Abstract

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DESIGN, TESTING, and FINITE ELEMENT ANALYSIS FOR VEHICLE SPACE FRAME

Vehicles are built because of their need and that need defines the type of the vehicle and the type of chassis used. Some vehicles are built to economize, some are built to last, some are built to race, some are built for comfort ability and some are built for military applications. Undoubtedly, space frames can serve in most of vehicles applications. Considering most of vehicles, torsional stiffness comes as a priority in chassis design as it greatly affects its dynamics. The problem investigated here is to develop a design methodology for designing tubular space frame used in vehicles in other applications. For this reason, a finite element model was made to evaluate torsional stiffness of vehicle frame and the results were validated by an experiment using a test rig that was designed and manufactured to test the torsional stiffness of that frame. The test rig was also used to find the deflection and the twist angle along the vehicle frame. After the FEA model was validated, a study of the parameters affecting space frame stiffness was conducted to know the impact of varying tube cross sections, length ratio, triangulation, intermediate sections and materials on both frame stiffness and frame stiffness to weigh ratio. From this extensive study, several guidelines for designing tubular space frame were concluded and a novel design methodology for tubular space frame in general application and in vehicle application was deduced. To test the novel design methodology, it was applied in designing a Formula SAE tubular space frame. Then a finite element analysis was done to find the torsional stiffness of the frame. Also, a rollover analysis was carried out to find the deflection in the Main hoop and the Front hoop when it is loaded by the weight of the vehicle.