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SAE Baja Custom Caliper and Upright Design

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*redacted version to maintain confidentiality of the Zips Baja team

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Abstract

The Zips Baja Off-Road Racing team had a successful 2018 season however some aspects of the car needed to be updated and improved for the 2019 season. This reports captures the design cycle performed to improve the cost, integration, and reliability of the front braking caliper and upright.

Executive Summary

The Zips Baja Off-Road racing Team 2018 season although successful was plagued with inconsistent braking within the front braking system. After the season and further investigation of the front brake system, it was concluded that new front calipers were needed. With these new calipers a need to redesign the upright was created and so the beginning of the front assembly redesign was established.

After the establishment and further research of the issue was performed potential solutions were brainstormed with black box analysis and a morphological chart with consideration towards the teams goals of increasing acceleration and decreasing cost by 20% were main drivers during the design process. The upright assembly integrates the braking system in the form of the calipers with the suspension and steering systems; the changes made to the upright could not affect the geometries of these systems specifications created by the team designers. This required that the mounting of the steering arm and suspension arms remain the same to limit any change in the degrees of freedom.

Each Iteration of the upright caliper assembly went through a cost analysis, finite element analysis, and fitment test. The results were compared to the 2018 model to quantify the improvements made. 3D models were created of favorable iterations to test physical fitment on the 2018 car rather than exclusively in SolidWorks®. The caliper also went through a bench top test to ensure that it sealed properly as well as coefficient of friction tests were conducted to chose pad and rotor material. Based on these results the optimal design was chosen and machine. Additional dynamic tests such as static and dynamic brake checks, steering U-turn tests, and endurance like simulation were performed on the assembly on the 2018 vehicle.

The assembly's performance was analyzed and some further optimizations to the upright and caliper were added. The finalized assembly was placed on the 2019 vehicle and the same static and dynamic tests were performed again to ensure the changes made were acceptable and enhanced the cost score, reliability and performance of the vehicle when compared to the 2018 vehicle assembly.

The resulting solution had a 77% decrease in cost, passed both dynamic and static brake checks consistently, and reduced weight by 42%, without compromising the integrity of the system which passed the specification of a minimum factor of safety of at least 1.4.

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