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Visual detection welding defects in dust perception and correction

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Abstract

The research solve problems of welding defects for dust perception in AL Janoob cement factory .Assembly of steel structures type carbon steel DIN St37by using manual metal arc welding process and electrode type low hydrogen ESAB 48.00 equivalent to American welding society AWS E7018.

From visual inspection to assembly appeared many welding defects. In this research used liquid penetration methods helped to detection of fine defect and crack opening to surface that cannot be detection by visual inspection .where fined many types of welding such as(under cut ,spatter, porosity, nonmetallic inclusion, under fill, excessive reinforcement ,surface roughness, arc strikes) defects due to pin holes restricted in welding joint (appear by given cross section in many welding joint by visual inspection and liquid penetration also we don't using other method of inspection because acceptable requirement only visual and liquid penetration) and others because used of high welding current and welding travels speed. These problems solved by removing welding defects and re-welded by using drier electrode (250°C for 4hr) and using the proper welding current and speed.

(ومعالجتها الغبار ترسيب منظومة في اللحام عيوب لتحديد البصري الفحص)

الخلاصة

تضمن البحث معالجة مشاكل عيوب اللحام في منظومة ترسيب الغبار الخاصة بمعمل سمنت الجنوب حيث تم تجميع المقاطع الحديدية من نوع (Carbon steel DIN St 37) للمرسب بطريقة لحام القوس الكهربائي اليدوي وباستخدام أسلاك أسلاك لحام من نوع المنخفض الهيدروجين (Low hydrogen electrode EASB OK 48.00)والمكافئ لمواصفات الجمعية الأمريكية للحام (AWS E7018) .

وبعد أكمال تجميع وربط أجزاء المرسبة ظهرت عيوب في مناطق اللحام تم تحديدها خلال الفحص البصري بأستخدام العدسات المكبرة وكذلك تم أستخدام طريقة السوائل النافذة للمساعدة في كشف العيوب و الشقوق النافذة للسطح التي لا يمكن تحديدها بالفحص البصري .

حيث وجدت أنواع مختلفة من عيوب اللحام منها العيوب الناتجة عن وجود فقاعات ومتضمنات محصورة (تم الكشف عنها بأخذ مقاطع عرضية لبعض مناطق اللحام وفحصها بصريا بأستخدام المكبرات وكذلك السوائل النافذة ولم يتم استخدام طرق اخرى للكشف لان متطلبات القبول تقتصر على الفحص البصري والسوائل النافذة فقط) وأخرى ناتجة عن استخدام تيارات لحام عالية وسرعة عمل تمريرات اللحام وقد تم معالجة هذه العيوب بإزالة اللحام في المناطق التي تم تحديدها في البحث وإعادة لحام المناطق المتضررة بأسلاك لحام مجففة إلى درجة حرارة° 250 م لمدة أربع ساعات واستخدام التيار والسرعة المناسبة لقطر سلك اللحام.

1-Introduction

An electrostatic precipitator used in AL-Janoob cement factory, industrial emission-control unit. It is designed to trap and remove dust particles from the exhaust gas stream of cement process. In many industrial plants, particulate matter created in the industrial process is carried as dust in the hot exhaust gases. These dust-laden gases pass through an electrostatic precipitator that collects most of the dust. Cleaned gas then passes out of the precipitator and through a stack to the atmosphere. Precipitators typically collect 99.9% or more of the dust from the gas stream. Precipitators function by electrostatically charging the dust particles in the gas stream.. [2]

2-Shielded metal arc welding

Shielded metal arc welding commonly called stick, or covered electrode, welding, is a manual welding process whereby an arc is generated between a flux-covered consumable electrode and the work piece. The process uses the decomposition of the flux covering to generate a shielding gas and to provide fluxing elements to protect the molten weld-metal droplets and the weld pool.

Most manufacturing operations that require welding will strive to utilize the mechanized processes that offer greater productivity, higher quality, and, therefore, more cost-effective production. For these reasons, the SMAW process has been replaced where possible. However, the simplicity and ability of the SMAW process to achieve welds in areas of restricted accessibility means that it still finds considerable use in certain situations and applications. Heavy construction, such as shipbuilding, and welding "in the field," away from many support services that would provide shielding gas, cooling water, and other necessities, rely on the SMAW process to a great extent. Although the SMAW process finds wide application for welding virtually all steels and many of the nonferrous alloys, it is primarily used to join steels. [4]

3-Welding defects

Visually examine weld surface and verify that the weld contour con-cavity and convexity meet acceptance criteria required by the contract documents (in this work the acceptable requirement only visual inspection and liquid penetration to inspection welded joint).Workmanship standards may address such items as surface roughness, weld spatter, and arc strikes. Most codes and specifications describe the type and size of discontinuities that are acceptable. Many of these discontinuities (Porosity ,Incomplete fusion4 ,Incomplete joint penetration, Undercut ,Under fill ,Overlap ,Cracks ,Metallic and nonmetallic inclusions ,Excessive reinforcement)can be found by visual examination of the completed weld. The following are typical discontinuities found at the surface of welds: [3,5]

Porosity one of main defects where occurred by gas entrapment during solidification. This discontinuity formed is generally spherical and may be elongated. A common cause of porosity is contamination during welding. Porosity is an indicator that welding parameter, consumables, or joint fitup were not properly controlled for the welding process selected or that the base metal is contaminated or of a composition incompatible with the weld filler metal being used.

Under cut. Undercut is a groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal. This groove creates a mechanical notch

which is a stress concentrator. When undercut is controlled within the limits of specifications it is not considered a weld defect.
Undercut is generally associated with either improper welding techniques or excessive welding currents, or both.

Under fill. Under fill is a condition in which the weld faces or root surface of a groove weld extends below the adjacent surface of the base metal. It results from the failure of the welder to completely fill the weld joint.

Incomplete Fusion. Incomplete fusion is a weld discontinuity in which fusion did not occur between weld metal and fusion faces or adjoining weld beads.. It is the result of improper welding techniques, improper preparation of the base metal, or improper joint design. Deficiencies causing incomplete fusion include insufficient welding heat or lack of access to all fusion faces, or both. Unless the weld joint is properly cleaned the tightly adhering oxides can interfere with complete fusion, even when there is proper access for welding and proper welding heats are used.

Incomplete Joint Penetration. Incomplete joint penetration is a joint root condition in which weld metal does not extend through the joint thickness. The unpenetrated and unfused area is a discontinuity described as incomplete joint penetration. Incomplete joint penetration may result from insufficient welding heat, improper joint design (e.g., thickness the welding arc cannot penetrate), or improper lateral control of the welding arc.

3-1 Inspection methods

As to their ability of detecting various geometrical forms of defects, the non destructive test (NDT)methods applied in testing of welded joints differ one from the other very much, i.e. they complement each other. In some cases they are interchangeable. In testing of welded joints, it is radiographic methods (Xray) which are most frequently used and which permit a very reliable detection of three-dimensional discontinuities such as pores, non-metallic inclusions, incomplete penetration and undercuts at the inaccessible root side. The method seems to be less reliable in detecting planar, i.e. two-dimensional, defects such as cracks. The ultrasonic methods seem to be the most universally applicable.

They may be applied to all types of defects but they are comparatively complicated and sensitive to various disturbances. They are less reliable, therefore, they are making themselves valued in welding very slowly.[6]

Simple and reliable methods are available for detection of cracks reaching the surface. Magnetic methods are suitable for ferromagnetic materials, while penetrant methods are suitable for all metals. Too little attention is, however, paid to visual inspection which should be performed prior to each NDT examination. The visual inspection provides basic information on the state of welded joints and the structure concerned. This is a guideline for further examinations. Fig.(1) schematically shows the application of various non destructive test (NDT) methods in testing butt and fillet welds.[6,7]

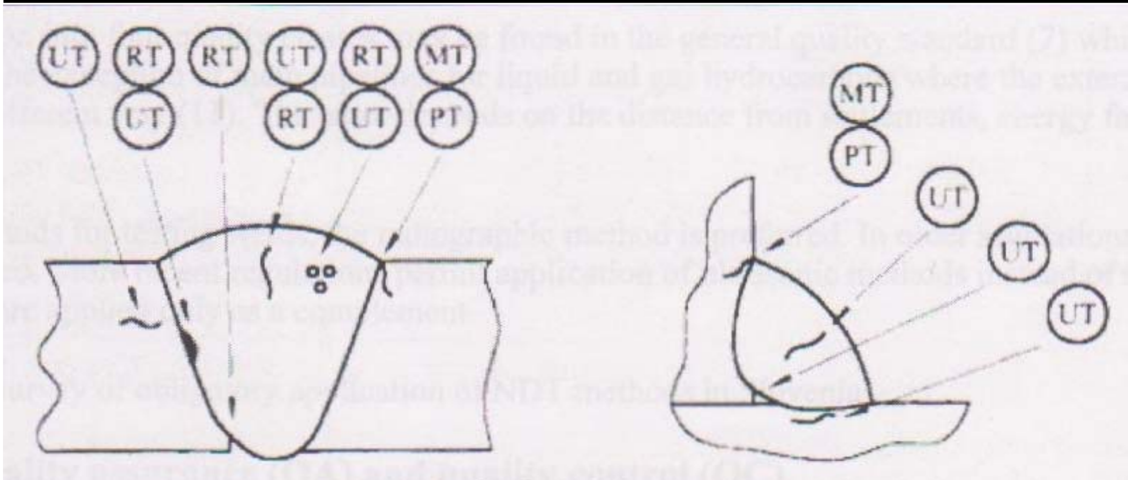

Fig. 1. Application of NDT methods

- RT: radiographic test (x-ray).
- UT: ultra sonic test.
- MT: magnetic test.
- PT: liquid penetration test.

4- Liquid penetrate inspection

In this research the liquid penetration used to a nondestructive method of revealing discontinuities that are open to the surfaces of solid and essentially nonporous materials. Indications of a wide spectrum of flaw sizes can be found regardless of the configuration of the work piece and regardless of flaw orientations. Liquid penetrates seep into various types of minute surface openings by capillary action. Because of this, the process is well suited to the detection of all types of surface cracks, laps, porosity, shrinkage areas, laminations, and similar discontinuities. It is extensively used for the inspection of wrought and cast products of both ferrous and nonferrous metals, powder metallurgy parts, ceramics, plastics, and glass objects. In practice, the liquid penetrate process is relatively simple to utilize and control. Liquid penetrate inspection is also used to inspect items made from ferromagnetic steels; generally, its sensitivity is greater than that of magnetic particle inspection. The major limitation of liquid penetrate inspection is that it can detect only imperfections that are open to the surface; some other method must be used for detecting subsurface flaws. Another factor that can limit the use of liquid penetrates is surface roughness or porosity. Such surfaces produce excessive background and interfere with inspection.[8]

Two type of penetrate generally used ,that is, fluorescent (type I) or visible (type II used in this research), penetrate inspection requires at least five essential steps, as follows: [8]

• **Surface Preparation:** All surfaces to be inspected, whether localized or the entire work piece must be thoroughly cleaned and completely dried before being subjected to penetrant inspection. Flaws exposed to the surface must be free from oil, water, or other contaminants if they are to be detected. The surface clean by using cleaning spray type (Cleaner 008A 100).

• **Penetration:** After the work piece has been cleaned, penetrant is applied in a suitable manner so as to form a film of the penetrant over the surface. This film should remain on the surface long enough to allow maximum penetration of the penetrant into any surface openings that are present penetrator type (Penetration 008A 015) exposed to surface 10-15 mint in many positions.

• **Removal of Excess Penetrant:** Excess penetrant must be removed from the surface. The removal method is determined by the type of penetrant used. Some penetrants removed by using cloth and cleaner type (008A 100) .uniform removal of excess surface pentrant necessary for effective inspection, but over removal must be avoided.

• **Development.** Depending on the form of developing agent to be used, the work piece is dried either before or directly after application of the developer. The developer forms a film over the surface.

• **Inspection.** After it is sufficiently developed, the surface is visually examined for indications of penetrant bleed back from surface openings. This examination must be performed in a suitable inspection environment. Visible penetrant inspection is performed in good white light. When fluorescent penetrant is used, inspection is performed in a suitably darkened area using black (ultraviolet) light, which causes the penetrant to fluoresce brilliantly. The operations for this process are illustrated schematically in Fig. 2.

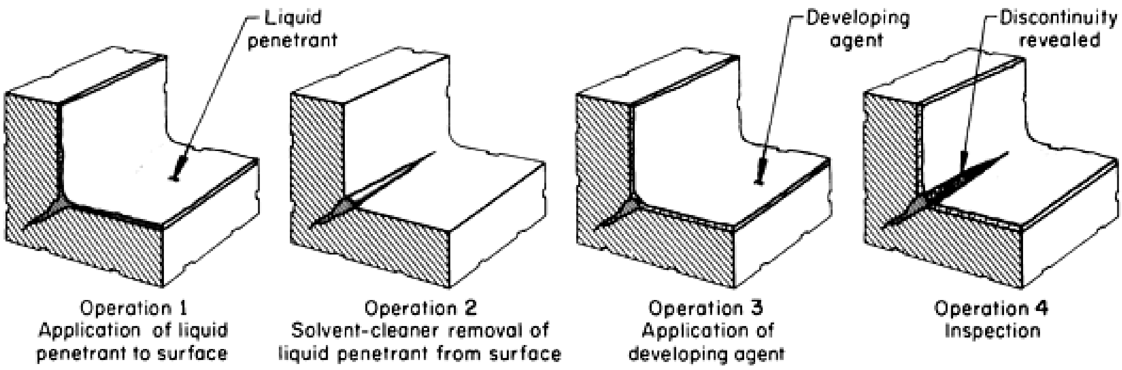

Fig. 2 Operations (in addition to precleaning) for the solvent-removable liquid penetrant system.

5-Welding Electrode and base metal:

In this work basic coated electrode E7018 (OK48.00), suited for welding operations on structural, fine-grained, tube and cast steels. Also indicated for crack-resistant joints of unalloyed steels with high carbon content (up to 0.6%), low alloy steels and cast steels sensitive to cracking. It is especially recommended for welding carbon steel St 37, chemical analysis of weld metal(C 0.07% Si 0.5%, Mn 1.2%).the mechanical properties of the weld metal Yield strength (N/mm2): 430 – 490, Tensile strength (N/mm2): 530 – 590, Elongation (%): 27 – 33. Chemical composition and mechanical properties for Carbon **Steel** St37 in table1.[9,10]

Standard	Grade	Chemical Composition%						Mechanical properties		
		C	Si	Mn	P	S	Cr	(Mpa) tensile strength	(Mpa) Yield strength	Elongation %
DIN	St37.0	≤0.17	-	-	≤ o.04	≤o.04	-	350-400	≤235	≤25

Table1. Chemical composition and mechanical properties for Carbon Steel St37**.**

5- Result and discussion

In this research testing of welded joints shows many welding defects(Slag inclusions, Spatters, Porosity, Under cut , Under fill, Excessive reinforcement , Arc strikes, Incomplete joint preparation) as shown in figures (3 -14) all these defects produced from high current, moisten electrode and non labor welder, high speed welding ,low voltage, improper joint design arc and large welding arc length .These discontinuities removed and re-welded by using dried low hydrogen electrode E7018(250°C for 4hr or 450°C for 2hr) with proper welding voltage ,current and travel speed to wire diameter.

Slag inclusions this defect produced from trapped of slag due to pad cleaning of end arc during passes to prevent this defect can increasing welding voltage and good cleaning before welding and during passes as shown in figures (3,4). Spatters due to separated globe of melted electrode metal to base metal this not affect on mechanical properties of welded. To prevent this defect must be reduced welding current whit used short arc and check polarity figures (3-4-8-11-12).Porosity can be prevent this defect by remove contamination from joint before welding by using low hydrogen electrode after drier electrode to (250°C for 4hr) with use short arc reduced welding current.

6- Conclusion:

Based on the experimental evidences and discussion presented, the flowing conclusions were made:

1. Precleaning of weld joint before welding from dirt, greasy, paint.
2. Good fitup of weld joint (beveling, gape, root).
3. Low hydrogen electrode must be drying before welding (250°C for 4hr).
4. Using the suitable (voltage, amperes, welding speed) with wire diameters according to (AWS) standers.

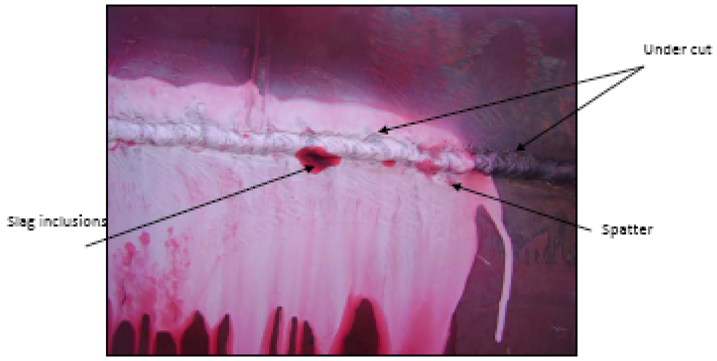

Fig (3) welding defects –butt joint /inter metallic-under cut and spatter.

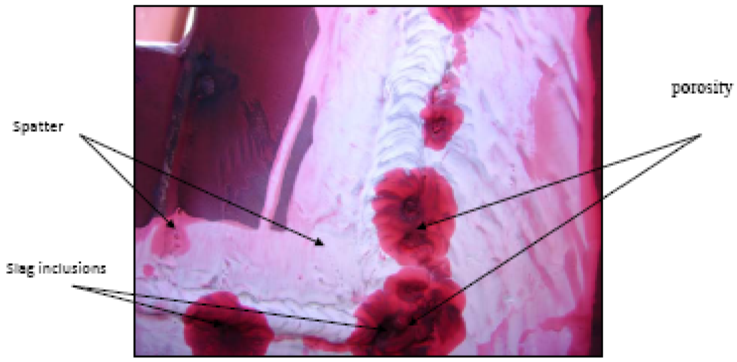

Fig (4) welding defects – porosity-spatter-non metallic inclusion.

Fig (5) welding defects – porosity.

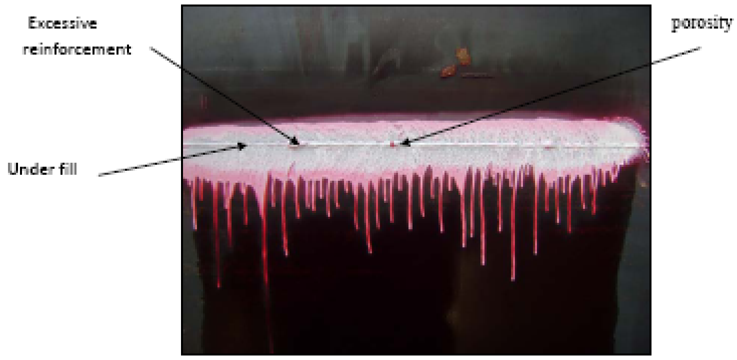

Fig (6) welding defects – porosity-excessive reinforcement-under fill.

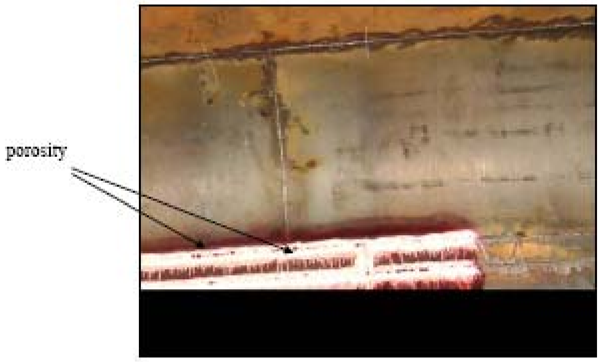

Fig (7) welding defects – porosity.

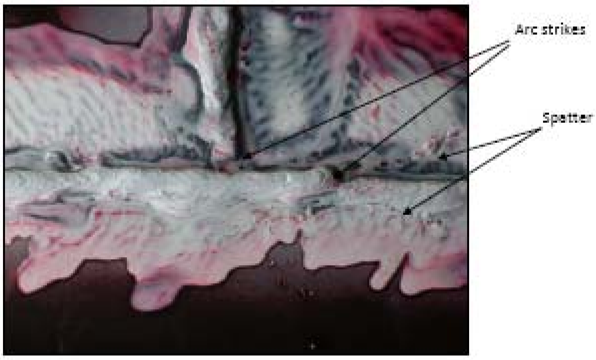

Fig (8) Arc strikes- spatter-roughness.

Fig (9)Welding defects- porosity-spatter -roughness

Fig (10) Welding defects- Arc strikes- spatter

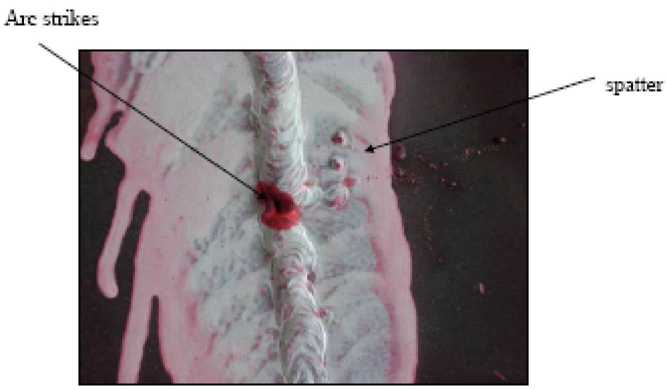

Fig (11) Welding defects- Arc strikes- spatter

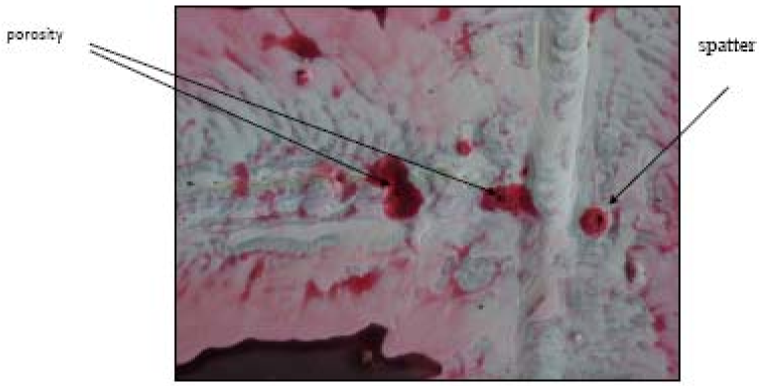

Fig (12) Welding defects- porosity-spatter-roughness.

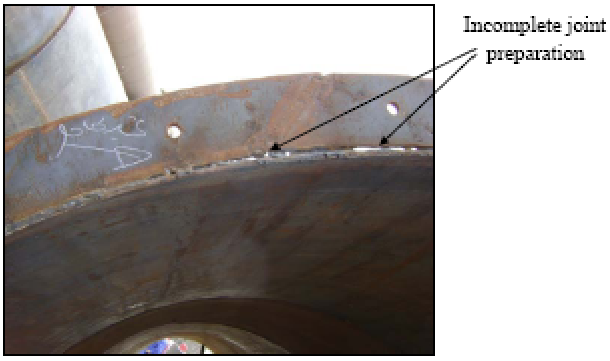

Fig (13)Welding defect - Incomplete joint preparation.

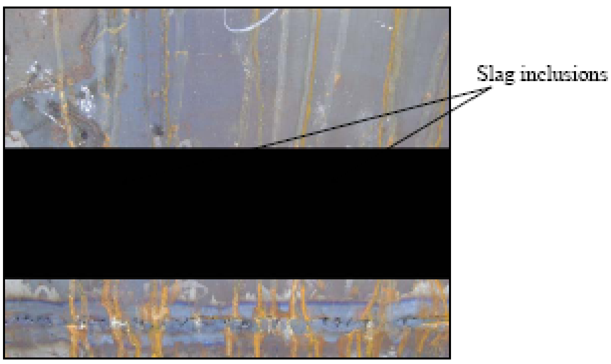

Fig (14) Welding defect - nonmetallic inclusion.

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