ADVANCED STRUCTURAL HEALTH MONITORING WITH CARBON-NANOTUBES: AN EDUCATIONAL HIGHWAY BRIDGE MODEL

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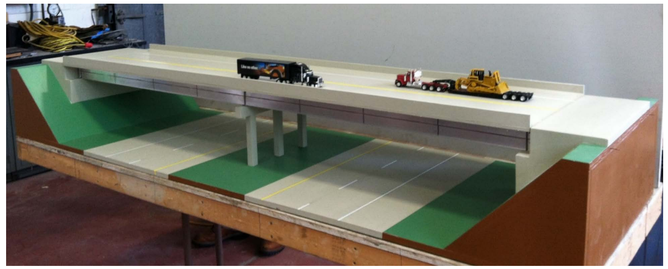
PROJECT OBJECTIVE

To design and construct a highway bridge model based on a typical bridge found in Delaware to be used as an educational tool and for showcasing the structural health monitoring (SHM) capabilities of Carbon Nanotube (CNT) based sensors.

Typical highway overpass in Delaware
(Source: www.aaroads.com)

HIGHWAY BRIDGE MODEL

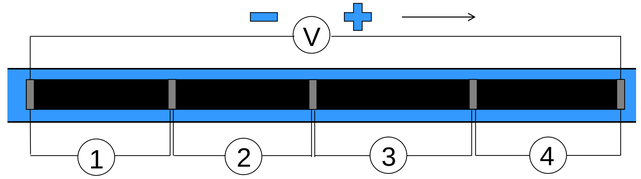


1:25 scale highway bridge modeled after a typical Delaware highway overpass

- Structural system: Two-span continuous, steel-concrete composite bridge, four main steel girders.
- Materials used: plywood (landscape, abutments and bents), aluminum (girders and bracings), and polyethylene (PE) (deck and Jersey barriers).
- Model has all details of a realistic highway bridge, including stiffener plates, cross bracings, and bridge bearings.

SENSING APPROACH

- Each bridge girder will be equipped with CNT-based sensing strips of a non-woven Aramid fabric.
- CNTs will be distributed using a sizing approach.
- Electrodes will be created by applying conductive silver paint to the sensing strip.
- CNT sensing strips are electrically conductive and are extremely sensitive to changes to strain.
- The strain increases the tunneling gap between CNTs which results in an increase in electrical resistance.
- Resistance changes can be measured between electrodes to determine strain.



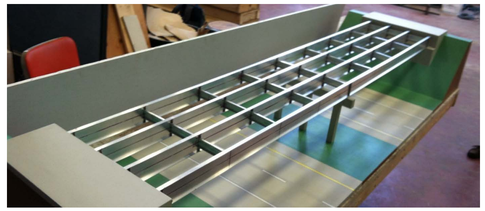
Example of a four channel sensing strip.

SENSING APPROACH (CONT.)

- Multiplexing = collecting data from many channels in a synchronized pattern using a DAQ.
- Channels on the bridge girders will be equally spaced 10” apart; there will be 32 channels on the bridge.
- Each bridge girder will have two sensing strips along the bottom, one on each side of the bent (= middle support) and each strip will have four channels (as illustrated in Fig. 3).
- LabVIEW will be used to control which channels are collecting data.

AN EDUCATIONAL TOOL

- Superstructure can be removed to reveal girders and support details
- Substructure (abutments and bent) built in accordance with bridge standards.
- Model will be employed in Civil and Mechanical Engineering courses.



Bridge superstructure with deck removed

A RESEARCH SHOWCASE

The model will showcase the latest technology in structural health monitoring:

- Distributed sensing for enhanced damage detection.
- Integrated sensing / reinforcement capabilities.
- Estimation of damage location based on multi-electrode measurements.
- Real-time monitoring and visualization of measured strains will allow students to study deformations and load distribution based on different load scenarios.

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WHERE DISCOVERIES BEGIN

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