

Bridge Load Posting Prediction

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Tran-SET

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\$180,122

Predicting bridge load posting using machine learning

12% of the 13,000 bridges in Louisiana that facilitate movement of people, goods, and services are load posted, i.e. they are deemed to lack the strength to safely carry all legal loads. With time, bridges will age and deteriorate; at the same time, legal loads might also become heavier. In this context, it is critical to estimate the expected number of load-posted bridges in future to allocate necessary resources during long-term planning and scheduling. Therefore, the research goal of this project is to quantify the number of load-posted bridges in Louisiana for the next 50 years by incorporating machine learning techniques, physics-based deterioration models, and probabilistic methods. To this end, first the National Bridge Inventory (NBI) database along with element level inspection data from Louisiana Department of Transportation and Development LADOTD (if available) will be used to gather data on bridges. Next, clustering techniques will be used to identify the key bridge parameters that most influence load posting decisions. Specifically, probabilistic clustering techniques like Gaussian mixture models will be used for clustering to enable incorporation of the uncertainties in the key parameters. Future values of the key parameters will be determined using Markov chain models whose transition probability matrices will be developed through available datasets (NBI and element level inspection data) and physics-based deterioration models for reinforced concrete and steel. To estimate the probability of load posting on a bridge given key parameters, logistic regression models will be developed. These load-posting probability estimates will be used in a probabilistic approach to estimate the number of load-posted bridges, along with confidence interval estimates.

Therefore, bridge condition has been a major concern for stakeholders at state and federal level. In this regard, to bridge safety, the Federal Aid Highway Act of 1970 established minimum data collection requirements and qualifications for bridge inspectors. These requirements were extended to all public bridges in the Surface Transportation Assistance Act of 1978. Additional requirements for inspection of bridge components that are under water and fracture-critical were introduced in the Surface Transportation and Uniform Relocation Assistance Act of 1987. The data collected from inspections of all the public bridges in the United States has been recorded in the National Bridge Inventory (NBI) database since 1983. Currently, the NBI database is one of the most thorough datasets with information on bridge condition of the past three decades. Since the NBI database includes information on the condition of the individual subsystems such as deck, super-structure, and sub-structure, several studies have used the NBI database to assess overall condition of a bridge. Furthermore, the NBI database consists of condition ratings of bridge subsystems over time, researchers have also developed models to predict the future condition of the sub-systems using data based simple regression models. Some studies have also tried to back predict sub-system condition ratings to fill missing data on past condition ratings.

Objectives

The research goal of this project is to quantify the number of load-posted bridges in Louisiana for the next five decades by integrating machine learning techniques, physics-based deterioration models, and probabilistic methods. The main objectives of this project are:

- Identify the key bridge, traffic, and climactic features (known as key bridge parameters from this point onwards) that determine load posting using unsupervised machine learning techniques.

Problem Statement

The public's safety using the transportation system mainly depends on the safety and load-bearing capacity of bridges. Furthermore, the load-carrying capacity of bridges is also vital for movement of goods and facilitating commerce.



- Estimate the future values of the key bridge parameters using probabilistic approaches that incorporate the effects of maintenance and rehabilitation.
- Calculate the likelihood of load posting for bridges given their key parameters and estimate the number of posted bridges in the inventory.
- Estimate the amount of load-posted bridges for the next 50 years by integrating the outcomes from objectives 1-3.

Intended Implementation of Research

Workforce Development: This will be achieved directly by training graduate, undergraduate, and high school students interested in pursuing a career in STEM or Transportation Engineering career.

Education and Outreach: PI-Kameshwar will train and help students write journal articles for their future projects. Additionally, the research findings will be disseminated via presentations at conferences, one of which will be at the TranSET conference. The PI will also organize outreach activities for school students in collaboration with the LSUEngage program to create expose school going children to careers in engineering. Specifically, hands-on activities will be developed for students visiting the LSU campus in Baton Rouge.

Anticipated Impacts/Benefits of Implementation

This research aims to estimate the amount of safe, load-posted bridges in Louisiana for future decades. The main deliverables of this project include:

1. A final report including a complete description of the problem, approach, methodology, findings, conclusions, and recommendations developed for the tasks.

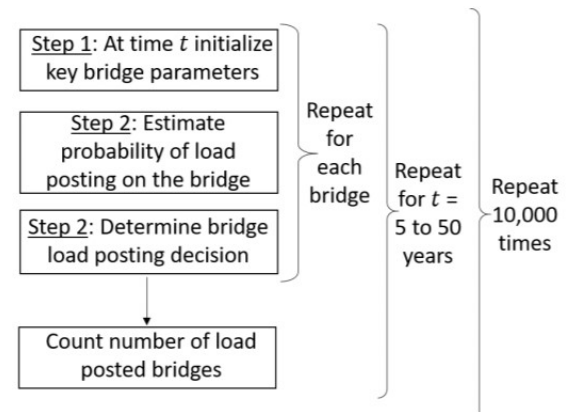


Figure 1: Procedure for estimating number of posted bridges for next 50 years

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 Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.

