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Introduction, Designing, Simulation and Fabrication of Inverted U- Plate Type Steering Mechanism

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ABSTRACT: In modern era, vehicle stability and handling have become the major aspect without any compromise in steerability and handling of vehicle, with keeping in mind the driver's safety and comfort. Our main intention is to design, fabricate and simulation testing of light weight, highly sensitive, less complex and economic steering mechanism. Since a electric powered vehicle for SAE Event, weight factor is the main concern and we have to reduce it as much as possible. So we have done a real world designing of inverted U- Plate type steering mechanism after its virtual solid modeling and simulation testing using CAD and CAE software respectively.

I. INTRODUCTION:

Steering creates interface between the driver and vehicle it helps to control the vehicles direction by steering the wheels or we can say that the act of guiding vehicle is done by steering system. In modern techniques, front wheel steering and the four wheel steering is used for the directional motion to control the vehicle. The steering system may or may not be consists of several links and gears. Steering system must be precise because more precise it is, more will be the stability. There are several things which affects the stability of the vehicle are Camber, Caster, Toyin, Toy-out. Caster angle is used for the reversibility of steering wheel, positive camber angle is used in heavy vehicle and negative camber angle is used in racing vehicles which helps in turning. There are so many types of steering geometries for perfect steering such as Devi's and Ackermann steering geometry. In Devi's steering geometry the major problem is that the inner wheel steers equal to the outer wheel which increases the turning radius and decreases the stability. In Ackermann steering geometry the inner wheel turns more than the outer wheel but gives very poor Ackermann percentage for the gear ratio of 1:1 in front wheel steering so we have used the horseshoe plate type steering mechanism instead of other steering systems to increase the stability at the same gear ratio.

II. DESCRIPTION:

As we see the problem of vehicle stability and lower Ackermann percentage Inverted U plate steering gives the better stability. In this type of steering initially the tie rods were at the inner wall of Inverted U plate in the rectangular section. When we turn the vehicle left the left hand side tie rod were directly forced but the right hand side tie rod will move some distance of 11.22mm from the inner wall to the outer wall of right hand side rectangular section after that the forces will act on it and it will move the wheel assembly. But the chances for the failure of horseshoe plate will be maximum when the vehicle is in dynamic condition so we have worked on it and got to know that the most sophisticated area of horseshoe steering is tearing of plate. Hence we restrict our consideration, Broaden our scope to the tearing part only and do calculation for the thickness of Inverted U plate.

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Fig1. Inverted U plate and tie rod assembly

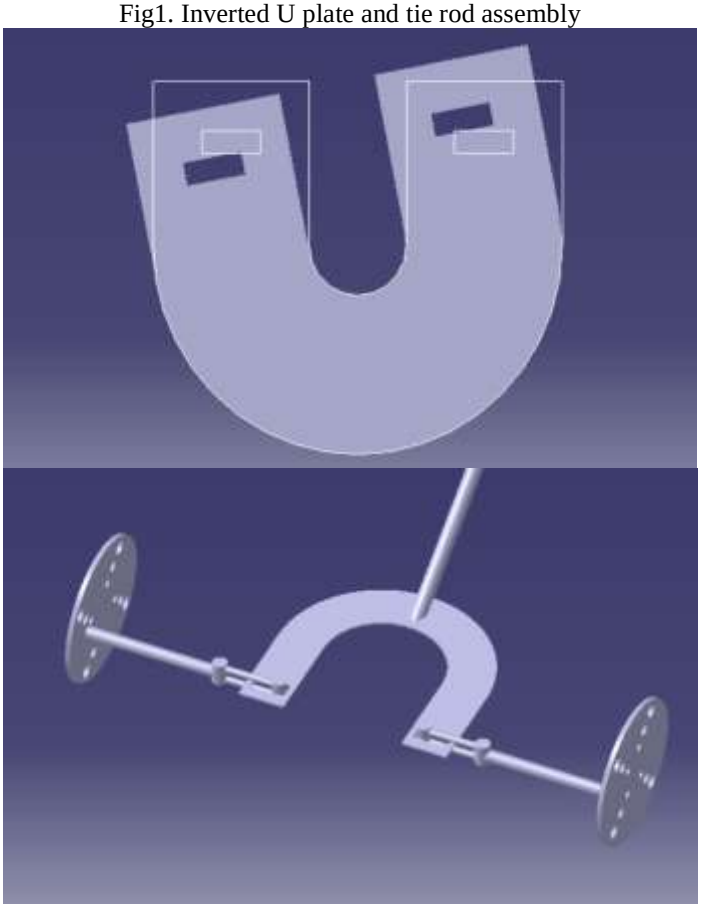
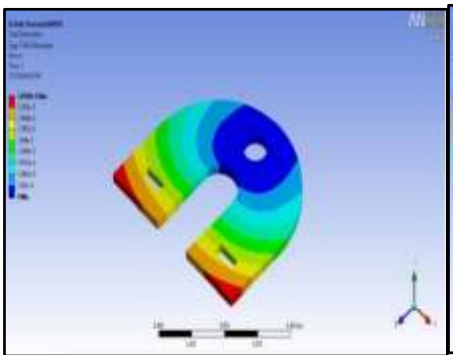


Fig.2. Rotation of Inverted U plate about fixed axis

D =Hole Diameter
P =Pitch length
ϭt= Allowable tensile stress of material
At=Tearing Area of plate
T =Thickness of plate
Pt=permissible tearing resistance of material
On Assuming Maximum force act on the Inverted U plate in dynamic condition= 490 N
D=7mm
Pitch,
P=1.5D
P=1.5*7=10.5mm
T= At /(P-D) = 7*10.5/(10.5-7) = 21mm
Pt= At *ϭt = 73.5*550 = 40425 N/mm2
This is very high, so we have to reduce the thickness, 490(maximum force in dynamic condition) < 40425 (Maximum permissible tearing resistance)
On assuming the tearing resistance will be 7000N
At=12.72
T=12.72/(7-1.5) = 2.31mm
T=2.31mm



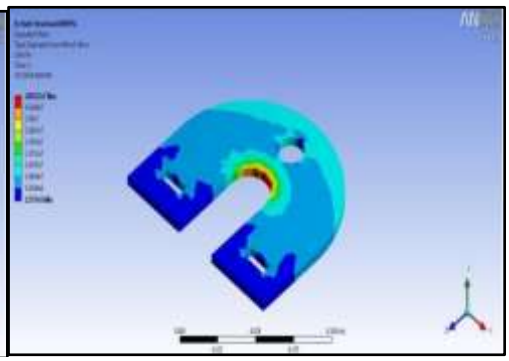


Fig.3 Deformation under Extreme Condition(0.026) Fig.4 Von-Mises Stress diagram

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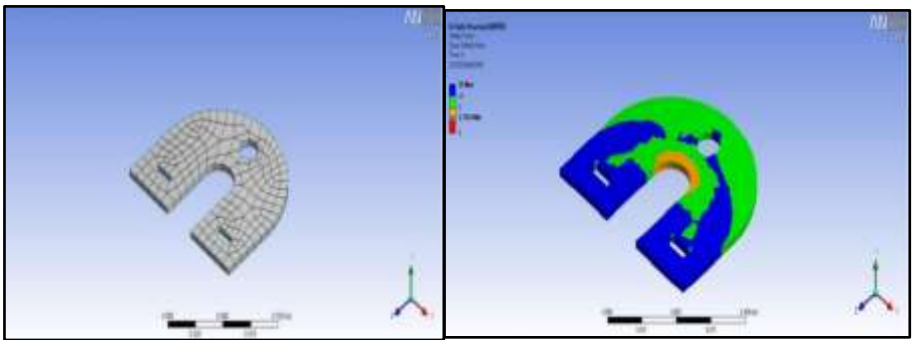

Fig.5 Meshed Modal of Horseshoe plate Fig.6 Fatigue Safety Factor

III. CONCLUSION:

Due to the working on Inverted U plate type steering system we got to know about its vital components, effective and essential modes of failure, and the overcoming of those failures. We have designed and fabricated the steering system with better Ackermann percentage, stability and which economic too. It reduces the turning radius without tilting the knuckle arm as not seen in the conventional type steering mechanism. It is very sensitive and reduces the driver's effort on steering wheel. To minimize the risk of failure of horseshoe plate, considerable amount of Factor of Safety is kept which makes it safe even on high applied loads and deformation.

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