HYBRID III RESPONSE IN A SAE, BAJA VEHICLE UNDER FRONTAL IMPACTS

**Introduction**

- The SAE Baja is a student design competition where participants design and build an off-road vehicle.
- The competition involves numerous off-road events to challenge student’s designs.
- SAE Baja rules require the driver to wear a 3.3 rated arm restraint and neck collar. Snell M2000 standard helmet, and a SFI/FIA rated four point seatbelt.
- The rules stipulate minimum chassis frame requirements to ensure the roll cage is adequate to protect the occupant.
- A top speed of 10.3 m/s (37kph/23mph) was recorded in the acceleration & speed event of the 2005 competition.

**Research Goals**

- To assess injury risks to the occupant in a Baja vehicle during frontal impacts.
- To develop an understanding of modeling a crash scenario.

**Methods**

**Simulation Setup**

- An explicit finite element program (LS-Dyna, LSTC) was used to simulate a frontal impact into a rigid wall.
- 2.5 m/s, 5 m/s and 10 m/s initial vehicle impact velocities were simulated. Each set of velocities were simulated with and without a neck collar, total of 6 simulation runs.
- The tubular chassis frame, seat, seatbelt, helmet, neck collar, and occupant were modeled to closely mimic driving conditions.
- Non-structural components were modeled as point masses.

**Injury Evaluation**

- Different criteria were used to evaluate injury risk to the driver, the thresholds were based on NHTSA frontal impact Standard, FMVSS 208.
- Chest Injury Criteria evaluates injury based on peak chest compression and peak acceleration.
- Head Injury Criterion (HIC15) evaluates head injury based on translational acceleration of the head over a 15 ms.
- Neck Injury Criterion (Nij) evaluates neck injury based on axial neck loads and neck joint moments.

**Results**

- The following figure shows vehicle response in terms of acceleration between three impact velocities.
- Little difference was noted between initial acceleration response of occupant’s chest and head, with and without neck collar in a high velocity impact.

**Discussion**

- **Thoracic Injury**
  - Chest compression and acceleration were below thresholds for all cases.
- **Head Injury**
  - The neck collar did not significantly change head injury results.
- **Neck Injury**
  - The neck collar did not significantly change neck injury results, in agreement with physical hybrid III testing with different neck collars by Glaster et al.

**Chassis Structural Integrity**

- Consider chassis geometry where side impact tubing may buckle inward and into the occupant under high velocity impact conditions.
- Improper bracing support to the seatbelt mounting points result in submaring of occupant, increasing the possibility of abdominal injury.

**Limitations**

- Due to simplified helmet and seat model, the flexion effect of the head and neck collar.
- Physical testing is needed to validate the chassis frame response.

**Conclusions**

- In all cases studies, no injuries were predicted based on simulation results and accepted injury thresholds.
- Nij appeared to be the most probable injury in higher velocity crashes.
- Contributions to increased Nij values include a stiff vehicle chassis, which the occupant is tightly restrained to, no crush structure, and added helmet mass to the head.
- Including lateral impact and rollover simulations would be useful for the development of the Baja competition vehicle requirements.

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**References**