

NANCY AMPIAH, MSC (2008)

RESEARCH SUMMARY

SAMPLES USED FROM A CAST IRON PIPE REPAIR PROJECT IN HAMILTON

SPLIT-DISK TESTING USED TO STUDY EFFECT OF WRINKLES ON STRENGTH

EFFECT OF WRINKLE SIZE AND SHAPE ESTABLISHED

STATIC AND CYCLIC LOADS MODEL SUSTAINED AND SURGE PRESSURE EFFECTS

EFFECT OF LINER'S TEXTILE AND EPOXY COMPONENTS ESTABLISHED

USE OF FINITE ELEMENT ANALYSIS TO STUDY FRACTURE INITIATION

HIGHLIGHTS

- NSERC funding supported a team of students studying deteriorated pipes, and repair using liners.
- Tests reveal that wrinkles do influence strength, but design strength requirements are met by this system
- Both static and surge loads are satisfied.

For some time, trenchless installation methods have permitted lining of gravity flow sewers and culverts, restoring both hydraulic and structural integrity. However, it was not until recently that Sanexen of Montreal developed the first cast in place liner to repair Cast Iron water pipes. This innovative system permits lining, then reopening of customer connections using a remote controlled robot. This system is growing in use across North America.



Small access pits are excavated at either end of the cast iron water pipe to be repaired. A resin-impregnated tube is then pulled into place within the cast iron pipe. Hot water is used to cure the composite liner. However, variable inner circumference in the cast iron pipe leads to excessive liner circumference, and the liner wrinkles as it is pushed by the hot water out against the inner wall of the old pipe.

A review of the system for Hamilton City in 2004 revealed that wrinkles can form in these composite liners. Nancy Ampiah developed procedures to test the strength of wrinkled liner specimens cut from samples exhumed after the field trial in Hamilton. Resin fracture occurs first, and leads to reductions in hoop stiffness of the composite liner. These fractures invariably occur in the vicinity of the wrinkle. Loading rate had no effect on cracking load for the liner, but sustained load reduces the ultimate strength of the liner system. All liners tested had strength sufficient to resist the design loads.



The split disk test procedure from ASTM D2290 used to investigate strength of the wrinkled liner.

FINITE ELEMENT ANALYSIS OF COMPOSITE LINER USING ABAQUS

Nancy developed finite element models of the composite liner, with explicit representation of the textiles at the inner and outer surface of the liner, and the resin within. These models were used to investigate locations of stress concentration, and explore the ability of the analysis to model how wrinkle shape and size influence behaviour. Fracture in the resin corresponded to stress concentrations in the finite element analysis.

Supervisors:

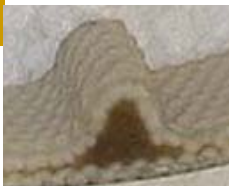
Amir Fam, PhD, PEng

Canada Research Chair in Innovative and Retrofitted Structures
 fam@civil.queensu.ca tel: 613 533 6352

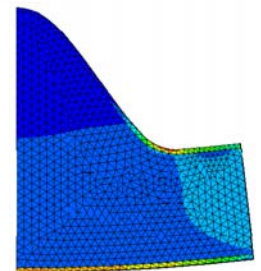
Ian D. Moore, PhD, PEng, FCAE, FEIC

Canada Research Chair in Infrastructure Engineering
 moore@civil.queensu.ca tel: 613 533 3160

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Resin infill and wrinkling of one or both textile components of the composite



Finite element model of the wrinkled liner