

## JIANFEI YE, PHD (2008)

### RESEARCH SUMMARY

**PROJECT ON PVC PIPE FITTINGS FOR IPEX OF MISSISSAUGA ONTARIO**

**CALCULATIONS OF DOWNDRAW ON RISERS AND FITTING STRENGTH**

**MEASUREMENTS OF DOWNDRAW AND BENDING IN TEE AND WYE FITTINGS**

**3D FEA USING ABAQUS FOR FITTING STRENGTH AND LOADS**

**SIMPLIFIED ANALYSIS DEVELOPED TO PROVIDE EXPECTED DOWNDRAW FORCES**

**LARGE SCALE TEST ON STORMWATER DETENTION SYSTEM FOR BRENTWOOD.**

### HIGHLIGHTS

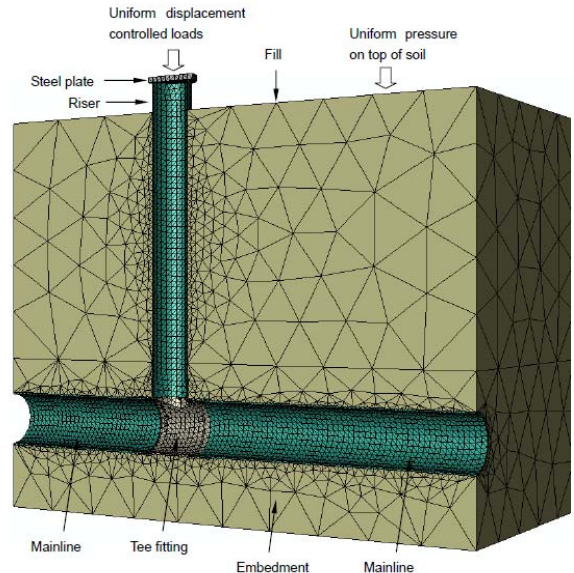
- First rational study of risers explains both demand on and resistance of these structures
- Unique measurements of stormwater detention system to establish stability under AASHTO axle loads
- Now with Gibson Associates (Ontario).

### DOWNDRAW FROM VERTICAL RISERS TO TEES & WYES

Contractors often use vertical risers for service connections into sewer pipes. However, down-drag from trench backfill produces large vertical forces that can damage the TEE or WYE fitting between the riser and the main sewer.

Jianfei Ye completed a PhD in 2008, which represents the first rational study of this problem. He used tests in the biaxial pipe test cell at Queen's and 3D analysis using ABAQUS to establish the expected loads on the fitting and the ability of the fitting to resist those loads. This combination of physical and computational modeling establishes new design procedures for estimating the down-drag forces and determining the nature of fitting failure. Tee fittings experience severe local bending and fracture at the point where the vertical cylinder intercepts the horizontal sewer pipe. Wye fittings were found to experience failure at the base of the vertical riser due to the eccentric nature of the applied loads. IpeX is working to redesign their fittings to withstand these loads.

The use of ABAQUS permits complex three dimensional geometry to be modeled, and consideration of interactions between the fitting, the riser, and the surrounding soil.



Three dimensional finite element analysis using ABAQUS to determine stresses and deformations .

#### Supervisor:

**Ian D. Moore, PhD, PEng, FCAE, FEIC**  
 Professor and Canada Research Chair in Infrastructure Engineering  
 moore@civil.queensu.ca tel: 613 533 3160

### STRENGTH OF STORMWATER DETENTION SYSTEM

Work for Brentwood Industries in 2007 involved unique tests to establish the strength of a new polymer stormwater detention system. Buried in the large scale buried test facility at Queen's, a new reaction frame and servo-controlled test system demonstrated that this infrastructure could support a fully factored AASHTO-CHBDC truck. Jianfei used a novel approach to measure loads in the polymer structure and explain load sharing at working and ultimate loads.



Data acquisition for Brentwood test