Formula Student car chassis – research on the torsional stiffness

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Abstract. In the article, the torsional stiffness of a formula student's space frame was analyzed. The article mainly focuses on the comparison of the stiffness between different frame designs, which were used in three consecutive formula student cars designed by the weracing™ team as well as a comparison of the result of two calculation methods. The calculations were made in computer-aided engineering software, i.e. ABAQUS dedicated to analyzing Finite Elements models. The assumption for analysis was to check the rotation of the frame after applying a 5000 Nm load. The torsional load was introduced by first fixed the four rear bulkhead joint and then subsequently applying a force couple to the upper front wishbone mounts. Having a distance between joint from the central line and torque moment, the force for specific nodes can be calculated. The calculation for each model was performed. The obtained differences result from the construction of frames and applied methods of calculations.

1 Introduction

In the field of vehicle engineering, especially in the context of sports car design, investigating the torsional stiffness of the frame plays a crucial role in ensuring excellent control and safety under extreme operating conditions. Buggies, racing cars, and other sports vehicles require an optimized frame design that guarantees both precise handling during cornering and minimizes deformations under the influence of forces during dynamic driving.

In the many research of racing vehicles, torsional stiffness of the chassis plays a crucial role, ensuring precise steering and stability during extreme driving conditions [1-7]. While torsional stiffness is the predominant factor, vibrations also impact the vehicle's behavior. Past studies on the influence of vibrations on vehicle construction have shown that, although they may be less significant than torsional stiffness, they can still affect the overall performance of the vehicle. In [8] AFSV (articulated frame-steered vehicle) and HPS (hydro-pneumatic suspension) were applied in the research on the torsional stiffness of the vehicle within the context of a three-dimensional dynamic model. The study included an analysis of the influence of HPS parameters on the steering behavior of AFSV, encompassing directional stability and ride comfort, which was crucial for optimizing the vehicle's design in terms of torsional stiffness.

Some researchers [9] have focused their research on the impact of vibrations on racing vehicles. Their work has included analyzing how vibrations can affect the dynamic parameters of the vehicle and how to minimize the negative effects of these vibrations on performance and driving comfort. An important aspect is also the distribution of forces in the chassis during braking [10]. Thus, while torsional stiffness remains a crucial element, understanding and controlling vibrations constitute an additional area of research aimed at optimizing the overall construction of a racing vehicle. In the construction of vehicles of this