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PROJECT SUMMARY REPORT

Adhesive Anchors for Retrofit/Repair of Bridge Rails: Summary Report

The Texas Department of Transportation (TxDOT) Types T501 and T203 concrete bridge rails are widely used on bridges throughout the state. These bridge rails, which are anchored to the supporting deck superstructure, are occasionally damaged due to "out-of-envelope" crash forces from vehicular impacts. Crash loads applied to the rail are transferred to the supporting deck superstructure via rail anchorage reinforcement. Repairs made to damaged rail anchorage or rail support superstructure should have sufficient strength to resist the applied loading as stated in the current American Association of State Highway and Transportation Officials (AASHTO) and National Cooperative Highway Research Program (NCHRP) 350 rail loading requirements.

Another problem similar to repair of rail anchorage members due to impacts is retrofitting new or modified rails onto existing, undamaged bridge support superstructures. Oftentimes, the existing bridge rail, designed and constructed under requirements of the time, does not meet current requirements for strength or vehicle performance. In cases such as this, retrofitting an anchorage system into the existing superstructure is required. Like the requirements for a repair, the retrofit anchorage must be sufficient to withstand the transmitted forces from errant vehicles. These transmitted forces vary depending on bridge rail geometry, rail anchorage details, and magnitude and location of force applied to the rail.

This project focused on determining the magnitude and location of force to the rail anchorage reinforcement for two current TxDOT bridge rail systems, the T501 and the T203 concrete bridge rails under severe loading conditions. These rails were studied so that an acceptable structural repair using adhesive anchors could be made to rails damaged due to impacts. The project explored the ultimate strengths of the T501 and T203 bridge rails and the transfer of these forces to the rail anchorage systems for both the T501 and T203 bridge rails with the intent to develop suitable repair and/or retrofit designs.

What We Did...

To accomplish the objectives of this project, the following steps were taken:

- Researchers constructed a full-scale test installation of the T501 and T203 bridge rail systems conventionally attached to a simulated deck overhang for static load testing. The rail anchorage reinforcement for both rails was instrumented with strain gages. Strain generated in the rail anchorage was recorded while the rails were static-loaded to failure.

- Researchers constructed a minimum of three full-scale test specimens of the T501 and T203 bridge

rails for dynamic testing. Like the static testing, the conventional rail anchorage reinforcement for both rails was instrumented with strain gages. Strain generated in the rail anchorage was recorded during the dynamic testing.

- Based on the data obtained from the static and dynamic testing, the Texas Transportation Institute (TTI) worked closely with TxDOT personnel to develop a repair and/or retrofit design for the T501 and T203 bridge rails. The use of adhesive anchoring systems and the long-term effects on these systems were considered in the repair/ retrofit designs. Analyses were performed on the new designs considering the strength data obtained from the static and dynamic testing. Finalized details for the adhesive anchor retrofit/repair designs were developed. Data obtained from the dynamic testing can also be useful in developing other repair/retrofit rail anchorage designs.
- A repair/retrofit design for each rail type was constructed using the previously tested samples for the T501 and

T203 bridge rails. Researchers dynamically tested these new designs to validate that the strengths of the repair and/or retrofit design were acceptable.

What We Found...

This project provided TxDOT with a repair/retrofit design using adhesive anchors for both the T501 and T203 bridge rails. We found from this research that for severe crash conditions from errant vehicles, the forces transmitted to the conventional cast-in-place reinforcing anchorage for the T501 bridge rail vary from approximately 10 to 12 kips per bar. Based on this information, a retrofit/repair design utilizing a commercial adhesive anchoring system was developed and tested. Details of this retrofit/repair design are provided in Figure 1.

For the T203 bridge rail, we found that for severe crash conditions from errant vehicles, the forces transmitted to the conventional anchorage vary from approximately 8 to 10 kips per bar. Based on this information, a retrofit/repair design utilizing a commercial adhesive anchoring system was developed and tested for the T203. Details of this

retrofit/repair design are provided in Figure 2.

A summary of the static and dynamic testing for both bridge rails is presented in Table 1. The retrofit/repair strengths from the dynamic and static testing for both the T501 and the T203 compared very closely to the dynamic and static strengths of the conventionally anchored strength capacities. The static strengths were very close to the dynamic strengths obtained from the surrogate vehicle (bogie) testing.

The Researchers Recommend...

The new retrofit/repair designs developed and tested for this project were recommended for implementation for use on any new or existing bridge projects. The use of a commercial adhesive anchoring system was very successful in achieving the strengths needed to adequately anchor the retrofit/repair reinforcement for both the T501 and the T203 bridge rails. The information learned from this project can be used to retrofit and repair other bridge rail designs in the future.

Table 1. Summary of Analytical and Full-Scale Testing.

No.	Case	Calculated Conventional Anchored Strength (kips)	Static Strength Conventional Anchored Design (kips)	Dynamic Strength Conventional Anchored Design 50-ms Avg. (kips)	Retrofit Design Strength (Dynamic) 50-ms Avg. (kips)
1	T501 Mid-span (Avg. 2 Tests)	59.7	70.5	68.0	62.8
2	T501 End/Joint	36.4	41.0	46.0	50*
3	T203 End/Joint	23.2	33.0	N/A	39.5
4	T203 Mid-span (Avg. 2 Tests)	71.0	72.8	71.0	68.3

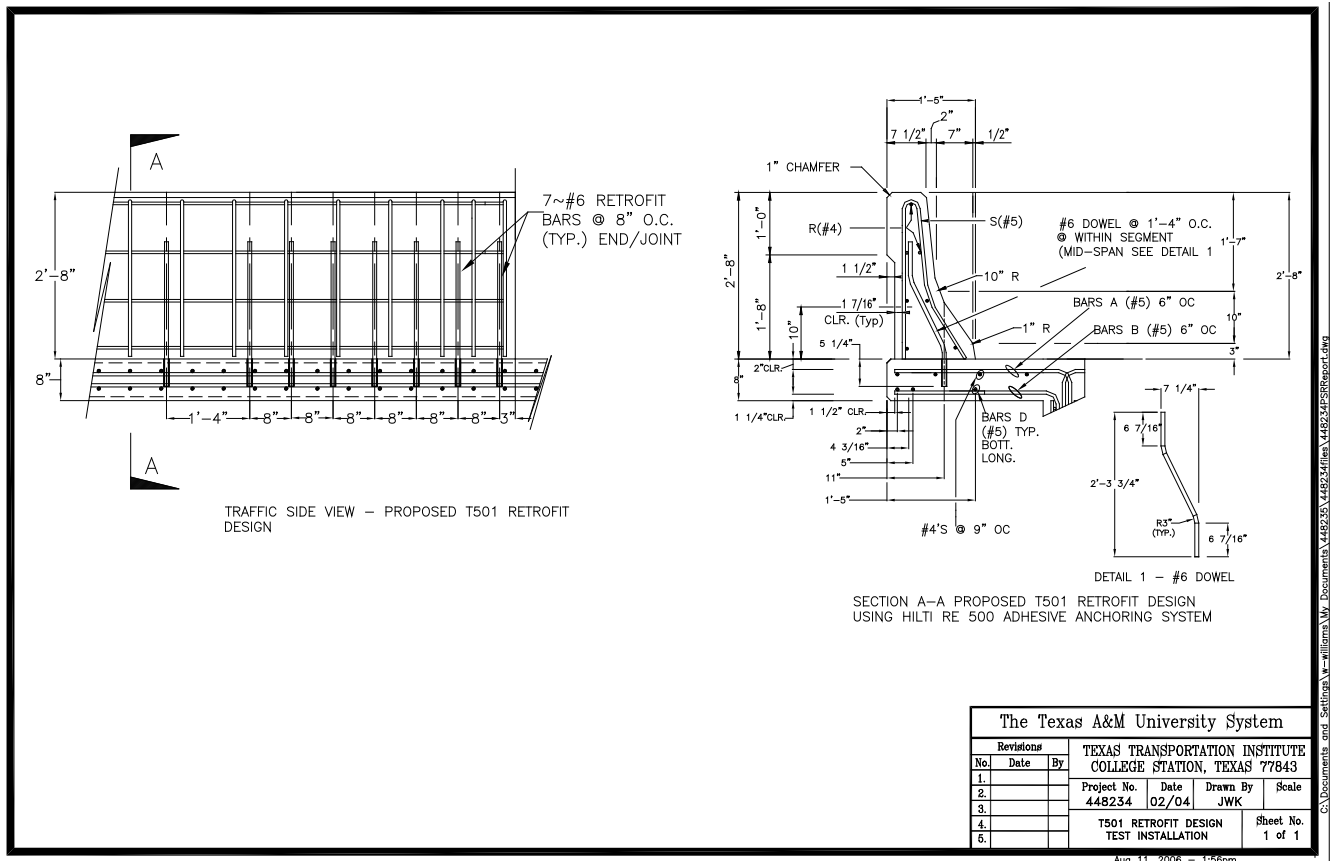* Denotes result obtained from static testing on 5-12-06

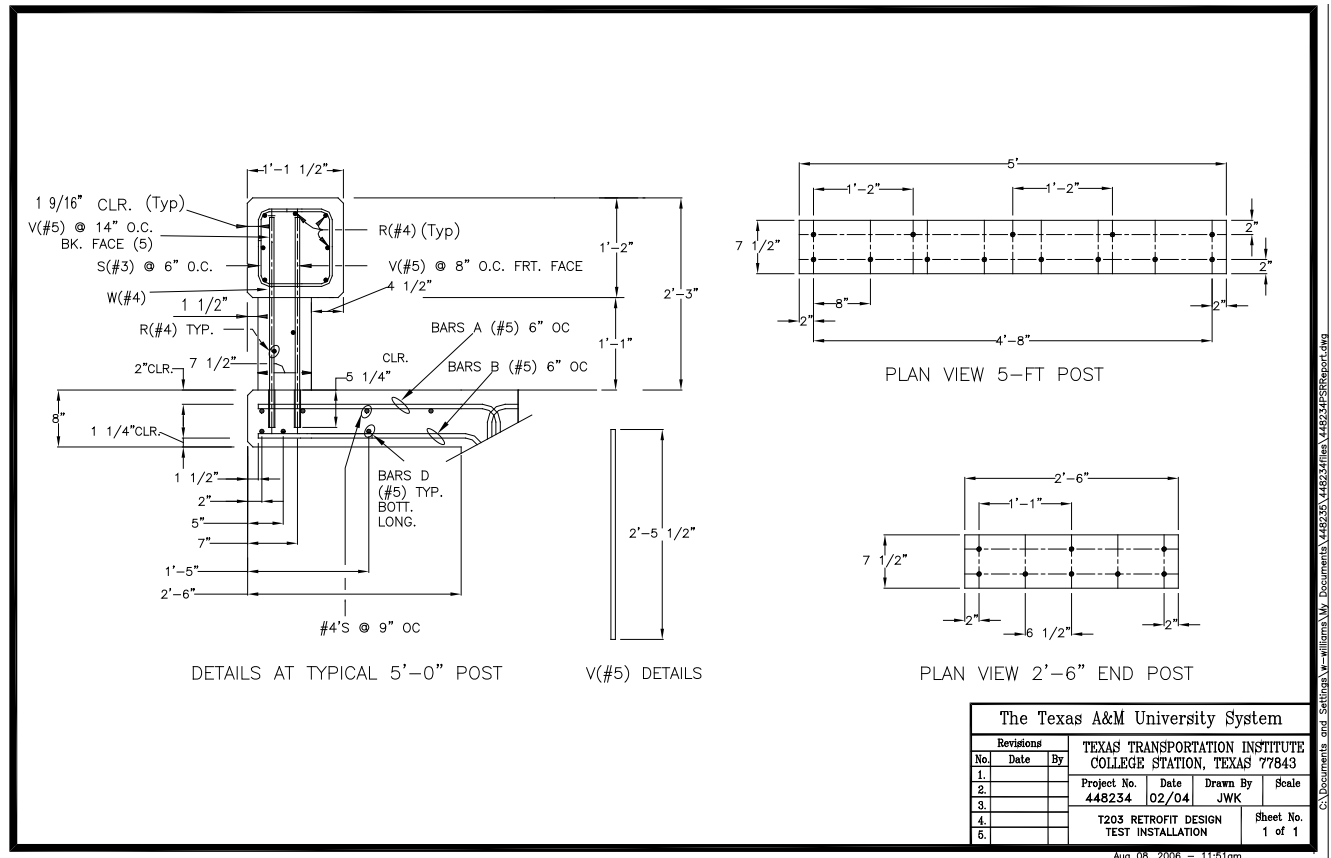Figure 1. Proposed Retrofit/Repair Design T501 Bridge Rail.

Figure 2. Proposed Retrofit/Repair Design T203 Bridge Rail.

For More Details...

The research is documented in:

Report 0-4823-T1-1, *Repair/Retrofit Anchorage Designs for Bridge Rails*

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