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STATIC ANALYSIS OF TRAILING ARM

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ABSTRACT

Independent suspension is the most important part of any automobile suspension system that leads to move each wheel vertically on the same axle and independently of each other. Rear suspension system consists of several parts, trailing arm is one of the components in the suspension system, it can also be referred as trailing link in a vehicle suspension design. One or more arms are connected between the axle and a pivot point. Rear wheel assembly is directed by the trailing arm wheel suspension system. The arm is quite bigger than other type of suspension arms. It is much rigid at the wheel point which stops its false movement. To design the existing trailing arm and in order to carry out the finite element analysis the model is discritised by using HYPERMESH tool. After completion of meshing, the arm is subjected to static analysis by applying the load. The result revealed that the stress concentration was observed near the junction of welded joint and trailing arm.

KEYWORDS: Trailing arm; static analysis; von-mises stress; FEM

INTRODUCTION

In this modern busy world humans are depended on transportation. Most commonly used transportation vehicle is cars. People sit in car comfortably due to suspension system. Automobile chassis is not directly connected to axial, in between there are spring placed. It is attached in order to avoid the road shocks to vehicle body such as pitch, sway, bounce, and roll. Suspension system is a form of linkage that allows wheels to move along with the vehicle body. The vehicle's frame, body, engine & power train are suspended above the wheels by the use of front and rear springs is referred as suspension [1].

When vehicle is having rigid axle suspension system that encounters the road irregularities in a longer period the wheels does not remain vertical, because of this effect the wheel, vehicle may tilt on one side. In order to avoid this effect, the wheels are sprung independent of each other; therefore tilt on one side of the vehicle does not have any effect to the other wheel.

Independent suspension system is an advantage over the rigid axle suspension system. In independent suspension system to reduce the rolling effect softer spring is used which will improve ride comfort. Even soft springs are used in anti-roll bar, in event of vehicle cornering, it will give necessary force to resist body roll [2].

The rear wheel does not have any connection with the steering geometry as the power has to be transmitted to the rear wheels. Trailing arm suspension is having two trailing arms both front edges are pivoted to the car body. Compared to other suspension's control arms these arms are relatively larger because it's a single piece and coil spring are supported on upper surface. Arm's of other end is rigidly fixed to the wheel.

The front wheel drives vehicles are most popularly use the trailing arm axle because it is relatively simple in design and assembly. The up and down movement of the wheel are to be taken care by the trailing arm in order to deal with the bump. Fig1 shows trailing arm system.

It restricts the lateral movement and chamber change but change of camber angle take place when car rolls into the corner. [3, 4] The trailing arm also rolls the same degree according to the road surface. Here under steer is observed because both wheels bend over the outside corner. This is the reason semi trailing arm are adopted than the pure trailing arm [5, 6].

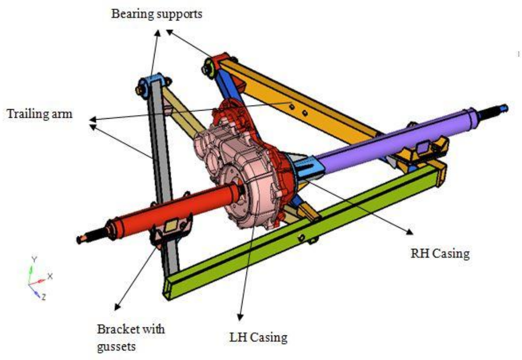

Fig 1 Trailing arm system

FINITE ELEMENT MODELLING AND ANALYSIS

Modeling of trailing arm system is created by CATIA the whole assembly parts are designed individually and then assembled to get the final model as shown in Fig 2. The analysis was carried out by ANSYS 15 applying boundary conditions to the imported model and the results are obtained by post processor.

The finite element model of trailing arm is to be prepared in the HYPERMESH software. The first step in HYPERMESH is geometrical clean up [7]. Further, the component is to be meshed with mesh types of 'trias' with the element size of 6 the mesh should be completely closed. After the 2D meshing it has to be converted to 3D mesh by using the solid 95 elements as shown in Fig 3. In this model, the total number of nodes is 340879 and the total number of elements is 1288809.

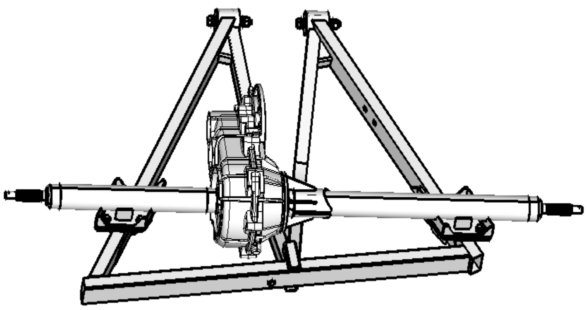

Fig 2 Modeled trailing arm system

Once the meshing is over, the properties of components are updated. The loads are applied with respect to the given condition and finally all data's of elements are updated in the element table. All components are made up of Steel expect casing box that is made up of aluminum materials (Table 1) [8].

Fig 3 Finite element modeling of the trailing arm system

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Load case and boundary conditions

The trailing arm model is constrained at bearing support because it is rigidly fixed to the chassis of vehicle. At that point all the three degree of freedom are fixed, and the degree of rotation are free as bearing are free to rotate while displacement is fixed. Here four different types of bolts are used in casing box arrangement all the four types of bolts experience the preload on it. They are having preload of 1200 kg on each bolt.

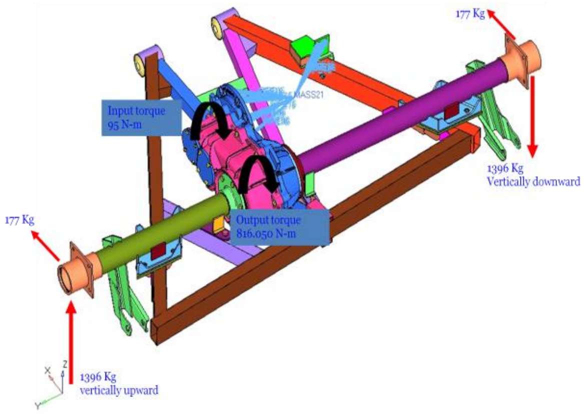

Fig 4 Fully loaded model

Casing box contain the gearing arrangement that are used to transmit the power. Rotational energy to the wheels is supplied form the casing box. The Input torque supplied to the casing box is 95 N-m; the improved output torque is 816.05 N-m. The output torque is supplied to wheels. The input and output torque are applied to casing inner surfaces.

The Vibration Bump load of 1396 kg is applied in upward direction on left hand (LH) side wheel hub and in downward direction on right hand (RH) side wheel hub vertically and Brake load of 177 kg is applied on LH and RH wheel hub horizontally as shown in Fig 4. Once these all loads are applied in HYPERMESH then it is exported to ANSYS by using solver disk option to analysis the loaded model.

The materials used for trailing arm are steel and aluminum, mechanical properties of those materials are shown in the Table 1.

Table 1: Material Properties

SL. NO.	Material	Modulus of Elasticity (Mpa)	Poisson's Ratio	Density (kg/mm^3)
1	Steel A36	210000	0.3	$7850e^{-9}$
2	Aluminum	71000	0.35	$2750e^{-9}$

RESULTS AND DISCUSSION

The model is imported in ANSYS 15 and all loads are applied to the model. Static analysis is carried out in ANSYS 15. First step is to deactivate the element shape checking option by using the command shpp off. This option will help in keeping element shape same and no alteration will take place. But this setting reduces the accuracy of results, as it allows the poor shaped elements.

Static analysis results

The static analysis is carried out to identify the maximum displacement and Von-mises stress of the component, when it is subjected to applied loading and boundary conditions. The overall displacement of the model is given in Fig 5.

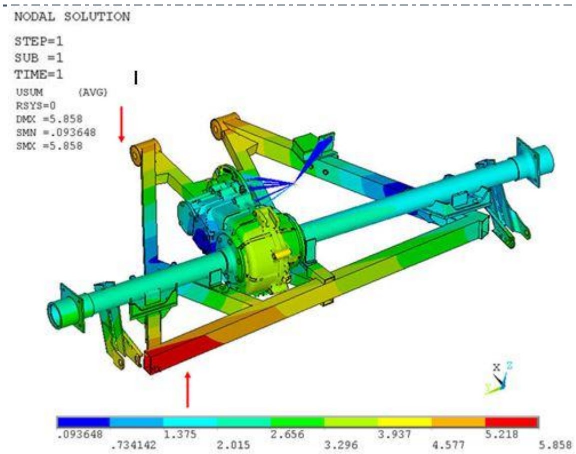

Fig 5 Displacement plot

Due to the combined load effect on the trailing arm, maximum displacement is 5.858 mm in the bump loading area. The experimental setup on the actual component was carried out which showed maximum displacement of 6.34 mm. The results of experimental and ANSYS have an error of 7.6% which is in the acceptable range.

The resultant contour plots of von-mises stress are shown in Fig 6. It shows that the welded region is weaker in this component as it experiences maximum stress.

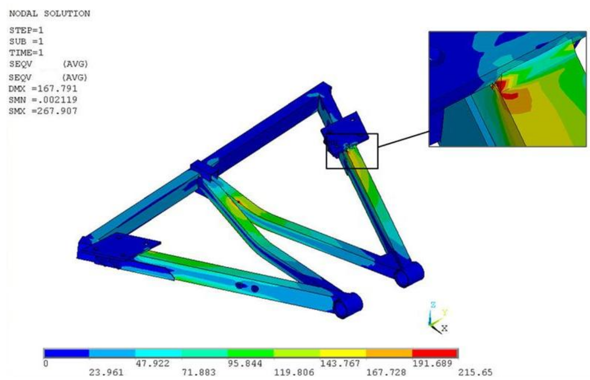

Fig 6 Von-mises Stress distribution plot

Due to the combined load effect on the trailing arm, maximum stress will be developed in the welded region which is 215.65 N/mm^2 [9,10]. The experimental setup on the actual component was carried out which showed maximum stress of 230.8 N/mm^2. The results of experimental and ANSYS have an error of 6.5% which is in the acceptable range.

CONCLUSIONS

The trailing arm is modeled in CATIA and imported to HYPERMESH software for discritization. Solid 95 element is used to mesh the complete model. As the warpage and Jacobian were below 15̊ and 0.6 respectively, the data's are updated to the element table. Combined loads are applied to the meshed model in HYPERMESH and for solving it is imported to ANSYS. Maximum displacement and von-mises stress result plot is found to be 5.858 mm and 215.65 N/mm^2 respectively. The obtained results were compared with experimental results; error obtained is below 10% and hence it is in the acceptance level.

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