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**NATIONAL CERTIFICATE**

**STRENGTH OF MATERIALS AND STRUCTURES N5**

**July 2021**

**28**

**This marking guideline consists of 6 pages.**



**MARKING GUIDELINE**

**QUESTION 1**



1.1 𝜎𝜎𝑙𝑙𝑙𝑙𝑙𝑙 = 𝐹𝐹𝐴𝐴𝑙𝑙𝑙𝑙𝑙𝑙𝐼𝐼 = 𝜋𝜋.(0,0215113 0002) = 311,252 𝑀𝑀𝑀𝑀𝑀𝑀  (3)

4 



1.2 𝐸𝐸 = 𝐴𝐴𝐹𝐹𝐼𝐼𝑙𝑙𝑙𝑙𝑙𝑙.𝑋𝑋𝑙𝑙𝑙𝑙𝑙𝑙.𝐿𝐿 = 𝜋𝜋4.(0,02151132) .(0000 ,00121.(0,09 × ) 10−3) = 23 152,948 𝐺𝐺𝑀𝑀𝑀𝑀  (3)



1.3 𝜎𝜎𝑦𝑦 = 𝐹𝐹𝐴𝐴𝑦𝑦𝐼𝐼 = 4 = 710,645 𝑀𝑀𝑀𝑀𝑀𝑀  (3)

258

000

𝜋𝜋

.(0,0215

2

)



449

000

𝜋𝜋

.(0,0215

2

)

1.4 𝜎𝜎𝑚𝑚𝑀𝑀𝑚𝑚 = 𝐹𝐹𝑚𝑚𝐴𝐴𝐼𝐼𝑀𝑀𝑚𝑚 = = 1236,743 𝑀𝑀𝑀𝑀𝑀𝑀 (3)

4



1.5 𝜎𝜎𝐹𝐹 = 𝐴𝐴𝐹𝐹𝐹𝐹𝐹𝐹 = 𝜋𝜋4.(0,01488162 0002 )= 931,578 𝑀𝑀𝑀𝑀𝑀𝑀 (3)



1.6 %∆𝑋𝑋 = 𝑋𝑋𝐹𝐹 = 9,264 . 100 = 10,293%  (3)

𝐿𝐿 90 



𝐴𝐴𝑙𝑙−𝐴𝐴𝐹𝐹 21,52−14,882

1.7 %𝐴𝐴𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟𝑟 = 𝐴𝐴𝑙𝑙 = 21,52 . 100 = 52,1%  (3)

0

113

258

240

449

162

0

50

100

150

200

250

300

350

400

450

500

0

0,00121

1

,

1

1

,

3

4

9,264

force (kN)

extension (mm)













1.8

(6)

 

1.9 𝑈𝑈 = 12 . 𝐹𝐹𝑙𝑙𝑟𝑟𝑙𝑙. 𝑋𝑋𝑙𝑙𝑟𝑟𝑙𝑙 = 12 . (113 000 ). (0,00121 × 10 −3) = 0,0683  𝐽𝐽 (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 *PD*

σ=

4 *t*η

= P D

4 × t

= 4,8 × 106 × 0,2

4 × 0,004

= 60 MPa (5)

2.2.2 *F*

σ=

*A*

F = 60 × 106 × 3,142 × 0,2 × 0,004

= 150,8 kN (3)

**[14] QUESTION 3**

33,2 kN













66

,075 kN/m

,2 kN

11

-

,3 kN

11

-

41

,3 kN

66

,4 kN/m

,8 kN/m

88

,675 kN/m

88

-

16

,525 kN/











tan 𝛽𝛽 = tan 𝛽𝛽

16,525 66 ,075

𝑥𝑥 = 2−𝑥𝑥





* 16,525. (2 −𝑚𝑚) = 66,075. 𝑚𝑚

∴ 𝑚𝑚 = 0,4 𝑚𝑚 𝑓𝑓𝑓𝑓𝑙𝑙𝑚𝑚 𝐿𝐿𝐿𝐿𝐿𝐿 **[17]**

**QUESTION 4**

The critical (least) resistance to bending:

* 𝐼𝐼𝑦𝑦𝑦𝑦= 𝐷𝐷12.𝐵𝐵3  0,008.(0,0045 12 3)  −6 4

= = 0,0135 × 10 𝑚𝑚

Consider as two pinned ends: 𝑀𝑀𝑒𝑒 = 2.𝐸𝐸2.𝐼𝐼𝑦𝑦𝑦𝑦 = 𝜋𝜋2.(88 × 109).(0,01352 × 10 −6) = 6,2 𝑀𝑀𝑀𝑀  

𝜋𝜋

𝐿𝐿𝑒𝑒 0,0435 

Consider as two fixed ends: 𝑀𝑀𝑒𝑒 = 𝜋𝜋2.𝐿𝐿𝐸𝐸𝑒𝑒2.𝐼𝐼𝑦𝑦𝑦𝑦 = 𝜋𝜋2.(88 × (010,5 × 9).(0,01350,0435)2 × 10 −6) = 24,786 𝑀𝑀𝑀𝑀 

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

**QUESTION 5**

* 

5.1 𝑇𝑇 = 𝐽𝐽.𝜏𝜏 = 𝜋𝜋.0,2154.(27 × 106) = 52 687,675 𝑀𝑀𝑚𝑚 

32

.(

0

,

215

2

)

𝑅𝑅



* 2𝜋𝜋.

(400). (52 687,675)60 = 1 103,488  𝑘𝑘𝑘𝑘 (7)

𝑀𝑀 = 2𝜋𝜋. 𝑀𝑀. 𝑇𝑇 =

5.2 𝑇𝑇 𝜋𝜋 . 𝐷𝐷3. (32 × 106)  3 = 0,008386 = 4 𝐷𝐷− 𝑟𝑟4 

𝐷𝐷

∴ 𝐷𝐷

∴ 0,008386= 2204 − 𝑟𝑟4





∴ 𝑑𝑑 = 5,3 𝑚𝑚𝑚𝑚 (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**