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Relevant OPS:
OPSS 410, 421, 501, 514 and 1004
OPSD 802.030 to 802.034
OPSD 807.01, 807.03 and 807.04

Specifications for designs and installations of drainage pipes in Ontario are provided in various Ontario Provincial Standards (OPS). These specifications (OPSS) represent the best practice and have been widely and successfully used in Ontario. However, like most other specifications on buried pipe, the OPSS are based on the Marston-Spangler theory for earth loads in trench and embankment installations. The recent development of the direct design method for rigid concrete pipe and its bedding systems - Standard Installations Direct Design (SIDD) method - has not been incorporated in the OPSS. There is a pressing need to review and update the relevant specifications and drawings on rigid concrete pipe in OPS so that cost-effective designs and installations can be achieved.

The Ontario Concrete Pipe Association, Ontario Ministry of Transportation, the Region of Ottawa-Carleton (RMOC) and the Institute for Research in Construction (IRC) at the National Research Council of Canada (NRC) have undertaken a collaborative research project on the performance of a concrete pipe installed using the SIDD method. The objectives of this project are to verify the application of the SIDD method in typical climatic conditions encountered in Ontario, and to provide recommendations for updating the relevant OPSS.

As part of the overall project, type 2 and type 3 SIDD installations were included in a 1,350 mm (54") diameter culvert installation under a regional road on the outskirts of Ottawa. The average cover depth was about 1.5 m.

The concrete pipe was manufactured by M-Con Products Inc. in Carp, ON. and donated through OCPA. Prior to casting, strain gauges were fastened to the reinforcing cages and the cables were run between the cages to the connection boxes for protection during casting (Photo right). These two instrumented pipe sections were laid on either side of the road centreline, separated by a regular pipe section. Granular 'A' material was used for bedding and backfill up to the springline for the entire culvert, however, the degree of compaction was carried out according to type 2 SIDD specification on one side of the road centreline and type 3 on the other. The trench above the springline was backfilled with the excavated native soil.

On each test pipe, five earth pressure cells were installed on the pipe surface to measure normal pressures at the maximum and minimum points in the Heger pressure distribution. In addition, four earth pressure cells were installed in the embedment soil at the top, springline and bottom to measure soil pressures that are perpendicular to normal pressures. The plane of the pressure cells corresponds to the plane of the embedded strain gauges for both test pipes.

Vertical thermocouple arrays were installed at the pipe centerline and on the side at the springline of both test pipes. Three thermal conductivity probes and three TRD probes were also installed in the pipe embedment soil. These sensors will provide information on thermal loading that may play an important role in the performance of the pipe installed using the SIDD method, and moisture content in the backfills.

All the installed sensors are connected to and controlled by two on-site dataloggers that are housed in an instrumentation box provided by RMOC. Remote communication with the monitoring system is established via a modem. Surface settlement survey is scheduled to take place four times a year.

The intended monitoring period is three years starting in August 2000. The data obtained for the first three months indicates that the system is working properly. The project is expected to provide useful data on strains in the concrete pipe, on external loads, and on thermal performance of the pipe-soil system. The results of this in-situ performance monitoring will provide a better understanding of the pipe behavior and pipe-soil interaction, and will be used to verify the predicted performance of the SIDD method. The report on the site instrumentation will be submitted in the spring of 2001.

Instrumentation Details:
- embedded strain gauges: 40
- embedded thermocouples: 12
- earth pressure cells: 18
- TDR probes: 3
- thermal conductivity probes: 3
- thermocouples in soil: 38
- surface survey pins: 35
- piezometer: 1

The NRC research team is assisted by the steering committee members – M. Ayton and H. Farghaly of MTO, P. Smeltzer of OCPA, M. Lalonde of M-Con, V. Sahni and W. Gryz of RMOC, and B. Rajani of NRC. Collaboration of the NRC team with R. Perry, J. Dasilva of RMOC, and Drummond's work team (the contractor) made the implementation of the performance monitoring system a success.