

Troughed belt conveyors — Specification

ICS 53.040.10

Committees responsible for this British Standard

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- Association of Consulting Engineers
- Automated Material Handling Systems Association
- Health and Safety Executive
- Institution of Mechanical Engineers
- Materials Handling Engineers Association (MHEA)
- Minerals Engineering Society
- Quarry Products Association
- Solids Handling and Processing Association Ltd.
- Co-opted Members

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Foreword

This British Standard has been prepared by Technical Committee MHE/9. It supersedes BS 2890:1989 and BS 5934:1980 which are withdrawn.

BS 8438:2004+A1:2010 supersedes BS 8438:2004, which is withdrawn.

The start and finish of text introduced or altered by amendment No. 1 is indicated in the text by tags **A1** **A1**. Minor editorial changes are not tagged.

This standard incorporates information previously contained within BS 2890 and BS 5934 and includes requirements with regard to basic conveyor and component selection, typical values for basic calculation purposes and typical conveyor calculation examples. The relationship between the dimensions specified in this British Standard and those published by the International Organization for Standardization (ISO) is also given.

This standard applies to the mechanical parts of troughed belt conveyors on which belts conforming to BS 490-1 are used.

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 cannot 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 57 and a back cover.

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1 Scope

This British Standard specifies the mechanical design, dimensional requirements and methods for calculating the operating power requirements for non-mobile troughed belt conveyors incorporating carrying idlers. The standard also specifies methods for calculating the forces exerted on the belt.

This standard applies to conveyors using either rubber or plastic belting, with textile reinforcement (conforming to BS 490-1), carrying loose bulk materials, having a maximum speed of 6 m/s.

This standard does not cover the safeguarding of hazard points. BS EN 620:2002 covers the safeguarding of hazard points on fixed troughed belt conveyors and BS EN 618:2002 deals with safeguarding of hazard points on fixed belt conveyors that are built into or attached to machines.

This standard does not apply to the following categories:

- a) underground mining conveyors;
- b) conveyors handling materials that do not behave as bulk solids.

NOTE 1 Annex A provides guidance on the information to be supplied by the purchaser at the time of enquiry and/order.

NOTE 2 Portable and mobile conveyors are covered in BS 4531.

NOTE 3 Belt speed in excess of 6 m/s might require analysis of forces not considered in this specification.

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.

BS 490-1, *Conveyor and elevator belting — Part 1: Specification for rubber and plastics conveyor belting of textile construction for general use.*

BS 2890, *Specification for troughed belt conveyors.*

BS 5512, *Method of calculating dynamic load ratings and rating life of rolling bearings.*

BS 5934 (ISO 5048), *Method for calculation of operating power and tensile forces in belt conveyors with carrying idlers on continuous mechanical handling equipment.*

BS 6323-5, *Seamless and welded steel tubes for automobile, mechanical and general engineering purposes — Part 5: Specific requirements for electric resistance welded and induction welded steel tubes.*

ISO 3870, *Conveyor belts (fabric carcass), with length between pulley centres up to 300 m, for loose bulk materials — Adjustment of take-up device.*

ISO 5293, *Conveyor belts — Formula for transition distance on three equal length idler rolls.*

3 Terms and definitions

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

NOTE Typical forms of conveyors and their components are shown in Figure 1 and Annex B.

3.1

head of the conveyor

discharge end of the conveyor

3.2

carrying idler

idler which supports the loaded belt

3.3

return idler

idler which supports the empty side of the belt

3.4

take-up device

device for taking up slack and applying tension to the belt

3.5

driving pulley

pulley that drives the belt

3.6

snub pulley

pulley used to develop the necessary arc of contact (angle of wrap) of the belt on the driving pulley

3.7

bend pulley

pulley used to change the direction of the belt

3.8

tail pulley

terminal pulley at the tail of a conveyor

3.9

take-up pulley

travelling pulley used in the take-up device

3.10

delivery pulley

pulley over which the conveyor material discharges

3.11

drive

equipment which drives the belt, consisting of a power unit, transmission and driving pulley

3.12

power unit

conveyor power source

NOTE Examples of power units are an electric motor, internal combustion engine, motorized pulley.

3.13

transmission

assembly of devices coupling the power unit to the driving pulley for driving the belt at the desired speed

3.14

safeguard

guard or device designed to protect persons from danger

3.15

regenerative conveyor

conveyor for which the head is substantially lower than the tail, giving a negative power requirement

3.16

cleaner

device for removing adherent material from the belt or a pulley

3.17

overend discharge

discharge over the head of the conveyor

3.18

tripper

device mounted either in a fixed position or on a travelling carriage, for discharging material from a belt conveyor at selected points or at any point along the length

3.19

shuttle conveyor

belt conveyor having overend discharge, the whole being mounted on a travelling carriage capable of being shuttled backwards and forwards

3.20**plough**

blade or blades mounted obliquely across the belt to discharge the material by deflecting it from the belt

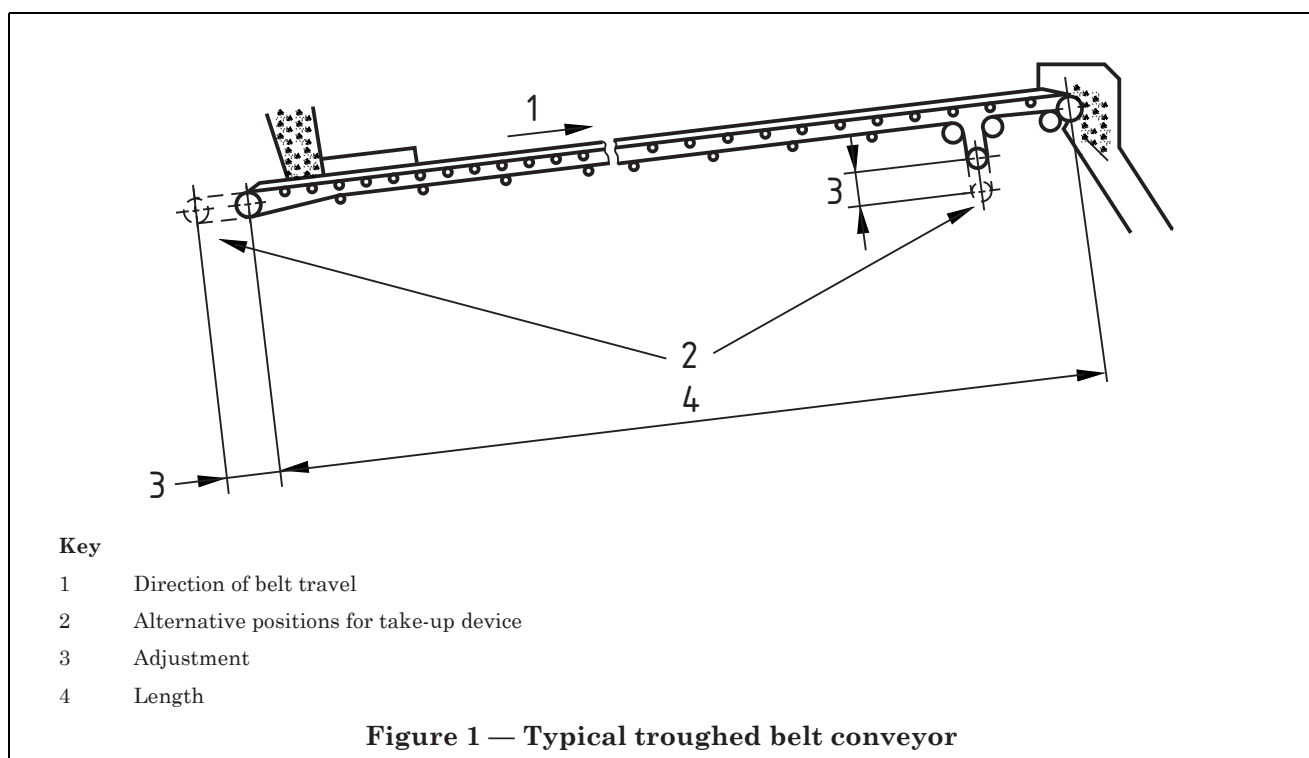
NOTE This is useful where headroom and space are limited but it is not recommended for any duty other than slow speed conveyors handling non-abrasive free-flowing materials.

3.21**edge idlers**

roller sets positioned vertical to and just clear of belt edge to minimize the belt running off track

3.22**sized material**

material whose size distribution can be expected to be consistent either due to its natural form or due to physical separation having taken place



4 Belting

4.1 Belt width

Belt width shall be selected from the values given in Table 1.

Table 1 — Belt width and belt edge clearance

Dimensions in millimetres	
Belt width	Minimum clearance
400 ^a 500 ^a 600 650 ^a	50
750 800 ^a 900 1 000 ^a 1 050 1 200 ^a 1 350 1 400 ^a	75
1 600 ^a 1 800 ^a 2 000 ^a	100
^a The clearances for these values are identical with those specified in ISO 1535.	

4.2 Belt capacity and speed

Belt width and speed shall be chosen to ensure the load on the conveyor is within the nominal cross-sectional allowance in accordance with Annex C.

The maximum capacity of a belt conveyor, I_v in cubic metres per second (m^3/s), shall be calculated from Equation (1):

$$I_v = Svk \quad (1)$$

where

- S is the maximum cross-section of the material on the belt in square metres (m^2) in accordance with Annex C;
- v is belt speed in metres per second (m/s);
- k is the slope factor (see Figure 2).

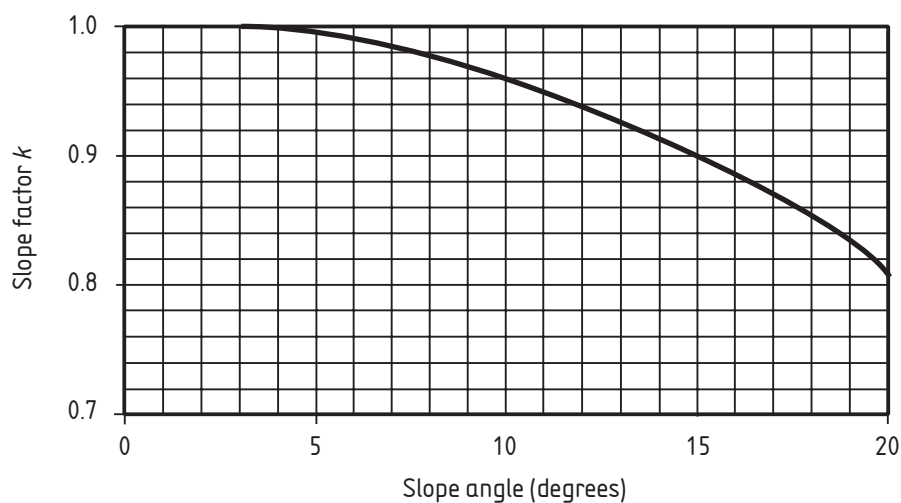


Figure 2 — Factor k as a function of slope angle δ

Belt width and speed shall be chosen to suit the particular application with due regard to the nature, size grading, characteristics and angle of repose of the material to be handled.

NOTE The minimum width of the conveyor belt might be limited by:

- a) the troughability of the selected grade of conveyor belt; and/or
- b) the size of the maximum lump size of the material to be handled in accordance with Table 2.

Table 2 — Maximum lump size for given belt width

Dimensions in millimetres

Minimum belt width	Sized material	Non-sized material
400	50	100
500	80	150
600	100	180
650	130	200
750	160	250
800	200	300
1 000	250	400
1 050	260	430
1 200	350	500
1 350	390	560
1 400	400	600
1 600	450	650
1 800	550	700
2 000	600	800

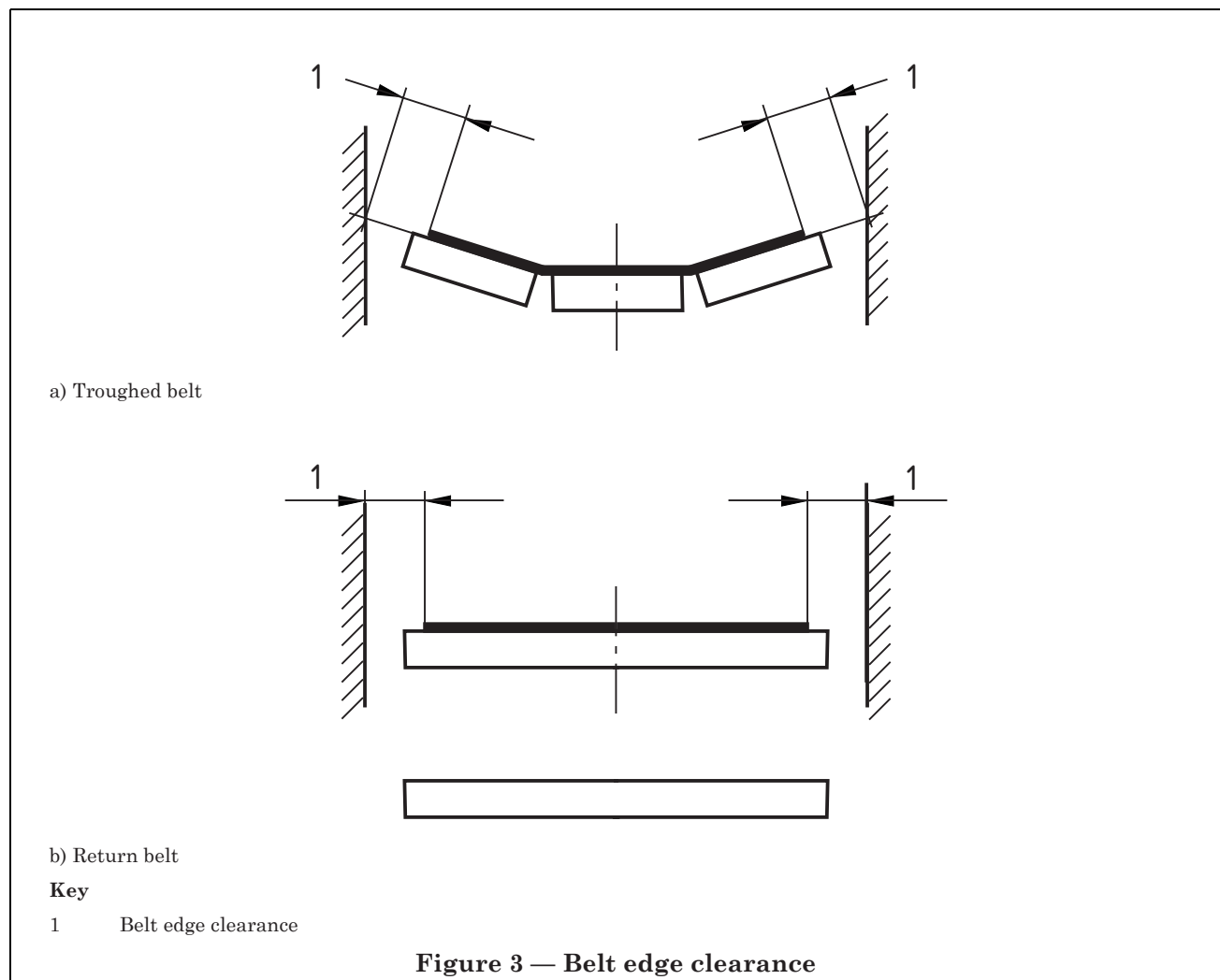
NOTE Sized material refers to where in excess of 95 % of material is less than the stated size.

4.3 Belt edge clearance

The minimum clearance between the edge of the belt and the conveyor structure when determined as shown in Figure 3 shall be in accordance with Table 1.

The minimum clearance shall also apply to surrounding structures when the conveyor is installed.

Where possible, the use of edge idlers shall be avoided and, to minimize damage to the belt, the conveyor structure shall present smooth surfaces in the line of belt travel.



5 Pulleys

5.1 Minimum pulley face length

The minimum pulley face length shall be as given in Table 3.

Table 3 — Minimum pulley face length

Dimensions in millimetres

Belt width	Minimum pulley face length
400 ^a	500 ^{b c}
500 ^a	600 ^{b c}
600 ^a	700
650 ^a	750 ^{b c}
750	900
800 ^a	950 ^{b c}
900	1 050
1 000 ^a	1 150 ^{b c}
1 050	1 200
1 200 ^a	1 350
1 350	1 500
1 400 ^a	1 550
1 600 ^a	1 800 ^c
1 800 ^a	2 000 ^c
2 000 ^a	2 200 ^c

^a These values are identical to those specified in BS 490-1 and ISO 251.
^b These values are identical to those specified in ISO 1816.
^c These values are identical to those specified in ISO 1536.

5.2 Pulley nominal diameter

The pulley nominal diameter (which includes any pulley lagging) shall be selected from the recommended minimum pulley diameter values given in Table 4, subject to 5.4.

Where pulleys are used within a tandem drive then the dice pulley diameter selected shall be the next size up from that recommended in Table 4.

5.3 Profile

The pulley surface in contact with the belt shall have either a flat or crowned profile. When crowned, the shape of the profile shall be regular and symmetrical. A flat central part shall not exceed 40 % of the width of the pulley. The transition between a flat central part and sloping parts of a crowned pulley shall be free from sharp edges.

The pulley nominal diameter shall not exceed the edge diameter by more than 1 %.

NOTE 1 The use of a flat or crowned pulley depends upon the conveyor application. Crowning can assist in centralizing the running of the conveyor belt but it should not be applied to close coupled pulleys.

NOTE 2 Steel cord belt might require special consideration for profiled (i.e. crowned) pulleys. The intended belting manufacturers recommendation should be sought.

5.4 Minimum pulley diameter appropriate to nominal belt carcass thickness

The minimum pulley diameter shall be as given in Table 4 for the appropriate belt carcass thickness and pulley type.

NOTE 1 Use of driving pulleys of larger diameter than those shown in Table 4 will not permit employment of a belt tension in excess of the recommended maximum tension.

NOTE 2 Use of pulleys having diameters which are too small for the belt carcass thickness can lead to premature failure of the belt.

NOTE 3 The diameters given in Table 4 are the minimum values necessary to ensure satisfactory belt life.

NOTE 4 Care should be taken to provide driving pulleys of sufficient diameter to ensure adequate traction.

NOTE 5 Due to method of construction some forms of steel cord belt can be used with smaller pulley diameters than indicated in Table 4.

NOTE 6 It is good practice to utilize pulley diameters larger than the minimum wherever possible.

Table 4 — Minimum pulley diameter appropriate to belt construction

Anticipated maximum belt tension kN/m	Material of the warp										Percentage (%) of the conveyor belt recommended maximum tension used								
	Cotton		Polyamide and cotton/polyamide		Cotton/polyester		Polyester		Rayon		Over 60 % up to 100 %			Over 30 % up to 60 %			Up to 30 %		
	Carcass thickness										Type of pulley								
	mm										A	B	C	A	B	C	A	B	C
	From	To	From	To	From	To	From	To	From	To	Recommended minimum pully diameter								
											mm								
Less than 20	—	1.2	—	1.1	—	1	—	0.9	—	0.8	100	—	—	—	—	—	—	—	—
	1.3	1.5	1.2	1.3	1.1	1.2	1	1.1	0.9	1	125	100	—	100	—	—	—	—	
	1.6	2	1.4	1.7	1.3	1.6	1.2	1.4	1.1	1.3	160	125	100	125	100	—	100	100	
	2.1	2.5	1.8	2.2	1.7	2	1.5	1.8	1.4	1.6	200	160	125	160	125	100	125	125	
20 to 40	2.6	3.1	2.3	2.7	2.1	2.5	1.9	2.3	1.7	2.1	250	200	160	200	160	125	160	160	
	3.2	3.9	2.8	3.5	2.6	3.2	2.4	2.9	2.2	2.6	315	250	200	250	200	160	200	200	
	4	5	3.6	4.4	3.3	4	3	3.7	2.7	3.3	400	315	250	315	250	200	250	250	
	5.1	6.2	4.5	5.5	4.1	5.1	3.8	4.6	3.4	4.2	500	400	315	400	315	250	315	315	
40 to 200	6.3	7.8	5.6	7	5.2	6.4	4.7	5.8	4.3	5.3	630	500	400	500	400	315	400	400	
	7.9	10	7.1	8.8	6.5	8.1	5.9	7.4	5.4	6.7	800	630	500	630	500	400	500	500	
	10.1	12.5	8.9	11.1	8.2	10.2	7.5	9.2	6.8	8.4	1 000	800	630	800	630	500	630	630	
	12.6	15.6	11.2	13.8	10.3	12.7	9.3	11.5	8.5	10.5	1 250	1 000	800	1 000	800	630	800	800	
Above 200	15.7	17.5	13.9	15.5	12.8	14.2	11.6	12.9	10.6	11.8	1 400	1 250	1 000	1 250	1 000	800	1 000	1 000	
	17.6	20	15.6	17.7	14.3	16.3	13	14.8	11.9	13.5	1 600	1 250	1 000	1 250	1 000	800	1 000	1 000	
	—	—	17.8	20	16.4	18.3	14.9	16.6	13.6	16.2	1 800	1 400	1 250	1 400	1 250	1 000	1 250	1 250	
	—	—	—	—	18.4	20	16.7	18.5	15.3	16.9	2 000	1 600	1 250	1 600	1 250	1 000	1 250	1 250	
A = Drive pulleys and pulleys exposed to high belt tension, e.g. delivery pulleys under full tension.																			
B = Snub pulleys in the return run under lower tension, e.g. tail pulleys (in the case of head end driving), pulleys in take-up devices etc.																			
C = Bend pulleys for a change of belt direction of less than 30°.																			

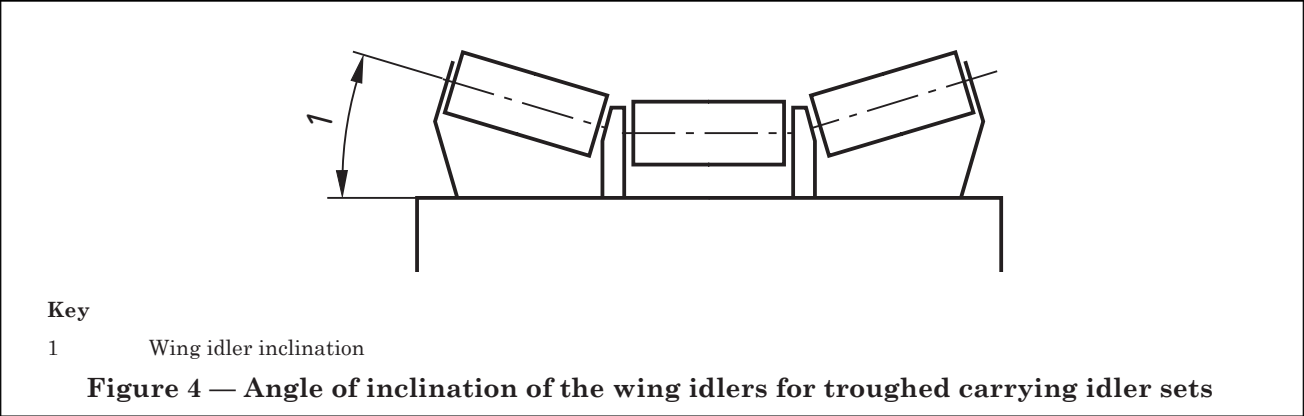
6 Idlers and idler sets

6.1 General

Idler sets shall have a multiplicity of idler rolls (generally 3 or 5). Idler rolls shall be either the secured or drop-in type.

NOTE 1 Figure 4 illustrates a typical idler set.

NOTE 2 Rubber covered or disc idlers might be necessary for impact absorption at loading points or to cater for dirty conditions on the return strand.



6.2 Materials

Where used, steel idler rolls shall be of electric resistance or induction welded (ERW) steel tube conforming to BS 6323-5.

6.3 Nominal outside diameters of idlers

The nominal outside diameters of carrying and return idlers (see Figure 5) shall be selected from the values given in Table 5.

Table 5 — Minimum radial clearance for carrying and return idlers

Dimensions in millimetres	
Idler diameter	Minimum clearance
101.6 ^a 108 ^a 127 ^a 133 ^a	30
152.4 ^a 159 ^a 168.3 ^a	40
^a These dimensions are identical to those given in BS 6323-5 and ISO 1537.	

6.4 Nominal idler lengths

The nominal lengths of carrying and return idlers (see Figure 5) shall be selected from the values given in Table 6.

Table 6 — Nominal lengths of carrying and return idlers appropriate to belt width

Dimensions given in millimetres

Belt width	Nominal length of idler (see Figure 5)		
	L_1	L_2	L_3
400	160 ^a	500 ^{a b}	—
500	200 ^{a b}	600 ^{a b}	—
600	240	700	—
650	250 ^{a b}	750 ^{a b}	—
750	295	900	—
800	315 ^{a b}	950 ^{a b}	465 ^{a b}
900	350	1 050	530
1 000	380 ^{a b}	1 150 ^{a b}	600 ^{a b}
1 050	410	1 200	600
1 200	465 ^a	1 350	670 ^a
1 350	530	1 500	750
1 400	530 ^a	1 600 ^a	800 ^a
1 600	600 ^a	1 800 ^a	900 ^a
1 800	670 ^a	2 000 ^a	1 000 ^a
2 000	750 ^a	2 200 ^a	1 100 ^a

NOTE Carrying idler lengths L_1 apply to both in-line and staggered idler sets.

^a These values are identical to those specified in ISO 1537.

^b These values are identical to those specified in ISO 2109.

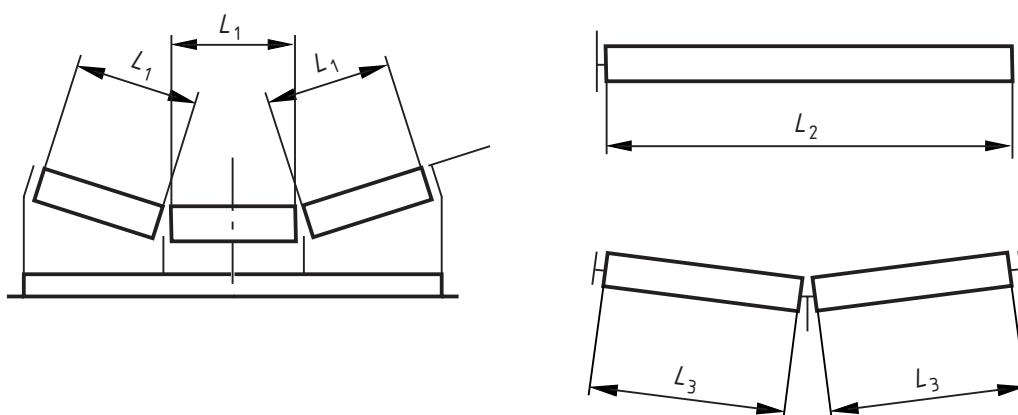


Figure 5 — Nominal idler lengths for three-idler carrying sets, flat and vee return idlers

6.5 Arrangement of carrying idler sets

6.5.1 In-line and staggered idler sets

6.5.1.1 General

Troughed carrying idler sets shall be arranged with the idlers either in-line or staggered in the plane of the belt as shown in Figure 6.

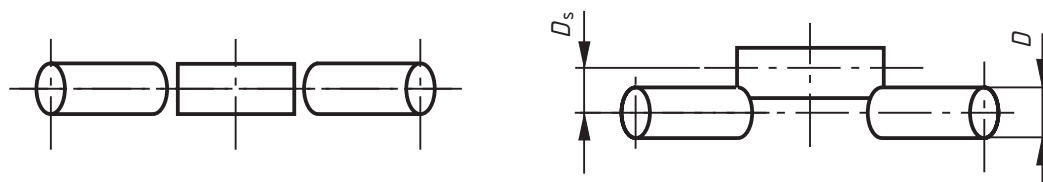
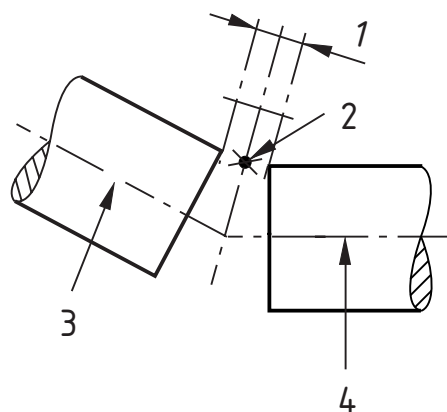


Figure 6 — Plan views of in-line and staggered idler sets

6.5.1.2 In-line idler sets

The gap between adjacent ends of the idlers shall be not greater than 10 mm (see Figure 7).



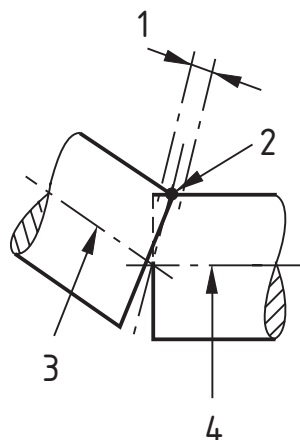
Key

- 1 10 mm max. gap
- 2 Intersection of projection of belt contact surfaces
- 3 Wing idler
- 4 Centre idler

Figure 7 — Part view of in-line idler set

6.5.1.3 Staggered idler sets

In plan view, the displacement of the axis of an idler from the axis of the adjacent idler (D_s) shall not exceed the nominal diameter of the idlers plus 5 mm [$(D + 5)$ mm] as shown in Figure 6. The idler set shall be arranged with adjacent ends of idlers overlapping by a minimum of 10 mm (see Figure 8).

**Key**

- 1 10 mm min. overlap
- 2 Intersection of belt contact surfaces
- 3 Wing idler
- 4 Centre idler

Figure 8 — Part view of staggered idler set**6.5.2 Troughing angle**

The angle of inclination of wing idlers in three-idler sets shall be 20°, 25°, 30°, 35°, 40° or 45° when measured in the plane shown in Figure 4.

NOTE Idler sets having troughing angles other than those specified might be necessary for the transition between flat and troughed sections of a conveyor adjacent to the terminal pulleys.

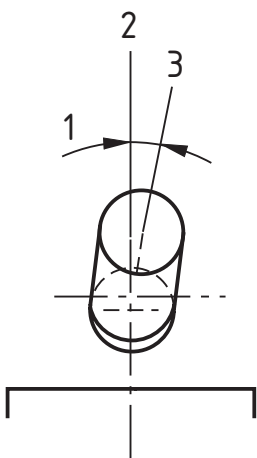
6.5.3 Forward tilt

When wing idlers are required to be tilted forward in the direction of belt travel to assist belt alignment (see Figure 9), the angle of tilt shall not exceed 3°, measured relative to the transverse plane. Idler sets having forward tilt shall be clearly and permanently marked with an arrow indicating the direction of belt travel. Idler sets with forward tilt shall not be used on reversible conveyors.

NOTE The angle of tilt should be the minimum commensurate with the particular applications.

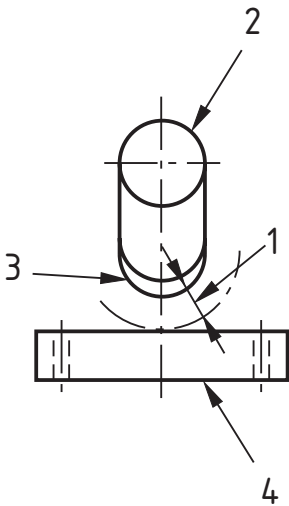
6.5.4 Clearance between carrying idler and supporting structure

The minimum radial clearance between a carrying idler shell and its mounting transom or framework (see Figure 10) shall be as given in Table 5.



- Key**
- 1 Angle of tilt
 - 2 Centre line of centre idler
 - 3 Centre line of wing idler

Figure 9 — Side elevation of wing idler with forward tilt *E*



- Key**
- 1 Minimum clearance
 - 2 Wing idler
 - 3 Carrying idler
 - 4 Framework

Figure 10 — Clearance between carrying idlers and supporting structure