Young modulus of elasticity of various steel compositions atdifferenttemperatures...

Health & Medicine, Stress

Question One

It is essential to understand the four classes of materials; this is because it makes us have a clear understanding of the properties that specific materials should exhibit. This plays an important role whenever there is a need to select materials for use in applications. (Ashby, Hugh and Cebon, 2007). This is due to the fact that for every application there are specific properties required, there is always a need to select that material that has exactly the needed property. Hence, the understanding of such properties ensures that the right material is chosen for the correct application. The four classes of materials are composite materials, polymers, ceramics and glasses, and metal alloys materials each of them is used for specific functions which are quite related to the unique characteristics of that material (Askeland and Phulé, 2005).

Steel, for instance, is a metal alloy. It has diverse applications which are highly dependent on the metallic alloy and other unique properties of steel. The fact that steel is an alloy of iron and carbon gives it some unique properties. The hardness and tensile strength of steel is determined by the quantity of carbon present in the alloy. These specific properties of steel are therefore very crucial in determining specific applications of the steel. (Callister, 2000). Hence, the applications of steel may vary from heavy to midland then light which is dependent on the quantity of carbon present.

Question Two

The Yield strength of materials is one of the most crucial indicators used in the field of material science and engineering designs. For every material, the yield strength is dependent on couples of factors, among which are; quality of the raw material, the chemical composition, the heat treatment process, etc. The yield strength is one of the most essential values that need to be determined in every structural design. If the application being designed will be required to pass through some kind of force, it must therefore be ensured that the yield strength of such materials is greater than the force it would pass through so as to avoid exceeding its elastic limit and prevent plasticity (Davies and Oelmann, 1983). Thus, the yield strength becomes essential in making sure that the selected component has high yield strength so that the produced stress does not go beyond yield strength.

The tensile strength, on the other hand, is not that required in engineering design due to the fact that materials used in engineering are not required to become deformed while in use. The tensile strength is only required for the application of ductile materials mostly because many of the plastic deformation usually occurs before it is reached. Hence, despite the fact that the tensile strength gives some information about the hardness and defects of materials, relative to the yield strength there is little or no need to determine the tensile strength of materials for certain designs (Askeland, 1988). The yield strength of a material can be determined via a stress-strain curve as indicated in the diagram below:

Question Three

The main component of steel is iron. The addition of any component to the basic component of steel, i. e. iron and carbon, ends up affecting its properties, physically and chemically. This explains why the way steel react to various fabrication processes vary. The variations in the addition of steel compositions are accounts for the huge variety of steel grades, and consequently, varied steel properties (Smith, 1990). An effective steel composition would lead to an enhanced toughness and strength which leads, also, to a cost-effective as well as straightforward method of heat-treatment.

However, the extent of steel alloying results to a varying elasticity modulus of steel. This varying modulus is dependent on the composition of the steel. Steel created with high levels of carbon tend to be resistant to heat treatment and records higher elastic modulus (Smith, 1990).

Reference

Smith, W. F. 1990. Principles of Materials Science and Engineering. New York: McGraw-Hill.

Question Four

Hardness testing is often preferred to tensile testing principally because hardness testing is an effective way to determine, rapidly and non-destructively, hardness of a material (Francois, 2008). Hence, hardness testing can actually be used to determine the strength of a material through a non-destructive way thereby providing an easier way of ensuring that the strength of that particular material is determined without necessarily testing the elongation of the material mostly used in tensile testing (Francois, 2008). Tensile testing, on the other hand, deforms the material as opposed to hardness testing which determines the strength of the material non-destructively.

In addition, the hardness testing, apart from determining the hardness of a material, also determines its strength while tensile testing can only be used to test the strength of a material. Moreover, after the determination of the hardness of a material through hardness testing it is possible to use it in approximating the tensile strength of various materials (Francois, 2008).

As far as steel and some other certain materials, there is a relationship between hardness testing and tensile testing. That is, in general the higher the tensile strength, the harder the material will be. This relationship is quite linear for steel over a large range of hardness.

A good reason the hardness testing is often performed in preference to tensile testing is that it is much quicker and less expensive, and reasonably accurate especially if the relationship between hardness and tensile strength has been determined. Finally, due to the ease at which the hardness testing is conducted in comparison to complex tensile tests makes the former to be more preferred and often used in preference for the latter.

Question Five

In selecting the right material for a particular application, the determination of the fracture toughness (Kc) has several advantages over the Charpy impact test results. This is mainly because the former indicates the ability of a material having a crack to resist fracture, thereby making it one of the most significant properties of any material used in almost every design applications (Anderson, 1995). However, despite the Charpy impact test being a quick, cheap and easy method of determining the hardness of a material its results remains to be comparative in comparison to the specific ones obtained in fracture toughness (Anderson, 1995).

In addition, the fracture toughness can be used quantitatively to express a resistance of a material to brittle fracture in presence of a crack. Therefore, if a material consists of more fracture toughness then it will possibly undergo ductile fracture. Moreover, brittle fracture is indicative of a material with less fracture toughness. On the other hand, charpy impact test can also use to determine these factors but only on percentage basis (Anderson, 1995).

Question Six

Yield Strength = Force (Newton) Area (m2)

= (100 1000) ÷ (πr2)

= 100000 ÷ π ×0. 004×0. 004

= 1988071570 Pa

= 1. 9 × 109 Pa

Elasticity Modulus

E = (F)(L 1)/(A)(L 2)

Where E = Elastic Modulus

F = force applied

A = the cross-sectional area

L 2 = change in length

L 1 = original length

Where: F= (100×1000 Newton); A= (πr2 0. 004×0. 004= 0. 0000503) m2 ;

L 2 (1. 0-0. 2= 0. 8) ; L 1 (50 mm= 0. 05 m)

E = 5000 ÷ 0. 00004024

E = 124254473. 16

E = 1. 2 × 108 Psi

Elongation

= 1. 0 mm- 0. 2 mm

= 0. 8 mm

Therefore; 50 + 0. 8 = 50. 8 mm

References

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