

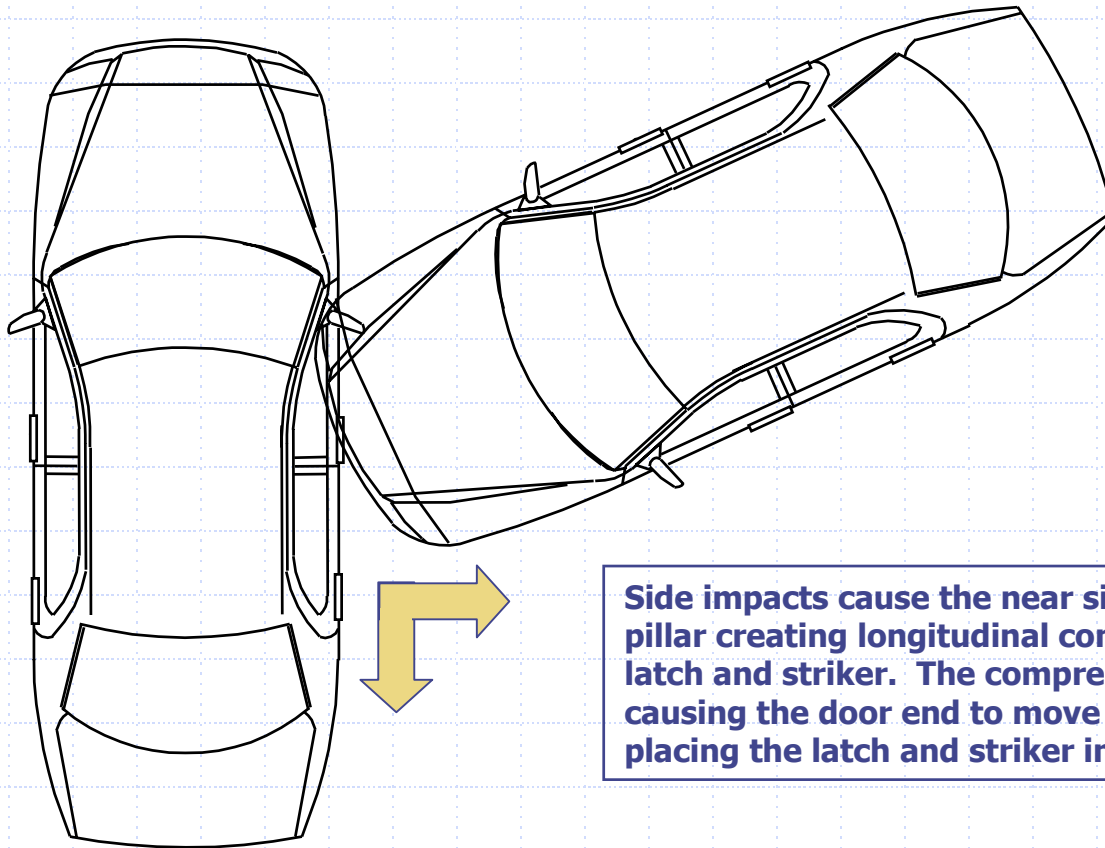
Justification for Combination Test

National Highway Traffic Safety
February 2004

Case Study of Combination Forces (Longitudinal Compression and Lateral Tension) causing Door Openings

Illustration of Door Openings caused by Longitudinal Compression and Lateral Tension Forces in Side Impacts

- ◆ Involves all near side door openings in side impacts



Side impacts cause the near side door to shift into the B-pillar creating longitudinal compression between the latch and striker. The compression then translates to causing the door end to move outwards from the vehicle placing the latch and striker in tension laterally.

NASS Case Study – Near Side Door Opening in Side Impact

- ◆ Case Vehicle - 1997 Chevy Cavalier
- ◆ NASS Case ID: 656500511
- ◆ Delta-V: 35 km/h
- ◆ Crash Summary
 - The vehicle experienced a near side impact, in the left side, at a two way intersection
 - Left front door opened during collision due to structural damage to the latch/striker and hinge.

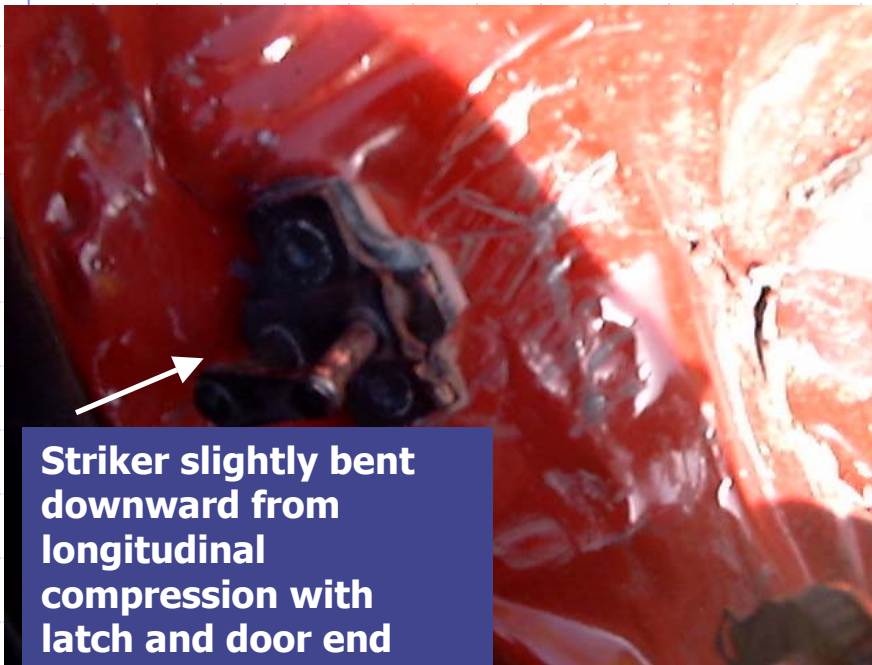




Evidence of rearward displacement of the door



Door end moves rearward of pillar



Striker slightly bent downward from longitudinal compression with latch and door end

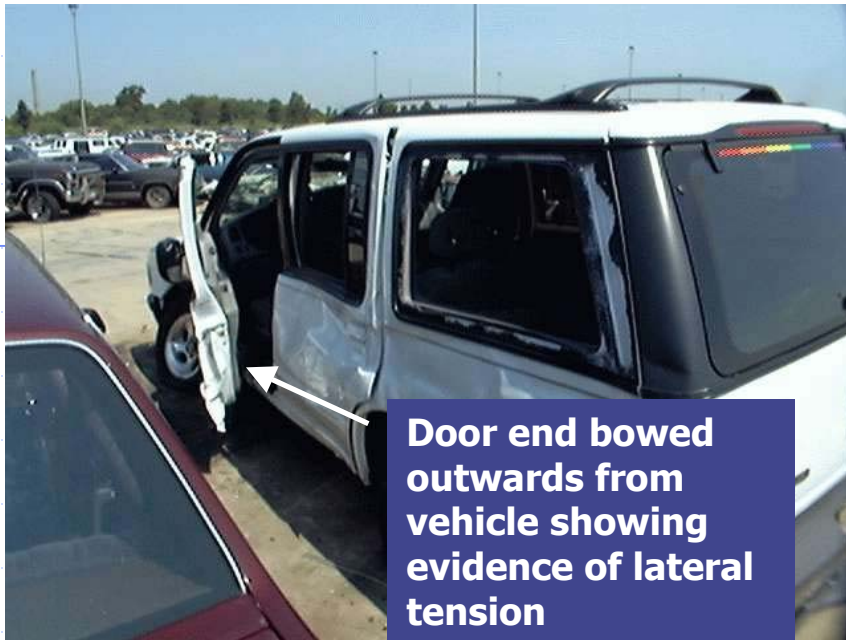


Latch is torn from door in direction showing lateral tension with striker

NASS Case Study – Near Side Door Opening in Side Impact

- ◆ Case Vehicle - 1997 Ford Explorer
- ◆ NASS Case ID: 626400241
- ◆ Delta-V: Unknown
- ◆ Crash Summary
 - Case vehicle was heading west bound entering an intersection when another vehicle heading north impacted its left side.
 - Left front door opened during collision due to structural damage to the latch/striker.

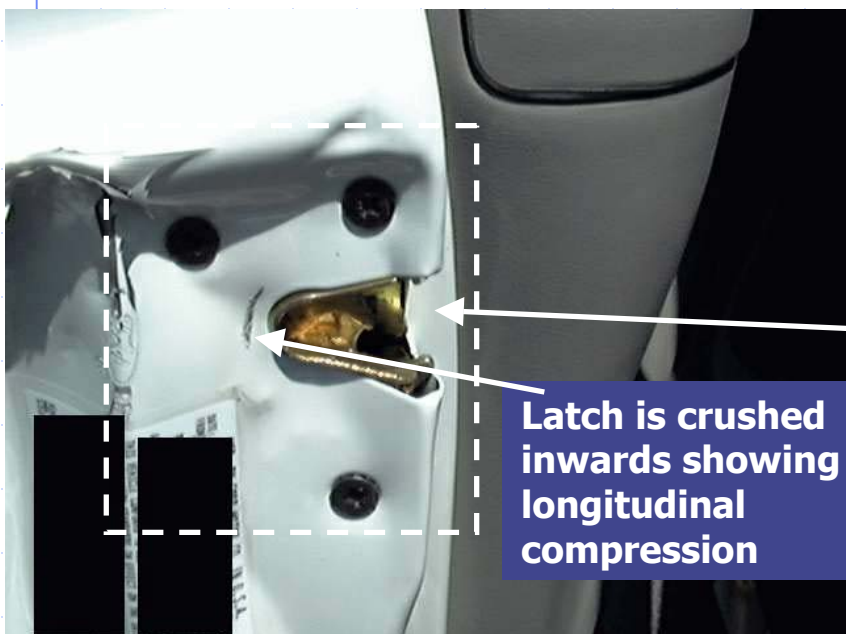




Door end bowed outwards from vehicle showing evidence of lateral tension



Separation between the door and pillar shows rearward displacement of the door



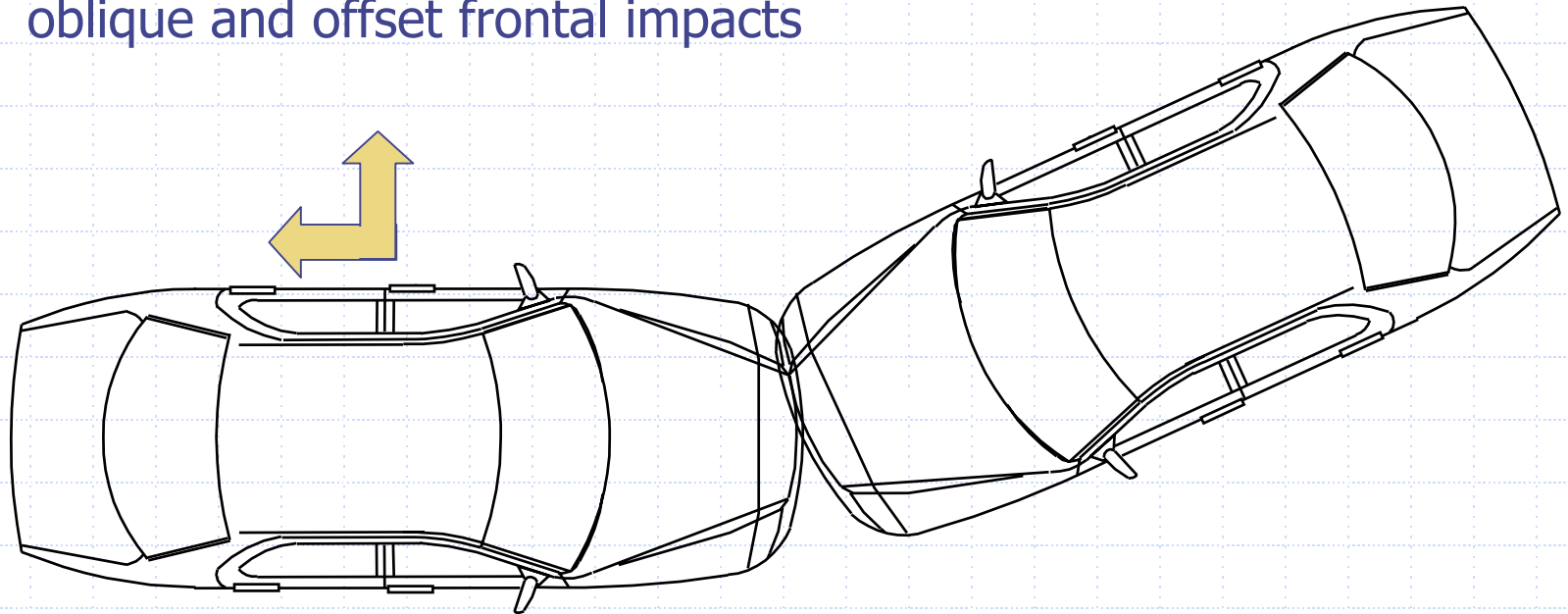
Latch is crushed inwards showing longitudinal compression



Latch and striker in good condition showing possible bypass failure

Illustration of Door Openings caused by Longitudinal Compression and Lateral Tension Forces in Frontal Impacts

- ◆ Involves all near side door door openings in full, oblique and offset frontal impacts



These frontal impacts cause the front fenders to crush into the door moving it into the pillar. The door then bows outwards causing the latch system to be in compression longitudinally and in tension laterally.

NASS Case Study – Frontal Offset Impact with Near Side Door Opening

- ◆ 1998 Chevy S-10 Blazer
- ◆ NASS Case ID: 129000735
- ◆ Delta-V: 37 km/h
- ◆ Crash Summary
 - The vehicle left the roadway, striking a telephone pole with its front end. The vehicle rotated around the pole bounced off and contacted an 8' chain link fence with its right side. This caused a large amount of scraping and crush down the vehicle's right side.
 - Right door came open during collision



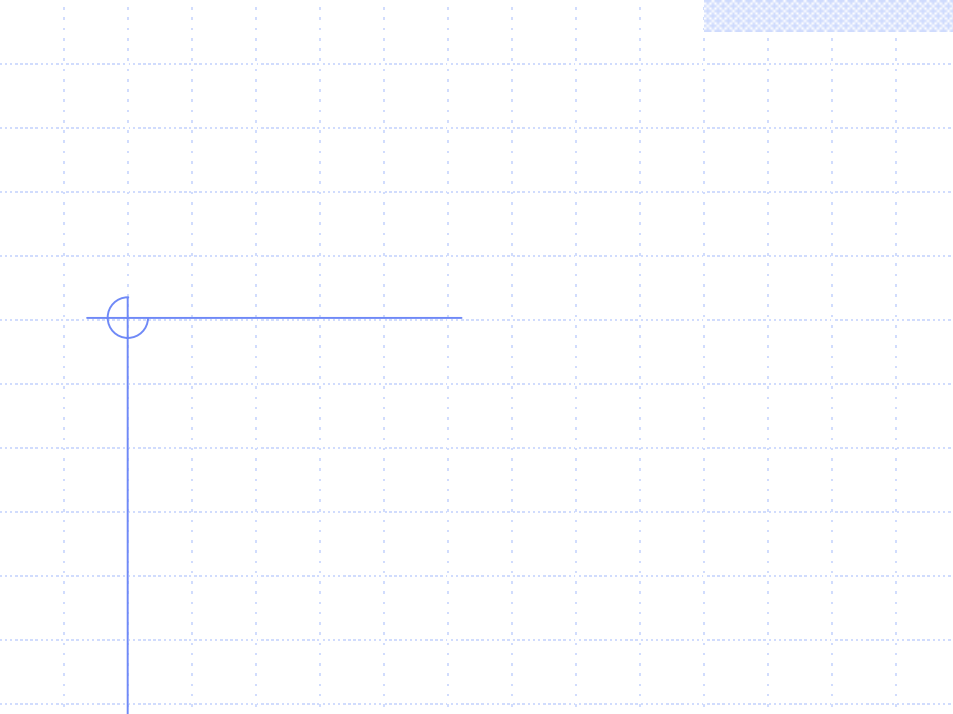
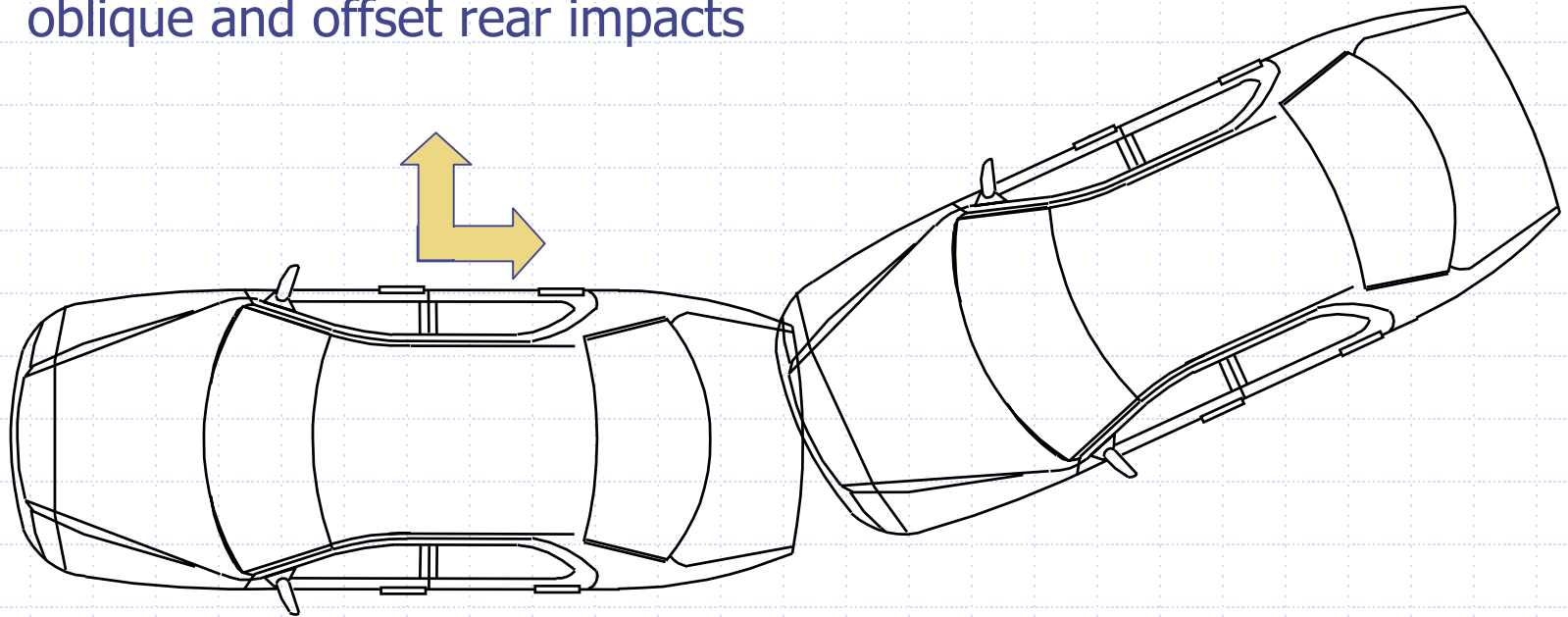


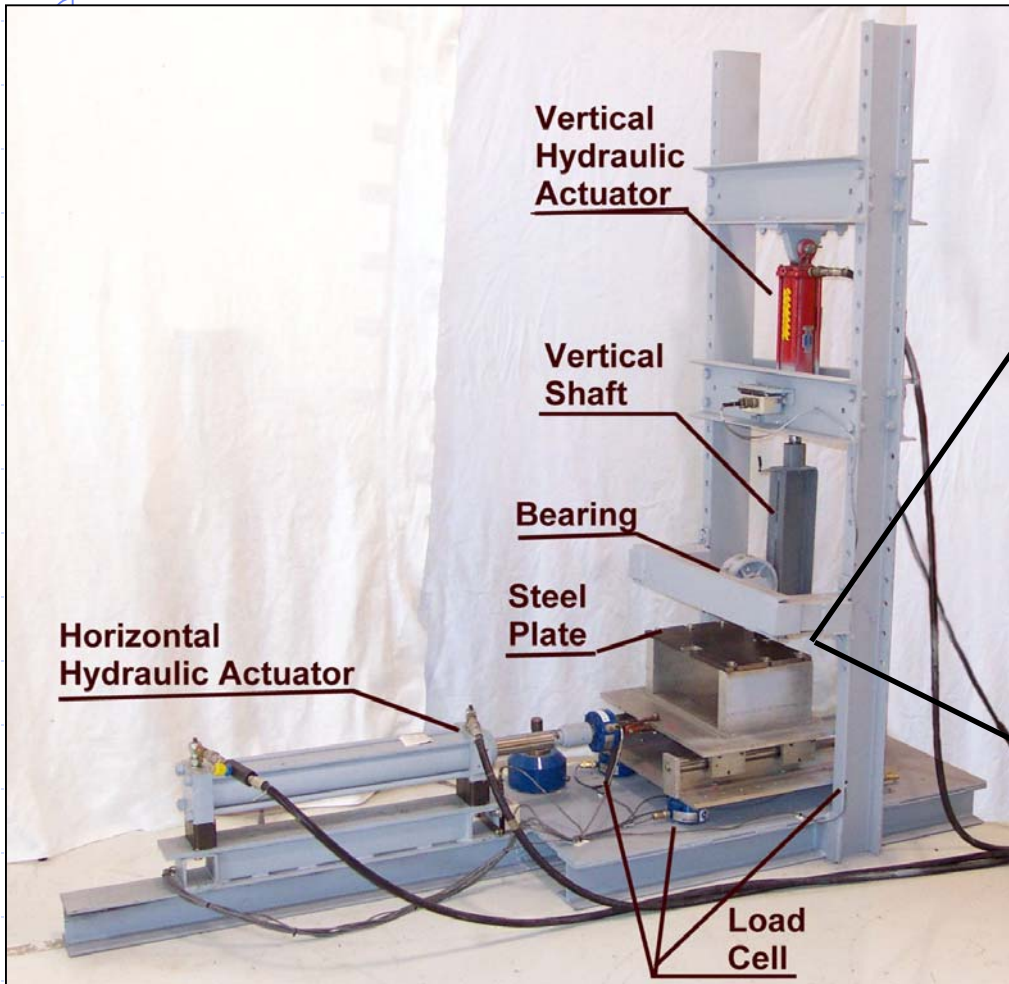
Illustration of Door Openings caused by Longitudinal Compression and Lateral Tension Forces in Rear Impacts

- ◆ Involves all near side door openings in full, oblique and offset rear impacts



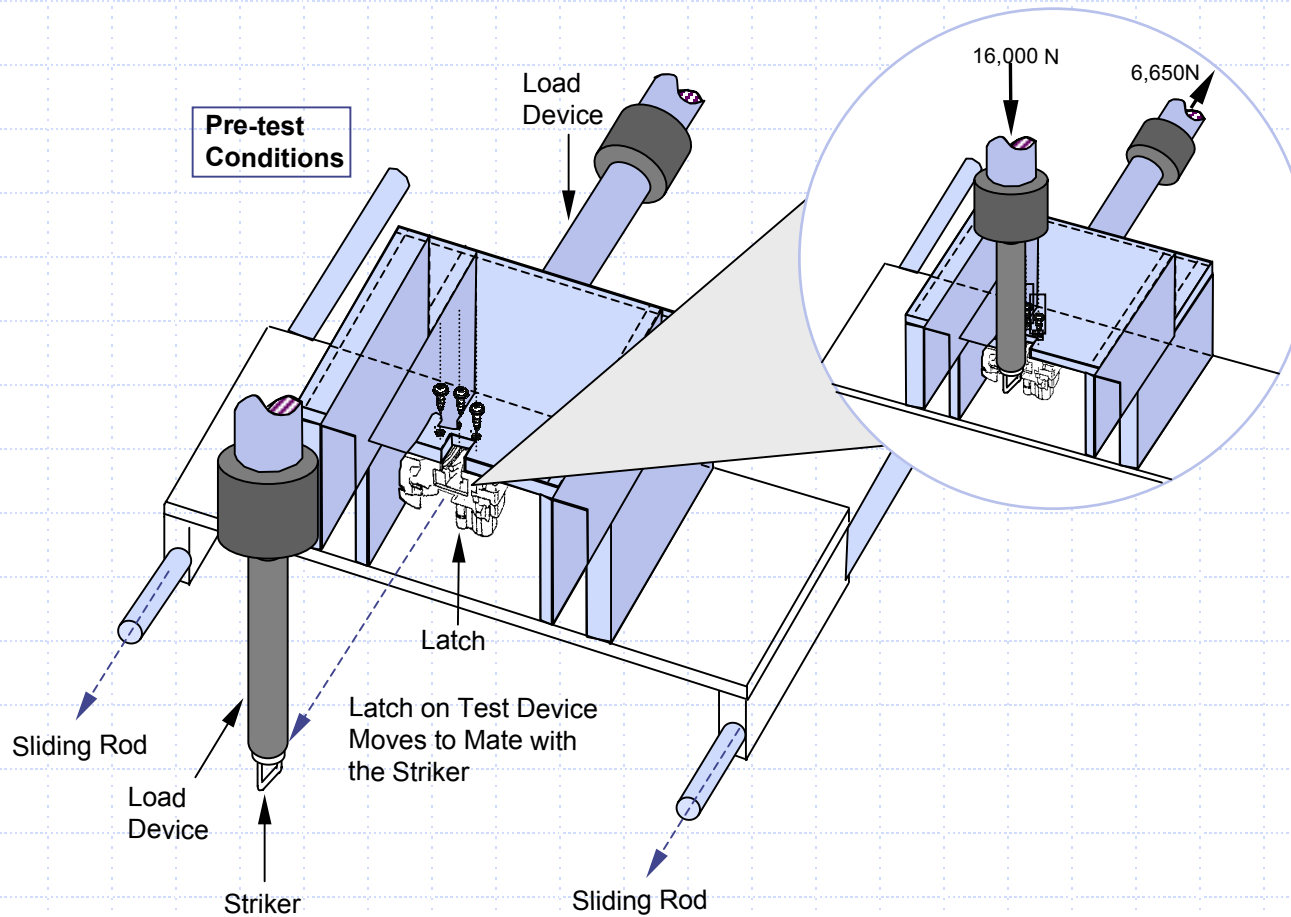
These rear impacts cause the rear fenders to crush into the door moving it into the pillar. The door then bows outwards causing the latch system to be in compression longitudinally and in tension laterally.

Photos of Combination Test



Striker attachment to loading device

Directions of Forces in Combination Test



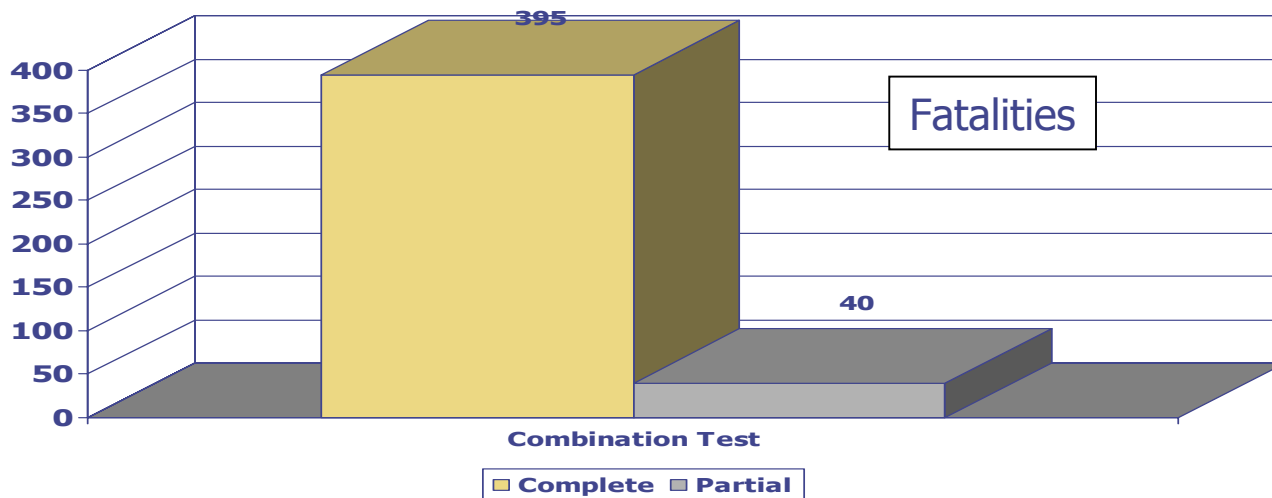
Agency Research Findings

- ◆ Door openings occur due to simultaneous forces acting between the latch and striker depending upon the direction of impact in a crash
- ◆ Combination test accounts for longitudinal compression and lateral tension forces

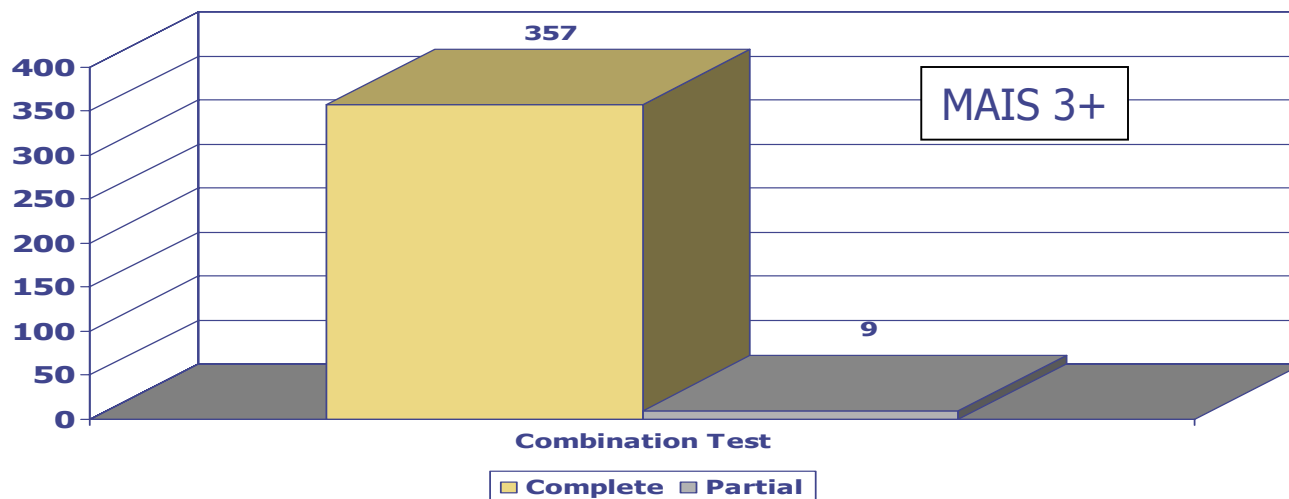
Relation to Realworld Crashes

TARGET POPULATION OF COMBINATION TEST

1995-2002 NASS and FARS Door Ejection Fatalities and MAIS 3+ Injuries based on Door Openings and Failure Modes



Test Type	Fatal	MAIS 3+
Combination Test	435	366



Range of Loads for Combination Test

- ◆ 17,000 N – Minimum average force experienced by vehicles that did not have door openings in NASS
- ◆ 19,000 – Maximum average force experienced by vehicles that had door openings in NASS
- ◆ On average doors that open in crashes experience an additional 2,000 N force

Effectiveness Estimates for Combination Test

Test Load	Reduction in Door Open Rate	Fleet Failure Rate
@15,000 N*	0.089	39%
@17,000 N	0.133	43%
@19,000 N	0.242	67%

* 15, 000 N selected for sensitivity evaluation

Benefit Estimates for Combination Test

	@15,000 N	@17,000 N	@19,000 N
Fatalities Prevented			
Complete	25	37	68
Partial	3	4	7
Total	28	41	75
MAIS 3+ Injuries Prevented			
Complete	17	26	47
Partial	0	1	1
Total	17	27	48

Cost Estimates

- ◆ The maximum upgrade cost per door for combination test = \$0.21