

February 6, 2015

Full Scale Crash Testing of the ET-Plus Guardrail Terminal with 27 3/4" Guardrail

Executive Summary

From December 10, 2014 to January 6, 2015, the ET-Plus guardrail end terminal manufactured by Trinity Highway Products was crash tested in accordance with NCHRP Report 350 criteria. These tests were conducted at the Southwest Research Institute (SwRI) in San Antonio, Texas. All of these tests were conducted with the terminal installed on a guardrail with a nominal height of 27-3/4" above the ground.

FHWA, SwRI, and Dr. H. Clay Gabler, an independent expert contracted by FHWA to conduct an analysis of the crash test results, each independently evaluated the crash test results, both the test report and the video documentation, and determined that all 4 tests passed the NCHRP Report 350 criteria.

Crash Test Summary

From December 10, 2014 to January 6, 2015, the ET-Plus guardrail end terminal manufactured by Trinity Highway Products was subjected to 4 crash tests in accordance with NCHRP Report 350 criteria. These tests were conducted at the Southwest Research Institute (SwRI) in San Antonio, Texas. All of these tests were conducted with the terminal installed on a guardrail with a nominal height of 27-3/4" above the ground. The tests were:

NCHRP Report 350 Test	Test Vehicle	Impact Speed (km/hr)	Impact Angle	Impact Location
3-30	820C	100	0 degree	Vehicle front offset ¼ vehicle width from vehicle centerline
3-31	2000P	100	0 degree	Vehicle front at centerline
3-32	820C	100	15 degree	Vehicle front at centerline
3-33	2000P	100	15 degree	Vehicle front at centerline

FHWA extended the opportunity to all the State DOTs to witness the tests and to examine the test articles and test set-up. The following States took advantage of this opportunity for these four tests - NH, VA, OH, TX, FL, & CA. The State DOT representatives evaluated the set-up including the heads and the posts and either individually measured or concurred in the measurements of heads and the height of the guardrails. For those that witnessed the tests, they were provided full access to the devices that had been previously crash tested. Dr. Gabler witnessed two of the tests at 27 3/4" and was provided the same access to the test articles, set-up and post crash test examination as provided to the State DOT representatives.

At FHWA's encouragement, the opportunity for the media to be present at the crash tests was provided to two members of the media. FHWA and a representative of AASHTO provided media availability after each crash test for the media to ask questions about the test.

The observers for each test were:

	Dec 10 ET27 Test 3-33	Dec 16 ET27 Tests 3-31	Dec 17 ET27 Test 3-32	Jan 6 ET27 Test 3-30
U.S. DOT				
Eduardo Arispe	X			
Dick Albin	X	X	X	X
Tony Furst	X	X	X	X
Ryan Daniels	X			
Jamie Mazzone	X			
Tanya Chavez	X			
States				
John Jewell – California DOT	X			
Trey Tillander - Florida DOT	X			
Keith Cota - New Hampshire DOT		X	X	X
Maria Ruppe – Ohio DOT		X	X	
Mark Marek – Texas DOT	X			X
Rory Meza - Texas DOT	X			
Bob Kaufman - Texas DOT	X			
Charles W. Patterson - Virginia DOT	X	X	X	X
Michael C. Brown - Virginia DOT	X	X	X	
Matt Barret - Virginia DOT				X
AASHTO				
Tony Dorsey	X			
Independent Expert				
Clay Gabler – Virginia Tech		X	X	
Media Representatives				
Jace Larsen – KPCR Houston NBC affiliate	X	X		
Cindy Galli – ABC News	X	X	X	
Tonya Kerr – ABC News				X
Shari St. Clair – KSAT San Antonio ABC affiliate				X

A Summary of the results is shown below:

Evaluation Factor	Evaluation Criteria	Test Results			
		ET27-33	ET27-31	ET27-32	ET27-30
Structural Adequacy	C. Acceptable Test Article Performance may be by redirection, controlled penetration, or controlled stopping of the vehicle.	Pass	Pass	Pass	Pass
Occupant Risk	D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment or present an undue hazard to other traffic, pedestrians, or personnel in a work zone. Deformations of, or intrusions into, the occupant compartment that could cause serious injuries should not be permitted	Pass	Pass	Pass	Pass
	F. The vehicle should remain upright during and after collision although moderate roll, pitching and yawing are acceptable.	Pass	Pass	Pass	Pass
	H. Occupant Impact Velocity (OIV) limits: Preferred= 9m/s Maximum=12 m/s	Pass	Pass	Pass	Pass
	I. Occupant Ridedown Accel (ORA) Limits: Preferred = 15 g Maximum =20 g	Pass	Pass	Pass	Pass
Vehicle Trajectory	K. After collision, it is preferable that the vehicle's trajectory not intrude into adjacent lanes	See Note ¹	See Note ¹	See Note ¹	See Note ^{1,2}
	N. Vehicle trajectory behind the test article is acceptable	Pass	Pass	Pass	Pass

Note ¹: As stated in Report 350, this criterion is preferable, but not required.

Note ²: The design of Test 3-30 of Report 350 will cause the test vehicle to spin-out on the traffic side of the installation when the vehicle is initially offset towards the traffic side.

FHWA's analysis of the test report found:

- The tests were conducted in conformity with NCHRP Report 350
 - o Vehicle impact speeds and angles were within recommended tolerance
 - o Impact Severity was within recommended tolerance
- The test vehicle specifications were within NCHRP Report 350 tolerances with one minor exception (* discussed below)
- The test results for Occupant Impact Velocity and Ridedown Acceleration were within the recommended limits
- There was no penetration of the vehicles by the test articles and no deformation to the occupant compartments resulting from the tests
- The vehicle post-impact trajectory was acceptable, with no rollover.

* Test vehicle measurement: In Test ET27-31, the track width of the vehicle was measured at 72 inches (182.88 cm); this exceeds the recommended tolerance by 2.88 cm, or approximately 1.125 inches. For the NCHRP Report 350 Test 3-31, the trajectory and stability of the vehicle is not the focus of the test - this test primarily addresses structural adequacy and occupant risk. Therefore, it is FHWA's opinion that the wider track width is inconsequential to the evaluation of this test's results.