

Design and Analysis of Auto Speed Control Mechanism in Automotive for Anti Roll Back

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Abstract:

Without pulling or pushing the lever, the parking brake will not work. Also, sometimes due to negligence or in emergency conditions, we humans often forget to apply parking brakes. This may lead to rolling of vehicle in case of slopes and collision with other vehicles in parking area. Sometimes if service brake fails parking brakes are used as an emergency brake to stop the vehicle. This thesis provides a new concept design of the parking brake system that has simple and low-cost characteristics. This research deals with designing and analysis of such mechanism for anti-roll back effect.

In this work the mechanism has been developed to stop the vehicle from rolling backwards when the vehicle is moving in the hill roads. Ratchet and Pawl mechanism has been identified to arrest the motion to the front axle. Anti-Roll Back mechanism has been design and analysis by using CAD tool like Solid work 2016 for checking design possibility as per application on the front axle assembly. The mechanism works well.

Keywords: Brake, Torque, Braking Force, low cost.

1. Introduction

Ratchet and pawl mechanism is used in many applications effectively where the one side power transmission is required for example in (i) Giant wheel- It is the large wheel used in the amusement parks to rotate along the horizontal axis to rotate in one direction while carrying the number of passengers. (ii) Clocks- where the hands rotate in clockwise directions only. (iii) Baffle gates- in the entrances of many buildings which rotates about vertical axis in one direction. (iv) Shaping Machines –in the crank and slotted arm.

In the hill station, the most common problem to the drivers is to park their cars in the slope and to start up the car. While waiting in the traffic, the cars have to move on step by step very slowly, this situation is a difficult one for the drivers to make their car not to roll back in the slope. So the mechanism has to be developed to stop the vehicle from rolling back and it should not stop the vehicle in accelerating forwards. This function can be achieved by using the ratchet and pawl mechanism.

2. Design and CAD Modelling of Ratchet and Pawl Mechanism

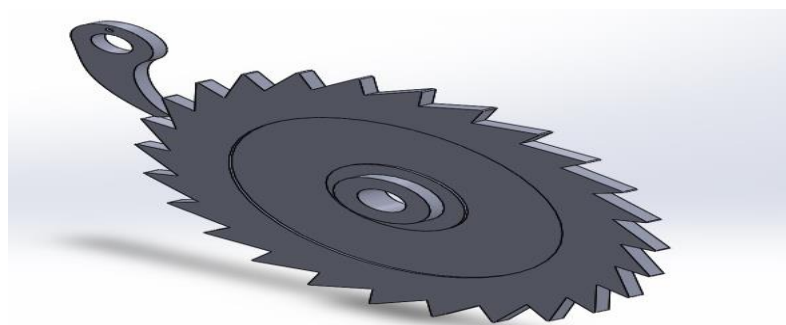


Fig.1 Isometric view of Ratchet and Pawl Mechanism

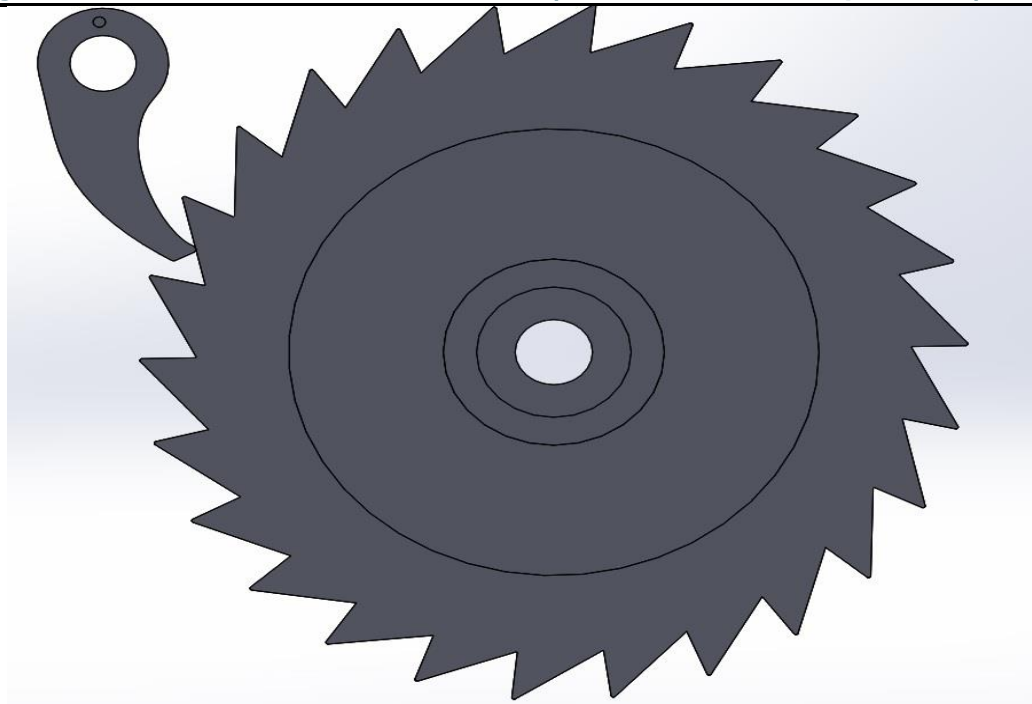


Fig.2 Front view of Ratchet and Pawl Mechanism

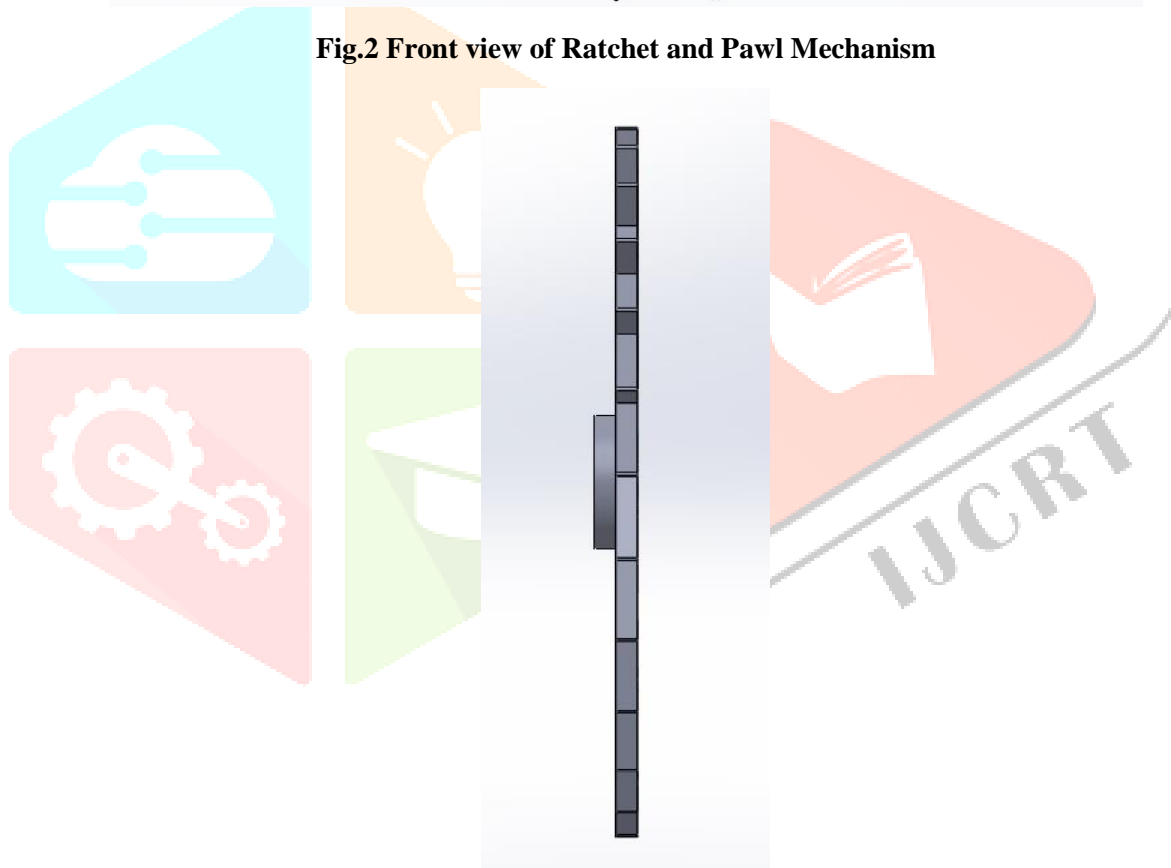


Fig.3 Side view of Ratchet and Pawl Mechanism

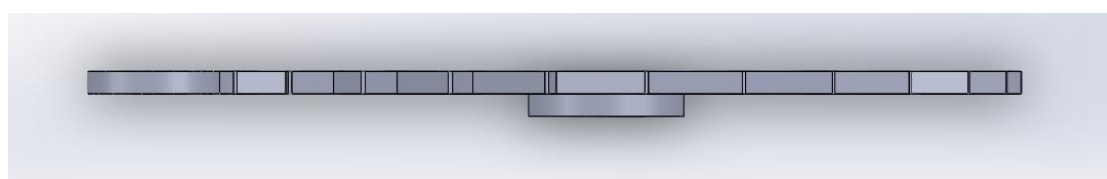


Fig.5 Top view of Ratchet and Pawl Mechanism

As shown in Figure 1 to 5, there are different orientations of Passion plus Chassis as isometric view, front view, top view and side view.

The hand driven lever is turned in forward direction, similar to forward motion of the car, the pawl does not stop the ratchet to rotate. The hand lever is turned in opposite direction similar to the reverse motion of the car in the hill road, and the pawl stops the rotation of the ratchet. So, the drive shaft and the wheels did not rotate. Therefore the reverse motion of the wheels is arrested. The same can be achieved if this model is fitted in the car. This will be the case while fitting this mechanism in the drive shaft of the car. When it has been done the car cannot move in reverse direction in the slope as the pawl locks the ratchet.

2. Finite Element Analysis (FEA)

Solid Works 2016 precision finite element model-building tool, offers many design scenarios and mesh enhancement capabilities. Solid Works 2016 enables several design classes, including 2- and 3-D surface and solid models, beam or truss and plate/shell. Solid Works 2016 also enables engineers to build compound models having mixed element types. Solid Works 2016 provides access to Merlin Meshing Technology for automatic surface mesh enhancement or enables engineers to work directly on an FEA model surface for manual mesh enhancement. Engineers can choose tetrahedral, brick or hybrid (bricks outside and tetrahedral inside) solid FEA meshes.

Solid Works 2016's linear static and dynamic stress analysis capabilities determine stresses, displacements and natural frequencies as well as predict dynamic response to static and dynamic loading. These capabilities are highlighted throughout this brochure. Solid Works 2016's FEA, Mechanical Event Simulation, modeling and CAD/CAE interoperability tools are designed to help engineers develop products that are more reliable and less costly to produce with faster times-to-market. To provide the best cost/benefit solution for each customer, Solid Works 2016's High Technology Core Packages and Extenders can be purchased at special combination pricing or separately to best fit individual needs while allowing for future growth and change.

The finite element method (FEM), sometimes referred to as finite element analysis (FEA), is a computational technique used to obtain approximate solutions of boundary value problems in engineering. Simply stated, a boundary value problem is a mathematical problem in which one or more dependent variables must satisfy a differential equation everywhere within a known domain of independent variables and satisfy specific conditions on the boundary of the domain. Boundary value problems are also sometimes called field problems. The field is the domain of interest and most often represents a physical structure.

The field variables are the dependent variables of interest governed by the differential equation. The boundary conditions are the specified values of the field variables (or related variables such as derivatives) on the boundaries of the field. Depending on the type of physical problem being analyzed, the field variables may include physical displacement, temperature, heat flux, and fluid velocity to name only a few.

3. Structural Analysis of Ratchet and Pawl Mechanism

3.1 Basic Steps of FEA Analysis for Ratchet and Pawl Mechanism

From the perspective of FEA software, each application of FEA requires three steps:

1. Preprocessing of the FEA model, which involves defining the model and then splitting it into finite elements

2. Solving for desired results
3. Post-processing for results analysis

We will follow the above three steps in every exercise. From the perspective of FEA methodology, we can list the following FEA steps:

- Building the mathematical model
- Building the finite element model by discretizing the mathematical model
- Solving the finite element model
- Analyzing the results

Step-1 Pre-processing

1) First Prepare Parts in Solidworks 2016.

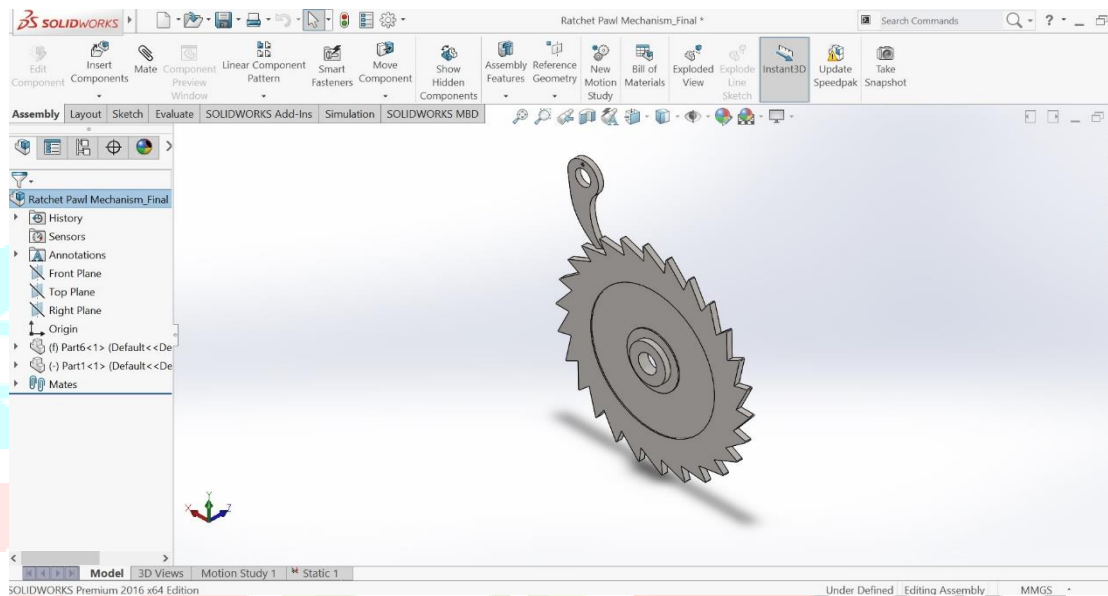


Fig. 6 Geometry of Ratchet and Pawl Mechanism using static analysis

The starting point to analysis with SOLIDWORKS Simulation is a SOLIDWORKS model. Geometry of the model needs to be meshable into a correct finite element mesh. This requirement of meshability has very important implications. We need to ensure that the CAD geometry will indeed mesh and that the produced mesh will provide the data of interest (e.g. stresses, displacements or temperature distribution) with acceptable accuracy.

2) Check the Geometry for Meshing.

It is important to mention that we do not always simplify the CAD model with the sole objective of making it meshable. Often we must simplify a model even though it would mesh correctly “as is”, because the resulting mesh would be large (in terms of the number of elements) and consequently, the meshing and the analysis would take too long. Geometry modifications allow for a simpler mesh and shorter meshing and computing times.

1) Apply Material for Each Component

Table 1 Ratchet Wheel Material Properties

Mass Density	7800 kg/m ³
Tensile Strength	700 MPa
Yield Strength	355 MPa
Elongation %	13%
Modulus of Elasticity (E)	206 X 10 ³ N/mm ²
Hardness	201 to 255 HB

Table 2 Pawl Material Properties

Mass Density	7850 kg/m ³
Tensile Strength	425 MPa
Yield Strength	360 MPa
Shear Modulus	80 MPa
Modulus of Elasticity (E)	190-21- GPa
Hardness	156 HB
Poisson Ratio	0.27 – 0.30
Specific Heat Capacity	0.46
Thermal Conductivity	58.6 W/mk

Having prepared a meshable, but not yet meshed geometry, we now define material properties (these can also be imported from a CAD model), loads and restraints, and provide information on the type of analysis that we wish to perform.

Static study is the only type of study available in some SOLIDWORKS packages. Working with Static study we need to accept important limitations: material is assumed as linear, and loads are static.

Linear material

Whatever material we assign to the analyzed parts or assemblies, the material is assumed to be linear, meaning that stress is proportional to the strain (Figure 7).

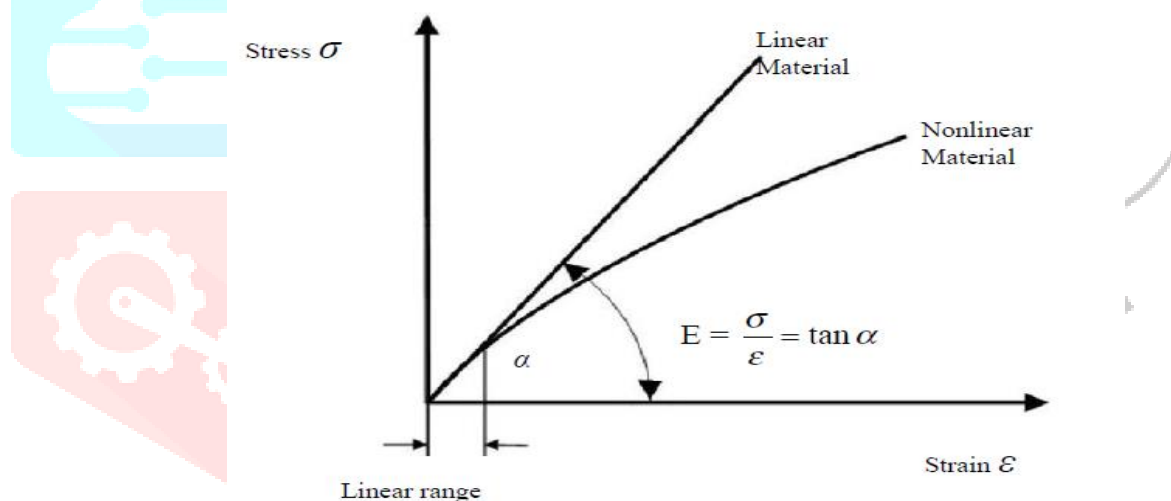


Fig. 7 The linear material model assumed in SOLIDWORKS Simulation

With a linear material, stress is linearly proportional to strain. The linear range is where the linear and nonlinear material models are not significantly different. Using a linear material model, the maximum stress magnitude is not limited to yield or to ultimate stress as it is in reality. Material yielding is not modeled, and whether or not yield may in fact be taking place can only be established based on the stress magnitudes reported in results. Most analyzed structures experience stresses below the yield stress, and the factor of safety is most often related to the yield stress. Therefore, the limitations imposed by linear material seldom impede SOLIDWORKS Simulation Professional users.

4) Create mesh.

Beam elements

Beam elements are created by meshing curves (wire frame geometry). They are a natural choice for meshing weldments. Assumptions about the stress distribution in two directions of the beam cross section are made. A beam element does not have any physical dimensions in the directions normal to its length. It is possible to think of a beam element as a line with assigned beam cross section properties.

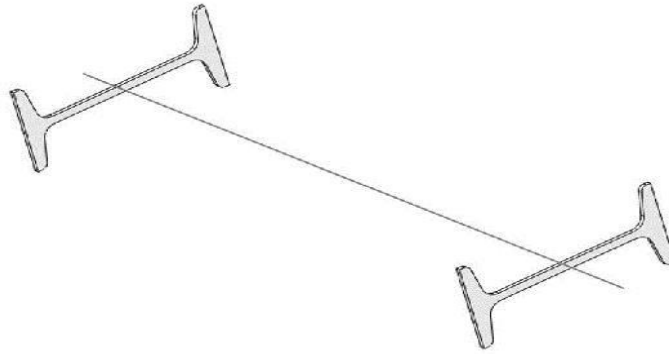


Fig. 8 Conceptual Representation of a Beam Element

Solid mesh (Beam mesh) which is programme generated.

Fine Meshing is apply

No. of Nodes:- 20351

No. of Elements:- 10709

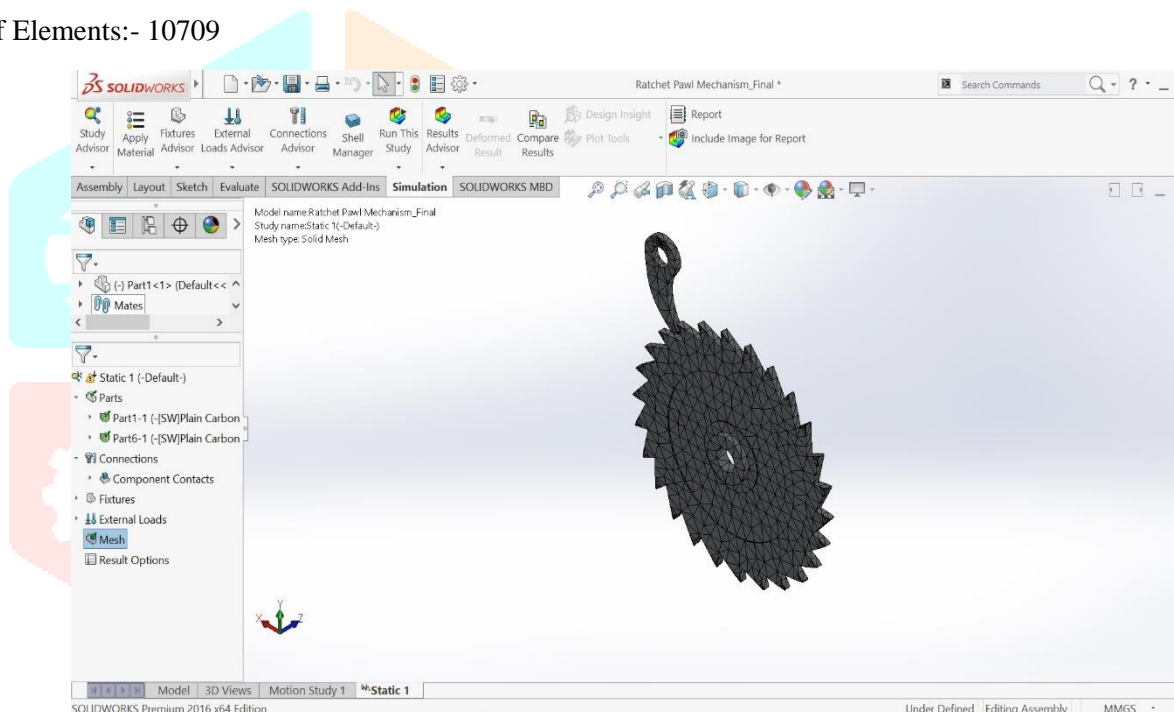


Fig. 9 Meshing of Ratchet and Pawl Mechanism using static analysis

5) Define Boundry condition

Apply fixed support at base of frame where it is stand. There is not movement in X,Y and Z Linear and Rotational. Frame is fixed at base stand so takes as fixed boundary condition.

Before we proceed with the classification of finite elements we need to introduce the concept of nodal degrees of freedom which are of paramount importance in FEA. The

degrees of freedom (DOF) of a node in a finite element mesh define the ability of the node to perform translation and rotation. The number of degrees of freedom that a node possesses depends on the element type.

In SOLIDWORKS Simulation, nodes of solid elements have three degrees of freedom, while nodes of shell elements have six degrees of freedom. This is because in order to describe the transformation of a solid element from the original to the deformed shape, we only need to know three translational components

of nodal displacement. In the case of shell and beam elements, we need to know the translational components of nodal displacements and the rotational displacement components.

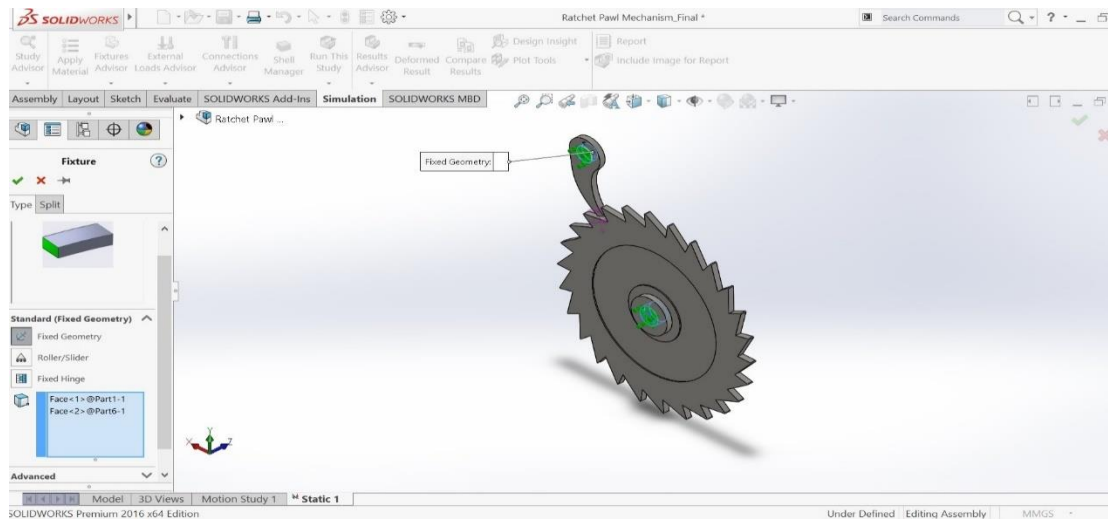


Fig. 10 Boundary condition of Ratchet and Pawl Mechanism using static analysis

Apply Force

Force magnitude on upper pawl and lower ratchet is 200N. (Consider weight both mechanism components are 20kgf)

Static loads

All structural loads and restraints are assumed not to change with time. Dynamic loading conditions cannot be analyzed with Static study. This limitation implies that loads are applied slowly enough to ignore inertial effects.

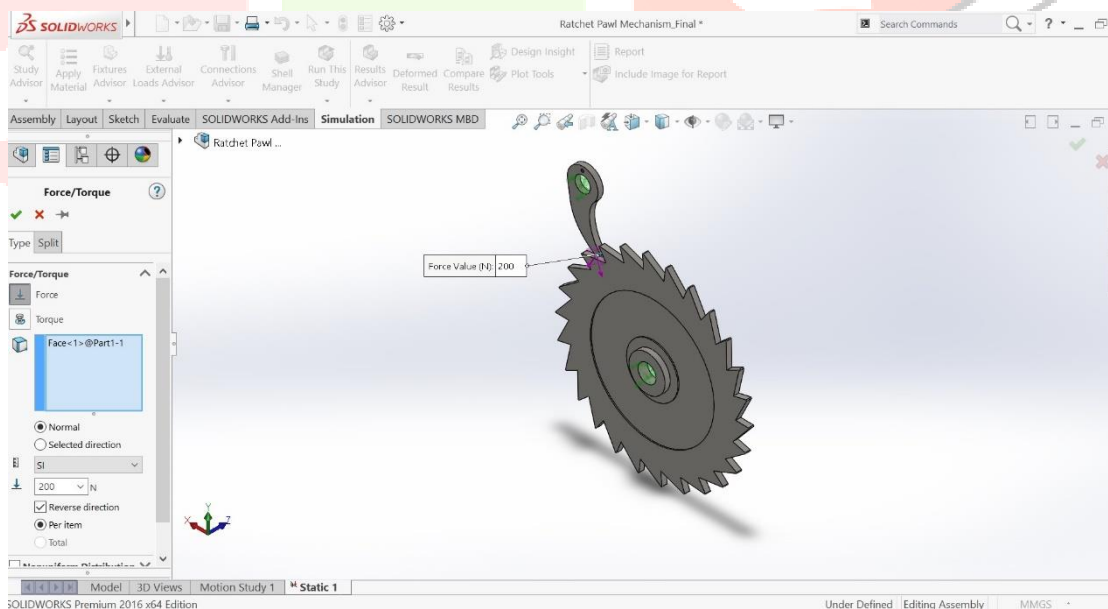


Fig. 11 Force applying on Ratchet and Pawl Mechanism

Results of Analysis

Equivalent Stress for static analysis

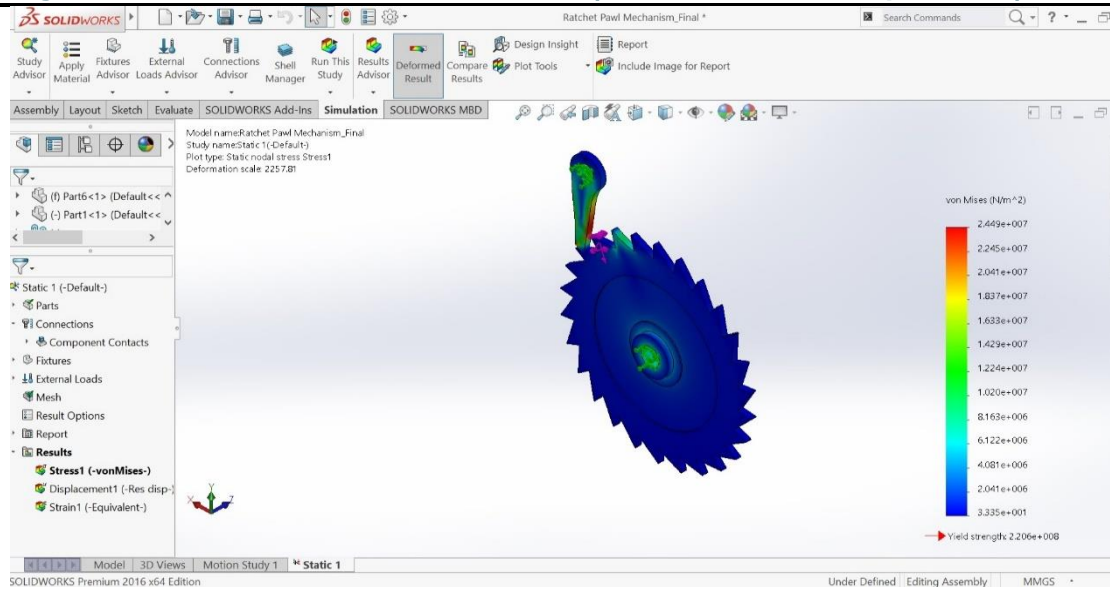


Fig. 12 Von mises Stress analysis of Ratchet and Pawl Mechanism

Total Deformation

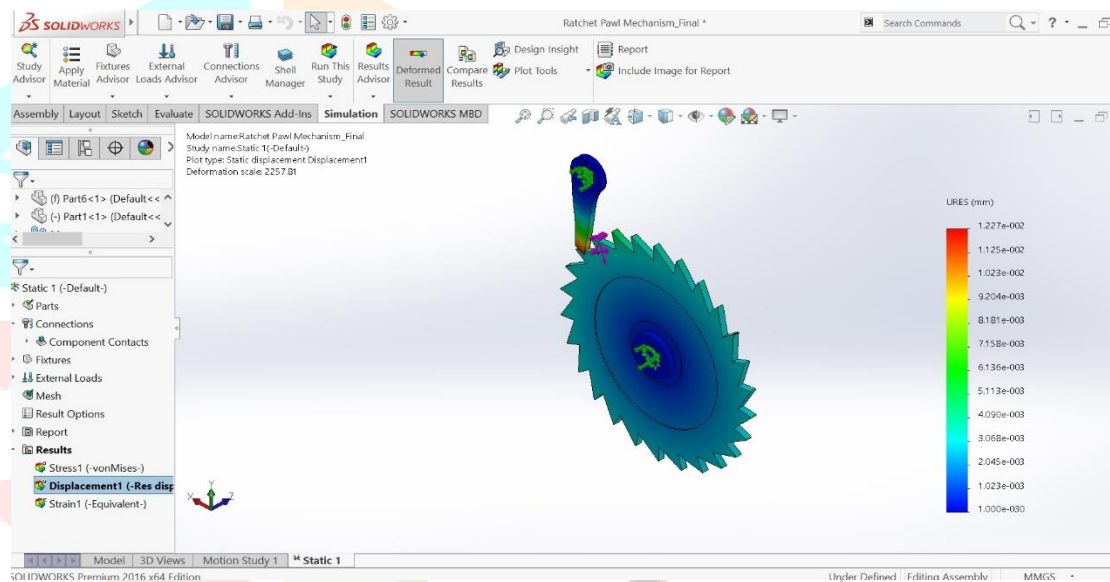


Fig. 13 Deformation of Ratchet and Pawl Mechanism

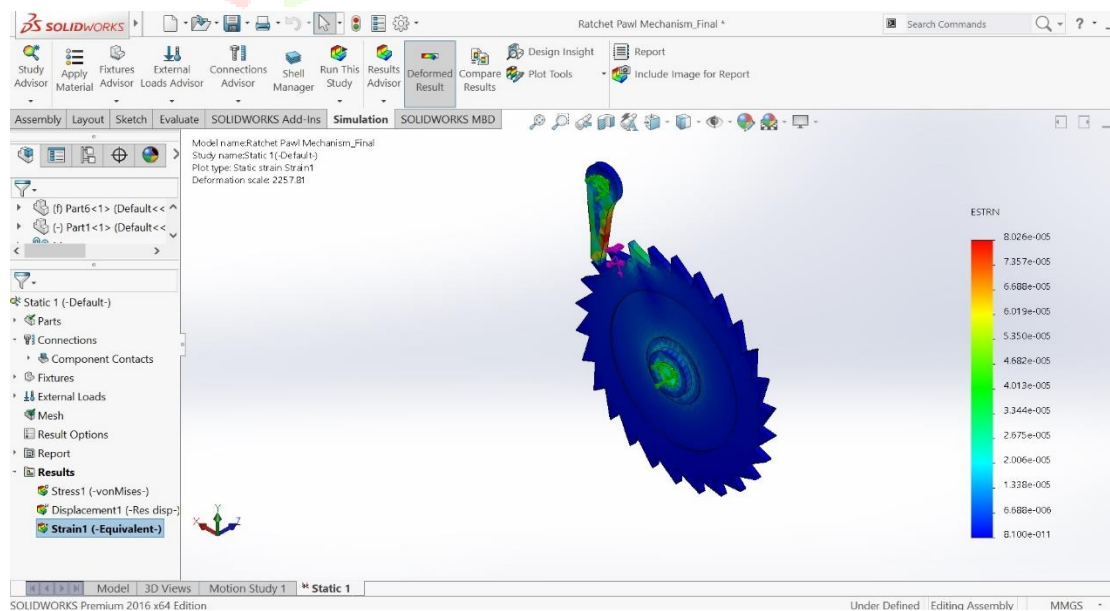


Fig. 14 Strain of Ratchet and Pawl Mechanism

Table 3 Result

Stress in MPa	Deformation in mm	Strain
24.48	0.0122714	8.02×10^{-5}

4. Conclusion

By using Solid work 2016 for CAD modelling as per design consideration of ratchet and pawl mechanism as functional analysis in consideration as static analysis to gives von mises stress, deformation and strain are 24.48MPa, 0.0122714mm and 8.02×10^{-5} respectively.

5. References

- [1] Abhishek Singh Yadav, Akshay Wagela, Chirag Jain and Kaushik Kher," Design and Fabrication of Electronic Anti Roll Back and Anti Roll Front System", International Journal of Innovative Research in Science, Engineering and Technology, 10.15680/IJRSET.2017.0605139.
- [2] Mr. Khartode Ankush .N, Prof. Gaikwad. Mahendra. U, "Design and Analysis of Antiroll Bars for Automotive Application ", International Journal on Recent and Innovation Trends in Computing and Communication, Volume: 4 Issue: 6, June 2016.
- [3] V. D. Kolate, R. R. Kurup, A. M. Latake, "Design and Development of Anti-Roll Back Mechanism ", International Journal of Science and Research (IJSR), Volume 6 Issue 6, June 2015.
- [4] Prateek Chaturvedi, Dharmender Sharma, Prof. (Dr.) Sanjeev Dahiya," Anti-Roll Back Mechanisms: a Review ", International Journal for Research in Applied Science & Engineering Technology, Volume 3 Issue V, May 2015.
- [5] M. Krid, F. Benamar, Z. Zamzami," Design and control of an active anti-roll system for a fast rover ", Preprint submitted to Robotica, 10 mars 2015.
- [6] A.Arunkumar , T. Muthumani , V. Balasubramani ," Design and Fabrication of Anti Roll Back System in Vehicles Using Ratchet and Pawl Mechanism ", International Journal of Emerging Technology in Computer Science & Electronics, Volume 12 Issue 3 –JANUARY 2015.
- [7] Amol Bhanage, K. Padmanabhan, "Static and Fatigue Simulation of Automotive Anti Roll Bar before DBTT ", Deepa B Chavan et al Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 4, Issue 4 (Version 9), April 2014, pp.13-16.
- [8] Pravin Bharane, Kshitijit Tanpure, Amit Patil, Ganesh Kerkal,"Design, Analysis and Optimization of Anti-Roll Bar ", Pravin Bharane et al. Int. Journal of Engineering Research and Applications, Vol. 4, Issue 9(Version 4), September 2014, pp.137-140.
- [9] P.H. Cronje, P.S. Els," Improving off-road vehicle handling using an active anti-roll bar ", Available online at www.sciencedirect.com, Journal of Terramechanics xxx (2009) xxx–xxx.
- [10] A.J.P. Miège and D. Cebon," Design and Implementation of an Active Roll Control System for Heavy Vehicles ", AVEC'02.
- [11] Mohamed Krid and Faiz Benamar," Design and control of an active anti-roll system for a fast rover ", FAST project (Fast AutonomouS all- Terrain robot) of ANR-PSIROB program.