

PROJECT TITLE:**Project No. 3: Short-Radius Guardrail with Large Radii (Wisconsin DOT)****STATE'S PROBLEM STATEMENT:**

Currently, no short-radius guardrail system has been successfully developed to meet the safety requirements of NCHRP Report No. 350. However, many state DOTs have locations where short-radius guardrail systems would be suited for use. At the present, the available guidance for states is provided in FHWA Technical Advisory T5040.32. The technical advisory suggests that designers use a short-radius design that was developed by the State of Washington using much older crash testing guidelines. Guidance for installing the short-radius guardrail is given for systems with radius sizes ranging between 8.5 ft and 35 ft. There are a number of states that have standard intersections with radii between 35 and 70 ft. The FHWA guidance does not address the larger radii above 35 ft. Thus, there exists a need to develop details for short-radius guardrails with radii much larger than those provided in the FHWA technical advisory.

BACKGROUND:

FHWA Technical Advisory T5040.32 recommends the use of a short-radius guardrail that was developed by the State of Washington. This design was tested under the impact requirements set forth in NCHRP Report No. 230. The crash testing demonstrated that the system could contain a 1,800-lb small car and a 4,500-lb sedan. However, the testing program was not complete, and the results were marginal in some cases. Guidance for installing the short-radius guardrail is given for systems with radii ranging between 8.5 and 35 ft. FHWA's guidance is given with regards to radii larger than 35 ft and is as follows:

"These curved guardrail designs are for radii of 8½ and 35 ft. Crash test results and technical experience indicate that this system will also perform satisfactorily with other intermediate radii. Situations which require a curved guardrail installation which falls beyond this range of radii should be designed individually and not subjected to a "make it fit" misapplication of these details."

The technical memorandum also notes that testing conducted on a 35-ft radius Washington State design did not perform adequately when impacted at 60 mph by a large vehicle (4740 lbs). Satisfactory results were obtained for the 35-ft radius system when a test was performed at a reduced speed of 50 mph with the large vehicle. However, MwRSF believes that short-radius designs are generally more critical when used with smaller radii. In subsequent discussions between MwRSF and FHWA representatives, it was agreed that the Washington State design could be developed to employ radii over 35 ft if appropriate engineering analysis was conducted to support the modification.

OBJECTIVE:

The objective of this research effort is to develop modified details for the Washington State short-radius guardrail system with a radius size up to 70 ft. The modified system would not be applicable for any other type of curved guardrail or similar installation. It should also be noted that these details will be based on engineering analysis and judgment. The recommended design will not be crash tested or considered to meet any test standard, such as NCHRP Report No. 350 or MASH-08.

RESEARCH PLAN:

The first step in the research effort will be a literature search to collect detailed information on the Washington State short-radius guardrail as well as the full-scale crash testing program. Next, LS-DYNA computer simulation modeling will be used to develop an FEA model of the Washington State short-radius design. The FEA model will be used to simulate impacts with the 2000P vehicle model. The impact speed for these impacts will be lowered until the Washington State short-radius design demonstrates acceptable impact performance. Subsequently, the model will be modified to incorporate a larger radius and used to determine performance. Design modifications will be made to the large radius design until it

performs at a similar level as the original design. While this type of comparison is by no means predictive, it should provide a good indication of the safety performance of large radius systems as compared to the original Washington State short-radius guardrail design.

The research and simulation effort will be documented in a summary report. This design will not be submitted to FHWA to seek acceptance.

Major Task List

Literature Search:	Review the Washington State short-radius design in the FHWA technical advisory.
Simulation:	Perform LS-DYNA simulation of the as-tested Washington State short-radius design using the 2000P model. Conduct LS-DYNA simulation and evaluation of the large radius Washington State short-radius system using the 2000P model.
Summary Report:	Document and report simulation effort.

BENEFITS:

Completion of this project will provide state DOT's with an option of guardrail at intersecting roadways with radii larger than those previously recommended by FHWA.

RELEVANCE TO SHSP EMPHASIS AREA:

This project relates to issue area nos. 6 and 9: minimize the consequences of leaving the roadway and keep vehicles on the roadway. By minimizing the amount of barrier required and by providing adequate deflection distance from barrier to fixed object, designers will minimize the consequences of a vehicle leaving the roadway.

COST:

The project cost is estimated to be \$57,929 (see Table 3).