8th European Solid Mechanics Conference
Gerhard A. Holzapfel and Ray W. Ogden (Eds)
Graz, Austria; July, 2012

Mechanical Properties of Structural Element with Non-Homogeneous Fiber Distribution in Concrete

A. Krasnikovs[†], **O. Kononova**[†], **E. Machanovsky**[†], **V. Lapsa**[‡], **V. Lusis**[‡]

[†]Institute of Mechanics, Riga Technical University, Ezermalas str. 6, LV 1006, Riga, Latvia
akrasn@latnet.lv

[‡]Concrete Mech. laboratory, Riga Technical University, Āzenes 16/20, LV 1048, Riga, Latvia
valapsa@latnet.lv

ABSTRACT

Fiberconcrete is important material for load bearing structural elements. Fibers are bridging the cracks in the concrete, providing resistance to crack propagation and crack opening before being pulled out (main mechanism for commercially available fibers). Traditionally fibers are homogeneously dispersed in concrete. At the same time in many situations fiberconcretes with homogeneously dispersed fibers are not optimal (majority of added fibers are not participating in the load bearing process). Is obvious, that is possible to create construction with non-homogeneous fibers distribution in it, in different ways. Present research is devoted to one of them. Technologically, our observed, non-homogeneous fiberconcrete structure creation consists of: concrete mixture without fibers preparation, placing it in a mould and further compaction (at this stage is possible to vibrate the mould with a concrete). After that,

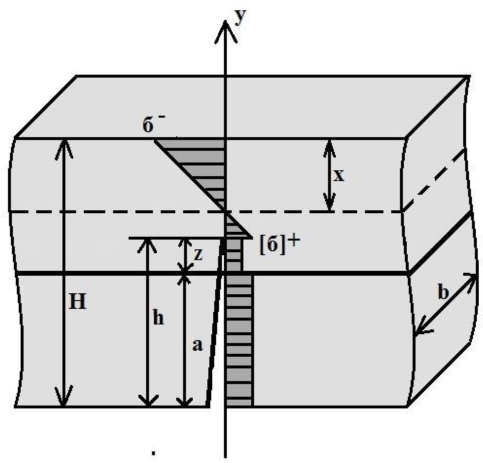

Figure 1: Stress and loads distributions in cracked fiberconcrete beam with non-uniform fiber distribution.

precise amount of steel fibers is non-uniformly strew on the upper surface of the concrete construction member and is pressed into the concrete till the necessary (may be diverse within one construction) depth. Device by which fibers are pressed into concrete may have a form of a lattice (wire or metal strip made). Lattice cell size must be some millimeters smaller than the length of strewed fibers. Vibration can be applied to the device during the pressing process. Experimentally were fabricated prisms with non –uniform fibers distribution: a) with two similar fibers concentrations were pressed at the depth of ¼ th and ¾ th of the thickness of the prism; b) with two different fibers concentrations (one fourth part of all amount of fibers were pressed at the depth of ¼ th of the thickness of the prism and three of fourth parts of all amount of fibers were pressed at the depth ¾ th of the thickness of the prism. Simultaneously prisms with the same fibers content distributed uniformly (produced in traditional way - adding fibers into the mixer with a concrete) were fabricated. All prisms were tested under four point bending conditions till the macro-crack opening displacement was reached 8mm. Material fracture process was modeled, based on a single fiber pull-out law, which was determined experimentally. For this purpose experimental program was realized and pull-out force versus pull-out fiber length was obtained (for fibers embedded into concrete at different depth and under different angle) [1]. When macro-crack is growing and opening, position of a neutral line in crack's crossection is changing, depending on the size of crack and was determined summarizing forces caring by fibers in crack's opened part (was supposed then in upper half of the beam is the concentration of fibers were pressed at the depth ¼ th of the beam's thickness and in lower half of the beam is the concentration of fibers were pressed at the depth ¾ th of the beam's thickness) and linear stress distribution in the beam's virgin part was accepted (see Fig. 1). Depending on crack size and opening, different crack parts (along the crack) are bearing different load. As the load carried by each fiber at a constant crack opening is known from micro-mechanical investigations, the corresponding total bending load P for a beam was obtained through equilibrium conditions. Beams with uniform and non-uniform fibers distribution were tested and their mechanical behavior under bending loading conditions was numerically simulated. Numerical modeling results were compared with experiments and recommendations about fibers non-uniform distribution in the beam body were done.

Acknowledgement. This research was supported by ESF Project Nr. 2009/0201/1DP/1.1.1.2.0/09/APIA/VIAA/ 112, 'Nano-technological research of the mechanical element surface and internal structure in mechanical engineering'.

References

[1] A. Krasnikovs, O. Kononova and A. Pupurs, Micromechanical Investigation of Steel Fiber Reinforced High-Performance Concrete Post -Cracking Behavior. Proceedings of 5th International Conference Fiber Concrete2009 Technology, Design, Application, 17th – 18th September 2009, Prague P.155-160.