

Implementation of the Digital Image Correlation Method as a Bridge Condition Assessment & Bridge Performance Measurement Tool

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Highlights of Presentation

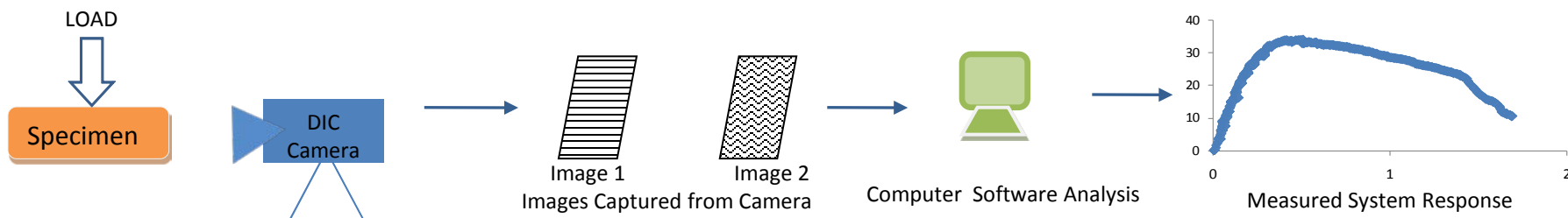
- Introduction
- DIC Method Background
- Civil Engineering-Bridge Applications
- Performance Condition Measurement
- Evaluation of Method
- Future Work & Closing Remarks
- References & Acknowledgements

Introduction

- **Digital image correlation** (DIC) is an optical technique that consist of correlating pixels in a series of images to determine variations
- This technique can be used to capture 2-D & 3-D movement
- **Structural health monitoring** (SHM) is referred to as the process of implementing damage characterization strategies
- **Load Rating** is the measurement of bridge live load capacity for structural safety concerns
- Advanced methods such as **DIC** are being considered for SHM and load rating design purposes

DIC Background

- DIC was originated in the 1980's to measure full-field in-plane displacements and displacement gradients of a strained body
- Further advancements of this method included more variety of testing materials, advance loading capabilities and vibration behavior



DIC Concept

Civil Engineering Applications

- DIC has been applied to various fields; applied to CE bridge components such as steel I-beams, concrete beams and pylons
- Method can detail measurements such as strains, rotations, deflections
- Easily comparable to methods such as Finite Element Analysis (FEA) for behavior response validation



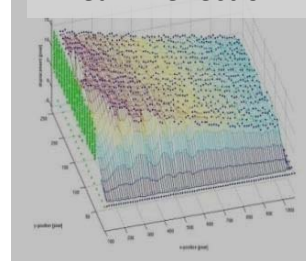
Loaded Steel Beam



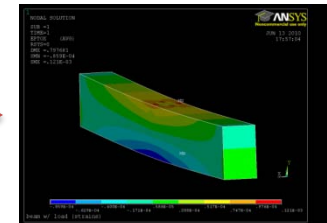
Enhanced Tracking Pattern

Sample results

Beam Deflection

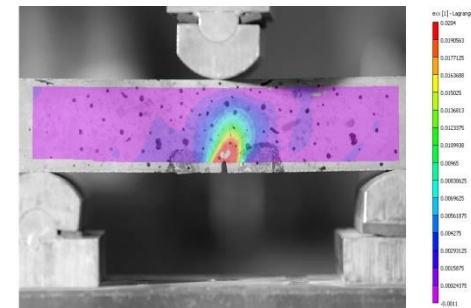
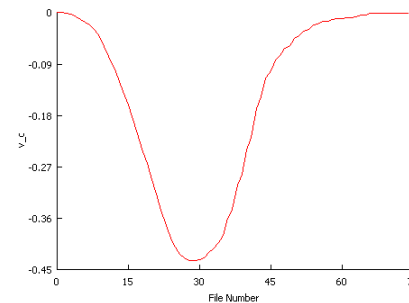
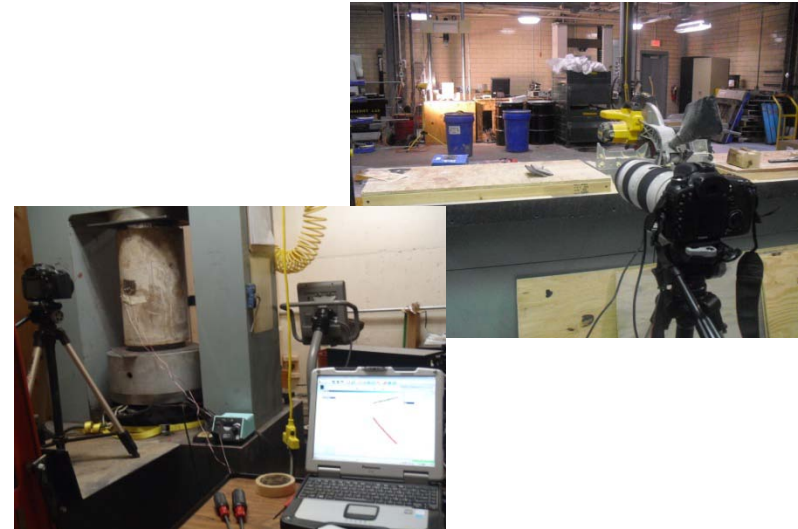


Comparisons w/ FEA Models



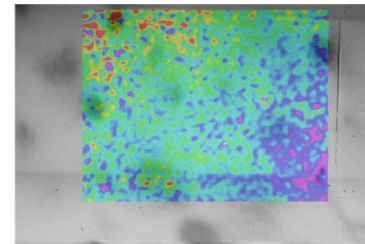
CE Applications Testing Results

- DIC technique can display accurate deflections and strains *within* 10% error
- Can be used on diverse testing materials and at different stand-off distances
- Enables assessment of materials tested, indicating structural deficiencies in specimens



CE Bridge Applications

- Apply DIC method to bridge systems measurements
- In field-instrumentation helps to validate measurements
- Research in the field shows the method can detect displacements due to loading conditions
- Allows for moving analysis of the truck load across bridge deck
- Environmental concerns are an issue with excessive camera movement or vibration on bridge system



Performance Condition Measurements

- DIC allows current bridge condition to be assessed
- Can create deflection and stress distribution curves that can detail linear-elastic performance measures
- DIC can also be used in **Load Rating** process in conjunction with *AASHTO LRFR* specified guidelines
- Provide current estimations of necessary bridge rating changes
- Method allows for alternative load rating determination to standard diagnostic load testing used in practice

Evaluation of Method

- DIC shows promise for bridge condition assessment and load rating purposes
- This method has many benefits and challenges

Benefits

- *Non-contact measurements/NDE*
- *Allows for varied testing specimens*
- *Low preparation requirements*
- *Flexibility in testing locations*
- *Low overall cost system*

Challenges

- *Seems not best suited for in-field setting as in controlled laboratories*
- *Sensitivities to light/pattern detection*
- *Tedious calibration & algorithm processes*



- Further investigation is currently being done to address challenges of this method

Future Work & Closing Remarks

- DIC can be used for structural integrity evaluation
- Improvements for the DIC system will be investigated for deployable field testing environments
- More investigation of DIC performance measurements will be evaluated and further applicability for load rating design processes and practice
- DIC will be evaluated as a component of more comprehensive project analysis for an integrated decision support system for bridge inspection practice

References

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- *Manual for Condition Evaluation of Bridges, AASHTO 2005.*
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- *National Consortia on Remote Sensing in Transportation. “Bridge Condition Assessment Using Remote Sensors” Michigan Tech Research Institute and Michigan Tech Transportation Institute. USDOT RITA <http://www.mtri.org/bridgecondition/> Accessed Jan 1 2011.*

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Thank You!

Questions?...

Project website for more information:

<http://www.mtri.org/bridgecondition/>

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