C21 Evaluating the Effect of Assembly Hardware on Breaking Strength of Seat Belt Webbing

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After attending this presentation, attendees will understand the effect of seat belt component designs in relation to reducing the ultimate strength of the seat belt webbing.

This presentation will impact the forensic community and/or humanity by demonstrating seat belt designs which are certified pursuant to federal safety standards can fail at force levels below the intended required values.

The injury-mitigating potential of seat belts in motor vehicles is widely accepted. Seat belts must be certified to conform to all applicable federal safety standards. However, in real world loading conditions, it has been observed that some seat belt assembly hardware can reduce the breaking strength of the webbing, apparently to levels below those specified in Federal Motor Vehicle Safety Standard (FMVSS) 209. Two test series were conducted on new and used seat belt assemblies to evaluate the effect of assembly hardware on the breaking strength of seat belt webbing under reasonably anticipated forces due to occupant loading.

The first series contained four tests to evaluate the breaking strength of the webbing alone, without any effect from the latch plate/ buckle component. The webbing samples tested were sectioned from the portion of webbing adjacent to the seat belt retractor. Each end of the webbing was held by split drum grips as specified under FMVSS 209. One split drum grip was rigidly anchored to the test bench, while the other grip was accelerated by a hydraulic cylinder to a speed of between approximately 0.91 and 1.22 meters per second.

To investigate the effect of the latch plate design on reducing the breaking strength of the webbing, a second series of tests was performed. The second series contained sixteen tests on sixteen different webbing samples. Three-point anchoring held the seat belt webbing in a “V” shape, with an included angle of approximately 45 degrees, similar to invehicle use geometry. One end of the webbing was secured to a hydraulic cylinder using the OEM anchor bracket to which the webbing was sewn. The hydraulic cylinder provided a pelvic restraint webbing pre-load between 227 and 454 kilograms. The end of the upper torso restraint webbing was held by a split drum grip. The split drum grip was accelerated by a hydraulic cylinder to a speed of approximately 1.5 meters per second.

FMVSS 209 specifies that the webbing of a type 2 seat belt assembly shall have a breaking strength of not less than 2,270 kilograms for the pelvic restraint, and not less than 1,810 kilograms for the upper torso restraint. The first test series showed that without stress concentrations induced by the latch plate, webbing failure loads ranged between 1,887 and 2,209 kilograms. When compared to the requirement of FMVSS 209, these loads are somewhat less than the 2,270 kilograms minimum strength for the pelvic restraint.

FMVSS 209 specifies that any webbing cut by the hardware during test shall have a breaking strength of not less than 1,590 kilograms at a cut in webbing of the pelvic restraint, or not less than 1,270 kilograms at a cut in webbing of the upper torso restraint. The second test series demonstrated that the webbing was being cut by the seat belt buckle hardware. The metal edge of the locking latch plate caused stress concentrations and allowed the webbing to rip much like a ruler is used to tear paper. This metal edge is common to both the pelvic and the upper torso restraint. The measured loads at failure range from 827 kilograms to 1,103 kilograms, and are far below those specified by the standard.

The test series demonstrate that the breaking strength of the seat belt webbing material is dramatically reduced by the locking bar of the latch plate assembly. Some latch plate designs reduce the strength of the seat belt system so that they no longer pass the intent of the applicable Federal Motor Vehicle Safety Standards. This reduction in restraint load capability results in a vulnerability to total loss of seat belt restraint in traffic collisions.

Seatbelt, Failure, Testing

 ** Presenting Author*