ҚАЗАҚСТАН РЕСПУБЛИКАСЫ БІЛІМ ЖӘНЕ ҒЫЛЫМ МИНИСТРЛІГІ
Л.Н. ГУМИЛЕВ АТЫНДАҒЫ ЕУРАЗИЯ ҰЛТТЫҚ УНИВЕРСИТЕТІ

СОВЕТ МОЛОДЫХ УЧЕНЫХ

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В сборник вошли доклады студентов, магистрантов, докторантов и молодых ученых по актуальным вопросам естественно-технических и гуманитарных наук.

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ANALYSING DEFORMATIONS USING LASER SCANNING IN ASTANA

Uakhitov A.B.
almat.uakhitov@gmail.com
Master of the Department of Geodesy and Cartography of L.N.Gumilyov Eurasian National University
Supervisor – c.t.s., professor Igilmanov Zh.A.

Being sure is very important that the movements of an engineering structure, which serves the human life of today's modern world, are exhibiting safe behaviors. So, a lot of deformation monitoring studies for determining and analyzing different kinds of engineering structures such as high-rise buildings, dams, bridges, viaducts, industrial complexes etc., are implemented. During these studies, the used measurement techniques and systems, which could be geodetic or non-geodetic, are determined considering the type of the structure of which deformations will be monitored, its environmental conditions and expected accuracy from the measurements. As related the used monitoring techniques, the deformation measurement equipments are varied. Also according to professions who use the deformation monitoring techniques, these techniques and instrumentation have traditionally been categorized in to two groups: geodetic surveys, which include conventional (terrestrial such as precise leveling measurements, angle and distance measurements etc.), photogrammetric (terrestrial, aerial and digital photogrammetry), satellite (such as Global Positioning System-GPS, InSAR), and some special techniques; geotechnical/structural measurements, using lasers, tiltmeters, strainmeters, extensometers, joint-meters, plumb lines, micrometers etc. In this paper, some of these deformation measurement techniques which are thought as more important and mostly used by the geodesy specialists will be reviewed. The importance and need of carrying out the deformation measurements periodically in engineering structures will be emphasized. [3]

Aldar Properties has appointed a consortium consisting of CCC and Arabtec to develop the new Abu Dhabi Plaza planned by the firm for Astana in Kazakhstan. The plan involves the construction of five towers, the tallest of which will be 320m, on a 500,000m^2 site. The mixed-use development will contain 556 luxury apartments, 107,000m^2 of office space, a five-star hotel with serviced apartments and a 50,000m^2 retail podium with four large basement car parks. The project originally was assigned to another contractor in 2007 and then recently taken over by CCC. One of the most important challenges at this stage is to review the work which has been done by the previous contractor. The inspection of the existing construction helps the engineers to decide whether to carry on or to modify it. [1]

The objective was the structural inspection of the diaphragm (Dwall) wall (Figure 1) in comparison to theoretical position. In this case, the level of tolerance of the deviation from the theoretical position must be minimal since the design involves the construction of the inner wall (or parking wall) along the diaphragm wall, within a distance of 15 cm. More specifically, the distance between the inner side of the diaphragm wall to the outer side of the parking wall must be 15cm, according to the design (Figure 2). [1]

Figure 1a: Abu Dhabi Plaza

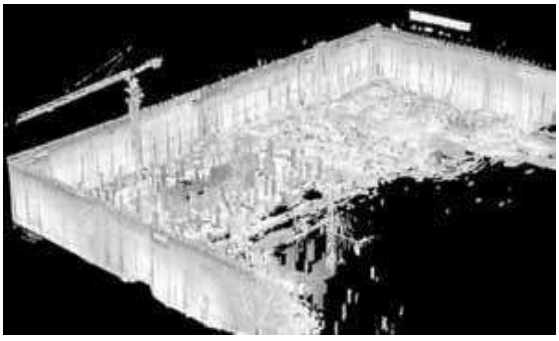

Figure 1b: Point clouds

The high level of detail which is required made it necessary to utilize a method which allows us to get the as-built situation as it is and to analyze into an advanced CAD system. [2]

Recent advances in generating 3D environments using laser scanning technologies, and acquiring quality information about built environments using embedded and other advanced sensors provide the capability to frequently gather an integrated and accurate three-dimensional and material quality related as-built data. This information is combined with the design model with an objective to create an integrated model which is dynamically updated during the construction period. [2]

Figure 2: Diaphragm wall position in comparison with the inner wall

The site scanning, with the usage of the laser scanner technology, was completed in four days with 400 scans in total. Advanced computer software gives us the ability to generate vertical and horizontal cross sections, along the diaphragm wall, allowing the user to define the interval between the consecutive cross sections. The interval of the cross sections was determined with the assistance of the project's engineers. The decision was based on the length of the panels which constitute the diaphragm wall. Therefore, an interval of five meters between two consecutive cross sections allows us to check the as-built condition of every panel. [2]

Figure 3: Image generated from the laser scanner illustrating the facade of the west section of the Dwall

The resulting cross sections highlight the parts of the wall where the deviation exceeds the critical tolerance of 15cm from the theoretical position. Furthermore, the software allows us to generate horizontal cross sections. The horizontal cross sections were generated in three elevation spots: one in the lower, one in the middle and one in the upper part of the wall. In total 150 vertical cross sections were generated and also 12 horizontal cross sections. In sectional view (Figure 4) the slope of the wall and the verticality is highlighted as well as the direction of the deviation. [2]

In this figure it can be seen that the wall does not follow the verticality rules since there is a curve in the middle of the wall. On the right side of Figure 4 the as-built is represented superimposed by the design (red line) indicating the value and the direction of the deviation from the hypothetical wall position. In this example, the distance between the as-built Dwall position (white line) and the theoretical Dwall position (red line) is 25cm, a value which violates the design specification. [2]

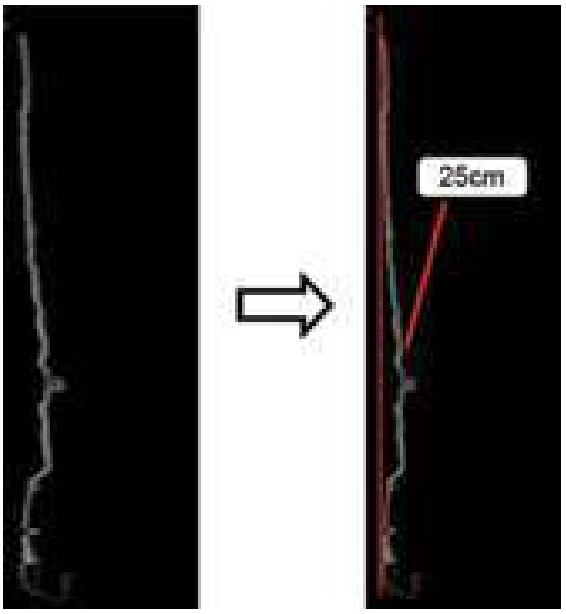

Figure 4a: Vertical cross section of the wall

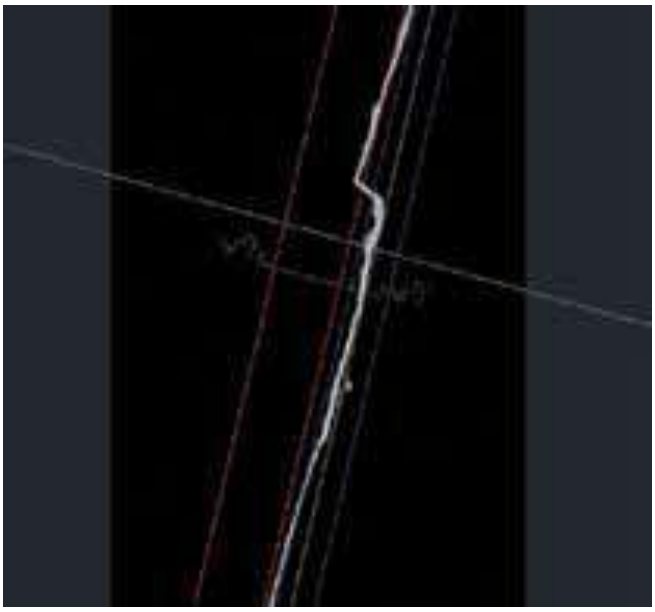

Figure 4b: Horizontal cross section

The next figure indicates a horizontal cross section. As can be seen, the as-built Dwall position (white line) exceeds the theoretical position (red line) and penetrates into the boundary of parking wall (blue line). The sectional analysis cannot cover the whole surface of the wall since the as-built conditions of the areas between the intervals are unidentified. Therefore, we need an integrated project model were the deviation is depicted in the whole surface of the wall providing the value and the pattern of the deviation in every spot. [2]

Identification of deviation can be completed by comparing the as built data, acquired by the laser scanner, to the given design model. Once the magnitude of deviation is found, it can be evaluated according to construction specification to define if any detected deviation violates any specification and as a result constitutes a defect. [2]

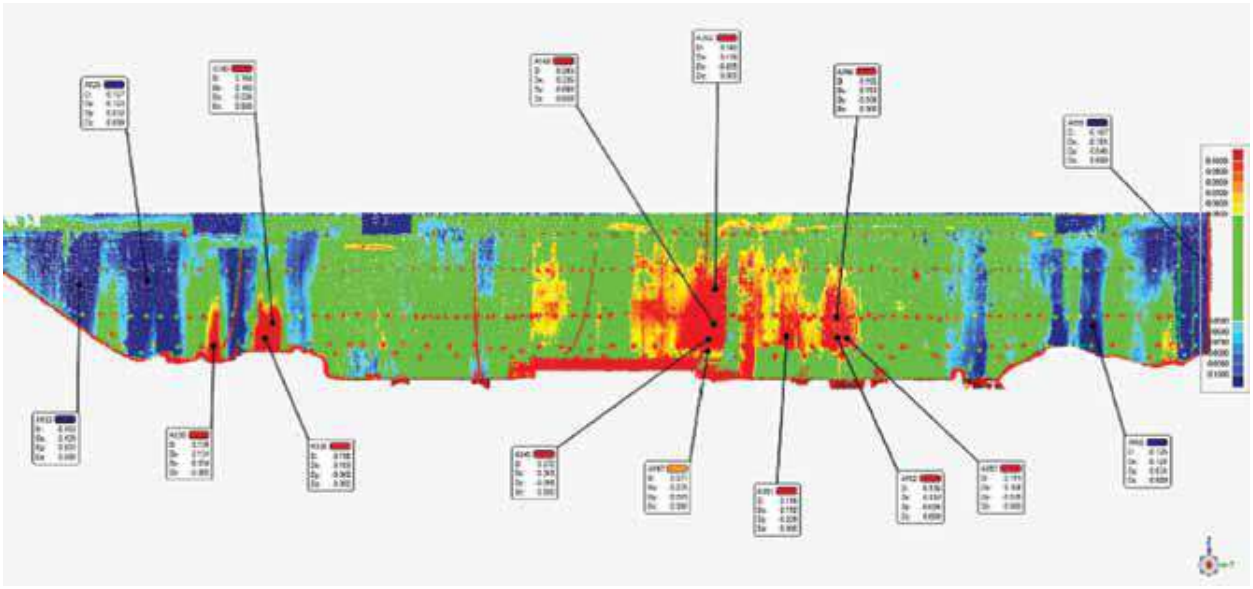

Figure 5: Color based deviation model of the west section of the wall

The resulting model constitutes a color-based deviation model, as is indicated in Figure 5. The color is assigned according to the value of the deviation between the as-built measured data and the design model. In Figure 5, the areas which are colored red represent the highest deviation with values which exceed 150mm, in contrast to the green colored areas which present the lowest deviation with the values which fluctuate between 0mm and 150mm. The positive pattern of deviation is illustrated in red while the negative deviation is in blue. The red colored areas (Figure 5) indicate the areas where the wall penetrates the parking wall and therefore must be trimmed. The green areas indicate the parts of the wall where the deviation fluctuates within acceptable limits while the blue color indicates the areas where the wall deviates into the opposite direction. [2]

The engineers also requested the inspection of the existing rafts (Figure 6) which were constructed by the previous contractor. The rafts inspection involves the review of the slopes and comparison of the elevation with the design. Figure 6 indicates the fluctuation of the slopes of the foundation. The dark red shows the areas where the distance from the theoretical raft position exceed 10cm while the green indicates the areas where the deviation is lower than 5mm. [2]

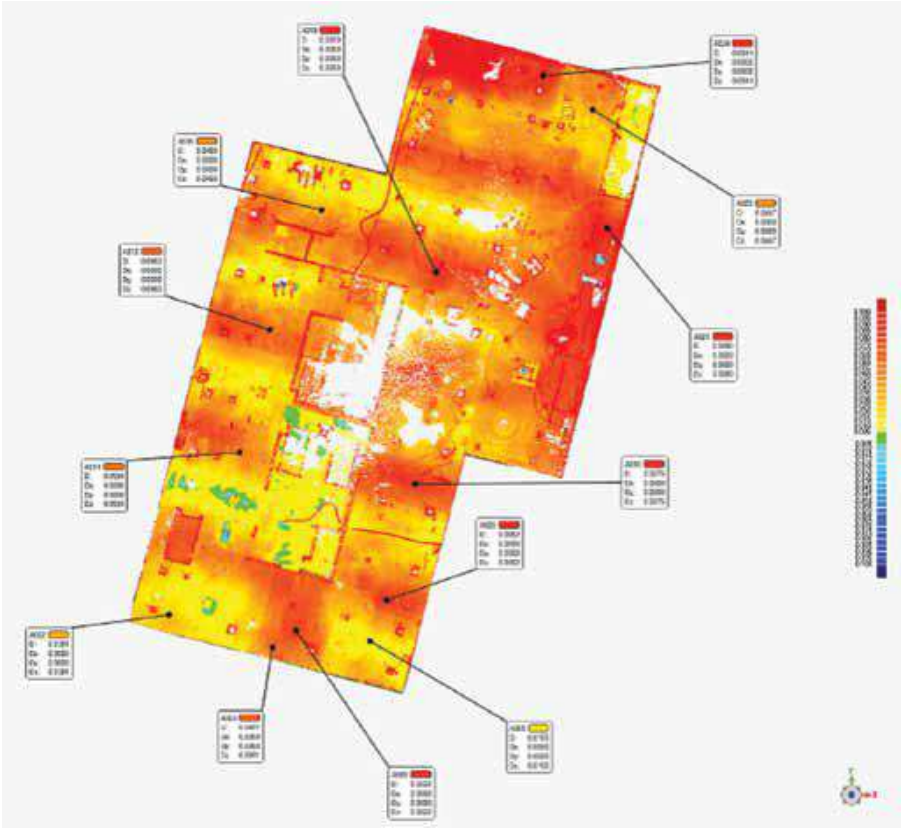

Figure 6: Raft inspection

The utilization of laser scanner technology on construction sites can improve the as- built data collection procedure. Laser scanning technology can be used to optimize the project quality control processes since it provides a detailed view of the as-built situation. The engineers acquired a thorough view of the existing construction and were able to evaluate whether the existing construction obeys the design specification or violates it. The implementation of 3D technologies in combination with advanced software enables engineers to locate the defects accurately and effectively. [2]

After the data acquisition stage, the as-built data are compared with the design with the objective of detecting any deviations. In the case where there are deviations which exceed the acceptable limits (according to the specifications) then a further analysis is required. The quality control approaches which have been used so far provide information only for a specific location without reflecting the pattern and the magnitude of the deviation between the as-built data and the design. The current approach, employing new technologies in the field of surveying, establishes an automated procedure for extracting the quality control report and provides integrated information about the status of the work on construction sites. [2]

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ТҰРАҚТЫ ЖҰМЫС ЖАСАЙТЫН СПУТНИКТІК РЕФЕРЕНЦ СТАНЦИЯЛАР ЖӘНЕ ОЛАРДЫҢ АЙМАҚТЫҚ ЖЕЛІЛЕРІ

Хасен К.Х