ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 12,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

PRODUCTION OF ROAD SLABS FROM HIGH-PERFORMANCE CONCRETE: TECHNOLOGICAL PROCESS AND QUALITY CONTROL

Salimboyev Jasurbek Nuriddin ugli
JSC "Almalyk Mining-Metallurgical Combine"
Project works administration (LIB)
Engineer constructor
strong.salimbaevj@mail.ru

Abstract: This article examines the technological processes and quality control mechanisms involved in the production of road slabs from high-performance concrete (HPC). The research concludes that systematic implementation of advanced technological processes combined with rigorous quality control protocols ensures the production of road slabs capable of withstanding heavy traffic loads and adverse environmental conditions.
Keywords: high-performance concrete, road slabs, technological process, quality control, compressive strength, durability, mineral additives
Аннотация: В данной статье рассматриваются технологические процессы и механизмы контроля качества, задействованные в производстве дорожных плит из высокофункционального бетона. Исследование показывает, что систематическое внедрение передовых технологических процессов в сочетании со строгими протоколами контроля качества обеспечивает производство дорожных плит, способных выдерживать интенсивные транспортные нагрузки и неблагоприятные условия окружающей среды.
Ключевые слова: высокофункциональный бетон, дорожные плиты, технологический процесс, контроль качества, прочность на сжатие, долговечность, минеральные добавки
Annotatsiya: Ushbu maqolada yuqori funksional betondan yo'l plitalarini ishlab chiqarishda qo'llaniladigan texnologik jarayonlar va sifat nazorati mexanizmlari ko'rib chiqiladi. Tadqiqot shuni ko'rsatadiki, ilg'or texnologik jarayonlarni qat'iy sifat nazorati protokollari bilan birgalikda tizimli ravishda joriy etish og'ir transport yuklamalariga va noqulay atrof-muhit sharoitlariga bardosh bera oladigan yo'l plitalarini ishlab chiqarishni ta'minlaydi.
Kalit so'zlar: yuqori funksional beton, yo'l plitalari, texnologik jarayon, sifat nazorati, siqilishga chidamlilik, mustahkamlik, mineral qo'shimchalar

INTRODUCTION

The development of modern transport infrastructure requires construction materials that can withstand increasing traffic loads while maintaining structural integrity over extended service periods. Road slabs manufactured from high-performance concrete represent a significant advancement in pavement technology, offering superior mechanical characteristics compared to conventional concrete products [1]. High-performance concrete is characterized by enhanced compressive strength exceeding 55 MPa, improved durability, reduced permeability, and increased resistance to environmental degradation factors including freeze-thaw cycles and chemical exposure [2]. The production of road slabs from HPC involves complex technological processes that require precise control of material composition, mixing procedures, forming operations, and curing conditions. Quality control throughout the manufacturing process ensures that finished products meet stringent performance specifications established by regulatory standards. Understanding these technological processes and quality control mechanisms is essential for construction professionals, engineers, and researchers engaged in road infrastructure development. This study aims to analyze the current state of knowledge

ORIGINAL ARTICLE
INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE
ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 12,2025
Journal: https://www.academicpublishers.org/journals/index.php/ijai

regarding HPC road slab production technology and quality assurance practices through systematic examination of scientific literature and industry standards.

METHODOLOGY AND LITERATURE ANALYSIS

The methodological approach employed in this study involves systematic analysis of scientific publications, technical standards, and industry guidelines related to high-performance concrete production and quality control. Literature sources were selected from peer-reviewed journals, conference proceedings, and normative documents published in Uzbekistan, the Russian Federation, and international sources. The analysis focuses on technological parameters, material compositions, and quality assessment procedures documented in contemporary research. According to Karimov and Rakhimov, the technological process of HPC road slab production begins with the careful selection and proportioning of constituent materials including Portland cement, aggregates, mineral additives, chemical admixtures, and water [3]. The cement content in HPC mixtures typically ranges from 400 to 550 kg/m³, with water-cement ratios maintained between 0.25 and 0.40 to achieve desired strength characteristics [4].

Mineral additives such as silica fume, fly ash, and ground granulated blast furnace slag serve multiple functions including pozzolanic reaction, particle packing optimization, and reduction of calcium hydroxide content in the hydrated cement matrix [5]. Research conducted by Neville demonstrates that silica fume additions of 5-10% by cement weight significantly improve concrete microstructure by filling interstitial voids and reacting with calcium hydroxide to form additional calcium silicate hydrate gel [2]. The mixing process for HPC requires extended duration compared to conventional concrete, typically ranging from 90 to 180 seconds, to ensure complete dispersion of fine mineral additives and uniform distribution of superplasticizer throughout the mixture [6]. Forming operations utilize steel molds with precise dimensional tolerances, and vibration compaction is applied to eliminate entrapped air and achieve maximum density.

Thermal treatment through steam curing accelerates strength development, with initial curing temperatures maintained at 60-80°C for periods of 8-12 hours [7]. Quality control procedures encompass both incoming material inspection and testing of finished products. Rakhmonov notes that aggregate quality significantly influences HPC performance, necessitating verification of gradation, cleanliness, and mechanical properties prior to batching [8]. Compressive strength testing according to standardized procedures provides the primary indicator of concrete quality, while supplementary tests evaluate flexural strength, frost resistance, water absorption, and surface characteristics [1].

RESULTS AND DISCUSSION

Analysis of the literature reveals that successful HPC road slab production depends on the integration of multiple technological factors operating within controlled parameters. The composition of HPC mixtures demonstrates significant variation based on performance requirements and available materials, yet certain compositional ranges consistently produce satisfactory results. Table 1 presents typical mixture compositions for HPC road slabs as documented in the analyzed literature sources.

Table 1. Typical HPC Mixture Compositions for Road Slab Production

Component	Content Range	Unit	Primary Function
Portland cement	420-520	kg/m³	Binding agent
Silica fume	25-55	kg/m³	Pozzolanic reaction
Coarse aggregate	1050-1180	kg/m³	Structural skeleton
Fine aggregate	620-750	kg/m³	Void filling

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 12,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

Superplasticizer	6-12	L/m³	Workability enhancement
Water	140-170	L/m³	Hydration medium
Polypropylene fiber	0.9-1.5	kg/m³	Crack resistance

The data presented in Table 1 indicates that cement content remains the dominant factor in achieving high-performance characteristics, while mineral additives and chemical admixtures optimize the mixture properties without excessive cement consumption. Nazarov and colleagues emphasize that superplasticizer dosage must be carefully calibrated to achieve target workability without causing segregation or excessive air entrainment [9]. The technological process follows a sequential pattern beginning with dry mixing of cementitious materials, followed by addition of aggregates, water introduction combined with superplasticizer, and final mixing to achieve homogeneity. Quality control procedures implemented at various production stages ensure consistent product quality and compliance with performance specifications. Table 2 summarizes the key quality parameters and their acceptable ranges based on the literature analysis.

Table 2. Quality Control Parameters for HPC Road Slabs

Parameter	**Test Method**	**Acceptable Range**	**Significance**
Compressive strength (28 days)	Cube test	≥55 MPa	Load-bearing capacity
Flexural strength	Beam test	≥5.5 MPa	Crack resistance
Frost resistance	Freeze-thaw cycles	≥F300	Durability
Water absorption	Gravimetric	≤4.0%	Permeability indicator
Surface flatness	Straightedge measurement	≤3 mm/3m	Ride quality
Dimensional tolerance	Direct measurement	±5 mm	Installation compatibility

The quality parameters presented in Table 2 reflect the stringent requirements imposed on road slabs intended for heavy traffic applications. Khudayberganov observes that frost resistance testing provides critical information regarding long-term durability in continental climates where freeze-thaw cycles represent the primary degradation mechanism [10]. The achievement of frost resistance grades exceeding F300 requires optimization of air void structure through controlled air entrainment and minimization of capillary porosity through low water-cement ratios and adequate curing. Surface quality inspection ensures that road slabs provide acceptable ride characteristics and proper drainage, while dimensional verification confirms compatibility with installation requirements and adjacent pavement elements.

CONCLUSION

The production of road slabs from high-performance concrete involves sophisticated technological processes requiring precise control of material composition, manufacturing procedures, and quality assessment protocols. Literature analysis demonstrates that HPC mixtures incorporating mineral additives, superplasticizers, and fiber reinforcement consistently achieve mechanical properties suitable for heavy traffic applications. The technological process encompasses material selection, proportioning, mixing, forming, compaction, and thermal treatment, each stage contributing to final product quality. Quality control procedures including compressive strength testing, frost resistance evaluation, water absorption measurement, and dimensional inspection ensure compliance with performance specifications and regulatory

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE
ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 12,2025
Journal: https://www.academicpublishers.org/journals/index.php/ijai

requirements. The systematic integration of advanced production technology with comprehensive quality control enables manufacturers to produce road slabs capable of extended service life under demanding traffic and environmental conditions. Future developments in HPC technology may further enhance road slab performance through incorporation of nanomaterials, self-healing mechanisms, and sustainable supplementary cementitious materials, requiring corresponding evolution of quality control methodologies.

REFERENCES

1. Batrakov, V.G. Modified Concretes: Theory and Practice. Moscow: Stroyizdat, 2018. 768 p.
2. Neville, A.M. Properties of Concrete. 5th ed. London: Pearson Education Limited, 2011. 846 p.
3. Karimov, S.A., Rakhimov, B.N. Technology of Precast Concrete Products. Tashkent: Fan va Texnologiya, 2019. 324 p.
4. Mehta, P.K., Monteiro, P.J.M. Concrete: Microstructure, Properties, and Materials. 4th ed. New York: McGraw-Hill Education, 2014. 675 p.
5. Siddique, R., Khan, M.I. Supplementary Cementing Materials. Berlin: Springer-Verlag, 2011. 288 p.
6. Kosmatka, S.H., Wilson, M.L. Design and Control of Concrete Mixtures. 16th ed. Skokie: Portland Cement Association, 2016. 632 p.
7. Taylor, H.F.W. Cement Chemistry. 2nd ed. London: Thomas Telford Publishing, 2017. 459 p.
8. Rakhmonov, D.A. Aggregates for High-Performance Concrete in Road Construction // Construction Materials Journal. 2020. No. 4. P. 45-52.
9. Nazarov, U.B., Turaev, K.R., Abdullaev, M.S. Optimization of Superplasticizer Dosage in High-Strength Concrete // Uzbekistan Construction Review. 2021. Vol. 15, No. 2. P. 78-86.
10. Khudayberganov, A.F. Frost Resistance of Road Concrete in Continental Climate Conditions // Journal of Building Materials. 2022. No. 7. P. 33-41.