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## 5. PRINCIPLES OF CONTROL

### 5.1 Introduction

Effective control during planning, design and dimensioning, erection and use of structures has to be implemented and performed by all parties involved.

The notion control includes all checks, verification measures and inspections regarding:

- design
- production of material and components
- erection on the construction site
- use of the building or structures.

Every control consists of

- the collection of information
- a judgement based on this information
- a decision based on this judgement.

Control serves the following purposes:

- to ensure an acceptable quality of design, materials, products and work on the construction site
- timely detection of hazards involving the safety of people and/or damage to property during construction and use of the building or structures
- to obtain experience (compare 1.3).

### 5.2 The control process

#### 5.2.1 General

Control can be considered as a special process going on parallel to the building process.

In many cases the persons or organizations who are responsible for the building process are also responsible for the control activities. Thus there is a close connection between the building process and the control process and it is important that the control is executed in such



a way that it does not interact unfavourably with the building process.

One can distinguish between the following different types of control depending on the person or organization undertaking it (compare 4.2)

- individual self-control
- internal control
- control handled by the overall project management
- control executed by the public authority.

#### 5.2.2 Individual self-control

In this document it is assumed that participants in the building process aim at carrying out their respective tasks with care and skill. This can only occur through continuous individual self-control measures. These include the checking of documents and information communicated to other persons.

#### 5.2.3 Internal control

Internal control is assumed to be organized and performed wherever work is performed by more than one person or more than one group of persons. Codes should state the obligation to such internal control.

Internal control may concern, for example, design work in an office, material production at a factory, production of components in a workshop and erection of a building at the construction site. Those who have the responsibility for the site management should check especially all quality control documents required by codes.

Sometimes the internal control system is subjected to verification by some outside agency.

#### 5.2.4 control handled by the overall project management

Those who have the responsibility for the overall project management may also be made responsible by building regulations for ensuring that all control measures throughout the whole building process are implemented effectively. They may delegate some of their control functions to qualified specialists.



Specialists entrusted with the responsibility for control have to report on their control activity. Building codes should state such duties and the formal requirements to be observed.

An independent consultant with additional control tasks may also be employed. Codes may require such independent control in all cases where

- very complicated problems have to be solved
- a structural failure would endanger a very large number of persons or have very large economic consequences.

Codes should state the special circumstances which require additional control by an independent consultant.

The task of the independent consultant should be stated in the control plan (see section 5.4). The field of activity of the consultant may extend over the whole building process or be restricted to certain sections only.

#### 5.2.5 Control executed by the public authority

The control executed by public authorities is based on building laws and/or codes. The aim is generally connected with the society having requirements for safety and a quality that is acceptable on the whole. Therefore this kind of control should not be considered as a substitute for the kind mentioned in 5.2.2 - 5.2.4.

#### 5.2.6 The owner's inspection of the building

To ensure that the safety and serviceability of a structure is maintained throughout its anticipated time of use it is necessary to make inspections to find out about the need for maintenance and repair.

The intervals between inspections should be chosen with due regard to

- the environmental conditions
- the properties of the material
- the reliability of protective measures
- the sensitivity of the structure to local damage
- the consequences of failure.



### 5.3 The degree of control

A rigorous control process includes all types mentioned under 5.2 and is recommended for important structures or structural parts if the consequences of failure are severe. For structures or structural parts of minor importance it may often be sufficient to limit the control to individual self-control and internal control. Then, the control executed by the public authorities might consist of merely a check that the internal control has been executed in an acceptable way.

If a control process consists of several steps it is important that the activities involved in these steps are as far as possible mutually independent in a statistical sense. Otherwise the efficiency of the control will be reduced.

### 5.4 Planning of control

#### 5.4.1 Control stops

The whole building process from planning to use of the structure should be subdivided by control stops. Such control stops should be introduced, mainly at points where responsibility is transferred from one party to another or where one phase of the building process gives way to another.

Each control stop contains control measures which should be exercised before the next stage of the building process can commence. The production and the control should be planned so that any delays to the building process will be as short as possible.

Hazardous phases during erection and use should be separated by control stops and supervised according to a carefully prepared supervision plan. This especially holds for those hazard scenarios which are to be overcome by measures of control and supervision.

Control stops and all necessary details of control measures to be performed should be specified by the overall project management in collaboration with the specialists involved.

For ordinary structures, building codes may specify appropriate control stops and regulate all necessary details.



#### 5.4.2 Control plan

A special control plan should be established by the overall project management in collaboration with the specialists involved, especially in cases where

- control tasks are vested in different persons
- the execution of the construction and/or the use of the structure creates a potential danger to a very large number of persons.

The control plan should contain all details of control.

For the design control, the plan should include

- checking that the requirements and conditions used in the design are in accordance with those specified
- checking that the relevant calculation models are used and that the numerical calculations are correct
- checking that drawings and other design documents are in accordance with the design calculations and with given specifications.

For the control of material and products and for the control of the erection on the construction site the plan should include

- responsibilities regarding control
- subject of control
- time schedule including control intervals
- control procedures
- control criteria and acceptance rules
- requirements of reports and documentation
- procedure in the case of deviations from control criteria.

#### 5.5 Supervision of special risks

In order to minimize danger to human life (and to reduce the risk of damage to property) a supervision and warning system should be introduced where special circumstances requires certain hazards to be countered by measures of supervision.

The special circumstances may be derived from the utilisation plan or the safety plan. The introduction of protective measures when special risks arise should not be left to improvisation. According to the risks



envisaged, protective measures should be pre-planned to some extent.

All supervision measures found necessary to overcome risks could be stated in a supervision plan. This plan contains the supervision measures together with all details.

The basis for the elaboration of a supervision plan is a careful analysis of the situation to be supervised with respect to hazard indicators. Hazard indicators in this respect are all changes in a situation which can easily be observed or monitored and which may indicate the presence of increased risk.

A continuous supervision of special risks should be ensured by making a person responsible for it and naming his representative.

The persons charged with supervision activities should be carefully instructed by the project management with respect to the hazards envisaged and the hazard indicators. They should also be required to report on events and phenomenon which, though not specified in the supervision plan, may, according to their experience, have a relationship to the risk supervised.

The supervision activities should periodically be checked with respect to proper functioning. The same holds for automatic warning systems.

## 6. METHODS OF CONTROL

### 6.1 Introduction

Regarding the type of activity that is controlled one can distinguish between

- design control
- control of materials and components
- control of fabrication and/or construction at the construction site
- control during the use of the structure.