MEASUREMENT OF BACKFILL EFFECTS ON CIRCUMFERENTIAL BENDING IN LINED-CORRUGATED THERMOPLASTIC PIPES AND FIBRE REINFORCED CEMENT PIPES

by

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ABSTRACT

Large scale laboratory testing and analyses have been conducted on a number of different pipe products using a variety of different backfill conditions. Six tests were performed on 600 mm nominal diameter lined-corrugated thermoplastic pipes (HDPE – high density polyethylene and PVC - polyvinylchloride) and two tests were performed on 381 mm nominal diameter fibre reinforced cement pipes (FRC). All testing was conducted in a 2.0 m wide by 2.0 m long by 1.6 m high soil box at overburden pressures of up to 200 kPa and 550 kPa for HDPE/PVC and FRC pipes respectively through a pressurized air bladder.

Limit states design procedures are being developed by the American Association of State Highway and Transportation Officials (AASHTO) to guide thermoplastic pipe design. Design calculations must include the evaluation of maximum circumferential and local bending strains that develop in the profile wall of the pipe as a result of non-uniform soil support. Maximum bending strains can be estimated through scaling bending deflections by a semi-empirical strain factor, D_f. Deflections and strains were measured and a strain factor, D_f, back-calculated for six large scale thermoplastic pipe tests to provide additional input with regards to bending strains for these types of pipe.

HDPE and PVC pipes were backfilled with three different burial conditions (compaction with rammer, compaction with plate tamper, and rigid base with loose sand up to springline and compaction above) and two soil types (high stiffness and low stiffness).

The largest strain factors, D_f, were observed on the PVC pipe buried in a high stiffness backfill and compacted with a plate tamper. Strain factors for pipes tested in the low stiffness soil were at or near a value of D_f equal to 3 which corresponds to the elastic pipe-soil interaction solution for uniform soil support. The largest local bending was found to occur in three areas of the pipe; the springline, the invert, and the haunch.

Measured deflections and circumferential strains are also reported for two 381 mm nominal diameter fibre reinforced cement pipes. These pipes were saturated with water and then tested under simulated embankment conditions to determine the effects of different types of soil support on the structural integrity of the pipe. Hoeg (1968) theoretical calculations were performed and compared with measured deflections and strains. These demonstrated the "semi-rigid" nature of FRC pipe response, with decreases in moment below rigid pipe limits, in particular when buried in stiff backfill. Hoeg theory is an effective method for estimating both deflections and moments within the linear (rigid) range of fibre reinforced cement pipes.