Int. J. Chem. Sci.: 14(S2), 2016, 543-548
ISSN 0972-768X
www.sadgurupublications.com

DESIGN OPTIMISATION AND BUCKLING ANALYSIS OF TUBE IN TUBE DRAG LINK

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ABSTRACT

Drag link is an integral part of vehicle's steering system. It is a linkage that connections Drop Arm attached to the Steering gear output shaft and the steering arm, controlling the movement of the front wheel. The requirement of the project is to increase the buckling load capacity of drag link. To increase the buckling load capacity of the drag, link a tube in tube concept is used. The tube is placed in such a way to increase the buckling strength of the steel tube. The testing of drag link is also done with computerised drag link testing facility rig. The results obtained from test rig are compared with the buckling load values obtained from the FEA results. Cost effective products can be achieved using design optimization. Modelling of drag link is done using CREO software. Finite Element Analysis (FEA) model of drag link is analysed using ABAQUS software. The drag link model is optimised by placing a tube with a diameter equal to inner diameter of the drag link tube

Key words: Drag link, Buckling load, Abaqus.

INTRODUCTION

Sudden undesired high load acting on a rigid steering linkage would cause the structure of the linkage to collapse due to buckling rather than breaking. To ensure this effect in a steering linkage system, linkages are designed to buckle before actual break occurs. Buckling is a failure/warning indicator in the linkage system[2], once buckling occurs in a steering linkage system[3], it alters the steering geometry and thereby draws attention of the driver preventing complete failure of system.

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Lead time is very high for changing the material because it must be tested for all conditions. If the material is not available in market, then cost is very high and increasing diameter will lead fouling of the draglink with the chassis and it also leads to packaging problem. With above difficulties we go for a new concept called tube in tube. Instead of increasing the entire tube thickness we are placing a tube inside the tube in the bending region where the maximum buckling occurs[4].

EXPERIMENTAL

The experiment is conducted using buckling test rig facility. The assembled drag link with ball joints is fixed with test rig with one end of ball joint fixed[1]. The another end of ball joint is loaded using a hydraulic unit. The test unit is fitted with linear potentiometer, load cell. The load cell detects the amount of load applied[7] and the linear potentiometer determines the linear displacement of the drag link. The total displacement and amount of load applied is taken as an output from the system attached with test setup. The Fig. 1 shows the buckling test setup of drag link

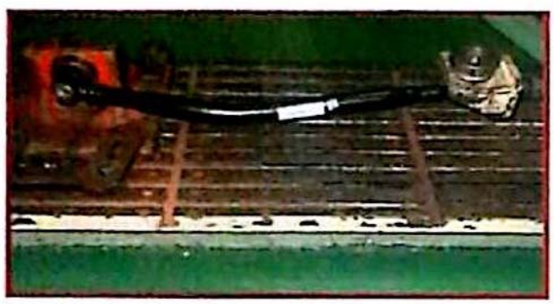

Fig. 1: Buckling test setup

Analysis of trials

To simulate failure mode of the Drag Link Assembly, when the system is subjected to excessively high compressive load[5] for following iterations.

1. Normal tube (Yield strength 355 N/mm^2)
2. High strength tube (Yield strength 700 N/mm^2)
3. Tube in tube (Both tubes normal strength, 355 N/mm^2)
4. Tube in tube (Outer tube high strength 700 N/mm^2, Inner tube normal strength 355 N/mm^2)

5. Tube in tube (Both tube high strength, 700 N/mm^2)

RESULTS AND DISCUSSION

The tube in tube concept drag link has shown significant improvement in buckling load of drag link with refrence to Table 1. The Fig. 3 shows the improvement in buckling load by 2315 kgf, when compared to normal tube buckling load capacity[6]. The Fig. 4 shows the high buckling load improvement by using high strength tube outside and normal tube inside. The increase in buckling load obtained by using with high strength tube outside and normal tube inside is 2200 kgf, when compared to high strength tube. The buckling strength is further increased by using both the tubes with high strength. Hence the reinforcement of tube at the centre buckling zone shows improvement in buckling load capacity.

Table 1: Comparison of result

S. No.	Concept	CAE Results for buckling strength (Kgf)	Actual buckling strength (Kgf)
1	Normal tube	4054	3975
2	High strength tube	7650	8716
3	Tube in tube (Both tubes normal strength)	5445	5927
4	Tube in tube (Outer tube high strength, Inner tube normal strength)	9276	10916
5	Tube in tube (Both tube high strength	10150	11675

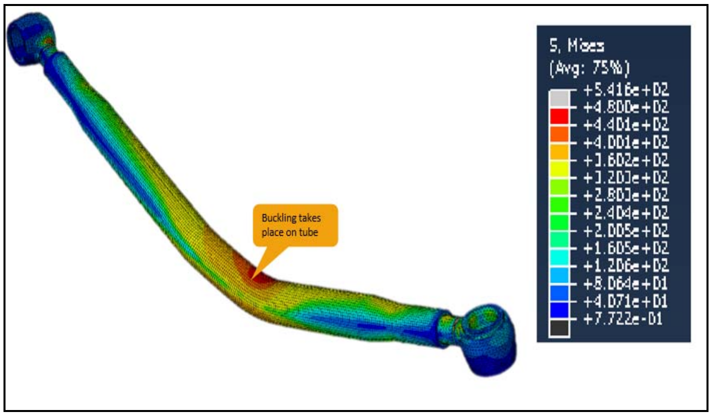

Fig. 1: Displacement plot for Ø50 x 6 tube buckling load: 4054 kg

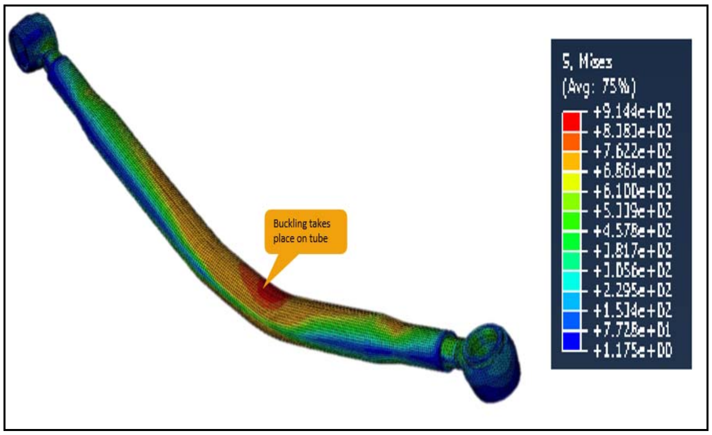

Fig. 2: Displacement plot for Ø50 x 6 tube buckling load: 7650 kg

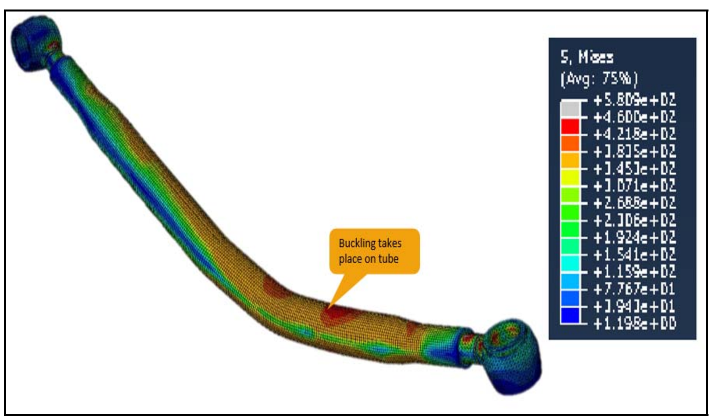

Fig. 3: Displacement plot for Ø50 x 6 tube buckling load: 5445 kg

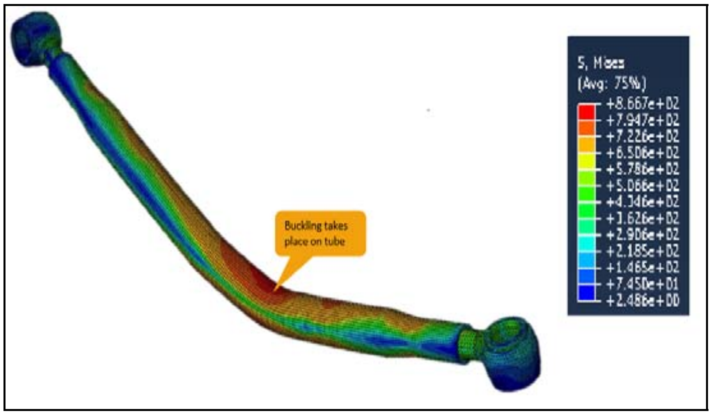

Fig. 4: Displacement plot for Ø50 x 6 tube buckling load: 9276 kg

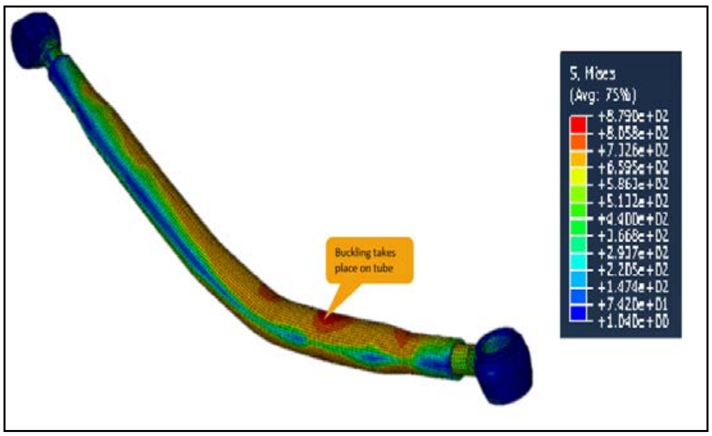

Fig. 5: Displacement plot for Ø50 x 6 tube buckling load: 10150 kg

CONCLUSION

The results obtained from CAE and buckling test rig proves that the buckling load of the drag link can be improved by providing reinforcement at the buckling zone. The future work of this project work deals with reinforcement of composite material over the buckling zone of the tube and reducing the diameter of the steel tube to avoid fouling.

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Accepted : 01.07.2016