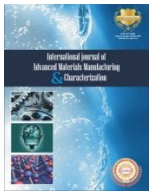

Advanced Materials
Manufacturing & Characterization

journal home page: www.ijammc-griet.com

Why Multi shot should be conducted for Radiography Examination..?

S V Ranganayakulu, R.Gowtham, M.Premkumar

Centre for Non Destructive Evaluation, Guru Nanak Institutions – Technical Campus Hyderabad – 501516, R.R.Dt, Andhra Pradesh, India

ARTICLE INFO

Article history:
Received 16 Nov 2012
Accepted 26 Dec 2012

Keywords:
Planar defect,
X-ray radiography,
Ultrasonic pulse-echo technique

ABSTRACT

Ultrasonic pulse echo method is approved for planar defect in the weld joint against radiography examination. The most important point in this evaluation is planar defects are effectively traced in radiography. Due to its excellent weldability, carbon steel is suitable for submerged arc welding. Ultrasonic and Radiography inspection is conducted for weld joint. During radiography method, planar defect (Lack of fusion) is detected and as verification ultrasonic pulse-echo method is also conducted to grasp planar defect. Primarily a demerit in radiography is shown as plus point in ultrasonic method. Secondarily, Lack of fusion is very common type of defect in weld defects. Lack of fusion is not notice as weld defect, as they are characterized as planar defect. As a final point, lack of fusion is not noticed by radiography examination, and may probably determine by ultrasonic method. The merits of Ultrasonic evaluation over X-ray Radiography inspection are discussed in these studies.

Introduction

Radiographic Testing (RT) or industrial radiography is a nondestructive testing (NDT) method of inspecting materials for hidden flaws by using the ability of short wavelength electromagnetic radiation (high energy photons) to penetrate various materials. Principle of radiography is differential absorptionand X-ray radiography can be used as source for detection of defectSince the amount of radiation emerging from the opposite side of the material can be detected and measured, variations in this amount (or intensity) of radiation are used to determine thickness or composition of material. Penetrating radiations are those restricted to that part of the electromagnetic spectrum of wavelength less than about 10 nanometer. Radiography defects such as planar cracks are difficult to detect using radiography; hence Ultrasonic is the preferred method for detecting this type of discontinuity.Ultrasonic pulse-waves of short wave length with center frequencies [3] ranging from 0.1-15 MHz and occasionally up to 50 MHz are launched into materials to detect internal flaws or to characterize materials.Radiography and ultrasonic inspection are the two generally non-destructive methods used in these investigations Non-destructive inspection methods that can [1] detect embedded flaws that are located well below the surface of the test part. Neither method is limited to the detection of specific types of internal flaws. In order to evaluate the stability of a casting component, the shape of a defect inside it is discriminating for the evaluation and acceptance criteria which shall be adopted. Defect shape is usually classified in two types; in volumetric defects, which the ratio between height and width is next to unity, and [7] in planar defects, whose width is indeed, very small with respect to the height. Radiography capability allows the inspection of internal mechanisms and enhances the detection of cracks and planar defects by manipulating the part to achieve the proper orientation for flaw detection.

Sample preparation

Surface preparation of weld

According to the American Iron and Steel Institute (AISI) standards the series of steel used in this study is 10XX. So that low carbon steel contains [8] about 0.1%Carbon and microstructure consists of Pearlite and ferrite. Due to its excellent [9] weldability, sub-merged arc welding is used to join two carbon steel pieces. Typical uses of carbon steel are connecting rods, automobile body panels etc. The complete surfaces of the welds are examined by X-ray. It has to be adequately free from irregularities that may mask or interfere with the X-rays.

- Corresponding author: S V Ranganayakulu,
- E-mail address: nayakulu@rediffmail.com
- Doi: http://dx.doi.org/10.11127/ijammc.2013.02.086

Specification of weld

Table-1: Specification of Weld sample

Sl.no	Specification	Range
1	Composition	0.15%carbon
2	Yield strength (MPa)	200-300
3	Tensile strength (MPa)	00-370
4	%Elongation	28-40
5	ASTM grain size	8
6	Microstructure	Fine ferrite and pearlite
7	Dimensions	200×100×10(millimeter)

Experimental Studies

X-ray Radiography and Ultrasonic pulse echo method (da vanci alpha) are used for weld inspection for detection of defects.

Radiography experimental setup

Arrangement of radiography setup as follows-X-ray radiography was used for the practical experiments and normal incidence exposures taken. A single-wall technique was used. Wire penetrameter type image quality indicator (IQI) is placed on the source side of the test object and in close contact

Fig-1: Top view of weld sample

with the surface of the object. Specifications have given below.

- SFD (Source - to - film distance) value is 1000 mm.
- Focal spot size is 2×2mm maintained at X-ray tube.
- Voltage and current should be maintained at 150 kv(kilovolts) and 10mA(miliamperes)

.

Then X-rays are exposed on the whole weld surface and time of exposure is given about 3 minutes. After completion of time of exposure, film is taken to dark room for developing purpose. Following Radiographs film were evaluated by using illuminator.

Interpretation of film

During interpretation, point defect was observed but originally it was notice that, one planar defect was detected, by passing X-rays from other side of the weld sample as shown in the figure 2.

Fig-2: X-ray setup

Ultrasonic Evaluation

Ultrasonic testing is conducted on the same sample for evaluation of defect. Next inspection was carried out from the upper surface only. Scanning sensitivity was set by plotting a DAC curve on side drilled hole diameter which was about 2mm as shown in the figure 3. The gain was increased by +6dB for scanning.

Fig-3: side drilled hole

Interpretation

A range of different probes of 45^0 and 60^0 were used for detection of defects. During interpretation of weld surface, a defect is observed near the Heat Affected Zone (HAZ) area, and recorded as shown in fig-

Computation

Beam path (BP) can be calculated by the equation given below.

BP= T/cosθ where T=Thickness…… (1)

Surface distance (SD) can be calculated by the equation given below

SD=T×tanθ…… (2)

using thin weld sample. The results showed that, the radiography technique is unsuitable for detecting planar defects

Comparisons of Ultrasonic VS X-ray Radiography inspection

The restrictions of flaw detection by use of Ultrasonic inspection and Radiography inspection methods are based on the interaction of the specimen with the method applied. Crack-like defects are especially critical, since they are two dimensional. In addition, crack-like defects on the surface showed interaction with the surface, which can limit the capability of detection. Radiography method is implemented to detect the defect in the weld sample. Finally point defect was traced out in the one shot of X-ray penetration of Radiography examination. Again for verification, Ultrasonic inspection is conducted to detect the

planar defect for which radiography is undetected. So, Investigations using radiography, ultrasonic pulse-echo method technique were done in the laboratoryusing thin weld sample. The results showed that, the radiography technique is unsuitable for detecting planar defects**.**

Results and discussion

According to the ultrasonic pulse echo method defect is detected as shown in fig-4**;**Experimental values of Ultrasonic Testing by da vinci alpha Ultrasonic flaw detector are recorded in table-2. The probability of defect (lack of fusion) can be significantly detected by ultrasonic method, and it is not as sensitive as radiography.

Table-2: range of defect in the sample

Sound path	Theoretical values		Experimental values		Angle
	BP	SD	BP	SD	θ
½ V	21.21	15	20.62	13.54	45^0
1 V	42.42	30	41.25	29.12	45^0
1 ½ V	63.63	45	62.14	44.09	45^0
½ V	20	17.32	19.98	17.99	60^0

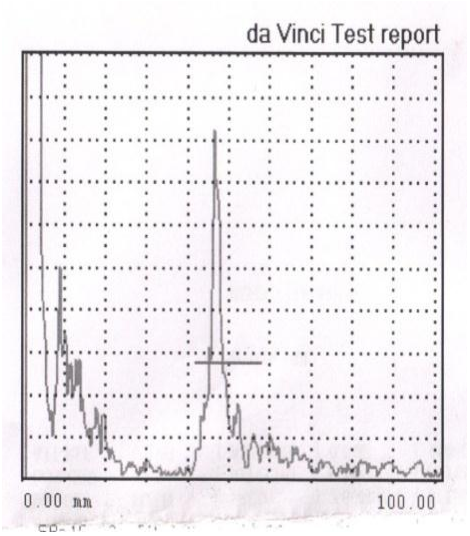

Fig-4: Graphical representation of defect of da vinci alpha Ultrasonic flaw detector

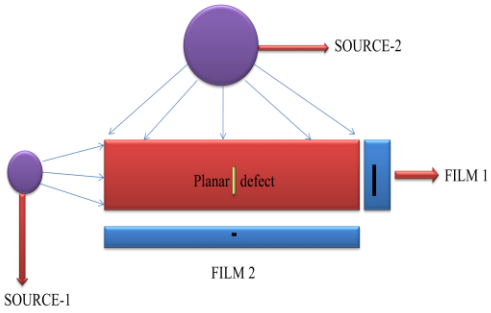

Fig-5 side view of weld sample for multi-shot examination in radiography

Individually radiography is high penetration method and it cannot detect the presence of planar defect in one shot of X-ray exposure, So that, from the above fig-5, multi-shot of X-ray exposure should be carrying for radiography examination to point out defect in the weld sample. Radiography and ultrasonic are the most commonly used methods for planar defects in welds. These two NDT methods have advantages and disadvantages as far as flaw detection, identification and sizing are concerned. Radiography is particularly suitable for detection and identification of volumetric defects, incomplete penetration where a gap exists. Ultrasonic flaw detection is highly suitable for the detection and sizing of planar defects such as lack of fusion. The Ultrasonic pulse echo technique is capable of detecting all the critical defects (such as cracks) used for the study unlike Radiography. Selection of suitable methods is based on some properties such as economic, health and safety considerations.

Conclusions

In X-ray Radiography, specimen is exposed to multi-shot for detection of defects because planar defects are effective. By Ultrasonic inspection method is applied to weld sample to evaluate the planar defect. Hence Ultrasonic pulse echo method is suggested for test and evaluation of planar defects.

Acknowledgements

Authors are grateful to AICTE for carrying out research under Research Promotion Scheme **(Project No: 8023/RID/RPS-58/ (POLICY-III) (pvt)/2011-2012).**Gratefully acknowledgements due to **Sardar G S Kohli**, Vice Chairman, and "**Dr H S Saini**, Managing Director, Guru Nanak Institutions, Ibrahimpatnam, for cooperation and encouragement.

References

1. Erhard A and Ewert U. 1999 "The TOFD Method -Between Radiography and Ultrasonic in Weld Testing", *DGZP Jahrestagung*, Celle, page no: 10-12,

2. De Raad J.A., Dijkstra F.H., 1995 "Mechanized UT Now Can Replace RT on Girth Welds During Pipeline Construction", *Pipeline Technology*, Volume II, Elsevier Science.

3. Silk M.G, 1977 "Sizing Crack like Defects by Ultrasonic means, Research Techniques in Non-Destructive Testing", Vol.3, by *R.S. Sharpe, Academic Press*, London. page no: 48-56.

4. Verkooijen, J., 1995 "*TOFD* used to replace radiography", *Insight publications*, Vol. 37(6), pp. 433-435,

5. BS EN 1435: 1997 "Non Destructive Examination of Welds – Radiographic Examination of Welded Joints".

6. G A Georgiou and C R A Schneider, 2003 'Radiography of thin-section welds' *Insight* Vol.45 No2, February,

7. "Causes for Weld Defects". IIW Doc. XII-B-046-83, *International Institute of Welding*, 1983.

8. "Directions for Execution of Process. Avoidance of Lack of Fusion". IIW Doc. XII-B-049-83. *International Institute of Welding*, 1983.

9. Wooldridge A B. Chapman R K, Woodcock G S. Munns I J and Georgiou G A (1997),"Reliability of radiography for detection of planar manufacturing defects in thick sectionwelds". *Insight*, 39 (3), pp 139-147.

10. American Society for Metal; "Non Destructive Inspection and Quality Control", *Metal Hand book* Vol.11; ASM Metals Park, Ohio.

11. Little Richard L, 1997 "Welding and Welding technology"; *Tata McGraw- Hill Publication Company ltd*.,