RATIONAL STRUCTURE OF A TSEMENTOBETON FOR A COVERING OF HIGHWAYS

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Abstract: The article examines the effect of providing the necessary physical, mechanical and operational characteristics of the road pavement material from cement concrete intended for highways. Studies carried out in this area have shown that the technical, economic and operational characteristics of such coatings are largely due to the rational choice of the material composition. In the author's proposed work, a study was made of the effect of durability under compression (fck.cube) and on bending (fctk) and abrasion (G). Changes in these characteristics are achieved by introducing into the cement concrete plasticizer (Dynamon Easy 11), filler (microsilica) and polypropylene fiber (MAPEFIBRE NS 12/ NS 18). The obtained researches made it possible to draw a conclusion that, with rational selection, the composition significantly increases the physico-mechanical and operational characteristics of the material of the pavement from cement concrete.

Keywords: a cement concrete, a paving, a highways, filler, a fiber, the plasticizing additive.

1. Relevance of work

The analysis of works [1-4] shows that when using a tsementobeton as a covering for highways, their operational technical characteristics improve [1, 3, 4]. Such covering allows to cut a consumption on the contents and repair of the road, on 7-10% reduces fuel consumption of motor transport [5] and improves ecology. Wear of a paving [1-5], depends on intensity of a transport stream and climatic conditions in which the highway is operated. Quality of the applied material, its physicomechanical and operational indicators has essential impact on wear of a covering. Requirements to paving material from a tsementobeton for the countries of Europe are provided in the table 1 [6].

2. Work purpose

The purpose of work is, to develop rational composition of material from a tsementobeton for a covering of highways due to introduction to its structure of additives, a filler and a fiber.

Proceeding from a goal, the following research problems were accepted:

1. To study influence on quality indicators of material from a tsementobeton for a covering of the quantity entered into its structure:

a) Dynamon Easy 11 softener (TU At B.2.7-24.6-02498197-385-2004), ρ = 1,04 x 10-3 kg/m^3, (Mapei firm, Italy);

b) microsilicon dioxide (size of particles <1 microns, ρ: not condensed 130 - 350 kg/m^3, condensed 480 - 720 kg/m^3, suspension of 1320 - 1440 kg/m^3);

v) a polypropylene fiber - MAPEFIBRE NS 12/NS 18 (diameter – 0,34 microns, length of fiber is 12-18 mm, ρ – 0,91 x 10-3 kg/m^3, tensile strength – 700 MPa), (Mapei, Italy).

2. To conduct researches of change of characteristics of material, at change of the entered quantity of the considered components.

3. Using the received results to calculate mathematical models which describe changes of quality of material which is investigated.

4. To carry out the analysis of the received results and to offer recommendations about regulation of quality of a paving from a tsementabeton for highways.

Table 1

Requirements to a tsementobeton for a paving of highways in the countries of Europe [6]

Indicators	Requirements EN
Water cement relation	0,4
Classes on durability on compression (MPA)	52,5H
Durability on stretching at a bend (MPA)	6,5
Water tightness	there are no requirements
Frost resistance	there are no requirements
Istirayemost	there are no requirements
The volume of the involved air in BS for fine-grained concrete	<7%
Cement designation	TSEM I 52,5H

3. Main part

The preliminary tests which are carried out by the author and described in works [3, 7, 8] allowed to define basic composition of concrete and range of change of quantity of the entered components (table 2). The plan of carrying out experiences (tab was developed for decrease in labor input 2) and its randomization.

Factors of influence and range of their variation got out by results of preliminary experiments [3, 13, 14]. The following factors influencing quality of concrete were investigated:

x_1 - quantity of the plasticizing additive of Dynamon Easy 11 (PA) from 0% up to 1% of the mass of cement;

x_2 – quantity of a polypropylene fiber of MAPEFIBRE NS 12/NS 18 (F), from 0 to 0,6 kg/m^3;

x_3 – quantity of a filler – microsilica (M), from 0 to 15 kg/m^3 from the mass of cement.

Experiments were made in the following sequence:

- selection of compositions of the studied paving materials was carried out, and then production of necessary quantity of samples (table 2) was carried out. Samples were produced in number of 9 pieces for each point of the plan (table 2) with sizes: 0,1x0,1x0,1 m, 0,07x0,07x0,07 m and 0,04x0,04x0,16 m,

- the made samples were maintained in the conditions of normal curing within 28 days (t=200C, W=80%);

- for the 28th days samples of 0,1x0,1x0,1 m, were subjected to test for durability at compression on the 100th ton press of TESTING PL 100 firm in laboratory of firm Heidelberg Ukraine Cement,

- samples of 0,04x0,04x0,16 m were subjected to test for durability at their bend in laboratory of chair of construction materials of the Odessa state academy of construction and architecture (OGASA);- samples of 0,07x0,07x0,07 m were subjected to test for attrition, on the LKI-3 device in laboratories of chair of design, construction and operation of

Table 2

Plan of experiment (x_1... x_3) and compositions of the studied concrete (X_1 ... X_2)

№	X_1	X_2	X_3	x_1	x_2	x_3
	PA	F	M	PA	F	M
1	0	0	0	- 1	- 1	- 1
2	0	0,3	0	- 1	0	- 1
3	0	0,6	0	- 1	1	- 1
4	0,5	0	0	0	- 1	- 1
5	0,5	0,3	0	0	0	- 1
6	0,5	0,6	0	0	1	- 1
7	1	0	0	1	- 1	- 1
8	1	0,3	0	1	0	- 1
9	1	0,6	0	1	1	- 1
10	0	0	7,5	- 1	- 1	0
11	0	0,3	7,5	- 1	0	0
12	0	0,6	7,5	- 1	1	0
13	0,5	0	7,5	0	- 1	0
14	0,5	0,3	7,5	0	0	0
15	0,5	0,6	7,5	0	1	0
16	1	0	7,5	1	- 1	0
17	1	0,3	7,5	1	0	0
18	1	0,6	7,5	1	1	0
19	0	0	15	- 1	- 1	1
20	0	0,3	15	- 1	0	1
21	0	0,6	15	- 1	1	1
22	0,5	0	15	0	- 1	1
23	0,5	0,3	15	0	0	1
24	0,5	0,6	15	0	1	1
25	1	0	15	1	- 1	1
26	1	0,3	15	1	0	1
27	1	0,6	15	1	1	1

Table 3

Results of experiments

№	$f_{ck.cube}$ (MPa)	f_{ctk} (MPa)	G ($x10^3$ kg/m^3)
1	59,15	8,15	0,30
2	61,78	6,30	0,57
3	63,40	8,00	0,27
4	58,50	6,21	0,61
5	55,34	7,60	0,40
6	52,20	5,43	0,67
7	56,35	6,83	0,37
8	53,20	5,65	0,55
9	52,90	7,30	0,43
10	48,34	5,41	0,82
11	44,30	6,90	0,41
12	53,58	5,89	0,48
13	43,34	6,80	0,46
14	47,89	5,38	0,74
15	46,45	6,70	0,45
16	43,62	5,00	0,97
17	55,30	5,26	0,68
18	47,40	5,35	0,56
19	55,38	5,70	0,70
20	48,42	5,81	0,63
21	52,25	5,50	0,75
22	52,57	5,45	0,66
23	52,40	7,30	0,38
24	52,63	5,30	0,59
25	53,42	6,90	0,55
26	49,23	5,70	0,54
27	52,55	6,05	0,61

OGASA. By results of experiences there were obtained data on durability of samples at compression ($f_{ck.cube.}$), durability at a bend ($f_{ctk.}$) and resistance to attrition (G). Results of experiments are given in table 3.

Results of experiences allowed to calculate a number of mathematical models. Models describe durability at compression ($f_{ck.cube}$) (1), durability at a bend (f_{ctk}) (2) and firmness at attrition (G) (3).

The calculated mathematical models:

$f_{ck.cube.}$ (MPa) = 46,768-1,257x_1+ 1,552x_{12} + 1,753x_1x_3-2,443 x_3 +6,735 x_{32}+ (1)

$f_{ctk.}$ (MPa) = 5,854 - 0,201 x_1 + 0,359 x_1x_3-0,431 x_3 +0,544 x_{32} (2)

G (x10^3 kg/m^3) =0,619 +-0,049 x_1x_3 ++0,069 x_3 - 0,087 x_{32} (3)

4. Conclusions

On the basis of the executed researches it is possible to draw the following conclusions:

- At introduction to composition of concrete of a filler of microsilica (to 15 kg/m^3) durability on stretching at a bend on 15 increases. 20%. Durability at compression increases from 45 to 60 MPa (33%), at introduction - 1% of an additive of Dynamon Easy 11 with a filler microsilica (to 15 kg/m^3).

For convenience of the analysis of [9] models (1-3) are presented in the graphic form (figure 1, 2, 3).

- Introduction to composition of concrete of an additive of Dynamon Easy 11 in quantity from 0,8 reduces to 1% of the mass of cement V/C the mix relation from 0,5 to 0,36 (more than 20%).
- Application of a fiber from 0,3 to 0,6 kg/m^3 demands increase in an amount of water of a zatvoreniye on 8. 10%. Increases durability on stretching at a bend - 20-25%.

At introduction to 0,6 kg/m^3 of a fiber to concrete wear of concrete effectively decreases to 0,3 x 10^{-3} kg/m^3 (more than for 60%).

Thus, it is possible to draw a conclusion that application of the considered additives and a filler can be recommended in transport construction in the countries of Europe as a covering for highways.

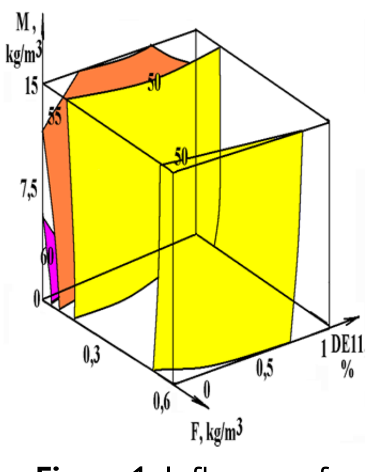

Figure 1. Influence of number of the PA (x_1), M (x_2) and F (x_3) on durability at compression (MPa)

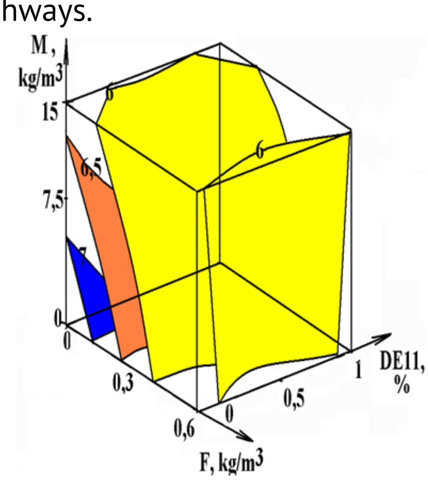

Figure 2. Influence of number of the PA, F and M on their durability on stretching at a bend (MPa)

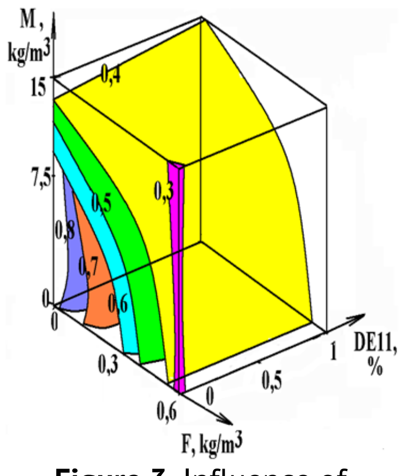

Figure 3. Influence of number of the PA, F and M on an istirayemost of G (x 10^{-3} kg/m^3)

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