

Design of the Tadpole Type Three-Wheel Vehicle with Dynamic Conditions

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Abstract - Study of the effect of lateral stability and ride comfort of a three-wheeled vehicle, which has two wheels in the front and one in the back, known as a tadpole design. Also presents a methodology for chassis design of the three-wheel tadpole design vehicle. Since the three-wheeled vehicle in this study is a light and narrow vehicle, controlling the stability of this vehicle, particularly during turning and cornering is a very challenging task.

Keywords - Three wheeler tadpole design, vehicle dynamics, chassis design, CAD model Creo parametric

1. INTRODUCTION

The configuration of three wheeler is divided into two types

1. Tadpole Configuration
2. Delta Configuration

The tadpole trike has the two wheels at the front, the delta trike has the two wheels at the rear. One of the original and best known tadpole trike designs is the Wind cheetah by Advanced Vehicle Design.

2. CROSS SECTION SELECTION FOR CHASSIS

The chassis has been made by superimposing the tubular structure on a base frame. In this section we have compared four types of cross section to identify which one will be the most suitable for our desired strength and mass properties. In this project space frame (roll cage) chassis was chosen with beam element of tubular sections.

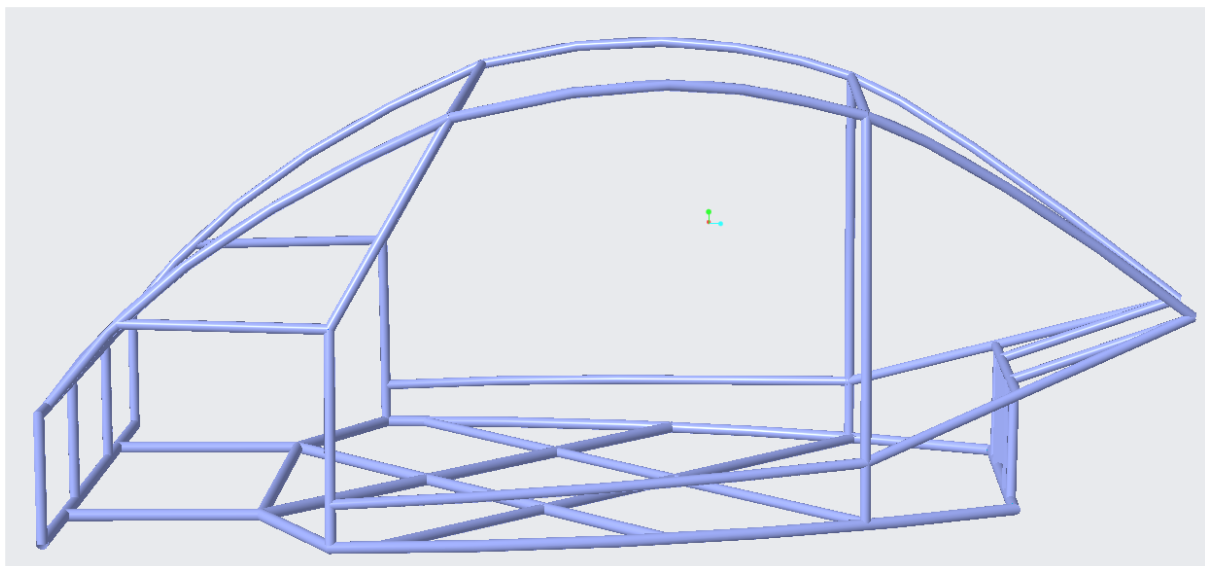


Figure -1: Chassis

The bending moment and torsional advantages of tubular section over all other available sections enabled the criteria of its choice.

Section		Mass (kg/m)	Torsion constant I_t (10^4 mm ⁴)
C section	UPN 200	25.3	11.9
I section	INP 200	26.2	13.5
Box section	140*140*6	24.9	14.75
Tubular section	168.3*6	24.0	20.17

Table -1: Various beams of chassis frame

As per the above Table 1, a comparative study shows that tubular sections are structurally stronger than other types of sections.

3. STEERING MECHANISM

Vehicles with two front wheels mostly use steering arrangement to turn the front wheels using a hand-operated steering wheel which is placed in front of the driver, via the steering column. There are various available steering systems which may be used, the sole purpose of them all is to provide correct steering angle and take up the torque produced in the system.

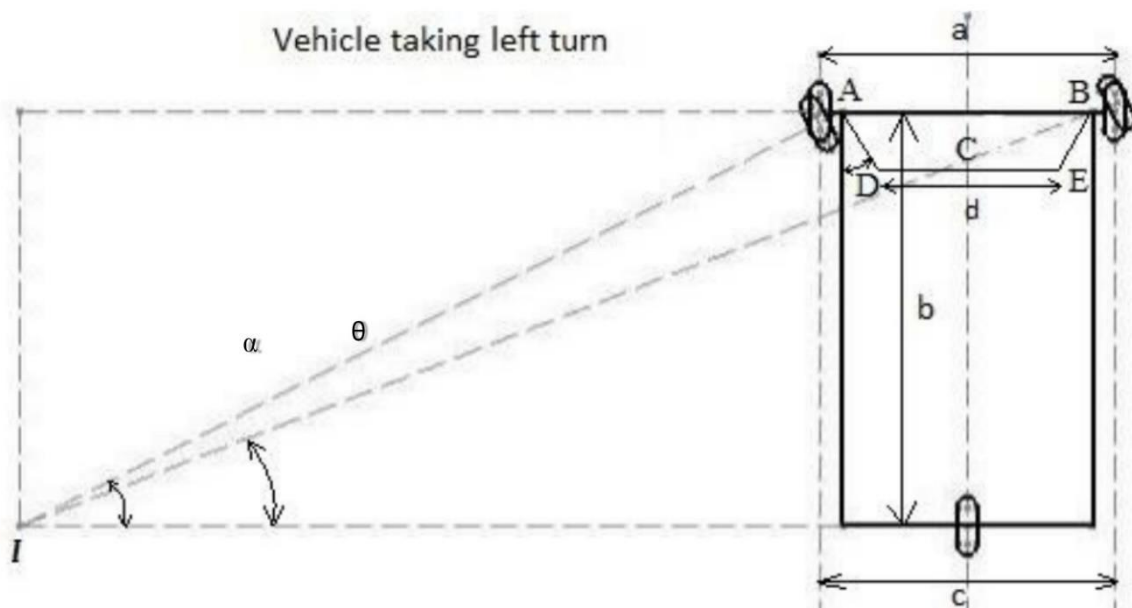


Figure -2: Steering angles and geometry

As shown in Figure 2, when the front wheel is turned, the axes of the wheels must be turned in through same angles α and θ , so that point I of their intersection is always on that axis produced.

3.1 Turning

Under turning forces the delta rider's CG is well placed. Likewise under combined turning and braking forces the CG is also well placed.

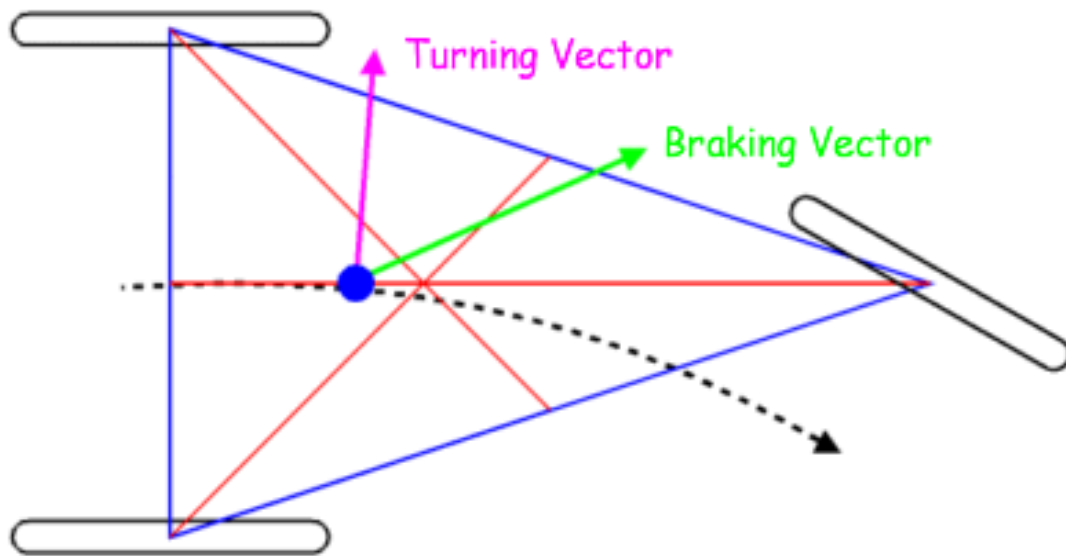


Figure -3: delta turning vectors

However as we will see in this implementation, the CG is too high. The long wheel base of the delta also decreases the twitchiness of the steering, improving high speed steering control and precision. The rearward weight distribution also favours oversteer, meaning the trike would tend to spin out as a result of losing traction on loose gravel.

Under turning forces the tadpole rider's CG is well placed, and combined with the low seat, more stable than the delta.

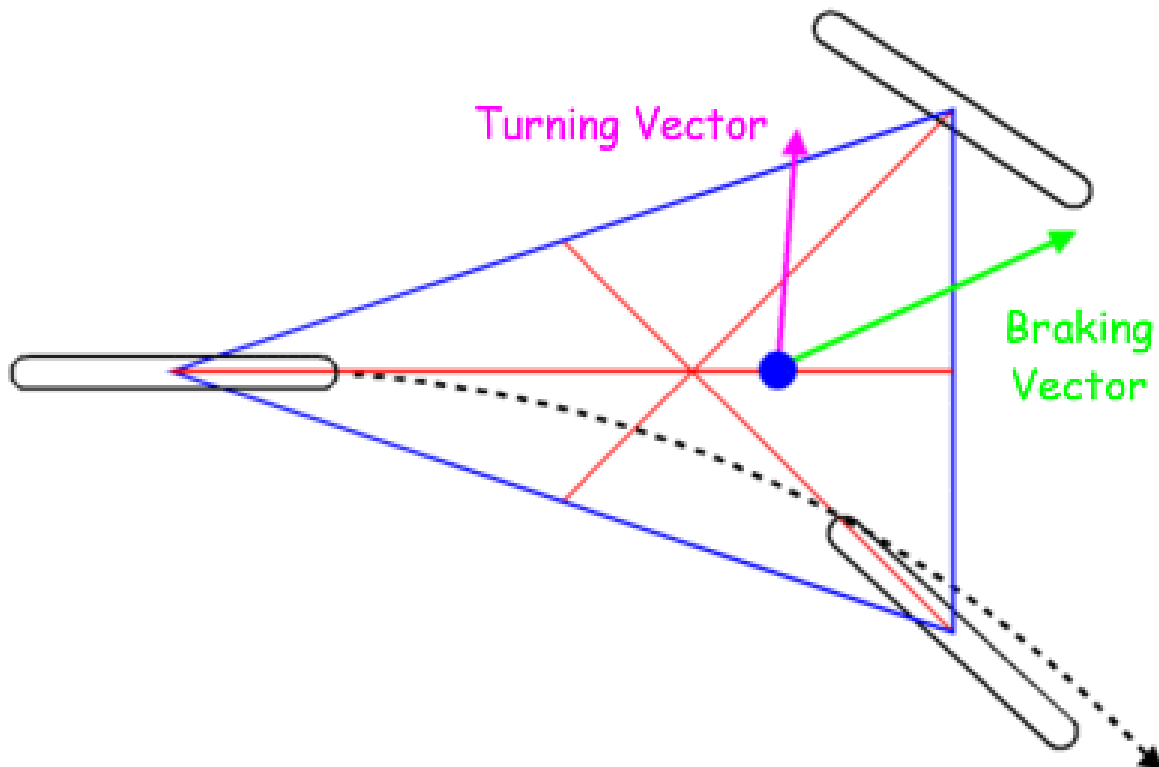


Figure -4: Tadpole turning vectors

However under combined turning and braking forces there is still the possibility of tipping forward [1].

4. STABILITY

A conventional, non-tilting three-wheeler car can equal the rollover resistance of a four-wheeler car, provided the location of the centre-of-gravity (CG) is low and near the side-by-side wheels. Like four-wheeler vehicle, a three-wheeler's margin of safety against rollover is determined by its L/H ratio, or the half-tread (L) in relation to the CG height (H).

A simple way to model a three-wheeler's margin of safety against rollover is to construct a base cone using the cg height, its location along the wheelbase, and the effective half-tread of the vehicle. 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. A one-g load acting across the vehicle's cg, for example, would result in a 45-degree projection toward the ground plane. 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 [2]. Figure 5 showing a base-cone illustration of single front wheel (1F2R) and single rear wheel (2F1R) vehicles (left).

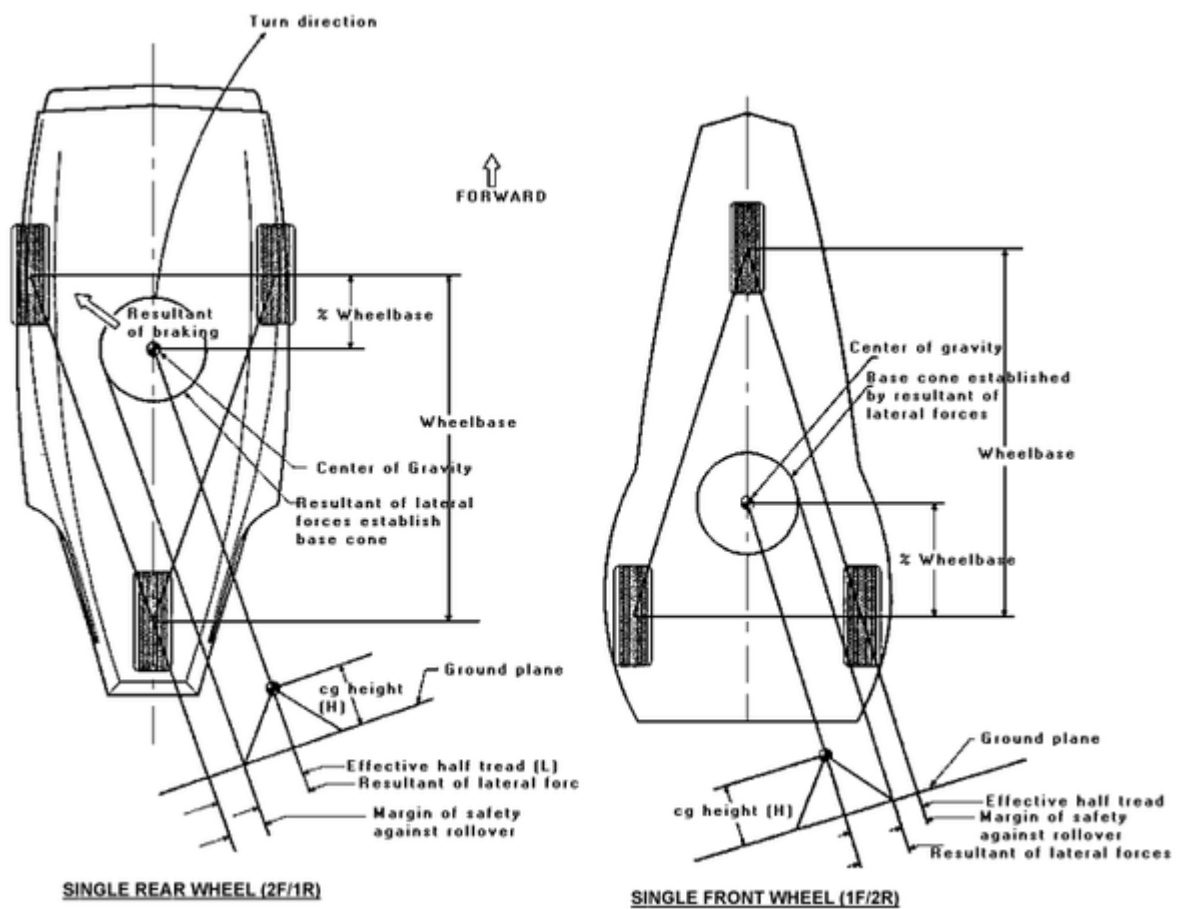


Figure -5: Comparison of tadpole and delta three wheeler steering

5. DESIGN PROCESS

The design of the chassis was done in CREO. The detailed design used CREO to detail all information from real world analysis, packing all the components in their specific location. The use of CREO to finalise the design of the frame will make the manufacturing process of the chassis simplified. The program gives the dimension to all the parts including, bend angles, notch angles and joint fitting parameters.

5.1 Creo Modelling

After the minimum required dimensions of the foot-well was decided, the design of the chassis was made taking into the following considerations:

1. The vehicle should have enough room to seat 3 people comfortably with extra space to hold their luggage.
 2. It should be able to sustain the torsional load acting on it.
 3. The weight of the chassis should be kept to a minimum to increase the performance of the vehicle.
 4. Weight distribution in the chassis is required for efficient performance and to ensure safety
 5. The material used for the making of the tubular frame determines the capability of the chassis to sustain load.
- Keeping in mind the above factors, the chassis has been designed in CREO.

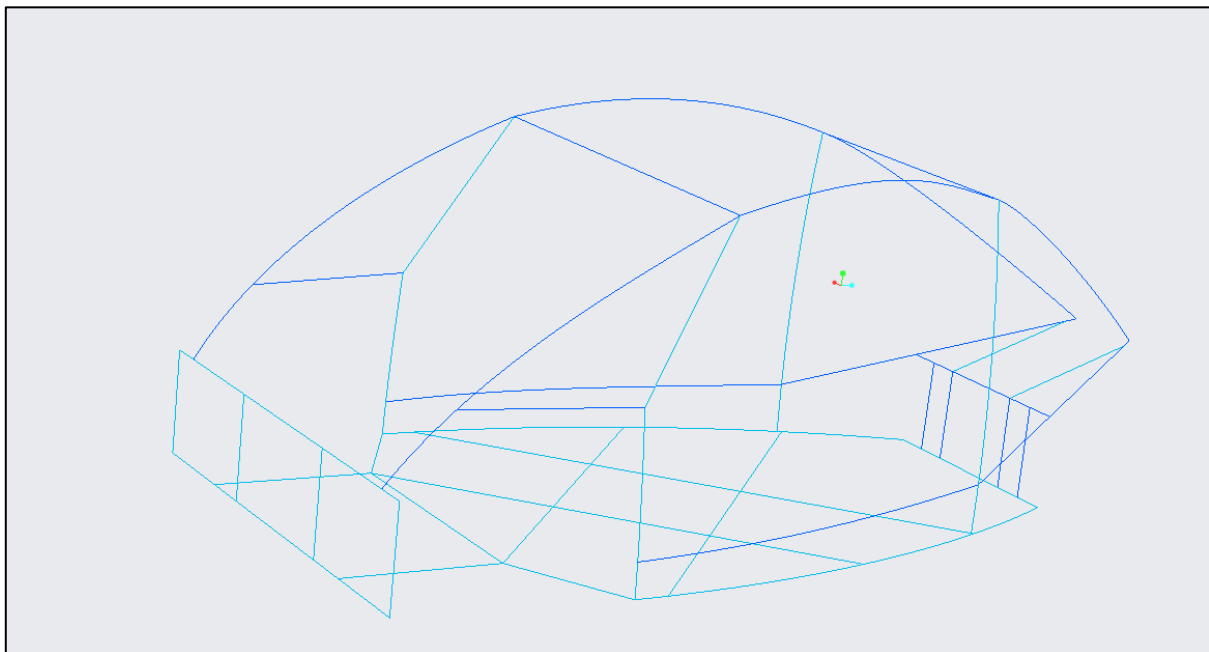


Figure 5.1 Wire drawing of chassis

6. CONCLUSION

For three wheel vehicles the tadpole is clearly the best option. The weight of the vehicle transfers to the front when you decelerate, the front wheels on any vehicle provide the majority of your stopping power. This puts the delta at a disadvantage as it has one less front tire to take the weight of the vehicle and brake on. The tadpole design lends itself better to the aerodynamic tear drop with the correct length/width ratio more easily than the delta.

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