Manufacturing:

1 # Metals: main element "Iron "Fe" ".

1. Ferrous.
2. Non-Ferrous.

Steel: 1. Plained steel (Iron + carbon).

2. Alloyed steel (ex.: stainless steel).

↳ "3-elements" or more ⇒ (carbon + Iron + another element).

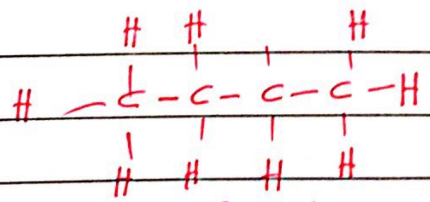
→ Cast-Iron: very brittle.

→ Steel: كل ما زادت نسبة ال Carbon تزيد ال strength وتقل ال Ductility.

→ Titanium alloys: Bio compitable (لا تسبب تسمم).

2 # Ceramics:

1. Traditional
2. Modern
   - → Crystalline (↑ ρ) → الذرات مرتبة بـ Range معين (معتمة)
   - → Amorphous (↓ ρ) → الذرات غير مرتبة (شفافة).



(Mers)

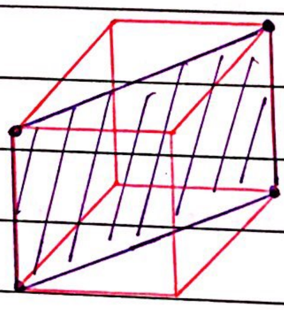
3 # Polymers:

* Thermosetting ⇒ Exothermic
* Thermoplastic ⇒ تتحمل درجات حرارة بـ Range معين
* Elastomer ⇒ High Elasticity

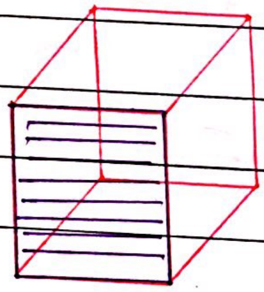
slide (10)

~> Assembly operations8 1. Joints 2. welding 3. gluing

5. 10. 2016



plane
* BCC * [110]



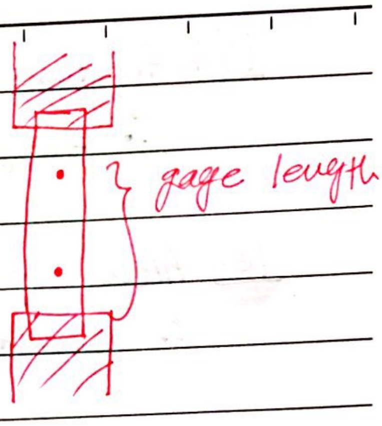
plane
* BCC * [100]

17.10.2016

* CH.3 problems.

#3.18

$L_o = 50\ mm$, $A_o = 200\ mm^2$



$F_y = 98000\ N$ → $L_y = 50.23\ mm$] 0.2% yield point.

$F_m = 168000\ N$ → $L_m = 64.2\ mm$] plastic deformation.

$\boxed{a.}$ $\sigma_y = \frac{F_y}{A_o} = \frac{98000\ N}{200\ mm^2} = 490\ MPa$

$\Rightarrow V = A_o * L_o$ ⇝ (V ≡ constant.)

$= (200)(50) = 10\,000\ mm^3$

⇝ $\frac{V}{L_y} = A_y \Rightarrow A_y = \frac{10000}{50.23} = 199.08\ mm^2$

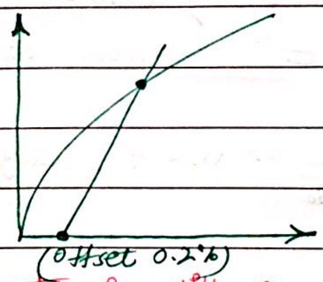
* $\sigma_y(\text{true}) = \frac{98000}{199.08} = 492.3\ MPa$; its almost the same stress. ($490 \cong 492.23$)

$\boxed{b.}$ E = ?! Hooke's law.

$\sigma = E * e$

$E = \frac{\sigma e}{e}$

⇝ $e = \frac{\Delta L}{L} - \underbrace{0.002}_{\text{offset strain.}}$



* subtracted to ensure that i still in the elastic Region.

$e = \frac{50.23 - 50}{50} - 0.002 = (0.0026)$

$E = \frac{490}{0.0026} = 188.46\ GPa.$

$\boxed{c.}$ $\sigma_{TS} = \frac{F_m}{A_o} = \frac{168000}{200} = 840\ MPa.$

[d.] Fracture: $L_f = 67.3$ mm

% Elongation $= \frac{67.3 - 50}{50} = 34.6$ %

[e.] Area of necking $= 92$ mm^2

% Reduction in A $= \frac{200 - 92}{200} = 54$ %

* Ex. 3.108

$L_0 = 5cm = 50mm$, $A_0 = 3.125$ cm^2 $= 312.5$ mm^2

~> $L_1 = 6.25$ cm $= 62.5$ mm
$\sigma_e = 165$ MPa

~> $L_2 = 80$ mm
$\sigma_e = 193$ MPa

* K, n

Flow curve equations

$\Rightarrow \sigma_t = K \epsilon^n$ "true stress, strain".

{1.} $\sigma_e = \frac{F}{A_0}$ ~> doesn't change

$165 = F/312.5$, ~> $F = 51562$ N

$\Rightarrow V = A_0 L_0 = 312.5 * 50 = 15625$ mm^3

~> $A_i = \frac{V}{L_1} = \frac{15625}{62.5} = 250$ mm^2

~> $\sigma_t = \frac{51562}{250} = 206.24$

$\epsilon_1 = \ln\left(\frac{L_f}{L_0}\right) = \ln\left(\frac{62.5}{50}\right) = 0.223$

the same procedure.

2. $\sigma_f = 308.8$ MPa.

$\varepsilon_2 = 0.470$

* another solution :

$\sigma_f = \sigma_e (1 + e)$

Engineering.

$= 165 \left(1 + \frac{62.5 - 50}{50}\right)$

* $\sigma_f = K \varepsilon^n$

$206.24 = K\ 0.223^n$

$308.8 = K\ 0.470^n$

$\ln \frac{308.8}{206.24} = \ln \left(\frac{0.47}{0.223}\right)^n$

$\Rightarrow n = 0.5414$

$\Rightarrow K = 464.75$ MPa.

→ Flow curve Parameters.

#3.198 $K = 1100$ MPa , $n = 0.35$

$F = ?!$

$A_o = 1000\ mm^2$, $h_o = 75$ mm.

$h_1 = 58$ mm.

* $\sigma = \frac{F}{A}$

* $\sigma_f = K \varepsilon^n$

$= (1100)\left(\ln \frac{75}{58}\right)^{0.35} = 683.7$ MPa.

$\ln\left(\frac{58}{75}\right)$ negative means compression.

$\rightsquigarrow A_i = ?!$

$V = A_o * h_o = (1000)(75) = 75000\ mm^3$

$A_i = \frac{V}{h_1} = \frac{75000}{58} = 1293.1\ mm^2$

$\rightsquigarrow 683.7 = \frac{F}{1293.1}$; $\Rightarrow F = 884094$ N.

#3.238 $R = 25\ mm$, $t = 3\ mm$, $l_o = 50\ mm$

$T = 900\ N\cdot m \Rightarrow \alpha = 0.3^\circ$

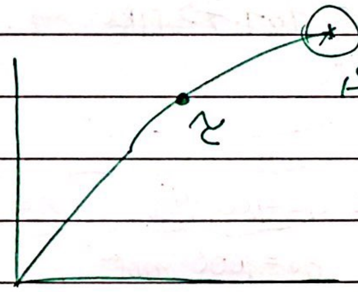
[a] $\tau = \dfrac{T}{2\pi R^2 t} = \dfrac{(900)*(10^3)}{(2\pi)(25)^2(3)} = 76.4\ MPa.$

[b.] $\gamma = \dfrac{R\alpha}{L}$, $\alpha = \dfrac{2\pi}{360}(0.3) = 0.005236$ (should be In radians).

$\gamma = \dfrac{(25)(0.005236)}{50} = (2.6)(10^{-3})$

[c.] $\tau = G\gamma$

$\Rightarrow G = 29.18\ GPa$



S ≡ shear strength of the material.

[d.] $S = ?!$

Failure at $T = 1200\ N\cdot m$

$\alpha = 10^\circ$

$S = \dfrac{(1200)(10^3)}{(2\pi)(25)^2(3)} = 101.9\ MPa.$

$\Rightarrow$ all problems are suggested :p

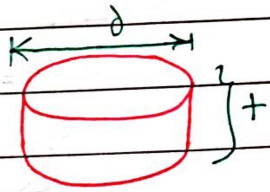
CH "10+11" Castings

19.10.2016

9.18

* heated volume = 5% larger than what's needed to fill the cavity?

H = ?!



$d = 40$ cm

$t = 5$ cm $= h$

$T_m = 660°C$

$T_p = 800°C$

$T_0 = 25°C$

$H_f = 389.9$ J/g → heat fusion.

$C_s = C_L = 0.21$ cal/g.°C $= 0.88$ J/g.°C

$\Rightarrow H = \rho V \{ C_s(T_m - T_0) + H_f + C_L(T_p - T_m) \}$

$\Rightarrow V = \frac{\pi}{4} D^2 h = \frac{\pi}{4}(40)^2(5) = 6283.2 \text{ cm}^3$

$V = (6283.2) * 1.05 = 6597.3 \text{ cm}^3$

$\Rightarrow \rho = 2.7 \text{ g/cm}^3$.

$\Rightarrow H = 19082756$ J

9.88

24.10.2016

a. $V = \sqrt{2gh}$

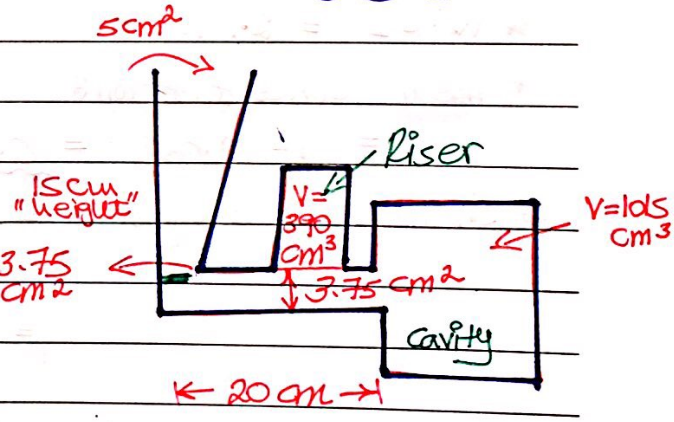
$= \sqrt{(2)(981)(15)}$

$= 171.5$ cm/s

$Q = VA$

$= (171.5)(3.75)$

$= 643.1 \text{ cm}^3/\text{s}$



b. $V_{mold} = 1015 + 390 + (3.75)(20) + \frac{(5 + 3.75)}{2} * 15$ → avg. area.

$= 1545.6 \text{ cm}^3$.

c. Actual $Q = \frac{1545.6}{3} = 515.2 \text{ cm}^3/\text{s}$

Actual $V = 515.2 \frac{\text{cm}^3}{\text{s}} / 3.75 \text{ cm}^2 = 137.38$ cm/s

d. Loss of head due to friction ?!

→ $v = \sqrt{2gh} = \sqrt{2(981)(h)}$

↳ $137.38 = (2 \times 9.81 \times h)^{0.5}$

↳ $h = 9.622$ ⇒ loss of head $= 15 - 9.622$

$= 5.388$ cm.

*

* Shrink Rule:

* liquid state ← تعويض النقص في الحجم اللي بصير بالجسم *

* ex. : Ruler in solid state ; $L = 1$ m

" Liquid state ; $L = 1.2$ m

⤳ since during solidification it will shrink.

⤳ note: Each material has its own "shrinking Rule".

*

\# 9.9 :

* W.C.I $= 2.1\%$

* linear concentration:

$= 1 - 0.021 = 0.979$

* Shrink Rule Elongation $= \dfrac{1}{\text{linear concentration}}$

$= \dfrac{1}{0.979} = 1.02145$.

* For a 100-cm length / rule :

$= 1.02145 \times 100$ cm

$= 102.145$ cm

* Elongation / m length :

$= 2.145$ cm.

26.10.2016

* 9.20 8

Riser 8 Spherical => $\partial = ?!$

Castings Rectangular

$L = 200$ mm / $\omega = 100$ mm] TST = 3.5 min.

$t = 18$ mm

* [$TST_{riser} = 1.25 * TST_{, casting}$] *

* $TST = C_m \left(\frac{V}{A}\right)^{n=2}$

↳ I have to find Cm first.

* $TST_{(casting)} = 3.5 \text{ min.} = C_m (\quad)$

~> $V = (200)(100)(18)$
$= 360,000 \text{ mm}^3$

~> $A = 2(200*100) + 2(100*18) + 2(18*200)$ ≡ total surface Area.
$= 50,800 \text{ mm}^2$

$(n = 2) \Rightarrow C_m = 0.0697 \text{ min/mm}^2$

~> $TST_{riser} = (1.25)(3.5) = 0.0697 (0.1667D)^2$

~> $V = \pi D^3/6$
~> $A = \pi D^2$ $\Rightarrow \frac{V}{A} = 0.1667D$

$\Rightarrow$ D = 47.5 mm

Five Apple

7.11.2016

* Ex. 8 P.179

$V_{core} = 1875\ cm^3$

$F_b = ?!$

casting made of "Lead".

$\rightsquigarrow F_b = \omega_m - \omega_c$

* $\rho_{sand.} = 1.6\ g/cm^3$
* $\rho_b = 11.3\ g/cm^3$

$\rightsquigarrow \omega_m = m \times g = \rho V g$

$= (11.3)(1875)(981) = 20784937.5 = 207.85 N.$

$= \frac{g}{cm^3} * cm^3 * \frac{cm}{s^2} = \frac{cm \cdot g}{s^2}$

$[N] = \frac{kg.m}{s^2}$

$\rightsquigarrow \omega_c = (1.6)(1875)(981)$

$= 29.43 N$

$\Rightarrow F_b = 207.85 - 29.43$

$= 178.4 N.$

14. 11. 2016

* 10.6 8 GF = ? , is the operation succeful ?

L = 105 cm

OD = 20cm "outside diameter".

t = 1.25 cm

N = 500 RPM.

** $GF = v^2/R.g$

$$V = \frac{2\pi R N}{60} = \frac{\pi R N}{30} = \frac{\pi(10)(500)}{30} = 52.4 \text{ cm/s}.$$

$$GF = \frac{(52.4)^2}{(10)(981)} = 28.02$$, not succeful since 28.02 < 60 .

* 10.78 IMPORTANT .

casting

L = 10 cm

OD = 15 cm

ID = 12 cm

$\left.\right\}$ t = 3 cm

a) N = ?

GF = 70

$$\rightsquigarrow N = \frac{30}{\pi}\sqrt{\frac{2 g . GF}{D}} = \frac{30}{\pi}\sqrt{\frac{(2)(981)(70)}{15}} = 913.7 \text{ RPM}.$$

b) τ = ?! , $\tau = F_c/A$

$\rightsquigarrow F_c = \frac{mv^2}{R}$, $m = \rho V$, $V = \pi(R_o^2 - R_i^2) * \ell$

$= \pi(7.5^2 - 6^2) * 10 = 636.2 \text{ cm}^3$

$m = (8.62)(636.2) = 5484 g$

$\rightsquigarrow v = \frac{2\pi R N}{60} = \frac{2(\pi)(7.5)N}{60}$ → avg diameter not $(7.5) = \left(\frac{7.5+6}{2}\right)$

$= 645.85 \text{ cm/s}$

$\tau = \frac{F_c}{A}$ surface
$A \rightarrow$ area of the mold (Inner diameter).

$$F_c = \frac{mv^2}{R} = \frac{(5484)(645.85)^2}{6.75 \rightarrow \text{avg rad.}} = 338.89 * 10^6 \ \frac{g.cm}{s^2}$$

$$\rightarrow N = \left[\frac{kg.m}{s^2}\right] = 33888.9N$$

$$A_{mold} = (2\pi R)(L)$$
$$= 2\pi (7.5)(10) = 471.23 \ cm^2$$

$$\tau = \frac{F_c}{A} = \frac{3.4*10^3}{471.23*10^2 \ mm^2} = 0.072 MPa \ *$$

Scanned by CamScanner

* Rolling *　　　　　　　　　　21. 11. 2016

*Ex-18

$w_g = 300$ mm , $t_o = 25$ mm
$R = 250$ mm
$t_f = 22$ mm
} In One Pass.

$N = 50$ RPM
$K = 250$ MPa
$n = 0.15$.
$\mu = 0.12$.

* Friction is ok ?!
to give $d = 3$ mm?
⇝ If <u>YES</u> ; F, T, P = ?!

$$\ast d_{max.} = \mu^2 R = 0.12^2 \ast 250 = 3.6 \text{ mm}. \quad (\text{ok})$$

⇝ $F = \bar{Y}_f \, wL$

$$\Rightarrow \bar{Y}_f = \frac{K\varepsilon^n}{1+n} = \left(250 \ln\left(\frac{25}{22}\right)\right)^{0.15} / 1.15 = 175.7 \text{ MPa}$$ "Reduction".

$$\Rightarrow L = \sqrt{R \ast d} = \sqrt{250 \ast 3} = 27.4 \text{ mm}.$$

$$F = 175.7 \ast 300 \ast 27.4 = 1444786 \text{ N}$$

⇝ $T = 0.5 \, FL$

$$= (0.5)(1444786)(27.4) = 197.86 \ast 10^3 \text{ N.mm}.$$

⇝ $P = 2\pi NFL$

$$= 12432086 \text{ N.m/min} = 207201 \text{ N.m/s}$$

$$= 207201 / 745.7 = 278 \text{ hp}.$$

* Forging. 28. 11. 2016

* Ex. 28

$h_0 = 75$ mm

$D_0 = 50$ mm

$h_f = 36$ mm

$k = 350$ MPa

$n = 0.17$

$\mu = 0.1$

1. Force on the process begins
2. Force at $h = 62$ mm
3. " " $h = 49$ mm
4. at 36 mm

$\rightsquigarrow F = K_f Y_f A$

$\rightsquigarrow K_f = 1 + \dfrac{0.4 \mu D}{h}$

$\rightsquigarrow Y_f = k \varepsilon^n$

* The Right solutions

$0.002 = \ln\left(\dfrac{75}{h_f}\right)$

$\hookrightarrow h_f = 74.98$ mm

$A_f h_f = A_o h_o$

$\hookrightarrow D_f = 50.006$ mm.

1. $\varepsilon = 0.2\% = 0.002$

$\rightarrow Y_f = (350)(0.002)^{0.17} = 121.686$ MPa

$\rightarrow K_f = 1 + \dfrac{(0.4)(0.1)(50)}{75} = 1.0267$

$\rightarrow F = (1.0267)(121.686)\left(\dfrac{\pi}{4}\right)(50)^2 = 245.309$ kN

2. $\varepsilon = \ln\left(\dfrac{h}{h_0}\right) = \ln\left(\dfrac{62}{75}\right) = 0.1904$

$\rightsquigarrow$ volume constant.

$A_o h_o = A h$

$\left(\dfrac{\pi}{4}\right)(50)^2(75) = \left(\dfrac{\pi}{4}\right)(D)^2(62)$

$D \cong 55$ mm

$\rightarrow Y_f = (350)(0.1904)^{0.17} = 264.005$ MPa

$\rightarrow K_f = 1 + \dfrac{(0.4)(0.1)(55)}{62} = 1.0355$

$\rightarrow F = (264.005)(1.0355)\left(\dfrac{\pi}{4}\right)(55)^2 = 649.5$ kN

3. $\varepsilon = \ln\left(\frac{75}{49}\right) = 0.426$

$A_0 h_0 = A h$

$(75)\left(\frac{\pi}{4}\right)(50)^2 = \left(\frac{\pi}{4}\right)(D^2)\,49 = 61.8 \text{ mm}$ D=

$\rightarrow Y_f = K\varepsilon^n = (350)(0.426)^{0.17} = 302.74 \text{ MPa}$

$\rightarrow K_f = 1 + \frac{(0.4)(0.1)(61.8)}{49} = 1.05$

$\rightarrow F = K_f Y_f A = (302.74)(1.05)\left(\frac{\pi}{4}\right)(61.8)^2 = 953.512 \text{ kN}$

4. $\varepsilon = \ln\left(\frac{75}{36}\right) = 0.734$

$A_0 h_0 = A h$

$(75)\left(\frac{\pi}{4}\right)(50)^2 = \left(\frac{\pi}{4}\right)(D^2)(36) \Rightarrow D = 72.2 \text{ mm}$

$\rightarrow Y_f = K\varepsilon^n = (350)(0.734)^{0.17} = 332.075 \text{ MPa}$

$\rightarrow K_f = 1 + \frac{(0.4)(0.1)(72.2)}{36} = 1.0802$

$\rightarrow F = K_f Y_f A = 1468.604 \text{ kN}.$

5-12-2016

*Ex.38

l_0 = 75 mm

D_0 = 25 mm

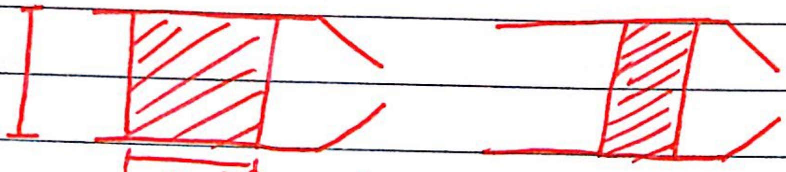
r_x = 4.0

k = 415 MPa

n = 0.18

a=0.8 , b=1.5

~> using Johnson's formula!!



* diameter still the same, but length changed.

$* P = \bar{Y}_f \left(\varepsilon_x + \frac{2L}{D} \right)$ ~> variable ~> constants.

$* \varepsilon = \ln r_x = \ln 4 = 1.3863$

$* \bar{Y}_f = k\varepsilon^n / 1+n = (415)(1.3863)^{0.18} / 1.18$

$= 373$ MPa.

~> $\varepsilon_x = a + b \ln r_x = 0.8 + (1.5)(1.3863)$.

$= 2.8795$

~> at "L=75 mm" "max."

$p = (373)\left(2.8795 + \frac{2*75}{25}\right)$.

$= 3312$ MPa.

~> at "L= 50 mm" , D=25

P = 2566 MPa.

~> at "L= 25 mm"

P = 1820 MPa.

~> at "L=0" , D=25

P = Minimum , P = 1074 MPa the minimum amount of pressure to make extrusion.

7.12.2016

* Ex. 48 $\sigma_d = ?$, $F_d = ?$

$\alpha = 15°$

$D_o = 2.5$ mm

$D_f = 2.0$ mm

$\mu = 0.07$

$K = 205$ MPa

$n = 0.2$

$F = A_f \sigma_d = A_f \bar{Y}_f \left(1 + \frac{\mu}{\tan\alpha}\right) \phi \ln\left(\frac{A_o}{A_f}\right)$.

* $\bar{Y}_f = K\varepsilon^n / 1+n \Rightarrow \varepsilon = \ln\left(\frac{A_o}{A_f}\right) = \ln\left(\frac{D_o}{D_f}\right)^2 = 2\ln D_o/D_f$

$= 2\ln \frac{2.5}{2} = 0.446$

$= 205\,(0.446)^{0.2}/1.2 = 145.4$ MPa

* $\phi = 0.88 + 0.12\,\frac{D}{L_c} \Rightarrow D = \frac{D_o + D_f}{2} = \frac{4.5}{2} = 2.25$ mm.

$L_c = \frac{D_o - D_f}{2\sin\alpha} = \frac{2.5 - 2}{2\sin 15} = 0.966$ mm.

$\Rightarrow A_f = \frac{\pi}{4} D_f^2 = \frac{\pi}{4}(2)^2 = 3.14$ mm^2

$\phi = 1.16$

* $F = (3.14)(145.4)\left(1 + \frac{0.07}{\tan 15}\right)(1.16)(0.446)$

$= 259.5$ N

* $\sigma_d = \frac{F_d}{A_f} = 94.1$ MPa.

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*prob 28. 8 important.

$D_o = 5 cm$ } Before
$L_o = 7.5 cm$ } "cylinder"

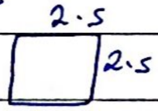
Edge Length = 2.5 cm
$K = 180 MPa$
$u = 0.2$
$a = 0.8$, $b = 1.2$
} After "square".

(a) $r_x = 7.854$

$\varepsilon = 2.061$

$\varepsilon_x =$

(b) $K_x = 0.98 + 0.02\left(\frac{C_x}{C_c}\right)^{2.25}$ → 10 , 8.86



, $A_{square} = (2.5)^2 = 6.25 cm^2$

, $A_{circle} = \frac{\pi}{4} d^2$

$\hookrightarrow d = 2.82 cm$

*$C_x = 10 cm$

*$C_c =$ 8.86

*per. of circle $= \pi d$

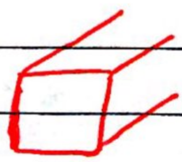
$= \pi (2.82) = 8.86 cm$

$K_x = 1.006$.

K_x is reduced by increasing the complication of the shape.

(c) $l = 19.635 cm$.

(d) $P = 571 MPa$.



monday
19/12/2016

Example : 1 : (Blanking operation)

$D_b = 150$ mm

$t = 3.2$ mm

$A_c = 0.075$

$S = 310$ MPa

$D_{Punch} = ?$

$D_{Die} = ?$

$C = (A_c)(t) = (0.075) \times 3.2 = 0.24$ mm

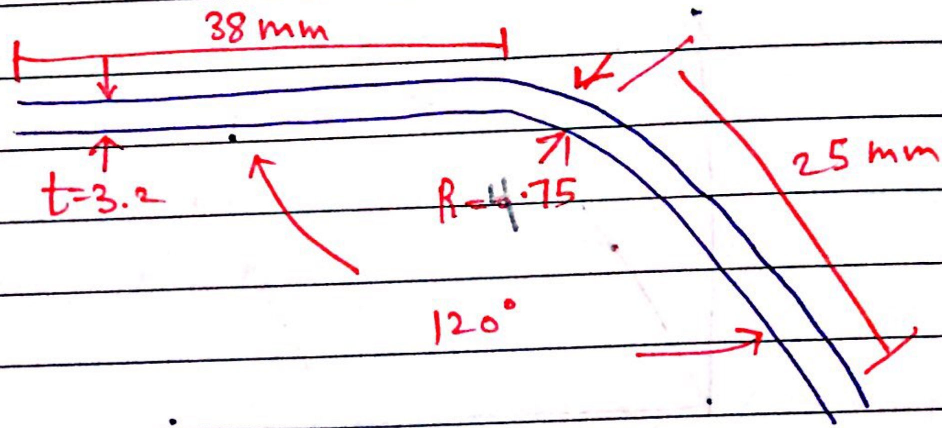
$D_{Punch} = 150 - 2(0.24) = 149.52$ mm

$D_{Die} = 150$ mm

$F = StL = (310)(3.2)(\pi\, 150) = 467469$ N

≈ 53 ton.

Example: 2:

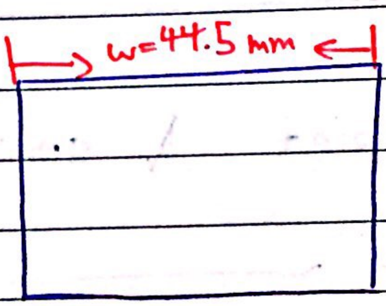


E = 205 GPa

Y = 275 MPa

UTS = 450 MPa

ⓐ The starting blank size?



$$A_b = \frac{2\pi\alpha}{360}(R + K_{ba}t)$$

$K_{ba} \rightarrow$ 0.33 because $R < 2t$

$$A_b = (2\pi)\left(\frac{60}{360}\right)(4.75 + (0.33 \times 3.2)) = 6.08\ mm$$

The starting blank size = 6.08 + 25 + 38 = 69.08 mm

ⓑ Bending Force? D = 25 mm, V-die is used:

$K_{bf} \rightarrow 1.33$

$$F = \frac{K_{bf}(TS)wt^2}{D} = \frac{(1.33)(450)(44.5)(3.2)^2}{25}$$

$$= 10909\ N$$

* Drawing.

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* Ex. 38

$D_i = 75$ mm $= D_p$

$h = 50$ mm

$D_b = 138$ mm

$t = 2.4$ mm

⇒ Is the operation feasible?!

* $DR = D_b / D_P$

$= \frac{138}{75} = 1.84 \leq 2$ ✓

* $r = \frac{D_b - D_P}{D_b} = \frac{138 - 75}{138} = 0.456 < 0.5$ ✓

* $t / D_b = 2.4 / 138 = 0.017 = 1.7\% > 1\%$ ✓

⇝ so, the process is feasible.

* Ex. 48

a) drawing force (F)

b) holding force (F_h)

$UTS = 300$ MPa, $\sigma_y = 175$ MPa, $R_d = 6$ mm.

* $F = \pi D_p t (TS) \left(\frac{D_b}{D_p} - 0.7 \right)$

$= \pi (175)(2.4)(300)\left(\frac{138}{75} - 0.7 \right) = 193396$ N

* $F_h = 0.015 \sigma_y \pi \left(D_b^2 - (D_p + 2.2(t) + 2R_d)^2 \right)$

$= 86824$ N

⇝ $F_h / F = 0.445$.