Conclusions:

Mode Shapes for Cantilever Beam

* Displacement of beam at point can be predicted based of the predicted mode shape.
* Displacement along the beam and be related to the acceleration along the beam.
* Knowing the expected displacement and acceleration along the beam, locations for the transducers can be chosen. Chosen locations maximize the transducers output without overloading. Preventing quantization and clipping errors.

Measuring Beam Tip Displacement with Eddy Current Probe

* Eddy current probe’s linear range and sensitivity was found at the beam tip (location of micrometer) and at its final position (3 in from fixed end). Linear range is small; calibration must be done in small increments.
* Displacement at ECP’s position can be related to the displacement at the beam tip using the mode shape.

Measuring Beam Tip Displacement with Accelerometers

* 1 V/g and more sensitive 0.1 V/g accelerometers were available and used.
* The more sensitive accelerometer was located closer to the fixed end to accurately record the lower acceleration.
* The less sensitive accelerometer was located at the beam’s tip (the location of interest).
* The 0.1 V/g accelerometer showed higher frequencies on top of the frequency of interest (mode 1 ≈31Hz). Placing this accelerometer at the node of mode 2 improved resolution of mode 1.
* Simpson’s Rule for integration can be used to find displacement with acceleration data.
* Drift resulting from integration can be corrected by removing the dynamic offset.
* Mid beam acceleration → mid beam displacement → tip displacement.

Three Transducers at Three Locations

* 3 transducers measured similar tip displacements.
* Any one of these could be used on their own.

Natural Frequency and Damping ratio

* Calculated natural frequency was very close to measured natural frequency.
* Mass of accelerometers impacts natural frequency of beam.
* Damping

Measurements on a Wind Turbine Blade

* These transducers could be used to measure the dynamic characteristics of a wind turbine blade. However, locations and sensitivities will need to be evaluated as documented in the analysis.
* Based on the wind turbine blade’s size the use of an eddy current probe may not be ideal due to its small linear range.
* The natural frequency of the blade can be found using these methods as appose to an analytical approach. Blade’s dimensions and properties are more complicated than a beam’s.

What would we do different?

* More effort focusing on calibrating the ECP. It was underestimated how long this would take.
* Obtain more detail on the ECP equipment.
* Further study of the frequency response of the ECP.
* Calibrate the accelerometers with a shaker shaking at approximately 30 Hz. Need reference accelerometer.
* Further study: Attach shaker at approximately 30 Hz to the beam to study tip response in resonance.

|  |  |  |  |
| --- | --- | --- | --- |
| **Transducer** | **Tip Displacement (m)** | **Natural Frequency (Hz)** | **Damping Ratio** |
| Theoretical | 0.002159 | 29.7 | N/A |
| **Calculated** | | | |
| Eddy Current Probe | 0.00213 | 26.86 | 0.012 |
| 0.1 V/g Accel | 0.0022 | - | - |
| 1 V/g Accel | 0.0022 | - | - |