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DESIGN AND ANALYSIS OF INTERMIDIATE COMBINATION OF STRUCTURAL STEEL AND GRAY CAST STEEL LEAF SPRING STRUCTURES

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Abstract*— The aim of the project is to design a new class leaf spring by using practically reviewed material and practically reviewed structural concept. Analysis is done on leaf spring of different materials having high structural strength and damping capacity. We know that every material does not have both the properties. We can achieve both properties in composite materials but we can't use it for heavy vehicles and also it is costly. We can also achieve the both properties in conventional material leaf spring by applying the concept of PRM & PRS. In static analysis deformation, stress, strain can be found out. Modal analysis is done to find natural frequency. With optimization in design & material we can determine best quality of leaf spring structure. The modelling of the leaf spring has been done in SOLID WORKS. Finite analysis of the leaf spring is carried out in ANSYS 14.5 work bench.

***Keywords*— Practically reviewed Material, Practically reviewed Structure, Natural Frequency, static Analysis.**

I. INTRODUCTION

LEAF SPRING:

Initially it is called as overlaid or carriage spring, a leaf spring is a straightforward type of spring that normally utilized for suspension in wheeled vehicles. It is additionally one of the most seasoned springing and going back to medieval circumstances.

The upside of leaf spring contrast with helical spring is that the finish of the springs might be guided with a positive way.

Infrequently it alluded to as a semi curved spring, it looks like the type of a slim circular segment formed length of spring steel of a rectangular cross-area. The focal point of the bend gives the area for the pivot, and tie openings are given at both end to appending to the vehicle body. For substantial obligation vehicles, a leaf spring can be produced using number of leaves stacked over each other in a few layers, frequently with logically shorter clears out. Leaf springs can serve finding and to some degree damping and additionally springing capacities. While the interleaf contact gives a decent damping activity, it isn't very much controlled and results in striction in the movement of the suspension. Hence designs have tried different things with mono leaf springs.

CONSTRUCTION OF LEAF SPRING:

The leaves are regularly given an underlying arch or cambered with the goal that they will have a tendency to rectify under the heap. The leaves are set together by methods for band contracted around them at the inside or by a jolt going through the middle. Since, the band applies hardening and reinforcing impact, consequently successful length of the spring for bowing will be general length of the spring less width of the band. If there should arise an occurrence of an inside dart, keeping in mind the end goal to discover compelling length, two-third separation between focuses of U-jolt ought to be subtracted from the general length of leaf spring. The spring is clasped to the hub lodging by methods for U-jolts. The longest leaf known as ace leaf has its finishes framed in the state of an eye through which the jolts are passed to secure the spring to its backings. Alternate leaves of the spring are called as graduated clears out. To forestall delving in the nearby leaves, the finishes of the graduated leaves are trimmed in different shapes. Bounce back clasps are situated at moderate positions in the length of the spring, with the goal that the graduated leaves likewise take the pressure instigated in the full length leaves when the spring bounce back.

MATERIALS FOR LEAF SPRINGS:

The material utilized for assembling leaf springs is typically a plain carbon steel having a carbon 0.90 to 1.0 percent. The leaves are subjected to warm treatment after the framing procedure. The warmth treatment of spring steel items gives more prominent quality, more prominent load limit, more noteworthy scope of avoidance and better weakness properties.

In late improvement composite materials are additionally used to make leaf spring structures. By utilizing these materials there is probability to get high weight lessening and great quality also. Be that as it may, these composite leaf springs are not appropriate for substantial obligation vehicles.

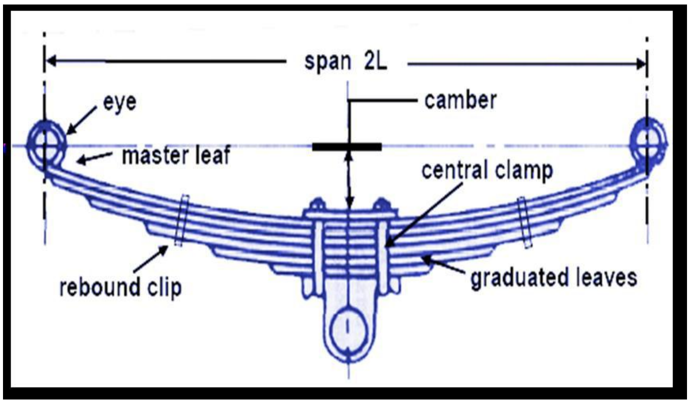

Fig.1 Construction of Leaf Spring

PRACTICALLY EVALUATED MATERIAL STRUCTURE:

A structure is composed by the need or for a specific capacity is called practically reviewed structure. For instance, consider a uniform cross segment shaft conveying load at free end for this situation the pillar subjected to a substantial worry at the settled end. To decrease the pressure acting it is important to change the structure of the pillar. Thus uniform cross area shaft changes into decreased cross segment, with the goal that the pressure acting at settled end is lessened.

Properties of Structure steel :

Material	Structural Steel
Young's Modulus	$2*10^5$Mpa
Poisson's Ratio	0.3
Density	7850 kg/m^3
Shear Modulus	$7.6323*10^4$
Tensile Yield Strength	250Mpa
Tensile Ultimate Strength	460Mpa
Compressive Yield Strength	250Mpa

Table 1 Properties of Structural steel

Properties of Grey cast iron :

Material	Grey Cast Iron
Young's Modulus	138Gpa
Poisson's Ratio	0.28
Density	7250 Kg/m^3
Thermal Conductivity	57K ($w/m^{\circ}c$)
Specific Heat	460 $J/kg^{\circ}c$
Thermal Expansion	$10.85*10^{-6}{}_{K}$

Table 2 Properties of Grey Cast Steel

II. EXPERIMENTAL METHOD

According to practically evaluated material:

- Preparing the Model by utilizing SOLID WORKS.

- Five CAD models are made including three leaves of various blends of materials.
- The chose materials are auxiliary steel and dim cast press and the mixes are GGG, GGS, GSS, SGS, SSG and SSS (G – dark cast press, S – basic steel).
- Importing these models to ANSYS 15 work seat for cross section and investigation reason.
- Analysis to improve the situation of different blend of materials.
- Structural examination is done to discover misshapening, anxiety.
- Modal examination is done to discover regular recurrence.
- Tabulating and analyze the outcomes at that point select the best material blend leaf spring.

According to practically evaluated structure:

- Prepare three CAD models of leaf springs comprises of three leaves in each model which are comprised of same material (auxiliary steel) utilizing SOLID WORKS.
- Basic Model – No variety in outline.
- Model - 1 – Having opening at base layer and expulsion at top layer.
- Model - 2 – Having opening at top layer and expulsion at base layer.
- Static investigation is done on three models to discover disfigurement, stress and characteristic recurrence.
- Tabulate and analyze the outcomes and select the best model of leaf spring structure.
- Combine the two design idea that is, by choosing the best material mix from first examination and by choosing best basic model from second investigation manufacture a best improved leaf spring structure.

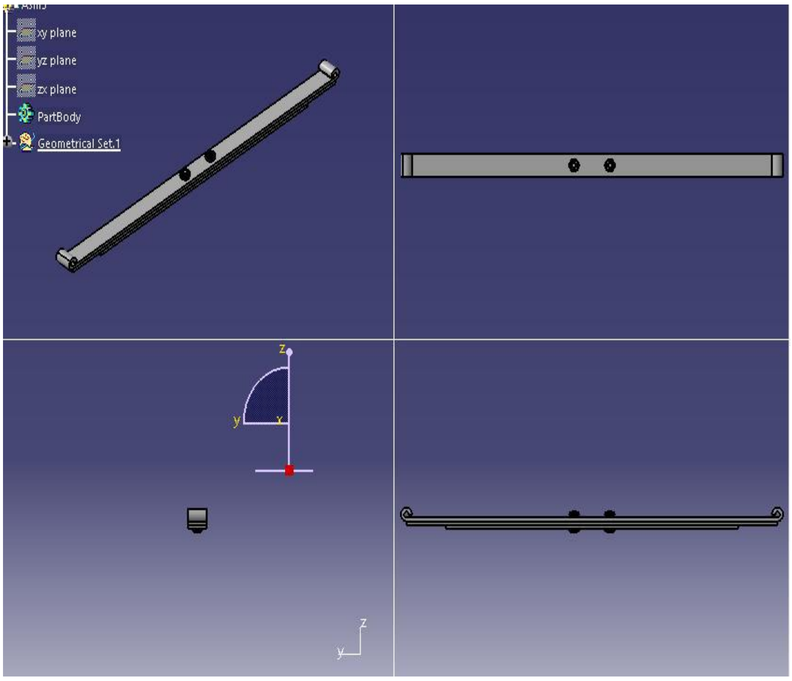

Fig 2. Complete Design of Leaf Spring

III. EXPERIMENTAL RESULTS AND DISCUSSION

FINITE ELEMENTAL ANALYSIS:

BY VARYING THE STRUCTURE – Static Analysis

SL NO	DEFORMATION In m
BASIC	0.00029076
MODEL 1	0.0002667
MODEL 2	0.00026673

Table 3. Deformation value of different type of structure

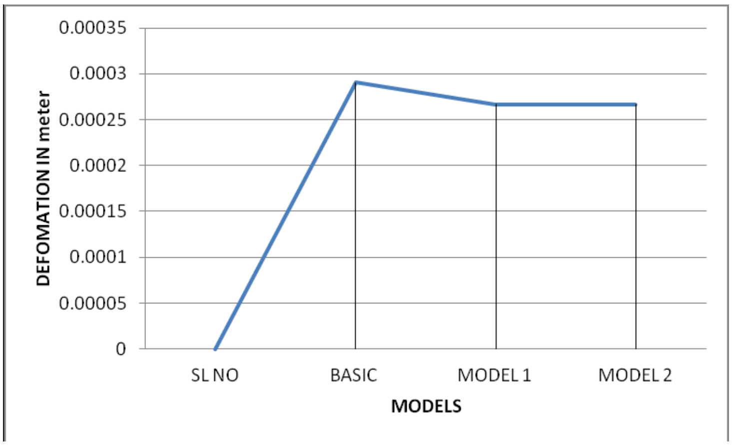

Fig 3 Deformation Value of Different Type of Structure.

SL NO	STRESS In pa
BASIC	1.76E+07
MODEL 1	2.32E+07
MODEL 2	2.32E+07

Table 4 Stress Value of Different Type of Structure

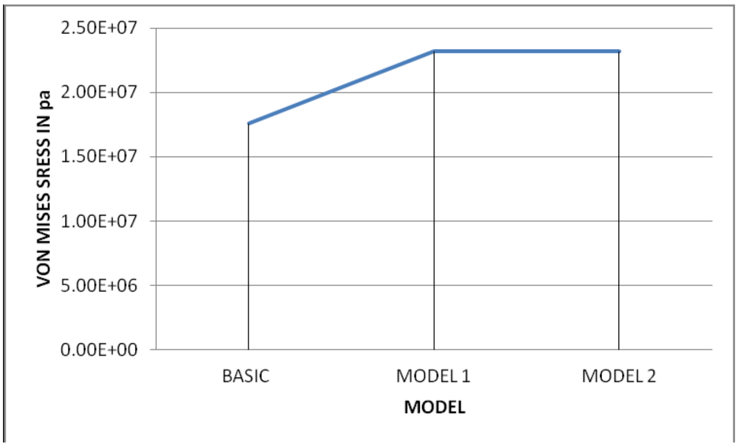

FIG 4 STRESS VALUE OF DIFFERENT TYPE OF STRUCTURE

SL NO	STRAIN
BASIC	8.94E-05
MODEL 1	0.000117
MODEL 2	0.000117

Table 5 Strain Value of Different Type of Structure

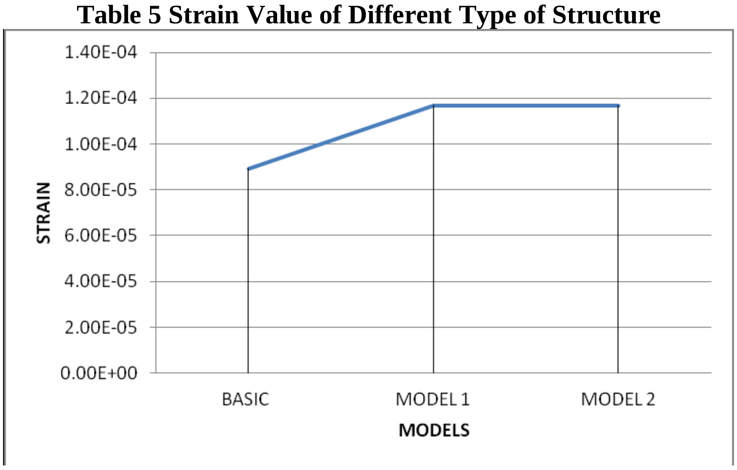

Fig 5 Strain Value of Different Type of Structure

CONTOUR PLOTS OF SIMULATION:

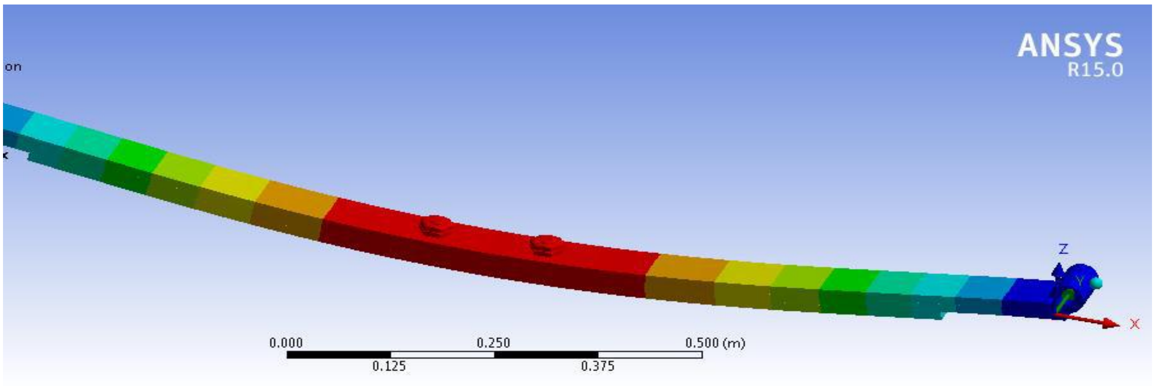

Fig 6 Deformation of Basic Model

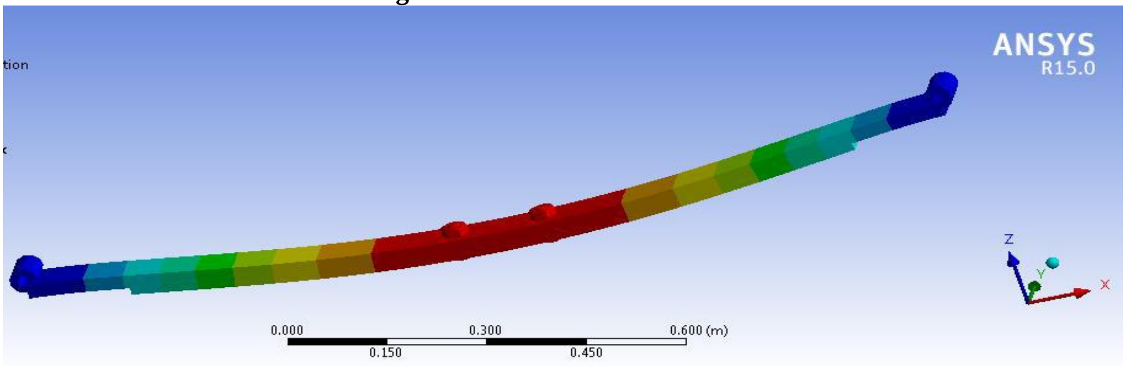

Fig 7 Deformation of Model 1

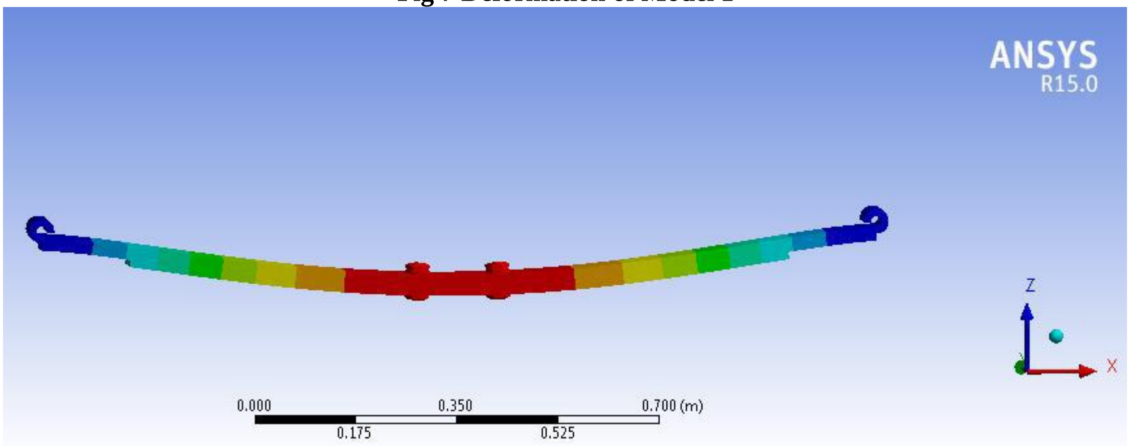

Fig 8 Deformation of Model 2

MODAL ANALYSIS:

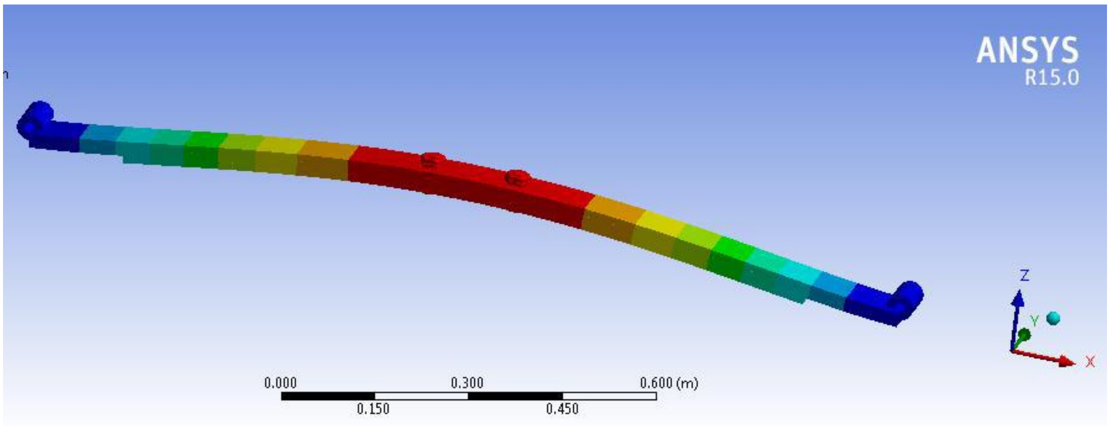

Fig 9 Natural frequency of Basic Model

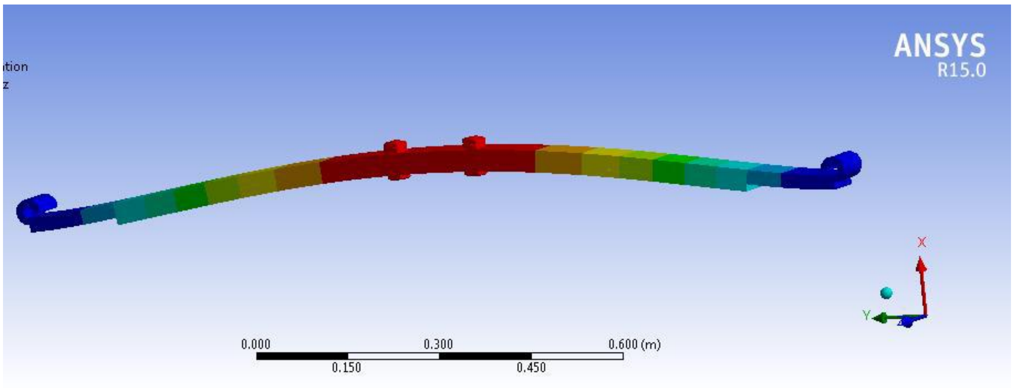

Fig 10 Natural frequency of Model 1

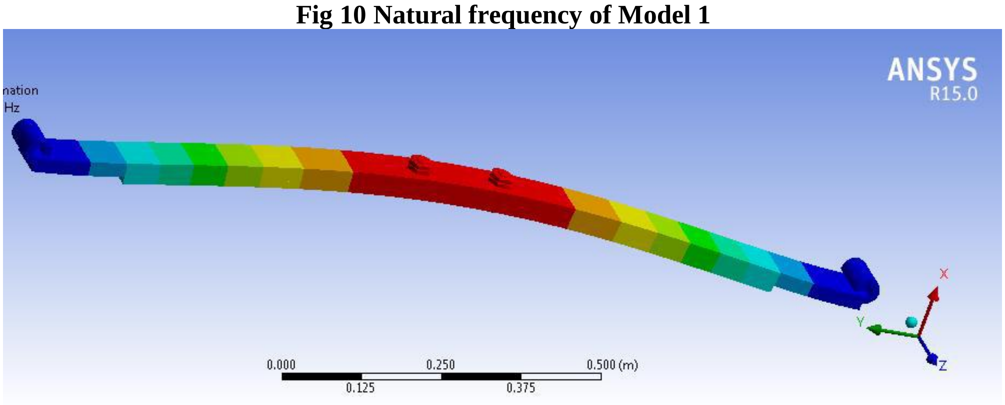

Fig 11 Natural frequency of Model 2

TYPE OF MODEL	MODE 1 NATURAL FREQUENCY IN Hz
BASIC	61.757
MODEL 1	63.976
MODEL 2	63.977

Table 6 Natural frequency of the different models

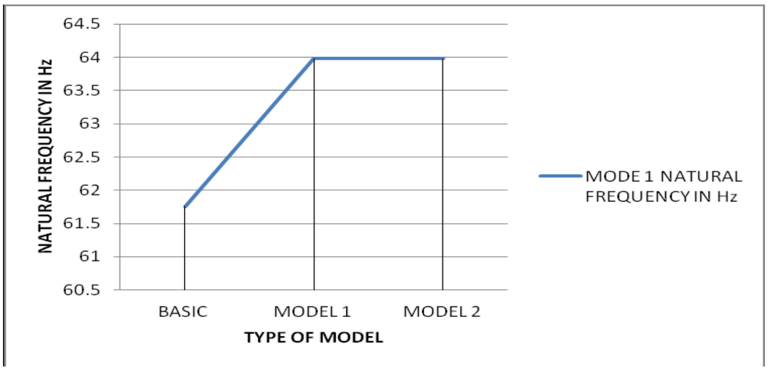

Fig 12 Natural Frequency of the Different Models

ACCORDING TO FUNCTIONALLY GRADED MATERIAL:

TYPE OF FGS	DEFORMATION in m	STRESS IN pa	STARIN	NATURAL FREQUENCY in Hz
SGS	0.00027696	2.26E+07	0.0001132	63.534
SSG	0.00031483	2.72E+07	0.0001361	59.719
SSS	0.0002667	2.27E+07	0.00011388	63.977
GSS	0.00031054	1.84E+07	0.0001331	59.91
GGS	0.00032209	1.86E+07	0.00013506	59.555
GGG	0.00038424	2.27E+07	0.00016477	55.331

Table 7 Static and Modal Analysis of Functionally Graded Material Structure

IV. CONCLUSIONS

The above graphs and tables shows deformation is less for the combination of SSS and stress is minimum for GSS and natural frequency is minimum for GSS & GGS. Natural frequency is minimum for GGG combination.
The above analysis is shows that SSS combination has less deformation and GGG combination has high damping capacity.

The intermediate combination GSS & GGS provides moderate structural strength and moderate damping capacity.
By the combination of Functionally Graded Material and Functionally Graded Structural concept, GSS (grey cast iron, structural steel, structural steel) and GGS (grey cast iron, grey cast iron, structural steel) combined with MODEL 1 is best optimized leaf spring model.

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