THE MODELS SUITABLE FOR APPLICATION OF FIBRE CONCRETE WITH RECYCLING MATERIAL

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Summary

This contribution deals with fibre concrete made of recycled masonry or concrete aggregate, which substitutes fully the natural aggregate in terms of its characteristics. Examples of possible application are also presented.

Combination of recyclable building waste, synthetic fibres and binder yields a novel composite material with limited, but well utilizable properties for building structures

Keywords: Fibre concrete, recycling, construction and demolition waste

1 Introduction

Fiber concrete which uses only recycled aggregate is an interesting alternative for building industry. Several areas of application have been recognized however full-scale use of such fiber concrete is still hindered by the high cost, which is inacceptable for investors. The examples of application of such fiber concrete, which would help to meaningfully utilize the demolition waste, are so far based on numerical simulations and developed laboratory models.

Based on the experiences gathered during experiments, which focused on determination of mechanic-physical properties of this composite, the possible applications are:

- reinforcing layers (slabs) in earth structures (e.g. road and railway embankment),
- flood-resistant dikes and water reservoir dams.

The fiber concrete slabs can be placed in the earth structures which increase their slenderness and thus contribute to reduction of the volume of earth work. Another example of possible application, which is the current topic of research, is reinforcement of earth-fill dams, which extends the operating lifetime in the case of overspill during floods. When the high water spills over the dam crest, the dam can be subjected to the surface erosion. The inserted fiber concrete slabs in the earth-fill dams also in this case contribute to the stability and slenderness of the structures. Another advantage can be seen in the anchoring of the anti-erosion mats or reinforced geosythetics to the fiber concrete slabs. The exact thickness, the distance and location of the layers depends on the specific application (or structure) and optimization of the design, and always it will be the result of static check of the tackled structure.

In order to verify the presumed effect of the reinforcing layers, a laboratory model of a dam was designed and produced.

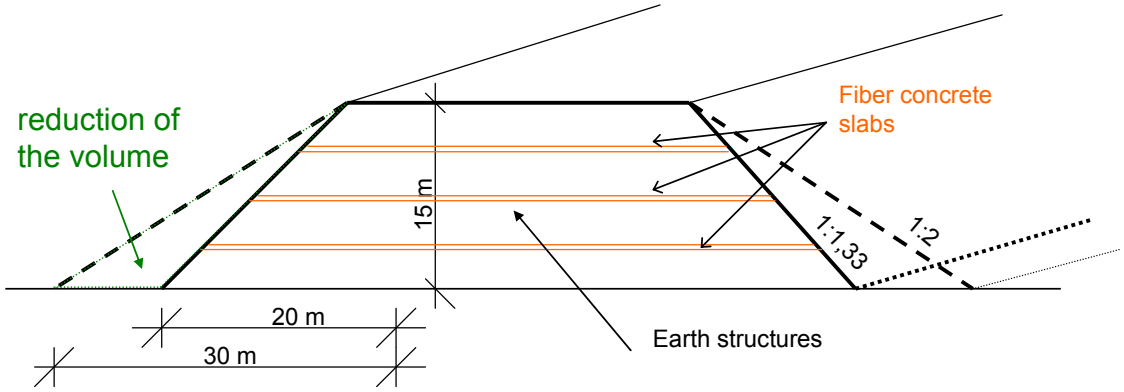

Fig. 1 Example of earth structures with inserted fiber concrete slabs

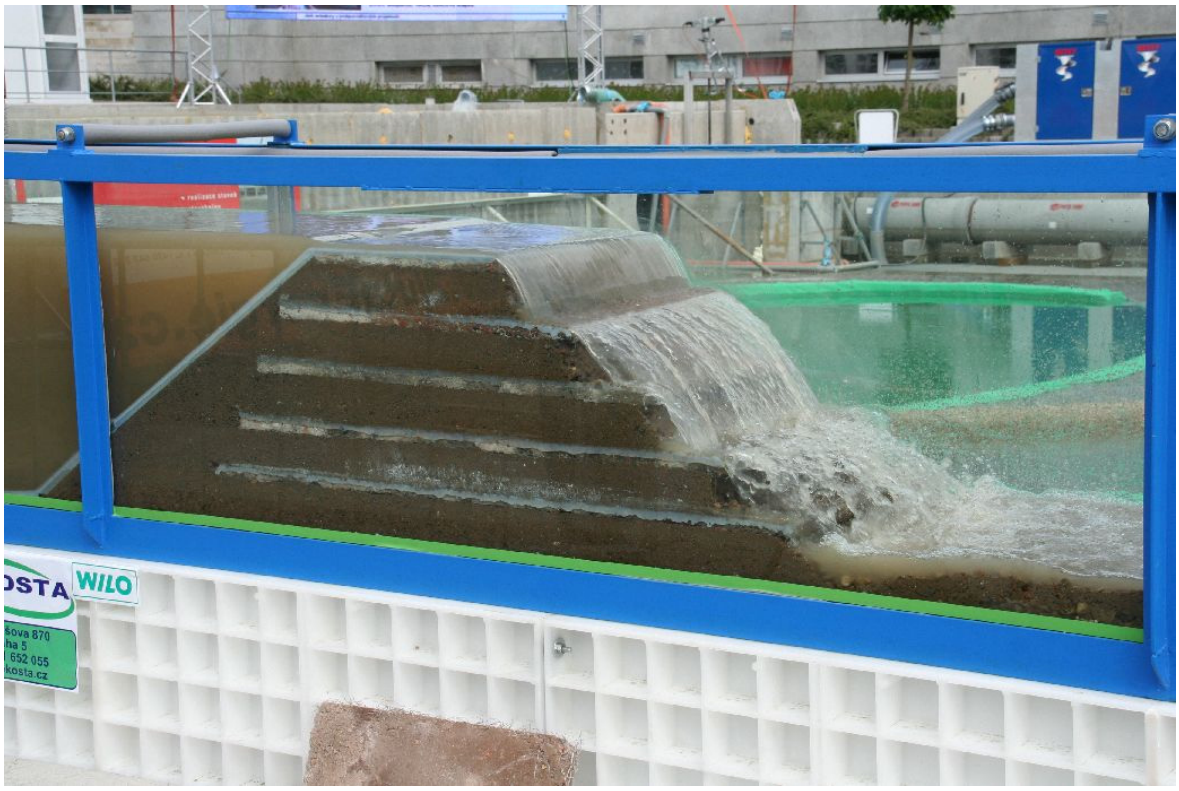

Fig. 2 Model of earth-fill dam demonstrating stability of dam after overspill lasting fore several hours

The effect of inserted fibre concrete slabs has been investigated experimentally in the Experimental Centre of Faculty of Civil Engineering, Czech Technical University in Prague Both presented examples should help to propagate the new method of application of recycled demolition waste.

2 Composition of fiber concrete

There are circa 150 recycling centers in the Czech Republic which process demolition waste. Recycled masonry and concrete waste, which is the product of these centers, can be graded according to the customer's requirements at the most strict grading when the recycled material should be used as aggregate in ordinary concrete.

The general procedure of testing of composites mostly follows the economic criteria (cost minimization) with respect to simplicity of technology and possible applicability in practice, which would contribute to the building sustainability.

In the case of preparation of fiber concrete for the intended reinforcing slabs, which are inserted in the earth structures (Figs. 1 and 2), the recycled material can be limited by the maximum particle size according to the thickness of the design slab and the length of the synthetic fibers, whose use in the fiber concrete is anticipated. The recycled aggregate graded according to this limitation can be characterized as to be of the so-call wide grading curve. The fiber concrete with the recycled aggregate with this characteristic is beneficial in the presented applications both in the fresh and hardened state.

1. Fiber concrete is porous and thus it is not water-resisting.
2. The pores and gaps contribute to the interaction with the surrounding earth, with increases the effect of the inserted slabs in the case of earth structures.
3. The porous structure of the composite allows higher ductility in tension under the condition, when the dispersed synthetic fibers are anchored with the hydrated cement paste to the recycled aggregate.

The advantage of the wide grading curve of the used recycled aggregate is apparent in the design of fiber concrete. The design can be based only on determination of the density of the compacted recycled aggregated regardless to its saturation, and the remaining components can be just added. The amount of cement should ensure the bond between the fibers and the recycled aggregate, and the amount of fibers should ensure the required uniaxial tensile strength. The amount of water should be decided according to workability requirements. The design procedure for fiber concrete with recycled aggregate can be divided into several consecutive steps (Fig. 3, 4). The mix composition is based on the following principles:

- recycled aggregate of wide grading curve (a single grade),
- constant-minimum amount of binder (cement),
- weight of fibers according to the requirement of fiber concrete properties,
- amount of water according to required workability.

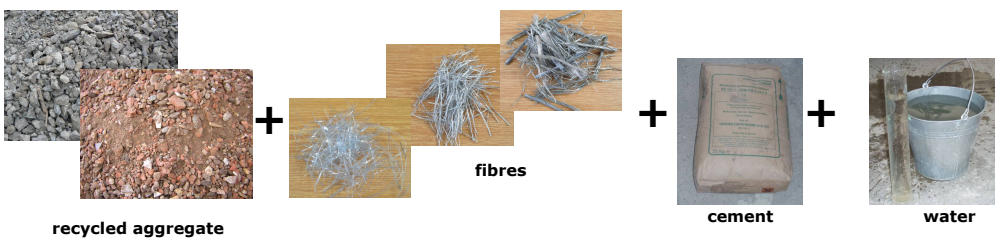

Fig. 3 Components of fibre concrete with recycled aggregate

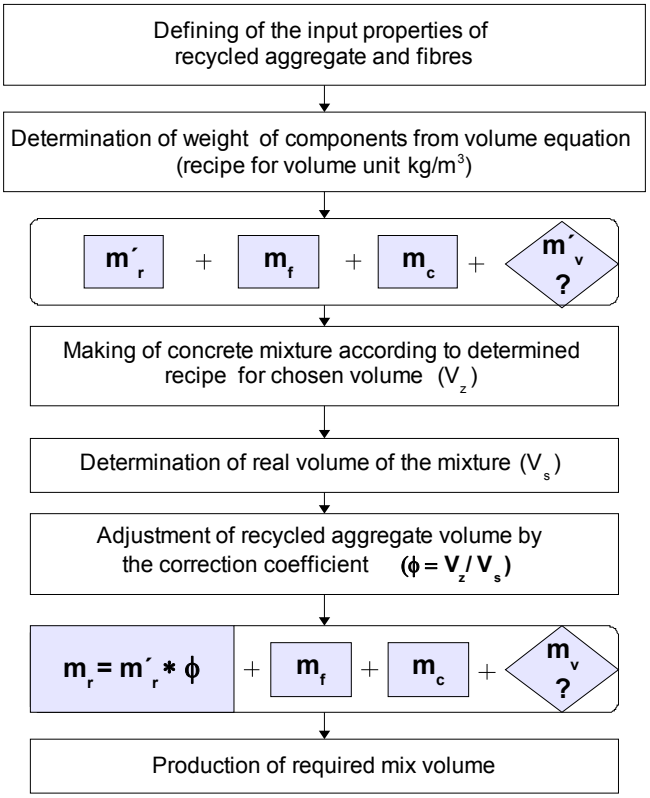

Fig. 4 Mix design of fiber concrete with recycling material

3 Conclusion

The presented examples of possible application of fiber concrete with only recycled aggregate and the presented procedure of design of fiber concrete composition shows the feasibility of processing of demolition waste. The presented examples also show the way how to solve the issue with building waste with the desired social effect.

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