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Stress Analysis of U-bolt used in Leaf Spring of Automobile for various Loads

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Abstract:-Most of Mechanical connection are subjected to dynamic loads. Rotating and reciprocating machinery generates significant cyclic loads (fluctuating).Threaded fastener such as U bolts are probably the best choice to apply a desired clamp load to assemble a joint or connection. The main characteristic of holding U-bolt of automobile wheel is being under cyclic load which are applied by bumpy rods. So it is necessary to prevent the failure of U bolt under different condition. As it is not possible practically to do experimental testing for every new design of bolted connection. So the actual testing is presented this testing is validated by FE software like ANSYS. The U bolt for testing will be taken of various material such as stainless steel and boron steel. The different load is acting on different portion of U bolt so there are three boundary condition taken. Experimental test conducted in order to validate the result obtained in FEA.

Keywords:- Stress, U bolt, ANSYS.

I. Introduction

Over last decades there has been growing interest from the automobile Industry in reducing cost of productive process in aggregating new technologies in vehicle component. Material and processes showed constant development in an attempt to improve mechanical properties of these parts This tendency has also been observed in the production of suspension systems of automotives vehicles, which are constituted of leaf springs kept together using U-bolts. Primarily the U bolt provides the force required to clamp the leaf spring and related component firm together. The properly installed U bolt eliminates any flexing of the leaf spring in area between U bolt. This is particularly critical since the hole for centre bolt in each leaf act as stress concentration which would lead to rapid leaf breakage if spring flexing was not totally eliminated by U bolt clamping force.

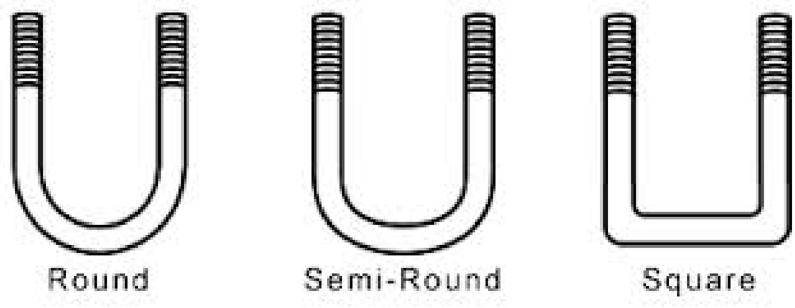


Fig 1. Formats of the bolts used in suspensions of vehicles (a)Round (b)Semi-round and c) Square.

Three basic types of bend are used on U bolt depending on suspension design and shape of mating parts such as Round, Semi-round bend, Square bend. Additionally each of these bend types may use forged material such as stainless steel and Boron steel.

1.1Problem Definition

It is found that most of mechanical failure caused by dynamic loading. Fatigue is one of the most dangerous mechanical failure because it occur under load that are lower than static strength of material. The U bolt of automobile are failed due to jerk because U-bolt are under compressive loading and when it is subjected to jerk it fails. Reduce the failure and to improve the quality of the U bolt. As it is not possible practically to do experimental testing for every new design of bolted connection. So the actual testing is presented this testing is validated by FE software like ANSYS is the main objective of the work.

1.2 Mathematical Modelling:-

The structure with bolted joints to be analyzed is discretized with a number of elements and then assembled at nodes. The elements of different type and shape with complex loads and boundary conditions can be used simultaneously using FEM. Consider an element of volume V bounded by a surface S with the traction vector $\bar{t}$ prescribed on a part of the surface SF. The finite element formulation is to begin with a variational principle related to total potential energy as follows:

$$\Pi = \int_V \sigma^T \varepsilon dV - \int_{SF} u^T \bar{t}\, dS = 0 \qquad (1)$$

where σ, ε and u are stress, strain and displacement vector, respectively. The first order variation of the functional Eq. (1) can be written as

$$\delta\Pi = \int_V \sigma^T \delta\varepsilon dV - \int_{SF} \delta u^T \bar{t}\, dS = 0 \qquad (2)$$

Using constitutive equation $\sigma = D\varepsilon$ and strain–displacement relation $\varepsilon = Bu$, the Eq. (2) is derived as

$$\delta\, u^T \left[\int_V B^T DB\, dV\right] u - \delta\, u^T \int_{SF} N\bar{t}\, dS = 0 \qquad (3)$$

where N is matrix of shape functions. Eq. (3) is the basic equation for the finite element discretization and can be converted to algebraic equations as follows:

$$Ku = f \qquad (4)$$

where K is the element stiffness matrix, f is the vector of surface loads.

1.3 Methodology:-

We will made up different bend type U bolt of stainless steel and boron steel without heat treated and with heat treated of same dimension.

1.4 Material and Specification:-

Material Properties	Stainless Steel		Boron Steel	
	Min	Max	Min	Max
Density(mg/m^3)	7.87	8.07	2.3	2.55
Young Modulus(Gpa)	190	205	362	472
Poisson Ratio	0.265	0.275	0.18	0.21

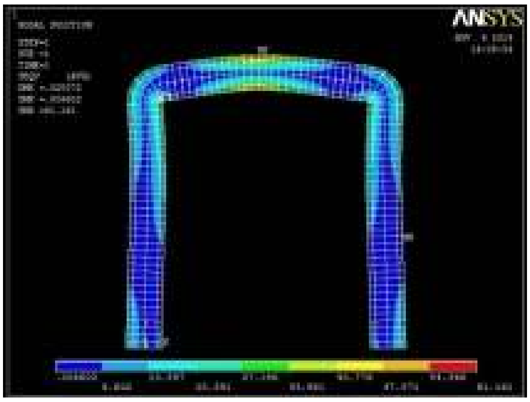
II. FEA

In this study,first I will preapered the model in CATIA V5 R17(Student version) software.then model will be import in Hypermesh for meshing and lastly the simulation of U bolt will be done in ANSYS 13.0(Student version). The boundary condition and different loads acting on the model will applied. The loads applied for this problem in hypermesh programe will be DOF and Forces.

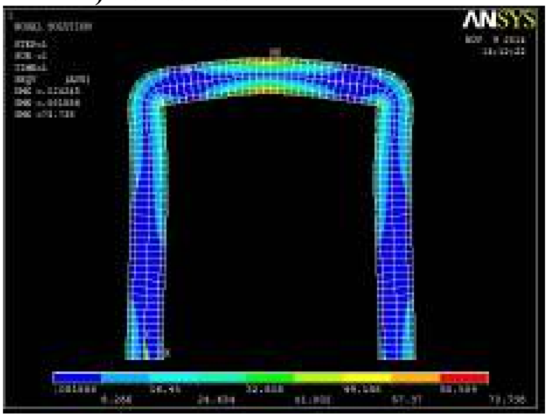
2.1 Stresses For different cases at different loads for Stainless Steel

1) For Point Load

i) For 500 N

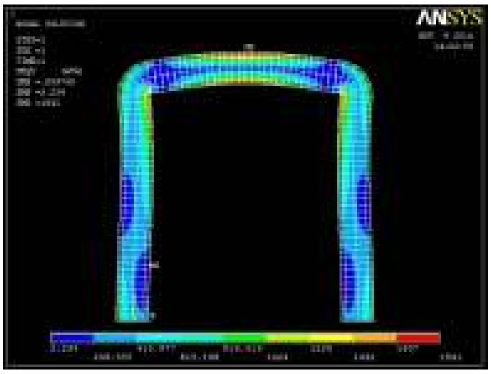


ii) For 600 N

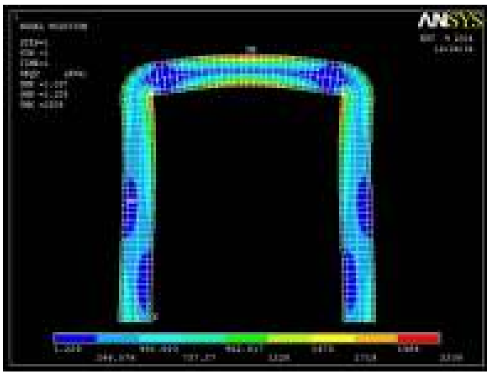


2) For Uniform Distributed Load

i) For 500 N



ii) For 600N

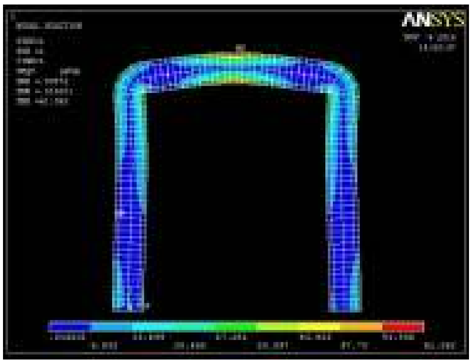


2.2 Stresses For different cases at different loads for Boron Steel

1) For Point Load

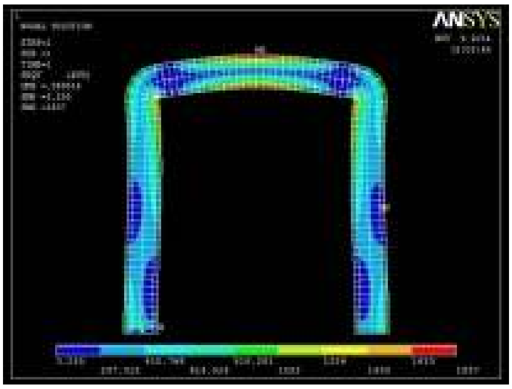
i) For 500 N

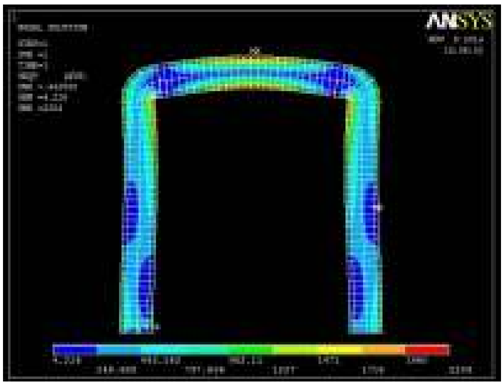
ii) For 600 N



2) **For Uniform Distributed Load**

i) For 500 N **ii) For 600 N**





III. RESULT

3.1Result of Software Work for Stresses in Stainless Steel for different loads

SR NO.	CASE	LOAD APPLIED (N)	MAX. STRESS (N/mm^2) by FEA method	MAX. STRESS (N/mm^2)by Exp.method
1	POINT LOAD	500	61.161	65.90
2		600	73.738	78.60
3	UNIFORM LOAD	500	1841	1985
4		600	2209	2352

3.2Result of Stresses in Boron Steel for different loads

SR NO.	CASE	LOAD APPLIED (N)	MAX. STRESS (N/mm^2) by FEA method	MAX. STRESS (N/mm^2) by Exp.method
1	POINT LOAD	500	61.362	66.36
2		600	74.942	80.40
3	UNIFORM LOAD	500	1837	2054
4		600	2204	2360

IV. CONCLUSION

From FEA and Experimental result it is concluded that the FEA technique can be suitably employed for the design analysis of U-bolt. It is not possible practically to do experimental testing for every new design of U-bolt. Also boron steel is more suitable than stainless steel for high compression strength of a new design of U-bolt.

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