Recent Austrian Activities in Bridge Monitoring

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Summary

During the last decades possibilities in terms of structural monitoring methods have been continuously developed. Several applications of different systems and approaches have shown a constant trend towards support of conventional visual inspection using objective measurement data. The focus is on monitoring and surveillance of bridges which represent exceptionally sensible engineering structures. Knowledge gained from long-standing activities in the area of bridge monitoring in Austria are represented in this paper.

Keywords: Bridge Monitoring, Measurements, Damage Detection, Permanent Monitoring, Structural Assessment

1. Introduction

Modern methods of measuring are increasingly being employed to monitor built structures, particularly in the field of bridge maintenance. One highly ambitious aim in the past was to make statements about the condition of a bridge on the basis of actual measurements carried out on the structure in conjunction with recalculations conducted in parallel. For a long time attempts were made to establish these monitoring procedures as an alternative to the tried and tested conventional methods of bridge testing, too. But this idea has – quite understandably – failed to gain acceptance among specialists. The information content of conventional bridge testing goes well beyond what measuring and analysis can achieve, assuming that the monitoring methods are employed cost-effectively.

However, scientific experiments have demonstrated beyond doubt that monitoring procedures can detect damage. In such experiments, though, the unknown parameters – such as extent of loading, effects of changes in temperature, earlier damage, geometry of the built structure, material characteristics etc. were either left out of account or also investigated in detail. So practical applications normally need to take a large number of unknowns into account – and the influence of these on the data obtained is of the same order as that of significant damage, or even greater.

2. Definition

Inspired by the successes of monitoring in mechanical engineering, people have attempted to apply monitoring in the field of bridge maintenance, too. However, here it is vital to provide various definitions in connexion with monitoring:

As a general rule, monitoring built structures is taken to mean performing data-based investigations on an existing object.

These investigations involve gathering data for a wide variety of parameters selected to match the current assignment. The parameters in question may be static, as in the case of deformation, inclination, stresses etc., or dynamic, as in the case of vibration: here vibration velocity or vibration acceleration are the relevant parameters.

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It is also important to distinguish between global and local methods. With global methods the assumption is that measuring at relatively few points suffices to describe the behaviour of the system accurately, whereas local methods are confined to a limited area of the built structure, which they investigate in detail.

As regards duration, a distinction is also to be made between long-term and short-term (occasional) measuring activities. For long-term measurements a system is installed on a built structure more or less permanently, and the relevant parameters are observed continuously. For occasional measurements data are gathered only at certain times. However, the distinction is not hard-and-fast, since intermediate cases are possible.

Monitoring built structures sometimes involves comparison with calculations based on finite-element modelling, to refine the analysis, or the data collected are used to improve an existing model. This way of updating models is a subject in its own right; at the moment a great deal of further research is needed here.

3. Theses

In the context described monitoring built structures is intended to provide objective data that should help us to understand the structure's behaviour under load, and changes in its behaviour, better. The following theses are at the centre of the approach to applying monitoring presented here and are elaborated in the full paper:

- Global methods do not permit early diagnosis of damage at acceptable cost.
- Data-based investigation is ideally suited to observing known problems or damage and changes in these over time.
- Objective data are collected as input parameters for further investigations.

4. Successful Projects in Austria

In the course of the last years activities numerous field tests were carried out on bridges within research projects as well as commercial applications, in order to gain experience and to find out how useful the approaches and hypotheses developed in context of monitoring are in practice. In the full paper some selected applications and the results obtained there are used for presentation dealing with the following topics:

- Continuous Bridge Monitoring
- Investigation of Railway Bridges
- Cable Force Determination
- Integral Bridges

5. Conclusion

This publication is intended to discuss selected parts of Austrian monitoring projects and the conclusions derived from them. The aim has been to provide an overview of what techniques of measurement and analysis can and cannot do, and to present a realistic picture of useful applications.

In conclusion, it should be emphasized that early diagnosis of damage (which is of course desirable) cannot be achieved with global methods at reasonable expense. Thus monitoring cannot replace conventional bridge testing, though it can assist the tester by providing objective data. Data-centred investigation is an excellent way of observing problems or damage already known to exist and changes in these over time. Data from measurements can also serve as input parameters for further investigation.

If monitoring methods are employed on built structures in line with the above points, they have considerable potential for preserving our engineered structures.