A Workable Solution to Conflicting Crashworthiness Requirements

Glenn Gough
Systems Engineer, Vehicle Structure & Calculations
Siemens Industry, Inc.
Sacramento, CA

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- Background
- Challenge
- Approach
- Validation
- Discussion
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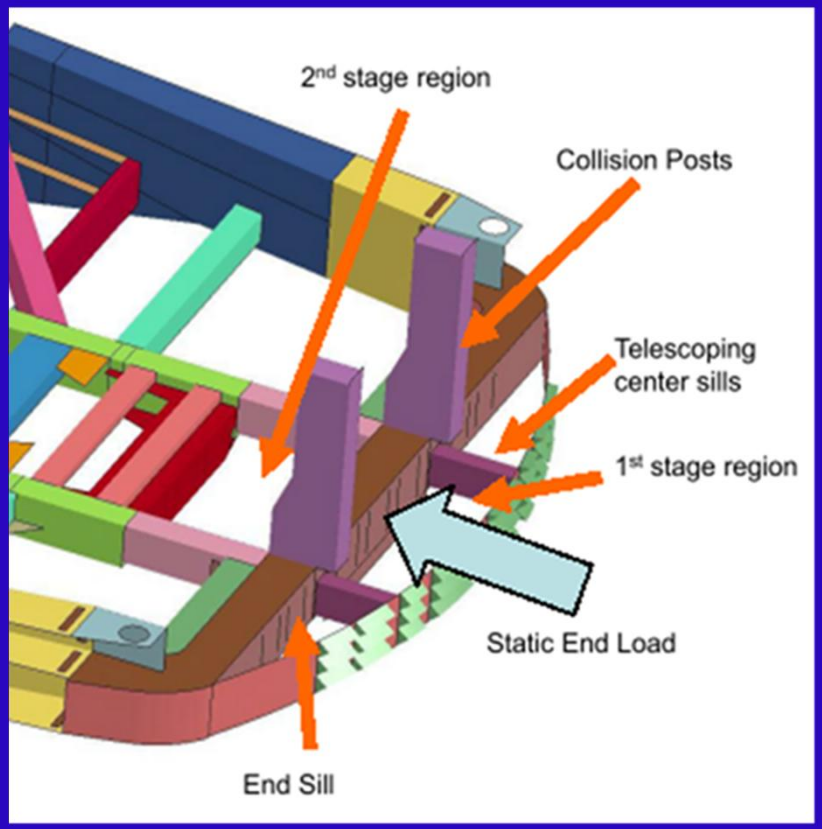
Background

- When the first S70 was delivered, ‘safety-through-strength’. i.e., 2G static end load, was required
- In 2011, Siemens decided to update the S70 with dedicated crash elements in anticipation of the future direction of ‘safety-through-managed-failure’, commonly referred to as crash energy management or CEM.
- This was triggered by two factors: publication of ASME RT1 – 2009, and Twin Cities requirement of an AW3 loading for a 20 mph collision of like single vehicles.

Challenge

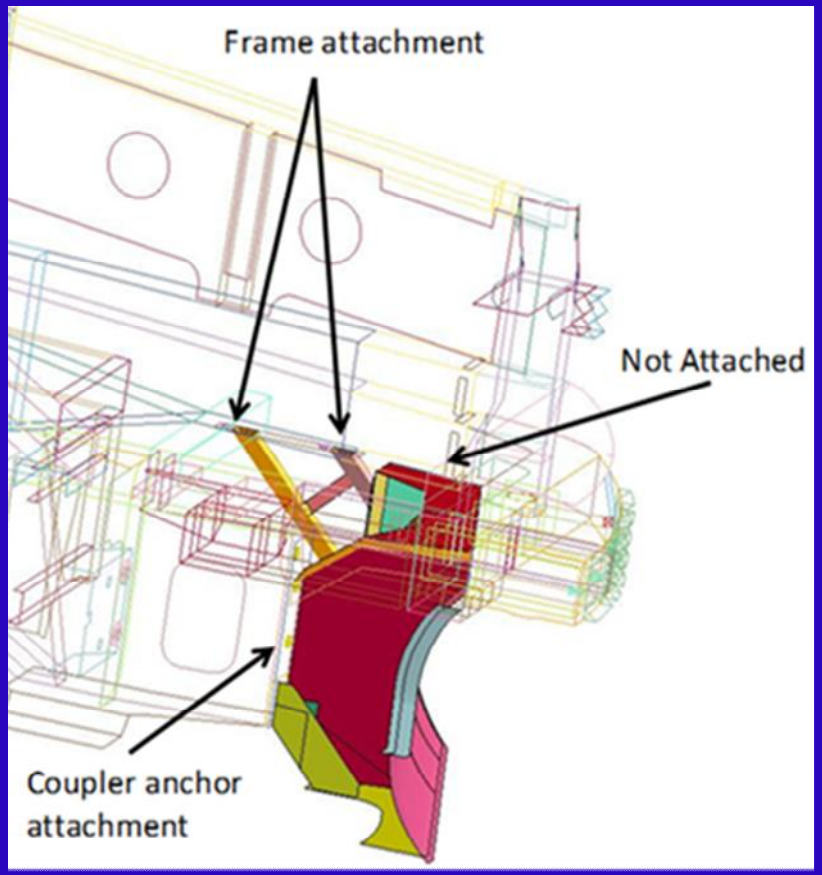
- The industry is seeing a transition between two approaches to rail car collisions:
  - ‘safety through strength’ relies on very strong structures to prevent damage and preserve occupied space.
  - ‘safety through managed failure’ relies on structures to fail in a planned way to absorb energy to mitigate damage and loss of occupied space.
- These approaches can conflict if certain parts of the structure need to fulfill both approaches.
- In addition, a structural snow plow was to be provided.

Approach



- The approach was to uncouple the requirements.
- ‘safety through strength’ met with a traditional ‘2G’ underframe, collision and corner posts, shaded in the illustration.
- ‘safety through managed failure’ provided by adding dedicated crush elements in two regions, one forward and one aft of the end sill.
- First stage reduces cab intrusion. Second stage adds to energy absorption once the 2G frame is overloaded at trigger points.

Approach

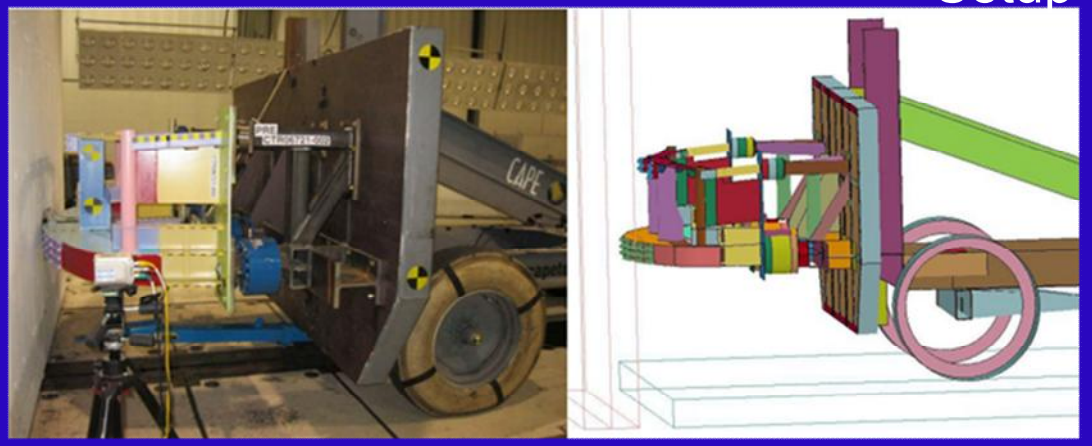


- The main load path of the structural snow plow is through coupler anchor. This allows it to be uncoupled from the crush element and 2G frame triggers.
- The shape of the face of the plow is similar to the Type I vehicles. Experience indicates it helps keep the LRV from overriding smaller objects.

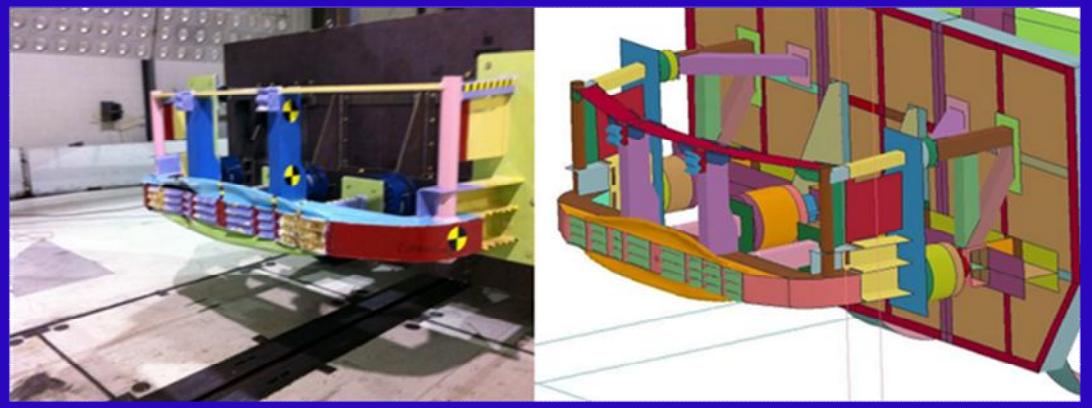
Validation

- Validation of simulations a critical part of the process.
- Test performed to demonstrate the first stage would be consumed before the underframe would be overloaded.
- Demonstrated with a front end structure weldment at the CAPE Institute. SAE crash test standards used.

Setup



Post test



Discussion

Several aspects should be highlighted:

- Apparently conflicting methodologies can be integrated, improving safety, by an uncoupling approach.
- Historical values used for ‘safety through strength’ lead to structures that have shown to be necessary to support forces developed by crush elements needed for energies required.

Discussion

Several Aspects should be highlight:

- Adding crush elements forward of occupied space can significantly raise impact speeds that cause cab intrusion. This requires a re-interpretation of how traditional static loads are introduce into the carbody . The role of the anti-climber is crucial in this discussion.
- Snow plow was integrated by attaching to the coupler anchor. This allows crush elements and end frame triggering to function independently. It functions as an obstacle deflector is standard in European Norms.

Discussion

Several aspects should be highlighted:

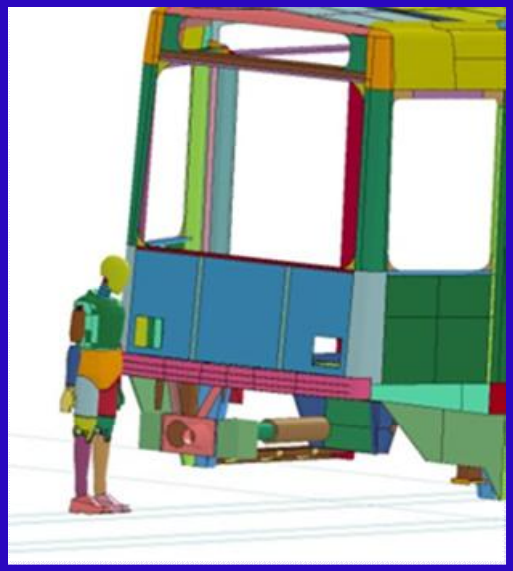
- Although ‘safety through managed failure’ has shown to improve LRV to LRV outcomes, ‘safety through strength’ is still a relevant approach for unpredictable impacts as seen by corner and collision posts. LRV to LRV is unique in nature, it can be well defined.

Future Direction

- The Twin Cities S70 is a major step forward in terms of reconciling ‘safety through strength’ and ‘safety through managed failure’. With the lower anticlimber, crush elements, and structural snow plow, it is a less aggressive front. This is a result of a close collaboration during the design phase.

Future Direction

- Next steps will be viewing the performance of the car in a total system safety approach, considering asymmetric interactions of small and large masses. ‘safety-through-strength’ is expected to continue a complimentary role and provide support for future devices intended to interact with pedestrians and automobiles.



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Richard Carey
Senior Engineer
Metro Transit
Richard.Carey@metrotransit.org

Glenn Gough
Systems Engineer, Vehicle Structure & Calculations
Siemens Industry, Inc.
glenn.gough@siemens.com

George C. Hud, Ph.D., P.E.
Senior Engineer
LTK Engineering Services
ghud@LTK.com

TRB

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