

Specification for

Large (vee-throated) haulage rope pulleys for mines and quarries

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- British Electrical and Allied Manufacturers' Association
- British Steel Industry
- Council of Underground Machinery Manufacturers
- Department of Trade and Industry*
- Engineering Equipment Users' Association
- Federation of Manufacturers of Construction Equipment and Cranes
- Institute of Quarrying
- Institution of Mechanical Engineers
- Institution of Mining Engineers
- National Coal Board*

The Government department and industrial organization marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- Council of Ironfoundry Associations
- Federation of Wire Rope Manufacturers of Great Britain

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Foreword

This British Standard has been prepared under the authority of the Mining and Quarrying Requisites Industry Standards Committee to cover a range of large diameter pulleys designed primarily for haulage purposes at mines and quarries, and intended for use with steel wire ropes complying with the requirements of BS 330.

The pulleys covered by this British Standard have been specifically designed for return wheel duty, i.e. where the lap of the rope on the pulley is 180° . However, the pulleys are suitable for other conditions, where the rope lap is less than 180° . Pulleys and shafts embodying rolling bearings are regarded as a composite unit. However, in the case of pulleys having bronze bushed bearings, all components are intended to be interchangeable for a given pulley diameter. It is also intended that, for a given pulley diameter, a rolling bearing pulley assembly and a bronze bushed bearing pulley assembly will be interchangeable.

Rolling bearings in the pulley boss are specified throughout a full range of pulley diameters and it is recommended that, wherever possible, rolling bearings should be used to reduce to a minimum the necessity for service and maintenance.

Phosphor bronze bearing bushes in pedestals are specified up to a maximum pulley diameter of 1 350 mm and are not intended to be used with the shaft in a vertical position.

The pulleys covered by this standard are not designed to be hoisted in the horizontal position by means of attachments to the rim or spokes, nor for multiple stacking, storage or lifting one on top of the other.

It is not intended to cover U-shaped groove pulleys, or multiple pulley arrangements, although certain parts of the specification are pertinent to such designs and should be used where possible.

A method of determining minimum pulley diameters is given in Appendix A, taking into account the normal haulage loads in a straight rope and the induced loads when it is bent around a pulley.

NOTE While this is a metric standard, certain principal dimensions are stated in (approximate) imperial units for convenience at this stage; reference may be made to BS 350, "*Conversion factors and tables*".

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their 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 28, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 General

1.1 Scope

This British Standard specifies requirements for a range of haulage pulleys (with shafts) and pedestals designed to incorporate, appropriately, either rolling bearings or plain bearings.

NOTE The titles of the British Standards referred to in this standard are listed on the inside back cover.

1.2 Definitions

For the purposes of this British Standard, the following definitions apply:

1.2.1

rope diameter

the value by which the nominal diameter of the wire rope is designated

1.2.2

pedestal

a device designed to support the ends of a shaft upon which a pulley rotates on rolling bearings

1.2.3

bearing housing

a device, embodying bronze bushes, designed to support the ends of a rotating shaft

1.2.4

bearing (rolling)

a bearing of the ball, roller, or the taper roller type

1.2.5

tread diameter

the nominal diameter of the pulley, measured at the root of the rope groove

NOTE The following terminology phrases are provided for information and guidance:

One-piece solid casting. A pulley without spokes.

Pulley assembly. The designed combination of pulley, shaft, bearings and shaft pedestals.

2 Pulleys

2.1 General

The following principal pulley arrangements are covered by this standard:

- 1) Pulleys of 600 mm to 2 100 mm diameter, incorporating rolling bearings in the boss (see Figure 4, Figure 5, Figure 6 and Figure 7); and
- 2) Pulleys of 600 mm and 1 350 mm diameter, incorporating phosphor bronze bushes in the associated pedestals (see Figure 8, Figure 9, Figure 10 and Figure 11).

2.1.1 Design criteria. A pulley complying with the requirements of this British Standard shall be capable of withstanding a load equal to twice the minimum breaking load of the largest diameter of rope nominated for use with that pulley (see Figure 1, Figure 2 and Figure 3), assuming a rope lap of 180° (i.e. return pulley conditions), without permanent deformation of any part of the pulley assembly.

2.1.2 Classification. Pulleys shall be in accordance with the classification shown in Table 1.

Table 1 — Pulley classification

Description		Pulley size			
Group	Construction	Diameter at rope tread			Type reference
		mm	ft	in	
C	One-piece solid casting	600	2	0	C.60
		750	2	6	C.75
		900	3	0	C.90
S	Cast rim and hub, with spokes (one-piece)	900	3	0	S.90
		1 050	3	6	S.105
		1 200	4	0	S.120
		1 350	4	6	S.135
		1 500	5	0	S.150
SH	Cast rim and hub, with spokes (two-piece)	1 350	4	6	SH.135
		1 500	5	0	SH.150
		1 800	6	0	SH.180
		2 100	7	0	SH.210

2.2 Materials

2.2.1 Pulley rims and hubs. The materials of pulley rims and hubs shall comply with the requirements of one or other of the following British Standards, subject to agreement between the purchaser and the manufacturer:

BS 1452, Grade 14 grey cast iron (as minima)

BS 2789, Grade SNG37/2 nodular graphite cast iron

BS 3100, (BS 592, Grade B carbon steel)

BS 3100, (BS 1456 Grade A 1½ % manganese steel)

2.2.2 Spokes. The material of pulley spokes shall be either mild steel complying with the requirements of Grade 43A of BS 4360, or wrought iron complying with the requirements of BS 2772, subject to agreement between the purchaser and the manufacturer.

2.3 Rim section

The rim section shall conform appropriately to the principal dimensions of Figure 1, Figure 2 or Figure 3.

The rope groove radius of the pulley shall be approximately 10 % greater than the nominal radius of the rope to be used with the pulley.

NOTE The rim sections illustrated in Figure 1, Figure 2 and Figure 3 provide a progressive range of nine pulleys for rope diameters complying with the requirements of BS 330. Users are advised to consult Appendix A, which gives a method of determining minimum pulley diameters and takes account of necessary factors in order to limit to an acceptable maximum the loading of a rope bent around a pulley.

2.4 Hubs

2.4.1 For solid type pulleys. The hubs for one-piece solid cast pulleys shall conform to the general arrangement of Figure 4, Figure 5, Figure 8 and Figure 9, as appropriate.

2.4.2 For spoked pulleys

2.4.2.2 The hubs for one-piece spoked type pulleys shall conform to the general arrangement of Figure 6 and Figure 10, as appropriate.

2.4.2.2 The hubs of spoked type split pulleys shall conform to the general arrangement of Figure 7 and Figure 11, as appropriate.

2.5 Machining

2.5.1 Rims. Unless otherwise agreed between the purchaser and the manufacturer, rope grooves shall be “as cast”. Where high spots, or areas of undue roughness occur, these shall be dressed smooth and flush with the general contour of the groove. The tolerance on diameter for “as cast” pulleys shall be $\pm \frac{3}{0}$ mm. The total variation from true running for “as cast” rope grooves shall not exceed 3 mm in any direction.

Where machined rims are required by the purchaser the rope groove radius shall comply with the requirements of 2.3. The machined radius shall blend smoothly into the flanks of the “vee” without step or undercut.

The tolerance on diameter for machined rope grooves shall be $\pm \frac{1.5}{0}$ mm. The total variation from true running of the machined rope groove radius shall not exceed 0.5 mm in any direction.

2.5.2 Hubs

2.5.2.1 Hubs for keyed shafts shall be faced on both sides subject to a tolerance on width of $\pm \frac{0.5}{0}$ mm. The bores shall comply with H8¹⁾ limits for holes.

2.5.2.2 Hubs to accommodate rolling bearings shall be concentric within the tolerance grade IT 4¹⁾ and be subject to a tolerance on width of $\pm \frac{0.5}{0}$ mm. The tolerances on bores shall comply with the N6¹⁾ limits for holes.

2.5.3 Split pulleys. The mating faces of split pulleys shall be machined flat and square with the plane of the rope tread.

The bolt holes in the mating faces of split pulleys shall be accurately drilled, and then countersunk 1.5 mm at 45° on the face. The nut seatings shall be spotfaced to provide square seating for the nuts.

Means, additional to fixing bolts, shall be provided to ensure accurate assembly of the components.

2.6 Keyways

Any pulley having a keyed shaft shall have a rectangular keyway, complying appropriately with the requirements of BS 4235, cut in the hub bore (see also Section 7).

¹⁾ See BS 4500.

2.7 Spokes

The number of spokes per pulley and their respective diameters shall be as given in Table 2.

All spokes shall be set (cranked) at both ends, to enter the rim bosses and the hub at right angles to the axis of the shaft. The set of a spoke shall be as near as possible to the point where the spoke enters the hub and the rim boss; the set shall in no case be inside the boss or hub.

The spoke ends shall be knuckled (as shown in Figure 2 and Figure 3) by swaging or rolling. Spoke ends shall be cleaned and evenly tinned after knuckling, such tinning to extend clear of the finished casting.

The root diameter of each knuckle shall be not less than the nominal diameter of the spoke. The contour of the knuckle shall be fully radiused and have no sharp lines. There shall be 1) a 20 mm minimum parallel portion of the spoke end immediately inside the rim boss and hub, 2) a 58 mm minimum length of spoke inside the rim boss and hub and 3) a 20 mm minimum of material covering the end of each spoke in the rim and hub after any machining.

Table 2 — Details of spokes

Pulley diameter			Number of spokes	Diameter of spokes (minimum)	
mm	ft	in		mm	in
900	3	0	12	25	1
1 050	3	6	12	25	1
1 200	4	0	16	29	1 ¹ / ₈
1 350	4	6	16	29	1 ¹ / ₈
1 500	5	0	16	29	1 ¹ / ₈
1 800	6	0	16	32	1 ¹ / ₄
2 100	7	0	20	38	1 ³ / ₈

3 Shafts

3.1 Material

The material for keyed (rotating) shafts shall comply with the requirements of BS 970-1, grade 070M20 (hot rolled, forged, or normalized).

The material for fixed shafts shall comply with the requirements of BS 970-1, grade 070M26 (cold drawn from hot rolled condition).

In either instance the material shall be free from seams, laps and other such defects.

3.2 Machining

3.2.1 Shafts for use with phosphor bronze bearings. The surface finish on journals, pulley seatings and radii on shafts in accordance with Figure 8, Figure 9, Figure 10 or Figure 11 shall be of a quality grade complying, both diametrically and longitudinally, with $63R_a^{2)}$.

Fillet radii shall blend smoothly, without step or undercut, into the journal. All burrs and sharp edges shall be removed.

3.2.2 Shafts for rolling bearings. The surface finish on all parts of the shaft which come into contact with rolling bearings shall be of a quality grade complying, both diametrically and longitudinally, with $63R_a^{2)}$.

Fillet radii shall blend smoothly. All burrs and sharp edges shall be removed.

Thread holes for lubricators shall be countersunk at 45° to the depth of the first thread.

3.3 Dimensions and tolerances

3.3.1 Shafts for phosphor bronze bearings.

Shafts for phosphor bronze bearings shall conform appropriately to the dimensions given in Figure 8, Figure 9, Figure 10 or Figure 11, subject to the following machining tolerances:

Dimension	Tolerance
Journal diameter	f6 ^a limits for shafts
Shaft body diameter	g6 ^a limits for shafts
Shaft body length	± 0.4 mm
Journal length	± 0.8 mm
Journal fillet radius	+0.25 mm –0
Depth of key seat	+0.15 mm –0

^a See BS 4500.

3.3.2 Shafts for rolling bearings. Shafts for use with rolling bearings shall be concentric within the tolerance grade IT 4³⁾ and shall conform appropriately to the dimensions given in Figure 4, Figure 5, Figure 6 or Figure 7, subject to the following machining tolerances:

Dimension	Tolerance
Journal diameter	e8 ^a limits for shafts
Bearing seating	g6 ^a limits for shafts
Shaft body length	± 1.5 mm

^a See BS 4500.

²⁾ See BS 1134.

³⁾ See BS 4500.

3.4 Bearing pedestal centres

The bearing pedestal centres for all shafts shall be as follows:

Pulley diameter mm	Bearing/pedestal centres mm
600 and 750	335
900 and 1 050	370
1 200	440
1 350	455
1 500	470
1 800	495
2 100	500

NOTE The bearing centres given for shafts in Figure 8, Figure 9, Figure 10 and Figure 11 allow 2 mm end float for the pulley.

4 Bearing pedestals

4.1 General

4.1.1 Where pedestals are required to accommodate shafts normally operating in the vertical position, for pulleys embodying rolling bearings, an end cap in accordance with Figure 12 shall be provided for the lower pedestal.

4.1.2 Pedestals embodying phosphor bronze bushes shall be provided with means of lubrication (see 5.2).

4.1.3 Each pedestal for use with a pulley containing rolling bearings shall be fitted with an M16, 8.8 grade, half-dog pointed set screw of sufficient length to engage and bottom in a suitable blind hole drilled in the shaft.

4.1.4 Where an end cap is provided for a pedestal, such pedestal shall be drilled and tapped concentrically with the bore, the holes being equally spaced within a tolerance of ± 0.08 mm on the pitch circle. (See Figure 12.)

4.2 Material

4.2.1 Bearing housings (see Figure 13) and pedestals (see Figure 12) shall be cast in material not inferior to Grade 14, grey cast iron, complying with the requirements of BS 1452.

4.2.2 End caps (see Figure 12) shall be made of mild steel complying with the requirements of Grade 43A 6f BS 4360.

4.3 Machining

4.3.1 The surface finish of the bores shall be of a quality complying with $125R_a^{4)}$

⁴⁾ See BS 1134.

The bottom face of pedestals shall be machined flat and parallel with the bore.

All burrs and sharp edges shall be removed.

4.3.2 Where required by the purchaser, bases shall be left undrilled.

4.3.3 Threads for lubricators shall be countersunk at 45° to the depth of the first thread.

4.4 Dimensions and tolerances

4.4.1 Bearing housings for phosphor bronze bushes. These bearing housings shall conform to the dimensions given in Figure 13, subject to the following tolerances:

Dimension	Tolerance
<i>C</i> (Diameter)	H8 ^a limit for holes
<i>F</i> (Width)	+0 −0.4 mm
<i>G</i> (Hole centres)	± 0.8 mm
<i>H</i> (Base length)	± 2 mm
<i>h</i> (Centre height)	± 0.13 mm

^a See BS 4500.

4.4.2 Pedestals for shafts with rolling bearings. Pedestals for these shafts shall conform to the dimensions given in Figure 12, subject to the following tolerances:

Dimension	Tolerance
<i>A</i> (Diameter)	H8 ^a limit for holes
<i>F</i> (Width)	+0 −0.4 mm
<i>G</i> (Hole centres)	± 0.8 mm
<i>H</i> (Base length)	± 2 mm
<i>h</i> (Centre height)	± 0.13 mm

^a See BS 4500.

4.4.2.1 Bearing end caps shall conform to the dimensions given in Figure 12, subject to the following tolerances:

Dimension	Tolerance
<i>d</i> (Diameter)	+0 −1.0 mm
<i>P.C.D</i> (Pitch circle diameter)	± 0.13

The holes in the end cap shall be drilled to accord with those in the pedestal (see 4.1.4).

4.4.2.2 Fixing screws in accordance with Figure 12 shall be provided with each bearing end cap.

5 Bearing bushes

5.1 Material

The material for bearing bushes (and thrust washers) shall be phosphor bronze complying with the requirements of Grade PB4 of BS 1400. Other suitable bearing materials may be used, subject to agreement between the purchaser and the manufacturer; in such an event, the recommendations of the relevant material manufacturer shall apply in respect of the machining finishes, tolerances and lubrication.

5.2 Machining

The surface finish of bush bores and working faces of thrust washers shall be of a quality grade complying with $32R_a^{5)}$.

The radius “*R*” at the inner end of bearing bushes (see Figure 14) shall blend smoothly, without step or undercut, into the bore and shall be concentric with the bore. Bushes and thrust washers shall be machined to permit adequate lubrication.

All burrs and sharp edges shall be removed.

5.3 Dimensions and tolerances

5.3.1 Bearing bushes shall conform to the dimensions of Figure 14, subject to the following tolerances:

Dimension	Tolerance
A(Diameter)	H8 ^a limit for holes (after fitting)
C(Diameter)	s6 ^a limit for shafts
M(Length)	+0 −0.4 mm
R(Radius)	+0.25 mm −0

^a See BS 4500.

5.3.2 Thrust washers shall conform to the dimensions of Figure 14, subject to the following tolerances:

Dimension	Tolerance
P(Diameter)	± 0.8 mm
Q(Diameter)	± 0.8 mm
Thickness	± 0.13 mm

The thrust faces shall be parallel within the specified thickness tolerance.

6 Rolling bearings

6.1 Bearings

Where rolling bearings are required they shall be fitted in the pulley boss. Rolling bearings shall have a minimum life rating of 25 000 hours (see Note 1).

The assembled bearings shall be capable of withstanding without undue deterioration a static load of twice the breaking load⁶⁾ of the appropriate rope shown in Figure 1, Figure 2 or Figure 3.

NOTE 1 The life rating of the rolling bearing assembly is calculated on an assumed radial working load of 25 % of twice the breaking load of the appropriate maximum diameter haulage rope indicated in Figure 1, Figure 2 or Figure 3 with an axial load on the bearings of one tenth of the above stated working load. The rope is assumed to be travelling at a speed of 10 km/h. Calculations on bearing life and load ratings should be in accordance with the recommendations contained in Appendix B of BS 292.

NOTE 2 Where agreed between the purchaser and the manufacturer, cartridge assembled rolling bearings may be used.

6.2 Seals

Adequate seals shall be provided, where appropriate, with each rolling bearing. These seals shall be effective against the normal ingress of dust and water. Provision shall be made for the ease of seal replacement.

6.3 Bearing lubrication

A lubrication point shall be provided.

7 Keys

7.1 Details

The material for keys shall be steel complying with the requirements of grade 070M26 of BS 970-1, unless decided otherwise between the purchaser and the manufacturer.

Keys shall be of rectangular close fit, gib head, taper type complying with the requirements of BS 4235.

The finished fitted key shall not protrude outside the width of the pulley boss.

The gib head shall be removed when the key has been worked down to size and fitted.

8 Bolts for split pulleys (with nuts and washers)

8.1 Bolts

The material for the clamping bolts for split sheaves shall comply with the requirements of grade 220M07 of BS 970-1.

⁵⁾ See BS 1134.

⁶⁾ To cater for return pulley condition, i.e. 180° lap of rope on the pulley.