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Monitoring to Become Wiser: A Case Story

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Summary

The last two decades have revealed an enormous development of computers and computer software. This development has given structural engineers very powerful tools such as finite element (FEM) programmes which allow very detailed analyses of new as well as existing structures. FEM analyses are based on assumptions to some extent e.g. static boundary conditions often has to be assumed or the loading is based on codes or qualified assumptions.

The tremendous development of computers and computer software have fortunately also been to the benefit of hardware and software for monitoring and measurement equipment such as dataloggers. Performing measurements on complicated structures, which has previously been analysed by FEM, can provide valuable information to verify whether calculation assumptions. Adjustments to the structure or the service manual can be implemented before the structure is taken into service.

Performance tests on new structures can help prevention of unexpected interruptions of the structural service.

Performing short and uncomplicated measurement routines on existing and new structures exposed to fatigue can give a more reliable prediction of fatigue life.

The increase in transport by railway as well as automobile has been the reason for the strengthening of many existing bridges. By performing measurements, strengthening can in some cases be avoided or postponed due to a clarification of the structural behaviour and/or the loading. Measurements can also serve as documentation for the efficiency of a performed strengthening.

This paper will be based on the following three case stories, which illustrate the benefit from measurements.

- New railway expansion joints on the Great Belt Bridge before being put to service.
- Fatigue life predictions on a bascule bridge which had failed due to fatigue
- Efficiency of a strengthening of a 90 years old riveted railway bridge will be demonstrated. Integrated use of three dimensional non-stationary dynamic FEM analyses will be presented in relation to the performed measurements.

Conclusion

Based on the briefly presented case stories we find that monitoring of structures can be beneficial in the following cases:

- Existing structures which do behave in an unpredictable way. In this case the behaviour can be clarified and the test results can be evaluated e.g. in the same way as if the information has been obtained by FEM analyses.
- Existing structures which have to be upgraded. In this case complicated FEM models can be either calibrated or confirmed by measurements.
- The effect of a strengthening of an existing structure. Performing a measurement before and after a strengthening has taken place, the effect of the strengthening can be evaluated or documented.
- Design assumptions can be confirmed or even determined before the final design is completed.
- The performance of a new structure can be clarified or documented before hand over. E.g. deformations can be documented to be with in specified limits etc.