REVEW OF FATIGUE TESTNG MACHINE

Antony Varghese[1], A.Vijayakmar[2], Dr. J. Amos Robert Jayachandran[3]

[1] Student, Mechanical Engineering Department, Kathir College of Engineering, Tamil Nadu, India
[2] Associate professor, Mechanical Engineering Department, Kathir College of Engineering, Tamil Nadu, India
[3]Dean & HOD- Mechanical Engineering Department, Kathir College of Engineering, Tamil Nadu, India

ABSRACT

Fatigue testing for spring is essential for making and maintaining precise and accurate mechanisms and machineries, This machine is used to check the changing stiffness of the spring due to continuous deflection. This machine givescontinuousdeflection of spring and check the deflection , indicate the load stiffness value. This machine helps to observe thestiffness value and we can decide the spring,reject or accept by checking the value with in the limit or not.

Keywords ; *spring fatigue testing machine, principle , testing procedure.,*

1.INTRODUCTION

Compression spring plays a vital role in automobile suspension system. The properfunction of springs will ensure passenger comfort and long run of the vehicleCompression springs in the suspension system are subjected to various kinds of stresses. Fatigue testing ensures better quality of springs to be selected and employed in the suspension system. The test involves the continuous compression of spring for a particular No: of cycles. If the spring parameters are the same as that before testing, for the spring is selected. The main objective of this project is to develop a fatigue testing machine for Kerala Automobiles Ltd. Helical compression spring for which fatigue strength is to be tested is used in front fork suspension of three wheelers.

2.SUSPENSION SYSTEM

The primary function of a good suspension system is to isolate the structure, as far aspracticable, from shock loading and vibrations due to the irregularities of the road surface by using spring and spring dampers. Principle of suspension are to restrict the vibrations from being transmitted to various components of vehicle, protect the person sitting inside the vehicle from the road shocks, and to maintain stability of the vehicle in pitching or rolling, when it is in motion

1. Rolling , Brake dip, Side thrust and Unsprung weight :

The centre of gravity of the vehicle is kept much above the ground.when the vehicle takes a turn the centrifugal force acts outwards on the centre of gravity of vehicle create a couple and turns the vehicle about longitudinal axis.This phenomenon is called rolling. Different movements are caused due to sudden acceleration and applyingof brakes which are taken care of by suspension system. On applying brakes to amoving automobile the vehicle tends to be lowered or dip. While in motion there are many forces which may come into existencelike wind, cambering of rod etc. Also when the vehicle takes a turn, centrifugal forcecreate a force called side thrust.Unsprungweight means that part of vehicle body which are not supported by springs. The weight of automobile component between the suspension and road Surface is called as unsprung weight.

3. SUSPENSION SPRINGS

The springs are located between the wheels and the vehicle body. After the wheel hits a bump or pit the spring deflects and is stretched outwards. It is then pulled back due to elasticity there by extracting the energy created due to bumps. The amplitude of the spring deflection decreases gradually due to its internal friction and the friction of suspension joints, until the spring comes to rest.

4.KERALA AUTOMOBILES LIMITED

Incorporated in 1978 as a Government of Kerala undertaking, is set up in the
picturesque back drop. The Company manufactures Three Wheelers (Diesel, Petrol, LPG&CNG) suitable for passenger and goods traffic in the brand name of Kerala. KAL is also manufacturing sophisticated components to be used in various space programs of ISRO (VSSC, LPSC, IISU). KAL product range comprises of Three Wheelers (Diesel, Petrol & CNG) in thebrand name of KERALA, suitable for passengers and goods traffic, KAL Leo RE, Tusker, Chassis (Diesel), Pick up van,Tipper Long chassis (MX 400) Pick up van Chassis (Petrol) ,Auto Rickshaw- 3seater , Delivery van.

5.FATIGUE TESTING MACHINE

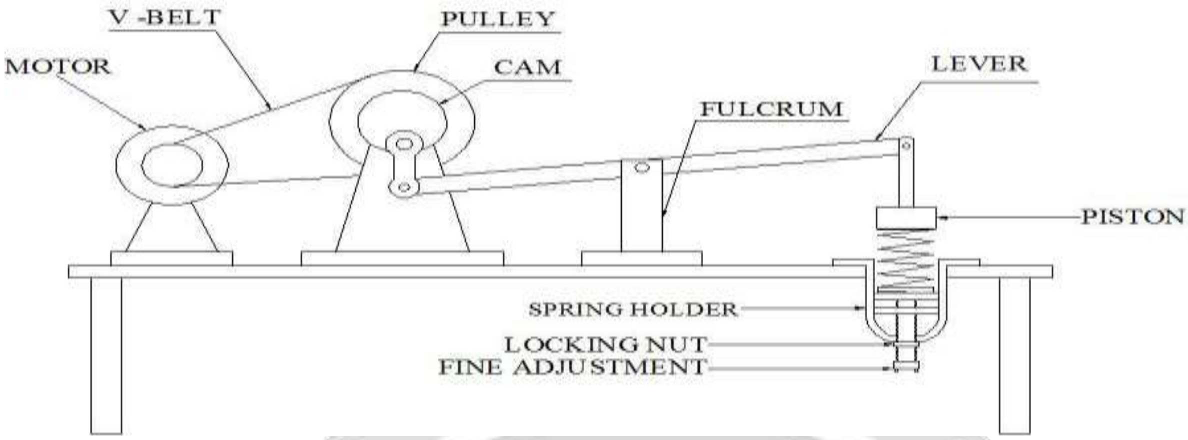

Fig ;Machine structure

6.COMPONENTS

1. Motor; Motor is used as a prime mover. 1.15Hp single phase
2. The table ; It is structure made of mild steel for fixing all components, motor, lever, spring holder etc..
   Breadth, b =460mm Length,L =570mm Height, h =470mm
3. Pulleys(2 Nos) & V belt; It is used to transfer the motion from the motor to the crank shaft.The larger pulley used at one end of shaft is made of cast iron. During the return stroke, when the spring is compressed and released and small pulley is fixed on the motor drive shaft.Diameter of pulley, d(small)= 75mm, D(larger) =225mm
4. Cam and Connecting rod; These are used to change the rotational motion to the reciprocating motion.
Cam radius, r =15mm ,Crankdia=130mm, Dia of big end, D=17.88mm ,Dia of small end =13.9mm ,Length, L=75mm
5. Piston ; piston is used to compress and release the spring which want to test.
Piston Dia, D =67mm Piston length, L =67mm
6. Fulcrum and lever; These are used to transfer the equal and opposite motion from the connecting rod topiston ,
Total length L =460mm ,Length L1 =230mm, Thickness t =12.7mm
7. Spring holder; It keeps the spring without go lateral direction while compressing and releasing.

7.DESIGN OF COMPONENTS

7.1 DESIGN OF CRANK PIN AND PISTON PIN

Load on piston = Force on connecting rodie , F-L= Fc/ Fp
Fc= cosφ
Fp= 3100 Cos 14.4= 3200.5 N

7.2CRANK PIN

dc= crank p in diameter =17.88mm
lc= length of crank pin (lc=1.25 dc to 1.5 dc)= 1.25mm, Pbc=7 to 12 N-mm2
dc× lc × Pbc=22.36mm
dp = piston pin diameter =13.9mm, Pbp= 10 to 15 N-mm2,
lp = length of piston pin (lp=1.5 dp to 2 dp)= 1.5 dp
dp × lp× Pbp = 1.5 × 13.9 = 20.85mm

7.3 DESIGN OF CRANK

Radius of crank =15
Thickness of crank, t= 0.45 dc to 0.75 dc [PSG 7.123]= 0.70×17.88= 12.5mm

7.4 DESIGN OF CONNECTING ROD

Length of connecting rod / Radius of crank = 4 to5 l/r = 5
l/ 15 = 5, L= 75 mm
Diaof big end bearing, dc = 17.88mm ,Dia of small end bearing, dp =13.9 mm

7.5 DESIGN OF CRANKSHAFT

1. Calculation of length of drank shaft bearing (L) and dia of crankshaft(D) Take L/D ratio and bearing pressure (N/mm 2)[PSG 7.31]

L/D = 1.5 TO 3 = 3, L =3D, Bearing pressure, Pb = P/ L×D = 48.4 mm

2. Determination Of Horse Power Of The Motor
1HP = 0.746 Kw, Given P = 0.8652 Kw
Motor horse power = 0.8652/0.746 = 1.15Hp

3. Calculation of length of drank shaft bearing (L) and diameter of crankshaft(D) Take L/D ratio and bearing pressure (N/mm 2)[PSG 7.31]
L/D = 1.5 TO3 = 3 ,L =3D, Bearing pressure, Pb = P/ L×D
1.75= 3D×D3100
D = 24.2 mm, L=2D=2× 24.2= 48.4 mm

7.6 DESIGN OF V-BELT DRIVE

Speed ratio, i= D/d = n1/n2 = 1440/480 =3
d=75mm ,D=2d = 3× 75 =225mm
Selection of centre distance ,C/.D= 1
C = 1×225 = 225mm
Cmin= 0.55(D+d)+ T = 0.55(225+75)+8=173.75mm
Cmax= 2(D+d) =2(225+75)= 600 mm

1. Determination of nominal pitch length Pitch length. L=2C+π/2(D+d)+(D − d)2/4c
= 2×225+pi/2(225+75)+(225 − 75)2/ 4×180 = 941.82 mm
2. Calculation of maximum power capacity
KW= [0.45 S^_0.09- 19.62/de – 0.765 × 10^-4 s 2] s
Where S= belt speed= πdN1/60 ,π×0.075×1440/60 =5.62 m/s
dp =pitch diameter of smaller pulley=d=75mm
Fb =smaller diameter factor for speed ratio of 3=1.14
De =equivalent pitch diameter =dp × Fb = 75 × 1.14 = 85.5mm
KW= [0.45 5.65^0.09-(19.62)/85.75-0.765×10^¯4 5.65^2]5.65 = 0.8652 KW
3. Determination of power to be transmitted, P:
No of belts used=1
nb = P × Fa/ KW×Fc×Fd, l = P × 1/ 2.03×0.88×0.9= P = 1.35Kw

8.WORKING OF FATIGUE TESTING MACHINE

The spring testing rig is used for testing the fatigueness of the helical compressionsprings used in the suspension system. The test rig can be adjusted for the required speed andstroke length as per requirements. The motor connected to the crank runs at a maximum of 1440 rpm. Running themachine in this rpm will result in vibration and may affect efficient functioning of themachine. Hence it is reduced to 480 rpm by manufacturing the pulleys in the ratio of 1:3. This power is then fed to the crank through the driven shaft. The crank converts the rotarymotion to reciprocating motion of the piston through the lever.The spring holder is attached to the base of the system and the spring is placed inside the vessel. The spring will have a clearance of 4 mm with the vessel. If a spring having lesserdiameter is to be tested, sleeves of different sizes are made according to the external diameterof the spring. Then it placed in the sleeve and this assembly is placed in the spring holder andwill be a correct fit, so as the spring won't dislocate.When the motor switched on, the cam rotates there by creating an upward motion inthe lever, which in turn compresses the spring which is attached to other end of the lever.One end of the lever is attached with the cam using connecting rod and the other end havingconnecting rod and piston which is in contact with the spring. So when the electronic camrotates it lifts the lever upwards, this causes the connecting rod to reciprocate at other end.Piston attached to the small end of the connecting rod compresses the spring to requireddimension.The deflection that needs to be obtained is 74 mm. The spring starts continuous compression and jounce at the rate of 480 cycles/min. This process continues until the springundergoes 3,50,000 cycles.

9.SUSPENSION MECHANISMS

K A L mainly employs two types of suspension system in the three wheelers.
1. Leading link mechanism
2. Trailing link mechanism
Compression springs that are used in these mechanisms as per K A L standard areas follows. These two springs have to be fatigue tested.

10.TESTING PROCEDURE

1. The compression spring selected is placed in the spring holder of the fatigue testing machine and fixed using locking nut, so that this spring will not dislocate.
2. The motor connected to the machine runs at a speed of 480rpm.
3. This in turn turns the crank and the lever is reciprocated.
4. The spring is under gone actual deflection from free length to maximum compression length permissible.
5. Spring is deflected up to 74mm.
6. The spring is subjected to continue compression and jounce at a rate 480 cycle/min.
7. The process continues until the spring undergoes 3, 50, 00 cycles.
8. After the completion of required number of cycles the spring is taken out of the machine.
9. The spring is tested in universal testing machine.
10. The spring parameters such as spring rate, solid height, coil pitch, coil angle, wire length, spring mass are also checked.
11. The load/length relaxation shall not exceed 3%.
12. If the spring is within the limit, it is selected or else rejected.

11.SCOPE FOR FURTHER INVESTIGATION

1. For the same purpose to be successfully done, the motor should be replaced by muchmore powerful motor.
2. An optical read out device can be attached to count the number of cycles completedby the spring
3. The existing mechanism can be done with hydraulic and pneumatic system providedthe cost will be increased considerably.

12.CONCLUSION

A fatigue testing machine for compression springs have been envisaged and designed. This machine can be utilized in automobile industries for checking the reliability of springs. Comparing with existing mechanism this project is found to be cost effective. It is hoped that this project will help in efficient functioning of the automobiles in which suspension springs are used

13.REFERENCES

[1]. Literature review on design, analysis and fatigue life of a mechanical spring /SupriyaBurgulIssn (online): 2321-3051 international journal of research in aeronautical and Mechanical engineering Vol.2 Issue.7, July 2014.Pgs: 76-83.

[2]. CAE analysis for fatigue failure for coiled spring life enhancement in press machine stamping operation PurushottamSarjeraoSuryawanshi, Prof. T. S. Shikalgar, SwapnilS. Kulkarni .International Journal of Advanced Engineering Research and Studies EISSN22498974.

[3]. “FATIGUE STRESS ANALYSIS OF HELICAL COMPRESSION SPRING:A REVIEW” Gajendra Singh Rathoreand Upendra Kumar Joshi /International Journal ofEmerging Trends in Engineering and Development Issue 3, Vol.2 (May 2013)

[4]. “Design, Analysis and Experimental Validation for Fatigue Behaviour of a Helical Compression Spring Used For a Two Wheeler Horn” Mr.J.J.PharneDr. R.G.TodkarDr.N.D.Sangle IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 6 Ver. III (Nov- Dec. 2014),PP 05-11

[5]. “Design and Manufacturing of Fatigue Testing Machine for Tension and Compression Springs “N.V.Chavan, P.G.Damle, N.K.Patil international journal of advanced electronics & communication systems /February, 2014.

[6]. K K Jain and R B Astana, “Automobile Engineering” Tata M C Grave Hill Publishing company Limited 2002.

[7]. Michael F. Ashby “Material design in mechanical design” Elsevier India Pvt limited Third edition 2005

[8]. R S Khurmi and J K Gupta “Machine design” S.CHAND & COMPANY LTD.2003 reprint.

[9]. R K Jain”Machinedesign”Khanna Publishers Delhi.Second Reprint 1999IS 7906(Part7) “Quality requirements for cylindrical coil compression springs used mainly as vehicle suspension springs”.

[10]. IS 6886 “Method of dynamic force calibration of axial load fatigue testing machine by means of a strain gauge technique”.

[11]. I S 7906(Part 8)”Method of inspection of hot coiled compression springs made from circular section bars.