BRITISH STANDARD

BS EN
14653-2:2005

Manually operated hydraulic shoring systems for groundwork support —

Part 2: Assessment by calculation or test

The European Standard EN 14653-2:2005 has the status of a British Standard

ICS 93.020

National foreword

This British Standard is the official English language version of EN 14653-2:2005.

The UK participation in its preparation was entrusted by Technical Committee B/514, Access and support equipment, to Subcommittee B/514/29, Trench support systems, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 12, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 5 May 2005

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 45962 4

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14653-2

April 2005

ICS 93.020

English version

Manually operated hydraulic shoring systems for groundwork support - Part 2: Assessment by calculation or test

Composants des blindages de tranchées - Partie 2: Essais et évaluation

Manuell gesteuerte hydraulische Grabenverbaugeräte - Teil 2: Nachweis durch Berechnung oder Prüfung

This European Standard was approved by CEN on 28 February 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 14653-2:2005: E

Contents

Page

Foreword

This document (EN 14653-2:2005) has been prepared by Technical Committee CEN/TC 53 “Temporary works equipment”, the secretariat of which is held by DIN.

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 October 2005, and conflicting national standards shall be withdrawn at the latest by October 2005.

This European Standard with the general title *Manually operated hydraulic shoring systems for groundwork support* consists of the following parts:

Part 1: Product specifications

Part 2: Assessment by calculation or test

These standards are to be read in conjunction with EN 12811-2 and EN 12811-3.

This document includes a Bibliography.

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

Introduction

Manually operated hydraulic shoring systems comprise prefabricated equipment to support sheeting to the sides of excavations. This document covers two types of equipment whose adjustment is by hydraulic or a combination of hydraulic and mechanical means:

a) hydraulic bracing frames;

b) hydraulic waler frames.

A variety of components exist which when assembled forms a full system. The instruction manual provides all the necessary information in the safe use of the systems.

The prefabricated components are used to make frame assemblies of different dimensions and structural capacities.

This equipment is frequently used in conjunction with supplementary equipment, e.g. knee braces and intermediate hydraulic bracing struts.

1 Scope

This document specifies methods of calculation and test to assess the conformity of manually operated hydraulic systems for groundwork support whose performance is specified in EN 14653-1.

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 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 10204, *Metallic products — Types of inspection documents*

EN 12811-3:2002, *Temporary works equipment — Part 3: Load testing*

EN 14653–1:2005, *Manually operated hydraulic shoring systems for groundwork support — Part 1: Product specifications*

ENV 1993-1-1:1992, Eurocode 3: *Design of steel structures — Part 1-1: General rules and rules for buildings*

ENV 1999-1-1, Eurocode 9: *Design of aluminium structures — Part 1-1: General rules — General rules and rules for buildings*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:1999)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14653–1:2005 apply.

4 Symbols

For the purposes of this document, the symbols given in EN 14653-1:2005 and EN 12811-3:2002 apply.

5 Requirements

5.1 General

All manually operated hydraulic shoring systems and components and their associated instruction manuals shall be assessed to ensure conformity to all of the requirements of EN 14653-1.

5.2 Structural configurations to be assessed

Manually operated hydraulic shoring systems and components shall be assessed under the structural configurations, that will induce the most severe loading effects specified by the manufacturer.

5.3 Loading configurations to be considered

Manually operated hydraulic shoring systems shall be assessed all under the loading configurations specified in EN 14653-1:2005, 7.4.

5.4 Testing or calculation

5.4.1 Assessment shall be carried out by calculation in accordance with ENV 1993-1-1 (Eurocode 3) for steel or ENV 1999-1-1 (Eurocode 9) for aluminium. For cast iron ENV 1993-1-1 shall be used, subject to 6.2 of EN 14653-1:2005. When appropriate calculation models are not available, structural testing shall be undertaken.

5.4.2 Assessment shall be carried out by structural testing for the following circumstances:

a) when a calculation model is not available to represent a particular structural component or assembly;

b) when there is a degree of uncertainty in the validity of the model chosen;

c) when verification of structural performances is required by EN 14653-1.

The following shall be assessed by structural testing:

1) the axial compressive resistance of hydraulic waler struts with spigot type extension bars as defined in EN 14653-1:2005, 3.13.1 c).

2) the axial compressive resistance of rams and struts with restraints conditions not conforming to those described in EN 14653-1:2005, 8.5.

3) mechanical locking mechanisms on waler struts as defined in EN 14653-1:2005, 3.12.1.

4) Non-proprietary valves as defined in EN 14653-1:2005, 8.8.

6 Assessment by calculation

The internal forces and moments shall be calculated using elastic analysis methods. No plastic redistribution of moments and forces are permitted.

The influence of the deflections on the internal forces and moments shall be determined either by using second order analysis or first order analysis combined with a provision for second order effects.

NOTE This is of particular importance when assessing hydraulic bracing legs for the combined effects of bending and axial load.

7 Assessment by testing

7.1 General

Unless otherwise stated in 7.2 and 7.3, structural testing shall take account of EN 12811-3.

7.2 Examination of material properties

When available the relevant material properties shall be taken from 3.1.B certificates (in accordance with EN 10204). Hardness tests in accordance with EN ISO 6506-1 shall be performed on 20 % of the components under test in order to confirm that they are the materials declared in the 3.1.B certificates.

If 3.1.B. certificates are not available, yield strength, tensile strength and fracture elongation shall be established in tensile tests of the relevant materials in accordance with EN 10002-1.

7.3 Test procedures

7.3.1 Structural tests for hydraulic waler struts and for rams

7.3.1.1 Principle

The value of the characteristic compression resistance R_{kc} is determined or verified.

7.3.1.2 Apparatus

The test apparatus shall be any calibrated hydraulic testing machine capable of:

a) accepting the sample size;

b) delivering a force in excess of that predicted at failure.

7.3.1.3 Procedure

The procedure shall take the following points into account:

a) compression tests shall be carried out in which the load is applied until failure, the point at which no further increase in load is possible, is reached. Alternatively, if reaching failure of the component is not required, the test shall cease where a load value is reached that satisfies the design requirements determined in EN 14653-1. Tests shall be carried out by force controlled methods only;

b) the test load shall either be applied in increments not exceeding 20 % of the estimated failure load, or alternatively load shall be applied continuously at a constant rate not exceeding 20 % of the estimated failure load per minute;

c) axial, and lateral deflections shall be monitored at the point at which their greatest values are expected to occur. All displacements shall be plotted on force-displacement diagrams;

d) the specimens shall be mounted horizontally in the test apparatus. End conditions shall closely represent those likely to occur when in use. The waler struts shall be mounted in sections of waler rail;

e) only screws, bolts, nuts and pins that are specified in the instruction manual shall be used to connect components. Screws, bolts, and nuts shall be tightened to the specified torques;

f) where it is necessary to test the specimens in a vertical plane, a horizontal load equal to half the combined weight of the strut and extension bars shall be applied to the centre of the strut assembly before and during the test;

g) where one value is to be declared for the full operating range of the hydraulic waler strut or ram, the test configuration shall be with the ram or strut fully extended with the maximum permitted number of extension bars fitted. Where a range of values are to be declared over the operating range of the strut or ram, (or a load curve produced), tests shall be carried out on a total of four strut lengths throughout the operating range. In the case of struts with fewer than four extension bars, tests shall be carried out at each incremental length with the strut or ram at its maximum extension.

   Where only one characteristic value for a system is to be used, the tests shall be carried out on the longest strut length only;

h) all tests shall be carried out with the hydraulic portion of the hydraulic waler strut or ram extended to 95 % of its stroke at the start of the test;

i) hydraulic rams shall be cycled between end positions several times until smooth operation occurs in order to expel any air within the cylinder prior to expanding it to the test length;

j) prior to the test, a load equal to 50 % of the predicted characteristic load shall be applied and removed in order to bed down each specimen onto the test rig.

7.3.2 Tests for members subject to bending and axial load

If tests are to be carried out on structural members of components to assess conformity with EN 14653-1, the general planning and form of these tests shall follow the recommendations specified in ENV 1993-1-1:2005, Annex Y.

7.3.3 Tests for hydraulic waler strut mechanical locking devices

7.3.3.1 Principle

The adequacy of hydraulic waler strut mechanical locking devices to retain the load is examined from the test procedure described in 7.3.3.3.

7.3.3.2 Apparatus

The test apparatus shall be any calibrated hydraulic testing machine capable of:

a) accepting the sample of size;

b) delivering a force in excess of that predicted at failure.

7.3.3.3 Procedure

The procedure shall be as follows:

a) compression tests shall be carried out in which a load equivalent to the test load is applied and held. Hydraulic failure shall then be simulated in order to actuate the mechanical device;

b) tests shall be carried out by force control methods only;

c) the specimen shall be either mounted horizontally or vertically in the test apparatus;

d) tests shall be carried out on a minimum of three struts;

e) the hydraulic ram shall be cycled between end positions until smooth operation is achieved;

f) all the tests shall be carried out with the hydraulic portion of the strut extended to 95 % of its stroke at the start of the test;

g) prior to the test a load equal to 50 % of the predicted load shall be applied and removed in order to bed down each specimen onto the test rig.

Failure of the locking device shall be deemed to have occurred if:

1) there is a reduction in length of 5 % of the overall length of the strut;

2) the locking device fails to hold the specified load for at least thirty minutes.

7.3.4 Tests for proprietary valves

The manufacturer shall provide full test data in order to substantiate their recommendations.

7.3.5 Tests for non-proprietary valves

7.3.5.1 Principle

The procedure is intended to establish if the valve will burst or leak below its rated pressure x 1,5.

7.3.5.2 Apparatus

The test apparatus shall be any appropriately sized and calibrated hydraulic testing machine capable of:

a) accepting the sample size;

b) delivering a fluid pressure in excess of that predicted at failure.

Alternatively the valve may be tested in a proprietary test block connected to a test pump capable of delivering a fluid pressure in excess of that predicted at failure.

7.3.5.3 Procedure

The procedure shall be as follows:

a) tests shall be carried out in which the fluid pressure is applied until failure, is achieved or a value 1,5 x above that of the design requirements is reached;

b) the test load or fluid pressure shall either be applied in increments in which no increment exceeds 20 % of the estimated failure value or applied continuously at a constant rate that does not exceed 20 % of the estimated value per minute;

c) tests shall be carried our on a minimum of three valves with the valves in both the open and closed positions.

7.4 Evaluation of characteristic resistance from test results

The adjustment of test results shall be in accordance with Clause 10 of EN 12811-3:2002. A calculated example is given in Annex A.

Annex A
(informative)

Example for the statistical evaluation of test results

A.1 Basis

The annex shows an example of compression tests on a hydraulic waler strut from a series of four identical tests in accordance with 7.3.1.

The test results $r^{c}_{u,i}$ were determined as the failure load (kN) in accordance with 7.3.1.3.

After evaluating the results in accordance with EN 12811-3:2002 Clauses 10.6 and 10.7 the four values $r^{c}_{u,i}$ of Table A.1 result.

Table A.1 — Partially evaluated test results $r^{c}_{u,i}$

1	Test number *i*	1	2	3	4
2	$r^{c}_{u,i}$ (kN)	145,1	146,3	148,4	144,3
3	$y_i = \ln r^{c}_{u,i}$	4 977	4 986	5 000	4 972

A.2 Calculations

A.2.1 Transform the values $r^{c}_{u,i}$ to logarithmic values y_i using the Equation (A.1).

$$y_i = \ln r^{c}_{u,i} \tag{A.1}$$

For the example, the results are given in the row 3 of Table A.1.

A.2.2 Calculate the average value of the values y_i from the Equation (A.2) and the standard deviation from the Equation (A.3):

$$\varphi = (1/N)\sum_{i=1}^{n} y_i \tag{A.2}$$

$$s_y^2 = [1/(n-1)]\sum_{i=1}^{n}(y_i - \varphi)^2 \tag{A.3}$$

For the example of Table A.1 the results are y = 4,984 and s_y = 0,0122 9.

A.2.3 Calculate the 5 % quantile from the Equation (A.4) for the 75 % level of confidence:

$$Y_5 = y - (k_{s,k} \times s_y) \tag{A.4}$$

The factor $k_{s,k}$ = 2,68 is taken from Table 4 of EN 12811-3:2002 for n = 4.

This results in the quantile y_5 = 4,951.

A.2.4 Reverse the logarithmic transformation to obtain the basic characteristic value of the resistance using the Equation (A.5).

$$R_{KB} = e^{(y5)} \quad \text{(A.5)}$$

Therefore

$$R_{KB} = 141{,}3\text{kN} \quad \text{(A.6)}$$

A.2.5 Calculate the nominal characteristic value of the resistance using the Equation (A.6). With the partial safety factor γ_{R2} = 1,25 from EN 12811-3:2002, Figure 3, 10.6.

NOTE If the dissipation of energy quotient q_e has not been evaluated, γ_{R2} is taken to be equal to 1,25.

$$R_{K,nom} = R_{KB}/\gamma_{R2} \quad \text{(A.7)}$$

Therefore the nominal characteristic value of the resistance becomes

$$R_{K,nom} = 113{,}1 \text{ kN}. \quad \text{(A.8)}$$

Bibliography

[1] EN 12811-2, *Temporary works equipment — Part 2: Information on materials*

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL