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SIX-BAR STEERING MECHANISM

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ABSTRACT

A six bar steering system is mainly designed for a Low weight vehicles like BAJA or SUPRA car, in which a rack-and-pinion steering mechanism is used. The theoretical designmodelling of the steering system along with the derivations for optimalvaluesof parameter find out with optimization and are shown here. Firstly, the steering or turning angles for the front wheels are find out on thebasis of the geometry of the steering mechanism system. Second, linear equations showing the axial lines for the front are estimated from the steering angles of the front tyres. Then the Ackermann steering errors are calculated on the axial line of the rear tyre using the axial lines of the front wheels of the vehicles. Finally, the optimum design values for the parameters of the steering mechanism system are calculated with the help of computer programming such that the calculated values of the parameters will be optimise value of the design which minimize the error in Ackermann steering on the wheels axial line of the rear wheels

Keywords: steering mechanism, design iterations,.

I. INTRODUCTION

The steering systems assume to be the critical role in maneuvering or moving with skill vehicles, yet they additionally need to give good ergonomics. Significantly innovative development and research work have been performed for the enhancement design and optimization of design in the steering system of a vehicle. There are mainly two types of steering systems for modern cars and light weights trucks: the ordinary linkage steering system and the rack-and-pinion framework steering system. The conventional system was the main sort used until the 1970s. In small cars and automobiles, it has been supplanted by the rack-and-pinion framework steering, however the regular steering system is yet utilize for many light trucks. The benefits of the rack and pinion steering mechanism system is that it is very simple to work and construct, economical to manufacture, and compact and easy to operate.

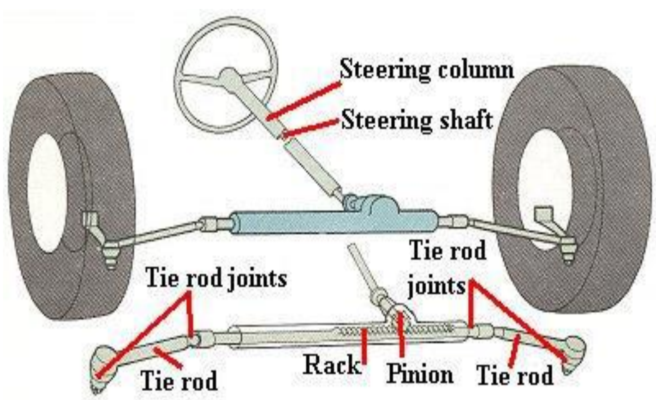

Fig.1. Steering mechanism

This mechanism was created by the German carriage builder Georg Lankensperger in Munich in 1817, Then patent was made by his agent in England, Rudolph Ackermann (1764–1834) in 1818 for horse-drawn carriages. Erasmus Darwin may have a earlier claim as the creator dating from 1758.

The steering mechanism which control vehicles like a car must take after the Ackermann guideline to decrease the skidding and wear of the tires. This rule expresses that all the hub lines of the wheels must meet at a point, i.e. the moment focal point of turning. Genuine guiding instruments are mind boggling and spatial in nature. Be that as it may, the genuine rack and pinion directing linkage might be demonstrated as a planar linkage for the examination of the Ackermann conditions.Along these lines, in this paper, the directing component of a vehicle is considered as a planar linkage In this paper, the ideal separation from the front wheel hub to the guiding rack pivot is gotten to such an extent that the controlling framework fulfills the Ackermann guideline with least guiding blunder on the hub line of the back wheel. In the first place, the directing edges of the front wheels are inferred in view of the geometry of the steering system.

At that point straight conditions speaking to the pivotal lines of both front wheels are gotten in light of the controlling edges, the separation between the left and right wheels, and the separation between the front and back axles. At long last, the guiding mistake, in light of the Ackermann guideline, is processed as a component of the uprooting of the controlling rack and the separation from the front hub to the directing rack hub.

II. STEERING SYSTEM

Ackerman principal of steering design :

Figure 2 shows the Ackermann principle, in which $\theta l$and θrdenote the left and right directing edge steering angles, respectively; $lw$and la denote the separation among the left and right wheels and the length from the front axle to the rear axle respectively. The Ackermann principle Need that the axial or pivoted lines of all the wheels must meet at the same point which shows the centre of turning. A steering framework linkage must be designed as per the Ackermann principle to assure pure rolling motion and to reduce the skidding to minimum and thus `wear of the tires. Rather than the producing turntable steering, where both front tyres makes turned around a common pivot angles, where each wheel obtain its own pivot angle, close to its own hub radius. While it is more complex structure, this arrangement increase the controllability and stability by reducing large inputs to vehicle from road's surface variations being applied to the end of a long lever arm, as well as highly decreasing the fore-and-aft travel of the steered wheels.

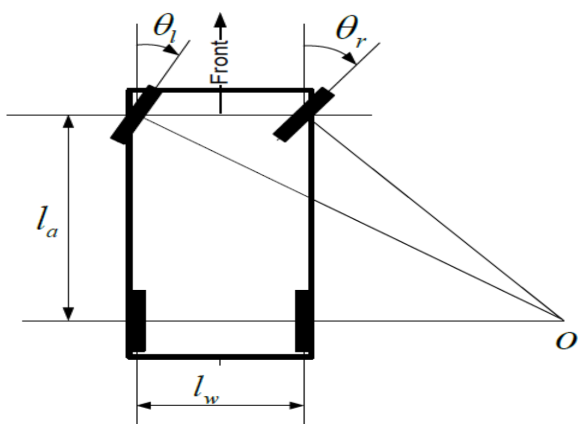

Fig.2. Ackermann principle of steering

A linkage between these hubs rotate the two wheels together, and by caution causes the linkage measurement the Ackermann geometry could be approximated. This was obtained by making the linkage not a basic parallelogram, but rather by making the length of the tie rod (the moving link between the hubs) lesser than that of the axle, therefore the steering arms of the hubs seen as to "toe out". Hence As the steering moves, the tyres swung according to Ackermann, while the inner wheel turning further.If the track rod is placed in front of the axle, it should bemore longer in comparison, thus preventing this same "toe out"

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Ackermann steering design

The Ackermann principle states that the extended lines from the steering arms axle must meet at the exact middle of the rear axle as shown in Fig. 3.

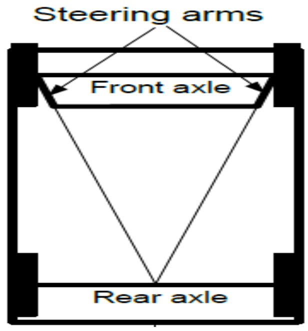

Fig.3.Wheel and axle positions

A rack-and-pinion steering mechanism which conventionally used, shown in Fig. 3, is majorly used in this steering design, in which the length from the front axle to the rare of axis is considered as a design parameter.

A straightforward estimate to consummate Ackermann guiding geometry might be created by moving the controlling turninward so as to lie on a line drawn between the steering kingpins and the centre of the rear axle The guiding turn focuses are joined by an unbending bar called the tie bar which can likewise be a piece of the controlling instrument, as a rack and pinion for example.With idealize Ackermannat any angle of steering, the centre point of all of the circles traced by all wheels will lie at a typical common pointNote this might be hard to orchestrate by and by with straightforward linkages,and designers are advised to draw or examine their steering systems over the full range of steering angles.

Now a daysModern cars does not use the steering principle of Ackermann, partly because of it avoids important dynamic kinematics and compliant effects, but the principle is good for low-speed manoeuvres.

Some racing cars make use of reverse Ackermann geometry to accommodate for the large gap in slip angle between the inner and outer front wheels while cornering at high velocity. The use of such geometries will helps to reducetemperatures of tyre during high-speed turning but this will reduce the performance in low-speed manoeuvresvehicle.

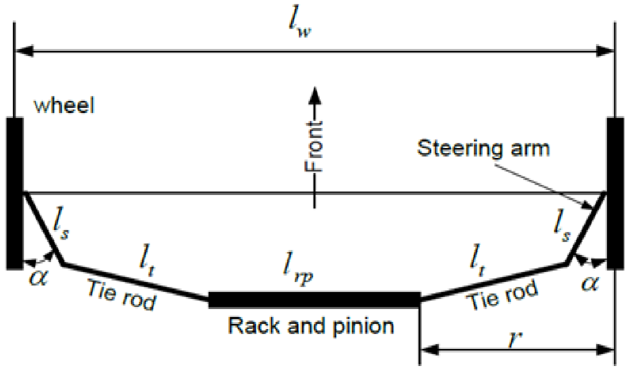

Fig.4.Rack and pinion system

The main design objectives in this research work is to find out an optimum value of design parameter like the gap between the front axle and the rare axis so that the optimum values of design parameter results in minimum steering

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error on the line of rear axle of rare wheel. The aim is to make the steering error is to be made as small as possible. The error can be found out by the difference of the actual six barsteering mechanism and the basic four bar steering mechanism which is to be minimal as possible.

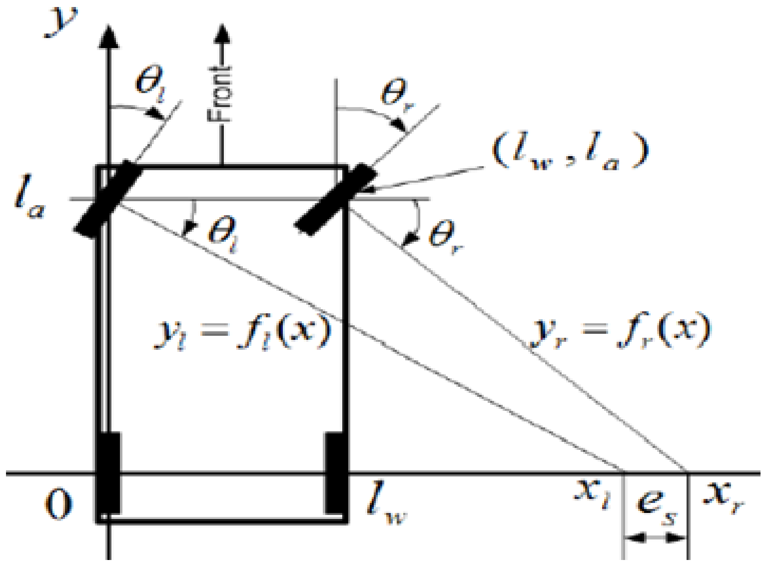

Fig.5. Design objective in front axle wheel

III. EFFECTS OF STEERING ERROR

Figure 5.shows the coordinate system that gives the steering error on the axial line of the rear tyres, which is based on the Ackermann principle. In other words The error can be find out as the length between the axis of rotation of the tyres when examine along the axis of rotation of the rear tyre. As we have using a non-standard ackerman principle system because or design constrains of other parameters like the depth of hub, off the shelf ackerman'arms ,or other link. If this errors are not eliminated, then this may cause many effects on the ergonomics and the design of the vehicle. As the vehicle maybe able to carry low speed into the corners.This is majorly due to incorrect instantaneous canters of rotations of the tyres,which further results in the skidding of the wheels on the road, which improve the slip angle of the vehicle and decrease the life of the wheel drastically.

Procedure for computation of steering error:

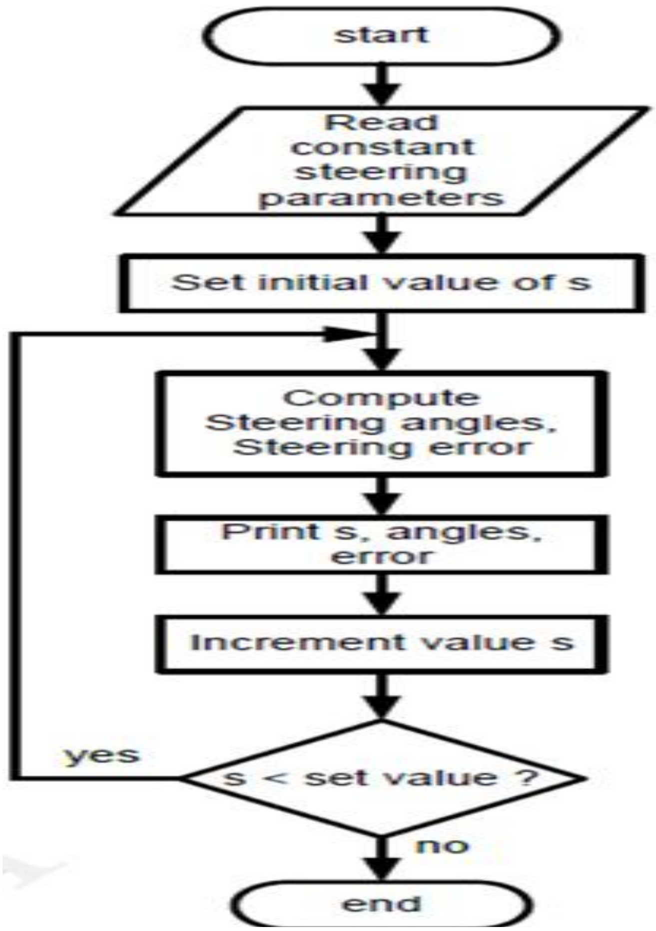

Fig. 6 error computation algorithm in design

Disadvantages of four bar mechanism

- Moving link member inside the cabin.
- Incorrect meshing of rack and pinion.
- Not able to adjust bump steer.

Advantages of six bar mechanism

- Reduce road shocks.
- Less efforts.
- Helps in correct meshing of rack and pinion.
- Low moving parts inside the cabin.
- Adjustment of bump steer possible.

IV. PROCEDURE

1. As we go on start the design process, the procedure for the six link steering mechanism, set the initial constant parameters of the vehicle for eg.rack length, wheelbase, track width.
2. Then also take into consideration the parameters which has to be fixed due to the design constraints of the other systems or stocking parts in vehicle.
3. Then take an initial guesses of the length between the rare axis and the kingpin to kingpin axis of the tyres.
4. According to it find out the distance of the tie rods of the mechanisms

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5. Further examine the steering error that has seen due to the design constrains and the set parameters for it.
6. Then find out various iterations for optimization so as to decrease the steering error and enhance the steering performance of the system.
7. If the iteration values give us a steering error which is greater than acceptable value, then we assume another lengthbetween the rack and the wheel axis
8. Repeat the same procedure until we obtain an acceptable value of theerror in steering in the iteration.
9. After getting ainitial value in iteration of the geometry of the mechanism, need to optimize parameter the steering mechanism by further iteration of design parameter the values taking in consideration the forces and the efforts required by the design operator.

V. RESULTS AND ITERATIONS

	A	B	C	D	E	F	G	H	I	J
1	WHEELBASE	KINGPIN TO KINGPIN	ACKERMAN ARM RADIUS	RACK TRAVEL()	TIEROD LENGTH	THETA	PHI	PHI IDEAL	RACK TO AXEL	RACK LENGTH
2	60	45	3.93	1.57	14.55109592	1	0.9890097	0.9870804	3.6811	11.944
3	60	45	3.93	1.57	14.54618376	2	1.9564905	1.9489956	3.6811	11.944
4	60	45	3.93	1.57	14.54202516	3	2.9030631	2.8867377	3.6811	11.944
5	60	45	3.93	1.57	14.5386451	4	3.829278	3.8012729	3.6811	11.944
6	60	45	3.93	1.57	14.53606839	5	4.7356237	4.6935398	3.6811	11.944
7	60	45	3.93	1.57	14.53431967	6	5.6225328	5.5644488	3.6811	11.944
8	60	45	3.93	1.57	14.53342338	7	6.4903881	6.414881	3.6811	11.944
9	60	45	3.93	1.57	14.53340375	8	7.3395268	7.2456887	3.6811	11.944
10	60	45	3.93	1.57	14.53428475	9	8.1702456	8.0576948	3.6811	11.944
11	60	45	3.93	1.57	14.5360901	10	8.9828039	8.8516932	3.6811	11.944
12	60	45	3.93	1.57	14.53884322	11	9.7774272	9.6284492	3.6811	11.944

Fig.7 iterations results for design

after multiple iterations the finalised dimensions were found as :

- Rack length= 11.944 inches.
- Ackerman angle=30.1450degrees.
- Ackerman arm radius=3.93 inches.
- Tierod length=14.55 inches.
- Wheelbase=60 inches.
- Track width=45 inches.

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VI. CONCLUSION

Themechanism of rack and pinion of steering system, mainly designed forMini Bajaor SELU car, was restricted to use the shelf commercial assemblies of a rack-and-pinionassembly of steering and a steering knuckle assembly designedfor go-carts. Because of this the outline can't be Ackerman consistent, therefore the design parametersareoptimized using the rest of the systemparameters geometry.

The ideal value of the length between the front axle and the steering rack axis has gotsystematically. Therefore the optimum value reduces error to minimum value of the Ackermann steering error on the axial line of the rear tyres.

This work gives as a guideline for the steering design of other Mini Baja cars or custom-built cars in future when production constraints do not make it possible to meet Ackerman compliance and thus optimization of other design parameters is necessary. The contribution is the methodology used to obtain the optimal design parameters using numerical methods.

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