VI INTERNATIONAL CONFERENCE ON FORMING 2002

Centro de Inovação Tecnológica em Processos de Conformação Mecânica - CITECOM **e** IGEA **- Instituto Gaúcho de Estudos Automotivos**

(LdTM/UFRGS)

Gramado, Brazil

Special Tool layout for the use of brittle material inserts in tools for cold forging

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CPM GmbH, Herzogenrath

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Wallram Werkzeugtechnik GmbH, Essen

CPM GmbH and Wallram GmbH investigated in new materials and related methodes for tool layout and tool production to use brittle materials in tool layouts for Cold forging.
Suitable construction and production methods as well as FEA calculations of the production process and the tools (done with Eesy-2-form) and shrink ring layout analysis by the Matria systems of Schweers were used.

October 2002

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There is a discussion ongoing for some time to use not only carbide inserts in cold forging tools but also other materials like ceramics. Ceramics may offer significant advantages because of is physical data. The question of separating the forged material from the tool material Which is important for steel materials is solved. By choosing the right lubrification a coating of the tools is no more necessary. Also the tool wear should be considerably better than with conventional materials. Corresponding attempts in the industry have not led to successes since the brittleness of these materials has already led to early breakage. Therefore no pertinent experiences over tool life could be gathered. Normally he cause for the premature failure was the sensitivity of these materials against any positive stresses. Tensile stresses could not be avoided completely by the chosen tool-layouts so that the tools failed early.

The task designation in the cooperation of CPM GmbH and Wallram GmbH was to find a suitable tool layout and construction to avoid tensile stress in tool inserts and therefore allows to use brittle materials in tools for cold forging. A way was chosen to do a suitable tool layout. This will be described in this presentation.

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First, the intended process was analyzed with the help of FEA simulations. Corresponding analyses of the tools were enforced and a tension-analysis of the tool-components (in accordance with the intended construction) was performed.

From these examinations, realizations were won over minimum pre-stressing of the components in order to guarantee a pure pressure condition also under load in the brittle-material-component.

With these results, the intended four-ring-system was examined with help of the program Matria. Hereby, the suitable interferences, with which the tools must be built, could be determined in order to generate the necessary pressure-stresses in the assembly.

An “easy to change”-system, with which in the wear-case only the reduction insert must be replaced, should be built because of the planned high production-number of pieces. The brittle insert should be covered by a carbide ring to reach high pre-stressing. A four-ring-system was chosen which in the sequence ring 1 in ring 2, ring 3 in ring 4 and then ring 1+2 in ring 3+4 („Sequence 1+2 in 3+4 “) was joined..

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In the first step the inside-pressure known from the FEM and the planned inside - and outside diameter were inputed and the tool-materials were selected. For standardization-reasons the joint-diameter D2 was fixed at 16 mm. The interferences and the diameters D3 and D4 were determined by using the available optimization-methods then.

The found interpretation seemed to be suitable to allow essential higher inner pressure as demanded. An examination of the producible-ness of the individual interferences made a correction of the interference in the first system necessary.

The interference S1 had to be limited to max. 0,12%. Using this a tool-system with a maximum loading capacity of 1500 N/mm**2 could be produced. The check of the stress-distributions in the tool-system showed that no altering Tensile/pressure-situations appeared.
Because of the different E-module of the brittle-material and the carbide-metal, another adaptation of the interferences was necessary in order to reach an uniform joint-pressure-distribution. With this the tool-system was laid out optimally.

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The to expected assembly- and disassembly-load was determined with the calculation-program Reibkra with 21 tons.

Last bad not least it needed a corresponding production-technology and assembly-method, that allowed to assemble the components with the demanded pre-stressing and precision.

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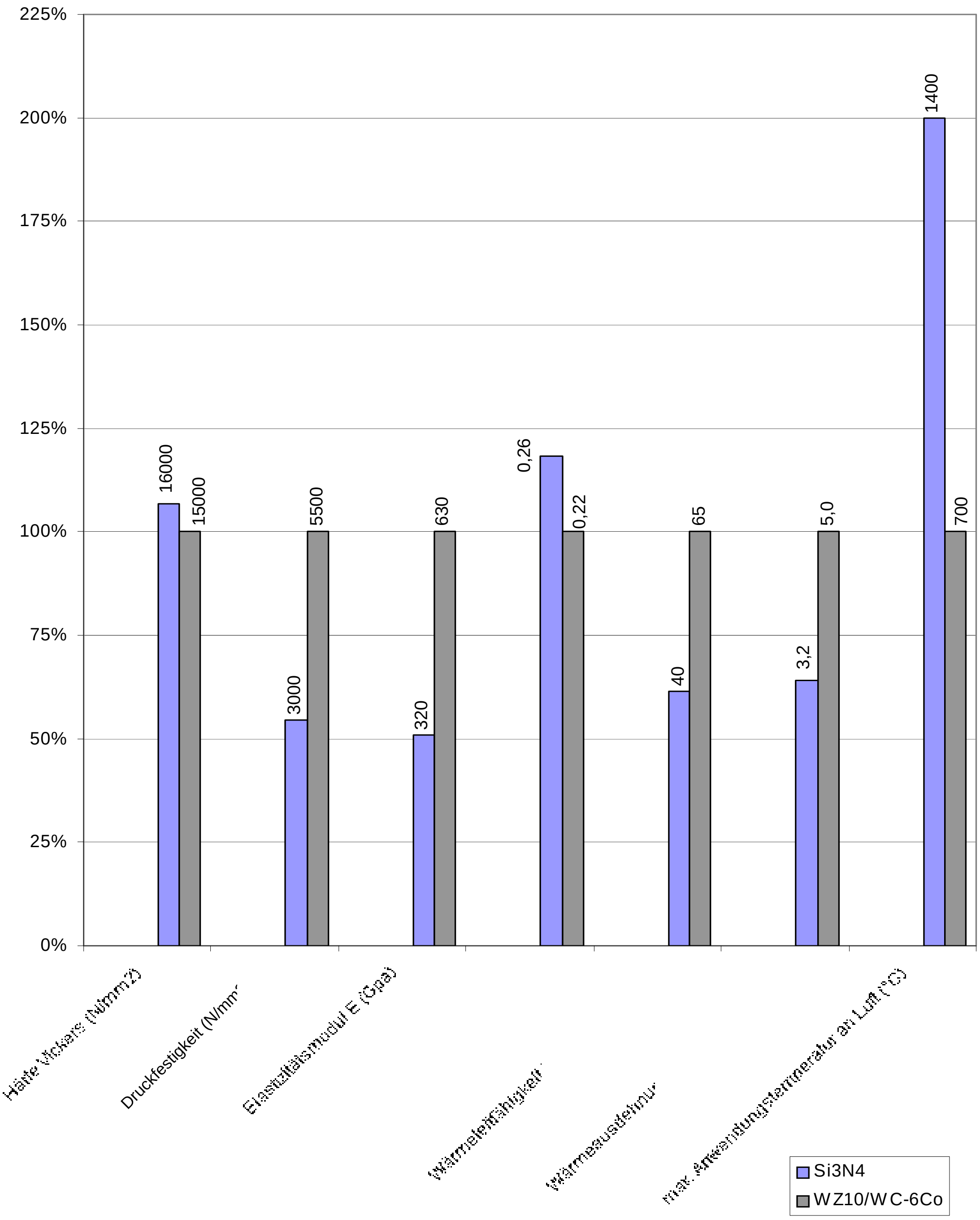
WALLRAM

Mechanic and Thermic Material Properties

Ceramik-Carbide



Die angegebenen Daten basieren auf Literaturangaben und sollten daher nur als Richtgrößen angesehen werden.

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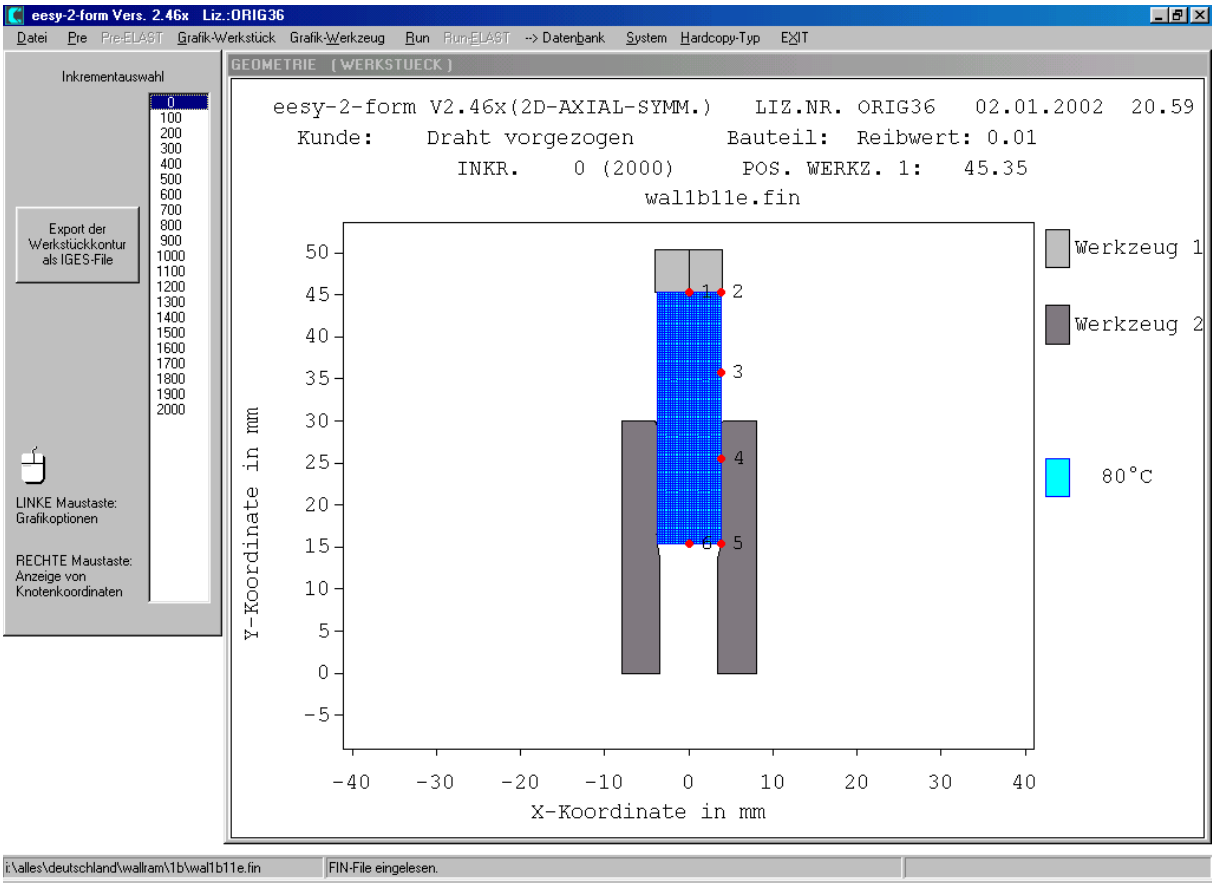

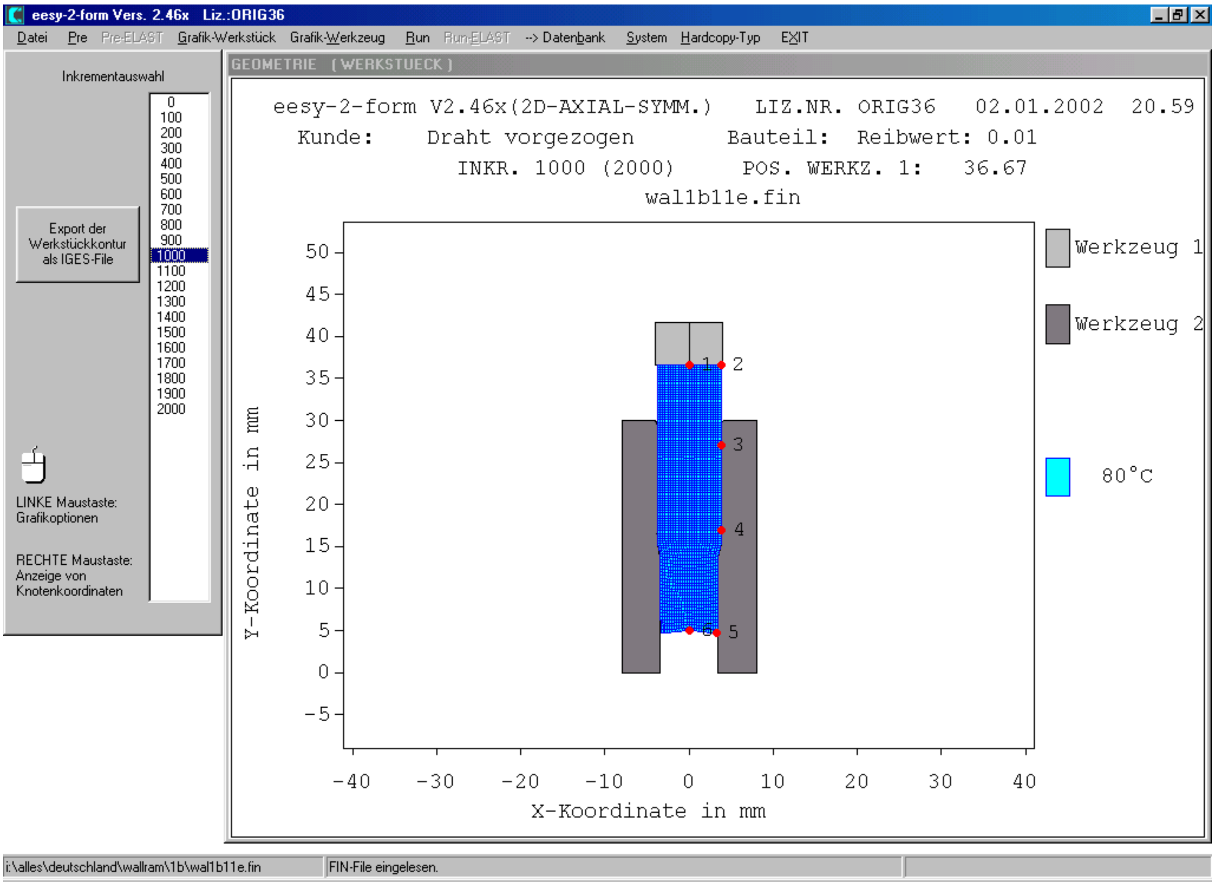

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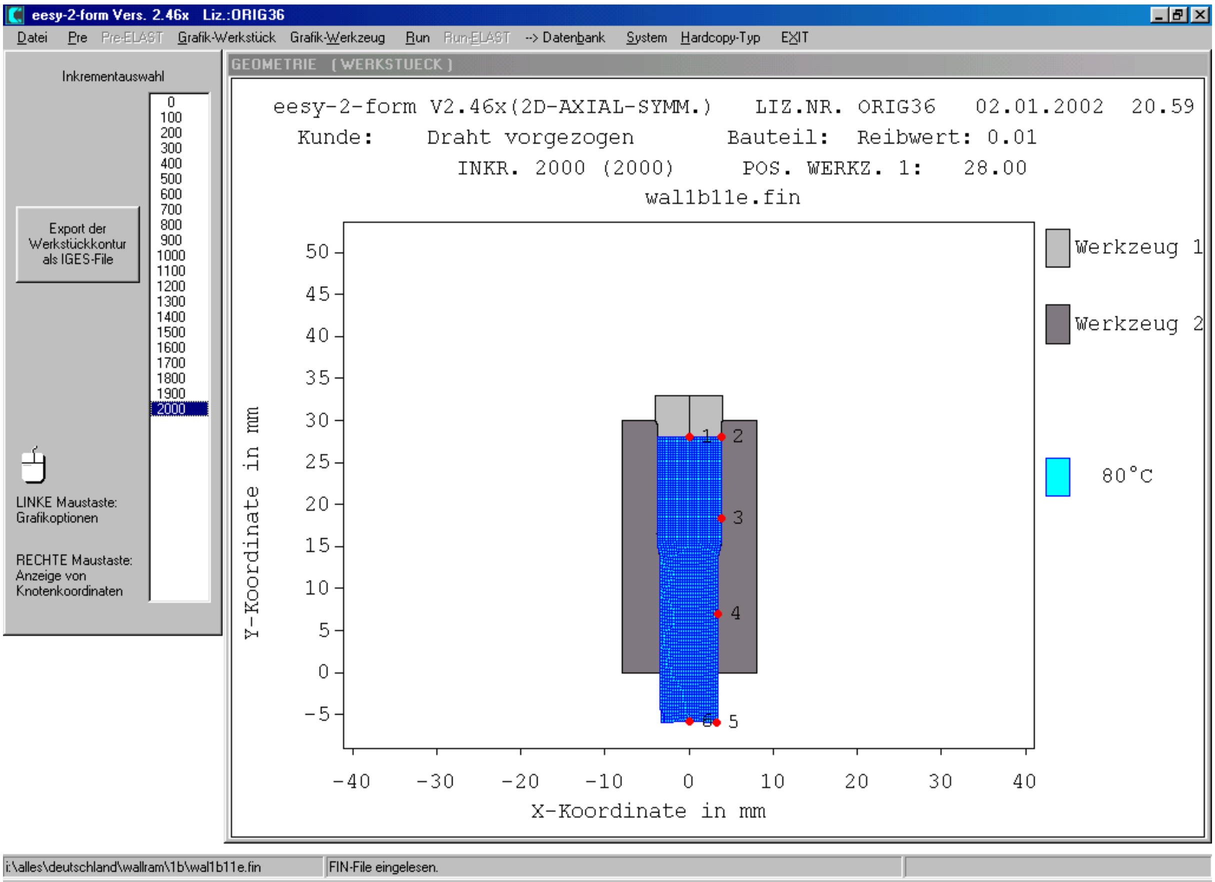

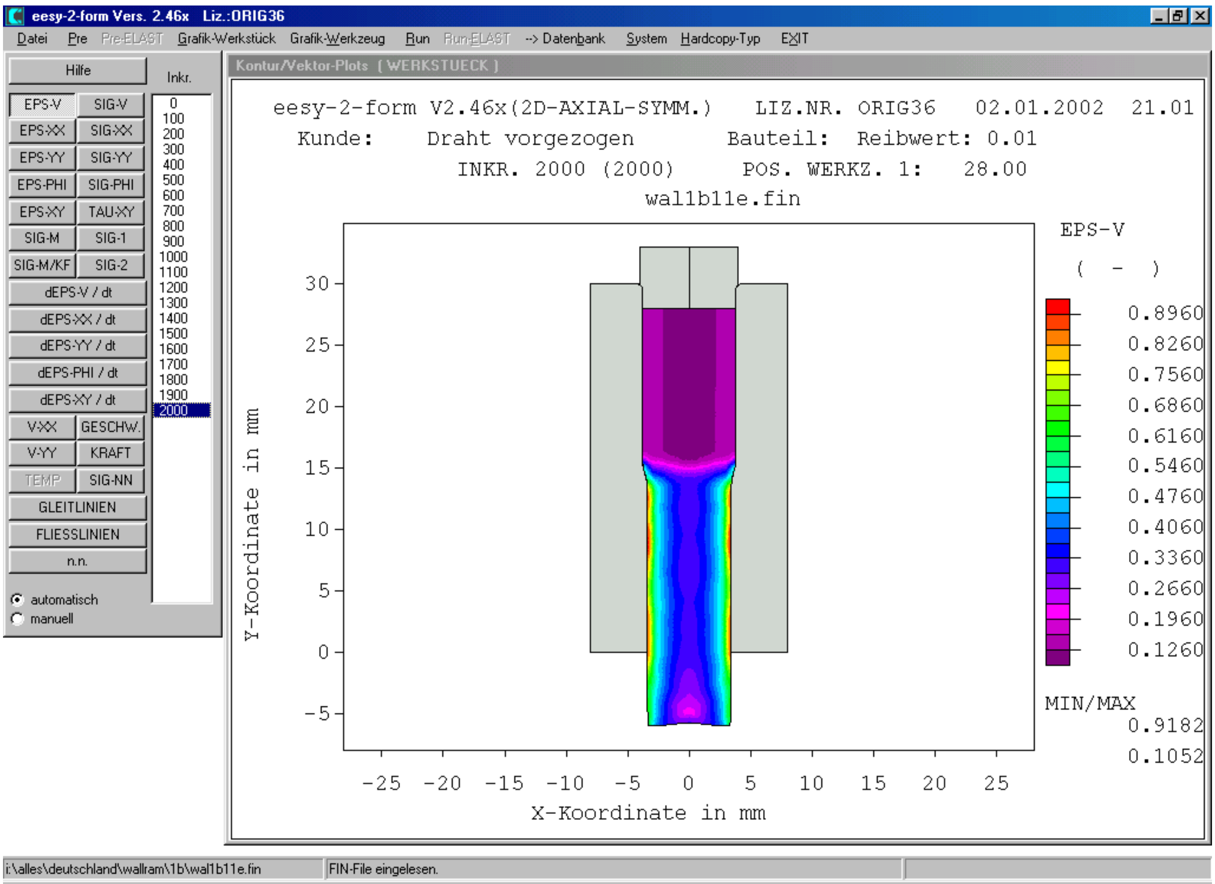

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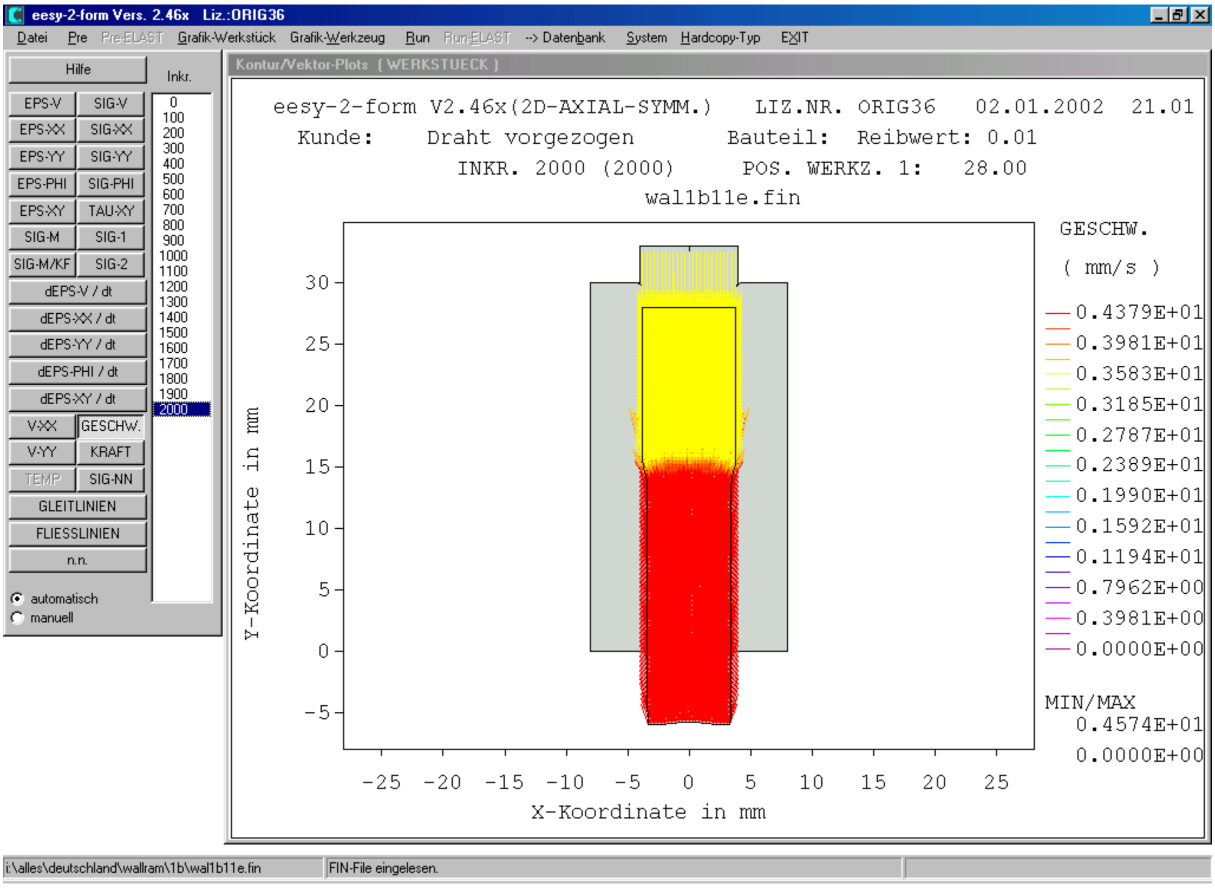

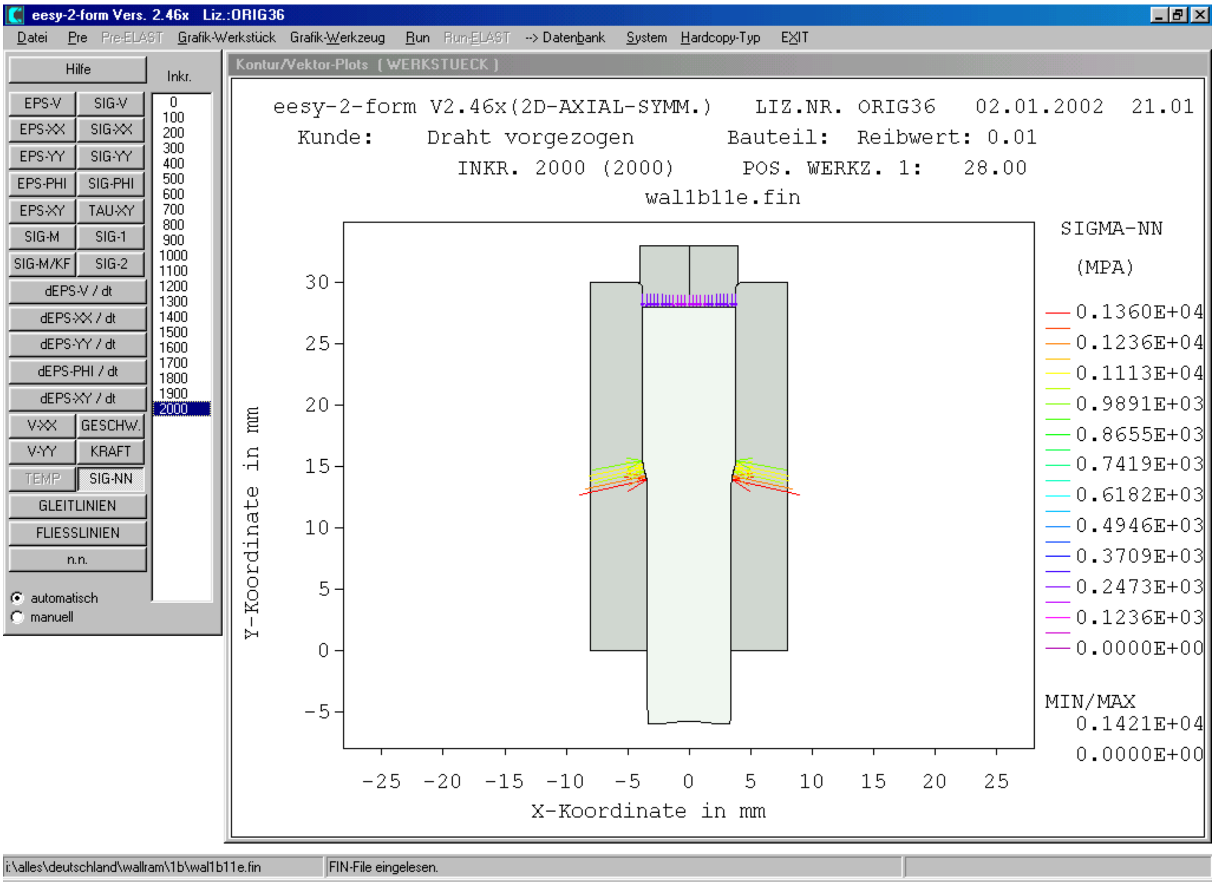

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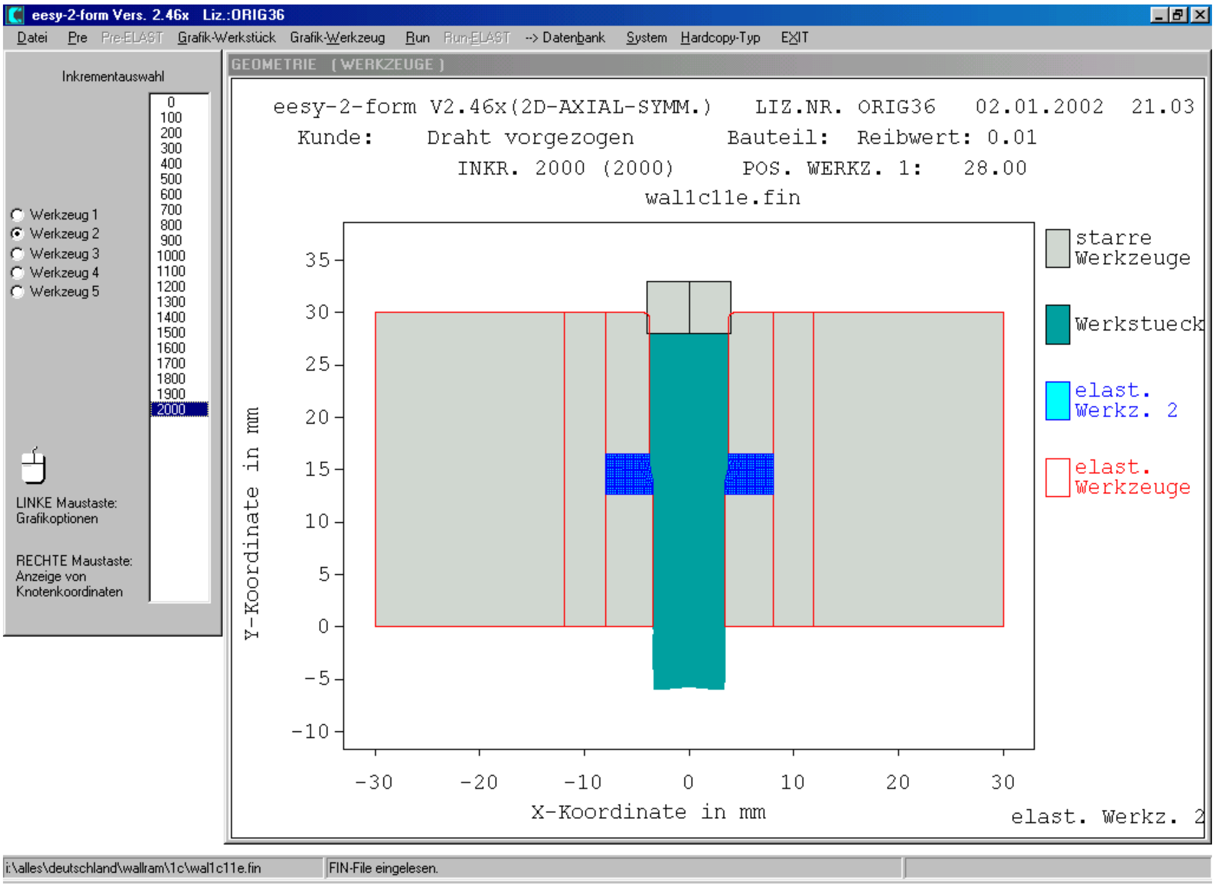

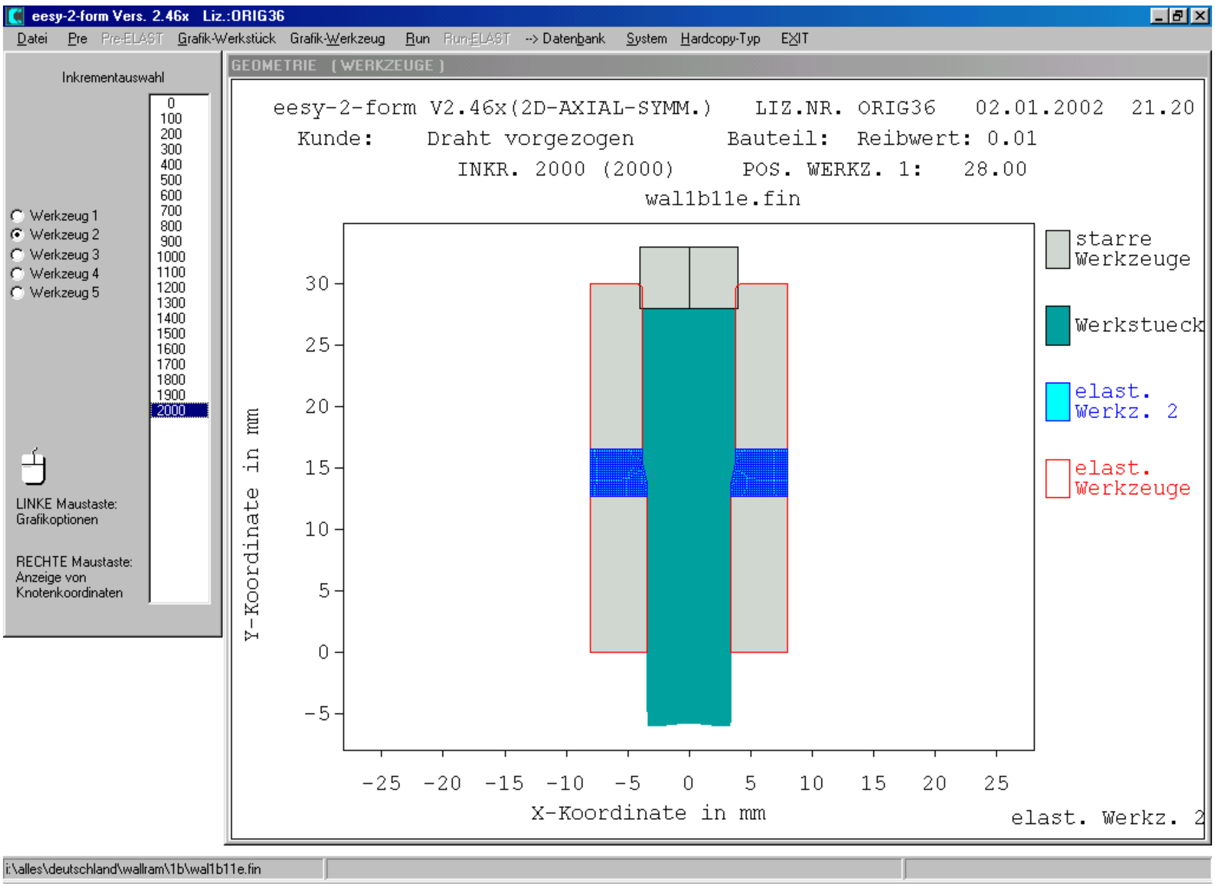

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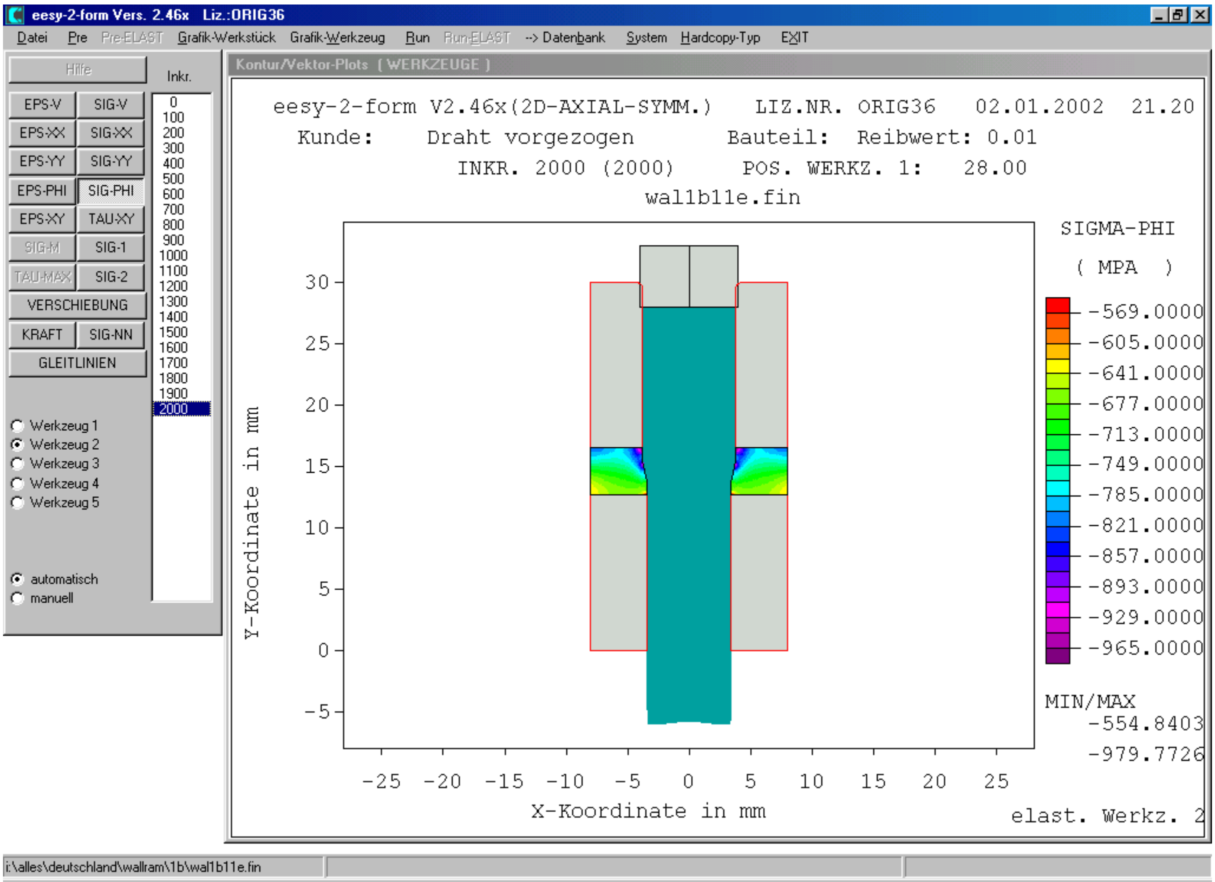

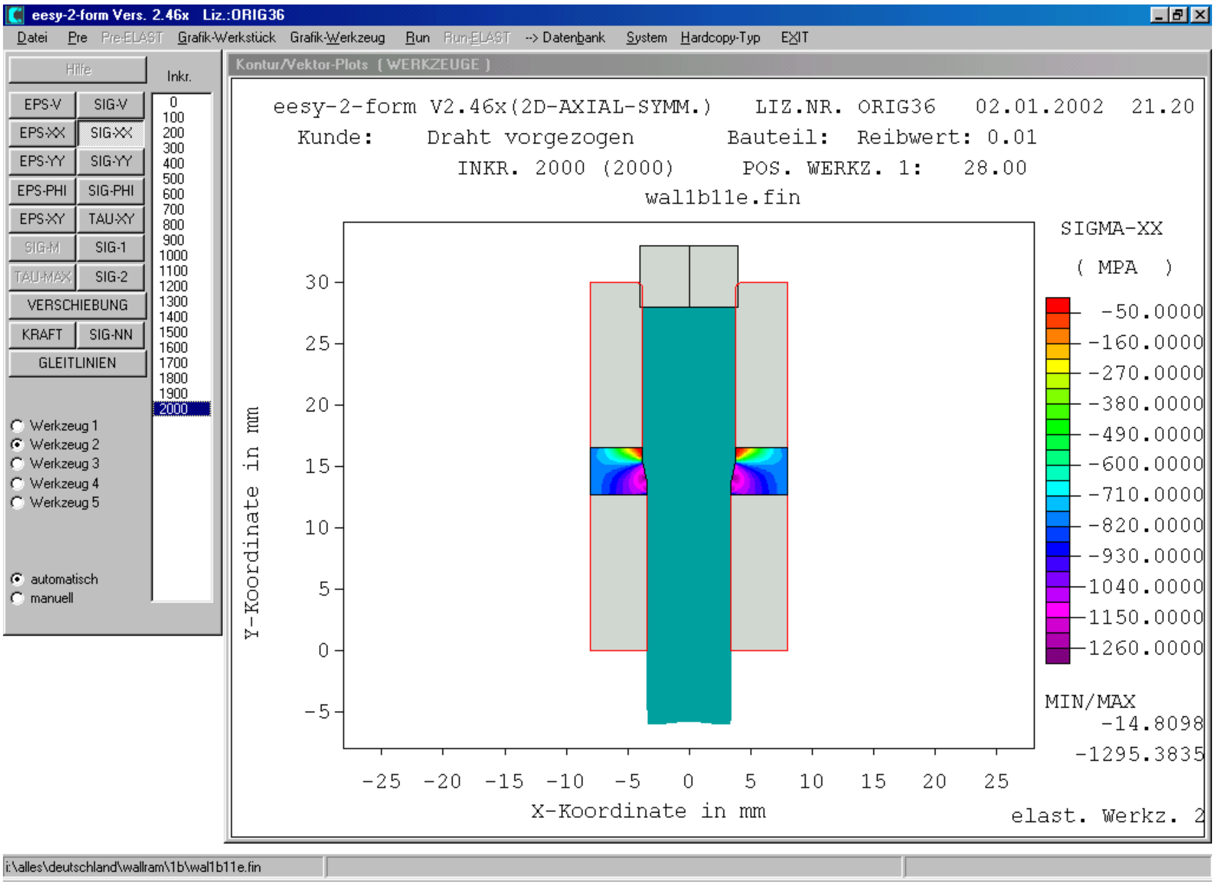

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D1 6,8 mm

D5 60 mm

Pi 1300 N/mm²

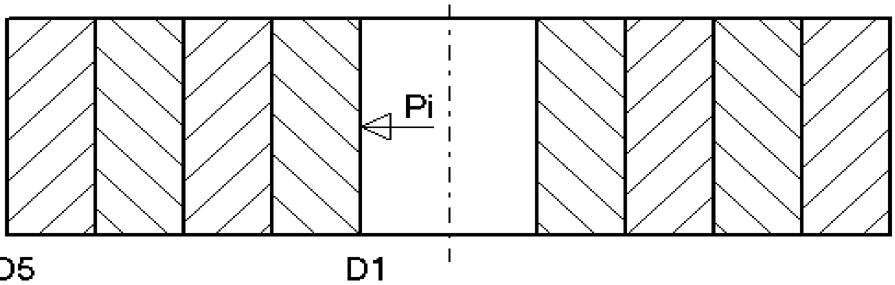
Willkommen im Schweers-Matrizen-Programm
für Dreifacharmierung (Vierringsystem)
Version: MatriB4.2 für WIN 95 und NT von 2001

Vertrieb: CPM, Kaiserstr.100, 52134 Herzugebrath

Bitte Werte eingeben

Oberfläche

OK Ende



Werkstoffdaten	Ring 4	Ring 3	Ring 2	Ring 1
Werkstoffbenennung	X40CrMoV51	X40CrMoV51	B40	SiN
Werkstoffnummer	1.2344	1.2344		
E-Modul in kN/mm²	216	216	510	320
Poissonsche-Zahl	0,28	0,28	0,27	0,26
Festigkeit in N/mm²	1670	1800		
Streckgrenze in N/mm²	1470	1600		
Anlaßtemperatur in °C	600	585		
OK	Andere	Andere	Andere	Andere

1.2343 / 1570
1.2343 / 1800
1.2343 / 1900
1.2344 / 1330
1.2344 / 1670
1.2344 / 1800
1.2344 / 1900
1.2344 / 2050

Die Zahl nach dem / = die Festigkeit

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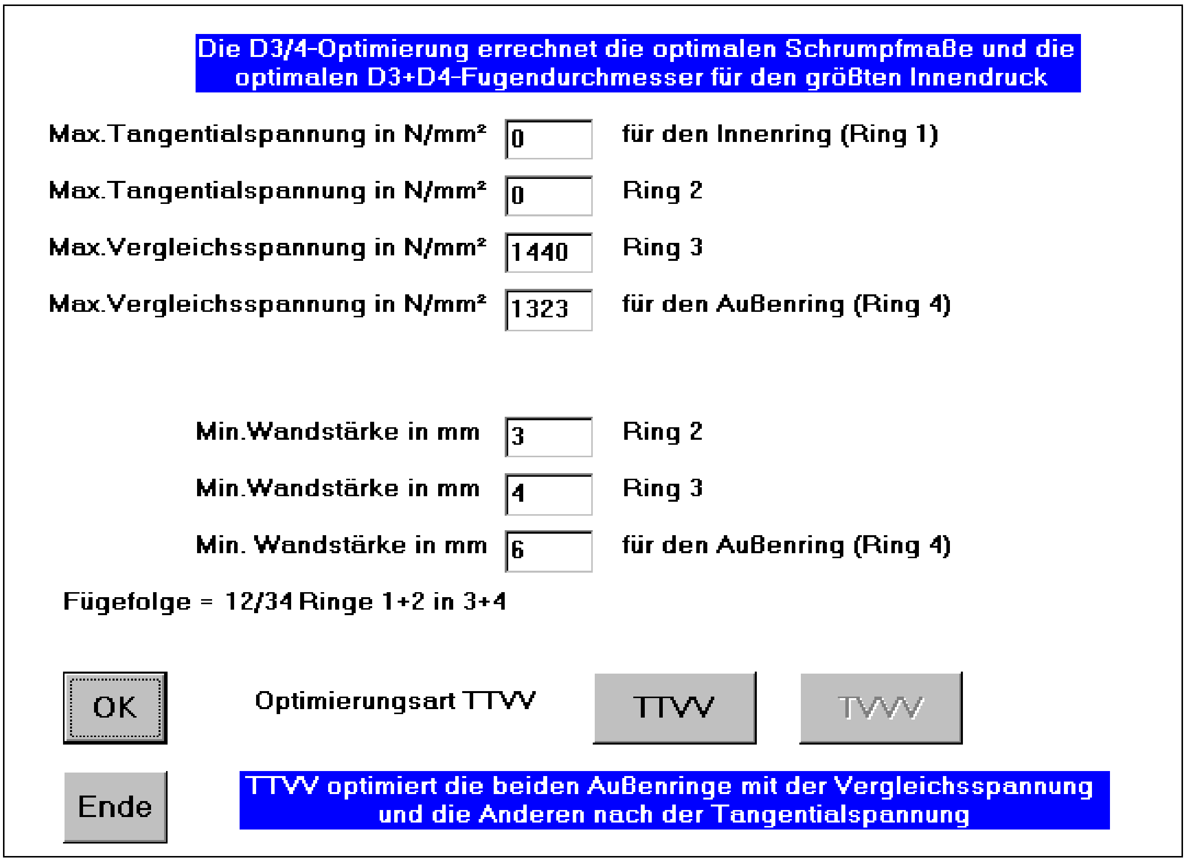

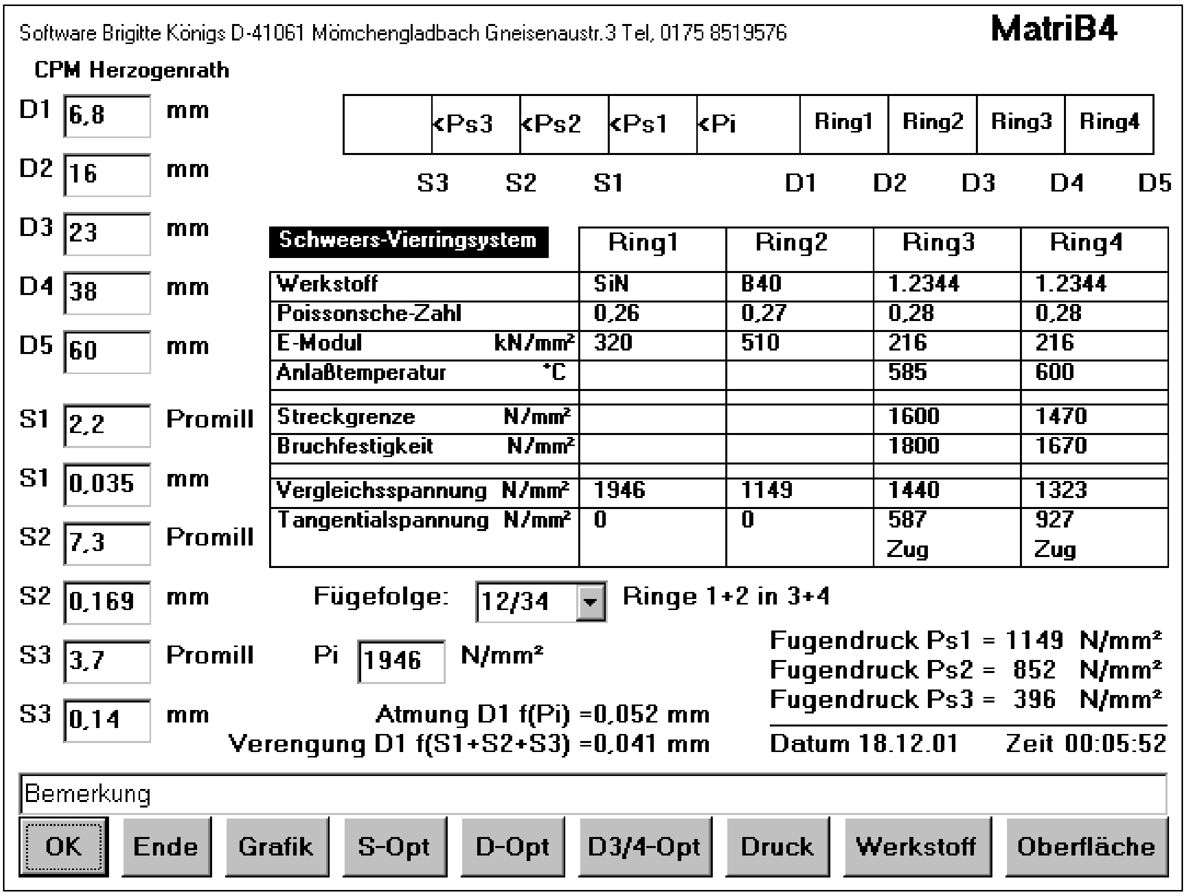

Schweers-Vierringsystem	Ring1	Ring2	Ring3	Ring4
Werkstoff	SiN	B40	1.2344	1.2344
Poissonsche-Zahl	0,26	0,27	0,28	0,28
E-Modul kN/mm²	320	510	216	216
Anlaßtemperatur °C			585	600
Streckgrenze N/mm²			1600	1470
Bruchfestigkeit N/mm²			1800	1670
Vergleichsspannung N/mm²	1946	1149	1440	1323
Tangentialspannung N/mm²	0	0	587 Zug	927 Zug

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Konstruktionsbüro Karl Schweers D-41061 Mönchengladbach Lessingstr.8, Tel 0175 8519576 **MatriB2**

CPM Herzogenrath

Warmtafel

Schweers-Zweiringsystem

Innendurchmesser Verengung 0,007 mm Atmung 0,000 mm	6,8	mm
Fugendurchmesser	16	mm
Außendurchmesser	23	mm
Innendruck	0	N/mm²
Schrumpfmaß	1,2	Promill
Schrumpfmaß	0,02	mm
Einführspiel 0,051 mm	71,72	%
Schrumpftemperatur	700	°C

Kernwerkstoff	SiN
Werkstoffnummer	
Poissonsche-Zahl	0,26
E-Modul	320 kN/mm²
Vergleichsspannung	310 N/mm²
Tangentialspannung	-310 N/mm² Druck
Fassungswerkstoff	B40 nur für Händling
Werkstoffnummer	
Poissonsche-Zahl	0,27
E-Modul	510 kN/mm²
Anlaßtemperatur	750 °C
Bruchfestigkeit	850 N/mm²
Streckgrenze	650 N/mm²
Vergleichsspannung	491 N/mm²
Tangentialspannung	365 N/mm²
Fugendruck	127 N/mm²
Datum 18.12.01	Zeit 01:21:02

Bemerkung

OK | Druck | Ende | Grafik | Kalt | Werkstoffe | D-Opt | S-Opt | Oberfläche

Software Brigitte Königs D-41061 Mömchengladbach Gneisenaustr.3 Tel, 0175 8519576 **MatriB4**

CPM Herzogenrath

D1	6,8	mm
D2	16	mm
D3	23	mm
D4	38	mm
D5	60	mm
S1	1,2	Promill
S1	0,02	mm
S2	6,5	Promill
S2	0,149	mm
S3	3,2	Promill
S3	0,12	mm

	kPs3	kPs2	kPs1	kPi	Ring1	Ring2	Ring3	Ring4

S3 S2 S1 D1 D2 D3 D4 D5

Schweers-Vierringsystem	Ring1	Ring2	Ring3	Ring4
Werkstoff	SiN	B40	1.2344	1.2344
Poissonsche-Zahl	0,26	0,27	0,28	0,28
E-Modul kN/mm²	320	510	216	216
Anlaßtemperatur °C			585	600
Streckgrenze N/mm²			1600	1470
Bruchfestigkeit N/mm²			1800	1670
Vergleichsspannung N/mm²	1500	909	1261	1144
Tangentialspannung N/mm²	-57 Druck	-264 Druck	519 Zug	802 Zug

Fügefolge: 12/34 Ringe 1+2 in 3+4

Pi 1500 N/mm²

Fugendruck Ps1 = 909 N/mm²
Fugendruck Ps2 = 742 N/mm²
Fugendruck Ps3 = 343 N/mm²

Atmung D1 f(Pi) =0,04 mm
Verengung D1 f(S1+S2+S3) =0,033 mm

Datum 18.12.01 Zeit 20:37:41

Auslegung für Reduzierstelle

OK | Ende | Grafik | S-Opt | D-Opt | D3/4-Opt | Druck | Werkstoff | Oberfläche

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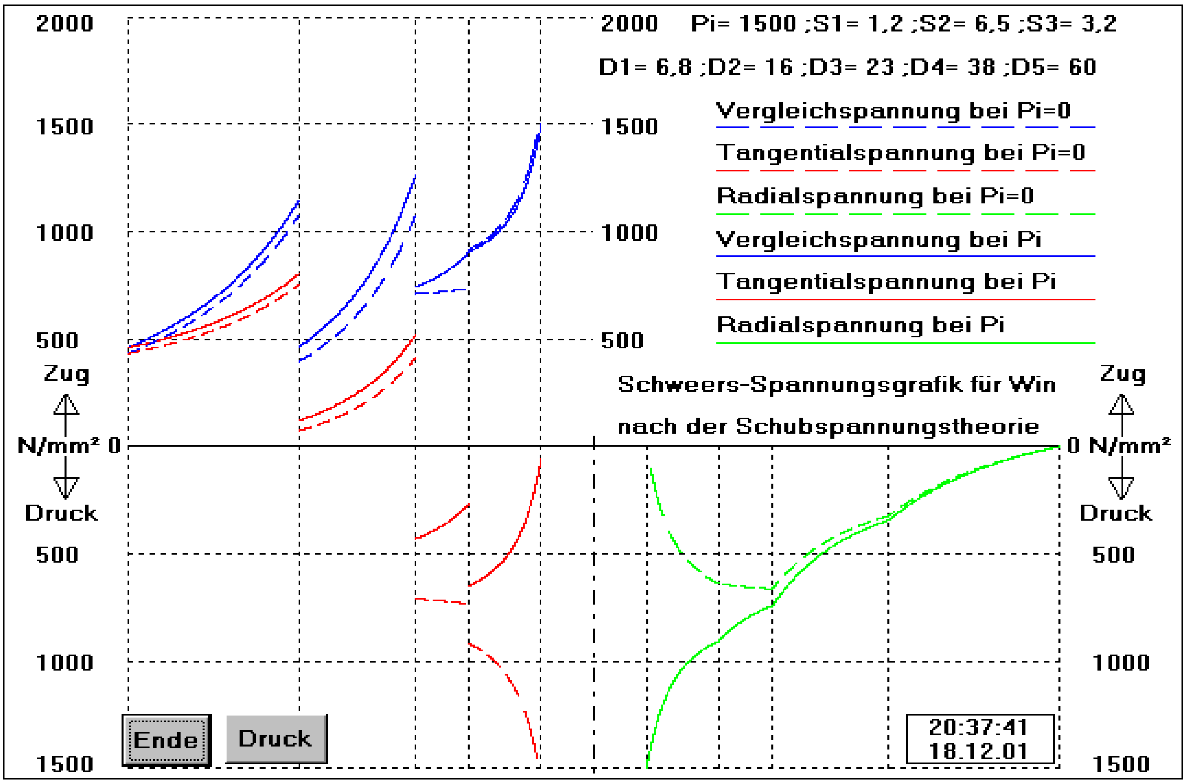

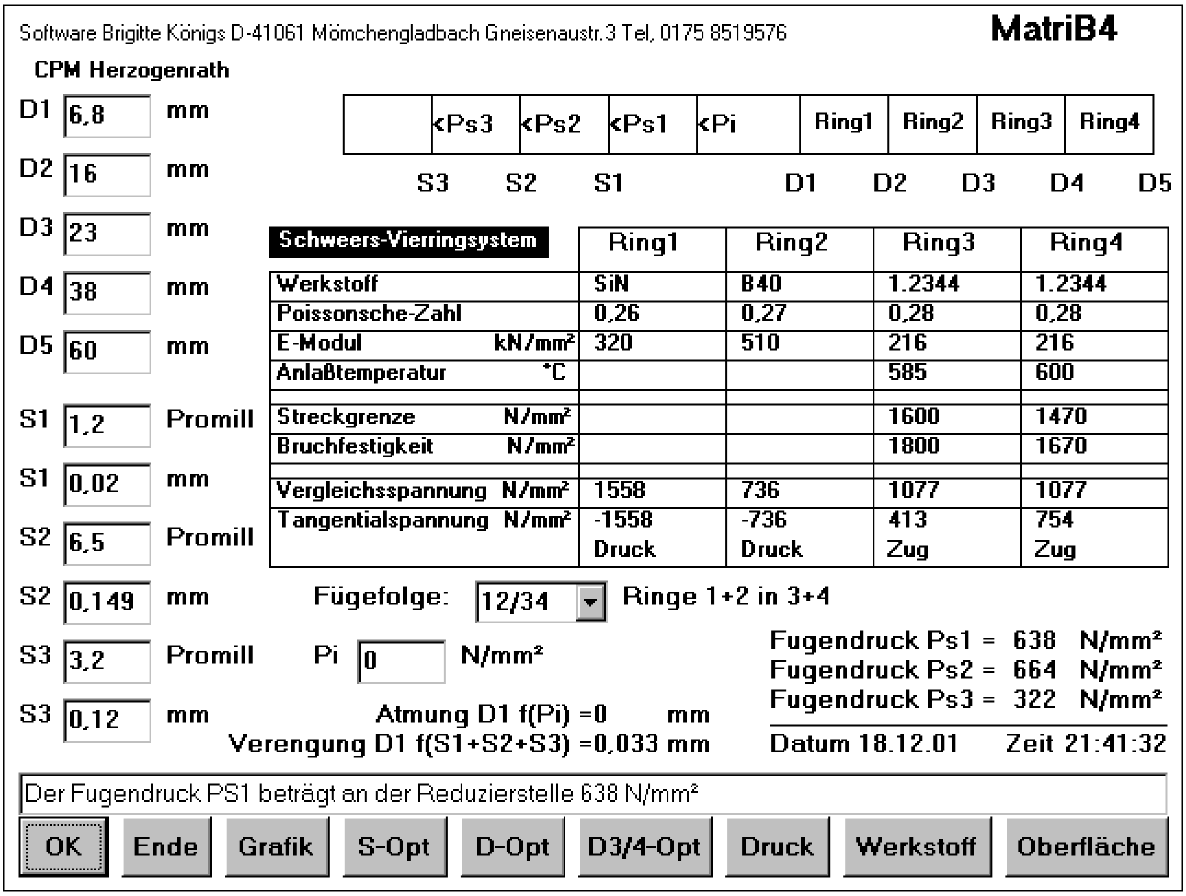

Software Brigitte Königs D-41061 Mömchengladbach Gneisenaustr.3 Tel, 0175 8519576

MatriB4

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D1	6,8	mm
D2	16	mm
D3	23	mm
D4	38	mm
D5	60	mm
S1	1,2	Promill
S1	0,02	mm
S2	6,5	Promill
S2	0,149	mm
S3	3,2	Promill
S3	0,12	mm

	<Ps3	<Ps2	<Ps1	<Pi	Ring1	Ring2	Ring3	Ring4

S3 S2 S1 D1 D2 D3 D4 D5

Schweers-Vierringsystem	Ring1	Ring2	Ring3	Ring4
Werkstoff	SiN	B40	1.2344	1.2344
Poissonsche-Zahl	0,26	0,27	0,28	0,28
E-Modul kN/mm²	320	510	216	216
Anlaßtemperatur °C			585	600
Streckgrenze N/mm²			1600	1470
Bruchfestigkeit N/mm²			1800	1670
Vergleichsspannung N/mm²	1558	736	1077	1077
Tangentialspannung N/mm²	-1558 Druck	-736 Druck	413 Zug	754 Zug

Fügefolge: 12/34 Ringe 1+2 in 3+4

Pi 0 N/mm²

Fugendruck Ps1 = 638 N/mm²
Fugendruck Ps2 = 664 N/mm²
Fugendruck Ps3 = 322 N/mm²

Atmung D1 f(Pi) =0 mm
Verengung D1 f(S1+S2+S3) =0,033 mm

Datum 18.12.01 Zeit 21:41:32

Der Fugendruck PS1 beträgt an der Reduzierstelle 638 N/mm²

OK | Ende | Grafik | S-Opt | D-Opt | D3/4-Opt | Druck | Werkstoff | Oberfläche

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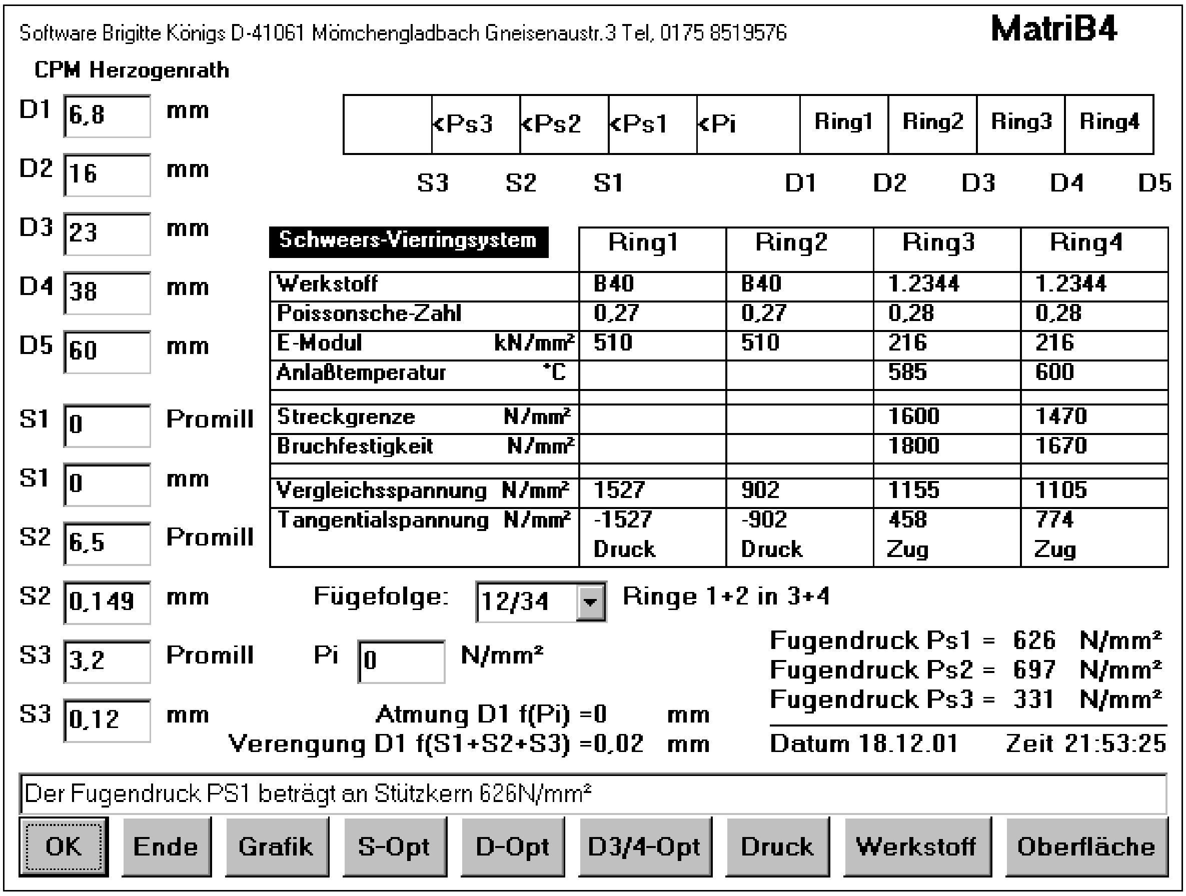

Software Brigitte Königs D-41061 Mömchengladbach Gneisenaustr.3 Tel. 0175 8519576 **MatriB4**

CPM Herzogenrath

D1 6,8 mm
D2 16 mm
D3 23 mm
D4 38 mm
D5 60 mm
S1 0 Promill
S1 0 mm
S2 6,5 Promill
S2 0,149 mm
S3 3,2 Promill
S3 0,12 mm

	kPs3	kPs2	kPs1	kPi	Ring1	Ring2	Ring3	Ring4

S3 S2 S1 D1 D2 D3 D4 D5

Schweers-Vierringsystem	Ring1	Ring2	Ring3	Ring4
Werkstoff	B40	B40	1.2344	1.2344
Poissonsche-Zahl	0,27	0,27	0,28	0,28
E-Modul kN/mm²	510	510	216	216
Anlaßtemperatur °C			585	600
Streckgrenze N/mm²			1600	1470
Bruchfestigkeit N/mm²			1800	1670
Vergleichsspannung N/mm²	1527	902	1155	1105
Tangentialspannung N/mm²	-1527 Druck	-902 Druck	458 Zug	774 Zug

Fügefolge: 12/34 Ringe 1+2 in 3+4

Pi 0 N/mm²

Fugendruck Ps1 = 626 N/mm²
Fugendruck Ps2 = 697 N/mm²
Fugendruck Ps3 = 331 N/mm²

Atmung D1 f(Pi) =0 mm
Verengung D1 f(S1+S2+S3) =0,02 mm

Datum 18.12.01 Zeit 21:53:25

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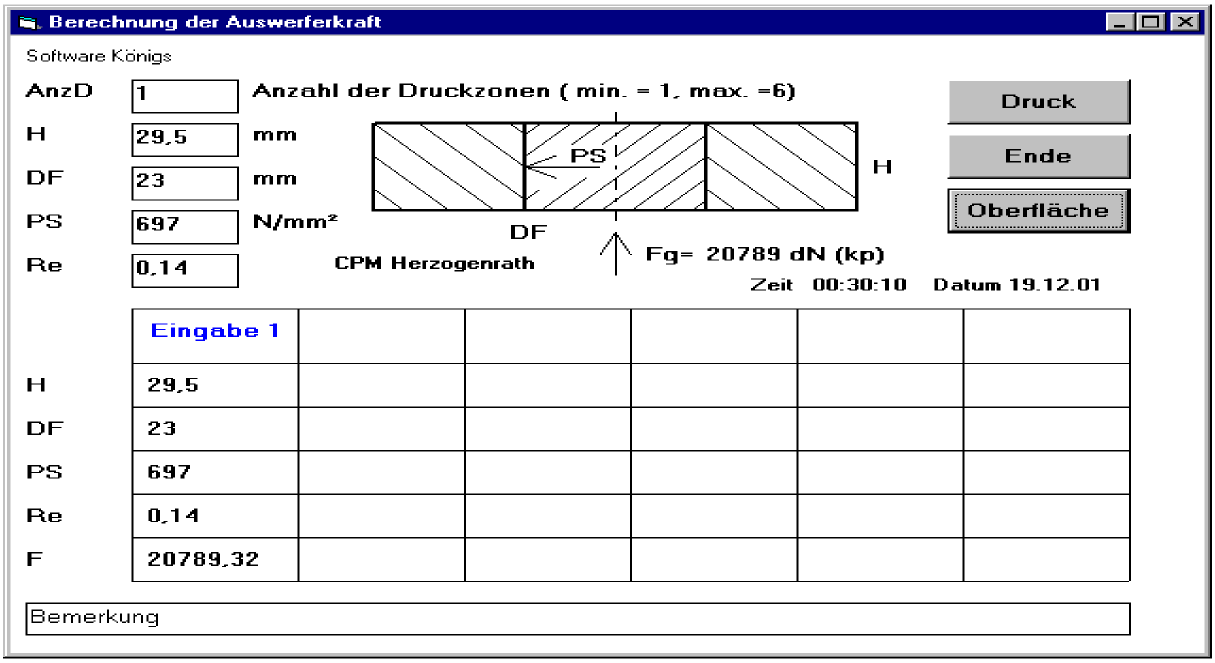
OK Ende Grafik S-Opt D-Opt D3/4-Opt Druck Werkstoff Oberfläche



Berechnung der Auswerferkraft

Software Königs

AnzD 1 Anzahl der Druckzonen (min. = 1, max. =6)
H 29,5 mm
DF 23 mm
PS 697 N/mm²
Re 0,14

CPM Herzogenrath

Zeit 00:30:10 Datum 19.12.01

Druck Ende Oberfläche

	Eingabe 1					
H	29,5					
DF	23					
PS	697					
Re	0,14					
F	20789,32					

Bemerkung

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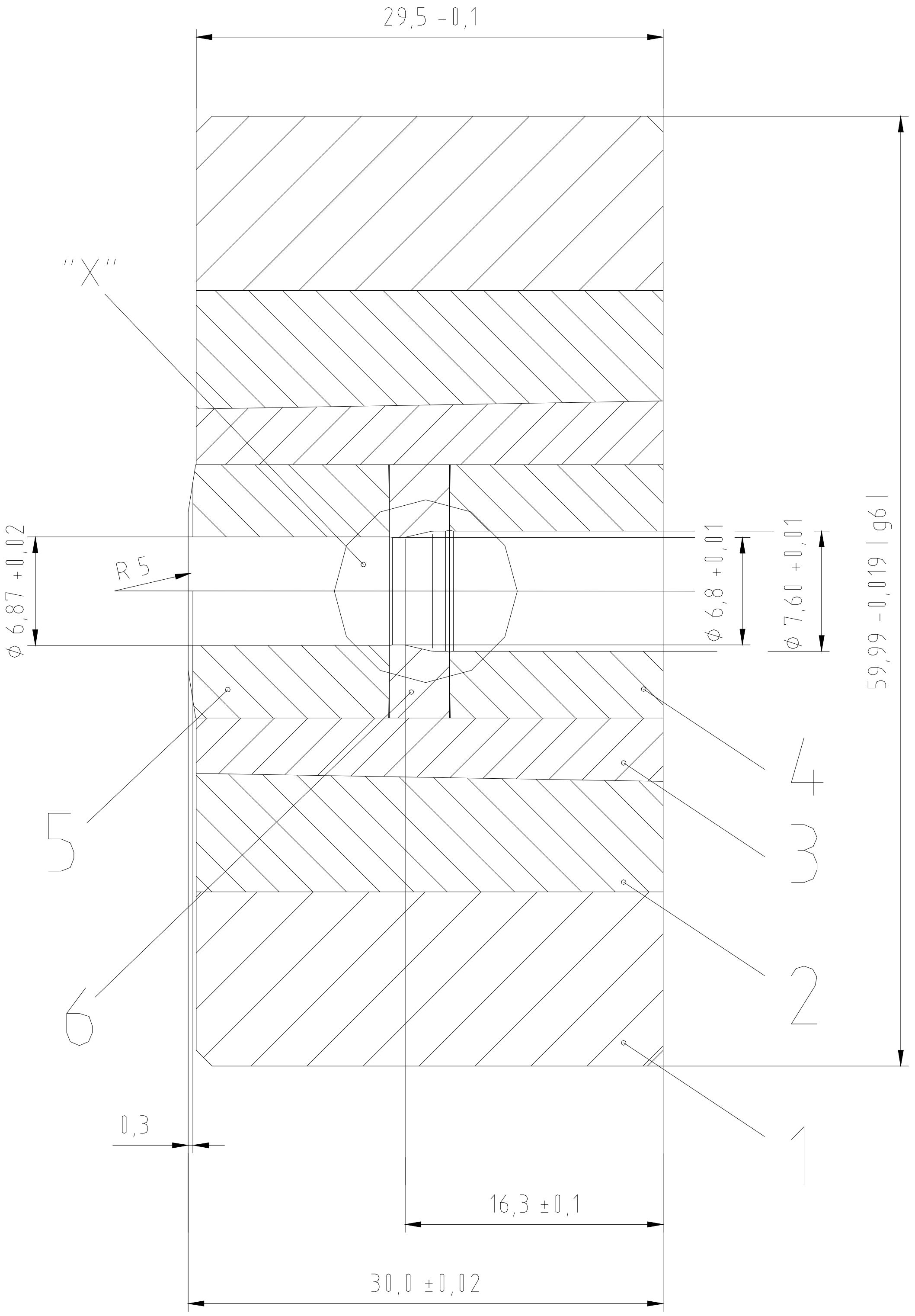

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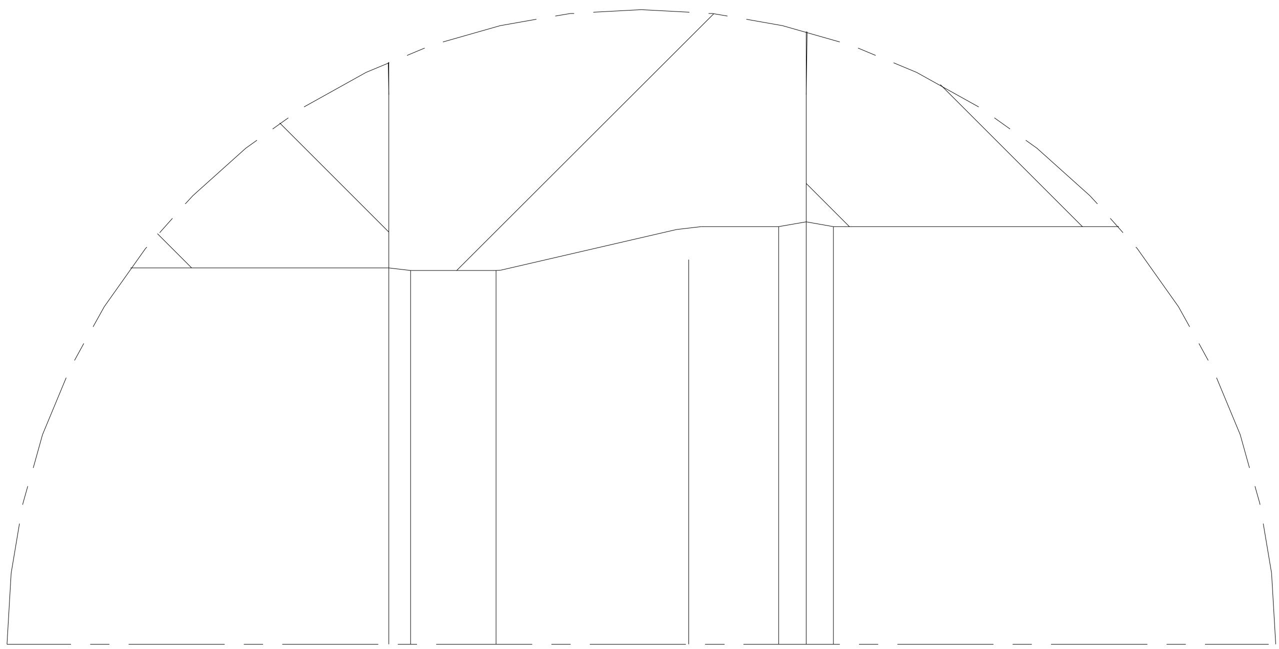

Einzelheit "X"

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