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Plate Cutting Error in Fabrication Shop & their Remedial Measure with Industrial Case Study

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Abstract— in this current scenario of industrialization, a fabrication shop plays vital role for any manufacturing industry. The initial steps involved in any fabrication shop are based on cutting of plate. For that modern manufacturing industries use's CNC oxy-fuel/plasma arc cutting machine. But these machines require high skills for their effective use and to be free from errors. In modern fabrication shops production process must adopt an advanced cutting system and proper cutting parameters. In this paper an investigation of the various causes and their remedial measures are discussed so as to increase productivity and elimination of rework in plate cutting, hence improving the profit margins and reducing the number of errors occurring during cutting process.

Index Terms— Error, Productivity, Quality, Plate, Fabrication

1 Introduction

Physically all fabrication shops require plate cutting as initial starting stage of fabrication process. The cutting method in all fabrication shops is based on two ways either they use manual gas/plasma cutting machines or can use CNC oxyfuel/plasma cutting machine. In today's modern fabrication shop they generally use CNC machines for plate cutting because these machines save their production time as well as reduce the cost of plate cutting. Today, there are many methods of cutting, but the mostwidely used in the industry is oxyfuel and plasma cutting. Oxyfuel flame cutting allows operator thermally cut very thick steel plate's upto 350mm. Oxyfuel has the lowest capital investment and can be a good choice if parts to be cut are few in number. Oxyfuel cutter cuts only low carbon and low alloy steel (i.e. E350/250). Plasma arc cutter can cut almost all known materials (i.e. A516 GR 70). A limitation in thickness for which a plasma cutter can cut is up to 25mm thickness plate but provides highest cutting speeds which increase the cutting efficiency.

Fig. 1- CNC oxyfuel/plasma cutting machines

2 Objective

- Minimization of errors occurred during plate cutting.
- Minimization of rework in plate cutting.
- Maintaining uncertainty of machine breakdown due to wrong technique and parameters used in cutting of plate.
- Ensure Continuous Improvement.

3 Methodology

Cause and Effect diagram is a powerful tool that aids in determining the control factors on quality output. The data was analyzed using Ishikawa Cause and Effect Diagram.

In this case study continuous observations of CNC oxyfuel/plasma cutting machine were taken for two weeks with previous data regarding plate wastage. After a rigorous discussion with all operators of particular machine and their in-charge. We finally found many errors were generated during cutting of mild steel plate of grade E350/250 with thickness from 8mm to 80 mm.

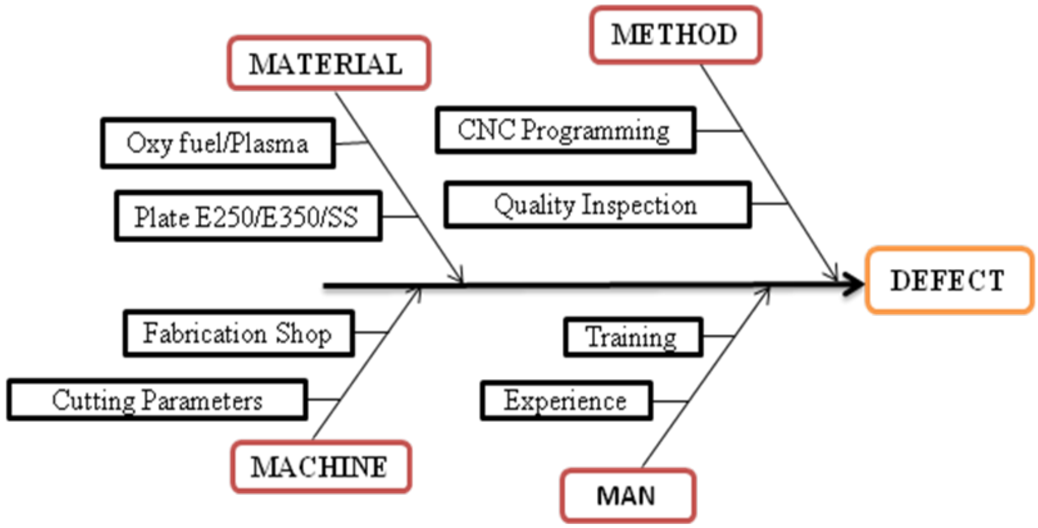
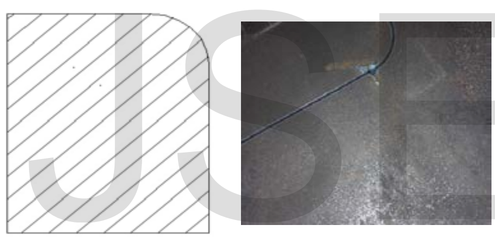
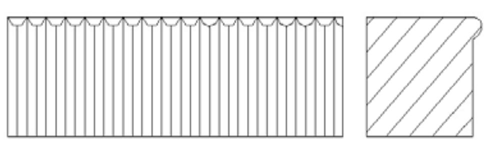
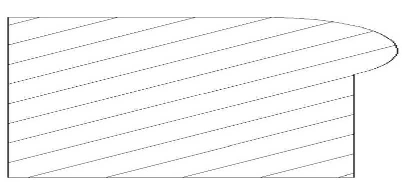
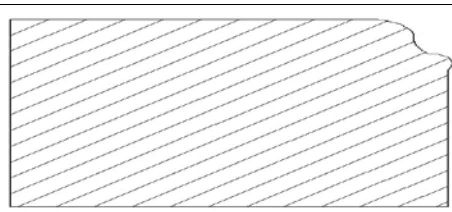


Fig. 2- Ishikawa Diagram

3 VARIOUS CAUSES AND THEIR REMEDIES IN PLATE CUTTING

Sr No	Errors	Section View	Causes of Errors
1.	Edge Fusion		Torch Feed Speed too low. Flame Too strong. Clearance between nozzle and plate too great. Clearance between nozzle and plate too small. Nozzle too large for the cutting thickness. Flame with excessive oxygen surplus.
2.	Chain of molten beads		Scale or rust on surface of plate. Flame too strong. Clearance between nozzle and plate too small. Clearance between nozzle and plate too great.
3.	Overhanging edge.		Flame too strong. Clearance between nozzle and plate too small. Flame with surplus fuel gas. Nozzle too large for the cutting thickness. Clearance between nozzle and plate too great. Torch feed speed too low.
4	Top edge cut away with adhering slag.		Cutting oxygen pressure too high. Clearance between nozzle and plate too great. Flame Too strong.

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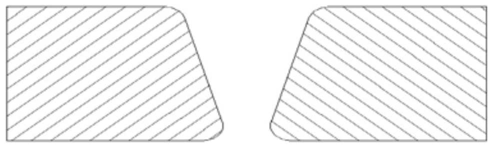
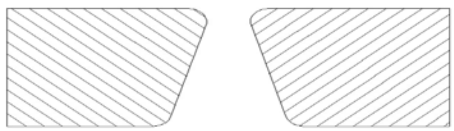
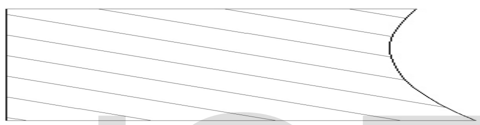
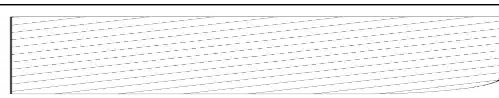
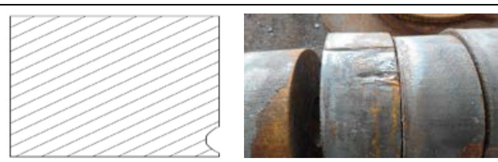
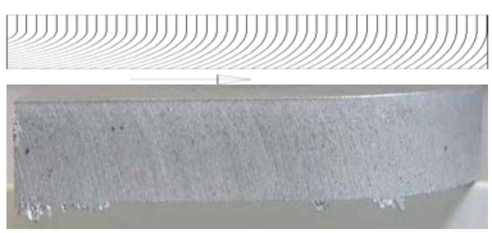
5.	Concave below top edge.		Cutting Oxygen pressure too high. Cutting Oxygen Jet turbulent. Nozzle Dirty. Clearance between nozzle and plate too great.
6.	Narrowing of cutting kerf (converging)		Torch feed Speed too high. Clearance between nozzle & plate too great. Nozzle dirty. Cutting oxygen jet deflected. Nozzle too small for the cutting thickness.
7.	Narrowing of cutting kerf (diverging)		Torch feed Speed too high. Cutting oxygen pressure too high. Too much cutting oxygen. Clearance between nozzle & plate too great.
8	Concave cross-section of cut surface.		Torch feed Speed too high. Nozzle too small for the cutting thickness Nozzle dirty Nozzle damaged or worn. Cutting oxygen pressure too low. Cutting oxygen jet deflected. Cutting pressure too high.
9	Undulating cross section of cut surface.		Torch feed Speed too high. Nozzle dirty Nozzle damaged or worn. Cutting Oxygen Jet turbulent. Cutting oxygen pressure too low. Nozzle too large for the cutting thickness.
10	Deviating angle of cut surface.		Incorrect angle of torch transverse to cutting direction. Cutting oxygen jet deflected.
11	Lower Edge rounded off		Nozzle damaged or worn. Nozzle dirty. Cutting oxygen jet turbulent. Torch feed speed too high. Cutting oxygen pressure too low.
12	Step at lower edge.		Torch feed speed too high. Nozzle damage or worn. Nozzle dirty. Cutting oxygen jet turbulent.
13	Excessive back scoring.		Torch feed speed too high. Nozzle too small for the cutting thickness. Not enough cutting oxygen. Cutting oxygen pressure too low. Clearance between nozzle and plate too grate.

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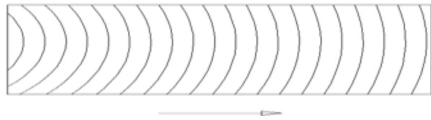
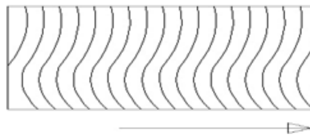
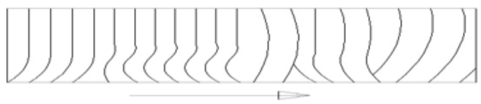
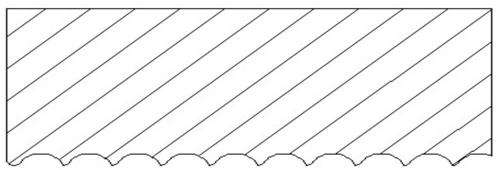
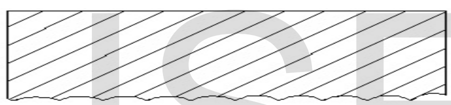
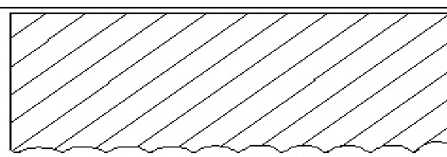
14	Forward scoring at top.		Incorrect angle of torch in cutting direction. Nozzle damage or worn Nozzle dirty. Cutting oxygen jet turbulent.
15	Excessive forward scoring at bottom.		Nozzle damage or worn Nozzle dirty. Cutting oxygen jet turbulent. Cutting oxygen jet deflected
16	Local deflection of scoring pattern.		Plate with finely distributed inclusions. Slag inclusions in plate. Segregation line in plate. Torch feed speed irregular.
17	Excessive scoring depth.		Torch feed speed too high. Torch feed speed irregular. Clearance between nozzle and plate too small. Flame too weak. Content of alloy components too high.
18	Irregular scoring depth.	 	Torch feed speed too high. Torch feed speed irregular. Flame too weak.
19	Cut surface undulating in direction of cut.	 	Torch feed speed too high. Content of alloy components too high. Carbon content too high. Cutting oxygen jet turbulent. Flame with surplus fuel gas. Nozzle damage or worn. Nozzle dirty. Nozzle too large for cutting thickness. Torch feed irregular.
20.	End not cut through.		Torch feed speed too high.

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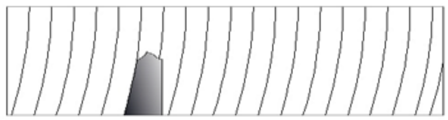
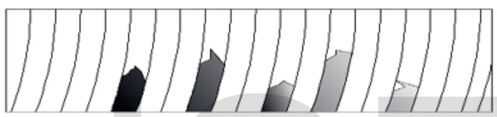
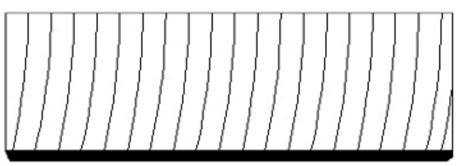
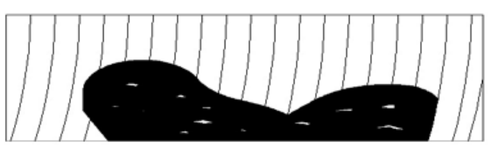
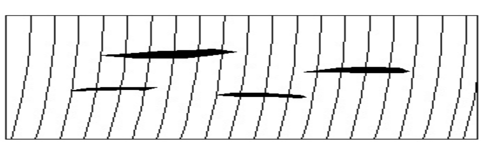
21	Cutting process interrupted.		Torch feed speed too high. Nozzle damaged or worn. Nozzle dirty. Nozzle too small for the cutting thickness. Flame too weak. Cutting oxygen jet turbulent. Surface of plate dirty e.g paint. Lamination in plate. Slag inclusions in plate. Segregation line in plate. Scale or rust on surface of plate. Not enough cutting oxygen. Clearance between nozzle and plate too great. Flame pops. Plate with finely distributed inclusions.
22	Isolated instances of erosion.		Surface of plate dirty e.g. paint. Scale or rust on surface of plate. Cutting oxygen supply briefly interrupted. Flame pops. Plate with finely distributed inclusions. Flame too weak.
23	Groups of eroded areas.		Torch feed speed too high. Surface of plate dirty e.g. paint. Scale or rust on surface of plate. Flame too weak. Clearance between nozzle and plate too small.
24	Erosion particular-ly in lower half of cut.		Torch feed speed too low. Nozzle damaged or worn. Nozzle dirty Cutting oxygen jet turbulent. Flame too weak.
25	Slag burs.		Torch feed speed too high. Torch feed speed too low. Cutting oxygen pressure too low. Surface of plate dirty e.g. paint. Surface or rust on surface of plate. Flame with surplus fuel gas. Flame too strong. Clearance between nozzle and plate too great.
26	Slag crust.		Content of alloy components too high.
27	In the cut surface.		Material Cold work hardened. Work piece cooled too quickly. Insufficient preheating of work piece. Steel susceptible to hot cracking. Content of alloy components too high. Carbon content too high.

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4 Conclusion

With this case study it is found that the technical aspect has feasible remarks on cutting technology which directly impacts the productivity of CNC oxy-fuel/plasma cutting machine as if fabrication skips proper cutting methods these above listed errors are always prone to take place which hampers the running cost of fabrication, leads to wastage of material and operation time. As it is know that this highly competitive business environment makes importance of a fabrication shop, for this recognitionadopting above causes and remedies of plate cutting are suggested so organizations can maximize their productivity and profit.

References

[1] Oxy fuel cutting http://www.twi-global.com/technical-knowledge/job-knowledge/oxyfuel-cutting- process-and-fuel-gases-049/
[2] Trkman, P. and M. Gradisar, One-Dimensional Cutting Stock Optimization in Consecutive Time Periods. European Journal of Operational Research, 2007. 179(1): p. 291-301.
[3] Scrap Minimization by Implementing Effective Nesting towards Improved Productivity Dr. Ashok G. Matani1, Ankush D. Bhishnurkar2, (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 5, May 2015.
[4] Doraid Dalalaha, Samir Khraisa, Khaled Bataineh, 11 December 2013, Waste minimization in irregular stock cutting, Presented at Jordan University of Science and Technology.
[5] Cutting stock problems and solution procedures, European Journal of Operational Research 54 (1991) 141-150 141 North-Holland.
[6] Zoran Djuri, Miodrag Mani, 2003, Intelligent nesting system, Yugoslav Journal of Operations Research, 13(2), (2003), pp. 229-243.
[7] M. Avila, Which metal-cutting process is best for your application, Welding Journal October (2012) 32-36.
[8] S.M. Ilii, M. Coteata, Plasma arc cutting cost, International Journal of Material Forming 2 (2009) 689-692.
[9] The great debate: plasma cutter or oxyfuel torch, www.millerwelds.com/resorces/articles/plasma-cutteroxyfuel.
[10] TWI World Centre for Materials Joining Technology, Cutting process - plasma arc cutting - process and equipment considerations, www.twi.co.uk.
[11] J.P. Kinos, D. Ott, A holistic study of automated plasma system costs, Welding Journal November (2012) 28-32.
[12] D. Cook, Cost of operation in mechanized plasma cutting, Welding Design and Fabrication, 2000.
[13] D. Jia, B. You, “An intelligent control strategy for plasma arc cutting technology”, Journal of Manufacturing Processes, vol. 13.
[14] VictorThermalDynamics.com. operators ready references.
[15] Torchmate CNC cutting system basic troubleshooting guide, revised June 2009.
[16] Weeland manual brochure for laser cutting and other sheet metal working, www.weeland.se.
[17] Moog animatics CNC plasma cutter manual.
[18] http://www.twiglobal.com/technicalknowledge/ job knowledge/ cuttingprocessesplasmaarccuttingprocessandequipmentconsiderations051/.
[19] Ni J. 1997. CNC machine accuracy enhancement through real-time error compensation. ASME Trans Journal of Manufacturing Science and Engineering. Vol. 119, pp. 717-724.
[20] Shape cutting system manual from Esab, esab-cutting.com.

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