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Studies on Static and Fatigue Loading Conditions of Steel and Unidiectional Metal Matrix Bo-Al Composite Material

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***Abstract*—Structural safety is the most important factor in each and every part of the automobile. Static and dynamic loads will be considered to find the damage of the material. Leaf spring is the one of the most important part in the automobile field, for the better suspension system in automobile vehicles parts used are leaf springs and shock absorbers. Leaf springs are effectively utilized which absorbs the maximum shock loads for the vehicle. The main function of leaf spring is not only to support vertical load but also to isolate road induced vibrations. It is subjected to millions of load cycles leading to fatigue failure. In the present work steel is used for the initial one and it has been made changed to another suitable material such as metal matrix Bo-Al composite to find the stiffness and Number of cycles to failure, the results were discussed and tabulated.**

Keywords—Leaf spring, Stiffness, Catia, Number of cycles to failure

I. INTRODUCTION

In the modern technology the automobile field has been changed rapidly and more versatile. The major of the automobile structures has been failed due to repeated loads. Fatigue leads an important path for the finding the structural damages and need to be calculate the Factor of safety Stiffness and Failure cycles were considerable parameters so that these were manageably more and the weight must be lesser in the composite materials when comparing with ideal steel material. The most important field of the automobile is a suspension system in which many of the researches has been carried out thoroughly based on the comfort requirements.

Some of the papers has been mentioned that the static loading conditions of steel as well as other composite materials and found that the used composite material by considering the multi leaf springs[3]-[5]-[6]-[7].

Instead of using only static condition in some of the papers they have clearly given the fatigue loading conditions for the leaf springs and has been compared the results[4]-[8]-[9]-[10]. Some of the papers were given the Calculations, Proper standard designing and Formulae were be considered by using [1]-[2].

II. PROBLEM IDENTIFICATION AND SCOPE OF PRSENT WORK

A. *Objectives*

- Comparing the results of the Steel and the considered composite material Bo-Al used in the leaf spring.
- Analytical as well as theoretical results were tabulated for Stresses and deflections for Static and cyclic loads to find the stiffness and failure cycles and opting suitable material.

B. *Methodology*

- The problems were analyzed by studying the various literature surveys.
- Taking ASME standard dimensions and boundary conditions.
- Modeling and meshing of a leaf spring has been made using Catia software.
- Using ANSYS, apply the boundary condition to the model of a leaf spring so that the stresses and displacements were found and calculated the Stiffness and failure cycles.

C. Geometric parameters

i. *Design of a mono leaf spring and its specifications*

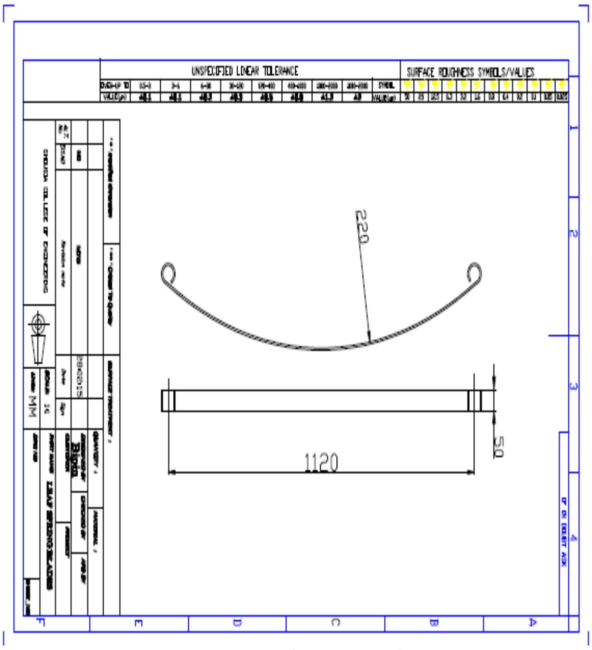

Fig.1. 2d model of a mono leaf spring

The specifications all are represented in the fig.1, such that the thickness is considered as 10 mm for a mono leaf spring. Static load is considered as 2000N and the cyclic load is varied from 4000 to 8000N at the time variation of 10 seconds.

ii. Meshed model of a mono leaf spring

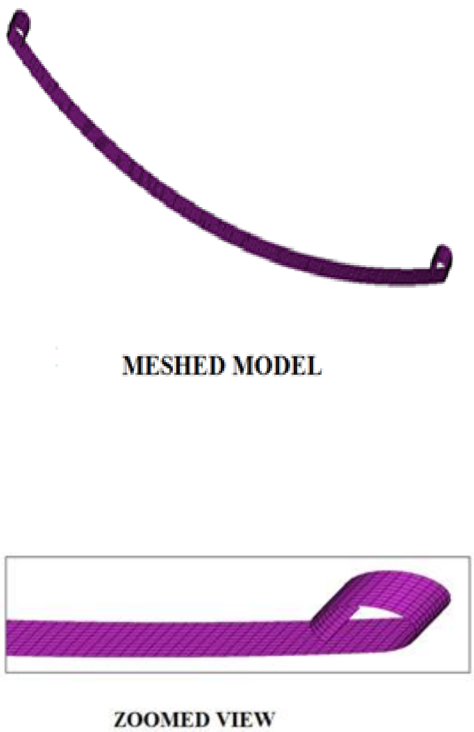

Fig.2. Meshed model of a leaf spring

iii. *Boundary condition*

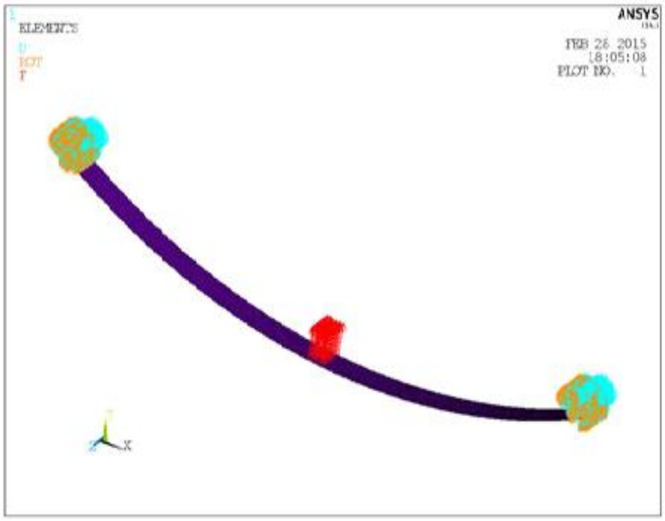

Fig.3. Boundary conditions of a leaf spring

Boundary condition applied for leaf spring fixed in all directions and loaded centrally, both static and cyclic loads were applied with varying time.

D. Material properties

Table I Represents the material properties

Sl. No.	Properties	Steel	Bo-Al
1.	*Young's modulus (N/mm^2)*	$2.1X10^5$	$2.35X10^5$
2.	υ	0.23	0.285
3.	*Density (gm/cm^3)*	7.75	2.7

III. RESULTS AND DISCUSSION

1. Results

I. Analytical Results

(i) For Static loading condition

A. Stress Analysis – (a) Steel material

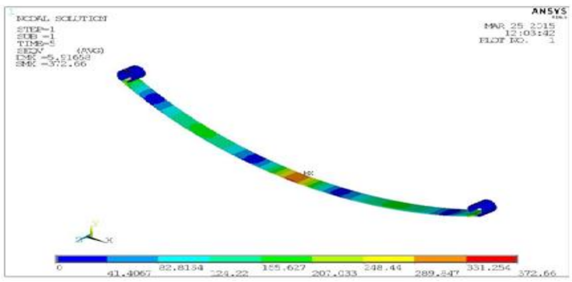

Fig.4. shows the value of stress for static load.

b) Bo-Al material

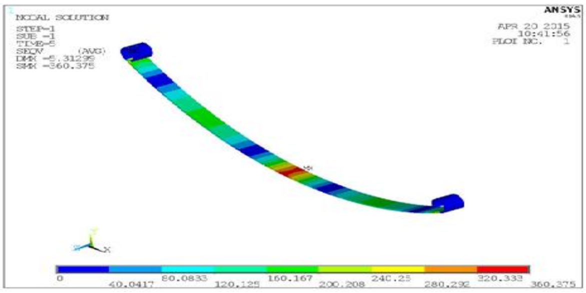

Fig.5. shows the value of stress for static load.

B. Displacement Analysis – (a) Steel material

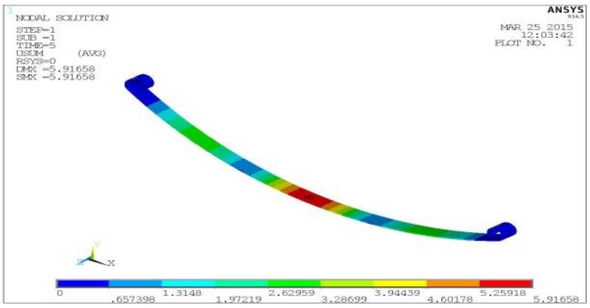

Fig.6. shows the value of displacement for static load.

b) Bo-Al material

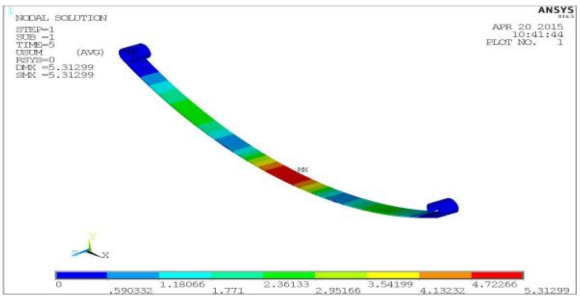

Fig.7. shows the value of displacement for static load.

(ii) For Cyclic loading condition

A. Stress Analysis – (a) Steel material

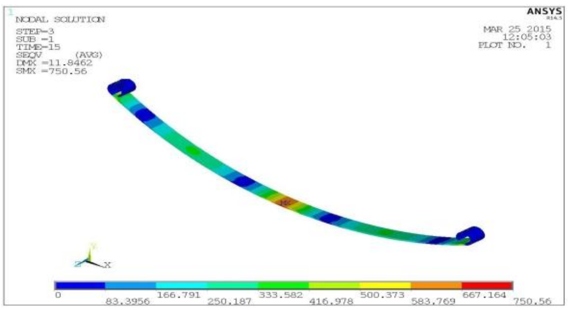

Fig.8. shows the value of stress for cyclic load of 4000N at the time interval of 15 seconds.

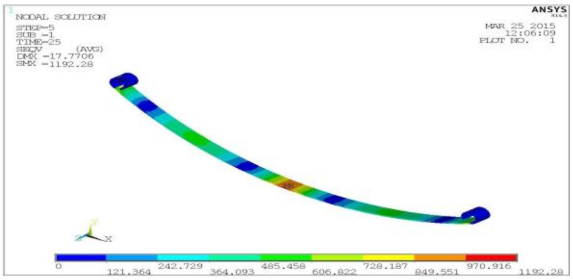

Fig.9. shows the value of stress for cyclic load of 6000N at the time interval of 25 seconds.

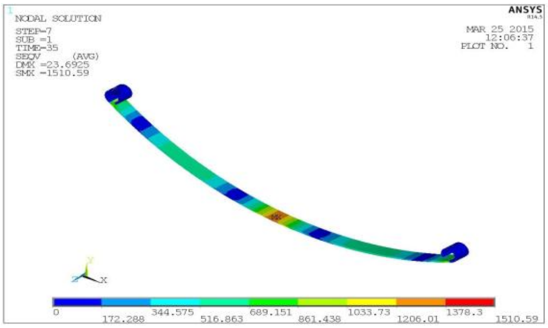

Fig.10. shows the value of stress for cyclic load of 6000N at the time interval of 25 seconds.

(b) Bo-Al material

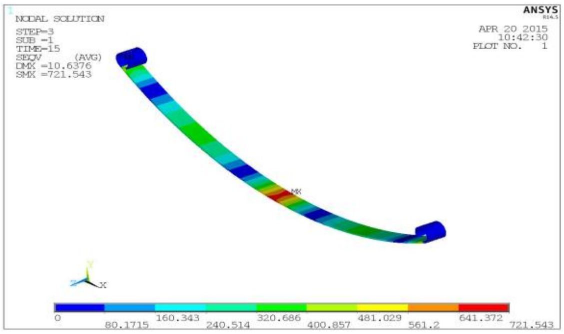

Fig.11. shows the value of stress for cyclic load of 4000N at the time interval of 15 seconds.

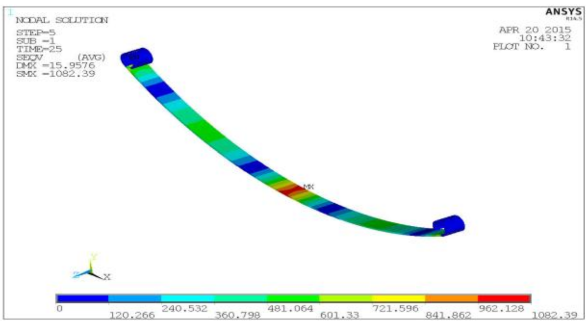

Fig.12. shows the value of stress for cyclic load of 6000N at the time interval of 25 seconds.

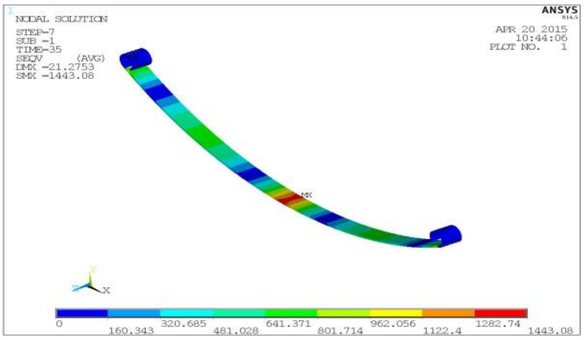

Fig.13. shows the value of stress for cyclic load of 8000N at the time interval of 35 seconds.

B. *Displacement Analysis – (a) Steel material*

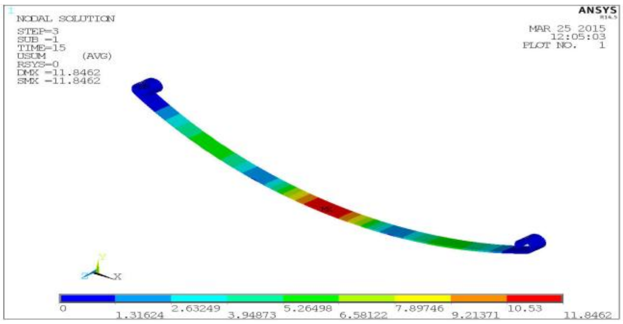

Fig.14. shows the value of displacement for cyclic load of 4000N at the time interval of 15 seconds.

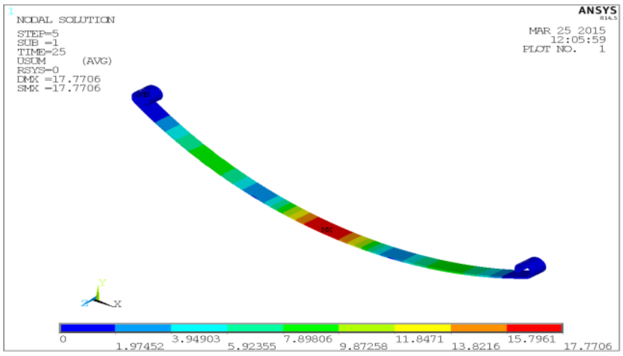

Fig.15. shows the value of displacement for cyclic load of 6000N at the time interval of 25 seconds.

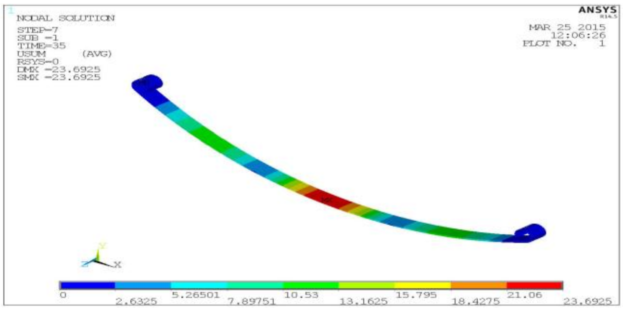

Fig.16. shows the value of displacement for cyclic load of 8000N at the time interval of 35 seconds.

(b) Bo-Al material

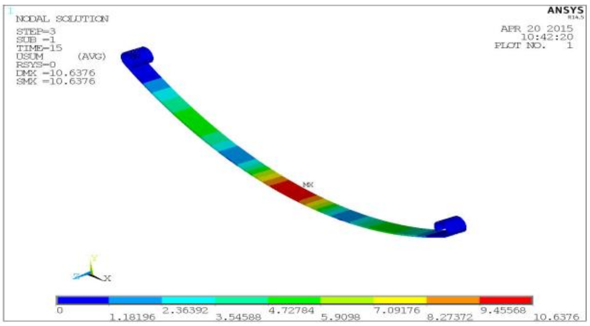

Fig. 17 shows the value of displacement for cyclic load of 4000N at the time interval of 15 seconds.

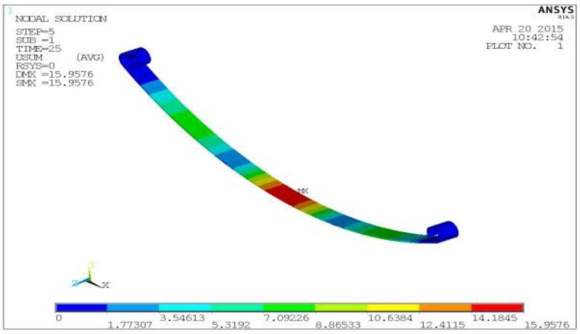

Fig.18. shows the value of displacement for cyclic load of 6000N at the time interval of 25 seconds.

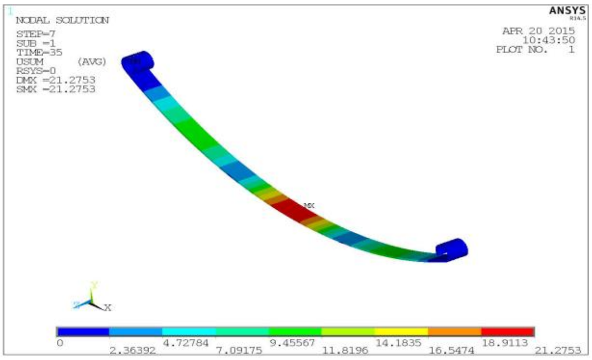

Fig.19. shows the value of displacement for cyclic load of 8000N at the time interval of 35 seconds.

II. *Theoretical Results*

TABLE II. Theoretical results of steel and Bo-Al material for static load.

Sl. No	Condition	Steel		Bo-Al	
		Displacement (mm)	*Stiffness (N/mm)*	*Displacement (mm)*	*Stiffness (N/mm)*
1.	Static load 2000N	6.69	298.95	5.734	348.75

TABLE III. Theoretical results of steel and Bo-Al material for cyclic load.

Sl. No	Condition	Steel		Bo-Al	
		Displacement (mm)	*Stiffness (N/mm)*	*Displacement (mm)*	*Stiffness (N/mm)*
1.	Cyclic load 4000N at 15 seconds	13.38	298.95	11.64	348.785
2	6000N at 25 seconds	20.07	298.925	17.2	348
3	8000N at 35 seconds	26.7	298	22.9	348

Number of cycles to failure, Considering the loading condition as 2000N such that Ultimate strength of the Bo-Al material is 1100Mpa and Sa=160.2 By using the graph [2], N_f has been calculated. The value of N_f for Bo-Al is 1 X 10^7cycles.

2. *Discussions*

TABLE IV. CORRELATING RESULTS TABLE

Sl. No	Load (N)	Steel		Bo-Al	
		Deflection(mm)		*Deflection(mm)*	
		Analytical	*Theoretical*	*Analytical*	*Theoretical*
1	2000	5.9	6.7	5.3	5.7
2	4000	11.8	13.4	10.6	11.6
3	6000	17.7	20.07	15.9	17.3
4	8000	23.7	26.7	21.2	22.8

Table IV. Represents the comparison of deflections in both Steel and uni directional metal matrix bo-al composite materials. The Stiffness of the Steel material for Analytical and theoretical values are 338 and 298.95 N/mm respectively and for the Bo-Al material the Stiffness values are 377 and 348.75 N/mm.

The Number of cycles to failure of steel is10^5 cycles [2] whereas the considered Bo-Al material has 10^7 cycles.

IV. CONCLUSION

- Comparative study has been made between Steel and the Bo-Al material with respect to stress and deformation analytically and theoretically to find the Stiffness and failure cycles.
- While comparing the stiffness the Bo-Al material is 11% more stiffer than steel in Analytical way and 17% more stiffer in Theoretical manner.
- The number of cycles to failure in Bo-Al is more than 10^5 cycles, which is more than the Steel material.
- Hence concluding that the Uni directional metal matrix Bo-Al composite material is better replacement material instead of steel material in all the considered parameters for a mono leaf spring.

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REFERENCES

[1] Mahmud M. Shokrieh , Davood Rezaei, “Analysis and optimization of a composite leaf spring, Composite Structures” 2003(60), pp. 317–325.
[2] Seyyedvahid Mortazavian, Ali Fatemi “Fatigue behavior and modeling of short fiber reinforced polymer composites” Elsevier International journal of Fatigue 70(2015)
[3] Baviskar A. C., Bhamre V. G., Sarode S. S. Design and Analysis of a Leaf Spring for automobile suspension system: A Review International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 6, June 2013)
[4] Al-Qureshi H A (2001), “Automobile leaf springs from composite materials”, Journal of Materials Processing Technology, 118(2001) pp. 58-61.
[5] V. Pozhilarasu,Dr. T. Parameswaran Pillai, “Performance Comparison of convention and composite leaf spring”, International Journal of Engineering science and Technology, ISSN 2333-9721.
[6] Pankaj Saini, Ashish Goel, Dushyant Kumar “Design and analysis of composite leaf spring for light vehicle” International Journal of Innovative Research in Science, Engineering” and Technology ISSN: 2319-8753Vol. 2, Issue 5, May 2013.
[7] B.Vijaya Lakshmi, Satyanarayana,; Static and dynamic analysis on composite leaf sprig in heavy vehicle, International Journal of Advanced Engineering Research and Studies, 2012(2), pp80-84.
[8] [Manjunath H.N, Manjunath.K, T.Rangaswamy Static Analysis and Fatigue Life prediction of Composite Leaf Spring for aLight Commercial Vehicle International Journal of Engineering Research ISSN: 2319-689, Volume No.3, Issue No.7, pp : 422-425 01 July 2014 IJER@2014 Page 422.
[9] M.Venkateshan , D.Helmen Devraj, “design and analysis of leaf spring in light vehicles”, IJMER 2249-6645 Vol.2, Issue.1,pp.213-218, Jan-Feb 2012.
[10] [Hou J P et al. (2007), “ Evolution of the eye end design of a composite leaf spring for heavy axle loads”, Journal of composite structures78(2007), pp. 351-358.