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Strongest Link Principle

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INTRODUCTION

To prevail in a products liability action it is necessary to establish that the challenged design contains a defect and that the defect is a proximate cause of the accident. This paper does not deal with the difficult problem of establishing a defect, but focuses on whether an alleged defect is proximately related to injury or property damage.

Use of the Strongest Link Principle may be illustrated by an example of an auger elevator which killed a farmer when its right angle gear box disintegrated freeing the outboard end of a rotating power take off shaft and allowing it to violently flail about. It was alleged that the gear box was defective because it lacked the structural integrity to survive the vibratory loading environment characteristic of a tractor driven appliance.

An exemplar (duplicate) auger elevator was operated at its natural frequency which greatly accelerated the vibratory loading environment. The test was terminated when the auger elevator exhibited multiple failure modes. All the drive line support bearings were destroyed, the inlet guard and drive line power transmission guards fell off the auger elevator, and the gear box and drive line shaft rotated out of position. The gear box had not yet disintegrated.

If the accident auger elevator had failed because of the gear box design, we would have expected all of the weaker elements of the auger to have failed first. Because these weak elements did not fail on the artifact, the design of the gear box could not have proximately caused the accident.

The elements of this example which should be noted are as follows:

1. The exemplar accurately reflects the manufacturer's intended design.
2. The loading environment used in the testing program retained all the normal characteristics of loading, but was accelerated by choosing an rpm which caused an extreme vibratory condition because of resonance.
3. The exemplar gear box did not fail.
4. Characteristic failures were manifest throughout the exemplar which differed from those observed in the artifact.

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The strongest link principle may now be stated generally:

> **Strongest Link Principle**
> If a challenged design feature on an exemplar is unaffected by a simulated or accelerated loading program which causes the exemplar to undergo changes which differ from the artifact, then failure of the artifact is not proximately caused by the design feature.

HIGH CHAIR

A 21 month old infant submarined below the lap belt on a floor mounted high chair and was found hanging with his neck wedged against the tray. Upon seeing his child, the father became so distraught that he smashed the high chair repeatedly against a tree completely destroying all evidence of this artifact. It was alleged that the double D-ring lap belt fastener system illustrated in Figure 1 was defectively designed and this defect allowed the belt to loosen under the expected movements of the child and that the resulting elimination of restraint caused the child's eventual strangulation.

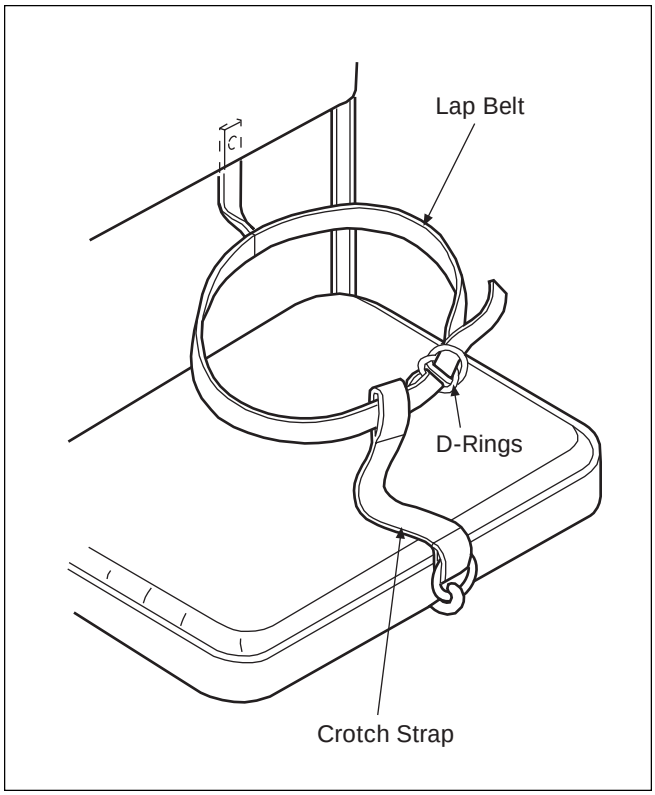

Fig. 1 High Chair Lap Belt Fastener System

During a videotape deposition of the father, he was asked to duplicate his application of the lap belt using an exemplar high chair and an anthropomorphic dummy of the height and weight range of the infant. This characterization of the attachment method was replicated in the laboratory with an exemplar high chair mounted on a shake table. The fastener belt relationship was marked on the lap belt. The shake table was operated with sufficient violence to cause almost total destruction of the high chair elements. In spite of the loading violence that was clearly beyond the capability of any infant, there was no migration of the lap belt through the D-rings. This established the D-rings as the strongest link in the high chair design and showed that any structural loadings produced by the child that might lead to failure of the D-rings would first have imprinted the high chair with characteristic failures which were in fact not found or described by the child's father. The location of the D-rings precluded unfastening by the child; hence, the only explanation of the tragedy was the failure of the father to apply the lap belt or the father's improper application.

CONCLUSION

The strongest link principle essentially turns an exemplar into a meter which allows one to gauge and identify precursor phenomena to the challenged behavior. By simulating or accelerating the loading environment, fingerprints are produced which characterize the system's behavior. The absence of these fingerprints taken together with the survival of the challenged design feature indicates that failure in an artifact under examination did not occur because of the loading environment. Alternatively, the loading environment required to compromise the challenged design is greater than the loading experienced by the artifact, and consequently, the challenged design feature is not a proximate cause of the accident being investigated.

Application of the strongest link principle makes a major contribution to the art of communication. The dramatic testing programs are interesting, are easy to comprehend, and enhance a jury's understanding of the concept of proximate cause as opposed to design defect.