

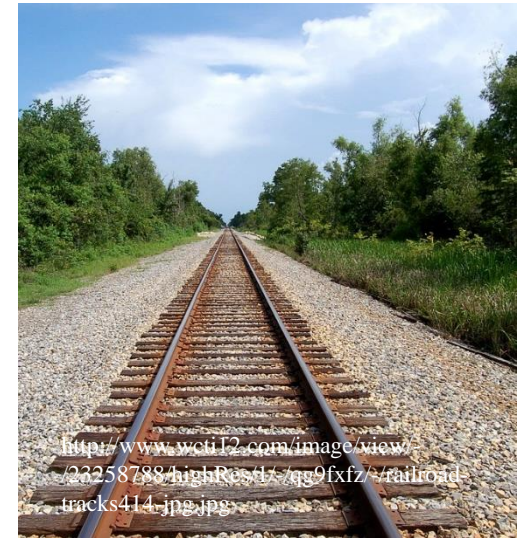
Measurement of Structural Stresses by Hole-Drilling and DIC

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Structural Stresses



- **Pre-tensioning**
- **Dead-loads**
- **Settling-loads**

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- **Settling-loads**

- **Temperature induced loads**



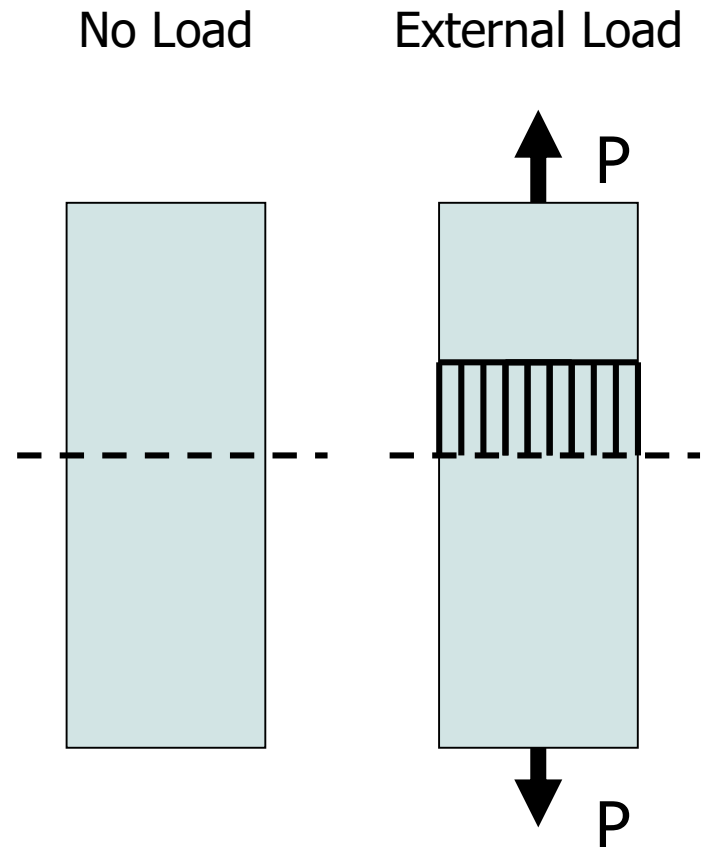
Load Measurement Types

1. Relative measurements

- ◆ for live loads



Photo: www.stockphotosforfree.com





Load Measurement Types

2. Absolute measurements

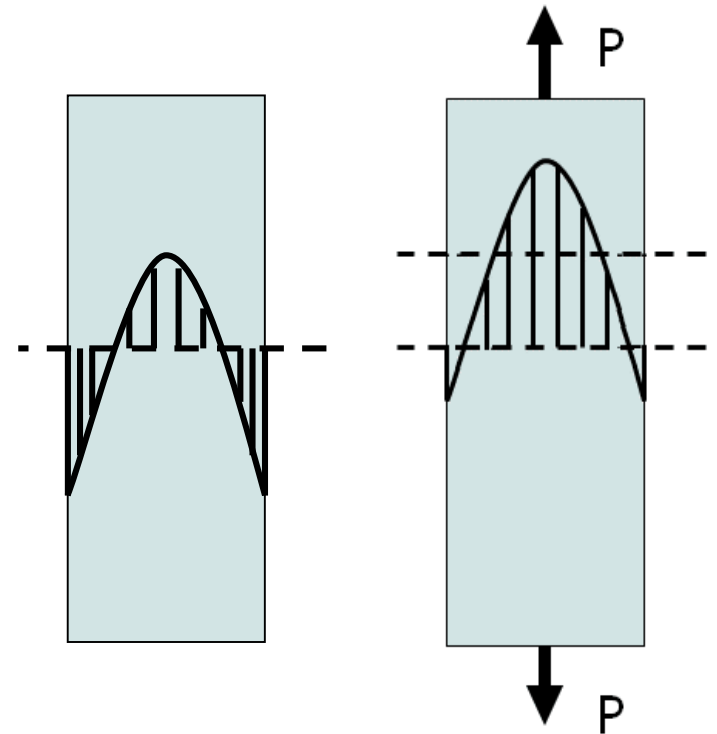
- ◆ for residual stresses
- ◆ also for redundant loads

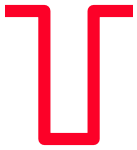


Photo: Ken Hircock - Flickr

Residual Stress

Load + RS





Residual Stress Measurements

Desired features:

- ◆ reliable and accurate
- ◆ measures general materials
- ◆ minimal structural damage
- ◆ suitable for field use

Chosen technique:

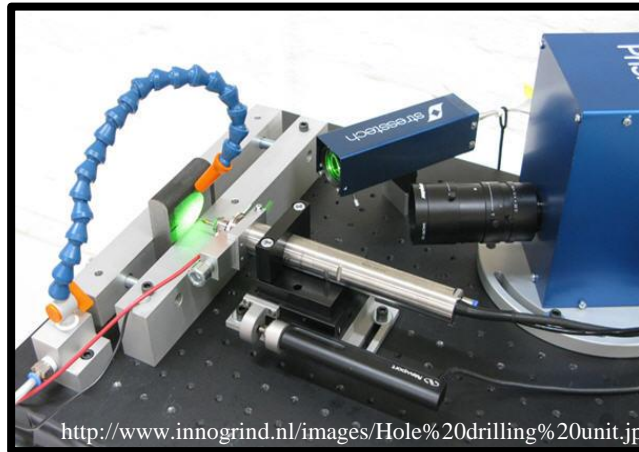
- ◆ hole-drilling method



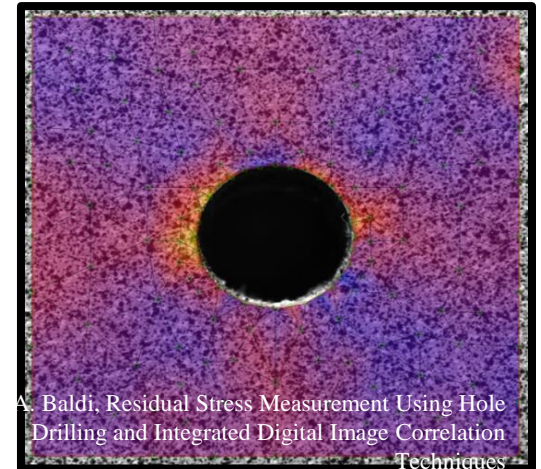
Hole-Drilling Method



STRAIN
GAUGE



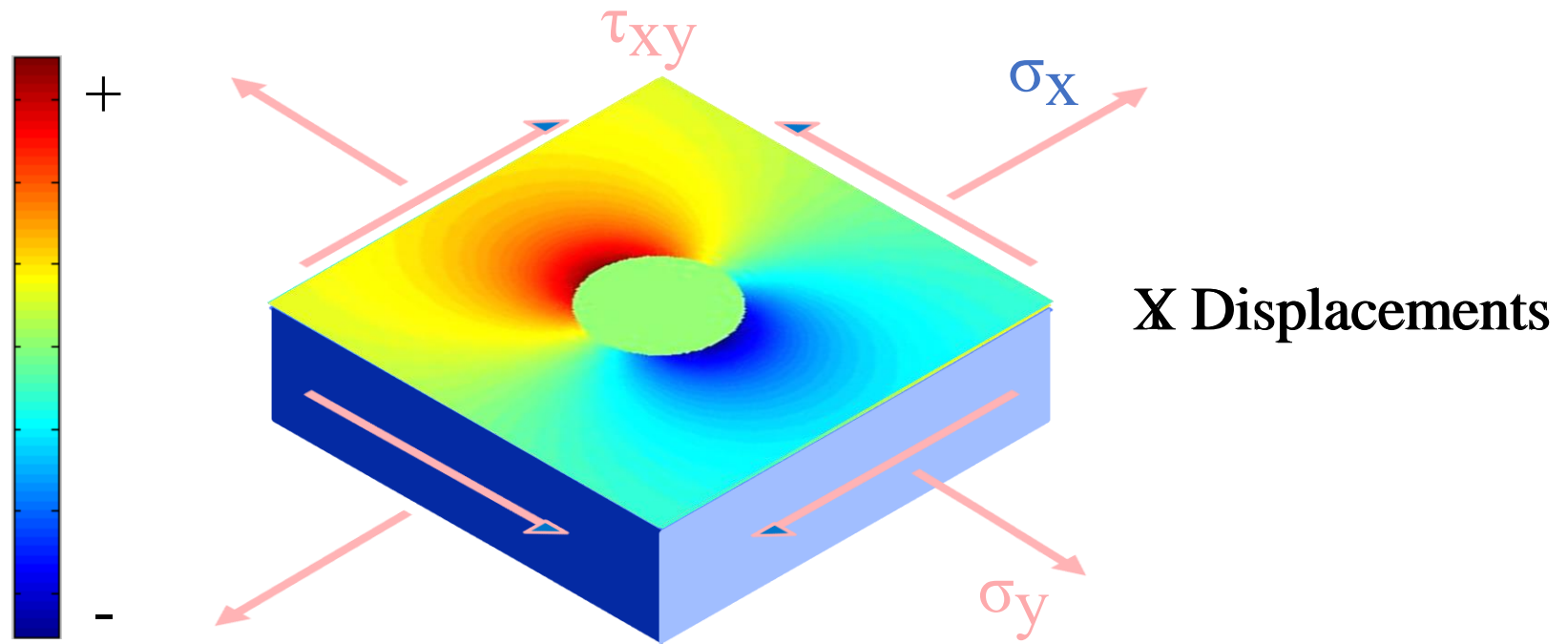
INTERFEROMETRY



DIGITAL
IMAGE
CORRELATION

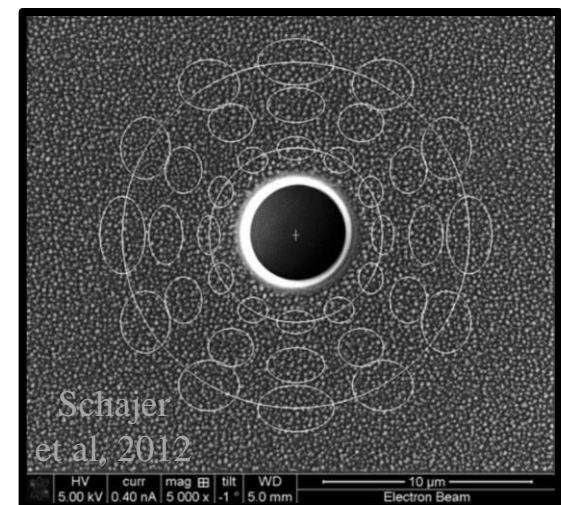
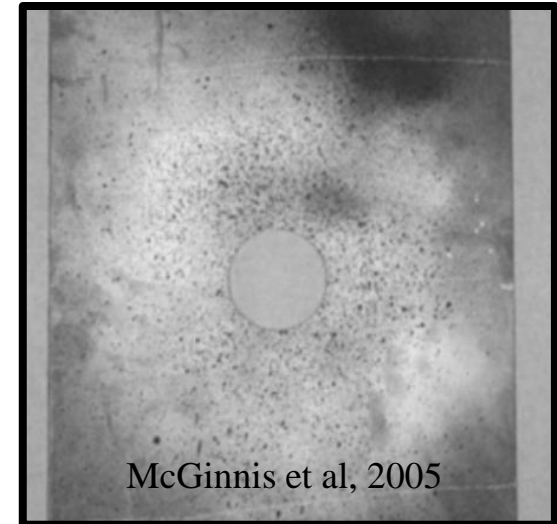


Hole-Drilling Method



U DIC Hole-Drilling

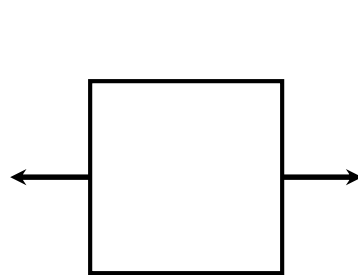
- non-contact
-- no strain gauges
- rugged for field use
- scale independent
- redundant data allows artifact correction



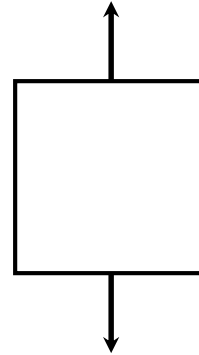


DIC Response Sources

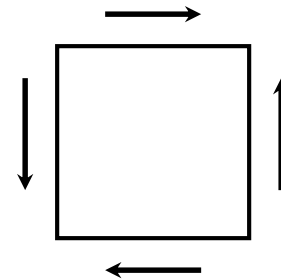
Stresses:



x-stress

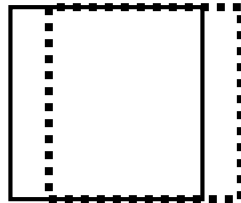


y-stress

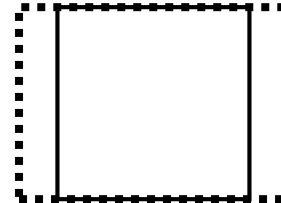


xy-shear

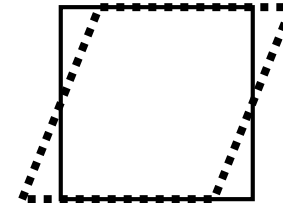
Artifacts:



x-displacement



x-stretch



x-shear



Practical Measurements



Annular Cutters

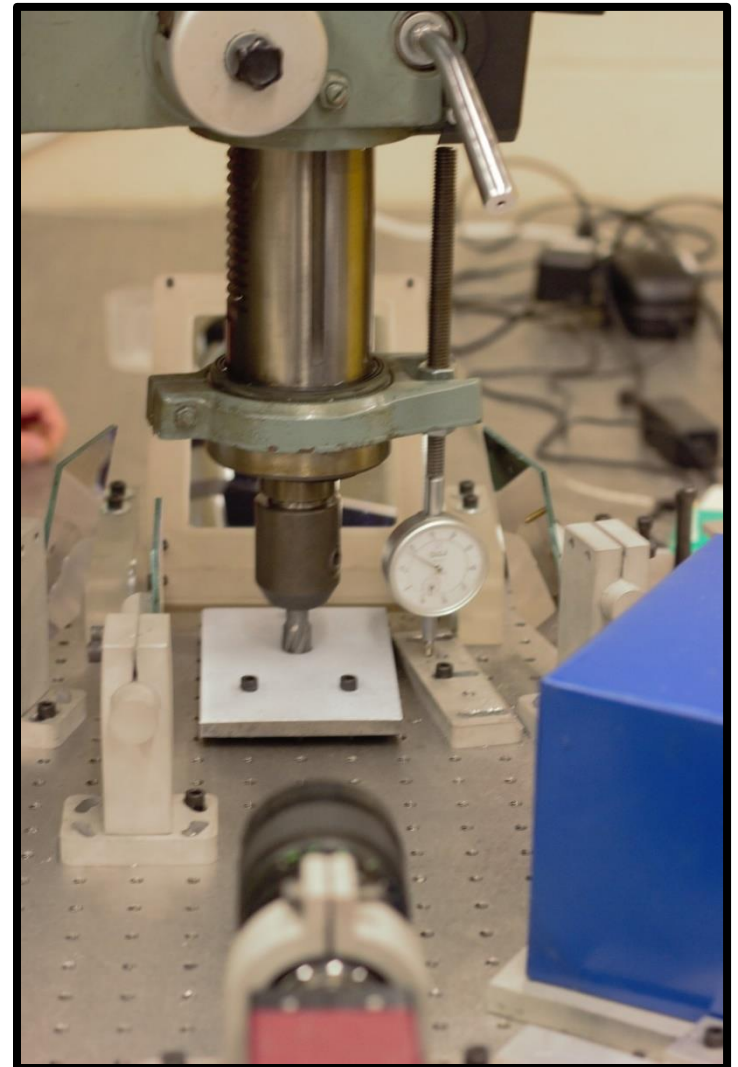


Mag Drill

U Experiments

Check for:

- Temperature artifacts
- Cutting stresses
- Axial load indication
- Residual stresses





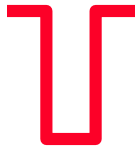
Experiments



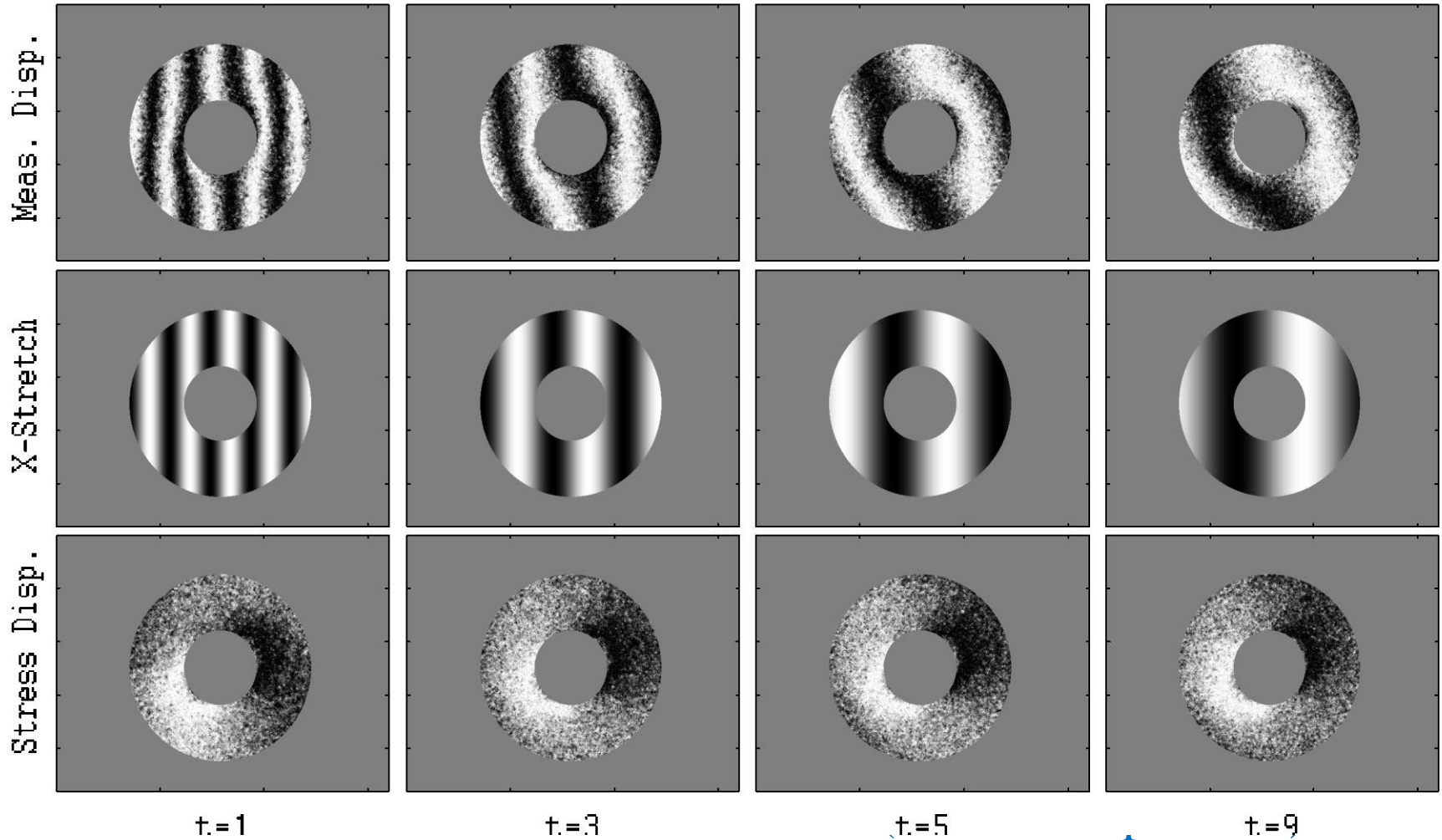
Compression
Loading

Specimen

Camera

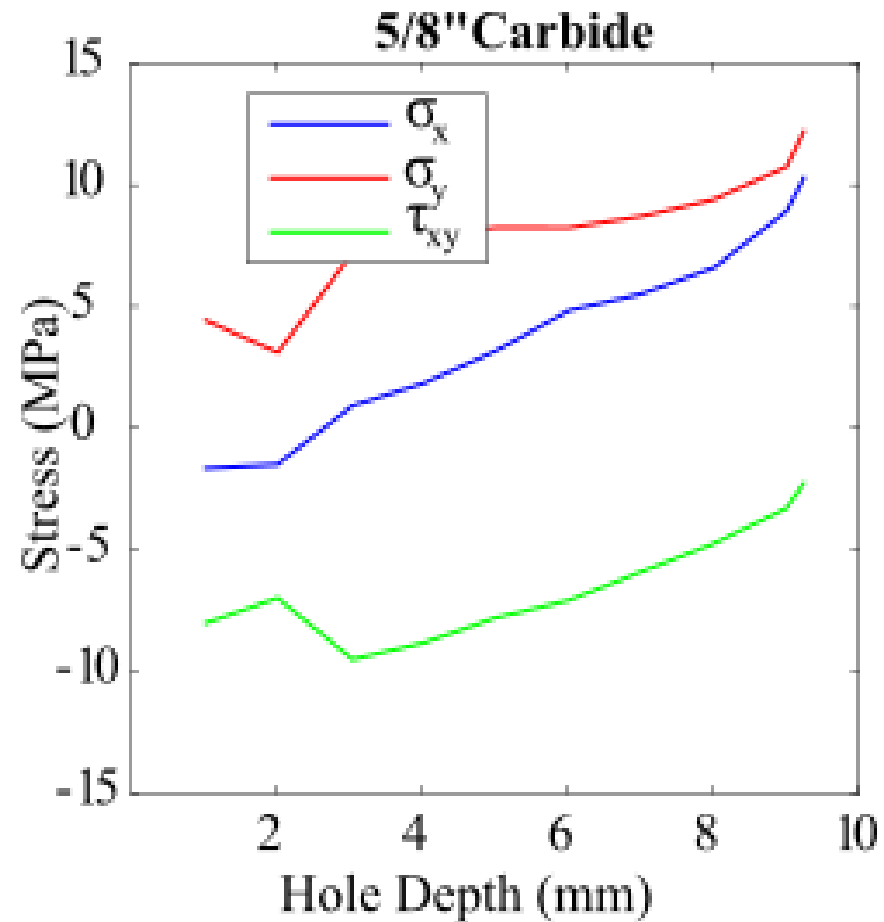
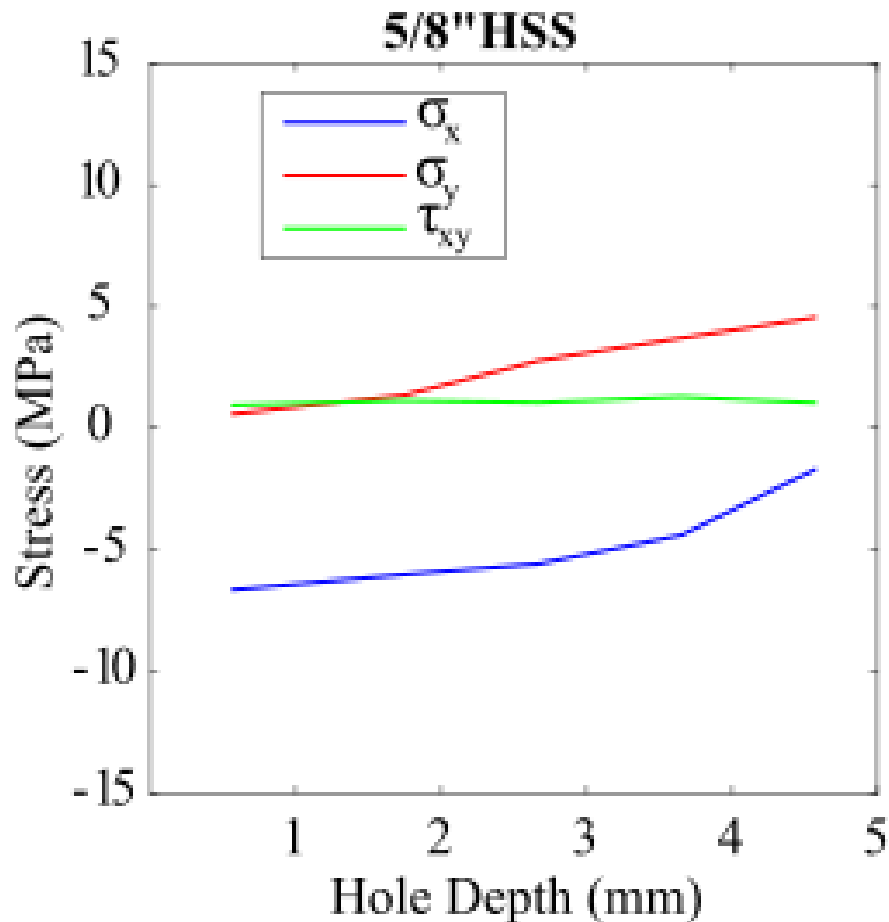


Temperature Artifacts



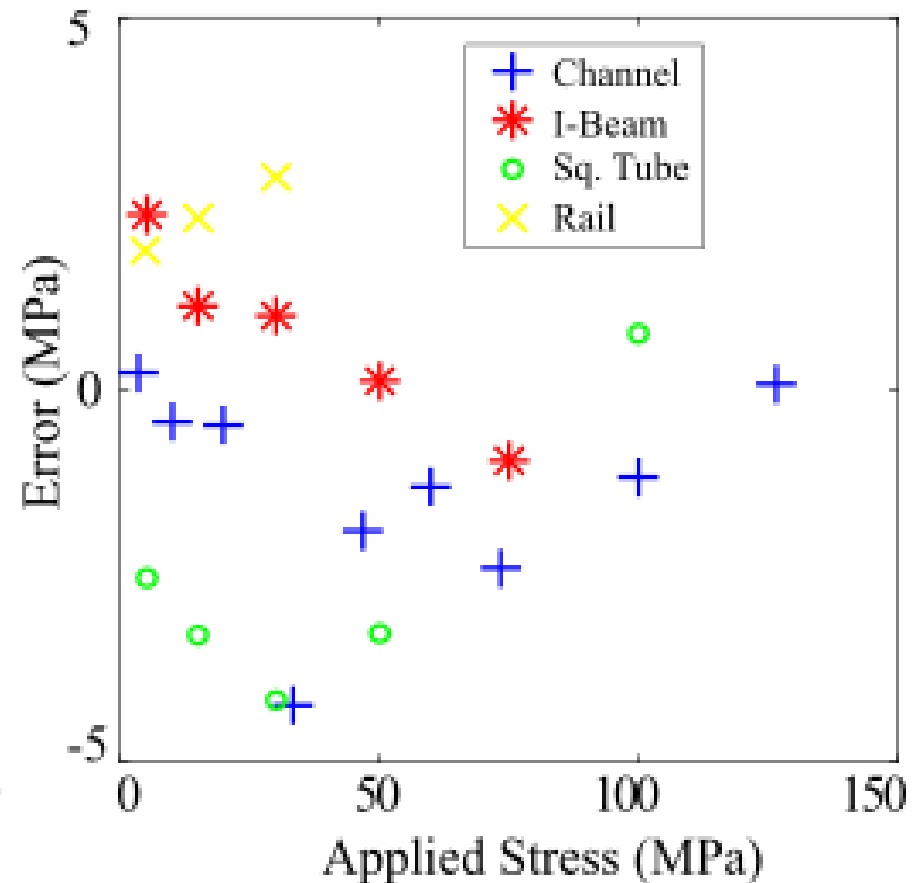
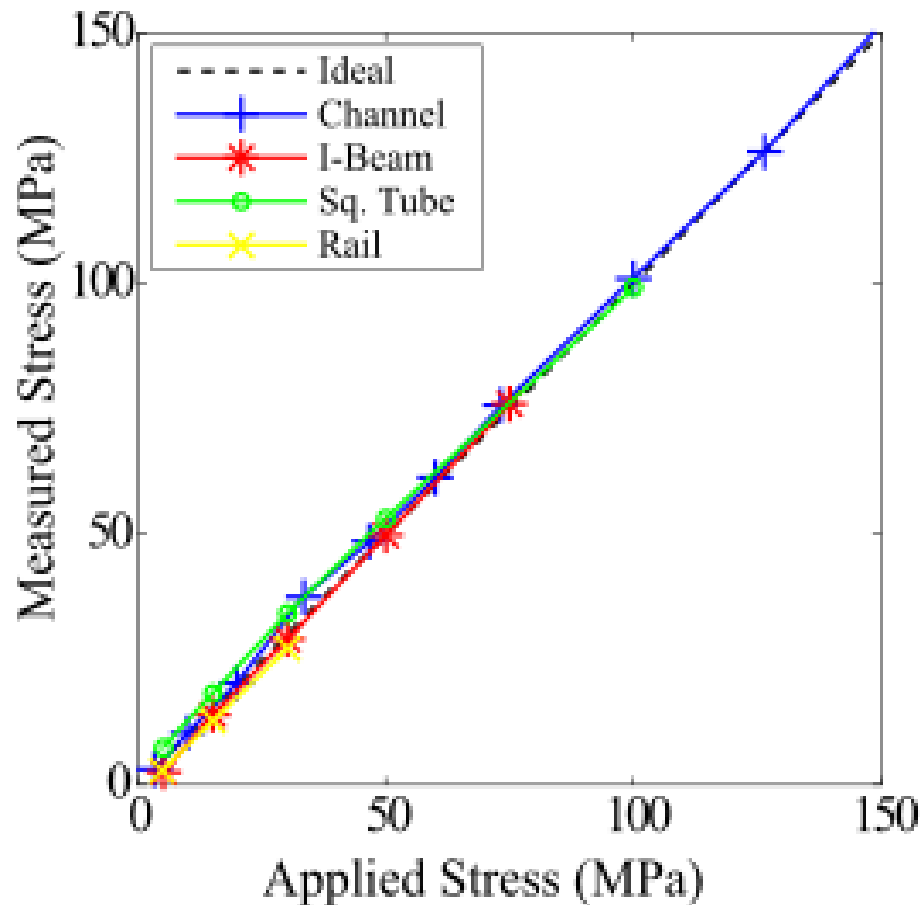


Cutting Stress Test



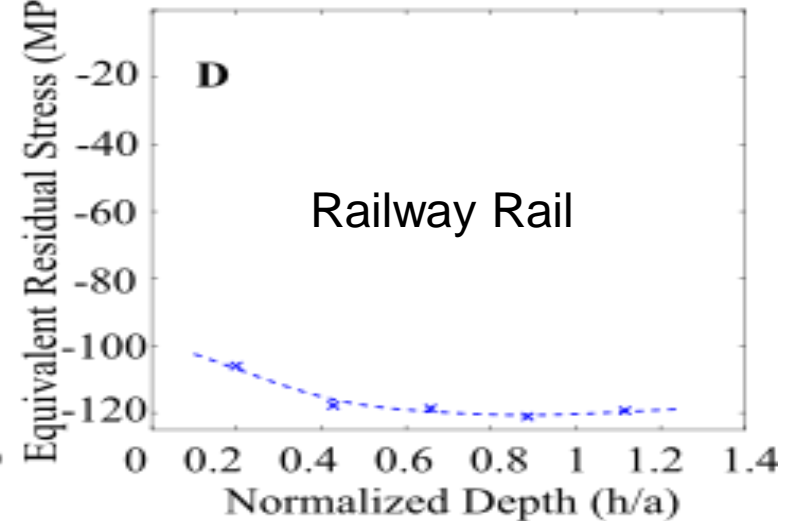
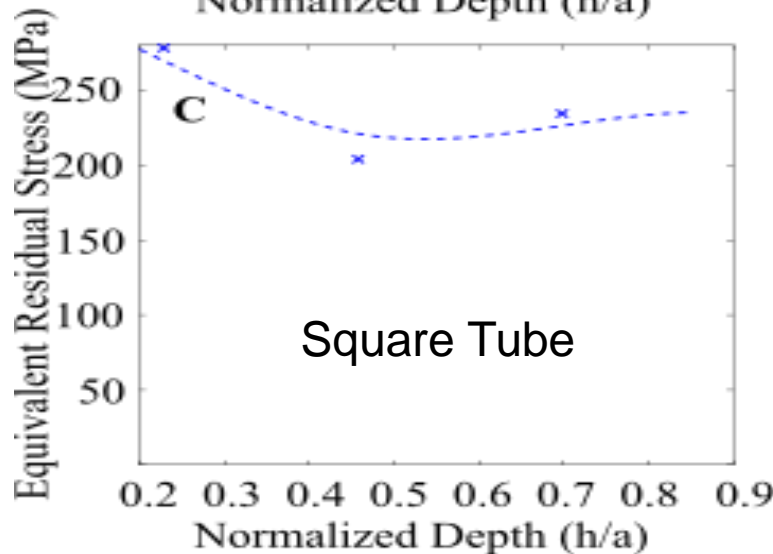
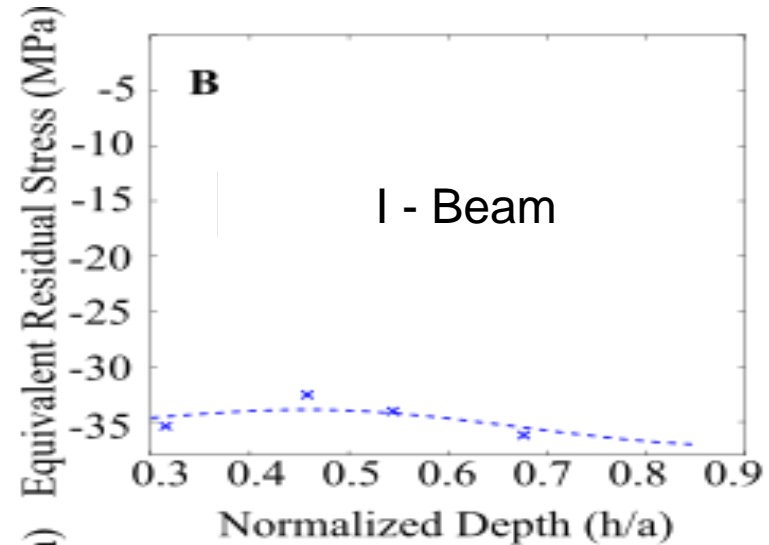
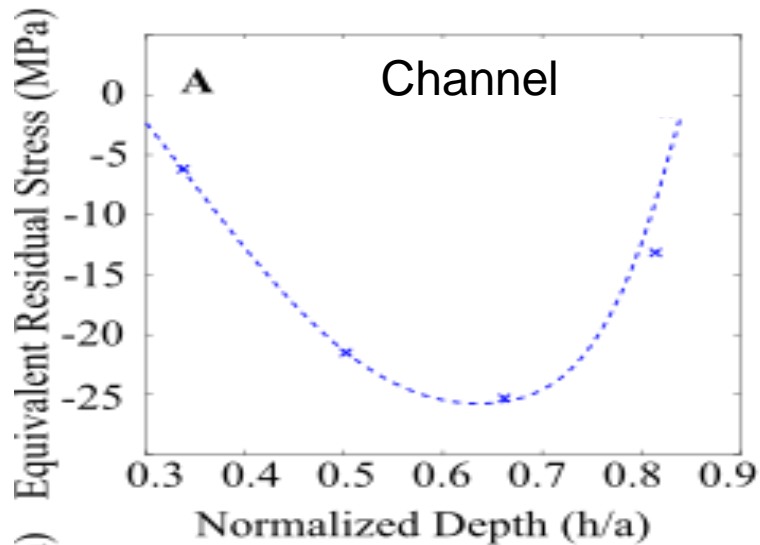


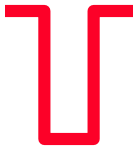
Axial Load Test



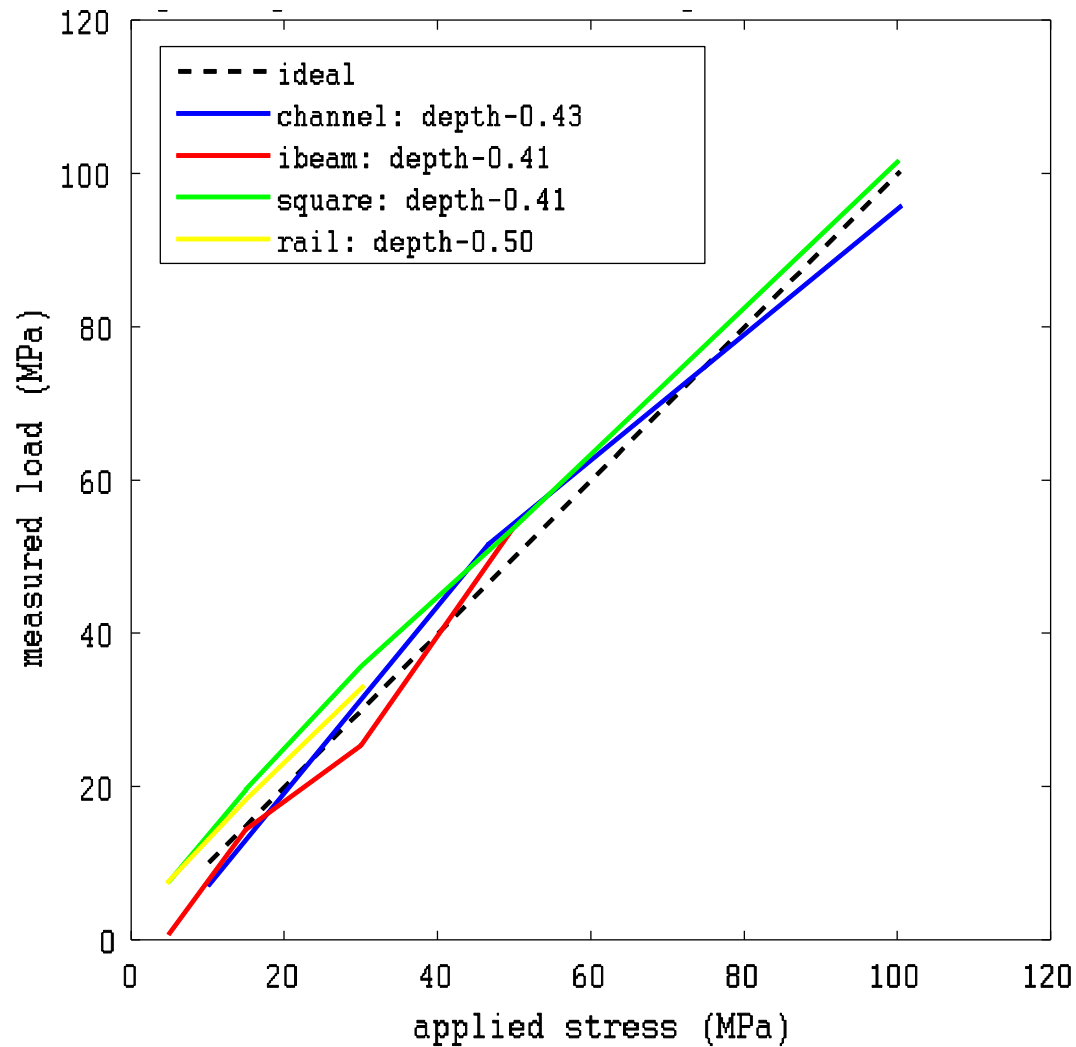


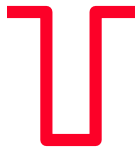
Residual Stress Test





Structural Load Measurement





Summary

- DIC hole-drilling can measure structural stresses
- Method is suitable for industrial / field use
- Artifact correction compensates thermal effects
- Structural stresses are accurately modeled
- Residual stresses combine with structural stresses
- Further work required to handle residual stresses



Acknowledgments

- ◆ American Stress Technologies, Inc.



- ◆ Natural Sciences and Engineering Research Council of Canada



U Questions ?



Q's ?