

NANOSIZE SCALE ADDITIVES MIX INFLUENCE ON THE PROPERTIES OF THE HIGH PERFORMANCE CONCRETES

Dr Andrey Ponomarev*

St.Petersburg State Polytechnical University, St.Petersburg, Russia

Dr Miloš Knezević

University of Montenegro, Podgorica, Montenegro

Dr Nikolay Vatin

St.Petersburg State Polytechnical University, St.Petersburg, Russia

Svetlana Kiski

St.Petersburg State Polytechnical University, St.Petersburg, Russia

Ilya Ageev

St.Petersburg State University, St.Petersburg, Russia

It was experimentally founded, that the size and the topology of the active additives particles in the composition of the new kinds of high performance concretes is a very important parameter (as its chemical activity), especially if the combination of these additives enables realization of nonlinear phenomena. The sample which is combination of highly dispersive silica fume and nanocarbon particles of the fulleroid type - Astralenes®, was investigated. Also, the possibility to enlarge the lifetime of the polymer components in composite concretes due to the presence of the nanoparticles of fulleroid type was determined.

Key Words: Nanosize scale additives mix, Micro amount of additives, Silica fume, Astralenes®, Optimal structure of the cement stone, Improved mobility of concrete solution, Improved pressure strength, Life-time of polymer components

INTRODUCTION

A lot of different additives for concrete exist and most of them influence on the strength and the other main concrete parameters, functioning as chemical active components in concrete mixtures [02, 03, 07, 10, 11, 13, 14, 15, 16, 17]. Also, for the high performance concretes, a lot of good results have been achieved by using cement that was modified by different modifiers [01]. In same new works even the copper slag was successfully used for improving the property of the concrete [05]. There are not so much information on the dependence between the size and the topology form of the particles of these additives and their efficiency, except for example in the article [06]. The possibility of improving the properties of high performance fine-aggregate concretes (HPC) by using the nanosize scale mix of silica foam and a carbon nanoparticles of fulleroid type - Astralenes® was investigated in articles [08, 04].

Method, experimental results, discussion.

It is well known that the dependence between the catalyzation amount of the silica fume or the carbon nanoparticles and the properties of the concrete mix is not precisely researched, although it is well known that the Astralenes® influence on the properties of the composite concretes and the synergetic phenomena of mixing the micro disperse additives into concretes have been founded [09, 12]. Our work was dedicated to detail research on the influence of the micro concentration of the active silica dioxide in high disperse form (silica fume) and Astralenes® on the mobility of the high quality fine-aggregate concrete mixture and on the pressure strength of the test specimens made of this concrete. The special high disperse silica fume and Astralenes® containing modifier TC 2166-004-13800138-2004 in the concentration diapason of 10-2 – 10-5 relatively to total concrete mass was used for this research. The fine-aggregate con-

crete was made of usually used Portland Cement CEM 42,5, dry river sand 0 – 0,5 mm and mix of different doping agents, which amounts and recipe were varied. In the most experimental cases the plasticizer Penta Flow PC-AC and MF 5581 were used. The water-cement ratio usually was in the range 0,25-0,4. The mobility of the concrete mix was determined as the slump flow of the cone on the shaking table. The pressure strength of the test patterns was measured by the special digital hydroelectric measuring press with the pressure strength range till the 150 tons. The additional grinding of the silica fume have been made in a grinding mill. The grinding mill is the effective grinding equipment for grinding

the materials to the ultra disperse powders. The base material was loaded into the special grinding volume of the mill. The steel balls with the diameter 8 - 28.6 mm were inside the drum. The balls grind up the silica fume for a few hours. The particle size distribution of the silica fume before and after 5 hours of grinding was measured by laser particle size analyzer Mastersizer 2000. Measurements of the sizes of the particles have been made in a wide range between 0.02 and 2000 microns. Because the silica fume is not a very hard material the steel particles were absent into the grinded silica fume.

On the Figure 1 the size distribution for the initial and for the grinded silica fume are shown.

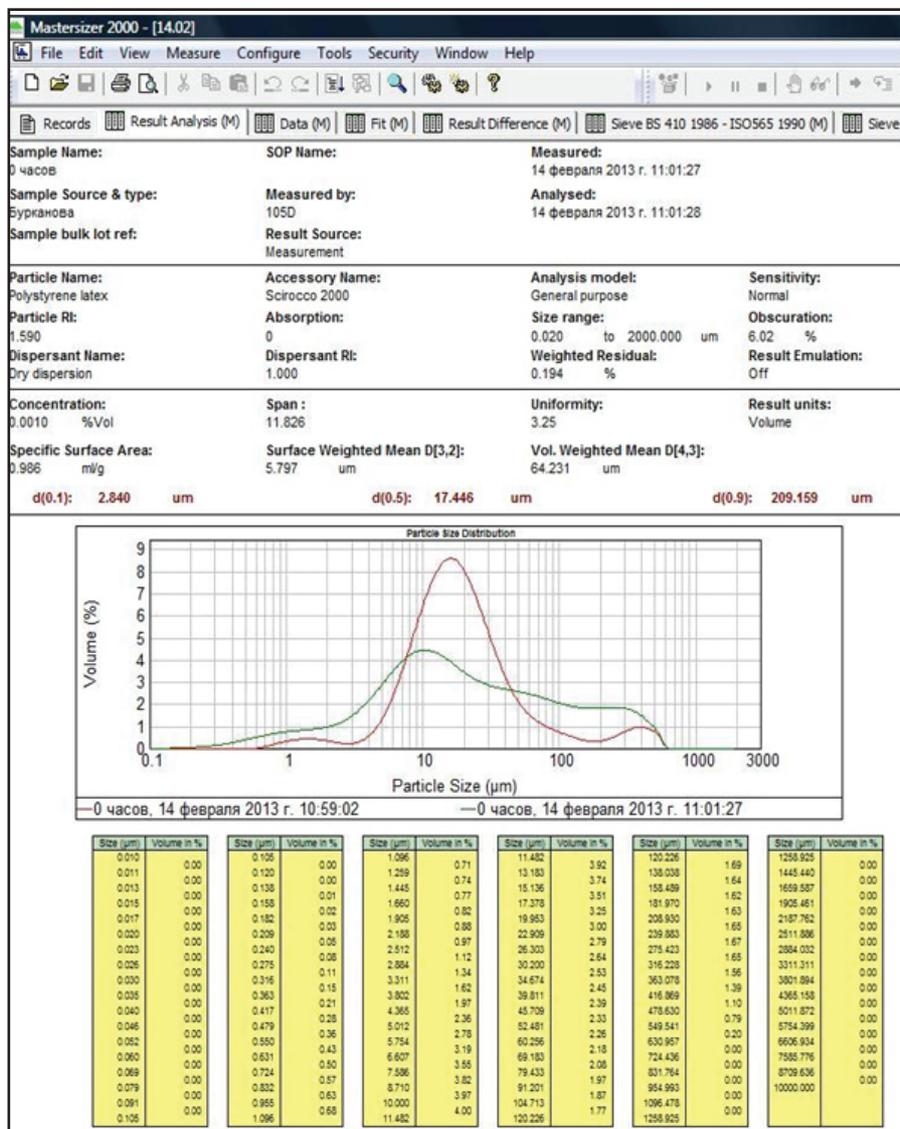


Figure1: Particle size distribution of the high disperse silica fume after 5 hours of grinding ball drum proces ing and underlying distribution red line – underlying distribution of the high disperse silica fume particles green line – the high disperse silica fume particles distribution after 5 hours of grinding

As it can be found out from Figure 2, the diapason of the additive concentration 8-30 ml/l results in nonlinear growth of the mobility of the concrete solution. The fact is, that exactly in this interval the maximum of pressure strength take place.

This phenomena is fixed on the Figure 3. Also in this concentration diapason the phenomena of the nonlinear increasing the mobility of the concrete solution have appeared even without the presence of any plasticizer, as it is possible to be seen on the Figure 4.

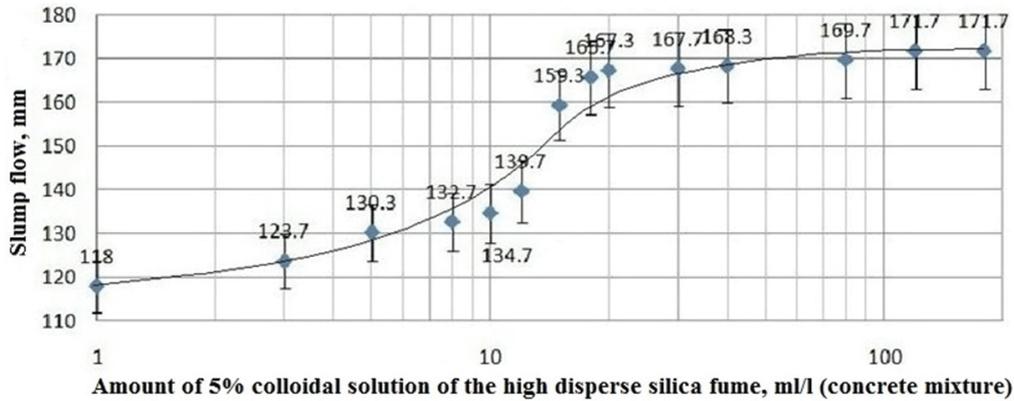


Figure 2: The micro quantity of the high disperse silica fume influence on the mobility of the modified fine-aggregate concrete mixture with hyperplasticizer MF5581 (0.4% of cement mass), W/C=0.4

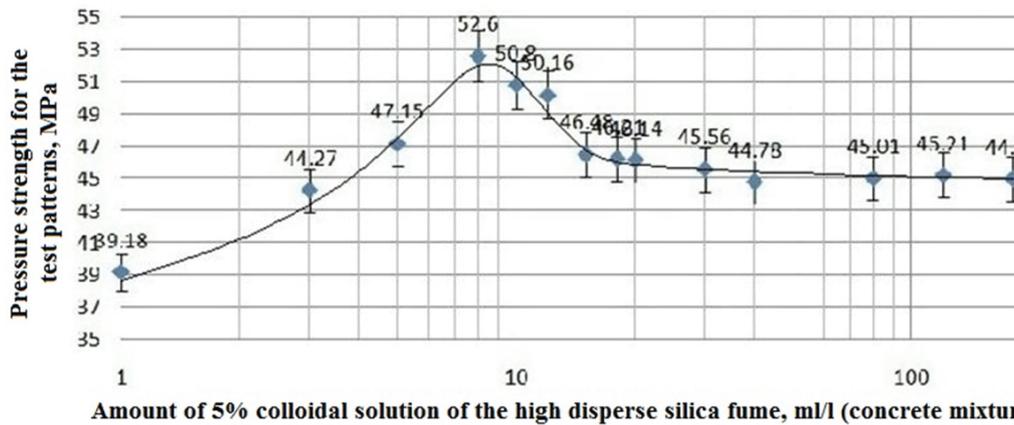


Figure 3: Micro quantity of the high disperse silica fume influence on the pressure strength of the test specimens made of modified fine-aggregate concrete with hyperplasticizer MF5581 (0.4% of cement mass), W/C=0.25

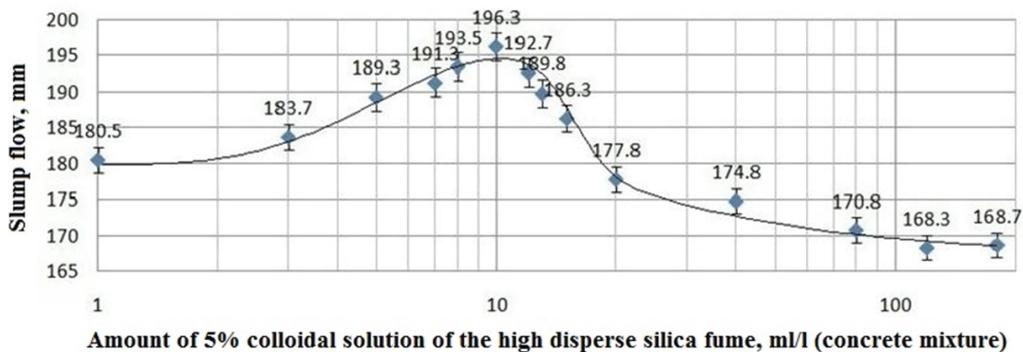


Figure 4: Micro quantity of the high disperse silica fume influence on the mobility of the concrete solution with W/C=0.4 (without any plasticizer)

By using only Astralenes® (the tor-like structure of Astralenes® is shown on the Figure 5), or Astralenes® containing modifiers as fine additive in concrete mixture also lead to increasing the pressure strength of test pattern made of modified concrete, as it is shown on Figure 6.

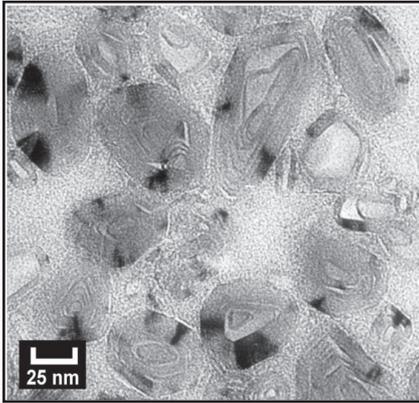


Figure 5: TEM photo of Astralenes®

The most biggest increasing of the pressure strength possibly lie in the concentration diapason $6 \times 10^{-4} - 6 \times 10^{-5}$ % of mass. Due to the nonlinear concentration dependences it was possible to find the synergy optimal relation between the amount of high disperse silica fume and amount of the Astralenes®.

By using these tools of preparing the new concretes, the light HPC (LHPC) with the density 1500 g/cm^3 (Leopor filler made) have been developed. The LHPC parameters: D1500; $\sigma_{pr} = 70 \text{ MPa}$; W20, F300 and R6 were reached.

Additionally, the very important phenomena of Astralenes® application in polymer media was founded. Exactly concentration of $6 \times 10^{-4} - 6 \times 10^{-5}$ % mass of Astralenes® lead to dumping the thermo-oxidation, photo-oxidation and radiation oxidation destruction of the different polymers, if it may be added to concrete recipes. This is the reason for increasing the life-time of polymer-concretes during its exploitation.

CONCLUSION

The non-linear dependences of the improvements of the mobility and pressure strength of the fine-aggregates concretes by doping the catalization amount of the nanosize silica fume and tor-like carbon nanoparticles (Astralenes®) were founded. The level of the maximal mobility improvement of the fine-aggregate concrete mixtures can reach more than 50%, the pressure strength improvement of the modified concrete can reach more than 40%. By using the technology of doping the very small amount of the fine disperse silica fume and same also very small amount of Astralenes® containing modifier it is possible to move in practically important branches of building industry and permit to construct the new kind of HPC (including LHPC) with the high levels of its parameters. It is especially important, that a new possibility of increasing the life-time of polymer-concretes have appeared.

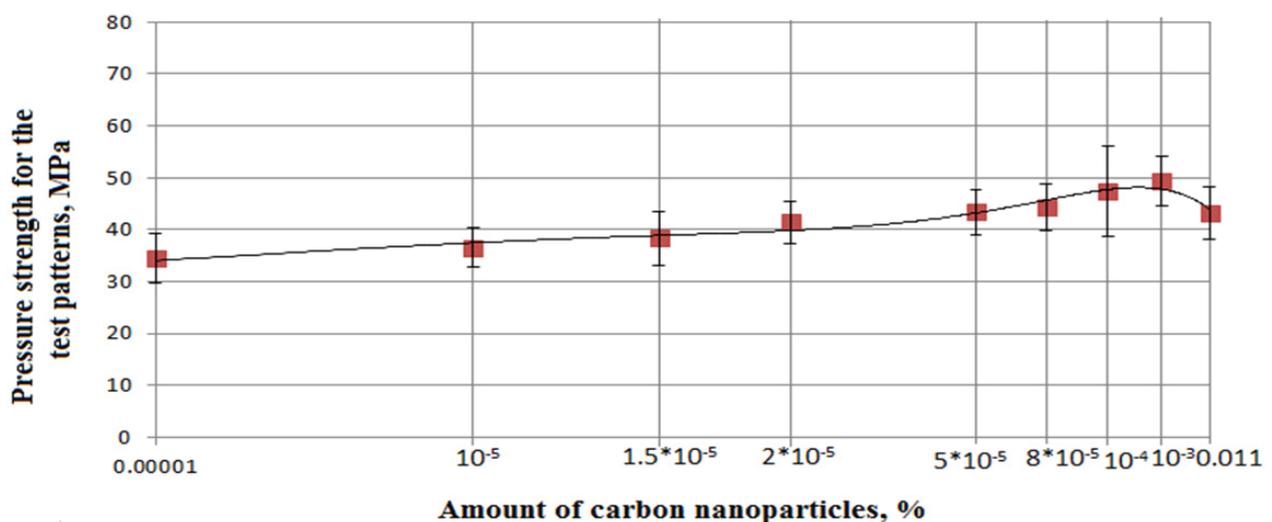


Figure 6: Dependence of the pressure strength of the concrete modified by Astralenes® from modifier concentration into the concrete mixture

SUMMARY

The task treated in this paper is fulfilled. The limit of the mobility improvement of the researched concrete mixture and the limit of the pressure strength improvement of the concrete were defined. The concentration dependences of these improvements are non-linear and it was possible to determine the intervals of the maximal levels of this improvements. We hope that the results achieved in this research are possible to become a practical tool in building materials science.

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