

# Design and Fabrication of Tilting Bike

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**Abstract-** As we know that safety of the vehicle is the first and the foremost thing to be considered. In 2-wheelers the safety of the vehicle from accident was understated on two major factors, Directional stability and the Aerodynamic force both are correlated to each other. The tilting mechanism would dramatically increase the maximum speed in curves. The use of tilting mechanism in automobile would decrease the rate of accidents due to slippage. It will give better dynamic stability as well as directional stability to the vehicle, better road grip, better comfort to the passengers, and the most important load carrying capacity of vehicle increases<sup>[1]</sup> By this leaning, the centre of gravity balances the centrifugal force which is acting on the vehicle and makes it more stable during turning.

**Keywords:** Tilting mechanism, slippage, directional stability, leaning

## 1.Introduction

Today, the use of more efficient vehicles is being discussed to improve the energy performance and to better utilize the space of existing roads in the cities. To solve the problems relating to traffic in cities, the design of smaller vehicles, with a better weight/load relation are to be developed. According to design three wheeled automobiles has two main types that is Delta and Tadpole. When there is one wheel at front and two at rear configuration is called as delta whereas two wheels at front and one wheel at rear configuration is called as tadpole or reverse bike. Tadpole designs are more stable than delta configuration because the rear wheel drives the vehicle while the front two wheels are responsible for steering. Our tilting bike has tadpole design. Tilting three wheelers are designed as they can lean while cornering like a motorcycle. A tilting three wheeler tilt in the direction of the turn such vehicles can corner safely even with a narrow track.

## 2.Principle

A tilting bike has the advantages of both the type of vehicle that is cars and bikes. If the vehicles lean into corners it makes it a perfect, virtual single track vehicle and even though having three wheels it can be driven like a motorcycle, and the third extra wheel gives the vehicle more traction to make it safe even at high speeds But these vehicles are divided into two categories namely leaning reverse trikes and non-leaning reverse trike. On the one side when we consider the non-leaning vehicle, they are stable like a car and are best at low speed and in traffic conditions but have to struggle with centrifugal force at high speed during cornering that is taking a large curve. On the other side if we consider a leaning reverse trike they are very good at high speeds and counteracts the centrifugal force by their leaning action but, this type of vehicles cannot be used under heavy traffic regions<sup>[2]</sup>

## 3.Positioning of center of gravity<sup>[3]</sup>

Consider first a 4-Wheeler as seen from the rear, like here to the right. If the vehicle is in a curve towards the left, for example, we can imagine that a centrifugal force (magenta color) is exerted on the center of gravity (black and yellow circle) of the vehicle-occupants system, while the vehicle's weight exerts a downward gravitational force (cyan color).

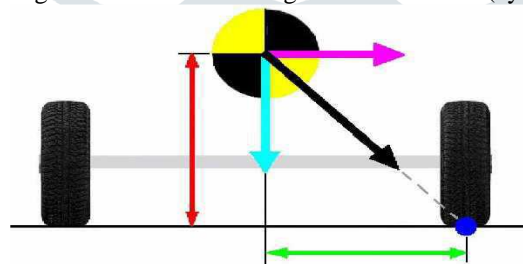


Fig (1): center of gravity(a)

Thus, the centrifugal force (magenta) tends to roll the vehicle over towards the right, around an imaginary point (deep blue) under the right tires, while the gravitational force (cyan) holds the vehicle back to avoid rollover. It's as though the centrifugal force and the gravitational force combined together into a resulting force (black) exerted on the center of gravity to turn it around this imaginary point (deep blue). We can easily understand that if the center of gravity height (red) is greater than the half-track (in green) (the half distance between the two wheels seen from the rear), the resulting force (black) will be aligned over the imaginary point (deep blue) and will thus roll the vehicle over in a curve. The ratio of the center of gravity height (red) to this half-track (green) thus plays an important role in determining the stability against rollover of a 4-Wheeler vehicle. Ideally, this center of gravity height (red) should be low like for a sports car, in order to insure a safety margin against rollover. In the case of 'sport-utility' 4X4s, this height is relatively larger than for regular family cars. This explains why these vehicles have a higher rollover propensity. In the case of 3-Wheelers, another factor comes into play: As can be seen for a 4-Wheeler, the 4-Wheeler rolls over around a line (blue) corresponding to the imaginary point (deep blue) of the previous illustration.

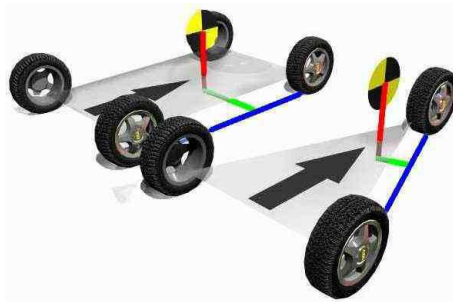


Fig (2): center of gravity(b)

But in the case of a 3-Wheeler, the vehicle rather rolls over around a line (blue) going from the unique wheel to one of the two symmetrical wheels. We can immediately see that the green line between the center of gravity and the rollover line is thus shorter than in the case of the 4-Wheeler, even though the center of gravity height, the length and the track of the 3-Wheeler are the same as those of the 4-Wheeler. The center of gravity height (red) is thus proportionately greater, which reduces the safety margin against rollover in curves. Moreover, a 3-Wheeler in a curve can also be subject to a braking or accelerating force that will combine with the lateral centrifugal force, which may further increase chances of rolling over of this 3-Wheeler. For example in the case of the single-front-wheel 3-Wheeler, here above to the right, braking in a curve towards the left will increase chances of rolling over this 3-Wheeler. So in the case of a 3-Wheeler: The center of gravity height should be low in relation to the half-track, like for a 4-Wheeler. But the center of gravity's position also has importance: The farther it is from the two symmetric wheels towards the single wheel, the shorter is the distance from the center of gravity to the rollover line, which reduces the safety margin against rollover of the 3-Wheeler compared to the 4-Wheeler.

3.1 Rollover Stability of a Tilting Bike

The only way to model a three-wheeler's margin of safety against rollover is just to construct a base cone (fig.2) using the center of gravity height, its location along the wheelbase. Maximum lateral g-loads are determined by the tire's friction coefficient. Projecting the maximum turn force resultant toward the ground forms the base of the cone. If the base of the cone falls outside the effective half-tread, the vehicle will overturn before it skids. If it falls inside the effective half-tread, the vehicle will skid before it overturns.

4.2D Drawing of the Tilting Bike

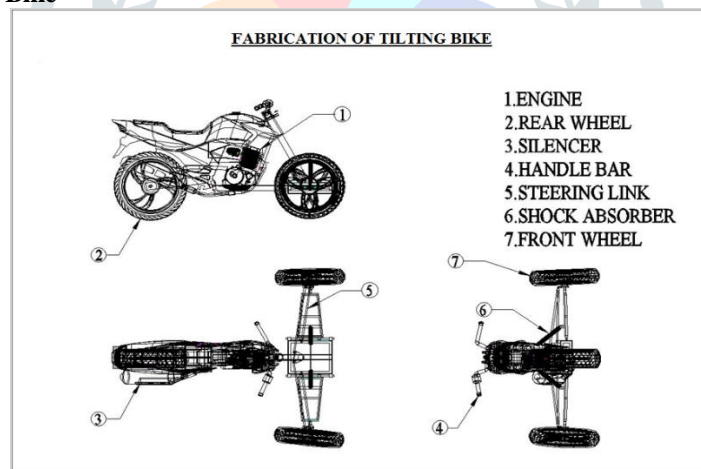


Fig (3): 2D drawing

The figure3 shows the 2d drawing of the tilting bike and the list of components are detailed in the table 1.

Sl. No.	PARTS	Qty.	Material
1	Frame Stand	1	M.S
2	Bearing with Bearing Cap	1	
3	Engine	1	100 Cc
4	Chain with Sprocket	1	M.S
5	Connecting Tube	1 meter	Plastic
6	Bolt and Nut	AS REQUIRD	M.S
7	Wheel Arrangement	1	-

Table.1

### 5.3D Design of the mechanism

The mechanism for the tilting bike is designed using the modeling software SOLIDWORKS. Using the different options in the software like extrude, extrude cut, revolve etc. the required model is made. The first model we have designed is a simple mechanism. The mechanism is having a base over which the upper part of the mechanism tilts when the bike is tilted. The mechanism is equipped with pair of suspension springs.

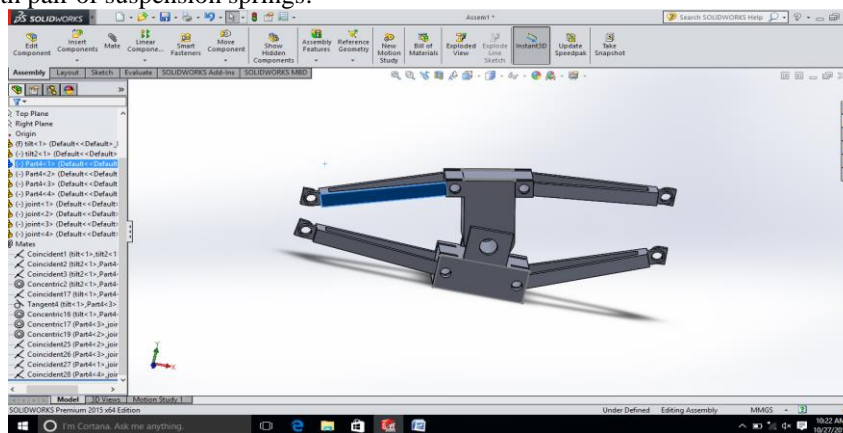


Fig (4) : 3D design [a]

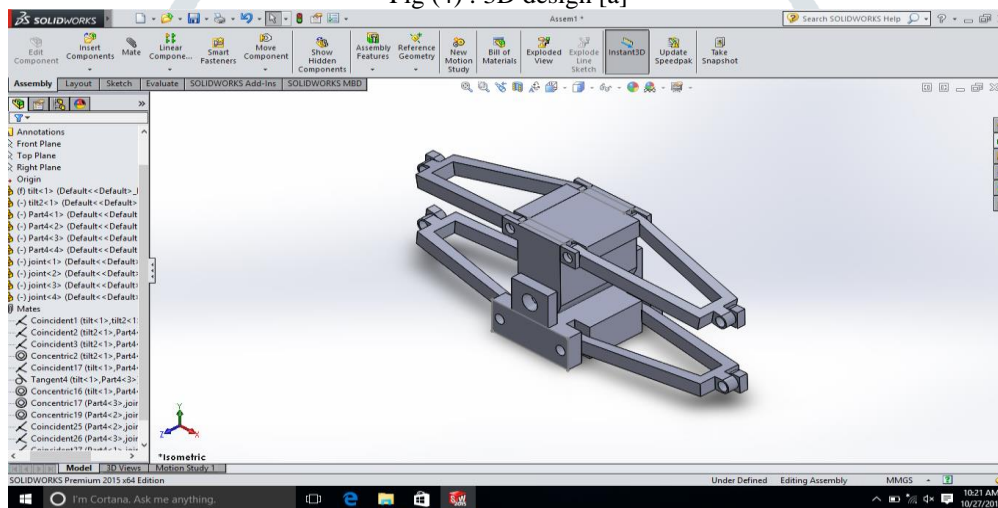


Fig (4) : 3D design [b]

The problem that occurred after this design was that the required design could not provide the space for placing the suspension system. The suspension system used in this is the independent suspension system. The design is complex to construct and the required tilting could not be acquired on the bike. The design has an upper moving part which makes the vehicle to tilt during taking a turn. But in the design the mechanism when attached with the chaise the required the tilting could not be required.

#### 5.1 Re-design of mechanism

To overcome the problem that occurred in the previous design, a simple design was adopted for the tilting.

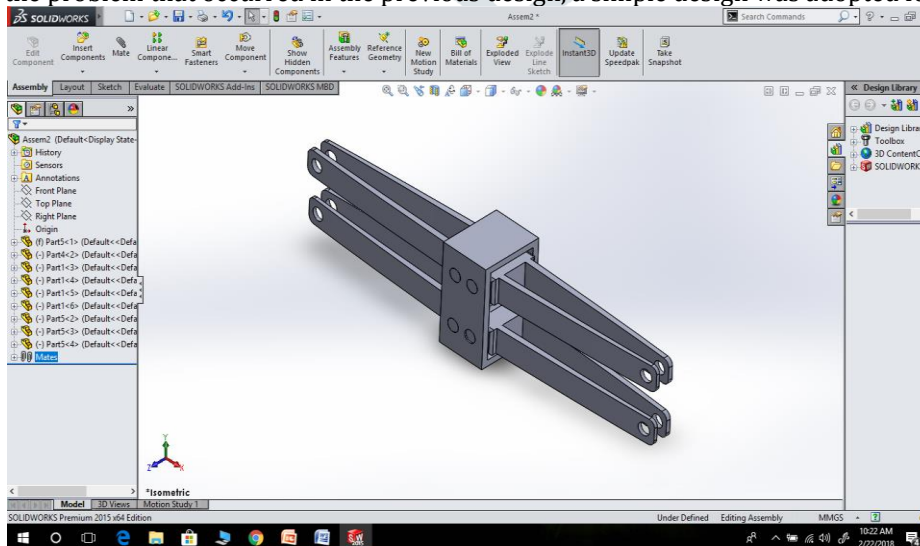


Fig (5): re-design

This design was adopted for easy construction and the problem of placing the independent suspension. The design was done in solidworks using the tools with the required dimensions.

## 6. Construction of Tilting bike

### a) Frame

Frame of the tilting mechanism is important part because it holds the overall weight of the bike as well as the weight of the rider. So the material used should have the ability to bare the total load. Here mild steel is used to construct the frame for the tilting mechanism.



Fig (6): frame and suspension system

The figure shows the frame above which the suspension system is being welded over the top. Suitable nuts and bolts are used to place the suspensions intact with the tilting frame.

### b) Front A-arm

The front A-arm is the important component of the suspension geometry and is made with the same material with which the frame is made. The A-arm supports the suspension system. The arm placed at the top and bottom of the frame is welded together to hold the tyre and the steering mechanism.

### c) Wheel hub

It is the part which connects the wheels with the control A-arms, it provides the wheels to be mounted on to them and on the other hand it is connected to the upper and lower control arms.

#### 6.1 Equation theoretical calculation of leaning angle

Bikes lean during a turn to balance the relevant forces: gravitational, inertial, frictional, and ground support. The angle of lean,  $\theta$ , can easily be calculated using the laws of circular motion:

$$\text{The angle of lean, } \theta = \tan^{-1} (v^2/gr)$$

where  $v$  is the forward speed,  $r$  is the radius of the turn and  $g$  is the acceleration of gravity.

### 1. Fabrication



Fig (7): Front A-arm attached to wheel hub

Using the arc welding techniques the components of the mechanism is welded together. The figure shows the suspension being welded to the bottom arm which is coming from the frame. The two arms are then attached to the wheel hub. The frame is then attached to the chase of the bike. Strong welds are provided at the chase to hold the mechanism in place. Before placing the wheels the alignment is done and the wheel is welded to the hub. The above two figure shows the completed fabrication of the bike.

### 7.Results and Discussion

On studying various vehicles and developing concept vehicle we came to a conclusion that leaning reverse bike has a great potential to bring new changes to the existing vehicle industries.It was found that the maximum leaning angle in each direction is 36 degree from the vertical. This allows the rider to take turns confidently without having the fear of falling or skidding. Due to leaning the center of gravity of the vehicle is always balanced and the resultant forces and their reactions are lined up which increases the life of the mechanical components.

### 8.Conclusion

We have successfully achieved leaning angle upto a certain degrees. This universal tilting trike mechanism fits onvehicles having bracket is fixed on chassis. By implementing this tilt mechanism on moped scooters it can be suitable for handicapped person.This Tilting trike gave response as we desired. It reduces accidents which occurs due to skidding.

### Acknowledgements

I sincerely thank Asst professor Christy v Vazhapilly for his guidance and encouragement in carrying out this project work. I also wish my gratitude to all the officials and staff members of jyothis engineering college who rendered their help during the period of my project work.

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