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Quality Assessment and Damage Detection by Monitoring

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Abstract

Owners of structures realize the need for quality control tools to be applied for maintenance and rehabilitation planing as well as lifetime assessment. Practicing engineers highly desire quality control of construction and a feedback from structures for more economic design and better understanding of the performance. Researchers were always fascinated by the potential of full scale dynamic tests of structures. These common aspects triggered the development of structural monitoring. Each structure has it's typical dynamic behavior which may be addressed as vibrational signature. Any changes in a structure, such as all kinds of damages leading to decrease of the load carrying capacity have an impact on the dynamic response. This suggests the use of the dynamic response characteristic for the evaluation of quality and structural integrity. Monitoring of the dynamic response of structures makes it possible to get very quick knowledge of the actual conditions and helps in planing of rehabilitation budgets.

General

Monitoring the quality of structures comprises a wide field of engineering tasks. The most promising recent development has been achieved with Ambient Vibration Testing and dynamic System Identification tools.

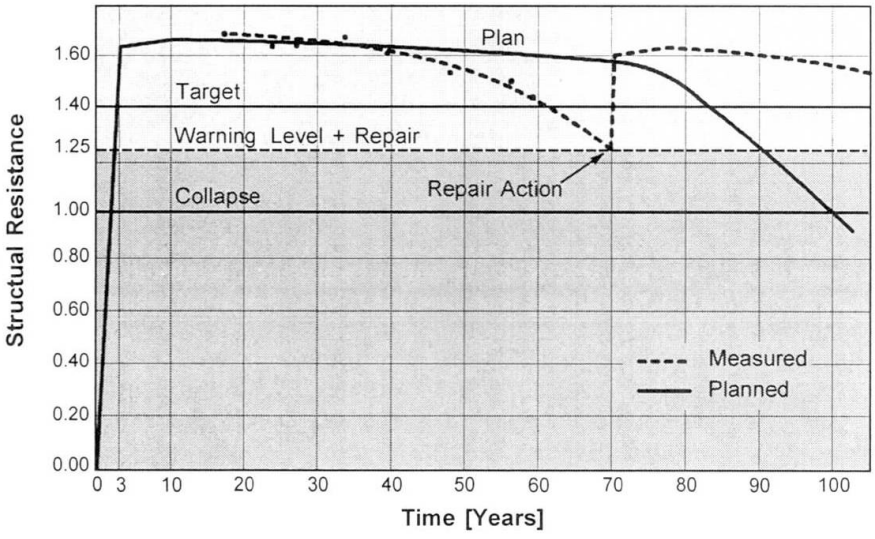

Fig. 1 Development of resistance over time

Therefore this contribution concentrates on this subject. Life time assessment is another high light. The full paper provides a brief history of monitoring, an introduction to the most important tools of system identification. 12 examples of application are provided out of which 2 are shown in the following page. There seems to be no limit in application.

Quality Control of Construction

The vibrational characteristic changes with each construction stage. Monitoring instruments are able to record these changes and therefore confirm the quality of construction steps carried out. Another benefit is that major impacts are recorded which might influence the quality of the structure. In case of cable stayed bridges the stresses in the cables can be monitored and compared to the desired values. Another application is the check of the removal of temporary fixations during construction. Complex systems can so be checked easily as demonstrated in Fig. 2.

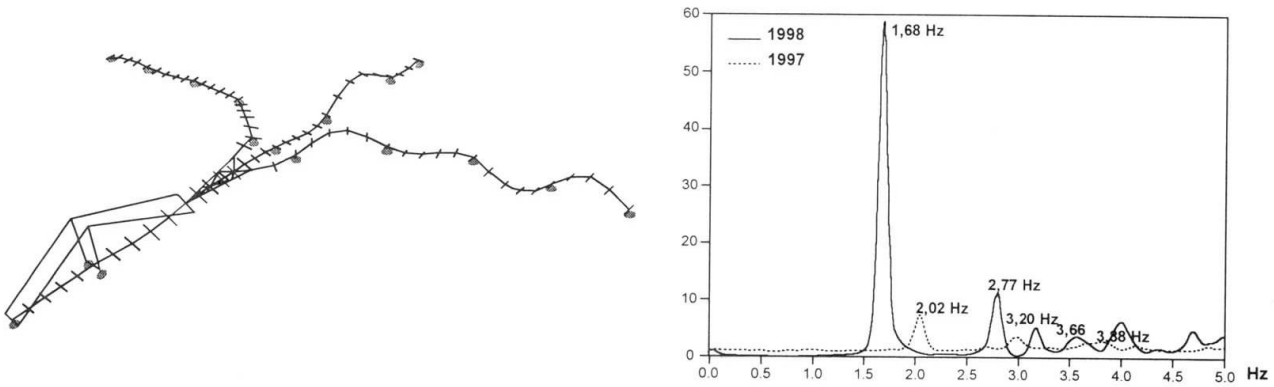

Fig. 2 Hall West Bridge, effect of the release of a horizontal restraint

Structures of the Cultural Heritage

The described method is not limited to bridges and towers, but can also be applied at monuments of the cultural heritage. The exceptional statue of Erzherzog Karl at the Heldenplatz in Vienna represents one of the two largest statues with a horse-rider situated on the two back shoes only. This 12 m high Bronze-statue is surrounded by thousand of tourists daily. The material properties of the structure formed 160 year ago can be assessed by the application of the vibrational characteristic method (Fig. 3). Consecutive measurement over a period of time provides information on the development of the structural integrity. Further application in this respect are the assessment of cantilever staircases built from natural stone, the assessment of the tiny structural members of Gothic churches and the integrity of Frescos and Mosaics.

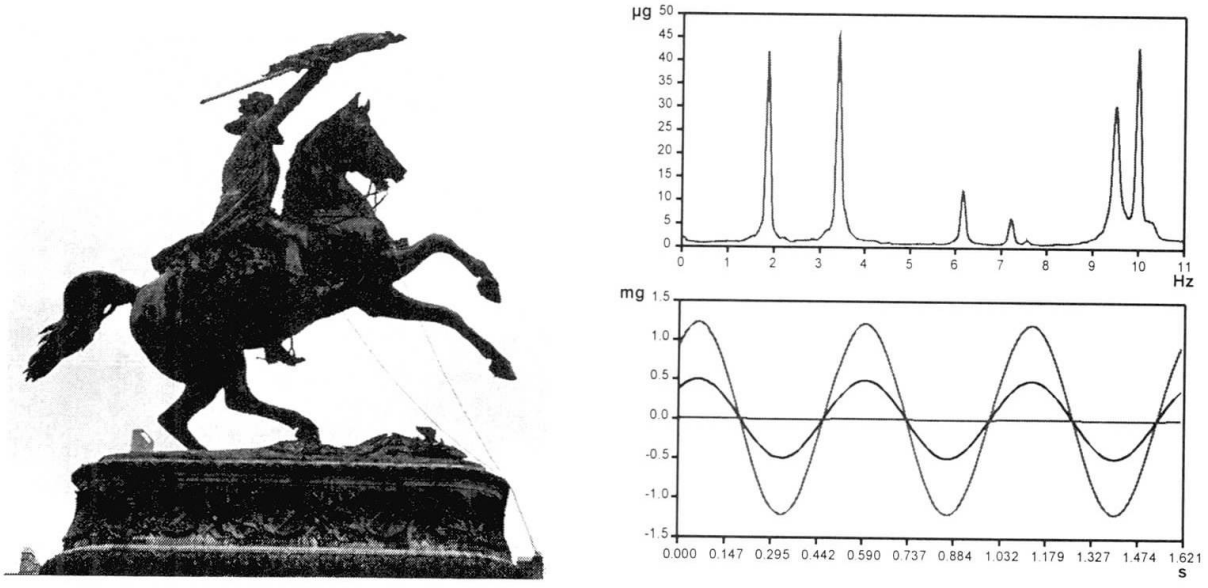

Fig. 3 Erzherzog Karl Statue with ambient spectrum and damping window