THE HISTORY AND FUTURE OF FIBRE CONCRETE

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Abstract

Fibre concrete has had modest beginnings in the Czech Republic, but has been available for use for the past 50 years. Fair fibres range. Great number of defects. Low attention to structural design. Average outlook.

Keywords: Fibre concrete, fibres, history of designing fibre concrete

1 Introduction

It is interesting to note that the reinforcement of concrete has been practiced for almost the same length of time as the use of concrete itself. Concrete is a fragile material, historically the following have been adopted for tension hardening:

- reed in plaster
- Elephant grass in concrete (New Guinea)
- Amianthus in asbestos cement
- wood profiles for hardening rings
- willow, bamboo and reed bars for tension stress (not very good – low cohesion with concrete)

Around 1930 in Germany Adolf Hitler published a thematic task to increase the tensile strength of concrete with reduced volumes of steel reinforcement – it was necessary to use the steel for the production of munitions. This task has not ever been finished and probably will not be in the near future.

It is possible to reinforce concrete using classic steel reinforcement, by prestressed reinforcement and by non-metallic materials. Increasing the tensile strength of concrete could be achieved by the adoption of fibre concrete (or steel-fibre-reinforced concrete).

2 The history of fibre concrete

Efforts to reinforce concrete using steel fibres began before World War II. Between 1938 and 1948 interest in developing this method waned (except in England and SSSR). Between 1958 and 1960 ing. K. Koruloš (Institute of Civil Engineering and Architecture,

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Bratislava) revived interest in this method of reinforcement by producing and testing beams and cubes.

After reading papers in magazines, I became interested in the development of fibre concrete since 1960 in the Faculty of Civil Engineering CTU Prague.

From literature I knew that for fibre concrete abroad, fibres used have a circular cross-section (diameter between 0,2 and 0,3 mm) and length equal to 100 times the diameter – 20 to 30 mm. Having visited the biggest hardware store in Prague, I discovered that it was not possible to buy wire of these diameters, the minimum diameter available being 0.63mm.

So I decided to buy a few kilograms of this wire. We (two students and I) cut this wire using normal clippers into elements with length 100 times the diameter of the wire – i.e. 63 mm, also with half this length - 30 mm. We then had to decide the number of fibres in: a cube with 200 mm sides, a standard beam, and decks 500 × 500 mm of thickness 30 to 50 mm. It appeared that the addition of a low value of fibres had no effect, and on the contrary, an excessive value of fibres made the workability of fresh concrete worse, 'hedgehogs' appeared. The resulting concrete, without an optimised value of fibres, was more expensive and was not found to have additional tensile strength.

3 First interests in fibre concrete

Immediately we published information about fibre concrete in the magazines *Vodní stavby* and *Pozemní stavby***.** For the first time, progressive workmen from some engineering companies wanted to use fibre concrete in practice. At first fibre concrete, with its increased tensile strength for bending loads, was practical for use in underground soffits to replace press-concrete, as this was impossible to reinforce due to technical reasons. The use of fibre concrete was also feasible for pipes, the mouth of piles, floors etc.

After some years our working team (two students, a lab technician and I) was completed by Ing. J. Vodička, CSc., Ing. J. Krátký, CSc. and Ing. K. Trtík, CSc. Gradually we arrived at an optimum value of fibres – 40 kg of fibres for 1 m^3 of concrete. Our conclusions were regularly published.

4 Our next development and the testing of fibre concrete

After the addition of our colleagues to the team, we began to produce and test larger fibre concrete elements for use in practice. We produced and tested decks with different values of fibres and beams with different fibre lengths, substituting stirrups for shear loading. We attempted to find an optimal value and length of fibres. At this time we also used fibre concrete, for example, for gunite-concrete. We published our results again in the magazine *Vodní stavby*.

5 Present situation

The present situation is well known to all conferees and I don't wish to mention it here. I present only some notes:

- production of different fibres and wires is now very good, as is the price (for using great number of fibres)
- conferences and meetings about fibre concrete are now organized with very good focus of conferees
- subjects of papers in these conferences are often duplicated, attention is mainly focused on testing elements which although important, is only of use in designing real structures
- the number of fibre concrete structures (compared with other countries) is not very great
- little attention is oriented to the collapse, trouble or reconstruction opportunities of fibre concrete structures
- the opinion that classical reinforcement could be substituted by fibres and wires, is incorrect
- for some parts of structures fibre concrete is very good
- the older idea about alignment during casting is not adopted in the Czech Republic, in some cases it could be both useful and economical
- fibre concrete is most often used in floors, but most troubles appeared here; the reason for these problems is the low value of fibres and low quality casting (segregation of the fibres near bottom surface)
- use of reinforcement meshes is competition to the use of fibre concrete
- use of non-metallic fibres is low

6 The future of fibre concrete

I think we should approach the future of fibre concrete with restraint. We have a great number of fibres (steel and non-metallic), technologies of fresh concrete processing and different categories of cements and additives.

Development of fibre concrete should be orientated towards the design and application of fibre concrete on real structures, and use during reconstruction. It must be noted that this concrete will not cause any revolution in concrete structures and will always be only an addition to the present technologies of concrete reinforcement. The use of reinforcement meshes is also an important competitor to fibre use. The aim is to reduce the number of wide cracks – compare these cracks to the greater number of thin cracks.

The effort to substitute classical stirrups by scattered fibres has no major future. The future of fibre concrete is in end-block reinforcement, floors, around openings, under the lonely forces and as a supplemental reinforcement for precast parts of structures.

7 Conclusions

This paper reports the beginnings of fibre concrete at the Department of Concrete and Masonry Structures at CTU Prague. It shortly describes the present situation and the future of this method of reinforcement. It is recommended to develop the design of fibre concrete structures, as an additive structure. This has a good future.

A lot of specialists are interested in the development of fibre concrete, but from the beginning of using this material – about 47 years ago – the use of fibre concrete is still in modest beginnings. The partial increase of tensile strength will be very important for concrete structures, see introduction. It is possible to await some particular conclusions in the near future.

Aknowledgements

This outcome has been achieved within activities No. VZ MSM 6840770001 – "Reliability, optimisation and durability of constructional materials and structures".