On the Strain Figures Appeared on the Surface of Welded Plate

SUHARA, Tashiro
Research Institute for Applied Mechanics, Kyushu University

TSUJI, Isamu
Research Institute for Applied Mechanics, Kyushu University

https://doi.org/10.5109/7162061

出版情報：Reports of Research Institute for Applied Mechanics. 5 (17), pp.27-30, 1957. 九州大学応用力学研究所
バージョン：
権利関係：

NOTE

On the Strain Figures Appeared on the Surface of Welded Plate

Toshiro SUHARA and Isamu TSUJI

In the process of welding, both deposited and adjacent metal are subjected to such marked and non-uniform temperature changes that plastic flow or yielding must occur. In order to explain the state of stress thus produced, it is available to observe the strain figures appearing on the surface of the plate and analyse the characteristics of the flow. Such a method of analysis has been utilized by several researchers (1)～(3) and in this note photographs of strain figures appeared on the surface of plate with its central part plug-welded are shown.

The specimen was a square plate 500 × 500 × 12.5 mm of ordinary mild-steel with a central circular hole of 40 mm ϕ which was filled up by deposited metal. (Fig. 1). The both surfaces of the plate had been preliminarily prepared by polishing to a degree 0000 by emery papers and applying silicon oil in order to prevent the oxidation as possible. The welding procedures are given in table below and photograph P. III shows the arrangement of equipments to take the photograph of strain figures.

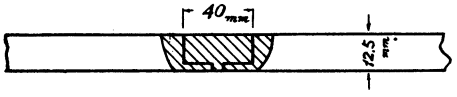


Fig. 1. Test specimen.

Electrode	D 4301 5 ϕ
Arc voltage	35 volts
Arc current	230 amps. A.C.
Weld time	33 sec.

It will be seen in the photograph P. I, P. II or Fig. 2 that the flow lines can be classified into three different groups, i.e., the first is radial line type, the second is logarithmic spiral type and the last is concentric circle type and further the first may be classified into two sub-groups I and II. The sequence of appearance of the slip lines is thus: The radial line type I appeared in the first place soon after the beginning of welding, then the spiral type appeared after several ten seconds and finally the concentric circle type and radial line type II appeared after the elapse of considerably long time. The state of stresses in the plate above mentioned are given by the analysis of M. Otani (4) as follows.

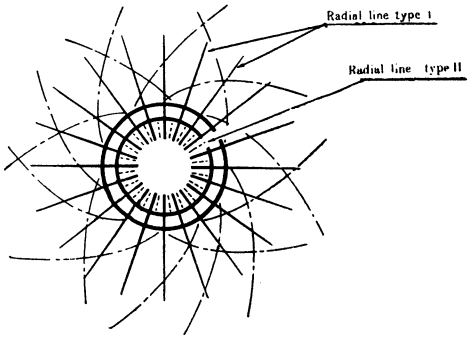


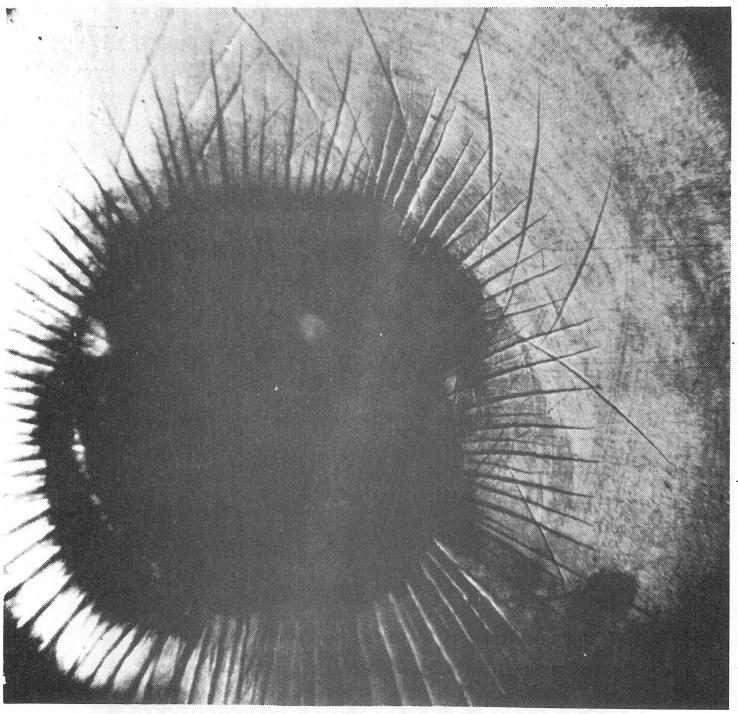
Fig. 2. Schematic representation of flow lines.

1) Radial line type I, $\sigma_\theta = -\sigma_0$, $(\sigma_r < 0)$.
2) Logarithmic spiral type, $\sigma_r - \sigma_\theta = \sigma_0$, $(\sigma_0 > \sigma_r > 0 > \sigma_\theta > -\sigma_0)$.
3) Concentric circle type and radial line type II, $\sigma_r = \sigma_\theta = \sigma_0$.

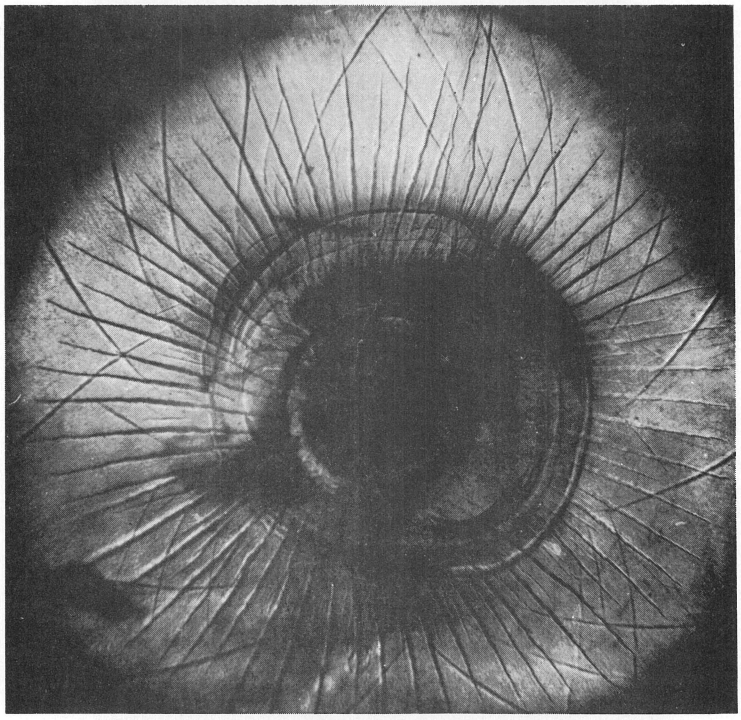
where σ_0 is the lower yield point of mild-steel under uniaxial tension at corresponding temperature, σ_r and σ_θ are radial and circumferential components of stresses respectively in polar co-ordinates of which the origin is at the center of the plate and stress σ_z normal to the surface of plate is assumed to be zero.

(1) "On the Thermal Stress Induced in A Thin Circular Disc of Mild Steel When the Central Part Is Welded." by K. Nakane. Journal of Japan Welding Society. Vol. 17, No. 1.
(2) "A Study on Strain Figures Observable in Mild Steel Arc-Weld Joints." by K. Nakane. J. Japan Weld. Soc. Vol. 22, No. 2.
(3) "Thermal Stress Due to Welding on the Thin Steel Plate." by T. Naka and T. Okumura. J. Japan Weld. Soc. Vol. 17, No. 3.
(4) "Graphical Solution of Thermal Stresses by Welding." by M. Otani. J. Japan Weld. Soc, Vol. 17, p. 349.

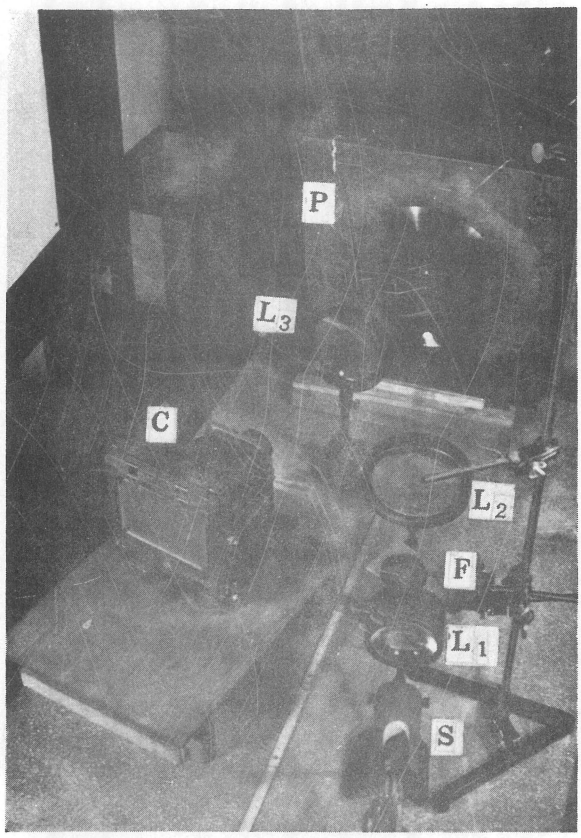
(Received January 1957)



P. I. Strain figure on plug-welded steel specimen.
The central dark part is the deposited metal.



P. II. Strain figure on the reverse side of the specimen shown in P. I.



P. III. Equipment for taking a photograph of strain figures. S, light source. L_1, condenser lens. L_2, L_3, large lens. F, filter. P, test-specimen. C, camera.