International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 05, May-2019

Tiltable Stabilizer for Handicapped Personals

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***Abstract* – Through the accomplishment of this work we aim to provide better comfort and safety to the disabled people that use stabilizers to ride a two wheeler. Our project "TSHP" (Tiltable Stabilizer for Handicapped Personals) utilizes newly designed suspension geometry for the stabilizer. This enables the rider to take the turns in the road at reasonable speeds. The current market solution keeps the vehicle upright respective to the road and even though they are equipped with suspension they are not perfect in many ways. In an ordinary system the rider has to shift his or her weight to overcome the centrifugal forces acting on the vehicle. And of the vehicle is turned at high speeds it may result in an accident and possible injury to the rider. And our project aids in cornering stability to these vehicles by tilting the vehicle to a predetermined angle to reduce the effect of centrifugal force and better suspension.**

The details and construction of TSHP and the analysis of the forces acting on the components and hoe we arrived at the current design is discussed here after.

Key Words: Tiltable Stabilizer, Design of suspension, Analysis on Force and stress deformations, Stability, Protection for Handicaps etc.

1. INTRODUCTION

We live in a world where mistakes are natural. We humans and all other living things make mistakes. Due to these mistakes some people among us cannot see walk, talk and hear. These people also does there daily routines like us but differently hence they are called 'Differently abled personals'. People who can't walk move around short distances with help of some sort of aid or with help from others. If the distance to be covered is large then they use two-wheelers or car which is adapted for their use. In our current economy car is still considered as a luxury, so the common people utilize the two wheeler with side attachment. Everybody who rides a two wheeler leans into the corner. That's because a vehicle in turn experiences inertia that is proportional to the momentum of vehicle which is similar to centrifugal force developed in a body in circular motion. This force tends to push the vehicle away from the turn tangentially. When the rider turns without any lean the inward force due to friction will create a torque at the bikes centre of gravity acting outward the curve. This causes the vehicle to turn over. When the biker leans inwards the curve, as he turns, there will be an inward torque due to gravity. This torque, depending on the angle of lean, will balance the outward torque created by the centrifugal force. As far as the biker balances the two torques throughout the curve, he will make a proper and stable turn. We all are used to the vehicles that are used by the physically handicapped personal. It mainly consists of the 2 wheeler and a stabilizers to stabilize the vehicle from left to right. As we all know a two wheeler tilt during a corner but in case of the handicapped personals vehicle the stabilizers do not allow the vehicle to tilt. To minimize the effect of centrifugal force and gravity our new product design aims to make a change in this this situation. Our system uses new suspension geometry to allow the vehicles to tilt into the corners for more stability around corners at traffic speeds. It is an attachment that could be fit to any commercially available scooters or bike with slight modifications. To make safer and stable ride to the occupant.

Our product can be considered as a revolution to the current solution of two wheels on each side.

2. LITERATURE REVIEW

In this paper it deals with the problems faced by the occupants of handicapped personals vehicles on common drive basics. Our solution solves a common and prolonged problem faced by the users and by solving this problem we were able to address other problems also. Our research on this topic also includes the below mentioned papers.

"Tilting independent suspension for the motorcycle trike" [1] written by Lawayne Matthies, Mountain Creek Pkwy. Dallas, TX (US). The papers main objective was achieved by providing a suspension system that automatically tilts the frame of the trike when the trike turns. The tilting Suspension system has sensors that sense the orientation, speed, and/or acceleration of the trike.

"Tilt Suspension System for Three Wheelers and Reverse Trikes" [2] is written by Atheender A, GautamM, ArshathGani A, Veneeth T S. In this paper reverse trike with the tilt suspension system has proved its capabilities in off-road terrains with improved stability and riding performances. The turn radius of 1.75 m helps the trike to take sharp turns and makes it very easy to maneuver around both on-road and off road tracks.

"Four Wheel Leaning Suspension Vehicles" [3] is written by Mr. Ishwar P. Ambare1, Mr. Nakul N. Mopari. In this Four wheel leaning suspension bike which is used in hilly areas and widely used for comfort zones the name itself indicate that which is used for human comfort and which is also used for safety purpose.

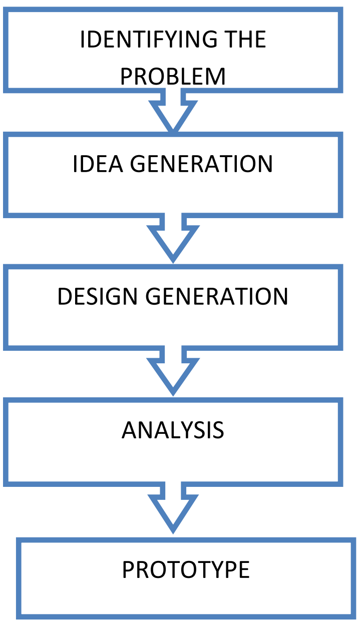
"Design, Modification & Implementation of Tilting Steering System" [4] by Nilesh, Vijay Sabnis. Both the in this paper they describe about how they developed by them i.e. steering systems (tilt & turn) have their own unique advantages so if both the steering systems are added then it will be more beneficial for the vehicle. As part of their project "Modifications in tilt steering" they were able to design such a steering system that can allow both tilting & turning of wheels.

“Design and Analysis of Active Leaning Suspension” [5] by Siddhesh Kadam published a journal about a tilting suspension system design from their Current feasibility study they were able to find that the tilting action is highly sensitive to weight distribution. It will be important and challenging to design the vehicle such that all components coordinate to produce the desired tilting effect. And their mechanism was able to negate the forces coming on the vehicle at high speeds.

“Leaning vehicle suspension” [6] by Steven W. Lucas designed the suspension for leaning. In this paper the author describes about the main features of the system he has developed. The suspension includes a planar central upright frame which is mounted coaxially to the main frame of the tricycle. An inverted rocker assembly is hinged to the central frame, pivotable about the front and rear ends of the central frame at points located in the upper third of the distance between the top and bottom of the central frame. The inverted rocker assembly provides connection points for shock absorbers which interconnect the inverted rocker assembly with each link member of the lower control arm on each side of the central frame.

Edward M. Smith, Robert E. McIver introduced a patented paper [7] on leaning vehicle suspension where they designed linkages for leaning suspension which can be fitted in a four wheeled bike. In order to improve the cornering ability and to reduce the susceptibility of bikes to road accidents. Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads, the template will do that for you.

3. METHADOLOGY



4. RESEARCH GAP

From our search it was found that all the aids for the handicapped personals are still using or following the designs that were developed decades ago. Conventional styles use fixed wheels to stabilizer the vehicle left to right to prevent rider from falling. New system uses in-depended suspension to the wheels to improve the ride quality there are some amount of suspension travel in the wheels which is not adequate for effective turning through the corner. And in some modern versions there are system to protect the occupant form the elements like wind and rain.it was found that there are little or no development in the field of providing better driving dynamics to the occupant. So from our search to find a solution we have come up with a suspension system that can allow the two wheeler to tilt to a safe limit and remain upright during stopping and low speeds.

By allowing a reasonable amount of tilt to the vehicle to enable easier driving through the corners we can avoid the shifting the weight of the passenger through the corners as usually done by the riders. It can also produce better traction by always keeping the tires in contact with the ground by the suspension system. With our system it is possible to prevent the driver from getting high centered and getting stuck on an irregularity on road by the drive being kept at a higher position than the ground level our systems uses in-depended suspension and the tilting mechanism to prevent this situation from ever occurring again. And our products in large scale can be manufactured at a reasonable cost which can compete with other stabilizers in market. Template sample paragraph .Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, SC, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

5. INITIAL DESIGN OF THE SYSTEM

A tilting vehicle can’t work properly unless it has correct suspension action. A motorcycle has correct suspension movement. In a motorcycle the wheel always moves in the plane of its inclination. This system can be called "in the plane suspension”. Many people fit laterally running parallel wishbones to tilting vehicles because they have observed this style on racing cars but this can result in a less than ideal suspension when applied to a tilting vehicle wheel rolling from a flat surface then onto an undulation/bump. There is a "natural rolling path" that this wheel will follow and this path is only possible if the suspension of the wheel is arranged to move in the inclined plane.

To achieve the tilt as required new suspension geometry was need. With the help of solid works, we were able to design the parts and test its feasibility before making it into production. Main parts needed were

1. Suspension housing
2. Upper and lower control arm
3. Holding nut and bolt
4. Stub axle
5. Sub frame

5.1 SUSPENSION HOUSING

The suspension housing is used to support the wheels and to provide a pivot point to the suspension incorporated in the system. The unit is situated behind the rear wheel of the vehicle to minimize the bulk of the vehicle and to reduce the foot print of the vehicle.

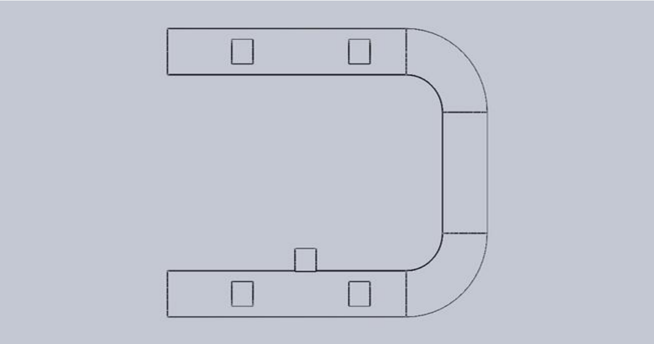


Fig -1: Suspension housing

5.2 UPPER AND LOWER CONTROL ARM

The upper and lower control arms are used to support the wheels. They are connected to the suspension housing using nuts and bolts. And also allows the hub to move/tilt according to the driving conditions. The lower arm also houses a socket for connecting the suspension.

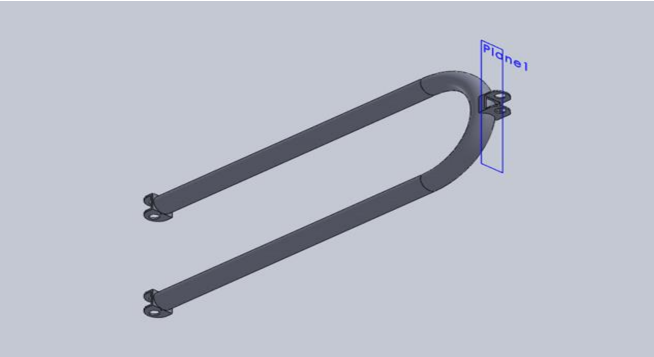


Fig -2.a: Upper control arm

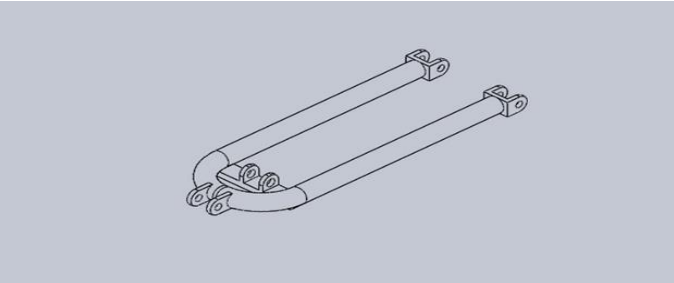


Fig -2.b: Lower control arm

5.3 HOLDING NUT AND BOLT

Fig -3: Holding nut and bolt

The holding pins are used to fasten the joints for quick release capabilities.

5.4 STUB AXLE

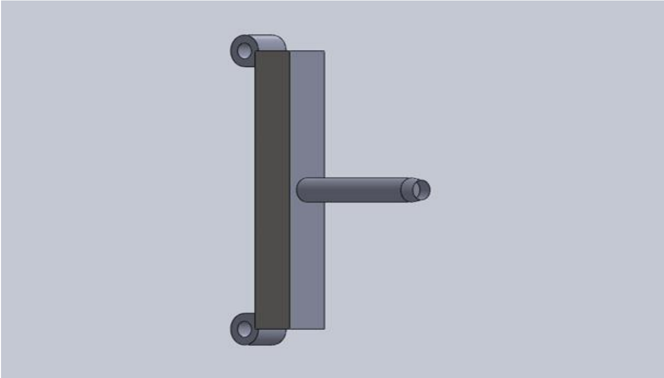


Fig -4: Stub axle

The stub axle is the connecting link between the wheel and the lower and upper control arm. The wheels are connected to the stub axle with the help of bearings to reduce the frictional loss and to increase the service life of the product. All the connection is made with proper washers to reduce metal to metal contact and in turn reduce the chance for failure.

5.5 SUB FRAME

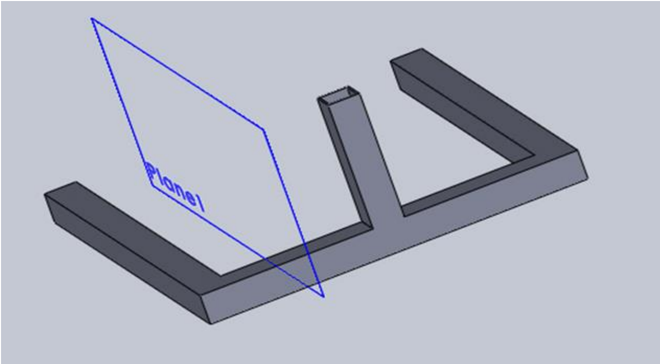


Fig -5: Stub frame

A metal frame structure was designed. This is directly bolted to the chassis of the vehicle to provide a firm and rigid support to the vehicle. It is manufactured according to the width of the vehicle since the tilting mechanism can be utilized on the many two wheelers of different form. It has multiple mounting points to the chassis to ensure rigidity to the system.

5.5 ASSEMBLED VIEW OF THE REAR SUSPENSION MECHANISAM

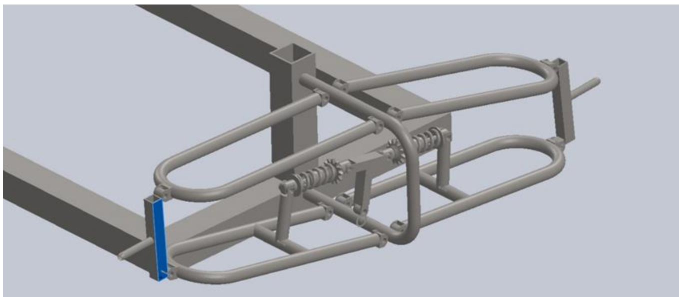


Fig -6.a: Rear suspension mechanism

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 05, May-2019

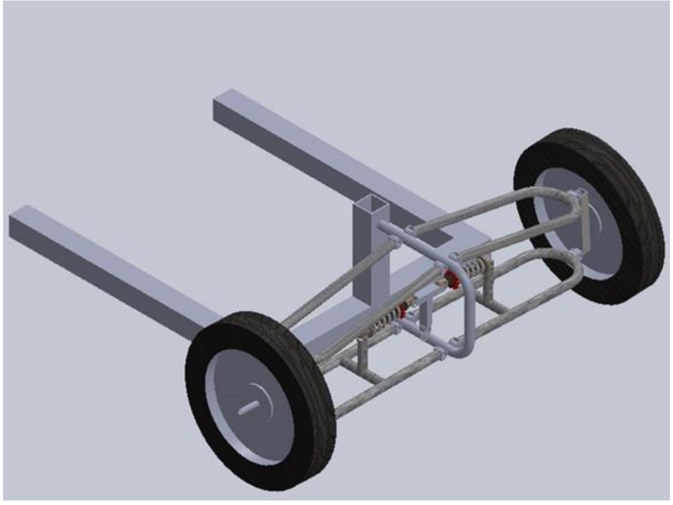


Fig -6.b: Assembled view of rear suspension

6. MATERIAL STUDY

The materials selected for the construction of the system basically consist of circular steel pipes (GI) varying from ¾ to 1 inch in diameter and steel square tube to support the suspension housing of 2.5 x 2.5 in dimension. The metal to metal contact is prevented at joint to enable smooth operation and to reduce friction. To prevent contact between metals a polythene bushing is used to reduce any noise during operation and to increase the durability of the joints. The vehicle selected was a ladies scooter which enables easy ingress, egress for the disabled person due to its constructional features.

GI pipes were selected due to their easy availability and there wide range in size and shapes.GI stand for galvanized iron. This is an important class of pipes used in a variety of applications as well as industries. Galvanization is a process in which iron or steel is coated with a layer of zinc to protect them from corrosion or rusting. Pure iron is very ductile and contains no carbon. The metal zinc lasts long and helps to increase the life of iron or steel. Galvanized Iron pipes and steel are used in most of the structural applications and come with a layer of zinc to give 100% protection from rusting.GI pipes have higher longevity as well as durability, they are easier to weld and rigorous fabrication which can in turn reduce the cost of fabrication also. GI pipe due to the presence of zinc comes with an anti-rust coating and high quality finish from the manufacturer Depending on the tube size and gauge, the mechanical properties of the finished tube shall have minimum yield strength of 345MPa and a minimum tensile strength of 510Mpa which is set as an industry standard.

6.1 COST ESTIMATION

From the local distributer we were able to generate an estimate for the materials needed for the project.

Table -1: Cost of product

ITEMS	Qty	UNIT PRICE	TOTAL COST
GI Pipe 3/4inch	6m	90/kg	675
Square tube	6m	71/kg	816
Wheel and tire	2	1100/side	2200
Welding supplies And bending charge			4000
Labor cost			3000
Miscellaneous expenses			2000
Shocks	2	500	1000
TOTAL COST OF PRODUCT(Without vehicle)			13691

Which can be further reduced with large scale production.

Table -2: Cost of tools

Sl no	item	Qty	Cost/Unit	Total cost
1	Spanner set	1	550	550
2	Hammer	1	150	150
3	Measuring tape	1	80	80
4	Cutting player	1	700	700
5	Steel rule	1	30	30
TOTAL COST				1510

Table -3: Cost of machinery

Sl no	Item	Qty	Cost/unit	Total cost
1	Welding Machine	1	2000	2000
2	Drilling machine	1	1000	1000
3	Cutting machine	1	1000	1000
4	Drill bit	3	50	150
5	Welding rod	1kg	850	850
6	Cutting wheel 4inch	1	350	350
7	Grinding wheel	1	300	300
8	Cutting wheel 8inch	1	450	450
TOTAL COST				6100

Total cost of tools = 1510
Total cost of machinery = 6100
Production cost = 13691
Vehicle cost = 5000
TOTAL COST = 26301

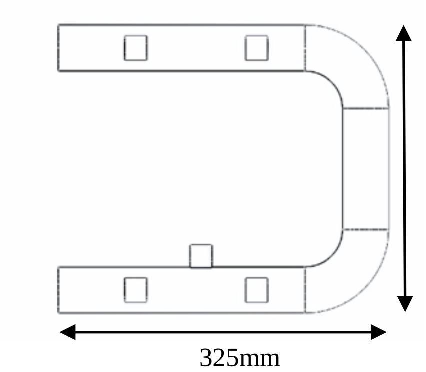
The total amount of money spend for the completion of project accumulates to a Rs27000

7. ANALYSIS

7.1 THE FORCE ANALYSIS ON THE HOUSING

The housing is where all the weight of the mechanism is supported. Therefore we calculate the load acting on the suspension system.

Load acting on housing P = 1700N
Length, L =325mm
Outer diameter =48mm
Inner diameter =44mm
Distance between R1 and strut, a=150mm
Distance between R2 and strut, b=175mm



Section 1

Reaction forces on housing are
Taking moment about R_2

R_1 = (P× b)/L
= 1700× (175) / (325)
= 915.384N

Taking moment about R_1

R_2 = (P× a)/ L
= (1700× 150) / (325)
= 784.61N

Maximum bending moment on housing,

$[M_c]$ max = - (P× a× b)/L^3 + R_1
= - (1700 × 150× 175)/ 325 + (947.88 ×150)
= 68247.088

Bending stress acting on the housing,

σ_b =$[M_c]$max /Z
=68247.088/3003
= 22.72 N/mm^2

Section 2

Direct stress σ_d = P/A
Load P = 1700N
Area A = π/2 × (r^2 – r^2)
= π/2 * (576-484)
= 144.51mm^2
σ_d=1700/144.51
= 11.7638 N/mm^2
σ_b=M/z
=(P× a)/z
= (1700×150)/3003
= 84.91 N/mm^2

Total bending stress acting on the housing

$\sigma = \sigma_b + \sigma_d$
= 84.91+11.7638
=96.6738 N/mm^2

Since the stress on the component is 96.6738 N/mm^2. The factor of safety of the part is 3.565. The housing was subjected to analysis in ANSYS 2019 R1. A load of 1700 N was applied to the pivot point of suspension link and free ends considered as fixed.

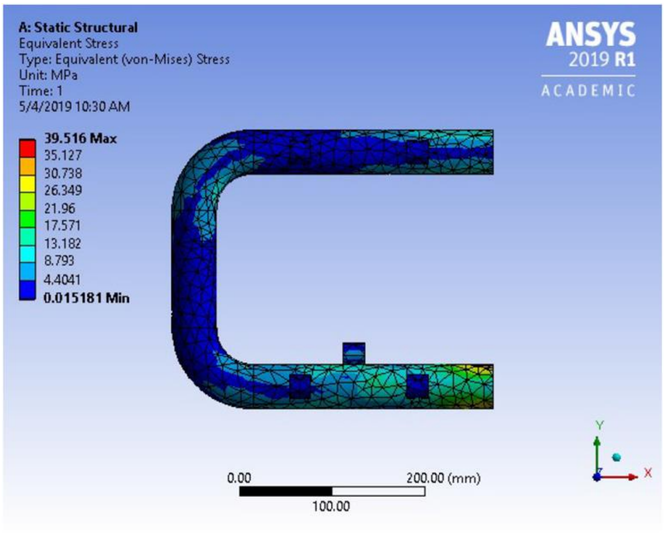


Fig -7: Equivalent stress analysis

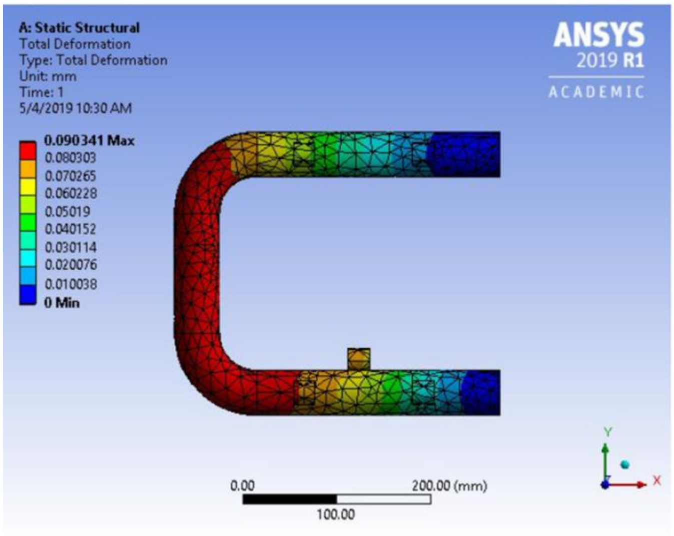


Fig -8: Total deformation

The maximum deformation was found to be 0.9 mm
Max stress 39.515 MPa

7.2 FORCE ACTING ON THE SPRING

Reaction force on the wheel = Mass per wheel× acceleration due to gravity (Weight)
= 576.82 N

Distance of strut from hinge point = 330mm
Total distance of the arm = 508mm
576.82 × 508 = spring force × 330
Spring force = 293024.56/330
= 887.95N

Taking the dynamic factor as 2
Dynamic force acting on the spring =887.95×2
=1775.9N

The optimum spring travel should be approximately 50 mm
Therefore the spring stiffness

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=Dynamic spring force/spring Deflection
=1775.9/50
=35.518N/mm

7.3 THE FORCE ACTING ON LOWER CONTROL ARM

The dimensions of the arm were based on the dimensional constraints of the vehicle. The strut is mounted on the lower arm and the hub is attached to the con troll arm by a pivot joint. As a result most of the force acts on the lower arm. The part was subjected to analysis in ANSYS2019 R1. The hinge points and the hub joint were considered as fixed joints and a load of 1775.9 N (dynamic spring force) was applied to the strut joint.

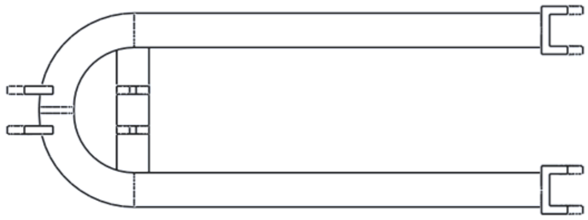

Fig -9.a: Lower control arm (Top view)

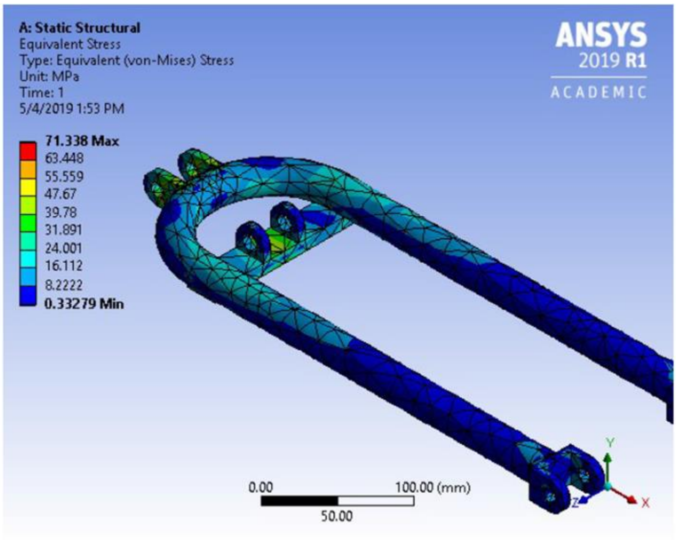

Fig -9.b: Equivalent stress

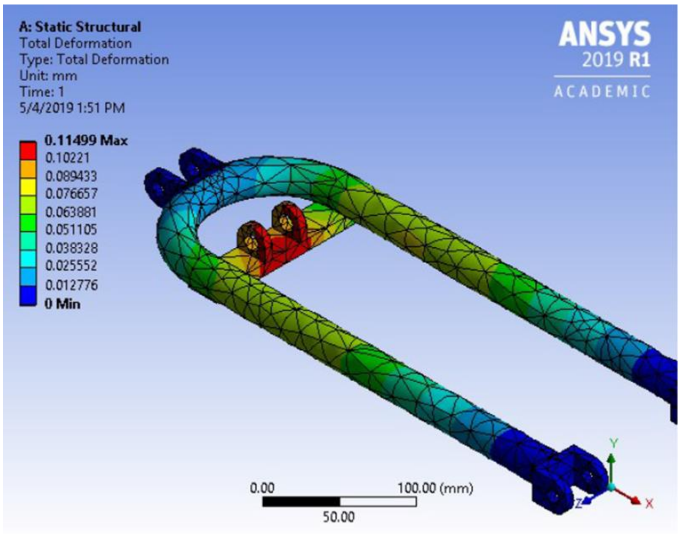

Fig -10: Total deformation

Maximum stress = 71.338 MPa
Maximum deformation = 0.114mm

Fig -11: Final view of prototype

8. ADVANTAGES

The TSHP is not only an alternative to the current setup but it is also an revolution to the among other manufactures products which not only increase the driving characteristics but also the driving dynamics of the vehicle

- The effort required by the a rider is reduced
- The leaning of bike/scooter makes easier cornering capabilities
- Enhanced comfort and riding dynamic
- The safety of the rider is greatly increased
- The vehicle stability is increased
- The handling characteristics also increases
- The chance of vehicle being overturned is eliminated due to the lean system
- The risk involved for the passengers are vastly reduced

- Easy maintenance and repair
- Long lasting and has excellent anti-corrosion characteristics which can increase its durability
- The independent suspension enables the vehicles to travel over un even terrain far better than conventional stabilizers

9. APPLICATIONS

- The TSHP system can be implemented on to any two wheelers that the rider wishes to drive.
- The mechanism can be adapted to any vehicle with minor modifications in vehicle.
- The TSHP can also be incorporated into two wheels to aid in stability and more traction as in an ATV (all-terrain vehicle)
- This system can also be adapted to fit on trike and other vehicles which does not lean inherently
- This system can also implemented into vehicles to aid more tractability

10. CONCLUSION

The project deals with the development of a suspension system for a two-wheeled stabilized vehicle that is capable of tilting like a conventional two-wheeled vehicle. This reverse trike with the tilt suspension system has superior capabilities in off-road terrains with improved stability and riding performances the suspension system enables the vehicle to tilting to a maximum of 30 degrees which is the nominal lean angle for an amateur rider. After 30 degrees of tilt, the vehicle is prevented from leaning more which prevents them from falling to its sides. The vehicle has an extended track width the broad track width helps to maintain the center of mass of the vehicle within the wheels even at maximum tilted position. Thus all these parameters prove that the new system offers improved riding characteristics than any conventional system in use.

ACKNOWLEDGEMENT

To bring something into existence is truly the work of ALMIGHTY. We thank GOD ALMIGHTY for making this venture a success. We thank our Principal Dr. K MATHEW, for providing the facilities for our studies and constant encouragement in all achievements.

At the outset we wish to place on record our sincere thanks to quite a few people without whose help, this venture would not have been a success. We would like to express profound gratitude to our Head of the Department Mr. NAVEESH KUMAR, our project coordinator, Mr. NITHIN K RAJAN and our guide Mr. RUBEN RAJ MATHEW for his encouragement and for providing all facilities for carrying out this project. We express our highest regard and sincere thanks to our guide, who provided the necessary guidance and serious advice to carry out this project. We also extend our sincere thanks to all the staff members of Mechanical Department who guided us throughout the entire course.

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