DESIGN AND MANUFACTURING OF TEXTILE STRUCTURAL COMPOSITES (TXL766)

MINOR I (20%)

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Date: 5 Feb 2020 Venue: LH318 Time: 1 h

1. Select examples (from box) for the following: (4)

- Isotropic body
- Homogeneous body
- Homogeneous body that is not isotropic
- Isotropic body that is not homogeneous

> 1. Steel rod
> 2. Steel rod heated from one end
> 3. Wood
> 4. Wood with knots

2. From the values provided in Table 1, answer the following:

- Identify the strongest and the weakest fibre for the composite application. What is the ratio of their strength? (2+2)
- Identify the fibre with the minimum or the maximum stiffness (ability to resist deformation) for the composite application. What is the ratio of their stiffness? (2+2)
- Select the fibre and the matrix combination for an unidirectional continuous composite to achieve the maximum specific longitudinal modulus at $(V.F.)_{fibre} = 50\%$. Find its value. (2+2)
- A unidirectional continuous hybrid composite is made from the epoxy matrix (volume fraction 60%) which is reinforced with Kevlar (20%) and Boron (20%) fibres. Find the strength of the composite in its longitudinal direction. (Assume: A composite fails as soon as any fibre breaks). (4)

Bonus (+5)

A unidirectional continuous composite of Carbon-Epoxy (Fibre Volume Fraction = 50%) is under stress condition as shown. Find the strains in longitudinal and transverse direction.

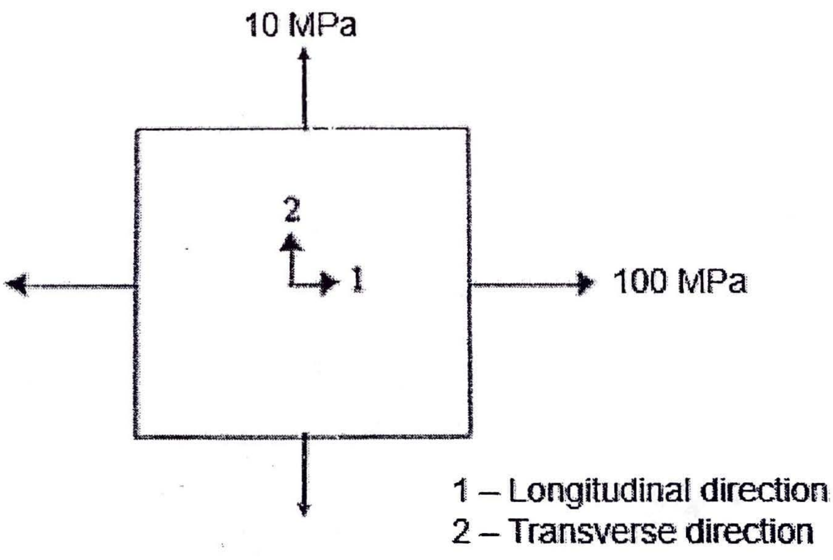

Table 1: Mechanical Properties of Textile Fibres and *Matrixs* for Composite

Materials	Density (Kg/m^3)	Modulus (GPa)	Breaking Stress (GPa)	Breaking Strain (%)	Poisson's Ratio
Carbon	2100	500	7	3	0.3
Glass	2600	40	1	5	0.25
Kevlar	1440	300	3.6	.012 7	0.35
Boron	2380	200	1.4	.007 4	0.2
Steel	7800	207	.99	2	0.2
Polyester	1500	4	0.15	2	0.3
Epoxy	1400	6	0.1	.016 6	0.34
Polypropylene	920	2	0.0414	15	0.36
Polystyrene	1060	5	0.069	2.5	0.34
Nylon 6	1140	3	0.079	20	0.37

Assume Fibre and Matrix as a Isotropic Material

Relationship of σ/ϵ for a Thin Lamina (Orthotropic) under Plane Stress Condition

$$\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \gamma_{12} \end{bmatrix} = \begin{bmatrix} \frac{1}{E_1} & -\frac{\nu_{12}}{E_1} & 0 \\ -\frac{\nu_{21}}{E_2} & \frac{1}{E_2} & 0 \\ 0 & 0 & \frac{1}{G_{12}} \end{bmatrix} \begin{bmatrix} \sigma_1 \\ \sigma_2 \\ \tau_{12} \end{bmatrix}$$