Study & Analysis of Structural Behavior of Front Suspension Rear Shackle Bracket

Mr. Dattatray Gavade[1] Prof. Satej Kelkar[2]
[1,2]Department of Mechanical Engineering
[1,2]Jayawantrao Sawant College of Engineering, Hadapsar, Pune

Abstract— This paper reviews work done in the area of Design & optimization of Suspension Shackle Bracket by FEM. Shackle Bracket is part of leaf spring mechanism/ assembly, which accommodate leaf deformation, when subjected to operational load. Simple, to allow for length changes of a leaf spring. A leaf spring suspension is a pretty simple thing, leafs position the axle under the vehicle, and supports the weight of the vehicle. As a leaf spring flexes up or down, its length from eye to eye changes. Since one end is mounted solidly, and can't move, all the length change happens at one end, which has a shackle between the spring and frame to allow for movement. Provides support for front spring and Transfers forces to frame. Shackle bracket is made from casting and forming process. In this paper shackle bracket structure is used for study the structural behavior of main whole structure under different working load conditions. Pro-E software is used for 3D modeling of structure & Nastran software is used to carry out Nonlinear & linear Static analysis of structure to find out the maximum stresses & deformation.

Key words: Suspension Shackle Bracket, FEA

I. INTRODUCTION

The Front Suspension is fitted with Semi elliptical leaf springs with shackle on rear side. This is a conventional suspension and lubricated with graphite grease to reduce the inter leaf friction. Functions of suspension system are 1) Maintain correct vehicle ride height, 2) Support vehicle weight, passenger weight and other load, 3) To safeguard the occupants from the road shocks, 4) To prevent the road shocks from being transmitted to the vehicle components, 5) To preserve the stability of the vehicle in pitching or rolling, while in motion, 6) Maintain correct wheel alignment, 7) Keep the tires in contact with the road.

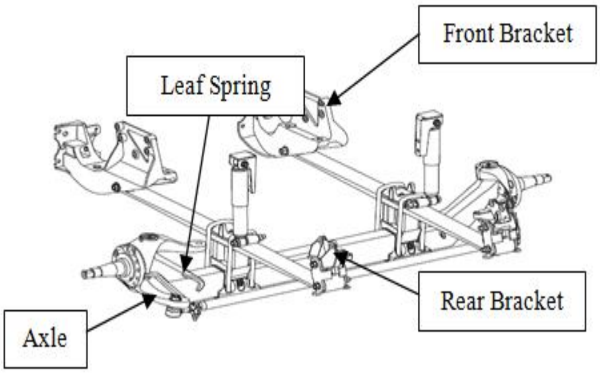

Fig 1.1: Front suspension system

II. EXPERIMENTAL SETUP

The flow of the study is shown in Fig.2.1. First, we will grasp the basic structure characteristics. The basic structure of suspension shackle bracket will be determined with a conventional design method, and strength analysis will be conducted. Next, conditions for optimization will be set. Characteristics to be improved will be set as objective function. And parameters which are considered to greatly contribute to the objective function will be determined as design variables. Optimization study using the simplified model will be conducted and the obtained result will be studied. Last, the advantage of the structure and validity of the study method will be verified vehicle model analysis on the structure identified.

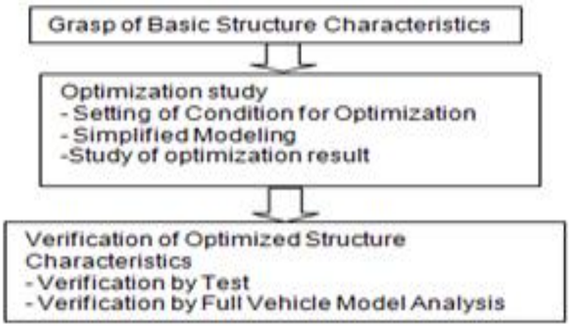

Fig. 2.1: Flow of Study

A. *Optimization Methodology:*

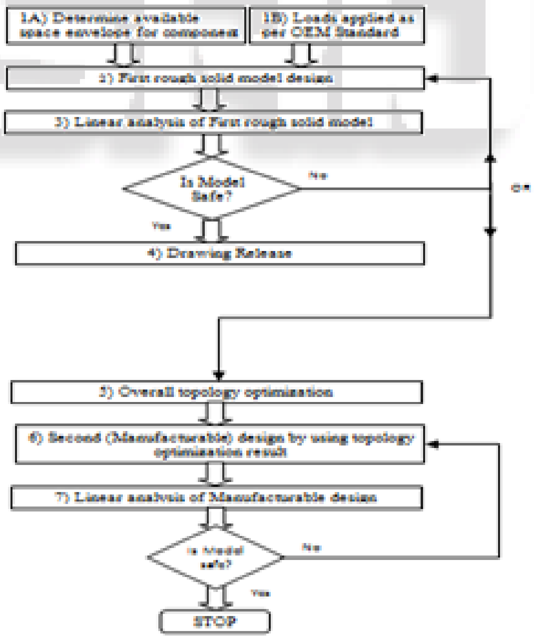

Fig. 2.2: Optimization Methodology

III. ANALYSIS OF SUSPENSION BRACKET

Prepare the G.A. drawing as per the dimension with techniqual data & calculate the all loads coming on structure. After final approve of GA prepare the part drawing. With the help of part drawing, prepare the 3D part modeling & then assemble. Convert the all 3D data in .step format for further work of analysis. In analysis work, create the mid-surface model, apply the boundary conditions like material & properties, constrains, apply the load, run the model for analysis. See the result & compare with standard specification. Create the final report & send for final modification.

Degree of Freedom: Any combination of the six nodal degrees of freedom (TX, TY, TZ, RX, RY and RZ) can be selected. In many cases however, standard combinations of degrees of freedom will be needed.

IV. LINEAR ANALYSIS

The linear analysis of the model is carried out after the nonlinear analysis of the model, as the optimization is linear process. The advantages of the linear process over the non-linear process are as follows:1) It is a simple process, 2) It requires very less time for optimization process, 3) The required accuracy can be achieved.

- Vertical load: Load act on vehicle when vehicle come across a bump.
- Longitudinal load: Load act parallel to the vehicle.
- Lateral load: Cornering force act while taking turn or force act in axial direction of wheel.
- Cross twist: Vehicle is twist when one front wheel is bump and rear cross wheel is in bump condition and remaining wheel in rebound condition called cross twist
- Bogie twist: Vehicle is twist between cab and bogie called bogie twist.
- Slow turning event: When a tractor with trailer is experiencing a turning event with very low speed, one of the rear axle shows a tendency to slip. This is called as "racking" or Slow turning event

A. Loads and Boundary Conditions:

Location	A	B	C	D	E	F
Constraints	123	123	123	123	123	123

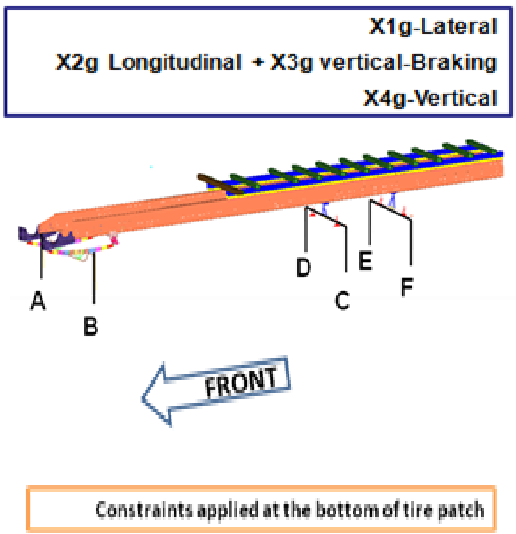

Fig. 4.1: Boundary Conditions for Inertial Loadings

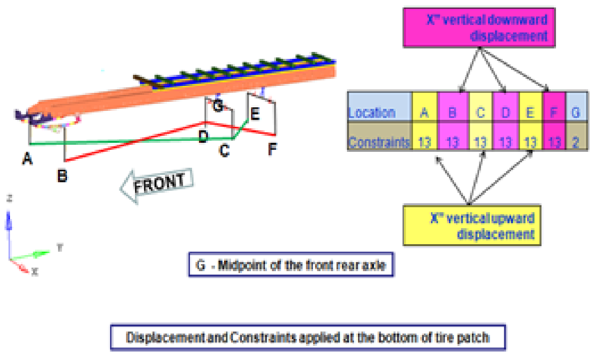

Fig. 4.2: Loads and Boundary Conditions – Cross Twist

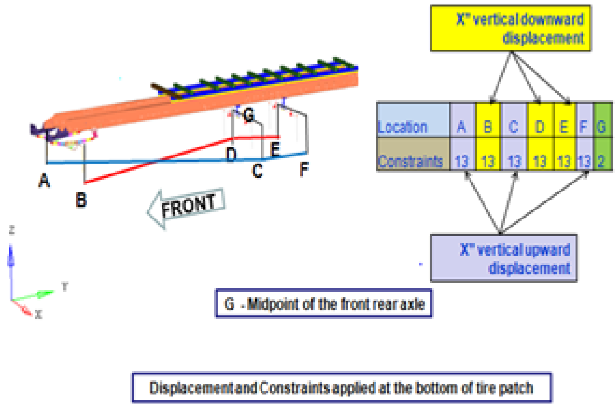

Fig. 4.3: Loads and Boundary Conditions –Bogie Twist

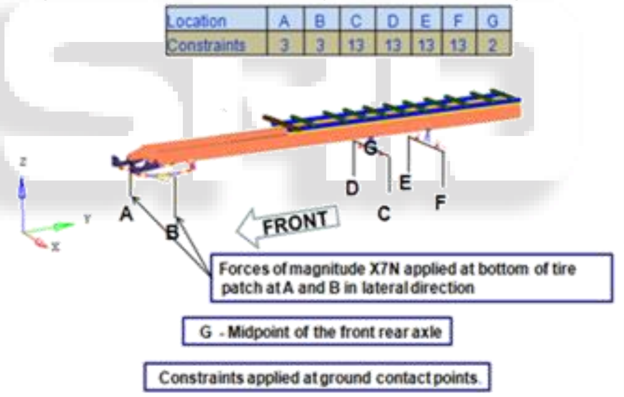

Fig. 4.4: Loads and Boundary Conditions – Slow turning event.

Fig. 4.5: Von Misses Stress plot: Vertical Load case

Fatigue events	Cycle	Target Strength (MPa)
Lateral	2,50,000	200
Slow turning event	1,00,000	250
Twist	45,000	300

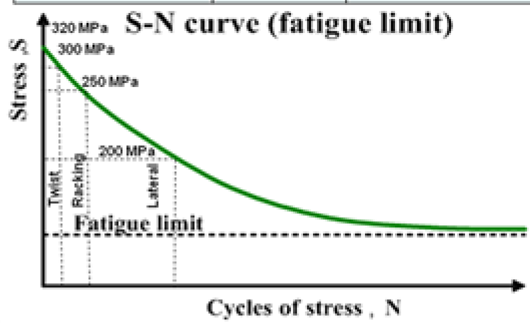

Fig. 4.6: Fatigue data

V. CONCLUSION

Thesis includes literature review that is deemed to be significant for this analysis, complete modeling of suspension shackle bracket structure .Following is the conclusions drawn from analysis,

- The loads are used in FE analysis of suspension shackle bracket structure and stresses are found out for each load i.e. vertical, longitudinal, lateral, racking, bogie twist and cross twist results shows maximum stresses are found near holes.
- So it is important to optimize the all parts of shackle body, & find out Topology Optimization method.
- By this study only completed the first step of Project.
- All the steps of the optimization methodology are study clearly. This methodology can be used to optimize any structure. The suspension shackle bracket is optimized to show application of this methodology.
- The topology optimization is advanced function of many analysis software this is the functionality to empower design/analysis specialist with these currently available in the market useful tools to optimize any geometry.

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