THE PRACTICAL EFFECTS OF FIVE-ROLL IDLERS ON BELT TRACKING

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1. INTRODUCTION

Historically, belt tracking has been linked to belt troughability. The majority of conveyor systems were of the three-roll type and almost no tracking problems were experienced. The modern tendency is to go bigger and wider with a concurrent increase in the tonnes-per-hour conveyed. This is achieved by either increasing the belt speed or increasing the belt width. The current popularity of wider belts, even up to a width of four metres, has led to the introduction of five-roll idler systems to eliminate idler junction stresses on wider belts. During research into these systems, it was evident that great care should be taken when selecting an idler configuration and the belt type to ensure belt tracking is not sacrificed.

2. PURPOSE

This paper highlights the effect that various idler configurations have on belt tracking and how this influences belt design.

The basics of belt tracking are discussed as well as the influence that various idler designs are likely to have on belt tracking.

This paper also illustrates how FEA modelling can be effectively used in customising belt design for different idler configurations.

3. ADVANATAGES OF FIVE-ROLL IDLERS

Because belts are bigger and wider, the use of five-roll idlers is increasing. Five-roll idlers have the benefit of lower roll weight for wide belts.

- Example:
  For a 1 500 mm belt width, five-roll length = 340 mm face versus three-roll = 560 mm face.
- Shorter idler lengths make idler change-out easier and faster.
- The idler life is increased due to the reduction in the idler bearing pressures.

4. DISADVANTAGES OF FIVE-ROLL IDLERS

- Generally, there are no international standards established for five-roll idlers, although in South Africa it is specified in SANS 1313.
- Different manufacturers use different geometries, despite the fact that the geometry is specified in SANS 1313.
- Belt tracking can be compromised due to lower center roll contact.

5. THREE-ROLL vs FIVE-ROLL IDLER CENTRE ROLL CONTACT

In the three-roll configuration, the majority of the weight is on the centre roll and this allows for easy belt tracking. In the five-roll configuration the weight is split predominantly between the bottom three rolls.

The reduction in contact force between the belt and the centre roll results in reduced belt tracking.

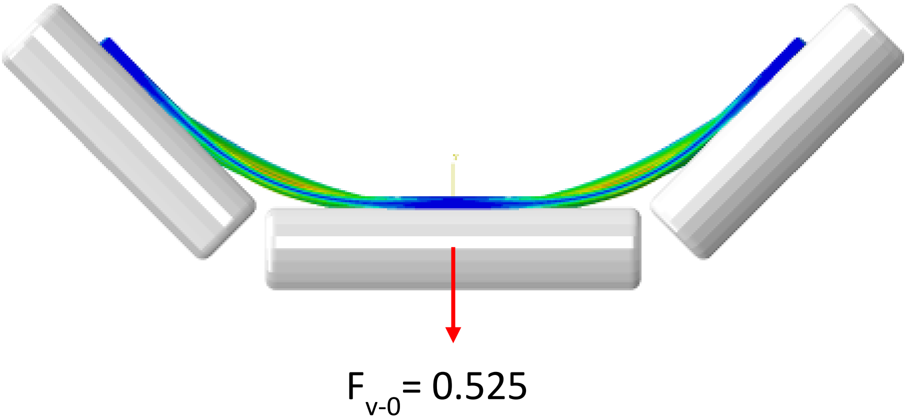

Figure 1. Three-roll 45° idler configurations
Centre roll force = 52.5% of belt weight

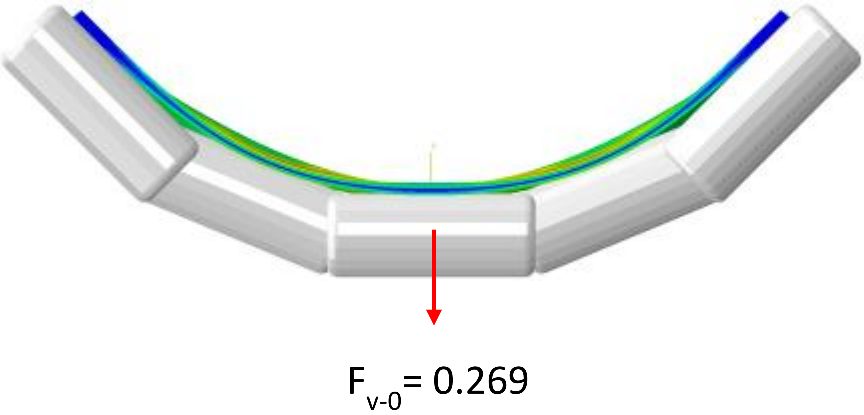

Figure 2. Five-roll 45° idler configurations
Centre roll force = 26.9% of belt weight

The various manufactures also have different configurations for the five-roll systems. This will also influence the centre roll contact force.

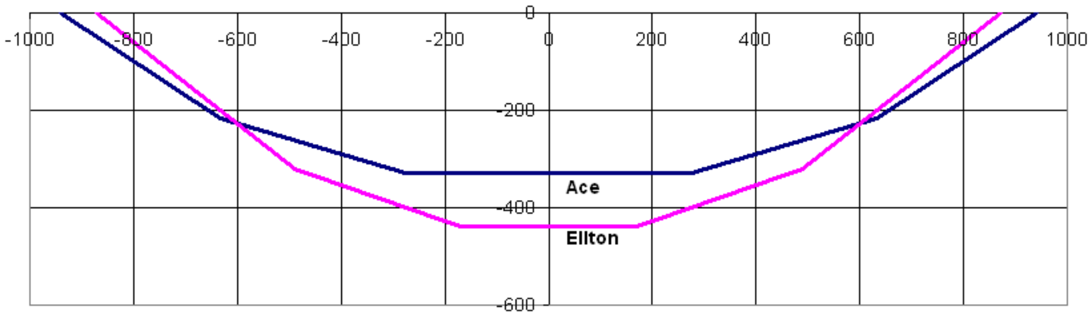

Figure 3. Chart showing different five-roll idler profiles

- Wide centre roll — Used at Carborough Downs
- Narrow centre roll — Used at Wonga Mines

Note the difference in centre roll lengths. The 'Ace' system has a wider centre roll which results in better belt contact, and thus better tracking. However, for stockholding and standardisation purposes, the equal five-roll systems are preferred.

6. METHODOLOGY USED TO PREDICT CENTRE ROLL CONTACT FORCES

Centre roll contact is affected mainly by idler configurations and belt transverse stiffness.

- In the past very little scientific research was done to determine the contact forces between the belt and the rolls. We have now done extensive FEA modeling and this data is used to predict idler contact lengths and forces.
- The FEA model was validated by laboratory testing as well as full scale belt testing in the field.
- This model is now used for each application after obtaining the unique idler geometry from the customer.
- Each belt construction is customised to fit the idler configuration in use.
- For thick belts, idler troughability can be predicted using FEA modelling.

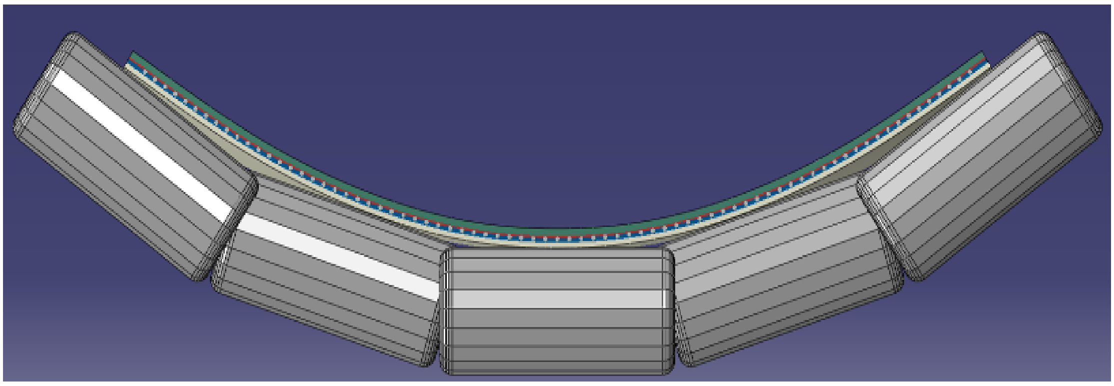

Figure 4. Five-roll idler

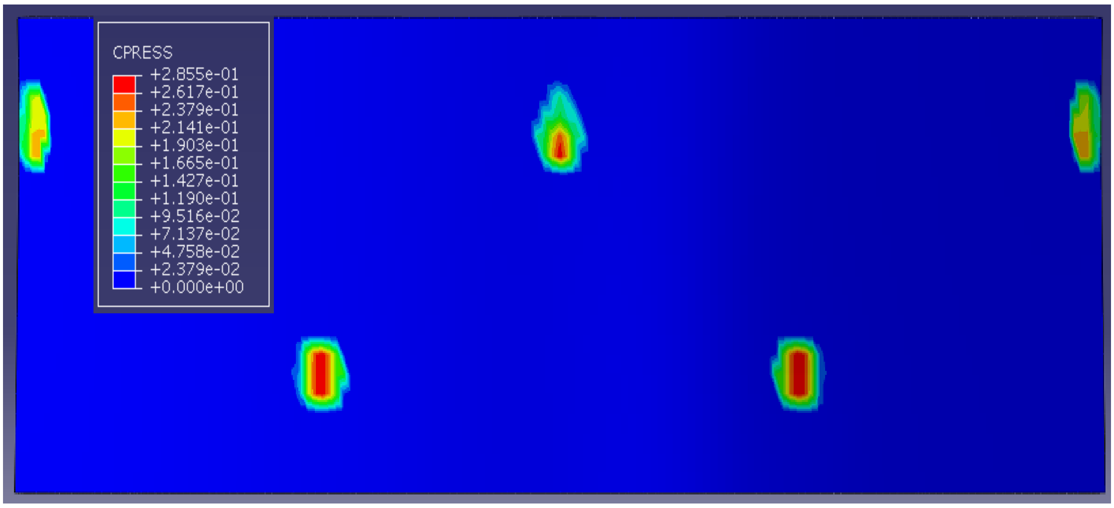

Figure 5. Fabric belt FEA model

- Contact length—center roll: 73 mm
- Contact length—17.5° wing roll: 74 mm
- Contact length—35° outmost wing roll: 51 mm

7. CONTACT PRESSURES: EMPTY vs LOADED

The contact pressure and length were measured for ST 10 000 on 30° idlers in the empty and loaded state. Results obtained are illustrated below.

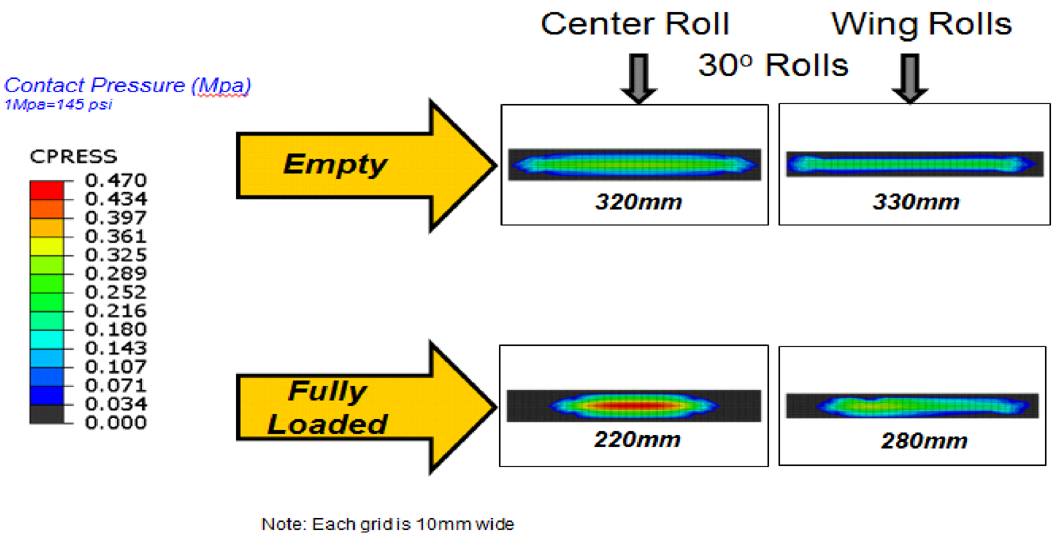

Figure 6. Empty and loaded state contact pressures

It's interesting to note that these test measurements showed a centre roll contact reduction as the load increased, yet the contact force increased by a factor of five.

8. FIELD APPLICATION EXAMPLES

Tracking problems on installations in the field were being experienced on a stockyard conveyor where a 1 800 mm EP2000/4 belt is installed. The idler configuration in place (Type 1) was: centre roll: 550 mm; inner and outer wing rolls: 375 mm.

The belt has a troughability value of 0.34 which is much higher than the minimum value of 0.18 as per SANS 1173.

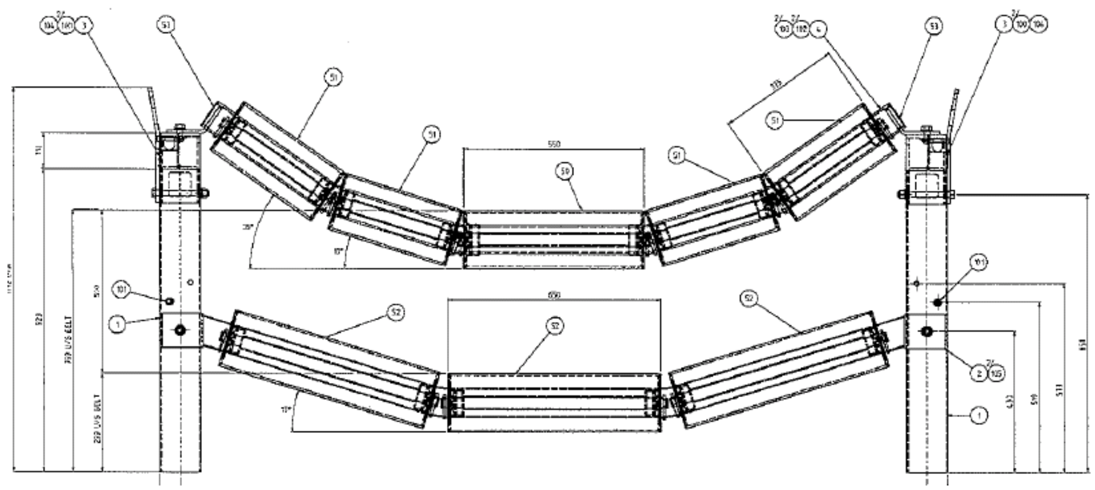

Figure 7. Type 1 idler configuration on stockyard conveyor

Figure 8. Type 1 belt contact with the idlers

The same belt was then installed on an alternative idler configuration, (Type 2): centre: three-rolls: 340 mm; outer wing rolls: 500 mm. Note the major improvement in the belt contact.

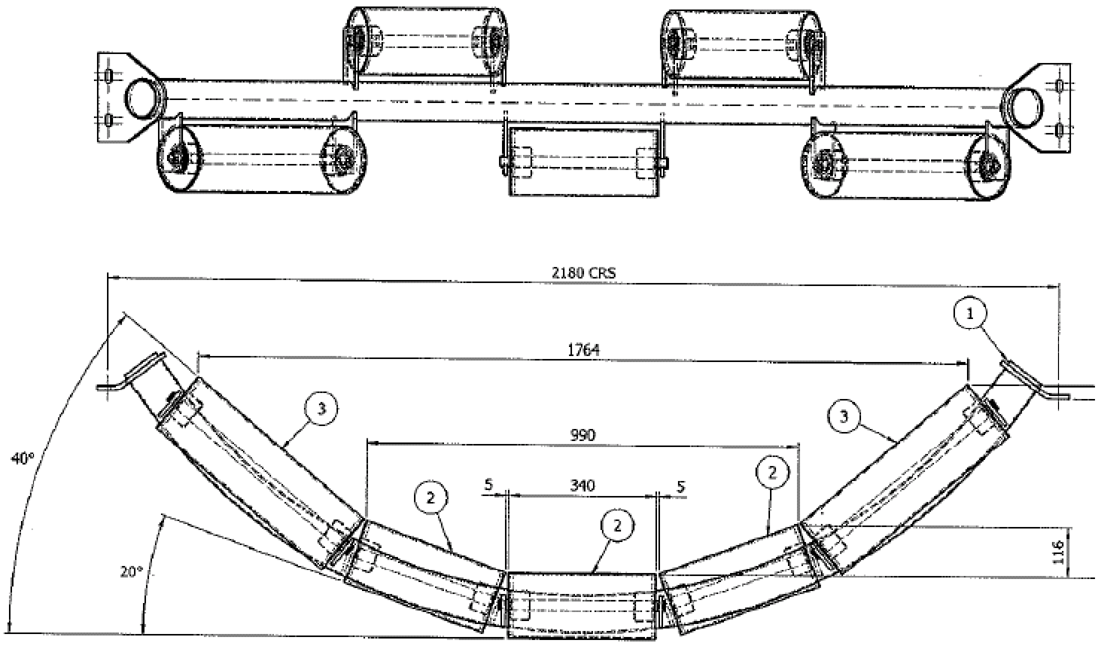

Figure 9. Type 2 idler configuration on stockyard conveyor

Figure 10. Type 2 belt contact with idlers

The contact areas were then measured under the same tension.

Idler Location	Centre	Inner Wing	Outer Wing	Total Contact % Belt Width
Type 1	50 mm	25 mm	155 mm	23%
Type 2	140 mm	80 mm	250 mm	44%

Table 1. Contact length

Since the customer already had an existing structure, a recommendation could not be made that the design be changed. The belt construction was re-engineered to increase the belt troughability and the data verified on the FEA model to ensure that sufficient contact force and length would be achieved.

Following these measurements, the belt troughability was adjusted to reach an improvement factor of 0.38, and installed on the stockyard system. This eliminated the tracking problems.

Initial construction F = 0.34 New Construction F=0.38

Figure 11. Belt troughability improvement

9. CONCLUSION

The belt characteristics, coupled with the tension and idler profile, can drastically influence belt tracking. By using FEA modelling, more accurate predictions can be made regarding the centre roll contact pressure, and therefore, designing a belt to suit a structure and idler configuration becomes realistic proposition.

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Ben-Piet obtained his B.Sc. degree in 1994 at the University of Port Elizabeth. The following year he completed his B.Sc. Honours in polymer chemistry at the University of Port Elizabeth.

In 1996, Ben-Piet started his journey into the wonderful world of rubber, where 17 years later, he still finds himself. On his path he has been a rubber compounder, laboratory technician, quality manager and technical manager.

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