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Design of Leaf Spring Testing Machine

Satish Chandbodhale[1], C.C Handa[2]

[1] *M.Tech. Student, Department of Mechanical Engineering, KDK College of Engineering, Nagpur, India*

[2]*Professor, Department of Mechanical Engineering, KDK College of Engineering, Nagpur, India*

***Abstract*—The spring in Automobiles plays a vital role as it supports the total weight as well as provide the damping for bumps and road irregularities. Failure of spring function may raise the huge impact so it is essential that springs needs to be tested before its final assembly. For automotive springs, the most relevant performance characteristic is stiffness under load. Stiffness of the spring means load required for unit deflection, Leaf spring Stiffness checking machine is useful for spring manufacturer as well as spring purchasers for checking the stiffness. This project is an industrial project for Dulocos Conveyors and Moulds Private Limited which involves the designing and analyzing leaf spring testing machine. In this study Design calculations and Cad modeling of the spring testing machine performed carrying requirements in mind. The suspension mechanism in an automobile significantly affects the behavior of vehicle. Leaf springs are subjected to millions of varying stress cycles loading to fatigue failure. So, it becomes mandatory to check for the spring stiffness and its strength before it is installed to perform for any applications.**

Index Terms—leaf spring, spring testing, CAD, hypermesh.

I. INTRODUCTION

Springs are elastic bodies (generally metal) that can be twisted, pulled, or stretched by some force. They can return to their original shape when the force is released. In other words it is also termed as a resilient member.

The center of the arc provides the location for the axle, while the tie holes are provided at either end for attaching to the vehicle body. Heavy vehicles, leaves are stacked one upon the other to ensure rigidity and strength. It provides dampness and springing function. It can be attached directly to the frame at the both ends or attached directly to one end, usually at the front with the other end attached through a shackle, a short swinging arm. The shackle takes up the tendency of the leaf spring to elongate when it gets compressed and by which the spring becomes softer. Thus depending upon the load bearing capacity of the vehicle the leaf spring is designed with graduated and Ungraduated leaves. Leaf spring ends are guided along a definite path so as to act as a structural member in addition to shock absorbing device, this is the main advantage of leaf spring over helical. This is the reason why leaf springs are still used widely in a variety of automobiles.

Because of the difference in the leaf length, different stress will be there at each leaf. To compensate the stress level, prestressing is to be done. Prestressing is achieved by bending the leaves to different radius of curvature before they are assembled with the center clip. The radius of curvature decreases with shorter leaves. The extra initial gap found between the extra full length leaf and graduated length leaf is called as nip. Such prestressing achieved by a difference in the radius of curvature is known as nipping.

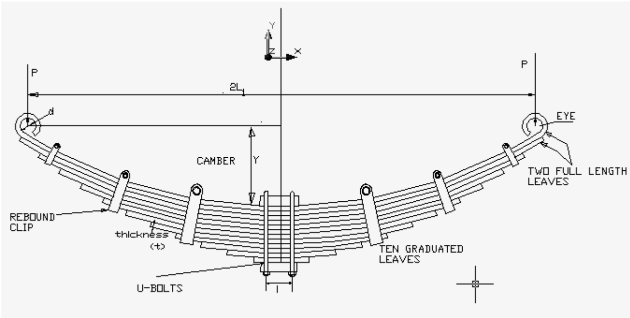


Fig. 1. Leaf spring nomenclature

II. DATA ACCUMULATION

Maximum load acting on single spring for Tata LPS 4018 Tanker trailer [1]
Gross weight of truck = 295380 N
This will be carried by 6 springs = 295380/6 = 49230 N
Load on single spring = 49230 N = 5 Ton
This is static load, due to road irregularity and bumps dynamic loading should be considered,
Hence spring testing machine should range between 1 Tonne to 50 Tonne capacity
Hydraulic piston diameter = 100 mm
Area = 7854 mm^2
Pressure range = 12.5 bar to 624.5 bar

Power Pack specification:

Technical Data	
Operation Pressure	700 bar (10150 psi)
Pressure Displacement	Double speed Switchover at approx. 100 bar
Useable oil capacity	12 Liter (standart size)
Remote Control	Only for (WAE-2 & WAE-4)
Manometer / Pressure Gauge	Gliserin filled, 63mm 1.000 bar
Sizes	467 x 340 x 430 mm
Connection thread	2 x 3/8" NPT

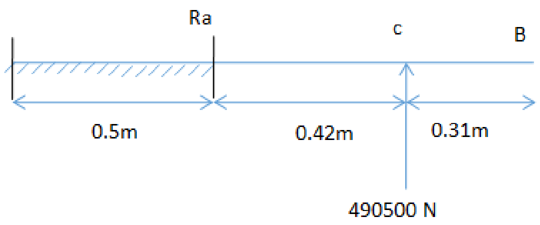
WAE-2 Hydraulic Power Pack

Product Selection Chart						
Model No	Electroengine			Flow Rate		Valve & Function
	Volt	kW	rpm	100 bar / 1. stg	700 bar 2. stg	
ww-WAE-1	230 V	2,2	2850	4,8 Lt/min	1,0 Lt/min	4/3 - Hand Slide Valve
ww-WAE-2	230 V	2,2	2850	4,8 Lt/min	1,0 Lt/min	4/3 - Directional Seated Valve
ww-WAE-3	380 V	1,5	2850	4,8 Lt/min	1,0 Lt/min	4/3 - Hand Slide Valve
ww-WAE-4	380 V	1,5	2850	4,8 Lt/min	1,0 Lt/min	4/3 - Directional Seated Valve

III. DESIGN CALCULATIONS

Design calculations carried out for Base frame and Hydraulic cylinder support as Hydraulic cylinder member and

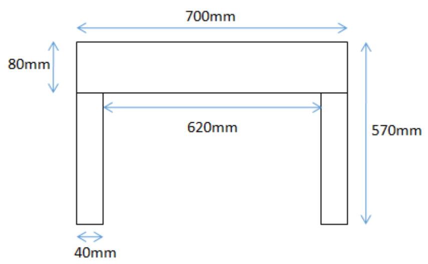
bed are critical for given loading condition.
Step 1. Design of Hydraulic cylinder member:
Maximum load of 490500 N will act at this section.



Ra = 490500 N

$$\text{Maximum bending moment} = 490500 \times 0.42$$
$$= 206010\ \text{N.m}$$

Moment of inertia of C section.



$$I = \frac{BD^3 - bd^3}{12} = \frac{(700 \times 570^3) - (620 \times 490^3)}{12}$$
$$= 4724393333.34\ \text{mm}^4$$

Maximum distance from neutral axis,
A1 and A3 = 19600 mm2
A2 = 56000 mm2
y1 and y3 = 490/2 = 245 mm
y2 = 490+80/2 = 530mm

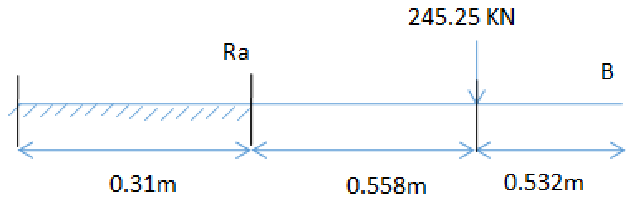
$$y = \frac{A1y1 + A2y2 + A3y3}{A1 + A2 + A3} = 412.6\ \text{mm}$$

$$\frac{M}{I} = \frac{\sigma}{y}$$

$$\sigma = \frac{206010000 \times 412.6}{4724393333.34} = 18\ \text{MPa}$$

Maximum calculated stress is 18MPa

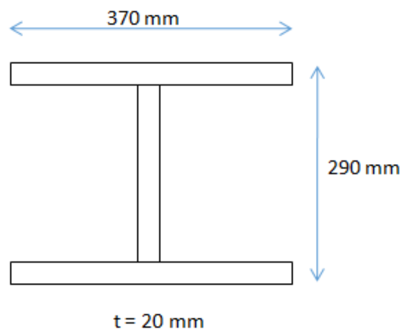
Step 2. Design of Bed:
Maximum load of 490500 N acts on Bed through rolling support at 2 points



Ra = 245.25 KN

$$\text{Maximum Bending Moment} = 245.25 \times 0.558$$
$$= 136.8495\ \text{KN.m}$$

Moment of Inertia of I section,



$$I = \frac{370 \times 290^3 - [(370 - 20) \times (290 - 40)^3]}{12}$$
$$= 296265000\ \text{mm4}$$

$$y = \frac{290}{2} = 145\ \text{mm}$$

Bending moment equation, $\frac{M}{I} = \frac{\sigma}{y}$
Maximum calculated stress is 67MPa.

TABLE I
ANALYTICAL CALCULATION RESULTS

Sr. no	Member	Material	Thickness	Stress	Yield stress (Mat S 275)
1	Hydraulic supprting member	Mat S 275	40mm	18 MPa	275 MPa
2	Supprting bed members	Mat S 275	20mm	67 MPa	275 MPa

IV. CAD MODEL

Three dimensional modeling is the first stage in finite element analysis design process. In this stage the design generates the three dimensional model on the computer aided design plateform. This model is geometric replica of the original geometry. The geometry can be generated using the 2

dimensional drawing or through the designers own concepts. The three dimensional modeler uses various cad tools like CATIA, SOLIDWORKS, UNIGRAPHICS, PROE etc.
From the existing and calculated data a CAD Model of Spring testing machine created using CAD package Solidworks V. 2016.

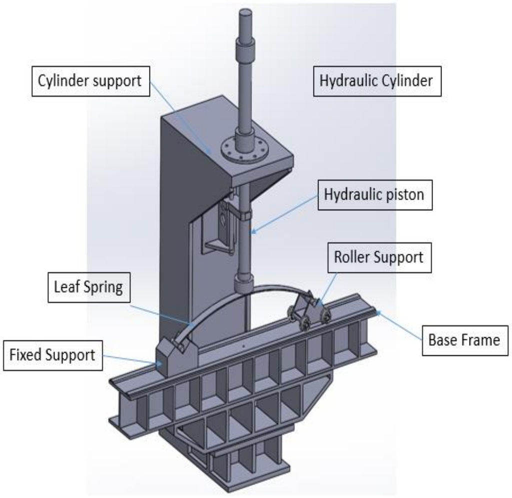


Fig. 2. Isometric view

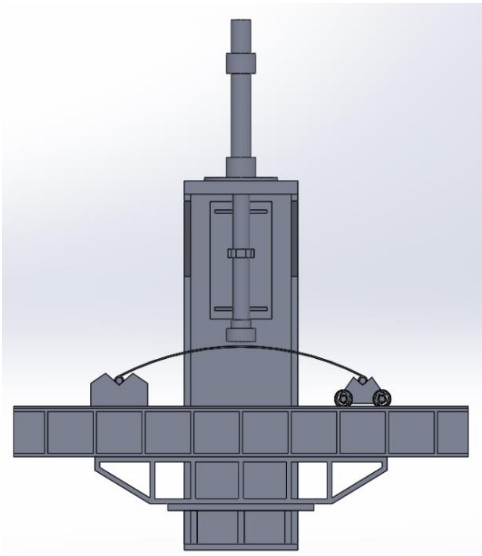


Fig. 3. Front view

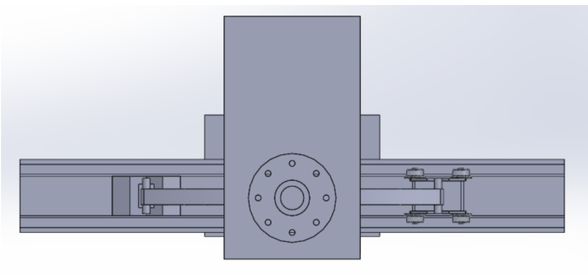


Fig. 4. Top view

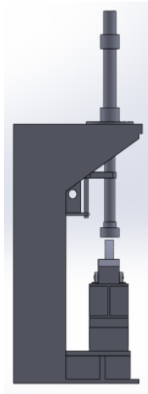


Fig. 5. Side view

V. Finite Element Analysis

Linear Static Analysis Results:

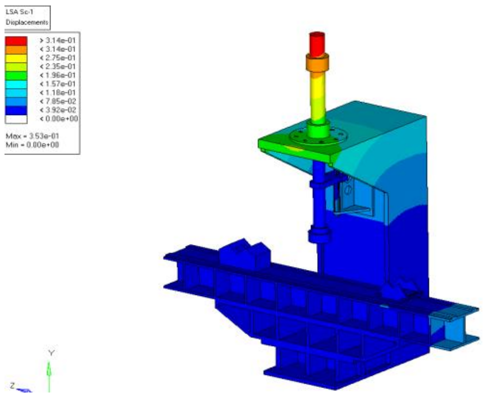


Fig. 6. Maximum Displacement is 0.35 mm

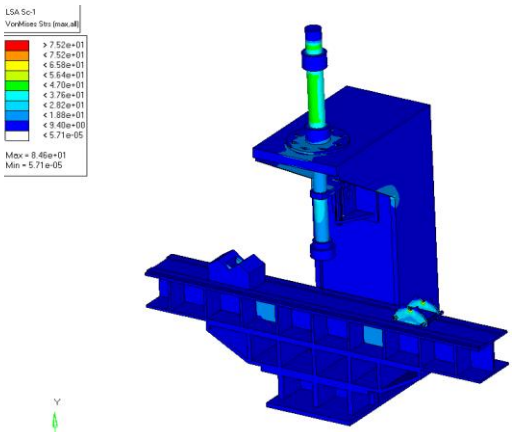


Fig. 7. Maximum Stress is 84.6 MPa

Leaf spring testing machine is designed and analyzed using CAD and FEA techniques. A linear static analysis is performed to validate the structure stiffness for operation forces. From the finite element analysis it is seen that the maximum stresses developed in the structure of leaf spring testing machine are 84.6 MPa where yield point stress of the structure material is 205 Mpa. From the results it is noticed that with maximum possible load stresses developed in structure are less than the material yield stress.

VI. Conclusion

The project involves the detailed study of design and analysis of spring testing machine of leaf type springs. In this article we have presented the design calculations and CAD model of the spring testing machine in detail. From the study we conclude that with the help of design calculations a cad model is generated, to validate the design a FE analysis is carried out that leads to the safe design. This machine will fulfill the industry testing requirement.

References

[1] DESIGN AND ANALYSIS OF LEAF SPRING FOR TANKER TRAILER SUSPENSION SYSTEM by PratikshaPadmakarShahane, 2 Syed Aalam H, Global Journal of Advanced Engineering Technologies Volume 4, Issue 3- 2015.

[2] American Journal of Engineering Research Design and Construction of a Spring Stiffness Testing Machine by OlugbojiOluwafemiAyodeji, Matthew Sunday Abolarin , JiyaJonathanYisa ,AlayaGarbaMuftau, Ajani Clement Kehinde (Mechanical Engineering Department, Federal University of Technology, Minna, Niger State, Nigeria.

[3] International Research Journal of Engineering and Technology “A REVIEW ON TESTING OF STEEL LEAF SPRING” by Mr. Ajay D. Dighe, Mechanical Engineering Department, Pravara Engineering College, Loni, Maharashtra, India.

[4] Design and analysis of leaf springs using the FEA approach by Hareesh and Thillikkani, Mechanical Engineering, Vidya Academy of Science and Technology Thrissur - 680501, India.

[5] Parabolic leaf spring optimization and fatigue strength evaluation on the base of road load data, endurance rig tests and non linear finite element analysis by AhmetKanbolat ,MurathanSoner, Mustafa Karaagaç, TolgaErdogus

[6] “Investigation of Stresses and Deflection in Multi Stage Leaf Spring of Heavy Duty Vehicle by FEM and Its Experimental Verification” by Ruchik Tank , SrinivasKurnar .

[7] "DIFFERENT TYPE OF LEAF SPRING TESTING MACHINES" research paper presented at National conference SPARK event at KDK college of engineering Nagpur on 16/03/2018.

[8] LEAF SPRING TESTING MACHINE: A REVIEW by Satish Chandbodhale and Prof. C. C Handa, IJSRD Paper ID: IJSRDV6I20717 Published in: Volume : 6, Issue : 2 Publication Date: 01/05/2018 Page(s): 1398-1401

[9] Development of Leaf Spring Testing Machine by Mr. Satish Chandbodhale and Prof. C.C Handa, International Journal for Research in Technological Studies| Vol. 5, Issue 7, June 2018 | ISSN (online): 2348-1439.