BELTCON 6

CONVEYOR IDLER STANDARDS

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IMHC

INTERNATIONAL MATERIALS HANDLING CONFERENCES

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1.0 INTRODUCTION:

Conveyor idler standards, who sets them, what they are and what they should be.

Prior to 1980 local conveyors were fitted with idlers manufactured to various American and European standards.Each idler manufacturer produced idlers with unique dimensions and roll fixing arrangements. In general the company who was responsible for the original equipment supply was ensured of a captive market for replacement spares. The users, who over the years installed idlers emanating from various manufacturers on different conveyors within their plant, had to keep a multitude of non-interchangeable idlers and spare rolls in stock for maintenance purposes. This resulted in the user incurring high inventory costs and suffering from high obsolescence costs as critical dimensions changed with time.

The need for a standard became obvious, and thus SABS 1313 was created in 1980.

As to who sets the standard, SABS 1313 was intended to suit the individual needs of all interested parties. This was achieved by utilising a forum whose delegates were drawn from:

- USERS
- SUPPLIERS
- NATIONAL STANDARDS ORGANISATION.

This paper discusses the current contents of SABS 1313, 1980 and suggest areas where improvements are possible to further enhance the standard.

2.0 SABS 1313 - THE CURRENT STATUS:

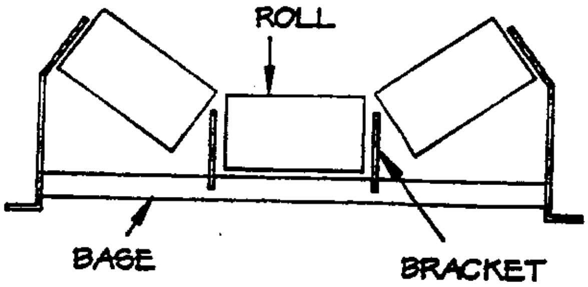
2.1. FUNDAMENTAL DEFINITION:

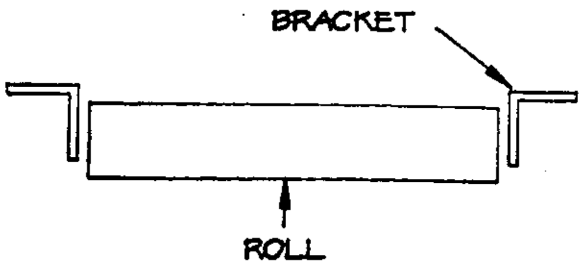
Prior to analysing the various elements it is important that the nomenclature "IDLER" as defined in SABS 1313 is clearly understood.

2.1.1 The idler is defined as the complete assembly comprising the base and or brackets and roll or rolls.

2.1.2 The roll is defined as the revolving, cylindrical part of an idler, complete with shaft, bearings and seals.

The basis of the definition is illustrated below:





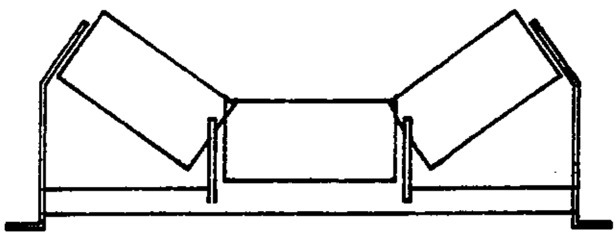
In many cases this basic definition is not clearly understood or applied and often the purchaser's request is for an idler although his requirement is for a roll only.

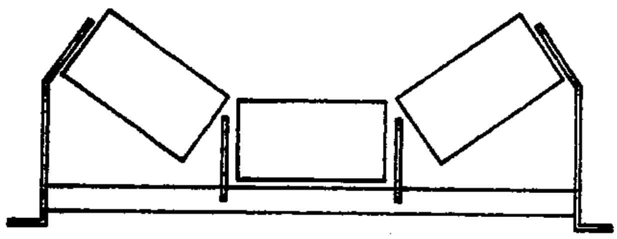
2.2 RANGE OF APPLICABILITY:

The existing South African Standard covers the dimensional specification for both carrying side and return side conveyor idlers for belt widths 400mm to 2400mm.

The following idler types are considered.

2.2.1 3 Roll Trough and Impact in both offset and in-line configuration.

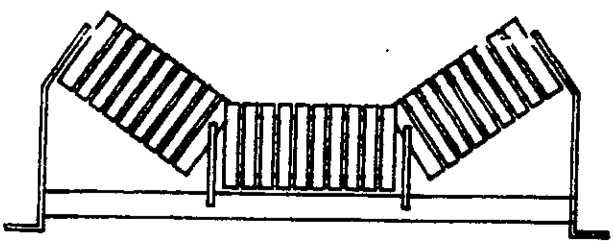


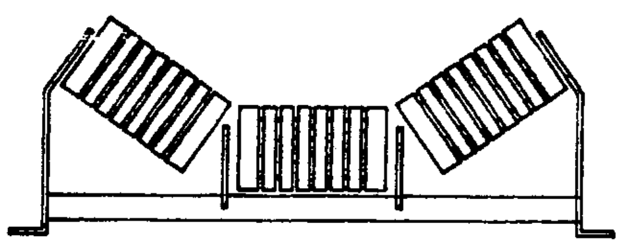


OFFSET CONFIGURATION

IN LINE CONFIGURATION

3 ROLL TROUGH



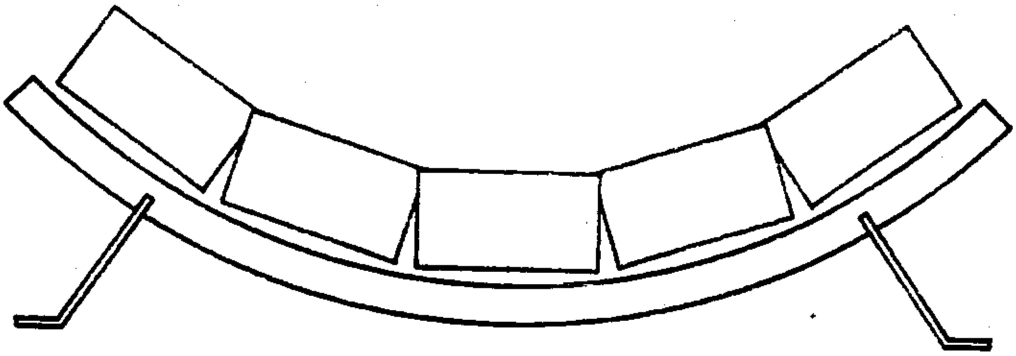


OFFSET CONFIGURATION

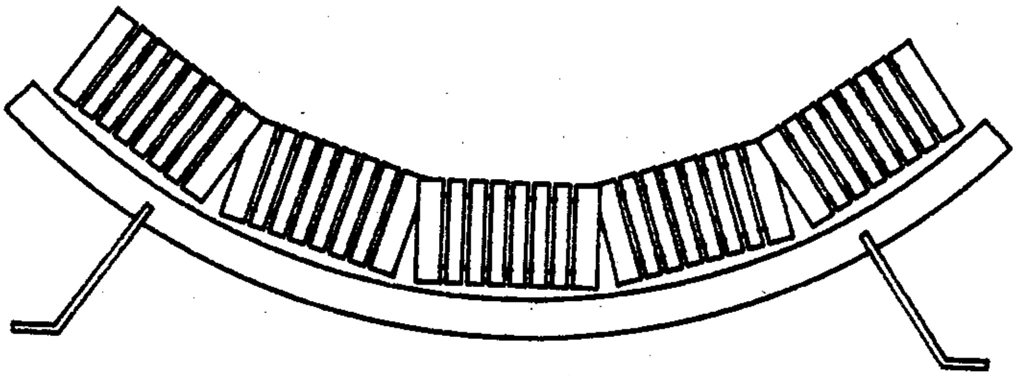
IN LINE CONFIGURATION

3 ROLL IMPACT

2.2.2 5 Roll Trough and Impact in offset configuration.

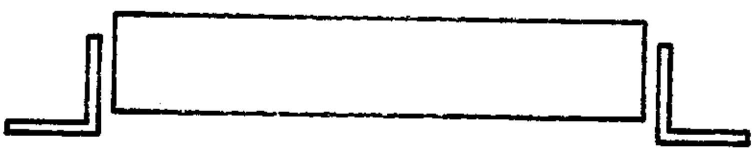


5 ROLL TROUGH IDLER



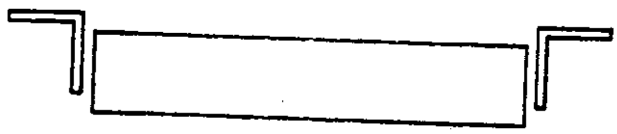
5 ROLL IMPACT IDLER

2.2.3 Flat, single roll carrying idler.



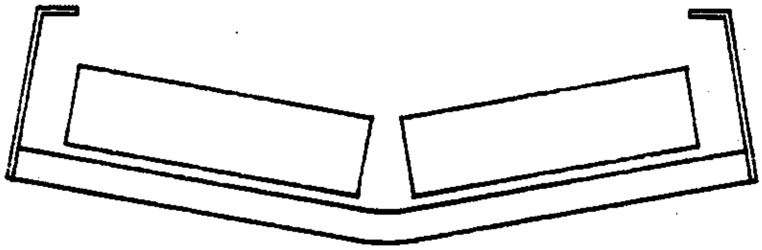
FLAT CARRYING IDLER

2.2.4 Single Roll flat return idler.



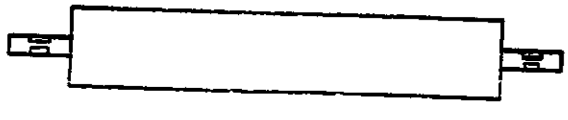
FLAT RETURN IDLER

2.2.5 Two roll V Return idler.



V RETURN IDLER

2.2.6 "SPECIAL" return roll - more commonly known as underground or Colliery return roll. The face length and shaft length of this type of roll are longer than the standard for the specific belt size and was designed to facilitate the training of the return belt in underground applications. The nomenclature 'special' should not be used in a standard and it is recommended that this be replaced by 'extended'.



EXTENDED RETURN ROLL

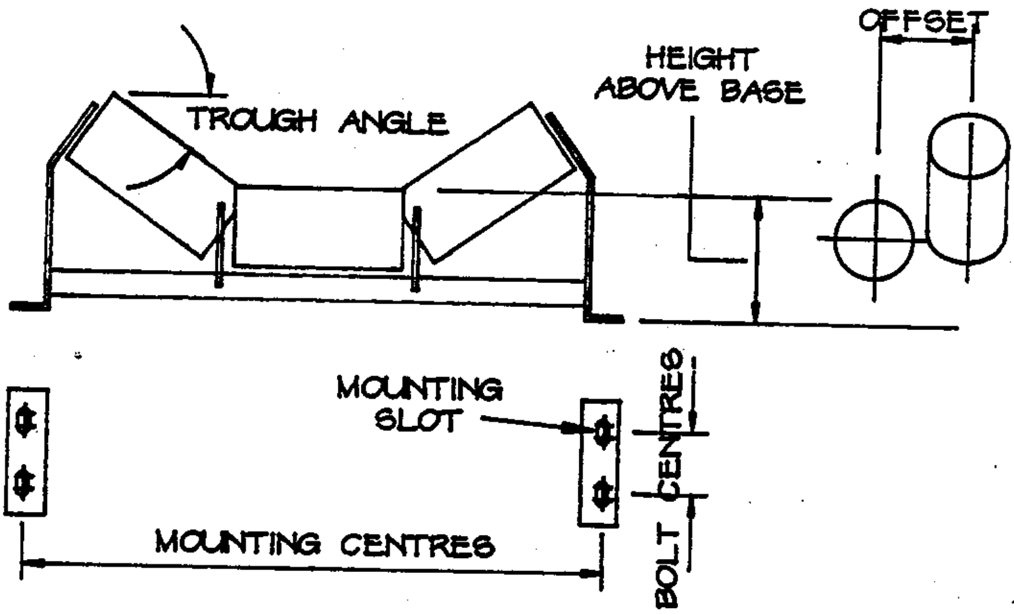
2.3 DIMENSIONAL SPECIFICATIONS:

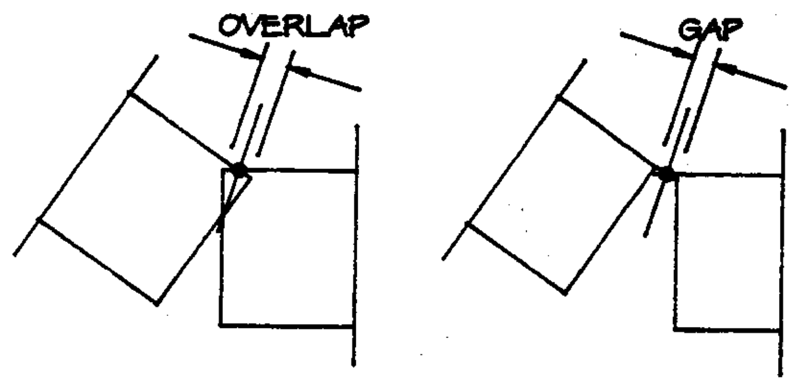
Having defined the various idler types consider now the dimensions specified in SABS 1313 to ensure interchangeability.

2.3.1 IDLER:

The dimensions defining the idler are dependant on belt size and roll type. The following dimensions are specified:

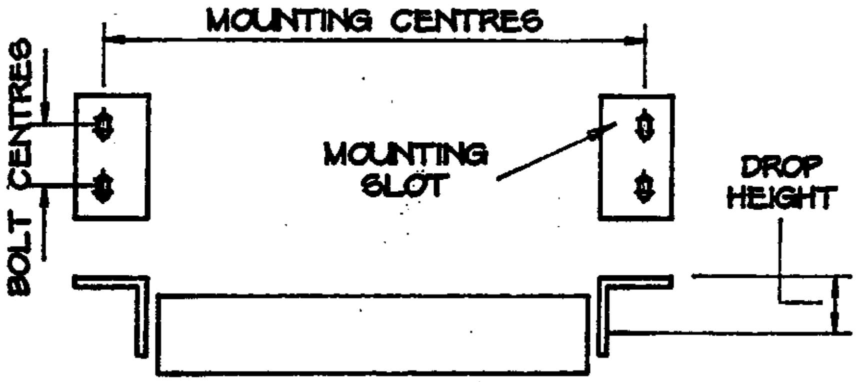
2.3.1.1 CARRY SIDE:

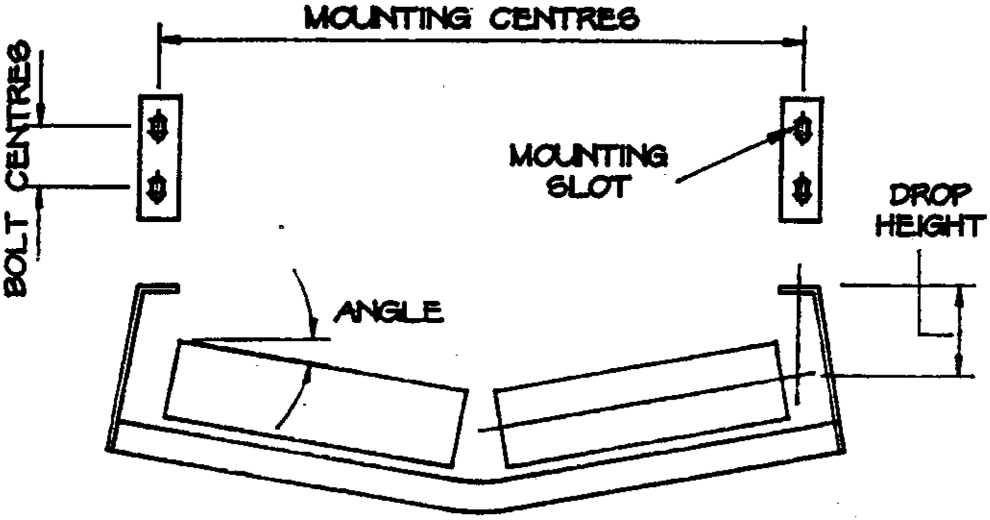




- MOUNTING CENTRES - Dependant on belt size.
- FIXING DIMENSIONS - Dependant on belt size and roll series
  The length and diameter of mounting slot is defined.
- TROUGH ANGLE - Note that the angles specified are 20°, 25°, 35° and 45° for the offset configuration and only 35° or 45° for the in line configuration.
  The problem with in line idlers is that for smaller troughing angles the gap cannot be maintained.
- HEIGHT ABOVE BASE - Dependant on roll diameter and series.
  Note that the roll height is different for in line and offset configuration.
- GAP BETWEEN ROLLS - (IN-LINE)
- OVERLAP BETWEEN ROLLS (OFF SET)
- SPACING OF OFFSET ROLLS

2.3.1.2 RETURN SIDE:



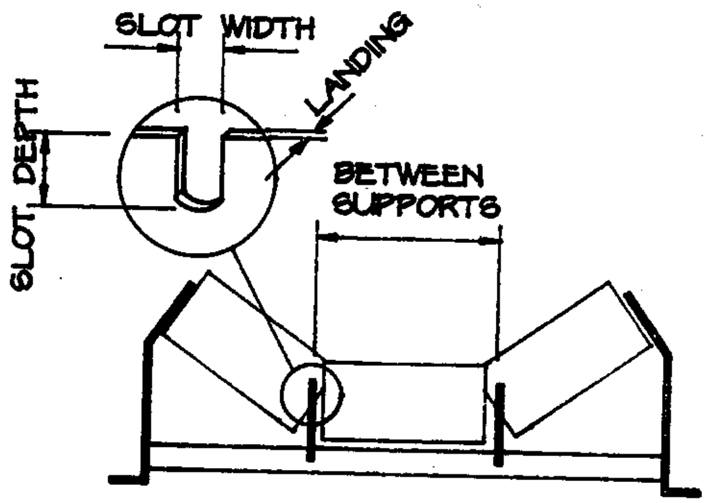


The same basic dimensions as per carry side idlers are defined. The roll height below the base is now defined as drop height. The dependancy of roll diameter on roll height is removed by defining the drop height as the dimension between the support point and the centre line of roll shaft. There are two angles specified for the V return, 5° and 10°.

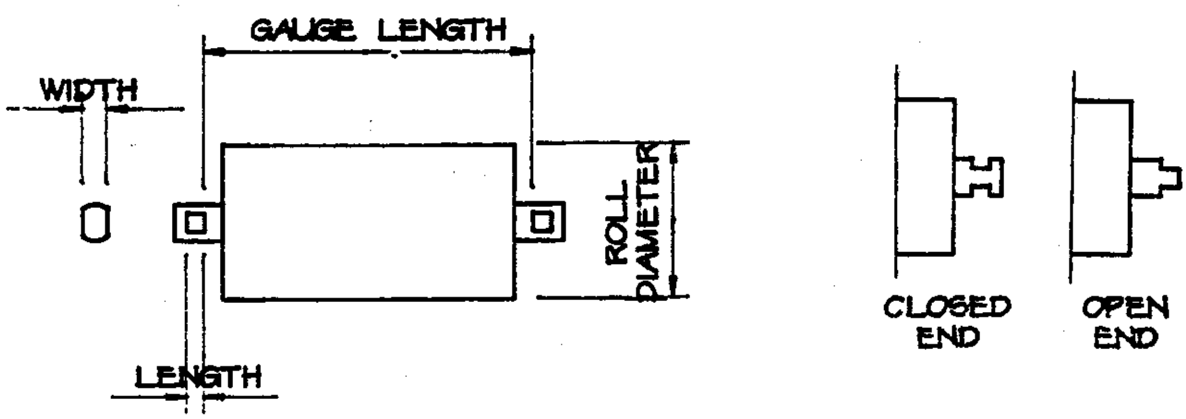
2.3.1.3 BASE:

The configuration of the base is basically defined by the configuration of the complete idler and only two other dimensions are specifically defined.

- THE GAP BETWEEN ROLL SUPPORTS (a function of roll dimensions)
- THE ROLL SUPPORT where the following are defined:
  - slot depth
  - slot width
  - landing



2.3.1.4 THE ROLL:



- The basic dimensions defining the roll are:
- ROLL DIAMETER - Rolls in accordance with SABS 1313 are restricted to those manufactured from tubing in accordance with SABS 657 part III, which ensures minimum standards of ovality and straightness. The currently listed diameters are 102, 127, 152, 165 and 178mm. The standard defines a minimum wall thickness with actual wall thickness being left open. It is recomended that a range of standard wall thicknesess applicable to each diameter be created to eliminate the current trend in variations to purchaser required wall thickness (e.g. 3,5; 3,8; 4; 4,5; 5; 6,3mm)
- GAUGE LENGTH - distance between the inner shoulders of the flats of the roll shaft ends.
- SHAFT ENDS - defined by length and width of flats in either open end or closed end configuration as illustrated above. These dimensions vary in accordance with the roll series specified.

- SERIES - is defined by the nominal shaft diameter. In general the "series" should give an indication of the load carrying capacity of the roll. However the current definition is not specific and it is generally accepted that "series" relates to the diameter of the shaft at its ends and ensures correctness of fit between roll and bracket. For example, a roll having 30mm diameter bearings but turned down at its ends to suit roll support for a 25mm diameter shaft would be termed a series 25. This definition is required to be more specific.

The currently defined series are 20. 25. 30 and 40. There is a trend towards series 35 and the range should be extended to include for this. Note that a series 30, 127 diameter roll does not form part of the current standard, although many of these rolls are in use. The range should be further extended to include for this.

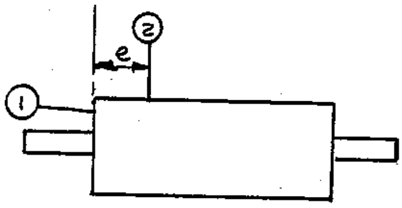
2.4 PERFORMANCE:

The only topic related to performance in the current standard is that of TOTAL INDICATED READING - T.I.R.

This is defined as; T.I.R. (max) = L/600 + 0,55.

With a maximum reading of 0,5mm at the roll ends.

As roll ends are not defined there could be misunderstanding as to where to measure the T.I.R. e.g.



It is assumed that the reading at the roll ends is to be taken at point 2. The point or range over which this measurement should be taken must be defined by specifying dimension "e". The specification should also include some allowance for the possibility of taking measurements at points where surface irregularities of the tube exist.

Minimisation of roll runout is important in roll and indeed conveyor belt performance in that:

a) A reduction in runout implies a reduction of out of balance forces acting on the bearings hence resulting in improved roll performance.

b) Roll Runout has a significant influence on belt vibrations, which result in additional loads on both the supporting structure and the idler rolls. Additional loads which are often neglected and difficult to account for in the design process.

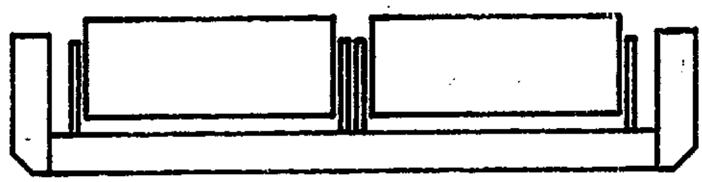
2.5 QUALITY:

The dimensions used to specify the idler, base or roll are allowed to vary within specified tolerances.
The current specification defines the size of sample to be inspected dependant on the lot size submitted for inspection.

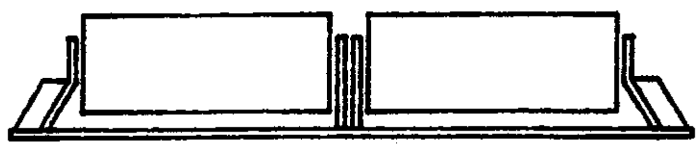
3.0 EXTENSIONS TO THE RANGE:

Although the range discussed in section 2.2 is extensive, there is a need, as established by purchaser requirements, for additional items to be included.
Some of the more common, which could be relatively easily included by utilising the existing roll dimensions and the addition of relative belt line dimensions are:

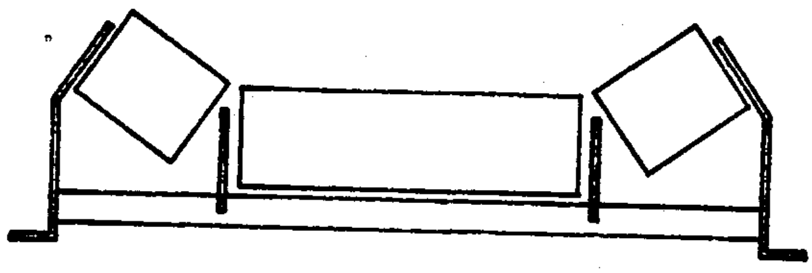
- Two roll flat return idler:



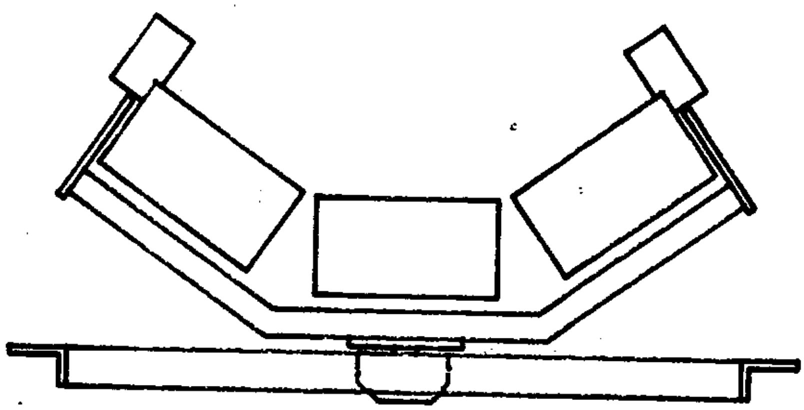
- Two roll flat carry idler:



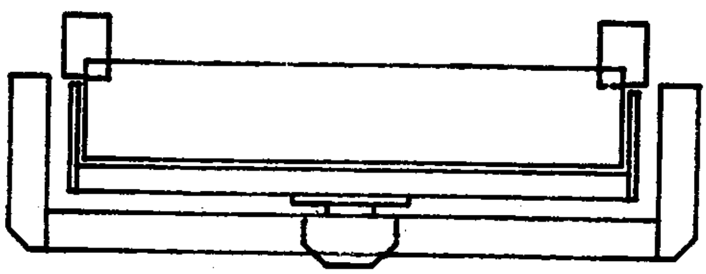
- Picking idlers:



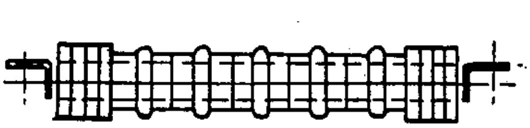
- Trough Training idlers:



- Return Training idlers:



- Rubber disc return idlers.

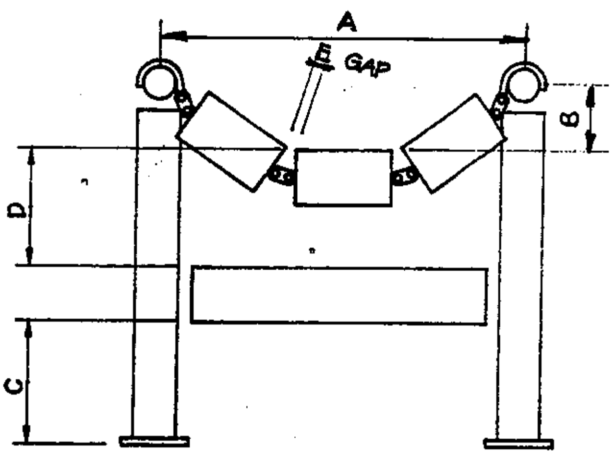


3.1 COLLIERY REQUIREMENTS:

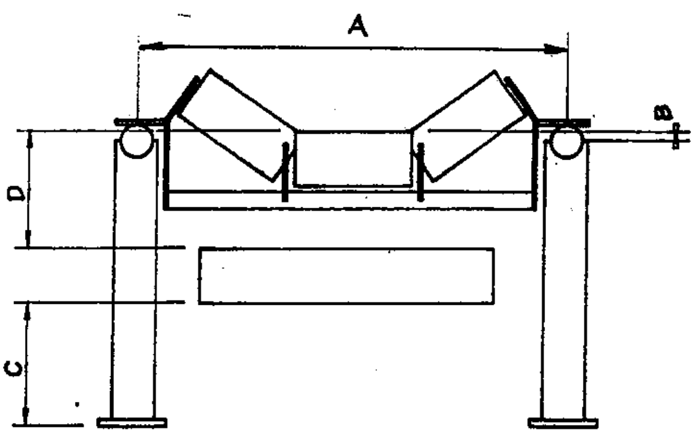
The largest single user of conveyor idlers is the underground coal mining industry. Their need for continuous production and frequent movement of conveyors between operating sections requires a constant availability of replacement idlers.
The need for a specific standard applicable to idlers operating on these conveyors has been partially addressed by the introduction of the "special" return roll in SABS 1313.

Apart from the standard trough idlers defined in SABS 1313 there are generally two other idler types utilised on the carrying side. These are:

- the suspended or garland type idler where the use of a base is eliminated and the rolls are interlinked and supported on the structural elements by means of suitable fixings.
- the underslung fixed form trough idler where the belt line is below the base mounting point.



TYPICAL GARLAND SYSTEM



TYPICAL UNDERSLUNG SYSTEM

Garland idler users have been plagued with the problem of varying belt heights when using garland idlers supplied by different manufacturers.

The illustrations show that interchangeability of idlers can be ensured by defining:

- Type of fixing
- Mounting centres
- Drop Height

In fact the supporting structure could form part of the specification by including:

- Dimension between trough and return belt
- Minimum return belt height

3.2 OTHER MATERIALS:

SABS 1313 currently covers only steel rolls produced ex tube to SABS 657, the only variation being for impact idlers.
In the case of impact idlers variations in dimensions in rubber disc diameters used by various manufacturers is included for by allowing for a broad tolerance band in the specified belt height dimensions.
In order to ensure some conformity the diameter and possibly the properties of the rubber compound used should be specified.
There has also been a trend to produce rollers ex polymer material and the specification should be extended to include for non-metallic rolls.

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4.0 IDLER STANDARDS - WHAT SHOULD THEY BE ?

A standard should be such as to ensure that the manufacturer and the user have clear,unambiguos specifications which are based upon realistic requirements which can be uniformly applied.

To summarise the standard should:

(i) Ensure dimensional interchangeability.

(ii) Ensure that the product is suitable for the application i.e. performance and design standards.

(iii) Ensure that the product is manufactured to acceptable standards of quality.

As discussed in the previous section the question of dimensional interchangeability is generally well covered in the existing SABS 1313. However, the greatest failing of the existing specification is that it can be considered as ONLY a dimensional specification. There are basically no guidelines as to design and performance standards nor are the quality requirements adequately covered.

This has led to the creation of numerous individual user standards which account for the missing specifications in the current SABS 1313. Where user standards are unavailable the idler supplier is generally asked to supply idlers in accordance with SABS 1313 and the final decision as to contract award is based solely on commercial criteria.

After all, " the items are produced to a nationally acceptable standard and are therefore equal." A true statement, only if performance, design and quality criteria were included in the SABS 1313 standard.

The following is a list of recommendations for inclusion or amendment to the existing standard.

4.1 DESIGN STANDARDS:

4.1.1 IDLER LOAD:

The importance of having a unified formula for establishing selection parameters has been clearly illustrated in previous Beltcon papers (e.g. paper presented by A MATTHEE at BELTCON 5).

The formula for idler load must account for the following elements:

- Mass of material transported.
- Mass of the belt.
- Mass of the roll.
- Additional loads due to vertical misalignment.
- Additional loads imposed in convex curve zones.
- Additional loads due to dynamic effect.

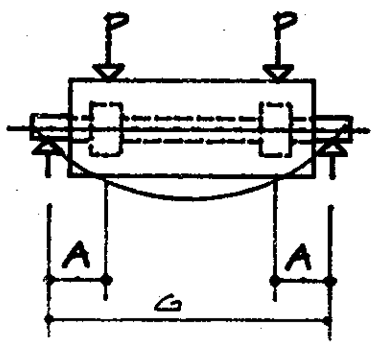
4.1.2 ROLL - SHAFT/ BEARING SELECTION CRITERIA:

Idler rolls are generally selected on the basis of:

- minimum calculated bearing life.
- maximum allowable shaft deflection.

The two criteria are interdependant in that the amount of deflection between the inner and outer race of the bearing has a significant effect on bearing life.

4.1.2.1 SHAFT DEFLECTION:



The shaft deflection is dependant on the distance between roll support points and the distance between bearing centre line and the adjacent support point. Although the distance between support (G) is specified in SABS 1313 (gauge length) dimension A is not constant and is dependant on the sealing system utilised by the various roll manufacturers.

The following maximum allowable shaft deflections, based on bearing supplier's specifications and allowing for assembly tolerances, are recommended.

"SEIZE RESISTANT" BALL BEARING: 10 minutes

DEEP GROOVE BALL BEARING C3 CLEARANCE: 6 minutes

TAPER ROLLER BEARING: 2 minutes

4.1.2.2 SHAFT BENDING:

In critical applications the selected shaft diameter (based on the deflection criterion) should be checked to ensure that the maximum allowable bending stress is not exceeded.

4.1.2.3 BEARING LIFE:

In general the load carrying capacity of an idler, due to the dependency on belt speed, is defined by the calculated bearing life.

In general the ISO formula for calculating bearing life, based on endurance limit, is used.

No limits of acceptability are stipulated in SABS 1313 and manufacturers base their design on individual user specifications. The figures used in the South African market are in the range of 75 000 hours to 100 000 hours. These differ substantially from the European Specifications of 25 000 to 30 000 hours, with 50 000 hours being used in critical applications.

The European figures are the more realistic as grease manufacturer's specified grease life does not generally exceed 30 000 hours. Calculated bearing life would obviously decrease with decreasing lubricant efficiency.

There is a general reluctance amongst local users to accept the European standards. This is probably due to:

- lower levels of conveyor installation maintenance.
- lack of confidence in idler supplier meeting the required manufacturing tolerances to ensure optimum bearing life.

It is therefore suggested that the design criterion for bearing life be based on a compromise limit of 50 000 hours.

In general bearing failure in idler rolls occurs by the ingress of contaminants into the bearings and not by fatigue (endurance limit) failure.
This was the basis for the design of the S.K.F "seize resistant" type bearing which shows increased life characteristics (when compared to the standard deep groove bull bearing range) when used in contaminated conditions. S.K.F have developed formulae, applicable to the seize resistant range, which account for this (wear) mode of failure. These formulae generally tend to yield more realistic results than the conventional bearing life formulae. As the use of these bearings, particularly in the series 25 idlers, are in general use, it is recommended that they form part of any design standard.

4.1.3 IDLER BASE:

The rigidity of the idler base has a significant influence on idler and overall belt performance. Most users have recognized this and specify a maximum acceptable deflection of the load carrying member in their specifications.
It is recommended that general steelwork design practice be used and that the maximum deflection be limited to the lower of 1/360 or 5mm (where 1 = free length of load carrying member).

4.2 PERFORMANCE STANDARDS:

Once an idler has been designed to perform under the specified load conditions and selected in accordance with the applicable dimensional specifications the user's final selection should be based on some measure of performance.
In general the relative performance of idler rolls may be compared by testing for the attributes required for good performance viz:

- Maximum ease of rotation
- Maximum seal efficiency

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4.2.1 ROLLING RESISTANCE:

The rolling resistance of an idler roll i.e. its frictional resistance to movement under load, is dependant on the roll diameter to bearing diameter ratio, the operating speed, the load on the roll, and factors specifically applicable to individual roll design such as internal resistance due to seal construction.

Maximum values of rolling resistance should be specified so as to ensure the accuracy of conveyor belt designs. It is recommended that DIN 22112, which includes a table of maximum values based on roll diameter be used as a basis for creating a local standard. Modifications would be required to account for the range of locally available tubing which is different to that specified in the DIN standards.

4.2.2 SEAL EFFECTIVENESS:

Methods of testing the effectiveness of the seal in dusty and wet conditions are also defined in DIN 22112. There is however no definition as to the acceptable limits of contaminations when the roll is subjected to the specified conditions Thus the results obtained from the test may only be used as comparative figures between different types of sealing arrangements.

Ultimately the selection of the sealing arrangement is a compromise between maximum seal efficiency and minimum rolling resistance and would be dependant on prevailing operating conditions.

Therefore the only inclusion in the SABS specification should be a description of the methodology required for testing the seal effectiveness.

4.3 STANDARDS OF MANUFACTURE:

Having defined the required dimensions and applicable tolerances and the minimum acceptable limits of design and performance, the standard should also include specifications as to the acceptable standards of manufacture.

Items to be addressed should include:

IDLER BASE:

- Minimum material specification
- Welding specification.

IDLER ROLL:

- Tube material specification.
- Shaft material specification.
- Welding specification.
- Bearing seat tolerance on the shaft.
- Locating tolerance of bearing in bearing housing.
- Maximum allowable shaft axial float.
- Total Indicated Runout.

As previously discussed the reduction of Total Indicated Runout is important to the overall performance of the idler and is probably the most debated issue between users and manufacturers. In establishing mutually acceptable limits consideration should be given to:

- influence of belt speed on T.I.R. limits imposed.
- tolerances of the available tubing (e.g. the straightness tolerance on tubing could account for 2mm T.I.R. at the centre of a 1 m long roll).

5.0 CONCLUSION:

The local idler standard, SABS 1313 1980, has served its purpose in establishing a basis for the dimensional specification, hence ensuring the interchangeability, of conveyor idlers.
The standard is currently under review by a commitee comprising users, manufacturers and the South African Bureau of Standards.
A preliminary revised standard incorporating design, performance and manufacturing specifications has been published and its eventual implementation will ensure that the manufacturer produces a product which is readily acceptable to the user.

6.0 ACKNOWLEDGMENTS:

The authors extend their thanks to the management and staff of the Melco Group of Companies for their assistance in the preparation of this paper.