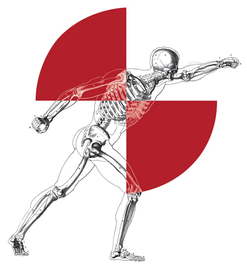

The Effects of Various Parameters on Dynamic Loads at the Top Tether Anchor

J. Majstorovic[1], R. Ramachandra[1], A. Belwadi PhD[2], M. Maltese PhD[2,3], J. Bolte IV PhD[1], Y. Kang PhD[1]

[1]The Ohio State University, [2]The Children's Hospital of Philadelphia, [3]The University of Pennsylvania

INTRODUCTION

- Lower anchors and tethers for children (LATCH) is a standardized method for attaching child restraints systems (CRSs) to vehicle seats, in an effort to reduce misuse and improper installation.[1]
- The Federal Motor Vehicle Safety Standard (FMVSS) No. 225 evaluates the strength of the LATCH child restraint anchorage systems in vehicles under a static loading test.[2]
- The drawback with the static loading evaluation is the dynamic conditions of a motor vehicle crash are not taken into account, and the evaluation of the top tether anchor independently from the lower anchors is not covered by the standard.
- The goal of this study was to further understand the dynamic loads experienced at the top tether anchor and the effect of various parameters on these loads.

METHODS

PHASE 1

- Constructed a finite element (FE) sled test environment simulating frontal impacts, described by the FMVSS No. 213 standard.[3]
- Sled Test Setup:
  - FMVSS No. 213 test bench
  - Forward-facing CRS
  - Hybrid III 6YO ATD
  - Flexible LATCH system

PHASE 2

- Validated the model with top tether and lower anchor loads from a sled test performed by Transport Canada.

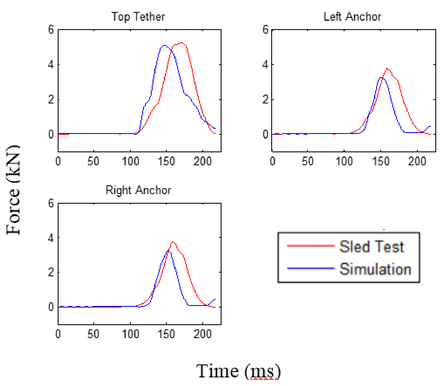

Figure 2: Comparison of LATCH anchor loads from the sled test and FE simulation.

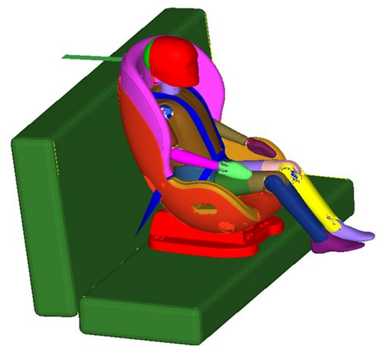

Figure 1: FE model of the frontal impact sled test environment.

PHASE 3

- Parametric Study 1:
  - Soft, stiff, rigid seat foam stiffness
  - CRS A and CRS B
  - Top tether anchor location: shelf, roof, seatback, and floor
- Parametric Study 2:
  - Top tether angle

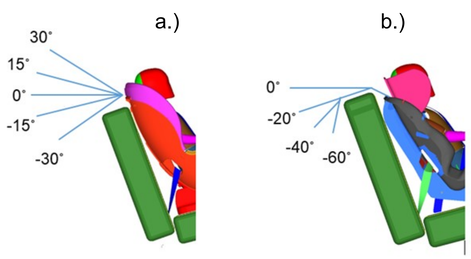

Figure 3: Top tether angles for a.) CRS A and b.) CRS B

RESULTS & DISCUSSION

Parametric Study 1

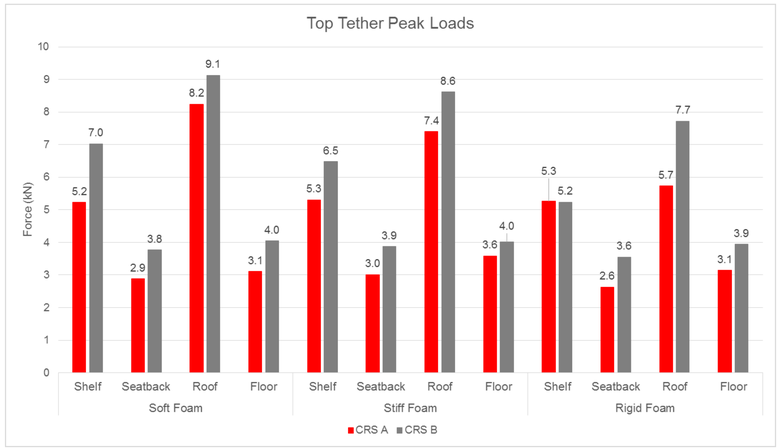

Figure 4: Top tether peak loads from Parametric Study 1.

- The largest to smallest top tether peak loads were observed at the following top tether anchor locations in order: (1) roof (2) shelf (3) floor (4) seatback. This trend held true regardless of the seat foam stiffness and CRS used in the simulation.
- CRS B generated larger top tether loads except in the rigid foam, shelf top tether anchor location scenario.
- There was no consistent trend in top tether loads as seat foam stiffness was varied.
- Top tether interaction with the seatback and CRS compression of the seat pan were found as mechanisms for reducing top tether anchor loads.

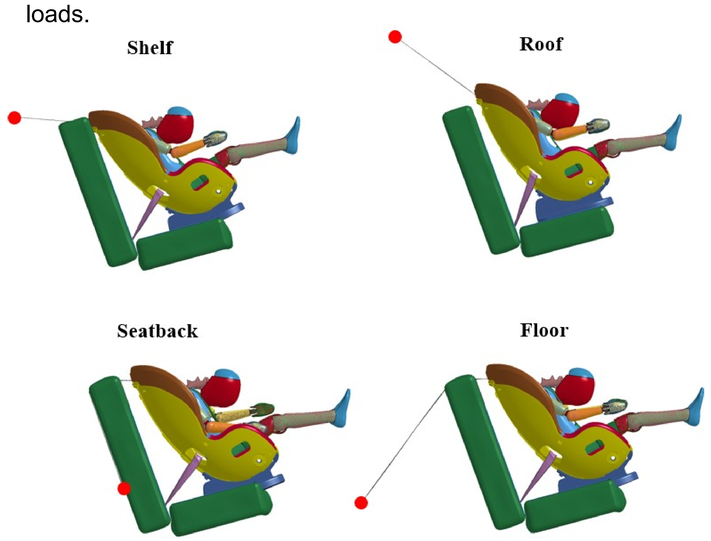

Figure 5: FE simulations for the four top tether anchor locations.

Parametric Study 2

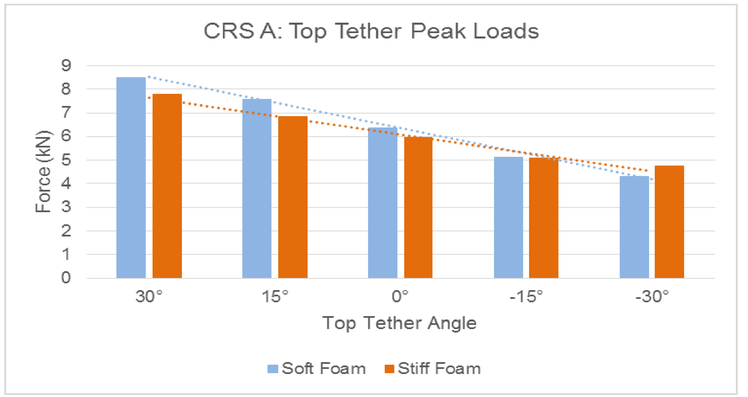

Figure 6: CRS A top tether peak loads from Parametric Study 2.

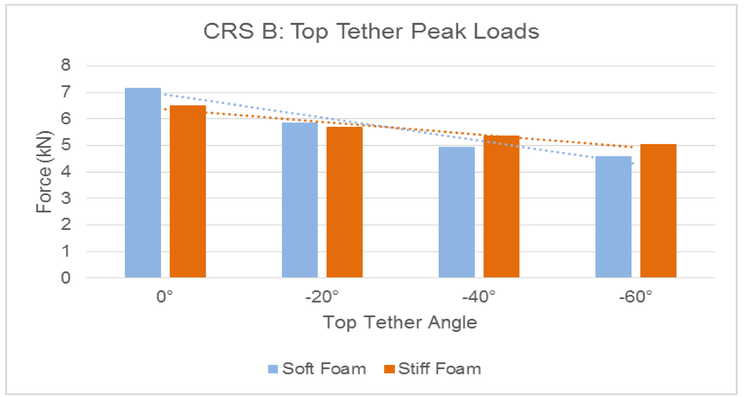

Figure 7: CRS B top tether peak loads from Parametric Study 2.

- Top tether anchor loads displayed a decreasing trend when top tether angle decreased. This was true regardless of CRS and seat foam stiffness.

CONCLUSIONS

- From Parametric Study 1, the top tether loads ranged from 2.9 - 9.1 kN and top tether anchor location and CRS had noticeable effects on these loads.
- From Parametric Study 2, the angle of the top tether was determined as a factor that will directly affect top tether anchor loads.
- Future work is to perform this study in the side impact test scenario.

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ACKNOWLEDGEMENTS

The authors thank the Center for Child Injury Prevention Studies (CChIPS), a research collaboration between the National Science Foundation (NSF) and industry, at The Children's Hospital of Philadelphia (CHOP) for sponsoring the project. The views presented are those of the authors and not necessarily the views of CHOP or CChIPS member companies.