Appendix B

Bridge Pin Ultrasonic Testing Report
(Capitola Railroad Truss)

CAPITOLA RAILROAD TRUSS

over the

SOQUEL CREEK in CAPITOLA, CA

2012 BRIDGE PIN ULTRASONIC TESTING REPORT

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2012 ULTRASONIC BRIDGE PIN INSPECTION REPORT

INTRODUCTION

The Capitola Railroad Truss is a single-track, open deck railroad structure. The bridge is located in Capitola, CA over the Soquel Creek. The deck truss portion of the bridge consists of a single 150-foot long pin-connected deck truss spans. The span has 20 pin connected truss joints including the bearing pins. The bridge panel points are numbered from the geographic south end of the bridge (lower mile post) to the north end of the bridge (higher mile post) and are designated as east or west (e.g. Panel Point L0E is the southeast lower chord pin).

Modjeski and Masters, Inc. completed a detailed ultrasonic inspection of 20 truss pins. The pin inspections were conducted by Mr. B. C. Croop, P.E., NDE UT Level II Pin of Modjeski and Masters, Inc. between April 23 and April 24, 2012. Mr. R. S. Brannon, P.E. of Modjeski and Masters, Inc. assisted with pin surface preparation.

The ultrasonic inspection was conducted in accordance with the FHWA Guidelines for Ultrasonic Inspection of Pins and Modjeski and Masters' Ultrasonic Testing Procedure for the Inspection of Bridge Pins. The bridge pins were inspected using the straight beam ultrasonic pulse echo technique. Photographs of general and specific conditions are included in Appendix A.

Ultrasonic testing revealed discontinuities (ultrasonic reflectors) in most pins. The discontinuities vary in size and most appear to be wear grooves or section loss caused by corrosion. The readings from these discontinuities have been classified as Minor, Moderate, or Significant as a function of a combination of the distance and the amount of sound reflected by a given discontinuity.

For reference purposes throughout the report, eyebars are numbered starting from the outboard side of each panel at any particular joint; the outboard face of the bridge pins are referred to as Face A, and the inboard face of the bridge pins are referred to as Face B. A clock orientation is used to identify the radial location of the ultrasonic transducer where a particular reading was recorded. This orientation is based on Face A of the pin, with 12:00 being at the top of the pin. Radial distances from the center of the pin are recorded to specify the transducer location where indications are found.

ULTRASONIC BASICS

Ultrasonic testing (UT) inspection of bridge pins is a relatively involved method of inspection used for the purpose of detecting internal discontinuities and pin barrel surface irregularities.

Ultrasonic inspection utilizes a mechanically generated high frequency sound wave induced by a transducer probe. The sound wave travels through the bridge pin at a constant velocity for a given material and is reflected or deflected by the discontinuities and the various pin boundaries. Knowing the type of material, the ultrasound machine can measure the time between out-going and in-coming sound wave signals and convert the time to distance based on calibration settings.

For the machine to measure accurately, it must be properly calibrated to each probe and test material. The reflector could be the end of the pin or a discontinuity located within the length of the pin. The return signals are amplified and displayed on the screen of the ultrasonic testing machine as an A-scan display. The horizontal axis of the A-scan display represents a given distance and the vertical axis represents the magnitude of a returning signal.

The intensity of the return signal of the end of the pin, referred to as the "backwall" is adjusted to read to a given percent of the screen height (80%) in order to establish a baseline for comparisons called a Reference Level. A minimum of 6dB of sound energy is added to the Reference Level to establish a Scanning Level which exaggerates small reflectors to more easily identify them. Signals of reflectors are compared to various established reflectors in comparative test pins and to distance amplitude correction graphs generated from our experience with ultrasonic pin inspection. The amplitude of return signals is primarily a function of the transmission signal strength, the size of the reflector, the distance to the reflector, the position and orientation of the reflector and surface preparation quality.

Ultrasound testing can be extremely precise when reading the reflected surface of discontinuities that are exactly 90-degrees to the propagating sound wave; however, field conditions and the actual sound reflectors rarely approach ideal conditions. The ends of the pins are neither uniformly flat nor uniformly smooth, the reflective surfaces of discontinuities can be at a variety of angles, and the material of the pin can have various properties that might hamper the inspection. Normal oriented reflectors generally yield good results and can generally be sized using well established techniques (6dB drop method, DAC curves, pitch-catch techniques or comparative analysis).

Consequently, interpretation of the A-scan information must be made by a qualified UT operator. Interpretations are generally approximate and are based on the training, experience and best judgment of the UT operator at the time of the inspection.

EQUIPMENT

The bridge pins were non-destructively examined with the use of a Krautkramer USM-35 portable ultrasonic flaw detector. The primary transducer used was a 0-degree 2.25 MHz, 0.5" diameter longitudinal wave probe. Additional transducers available for the investigation included an AWS 2.25 MHZ, 0.63" x 0.63" shear wave probe with 45-degree and 70-degree wedges; a Krautkramer 2.25 MHz, 0.5" diameter QC probe with 45-degree, 12-degree, 5-degree and 20"-radius rocker wedges; a 0-degree Krautkramer 5.0 MHz, 0.5" diameter longitudinal wave probe; and a 0-degree Krautkramer 5.0 MHz 0.75" diameter longitudinal wave probe.

The pins were accessed by utilizing Technical Access (TA) solo climbing techniques (see Photograph 1).

BRIDGE PIN DETAILS

All 20 of the bridge pins were visually and ultrasonically examined to give an accurate appraisal of the overall condition of the bridge pins. All the bridge pins are 5-13/16" diameter shoulder mounted pins with an exposed face of approximately 4" diameter. The pins pass through truss and eyebar members and are retained by lomas nuts on the inboard and outboard sides. The pins range in length from 18-3/4" to 28-1/4" long with approximately 2" of threads at each end.

PIN SURFACE PREPARATION

Pin surface preparation is an integral part of a thorough ultrasonic pin investigation, as the surface preparation affects the sensitivity of results. The ends of the pin from which the ultrasound readings are taken must have a smooth and uniform surface to yield clear results.

Generally, the pin face is cleaned with an 80-grit sanding disk on a 4-1/2" angle grinder (see Photograph 2). In cases where there is significant corrosion, pitting or extensive surface irregularities, more aggressive grinding may be necessary prior to polishing with sanding disks. Upon completion of the ultrasonic examination, the pin face is cleaned and covered with a high quality zinc rich cold galvanizing paint and the pin caps are replaced (see Photograph 3).

FINDINGS

Visually, surface corrosion was typically noted on the end faces of the various pins. Many of the pins have gouges or indentations in the pin faces due to heavy impacts used to drive the pins in place during construction. Some of these indentations are up to 3/16" deep (see Photograph 4). Some of the pin faces also had a raised circular protrusion of approximately 1-1/2" diameter x 3/16" thick at the center of the pin (likely leftover from the manufacture of the pins). These protrusions were ground smooth to achieve a better testing surface. The few locations where the barrels of the pins were exposed had pitting from corrosion; however, the configuration of the eyebar-pin setup made measurements of the corrosion difficult and inaccurate (see Photograph 5). At Panel Point U4E, the edges of the pin were previously rounded for approximately 3/4" wide throughout its circumference and the pin has numerous deep gouges both faces (see Photograph 6). Representative A-Scans, depicting typical pin conditions, are included in Appendix C.

Ultrasonically, full circumference and partial circumference wear grooves and surface corrosion with minor section loss was found at most truss pins. Four of the 20 pins have irregular inclusions or areas of porosity within the barrel of the pin. These types of indications are not uncommon in pins of this age and have likely existed since their manufacture.

Wear grooves are characterized as indications that coincide with the bearing areas of eyebars on the pins, located along the barrel surface, and extend over an arc length of the pin surface. The wear groove indications were generally consistent with wear grooves having a depth of less than 1/16" deep to approximately 1/4" deep, based on comparison with known wear groove reflectors of calibration pins and our experience with other bridge pins. The severity of the individual wear groove indications is listed in the table of Appendix B.

Corrosion indications are generally characterized by the broad and shallow nature of the return signals. Almost all of the pins (16 of 20), have corrosion indications throughout the barrel of the pin. The section loss due to this corrosion is approximately 1/16" for most occurrences. Pins at Panel Points L1E and L2W have section losses due to corrosion of approximately 3/16". Two pins, U1W and U2E, have surface indications that do not extend over a significant arc length, and are not detectable for a depth beyond the surface. These indications are approximately 1/16" deep and are likely isolated areas of pitting or other pin surface imperfections.

Internal indications are generally characterized as small in magnitude of return signal at very isolated locations within the body of the pin. Internal indications were found in four pins: L0W, L0E, U1W and L2E. The internal indications have return signal characteristics consistent with small inclusions, piping or porosity and do not extend to the pin surface. It is likely that these internal defects have existed since the fabrication of the pins.

ULTRASOUND RATINGS

Indications documented during an ultrasonic inspection are categorized according to the following descriptions:

Negligible	UT discontinuity reflections too small to quantify or do not exist
Minor	UT reflections consistent with discontinuities less than 1/16" deep
Moderate	UT reflections consistent with discontinuities between 1/16 and 1/8" deep
Significant	UT reflections consistent with discontinuities between 1/8" and 1/4" deep
Severe	UT reflections consistent with discontinuities over 1/4" deep or cracks

Each of the 20 pins of the Capitola Railroad Bridge that were inspected in this investigation were rated according to the categories noted above. Each recorded indication is individually rated; however, the overall rating for a pin is based on the worst individual indication identified for that particular pin.

Of the 20 pins ultrasonically inspected, 16 are rated as having Minor indications and 4 are rated as having Moderate.

CONCLUSIONS and RECOMMENDATIONS

The Capitola Railroad Bridge pins are generally in satisfactory condition. There do not appear to be any cracks in the pins examined; however, any discontinuities in the pin surfaces could act as stress risers, increasing the potential for crack development.

The truss pins generally have areas of minor corrosion and most pins have minor to moderate wear grooves. The majority of deficiencies noted were minor wear grooves of 1/16" or less in depth at the locations where the eyebars bear on the barrel of the pins.

During the next ultrasound investigation, it is recommended that particular attention be paid to the truss pins that exhibited internal indications at Panel Points L0W, L0E, U1W and L2E, and the two upper chord pins with surface indications at Panel Points U1W and U2E.

APPENDIX A

PHOTOGRAPHS

Photograph 1 - View of Technical Access solo climbing techniques being used to examine a lower chord pin.

Photograph 2 - View of typical pin face after polishing with a grinder.

Photograph 3 - View of typical pin face after application of galvanizing paint.

Photograph 4 - Panel Point L2E. View of surface gouges in the inboard pin face.

Photograph 5 - Panel Point L2E. The barrel of the pins were typically not available for visual inspection.

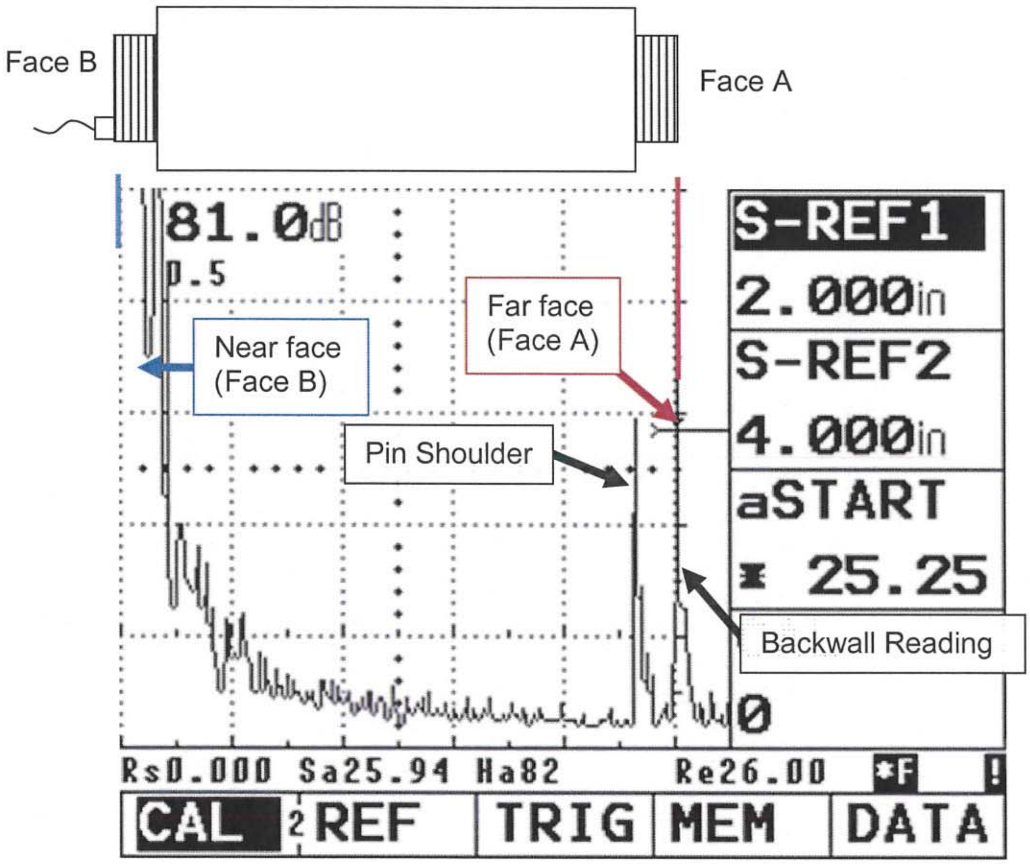
Photograph 6 - Panel Point U4E. The edges of the pin's outboard face have been previously rounded for up to 3/4". The pin face also has deep gouges throughout both faces.

APPENDIX B

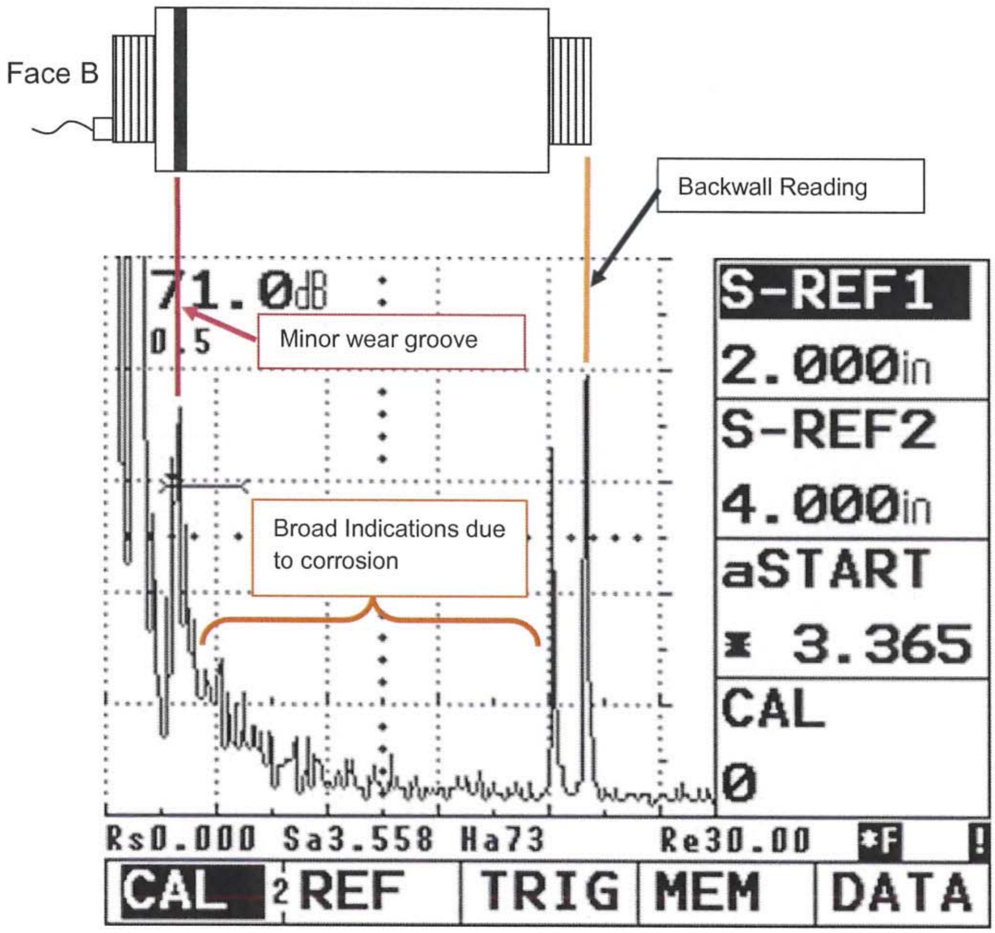
INVENTORY OF TRUSS PIN ULTRASONIC INDICATIONS

APPENDIX C

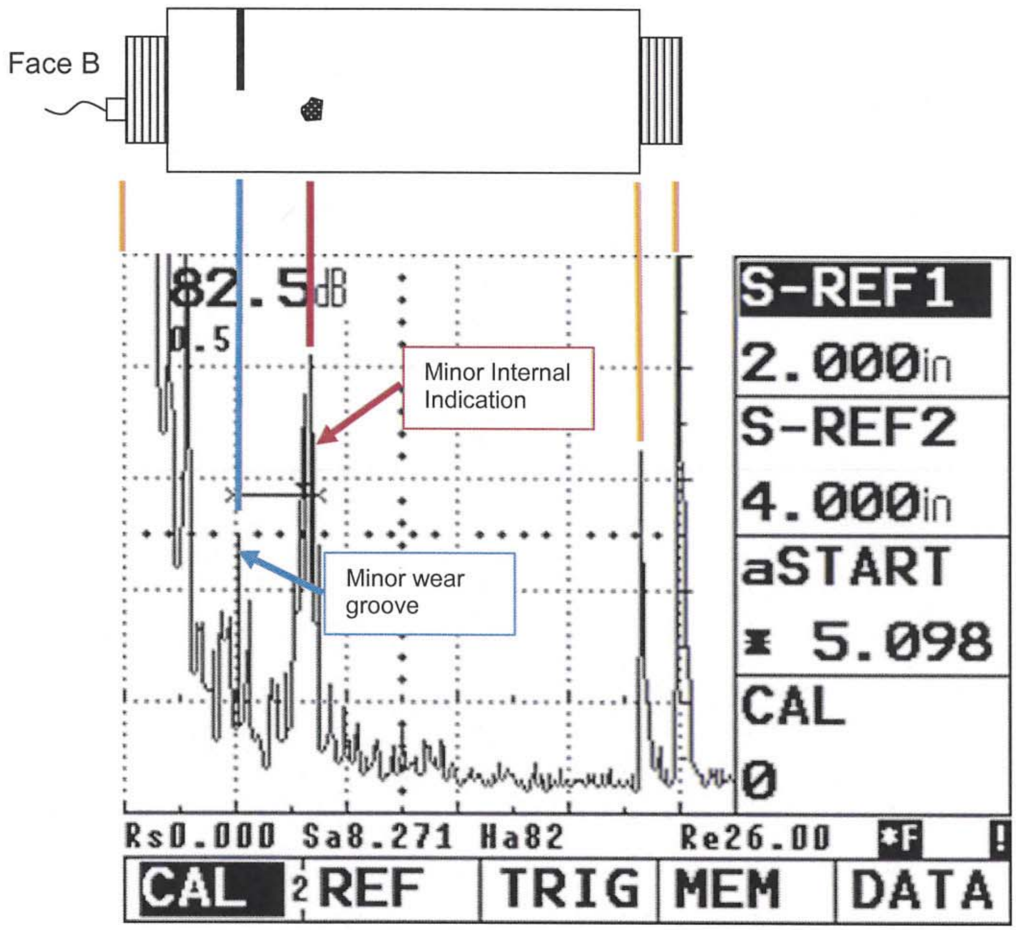
REPRESENTATIVE A-SCANS



A-scan 22- Panel Point L0W. View of a typical pin backwall reading viewed from Face B.



A-scan 44- Panel Point L5W viewed from Face A. There is a full-circumference wear groove located 3.558" from Face A. Minor corrosion is also present throughout the surface of the pin barrel as indicated by the numerous shallow indications between the pin shoulders. The data set was recorded at Reference Level, so the minor indications are approximately 1/16" deep. Ratings minor are a function of return signal attenuation for a given depth from the scanned pin face. For this reason, smaller indications at a greater depth from the scanned face are more significant than large indications closer to the scanned face.



A-Scan 21 - Panel Point L0W viewed from Face A. There is an approximately 1" diameter internal inclusion in the pin located 8.271" from Face A. The indication is located 1" from the center of pin at 12:00. There is also a minor wear groove from 3:00 to 9:00 located 4.390" from Face A.