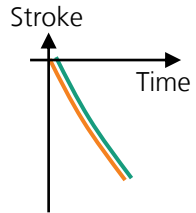


Advanced Deep Drawing Processes

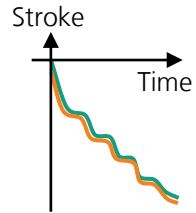
Bi-Directional-Drawing (BDD) and Cushion-Ram-Pulsation (CRP)

Pulsation in Sheet Metal Forming

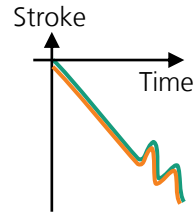
Technology overview



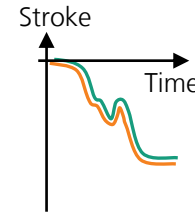
deep drawing



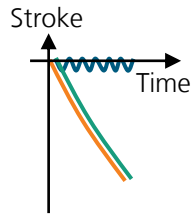
interrupted deep drawing



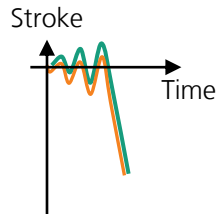
stroke return deep drawing



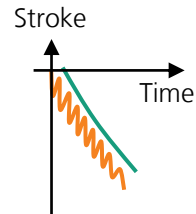
adapted deep drawing



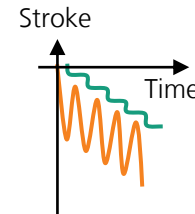
Punch pulsation



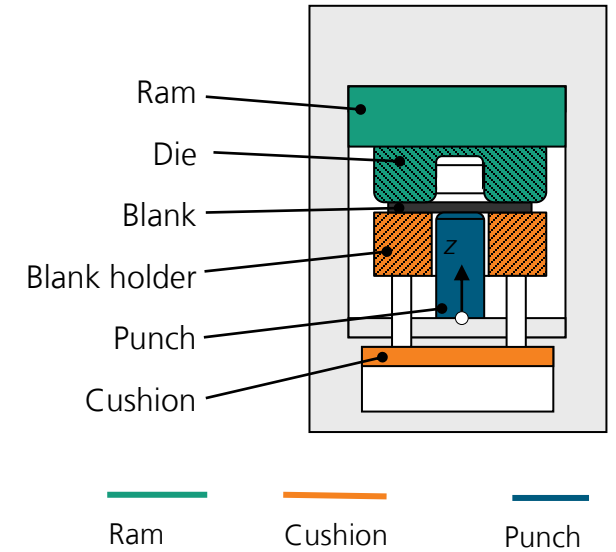
Bi-Directional deep Drawing (BDD)



cushion pulsation



Cushion-Ram Pulsation (CRP)



Bi-Directional Drawing (BDD)

Overview

»BDD-Effect«

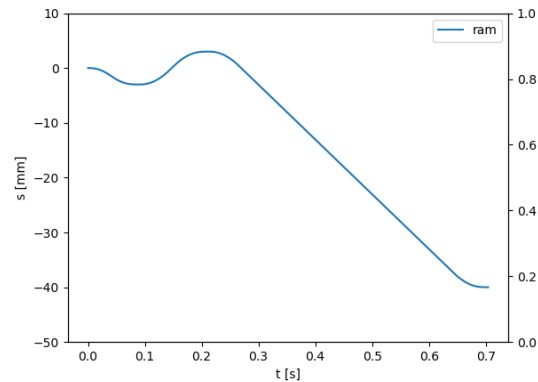
The initial »alternate bending« leads to material hardening in the area of the stamp radius. Thus, non-hardened areas started earlier to flow and higher forces can be transmitted in the sheet metal.

Benefits

- Improved formability
- Increased drawing depth up to 30% (depending on geometry and material)
- Less springback

Applications

- Small series
- Series production
- Body parts



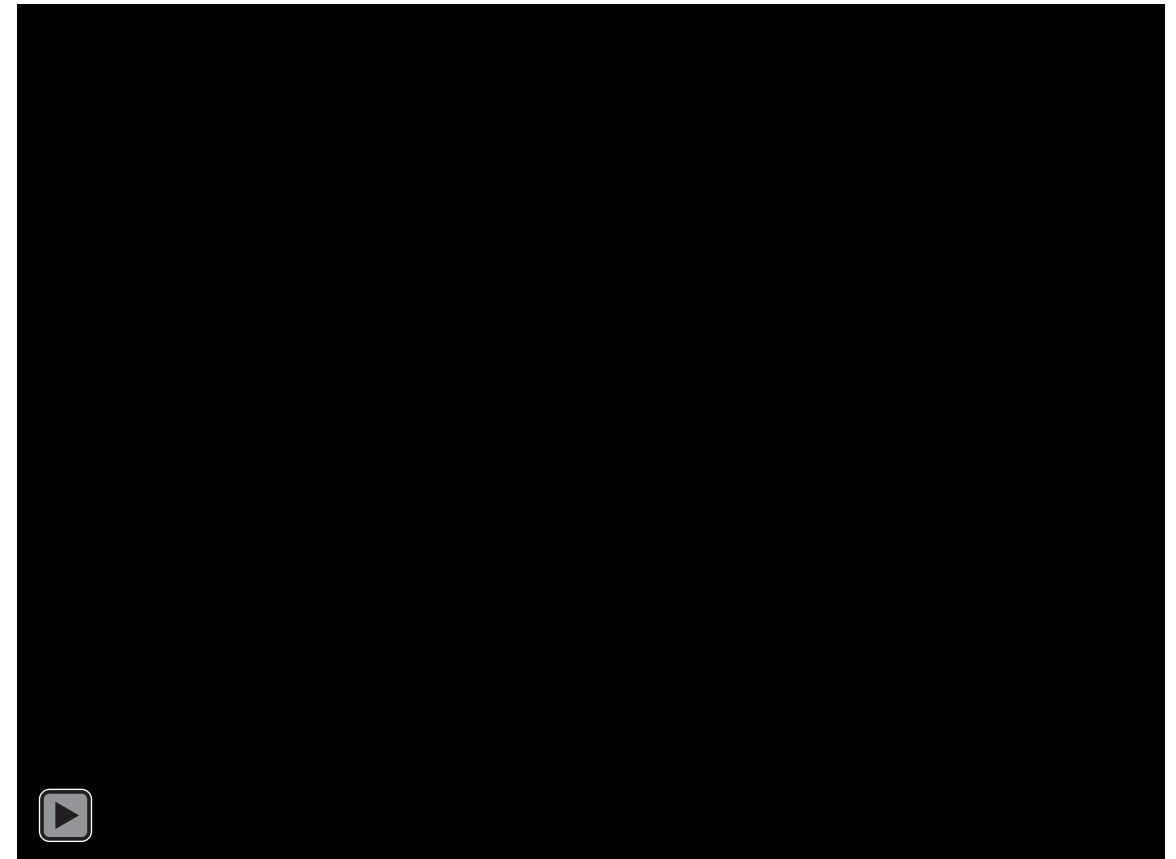
Challenges

- Complex process development
- Machinery

Materials

- Steep hardening material
- High and ultra high strength materials

(Enable Multimedia and 3D content in Adobe Acrobat Reader or [click here](#) to view video.)

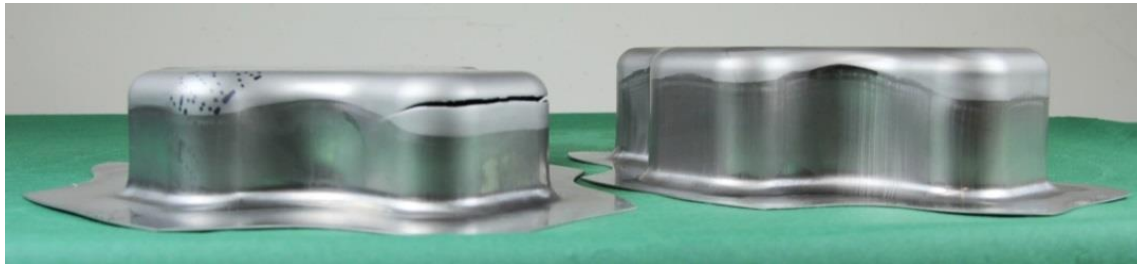


Bi-Directional Drawing (BDD)

Example parts

Deep drawing 45 mm with crack

BDD and deep drawing 60 mm



Cross cup (Daimler-Benchmark)

- Material: stainless steel (1.4301)
- Thickness: 1.0 mm
- 30% higher drawing depth with BDD

Deep drawing 20,5 mm with crack

BDD and deep drawing 29 mm

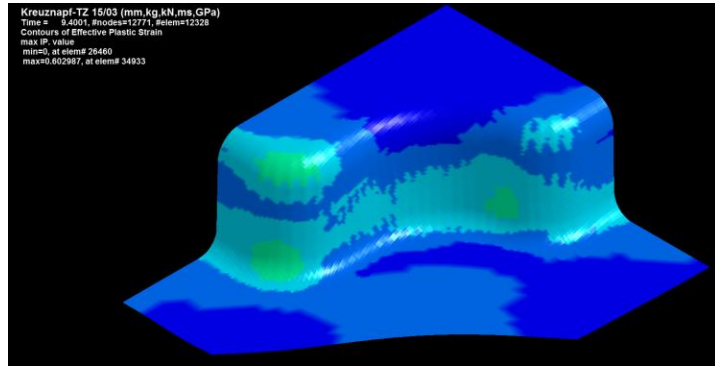


Sharp edge with R2.5 mm and R20 mm

- Material: DP800
- Thickness: 1.0 mm
- 50% higher drawing depth with BDD

Bi-Directional Drawing (BDD)

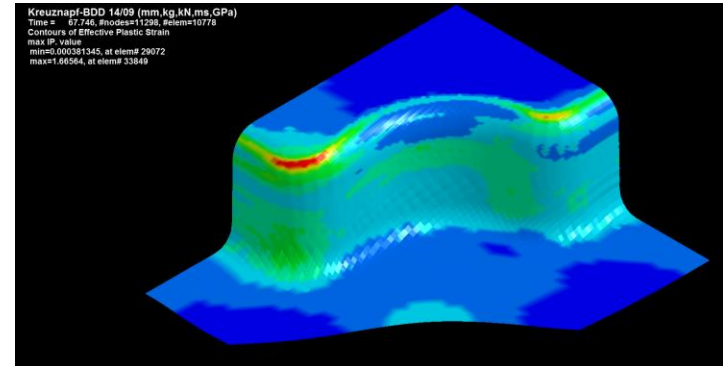
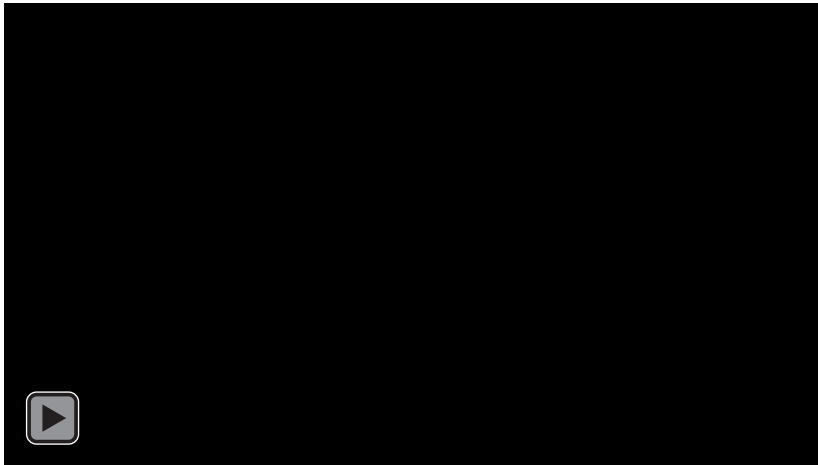
Simulation



Deep drawing
46 mm

Hardening - effective plastic strain

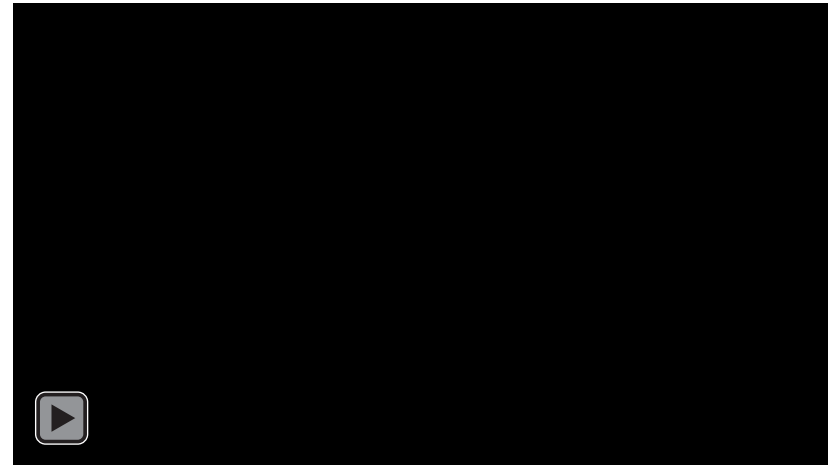
(Enable Multimedia and 3D content in Adobe Acrobat Reader or [click here](#) to view video.)



BDD
60 mm

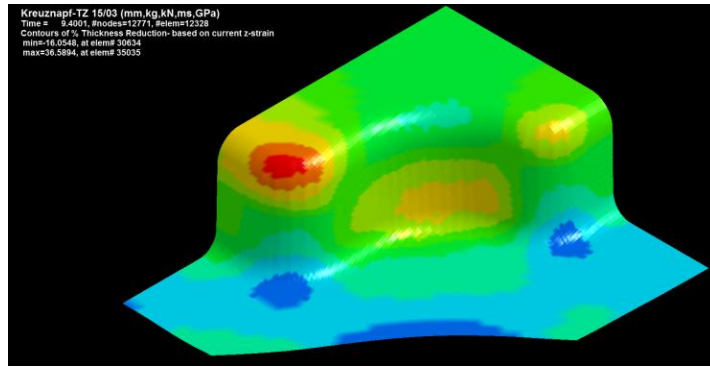
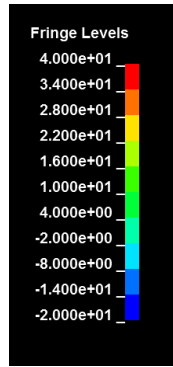
Hardening - effective plastic strain

(Enable Multimedia and 3D content in Adobe Acrobat Reader or [click here](#) to view video.)



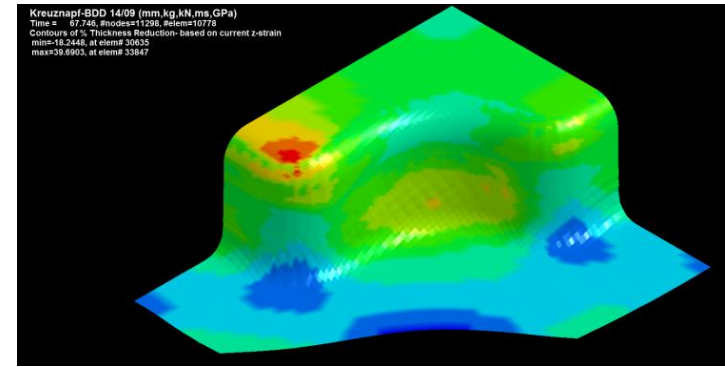
Bi-Directional Drawing (BDD)

Simulation



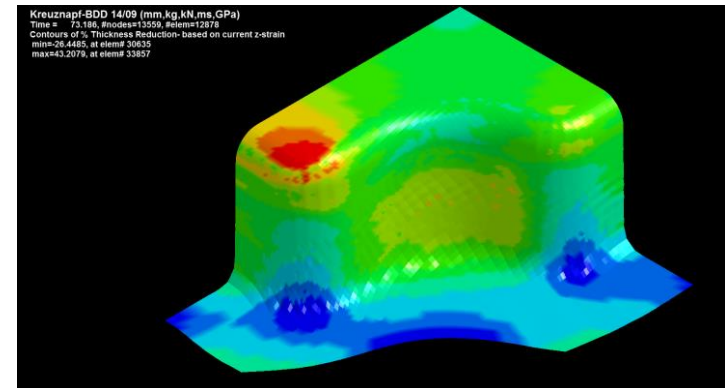
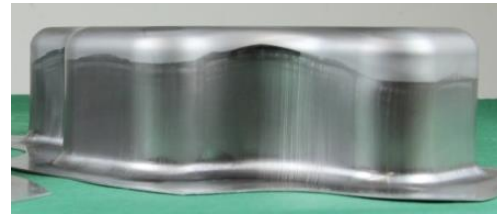
Deep drawing
46 mm

Thinning



BDD
46 mm

Thinning



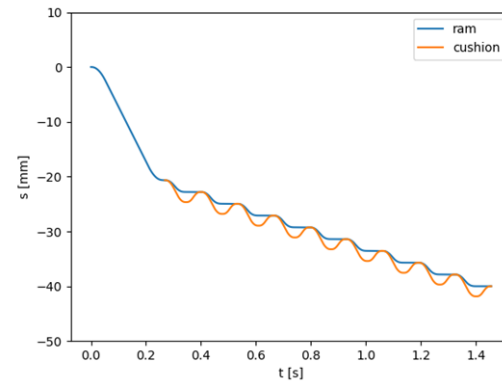
BDD
60 mm

Cushion-Ram-Pulsation (CRP)

Overview

»CRP-Effect«

The gap between cushion and ram enables a better material flow during the drawing. This results in lower forces having to be transmitted in the sheet metal. While the ram stops, cushion flattens occurring wrinkles.



Benefits

- Improved formability
- Increased drawing depth up to 50% (depending on geometry and material)

Applications

- Small series
- Body parts (no visible parts)

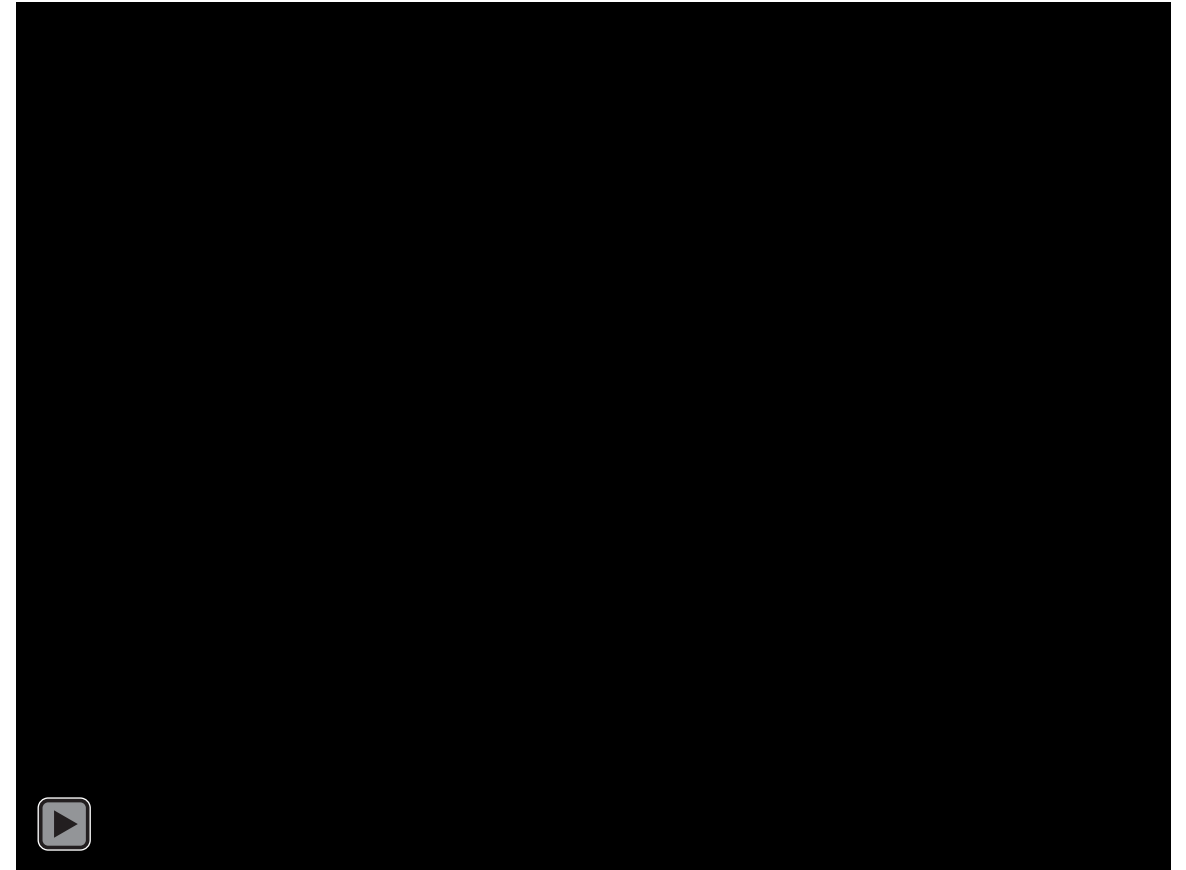
Challenges

- Complex process development
- Expensive machinery
- High processing times
- Potential occurring wrinkles

Materials

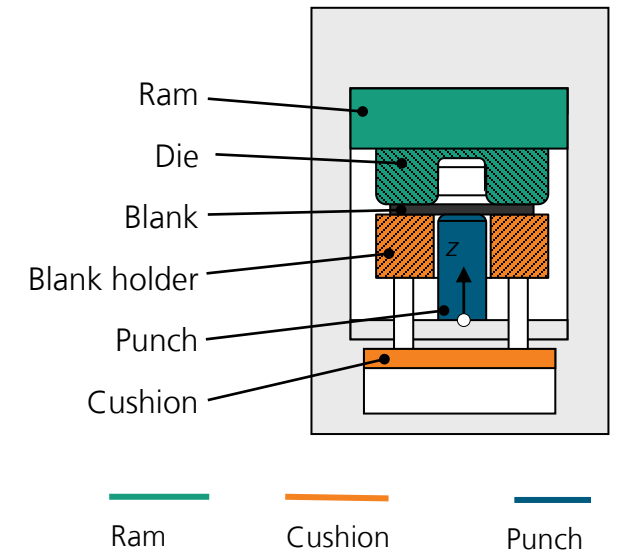
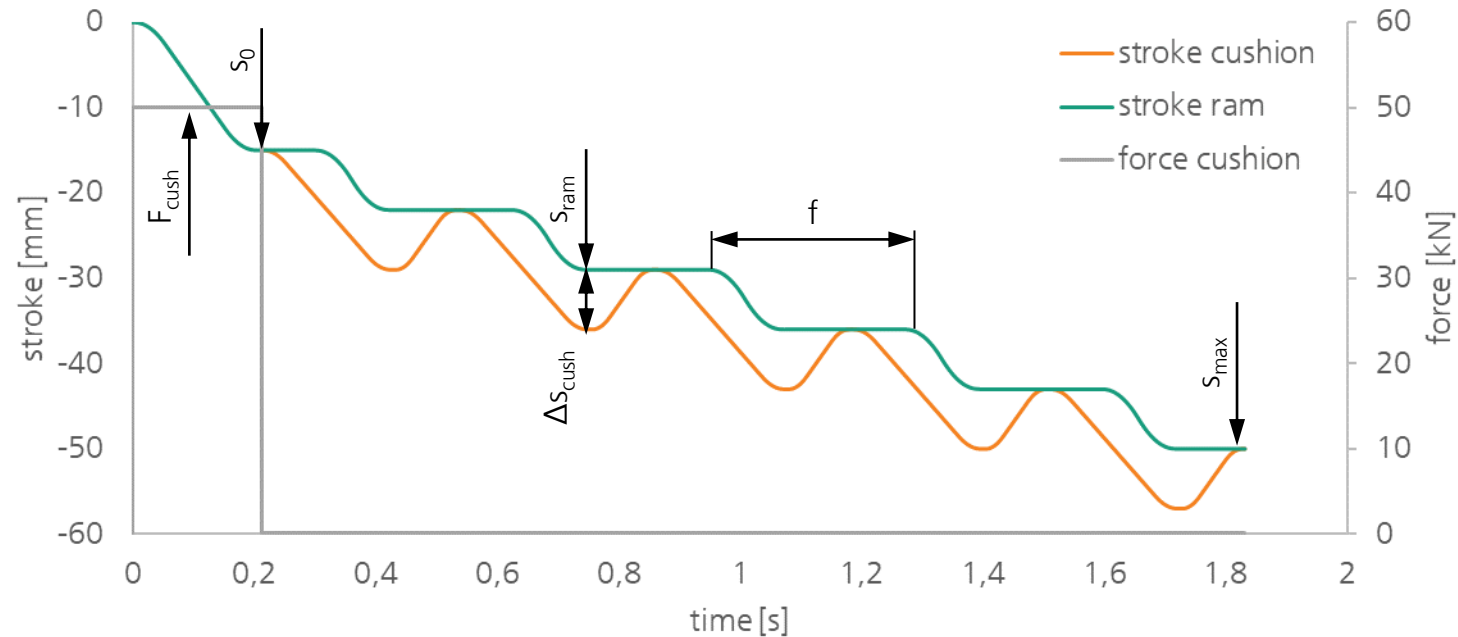
- Mild and high strength materials
- E.g.: DC06, DP800

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Cushion-Ram-Pulsation (CRP)

Principle



Parameter

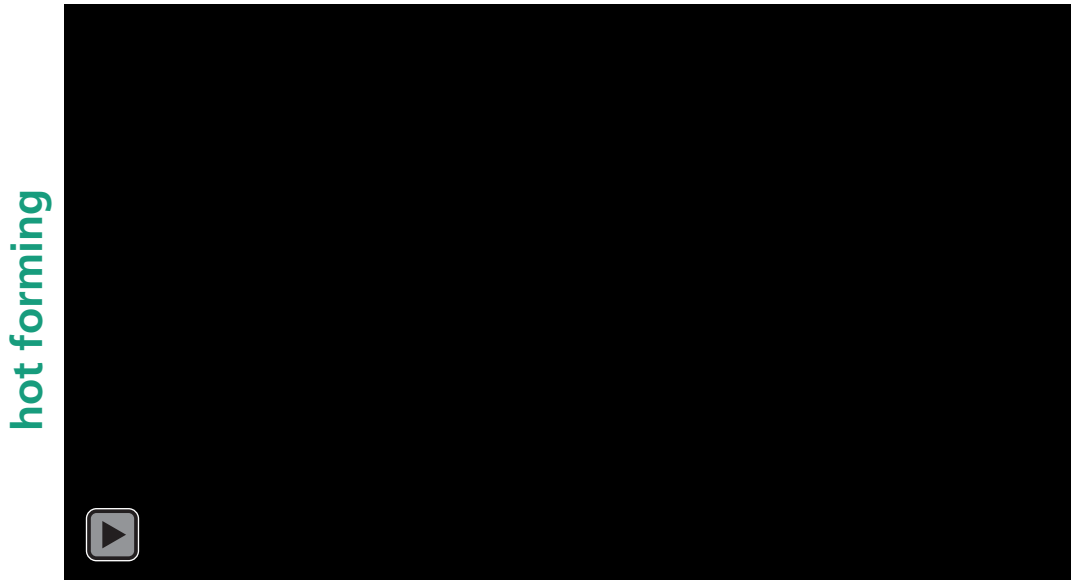
1. Drawing depth (s_{max})
2. Initial drawing depth (s_0)
3. Force cushion (F_{cush})
4. Frequency pulsation (f)
5. Stroke ram (s_{ram})
6. Additional stroke cushion (Δs_{cush})

* Pulsation can run at more than 10Hz; this corresponds to 600ms for 6 cycles; assuming a process time of 10s for a standard process, pulsation increases the time by 6% or less

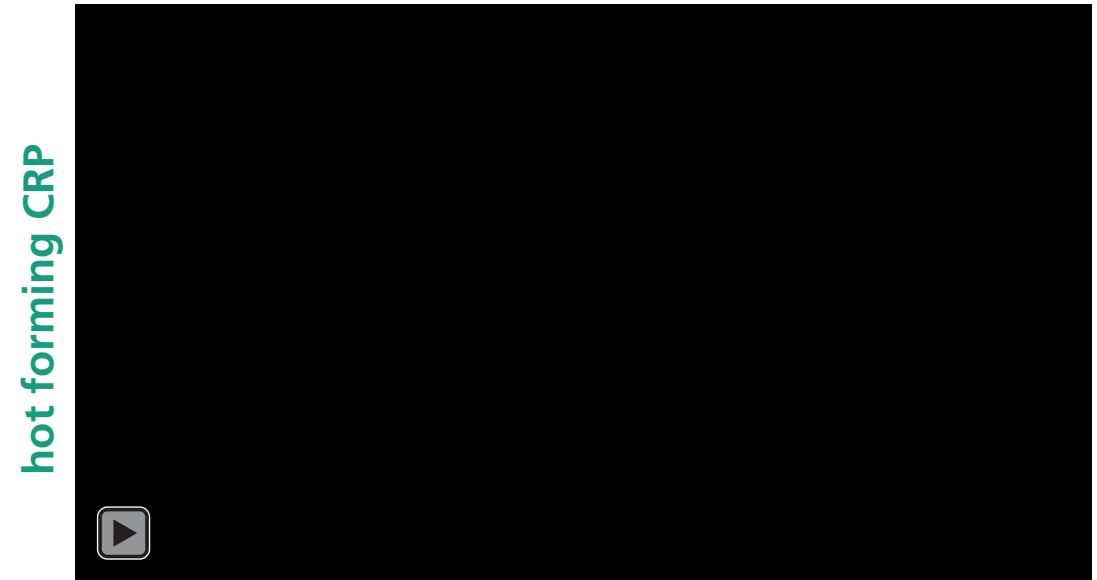
Cushion-Ram-Pulsation (CRP)

Example parts - hot forming

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Heating

- Material: 22MnB5
- Temperature furnace: 950 °C
- Heating time: 8 min
- Transfer time: 6 s

Forming

- blank diameter: 170 mm
- ram speed: 200 mm/s
- flange gap: 2 – 4 mm
- variable motion profiles*

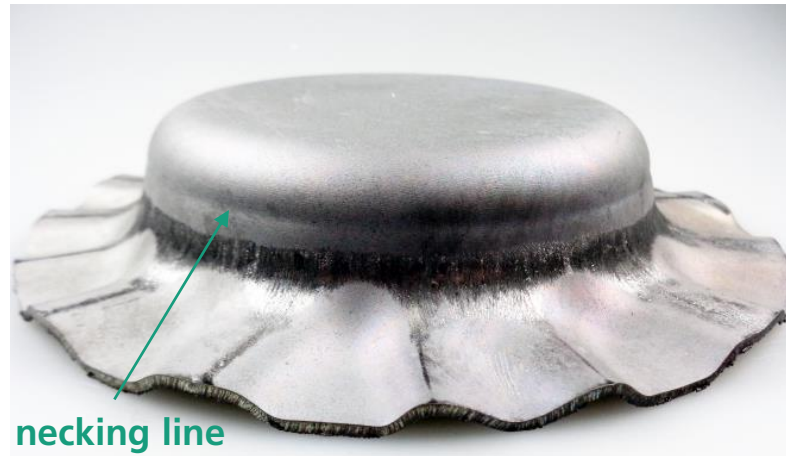
Quenching

- non-cooled tool ($T_{\max} < 100$ °C)
- tool holding time: 7 s

Cushion-Ram-Pulsation (CRP)

Example parts - hot forming

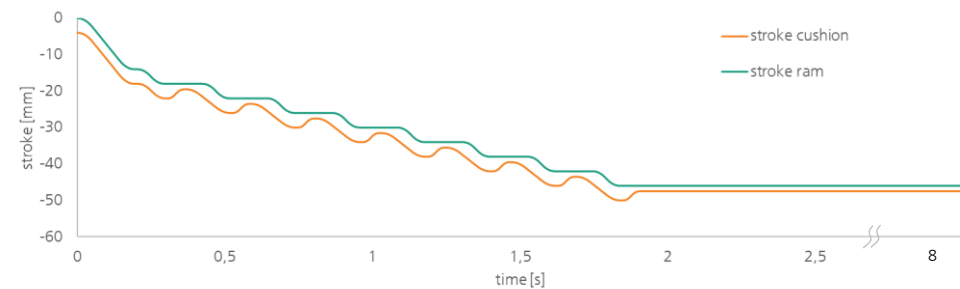
hot forming



hot forming CRP



	hot forming	hot forming CRP
max. drawing depth	26 mm	46 mm
max. hardness level	460 HV1 (bottom)	520 HV1 (wall)
max. sheet thinning	18.7 %	14 %



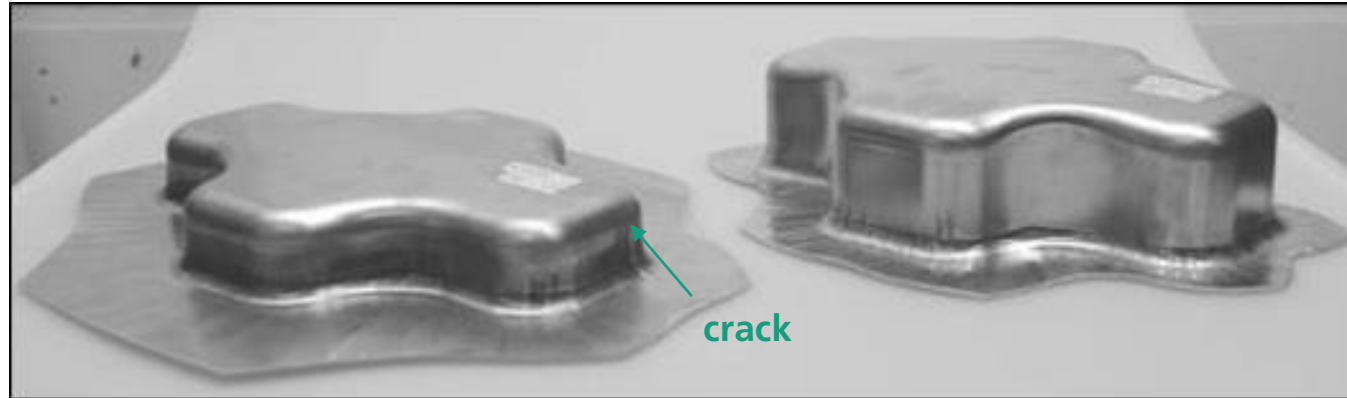
Cushion-Ram-Pulsation (CRP)

Example parts - cold forming (Aluminum)

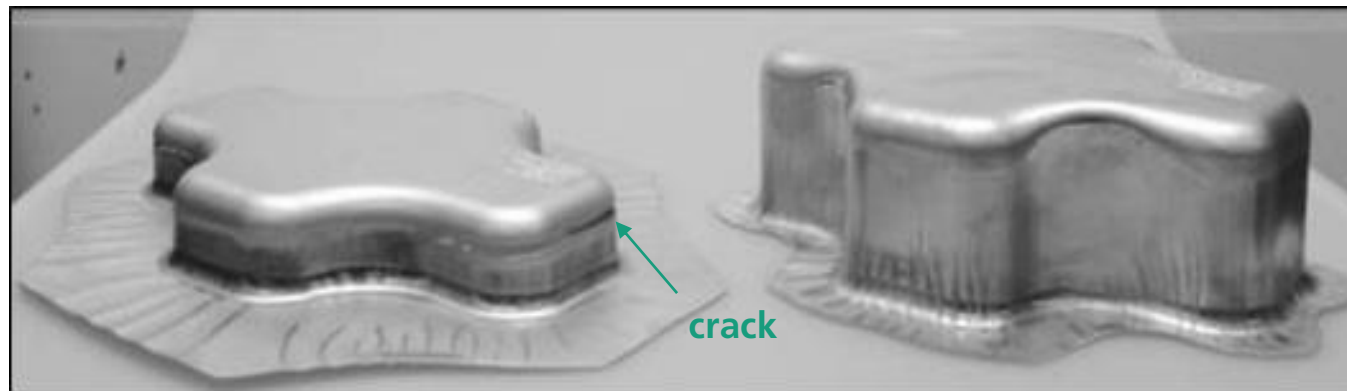
Deep Drawing

CRP

AA5083

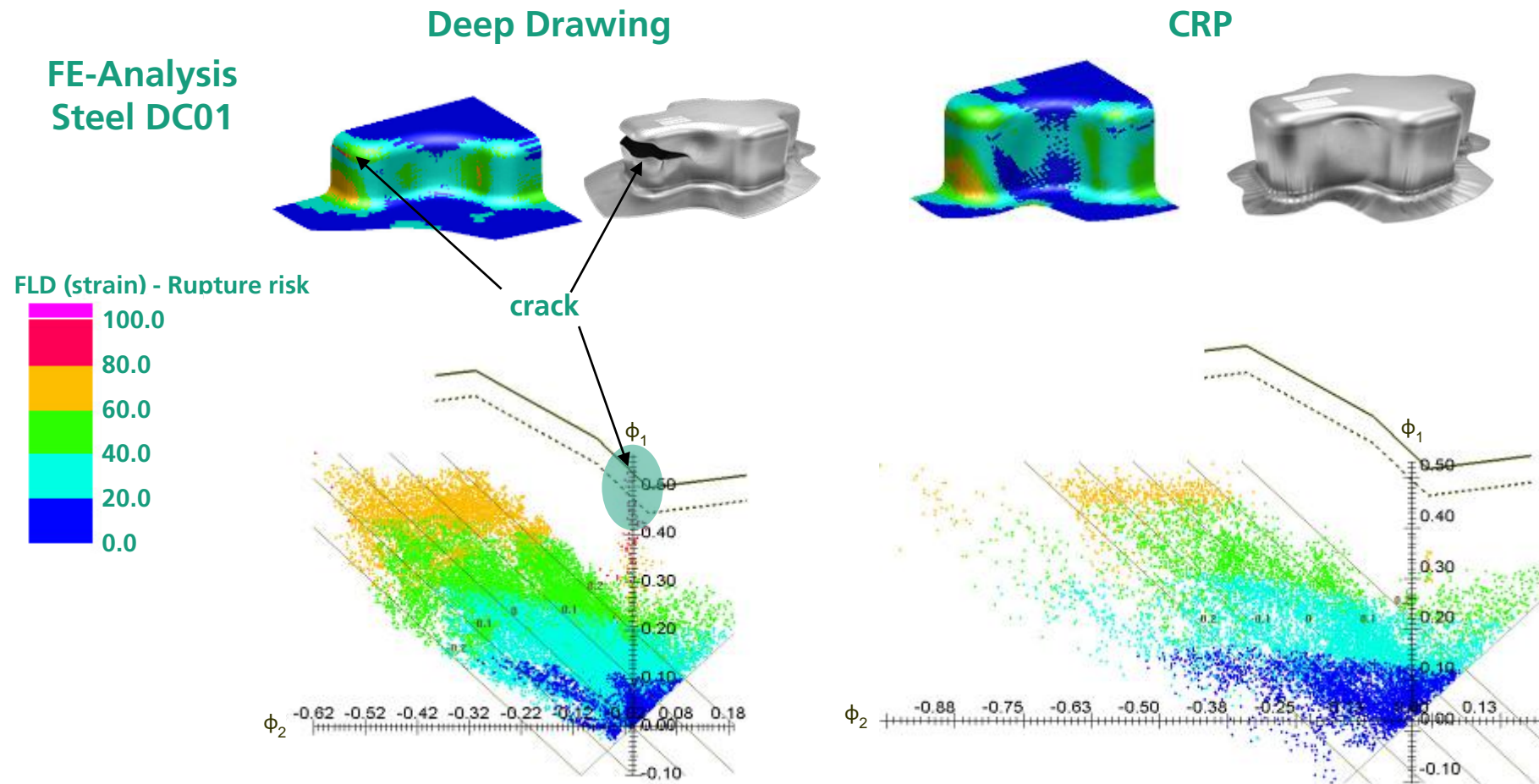


AA6016
300x150 mm



Cushion-Ram-Pulsation (CRP)

Simulation



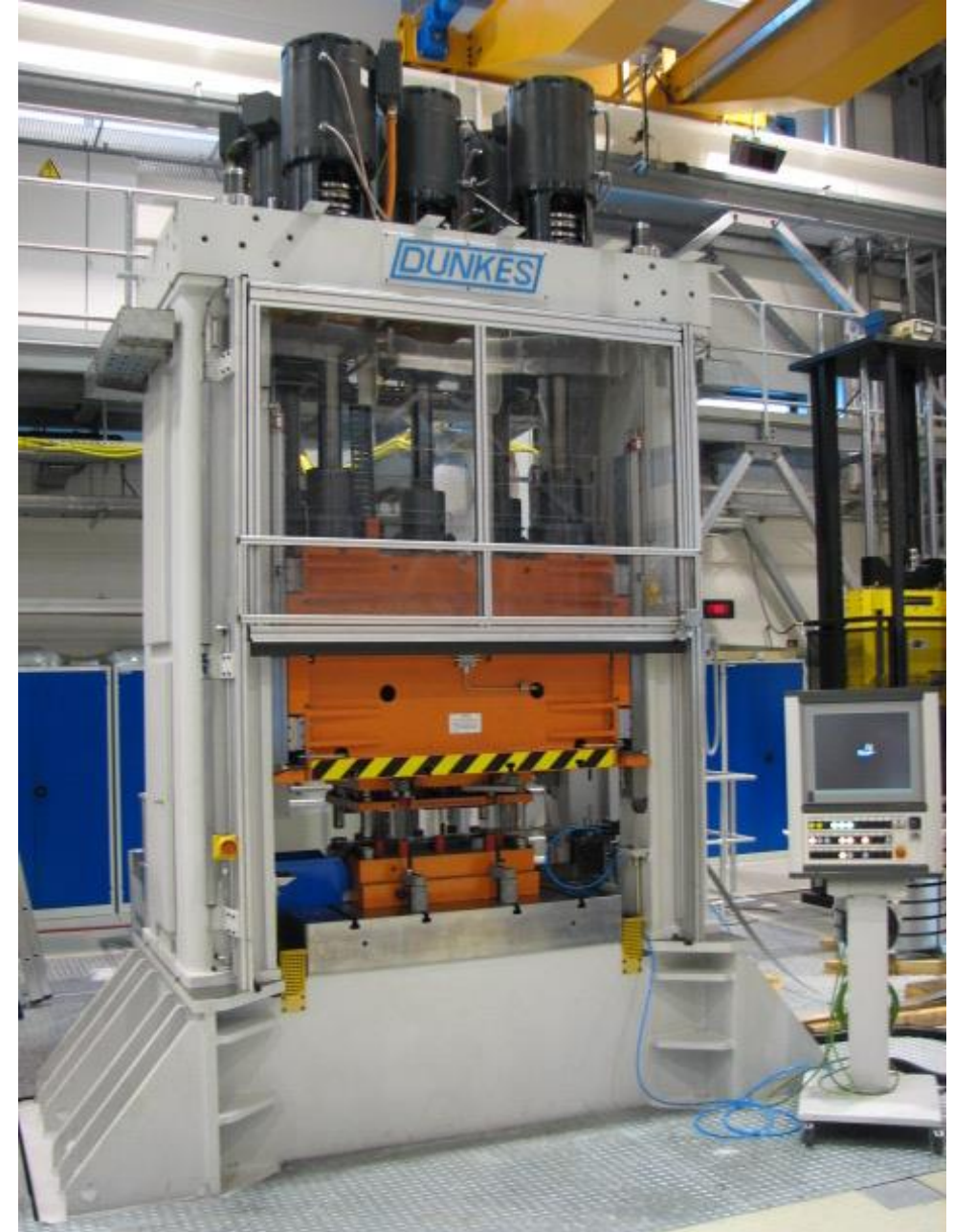
Machinery

Servo-spindle press

Servo-press is installed in lab at Fraunhofer IWU in Dresden (Germany).

Technical data:

	ram	cushion
Force [kN]	1,600	1,200
Stroke [mm]	645	180
Dimension table [mm]	1,000 x 1,400	
Velocity [mm/s]	290	100
Acceleration [mm/s ²]	2,000	3,500





Patrick Link

Phone +49 351 4772-2621

patrick.link@iwu.fraunhofer.de



Prof. Dr. Reinhard Mauermann

Phone +49 351 4772-2400

reinhard.mauermann@iwu.fraunhofer.de

Fraunhofer IWU

Nöthnitzer Strasse 44

01187 Dresden, Germany

www.iwu.fraunhofer.de