The Ohio Department of Transportation
Office of Research & Development
Executive Summary Report

Monitoring of Bridge Abutment Walls at SR 33 over East State St. (Athens, Ohio)

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Background

ODOT District 10 personnel noticed signs of on-going problems (cracks, backfill washout) on the bridge abutment walls existing at the SR 33 bridge over E. State St. in Athens, Ohio (shown in Figure 1).

The Ohio Research Institute for Transportation and the Environment (ORITE), Ohio University, received a contract to monitor the field performance of these abutment walls because of its past experience in monitoring abutment walls and the project site's close proximity to the Ohio University campus. The ORITE researcher utilized a sensitive tilting measurement system to record the rotational movements of the abutment wall panels existing the site at least monthly. Also, other methods such as cone penetration tests (CPT) and visual inspection technique were employed to obtain additional data to both verify the findings reflected in the tilt-meter sensor readings and/or gain further insights into the conditions existing at the project site.

Project Tasks

- Make a reconnaissance trip to the project site. Examine the existing site conditions and develop details of the field monitoring plan.

- Establish tilting monitoring stations on the abutment walls. Perform initial data

collection.

- Continue collecting the field data, even while the rehabilitation work is in progress.

- Perform CPT sounding of embankment soil fill behind the north abutment wall, at locations recommended by ODOT District 10.

- Issue a final report, which summarizes all the data collected and the findings made during the project.

Visual Inspections

Visual inspection of the abutment wall facings were made at the beginning, a mid way through, and at the end of the project to document the locations and nature of hairline cracks and other structural distress, using hand sketches and digital photographs.

Tilt Angle Measurements

An accelerometer-based tilt measurement system (Digi-Tilt by Slope Indicator, Seattle, Washington; shown in Figure 2) was utilized to measure accurately the degree of tilt of each abutment wall panel. Figure 3 shows the general locations of the ten (10) measurement stations.

Additional Field Measurements

In addition to the tilt measurements taken by the sensor, a set of manual measurements were taken at the top of the abutment walls (shown in Figure 4) to detect joint movements taking place within the upper sections.

CPT Soundings

CPT sounding (seen in Figure 5) was conducted in October 2004 to collect high-resolution subsurface exploration (including tip resistance, sleeve friction, and pore water pressure) data for the highway embankment fill material at three locations behind the north abutment wall.

Field Monitoring/Test Results

Visual Inspections At the beginning of the project, one or two major vertical hairline cracks were detected on each abutment wall panel, in addition to signs of backfill soil washout at their joints. No horizontal hairline cracks were observed anywhere. The visual inspection conducted a mid way through and at the end of the project detected no changes in the conditions of the abutment wall structures.

CPT Soundings CPT sounding of the highway embankment fill material was performed at three (3) locations behind the north abutment wall. No apparent shear failure planes or zones of seepage flow were detected during the CPT sounding.

Tilt Angle Measurements Tilting of the ten (10) abutment wall panels was monitored using the Digi-Tilt system. The collected data showed that most of the abutment wall panels remained stable during the two-year monitoring period (see Figure 6). Only the wall panels N-1, N-3, and S-1 experienced small rotational movements during the early stage of the project. The manual measurements taken at the top of the abutment wall panels confirmed the outcome reflected in the tilt angle measurements.

Conclusions

The initial site visit identified one or two major cracks running vertically on each panel, and signs of soil infiltration were also noted at some wall joint sections on the north side of East State St.

The high-resolution CPT soundings data collected on Oct. 20, 2004 identified mostly dry silty clay soil in CPT Hole #1 and relatively soft and wet soils in CPT Holes #2 and #3.

The tilt-meter readings collected during the project showed that most of the abutment wall panels had remained stable over the two-year period. Only the abutment wall panels N-1, N-3, and S-1 experienced small rotational movements initially. The manual measurements taken at the top of the abutment walls suggested that the abutment wall panels N-1, N-5, S-1, and S-5 might have moved slightly during the initial period. The visual inspections conducted on April 25 and Aug. 16, 2006 identified no new cracks on the abutment wall panels at the site. These facts point out that these bridge abutment walls have been very stable during the life of the current project (which also included the abutment wall performance in the post-rehabilitation work period).

Recommendations

The site conditions observed during the first year of the project suggested the following remedial actions to be taken by ODOT: water-proving the abutment wall front faces; complete reconstruction of the end sections of the bridge deck; installation of upgraded drainage system under each end section of the bridge deck; complete reconstruction of the sidewalk on the north side of East State Street; installation of drain gutter along the edge of the sidewalk on the north side of East State Street; and filling of the joint gaps existing between abutment wall panels. Most of these remedial actions were taken during the actual rehabilitation project, which lasted from March to September of 2006.

Implementations

The following implementation plans are recommended by the author:

- There is no need to perform major reconstruction or rehabilitation work on the abutment walls.
- Additional horizontal drains may need to be integrated into the existing embankment structure. The horizontal drains installed during the summer of 2006 appear to have very limited capability to drain the embankment soils.
- The gap existing between the wall panels should be filled with suitable durable joint material to prevent further loss of backfill soil.
- There will be no need to keep monitoring the movements of the abutment walls with tilt-meter system in the future. The bridge and wall structures should be inspected occasionally by the ODOT District personnel. The sensor monitoring should be resurrected only if additional signs of possible wall movements are detected.

Figure 1: General View of Project Site

Figure 2: Digi-Tilt Sensor System

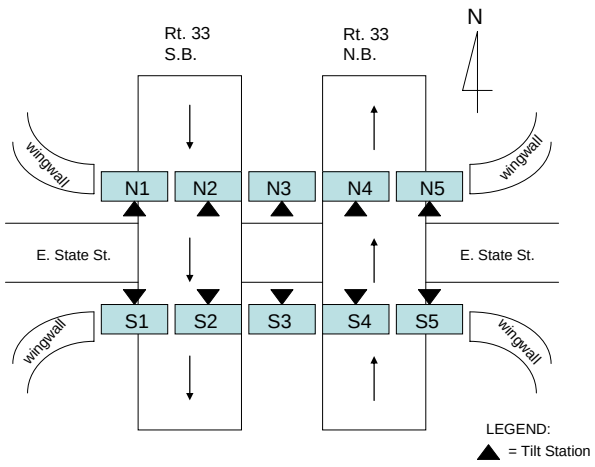

Figure 3: Locations of Tilt Stations

Figure 4: Manual Measurements Taken at Top of Abutment Walls

Figure 5: CPT Sounding of Highway Embankment Fill

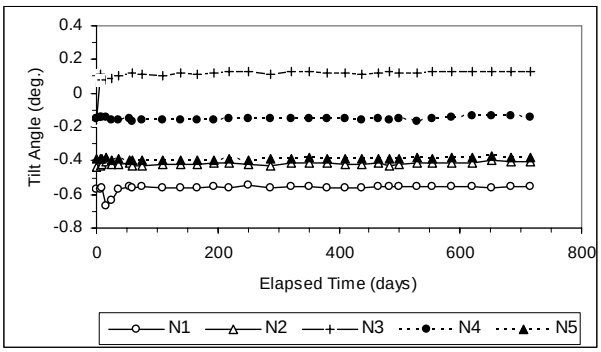

Figure 6: Tilt Angle vs. Time for Abutment Wall Panels on North Side