Pressure Distribution Around A Metal Pipe Under Deep Cover - By: Dr. Shad Sargand, Ohio University

Structural plate corrugated metal pipes have been used in engineering since 1931. The popularity of these structures has increased dramatically over the years, largely due to design improvements made on corrugated metal plate pipes such as keyhole slots, larger diameters, and irregular shapes. Structural plate corrugated metal pipes present a lower cost option for spanning streams, creeks, and ravines than bridges. There has been an increasing trend to use the pipes in deep-fill installations, and it is no longer uncommon for deep-burial installations to reach a depth of 75 feet or more. Although the use of corrugated metal plate pipes has been increasing slowly in the eastern United States, these pipes are currently used most widely in the western states. The mountainous terrain in these states often requires that pipes used for bridge structures have substantial amounts of fill over the crown.

During design of State Route 124 in Meigs County, Ohio, consultants initially recommended building a bridge at an estimated cost of more than $5 million. After review of this recommendation, Production Engineer Saleh El-Dabaja and his team at ODOT District 10 suggested the possibility of using a pipe as a more economical alternative at this site. Since the pipe was under an unusual height of cover, ODOT personnel decided to require long-term monitoring of deflection and pressure around the pipe.

In the fall of 2001, a large-diameter corrugated steel plate pipe was installed as part of the new road (see photo above). It was the first of its type installed in southeastern Ohio. The pipe cost $1.1 million, plus $0.5 million in labor to place the embankment fill, for a total cost of $1.6 million. Compared to an equivalent bridge structure, there was an estimated savings of at least $3.4 million (68%). The pipe had a nominal diameter of 21 feet (6.4 m) with approximately 75 feet (23 m) of embankment fill over the crown of the pipe. The pipe was 439 feet (134 m) long.

The Ohio Research Institute for Transportation and the Environment (ORITE) evaluated the structural performance of the pipe. The evaluation consisted of monitoring and modeling the stresses and deformations experienced by the pipe during and after construction. Vibrating wire earth pressure sensors were placed around the pipe during construction to measure the soil pressure at the top and sides of the pipe.

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OPREP 2006 - Call for Problem Statements

The Ohio Department of Transportation’s Office of Research and Development is now accepting problem statements for the ODOT Partnered Research Exploration Program (OPREP). The OPREP Program was created to:

♦ Consider relevant transportation research needs that may not have been identified by ODOT and included in our Strategic Research Plan.
♦ Encourage genuine partnerships within the research community.
♦ Recognize that while ODOT research needs are primarily of an applied nature, support of some basic research is critical to the long-term success of transportation research.
♦ Provide an opportunity to demonstrate the viability of innovative concepts and their potential to address long-range transportation needs.
♦ Leverage research funds and resources.

$100,000 is available for fiscal year 2006 for OPREP projects. Depending on the estimated budgets of the OPREP problem statements, funds may be awarded to one or more projects.

To qualify as an OPREP project, the duration of the project must be no longer than 15 months, which includes 3 months for the review of a draft final report and preparation of the final report. The proposing research agency is required to provide a minimum 50/50 match of the funds requested from ODOT. No more than one-half of the matching funds can come from in-kind donations from the proposing agency. Tuition and fees for graduate students cannot be used as a cash match; however, salaries, stipends and benefits paid to these students can be used as cash matching funds. Salaries, wages, and benefits for all other research personnel and their subcontractors are considered in-kind matching funds. Overhead/indirect costs and fees are considered in-kind contributions. Discounts on purchases are considered in-kind contributions. Expenses incurred prior to the start date of the contract are ineligible for consideration as matching funds. Depreciation on equipment, etc. is ineligible for consideration as matching funds. At least one other partner unaffiliated with the proposing agency must agree to support the project. All partnership agreements and funding commitments need to be established before a problem statement is submitted. Time extensions may be granted for an OPREP project; however, no funding extensions are permissible.

Formatting requirements and submission guidelines for OPREP problem statements are available on our website (http://www.dot.state.oh.us/divplan/research/announcements/announcements.htm). Non-compliance with these guidelines will disqualify the submission from consideration for the program. The Department reserves the right to reject any or all submittals. The deadline for submissions is March 28, 2005 at 4:30PM.

Calendar of Events

March - 2005

March 25 - Deadline for abstract submissions for OTEC 2005 - For more information go to www.otecohio.org
March 28 - OPREP 2006 Problem Statements due by 4:30 PM

April - 2005

April - Quarterly Reports due on all active research projects
April 4-15 - ODOT Research Review Sessions - For more information contact Omar at 614-752-5274

May - 2005

May 31 - OPREP 2006 Recipients Announced

For information on TRB Sponsored Conference and Workshops go to http://trb.org/calendar
Pressure Distribution Continued

To measure deflection, the height and width of the pipe were measured at every other transverse seam at 24 ft (7.3 m) intervals using a telescoping rod and a surveying tape. The deflections were measured both during and after placing the backfill around the pipe. The pipe behavior was modeled on a computer using the CANDE-89 finite element modeling program.

Pressure monitoring over several months showed that the pipe had stabilized. There was some slippage in the joints that caused positive arching in the soil, which significantly reduced the pressure at the crown. The deflection measurements showed peaking behavior where the pipe’s vertical diameter increased by 2.0 inches (5.1 cm or +0.79%) and the horizontal diameter decreased by 1.9 inches (4.8 cm or -0.75%). After construction, the vertical diameter decreased under the weight of the fill by 8.2 inches (20.8 cm or -3.3%) and the horizontal diameter increased by 6.2 inches (15.7 cm or +2.5%). The simulation, while showing the right trends in the final diameters, showed that the model needs some refinement to accurately predict the deflections.

The increase in the horizontal diameter experienced by the pipe ranged from 2.4% to 2.9% at the end of construction, and the decrease in the vertical diameter ranged from 2.9% to 3.4%. Vertical soil pressure measured at the crown of the pipe ranged from 26.7 psi to 6.2 psi, and vertical pressure measured at the springline was 20.1 psi at the end of construction.

This installation and evaluation demonstrated that the practice of using deeply buried metal pipes as a substitute for bridges promises to reduce costs substantially. Researchers found that CANDE does not predict displacement and pressure of deeply buried pipes very accurately. When the deeply buried metal pipes are installed according to specifications with high quality backfill, then a very high backfill height can be sustained due to the arching phenomenon.

The 56th Annual Ohio Transportation Engineering Conference (OTEC)

OTEC, the largest statewide conference for transportation professionals, will be held October 27 - 28, 2005 at the Greater Columbus Convention Center in Ohio. Abstracts are now being accepted for consideration. The theme for OTEC 2005 is “Achieving Safer Roadways Through Engineering, Enforcement, Education, and Emergency Services.” Submissions pertaining to transportation policy, planning, design, construction, maintenance, traffic & operations, management, environmental, pavement & materials, finance and local government are welcome.

Guidelines: Submit an abstract of 150 words or less. Deadline for receipt is March 25, 2005. Include abstract title, author name, affiliation, address, phone number, and e-mail address. Abstracts are to be e-mailed to: terri.barnhart@dot.state.oh.us.

This year’s conference marks the sixth edition of the successful Student Sponsorship Program, which matches Ohio college/university students from transportation-related disciplines with leading organizations throughout the Ohio transportation industry. For more information on this program contact Lisa Hall at lisa.hall@dot.state.oh.us.

Check out the OTEC website, www.otecohio.org, for updated information on the conference.
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If you have any suggestions, comments, or ideas for articles, please submit them to: research@dot.state.oh.us

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