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RESEARCH ARTICLE

COMPARISON STATIC STRESS ANALYSYS BETWEEN CONVENTIONAL & PARABOLIC LEAF SPRING.

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Abstract

Leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicle. Originally called a laminated or carriage spring, and sometimes referred to as a semi- elliptical spring or cart sprig. For uniform distribution of bending stress during the loading condition both full length and graduated leaf springs are clamp together and initially forged in a curved shape for initial residual stress. At the time of maximum loading all leaves become straight. This type of spring is called conventional leaf spring. One more concept of stress distribution has been generated that is with the change in thickness of spring in both full length as well as graduated leaves. This type of spring is called parabolic leaf spring. This research is to analyze the study of change in distribution of stress with respect to the length and thickness of leaves.
Author has visited JAMNA AUTO INDUSTRIES LTD. MALANPUR to analyze the stress distribution in both type of spring. Collecting data from industry Author has examine the stresses as well as deflection keeping same independent variables of both spring using SOLIDWORKS SOFTWARE.
Analyzing the results Author found that parabolic leaf spring is better than the conventional leaf spring suspension system in heavy vehicle.

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Introduction:-

Leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicle. Originally called a laminated or carriage spring, and sometimes referred to as a semi- elliptical spring or cart spring.

Calssification Of Leaf Spring:-
1. Elliptic
2. Semi-Elliptic
3. Three Quarter Elliptic
4. Quarter Elliptic
5. Transverse

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Conventional Leaf Springs:-

It consists of a set of rectangular leaves jolted together with the help of clamps. This spring is attached either on the top or bottom of the axle of the vehicle via the U- Bolts depending upon the requirements. The number of leaves is generally not limited to a few and there are a lot of leafs in the spring with graduated length as we move from top to bottom.The leafs are thin and have rectangular cross section for easy stacking. There is no Z bending in contrast to parabolic springs to allow more contact surface between the leafs

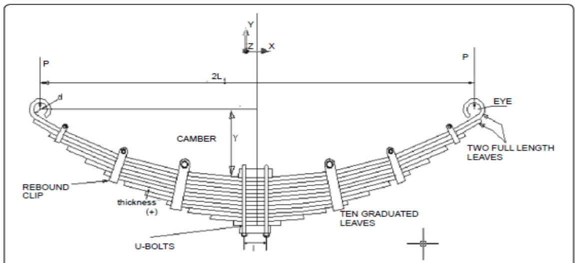


Figure 1: Leaf spring model.

Prabolic Springs:-

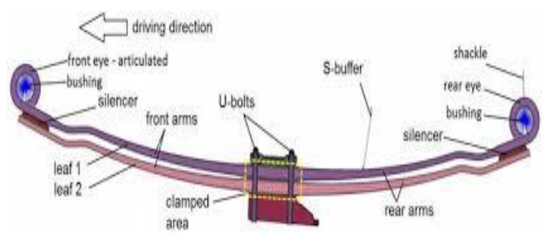
A new and modified version of conventional leaf springs is parabolic springs. Parabolic springs were made while keeping the idea in mind that normally leaf springs are generally stiffer and the vehicle ride can be uncomfortable for some commuters. To overcome these limitation parabolic springs were introducing which offer smoother springs action and thus make the ride comfortable.

Although, the manufacturers now have to lose on some weight loading capacity as conventional springs weight loading capacity as conventional springs have better load bearing capacity due to more area of contact. Thus conventional springs are preferred where ride quality is a concern over loading. Undoubtedly SUVs and off-roading cars. In parabolic spring the tapering occurs parabolic way, from centre where it is thick to the ends where it is thin. Meaning, the tapering follows the equation of the parabola.

i.e. Y=X square + n

Where Y and X are related of the leaf.

Also, the number of leaves is also reduced. Normally, a parabolic spring contains 4-5 leaves is total as opposed to normal 9-10 leaves in leaf springs. As the leaves are trapped like this and due to the parabolic shape reducing the contact surfaces, it is easier to compress and decompress these springs thus making the ride very comfortable. The life of these springs is also more due to less chances of corrosion due to less contact. Thought the leaf springs are obsolete in racing and sport cars due to their large span and absence of versatility in spring stiffness which is quite required and swift cars, Chevrolet, TATA SUVs, Mahindra Commercial vehicle still uses it in some of its cars.



Steps Of Manufacturing

Chemical Composition	Sup 9	Sup 11
C	0.50-0.60%	0.55-0.65%
Mn	0.65-0.95%	0.70-1.00%
Si	0.15-0.35%	0.15-0.35%
Cr	0.65-0.95%	0.70-1.00%
P	0.35% Max.	0.035%
S	0.035%Max.	0.035%
Al	0.020-0.060%	0.20-0.060
B	--	0.0005%

Methology:-

Step 1: First the collected data is validated with the standard mathematical calculation.
Step 2: And then formulated the finite element model in the SOLIDWORKS.
Step 3: Different modeling techniques are considered for analysis are presented.

1. Initial the leaf spring is modeled and performed the analysis for different loads and compared stress and stiffness with the theoretical values.
2. Secondly the model is refined for different contact stiffness values and performed the analysis for steel material, where a parametric study is performed by keeping the contact pairs and the comparison of the stresses variation at the different stages is closely monitored.
3. The variation for the deflection, stiffness and stress at different loads and contact stiff nesses are plotted.

Step 4: The same processes was continued with varying loads, contact stiffness and thicknesses for the composite material.
Step 5: Finally it is observed that by using the composite material the leaf spring thickness can be reduced without affecting the permissible conditions.
Step 6: Finding the weight reduction obtained by using the composite material for the leaf spring.
Step 7: For maintaining the smooth riding the model analysis is carried for finding the natural frequency of both standard steel leaf spring and replaced composite material leaf spring.

Data Collection:-

JAMNA AUTO INDUSTRIES LTD. MALANPUR
FATIGUE TESTING REPORT
DOC NO : FM-8B-17
REV. NO. : 0
DATE :09 2 2018

MODEL -: MTIPL SPRING FR
PART NO. -: 64.43402:0016
SECTION -: 90X1588X25
NO. OF LEAF -: 3 Nos
ASSY. CAMBER BEFORE TESTING -: 116 mm
MIN LOAD -: 14760 N
MAXLOAD -: 43970 N
TEST CYCLES SPEC. -: 1.38 Lacs

S. NO.	Starting Date	Starting Time	Finishing Date	Finishing Time	Initial reading of counter	Final reading of counter	Total no. of cycles	Cumulative cycles
1	09/02/18	05:35 PM	09/02/18	10:30 PM	00	8582	8582	8582
2	10/02/18	09:12 AM	10/02/18	10:30 PM	8582	14124	5542	14124
3	11/02/18	09:07 AM	11/02/18	10:35 PM	14124	40122	25998	40122
4	12/02/18	09:12 AM	12/02/18	10:32 PM	40122	58591	18469	58591
5	13/02/18	09:02 AM	13/02/18	10:30 PM	58591	86079	27488	86079
6	14/02/18	09:12 AM	14/02/18	10:30 PM	86079	115172	29093	115172
7	15/02/18	09:15 AM	15/02/18	10:35 PM	115172	138185	23013	138185

TOTAL NO. OF CYCLES : 138185
CONDITION OF LEAFS : OK WITHOUT FAIL
CAMBER OF AFTER TEST : 114 MM

JAMNA AUTO INDUSTRIES LTD. MALANPUR
FATIGUE TESTING REPORT
DOC NO : FM-8B-17
REV. NO. : 0
DATE :15 2 2018

MODEL -: MTIPL SPRING FR
PART NO. -: 64.43402:0016
SECTION -: 90X1588X25
NO. OF LEAF -: 4 Nos
ASSY. CAMBER BEFORE TESTING -: 116 mm
MIN LOAD -: 14760 N
MAXLOAD -: 43970 N
TEST CYCLES SPEC. -: 1.49 Lacs

S. NO.	Starting Date	Starting Time	Finishing Date	Finishing Time	Initial reading of counter	Final reading of counter	Total no. of cycles	Cumulative cycles
1	12/02/18	03:30 PM	13/02/18	09:00AM	00	30270	30270	30270
2	13/02/18	09:30 AM	14/02/18	09:00 AM	30270	71515	41245	71515
3	14/02/18	09:20 AM	15/02/18	09:00 AM	71515	110883	39363	110883
4	15/02/18	09:30 AM	16/02/18	09:00 AM	110883	149123	38240	149123

TOTAL NO. OF CYCLES : 14912
CONDITION OF LEAFS : OK WITHOUT FAIL
CAMBER OF AFTER TEST : 113MM

JAMNA AUTO INDUSTRIES LTD. MALANPUR

FATIGUE TESTING REPORT

DOC NO : FM-8B-17
REV. NO. : 0
DATE :10 2 2018

MODEL -: MTIPL SPRING FR ASSY. CAMBER BEFORE TESTING -: 116 mm
PART NO. -: 64.43402:0016 MIN LOAD -: 14760 N
SECTION -: 90X1588X25 MAXLOAD -: 43970 N
NO. OF LEAF -: 5 Nos TEST CYCLES SPEC. -: 2 Lacs

S. NO.	Starting Date	Starting Time	Finishing Date	Finishing Time	Initial reading of counter	Final reading of counter	Total no. of cycles	Cumulative cycles
1	12/02/18	01:00 PM	13/02/18	01:00 PM	00	36743	36943	36743
2	13/02/18	01:30 PM	13/02/18	09:00 PM	36743	50120	13377	50120
3	14/02/18	09:00 AM	14/02/18	10:30 PM	50120	78142	28022	78142
4	14/02/18	11:00 PM	15/02/18	10:30 PM	78142	125220	47078	125220
5	16/02/18	09:00 AM	17/02/18	10:00 PM	125220	177421	52201	177421
6	18/01/18	09:00 AM	18/02/18	09:30 PM	177421	205224	27803	205224

TOTAL NO. OF CYCLES : 205244
CONDITION OF LEAFS : OK WITHOUT FAIL
CAMBER OF AFTER TEST : 112MM

JAMNA AUTO INDUSTRIES LTD. MALANPUR

FATIGUE TESTING REPORT

DOC NO : FM-8B-17
REV. NO. : 0
DATE :10 2 2018

MODEL -: MTIPL SPRING FR ASSY. CAMBER BEFORE TESTING -: 116 mm
PART NO. -: 64.43402:0016 MIN LOAD -: 14760 N
SECTION -: 90X1588X25 MAXLOAD -: 43970 N
NO. OF LEAF -: 5 Nos TEST CYCLES SPEC. -: 2 Lacs

S. NO.	Starting Date	Starting Time	Finishing Date	Finishing Time	Initial reading of counter	Final reading of counter	Total no. of cycles	Cumulative cycles
1	12/02/18	01:00 PM	13/02/18	01:00 PM	00	36743	36943	36743
2	13/02/18	01:30 PM	13/02/18	09:00 PM	36743	50120	13377	50120
3	14/02/18	09:00 AM	14/02/18	10:30 PM	50120	78142	28022	78142
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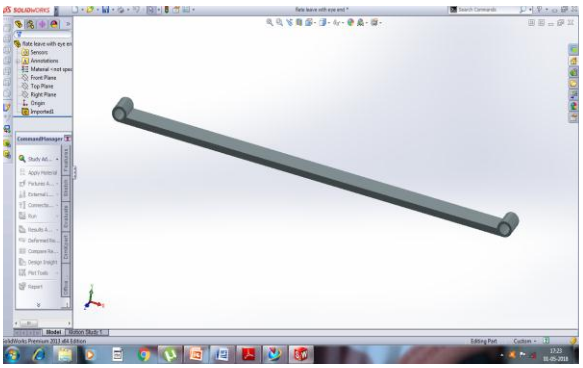
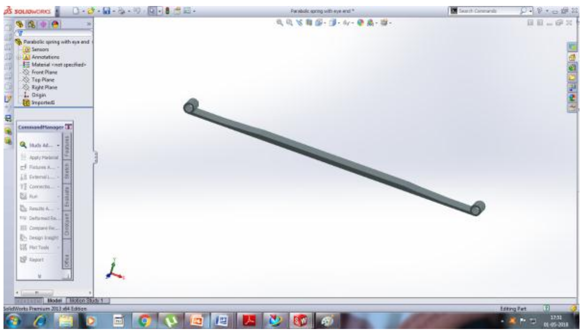
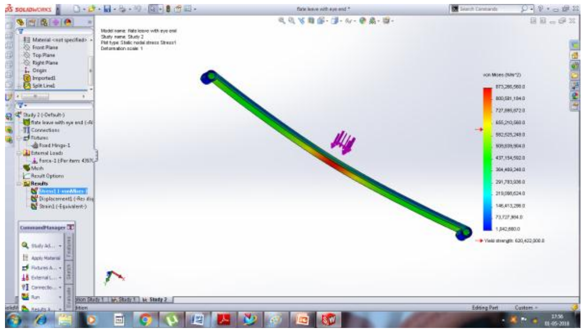
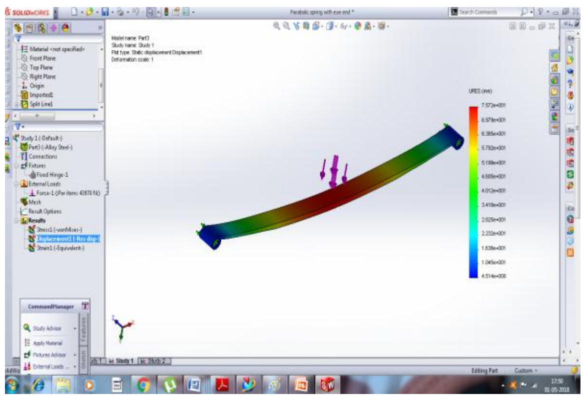
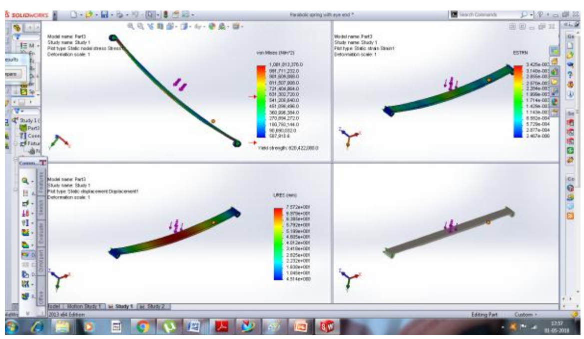
TOTAL NO. OF CYCLES : 205244
CONDITION OF LEAFS : OK WITHOUT FAIL
CAMBER OF AFTER TEST : 112MM

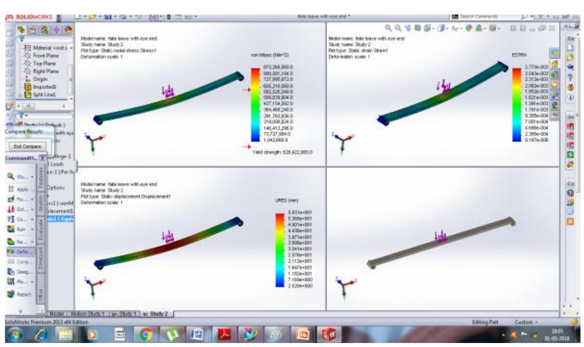


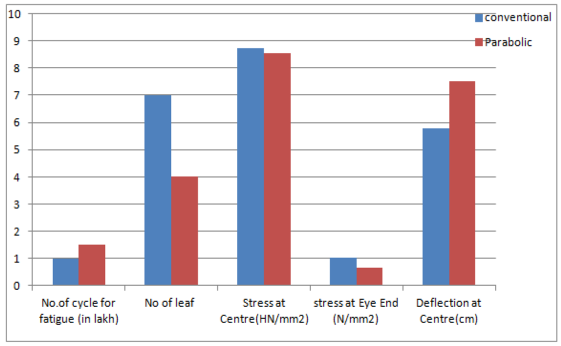












COMPARATIVE CHART BETWEEN CONVENTIONAL AND PARABOLIC SPRING

Conclusion:-

1. This research work is based on a complete study and analysis of Parabolic leaf spring and conventional leaf spring. Model has been deployed to optimize and Same materials are used to analyze. Author conclude that
2. 1 The behavior of parabolic leaf spring (with four leaves) is better than the conventional leaf spring (with seven leaves) under same load conditions.
3. 2 Behavior of parabolic leaf spring (with three leaves) is unable withstand during maximum load condition
4. 3 Behavior of parabolic leaf spring (with five leaves) is more stiff less elastic as per the required condition

Future scope:-

This research work is can be optimize by taking variation in width of leaf of spring and mathematical modeling can be developed for no required leaf on the basis of load,length, and deflection of spring.

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