Roll Forming Simulation with PROFIL and LS-DYNA

by Roland Brandegger, UBECO GmbH, Iserlohn (Germany)

Speaker:

Roland Brandegger

Company:

UBECO GmbH in Iserlohn/Germany

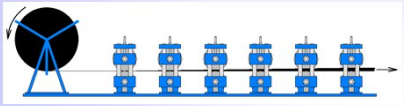
Product:

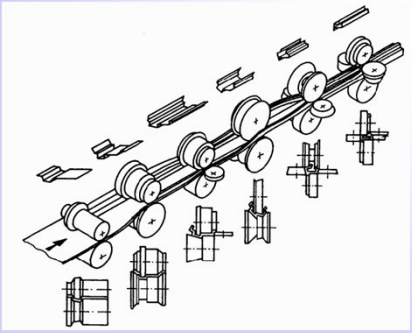
PROFIL

Software for Roll Forming Design

PROFIL

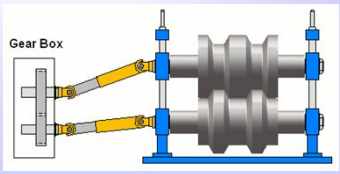
What is Roll forming?





Roll forming is a continuous bending operation in which sheet or strip metal is gradually formed in tandem sets of rollers until the desired cross-sectional configuration is obtained.

Roll forming is ideal for producing parts with long lengths or in large quantities.



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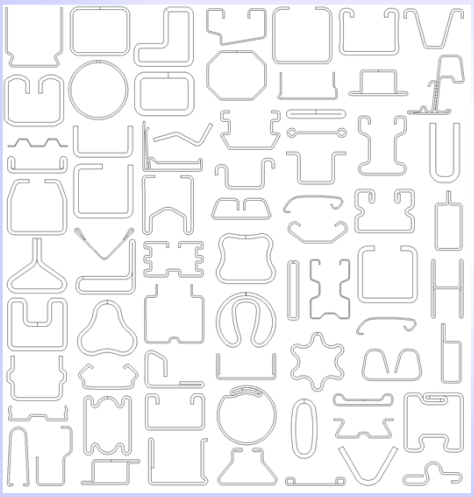
Application spectrum of roll formed profiles:



U and C channels, door frames, shutter profiles, trapezoidal profiles, corrugated sheet, screen doors, wall and roof cladding, roof bows and trusses, panels, gutters, purlins, fence posts, greenhouse profiles, grape stakes, logistic tracks, drawer slides, studs, beams, beads, shelf racks, sheet piling, guard rails, seat tracks, bumpers, truck and trailer components, window guide channel, seal retainer, cross-members, heat transfer pipes, garage doors, rack beams, duct flanges, drywall profiles, cable trays.

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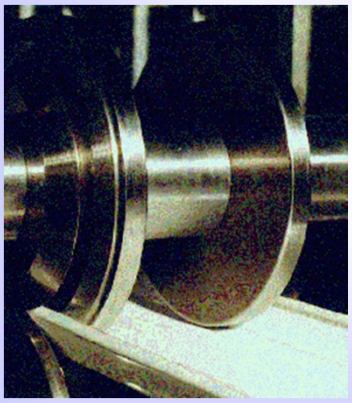
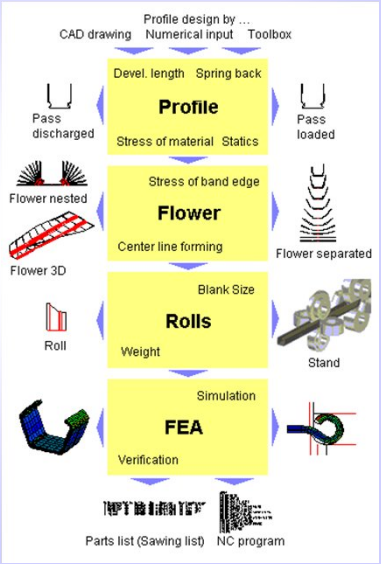
Preparing the roll forming operation





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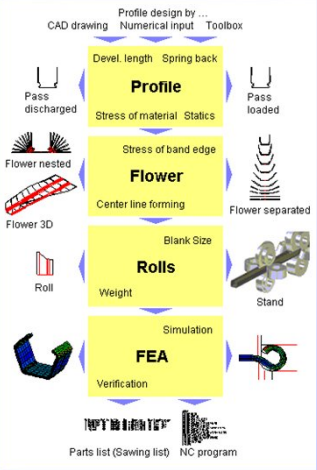

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Roll form design software for:

- defining the desired profile or tube cross-section and calculating the initial strip width
- defining the bending steps (flower pattern) dependent on the permissible longitudinal strain
- designing of the roll tools
- verifying the design by finite element analysis
- export of the manufacturing data

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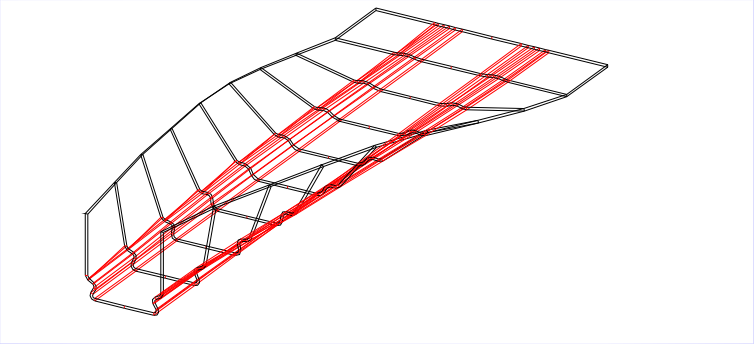
Strain in the longitudinal direction:



Problem:

- different profile segments take routes of different lengths
- this causes longitudinal strain especially at the edge
- exceeding the yield point leaves residual stress, causing unwanted deformations

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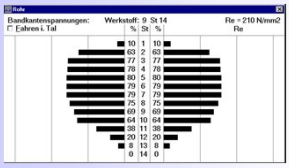
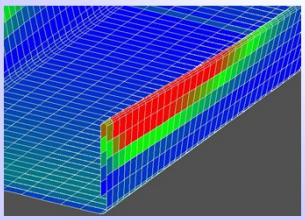
Fixing the Problem: 3-step Quality Management Concept

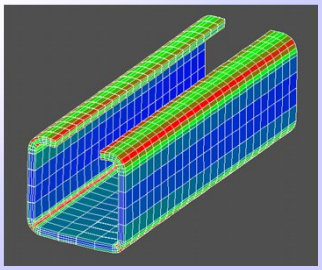
Step 1: Calculation of the stress of the edge



Step 2: Profile Stress Analysis (PSA)



Step 3: Virtual Rollforming Machine (Finit Element Analysis FEA)



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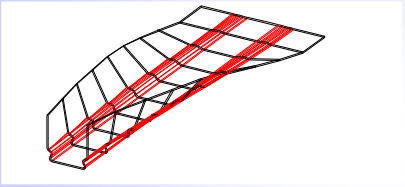
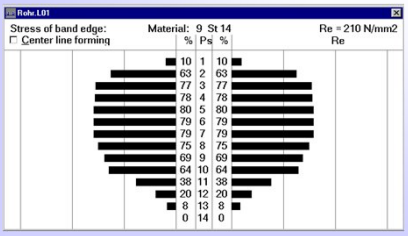
Calculation of the stress of the edge





Step 1 of the 3-step quality management concept. Calculation dependent on:

- distance between stands,
- yield point and Young's modulus of the material.
- center line or bottom line forming

Approximate calculation

- Useful during flower pattern creation, when rolls not yet exist
- Calculation at the edge only

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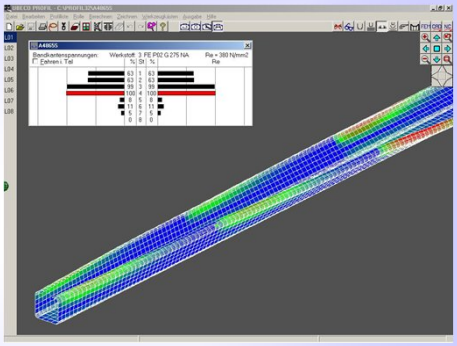
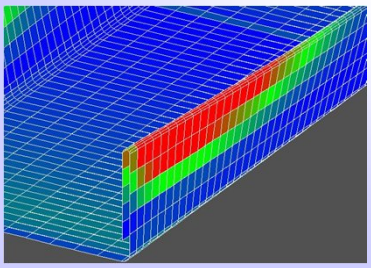
Profile Stress Analysis (PSA)

Step 2 of the 3-step quality management concept.

Calculation of the estimated longitudinal stress within the whole profile.

Without FEA.





Important for folded corners (hems)

Approximate calculation

- Useful during flower pattern creation, when rolls not yet exist
- Calculation in the whole profile cross-section

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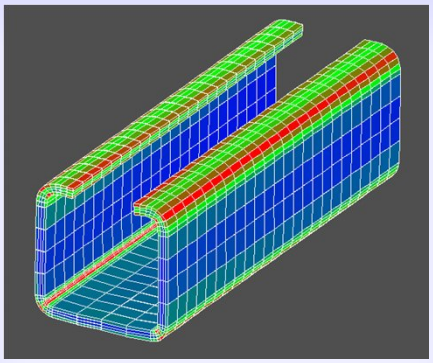

Simulation of the Roll Forming Process

with FEA (Finite Element Analysis)

Step 3 of the 3-step quality management concept

“Virtual Roll Forming Machine“

by Roland Brandegger, UBECO GmbH, Iserlohn (Germany)

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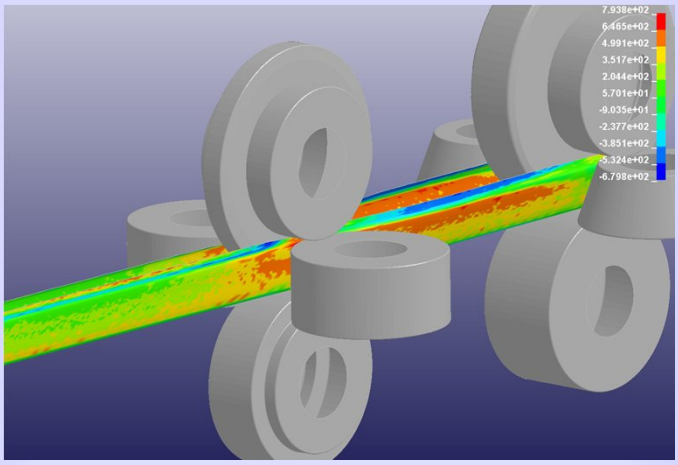

Interface to the FEA-System LS-DYNA
Developed in co-operation with DYNAmore

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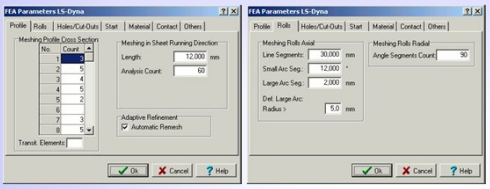
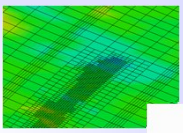
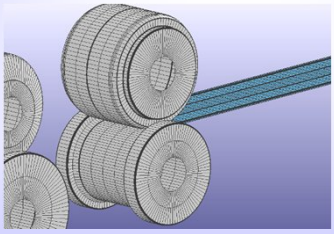
Proceeding the simulation:



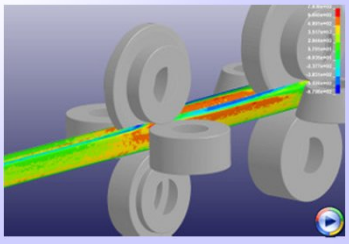
1. Entering the FEA parameter



Automesh



2. Running the solver



3. Analyzing the result

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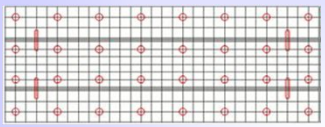
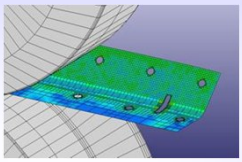
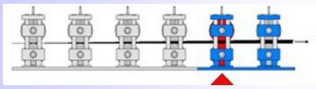
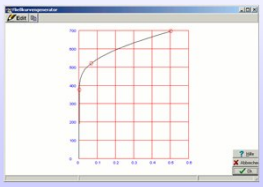
Defining bore holes and cut-outs

Restart after modifying a certain stand:



Entering the material properties

Stress-strain-curve generator

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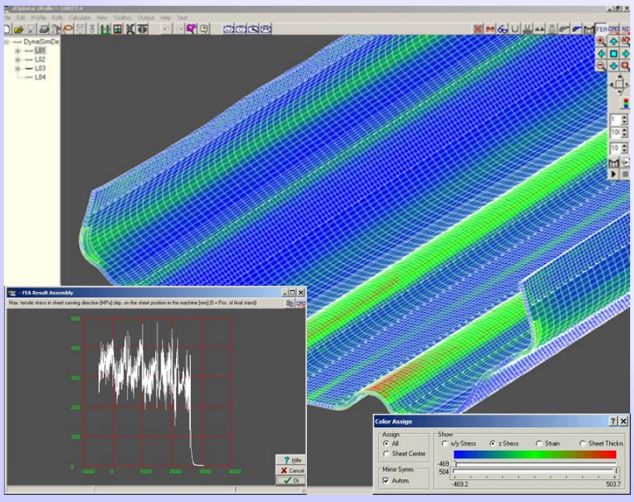
Analyzing the result of the FEA simulation with UBECO PROFIL



Representing the Results:

- Stress x/y
- Stress z
- Strain
- Sheet Thick-ness Reduction

at the:

- Top and Bottom Sheet Surface
- Sheet Center

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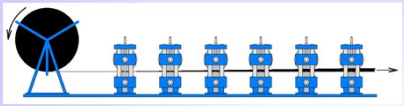
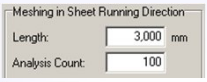
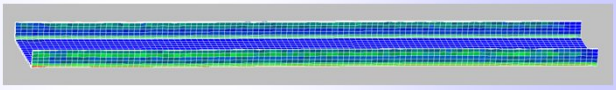


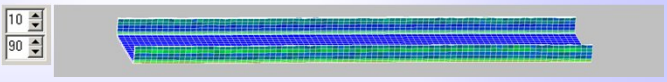
Reality:
Nearly unlimited length, decoiled from a coil

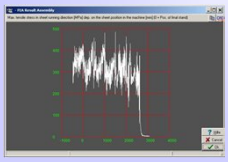
Simulation:
Sheet with finite length, thus deformations at the front and rear edge





Evaluation:
Trimmed sheet





Result:
Unrealistic deformations have no influence.

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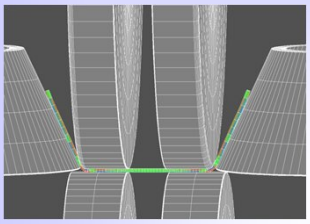

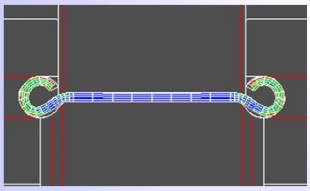

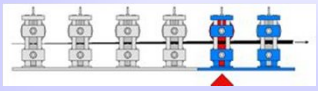

Analysing the results:

- Display the 2D cross section
- Check if dimensions are within specified tolerances

If unwanted deformations are shown:

- Step backwards to determine which stand causes the problem
- Modify the design
- Restart simulation

All this happens before the rolls are manufactured!