Original Research Paper Engineering

Study, Modification and Design of Steering Mechanism For an All-Terrain Vehicle

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ABSTRACT

This paper bull's eye at studying the design of the steering system of an ATV. Steering system is the vital part of any vehicle. Sterring system is responsible for the lateral motion of the ATV when it is in longitudinal motion. In this paper author hasdiscuss the modification of the steering system in TATA NANO to meet out the design requirements of SAEINDIA rulebook. A good steering system is one which allows the driver to sit back properly and control the ATV in all running conditions.Rack and pinion steering with ackerman sterring mechanism has been used and it is fabricated in the workshop both by theoretical and practical calculations.

KEYWORDS ATV, TATA NANO, Turning Radius, 2WS, SAEINDIA

INTRODUCTION

Steering system is one of most important part of an automobile that is used to give directional stability to the vehicle. Itcontrols the vehicle along the desired path and stability of the direction of motion of vehicle against external instabilities. The best characteristics of ATV is contolling system that steering provides.

OBJECTIVE

Study and analysis of a modified steering system according to the constraints provided by the RULEBOOK OF SAE BAJA to be used in single seat All-Terrain Vehicle. The objective of steering system is to provide max directional control of the vehicle and provide easy maneuverability of the vehicle in all type of terrains with appreciable safety and minimum effort. Typical target for a quad vehicle designer is to try and achieve the least turning radius so that the given feature aids while maneuvering in narrow tracks, also important for such a vehicle for driver's effort is minimum. This is achieved by selecting a proper steering system. The next factor to take into consideration deals with the response from the road. The response from the road must be optimum such that the driver gets a suitable feel of the road but at the same time the handling is not affected due to jerks. Lastly the effect of steering system parameters on other system like the suspension system should not be adverse.

PROBLEM FORMULATION

After considering all the advantages and disadvantages of the types of steering systems it was found that the rack and pinion steering system is suited to be implemented in an all-terrain vehicle. However, manufacturing of the entire system would have been very costly and difficult.

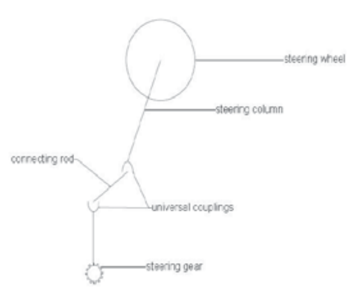
Therefore, it was decided that a standard steering system available in the market would be modified to meet the required constraints.

Since all standard steering systems available are right hand drive the actual problem definition of our project is to convert the standard right hand drive steering system into centrally aligned steering system. The standard steering system chosen was ofTata Nano.

Following are the specifications.

- Centre Drive.
- Understeer
- Steering Angles – I & O: 30 & 22.30
- Turning Circle Radius: 3.62m
- Rack Travel: 220mm
- Turns, rev: 3.5rev.
- Steering Ratio/rev: 15:1mm/rev
- IBJ Centre Distance: 120mm
- OBJ Centre Distance: 520mm
- Length of Rod: 300mm
- SCOPE OF WORK

In this project the conditions satisfying true rolling will be calculated from Ackermann steering Mechanism. Then the calculated values would be used to design the rack rod. The modified rack would be tested on software (Inventor/Ansys) for various modes of failure. Changes in the design would be made according to the test results. The rack housing would be improved accordingly. The length of the steering column will be varied according to the roll cage dimensions. Mounting points for steering system on the roll cage would be designed. Finally the steering system would be mounted on to the vehicle.



There are two ways in which the right hand drive could be converted into a central drive either by modifying the length of the steering column or by modifying the length of the rack rod as showing in above Figure.

An average man can turn a simple steering wheel with an average force of 300N with an average rpm 18, therefore

$$P = \frac{2\pi NT}{60}$$

$$P = \frac{2\times\pi\times 18\times(300\times 0.015)}{60}$$

$$P = 8.84 \text{ watts}$$

Efficiency of coupling is 90%

Therefore,

Connecting rod Power = 7.629 watts

Now,

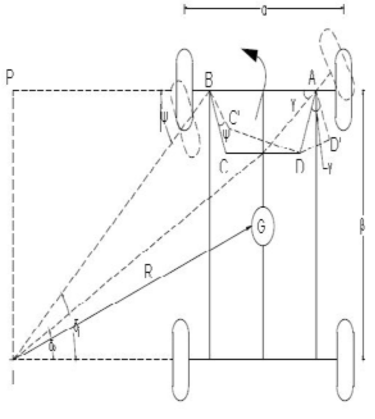
P =7.629 watts

T =4.05N-m

This shows that the connecting rod is now designed to deflect in angular direction.

Now, if we increase the length of connecting rod, we will have to simultaneously increase the diameter or the modulus of rigidity to keep the angular deflection zero.But it is not possible to vary either of the two parameters as the connecting rod is a critical member in the geometric assembly of the system. So weprefer to modify the rack arm, which is fairly simple.

ACKERMANN'S LAW MECHANISM
The law states that to achieve true rolling for a four wheeled vehicle moving on a curved path, the lines drawn perpendicular to the four wheels must be concurrent.



However in Ackermann steering mechanism this condition is achieved only for single angle or turn

Taking Maximum angle of turn – 30^0

Using Ackermann's formula,

$\cot\psi - \cot\gamma = c / b$

Where,

c = 58 inch

b = 77 inch

$\psi = 30^o$

'γ' is to be 22.30^o

Using Ackermann geometry the length rack rod is 330 mm

Turning radius = 3629.1 mm

CONCLUSION
From the kinematic analysis it is evident that the turning radius of the vehicle can be wheel symmetric steering system without crossing the practical limitations Thedesign and manufacturing of the system was completed as per requirement and is currently under testing.

FUTURE SCOPE
The successful implementation of 2 Wheel Steering using mechanical linkages & single actuator will result in the development of a vehicle with maximum driver maneuverability, uncompressed static stability, front tracking, and vehicular stability at high speed lane changing, turning radius and improved parking assistance. Furthermore, the following system does not limit itself to the benchmark used in this project, but can be implemented over a wide range of automobiles, This coupling with an overhead cost just provides one of the most economical steering system. For improvementit may further covert into power steering and 4 wheel drive ATV.

FABRICATED ATV

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