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TTL 362: Theory of Textile Structures

Minor Test 1

Maximum Marks = 25

Date: August 31, 2013, Saturday **Time: 2:30 pm – 3:30 pm** **Venue: IV LT3**

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1) *State, by giving reasons, whether the following statements are true or false.* 1×5

(a) The engineering strength of a fibre possessing higher tenacity is always higher than that of a fibre possessing lower tenacity. False [engineering strength = σ^*, tenacity = σ So there is factor of density coming into picture states that $\sigma^* = \sigma\rho$ So tenacity only cannot signify that engineering strength is higher or lower. This is only true when both fibres are of same origin.

1

(b) The tenacity of a blended fibre bundle always increases with the increase in proportion of more tenacious fibres in the blend. False It is not always the case, because when we have a fibre having tenacity P_1 at a_1. Then other fibre P_2 at a_2 but at a_1 strain if the value of $S(a_1) > P_1$ then tenacity increases otherwise it decreases.

1

(c) The number of fibres in the cross-section of a yarn is equal to the ratio of yarn count (tex) and fibre fineness (tex). False The number of fibres in the cross section is not always equal to ratio of yarn count and fibre fineness When we have parallel bundle then only valid, otherwise if helical not valid

1

(d) The twist intensity of a yarn is a function of fibre packing density only. False $K = \pi D Z$, μ = fibre packing density ⇒ The twist intensity depends on yarn count as well as fibre packing density both.

1

(e) The following expression can be used to calculate the diameter of all staple fibre yarns

$$\text{Yarn diameter (inch)} = \frac{1}{28\sqrt{\text{Yarn count (Ne)}}}.$$

False ⇒ This is true only for cotton fibres having density 1520 kg/m³ and $\mu = 0.6$. (packing density)

$D_{mm} = \sqrt{\frac{4T}{\pi \times \rho \times \mu}}$

$D_{mm} = \sqrt{\frac{4 \times 590.5}{Ne \times 3.141 \times \rho \times \mu}}$

$D(\text{inch}) = \frac{1}{28\sqrt{Ne}}$

2) *Fill in the blanks.* 1×5

5

(a) The diameter of a polyester fibre of 6 denier fineness is 24.8 µm.

(b) The breaking length of a polypropylene fibre having tenacity of 0.53 N/tex is 54.0265 km.

(c) The volumetric flow rate of air passing through a capillary of 20 µm diameter and 100 mm length under pressure drop of 125 Pa is 2.7572×10^{-13} m³/s.

(d) The ratio of pore diameter to fibre diameter in the closest hexagonally packed structure is 0.222375.

(e) The diameter of a cotton yarn of 50 tex count and 0.40 packing density is ~~0.3236~~ 0.3236154 mm.

0.82455

$d_{(mm)} = \sqrt{\frac{4T}{\pi\rho}}$

$d = \sqrt{\frac{4 \times \frac{6}{9}}{3.141 \times 1380}}$

$d = 0.02480$ mm

$d = \sqrt{\frac{4T}{\pi \mu \rho}}$

$d = \sqrt{\frac{200}{1909.728}}$

$d = 0.3236$

$d_p = \frac{1+2k}{(1+2)} \times \frac{1-\mu}{\mu} \times d$ $1+2k = R$

$= \frac{R}{1+2}\sqrt{\frac{1-\mu}{\mu}}$

$\frac{1}{\sqrt{2}} \times \sqrt{\frac{0.09}{0.91}}$

$= \frac{\pi d^4 \times \Delta P}{128 \eta l}$

$\frac{3.141 \times (20)^4 \times 10^{-24} \times 125 \times 10}{128 \times 1.78 \times 10^{-5} \times}$

1.78×10^{-5} Pa.S

2.7

3) Derive $d_p = \frac{1+q_p}{1+q}\frac{1-\mu}{\mu} d$; where d_p and q_p denote pore diameter and pore shape factor, respectively; d a[nd q] indicate fibre diameter and fibre shape factor, respectively; and μ stands for fibre packing density.

We will consider $A_p = A$ (for this calculations) (Surface areas Total)

3

$y_p = \frac{A_p}{V_p}$

$y_p = \frac{A_p \times V_g \times V_c}{V_p \, V_g \, V_c}$

$y_p = \frac{A_p}{V_g} \times \frac{\mu}{(1-\mu)}$

$y_p = \frac{A_p}{V_g} \times \frac{\mu}{(1-\mu)} \left[\mu = \frac{V_g}{V_c},\ 1-\mu = \frac{V_p}{V_c} \right]$

we know $A_p = A$

$y_p = \frac{A}{V_g} \times \frac{(\mu)}{(1-\mu)}$

$y_p = y \times \frac{\mu}{(1-\mu)} \left[y_p = \frac{4(1+q_p)}{d_p},\ y = \frac{4(1+q)}{d} \right]$

$\frac{4(1+q_p)}{d_p} = \frac{4(1+q)}{d} \times \frac{\mu}{(1-\mu)}$

$d_p = \frac{1+q_p}{1+q} \times \frac{1-\mu}{\mu} d$

generally $A_p < A$ but to value this $A_p = A$ this is the approximation.

4) Calculate the percentage of cotton and wool fibres in a cotton-wool blended fibre bundle that shows minimum strength where cotton fibers have tenacity of 0.36 N/tex and breaking strain of 11%, wool fibers have tenacity of 0.13 N/tex and breaking strain of 46%, and wool fibers show specific stress of 0.06 N/tex at a strain of 11%. Also calculate the minimum strength of this bundle. 3+3

$g_1 = \frac{m_1}{m}$, $g_2 = \frac{m_2}{m}$

$\frac{P_\varepsilon}{T} = \max\left[\left[\frac{g_1 P_1}{t_1} + \frac{g_2 S_2(a)}{t_2}\right], \left[\frac{g_2 P_2}{t_2}\right]\right]$

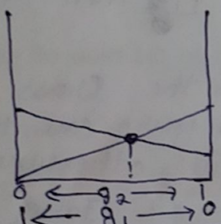
Lets consider

$a = 11\%$

$\frac{P_1}{t_1}$ = tenacity

$\frac{P_1}{t_1} = 0.36$ N/tex

$\frac{P_2}{t_2} = 0.46$



For minimum

$\frac{g_1 P_1}{t_1} + \frac{g_2 S_2(a)}{t_2} = \frac{g_2 P_2}{t_2}$ $\left[g_1 + g_2 = 1,\ g_1 = 1 - g_2 \right]$

$\frac{P_1}{t_1} = \frac{g_2 P_2}{t_2} + \frac{g_2 P_1}{t_1} - \frac{g_2 S_2(a)}{t_2}$

$\frac{P_1/t_1}{\left(P_2/t_2 + P_1/t_1 - \frac{S_2(a)}{t_2}\right)} = g_2$

$\frac{0.36}{0.46 + 0.36 - 0.06} = g_2$

$g_2 = 0.473684$

$g_1 = 0.526316$

% of Cotton = 52.6316%

% of wool = 47.3684%

2

strength = $\frac{P_2 g_2}{t_2} = \frac{P_1 g_1}{t_1} + \frac{g_2 S_2(a)}{t_2}$

$= 0.46 \times 0.473684$

$= 0.21789$ N/tex

5) A cotton carded ring spun yarn of 11 tex count needs to be prepared from long staple cotton fibres of 0.13 tex fineness. Calculate the suitable twist required for this yarn. 6

$\frac{\mu^{1.5}}{\left(1-\left(\frac{\mu}{0.8}\right)^3\right)^3} = \frac{R[T_{tex}^{0.5}]}{\sqrt{T}\left(1-\frac{\sqrt{t}}{\sqrt{T}}\right)^2}$ — (1), value of R = 2.145

6

$= \frac{2.145}{\sqrt{11}\left(1-\sqrt{\frac{0.13}{11}}\right)^2}$

$= \frac{2.145}{2.63471}$

$= 0.814131$

$\boxed{\text{For } \mu = 0.50}$

$\frac{\mu^{1.5}}{\left(1-\left(\frac{\mu}{0.8}\right)^3\right)^3} = \frac{0.35355}{0.43184} = 0.81870$

equal (app)

So by using this

$\frac{\mu^{2.5}}{\left\{1-\left(\frac{\mu}{0.8}\right)^3\right\}^3} = C\left(\frac{m}{\sqrt{t_{tex}}} Z_{tm}^2 T^{1/4}\right)^2$ — (2)

0.961
1520
2.145

$= \frac{0.1767767}{0.43184}$

$\Rightarrow 0.40935 = 0.961 \times 10^{-7} \times Z^2 \times \sqrt{T}$

$1.28434 \times 10^6 /m = Z^2$

$1.133287 \times 10^3 /m = Z$