DESIGN AND ANALYSIS OF MAGNETIC SUSPENSION SYSTEM

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Abstract: This project is based on suspension system of two wheelers which were formally depending upon spring type, hydraulic and pneumatic suspension systems. This report gives information about magnetic suspension system and the magnetic suspension system is turning out to be the new option to these conventional suspension systems. The aim of this project is to study and investigate the response of system, when it is subjected to road surface irregularities with the hope that it would help automobile industry. This project presents design, construction and working of magnetic suspension system. This system uses magnets and spring as passive dampers, which are used to reduce displacement and acceleration of sprung mass in order to improve ride comfort. By using this type of absorber we can absorb the more number of shocks and variations are absorbed with more accuracy. This type of Suspension has no problem of leakage of oil like hydraulic shock absorber. Also this has less maintenance than other types of shock absorber that we can made this type of shock absorber for the efficient work of vehicle and for reducing the maintained cost of vehicle

IndexTerms **- Magnets, Coil Spring, Design Parameter.**

I. INTRODUCTION

Magnetic suspension system is mainly based on the property of magnets that like poles of magnets repel each other. This characteristic of magnets is used for suspension work of system. This system also contains spring in between these two magnets to avoid direct contact of two magnets due to overloading. This system finds large number of applications in automobile industry. In today's world automobile sector has reached its peak. In two wheeler suspensions system used in coil spring is that after some time it becomes not only harder but also reduces cushioning effect. This limitation has overcome by magnetic suspension. The cushioning effect is provided by magnetic suspension is existing for long time. There is one magnet fixed at the top of the inner portion of the cylinder. The second magnet placed at bottom of the inner portion of cylinder that reciprocates up and down due to repulsion. The two magnets fight against each other to achieve the aspect of suspension. Causing the formation of suspension to the vibrations formed in vehicle, which are caused due the road irregularities in order to offer the comfort to both the vehicle assembly and passengers on the vehicle. This system is having the tendency to eliminate the use of conventional suspension system due to its low cost and less maintenance capacity.

We made a model of the Magnetic Shock Absorber which is mainly based on the application of magnetic property like when the same poles of two magnets come in contact with each other then they are repulsed from each other. This unit is mounted in vehicle such as other type of shock absorber. The working of this absorber is very simple. Two magnets are mounted in this way that one is mounted below and other is on upper side. Poles of these magnets are same at inner side so that they are repulsed from each other and space is made between them due to this. When the vehicle is running on the bump or the muddy road then the space between two magnets is reduced and then shocks and variations present in the vehicle absorbed by repulsion property of the magnet. The automobile chassis is mounted on the axles not direct but through form of springs.

Objectives

- To eliminate the road shocks from being transmitted to the vehicle and its Components.
- To safeguard the occupants of vehicle from road bumps.
- To maintain the stability of vehicles.
- To control the maintenance as well as initial cost.
- To give the good road holding while driving, cornering and braking.
- To maintain good cushioning effect.
- To validate the design by testing prototype model.
- To prevent the road shocks from being transmitted to the vehicle Components.

2. LITERATURE SURVEY

[1] S. Gopinath, R.J. Golden Renjith, J.Dineshkumar In this project two magnets are placed in a piston. One magnet is fixed with piston. Another one is movable, which is connected with rod. With magnets are replaced by air. Our magnetic shock absorber works on the basic principle of magnet that "opposite poles attract each other and same poles repel each other". In this both magnets are facing same poles (both magnets are placed facing north and north or south and south). Both magnets are same pole. When the rod moves inside the piston movable magnet move towards the fixed magnet. Since both magnets are of same pole repulsion force is created between the magnets. So the movable magnet opposes the rod action and moves the rod up. The piston or cylinder is made up of non-magnetic material.

[2] **Chandrakant Chavan, 2G.M.Kakandikar, 3Swapnil S. Kulkarni.**describe about the analysis of suspension spring to determine and its fatigue life using finite element methodology. One of the most important part of the suspension system is the coil spring which are helical in shape steel bar that absorb the shock

[3] **V.V.Borole et al. [2015]** studied and described the Electromagnetic suspension system for automobile and studied different ways to recover energy from suspension system by using piezoelectric material to increase the efficiency of the automobile. Vehicle during running condition vibrate by means suspension operate by using motion of the shock absorber produce energy. Due to this tried to generate electricity from this system they proposed to use this electricity for headlamps and indicators etc. They also proposed to use these electro-magnets for preventing the tyres of vehicles from puncturing due to nails by attracting them to the magnets.

[4] **Suvriti Dhawan, Ravi Nandu** studied and describes the disadvantages of other types of suspension system with magnetic suspension the material properties used for the magnet, coil spring, shaft according to author the magnetic system have more and more advantages than the air, hydraulic suspension. The hydraulic and air suspension have leakage problem and which is dangerous for any suspension system because of that big reason magnetic suspension system were used.

3. DESIGN

Design of main spring:

The spring is mounted in between two magnets to avoid impact of magnets. The outer diameter of spring can be selected considering the clearance between casing diameter and spring which avoid jam of spring.

Outer diameter of the spring D_0=48mm

As per design data book for cold drawn wire steel wire diameter d = 6 mm,

Inner diameter of spring,

Di = 48-12 = 36 mm

Calculating the load bearing capacity of spring For any service life,

Shear stress = 0.5 Sut = 0.51190 = 595 N/mm2

Spring index C= Do/d = 48/6 =8

C = 8

Then Wahl factor of spring,

K= (4C-1)/(4C-4)+0.615/C

For C =8

K= 1.18

Now to Find load holding by spring P,

Shear stress = k (8PC/(d2))

P = 618:47N

Thus spring hold the load of 708.54 N remaining load is absorbed by magnet.

Deflection of spring (δ) can calculate by,

δ = (8PD3N)=(Gd4)

δ = 56:04mm

Spring rate = P= = 11N=mm

Spring stiffness = K = 11N=mm:

Number of turns = N = 17

As spring has square and ground ends number of Inactive turns = 2

Total number of turn, N= 17

Free length of spring,

Lf = solid length + deflection + axial gap

= 55 + 56 + 0.15(56)

= 55 + 56 + 0.15(56)

Lf = 120mm:

Pitch of spring = Lf=N

Pitch of spring = 13.33mm

Design of Magnet:

Power Magnet Pair =**10,000GP** (Gauss Power) Weight Vehicle Body =110kg = 1080N

Weight Of Person Setting On Vehicle = 140kg =1374N

Total Load = Weight Vehicle Body + Weight Of Person Setting On Vehicle

=1080+1374

Total Load =1080+1374

=2454 N

Rear Suspension = 65percentage2454

=1595.1 N

Considering Dynamic Loads Double (W)= 1595.12

=3190.2 N

For Single Shock Absorber Weight (W/2)= 3190.1/2 = 1595.1 N

Taking Factor Of Safety = 1.2

So Design Load=1914.92N

Magnetic Power Per Unit Area =2N/mm^2

So Area Required For Suspension Of 300kg load

2 = 1914.12=A

A = 957.06mm^2

A = 4d2

957.06 =4d^2

d = 34.90mm35mm

d = 35mm

Diameter of magnet = 35mm

Design of shaft

The shaft is subjected to pure bending stress

Design force = 1914.12 N

Bending length = 165 mm

Bending moment = F L

= 1914.12 165

= 315829.8 N-mm M /32 F(b)d^3

315829.8 = 32599.13 d^3

d = 18mm

Design of hollow shaft:

M = F(b)l

M = 1914.12200

M = 382824 N/mm

M = =32F(b)d_0^3(1k^4)

382824 = 32F(b)873(10.894)

F(b) = 15.893N=mm^2

F(b) = 20 < 35N=mm^2

As induced stress is less than allowable stress the design of hollow cylinder is safe

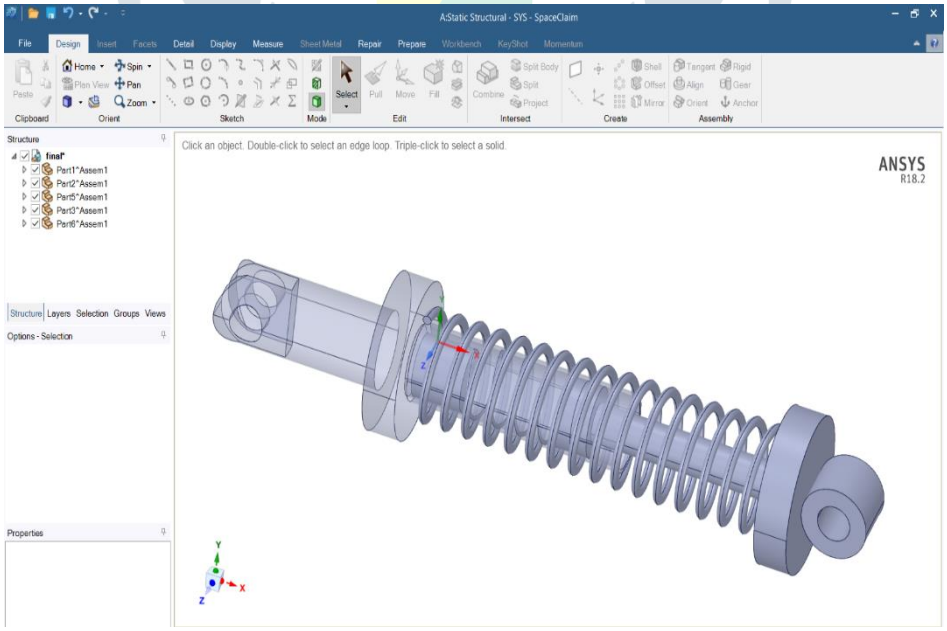


Fig 3.1 View of design in solid works

4. ANALASYS

Static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. A static analysis, however, includes steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads

A. ANALYSIS

Designers and engineers primarily use structural simulation to determine the strength and stiffness of a product by reporting component stress and deformations. The type of structural analysis performs depends on the product being tested, the nature of the loads, and the expected failure mode. A short/stocky structure will most likely fail due to material failure (that is, the yield stress is exceeded).For the given below specification of the allow wheel, the static analysis is performed using solid works to find the maximum safe stress and the corresponding pay load. After geometric modeling of the alloy wheel with given specifications it is subjected to analysis. The Analysis involves the following discretization called meshing, boundary conditions and loading.

B. ABOUT ANALYSIS WITH ANSYS

The reliability of ANSYS software proved by doing valediction problem in simply supported beam, which is shown appendix 1. The theoretical values of simply supported beam compared with ANSYS values and it's almost same. So we consider ANSYS software for our analysis to get accurate results. The ANSYS computer program is a large-scale multipurpose finite element program. ANSYS is used for solving several engineering analyses. The analysis capabilities of ANSYS include the ability to solve static and dynamic structural analyses, steady-state and transient heat transfer problems, mode frequency and buckling Eigen value problems, static or time varying magnetic analyses and various types of field and couple field application.

C. MATERIALS REQUIRED FOR ANALYSIS OF DESIGN

Structural Analysis for bike weight (113kg)

SPRING:

Material: Spring Steel (ASTM A227)

Modulus of Rigidity G = 78600N/mm^2

Properties: Young's Modulus (EX):1.965×105 N/mm^2

Poisson's Ratio (PRXY): 0.25

Density:7.86×10-6kg/mm^3

MAGNETS:

magnets > Constants

Density	7.5e-006 kg mm^-3

magnets > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	1.6e+005	0.24	1.0256e+005	64516

magnets > Compressive Yield Strength

Compressive Yield Strength MPa
780

SHAFTS

Structural Steel

Density	7.85e-006 kg mm^-3
Isotropic Secant Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat Constant Pressure	4.34e+005 mJ kg^-1 C^-1
Isotropic Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Isotropic Resistivity	1.7e-004 ohm mm

Structural Steel > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

Structural Steel > Compressive Yield Strength

Compressive Yield Strength MPa
250

Structural Steel > Tensile Yield Strength

Tensile Yield Strength MPa
250

Structural Steel > Tensile Ultimate Strength

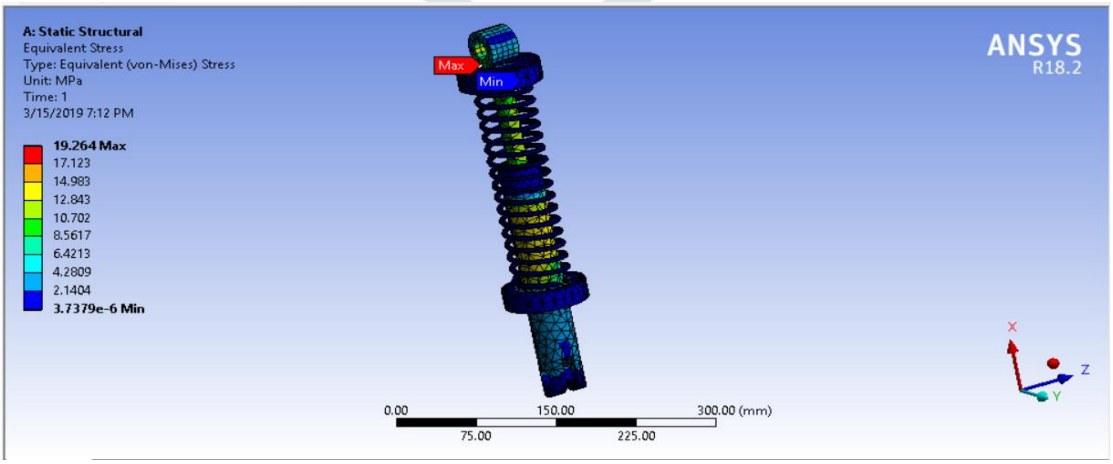
Tensile Ultimate Strength MPa
460

Structural Steel > Isotropic Secant Coefficient of Thermal Expansion

Zero-Thermal-Strain Reference Temperature C
22

5. RESULTS AND CONCLUSIONS

RESULT:



STRESSES PRODUCED:

Model (A4) > Static Structural (A5) > Solution (A6) > Results

Object Name	*Total Deformation*	*Equivalent Stress*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Total Deformation	Equivalent (von-Mises) Stress
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	0. mm	3.7379e-006 MPa
Maximum	1.8904e-002 mm	19.264 MPa
Minimum Occurs On	Part 4	
Maximum Occurs On	Part 6	
Information		

DEFORMATION:

Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.	0.	1.8904e-002

CONCLUSION:

This project has provided us an excellent opportunity and experience to use our limited knowledge. We gained a lot of practical knowledge regarding planning, purchasing assembling and machining while doing our project work. We feel that the project work is a good solution to bridge the gate between institution and industries. We are proud that we have completed the work with the limited time successfully. MAGNETIC SUSPENSION SYSTEM is working well. We are also able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work, let us add a few more lines about our impression on project work. Thus we have developed a MAGNETIC SUSPENSION SYSTEM which helps to know how to achieve low cost and minimize the size.

6. FUTURE SCOPE

It is possible to do make modification in the magnetic shock absorber some of them are explained below:-

1) If the coils are fitted at the outer side of magnet then it is possible to generate electricity which is possible to use for head lamp or for battery charging.

2) If electric magnets are fitted in front of wheel & back, it will possible to give protection to vehicle by puncture down by iron metals.

3) If a path of electro magnet make and the magnet connected at down side of vehicle then it is possible to drive vehicle without energy and due to this there is no pollution.

7. ACKNOWLEDGEMENT

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MR. M. SHANKAR
MR. K. SHANMUKH SAI KRISHNA

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