Forming of locally made sheet steels

Issues and Opportunities

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Local or locally?
Content

Local material
Process of press forming
Material characterisation
Strain analysis

inFOrming

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Challenges

Aim:

Use local material to produce press formed parts

Steps:

• Process requirements
  - Which material parameters are required by the process to achieve acceptable and reliable products
  - Which process parameters are of influence for the material

• Formability of material
  - What are the forming limitations of the given material and how can we measure them
  - Influence of coating to forming limitation

• Interaction between material / process
  - Surface, Lubrication, Material flow….
The local material
Local sheet material

- Made from black iron sand
- Thickness: ~ 0.3 mm to ~2.0 mm
- Base material: G250 to G550
- Alloying elements: C, P, Mn, S, Si, Al, N
- Coating:
  - Galvanized (Zinc)
  - Zinc/Aluminum
  - Colour
Process of press forming
Press forming

part samples

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Forming process

**Input parameter**
- Material properties
- Surface
- Lubricants
- Environment

**Process parameter**
- Machine parameter
- Tool parameter
- Material flow
- Tribology

**Output parameter**
- Material properties
- Part geometry
- Surface quality
- Accuracy

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Deep drawing

Tool is in the open position
Load new blank
Start process

Closing of the tool
High speed
Low force

Forming of the shape
Blankholder to prevent wrinkles
High force

Opening of the tool
Eject pressed part

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Process parameter
of influence to the forming result

- Punch and Die radii
- Punch-to-die-clearance
- Restraint of material flow
- Press speed

Errors
- Wrinkles
- Cracks
- Buckling
- Excessive thinning

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Material characterization
Formability...

Material characterisation with regards to forming operations

... depends on
  the deformation process
  bending [B]
  biaxial stretching [BS]
  drawing [D]
  plane-strain stretching [P]
  unbending [U]

... is not a material property

... of material can change with conditions

... is a combination of different tests results

Aim:
Complete description of forming limitations of the material!
Tensile testing
(uniaxial)

- Basis for defining mechanical properties of materials
- Highly standardised (AS, ISO, …)

Results
- Young’s Modulus $E$
- Yield strength
- Tensile strength UTS
- Uniform elongation
- Total elongation
- Strain Hardening exponent $n$
- Plastic strain ratio $r$
- Normal anisotropy $r_m$
- Planar anisotropy $\Delta r$

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Typical materials used in the automotive industry

- DC: Mild steel (drawing quality)
- BH: Bake Hardening steel
- IF: Interstitial Free steel
- DP: Dual Phase steel
- TRIP: Transformation Induced Plasticity steel
- CP: Complex Phase steel
- MS: Martensitic steel

Graph showing the relationship between elongation and ultimate tensile stress for various materials:

- Steel types: DC 04-06, G250, G300, G550, TRIP
- Aluminium types: 5xxx, 6xxx, 7xxx, 7StE, G550

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Strain analysis

Based on Forming Limit Diagram (FLD) and Forming Limit Curve (FLC)

Method

- Grid is applied to surface of flat steel sheet
- Material is formed to desired shape
- Circles become ellipses
  - longest dimension is major axis
  - shortest dimension is minor axis
- Measure length of axes
- Calculate strain
- Add value pair to Forming limit diagram
Use of strain analysis

- Analysis and optimisation of the forming process
- Shorter prototype development time
- Quality control of serial parts
- Verification of FE-simulations
- Measurement of sheet thickness (indirect)
Objectives:

- Be research institution for metal forming in NZ
- Support NZ industry in all questions concerning forming of sheet metals
- Develop an industry sector group
- Strengthen position of NZ companies by combined research activities
Capabilities:

- Experimental & theoretical analysis of press forming processes
- Experimental & theoretical analysis of roll forming processes
- Analysis of metallurgical composition of materials
- Material characterisation
  - Strain analysis
  - Tensile testing with longitudinal and transversal extensometer
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Technical data:
Capacity: 80 ton
Daylight: 762 mm
Stroke: 350 mm
Table Size: 505 x 650 mm
Drive: Hydraulic
Type: Single acting

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Thank you

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