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DESIGN AND DEVELOPMENT OF LINKAGE BASED FOUR WHEEL STEERING MECHANISM FOR VEHICLES

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Abstract-*The majority of vehicles are equipped with the steering mechanism of front two wheels only. This limits the turning of vehicle and increases the complexity in driving specially during the heavy traffic and parking where the effective driving skills are required to handle the vehicle. So in order to reduce this effort and increase the turning ability of car the four wheel steering system is used. This report is an attempt to develop an effective way of turning the vehicle with possible minimal cost and complexity of system.in this running world the steering system plays very important role for an vehicle.*

Keywords-four wheel steering, linkages, turning radius.

I .INTRODUCTION

Four wheel steering is a method developed in automobile industry for the effective turning of the vehicle and to increase the maneuverability. In a typical front wheel steering system the rear wheels do not turn in the direction of the curve and thus curb on the efficiency of the steering. In four wheel steering the rear wheels turn with the all four wheels thus increasing the efficiency of the vehicle. The direction of steering the rear wheels relative to the front wheels depends on the operating conditions. At low speed wheel movement is pronounced, so that rear wheels are steered in the opposite direction to that of front wheels. In city driving conditions the vehicle with higher wheelbase and track width face problems of turning as the space is confined, the same problem is faced in low speed cornering. Usually customers pick the vehicle with higher wheelbase and track width for their comfort and face these problems, so to overcome this problem a concept of four wheel steering can be adopted in the vehicle. Four wheel steering reduces the turning radius of the vehicle which is effective in confined space, in this project four wheel steering is adopted for the existing ATV vehicle and turning radius is reduced without changing the dimension of the vehicle and making changes at steering system.

II. BASIC CONCEPTS IN STEERING AND THEORY :

Steering is a system of vehicle which converts rotary motion of wheel into translator motion. The function of the steering system is to steer the front wheel in response to driver command input in order to provide overall directional stability. The design of the steering system has an influence on the directional response behavior of the motor vehicle. The function of the steering system is to steer the front wheel in response to the driver command input in order to provide overall directional control of the vehicle. However, the actual steer angle is achieved are modified by the suspension geometry and the reactions within the steering system and in case of front wheel drive.

There are two types of the steering geometries,

1. Ackerman Steering system
2. Davis steering system

- **Davis steering system:** Davis steering system uses the trapezoidal steering mechanism to incorporate proper turning of vehicle during cornering without any slip. The system uses sliding pairs to get the final turning results. But due to use of sliding pairs, there is large amount of friction between the pairs and this will restrict the long time functioning and may leads to failure. This system was used in early stage but, replaced by Ackerman system due to its serious drawbacks.

- **Ackerman Steering System:** Ackermann steering geometry is a geometric arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radii. The intention of Ackermann geometry is to avoid the need for tires to slip sideways when following the path around a curve. The geometrical solution to this is for all wheels to have their axles arranged as radii of circles with a common center point. As the rear wheels are fixed, this center point must be on a line extended from the rear axle. Intersecting the axes of the front wheels on this line as well requires that the inside front wheel is turned, when steering, through a greater angle than the outside wheel.

Rather than the preceding "turntable" steering, where both front wheels turned around a common pivot, each wheel gained its own pivot, close to its own hub. While more complex, this arrangement enhances controllability by avoiding large inputs from road surface variations being applied to the end of a long lever arm, as well as greatly reducing the fore-and-aft travel of the steered wheels. A

linkage between these hubs pivots the two wheels together, and by careful arrangement of the linkage dimensions the Ackermann geometry could be approximated. This was achieved by making the linkage simple a simple parallelogram, but by making the length of the track rod (the moving link between the hubs) shorter than that of the axle, so that the steering arms of the hubs appeared to "toe out". As the steering moved, the wheels turned according to Ackermann, with the inner wheel turning further. If the track rod is placed ahead of the axle, it should instead be longer in comparison, thus preserving this same "toe out".

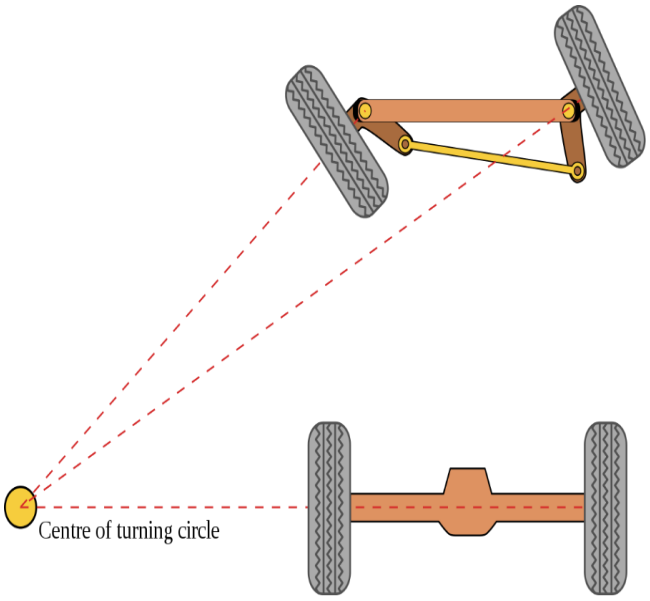

Figure 1:Akerman steering geometry (source -google)

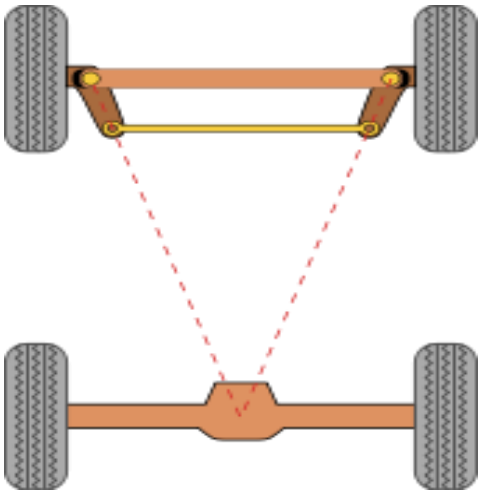

Figure 2: 100% Akerman steering geometry(source-google)

III. STEERING CALCULATION FORMULA AND ANGLES:

True rolling condition is given by,

$\cot\phi - \cot\theta = c/b$

Where,

Θ = Angle of inside lock Φ = Angle of outside lock
c = track width
b= Wheelbase

- Steering angles without four wheel steering (normal steering)-
- Steering parameters considered

Outside angles	Inside angles	Turning radius (without 4)
10	14.73	7.94 m
20	27.87	5.96 m
30	48.81	4.4 m
40	71.49	3.1 m

Table no 1: steering angles

Parameters	Respected value
Steering wheel dia	14.5 inches
Steering ratio	17:1
Steering torque	260 Nm
Lock to lock distance	157.62
column angle	30

Table no 2: Steering parameters considered

- Rack and pinion dimensions:

No of teeth on Front Pinion = 20
No of teeth on Front and Rear Rack = 26
Module of Rack = 1.25mm

IV. FOUR WHEEL STEERING MECHANISM

Four wheel Steering System is employed in vehicles to achieve better maneuverability at high speeds, reducing the turning circle radius of the car and to reduce the drivers steering effort. In most active four wheel steering system, the guiding computer or electronic equipment play a major role, in our project we have tried to keep the mechanism as much mechanical as possible which can be easy to manufacturing and maintenance.

This project focuses on a mechanically feasible & innovative design involving a double rack and pinion system for rear wheels enclosed within a casing, connected to the steering column by a combination of a bevel gear assembly & telescopic shaft. The movement of the rear wheels is done by the movement of the rear pinions which in turn move the newly designed spindle to achieve the required movement of the rear wheels.

- Slow and High Speed Modes

At Slow Speeds rear wheels turn in direction opposite to that of front wheels. This mode is used for navigating through hilly areas and in congested city where better cornering is required for U turn and tight streets with low turning circle which can be reduced as shown in Fig

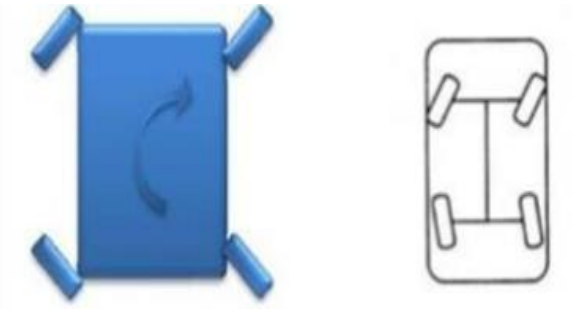

Figure 3:Counter turning(source-google)

The 4WS system performs two distinct operation, the rear wheels are turned in the opposite direction. The 4WS system is effective in the following situations:

Lane Changes
Gentle Curves
Junctions
Narrow Roads
U-Turns

- Actual CAD model of linkage-

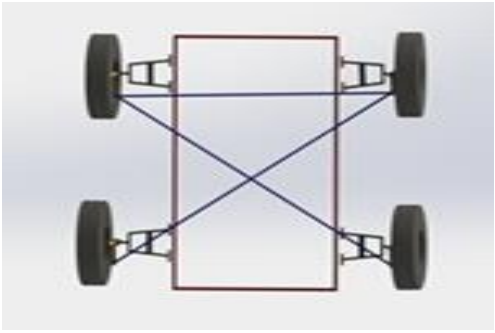

Figure 4:CAD model of the mechanism

- Actual model of four wheel steering mechanism

Figure 5:Actual model after changes

V. ACTUAL RESULT AFTER CHANGES-

Side	Front	Rear
Inside	48.81	42
Outside	30	26.63

Table no 3: Actual result

The turning radius due to use of 4-wheel steering is reduced from **4.4m to 2.8m**

VI. CONCLUSION

- Earlier the turning radius of the vehicle was 4.4m and after modification and applying new steering mechanism the turning radius has reduced to 2.8m

- The overall steering efforts has been reduced.
- It is simple in modification and has very minimum cost with respective to other mechanisms present in market of production and fitting.

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