

MISG Project: Strip Track-Off and Buckling between Transport Rolls.

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About BlueScope Steel:

BlueScope Steel is the leading steel company in Australia and New Zealand, supplying a large percentage of all flat steel products sold in these markets. It specialises in the production of flat steel products, including hot and cold rolled coil, plate and value-added metallic coated and painted steel products. Within Australia, our BlueScope Lysaght business rollforms and supplies a range of steel building products, including roof and wall cladding, steel house framing, rainwater products such as guttering and downpipes, fencing together with structural products such as purlins and flooring systems, meshes and walkways.

Project Aim:

Rolls are commonly used to transport and guide strip through mills and strip coating lines. A better understand is sought on the mechanics of the strip transport, with special emphasis on explanations of observed strip defects and tracking instability. Strip defects of interest include the generation of strip buckling/wrinkling between transport rolls due to roll misalignment or roll profile, the latter being the variation in roll diameter along the roll axis.

Also of interest is the connection between strip tracking stability and the roll profile. Convex roll, with larger diameters in the middle of the roll length, are known to reduce track-off where the travelling strip wanders off-centre of the roll. However, such roll profiles are more susceptible to generating wrinkling form of defects. Moreover, there is a reduced region of contact between the moving strip and the supporting roll at the strip edges, with the possibility of separation from the supporting roll completely. Prediction of the extent of the region of contact in terms of parameters such as roll radius, applied strip tension and roll camber would be useful.

I. Modelling of Strip Wrinkles

Observations:

If there is no misalignment between the rolls the strip is transported flat, see Figure 1a below. For small misalignments a localised single wrinkle of small amplitude is often observed along the length of the span between the rolls. If the misalignment is increased the amplitude of the wrinkle increases together with the angle of the wrinkle to the strip. The observed limiting case for large misalignments is that of a single wrinkle of large amplitude, and at an angle to the strip such that the ends of the wrinkle are aligned to the span corners as shown below. A linearised buckling theory has been used to investigate small misalignments, which predicts a periodic wave across the strip width. A non-linear analysis may be necessary to describe the observed single wrinkle.

Results of Interest

1. Develop physical based model that is sufficiently:
 - sophisticated to incorporate physics of problem
 - transparent to provide understanding of mechanics
2. From model obtain:
 - estimates for critical roll misalignment for onset of wrinkle.
 - description of single wrinkle solution and relationship between wrinkle height, wrinkle angle and the degree of roll misalignment.
 - critical buckle height, and corresponding roll misalignment, to produce a wrinkle sufficiently large such that plastic deformation of strip occurs.



Figure 1.

(a) no roll misalignment

(b) small misalignment

(c) large misalignment

II. Roll/Strip Conformity and Track-Off:

Observations

Consider a flat strip of uniform thickness across its width. Such a strip would be in full contact with a perfectly flat roll, with uniform diameter across its length. In addition the

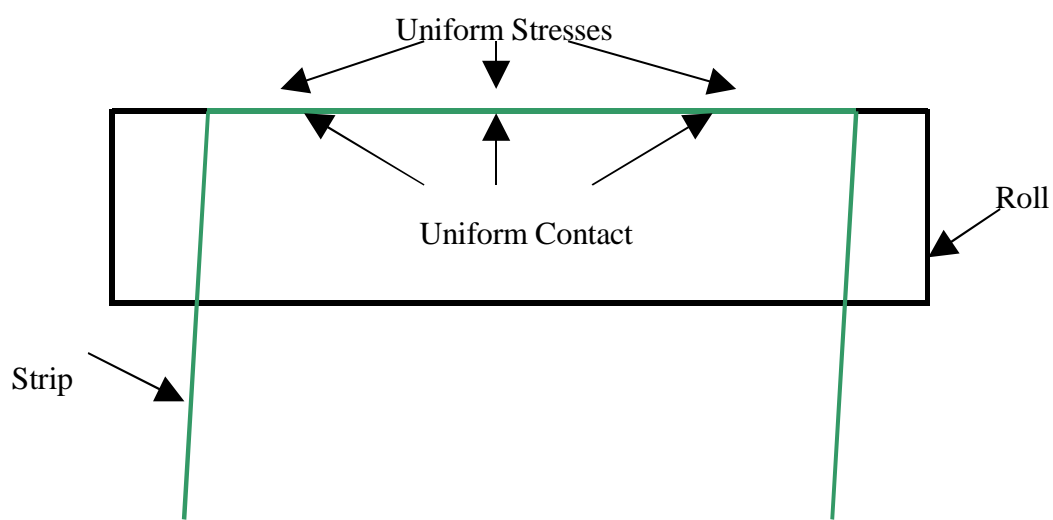
strip stress may be considered to be uniform across its width as is portrayed below in Figure 2a below. For a concave roll, see Figure 2b, contact between the strip and the roll may be limited to the central region, being a region of higher strip pressures and stresses. Conversely, for concave rolls, the strip would have contact at the edges.

It has been observed that convex roll reduce track-off where the travelling strip wanders off-centre of the roll. Such roll profiles, however, have been shown experimentally to be more susceptible to generating wrinkling form of defects.

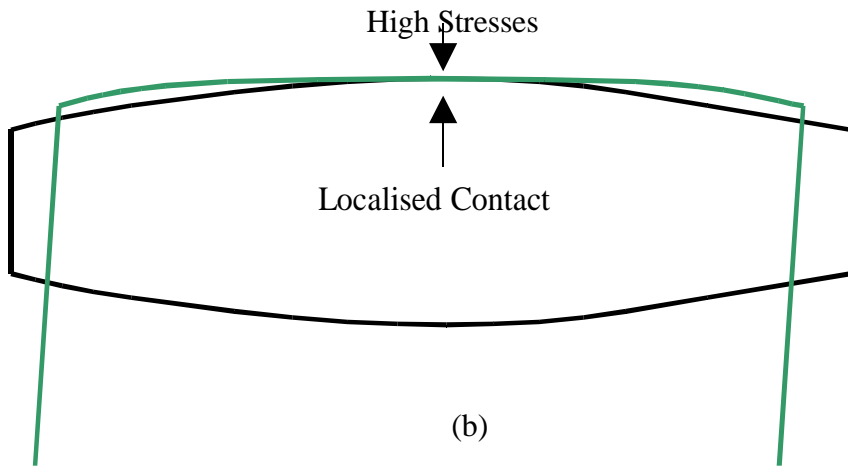
Results of Interest

To better understand how the region of contact between a moving strip and a supporting roll varies with parameters such as roll radius, applied strip tension and roll profile. Also to understand how roll profiles effect tracking stability and the formation of wrinkles.

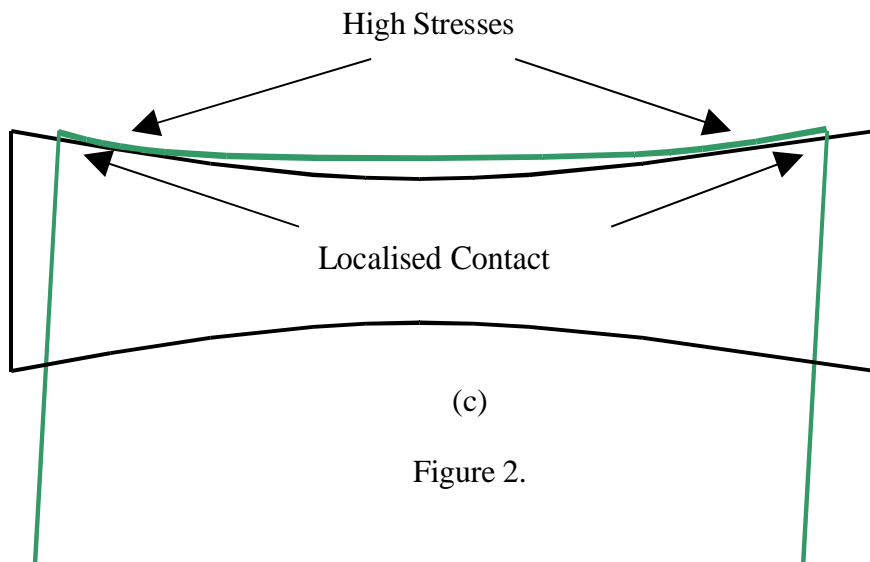
1. Develop model to predict contact region between strip and the roll for defined roll profile and applied strip tension conditions. Model must be sufficiently;
 - sophisticated to account for physics of problem
 - but sufficiently transparent to provide understanding of mechanics
2. From model obtain;
 - estimates for contact region between strip and roll for a given roll profile
 - estimate for strip stresses
 - stability assessment of strip motion, i.e. conditions where track-off would be self correcting
 - possibility of formation of wrinkle type defects



(a)



(b)



(c)

Figure 2.