BELTCON 6

BELT CONVEYOR STANDARDS - WHAT THEY ARE AND WHO SETS THEM.

CONVEYOR PULLEY STANDARDS - A POSSIBLE SOLUTION.

A E M BELL

Managing Director

Bosworth Holdings

M F SCHENCK

General Manager-Pulley Division

Bosworth Holdings

SYNOPSIS

As one of the major suppliers of conveyor pulleys in South Africa, Bosworth Holdings has built thousands of pulleys for all of the major users.

With the lack of an existing standard the major users have each developed their own independent standards. It is interesting to note that a large number of similarities exist amongst these standards and that some of their differences are so slight that all that would be required to have a universal standard are a few minor changes.

It is our intention that by examining these standards we will be able to find some common ground and in so doing develop a universal standard that could be used by all.

The major issues in developing such a standard are as follows :-

1. Rationalization of Dimensions.
2. Methods of Construction.
3. Crowning.
4. Lagging.
5. Bearing/Plumber Block Selection.
6. Quality Standards.

INDEX

1. PULLEY DIMENSIONS

By looking at the various specifications, both locally and internationally, we find that in some areas there are significant similarities and in others vast differences.

In order to address this area we will break the dimensions into the following sections :-

1.1. Pulley Diameters.

1.2. Belt Widths and Face Widths.

1.3. Bearing Centres.

1.4. Shaft and Bearing Diameters.

1.1. PULLEY DIAMETERS

This is an area where there appears to be the least significant problems. As can be seen from the following table (Table 1) most users are adhering to an acceptable standard range of sizes.

User 1	User 2	User 3	User 4	ISO 1536
		100		
		125		
		160		
		200		200
		250		250
315		315	315	315
400	400	400	400	400
500	500	500	500	500
630	630	630	630	630
700		700		
	710			
800	800	800	800	800
900		900		
1000	1000	1000	1000	1000
1250	1250	1250	1250	1250
	1400	1400	1400	1400
		1600		1600

Table 1

From Table 1 it is quite clear that all users would be able to conform to a universal standard and that it should be the same as the ISO standard.

From a manufacturers point of view we would propose that we adopt this as part of a standard and feel that we must restrict the maximum diameter to 1250 mm and treat all other sizes as a special.

Therefore the universal standard for pulley diameters will be as follows :-

Diameter mm
200
250
315
400
500
630
800
1000
1250

Table 2

It must be noted that all the above dimensions are "over steel".

1.2 BELT WIDTHS AND FACE WIDTHS

This is where we will encounter our fist problems. Some major users differ vastly while it appears that our belt widths do not always coincide with those used internationally.

From the SABS Standard Specification for Steel-cord-reinforced conveyor belting we are able to determine the preferred belt widths used in the South African market.

Using these as a basis and tabulating the various face widths we arrive at the following table (Table 3).

BELT WIDTH	User 1 Face	User 2 Face	User 3 Face	User 4 Face
500			600	
600		700	700	700
750	800	900	900	900
900	950	1050	1050	1050
1050	1100	1200	1200	1200
1200	1275	1350	1400	1350
1350	1425	1500	1550	1500
1500	1575	1700	1700	1700
1650			1850	
1800		2000	2000	2000
2100		2300	2300	2300

Table 3

By rationalizing the sizes in the above table (Table 3) we can see that for most users there are little or no changes if we accept the following table (Table 4) as a standard.

BELT WIDTH	FACE WIDTH
500	600
600	700
750	900
900	1050
1050	1200
1200	1350
1350	1500
1500	1700
1650	1850
1800	2000
2100	2300

Table 4

1.3. BEARING CENTRES

It is in this area that we find vast differences between the various users. The differences are so significant that it is incredibly difficult to arrive at an acceptable standard. A typical example of this is where on a 1500 mm wide belt, two users differ by 320 mm on bearing centres.

Since the bearing centres are one of the important dimensions in a pulley it is necessary for us to arrive at some form of standard since the design and ultimately the performance of the pulley will be effected by this dimension.

From a manufacturers point of view the most significant problem encountered while producing pulleys is that if the bearing centres are too narrow the bearings will foul the pulley hubs.

To overcome this type of problem we often have to change our hub to shell edge distance to accommodate the bearing. This practice has some design implications that cannot always be accommodated.

By limiting the bearing centres to a minimum we would be able to effect savings on the shaft of the pulley and thus also the bearings.

The following tables (Table 5 & 6) illustrate the differences in the bearing centres amongst the major users.

a) Wide Bearing Centres.

	BELT WIDTH (mm)									
	600	750	900	1050	1200	1350	1500	1650	1800	2100
User 1		1170	1370	1520	1680	1830	1980			
User 2	1140	1370	1520	1670	1850	2000	2300		2630	2930
User 3	1050	1200	1400	1550	1700	1900	2100	2250	2500	

Table 5

b) Narrow Bearing Centres.

	BELT WIDTH (mm)									
	600	750	900	1050	1200	1350	1500	1650	1800	2100
User 1		990	1140	1300	1450	1600	1750			
User 2	1040	1270	1420	1570	1750	1900	2200		2530	2830
User 3	850	1000	1150	1300	1450	1600	2000	2150	2400	

Table 6

If we consider that the bearings have a

characteristic width and hence half width, we are able to determine a minimum bearing centre based on the following equation.

$$B/C = F + 2*(W + f + R) + x$$

Where B/C = Bearing Centre

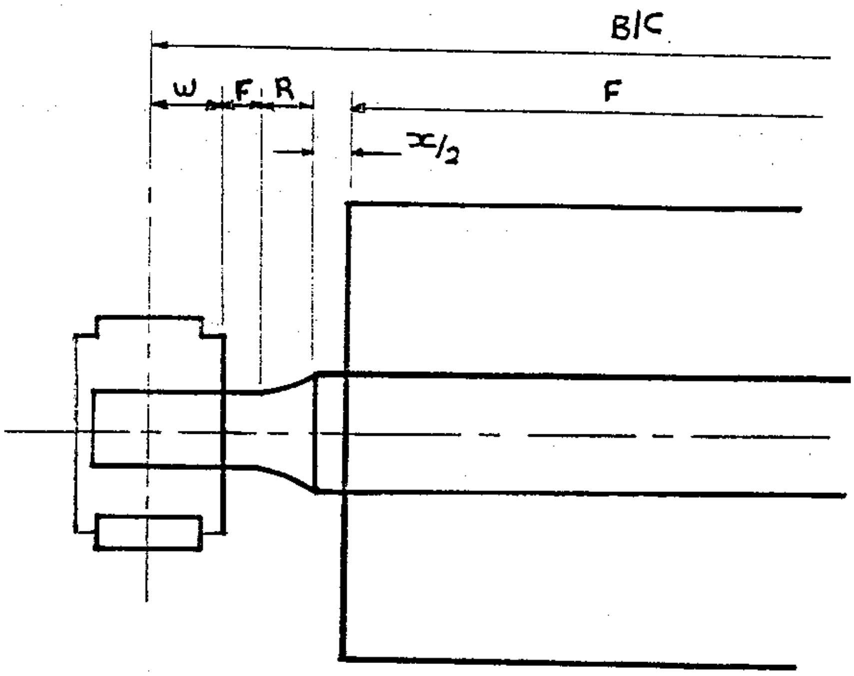
F = Face Width

W = Bearing 1/2 Width

f = Bearing Float Allowance

R = Radius Allowance for Shaft Journal (10% of Shaft Diameter)

x = 40 mm for Shafts greater than or equal to 200 mm diameter due to locking element bolts on the T & L constructions.



Using the above equation and rounding the numbers up to the nearest 10, we arrive at the following table (See Table 7) :-

Shaft dia. (mm)	Belt Width (mm)										
	500	600	750	900	1050	1200	1350	1500	1650	1800	2100
< 50	730	830	1030	1180	1330	1480	1630	1830	1980	2130	2430
< 100	820	920	1120	1270	1420	1570	1720	1920	2070	2220	2520
< 150	890	990	1190	1340	1490	1640	1790	1990	2140	2290	2590
< 200	1000	1100	1300	1450	1600	1750	1900	2100	2250	2400	2700
< 250	1040	1140	1340	1490	1640	1790	1940	2140	2290	2440	2740
< 300	1100	1200	1400	1550	1700	1850	2000	2200	2350	2500	2800

Table 7

If we now consider that for each belt width there will be a certain shaft restriction ie. we could not have a 300 mm shaft in a pulley with a 500 mm belt width. If we limit these diameters as follows then we would be able to arrive at a minimum bearing centre for each belt width.

Belt	500	600	750	900	1050	1200	1350	1500	1650	1800	2100
Shaft	150	150	150	200	200	200	250	250	250	300	300

Also if we require wider bearing centres then we could use the maximum sizes from Table 7 above. The final bearing centres will then be as follows :-

Belt	500	600	750	900	1050	1200	1350	1500	1650	1800	2100
Narr.	890	990	1190	1450	1600	1750	1940	2140	2290	2500	2800
Wide	1100	1200	1400	1550	1700	1850	2000	2200	2350	2500	2800

Table 8

1.4 SHAFT AND BEARING DIAMETERS

The selection of these diameters are an easy task. Since the introduction of locking elements and the ISO standard for bearings we find that the table below adequately covers the available diameters. Some users may choose to restrict the diameters used to facilitate standardization.

Shaft Dia. (mm)	Bearing Dia. (mm)
40	40
45	45
50	50
55	55
60	60
65	65
70	70
75	75
80	80
85	85
90	90
95	N/A
100	100
110	110
120	115
130	125
140	140
150	150
160	160
170	170
180	180
190	N/A
200	200
220	220
240	240
260	260
280	280
300	300
320	320
340	340
360	360
380	380
400	400

Table 9

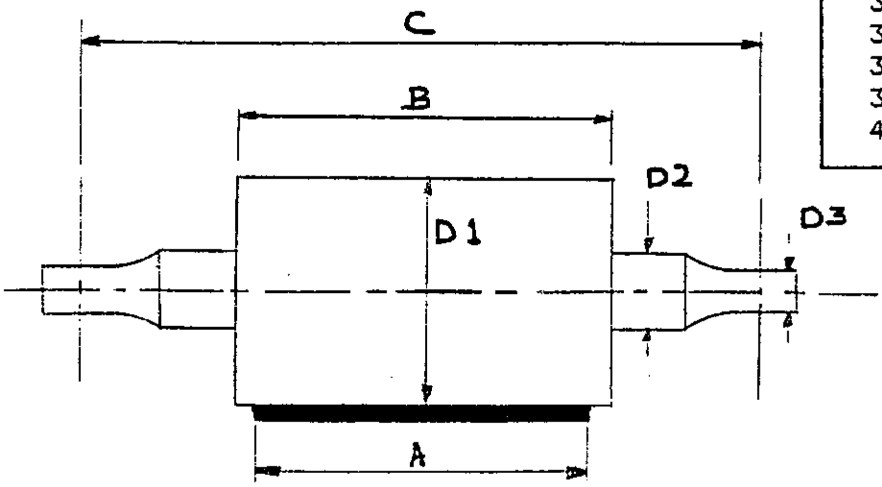
We can therefore summarize the dimensional standard as follows :-

1.5 PROPOSED DIMENSIONAL STANDARD

BELT WIDTH A	FACE WIDTH B	WIDE BEARING CENTER C	NARROW BEARING CENTER C
500	600	1100	890
600	700	1200	990
750	900	1400	1190
900	1050	1550	1450
1050	1200	1700	1600
1200	1350	1850	1750
1350	1500	2000	1940
1500	1700	2200	2140
1650	1850	2350	2290
1800	2000	2500	2500
2100	2300	2800	2800

SHAFT DIA. (mm) D2	BEARING DIA. (mm) D3
40	40
45	45
50	50
55	55
60	60
65	65
70	70
75	75
80	80
85	85
90	90
95	N/A
100	100
110	110
120	115
130	125
140	140
150	150
160	160
170	170
180	180
190	N/A
200	200
220	220
240	240
260	260
280	280
300	300
320	320
340	340
360	360
380	380
400	400

Diameter (mm) D1
200
250
315
400
500
630
800
1000
1250



2. METHODS OF CONSTRUCTION

All the major users agree that the pulleys shall consist of a welded steel shell, hubs and shafts fitted by locking elements or a shrink fit shaft attachment.

Since the duty requirements of conveyor pulleys is vast, varying from resultant loads of less than 1 kN to more than 1000 kN, different installations require varying life expectance and there are associated cost considerations, the pulley manufacturers have found that the following methods of construction adequately cover the requirements in the current market.

2.1. BOSS TYPE PULLEY

2.2. TURBINE TYPE PULLEY

2.3. L-BOTTOM TYPE PULLEY

2.4. T-BOTTOM TYPE PULLEY

2.1. BOSS TYPE PULLEY

The Boss type pulley is specifically suited for light and medium duty applications. These time proven cost effective pulleys incorporate plates fillet welded to mild steel bosses which are fitted to the shaft with an interference fit. Drive pulleys have parallel keys between the shaft and boss where torque requirements necessitate their use.

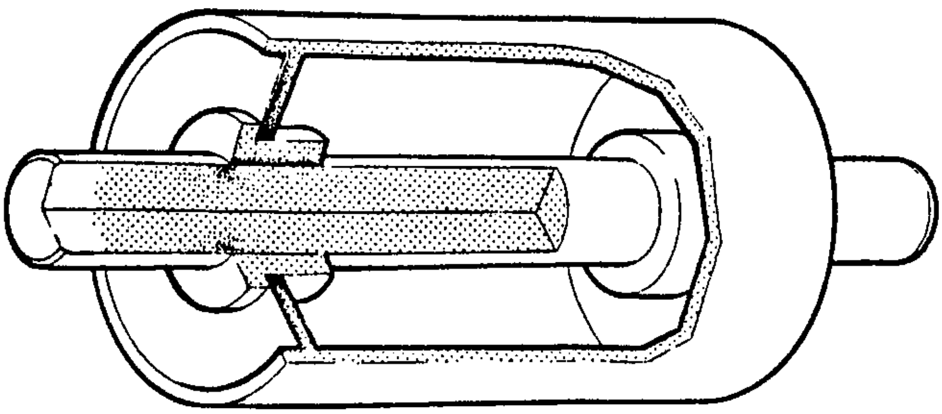


fig. 1.

Figure 1 above shows a typical boss type pulley. The Boss type pulley is available in the following size ranges :-

Diameter	200mm to 1000mm
Belt Width	500mm to 1200mm
Shaft Dia.	40mm to 150mm

ADVANTAGES

1. Low Cost
2. Maintenance Free
3. Shaft Fixed For Life
4. Tolerates Higher Deflection

DISADVANTAGES

1. Shafts Are Not Removable

2.2 TURBINE TYPE PULLEY

This type of construction is well suited to medium duty applications and has the option of a removable shaft. The hub is so designed to allow for the flexion of the end plates, preventing high stresses on the locking assemblies and welds. Care has to be taken in the case of drive pulleys to ensure that the transmittable torque of the locking element is not exceeded.

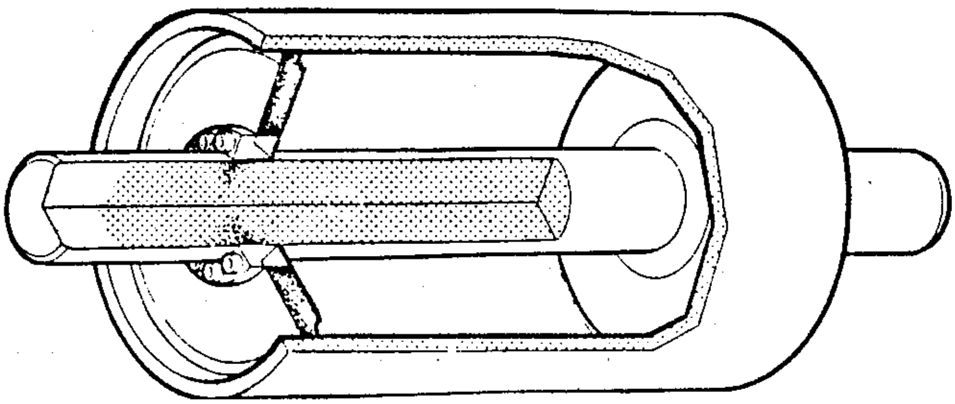


fig. 2.

Figure 2 above shows a typical Turbine type pulley.

The Turbine type pulley is available in the following size ranges :-

Diameter	200mm to 1250mm
Belt Width	500mm to 2100mm
Shaft Dia.	50mm to 260mm

ADVANTAGES

1. Cost Effective
2. Removable Shaft
3. Solid End Plate - No Welds in Shaft area

DISADVANTAGES

1. Locking Element Failure if Overloaded
2. Tolerated Less Deflection Than Boss Type

2.3. L-BOTTOM TYPE PULLEY

The L-Bottom pulley uses the principle that the concentration of stresses in the end plate due to its bending and the close proximity of the weld can be reduced by moving the weld along the face of the pulley.

This type of construction is normally used when shafts are greater than or equal to 200 mm and the pulleys are non-drives or in the case of drives where the torque transmission capacity of the narrow locking element has not been exceeded. This type of pulley can only be used on wide bearing centres. Stress relieving of the hub to shell weld is recommended.

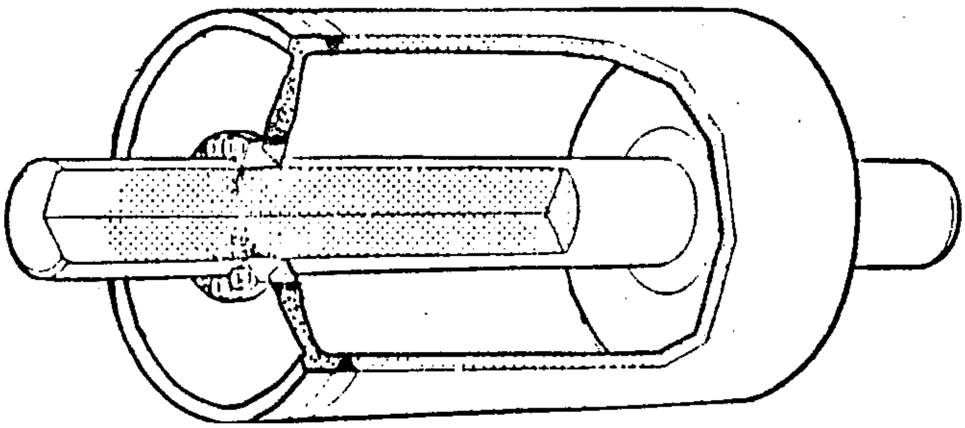


fig. 3.

Figure 3 above shows a typical L-Bottom type pulley.

The L-Bottom type pulley is available in the following size ranges :-

Diameter	200mm to 1250mm
Belt Width	500mm to 2100mm
Shaft Dia.	50mm to 300mm

ADVANTAGES

1. Removable Shaft
2. Solid End Plate - No Welds in Shaft area
3. Shell Weld is in a Low Bending Stress area

DISADVANTAGES

1. Locking Element Failure if Overloaded
2. Tolerates Less Deflection Than Boss Type
3. Difficult to Handle since it has no Lip
4. Locking Element Bolts Protrude past Face

2.4. TAS 3015 T-BOTTOM TYPE PULLEY

The T-Bottom pulley uses the same principle as the L-Bottom pulley namely the face welded end plate.

This type of construction is normally used when shafts are greater than or equal to 200 mm and the pulleys are drives where the torque transmission capacity of the TAS 3006 locking element has been exceeded and we have to employ the higher torque carrying capacity of the wider locking element.

Since this type of construction is particularly well suited to heavy duty applications it is not uncommon to use this type of pulley for non-drive pulleys as well as the drives referred to above.

This type of pulley can only be used on wide bearing centres. Stress relieving of the hub to shell weld is recommended.

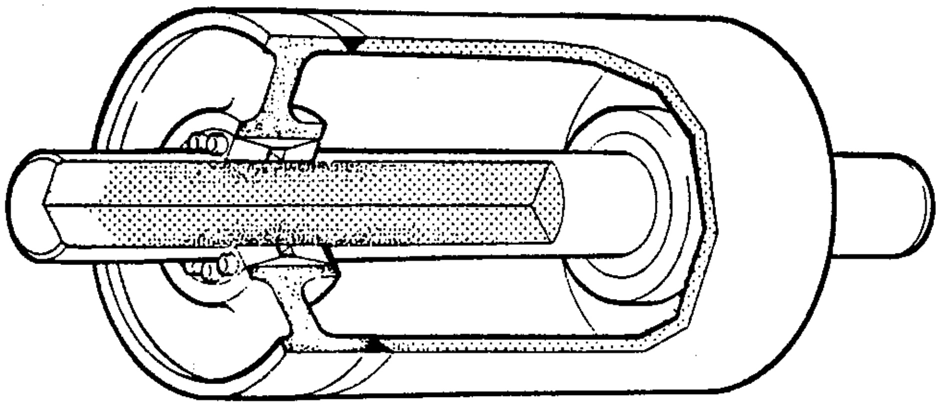


fig. 4.

Figure 4 above shows a typical T-Bottom type pulley.

The T-Bottom type pulley is available in the following size ranges :-

Diameter	200mm to 1250mm
Belt Width	500mm to 2100mm
Shaft Dia.	100mm to 400mm

ADVANTAGES

1. Heavy Duty
2. Removable Shaft
3. Solid End Plate - No Welds in Shaft area
4. Shell Weld is in Low Bending Stress area

DISADVANTAGES

1. Expensive
2. Tolerates Less Deflection Than Boss Type
3. Locking Element Bolts Protrude past Face

3. CROWNING

The crowning of pulleys is a very controversial subject. Observations indicate that the crowning of all pulleys on short centre conveyors is most beneficial to assist in the tracking of the belt. On medium length conveyors it is a help and definitely does effect the tracking of the belt up to 15-20m from the crowned pulley. However on long conveyors, it only assist local to the pulleys.

These observations bear out the argument that crowning is added to a pulley, not to make the belt run true, but to keep the belt from running off the pulley due to pulley misalignment. This happens due to the fact that the belt will always move onto the high spot on the pulley.

When using steel cord belts one should limit the amount of crowning since the degree of crowning will proportionally increase the stress in the belt.
The methods of crowning currently in use are:-

1) Full Crown.

This is from the centre line of the pulley to the outer edge at a ratio of 1:100. It is suitable for narrow belts.

2) Strip Crown

This is from the first third and last third of the face to the outer edge at a ratio of 1:100 with the centre flat. It is suitable for wider belts.

4. LAGGING

When it comes to the lagging of pulleys, most users specify similar properties of hardness and thickness. There is some difference in spacing of the grooves on chevron and diamond lagging.

Grooving of lagging is normally only done on drive pulleys. It is worth the extra cost. When a conveyor is carrying wet, moist or sticky material there is always a skin of slime or slurry which flows from the carrying side to the underside of the belt as the belt flexes into the shape of the troughing idlers.

The grooving can be either diamond pattern or take the shape of herring-bone or chevron pattern cut into the lagging.

Their purpose is to improve traction between the belt and the pulley by removing the slime or slurry from the belt. The interface pressure squeezes dirt down the grooves and off at the ends of the pulley face. This self cleaning action is improved with the herring-bone type, in preference to the diamond pattern. The hardness of lagging on drives should be +-70 Shore A.

Lagging used on snub or bend pulleys on the other hand, which contact the dirty carrying sides of the belt, should be much softer, say +-50 Shore A. This softer rubber recovers and expands thus flaking off a good proportion of the dirt picked up. Also it allows any trapped hard solid object to inbed in the lagging rather than in the belt.

When conveying abrasive materials such as coke, it also pays well to lag snub pulleys behind the discharge pulley, also those before and behind the drive pulley of an underneath drive. It is also good practice with coke to rubber cover all pulleys and return idlers to reduce abrasive wear on pulley faces.

We believe that the following specification will adequately satisfy all users and also will conform to the standard used by lagging contractors.

PULLEY TYPE	PATTERN	HARDNESS (shore)	LAGGING THICK(mm)	TYPE
Drive	Diamond	70+-5	12	Natural Rubber
Drive	Diamond	50+-5	12	* Neoprene
Drive	Chevron	70+-5	12	Natural Rubber
Drive	Chevron	50+-5	12	* Neoprene
Non Drive	Plain	55+-5	10	Natural Rubber
Non Drive	Plain	50+-5	10	* Neoprene

Table 12 (* = Flame Resistant)

5. BEARING / PLUMBER BLOCK SELECTION

Since all the leading bearing manufacturers conform to an international standard regarding all the major aspects of the plumber blocks and bearings we will adopt their standards. The only area where some differences occur are in the sealing arrangements and types.

The major users vary slightly in their specifications regarding the following :-

1. L10 life
2. Standard Sizes
3. Brand Names to be used
4. Use off 22 Series or 23 Series
5. Use of Hydraulic Sleeves
6. Type, Size and Quantity of Grease Nipples.

In order for us to develop a universal standard and based on the current trends in the market we propose that the following becomes the standard for Bearings and Plumber Blocks :-

1. L10 life of 100 000 hours.
2. All below 150 mm Diameter are 22 Series Bearings with 2 hole fixing of the Housings.
3. All 150mm Diameter and above are 23 Series and Hydraulic Sleeves with 4 hole fixing of the Housings.
4. All Housings fitted with Labyrinth Seals

5. 1/8" BSP Grease Nipples, one for the bearing and one to flush each Labryinth seal.
6. All housings must be fully charged with grease to prevent moisture ingress into the housings during site storage.

6. QUALITY STANDARDS

All the major users specify some form of quality standard regarding welding, NDT, Stress Relieving, dimensions and balancing.

As a manufacturer we believe the following to be the minimum quality requirements of our clients.

1. An Approved Quality System - SABS 0157 Part II

2. Welds performed by Qualified Welders to proven procedures which include ultrasonic tests and stress relieving where necessary.

3. Dimensional inspections be carried out on all stages of manufacture and recorded to ensure that they conform to specifications.

4. All materials are certified and traceable to approved specifications.

5. All materials are 100%ultrasonically tested for soundness and recorded.

6. Shafts over 150mm in diameter are heat treated.

7. CONCLUSIONS

By adopting these proposals the users of Conveyor pulleys will benefit as a result of the following :-

1. Rationalized Pulley Sizes and Types.
2. Smaller range of spare pulleys to be kept in stock.
3. Consistency in the pulleys.
4. A more cost effective pulley.
5. A Quality Product.

Although the proposed standard shows size restrictions, one must bare in mind that it caters for all normal pulley applications and that all special applications will have to be verified by a pulley manufacturer.

8. REFERENCES

1. Secunda Specification TAA

2. Secunda Specification SSP 01 001

3. AAC Specification 371/1

4. Allanson and Warman Specification RTMS

5. Escom Specification NWS 1556

6. Genmin Specification ECM 009

7. Genmin Specification ECM 006

8. ISO 1536 - 1975 (E)

9. Iscor Specification CSP/3910/7 Part 2

10. TAS Schafer Locking Element Catalogue

11. Bosworth Holdings Conveyor Pulley Standard BH/STD1 1989

12. Recommended Practice for Troughed Belt Conveyors