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STANDARDS AND THEIR EFFECT ON CONVEYOR SYSTEMS

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BELTCON 6

STANDARDS AND THEIR EFFECT ON CONVEYOR SYSTEMS

Whilst numerous standards from various origins apply to conveyor systems are frequently specified, it can be seen that some are in conflict and others are open to interpretation.

One of the more noticeable areas of conflict or should we say terminology is that of the surcharge angle as specified in DIN and that specified in ISO, CEMA etc., were the angle value is calculated differently and therefore volumetric capacities for the same angle are some 50% in variance.

There are a number of areas such as this where DIN, ISO, CEMA approach items in a different manner and here in South Africa we really need to determine what our standards will be.

There are also areas where standards are not readily available or are weak and require revision to give to control we desire to the equipment supplied.

This paper looks at 2 main aspects where the latter is the case and attempts to highlight the problem areas. These areas being that of idlers and their supporting structures.

For years consumers have been plagued by premature idler roll failures and installations in which the belts refuse to train. They have lived with seal failure, bearing failure and roll failure.

The industry has attempted to correct the situation by specifying the L10 life of the idler roll bearings, specifying the bearings themselves, specifying the maximum allowable deflection in the shaft. They have specified shaft tolerances, end float, the run out on the roll diameter, yet failures still persist.

What we all possibly fail to do is to look at the root cause of the failures or the contributing factors.

DESIGN REQUIREMENTS

What is the information required to correctly select an idler roll, its bearings, its shaft diameter and its life expectancy. Normally a client will specify the following :

1. Required L10 life

Occasionally he will specify :

2. Roll diam.
3. Shaft diam.

Infrequently he will specify :

4. Bearing type
5. End float
6. Overseas spec requirements (DIN etc)

A contractor will approach the idler manufacturer and further specify or give additional information :

7. Belt speed
8. Carrying capacity
9. Mass of the belt
10. The idler pitch

The idler manufacturer will then calculate the load conditions of the idler roll from the information supplied and will make his recommendations and offer of supply accordingly. If we are lucky he will have made additional assumptions which will have a dynamic effect on the idler rolls which will make his L10 calculations a little more realistic.

But has the information given to the manufacturer been adequate to allow the manufacturer to make his selections confidently?

The answer to this question is most equitably no.

The answer where we initially went wrong we must look at what the manufacturer has done with the information and what assumptions he has made.

When the contractor gives the handling rate in tons per hour and the belt speed, the manufacturer assumes that at this rate the belt will be full. He then proceeds with his calculations using a centre roll loading factor of 67% (in the case of 3 roll idlers) or 47% in the case of 5 roll idlers. If the conveyor is to carry different materials or the same material at different densities, i.e. varying moisture content, this information is vital to the calculation since the loading factors vary tremendously as the conditions change.

OVERLOADING

What is the possibility of overloading the conveyor?

We can define overloading in 3 ways as follows :

1. Deliberate overloading to increase production of the plant (Continuous)

2. Accidental overloading due to abnormal circumstances (Infrequent)

3. Feed rate is an average and the feed generates slugs of material along the length of the belt (Continuous)

In all the above cases the spare carrying capacity of the belt allows overloading conditions to persist relatively un-noticed by the operator or maintenance team.

The effect of overloading through condition 3 are easily overlooked, but it should be remembered that to achieve an average of 2000 tons per hour, peaks of the equivalent of 2400 or 2600 tons per hour may be occurring in the slugs allowing permissable shaft deflections to be exceeded on a cycle basis throughout the life of the system.

The effects of overloading and the resulting reduction in expected life can be demonstrated in the following table.

DESIGN 2000 T.P.H.	O/L 2200 (CONT)	O/L 1400 - 2600 (CYCLE)
100 000 L10	74 000 L10	70 000 L10

DENSITY CHANGES

What are the effects of varying density?

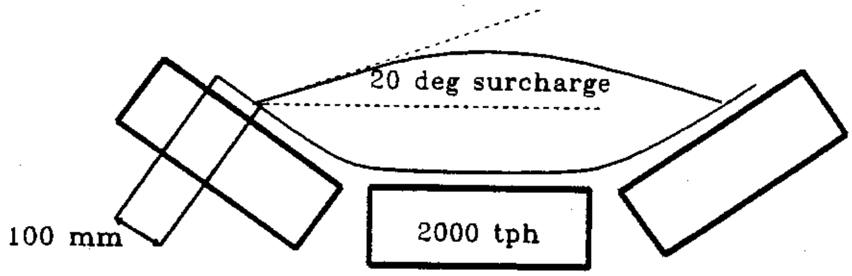
Should the feed control be monitored it will most likely be in the form of ton per hour monitoring. Where the density of the material increases the cross-sectional area of material on the belt decreases. This may look perfectly in order since the belt does not visually appear to be carrying full capacity. The loading on the centre roll is however increasing as the proportion of load between the wing and centre load changes.

Should no measuring device be installed then the temptation to increase the feed to the belt volumetric capacity will cause considerable overload which may be taken up by surplus motor power but not in shaft deflection and bearing loading. Clearly then the need for standardisation in the compilation of design criteria needs to be generated.

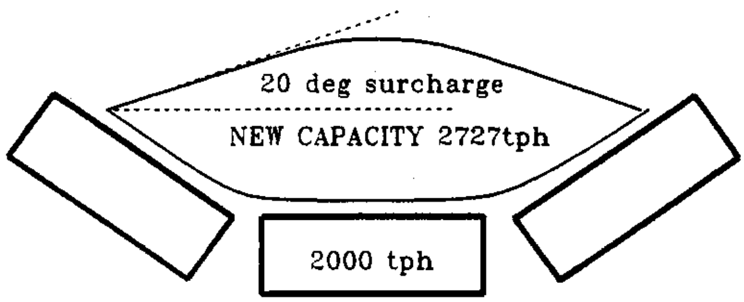
On a product such as fly ash the dry density with airyation may fall as low as 0,8 T/m^3. With standard edge clearances ruling as the maximum capacity of the belt, tonnages and loadings for a specific belt width and speed may be as follows :

FOR A FULL BELT (ISO)				ISO CAPACITY	MAX
BELT WIDTH	BELT SPEED	DENSITY	ANGLE OF REPOSE		
1500	3.0	0.8	15	2100	2870
1500	3.0	1.0	15	2625	3582
1500	3.0	1.2	15	3150	4300
1500	3.0	1.4	15	3775	5015

STANDARD ISO PROFILE NORMAL CAPACITY

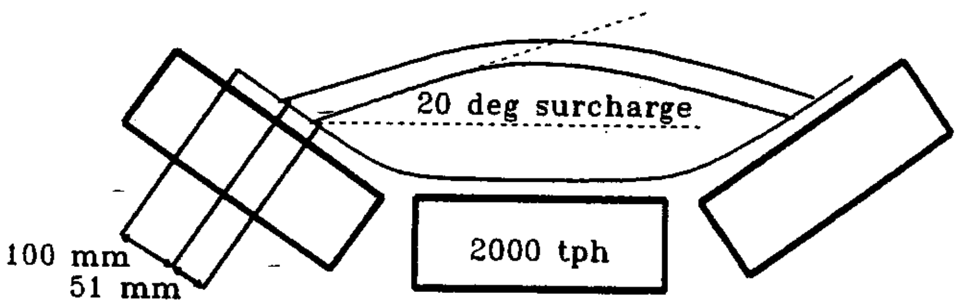


STANDARD ISO PROFILE
OVERLOADED TO MAXIMUM CAPACITY

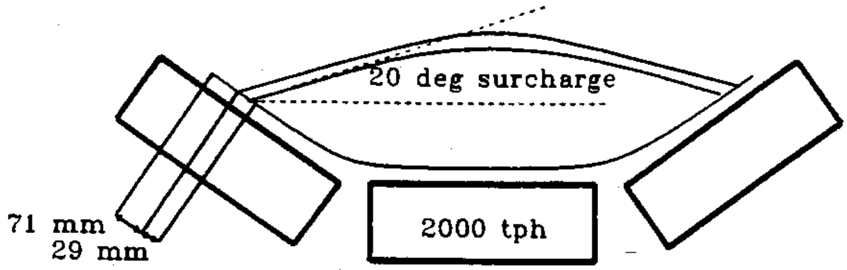


FOR A CONSTANT TONNAGE 2000				EDGE DISTANCE
BELT WIDTH	BELT SPEED	DENSITY	ANGLE OF REPOSE	
1500	3.0	0.8	15	114
1500	3.0	1.0	15	173
1500	3.0	1.2	15	215
1500	3.0	1.4	15	248

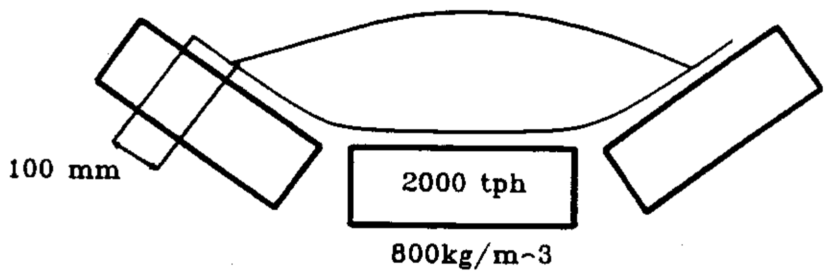
BELT DESIGNED FOR 20% SPARE CAP

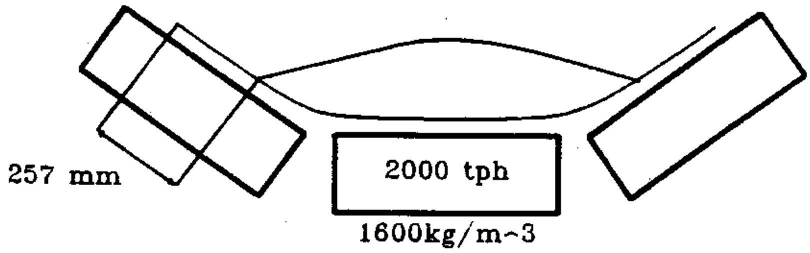


STANDARD ISO PROFILE WITH 10% OVERLOAD



MATERIAL VOLUME AS AFFECTED BY DENSITY





IDLER MANUFACTURE

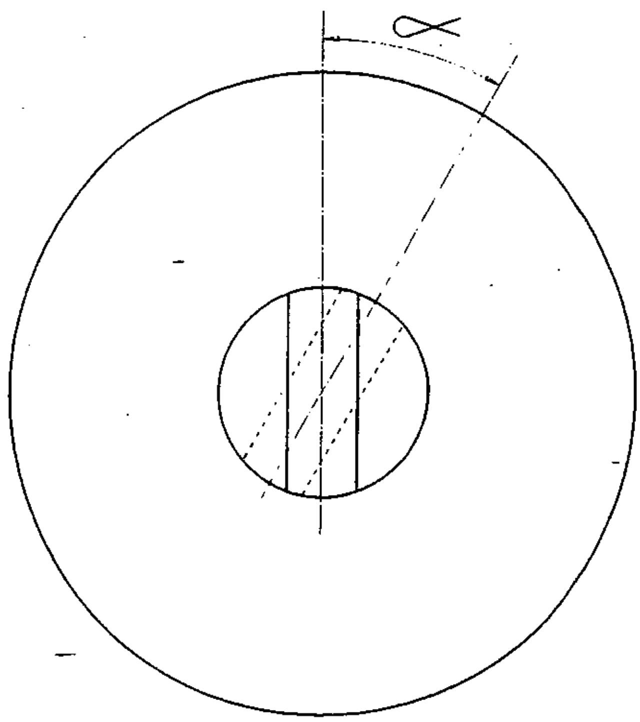
The above briefly looks at the design considerations, however the idler manufacture itself often leaves a lot to be desired.

SABS 1313 introduced some 11 years ago was a milestone in the standardisation of idler roll and configurations of idler sets which gave the consumer for the first time the then luxury of interchangeability.

At that time the standard was most welcome as it bravely attempted to cater for the demands of both the end user and the various idler manufacturers.

Discrepancies, omissions or areas open to misinterpretation have since been highlighted and the specification does need to address these issues.

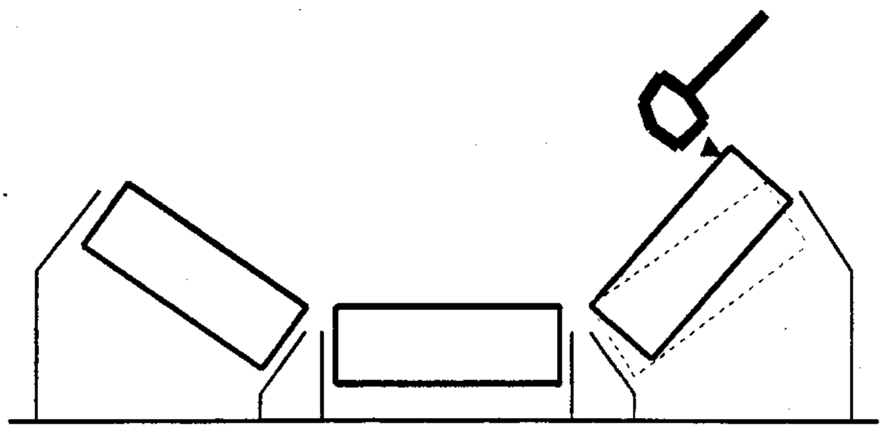
The slotted ends of an idler roll whilst dimensionally detailed and toleranced fails to make reference to the relationship of the slots at either end of the roll and the angular tolerance of misalignment of the slots.



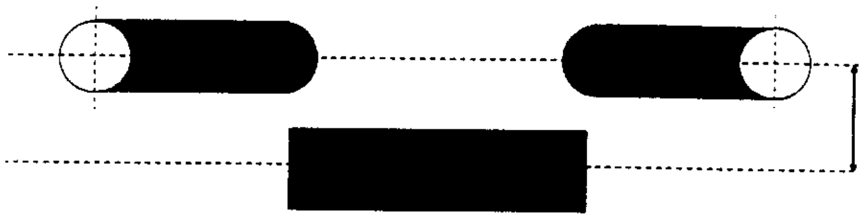
ANGULAR MISALIGNMENT OF THE SHAFT END SLOTS

This deficiency often results in the idler being unable to be fitted into the idler bracket or it having to be forced in.

IDLER FORCED INTO BRACKET



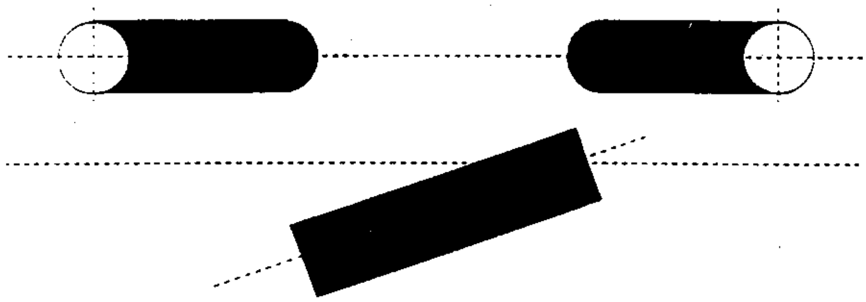
ANGULAR ALIGNMENT OF IDLER ROLLS



Whilst the specified offset is covered in SABS 1313 "4.1.6..............." the angular tolerance is not

The wording "when aligned parallel" is open to interpretation and could refer to either perfect alignment or mathematically corrected to parallel with each end of the roll capable of being mis-aligned by up to 5 mm.

ANGULAR ALIGNMENT OF IDLER ROLLS



Such mis-alignment translates into :

Idler set	400	1200	1800
Gauge length	180	460	670
Angular displacement	1,6°	0,6°	0,4°

Idler manufacturers say quite confidently that ½° degree of mis-alignment is acceptable. However what does ½° degree represent? If we look at the idler set in another light we can make some comparisons.

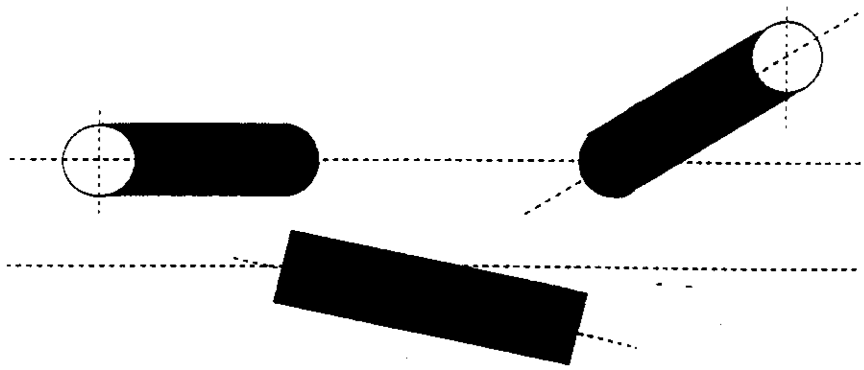
Idler set	400	1200	1800
Fixing centres	634	1448	2058
Fixing slot length	25	30	30
Angular displacement	2,26°	1,19°	0,83°

The possible angular displacement on the idler roll is half the possible correctional allowance on the idler frame slots. Belt mis-alignment and training is therefore increased together with power requirements, tension requirements, roll wear and increased bearing loads.

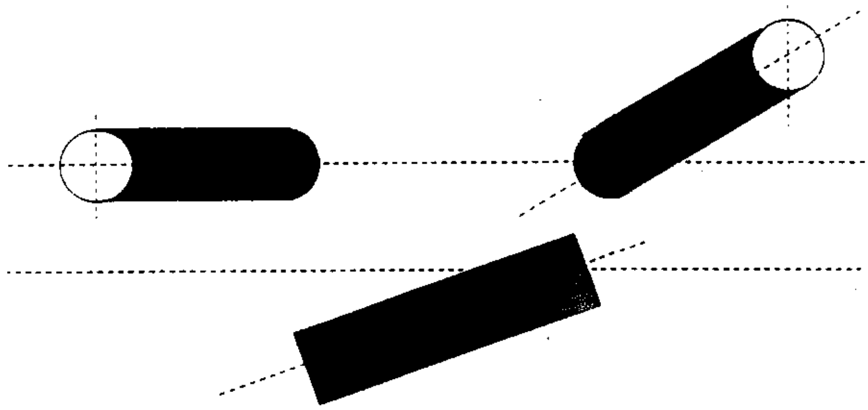
One may relate to a car where the front wheel alignment is incorrect and poor steering, high fuel consumption and rapid wear results.

When the tolerance of forward tilt on an idler is considered a more grotesque picture emerges.

ANGULAR ALIGNMENT OF IDLER ROLLS



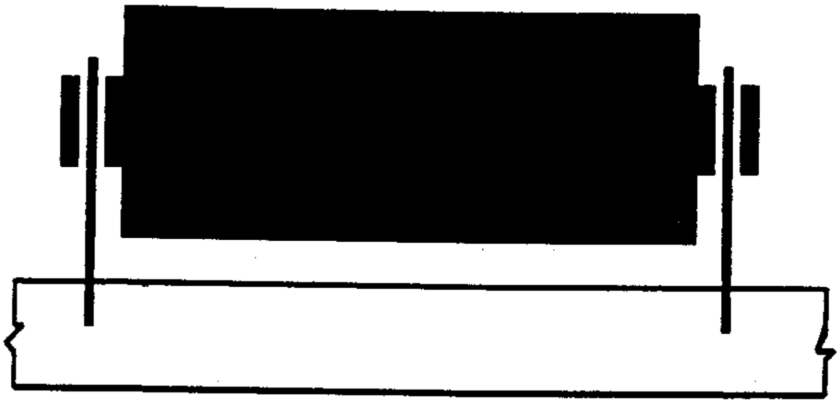
ANGULAR ALIGNMENT OF IDLER ROLLS



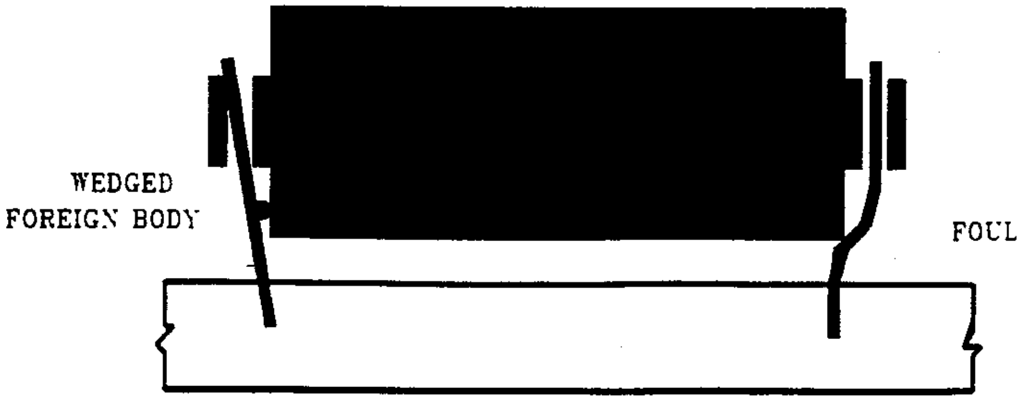
IDLER BRACKETS

Whilst the need for parallel support brackets is obvious and SABS 1313 states that 2 mm should be added to the gauge length to ensure adequate clearance. The standard fails however to mention or tolerance the parallism of the roll support brackets and this is conveniently frequently mis-read to the extent clearances between the roll and the bracket at the edge of the roll outside diameter may be small enough to trap foreign matter, be non-existent, or, in extreme cases, even foul the roll. Such interpretations go outside the spirit of the standard and are detrimental to the well being of the installation. This and other loop holes need desperately to be closed.

IDLER ROLL BRACKET ALIGNMENT



IDLER ROLL BRACKET ALIGNMENT



IDLER BASE MANUFACTURE

In general SABS 1313 concentrates itself on idler roll and shaft dimensions. We have a need to apply standards and controls to the manufacture of the idler bases. It is the idler bases that determine the alignment of the rolls, their ease of fixing, their additional loadings and subsequently the life of the rolls themselves.

Where SABS 1313 was carefully written to cater for idlers with and without forward tilt. It would now appear that the degree of forward tilt is read as a tolerance of deviation between the two wing rolls on an idler set.

We may console ourselves by saying, yes this is fair enough, the odd idler may suffer from the above but it, individually, will have little effect on the system. Dangerous words indeed since the idler frames were inevitably jig manufactured and if one idler set suffers from the above, the chances are that they all will.

But how good is the jig from which the idler frames were made. Certainly here there are no standards, very seldom will any client, consultant or system supplier take note of the jigs and give specifications for this important part of the base manufacture. This task is left to the skill, expertise and pride of the idler manufacturer.
If however the manufacturer lacks in one of three areas above, problems occur. The jigs may then vary from precision tools to pieces of scrap tacked together.
To prevent this the options are simple :

1. The client writes his own specs.
2. The client involves him self in greater inspection and quality control.
3. The client puts blind faith in the idler manufacturer.
4. A standard is generated for all manufacturers to work to.

Options 1 and 2 relate to interference in the manufacturing process and also the reduction in quality control. Why should the manufacturer spends large sums on inspection when someone else will do it for him?

As more and more clients enter the field of specifying in detail production matters with deferring requirements the continuity, standardisation, cost and risk of error all turn against the client and eventually he will pay extra for someone elses specification which may not suit his needs.

Today Option 3 is exercised with the results previously mentioned.

Option 4 is clearly the only answer. With a national specification for the manufacture tolerance and upkeep of idler roll and base jigs errors in the manufactured items should be few and far between.

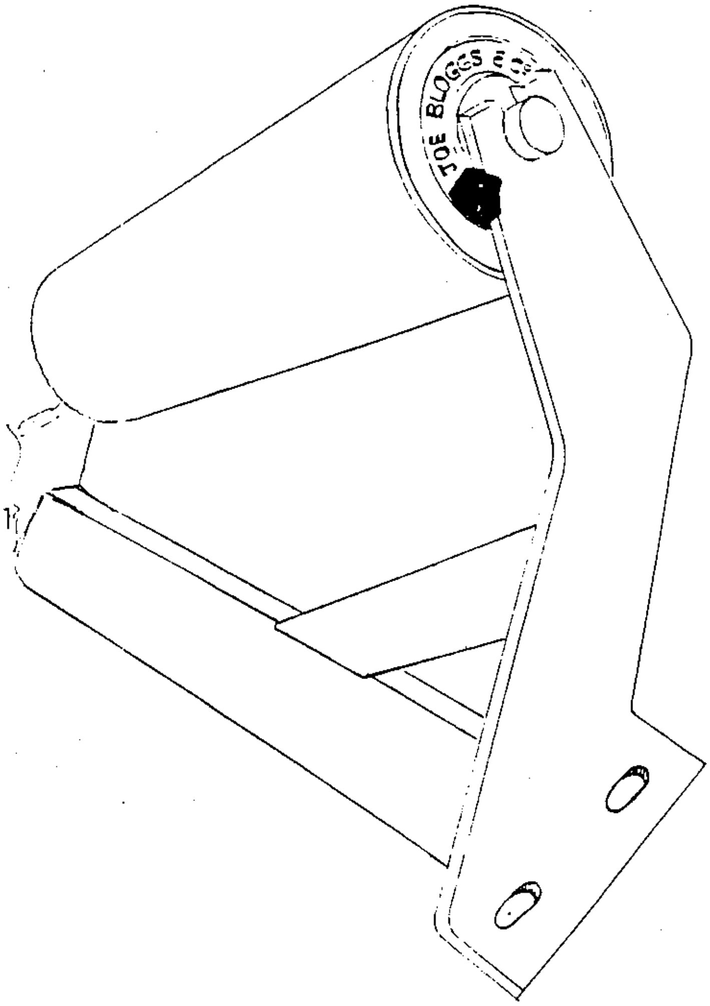
An added bonus to the end user would be that reputable manufacturers would not be tempted to lower their standards to compete with back street suppliers.

SABS 1313 is and should remain a dimensional standard. The standard does however require substantial bolstering to make it adequate to control the market conditions.

IDLER MARKINGS

The marking of idler rolls may appear insignificant in a standard but these markings can have an influence on the operation and life of an idler.

Take for example an idler with raised lettering on the end cap, or depressions in the end cap. These irregularities on the roll are sufficient to wedge a small piece of material between the roll and the idler frame stopping the roll from turning. A flat spot will soon develop especially if the roll is an impact, rubber disc or rubber lagged type.



During maintenance when the roll is checked it is found to rotate freely but must be replaced because of the flat.

OTHER STANDARDS REQUIRED

Additional areas discussed today should however form part of new specifications which may control in detail the requirements of those items.

i.e.	Shafting	-	materials, surface finish, tolerances
	Bearings	-	types, locations, tolerances, grease types and fittings, deflections etc.
	Seals	-	dust resistance, water resistance testing procedures
	Idler Bases	-	dimensional tolerances
	Idler Jigs	-	construction methods, rigidity, tolerances, periods and methods of checking and re-setting.

Notwithstanding the requirements of SABS 1313 it's own recommended sample testing dictates that anything between 4% and 10% of idlers in non-compliance is sufficient for acceptance of a batch of idlers. Food for thought indeed.

It is on the strength of SABS 1313 that South Africa pins its hopes on the export market. This is clearly not sufficient and additional standards need to be developed along the DIN and other leading standards.

Such standards should be separate from SABS 1313 and should include detailed testing and inspection procedures for idler rolls, seals, bearings, shafting etc. In this manner the most suitable standards to suite the application may be included or deleted at the purchaser/designers discretion whilst maintaining the basic idler requirements dictated in a stronger updated SABS 1313.

It would be heart warming indeed if an ISO, DIN or other specification was introduced with an opening remark "Based on SABS ****"

STRUCTURAL ALIGNMENT

Care taken at the time of erection of a conveyor save at least an equal portion of time at the commissioning stage and can relieve unnecessary idler loading, belt tracking wear and spillage problems!

If a conveyor structure is accurately aligned then the requirement for belt training becomes an unusual occurrence. Yet contractors often overlook this point and instal the steelwork to a "general" tolerance which is usually unspecified. They then try desperately to train the belt by adjusting the idlers and look in disbelief when after the first rain or when a wet material is transported the belt moves back to its original mistracking.

Most contractors sub-let their erection work and it really costs them nothing to have the steel work correctly and adequately aligned. This however assumes that they have given their erector a suitable erection specification with tolerances. If not they will incur heavy costs for tracking the belt in the loaded, unloaded, wet and dry conditions and frequent re-calls to the plant during the maintenance/guarantee period.

A number of contractors have their own "in-house" specifications which ensure good results first time. It is a pleasure to see a long narrow fabric belt start for the first time without requiring tracking and sad to see a wide belt run off by up to 300 mm, when in fact the reverse could be expected.

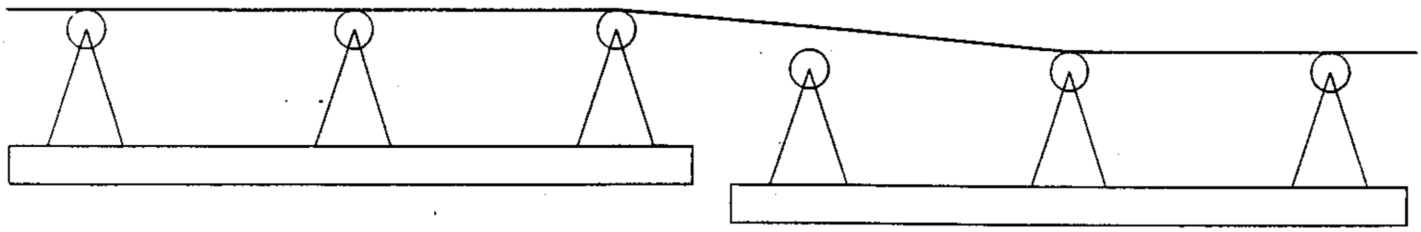
It is appreciated that the tolerances for structures may vary for the application e.g. surface and underground, but standards need to be written and implemented.

Like all standards they need to be the minimum acceptable and the contractors in-house standards could well be expected to improve upon their requirements.

A conveyor is a machine and machine type tolerances are required not general structural tolerances. The nature of the structure is such that close tolerances can be readily achieved.

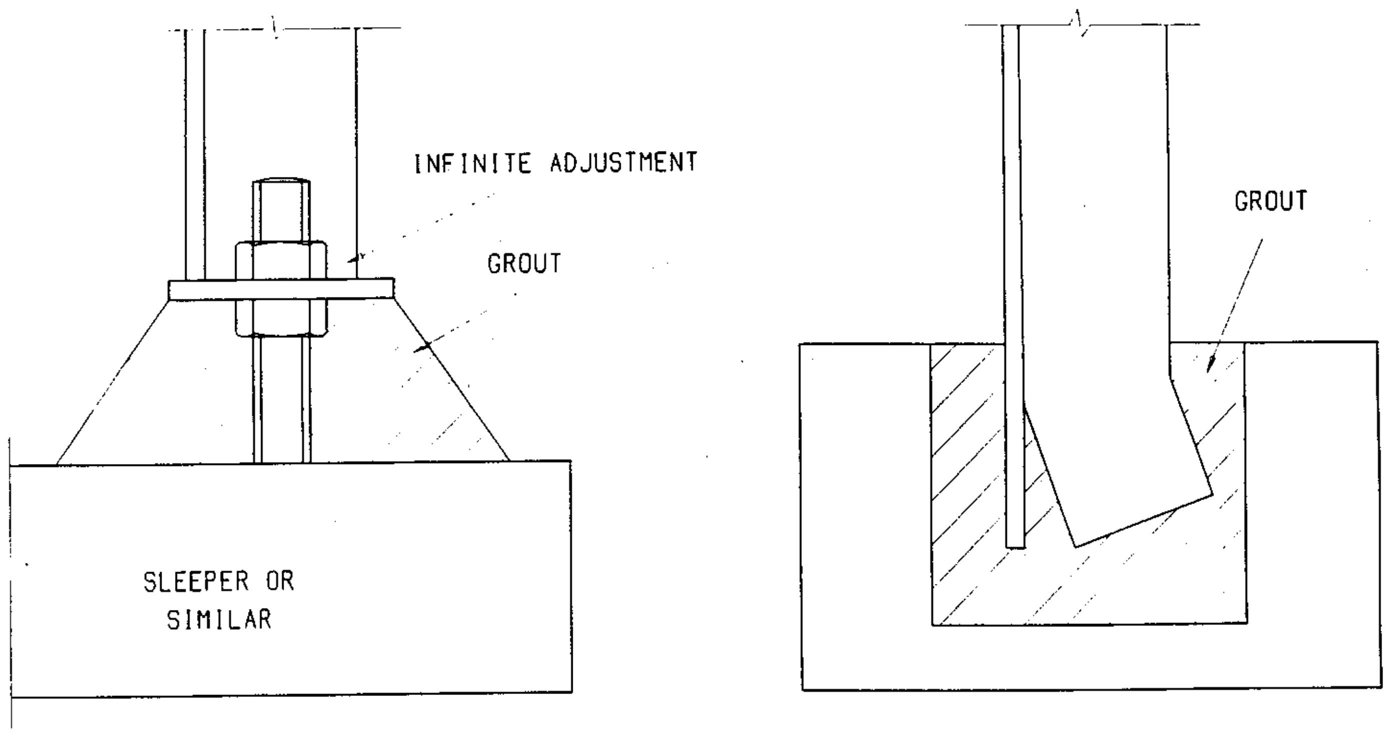
VERTICAL TOLERANCE

Unevenness in the stringer section induces unnecessary loads on the idlers in that area.



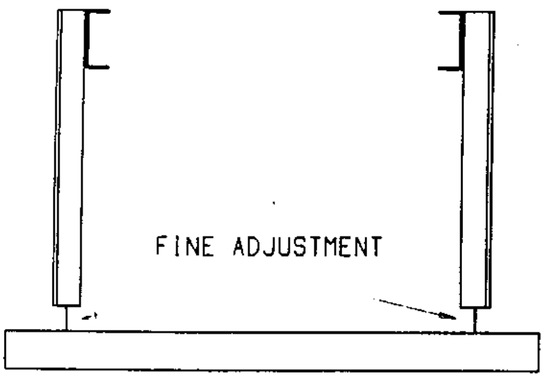
VERTICAL MISALIGNMENT OF STRINGERS

Yet near perfection in this plain is possible. Regardless of whether a stringer leg is mounted on foundation bolts or cast into pockets.

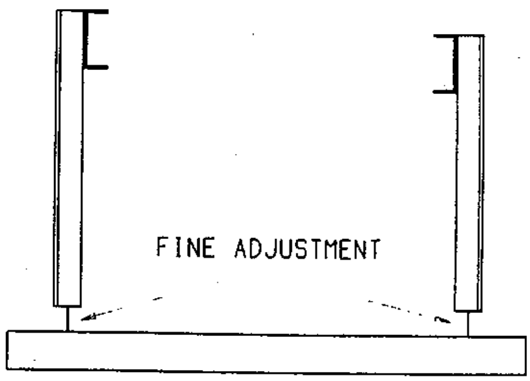


METHODS OF FIXING STRINGER LEGS

Alignment within 1 m prior to grouting is easily achievable. Likewise the levelling of adjacent stringers can also be close to perfection.



GOOD ALIGNMENT
EASY TO ACHIEVE

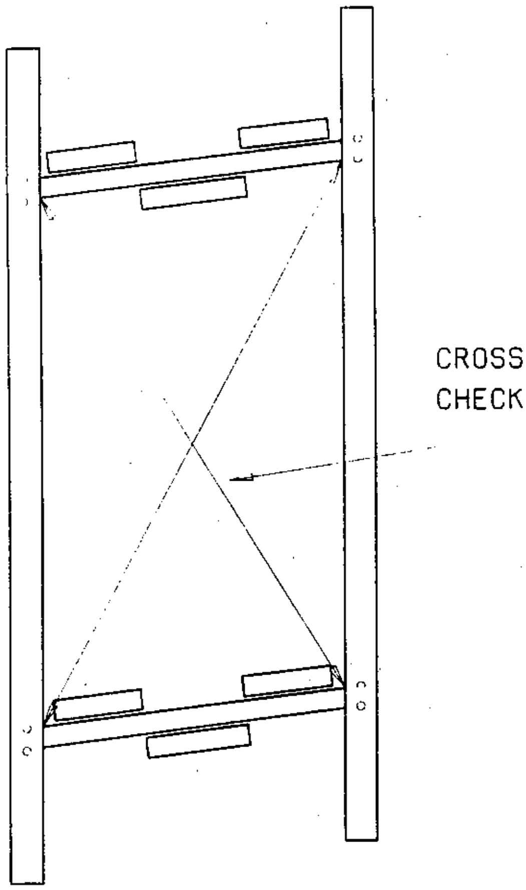


BAD ALIGNMENT
UNNECESSARY

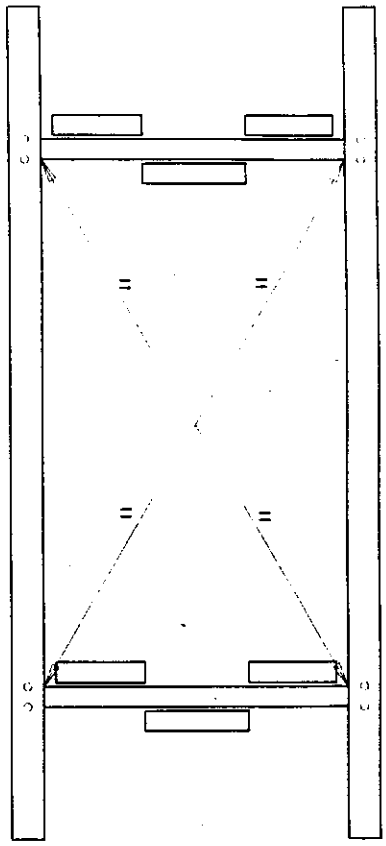
Stringers which are not level have the effect of raising the idler on one side, similar to that required to generate a curve in a belt. Small wonder then that bad tracking results.

Squareness of the module is also important but frequently overlooked.

If the module is not square then the idlers are also not square and considerable tracking is required. In extreme cases the idler shots may not provide sufficient adjustment to train the belts.

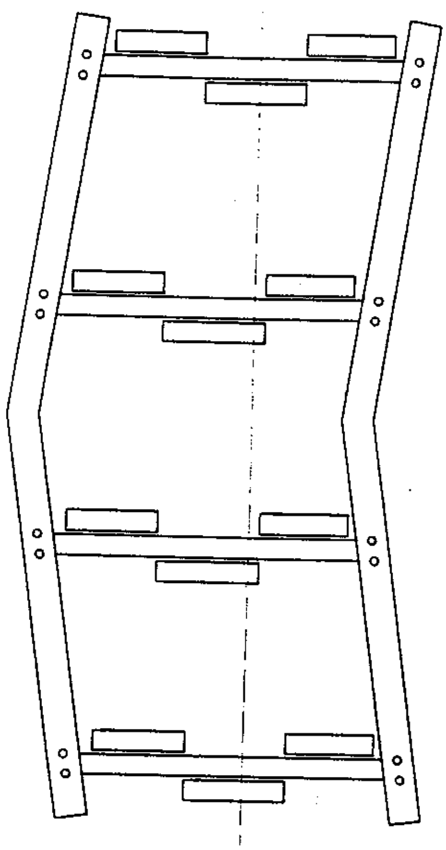


STRINGER MISALIGNMENT

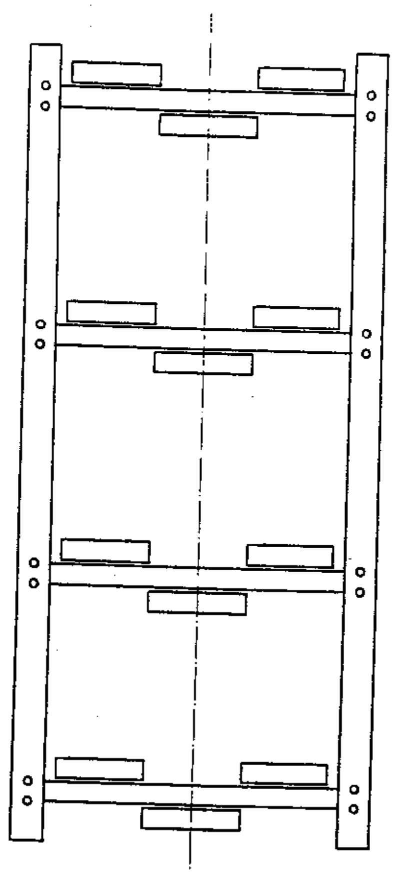


GOOD ALIGNMENT

Horizontal stringer alignment also needs to be toleranced for reasons which are self explanatory.



STRINGERS MISALIGNED HORIZONTALLY



GOOD ALIGNMENT

In all a national standard is required to which all conveyor structures and modules should be erected. The benefits would be reaped in reduced idler wear and failures, reduced maintenance, lesser spillage for the end user reduced commissioning and maintenance time for the contractor for the premium of good supervision of the erector.

The down-time, loss of production, high maintenance costs, high roll failures, spillage and high spares costs are generated by a casual approach to conveyor components and conveyor structures. Well written comprehensive standards for the industry will assist in eliminating such wastes.