higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N6

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This marking guideline consists of 8 pages.

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QUESTION 1

1.1 $speed\ ratio = \frac{N_f}{N_s} = \frac{1440}{804{,}469}$ ✓ $= 1{,}79$ ✓ (2)

1.2 $service\ factor = 1{,}3$ ✓ (1)

1.3 $Design\ Power = Engine\ power \times service\ factor$

$= 23 \times 1{,}3$ ✓

$= 29{,}9kW$ ✓ (2)

1.4 $Minimum\ pulley\ diameter = 140mm$ ✓ (1)

1.5 $Correct\ center\ distance = 892mm$ ✓ (1)

1.6 $(Pulley\ pitch\ diameters) D = 140mm$ ✓ $and\ d = 250mm$ ✓ (2)

1.7 $Belt\ length = 2400mm$ ✓ (1)

1.8 $Correctional\ factor = 0{,}9$ ✓ (1)

1.9 $Basic\ Power\ per\ belt = 5{,}73kW$ ✓ (1)

1.10 $Additional\ power\ per\ belt = 1{,}06kW$ ✓ (1)

1.11 $Correctional\ power\ per\ belt$
$= (Basic\ power + Additional\ power) correctional\ factor$

$= (5{,}73 + 1{,}06)0{,}9$ ✓

$= 7{,}401kW$ ✓ (2)

1.12 $Number\ of\ belts = \frac{Design\ power}{Correctional\ power}$

$= \frac{29{,}9}{7{,}401}$ ✓

$= 4{,}04$ ✓

$= 5\ belts$ ✓ (3)

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QUESTION 2

2.1 $P = \frac{2\pi NT}{60}$

$12 \times 10^3 = \frac{2\pi(800)T}{60}$ ✓

$T = 143{,}239Nm$ ✓

$T = \mu(F_c - S)R \times n$

$143{,}239 = 0{,}3(F_c - S)O,15 \times 4$ ✓

$F_c - S = 636{,}619N$ ✓

$w_1 = \frac{2\pi N_1}{60} = \frac{2\pi(800)}{60} = 83{,}776rad/s$ ✓

$w_2 = \frac{2\pi N_2}{60} = \frac{2\pi(0{,}65 \times 800)}{60} = 54{,}454rad/s$ ✓

$F_c - S = m({w_1}^2 - {w_2}^2)R_g$

$636{,}619 = m(83{,}776^2 - 54{,}454^2)0{,}13$ ✓

$m = 1{,}208kg$ ✓ (8)

2.2 $F_c = m{w_1}^2 R_g = 1{,}208(83{,}776)^2 0{,}13 = 1102{,}172N$ ✓

$S = m{w_2}^2 R_g = 1{,}208(54{,}454)^2 0{,}13 = 465{,}661N$ ✓

$New\ spring\ force$
$= Force\ on\ the\ spring\ before\ wearing$
$+ Additional\ force\ on\ the\ spring\ due\ to\ wearing$

$642{,}5 = 465{,}661 + S_w$ ✓

$S_w = 176{,}839N$ ✓

$S_t = \frac{S_w}{X} = \frac{176{,}839}{4}$ ✓ $= 44{,}21N/mm$ ✓ (6)

2.3 $F_c - S = 1102,172 - 642,5 = 459,672N$ ✓

$T_q = \mu(F_c - S)R \times n$

$= 0,3(459,672)(0,15)(4)$ ✓

$= 82,741Nm$ ✓

$$\%reaction\ in\ Torque = \frac{T_q(before\ wearing) - T_q(after\ wearing)}{T_q(before\ wearing)} \times 100\%$$

$$= \frac{143,239 - 82,741}{143,239} \times 100\%$$ ✓

$= 42,24\%$ ✓ (5)

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QUESTION 3

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

$25 \times 10^3 = \frac{2\pi(1000)T}{60}$ ✓

$T_A = 238,732Nm$ ✓

$T_B = T_A(\frac{N_A}{N_B})$

$T_B = 238,732 \times 4 = 954,928Nm$ ✓

$F_t = \frac{2T}{PCD_A} = \frac{2(238,732)}{0,12}$ ✓ $= 3978,867N$ ✓

$F_N = \frac{F_t}{cos\emptyset} = \frac{3978,867}{cos20°}$ ✓ $= 4234,222N$ ✓

$Vertical\ reaction$

$T = 2,8T_2 \ldots\ldots\ldots(1)$ ✓

$T_B = (T_1 - T_2)R \ldots\ldots\ldots(2)$

$954,928 = (2,8T_2 - T_2)0,15$ ✓

$T_2 = 3536,77N$ ✓

$T_1 = 2,8(3536,77) = 9902,956N$ ✓

$\Sigma_{cwm} = \Sigma_{Acwm}$

$W_f \times 0{,}5 + \left[W_p + (T_1 + T_2)cos30°\right] \times 1{,}25 = F \times 1 + F_N sin50° \times 0{,}2$

$(400 \times 9{,}81)0{,}5 + [(40 \times 9{,}81) + (9902{,}956 + 3536{,}77)cos30°] \times 1{,}2 = F \times 1 + 4234{,}222sin50° \times 0{,}2$

$1962 \checkmark + 15039{,}43 \checkmark = F + 648{,}72 \checkmark$

$F = 16352{,}71N \checkmark$

$E + F = W_f + W_p + (T_1 + T_2)cos30° - F_N sin50°$

$E = 3924 + 392{,}4 + (9902{,}956 + 3536{,}77)cos30° - 4234{,}222sin50° - 16352{,}71 \checkmark$

$E = -3639{,}542N$

$E = 3639{,}542N\ down \checkmark$

Vertical bending moments

$M_B = -E \times 0{,}2 = -3639{,}542 \times 0{,}2 \checkmark = -727{,}908Nm \checkmark$

$M_C = -E \times 0{,}5 + F_N sin50° \times 0{,}3$

$= -3639{,}542 \times 0{,}5 + 4234{,}222sin50° \times 0{,}3 \checkmark$

$= -846{,}69Nm \checkmark$

$M_F = -[W_p + (T_1 + T_2)cos30°] \times 0{,}25$

$= -[392{,}4 + (9902{,}956 + 3536{,}77)cos30°] \times 0{,}25 \checkmark$

$= -3007{,}886Nm \checkmark$

Horizontal Reaction

$\Sigma_{cwm} = \Sigma_{Acwm}$

$(T_1 + T_2)sin30° \times 1{,}25 = F_N cos50° \times 0{,}2 + F \times 1$

$[(9902{,}956 + 3536{,}77)sin30°] \times 1{,}25 = 4234{,}222cos50° \times 0{,}2 + F \checkmark$

$8399{,}829 \checkmark = 544{,}341 \checkmark + F$

$F = 7855{,}488N \checkmark$

$\Sigma F_{Left} = \Sigma F_{Right}$

$E + F + F_N cos50° = (T_1 + T_2)sin30°$

$E + 7855{,}488 + 4234{,}222cos50° = (9902{,}956 + 3536{,}77)sin30°$ ✓

$E = -3857{,}33N$

$E = 3857{,}33N\ LEFT$ ✓

Horizontal bending moment

$M_B = -E \times 0{,}2 = -3857{,}33 \times 0{,}2$ ✓ $= -771{,}466Nm$ ✓

$M_C = -E \times 0{,}5 + F_N cos50° \times 0{,}3$

$= -3857{,}33 \times 0{,}5 + 4234{,}222cos50° \times 0{,}3$ ✓

$= -1112{,}153Nm$ ✓

$M_F = -(T_1 + T_2)sin30° \times 0{,}25$

$= -(9902{,}956 + 3536{,}77)sin30° \times 0{,}25$ ✓

$= -1679{,}966Nm$ ✓

Maximum bending moment for the beam

$M_{MAX} = \sqrt{{M_{f_{VERTICAL}}}^2 + {M_{f_{HORIZONTAL}}}^2}$

$= \sqrt{3007{,}886^2 + 1679{,}966^2}$ ✓

$= 3445{,}238Nm$ ✓

$T_e = \sqrt{(M \times k_B)^2 + (T \times k_T)^2}$

$T_e = \sqrt{(3445{,}238 \times 3)^2 + (954{,}928 \times 2{,}5)^2}$ ✓

$T_e = 10{,}608kNm$ ✓

$T_e = \frac{\pi}{16} D^3 \tau_{MAX}$
$10608 = \frac{\pi}{16} D^3 (55 \times 10^6)$ ✓

$D^3 = 9{,}823 \times 10^{-4}$

$D = 99{,}406mm$ ✓

$\therefore D = 100mm$ ✓

$M_e = \frac{1}{2}[M + T_e]$

$M_e = \frac{1}{2}[3445{,}238 + 10{,}608 \times 10^3]$ ✓

$M_e = 7027kN$ ✓

$M_e = \frac{\pi}{32} D^3 \sigma_n$

$7027 = \frac{\pi}{32} D^3 (60 \times 10^6)$ ✓

$D^3 = 1{,}193 \times 10^{-3}$

$D = 106{,}055mm$ ✓

$\therefore D = 110mm$ ✓

The suitable shaft size should be $110mm.$ ✓ **[48]**

QUESTION 4

$\mathrm{W} = \mathrm{P} \times \mathrm{L} \times \mathrm{D} = (1{,}8 \times 10^{-3})(0{,}12 \times 0{,}08)$ ✓ $= 17{,}28kN$ ✓

The minimumu clearence

$D_{shaft} = 80^{-0{,}012}_{-0.034}$

$D_{bearing} = 80^{0{,}035}_{0{,}000}$

$diameteral\ clearence = 80{,}012 - 80$ ✓ $= ,012mm$ ✓

$\frac{L}{D} = \frac{120}{80} = 1{,}5$ ✓

$k = 0{,}002$ ✓

$f = 0{,}326\left[\frac{\mu \times N}{P}\right] \times \frac{D}{C} + k$

$f = 0{,}326\left[\frac{0{,}098 \times 800}{1{,}8 \times 10^6}\right] \times \frac{80}{0{,}012} + 0{,}002$ ✓

$f = 0{,}0967$ ✓

$H_{generated} = \frac{f \times w \times \pi \times D \times N}{60}$

$H_{generated} = \frac{0{,}0967 \times 17280 \times \pi \times 0{,}08 \times 800}{60}$ ✓

$H_{generated} = 5597{,}22W$ ✓

$H_{dissipated} = H_{generated}$

$H_{dissipated} = \frac{(\Delta T + 18°)^2 \times L \times D}{k}$

$5597{,}22 = \frac{(\Delta T + 18°)^2 \times 0{,}12 \times 0{,}08}{0{,}002}$ ✓

$(\Delta T + 18°)^2 = 1166{,}09$ ✓

$\Delta T = 16{,}148°$ ✓

$\Delta T = \frac{1}{2}[T_{bearing} - T_{absolute}]$

$16{,}148 = \frac{1}{2}[T_{bearing} - 25]$ ✓

$T_{bearing} = 57{,}296°$ ✓ **[15]**

TOTAL: 100

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