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INCREASE IN CRACK RESISTANCE OF BENDING REINFORCED-CONCRETE ELEMENTS BY LOCAL DISPERSAL REINFORCEMENT OF THE TENSILE ZONE

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Introduction

Reinforced-concrete structures are the most common material for the construction of multiple purpose buildings and structures in the construction practice of all the world countries. The peculiarity of performance of the bending reinforced-concrete elements manifests itself in appearance of both compressive and tensile stresses under the loading in their transverse and sloping sections. Therefore, concrete layers of varying strength can be obtained by adding one of the fiber layers to the concrete, thus obtaining in the height of the section the reinforced-concrete elements which are characterized by local dispersal reinforcement, which in turn significantly increases the strength, especially tensile and bending strengths, crack resistance, resistance to impact and vibrational influences, that is, significantly improves the performance efficiency of the structures. It is proposed to arrange a layer of concrete with dispersal reinforcement by means of steel fiberin the tensile zone in order to increase the crack resistance of ordinary bending reinforced-concrete elements.

Material and Methods

The stress-strained (mechanical) condition of the normal section of the bending element is shown in Figure 1. In the normal section, the effect of the following internal forces is considered: S_c is the resultant of forces in the compressed zone of concrete; S_{ct} is the resultant of forces in the tensile zone of the main concrete; S_{cft} is the resultant of forces in the tensile zone of dispersal reinforced-concrete; S_s is the loading in the tensile longitudinal reinforcement. The cracking moment in the bending element with the lower layer of dispersal reinforced-concrete depends on the average tensile strength of the dispersal reinforced-concrete, the thickness of the layer of dispersal reinforced-concrete and the coefficient of reinforcement with longitudinal reinforcement. For certain structures with the given geometric parameters and initial materials, the efficiency of placing a layer of dispersal reinforced-concrete for increasing the crack resistance depending on the named influence parameters can be deduced from experiments, including the numerical mathematically designed experiment.

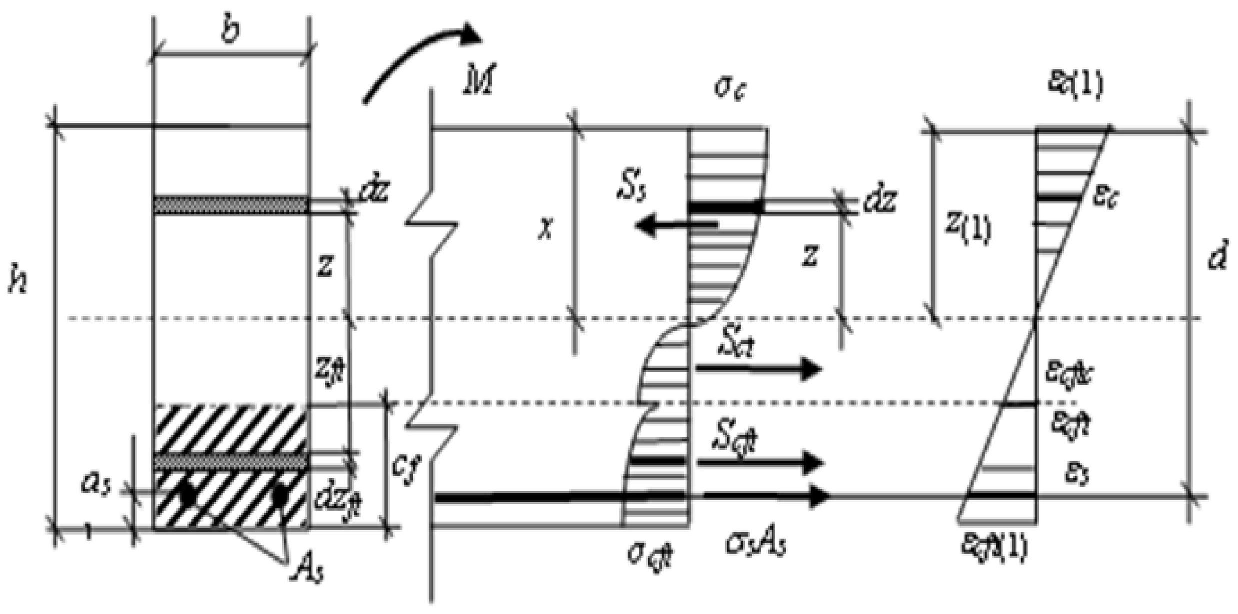
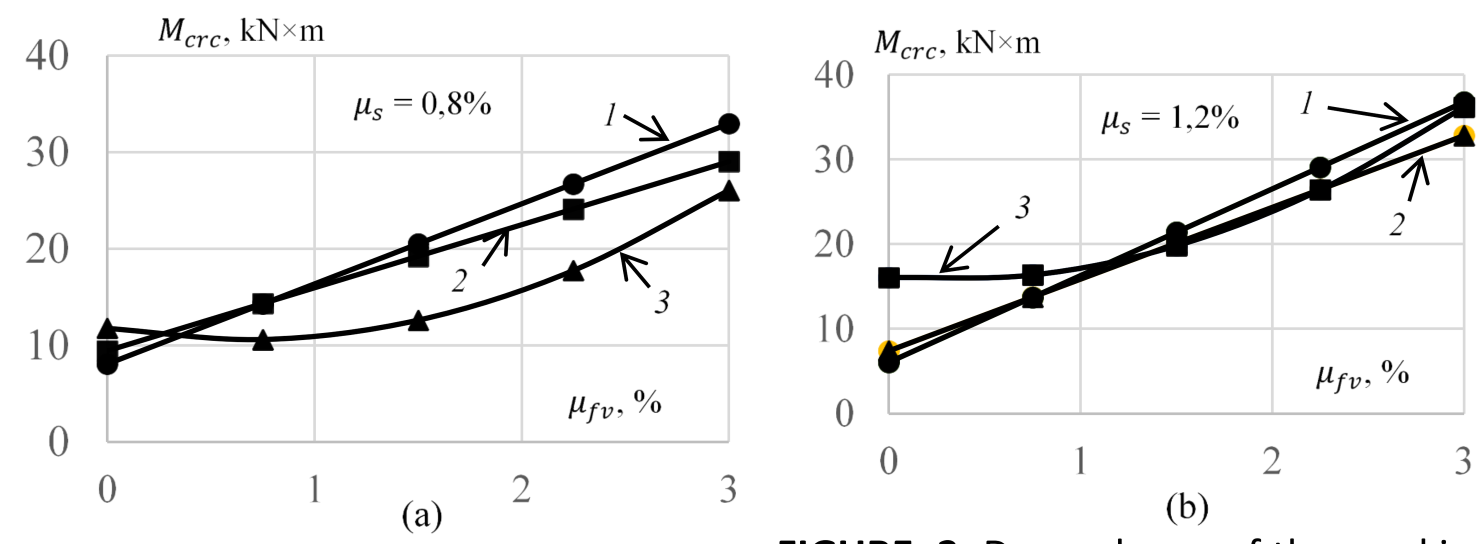


FIGURE 1. The stress-strained (mechanical) condition of the normal section of the bending element

Results

For the experiment, single reinforcement bending element of the rectangular section of the following size b × h = 20 × 50 cm, which is made of concrete of the C25/50 class and reinforced with rods of the A500C class, has been chosen. The optimal percentage, which is widely used in practice, has been adopted for longitudinal reinforcement, the values which do not exceed 3% (such percentage of fiber reinforcement is economically feasible) have been selected for the contents of fibers, the height of the concrete layer with dispersal reinforcement has been adopted in the intent that it does not exceed half of the element's height. Figure 2 shows how the coefficient of three-dimensional reinforcement with steel fiber affects the value of the cracking moment, depending on the coefficient of longitudinal reinforcement and the height of the dispersal reinforcement layer, for the construction of the bending element considered in the numerical experiment. The cracking moment equals 7.4 kNm for the coefficient of longitudinal reinforcement μ_s = 1.2% under the thickness of the dispersal reinforced layer c_f/h = 0.35 in the absence of dispersal reinforcement. This value increased to 32.8 kNm under the percentage of three-dimensional reinforcement with fiber μ_{fv} = 3.0%, that is the increase in value of the cracking moment is above4 times. It is necessary to note that it is not appropriate to make the thickness of the fiber-reinforced concrete layer more than 0,35h.



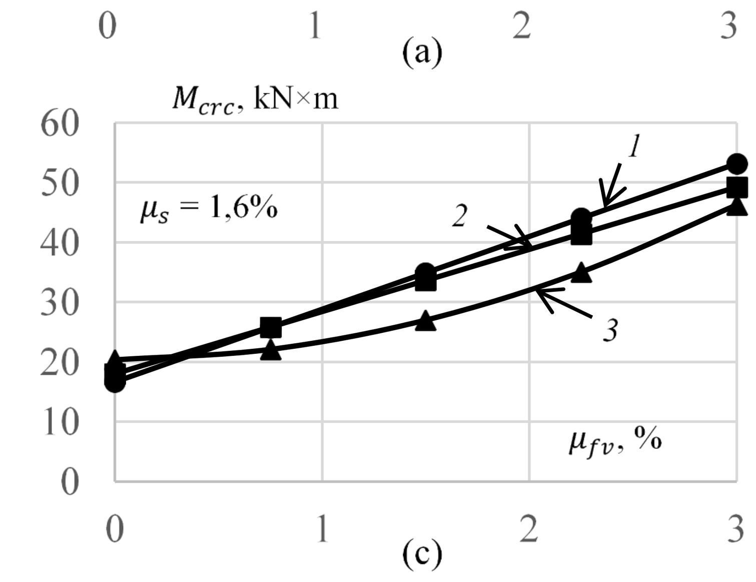


FIGURE. 2. Dependence of the cracking moment M_{crc} on the coefficient of three-dimensional reinforcement with steel fiber μ_{fv}:
(a) μ_s = 0.8%;
(b) μ_s = 1.2%;
(c) μ_s = 0.8%
1 $c_f = 0.2h$;
2 $c_f = 0.35h$;
3 $c_f = 0.5h$;

Discussions & Conclusions

1. The use of local dispersal reinforcement in the tensile zone of bending reinforced-concrete elements makes it possible to increase, in large part, their crack resistance.
2. Mathematical apparatus for determining the internal loading in the standard cross section of bending reinforced-concrete elements with local dispersal reinforcement in the tensile zone has been developed on the basis of the modern deformation methods.
3. The numerical mathematically designed three-factor experiment has been carried out. The mathematical model for determining the cracking moment in bending reinforced-concrete elements with local dispersal reinforcement in the tensile zone has been obtained on the basis of the above experiment.
4. It has been proved that the application of local dispersal reinforcement in the tensile zone of reinforced-concrete elements can increase the crack resistance by 4 times and above.

Acknowledgements

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