PERFORMANCE OF BUMPER SYSTEMS WITH RESPECT TO PEDESTRIAN PROTECTION AND BUMPER DAMAGEABILITY REQUIREMENTS

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BACKGROUND & OBJECTIVES

- **Pedestrian protection standards implemented globally**
  - GTR No. 9 adopted (2008)
  - FlexGTR legform in process of being added (WP.29 vote May 2014)

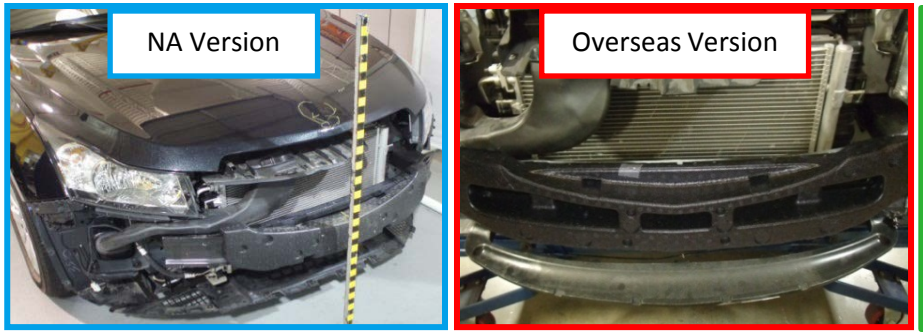
- **Bumper damageability requirement in U.S.**
  - Part 581 limits damage to vehicle front end in low speed impacts

- **Objective: Examine feasibility of passing both GTR9 and Part 581**
  - Test multiple versions of global platform vehicles with FlexGTR (GTR9)
  - Test same vehicle configurations in Part 581
  - Relate test results in 581/GTR9 conditions
  - Evaluate bumper part design characteristics associated with meeting GTR9 or both GTR9 & Part 581

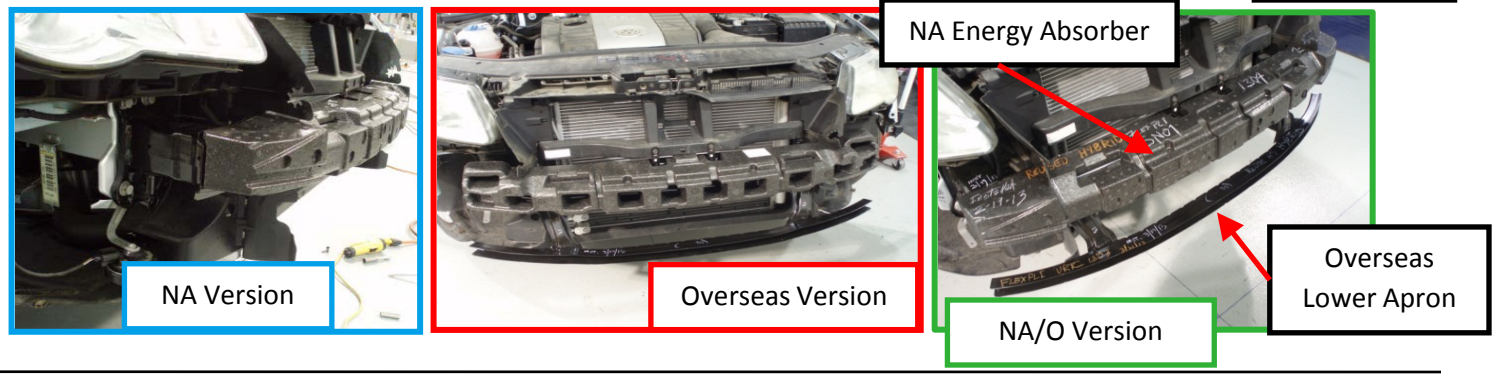
VEHICLES & CONFIGURATIONS

2013 Ford Fusion

2011 Chevrolet Cruze

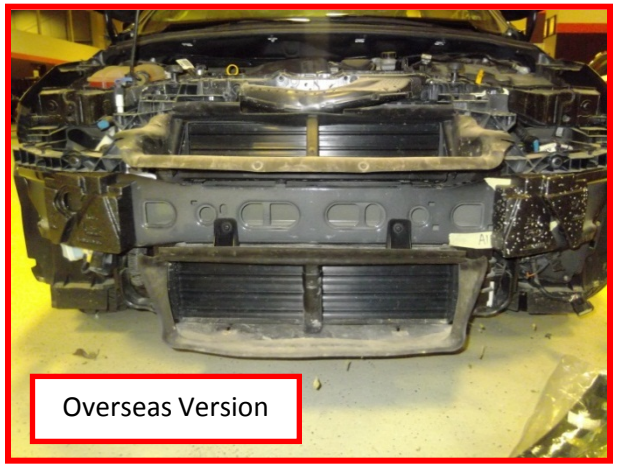


2006 Volkswagen Passat

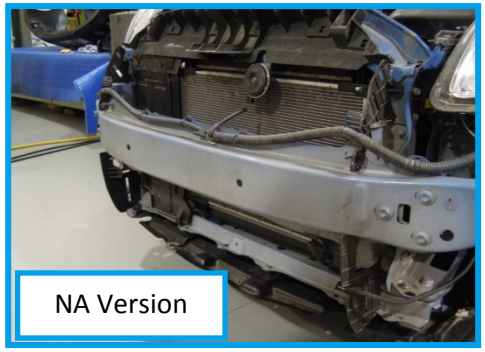


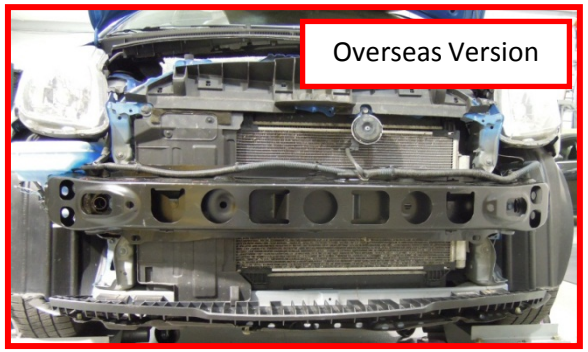
VEHICLES & CONFIGURATIONS (CONT.)

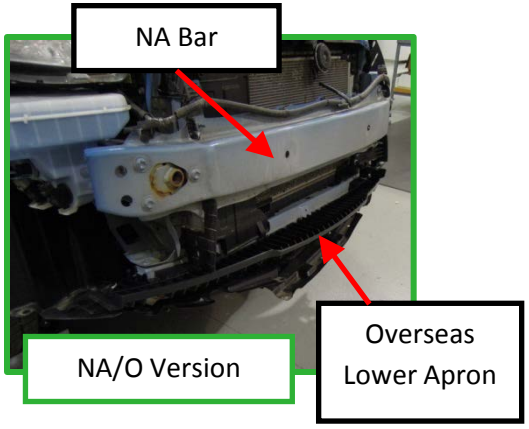
2012 Ford Focus



2010 Toyota Yaris

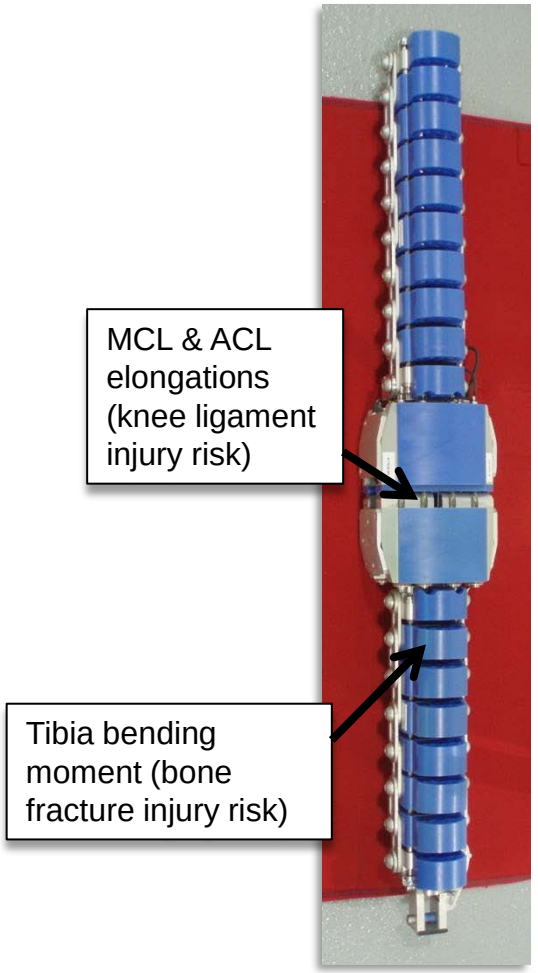




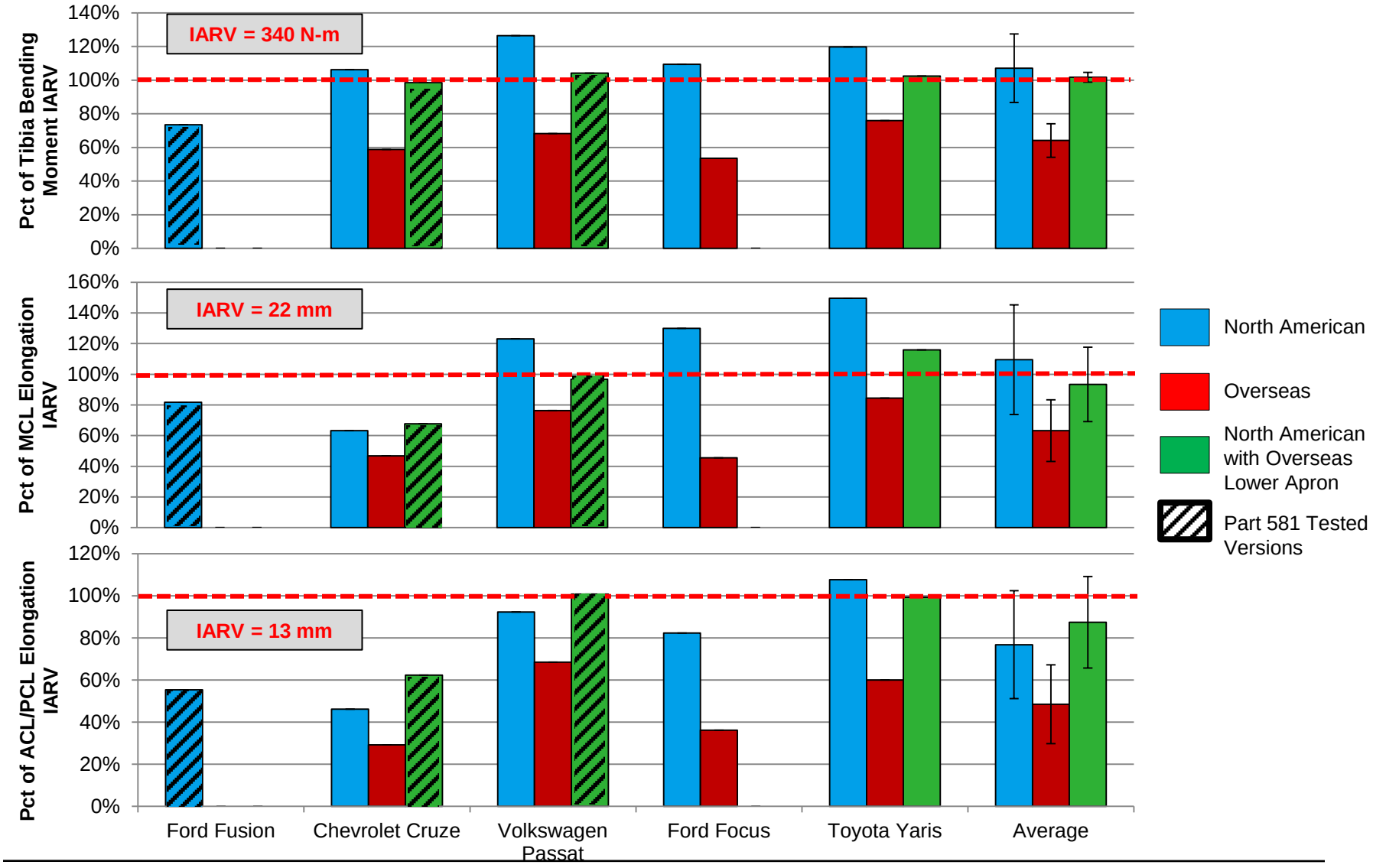


METHODS: FLEXGTR TESTING

- **GTR9 Test Procedure**
  - FlexGTR legform instead of EEVC legform

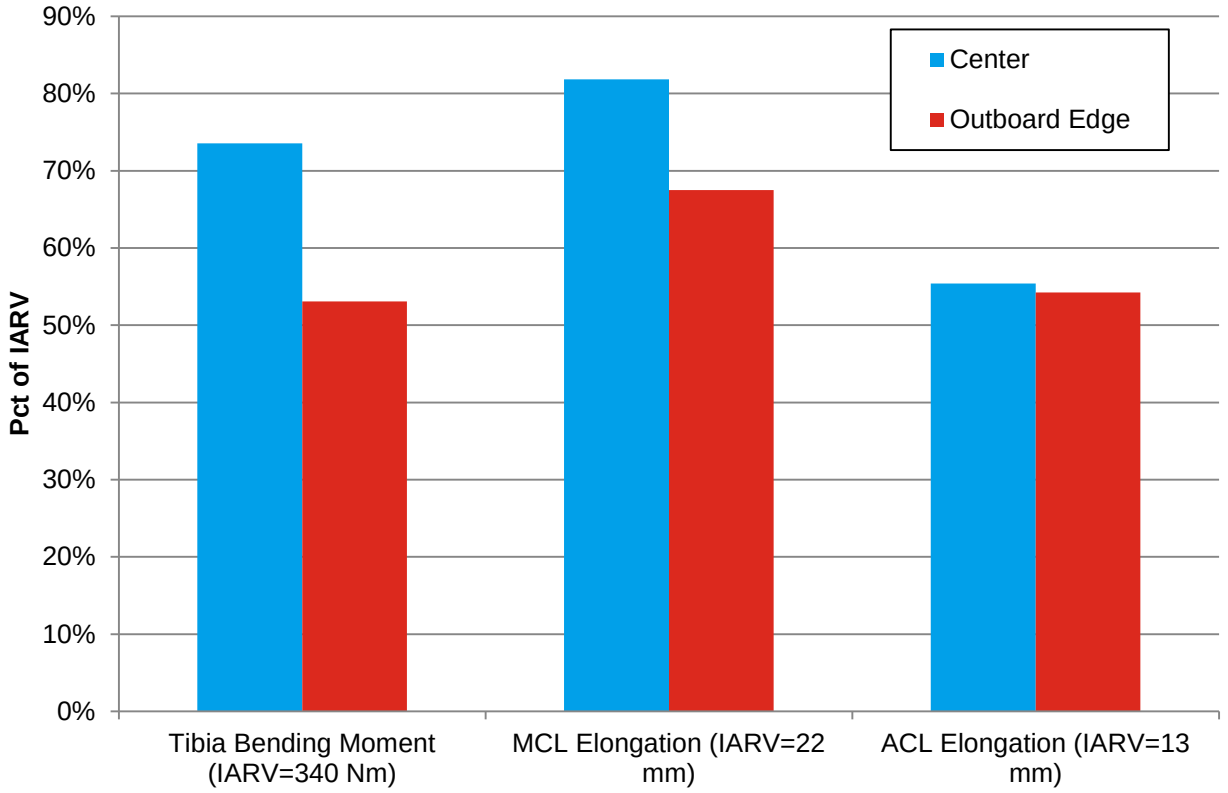


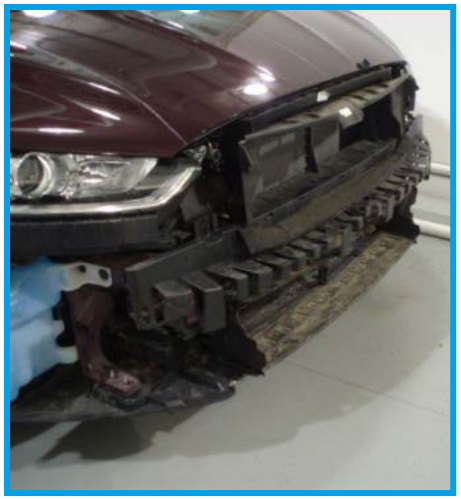
RESULTS: FLEXGTR TESTS



RESULTS: FUSION

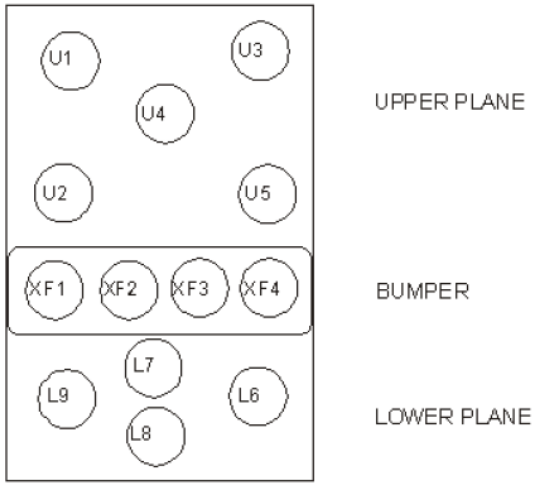
- **Fusion passed proposed FlexGTR IARV across bumper width**
  - Outboard edge < center is opposite trend from previous FlexGTR testing on other NA bumper version vehicles (outboard stiffer due to supports)

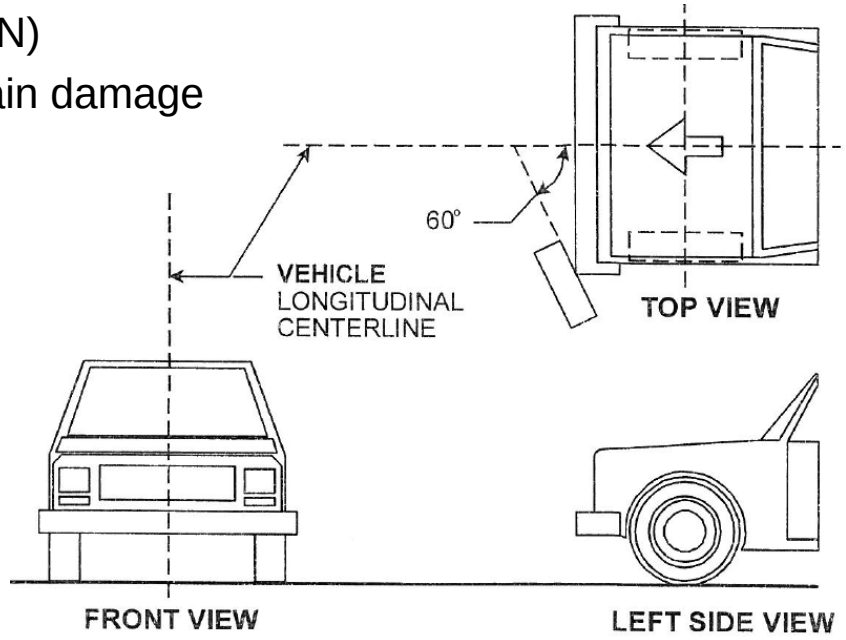




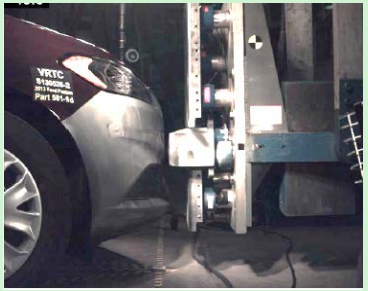
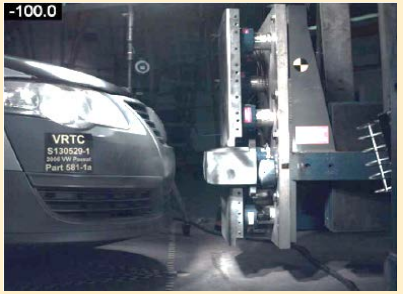
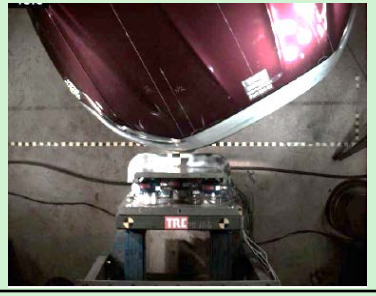
METHODS: PART 581 TESTING

- **Three “global platform” vehicles that passed (or came close to passing) GTR9 with FlexGTR legform**
  - Fusion (NA), Cruze (NA/O), Passat (NA/O)
- **Only frontal pendulum portion of series**
  - B Plane not used (16-20” with mid-plane center matching bumper bar height)
  - One longitudinal @ 2.5 mph, one corner @ 1.5 mph
- **Part 581 criteria**
  - Upper + lower plane < 2000 lbs (8896 N)
  - No non-bumper components can sustain damage

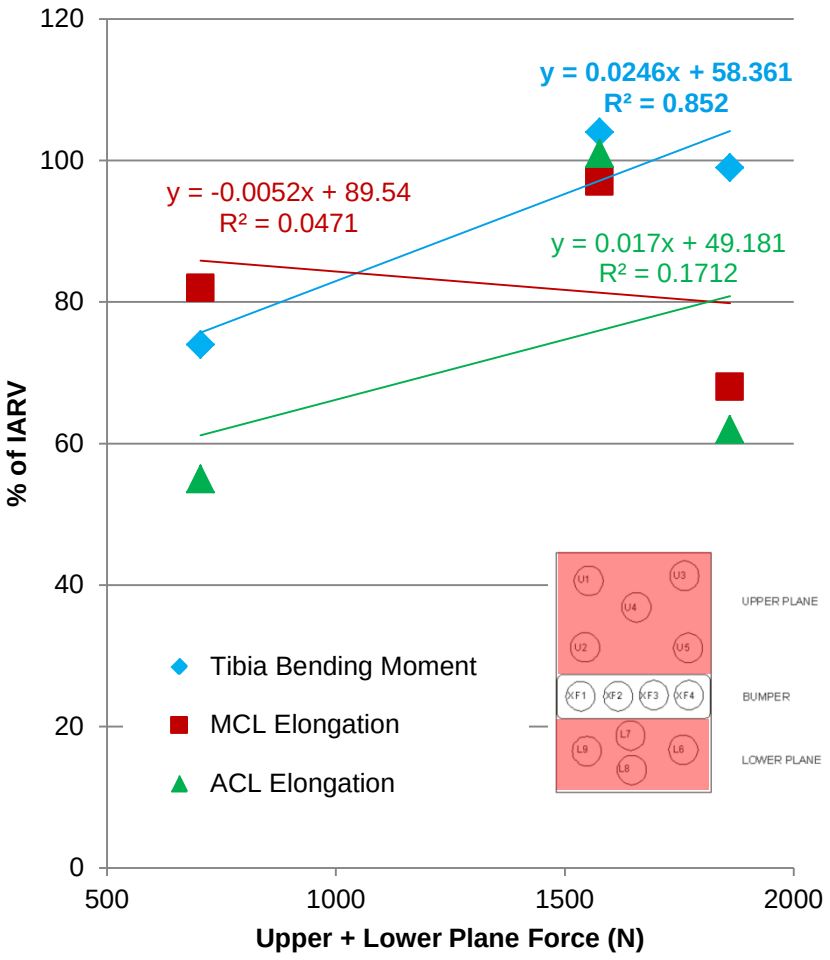


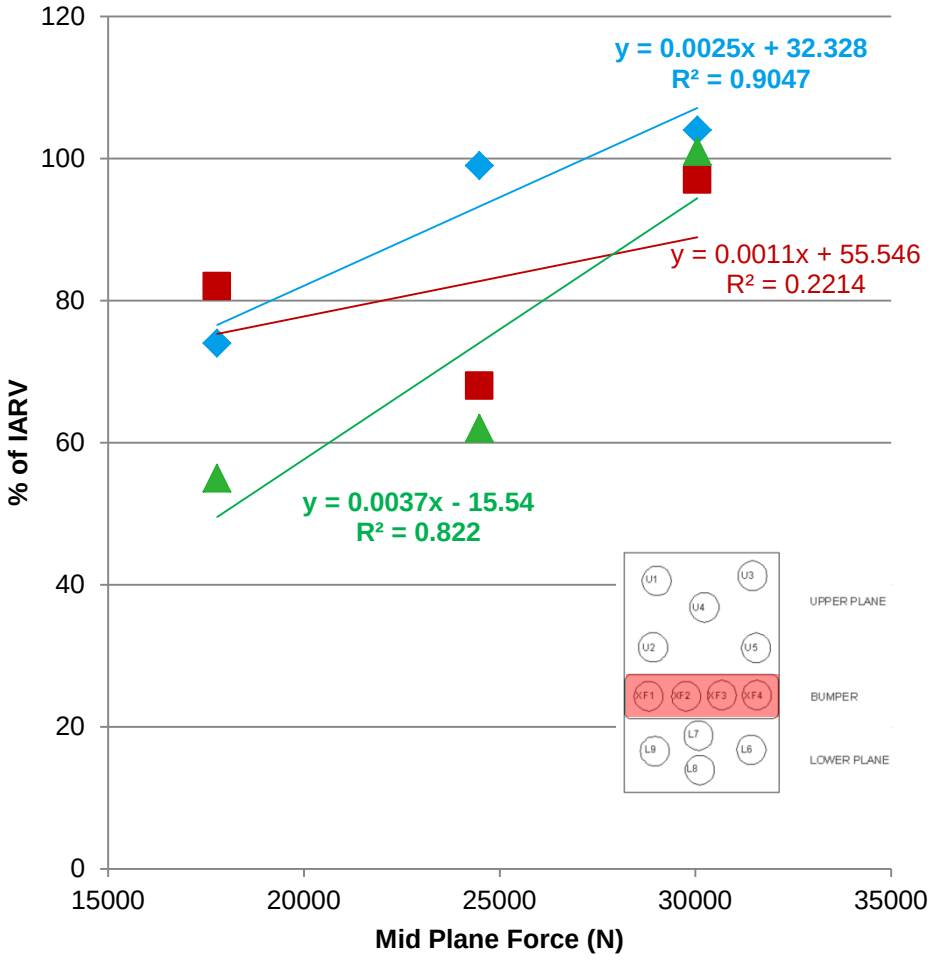


RESULTS: PART 581 TESTS

	Fusion (NA)	Cruze (NA/O)	Passat (NA/O)
2.5 mph Longitudinal			
Upper + Lower Plane Force (N) [Limit: 8896 N]	704	1861	1576
Mid Plane Force (N)	17783	24485	30048
1.5 mph Corner			
Upper + Lower Plane Force (N) [Limit: 8896 N]	1043	1527	770
Mid Plane Force (N)	24791	24452	15675
Non-Bumper Damage?	No	No	No

RESULTS: FLEXGTR IARV % vs. PART 581 FORCES





2.5 MPH Longitudinal Pendulum Test

BUMPER PART OBSERVATIONS

- **No drastic changes from the N.A. version of the front-end in order to conform to FlexGTR IARV & Part 581**
  - Fusion needed no change
  - Cruze and Passat needed stiffened lower apron
- **Different strategies employed by OEMs to meet GTR9 with EEVC legform**
  - Crushable bumper bar with space between fascia and beam (Yaris)
  - Modular energy absorber (Fusion)
  - Softer energy absorber combined with stiffer lower apron or “lower leg catcher” (Focus, Passat, Cruze)
- **These design strategies to meet EEVC IARV also meet FlexGTR IARV**

ASSUMPTIONS & LIMITATIONS

- **Part 581 assumption: overseas versions would fail, North American versions would pass**
- **Full Part 581 series was not conducted; only frontal pendulum**
  - Modified systems could have sustained damage in subsequent tests
- **Countermeasures expected to provide comparable improvements across bumper width**
  - Fusion: lower FlexGTR measures near test zone edge than at center
- **Analysis limited to global passenger cars (no large vehicles)**
  - MPVs and Trucks are currently exempt from Part 581 (74 FR 28210)

SUMMARY

- **Part 581, GTR9, and 581/GTR9 version bumper systems from five “global platform” vehicles tested**
- **One production & one slightly modified vehicle met both proposed FlexGTR IARV & Part 581 (frontal pendulum only) criteria with single bumper system**
  - Modular EA, soft EA + stiff lower apron, and crushable bumper beam were observed in GTR9-passing bumper systems
- **Overseas systems designed to meet GTR9 with EEVC leg also did well with FlexGTR**
  - Design strategies vary but none were drastic overhauls from NA system
- **Of FlexGTR injury measures, tibia bending moment had strongest correlation with Part 581 pendulum forces**

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