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MUHAMMADAMIN KABULOVICH TOHIROVNING TAVALLUDINING 80 YILLIGIGA BAG‘ISHLANGAN "SAMARALI QURILISH MATERIALLARI, KONSTRUKSIYALARI VA TEXNOLOGIYALARI" MAVZUSIDAGI XALQARO ILMIY-AMALIY KONFERENSIYASI ILMIY ISHLARI TO‘PLAMI

Toshkent davlat transport universiteti Rossiya Arxitektura va qurilish fanlari akademiyasining akademigi, O‘zbekiston Respublikasida xizmat ko‘rsatgan yoshlar murabbiysi, texnika fanlari doktori, professor **Muhammadamin Kabulovich Tohirovning tavalludining 80 yilligiga** bag‘ishlangan **"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari"** mavzusidagi xalqaro ilmiy-amaliy konferensiya ilmiy ishlari to‘plami chop etildi.

Muhammadamin Kabulovich kompozitsion qurilish materiallarining polistrukturaviy nazariyasini rivojlantirishga ulkan hissa qo‘shgan olimdir. 1995-yilda Muhammadamin Kabulovich Rossiya Arxitektura va qurilish fanlari akademiyasining (RAASN) xorijiy a’zosi etib saylangan, bu esa ularning qurilish materialshunosligi sohasiga qo‘shgan ilmiy hissasining xalqaro miqyosdagi e’tirofi bo‘ldi. Ular o‘z ilmiy faoliyati davomida 6 ta monografiya, 200 dan ortiq ilmiy maqola va 25 ta ixtiroga mualliflik guvohnomasi yaratganlar.

Ushbu konferensiyaning asosiy maqsadi – qurilish materialshunosligi, bino va inshootlarni loyihalash hamda qurilish sohasidagi zamonaviy ilmiy tadqiqotlar natijalarini muhokama qilish, shuningdek, muhandislik ta’limini takomillashtirish yo‘llarini aniqlashdir.

Konferensiyada O‘zbekiston Respublikasi hamda xorijiy mamlakatlarning oliy o‘quv yurtlari va ilmiy-tadqiqot institutlari olimlari, shuningdek, muhim ilmiy tadqiqot natijalariga ega bo‘lgan ishlab chiqarish vakillari o‘z ilmiy ishlari bilan ishtirok etdilar.

"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari" mavzusidagi xalqaro ilmiy-amaliy konferensiyaning asosiy yo‘nalishlari quyidagilardan iborat:

1. **Resurs va quvvatni tejaydigan qurilish materiallari va texnologiyalari** – zamonaviy ekologik va iqtisodiy talablarni qondirishga qaratilgan innovatsion yechimlar.
2. **Bino va inshootlarning qurilish konstruksiyalari, zamonaviy hisoblash va loyihalash usullari - muhandislik** va texnologik yechimlarni takomillashtirish yo‘nalishlari.
3. **Arxitektura va shaharsozlik** – estetik va funksional jihatlarni uyg‘unlashtirgan zamonaviy loyihalar yaratish.
4. **Zamonaviy muhandislik ta’limi tizimini takomillashtirish** – kelajak mutaxassislarini yuqori malakali darajada tayyorlash uchun ta’lim jarayonini modernizatsiya qilish.

Mazkur konferensiya ilmiy hamjamiyatning turli vakillarini bir joyga jamlab, qurilish materialshunosligi sohasidagi zamonaviy muammolar va istiqbollarni muhokama qilish uchun qulay platforma vazifasini bajardi.

Study of porous structure of concrete on the basic of polyfunctional additive and low-active mineral filler

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Abstract: This study investigates the porous structure of concrete modified with a multifunctional additive and a low-activity mineral filler. The research, conducted at Tashkent State TranSMWrt University, examines the effects of pore characteristics—size, shape, and volume—on the physical and mechanical properties of concrete, such as strength, permeability, and durability.The study categorizes pores into capillary, sedimentation, shrinkage, and technological types, each influencing concrete performance. A mercury porosimetry method was used to analyze porosity. Experimental concrete samples were prepared with different compositions and tested after 28 days of curing.The results show that using a complex modifier significantly reduces porosity. The composition incorporating both a multifunctional additive and steelmaking waste (composition No. 2) achieved a 30.11% reduction in total porosity compared to the control. The combination was more effective than using either component alone.The findings suggest that optimizing porosity through mineral fillers and chemical additives can enhance concrete durability and performance, making it a promising approach for advanced construction materials.

Keywords: Porous structure, Concrete, Physical and mechanical properties, Multifunctional additive, Mineral filler, Mercury porosimetry, Permeability, Durability, Capillary pores, Sedimentation pores, Technological porosity, Modifier, Pore space structure, Steelmaking waste (SMW)

1. Introduction

Numerous studies of physical and mechanical properties of concrete, such as strength, deformability, permeability and frost resistance, convincingly demonstrate their dependence on pore space characteristics, including pore size, configuration and volume. The porosity of cement stone and concrete is formed as a result of the complex processes of cement binder hydration, concrete mix placement and subsequent curing of the material [1-3].

Depending on the mechanism of formation, pores in cement stone are classified into several types: capillary, sedimentation, contractile and technological. Each of these types of porosity has a significant impact on key physical and mechanical properties, determining the performance of the material [4].

Capillary pores are formed as a result of the evaporation of excess water required to ensure the workability of the concrete mixture. During the hydration process, some of the water binds to form hydrate phases, while the remaining water evaporates to form a system of capillaries and pores. The sizes of these pores vary from nanometres to micrometres, which has a significant effect on the permeability and water absorption of concrete [4].

The presence of sedimentation pores is due to structural defects resulting from external and internal water shedding. External water separation leads to the formation of a system of capillary pores interconnected and directed along the surface of the coarse aggregate. Internal drainage leads to the accumulation of water in the zones of contact ‘binder-filler’ with the formation of sedimentation pores, the size of which is usually 50-100 microns [4].

Contraction porosity occurs as a result of cement penetration during the curing process. This phenomenon is caused by a decrease in the volume of hydrated cement and evaporation of water, which leads to the formation of microcracks [4].

Technological porosity is caused by the process of preparing and placing the concrete mix. This type of porosity includes pores and air bubbles that may be formed when the concrete mixture is not compacted sufficiently. Technological porosity is characterised by a random distribution of pores in size and volume, which makes it difficult to predict its effect on concrete properties. As a rule, an increase in technological porosity leads to a decrease in the strength, durability and water resistance of concrete [4].

Thus, the porous structure of concrete plays a key role in the formation of its physical and mechanical properties. The control and optimisation of porosity parameters, including pore size, configuration and volume, is an important task to ensure the required performance of the material.

As it was shown above, the formation of porous structure in concrete has a negative impact on its physical and mechanical properties and durability. In this regard, the development of effective methods of reducing the porosity of cement composites is an urgent task.

2. Materials and methods

Currently, there are many known ways to reduce the porosity of concrete. One of the most accessible and promising approaches is the use of complex modifiers combining mineral filler and chemical additive. Modern chemical admixtures, in addition to water-reducing properties, have other useful functions, such as intensification of setting, air entrainment, etc [5, 6].

Despite the existing achievements in the field of concrete modification, the effect of low-active mineral admixtures such as steelmaking waste (SMW) on concrete porosity

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remains insufficiently studied. In this regard, the evaluation of their effect on the structure of the pore space is an important scientific and practical problem.

This paper examines the effect of complex modifier based on polyfunctional chemical admixture and mineral filler on the porosity of cement concrete.

In this paper, mercury porosimetry method was used to determine the porosity of concrete.

3. Conclusion

Experimental concrete specimens with different content of components as given in Table 1 were stored under normal conditions for 28 days. After reaching 28 days of age, the specimens were dried to constant weight at 105°C.

Table 1

Investigated compositions of self-compacting concrete mixtures

Compositions	Concrete class	Cone settlement (cm)	Material consumption per 1 m3 (kg)						
			Cement	Sand Mk=2.5	Crushed stone Fr.10-20	Water	SMW	POLIMIXJBI/ POLIMIX	W/C
			kg	kg	kg	l	kg	kg	-
1			510	541	1100	220	-	-	0,43
2	B30	П4 (20)	331	672	1100	140	110	1,4/-	0,41
3			331	672	1100	143	110	-/2.83	0,42

For porosity analysis dried samples were placed in a dilatometer type CD3, where a vacuum was created and pores were filled with mercury. After reaching the set vacuum value, the dilatometer with the sample and mercury was placed in the autoclave compartment of a Thermo Scientific Pascal 240 mercury porosimeter to obtain porograms.

The obtained porograms were processed using SOLID EVO software, which allowed the calculation of porous structure parameters such as relative pore surface size (mm^3/g) (Fig. 1) and the size distribution of total porosity (%) (Fig. 2).

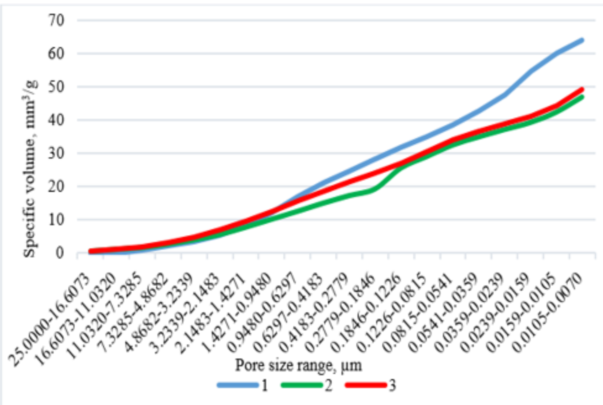

Fig. 1. Specific pore volume of the investigated compositions

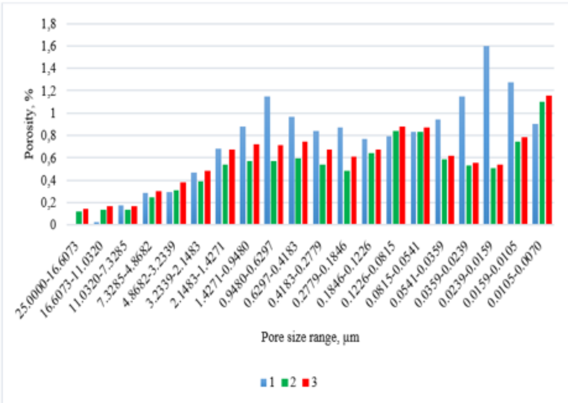

Fig. 2. Pore size distribution for the investigated compositions

4. Conclusion

Studies of the porous structure of the compositions showed that the introduction of the complex admixture has an effect on the change in the porosity of concrete. In particular, the total porosity of composition No. 3 decreased by 20.25% compared to the control sample. The most significant decrease in porosity was recorded in composition No. 2, where the porosity of the modified composition based on PFA and SMW decreased by 30.11% compared to the control specimen.

Comparison of the porous structure of different concrete compositions showed that the best reduction of all porosity indices was observed in composition No.2.

Porosity analysis of the investigated composition showed that the use of complex modifier based on polyfunctional additive (PFA) and low-active mineral filler from steelmaking waste leads to a significant reduction in the total porosity of concrete.

It is found that the total porosity of complex modified concrete is reduced by 30.11% compared to the control composition. Similar trend is also observed for relative pore volume which decreases by 26.68%.

The comparative analysis with POLIMIXJBI and SMW based compositions revealed that the complex modifier shows higher efficiency in reducing porosity. Thus, compared to POLIMIX and SMW based compositions, the reduction in total porosity is 12.3% and 4.9%, respectively.

The results obtained indicate a positive effect of the complex modifier on the formation of the pore space structure of concrete. The reduction of total porosity and relative pore volume is probably due to the complex effect of PFA and SMW.

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CONTEXT / MUNDARIJA

1 section. Resource- and energy-saving construction materials and technologies