BRITISH STANDARD

BS EN 1225 : 1996
BS 2782 :
Part 12 :
Method 1214 C :
1996

Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the creep factor under wet conditions and calculation of the long-term specific ring stiffness

The European Standard EN 1225 : 1996 has the status of a British Standard

ICS 23.040.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PRI/61, Plastics piping systems and components, upon which the following bodies were represented:

British Gas plc
British Plastics Federation
British Plumbing Fittings Manufacturers' Association
British Valve and Actuator Manufacturers' Association
Chartered Institution of Water and Environmental Management
Department of the Environment (British Board of Agrément)
Department of the Environment (Building Research Establishment)
Department of Transport
Electricity Association
Federation of Civil Engineering Contractors
Health and Safety Executive
Institute of Building Control
Institute of Materials
Institution of Civil Engineers
Institution of Gas Engineers
National Association of Plumbing, Heating and Mechanical Services Contractors
Pipeline Industries Guild
Plastics Land Drainage Manufacturers' Association
Society of British Gas Industries
Society of British Water Industries
Water Companies Association
Water Services Association of England and Wales

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Consulting Engineers
Engineering Equipment and Materials Users' Association
Institution of Mechanical Engineers
RAPRA Technology Ltd.

This British Standard, having been prepared under the direction of the Sector Board for Materials and Chemicals, was published under the authority of the Standards Board and comes into effect on 15 December 1996

Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
Committee reference PRI/61
Draft for comment 93/313470 DC

ISBN 0 580 26740 7

Contents

National foreword

This British Standard has been prepared by Technical Committee PRI/61 and is the English language version of EN 1225 : 1996 *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the creep factor under wet conditions and calculation of the long-term specific ring stiffness* published by the European Committee for Standardization (CEN).

It is incorporated into BS 2782 *Methods of testing plastics : Part 12 : Reinforced plastics pipes, fittings and valves* as Method 1214C : 1996 for association with related test methods for plastics materials and plastics piping components.

This test method has been prepared for reference by other standards under preparation by CEN for specification of reinforced plastics piping systems and components. It has been implemented to enable experience of the method to be gained and for use for other fresh applications.

It is also for use for the revision or amendment of other national standards as practicable, but it should not be presumed to apply to any existing standard or specification which contains or makes reference to a different test method until that standard/specification has been amended or revised to make reference to this method and adjust any requirements as appropriate.

No existing British Standard is superseded by this Method.

Cross-references

Publication referred to	Corresponding British Standard
EN 705	BS EN 705 : 1995 BS 2782 : Part 12 : Methods 1220A to C : 1995 *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods of regression analysis and their use*
EN 1228	BS EN 1228 : 1996 BS 2782 : Part 12 : Methods A and B : 1996 *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial specific ring stiffness*

Warning note. This British Standard, which is identical with EN 1225 : 1996 does not necessarily detail all the precautions necessary to meet the requirements of the Health and Safety at Work etc. Act 1974. Attention should be paid to any appropriate safety precautions and the method should be operated only by trained personnel.

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

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1225

June 1996

ICS 23.040.20

Descriptors: Pipelines, plastic tubes, reinforced plastics, glass-reinforced plastics, thermosetting resins, creep tests, testing conditions, humidity, rigidity, flexing

English version

Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the creep factor under wet conditions and calculation of the long-term specific ring stiffness

Systèmes de canalisations en plastique — Tubes en plastique thermodurcissable renforcé de verre (PRV) — Détermination du facteur de fluage en conditions mouillées et calcul de la rigidité annulaire spécifique à long terme

Kunststoff-Rohrleitungssysteme — Rohre aus glasfaserverstärkten duroplastischen Kunststoffen (GFK) — Ermittlung des Kriechfaktors unter Feuchteeinfluß und Berechnung der spezifischen Langzeit-Ringsteifigkeit

This European Standard was approved by CEN on 1996-01-04. 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, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 1225 : 1996 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 155, Plastics piping systems and ducting systems, the Secretariat of which is held by NNI.

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 December 1996, and conflicting national standards shall be withdrawn at the latest by December 1996.

This standard is based on the draft International Standard ISO/CD 10468 *GRP pipes and fittings — Determination of long-term specific ring stiffness and creep factor of pipes under wet conditions*, prepared by Subcommittee 6 of Technical Committee 138 of the International Organization for Standardization (ISO). It is a modification of ISO/CD 10468 for reasons of applicability to other test conditions and alignment with texts of other standards on test methods.

The modifications are:

– test parameters (pressure, time, temperature) are not specified;

– material-dependent or performance requirements are not given;

– editorial changes have been introduced.

The material-dependent test parameters and/or performance requirements are incorporated in the referring standard.

Annex A, which is informative, provides values of equal lg [time] increments.

This standard is one of a series of standards on test methods which support System Standards for plastics piping systems and ducting systems.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This standard specifies a method for determining by extrapolation both the long-term specific ring stiffness and the creep factor for glass-reinforced thermosetting plastics pipes under wet conditions.

2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 705 *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analyses and their use*

EN 1228 *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial specific ring stiffness*

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 compressive load (F)

The load applied to a pipe to cause a diametric deflection.

It is expressed in newtons.

3.2 specific ring stiffness (S)

A physical characteristic of the pipe which is a measure of the resistance to ring deflection under external load.

This characteristic is determined by testing and is defined, in newtons per square metre, by the equation:

$$S = \frac{E \times I}{d_m^3} \quad (1)$$

where:

E is the apparent modulus of elasticity as determined in the ring stiffness test, in newtons per square metre;

I is the moment of inertia (the second moment of area) in the longitudinal direction per metre length, expressed in metres to the fourth power per metre, i.e.:

$$I = \frac{e^3}{12}$$

where:

e is the wall thickness of the pipe, in metres;

d_m is the mean diameter (see **3.3**) of the pipe, in metres.

3.3 mean diameter (d_m)

The diameter of the circle corresponding with the middle of the pipe wall cross-section.

It is given, in metres, by either of the following equations:

$$d_m = d_i + e$$

$$d_m = d_e - e$$

where:

d_i is the average of the measured internal diameters (see **7.3**), in metres;

d_e is the average of the measured external diameters (see **7.3**), in metres;

e is the average of the measured wall thicknesses of the pipe (see **7.1**), in metres.

3.4 initial specific ring stiffness (S_0)

The initial value of S (see **3.2**) obtained by testing in accordance with EN 1228.

It is expressed in newtons per square metre.

3.5 long-term wet specific ring stiffness at 'position 1' ($S_{x,1,\text{wet}}$)

The value of S at the reference position, position 1 (see clause **6** and **9.2**) at x years, obtained by extrapolation of long-term deflection measurements at a constant load under wet conditions (see **3.2** and **9.2**).

It is expressed in newtons per square metre.

3.6 calculated long-term wet specific ring stiffness ($S_{x,\text{wet}}$)

The calculated value of S at x years given by the following equation:

$$S_{x,\text{wet}} = S_0 \times \alpha_{x,\text{wet}} \quad (2)$$

where:

x is the time specified in the referring standard, in years;

$\alpha_{x,\text{wet}}$ is the wet creep factor (see **3.7**);

S_0 is the initial specific ring stiffness (see **3.4**), in newtons per square metres.

It is expressed in newtons per square metre.

3.7 wet creep factor ($\alpha_{x,\text{ wet}}$)

The ratio of the long-term specific ring stiffness determined under wet conditions to the initial specific ring stiffness, both measured at reference position 1 (see **9.2**). It is given by the following equation:

$$\alpha_{x,\text{ wet}} = \frac{S_{x,1,\text{wet}}}{S_{0;1}} \quad (3)$$

where:

$S_{0;1}$ is the initial specific ring stiffness at positon 1 determined in accordance with EN 1228, in newtons per square metre.

3.8 vertical deflection (y)

The vertical change in diameter of a pipe in response to a diametric compressive load (see **3.1**).

It is expressed in metres.

3.9 long-term vertical deflection ($y_{x,1,\mathrm{wet}}$)

The value of the vertical deflection, y, at the reference position 1, (see **9.2**), at x years obtained by extrapolation of long-term deflection measurements at a constant load under wet conditions (see **3.1** and **9.2**).

It is expressed in metres.

3.10 deflection coefficient (f)

A dimensionless factor which takes into account the theory of second order. It is given by the following equation:

$$f = (1860 + (2500 \times y_{x,1,\mathrm{wet}} / d_\mathrm{m})) \times 10^{-5} \quad (4)$$

where:

$y_{x,1,\mathrm{wet}}$ is the long-term vertical deflection (see **3.9**), in metres;

d_m is the mean diameter (see **3.3**), in metres.

4 Principle

A cut length of pipe supported horizontally is loaded throughout its length to compress it diametrically to a specified vertical deflection.

NOTE 1. Load application surfaces of bearing plates or beam bars are considered equally valid.

The pipe is immersed in water at a specified temperature for a period of time during which the load remains constant and the vertical deflection is measured at intervals. The long-term deflection is estimated by extrapolation. From this deflection and the load, the long-term specific ring stiffness under wet conditions is calculated.

The wet creep factor is then determined from the long-term wet specific ring stiffness and the initial specific ring stiffness of the same test piece.

NOTE 2. It is assumed that the following test parameters are set by the standard making reference to this standard:

a) the time to which the values are to be extrapolated (see **3.6** and **10.1**);

b) the test temperature (see **5.3** and **9.1**);

c) the length of the test piece and its permissible deviation (see clause **6**);

d) if applicable, conditioning, e.g. temperature and environment, and its period (see clause **8**);

e) the duration for maintaining the estimated load on the test piece (see **9.4**).

5 Apparatus

5.1 *Compressive loading machine*, comprising a system capable of applying a load, without shock, through two parallel load application surfaces conforming to **5.2** so that a horizontally orientated test piece of pipe conforming to clause **6**, which is immersed in water, can be compressed vertically and maintained under constant load in accordance with **9.4**.

Additional equipment shall be available for measuring the load applied to within ±1 % of the maximum measured load.

NOTE. Care may be necessary to ensure that the applied load is not affected by friction or buoyancy effects.

5.2 *Load application surfaces*

NOTE. The method allows the use of either bearing plates or beam bars for loading the test piece, subject to reporting the choice used.

5.2.1 *General arrangement*

The surfaces shall be provided by a pair of plates (see **5.2.2**), or a pair of beam bars (see **5.2.3**), or a combination of one such plate and one such bar, with their major axes perpendicular to and centred on the direction of application of load F by the compressive loading machine, as shown in figure 1. The surfaces to be in contact with the test piece shall be flat, smooth, clean and parallel.

Plates and beam bars shall have a length at least equal to the test piece (see clause **6**) and have a thickness such that visible deformation does not occur during the test.

5.2.2 *Plates*

The plate(s) shall have a width of at least 100 mm.

5.2.3 *Beam bars*

Each beam bar shall have rounded edges, a flat face (see figure 1) without sharp edges and a width dependent upon the pipe as follows:

a) for pipes with a nominal size not greater than DN 300 the width shall be (20 ± 2) mm;

b) for pipes of nominal sizes greater than DN 300 the width shall be (50 ± 5) mm.

The beam bars shall be so constructed and supported that no other surface of the beam bar structure shall come into contact with the test piece during the test.

5.3 *Water container*, large enough to accommodate submerged test pieces in accordance with clause **6** while subject to a compressive load in accordance with **9.3**.

The liquid shall be tap water having a pH of 7 ± 2 and kept at the specified temperature.

The water level shall be maintained sufficiently constant to avoid any significant effect on the value of the vertical load applied to the test piece.

5.4 *Dimensional measuring devices*, capable of determining:

– the necessary dimensions (length, diameter, wall thickness) to an accuracy of within ±0,1 mm;

– the deflection of the test piece in the vertical direction to an accuracy of within ±1,0 % of the maximum value.

NOTE. When selecting the device to measure the change in diameter of the test piece, consideration should be given to the potentially corrosive environment in which the device is to be used.

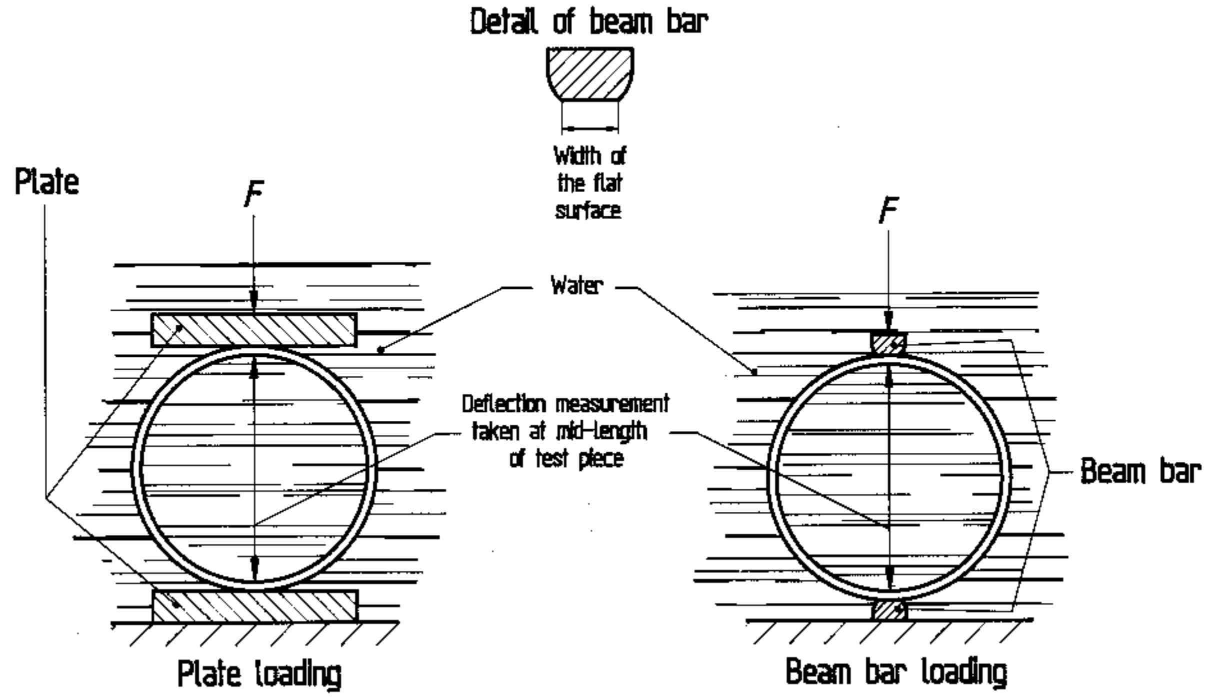

Figure 1. Typical test arrangement

6 Test pieces

6.1 Preparation

The test piece shall be a complete ring cut from the pipe to be tested. The length of the test piece shall be as specified in the referring standard, with permissible deviations of ±5 %.

The cut ends shall be smooth and perpendicular to the axis of the pipe.

Straight lines shall be drawn on the inside or the outside along the length of the test piece and repeated at 60° intervals around its circumference, to serve as reference lines.

6.2 Number

One test piece shall be used.

7 Determination of the dimensions of the test piece

7.1 Length

Measure the length of the test piece along each reference line with an accuracy to within ±1,0 % to determine whether or not each test piece conforms to clause **6**. Trim or replace, as applicable, the test piece if it does not conform.

Calculate the average length, L, in metres, of the test piece from the six measured values.

7.2 Wall thickness

Measure to within ±0,2 mm the wall thickness of the test piece at each end of each reference line.

Calculate the average wall thickness, e, in metres, of the 12 measured values.

7.3 Mean diameter

Measure to an accuracy of within ±0,5 mm either of the following:

a) the internal diameter, d_i, of the test piece between each diametrically opposed pair of reference lines at their mid-length, e.g. by means of a caliper;

b) the external diameter, d_e, of the test piece at the mid-points of the reference lines, e.g. by means of a circumferential wrap steel tape.

Calculate the mean diameter, d_m, of the test piece using the values obtained for wall thickness and either the internal or the external diameter (see **3.3**).

8 Conditioning

If applicable, condition the test piece in accordance with the referring standard.

9 Procedure

9.1 Conduct the following procedure at the temperature specified in the referring standard.

9.2 Determine and record in accordance with EN 1228 the initial specific ring stiffness, S_0, of the test piece. Choose a pair of reference lines to be designated 'position 1'. Use the measured value of the initial specific ring stiffness at position 1, $S_{0;1}$, to estimate the load, F, required to compress the test piece to between 98,0 % and 98,5 % of its mean diameter, d_m.

9.3 Place the test piece in contact with the upper and lower plate or beam bar with the pair of diametrically opposed reference lines designated position 1, in accordance with **9.2**, vertically aligned. Ensure that the contact between the test piece and each bearing plate or beam bar is as uniform as possible and the plates and/or beam bars are not tilted laterally. Place the apparatus in the water container.

9.4 Taking account of the mass of the upper plate or beam bar, apply the vertical compressive load, F, estimated in accordance with **9.2** so that the corresponding vertical deflection is reached within 3 min and record the actual deflection achieved. Fill the water container with water so that the test piece is fully immersed.

Hold the load, F, constant throughout the duration of the period under load in accordance with the referring standard. Measure and record to within ±2,0 % of the measured value the vertical deflection of the test piece at intervals at increments of lg [time], such that at least three readings are taken for each decade of lg [time] where the time is expressed in hours.

NOTE. In annex A, table A.1 gives values of equal lg [time] increments which may be useful to the observer.

10 Calculation

10.1 Extrapolation of the deflection data for position 1 to obtain the *x* year value ($y_{x,1,\mathrm{wet}}$)

Using the data obtained in accordance with **9.4**, plot lg [deflection] as function of lg [time].

From the series of measured deflections and corresponding time intervals, determine in accordance with method C of EN 705 the second order polynomial.

Calculate in accordance with method C of EN 705 the extrapolated logarithm of the deflection at x years, lg $y_{x,1,\mathrm{wet}}$, and then the deflection, in metres, $y_{x,1,\mathrm{wet}}$.

10.2 Calculation of the long-term specific ring stiffness under wet conditions for 'position 1'

Calculate the long-term specific ring stiffness under wet conditions for position 1 using the following equation:

$$S_{x,1,\mathrm{wet}} = \frac{f \times F}{L \times y_{x,1,\mathrm{wet}}} \qquad (5)$$

where:

$S_{x,1,\mathrm{wet}}$ is the long-term wet specific ring stiffness for 'position 1', in newtons per square metre;

f is the deflection coefficient (see **3.10**);

F is the constant load applied, in newtons;

L is the average length of the test piece, in metres;

$y_{x,1,\mathrm{wet}}$ is the extrapolated value for the deflection after x years at position 1 under wet conditions, in metres.

10.3 Calculation of the wet creep factor

Calculate the wet creep factor, $\alpha_{\mathrm{x,wet}}$, using the following equation:

$$\alpha_{x,\mathrm{wet}} = \frac{S_{x,1,\mathrm{wet}}}{S_{0;1}} \qquad (3)$$

where:

$S_{x,1,\mathrm{wet}}$ is the long-term wet specific ring stiffness for position 1, in newtons per square metre;

$S_{0;1}$ is the initial specific ring stiffness at position 1, in newtons per square metre.

10.4 Calculation of the long-term wet specific ring stiffness

Calculate the long-term wet specific ring stiffness, in newtons per square metre, using the following equation:

$$S_{x,\mathrm{wet}} = \alpha_{x,\mathrm{wet}} \times S_0 \qquad (6)$$

where:

$\alpha_{x,\mathrm{wet}}$ is the wet creep factor;

S_0 is the initial value of S obtained in accordance with EN 1228, in newtons per square metre.

11 Test report

The test report shall include the following information:

a) a reference to this standard and the referring standard;

b) the full identification of the pipe tested;

c) the dimensions of the test piece;

d) the position in the pipe from which the test piece was obtained;

e) the initial specific ring stiffness, S_0, and the initial specific ring stiffness at position 1, $S_{0;1}$, of the test piece;

f) the equipment details, including whether beam bars and/or plates were used;

g) the temperature and pH of the water;

h) the conditioning parameters (see clause **8**);

i) the plot of measured deflection versus time;

j) the calculated long-term wet specific ring stiffness, $S_{x,1,\mathrm{wet}}$, at position 1;

k) the wet creep factor, $\alpha_{x,\mathrm{wet}}$;

l) the calculated long-term wet specific ring stiffness, $S_{x,\mathrm{wet}}$;

m) a description of the test piece after testing;

n) any factors which may have affected the results, such as any incidents or any operating details not specified in this standard;

o) the dates of the testing period.

Annex A (informative)

Equal increments of lg [time]

A.1 Table A.1 presents intervals of time in minutes, hours or days which correspond to successive equal increments of 0,1 in lg t_h, where t_h is the time in hours. This information is provided for assistance in scheduling measurements of the vertical deflection.

Table A.1 Equal increments of lg t_h and corresponding times t_h

lg	**Time**			**lg**	**Time**		
t_h	min	h	days	t_h	min	h	days
0,1	75,5	1,26	0,052	2,6	23886	398	16,6
0,2	95,1	1,58	0,066	2,7	30071	501	20,9
0,3	120	2,00	0,083	2,8	27857	631	26,3
0,4	151	2,51	0,105	2,9	47660	794	33,1
0,5	190	3,16	0,132	3,0	60000	1000	41,7
0,6	239	3,98	0,166	3,1	75536	1259	52,5
0,7	301	5,01	0,209	3,2	95094	1585	66,0
0,8	379	6,31	0,263	3,3	119716	1995	83,1
0,9	477	7,94	0,331	3,4	150713	2512	105
1,0	600	10,0	0,417	3,5	189737	3162	132
1,1	755	12,6	0,525	3,6	238864	3981	166
1,2	951	15,8	0,660	3,7	300712	5012	209
1,3	1197	20,0	0,831	3,8	378574	6310	263
1,4	1507	25,1	1,05	3,9	476597	7943	331
1,5	1897	31,6	1,32	4,0	600000	10000	417
1,6	2389	39,8	1,66	4,1	755355	12589	525
1,7	3007	50,1	2,09	4,2	950936	15849	660
1,8	3786	63,1	2,63	4,3	1197157	19953	831
1,9	4766	79,4	3,31	4,4	1507132	25119	1047
2,0	6000	100	4,17	4,5	1897367	31623	1318
2,1	7554	126	5,25	4,6	2388643	39811	1659
2,2	9509	158	6,60	4,7	3007123	50119	2088
2,3	11972	200	8,31	4,8	3785744	63096	2629
2,4	15071	251	10,5	4,9	4765969	79433	3310
2,5	18974	316	13,2	5,0	6000000	100000	4167

blank

List of references

See national foreword.

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: 020 8996 9000. Fax: 020 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: 020 8996 9001. Fax: 020 8996 7001.

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: 020 8996 7111. Fax: 020 8996 7048.

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: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL