PRACTICAL APPICATION OF FIBRE CONCRETE

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Abstract

The contribution describes an application of fibre concrete to reinforcing of pipes of various sizes. The fibres used are steel fibres Fibrex and Arcelor, and synthetic fibres Forta Ferro. The effect of the fibres is compared among each other and with reference plain concrete.

Keywords: Fibre concrete; steel fibres, synthetic fibres, pipes, application.

1 Introduction

Fibre concrete as a specific building material have been investigated and used for decades in the world, and the tradition of research, development and utilization is long also in the Czech Republic. The use of fibre concrete has been so far limited only to industrial floors and structures where it is necessary to eliminate the number, width and depth of cracks in concrete, or to a composite material for precast production of members of various sizes. Recently, an increase in use of fibre concrete has been registered in building industry with its application to structural members, such as foundations, basement walls, and other various vertical and horizontal structural members.

2 Practical application of fibre concrete to reinforced concrete pipes

An example of application of fibre concrete long-term research results in practice is represented by substitution of the conventional rebars in reinforced concrete pipes with fibre concrete in precast concrete production. The production was prepared within the scope of the grant project financed by the Ministry of Industry and Trade of the Czech Republic "Development of technology, material models, design methods and application of fibre concrete" in cooperation among the Czech Technical University in Prague – Dept. of Concrete and Masonry Structures, a precast concrete factory and Betotech, s r.o.

2.1 Description of project

The project consisted of the following stages:

- Choice of a product suitable for testing
- Choice of suitable fibres

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- Verification of concrete properties
- Verification of final product properties

2.2 Choice of a product suitable for testing

Reinforced concrete pipes are a very suitable product where the conventional rebars can be substituted with fibres. The products contains reinforcement cage made of spiral reinforcement, which is stiffened by longitudinal rebars. The reinforcement cage is produced using a point welding machine and its production is rather tedious. Therefore, the objective of the research was to substitute the hard work by production of fibre concrete directly in the mixing plant.

The pipe of the type 300-1200 mm is reinforced by a single reinforcement cage arranged at the centre of thickness of the wall. The pipe of the type 1400-1600 mm is reinforced with two reinforcement cages.

These products have a clearly defined and measurable parameter – the load bearing capacity at the peak compression. Conventional reinforcement increases this parameter by mere cca 10 % and its major role is keep the pipe in one piece after its collapse so that it can be moved.

The pipe with the inner diameter of 600 mm and a single reinforcement cage (Type A) and the pipe with the inner diameter of 1400 mm and a double reinforcement cage (Type B) were the most suitable for the experiments and thus they were selected.

2.3 Choice of suitable fibres

The choice of the suitable fibres was based on the extensive experience gathered in experiments conducted at the Department of Concrete and Masonry Structures, Faculty of Civil Engineering, Czech Technical University in Prague. For the initial tests of concrete, two types of steel fibres (Fibrex and Arcelor) and a synthetic fibre (Forta Ferro) were selected.

2.4 Verification of concrete properties

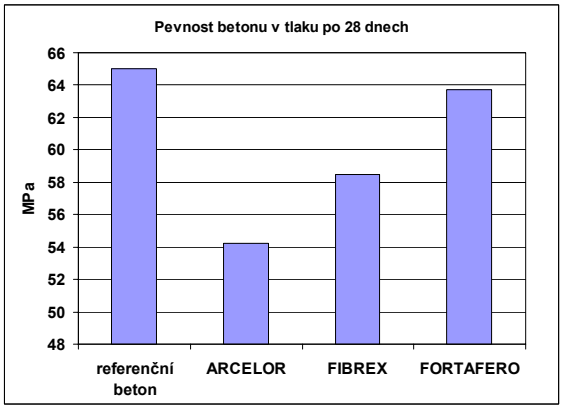

Fig. 1 Compressive strength at 28 days

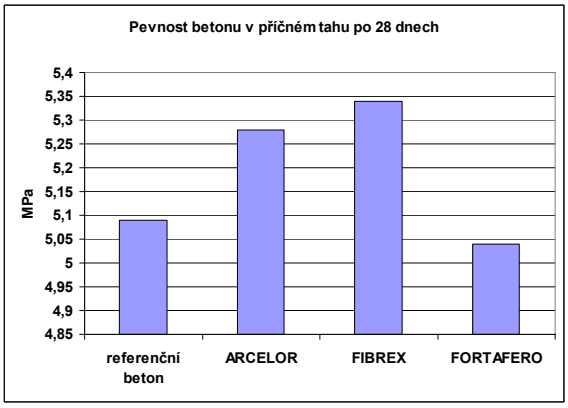

Fig. 2 Splitting tensile strength at 28 days

For verification of the properties of concrete, the class C35/45, XF4, XC0, Dmax16, Cl 0,1 was selected as it is used for production of the above mentioned pipes. Concrete was produced with a slightly wet consistency (index of compation of 1,5 to 1,6). For

comparison beside the fibre concrete, a reference plain concrete was prepared. The amount of fibre was in the case of steel fibre 40 kg/m^3 and in the case of synthetic fibres was 4,6 kg/m^3. According to the results obtained none of the types of fibre concrete was not excluded from further testing as the steel fibres reduced compressive strength of concrete and the synthetic fibres reduced the splitting tensile strength, see Figs. 1 and 2.

2.5 Verification of properties of products

Fig. 3 Setup of experiment

Fig. 4 Final crack

Type A pipes made of fibre concrete

In order to verify production process, transport and compaction of fibre concrete in the mould, and the ultimate performance of the products, five pairs of pipes made of plain concrete, reinforced concrete and fibre concrete were produced.

For tests of load bearing capacity at the peat compression, one-metre rings were cut out of the pipes and tested at the age of 28 days. During the tests, the ultimate force at crack initiation and the ultimate force at the load capacity after cracks occurred were recorded for each pair of the rings made of particular type of concrete.

Steel fibres showed higher load bearing capacity at crack initiation, while the synthetic fibres showed load bearing capacity comparable with the reinforced concrete. Further loading to the ultimate load bearing capacity showed greatest effectiveness of the Arcelor steel fibres (the rings showed measurable load bearing capacity even though lower than the common reinforced concrete). The rings made of synthetic fibres did not show any measurable residual load bearing capacity, however total collapse did not occur. The rings made of Fibrex steel fibres, which showed higher load bearing capacity at crack initiation, collapsed, though.

Type B pipes made of fibre concrete

With regard to the results obtained from the test with the Type A pipes with smaller inner diameter, the Fibrex steel fibres were excluded from experiments conducted with the Tybe B pipes. Three pipes made of reinforced concrete, fibre concrete with the Arcelor fibre and fibre concrete with the synthetic Forta Ferro fibres were prepared and used for testing the ultimate performance of the pipes. The pipes were tested in the same manner as the Type A pipes.

During the tests, the ultimate force at crack initiation and the ultimate force at the load capacity after cracks occurred were recorded for each ring made of particular type of concrete.

The steel fibres showed practically the same load bearing capacity at crack initiation as the reinforced concrete did. The synthetic fibres showed a considerable lower load bearing capacity. Further loading to the ultimate load bearing capacity was best resisted by the reinforced concrete, which could be expected, (the load bearing capacity was still increasing). The steel fibres showed a prominent decrease in the load bearing capacity and

the synthetic fibres did not yield any measurable quantity. After the test when the pipes were moved, the pipe made of synthetic fibres collapse, while the that made of steel fibres resisted the stresses related to the moving.

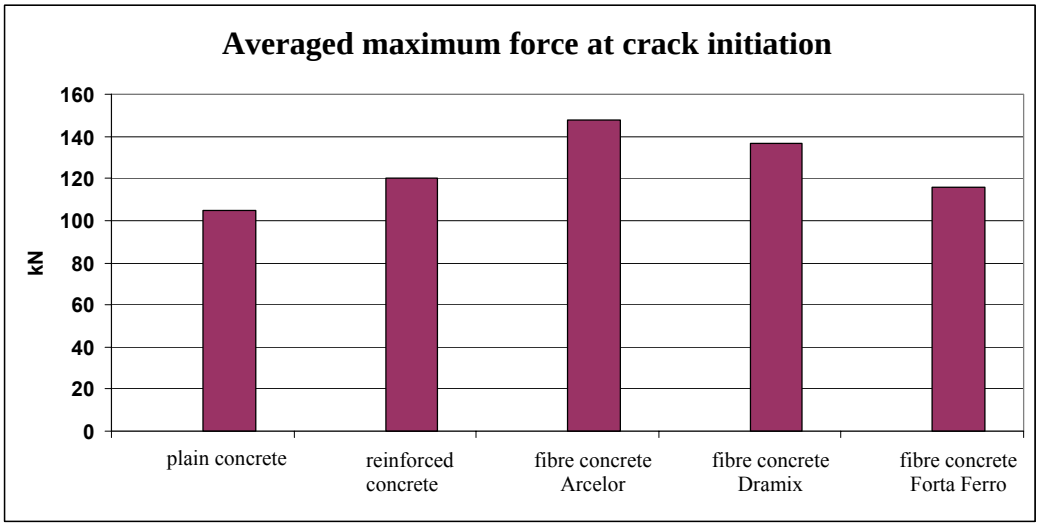

Fig. 5 Averaged maximum strength at crack initiation

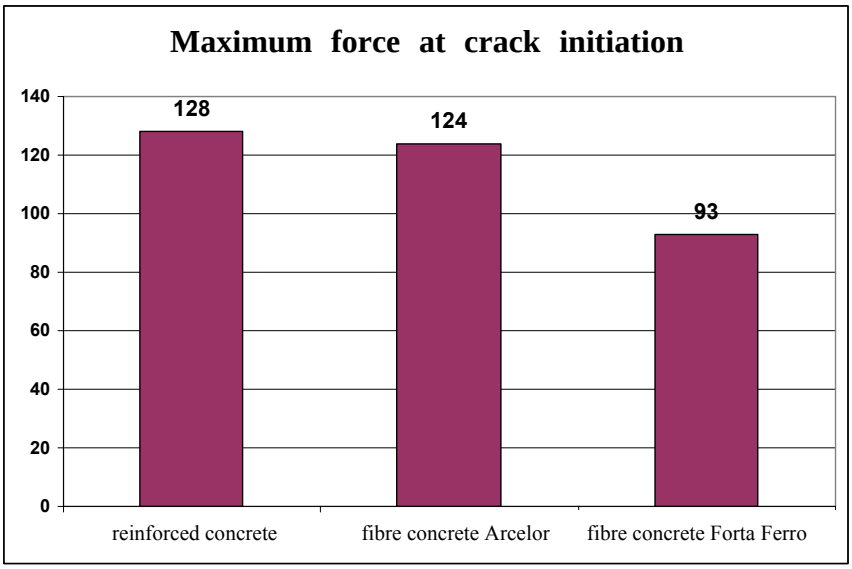

Fig. 6 Maximum strength at crack initiation

3 Conclusions

The results of this project showed that fibre concrete is suitable for application in production of reinforced concrete pipes, however not every type of a fibre available at the market is suitable for this particular application.

Aknowledgements

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