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STUDY ON MATERIAL SELECTION FOR PARTICULAR DESIGN

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Abstract- *This paper demonstrates the importance of Material selection in engineering design is all aspects. When selecting a material for a specific application based on properties appropriate testing must be performed to ensure that the material will remain suitable for its intended application throughout the intended life of the product.* Tensile testing *is a way of determining how something will react when it is pulled apart, when a force is applied to it in tension.* Tensile testing *is one of the simplest and most widely used mechanical tests. By measuring the force required to elongate a specimen to breaking point, material properties can be determined that will allow designers and quality managers to predict how materials and products will behave in their intended applications.*

***Keywords*: Digitally controlled universal testing system, Strain gauge, tensile testing, Al alloy 6061-T6, Al alloy 2024-T3.**

1. INTRODUCTION

Material selection in engineering design is very important in all aspects. There are numerous engineering design criteria and facts have to be considered when selecting a particular material for a certain design. Material selection is one of the main functions of effective design and it determines the reliability of the design in terms of industrial and economical aspects. If the product does not meet appropriate material combination a great design may fail to be profitable product. So, it is important to know the best materials for particular design. How to get an idea about the best materials for a design? In this aspect engineers use numerous facts of materials to make the reasonable decision. They are mainly concentrating on the properties of the material which are identified for that specific design.

Advancement of material science and the techniques for processing material have been made from the second half of 20th century. As a result, a wide range of material is now available for any imaginable applications. The development of modern transport, particularly the airplane is associated with a huge increase in varieties of materials and making full use of their properties. For example, in development of modern transports entirely alloy material and new composite materials are used, because exhibiting properties could not be achieved by ordinary metals. The principles governing the behavior of materials are grounded in science and are understandable. The properties of a given material are determined by its structure and it changes according to environmental conditions. When selecting a material for a specific application, sufficient and appropriate testing must be performed to ensure that the material will remain suitable for its intended application throughout the intended life of the product [1].

2. TYPES OF MATERIAL AND ITS PROPERTIES

Generally, materials are classified into groups. One could classify them according to structure, properties, use. In metals the valence electrons are detached from atoms, and spread in an 'electron sea' that "glues" the ions together. Metals are usually strong, conduct electricity and heat dissipation and are opaque to light (shiny if polished). Examples: Aluminum, steel, brass, gold. In Semiconductors, the electrons are shared between atoms. They are opaque to visible light but transparent to the infrared. Examples: Si, Ge, GaAs. Ceramic atoms behave either positive or negative ions, and they are bound by Coulomb forces between them. They are usually combinations of metals or semiconductors with oxygen, nitrogen or carbon. Examples: glass, porcelain, many minerals. Polymers are bounded by covalent forces and also by weak van der Waals forces, based on H, C and other non-metallic elements. They decompose at moderate temperatures (100–400C), and are lightweight. Other properties vary greatly. Examples: plastics (nylon, Teflon, polyester) and rubber. Some categories are not based on bonding. Particular microstructure identifies composites, made of different materials to intimate the contact for achieving specific properties. Example: fiberglass, concrete, wood. Biomaterials can be any type of material that is biocompatible and used for instance, to replace human body parts [2].

Advanced Materials used in "High-Tec" applications, usually designed for maximum performance, and normally expensive. Examples are titanium alloys for supersonic air planes, magnetic alloys for computer disks, special ceramics for the heat shield of the space shuttle, etc. There are many. Use of nuclear energy requires solving problem with residues, or advances in nuclear waste processing. Hypersonic flight requires materials that are light, strong and resist high temperatures. Optical communications require optical fibers that absorb light negligibly. Structures require strong materials like metals and resist corrosion like plastics [2].

When selecting a material for a given application the material properties must satisfy the function and the operating conditions of the component or the structure

being designed. Properties are the way; the material responds to the environment. For example, the mechanical, electrical and magnetic properties are the responses to mechanical, electrical and magnetic forces, respectively. Other important properties are thermal (transmission of heat, heat capacity), optical (absorption, transmission and scattering of light), and the chemical stability in contact with the environment (like corrosion resistance). Processing of materials is the application of heat (heat treatment), mechanical forces, etc. to affect their microstructure and their properties. The properties, which directly influence the choice of material, are mechanical properties e.g. stiffness, strength, ductility, hardness, toughness, etc. Physical properties: e.g. density, electrical conductivity, thermal conductivity, etc. Chemical properties e.g. corrosion resistance in various environments. Manufacturing properties e.g. formability, machinability, ease of joining, etc. The functional requirements of a product are directly determined by the mechanical, physical, chemical properties.

For the product to be technically manufacturable, the material must have the right manufacturing properties. For example, a forged component requires a material with sufficient flow ability without cracking during forging, a cast component requires a material that flows readily in the molten state and fills the mold and on solidification does not produce undesirable pores and cracks. So, many testing are done to find the capability of material for the product manufacturing and while selecting a material for a specific application. Example tensile testing, compression testing and fatigue testing are done for aircraft structure.

3. TENSILE TESTING ON DIFFERENT ALUMINUM ALLOY

Tensile testing is one of the simplest and most widely used mechanical tests. By measuring the force it is required to elongate a specimen at breaking point, so the material properties can be determined that will allow designers and quality managers to predict how materials and products will behave in their intended applications. Tensile testing is generally done using digital universal testing system. Tensile testing is done on aluminum alloy 6061-T6 and aluminum alloy 2024-T3 specimen. Strain gauge sensor is bounded on the specimen. Foil strain gauge based on wheatstone bridge configuration is selected. Because strain measurement typically requires the detection of very small mechanical deformations, and small resistance changes, the resultant magnitude of most strains measurements in stress analysis application. The wheatstone bridge is comprised of four resistive arms arranged in the configuration of a diamond. An excitation voltage is applied across bridge input, and a resultant output voltage can be measured across the other two vertices [3].

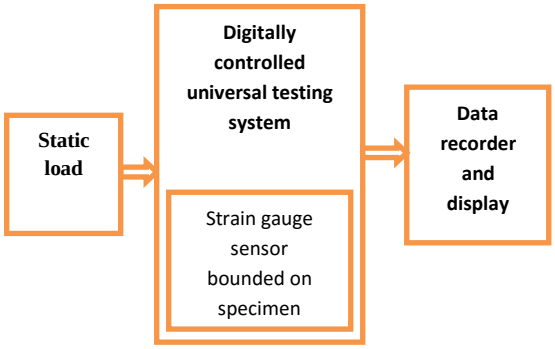

Fig -1: Tensile testing block diagram

As shown in the figure1 specimen is connected to digitally controlled universal testing system. When static load is applied to the specimen it experiences the pull-off force. After some time of elongation, the specimen takes place and plastic deformation occurs. The data of stress and load with respect to time will be recorded and displayed by digitally controlled universal testing system. Plotting stress v/s strain graph gives the point of distraction, yield point/ strength, young's modulus, ductile strength [4].

4. RESULT AND DISCUSSION

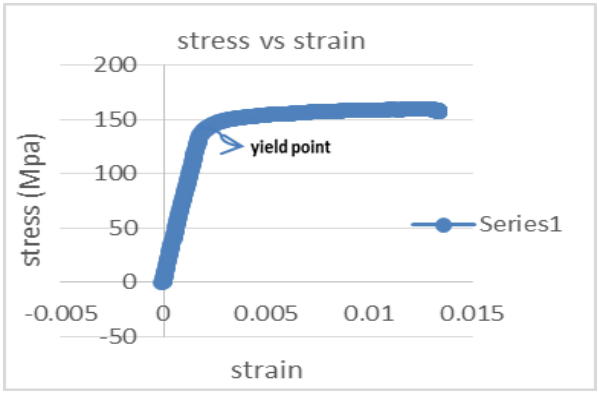

Chart -1: graph of stress v/s strain for aluminum alloy 6061-T6

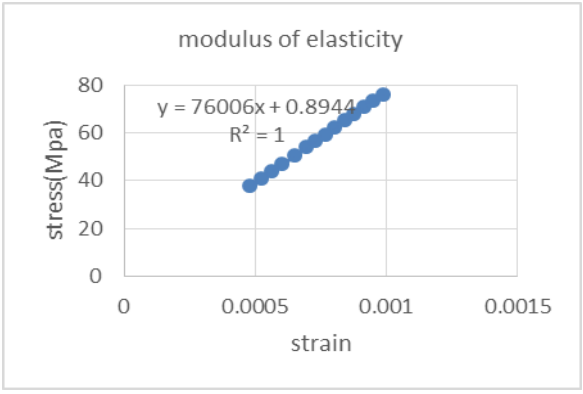

Chart -2: Modulus of elasticity for aluminum alloy 6061-T6

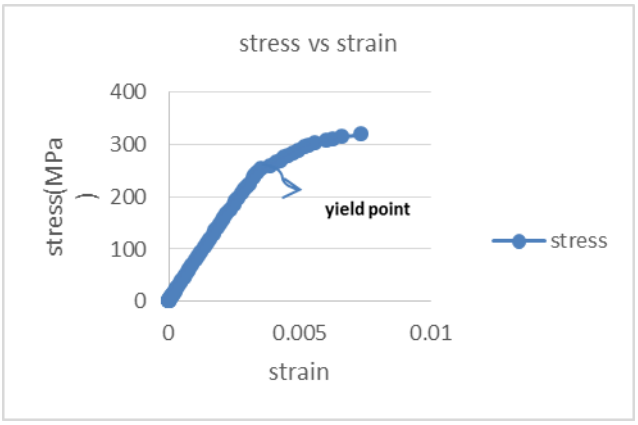

Chart -3: graph of stress v/s strain for aluminum alloy 2024-T3

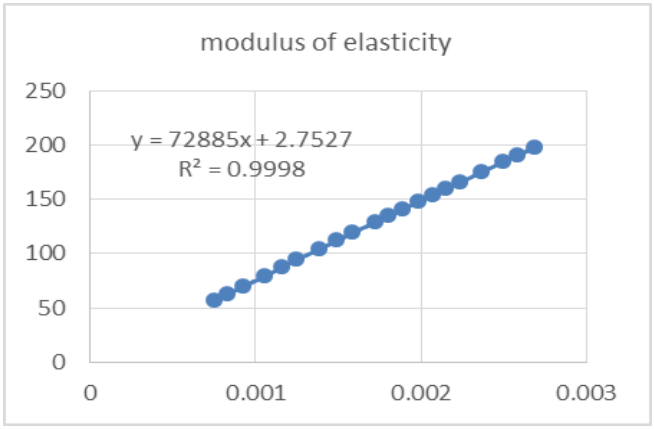

Chart -4: Modulus of elasticity for aluminum alloy 2024-T3

The result shows in the Chart -1 and Chart -3 in the graph of stress v/s strain for each specimen shows the yield point were the deformation of specimen starts under static load. Point of distraction is 158 Mpa, Modulus of elasticity is 76 Gpa and ultimate tensile strength is 160 Mpa for specimen aluminum alloy 6061-T6. Point of distraction is 146 Mpa, Modulus of elasticity is 72 Gpa and ultimate tensile strength is 320 Mpa for aluminum alloy 2021-T3 [5].

5. CONCLUSION

This paper is concluded with tensile testing on two different aluminum alloy material which shows the point of destruction, modulus of elasticity and ultimate tensile strength. In this tensile test aluminum alloy 6061-T6 is having more point of destruction and modulus of elasticity at early stage of testing compared to aluminum alloy 2024-T3, also there is different ultimate tensile strength. So, aluminum alloy is used based on requirement of their strength for different applications like Aerospace Industry, Automotive Industry, Beverage Industry and Construction Industry.

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