The results of the finite element analyses also indicated that minimizing deformation of the PCB connection joints would significantly reduce the potential for vehicle snagging at the joints and for the vehicle overriding the barrier. The pin-and-loop design of the 50-inch PCB maintained the integrity of the joint connection during impact resulting in negligible deformation of the joint (i.e., there was no deformation of the pin-and-loop connection during impact).

Joint connection of the PCB after test 060412

CONCLUSIONS

A 50-inch tall portable concrete barrier was developed that satisfies all safety criteria of NCHRP Report 350 for test level 3. The 50-inch PCB barrier demonstrated a significant improvement in crash performance over the 32-inch PCB design for NCHRP Report 350 Test 3-11 regarding vehicle trajectory and work-zone safety.

The ODOT 50-inch PCB has been approved by the FHWA as NCHRP Report 350 TL-3 system (Letter B-149) and may be used on the National Highway System at the state's discretion.

IMPLEMENTATION POTENTIAL

Implementation of the ODOT 50-inch PCB should be efficient and cost effective since the design includes many of the standard materials already used in the current ODOT 32-inch PCB for which materials should be readily available.

An important attribute of the 50-inch barrier is the added safety to both vehicle occupant and work-zone personnel. The trajectory of the vehicle during impact with the 50-inch PCB was very stable and the height of the barrier successfully prevented most debris as well as any part of the vehicle from penetrating behind the barrier into the work-zone area.

Additionally, the 50-inch PCB is tall enough to serve as its own glare-shield, providing an effective, low maintenance solution for inhibiting headlight glare and driver distraction in work-zones.

The Ohio Department of Transportation
Office of Research & Development
Executive Summary Report

Development of an NCHRP Report 350 TL-3 New Jersey Shape 50-inch Portable Concrete Barrier

Start Date: 07/01/2004
Duration: 24 months
Completion Date: 06/30/2006
Report Date: June 2006
State Job Number: 134162
Report Number: *FHWA/OH-2006/16*
Funding: $137,412

Contract Agency:
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For copies of this final report go to http://www.dot.state.oh.us/divplan/research or call 614-644-8173.

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PROBLEM

The purpose of the project was to develop a temporary portable concrete barrier (PCB) with an integral glare shield for use in roadside work-zone areas. Currently-available 32-inch portable concrete barriers require the use of an add-on glare shield attached to the top of the barrier. The add-on glare shields are an extra expense and complicate barrier set-up and handling. The solution was to develop a portable concrete barrier tall enough to serve as its own glare-shield, thereby, providing an effective, low maintenance solution for inhibiting headlight glare and driver distraction in work-zones.

OBJECTIVES

The primary objective of this project was to develop a 50-inch high portable concrete barrier that would meet the requirements of NCHRP Report 350 for test level 3. The currently approved PCB used in Ohio is the 32-inch New Jersey shape with pin-and-loop connection. The additional 18 inches in the new 50-inch PCB design is to provide an affordable, low maintenance solution for inhibiting headlight glare and driver distraction in work-zones.

The project consisted of the following tasks:

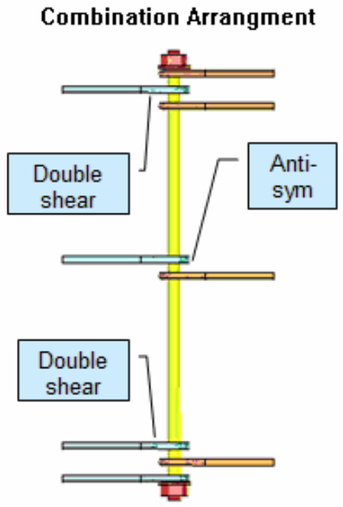
1) Develop a finite element model of the existing 32-inch PCB and verify model validity by comparing results to full-scale crash test,
2) Identify a number of 50-inch PCB design options that would have a high potential for success
3) Evaluate the design alternatives using finite element analysis,
4) Conduct full-scale crash test to verify barrier performance for TL-3 conditions

DESIGN AND ANALYSIS OF A 50-INCH PCB

The new 50-inch PCB design retains many of the geometric dimensions of a New Jersey shape barrier. The only difference is the slope of the barrier's face between the first slope break point at 13 inches from the ground and the top of the barrier (i.e., the 50-inch barrier is three degrees steeper than the standard New Jersey Shape).

The 50-inch barrier design uses a simple pin-and-loop connection with a single pin passing through three set of loops at each PCB segment end. The arrangement of the loops was an important consideration since it was desired to achieve as strong a connection as feasibly possible. Several arrangements of the loops were analyzed to determine their affects on the performance of the barrier system. The analyses showed that the symmetrical arrangement, which is commonly used in PCB designs, resulted in a much more flexible connection that lead to excessive joint opening and relative displacement between adjacent barrier segments and increased the potential for vehicle "snag" at the barrier joints.

The arrangement used in the final design of the 50-inch PCB was a "combination arrangement" with a double-shear connection at the top and bottom and an anti-symmetrical connection in the center.



Finite element analyses were conducted on PCB systems using 10-ft long PCB segments and 12-ft long PCB segments. The analyses indicated that the barrier system with both 10-ft sections and 12-ft sections would perform well and would satisfy all NCHRP Report 350 safety criteria; however, the PCB with 12-ft sections demonstrated better crash performance.

FULL-SCALE CRASH TEST

Based on the results from the FE analyses, which indicated that the 50-inch PCB system would successfully meet all safety requirements of NCHRP Report 350 for test level 3, a full-scale crash test was conducted on the new 50-inch PCB system at the Transportation Research Center (TRC) in East Liberty, Ohio.

The 50-inch PCB system successfully passed all NCHRP Report 350 evaluation criteria for test 3-11. The impacting vehicle did not penetrate the barrier and came to rest 165 ft longitudinally from the critical impact point and 6.9 ft laterally outside the theoretical work zone area. The occupant impact velocity was 14.8 ft/s and 20.0 ft/s in the longitudinal and lateral directions, respectively. The highest 0.010-second occupant ridedown acceleration was -5.4 g and -8.6 g in the longitudinal and lateral directions, respectively. The connections of the PCB units successfully prevented any opening of the PCB joints during impact (e.g., there was no noticeable deformation of the pin-and-loop connections after the test).

The 50-inch PCB barrier demonstrated a significant improvement in crash performance over the 32-inch PCB design for NCHRP Report 350 Test 3-11 regarding vehicle trajectory and work-zone safety. The trajectory of the vehicle during impact with the 50-inch PCB was very stable and the height of the barrier successfully prevented most debris as well as any part of the vehicle from penetrating behind the barrier into the work-zone area. In the full-scale test, there were no "flying" debris from the barrier (e.g., no spalling of concrete except on the lower curb part of the barrier) and most of the broken glass and other debris from the vehicle were contained on the traffic side of the barrier.