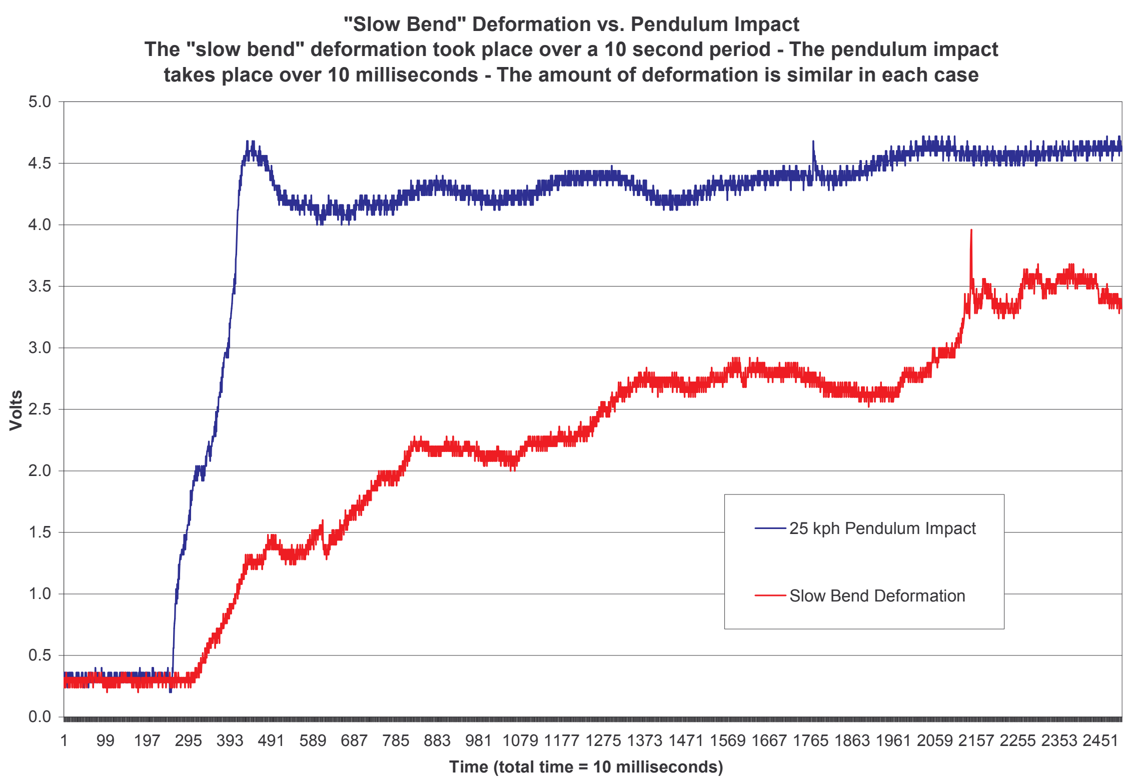
Variable Speed Impact Testing on Flexpoint Pedestrian Impact Detection System

This is a summary of the testing that Flexpoint conducted in our Draper, Utah facility. We set up our pendulum to impact a leg form and the steel pole (that we have previously tested) at 5 kph, 10 kph, 15 kph, 20 kph, and 25 kph. The same sensor was used for all tests reported here. The request was made to demonstrate how the Bend Sensor® can be used as a switch and/or discriminator in defining an impact. To this end we are presenting the following data to show several scenarios and corresponding outcomes.

First, the Bend Sensor behaves very differently in a dynamic impact, versus the same "bend" radius in a static condition.



As noted in the graph the amount of deformation between an impact and the static bend (of similar depth and radius) is different in both the magnitude of change and the slope of the change. The time of the deformation curve should be 1000 times longer than shown, but was reduced to fit on the same graph as the slow bend deformation. The slopes are significantly different. Even more so than it appears due to the time differential.

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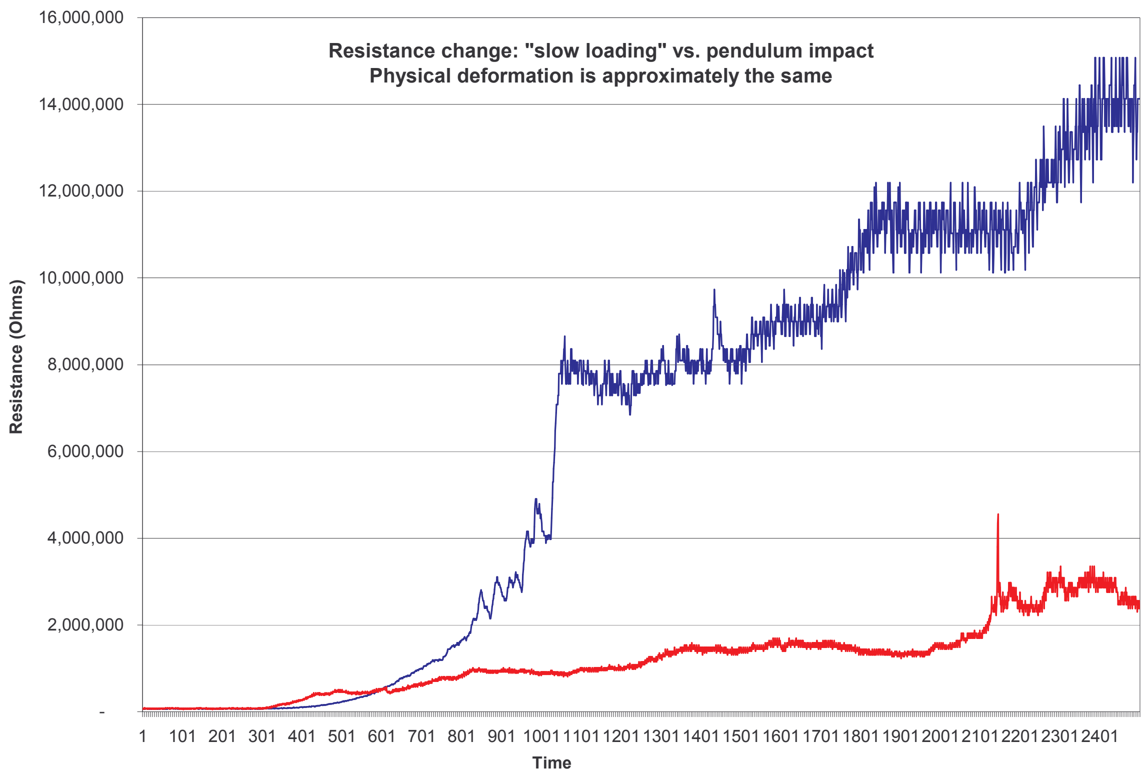
The change in resistance due to an impact vs. that which is attributable to statically bending it around a form is different by orders of magnitude.



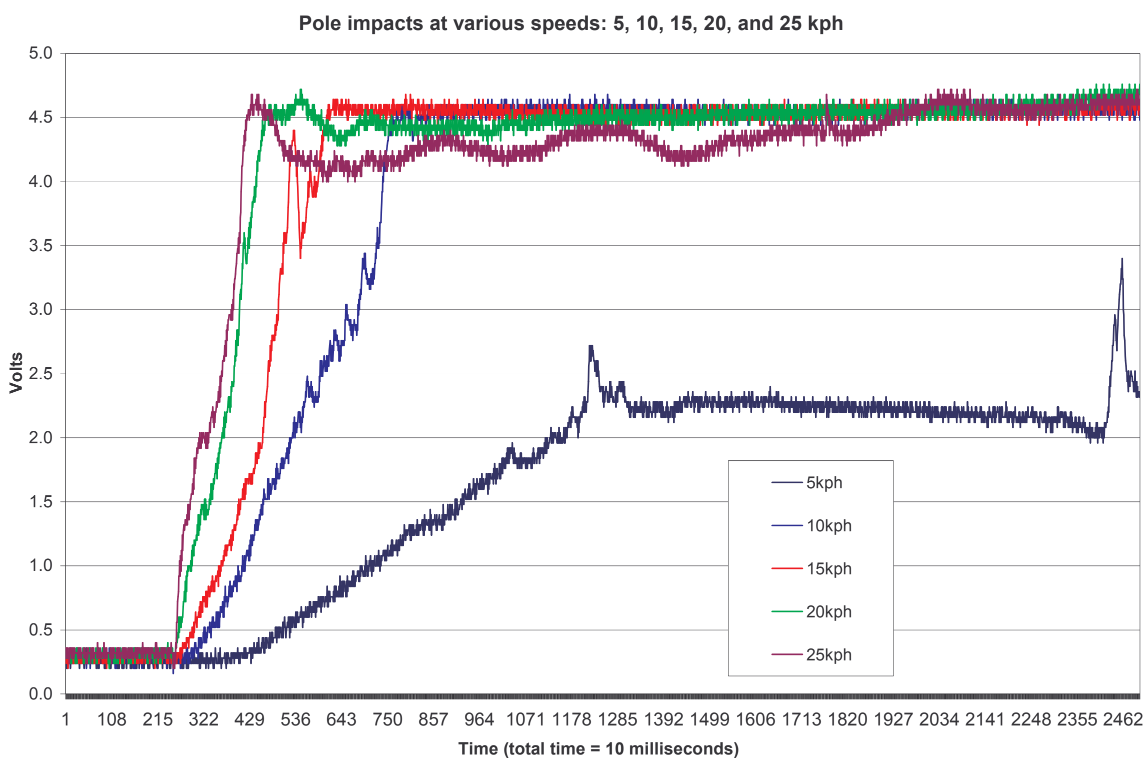
Therefore, the un-impacted resistance values, or range of values, and the impacted resistance values, or range of values, (considering all manufacturing variances and environmental factors) are different enough that those two groups will not have any overlap.

Items that differentiate the sensor when incorporated into the bumper system:

1. The sensor is mounted such that the Bend Sensor "ink" is much further from the neutral axis of its assembly due to the bumper fascia (0.125" thick). The tension seen in this case being much greater and yielding the 2 to 3 mega ohm value. In the dynamic situation of a collision there is localized elongation that contributes to the dramatic increase seen above which yields the 13 to 14 mega ohm readings. These are things that the phase two test would not have shown.
2. The sensor is fully adhered to the length of the bumper fascia.

If desired, it is still a viable approach to program a microprocessor (whether stand alone or on the vehicle) to use two resistance "bands" or "ranges" to define an impact. As an example, if the resistance is less than 100 Kilo ohms then it is "off", and if the resistance increases to greater than 5 or 6 mega ohms then it is "on". This method can be used but eliminates much of the potential of the Bend Sensor.

The other manner to use the sensor as a switch or discriminator is to monitor the rate of change along with the amount of change. In this way all environmental considerations and minor damage to the bumper fascia are irrelevant. Minor damage being defined as anything less than a torn sensor. The following graphs show the rate of change and amount of change for impacts that range from 5 kph to 25 kph (all on the same sensor).



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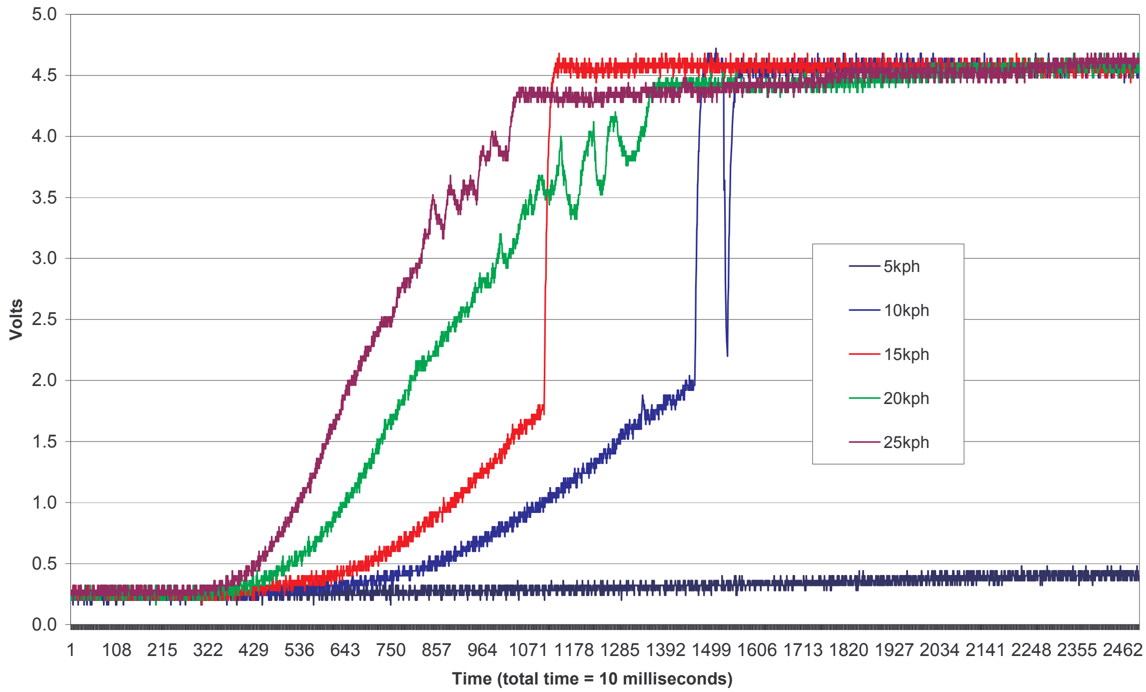
Leg impacts at various speeds: The spikes at 10 and 15 kph deliniate the point at which the impact moves through the foam "skin" and impacts the central steel structure



The microprocessor would be required to "store" a few milliseconds of baseline data. Since the impacts register in less than 2 milliseconds, and are defined in less than 5 milliseconds, the algorithm would look at the rate/slope and then be able to switch on or give more definitive information. The slope in all cases is about 1 Mega ohm per millisecond.

In summary: the tests shown here were performed in a very short period of time. I do not dispute the results based on the fact that they show the same things we saw in the results obtained by MGA Research (pendulum and linear impactor) and the testing Flexpoint conducted several months ago. The primary conclusion is that loosely adhering sensors to a bent plate (static test) will not give the same change in resistance as sensors that are securely adhered and then dynamically impacted. In order to evaluate the effectiveness of a sensor in an impact, they must be tested with a dynamic impact apparatus such as a pendulum or linear impactor.

Our quick tests show that an impact yields peak resistances in the range of 13 to 14 Mega ohms, this in contrast to the 2.5 to 3 Mega ohms seen in the "slow bend" test. Baseline resistances still are about 75 Kilo ohms for this test sensor even after the large number of impacts it endured.

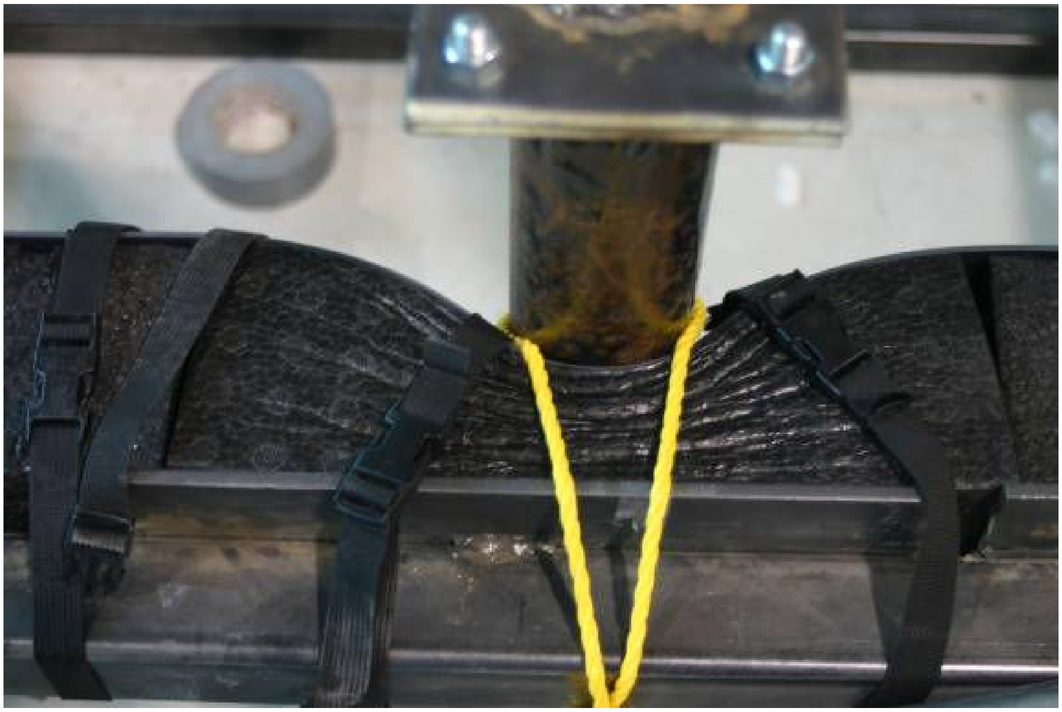


Figure 1: Rear view after being "clamped" to the bumper block.

Figure 2: Front view after being "clamped" to the bumper block. Notice the re-entry radii.

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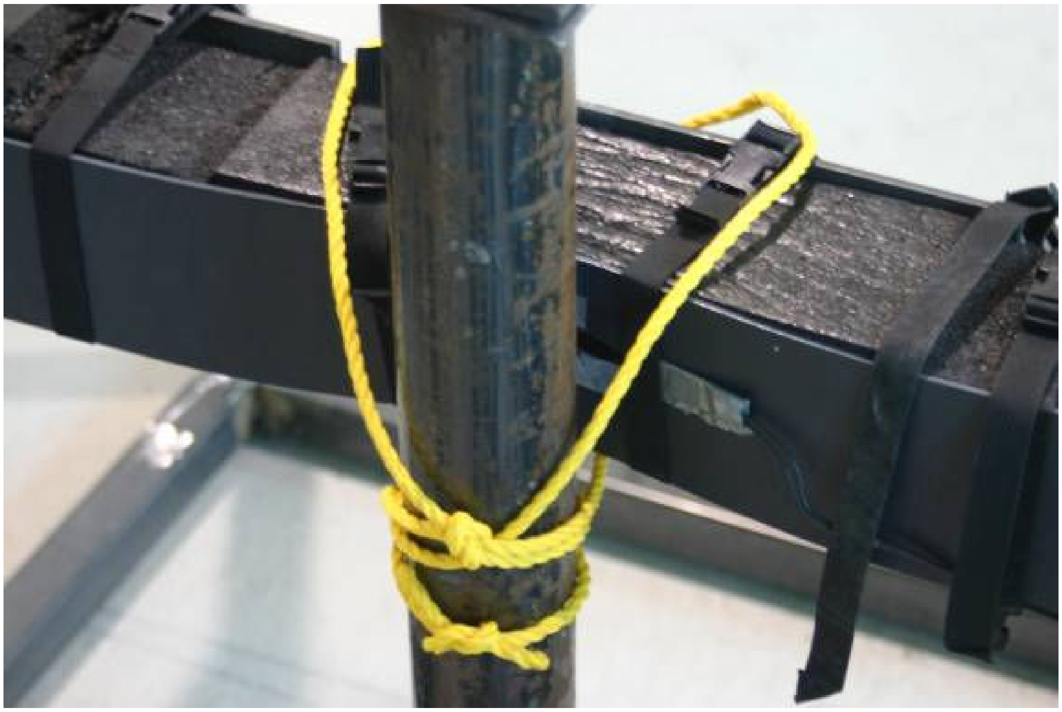

Figure 3: Unloaded bumper block. The indentation is from the repeated impacts, the sensor still performed well.

Figure 4: The angle iron block support was relieved to prevent damage to the leg and pole during impacts.