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DETERMINATION OF CRITICAL STRESS FIBER INTENSITY FACTOR OF CONCRETE BY TEARING OFF WITH A SPLITTING

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Annotation. There are no particular obstacles for crack propagation in high-strength concrete. However, in the dispersion-reinforced concrete obstacles in the form of fibers hamper the spread of the crack. It is clear that under the action of the load, the development of a crack is inevitable, but additional energy is expended on overcoming each obstacle in the form of a fiber, so the process of cracking can gradually fade. Thus, the fibers in the concrete are crack inhibitors. Crack resistance is a local physico-mechanical property of a solid that characterizes the ability to resist the propagation of cracks in it. Fiber concrete is a building material for which a distinctive feature is the improvement of crack resistance characteristics. The determination of the stress intensity factor makes it possible to correctly assess the resistance of the material during the formation and development of cracks. The stress intensity factor is one of the most important indicators of the crack resistance of a material such as fiber-reinforced concrete. For this reason, the methods and methods for determining this indicator should most fully disclose all the features of work under load and the quality of fiber-reinforced concrete. To determine the stress intensity factor in the laboratory, you can use the technique of Leonovich S.N., Piradov K.A., Guzeev E.A. The essence of the method consists in determining the maximum loads destroying control

specimens in compression and calculating the critical values of the stress intensity. For the authors, the task was to find a way to determine the stress intensity factor in already existing fiber-reinforced concrete structures.

This article describes a method for determining the critical stress intensity factor of structural steel fiber concrete with normal separation. On the surface of the structure, a stress concentration zone is carried out, which is loaded through an anchor installed in a hole drilled in a fiber-reinforced concrete before the microvolume is pulled out. The data obtained determine the critical stress intensity factor. In addition to the pull-out force, geometrical measurements of the truncated cone of fracture of the structural steel fiber-reinforced concrete are made. In the established relationship between them, determine the critical stress intensity factor K_{IC} of steel fiber concrete with normal separation.

Introduction. Forming and distribution of cracks in a body of reinforced concrete structures has significant effect on operational properties of the building. For the correct assessment of strength of structural concrete with the cracks formed in it, there is a need of establishment of such parameter as crack resistance, namely the critical stress intensity factor (CSIF) which is defined experimentally and is a constant for material. Especially this question is relevant at construction and exploitation of buildings and constructions with a fibrous concrete. The main distinctive feature of a fibrous concrete from the concrete reinforced by steel rebars is the increased characteristics of crack resistance [1-3].

There is a number of ways of concrete crack resistance determination on samples in laboratory conditions. However the greatest interest is attracted by a possibility of determination of fracture toughness of structural concrete, using nondestructive methods. So some possible options of obtaining parameters of crack resistance of a fibrous concrete are given in literature.

The quality control method of a fiber reinforced concrete [4] consisting in installation of an anchor in a structure and creation in it pull out effort is known. In the course of a pull out of microvolume of a fiber reinforced concrete determine the size of its linear movements along a structure. Receive the schedule of dependence of linear movements of microvolume along a structure on the size of the effort enclosed to an anchor. Determine strength of a fiber reinforced concrete by the received schedule. Using a graph "loading - movement" for the pulled-out microvolume, estimate also quality of the fiber reinforced concrete working with cracks, applying special parameters.

Shortcomings of the considered method is the following: installation of a figured anchor in a timbering; considerable complication of a test procedure, at measurement of vertical linear movements of an anchor and the pulled-out microvolume of a fiber reinforced concrete; essential convention, uncertainty of the received results, complexity of recalculation, large volume of parallel tests of samples.

The method of determination of critical stress of intensity factor in a concrete structure [5] which entity consists in the following is known: in a product of rectangular section carry out a zone of concentration of tension which is loaded before destruction and determine critical strass intensity factor by according to the data. The zone of concentration of tension in concrete structure is carried out in the form of an angular segment in the place of intersection of its perpendicular edges. The forming zone is loaded on a surface of an angular segment to its break off then measure a rupture load and parameters of the broken-off angular segment, and the critical stress of intensity factor in a concrete structure is determined by a formula.

Shortcomings of this method are: impossibility of strength of high strength concrete; impossibility of installation on an uneven surface (roughness's more than 5 mm); impossibility of installation on the flat site of a design concrete structure (only structures of rectangular section).

Work purpose. The task in development of determination method of critical stress of intensity factor of a fiber reinforced concrete of the exploited concrete at a normal separation was set that will allow to exercise in turn quality control of a fibrous concrete directly in a concrete structure in such parameters as crack resistance, frost resistance and durability of material which can be predicted depending on stress intensity factor [6].

Mathematical modeling. The objective is solved by the fact that, in a way of determination of critical coefficient of intensity of tension of a fiber reinforced concrete in a design at a normal separation, being that on the concrete structure surface carry out a zone of concentration of tension which is loaded through an anchor, the installed in pull out shot in the fibrous concrete to a pull out of microvolume and determine critical stress intensity factor by the obtained data, at a normal separation directly from a concrete on the set site, besides pull out effort, make geometrical measurements of the truncated cone of destruction of a fiber reinforced concrete of a concrete structure and in the established dependence between them, determine critical stress of intensity factor of K_{IC} of a fiber reinforced concrete at a normal separation by a formula [7]:

$$K_{IC} = \frac{3P\left[\cos^2(90-\alpha) - \sin^2(90-\alpha)\right]}{2\pi h^2 \left(1+\frac{r_0}{r_0+h\cdot tg\alpha}\right)^5} \cdot \sqrt{2\pi l}\left[\frac{0,8}{\left(\frac{R}{l}\right)^3 - 1} + 0,7\right], \qquad (1)$$

where P – the forse of a pull out, MN;

α – a corner between forming a cone of destruction and the party of the shot;

$$\alpha = arctg\left(\frac{R}{h}\right)$$

l – length forming a destruction cone.

Difference between the maximum radius of a cone of destruction and radius of the shot:

$$R = r_{max} - r_o, \qquad (2)$$

where r_{max} – the maximum radius of a cone of destruction;

r_o – shot radius;

h – shot length.

The entity of an invention is explained by drawings where the truncated cone of destruction is represented (fig. 1)

a) *b)* *c)*

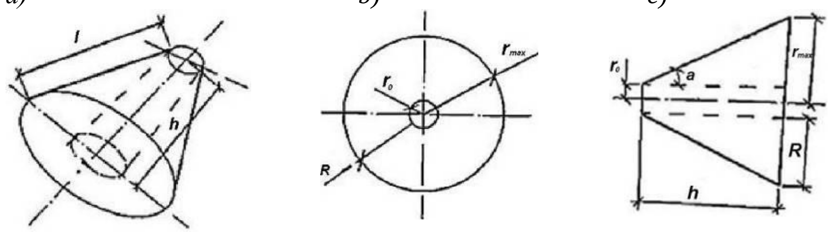

Fig. 1 – The truncated destruction cone: *a* – the scheme of the truncated cone of a pull out in an axonometric; *b* – the scheme of the truncated cone of a pull out – the front view; *c* - the scheme of the truncated cone of a pull out – a side view.

The method of determination of critical stress of intensity factor of a fiber reinforced concrete in a concrete structure at a normal separation is realized as follows. In the pull out shot in the fiber reinforced concrete the special anchor device is installed by the radius of r_0 and a part of a fibrous concrete is pulled out by the press pump, the HPPSC (hydraulic press pump self-centering) type, in the form of the truncated cone with the maximum radius of destruction of r_{max} and length of shot *h*.

Destruction happens on a cone surface, forming which coincides with the platform of the main tension.

In the course of a pull out of microvolume directly from a design on the set site besides the size of forse determine the sizes of the truncated destruction cone: r_o radius, shot *h* length, length of the forming destruction cone *l*, also calculate critical stress intensity K_{IC} of a fiber reinforced concrete by the developed formula (1).

Conclusion. In the course of testing in the way of a pull out of microvolume of a fiber reinforced concrete use characteristic only for dispersion reinforced materials the effect which is that after formation of the trunk crack determining the pulled-out microvolume the last does not separate from a construction body, and the forse from an anchor in sections with a crack is perceived by a fiber reinforcement, i.e. there is an opportunity at further loading to estimate behaviour of a fiber reinforced concrete after formation of cracks. When testing after formation of cracks there is a violation of coupling of a fiber with concrete which is followed by movement of the pulled-out microvolume along a construction body. Strength of a fiber reinforced concrete which is quality parameter is determined by force value, and calculation of critical stress intensity factor at a normal separation is made taking into account geometrical parameters of a spur and truncated cone of destruction. Thus this method belongs to nondestructive and can freely be used in already existing constructions from a fiber reinforced concrete for assessment of crack resistance.

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