Dynamics analysis of a leaf spring

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Abstract— A Four leaf spring used in suspension of a light vehicle is analyzed by Ansys 12 software. Design and modeling of leaf spring using CREO software. The Finite Element Results Showing stresses and Deflection Verified the Existing Analytical. Dynamic load Analysis analysis of leaf spring using Ansys 12 software

Key words: Design, Modeling, Dynamic analysis of leaf spring.

I. INTRODUCTION

Leaf springs absorb the vehicle vibrations and bump loads by means of spring deflections, so that the potential energy is stored in the leaf spring and then relieved slowly. Ability to store and absorb more amount of strain energy ensures the comfortable suspension system.

The spring is mounted on the axle of the vehicle. The entire vehicle load rests on the leaf spring. The front end of the spring is connected to the frame with a simple pin joint, while the rear end of the spring is connected with a shackle. Shackle is the flexible link which connects between leaf spring rear eye and frame. When the vehicle comes across a projection on the road surface, the wheel moves up, leading to deflection of the spring. This changes the length between the spring eyes. If both the ends are fixed, the spring will not be able to accommodate this change of length. So, to accommodate this change in length shackle is provided at one end, which gives a flexible connection. During loading the spring deflects and moves in the direction perpendicular to the load applied.

II. SPECIFICATION OF MAHINDRA COMMANDER 650 DI LEAF SPRING OF JEEP [2]

SR No	Parameter name	Value
1	Material	Steel EN45A (0.61%C,1.8%Si, 0.79%Mn,0.02%S, 0.024P)
2	Leaf span (2L)	1120 mm
3	No of Full length leaves	2
4	No of graduates leaves	8
5	No of leaves	10
6	Width (b)	50 mm
7	Thickness (t)	6 mm
8	Young Modulus of leaf spring (E)	210000 MPa
9	Ineffective length	100 mm

Table 1: Specification of mahindra commander 650 di jeep

A. Material properties of structural steel EN45 A [3]:

Steel	EN45 A
Young Modulus [E]	2.1×10^5 N / mm^2
Poisson Ratio	0.266
Ultimate tensile strength	1272 MPa
Yield Tensile strength	1158 MPa

Table 2: Material properties of leaf spring

SR No	Parameter	Value
1	Design load	6685N
2	Effective length of leaves	510 mm
3	Max stress	568mm
4	Deflection of leaf spring	106.6 mm
5	Camber length	58.5 mm
6	Eye diameter	9 mm
7	Diameter of center bolt	10 mm
8	Length of First Leaves	213 mm
	Length of 2nd Leaves	326 mm
	Length of 3rd Leaves	440 mm
	Length of 4th Leaves	553 mm
	Length of 5th Leaves	666 mm
	Length of 6th Leaves	780 mm
	Length of 7th Leaves	893 mm
	Length of 8th Leaves	1006 mm
	Length of 9th Leaves	1120mm
	Length of 10th Leaves	1167mm
9	Radius of 1st leaves	1452 mm
	Radius of 2nd leaves	1446 mm
	Radius of 3rd leaves	1440 mm
	Radius of 4th leaves	1434 mm
	Radius of 5th leaves	1428 mm
	Radius of 6th leaves	1422 mm
	Radius of 7th leaves	1416 mm
	Radius of 8th leaves	1410 mm
	Radius of 9th leaves	1404 mm
	Radius of 10th leaves	1398 mm
10	Width (b)	50 mm

11	Thickness (t)	6 mm
12	Diameter of center Bolt	10mm

Table 3: Design parameter

III. SOLID MODEL OF A LEAF SPRING

Fig. 1: Solid model of a leaf spring created in Creo software

IV. DYNAMIC ANALYSIS OF A LEAF SPRING

A. Dynamic Specification of Mahindra commander 650 di Jeep:

SR. No	Parameter	Value
1	Gross vehicle weight	2150 Kg
2	Wheelbase(b)	2680 mm
3	Engine	MDI3000
4	Type	Four stroke over square, Four cylinder inline
5	Weight of engine	275 kg
7	Suspension	Front and Rear :Semi Elliptical leaf spring
8	Wheel, Rim, tyre	6 × 16.6 inches
9	Track width	3 m
10	Turning circle radius	60 mm

Table 4: Specification of Mahindra commander 650 di Jeep

B. Calculation of load [5]:

When Jeep takes Right turn speed is 25 km/hr

SR No	Parameter	Value
1	Load on Front wheel 1	7.181 KN
2	Load on Front wheel 2	7.290 KN
3	Load on Rear wheel 1	3.255 KN
4	Load on Rear Wheel 2	3.364 KN

Table 5 Load acting on Wheel

When Jeep takes reverse direction speed is 10 km/hr

SR No	Parameter	Value
1	Load on Front Wheel 1	7.249 KN
2	Load on Front Wheel 2	7.249 KN
3	Load on Rear wheel 1	3.313 KN
4	Load On Rear Wheel 2	3.295 KN

Table 6: Load acting on Wheel

V. TRANSIENT ANALYSIS OF A LEAF SPRING

A. When Jeep Takes Right Turn [6]:

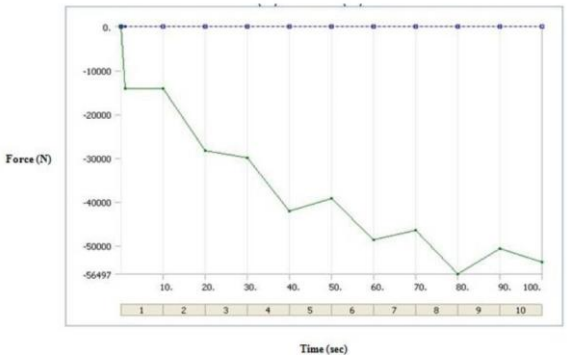

Fig. 2: Analysis result

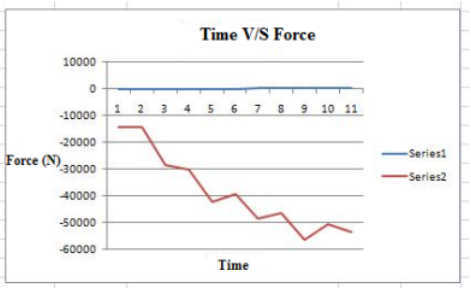

Fig. 3: Time V/S Force Diagram

Step	Time	X [N]	Y [N]	Z [N]
1	0	0	0	0
	1	0	-14191	0
	10	0	-14257	0
2	20	0	-28335	0
3	30	0	-29992	0
4	40	0	-42195	0
5	50	0	-39201	0
6	60	0	-48717	0
7	70	0	-46522	0
8	80	0	-56497	0
9	90	0	-50743	0
10	100	0	-53716	0

Table 7: Load between time

B. When Jeep Takes Reverse direction [6]:

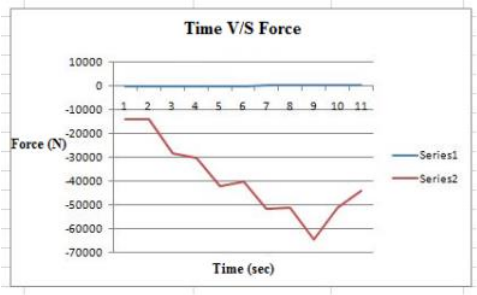

Fig. 4: Time V/S Force Diagram

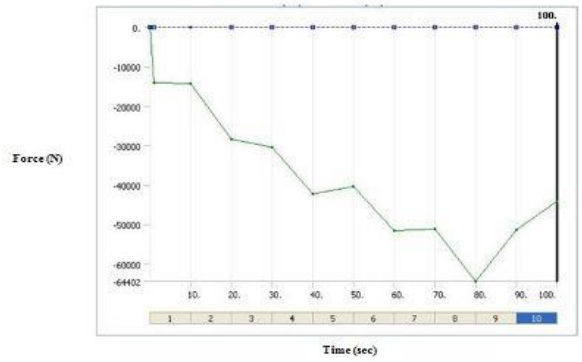

Fig. 5: Takes Reverse direction

Step	Time (sec)	X [N]	Y [N]	Z [N]
1	0	0	0	0
	1	0	- 14171	0
	10	0	- 14257	0
2	20	0	- 28376	0
3	30	0	- 30493	0
4	40	0	- 42218	0
5	50	0	- 40347	0
6	60	0	- 51554	0
7	70	0	- 51123	0
8	80	0	- 64402	0
9	90	0	- 51327	0
10	100	0	- 44052	0

Table 8: Load between time

VI. CONCLUSIONS

When Jeep Takes Right turn Jeep moves 31 to 40 sec load is decrease because deflection is 35.23 mm. Jeep moves 41 to 50 sec load is increase deflection 35.23 to 50.72 mm. Jeep moves 51 to 60 sec load decrease deflection is 46.88 mm. Jeep moves 61 to 70 sec load is increase because deflection is increase 46.88 to 59.16 mm. Jeep moves 71 to 80 sec load decrease because deflection 56.32 mm. Jeep 81 to 90 sec load is increase because deflection is increase from 56.32 to 69.32 mm.

When Jeep Takes Reverse Direction Jeep moves 31 to 40 sec load is decrease because deflection is 34.12 mm. Jeep moves 41 to 50 sec load is increase because deflection is increase from 34.12 to 48.27 mm. Jeep moves 51 to 60 sec load is decrease because deflection 45.98 mm. Jeep moves 61 to 70 sec load is increase because deflection 45.98 to 59.79 mm. Jeep moves 71 to 80 sec load is decrease because deflection 59.26 mm. Jeep moves 81 to 90 sec load is increase because deflection 59.26 to 75.82 mm.

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