Oar Measurement System Specification

Your Name

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1 Structural Analysis

1.1 Beam Theory Assumptions

Text for your beam assumptions goes here...

1.2 Buckling Analysis

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1.2.1 Thermal Amplification

Temperature variations do not only induce direct thermal expansion but also amplify existing imperfections in the measurement system. The resulting thermal effect can be represented as an effective change in both the measurement gain and offset.

The measured strain at temperature T is expressed as:

$$\varepsilon_{\text{meas}}(T) = A_T(T)\,\varepsilon_{\text{mech}}(T_0) + \varepsilon_{\text{offset}}(T) \tag{1}$$

where:

- $\varepsilon_{\text{mech}}(T_0)$ is the mechanical bending strain at the reference temperature T_0,
- $A_T(T)$ is a dimensionless thermal amplification factor,
- $\varepsilon_{\text{offset}}(T)$ is a temperature-dependent offset caused by assembly prestress, twist amplification and differential expansion.

For small excursions around T_0, the amplification factor may be linearised as:

$$A_T(T) \approx 1 + k_T\,(T - T_0) \tag{2}$$

where k_T [K^{-1}] is an effective thermal amplification coefficient to be obtained from calibration.

The linear approximation in Eq. (2) assumes that the operating temperature remains sufficiently close to the reference temperature T_0 such that higher–order thermal effects are negligible. This corresponds to a first–order Taylor expansion of $A_T(T)$, which is appropriate for modest temperature excursions where:

$$|T - T_0| \ll \frac{1}{|k_T|} \tag{3}$$

In the context of this system, the validity of the linear model will be verified experimentally during temperature calibration. If significant non-linear behaviour is observed, additional higher–order terms in temperature may be introduced.

Substituting Eq. (2) into Eq. (1) gives:

$$\varepsilon_{\text{meas}}(T) \approx \left[1 + k_T \left(T - T_0\right)\right] \varepsilon_{\text{mech}}(T_0) + \varepsilon_{\text{offset}}(T) \tag{4}$$

Equation (4) shows that thermal effects act as a multiplicative amplification of the mechanical strain measurement in addition to an additive temperature-dependent offset. Both parameters k_T and $\varepsilon_{\text{offset}}(T)$ must be determined experimentally during calibration.

2 Electronics and Signal Chain

Text about electronics...

3 Calibration and Testing

Text about calibration...