Welding Deformations of Thick Cylindrical-Vessels by Narrow-Gap GMAW of Longitudinal Joints

by Masaaki Ando, Hideaki Harasawa, Mitsuo Tsukamoto, Masao Toyoda and Kunihiko Satoh

Consideration is conducted on parameters controlling deformations of thick cylinrdical vessels due to narrow-gap multi-pass welding of longitudinal joints. The change in inner diameter and the deformations in the vicinity of welds caused by longitudinal welding is measured for actual cylindrical vessels, 50–200 mm thick, 900–3000 mm in inner diameter. Experiments for thick plate specimens under the same narrow-gap welding process are also made.

In the multi-pass welding of thick plate, the deformation occurs after the manner of angular change as the root part of groove hardly moves. Therefore the amount of angular distortion is obtained by $\Delta g_w/h$ using the measured value of shrinkage Δg_w at upper side of groove and plate thickness h. The above characteristics in deformation of multi-pass welds of both cylindrical vessel and plate specimen result in usefullness of the application of elastic theory based on dislocation model for estimating the deformation of cross-section of vessel due to longitudinal welds. According to the dislocation theory, change in inner diameter ΔD_i is proportional to the inner diameter D_i and is given by the equation

$$\Delta D_i=-\frac{\Delta g_w}{h}\cdot\frac{1}{2\pi}\left(1-\frac{1}{2\pi}\sin\theta\right)\cdot D_i \qquad (0°\leqq\theta\leqq180°)$$

where the sign of ΔD_i is defined as increase in D_i is given as positive, and θ is the angle from the weld joint. The applicability of the above equation based on dislocation theory is confirmed by the present experiments. In the above equation, the term $\Delta g_w/h$ of angular distortion of thick cylindrical-vessel has a constant value regardless of inner diameter and plate thickness when plate thickness is larger than 50 mm. Accordingly, it is presumed that the change in inner diameter is controlledby only one parameter of inner diameter of vessel.

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Development and Application of New Sampling Inspection System for Welds of Steel Buildings

by Teruyuki Nakatsuji, Mitsugu Kuramochi, Toshiaki Fujimori, Masao Toyoda and Kunihiko Satoh

A new sampling inspection system of NDT has been proposed to secure the quality of welds of steel buildings. In this system, the quality of welds is evaluated based on reliability-analysis in which probabilistic parameters such as detectability of NDT, sampling rate are considered. In the present new system, the whole processes of wleding works are diivded into a certain number of steps, and then, the reliability of every step is calculated by using the inspection data of that step. And the inspection plan is modified at any next step if necessary so that the average reliability of all welds will ocnform to satisfy the reliability requirement which was already given by the structural designer. In the present paper, the new system is termed "Step Inspection System".

The availability of Step Inspection System to secure the required reliability of welds was confirmed by applying actually to the 40-storied and 27-storied steel buildings.

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Low Temperature Toughness of MIG Weld Metal in SUS 316L Steel

by Toshiharu Hiro, Kazuo Agusa and Noboru Nishiyama

The toughness of SUS 316L MIG weld metal was investigated in relation to the oxygen ocntent, pass sequence, δ ferrite content and PWHT conditions, and also the effect of δ ferrite content on the hot crack susceptibility of the weld metal was discussed. (1) The toughness is greatly improved by decreasing oxygen content in the weld metal to about 50 ppm. The value of ${}_{V}E_{-269}$ reaches to as high as 15.2 kgf·m. (2) Welds with low oxygen contents can be attained by using rare-earths-bearing welding wires in a pure argon shield. (3) For preventing reheat embrittleness, decreasing δ ferrite content to about 1% and using narrow-gap MIG arc welding with 1 pass/1 layer are effective. (4) When the δ ferrite content is too high, the toughness of weld metal is deteriorated. This is because cracks propagate along the δ ferrite where precipitates of $M_{23}C_6$ produced by multiple welding thermal cycles are existing. (5) Decreasing δ ferrite content to about 1% is not so harmful to the hot crack resistivity of the weld metal so far as the contents of silicon, phosphorus and sulfur are sufficiently low. (6) Since PWHT deteriorates the weld metal toughness, it is desirable to be avoided. In the case that PWHT is required, the one at a relatively low temperature (about 600°C) is recommended.

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