TTCI Transportation Technology Center, Inc.

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IMPACT 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: FI 8-09

June 9, 2009

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REPORT OF IMPACT TEST – JUNE 9, 2009

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

SYNOPSIS:

A series of Impact Tests were conducted at TCI, Pueblo, CO June 8 - 11, 2009 to evaluate the performance of 4 new Bi-Level securement systems. 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.

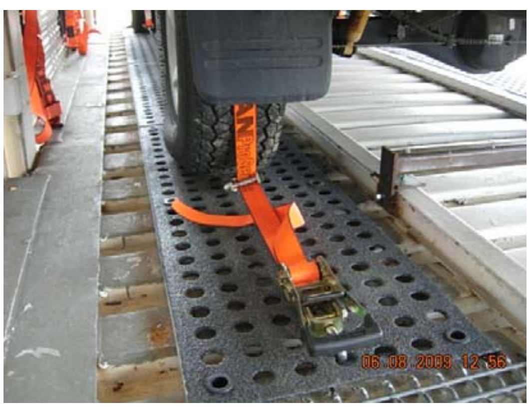
View showing lateral restraint paddle.

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 . The chock faceplate is adjustable in height.

View of ZefTek chock system w/o strap.

View of strap used with ZefTek chock.

The tests included impacts of 6 – 7 – 8 and 9 MPH in the forward direction (direction of headlights) and reverse impacts of 8 and 9 MPH. All impacts were into a anvil string with a minimum weight of 500,000 pounds. An inspection of each system was made following each impact.

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.

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 June 8, 2009 testing.

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 to measure force input when under impact conditions. 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

The impact series was conducted with forward target speeds of 6, 7, 8, and 9 MPH and reverse impacts with target speeds of 8 and 9 MPH. Each supplier installed their own system according to their recommendations to be properly applied, intact and ready for testing. The anvil string consisted of cars having a total weight of approximately 550,000 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
BN - 5227423	286,000 lbs

IMPACT NO. 1 – TARGET SPEED 6.0 MPH FORWARD DIRECTION – Actual speed was 6.2 MPH; Anvil string wheel slide was 7.5 inches. There was a general tightening of the load in the direction of the struck end of the car. There was no visible damage to test components, vehicles or railcar.

Both TrinityRail storage methods contained the securement system.

<u>IMPACT NO. 2 – TARGET SPEED 7.0 MPH FORWARD DIRECTION –</u> Actual speed was 7.0 MPH; Anvil string wheel slide was 11 inches. There was visible movement of all vehicles. The load continued to tighten toward the struck end of the autorack which created slight voids between the tires and face plate of the chock type systems. The Tundra and Yaris vehicles secured by the TrinityRail System and the Corolla secured by the ZefTek system have tightened toward the struck end of the autorack sufficiently for the tire to prevent removal of the hook from the grating without moving the vehicle. The vehicle movement was very limited (1 - 1 ½ inches) but due to application of the hook close to the tire practically any movement allows the circumference of the tire to interfere with hook removal.

Both TrinityRail storage methods contained the securement system.

<u>IMPACT NO. 3 – TARGET SPEED 8.0 MPH FORWARD DIRECTION</u> – Actual speed was 8.0 MPH; Anvil string wheel slide was 18 inches. There was visible movement of all vehicles but all were contained by the securement systems. The end panel of the TrinityRail decking system under the B-1 vehicle was pulled upward ½ inch. The panel appeared to only be under tension and not permanently deformed. (Note – This was observed later during the test after the tension was released and the panel returned to its original shape with no visible permanent deformation).

The TrinityRail strap storage system with the hook hanging on the lip of the side screen disengaged and was lying on the autorack deck. The storage system with the hook inserted through a hole in the side panel remained secured. There were no other defects noted, no visible damage to test components, vehicles or railcar.

<u>IMPACT NO. 4 – TARGET SPEED 9.0 MPH FORWARD DIRECTION</u> – Actual speed was 8.8 MPH; Anvil string wheel slide was 22.5 inches. There was considerable visible movement of the vehicles and the B-4 (Toyota RAV) vehicle moved out of the chocks and perched on top of the front chocks. The upper face plate of both front ZefTek chocks was severely deformed but did not fracture. The securement hook at the left rear tire of the A-1 unit secured with the ZefTek system equipped with a strap was severely blocked by the tire making it impossible to remove without moving the vehicle. The decking of the B-1 unit with the TrinityRail system remained under tension and raised ½ inch. There was no visible damage to any vehicles or railcar, the only noted damage was to the front chocks of the B-4 unit. The TrinityRail storage system with the hook placed through a hole in the side screen remained intact.

NOTE: The B-4 unit was re-positioned and new ZefTek chocks applied prior to the reverse impacts. Due to the noted movement of the B-4 unit, hold-down straps were also applied to the ZefTek system for added protection to the vehicle.

"Perched vehicle" on ZefTek device.

View of decking lifted by TrinityRail system.

IMPACT NO. 5 – TARGET SPEED 8.0 MPH REVERSE DIRECTION – Actual speed was 8.0 MPH; Anvil string wheel slide was 20.5 inches. There was considerable visible movement of vehicles and a tightening of vehicles in the direction of the impact resulting in slight voids created between the chocks and the faceplate of the chock type securement systems. The tension on the TrinityRail tie-down track under the B-1 vehicle was reduced and the track returned practically to the initial position. The hold down strap on the A-1 unit secured with the ZefTek system became slightly slack. There was no visible damage to test components, vehicles or railcar. The ZefTek system with straps on the B-4 unit contained the vehicle without exception. The TrinityRail storage system with the hook through the side panel hole, remained intact.

IMPACT NO. 6 – TARGET SPEED 9.0 MPH FORWARD DIRECTION - The actual speed was 9.0 MPH; Anvil string wheel slide was 25.5 inches. There was vehicle movement with the vehicles continuing to tighten against chocks in the direction of impact. Slight voids remained at the rear chocks. There was no visible damage to test components, vehicles or railcar. The ZefTek system with straps on the B-4 unit contained the vehicle without exception. The TrinityRail storage system remained in good condition.

SECUREMENT REMOVAL

Following this impact the securement systems were attempted to be removed. The vehicles secured by the ZefTek and Holland chock systems exerted pressure on the chocks and the chocks could not be removed until the parking brakes were released and the vehicle moved. The tires of the vehicles secured with the TrinityRail system and the ZefTek system that used a strap, prohibited the hooks from being removed from the grating until the vehicles were moved. The Holden America chocks were removed by releasing the locking handle as designed, no special handling of vehicles or chocks was required.

RESULTS AND OBSERVATIONS:

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 until higher than acceptable normal coupling speeds were reached. There were no broken securement systems, no visible damage to the autorack and no visible damage to the vehicles until the speed of 8.8 MPH was reached. Each of the systems contained the vehicles in position until the B-4 Toyota RAV “perched” on top of the front chocks at 8.8 MPH. It should be noted that the transmission of this vehicle was placed in “neutral” which is the manufacturer’s recommendation.

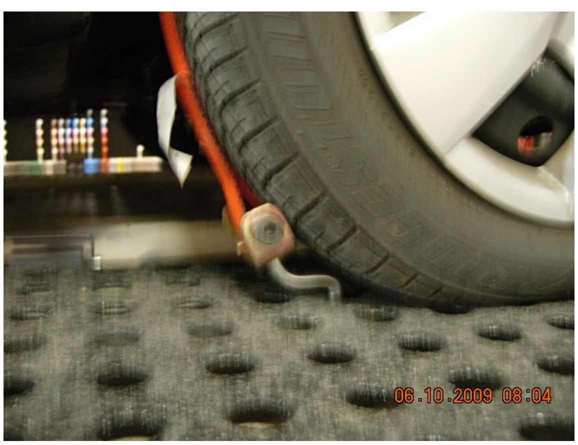
HOLDEN AMERICA – There was no problems with clearance issues with the vehicles (Lincoln Grand Marquis and Toyota Sienna) secured with this system. The Holden America system uses 8 chocks per vehicle, 2 chocks per wheel. This fact obviously requires more chocks and storage means as well as positioning 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. This feature was also instrumental in allowing easy removal of the chocks at the conclusion of the test, even with the vehicles exerting pressure against the chocks. 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 considerable 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.

Upon conclusion of the test, the vehicles exerted pressure against the chocks and the chocks could not be released and removed until the vehicles were moved. 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.

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 the other systems.



View showing hook blocked by tire.

Example the idler hook blocked.

TrinityRail Storage system.

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.

At 8.8 MPH (well above normal acceptable handling practices) the Toyota RAV in the B-4 position secured with the ZefTek system without straps perched on the front chocks. The front chocks were severely deformed but there was no fracture. There was no visible damage to the vehicle or railcar. Due to the extreme movement of the B-4 vehicle, straps were added to the ZefTek chocks for subsequent impacts as an added measure of safety. The system contained the vehicle throughout the remainder of the test without exception.

Upon conclusion of the test, the vehicles exerted pressure against the chocks and the chocks could not be released and removed until the vehicles were moved. In addition, the tires of the vehicles had moved slightly but still enough that the hooks on the straps were prohibited from being removed from the grating until the vehicles were moved. 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 chock is relatively heavy and feels 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. There were no problems with this during the test but should continue to be monitored.

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

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