"A REVIEW - LEANING REVERSE TRIKE"

Chandresh P. Rana[1], Jaimin A. Bhatt[2],Harsh S. Patel[3], Abdulqadir N.I. Usmani[4]

[1]*Asst. Professor, Mechanical Engineering Department, Vadodara Institute of Engg. Gujarat, India*
[234]*Mechanical Student Mechanical Engineering Department,Vadodara Institute of Engg. Gujarat, India*

ABSTRACT

A reverse trike is a vehicle which has two wheels up front and one in the back. The main advantage of leaning reverse trike is that it is more stable during high speed turns so that even a reverse trike can take turns like a sports bike by leaning to its side. The combined steering and tilting approach used for the leaning reverse trike that is very economical and fairly simple to drive. A tilting linkage is operably secured to a frame to allow a pair of spaced apart wheel to remain substantially aligned with the plane of the vehicle throughout its range of movements while still allowing the steering axes of each wheel to intersect the vertical centre line of each wheel. This review is to evaluate the performance of a three wheeled vehicle based on the leaning mechanism.

Keyword – *Reverse trike, Leaning Mechanism, Tilting Linkage, Steering*

---

1. INTRODUTION

A trike is a three-wheeled vehicle, it is conceivable that one wheel in the front and two at the back for power, or two in the front for directing, and one in the back for control, or some different sorts of plans. As a result of the managing transcendence of this vehicle, a relentlessly understood shape is the front-directing "tadpole" or "pivot trike" The likelihood of humbler, essentialness powerful vehicles as individual laborers appear to regularly show the three wheels organize. Sentiments commonly run either insistently for or unequivocally against the three-wheel design.

Promoters point to a lower fabricating costs, mechanically streamlined case, and prevalent dealing with attributes. Having one wheel in advance and two in the back is known as the delta design.

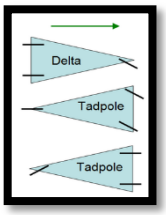
Adversaries censure the three-wheeler's inclination to upset. The two feelings have justified. Trikes are lighter and monetary to make. At the point when composed ineffectively a three-wheel stage is the less sympathetic format. Be that as it may, when planned accurately, a three-wheel auto can light new flames of energy under drained and routine driving encounters. Planning to the three wheeler's natural attributes can create a superior machine that will out corner numerous four wheelers.[1]

1.1 Formation of wheels in Trike

Two front

A configuration of two wheels in the front and one wheel at the back presents two advantages: it has improved aerodynamics, and that it readily enables small lightweight motorcycle powerplant and rear wheel to be used. Alternatively, a more conventional front-engine, front wheel drive layout as is common in four-wheeled cars can be used, with subsequent advantages for transversal stability (the center of gravity is further to the front) and traction (two driven wheels instead of one). Some vehicles have a front engine driving the single rear wheel, similar to the rear engine driving the rear wheel. With a single driven rear wheel, all power is directed through a single wheel. The wheel must support acceleration loads, as well as lateral forces when in a turn, and loss of traction can be a challenge in some model types.[2]

Two rear



Having one wheel in front and two in the rear for power reduces the cost of the steering mechanism, but greatly decreases lateral stability when cornering while braking.

When the single wheel is in the front (the "delta" form, as in a child's pedal tricycle), the vehicle is inherently unstable in a braking turn, as the combined tipping forces at the center of gravity from turning and raking can rapidly extend beyond the triangle formed by the contact patches of the wheels. This type, if not tipped, also has a greater tendency to spin out ("swap ends") when handled roughly.[2]

1.2 Reverse trike design aspects

Centre of gravity of reverse trike

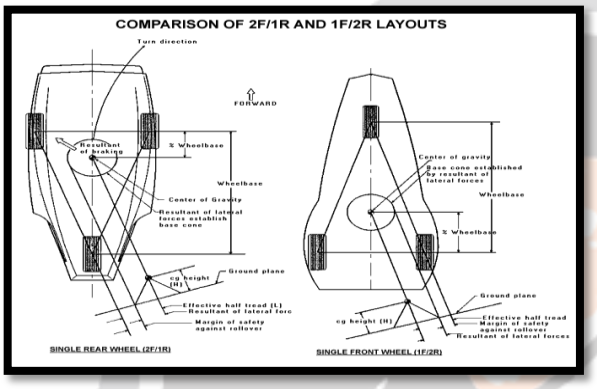


Fig 2: Comparison of tadpole and delta trikes[3]

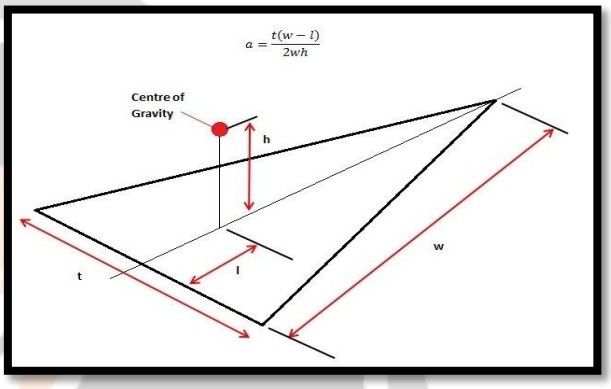


Fig 3: Design aspects of the trike[3]

Tilting Reverse Trike

A tilting three-wheeler is a three-wheeled vehicle whose body or potentially wheels tilt toward the turn. It is the most well-known inclining multi wheeler sort. Such vehicles can corner securely and easily regardless of having a thin track.

1.4 Understanding of Stability of the reverse trike

Lateral stability: The disadvantage of a three-wheel configuration is lateral instability- the car will tip over in a turn before it will slide. This can be prevented in 3 ways:

- by placing the centre of mass closer to the ground
- by placing the centre of mass closer to the front wheels
- by increasing the track width.

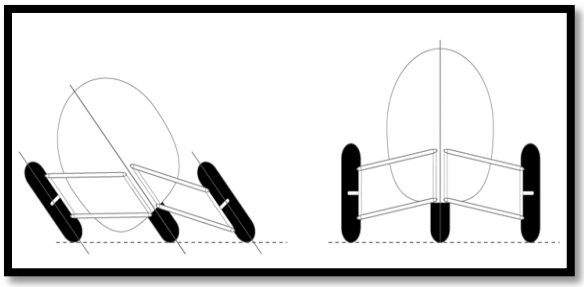


Fig 4: Simple leaning system and leaning action

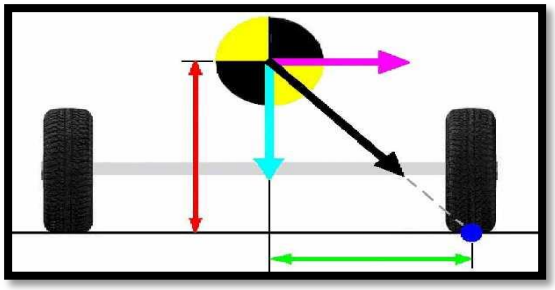


Fig 5: Hight of CG of reverse trike[3]

2. LITERATURE SURVEY

1. Jawwad A. K. Lodhi, Nafees P. Khan (December 2016) [1]
   Here they proved that a proactive design of a bike is possible when it has three wheels. Mainly they used wishbone suspension system as the active leaning mechanism. For the design process they used banding stress formula to calculate induced bending stress.

2. Kaustubh Dilip Patil, Prashant S. Mulmule2Vikrant S. Satalkar, Ramesh S. Thorat (September 2015) [2]
   They used a rocker arm design for the leaning mechanism, but this design is not reliable. They have used Mild steel black material for the construction of mechanism and mild steel for the construction of chassis. By this mechanism they success fully achieved 36 degrees of leaning.

3. Palash Patodi1 ,Vinay Saxena ,Yogesh Rathore (March 2014) [3]
   They have studied the centre of gravity of the reverse trike as well as dynamics of the tadpole designed vehicles. They shown that different countries has their own different regulations for the tadpole designed vehicle as well as three wheeled vehicle.

4. Deep Shrivastava (December 2014) [4]
   This is the research paper based on construction of ATV. In this research paper he gave all the important data related to construction of all terrain vehicle. He took 4130 steel material to construct the roll cage chassis. He also did stress analysis in ansys software. They also found that chassis deformation is about 2.95mm in side impact analysis, 0.46mm of deformation in roll over impact analysis, 0.62mm of deformation in rear impact analysis.

5. Savan Thacker, Antriksh Bhatt (July 2015) [5]
   In this literature they have studied the double wishbone suspension system in ANSYS in which they used steel and carbon fibre material as the main material and they done bending analysis. They found that carbon fibre has more displacement than steel and they also studied the behaviour of the suspension when the upper arm has low length than lower arm. In this study they found that in this type of design camber angle changes during suspension travel so that it is unstable.

6. Pratik Karkare, Prof. Kamlesh Gangrade (October 2016) [6]
   In the attempt of making a leaning bike they used a different mechanism which has individual two wheels connected with the arms which helps whole vehicle to lean at some angle. They also covered the vehicle with the roof to make it more comfortable in rainy weather. They used brush less DC motor to deploy the arms on the road and they used DC wet cell battery to operate the whole system.

7. M. Ravi Chandra, S. Sreenivasulu, Syed Altaf Hussain, (July-Aug 2012) [7]
   They gave the best data of the automobile vehicle chassis and also they studied the behaviour of the ladder chassis, monocoque chassis and backbone chassis. They have done different bending analysis on I,C and Box channel section chassis. They have considered steel, E-glass, S-glass, carbon epoxy materials.

8. Ayman A. Aly, and Farhan A. Salem (July 2013) [8]
   In this research paper they reviewed different suspension control system and they also gave a mathematical formulas to calculate the damping of the system. They shown 6 suspension controls and each of that has its own specific operating characteristic.

9. Jawwad A.K. Lodhi1 Nafees P. Khan (2016) [9]
   They have concluded that three wheeler has great potential to bring innovative design in the market. They also shown that accidental death is increasing day by day and they prove it by giving a data of number of accident.

10. Mr.Sandeep kumar gupta, Mrs.Veena.Gulhane (12-13th April 2014) [10]
    In this research paper they attempted to control the leaning action of the vehicle intelligently with the help of gyroscope and close loop system. They used different motion sensors to give feed back. They have also used servo motors to control the system.

11. Prakash Katdare, S.C.Shilwant (22nd November 2015) [11]
    They have made a software model of bajaj pulsar 180 chassis and they gave all the basic load list which acts on the chassis. They also gave strength of the different material like steel, aluminium alloy 6063, carbon fiber and titanium. They also did bending stress, displacement, torsional rigidity analysis in ansys software on each material.

12. Abhijit M. Mane, Jitendra M. Salunkhe, Akshay S. Chorge, Mr. Akshay Muragode, Mr. Pranesh Bamankar (4th May 2017) [12]
    In their research paper they tried to show their attempts to make a mechanical leaning mechanism. They mounted the suspension system on the bracket which is welded on the chassis to make a strong base for the suspension system. This paper is fairly latest and they used honda cb twister 135cc bike for the project.

13. Siddhesh Kadam, Suyash Karingwar, Anurag Gupta, Vinit Jaiswal, Abhinav Bhosale, Prashant Ingle,Amit Patil (March 2017) [13]
    They have done work in order to increase the stability of the reverse trike at corners during leaning action by improving the control arms and linkage. They are using four links to turn the wheel as well as lean the wheels precisely.

14. Asst. Prof. N.Vivekanandan, Abhilash Gunaki , Chinmaya Acharya, Savio Gilbert and Rushikesh Bodake (june 2014) [14]
    In this literature they have studied about materials like ASIS1018, ASIS1040 and ASIS4130. They also determined the allowable stress for ductile material about 345.83MPa. Also they determined the centre of roll by which roll over stability of the vehicle is considered. They made a model of wishbone in pro-e software using material ASIS1040 and got max displacement 6mm and max stress 320.14MPa.

15. Ogega Anyoka Patrick, Johana K. Sigey, Jeconiah A. Okelo, James M. Okwoyo & Kang'ethe Giterere (September 2015) [15]
    They have studied the dampers and spring system to make a system which can be changed according to road condition in vehicle. By changing damper fluid density which effect will be observed on the cushioning of the system that particularly they have studied. Indeed they observed spring behaviour at constant load but with variable spring stiffness. However the mathematical model of the spring and damper system is obtained.

3 LITERATURE CONCLUSION

- Because of limitation of bikes so many deaths are registered in 2012, around 32,318 people died in bike accident. For better performance and reliability mild steel and its alloys like mild steel black can be used in leaning mechanism.

- Vehicle skidding and losing control on road is reduced by 80% because of twice of the traction in leaning reverse trike. Wishbone suspension system is the best mechanism for making a leaning system in terms of handling ability as well as In terms of reliability. Back bone type chassis is good and appropriate to create a leaning mechanism and so as the box section type tubes has best stiffness and strength.

- Centrifugal force acts on the leaning vehicle is depends on the velocity of the vehicle. (CF α V),Gyroscope sensors and electrical control unit is the best way to make a self balancing vehicle.

- Bending stiffness is 3791.1 Nm^2, Bending strength is 467Nm of 4130 steel is very appropriate for the leaning mechanism . Aluminium alloy material has yield stress of 214MPa and has ultimate tensile stress of 241MPa. Maximum stress is concentrated and observed at the joints of the system.

- Tilting action of the vehicle is very sensitive to the weight distribution and centre of gravity of the vehicle. The stiffer suspension system offers very harsh ride quality but it also offers very stable ride and controlled cornering whereas the larger suspension travel of the.

- static load conditions deflection and stresses of steel lower wishbone arm and composite lower wishbone arm are found with the great difference. Carbon fiber suspension control arms that meet the same static requirements of the steel ones they replace. Deflection of Composite lower wishbone arm is high as compared to steel lower wishbone arm with the same loading condition.

4. REFERENCES

[1] Jawwad A.K Lodhi, Nafees P Khan, Performance Evaluation of Leaning Reverse Trike, Volume 02 | Issue 10 | December 2016, Journal for Research[1]

[2] KaustubhDilipPatil, Prashant S. MulmuleVikrant S. Satalkar, Ramesh S. Thorat, Design and Manufacturing of Tilting Trike Tiltra Msx-1, Vol. 4, Issue 9, September 2015, International Journal of Innovative Research in Science, Engineering and Technology.[2]

[3] Palash Patodi1 ,Vinay Saxena2 ,Yogesh Rathore, Review On Tadpole design – Issues & Challenges, Vol.2 Issue.3,March 2014. International Journal Of Research In Aeronautical And Mechanical Engineering[3]

[4] Deep Shrivastava, Designing of All Terrain Vehicle (ATV), Volume 4, Issue 12, December 2014, International Journal of Scientific and Research Publications [4]

[5] Savan Thacker, Antriksh Bhatt2, Research paper on Design and analysis Double Wishbone Suspension system using Finite Element Analysis, Volume 2, Issue 7, July – 2015, International Journal of Advance Research in Engineering, Science & Technology(IJAREST) [5]

[6] Pratik Karkare, Prof. Kamlesh Gangrade, Fabrication of Tilting Wheel Mechanism: A Vipra Bike, Volume 13, Issue 5 Ver. III (Sep. - Oct. 2016), IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)[6]

[7] Jawwad A.K. Lodhi1 Nafees P. Khan, Study of Personal Commuters Leaning Reverse Trike, *Vol. 4, Issue 10, 2016,IJSRD - International Journal for Scientific Research & Development* [7]

[8] Mr.Sandeep kumar gupta , Mrs.Veena.Gulhane, Design of Self-Balancing Bicycle Using Object State Detection, (ICIAC- 12-13th April 2014), International Journal of Engineering Research and Applications (IJERA) [8]

[9] M. Ravi Chandra, S. Sreenivasulu, Syed Altaf Hussain, Modeling and Structural analysis of heavy vehicle chassis made of polymeric composite material by three different cross sections, Vol.2, Issue.4, July-Aug. 2012, International Journal of Modern Engineering Research (IJMER) [9]

[10] Prakash Katdare, S.C.Shilwant, Design Optimization of Two Wheeler (Bike) Chassis, Special Issue 2 Page 4273-4277, 2015, International Engineering Research Journal (IERJ) [10]

[11]Abhijit M. Mane, Jitendra M. Salunkhe, Akshay S. Chorge, Mr. Akshay Muragode, Mr. Pranesh Bamankar, Design and fabrication of universal tilting three wheeler mechanism, Special Issue Page 102-104, 2017, International Engineering Research Journal (IERJ) [11]

[12] Siddhesh Kadam, Suyash Karingwar, Anurag Gupta, Vinit Jaiswal, Abhinav Bhosale, Prashant Ingle,Amit Patil, Design And Analysis Of Active Leaning Suspension, Volume 8, Issue 3, March-2017, International Journal of Scientific & Engineering Research [12]

[13] Ayman A. Aly, and Farhan A. Salem, Vehicle Suspension Systems Control: A Review, VOL.2 NO.2 July 2013, International Journal Of Control, Automation And Systems. [13]

[14]Asst. Prof. N.Vivekanandan, Abhilash Gunaki , Chinmaya Acharya, Savio Gilbert and Rushikesh Bodake, Design, Analysis And Simulation Of Double Wishbone Suspension, Volume 2, Issue 6, June 2014, International Journal of Mechanical Engineering (IIJME) [14]

[15] Ogega Anyoka Patrick , Johana K. Sigey , Jeconiah A. Okelo , James M. Okwoyo & Kang'ethe Giterere, Investigation of Variable Damping Shock Absorber Performance of Automotives in Shock Prone Areas, Vol. 3, No. 7, September 2015, Computer Science Engineering & its Applications (CSEA) [15]