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## Condition Investigation Prior to Renovation Process - a Systematic Approach

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### Summary

To determine the condition of a building or a structure by an investigation periodically during its lifespan is an essential part of maintenance. The methods to carry out a condition investigation are not, however, very advanced. Obviously, there are problems in recognising the phases in the investigation process as well as in detecting the points to be investigated. A systematic procedure to carry out a condition investigation as a whole is presented in this paper.

**Keywords:** Maintenance, Renovation, Condition investigation, Deterioration, Damage, Repair

### 1. Introduction

The condition investigation of a building or a structure is an essential part of its maintenance. The condition governs for example the serviceability of the structure and the repair options available in the maintenance as well as the repair costs to be expected.

Nowadays, the role of condition investigations has been acknowledged among house owners and consultants to some extent, but the procedures to carry it out are not very systematic or advanced. Especially the procedure to select the items to be investigated is usually more or less irrational. The procedure described in this paper is based on the development work carried out in some 100 condition investigation projects by the authors since the late 1980's.

### 2. Basic Principles of Condition Investigation

The basic aim of a condition investigation is to produce information about the factors affecting the performance of the structure and consequently the options for its maintenance for the client. A systematic condition investigation aiming at this consists of fairly simple and clear phases as discussed later. The phases are not totally separate and successive, but rather partly overlapping.

The first phase is to study what kind of a structure there is under investigation. This means to find out what kind of a structural system the structure has and what are the materials it has been constructed of. This information can be gathered from original construction documents and by a visual inspection. It is important that different types and parts of structures and identical

structures under different exposure conditions are distinguished from each other and that they are also investigated as separate groups of objects.

The second phase is to recognise what kind of problems may exist in the structure. This is considered on the basis of the type of structure and materials in it as well as the exposure conditions. The problems may be caused either by different kind of deterioration mechanisms or by malfunction of structures, for example problems with moisture. The list of potential problems can then be utilised directly as the list of items to be investigated. It is, however, essential to evaluate the mutual importance of various problems. The factors related to the safety and health of residents and other users (like bearing capacity of the structure and the safety of fixings) are naturally the most important items to be investigated carefully.

The third phase is to consider the feasible techniques for the maintenance and repair of the structure. This is important to do as early as possible because different remedial techniques require different amount and type of information of the structure to be repaired. These alternative measures have to be also re-evaluated from time to time during the investigation process whenever there becomes new information available about the condition.

The fourth phase is to gather objective information concerning the deterioration processes and malfunction of the structure. The information can be gathered usually by four ways: firstly by studying the construction documents which give information mostly concerning the vulnerability of the structures, secondly by a visual inspection which gives information of the minimum extent of the damage (all the damage is not visible), thirdly by different kinds of in-situ tests and measurements and fourthly by taking samples and by different kinds of laboratory tests. As many different methods as possible should be utilised in examining each separate problem in order to improve the reliability of the results. The gathering of information should be done in the ways which are also representative and statistically reliable.

The fifth phase of the investigation is to carefully analyse the information gathered during the earlier phases. Practically, this means seeking answers to the following six questions: what kinds of problems exist in the structures, what is the extent of each type of damage and malfunction, what is the stage of each damage and malfunction, what are the reasons for the problems noticed, what kind of effects do the problems have on the structure itself or on the users of the building and finally how the damage or malfunction will proceed in the future.

The sixth phase is to prepare a report in which the results are presented for the client. The report should not consist only of measured values etc. but rather of practical conclusions concerning the alternative practical measures for the client to manage with the structure. There are usually several options for repair, and all these methods should be evaluated shortly in the report.

### **3. Concluding Remarks**

A method to carry out a systematic condition investigation is presented. The method is general and fairly free from limitations as far as the object of the investigation is concerned. Therefore, the method can be utilised in numerous different cases in civil engineering where there is need to determine the condition of a structure and find the appropriate options for maintenance or repair.

The procedure described consists of rather simple phases which are quite easy to perform. The point of this method is how the simple parts are connected into a systematic procedure.