

# Design and Fabrication of Electronic Anti Roll Back and Anti Roll Front System

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**ABSTRACT:** An automobile is defined as a vehicle designed for operation on roads and usually has four wheels and a diesel or gasoline internal combustion engine. The objective of this research is to design and fabricate a mechanism so that vehicle will not roll due to the slope of the hill and gravitational pull. While driving on a hill road most of the drivers face the problem of rolling of a vehicle, it may be rolling backward or rolling forward which is termed as roll back and roll front respectively. To overcome such situations driver uses a hand-brake due to which brakes get wear out. The aim of the research is to arrest the motion of axle by using pawl and ratchet mechanism which will be operated electronically without utilizing the brakes. Design and fabrication of mechanism are carried on a prototype.

**KEYWORDS:** Pawl, Ratchet, Hill roads, Hand-brake, Prototype.

## I. INTRODUCTION

Ratchets and pawls are mechanical assemblies that are used to transmit intermittent rotary motion or to permit a shaft to rotate in one direction but not the other. In this work, the mechanism has been developed to stop the vehicle from rolling backward when the vehicle is uphill and from rolling forward when the vehicle moving downhill. Ratchet and pawl mechanism is used in many applications where one side power transmission is required for example- (i) Ratchet straps (ii) Socket wrench (iii) Shaper machines.

In hilly areas, the most common problem with the drivers is to start up the car parked on a slope or while waiting in the traffic the vehicles move backward as the brake pedal is released, this situation is difficult for the drivers to make their car not to roll back on the slope otherwise they may get colloid with the vehicle standing behind. Similarly taking reverse on a downward slope is also a difficult task for the drivers to make their car not to roll front on the slope. Thus mechanism has to be developed to stop the vehicle from rolling backward and it should not stop the vehicle from accelerating forward in case of climbing, whereas in the case of moving downwards the mechanism has to be designed to stop the vehicle from rolling forward and allowing the vehicle to accelerate backward. This function can be achieved by using the pawl and ratchet mechanism. The pawl and ratchet are designed to get fit in the front drive shaft in case of the front drive vehicles and similarly should be fitted in rear drive shaft for the rear drive vehicles.

## II. RELATED WORK

In the past few of the developments took place to sort out the problem of rolling back of the vehicle. This research was carried out in a different way by different scholars and made technological amendments in it, some of them carried out it electronically. A. Arunkumar et al. [2] in their research carried out the work by using pure mechanical ratchet and pawl mechanism. The limitation of the project was that vehicle can never go in the backward direction (that is the reverse gear can never be engaged with mechanism) therefore this system is not used for practical purpose. This research gives the information of pawl and ratchet mechanism. Prof. Harshal Ahire et al. [4] in their research make use of freewheel, which is attached to the differential. This freewheel is engaged with the help of actuator and is coupled with the bevel gear of the differential. The motion of freewheel is restricted in reverse direction. So, when the vehicle is

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moving in the forward direction then freewheel also moves in the forward direction, But when the vehicle is moving in reverse direction then the freewheel restricts the reverse motion. Since the mechanism was complex due to which wear between the gears is rapidly increasing thus power loss increases.

### III. EXPERIMENTAL WORK AND SETUP

#### Selection of Mechanism

The mechanism selected is ‘pawl and ratchet’ mechanism. The reason behind selecting the mechanism is that, in clockwise direction it engages the actuator whereas in the anti-clockwise direction it compresses the actuator. By this, we can restrict the motion of the vehicle in one direction and allow it in the other direction.

#### Schematic Diagram of Mechanism

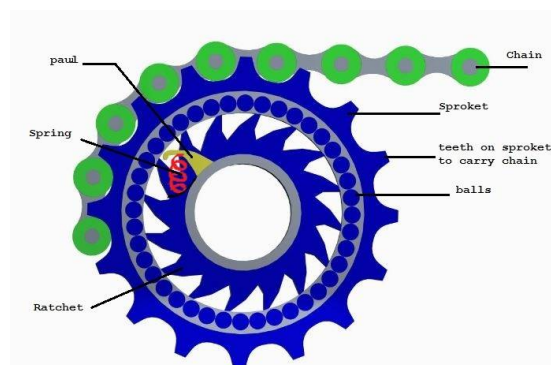


Fig.1.Pawl and ratchet mechanism used in bicycle

#### Components of Electronic Pawl and Ratchet mechanism are:

##### *Pawl*

A pawl is a pivoted bar or lever whose free end engages with the teeth of a ratchet so that the ratchet can only rotate in one direction. In this research, we have used actuator at the place of a pawl which also aims similar to the pawl but here actuator is not pivoted, it is connected with a shifter which moves up and down with the help of solenoid shifter.

##### *Ratchet*

A ratchet is a mechanical device consisting of a wheel with a set of angled teeth in which a pawl, cog, or tooth engages, allowing motion in one direction only.

##### *Solenoid shifter*

It is an electronic device consisting of a spring loaded plunger wrapped with a coil of wire that when energized, draws the plunger inwards, either opening or closing a hydraulic circuit. When power is removed from the solenoid, the plunger is then pushed by a spring to its normal position.

##### *Battery*

It is used to provide power to solenoid shifter via switches.

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Vol. 6, Issue 5, May 2017

## Switch

It is used to ON and OFF the solenoid shifter.

## Vehicle prototype

It consists of the vehicle body, chassis, axle and tyre. The solenoid shifter, pawl & ratchet arrangement is mounted on axle whereas the battery and switch are mounted on vehicle prototype.

## Positioning of components

The individual part of the side, front, and top view are interconnected to form the body. This body is thus placed over chassis with the help of L-joint, thus the body remains hinged to chassis. The rear and the front axle are supported with wheels on both the ends. The U-bolts are mounted on ends of axle thus joining the chassis giving support to chassis with the help of bolting. The mechanism consisting gears and casing are mounted on axle center. The actuator is connected to solenoid shifter and hinged to chassis from opposite end. The switch is mounted on the roof of vehicle prototype.

## Working on Electronic Pawl and Ratchet mechanism

ANTI ROLLBACK- As the battery is connected with switches supply power to the mechanism. The switch is made opposite in nature it tends to ON one shifter at a time and makes the other shifter to remain OFF. As the switch is turned ON the spring of shifter mounted on the front axle is compressed and the rear axle is in actual position. At this position when the vehicle moves in forwarding direction the gear and actuator connection deflect the spring at a fixed interval but when the vehicle moves in the reverse direction the gear teeth gets locked with the actuator thus resist to move in reverse direction.

ANTI ROLL FRONT- As the switch is turned OFF the spring of shifter mounted on the rear axle is compressed and the front axle is in actual position. At this position when the vehicle moves in the reverse direction the gear and actuator connection deflect the spring at a fixed interval but when the vehicle moves in the forward direction the gear teeth gets locked with the actuator thus resist to move in a forward direction.

## Selection of vehicle prototype

The vehicle prototype is prepared by considering Mahindra Bolero as a standard four-wheel vehicle because the axle of bolero have the enough space on it so that the attachment can be mounted properly and also selected as because it is widely used in hilly areas.

## Vehicle specifications

Engine Capacity	- 2523cc
Maximum power	- 46.3kW @ 3200rpm
Maximum torque	- 195Nm @ 1400-2200rpm
Tyre	- 215/75 R15
Turning radius	- 5.8m
Dimensions	- 1407*1745*1880 mm
Wheelbase	- 2680 mm
Weight	- 1615 kg
Maximum gradeability	- 16.7°

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Vol. 6, Issue 5, May 2017

### Force calculation on maximum slope

Force calculation of standard vehicle

Maximum Gradeability	= 16.7 degree
Mass of bolero	= 2021kg (loaded)
Acceleration due to gravity	= 9.81 m/s <sup>2</sup>
sinθ	= sin16.7°
sinθ	= 0.287
Force of reaction	= mgsinθ
F	= 2021×9.81×0.0287
F	= 5697.21N

At stationary condition the force of reaction is equal to friction force. Thus mechanism is made by considering this amount of force.

Force calculation of vehicle prototype

*Case:1- Considering force of reaction and scale ratio*

Force of reaction required on prototype will be

$$f = F/(\text{scale ratio})^3$$

$$f = 5700/15^3$$

$$f = 1.7 \text{ N} \approx 2 \text{ N}$$

*Case:2- Considering weight of prototype and maximum gradeability*

Mass of prototype (m) = 0.72 kg

Acceleration due to gravity (g) = 9.81 m/s<sup>2</sup>

Maximum gradeability (θ) = 16.7°

Force of reaction (f) = mgsinθ

$$f = 0.72 \times 9.81 \times \sin 16.7$$

$$f = 2 \text{ N}$$

### Design of prototype and mechanism

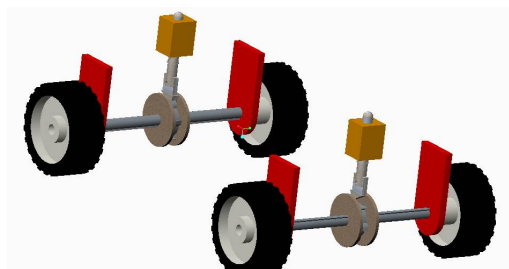


Fig. 2. Mechanism designed on CREO

The mechanism is made on CREO, it represents pawl, ratchet and solenoid shifter accompanied with U-bolt, axle and wheels. The frame will be mounted above the axle with the help of U-bolt. The body will be mounted on frame (Fig. 2).

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Vol. 6, Issue 5, May 2017



Fig. 3. Prototype designed on CREO

It is the final formed prototype presenting the isometric view. This prototype is formed by assembling body and mechanism, thus transforming it into a full functioning vehicle (Fig. 3).

### Analysis of Mechanism

The analysis was carried out of the pawl and ratchet Mechanism. Procedure used to carry out analysis is as follows:

1. Assembly was imported in .iges format in Ansys Workbench.
2. Tetragonal meshing was applied to the whole body.
3. Constraints were applied as follows:
  - i) The solenoid shifter upper body was fixed.
  - ii) The axle shaft was fixed.
  - iii) Force of 2N was applied at the point of contact of the actuator to the gear teeth.
4. The analysis was carried out and the results obtained are as shown in the Fig. 4 and Fig. 5.

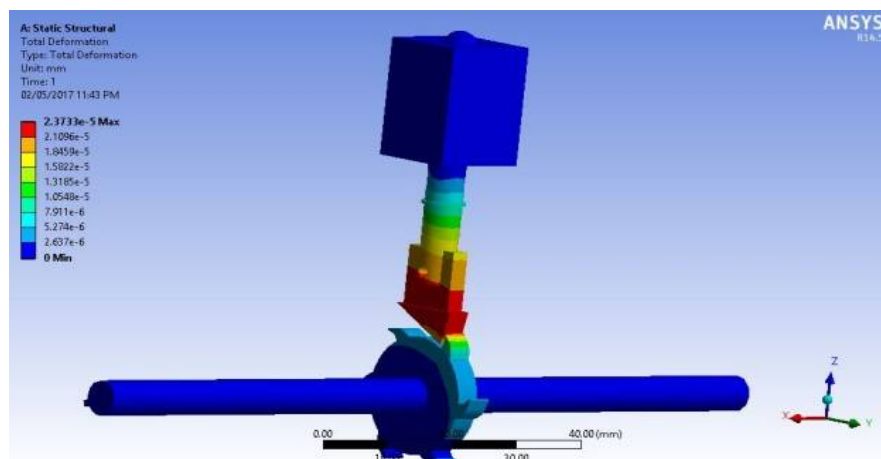


Fig. 4. Deformation analysis

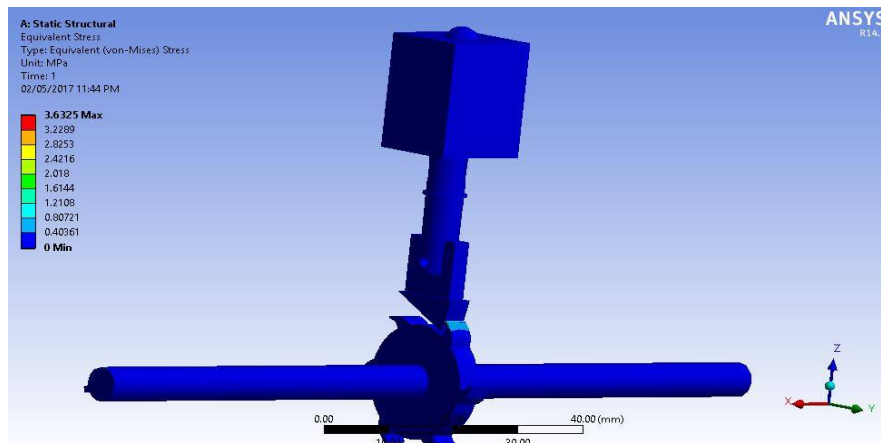


Fig. 5. Stress analysis

The red zone in the deformation figure shows that maximum deflection occurs at the area near the contact between gear teeth and actuator. And blue zone depicts that minimum deformation occurs at the fixed positions. The results obtained after carrying out Static Structural analysis was well under the limit of a factor of safety. And thus we can say that the body will not fail during its operation.

### Fabrication of Prototype and Mechanism

The fabrication of prototype was carried out by using laser cutting machine and material used to make the prototype was acrylic and forex. Acrylic was used to make chassis, actuator and gear. Whereas body of the prototype was made by using forex and shafts are made up of cast iron.

1. Firstly body of the vehicle was designed on CREO in separate parts (side part of the vehicle, top frame, gear, L-joint and actuator) in .prt format then was converted to .dxf format.
2. Then .dxf file of all parts is feed in the laser cutting machine.
3. Then both the shifters are assembled with chassis. Then chassis is assembled with the body which was done by using L-joints, which is connected by nut and bolts.
4. The fabricated mechanism is shown in the Fig. 6.
5. The final fabricated prototype is shown in Fig. 7.



Fig.6. Actual mechanism (bottom view)



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Vol. 6, Issue 5, May 2017



Fig.7. Fabricated prototype

## IV. RESULT

The developed mechanism will provide forward motion when the vehicle on uphill, as well as when required to move in a reverse direction or the reverse gear is engaged the mechanism allows reverse motion too. The strength of the mechanism is high as it's designed is formed by keeping the factor of safety 8. The response time of mechanism is very fast due to the use of electronic switching and shifter.

## V. CONCLUSION

The need of the other devices like handbrake can be minimized as the whole system can be made dependent on anti roll back device. The cost for handbrake arrangement can be saved as because the cost of ARB & AFB device is less than the cost of handbrake arrangement. Since the system depends upon electronic switches thus more durable and easy shift. The design is compact and modular thus can be used further for modification. The brake friction losses due to handbrake are removed by adopting this mechanism.

## REFERENCES

- [1] 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 and electronics, Volume 12, Issue 3, pp.1-4, 2015.
- [2] Prateek Chaturvedi, Dharmender Sharma, Prof. (Dr.) Sanjeev Dahiya, "Anti roll back mechanisms: a Review", International journal for research in applied science and engineering technology, Volume 3, Issue 5, pp.1-4, 2015.
- [3] Mrunmay Raut, Chetan Gajmal, Rahul Meher, Ashutosh Mishra, "Automobile reverse locking differential mechanism", International research journal of engineering and technology, Volume 3, Issue 3, pp.1-3, March 2016.
- [4] Benssin K.B, Blesson Abraham, Cyriac James, Jerrin Mathew, Cyriac James, "Design and Fabrication of Self-Locking Wheel Mechanism for Manual Transmission 4 Wheeled Automobiles Subjected to Positive Gradients", International Journal for Innovative Research in Science & Technology, Volume 3, Issue 11, pp.1-5, 2017.
- [5] Dr. R K. Bansal, "Fluid mechanics and hydraulic machines", revised ninth edition, 2017.
- [6] Er. R. K. Rajput, "A textbook of fluid mechanics", third edition, 2006.
- [7] Alvin H. Berger, "Vehicle transmission hill holder", US 5474164 A.
- [8] R.S Khurmi and J.K Gupta, "Theory of machines", fourteenth edition, 2005.