APPLICATION OF FIBRE CONCRETE WITH RECYCLED AGGREGATE IN EARTH STRUCTURES

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Abstract:

This paper deals with fibre concrete made of recycled masonry or concrete aggregate which substitutes fully the natural aggregate in terms of its characteristics. The combination of recyclable building waste, synthetic fibres and binder yields a novel composite material with limited, but well utilizable properties for building structures. The application of this composite material is ensured by the synthetic fibres, which along with the other components constitutes the tough structure of the composite favourable especially under tensile loading due to its high ductility. The paper also describes application of the presented composite material in earthwork and gravity dams. These efforts help to reuse building waste and increase resistance of gravity dams to overspill, which are in accord with the sustainable building development.

Keywords: (fibre concrete, recycled aggregate, gravity dam)

1 Introduction

This contribution deals with fibre concrete made of recycled masonry or concrete aggregate, [1-3], 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. The application of this composite material is ensured by the synthetic fibres, which along with the other components constitutes the tough structure of the composite favourable especially under tensile loading due to its high ductility.

2 Recycling in the Czech Republic

Over the last two decades, the production of building waste increases, which is documented in Figure 1. The two types of recycling (static and mobile), which are common in the Czech Republic, are shown in Figure 2.

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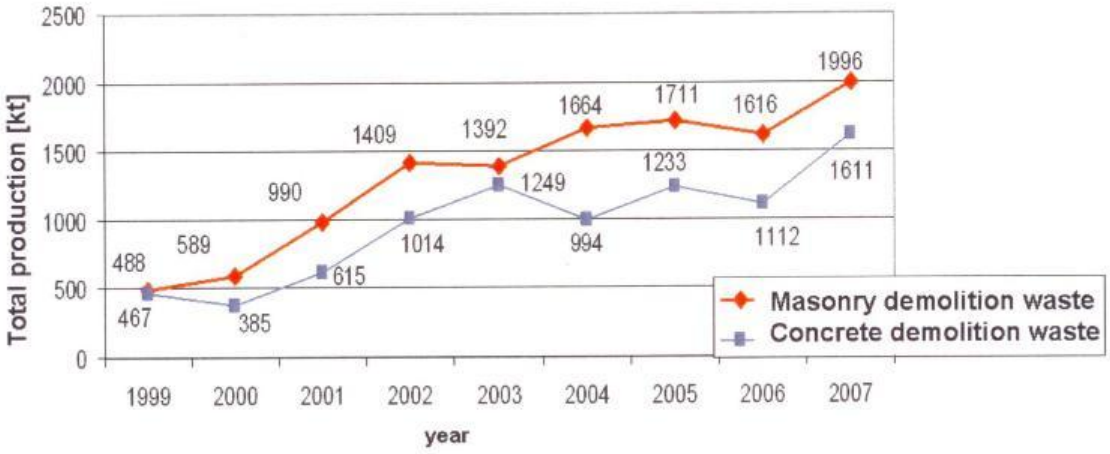

Fig. 1 Total production of building waste in recycling centres in t he Czech Republic.

Fig. 2 View of equipment used in recycling centres.

Figure 3 shows an example of demolition of a masonry structure and the piles of obtained building waste.

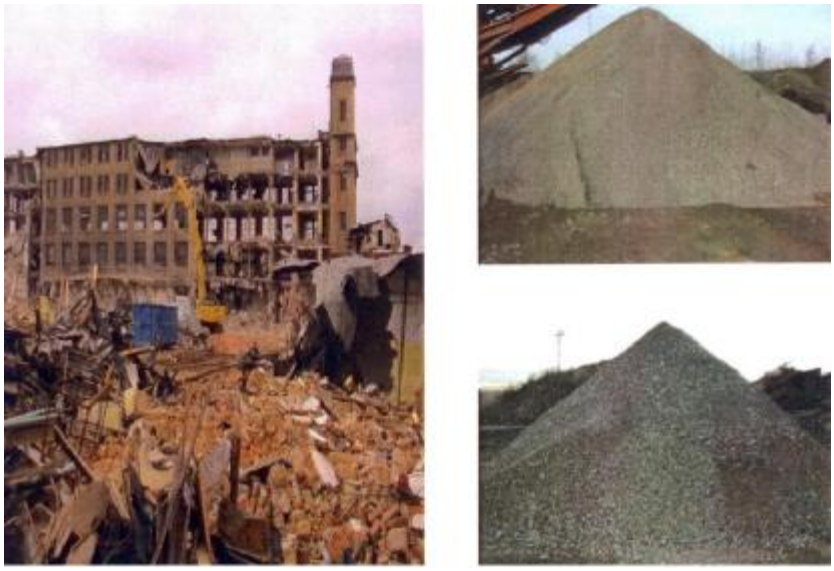

Fig. 3 Demolished structure and obtained masonry building waste, grades 0/8 and 8/32.

3 Characteristics of fibre concrete with recycled aggregate

The characteristic properties of this fibre concrete are defined by the method, or the philosophy, of the mix design, whose flow is shown in Figure 4.

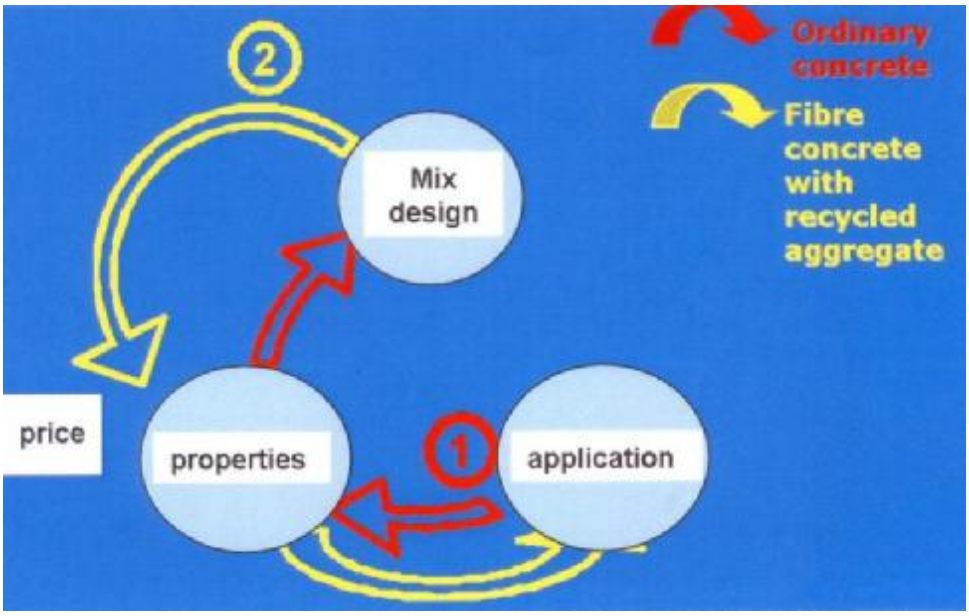

Fig. 4 View of equipment used in recycling centres.

While in the case of ordinary, or plain, concrete the material characteristics are defined by its application, which is reflected in the composition of fresh concrete, in the case of fibre concrete this process is its complete opposite. The composition is given in advance and subsequently its properties are proofed and its applicability in building industry sought.

The fundamental characteristics of the fibre concrete presented here are summarized in Table 1 and in Figure 5, which was obtained by four-point bending test with the 150 x 150 x 700 mm specimen. The percentage of fibres used is volumetric.

Tab. 1 Strength characteristics of fibre concrete with recycled masonry aggregate.

Samples	Volume of fibres FF	Bulk density	Compressive strength	Tensile-splitting strength	Flexural strength
					2 loads
		[kg/m³]	[MPa]	[MPa]	[MPa]
Test specimen 150x150x150 mm					150x150x700 mm
C 1	0,0%	2034	21,85	2,14	1,60
C 2	0,5%	2041	21,97	2,22	1,85
C 3	1,0%	2002	20,07	1,99	2,22

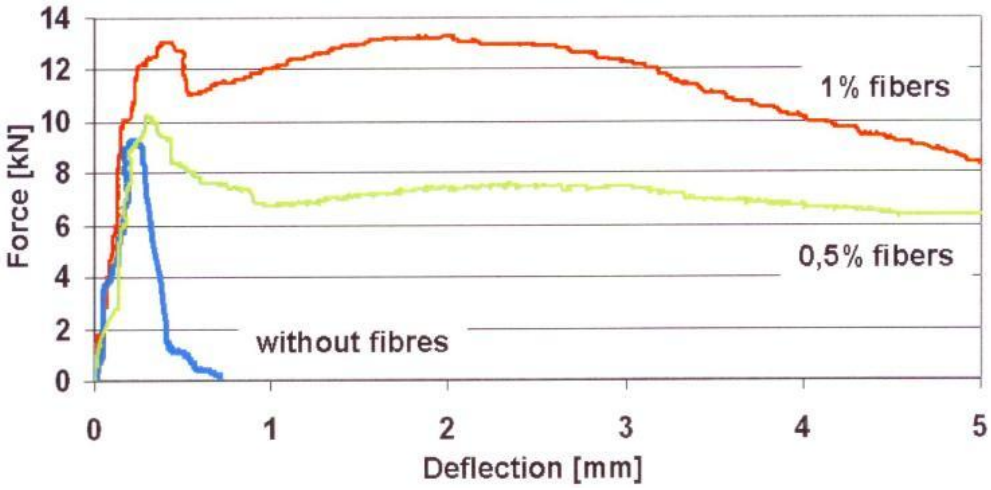

Fig. 5 Result of four-point bending test with fibre concrete with Forta Ferro fibres.

Based on the shown results, it can be concluded that fibre concrete with such characteristics is applicable in practice. The selected areas of application are small-scale, simple residential structures, earth structures and dams, which is described below.

4 Application of fibre concrete in earth structures

a) earthwork – effect of inserted slabs on its slenderness

The effect of inserted slabs on stability limit state in the shear zone has been investigated using numerical simulation. The savings in terms of smaller cross section of the embankment can be considered significant, which can be seen in Figure 6.

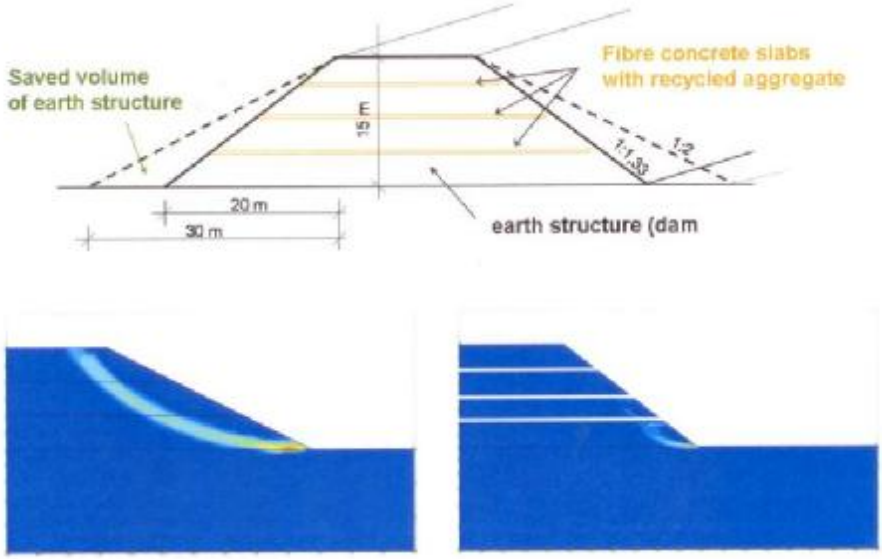

Fig. 6 Effect of inserted fibre concrete slabs in earth work (left: no slabs, right: three slabs inserted).

b) dams – effect of inserted slabs on the extent of erosion during floods

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. Figure 7 shows the original state of a test dam and its state after overspill. It is apparent that the inserted slabs change the progressing damage due to overspill considerably. The test with longer period of overspill showed that the damage reached a limit and thus the dam with inserted slabs proved serviceable in the long-term scope. The advantage of the approach to strengthening of dams can be seen in negligible increase of cost and the use of recycled waste material.

Fig. 7 Laboratory model of dam with inserted fibre concrete slabs.

Fig. 8 – 15 Model of dam presented on international exhibitions EDIT and WATENVI in Brno 2009

5 Conclusions

Combination of recyclable building waste, fibres and binder yields a novel tough composite material, whose properties offer new possible applications in building practice. The application of this material in earth structures allows processing of building waste while it effectively increases the resistance of earth dam against floods.

Acknowledgement

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