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A REVIEW PAPER ON COMPARATIVE STUDY OF DISSIMILAR METAL WELDED JOINT USING NICKEL AS BASE MATERIAL

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Abstract: Welding involves the joining of ferrous or nonferrous metals together using application of heat and with or without application of pressure. In present work the joining of nonferrous metals namely Nickel-Copper, Nickel-lead and Nickel-Tin are analyzed using ANSYS 14.0 workbench keeping Nickel as fixed metal to join with the other nonferrous metals like lead and tin which belong to same part family. Furthermore, a comparative study is carried out to see which metal gives the best outcome when joined with same metal in terms of strength and weldability. The modeling and assembly of metals are carried out using CATIA V5R12 software and the same is imported to ANSYS workbench for further analysis. It is being keeping in mind that the boundary conditions for each analysis are kept constant.
Keywords: Dissimilar metal, Welded joint, CATIA, ANSYS.

I. INTRODUCTION

The joining of nickel with copper, lead and tin found its application in various fields according to their use. The nickel with copper is used for the fabrication in piping industry working under sea water as it is corrosion resistant. On the other hand, the nickel and tin together when joint gives the resistance to surface imperfection and when employed to the surface of any metal. It also acts as a reagent which resist the attack of atmospheric contaminants to get dissolve and destroyed the base metal at any means. The nickel lead welding found its application in very few places but as it is having good density when compared with same family of material that is nickel, copper, tin etc. So one will be very curious to know what will be impact of joining this material with nickel and is it feasible to use for construction purpose or not.

II. LITERATURE REVIEW

The weldability of AISI 4140 and AISI 316 by Gas tungsten Arc welding (GTAW) method with and without filler metal. The filler metal used for welding these dissimilar metals was ER309L. and concluded that a proper welds of AISI 4140 and AISI 316 might be obtained by GTA welding method applying with and without filler wire martensite [1].The crack propagation (FCP) behavior within the surface boundary of the dissimilar joint between 6061- T6 aluminum (Al) alloy and kind 304 stainless-steel obtained by a friction stir welding (FSW) technique and concluded that the dissimilar Al/steel FSW joint of that the strength was 194 MPa was made with the welding condition of the rotating speed of 800 rev and also the tool offset of 0.2 mm [2]. The weldability of Bimetallic mixtures of Monel 400 and Hastelloy C276 in the heat applications by Gas tungsten Arc welding technique using ERNiCrMo-3 filler wire and a successful, defect free welds of Monel 400 and Hastelloy C276 is obtained[3]. The weldability, metallurgic and mechanical properties of the dissimilar joints of inconel 625 and AISI 304 dissimilar joints were obtained by gas tungsten arc welding method using ERNiCrMo-3[4]. welding of dissimilar AA2024 and AA6061 aluminum plates of 5mm thickness by friction stir welding (FSW) technique. Optimum method parameters were obtained for joints using applied mathematics approach[5]. The weldability of cast nickel base alloy 625 with cast martensitic 9-11 stainless steel, using electron beam welding (EBW). Similar (A625/A625) and dissimilar joint welding experiments on 50mm thick plates were made [6].

III. METHODOLOGY

Analytical calculation
Calculation for leg size

$$\mathbf{s = t(\cos\theta + \sin\theta)}$$

Where s = Leg size
t = Throat thickness
θ = Angle of plane of maximum sher stress
Shear stress calculation

$$\boldsymbol{\tau = \frac{p(\cos\theta + \sin\theta)}{2s \times l}}$$

Where τ = Shear stress
P = Applied load parallel to weld
l = length of weld

This stress will be maximum when we differentiate the shear stress with respect to angle of plane of maximum shear stress and put it equal to zero.

After calculation it is observed that for shear stress to be maximum $\theta = 45^\circ$
For maximum shear stress so the relation becomes

$$\boldsymbol{\tau_{max} = \frac{1.414P}{2s \times l}}$$

IV. RESULTS AND DISCUSSIONS

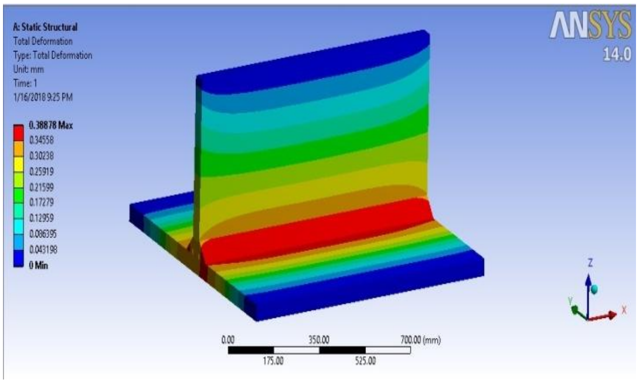

Figure 1 Total deformation occurred in Cu-Ni welding process

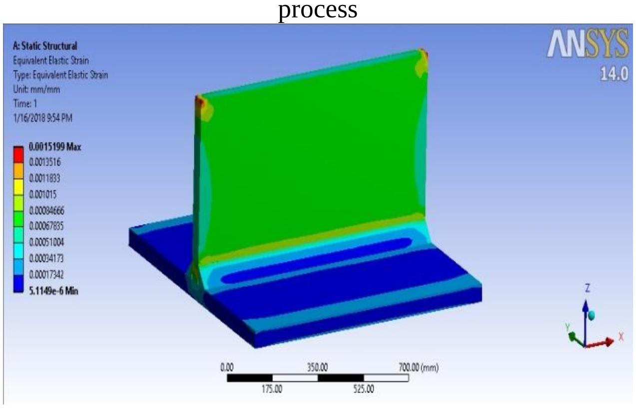

Figure 2 Elastic strains in Cu-Ni T Joint

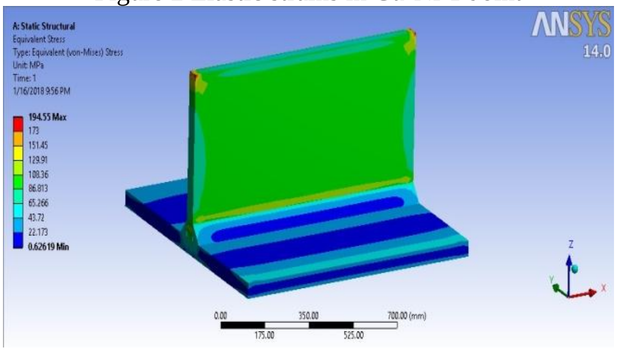

Figure 3 Equivalent Von Mises strain in Cu-Ni welding

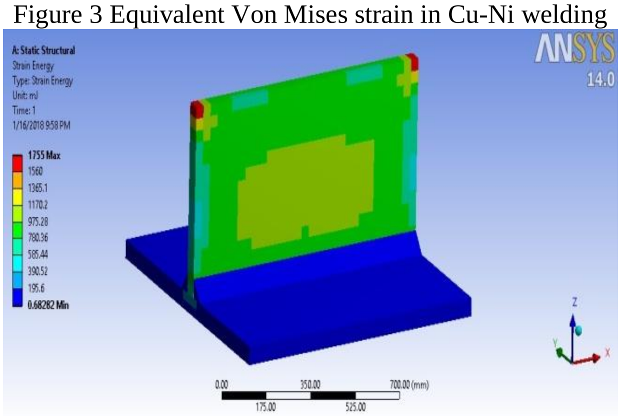

Figure 4 strain Energy in Cu-Ni welding of T Joint

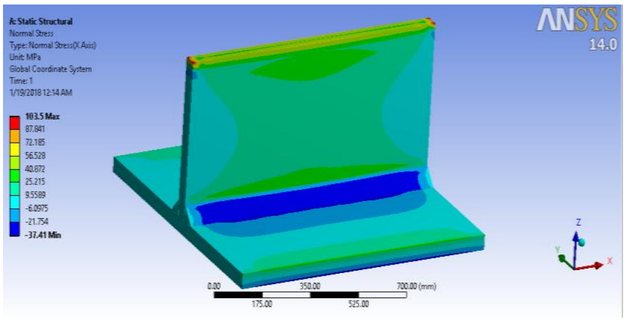

Figure 5 Normal stress in Cu-Ni welding of T Joint

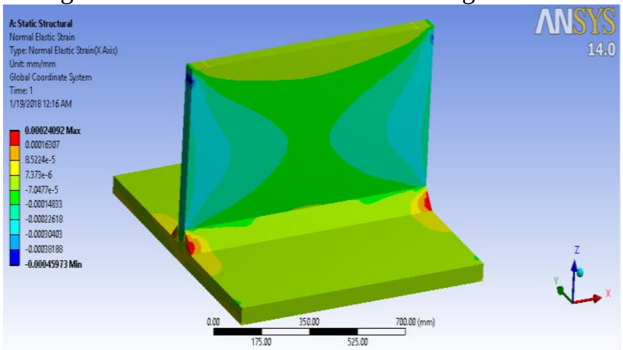

Figure 6 Normal elastic strain in Cu-Ni welding of T Joint

The above figure represents the deformation, elastic strain, von mises strain, strain energy, normal stress and normal elastic strain in Cu-Ni T joint as a result from Ansys workbench.

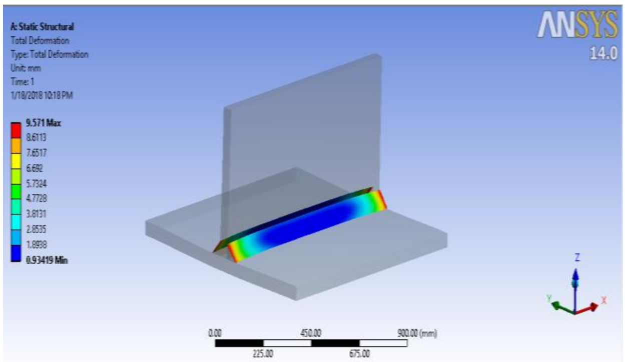

Figure 7 Total deformation occurred in Pb-Ni welding process

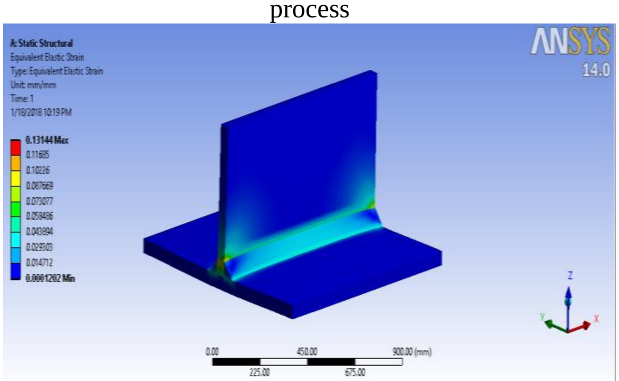

Figure 8 Equivalent Elastic strain in Pb-Ni T Joint

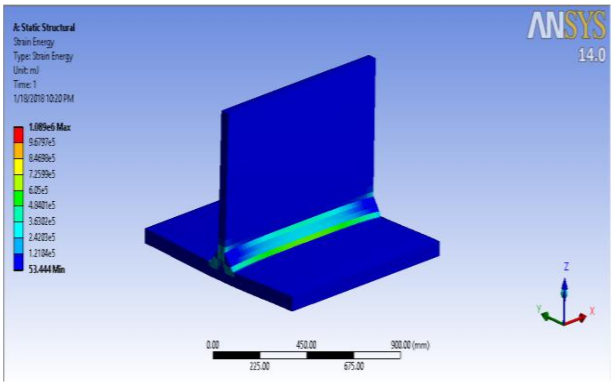

Figure 9 strain energy in Pb-Ni T Joint

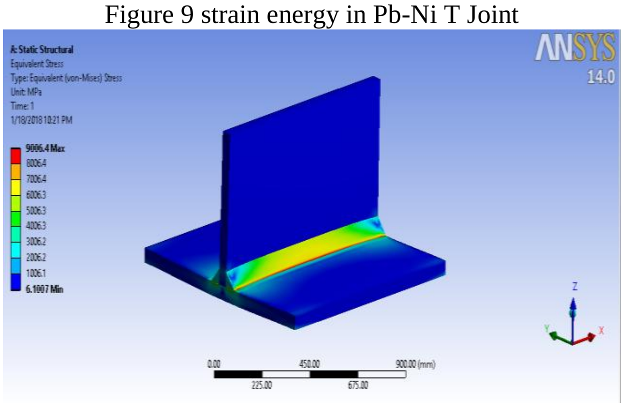

Figure 10 Equivalent von mises stress in Pb-Ni T Joint

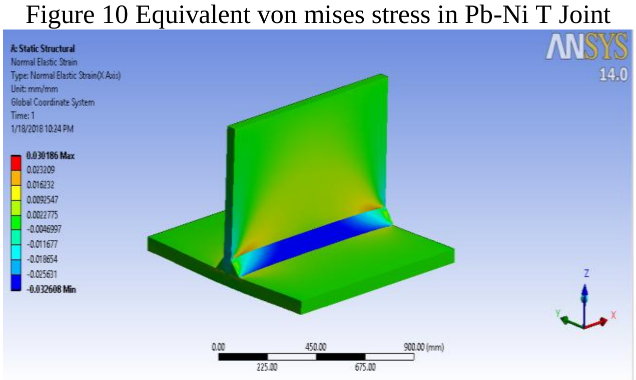

Figure 11 Normal Elastic Strain in Pb-Ni T Joint

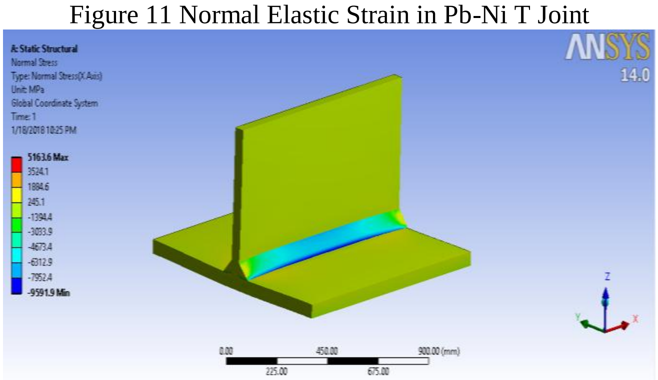

Figure 12 Normal stress in Pb-Ni T Joint

The above figure represents the deformation, elastic strain, von mises strain, strain energy, normal stress and normal elastic strain in Pb-Ni T joint as a result from Ansys workbench.

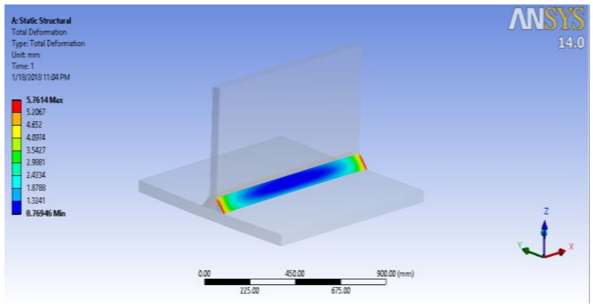

Figure 13 Total deformation in Ni-Sn T Joint

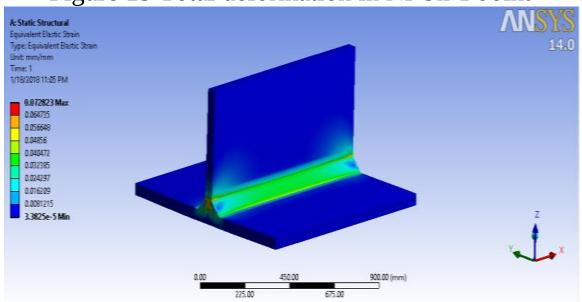

Figure 14 Equivalent elastic strain in Ni-Sn T Joint

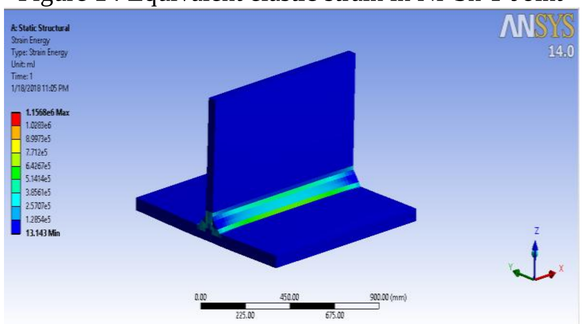

Figure 15 strain energy in Ni-Sn T Joint

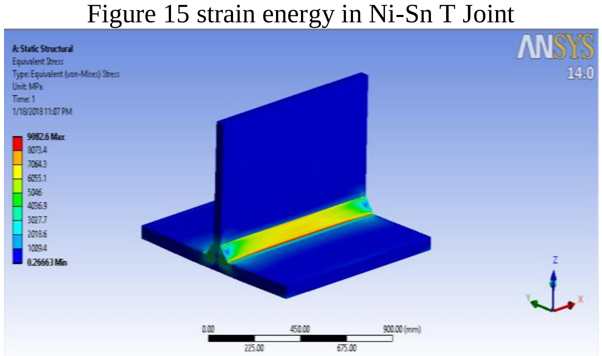

Figure 16 Equivalent stress in Ni-Sn T Joint

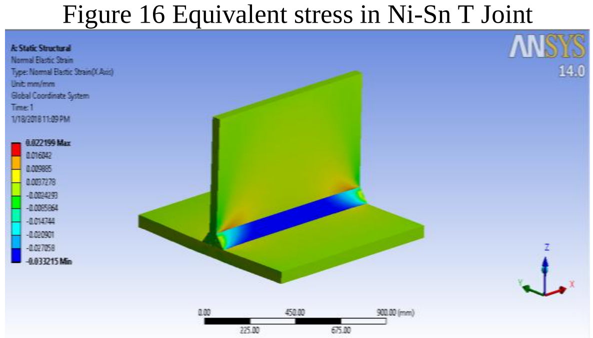

Figure 17 Normal elastic strain in Ni-Sn T Joint

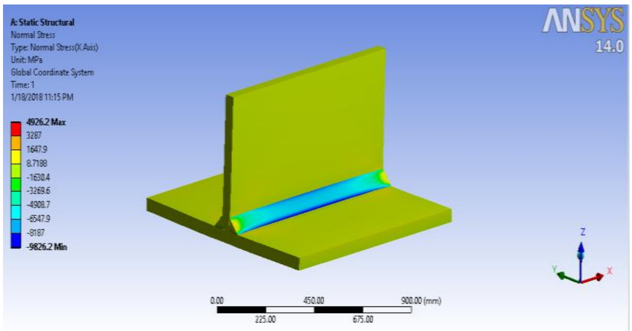

Figure 18 Normal stress in Ni-Sn T Joint

The above figure represents the deformation, elastic strain, von mises strain, strain energy, normal stress and normal elastic strain in Sn-Ni T joint as a result from Ansys workbench.

V. CONCLUSION AND FUTURE SCOPE

Conclusion: Following table represents the values obtained for deformation, elastic strain, von mises strain, strain energy, normal stress and normal elastic strain in T joint from Ansys workbench.

Table 1Result Table

Sr. No.	Parameter	Unit	Cu-Ni Welding	Pb-Ni Welding	Sn-Ni Welding
1	Total Deformation	Mm	0.38878	9.571	5.7614
2	Elastic strains	mm/mm	0.0015199	0.13144	0.072823
3	Von Mises strain	mm/mm	194.55	9006.4	9082.6
4	Normal Stress	Mpa	103.5	5163.6	4926.2
5	Normal Strain	mm/mm	0.00024092	0.030186	0.022199

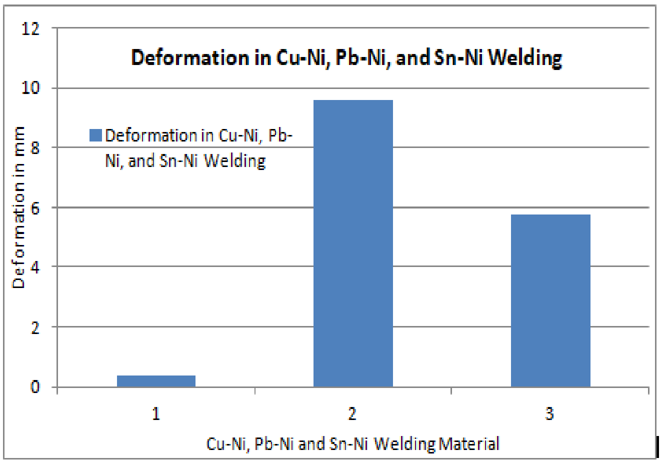

Figure 19 Represents the comparative values of Deformation for Cu-Ni, Pb-Ni and Sn-Ni Material

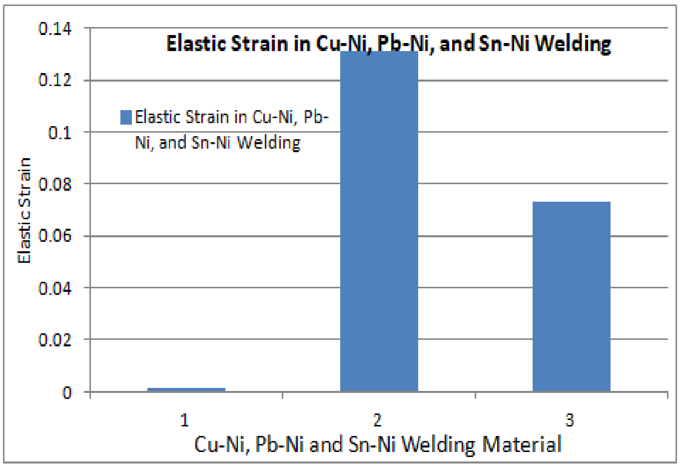

Figure 20 Represents the comparative values of Elastic Strain for Cu-Ni, Pb-Ni and Sn-Ni Material

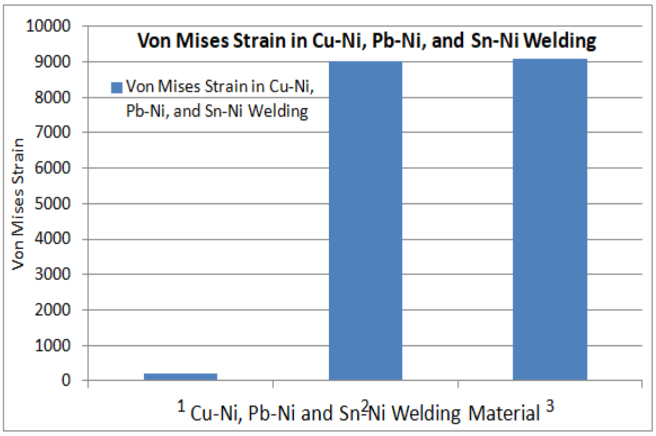

Figure 21 Represents the comparative values of Von Mises Strain for Cu-Ni, Pb-Ni and Sn-Ni Material

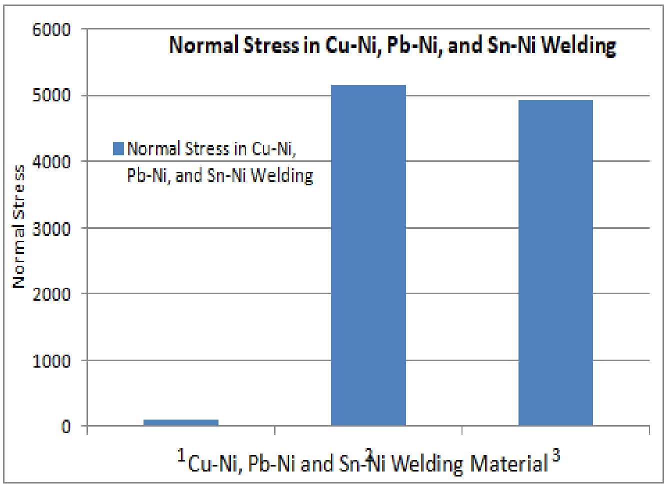

Figure 22 Represents the comparative values of Normal Stress for Cu-Ni, Pb-Ni and Sn-Ni Material

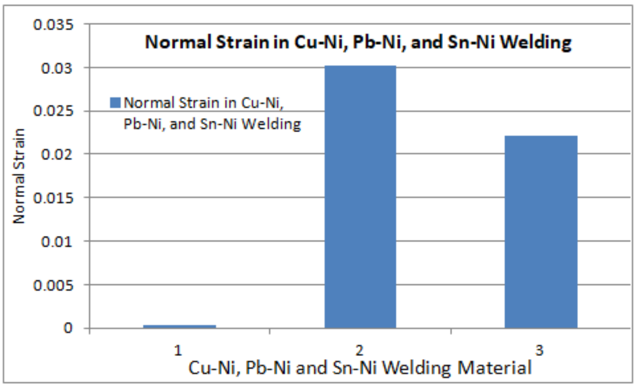

Figure 22 Represents the comparative values of Normal Strain for Cu-Ni, Pb-Ni and Sn-Ni Material

Welding can be performed on any material belongs to same/different family within the working range.

- The base material as well as the filler material plays an important role while doing welding. It can be also seen in the result table.
- A computer aided model of welded joint can be simulated using Ansys software and will best match the results obtained by empirical relations.
- The strength of weld can be predicted by simulation by analyzing the stress or deformation of the different materials at same temperature and boundary conditions.

Future Scope:

- In the present analysis we have used only the combination of materials belonging to same family, it can be extended by using some other type of material from different family to see how they behave when undergo welding.
- In the present analysis the non ferrous materials are tested for welding but the work can be extended by using the combination of ferrous nd non ferrous materials for welding purpose.
- Presently we are not taking pressure along with the heat for welding but in future the pressure may also be considered to analyze such cases.
- Present analysis only focus on T joint welding which is a much simpler welding because it does not require any edge preparation before doing the welding. This work can also be extended to do some kind of welding where in two adjacent plate of same shape and size are to be welded and for that case we should model the geometry such that the filler material penetrate easily to join the materials together.
- The ANSYS analysis software however produces much compatible results but can be validated by doing some kind of experimental set up and then obtaining the areas of maximum deformation in actual working conditions so that the software can be more promptly tested and verified.
- The simulation study can also be made by using some another software's like hypermesh, adam's, solid work etc to see which one is best suited to solve problems associated with welding processes.

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