Control measures and their application

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Description et application de mesures de contrôles

Kontrollmassnahmen und ihre Anwendung

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SUMMARY

This paper refers to measures against human errors in the building process more specifically to data control. It shows the necessity of systematic planning and realization of controls. Four principles are formulated. The important measures for planning and realization of controls are described and their application is discussed.

RESUME

Cet article traite de l'élimination des fautes lors des phases de la construction, et plus spécialement du contrôle de l'information. Il est nécessaire d'introduire une planification et une réalisation systématiques des contrôles. Quatre principes sont formulés. Les mesures importantes à prendre pour la planification et la réalisation des contrôles sont discutées en vue de leur application.

ZUSAMMENFASSUNG

Dieser Beitrag behandelt Massnahmen gegen Fehler im Bauprozess und insbesondere mit Datenkontrolle, Überwachung und Überprüfung. Es wird auf die Notwendigkeit einer systematischen Planung und Durchführung von Kontrollen eingegangen. Vier Kontrollprinzipien werden formuliert. Die massgebenden Massnahmen für die Planung und Durchführung von Kontrollen werden beschrieben und deren Anwendung wird diskutiert.

1. INTRODUCTION

Controls are usually effective as well as economical. Therefore, they occupy an important place in the field of quality assurance. Controls are applied in the building process to supervise accepted risks and to detect errors in time. More serious consequences or damage can thereby be avoided. This fact is also shown from analyses of damage. According to one analysis of structural damage [3], for example, 85% of cases with property losses and 90% of cases with personal injury could have been avoided through timely controls followed by corrective measures.

Controls were and are applied extensively in the building process, but often not at the most sensitive points. The controls are often not carried out in a systematic way, considering only some phases of the building process, e.g. testing of materials, checking of drawings, etc. As the analyses of damage show, such unsystematic use of controls is insufficient. What we need therefore, is a systematic introduction of controls. This introduction should be divided into two stages:
- planning of controls at the sensitive points in the building process ('control stops' [2]) and their documentation in the form of control plans, control instructions and checklists;
- realization of controls by using check and correction notes, control records and reports, and corrective measures.

2. CONTROL ACTIVITIES

In a general sense, controls involve four activities:
- identifying actual conditions
- comparing actual with assumed conditions
- assessing any detected discrepancies
- application of corrective measures.

The identification of actual conditions is carried out at a specific time, and is limited to a few important characteristics that can be measured. Therefore, controls are useful only if discrepancies can be easily identified using a few characteristics at the right time, and if these can be overcome with minimum effort.

Once the point of time and the characteristics of the control are established, it is necessary to determine people or bodies responsible for carrying out the controls. The following controls should be distinguished:
- self-control
- internal control
- control by people involved in the building process
- external control by other bodies.

In this connection, the control by people involved in the building process occupies a distinct place. The analysis of structural damage [3] shows, that many of the errors which slipped through the self-controls or the internal controls could have been detected without additional controls, provided the people involved in the building process had remained alert and followed the proper procedures according to their position in the hierarchy, from architects to engineers to contractors, etc.

3. CONTROL PRINCIPLES

The detection of discrepancies is based on four principles formulated with respect to the possible errors. Such errors occur if procedures or their results are:

- missing
- wrong
- insufficient.

The following principles should be used in the planning and the realization of controls:

1st principle: Actual conditions should be checked for completenes ('completeness principle').
The purpose of these control procedures is to identify any missing items without checking the circumstances in detail.

2nd principle: Actual conditions should be checked for correctness ('correctness principle').
These control procedures are detailed, and they determine whether the circumstances to be checked are reliable and correct on the basis of the available documents.

3rd principle: Actual conditions should be verified entirely and independently of any previous controls ('principle of independent overall check').
If the circumstances have been checked for completeness and correctness they are known in detail. A final, independent overall check allows possible 'gaps' and 'weak points' to be detected.

4th principle: The feedback from actual conditions should be assessed in terms of the building process ('feedback principle').
The integration of the actual conditions within the building process might result in errors at the various interfaces. Therefore, it is necessary to check the interface situation, and to assess any impact on the technical procedures of the building process, on the areas of responsibility and duties, on the flow of information, on the cooperation and on the people involved.

4. PLANNING OF CONTROL

Suitable aids including control plans, control instructions and checklists should be used to ensure a systematic planning of control.

A control plan provides full details of the proposed controls. It indicates what controls will be carried out by whom, how, and when. There are control plans for the building process as a whole, as well as for individual phases and activities. Control plans normally contain only the most important information. Details are often laid down in existing standards, guidelines, etc. If such is not the case, control instructions and checklists must be used.

Control instructions provide a detailed description of the relevant procedure. Depending on the type of controls and their importance, the instructions can be given verbally or in writing. The various steps in the control procedure should be set out in the form of a checklist.

Checklists describe individual control procedures, step by step, using key-words, short phrases and questions. Checklists should generally be based on the control principles. There are two types of checklists in terms of content:
- closed checklists which deal with a distinct, clearly defined content, e.g. checking of building components or individual steps of a procedure;
- open checklists which deal with less clearly defined circumstances, using questions to ensure personal thinking and judgement.

5. REALIZATION OF CONTROL

The systematic realization of control must be ensured by using control and correction notes, control records and reports and corrective measures.

The various control steps require that all errors be properly noted, along with any planned measures, so that nothing will subsequently be forgotten.

The results of control procedures which affect further operations and have some impact on the quality of the structure should be written down in records and reports. If several people are involved in control procedures, as it is in the case of acceptance checking, the records are prepared jointly. In other cases, the control results can be included in a report.

If detected discrepancies exceed the given tolerances, corrective measures must be used. The corrections can often be made directly within the procedure. In other cases, the corrective measures must be planned, realized and documented.

6. APPLICATION OF CONTROL

Controls are generally used to detect and to correct errors in time as well as to supervise the accepted risks taken in the building process.

Within the individual phases of the building process, documents are prepared, materials are ordered and put to use, structural components are built, etc. In such activities, errors can occur. To prevent any errors in one phase from being carried over to the next, controls must be planned and realized at the important interfaces in the building process, that is at the so-called 'control stops' [2].

The quality of buildings and structures is governed not only by the actual errors that occur, but also by the accepted risks taken in the construction and utililzation phases. Therefore, it is necessary to supervise the individual risk indicators such as deformations, smoke, ground movement, etc. A potential occurrence of damage can then be detected in time and measures applied to prevent or reduce the possible damage.

7. REFERENCES

1. M. MATOUSEK: Massnahmen gegen Fehler im Bauprozess, Bericht Nr.124, Institut für Baustatik und Konstruktion, ETH Zürich, Birkhäuser Verlag Basel und Stuttgart, 1982

2. J. SCHNEIDER: Organisation and Management of Structural Safety during Design, Construction and Operation of Structures, Proceedings of ICOSSAR'81, The Norwegian Institute of Technology, Trondheim, Norway, 1981

3. M. MATOUSEK, J. SCHNEIDER: Untersuchungen zur Struktur des Sicherheitsproblems bei Bauwerken, Bericht Nr. 59, Institut für Baustatik und Konstruktion, ETH Zürich, Birkhäuser Verlag Basel und Stuttgart, 1976