2013/14 Undergraduate Research Grant Scheme – Executive Summary

Project title:
Using distributed temperature measurements to characterise thermal stress variations in highway bridges

University:
University of Exeter

Supervisor:
Prakash Kripakaran

Contact details:
Harrison Building, North Park Road, College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter, EX4 4QF
Telephone: 01392 726 581
Email: p.kripakaran@exeter.ac.uk

Student: Matthew Wilson

Project summary:
Bridges are constantly expanding and contracting due to temperature changes, both in the short term and long term due to daily and seasonal temperature changes. Daily temperature changes due to solar radiation can cause non-uniform temperature distributions, causing different parts of bridges to expand and contract at different rates. These movements can cause stresses not accounted for by current design codes. The project aimed to determine the magnitude of these stresses using finite element analysis, using data collected using thermal imaging. Temperature data for two bridges made of steel and concrete were collected at three times of day using a thermal imaging camera, an innovative method for measuring temperatures in structures. Temperature data confirmed that non-uniform temperature distributions were present, with the transit of the sun causing uneven heating of bridges orientated in length from north to south. Numerical models of these bridges were then designed on the finite element analysis package ANSYS, and the temperature scenarios input to the models. These models show that high thermal stresses occur, especially when one side of the bridge is expanding at a greater rate than the other. Results also showed that stresses were high in the concrete bridge, due to the large volume of concrete which leads to high volumetric expansion when heated. Thermal stresses were compared to live-load induced stresses. For the concrete bridge, thermal stresses were greater than the live-load induced stresses, and for the steel bridge thermal stresses were lower than live-load induced stresses.