TTCI is a subsidiary of the Association of American Railroads

SIMULATION TEST REPORT

Bi-Level Motor Vehicle Securement Systems With Bi-Level and Tri-Level Products

NOTE: THIS TEST REPORT DOES NOT CONSTITUTE APPROVAL OR DISAPPROVAL OF THE EQUIPMENT, METHOD OR MATERIAL TESTED

TEST REPORT: VL 2 - 09

June 9, 2009

Report by:
Dwayne Florence
Senior Manager, Damage Prevention and Loading Services

Damage Prevention and Loading Services
AAR/TTCI
7001 Weston Parkway, Suite 200
Cary, NC 27513

August 7, 2009

REPORT OF SIMULATION TEST – JUNE 9, 2009

SUBJECT: Test of Motor Vehicle Bi-Level Securement Systems With Bi-Level and Tri-Level Products

SYNOPSIS:

A simulation test was conducted at TCI, Pueblo, CO June 8 - 11, 2009 to evaluate the performance of 4 new securement systems for use on bi-level autoracks. The test included both bi-level and tri-level type vehicles. Holden America, Holland Company, TrinityRail, and ZefTek (a Division of Standard Car Truck Company/ Wabtec) each provided individual designs of a securement system for evaluation. Each of the systems was designed for application to all four wheels of a vehicle although the TrinityRail representative advised that their system could be used on one side of the vehicle.

The **Holden America** system is an eight chock per vehicle system (2 chocks per wheel) that attaches to the chock grating currently equipped on most of the bi-level fleet. Vehicles are secured by a colored coded chock applied inboard and outboard of each tire. A **L**ime green colored chock is applied to the **L**eft side of the tire as a loader faces the tire, and a **R**ed colored chock is applied to the **R**ight side. The chock is constructed with a platform that attaches to the grating and when the locking handle is engaged the faceplate and upper portion of the chock moves forward to fill any void space between the tire and faceplate. The lateral restraint provision is applied to the outside of the tire. This lateral restraint is angled so that it contacts the outer tread area of the tire and not the sidewall. The chock is adjustable in height.

View of Holden America's system.

View showing lateral restraint paddle.

The **Holland Company's** system is a four chock system (one outboard of each tire) with each chock equipped with a strap that is to be placed over the vehicle tire and secured to the grating with curved locking fingers. The strap operates similar to a shoulder/seat belt in a vehicle as any slack that is created is automatically retracted. The chock has a lateral restraint paddle that is adjustable to either side. The chocks attach to the grating currently equipped on most of the bi-level fleet. The system locking handle is color coded **R**ed and **G**reen to indicate if the chock is locked in position. The strap has moveable rubber cleats that are to be positioned in the tread area of the tire when installing the system. These cleats also must fully retract to allow proper chock storage.

View of the Holland chock system.

View showing the attachment to grating.

The **TrinityRail** system was a strap only system that required a special track to be installed on the deck of the autorack to provide attachment points. The system included a strap, idler, hooks and a remotely placed and operated ratchet winch. The decking is ¾ inch in height with punched holes to accept securement hooks and is coated with an anti-skid material. Two systems were used to secure the decking to the car body. One system was huck bolted to the deck so it cannot be moved. The second system was attached with removable Shaft Locking pins which can be removed on one side of the deck so it can be raised for access under the deck for cleaning purposes.

Strap system and huck bolted decking.

Note Shaft Clips securing decking.

Two storage methods for the TrinityRail device were also used. One method was simply to hang the hook end of the strap over the edge of a side screen and a second method was to place the hook through one hole in the side panel.

ZefTek had two versions of their system, one with a strap for added vertical securement and one system without a strap. Both versions were a four chock system (one chock outboard of each tire) that will attach to the grating currently equipped on most bi-levels. The strap, on the system with a strap, attached to the chock with a hook and the other end attached to the track with curve "fingers" designed to engage the grating. The strap has a buckle to allow tensioning and the chock faceplate is adjustable in height.

View of ZefTek chock system w/o strap.

View of strap used with ZefTek chock.

BACKGROUND:

This test was conducted at the request of the Vehicle and Equipment Quality Task Force as part of the new securement system development project that was initiated at the April 20, 2006 AAR Town Hall meeting. At that meeting it was noted that vehicle designs are changing, some to the point that securement with the current system is difficult. Vehicle design changes include lower clearance underbodies, more and lower ground effects, air dams, and closing of wheel well openings. All of these changes reduce clearance areas for chock application. In addition, projections indicate that there will be more similar changes in the future to help increase fuel efficiencies and vehicle mileage. Based on these issues, suppliers were advised that the industry was interested in new securement systems.

The VEQ established that any new system must successfully complete the AAR impact test and over-the-road testing with a minimum of 25 shipments. In addition, the committee recommended that additional testing be conducted above the standard 4 – 6 – 6 and reverse 6 MPH impacts to help evaluate and understand the dynamics and effects of higher speed impacts that are above acceptable handling practices.

Suppliers responded and several systems were developed. Testing was conducted and in-service test shipments were made. However, after several shipments, exceptions were noted with each of the systems and the testing was stopped. Suppliers were advised to make required modifications to their systems and another series of test would then be conducted. In addition to the original test plans, the VEQ also advised that a simulation test should be conducted prior to the second test series.

Prior to the start of the test, the Multi-Level Pooling Executive Committee (MPEC), advised that an initial test of tri-level products on bi-level autoracks should be included. Therefore, a limited number of tri-level vehicles were included in the simulation test.

EQUIPMENT / LOAD DESCRIPTION:

The test car, bi-level TTGX-982500, was a typical representative of the multi-level fleet. Side panels were removed from one side of the rack for viewing and video purposes. The UP owned rack was built and Certified 08/95 at TCWI and the flat was certified 7/95 at HIIX. The car traveled approximately 568,734 miles since certification. The car has a Load Limit of 80,000 lbs. The car was equipped as follows: National Swing Motion, 5'8" Wheel Base, Special RB Adapters, Spring Group 6 Outer D7 Springs, 2 Special Snubber Outer 49421, FMI F15 MC2FT M921D units installed 7/95, and 60 inch couplers. The rack has Radial end doors and decks equipped with a Grate Lock Chock system except for the special decking applied in 2 positions for the TrinityRail securement system. Deck Settings are 87 ½ inches on "A" deck and 95 5/16 on "B" deck. The rack was condition Scored 9/05 in Roanoke, IN.

The autorack was loaded with 8 vehicles, 4 tri-level type products on "A" deck and 4 bi-level type products on "B" deck. A random system was used to assign the securement system to a vehicle and position. Representatives of each of the supplier companies applied their respective system as recommended and designed. Each system was applied to one vehicle on each deck. The vehicles and securement systems were:

Position	Vehicle	Securement System	Transmission Setting
A-1	Toyota Corolla	ZefTek w/Straps	Neutral
A-2	Toyota Yaris	TrinityRail	Neutral
A-3	Lincoln Grand Marquis	Holden America	Park
A-4	Ford Focus	Holland	Park
B-1	Toyota Tundra	TrinityRail	Park
B-2	Ford Edge	Holland	Park
B-3	Toyota Sienna	Holden America	Park
B-4	Toyota RAV	ZefTek	Neutral

All vehicles were loaded centered laterally on the autorack and spaced with over 3 inches between bumpers and 5 inches between bumpers and end doors. All parking brakes were all fully set. Vehicles in the A-1, A-2, and B-4 positions had automatic transmissions place in “Neutral” and the remaining vehicle transmissions were place in “Park”. Transmission placement was the normal shipping position as recommend by the manufacturer.

Note: The B-1Toyota Tundra, the B-2 Ford Edge and the A-1 Ford Focus were instrumented for data collection. This instrumentation and data collection was arranged as a special project between the securement system supplier and TTCI and is not included as part of this report.

TEST DESCRIPTION

Each supplier installed their own system according to their recommendations to be properly applied, intact and ready for testing. In addition to vibration inputs, the simulation test includes 2 series of impacts. The impacts are two at 5 MPH (one impact at each end of the car) and two at 6 MPH (one impact at each end of the car) with the simulation runs between the impact series. The anvil string of cars used during the impact portion of the simulation test had a total weight of approximately 250,000 lbs. All cars had their brakes applied. The anvil cars were:

MP-582911	57,900 lbs
CR - 433432	49,600 lbs
DRGW - 60971	81,100 lbs
DRGW - 60932	80,500 lbs

The simulation test includes placing the full size autorack on the vibration table and through a computer operated system, running data to replicate representative transit. The following details the information used for the simulation test.

Cycle 1

A) 2 Impacts - One at each end of the test car at 5 MPH (± 0.5 MPH)

B) Track data on VTU

1) Cycle 1

Run # / Filename	Duration (minutes)	Speed (mph)	Distance
410ctf12_60ft_70in_19mph_128sps_939sec.rcw	15.4	18.5	4.7
701ctf12_60ft_70in_25mph_128sps_418sec.rcw	6.9	24.8	2.8
403ctf12_60ft_70in_30mph_128sps_693sec.rcw	11.3	29.5	5.5
806ctf12_60ft_70in_40mph_128sps_553sec.rcw	9.0	39.0	5.8
424ctf12_60ft_70in_42mph_128sps_983sec.rcw	16.5	42.1	11.5
424ctf12_60ft_70in_42mph_128sps_983sec.rcw	16.5	42.1	11.5
420ctf12_60ft_70in_47mph_128sps_701sec.rcw	12.7	46.9	9.9
803ctf12_60ft_70in_51mph_128sps_549sec.rcw	8.9	51.0	7.6
605ctf12_60ft_70in_62mph_128sps_800sec.rcw	13.3	61.9	13.7
608ctf12_60ft_70in_62mph_128sps_818sec.rcw	13.5	62.3	14.0
508ctf12_60ft_70in_62mph_128sps_611sec.rcw	9.9	62.3	10.3
420ctf12_60ft_70in_47mph_128sps_701sec.rcw	12.7	46.9	9.9
424ctf12_60ft_70in_42mph_128sps_983sec.rcw	16.5	42.1	11.5
403ctf12_60ft_70in_30mph_128sps_693sec.rcw	11.3	29.5	5.5
403ctf12_60ft_70in_30mph_128sps_693sec.rcw	11.3	29.5	5.5
410ctf12_60ft_70in_19mph_128sps_939sec.rcw	15.4	18.5	4.7
Totals	201.1	40.3	134.4

Cycle 2

a) Track data on VTU

1) Cycle 2

Run # / Filename	Duration (minutes)	Speed (mph)	Distance
410ctf12_60ft_70in_19mph_128sps_939sec.rcw	15.4	18.5	4.7
701ctf12_60ft_70in_25mph_128sps_418sec.rcw	6.9	24.8	2.8
403ctf12_60ft_70in_30mph_128sps_693sec.rcw	11.3	29.5	5.5
806ctf12_60ft_70in_40mph_128sps_553sec.rcw	9.0	39.0	5.8
424ctf12_60ft_70in_42mph_128sps_983sec.rcw	16.5	42.1	11.5
424ctf12_60ft_70in_42mph_128sps_983sec.rcw	16.5	42.1	11.5
420ctf12_60ft_70in_47mph_128sps_701sec.rcw	12.7	46.9	9.9
803ctf12_60ft_70in_51mph_128sps_549sec.rcw	8.9	51.0	7.6
605ctf12_60ft_70in_62mph_128sps_800sec.rcw	13.3	61.9	13.7
608ctf12_60ft_70in_62mph_128sps_818sec.rcw	13.5	62.3	14.0
508ctf12_60ft_70in_62mph_128sps_611sec.rcw	9.9	62.3	10.3
420ctf12_60ft_70in_47mph_128sps_701sec.rcw	12.7	46.9	9.9
424ctf12_60ft_70in_42mph_128sps_983sec.rcw	16.5	42.1	11.5
403ctf12_60ft_70in_30mph_128sps_693sec.rcw	11.3	29.5	5.5
403ctf12_60ft_70in_30mph_128sps_693sec.rcw	11.3	29.5	5.5
410ctf12_60ft_70in_19mph_128sps_939sec.rcw	15.4	18.5	4.7
Totals	201.1	40.3	134.4

A) 2 Impacts at opposite ends of the test car - Each at 6 MPH (± 0.5 MPH)

B) Total Simulated Mileage Cycles 1 & 2: 268.8 miles

<u>IMPACT NO. 1 – TARGET SPEED 5.0 MPH FORWARD DIRECTION</u> – Actual speed was 4.9 MPH; Anvil string wheel slide was 11inches. There was a general tightening of the load in the direction of the struck end of the car. There were no visible damaged or defective test components, vehicles or railcar and no disengaged systems.

<u>IMPACT NO. 2 – TARGET SPEED 5.0 MPH REVERSE DIRECTION –</u> Actual speed was 5.1 MPH; Anvil string wheel slide was 16 inches. There was visible movement of all vehicles. There was a general tightening of the load toward the struck end of the autorack. There were no visible damaged or defective test components or damage to the railcar and no disengaged systems.

Note: The instrumentation package on the Ford Edge appeared to have made slight contact with the inner splash panel of the vehicle. There was a very slight witness mark that appeared as a slight scuff indicating some contact had been made. The panel did not show any deformation, scratch or broken paint areas. This contact was strictly due to the size of the instrumentation package and was not an issue with the securement system.

Following this impact series the simulation runs were made and upon conclusion the second impact series was conducted.

<u>IMPACT NO. 3 – TARGET SPEED 6.0 MPH FORWARD DIRECTION</u> – Actual speed was 6.0 MPH; Anvil string wheel slide was 23 inches. There was a general tightening of the load in the direction of the struck end of the car. There were no visible damaged or defective test components, vehicles or railcar and no disengaged systems.

<u>IMPACT NO. 4 – TARGET SPEED 6.0 MPH REVERSE DIRECTION –</u> Actual speed was 6.2 MPH; Anvil string wheel slide was 30 inches. There was considerable visible movement of all vehicles. There was a general tightening of the load toward the struck end of the autorack. There were no visible damaged or defective test components or damage to the railcar and no disengaged systems. Vehicles secured by the ZefTek and the TrinityRail systems that used straps moved enough that the circumference of the vehicle tires blocked removal of the hooks. The Holland system chock that used a strap did not experience this problem.

<u>RESULTS AND OBSERVATIONS:</u>

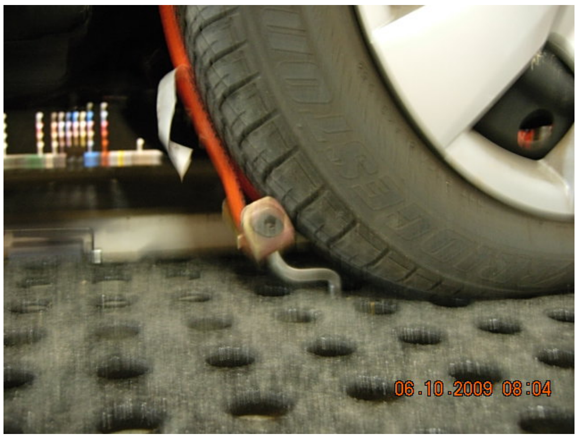
Each of the securement systems supplied by Holden America, Holland, TrinityRail and ZefTek secured both the bi-level products and the tri-level products in position. There were no broken securement systems, no visible damage to the autorack and no visible damage to the vehicles.

HOLDEN AMERICA – There was no problems with clearance issues with the vehicles (Lincoln Grand Marquis and Toyota Sienna) secured with this system. The Holden America system uses 8 chocks per vehicle, 2 chocks per wheel. This fact obviously requires more chocks and storage means as well as positioning 8 chocks is more work and time than positioning a lesser number. The actual application of each chock is fast and easy to accomplish. The color coded system works very well. The system is designed so a portion of the chock moves to contact the tire which will reduce any void. Removal of all voids is a great feature; however, moving parts are always a concern from a maintenance perspective. This feature must be observed over time. During the test the system performed as designed. The chock feels out of balance and is relatively heavy to handle with one hand as much of the weight is away from the handle position.

HOLLAND CO. – There was no problems with clearance issues with the vehicles (Ford Edge and Ford Focus) secured by this system. Users of this system must be aware of the retracting feature of the strap and be aware that it retracts quite quickly and may potentially contact a vehicle causing damage or cause personnel injury. Care must be exerted to control the hook end during this procedure. The strap also has moveable rubber cleats that are to be positioned in the tread area of the tire when installing the system. These cleats must also fully retract, or be moved by hand, to be against the chock to allow proper chock storage. Both the positioning of the cleats during application and ensuring the strap is fully retracted and the cleats are in proper position when storing will likely be an issue that will require training with loading and unloading crews. The Holland system did not experience the problem of hook removal as the other systems that used a hook. The system is relatively easy and fast to apply and remove. The chock is relatively heavy and feels out of balance when handled by the handle which is at the end of the chock. Most of the weight is forward of the handle making the chock very “nose” heavy and difficult to hold in a level position.

TRINITYRAIL - There was no problems with clearance issues with the vehicles (Toyota Yaris and Toyota Tundra) secured by this system. The TrinityRail securement track exhibited some slight distortion through a lifting action during the high speed impacts. Upon release of the applied pressure, the tracks returned to normal shape and did not show any signs of permanent deformation. Two systems for installation of the special tracks were used. The system permanently affixed to the deck will make it very difficult to remove and clean debris, snow, ice, etc. from under the track. There is concern with the use of the Shaft Locking pins on the deck that can be lifted to allow cleaning. The locking mechanism of the Shaft Pin is a wire fastener that can potentially be a hazard to snag clothing or footwear or can be easily be disengaged if stepped on. The ability to clean under the decking is desirable but a different locking feature is recommended.

Upon completion of the test, the securement system could not be removed until the vehicle was moved due to the curvature of the tire being over the securement hook which prevented the hook from being released from the track. There was only slight movement of the vehicle during the test but it was sufficient to prevent hook release. This is a major concern that would affect unloading personnel due to the extra handling and potential exposure to damage to the vehicle and it would also require additional unloading time. The length of the straps may potentially be an issue as the straps from one vehicle and those from another may overlap. The strap system is somewhat difficult to handle because of the winch at the end of the strap and the various hooks used to secured the strap to the deck.   Application is more time consuming than other systems.



View showing hook blocked by tire.

Example the idler hook blocked.

ZEFTEK – After installation of the securement system, there was only 1 inch clearance between the chocks and the ground effects at the front of the A-1 vehicle (Toyota Corolla), a tri-level product.   This was observed and monitored throughout the test and at the conclusion it did not appear that there had been any contact. There was adequate clearance between chock and body components of the other vehicle (Toyota RAV) secured with the ZefTek system.

View showing close clearance between chock and vehicle.

Example of hook being blocked by tire.

The chock feels relatively heavy and out of balance with much of the weight forward of the normal handling position. This makes it difficult to handle. There is concern with the strap application as it pulls directly vertically on the chock body which is a different force than in the original design. The strap has a buckle to assist in tensioning. The strap was much longer than required in this application resulting is a considerable length of strap lying on the car deck.

Test Attendees Included :

Jyll Boudreau, Holland
Kevin Merten, UP
Bruno Pietrobon, Holden America
Jean Iorio, Holden America
Diego Pino, Holden America
Jon Butler, Holland
Bob Cencer, TrinityRail
John Peach, ZefTek
Ed Vechiola, Wabtec/ZefTek
Mark Derickson, Toyota
Dwayne Florence, AAR/TTCI
Mike Sandoval, AAR/TTCI
John Blackman, AAR/TTCI
Assorted TTCI Test and Train crew

Dwayne Florence
Senior Manager
Damage Prevention and Training