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ORIGINAL RESEARCH PAPER

Engineering

STEERING SYSTEM DESIGN OF GO-KART

KEY WORDS: Thyroid swelling, FNAC, Histopathology.

Dhirendra Kumar Verma	Faculty Department of Mechanical Engineering, IIMT College of Engineering Gr. Noida (U.P)
Shivam Singh Tomar	Final year student B.Tech ME Department of Mechanical Engineering, IIMT College of Engineering Gr. Noida (U.P)
Jainesh Singh	Department of Mechanical Engineering, IIMT College of Engineering Gr. Noida (U.P)
Dr. D. R. Tiwari	Faculty Department of Mechanical Engineering, IIMT College of Engineering Gr. Noida (U.P)

ABSTRACT

This article focuses on the synthesis of a steering mechanism that completely based on the Ackermann steering geometry. It starts from reviewing of the four-bar linkage which acts as a double crank mechanism. Further steering column is modified by providing an external U-joint in the steering column. It helps to adjust the steering according to driver's comfort, due to this adjustment in steering the C.G of the vehicle can be shifted. The king pin inclination (K.P.I) can also be adjustable, which help to increase or decrease the turning radius.

Introduction:

The steering system is the direction control system of vehicle which is designed to provide direction manoeuvrability to the vehicle. Generally the steering is connected to the front wheel the vehicle. The stability of the vehicle is maintained by the steering system during the time of turning and while moving longitudinal direction, to obtain perfect rolling of all wheels about a single point.There is no definite functional relationship between the turning angle of the steering wheel made by the driver and the change in driving direction, because the correlation of the following is not line-ar

- Turns of the steering wheel,
- Alteration of steer angle at the front wheels,
- Development of lateral tire forces,
- Alteration of driving direction.

To move a vehicle, the driver must contin-ually adjust the relationship between turn-ing the steering wheel and the alteration in the direction of travel. The factors that are considered in steering are the roll inclina-tion of the body, the feeling of being held steady in the seat and the self-centering torque the driver will feel through the steering wheel. The most important infor-mation the driver receives comes via the steering moment or torque which provides him with feedback on the forces acting on the wheels.

Steering components:

Steering Column and Shafts:

The steering shaft is installed in the steer-ing column.Bearings are generally used to hold the shaft in position.The shaft and column assembly is usually removed an-dreplaced as a unit. However, individual parts are oftenreplaced without removing the shaft or column. In thissection, we will discuss the individual parts that make up-the steering column and shaft assembly.

Fig.1

Steering Wheel

The steering wheel size has an effect on the effortexpended by the driver to turn the vehicle. The larger thewheel, the less effort needed to turn it. This is due to the leverage exerted by the larger wheel.

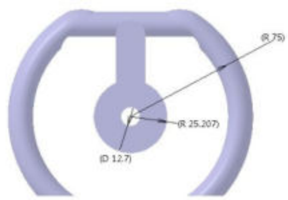

Fig. 2

Pitman Arm

It is attached to the tie rod and steering column. It converts the turning movement of the steering wheel to linear (back-and-forth) motion and transfers this motion to the steering linkages. The pitman arms have a hole to accept the ball socket shaft provided at the end of tie-rod.

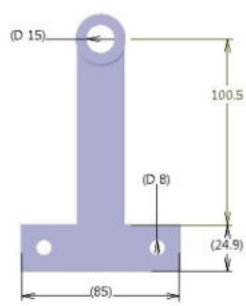

Fig.3

Tie Rods

A tie rod assembly is attached to each end of the relay rod. The tie rod assembly con-sists of inner and outer tie rods that are usually connected through an adjusting sleeve.

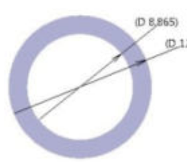

Fig.4

Fig.5

King pin inclination (K.P.I)

K.P.I is adjustable then the distance be-tween K.P.I and the centre of wheel may be increases or decreases and this adjust-ment helps to increasing or decreasing the camber. If the K.P.I is not adjustable then ground forces will act directly on the chas-sis which may cause jerks and tends to de-form the chassis. This problem can be re-solved by suspension system but the effort of turning will be higher, in order to reduce the turning forces king some inclination is provided to the king pin which reduces the scrub radius. The ground force acting on the K.P.I is resolved by the adjustable K.P.I and the effort of the driver is reduce.

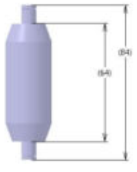

Fig.6

Knuckle

It is that part which contains the wheel hub or spindle, and attaches to the steering components. It is variously called a steer-ing knuckle, spindle upright or hub, as well.The wheel and tire assembly attach to the hub or spindle of the knuckle where the wheel rotates while being held in a sta-ble plane of motion by the knuckle assem-bly.

Fig.7

Steering ratio

The percentage of vehicle weight placed on the front wheels and whether the vehi-cle has front- or rear-wheel drive are also factors. The steering ratio is the amount of degrees you have to turn the steering wheel, for the wheels to turn an amount of degrees.

Steering ratio = (Lock to lock steering wheel angle)/(sum of inner and outer wheel angle)

Bump steer

The steer angle generated by the vertical motion of the wheel with respect to the vehicle body is called bump steering. Bump steering is usually an undesirable phenomenon and is a function of the sus-pension and steering mechanisms. If the vehicle has a bump steering character, then the wheel steers when it runs over a bump or when the vehicle rolls in a turn. As a result, the vehicle will travel in a path not selected by the driver. Bump steering oc-curs when the end of the tie rod is not at the instant centre of the suspension mech-anism. Hence, in a suspension deflection, the suspension and steering mechanisms will rotate about different centres. But in case of go-kart the suspension system is absent so the instantaneous centre on steer-ing arm and pitman plate should line at the centre of rear axle to avoid bump steer condition.

Scrub radius

The scrub radius is the distance between the king pin axis and the center of the con-tact patch, where both will touch the ground theoretically if seen in front view.

Inversion Of four bar Mechanism
Double Rocker Arrangement

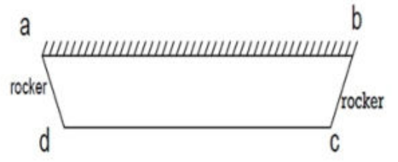

Fig.1

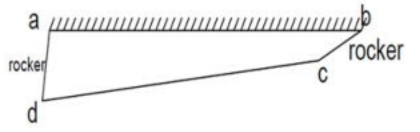

Fig.2

Ackerman geometry

It is a geometric arrangement of linkages in the steering of a car designed to solve the problem on the inside and outside of a turn need to trace out circles of different radi-us.

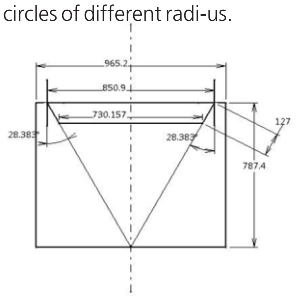

Fig.3

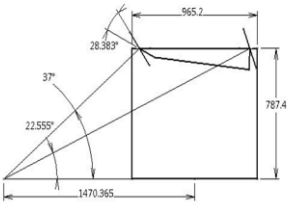

Fig.4

Mathematically

Θ = steering angle of inner wheel
Φ = steering angle of outer front wheel
c = distance b/w pivot point.
a = wheel track
b = wheel base.
y = distance from I.C to closest pivot point.
Turning radius

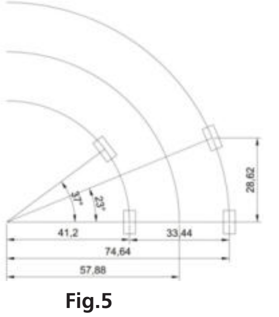

Fig.5

Equation for turning radius is:

$$= \frac{TW}{2} + \frac{WB}{Sin\alpha}$$

$$= \frac{38}{2} + \frac{31}{Sin26.024}$$

Our dimensions
a = 38", b = 31",c = 33".
For inner front wheel

$$Rif = \frac{b}{\sin\theta} - \frac{a-c}{2}$$

$$= \frac{31}{Sin37} - \frac{38-33}{2} = 1.244m$$

For outer front wheel

$$Rof = \frac{b}{Sin\ \Phi} + \frac{a-c}{2}$$

$$= \frac{31}{22.55} + \frac{5}{2} = 2.116m$$

For inner rear wheel

$$R_{ir} = \frac{b}{\tan\theta} - \frac{(a-c)}{2}$$

$$= \frac{31}{Tan37} - \frac{5}{2} = 0.987m$$

And

$$R_{or} = \frac{b}{\tan\Phi} + \frac{a-c}{2}$$

$$= \frac{31}{Tan22.55} + \frac{5}{2} = 1.95m$$

The equation for the correct steering

$$Cot\ \Phi = \frac{y+c}{b} \quad \text{or } Cot\ \Phi = \frac{y}{b} + \frac{c}{b}$$

Or

$$Cot\ \Phi = Cot\ \theta + \frac{c}{b} = Cot\ \Phi - Cot\ \theta = \frac{c}{b}$$

This equation represents the basic condition for steering mechanism for perfect rolling.

Knuckle design

Fig. 6

Maximum load on front tire on full braking = 1177.2N + 0.25% of 1177.2N

= 1471.5N

Load on each tire =735.75N

Maximum load on front knuckle = 735.75Cos100= 724.57 N

Material selected for Knuckle = EN8

Properties of EN8 (30C8)

Chemical composition		
Carbon	0.36-0.44%	
Silicon	0.10-0.40%	
Manganese	0.60-1.00%	
Sulphur	0.050 Max	
Phosphorus	0.050 Max	
Chromium	–	
Molybdenum	–	
Nickel	–	
Mechanical properties		
Max Stress	700-850 n/mm2	
Yield Stress	465 n/mm2 Min	(up to 19mm LRS)
0.2% Proof Stress	450 n/mm2 Min	(up to 19mm LRS)
Elongation	16% Min	(12% if cold drawn)
Impact KCV	28 Joules Min	(up to 19mm LRS
Hardness	201-255 Brinell	

Calculations	values
Total mass of the vehicle	1177.2N
Force on front tires	470.88N
Wheel Base	787.4mm
Track width	965.2mm
Negative castor	7^0
Camber	10^0

Scrub radius Z =
a = 91.69mm, b = 15.6mm
Z = 93mm

Steering effort at static condition
Normal reaction at front wheels
F = 470.88 N

Torque at steering arm
T = μ x Normal reaction x Scrub radius.
= 6.72 Nm

Force transmitted by steering arm
= 52.94N

Torque distributed to pitman plate
= 6.72Nm

Force at steering wheel = 10.08/0.15
= 44.8N

Steering effort considering dynamic weight distribution at full braking

Total load on each tire = 588 N
Torque at steering arm

T = μ x Normal reaction x Scrub radius
= 16.8Nm

Force transmitted by steering arm
= 132.31N

Torque distributed to pitman plate
= 16.8Nm

Force at steering wheel = 112N

Innovation in steering of a Go-kart

The steering of go-kart is made adjustable. The purpose of making steering adjustable was to make it comfort for drivers of different height. After analysing the ergonomics of different height drivers we have made the steering adjustable. The maximum turning of steering wheel is about 400 in go karts and there is negligible effect of steering column inclination on steering effort.

Fig.7

Fig.8

Conclusion

The components of steering system are designed on CATIA V5R20 and analysed using ANSYS WORKBENCH15.0. The various geometries such as Ackerman geometry, scrub radius, caster, camber, King pin inclination and various forces acting on the knuckle are completely analysed. This paper represents the suitable steering system of a Go-Kart which satisfies all the different kinds of geometries that is essential for perfect steering conditions.

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