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Study and analysis of structural steel sway bar using linear and nonlinear regression techniques

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Abstract

The primary goal of this project is to determine the effect of varying sway bar stiffness and the stress generated when the clamping distance of the anti-roll bar is changed. A sway bar effect on the rear suspension can only be detrimental to vehicle handling. To ensure a vehicle's desired handling characteristics, these installations should be tested under severe cornering conditions. The analysis has been done by using Beta CAE ANSA, MSC NASTRAN, and Beta CAE METAPOST software applications for generative structure analysis. This analysis is done on the basis of constant displacement but in the opposite direction since the main motive of the sway bar is achieved by twisting it. After gathering the engineering data, the prediction of bushing distance for the respective stiffness of the bar is calculated using a linear regression technique. In this study, observe the stiffness behaviour with respect to bushing position and predict the bushing distance for a target stiffness using a linear regression table.

Introduction

A sway bar, also known as a stabiliser bar, is part of the suspension and helps to stabilise the vehicle for handling purposes. Sway bars are torsional springs that are laterally assembled and resist the vertical displacement of tyres relative to one another [1]. The vertical suspension rate is not increased when both tyres are deflected simultaneously, but stiffness is increased for one tyre bump. Sway bars are typically installed in both the front and rear suspensions, or in the front suspension only. The use of the sway bar only on the rear suspension can have a negative impact on vehicle handling. Such a setup should be tested under cornering conditions to ensure that the desired handling characteristics are met [2], [3]. In this study, our primary aim is to observe the stiffness behaviour with respect to bushing position and predict the bushing distance for a target stiffness using a linear regression table (see Fig. 1).

When defining the constitutive and equilibrium equations for studies including geometric nonlinearity, changes in geometry as the structure deforms are taken into account. The use of massive deformation analysis based on geometric nonlinearity is necessary in many engineering applications, including metal forming, tyre analysis, and medical device analysis [4], [5], [6], [7]. Some applications, such as those involving cables, arches, and shells, call for small deformation analysis based on geometric nonlinearity. The nonlinear behaviour of a material depending on its present deformation, deformation history, rate of deformation, temperature, pressure, and other factors is referred to as material nonlinearity. Hyperelasticity and big-strain (visco) elasto-plasticity are two examples of nonlinear material models (in rubber and plastic materials). Kinematic constraints in the model might lead to constraint nonlinearity in a system [8], [9], [10]. By limiting a model's mobility, one may limit the degrees of freedom in its kinematics.

In order to get around problems like porosity, dispersion, and bonding of reinforcement in matrix materials, hybrid nanocomposites are now preferred as a viable substitute for traditional metal matrix composites.

Section snippets

Methodology

The pre-processing, calculation, and post-processing stages of the standard procedure for solving problems with the finite element method (FEM) were all completed before the linear static analysis could be carried out.

Post-processing

The run for all 11 experiments was done using MSC Nastran software, and post-processing was done using meta post software. The file is viewed in Meta, and the displacement sway bar to sway bar links, hard point, and max von misses are given in Table 2.

As per the table, the best and worst can be ranked and go ahead for further decisions. This study shows that more bushing distance results in lower stress and higher stiffness.

Results of EXP11

Linear elastic analysis combined with the idea of plastic hinges provides the starting point for more complex studies, which are frequently appropriate for computer-oriented methodologies. The linear stiffnesses of the frame are represented by these slopes. with frictionless pins inserted at the corresponding stress levels and sites where plastic hinges have formed.

Themaximum von mises stresses of the sway bar using the linear regression technique and the von Mises of the sway bar are shown in

Conclusion

When applied forces and displacements have a nonlinear relationship, the analysis is said to be nonlinear. Geometrical nonlinearities (large deformations), material nonlinearities (elasto-plastic material), and touch may all lead to nonlinear effects. Because of these factors, the stiffness matrix changes when the load is applied. In contrast, the stiffness matrix was constant in the linear static analysis. As a consequence, a separate solution method and, therefore, a different solver, are

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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