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VIBRATION ANALYSIS OF LEAF SPRING USING FINITE ELEMENT METHOD

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ABSTRACT

All the parts which perform the function of isolating the automobile from the road shocks are collectively called a suspension system. It includes the springing device used and various mounting for same. Suspension system components and how they work together, remember that a vehicle in motion is more than wheels turning. As the tire revolves, the suspension system is in a dynamic state of balance, continuously compensating and adjusting for changing driving conditions. Today's suspension system is automotive engineering at its best. The detail study about vibration analysis is required for any vehicle. It is specially required for heavy commercial vehicle like trucks, tipper, bus etc. This paper shows detail study about vibration analysis of leaf spring.

KEYWORDS: Suspension system, Leaf spring, Heavy commercial vehicle, Vibration analysis.

INTRODUCTION

Leaf springs are mainly used in suspension systems to absorb shock loads in automobiles like light motor vehicles, heavy duty trucks and in rail systems. It carries lateral loads, brake torque, driving torque in addition to shock absorbing [1]. The advantage of leaf spring over helical spring is that the ends of the spring may be guided along a definite path as it deflects to act as a structural member in addition to energy absorbing device [2]. According to the studies made a material with maximum strength and minimum modulus of elasticity in the longitudinal direction is the most suitable material for a leaf spring.

METHODOLOGY

2.1 Sources of vibration in leaf spring:

- Suspension noise generated by metal-to-metal impacts.
- Lack of lubrication may result in spring noise. Rattle caused because U bolts may be loose.
- Noise caused because shackle pins, bushes are loose and may be some defect in shock absorber.
- Any or more leaves of the sagging spring may be broken.
- There is bounce, pitch, roll or sway occur because of this rise to an uncomfortable ride and also cause additional stresses.
- Rise to a couple turning of vehicle about a longitudinal axis because while taking turns centrifugal force acts outwards on the c.g. of vehicle.

2.2 Solution of vibration in leaf spring:

Struts and shock absorbers that are in good condition will allow the suspension to oscillate through one or two diminishing cycles, limiting or damping excessive movement, and maintaining vertical load place upon the tyres. This helps keep the tyres in contact with the road

To avoid rough ride leaves of spring may be rusted or corroded resulting in excessive friction. The lubrication of springs should be done immediately to reduce friction. To avoid excessive soft suspension a good suspension system should be optimum compromise between softness and hardness.

Spring should be shot-peening to increased fatigue strength and hence the life of spring.

Avoid rattling or squeaking noise effect, parts such as U-bolt, shackle pins, bushes must be tightened.

2.3 Analysis of leaf spring used in truck:

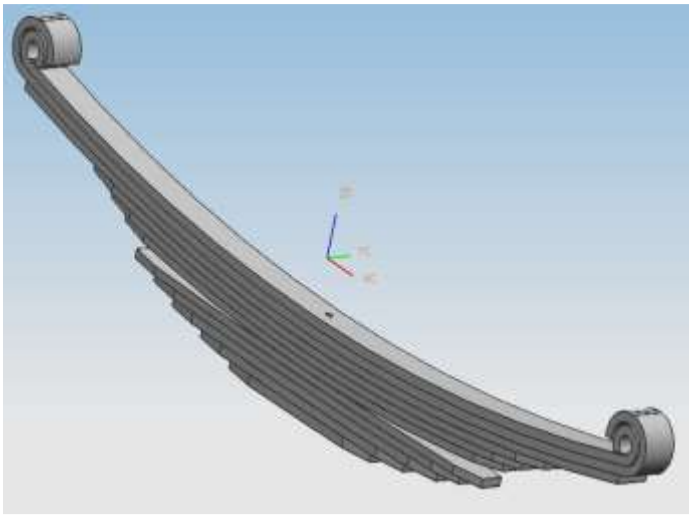

Fig.1.Leaf spring model

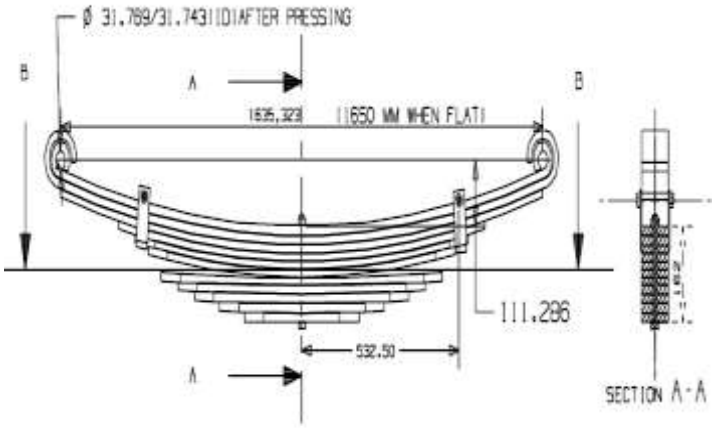

Fig.2.Leaf spring model with dimension

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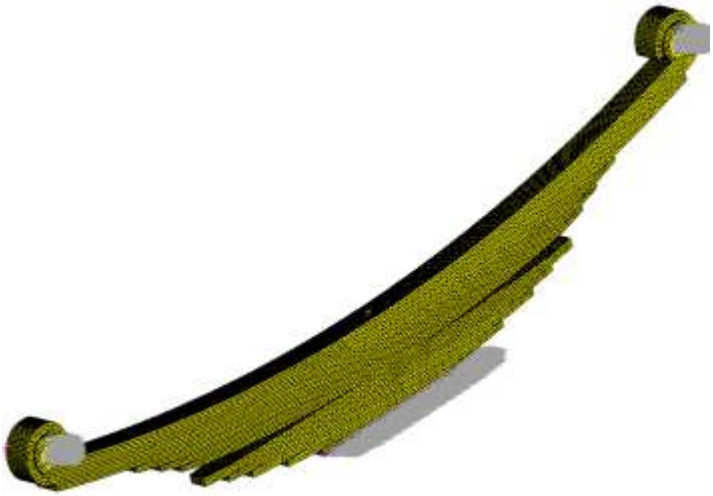

Fig.3. FEM Model of Leaf spring

2.4 Boundary condition

Constraint-

6 Dof fixed. At both side of leaf spring.

Forces-

Apply force in Z-direction = 3000kg.

Analysis-

Linear static type.
Seat length = 170mm
Curb load = 1167.5kg
Max design load = 3467.5kg
Tolerance for second stage camber = 1mm
Load at which second stages touches at first stage = 1967.5kg

2.4 Displacement and stress result of leaf spring:

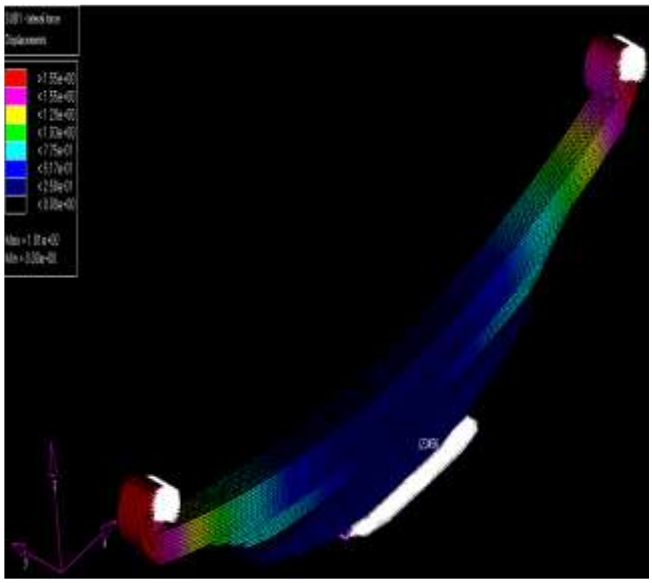

Fig.4. Displacement in Leaf spring

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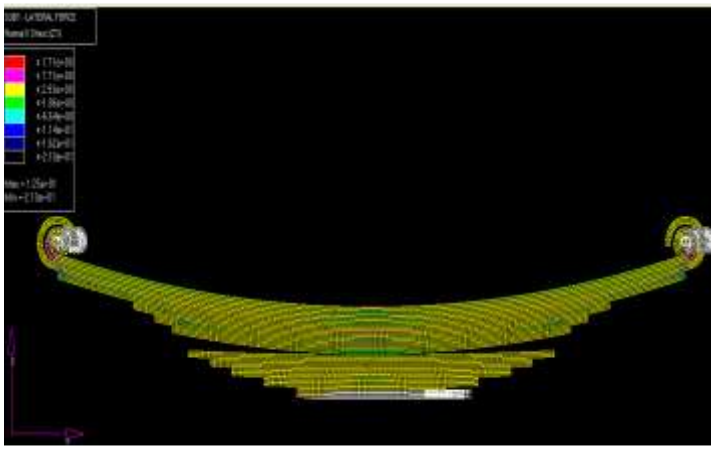

Fig.5. Stress result of Leaf spring

2.5 Theoretical calculation :

The leaf spring is based upon the theory of simply supported beam.

Bending Stresses

- $\delta = 6*W*L/n*b*t^2$.

Maximum deflection

- $\delta = W*L^3/n*3E*I$, where $I = b*t^3/12$.

Where W=3000kg, L=1650mm, n=11, b=90mm, t=16mm.

2.6 Theoretical and software result:

Table 1. Theoretical and software result

Result	Stresses	Deflection
Theoretical	11.71 N/mm^2	6.33 mm
Software	12.5 N/mm^2	5 mm

2.7: Cross Section of each leaf

Table 2. Cross Section of each leaf

Leaf No.	Thickness	Section	Sheared Length
1	16	90*16	1650

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2	16	90*16	1650
3	14	90*14	1650
4	14	90*14	1284.5
5	13	90*13	1135
6	13	90*13	1044.5
7	14	90*14	954
8	14	90*14	840.5
9	16	90*16	727
10	16	90*16	558
11	16	90*16	389

2.8: Load Deflection:

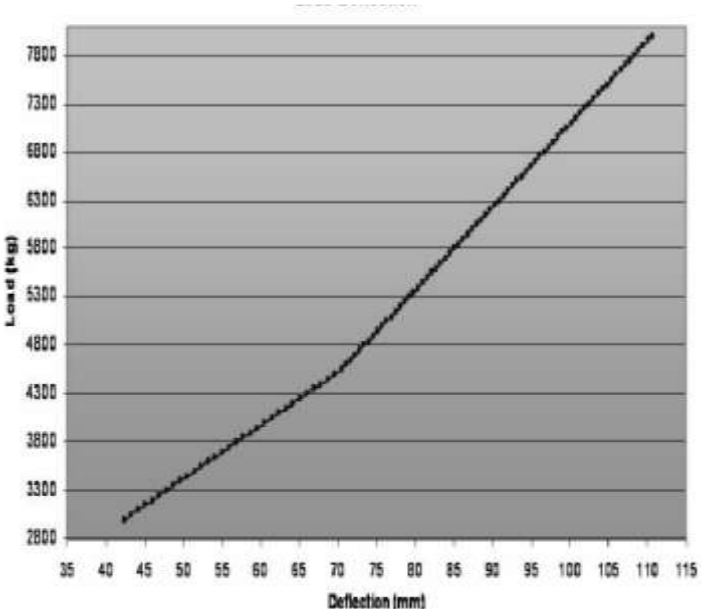

Fig.6. Load deflection curve according to no. of leaf

CONCLUSION

In this paper, Leaf spring isselected from suspension system for structure analysis. Theoretical and software result are compared. Generally shackle position are fixed and leaves are free. Maximum capacity of leaf spring is 3000kg load. With the theory of leaf spring and by Hypermesh software following result for structure analysis result is concluded.

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