Design and Fabrication of a wheel with Integrated Suspension

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Abstract

Innovation is the essence of inventing newer technologies by the means of creating a totally new invention which does not exist or inventing something new by the integration of preexisting technologies together to form a newer and more efficient product. Our project majorly deals with integrating a suspension system and a conventional wheel which enables us to have the luxury of a suspension system/vibration damping where it is not possible to install a independent suspension system and along with this it also reduces the material usage footprint which is eco-friendly for the environment as well. This has been achieved by searching through various research papers available on the internet and we had observed that preexisting designs have made the use of this technology but the main essence of difference between any other design and ours is that our design is the simple integration of the basic concept which can be understood by almost anybody and make amendments/modifications/repairs.

Our design consists of a 6 point mounting system on a simple circular wheel which will dampen the vibrations/shock impulses and dissipate kinetic energy suffered by the tire structure and not pass it on to the mounted frame. Here we've used creo parametric to design and Analysis Workbench for stimulate design model.

Introduction

Many inventors throughout the history have invented impulse dampening systems (shock absorbers) such as leaf spring and coil spring suspension systems. These have taken several years of design, development and testing to invent the required suspension set up for a desired condition/terrain/dampening req./vehicles. It was also difficult at the time due to absence of designing software, engineers had to make designs by hand then develop a prototype and test it through various tests to be able to bring it to the final production line/finished design. This required a lot of money and time. But with today's technologically advanced software systems we can potentially design anything in a matter of hours, test it on various factors and then move towards the fabricating process.

Our current invention/system as the name suggests is the integration of two preexisting mechanical devices which essentially improves the effiency of the entire system, that is; a conventional wheel and Single spring mono shock suspension. It is integrated in such a manner that 3-Mono shocks are arranged in a triangular formation (three on one) configuration one end of each mono shock is attached/fixed to the frame of the wheel with/to screw attachments so that the shocks can be replaced if damaged or the shocks can be used in another wheel in case of frame damage, these points of attachment gives the frame rigidity like spokes do in a conventional wheel (traditional spokes break or bend more easily due to the absence of flexibility/movement) and also provides the mono shocks to move in left or right direction or in up/down motion providing it with flexibility. The economic/common vehicles have the dampers in the chassis one end of the mono shocks are attached to the mounting point of the axel whereas the other is mounted to a fixed mounting point on the chassis. But in our design setup one end of a mono shock is fixed to the mounting point of the wheel frame and the other is attached to the center mounting point. This setup is revolutionary because it is more ecofriendly, compact, advanced and overall more efficient. More ecofriendly; It reduces carbon footprint as it reduces the use of materials for dampening vibrations, compact; as the need of separate suspension mounts on the chassis, positioning, etc is not required. It can also not be spotted from directly observing it from the front, it can only be spotted from the sides and is also

pleasing to the eyes when stationary or in action/use. This particular setup will mainly be used in light vehicles such as bicycles. The biggest advantage of this setup is that it can be used in Wheelchairs for handicapped/disabled people which the main purpose of this invention. Since there is not enough space for conventional suspension setup, this will reduce the impact forces on the backbone which are the major cause of further injuries on the body and since most back injuries are not fixable or at least takes many years to heal to an extent. This invention/design can be used in hospitals, homes, community centers, sports events for specially abled, rehabilitation centers and various other places. This will be extremely useful in sports competitions as too many people are participating in such events and this small addition brings a big change in the dynamics of such events.

Since this is the most simplified version of the invention/system almost anybody can do repairs or mods/up gradations anytime/anywhere themselves or at least it will be extremely easy to fix, for any mechanic/person, which will make it a popular choice of option amongst people.

The simplicity and cheapness to assemble the product will make it popular if taken to the Indian market and will help a lot-many cycling enthusiasts, various organizations such as hospitals/rehabilitation centers/etc and mostly, individually disabled/injured people as our country has a high population of such people and extremely less provisions/systems to make their life comfortable.

Suspension Integrated Wheel System

Literature Review

Many researchers performed various experimental investigations on the Suspension system which can easily fit in compact designs such as wheel chairs for physically disabled/injured or other two-wheelers where there is a lack of suspension dampening systems. The members of the group Rishabh Yadav & Sunkara Venkata Satya Sai Phani Krishna did work with cooperation and equally gave their time and attention in the work of this project.

Problem Statement

A two wheeler such as a wheelchair has a flaw of not having a impulse/shock dampening system as the required space on the design is not available or a bicycle chassis which requires additional integration of suspension setup. To deal with these challenges we require a robust, reliable, efficient and easy to understand system.

Main Objective/Theoretical framework

The main objective of this project is to preform the following analytical experimental investigation drawn in following point below:-

- To design all the parts of Wheel with Integrated suspension system; i.e. rim according to the requirement, mono-shock absorber, bearing, structure to hold the mono-shock absorber with modelling software Creo Parametric software according to proper dimensions.
- Structural analysis of entire system of Wheel with Integrated suspension system with ANSYS workbench software which delivers suitable results based on parameters such as deformation, non-mises stresses, load applied on the different components of the system.

Methodology of Designing the System

The procedure followed to design and do analysis of the wheel with integrated suspension system is represented below:-

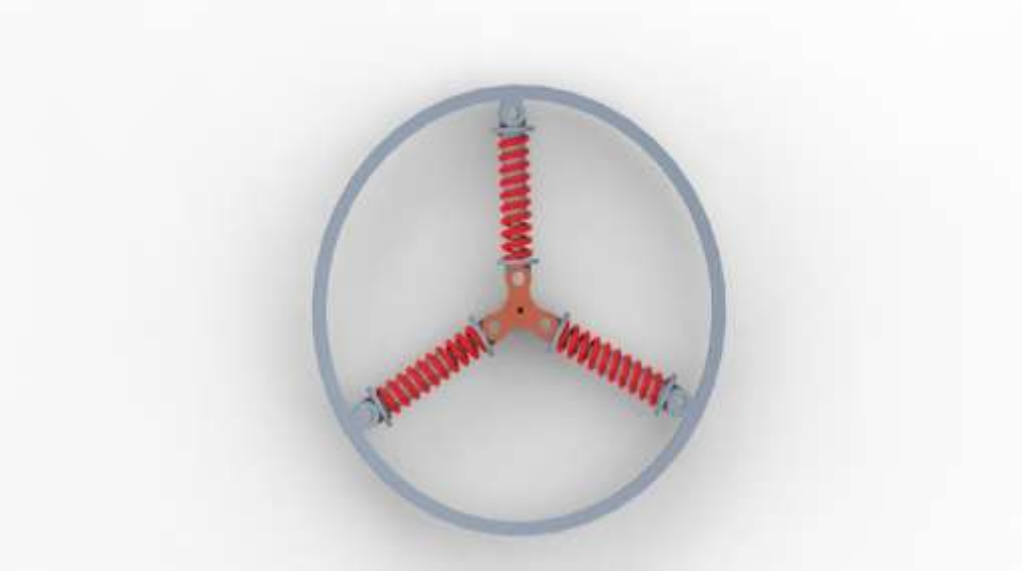
- Identify the various specifications of parts used for the design.
- Making sure about the safety measures required while using the wheel.
- Make sure about the easy availabilty of the components.
- Planning and designing of the wheel and mounting points of and mono shock absorbers.
- Sketch a design with integrated mono shock absorbers.
- Modelling of the sketch on the software Creo Paramatric.
- Finite element analysis of the model with suitable material (High Strength Steel with High Silicon Doping) on the software ANSYS Workbench.

Parts Assembled with cost to Form Wheel With Integrated suspension System

S.No.	COMPONENT	QUANTITY	PRICE IND.	FINAL PRICE
1.	Center mounting component	1	500	500
2.	Mono shock absorber	3	500	1500
3.	Rim	1	500	500
4.	Mountings in rim	3	300	100-200
	TOTAL ESTIMATION	8		2700 Apx

Mechanical Design & considerations

The mechanical design of the setup is such that it will be used as a ready to use on a bicycle or a wheelchair but it has various parameters to consider for it's functionality to be flawless such as reliability, motion & speed, payload capacity, reparability, upgradability and life span.



Raw Design of Suspension integrated wheel

Functionality:

The basic functionality of this system is to dampen vibrations/ absorb shock impulses and dissipate the kinetic energy. All the 3 mono shocks work in harmony to provide a comfortable experience by just changing the location of the center mounting point in the presence of an impulse force and bringing it back to it's original position.

Reliability:

The system should work continuously under varying impulse forces from all directions and successfully dissipating the KIENETIC ENERGY while bringing the mounting point to it's original position effortlessly. It will have to do the same under varying speeds as on lower speeds the mono shocks have more time to return to their original position but as the speed increases the recovery time decreases and under such circumstances it should not give in to stress and strain as the temperature of the mono shocks due to faster operations increase and a failure of any of the mono shocks can occur.

Payload capacity:

This system is mainly designed for physically disabled/injured people who have to go around/travel on wheel chairs which is quiet uneasy due to absence of impulse/vibration absorbing ability/system. Which leads to spinal injuries and complications further injuring the person. Besides this system can be used in a bicycle, motorcycle, 4-wheeler or above with minor variations in design and materials used.

The whole system can carry a payload of 120 Kilograms.

Materials:

The wise choice of materials will determine the strength, durability, life span, functioning and aesthetics. Any design project is struck with certain operational issues such as; environment (humidity, rain, dryness, temperature variation), terrain (mountainous, beach, desert, muddy, jungle, rocky), maintenance (frequency of maintenance/cleaning of foreign particles stuck in the system) and fatigue, as once a crack occurs it expands with time/cyclic process of stress and strain.

In this we've sort to use High Strength Steel with High Silicon doping. As it is used in heavy motor vehicles such as cars and bikes

like suspension coil springs and engine valve springs are alloyed because it has increased strength and hardness (solid solution hardening), higher sag resistance (resistance to load loss, resistance to stress relaxation), temper resistance (resistance to softening during tempering and stress relieving) and good amount of elastic limit. Contemporary spring steels are quenched and tempered to very high strength (1900-2150 MPa, 53-57 HRC, 560-640 HV). But since they are not directly in operation with the road, they are mostly mounted on the chassis and axel points to modulate the various forces, in this system it is in direct integration with the tire and axel/mounting point. It is being used due to the high strength and flexibility on different variation of temperatures and can be easily/cheaply be available. With polishing or paint coating this with an addition of colorful rubber coating will improve the aesthetics significantly and be adjusted to the choice of the user while also providing additional protection to the system from foreign particles and moisture/rusting.

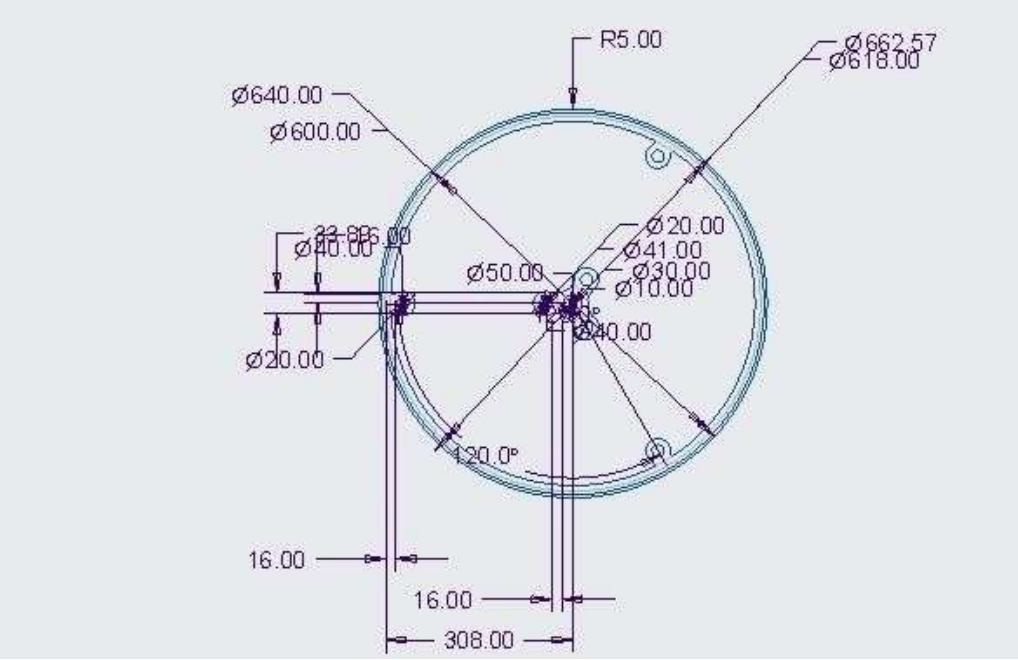
Wheel Design

Frame:

The frame (Rim) is of circular shape with a diameter of 640mm and width of 60mm . It is made of structural steel so it has characters such as flexibility which will evade the chances of bending or breaking under high stress. The exterior part is for the tire mounting and internal side is for mounting points for the mono shocks, which are to be manually welded to the frame with accurate measurements and welding

Dimensions of this part are;

Radius- 320mm Width- 60mm

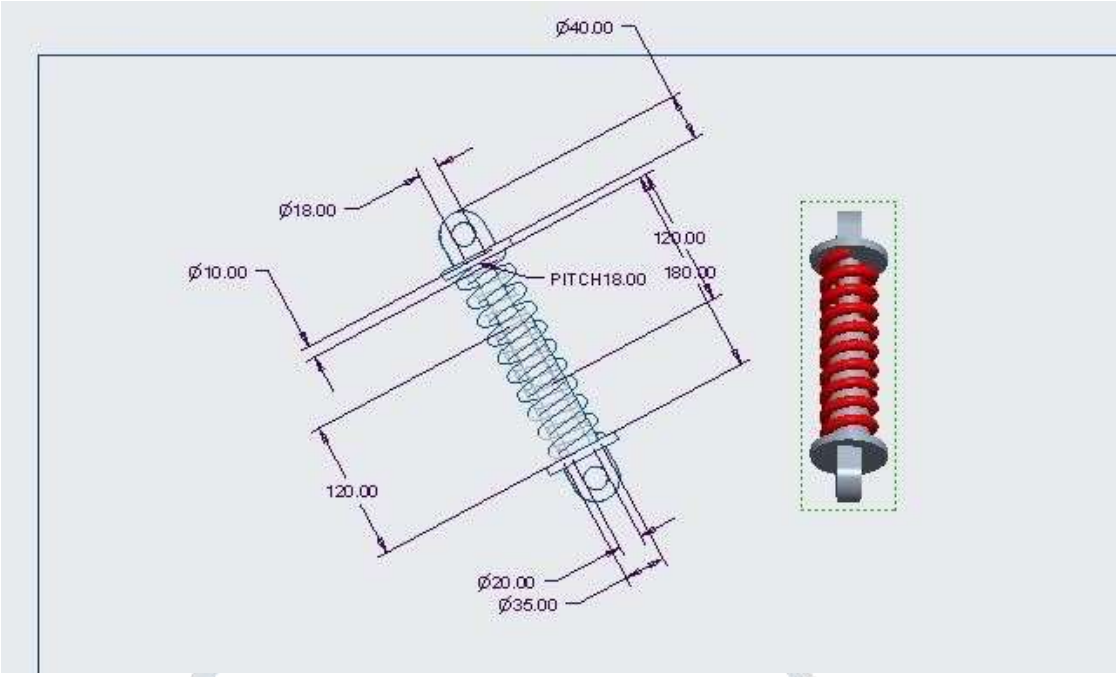


Dimensions of Frame/Centre mt. pt.

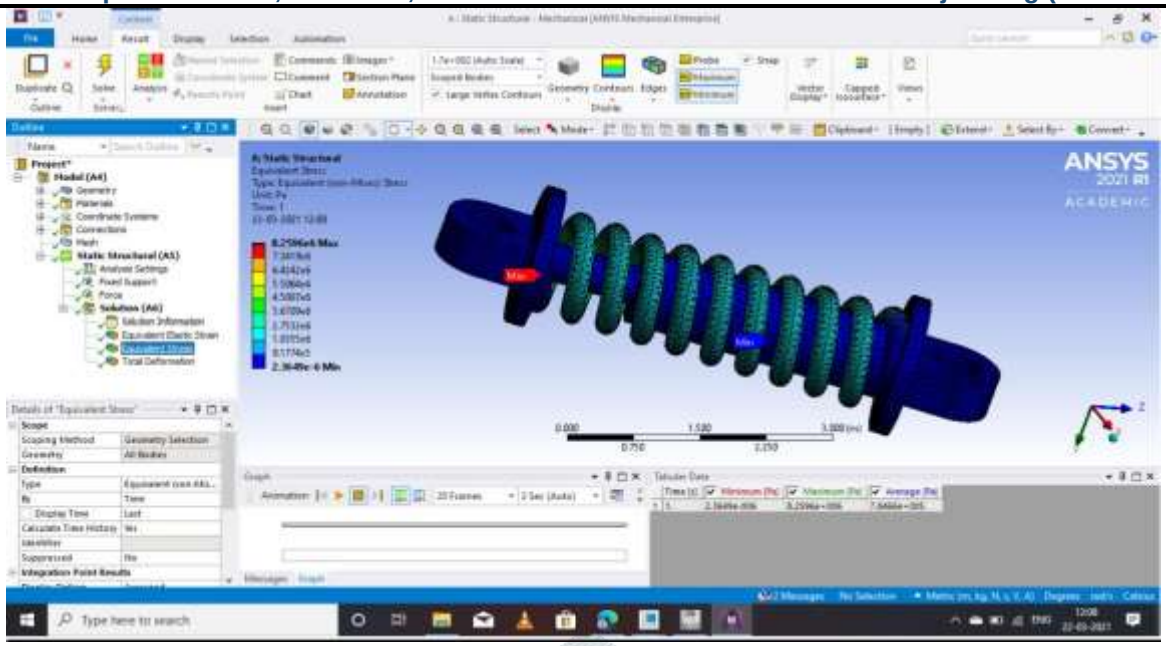
Supporting Structure:

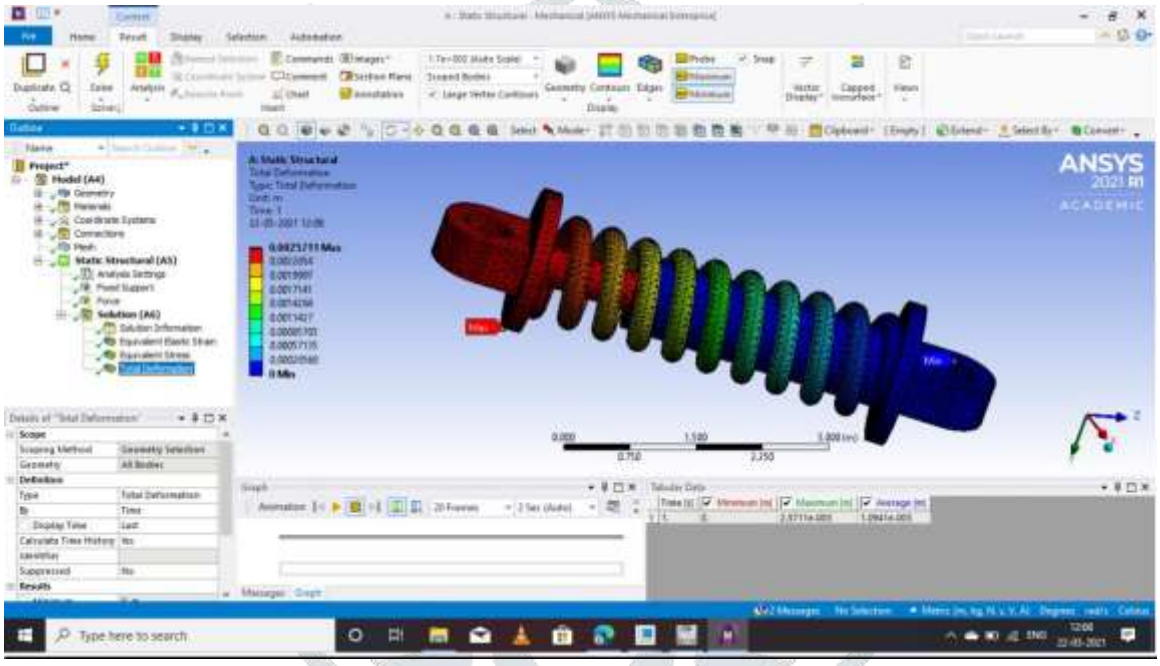
The mono shocks act as a supporting structure for the wheel and dampens impulse shocks which helps in a smoother functioning and reduces the stresses suffered by various other parts resulting in increase of life span of other parts. This consists of a single tube and a spring set up.

Whereas also reducing the requirements of stationary spokes for increased structural rigidity and strength.



Shock with labelled dimensions

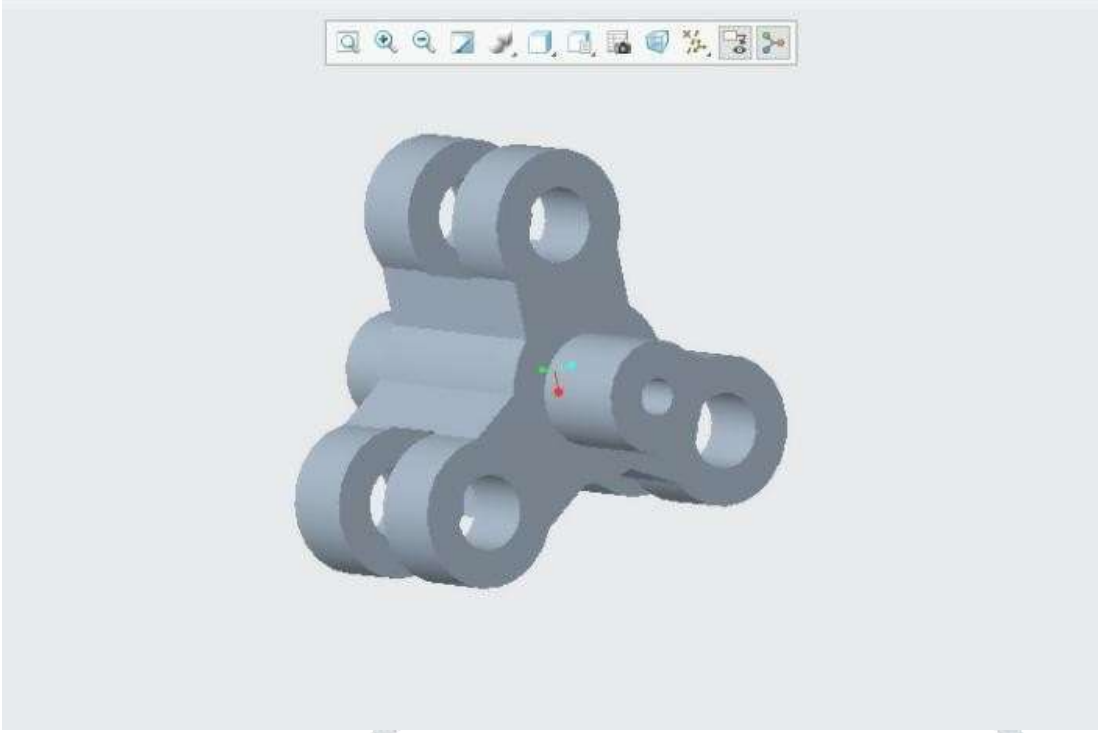


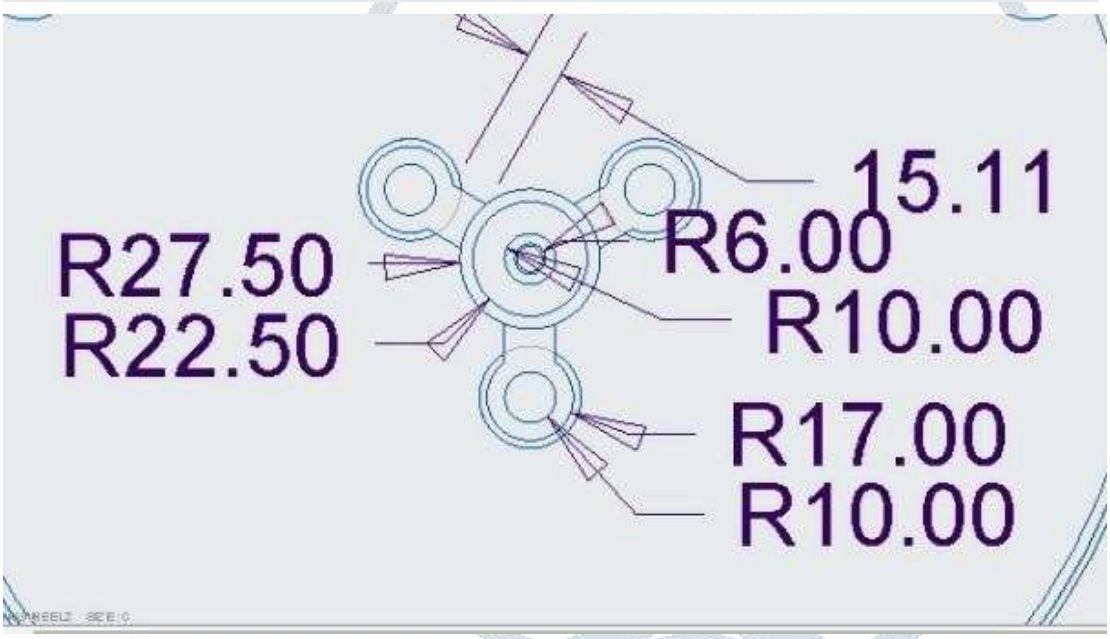


Force Analysis on each shock

Center mounting point/piece:

The Center mounting point consists of a center hole for mounting on the frame/chassis and has 3 individual mounting points for the the mono shocks to be mounted on. This part is meant to move in a 360 degree motion on a verticle movement scale which will inturn dampen the impulse shocks with the help of mono shocks and return to it's original center position after every displacement.



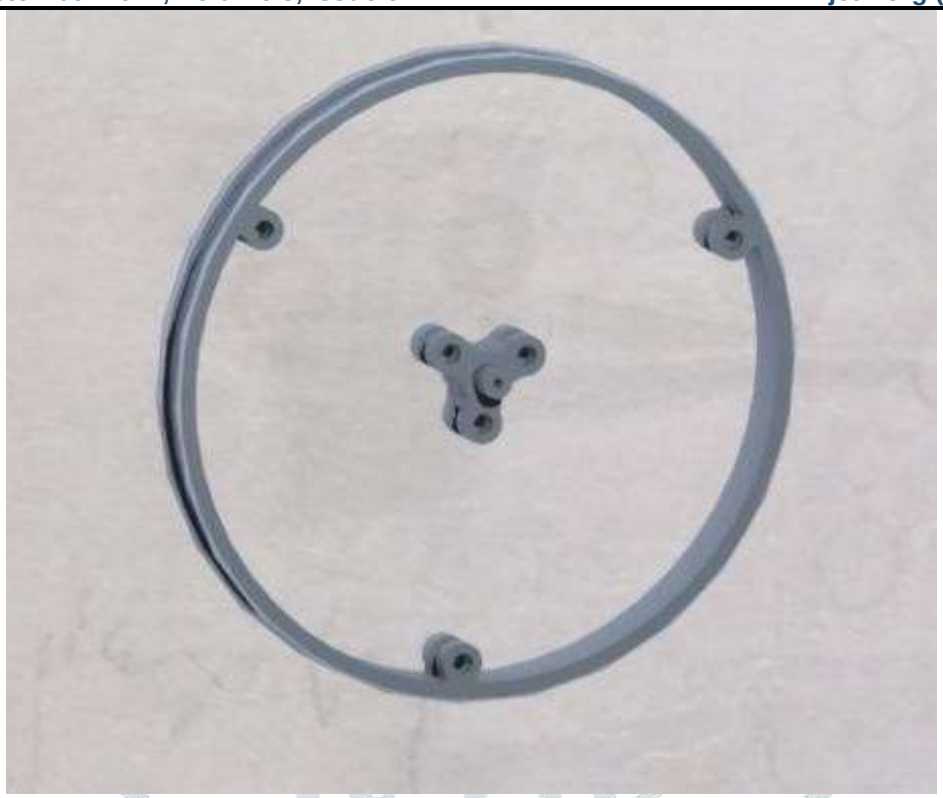


Centre mounting piece with/without dimensions

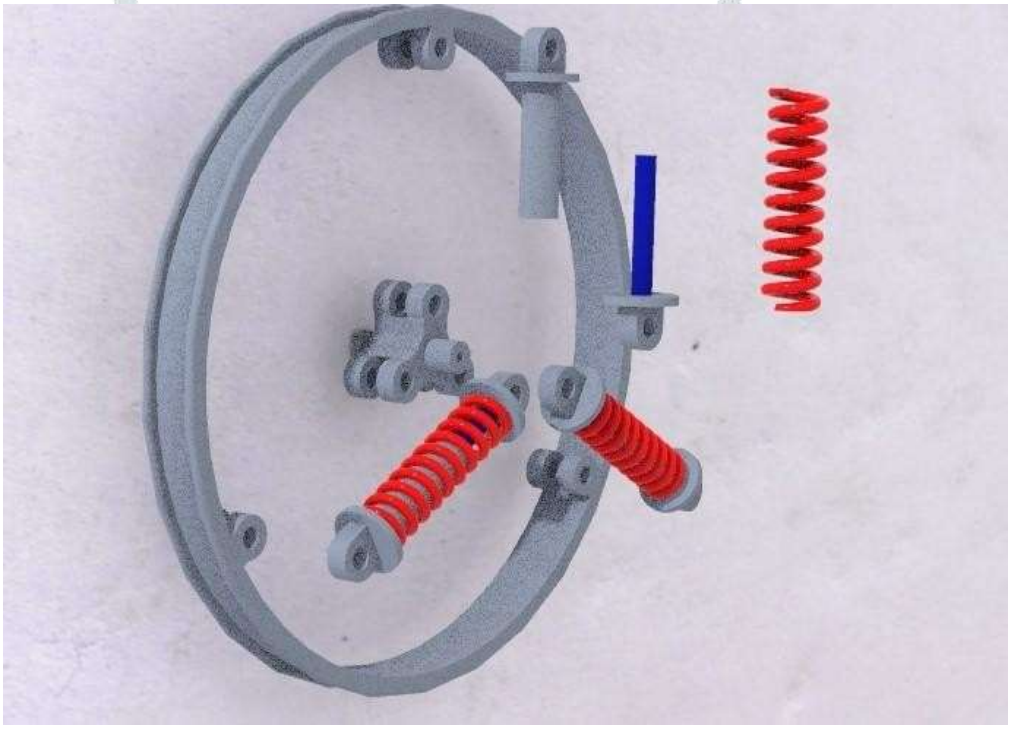
Assembly:

The final design is a result of the assembly of Part 1, Part 2 & Part 3.

- Part 1 is the base part, the rim is put in place which has 3 pre-fixed mounting points.
- Part 2 are the 3 mono shocks which are then attached to the mounting points on the rim.
- Part 3 is the center mounting point which is mounted on the chassis and the other 3 mounting points are attached to the other idle ends of the 3 mono shocks.



Frame with center and mounting points on each of them



Breakup/Assembly of every part

Conclusion:

The integration of a conventional circular wheel and mono shocks forms a totally new design/product. This design can be implemented in various places where a conventional suspension cannot be installed but required impulse shock dampening. This also reduces the carbon footprint as when a conventional rim breaks it is practically non usable as the breakage if the breakage is minor, it starts to spread and leads to a big failure of the part and if the breakage is to a non- usable extent initially then there is an immediate requirement of change of part and there is a total wastage of the part. Whereas in our system if a part breaks it can be replaced such as; if the rim breaks the mono shocks and center mounting point can be extracted and reused with another rim or if a mono shock breaks it can be easily replaced with a new one with the entire system being the same.

Acknowledgement:

It gives us an immense gratification to place on records of our profound gratitude and sincere appreciation to each and every one of those who have helped us in this endeavor. We express our sincere thanks to Lovely Professional University for giving us the opportunity to work with our Teachers, Fellow Students and also, for their encouragements and constant guidance, which has energized us to successfully complete our capstone project. Finally, we also express our sincere appreciation to all those who have helped us directly or indirectly throughout this project work. We would like to offer a special thanks to **Mr. Jasvinder Singh**, members of team whose timely support and assistance made our experience truly pleasant and memorable.

Reference:

- https://youtu.be/2vnqh3vmVlE Softwheel
- https://youtu.be/DgDlezuTAT8 Spiral wheel
- https://youtu.be/lLMq3TKnrDA Suspension integrated wheel
- The Shock Absorber Handbook, 2nd Edition by John C Dixon
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