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Case Study
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Design of a Conveyor Belt Turning Frame

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Abstract

The following report provides a summary of the design and operating parameters for a 10T 90° Turning Frame. The 10T 90° Turning Frame is designed to change the direction of the conveyor belt that is being installed by 90° and also to flip the conveyor belt over. Finite element analysis was used to determine the structural stresses induced by the belt tension during operation. The maximum belt tension was 10 tonnes. The maximum angular deflection from horizontal was also modelled. The stress resulting on the belt was determined to ensure that this did not exceed 2.8MPa which is the maximum the belt can withstand without damage. This report also addresses the lifting of the frame whilst fully assembled. Australian Standard AS3990 Mechanical Equipment – Steelwork has been utilized for determining the suitability of the design. The design meets the requirements of the standard for the proposed belt tension. The stress does not exceed allowable stress recommendations.

Keywords: Conveyor; Belt; Installation; Turning frame

Introduction

The following report provides a summary of the design and operating parameters for a 10T 90° Turning Frame. The 10T 90° Turning Frame is designed to the change the direction of the conveyor belt that is being installed by 90° and also to flip the conveyor belt over. That is, to result in the conveyor belt being flipped from cover side up (for example) to cover side down.

The purpose of this is most often to allow installation of a conveyor belt when there is insufficient space to flake the new conveyor belt at the head or tail of the system. When there is insufficient space, the conveyor belt must be flaked beside the conveyor system and hence the frames are used to manipulate the belt onto the system in the correct orientation. This is circumstance is visually presented in the Figure 1.

Finite element analysis was used to determine the structural stresses induced by the belt tension during operation. The maximum belt tension was 10 tonnes. The maximum angular deflection from horizontal was also modelled. The stress resulting on the belt was determined to ensure that this did not exceed 2.8 MPa which is the maximum the belt can withstand without damage. This report also addresses the lifting of the frame whilst fully assembled. Australian Standard AS3990 Mechanical Equipment - Steelwork has been utilized for determining the suitability of the design.

The following design assumptions have been made. The 90° Turning Frame will be used with belt of equal or less than 50 mm in thickness. The 90° Turning Frame will be used for belt widths between 1000 - 2000 mm. Maximum belt tension is not to exceed 10T. It is assumed that the belt has been oriented such that the centre-line of the belt is collinear with the centre-line of the 90° Turning Frame. As a result, no lateral loading along the length of the 90° Turning Frame is assumed. Maximum pressure on the belt from the rollers is not to exceed 2.8 MPa. Maximum vertical angular deflection upwards of the belt is not to exceed allowable stresses in the frame. The frame will be bolted to a fixed surface.

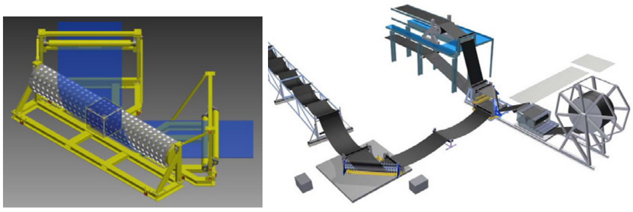

Figure 1: Overview of 10T 90° Turning frame showing rollers and belt (L) Typical belt installation at site showing use of Turning Frames 2 (R).

Finite Element Analysis

Autodesk Inventor Professional 2014 was used to analyse the 90° Turning Frame. The 90° Turning Frame was designed to be constructed from 350 grade material. This material has a yield stress of 360 MPa. The model reflected that the 90° Turning Frame would be installed on a flat surface (Figure 2).

The model also reflected that the 90° Turning Frame would be fixed at the two brackets shown in the figure. The force of the belt is evenly distributed as per the figure. The models were constructed to reflect the two extremes of belt width, namely 1000 and 2000 mm wide. The figure shows the area where the force is distributed which also represents the path of the belt around the 90° Turning Frame (Figure 3).

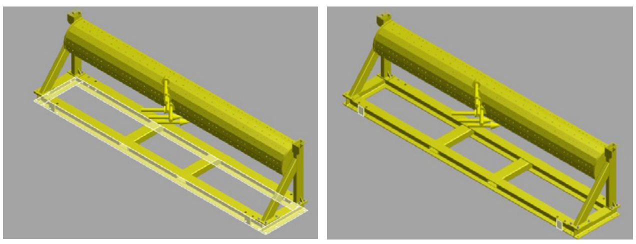

Figure 2: Turning Frame supported by level ground (L) Turning Frame fixed points(R).

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Loading By Conveyor Belt

For a centrally located 1000 mm wide belt, the maximum stress is 233.6 MPa. This is less than the maximum allowable of 237.6 MPa as per AS3990 for the selected construction material (Figure 4).

For a centrally located 2000 mm wide belt, the maximum stress is 237.5 MPa. This is less than the maximum allowable of 237.6 MPa as per AS3990 for the selected construction material [1,2].

Allowable Angular Deflection of Belt from Horizontal

In the field there are often instances where the belt is not absolutely parallel to the ground. What needs to be determined is what angle of belt deflection is allowable for the side frame from a structural perspective. In an operational sense, a maximum angular deflection of 60 from the horizontal is expected. The side frames are identical except for the height at which the rollers are placed. The side frame fixed areas are shown. The side frame is assumed to be fixed from the white areas, namely the bolted plates which affix to the turning frame itself (both lower plates and single upper plate). The side frame is also assumed to be fixed to a base by fixing bolts along the plate directly beneath the rollers (Figure 5).

Angular deflections of 60° were modeled using the 10T force. Forces were applied to the faces shown in order to simulate the load at the deflections outlined above. Note that there is no horizontal component as the belt is free to move on the roller. It was found that the 60° angular deflection resulted in a stress of 93 MPa which satisfies AS3990 for the material being used in the construction (Figure 6).

Roller Indentation

The maximum allowable stress on the belt is 2.8 MPa. This ensures that there is no damage to the new conveyor belt during the installation. A single rollers is shown in the figure. The force is directed perpendicularly to the belt surface as shown in Figure 7.

A force of 25 kN produces a stress in the belt of 2.3 MPa as shown

Figure 3: Force applied across width of 1000-2000 mm wide belt.

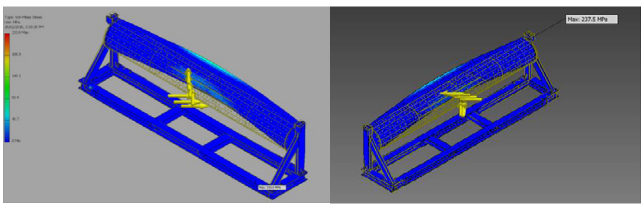

Figure 4: Maximum Stress in Turning Frame from 1000 mm wide belt (L) and from 2000 mm wide belt (R).

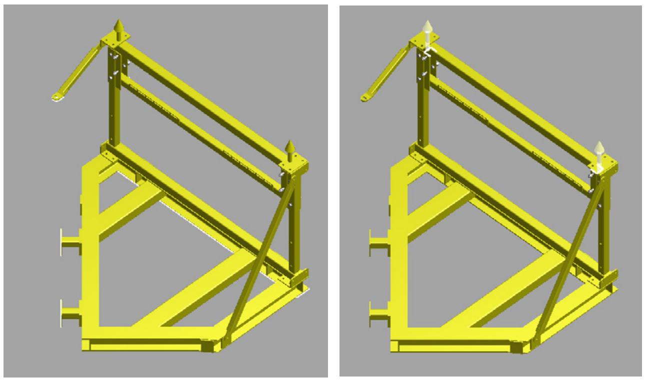

Figure 5: Fixed points for belt entry/exit roller frames (L) Force applied to belt entry/exit roller frames (R).

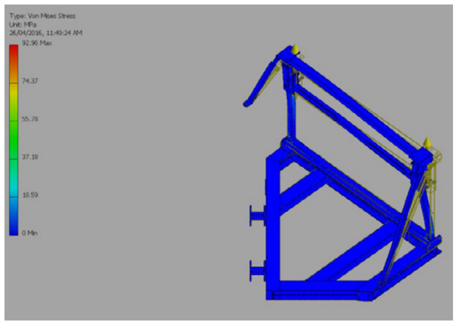

Figure 6: Maximum stress in belt entry/exit roller frames.

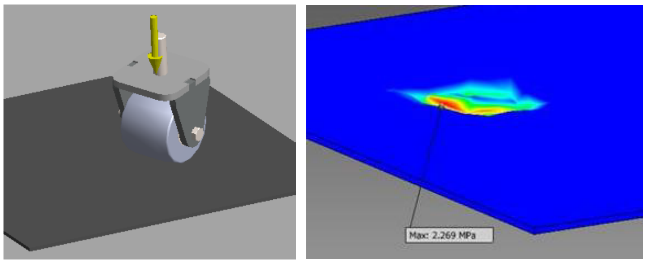

Figure 7: Force applied on roller to belt (L) Maximum stress on belt from one roller (R).

in the figure. There are 7 rollers across the width of the 1000 mm wide belt. Note the figure which shows 14 rollers across the width of the 2000 mm wide belt (Figure 8).

The rollers will support 17.5 tonne so that will be more than adequate to ensure that stress on the belt is less than 2.8 MPa.

Lifting

There is a requirement for the 10T 90° Turning Frame to be able to be hoisted while fully assembled. This will occur due to adjustments in placement of the Turning Frame during the operation.

The 4 lifting points are shown outlined in white in the Figure 9. The centre of gravity is shown by the arrow. As shown in the figure, the mass is 7795 kg.

The maximum stress in the assembly during lifting is 34.25 MPa which is well within the requirements of AS3990 [3-5].

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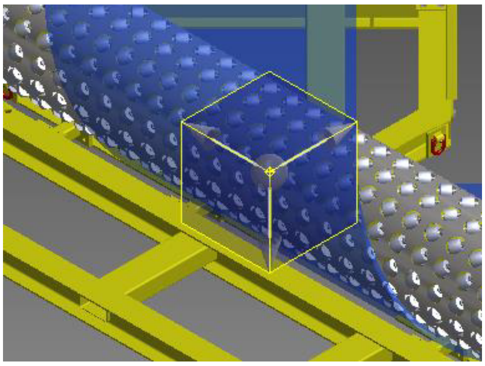

Figure 8: Rollers shown across 2000 mm wide belt.

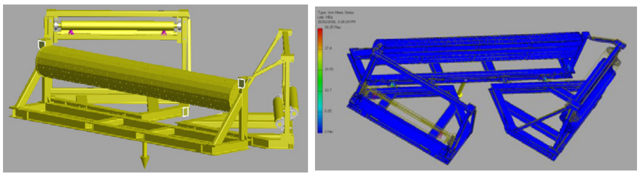

Figure 9: Hoist points and Centre of Gravity of Turning Frame assembly (L) Maximum stress in Turning Frame assembly during lifting.

Conclusion

The following report provides a summary of the design and operating parameters for a 10T 90° Turning Frame. The 10T 90° Turning Frame is designed to change the direction of the conveyor belt that is being installed by 90° and also to flip the conveyor belt over. Finite element analysis was used to determine the structural stresses induced by the belt tension during operation. The maximum belt tension was 10 tonnes. The maximum angular deflection from horizontal was also modelled. The stress resulting on the belt was determined to ensure that this did not exceed 2.8 MPa which is the maximum the belt can withstand without damage. This report also addresses the lifting of the frame whilst fully assembled. Australian Standard AS3990 Mechanical Equipment – Steelwork has been utilized for determining the suitability of the design. The design meets the requirements of the standard for the proposed belt tension. The stress does not exceed allowable stress recommendations.

References

1. AS3990 Mechanical Equipment – Steelwork.
2. http://www.bellebannevic.com.au/conveyor-belt-handling
3. Sprockel OL, Stamato HJ (2010) Design and Scale-Up of Dry Granulation Processes. Chemical Engineering in the Pharmaceutical Industry, pp: 727-755.
4. Kleinebudde P (2004) Roll compaction/dry granulation: Pharmaceutical applications. Eur J Pharm Biopharm 58: 317-326.
5. Parrott EL (1981) Densification of powders by concavo-convex roller compactor. J Pharm Sci 70: 288-291.