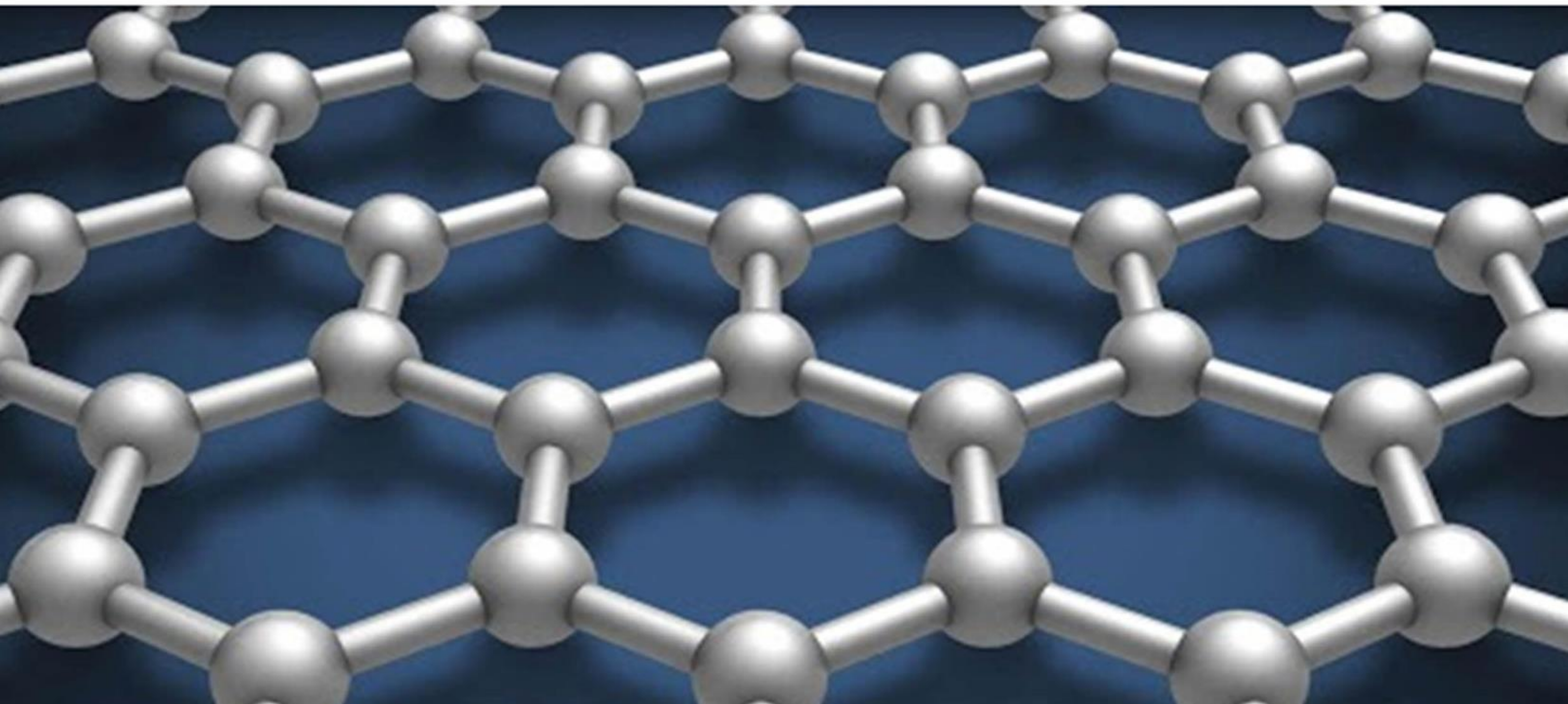
ISSN 2091-5527
№ 2/2024

O‘zbekiston

Kompozitsion Materiallar

Ilmiy-texnikaviy va amaliy jurnali



Узбекский научно-технический и производственный журнал

Композиционные материалы

Hozirgi vaqtda EYOP – EMS hali ham yuqori erish nuqtalariga ega bo‘lgan ba'zi qotishmalar qo‘shilgan yuqori qotishma po‘latni ishlab chiqarish uchun ishlatiladi.

Xulosa. Po‘lat suyuqlantirib olish jarayonida elektr yoy pechidan foydalanish orqali energiya hamda resurs tejamkorligini ta’minlash imkoni mavjud. Elektr yoy pechida issiqlik effektini suyuq metallni o‘zida tutib turish orqali energiya tejashi yuqori ko‘rib chiqilgan. Shixta materiallarini suyuqlantirish jarayonida oksidlarni hosil bo‘lishi hamda entalpiya usuli orqali pech ichidagi va elementlarni reaksiyalari tahlil qililgan.

Foydalanilgan adabiyotlar

[1] Logar V., Dovžan D. and Škrjanc I.: *Modeling and Validation of an Electric Arc Furnace: Part 2, Thermochemistry*, ISIJ Int., **52** (2012), No. 3, 413-423.

[2] Saidmakhamadov N. M. et al. Improve Casting Properties of Steel Alloy //Miasto Przyszłości. – 2023. – T. 40. – C. 323-328.

[3] Saidmakhamadov N. et al. Improvement of the technology of casting shaft components from 35XGCL brand steel in an electric arc furnace //American Journal of Interdisciplinary Research and Development.–2023. – T. 15. – C. 59-66.

Kalit so‘zlar: entalpiya, elektr yoy pechi, po‘lat, quyma, elementlar.

Annotatsiya: Ushbu maqolada elektr yoy pechida po‘lat suyuqlantirib olish jarayonida issiqlik effektini suyuq metallga sarf qilish orqali energiya tejamkorligini ta’minlash usullari tahlil qilingan bo‘lib, tahlillar natijasida Kirxgof va Gess qonunlari orqali po‘lat suyuqlantirishda energiya sarfini kamaytirish usullari tahlil qilingan.

Ключевые слова: энтальпия, электродуговая печь, сталь, литье, элементы.

Аннотация: В данной статье анализируются способы обеспечения энергосбережения за счет использования теплового воздействия на жидкий металл при выплавке стали в электродуговой печи и в результате анализа способы снижения энергозатрат при выплавке стали с использованием законов Кирхгофа и Гесса анализируются.

Saidmaxamadov N.M.	doktorant, Toshkent davlat texnika universiteti
Abdullayev K.X.	t.f.n., dotsent, Namangan muhandislik – qurilish instituti
Tadjiyev N.X.	v.b., dotsent, Toshkent davlat texnika universiteti
To‘xtaboyev I.T.	tayanch doktorant, Namangan muhandislik – qurilish instituti
G‘aybullayev M.N.	tayanch doktorant, Namangan muhandislik – qurilish instituti

FATIGUE BEHAVIOR AND STRUCTURAL INTEGRITY OF LATHE BEDS CONSTRUCTED FROM ULTRA-HIGH-PERFORMANCE CONCRETE (UHPC)

O.V. Tuyboyov, A.N. Bozorov, A.A. Ismatov, N.F. Raxmonova

Introduction. Ultra-high-performance concrete (UHPC) is a leading construction material renowned for its exceptional strength and durability, comprising a precise blend of cement, fine sand, silica fume, quartz flour, and steel fibers. Despite its advantages, the inclusion of coarse aggregate in UHPC can compromise its fatigue deformability and escalate damage progression [1]. This deterioration correlates linearly with bound water loss and macropore volume increase. UHPC with coarse aggregate experiences heightened stress concentration within the matrix, leading to premature fatigue failure. Conversely, UHPC without coarse aggregate exhibits superior fatigue properties. Introducing UHPC layers in orthotropic steel bridge decks enhances fatigue performance by reducing stress intensity. UHPC’s popularity stems from its high compressive strength, facilitating lighter and more cost-efficient designs, along with low permeability, reducing corrosion risk and extending structural service life, particularly beneficial in lathe bed construction [2]. UHPC’s mechanical strength, low porosity, and low water-to-binder ratio render it suitable for seismic-resistant infrastructure. UHPC overlays augment bridge deck capacity and durability by limiting water and chloride ingress, while its use allows downsizing of structural elements. Although research on UHPC has covered various aspects, including composition, mechanics, durability, fire resistance, and environmental benefits, a notable gap exists regarding its application in lathe bed construction. Lathe beds, critical in manufacturing, necessitate materials with high compressive strength and resilience to dynamic stresses. Hence, extending studies on UHPC towards enhancing the structural integrity and fatigue resistance of lathe beds is imperative [3].

Figure 1. lathe bed from Ultra-High-Performance Concrete (UHPC) [8]

Our study seeks to address this knowledge gap through a thorough investigation into the fatigue behavior and structural integrity of lathe beds constructed from UHPC (refer to Figure 1). We will focus on assessing not only the inherent material properties of UHPC but also its performance under the rigorous conditions specific to lathe beds [4]. Initially, we will closely examine the physical and mechanical properties of UHPC, emphasizing its compressive strength, durability, and particularly its fatigue resistance under cyclic loading, which significantly influences the operational longevity of lathe beds. Additionally, we will explore the impact of steel fibers in UHPC on resisting the initiation and propagation of microcracks under fatigue loading. This aspect is crucial, as UHPC's ability to delay or prevent microcrack development directly correlates with the structural longevity and performance of lathe beds. Previous research has indicated promising results regarding the inclusion of steel fibers in enhancing UHPC's fatigue resistance by providing a stress redistribution mechanism at the crack tip, thus offering a potential pathway to significantly improve the durability of lathe beds [5].

Materials and methods. The composition of Ultra-High-Performance Concrete (UHPC) varies according to its application. In building floor strengthening, UHPC composition and pouring technology are critical. UHPC offers advantages over conventional concrete but is limited due to design constraints and high costs. Specific compositions with high fiber contents and slope-casting ability are necessary for strengthening bridge decks. Research projects have developed appropriate mixes for UHPC, aligning with European codes and Czech recommendations (refer to Figure 2). Additives like silica nanoparticles, vegetable oil, and chemical substances enhance materials for lathe beds. Silica nanoparticles reduce interparticle adhesive forces, enhancing fluidity. Vegetable oil additives improve load-carrying capacity and reduce lubricant costs. Chemical additives in machine tool coolants eliminate static electricity, foam, and rust, enhancing wear resistance and lubricity of lathe bed materials [6].

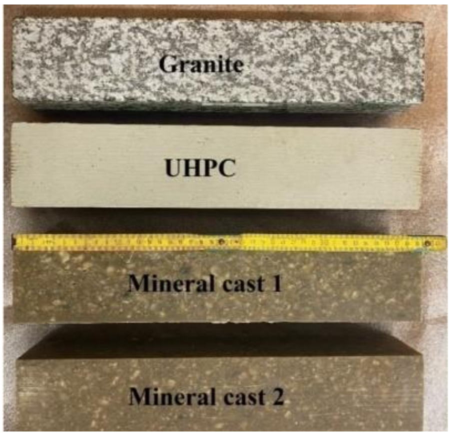


Figure 2. A picture of a granite, an Ultra-High-Performance Concrete (UHPC), mineral casted a specimen-1 and a specimen-2.

Fabricating UHPC lathe bed prototypes involves multiple steps, including mold manufacturing, core-making, casting, cooling, demolding, and cleaning. Virtual manufacturing technology simulates CNC lathe processes, ensuring code correctness and avoiding operational issues. Various processes, such as resin sand molds and multiple sprue gates, optimize rigidity, strength, and pouring efficiency in lathe bed casting [7].

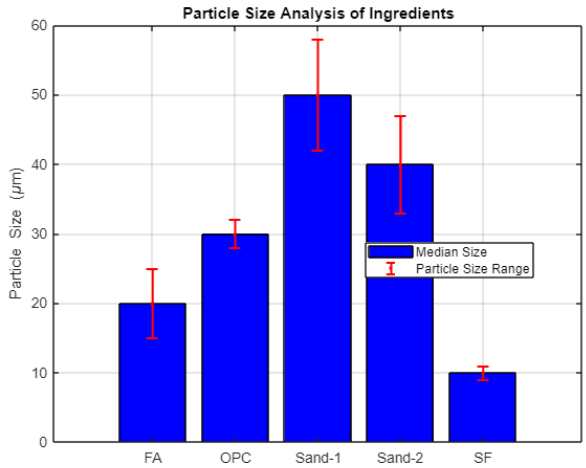


Figure 3. Particle Size Distribution Plot with Median and Range

Visual representation in Figure 3 compares median particle sizes and ranges for different ingredients, illustrating particle size distribution commonly used in particle size analysis studies. Blue bars represent central tendency, while red error bars depict variability or range in particle sizes per ingredient. This plot aids in understanding particle size distribution in materials.

Results. Conducting studies on the durability and performance of UHPC lathe beds over extended periods could provide valuable insights into their long-term behavior and potential maintenance requirements.

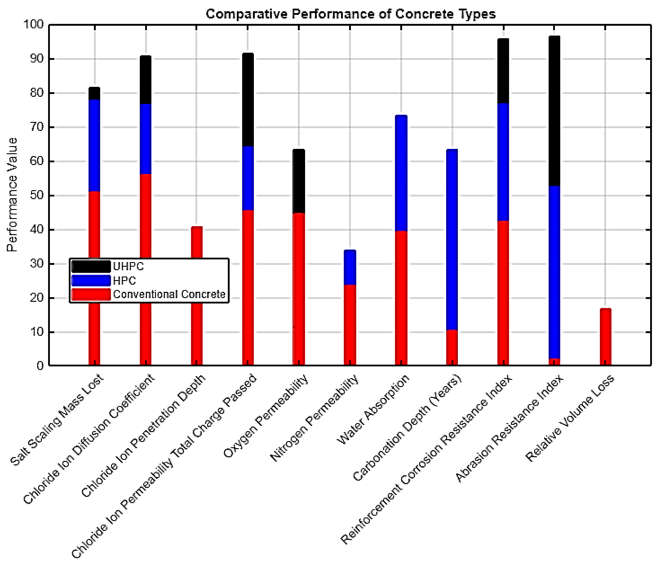


Figure 4. The performance of Normal Concrete, High Performance Concrete (HPC), and Ultra High-Performance Concrete (UHPC) in various parameters related to durability and permeability

The figure 4 are a bar graph compares the performance of Normal Concrete, High Performance Concrete (HPC), and Ultra High-Performance Concrete (UHPC) in various parameters related to durability and permeability. The parameters include Salt Scaling Mass Lost (28 cycles), Chloride Ion Diffusion Coefficient, Chloride Ion Penetration Depth, Chloride Ion Total Charge Passed, and Oxygen Permeability. Each parameter has three bars side by side representing Normal Concrete, HPC, and UHPC respectively. All bars for Normal Concrete are at the level of 1 as they are used as the baseline for comparison. Bars for HPC and UHPC vary in height indicating their performance relative to normal concrete [8].

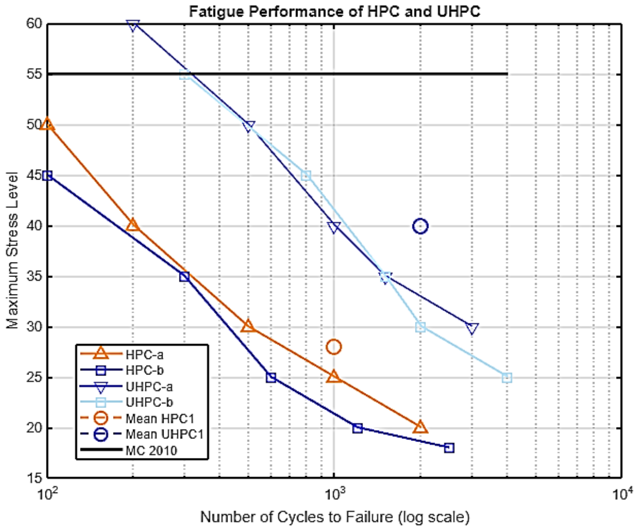


Figure 5. The number of cycles to failure for HPC (High Performance Concrete) and UHPC (Ultra High-Performance Concrete)

Figure.5 shows the number of cycles to failure for HPC (High Performance Concrete) and UHPC (Ultra High-Performance Concrete). The x-axis represents the Number of cycles to failure in logarithmic scale, and the y-axis represents the Maximum stress level. Different series are represented with various markers and lines: HPC-a is represented by orange triangles. HPC-b is represented by blue squares. UHPC-a is represented by dark blue triangles. UHPC-b is represented by light blue squares. Mean value HPC1 is shown with an orange circle connected with a dashed line. Mean value UHPC1 is shown with a blue circle connected with a dashed line. MC 2010 is depicted as a solid black line.

Conclusion. Long-term performance studies and comparative analyses reveal UHPC's superior durability and permeability compared to conventional concrete, indicating its potential for long-lasting infrastructure. Experimental data also demonstrate UHPC's extended fatigue life under cyclic loading conditions, reaffirming its suitability for critical components like lathe beds. Overall, this research advances construction materials and manufacturing processes by highlighting the benefits of UHPC in improving the performance and longevity of lathe beds. The findings can inform future developments in material science and engineering, extending to various infrastructure projects requiring high-strength and durable materials. Further optimization of UHPC compositions, advanced manufacturing techniques, and field testing are essential for validating the practical applicability of UHPC lathe bed prototypes.

REFERENCES

1. Amran, M., Huang, S. S., Onaizi, A. M., Makul, N., Abdelgader, H. S., & Ozbakkaloglu, T. (2022). Recent trends in ultra-high performance concrete (UHPC): Current status, challenges, and future prospects. *Construction and Building Materials*, *352*, 129029.

2. Li, L., Xu, L., Huang, L., Xu, F., Huang, Y., Cui, K., ... & Chi, Y. (2022). Compressive fatigue behaviors of ultra-high performance concrete containing coarse aggregate. *Cement and Concrete Composites*, *128*, 104425.

3. Li, L., Xu, L., Zeng, Y., Cui, K., Chi, Y., & Huang, L. (2023). Understanding the role of coarse aggregate on tensile fatigue behaviors of ultra-high performance concrete. *Cement and Concrete Composites*, *139*, 105069.

4. Yu, J., Zhang, B., Chen, W., & He, J. (2020). Experimental and multi-scale numerical investigation of ultra-high performance fiber reinforced concrete (UHPFRC) with different coarse aggregate content and fiber volume fraction. *Construction and Building Materials*, *260*, 120444.

5. Yu, Z., Wu, L., Yuan, Z., Zhang, C., & Bangi, T. (2022). RETRACTED: Mechanical properties, durability and application of ultra-high-performance concrete containing coarse aggregate (UHPC-CA): A review.

6. Mohammed, H. (2015). Mechanical properties of ultra high strength fiber reinforced concrete (Master's thesis, University of Akron).

7. Ullah, R., Qiang, Y., Ahmad, J., Vatin, N. I., & El-Shorbagy, M. A. (2022). Ultra-high-performance concrete (UHPC): A state-of-the-art review. *Materials*, *15*(12), 4131.