Determining the Depth of Hydro Demolition using Lidar Methods

by

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# Technical Report Documentation Page

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<td>Missouri S&amp;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.</td>
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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 ≤ ¼ inch or less in depth: 57.7%
- Average percent of area > ¼ 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 ≤ ¼ inch or less in depth: 64.3%
- Average percent of area ≤ ¼ 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 ≤ ¼ inch or less in depth: 30.2%
- Average percent of area ≤ ¼ 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 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 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 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