Leveling: Making Metal Flat

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Agenda

What is Leveling
Flatness / Stress relief
(Brief) Theory
Applications
- Aerospace
- Defense
Benefits
Design
Alternatives
Questions
Who is ARKU?

- Parts leveling
- Deburring and rounding machines
- Coil lines
- Service
What is leveling?
Flatness?
Stress relief
Before / after
Leveling in Action - Video
  • https://youtu.be/nQXpPw6BnZM
Why level?

Industries are demanding tighter tolerances
Leveling is widely used in a variety of industries
Flatness defects in the Coil

- **Coilset**: Caused during recoiling
- **Crossbow**: Caused during cooling
- **Twist**: Caused by uneven strip tension during recoiling
- **Camber**: Cause: slitting narrow strips having uneven pull
- **Edge waves**: Cause: worn roll stands, internal stress from rolling, Thickness variation
- **One-sided waves**: Cause: worn roll stands, internal stress from rolling, Thickness variation
- **Center buckles**: Cause: worn roll stands, internal stress from rolling, Thickness variation
Flatness defects are caused by:

- **Milling**
- **Slitting**: Slitting causes stress and deformation along the cutting edge. Recoiling can cause different shape issues like camber, buckles and edge waves,…
- **Parts production**: During parts production:
  1. Residual stress is relieved
  2. New stress can be added to material

This stress results in unflat parts.
Material Science Review

Fig. 2.1  Tensile test

\[ \sigma = \frac{F}{A} \quad \varepsilon = \frac{\Delta l}{l} \]

- \( F \) = tensile force [N]
- \( A \) = cross section [mm²]
- \( \Delta l \) = change in length [mm]
- \( l \) = sample length [mm]
- \( \sigma \) = tension [N/mm²]
- \( \varepsilon \) = elongation [%]

Fig. 2.2  Result tensile test

- \( R_m \) = yield point
- \( \sigma_y \) = rupture stress
- \( R_m \) = ultimate tensile strength
Fundamentals of roller leveling

Leveling is bending
The right leveler choice

Residual stress and numbers of leveling rollers

Leveling done well:
• Maximum flatness
• Minimum residual stress
• No surface issues

Numbers of leveling rollers

Residual stress

Wide nesting
Close nesting
Main principle of roller leveling

Stress curve during leveling process

FEM - Simulation of the leveling process
Leveler setting

Leveler with bank adjustment – the whole leveling unit is moving
There are two setting required:

On the **Inlet** you choose a value below material thickness.

On the **Outlet**, in general the setting is material thickness
Aerospace Application Video
Armor plate
Size matters (and so does strength)

- We can level up to 2.25” in thickness.
- Forces - However, we need to consider what kind of effect these immense force have on the machine.
- Therefore we offer two different versions of levelers; **mechanical** and **hydraulic**

Determining factors for deciding on hydraulic or mechanical?

- **Material thickness**
- **Yield strength**
- **Customer tolerances**
Gap Control Video

https://youtu.be/sGZ9jAPyaWg
Basic design of a (hydraulic) leveler

- Hydraulic Cylinders
- Leveling block
- Supporting rollers block
- Base machine frame
Why roller level?

- Reduces production costs
- Increases quality/consistency (reproducible results)
- Increases safety for operators
- Shorter processing times
- Salvage scrap materials
- Meet customer tolerances
- Optimize downstream processing (welding/bending)
How would you get these parts flat?
Disadvantages

What do these methods have in common?

- They all disregard stress relief
- They are slow
- They are inconsistent
- They require experienced operators
Leveling methods

- Servo-hydraulic leveler
  - FlatMaster®
  - 2 min
- Mechanical straightener
- Straightening press
- Bending roll
- Hammer and flame
  - 45 min
Improvements due to leveling

- Welding
- Robot welding
- Bending
- Assemblies
Questions?