5. Sýkora, M. Comparison of load combination models for probabilistic calibrations / M. Sýkora, M. Holický // Applications of Statistics and Probability in Civil Engineering; Proc. of the 11th International Conference ICASP'11. Ed.by K. Nishijima. – Taylor & Francis Group, London, 2011. – P. 977–985.
6. Santos, D. M. Reliability of beams designed in accordance with Brazilian codes / D.M. Santos, F.R. Stucchi, A.T. Beck // Rev. IBRACON Estrut. Mater. – 2014. – Vol. 7. – № 5. – P. 723-746.
7. TKP EN 1990-2011 (EN 1990:2002, IDT). Eurocode – Basis of structural design : – Minsk : Ministry of architecture and construction of Belarus, 2012. – 70 p. (in Russian)
8. TKP EN 1991-1-3-2009 (EN 1991-1-3:2003, IDT). Eurocode 1. Actions on structures – Part 1-3 : General actions – Snow loads. – Minsk : Ministry of architecture and construction of Belarus, 2009. – 40 p. (in Russian)
9. SNB 5.03.01–02. Concrete and reinforced concrete structures design. Minsk : Ministry of architecture and construction, 2003. – 139 p. (in Russian)
10. SNiP 2.01.07–85. Loads and actions. Moscow : Gosstroy USSR, 1986. – 37 p. (in Russian)
11. DBN B1.2-2:2006. Loads and actions. Structural code. – Kyiv : Ministry of construction of the Ukraine, 2006. – 78 p. (in Russian)
12. Ferry Borges, J. Structural safety / J. Ferry Borges, M. Castanheta. – 2 edition. – Lisbon : Laboratório Nac. De Eng. Civil, 1971. – 326 p.
13. Turkstra, C.J. Load combinations in codified structural design / C.J. Turkstra, H.O. Madsen // J. Struct. Div. ASCE., 1980. – Vol. 106. – P. 2527–2543.
14. JCSS Probabilistic Model Code // Joint Committee of Structural Safety [Electronic resource]. – 2001. – Mode of access : http://www.jcss.ethz.ch.
15. Raizer, V.D. Methods of the reliability theory in respect to problems of standardization of design parameters of structures / V.D. Raizer – Moscow : Stroyizdat, 1986. – 192 p. (in Russian)
16. Bulychev, A.P. et al. Variable loads on strictures in commercial buildings // Structural Mechanics and Construction Design. – 1989. – №3. – P. 57–59. (in Russian)
17. Gordeev, V.N. Loads and actions on buildings / V.N. Gordeev [et al] – Moscow : Publishing House ACB, 2007. – 482 p. (in Russian)
18. Markouski, D.M. Calibration of safety parameters for reinforced concrete structures based on the target reliability indices (PhD thesis) / D.M. Markouski. – Brest : Brest State Technical Unversity, 2009. – 260 p. (in Russian)
19. EN 1992-1-1:2004. Eurocode 2. Design of concrete structures – Part 1-1 : General rules and rules for buildings. – Brussels : European Committee for Standardization, 2004. – 225 p.

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SELF-COMPACTING CONCRETE – A MATERIAL OF A NEW GENERATION

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We consider the technological, technical and economic advantages of self-compacting concrete (SCC) compared with traditional concrete of vibrational compacting. We analyze the state of normative base for the application of self-compacting concrete in construction practice, as well as composition of SCC. We investigate the possibility for reducing the cost of self-compacting concrete.

One of the dominant trends in concrete technology during the last ten years has been growing interest in the self-compacting concrete.

In the literature we can find many definitions of the self-compacting concrete, but they characterize it in the same way. It is concrete, that is able without impact on it additional external energy to flow under its own weight, retaining its homogeneity, and also ensuring a complete compaction, filling formwork and encapsulation of rebar and embedded parts.

The advantages of self-compacting concrete in comparison with other traditional types of concrete are as follows:

– creation of building structures, having high strength and no defects caused by errors when compacting the concrete mix;

– the ability to create any geometry of concrete structure;

– the use of a simpler and less massive construction formwork (due to the lack of the concrete vibration process, on the formwork is not affected by additional static and dynamic load);

– the possibility of placing per shift larger volume of concrete;

– no necessity of concrete compacting and hence eliminating errors, which might arise during its compacting;

– work of the personnel in a safe conditions during concreting;

– the absence of noise and vibration, which have a negative impact on both the staff and the residents living near the construction site;

– shortening the duration of construction.

History of the self-compacting concrete began in Japan in 1990. Professor Haim Okamura [1] created and put into practice a new generation of concrete admixtures, that is high additives for improving the mobility of the concrete mix on the basis of polyacrylate and polycarboxylate. He managed to get the concrete mix, having a high plasticity and a low water content, allowing to provide high-quality performance and increased durability of the concrete. Due to the unique properties and advantages of the concrete, it quickly spread through Western Europe.

In November 2003, in Berlin, «German Committee for reinforced concrete" published normative document «DAfStb-RichtlinieSelbsverdichtenderBeton (SVB-Richtlinie)» [2], which set out the terms and definitions, methods for diagnosis of the self-compacting concrete, and linkages document with other European regulations.

Summing up the experience gained when using self-compacting concrete in 2005 European organizations BIBM, CEMBUREAU, ERMCO, EFCA, EFNARC in 2005 developed a document «European standards for liquefied self-compacting mixture», which regulates the technical characteristics and consumer qualities constructions, made from self-compacting concrete ; requirements to source materials and composition of concrete recommendations for its use At present the study of the self-compacting concrete and methods of its diagnostics is actively continuing. Recently the studies have been carried out in at the construction department of the Technical University of Berlin, under the supervision of Professor Bernd Hillemayera [3].

So far the regulations of the Russian Federation have no indication of the possibility for the construction of the self-compacting concrete. In the republic of Belarus research in the field of the self-compacting concrete has been conducted for eleven years and its the results have become the basis for the development of Technical Code of practice «Products and designs from self-compacting concrete. Rules for the manufacture» [4]. Technical Code provides requirements for the self-compacting concrete, guidelines for the appointment of technological modes of concrete works, technique of designing of concrete with the characteristics of the spreadability of the concrete mix, strength and deformability of concrete, kinetics of increase in strength for a given temperature and humidity conditions.

In the selection of composition of the self-compacting concrete most researchers consider that in solving this problem the most important thing is the rational selection of recipes for self-compacting concrete. The concept of this formulation is based on increasing the amount of small dust particles, the type and amount of additives. Traditional concrete mix, in which predominates possible high content of particulate filler and a low content of fine particles, is not used in the preparation of self-compacting concrete, instead suspended fine particles (cement + particulate filler with a grain size $\leq$ 0,125 mm + additives for concrete), mixing water and thinner SCC form a glue, in which a large granular filler just «floats».

At present in the production of self-compacting concrete they use thinners of new generation based on polycarboxylate, highly efficient complex chemical modifier, which appeared in the 1990s and referred to a PC or PCE. The action of plasticizers of a new type based on a set of electrostatic and spatial effect, which is achieved by means of lateral polyether chains of hydrophobic molecules of the polycarboxylate ether. On one side should be known, the interaction of cement polycarboxylate based diluent, on the other side when it is necessary to take into account the mobility characteristics based on temperature. Besides some thinners when mixed int he mixer can cause excessive thinning action, which is denoted as «sediment effect» and can lead to subsequent delamination concrete.

To maintain a high fluidity strength and prevent separation and prevent the concrete mixture must have a certain viscosity. This problem is solved by introducing in the concrete mixture of additives, thickeners or using highly mineral additives. Introduction of mineral additives such as silica fume, ground limestone together with a smaller loss of mobility gives concrete mixture the mineral additive for two hours than without.

Spherical particles of the additives function as «bearings» by reducing the friction between the particles. Mineral supplements function not only as thickening agents (increasing the viscosity of the concrete mix, and water retention capacity), but also increase hydration process of the binder, contribute to an increase in the degree of crystallinity and the resulting hydrate, among which the proportion increases of more stable and sustainable weakly basic Hydrosilicates calcium.

The composition and types of self-compacting concrete are constantly evolvtd by many researchers.

Thus Kotov D.S. [5] in his study of the properties of cement stone used cement PC 500-DO, superplasticizer CM-1, hyperplasticizers HP-1 and «Stachement-2000-MG30», mineral additive – fine dolomite.

The paper presents experimental and scientifically sound mathematical models of the compressive strength and tensile modulus, the longitudinal and transverse strains, strains of shrinkage of self-compacting concrete. It has been established that to obtain a more accurate mathematical models of physical and mechanical properties of the SCC it is advisable to use structural methods, and structural characteristics by proposed N.P.Bleschikom and employees of BelNIIS.

Ta Van Fan [6] revealed a pattern of influence of rice husk ash in combination with silica fume and superplasticizer on the pore structure and the strength of crystalline concretion own deformation of cement stone SCC.

In the opinion of N.M.Morozova, V.I.Avksenteva, I.V.Borovskih, V.G.Hozina [7] its economically effective to use as fillers crushing screenings generated during the production of aggregates. Screenings of crushed rubbles by their chemical nature zre close to the main components of concrete and they are non-corrosive, which

suggests that they are sufficiently effective in the composition of self-compacting concrete. In this study, consisting of crushed waste in SCC were used together with silica fume, allowing to obtain high processing properties of the mix and strength properties of the hardened concrete.

However Ivanauskas EV [8] revealed, that crushed granite screenings and ground quartz sand is not suitable as components of the SMS because of the low water-holding capacity, angular shape of the particles, large emptiness and pollution and he found that it is effective to use as a substitute for the cement. Dolomite cement wastes (up to 15 % by weight of cement).

Chan Le Hong [9] proved the possibility of obtaining special heavy self-compacting concrete mixtures of highly mobile benign on three fractions aggregate and finely divided filler of barite ores in combination with hyperplasticizer additive.

It has been established that the high content of more dense than conventional concrete cement stone does not impair the deformation properties of SCC – autogenous shrinkage values and the values of the initial modulus of tension.

S.L. Gorbunov, Y.B. Fedorov, B.J. Trofimov, E.A. Gamaliy [10] investigated the effectiveness of plasticizers in self-compacting mortar mixes. Used as a plasticizer – superplasticizer C-3, a new generation superplasticizer ADDIMENTFM 40 on polycarboxylate ethereal on the basis of firm ADDIMENTSika (Germany). Then obtained adequate mathematical specifications depending on the dosage of cement systems plasticizers and additives ash – for variable values water-cement ratio.

A.K. Dyatlov [11] justified a possibility of obtaining modified fine self-compacting concrete on the basis on Portland cement with integrated nano-containing additive using microfiller type «Mikrodur RX», containing up to 20 % of nanoscale grains < 1 mm, using microfiller type «Mikrodur RX», containing up to 20 % of nanoscale grains < 1 mm, and fine flour carbonate (2,1 – 6 mkm), would increase the degree of hydration of the binder due to accumulation of water, increase the volume of cement gel and reduce the capillary porosity.

The patent of Shan Sandrine (Fr.), TiboTeri (Fr.) [12] proposed to use for self-compacting concrete the mix of different types of calcined bauxite sand of different particle size distribution: fine sand with an average grain size of less than 1 mm and coarse sand with average granulometry of less than 10 mm, and if necessary, white carbon, where 90 % of the particles have a size less than 1 micron, with an average diameter of about 0,5 microns, contains fumed silica in an amount of not more than 15 parts by weight 100 parts cement, antifoaming agent, superplasticizer (predominantly used type of modified polycarboxylate superplasticizer ether additionally ultrafine calcium carbonate particles having a specific surface equal to or more than 10 m^2 / g).

J.A. Alexandrov from engineering marketing company «MC Bauchemi» [13] notes, that, in accordance with the experience of the application of plasticizers in the preparation of SCC outstanding results have only been achieved with hyperplasticizers based on ether polycarboxylates (PCE). Other types of additives (based on LST, SNF, etc.) cannot compete with ether polycarboxylates technical and economic parameters. Additives, including air-entraining, accelerating and decelerating hardening concrete, can be used in the same manner as in ordinary concrete, based on the additives manufacturer's recommendations for their use in a methods of introduction.

Analyzing the state of the regulatory framework for self-compacting concrete in general and primarily in the Republic of Belarus, it can be concluded that the current Technical Code of practice 45-5.03-266 contains guidelines and recommendations for the design, construction and use of heavy SCC, intended for the construction of concrete and reinforced concrete structures using formwork. These technical standards and regulations for self-compacting concrete for road surfaces are absent.

From the perspective of the priorities in road construction in the Republic of Belarus with cement concrete coaling, the development of technical regulations is important.

After analyzing the cost-effectiveness of SCC on the basis of the experience of using this type of concrete, it should be noted:

– self-compacting concrete because of its modified composition and cost of individual components of the concrete mix is more expensive than ordinary concrete the same species. The difference in price amounts 13 to 18 Euro per 1 cubic meter;

– the most effective mineral additives are metakaolin and silica fume. Metakaolin (kaolin thermally activated) was obtained by calcining kaolinite at a temperature of 650-8000 C. The process of obtaining this material is associated with high energy and fence material;

– significantly higher sealing effect in the structure of self-compacting concrete is achieved by the use of ultrafine microsilica (silica dust). Microsilica is the most expensive mineral supplement, the cost of which ranges from 0.25 to 0,50 EUR / kg;

– economy of means is possible by using the SMS due to the fact that there is no need of compacting the concrete mix at the construction site, the device breaks during concreting and its cost ranges from 3 to 6 euros

per 1 cubic meter of concrete. Besides, the production of high quality concrete structures of enhanced durability ensures long life of their operation without maintenance and major repairs.

Summarizing the above, it should be noted:

1. The use of self-compacting concrete in the manufacture of precast and construction of monolithic reinforced concrete structures is a perspective direction in improving technology and precast reinforced concrete and further development of the building complex Republic of Belarus.

2. Due to the high cost of SCC, we must carry out research so as to get economical components for self-compacting concrete.

REFERENCES

1. Болотских, О.Н. Самоуплотняющийся бетон и его диагностика [Электронный ресурс] / О.Н. Болотских // Электронный журнал ; Харьков. нац. акад. гор. хоз-ва. – 2014. – Режим доступа: http://www.pamag.ru/pressa/auto-beton. – Дата доступа: 02.11.2014.
2. Европейский нормативный документ по самоуплотняющемуся бетону : DAfStb-Richtlinie Selbsverdichtender Beton (SVB-Richtlinie) – Ausgabe November, 2003.
3. Breitenbucher, R. Selbsverdichtender Beton / R. Breitenbucher // Beton. – 2001. – № 9. – S. 496–499.
4. Бетонные и железобетонные изделия и конструкции из самоуплотняющегося бетона. Правила изготовления: ТКП 45-5.03-266-2012. – Введ. 20.08.12. – Минск : Мин-во архит-ры и строит-ва Респ. Беларусь, 2013. – 28 с.
5. Котов, Д.С. Физико-механические свойства тяжелого самоуплотняющегося бетона : автореф. дисс. … канд. техн. наук : 05.23.05 / Д.С. Котов. – Минск, 2013. – 18 с.
6. Та Ван Фан. Самоуплотняющиеся высокопрочные бетоны с золой рисовой шелухи и метакаолином : автореф. дисс. … канд. техн. наук : 05.23.05 / Та Ван Фан. – Ростов н/Д., 2013. – 18 с.
7. Применение отсевов дробления щебня в самоуплотняющихся бетонах / Н.М. Морозов [и др.] // Инженерно-строит. журн. – 2013. – № 7. – С. 26–31.
8. Иванаускас, Э.В. Особенности применения отходов нерудных строительных материалов в технологии самоуплотняющихся бетонов. / Э.В. Иванаускас, Ж.З. Руджионис, А.Б. Штуопис // Проблемы соврем. бетона и железобетона : сб. ст. III междунар. симпозиума. – Минск : БелНИИС, 2011. – С. 9–19.
9. Чан Ле Хонг. Особо тяжелый самоуплотняющийся бетон на баритовом заполнителе : автореф. дисс. … канд. техн. наук : 05.23.05 / Чан Ле Хонг. – М., 2011. – 18 с.
10. Эффективность пластифицирующих добавок в самоуплотняющихся растворных смесях / С.Л. Горбунов [и др.] // Вестн. Юж.-Ураль. гос. ун-та. Сер. Строительство и архитектура. – 2005. – № 13. – С. 43–49.
11. Дятлов, А.К. Мелкозернистый самоуплотняющийся бетон с комплексной наносодержащей добавкой : автореф. дисс. … канд. техн. наук : 05.23.05 / А.К. Дятлов. – М., 2013. – 18 с.
12. Патент 2359936. Самоуплотняющийся бетон со сверхвысокими свойствами, способ его приготовления и применение. [Электронный ресурс] / Шаню Садрин, Тибо Тьери. – 2014. – Режим доступа: http://www.findpatent.ru/patent/235/.html. – Дата доступа: 09.12.2014.
13. Александров, Я.А. «Хидетал» – гиперпластификатор нового поколения [Электронный ресурс] / Я.А. Александров // Белорусская строительная газета. – 2014. – Режим доступа: http://cnb.by/content/view/3275/47/lang,russian/ – Дата доступа: 09.10.2014.

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STRENGTH AND DEFORMABILITY OF CONNECTIONS OF REINFORCING BARS

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The aim of presented in this work experiment is to obtain experimental data on the strength and deformability of connections of reinforcing bars.

Selection of the binder in the composition in the form of the joint of the polymeric composition based on epoxy resins due to the possibility to obtain high strength during rapid-day material. Connection length in this combination is taken to be the initial 250 mm (diameter of the abutting rods multiplied by 10) based on the results of the tensile test samples of compounds with different length sleeves. With a length of pipe – 10 ∅25 tests showed stable values gap in median plane connection with efforts of relevant ultimate steel pipe (Fig. 1).