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Stress Analysis on Automobile Stabilizer Hanger

Godwin Anwara Ibe[a*]

[a]*Department of Mechanical Engineering, School of Engineering Technology, Akanu Ibiam Federal Polytechnic, Unwana, Ebonyi State, Nigeria*

[a]*Email: godwinanwaraibeo@yahoo.com*

Abstract

The stabilizer hanger is one of the few components of an automobile that experiences most deflection and torsional loading, especially on rough roads. This has often led to the short service life of the component. The owners of automobiles are compelled to repeatedly replace the failed part. Hence, the need for stress analysis on the stabilizer hanger cannot be overemphasized. In this study, the simulation of the specimen using Solidworks simulationXpress—Analysis wizard is discussed with a view to identifying critical errors of the design and manufacture, and finally proffering solutions. Also, deflection and stress are compared with hanger thickness. Results are analyzed by the effects of variation of these parameters.

Keywords: Stress analysis; Stabilizer hanger; Automobile; Steel; Deflection; Failure stress.

1. Introduction

The stabilizer hanger is linked to the antiroll bar interconnecting the lower suspension arms so as to reduce tilting of the vehicle during turning maneuvers [1]. The hanger connects the sway bar to the vehicle chassis [2]. The stabilizer hanger should withstand the high strain effect of the sway rod [3]. If the hanger does otherwise, the consequence is the premature failure on the part. The design of the hanger can be effectively done through proper simulation and optimization [4].

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* Corresponding author.

From the literature review on the subject of study, there is virtually no relevant study carried out on the automobile stabilizer hanger, rather major works were found regarding antiroll bars and bushings. A typical automobile stabilizer hanger for Mercedes Benz car is shown in Fig. 1 below.

Figure 1: Automobile stabilizer hanger for Mercedes Benz car

The upper end of the hanger with 10mm bolt is fastened to the car chassis. The lower side is clamped to the antiroll bar with the aid of rubber bushings. The hanger in the market is made of normalized steel (AISI 4340) of 3mm thickness. During body roll, the hanger is subjected to torsion. A vehicle tilts when its movement suddenly changes to curvilinear motion [5]. Translational motion enhances the dynamic equilibrium of a body. The premature failure of the component particularly in Nigeria is not unconnected with the dilapidated nature of the roads. This reality, therefore, calls for a review and redesign of the hanger in order to optimize its performance on rough terrains.

In this study, stress analysis of the hanger with two different steel materials (normalized and annealed steel) and of varying thicknesses (namely 3mm, 5mm, 7mm, 10mm, and 13mm) will be carried out with SolidWorks SimulationXpress wizard. The data generated in the simulation will be compared graphically so as to obtain optimal results. However, the analytical approach adopted for the study represents a first-pass simulation, and therefore, cannot guarantee efficient and comprehensive results often obtained from stand-alone optimization software.

2. Methodology

2.1 Assumptions and Restrictions

(i) All loads are applied slowly and uniformly, constant conditions such as shock loading, vibration, and fatigue are excluded.
(ii) Faces with fixtures are treated as perfectly rigid.
(iii) Each material used has its own specific properties such as Young's modulus, yield strength etc.
(iv) The material deforms in a linear fashion with increasing load. Nonlinear materials (such as many

plastics) are not required in the analysis).

2.2 Normalized steel (AISI 4340)

Stress analysis was done with the above material of the hanger at varying thicknesses namely 3mm, 5mm, 7mm, 10mm and 13mm respectively. However, the stress distributions along the span model of 3mm and 5mm thicknesses are shown in Fig. 2 below. Also, the variations of the deflection or displacement along the span of 3mm and 5mm thicknesses are shown in Fig. 3.

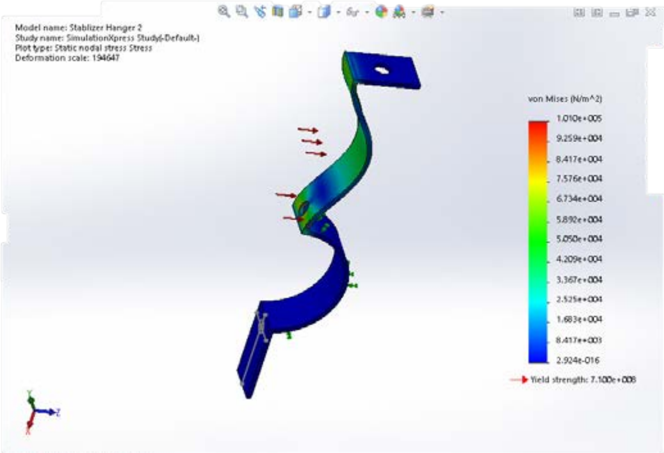

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Figure 2: Stress distribution of 3mm thick normalized steel

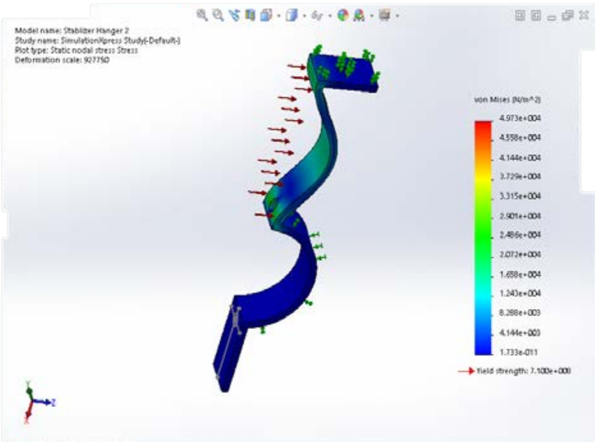

Figure 3: Stress distribution of 5mm thick normalized steel

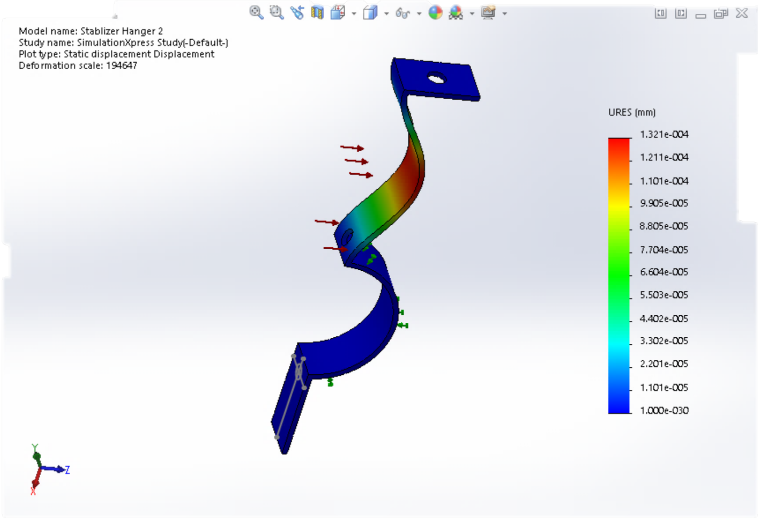

Figure 4: Variations of deflection of 3mm thick normalized steel

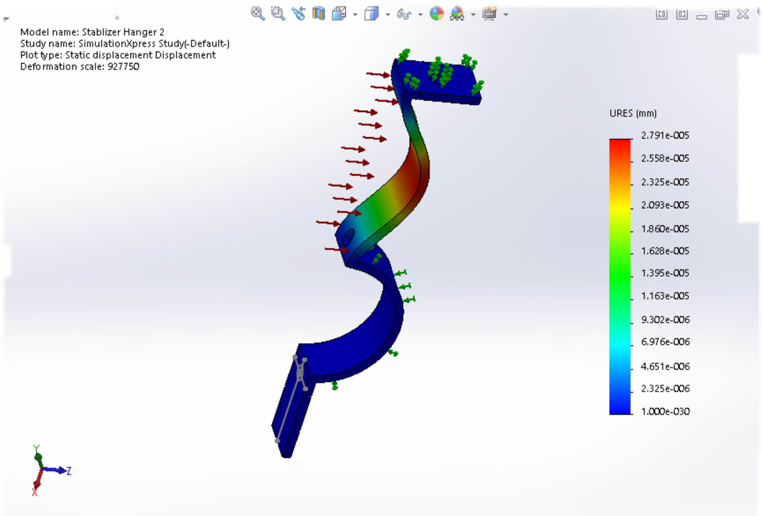

Figure 5: Variations of deflection of 5mm thick normalized steel

2.3 Annealed steel (AISI 4340)

Again stress analysis was conducted with annealed steel at varying thicknesses namely 3mm, 5mm, 7mm, 10mm, and 13mm respectively. With this material, the stress distribution and the variations of deflection for 3mm and 5mm thicknesses are shown respectively in Figs. 6, 7, 8 and 9 below

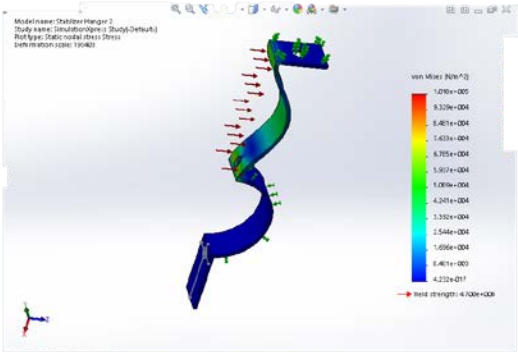

Figure 6: Stress distribution of 3mm thick annealed steel

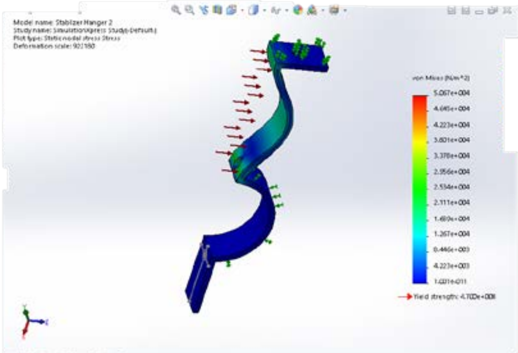

Figure 7: Stress distribution of 5mm thick annealed steel

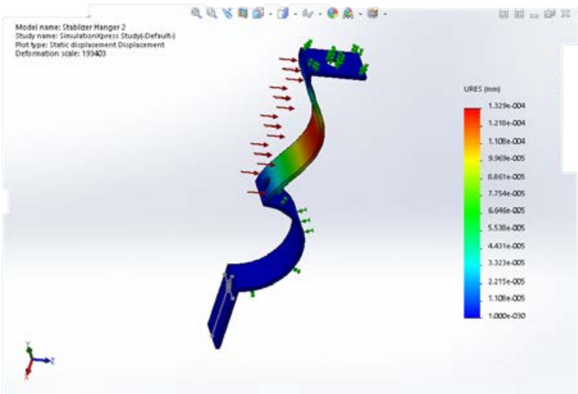

Figure 8: Variations of deflection of 3mm thick annealed steel

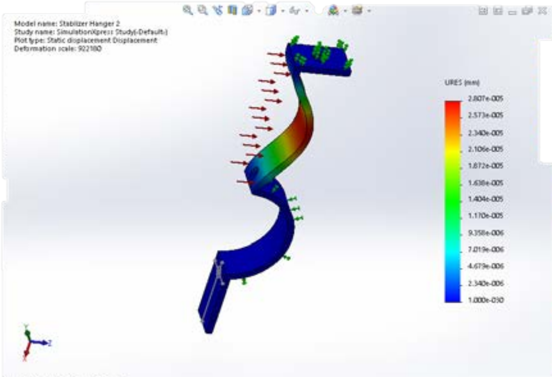

Figure 9: Variations of deflection of 5mm thick annealed steel

3. Results

The results of the stress analyses of the normalized steel and annealed steel regarding thickness versus failure stress are shown below in Table I.

Table I: Thickness Vs Failure Stress of both normalized and annealed steel

Thickness(m)	Failure Stress of Normalized Steel(N/m^2)	Failure Stress of Annealed Steel(N/m^2)
0.003	149.897	151.085
0.005	271.517	276.649
0.007	182.467	184.105
0.010	125.794	126.559
0.013	102.481	105.211

Table II below shows the results of thickness versus deflection of both normalized and annealed steel.

Table II: Thickness Vs Deflection of both steel materials

Thickness(m)	Max. Deflection of Normalized Steel	Max. Deflection of Annealed Steel
0.003	0.0242	0.0243
0.005	0.0188	0.0189
0.007	0.0247	0.0067
0.010	0.0081	0.0082
0.013	0.0036	0.0036

4. Discussion of Results

Using table I, a graph of stress versus thickness is shown below in Fig. 10. Also using table II, a plot of maximum deflection versus thickness is shown below in Fig. 11.

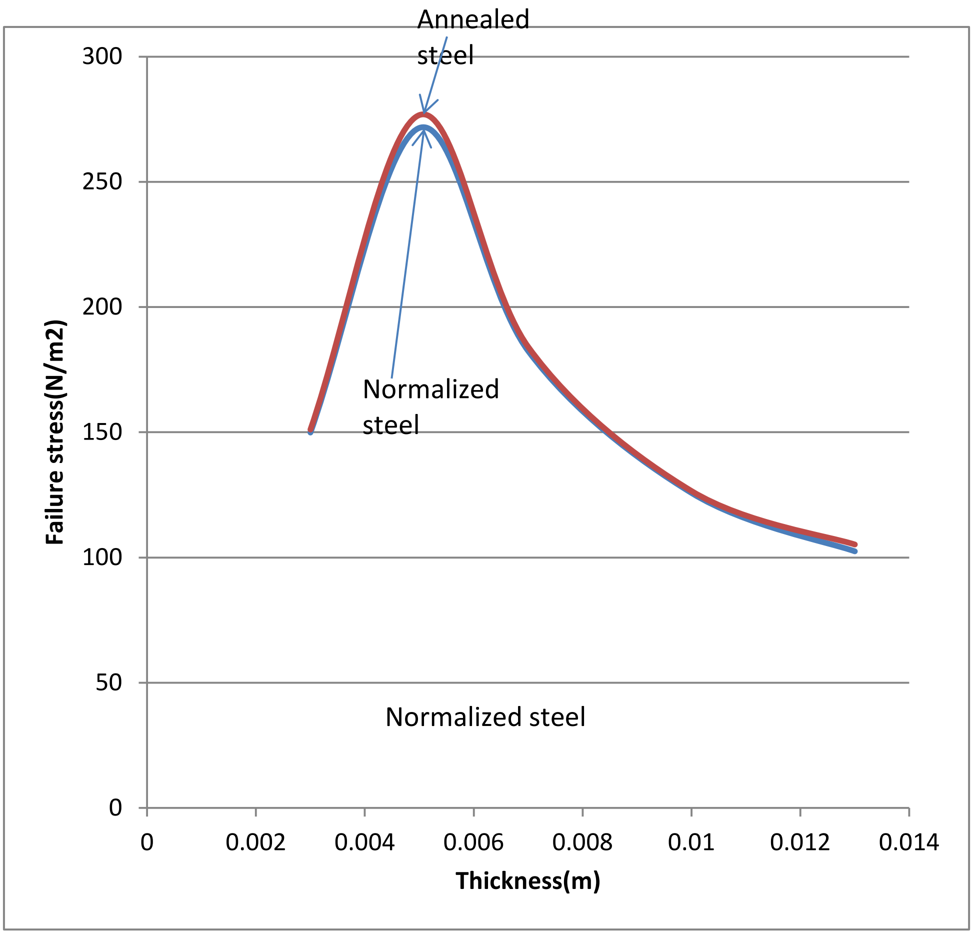

Figure 10: Stress vs Thickness

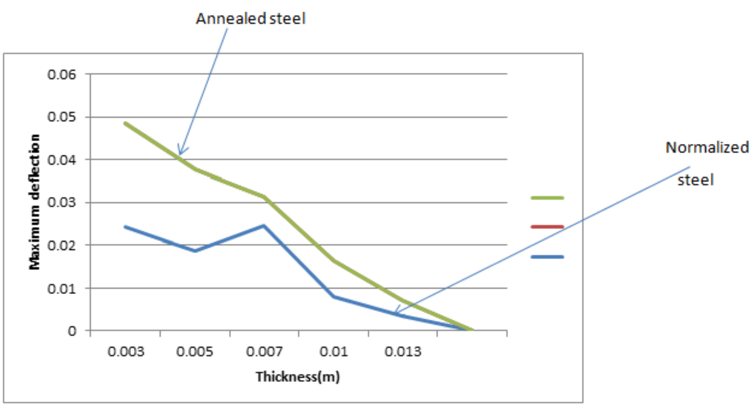

Figure 11: Maximum Deflection vs Thickness

From Figs. 10 and 11 above, the following observations and deductions have been made.

(a) The annealed steel gave the highest breaking stress of 276.649N/m^2 for the 5mm thickness.
(b) Both materials experienced the highest deflection for 3mm thickness.
(c) However, at 5mm thickness both materials show an abrupt decrease in deflection, signifying a suitable sample thickness.

5. Conclusions and Recommendations

The following conclusions and recommendations have been made concerning the study.

(i) At 5mm thickness, the highest failure stress of 276.649N/m^2 was recorded with the annealed steel sample.
(ii) The deflection at 5mm thickness of the sample is lower than that of the 3mm thickness, signifying better damage tolerance.
(iii) The 5mm thick annealed steel, therefore, is recommended to Mercedes Benz automaker instead of the 3mm thick normalized steel currently being adopted by the car manufacturer. The recommendation is based on the findings of the study that the 5mm thick annealed steel gave optimum performance.

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