WELDABILITY PREDICTION ON DIFFERENT MODES USING EXPERIMENTAL ANALYSIS

Mr.Shishir S Deshmukh

Department of Mechanical Engineering, Faculty of Dr.D Y Patil School of Engineering ,University of Pune, India

Dr. V G Arajpure

Department of Mechanical Engineering,Faculty of Bapurao Deshmukh College of Engineering ,University of Nagpur,India

Abstract

Weldability prediction analysis of weld plate is generally indicate the quality of weld .Weld chemical Inhomogenity is a type of failure mode that only occurs in rolled steel products that has been virtually eliminated with controlling weld pool mixture.This paper highlights the prominent factors which effect on weld joint. weldability vary with respect to material ,type of weld & weld design and its application .different types of welding defects effect on weldability , defects are not same for all weld it vary with material . More significant factor are welding process,residual stress & welding distortion some welding processes work better for a given material than others. Even within a certain process the quality of the weld may vary greatly depending on parameters, such as the electrode material, shielding gases, welding speed, and cooling rate.This paper present the analysis to control the poor weldability.

Keywords: weldability,welding defects,residual stress

1. Introduction

Weldability is effected due to residual stress & distortion, different weld defect during metal welding ,weld joint,weld design ,welding techniques & skill of Labour. There are different weld joints

1.Butt joint
2Lap Joint
3.Corner Joint
4. T Joint
5.Edge Joint
Different weld Design used for different Material
1.Fillet weld
2.Grove weld

Material to be weld and Penetration of Material. for brittle material weldability is poor compare to ductile material as well as if the grain size of weld metal should be smaller than parent metal . steel have more hardnability but poor weldability.There is a tradeoff between material strength & weld ability, Austentite stainless steel is more weldable but suffer from cracking & reduce corrosion resistance it distort due to high thermal resistance. Weldability of aluminium is depend upon the chemical composition of alloy. porosity & Cracks propogation were observed in welded specimen.
Copper metal have high conductivity required preheating to counteract heat sinkvTIG or MIG Welding is used for Copper & Alloy Generally poor weldability is occur due to small welding defect .Porosity, oxide inclusion,lack of fusion ,undercut, crack, distortation.different metal have different weldability we need to understand the nature of metal to be weld.

2 .Process Parameter and its effect:

Residual stresses are occur in weld due to removing the external load, after welding

weld metal is hot & metal is cold due to this cold metal stretching away from hot metal and develop a tensile stress, as well as area further away from weld metal generate compressive strength shown in below figure.1.0
Process parameter are the Welding speed, electrode used,Force acts during welding significantly effect on ultimate tensile strength,yield stress,distortion in welding,residual stress stress develop and cracks propogation which are cause failure due to variation in mechanical properties and get poor weldability.Process parameter differ for various process .

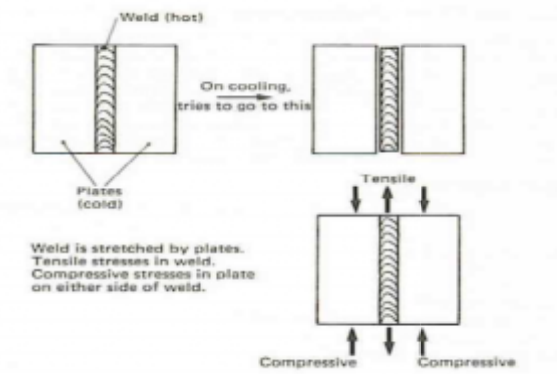


Figure 1.0

During welding its temperature & stresses is changing it effect on different zone of weld,the temperature changes effect on stresses induced it vary in every zone which is shown in figure.1.1
Initially Zero temp & stress distribution at A –A
Secondly Small compression in weld Zone & small tension in base metal at B-B during melting of base metal
Develping the tensile stress in the weld center and compression in the area further away at C –C

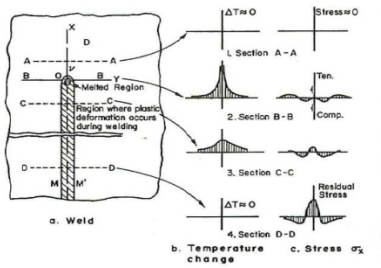


Fig 1.1. Weld Distribution

Further Contraction of Weld metal producing higher tensile stress in the weld center & Compressive in the base metal at D-D
In a Certain Patten weld distribution in weldment(Longitidinal) happen
Residual stress distribution across the weld shows the tensile in the weld metal and the adjacent base metal and then goes
compressive in the area further away from the weld metal.but resudial tensile stress is not desirable,which can cause problem such as hydrogen induced cracking and stress corrosion cracking shown in fig 1.2.

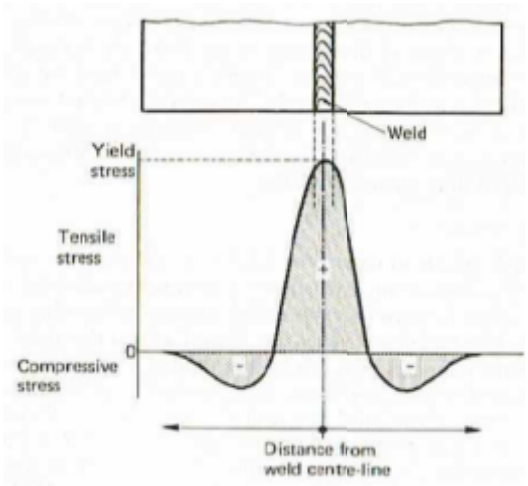


Figure 1.2: Stress development

To avoid residual stress post weld often heat treatment is used.temp effect with reference to time on stress to relief as the temp increase initial stress relief is also increase it is shown in fig 1.3

From the below figure 1.4 it is clear as the stress relieving temperature increases the the initial stress relief is also increase depends upon the duration.different graph shows with respect to duration after 6 hrs 100% stress is relief from weld.

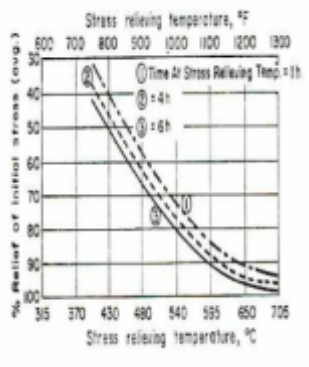
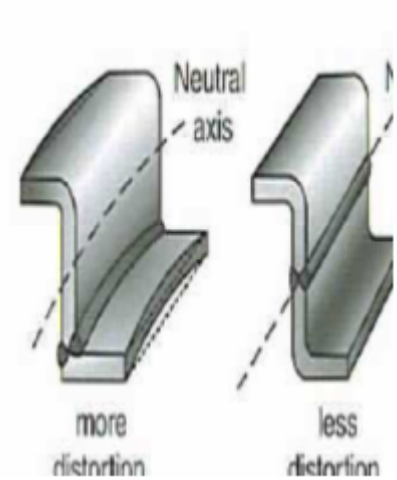


Figure 1.3. Stress relief Temperature with respect to time

2.1 Analysis of welding distortion:

Another defect effect on weldability is distortion is due to solidification shrinkage & thermal Contraction of the weld metal during welding.Upward angular distortion in weld usually occur top of the workpiece.the weld tends to wider at the top than the bottom cause more solidification shrinkage & thermal Contraction shown in fig 5

Angular distortion can be removed by several techniques



Reducing volume of weld metal

Using double V joint & alternate welding Placing weld around neutral axis

Controlling weld distortion

Figure 1.4.Placing weld around neutral axis

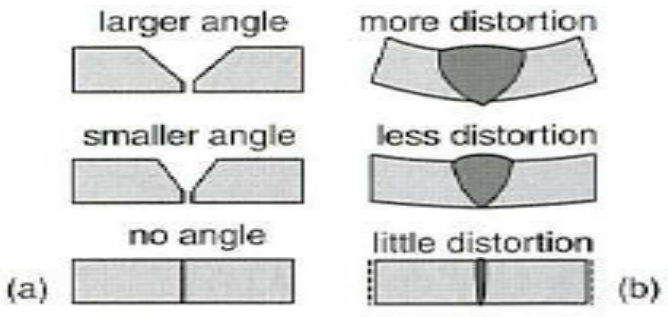


Figure1.5 Weld Distortion

Reducing volume of weld metal and

By using single-pass deep

Penetration welding

Balancing the angular weld distortion on other side of the double side V Joint

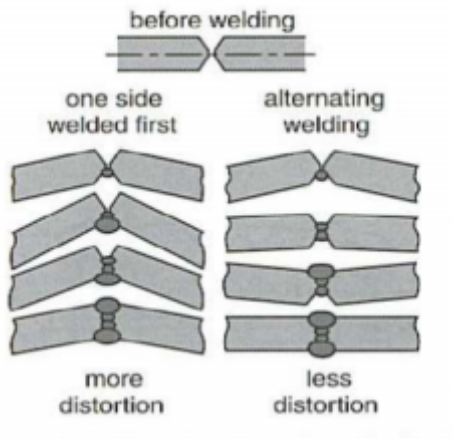


Fig 1.6. Using double-V joint and weld on either side

Using double-V joint and weld
alternately on either side of joint shown in Fig 1.6

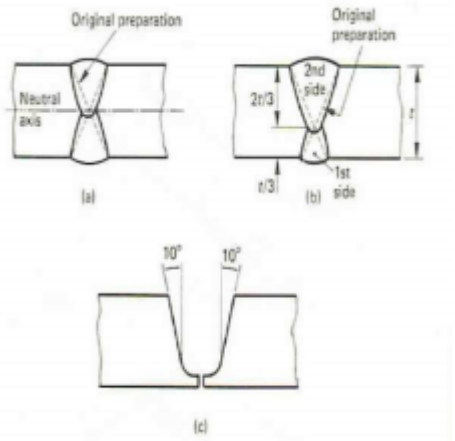


Figure 1.7. Double V Joint

Double V Joint balance the Shrinkage almost same amount of contraction in each side.
Asymmetric double V Joint – first weld almost produce more angular distortion – Second side is larger to pull back the distortion when the first weld is made.shown in fig 1.7
A single U joint gives a uniform weld with the section shown in Fig 1.8

1.3 Method for controlling angular weld distortion:

1.Presetting: By compensating the amount of distortion to occur in welding.
2.Elastic Pre Springing: Can remove angular changes after restraint is removed
3.Preheating & Post welding Technique.

1.3.1 Longitudinal Distortion:

Heating & Cooling Cycle along the Joint during welding built up a cumulative effect of longitudinal bowing.Remedies for this is to welding short length on a planned or random distribution are used to control this problems by use of mechanical methods strengthening press jacks ,clamps etc another one is a thermal method local heating to remove stresses but cannot be used for high conductive metal such as Al & Cu.

1.4.Weld Metal Chemical Inhomogenity Analysis

1.4.1.MICRO SEGREGATION
1.4.2.MACRO SEGREGATION
1.4.3.BANDING
1.4.4.INCLUSION AND GAS POROSITY

Micro segregation is due to lack of solid stage diffusion might cause micro segregation in weldments.Solid stage diffusion in a more closely packed FCC structure is more difficult than more open BCC structure Banding Occurs due to fluctuation in welding speed & Power output Inclusion & Gas Porosity produce slag metal& gas metal reaction Incomplete slag removal in multipass welding can cause slag inclusion trapped within the weld.Macro Segregation is occur specially of dissimilar metal or if the weld pool mixture is incomplete in a single pass welding & even multipass welding.

2. Analysis of Weld Cracking

There are various types of weld cracking

2.1 Solidification of weld Cracking

It occurs at the terminal stage of solidification due to Contraction of solidifying metal & thermal Contraction
Solidification cracking is intensified if the base metal is attached on to the non moving parts(building up tensile stress).less ductile metal weld metal is more likely solidification occurs
The different factors affecting solidification Cracking.
1.Grain Structure
2.Contraction Stresses
3.Restraining
Course Columnar Grain are more susceptible to solidification cracking than equiaxed grains.
Contraction stresses can due to thermal contraction, Solidification shrinkage as well as restraining the weldment is restrain after the first weld causing solidification cracking in the second weld in T Joints.

2.1.1 Remedies for Solidification Cracking

1.Controlling Composition of the metal to be weld
2.Using filler metal with proper Composition
3.Controlling Mn & S Contain in Carbon & Low alloy steel.
4.Controlling Solidification Structure: grain refining, arc Oscillation, Arc Pulsation.
1.Controlling weld geometry: Concave fillet weld suffer higher tensile stress on the face than the convex fillet weld,deep weld is more susceptible to solidification cracking.

Hydrogen Cracking occurs when hydrogen in weld metal: Source---moisture from metal surface, tool atmosphere ,flux.high stresses

2.1.2 Remedies for Cold Cracking.

Controlling welding parameter: Proper preheat & interpass temp
Post weld treatment: stress relief
Use Proper welding processes & Material(Low strength filler material)
Laminar tearing are occurring when tensile stress occurs on fiber structure causing de cohesion of non metallic inclusion

3.0 CONCLUSION:

Welding residual stress & distortion has been Analysis by different experimental techniques. the Phenomenon are clarified from the aspects weld

ability effect and following conclusion has been drawn.

1.The residual stress and distortion directly effect the weld ability of the welding joint which can be control by Post weld heat treatment process

2.Weldability can be measure on the basis of weld cracking. Weld cracking is likely to be more in ductile material due to solidification occurs.

3.More significant factors are welding process such as electrode material ,Welding speed, Cooling Speed effect the Quality of weld.

4.Distortion can be avoided by controlling the Solidification shrinkage & thermal Contraction

5.Weld metal Chemical Inhomogenity reduces the strength of welding joint.

6.It is shown that welding joint strength can accurately control by the compiling the data for using different welding method & Process Parameter in order reduce the defects & distortion during the process effects on strength of joint.

4. 0 REFERENCES

[1] Madureira, Luísa and Melo, Francisco (2004)"Stress Analysis of Curved Pipes with Hybrid Formulation", *Int Jour Pressure Vessels & Piping* 81:3

[2] Madureira, Luísa and Melo, Francisco (2000) "Ahybrid formulation in the stress analysis of curved pipes", *Engineering Computations* 17:8 pp 970-980

[3] Millard, A., Roche, R. (1984), "Elementary Solutions for the Propagation of Ovalization along Straight Pipes and Elbows", *Int. Journ of Press. Vessels & Piping*, Vol. 16 No 1, pp 101-129.

[4] Viswanatha, Bhate and Kushaha, (1997) "*Stressintensity factors for elbows with axial surface crack at crown*", Trans. SMiRT 14th, *International Conference in Structural Mechanics in Reactor Technology*, Lyon, France, 17-22 August, paper G06-5

[5] Oliveira, Melo, Castro, (1991) "The elastic analysis of arbitrary thin shells having part-through cracks, using the integrated line spring and the semiloof shell elements" *Engineering Fracture Mechanics*, Vol. 39, Nº 6, pp 1027-1035

[6] Carpinteri, Andrea; Brighenti, Roberto and Spagnoli, Andrea (1998) "*Part-through cracks in pipes under cyclic bending*", Nuclear Engineering and Design 185 pp 1-10

[7] Gonçalves, J P M and Castro, P M T (1999). Application of the line spring model to some complex geometries and comparison with three-dimensional results. Int. Journ. of Pressure Vessels & Piping. vol76:8