higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

STRENGTH OF MATERIALS AND STRUCTURES N6

18 NOVEMBER 2013

This marking guideline consists of 8 pages.

QUESTION 1

1.1 Weight of flywheel

$$M = \frac{WL}{4} = 15\,k = \frac{W3}{4}\ \surd$$
$$W = 20\,kN\ \surd$$

(2)

1.2 Revolutions

$$T_{mean} = \frac{36\,k}{1{,}2} = 30\,kNm\ \surd$$
$$N = \frac{800\,k \times 60}{2\,\pi \times 30\,k} = 254{,}649\ r/\text{min}\ \surd$$

(2)

1.3 Diameters of hollow shaft

$$M_e = \frac{1}{2}\left[15\,k + \sqrt{(15\,k)^2 + (36\,k)^2}\right]\surd$$
$$= \frac{1}{2}[15\,k + 39\,k] = 27\,kNm\ \surd$$
$$M_e = 27\,k = \frac{\pi}{32}\left(\frac{D^4 - d^4}{D}\right)120\,M\ \surd$$
$$\left(\frac{D^4 - (0{,}6D)^4}{D}\right) = 2{,}292 \times 10^{-3}\ \surd$$
$$7{,}716\,D^3 = 2{,}292 \times 10^{-3}\ \surd$$
$$D = 66{,}723\ mm\ \surd \ \text{and}\ d = 40\ mm\ \surd$$

(7)

1.4 Shear stress

$$T_e = 39\ kNm = \frac{\pi}{16}\left(\frac{0{,}066723^4 - 0{,}04^4}{0{,}066723}\right)\tau\ \surd$$
$$\tau = 767{,}867\ MPa\ \surd$$

(2)
[13]

QUESTION 2

2.1
- Cut one undamaged link from each end of a chain√
- Place each link on end and hammer or press them in a press√ while they are cold √
- Press or hammer the links till their length is equal to their original width √
- There must be no signs of fractures after the test √ (5)

2.2
- Material size must be correct
- Chains must move freely and be in good shape
- Welds must be correct
- Finishing must be bright and/or covered with a protective coating
- The correct marks must be on the chain
- Breaking strength must be to specifications
- Energy absorption factor must be to specifications (Any 4 × ½) (2)

2.3
- After heat treatment and machining√ (1)

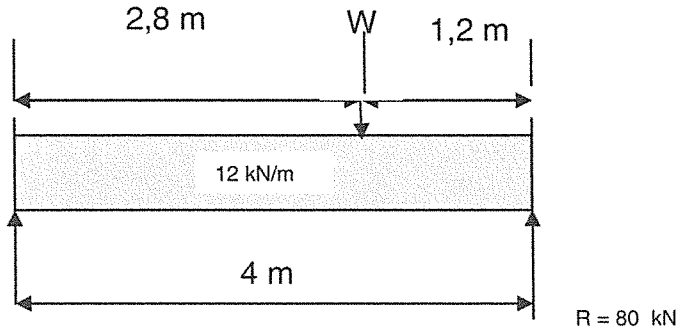
[8]

QUESTION 3

3.1 Maximum moment of resistance

$$M = (80\,k \times 1{,}2)\surd - \left(12\,k \times 1{,}2 \times \frac{1{,}2}{2}\right)\surd$$

$$= 96\,k - 8{,}64\,k = 87{,}36\,kNm\surd$$



(3)

3.2 Magnitude of point load

$$Moments\ about\ R: 4\,L = 1{,}2\,W\surd + \left(12\,k \times \frac{4^2}{2}\right)\surd$$

$$L = 0{,}3\,W + 24\,k\surd$$

$$Moments\ about\ W:\ M_{max} = 87\,360 = 2{,}8\,(0{,}3\,W + 24\,k)\surd - \left(12\,k \times \frac{2{,}8^2}{2}\right)\surd$$

$$\therefore 0{,}84\,W = 87\ 360 - 20\ 160\ \wedge$$

$$W = 80\,kN\ \wedge$$

(6)

3.3 Effective depth

$$\frac{\sigma_S}{\sigma_C} = \frac{m(d-n)}{n} = \frac{140}{7} = \frac{15(d-n)}{n} \surd$$

$$n = 0{,}429\,d \surd$$

$$l_a = d - \frac{0{,}429\,d}{3} = 0{,}857\,d \surd$$

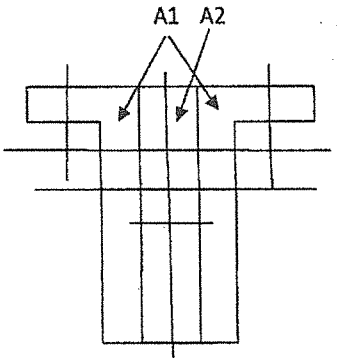
$$M_c = \frac{1}{2}\sigma_C b n l_a = 87\,360 = \frac{1}{2} \times 7\,M \times 0{,}4 \times 0{,}429\,d \times 0{,}857\,d \surd$$

$$d = \sqrt{0{,}1697} = 411{,}977\,mm \surd$$

(5)
[14]

QUESTION 4

4.1 PL at free end



$$\bar{y} A_T = 2(A_1 y_1) + A_2 y_2$$

$$\surd \qquad \surd \qquad \surd$$

$$\bar{y}\left(\{2 \times 3{,}39 \times 10^{-3}\} + \{0{,}02 \times 0{,}15\}\right) = 2\left(3{,}39 \times 10^{-3} \times 0{,}098\right) + \left(3 \times 10^{-3} \times 0{,}075\right) \surd$$

$$\bar{y}\left(6{,}78 \times 10^{-3} + 3 \times 10^{-3}\right) = 6{,}644 \times 10^{-4} + 2{,}25 \times 10^{-4}$$

$$\bar{y} = 90{,}945\,mm \wedge$$

$$I_{XX} = 2\left[I_{1XX} + A_1 h_1^2\right] + \left[I_{2XX} + A_2 h_2^2\right]$$

$$= 2\left[7{,}611 \times 10^{-6} + \left(3{,}339 \times 10^{-3} \times 0{,}007055^2\right)\right] \surd$$

$$+ \left[\frac{0{,}02 \times 0{,}15^3}{12} + \left(3 \times 10^{-3} \times 0{,}015945^2\right)\right] \surd$$

$$= 1{,}556 \times 10^{-5} + 6{,}388 \times 10^{-6} = 2{,}195 \times 10^{-5}\ m^4 \surd$$

$$\Delta = \frac{4}{360} = \frac{1}{200\,G \times 2{,}195 \times 10^{-5}}\left[\frac{570 \times 4^4}{8} + \frac{w \times 4^3}{3}\right] \surd\surd$$

$$48\,777{,}778 = 18\,240 + 21{,}333\,W \surd$$

$$W = 1{,}431\,kN \wedge$$

(11)

4.2 Compressive stress

$$M = \frac{570 \times 4^2}{2} \surd + 1\,431 \times 4 \surd = 4\,560 + 5\,724 = 10{,}284\ kNm \wedge$$

$$\surd$$

$$\sigma = \frac{My}{1} = \frac{10\,284 \times 0{,}090945}{2{,}195 \times 10^{-5}} 42{,}61\ MPa \wedge$$

(4)
[15]

QUESTION 5

5.1 Maximum and minimum pressure

$$\sigma_{max} = \frac{^{\sigma}Ultimate}{3} = \frac{213\ k}{3} = 71\ kPa \surd$$

$$\sigma_{min} = 71\ k \times 0{,}79 = 56{,}09\ kPa \surd$$

(2)

5.2 Weight of wall

$$W_1 = \frac{1}{2} \times 3 \times 5 \times 1 \times 2\,400\ g = 176\,580 \surd$$

$$W_2 = 1 \times 5 \times 1 \times 2\,400\ g = 117\,720 \surd$$

$$V = 294\,300\ N \surd$$

(3)

5.3 Position of RGR

$$\sigma_{max} = \frac{6Ve}{B^2} 71\ k = \frac{6 \times 294\,300 \times e}{4^2} \surd$$

$$e = 643{,}334\ mm\ from\ G \wedge$$

$$\times = \frac{B}{2} - e = \frac{4}{2} - 643{,}334 \surd = 1{,}357\ m\ from\ toe \wedge$$

(3)

5.4 Water depth

$$F_w = \frac{1}{2} \times 1\,000\ g \times H^2 = 4\,905\ H^2 \surd$$

$$\frac{F_w H}{3} = 4\ 905\ H^2 \times \frac{H}{3} = 1\ 635\ H^3 = \sum Fm \surd$$

$$W_1 x_1 = 176\,580 \times \frac{2}{3} \times 3 = 353\ 160 \surd$$

$$W_2 x_2 = 117\,720 \times 3{,}5 = 412\,020 \surd$$

$$\sum Wm = 765\,180\ Nm \wedge$$

$$\therefore Vx + \sum Fm = \sum Wm$$

$$294\,300 \times 1{,}357 + 1\,635\ H^3 = 765\,180 \surd$$

$$H = \sqrt[3]{223{,}74} = 6{,}071\ m \wedge$$

$$\frac{B}{6} = \frac{4}{6} = 666{,}67\ mm \rangle\ e \wedge$$

$$\therefore RGR\ still\ within\ middle\ 3rd, no\ tension\ in\ wall, wall\ is\ safe \wedge$$

(7)
[15]

QUESTION 6

6.1 Maximum hoop stress in sleeve

$$\frac{At}{By}\,d_1 = 80 : \sigma_R = 0 = A + \frac{B}{0{,}08^2}$$

$$A = -156{,}25\,B \ldots\ldots\ldots\ldots (1)\surd$$

$$\frac{At}{By}\,d_1 = 60 :\ \sigma_R = 30\,M = A + \frac{B}{0{,}06^2} \ldots\ldots\ldots\ldots (2)\ \surd$$

$$(1)\,in(2)\ \therefore\quad 30M = -156{,}25\,B + 277{,}78\,B$$

$$B = 0{,}247\,M\ \surd$$

$$A = -38{,}571\,M\ \surd$$

$$\frac{At}{By}\,d_1 = 60 :\ \sigma_{H\,max} = -38{,}571\,M - \frac{-0{,}247\,M}{0{,}06^2}\ \surd = 107{,}182\,MPa\,(T)\ \surd$$

(6)

6.2 Shrinkage allowance

$$\Delta = D_C \left[\left(\frac{\sigma_H - \gamma\sigma_R}{E}\right)\right] - \left[\left(\frac{\sigma_H - \gamma\sigma_R}{E}\right)\right]$$

$$= 0{,}06 \left[\left(\frac{30\,M - 0{,}28\times 30\,M}{210\,G}\right)\right]\surd - \left[\left(\frac{-107\,M - 0{,}3\times 30\,M}{95\,G}\right)\right]\surd$$

$$= 0{,}06\left[1{,}029\times 10^{-4} + 1{,}223\times 10^{-3}\ \right]$$

$$= 0{,}0796\,mm\ \surd$$

(3)
[9]

QUESTION 7

7.1 Maximum and minimum tension at the supports

$$\frac{x_1^2}{5} = \frac{(200 - x_1)^2}{5+6}\surd$$

$$\surd\ \therefore 1{,}483\,x_1 = 200 + x_1\surd$$

$$x_1 = 80{,}55\,m\ \surd$$

$$L - x_1 = 119{,}45\,m\ \surd$$

$$F\,\min = \frac{10\,k\times 80{,}55^2}{2\times 5} = 6{,}488\,MN\ \surd$$

$$F\,\max = \sqrt{(6{,}488M)^2 + (10\,k\times 119{,}45)}\ ^2\wedge = 6{,}597\,MN\ \surd$$

$$F\,\min\,support = \sqrt{(6{,}488\,M)^2 + (10\,k\times 80{,}55)}\ ^2\ \wedge$$

$$= 6{,}538\,MN\ \surd$$

(8)

7.2 Foundation dimensions

$$\text{Reaction in support} = w(L - x_1) + F_{VC}$$

$$= 10\,k(119{,}45)\ \surd + \frac{6{,}488\,M}{\tan 60^\circ}\surd = 4{,}941\,MN\ \surd$$

$$\text{Total load on soil} = 4{,}941\,M + (174\,g \times 10) = 4{,}958\,MN\ \surd$$

$$\text{Area} = \frac{4{,}958\,M}{260\,k} = 19{,}069\,m^2\ \surd$$

$$\therefore L = \sqrt{19{,}069} = 4{,}367\,m\ \surd$$ (6)

[14]

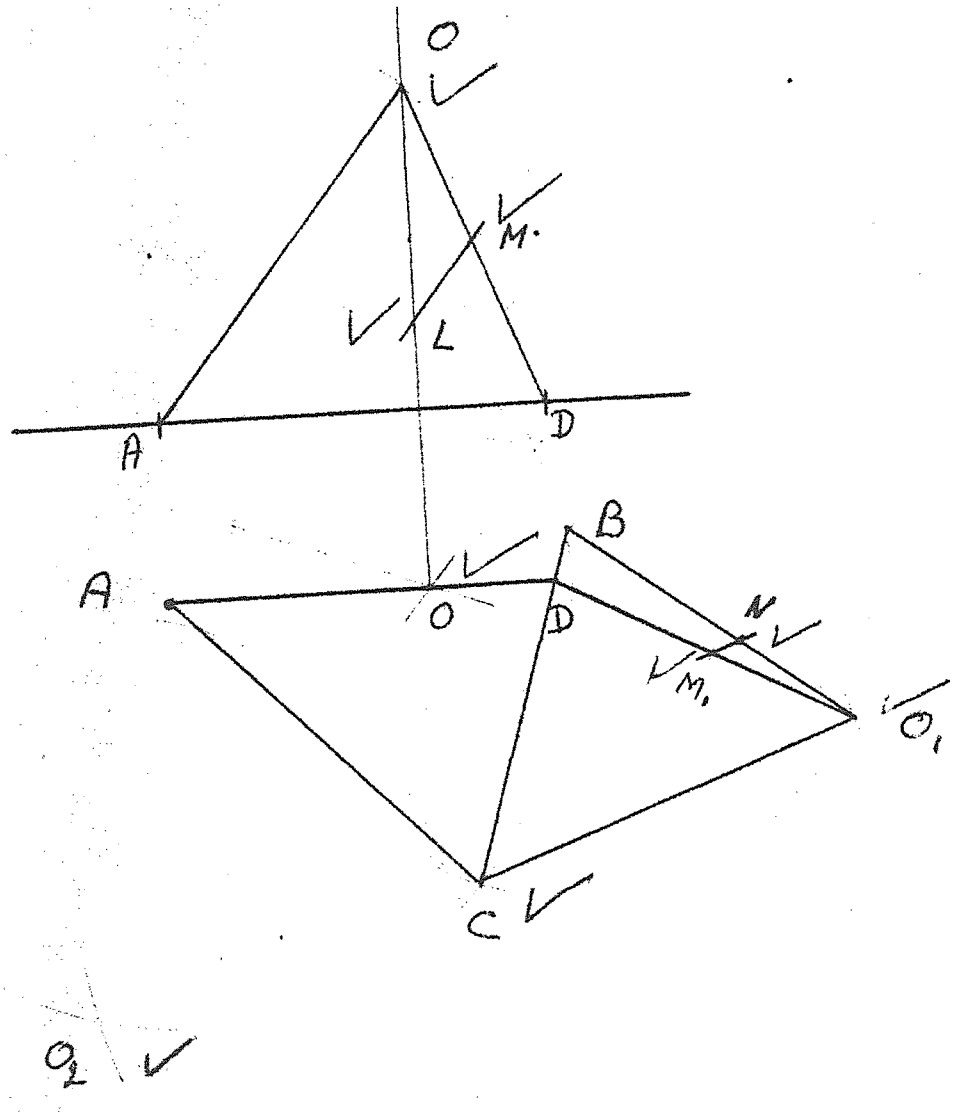
QUESTION 8

Scale: 1 cm = 1 m and 1 cm = 10 kN

8.1 Forces in legs OB and OC:
OB = $\overrightarrow{O_1N}$ = 20 kN√
OC = $\overrightarrow{NM_1}$ = 4,5 kN√ (2)

8.2 Load lifted
$OL = 32\ kN$ √

(NOTE TO MARKER: Please note that the exact correct size could not be shown here.)



(10)
[12]

TOTAL: 100