GACC South, Skills Initiative

Blue Book Training Exercises For GA CATT Exams

AHK German American Chambers of Commerce Deutsch-Amerikanische Handelskammern

GA CATT APPRENTICESHIP PROGRAM

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6

Calculation of

Main Productive Time - Drilling

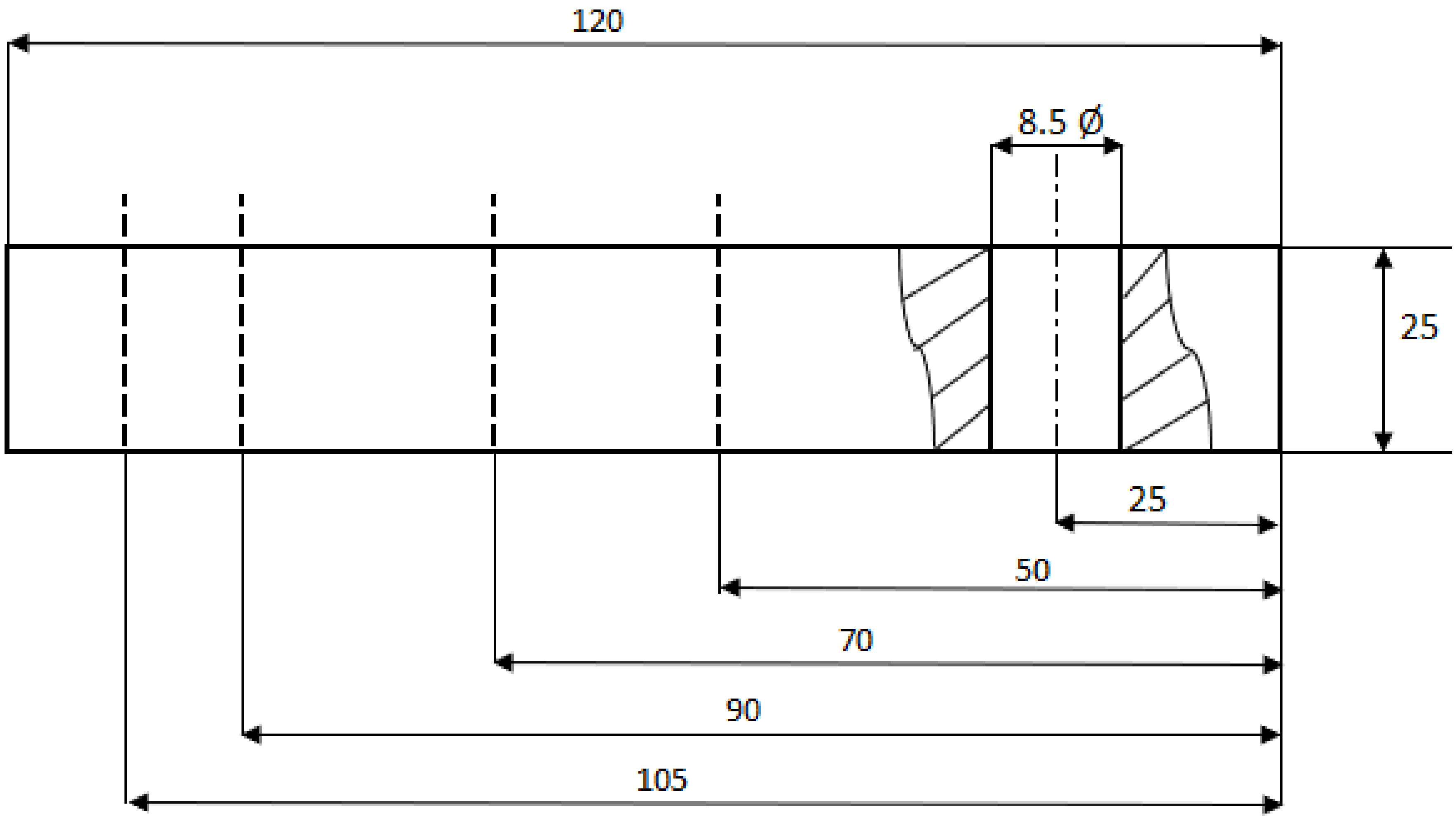
Task:

You want to drill 5 holes with a diameter of 8.5mm in a 25mm thick workpiece made out of unalloyed structural steel with an average tensile strength of 485 N/mm^2.

You are using a carbide drill.
The rotation speed is 3200 min^{1}.
Starting travel and overrun idle is 1mm.

Given is the sketch on the next slide.

Calculate the Main Productive Time.


120
8.5 Ø
25
25
50
70
90
105

What information do we have?

tp = Main Productive Time

Pg.342 in Bluebook

and **Pg.338**

$$tp = \frac{L * i}{n * f}$$

i = 5 holes

n = 3200 min^{1}

d = 8.5mm

l = 25mm

la = 1mm

lst = 0.29

Material = 485 N/mm^2

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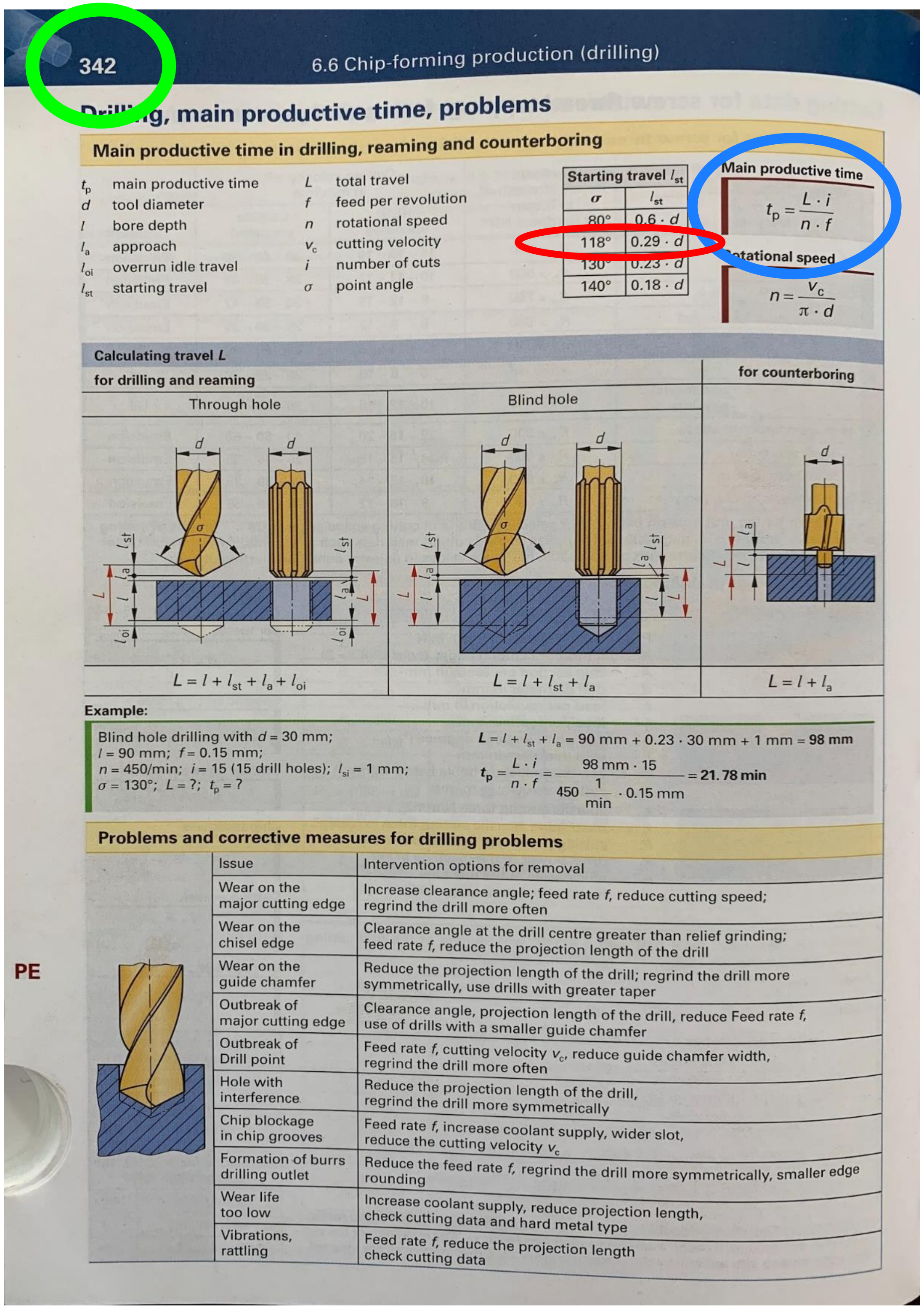

Dri[illegible]ng, main productive time, problems

Main productive time in drilling, reaming and counterboring

t_p	main productive time	L	total travel
d	tool diameter	f	feed per revolution
l	bore depth	n	rotational speed
l_a	approach	v_c	cutting velocity
l_{oi}	overrun idle travel	i	number of cuts
l_{st}	starting travel	σ	point angle

Starting travel l_{st}

σ	l_{st}
80°	$0.6 \cdot d$
118°	$0.29 \cdot d$
130°	$0.23 \cdot d$
140°	$0.18 \cdot d$

Main productive time

$$t_p = \frac{L \cdot i}{n \cdot f}$$

Rotational speed

$$n = \frac{v_c}{\pi \cdot d}$$

Calculating travel L

for drilling and reaming

Through hole: $L = l + l_{st} + l_a + l_{oi}$

Blind hole: $L = l + l_{st} + l_a$

for counterboring: $L = l + l_a$

Example:

Blind hole drilling with d = 30 mm; l = 90 mm; f = 0.15 mm; n = 450/min; i = 15 (15 drill holes); l_{si} = 1 mm; σ = 130°; L = ?; t_p = ?

$L = l + l_{st} + l_a$ = 90 mm + 0.23 · 30 mm + 1 mm = **98 mm**

$$t_p = \frac{L \cdot i}{n \cdot f} = \frac{98\ mm \cdot 15}{450 \frac{1}{min} \cdot 0.15\ mm} = \mathbf{21.78\ min}$$

Problems and corrective measures for drilling problems

Issue	Intervention options for removal
Wear on the major cutting edge	Increase clearance angle; feed rate *f*, reduce cutting speed; regrind the drill more often
Wear on the chisel edge	Clearance angle at the drill centre greater than relief grinding; feed rate *f*, reduce the projection length of the drill
Wear on the guide chamfer	Reduce the projection length of the drill; regrind the drill more symmetrically, use drills with greater taper
Outbreak of major cutting edge	Clearance angle, projection length of the drill, reduce Feed rate *f*, use of drills with a smaller guide chamfer
Outbreak of Drill point	Feed rate *f*, cutting velocity v_c, reduce guide chamfer width, regrind the drill more often
Hole with interference	Reduce the projection length of the drill, regrind the drill more symmetrically
Chip blockage in chip grooves	Feed rate *f*, increase coolant supply, wider slot, reduce the cutting velocity v_c
Formation of burrs drilling outlet	Reduce the feed rate *f*, regrind the drill more symmetrically, smaller edge rounding
Wear life too low	Increase coolant supply, reduce projection length, check cutting data and hard metal type
Vibrations, rattling	Feed rate *f*, reduce the projection length check cutting data

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Solution

$L = l + lst + la + loi$

$Loi = 0.29 \times 8.5mm = 2.465mm$

$L = 25mm + 1mm + 1mm + 2.465mm = 29.465mm$

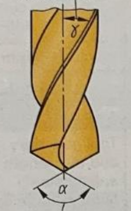
$$tp = \frac{L * i}{n * f}$$

$$tp = \frac{29.465mm * 5}{3200min^{1} * 0.22mm} = \frac{147.325mm}{704} =$$

$$\underline{0.21min}$$

Cutting data during drilling

Twist drill, drill types, angle



Type[1]	Application	Helix angle γ[2]	Point angle σ[3]
N	Universal application for materials up to $R_m \approx 1000$ N/mm², e. g. structural, case-hardened, and quenched and tempered steels	19°– 40°	118°
H	Drilling of brittle, short-chipping non-ferrous metals and plastics, e. g. CuZn alloys and PMMA (Plexiglas)	10°– 19°	118°
W	Drilling of soft, long-chipping, non-ferrous metals and plastics, e. g. Al and Mg alloys, PA (polyamide) and PVC	27°– 47°	130°

[1] Tool application groups for HSS tools according to DIN 1836
[2] depends on drill diameter and pitch
[3] Standard version

Standard values for drilling with HSS twist drills and carbide drills

[1]	Workpiece material: Material group	average Tensile strength R_m in N/mm² or hardness HB[3]	cutting velocity v_c[2),4)] in m/min: Twist drill HSS coated	Twist drill Carbide coated	Feed f in mm/revolution HSS and carbide twist drills, drill diameter d in mm: 2	5	8	12	16
P	Structural steel	$R_m \le 500$	38 – **50** – 63	70 – **85** – 100	0.05	0.13	0.22	0.27	0.32
P		$R_m > 500$	31 – **37** – 44	70 – **85** – 100	0.05	0.13	0.22	0.27	0.32
P	Free-cutting steel	$R_m \le 550$	31 – **37** – 44	70 – **85** – 100	0.05	0.13	0.22	0.27	0.32
P		$Rm > 550$	25 – **31** – 38	60 – **75** – 85	0.03	0.08	0.11	0.17	0.22
P	Case hardening steel, plain	$R_m > 550$	31 – **37** – 44	70 – **85** – 100	0.03	0.08	0.11	0.17	0.22
P	Case hardening steel, alloyed	$R_m \le 750$	19 – **22** – 25	60 – **75** – 85	0.02	0.05	0.09	0.13	0.15
P		$R_m > 750$	10 – **12** – 15	50 – **65** – 80	0.02	0.05	0.09	0.13	0.15
P	Quenched and tempered steel, plain	$R_m \le 650$	31 – **37** – 44	70 – **85** – 100	0.03	0.08	0.11	0.17	0.22
P		$R_m > 650$	25 – **27** – 31	60 – **75** – 85	0.02	0.06	0.10	0.15	0.19
P	Quenched and tempered steel, alloyed	$R_m \le 750$	19 – **21** – 25	60 – **75** – 85	0.02	0.05	0.09	0.13	0.15
P		$R_m > 750$	10 – **12** – 15	50 – **65** – 80	0.02	0.05	0.09	0.13	0.15
P	Tool steel	$R_m \le 750$	13 – **16** – 19	60 – **75** – 85	0.02	0.05	0.09	0.13	0.15
P		$R_m > 750$	10 – **12** – 15	40 – **55** – 70	0.02	0.05	0.09	0.13	0.15
M	Stainless steel, austenite	$R_m \le 680$	13 – **19** – 25	30 – **40** – 50	0.02	0.05	0.09	0.13	0.15
M		$R_m > 680$	10 – **15** – 19	25 – **35** – 45	0.02	0.05	0.09	0.13	0.15
M	Stainless steel, martensitic	$R_m > 500$	8 – **10** – 13	25 – **30** – 35	0.02	0.05	0.09	0.13	0.15
K	Flake graphite cast iron	≤ 200 HB	25 – **31** – 38	80 – **105** – 130	0.05	0.13	0.22	0.27	0.32
K	Spheroidal graphite cast iron	≤ 250 HB	31 – **37** – 44	70 – **85** – 100	0.05	0.13	0.22	0.27	0.32
K		> 250 HB	23 – **25** – 28	70 – **85** – 100	0.04	0.11	0.17	0.22	0.27
N	Wrought aluminium alloy	$R_m \le 350$	50 – **87** – 125	180 – **240** – 300	0.05	0.15	0.19	0.24	0.32
N	Al-alloy, short chip	$R_m \le 700$	38 – **56** – 75	120 – **170** – 230	0.05	0.15	0.19	0.24	0.32
N	Aluminium casting alloys	–	38 – **50** – 63	120 – **170** – 230	0.03	0.09	0.15	0.22	0.27
N	CuZn Alloy, short chip	$R_m \le 600$	75 – **100** – 125	120 – **170** – 230	0.09	0.19	0.27	0.32	0.28
N	CuZn Alloy, long chip	$R_m \le 600$	44 – **56** – 75	120 – **170** – 230	0.05	0.16	0.22	0.27	0.28
N	CuSn Alloy, short chip	$R_m \le 600$	31 – **50** – 63	120 – **170** – 230	0.05	0.09	0.15	0.22	0.27
N	CuSn Alloy, long chip	$R_m \le 850$	19 – **29** – 44	90 – **135** – 180	0.05	0.09	0.15	0.22	0.27
N	Thermoplastics	–	20 – **30** – 40	–	0.05	0.08	0.14	0.20	0.25
N	Thermosets	–	10 – **15** – 20	–	0.05	0.08	0.14	0.20	0.25

[1] Groups of cutting tool material as per DIN 513, page 309; only applies to hard cutting materials such as carbide
[2] **Selection criteria for cutting speed:** (Explanation of the processing conditions, page 316)
- The **starting value** is the **bold value** of v_c (**"normal"** machining conditions).
- In **"unfavourable"** machining conditions, a smaller v_c is set at the **lower limit**.
- In **"favourable"** machining conditions, a larger v_c is set up to the **upper limit**.

[3] Conversion table for hardness numbers and tensile strength on page 205, hardness numbers in delivery condition starting on page 137.
[4] Uncoated tools 70%

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