CITY AND COUNTY OF SAN FRANCISCO
San Francisco Municipal Transportation Agency
Request for Proposals
THE PROCUREMENT OF
30-Foot, 40-FOOT AND 60-FOOT LOW FLOOR
DIESEL HYBRID COACHES

Proposal Section	Title	Bid Submission Requirements
4-B	B. Strength Requirement	Supply certification that the proposed vehicle meets all of the requirements of the baseline advance design coach strength requirements in Section 2.1 of the Technical Specifications-Volume 2. The certification must state the dates of compliance testing. SFMTA will consider these requirements satisfied if the Components that have been modified or added since that date have been tested and found to comply with those requirements.

Throughout this proposal New Flyer is providing information that complies with the requirements of Section 2.1 of the specifications. The Altoona test report is found in Section 4-C.
Structural information can be found in Section 3-H.
Attached we have attached our test certification for side impact and crush load.

Crash Test of a 2001 Ford Taurus
Into the Right Side of a
New Flyer Industries SR-1212, Xcelsior D40 2010
Engineering Bus at 25.6 mph
TRC Inc. Test Number: 091027-1

Prepared by:
Transportation Research Center Inc.
10820 State Route 347
P. O. Box B-67
East Liberty, OH 43319

Final Report
October - November 2009

Prepared For:
New Flyer Industries Limited
Unit #7, 45 Beghin Avenue
Winnipeg, Manitoba, Canada R2J4B9

Notice

Transportation Research Center Inc. does not endorse or certify products of manufacturers. The manufacturer's name appears solely to identify the test article. Transportation Research Center Inc. assumes no liability for the report or use thereof. It is responsible for the facts and the accuracy of the data presented herein. This report does not constitute a standard, specification, or regulation.

Test Performed By: John Shultz, Test Supervisor

Report Approved By:

Diana Spurgeon Date November 9, 2009

Diana Spurgeon, Project Manager
Transportation Research Center Inc.

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List of Photographs

Section 1.0

Purpose and Test Procedure

This report documents a crash test of a 2001 Ford Taurus 4-door impacting the right side of New Flyer Industries SR-1212, Xcelsior D40 2010 Engineering Bus at 25.6 mph. The test was conducted on October 27, 2009. The purpose of the above test was to acquire data relative to the recommendations of the Standard Bus Procurement Guidelines dated May 8, 2000, paragraph 5.4.1.2, regarding crashworthiness.

The test setup was such that the 2001 Ford Taurus struck the bus right side structure 58.3 inches rearward of the front wheel vertical centerline at an angle of 90° relative to the bus' longitudinal axes.

A grid work of crush points was laid out along seventy-eight (78) inches of the bus side at six-inch spacings at the following heights: The New Flyer bus floor height, bumper height, the height of the H-point of a seated 50th percentile male passenger, and six (6) inches above and below the H-point height.

The impact event was recorded by three (3) high-speed digital cameras, and one (1) real-time digital camera.

Static Crush Test Results

Paragraph 5.4.1.2 of the referenced specification requires there be no more that three (3) inches of static deformation at the H-point height. The maximum static deformation for this test was 0.6 inches. In addition, there was no intrusion of the bus side structure into the bus occupant compartment nor were any sharp edges or protrusions generated.

Section 2.0

Vehicle Information

Low Floor Diesel Transit Bus

Vehicle manufacturer:	New Flyer Industries, Limited
Year/make/model:	SR-1212, Xcelsior D40 2010 Engineering Bus
VIN:	2FYD8FV148D034334
Color:	Grey
Transmission data:	_6_ speed, ___ manual, _X_ automatic, ____ fwd, _X_ rwd, ____ 4wd
Date vehicle received:	October 26, 2009
Odometer reading:	6061.8

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Air	Automatic speed control	No
Power seats	Yes	Tilting steering wheel	Yes
Power windows	No	Telescoping steering wheel	Yes
Tinted glass	Yes	Air conditioning	Yes
Radio/Cassette/CD	No	Anti-lock brakes	No
Clock	No	Rear window defroster	No
Other:	None		

Certification data from vehicle's label:

Vehicle manufactured by:		New Flyer Industries, Limited
Date of manufacture:		07/08
VIN:		2FYD8FV148D034334
GVWR:		42540 lbs.
GAWR:	Front:	14780 lbs.
	Rear:	27760 lbs.

Vehicle Information, Continued

Weight of test vehicle as received:

Front	7050 lbs.	Right rear	8880 lbs.
		Left rear	8240 lbs.
Total front weight	7050 lbs.	(29.2 % of total vehicle weight)	
Total rear weight	17120 lbs.	(70.8 % of total vehicle weight)	
Total delivered weight	24170 lbs.		
Total test weight	24170 lbs.		

Weight of ballast secured in cargo area: 0 lb

Components removed to meet target test weight: None

CG = ----[1] inches rearward of front wheel centerline.

Tires on vehicle (mfr., line, size): Michelin, XZU2, 305/70R22.5

Tire pressure with maximum capacity vehicle load: Front: Not recorded
Rear: Not recorded

Maximum width[1]: Not recorded

Wheelbase[1]: Not recorded

Location of label stating tire & capacity data: Left top of B-Pillar

Data from vehicle's "Recommended Tire Pressure" label:

Recommended tire size: 305/70R22.5

Recommended cold tire pressure: Front: 120 psi
Rear: 120 psi

Remarks:

1. Is the vehicle stock throughout? No
2. Does the vehicle show evidence of prior accident history? No
3. Does the vehicle show any significant corrosion? No
4. Condition of the front/rear bumper and frame? Good

Test vehicle attitude:

Delivered attitude:	LF	41.5 in;	RF	45.3 in;	LR	42.9 in;	RR	42.9 in
Pre-test attitude:	LF	43.1 in;	RF	39.4 in;	LR	43.1 in;	RR	43.0 in
Post-test attitude:	LF	42.8 in;	RF	43.7 in;	LR	43.1 in;	RR	43.1 in

[1] The maximum width and wheelbase were not recorded; therefore the Transit bus center of gravity could not be calculated or recorded.

Vehicle Information, Continued

Ford Taurus

Vehicle manufacturer:	Ford Motor Company
Year/make/model:	2001 Ford Taurus
VIN:	1FAFP52U91G276968
Color:	Silver
Engine data:	
Type:	Transverse
Cylinders:	6
Displacement:	3.0 liters
Transmission data:	_3_ speed, ___ manual, _X_ automatic, _X_ fwd, ___ rwd, ___ 4wd
Date vehicle received:	October 21, 2009
Odometer reading:	99,050

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Yes	Automatic speed control	Yes
Power seats	No	Tilting steering wheel	Yes
Power windows	Yes	Telescoping steering wheel	No
Tinted glass	Yes	Air conditioning	Yes
Radio/Cassette/CD	Yes	Anti-lock brakes	Yes
Clock	Yes	Rear window defroster	Yes
Other:	None		

Certification data from vehicle's label:

Vehicle manufactured by:		Ford Motor Company
Date of manufacture:		06/01
VIN:		1FAFP52U91G276968
GVWR:		4684 lbs.
GAWR:	Front:	2552 lbs.
	Rear:	2132 lbs.

Vehicle Information, Continued

Weight of test vehicle as received:

Right front	1075.4 lbs.	Right rear	578.9 lbs.
Left front	1048.1 lbs.	Left rear	608.0 lbs.
Total front weight	2123.5 lbs.	(64.1 % of total vehicle weight)	
Total rear weight	1186.9 lbs.	(35.9 % of total vehicle weight)	
Total delivered weight	3310.4 lbs.		
Total test weight	4001.4 lbs.		

Weight of ballast secured in cargo area: 700.0 lbs.

Components removed to meet target test weight: None

CG = 41.2 inches rearward of front wheel centerline.

Tires on vehicle (mfr., line, size): Bridgestone, Turanza P215/60R16

Tire pressure with maximum capacity vehicle load: Front: 30 psi
Rear: 30 psi

Maximum width: 72.8 in

Wheelbase: 108.5 in

Location of label stating tire & capacity data: Driver's door.

Data from vehicle's "Recommended Tire Pressure" label:

Recommended tire size: P215/60R16

Recommended cold tire pressure: Front: 30 psi
Rear: 30 psi

Remarks:

5. Is the vehicle stock throughout? Yes
6. Does the vehicle show evidence of prior accident history? No
7. Does the vehicle show any significant corrosion? No
8. Condition of the front/rear bumper and frame? Good

Test vehicle attitude:

Delivered attitude:	LF	27.2 in;	RF	27.4 in;	LR	26.3 in;	RR	26.6 in
Pre-test attitude:	LF	26.1 in;	RF	26.4 in;	LR	24.8 in;	RR	25.1 in
Post-test attitude:	LF	26.1 in;	RF	26.8 in;	LR	24.6 in;	RR	25.2 in

Section 3.0

Test Summary and Measurements

Test type:	Car into Right Side of Bus
Test date:	October 27, 2009
Test time:	12:48
Ambient temperature:	62.1° F
Impact angle[1]:	90
Impact velocity[2]:	Primary = 25.56 mph Secondary = 25.54 mph
Maximum static crush:	0.6 inches
Impact Point:	58.4 inches
Number of cameras:	
High-Speed:	3
Real-Time:	1

[1] Clockwise from front centerline of the test vehicle.
[2] Speed trap measurement (± .05 mph accuracy)

VEHICLE EXTERIOR PROFILES AND STATIC CRUSH

Zero Distance is at Projected Impact Point*

Pre-Test Profile (Distance in Inches from Reference Plane)**

LOCATION	Height (IN)	-36	-30	-24	-18	-12	-6	0	6	12	18	24	30	36	42
H-PT. +6 IN.	27.0	90.4	90.2	90.2	90.0	90.0	90.2	90.0	90.0	90.0	90.0	90.0	91.1	90.6	90.5
H-PT.	21.0	90.2	90.0	90.0	90.0	90.1	89.9	89.9	90.0	90.0	90.1	90.0	91.2	90.6	90.9
H-PT. -6 IN.	15.0	90.0	89.8	89.8	90.1	90.0	90.0	90.1	90.2	90.0	90.2	90.1	91.1	90.7	90.7
BUMPER	10.8	---[1]	89.6	89.5	89.6	89.5	89.6	89.5	89.5	89.5	89.4	89.4	91.7	90.0	91.1
BUS FLOOR	1.0	---[1]	84.8	84.7	84.7	85.0	85.0	84.9	85.0	85.1	85.0	85.0	85.2	85.1	85.1

Post-Test Profile (Distance in Inches from Reference Plane)**

LOCATION	Height (IN)	-36	-30	-24	-18	-12	-6	0	6	12	18	24	30	36	42
H-PT. +6 IN.	27.0	90.7	90.4	90.2	90.2	90.0	89.6	90.0	89.7	89.8	90.6	90.2	91.6	90.7	90.7
H-PT.	21.0	90.4	90.2	89.8	90.0	89.8	89.5	89.7	89.4	89.6	90.0	89.6	91.5	90.7	91.3
H-PT. -6 IN.	15.0	90.2	90.0	89.8	89.4	89.8	89.4	89.7	89.4	89.6	89.8	89.8	91.3	90.7	90.9
BUMPER	10.8	---[1]	89.0	88.6	88.7	88.8	88.4	88.7	88.5	88.5	88.6	88.8	89.6	90.0	90.9
BUS FLOOR	1.0	---[1]	84.8	84.6	84.6	85.0	84.8	85.1	85.0	85.0	85.2	85.0	85.2	85.2	85.1

Static Crush (Inches)

LOCATION	Height (IN)	-36	-30	-24	-18	-12	-6	0	6	12	18	24	30	36	42
H-PT. +6 IN.	27.0	-0.4	-0.2	0.0	-0.2	0.0	0.6	0.0	0.3	0.2	-0.6	-0.2	-0.4	-0.2	-0.2
H-PT.	21.0	-0.2	-0.2	0.2	0.0	0.3	0.4	0.2	0.6	0.4	0.1	0.4	-0.3	-0.2	-0.3
H-PT. -6 IN.	15.0	-0.2	-0.2	0.0	0.7	0.2	0.6	0.4	0.8	0.4	0.4	0.3	-0.2	0.0	-0.2
BUMPER	10.8	---[1]	0.6	0.9	0.9	0.7	1.2	0.9	1.0	1.0	0.9	0.6	2.1	0.0	0.2
BUS FLOOR	1.0	---[1]	0.0	0.1	0.1	0.0	0.2	-0.2	0.0	0.0	-0.2	0.1	-0.1	-0.1	0.0

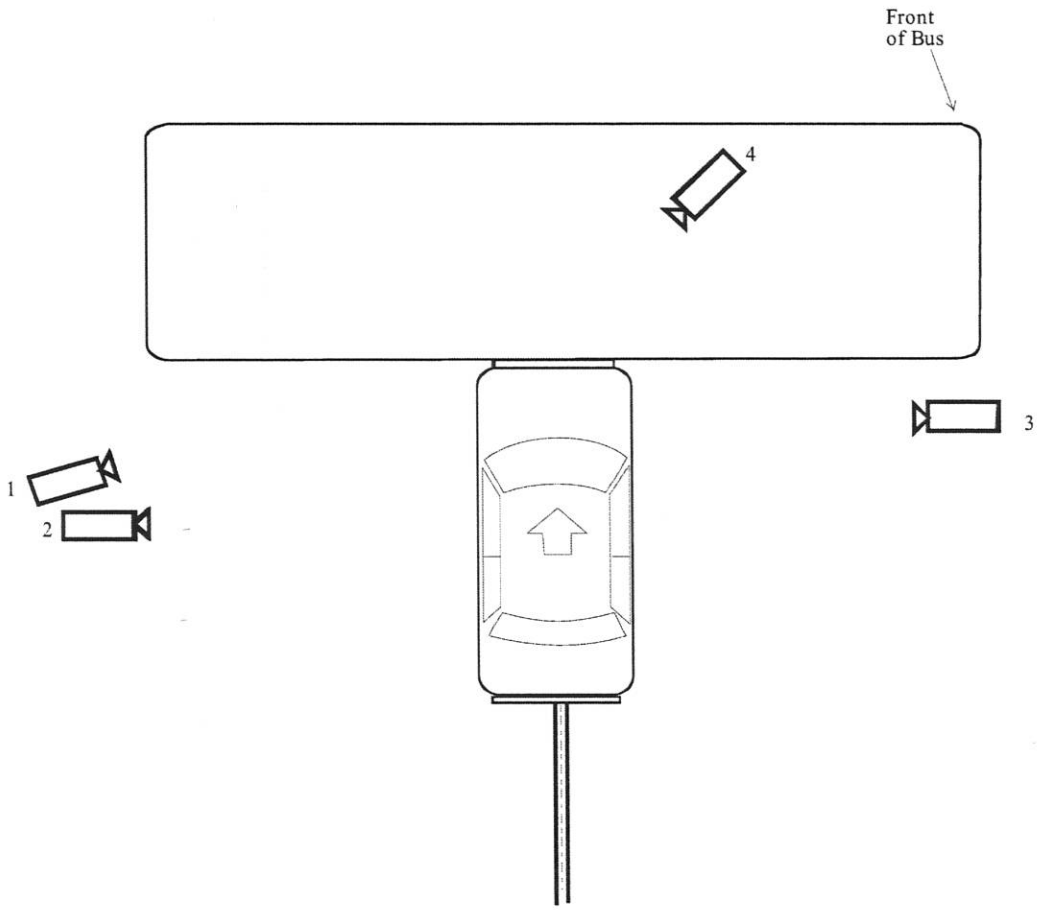
* Projected impact point is the centerline of the striking vehicle on the bus side and is 58.3 inches rearward of the front wheel verticle center line. Column readings are front to rear from left to right.

** Reference plane used is the interior of the non impact side along the rail at floor height.

[1] Unable to record measurement because of wheel well.

Test Summary and Measurements, Continued

Camera Information



Camera Number	Location	Type	Lens (mm)	Speed (fps)	Purpose of Camera Data
1	Event	Canon	Zoom	30	Real-time
2	Left side wide	Redlake LE	12.5	1000	Vehicle crush
3	Right side wide	Redlake LE	12.5	1000	Vehicle crush
4	Onboard bus	Redlake LE	6	1000	Intrusion

Appendix A

Photographs

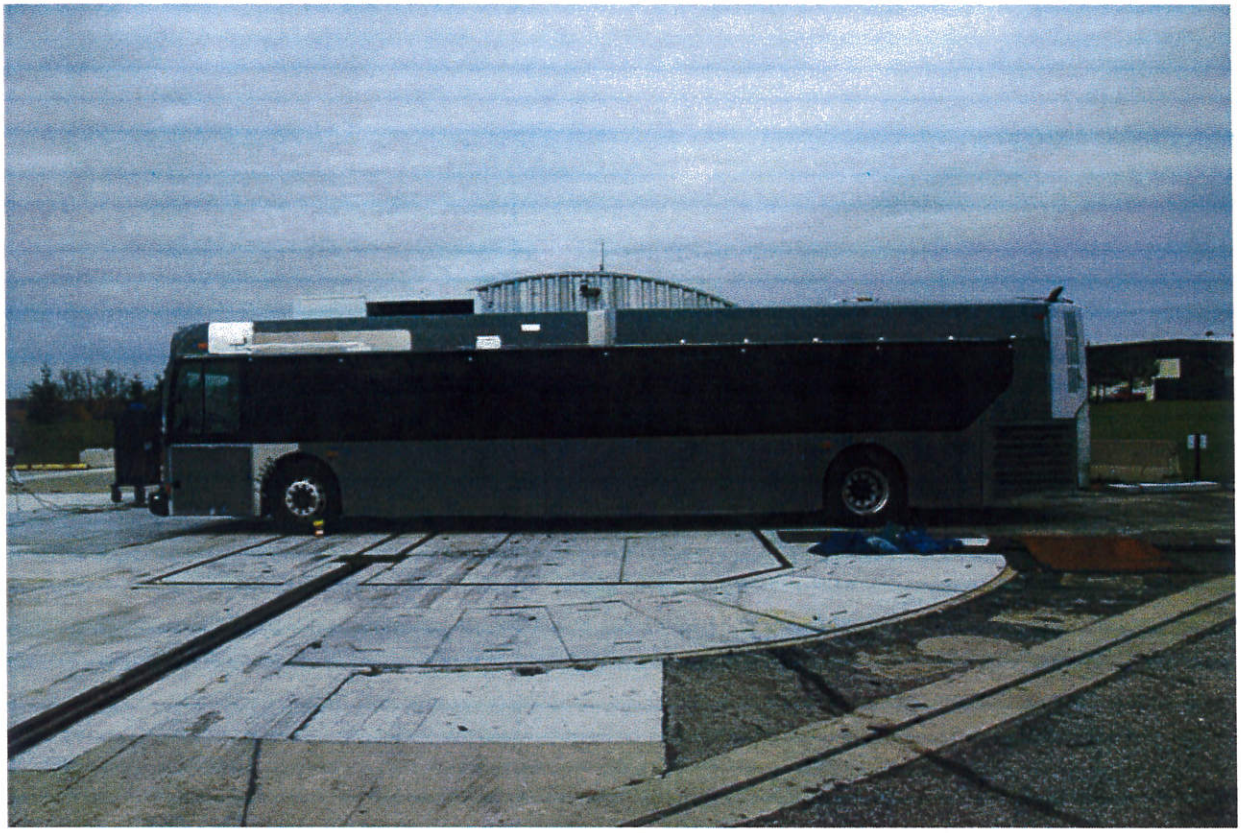


Figure A-1 Pre-Test Bus Left Side View

Figure A-2 Post-Test Bus Left Side View

Figure A-3 Pre-Test Bus Rear View

Figure A-4 Post-Test Bus Rear View

Figure A-5 Pre-Test Bus Right Side View

Figure A-6 Post-Test Bus Right Side View

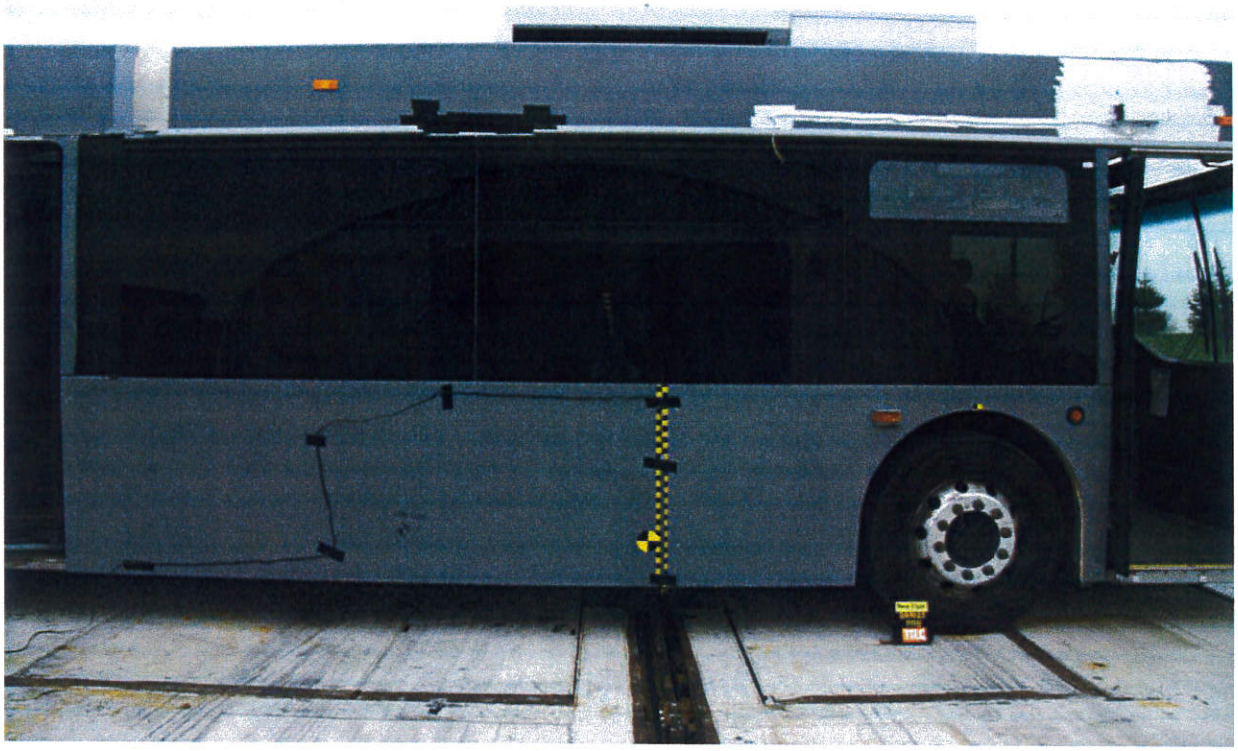


Figure A-7 Pre-Test Bus Right Side Close-up View

Figure A-8 Post-Test Bus Right Side Close-up View

Figure A-9 Pre-Test Vehicle to Bus Left Side View

Figure A-10 Post-Test Vehicle to Bus Left Side View

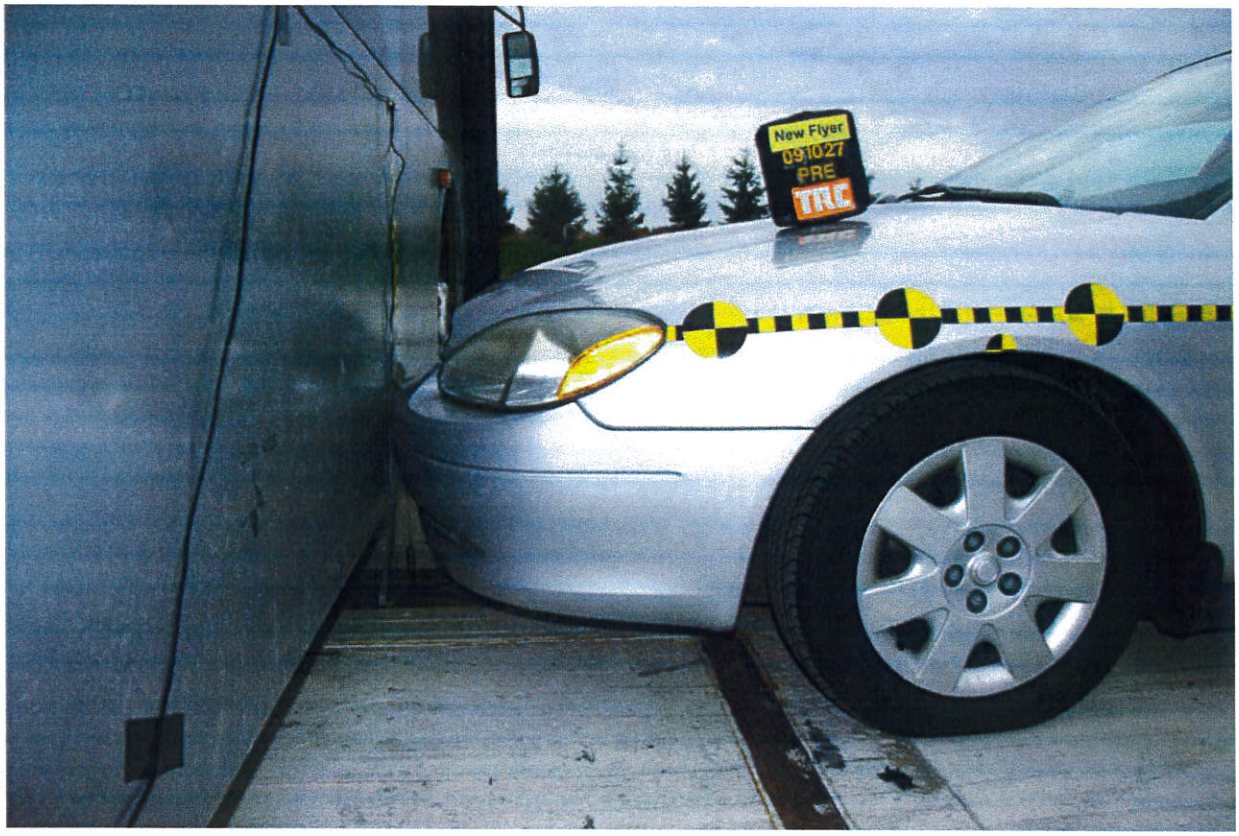


Figure A-11 Pre-Test Vehicle to Bus Left Side Close-up View

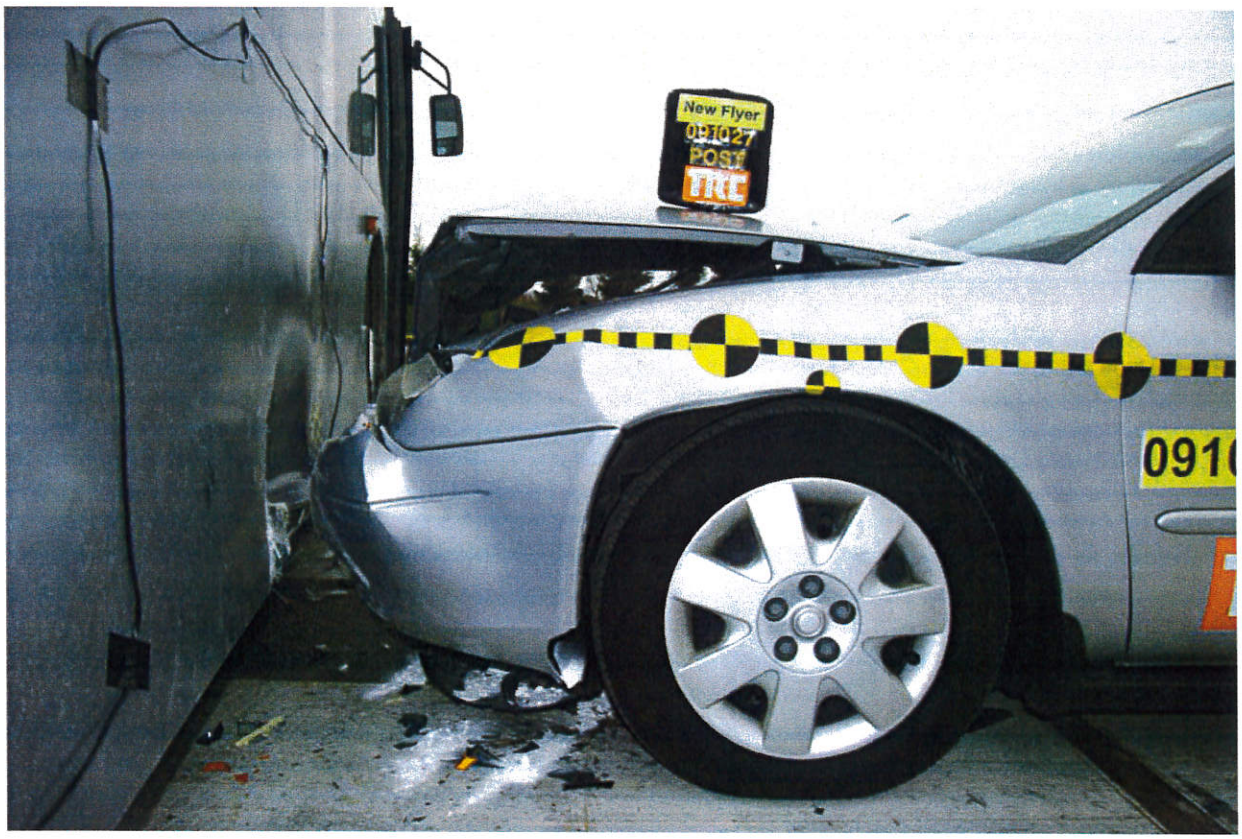


Figure A-12 Post-Test Vehicle to Bus Left Side Close-up View

Figure A-13 Pre-Test Vehicle to Bus Rear View

Figure A-14 Post-Test Vehicle to Bus Rear View

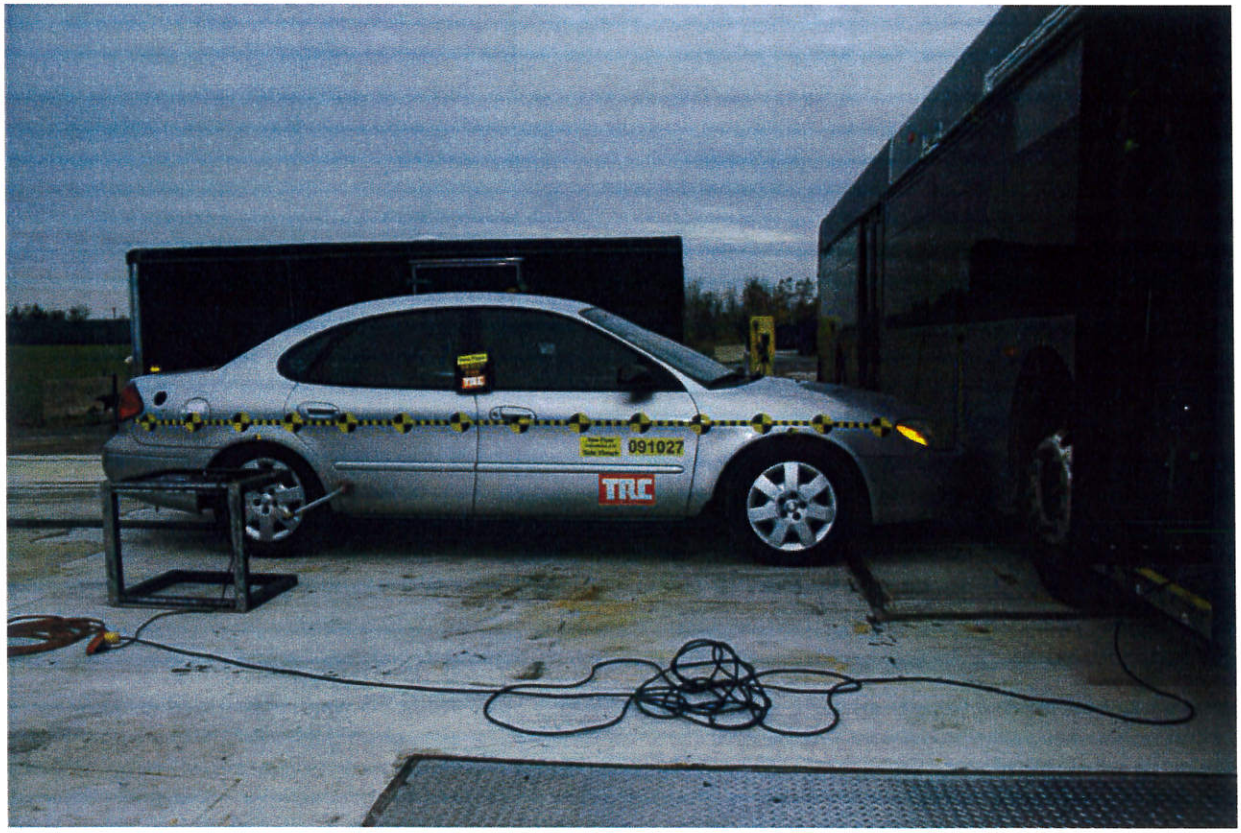


Figure A-15 Pre-Test Vehicle to Bus Right Side View

Figure A-16 Post-Test Vehicle to Bus Right Side View

Figure A-17 Pre-Test Vehicle to Bus Right Side Close-up View

Figure A-18 Post-Test Vehicle to Bus Right Side Close-up View

Figure A-19 Pre-Test Bus Floor Level Interior View

Figure A-20 Post-Test Floor Level Interior - View 1

Figure A-21 Post-Test Floor Level Interior - View 2

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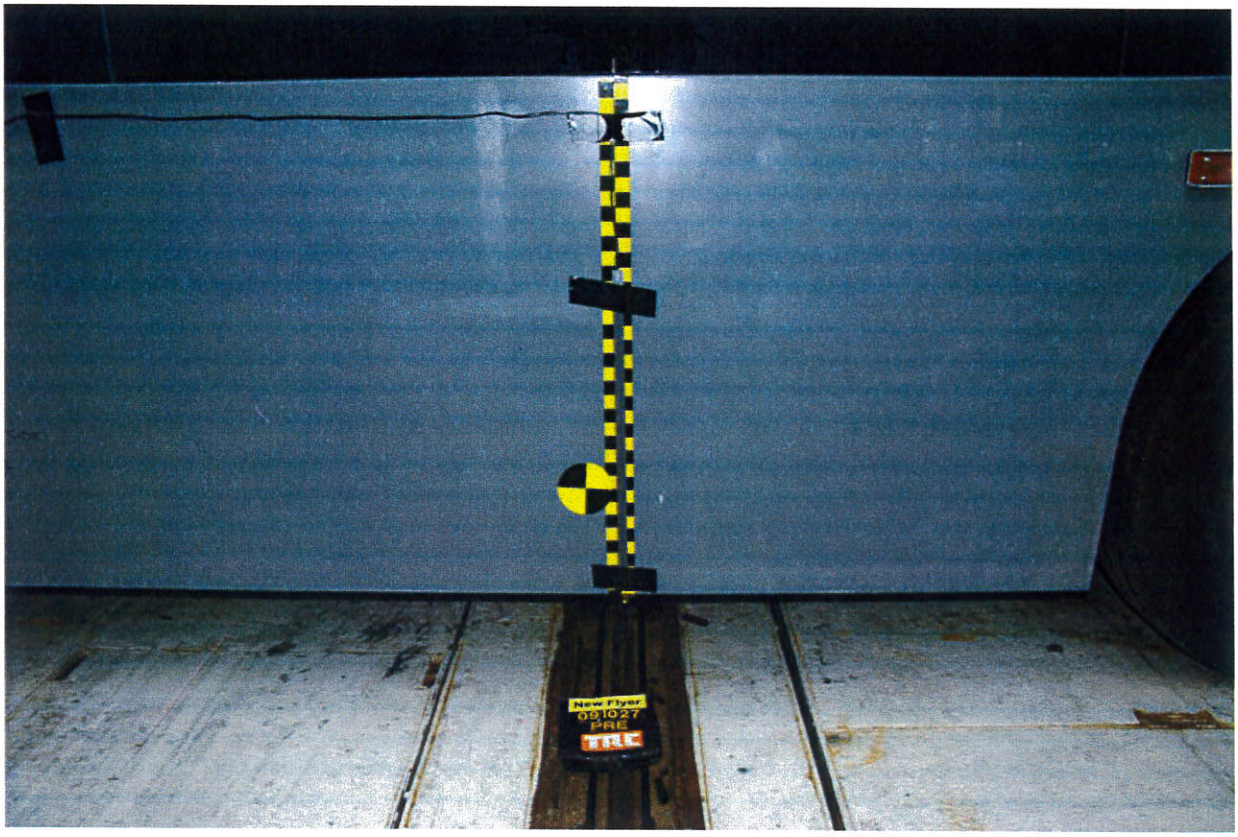

Figure A-22 Pre-Test Impact Point View

Figure A-23 Post-Test Impact Point View

Figure A-24 Pre-Test Impact Point Close-up View

Figure A-25 Post-Test Impact Point Close-up View

Author(s): Jordan Fast, P.Eng.
Test Date(s): November 5, 2009
Report Date: February 23, 2010
Revision: A

Technical Specifications and Reference(s):

- APTA Whitebook, section 5.4.1.2, Crashworthiness
- TR02-49, Low Floor Roof Crush test report

New Product Development Project Number:
NPD378, Xcelsior Bus Development SR-1212R (XD40)

Approved By:
Name: Jordan Fast, P.Eng.

Signature/Date:

Summary:
The roof of an Xcelsior 40ft bus was loaded statically to 1.5 x the maximum expected curb weight of any 40ft Xcelsior bus configuration. The test demonstrated that the Xcelsior 40ft bus meets the structural strength requirements of APTA 5.4.1.2.

1. Definitions:

[this section is empty]

2. Specifications / Pass/Fail Criteria:
APTA Whitebook Section 5.4.1.2 "Crashworthiness"

The bus body and roof structure shall withstand a static load equal to 150 percent of the curb weight evenly distributed on the roof with no more than a 6-inch reduction in any interior dimension. Windows shall remain in place and shall not open under such a load. These requirements must be met without components such as roof-mounted air conditioning installed.

3. Objectives:
To demonstrate that the Xcelsior structure meets the crashworthiness roof-loading requirement for 150% curb weight of the 2010 Diesel, 2010 Diesel-Electric hybrid and CNG configurations.

4. Test Description:
The Xcelsior 2010 prototype bus (designated SR-1212R) will be loaded with steel plates atop a plywood platform mounted on the roof to the three curb weights listed in section 3, starting with the lowest curb weight. For each load, internal deflection of the structure will be measured to ensure compliance with the Whitebook section 5.4.1.2 requirements.

5. Equipment:
- Roof bow deflection measuring tool (see appendix B for photos).
- Roof load frame – fabricated from treated lumber.
- Plate steel for weight.
- Overhead crane

6. Personnel:
- Jordan Fast, P.Eng., NPD, NFI Canada ULC
- Rick Briggs, NPD, NFI Canada ULC
- Crane Operator, Russel Metals
- Mark Somogyi, Operations Manager, Russel Metals (ph. 204-453-9787)

7. Preparations and Procedure:
- All roof equipment was removed from the prototype XD40 bus.
- A level, wooden frame was set on the roof skin of the bus. The frame allowed for even distribution of weight across the roof bows along the full length of the bus.
- The roof structure was loaded evenly by laying steel plate on the wooden frame resting on the roof structure.
- Downward deflection of all of the roofbows was measured using a weight and pulley system as shown in the photos in Appendix B.

Load Layers:

Roof loading of the bus was based on a target curb weights of 29,000lb for Xcelsior hybrid and 31,000lb for Xcelsior CNG. The APTA specification requires that the roof withstand a load of 1.5xcurbweight. Thus, the bus roof was loaded in two stages, first to 1.5x29,000lb (43,500lb) and then, 3,000lb were added to achieve 1.5x31,000lb (46,500lb). Table A, below shows the composition of layers to achieve these stages of loading.

Steel plate was loaded on the roof of the bus in the following layers, evenly distributed front to rear of the bus:

Layer	Plate Size (inches)	Qty	Weight/sheet (lb)	Total
1	3x96x240	1	19603	19603
1	3x96x98	1	8400	8400
1	0.5x96x48	3	653	1959
1	0.25x48x120	1	408	408
			Layer 1 Total	**30307**
2	3x96x57	1	5472	5472
2	3x96x97	1	5282	5282
2	0.5x96x48	4	653	2615
			Layer 2 Total	**13369**
			Layer 1 + Layer 3: Hybrid curb weight x1.5	**43676**
3			Steel material size NA	3000
			Layers 1 + 2 + 3: CNG curb weight x 1.5	**46,676**

Table A: Roof loads

8. Test Location:

- Russel Metals, 1510 Clarence Avenue, Winnipeg, MB

9. Results:

See Table B.1, Appendix B for roof bow deflection results. Deflections did not exceed 6" and no permanent deformation was observed. Windows and doors functioned normally following the test.

10. Discussion:

Roof bow deflection was measured using a system of weights and cables attached to each roof bow and run through the bus to a measuring board, as shown in Figure B.1 (Appendix B). The length and stretch of the cables introduces some error into the

measurement. However, the error is acceptable, given the nature of the measurement. Accuracy is +/- ½". And the specification allows for up to 6" of structural dimensional change.

11. Conclusions:

The Xclesior 40ft bus structure meets the crashworthiness requirements of APTA specification 5.4.1.2.

APPENDIX A: Test Photos – Test Set Up and Roof Load

Figure A.1 – Test configuration

Figure A.2 – Full roof load

APPENDIX B: Test Photos – Roof Bow Deflection Measurements

Bow	8	7	6	5	4	3	2	1
Pre-test	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Full load	7.8	8.3	8.1	7.5	7.5	7.5	8.1	8.1
Post-test	7.3	7.5	7.5	7.3	7.3	7.3	7.5	7.5

Table B.1 Roof bow deflections

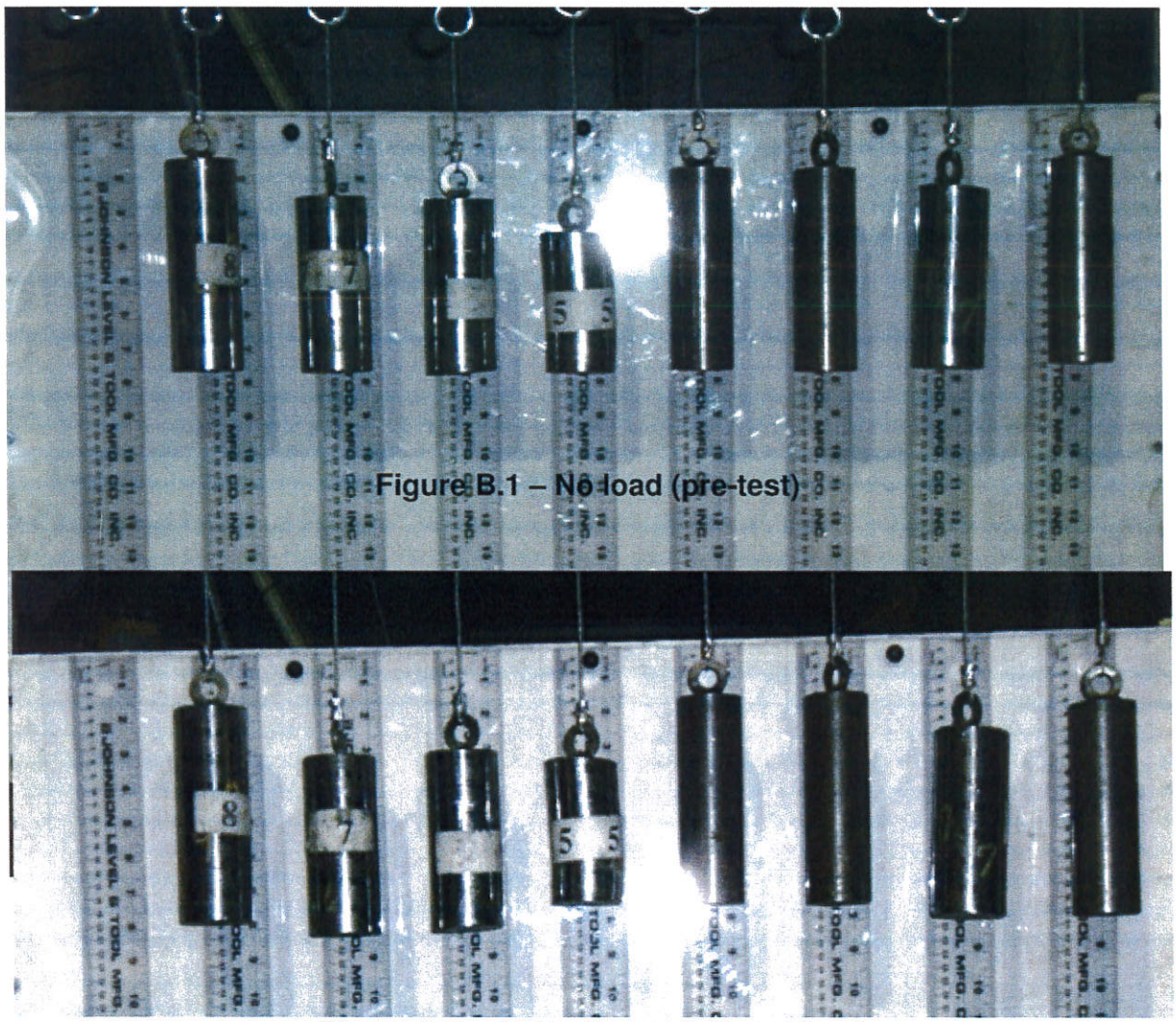

Figure B.1 – No load (pre-test)

Figure B.2 – Deflection at full roof load

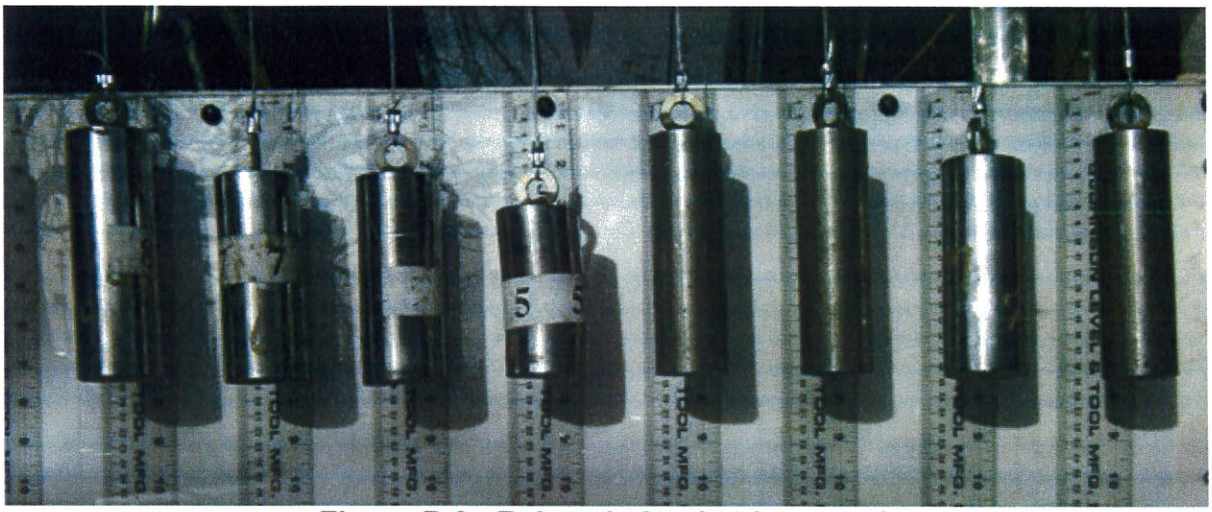

Figure B.3– Relaxed after load removal