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Research Article

Causes Of Destruction Of Cement Concrete Road Pavements

Submission Date: June 19, 2025, **Accepted Date:** July 29, 2025,

Published Date: August 31, 2025

Crossref doi: <https://doi.org/10.37547/ijasr-05-08-04>

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ABSTRACT

The increasing requirements for the reliability, serviceability, and strength of road pavements are caused by the growth in vehicle load capacity and traffic intensity on roads. Over the past decade, the automobile fleet of Uzbekistan has increased several times, and according to road specialists as well as designers, the traffic intensity on some roads is 1.5 to 3 times higher than the permissible level for this road category. The article highlights the issues of studying the causes of deformations and failures of cement concrete pavements of highways during operation.

KEYWORDS

roads, cement-concrete pavements, requirements, reliability, quality, deformations, failures.

INTRODUCTION

The growing demands for the reliability, serviceability, and strength of road pavements are driven by the increasing load capacity of vehicles and the rising intensity of traffic. Over the past

decade, the number of automobiles in Uzbekistan has multiplied significantly, and according to road specialists and designers, traffic intensity on some

roads exceeds the permissible level for their category by 1.5–3 times.

In Uzbekistan, great attention is being paid to the development of road construction. Road construction is one of the most important sectors of the transport industry, as it ensures connectivity between cities and various remote settlements of the country.

The leadership of the Republic has set large-scale tasks for road engineers that will transform Uzbekistan's transport infrastructure, making it even more attractive for foreign companies as a transit corridor from Asia to Europe.

Modern roads are subject to high requirements for quality, durability, safety, environmental sustainability, and comfort [1,2].

Research. Cement-concrete pavements best meet the increasing demands placed on roads. However, it is important to take into account that the construction of cement-concrete pavements requires a special approach, close attention, advanced technical equipment, high qualifications, and well-organized project management.

The tendency of monolithic concrete pavements to develop defects is primarily associated with the inherent nature of the material itself. In addition, cement-concrete pavements operate under complex stress conditions caused by repeated dynamic loads from vehicles and variable temperature and humidity effects [3].

When pavement slabs are heated or cooled, they tend to change their linear dimensions, but due to resistance to free movement along the base,

thermal stresses arise within them. The temperature gradient across the thickness of the cement-concrete pavement causes slab warping, curving downward at night or upward during the day, depending on the direction of heat flow.

When warping deformations cannot be fully realized, additional thermal stresses occur within the slabs, the magnitude of which depends on their self-weight and geometric dimensions. The operating conditions of cement-concrete pavements vary significantly across different zones (center, edge, end, corner of the slab, or wheel track). This unevenness leads to the accumulation of residual deformations along the slab perimeter and to partial loss of contact between the lower slab surface and the base, especially along edges and transverse joints.

As a result of significant separation of slabs from the base, suspended slab sections appear, where negative bending moments increase sharply when loads are applied near the joint. Thermal-moisture stresses in cement-concrete pavements, especially in hot and dry climates, combined with vehicle loads, contribute to the initiation and propagation of cracks in various locations and at different times. These cracks may vary in shape and direction.

Cracks can be hairline, surface, or through-cracks. Surface cracks may gradually extend in length and depth and branch in multiple directions. The danger of through-cracks is that they reduce the load-bearing capacity of cement-concrete pavements and create conditions for moisture penetration into the subgrade.

In addition to cracks, typical deformations and failures of cement-concrete pavements include surface scaling, corner and edge spalling, vertical slab displacements, warping, and the deterioration of joints and joint fillers.

Practical experience in cement-concrete pavement construction shows that it is very difficult to completely avoid defects. Numerous factors influence the development of cracks, warping, and scaling. It should be emphasized that in almost all cases, the occurrence of defects and failures is the result of the simultaneous impact and combination of several negative factors.

The most probable primary causes of cracks and other defects may include:

1. Result of poor selection of the concrete mix composition:

- unsuccessful selection of materials and suboptimal component ratios;
- use of incorrect aggregate grading, for example, applying a 5–20 mm fraction instead of the recommended 5–10 mm and 20–40 mm fractions;
- overestimation or excessive reduction of the water–cement ratio; increased cement content and mortar fraction;
- inappropriate selection of chemical admixtures and excessive dosage.

2. Defects in concrete mix production:

- defects of the specified mix design, inaccuracies in dosing;

- modification or use of low-quality aggregates, primarily with a non-optimal composition and high content of powdery and clayey particles;
- use of materials not specified in the mix design;
- insufficient mixing in the mixer;
- elevated temperature of the concrete mix.

3. Improper construction conditions, violations of placing technology, and unfavorable operating conditions:

- insufficient optimality of the adopted technical solutions during design (polyethylene film under the concrete pavement, absence of warping joints, expansion joints, etc.) and accuracy of pavement calculations, incomplete consideration of local conditions;
- excessive vibration during placing and segregation of the concrete mix;
- excessive troweling, especially with metal floats;
- rapid drying of the concrete surface due to windy, hot, and dry weather, as well as failure to follow curing rules during the initial hardening period;
- untimely cutting of joints;
- incorrect construction of joints;
- significant daily temperature fluctuations;
- application of loads when the pavement has weak contact with the base;
- use of anti-icing chemical agents in combination with intensive wheel loads and frequent cycles;
- alternating freezing and thawing of concrete in the first year of service.

CONCLUSIONS

It should be noted that in almost all cases, the causes of various defects and damages are the simultaneous impact and combination of several negative factors, which must be taken into account during the construction and operation of highways.

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