AN AUTOMOTIVE PERSPECTIVE TO SAVE MOTORCYCLISTS

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INTRODUCTION

Over the last 20 years, research on road safety has predominantly focused on protecting car occupants, with significant results, but the number of fatalities and injuries among other categories of road users has not fallen to the same extent; indeed, in some cases, it has risen[1]. In 2020, motorcyclists were nearly **28 times more likely to die than passenger car occupants** in a crash per vehicle miles traveled[2]. Thus, a transfer between these two fields is compelling.

OBJECTIVES

To evaluate the effectiveness of the Belted Safety Jacket (BSJ), a **concept device**[3] for riders, by correlating **real-world injury data with simulation results.**

METHODS

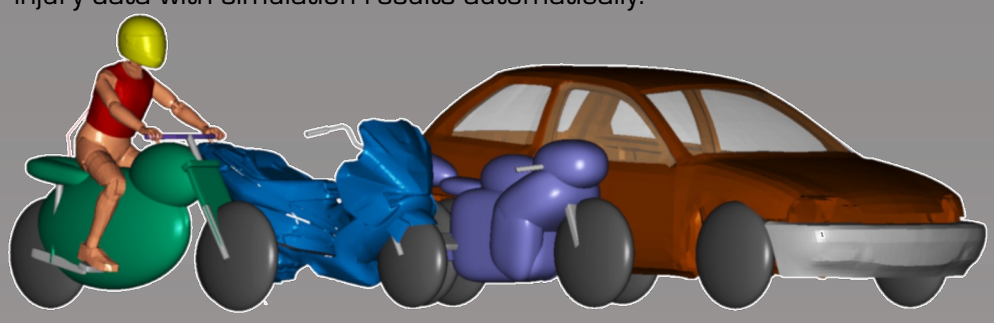
A total of **2679 accidents** were collected across ISO 13232, MAIDS, and GIDAS databases. Only collisions between motorcycles (MC) and passenger cars (OV), recognized as the **most frequent obstacle**[4] [5] [6], were considered. Two different simulation methods were needed to compute biomechanical indices and suffered injuries: i.e., Multi-Body (MB) and Finite Element (FE) computer simulations.

- MULTI-BODY -

A Madymo environment was set up to observe the behavior of the BSJ in various crash conditions. The environment included **three motorcycle styles** (sport touring, sport, and scooter), a family car (the Geo Metro model), and a facet dummy (MATD)[7].

- DATA GENERATION | MINING -

In HyperStudy, six variables were parametrized to automatically match each simulation up with the related crash event: (impact speed (x2), contact point (x2), Relative Heading Angle (RHA), and the BSJ).
A **probabilistic method**[8] was coded in MATLAB to correlate real-world injury data with simulation results automatically.

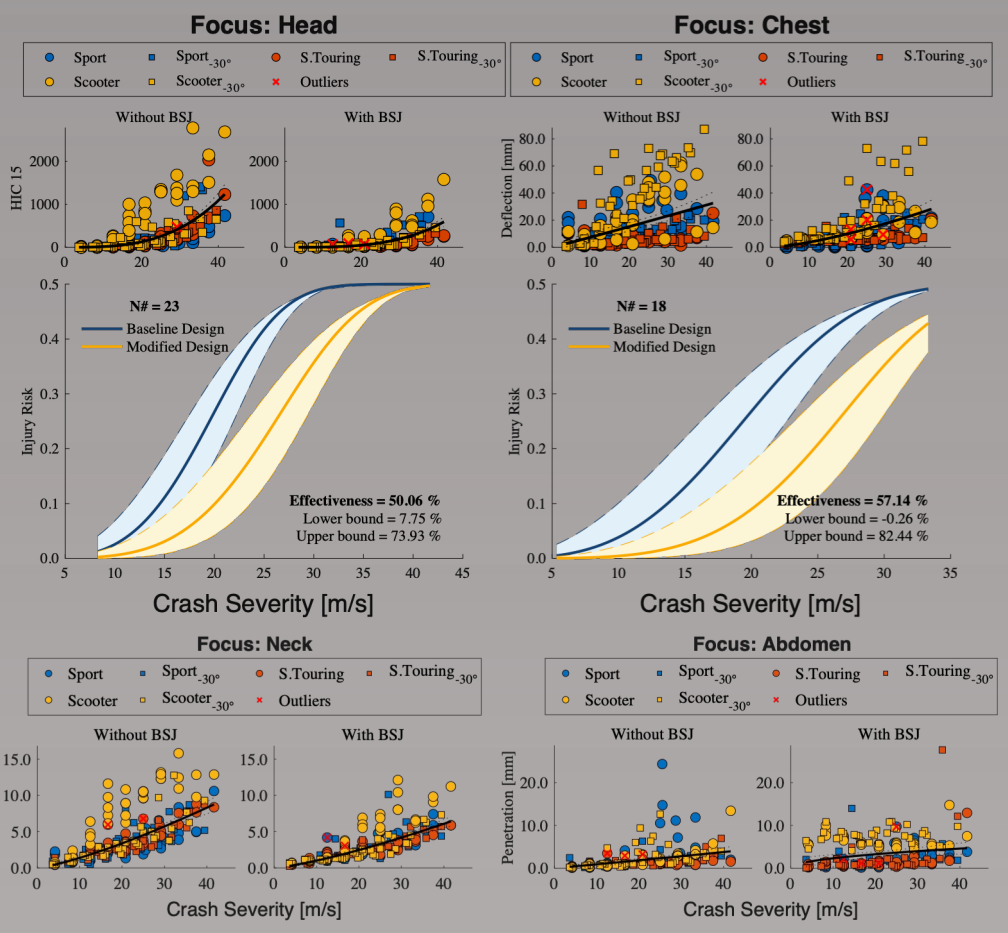


- FINITE ELEMENT -

In Ls-Dyna, the HBM (THUMS)[9], helmeted and adequately seated on the motorbike, was exploited for selected configuration to yield insights into human body injuries: bony fracture occurrences, organ tissue injuries, and more.

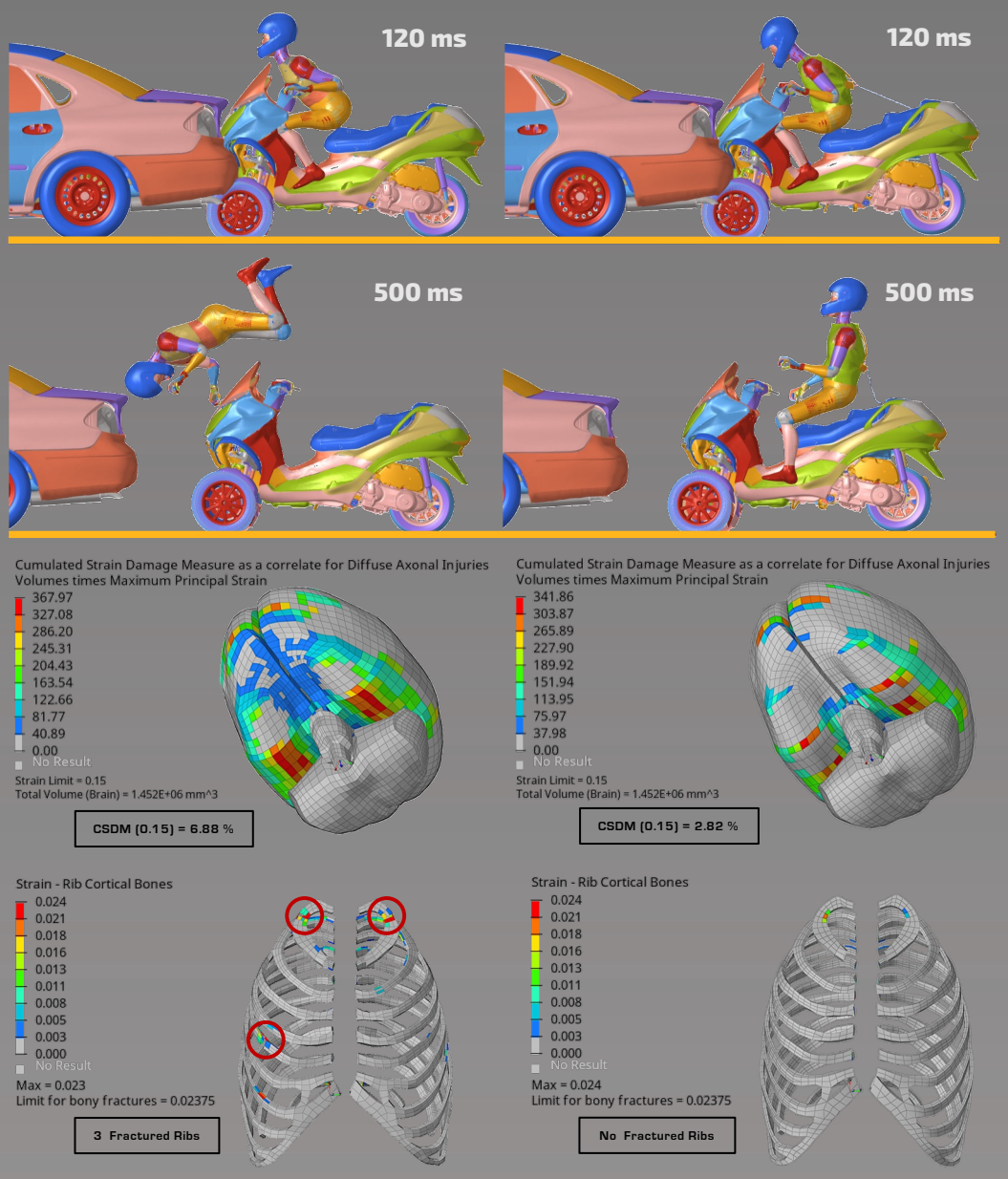
RESULTS

- MULTI-BODY [head-on collisions] -



* Crash severity was expressed through closing speed, which was found to be the best proxy for crash severity [10]

- FINITE ELEMENT (head-on-rear collisions) -



CONCLUSIONS

The outlined approach evaluated a concept device via:

- an overview of its **potential benefits by biomechanical indices** by correlating real-world injuries with MB analyses;
- an in-depth study of its **potential benefits by detailed injury analyses** on organs, over a small sample of configurations, via FE analyses.

The developed protective device exploited belt knowledge to protect riders. It turned out promising, providing valuable insights for policymakers, researchers, and manufacturers in improving the safety of riders and reducing the risk of road injuries by means of **personal protective equipment** (PPE).

REFERENCES

[1] Morris, A.P., Brown, L.A., Thomas, P., Davidse, R.J., Phan, V., Margaritis, D., Usami, D., Robibaro, M., Krupińska, A., Sicińska, K., Ziakopoulos, A., Theofilatos, A., Yannis, G., 2018. SAFERWHEELS Study on Powered Two-Wheeler and Bicycle Accidents in the EU.

[2] National Center for Statistics and Analysis. National Highway Traffic Safety Administration (NHTSA). 2022, May. Motorcycles: 2020 data -- Traffic Safety Facts. Report No. DOT HS 813 306.

[3] Grassi A, Barbani D, Baldanzini N, Barbieri R, Pierini M. 2018. Belted Safety Jacket: A new concept in Powered Two-Wheeler passive safety.

[4] ISO 13232: 2005. Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles.

[5] MAIDS: 2009. Motorcycle Accidents In Depth Study - Final Report 2.0.

[6] Puthan P, Lubbe N, Shaikh J, Sui B, Davidsson J. 2021. Defining crash configurations for Powered Two-Wheelers: Comparing ISO 13232 to recent in-depth crash data from Germany, India and China.

[7] TNO Automotive, 2013. Madymo Model Manual Version 7.5.

[8] Korner, J. 1989. A Method for Evaluating Occupant Protection by Correlating Accident Data with Laboratory Test Data.

[9] Toyota Motor Corporation, Toyota Central R&D Labs., Inc., 2019. Total Human Model for Safety (THUMS), AM50 Occupant Model Academic Version 5.03.

[10] Ding C, Rizzi M, Strandroth J, Sander U, Lubbe N., 2018. Motorcyclist injury risk as a function of real-life crash speed and other contributing factors.

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