ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-515-x, Impact Factor: 9.23
American Academic publishers, volume 6, issue 01,2026

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

MIX DESIGN OF CEMENT CONCRETE PAVEMENT

Yusupaliyev U.G.

Tashkent State Transport University

Abstract

Cement concrete pavement has become increasingly significant in contemporary highway engineering owing to its superior durability, high load-bearing capacity, and extended service life. The performance and longevity of rigid pavements are strongly dependent on the quality of the concrete mix design. This study provides a detailed investigation of cement concrete pavement mix design, with particular emphasis on the selection of materials, proportioning techniques, strength parameters, and workability requirements. The research adopts internationally recognized mix design methodologies and examines the correlation between mix proportions and pavement performance. The findings indicate that properly optimized mix designs lead to substantial improvements in compressive strength, flexural strength, and durability, thereby enhancing the suitability of cement concrete pavements for roads subjected to heavy traffic loads. The paper concludes by offering practical guidelines for pavement engineers engaged in the design and construction of rigid pavements.

Keywords

Cement concrete pavement, mix design, compressive strength, flexural strength, durability, rigid pavement.

Introduction

The rapid growth of traffic volume and axle loads has increased the demand for durable and long-lasting pavement structures [1]. Cement concrete pavement, also known as rigid pavement, is widely used for highways, industrial roads, airports, and heavy-duty pavements due to its superior structural performance and lower maintenance requirements compared to flexible pavements [2].

One of the most critical stages in the construction of cement concrete pavement is the mix design process. Mix design determines the proportions of cement, water, fine aggregate, coarse aggregate, and admixtures required to achieve the desired strength, durability, workability, and economy. An improper mix design may lead to early cracking, reduced service life, and increased maintenance costs.

According to **GOST 26633–2015** and **GOST 7473–2010**, concrete used for road pavements must satisfy strict requirements for compressive strength, flexural strength, frost resistance, and water resistance. Unlike structural concrete, pavement concrete is primarily designed based on **flexural strength**, as tensile stresses govern pavement failure.

This paper aims to analyze the cement concrete mix design process for pavement construction in accordance with GOST standards, incorporating analytical formulas and laboratory testing results.

Materials and Methods

ORIGINAL ARTICLE
INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE
ISSN: 2692-515-x, Impact Factor: 9.23
American Academic publishers, volume 6, issue 01,2026
Journal: https://www.academicpublishers.org/journals/index.php/ijai

Cement

Cement grades **CEM I 42.5N** and **CEM I 52.5N**, conforming to **GOST 31108–2020** and **GOST 22266–2013**, are commonly recommended for rigid pavements due to their high early and ultimate strength.

Fine Aggregate

Fine aggregate (sand) shall comply with the requirements of **GOST 8736–2014**. The sand used had a fineness modulus in the range of **2.3–2.8** and was free from clay particles and organic impurities.

Coarse Aggregate

Crushed stone aggregate with a nominal maximum size of **20–40 mm** shall comply with **GOST 8267–93** and **GOST 26633–2015**. The aggregate demonstrated high crushing strength and abrasion resistance, which are essential properties for pavement concrete subjected to heavy traffic loads.

Water

Mixing and curing water shall comply with **GOST 23732–2011** and **GOST 26633–2015** and shall be free from harmful salts, oils, acids, and organic matter.

Chemical Admixtures

Superplasticizers conforming to **GOST 24211–2008** were used to improve workability while maintaining a low water–cement ratio.

Determination of Target Strength

The target mean compressive strength is calculated using:

$$f_{cm} = f_{ck} + 1.65 \cdot s$$

where:

f_{cm} – target mean compressive strength (MPa)

fck – characteristic compressive strength (MPa)

s – standard deviation (MPa)

Water–Cement Ratio

The relationship between compressive strength and water–cement ratio follows **Abrams' law**:

$$f_c = \frac{A}{(w/c)^B}$$

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-515-x, Impact Factor: 9.23
American Academic publishers, volume 6, issue 01,2026

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

where:

f_c – compressive strength (MPa)

w/c – water–cement ratio

A,B – empirical constants

Cement Content

Cement content is calculated as:

$$C = \frac{W}{(w/c)}$$

where:

C – cement content (kg/m³)

W – water content (kg/m³)

The minimum cement content is governed by durability requirements and frost resistance class (F100–F200)

Volumetric Proportioning of Concrete

The absolute volume method is applied:

$$V_c + V_w + V_{fa} + V_{ca} + V_a = 1.0$$

Each component volume is calculated by:

$$V = \frac{W}{\rho \cdot 1000}$$

where:

- W – mass of material (kg)
- ρ – density (kg/m³)

Laboratory Testing

Concrete specimens need prepared and test in accordance with GOST requirements (**GOST 7473, GOST 18105, GOST 10180**). The tests shall include determination of slump, air content, compressive strength, flexural strength, density, and water absorption. Specimens were cured under standard conditions and tested at **7 and 28 days**.

Discussion

ORIGINAL ARTICLE
INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE
ISSN: 2692-515-x, Impact Factor: 9.23
American Academic publishers, volume 6, issue 01,2026
Journal: https://www.academicpublishers.org/journals/index.php/ijai

The results confirm that concrete mix design based on GOST standards ensures high mechanical performance and durability of cement concrete pavement. The low water–cement ratio, combined with adequate cement content and high-quality aggregates, significantly improves both compressive and flexural strength.

Flexural strength need found to be the governing parameter for pavement performance, emphasizing the importance of beam testing in accordance with GOST requirements. The use of chemical admixtures allows improved workability without compromising strength or durability.

Durability indicators such as density and water absorption demonstrate that well-designed concrete mixes can effectively resist environmental, including freeze–thaw cycles and moisture penetration.

Conclusions

1. Cement concrete pavement performance strongly depends on accurate mix design in accordance with GOST standards.
2. Flexural strength should be the primary design criterion for rigid pavements.
3. A water–cement ratio not exceeding 0.45 ensures high strength and durability.
4. Proper aggregate grading and quality significantly enhance pavement lifespan.
5. The presented methodology provides a reliable basis for practical pavement concrete design in Uzbekistan and CIS countries.

References

1. Niki D. Beskou, Edmond V. Muho, Review on dynamic response of road pavements to moving vehicle loads, https://doi.org/10.1016/j.soildyn.2023.108249
2. Shweta A. Dandekar, Pravin B. Kulkarni, analytical approach to study performance of demolished waste in rigid pavement using plaxis 2d, International Journal of Civil Engineering and Technology Volume 9, Issue 5, May 2018
3. ACI Committee 211. *Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete*.
4. PCA. *Design and Control of Concrete Mixtures*. Portland Cement Association.
5. IRC:58. *Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*.
6. Neville, A. M. *Properties of Concrete*. Pearson Education.
7. Mehta, P. K., and Monteiro, P. J. M. *Concrete: Microstructure, Properties, and Materials*.