Defects And Destruction On Roads With Cement Concrete Pavements

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ABSTRACT

The article analyzes various types of defects on cement concrete pavements, gives recommendations for their elimination during operation.

Keywords: Cement concrete, residual deformations, cracks, defects, chipping, shear, temperature, climatic factors, sealing, peeling.

Cement-concrete pavements operate in a complex stress state under the action of repeated dynamic loads from vehicles and variable temperature and humidity fields.

When the coating slabs are heated or cooled, they tend to change their linear dimensions, but due to the resistance to free movement along the base, thermal stresses arise in them.

When the temperature changes along the thickness of the cement concrete pavement, the slabs warp with a bulge downward (at night) or upward (in the daytime), depending on the direction of the heat flow. With failed warping deformations in the plates, thermal stresses also arise, the magnitude of which depends on their own mass and geometric dimensions.

The working conditions of the cement concrete pavement in its different zones (in the center, at the edge, end, corner of the slab, rolling strip, etc.) are significantly heterogeneous. This creates an opportunity for the accumulation of residual deformations of the bases under the peripheral part of the coating slabs along the entire perimeter and for partial disruption of the contact of their lower surface with the base, especially in the areas of the edge and transverse seams. As a result, hanging sections of the plate are formed, in which negative bending moments sharply increase when the load is located above the seam.

Temperature and humidity stresses, together with stresses from vehicles, lead to the initiation and development of cracks [1]. In a cement concrete pavement, they form at different times, in different places on the slabs, and have a different shape and direction. Cracks can be hairline, superficial and through. Surface cracks gradually increase in length and depth and can branch in different directions.

The danger of through cracks is that they reduce the bearing capacity of cement concrete pavements and create conditions for water to penetrate into the subgrade.

In addition to cracks, characteristic deformations and destructions of cement concrete coatings include peeling of the surface layer of concrete, spalling of corners and edges of slabs, their vertical displacements, warping, destruction of butt joints and joint fillers.

The characteristic most common deformations and destruction of cement concrete pavements of roads are presented in Table 1.

Table 1

Type of deformation and destruction	Characteristics and nature of distribution	The most likely causes of
1	2	3
Deformations and destruction of the coating		
Cracks	Transverse through:	
	а) technological	Untimely and poor-quality cutting of expansion joints
	б) operational	Changing the temperature of the coating with a greater than permissible distance between the seams of compression and expansion; operation of vehicles with loads exceeding the bearing capacity of the coating; load application at low contact of the coating with the base
	Transverse surface	The impact of vehicles during warpage of plates from uneven distribution of temperature over the thickness of the coating
	Transverse on the edge sections of the slabs along the seams	Poor cutting of expansion joints; incorrect installation of pin connections
	Longitudinal through	Defects in the device of longitudinal seams; inhomogeneous deformations of the subgrade
	Oblique on the corner sections of the slabs	Insufficient contact of the plate with the base; increased stresses in the plate during the passage of vehicles
	Hair shrink	Unsatisfactory selection of the composition of the concrete mixture; non-compliance with the rules for the care of the coating; insufficient concrete cover over reinforcement
Vertical slab offsets	The formation of irregularities (ledges, subsidence)	Poor compaction of the underlying soil or base; heaving of the soil in winter; washing out of the base material from under the coating
Destruction of slab edges	Local removal and collapse of the surface of the edges in the zone of expansion joints.	No expansion seams; clogging of expansion joints; the presence of ledges between adjacent plates

	Shearing of edge sections of slabs	
Destruction of the joint filler	Chipping of the sealing material, removing it from the seam by car wheels	Aging of the sealing material; poor deformation at low temperatures; low thermal stability; significant vertical and horizontal displacement of the edges of the plates
Warping of plates	Loss of longitudinal stability of pavement slabs	Lack of freedom of movement of plates under thermal stresses; poor quality butt joints; high annual fluctuations in air temperature
Deformations and destruction of the surface of the plates with sufficient strength of the pavement		
Wear (abrasion)	Reducing the thickness of the coating when exposed to vehicles. Occurs in braking areas of cars, on descents, before curves, at intersections, in areas with heavy heavy traffic	Insufficient wear resistance of the coating
Peeling	Detachment of scales of cement stone with subsequent chipping of the aggregate to a depth of up to 40 mm. It happens continuous, focal, along the seams	Violation of the technology of preparation and laying of concrete mixtures; low quality care for hardening concrete; use of anti-icing chemicals; early freezing of the concrete cover; combination of heavy application of wheel loads (especially with studded tires) with frequent cycles of alternate freezing and thawing of concrete
Potholes	Local destruction of the coating of oval and round shape with a diameter of 5-10 cm in plan and a depth of up to 10 cm	Insufficient resistance of the coating to tangential forces from vehicles; unstable adhesion of cement stone with aggregate; the presence of dirty and non-frost-resistant aggregate in concrete; low quality of compaction of individual sections of the coating
Sinks	Local destruction of the coating. Have the same shape as potholes, but smaller	The use of non-frost-resistant large aggregates; poor-quality surface finish of the coating and undercompacting of the concrete mix
Destruction of pavement		
Breaks	Complete destruction of pavement with a sharp distortion of the transverse profile	Low strength of pavement in comparison with that required by traffic conditions
Drawdowns and swelling	Sharp distortions of the coating profile, accompanied by longitudinal and oblique intersecting cracks	Waterlogging of subgrade soils; deep freezing of the subgrade

Continuously reinforced concrete pavement versus smooth concrete pavement with seams

Initially, CRCP designs usually cost more than SCP designs due to the greater amount of steel. However, they can show excellent long-term performance (with a typical design life of 30 to 40 years) and cost effectiveness. A number of state highway agencies prefer to use CRCP designs in their high traffic corridors where traffic over the life of the pavement can be in the order of tens of millions of equivalent load repetitions.

The topics and faults of the full depth pavement chapter are described below.

Surface defects

Minor deformations or defects that are limited to the surface of the concrete pavement are often referred to as surface defects. These damages usually do not cause significant damage to the structural integrity of the pavement, but may affect its performance and aesthetic appeal [2].

These surface defects are:

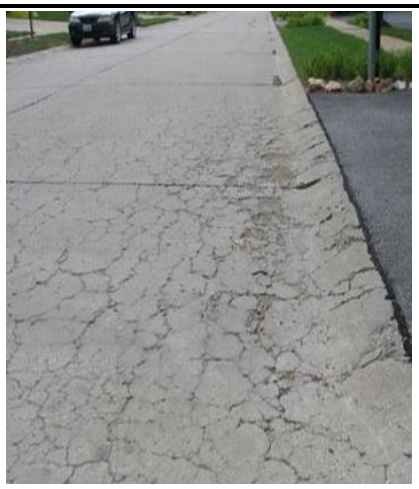
- Cartographic cracks
- Plastic shrinkage
- Scaling
- Surface polishing/wear

Surface flaking

Surface delamination of concrete pavements in appearance is closely related to the formation of deposits and delaminations. However, the failure mechanism is different, as discussed in detail in this one. Delamination can be considered as the development of a horizontal crack within the slab, which leads to separation of the surface layer to a depth of 1.25 to 5 cm from the rest of the concrete.

Depending on the underlying cause of the dissection, the dissection may be localized or widespread. Although delamination is typically seen near pavement joints and can extend 91 cm or more into the slab, it can also occur anywhere on the slab.

Compression spalling at seams or transverse cracks may also appear similar, but is due to penetration of incompressible materials.



Cracks associated with the material. Material-related damage is any damage to a concrete pavement resulting from the properties of pavement materials and their interaction with the environment. Material-related damage in concrete pavements is typically characterized by a network of numerous closely spaced cracks, often accentuated by stains or deposits. However, visual inspection alone cannot confirm the presence or absence of material-related problems. Laboratory testing of pavement core samples is required to definitively confirm mechanisms that may contribute to failure.

Material disasters include the following:

- D-cracking
- Alkali-silica reactivity (ASR)
- Alkaline carbonate reactivity (ACR)

Transverse and diagonal cracks

Transverse cracks, also referred to as mid-panel or slab cracks, are oriented transversely across the pavement and perpendicular to the centerline of the pavement. Diagonal cracks are oriented obliquely across the slab at an angle of approximately 30 to 60 degrees from the centerline of the pavement.

Slab cracking can also develop in the longitudinal direction, with the crack oriented parallel to the centerline of the pavement.

Transverse and diagonal cracks

Regardless of orientation, these types of cracks differ from mapping cracks or other surface cracks in that they are distinct cracks that typically run through the entire thickness of the slab**.**

Moreover, these cracks can also develop along with each other, forming what is often referred to as a collapsed or broken slab (when the slab is divided into three or more pieces). Although cracking is perhaps the most common structural failure in concrete pavements, not all cracks necessarily indicate structural failure.

Longitudinal cracking

Longitudinal cracks are nearly parallel to the center line of the pavement or the junction of the lane with the shoulder. The article deals with full depth cracks because they go through the entire depth of the pavement. Other types of cracks include transverse, diagonal and lamellar cracks.

Cracking corners

Corner cracks (also known as "corner breaks") are well-defined full-depth cracks in a bonded concrete pavement. Corner cracks cross adjacent transverse and longitudinal joints at an angle of approximately 45 degrees to the direction of travel. The length of the sides is rarely less than 30 cm and is always less than half the width of the slab (by definition) on each side of the corner. Fractures with longer branches are considered diagonal cracks..

Chipping - transverse and longitudinal joints and cracks

Spalling of transverse and longitudinal seams/cracks in concrete pavements is one of the most common, if not the most predominant, damage to a concrete pavement. Joint spalling is joint damage that refers to cracking, spalling or wear of a concrete slab joint or crack edges of transverse and longitudinal joints. Depending on environmental conditions, spalling may develop predominantly in the top few inches of the slab, or may develop deeper below the surface, eventually reaching full pavement thickness.

Chipping problems include:

- Broken section of pavement adjacent to joints or cracks

- Small vertical drops
- Roughness

Twisting and warping

Concrete slabs laid on a slope undergo uneven volumetric changes due to temperature and humidity gradients. The temperature gradient changes during the day, with the top of the plate generally colder than the bottom from late night to mid-morning, resulting in a negative temperature gradient. Under these conditions, the slab will tend to curl up due to the lower surface temperature. As the top of the stove heats up during the day, its temperature becomes warmer than the bottom, resulting in a positive temperature gradient. Downward curvature often develops as a result of concrete expansion at the surface.

Shift

Shear is the result of localized upward movement or failure of a slab along a transverse joint or crack.

Shifts often occur after heavy rains followed by high temperatures, resulting in a strong expansion pressure build-up that can be abruptly released when the pavement is pushed up or collapses.

Contributing factors are incompressible materials in the joint, high coefficient of thermal expansion of large aggregates with increasing concrete temperature and large transverse distance between joints.

Defects of cement-concrete coatings, technologically permissible errors in the construction of coatings, shortcomings in operation are considered. Deformation characteristics of cement concrete pavements Destruction of the edges of expansion joints and filling of the joint space with various objects.

Defects on the surface of the coating are mesh cracks and surface erosion, reduced adhesion of the coating and wheels, violation of the smoothness of the coating. Climatic factors affecting the cement concrete pavement are considered.[3]

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