Simulation of Roll Forming

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Outline

• Introduction
• Roll forming
• New developments
• Simulation of U-channel
• Summary and future work
Roll Forming

- Bending process
- Angle introduced continuously along straight line
- Set of contoured rolls
- Strip motion applied by rotation of rolls (friction)
- Alternatively, pulling of strip
- Unlimited length

Source: Schuler
Roll Forming - Boundaries

• Generally, materials that can be bent can also be roll formed

• Steel:
  – Thickness 0.1mm to 20mm
  – Width 3mm to 2m
  – Velocity 20m/min to 80m/min, some up to 160m/min
  – More demanding for higher yield strengths

• Product is prismatic
Typical Defects in Roll Forming

- **Camber**
  - Curving in horizontal plane
- **Bow**
  - Curving in vertical plane
- **Twist**
  - Rotation around longitudinal axis

Source: Halmos
Roll Forming – Latest Developments

- Flexible roll forming
- Rolls with addition DOF
  - Rotation
  - Lateral translation
- NC
- Variable cross sections
Roll Forming – Latest Developments

- **MONRO**
- Variable cross-section, different scale
- Stands separated, each side movable
- Applied as cladding of large buildings

Source: BEMO Systems

Source: The Fabricator
Forming specialities

- Linear flow splitting

- Double-sided flanges without joints
- Cold forming
- Excellent surface quality
- Considerable increase in hardness
Integration of processes

Laser assisted bending

- Appreciable extension of forming limits of high strength steel (up to 200%)
- Hardly any permanent softening of steel

Source: LFT
Aides for Manufacturing

• Simulation of forming process
  – Several software packages specialised on roll forming
    • PROFIL (Ubeco)
    • COPRA (dataM)
    • Shape-RF (SHAPE Co)
    • Simply Roll Design (Delta Engineering)
    • VTTube (VTT)
Simulation of U-channel

- Abaqus explicit
- 6 stands
- Stand spacing 300mm
- 4-node shell elements (S4R)
- Symmetric

<table>
<thead>
<tr>
<th>Model parameters</th>
<th></th>
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<tbody>
<tr>
<td>Material</td>
<td>Isotropic, linear hardening</td>
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<tr>
<td>Young’s modulus</td>
<td>210 GPa</td>
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<tr>
<td>Yield strength</td>
<td>300 MPa</td>
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<tr>
<td>Strip Thickness</td>
<td>1 mm</td>
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<tr>
<td>Strip Velocity</td>
<td>1 mm/ms</td>
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<tr>
<td>Coefficient of Friction</td>
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<tr>
<td>Roll diameter</td>
<td>200 mm</td>
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<tr>
<td>Roll material</td>
<td>Analytically rigid</td>
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</table>
Tool

- Constant Radius
- 15° angle increment
Simple U-Channel
Results: Strains at channel edge

![Graph showing strains at edge of flange (top) and (bottom)]
Results: Stresses at channel edge
Roll Former at AUT

- 7 Stands (5 currently in use)
- Rolls supported at both ends (Standard design)
- All lower and first upper roll driven (line of transfer gear-boxes)
- Max. strip width: 350mm
- Old production tool installed
- Cut-off die
- Decoiler
Simulation of existing tool
Summary and future work

• New developments
• Created simulation of
  – U-channel and
  – Production tool
• Develop versatile research tool
• Verify simulation
• Progress to more complex geometry
• Develop design aide for roll forming
Thank you