THE PERFORMANCE OF FIBRES: CE REGULATION, MINIMUM DOSAGE AND FURTHER DETERMINATIONS

Philipp Guirguis [1]

Abstract:

Since June 2008 only fibres with CE marking are allowed to be sold within the European member states. CE marking became mandatory for all fibres produced, sold and used in the EU. The CE mark is a conformity mark that harmonises technical specifications of many European products in the fields of health, safety and minimum quality levels. Time to take a look what makes the CE marking for Steel fibres so important.

Keywords: CE mark, CE-label, EN 14889, Quality control, Type of steel fibre, Fibre reinforced concrete, Effect on strength, Fibre performance

1. Introduction

Quality control is an essential element in providing safe and durable structures and the product quality is always linked to the quality control regime applied to a specific product. Steel fibres are no exception here. The minimum requirements are described in the European Norm 14889. This standard is linked to further EN standards in terms of test methods that need to be applied for fibres. The European Norm 14889 consists of two parts in which EN 14889-1 is subject to steel fibres and EN 14889-2 is issued for synthetic fibres. Focus will be laid on EN 14889-1 for steel fibres. The CE mark guarantees the same minimum quality in all European countries and this will lead to more confidence in quality of construction. However and distinguished later in this paper, there are two different systems of certification, depending on the use of the steel fibre. Since years it is well known that the performance of fibre reinforced concrete differs in dependency of the fibre type in use. Fibre is not equal to fibre and one crucial point in EN 14889 is a test procedure to reveal the “effect on strength”, where a minimum dosage for reaching a certain performance needs to be declared. The paper will give an overview about the European standard for fibres, the fibre performance within this regulation and crucial points to regard when using steel fibres for steel fibre reinforced concrete.

[1] Bekaert GmbH, Technical Manager Building Products, Otto-Hahn-Strasse 20, 61381 Friedrichsdorf, Germany, E-mail: Philipp.Guirguis@bekaert.com, www.bekaert.com/building

2. EN 14889 distinguish between class 1 and class 3

The European Norm 14889-1 distinguishes between two systems of conformity for steel fibres, system 1 and system 3. System 1 is specified as "fibres for structural use" and system 3 is specified as "fibres for other use". According to EN 14889-1, structural use of fibres is where the addition of fibres is designed to contribute on the load bearing capacity of a concrete component. System 3 fibres are therefore only considered where the load bearing capacity of the fibre concrete is not taken into account at all. Care needs to be taken not to confuse fibres with declaration of conformity (system 3) with fibres with EC-certificate of conformity (system 1). The difference between those products may be significant. System "1" certified fibres are indicated by an EC number of certification on the CE-label. As the steel fibre performance is taken in consideration in almost all relevant cases, it is strongly advisable just to choose fibres with conformity according system 1 (structural use) with an EC-certificate of conformity. Traceable that system 1 certified steel fibres need to undergo a stricter quality control, mainly carried out by an external body, which finally assures for the expected fibre performance. The following table shows the responsibilities for the quality control of steel fibres according EN 14889-1.

Table 1: Quality control in dependency of system conformity

	Responsibilities for quality control	
	Structural use, System "1"	**Other uses, System "3"**
Initial type testing	product certification body	notified test laboratory
Initial inspection of factory	product certification body	manufacturer
Continuous surveillance	product certification body	manufacturer
Approval of FPC 1)	product certification body	manufacturer
EC Certificate of conformity	product certification body	not applicable
EC Declaration of conformity	manufacturer	manufacturer

1) FPC = Factory Production Control

3. Relevant information which you can you find on the CE-label

The The CE label allows for a quick and effective estimation about the properties and henceforth the performance of individual steel fibre types. Specifications like geometrical and mechanical properties of the intended steel fibre type are presented herein. Furthermore essential characteristics like tensile strength, delivery form but mainly also the effect on strength, which will be illuminated somewhat deeper in the following caption, are revealed within the CE label. To assure that a steel fibre certified according System "1" is in use a certificate number needs to be mentioned on the CE-label (see also caption before). All essential characteristics are illustrated in the following pictures.

CE-symbol

identification number of certification body

reference to European Standard, last two digits of the year in which the marking was affixed

number of EC certificate of conformity (System 1)

description of the product

- **group I: cold-drawn wire;** → commonly used
- group II: cut sheet;
- group III: melt extracted;
- group IV: shaved cold drawn wire;
- group V: milled from blocks.

Fig.1: typical CE-label

- EN 10002-1, Metallic materials – Tensile testing – Part 1: Method of test at ambient temperature
- EN 10218-1, Steel wire and wire products - General – Part 1: Test methods
- EN 12350-3, Testing fresh concrete - Part 3: Vebe test
- EN 14845-1, Test methods for fibers in concrete – Part 1: Reference concretes
- EN 14845-2, Test methods for fibers in concrete - Part 2: Effect on concrete

relevant essential characteristics which are to be declared and are linked to further EN standards

result of performance testing: Minimum dosage of CE is linked to the performance of the fibre type

Fig.2: typical CE-label

4. Effect on strength of concrete

In order to determine the effect on strength of each individual fibre types, a deflection controlled beam test according EN 14651 is issued in the EN 14889. 12 notched beams per series are to be prepared in a reference concrete according EN 14845-1 with defined concrete composition and concrete properties.

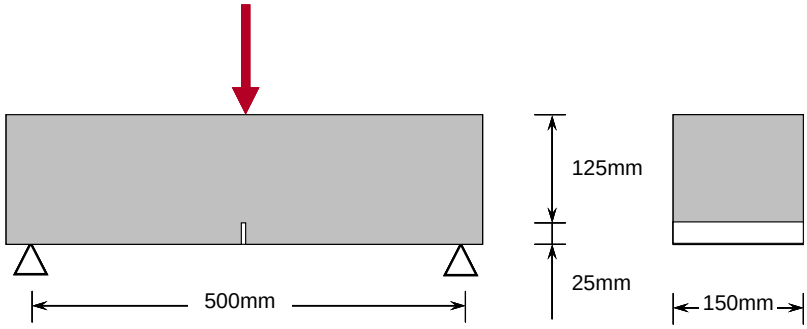

Fig. 3: Test setup according EN 14651: 3-Point bending test on a notched specimen

A minimum dosage of an individual fibre type has to be determined to obtain a minimum performance which is defined as follows and evaluated as mean value out of the 12 specimen:

A residual performance at low deflection (crack mouth opening of 0,5 mm) of at least:

$f_{res0,5}$ =1,5MPa.

A residual performance at big deflection (crack mouth opening of 3,5 mm) of at least:

$f_{res3,5}$ = 1,0MPa

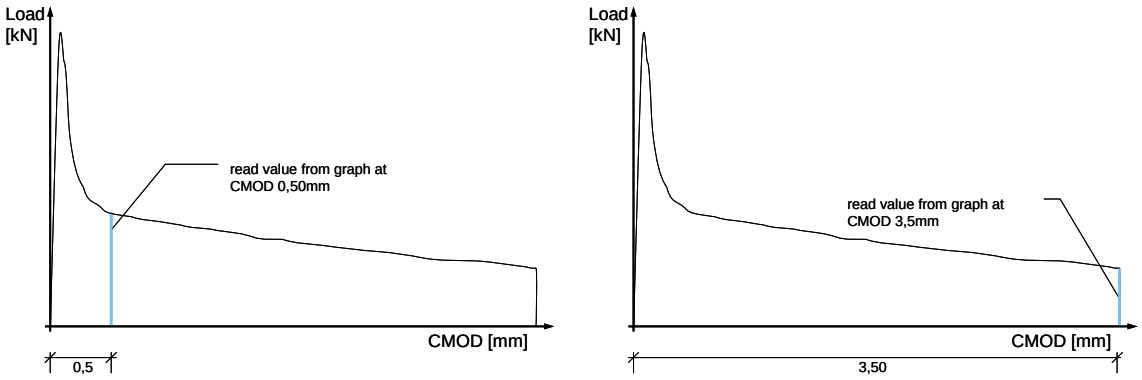

Fig.4: Load deflection curve, residual values for low and big deflections

It was already indicated that geometry and properties of a steel fibre play a decisive role in terms of the final performance in concrete. Especially the length, the diameter, the length/diameter ratio, the type of anchorage and a suitable wire tensile strength are crucial parameters to determine whether the performance is rather high or low for the same dosage in the same concrete. The following pictures are exposed to demonstrate the before mentioned parameters with their influence on performance in an illustrative way.

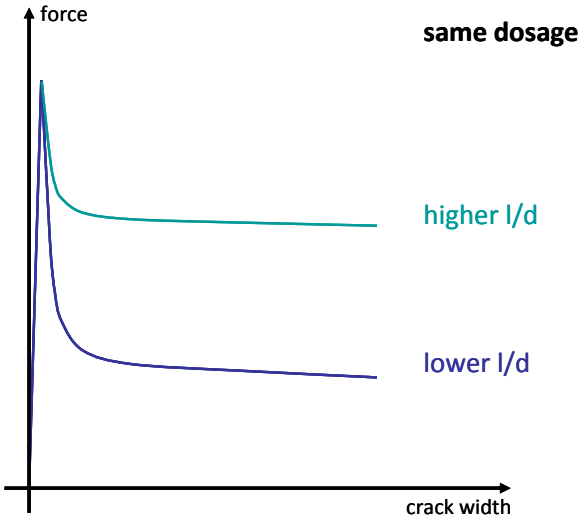

Fig. 5: effect of l/d-ratio

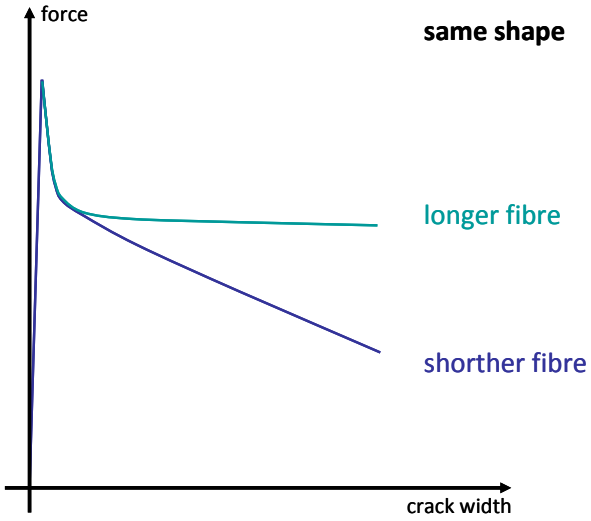

Fig.6: effect of fibre length

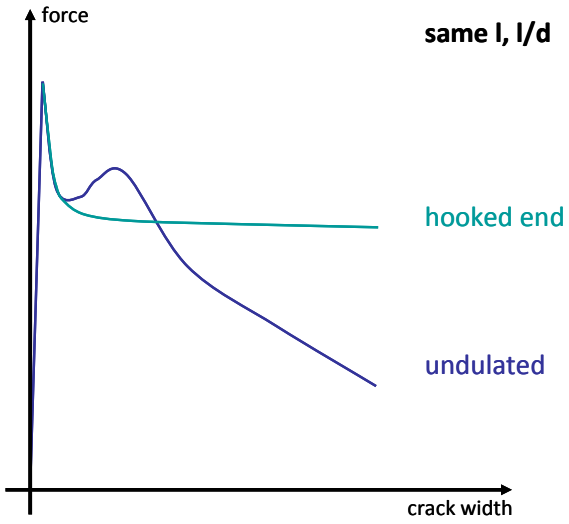

Fig.6: effect of anchorage

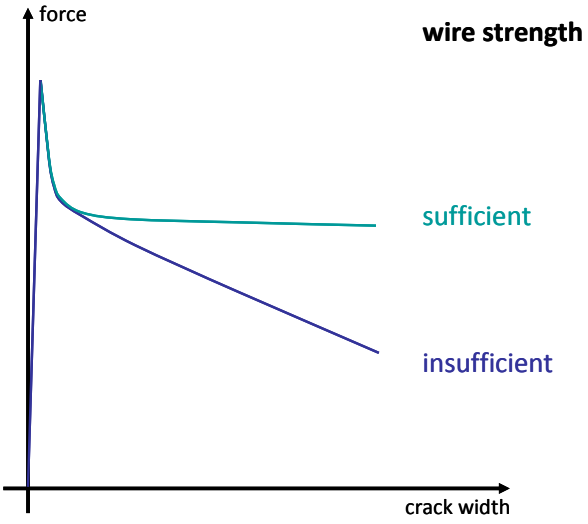

Fig. 7: effect of wire strength

5. Conclusions

International standards for production and quality control of steel fibres for concrete reinforcement are available. In Europe valid and mandatory is the harmonised European standard EN 14889-1. In order to avoid any potential risk, steel fibres should always comply with system "1", testified by an EC certificate of conformity.

In particular the CE-label, related to EN 14889-1, allows a quick but significant estimation of steel fibre properties. Important details, such as geometric data, tensile strength and l/d-ratio have to be revealed on that label. Furthermore and kind of determining information is made obviously with the minimum dosage that has to be declared and that is directly related to a required minimum performance level of a fibre. Though it is not a design value it serves as pretty good indicator to determine the performance of different fibre types. Comparing different kind of steel fibres by means of the CE-label offers the user a possibility to win an idea about the performance of different fibre types and finally about the performance of the steel fibre reinforced concrete.

References

[1] EN 14889-1: 2006 Fibres for concrete – Part 1: Steel fibres – Definitions, specifications and conformity

[2] EN 14845-1: 2007 Test methods for fibres in concrete – Part 1: Reference concretes

[3] EN 14845-2: 2006 Test methods for fibres in concrete – Part 2: Effect on strength

[4] EN 14651: 2005 Test method for metallic fibered concrete – Measuring the flexural tensile strength (limit of proportionality (LOP), residual)

[5] A.Lambrechts: The Variation of Steel Fibre Concrete Characteristics – Study on toughness results 2002-2003; proceedings of the conference "Fibre Concrete 2005", Malenovice, Czech Republic, 2005

[6] G.Vitt: Understanding Steel Fibre Reinforced Concrete – Version 1.0, Guidance to comprehending an extraordinary material

[7] VDS Merkblatt "CE-Kennzeichnung", Ausgabe 8/2008, www.vdsev.de

[8] G.Vitt, M.Schulz, W.Nell: Herstellung und Prüfung von Biegebalken nach DAfStb-Richtlinie Stahlfaserbeton, Beton- und Stahlbeton, Ausgabe 08/2009

[9] G.Vitt: CE-Kennzeichnung für Stahlfasern verbindlich, Beton 12/2008