UNIVERSITEIT VAN PRETORIA / *UNIVERSITY OF PRETORIA*
DEPT SIVIELE INGENIEURSWESE / *DEPT OF CIVIL ENGINEERING*

STRENGTH OF MATERIALS SWK210 STERKTELEER SWK210
SEMESTER TEST 2 – SEMESTERTOETS 2

VAN en VOORLETTERS	HANDTEKENING	STUDENTENOMMER
	Memorandum	1 2 3 4 5 6 7 8
SURNAME and INITIALS	SIGNATURE	STUDENT NUMBER

Volpunte / *Full Marks:* 60 **Tyd / *Time*:** 1½ ure / *hours* **24 April 2009**

1	2	3	4	Σ	
20	10	20	10	60	

INSTRUCTIONS ..... READ:
- ⇨ Answer all questions in the provided spaces.
- ⇨ The invigilators will supply no additional or loose pages.
- ⇨ Rough work may be done on the final blank page but this page will not be marked.
- ⇨ Answers in pencil will not be marked.
- ⇨ Tippex or any other similar product may not be used.
- ⇨ No highlighter may be used.
- ⇨ Students may ask no questions for whatever reason during the exam or test. If you are of the opinion that you need additional information, make assumptions and state these assumptions.
- ⇨ The relevant units must substantiate all answers.
- ⇨ All aspects as described in the EXAMINATION REGULATIONS are applicable.
- ⇨ All calculations to reach an answer must be shown.

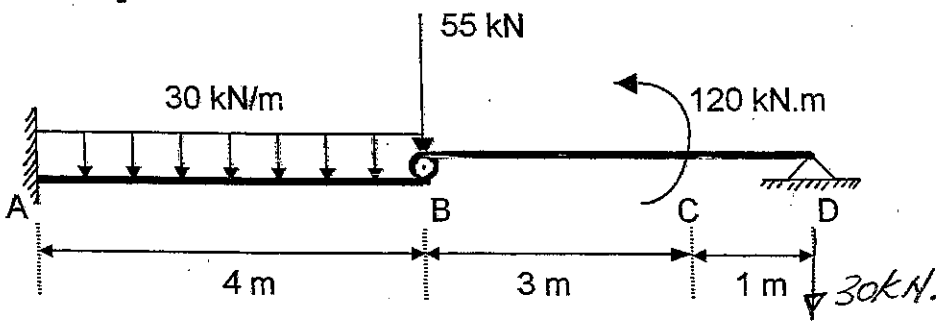
INSTRUKSIES..... LEES:

- ⇨ *Beantwoord alle vrae in die spasies voorsien.*
- ⇨ *Die toesighouers sal geen addisionele of los bladsye voorsien nie.*
- ⇨ *Rofwerk mag op die laaste blanko bladsy gedoen word en hierdie bladsy word nie gemerk nie.*
- ⇨ *Antwoorde in potlood word nie gemerk nie.*
- ⇨ *Tippex of enige soortgelyke produk mag nie gebruik word nie.*
- ⇨ *Geen glimpen ["highlighter"] mag gebruik word nie.*
- ⇨ *Studente mag nie tydens die eksamen vrae vra nie – om watter rede ookal. Indien u van mening is dat addisionele inligting benodig word, maak aannames en stel die aannames.*
- ⇨ *Alle antwoorde moet deur die nodige eenhede bevestig word.*
- ⇨ *Alle aspekte soos vervat in die EKSAMENREGULASIES is van toepassing.*
- ⇨ *Alle berekeninge om antwoorde te bepaal moet getoon word.*

Dosente / Lecturers:	Prof L Maree Prof C Roth Mr F van Graan
Eksterne Eksaminator / External Examiner:	Prof BWJ VAN RENSBURG

QUESTION 1 / VRAAG 1 **[20]**

Beam ABCD is built-in at A, supported by a pin at D and has a roller at B.
Balk ABCD is ingebou by A, word ondersteun deur 'n skarnier by D en het 'n roller by B.



1[a] Calculate all the reactions. **[4]**
Bereken al die reaksies.

BD: 120 kN.m ⊙ $\sum M_D = 0$:

55kN

$-4B_y + 4(55) + 120 = 0$

By 3m 1m Dy

$\therefore B_y = 85\ kN \rightarrow$

⊙ $\sum M_B = 0$: $-4D_y + 120 = 0$ $\therefore D_y = 30\ kN \rightarrow$

AB: M_A

580kN.m 30 kN/m B

⊙ $\sum M_A = 0$:

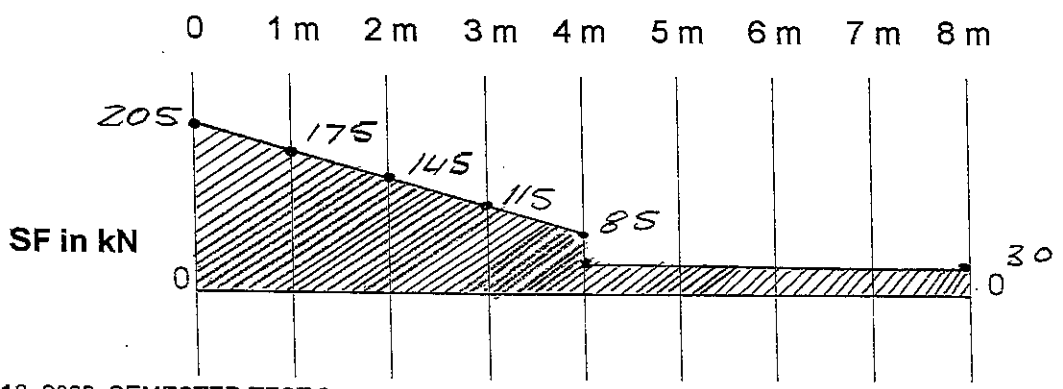
A A_y 4m 85kN $-30(4)(2) - 85(4) + M_A = 0$

$\therefore M_A = 580\ kN.m \rightarrow$

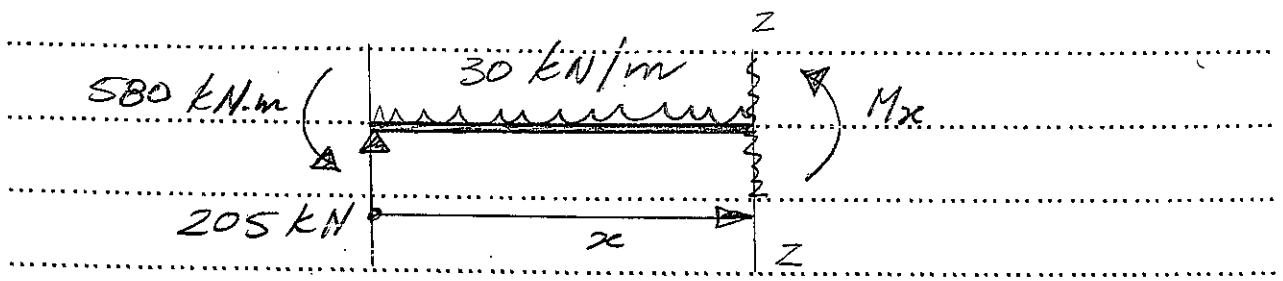
$\sum M_B = 0$: $580 - 4A_y + 4(30)2 = 0$ $\therefore A_y = 205\ kN \rightarrow$ ✓✓

⊙ Check: $\sum F_\uparrow = A_y = 205\ kN$ $\sum F_\downarrow = 55 + D_y + 30(4) = 205\ kN$

1[b] Draw the Shear Force Diagram for beam ABCD. Your diagram should give SF values at every 1 metre. **[5]**
Teken die Skuifkragdiagram vir balk ABCD. U diagram moet SK-waardes by elke 1 meter aangee.



1[c] Design an equation [in x] that gives the Bending Moment for section AB. **[5]**
Ontwerp 'n uitdrukking [in x] wat die Buigmoment in gebied AB gee.



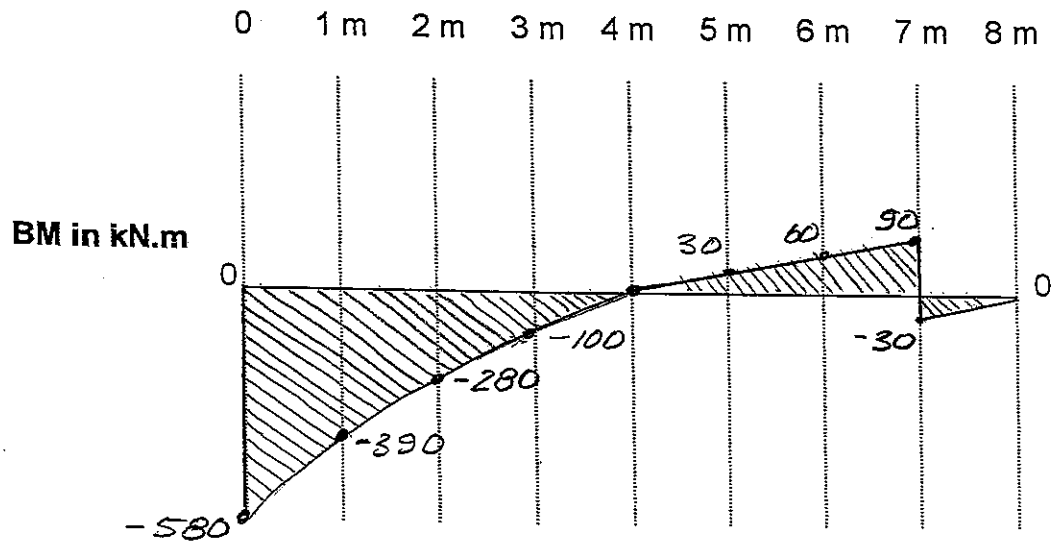
$\circlearrowleft \sum M_{zz} = 0$:

$$580 - 205x + 30 \cdot x \cdot \frac{x}{2} + M_x = 0$$

$$M_x = -15x^2 + 205x - 580$$

$$\therefore M_x = -5x^2 + 41x - 116 \longrightarrow$$

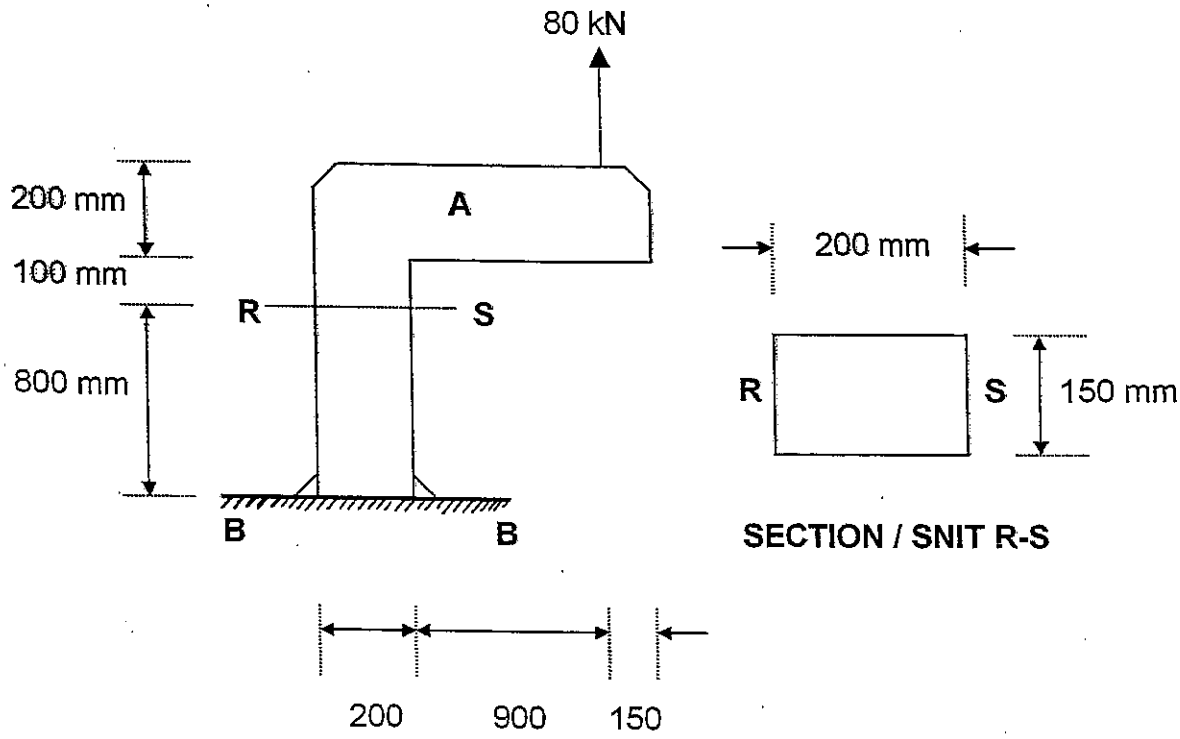
1[d] Draw the Bending Moment Diagram for beam ABCD. Your diagram should give BM values at every 1 metre. **[6]**
Teken die Buigmomentdiagram vir balk ABCD. U diagram moet BM-waardes by elke 1 meter aangee.



QUESTION 2 / VRAAG 2 **[10]**

The figure shows a hook **[A]** that is welded to a maritime container **[B]**.
The container, the hook as well as the content of the container weigh 80 kN.

Die figuur toon 'n haak **[A]** wat aan 'n skeepvraghouer **[B]** vasgesweis is. Die houer, die haak en die inhoud van die houer weeg 80 kN.



Calculate the magnitude and sense of the stresses on section R-S.
Bereken die grootte en aard van die spannings op snit R-S.

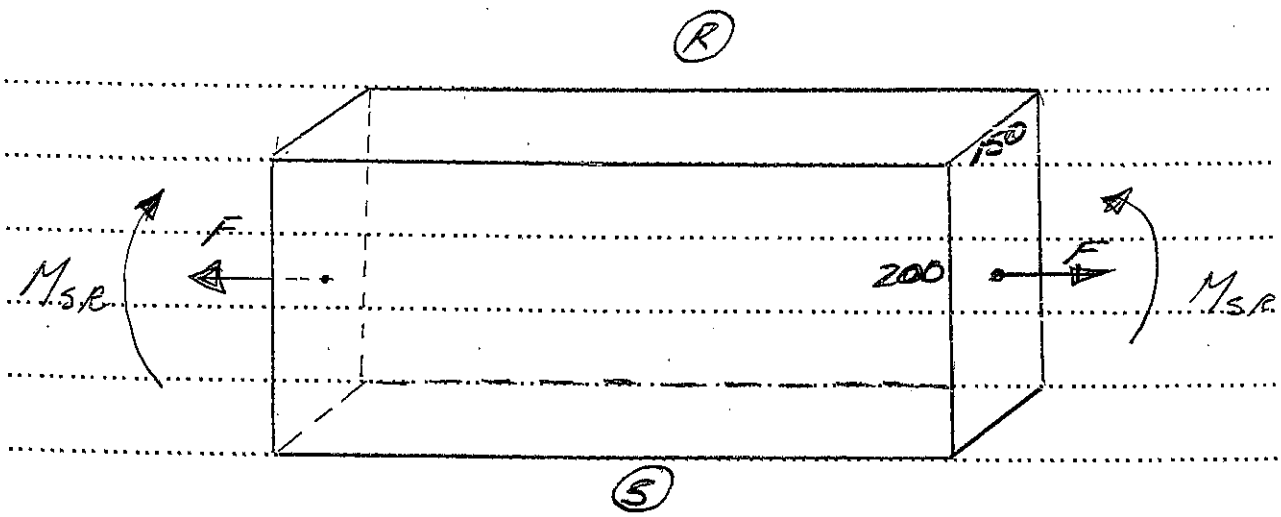
$\odot \quad M_{SR} = 80\,000 * 1000 \text{ N.mm}$

$= 80 * 10^6 \text{ N.mm} \rightarrow$

$\odot \quad F = 80\,000 \text{ N (T)} \rightarrow$

$\odot \quad I = \frac{1}{12}(150)(200)^3 = 100 * 10^6 \text{ mm}^4 \rightarrow$

$\odot \quad y = 100 \text{ mm}$



⊙ At R: $\sigma_R = \frac{F}{A} - \frac{My}{I}$

$\therefore \sigma_R = \frac{80\,000}{200 * 150} - \frac{80 * 10^6 * 100}{100 * 10^6}$

$= 2.67 - 80$

$= -77.3\ MPa$

$= 77.3\ MPa\ (C) \rightarrow$

⊙ At S: $\sigma_S = 2.67 + 80$

$= 82.67\ MPa\ (T) \rightarrow$

QUESTION 3 / VRAAG 3 **[20]**

Check the attached Figure Sheet.
A hinge at B and a roller at C support beam ABCD. The load diagram, the shear force diagram as well as the bending moment diagram is depicted on the Figure Sheet.
Figure 1 shows the cross section of the beam.
Material A is aluminium with E_A = 75 GPa and material B is brass with E_B = 105 GPa

Beskou die aangehegte Figuurvel.
'n Skarnier by B en 'n roller by C ondersteun balk ABCD. Die belastingsdiagram, die skuifkragdiagram asook die buigmomentdiagram word in die Figuurvel weergegee.
Figuur 1 gee die dwarssnit deur die balk.
Materiaal A is aluminium met E_A = 75 GPa en materiaal B is brons met E_B = 105 GPa

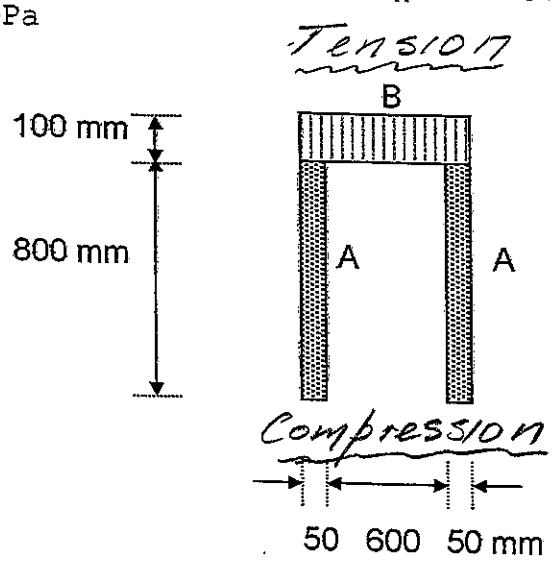


FIG 1

$$I = \frac{1}{12}bh^3$$

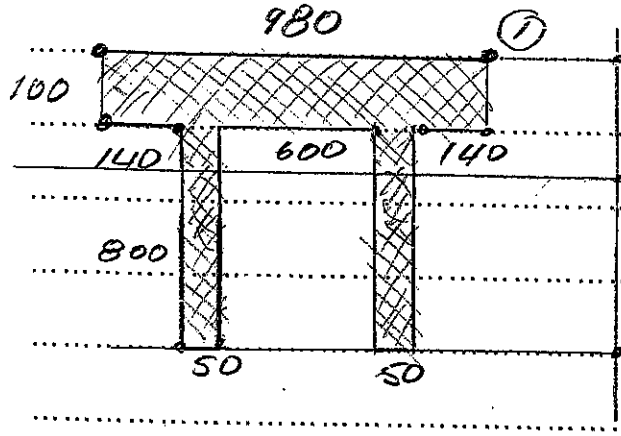
3[a] Calculate the maximum bending stress in the brass and state whether it is tension [T] or compression [C]. **[10]**
Bereken die maksimum buigspanning in die brons en dui aan of dit trekspanning [T] of drukspanning [C] is.

$n = \frac{105}{75} = 1.4 \rightarrow$

$\therefore b = 1.4 * 700$

$= 980\ mm \rightarrow$

(T)



⊙ $\bar{y} = \dfrac{980*100*850 + 2(800)(50)(400)}{980*100 + 2(800)(50)}$

$= \dfrac{115.3*10^6}{178*10^3} = 647.75\ mm \rightarrow$

⊙ $I_{NA} = \frac{1}{12}(980)(100)^3 + 100(980)(202.25)^2 + 2(\frac{1}{12})(60)(800)^3 + 2(800)(50)(247.75)^2$

$= 4090*10^6 + 9177*10^6$

$= 13\,267.434*10^6\ mm^4 \rightarrow$

⊙ Max bending stress in Brass at ①:

$\sigma_① = \dfrac{My}{I}$

$= \dfrac{600*10^6*252.25}{13.267.434*10^6} * 1.4$

$= 11.407 * 1.4$

$= 16\ MPa(T) \rightarrow$

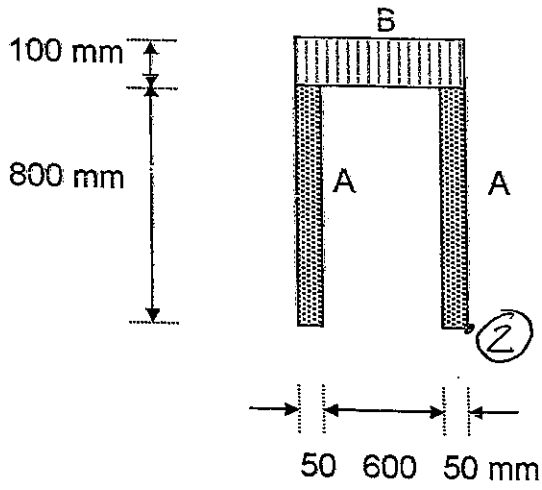


FIG 1

$$I = \frac{1}{12}bh^3$$

3[b] Calculate the maximum bending stress in the aluminium and state whether it is tension [T] or compression [C]. **[4]**

Bereken die maksimum buigspanning in die aluminium en dui aan of dit trekspanning [T] of drukspanning [C] is.

⊙ Max bending stress in Aluminium at ②:

$$\sigma_{②} = \frac{600 * 10^{6} * 647.75}{13267.434 * 10^{6}}$$

$$= 29.294 \text{ MPa } (C) \rightarrow$$

3[c] Draw a diagram **[with values]** that depicts the maximum bending stress distribution from top to bottom through the section. **[6]**

Teken 'n diagram **[met waardes]** wat die maksimum buigspanning-verdeling van bo tot onder deur die snit weergee.

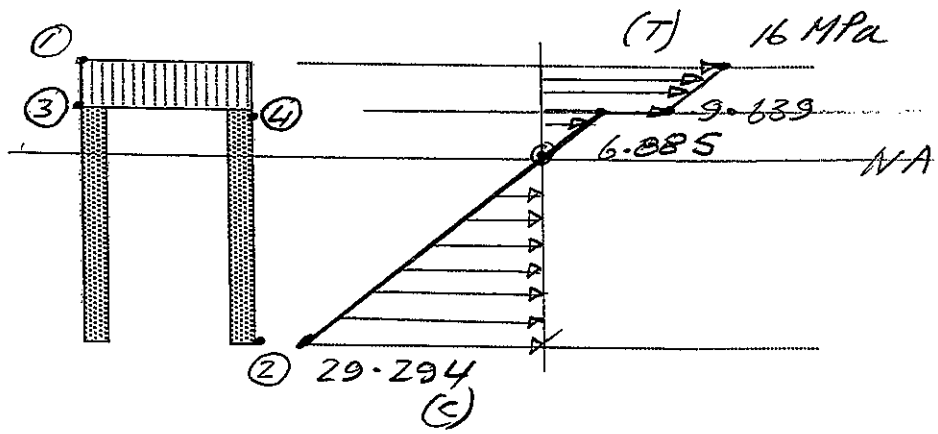
① : $\sigma_{①} = 16\ MPa\ (T)$

② : $\sigma_{②} = 29.294\ MPa\ (C)$

③ : $\sigma_{③} = 1.4 * \frac{600 * 10^6 * 152.25}{13\,267.434 * 10^6}$

$= 1.4 * 6.885 = 9.639\ MPa\ (T)$

④ : $\sigma_{④} = 6.885\ MPa\ (T)$



QUESTION 4 / VRAAG 4 **[10]**

Check the attached Figure Sheet.
A hinge at B and a roller at C support beam ABCD. The load diagram, the shear force diagram as well as the bending moment diagram is depicted on the Figure Sheet.
Figure 2 shows the cross section of the beam.
The material is aluminium with $E_A = 75$ GPa.

Beskou die aangehegte Figuurvel.
'n Skarnier by B en 'n roller by C ondersteun balk ABCD. Die belastingsdiagram, die skuifkragdiagram asook die buigmomentdiagram word in die Figuurvel weergegee.
Figuur 2 gee die dwarssnit deur die balk.
Die materiaal is aluminium met $E_A = 75$ GPa.

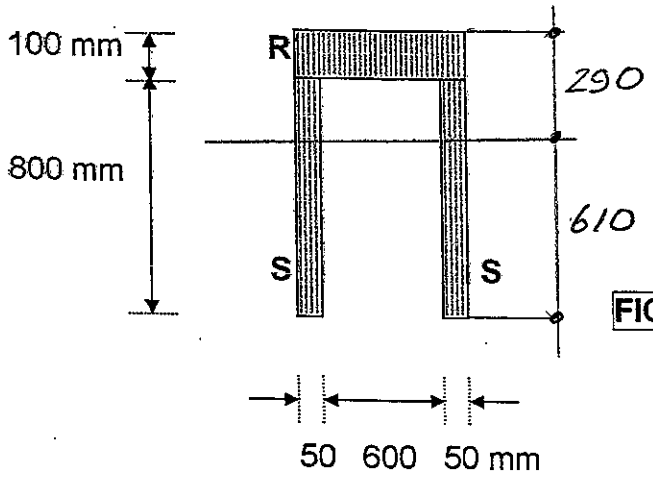


FIG 2

$$I = \frac{1}{12}bh^3$$

Calculate the maximum shear stress [in kPa] in part R of the cross-section. **[10]**
Bereken die maksimum skuifdrukspanning [in kPa] in deel R van die dwarssnit.

$$\bar{y} = \frac{100(700)(850) + 2(800)(50)(400)}{100(700) + (2)(800)50}$$

$$= \frac{91.5 * 10^6}{15 * 10^4}$$

$$= 610 \text{ mm} \rightarrow$$

⊙ $I_{NA} = \frac{1}{12}(700)(100)^3 + 700(100)(240)^2$

$+ 2\left(\frac{1}{12}\right)(50)(800)^3 + 2(50)(800)(210)^2$

$= 4090.33 * 10^6 + 7794.67 * 10^6$

$= 11\,885 * 10^6 \ mm^4 \rightarrow$

⊙ $Q = 100 * 700 * 240$

$= 16.8 * 10^6 \ mm^3 \rightarrow$

⊙ $\tau = \frac{VQ}{It}$

$= \frac{200 * 10^3 * 16.8 * 10^6}{11\,885 * 10^6 * 700}$

$= 0.403\,387 \ N/mm^2$

$= 0.403\,387 \ MPa$

$= 403.387 \ kPa \rightarrow$

SCRATCH PAD / ROFWERK