Deformation Monitoring Trials Using a Leica HDS3000

G W Roberts, M Baddley
IESSG, The University of Nottingham

www.nottingham.ac.uk/iessg
Gethin.roberts@nottingham.ac.uk

- Basics about the scanner
- Some trials
- Results
- Conclusions

Deformation Monitoring Using Laser Scanners

- Recently considered as a tool
- High quantity of 3D points
- Complete surface coverage
- Not only targets

Leica HDS3000

- High speed, high accuracy
- Various characteristics, ideal for engineering surveying
- 360º horizontal and 270º vertical field of view
- 1m to 100m optimal range
- 4mm accuracy and 60 micro-rads
- Targets can be acquired to 1.5mm at 1-50m range
- Cyclone 5.2 software

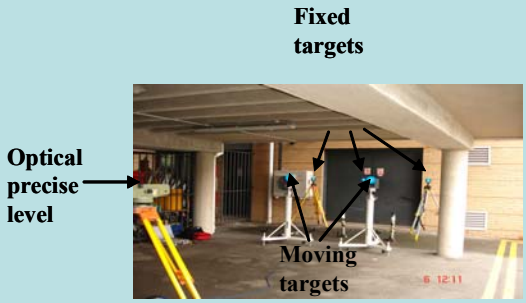
Leica HDS3000

Leica HDS3000

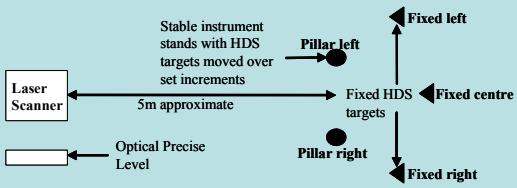
Deformation Sensitivity Analysis

- Targets placed on stable monuments 150cm apart
- Fixed targets also used
- Stands have vertical movements induced
- Wild NA2 precise level with parallel plate micrometer used to check

Deformation Sensitivity Analysis



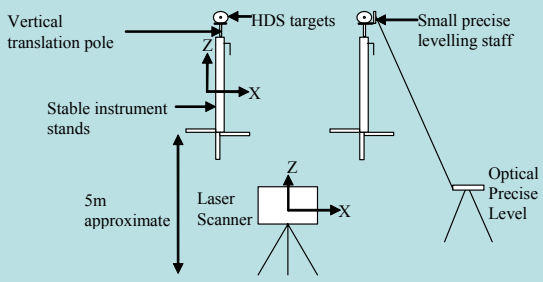
Deformation Sensitivity Analysis



Deformation Sensitivity Analysis

- First trial saw the targets lowered by 8.5mm, 6.5mm, 4.5mm and 2.5mm
- Second and third trials, targets were lowered by 2.5mm, 1.0mm and 0.5mm
- Point clouds with 1mm x 1mm grid at 5m range used

Deformation Sensitivity Analysis



Deformation Sensitivity Analysis

Deformation Sensitivity Analysis

The University of Nottingham

	Induced Z (m)	Deformation Vectors (m) ΔX	ΔY	ΔZ	Difference (m)	Increments Between Levelling (m)	Increments Between Scans (m)	Difference (m)
Scan 1	-0.0087	-0.0003	0.0022	**-0.0085**	**0.0002**	-0.0087	**-0.0085**	**0.0002**
Scan 2	-0.0152	-0.0002	-0.0018	**-0.0151**	**0.0001**	-0.0065	**-0.0066**	**-0.0001**
Scan 3	-0.0197	-0.0003	-0.0018	**-0.0198**	**-0.0001**	-0.0045	**-0.0047**	**-0.0002**
Scan 4	-0.0223	-0.0002	-0.0020	**-0.0225**	**-0.0002**	-0.0027	**-0.0027**	**0.0000**

TABLE 1, Pillar Right – Summary of large vertical displacements (trial one).

Deformation Sensitivity Analysis

The University of Nottingham

	Induced Z (m)	Vectors (m) ΔX	ΔY	ΔZ
Scan 1	0.0000	-0.0015	0.0027	-0.0004
Scan 2	0.0000	-0.0002	-0.0012	-0.0006
Scan 3	0.0000	-0.0004	-0.0010	-0.0010
Scan 4	0.0000	-0.0001	-0.0015	-0.0011

TABLE 2, Fixed Left – The 3D position uncertainty of a stationary target (trial one).

Deformation Sensitivity Analysis

The University of Nottingham

	Induced Z (m)	Deformation Vectors (m) ΔX	ΔY	ΔZ	Difference (m)	Increments Between Levelling (m)	Increments Between Scans (m)	Difference (m)
Scan 1	-0.0025	-0.0002	-0.0010	**-0.0017**	**0.0008**	-0.0025	**-0.0017**	**0.0008**
Scan 2	-0.0041	-0.0004	-0.0017	**-0.0028**	**0.0013**	-0.0015	**-0.0011**	**0.0004**
Scan 3	-0.0046	0.0002	-0.0001	**-0.0028**	**0.0018**	-0.0005	**0.0000**	**0.0005**

TABLE 3, Pillar Right – Summary of small vertical displacements (trial two).

Deformation Sensitivity Analysis

The University of Nottingham

	Induced Z (m)	Vectors (m) ΔX	ΔY	ΔZ
Scan 1	0.0000	0.0002	-0.0012	0.0007
Scan 2	0.0000	0.0002	-0.0006	0.0014
Scan 3	0.0000	0.0004	-0.0009	0.0016

TABLE 4, Fixed Left – The 3D position uncertainty of a stationary target (trial two).

Deformation Sensitivity Analysis

The University of Nottingham

	Induced Z (m)	Deformation Vectors (m) ΔX	ΔY	ΔZ	Difference (m)	Increments Between Levelling (m)	Increments Between Scans (m)	Difference (m)
Scan 1	-0.0025	0.0001	-0.0015	**-0.0025**	**0.0000**	-0.0025	**-0.0025**	**0.0000**
Scan 2	-0.0040	0.0000	-0.0029	**-0.0040**	**0.0001**	-0.0015	**-0.0015**	**0.0000**
Scan 3	-0.0045	0.0000	0.0010	**-0.0045**	**0.0001**	-0.0005	**-0.0005**	**0.0000**

TABLE 5, Pillar Right – Summary of small vertical displacements (trial three).

Deformation Sensitivity Analysis

The University of Nottingham

	Induced Z (m)	Vectors (m) ΔX	ΔY	ΔZ
Scan 1	0.0000	0.0010	-0.0022	0.0000
Scan 2	0.0000	0.0006	-0.0021	0.0002
Scan 3	0.0000	-0.0004	0.0015	-0.0001

TABLE 6, Fixed Left – The 3D position uncertainty of a stationary target (trial three)

Deformation Sensitivity Analysis

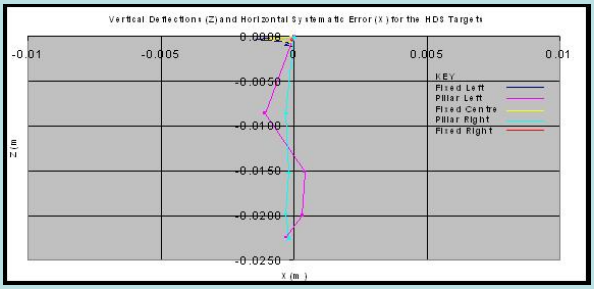


FIGURE 7, The vertical movement of the two HDS targets detected by the scanner.

Deformation Sensitivity Analysis

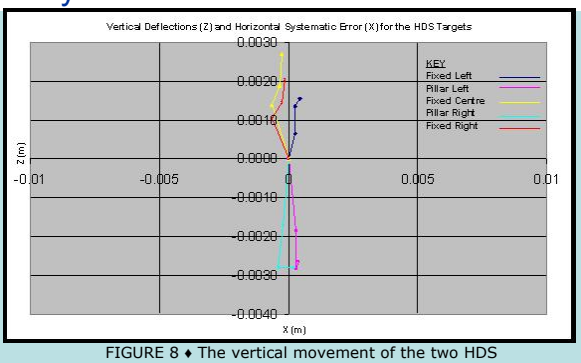


FIGURE 8 ♦ The vertical movement of the two HDS targets detected by the scanner.

Deformation Sensitivity Analysis

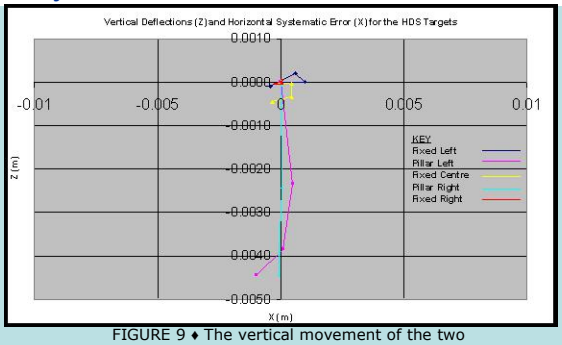


FIGURE 9 ♦ The vertical movement of the two HDS targets detected by the scanner.

Conclusions

- Basic tests have shown the potential of the scanner for mm level deformation monitoring
- Places the scanner in the same accuracy league as other survey methods
- Has the advantage of scanning the whole structure rather than only targets
- Induced movements in the tests were scanned from one set-up
- Other techniques would require more than one set-up
- Further trials carried out

Deformation Monitoring Trials Using a Leica HDS3000

G W Roberts, M Baddley
IESSG, The University of Nottingham

www.nottingham.ac.uk/iessg
Gethin.roberts@nottingham.ac.uk