Dynamic Monitoring of Load Tests by Kinematic Terrestrial Laser Scanning

David Grimm* & Hans-Martin Zogg*

*Institute of Geodesy and Photogrammetry ETH Zurich, Wolfgang Pauli-Strasse 15, CH-8093 Zurich ([grimm, zogg]@geod.baug.ethz.ch)

In relation with maintenance works of the runway at the Hamburg Airport in Germany, a convenient method to reinforce the soil surrounding the concrete runway was subject of investigation. A fixing of the soil is important with regard to aircrafts accidentally passing over the runway. To prove the suitability of the soil fixings, load tests were performed on three different purpose-built test fields (Figure 1).

For these tests, the aircraft was simulated by a crane with a weight of about 200 tons. The crane drove backwards into the test fields. Besides the sinking of the crane into the test fields, the size of the bow wave, which occurs on the first wheel while driving into the mud, was of main interest. The surface of the test fields had to be permanently monitored during the test drives.

For the dynamic monitoring of the occurring bow wave, three different geodetic measurement methods were considered: photogrammetry (videogrammetry), kinematic terrestrial laser scanning (TLS), and range imaging (RIM). Finally, the monitoring was performed by kinematic TLS. Photogrammetry would have required additional illumination of the scenery. Furthermore, the soil surface was homogeneous and colour variances could hardly be detected. The RIM technology, a new measurement technology for geodetic engineering (Kahlmann & Ingensand, 2007), did not fulfil the requirements in terms of measurement accuracy. Nevertheless, this new technology allows the acquisition of full 3D-images and promises big advantages compared to traditional measurement methods for the future. In addition, the soil was expected to be wet and partially inundated. Thus, a requirement of the used laser scanner had to be the feasibility to measure through a layer of water with a thickness of several centimetres (Vogel, 2008).

Consequently, the profile laser scanner SICK LMS200-30106 by Sick AG (Zogg & Grimm, 2008) was mounted underneath the crane in front of the crane wheel for the dynamic monitoring of the occurring bow wave during the load tests (Figure 2). The laser fan was adjusted along the driving direction of the crane (Figure 3). The crane was additionally tracked by three total stations for the localisation in a global coordinate system. For the detection of the bow wave size, the relative position of the profile scanner was sufficient. The surface, which had not been run over yet by the crane, served as horizontal reference for the profiles. This also enabled the elimination of inclination variations of the profile scanner along the driving direction.

To make possible a practicable analysis of the measurements, particular software was developed. The software automatically classified the point cloud into points on the wheel and points on the soil surface. Thus, the height of the bow wave could be detected in each scanning profile (Figure 4 and Figure 5). Finally bow waves with a size of up to 18 cm could be located. Accordingly, the tests pointed out that kinematic TLS was a qualified measurement method for this particular application.

Figure 1. Test field for the load tests.

Figure 2. 2D-laser scanner mounted underneath the crane.

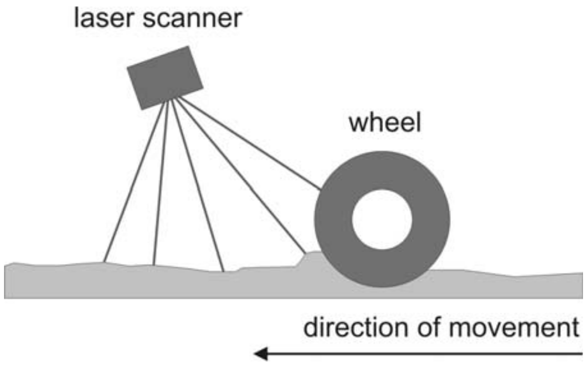

Figure 3. Measurement setup.

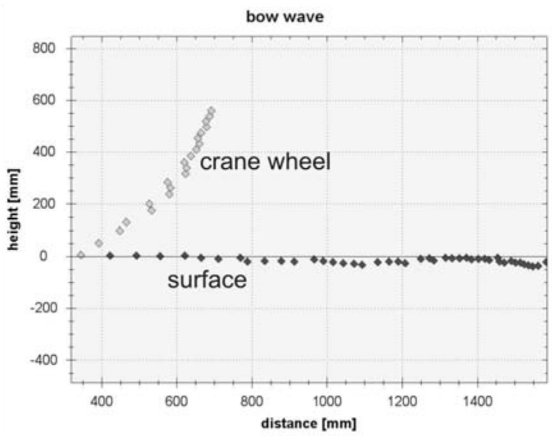

Figure 4. Profile measurements before the crane entered into the test field.

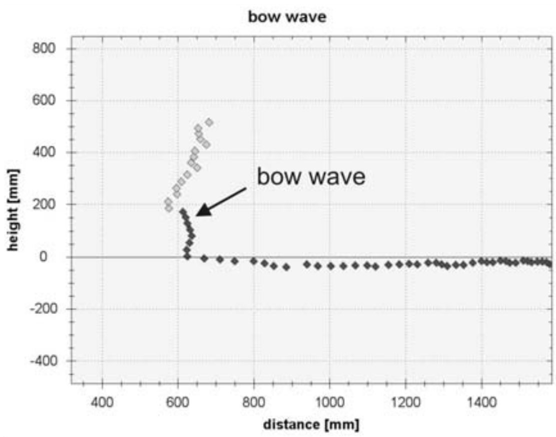

Figure 5. Detection of bow wave while driving into the test field.

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