ARTSA-i INSTITUTE

Roadtrain Couplings Project

ARTSA Institute led a world-first research project to work out the forces and determine what the future of heavy roadtrain couplings will look like in Australia.

The project was funded by the National Heavy Vehicle Regulator's (NHVR) Heavy Vehicle Safety Initiative (HVSI) that is supported by the Australian Government.

The project involved measurement of the coupling forces on quad-trailer 160 tonne roadtrains during routine daily journeys of hundreds of kilometres while underway in the Northern Territory, with part of the route on secondary roads.

ARTSA-i led an industry-wide working group bringing in key personnel from HVIA, ATA, and TIC. Engineers from the various coupling manufactures in Australia and Europe also contributed their expertise, including Ringfeder/ VBG engineers who brought their Swedish coupling integrity testing experience. The research team pulled together industry support from all corners of the country. A purpose-built dolly manufactured in Perth by Howard Porter was fitted with a custom drawbar in Melbourne by CIMC. The dolly was fitted with specially designed hardware and measurement sensors by Smedley's Engineers, before being transported to Direct Haul's facility near Darwin.

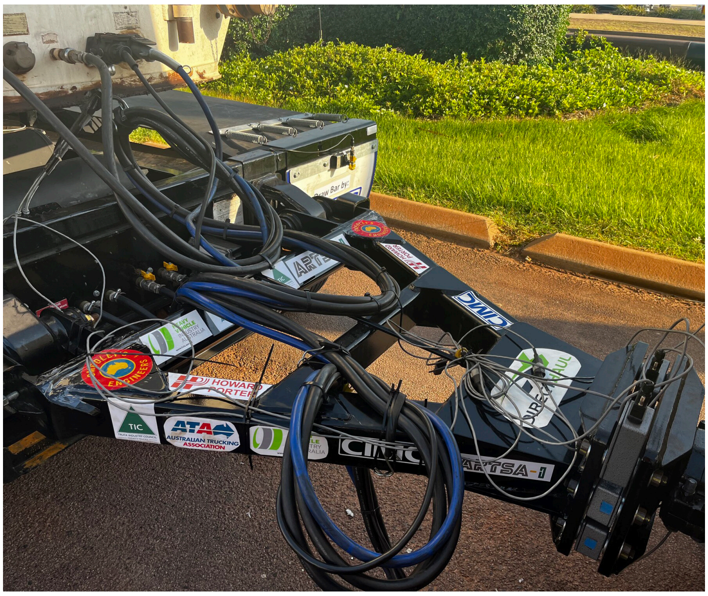
Both the automatic pin and fifth wheel couplings recorded an array of force, speed, GPS, accelerometer, and road topography data in real time collecting orders of magnitude more data than the 1980s testing program that preceded it. The challenging fieldwork, then the painstaking task of post-processing was undertaken by Smedley's Engineers, with mechanical engineer Dion Simms wrangling the mountains of collected data.

Three separate testing journeys took place. The instrumented hinged drawbar dolly was moved to the front, middle and rear positions in the quad combination for each respective journey, allowing the research team to compare coupling forces at the different locations.

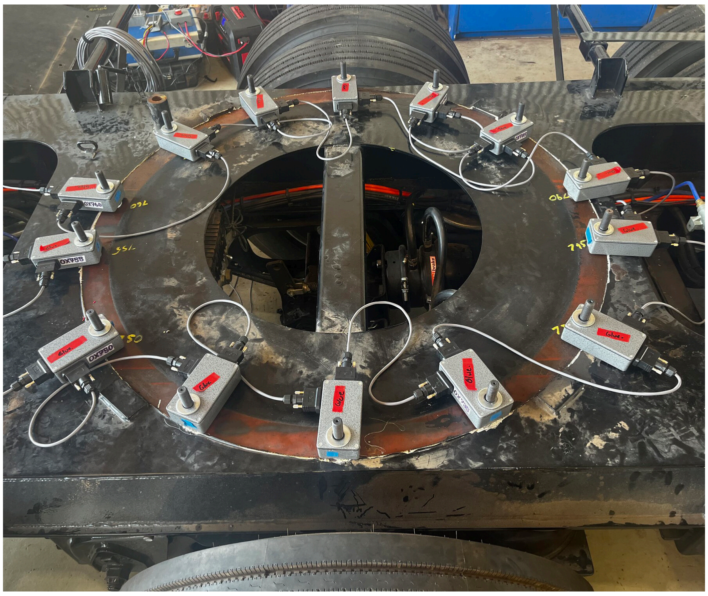
Instrumented Dolly

THE RESULTS

- The forces experienced by the couplings were similar whether the dolly was at the front, middle or rear locations within the roadtrain. This was due to dynamic forces and impacts as the roadtrain snakes along the road, including whiplash and shunting. This result was contrary to conventional understanding as reflected in the current Australian Standards, which anticipates lower forces for couplings further from the centre of the train.
- The worst-case peak forces were reasonably well predicted by the existing formulae in the Australian Standards, with forces increasing in proportion to the weight.
- By far the most common occurrence of very high forces was not when the roadtrain was underway at speed, but instead when slow or coming to a stop:braking, shunting, and manoeuvring.
- The highest peak forces were measured while underway at speed over floodways. These peak forces responded with a sudden pitch of the hinged drawbar dolly.
- Shunting (1.5 to 2 seconds) within the coupling connection when braking at any speed resulted in high coupling forces, due to the delay in air braking signal between the front and rear trailers.
- Measured forces were input to proprietary simulation software to calibrate a roadtrain computer model. It was found that even the most advanced simulation software available was severely limited when considering the complexities of the roadtrain combination being driven down a real-life road. Nothing replaces actual field measurement to observe and learn from the complex dynamic phenomena that occurs.



Instrumented drawbar



5th Wheel with sensors fitted

LESSONS LEARNED

What can operators do to reduce wear?

1. Electric brake systems, which coordinate brake application for all trailers at once, should for all roadtrains over a certain mass.
2. Reduced maximum wear tolerances could be considered for roadtrain couplings over a certain mass. This may be a lower wear limit than that allowed by coupling manufacturers.
3. Consideration of rigid drawbar dollies to reduce the peak forces due to the pitch – and – shunt forces over undulating terrain.

What about the Coupling Specs?

Given that peak forces were similar at all dolly locations, coupling's spec should be based on the worst case coupling within the entire roadtrain.

a. Taking this to the theoretical limit based on the formulae within existing standards, the maths reduces to the following simple formula: COUPLINGD-VALUE (in kN) = 1.5 X GCM (in tonne).

b. For example, a 160-tonne roadtrain would require a minimum D-Value of 240kN for all couplings. Put another way, a 240kN coupling would be 160-tonne“roadtrain” rated.

c. Standardising connections throughout the roadtrain has interchangeability benefits, and makes it easier for drivers, fleets and regulators to check the component specs.

FURTHER RESEARCH

Further research is needed to better understand worst case peak loads, particularly during low speed maneuvers, and in relation to optimal brake timing. This will be significant to help understand the dominant inputs to both coupling wear and coupling integrity.

THE BENEFITS

There are huge cost and logistical advantages in using regular coupling sizes on increasingly heavy combinations. It is hoped that strategies such as these will enable roadtrain drivers and operators to safely utilise conventional couplings on heavy roadtrain fleets into the future.

The full report can be downloaded from **www.artsa.com.au**

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