

BS EN 13411-8:2011



BSI Standards Publication

Terminations for steel wire ropes — Safety

Part 8: Swage terminals and swaging

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee MHE/2, Wire ropes.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Terminaisons à sertir et sertissage

Endverbindungen für Drahtseile aus Stahldraht - Sicherheit
- Teil 8: Stahlfittinge und Verpressungen

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Foreword

This document (EN 13411-8:2011) has been prepared by Technical Committee CEN/TC 168 “Chains, ropes, webbing, slings and accessories - Safety”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2012, and conflicting national standards shall be withdrawn at the latest by March 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] 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, and supports essential requirements of EU Directive.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

EN 13411, under the general title *Terminations for steel wire ropes — Safety*, consists of the following parts:

- *Part 1: Thimbles for steel wire rope slings;*
- *Part 2: Splicing of eyes for wire rope slings;*
- *Part 3: Ferrules and ferrule-securing;*
- *Part 4: Metal and resin socketing;*
- *Part 5: U-bolt wire rope grips;*
- *Part 6: Asymmetric wedge socket;*
- *Part 7: Symmetric wedge socket;*
- *Part 8: Swage terminals and swaging.*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard is a type C standard as stated in EN ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this standard.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

1 Scope

This European Standard specifies the minimum requirements for swage terminals and the securing of such terminals by a swaging process to carbon steel rope conforming to EN 12385-4 and EN 12385-5, spiral strand rope conforming to EN 12385-10 and stainless steel stranded rope.

This European Standard is not applicable to spiral rope incorporating full lock wires – see EN 12385-10 –, nor ropes with coverings and /or fillings (see 3.6.3 of EN 12385-2:2002+A1:2008).

This European Standard is applicable to swaged terminations that have a terminal efficiency factor, K_T , of at least 0,9 and are used as part of a wire rope accessory such as a sling, or wire rope assembly that performs a raising, lowering, hauling or supporting function on lifting machinery.

This European Standard is applicable to terminals of the following types that are made of carbon or stainless steel:

- open swage socket;
- closed swage socket;
- swage terminal with thread;
- swage terminal end stop.

This European Standard deals with all significant hazards, hazardous situations and events relevant to swaged terminations, when used as intended and under conditions of misuse which are reasonably foreseeable (see Clause 4).

This European Standard applies to swaged terminations which are manufactured after the date of its publication.

This European Standard is not applicable to swaged terminations used for anchoring ropes to winch drums.

2 Normative references

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

EN 12385-1, *Steel wire ropes — Safety — Part 1: General requirements*

EN 12385-2:2002+A1:2008, *Steel wire ropes — Safety — Part 2: Definitions, designation and classification*

EN ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

EN ISO 12100-2, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles (ISO 12100-2:2003)*

EN ISO 14121-1, *Safety of machinery — Risk assessment — Part 1: Principles (ISO 14121-1:2007)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12385-2:2002+A1:2008 and EN ISO 12100-1:2003 and the following apply.

3.1 swage terminal

3.1.1 open swage socket

swage terminal comprising swage shank (1) into which wire rope is inserted and then permanently attached by swaging and a fork coupling section (2) that enables the swaged termination to be connected to the load

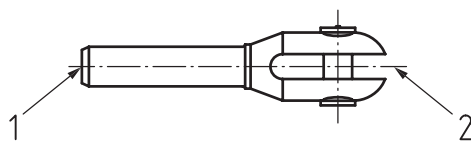


Figure 1

NOTE The open swage socket is normally supplied complete with pin.

3.1.2 closed swage socket

swage terminal comprising swage shank (1) into which wire rope is inserted and then permanently attached by swaging and a eye coupling section (3) that enables the swaged termination to be connected to the load

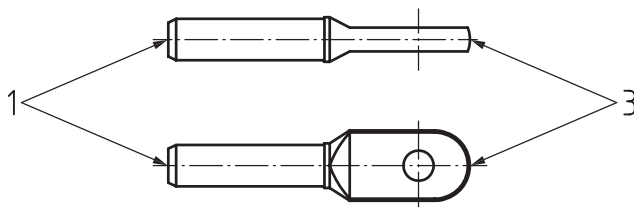


Figure 2

3.1.3 swage terminal with thread

swage terminal comprising swage shank (1) into which wire rope is inserted and then permanently attached by swaging and a male thread coupling section (4) that enables the swaged termination to be connected to the load

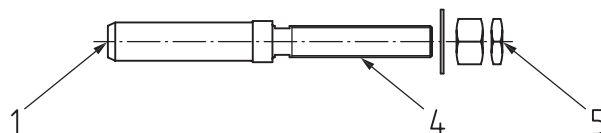


Figure 3

NOTE May be supplied with nut and locknut (5).

3.1.4

swage terminal end stop

swage terminal where the swage shank also directly supports the tension applied to the swaged termination

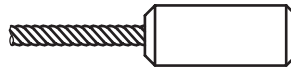


Figure 4

3.2

swaging

cold process by which the shank of a swage terminal is radially reduced with a die by pressing, rolling or hammering

NOTE Swaging by hammering is also referred to as 'rotary swaging'.

3.3

swaged termination

completed assembly of swage terminal and rope by swaging

3.4

swaging system

design parameters for the swage terminal, specifically including the before and after swage dimensions, and the process of attaching the terminal to the rope

3.5

swaging system designer

person or organization that designs the swage terminal and the swaging system and assumes responsibility for type testing

3.6

swage terminal manufacturer

person or organization that manufactures the swage terminals in accordance with the swaging system designer's specification

3.7

swaged termination manufacturer

person or organization that manufactures swaged terminations in accordance with the swaging system designer's instructions

3.8

slippage

relative linear displacement of the rope out of the swage shank

3.9

termination efficiency factor

K_T

factor which allows for the efficiency of the termination

NOTE In the case of swage terminations, $K_T = 0,9$.

3.10

characteristic breaking force

F_{uk}

product of the minimum breaking force of the rope (F_{min}) and the termination efficiency factor, i.e.:

$$F_{uk} = F_{min} \cdot K_T$$

**3.11
fin**

swage shank material that is squeezed out into the area between the die faces during the swaging forming a small material protrusion along the length of the swage shank

NOTE 'fin' is also termed 'flash'.

4 List of significant hazards

This clause contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this European Standard, identified by risk assessment as significant for this type of swaged termination that require action to eliminate or reduce the risk.

In particular, the hazard caused by accidental release of load due to failure of the swaged termination puts at risk, either directly or indirectly, the safety or health of those persons within the danger zone.

Table 1 contains those hazards that require action to reduce risk identified by risk assessment as being specific and significant for swaged termination assemblies.

Table 1 — Hazards and associated requirements

Hazards identified in A.1 and A.4 of EN ISO 14121-1		
	Origin	Potential consequences
Mechanical hazards	<ul style="list-style-type: none"> - Acceleration, deceleration (kinetic energy) - Falling objects due to inadequacy of tensile strength and fatigue performance of swaged termination - Moving elements 	<ul style="list-style-type: none"> - Impact - Crushing - Trapping
Hazardous events	<ul style="list-style-type: none"> - Stability of the machine and/or parts of the machine - Mechanical strength of parts of machine - Inadequacy of selection of ropes and accessories and their inadequate integration into the machine - Abnormal conditions of assembly/testing/use/maintenance 	<ul style="list-style-type: none"> - Loss of stability - Break up during operation - Uncontrolled movements

5 Safety requirements and/or protective measures

5.1 General

Machinery shall comply with the safety requirements and/or protection measures of this clause.

In addition, the swaging system shall be designed according to the principles of EN ISO 12100 for relevant but not significant hazards, which are not dealt with in this document.

5.2 Swaging system

5.2.1 General

The swaging system designer shall carry out type testing in accordance with 5.2.2.

The swaged termination shall be manufactured in accordance with the swaging system designer(s) instructions.

The instructions shall at least cover those items given in 5.2.3 and be supported with a written declaration that the system has passed the type testing requirements of 5.2.2.

5.2.2 Type testing

5.2.2.1 Sampling

The following shall apply for each class of rope and rope grade in accordance with EN 12385-2 and terminal material for which the system is designed.

Where the swage terminal design follows a mathematical progression throughout a given size range, rope diameters shall be selected for testing to represent the upper and lower quartiles of that range.

Where the swage terminal design does not follow a mathematical progression through a size range, each rope diameter within that range for which the system is designed shall be selected for testing.

For each rope diameter selected in accordance with the above, the rope grade and minimum breaking force of rope shall be the highest for which the system is designed and at least two (2) swaged terminations shall be tested.

NOTE The number of tests may be regarded as two when the test length has a swaged termination at both ends.

5.2.2.2 Tensile test

When tested in accordance with 6.1, the swaged termination shall be loaded to failure.

Two (2) swaged terminations shall sustain the characteristic breaking force F_{uk} [$\geq 90\%$ of the minimum breaking force of the rope] with no slippage occurring in the failed sample.

If slippage is detected, then a further six (6) swaged terminations shall be tested and all shall sustain a force $\geq 90\%$ of the minimum breaking force of the rope before slippage occurs.

5.2.2.3 Fatigue test

When tested in accordance with 6.2 for 75 000 cycles followed by a tensile test in accordance with 6.1 the swaged termination shall sustain a force of at least 80% of the minimum breaking force of the rope.

5.2.3 Instructions to be provided by the swaging system designer

The swaging system designer shall provide information/instructions on at least the following:

- a) rope sizes, constructions and/or classes, grades and minimum breaking forces for which the system is designed;
- b) material specification and dimensions of the swage terminals;
- c) matching of the swage terminal and its material to the rope diameter and type;
- d) preparation of the rope end;
- e) positioning of the rope end within the swage terminal;
- f) procedure for swaging;
- g) if applicable, procedure for removal of fins;
- h) dimensional requirements of the swaged termination;
- i) temperature limits for the application of the swaged termination.

5.3 Swage terminal

5.3.1 General

The swage terminal manufacturer shall provide instructions for swaging containing, at least, those provided by the swaging system designer.

5.3.2 Material

The material used by the swage terminal manufacturer shall conform to that specified and used by the swaging system designer when satisfying the type tests.

5.3.3 Dimensions

The dimensions of the swage terminal shall conform to those specified and used by the swaging system designer in the type tests.

5.3.4 Design strength

The swage terminal shall have a design strength at least equivalent to the characteristic breaking force of the rope(s) for which it is designed.

5.3.5 Certificate

The swage terminal manufacturer shall supply a certificate stating that the swage terminals (or whole batch of swage terminals) conform(s) to the swaging system designer's specification.

5.3.6 Marking

Each swage terminal shall be marked with its size and the swage terminal manufacturer's name or mark.

Alternatively, where the physical size of the terminal does not provide sufficient safe area for such marking without compromising its safety and/or performance, the package may be marked.

5.4 Swaging

5.4.1 General

The procedure adopted by the swaged termination manufacturer shall be in accordance with 5.4.2 to 5.4.4 and the instructions provided by the swage terminal manufacturer.

5.4.2 Matching of swage terminal to wire rope

Determine the rope description from the documentation supplied with the rope, see EN 12385-1, and ensure that the rope is within the scope of the swaging system as specified by the swage terminal manufacturer.

5.4.3 Swaging of the terminal

Swaging of the terminal shall be in accordance with the swage terminal manufacturer's instructions.

The contact and inner surfaces of the swaging dies shall be clean and lubricated.

The swaging dies shall not be misaligned.

5.4.4 Quality control after swaging of the terminal

At each set up of the tools, the swaged termination shall be checked to verify that it is within the after swaging dimensional limits specified by the swage terminal manufacturer.

The dimension(s) of the swage shank of each swaged termination shall be within the after swaging dimensional limits as specified by the swage terminal manufacturer.

Each swaged termination shall be free of any flaws and surface defects and shall not exhibit any sharp edges or rough surfaces.

6 Verification of the safety requirements and/or measures

6.1 Tensile type test (swaging system designer)

After 80% of the minimum breaking force of the rope F_{min} has been applied, the force shall be increased at a rate of not more than 0,5% of the minimum breaking force per second.

The minimum free test length, excluding terminations, shall be in accordance with Table 2.

The testing machine shall comply with EN ISO 7500-1.

Table 2 — Test lengths

Nominal rope diameter (d) (mm)	Minimum test length	
	Stranded rope (mm)	Spiral rope (mm)
Up to and including 6	300	500
Over 6 up to and including 20	600	1 000
Over 20 up to and including 60	30 x d	50 x d
Over 60	3m	

6.2 Fatigue type test (swaging system designer)

The test shall be carried out on an in-line tensile fatigue machine. The terminations shall not be allowed to rotate and the test shall consist of the application of a cyclic force from 15 % to 30 % of the minimum breaking force of the rope along the rope axis for 75 000 cycles.

The cyclical test frequency shall not exceed 5 Hz in an ambient temperature of 10° to 40° C.

The tensile test that follows the tensile fatigue test shall be in accordance with 6.1.

6.3 Swage terminal dimensions before swaging (swage terminal manufacturer)

The requirements of 5.3.3 shall be confirmed by measurement.

6.4 Swage terminal design strength (swaging system designer)

The requirements of 5.3.4 shall be confirmed by calculation.

6.5 Manufacture and quality control of swage terminal (swage terminal manufacturer)

The material requirements of 5.3 shall be confirmed by visual inspection of the material certificate.

6.6 Swage terminals (swaged termination manufacturer)

Compliance with the swage terminal requirements shall be through visual verification of the inspection document supplied with the swage terminals.

6.7 Matching of swage terminal to wire rope (swaged termination manufacturer)

The requirements of 5.4.2 shall be confirmed by visual inspection of the documentation supplied with the rope and the instructions provided by the swage terminal manufacturer and/or by measurement.

6.8 Swaging the terminal (swaged termination manufacturer)

The requirements of 5.4.3 shall be confirmed by visual inspection.

6.9 Quality control after swaging the terminal

The requirements of 5.4.4 shall be confirmed by measurement.

NOTE Use of a 'go/ no go gauge' is an accepted form of measurement.

The requirements for flaws and defects shall be confirmed by visual inspection.

7 Information for use

7.1 Marking

- The swaged termination shall be legibly and indelibly marked with the swaged termination manufacturer's name, symbol or mark; and
- The swaged termination shall be legibly and durably marked with the traceability code identifying the assembly with the certificate in 7.2.

7.2 Certificate

The certificate shall include at least the following information:

- name and address of the swaged termination manufacturer and, if appropriate, his authorized representative, including the date of issue of the certificate and authentication;
- number and relevant part of this European Standard;
- description of the assembly; and
- traceability code as per marking.

Annex ZA (informative)

Relationship between this European Standard And the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission [and the European Free Trade Association] to provide one means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC on machinery.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with Essential Requirement(s) of that Directive and associated EFTA regulations.

WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

- [1] EN 12385-4, *Steel wire ropes — Safety — Part 4: Stranded ropes for general lifting applications*
- [2] EN 12385-5, *Steel wire ropes — Safety — Part 5: Stranded ropes for lifts*
- [3] EN 12385-10, *Steel wire ropes — Safety — Part 10: Spiral ropes for general structural applications*

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