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English Version

## Guidance on the application of statistical methods for determining the properties of masonry products

Guide pour l'application de méthodes statistiques pour  
la détermination des propriétés des éléments de  
maçonnerie

Leitfaden für die Anwendung statistischer Methoden  
zur Bestimmung der Eigenschaften von Mauerwerk  
Produkten

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## European Foreword

This document (CEN/TR 16886:2016) has been prepared by Technical Committee CEN/TC 125 "Masonry", the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

## Introduction

This document is informative for the guidance of manufacturers and Notified Bodies (NBs), who want to use statistical methods for the evaluation of conformity and Factory Production Control of masonry products. Its use is optional. Other statistical methods and non-statistical methods may be used.

Quality control of building materials and components is an indispensable part of an overall concept of structural reliability. As quality control is generally a time-consuming and expensive task, various operational techniques and activities have been developed to fulfil safety requirements in buildings. Properly employed statistical methods are one way to provide efficient, economic and effective means of quality control.

**Background:** “The terms and definitions in EN 1990 (*Eurocode: Basis of structural design*) are derived from ISO 2394 (*General principles on reliability for structures*). For the design of structures, EN 1996-1-1 (*Eurocode 6: Design of masonry structures — Part 1-1: General rules for reinforced and unreinforced masonry structures*) is intended to be used together with EN 1990. ISO 12491 (*Statistical methods for quality control of building materials and components*) gives general principles for the application of statistical methods for the quality control of building materials and components, in compliance with the safety and serviceability requirements of ISO 2394. ISO 12491 is applicable to all buildings and other civil engineering works, existing or under construction, whatever nature or combination of materials used, e.g. concrete, steel, wood, bricks. The EN 771 series specifies that one method of satisfying the conformity criterion laid down in these product standards is to use the approach given in ISO 12491.”

This Technical Report gives guidance on how a statistical evaluation can be put into practice based on the background of ISO 12491.

A simplified method is also given based on information obtained from practice about the possible distribution in production for specific product characteristics.

The method may also be used for the evaluation of different properties at the different stages of the factory production control (FPC) with the aim to minimize testing costs for the manufacturer and to ensure that the requirements are fulfilled.

Detailed examples are given in Annex C. For other more sophisticated techniques and specific problems, other international standards can be applied.

The initial draft of this document was prepared by the joint working group CEN/TC 125/TG 5 and the Sector Group 10 of Notified Bodies under the Construction Products Directive. The CEN/TR is a tool available for manufacturers and Notified Bodies.

It is laid down in the hEN's of masonry products that the manufacturer should demonstrate compliance for his product with the requirements of the harmonized product standards.

The purpose of this Technical Report is to put statistical evaluation into practice. Detailed examples are given in the annexes.

## 1 Scope

In the masonry unit standards and in national legislation, some properties need to be declared based on a certain fractile and confidence level. To demonstrate compliance with that a statistical tool can be used.

The purpose of this Technical Report is to exemplify how a statistical tool can be used in practice. This document should not contradict nor extend the scope of the work and role of a Notified Body, nor impose additional burdens on the manufacturer, beyond those laid down in the Construction Products Regulation and the product standards.

Mechanical and other properties of building materials and components are in the report described by random variables with a certain type of probability distribution. The popular normal distribution (Laplace-Gauss distribution) is given in Annex A. Normal distribution may be used to approximate many actual symmetrical distributions. When a remarkable asymmetry is observed, then another type of distribution reflecting this asymmetry should be considered, leading to a more complex method to demonstrate compliance with the product standard. More information on the normality test of Shapiro-Wilk is given in Annex D.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1990, *Eurocode - Basis of structural design*

EN 1996 (all parts), *Eurocode 6 — Design of masonry structures*

## 3 Terms, definitions and symbols

For the purposes of this document, the following terms, definitions and symbols apply.

### 3.1 Terms and definitions

#### 3.1.1

##### **unit**

defined quantity of building material, component or element that can be individually considered and separately tested

#### 3.1.2

##### **population**

totality of units under consideration

#### 3.1.3

##### **variable**

##### **$X$**

variable which can take any of the values of a specified set of values and with which is associated a probability distribution

#### 3.1.4

##### **probability distribution**

function which gives the probability that a variable  $X$  takes any given value (in the case of a discrete variable) or belongs to a given set of values (in the case of a continuous variable)