Development of a Test Methodology for PMHS-Occupied Powered Two-Wheeler and Motor Vehicle Crash Scenario

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Introduction

Thousands of powered two-wheeler (PTW) occupants are killed every year, but there remains a lack of information regarding injury mechanisms needed to improve the safety of those occupants. Crash databases and literature were analyzed to determine common PTW crash configurations and the injuries sustained, but these studies lacked kinematic data, injury timing, and injury mechanisms needed to validate current safety tools such as anthropomorphic test devices (ATDs) and finite element (FE) human body models. Previous testing has utilized ATDs to simulate an occupant in a PTW versus motor vehicle crash, but lacked validation data from postmortem human subject (PMHS) testing which may limit the conclusions drawn from this testing. A repeatable test setup that mimics real world crash events using PMHS is required to further validate safety models and improve their injury predication capabilities before conclusions on injury mechanisms can be drawn. Therefore, the objective of this study was to create a repeatable methodology for crashing a PTW, occupied with an instrumented PMHS, into a stationary motor vehicle.

Methodology

Three tests were performed, each with a 50th percentile male PMHS instrumented with strain gages and 6 degree of freedom (DOF) motion sensors and seated on an instrumented 2022 KTM 390 Duke. The PTW traveled at 50 kph into the passenger side of a modern sedan offset by 30 degrees. Instrumentation on the PTW included rosette stain gages on both the front forks and each side of the gas tank, along with 6DOF blocks on the left front fork and at the PTW center of gravity. The PTW and sedan had both FARO points and laser scans taken before and after the test to evaluate the deformation caused by the impact. Over 160 channels of strain, acceleration, and angular rate were recorded between the PTW and PMHS per test, in addition to 6 high-speed videos to evaluate repeatability between tests. The PMHS was positioned on the PTW with a target of a 10 degree forward lean of the thorax with hands and heels on the handlebars and footpegs, respectively. The head angle was targeted to be 0° in the Frankfort plane. Angles of the humerus, forearm, and femur were recorded and kept consistent between tests. The head and shoulders were held up by a support system that released prior to impact. After the test, each PMHS underwent anatomical dissection to identify injury locations and severities.

Results and Conclusions

Data from the strain gages were used to calculate strain rate to determine fracture timing. Fracture timing was aligned with high-speed video to give more context to the impact, and to aid in determining the fracture mechanism. Results from the three tests showed comparable speeds, deformation, PTW impact location, and injuries amongst the PMHS which were also consistent with injuries found in the literature and database reviews. As a result, it was concluded that the study was successful in developing a repeatable test methodology between a motor vehicle and PTW with an instrumented PMHS occupant. With a reliable testing procedure, future work will focus on evaluating kinematic response and injury mechanisms to improve safety tools to enable development of protection systems for PTW occupants.