Guidelines for Inspection, Repair, and Use of Portable Concrete Barriers

In October of 2019, The Federal Highway Administration (FHWA) and the Texas Department of Transportation Research and Technology Implementation Office sponsored research on the Development of Guidelines for Inspection, Repair, and Use of Portable Concrete Barriers. Texas A&M Transportation Institute (TTI) conducted full-scale testing and calibrated computer simulations on several different types, shapes and sizes of reinforced concrete traffic barriers to define inspection criteria for assessment and to verify that current typical barrier types meet the latest AASHTO criteria for crashworthiness.

The researchers conducted both virtual and physical tests, using instrumented test vehicles and full-size trucks to validate a parametric computer model using Finite Element Analysis (FEA). While the tests were conducted on specific sizes and types of barriers, the results of the research, published in September 2022, may be applied to any size and shape of reinforced concrete barrier currently being produced in the United States.

While damage assessment of existing concrete traffic barriers is necessarily the responsibility of the owner or owner's engineer, the purpose of this research was to categorize different types of damage and to provide a uniform set of evaluation criteria to provide guidance for inspection and assessment based on results of both the parametric and physical tests.

In assessing damaged barrier sections, three types of damage are identified: spalls, cracks and connections. For each damage type, varying degrees of damage are classified as either acceptable, acceptable with repair, or unacceptable.

Spalling

The first type of damage is spalled concrete. Spalls of nearly any size are acceptable as long as no reinforcement is exposed, all unsound concrete in the area of the spall has been removed and cracking around the damaged area is kept to within specified limits (Figure 1). If the reinforcing steel is exposed and either has very little corrosion or no corrosion at all, then the barrier is deemed acceptable with repair. However, once any exposed reinforcing has begun to show signs of corrosion beyond a light red dust, regardless of whether it would affect the performance of the barrier, the barrier is deemed unacceptable and should be removed from service.

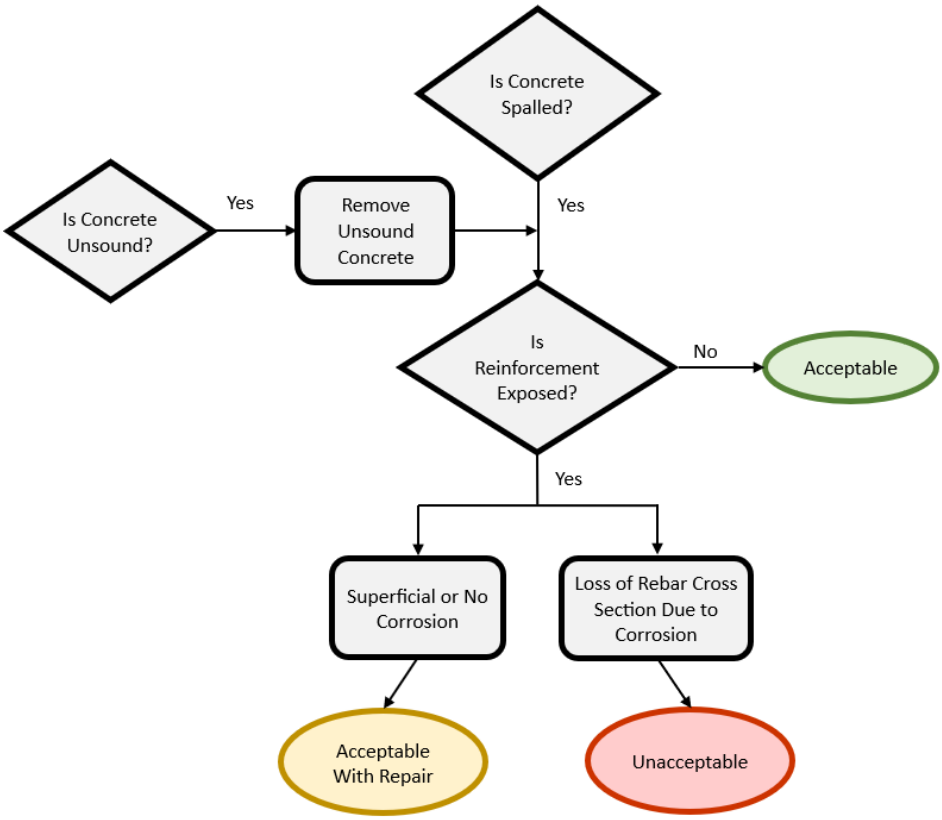

Figure 1: Spalling Evaluation Criteria Flowchart

Cracking

"Hairline" cracks (<0.003 in.) are acceptable without repair, regardless of length or number. A single crack no wider than ¼ in. or multiple cracks whose cumulative widths do not exceed ¼ in. within a 1 ft. longitudinal length of the barrier segment must be repaired, and once repaired, the barrier is acceptable for use. No width threshold is given for cracks needing repair, because cracks were not included as part of the parametric model. A practical crack width for consideration would be between 3/16 in. and ¼ in. before repairing. The direct reference to a ¼ in. crack width in the report comes straight from the physical tests in which a barrier section with a single ¼ in. wide crack at the point of impact was evaluated. The cracked barrier performed well, and the test vehicle did not deform past allowable limits. But the researchers determined that no further conclusions regarding crack widths could be drawn from the test data.

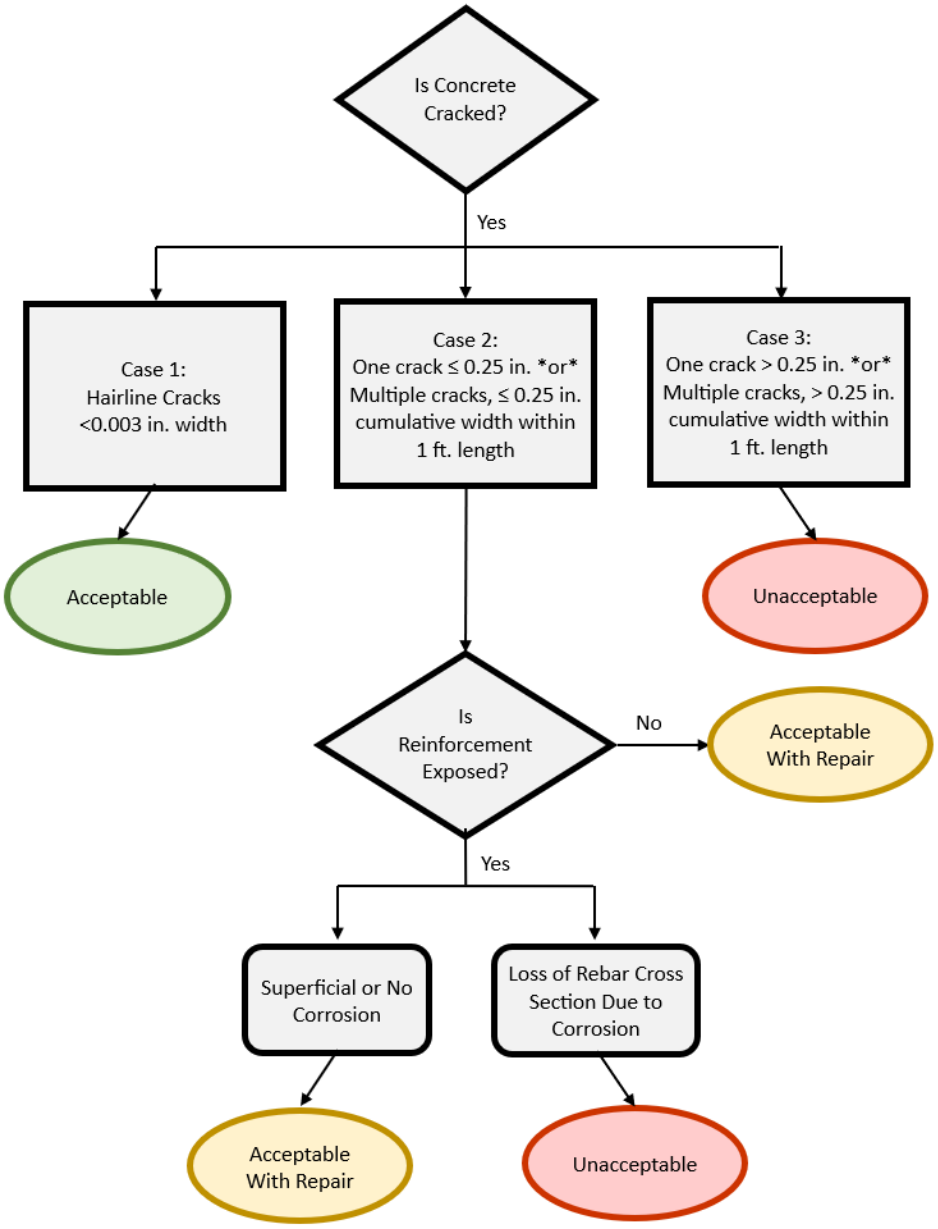

Figure 2: Cracking Evaluation Criteria Flowchart

The report makes no reference to the direction of the cracks in the barrier. Longitudinal cracks occurring along the length of the barrier are therefore treated the same as vertical cracks. The total length of the crack is also not addressed, just that all portions of one or more cracks appearing in any 1 ft. length of a barrier segment are the subject of evaluation. Should any one of those cracks, or the sum of multiple cracks occulting within a 1 ft. segment of barrier length, be greater than ¼ inches in width, then the barrier is unacceptable for repair and must be removed from service. As with spalling, if the cracks are small enough to repair but the steel reinforcement has been exposed and has begun to corrode, then the barrier section is unacceptable.

Connections

For damage to barrier connections, two main types of connections are addressed, with different recommendations given for each. For the "JJ Hook" connection, where embedded steel plates are fabricated in a hook shape so that they interlock at the connection, the maximum amount of rotation in the plane of the hook is 20°. Moreover, the opening inside the hook must not have been pried open more than 0.1 inch so that the entire hook opening does not exceed 1 inch, otherwise the barrier is unacceptable as best can be determined from the report. Any amount of corrosion or cracking in the JJ Hook is also unacceptable. No provision is made for straightening or reforming the steel hook plate, even if no corrosion or cracking in the steel is observed and there is no gap in the connection.

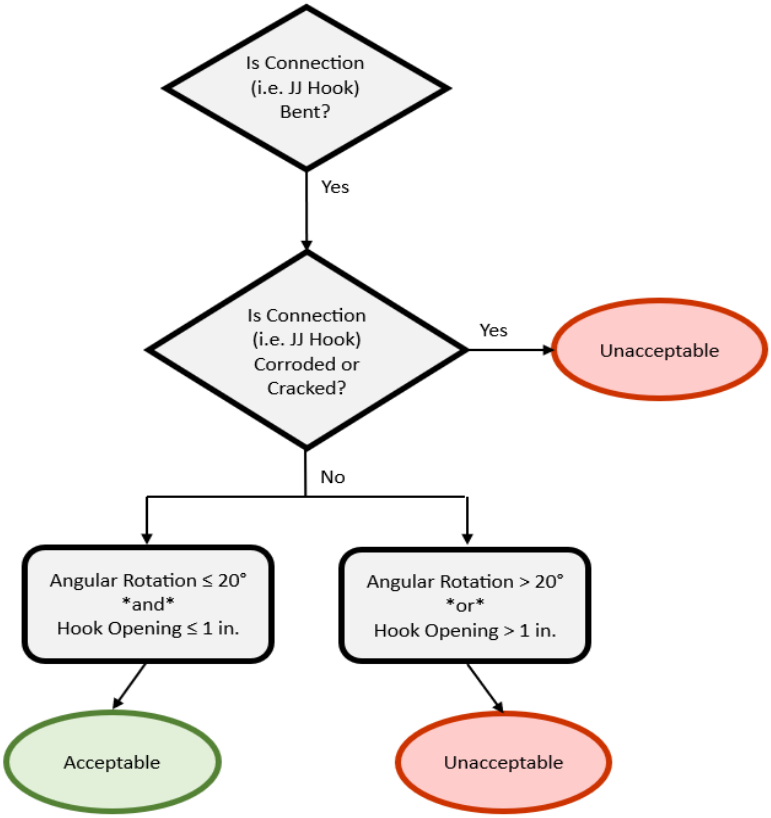

Figure 3: Connection Evaluation Criteria Flowchart

For bolted connections made with "Quick Bolts", "X-Bolts" or other types of bolted connections, there must not be any missing, deformed, cracked or corroded bolting hardware or cracks of any width in the concrete around embedded hardware, otherwise the barrier is unacceptable.

All barrier segments impacted during the course of this research study reportedly met all the performance criteria of AASHTO MASH Test 3-11. Since all physical tests were performed on full-scale existing barrier shapes and designs, precast barriers manufactured prior to the year 2020, the year AASHTO MASH was implemented, that meet the assessment criteria contained in this report are acceptable for continued use throughout their intended service life – and beyond.

References

Silvestri Dobrovolny, Chiara. “0-7059, Development of Guidelines for Inspection, Repair, and Use of Portable Concrete Barriers.” TxDOT Research Library - TxDOT Research Project, 2022, library.ctr.utexas.edu/Presto/content/Detail.aspx?ctID=M2UxNzg5YmEtYzMyZS00ZjBlLWIyODctYzljMzQ3ZmVmOWFl&rID=ODI0&qrs=RmFsc2U&q=MC03MDU5&ph=VHJ1ZQ&bckToL=VHJ1ZQ&rrtc=VHJ1ZQ.