higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N5

28 July 2021

This marking guideline consists of 6 pages.

QUESTION 1

1.1 $\sigma_{lop} = \frac{F_{lop}}{A_I} = \frac{113\,000}{\frac{\pi}{4}.(0{,}0215^2)} = 311{,}252\ MPa$ ✓✓✓ (3)

1.2 $E = \frac{F_{lop}.L}{A_I.X_{lop}} = \frac{113\,000.(0{,}09)}{\frac{\pi}{4}.(0{,}0215^2).(0{,}00121 \times 10^{-3})} = 23\,152{,}948\ GPa$ ✓✓✓ (3)

1.3 $\sigma_y = \frac{F_y}{A_I} = \frac{258\,000}{\frac{\pi}{4}.(0{,}0215^2)} = 710{,}645\ MPa$ ✓✓✓ (3)

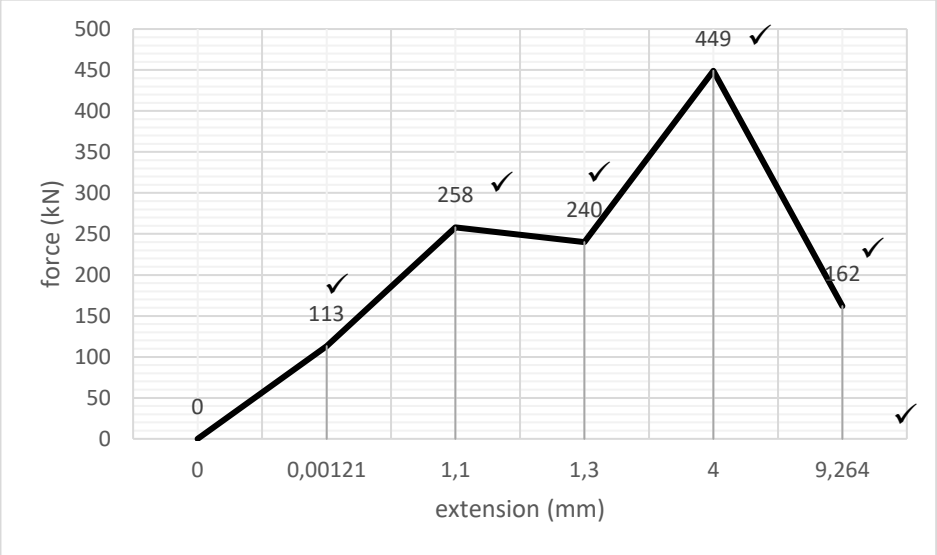
1.4 $\sigma_{max} = \frac{F_{max}}{A_I} = \frac{449\,000}{\frac{\pi}{4}.(0{,}0215^2)} = 1236{,}743\ MPa$ ✓✓✓ (3)

1.5 $\sigma_F = \frac{F_F}{A_F} = \frac{162\,000}{\frac{\pi}{4}.(0{,}01488^2)} = 931{,}578\ MPa$ ✓✓✓ (3)

1.6 $\%\Delta X = \frac{X_F}{L} = \left(\frac{9{,}264}{90}\right).100 = 10{,}293\%$ ✓✓✓ (3)

1.7 $\%A_{reduction} = \frac{A_o - A_F}{A_o} = \left(\frac{21{,}5^2 - 14{,}88^2}{21{,}5^2}\right).100 = 52{,}1\%$ ✓✓✓ (3)

1.8



(6)

1.9 $U = \frac{1}{2}.F_{lop}.X_{lop} = \frac{1}{2}.(113\,000).(0{,}00121 \times 10^{-3}) = 0{,}0683\ J$ ✓✓✓ (3)

[30]

QUESTION 2

2.1
- Weak subsoil✓
- Shrinkable subsoil (soft clay)✓
- Excessive vibrations due to traffic✓ and machinery✓
- Slipping of strata on a slope✓
- Movement of ground water✓ (6)

2.2.1 $$\sigma = \frac{PD}{4\,t\eta}$$

$$= \frac{P\ D}{4 \times t}$$

$$= \frac{4{,}8 \times 10^6 \times 0{,}2}{4 \times 0{,}004}$$

$$= 60\ MPa$$ (5)

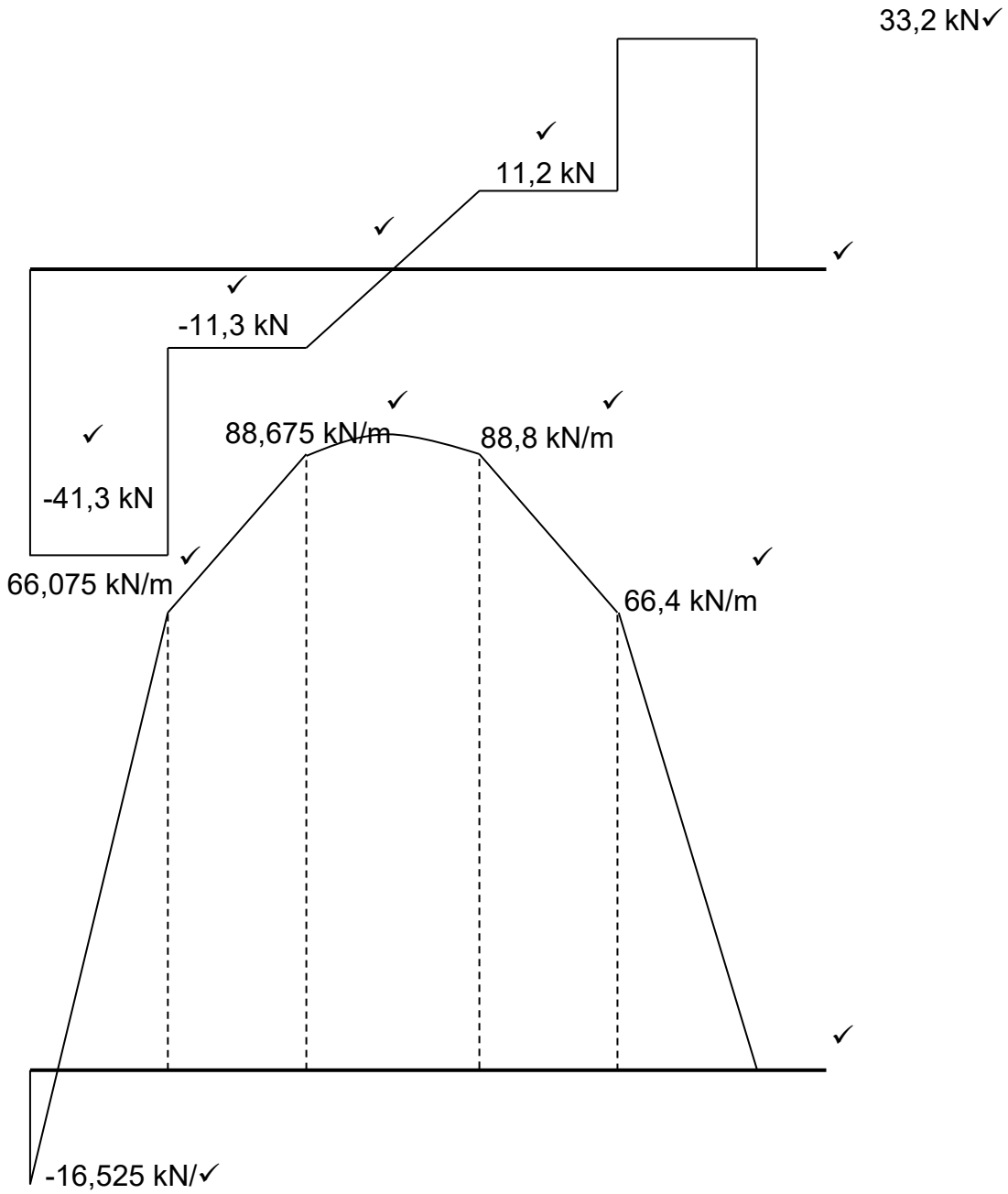
2.2.2 $$\sigma = \frac{F}{A}$$

$$F = 60 \times 10^6 \times 3{,}142 \times 0{,}2 \times 0{,}004$$

$$= 150{,}8\ kN$$ (3)

[14]

QUESTION 3



$\tan\beta = \tan\beta$ ✓

$\frac{16,525}{x} = \frac{66,075}{2-x}$ ✓ ✓

✓ $16,525.(2-x) = 66,075.x$

$\therefore x = 0,4\ m\ from\ LHS$ **[17]**

QUESTION 4

The critical (least) resistance to bending:

$$I_{yy} = \frac{D.B^3}{12} = \frac{0{,}008.(0{,}0045^3)}{12} = 0{,}0135 \times 10^{-6}\ m^4$$

Consider as two pinned ends:

$$P_e = \frac{\pi^2.E.I_{yy}}{L_e^2} = \frac{\pi^2.(88 \times 10^9).(0{,}0135 \times 10^{-6})}{0{,}0435^2} = 6{,}2\ MN$$

Consider as two fixed ends:

$$P_e = \frac{\pi^2.E.I_{yy}}{L_e^2} = \frac{\pi^2.(88 \times 10^9).(0{,}0135 \times 10^{-6})}{(0{,}5 \times 0{,}0435)^2} = 24{,}786\ MN$$

The critical safe load is 24,786 MN. **[13]**

QUESTION 5

5.1

$$T = \frac{J.\tau}{R} = \frac{\pi.(0{,}215^4).(27 \times 10^6)}{32.(\frac{0{,}215}{2})} = 52\,687{,}675\ Nm$$

$$P = 2\pi.N.T = \frac{2\pi.(400).(52\,687{,}675)}{60} = 1\,103{,}488\ kW$$

(7)

5.2

$$T = 52\,687{,}675 = \frac{\pi}{16}.D^3.(32 \times 10^6)$$

$$\therefore\ D^3 = 0{,}008386 = \frac{D^4 - d^4}{D}$$

$$\therefore\ 0{,}008386 = \frac{220^4 - d^4}{220}$$

$$\therefore d = 5{,}3\ mm$$

(7)
[14]

QUESTION 6

6.1
- Tensile test
- Compressive test
- Shear test
- Hardness test
- Impact test
- Fatigue test (6)

6.2
- Readings are independent of surface area✓
- Direct reading on the indicator disc✓
- Speed✓ and accuracy✓ of the test
- Will not damage surface excessively✓
- Small loss to accuracy due to a small indentation piece✓ (6)

[12]

TOTAL: 100