



U.S. Department  
of Transportation  
**Federal Highway  
Administration**

400 Seventh St., S.W.  
Washington, D.C. 20590

In Reply Refer To:  
HSA-10/B137C

July 12, 2006

Mr. Bill Neusch  
President, Gibraltar  
320 Southland Road  
Burnet, Texas 78611

Dear Mr. Neusch:

In your June 22, 2006, letter, you requested the Federal Highway Administration's (FHWA's) concurrence that your TL-4 cable barrier system would be acceptable as a National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 (TL-3) traffic barrier when placed as described below on a side slope as steep as 1V: 4H. At that time, you also provided staff members with preliminary test results. On July 11, Mr. Powers received a test report prepared by KARCO Engineering, LLC, entitled "Crash Test Report for Gibraltar TL-4 Cable Barrier System Installed on a 4:1 Sloped Median" and dated June 12, 2006.

In my letter dated September 9, 2005, the FHWA accepted a modified Gibraltar cable barrier system as a TL-4 design. This design consisted of three, 3/4-inch diameter 3 X 7 post-tensioned galvanized steel cables supported by steel C-posts 3.25 x 2.5 x 0.15-inches thick and 7-ft long. These posts were driven to a depth of 3.5 feet and installed on alternate sides of the cables. The 3 cables are locked in place by a 7/16-inch diameter x 24-inch long galvanized steel hairpin and lock plate that fits inside each post. For your TL-4 design, the bottom, middle, and top cable heights are set at 20 inches, 30 inches, and 39 inches, respectively.

A total of four tests were conducted with the TL-4 Gibraltar cable installed in a 7.3-m (24-foot) wide depressed median with 1V: 4H side slopes. For the first test, the barrier was located 2.7 m (9 feet) up the slope from the ditch bottom and the test vehicle crossed the ditch bottom and started up the backslope before impacting the barrier. For the remaining tests (NCHRP Report 350 tests 3-10 and 3-11), the barrier was located down the foreslope, 1.2 m (4 feet) from the edge of pavement. For the first two tests, all line posts were on 30-foot centers.

The first test was a modified 3-10 test in which a Geo Metro weighing 874 kg (1926 lb) was directed into the median at a 25° angle and 104.7 km/hr (65.1 mph), went down the slope, across the ditch bottom [located 3.7 m (12 ft) from edge of pavement] and 2.7 m (9 feet) up the far side of the ditch where it then impacted the backside of the cable [located 8.5 m (21 ft) from edge of pavement] at 97.5 km/hr (60.6 mph). The vehicle deflected the barrier 1.5 m (4.9 ft) laterally and was safely contained and redirected by the Gibraltar cable.



Enclosure 1 is the summary sheet for this test.

The second test was a standard NCHRP Report 350 3-11 test, with the Gibraltar cable, again with a 30-foot post spacing, located 1.2 m (4 ft) down the 1V: 4H slope from the edge of pavement. A Chevrolet C2500 3/4-ton pickup truck weighing 2,038 kg (4,494 lb) impacted the barrier at a 25-degree angle at 98.7 km/hr (61.3 mph). The maximum dynamic deflection of the barrier was not reported. Although the barrier contained the vehicle, cable deflection allowed the pickup truck to impact the backslope of the ditch and it subsequently overturned as it was being redirected by the cable. This test clearly demonstrated that adverse terrain behind a barrier can cause significant instability when barrier deflection allows an impacting vehicle to reach it, even when the barrier itself prevents penetration. Enclosure 2 is the test summary sheet for this test.

The third test was a repeat of the failed test, but the post spacing was reduced to 20 feet, and a heavier test vehicle was used, specifically a Dodge Ram 1500 weighing 2222 kg (4898 lbs). This is the new vehicle currently proposed for use in the draft Report 350 update. Impact conditions were 25 degrees and 97 km/h (60.3 mph). In this test, the pickup truck was contained and redirected upright with a maximum cable deflection of 2.6 m (8.6 ft). Test results are shown in Enclosure 3.

The final test was a standard NCHRP Report 350 3-10 test with the Gibraltar cable again located 1.2 m (4 ft) down the 1V: 4H slope from the edge of pavement. A Geo Metro weighing 919 kg (2,026 lb) impacted the barrier at a 20-degree angle at 101.6 km/hr (63.2 mph). The maximum dynamic deflection of the barrier was 1.4 m (4.7 ft), and the vehicle was safely contained and redirected by the cable. Enclosure 4 is the test summary sheet for this test.

Based on the test results summarized above, your TL-4 Gibraltar cable design is acceptable as a TL-3 traffic barrier when placed no farther than 1.2 m (4 feet) down a 1V: 4H slope (for adjacent traffic impacts) and no closer than 9 feet from the ditch bottom for opposite-side impacts. This offset may be decreased to 8 feet based on computer simulation done by the National Crash Analysis Center on the generic cable barrier and on our review of the vehicle position at that point in your test, provided the maximum down-slope offset remains at 4 feet. Although the tested design was your TL-4 system (successfully tested previously with the single unit truck on a flat slope), transportation agencies using this design on a 1V: 4H slope should understand that it has been tested only to TL-3 when installed on such a slope. Thus, it remains possible that the single-unit TL-4 truck may not be captured or contained by the barrier when installed on a 4:1 slope.

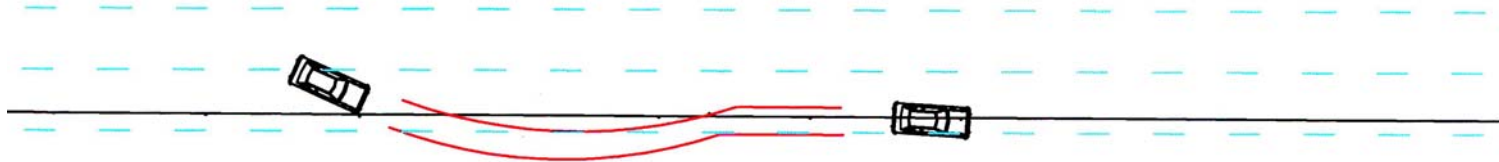
Sincerely yours,

**/original signed by John R. Baxter/**

John R. Baxter, P.E.  
Director, Office of Safety Design  
Office of Safety

4 Enclosures

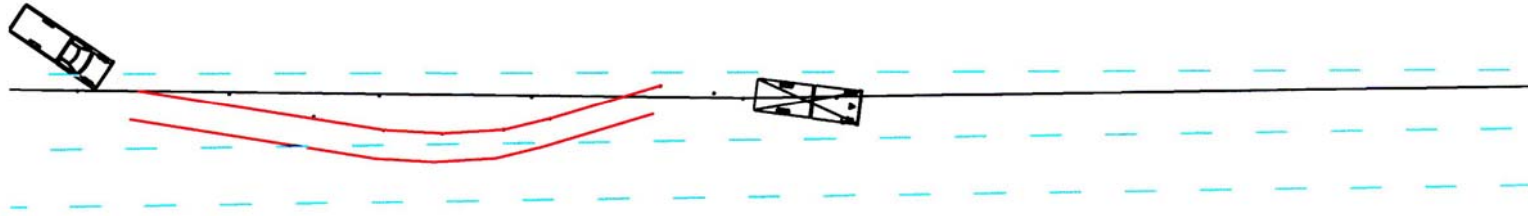
**DATA SHEET NO. 2**  
**SUMMARY OF RESULTS FOR TEST NO. P26133-01 (MODIFIED 3-10)**



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	Modified 3-10	X-DIRECTION	5.2
DATE	06/12/06	Y-DIRECTION	0.8
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	91.44 m (300 ft.)	X-DIRECTION	-7.4
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 30 ft. post spacings	Y-DIRECTION	-4.3
SOIL TYPE AND CONDITION	4:1 slope (upslope 25°)	PHD (optional)	
TEST VEHICLE	820C	ASI (optional)	0.84
TYPE	Production	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-10	DYNAMIC	1.50 m (4.92 FT.)
MODEL	Geo Metro	PERMANENT	N/A
MASS (CURB)	799 kg (1762 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	812 kg (1790 lbs)	EXTERIOR	
DUMMY(S) MASS	75 kg (165 lbs)	VDS	1-FR-4
GROSS STATIC WEIGHT	874 kg (1926 lbs)	CDC	01RDMN6
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	104.7 km/h (65.08 mph) 97.51 km/h (60.60 mph) at impact	OCDI	FR0000000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	34.8	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	22.7
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-41.0
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	6.7

\* Vehicle remained in contact with the cable barrier for the duration of the event.

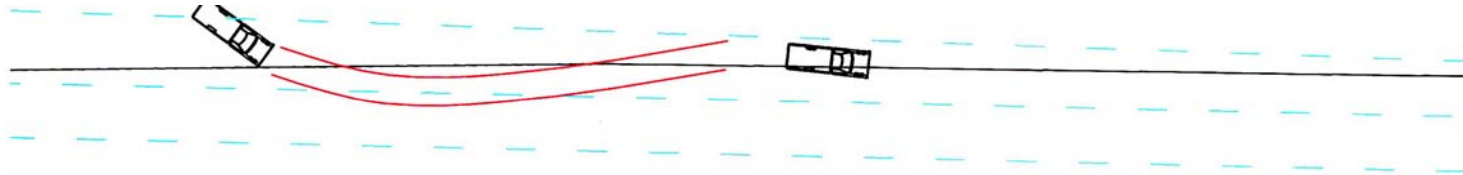
**DATA SHEET NO. 6**  
**SUMMARY OF RESULTS FOR TEST NO. P26133-02 (Test 3-11)**



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	3-11	X-DIRECTION	3.3
DATE	06/12/06	Y-DIRECTION	5.4
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	91.44 m(300 ft.)	X-DIRECTION	-15.1
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 30 ft. post spacings	Y-DIRECTION	10.4
SOIL TYPE AND CONDITION	4:1 slope	PHD (optional)	
TEST VEHICLE	2000P	ASI (optional)	0.49
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-11	DYNAMIC	
MODEL	2500	PERMANENT	N/A
MASS (CURB)	2210 kg (4872 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2038 kg (4494 lbs)	EXTERIOR	
DUMMY(S) MASS	N/A	VDS	1-L&T-6
GROSS STATIC WEIGHT	N/A	CDC	01RDGN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	98.65 km/h (61.31 mph)	OCDI	FS0100000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	89.5	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	258.7
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-49.3
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	35.5

\* Vehicle rolled over on the cable barrier.

**DATA SHEET NO. 10**  
**SUMMARY OF RESULTS FOR TEST NO. P26133-03 (Test 3-11)**

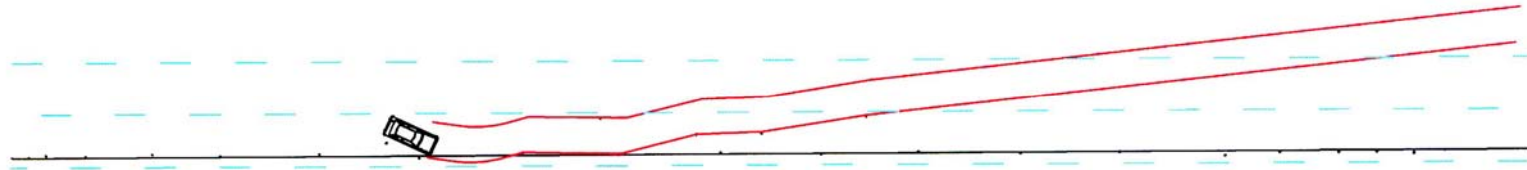


GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	3-11	X-DIRECTION	2.7
DATE	06/14/06	Y-DIRECTION	8.3
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	92.9 m(305 ft.)	X-DIRECTION	-3.6
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 20 ft. post spacings	Y-DIRECTION	-3.9
SOIL TYPE AND CONDITION	4:1 slope(down slope 25°)	PHD (optional)	
TEST VEHICLE	2270P	ASI (optional)	0.35
TYPE	Production	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-11	DYNAMIC	2.61 m (8.58 ft.)
MODEL	RAM 1500	PERMANENT	N/A
MASS (CURB)	2194 kg (4836 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2222 kg (4898 lbs)	EXTERIOR	
DUMMY(s) MASS	N/A	VDS	1-FR-2
GROSS STATIC WEIGHT	N/A	CDC	01RDEN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	97.05 km/h (60.32 mph)	OCDI	FS0000000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	144.7	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	23.8
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-44.3
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	-17.9

\* Vehicle remained in contact with the cable barrier for the duration of the event.



**DATA SHEET NO. 14**  
**SUMMARY OF RESULTS FOR TEST NO. P26133-04 (Test 3-10)**



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	3-10	X-DIRECTION	2.8
DATE	06/16/06	Y-DIRECTION	4.9
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	91.44 m (300 ft.)	X-DIRECTION	-4.8
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 30 ft. post	Y-DIRECTION	-5.6
SOIL TYPE AND CONDITION	4:1 slope (upslope 25°)	PHD (optional)	
TEST VEHICLE	820C	ASI (optional)	0.63
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-10	DYNAMIC	1.43 m ( 4.70 FT.)
MODEL	Geo Metro	PERMANENT	N/A
MASS (CURB)	858 kg (1892 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	845 kg (1862 lbs)	EXTERIOR	
DUMMY(S) MASS	75 kg (165 lbs)	VDS	1-FR-2
GROSS STATIC WEIGHT	919 kg (2026 lbs)	CDC	01RRGN8
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	101.63 km/h (63.16 mph)	OCDI	FS0000000
ANGLE (Deg.)	20		
IMPACT SEVERITY (kJ)	39.3	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	37.6
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-34.3
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	4.4

\*Test vehicle exit conditions occurred beyond the view of the overhead cameras.