Texas Transportation Pooled Fund Project – Progress Report

Project Title: Guidelines for Designing Bridge Piers and Abutments for Vehicle Collisions

Project Number: TPF-5(106) / 9-4973

Term of Contract: 3/26/07 to 3/31/09

Reporting Period: 10/1/07 to 12/31/07

Project Manager – Name & Contact Info:
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Work Performed and Progress:

Progress to Date, by Task

This project will develop warrants for design requirements and design loads for vehicle collisions with bridge piers. Warrants will be based on the results of accident analyses performed in task 1c and risk analysis methodology from task 1d. Design loads will be developed on the basis of information from the literature review, computer simulations of collisions, analysis of highway crashes, and full-scale vehicle crash tests.

Phase 1:

1a. Literature review-

The literature search has been completed and applicable documents have been collected and reviewed by the researchers.

Researchers will continue to monitor literature for any new publications.

1b. Computer simulations of vehicle/bridge column and abutment collisions-

Researchers have used a single-unit truck finite element model to simulate a collision with a rigid bridge pier. The model is working properly.

Researchers have focused on a single diameter pier simulation since previous simulation matrices did not show a sensitivity of the impact force with the diameter of the pier (assuming rigid pier). Hence pier of diameter 36 inch was select for impact velocity effects on the imparted load on the pier.

The dump truck and tractor trailer finite element models were used to simulate collision with the rigid 36-in diameter pier.

The simulations indicative that the collision incident consists of basically two impacts, the engine block impact with the pier and the rigid ballast impact with the pier (through the crushes cab). Different impact velocities were simulated as shown in the table below.

Simulation Matrix (Completed as of 1-8-07)					Force (Kips)	
	Pier Diameter (in)	Vehicle/Mass	Container	Impact Speed (mph)	Engine Block	Ballast
Matrix I	24	Dump Truck (65 klb)	Rigid	50	560	2490
	36	Dump Truck (65 klb)	Rigid	50	570	2430

	48	Dump Truck (65 klb)	Rigid	50	560	2160
Ballast Test Matrix	36	Dump Truck (65 klb)	Rigid	40	500	1470
	36	Dump Truck (65 klb)	Rigid	50	570	2430
	36	Dump Truck (19 klb)	Rigid	50	550	*No Ballast
Matrix II	36	Dump Truck (65 klb)	Rigid	40	500	1470
	36	Dump Truck (65 klb)	Rigid	50	570	2430
	36	Dump Truck (65 klb)	Deformable	60	590	-
	36	Tractor-Trailer (80 klb)	Rigid	60	-	-
	36	Tractor-Trailer (28 klb)	Rigid	60	460	-
	36	Tractor-Trailer (28 klb)	Rigid	50	510	-

As the impact velocity increased for the dump truck, the simulation becomes unstable since two rigid mass (pier and ballast) are squeezing a deformable cab at 60 mph. Therefore, the research team opted for incorporating elastic-plastic material behavior for the ballast (and the dump bed structure). This resulted in a much stable analysis as well as counting for movement and compliance of the ballast. However, dump trucks can carry a variety of cargo from a very stiff and rigidly attached to a very soft and loosely attached.

The research team will add the deformable bed and ballast simulation to the lower velocity cases in the upcoming quarter.

Figures 1 and two below depicts the two dump truck model used in the collision analyses.

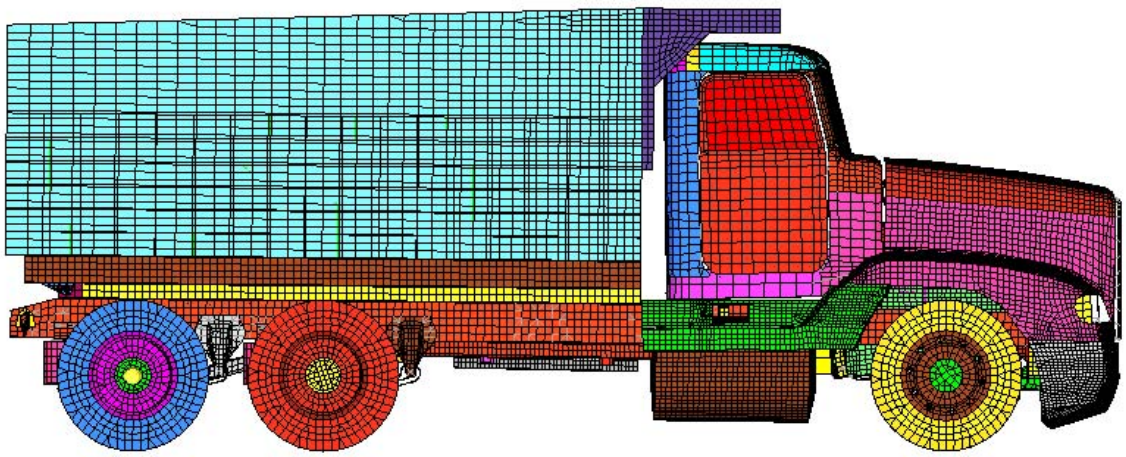

Figure 1: Dump Truck with Rigid Container

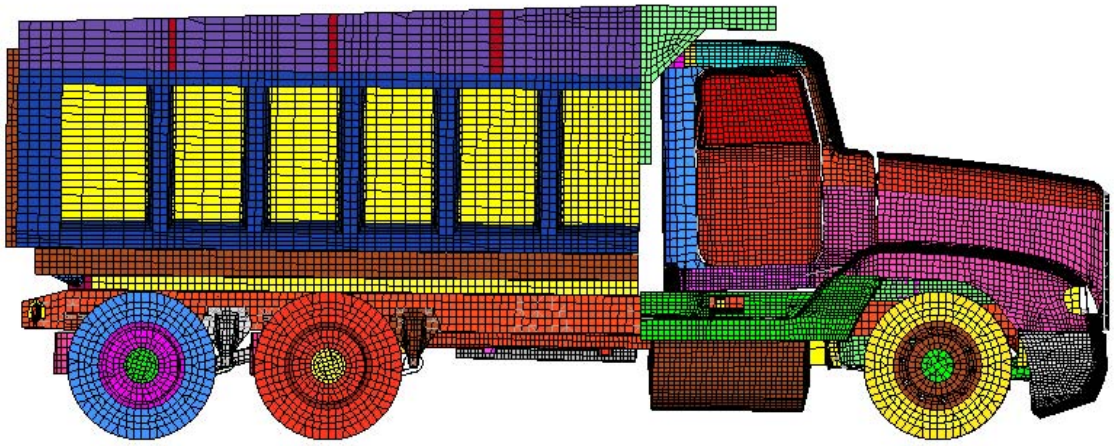

Figure 2: Dump Truck with Deformable Container

Additional simulations will be performed during the next reporting period.

1c. Accident survey and analysis study-

Researchers, assisted by TxDOT personnel have identified six accidents that have occurred in Texas where heavy vehicles have collided with bridge piers. Detailed information has been collected on two of them.

Accidents from other states will be identified and detailed information on them will be collected.

1d. Development of a risk analysis methodology for vehicle/bridge column and abutment collisions (analogous to AASHTO LRFD vessel impact requirements)

The researchers obtained a database related to truck collisions assembled using Texas data. The database was assembled last year by a master's student. The researchers are currently assessing its suitability for this project. The researchers have also contacted key personnel at TxDOT to obtain relevant crash and other related data for this project.

1e. Detailed justification and work plan for research (if any) to be conducted under Phase 2 of the project-

No work has been performed on this task.

1f. Provide facilities and host a meeting to present Phase 1 results to project sponsors, including pooled fund project contributors from other state DOT's-

No work has been performed on this task.

Phase 2:

No work has been performed on Phase 2.

Expenditures Life-to-date: $36,680
Report prepared by: Tom Yarbrough, P.E., TxDOT – RTI