Engineering material essay examples

Health & Medicine, Stress

Q1:

There are four classes/or types of materials that are considered as listed below

- Ceramics and Glasses
- Composite materials
- Polymers
- Metal alloys

First generalized properties of the materials will be discussed, and then based on these properties one material will be selected for a specific application.

- Ceramics and Glasses

Ceramics and Glasses are inorganic, non-metallic materials consisting of metallic and non-metallic elements bonded with ionic and covalent bonds. These are high strength bonding gives special characteristics to these materials.

The typical properties of these materials are as:

- Low to moderate density compared to metals,
- High modulus of elasticity,
- Provide good strength at elevated level of temperature, and resistant to high temperature,
- High compressive strength, as well as low to moderate shear and tensile strength,
- High value of hardness,
- Resistant to corrosion,
- Electrical insulation property,

- High value of thermal conductivity and expansion coefficient as well as brittle.

- Composite Material

The different combination of metals, polymers and ceramics formulate the composite materials. They are multi-phase layered structure. Mostly available material apart from elements forms of composite materials.

They exhibit very versatile properties such as high strength to weight ratio, fire resistive, electrical insulation properties, weathering and chemical resistant, high value of tensile strength, low thermal conductivity, they are anisotropic means the stiffness often depend upon the orientation of applied force.

- Polymers

Polymers are composed of many repeated subunits, known as monomers. Polymers both natural and synthetic are created by polymerization of many monomers.

The main properties of polymers are their low density, hardness, tensile strength, medium compressive strength, Young's Modulus, and stability, high thermal expansion, low thermal conductivity, water resistant, high electrical resistance, low oxidation resistance and medium chemical resistance.

- Metal Alloys

An alloy is formulated by mixture of two elements having one of that is metal. An alloy contains one or more of these: a solid solution of elements, and a mixture of metallic phases.

Inter-metallic compounds hold no distinct boundary between the phases.

They exhibit general properties of the followings reduced weight, resistance to corrosion, non-magnetic properties and mechanical strength (Allloy). Density, hardness, tensile strength, compressive strength, Young's Modulus, Melting point, Dimensional stability, thermal expansion, thermal conductivity, electrical resistance, chemical resistance are the properties on which component will be selected. Due to the water resistant property of polymers, polyethylene is used as electrical insulation for coaxial cables. In addition to the water resistant property low density, low to medium compressive strength, high thermal expansion, high thermal shocks, high electrical resistance are the properties that enable polyethylene to use as electrical insulation.

Q2:

Yield strength is the ability of a metal to resist gradual progressive forces without resulting in permanent deformation. Tensile strength is the capability of a material to resist internality developed forces that attempt to pull apart or permanent deform it.

The tensile strength of the material is kept higher than the value of yield strength. In the designing procedure, it is assumed that material tends to gain back its original shape during the application of stress to the material. So it is the reason one take in consideration Yield Strength comparative to Tensile Strength.

It can be seen in the following stress strain curve

Elastic region corresponds to the Yield Strength, and Plastic Limit corresponds to Tensile Strength. Materials are designed for Elastic region so that on the application of stress it can come back to its original shape.

Q3:

For steel and aluminum only yield strength is influenced by chemical compositions. Young's Modulus, Poison's Ratio and Density Ratio essentially remained constant. Young's Modulus is not much affected by additives for all iron based alloys.

Moreover, the change in the composition of steel or steel alloy changes its properties that enhance the uses of steel in different manufacturing and construction projects. For instance, 0-25 % addition of carbon in steel increases the ductility, 0. 25-0. 70%, increase elasticity, but carbon amount greater than 1. 50% reduce the ductility.

Source adopted: Raghavan V. Material Science and Engineering 4th Edition. p-396

Q4:

In certain materials like steel, there is a relationship b/w hardness and tensile testing. In general, high tensile strength of the material corresponds to hard material. As a matter of fact, soft materials are weaker in tension. Hence, it is obvious that the steel shows a linear relationship over a wide range in the context of hardness property. That means one can make simple and quick hardness test in order to locate the corresponding hardness of a material against tensile strength with the help of standard table of values.

The basic reason to perform hardness test to evaluate preferences for tensile testing include rapid and less expensive, and its accuracy (if one have established relation between hardness and tensile strength). The relation is not necessarily linear for all materials- one need to look it up to be sure, or make one’s own tensile/hardness chart.

Q5:

Fracture toughness is a property that describes the capability of a material having a crack to resist fracture. It is restricted to results of fracture mechanics tests that are applied to control fracture while fracture test emphasized on property of the material for resisting the fracture. The experimental standardization and measurement of fracture toughness play a significant role in application of fracture mechanics for assessment of structural integrity, damage tolerance design, residual strength analysis and fitness for service evaluation, and for various engineering structures and components. The value of fracture toughness is also used for basic characterization of material, quality assurance performance evaluation of specific engineering structures, including nuclear pressure vessels and piping, and tanks, petrochemical vessels oil and gas pipelines, automotive, aircraft and ship structures.

If the design requires impact resistance, the engineer has two basic options. The engineer selects a material subject to brittle fracture and based on economics. The low stress levels facilitate effective design in the procedure. The impact resistant of material can be made thinner or lighter as well as with higher stress levels. The designer can consider the risks and economics factors for the purpose of selecting a material. The material having more impact resistance value is given key priority. Q6:

Diameter= 14mm

Radius= Dia/2

= 7mm

Cross-sectional area of circular guage = Pi*(radius^2)

Radius^2=(7mm)^2

= 49e-6 m^2

- Yield Strength= Force at extreme of linear region/area of guage

= 100kN/Pi*r^2= 100kN/(153. 938e-6)= 649. 6120 Mpa

Tensile Strength:

If one extrapolates the force axis with interval of 20kN, then the ultimate tensile strength will be at 120kN as it is the maximum peak value in the graph region. So

- Tensile Strength= 120kN/ Pi*r^2

= 120kN/153. 938e-6= 779. 53 Mpa

- Elastic Modulus = Stress/Strain

It will be measured in the linear region, or at the end of the linear region, so in this region, value of stress will be equal to the value of yield strength that had been calculated in part 1.

So

Strain = Change in length/Original length

= 0. 2mm/50mm= 0. 004

Hence

Elastic Modulus= 649. 6120 Mpa/0. 004

= 162. 403 Gpa

- Percentage elongation

%age elongation

= (Elongation at point of rupture/Initial length)*100

= (1mm/50mm)*100= 2%

Reference

“ Alloy”(n. d.) Retrived from http://www. preferredtool.

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