

Textile carcass conveyor belting for use in underground mines (including fire performance) — Specification

ICS 53.040.20; 73.100.40

Committees responsible for this British Standard

This British Standard was prepared by Technical Committee, PRI/67, Conveyor belts, upon which the following bodies were represented:

- British Rubber Manufacturers' Association Limited
- HSE — Health and Safety Executive
- Institute of Materials, Minerals and Mining
- Tun Abdul Razak Research Centre
- University of Nottingham
- UK Steel Association

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 3 March 2005

© BSI 3 March 2005

First published November 1960
Second edition, December 1982
Third edition, August 1990
Fourth edition, March 2005

The following BSI references relate to the work on this British Standard:
Committee reference PRI/67
Draft for comment 04/30111059 DC

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 45426 6

Contents

	Page
Committees responsible	Inside front cover
Foreword	iii
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Construction	2
5 Fabric	2
6 Physical properties	2
7 Length	3
8 Width	3
9 Belting and carcass thickness	4
10 Cover thickness	4
11 Joints in fabric	5
12 Freedom from defects	5
13 Tensile strength and elongation at break	5
14 Adhesion	6
15 Tear strength	6
16 Electrical resistance	6
17 Fire performance	6
18 Sampling	7
19 Marking	8
Annex A (normative) Method for determination of mean belting thickness	9
Annex B (normative) Method of measuring cover thickness	10
Annex C (normative) Method of test for tensile strength and elongation at break	15
Annex D (normative) Method of test for adhesion	17
Annex E (normative) Method of test for tear strength	20
Annex F (normative) Method of test for electrical resistance	22
Annex G (normative) Methods of tests for fire performance	25
Annex H (normative) Tensile testing machine	45
Bibliography	47
Figure A.1 — Test piece for measuring belting thickness and cover thickness	10
Figure B.1 — Measurement of cover thickness (for covers applied directly on to carcass) and measurement of edge cover thickness	11
Figure B.2 — Measurement of cover thickness (for additional covers applied on to standard cover)	12
Figure C.1 — Test piece for tensile strength and elongation at break tests	15
Figure C.2 — Example of a die used to cut test pieces for tensile strength and elongation at break tests	16
Figure D.1 — Test piece for determination of internal adhesion	19
Figure D.2 — Determination of mean and minimum values of stripping force from the autographic record	19
Figure E.1 — Test piece for tear strength test	20
Figure E.2 — Arrangement of test pieces and their marking for tear strength test	21
Figure E.3 — Illustration of the two senses of testing for tear strength	22
Figure F.1 — Layout and dimensions of brass contact pieces for electrical resistance test	23

	Page
Figure F.2 — Electrode system for electrical resistance test	24
Figure G.1 — Drum friction test apparatus	27
Figure G.2 — Cross-section of stainless steel drum and thermocouple housing for drum friction test	30
Figure G.3 — Basic dimensions of tensioning system for drum friction test apparatus	31
Figure G.4 — Cabinet for spirit burner flame test	32
Figure G.5 — Layout for spirit burner flame test	35
Figure G.6 — Laboratory-scale fire tunnel	37
Figure G.7 — Laboratory-scale fire tunnel details	38
Figure G.8 — Trestle (belt support frame)	40
Figure G.9 — Gas burner assembly	41
Figure G.10 — Jets for burners	41
Figure G.11 — Typical exhaust temperature calibration curve	44
Table 1 — Designation and physical properties of finished belting for use in underground coal mines	2
Table 2 — Designation and physical properties of finished belting for use in underground mines (other than coal mines)	3
Table 3 — Widths of belting	3
Table 4 — Mean belting thickness and carcass thickness for use in underground coal mines	4
Table 5 — Minimum cover thicknesses within 25 mm and 12 mm of belting edges	4
Table 6 — Number of longitudinal joints in the plies of plied belting	5
Table 7 — Adhesion properties	6

Foreword

This British Standard has been prepared by Technical Committee PRI/67. It is a revision of BS 3289:1990, which is withdrawn. A number of changes have been made by this edition. In particular, the following should be noted.

The high-energy fire propagation test has been replaced with a more practicable mid-scale test [Prepared by Cerberus (Mining Acceptance Services) Ltd for the Health and Safety Executive].

The purpose of this standard is to enable belting to be obtained and installed in underground mines in the confidence that it will perform satisfactorily the job it is required to do, and that it is not a flammability hazard.

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, pages i to iv, pages 1 to 47 and a back cover.

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

1 Scope

This British Standard specifies requirements for textile carcass conveyor belting for use in underground mines (including fire performance).

NOTE 1 For guidance on storage and handling of finished belting, reference should be made to BS ISO 5285.

WARNING In the overall assessment of the suitability of conveyor belting for a given use, and in particular for single entry headings, account should be taken of the flame propagation and smoke and toxic fume emission characteristics of the belting material, as well as of the fire precautionary measures, such as smoke detection, over-temperature protection, below ground ventilation, etc. embraced within the total system.

NOTE 2 DD 180 describes threshold toxic atmospheres and provides methods for their assessment; reference to this publication is recommended.

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 the amendments) applies.

BS 871:1981, *Specification for abrasive papers and cloths*.

BS 907, *Specification for dial gauges for linear measurement*.

BS 970-1:1996, *Specification for wrought steels for mechanical and allied engineering purposes — Part 1: General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels*.

BS 3591, *Specification for industrial methylated spirits*.

BS 4250, *Specification for commercial butane and propane*.

BS EN ISO 7500-1:1999, *Metallic materials. Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*.

BS EN 10216-2, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties*.

BS EN 10217-2, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties*.

BS EN ISO 340:2004, *Conveyor belts — Laboratory scale flammability characteristics — Requirements and test method*.

BS EN 60584-1, *Thermocouples — Part 1: reference tables*.

BS ISO 5893:2002, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*.

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

3.1

fire retardant

substance added, or treatment applied to a material in order to suppress, significantly reduce or delay the combustion of the material

3.2

fire performance

ability to pass the tests described in Annex G

3.3

full thickness tensile strength

maximum force that a test piece cut from the full thickness of the belting withstands during test divided by the original width of the narrowest part of the gauge length portion of the test piece

4 Construction

The belting shall be of solid woven construction or it shall consist of plies of woven fabric. The carcass shall be impregnated with a fire retardant compound and have a fire retardant cover, the whole being fused or vulcanized together.

Belting having a plied construction shall contain not less than four plies.

The edge of the belting shall be completely sealed by a fire retardant compound.

Where the edge cover material is manufactured and applied separately in the form of a strip, it shall be fused or vulcanized to the edges of the surface covers and the fabric, and shall demonstrate good adhesion (see 14.2).

5 Fabric

The fabric used shall be evenly and firmly woven and free from foreign matter and defects such as knots, lumps and irregularities of twist.

6 Physical properties

Belting for use in underground coal mines shall be designated according to its physical properties as given in Table 1. Belting for use in underground mining (other than coal mines) shall be designated according to its physical properties as given in Table 2.

Table 1 — Designation and physical properties of finished belting for use in underground coal mines

Belting type	Minimum full thickness tensile strength		Minimum elongation at break		Minimum tear strength kN	Minimum belt thickness mm
	Longitudinal N/mm width	Transverse N/mm width	Longitudinal %	Transverse %		
3	580	245	17	18	1.0	7.5
4	700	265	17	18	1.1	8.0
5	875	280	15	18	1.2	8.5
6	1 140	350	OPEN	18	1.6	9.0
8	1 400	350	OPEN	18	1.6	9.0
10	1 750	OPEN	OPEN	18	OPEN	9.0
12	2 100	OPEN	OPEN	18	OPEN	9.0
15	2 625	OPEN	OPEN	18	OPEN	9.0
Clause	13	13	13	13	15	9
Method of test	Annex C				Annex E	Annex A
NOTE The values left “open” are not standardized.						

Table 2 — Designation and physical properties of finished belting for use in underground mines (other than coal mines)

Belting type	Minimum full thickness tensile strength		Minimum longitudinal elongation at break %
	Longitudinal N/mm width	Transverse N/mm width	
160	160	63	10
200	200	80	10
250	250	100	10
315	315	125	10
400	400	160	10
500	500	200	10
630	630	250	10
800	800	270	10
1 000	1 000	315	10
1 250	1 250	—	10
1 600	1 600	—	10
2 000	2 000	—	10
2 500	2 500	—	10
Clause	13	13	13
Method of test	Annex C	Annex C	Annex C

7 Length

The tolerance on length on individual rolls shall be $+2_{-0.5}$ % and the total length supplied for a specific installation shall be not less than the specified length.

8 Width

The width of the belting shall be selected from the widths specified in Table 3. This table also specifies the permitted tolerances on these widths.

Table 3 — Widths of belting

Width mm	Tolerance on width	Total variation in any one length
300, 400, 500, 600	+10 mm −5 mm	10 mm
650, 750, 800, 900, 1 000, 1 050, 1 200, 1 350, 1 400, 1 500, 1 600, 1 800, 2 000	+2 % −1 %	2 %

9 Belting and carcass thickness

9.1 Belting thickness

The belting thickness shall be determined in accordance with Annex A and Annex B. The difference between any two of the measurements taken in the same method shall not exceed:

- a) 1 mm for belting of which the mean thickness does not exceed 10 mm;
- b) 10 % of the mean belt thickness for belting of which the mean thickness exceeds 10 mm.

9.2 Carcass thickness

The carcass thickness, for all belting, shall be derived by subtracting the mean thickness of top and bottom covers, as calculated in accordance with **B.5.1**, from the mean belting thickness as calculated in accordance with Annex A.

9.3 Coal mining belts

The mean belting thickness (see **9.1**) and the derived carcass thickness of belting (see **9.2**) for use in underground coal mines shall be not less than that shown in Table 4.

Table 4 — Mean belting thickness and carcass thickness for use in underground coal mines

Belting type	Minimum mean belting thickness mm	Minimum carcass thickness mm
3	7.5	5.9
4	8.0	6.4
5	8.5	6.9
6 and above	9.0	7.4

10 Cover thickness

10.1 Mean cover thickness

When measured in accordance with **B.4.1** and calculated and expressed in accordance with **B.5.1**, the mean cover thickness shall be not less than the specified cover thickness.

NOTE Cover thicknesses should be decided when the specific site application is fully detailed.

10.2 Localized thin cover thickness

When measured in accordance with **B.4.2** and calculated and/or expressed in accordance with **B.5.2**, any localized thin cover thickness shall be not less than 70 % of the specified cover thickness (see Note to **10.1**).

10.3 Minimum cover thickness within 25 mm and 12 mm of belting edges

When measured in accordance with **B.4.3** and expressed in accordance with **B.5.3**, the minimum cover thickness within 25 mm and 12 mm of belting edges shall be not less than the appropriate values given in Table 5.

10.4 Edge cover thickness

When measured in accordance with **B.4.4** and expressed in accordance with **B.5.4**, edge cover thickness shall be not more than 9 mm. In cases where edge covers are trimmed, the belt carcass shall not be exposed.

Table 5 — Minimum cover thicknesses within 25 mm and 12 mm of belting edges

Belting width mm	Specified cover thickness mm	Minimum cover thickness	
		Within 25 mm of belt edge %	Within 12 mm of belt edge %
≤ 1 350	< 1	50	Not applicable
> 1 350	< 1	50	20
≤ 1 350	≥ 1	70	Not applicable
> 1 350	≥ 1	70	20

11 Joints in fabric

11.1 Transverse joints

11.1.1 Solid woven belting. In solid woven belting there shall be no transverse joints in the fabric.

11.1.2 Plied belting. In the fabric plies of multi-ply belting any transverse joints shall be at an angle of not greater than 70° and not less than 45° to the longitudinal axis. The minimum distance between joints shall be as follows.

- a) Joints in outer plies shall be not less than 100 m apart in the same ply. The adjoining edges shall butt closely together and shall not overlap.
- b) Joints in inner plies shall be not less than 15 m apart in the same ply and there shall be not more than two joints in any one ply in each 200 m belting.
- c) Joints in adjacent plies shall be not less than 3 m apart.
- d) Joints in non-adjacent plies shall be separated by a distance not less than twice the width of the belting.

11.2 Longitudinal joints

11.2.1 Solid woven belting. There shall be no longitudinal joints in the fabric of solid woven belting.

11.2.2 Plied belting. For plied belting, the maximum number of longitudinal joints in the plies shall be as given in Table 6.

11.3 Spliced joints in finished belting

11.3.1 Solid woven belting. Solid woven belting shall not contain spliced joints.

11.3.2 Plied belting. Plied belting in lengths of 50 m or less shall not contain spliced joints. For lengths over 50 m, one spliced joint shall be permitted, which shall be not less than 10 m from the end of the belting.

NOTE The manufacturer should provide information on the position in the belting length of any spliced joint made during manufacture.

Table 6 — Number of longitudinal joints in the plies of plied belting

Width of belting mm	Maximum number of longitudinal joints	
	External ply	Internal ply
Up to and including 1 200	0	0
Above 1 200 up to and including 1 600	1	2
Above 1 600 up to and including 2 000	2	2

12 Freedom from defects

The belting shall be straight when rolled out flat. The surfaces and edges of finished belting shall be free from blisters and other surface defects and shall be completely sealed against ingress of moisture.

13 Tensile strength and elongation at break

The average values for tensile strength (both longitudinal and transverse) and the elongation at break, when determined and calculated in accordance with Annex C, shall be taken as the value of tensile strength and elongation at break of the finished belting. These values shall be not less than the values given in Table 1 or Table 2, as appropriate.

14 Adhesion

14.1 Cover to carcass or internal adhesion

The adhesion between cover and carcass and internal adhesion shall be tested longitudinally and transversely in accordance with Annex D and the values recorded shall be not less than the values given in Table 7.

14.2 Edge strip adhesion

Where appropriate (see Clause 4) the force required to strip the edging from the belt at a grip separation rate not exceeding 50 mm/min shall be not less than 2.6 N/mm of belt thickness when measured in a direction parallel to the edges of the belting, in accordance with Annex D.

14.3 Separation of additional cover from standard cover

The adhesion between additional cover and standard cover shall be tested in accordance with Annex D, and the values recorded.

NOTE The values for adhesion between additional cover and standard cover are not standardized.

Table 7 — Adhesion properties

Annex D test results to be used	Adhesion between cover and carcass N/mm	Internal adhesion of solid woven belting N/mm	Ply to ply adhesion N/mm
Average of the two mean values of force from the two tests	4.0	4.0	4.0 for fabrics containing natural fibres or 4.5 for 100 % synthetic fabrics
Lower of the two minimum values of force from the two tests	3.25	3.25	3.25

15 Tear strength

The tear strength of the finished belting shall be measured in accordance with Annex E. For underground coal mines, the average value in sense A and the average value in sense B shall be not less than the value given in Table 1. For other underground mines, the average values should be agreed between the supplier and the customer.

16 Electrical resistance

Electrical resistance shall be measured in accordance with Annex F and the average value on both the upper and lower surfaces of the belting shall be not greater than $3 \times 10^8 \Omega$. This figure shall also represent a maximum during the working life of the belting.

17 Fire performance

17.1 Drum friction test

When tested in accordance with **G.1**, there shall be no flame or glow on any part of any one of the test pieces either during each test or after each test piece breaks.

Temperature measurements of the surface of the drum taken during each test shall not exceed 325 °C.

17.2 Spirit burner flame test

17.2.1 General. When tested in accordance with **G.2**, the belting shall comply with **17.2.2**, **17.2.3** and **17.2.4**, as appropriate.

17.2.2 For the six test pieces with the outer covers intact. The average time for all flame or glow to disappear after withdrawal of the burner shall not exceed 3 s. No individual test piece shall flame or glow for more than 10 s.

In the event that an individual test piece continues to flame or glow for more than 10 s and the average flame or glow time does not exceed 3 s, a further six test pieces shall be tested.

If none of the further six test pieces flame or glow for more than 10 s, and the average flame or glow time does not exceed 3 s, the sample shall be deemed to have met the requirements. Otherwise, the sample shall be deemed to have failed.

17.2.3 *For the nine test pieces (cut longitudinally and parallel to the length of the belting) with covers removed.* The average time for all flame or glow to disappear after the withdrawal of the burner shall not exceed 5 s. No individual test piece shall flame or glow for more than 15 s.

In the event that an individual test piece continues to flame or glow for more than 15 s and the average flame or glow time does not exceed 5 s, a further nine test pieces shall be tested.

If none of the further nine test pieces flame or glow for more than 15 s, and the average flame or glow time does not exceed 5 s, the sample shall be deemed to have met the requirements. Otherwise, the sample shall be deemed to have failed.

17.2.4 *For the nine test pieces (cut transversely and at right angles to the length of the belting) with covers removed.* The average time for all flame or glow to disappear after the withdrawal of the burner shall not exceed 5 s. No individual test piece shall flame or glow for more than 15 s.

In the event that an individual test piece continues to flame or glow for more than 15 s and the average flame or glow time does not exceed 5 s, a further nine test pieces shall be tested.

If none of the further nine test pieces flame or glow for more than 15 s, and the average flame or glow time does not exceed 5 s, the sample shall be deemed to have met the requirements. Otherwise, the sample shall be deemed to have failed.

17.3 Mid-scale fire propagation test

When tested in accordance with **G.3**, the belting shall comply with one of the following in each test run.

NOTE See **G.3.8** for criteria for assessment of damage and length of belting consumed.

The belt shall have met the requirements of this test if, for each of the test pieces, either:

- a) the minimum length undamaged for each test piece is not less than 600 mm; or
- b) the minimum length undamaged is not less than 50 mm, the maximum average temperature rise is not greater than 140 °C, and the maximum length consumed by mass is not greater than 1 250 mm.

Where any of the tests is terminated prematurely for reasons of safety to persons or equipment the belt shall be deemed to have failed to meet the requirements of this test.

18 Sampling

18.1 Representational samples

Samples shall be taken that are representative of the manufacturing batch from which they are drawn and from which specimens for testing shall be selected. Sampling shall be carried out at the discretion of the testing authority. Samples shall not be tested within 48 h of completion of manufacture.

18.2 Sample dimensions

The sample size shall be sufficient to conduct all the tests specified in this standard. Individual test piece requirements are detailed in the appropriate annexes.

19 Marking

The following information shall be marked on one face of the belting, using characters not less than 20 mm high:

- a) month and year of manufacture, e.g. 6.04;
- b) any approval number allocated by the purchaser;
- c) belting type number, where applicable, or tensile value, together with the number and date of this British Standard, e.g. Type 3 BS 3289:2004 or 1200/BS 3289/04;
- d) specified cover thickness;
- e) letters or trade mark identifying the manufacturer;
- f) manufacturer's batch number.

Markings shall be repeated at a maximum longitudinal spacing of 10 m, at approximately 100 mm from the left and right edges alternately.

In the case of belts of unequal cover thickness, the markings shall be on the thicker cover.

The manufacturer's production batch number or P-number shall be applied to the outer face of the rolled belting at a distance of approximately one metre from the end of the belting. The characters shall be not less than 40 mm high. The marking shall be sufficiently durable to withstand abrasion during transport, handling and during installation.

Annex A (normative)

Method for determination of mean belting thickness

A.1 Principle

The belting thickness is measured at seven positions, and the average of the seven results is reported as the mean belting thickness.

Belting thickness and cover thickness measurements shall be taken from the same test piece.

A.2 Apparatus

A.2.1 *Micrometer dial gauge*, firmly located in a rigid stand over a flat baseplate, the top surface of which should be at least 100 mm square. The gauge shall be graduated in divisions of 0.01 mm and shall comply with BS 907.

The dial gauge shall be fitted with a flat contact of diameter (19 ± 2.0) mm which shall be square to the plunger and parallel to the baseplate.

The working force at the contact surface, measured with the dial gauge in the vertical position, shall be (0.50 ± 0.20) N.

A.3 Preparation of test piece

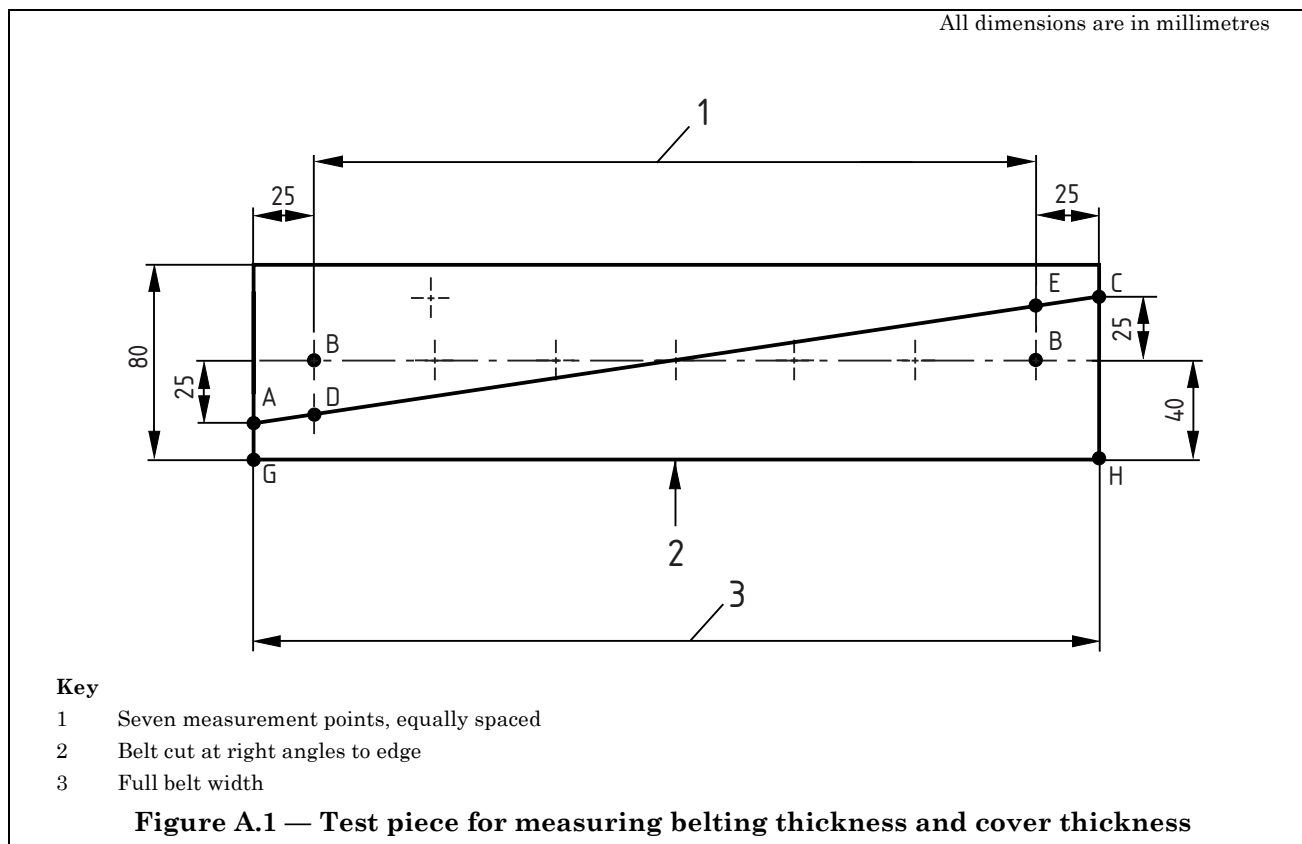
Cut a rectangular test piece, 80 mm long $\times$ full belting width. Cut the belting cleanly across its full width at right angles to the edges of the belt. Ensure that the surface of the test piece is devoid of any embossed markings. Mark the test piece as shown in Figure A.1.

A.4 Procedure

Hold the test piece flat on the baseplate using finger pressure where necessary. Overhanging belting should be supported at the same height. Measure the thickness of the belting at seven positions along line B-B as indicated in Figure A.1.

A.5 Calculation and expression of results

Record the measured thickness of the belting at each of the seven points (see A.4) rounded to two decimal places, and calculate the average of the seven results. Report the resulting figure as the mean belting thickness (in millimetres).



Annex B (normative)

Method of measuring cover thickness

B.1 Principle

The top and bottom cover thicknesses are measured on a cut edge of unstripped belting.

NOTE Belting thickness and cover thickness measurements are taken from the same test piece. Complete belting thickness measurements (see Annex A) before proceeding with cover thickness measurements.

B.2 Apparatus

B.2.1 Optical magnifier, incorporating a scale graduated in divisions of 0.1 mm.

B.3 Preparation of test piece

Cut the test piece, prepared in accordance with **A.3**, cleanly along line A–C as indicated in Figure A.1, at right angles to the surface of the test piece.

NOTE With certain colours of cover material and impregnation compound, difficulty can be experienced in determining the outline of the fabric knuckles. In these cases, it is permissible to colour the textile fabric with a suitable colour stain.

B.4 Procedure

B.4.1 Mean cover thickness

NOTE The procedures are the same for measuring mean cover thickness of the top and bottom covers.

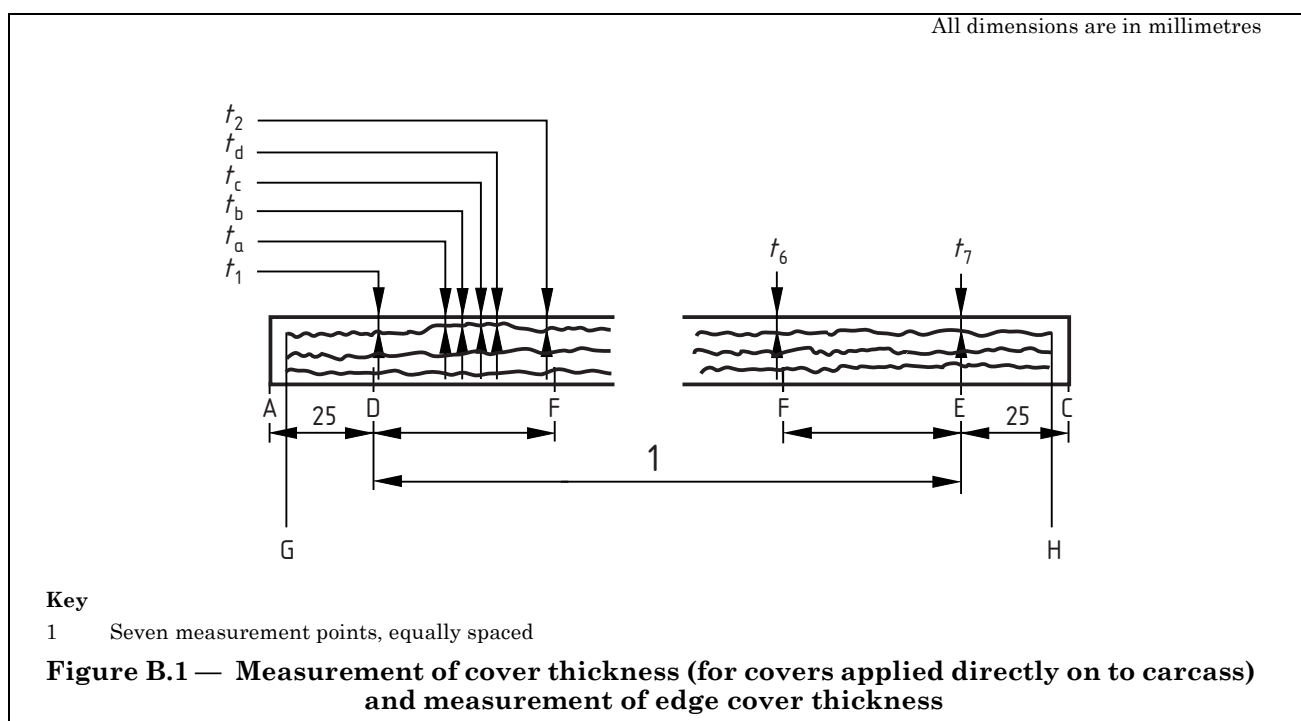
B.4.1.1 For belting where the cover material is applied directly to the belting carcass, make seven measurements (in millimetres) of the distance between the surface (top cover) and the top of the exposed fabric knuckles, as follows (see also Figure B.1):

a) t_1 and t_7 are the distances between the surface (top cover) of the belting and the exposed fabric at the nearest knuckle to each of the two lines D and E;

NOTE 1 The lines D and E are situated at points 25 mm from each edge of the belting.

b) t_2 and t_6 are the distances between the surface (top cover) of the belting and the exposed fabric at the nearest knuckle to each of the five lines F.

NOTE 2 The five lines F are situated, at equally-spaced intervals, between D and E across the width of the belting.



B.4.1.2 For belting where a material that is different from, but compatible with, standard top cover material is fused or vulcanized onto existing standard cover material as additional cover thickness, make seven measurements (in millimetres) of the distance between the surface (top cover) of the belting and the interface between additional and standard cover material as follows (see also Figure B.2):

a) t_1 and t_7 are the distances between the surface (top cover) of the belting and the interface between additional and standard cover material at each of the two lines D and E;

NOTE 1 The lines D and E are situated at points 25 mm from each edge of the belting.

b) t_2 and t_6 are the distances between the surface (top cover) of the belting and the interface between additional and standard cover material at each of the five lines F.

NOTE 2 The five lines F are situated, at equally-spaced intervals, between D and E across the width of the belting.