# Experimental Investigation and Comparative Study on Properties of 2205 Duplex Stainless Steel, 2507 Super Duplex Stainless Steel, Copper and Tungsten

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***Abstract* — Many materials, when in service, are subjected to various kinds of loads and forces: for instant consider duplex stainless steel which is being used at the hull of marines. In such situations it is necessary to know the characteristics of the material and to design the member from which it is made such that any resulting deformation will not be excessive and fracture will not occur. The mechanical behavior of the material reflects relationship between its response and deformation to its applied load or force. Important mechanical properties are strength hardness and ductility. Hence this paper presents an experimental investigation and comparison on properties of 2205 duplex stainless, 2507 super duplex stainless steel, copper and tungsten as they all have good corrosive resistant characteristics, ductile property and good thermal expansion and electrical conductivity.**

***Keywords*— Duplex stainless steel (DSS), super duplex stainless steel (SDSS), copper, tungsten, mechanical property, ductile, ferrite.**

## I INTRODUCTION

Duplex stainless steel family was introduced commonly about 1920's mainly intended for pulp and paper industry. However the original duplex alloy suffered from brittleness and low ductility. A second generation with improved weld-ability, mainly due to higher addition of nitrogen was developed in the early 1980's. This was the breakthrough for duplex stainless steel and the use and fields of application increased contentiously. The two phase structure of ferrite and austenite combines beneficial effects of the phases and allows the steel to obtain high strength (ferrite) and toughness (austenite) even at low temperature. Thus the material offers good resistance to corrosion due to high Cr, Mo and N additions, and stress corrosive cracking, due to the ferrite content. Other advantages of duplex stainless steel are satisfactory fatigue properties and modest thermal expansion. The phase balance in duplex stainless steel obtained by careful heat treatment is crucial for the mechanical properties. The chloride pitting and crevice corrosion resistance of the duplex stainless steel is a function of chromium, molybdenum and nitrogen content. The hull portion of duplex stainless steel experiences a wide range of temperature difference due to sailing of ship at various parts of globe. As the ship sails through different temperature zones a stress cycle experiences a on the structure due to difference in temperature variation in climatic conditions accelerates the process of corrosion and it may lead to change in property of the steel.

## II. METHODOLOGY

The methodology involves the preparation of specimen of 2205 duplex stainless steel, 2507 super duplex stainless steel, copper and tungsten for various mechanical tests to characterize its hardness, impact test and UTS results as per the standards of ASTME. Also comparative study is also made between 2205 duplex stainless steel, 2507 super duplex stainless steel, copper and tungsten to identify which exhibits mechanical better mechanical properties for applying at hulls of marine.

### *A. Hardness test*

Steels, copper and tungsten falls under the category of soft ferrous, hence in this work it is suitable to select Brinell hardness test for the determination of hardness.

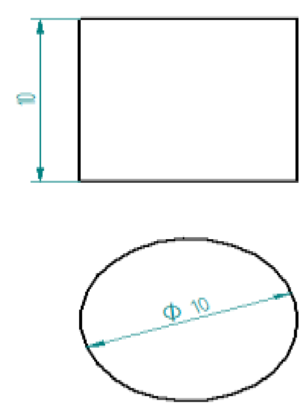


Fig.1. Brinell hardness test specimen specification

*B. Impact test*

The main intention of conducting impact test is to determine the amount of impact energy applied at the hull of marines and study the ability of the material to withstand shock loading due to waves.

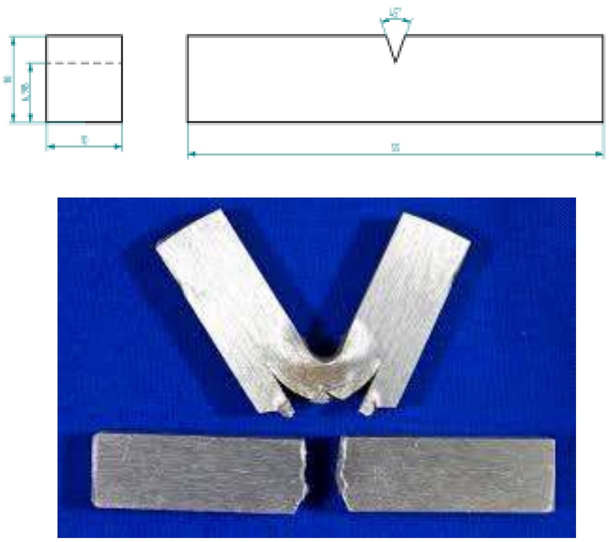

Fig.2. Impact test specimen specification

*C. Tensile test*

Tensile test is used to determine ultimate tensile strength and several other properties such as Youngs modulus, yield strength, proof strength of materials and the test also helps in the study of fracture behaviour of the material.

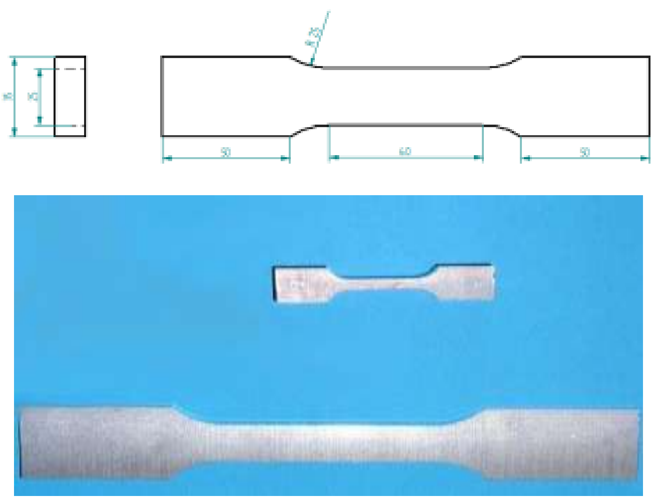

Fig.3. Tensile test specimen specification

## III. RESULTS AND DISCUSSION

The results extracted from the current work on examining the mechanical properties of 2205 duplex stainless steel, 2507 super duplex stainless steel, and copper and tungsten serves as a basic for predicting which of the above material gives better mechanical properties comparatively.

*A. Hardness test result*

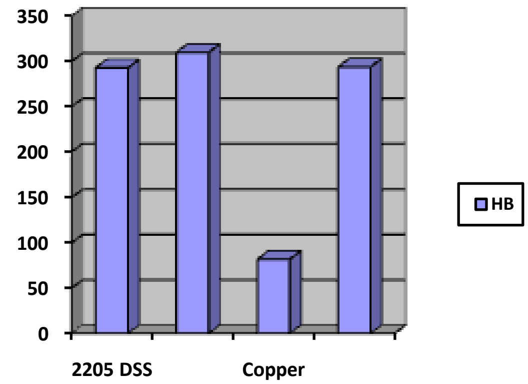


Fig.4. Brinell hardness test result

Brinell hardness test results explains that the ductility in copper is more and thus copper possesses more load bearing capacity before fracture when compared with 2205 duplex stainless steel, 2507 super duplex stainless steel and tungsten.

*B. Impact test result*

From impact test, it is evident that impact toughness of fracture energy for tungsten is higher when compared with 2205 duplex stainless steel, 2507 super duplex stainless steel and tungsten when tested under Charpy scale. It is observed from the above graph that tungsten absorbs more impact energy when compared with 2205 duplex stainless steel, 2507 super duplex stainless steel and copper. Thus it is very much essential for the hulls of marines in order to withstand impact loads due to waves and wind.

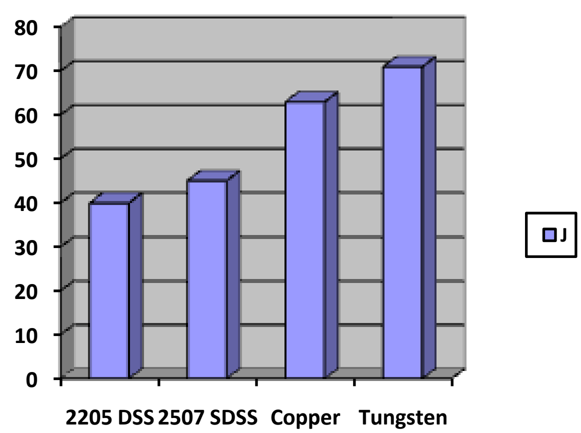


Fig.5. Impact test result

### *C. Tensile test result*

Table 1 Tensile test result

| | Poisson's Ratio | Young's Modulus in Mpa | Yield (or) ultimate strength in Mpa | Tensile strength in Mpa | % of elongation |
|---|---|---|---|---|---|
| **2205 DSS** | 0.3 | $1.9x10^5$ | 448 | 621 | 25 |
| **2507 SDSS** | 0.3 | $2.0x10^5$ | 550 | 795 | 15 |
| **Cu** | 0.34 | $1.17x10^5$ | 69 | 220 | 40 |
| **W** | 0.28 | $40.5x10^5$ | 800 | 172 | 23 |

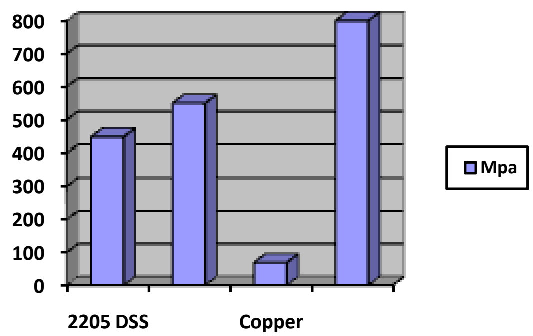


Fig.6: Yield strength test result

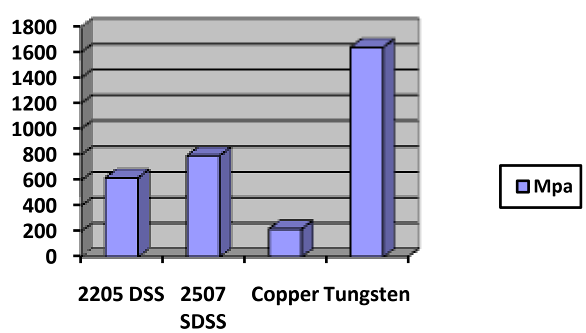


Fig.7: Tensile strength test result

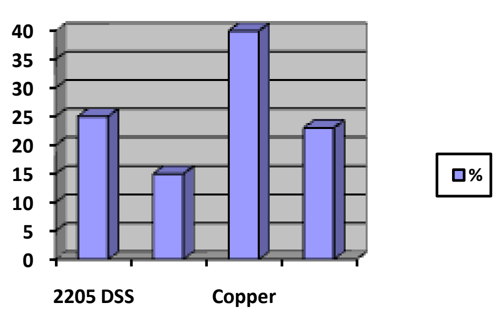


Fig.8. % of elongation

Tensile test revels that the ultimate yield strength of copper is less and it signifies that copper will withstand relatively less load then 2205 duplex stainless steel, 2507 super duplex stainless steel and tungsten. It is also clearly identified that % of elongation for copper is more compared to 2205 duplex stainless steel, 2507 super duplex stainless steel and tungsten.

## IV. CONCLUSION

From the comparative study among, 2205 duplex stainless steel, 2507 super duplex stainless steel, copper and tungsten, they yield the following conclusion:

The result of hardness test revels that, copper gets less hardness value among 2205 duplex stainless steel, 2507 super duplex stainless steel and tungsten and thus copper shows the sign of reduced embrittlement which is desirable in the hull of marines.

Impact test explains that tungsten sustain more load (due to waves) before fracture in comparison with 2205 duplex stainless steel, 2507 super duplex stainless steel and copper due to more toughness.

Tensile test results copper have less ultimate tensile strength and have higher % of elongation among 2205 duplex stainless steel, 2507 super duplex stainless steel and tungsten. The lesser value of ultimate tensile strength proves the loss of embrittlement.

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