Analysis of Welding Joints and Processes

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ABSTRACT
A welding joint is a point or edge where two or more pieces of metal or plastic are joined together. They are formed by welding two or more work pieces (metal or plastic) according to a particular geometry. The strengths of these joints are of great concern as in today's world these joints find a very crucial place in growths of structures and machine parts and it is the strength of such joints and welding which decides the service life of such structures and thus prevent from loss whether be it human loss, economic loss or the any such losses. In this paper we have taken few special and most commonly joints which is used by the industry and dealt with their microscopic and macroscopic behaviour when subjected to certain general types of loading.

Keywords
Welding joint, Strength, Arc Welding, Bending Moment of welding joint, Deflection, Universal testing machine

1. INTRODUCTION
Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence generated by with or without pressure and with or without temperature.

This is frequently done by melting the work pieces and adding a filler material to form a loch of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which contain melting a lower melting-point material between the work pieces to form a bond between them, without melting the work pieces.

2. LITERATURE REVIEW
As the world has progressed a lot of work has been done in this area and today we have number of processes which are efficient enough to do this job. They are:-

2.1 GMAW or Gas Metal Arc Welding
GMAW or Gas Metal Arc Welding more commonly called MIG or Metal Inert Gas welding or (MAG or Metal Active Arc welding). This welding type is the best method for welding which is widely used for industry and home use. The GMAW process is suitable for fusing mild steel, stainless-steel as well as aluminium. In GMAW an electric arc form between a consumable wire (carbon coated mild steel) and the work piece material.

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2.2 Arc Welding or SMAW
Arc welding is the method in which we weld metals by using the heat generated by an electric arc. There are mainly two types of arc welding-

1) Consumable Electrode methods- A.C. Arc Welding, D.C. Arc Welding, GMAW or MIG Welding etc.
2) Non-Consumable Electrode methods- GTAW or TIG welding

2.3 Gas or Oxy Acetylene Welding and Cutting
This welding process is not generally preferred for welding of mild steel. Oxy acetylene welding is widely used for welding of metals having thickness range of 1/64" to 3/16". Oxy Acetylene Cutting is used for cutting of metals having thickness range of. There are many components that make up the Oxy-Acetylene outfit such as cylinders, regulators, hoses etc. Consists of mixing for oxygen and acetylene gas cylinder to create a flame capable of melting steels.. The most accessible of thermal cutting gear is by oxy-acetylene gas cutting and plasma cutting machines.

Similarly there are various types of joints to be welded which can be one of the following:-

Butt joint, Lap joint, Tee joint, edge joint, corner joint etc.

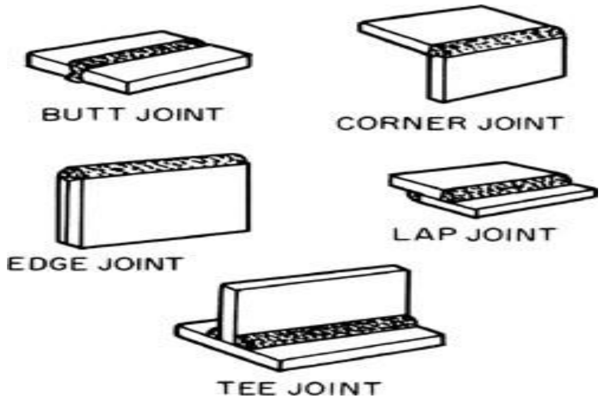


Fig 1: Different types of welded joints

Now, we have various combinations of welding process and welding joints i.e. how to select a particular welding process for a specific type of joint as we need to get best of the strengths which can be obtained for a particular process.

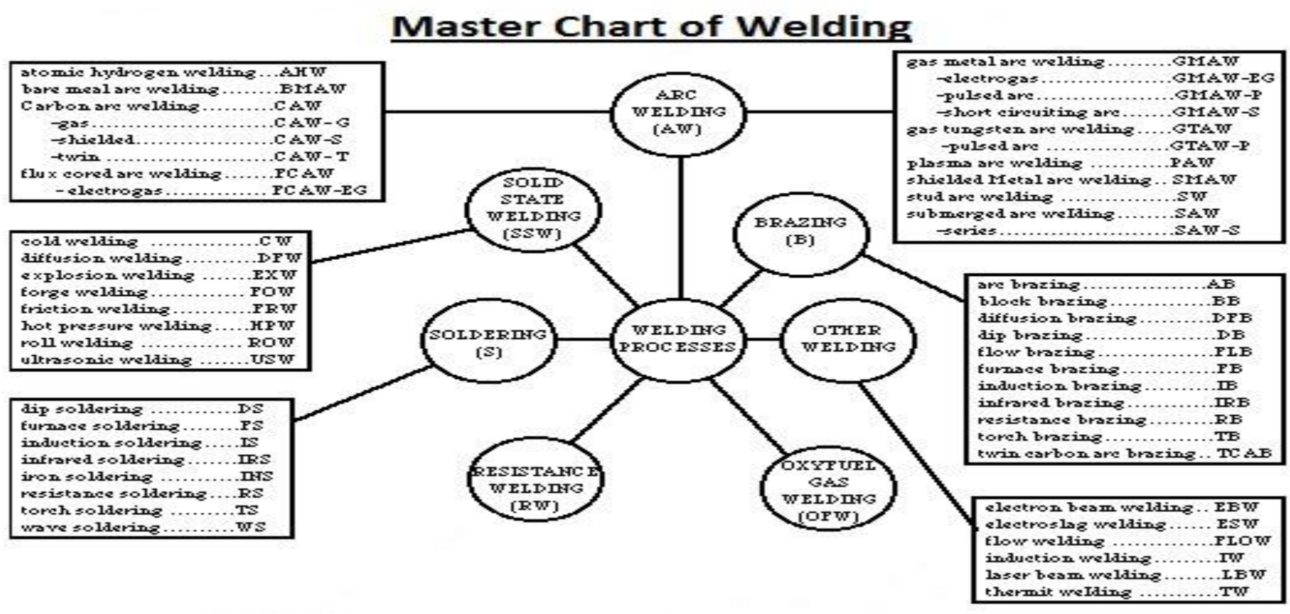


Fig 2: Master chart of welding and allied processes

3. EXPERIMENT DESIGN

In this paper we have taken three welding joints and welded them by three processes and then we have obtained its microscopic structure with the help of a metallurgical microscope and then have tested it on UTM machine so as to obtain its strength. Then we have plotted the strengths on the graph so as to suggest the best welding process for a particular joint.

3.1 Welding joints considered:-

- Butt joint
- Lap joint
- Tee joint

3.2 Material Used: - low carbon steel/mild steel/M.S.

3.3 Welding processes considered:-

- DC arc welding
- AC arc welding
- MIG welding

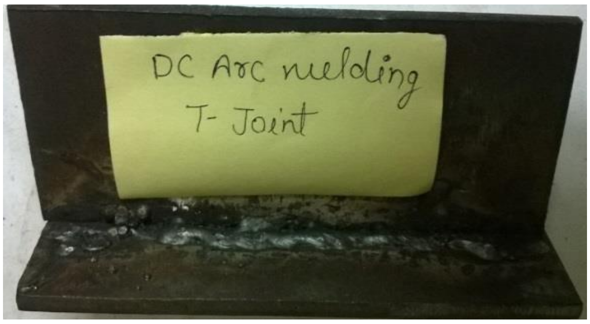


Fig 3: Welded joints considered for experiment

4. RESULTS AND DISCUSSIONS

Each of the welded joints was put under metallurgical microscope and the welded. Portion was examined for change in actual structure of the material.

A. Ideal structure of MS (MILD STEEL)

This is the microstructure of high carbon steel, also known as mild steel. It contains about 0.1% C by weight, alloyed with iron. The steel has two major constituents, which are ferrite and pearlite. The light colored region of the microstructure is the ferrite. The grain boundaries between the ferrite grains can be seen quite clearly. The dark regions are the pearlite. It is made up from a fine mixture of ferrite and iron carbide, which can be seen as a "wormy" texture. You can also see small spots within the ferrite grains. These are inclusions or impurities such as oxides and sulphides. The properties of the steel depend upon the microstructure. Decreasing the size of the grains and decreasing the amount of pearlite improves the strength, ductility and the toughness of the steel. The inclusions can also affect the toughness. For example, they can encourage ductile fracture. Mild steel is a very versatile and useful material.

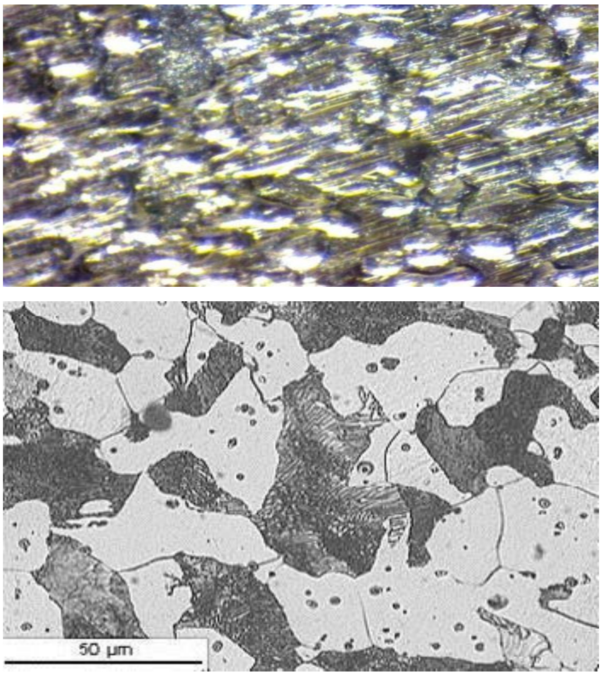
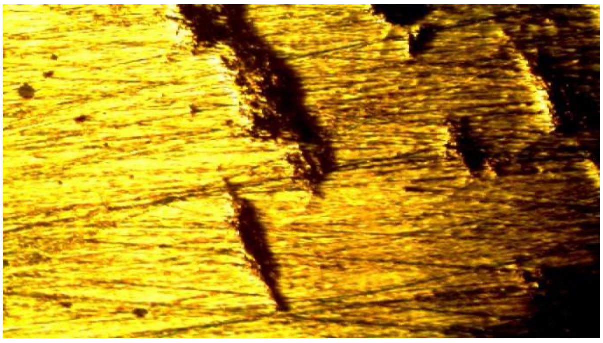
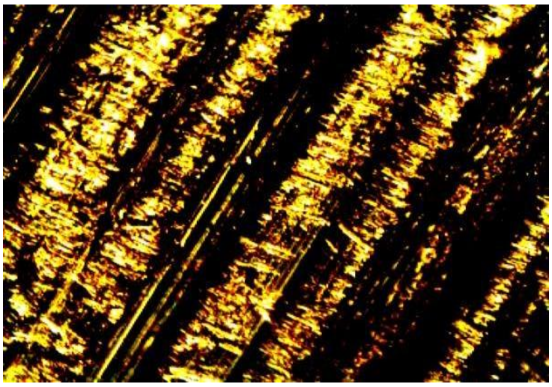


Fig 4: Ideal structure of MILD STEEL

It can be machined and worked into complex shapes, has low cost and good mechanical properties.



(a)



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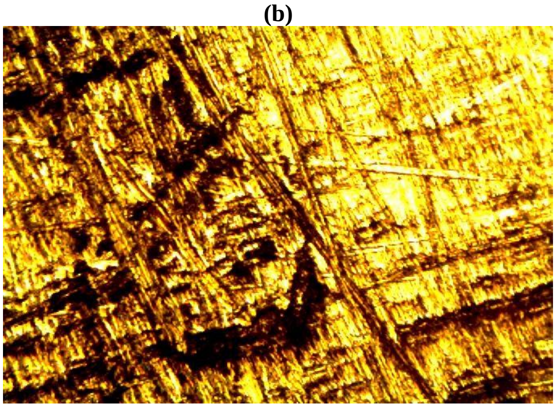

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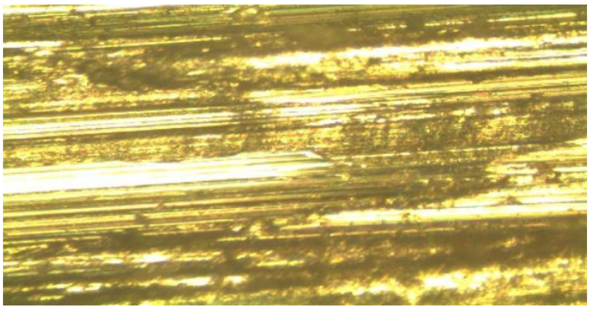

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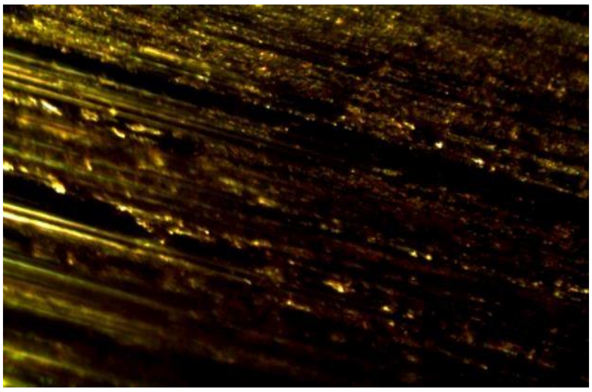

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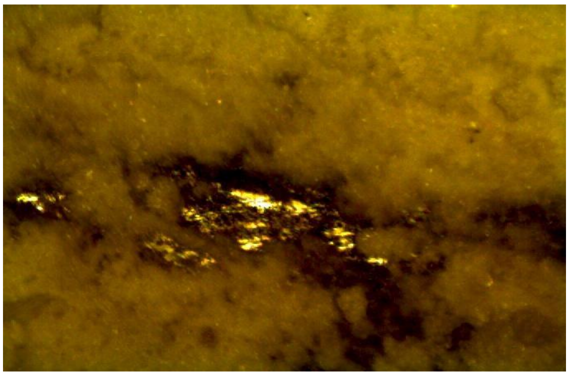


(f)

Fig 4: Microscopic structures of different types of welded joints (a) Butt joint through BC Arc welding process (b) Butt joint through AC Arc welding process (c) Butt joint through MIG welding process (d) Lap joint through AC Arc welding process (e) Lap joint through DC Arc welding (f) Lap joint through MIG welding process

Table 1. Points to be noted among obtained results from Figures 5

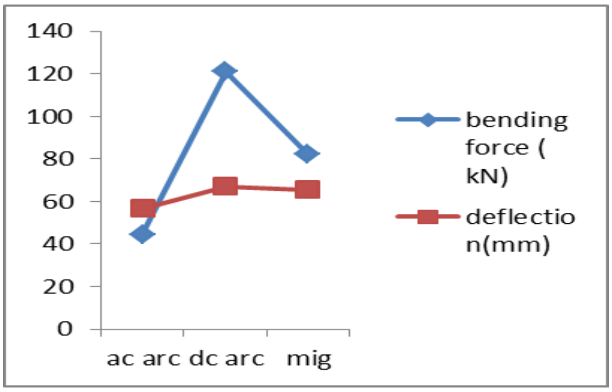
TYPE OF JOINTS	**WELDING PROCESSES**	**DETAILS FOUND IN OBTAINED STRUCTURES**	**REMARKS**
BUTT	AC ARC	Ferrite and pearlite are in equal distribution grain boundaries are arranged parallel to each other	Balanced strength i.e. b/w maxima and minima strength of possible strengths Intermediate ductility
BUTT	DC ARC	Very less Pearlite structure	High ductility

		Mostly consist of ferrite structure, Expansion of grain boundary	Low strength
BUTT	MIG	Pearlite structure in excess grain boundaries are moderate fine surface	High ductility Moderate strength
LAP	AC ARC	Pearlite structure in excess fine surface Grain boundaries are small	High ductility High strength
LAP	DC ARC	Ferrite structure in excess Mixed alignment of grain boundaries (parallel + perpendicular + criss cross)	Low ductility Strain raisers in excess Highly stained structure
LAP	MIG	Not clearly observable but perlite structure seems to be more dominant	High ductility High strength

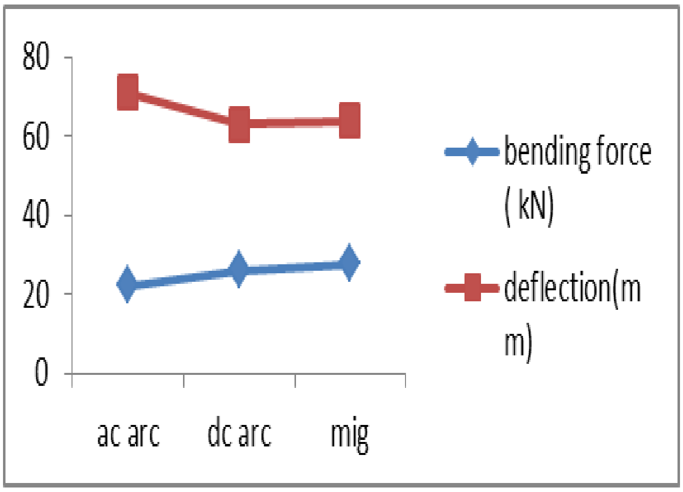
B. **Bending test of welding joints**
Each joint was subjected to bending test in UTM and following result was observable:-

Table 2. Bending moment experimental data

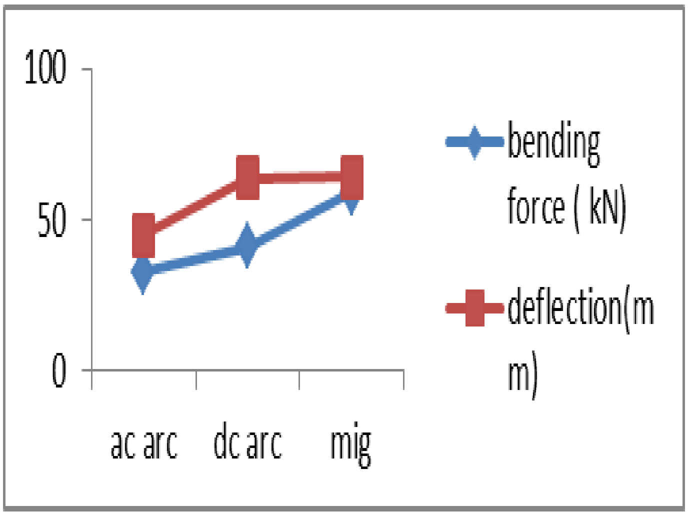
JOINT	WELDING PROCESS	BENDING FORCE (KN)	DEFLECTION(below origin)/(-)ve/(mm)
LAP	AC ARC	44.5	56.80
LAP	DC ARC	121	67
LAP	MIG	82	65.5
BUTT	AC ARC	22.2	70.97
BUTT	DC ARC	25.9	63.08
BUTT	MIG	27.7	63.75
Tee	AC ARC	32.8	44.8
Tee	DC ARC	41.2	63.73
Tee	MIG	58.9	64.23



Graph 1: of lap joint:-welding process vs bending force vs deflection



Graph 2: of butt joint:-welding process vs bending force vs deflection



Graph 3: of T joint:-welding process vs bending force vs deflection

5. CONCLUSIONS

In present era it is necessary to build or create such type of joints which are heavy duty and durable for a long period of time so that prevent from any type of tragedy and to get maximum possible strength.

Now in days it is very hard to choose a right one method for welding of metals. So we have done number of experiment for welding strength of mild steel to get the right one method for different type of joints. As shown in the Table 1 we have discussed about the microstructural effect of various welding processes on different welded joints. In table 2 we have discuss about the bending moment data of different welded joints.

So by careful observation of the above results shows that when a welding process is to be selected while welding following combinations would yield the best result:-

LAP JOINT - DC ARC WELDING

BUTT JOINT - MIG WELDING

T-JOINT - MIG WELDING

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7. REFERENCES

[1] Khanna, O. P. A textbook of Welding process (Dhanpat Rai Publications)

[2] Welding Complete: Technique, Projects Plans & Instructions by Editors of CPI

[3] Jeffus, Larry. (7th Edition) Welding: Principles and Applications

[4] Brumbaugh, James E. and Miller, Rex Audel. Welding Pocket Reference

[5] Galvery Jr., William L. and Marlow, Frank B. Welding Essentials

[6] Proctor, Thomas E. and Gosse, Jonathan F. Print reading for Welders

[7] http://www.weldingtypes.net/

[8] http://www.deecometals.com/wire-welding-products/welding-rod

[9] https://sites.google.com/site/l3mip2015/04-pass-assignments/02-2014

[10] http://weldingteacher.com/WelderTrainandCertMa%232E33E8.htm