Determining the Depth of Hydro Demolition using Lidar Methods

by

Norbert Maerz
and
Ken Boyko

**NUTC
R334**

Disclaimer

The contents of this report reflect the views of the author(s), who are responsible for the facts and the accuracy of information presented herein. This document is disseminated under the sponsorship of the Department of Transportation, University Transportation Centers Program and the Center for Transportation Infrastructure and Safety NUTC program at the Missouri University of Science and Technology, in the interest of information exchange. The U.S. Government and Center for Transportation Infrastructure and Safety assumes no liability for the contents or use thereof.

Technical Report Documentation Page

1. Report No. NUTC R334	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Determining the Depth of Hydro Demolition using Lidar Methods		5. Report Date February 2014
		6. Performing Organization Code
7. Author/s Norbert Maerz		8. Performing Organization Report No. Project #00042275
9. Performing Organization Name and Address Center for Transportation Infrastructure and Safety/NUTC program Missouri University of Science and Technology 220 Engineering Research Lab Rolla, MO 65409		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTRT06-G-0014
12. Sponsoring Organization Name and Address U.S. Department of Transportation Research and Innovative Technology Administration 1200 New Jersey Avenue, SE Washington, DC 20590		13. Type of Report and Period Covered Final
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Missouri S&T was contracted to conduct research on the effectiveness of using ground-penetrating radar (GPR) to assess several highway bridges in rural Missouri. The assessment was to be based on the principle that sound concrete has a different density than unsound concrete, and this property could be used to map areas of bridge decks requiring repair.While the GPR assessment involved a dozen bridges, three bridges were selected to provide ground-truth data to calibrate the GPR-based assessment process.

17. Key Words Hydro mining, LIDAR, thickness	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.		
19. Security Classification (of this report) unclassified	20. Security Classification (of this page) unclassified	21. No. Of Pages 15	22. Price

Form DOT F 1700.7 (8-72)

Final Report

Determining the Depth of Hydro Demolition
using
Lidar Methods

Osage River Bridge (A1479)
Lamine River Bridge (A1193)
Union Pacific RR Bridge (A1297)

Lidar Applications Team
Missouri University of Science and Technology
February 26, 2014

Summary

Missouri S&T was contracted to conduct research on the effectiveness of using ground-penetrating radar (GPR) to assess several highway bridges in rural Missouri. The assessment was to be based on the principle that sound concrete has a different density than unsound concrete, and this property could be used to map areas of bridge decks requiring repair. While the GPR assessment involved a dozen bridges, three bridges were selected to provide ground-truth data to calibrate the GPR-based assessment process.

The ground-truth data required equated to creating maps showing the distribution of concrete removed during the hydro-demolition process. These maps were created by scanning the bridge decks prior to hydro-demolition, and scanning them again after hydro-demolition. The scanning was accomplished using a high-precision Leica ScanStation-II Lidar instrument. After the two scans were registered to each other, they were subtracted from one another to produce a "difference" surface. These difference surfaces were analyzed to generate statistics on the average depth of rebar, percentages of area at various depths, and to aid in the GPR calibration process.

GPR Correlation Results

The GPR predictive maps generally agreed with the Lidar-based ground truth data. The best correlation was achieved on the Union Pacific Railroad bridge:
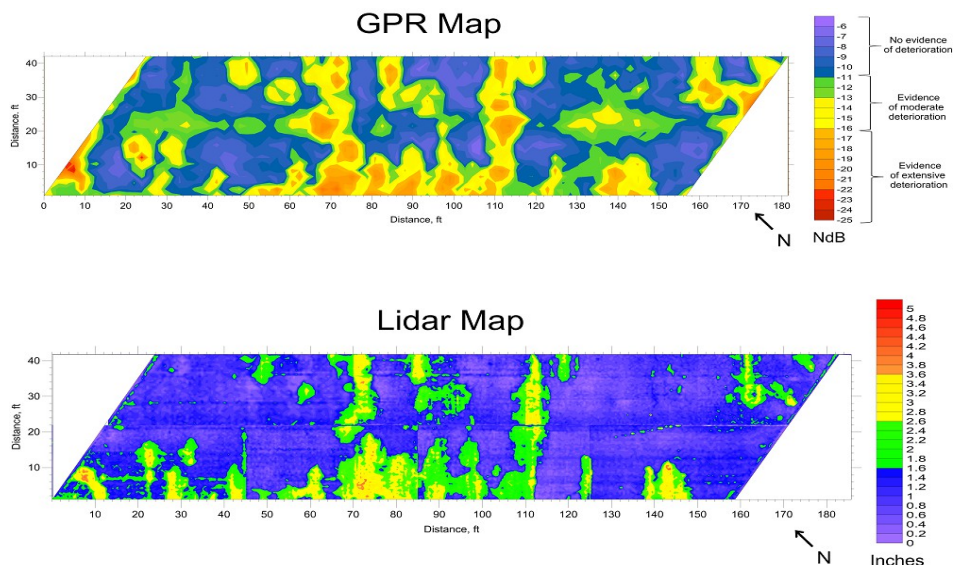
Osage River Bridge (A1479) Results

The average depth of rebar for the WB bridge was determined to be **1.48 inches below original surface.**

Average percent of area ¾ inch or less in depth: **57.7%**
Average percent of area > ¾ inch to the top of rebar: **26.7%**
Average percent of area deeper than top of rebar: **15.6%**

Lamine River Bridge (A1193) Results

The average depth of rebar for both lanes was determined to be **1.94 inches below original surface.**

Average percent of area ¾ inch or less in depth: **64.3 %**
Average percent of area ¾ inch to top of rebar: **28.6 %**
Average percent of area deeper than top of rebar: **7.1 %**

Union Pacific Railroad Bridge (A1297) Results

The average depth of rebar for both lanes was determined to be **1.76 inches below original surface.**

Average percent of area ¾ inch or less in depth: **30.2 %**
Average percent of area ¾ inch to top of rebar: **47.5 %**
Average percent of area deeper than top of rebar: **22.3 %**

Difference Surface Images used to determine 'top of rebar' and preliminary areal statistics:
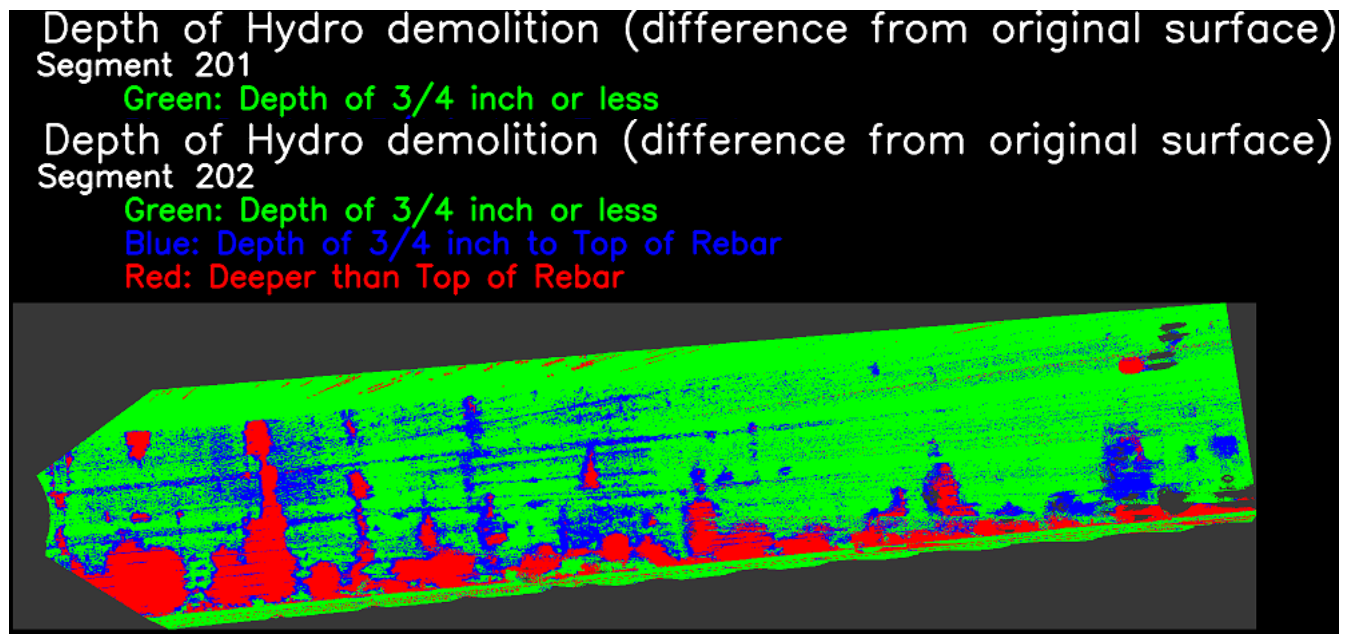
Depth of Hydro demolition (difference from original surface)
Segment 203
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar
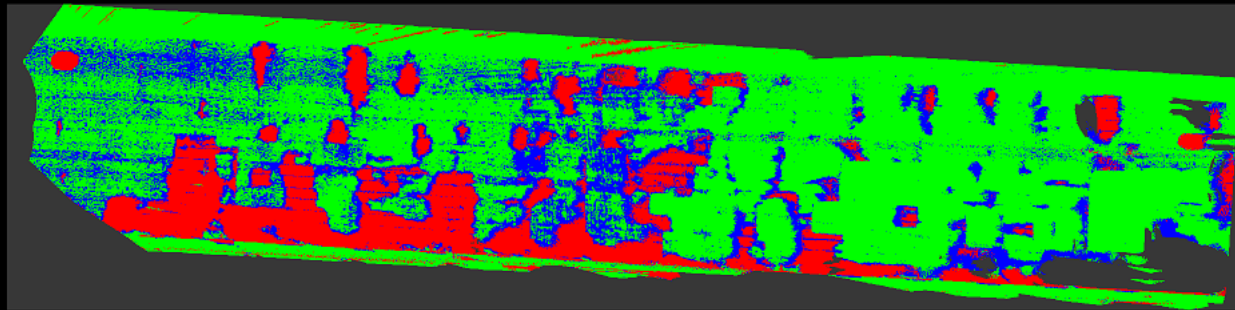
Depth of Hydro demolition (difference from original surface)
Segment 204
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
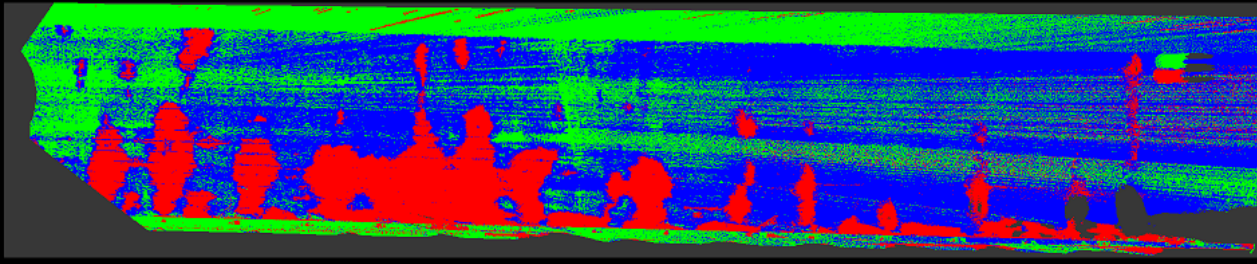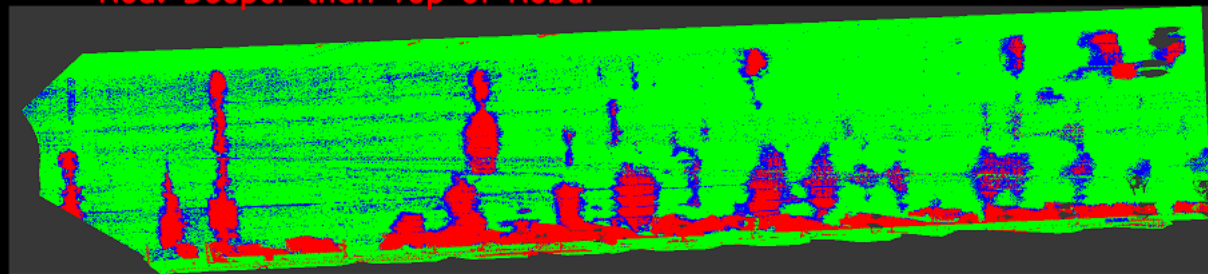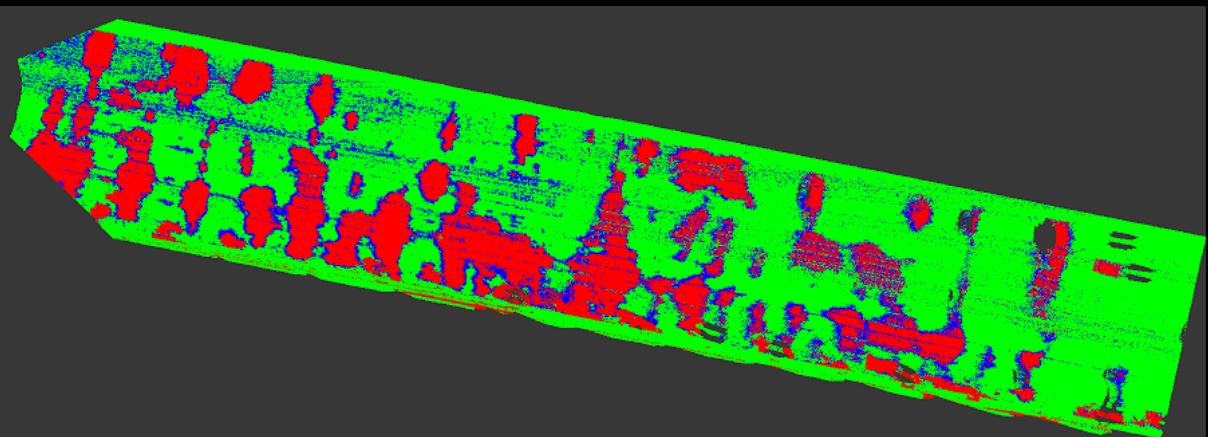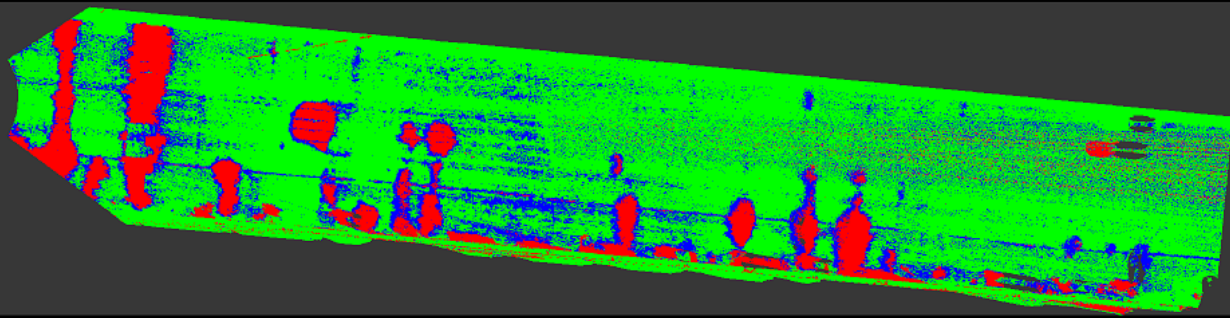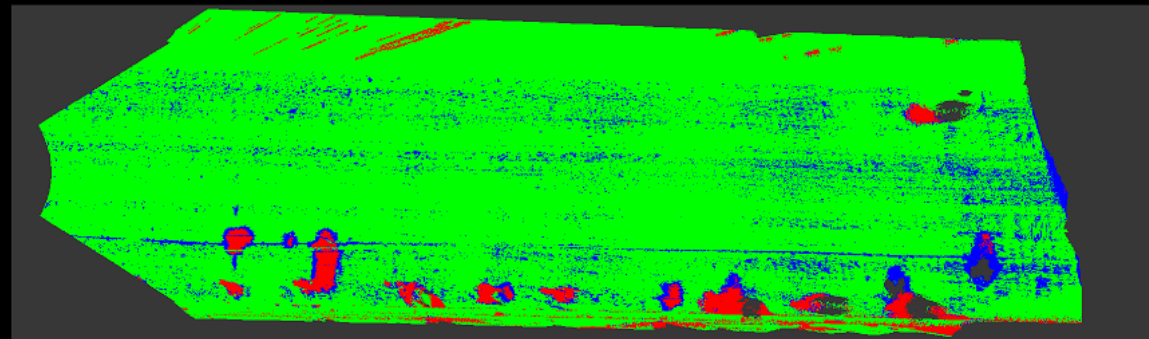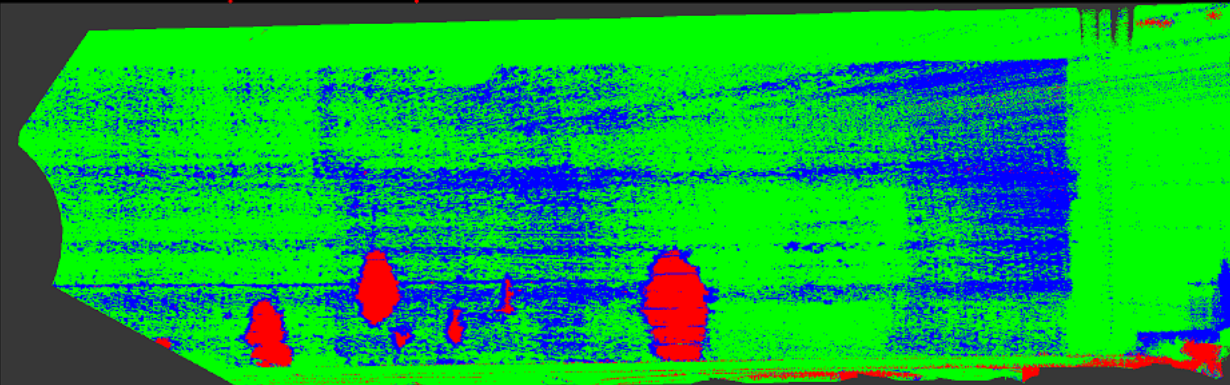Red: Deeper than Top of Rebar
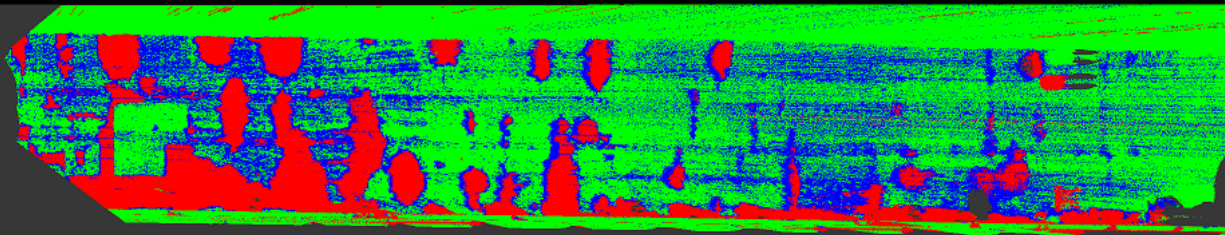
Depth of Hydro demolition (difference from original surface)
Segment 205
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar
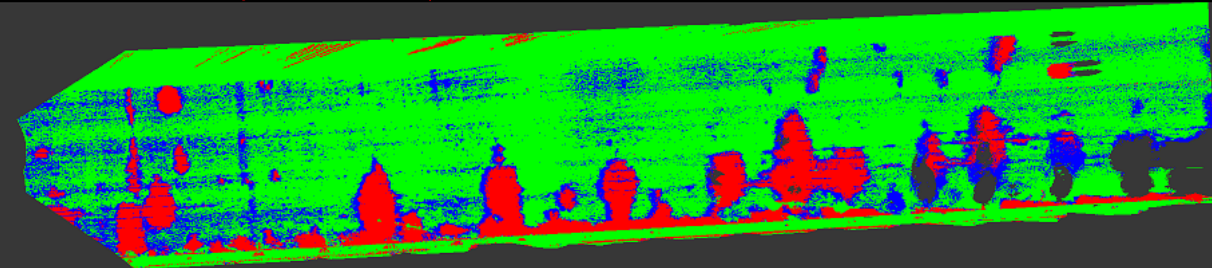
Depth of Hydro demolition (difference from original surface)
Segment 206
Green: Depth of 3/4 inch or less
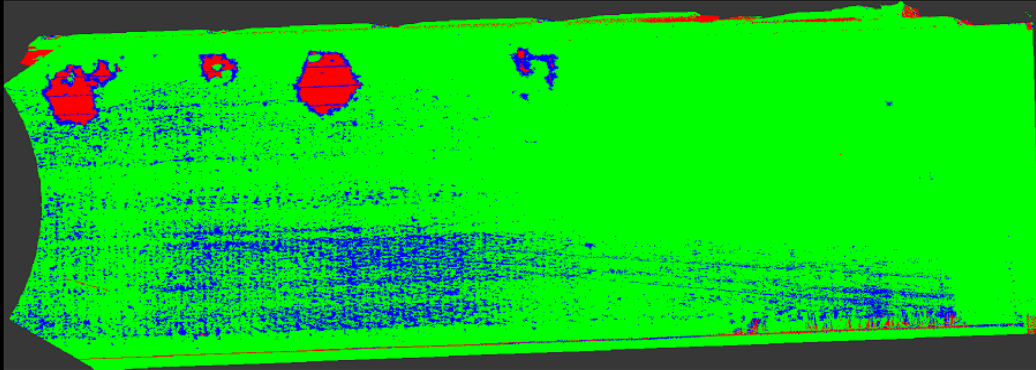Blue: Depth of 3/4 inch to Top of Rebar
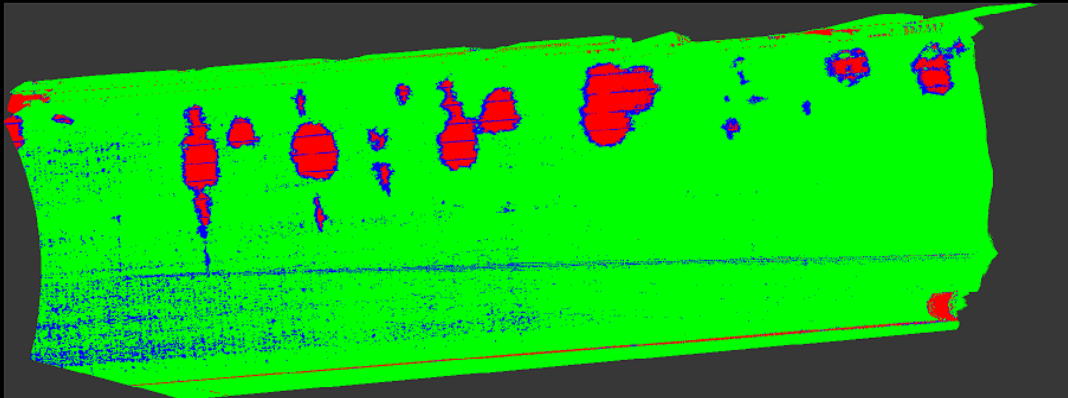Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 207
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar
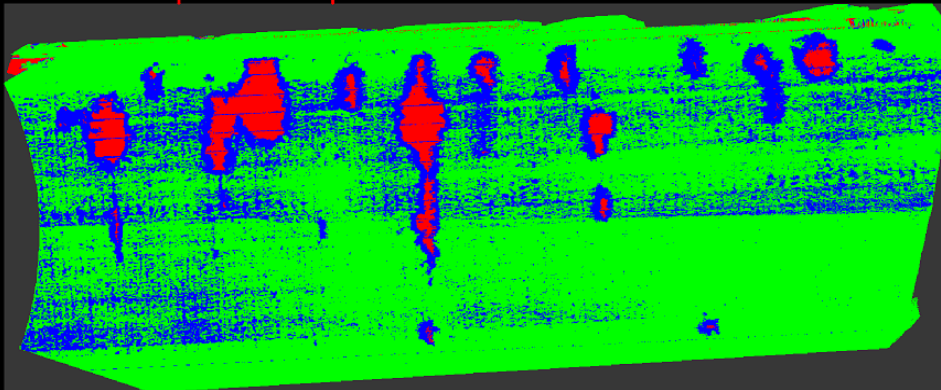

Depth of Hydro demolition (difference from original surface)
Segment 208
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)

Segment 209

Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
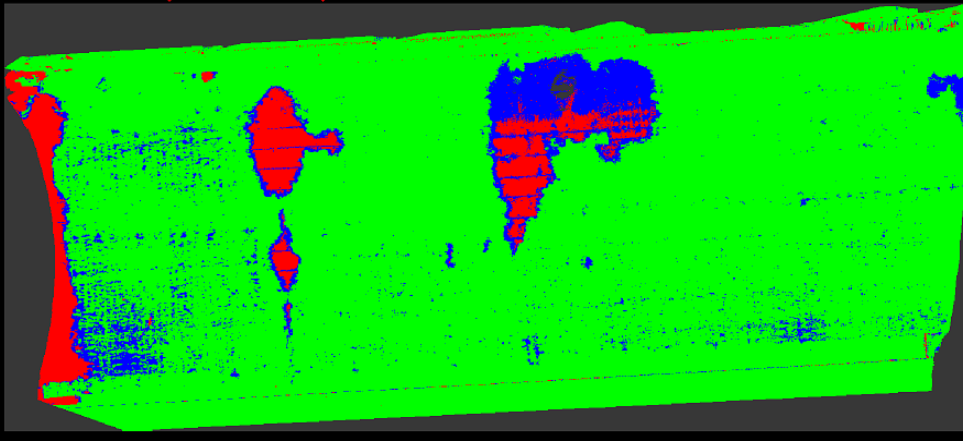Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)

Segment 210

Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)

Segment 211

Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
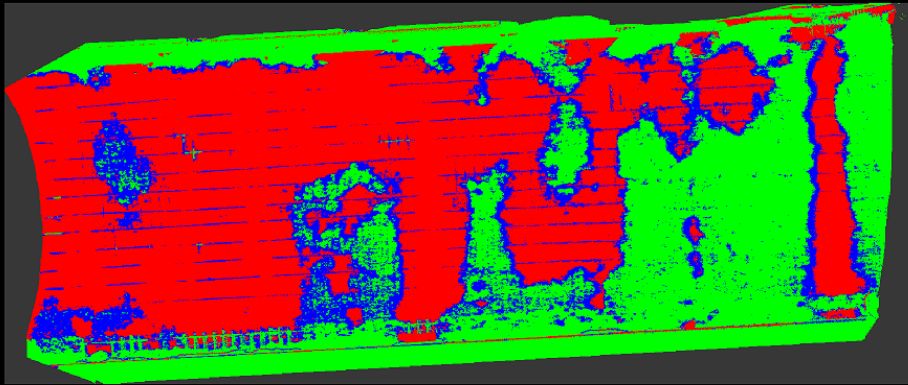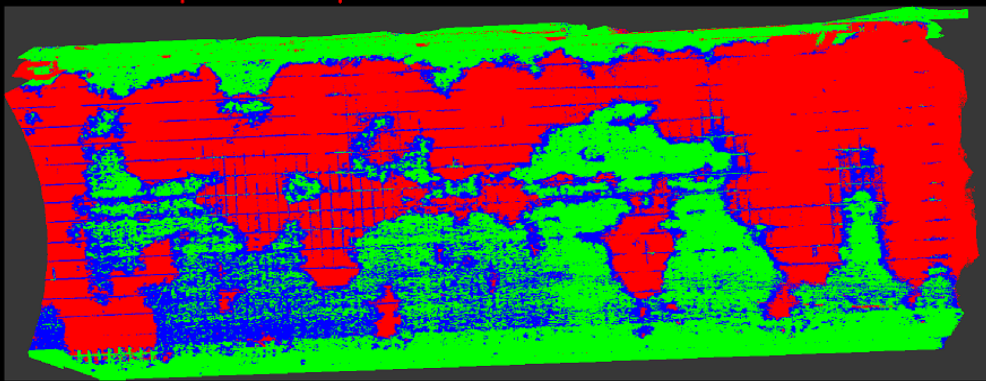Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 301
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar
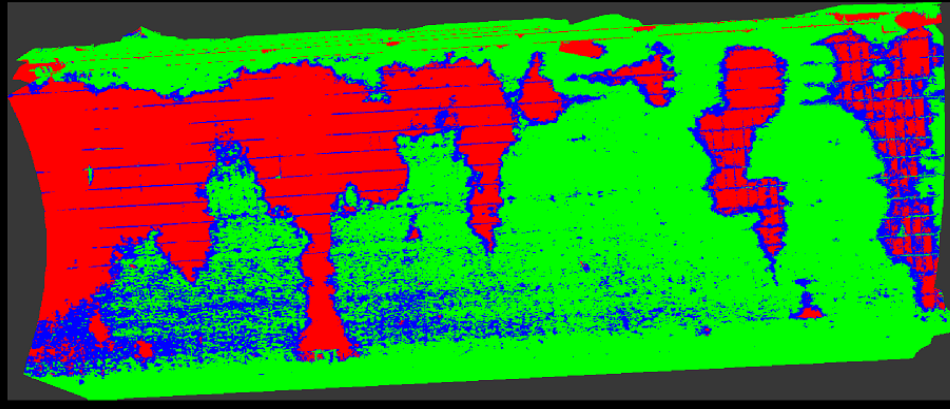
Depth of Hydro demolition (difference from original surface)
Segment 302
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 303
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 304
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
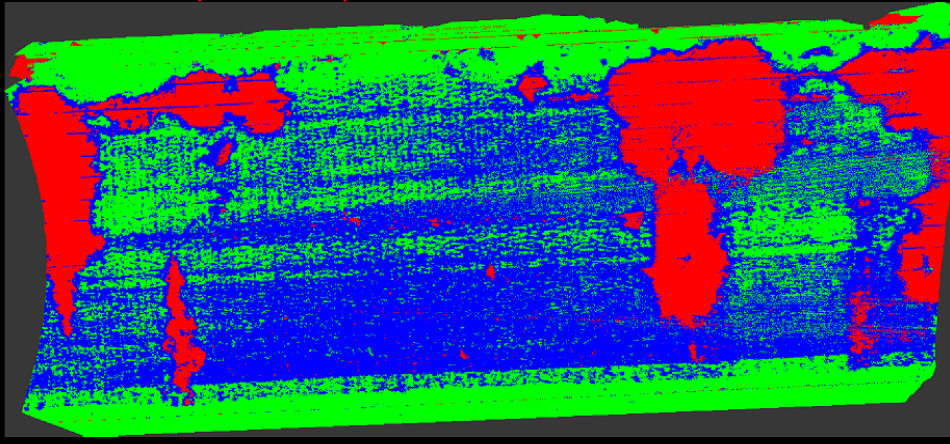Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 305
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar
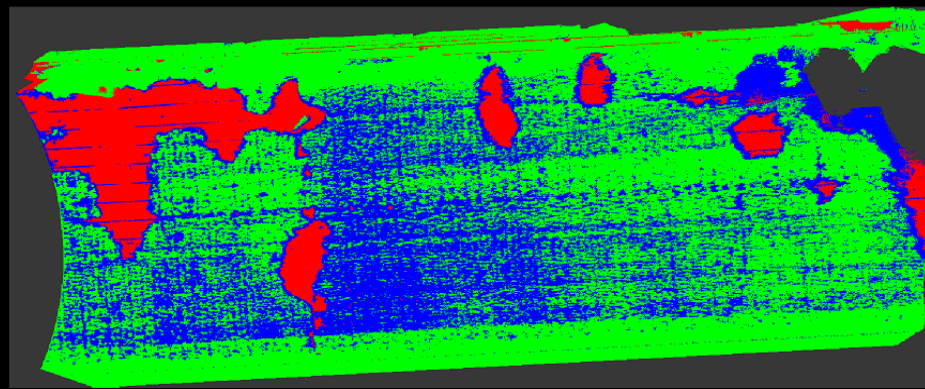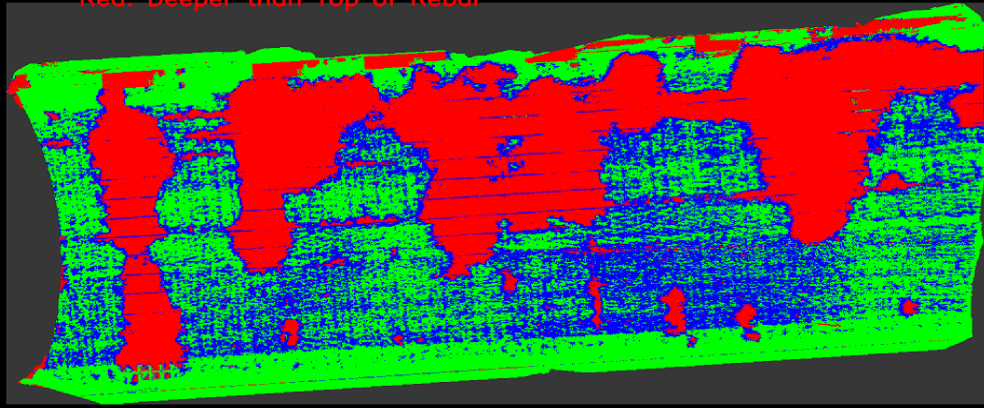

Depth of Hydro demolition (difference from original surface)
Segment 306
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 307
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 308
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 309
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
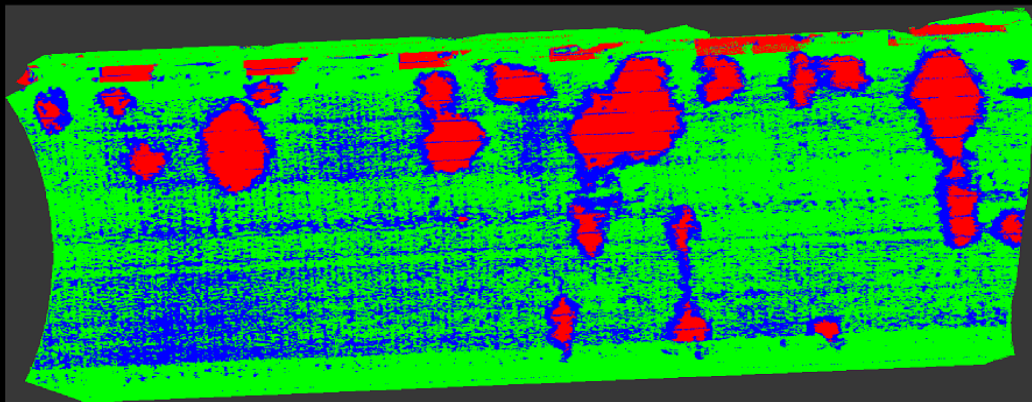Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 310
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
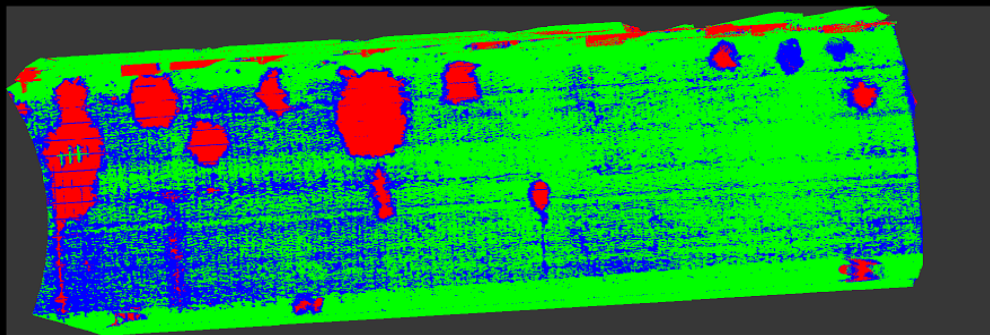Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 311
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
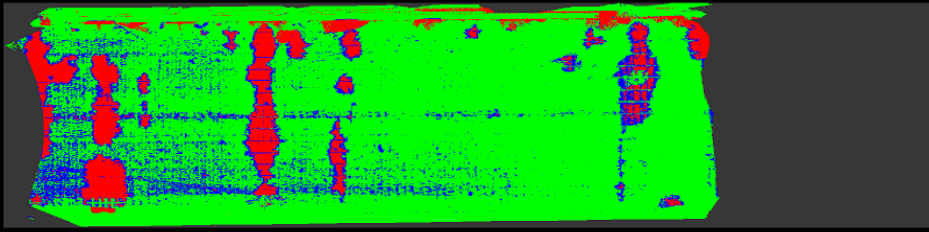Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 312
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
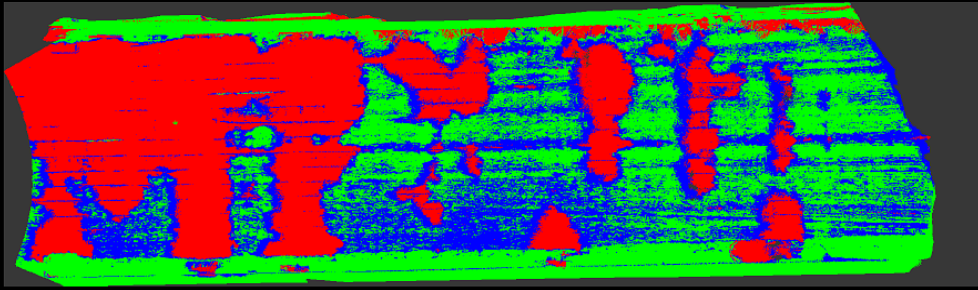Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 313
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
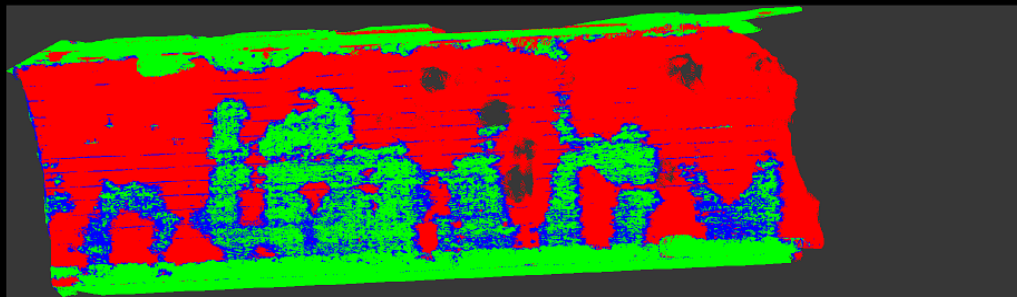Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 314
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 315
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
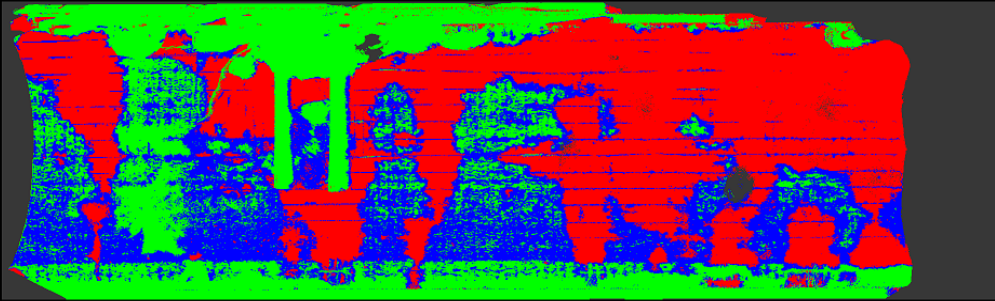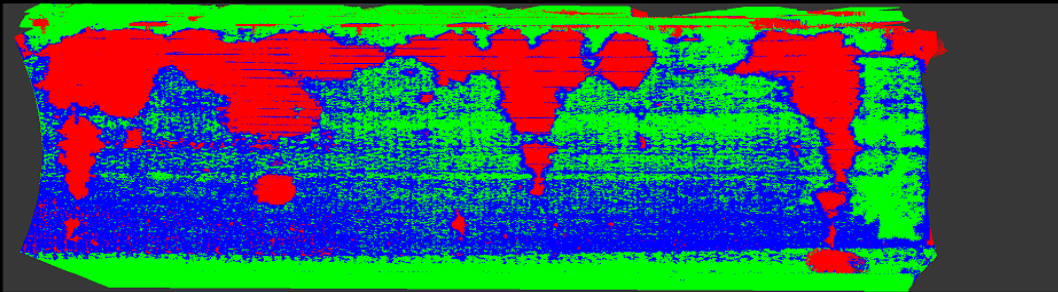Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 316
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 317
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar
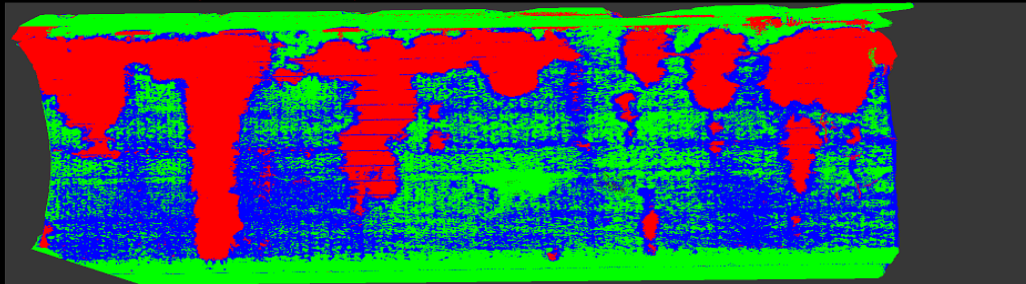

Depth of Hydro demolition (difference from original surface)
Segment 318
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 319
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar

Depth of Hydro demolition (difference from original surface)
Segment 320
Green: Depth of 3/4 inch or less
Blue: Depth of 3/4 inch to Top of Rebar
Red: Deeper than Top of Rebar