

REVIEW ARTICLE



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## EFFECT OF TENSILE TEST & SALT SPRAY TEST ON EN19 & EN8D ALLOY STEEL-A LITERATURE REVIEW

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### ABSTRACT

The present research work is reporting the tensile testing & salt spray testing of EN19 & EN8D material. Applications of EN19 are axles; drive shafts; crankshafts; connecting rods; high tensile bolts; studs; propeller shaft joints; rifle barrels; induction hardened pins; high tensile bolts & studs; connecting rods; gears etc. Applications of EN8D are in the fabrication of crank shafts; axle beams, connecting rods, bolts and nuts, machine components, etc; for engineering units; forging industries and machine component manufactures. The purpose for investigate on these materials is because of the fact that EN19 has following characteristics i.e.a 6% allowance should always be made for removal of surface defects during machining; Machinability good.; Easily Weldable & EN8D has following characteristics i.e.Precise chemical composition; Narrow band of hardness; Dimensional tolerance; Defect-free surface.Due to its wide application it is crucial to study the effect of salt spray test & tensile test on these materials.This paper will focus on tensile test, corrosion resistance.

Keywords - salt spray test, tensile test, corrosion, welding.

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### I INTRODUCTION

EN for steel stands for "Emergency Number" or "European norms" in British standards.This standard was created during the start of Second World War in the year 1939. Before this, steel was designated by their carbon content & some time is called by the name of mill or steel manufacturer. EN-19 & EN8D are grades of steel. These are formally known as alloy steel. These materials have their great importance for industrial purposes.EN19 is oil hardenable chromium molybdenum steel used for gears & high strength shafts etc. with better resistance to shock loads. Available in black round or square bar & bright round, hexagonal bar.EN8D is medium carbon & medium tensile steel.

**I.1-TENSILE TEST**-Tensile tests are experimented for several reasons. The results outcomes from tensile tests are beneficial in selecting materials for engineering applications. Material specifications is important to be known for tensile testing so to ensure quality to the material. For development of new materials, tensile testing is experimented on this material & thus tensile properties are then measured which is then used to compared with the property of different material. Finally, tensile properties are used to predict the behavior of a material under loading. The strength of a material is also a primary concern. The strength of a material is calculated in terms of the stress which the material can bear or withstand. This calculation of strength is used with appropriate caution in the form of safety factors in engineering

design. Materials ductility is important property which dealt with the good performance of tensile testing. Material's ductility is a measure of its elasticity that how much this material can be deformed before getting fracture. Material's ductility is included as an significant material specification to impact quality & toughness. Material's low ductility in a tensile test provide low resistance to fracture under loading which leads to low strength & getting fracture in a less time. An elastic property is of very interest but special techniques are required to measure these properties during tensile testing experimentation.

**I.2-SALT SPRAY TEST**-The salt spray test is a standardized laboratory test method which is used to check corrosion resistance of coated samples. Coating prevent metal from being corroded thus coatings provide corrosion resistance to metallic parts made of steel,brass etc. As we know that high corrosion resistance can be provided to metallic parts by coating so it is necessary to check the resistance offered by the coated material to corrosion by other means so to predict the life of the part in use. Salt spray test is an accelerated laboratory corrosion test which produces a corrosive attack to the coated samples in order to predict or to check its suitability in use as a protective film or finish. The appearance of corrosion products (oxides) is evaluated after a period of time. Duration of the test depends on the corrosion resistance of the coating; the more corrosion resistant the coating is, then the longer the period in testing without showing signs of corrosion.

## II-LITERATURE REVIEW

1 Thiago J. Mesquita et.al (2014) worked on Corrosion and metallurgical investigation of two supermartensitic stainless steels for oil and gas environments. In their work, the corrosion properties of two supermartensitic stainless steels were studied in chloride and H<sub>2</sub>S environments. The two SS grades 1.4542 and 1.4418 heat treatment and their microstructure studied. In H<sub>2</sub>S media, the 1.4418 presented a higher stability and passivation compared to 1.4542. The Electron backscattering and X-ray diffraction were used to characterize the amount of retained austenite in the 1.4418 and then its influence on pitting and SSC resistance investigated.

2 A K Lakshminarayanan et. al(2013) worked on Analysis of Corrosion Prevention Methods in Railway Coaches and Bogies. In their work, they studied about the effect autogenously arc welding processes on tensile and impact properties of ferritic stainless steel conformed to AISI 409M grade. They have used Rolled plates of 4 mm thickness used as the base material for preparing single pass butt welded joints. Evaluation of Tensile and impact properties, micro hardness, microstructure, and fracture surface morphology of continuous current gas tungsten arc welding (CCGTAW), pulsed current gas tungsten arc welding (PCGTAW), and plasma arc welding (PAW) joints are done & results are compared. It is resulted out that the PAW joints of ferritic stainless steel show high tensile and impact properties when compared with CCGTAW and PCGTAW joints which is mainly due to lower heat input, finer fusion zone grain diameter, and higher fusion zone hardness.

3. A K Lakshminarayanan et.al(2009) worked on Effect of Welding Processes on Tensile and Impact Properties, Hardness and Microstructure of AISI 409M Ferritic Stainless Joints Fabricated by Duplex Stainless Steel Filler Metal. In their work, they studied about the effect of welding processes such as shielded metal arc welding, gas metal arc welding and gas tungsten arc welding on tensile and impact properties of the ferritic stainless steel conforming to AISI 409M grade. They have used Rolled plates of 4 mm thickness used as the base material for preparing single pass butt welded joints. Evaluation of Tensile and impact properties, microhardness, microstructure and fracture surface morphology of the welded joints and the results are compared. After result it is found that gas tungsten arc welded joints of ferritic stainless steel have high tensile and impact properties compared to shielded metal arc and gas metal arc welded joints which is mainly due to the presence of finer grains in fusion zone and heat affected zone.

4. A. Heidarzadeh et. al(2012) worked on Tensile behavior of friction stir welded AA 6061-T4 aluminum alloy joints. In their research work, they have studied about surface methodology to develop a mathematical model predicting the tensile properties of friction stir welded AA 6061-T4 aluminum alloy joints. They work with three welding parameters &

are tool rotational speed, welding speed and axial force. Evaluations of the effects of the welding parameters on tensile properties of friction stir welded joints were analyzed. The results showed that the maximum of tensile elongation was obtained at 1300 rev/min, 60 mm/min and 8 kN.

5. S.T. Selvamani, K. Palanikumar (2014) worked on Optimizing the friction welding parameters to attain maximum tensile strength in AISI 1035 grade carbon steel rods. In their research work, they have studied the effect of friction welded 12mm diameter AISI 1035 grade steel rods with an aim to optimize the process parameters. Experiments are prepared to predict the ultimate tensile strength, notch tensile strength, and % of elongation of the welded joints.

6. Jun Yanet. al (2010) worked on Study on microstructure and mechanical properties of 304 stainless steel joints by TIG, laser and laser-TIG hybrid welding. In this research paper they have investigated about the microstructure and mechanical properties of 304 stainless steel joints by tungsten inert gas (TIG) welding, laser welding and laser-TIG hybrid welding, tensile tests were performed and the fracture surfaces were analyzed. It is resulted out that the joint by laser welding had highest tensile strength.

7. M.P. Papadopoulos et. al (2007) worked on Effect of salt spray corrosion exposure on the mechanical performance of different technical class reinforcing steel bars. For experimentation artificial corrosion is done on the tensile specimens of different reinforcing steel bars in laboratory salt spray tests & then the pre-corroded specimens were tensile tested to study the degradation of the mechanical properties of the material with accumulating corrosion damage.

8. P. Sathiyat. al (2008) worked on Some experimental investigations on friction welded stainless steel joints. In this research paper, they have emphasizes on joints of two types of industrially important stainless steels such as austenitic and ferritic stainless steels. In this study of cylindrical specimen of austenitic stainless steel and ferritic stainless steel of similar composition and shape (equal diameter and length) has been done. They have studied about the characteristics such as tensile strength, toughness, hardness across the joint zone

and microstructural aspects exhibited by friction processed joints which were compared to the respective parent materials. Joints done by this method shows better properties when compared to the fusion processed joints.

9. Sare Celik, Ismail Ersozlu (2009) worked on Investigation of the mechanical properties and microstructure of friction welded joints between AISI 4140 and AISI 1050 steels. In their research work, they have done the Joining of dissimilar metals. In their study, joining of two dissimilar metals ie AISI 4140 steel (medium carbon and low alloy steel) and AISI 1050 steel (medium carbon steel) was done. joint strength was tested and optimum welding parameters were obtained. In the end it is resulted out that the highest tensile strength acquired in the welded specimens is 6% higher than parent AISI 1050 steel and the lowest tensile strength resulted out was 1.9% lower than the parent AISI 1050 steel.

10. D. Ananthapadmanaban et. al (2009) investigated on A study of mechanical properties of friction welded mild steel to stainless steel joints. The aim of their work is to study variation of mechanical properties under different friction welding conditions for mild steel stainless steel joints. Report of Yield strength, ultimate tensile strength, percentage elongation of the welded joints and hardness variations across the weld interface have been prepared.

11. Mohsen Hamediet. al (2010) worked on Numerical simulation of tensile strength of upset welded joints with experimental verification. In this research paper, numerical simulation and experimental investigation of Resistance upset welding (UW) process parameters is done. The result out from this numerical simulation is used to study the weldment and therefore evaluate the quality of the weld at the joint. Both numerical and experimental results suggest an optimum set of welding parameters yields a maximum value for the tensile strength of the joint.

12. N. Shanmuga Sundaram, N. Murugan (2010) worked on Tensile behavior of dissimilar friction stir welded joints of aluminium alloys. In their work, they have studied about the tensile behavior of the heat treatable aluminium alloy AA2024. The heat treatable aluminium alloy AA2024 is used extensively in the

aircraft industry because of its high strength to weight ratio and good ductility property. Experimental performance are developed to predict the ultimate tensile strength (UTS) and tensile elongation (TE) of the dissimilar friction stir welded joints of aluminum alloys. Joints fabricated using profile of tapered Hexagon tool pin have the highest tensile strength and tensile elongation, whereas the profile of the Straight Cylinder tool pin have the lowest tensile strength and tensile elongation. The results are beneficial to have a better understanding of the effects of process parameters, to fabricate the joints with desired tensile properties.

13. Shaogang Wang et. al(2011) worked on Characterization of microstructure, mechanical properties and corrosion resistance of dissimilar welded joint between 2205 duplex stainless steel and 16MnR. In their research work, The joint of dissimilar metals is done between 2205 duplex stainless steel and 16MnR low alloy high strength steel are welded by tungsten inert gas arc welding (GTAW) and shielded metal arc welding (SMAW) respectively. It is resulted out that mechanical properties of joints welded by the two kinds of welding technology are satisfied & the corrosion resistance of the weldment produced by GTAW is superior to that by SMAW in chloride solution using salt spray test in laboratory.

14. HeeSeon Bang et. al(2011) worked on A study on mechanical and microstructure characteristics of the STS304L butt joints using hybrid CO<sub>2</sub> laser-gas metal arc welding. In this research work, they have examined the mechanical characteristics of the stainless steel (STS304L) hybrid welded butt joints & two-dimensional thermal elasto-plastic analysis has been carried out. The calculation of the residual stress distribution in weld metal (WM), heat affected zone (HAZ) and base metal (BM) characteristics has been done. After calculation it is resulted out that longitudinal residual stress in the hybrid welded joints is less (13–15%) than that of the Submerged arc welded joints.

15. N. Arivazhagan et. al(2011) worked on Investigation of AISI 304 austenitic stainless steel & AISI 4140 low alloy steel dissimilar joints by gas tungsten arc, electron beam and friction welding. In this research work, they have study the microstructure and mechanical properties of AISI 304

stainless steel and AISI 4140 low alloy steel joints by Gas Tungsten Arc Welding (GTAW), Electron Beam Welding (EBW) and Friction Welding (FRW). Detailed analysis is carried out on each of the weldment, analysis conducted on the phase composition, microstructure characteristics and mechanical properties. At the end analysis resulted out which shows that the joint made by EBW has the highest tensile strength (681 MPa) than the joint made by GTAW (635 MPa) and FRW (494 MPa).

16. Subodh Kumar, A.S. Shahi(2011) worked on Effect of heat input on the microstructure and mechanical properties of gas tungsten arc welded AISI 304 stainless steel joints. In this research work, they have studied about the influence of heat input on the microstructure and mechanical properties of gas tungsten arc welded 304 stainless steel (SS) joints. Their study is to analyze the effect of thermal arc energy on the microstructure and mechanical properties of these joints by making a welding joint using three combinations designated as low heat (2.563 kJ/mm), medium heat (2.784 kJ/mm) and high heat (3.017 kJ/mm) which were subjected to microstructural evaluations and tensile testing. In the end result opted out that joints made using low heat input exhibited higher ultimate tensile strength (UTS) than those welded with medium and high heat input

17. Y. Ruan et. al(2012) worked on Mechanical properties and microstructures of 6082-T6 joint welded by twin wire metal inert gas arc welding with the SiO<sub>2</sub> flux. In their work, they employed twin wire MIG (metal inert gas) welding on 6mm thick 6082-T6 Al-alloy plate partially with SiO<sub>2</sub> activating flux. Study of mechanical properties i.e. micro-hardness & tensile testing is done. The result is evaluated out which shows that the tensile test specimens prepared with and without the flux all showed plastic dimple fracture surfaces, SiO<sub>2</sub> flux did not show any obvious effect on the micro-hardness and strength of the weld joint.

18. Yong Zhao et. al(2014) worked on Defects and tensile properties of 6013 aluminum alloy T-joints by friction stir welding. In their research work, they employed friction stir welding by using different welding parameters on 6013-T4 T-joints. The distribution features and formation mechanisms of defects in T-joints were observed and analyzed & the

investigation on the effect of defects and welding parameters on tensile properties of T-joints was done. The result opted out shows that the T-joint without tunnel defect only can be obtained with the traverse speed of 100mm/min in this experiment.

19. S.X. Liang et. al(2014) worked on Structure and mechanical properties of the annealed TZAV-30 alloy. In their research work, various annealing heat treatments were investigated of Ti-30Zr-5Al-3V (wt.%, TZAV-30) alloy having good mechanical properties is a potential structural material to apply in the aerospace industry. The specimens are annealed from 500 to 800 °C are composed of  $\alpha$  and  $\beta$  two phases. Three microstructural parameters were measured of the annealed specimens ie. thickness of plate  $\alpha$  phase, relative fraction of  $\beta$  phase and aspect ratio of  $\alpha$  grains. As the alloy annealed in the range from 500 to 800 °C, it is resulted out the average thickness of plate  $\alpha$  grains increases with the increasing annealing temperature from 500 to 700 °C but decreases while annealed at 800 °C. It is examined that due to variation of these microstructural parameters it is resulted out that the strength of alloy varies from 1269 to 1355 MPa for tensile strength and from 1101 to 1190 MPa for yield strength, inversely, the elongation changes in the range from 12.7% to 8.4%.

20. P.P. Lean et. al(2003) worked on Dissimilar welds between unreinforced AA6082 and AA6092/SiC/25p composite by pulsed-MIG arc welding using unreinforced filler alloys (Al-5Mg and Al-5Si). In their research work, gas shielded metal arc welding is done with dissimilar welds & then the tensile test is done on the welded specimen. It is resulted out that tensile strengths, for all these welding conditions, were very similar and close to 223MPa.

21. M.P. Papadopoulos et. al(2011) worked on Corrosion of exposed rebars, associated mechanical degradation and correlation with accelerated corrosion tests. In their research work, they have studied about corrosion in a large number of steel reinforced concrete buildings in Greece in which sapling of the cement has left the steel reinforcement (rebars) exposed to the atmosphere. A large number of samples (sections of exposed rebars) were collected from buildings up to 96 years old, and weight loss measurements, tensile testing and

fractographic analysis were carried out. Salt spray testing is carried out on new similar grade rebars in order to establish a correlation with the naturally corroded exposed rebars. It was resulted out that exposed rebars suffer from uniform corrosion followed by degradation of mechanical properties.

22. L.A. Dobrzanski et. al(2007) worked on Corrosion resistance of sintered duplex stainless steels in the salt fog spray test. In this research work, they have studied that the corrosion properties have been studied through salt fog spray test which is applied by the automotive industry end-users. It is resulted out that sintered duplex stainless steels shows good corrosion properties in chloride environment.

23. A.Raveendra, Dr.B.V.R.RaviKumar(2013) worked on Effect of pulsed current on welding characteristics of EN19 alloy steel using gas tungsten arc welding. In this research work, they have studied about destructive and non-destructive properties of weldments EN19 alloy steel using GTAW with non-pulsed current and pulsed current at different frequencies of 2Hz, 4Hz & 6Hz is done. The experimental work is so performed to see the effect of pulsed current on the quality of weldments.

24. Shashikant et. al(2014) worked on Optimization of machine process parameters on material removal rate in EDM for EN19 material using RSM. In this research work, they have studied about the relationships and parametric interactions between the measurable and controllable variables on the material removal rate (MRR) in die sinking EDM of EN19 material. This material is extensively being used for the application in High speed components e.g. gears. For performing of the experiments, four process variables viz. pulse on time, pulse off time, discharge current and gap voltage were considered and electrolytic copper was used as the electrode material. The experimental results were analyzed using Response Surface Model (RSM). From the analysis it is found that pulse off time, discharge current, gap voltage and the interaction terms were significant where as the pulse on time had almost negligible effect towards MRR.

25. Stefano Maggiolino, Chiara Schmid(2008) worked on Corrosion resistance in FSW and in MIG welding techniques of AA6XXX. In this research work, they have done a comparison of the corrosion resistance



of AA6060T5 and AA6082T6 jointed surfaces via Friction Stir Welding (FSW) and Metal Inert Gas (MIG). They put the welded and polished sample acid salt solution. The result opted out that the joint welded via Friction Stir is more resistant than that welded via Metal Inert Gas technique.

26. Ming Gao et. al(2012) worked on Process and joint characterizations of laser–MIG hybrid welding of AZ31 magnesium alloy. They evaluated the mechanical properties of welded joints by tensile tes. It was resulted out that the tensile strength efficiency of welded joints recovered 84–98% of the substrate. It was also found that the arc was compressed and stabilized by the laser beam during the hybrid welding.

**III-CONCLUSION-** The literature survey shows that there was very less work reported on tensile test on EN19 alloy steel material. No work has been done on EN 19 & EN8D material for salt spray test, so this for the first time a work has been reported by me on EN19 & EN8D material for salt spray test .It is very important to conduct test on these materials as they have various applications in engineering fields & thus this test will make aware regarding parameters of tensile test &also gives an experimental view regarding salt spray test for future scope.

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