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Depth Beyond Knowledge™

YU WANG, MASC (2013)

RESEARCH SUMMARY

USE OF SIMPLIFIED KINEMATIC APPROXIMATIONS TO DEVELOP CLOSED FORM DESIGN EQUATIONS FOR MAXIMUM ROTATION AND SHEAR FORCE ACROSS JOINTS

SOLUTIONS FOR JOINT RESPONSE TO WHEEL LOADS ON THE GROUND SURFACE

EVALUATION OF JOINT RESPONSE TO EARTH LOADS ARISING FROM NONUNIFORM SOIL SUPPORT

PARAMETRIC STUDY CONSIDERING BURIAL DEPTH, PIPE DIAMETER, AND SOIL STIFFNESS

MEASUREMENT OF ROTATIONAL AND SHEAR CHARACTERISTICS OF JOINTS USING A NEW TEST FRAME

HIGHLIGHTS

- **Performance testing of joints in corrugated steel, reinforced concrete and thermoplastic pipes**
- **Developed equations for use in culvert joint design in the AASHTO LRFD Bridge Design Specifications**
- **Now working for EBA Engineering in BC**

SIMPLIFIED DESIGN EQUATIONS AND LABORATORY TESTS OF PIPE JOINTS

The long term performance of culverts and sewers often depends on the effective design and installation of culvert joints. One of three graduates students working on National Cooperative Highway Research Project 15-38 'Structural design of culvert joints, Yu Wang made major contributions to the development of design equations for joints for both rigid and flexible culverts. Using simplified kinematic models for pipe response to vehicle and earth loads, beam-on-elastic-spring modeling was used to derive closed form solutions to estimate the key demands: the shear forces transferred across joints, and the rotations or bending moments that also arise. A parametric study was performed to assess the effects of pipe diameter, burial depth, and the soil and pipe stiffnesses. Comparisons with measurements of pipe response indicate that the equations provide the correct trends seen in the experiments of Becerril Garcia (2012), and they generally provide reasonable conservative estimates of expected demand for use in design.

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Yu Wang with Civil Technologist Graeme Boyd using the new pipe joint testing frame on corrugated steel pipe.

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TESTING FRAME TO EVALUATE CULVERT JOINTS

In addition to contributing to assessment of expected values of shear and bending, work was conducted to assess the capacity of corrugated steel, thermoplastic, and reinforced concrete pipe joints (their ability to accommodate shear force, and either bending moment or rotation between one pipe and the next). A specialized test frame (seen in the figure above) was developed to undertake shear force and articulation (bending) tests. Tests on each of three example pipes demonstrated that the example pipes each had the capacity to support demands expected for burial between 2 ft (0.6 m) and 20 ft (6 m). The tests also revealed that 'hugger band' connections used to join the corrugated steel test pipes featured significant compliance, so behaved more like a moment-release than a moment-transfer joint.

Reinforced concrete pipe responding to shear force.