IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT
Impact Factor: 6.252

Volume 2, Issue 2, March 2022

Application of Modern Technology of LIDAR in Checking Verticality of Piles

Ms. Sayyad Tabssum Rafik
Government College of Engineering, Karad, Maharashtra, India
sayyadtabssum2011@gmail.com

Abstract: *LIDAR imaging systems are one of the hottest topics in the optronics industry. However, the diversity of state-of-the-art approaches to the solution brings a large uncertainty on the decision of the dominant final solution. LIDAR has various applications in today's industrial world as security cameras, event lighting, in autonomous vehicles, etc. which enables a picturesque images of projected area along with distance. It's widely used in thick forest surveys which produces better results as compare to photogrammetry. It has been used for surveying a large area but not into the construction repairs and maintenance industry. This paper represents the application of LIDAR system in the distress management and repairs and rehabilitation of an off shore structure which got disrupted in tauktae in 2021 and by using the technology an attempt to check the verticality of piles of jetty is made. LIDAR data have been proven beneficial in the last few years, since it provides information like the height and properties of objects, statistics for wide areas, and it all becomes available by recording the intensity of backscattered pulse in addition to the 3D coordinates. Using the different types of LIDAR help us to discover places we could not see before, like top of mountains, sea floors and other places in our wide world, depending on airborne system or bathymetric system. In this paper, an overview of LIDAR components and basic principle to measure eccentricity in piles are provided and the methodology is explained. Also, a list of the effective parameters which cause errors while collecting data is provided, and how to minimize the error of estimated values by processing many correction steps. Finally, for extraction of eccentricity occurred in piles of jetty structure in the region of Maharashtra and Gujrat in Arabian sea, the obtained data is overlapped with original data and eccentricity is calculated.*

Keywords: LIDAR.

I. Problem Statement

A part of jetty structure has been collapsed due to tauktae in 2021. It has been a 'V' shaped jetty with approach from the shore and due to the disruption by the typhoon the angular part of jetty has been collapsed and some of pile were seen settled into the strata underneath. When any disruption due to any external actions occurs, structure can deflect in 3 Dimensions. But, when attempting to measure the deflection, some well-known instrumentation could have failed as it would has given in 2 dimensions. E.g. Theodolite, etc. But, then LIDAR came into the picture due to its scope and wide application features, in various industries like autonomous vehicles, forestry, surveying, etc. As it is easy to handle and it produces high definition images of actual data. When it is overlapped with the original plans/ drawings of the structure, it gives actual information thereby extracting eccentricity in the piles.

1.1 Scope

Study elaborates wide scope of LIDAR growing in various industries like unearthing geomorphology, military uses, augmented reality, autonomous vehicles, surveying, etc. but, there is limited study in maintenance and repair industries. Since use of LIDAR haven't been made in checking eccentricity of piles in off-shore/onshore structures. Therefore, it has an unexplored scope in repair industry. So, we can carry out the experimentations in checking verticality of piles and calculating magnitude of eccentricity in structures

1.3 Objectives of the Project

1. To evaluate the damages and disruptions caused to the structure and finding the reason or provoking factors
2. To analyse the working of LIDAR and its correlation with the project
3. To investigate the feasibility of the application of LIDAR in calculation of eccentricity in structures.
4. Correlate the outcome of LIDAR survey with the original drawings of the structure to measure the eccentricity occurred.

II. LIDAR

LIght Detection And Ranging (LIDAR) mapping is an accepted method of generating precise and directly georeferenced spatial information about the shape and surface characteristics of the Earth. Recent advancements in LIDAR mapping systems and their enabling technologies allow scientists and mapping professionals to examine natural and built environments using a wide range of scales. LIDAR uses lasers to measure the elevations of things, like ground, forests and even buildings. It looks like a radar which uses radio waves to map things, or sonar which uses sound waves to map sea lines, but a LIDAR system uses light transmitted from a laser. LIDAR, which is commonly spelled LIDAR and also known as LADAR, refers to optical remote sensing technology which measures properties of scattered light to find range and/or other information of a distant target.

2. Basic Components of LIDAR

LIDAR consists of the following separate components that operates independently:

- Laser ranging device.
- GPS: Global Positioning System, to track plane (x,y,z) position.
- IMU: Inertial Measurement Unit, to track planner position.
- Inertial System, such as a computer to record data.
- Digital Camera (Optional).

2.2 Working Principle of LIDAR

The main principle of this technology is to emit a pulse of light, and then receive the returned one in order to compute the difference in time between these two pulses. This difference in time, with the angle at which the pulse of light was fired, and the location of the system itself, the system will be able to give the three-dimensional coordinates of the target object.

As long as the pulses of lasers travel at the speed of light so the distance that the pulse traveled can be calculated using the following equation:

$$\text{Distance} = \tfrac{1}{2}[time\ travel \times speed\ of\ light]$$

And it`s divided by two since the light travels to the ground and back to the system

III. Proposed Methodology

The methodology for this research is as follow

The basic aim of the project is to extract the eccentricity that has occurred into the piles over the period of time regardless of the triggering factors (Disruption due to typhoon in this case). For calculating such, one must be able to map the pile profile in all three dimensional perspective. Application of LIDAR itself is superior over other traditional instruments as instruments like plumb bob, piano string, theodolite, etc. that was unpractical as they have limitations in calculating 3D measurements. The project has been carried out in following steps.

3.1 Reconnaissance Survey

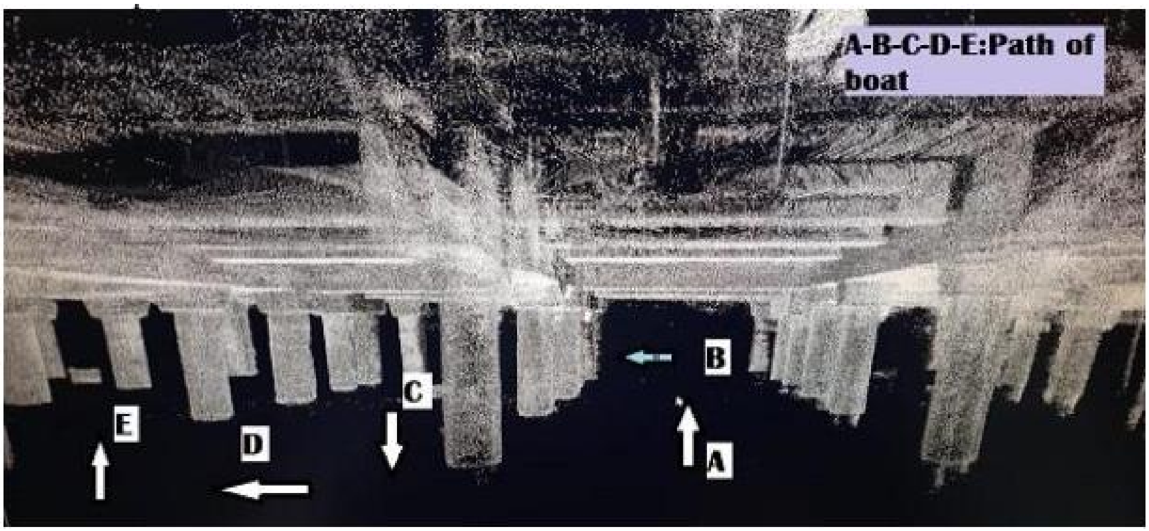
While carrying LIDAR survey the actual scope of work and understanding extend of the whole project plays an important role. For the case study, the part of jetty structure which has been left undamaged was visually inspected for the evaluation of extend of damage and to select the path of LIDAR survey through the piles.

3.2 Carrying LIDAR Survey

A best suitable LIDAR is then selected to perform the desired job for high precision images. Here, there were total 1081 no.s of piles, some severely settled and tilted. The survey requires a fixed reference point from where the data is measured, therefore it is fixed at one position in reference to the satellites, at one end of the boat which covers all piles in the selected path.

3.3 Acquisition and Interpretation of Data

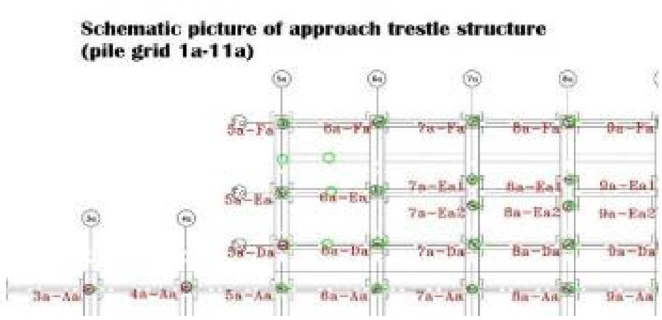
During the survey itself the processing unit records and saves data in the form of point cloud data. After the completion of survey, the final picturesque images are extracted from the point cloud data.

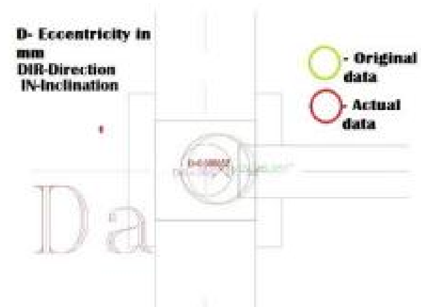


Img 3.3.1: Path of the boat through piles (LiDAR output data)

3.4 Calculating Eccentricity

The actual data obtained from LIDAR is then overlapped with the original data which can be present in the form of drawings, plans, etc. which in the end gives the exact magnitude of eccentricity occurred in the piles.





Img 3.4.1: A part of approach trestle structure (1a-11a) **Img3.4.2:** Calculating offset by overlapping

Then this data is compared to the standard/ maximum allowable eccentricity and safety of the pile structure is check.

IV. Conclusion

This study represents the use of LIDAR for verticality checking of piles and calculating the exact magnitude of eccentricity.

Testing experimentations using LIDAR application is successfully implemented which enables to conclude that the application of LIDAR for calculating eccentricity in all the 3 dimensions is feasible and is applicable in repairs and maintenance industry. When the outcome of LIDAR is overlapped with the original data available, one can easily find the offset and measure the distances. The system usually gives it in the form of inclination in the co-ordinates which when converted to millimetres from in degree. Based on the Indian code, The Pile verticality tolerance that is verticality of each pile shall not deviate at any point below the ground by more than 1 in 75 from the true vertical position [AISC 1973], i.e. allowable eccentricity is 75 mm in both directions. In this case, the obtained eccentricity of piles are, below 75mm except 10 no. piles eccentricity exceeds the limit. We are able to extract the magnitude with 100% accuracy as it deals with the shift in co-ordinates provided by the satellites. The resulting information can be used for checking the safe pile group performance.

REFERENCES

[1] Biswajeet Pradhan, Husam A. H. Al-Najjar et al (2020) Landslide Detection Using a Saliency Feature Enhancement Technique From LiDAR-Derived DEM and Orthophotos IEEE Access PP(99):1-1

[2] M. J. Lato; S. Anderson, M.ASCE; and M. J. Porter (2019) Reducing Landslide Risk Using Airborne Lidar Scanning Data, Journal of Geotechnical and Geo environmental Engineering, Vol. 145, Issue 9 (September 2019)

[3] Jon Sinnreich, P.E.; Roberto J. Singh, P.E.; and Colm M. O'Doherty (2018) Assessment of Bored Pile Verticality Using an Ultrasonic Caliper IFCEE 2018,American Society of Civil Engineers

[4] Azhar Ahmed, Norsharizal Sahlan et al (2017) On-Site Field Solutions To Pile Eccentricities (Revised) International Invention, Innovation & Design Johor 2017

[5] Lawrence Charlemagne G. David; Alejandro H. Ballado; Shydel M. Sarte; Rolando A. Pula (2016)Mapping inland aquaculture from orthophoto and LiDAR data using objectbased image analysis, 2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)