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A Reduction in Steering Effort for Racing Vehicle

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***Abstract*: The theory is included in this work and the article focus on the conventional and general steering arrangement on the synthesis of design and analysis of steering system. To guide the motor vehicle through direction of the road is totally the responsibility of the driver for steering the racing vehicle, it requires the driver to look straight ahead at the intended path relative to the car and somehow analyzing and give the car a controlled desired input with the path way. There is a significant role of the steering system in each and every vehicle too make the handling convenient and to enhance the stability of the vehicle. Aspects like wheels, tyres steering assembly plays an important role to improve vehicle handling. Considering different steering modes changes the need of steering system of go kart. Under consideration of short turning radius, steady road conditions A steering wheel which is hand operated which is used on basis to turn the wheels on the front axle and is positioned by the driver controlling the steering wheel.**

***Keywords*: Steering system, Ackermann, Steering geometry, Kingpin, Castor, Design, Calculations**

1. Introduction

Steering is one of the most vital sub-system of any car. In case of formula 9 car, it is even more significant. Since this vehicle is designed to compete in circuit races and the objective of the team is to win, any failure in the system will lead to disastrous effect to the car and the driver. Increasing the performance of any one of these elements can enhance the competitive level of a racing team and improve the chances of achieving the ultimate goal of winning races. This relationship is true when describing the driver and racing car interface. The driver must be able to control and exploit racing car performance improvements to affect increases in speed and hence reduction in wearing. The steering effort is an important characteristic of vehicles because it influences driver comfort directly. Steering effort and steering feel are the interest of this project. steering effort according to the vehicle speed and steer speed is directly affecting the steering feel and driving comfort. The idea of steering system in racing vehicle or normal vehicle to be perform smoothly, effort less, safely all these problems are focused in this project. Although the designing starts with study of parameters used for any general passenger car, it forms the foundation for designing the steering system for a Formula 9 car which is quite different. The steering effort and infinitely complex human beings that makes the sport so intriguing for participants and spectators alike. As vitally important as the driver, this project concentrates on the vehicle steering which can be modified to enhance performance and facilitate driver control.

2. Summary

In The steering system we considering various aspect to solve this on various condition .to give better performance to get good result will target driver who face these issues on delay basis practical errors can make the vehicle go negative under steer and is harmful for a driver as well as vehicle on running condition. Practical implementation of kingpin and caster is difficult in practice. There is no suspension and differential involved in this formula vehicle hence total effort acts on steering system as well as speed distribution ratio is totally implemented by steering system.

3. Literature

The steering linkages proposed for improving the stability by mounting smaller front wheels on a turntable to provide a single pivot steering layout. With the disadvantage of shock loads acting on linkages and the vehicle hence difficult to control the vehicle. Ackermann steering linkage was that the wheels swiveled at equal angles when the vehicles followed a curved path to overcome it the inner wheel should be swiveled to a greater angle than the outer wheel by arranging the geometry as the angular difference between the steered wheels had to be related to the width of track and length of wheelbase. Also by arranging the side steering arm to lie along lines that met at the centre of the rear axle. Implementing the Ackermann Steering Geometry.

Development of adjustable systems for a go-kart, Author: Abhijit Singh, Tarun Singh, Vansh Mudgil

The three systems adjustable camber setting, adjustable engine mounting and adjustable pedal arrangement were installed in the go-kart in place of the conventional systems The

material selected for manufacturing was selected after comprehensive analysis hence keeping the gross weight of the vehicle as low as possible [1].

Steering System of Go-Kart, Author: Mohd. Anwar, Ashraf Shaik, Mohd Sohail

The manual mechanical linkages steering system is not used in heavy weight, although it is simple in design and easy to manufacture, therefore it is commonly used in light weight vehicles. The values calculated may differ practically due to steering linkages error or due to improper steering geometry [7].

Steering system design of go-kart, Author: Dhirendra, Kumar Verma, Jainesh Singh

The various geometries such as Ackermann geometry, scrub radius, caster, camber, King pin inclination and various forces acting on the knuckle are completely analyzed [11].

4. Objective

a) Primary objectives to design as safe and Functional steering system considering the reduction steering effort using Various factor such as Ackermann principle, steering geometry factors such as, under steer, caster, camber, toe outs on turn, wheel jacking and kingpin Inclination and also effects on steering components such as steering Column plate, steering bush, stub axle, steering arm.
b) Secondary objective to enhance driver comfort and safety by reducing Road vibration of racing track without suspension system during cornering by reducing the turning radius and increase performance and Maneuverability of vehicle.

5. Steering system to be used

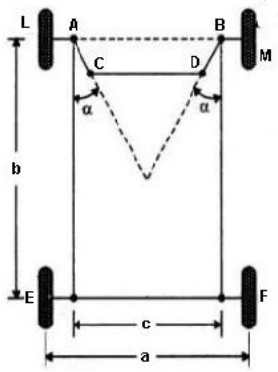

Fig. 1. Ackermann steering mechanism (Straight Drive) [13]

The steering system to be used is Yoke type steering system and the mechanism to be used is Ackermann Steering Mechanism. The mechanism gives only 3 positions for correct steering, one when θ = 0 (Straight drive) and the other two each corresponding to the turn to right or left (at a fixed turning angle). However, for other angles also it gives a close approximation to the ideal condition. Further this has the advantage that it employs pivots and not sliding constrains, due to which reason its maintenance is easier. That is why it is universally employed However, lately the automobile designers do not care to follow the Ackermann mechanism very strictly on account of the improvement in the tyres sidewall flexibility and tread distortion Rather it is endeavored to obtain the smallest value of the turning circle. It may be noted that while parking, it is easier to steer a vehicle in reverse than in the forward direction because the rear wheel turn on smaller radius than the front wheels.

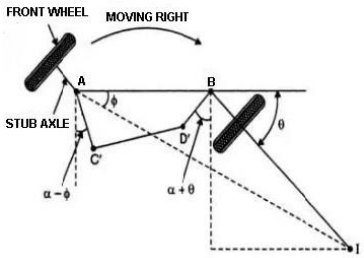

Fig. 2. Ackermann steering mechanism (Turning Right) [13]

1. The various parameters on which the geometry depends are listed below:
    a) Stub Axle Length.
    b) Steering Arm Length.
    c) Angle Between Stub Axle and Steering Arm.
    d) Dimensions of Triangular Plate.
    e) Dimensions of Tie-rod.
    f) Vehicle width track and wheel base.
    g) Vehicle weight.
    h) Understeer and Oversteer.
    i) Turning radius.
    j) Ackermann angle.

2. Steering geometry:
    a) Kingpin inclination angle.
    b) Castor angle.
    c) Camber angle.
    d) Toe in.
    e) Toe out on turns.

3. Ackermann geometry:
    a) Track width.
    b) Wheel base.
    c) Distance between pivots.
    d) Ackermann angle.
    e) Outer angle.
    f) Inner angle.
    g) Turning radius.
    h) Inner turning radius.
    i) Outer turning radius.
    j) Steering axis angle inclination.
    k) Steering ratio.

4. Ackeermann Assumptions:
    a) 100% Ackermann steering geometry.
    b) Maximum road bank angle is 20 degree.
    c) 12 degree optimum king pin inclination angle.
    d) 10 degree optimum castor angle.
    e) 40:60 front to rear weight ratio.
    f) Taking 10m/s^2 as acceleration due to gravity [3] [5].
    g) Steering ratio is considered approximately 1:1 for Go-kart.

6. Components to be listed

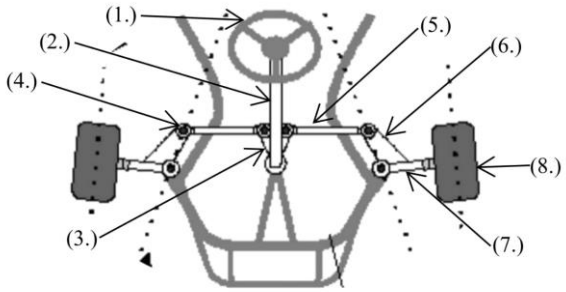

Fig. 2. Reference Assembly [14]

Components list according to assembly.

1. Steering Wheel.
2. Steering Column.
3. Pit-man Arm (Intermediate Plate).
4. Eye Bolt.
5. Tie rod.
6. Steering arm.
7. Stub axle.
8. Wheels.

7. Analysis of the steering system components

In order to determine the components safety some external factors such as loads, temperature, pressure etc. are external factors which are applied on the components for analyzing the components and obtaining the approximate or appropriated values such as stresses (bending, tangential and normal), deformation in the components after the application of external load when implemented in practical use. To understand various factors with an ease applicable in the process it gives optimum results of the safety of component. This analysis gives the approximate or appropriated, optimum result of the safety of component and by minimizing the chances of failure. ANSYS, Solid works, etc., this are the various computer simulation software packages available in the markets to carry out such type of analysis under various loading conditions [7].

A. Two Major Analysis Carried Out

1. Deformation analysis
2. Stress analysis

B. Various Components Analyze

1. Steering Stub Axle
2. Steering Arm
3. Steering Knuckle C
4. Steering Pit-man Arm (Intermediate Plate)
5. Steering Tie Rod

C. Analysis Performing Process

1. Making or importing the geometry to software interface (GUI).
2. Defining the field.
3. Applying the material properties.
4. Meshing the components with appropriate element size.
5. Applying the actions such as load, pressure etc on the component body.
6. Applying the boundary conditions such as fixed supports (constraints).
7. Solving the problems using the solver.
8. Obtaining the required reactions or values of stresses acting on the components and the deformation of the body member under certain acting loads [7].

8. Conclusion

In this review paper, the focus is on the best to the knowledge basics with design parameters and assembly of the steering system is gathered with the help of the researchers and their documentations, the purpose of the steering system their objective, the literature survey, the overview of the steering system used in the go-karts, the steering system to be used their components to be consider, steering system has cornering capability, steering response, straight-line stability, low speed maneuverability The steering mechanism used which is Ackermann steering geometry is discussed with the steer cases and is explained in simple form with terms considered in mechanism and the assumptions made during the solution of the Ackermann steering geometry problems. The analysis of the steering system components through various software's can be performed which determines the stresses, loads and deformation of the steering system from which the design engineers can predict the safety of the system and can also be modified and minimization of the errors in the systems can be done, this is the knowledge and data about the design, assembly and analysis without any mathematical considerations. Also focuses on the steering geometry of the vehicle giving it the most importance for the reduction of steering effort under steer and over steer effects considering the vehicle stability.

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