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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N5

8 AUGUST 2018

This marking guideline consists of 9 pages.

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QUESTION 1

1.1

$$X_T = F.(\frac{L_1}{A_1.E_1} + \frac{L_2}{A_2.E_2} + \frac{L_3}{A_3.E_3})$$

$$0{,}201\times10^{-3} = F.[\frac{0{,}1}{(1{,}59\times10^{-3}).(200\times10^{9})} + \frac{0{,}08}{(7{,}069\times10^{-4}).(80\times10^{9})} + \frac{0{,}08}{(3{,}801\times10^{-4}).(70{,}5\times10^{9})}]$$ ✓ ✓ ✓

$$\therefore F = 42634{,}426\ N$$ ✓

(4)

1.2

$$X_{single} = \frac{F.L}{A.E}$$

$$0{,}201\times10^{-3} = \frac{42634{,}426.(0{,}26)}{A.(200\times10^{9})}$$ ✓ ✓

$$\therefore A = 2{,}7575\times10^{-4}\ m^2$$ ✓

$$A = 2{,}7575\times10^{-4} = \frac{\pi}{4}.[(1{,}2^2).d^2 \quad d^2]$$ ✓

$$\therefore d = 28{,}248\ mm$$ ✓

$$D = 33{,}897\ mm$$ ✓

(6)
[10]

QUESTION 2

2.1

$$\eta_{joint} = (\frac{p-d}{p}).100$$

$$= (\frac{90-25}{90}).100$$ ✓

$$= 72{,}22\%$$ ✓

(2)

2.2

$$\sigma_T = \frac{\sigma_{T_{MAX}}}{SF}$$

$$= \frac{280}{5}$$ ✓

$$= 56\ MPa$$ ✓

$$\sigma_T = \frac{P_i.D}{2.t.\eta_j}$$ ✓

$$56\times10^{6} = \frac{P_i.(2)}{2.(0{,}015).(0{,}7222)}$$ ✓

$$\therefore P_i = 606{,}665\ kPa$$ ✓

(5)

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2.3 $F_{Tensile} = \sigma_{Tensile}.(p-d).t$ ✓

$= 56\times10^{6}.(0{,}09-0{,}025).0{,}015$ ✓

$= 54600\ N$ ✓

$F_{Tensile_{Coverstraps}} = \sigma_{Tensile_{\text{cov erstraps}}}.(p-d).t_{\text{cov erstraps}}.n$ ✓

$54600 = \sigma_{Tensile\,\text{cov erstraps}}.(0{,}09-0{,}025).(0{,}01).(2)$ ✓

$\therefore \sigma_{Tensile\,\text{cov erstraps}} = 48\ MPa$ ✓ (6)

2.4 $F_{Shear} = \tau.\frac{\pi}{4}.(d)^2.n.x$ ✓

$54600 = \tau.(\frac{\pi}{4}).(0{,}025)^2.(2).(1{,}75)$ ✓

$\therefore \tau = 31{,}780\ MPa$ ✓ (3)

2.5 $F_{Crushing} = \sigma_{Crushing}.(d).(t).n$ ✓

$54600 = \sigma_{Crushing}.(0{,}025).(0{,}015).(2)$ ✓

$\therefore \sigma_{Crushing} = 72{,}8\ MPa$ ✓ (3)

2.6 Number of rivets per row = cylinder length/pitch

$= \frac{4{,}215}{0{,}09}$ ✓

$= 46{,}833$ rivets per cylinder length ✓ (2)

2.7 Number of rivets per metre = 1000/pitch

$= \frac{1000}{90}$ ✓

$= 11{,}111$ rivets per metre ✓ (2)

[23]

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QUESTION 3

3.1

$$F.[\frac{L_1}{A_1.E_1}+\frac{L_2}{A_2.E_2}]=\Delta T.[\alpha_2.L_2+\alpha_1.L_1]$$

$$F.[\frac{0,21}{2,376\times10^{-3}.(31,8\times10^{9})}+\frac{0,188}{1,134\times10^{-3}.(113,8\times10^{9})}]=80.[9,2\times10^{-6}.(0,21)+23\times10^{-6}.(0,188)] \quad \checkmark$$

$$F.(4,0184\times10^{-9})=5,0048\times10^{-4}$$

$$\therefore F=124547,083\ N \quad \checkmark$$

$$\sigma_1=\frac{F}{A_1}$$

$$=\frac{124547,083}{2,376\times10^{-3}}=52,419\ MPa[C] \quad \checkmark$$

$$\sigma_2=\frac{F}{A_2}$$

$$=\frac{124547,083}{1,134\times10^{-3}}=109,83\ MPa[T] \quad \checkmark$$

(8)

3.2

$$\delta L_{final_1}=\Delta L_1-\Delta X_1$$

$$=\alpha_1.\Delta T.L_1-\frac{F.L_1}{A_1.E_1} \quad \checkmark$$

$$=23\times10^{-6}.(80).(0,21)-\frac{124547,083.(0,21)}{2,376\times10^{-3}.(31,8\times10^{9})} \quad \checkmark$$

$$=(3,864-3,462)\times10^{-4}$$

$$=0,402\times10^{-4}\ m \checkmark$$

$$L_{final}=L_1+\delta L_{final_1}$$

$$=210,0000402\ mm \checkmark$$

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3.3

$$U_1 = \frac{F^2.L_1}{2.A_1.E_1}$$

$$= \frac{124547{,}083^2.(0{,}21)}{2.(2{,}376\times10^{-3}).(31{,}8\times10^{9})} \checkmark$$

$$= 21{,}557\ J \checkmark$$

$$U_2 = \frac{F^2.L_2}{2.A_2.E_2}$$

$$= \frac{124547{,}083^2.(0{,}188)}{2.(1{,}134\times10^{-3}).(113{,}8\times10^{9})} \checkmark$$

$$= 11{,}299\ J \checkmark$$

(4)

3.2

$$\varepsilon_1 = \frac{F}{A_1.E_1}$$

$$= \frac{124547{,}083}{2{,}376\times10^{-3}.(31{,}8\times10^{9})} \checkmark$$

$$= 1{,}648\times10^{-3} \checkmark$$

$$\varepsilon_2 = \frac{F}{A_2.E_2}$$

$$= \frac{124547{,}083}{1{,}134\times10^{-3}.(113{,}8\times10^{9})} \checkmark$$

$$= 9{,}651\times10^{-4} \checkmark$$

(4)
[21]

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QUESTION 4

4.1

$$I_{XX_{FIX-FIX}} = \frac{1}{12}.B.D^3$$
$$= \frac{1}{12}.(0{,}03).(0{,}018^3) \checkmark$$
$$= 1{,}458 \times 10^{-8}\ m^4 \checkmark$$

$$I_{YY_{PIN-PIN}} = \frac{1}{12}.D.B^3$$
$$= \frac{1}{12}.(0{,}018).(0{,}03^3) \checkmark$$
$$= 4{,}05 \times 10^{-8}\ m^4 \checkmark$$

$$P_{E_{YY}} = \frac{\pi^2.(E).(I_{YY})}{L_E{}^2}$$
$$= \frac{\pi^2.(210 \times 10^9).(4{,}05 \times 10^{-8})}{(0{,}22)^2} \checkmark \checkmark$$
$$= 1{,}734\ MN \checkmark$$

$$P_{E_{XX}} = \frac{\pi^2.(E).(I_{XX})}{L_E{}^2}$$
$$= \frac{\pi^2.(210 \times 10^9).(1{,}458 \times 10^{-8})}{(0{,}22 \times 0{,}5)^2} \checkmark \checkmark$$
$$= 6{,}937\ MN \checkmark$$

(10)

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4.2

$$k = \sqrt{\frac{I_{Least}}{A}}$$
$$= \sqrt{\frac{1,458\times10^{-8}}{(0,03).(0,018)}} \checkmark$$
$$= 5,196\times10^{-3}\ m \checkmark$$

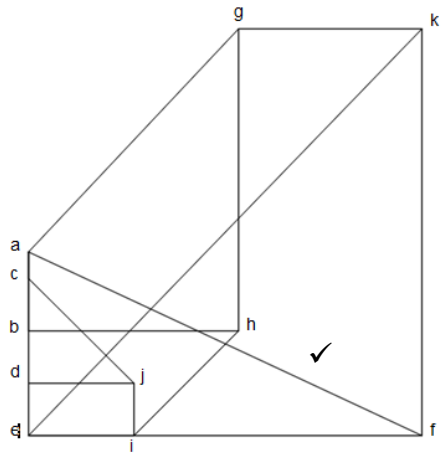
$$SR = \frac{L_E}{k}$$
$$= \frac{0,22}{5,196\times10^{-3}} \checkmark$$
$$= 42,34 \checkmark$$

$$P_R = \frac{\sigma_Y.(A)}{1+\frac{1}{7500}.(SR)^2}$$
$$= \frac{260\times10^6.(0,03).(0,018)}{1+\frac{1}{7500}.(42,34)^2} \checkmark \checkmark$$
$$= 113,315\ kN \checkmark$$

(7)
[17]

QUESTION 5

5.1 Reaction at fixed support = af = 166 N ✓



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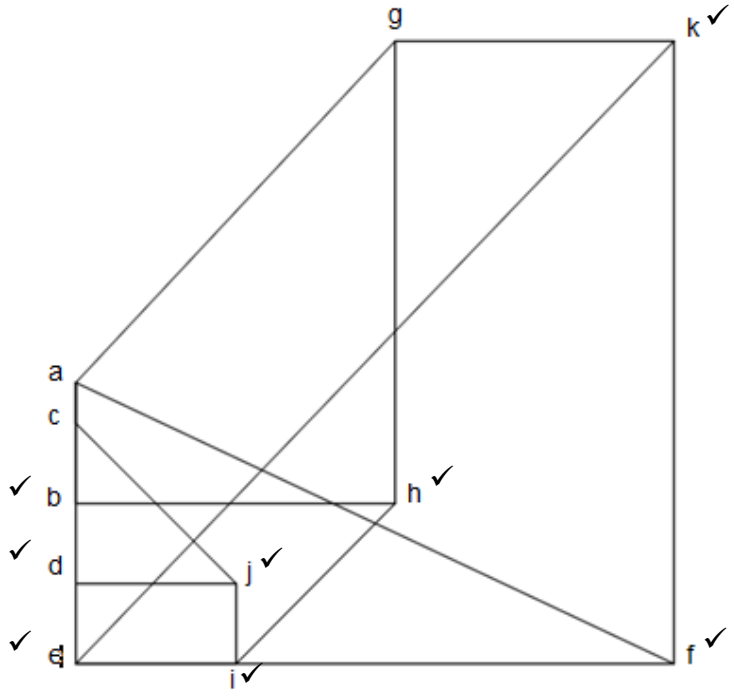
5.2



Member	Force (N)	Nature
bh	80 ✓	Tie (T) ✓
ij	19 ✓	T ✓
ih	55 ✓	Strut (S) ✓
fk	156 ✓	T ✓
ek	218 ✓	S ✓

(18)
[20]

QUESTION 6

6.1

$$I_{XX} = \frac{\pi}{64}.(D^4 - d^4) = \frac{\pi}{64}.(0{,}39^4 - 0{,}35^4) \checkmark$$
$$= 398{,}99 \times 10^{-6}\ m^4 \checkmark$$

$$M = \frac{1}{8}.\omega.L^2 \checkmark = \frac{1}{8}.(1819 + 898).(3^2) \checkmark$$
$$= 3056{,}625\ N.m \checkmark$$

$$\sigma = \frac{M.\bar{y}}{I_{XX}} = \frac{3056{,}625.(\frac{0{,}39}{2})}{398{,}99 \times 10^{-6}} \checkmark$$
$$= 1{,}494\ MPa \checkmark$$

(7)

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6.2 $$Z = \frac{I_{XX}}{\bar{y}} = \frac{399{,}98 \times 10^{-6}}{(\frac{0{,}39}{2})}$$ ✓

$$= 2{,}046 \times 10^{-3}\ m^3$$ ✓

(2)
[9]

TOTAL: 100

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