Bridge Construction Monitoring using LIDAR for Quantified, Objective Quality-Control Quality-Assurance (QOQCQA)

Development and implementation of a methodology to measure construction progress and compare it with the projected 3D shape, quantifying the difference

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Principal Investigator(s):
Fernando Moreu
University of New Mexico
fmoreu@unm.edu
Chris Lippitt
University of New Mexico
clippitt@unm.edu

Lead Institution:
University of New Mexico

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$75,000

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Tran-SET
University of New Mexico

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$150,000

The New Mexico Department of Transportation (NMDOT) is interested in exploring new technology available and implementing it in the quality-control quality-assurance (QCQA) of bridge construction, in particular during concrete pour and concrete finishing. To date there are no 3D requirements in the form of QCQA standards for the constructed concrete structures (in particular bridge decks). According to NMDOT, the current QCQA requirements are limited to the measurement of discrete points. If the entire volume/surface could be compared with the designed profile (in 3D) then the quality of the finished surface would be quantified and assessed with more precision. This study will develop and implement a methodology to measure construction progress and compare it with the projected 3D shape, quantifying the difference. This project will propose its implementation for the development of DOT standards that can be added in upcoming future bridge construction documents.

Problem Statement

The New Mexico Department of Transportation is interested in exploring new technology available and implementing it in the quality-control quality-assurance (QCQA) of bridge construction, in particular during concrete pour and concrete finishing. To date there are no 3D requirements in the form of QCQA standards for the constructed concrete structures (in particular bridge decks). According to NMDOT, the current QCQA requirements are limited to the measurement of discrete points. If the entire volume/surface could be compared with the designed profile (in 3D) then the quality of the finished surface would be quantified and objective with more precision.

State Departments of Transportation are facing three related problems without this technology: (1) the quality of the construction is not comparable across different projects, and errors may be carried over without being noted causing future costs, or unsafe structures; (2) high quality construction projects cannot be rewarded, and low-quality projects go unnoticed; (3) because the error cannot be measured today, the standards cannot be changed or imposed. If there would be a measuring technique, new requirements could be imposed, and the quality of the constructed surface as compared with the design surface could be increased.

Objectives

This research project will promote the use of new technologies (LIDAR) to solve a problem identified for NMDOT bridge engineers (specifically Kathy Crowell) which is the measurement of the quality of the bridge surface (especially bridge decks) during and after construction.

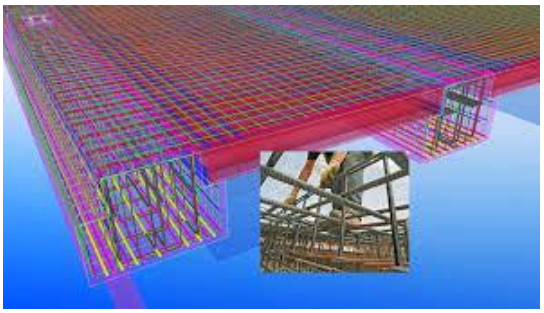

Figure 1. LIDAR to monitor construction activities.

The objectives of this project are:

a) To develop research in assessing if LIDAR technology can quantify bridge construction quality (specifically, reinforced concrete.)

b) To summarize the findings about LIDAR technology for the workforce and to receive their feedback if this technology can be used in their day-to-day activities.

c) To compare the value of LIDAR with alternative similar technologies.

d) To develop a draft of new bridge specifications that use LIDAR technology to quantify bridge construction quality, using feedback from NMDOT.

e) To promote outreach activities using technology and bridge engineering in open

houses, STEM, and high school summer camps as they relate to this project.

f) To promote workforce development by sharing new technologies that can be used as quality assurance during construction of the bridge that otherwise would not be discussed.

Intended Implementation of Research

Education and Workforce Development: The involvement of precollege, undergraduate students, and inspectors and infrastructure owners will enable the training of students and existing inspectors in new technologies while developing them and testing them in their operations. This project will develop STEM courses for undergraduate students that will be taught by graduates. This research will also expose existing inspectors to LIDAR technologies to quantify construction quality. The PI has conducted numerous workshops in previous projects involving the DOTs and the stakeholders as presenters, where the interaction with students and industry proved to benefit both educational and professional development goals. A new workshop in new technologies and their implementation in industry will be planned in New Mexico as part of the implementation phase of this research.

In terms of the workforce development, the research team acknowledges that DOT maintenance employees have already been overloaded due to the limited resources available. In order to avoid that the proposed new technology becomes a burden instead of a solution, the research team will always quantify the application that can be used realistically by NMDOT, by following these steps: (1) Collect feedback from NMDOT in Tasks 1-8 regarding current inspection challenges/needs (time, precision, field access) so the new method can be quantified in terms of the employees concerns, (2) determine in which types of projects this implementation would be an option, (3) for selected implementation projects, propose a realistic frame for state DOTs employees to use this technology, (4) quantify strengths and weaknesses of this technology using NMDOT's feedback in terms of quality of work improvement.

Outreach Activities: The participation of a wide variety of transportation experts in the review panel will ensure significant outreach in this project. This research project will also be presented during Engineering Open House activities, high school meetings, and other community events like STEM and STEAM-H that introduce young students to the importance of transportation engineering. The PIs are committed to increment their collaborations with the national laboratories of New Mexico in the area of bridge technologies that have an impact in both industry but also in younger generations that are attracted to technologies. More specifically, the PI has been a mentor of the Summer Transportation Institute (STI) and has also been very involved in high school presentations of new technologies associated to bridge monitoring. With this grant and the description of current needs to monitor bridges during construction, the PIs will attract younger generations to the transportation industry as a possible career in the context of smart transportation systems, smart cities and communities, and intelligent management of infrastructure

Anticipated Impacts/Benefits of Implementation

Gathering the experience of the team in LIDAR, collaborating with the railroad and the Los Alamos County, the results obtained from this research to develop a transportation infrastructure construction methodology using objective data in the field.

Web links

- TranSET's website (https://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1644245)

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.