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Steering System of Electric Go-Kart

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Abstract-: Manual rack and pinion steering systems are commonly used due to their simplicity in construction and compactness. The main purpose of this paper is to design and Manufacture manual rack and pinion steering system according to the requirement of the vehicle for better Manoeuvrability. Quantities like turning circle radius, steering ratio, steering effort, etc. Are inter-dependent on each other and therefore there are different design consideration according to the type of vehicle. A virtual rack and pinion assembly can be created using software like Solid works and Ansys.
Keywords: Go-kart,Rack and pinion, Ansys, Ackerman, camber, caster.

I. INTRODUCTION

The steering system is of important part of the dynamic design of any automobile to facilitate a smooth change of directions and make use of the tires ability to generate lateral forces to the highest extent. A racing driver's sensory inputs supply visual, tactile, and inertial information used in developing a "feel" for car handling and performance. This feedback is necessary in enabling the driver to extract maximum performance from the race car. Hence the steering is an important feedback mechanism giving driver information on stability and directional control.

II. OBJECTIVES

To enable smooth and stable manoeuvring of the vehicle.
To provide feedback to the drive.
To optimize the steering effort
Provide adjustability for parameters such as caster angle and toe.
To select and implement the best mechanism that suits the purpose.

III. SELECTION OF STEERING SYSTEM

A. Rack and pinion is used in most of vehicle because of the following reasons

It reduces reaction torque on the steering wheel and provides the driver actuate feeling of existing lateral tire road friction
It as the simplicity of mechanism reduced friction between tooth flanks.
It has very good mechanical efficiency.
It provides a good steering response.
It reduces the space requirement.
Contact between the steering rack and pinion is free play and even internal damping is maintained.
Helical gears are used in rack and pinion steering to allow a large transverse contact ratio.

IV. DESIGN METHODOLOGY

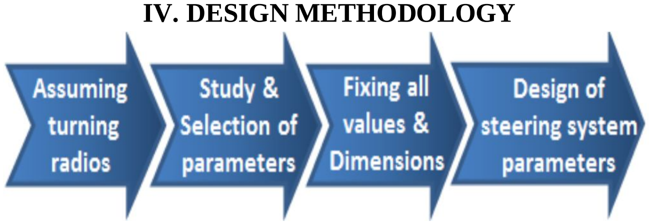

Fig.1 Design methodology

There are many types of steering systems and mechanisms are there in various automobile vehicles; but they having low response timing. For go-kart which is used for racing vehicle have to be equipped with quick response and actuating steering system for that the steering system used in this vehicle is newly designed and modified from many systems i.e. reverse pitman arm steering. Unlike

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other systems it having steering rods connected to a single disc which is directly welded to the steering rod for zero lagging and quick response

V. CAD MODEL

We have designed complete assembly of rack and pinion inSolid works 2015, the complete design of rack and pinion and its assembly in Solidworks2015 are shown below

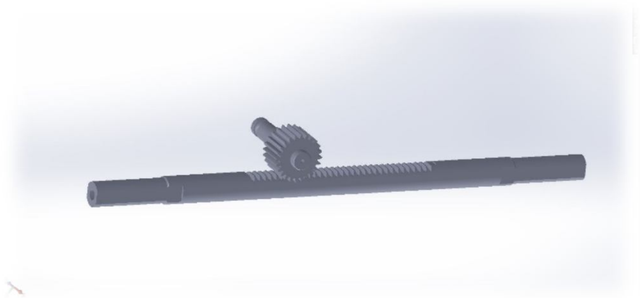

Fig.2 Cad Model of rack and Pinion

VI. ANALYSIS OF COMPONENT

Analysis is process of analysing the components by applying load, temperature, pressure etc. and obtaining thevalues such as stresses (bending, tangential and normal), deformations, safety factor etc and in order to determine the safety of the components when done in practical. This Analysis gives optimum result of safety of components and minimizes the chances of failure.

Three major analyses of rack and pinion on Ansys arecarried out here:

Total Deformation

Equivalent Stress

Factor of Safety

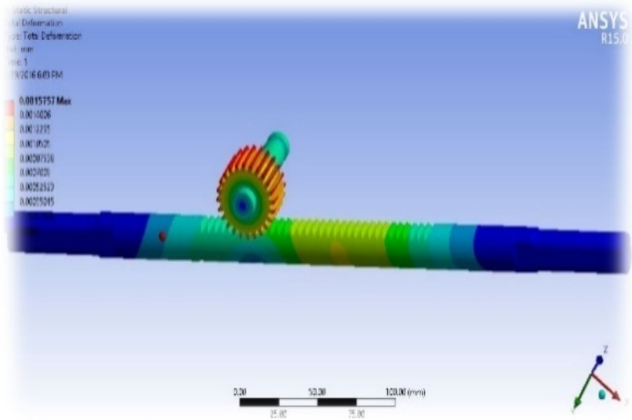

Fig.3 Total Deformation

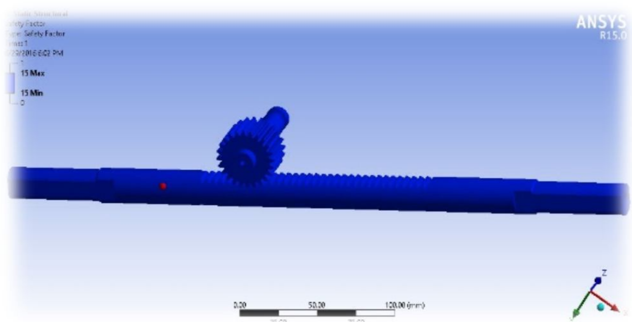

Fig.4 Factor of Safety

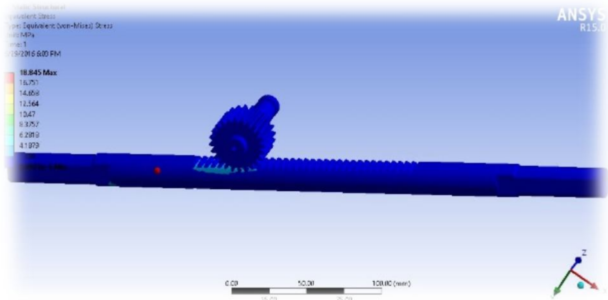

Fig.5 equivalent stress

VII. CONSIDERATIONS

Camber: The camber angle is set to zero degree as there is no suspension system to provide dynamic camber during cornering.

Caster: It is the angle made by the kingpin with the vertical measured from the side of the tire. Positive caster angle, although increases steering effort, is necessary to obtain self-aligning torque and also enable the inside rear wheel to lift during cornering since the kart does not have a differential at the rear axle.

Kingpin Inclination: Due to the geometry of the stub axle the King pin offset is high, which demands large kingpin inclination to minimize scrub radius which is not feasible. Hence it is set to 0(zero) degree.

VIII. STEERING GEOMETRY

We decided to adopt Ackerman steering geometry with rack and pinion mechanism This geometry makes the inside wheel steer to a greater angle than the outside wheel and all the wheels roll about a common turn center. Since the cornering speeds are small, Ackerman geometry is an ideal choice. The mechanism was simulated in solid works software and after several trials the following configuration was obtained which satisfied Ackerman condition with minimal error.

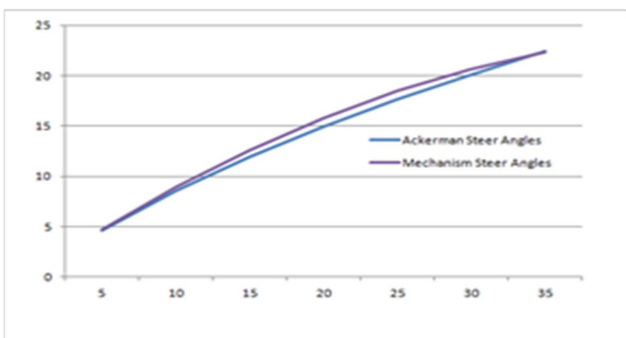

Fig.6 Steering Mechanism

TABLE.1
OBTAINED VALUES

Steering system	Ackermann steering(rack and pinion)
Wheel base	1474.4mm
Track width	1032.5mm
Turning radius	3796.31mm
Steering ratio	4:1
Inside angle	22.73
Outside angle	30.69

IX. CALCULATIONS

Considering the turning radius of 3m, using the

Ackerman equation for the dimensions of our go-kart, the maximum steering angles was calculated.

Wheelbase (L): 1474.4mm

Track width (T): 1032.08mm

Actual Turning Radius (R): 3796.31mm

OUTER ANGLE :

Tan A= L / (R - d/2)

=1474.4 / (3000-1032.08/2)

Tan A = 0.59

A=Tan^{-1} (0.59)

A=30.69

INNER ANGLE

Tan B = L /(R + d/2)

= 1474.4 / (3000+1032.08/2)

Tan B = 0.419

B= Tan^{-1} (0.419)

B=22.73

Actual Turning Radius :

= d/2+L cosec (30.69/2 + 22.72/2)

=3796.31 mm

%Ackermann = A-B/ Tan^{-1} (1/tanB-1)-B

=30.69-22.73 /31.47

=0.96*100 =96%

The steering ratio is set to 4:1 for a quick vehicle response.

X. CONCLUSIONS

The manual rack and pinion steering system is notused in heavy weight vehicles due to high axle loads, although it is simple in design and easy to manufacture, therefore it is commonly used in light weight vehicles. The values calculated in the paper may differ practically due to steering linkages error or due to improper steering geometry, so these values are useful to understand the interdependency of the quantities on each other and to design an ideal manual rack and pinion system for the vehicle.

XI. ACKNOWLEDGEMENT

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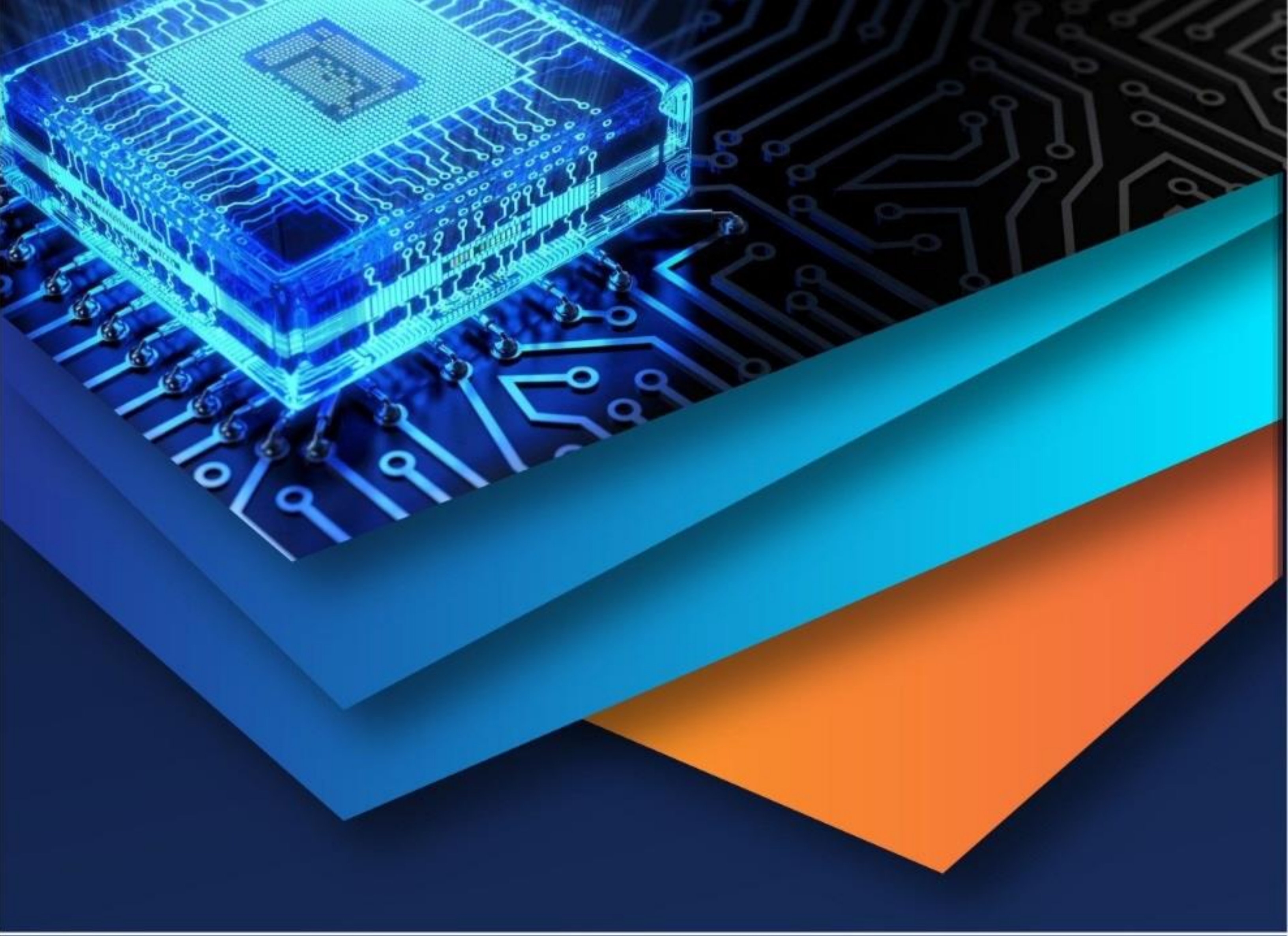

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