Study and Design of Advance Suspension System For Two Wheeler

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Abstract - Now a day's various types of suspension are available in market but for optimizing the better and efficient cushioning effect. It's a need of today to improve and advancement in suspension system. In This research literature we thoroughly study design parameters required to design magnetic suspension system and gives information about various types of rear suspension of two-wheeler .Research literature describes techniques for the design, construction of magnetic suspension system.

Key Words: Magnetic Suspension, Repulsion, Bumps, Polarity.

1. INTRODUCTION

At present, most of the two-wheeler are using a passive hydraulic suspension. One of the main features of hydraulic suspension is it uses hydraulic oil as a damper. Whenever a vehicle experiences road irregularity, the excitation force from road surface is absorbed by the damper. The absorbed energy is converted into heat inside the damper. The vehicle body weight is supported by the mechanical spring attached with the damper. However, there are some disadvantages of hydraulic system. According to Gysen, hydraulic damper contributes to environmental pollution due to hose leaks and ruptures, where hydraulic fluids are toxic. Then, the hydraulic systems are considered inefficient due to the required continuously pressurized system. On the contrary, magnetic suspension systems (MS) not require hydraulic fluid. It consist two magnets and two springs. one magnet and spring is attached to the chassis and another spring and magnet is connected to the road wheels. Basically, faradays law of electromagnetic invention is main supportive law for that also, everyone knows about maglev train one of the best invention today's modern technology and maglev train works on the magnetic levitation and easily maintained gap between track and railway. Same concept using for electromagnet suspension electromagnetic suspension system due to it have a relatively high force density that can control the vehicle body vibration same as hydraulic damper.

2. LITRATURE REVIEW

2.1 Samuel Earnshaw was the one to discover in 1839 that "a charged body placed in an electrostatic field cannot levitate at stable equilibrium under the influence of electric forces alone "

2.2 Braunbecks extension (1939) state that a system of permanent magnets must also contain diamagnetic levitation or suspension

2.3 Emile bachelet applied earnshaws theorem and the braubeck extension and stabilized magnetic force by controlling current intensity and turning on and off power to the electromagnets at desired frequencies he awarded a patent in march 1912 for his "levitating transmitting apparatus "

2.4 In 1934 hermann kemper applied bachelets concept to large scale calling it " monorail vehicle with no wheels attached"

2.5 In 1979 the transrapid electromagnetically suspended train carried passengers

2.6 The first commercial maglev train for routine service was opened in Birmingham ,England in 1984 using electromagnet suspension and liner induction motor for propulsion

3. METHODOLOGY

In two-wheelers suspension system is used coil spring but the limitation of that coil spring is that after some period of time it becomes not only harder but also reduced cushioning effect. This limitation is overcome by magnetic suspension. The cushioning effect provide by magnetic suspension is existing for long time.

Unlike poles of a magnet attract each other and like poles repel each other. When we place two north pole or south poles facing each other and when they are brought closer they are repelled. this concept is used in magnetic suspension .in this suspension a set of magnets have been selected like poles then one magnet is fixed at chassis and another magnet is placed at road wheel. When two magnets are brought closer to each other they are repelled due to similar polarity and the aspect of suspension is achieved

4. PREVIOUS DESIGNS

4.1 *Suspension (motorcycle)* : A motorcycle's suspension serves a dual purpose: contributing to the vehicle's handling and braking, and providing safety and comfort by keeping the vehicle's passengers comfortably isolated from road noise, bumps and vibrations….[3]

4.2 *Early rear suspensions*: While front suspensions were almost universally adopted before World War I, several manufacturers did not use rear suspension on their bikes until after World War II. However, motorcycles with rear suspension were offered to the public before World War I. Notable among these are the 1913 Indian Single with a swingarm suspended from a leaf spring and the 1913 Pope with wheels supported on a pair of plungers which were each suspended by a coil spring. …[4]

4.3 *Plunger suspension*: Several motorcycles before and immediately after World War II used plunger suspension in which the vertical movement of the rear axle was controlled by plungers suspended by springs…[4]

4.4 *Swing arms*: The basic motorcycle swing arm is a quadrilateral, with one short side connected to the motorcycle's frame with bearings so that it can pivot. The other short side is the rear axle around which the rear wheel turns. The long sides are connected to the motorcycle's frame or rear sub-frame with one or two shocks with coil-over spring [5]

4.5 *Shock absorbers*: The hydraulic shock absorbers used on the rear suspensions of motorcycles are essentially the same as those used in other vehicle applications.Motorcycle shocks do differ slightly in that they nearly always use a coil-over spring. In other words, the spring for the rear suspension is a coil spring that is installed over, or around, the shock [6]

4.6 *Twin shock absorbers*: Twin shock refers to motorcycles that have two shock absorbers. Generally, this term is used to denote a particular era of motorcycles, and is most frequently used when describing off-road motorcycles [7]

4.7 *Single shock absorber*: On a motorcycle with a single shock absorber rear suspension, a single shock absorber connects the rear swing arm to the motorcycle's frame. Typically this lone shock absorber is in front of the rear wheel, and uses a linkage to connect to the swing arm. Such linkages are frequently designed to give a rising rate of damping for the rear [8]

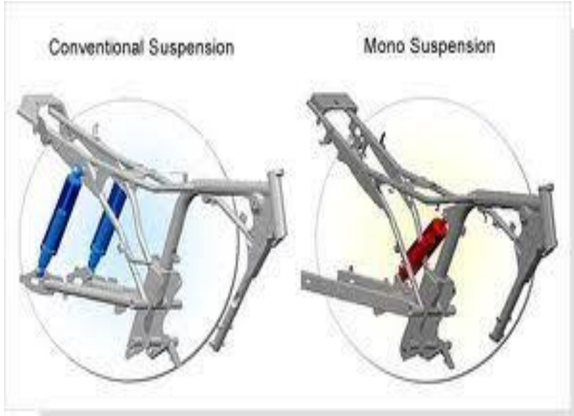


Fig: 1 Previous Design

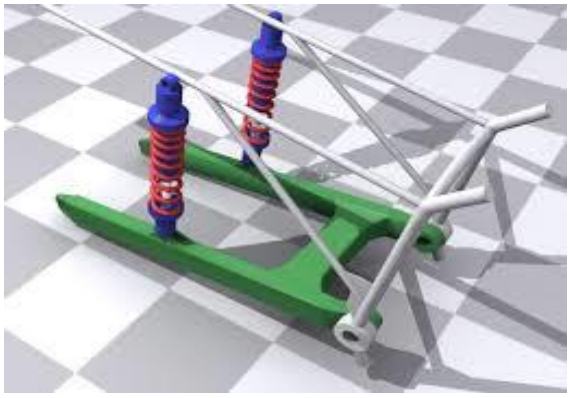


Fig: 2 Previous Designs

5. DESIGN of SUSPENSION SYSTEM

Final design for this system is as shown below which much more effective than existing system.

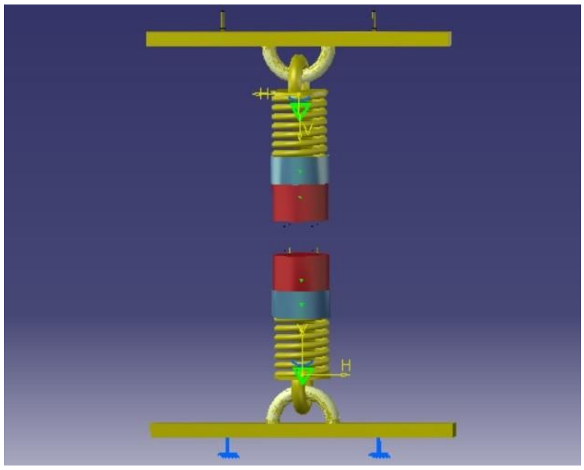


Fig: 3 New System

5.1 DESIGN ANALYSIS OF MAGNTIC SUSPENSION

5.1.1 DESIGN OF SPRING

Two spring is mounted on either side 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. ..[1, 2]

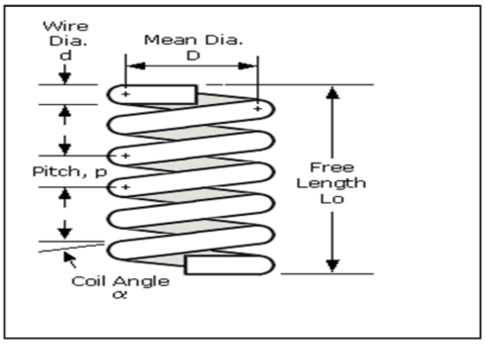


Fig: 4 General Diagram of Spring

W_v – weight of vehicle body = 135 Kg= 1324 N

W_p – human weight sitting on bike = 150 Kg = 1471 N

Total Weight

W = Wv + W_p = 135 + 150 + 285 Kg = 2795 N

i. Weight acts on rear suspension (W_s)
 W_s = 65% of total load
 = 0.65*2795
 = 1817 N
ii. In dynamic condition (W_d)
 W_d = 2* W_s
 = 2*1817
 = 3634 N
iii. Load acting on shock absorber
 W_{shock} = $W_d/2$
 =3634/2
 =1817 N
iv. Load on single spring = 1090 N

Factor of Safety = 1.2 .....(Range = 1 to 12)

v. Design Load (W_{design})
 W_{design} = 1090
 = 1090 N

Maximum shear stress = 320 mpa =360 N/m

Modulus of Rigidity (G) = 84 Gpa = 84*10³ N/mm

Mean Diameter of Spring (D) = 70 mm

Wire Diameter (d) = 10 mm

1. Inside Diameter (D_i) = D – d
 = 70 – 10
 = 60 mm
2. Outer Diameter (D_o) = D + d
 = 67 +10
 = 80 mm
3. $Spring\ index\ = \frac{D}{d}$

 $Spring\ index\ = \frac{70}{10}$

 $Spring\ index\ = 7$
4. Whals curvature factor or stress factor

 $$K = \frac{4c-1}{4c-4} + \frac{0.165}{c}$$

 $$K = \frac{4*7-1}{4*7-4} + \frac{0.165}{7}$$

 $$K = 1.21$$
5. Shear stress (τ)

 $$\tau = \frac{8W_{design}D_oK}{\pi d^3}$$
6. Deflection (δ)

 $$\delta = \frac{8WGD_o{}^3n}{GD^4}$$

 $$= \frac{8*1090*80^3*8}{84*10^3*10^4}$$

 $$= 5.31\ mm$$
7. Total number of active turn
 $n' = n + 2$

 $n' = 8 + 2$
 $n' = 10$
8. Solid length (L_s)

 $L_s = n' * d$

 $L_s = 10 * 10$

 $L_s = 100\ mm$
9. Free length (L_f)

 $L_f = L_s + \delta + 0.15 * \delta$

 $L_f = 100 + 5.31 + 0.15 * 5.31$

$L_f = 106.11\ mm$

10. Pitch

$$P = \frac{106.11}{8}$$

$$P = 13.26\ mm$$

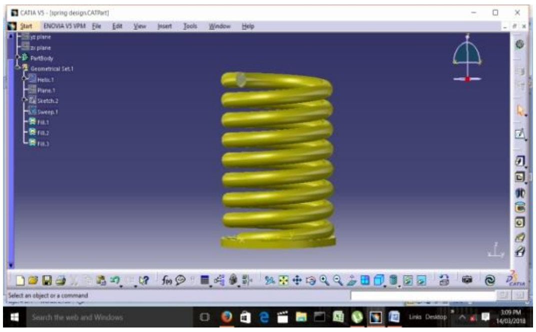


Fig: 5 DESIGN OF SPRING

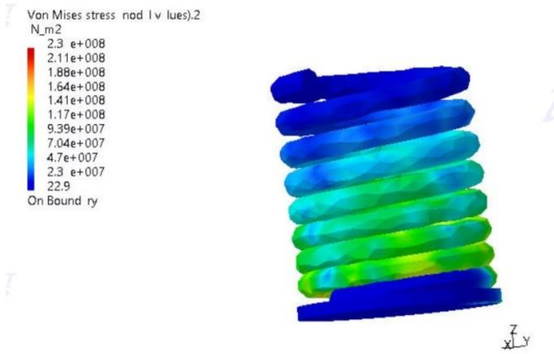


Fig :6 CATAIA DESIGN MODEL

1.1.2 DESIGN OF MAGNET

The magnet we are using here is permanent type magnet which has following properties.

- Power of magnet pair = 10000 Gauss power
- Weight = 0.5 Kg .....[9]

1.1.3 MAGNET SELECTION

Repelling force required between two magnet calculated by using repulsive force calculator.

The surface rolls the data is only valid for point along center axis of three spaces. **Grade :** grade shows energy of magnet. Higher grade stronger magnet

Magnet specification :

Material use: neodymium Grade : 52

Diameter of magnet = 80mm

Length of magnet=70mm

Permeance coefficient (pc) : 2.9

Dipole Moment (m) : 414 Am^2

Force Range = 330N-1980N

Magnetic visualization of single magnet in free space (for 3 conditions)

Field strength calculation

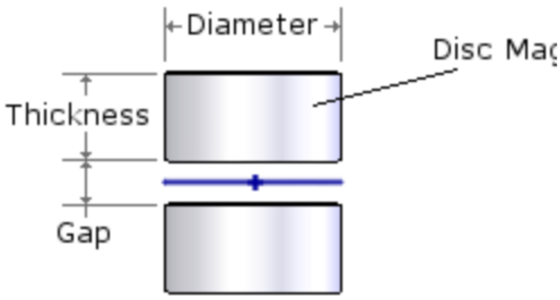
Strength between two new dynamic magnet field separate by small gap

Magnetic field strength at field center: 6038 gauss

Table shows the repulsive force, magnetic field in relation with distance between magnets.

Load (Kg)	Repulsive force(Kg)	Distance (mm)	Magnetic field (Gauss)
87.75	33.73	70	690
152.75	72.44	40	1722
282.75	195	10	4824

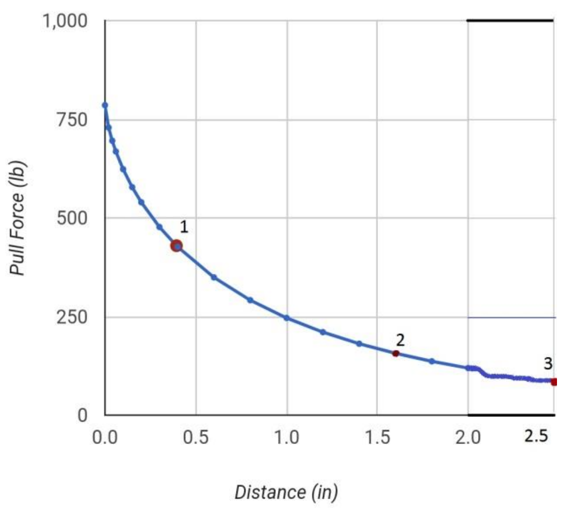
Table:01 Magnet Specification



fig;7 CATAIA DESIGN MODEL

Grade = N52 .[10]
Diameter = 80 mm
Thickness = 70 mm
Case-1
Distance = 10 mm
Repulsive Force = 33 Kg
Case-2
Distance = 40 mm
Repulsive Force = 72Kg

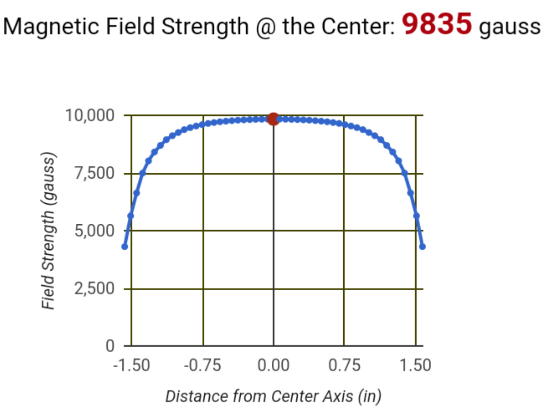
Case-3
Distance = 70mm
Repulsive force = 195



Graph:01 Pull force (Repulsive Force) Vs. Distance

The gap calculator estimates the magnetic field strength between tow neodymium magnets separated by a small gap.

The magnets are positioned with opposite poles facing one another, so that the magnet are attracting towards one another.



Graph:2 Distance vs Field Srenght

The graph above depicts the magnetic field strength in the vertical direction, along a line equidistant between the two magnets, as shown below.
A single magnet in free space has strong magnetic field around it. However, the further away from the surface of the magnet that you measured it, the weaker it get.

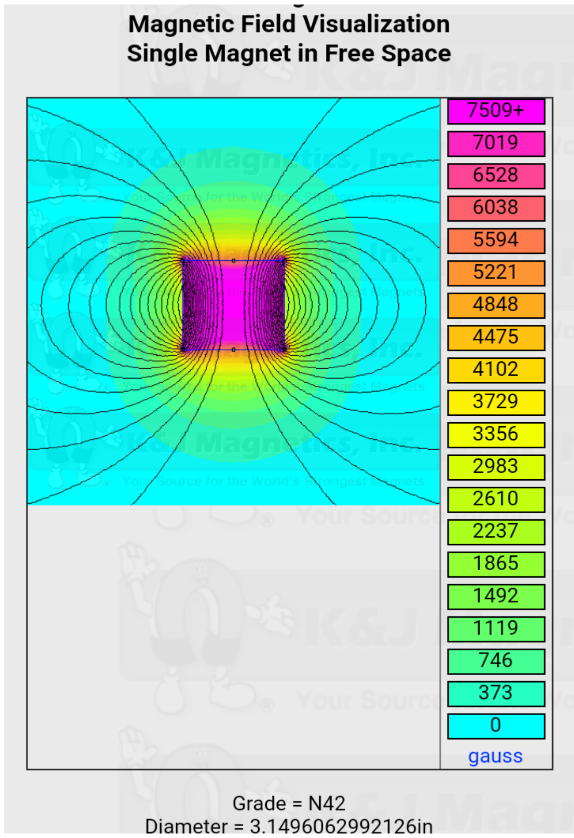


Fig:8 magnetic field visualization

Following table shows the relation of field strength and change the distance with angle from the axis x and y.

Fig: 4(a) static Case Solution.1 – Vonmises stress

Loading conditions are assumed to be static. By analyzing loading condition we found the location of maximum deflection and

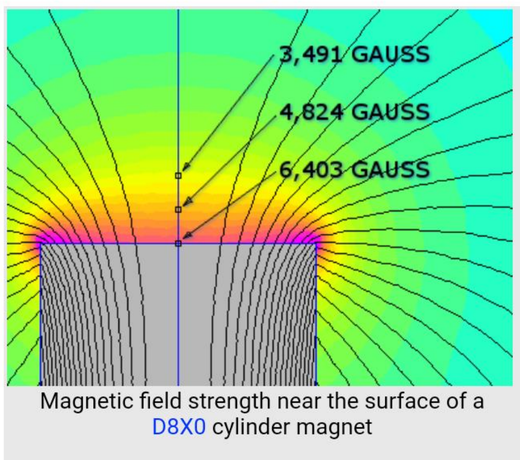
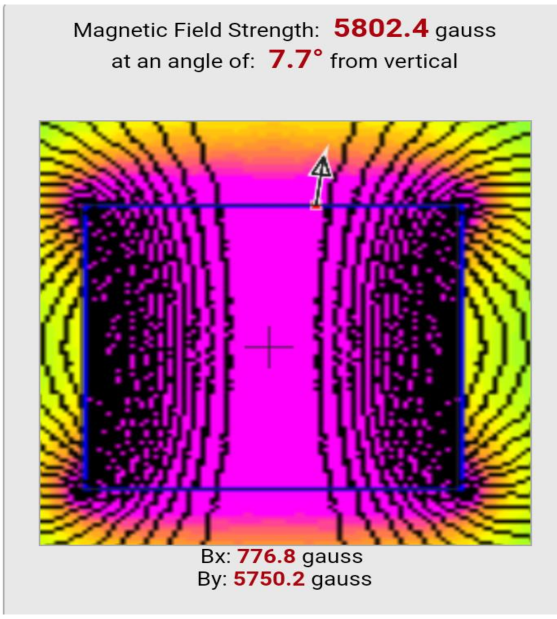


Fig:9 Magnetic Field Strenght Near The Surface of a d8X0 cylinder magnet

For calculating the magnetic field at different angle and varying the distance from x and y axis there is number of co-relation generate. As we see the following fig.



Graph:3 Field Strength vs. Distance From Center Axis.

Angle (in °)	X (mm)	Y (mm)	Gauss Power
0	0	70	2112.3
0	0	60	2945.6
0	0	50	4145.4
0	0	40	5533.7
0	0	35	6368.7
7.7	10	35	6501.9
15.9	20	35	6666.2
27.5	30	35	7435.9
59.7	40	35	6355.4
8.2	10	40	5572.3
17.8	20	40	5678.5
31.8	30	40	5860.7
60.6	40	40	5250.2
9.5	10	50	4093.3
17.8	20	40	5678.5
31.8	30	40	5860.7
60.6	40	40	5250.2
9.5	10	50	4093.3
20.6	20	50	3981
34.2	30	50	3751.3
52.2	40	50	3081
9.9	10	60	2928
21.1	20	60	2795.1
33.1	30	60	2517.8
46.9	40	60	2115
9.9	10	70	2102.8
20.1	10	70	1979.5
31	10	70	1771.4
42.5	10	70	1502.7

Table 02 variation in magnetic field according to distance and angle between two axis.

6. ADVANTAGES

A. Less wear and tear as there is no mechanical contact
B. Simple design
C. Less vibrations
D. Long life span
E. Reliable
F. It reduces energy consumption
G. Largely obviating friction

7. CONCLUSION

As analyzing the data we realized that it provide better cushioning effect, increased comfort as compare with other system . In the conventional damping system the kinetic energy is convert into heat of oil but in this case unnecessary moment of damper is take place this is totally avoid in above invention. It is not as much of expensive so it reduced production cost.

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