

JERSEY DOT'S

"Turning Problems into Solutions"



Tech Brief

Implementation of Advanced Fiber Optic and Piezoelectric Ceramic Sensors

FHWA/NJ-1999-029

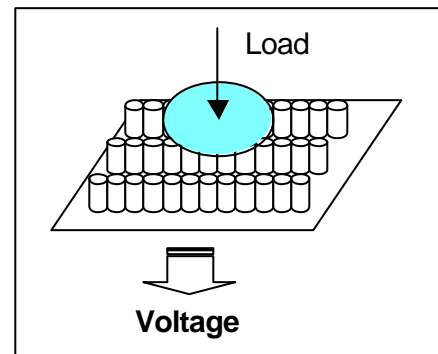
February 1999

WHAT DO YOU USE A PIEZOELECTRIC SENSOR FOR ANYWAY?

The piezoelectric sensor is part of a Weigh-In-Motion (WIM) Systems that can be used to measure the weight of the vehicle that is rolling over them.

WELL, HOW DOES IT DO THAT?

Piezoelectric sensors produce a voltage proportional to the load that is put upon it. So, it creates a voltage, the data is collected, and then the data is analyzed and the weight of the car or truck is estimated.



WHAT IS PIEZOELECTRICITY ANYWAY?

When certain materials are loaded (stressed), the sensor material is compressed causing a piezoelectric effect or a change in polarization which produces a voltage charge. So when trucks run over the sensor, they create a charge within the sensor. The charge is variable depending on how much the truck weighs and some other factors. The data from the sensors is stored in a computer at the site and is used to calculate the weight of passing trucks.

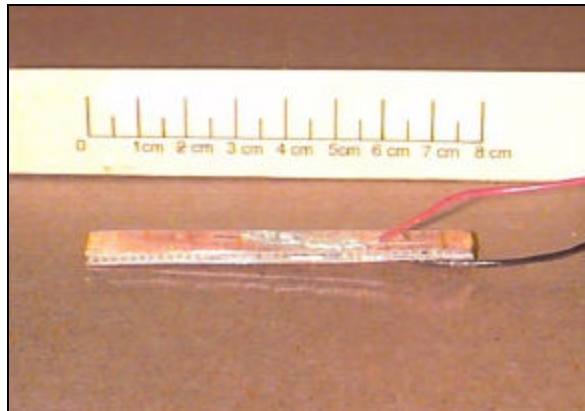
WHAT DID WE DO?

Well, we took several different types of piezoelectric sensors and tested them to determine their effectiveness with regards to:

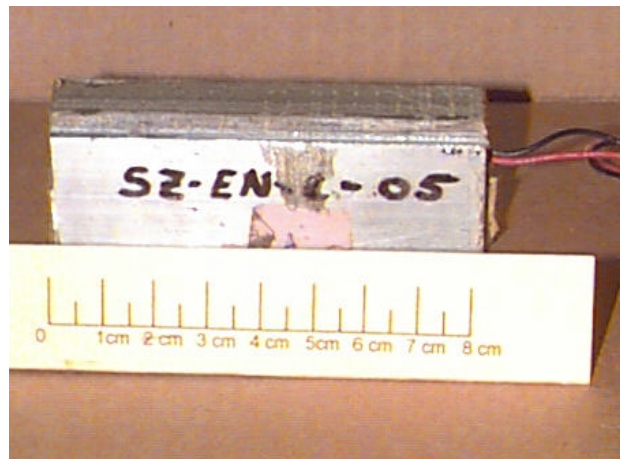
- Accuracy in measuring the weight or load applied
- The effect of Temperature on weight determination
- The Durability of the sensor unit

We built sensors, placed them in an aluminum channel, encapsulated the sensor in an epoxy and then tested them in the laboratory to simulate passing vehicles.

HERE'S WHAT IT LOOKS LIKE BEFORE ENCAPSULATION



HERE'S WHAT IT LOOKS LIKE AFTER ENCAPSULATION

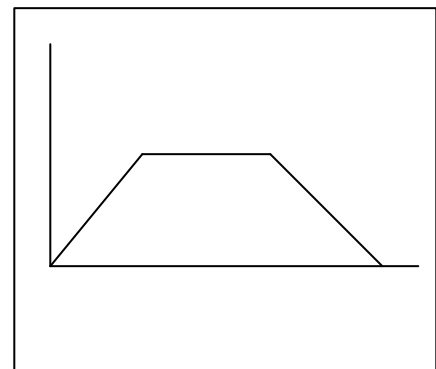


AND HERE'S HOW WE DID IT

We used an MTS universal testing machine with an environmental chamber to apply compressive loads to the sensor at two different temperatures, 23 and 65degrees Celsius. The MTS machine was hooked up to and a data acquisition device with load measuring software. Then we conducted a series of tests.

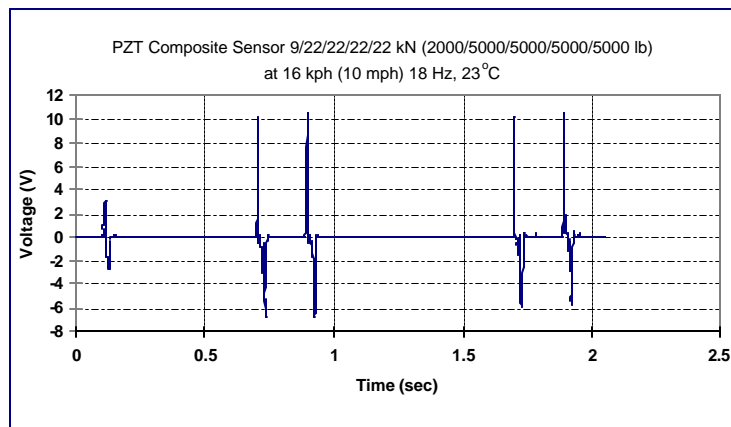
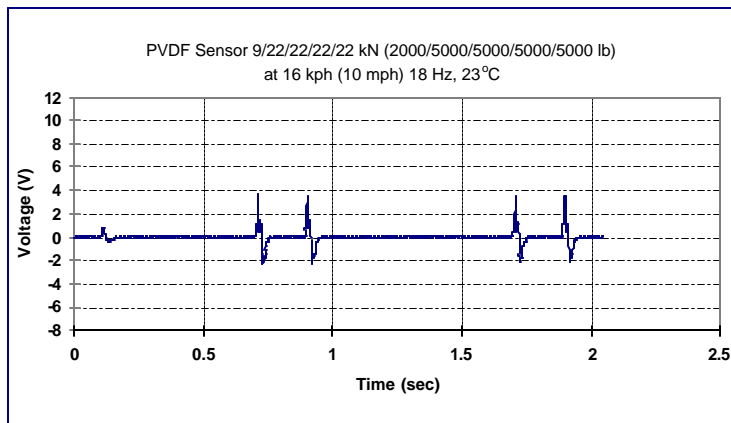
BUT WHAT ABOUT TESTING FREQUENCY???

When a car rolls over a point in the road, first the front tires hit it and then the back. Well, a truck is similar to this except that it can have a variety of axle configurations (single axle, tandem axles, single tires, or dual tires). A portion of the truck's weight is transferred to each axle and then to the tires. The



truck's weight is transmitted to the pavement over the area that comes in contact with the road. That is usually about 95 square inches. Only a certain portion of the wheel's loaded area will come in contact with the sensor and will only last a short time (0.2 seconds at 50 mph). The testing frequency is base on the rate of loading of the sensor, the duration of the load, and rate that the load is removed. Graphs of the laboratory simulation were provided showing the testing frequency and the oscillations in the voltage within the sensor. A graph is shown below.

A COMPARISON OF DATA OUTPUT FOR TWO DIFFERENT TYPES OF SENSORS



HERE'S WHAT WE CAME UP WITH...

Based on these laboratory tests, the piezoelectric sensors performed far better than their predecessors in almost every category.

THE BOTTOM LINE...

The testing produced excellent results and provided the basis for further research in the area. The followup research being conducted will evaluate the repeatability for the sensor systems in the field under a variety of temperatures. The next step will be to take this sensor technology and apply it on actual in-service road.

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A full-text final report is available online at

<http://www.state.nj.us/transportation/research/research.html>

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to

Research.Bureau@dot.state.nj.us and ask for:

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