

Design and Modification of Rack and Pinion Steering System

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Abstract: In this paper consist of improved work details with the design and simulation of rack and pinion steering using sphere gear. For the modification purpose they buy the old steering rack from garage. The concept has been developed to reduce the driver's effort during parking or maneuvering sharp curves. Steering ratio decides how far the driver has to turn the steering wheel to get the wheels to turn a given distance. Using the sun gear with the existing steering gear box, steering ratio can be changed and hence the input speed to the steering wheel can be altered when to the steering gear box. The main purpose of this project is to provide the methodology for design and manufacturing of manual rack and pinion steering system. According to the vehicle requirement for better maneuverability of the vehicle, an steering system of the vehicles designed for, the steering system will works well in every difficult road condition and provide maximum directional stability, pure rolling motion to the wheel with minimum turning radius. The objective of this project is to design efficient, durable rack and pinion mechanism. They used the SOLIDWORK software for design of sphere gear and rack after that manufacturing is also done according to the design and calculations.

Keywords: Rack, pinion gear, Design and simulation, tubular casing, tie rode, modification in steering gear.

I. INTRODUCTION

The rack and pinion, also known as the steering rack, is an assembly in your vehicle that allows your wheels to rotate from side to side when you turn your steering wheel. The rack and pinion got it's from the type of gears used in the assembly. A small pinion gear is connected to the steering wheel that connects with a long rack gear. Connected to both ends of the rack is a tie rod that connects the steering arm on the spindle. When you turn your steering wheel, it pushes the rack right or left. The rack and pinion make it easier to turn your wheels and converts the rotating motion of your steering into the linear motion need to turn your wheels. Rack and pinion steering is fast becoming the most common type of steering in cars, small trucks. It's actually a pretty straightforward mechanism. The rack and pinion set is enclosed in a metals tube, with each end of the racks protruding from the tube. The rod called a tie rod is attached to each end of the rack. Rack & pinion is a type of steering with a pair of gears that convert rotary motion into linear motion. These systems consist of a circular gear called a pinion with teeth attached to a linear gear shaft called a rack.

Types of Steering:

- Recirculating ball steering system
- Rack and pinion steering system
- Worm and roller steering
- Power steering
- Cam and roller steering

II. LITERATURE REVIEW

[1] Dr. S.R. Shank pal developed a four-wheel steering system for a car. Production cars are designed to understand and rarely do they over steer. If a car could automatically compensate for an over steer problem the driver would enjoy nearly neutral steering under varying operations conditions. In situation like low-speed cornering, vehicle parking and driving in city conditions with heavy traffic tight spaces. Driving would be very difficult due to vehicles larger wheel base and track width. Hence there is a requirement of a mechanism which results in less turning radius and it can be achieved by implementing four-wheel steering mechanism instead of regular two-wheel base.

[2] S.H. Yadav made an investigation of failure of planetary gear train due to pitting; planetary gear train is a gear system consisting of one or more planet gears, revolving about a sun gear. And it is widely used in industries. An epicyclic gearing system is particularly well suited for achieving a high reduction ratio in a relatively small, power dense package. It is widely recognized that the load sharing is not equal among the planetary gear meshes. Similarly, the stress distribution at each mesh point contains variability. Pitting is a surface fatigue failure of the gear tooth. It occurs due to misalignment; wrong viscosity selection of lubricant used, and contact stress exceeding the surface fatigue strength of the material.

[3] R.Mailmanni made an experimental analysis of reducing steering ratio to reduce turning ratio, the concept has been developed to reduce the driver's effort during parking or maneuvering sharp curves. Using the additional planetary gear set with the existing steering gear box, steering ratio can be changed and hence the input speed to the steering wheel can be altered when to the steering gear box. On installing the planetary gear set and the modified rack and pinion steering gear box, the number of rotations made by the steering

[4] Dr.Dinesh N. Kamble has developed a concept based on the analysis of the transmission mechanism of angle superposition with active front steering system. A controller of variable steering ratio for AFS system is designed and virtual road tests are made in car. The results of simulation tests validate the controller performance and the advantage of the variable steering ratio function, also show that the driving comfort is improved at low speed especially due to the active front steering system alters the steering ratio according to the driving situation.

[5] Dr. Daniele Vecchia to did a tooth contact analysis of an isostatic gear train for various cases. TCA proved to be a self-regulated system due to the existence of floating gears. All previous reviews broadly focus on newly innovative design and operations ignoring the major function of providing effective buffering and efficient steering rack. Appropriate design and improvement will increase the performance and use of rack and pinion steering system.

III. EXPERIMENTAL DETAILS

Requirements:

1. Rack
2. Pinion
3. Tubular casing
4. SOLIDWORKS Software
5. Old rack and pinion steering

WORKING PRINCIPLE:

Rack and pinion adapt changes over revolution motion into linear motion. The level and toothed part is known as the rack and the gear part is known as the pinion. The rack and pinion mesh with each other in order to change the direction of wheel and converts the direction of motion. Rack and pinion is used for various activities like mechanism used for lifting objects (vertical movement), horizontal movement, positioning oriented mechanisms, stoppers, etc. They are also used in steering systems in automobiles to change the direction. Rack and pinion has the accompanying qualities: straightforward structure, high unbending nature, minimized and lightweight, and touchy and sensitive responsiveness. The pinion which is mounted to the guiding shaft is fitted with a directing rack to transmit rotating movement along the side.

OBJECTIVE AND METHODOLOGY:

Objective:

The main aim of project is to modify the old rack and pinion steering by using spur gear and the dimensional changes and restoration in rack for maneuverability.

- Reducing the wear and backlash in steering system.
- pure rolling motion to the wheel with minimum turning radius.
- Inspection and maintenance of old rack and pinion steering.
- Replace of sun gear with spur gear.
- Reduce the noise during the turning of vehicle.
- Reduce the driver effort.
- The steering system has design to meet weight reduction requirements along with mind of driver comfort.
- Design consist of calculation of sun gear consideration of rack travel length etc.

Methodology:

Step 1: Design a CAD model using SOLIDWORKS.

Step 2: Design the rack and pinion separately and do the assembly.

Step 3: Do the 3D static structural design of rack and pinion on different forces to simulate the real-time conditions and get the optimum results. First, the simulation is done on the rack and pinion.

Step 4: Define the parameters and get result.

Step 5: Compare the performance of steering system using sun gear and sphere gear.

Step 6: Simulate on SOLIDWORKS software and print a scaled-down 3D printed model

III. EXPERIMENTAL SETUP



Fig 1 - Old rack and pinion steering

For design modification we required a steering system so we buy an old rack and pinion steering system from garage after that we inspecting steering system like conditioning of rack and pinion gear box conditioned the teeth of rack, we inspecting this because our aim is to done the modification changes in the gear box. Oiling and greasing of the component etc.

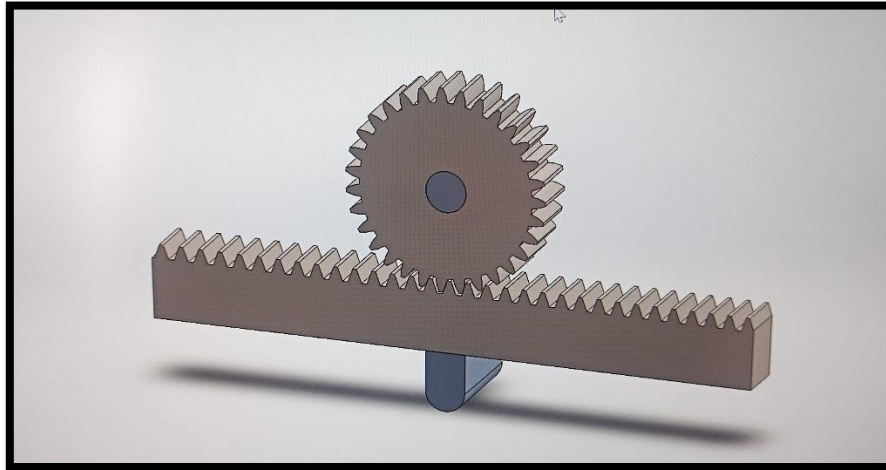


Fig 2 – Design of rack and pinion in SOLIDWORKS

IV. FINAL PRODUCT



Advantages:

- A. Simple construction.
- B. Economical and uncomplicated to manufacture.
- C. Easy to operate due to good degree of efficiency.
- D. Tie rod can join directly by steering rod.
- E. Compact that's why this type of steering is fitted in all European and Japanese front wheel drive vehicle.

Disadvantage

- A. Greater sensitivity to impact.
- B. Greater stress in the case of tie rod angular forces.
- C. Size of the steering angle dependent on steering rack travel.
- D. Tie rod length sometimes too short where it is connected at the ends of the rack side take off design.

VI. CONCLUSION:

In a conclusion, steering system is one of the most important feature in automobile. This system will control all of the direction and movement of the wheel of our vehicle. Besides, the components that are involved in this system are steering knuckle, center link, anti-sway bar, upper control arm and adjusting sleeve. This components must always in good condition so that steering system will run smoothly and more efficient to provide the driver with good experience of driving on the road. For this group assignment we are all the details about working and design of improved rack and pinion steering system.

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