RTI
Semi-Annual Progress Report

Fiscal Year 2008

Date of This Report: March 1, 2008 **Project Number:** TPF-5(106)/9-4973 **RMC:** 5

Period Covered by This Report: September 1, 2007 through February 29, 2008

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

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1. Requested Changes for Possible Project Modification

Project Personnel: No changes.

Work Plan: No changes.

Deliverables Table: No changes.

Project Termination: No change anticipated

Project Budget: No changes.

2. Equipment

No equipment purchased.

3. 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 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 collisions with the rigid 36-in diameter pier.

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

Simulation Matrix (Completed as of 1-8-08)					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, the simulation becomes unstable since two rigid masses (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 more stable analysis. 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 future. Figures 1 and 2 below depict the two dump truck model used in the collision analyses. Figure 3 shows the movement of the non-rigid ballast for a fully deformable truck.

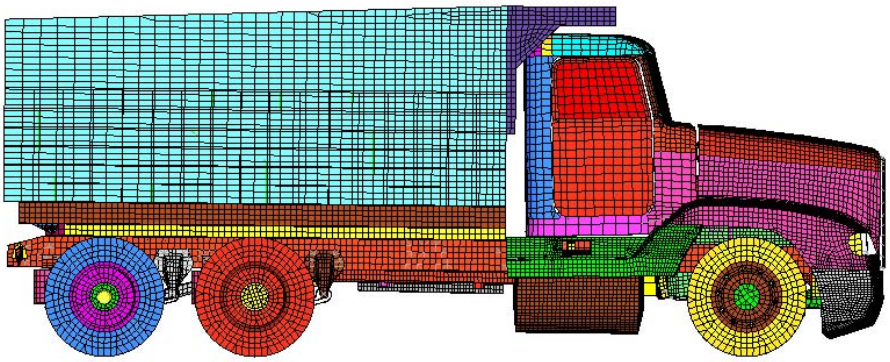

Figure 1: Dump Truck with Rigid Container

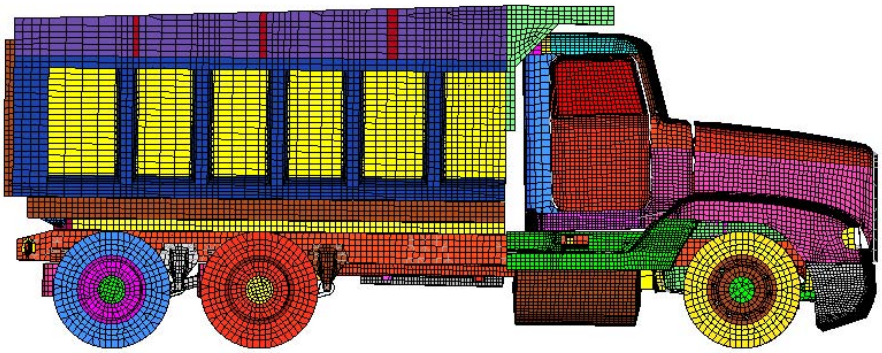

Figure 2: Dump Truck with Deformable Container

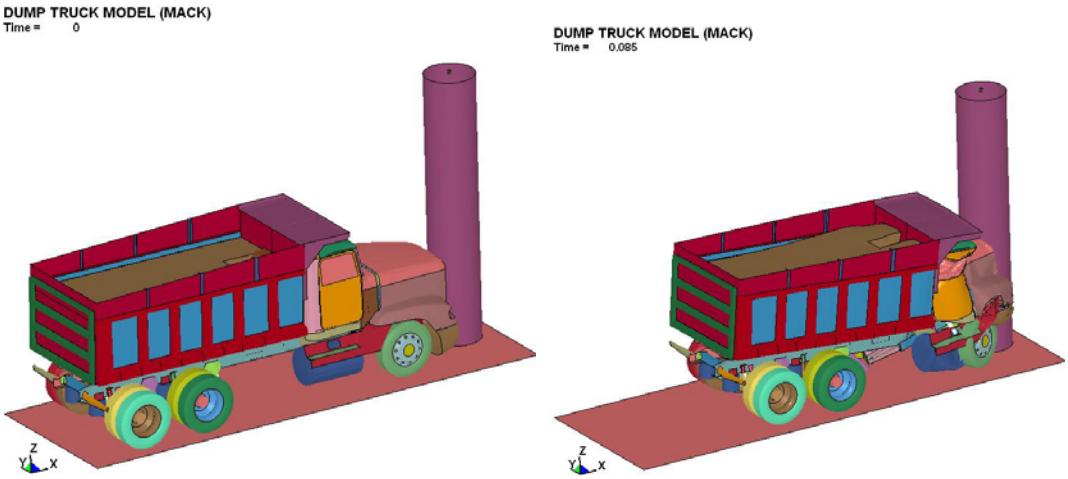

Figure 3 Movement of the non-rigid cargo (e.g., sand) in a deformable truck ballast simulation

Additional simulations will be performed during the next reporting period.

1c. Accident survey and analysis study-

Researchers, assisted by TxDOT personnel have identified several accidents that have occurred in Texas and several other states where tractor trailers have collided with bridge piers. Preliminary information has been collected on 15 accidents to date involving heavy tractor trailers collisions with bridge piers. Detailed accident information from 6 accidents was collected during this reporting period.

During this reporting period the researchers visited three of the accident sites involving collisions of heavy tractor trailers with bridge piers. These visits included meeting with Texas Department of Public Safety Officers to discuss specific details of the accidents, review accident photos, and reviewing the sizes and weights of the vehicles and vehicle impacting speeds. All the officers visited were actually on the scenes of the accidents and recorded important information that is useful for this study.

The accident sites visited during this reporting period are as follows:

1.) Accident at IH10 near Sealy, Texas at Mile Post 717 West Bound Lane on January 28, 2004
2.) Accident at IH 37 in Corpus Christi, Texas (Tancauhua Street over IH 37) West bound Lane on May 14, 2004
3.) Accident at IH45 near Corsicana, Texas at Mile Post 232 South Bound Lane on May 30, 2007.

Several more know accident site visits involving large truck collisions with bridge piers are planned within Texas in March, 2008.

In addition, inquiries have been made with the other supporting states for this project (California, Nebraska, Ohio, and Tennessee) concerning heavy tractor trailer collisions with bridge piers in these states. Any accident data obtained from these supporting states will be included in our data base and reported next reporting period.

Structural analyses were performed on several bridge pier sizes that are typical to TxDOT Bridges. Lateral shear capacities were calculated for four different pier sizes with differing reinforcing details. These calculated lateral capacities will be used in conjunction with the information obtained from the dynamic computer simulation analyses.

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)

Researchers have started to assemble crash and roadway data covering the period 1997-2001, pending the availability of more recent data (i.e., CRIS). Some exploratory analyses have been conducted on the data.

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.

4. Progress on Development of "Product" Deliverables

No Product deliverables have been developed.

Product #	Product Description	Progress to Date & Implementation Status
P1	Guidelines supplementing current AASHTO LRFD Specifications for collision loads on piers and abutments, including example utilizing proposed methodology.	
P2	Presentation materials in suitable format for use in introducing concepts and new methodology to bridge design engineers.	

5. Meetings/Conferences

None scheduled.

6. Possible Candidates for Formal Presentations at the Upcoming RMC Meeting

Not at this time.

7. Miscellaneous