Crack initiation in plain concrete*

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In his paper, Dr Walsh has indicated that, for the theory of linear fracture to be applicable to concrete, it is necessary for the specimens to be at least a certain minimum size. Following the notation in Figure 2 of the paper, tests to determine the critical stress-intensity factor (K_{IC}) will only be valid if $a \geq 2a_0$ and if the depth of the beam is at least equal to $3a$ with $a_0 = 39F_c'/\sigma_c^2$. Because of this, Dr Walsh calls in question the validity of the work of Kaplan and of Welch and, with even greater reason, the results so far published in the English literature on the subject of tests carried out on small specimens.

Nevertheless, taking account of the formulae for K_{IC} proposed by Dr Walsh, of the definition of a_0 and of the figures given in Table 1 of the paper for the properties of three types of concrete, the values of K_{IC} found in the following Table I are identical with those of Kaplan⁽¹⁾, Welch⁽²⁾ and others⁽³⁻⁹⁾.

What I expected from this study was a much higher value of K_{IC} and of the size of the disturbed zone at the crack tip. Entov and Yagust⁽¹⁰⁾ found values of K_{IC} at least twice as great ($K_{IC} = 110$ to $237 \text{ kg cm}^{-1/2}$). Their tests were made on large specimens and taking account of slow crack propagation. The disturbed zone at the crack tip covered a length of something in the region of 100 mm. Only a small part of the rupture

TABLE I: Critical stress-intensity factors for the three categories of concrete in Table 1 of the paper.

Class of concrete	Cylinder compressive strength, F_c' (N/mm ²)	Modulus of rupture, σ_c (N/mm ²)	Depth of notch, a (mm)	$K_{IC} \times 10^7$ * (dyn cm ^{-1/2})
1	13.2	3.40	44.53	5.74
2	35.0	4.78	59.73	9.50
3	68.0	9.07	32.34	13.027

$$*K_{IC} = 5\sqrt{F_c'} = 0.8\sigma_c a_0^{0.5}$$

energy (2%) is used in the formation of fracture surfaces, a substantial part (26 to 35%) is used in the formation of microcracks, and the rest is dissipated in the form of heat.

It follows from what has been said that the application of the theory of fracture to concrete necessitates a study of slow crack growth before it is possible to characterize the behaviour of the fracture under external loads acting in the concrete containing the crack. For this study, it will be necessary to use specimens of a sufficient size and to carry out the tests in such a way as to obtain controlled failure of the specimen.

*Pages 37 to 41 of MCR 94.

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