

# NUMISHEET 2002 Benchmark:

## Benchmark Test B. Unconstrained Cylindrical Bending

Blank Material: Steel (High Strength Steel)

Blank Cutting Angle: 90° from RD

1. Punch force vs. Punch displacement 2. Angles before and after springback 3. Angles between  
(number of points: at least 10, max. 10 (at the final punch stroke of 28.5mm) (which are the first

No.	punch displacement	punch force
	d (mm)	F (kN)
1	0	0
2	-0.4	-0.05364
3	-0.8	-0.106956
4	-1.2	-0.132941
5	-1.6	-0.14336
6	-2	-0.149838
7	-2.4	-0.154847
8	-2.8	-0.158756
9	-3.2	-0.162189
10	-3.6	-0.16547
	-4	-0.168411
	-4.4	-0.170941
	-4.8	-0.174147
	-5.2	-0.175227
	-5.6	-0.17835
	-6	-0.180404
	-6.4	-0.184076
	-6.8	-0.187512
	-7.2	-0.190414
	-7.6	-0.193592
	-8	-0.197571
	-8.4	-0.200051
	-8.8	-0.202541
	-9.2	-0.206498
	-9.6	-0.209423
	-10	-0.212744
	-10.6	-0.216893
	-11	-0.219834
	-11.4	-0.222376

	angle
	$\theta$ (°)
Before springback	21.95
After springback	35.7

punch stroke (mm)
7
14
21
28.5

-11.8 -0.227434  
-12.2 -0.229985  
-12.6 -0.233816  
-13 -0.23573  
-13.4 -0.239209  
-13.8 -0.242639  
-14.2 -0.249759  
-14.6 -0.251931  
-15 -0.256817  
-15.4 -0.261243  
-15.8 -0.264321  
-16.2 -0.265652  
-16.6 -0.269769  
-17 -0.273945  
-17.4 -0.273053  
-17.8 -0.280448  
-18.2 -0.281636  
-18.6 -0.287413  
-19 -0.288497  
-19.4 -0.296696  
-19.8 -0.294378  
-20.2 -0.295911  
-20.6 -0.303785  
-21 -0.305164  
-21.4 -0.310162  
-21.8 -0.31246  
-22.2 -0.305242  
-22.4 -0.311899  
-22.6 -0.314936  
-22.8 -0.316537  
-23 -0.313708  
-23.2 -0.312707  
-23.4 -0.320243  
-23.6 -0.319488  
-23.8 -0.319  
-24 -0.314522  
-24.2 -0.316227  
-24.4 -0.31745  
-24.6 -0.313995  
-24.8 -0.310283  
-25 -0.316946  
-25.2 -0.314902

-25.4	-0.313675
-25.6	-0.307798
-25.8	-0.305719
-26	-0.310088
-26.2	-0.308233
-26.4	-0.304399
-26.6	-0.29492
-26.8	-0.297071
-27	-0.2948
-27.2	-0.290584
-27.4	-0.292064
-27.6	-0.291025
-27.8	-0.282947
-28	-0.275312
-28.2	-0.26807
-28.4	-0.26363
-28.5	-0.259736
-28.5	0
-28.5	0
-28.5	0
-28.5	0
-28.5	0

two contact points,      4. Bifurcation stroke of contact state  
hest from the centerline)

angle
$\theta$ (°)
18.61
60.62
106.63
151.45

stroke (mm)	5.1
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