Hydraulic fracturing of concrete cylinders in an non-uniform stress field

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In this study, we compared numerical calculations for different fracture criteria with experimental data on hydraulic fracturing of cylindrical specimens made of concrete in an inhomogeneous stress field, in order to determine the most suitable for this purpose. Real wells have a significantly larger diameter than laboratory models. Therefore, it is important to investigate the scale factor, which, according to the literature, takes place during hydraulic fracturing. It is known that in the presence of stress concentration, the scale factor manifests itself at a much greater degree than under a homogenous stress state.

An experimental study of the hydraulic fracture of thick-walled cylinders with the application of a diametrical load was carried out on specimens in the form of cylinders with a central circular hole and a circular hole located at a distance of half the radius from the center of the cylinder at an angle of 45 degrees to the load application line. Experiments on hydraulic fracturing were carried out using the machine that creates a high oil pressure. Before applying the oil pressure, the cylinders were compressed in diameter using a lever system with suspended loads. Cylinders of different diameters with different hole diameters were tested to study the scale effect. Specimens were made of concrete based on aluminous cement. The preparation of a solution for casting samples was carried out by mixing sand, cement and water in the proportion 3/2/1. The value of the critical stress intensity factor of concrete that was used in non-local fracture criteria was obtained by compression of the cylindrical specimens with a notch. The modeling of the fracturing process taking into account the inhomogeneity of the stress state near the hole was carried out using the boundary elements method (in the variant of the fictitious load method). Calculation results of the ultimate pressure were compared with experimental data.

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