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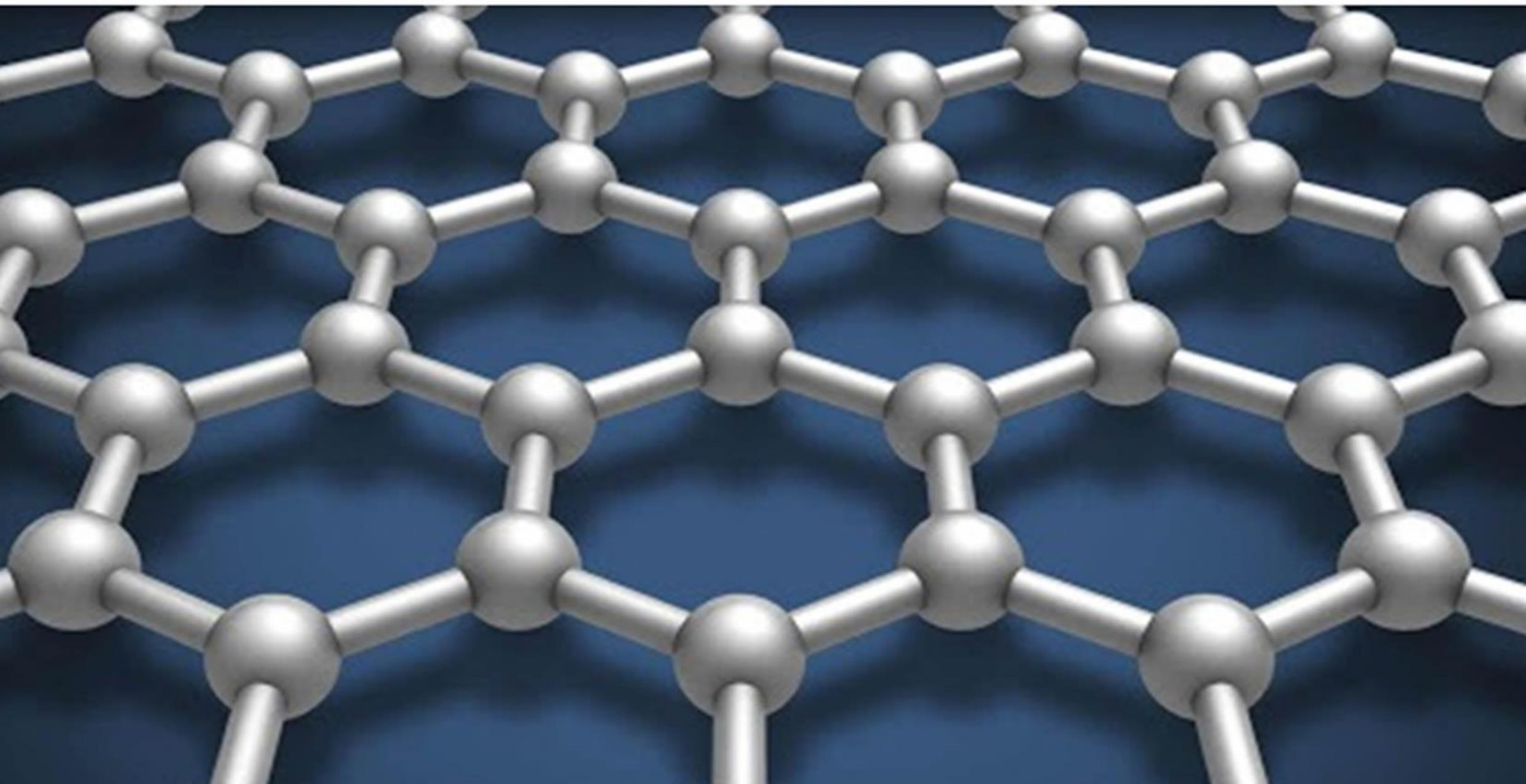
O‘zbekiston

Kompozitsion Materiallar

Ilmiy-texnikaviy va amaliy jurnali



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Композиционные материалы

3. Ismailov O. Yu., Khurmamatov A. M., Yusupov R. A., Isamatova D. N. “Increasing the efficiency of the condensation process in shell-pipe plants”, Science and innovation international scientific journal Volume 2 ISSUE 6 June 2023 UIF-2022: 8.2 | ISSN: 2181-3337 | Scientists.uz https://doi.org/10.5281/zenodo.8033657

4. О.Ю. Исмаилов, М.Х.Исмаилов, Д.Н. Исаматова. Қиздириш жараёнида оптималлаштириш масаласини қуйилиши. “Фан ва ишлаб чиқариш интеграцияллашуви шароитида кимё-технология, кимё ва озиқ-овқат соҳасидаги муаммоларнинг инновацион ечимлари” Халқаро илмий-амалий анжуман материаллар тўплами. НамМТИ 6-7 ноябрь 2023 й. Наманган-2023, стр 449-451.

Аннотация. В статье приведены результаты изучения процесса изменения конечной температуры теплоносителя в трубчатом теплообменнике. В ходе опытов при массовым расходе G = 2 кг/мин с установлением в трубе стержня диаметром 10 мм температура сырья выхода от трубы повышается дополнительно на 2 ºC. С установлением стержня диаметром 12 мм температура сырья повышается на 5 ºC, а с установкой стержня 15 мм на трубу температура сырья повышается на 9 ºC. Во всех объектах исследования также повышается выходная температура от 2 до 10 ºC в зависимости от диаметра стержня.

Ключевые слова: нефть, газовый конденсат, нафта, керосин, дизель, стержень, температура.

О.Ю. Исмаилов - Институт общий и неорганической химии АНРУз Ташкентский химико-технологический институт

А.М. Хурмаматов - Институт общий и неорганической химии АНРУз Ташкентский химико-технологический институт

Д.Н. Исаматова - Институт общий и неорганической химии АНРУз Ташкентский химико-технологический институт

Р.А. Юсупов - Институт общий и неорганической химии АНРУз Ташкентский химико-технологический институт

М.Ж. Балтабаева - Институт общий и неорганической химии АНРУз Ташкентский химико-технологический институт

HOUSING PARTS AND BEDS OF MACHINE TOOLS CASTED FROM ULTRA HIGH-PERFORMANCE CONCRETE

O.V. Tuyboyov, A.N. Bozorov, A.A. Ismatov, M.I. Dadayev

Introduction. Ultra-High-Performance Concrete (UHPC) is characterized by exceptional mechanical strength, durability, and low porosity [1], achieved through specific cementitious materials and optimized mixture ratios. Its applications range from underwater operations to bridge deck overlay and repairs [2]. UHPC formulations are tailored for each application: anti-dispersion properties and low cement loss rate are crucial for underwater operations, while reducing shrinkage and cracking potentials is prioritized in bridge deck overlay. Thixotropic UHPC aids sloped casting. In bridge repairs, UHPC offers cost-effective solutions with reduced life cycle costs compared to conventional concrete. UHPC's unique properties, including high strength, durability, and ductility, make it promising for seismic-resistant infrastructure [3]. Overall, UHPC provides advanced material options for diverse construction applications.

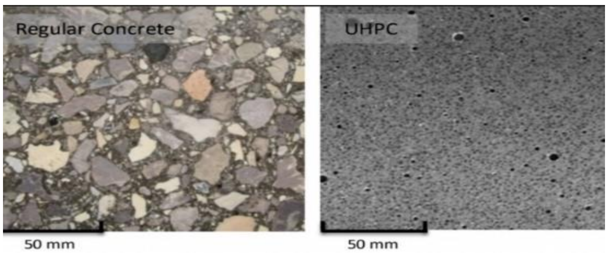

Figure 1. images of regular concrete and Ultra-high-performance concrete a compressive strength of at least 150 MPa and energy dissipation capacity

Machine tool housing parts and beds are integral to industrial manufacturing [4], crucial for ensuring stability and vibration control. The design of the bed aims to mitigate resonant vibration, such as that caused by the grinding wheel stand. Additionally, the bed supports various machine tool components, including the spindle. Housing parts are essential for efficient assembly and installation processes, with methods like assembling individual sheet metal and electrical parts reducing delivery time and improving production efficiency. Ensuring a secure connection between element beds in the machine tool bed is vital for maintaining structural integrity [5], often achieved through seal grooves and sealants. Overall, machine tool housing parts and beds are indispensable for enhancing the performance, stability, and assembly efficiency of machine tools in industrial manufacturing.

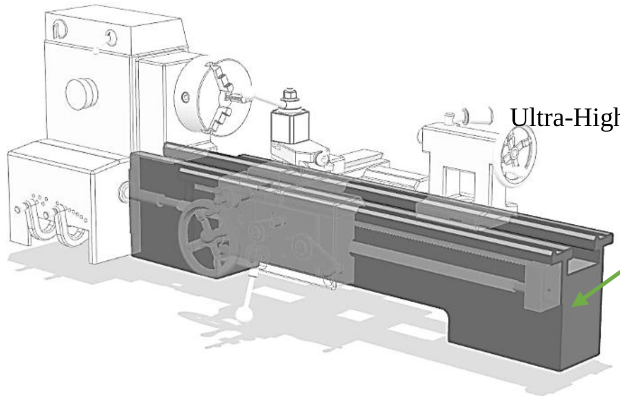

Figure 2. The lathe bed of turning machine tool

The construction of machine tools necessitates durable, high-performance materials with properties like high hardness, wear resistance, impact resistance, and corrosion resistance. Material selection directly impacts tool performance and functionality, considering factors such as manufacturability, stiffness, strength, and thermal properties [6]. Advanced materials like carbon fiber ceramic-matrix composites and ceramics with carbides, nitrides, and oxides enhance cutting tool durability and performance [7]. Integrating digital technologies and machine learning offers opportunities to optimize material properties and design features for increased productivity and accuracy in machine tools.

Materials and methods. In this study, Portland cement, silica fume, limestone powder, slag powder, natural quartz sand, and a polycarboxylate superplasticizer were employed. Nine groups of mix proportions were designed, varying combinations of limestone powder and slag powder with cement. Specific ratios for water-binder, binder-sand, and superplasticizer content were established. Experimental procedures included the preparation of ultra-high-performance concrete (UHPC) samples, fractal theory-based particle size analysis, and various tests (fluidity, compressive strength, autogenous shrinkage, and microstructural analysis) [8].

Table 1

Chemical Composition and Physical Properties of OPC, SF, LP, and SP

Material	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Specific Area (m^2/kg)	Density (kg/m^3)
OPC	18.2	3.7	3.3	66.1	2.4	4.5	371	3,090
SF	95.5	-	-	1.0	0.7	-	18,100	2,320
LP	1.6	0.2	0.2	54.2	5.0	0.2	648	2,680
SP	29.2	12.7	1.0	44.4	8.3	2.1	520	3,050
OPC	18.2	3.7	3.3	66.1	2.4	4.5	371	3,090

Table 1 presents various data points related to different mixtures of Ultra-High-Performance Concrete (UHPC) with limestone powder (LP) and slag powder (SP). The table includes information such as the composition of the mixtures, compressive strength, fluidity, packing density, and fractal dimensions of particle size distributions. It categorizes the mixtures into different groups based on the materials used and provides detailed results for each group. The data in Table 1 is crucial for understanding how the different components affect the properties of UHPC, such as strength, fluidity, and packing density.

Experiments. Standard curving was adopted at 20°C±5°C with a relative humidity over 95%. Conducted following the Test Method for Fluidity of Cement Mortar (GB/T 2419-2005) [10]. Measured based on the Method of Testing Cements-Determination of Strength (GB/T 17671-1999) using 40 mm × 40 mm × 160 mm specimens after curing for 7 days and 28 days. Performed according to the Standard for Test Methods of Long-term Performance and Durability of Ordinary Concrete. LP mixed systems showed higher packing densities compared to SP mixed systems due to finer LP particles filling pores in cement. LP ternary systems exhibited higher fractal dimensions than SP ternary systems, indicating increased fine particles and complex forms. LP or SP in ternary systems enhanced fluidity initially but decreased after reaching certain levels due to water absorption by particles. LP and SP ternary systems showed increased compressive strength with more LP or SP added, consistently higher than benchmark systems. LP inhibited autogenous shrinkage, while SP had a complex influence, inhibiting within a certain range but promoting excessive shrinkage.

Results. Figure 3 presents a comparison of the packing densities of different samples of Ultra-High-Performance Concrete (UHPC) and other materials. Packing density is a measure of how closely the particles in a material are packed together. It is a crucial property in materials science as it can significantly influence the mechanical properties of the material, such as strength and durability. From the chart, we can observe that the packing densities of the samples vary between approximately 0.62 and 0.72. The sample 'css3' exhibits the highest packing density of around 0.72, suggesting that its particles are packed more closely together than those in the other samples. This could potentially result in superior mechanical properties, such as higher strength and durability.

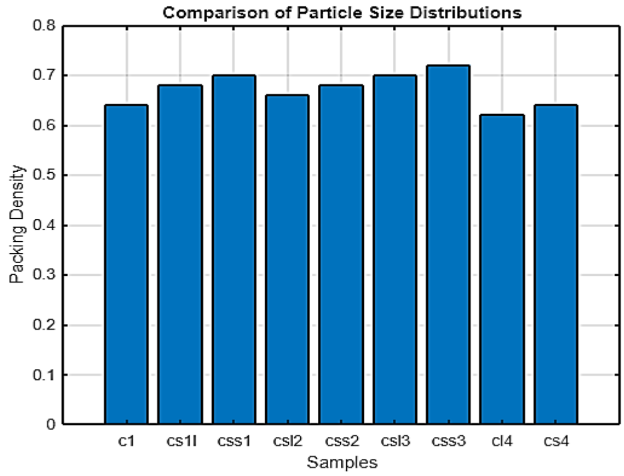

Figure 3. A comparison of the packing densities of different samples of Ultra-High-Performance Concrete (UHPC) and other materials

On the other hand, the sample 'cl4' has the lowest packing density of around 0.62, indicating a less compact arrangement of particles. This could potentially lead to lower mechanical strength and durability compared to the other samples. It's important to note that while packing density can provide insights into the potential performance of a material, other factors such as the material's composition, the size and shape of the particles, and the manufacturing process also play a significant role in determining its overall properties and performance. Therefore, a comprehensive analysis considering all these factors is necessary for a more accurate prediction of the material's performance in real-world applications.

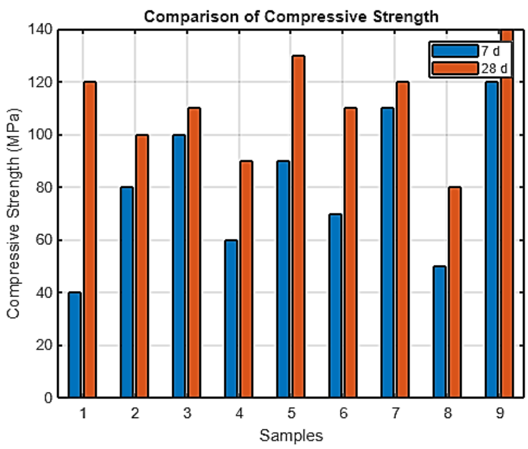

Figure 4. Comparative Compressive Strength of UHPC Samples

Figure 4. presents a comparison of the compressive strengths of different samples of Ultra-High-Performance Concrete (UHPC) at two different curing times: 7 days and 28 days. Compressive strength is a key mechanical property of concrete, indicating its ability to resist compression forces. From the chart, we can observe that the compressive strengths of all samples increase from 7 days to 28 days. This is expected as concrete continues to harden and gain strength over time due to the ongoing hydration of cement. The samples 'cs4' and 'css3' exhibit the highest

compressive strengths at both 7 and 28 days, suggesting that these samples have superior mechanical properties. On the other hand, the samples ‘c1’ and ‘cl4’ show the lowest compressive strengths at both time intervals, indicating a less optimal performance under compression. It’s important to note that while compressive strength is a crucial property, other factors such as durability, workability, and cost also play significant roles in determining the suitability of a concrete mix for a particular application. Therefore, a comprehensive evaluation considering all these factors is necessary for the optimal selection and design of concrete mixes.

These line graphs (in Figure 5 and 6) present the autogenous shrinkage of different samples of Ultra-High-Performance Concrete (UHPC) over time. Autogenous shrinkage is a phenomenon that occurs in cementitious materials like concrete, where the material shrinks due to the chemical reactions taking place within it, without any external drying.

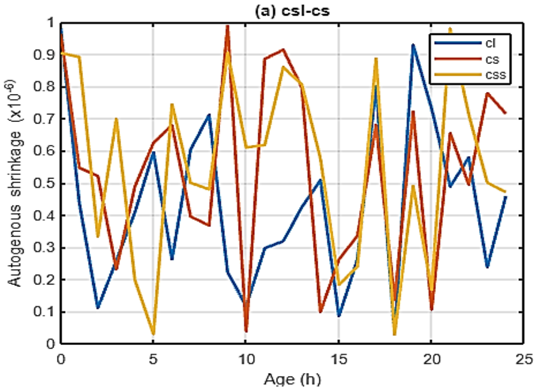

Figure 5. Autogenous Shrinkage of UHPC Samples Over Time (csl-cs)

From the charts, we can observe that the autogenous shrinkage of all samples increases with time. This is expected as the hydration reactions in the cement continue over time, leading to a reduction in the overall volume of the material, which is observed as shrinkage. In both graphs, the samples ‘cl’, ‘cs’, and ‘css’ show different rates of autogenous shrinkage. This could be due to differences in their composition, such as the type and amount of cement used, the water-to-cement ratio, and the use of any admixtures. These factors can significantly influence the rate and extent of hydration reactions, and hence, the autogenous shrinkage.

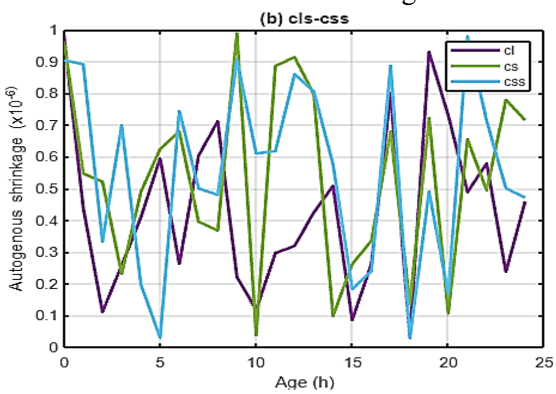

Figure 6. Autogenous Shrinkage of UHPC Samples Over Time (cls-css)

Conclusion. The paper explores the potential of Ultra-High-Performance Concrete (UHPC) in the manufacturing of machine tool housing parts and beds, addressing a noticeable gap in the literature. While UHPC has been extensively studied and applied in various fields such as underwater operations, bridge construction, and repairs, its utilization in the realm of machine tool manufacturing remains relatively unexplored. The unique properties of UHPC, including its high strength, durability, and ductility, make it a promising material for enhancing the performance and longevity of machine tools. The findings presented in this paper underscore the potential benefits of incorporating UHPC into machine tool construction, particularly in terms of stability, vibration control, and assembly efficiency. However, it’s essential to acknowledge that the manufacturing of machine tools demands materials with specific characteristics such as high hardness, wear resistance, impact resistance, and corrosion resistance. While UHPC possesses some of these properties, further research is warranted to optimize its performance in this context. Factors such as manufacturability, stiffness, thermal properties, and function integrability must be carefully considered when integrating UHPC into machine tool design and construction processes.

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Keywords: Ultra-High-Performance Concrete (UHPC), Machine tool manufacturing, Housing parts, Beds, Mechanical properties, Durability Limestone powder, Slag powder, Integration, Optimization.

Ultra-High-Performance Concrete (UHPC) has garnered significant attention for its exceptional mechanical properties, including high strength, durability, and low porosity. While extensively studied in various construction applications, its potential in machine tool manufacturing remains underexplored. This paper addresses this research gap by investigating the feasibility of utilizing UHPC in the construction of machine tool housing parts and beds. Through a comparative study on the macroscopic and microscopic properties of UHPC mixed with limestone powder and slag powder, this research examines the potential benefits and challenges of integrating UHPC into machine tool design.

Kalit soʻzlar: oʻta-yuqori qattiqlikdagi beton (UHPC), dastgohlar ishlab chiqarish, qurulish, staninalr, mexanik xususiyatlar, chidamlilik, Ohaktosh kukuni, shlak kukuni, integratsiya, optimallashtirish

Ushbu maqolada oʻta-yuqori qattiqlikdagi beton (UHPC) dan metal kesuvchi dastgohlarning korpus tipidagi detallarini qoʻyib olish va ushbu aralashmaning mexanik xususiyatlari, yuqori mustahkamlik, chidamliligi haqida maʼlumotlar tahlil qilinadi. Oʻta-yuqori qattiqlikdagi beton qurulish dasturlarida keng oʻrganilgan, ammo uning dastgohlarning korpuslarini ishlab chiqarishdagi salohiyati hali ham oʻrganilmagan. Ushbu maqola dastgohlar korpusi qismlari va staninalarini tayyorlashda oʻta-yuqori qattiqlikdagi betondan foydalanishning maqsadga muvofiqligini oʻrganish orqali ushbu tadqiqot boʻshligʻi hal qilinadi.

Tuyboyov Oybek Valijonovich	Tashkent state technical university, associate professor of the Department of Mechanical Engineering
Bozorov Aminjon Nurilloevich	State Unitary Enterprise “Fan va Tarakkiyot” at Tashkent State Technical University, PhD, senior researcher
Ismatov Abduxalil Abdusamatovich	Tashkent state technical university, associate professor of the Department of Technical Service
Dadayev Mirzahmad Ilxom ogli	Tashkent state technical university, assistant of the Department of Mechanical Engineering