3. The other reinforcing type $\lambda_2$ is slightly more advantageous in the case of a slowly varying stressed state ($\tau \approx 1$).

It should be noted that improvement of the integral criterion $K_2$ is convenient for rapidly varying stressed states, since application of this criterion is simple (when compared with application of the criterion $K_1$).

LITERATURE CITED


USE OF LINEAR AND NONLINEAR FRACTURE MECHANICS FOR ASSESSING RESISTANCE TO CRACK PROPAGATION IN 15Kh2NMFA STRUCTURAL STEEL


This note considers a possibility of application of linear and nonlinear fracture mechanics for the assessment of resistance to crack propagation in the 15Kh2NMFA steel of a special melt using the results obtained in testing specimens of different sizes.

Experimental Procedure. The blanks were cut from a 300-mm-thick rolled steel plate. The plate was previously heat-treated by the following method: hardened at 925°C for 10 h in water, tempering at 675°C for 10 h. The short-term mechanical properties of the steel being investigated at room temperature were as follows:

- $\sigma_b = 65-71$ kgf/mm$^2$
- $\delta = 18-21\%$
- $\sigma_{0.2} = 52-54$ kgf/mm$^2$
- $\psi = 44-56\%$

The specimens recommended for the three-point bending test [1] were cut from the plate so that their cross section was normal to the direction of rolling. With regard to their size the specimens were divided into six series (Table 1).

In specimens with thickness to height ratio $B/W = 0.75$ the direction of crack propagation was normal to the plane of rolling, while in specimens with $B/W = 0.5$ it was parallel to this plane. A fatigue crack was produced in the notches following the well-known recommendations [1]. For this purpose, specimens Nos. 1 and 2 were subjected to cyclic loading on a TsDM-200Pu machine, while the other specimens were tested on a TsDM-100Pu machine. Static tests were carried out on different machines. Specimens of No. 1 series were tested in an IPS-1000 press, specimens of series No. 2 were tested in a MAN press (static load to 500 tons), and all others on a GRM-1 machine. The tests involved the measurement of the opening of the notch edges using a gauge. The load was measured by means of strain gauges mounted on a loading roll. The graph
Fig. 1. Force-displacement of notch edges graph for specimens Nos. 1 (a) and 16 (b).

Fig. 2. Experimental (dots) and calculated (solid line) limiting load as a function of crack length for specimens recommended for three-point bend tests: 1-6) series 1, 2, 3a, 3b, 4a, and 4b, respectively.

TABLE 1. Dimensions of Specimens

<table>
<thead>
<tr>
<th>No. of series</th>
<th>No. of specimens</th>
<th>b, w, s* mm</th>
<th>Weight, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1–2</td>
<td>300×400×1550</td>
<td>1470</td>
</tr>
<tr>
<td>2</td>
<td>3–5</td>
<td>129×172×700</td>
<td>106–121</td>
</tr>
<tr>
<td></td>
<td></td>
<td>93×197×810</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>82×202×820</td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>6–8</td>
<td>60×80×320</td>
<td>14,4</td>
</tr>
<tr>
<td>3b</td>
<td>9–11</td>
<td>40×80×320</td>
<td>10,1</td>
</tr>
<tr>
<td>4a</td>
<td>12–15</td>
<td>27×36×148</td>
<td>1,13</td>
</tr>
<tr>
<td>4b</td>
<td>16–17</td>
<td>18×36×148</td>
<td>0,75</td>
</tr>
</tbody>
</table>

* B, specimen thickness; W, height of cross section; S, span of supports.

representing the load P versus the displacement of crack edges V was recorded by a PDS-021 recorder. On most specimens of series 3 and 4 the displacement of the point of application of load Δ was measured using a dial gauge.

Experimental Results. Large specimens produce on a P–V graph a nonlinear section ending in a sharp load drop.

In all other cases the P–V diagram ends in a sloping section while the fracture takes place after a considerable smooth reduction in load (a load jump was observed only in No. 5 specimen). Examples of graphs of both types are given in Fig. 1. The presence of a sloping section in P–V coordinates shows that in all specimens with the exception of the largest, fracture took place under the conditions of general plastic flow. The same can be determined as follows. The ultimate load for specimens with a sufficiently long crack tested for a three-point bend can be determined from the theory of slip lines [2]:

\[
P_L = 1.456\sigma_T \frac{B}{S} (W - l)^2,
\]

where \(\sigma_T\) is the yield point and \(l\) is the crack length.

Figure 2 shows the values of the nondimensional load \(3PS/2BW^2\sigma_T\) determined from the experimental results and calculated from Eq. (1). It may be seen that the experimental points, obtained for all specimens, with the exception of the largest, are located above the theoretical curve. This confirms once more that all specimens, with the exception of the largest fracture during general plastic flow. It should be noted that the two largest specimens considerably differing in crack length fracture under practically similar loads. Consequently, the level of local stress at the tip of the larger crack (specimen No. 2) was higher.

A tough area was found by a microscopic examination of the rupture surface of No. 2 specimen near the fatigue crack tip. It was apparently formed during the subcritical crack growth; no areas of this type were observed in No. 1 specimen. Visual observation revealed characteristic jumps on the rupture surfaces of the largest specimens (Nos. 1 and 2). In specimen No. 5 only one jump took place. The fracture surfaces of other specimens were tough.