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OCE 495/496 Bridge Team 2014-2015

Write-up for final report on Background research section

(under) **Introduction** section

**Claiborne Pell (Newport)Bridge**

1. Claiborne Pell Bridge background, other bridges etc.

The structure of focus for this project is the Claiborne Pell Bridge, known simply as the Newport Bridge, located between Jamestown and Newport Rhode Island. Virtually any suspension bridge would serve as a suitable subject for this projects testing, however, close geographic location to the University of Rhode Island’s engineering facilities, as well as prior contacts within the Rhode Island Bridge Authority, made the Newport Bridge an easily selected test subject.

Operated by the Rhode Island Turnpike and Bridge Authority, construction of the bridge began in 1966 and completing in 1969 by the Parsons, Brinckerhoff, Quade & Douglas Company. On average, the bridge carries 27,000 vehicles on a given day across its 11,248 foot length and four lane, 48 foot width. Naturally, of particular interest to this project are the bridges main support cables, which are relied on to carry the load of the bridges main span length of 1,600 feet. Level of detail allowable for public release here? Hundreds of individual steel wires, divided into individual strand groups comprise each of the bridges two main support cables, constituting the area of of acoustic health monitoring that this project examines. Both the ‘hand ropes’ (running parallel with the main cables, and ‘suspender ropes’ (running vertically from the main cables to bridge deck) will not be examined in this report. The current means of health monitoring of the Newport Bridge’s main suspension cables conducted by the Rhode Island Turnpike and Bridge Authority were first examined. Don’t have much on the destructive testing that they actually do utilize. At this point, ‘Other Bridges’ now gets into Mikes introduction wit Bear Mountain Bridge.

**Literature Review**

1. Existing devices, patent search (passive were found to be cumbersome and complex, active was seeming like the better choice)
2. Experiments now, signal sending, waveguides, piezoelectric exciters

When tasked with finding a solution to any engineering problem, it is essential to have extensive background knowledge of the topic, as well as information on existing methods or solutions. From an economic and practical standpoint, simpler is usually better and while sometimes necessary, ‘reinventing the wheel’, should not be a projects starting point. To this end, since the structural monitoring of bridges has been carried out since the first was built; preexisting methods and devices specific to monitoring the cables were researched.

A variety of methods were found to be employed, including previously mentioned visual inspection methods & destructive testing, complex sensor arrays consisting of accelerometers, strain gauges, displacement transducers, level sensing units and weight-in-motion sensors[[1]](#endnote-1). The majority of electronic sensor arrays found however, pertained to the monitoring of other areas of the bridge structure, rather than its cables[[2]](#endnote-2).

**Passive Vs. Active Acoustic Systems**

**Acoustic Waveguides**

The use of acoustic waveguides was explored to be used as a possible means of remote passive sensing or even active acoustic longitudinal excitation. Waveguides, as the name suggests, serve as a path to guide traveling waves to a potentially more useful location. Doing so allows for data that has less interference from outside factors (i.e. noise), spreading, propagation through air, etc, resulting in more accurate data.[[3]](#endnote-3) Various physical materials of which to comprise the waveguide, as well as its shape were studied at the University of Western Australia, Perth.[[4]](#endnote-4) Experiments found no significant attenuation, however signals did appear contaminated by reflections and resonance. The consensus of the experimentation cited that “When implementation of this technology is necessary, specific designs should be tested prior to installation to determine actual transmission characteristics”.

**Acoustic Waveguides**

University of Colorado, Boulder

<http://spot.colorado.edu/~pricej/pdf%20docs/Acoustic%20Waveguides.pdf>

* The whole idea is to obtain data that has less interference from outside factors: Uses example of a bugler in a room (sound bouncing off walls, non-uniform emission, etc.)
* If you instead record the sound when it is still inside of the bugle, it is more direct and ‘cleaner’
* Lots of elementary acoustics equations, spreading
* Mostly focusing on propagation through air (inside of sound tube waveguide

**The Effect of Waveguide Material and Shape on Acoustic Emission Transmission Characteristics**

<http://www.ndt.net/article/jae/papers/22-264.pdf>

* ” This paper presents the effects of varying waveguide material and/or shape on traditional
* acoustic emission characteristics of pulsed events”
* Experiments found no significant attenuation, however signals did appear contaminated by reflections and resonance.
* “When implementation of this technology is necessary, specific designs should be tested prior to installation to determine actual transmission characteristics”

**A Wire-Guided Transducer for Acoustic Emission Sensing**

<http://users.ece.cmu.edu/~dwg/research/6529_35Wireguided.pdf>

* “A novel transducer for active or passive sensing has been developed and tested experimentally.”
* Small wire can act as a ‘middleman’ (waveguide) from material being tested to a piezoelectric sensor- useful for source localization, high temperatures and otherwise problematic mounting areas

**Concept Generation**

A firm background knowledge of existing systems for acoustic health monitoring of structures was necessary to be obtained first for this project.

1. <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=982652> [↑](#endnote-ref-1)
2. <http://www.hindawi.com/journals/tswj/2014/689471/> [↑](#endnote-ref-2)
3. <http://spot.colorado.edu/~pricej/pdf%20docs/Acoustic%20Waveguides.pdf> [↑](#endnote-ref-3)
4. <http://www.ndt.net/article/jae/papers/22-264.pdf> [↑](#endnote-ref-4)