higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

MEGANIESE TEKENE EN ONTWERP N5

23 Julie 2021

Hierdie nasienriglyn bestaan uit 12 bladsye.

Kopiereg voorbehou

VRAAG 1

DATA: d = 20 mm; L = 380 mm;
N = 2000 rpm; $\theta = 3{,}06°; G = 82 \times 10^9 Pa;\ \ P = ?;\ \tau = ?$

Vind die maksimum wringkrag (T_{maks})

$$\theta = \frac{584 \times T_{max} \times L}{G \times d^4}$$

$T_{max} = \frac{G \times d^4 \times \theta}{584 \times L}$ ✓

$T_{max} = \frac{82 \times 10^9 (0{,}02)^4 \times (3{,}06)}{584 \times 0{,}38}$ ✓

$T_{max} = \boxed{180{,}91\ Nm}$ ✓

Vind die drywing (P)

$$P = \frac{2\pi NT}{60}$$

$P = \frac{2\pi(2000)(180{,}91)}{60}$ ✓

$P = 37889{,}37\ W$

$P = \boxed{37{,}9\ kW}$ ✓

Vind die skuifspanning (τ)

$T_{max} = \frac{\pi}{16} {d_s}^3 \tau_s$

$$\tau_s = \frac{16\ T_{maks}}{\pi \times {d_s}^3}$$

$\tau_s = \frac{16\ (180{,}91)}{\pi \times (0{,}02)^3}$ ✓

$\tau_s = 115169887\ Pa$

$\tau_s = \boxed{115\ MPa}$ ✓

[7]

VRAAG 2

DATA: $t = 15\,mm;\ d = 6\sqrt{t};\ n = 2;\ \ \sigma_t = 463\,MPa;\ \sigma_c = 618\,MPa;$

$\tau = 386\,MPa\ \ looking\ for\ d; P; F_t;\ F_s;\ F_c;\ F_{safe};\ \eta_c;\ \eta_s;\ \eta_t; \eta_{joint}$

Vind die deursnee van die klinknael (d)

$d = 6\sqrt{t}$

$d = 6\sqrt{15}$

$d = 23{,}24$

Gebruik $d = 24\,mm$ ✓ *(Standaardgrootte)*

Vind die steek (P)

$F_t = F_s$

$(P - d)t \times \sigma_t = n \times \frac{\pi}{4} d^2 \tau$

$(P - 24)(15) \times 463 \times 10^6 = 2 \times \frac{\pi}{4}(24)^2(386 \times 10^6)$✓

$(P - 24) = 50{,}29$ ✓

$P = 74{,}29\,mm$

$P = \boxed{74\,mm}$ ✓

Gee volpunte selfs al het die kandidaat mm na m omgeskakel, nie die veiligheidsfaktor gebruik gebruik nie en P = 85,6 mm gebruik in plaas van 86 mm.

Vind die (F_t)

$F_t = (P - d)t \times \sigma_t$

$F_t = (0{,}074 - 0{,}024)0{,}015 \times 463 \times 10^6$ ✓

$F_t = 354195\,N$

$F_t = \boxed{354{,}2\,kN}$ ✓

Vind die (F_s)

$F_s = n \times \frac{\pi}{4} d^2 \tau$

$F_s = 2 \times \frac{\pi}{4}(0{,}024)^2(386 \times 10^6)$ ✓

$F_s = 349245\,N$

$F_s = \boxed{349{,}25\,kN}$ ✓

Vind die (F_c)

$F_c = n \times d \times t \times \sigma_c$

$F_c = 2 \times 0{,}024 \times 0{,}015 \times 618 \times 10^6$ ✓

$F_c = 444960\ N$

$F_c = \boxed{444{,}96\ kN}$ ✓

Vind die (F_{Solied})

$F_t = P \times t \times \sigma_t$

$F_t = (0{,}074)0{,}015 \times 463 \times 10^6$ ✓

$F_t = 513930\ N$

$F_t = \boxed{513{,}93\ kN}$ ✓

Bereken die trekrendement (η_{trek})

$\eta_t = \frac{F_t}{F_{Solid}} \times 100\%$

$\eta_t = \frac{354{,}2}{513{,}93} \times 100\%$ ✓

$\eta_t = \boxed{68{,}9\ \%}$ ✓

Bereken die skuifrendement $(\eta_{shearing})$

$\eta_s = \frac{F_s}{F_{Solied}} \times 100\%$

$\eta_s = \frac{349{,}25}{513{,}93} \times 100\%$ ✓

$\eta_s = \boxed{67{,}9\ \%}$ ✓

Bereken die breekrendement (η_{breek})

$\eta_c = \frac{F_c}{F_{Solied}} \times 100\%$

$\eta_c = \frac{444{,}96}{513{,}93} \times 100\%$ ✓

$\eta_c = \boxed{86{,}6\ \%}$ ✓

Vind die veilige las (F_{veilig})

Die veilige las $= \boxed{349{,}25\ kN}$ ✓ die kleinste laswaarde

Kopiereg voorbehou

Bereken gesamentlike rendement (η_j)

$$\eta_j = \frac{F_{veilig}}{Sterkte\ van\ soliede\ plaat} \times 100\%$$

$\eta_j = \frac{349,25}{513,93} \times 100\%$ OF *Gee volpunte selfs al het die kandidaat net die kleinste waarde van die drie rendemente neergeskryf.*

$\eta_j = \boxed{67,9\ \%}$ ✓ **[20]**

VRAAG 3

DATA:

$D = 0{,}5\ m;\ L_{slag} = 0{,}6\ m;\ L_k = 1{,}5m; P = 550\ kPa;\ F_r = ?\ ;\ F_k = ?\ ;\ \sigma_{kruiskoppen} = ?$

$d_{Kruiskoppen} = 0{,}09\ m;\ L_{Kruiskoppen} = 0{,}114\ m;$

$$\left\{\begin{array}{c} NB: \\ Die\ kruk\ vorm\ 'nhoek\ van\ 90°\ met\ die\ dryfstang \rightarrow\ \ tan\theta = \frac{L_{kruk}}{L_k}\ \ cos\theta = \frac{F_p}{F_k} \end{array}\right\}$$

3.1 Vind die drukkrag op die kruiskopleibaan (F_r)

$F_p = P \times A$

$F_p = P \times \frac{\pi}{4} D^2$

$F_p = 550 \times 10^3 \times \frac{\pi}{4}(0{,}5)^2$ ✓✓

$F_p = 107992{,}248\ N$

$F_p = \boxed{107{,}992\ kN}$ ✓

$Slaglengte = 2 \times L_{kruk}$

$L_{kruk} = \frac{0{,}6}{2}$ ✓

$L_{kruk} = \boxed{0{,}3\ m}$ ✓

$\tan\theta = \frac{L_{kruk}}{L_k}$

$\tan\theta = \frac{0{,}3}{1{,}5}$ ✓

$\theta = \boxed{11{,}31°}$ ✓

$\tan\theta = \frac{F_r}{F_P}$

$F_r = F_P \times \tan\theta$

$F_r = 107992{,}248 \times \tan 11{,}31$ ✓

$F_r = \boxed{21{,}599\ kN}$ ✓ (9)

3.2 Vind die krag in die dryfstang (F_k)

$\cos\theta = \frac{F_P}{F_k}$

$F_k = \frac{F_P}{\cos\theta}$

$F_k = \frac{107{,}992}{\cos 11{,}31}$ ✓

$F_k = \boxed{110{,}131\ kN}$ ✓ (2)

[11]

VRAAG 4

DATA: $F_t = 50\ kN;\ \sigma_t = 72\ MPa;\ \tau = 60\ MPa;\ \sigma_c = 180\ MPa; t = 9\ mm$

4.1.1 Die deursnee van die staaf

$$F_t = \frac{\pi}{4} d^2 \sigma_t$$
$$d^2 = \frac{4 \times F_t}{\pi(\sigma_t)}$$
$$d^2 = \frac{4 \times 50 \times 10^3}{\pi(72 \times 10^6)} \quad ✓$$
$$d^2 = 8{,}8419 \times 10^{-4} \quad ✓$$
$$d = 0{,}02974\ m$$
$$d = 29{,}7\ mm$$
$$d = \boxed{30\ mm} \quad ✓ \quad \textit{(Standaardgrootte)}$$ (3)

4.1.2 Die deursnee van die staaf se punt by die spy se gat

$$F_t = \left[\frac{\pi}{4} {d_1}^2 - (d_1 \times t)\right] \sigma_t$$
$$50 \times 10^3 = \left[\frac{\pi}{4} {d_1}^2 - (d_1 \times 0{,}009)\right] 72 \times 10^6 \quad ✓$$

$$\left[0{,}785 {d_1}^2 - 0{,}009 d_1\right] = 6{,}944 \times 10^{-4}3$$

$$\left[0{,}785 {d_1}^2 - 0{,}009 d_1\right] - 6{,}944 \times 10^{-4} = 0 \quad ✓$$

$$d_1 = \frac{-\mathrm{b} \pm \sqrt{\mathrm{b}^2 - 4\mathrm{ac}}}{2\mathrm{a}}$$

$$d_1 = \frac{-(-0{,}009) \pm \sqrt{(-0{,}009)^2 - 4(0{,}785)(-6{,}944 \times 10^{-4})}}{2(0{,}785)} \quad ✓$$

$$d_1 = \frac{0{,}009 \pm 0{,}048}{1{,}57} \quad ✓$$

$$d_1 = 0{,}0363\ m$$

$$d_1 = 36{,}3\ mm$$

$$\textit{Gebruik die naaste waarde} \qquad d_1 = \boxed{36\ mm} \quad ✓$$ (5)

4.1.3 Die buitedeursnee van die sok se punt by die spy se gat

$$F_t = \left[\frac{\pi}{4}(D^2 - d^2) - (D - d)t\right]\sigma_t$$
$$50 \times 10^3 = \left[\frac{\pi}{4}(D^2 - 0{,}036^2) - (D - 0{,}036)0{,}009\right]72 \times 10^6 \quad ✓$$
$$\left[\frac{\pi}{4}(D^2 - 0{,}036^2) - (D - 0{,}036)0{,}009\right] = 6{,}944 \times 10^{-4}$$
$$0{,}785D^2 - 1{,}018 \times 10^{-3} - 0{,}009D + 3{,}24 \times 10^{-4} = 6{,}944 \times 10^{-4} \quad ✓$$
$$0{,}785D^2 - 0{,}009D - 1{,}388 \times 10^{-3} = 0$$
$$D = \frac{-\mathrm{b} \pm \sqrt{\mathrm{b}^2 - 4\mathrm{ac}}}{2\mathrm{a}}$$
$$D = \frac{-(-0{,}009) \pm \sqrt{(-0{,}009)^2 - 4(0{,}785)(-1{,}388 \times 10^{-3})}}{2(0{,}785)} \quad ✓$$
$$D = \frac{0{,}009 \pm 0{,}067}{1{,}57} \quad ✓$$
$$D = 0{,}0482\ m$$
$$D = 48{,}2\ mm$$
$$Gebruik\ die\ naaste\ waarde \quad D = \boxed{48\ mm} \quad ✓ \qquad (5)$$

4.1.4 Die gemiddelde breedte van die spy

$$F_s = 2bt\tau$$
$$50 \times 10^3 = 2b(0{,}009)(60 \times 10^6) \quad ✓$$
$$b = \frac{(50 \times 10^3)}{2(0{,}009)(60 \times 10^6)} \quad ✓$$
$$b = 0{,}0463\ m$$
$$b = 46{,}3\ mm$$
$$b = \boxed{46\ mm} \quad ✓ \qquad (3)$$

4.2.1 Toets die breeksterkte tussen die spy en staaf

$$F_c = d_1 t\sigma_c$$
$$F_c = (0{,}036)(0{,}009)(180 \times 10^6) \quad ✓$$
$$F_c = 58320\ N$$
$$F_c = \boxed{58{,}32\ kN} \quad ✓ \qquad (2)$$

4.2.2 Toets die breeksterkte tussen die spy en sokflens

$$F_c = (\mathrm{D}_1 - d_1)t\sigma_c$$
$$F_c = (2{,}42 \times 0{,}03 - 0{,}036)(0{,}009)(180 \times 10^6) \quad ✓ \qquad (\mathrm{D}_1 = 2{,}42\ d) \quad ✓$$
$$F_c = 59292\ N$$
$$F_c = \boxed{59{,}3\ kN} \quad ✓ \qquad (3)$$

[21]

VRAAG 5

DATA: $F = 80\,kN;\ \tau = 85\,MPa; t_1 = 28\,mm;\ t_2 = 16\,mm;$ $looking\ for: d_1;\ \sigma_{c_{Pin\ \&\ eye}};\ \sigma_{c_{Pin\ \&\ fork}}$

Vind die deursnee van die pen (d_1)

$F = \tau \times 2 \times \frac{\pi}{4} {d_1}^2$

$80 \times 10^3 = 85 \times 10^6 \times 2 \times \frac{\pi}{4} {d_1}^2$ ✓

${d_1}^2 = \frac{80\,000 \times 4}{\pi(85 \times 10^6)(2)}$ ✓

${d_1}^2 = 5{,}9917 \times 10^{-4}$ ✓

$d_1 = 0{,}02448\,m$

$d_1 = 24{,}48\,mm$

$d_1 = \boxed{25\ mm}$ ✓ *(Standaardgrootte)*

Breekspanning tussen die pen en die oog $\left(\sigma_{c_{Pin\ \&\ eye}}\right)$

$F = \sigma_c \times d_1 \times t_1$

$\sigma_c = \frac{F}{d_1 \times t_1}$

$\sigma_c = \frac{80 \times 10^3}{0{,}025 \times 0{,}028}$ ✓✓

$\sigma_c = 114285714{,}3\,Pa$

$\sigma_c = \boxed{114{,}29\,MPa}$ ✓

Breekspanning tussen die pen en die vurk $\left(\sigma_{c_{Pin\ \&\ fork}}\right)$

$F = \sigma_c \times 2 \times d_1 \times t_2$

$\sigma_c = \frac{F}{2 \times d_1 \times t_2}$

$\sigma_c = \frac{80 \times 10^3}{2 \times 0{,}025 \times 0{,}016}$ ✓✓

$\sigma_c = 100\,000\,000\,Pa$

$\sigma_c = \boxed{100\,MPa}$ ✓ **[10]**

VRAAG 6

DATA: $d_s = 60\ mm; \tau_s = 62\ MPa; D = 160\ mm; d = 80\ mm; w = 32\ mm;$

$\tau_{key} = 50\ MPa; \quad \sigma_{c_{key}} = 148\ MPa; n = 3 \quad \tau = ?;\ \sigma_c = ?;\ L_{key} = ?;$

6.1 Die skuif- en drukspanning in die kloue

$T_{maks} = \frac{\pi}{16} {d_s}^3 \tau_s$
$T_{maks} = \frac{\pi}{16}(0{,}06)^3(62 \times 10^6)$ ✓
$T_{maks} = \boxed{2629{,}51\ Nm}$ ✓

<u>Vind die oppervlaktes</u>

$A_s = \frac{\pi}{8}(D^2 - d^2)$
$A_s = \frac{\pi}{8}(0{,}16^2 - 0{,}08^2)$ ✓
$A_s = \boxed{7{,}54 \times 10^{-3}\ m^2}$ ✓

$A_c = n \times w \times \frac{D-d}{2}$
$A_c = 3 \times 0{,}032 \times \frac{0{,}16-0{,}08}{2}$ ✓
$A_c = \boxed{3{,}84 \times 10^{-3} m^2}$ ✓

Vind die gemiddelde radius

$R_{Gemiddeld} = \frac{D+d}{4}$
$R_{Gemiddeld} = \frac{160+80}{4}$ ✓
$R_{Gemiddeld} = \boxed{60\ mm}$ ✓

Vind die kragte

$\{T_{kloue} = T_{as} = T_{maks} = 2629{,}51\ Nm\}$

$T_{maks} = F_s \times R_{Gemiddeld}$
$2629{,}51 = F_s \times 0{,}06$ ✓
$F_s = \frac{2629{,}51}{0{,}06}$ ✓
$F_s = 43825{,}17\ N$
$F_s = \boxed{43{,}825\ kN}$ ✓

$T_{maks} = F_c \times R_{Gemiddeld}$
$2629{,}51 = F_c \times 0{,}06$ ✓
$F_c = \frac{2629{,}51}{0{,}06}$ ✓
$F_c = 43825{,}17\ N = F_s$
$F_c = \boxed{43{,}825\ kN}$ ✓ (Gee volpunte selfs al skryf die kandidaat net die antwoord neer.)

Vind die spannings

$F_s = \tau \times A_s$

$\tau = \frac{F_s}{A_s}$

$\tau = \frac{43825,17}{7,54\times10^{-3}}$ ✓

$\tau = 5812356,76\ Pa$

$\tau = \boxed{5,8\ MPa}$ ✓

$F_c = \tau \times A_c$

$\sigma_c = \frac{F_c}{A_s}$

$\tau = \frac{43825,17}{3,84\times10^{-3}}$ ✓

$\tau = 11412804,69\ Pa$

$\tau = \boxed{11,4\ MPa}$ ✓

Die minimum lengte van die spy

Uit die tabel *(Waar $d_s = 60\ mm$)* $w = 18\ mm\ \&\ t = 11\ mm$ (18)

6.2 Vir skuif

$Wringkrag\ op\ as = Wringkrag\ op\ spy\ a.g.v.skuif$

$Wringkrag\ op\ as = w \times l \times \tau \times \frac{d}{2}$

$2629,51 = 0,018 \times l \times 50 \times 10^6 \times \frac{0,06}{2}$ ✓

$l = \frac{2629,51\times2}{0,018\times50\times10^6\times0,06}$ ✓

$l = 0,09739\ m$

$\boxed{l = 97,39\ mm}$ ✓

Vir breek

$Wringkrag\ op\ as = Wringkrag\ op\ spy\ a.g.v.breek$

$T = \frac{t}{2} \times l \times \sigma_c \times \frac{d}{2}$

$2629,51 = \frac{0,11}{2} \times l \times 148 \times 10^6 \times \frac{0,06}{2}$ ✓

$l = \frac{2629,51\times2\times2}{0,11(148\times10^6)(0,06)}$ ✓

$l = 0,01077\ m$

$\boxed{l = 10,77\ mm}$ ✓

Antwoord: Gebruik: Lengte = 97,39 mm ✓ (vir veiligheid) (7)

[25]

VRAAG 7

DATA: $L_e = 252\ mm;\ \tau = 90\ MPa;\ t_1 = 6\ mm;$

Keeldikte (t)

$t = 0{,}707 \times t_1$

$t = 0{,}707 \times (0{,}006)$ ✓

$t = 0{,}004242\ m$

$t = \boxed{4{,}242\ mm}$ ✓

Area van sweislas (A)

$A = L_e \times t$

$A = 252 \times 4{,}242$ ✓

$A = 1068{,}984\ mm^2$

$A = \boxed{1{,}069 \times 10^{-3}\ m^2}$ ✓

Treklas (F)

$F = \tau \times A$

$F = 90 \times 10^6 \times 1{,}069 \times 10^{-3}$ ✓

$F = 96210\ N$

$F = \boxed{96{,}210\ kN}$ ✓ **[6]**

TOTAAL: 100

Kopiereg voorbehou