CONTROL OF DOSAGE RATE AND DISTRIBUTION OF STEEL FIBRES IN CONCRETE MIXTURE USING DOSOMETER

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Abstract

This paper details the results of controlling steel fibres dosage rate, using Dosometer, a device developed by Arcelor. The following article contains results achieved during laboratory testing as well as directly at an industrial floor jobsite.

Keywords: steel fibres, fibre dosage, distribution

1 Introduction

One of the basic expectations of steel fibre reinforced concrete (SFRC) properties is perfect three-dimensional distribution of fibres in the whole concrete structure. Regarding publication [1], it is possible to carry out this experiment by a "wash away method" - by adding large amounts of water to a specimen of concrete, washing away most of the fine elements and gravel, and manually separating the steel fibres. This test should be performed on several concrete specimens of sufficient volume. In reality, this type of experiment is probably never used. A new device, developed by Arcelor, offers extensive possibilities to easily test the distribution of fibres in a relatively short amount of time.

2 Dosometer device

This piece of equipment is designed to allow for the extraction of the absolute majority of steel fibres from an adequately large specimen of concrete. The Dosometer (see fig. 1) does not require any source of energy, because the extraction of fibres is done by a high-efficiency magnet. A specific number of samples with an optimal size of 10 litres are taken from a concrete mixture. Sample mixture falls through the testing device, and separates majority of steel fibres from the rest of the concrete mixture. Steel fibres are washed, dried and weighed (see fig. 2). Because the volume or weight of the used concrete sample is known, it is possible to measure dosage of fibres both in the sample and volume unit.

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Fig. 1 The Dosometer and sample of concrete mixture before test

Fig. 2 Cleaned and dried steel fibres, separated from SFRC mixture using the Dosometer device

3 Laboratory measuring

A SFRC mixture was prepared in a mixer in the laboratory of the faculty of civil engineering. The mixture was roughly divided in four pieces of similar size. Each of the four specimens was weighed and subsequently falls through the Dosometer. Separated fibres were washed, dried and weighed. Achieved results are summarized in Tab. 1. Approximately 40 kg of concrete mixture was tested, which means that one sample had a smaller volume (10 kg) then the above-mentioned optimal volume (10 l). The actual fibre dosage of the concrete was 25 kg/m^3.

Sample	Sample weight [kg]	Separated fibres [kg]	Dosage in sample [kg/m^3]	Deviation [%]
1	9,254	0,110	27,53	+ 10,1
2	11,196	0,101	21,68	- 13,3
3	11,851	0,107	21,70	-13,2
4	9,840	0,085	20,76	- 16,9
Average dosage kg/m^3			22,92	- 8,33

Tab.1: Results of laboratory testing

The total added amount of fibres was 0.42 kg, while during testing 0.399 kg of fibres was separated. This means that 95% of the fibres were separated. This number shows efficient performance of the Dosometer, because the missing 5% includes fibres that, for example remained in the mixer or in buckets used for moving the concrete samples. Last but not least, wasting during dosing influences this difference.

4 Control at a jobsite

Below mentioned results were achieved during testing of concrete used for SFRC industrial floor with area of several thousand sq m. Steel fibres were dosed into truck mixers with concrete at a batching plant, shortly after each truck was loaded. Fibres were dosed using a conveyor belt. The capacity of the truck mixers differed anywhere from 6 m^3 to 12 m^3. Testing was performed in three different phases. At first, one sample taken from four randomly selected truck mixers and measured, this occurred approximately in the middle of concreting. Obtained results are listed in Tab. 2. In the second stage, three samples were taken from two different truck mixers (in the very beginning, middle and the end of pouring). Results are listed in Tab. 3. Because obtained results were not satisfactory, the time of mixing was adjusted – besides mixing on the way to the jobsite, each truck mixed concrete at the maximum rotation speed for 5 min before concrete pouring. After this procedure, three samples from two different trucks were tested. Results are summarized in Tab. 4.

Sample No.	Volume	Weight of fibres	Fibre dosage	Difference	Difference
	[l]	*[g]*	*[kg/m³]*	*[kg]*	*[%]*
1	11,0	225	20,5	-19,5	-48,9
2	10,5	252	24,0	-16,0	-40,0
3	10,0	400	40,0	0,0	0,0
4	10,0	291	29,1	-10,9	-27,3
Average			**28,4**	**-11,6**	**-29,0**

Tab.2: Results of the 1st phase of testing (four samples from four truck mixers)

Truck mixer	Sample No.	Volume	Weight of fibres	Fibre dosage	Difference	Difference
		[l]	*[g]*	*[kg/m³]*	*[kg]*	*[%]*
1	**1**	10,0	748	74,8	34,8	87,0
	2	10,0	367	36,7	-3,3	-8,2
	3	10,0	353	35,3	-4,7	-11,8
2	**4**	10,0	820	82,0	42,0	105,0
	5	10,0	426	42,6	2,6	6,5
	6	10,0	272	27,2	-12,8	-32,0
	průměr			**49,8**	**9,8**	**24,4**

Tab.3: Results of the 2nd phase of testing (two times three samples from two truck mixers)

Truck mixer	Sample No.	Volume	Weight of fibres	Fibre dosage	Difference	Difference
		[l]	*[g]*	*[kg/m³]*	*[kg]*	*[%]*
1	**1**	10,0	480	48,0	8,0	20,0
	2	10,0	353	35,3	-4,7	-11,8
	3	10,0	403	40,3	0,3	0,7
2	**4**	10,0	487	48,7	8,7	21,8
	5	10,0	445	44,5	4,5	11,3
	6	10,0	398	39,8	-0,2	-0,5
	průměr			**42,8**	**2,8**	**6,9**

Tab.4: Results of the 3rd phase of testing (two times three samples from two truck mixers)

5 Conclusions

The above-mentioned results show, that it is not easy to achieve uniform distribution of fibres, not even at laboratory conditions. Results are influenced by many factors. First of all, it is way of dosing fibres. It is probable, that considerably better results could be achieved if a blast machine (a dosing equipment which uses a air flow to move fibres in a mixer) is used (see Fig. 4).

Fig. 3 Conveyor belt for dosing fibres

Fig. 4 Blast machine for dosing fibres by airflow

In any case it is obvious, that the Arcelor Dosometer, used during this pilot project, is a very suitable piece of equipment. It opens a wide range of possibilities for the quick, easy, and sufficiently accurate measuring of steel fibre distribution and dosage, an important property of SFRC that, up to now, was presumed but almost impossible to control. Therefore Dosometer is device, which allows significant improvement in the field of technology of steel fibre reinforced concrete.

References

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