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FINITE ELEMENT ANALYSIS OF SHOCK ABSORBER USING ANSYS

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ABSTRACT

Over a period of time conventional shock absorbers looses their life and demands for replacement very often. The reason for this can be attributed to self induced vibration of the shock absorber. This self-induced vibration further causes wear and tear in the parts of shock absorber and hence leads to need for replacement. Frequent replacement of shock absorber becomes cost implication for the user. More over this self-induced vibration generates noise, which causes discomfort and diverts the attention of rider of the vehicle incorporating shock absorber. Hence novel design of shock absorber is taken up in this project, which will be free from above said two problems. The proposed design will be a piston cylinder kind of arrangement. The relation between the friction coefficient between piston and cylinder and the geometric parameters of the arrangement, which is essentially required to be followed to get rid of self induced vibration and noise will be brought out as an out come of this project.

Key words: *Vibration**, design, noise, self induced.***

I. INTRODUCTION

Shock absorbers are basically used to absorb shocks in automobiles during their course of application. The primary objective of shock absorber is to see to it that shock experienced by the base of the vehicle due to pot holes, speed breakers, etc, will not get transfer to the passengers. Shock absorber consists of two basic elements out of which one is spring and the other one is damper. The advantage with spring is it absorbs the shock and stores in it as strain energy. But the disadvantage of spring is it will not permanently store the energy and it will release back after some time. Spring will be designed against certain load (Weight of total vehicle along with the passengers). If any deviation in the load against the designed value while releasing the strain energy it boosts up the energy. Which means passenger will get more shock than what is imparted by the road roughness like pot holes. In order to gain from advantage lying with spring and to get rid of the disadvantage of spring, damper is provided in combination with spring in a typical shock absorber. Damper will act as a controller for spring. Damper is basically a cylinder piston arrangement which may be hydraulic or pneumatic. In most of two wheeler type installations damper will be of hydraulic (Oil). In shock absorber damper and spring will be connected in such a way that while absorbing the shock spring has to spend part of energy in compressing the piston against the oil in the cylinder. That is how most of the energy will be dissipated while it is received by the spring itself. Coming to the damper as it is a piston cylinder arrangement, piston and cylinder which are mating will have relative motion and hence friction exists. Certain value of coefficient of friction between the mating surfaces of piston and cylinder is to be maintained to maintain the

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friction within limits which otherwise leads to bending of piston relative to cylinder. Lubrication is required to maintain the desired value of coefficient of friction. But in a typical two wheeler automobile vehicle more concentration will be towards the IC engine and its lubrication. It is practically difficult to maintain lubrication in shock absorber. Due to lack of lubrication piston in the cylinder bends after some time and it results into noise and followed by vibration and finally it leads to expiration of life of shock absorber. User of the automobile vehicle has to either replace the shock absorber frequently or he has to live with the situation. To overcome this problem a solution is proposed in the present project. An alternative approach to achieve the desired value of coefficient of friction is brought out. When it is not possible to maintain lubrication in a shock absorber, still the desired value of coefficient of friction can be achieved by selecting the dimensions of the piston in a certain fashion. An optimum combination of piston dimensions which will lead to the desire value of coefficient of friction is derived in this project. The final outcome of this project would be a optimum design solution to increase life for a shock absorber.

II. SELECTION OF THE DESIGN PARAMETERS

The Optimum range of μ is 0.05 to 0.08. For practical purposes the preferable coefficient friction is ≥ 0.1. Hence the design can be followed by considering coefficient of friction of 0.1.

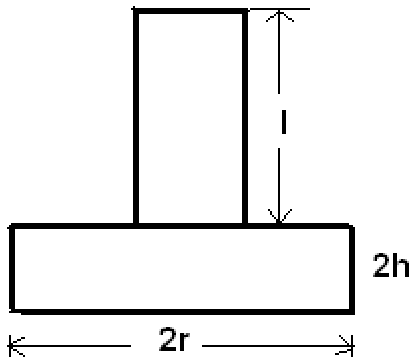

Fig.4.1

L= 750 mm=0.75m

2r= 200mm

Height of The Piston Head:

S.No	**EXISTING DESIGN CONDITION ($\mu > 3h^2/rl$)**			**MODIFIED DESIGN CONDITION ($\mu \leq 3h^2/rl$)**		
	h	**μ**	**$3h^2/rl$**	**h**	**μ**	**$3h^2/rl$**
1	**15**	**0.1**	**0.01**	44	0.1	0.077
2				46	0.1	0.08
3				48	0.1	0.092
4				**50**	**0.1**	**0.1**
5				52	0.1	0.108

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III. FINITE ELEMENT ANALYSIS FOR EXISTING DESIGN CONDITION (GUI)

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX UX REAL	IMAGINARY
2.0000	0.338601E-04	-0.794510E-07
3.0000	0.362303E-04	-0.136456E-06
4.0000	0.401670E-04	-0.223651E-06
5.0000	0.466902E-04	-0.377798E-06
6.0000	0.582537E-04	-0.705887E-06
7.0000	0.823588E-04	-0.164680E-05
8.0000	0.157525E-03	-0.689693E-05
9.0000	**-0.154785E-02**	**-0.201369E-02**
10.000	-0.131453E-03	-0.600757E-05
11.000	-0.635795E-04	-0.154408E-05
12.000	-0.406000E-04	-0.686895E-06
13.000	-0.291448E-04	-0.383563E-06
14.000	-0.223358E-04	-0.242694E-06
15.000	-0.178538E-04	-0.166214E-06
16.000	-0.146993E-04	-0.120239E-06
17.000	-0.123714E-04	-0.905424E-07
18.000	-0.105915E-04	-0.703093E-07
19.000	-0.919256E-05	-0.559428E-07
20.000	-0.806864E-05	-0.454007E-07

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX UX REAL	IMAGINARY
21.000	-0.714917E-05	-0.374548E-07
22.000	-0.638552E-05	-0.313305E-07
23.000	-0.574310E-05	-0.265205E-07
24.000	-0.519667E-05	-0.226811E-07
25.000	-0.472738E-05	-0.195734E-07
26.000	-0.432093E-05	-0.170268E-07
27.000	-0.396626E-05	-0.149175E-07
28.000	-0.365468E-05	-0.131534E-07
29.000	-0.337930E-05	-0.116653E-07

30.000	-0.313460E-05	-0.104002E-07
31.000	-0.291606E-05	-0.931715E-08
32.000	-0.272000E-05	-0.838397E-08
33.000	-0.254337E-05	-0.757521E-08
34.000	-0.238364E-05	-0.687054E-08
35.000	-0.223868E-05	-0.625351E-08
36.000	-0.210667E-05	-0.571077E-08
37.000	-0.198611E-05	-0.523137E-08
38.000	-0.187566E-05	-0.480625E-08
39.000	-0.177423E-05	-0.442790E-08

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX	
	UX	
	REAL	IMAGINARY
40.000	-0.168083E-05	-0.409004E-08
41.000	-0.159462E-05	-0.378739E-08
42.000	-0.151487E-05	-0.351548E-08
43.000	-0.144095E-05	-0.327054E-08
44.000	-0.137228E-05	-0.304931E-08
45.000	-0.130838E-05	-0.284904E-08
46.000	-0.124880E-05	-0.266734E-08
47.000	-0.119316E-05	-0.250215E-08
48.000	-0.114111E-05	-0.235169E-08
49.000	-0.109235E-05	-0.221441E-08
50.000	-0.104660E-05	-0.208894E-08
51.000	-0.100360E-05	-0.197412E-08
52.000	-0.963152E-06	-0.186889E-08
53.000	-0.925038E-06	-0.177235E-08
54.000	-0.889084E-06	-0.168369E-08
55.000	-0.855124E-06	-0.160220E-08
56.000	-0.823010E-06	-0.152724E-08
57.000	-0.792609E-06	-0.145827E-08
58.000	-0.763796E-06	-0.139479E-08

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX	
	UX	
	REAL	IMAGINARY
59.000	-0.736460E-06	-0.133634E-08
60.000	-0.710498E-06	-0.128255E-08
61.000	-0.685816E-06	-0.123307E-08
62.000	-0.662328E-06	-0.118757E-08
63.000	-0.639956E-06	-0.114580E-08
64.000	-0.618626E-06	-0.110750E-08
65.000	-0.598271E-06	-0.107246E-08
66.000	-0.578829E-06	-0.104048E-08
67.000	-0.560243E-06	-0.101140E-08
68.000	-0.542460E-06	-0.985068E-09
69.000	-0.525430E-06	-0.961363E-09
70.000	-0.509107E-06	-0.940173E-09
71.000	-0.493450E-06	-0.921409E-09
72.000	-0.478418E-06	-0.904997E-09
73.000	-0.463974E-06	-0.890879E-09
74.000	-0.450084E-06	-0.879015E-09
75.000	-0.436714E-06	-0.869381E-09
76.000	-0.423835E-06	-0.861967E-09
77.000	-0.411416E-06	-0.856782E-09

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX	
	UX	
	REAL	IMAGINARY
78.000	-0.399432E-06	-0.853852E-09
79.000	-0.387856E-06	-0.853222E-09
80.000	-0.376664E-06	-0.854956E-09
81.000	-0.365832E-06	-0.859140E-09
82.000	-0.355339E-06	-0.865885E-09
83.000	-0.345162E-06	-0.875330E-09
84.000	-0.335282E-06	-0.887641E-09
85.000	-0.325679E-06	-0.903023E-09
86.000	-0.316332E-06	-0.921719E-09
87.000	-0.307223E-06	-0.944020E-09

88.000	-0.298334E-06	-0.970271E-09
89.000	-0.289645E-06	-0.100089E-08
90.000	-0.281137E-06	-0.103635E-08
91.000	-0.272792E-06	-0.107726E-08
92.000	-0.264590E-06	-0.112429E-08
93.000	-0.256511E-06	-0.117831E-08
94.000	-0.248533E-06	-0.124031E-08
95.000	-0.240634E-06	-0.131152E-08
96.000	-0.232789E-06	-0.139343E-08

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX	
	UX	
	REAL	IMAGINARY
97.000	-0.224971E-06	-0.148790E-08
98.000	-0.217151E-06	-0.159719E-08
99.000	-0.209294E-06	-0.172414E-08
100.00	-0.201363E-06	-0.187234E-08
101.00	-0.193311E-06	-0.204637E-08
102.00	-0.185086E-06	-0.225212E-08
103.00	-0.176624E-06	-0.249733E-08
104.00	-0.167845E-06	-0.279223E-08
105.00	-0.158651E-06	-0.315069E-08
106.00	-0.148919E-06	-0.359175E-08
107.00	-0.138485E-06	-0.414224E-08
108.00	-0.127135E-06	-0.484086E-08
109.00	-0.114579E-06	-0.574505E-08
110.00	-0.100408E-06	-0.694314E-08
111.00	-0.840324E-07	-0.857647E-08
112.00	-0.645681E-07	-0.108827E-07
113.00	-0.406217E-07	-0.142864E-07
114.00	-0.986801E-08	-0.196074E-07
115.00	0.318704E-07	-0.285969E-07

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX	
	UX	
	REAL	IMAGINARY
116.00	0.928593E-07	-0.455530E-07

117.00	0.191653E-06	-0.833873E-07
118.00	0.376041E-06	-0.195423E-06
119.00	0.703341E-06	-0.742988E-06
120.00	-0.877301E-06	-0.145264E-05
121.00	-0.857254E-06	-0.317834E-06
122.00	-0.608559E-06	-0.114754E-06
123.00	-0.482859E-06	-0.575344E-07
124.00	-0.409779E-06	-0.343294E-07
125.00	-0.362042E-06	-0.227588E-07
126.00	-0.328219E-06	-0.161853E-07
127.00	-0.302815E-06	-0.121009E-07
128.00	-0.282884E-06	-0.939233E-08
129.00	-0.266711E-06	-0.750486E-08
130.00	-0.253233E-06	-0.613737E-08
131.00	-0.241757E-06	-0.511501E-08
132.00	-0.231811E-06	-0.433065E-08
133.00	-0.223064E-06	-0.371570E-08
134.00	-0.215274E-06	-0.322461E-08

***** ANSYS POST26 VARIABLE LISTING *****

FREQ	1 UX	
	UX	
	REAL	IMAGINARY
135.00	-0.208263E-06	-0.282615E-08
136.00	-0.201897E-06	-0.249835E-08
137.00	-0.196071E-06	-0.222541E-08
138.00	-0.190702E-06	-0.199568E-08
139.00	-0.185726E-06	-0.180047E-08
140.00	-0.181090E-06	-0.163316E-08
141.00	-0.176751E-06	-0.148865E-08
142.00	-0.172673E-06	-0.136296E-08
143.00	-0.168827E-06	-0.125293E-08
144.00	-0.165187E-06	-0.115604E-08
145.00	-0.161734E-06	-0.107027E-08
146.00	-0.158448E-06	-0.993967E-09
147.00	-0.155314E-06	-0.925770E-09
148.00	-0.152319E-06	-0.864561E-09
149.00	-0.149452E-06	-0.809407E-09
150.00	-0.146701E-06	-0.759525E-09

From The above result it is clearly observed that

Maximum displacement = 1.54mm

Similarly for modified design

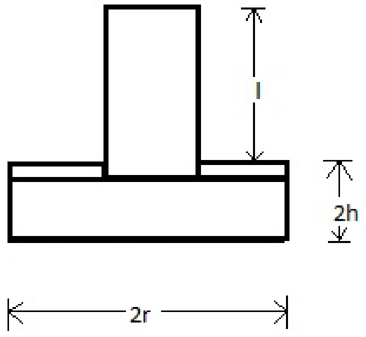
Maximum displacement = 0.46mm

IV. RESULTS & DISCUSSION

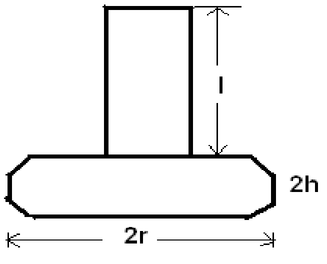
PARAMETER	EXISTING DESIGN CONDITION ($\mu > 3\ h^2 /r\ l$)	PROPOSED DESIGN CONDITION ($\mu \leq 3\ h^2 /r\ l$)
Maximum Displacement	1.54mm	0.46mm

As displacement is indirectly proportional to the lifetime, from the above result it is clearly observed that the life will be more for the proposed design condition.

For the Existing shock absorber if we want to apply the proposed design condition, it is possible to increase the value of h i.e piston head height, by means of welding.



In the same way if we want to reduce the value of h it is possible by removing the extra material at the edges as shown below:



V. CONCLUSIONS

- An alternative design solution is proposed to maintain the coefficient of friction when it is not possible to maintain lubrication in a shock absorber by selecting the piston dimensions in a certain fashion.
- An optimum combination of piston dimensions which will lead to the desired value of coefficient of friction is derived.
- Finite element Analysis is carried out to analyse how the proposed design condition enhances the life of the shock absorber.

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- The maximum displacement for the existing design condition is 1.54mm.
- The maximum displacement for the proposed design condition is 0.46mm.
- From the results & discussion it is clearly observed that the proposed design condition to change the design parameters enhances the life of the shock absorber.

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