ATTACHMENT B

NCHRP Project 22-28, FY 2011
Criteria for Restoration of Longitudinal Barriers, Phase II
Comments on the June 2014 Quarterly Report

Below are comments from the panel on the June 2014 QPR. The research team's responses are indicated in an italicized font.

Reviewer No. 1

The researchers appear to be making good progress on the physical analysis of damaged guardrail. It is unfortunate that there is not much state DOT interest in putting the guidelines to a practical test. Would it be useful to share the guidelines with the ATSSA Guardrail Committee for their input? The committee includes manufacturers, distributors, and installers of roadside barriers, and you may find individuals with real world experience with guardrail installation and/or repair.

The project is in the final stages and the draft final report is approximately 80% complete; however, there may still be time to get feedback from the ATSSA group before final revisions are made and the project is closed. We will contact John Durkos in the coming quarter and ask him to distribute the field guide to the ATSSA group and to solicit feedback.

Reviewer No. 2

I appreciate the continual "in-progress" reporting of the research team – it is much more efficient to digest small chunks of the project/progress than to do so only once the draft final report is submitted.

Thank you.

Progress in this quarter seems good although I am a bit disappointed (as is the research team) with the difficulty of getting maintenance volunteers to field test the guide.

A few specific comments on this QPR:

1. In the recommendations for end-terminal damage (Table 2 in the main QPR report), foundation tube damage levels greater than 4 inches but less than 7 inches are categorized "medium" while greater than 9 inches is categorized as "high." In terms of clarity for the maintenance persons using the guide, I would suggest eliminating the "grey" area between 7 and 9 inches if possible (I wasn't sure if the gap was a result of the relatively strange results with the 8" stub height or not). One conservative option might be to indicate that 7 inches or more is "high" priority.

   This was a mistake in the Task Report and has been corrected in the final report, as well as in the field guide. In Chapter 12 of the final report the damage mode is now defined in *terms of both "reduced embedment depth" and "stub height."* In the Field Manual, *however, only "stub height" is used to avoid confusion. An excerpt from Chapter 12 discussing the results of the study in the "Summary and Discussion" section* is shown *below:*

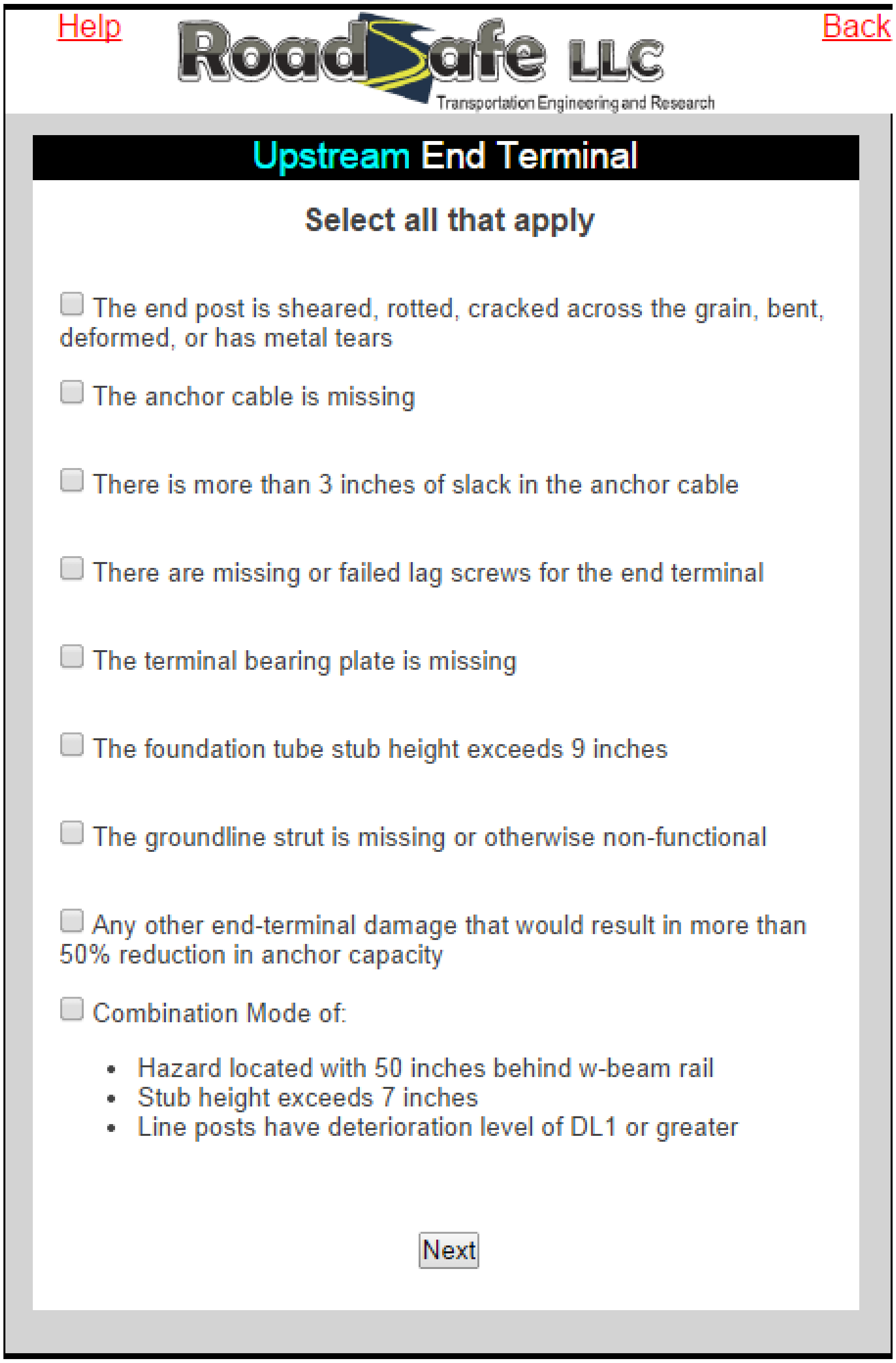
> *"Based on the results of these tests combined with those from Gabler's study, it was concluded that:*
>
> - *When the "stub height" of the foundation tube, as measured from the top of the foundation tube to the ground, is greater than 4 inches and less than 9 inches (i.e., reduced embedment of 1 to 6 inches), repair should be considered if other system maintenance is being performed. The performance of the anchor is not compromised when stub height is less than 7 inches; however, there is an increased potential for small cars snagging on the top of the foundation tube as well as an increased potential for the breakaway mechanism of the end-terminal to not activate properly during end-on hits at stub heights exceeding 4 inches.*
> - *When stub height exceeds 9 inches (i.e., reduced embedment exceeds 6 inches) the performance of the anchor may be significantly compromised due to significant reduction in anchor strength and the high probability of complete anchor loss at relatively low anchor displacement."*

The commentary in the Field Manual regarding "Stub Height" then states:

> *"A properly installed foundation tube normally protrudes approximately 2-3 inches above ground to facilitate connection of the groundline strut and for proper positioning of the bearing plate against tube. Stub heights have been observed to exceed this limit due to incorrect installation and, in some areas, due to frost heave.*
>
> *A stub height exceeding 9 inches corresponds to excessive reduction in anchor strength and is therefore considered <u>high priority for repair</u>. This condition is evident when the soil plate on the foundation tube protrudes more than 1 inch above grade.*
>
> *Stub heights extending from 4-9 inches above ground are considered to be <u>medium priority for repair</u>. When stub heights extend more than 4 inches above ground there is an increased potential for small vehicles to snag on the foundation tube. Also, further increases in stub height may prevent proper activation of the breakaway mechanism of the end-terminal during end-on crashes.*
>
> *Additionally, for wood post guardrail systems such as the G4(2W), when a fixed/rigid hazard is located within 50 inches behind the face of the guardrail, then a stub height greater than 7 inches is considered high priority for repair <u>if</u> the guardrail line posts have deterioration level of DL1 or greater."*

2. Along the same lines, the "other" category in Table 2 might be a bit specific. I certainly appreciate it from a research standpoint but unless the maintenance person had a reasonable high level of expertise, I'm not sure it would help them.

   Regarding the information in the "Other" category in Table 2 – We agree that the criteria is a bit specific, but we think it is useful to include these in the field guide in the format shown below (see last two criteria). The maintenance person would simply leave the box "unchecked" if the information is unknown.


Help Back

RoadSafe LLC Transportation Engineering and Research

Upstream End Terminal

Select all that apply

- [ ] The end post is sheared, rotted, cracked across the grain, bent, deformed, or has metal tears
- [ ] The anchor cable is missing
- [ ] There is more than 3 inches of slack in the anchor cable
- [ ] There are missing or failed lag screws for the end terminal
- [ ] The terminal bearing plate is missing
- [ ] The foundation tube stub height exceeds 9 inches
- [ ] The groundline strut is missing or otherwise non-functional
- [ ] Any other end-terminal damage that would result in more than 50% reduction in anchor capacity
- [ ] Combination Mode of:
  - Hazard located with 50 inches behind w-beam rail
  - Stub height exceeds 7 inches
  - Line posts have deterioration level of DL1 or greater

Next

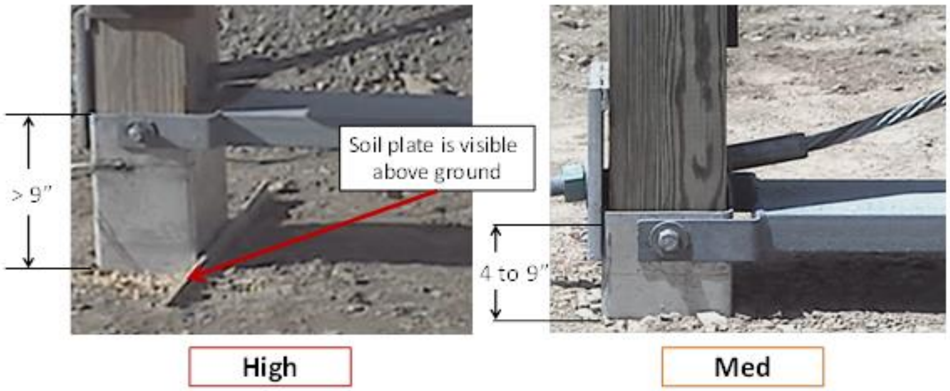
I do like your list of examples, though, on the bottom of page 12. Perhaps there is some graphical method to convey the combinations of terminal damage (embedment depth reduction and cable slack) that correspond to the "medium" and "high" levels. An example would be Figure 3-6 and 3-7 in the RDG.

The current example included in the Field Manual is shown below. We think this is sufficient but will consider other graphical formats for conveying the damage mode.

End-Terminal Condition

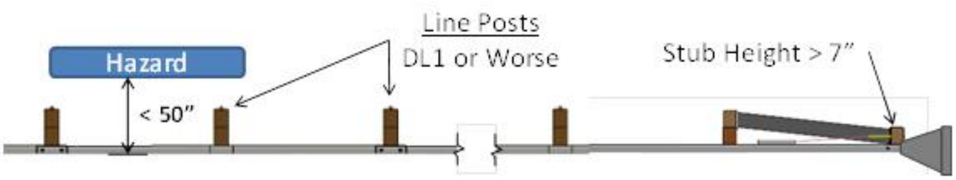
Foundation Tube:

Stub Height:



Stub Height =
- >9" — **High**
- 4-9" — **Med**

Combination Mode:



Combination Mode =
- Hazard within 50" behind rail, and
- Stub height > 7" and
- Line posts DL1 or worse

→ **High**

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3. While I understand the time and monetary limitations, it seems like it would be worth determining the CIP location for one additional erosion condition (other than 6") if time permits. I wouldn't suggest rerunning simulations with the new CIP but at least we would have some idea of how sensitive CIP is to different levels of erosion (and perhaps it doesn't change the CIP significantly).

For the case of erosion at two consecutive posts, Figure 38 in Attachment D of QPR 11 shows that the maximum rail deflection occurred 15-34 inches upstream of the critical splice connection for all cases. Although using the actual critical impact point would result in higher loading on the splice, the research team does not think the increase would be significant for those cases.

Regarding the cases of erosion at a single post, however, Figure 32 in Attachment D shows that the maximum deflection occurred at the critical splice connection for the 9" and 12" erosion cases. It is possible that an impact point slightly farther upstream may result in deeper pocketing which could cause notably higher loads on the splice. We will run at least one additional analysis for the 9" inch erosion case with the vehicle positioned at 16 inches farther upstream.

Reviewer No. 3

Project looks good. Looking forward to the erosion at single post research results.

Thank you. The Erosion Assessment task was completed this quarter and is documented in the October 2014 Quarterly Report.

Unfortunately there has not been a good response for testing the inspection materials. I tried to get our state to do this, but did not receive any responses.

It seems that there is not much interest in using a formal damage assessment procedure, at least at the maintenance level who would be the ones actually carrying out the assessments. It is becoming more apparent that the adoption of such procedures will have to be mandated from higher levels within the DOT.

Reviewer No. 4

Great progress so far but there are still a couple of issues that we need to pay close attention to. First is the ability to acquire damaged w-beam splices and how it might delay results for Task 4A-5. If the required number of damages splices are not acquired is there a contingency plan in place or will this damage mode not be reported on the final Field Guide?

We were only able to procure 16 damaged splice specimens; and of those, several did not have sufficient damage for consideration. It was decided to move forward with the physical testing, although there were not a sufficient number of specimens with a reasonable range of damage levels for each damage mode case. Three damage modes are being investigated: (1) rail flattening, (2) longitudinal slip in the splice (3) splice separation (gap between panels at the downstream splice bolts). One test is also being performed to evaluate "rail crush" damage. The complete test matrix is shown below. We will not know until the testing is complete, but we are hopeful that useful information will be garnered from these limited tests for developing repair guidance.

Test #	Specimen #	Damage Mode	Completed
14004A	4A5-ME003	-	⚐
14004B	4A5-ME005	-	⚐
14004C	4A5-ME008	Rail Flattening	⚐
14004D	4A5-ME005	-	⚐
14004E	New	Undamaged	⚐
14004F	4A5-ME001	Rail Flattening / Crush	⚐
14004G	4A5-ME011	Rail Flattening	⚐
14004H	4A5-ME014	Long. Slip	⚐
14004I	4A5-ME017	Long. Slip	
14004J	4A5-ME004	Rail Crush	
14004K	4A5-ME010	Splice Separation	
14004L	4A5-ME007	Splice Separation	
14004M	4A5-ME018	Splice Separation	
14004N	New	Undamaged	

My only other concern is with the use of the "draft" field guide and what we might be able to do to get more people to use it. Other than re-soliciting for field testers what else could be done?

See response to Reviewers 1 and 3 above.

<u>Reviewer No. 5</u>

No comment.

<u>Reviewer No. 6</u>

I read all the reports and the research seems to be on track. They are getting into the items that will provide field personnel will good direction. Amount of slack in the cable of the end treatments. We can never keep the cables tight, this will give us some tolerance that we need. Keep up the good work this will benefit maintenance forces and the design that write the specs.

Thank you.