

## ERIC POON, MASC (2015)

### RESEARCH SUMMARY

**STUDY TO UNDERSTAND JOINTED PIPE RESPONSE TO DIFFERENTIAL GROUND MOTION**

**VITRIFIED CLAY PIPES WITH GASKETED BELL AND SPIGOT JOINTS**

**FOUR SEGMENT PIPELINE ASSEMBLED AND TESTED**

**LINEAR POTENTIOMETERS USED TO MONITOR AXIAL AND ROTATIONAL JOINT MOVEMENTS**

**STRAIN GAGES ALSO INSTALLED TO MONITOR CURVATURES ALONG THE PIPE SEGMENTS**

**ACCELEROMETERS USED TO MONITOR ROTATION OF PIPE SEGMENTS**

### HIGHLIGHTS

- First measurements of jointed clay pipe responses to differential ground movements
- Joint monitoring system recorded joint extensions and rotations
- New test chamber developed to simulate ground faults
- Measurements confirm effectiveness of existing design equation

### VITRIFIED CLAY PIPE JOINT BEHAVIOUR UNDER DIFFERENTIAL GROUND MOVEMENT

Vitrified clay pipelines have historically been used for sanitary sewers in many cities. Long term performance can be limited by soil erosion resulting from joint leakage. However, no studies have previously been performed to investigate joint response in pipelines subjected to differential ground movements. The MASc project involved assembly of a test pipeline from four segments of 150mm diameter vitrified clay pipe. The three joints were monitored using linear potentiometers mounted under the crown, and adjacent to the two haunches, with movements analysed to infer joint rotations and extension or compression. Pipe segments were also fitted with accelerometers (slope indicators) so the pipeline motion could be monitored as the tests were conducted.

Experiments were undertaken for the pipe at two different burial depths within the olivine test sand. The measurements indicated that three of the four pipe segments remained largely horizontal, so that almost all of the differential ground motion was accommodated by rotation of the third pipe segment. Tests were conducted up to 30mm floor movement (settlement), at which point two of the joints had experienced rotations of about 1 degree, well within the limit recommended by the pipe manufacturer. The joint rotations are very effectively estimated using a simple design equation developed as part of previous research work.

Longitudinal pipe strains were measured at three positions along the crown and invert of each pipe segment, so the curvatures and bending moments resulting from the differential ground movements could be estimated. At completion of each test (when the rotational limits of the joints were reached), the tensile bending strains along the pipe barrels reached about half of the tensile strain limits expected for this vitrified clay material. Therefore, for this pipe in these burial conditions, the pipe segment lengths and joint conditions prevented ring fractures from developing in the barrels. Further studies are underway to investigate the development of joint leakage and the strength limits of these pipelines and the joints that connect them.

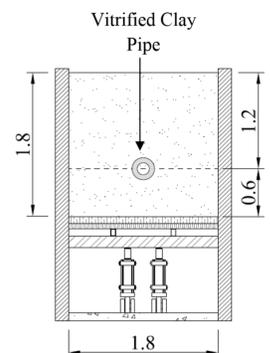
*Assembled pipeline installed in the test chamber prior to burial*



### TEST CHAMBER SIMULATING NORMAL GROUND FAULTS

A new test chamber was designed and constructed to generate differential ground movements associated with normal ground faults. Previous reduced scale work conducted in a geotechnical centrifuge by doctoral student Saiyar, was extended through development of a prototype-scale test facility of width 1.8m, depth 1.8m, and length 7.3m. While one half of the floor of the new test chamber is stationary, the other half is supported by four screw jacks that can be lowered in stages to impose differential settlements on the pipeline buried within. Working with doctoral student Pengpeng Ni, Eric designed the test chamber and assisted with construction and commissioning the facility. This test chamber is now being used to investigate a range of buried pipe problems.

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Chamber cross-section