Deformation Monitoring and Analysis of Structures Using Laser Scanners

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Laser Scanner

- Leica HDS3000
- State of the art Cyclone 5.1 software
- 360° horizontal and 270° vertical field of view
- Internal colour camera for overlaying images
- Stated accuracies of 6mm at 50m and 1.5mm for purpose built targets
- Recommended range of 1.5 to 50m, 0-40°c and not advised to work in rain

Laser Scanner for Deformation Monitoring

- Millions of points gathered in a short period of time
- Possibly picking up cracks
- Whole surface scanned not only targets
- Registration targets can be set up on and adjacent to structure
- Tests conducted to find the possibilities

IESSG building scan

IESSG building scan

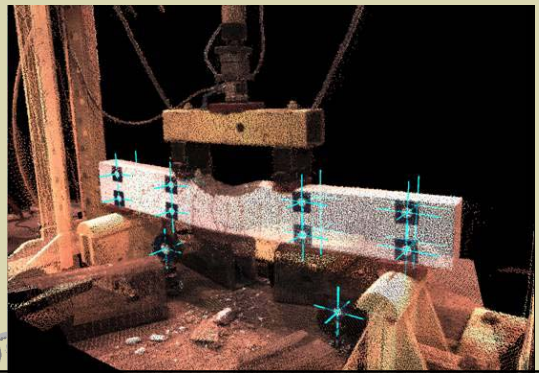
- Building scan used to acquaint users with scanner
- Three scans registered using 4 freestanding HDS targets
- Paper targets used as well as Leica targets
- Paper targets created large errors
- Targets used in front and behind glass, no difference in results
- Further trials planned to re-scan and compare

Beam Cracking

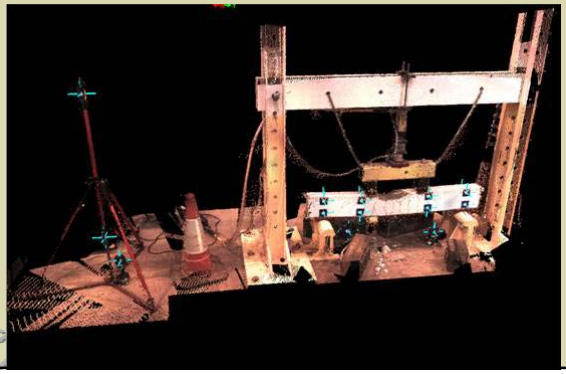
- Beams cracked in the Civil Engineering lab
- Various trials with a variety of beams
- Targets placed on and adjacent to the beams
- Scans taken before and after the beam is deformed
- Leica TCA2003 and TCR705 used to compare results

Cyclone 5.1

Deformed beam from the back



Back view showing beam targets and free standing targets



Results

Difference between Total Station and Cyclone Movements (mm)

Target	X	Y	Z
B1	0.0008	0.0034	0.0011
B2	0.0020	0.0013	0.0010
B3	0.0003	0.0000	0.0008
B4	-0.0020	-0.0002	-0.0003
B5	-0.0009	0.0021	0.0004
B6	-0.0007	0.0012	0.0008
B7	0.0003	-0.0002	0.0005
B8	-0.0010	0.0003	0.0017

Results

Difference between Total Station and Cyclone Movements (mm)

Target	X	Y	Z
F1	0.0012	0.0091	-0.0008
F2			
F3	0.0016	0.0055	-0.0005
F4	0.0006	0.0064	-0.0008
F5	0.0020	0.0087	-0.0015
F6			
F7	0.0014	0.0061	-0.0009
F8	-0.0003	0.0061	-0.0002

Comments

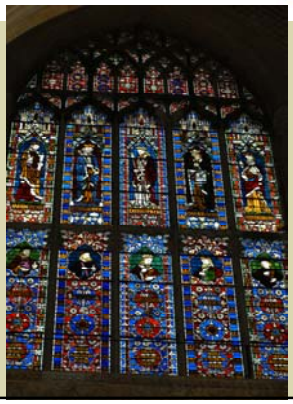
- Total station may have been moved, due to other lab work
- Only comparison of HDS targets used
- Future work to compare the concrete movements as well as HDS targets

Lincoln Cathedral

- 1,000 year old structure
- Taller than the Egyptian Pyramids
- Prone to long term deformations
- Point cloud created for future analysis
- Record the general layout
- Record intricate detail
- Two day survey
- In conjunction with English Heritage

Lincoln Cathedral intricate detail

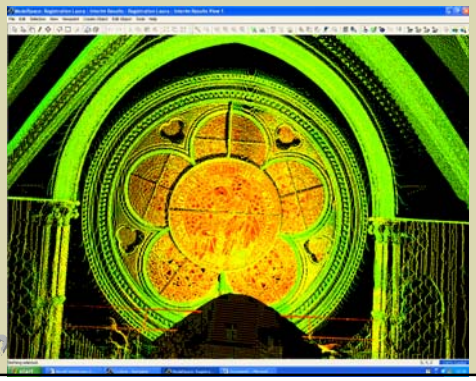
Lincoln Cathedral intricate detail



Lincoln Cathedral

- HDS targets set up within the Cathedral
- Scans taken of the entire space
- Finer scans of stain glass windows and ornamental detail taken
- Targets can not be placed on the walls
- Members of the public have to be watched
- Good results

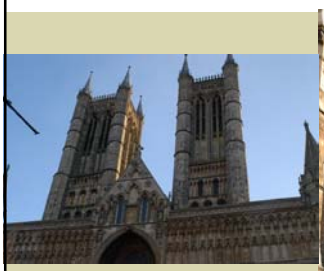
Lincoln Cathedral indoor

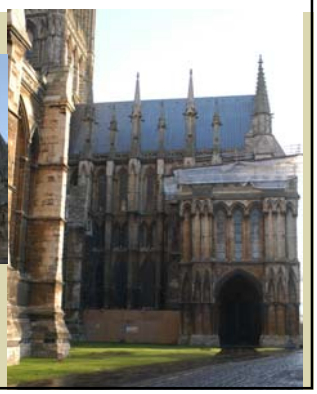


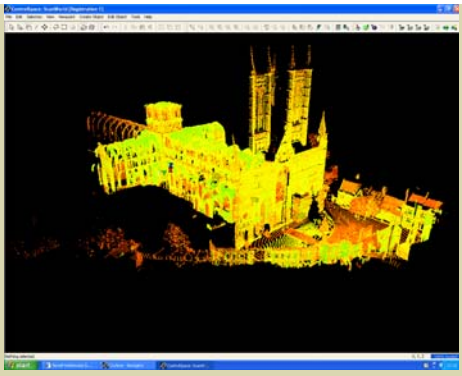
Lincoln Cathedral

- Tying the outside scan with the indoor data difficult
- Unique points used rather than HDS
- Targets moved by public etc
- 1mm by 1mm grid of points at approximately 5m would take almost 600 mins
- Material having different resolution in the results, due to strength of signal returned; record of material?
- Wind caused problems

Lincoln Cathedral outdoor







Conclusions

- Work underway, plan to use laser scanner for long term deformation monitoring
- Ability to record and document structural architecture; renovation work
- Trials underway to assess potential accuracies
- Location of targets also under investigation

Acknowledgements

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