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DETERMINATION OF THE TIME OF CUTTING SEAMS ON FRESHLY LAID MONOLITHIC CEMENT CONCRETE PAVEMENTS

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Abstract*. This article determines the time for cutting joints in freshly laid cement concrete pavements depending on air temperature and concrete strength based on test and observation results.*

Keywords*: deformation, compression joint, expansion joint, chips, cracks, chamfer, concrete, reinforcement, construction, strength, weld cutter, concrete slab.*

The specific natural and climatic conditions of the regions of our republic, the properties of concrete mixtures prepared on the basis of local building materials, the automation of construction technology and the quality of the work being performed, and the correct organization of the time of cutting seams in newly laid cement concrete pavements affect the long-term durability of cement concrete pavements.

As a result of not being able to correctly choose the time of cutting the seams in cement concrete pavements, dents, fractures, and abrasions are formed on the edges of the seams, which deteriorates the quality and causes various inconveniences to the driver of the vehicle, leading to an increase in transportation costs [1].

For this purpose, 228-315 km (87 km) of the reconstructed section of the A-380 Guzar-Bukhara-Nukus-Beynov highway was selected as the object of study (Figure 1).

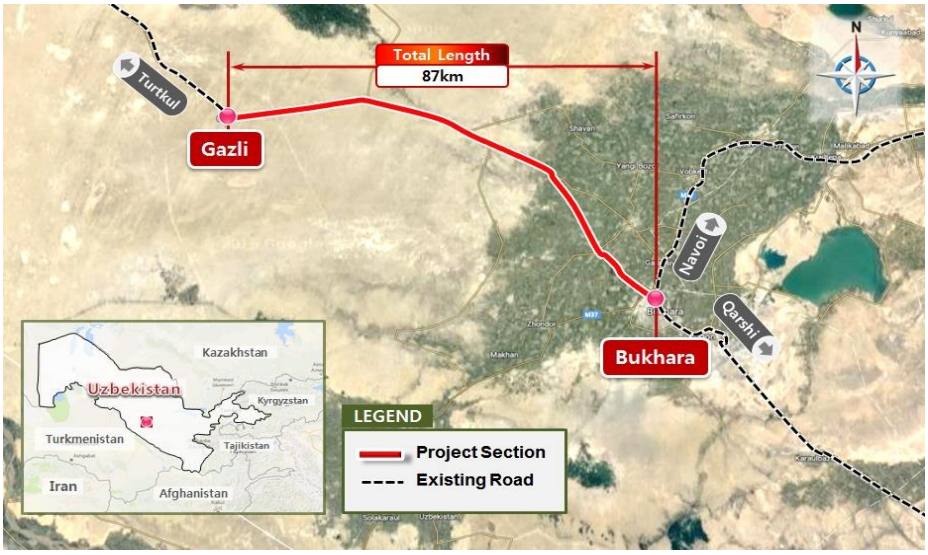

Figure 1. Location of the research object

As part of the project, China Railway 20 Bureau Group Corporation of the Republic of China brought modern machinery and high-precision measuring instruments and test equipment to ensure the quality of construction work at this facility.

Execution of consulting services on quality control at the construction site is carried out by Dohwa Engineering Co. of the Republic of South Korea. Ltd. specialists.

Construction of a 25-cm-thick, B30 ($B_{tb}4.0$) strength cement concrete coating is planned for the facility. Figure 2 shows an example scheme of a monolithic cement concrete pavement.

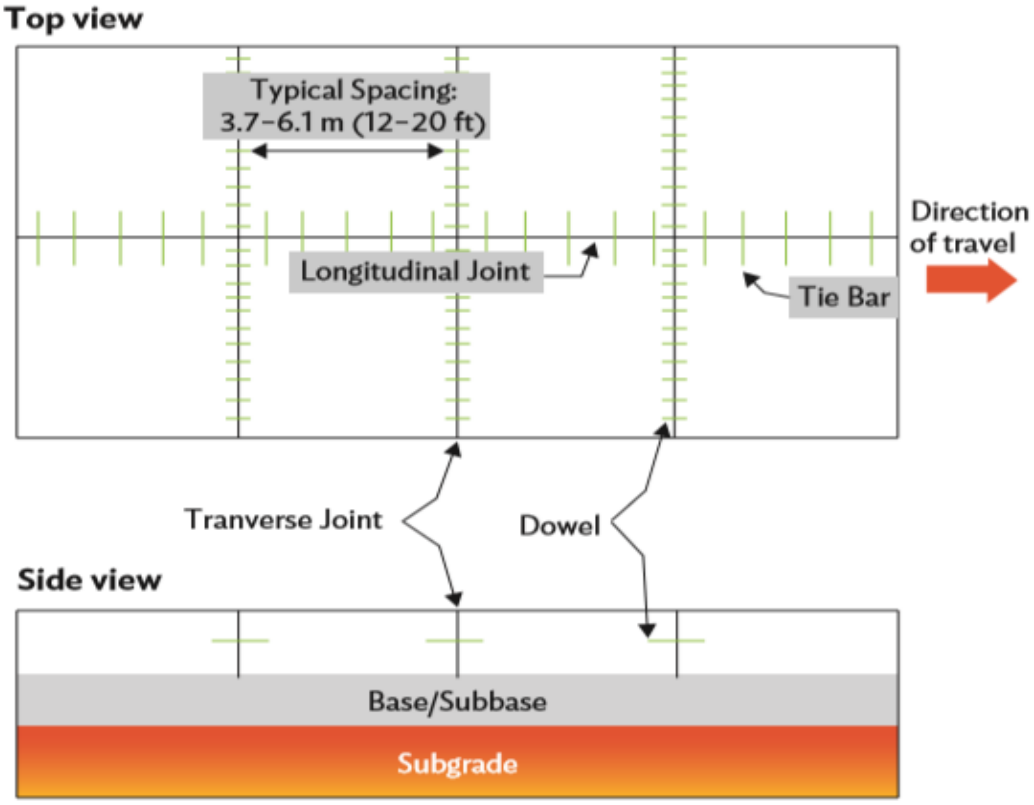

Figure 2. Typical layout of jointed plain concrete pavements

The experience of operating cement concrete pavements shows that over time steps of several millimeters can appear as a result of elevations between slabs. The formation of bumps worsens the longitudinal smoothness of the carriageway, increases resistance to movement, reduces the ease of movement of vehicles, causes vertical vibration of vehicles, and increases the load on the carriageway [2].

Therefore, in order to eliminate the appearance of steps between the adjacent plates and to smoothly transfer the compressive force partially from one plate to the other, usually the plates should be connected with steel rods installed along the seams [3].

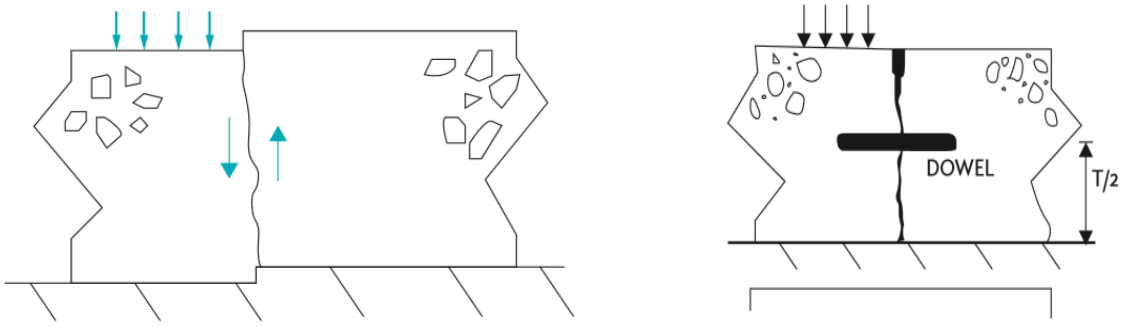

Figure 3. Dowelled Joint vs undowelled Joint

Timely cutting of deformation seams, compliance with the geometric dimensions of seam cracks, quality of edges, filling of seams with sealing materials and the filling process ensure the long service life of cement concrete roads.

The formation of defects and distortions in cement concrete coatings mainly starts from the seams. One of the causes of defects in seams is that the seam cutting time is not adjusted to the

weather temperature. As a result of not being able to choose the time of cutting the seam correctly, the formation of various defects near the joint groove is shown in Fig. 4. Such cases reduce the quality of the weld edges.

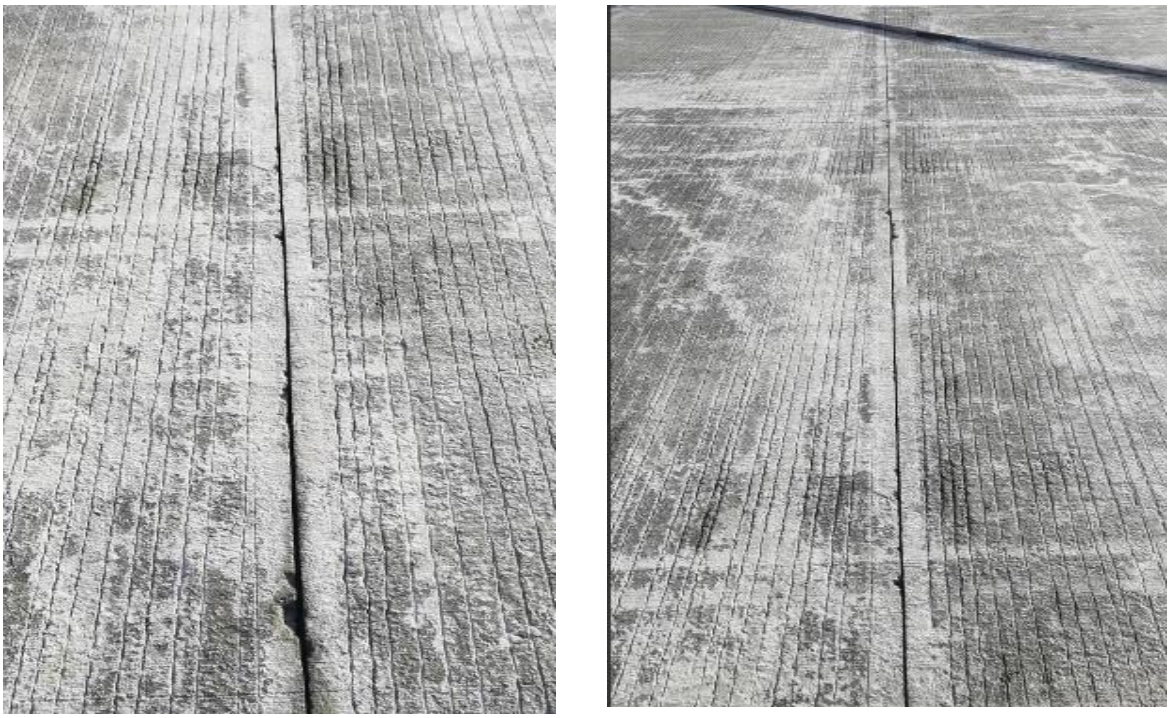

Figure 4. Disruption of joint edges

According to the results of the inspection and testing, the dependence of the time of cutting the seam on the cement concrete coating in different seasons of the year was studied, and it was found that the choice is the most effective and at the level of demand when the strength of 8-10 MPa is reached. The relationship between seam cutting time and concrete placement weather temperature is shown in Figure 5.

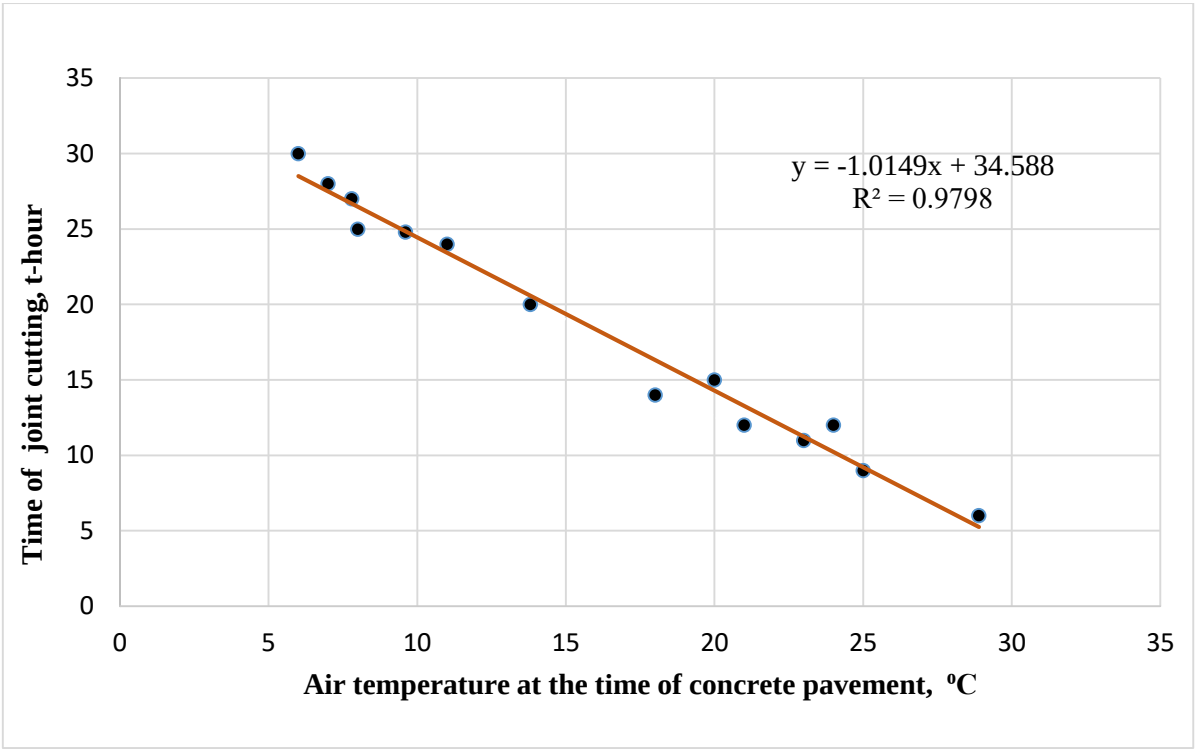

Figure 5. The graph of the dependence of the joint cutting time on weather conditions

Compression joints should be cut in 2 stages. At the first stage, it is recommended to cut 1/3 of the coating thickness and 4 mm wide (as shown in Figure 6) when the compressive strength of concrete is 8-10 Mpa [4].

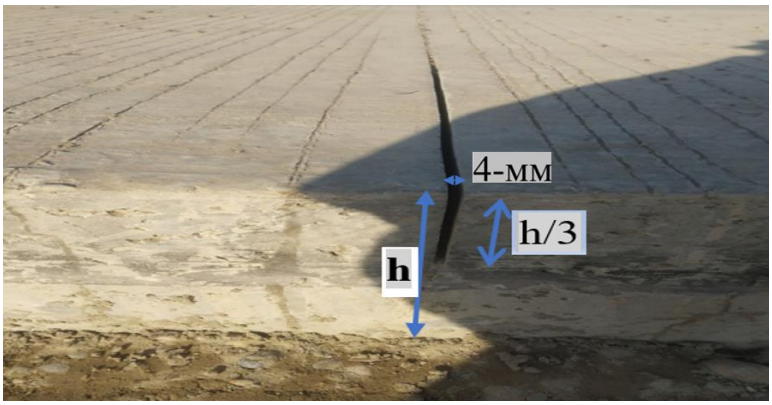

Figure 6. A view of the compression joint after it was cut in step 1.

The second cut is made in hardened concrete. In this case, the cutting depth is 40 mm, and it is recommended to cut the width to 8 mm. The joint edges are chamfered with a 3mm chamfer to prevent vehicle breakage and damage to vehicle wheels. Faska is opened by a package of disks. Another factor affecting the quality of joints is the expansion of concrete slabs due to changes in air temperature and the intensity of solar radiation.

Concrete cast in the winter will expand at first during the early stages because of heat of hydration, after which it will contract (thermal and hydraulic shrinkage). The net result is contraction. Concrete cast in the summer will expand first and it will contract afterward. The net result is expansion, because the magnitude of contraction is lower than the magnitude of expansion (Figure 7).

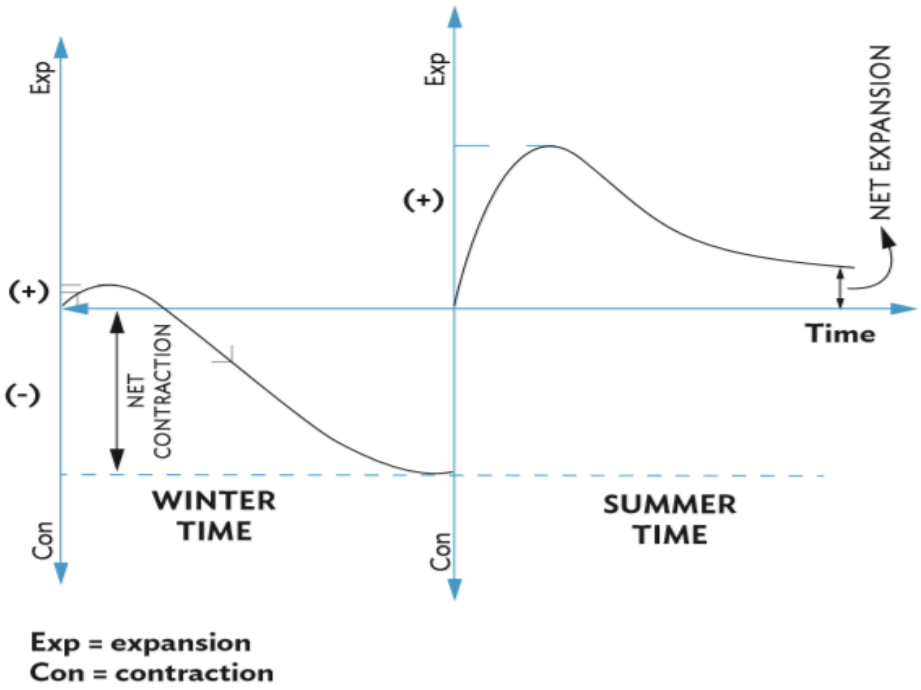

Figure 7. Concrete Expansion and Contraction

The opening ΔL for the distance L between two consecutive seams in cement concrete pavement is calculated by the following formula [5]:

$$\Delta L = R \cdot L \cdot (\alpha \Delta T + \varepsilon) \qquad (1)$$

Here: ΔL-joint opening width, mm

R-base restriction coefficient (for bases reinforced with cement - 0.65, for non-reinforced bases 0.8);

L- the distance between 2 successive seams, i.e. the length of the plate;

α-coefficient of heat board of concrete ($\mu\varepsilon/°C$);

ΔT- maximum temperature range (usually the temperature of concrete at the time of laying, minus the average daily minimum temperature, in °C in January;

ε-hydraulic shrinkage of concrete [28].

Through the values of (1) at air temperatures at which concrete can be laid, we can see how much concrete expands at what temperature:

$$\Delta L = 0.65 * 5000(12 * 10^{-6} * 10 + 0.0006) = 2.34 \text{ mm}$$
$$\Delta L = 0.65 * 5000(12 * 10^{-6} * 15 + 0.0006) = 2.535 \text{mm}$$
$$\Delta L = 0.65 * 5000(12 * 10^{-6} * 20 + 0.0006) = 2.73 \text{ mm}$$
$$\Delta L = 0.65 * 5000(12 * 10^{-6} * 25 + 0.0006) = 2.92 \text{ mm}$$
$$\Delta L = 0.65 * 5000(12 * 10^{-6} * 30 + 0.0006) = 3.12 \text{ mm}$$
$$\Delta L = 0.65 * 5000(12 * 10^{-6} * 35 + 0.0006) = 3.315 \text{ mm}$$
$$\Delta L = 0.65 * 5000(12 * 10^{-6} * 40 + 0.0006) = 3.51 \text{ mm}$$

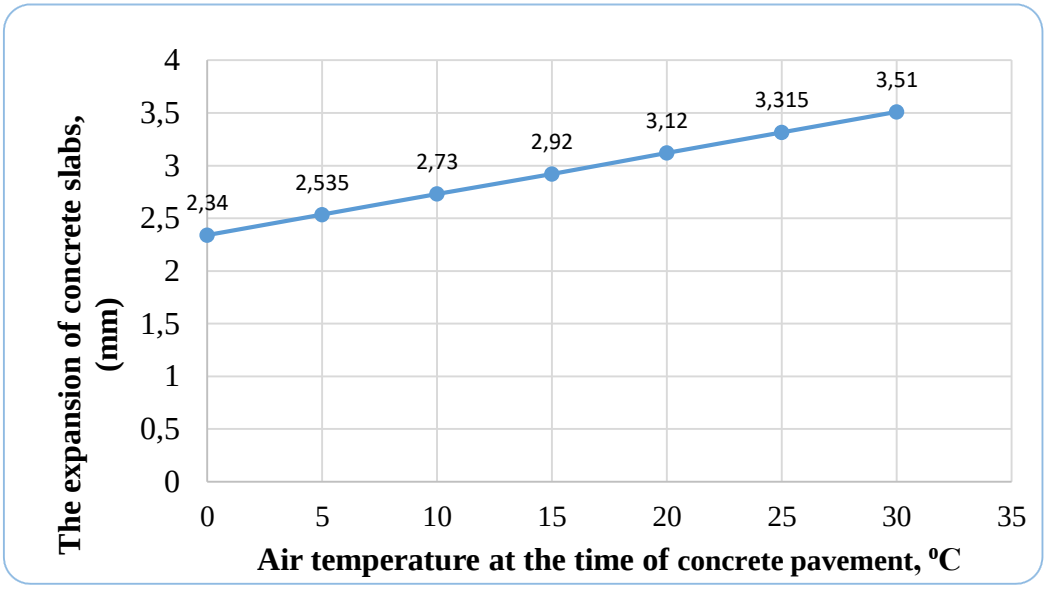

Figure 8. The expansion of concrete depending on the air temperature at the time of placing the concrete mixture

Judging from the obtained graph, the maximum temperature at which the concrete slabs can be laid has reached an expansion of 3.51 mm at 30 ºC, in this case, no expansion joints or construction of 1 expansion joint during the shift recommend

In conclusion, the selection and cutting of seams in newly laid cement concrete pavements depending on the weather temperature has a high impact not only on the quality of the seam, but also on the service life of the cement concrete pavement. High-quality cut seams prevent the increase in transport costs, improve the smoothness of the pavement and do not make drivers feel uncomfortable.

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