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Autor: Jensen, J. Laigaard / Pedersen, Lars
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Design of Structural Monitoring Systems

J. Laigaard JENSEN
Dr. Eng..
COWI
Lyngby, Denmark

Jakob Laigaard, born 1961, received his civil engineering degree from the Aalborg University, Denmark in 1986. He has specialised in structural monitoring and structural dynamics.

Lars PEDERSEN
Civ. Eng.
COWI
Lyngby, Denmark

Lars Pedersen, born 1966, received his civil engineering degree from Aalborg University, in 1991. He has specialised in structural monitoring and instrumentation of large structures.

Abstract

This paper reviews and discusses approaches and processes involved in the design of structural monitoring systems. Within the civil and offshore engineering industry, monitoring systems are used either as permanent or as ad hoc systems (testing) providing information with objectives of obtaining information maximising revenue with respect to design, construction, operation and maintenance, and repair of structures.

The design of such systems may simply be carried out based on a pragmatic basis resting on compromises within what may be called good engineering judgement, or the design decisions may be made on a more rigor basis applying rational cost-benefit analyses.

Through a discussion of principles and examples, this paper discusses these aspects of the design of structural monitoring systems. It is argued that there are very good reasons for forcing the design process into a more rigor framework based on rational decision approaches, well-known from experimental design in general.

1. Structural Monitoring Objectives

In reviewing the design of structural monitoring systems, it is important to focus on the fact that the product being sold is information. The information from structural monitoring systems may interact with decisions to be made with respect to design, construction, operation and maintenance of the structure and the paper discusses some of the main objectives in this respect.

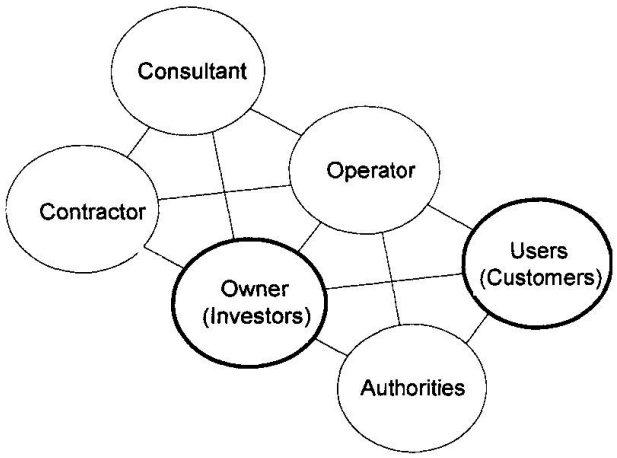
The need for a structural monitoring system should be seen in the light that it is expected that the system will provide information which will have an impact on decisions to be made. This implies answering the questions:

- Should structural monitoring be carried out at all?
- What would the allowable monitoring costs be?
- Of a number of alternative structural monitoring alternatives which should be chosen for implementation?

Answering these questions may be carried out on a quite pragmatic basis or it may be attempted to go through a more rigor and rational decision process.

2. Design in a Pragmatic Framework

In practice, design of structural monitoring systems is quite frequently carried out on a fairly pragmatic basis leading to decisions based on compromises between interests involved. The interests involved are represented by a number of players who are engaged in the design decisions.



However all players points of views may not only rest on strict rational arguments with respect to economy and safety issues but also on less rational arguments which may be related to personal, political or secondary commercial interests.

In total, this complexity means that a pragmatic decision process may very well depend somewhat randomly on the power balance of interest involved and thus lead to less efficient structural monitoring systems where benefits are not balanced by the costs.

3. Design in a Rational Framework

To avoid ineffective structural monitoring systems, the best approach is to seek to put the decision process into a rational framework with the objective of identifying the expected benefits and costs of the structural monitoring items. In the rational approach, as outlined in the paper, a cost-benefit study is carried out based on a probabilistic assessment of the expected value of gathering information by a structural monitoring system compared to the expected costs of obtaining this information.

The decision maker is hereby forced to face and discuss the consequences and uncertainties associated with the decision process which will result in better and more efficient structural monitoring systems. It is therefore emphasised that this type of rational decision approach are going to become a more important and frequently used tool in the design of structural monitoring systems.

4. Structural Monitoring in Practice and Conclusion

A number of examples from Danish bridges suggest that rational aspects in structural monitoring can be identified, and there is a sound basis for maturing the design practice into a rational framework for design of structural monitoring systems. It is foreseen that in the future, design practice will mature and use rational methods for the design of structural monitoring system.