UNIVERSITÀ DI PISA

Dipartimento di Ingegneria Civile e Industriale

UNSIDER

Ente Italiano di Unificazione Siderurgica

La nuova revisione delle UNI EN 15630:2019
Acciaio per calcestruzzo armato e calcestruzzo armato precompresso - Metodi di prova

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05 Giugno 2019 – Sede UNSIDER - Via Crescenzago 55 – Milano.

Sommario:

Introduzione

- *Novità comuni alle parti della Norma 15630*

Le novità viste dai laboratori (parti 1, 2 e 3):

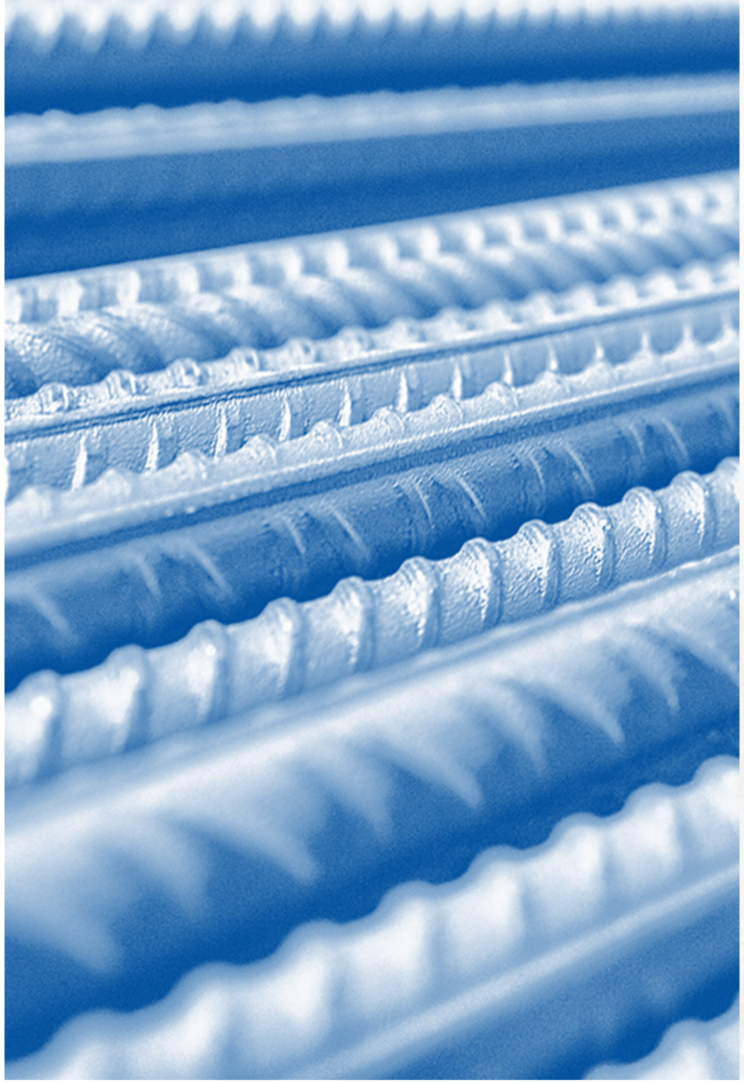
- *Le prove effettuate ad alte e basse temperature*
- *Le prove di fatica effettuate a basso numero di cicli (LCF)*

Le novità viste dai laboratori (parte 2):

- *Prove sui nodi dei tralicci (lattice girders)*
- *Prove sui «clamped joint»*

Le novità viste dai laboratori (parte 3):

- *Wrapping Test*



Introduzione

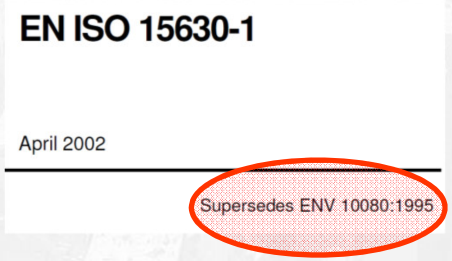
Introduzione

Tappe di sviluppo della norma EN 15630

1995 - - - - - **2002** —— **2010** —— **2019**

ENV 10080:1995

EN ISO 15630-1:2002
EN ISO 15630-2:2002
EN ISO 15630-3:2002



EN ISO 15630-1

April 2002

Supersedes ENV 10080:1995

EN ISO 15630-1:2010
EN ISO 15630-2:2010
EN ISO 15630-3:2010

EN ISO 15630-1:2019
EN ISO 15630-2:2019
EN ISO 15630-3:2019

Introduzione

Novità introdotte nelle nuove versioni della EN 15630-*:2019

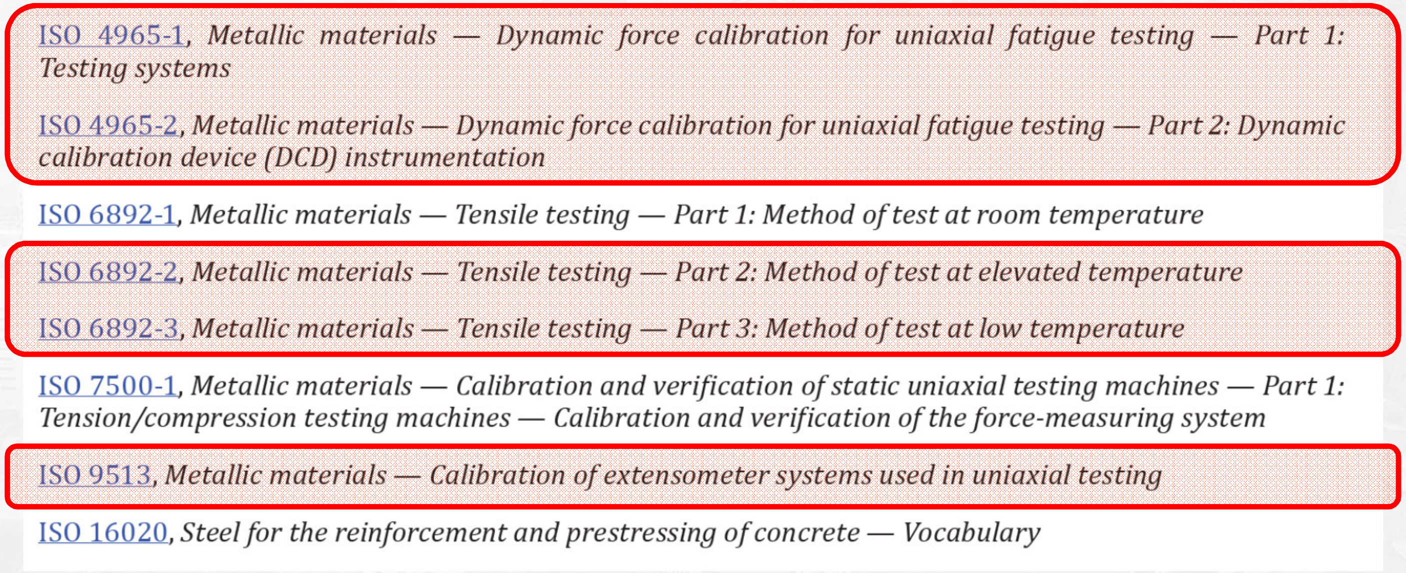
Le nuove versioni delle norme EN 15630 introducono alcune novità relative a:

- regolamentazione dell’utilizzo della strumentazione elettronica per la valutazione delle deformazioni (estensometri)
- maggiore attenzione alle diverse tipologie di acciai (es. acciaio inossidabile)
- esecuzione delle prove alle alte o basse temperature;
- nuove tipologie di prove per la caratterizzazione del comportamento meccanico delle barre (es. prove a fatica a basso numero di cicli)

Introduzione

Riferimenti normativi

Tali novità si deducono anche solo dai nuovi riferimenti normativi:



Macchine di prova a fatica

ISO 4965-1, *Metallic materials — Dynamic force calibration for uniaxial fatigue testing — Part 1: Testing systems*

ISO 4965-2, *Metallic materials — Dynamic force calibration for uniaxial fatigue testing — Part 2: Dynamic calibration device (DCD) instrumentation*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

Temperatura

ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

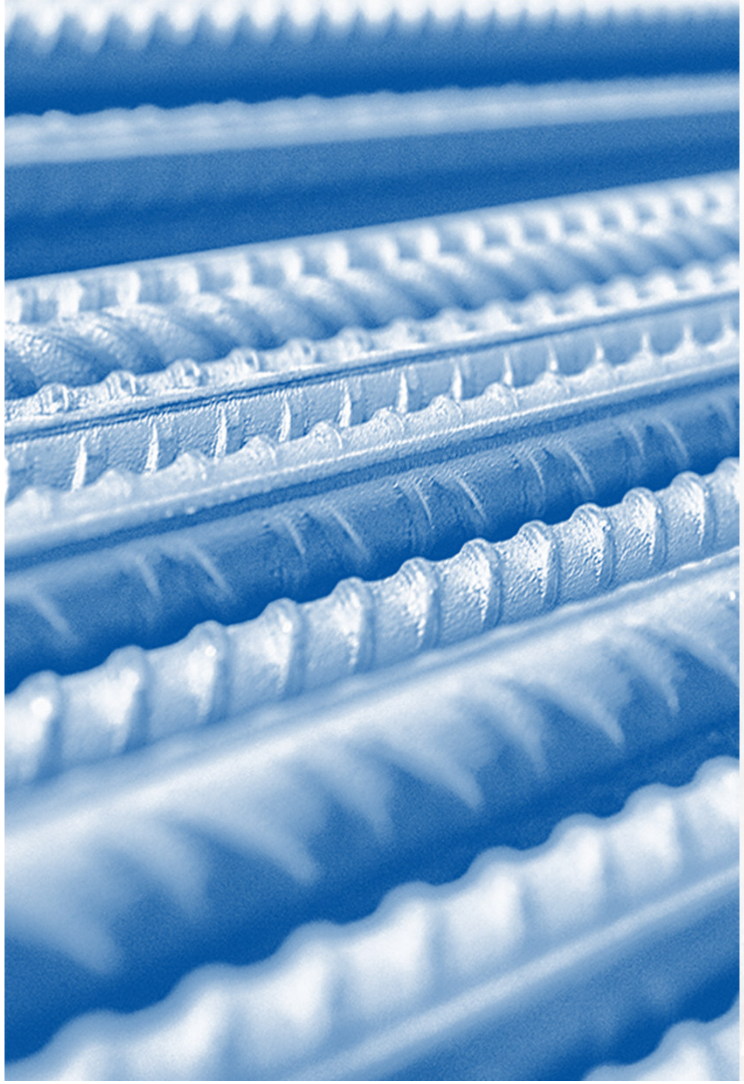
ISO 6892-3, *Metallic materials — Tensile testing — Part 3: Method of test at low temperature*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

Estensometri

ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

ISO 16020, *Steel for the reinforcement and prestressing of concrete — Vocabulary*

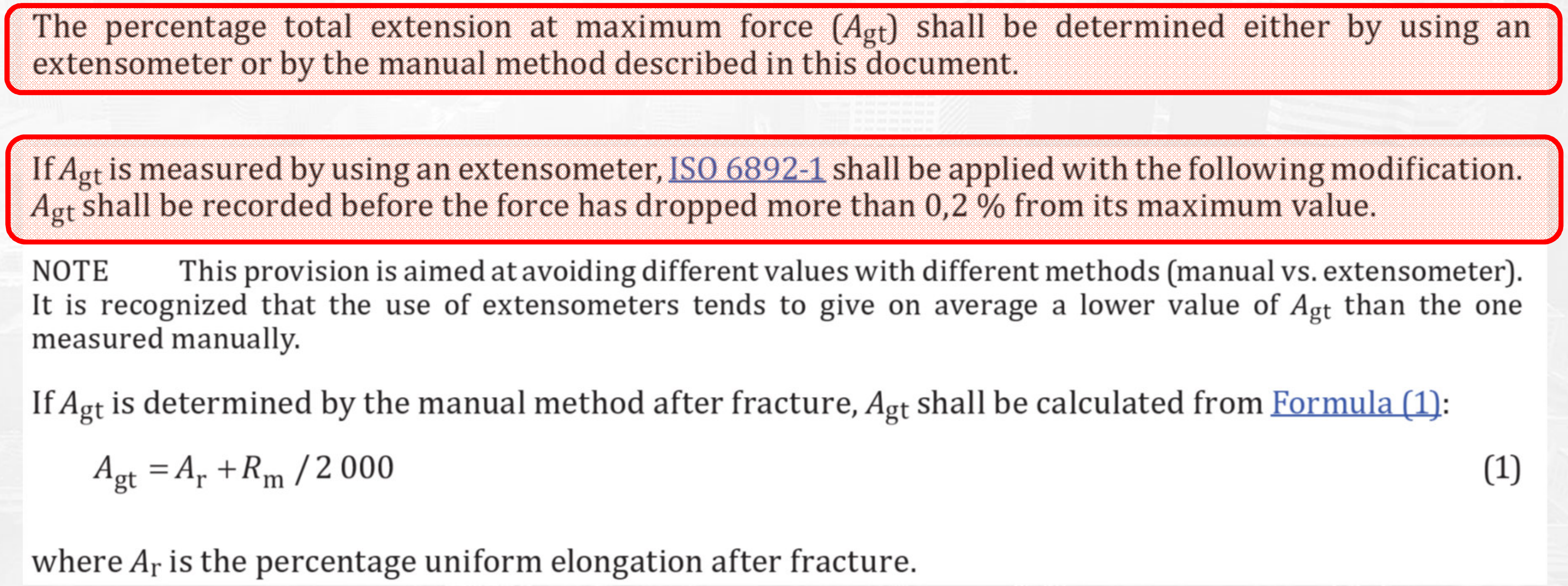


Estensometri

Valutazione dell’Agt mediante estensometro

Indicazioni della norma EN 15630

Possibilità di utilizzo del metodo manuale oppure delle misure mediante estensometro:



The percentage total extension at maximum force (A_{gt}) shall be determined either by using an extensometer or by the manual method described in this document.

If A_{gt} is measured by using an extensometer, ISO 6892-1 shall be applied with the following modification. A_{gt} shall be recorded before the force has dropped more than 0,2 % from its maximum value.

NOTE This provision is aimed at avoiding different values with different methods (manual vs. extensometer). It is recognized that the use of extensometers tends to give on average a lower value of A_{gt} than the one measured manually.

If A_{gt} is determined by the manual method after fracture, A_{gt} shall be calculated from Formula (1):

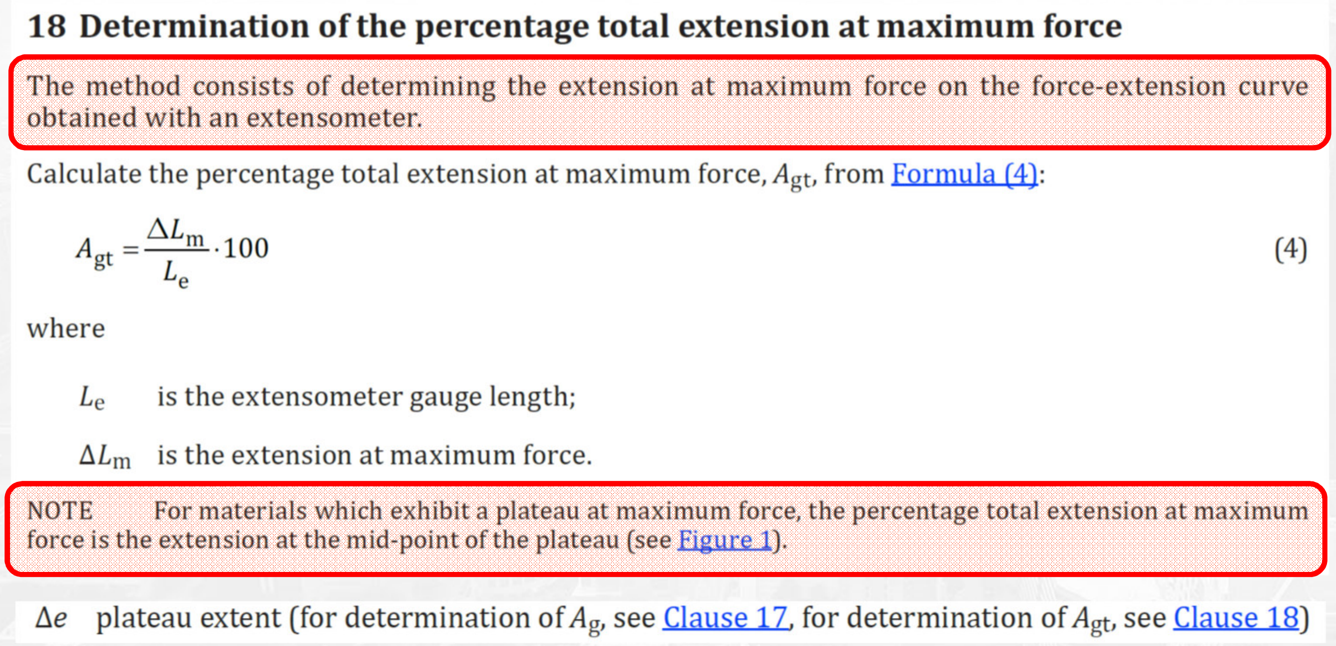
$$A_{gt} = A_r + R_m / 2\,000 \qquad (1)$$

where A_r is the percentage uniform elongation after fracture.

Valutazione dell’Agt mediante estensometro

Indicazioni della norma EN ISO 6892-1:2016

EN ISO 6892-1:2016:



18 Determination of the percentage total extension at maximum force

The method consists of determining the extension at maximum force on the force-extension curve obtained with an extensometer.

Calculate the percentage total extension at maximum force, A_{gt}, from Formula (4):

$$A_{gt} = \frac{\Delta L_m}{L_e} \cdot 100 \qquad (4)$$

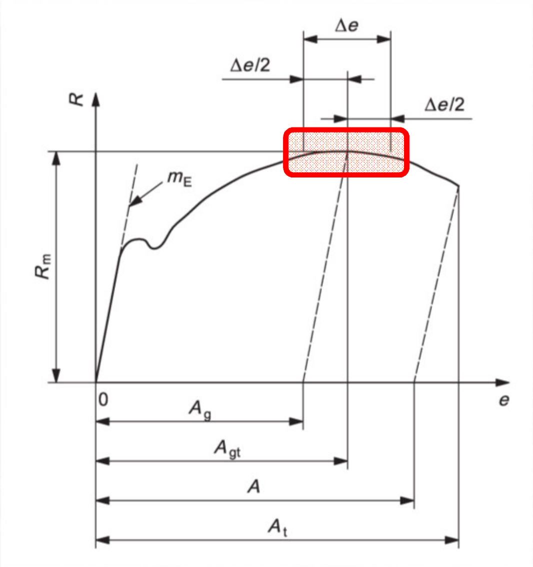
where

L_e is the extensometer gauge length;

ΔL_m is the extension at maximum force.

NOTE For materials which exhibit a plateau at maximum force, the percentage total extension at maximum force is the extension at the mid-point of the plateau (see Figure 1).

Δe plateau extent (for determination of A_g, see Clause 17, for determination of A_{gt}, see Clause 18)

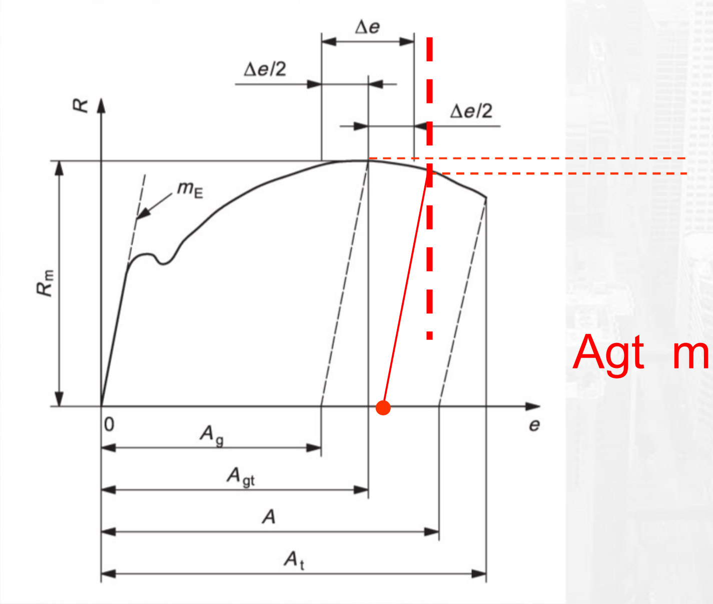


Valutazione dell’Agt mediante estensometro

Indicazioni della norma EN 15630

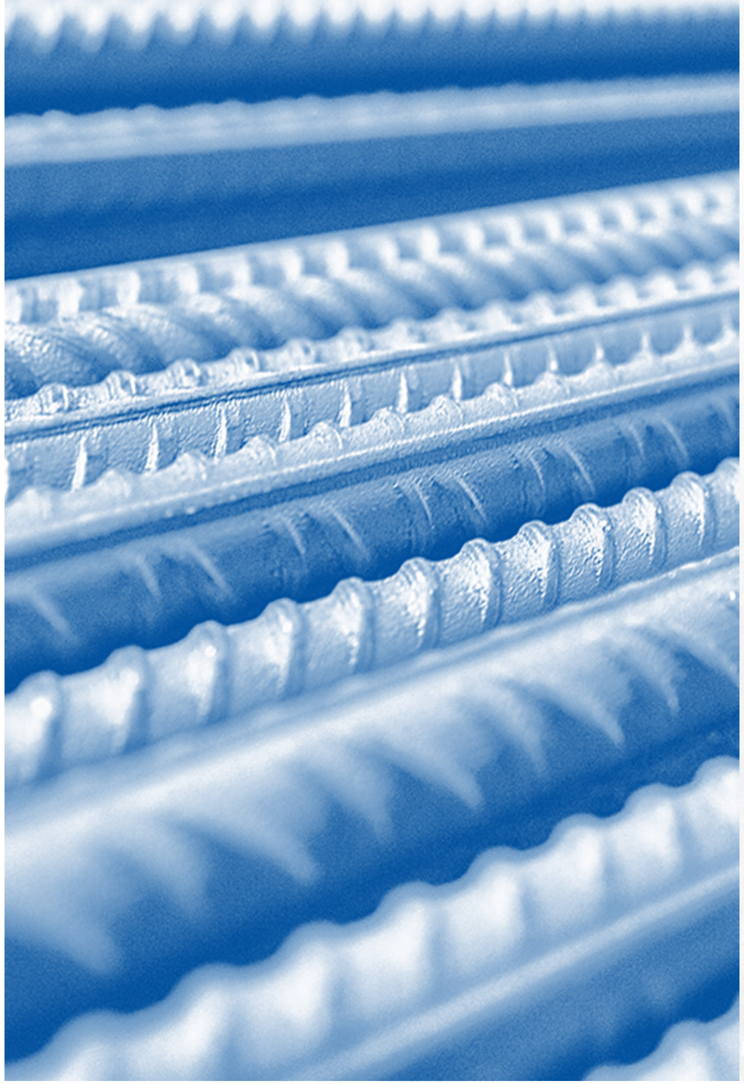
La norma EN 15630 fissa un valore massimo desumibile dalle misure:

> If A_{gt} is measured by using an extensometer, ISO 6892-1 shall be applied with the following modification. A_{gt} shall be recorded before the force has dropped more than 0,2 % from its maximum value.



0,2% Rm

Agt massimo ottenibile dal grafico



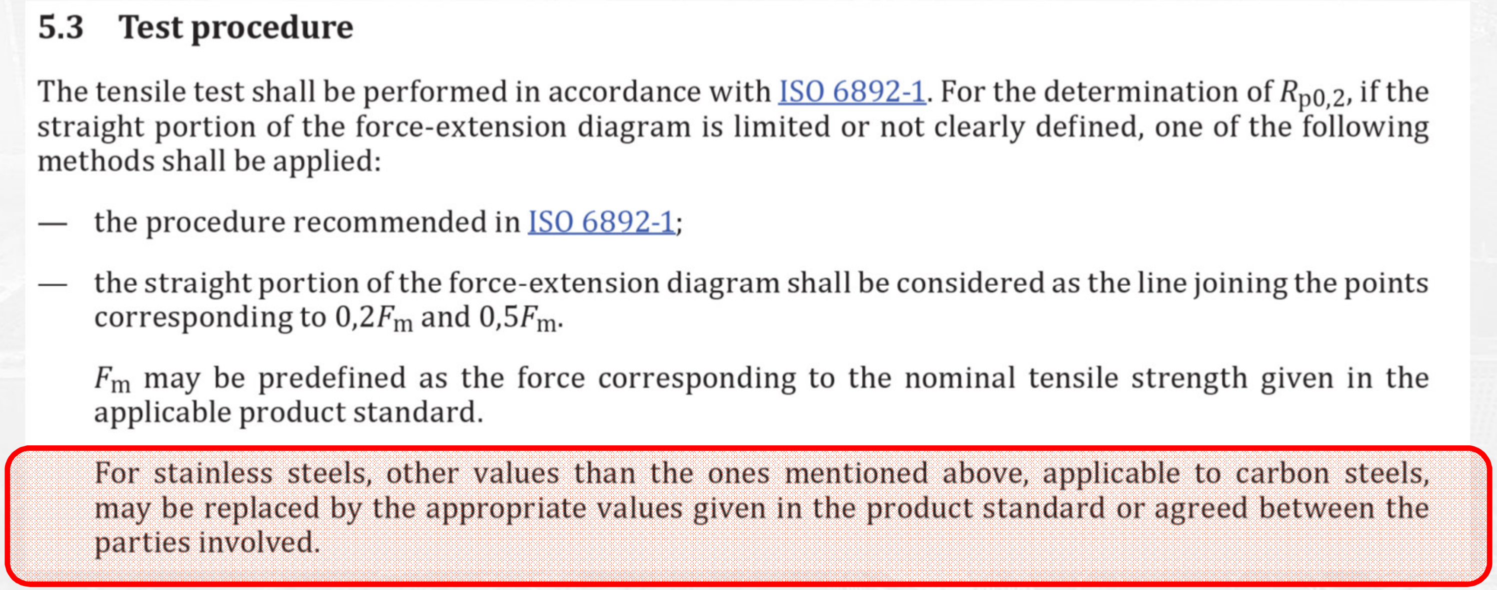
Acciai Inossidabili

«Stainless steel»

Acciai inossidabili

Indicazioni della norma

Esecuzione della prova di trazione:



5.3 Test procedure

The tensile test shall be performed in accordance with ISO 6892-1. For the determination of $R_{p0,2}$, if the straight portion of the force-extension diagram is limited or not clearly defined, one of the following methods shall be applied:

— the procedure recommended in ISO 6892-1;

— the straight portion of the force-extension diagram shall be considered as the line joining the points corresponding to $0,2F_m$ and $0,5F_m$.

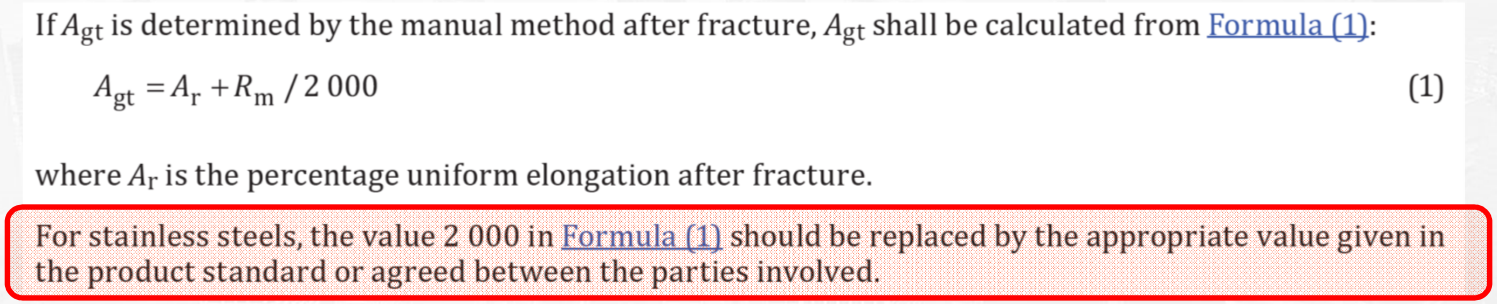
F_m may be predefined as the force corresponding to the nominal tensile strength given in the applicable product standard.

For stainless steels, other values than the ones mentioned above, applicable to carbon steels, may be replaced by the appropriate values given in the product standard or agreed between the parties involved.

Acciai inossidabili

Indicazioni della norma EN 15630

Valutazione dell'A_{gt}:



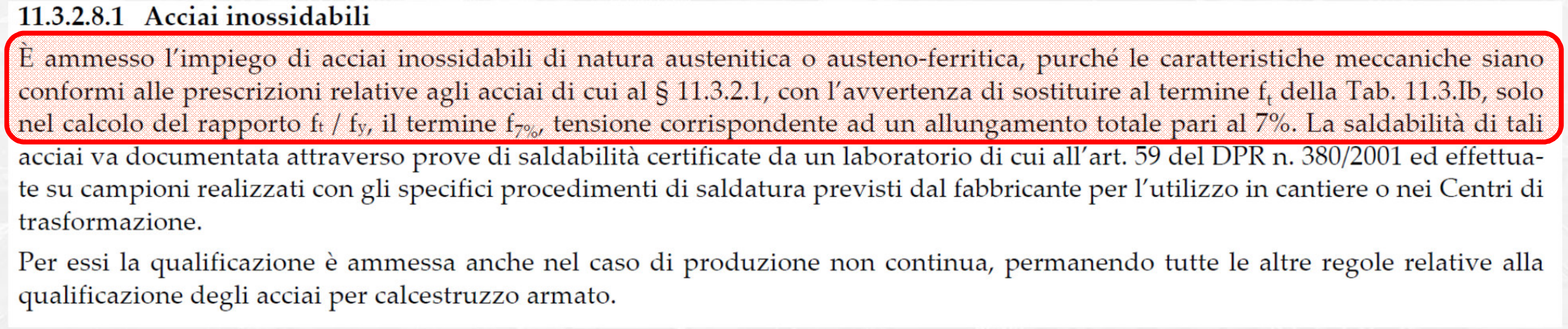
If A_{gt} is determined by the manual method after fracture, A_{gt} shall be calculated from Formula (1):

$$A_{gt} = A_r + R_m / 2\,000 \qquad (1)$$

where A_r is the percentage uniform elongation after fracture.

For stainless steels, the value 2 000 in Formula (1) should be replaced by the appropriate value given in the product standard or agreed between the parties involved.

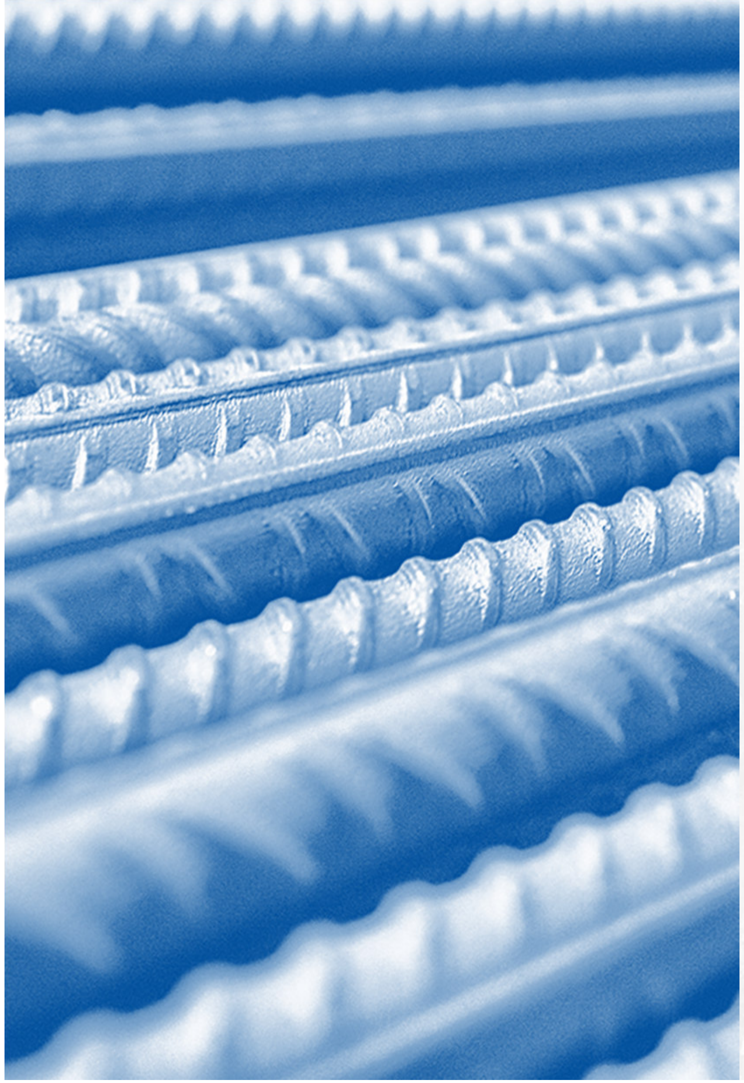
Nota dalle NTC 2018:



11.3.2.8.1 Acciai inossidabili

È ammesso l'impiego di acciai inossidabili di natura austenitica o austeno-ferritica, purché le caratteristiche meccaniche siano conformi alle prescrizioni relative agli acciai di cui al § 11.3.2.1, con l'avvertenza di sostituire al termine f_t della Tab. 11.3.Ib, solo nel calcolo del rapporto f_t / f_y, il termine $f_{7\%}$, tensione corrispondente ad un allungamento totale pari al 7%. La saldabilità di tali acciai va documentata attraverso prove di saldabilità certificate da un laboratorio di cui all'art. 59 del DPR n. 380/2001 ed effettuate su campioni realizzati con gli specifici procedimenti di saldatura previsti dal fabbricante per l'utilizzo in cantiere o nei Centri di trasformazione.

Per essi la qualificazione è ammessa anche nel caso di produzione non continua, permanendo tutte le altre regole relative alla qualificazione degli acciai per calcestruzzo armato.



Prove eseguibili ad alte o basse temperature

Prove alle alte e basse temperature

Indicazioni della norma

- Prove con provini ed apparecchiature analoghe a quelle utilizzate per la temperatura ambiente rimandando alle Norme EN ISO 6892-2 e 6892-3 per la definizione delle modalità di prova.
- Le macchine utilizzate devono essere dotate di unità per il riscaldamento o camere climatiche per le basse temperature.

IPC global
CONTROLS GROUP
UTM-130

MTS
MPTL-TF-3
MTS

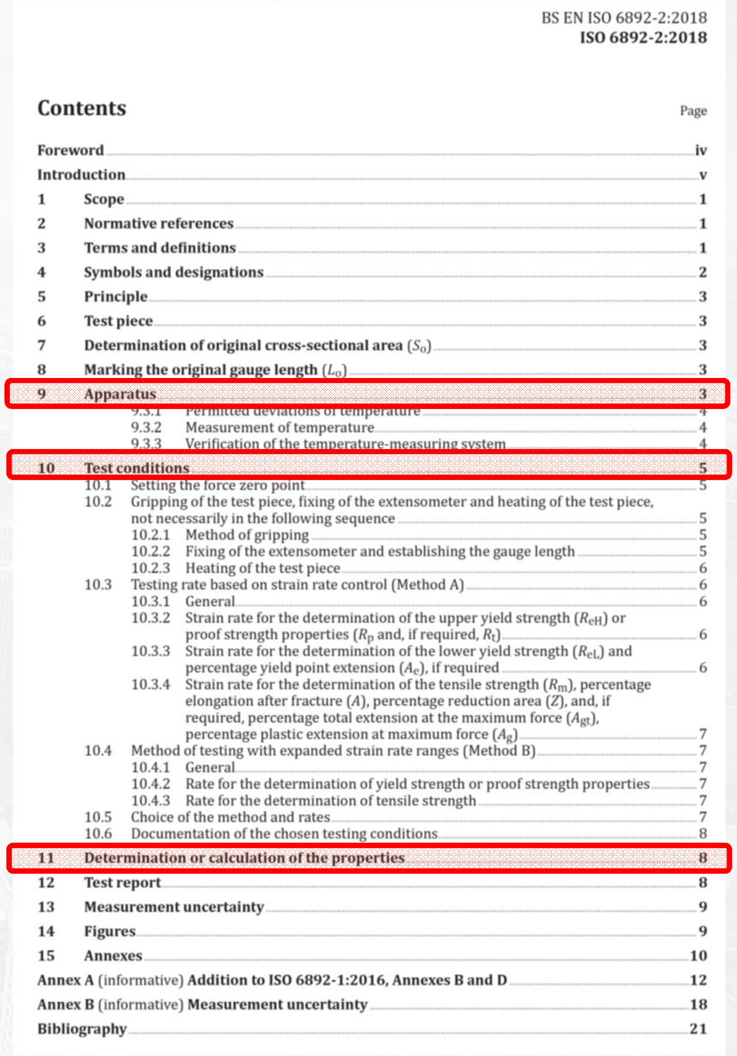
Prove alle alte e basse temperature

Indicazioni della norma (es. 6892-2:2018)

Apparato di prova

Condizioni di esecuzione di prova, comprese le velocità di incremento delle tensioni o delle deformazioni e le modalità di gestione dell'estensometro

Modalità per la determinazione ed il calcolo delle proprietà meccaniche a partire dai risultati della prova



BS EN ISO 6892-2:2018
ISO 6892-2:2018

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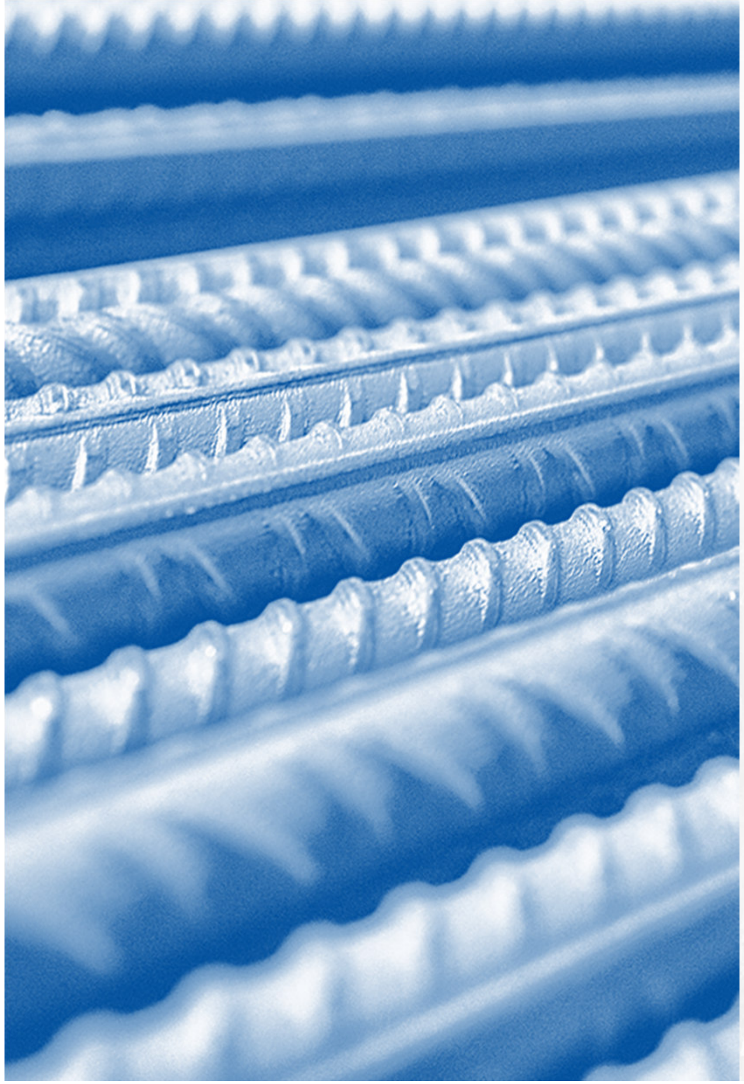


Prove LCF

«Low Cicle Fatigue Tests»

Prove a fatica a basso numero di cicli

Alcune indicazioni precedentemente adottate da altre normative europee

LOW-CYCLE FATIGUE TEST : SPAIN (UNE 36065) – PORTUGAL (E 455-2008)

The samples has to be subjected to **3 complete symmetric hysteresis cycles**, applicating at the ends of the sample following deformations of tension and compression, as indicated in the table below.

bar size (mm)	Free Length (mm)	Deformation (%)
≤ 16	5d	±4
> 16, < 25	10d	±2,5
≥ 25	15d	±1,5

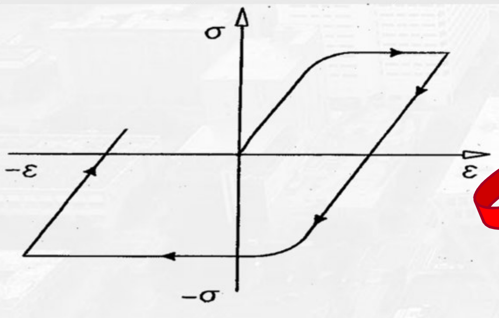


Fig. 7 – Diagrama tensión-deformación. Ciclo de histéresis

SPAIN

The samples has to be subjected to **10 complete symmetric hysteresis cycles**, applicating at the ends of the sample following deformations of tension and compression, as indicated below.

Frequency	$f \le 3{,}0\ Hz$
Deformation	$\varepsilon_{\max}\ \pm 2{,}5\,\%$
L_0	$L_0 \ge 10 \cdot d$
Temperature	$10° \div 35°$

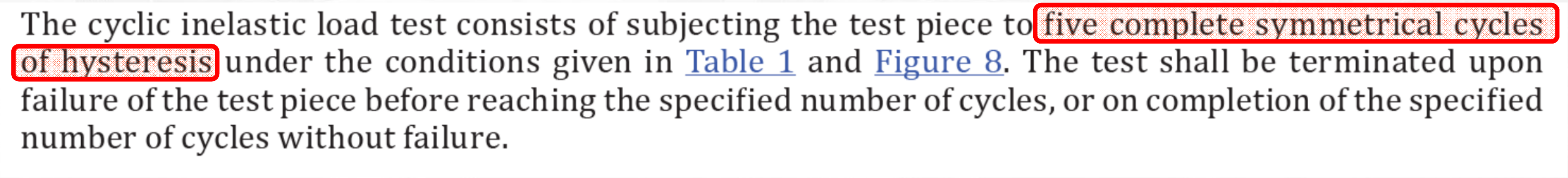
PORTUGAL

The test will be considered satisfied if the samples arrive to the end of the testing procedure without encountering problems of cracking (total or partial failure)

Prove a fatica a basso numero di cicli

Indicazioni delle norme 15630

Modalità adottate dalle norme 15630:



The cyclic inelastic load test consists of subjecting the test piece to five complete symmetrical cycles of hysteresis under the conditions given in Table 1 and Figure 8. The test shall be terminated upon failure of the test piece before reaching the specified number of cycles, or on completion of the specified number of cycles without failure.

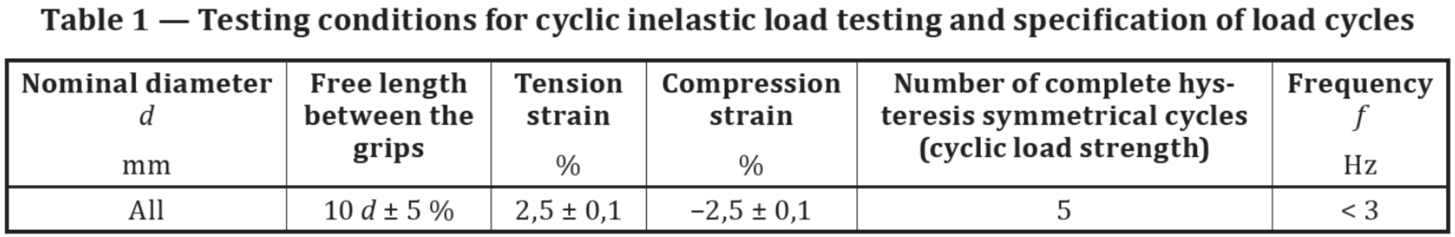
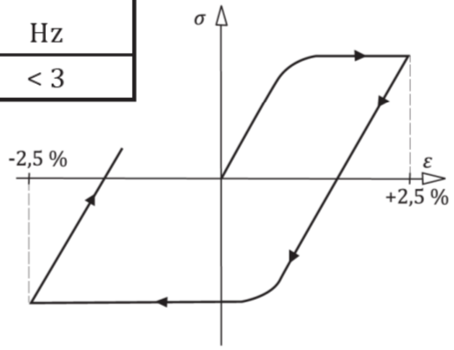


Table 1 — Testing conditions for cyclic inelastic load testing and specification of load cycles

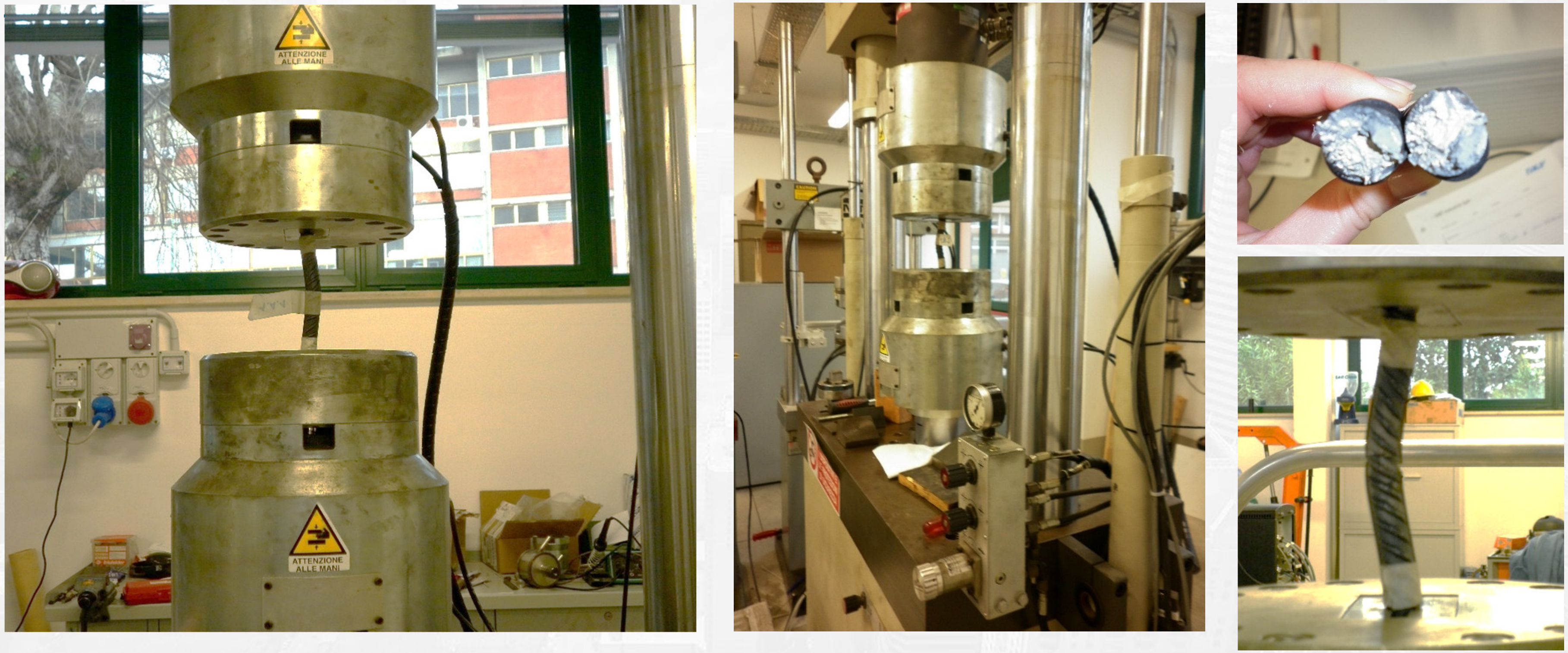
Nominal diameter d mm	Free length between the grips	Tension strain %	Compression strain %	Number of complete hysteresis symmetrical cycles (cyclic load strength)	Frequency f Hz
All	10 d ± 5 %	2,5 ± 0,1	−2,5 ± 0,1	5	< 3



Prove a fatica a basso numero di cicli

Esempio di realizzazione della prova

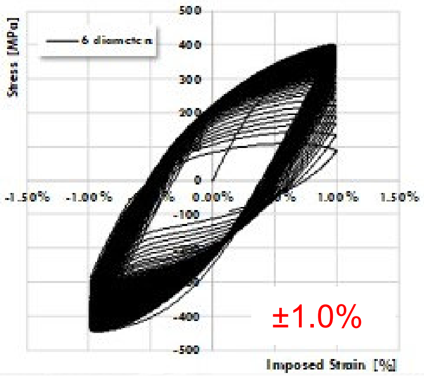
Low-Cycle Fatigue (LCF) tests eseguite secondo il protocollo adottato del Progetto di ricercar RFCS RUSTEEL

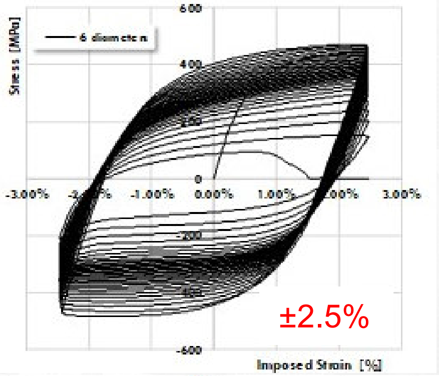

ATTENZIONE ALLE MANI
ATTENZIONE ALLE MANI

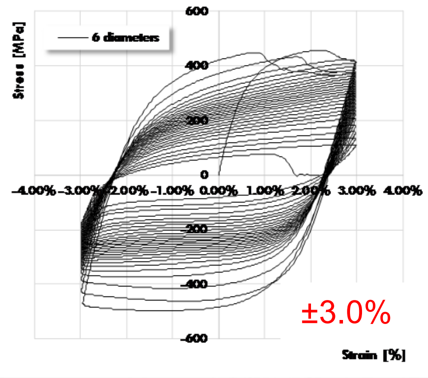
Prove a fatica a basso numero di cicli

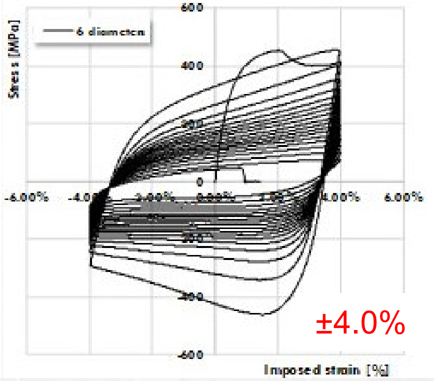
Esempio di realizzazione della prova

Low-Cycle Fatigue (LCF) tests eseguite secondo il protocollo adottato del Progetto di ricercar RFCS RUSTEEL.







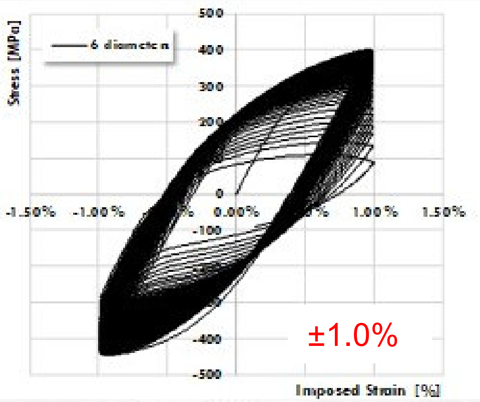


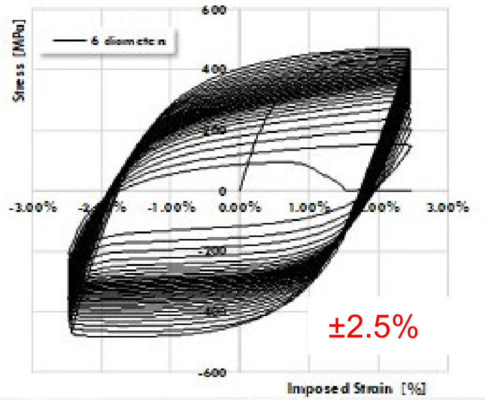
Low-cycle fatigue testing protocol

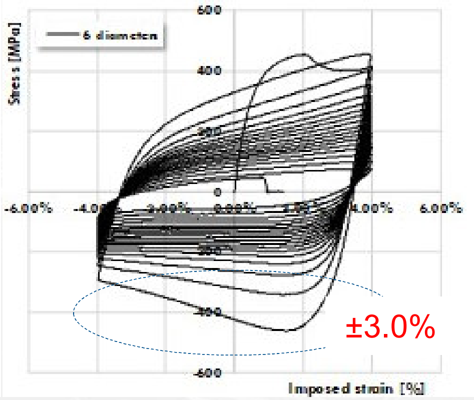
- Testing frequency 2.0 Hz (reduced to 0.5 Hz for high deformations due to machine’s requirements).
- Four levels of imposed deformation ($\Delta\varepsilon$), equal to ±1.0%, ±2.5%, ±3.0% and ±4.0%.
- Number of cycles (N_{cycles}) up to failure.
- Length (L_0) of the specimen: 6ϕ and 8ϕ (stirrups’ sp acing according to EN1998-1:2005).

Prove a fatica a basso numero di cicli

Esempio di realizzazione della prova

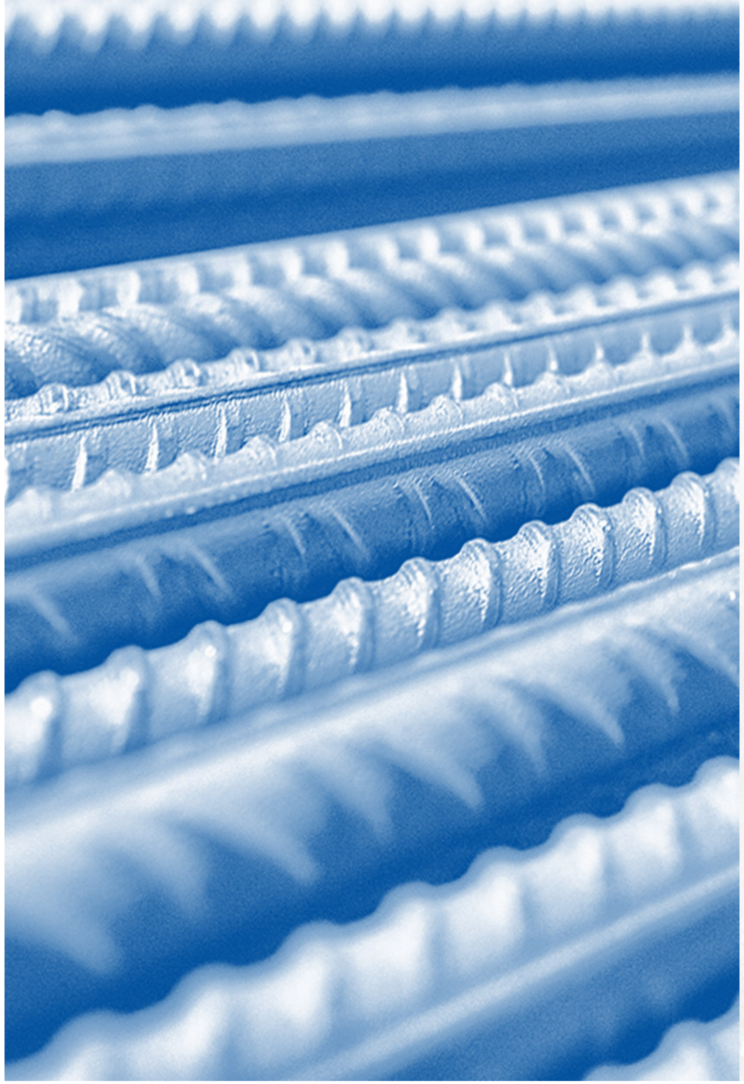






Valori medi – 3 provini per ciascun rapporto deformazione / lunghezza libera

Φ_{eff} (mm)	L_0 (mm)	$\Delta\varepsilon_{imp}$ (%)	Δl_{imp} (mm)	f (Hz)	σ_{max} (MPa)	σ_{min} (MPa)	dE_{tot} (MPa)	N_{cycles} (-)
15.83	6ϕ	±1.0%	±0.96	2,0	397.61	-449.96	1795.66	329
15.81	6ϕ	±2.5%	±2.40	2,0	473.08	-491.07	700.83	32
15.84	6ϕ	±3.0%	±2.88	2,0	458.23	-501.22	585.10	26
15.82	6ϕ	±4.0%	±3.84	0.5	479.55	-499.75	514.06	15
15.82	8ϕ	±1.0%	±1.28	2,0	403.25	-449.88	991.95	159
15.81	8ϕ	±2.5%	±3.20	2,0	454.43	-457.40	383.27	25
15.82	8ϕ	±3.0%	±3.84	0.5	449.44	-425.82	363.78	20
15.80	8ϕ	±4.0%	±5.12	0.5	447.06	-468.03	362.16	16



Prove sui nodi dei tralicci

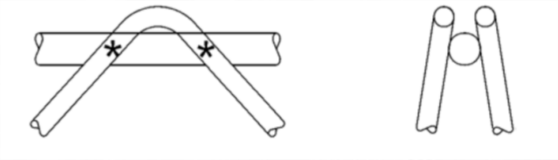
«lattice girders»

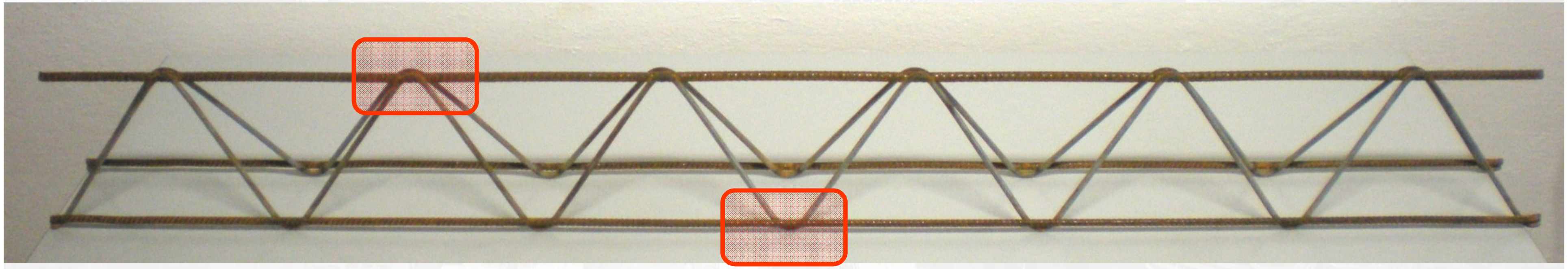
Prove sui nodi dei tralicci

Indicazioni della norma

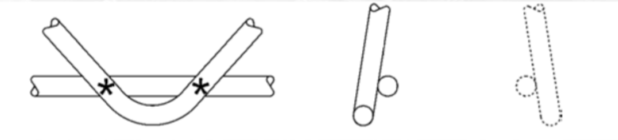
Individuazione dei nodi:

Nodo superiore





Nodo inferiore

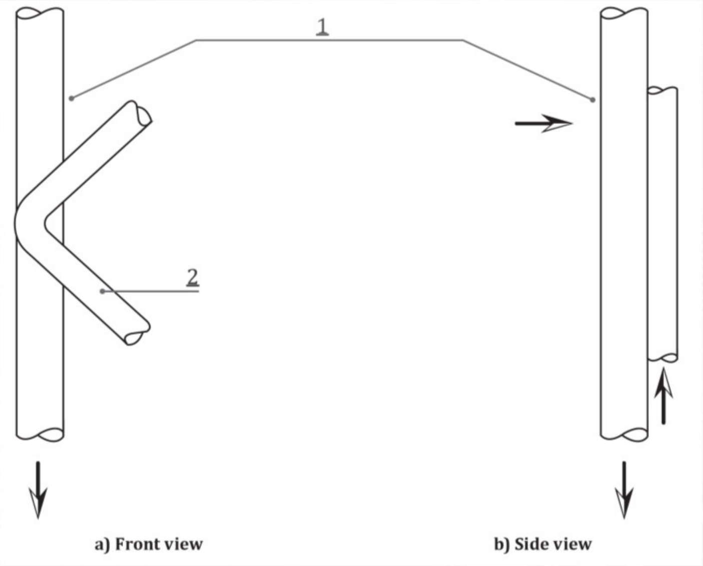


Prove sui nodi dei tralicci

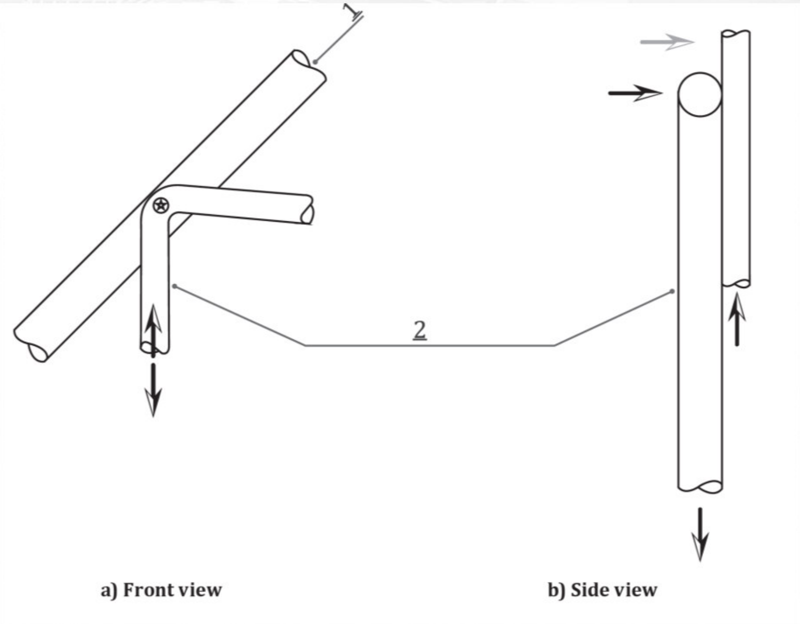
Indicazioni della norma 15630-2:2019

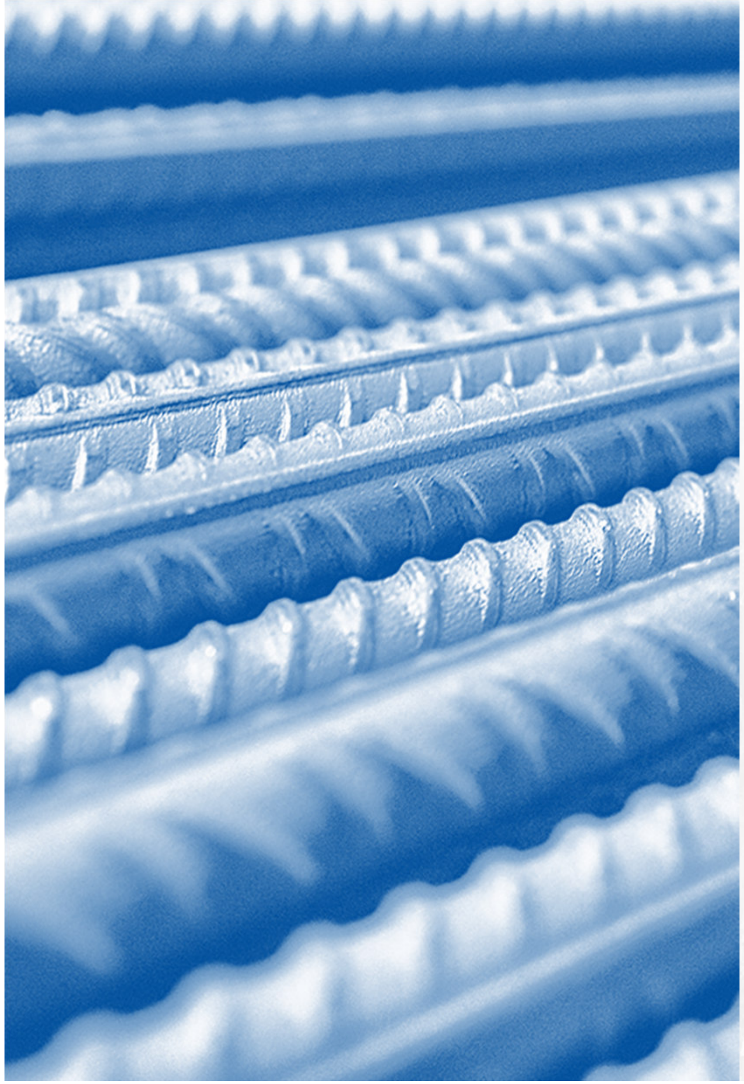
Possibili metodologie per l'esecuzione della prova:

Metodo 1


1
2
a) Front view
b) Side view

Metodo 2


1
2
a) Front view
b) Side view



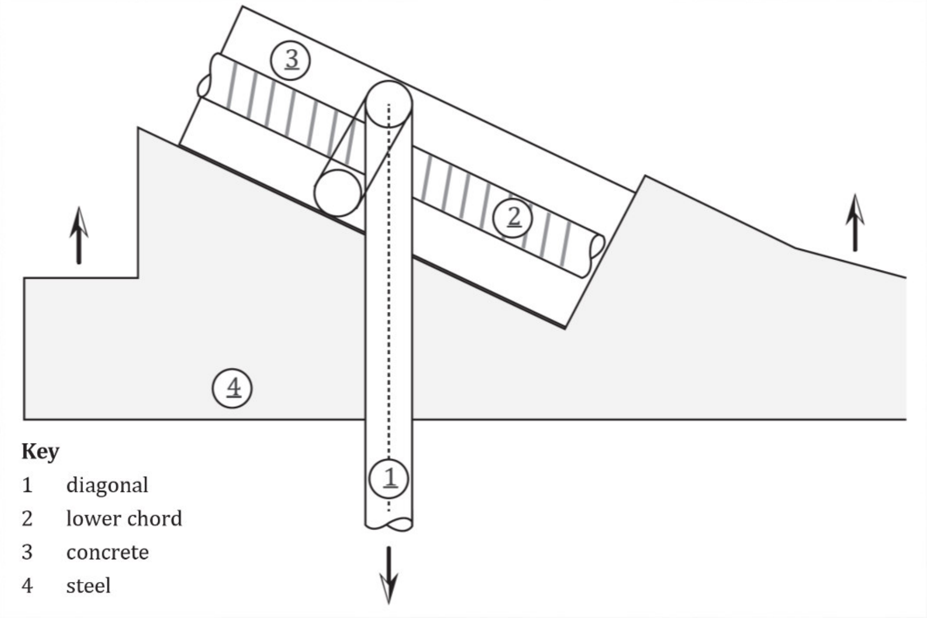
Prove sui nodi «clamped»

Prove sui nodi «clamped»

Indicazioni della norma 15630-2:2019

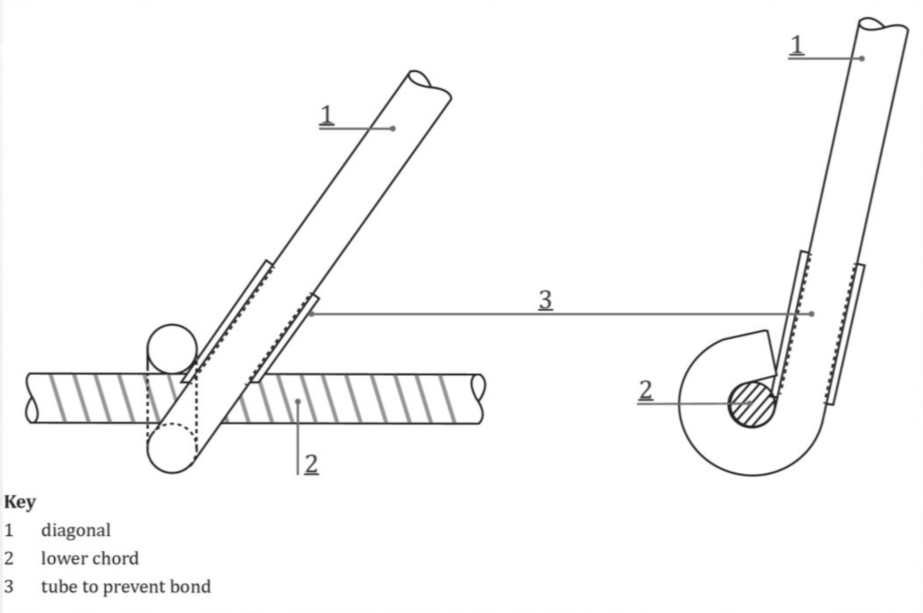
Metodologia per l’esecuzione delle prove di tipo:

Schema della prova



Key
1 diagonal
2 lower chord
3 concrete
4 steel

Particolare dell’armatura del provino



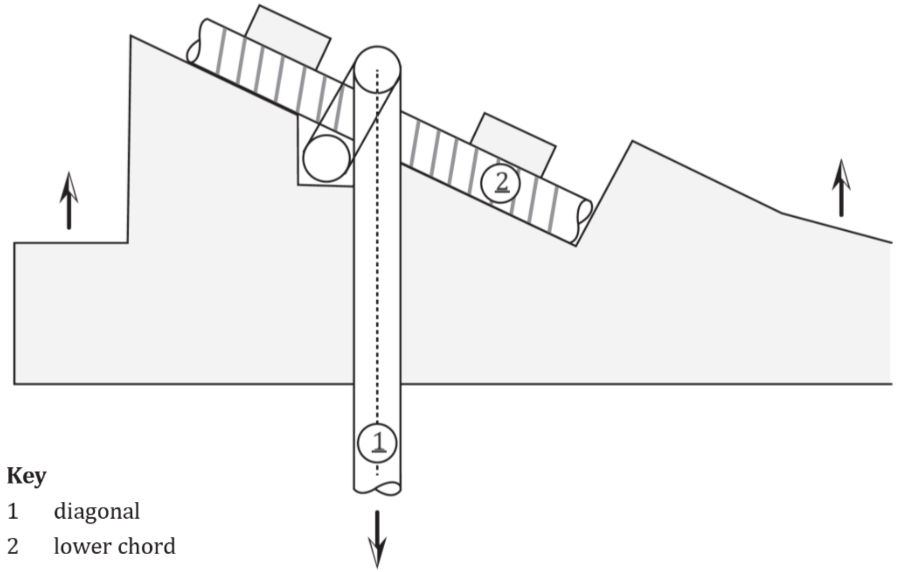
Key
1 diagonal
2 lower chord
3 tube to prevent bond

Prove sui nodi «clamped»

Indicazioni della norma 15630-2:2019

Metodologia per l’esecuzione delle prove per il controllo di produzione:

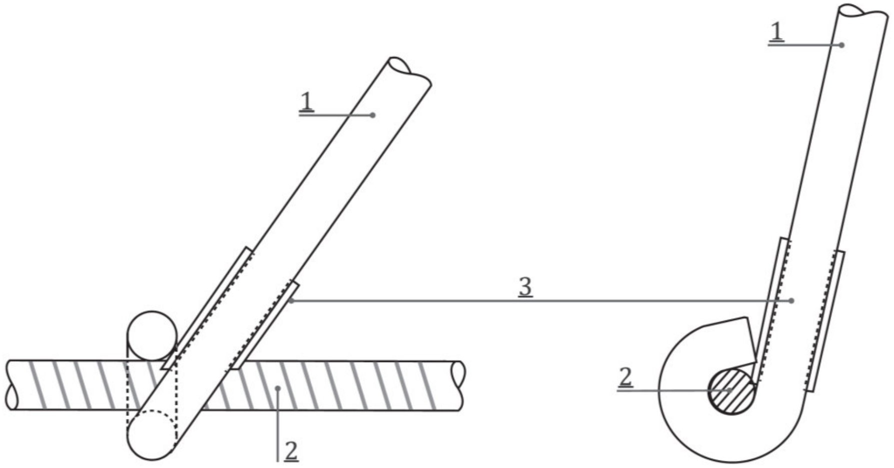
Schema della prova



Key

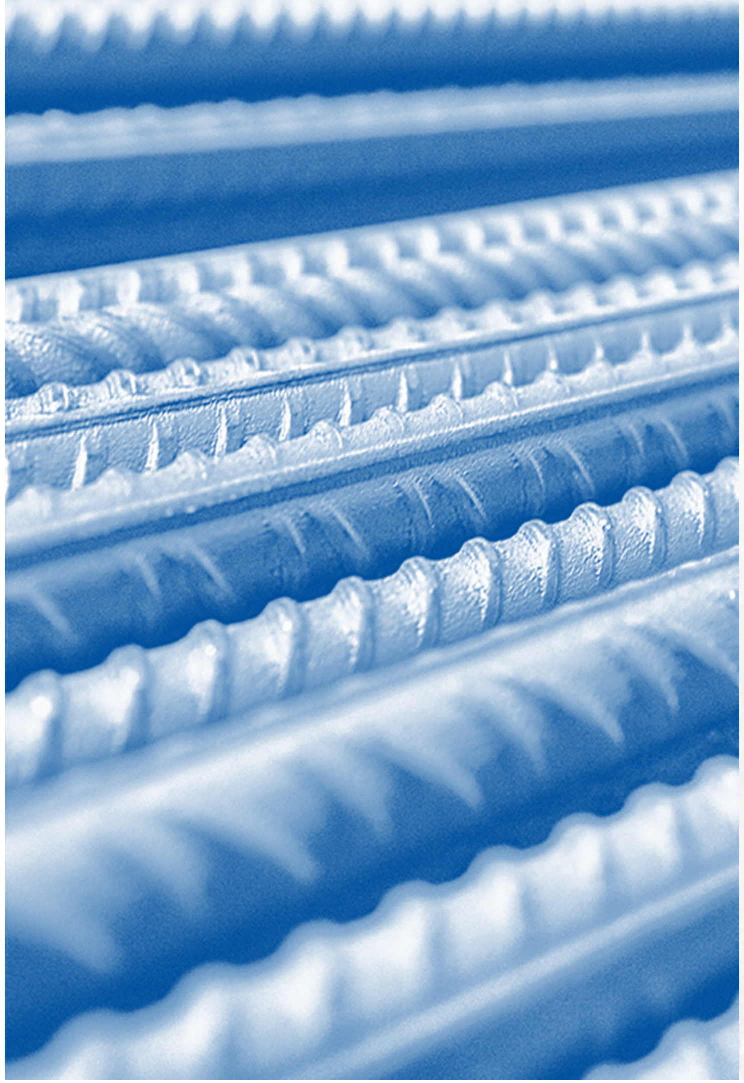
1	diagonal
2	lower chord

Particolare dell’armatura del provino



Key

1	diagonal
2	lower chord
3	tube to prevent bond

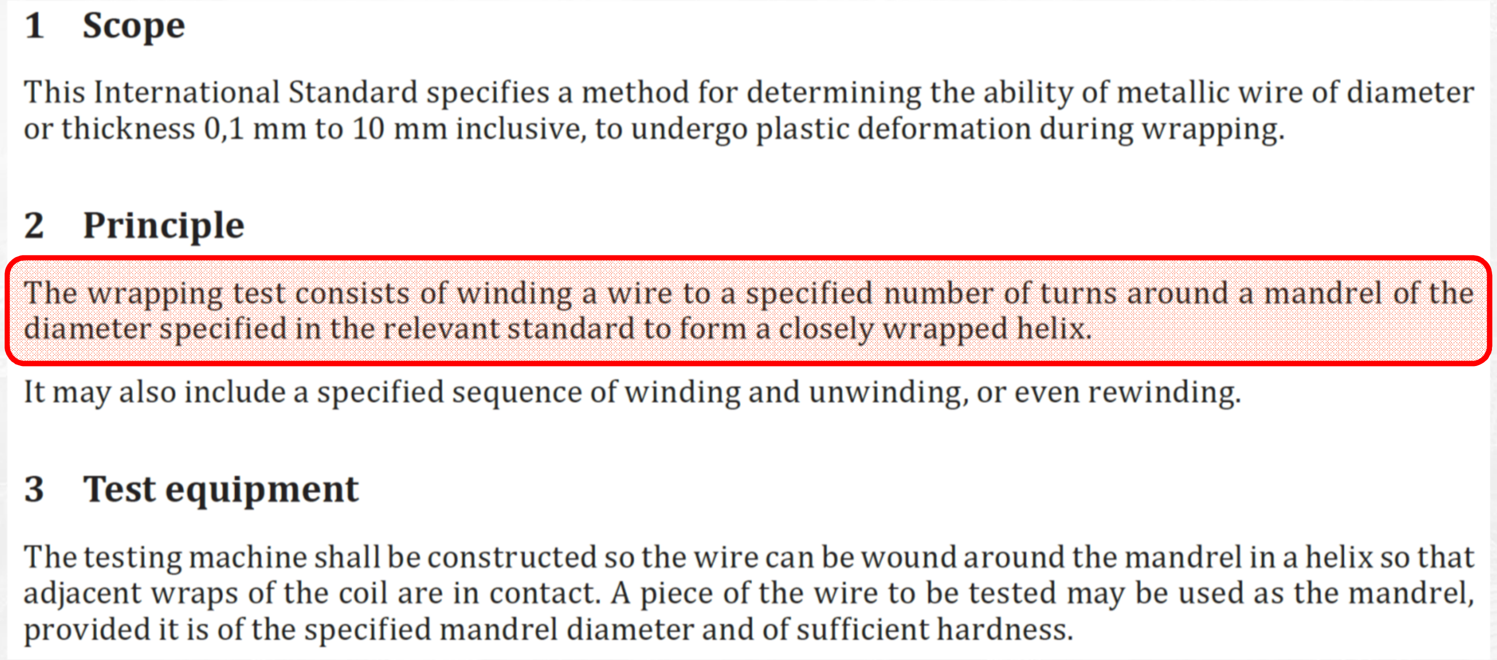


«Wrapping Test» su acciaio da c.a.p.

«Wrapping test»

Indicazioni della norma 15630-3:2019

Metodologia per l’esecuzione della prova indicata dalla ISO 7802:



1 Scope

This International Standard specifies a method for determining the ability of metallic wire of diameter or thickness 0,1 mm to 10 mm inclusive, to undergo plastic deformation during wrapping.

2 Principle

The wrapping test consists of winding a wire to a specified number of turns around a mandrel of the diameter specified in the relevant standard to form a closely wrapped helix.

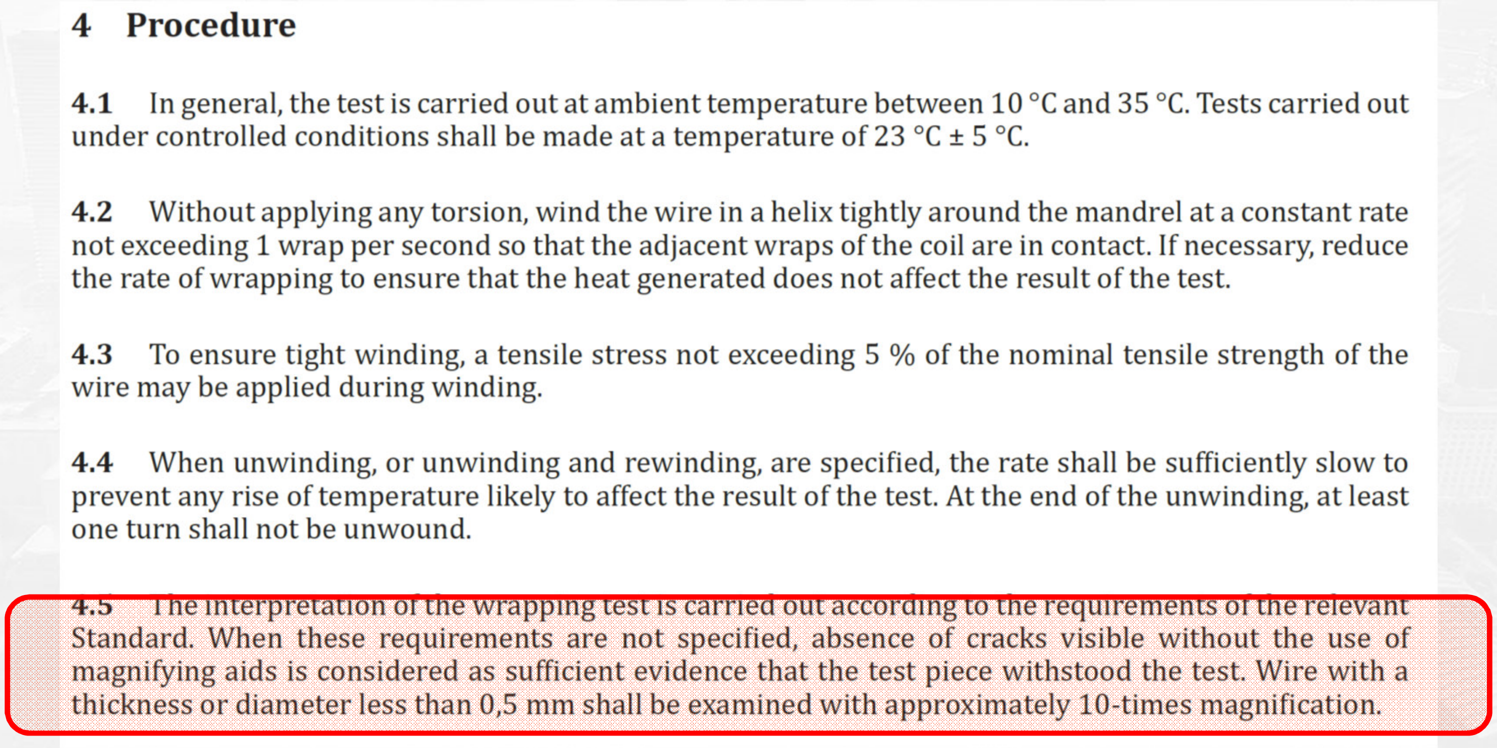
It may also include a specified sequence of winding and unwinding, or even rewinding.

3 Test equipment

The testing machine shall be constructed so the wire can be wound around the mandrel in a helix so that adjacent wraps of the coil are in contact. A piece of the wire to be tested may be used as the mandrel, provided it is of the specified mandrel diameter and of sufficient hardness.

«Wrapping test»

Indicazioni della norma 15630-3:2019



4 Procedure

4.1 In general, the test is carried out at ambient temperature between 10 °C and 35 °C. Tests carried out under controlled conditions shall be made at a temperature of 23 °C ± 5 °C.

4.2 Without applying any torsion, wind the wire in a helix tightly around the mandrel at a constant rate not exceeding 1 wrap per second so that the adjacent wraps of the coil are in contact. If necessary, reduce the rate of wrapping to ensure that the heat generated does not affect the result of the test.

4.3 To ensure tight winding, a tensile stress not exceeding 5 % of the nominal tensile strength of the wire may be applied during winding.

4.4 When unwinding, or unwinding and rewinding, are specified, the rate shall be sufficiently slow to prevent any rise of temperature likely to affect the result of the test. At the end of the unwinding, at least one turn shall not be unwound.

4.5 The interpretation of the wrapping test is carried out according to the requirements of the relevant Standard. When these requirements are not specified, absence of cracks visible without the use of magnifying aids is considered as sufficient evidence that the test piece withstood the test. Wire with a thickness or diameter less than 0,5 mm shall be examined with approximately 10-times magnification.

«Wrapping test»

Indicazioni della norma 15630-3:2019

Macchina per «Wrapping Test»

UnitedTest

https://unitedtest.en.made-in-china.com/product/djnJRMZrZAcK/China-ISO-7802-Metal-Wire-Wrapping-Test.html

Macchina per «Rebend Test»

UnitedTest

http://www.unitedtest.com/application/Testing_materials/Metal_testing/64.html

Crediti

Ringraziamenti

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Grazie

Domande o chiarimenti?