16.4 (a) What is the distinction between cement and concrete?

(b) Cite three important limitations that restrict the use of concrete as a structural material.

(c) Briefly explain three techniques that are used to strengthen concrete by reinforcement.

16.12 In an aligned and continuous carbon fiber-reinforced nylon 6,6 composite, the fibers are to carry 97% of a load applied in the longitudinal direction.

(a) Using the data provided, determine the volume fraction of fibers that will be required.

(b) What will be the tensile strength of this composite? Assume that the matrix stress at fiber failure is 50 MPa (7250 psi).

|  |  |  |
| --- | --- | --- |
|  | ***Modulus of Elasticity [GPa (psi)]*** | ***Tensile Strength [MPa (psi)]*** |
| *Carbon fiber* | *260 (37 × 106)* | *4000 (580,000)* |
| *Nylon 6,6* | *2.8 (4.0 × 105)* | *76 (11,000)* |

16.16 It is desired to produce an aligned carbon fiber–epoxy matrix composite having a longitudinal tensile strength of 500 MPa (72,500 psi). Calculate the volume fraction of fibers necessary if (1) the average fiber diameter and length are 0.01 mm (3.9 × 10–4 in.) and 0.5 mm (2 × 10–2 in.), respectively; (2) the fiber fracture strength is 4.0 GPa (5.8 × 105 psi); (3) the fiber–matrix bond strength is 25 MPa (3625 psi); and (4) the matrix stress at composite failure is 7.0 MPa (1000 psi).

16.24 (a) Cite several reasons why fiberglass-reinforced composites are used extensively.

(b) Cite several limitations of this type of composite.

16.26 (a) Write an expression for the modulus of elasticity for a hybrid composite in which all fibers of both types are oriented in the same direction.

(b) Using this expression, compute the longitudinal modulus of elasticity of a hybrid composite consisting of aramid and glass fibers in volume fractions of 0.25 and 0.35, respectively, within a polyester resin matrix [Em = 4.0 GPa (6 × 105 psi)].

17.6 An electrochemical cell is composed of pure copper and pure cadmium electrodes immersed in solutions of their respective divalent ions. For a 6.5 × 10–2 M concentration of Cd2+, the cadmium electrode is oxidized, yielding a cell potential of 0.775 V. Calculate the concentration of Cu2+ ions if the temperature is 25°C.

17.12 A thick steel sheet of area 100 in.2 is exposed to air near the ocean. After a one-year period it was found to experience a weight loss of 485 g due to corrosion. To what rate of corrosion, in both mpy and mm/yr, does this correspond?

17.22 For each form of corrosion other than uniform, do the following:

(a) Describe why, where, and the conditions under which the corrosion occurs.

(b) Cite three measures that may be taken to prevent or control it.

17.28 For each of the metals listed in the following table, compute the Pilling–Bedworth ratio. Also, on the basis of this value, specify whether you would expect the oxide scale that forms on the surface to be protective, and then justify your decision. Density data for both the metal and its oxide are also tabulated.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Metal*** | ***Metal Density (g/cm3)*** | ***Metal Oxide*** | ***Oxide Density (g/cm3)*** |
| *Mg* | *1.74* | *MgO* | *3.58* |
| *V* | *6.11* | *V2O5* | *3.36* |
| *Zn* | *7.13* | *ZnO* | *5.61* |

17.30 The following table gives weight gain–time data for the oxidation of nickel at an elevated temperature.

|  |  |
| --- | --- |
| ***W (mg/cm2)*** | ***Time (min)*** |
| *0.527* | *10* |
| *0.857* | *30* |
| *1.526* | *100* |

(a) Determine whether the oxidation kinetics obey a linear, parabolic, or logarithmic rate expression.

(b) Now compute W after a time of 600 min.