

FIELD NOTES

Structural Surveying: Quantifying Measurement Accuracy

Structural surveying is an important step in urban design, from construction through to historical preservation. Using traditional methods, structural surveying is a time-intensive and costly undertaking. Optech's ILRIS-3D laser imaging system provides the means to reduce the time and cost significantly.

Since the introduction of laser scanning technology there has been a misconception that the technology is not suitable for structural surveys due to accuracy limitations. The strength of a laser scanner is not in its single shot precision but in its ability to oversample the target area. The typical single measurement precision for an Electronic Distance Meter (EDM) is 1-2 mm; while typical single measurement precision for most laser scanners is 6-10 mm, the use of multiple hits in the same area to model a point significantly increases the accuracy of the data to be comparable to traditional survey results.

To test this theory a building structure at Toronto's York University was surveyed using conventional methods, and was subsequently scanned with the ILRIS-3D laser scanner. Using conventional measurements as the benchmark, the accuracy of the laser data was determined.

The Benchmark Process

To benchmark targets on the building surface, they were surveyed by a local surveyor in Toronto. The firm used a 1 Arc-Second total station to locate the target centres. Due to line-of-sight constraints, the survey was done from two geodetic control monuments in the area. A total of 100 measurements were collected on the building surface with a projected accuracy of 2-5 mm. When the survey was complete, co-ordinates and baseline distances were calculated and provided to Optech.

Surveying with ILRIS-3D

After the benchmark baselines were established, the building was scanned with ILRIS-3D. The range of the scan was 50 m and the measurement spacing was approximately 1 mm. A very high density scan was done to ensure that multiple measurements on the target would be recorded.

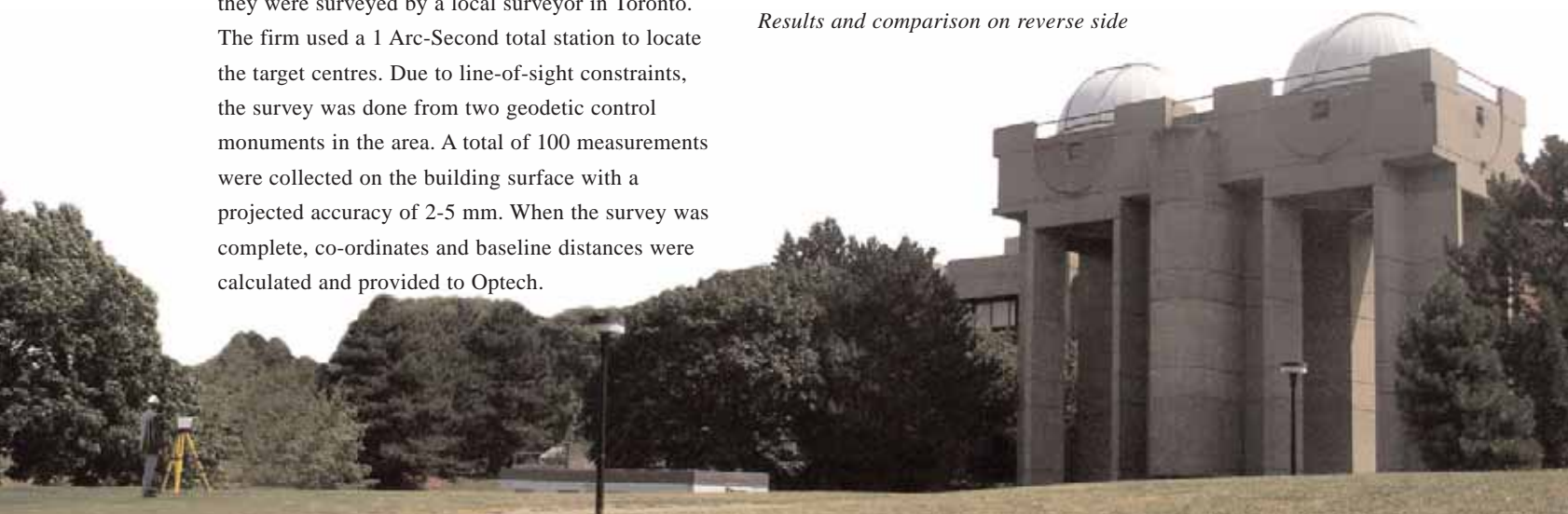
Using ILRIS-3D software, the centre of each target was automatically calculated. Baseline distances were then calculated and compared to the results of the benchmark process.



A high resolution, detailed point-cloud image was used to create a metrically accurate solid model of the building.



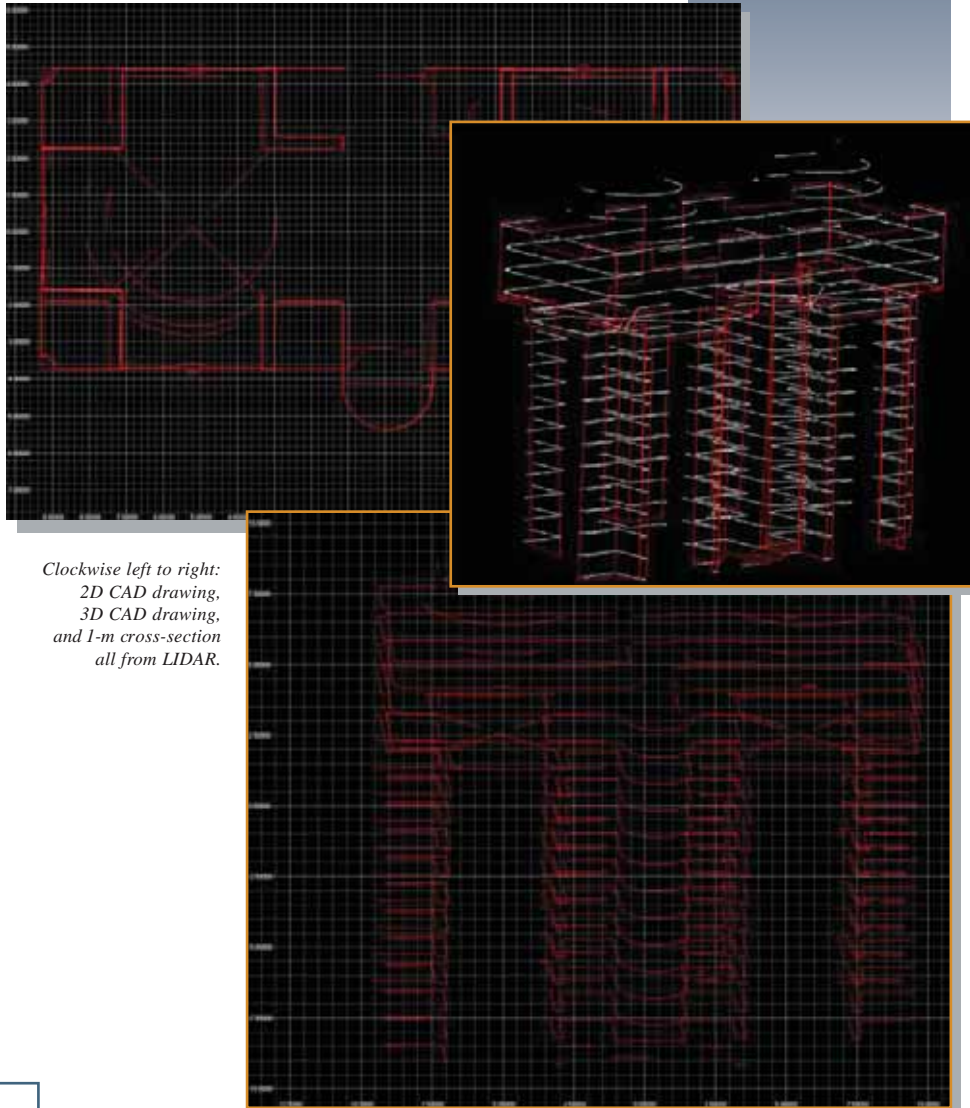
Results and comparison on reverse side



Results and Comparison

To complete this test the baseline distances between targets as measured by ILRIS-3D were compared to the distances established by the total station. As can be seen in the Control vs Laser Baseline table the RMS of the difference was 5 mm. This is a very significant number since it falls within the uncertainty margin of the benchmark measurements (2 mm - 5 mm). Furthermore, the average difference of 0 indicates that there is no bias in the baselines established by ILRIS-3D. In essence, the user was able to obtain the same level of accuracy using both methods.

This project has demonstrated that a significant improvement in field efficiency can be gained by deploying tripod-based laser scanners in place of traditional survey techniques for conventional structural survey. The outlined method obtains accuracies within millimetres of ground truth as established by conventional methods, and captures complete data of areas that would otherwise be impossible using any other method. Efficiencies translate across all areas, from field data collection to data processing and creation of customer deliverables, all with greatly reduced propensity for manually introducing error.



*Clockwise left to right:
2D CAD drawing,
3D CAD drawing,
and 1-m cross-section
all from LIDAR.*

Control vs. Laser Baseline

Sigma:	5 mm
Mean:	0 mm
RMS:	5 mm
Total:	1,156 samples

	Control Survey	Laser Scan
Number of Measurements	100	~2,000,000
Data Collection Time:	6 hours	0.5 hours
Data Processing Time:	2 hours	1 hour



**A safer, higher-density, better data set
was created with ~80% TIME SAVINGS**



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