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Title: Experimental proposal of a 'HALO'-type security device in a FORMULA SAE 2023 type vehicle

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INTRODUCTION

According to the 2022 fatality statistics from the Insurance Institute for Highway Safety (IIHS), 10,229 deaths resulted from frontal collisions or rollovers, accounting for 73% of the total accidents (combined).

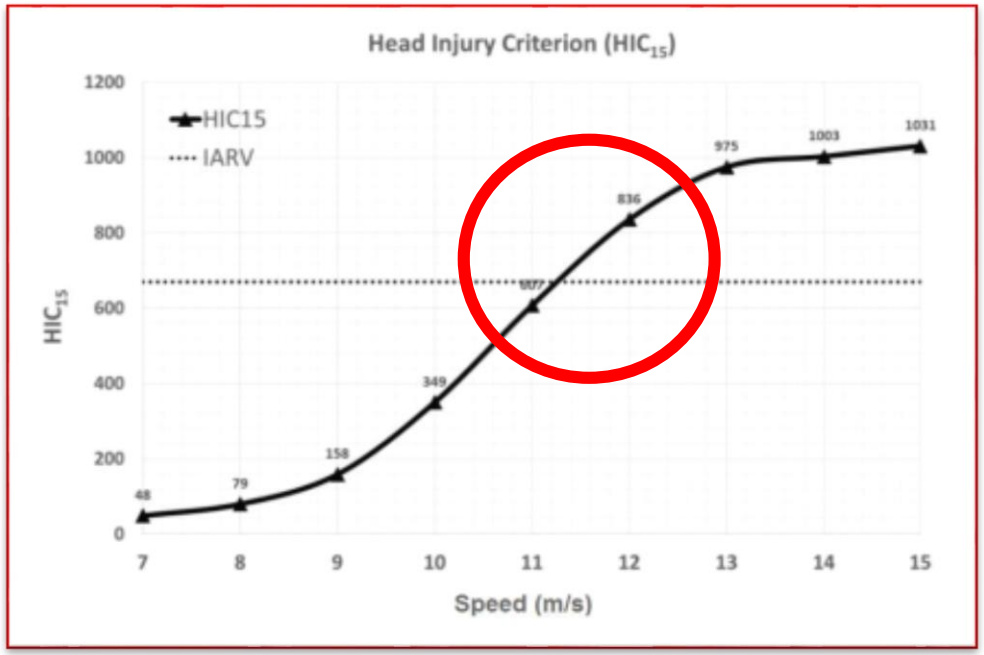
Passenger vehicle occupant deaths in all crashes by impact point and vehicle type, 2022

Point of initial impact	Car occupants		Pickup occupants		SUV occupants		All occupants	
	Number	%	Number	%	Number	%	Number	%
Frontal	8,076	58	2,811	60	4,043	59	15,192	59
Side	3,551	26	811	17	1,271	19	5,697	22
Rear	744	5	187	4	385	6	1,342	5
Other (mostly rollover)	1,449	10	892	19	1,104	16	3,495	14
Total*	13,820	100	4,701	100	6,803	100	25,726	100

*Total includes other and/or unknowns

Table 1. Fatality Facts 2022, IIHS, 2022.

For speeds below 40 km/h, the attenuator required by regulations may be sufficient to prevent severe trauma, as indicated by the Head Injury Criterion (HIC), which produces safe values below 700. However, once speeds exceed 43 km/h (12 m/s), these values rise, increasing the risk of severe injuries.



Graphic 1. Head Injury Analysis of Vehicle Occupant in Frontal Crash Simulation: Case Study of ITBâs Formula SAE Race Car, Mihradi Sandro, Golfianto Hari, 2017.

In competitive events, where the risk of accidents is inherent, it is vital to prioritize the safety of participants to minimize the potential for severe injuries.

Implementing advanced safety measures not only protects the drivers but also enhances the overall integrity of the event.

This study focuses on enhancing driver safety in Formula SAE vehicles by integrating a HALO-type device, similar to the one used in Formula 1 cars.

- The primary objective is to adapt this proven safety feature to the specific requirements of Formula SAE, aiming to reduce the risk of injury in high-impact scenarios.

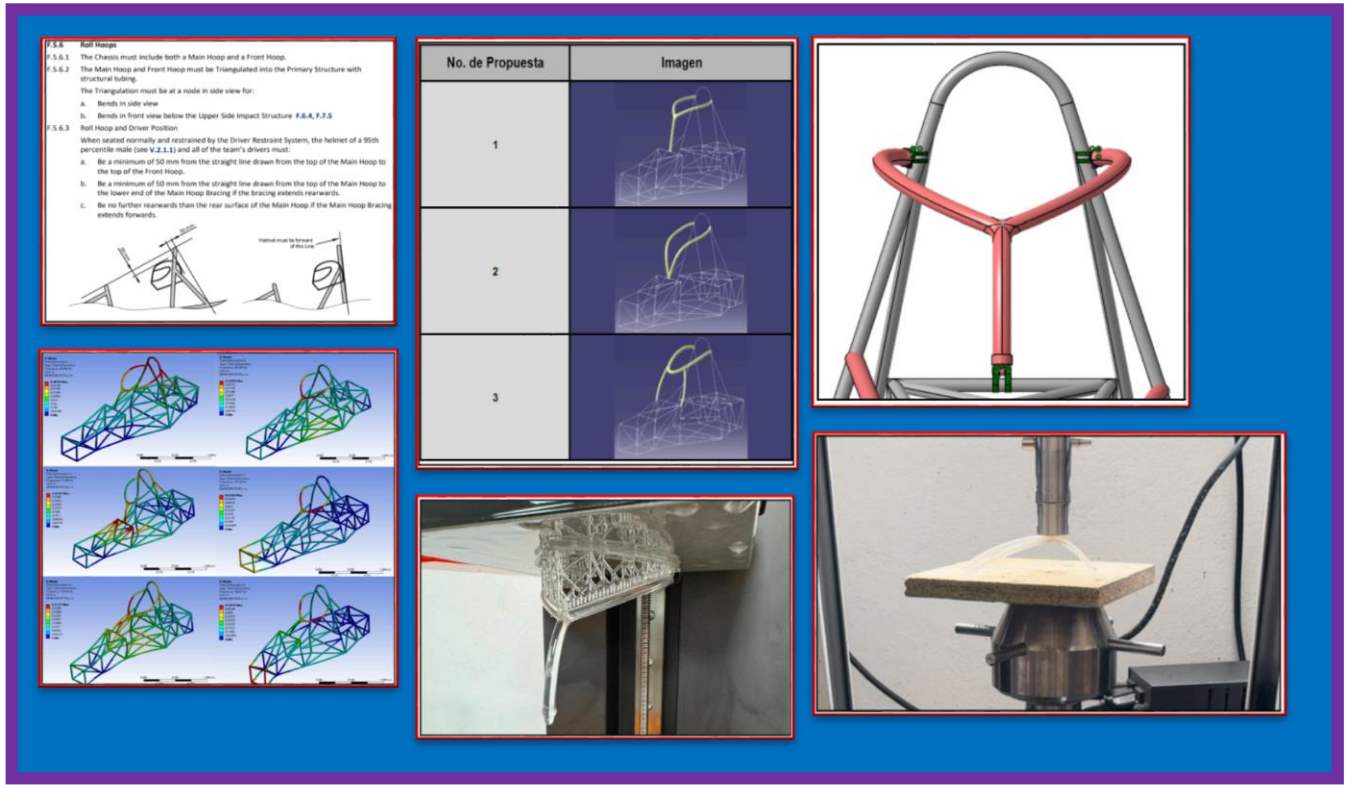
- Additionally, the implementation of this device promotes innovation in vehicle design and could potentially pave the way for safer wheel-to-wheel racing within the Formula SAE competition.

Figure 1. Halo device used in F1

Figure 2. Halo device protection against objetcs and rollovers

METHODOLOGY

1. Halo Safety Device Proposal
2. Research for FSAE Rules and FIA regulations
3. Planning the proposal
4. Generating the CAD models
5. Proposal selection
6. Proposal validation (ANSYS and CATIA V5)
7. 3D Printing and physical testing
8. Results

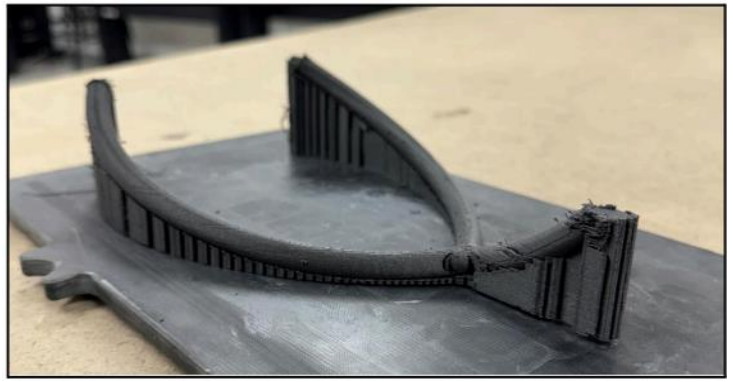


Creating the Proposals

- Research for limitations (experimental)
- Generating CADs
- Validating CADs

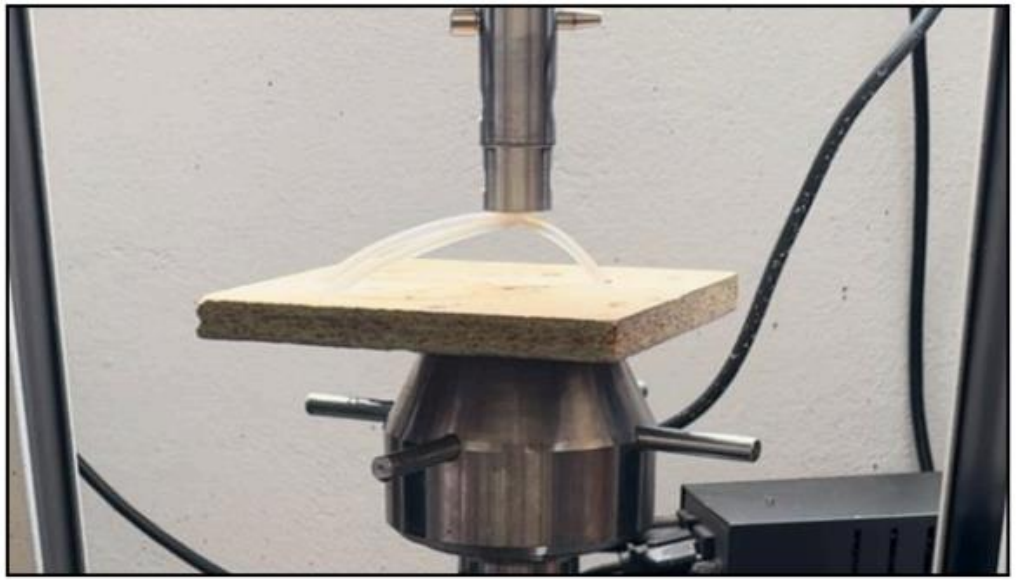
Testing the Proposal

- 3D Printing



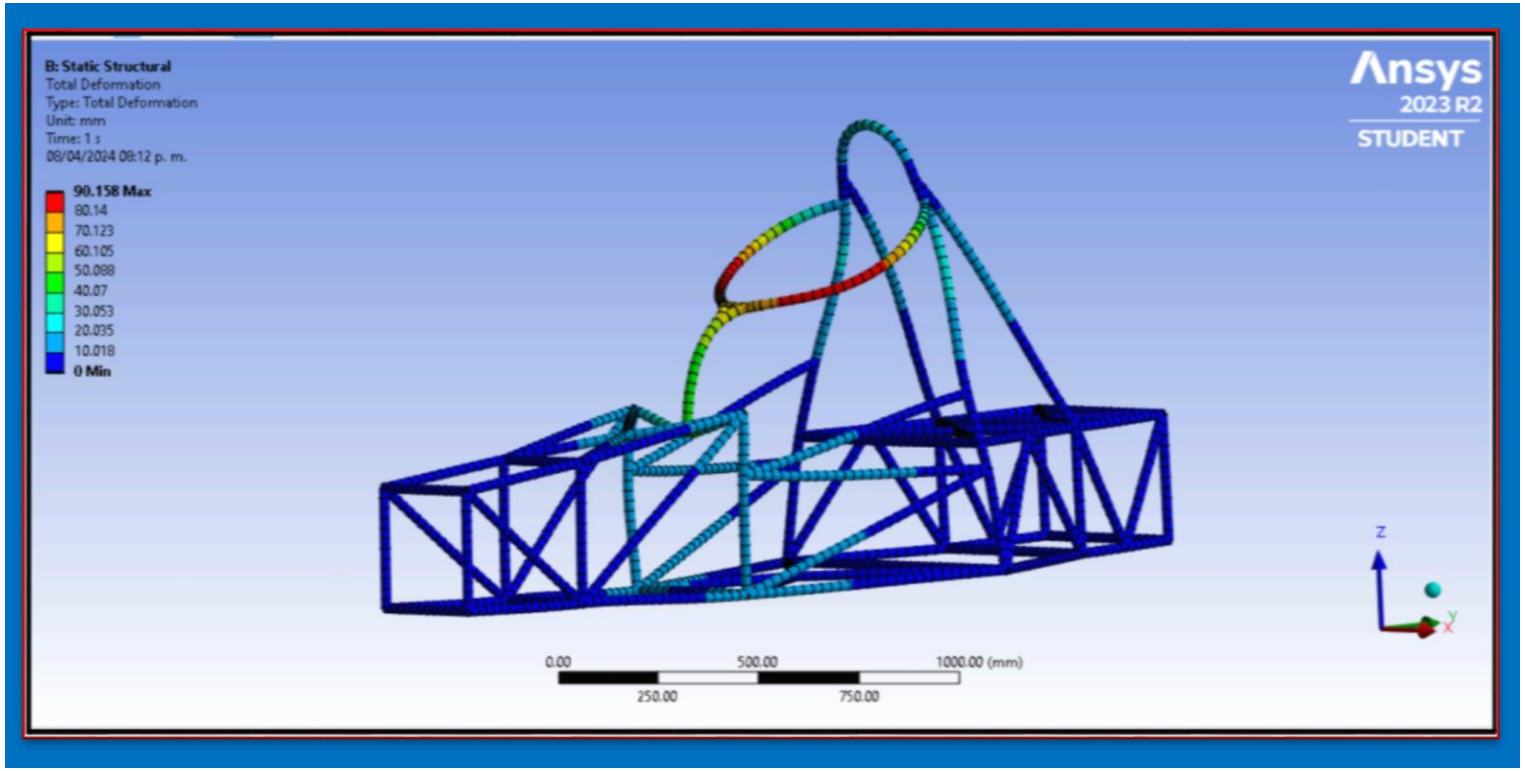
- Physical Testing

- Results



RESULTS

Under the defined deformation tolerance of 90 mm, the total deformation from the analysis with the proposed material and geometry is recorded at 90.158 mm. This exceeds the specified value by 0.158 mm while still maintaining the frequency range. It is important to note that this is merely an experiment, and the results are considered acceptable given the variable conditions during testing and the materials selected for the trials.



CONCLUSIONS

This experiment helped us to put in practice a lot of the subjects involved in the major, this project required the matching of some knowledge (CAD, design evaluation, structural design, etc.). And we can conclude that the idea of integrating an additional device is promising. While it may be costly due to manufacturing considerations, it could yield significant design points by evaluating the validity and legality of the proposal within the Formula SAE regulations.

Moreover, this integration is considerated beneficial as it helps prevent direct contact between the driver and the surface or object upon impact. Furthermore, successful implementation could pave the way for wheel-to-wheel racing within the competition, enhancing the overall racing experience.

ANNEXES

- [A] Análisis del Modo y Efecto de la Falla del diseño (AMEFP) - Diseño Tipo Halo para formula SAE

- [B] Clear Resin V5 Datasheet

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