Announcing the Final Examination of Jeanne Bowie for the degree of Doctor of Philosophy

Time & Location: January 18, 2011 at 3:00 PM in Engineering II 211 Conference Room
Title: Development of a Weigh-in-Motion System Using Acoustic Emission Sensors

This dissertation proposes a system for weighing commercial vehicles in motion using acoustic emission sensors attached to a metal bar placed across the roadway. The signal from the sensors is analyzed by a computer and the vehicle weight is determined by a statistical model which correlates the acoustic emission parameters to the vehicle weight. Such a system would be portable and low-cost, allowing for the measurement of vehicle weights in much the same way commercial tube and radar counters routinely collect vehicle speed and count. The system could be used to collect vehicle speed and count data as well as weight information.

First, the concept was tested in a laboratory setting using an experimental apparatus. A concrete cylinder was mounted on a frame and rotated using a motor. The metal test bar was applied directly to the surface of the cylinder and acoustic emission sensors were attached to each end of the bar. As the cylinder rotated, a motorcycle tire was pushed up against the cylinder using a scissor jack to simulate different loads. The acoustic emission response in the metal test strip to the motorcycle tire rolling over it was detected by the acoustic emission sensors and analyzed by the computer. Initial examinations of the data showed a correlation between the force of the tire against the cylinder and the energy and count of the acoustic emissions.

Subsequent field experiments were performed at a weigh station on I-95 in Flagler County, Florida. The proposed weigh-in-motion system (the metal test bar with attached acoustic emission sensors) was installed just downstream of the existing weigh-in-motion scale at the weigh station. Commercial vehicles were weighed on the weigh station weigh-in-motion scale and acoustic emission data was collected by the experimental system. Test data was collected over several hours on two different days, one in July 2008 and the other in April 2009. Initial examination of the data did not show direct correlation between any acoustic emission parameter and vehicle weight. As a result, a more sophisticated model was developed.

Dimensional analysis was used to examine possible relationships between the acoustic emission parameters and the vehicle weight, revealing a possible relationship between the acoustic emission parameters and the vehicle weight. Statistical models for weight using the laboratory data and using the field data were developed using dimensional analysis variables as well as other relevant measurable parameters. The model created for the April 2009 dataset was validated, with only 27 lbs average error in the weight calculation as compared with the weight measurement made with the weigh station weigh-in-motion scale. The maximum percent error for the weight calculation was 204%, with about 65% of the data falling within 30% error.

Additional research will be needed to develop an acoustic emission weigh-in-motion system with adequate accuracy for a commercial product. Nevertheless, this dissertation presents a valuable contribution to the effort of developing a low-cost acoustic emission weigh-in-motion scale.

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Approved for distribution by Dr Essam Radwan, Committee Chair, on November 10, 2010.

The public is welcome to attend.