CALIBRATION OF BTT MEASUREMENT WITH RESPECT TO SENSOR POSITION OVER SHROUDED LSB

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In order to increase efficiency and reliability of steam turbines, last stage blades are equipped with mid-span tie-boss and shroud. We can use Blade Tip-Timing method (BTT) to measure vibration of shrouded blades, but the measured level of vibration is dependent on position of sensor over blade shroud. Hence, the results of BTT measurement have to be compared with other measurement techniques, like strain gauges, and with FEM analysis, to interpret these results right. This article provides findings we made on measurement of shrouded blades in test rig with eddy-current sensors, optical sensors and strain gauges at different positions of sensors over blade shroud. Measurement is also compared to FEM analysis.

Keywords: Blade Tip-Timing, Calibration, Sensor

1. Measurement description

The measurement was done in Campbell test rig on LSB for 60 Hz. The Campbell test rig operates without steam, blades rotate in vacuum. To excite blades an electro-magnet, oil jets or torsional shaking can be used.

The blade vibration was measured by strain gages and BTT. For BTT measurement optical and eddy-current sensors were used to compare results from them.

The signal from eddy-current is sensitive on position of magnet and coil inside the sensor, on position of sensor over blade shroud and on rotational frequency. In this context, sensors were attached to a threaded rod with stepper motor, that allowed us to move those sensors along the blade shroud step by step and measure on different positions. Therefore there was no requirement of running-down and moving the sensors manually as presented in [1] on different type of blade.

By optical sensor we can measure both edges of the blade, so by moving it along the blade shroud we are able to scan the shape of the shroud.

2. Results

Two types of measurement were done: First, test of how are the data form sensor effected by its orientation. Five different positions of coil and magnet inside the sensor were chosen and results are in the Figure 1 (left), where color represent orientation of sensor. Second measurement focused on the amplitude of vibration
on natural frequency and comparison of different sensors. Results for 0ND are in the Figure 1 (right), where color represent amplitude measured on natural frequency.

![Figure 1: Eddy-current data with different orientation of sensor (left), amplitude from optical sensor ($s_o$) and from eddy-current ($S_e$) on natural frequency 0ND.](image)

3. Conclusion

The measurement brought a new look on measuring with eddy-current sensor and we found an optimal position of sensor over blade shroud for this type of blade.

We expect a repetition of this measurement in the test rig with another type of blade with larger diameter. This could demonstrate the difference of sensor signal behaviour, especially on leading edge, where the measuring point of eddy-current for this blade is unclear.

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References


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