUIRED

For this project, what we have proposed is a frame made up of mild steel because this is suitable to limited budget. Mild steel imparts strength to the frame and at the same time it is relatively cheap. Mild steel is available in the market profusely and is easy to work with. Also the load carrying capacity of mild steel is high which makes it more favorable to use[5].


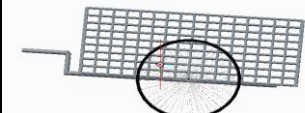

3.7 COMPONENTS

A number of "bought in" components are required in the designs. There are three essential requirements of any component used in a bicycle trolley design:

- It should be durable enough to meet the loads and forces imposed on the trolley;
- It should be easily available in the market place;
- It should be easily repairable, and any required spare parts should be available in the areas where the trolley is to be used.

The basic structure of Trolley was drawn in AutoCAD software and following are they shown. The design have been developed only by consideration of basic dimensions like Length, width and height (with reference of Table 2).

TABLE 1: Design made in autocad software.

<p>Fig. 6.1 Trolley design (3D view)</p>	
<p>Fig. 6.2 Side view</p>	
<p>Fig. 6.3 Top view</p>	

3.8 HITCH DESIGN

3.8.1 DESCRIPTION

It uses the rear axle of a bicycle as a mounting point so the trolley Frame is to be decided keeping in mind the configuration of the trolley being attached to it. The rotational movement is provided by a rubber coupling in this type of hitch which rotates about a single axis in a clamp and allows movement in clamp for other two axes.

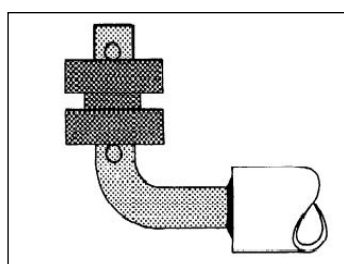


Fig. 7 Rubber Coupling.

It's attached to a rear axle and is clamped on either one of chain sties and is bee mounted along with other mountings on that part. The idea of providing joint at rear is because the cycles available in rural areas have a carriage and therefore the old style of mounting underneath the seat rod cannot be used because the rear sitter might not be able to enjoy the comfort. Basically the end part is attached by opening the swing clamp and then closed around rubber coupling and then secured by padlock. It provides a snatch free mounting and also provides an additional advantage for security.

3.8.2 COMPONENTS

The below mentioned is required to make this type of hinge

- Mild steel strip
- retaining pin for coupling
- Nuts & bolts.

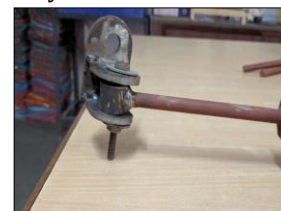
3.8.3 PRODUCTION EQUIPMENT:

The equipments which would be required for the below support

- Cutting Machine
- drilling Machine
- welding Machine
- Metal bending machine

3.8.4 HITCH USED

The Hitch used is of simple shuttle type. The working is simple and works perfectly regarding the load to be carried by a bicycle. Hitch of this type are simple in construction and easy to make. The numbers of components required are low



and so cost of construction is relatively lower than other types available. The attachment and detachment of hitch of this type is simple. And due to its easy working saves time while removing and attaching it.

Fig. 8 Simple Shuttle Hitch.

3.8.5 ADVANTAGES & DISADVANTAGES

ADVANTAGES

- Bicycle can be used with rear carrier
- Simple construction
- No free play which would cause 'snatching'
- Security

DISADVANTAGES

- Trolley configuration cannot be easily used as a hand cart;
- Rubber coupling may not be durable in sane climates;
- It cannot be used with some types of cycle stand.

3.9 THE FRAME

3.9.1 Frame size

The factors which depend on the size of the trolleys are:-

- The cost
- The load carrying capacity
- Regulations in the traffic
- Traffic density
- Conditions of the road
- Standard containers dimensions and its size

A large trolley is not applicable in the traffic as it may cause failure in frames and sorts of accidents.

Consider the following as the maximum dimension for a two wheel trolley:-

TABLE 2 : Considered Dimensions for Bicycle Trailer

1.	Overall trolley's width including the wheels	900 mm
2.	Overall load container's length	1000 mm
3.	Overall load container's depth	500 mm

3.9.2 Materials that can be used for base frame:

For making a frame for a trolley there are number of materials that can be used. While choosing a material we need to survey its cost, its weight, its efficiency, its stability and durability.

Some of the Materials that can be used are:-

1. Mild steel tube
2. Aluminum tube
3. Mild steel sheet
4. Aluminum sheet
5. Mild steel angle
6. Aluminum angle
7. Mild steel strip
8. Aluminum strip



Fig 5.2(a) Mild steel tube

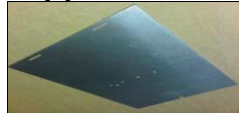


Fig 5.2(b) Aluminium Sheet

3.9.3 Base Frame design

Frame design is one of the most important topic in this section. Without the design of the frame we won't be able to construct a frame for the trolley.

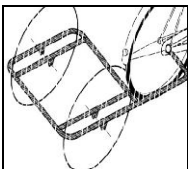


Fig. 9 Platform Frame.



Fig. 10 Platform Frame.

The frame which has been used for the construction of this trolley is called PLATFORM FRAME. It is the simplest design for a bicycle trolley frame. It is also a suitable design considering the attachment to be made to the cycle and also to carry heavy loads without bending. The frame is simple in

construction and considering the fact that our project is foldable this frame serves to be a better option to use with.

3.9.4 Material used and method applied:







The material being used for the construction of frame is mild steel since the weight to be carried is high. Also another advantage of using mild steel is that it is cheaper which has been discussed above.





The frame is constructed using welding and metal cutting processes. The welding used for this type is MIG welding. Since the construction of the base frame is quite simple it is easy to manufacture and also has less cost[5,6].

3.9.5 Body Frame

The frame which encompasses the whole trolley.

TABLE 3 : Fabrication Work of Frame and Body

Step 1- Cutting of desired length MS rods.	
Step 2- Designing the body frame	
Step 3- Attaching Base Frame	
Step 4- Welding of Side Frame	
Step 5- Making attach of side frame.	
Step 6- Attachment for Simple Hitch	

<p>Step 7- Developed combination of Frame and Body.</p>	
<p>Step 8- Attaching of Connecting Rod</p>	
	
<p>a)Final Frame condition during Open phase. (When in used)</p>	<p>b)Final Frame condition during close phase. (When not in used)</p>

3.9.5 Side Frames

Since the project is majorly constructed on mild steel, the use of mild steel has also been applied to create side frames.

3.9.6 Side Frame Folding

The folding mechanism in side frames have been applied by the use of Hinge mechanisms which can be seen in doors. It keeps the construction simple and also provides a great folding ability. The folding mechanism makes it compact and it can be easily be stored without taking much area for storage

3.9.7 Guide Pins

Also guide pins are used to lock the side frames from being detached. The use of lock pins eliminates the error of side frame being opened and it makes the side frames stiff. These guide pins can be easily made from leftover scraps of mild steel indicating lesser amount of wastage



Fig. 11 Guide Pins.

3.10 WHEELS

A **wheel** is a circular component that is intended to rotate on an axle bearing. The wheel is a device that enables efficient movement of an object across a surface where there is a force pressing the object to the surface. Common examples are a cart pulled by a horse, and the rollers on an aircraft flap mechanism.



Fig. 12 Spoke wheel.

Wheels are used in conjunction with axles; either the wheel turns on the axle, or the axle turns in the object body. The mechanics are the same in either case.

3.10.1 WHEEL USED

The wheel that we selected to use it in our trolley is a 16 inch wire spoke wheel. This kind of wheel is easily available in commercial market and costs less. They are light in weight.



Fig. 13 16 inch Spoke Wheel.

3.10.2 REQUIREMENTS

The technical requirement of wheels for a bicycle trolleys depends on the weight to be carried.

Some estimated Technical requirements are as follows:-

1. Capable of supporting the load of 100-150 kg.
2. Capable of withstanding shock and axial loads
3. Made from locally available components.
4. Capable of repairing using locally available facility.
5. Low friction bearing in the hubs.

The cost of the wheels used on the trolley will have significant influence on the overall price of the product.

3.11 ATTACHMENT OF WHEEL TO FRAME

The base frame here is attached to wheels with the help of slotted plates type of arrangement. The advantage of using this type of arrangement is that the wheels of the trolley can easily be removed and attached when required to be work. This makes the trolley even more user friendly and even helps in easy storage, also it is to be noted that this arrangement allows easy motion of the trolley. The fig below shows the slotted arrangement of attachment.

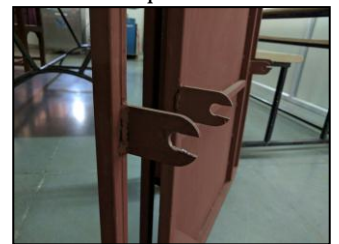


Fig. 14 Wheel attachment slot (Frame).

4 FINAL TROLLEY AFTER ASSEMBLING COMPONENTS

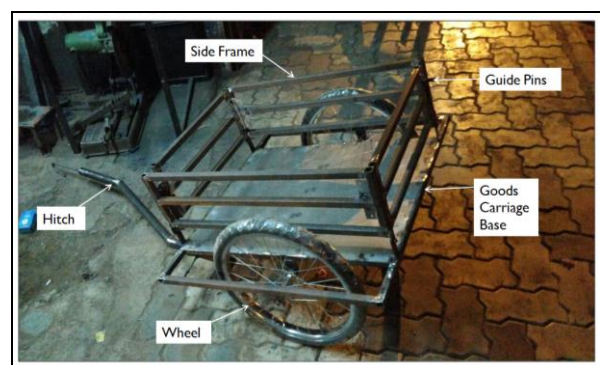


Fig. 15 Finished Bicycle Trolley.

4.1 IMPLEMENTATION

The project is highly efficient and can be easily used in various sectors. Due to its low weight and easy load carrying capacity makes it favourable to use. In rural areas people face problem to carry load with them so they attach equipment with a cycle with a rope. Apart from that there are also various other sectors where problems like these can be eliminated by use of our project. Because of its friendly use it can be applied in various operations which includes:

- In manufacturing plants to carry small parts.
- In construction sites to carry bricks and cements.
- Can be used to carry vegetables by a vegetable vendor.
- Used by farmers to carry farm equipment.
- Can be used even for day to day life

4.2 SAFETY, STABILITY AND MAINTENANCE OF THE TROLLEY

4.2.1 SAFETY

The maximum suggested load for a bicycle trolley is: 120kgs (when attached to bicycle as trolley)

But this maximum load may vary from person to person while in operation, so for effective working of the trolley this varying load capacity is compensated during the design phase by including factor of safety for critical members but under certain limit so as not to result in an excessively heavy damage. Safe loading involves:

- Placing the load as near as possible to the axle line of the trolley.
- Loading should be biased on the front side of axle line of the trolley
- Load which can move during transit should be tied specially heavy once.
- Very heavy load should be avoided exceeding.

4.2.2 STABILITY

The stability of the bicycle is adversely affected by:

- Cornering too quickly
- Riding faster on rough grounds
- Turning very sharp corners
- Untied heavy loads

The stability however depends on the extent to which the trolley is loaded with and the type of load. Some care should have to be taken while operating it.

Again it depends on the loading, if trolley is loaded with load over the axle line than it is more favorable. The positioning of the axle line and the shape of the trolley also affects the stability of the trolley in operation.

4.2.3 MAINTENANCE

The part of the trolley which requires the most frequent maintenance is the hitch mechanism. The most important checks are:

- Greasing all the moving parts of the mechanical designs.
- Tightness and alignment of the connection between the cycle and the hitch.
- Degree of 'snatch' in the hitch - this should be kept to a minimum.
- Condition of the pin, if any, which secures the trolley to the hitch.
- Wheels also require regular checks on the bearings, spokes, tyres and rims. Failure to this may result in sudden - and dangerous - wheel failure. The frame of the trolley may weaken over time, periodic inspection and proper actions are required for effective usage.

5. CONCLUSIONS

In a nutshell, the final product serves increment in load carriage despite of being very simple from design point of view. The fabrication was done in local markets. Thus, it can be said that its manufacturing will be relatively easy for the local manufacturers (INDIAN) who normally has very basic machineries. Also, the final product is compact and portable. The parts used in the design including MS channels, Aluminum sheets, hinges, door latch type locks, rubber friction pads etc. are easily available in the market. In addition, the final product can be used for max load carriage i.e. load carrying capacity up to 120kg when used as an attachment with bicycle and 80 kg without being in attachment. Changes can also be made in the design depending upon the requirements.

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