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Effect of Environment on the Mechanical Properties of Mild Steel

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ABSTRACT

Mild steel is a material which is universally used, especially in developing countries for several engineering applications. This research investigated the effect of the environment on the mechanical properties of mild steel. It was discovered that the environment were the mild steel is kept before and after engineering applications has a role to play in the final mechanical properties of the material. It was observed that for applications that requires strength, the material should be left in an Air conditioned environment for a period of time before usage as this will give the material the best result for strength. It gave about 171.55571MPa while for hardness; Air conditioned environment had the highest hardness value of 59.333 while outside environment had the least hardness value.

Keywords: *Material, mild steel, environment, testing, mechanical*

1. INTRODUCTION

Mild steel is a material which is universally used, especially in developing countries. Mild steel refers to low carbon steel; typically the American Iron and Steel Institute (AISI) grades 1005 through 1025, which are usually used for structural applications (Wagner, 2003). The numerous successful uses of mild steel in critical components in all sectors of industry highlights its versatility and suggests many additional applications, hence the need to investigate its behavior in various environments becomes imperative. This research investigated the effect of the environment (Air conditioned room, open air, and inside environments) on the mechanical properties of mild steel.

Mild steel has become one of the mostly used materials in the field of engineering all over the world. It is used widely in the construction of roads, railways and in other infrastructures, appliances and buildings. Most large modern structures such as stadia and sky scrapers, bridges and airports are supported by steel skeleton. It is also used as reinforcement in concrete structure. Despite growth in usage of aluminum, mild steel is still the main material for car bodies, steel is used in other variety of other construction materials such as bolts, nails and screws, other common applications include shipbuilding, pipeline transport, mining, offshore construction, aerospace, washing machine, also new equipment such as bulldozers, office furniture, steel wood tools and armor in the form of personal vests or vehicle amour (better known as rolled homogenous armor in this role). However, the rate at which structures are collapsing as a result of failure is a course for concern by all the stakeholders in the use of steel products.

1.1 Storage of Mild Steel

Mild steel is commonly stored through the following ways:

(i) **Industrial Storage**: This is the form of storage done by industries that use it for their construction purposes. They store it alongside other forms of materials like ductile iron. It is stored in the warehouses; this warehouse could either be air-conditioned office or just an open roofed space (Ukoba et al, 2012).

(ii) **Commercial Storage:** This is the one done by the sellers of mild steel. The wholesalers usually store it in Air-conditioned environment, like the place where the specimen used for this study was bought. While the retailers usually leave them in atmospheric corrosion environment (outside).

With the above storage in different environments, nobody seems to find out the effects of the environments of storage on the mechanical properties of the stored mild steel to know if there is relationship between storage environments, mechanical and other properties of stored mild steel and failure of structures and products produced from the stored mild steel over the years, so that the users will not be assuming that the mild steel have the same quality as at when produced from the factory. Hence, the needs for this research work to investigate the relationship.

1.2 Tensile Testing

Also known as tension testing is a fundamental materials science test in which a sample is subjected to uniaxial tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area (Davis, 2004). From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics.

1.3 Hardness Test

It is a measure of the difficulty of scratching of a material (Jim, 1995). Also, hardness can be said to be a measure of how resistant solid matter is to various kinds of permanent shape change when a force is applied. Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore there are different measurements of hardness: scratch hardness, indentation hardness, and rebound hardness. Hardness is dependent on ductility, elasticity, plasticity, strain,

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strength, toughness, viscoelasticity, and viscosity (Wikipedia, 2011).

1.4 Previous Work

Some works have been done in terms of studying the effect of environment on material. Worthy of note are those by Ukoba et al, 2011 worked on galvanized steel were they studied the "Environmental Impact on Engineering Materials: Galvanized Steel". They also studied that of ductile iron "Corrosion Behaviour of Ductile Iron in Different Environment" in 2012 but none has focused on mild steel.

2. METHODOLOGY

The mild steel used for this research work was bought wholesale from Lagos, Nigeria. The 2mm thick mild steel was cut into machine able pieces. The pieces were machined using Lathe machine into American Association of Materials and Testing (ASTM) standard 1985. These were placed into three different environments (Air conditioned environment, room environment and Open air environment). Various tests (Tensile test and hardness test) used for determining mechanical properties of material were performed on these samples to determine the properties of mild steel. These were left in the three different environments coinciding to the environments where the material is likely to be stored after production/purchase and also in the environment where the material finds applications.
Instron Universal tester was used to perform the tensile test on the samples every month for six months according to ASTM (1985) E8 Standard Test while Vicker's Microhardness Indentation was used to perform the hardness test on the samples. This experiment was performed in Akure, Ondo State, Nigeria, reflecting the south western Nigeria. Below is a list of some of the equipment and materials used.

2.1 Materials and Equipment

Used include Mild steel plate (2mm thickness), Hack Saw for cutting them into machine able piece, Lathe machine for machining them to the required ASTM standard, Instron Universal Tensile Tester for tensile testing, Micro hardness Vickers tester.

2.2 Experimental Method

Three samples per environment were taken and the following tests ran on them; tensile test and hardness test. The cut pieces of mild steel were machined according to ASTM E8 Standard Test Methods for Tension Testing of Metallic Materials (Wikipedia, 2011) standard as shown in the fig 1.0, with gage length of 40mm and diameter of 6mm while the grip length is 30mm with a diameter of 8mm, using Instron universal tester series 3369 shown in fig 1.1

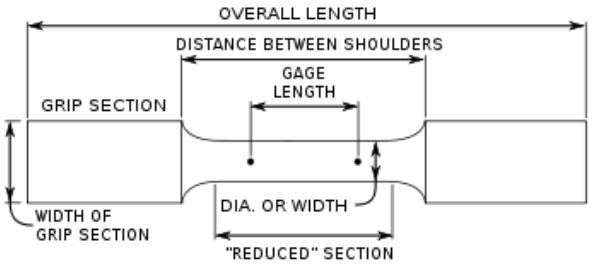

Fig 1.0: Tensile test specimen (source: Wikipedia, 2011)

Fig 1.1: Tensile test machine (Instron Universal tester series 3369)

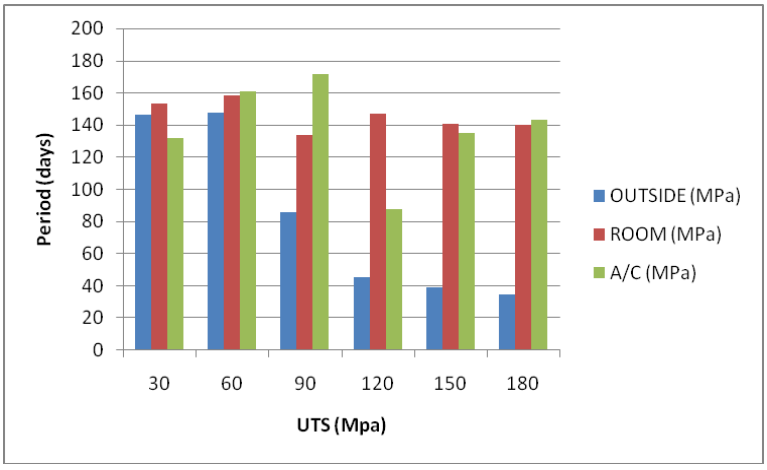

Fig 1.2: Chart of Ultimate Tensile Strength (UTS) of mild steel in various environments

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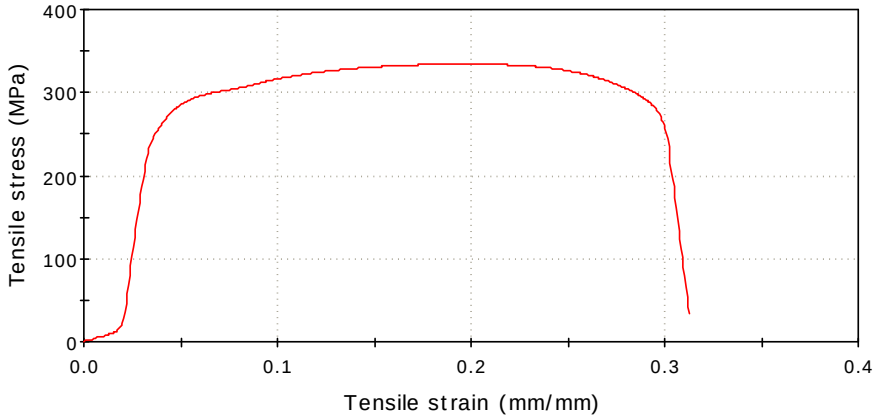

Fig 1.3: Chart of Tensile stress versus tensile strain for outside environment for 180days

2.3 Hardness

For each of the environment where the samples were subjected to, hardness test was carried out. Various readings were taken and the average value was determined. The result is shown in fig 1.4

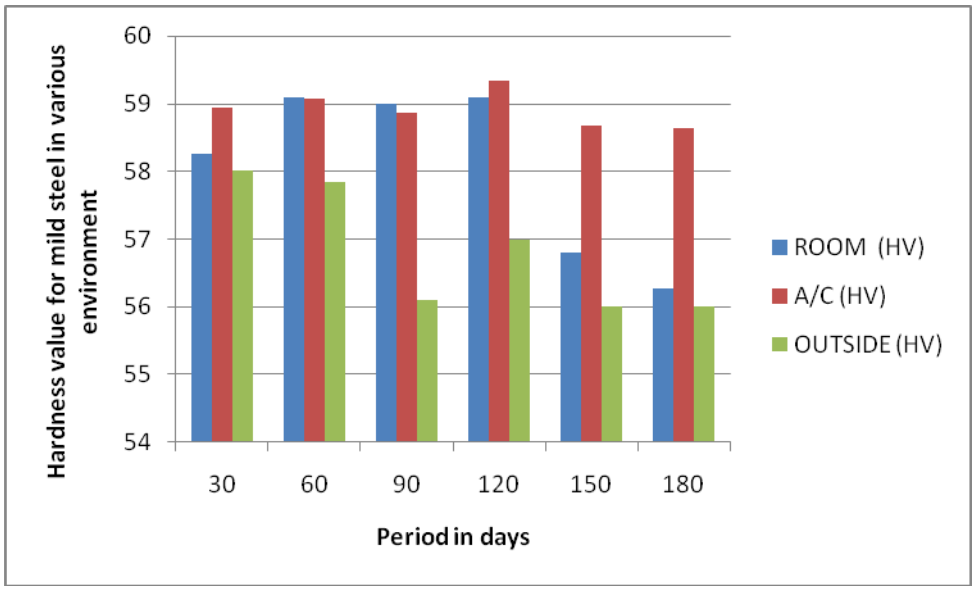

Fig 1.4: Hardness value of mild steel for various environments

Fig1.5: Vicker's Microhardness

3. CONCLUSION

On the strength of the results presented, the following conclusions are drawn; for applications that requires strength, the material should be left in an Air conditioned environment for a period of time before usage as this will give the material the best result for strength. It gave about 171.55571MPa while for hardness; Air conditioned environment had the highest hardness value while outside environment had the least hardness value.

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