OPTIMALIZATION OF THE FIBRE-CONCRETE MIXTURE

J. Cigánek[1], A. Materna[2], J. Brožovský[3]

Annotation:

The proportioning of diffused micro-reinforcing constituents into concrete mixtures is a delicate and sensitive process. While their inadequate proportioning doesn't have any real effect on increase in quality, their over proportioning can be pronouncedly disastrous and can have a negative effect on the quality of the fibre-concrete mixture. It is therefore considered beneficial to conduct methodical experiments in the optimization of fibre-concrete mixtures and the various ways of exacting the optimization for parameters and proportioning of micro-reinforcing.

Key words: optimization of fibre-concrete, fibre concrete

1 Introduction

The optimization of fibre-concrete mixtures incumbent on the design of their composition, above all their assessed micro-reinforcing parameters and their proportioning, is a delicate issue. For example, inadequate proportioning of micro-reinforcing may not have any real effect on increase in quality, while over proportioning can lead to a distinctive worsening in qualitative indicators.

For the optimizing of fibre-concrete composition it is possible to use theoretical methods. These methods however, usually aren't sophisticated enough to provide satisfactory results. The main bulk of all research is therefore still conducted experimentally.
This contribution is therefore entirely dedicated to experimental research in the optimization of fibre-concrete mixtures and submits a verified and reliable model of laboratory research in optimization and, in particular, various methods of evaluation.

2 Experimental batch sets

For the proposed fibre-concrete mixtures, the project leader had at their disposal the following mixtures:

2.1 Fibre

- can vary in length, diameter, shape and material. For such research it is suitable to always use fibre whose origin and quality is such that the grading of the fibre-concrete's

[1] Prof. Ing. Jindřich Cigánek, CSc., VŠB - TU Ostrava, FAST, jindrich.ciganek@vsb.cz
[2] Doc. Ing. Alois Materna,CSc., MBA, VŠB -TU Ostrava, FAST, alois.materna@vsb.cz
[3] Doc. Ing. Jiří Brožovský, Ph.D., VŠB - TU Ostrava, FAST, jiri.brozovsky@vsb.cz

quality can be based solely upon the fibre's length and proportioning and eliminates all other influences (shape, anchoring method, diameter, cohesion etc.)

2.2 Gravel-sand mix

Matrix- the granular-metrical composition and maximum grain-size of which must correspond to the maximum length of the fibre so as not to result in their collapse (and furthermore to a decrease in density or quality of the fibre-concrete). Earlier we proved that in isolated gravel-sand mixtures the entire length of fibre for optimal composition in a 1 m^3 unit of concrete must not exceed the total length of all fibre- L_{total}.

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$$L_{total} = \frac{6\sqrt{2}}{D_0^2} \qquad [m]$$

Where D_0 is the maximum size of the grain mixture in use [m]

It is essential to note that the higher the ratio of small grains in the mixture (taken from the measurement of the largest grain), the higher the possibility to exceed the total length according to the formula given above.

2.3 Mixture composition

The composition and granular-metrical parameters of each mixture must be constant and can vary only in length and proportioning of the fibre being used.

For the production of a triad of testing bodies following the identification of their qualitative indicators we can obtain a table of measured values which form the basis for evaluation. For example, Table 1.displays the average cross-strength values established from 3 cubes of diameter 150mm using DRAMIX fibre of varying lengths (25, 50 and 60mm) and proportioning (0, 25, 50, and 75kg/m^3).

Fibre length [mm]	Proportion of fibre kg/m3 in fibre-concrete mixture			
	0	25	50	75
25	3,18	3,48	4,25	4,03
50	3,18	4,59	5,86	4,90
60	3,18	4,13	5,07	4,09

Tab. 1 Measured average cross-strength of fibre-concrete

3 Evaluation of fibre-concrete mixtures

The evaluation of the ascertained qualitative indicators can be achieved in two different ways.

3.1 Thin slab flexion method

For data approximation it is possible to use a range of other approaches. If there is no specialized software available that can work with splines then an alternative possibility is to use a random final-constituent program which implements an iso-parametric final-constituent program for slab analysis. Slab deformation is, in theory, flexibility that is represented by polynomials whose function is exploited during the creation of the final constituents.

During trial and error it is possible to consider that the influencing value is that of flexibility of thin slabs. Known values are set such as prescribed flexure (‘slack support’ of the slab) and following the static calculation gained from the flexural extent of the slab it can then be regarded as an approximation of the sought after data which ranges through all desired points.

The applied iso-parametrical final constituents are used for the static analysis of the slabs and are described as a bi-linear function (therefore polynomials of the first degree). It could be considered to be inadequate however a more precise result can be achieved by thickening the matrix of the final constituents. The creation of a suitable (preferably regular) final-constituent matrix is, as a rule, facilitated by circumstances in which the desired results of the experiment are usually formerly verified results of samples with systematically transforming and, therefore, regularly distributed characteristics.

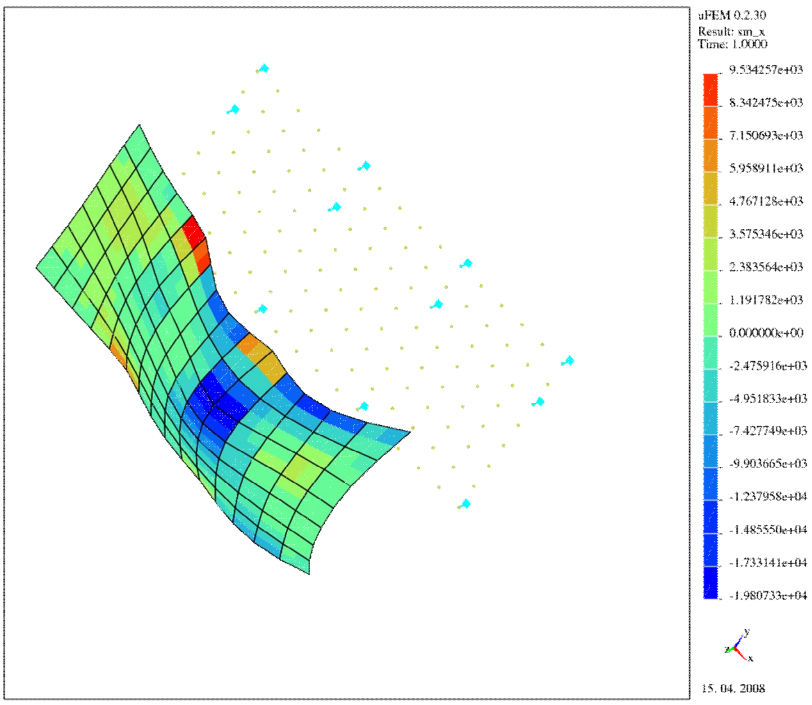


Fig. 1 Calculation of slab deformation using the final-constituent method

For the described method it is possible to use a suitable random final-constituent program which disposes iso-parametric elements for slab treatment. Illustration 1 is displayed using the software program uFEM which is utilized by the faculty for construction at The Technical University of Ostrava. Some other commercial software such as ANSYS would work just as well.

Based on the studied data a calculation was made in which wire mass values in a unit of concrete as well as the length of wire used were plotted on an x and y axis of a rectangular slab. The results attained were then established as the specified flexure in corresponding positions. Other marginal conditions were not taken into consideration. With respect to the character of approximation, the selective thickness of the slab does not have any significant influence on the calculated results.

After carrying out the calculations (the use of modern accessible computing technology means that this takes a matter of seconds) the gained results were converted to Gnuplot software which enabled the plotting of a transparent isoline. The results of the final-constituent calculated using the uFEM program are displayed in illustration 1, whose further graphic interpretations are displayed in illustrations 2 and 3.

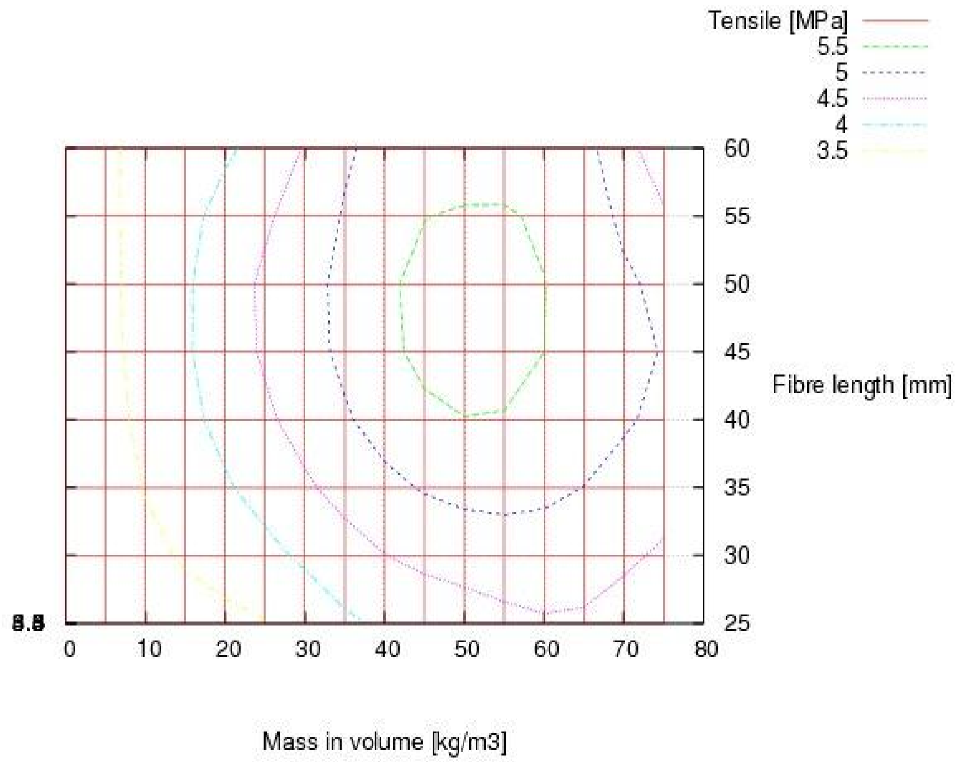


Fig. 2 Results calculated in isoline form

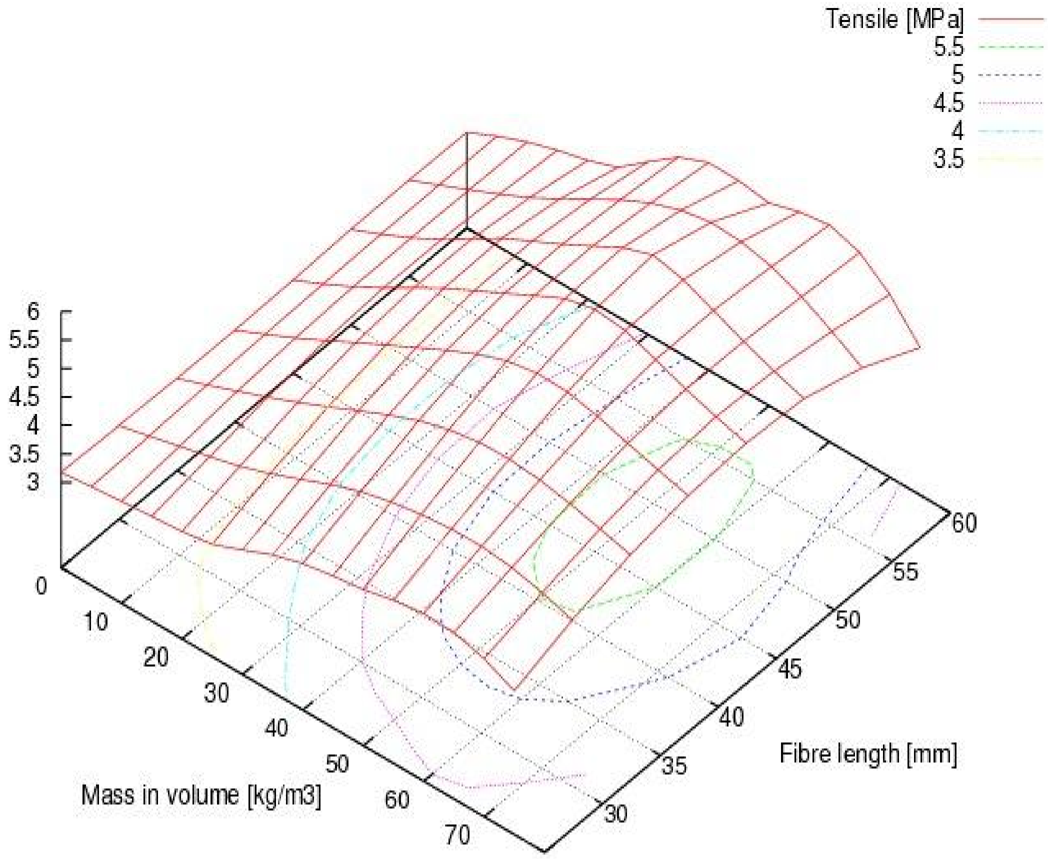
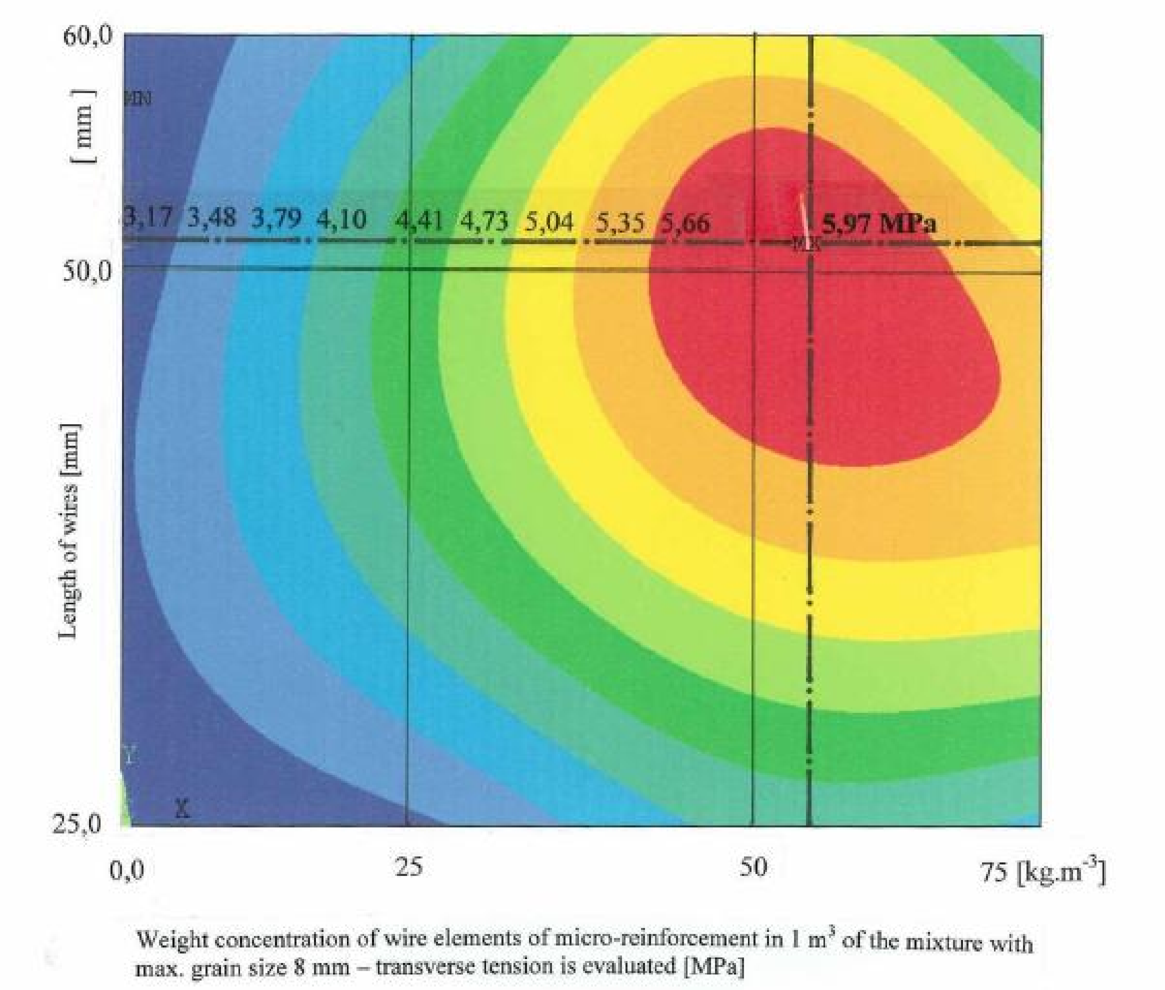


Fig. 3 Calculated results in the 3D form

Finally, with the utilization of table 1, we obtain illustration 4. This denotes zones of suitable qualitative characteristics.



Obr. 4 Example of evaluation of the optimal structure of fibre-concrete mixture

3.2 Methods of topographic planes

For a cognitive conclusion it is possible to utilize the evaluations from the results in table 1. as a set of measurements which form a topographic plane of the investigated qualities of fibre-concrete, at the culmination of which lies the optimal composition and proportioning of fibre-concrete. The evaluation can then be run through common geodetic software programs, for example GRAPHER and SURFER to assess a topographic plane. The specific example of result evaluation from table 1 is displayed in illustration 5 whereby the significant conformity of the set optimal area for the preceding method is perceivable.

OPTIMIZATION OF PROPORTIONING OF MICRO-REINFORCING

(length of mico-fibres)

(bulk weight of proportioned fibre kg/m^3)

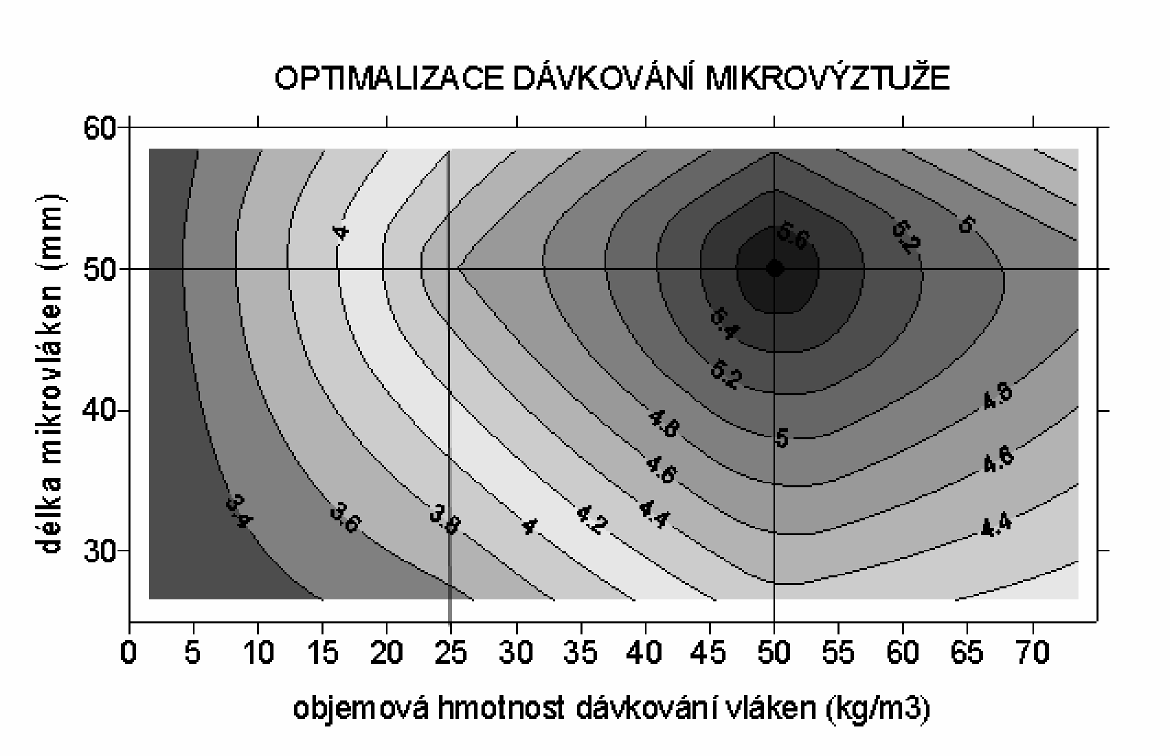


Fig. 5 Optimization of proportioned micro-reinforcing according to a set cross-strength value established by the topographic plane method

4 Conclusion

The evaluation of experimental measurement of qualitative characteristics of fibre-concrete with varying parameters of micro-reinforcing is a delicate and highly responsible matter. Various methods can be used for evaluation which shows that optimal results can be achieved only in a narrow field of micro-reinforcing parameters and their proportioning. Any deviation from these optimal parameters results in an appreciable weakening in the achievable quality of fibre-concrete which is extremely undesirable.

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