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# BASIC REQUIREMENTS FOR THE INSTALLATION OF GRAVEL AND MASTIC EXPANSION JOINTS ON BRIDGE STRUCTURES

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**ABSTRACT**

The article deals with the technological process of arranging crushed stone and mastic expansion joints on bridges, which are important elements for ensuring stable and safe operation of bridge structures. The main attention is paid to the peculiarities of using crushed stone and mastic materials that provide high elasticity, strength and waterproofing, which allows compensating for deformations caused by mechanical loads and temperature fluctuations.
The article describes the stages of such joints, starting from the preparation of the base to the laying of materials, and also notes the importance of choosing the right components for the production of crushed stone and mastic mixtures. The basic requirements for materials, such as crushed stone, mastics and special additives, which ensure long-term operation of the joints even in difficult climatic conditions, are considered.
The article pays special attention to the technology of laying crushed stone mastic joints, which includes thorough cleaning of the joint, uniform distribution of materials, and control over their quality during installation. Technological procedures are described, such as the use of primers to improve adhesion, reinforcement of joints to increase their mechanical properties, as well as checking the tightness and strength after the work is completed.
In general, the article contributes to a deeper understanding of the technology of arranging crushed stone-mastic expansion joints, which is an important tool for ensuring the safety and durability of bridge structures.

**KEYWORDS**

Crushed Stone and Mastic Joints, Expansion Joints, Bridges, Joint Arrangement, Installation Technology, Joint Materials, Bridge Structures, Joint Strength, Tightness, Bridge Operation, Standard Requirements, Durability, Climatic Conditions, Bridge Safety

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**Introduction.**

Bridges, as complex engineering structures, play an important role in providing transportation infrastructure, ensuring safe and continuous traffic flow. However, over time, they are exposed to a variety of mechanical and natural factors, such as temperature fluctuations, vibrations, traffic loads and other dynamic effects. As a result of these influences, deformations occur in bridge structures that can lead to damage or even accidents. Expansion joints are one of the most important elements to compensate for these deformations and ensure the integrity and safety of bridges.

Due to their unique properties, gravel-mastic expansion joints are becoming increasingly popular in modern bridge construction. They are able to effectively absorb mechanical deformations and movements of structures without losing their tightness and reliability for a long time. This is achieved thanks to a special combination of crushed stone base and mastic coating, which creates a strong and at the same time elastic structure.

The technical requirements for the construction of crushed stone mastic expansion joints are complex and require detailed consideration. Inconsistency of materials or technological processes can lead to inefficient joints, which in turn will affect the durability and safety of the entire bridge structure. Therefore, it is very important to adhere to clearly defined standards and requirements when designing and installing such joints. The article will discuss the key technical aspects that ensure the proper functioning of crushed stone mastic expansion joints, requirements for materials, as well as technological processes for their installation.

**Presentation of the main material.**

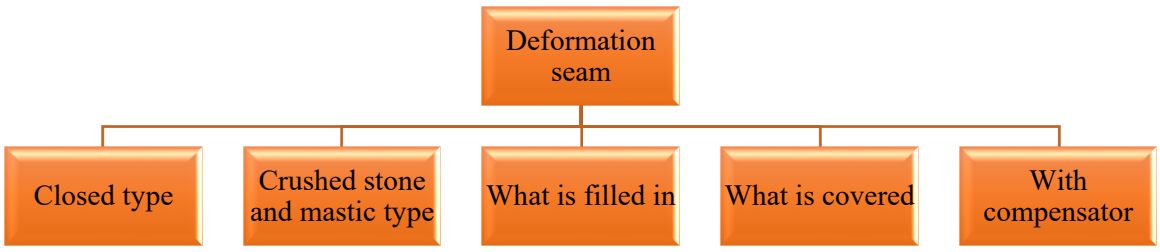
A large number of bridge inspections have shown that most expansion joint designs used in Ukraine over the past 10-30 years do not meet the requirements of modern operating conditions. Failure of the joints leads to significant operating costs for both their repair and maintenance. In addition, the safety of traffic and pedestrians directly depends on the condition of expansion joints.

In Ukraine, the requirements for the design and installation of expansion joints are regulated by existing regulatory documents [1], which set requirements for such structures depending on the conditions of further operation of bridge structures and types of structures, both in terms of length and construction material. At the same time, the minimum design life of expansion joints on bridges should be at least 20 years [2].

Expansion joints are an important element of bridge structures, and their proper functioning is critical to maintaining the durability and comfort of bridge travel. If they do not function properly, it can lead to rapid damage to other parts of the bridge. Expansion joints are subject to both static and dynamic loads. They are exposed to temperature changes, movements in different directions, and mechanical contact with vehicle wheels, which leads to combined loads. To ensure the efficient operation of the joints, their design must meet high requirements, namely: durability and reliability; tightness; ability to withstand the necessary movements in all directions; ensuring comfortable conditions for movement through the joint; resistance to dynamic loads from transport; resistance to chemical attack by reagents used during the winter maintenance of bridge structures [3].

According to the current regulatory documents [1], expansion joints are classified into five types, namely: closed, crushed stone and mastic, filled, overlapping, and with elastomeric expansion joints. A more detailed overview of the types of expansion joints is given in Table 1.

**Table 1.** Classification of expansion joints.




Deformation joints of the crushed stone and mastic type are arranged over the entire width of the bridge structure. The design of the joint is designed to cover the gaps at horizontal calculated displacements of the end sections of the span structures from 10 mm to 30 mm.

The main parameters of crushed stone and mastic expansion joints are shown in Table 2.

**Table 2.** Main parameters of crushed stone and mastic expansion joints

| Seam parameters (characteristics) | Calculated displacement of the beam ends in the joint, mm | | | |
|---|---|---|---|---|
| | 10-20 | 20-25 | 25-30 | до 30 |
| Seam width | 400±20 | 500±20 | 600±20 | 700±20 |
| Seam depth (gouges) | 70-80 | 80-120 | 120, not less than | 120, not less than |
| The gap that overlaps the seam (seam mouth) | 30±5 | 40±5 | 50±5 | 50±5 |
| Steel plate for closing the gap | Length 1 000<br>Thickness 4-6<br>Width 200 | | | |
| Steel plate for closing the gap | Width 250 | | | |

Domestic and foreign operational experience has shown [4, 5, 6] that the magnitude of the largest displacements is recommended to be limited to 25 mm or the scope of application is limited to temporary use before the installation of a permanent structure [5]. The reason for this is the non-compliance with the requirement [7] regarding the design service life in accordance with [2]. It is not recommended for use on roads of I-II categories, with significant differences in vertical displacements (>3 mm), in places of intensive braking and acceleration of vehicles (near traffic lights, on acceleration and deceleration lanes, etc.) [5].

A diagram of a rubble-mastic expansion joint is shown in Fig. 1.

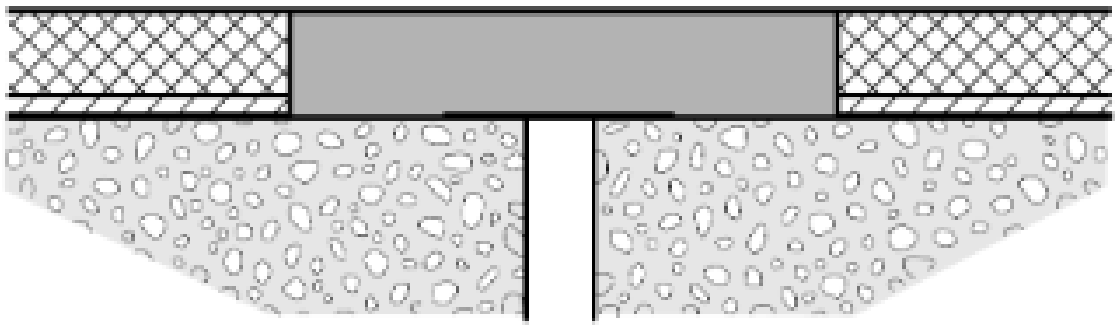


***Fig. 1.*** *Scheme of a crushed stone and mastic expansion joint*

To fill the seam, use: elastomeric bitumen mastic (polymeric) in accordance with [8]; crushed stone in accordance with [9-12]; polyurethane fixative in accordance with [13]; waterproofing in accordance with [14]; polyurethane-based primer and silicone anti-adhesive in accordance with the manufacturer's certificate or declaration of conformity; metal embedded part (metal expansion joint) in accordance with [15].

In the process of seaming, an adhesive (self-adhesive) strip is used as a technological material in accordance with the manufacturer's certificate or declaration of conformity.

*Requirements for crushed stone*

It is necessary to use single-fraction washed cubic crushed stone, which is obtained by crushing igneous or metamorphic rocks with a compressive strength of at least 100 MPa.

Grain size of crushed stone from 6 mm to 8 mm inclusive, and from 11 mm to 16 mm inclusive It is allowed to use crushed stone with a grain size of 5 (3) mm to 10 mm inclusive and from 10 mm to 20 mm inclusive.

Before use, the crushed stone should be treated with road bitumen according to [16] or elastomeric mastic according to [17], at the rate of 40-50 kg per 1 m3 of crushed stone. It is allowed to use crushed stone treated with bitumen in the plant, provided that it is heated to a temperature of 160-170 °C before use.

*Requirements for bitumen-based primers*

For the work, use a ready-made primer or prepare it on site from liquid road or construction bitumen according to [18] as a solution in diesel fuel (gasoline) according to [19]. To do this, for the purpose of dehydration, the bitumen is heated to a temperature of plus 120 °C, allowed to cool to a temperature of plus 70-90 °C and carefully poured into a container with diesel fuel (gasoline, kerosene), then mixed until smooth.

*Requirements for the backing plate*

To fix the plate in the seam structure, weld clamps made of reinforcement of class A 240 C and above according to [20] with a diameter of 12 mm and a length of 50 mm in the center of the seam. For plate dimensions of 1,000 mm x 200 mm, it is recommended to use 5 clamps with a 300 mm spacing. The first clamp is welded at a distance of 50 mm from the edge of the plate.

*Technology of the device*

The technology of installing crushed stone mastic expansion joints on bridges involves several stages, including preparation of the base, laying of materials, installation of joints and their verification for compliance with the requirements. Here are the main stages of this technology:

1. Preparing the base for laying the joint.

The first step is to thoroughly prepare the surface for the installation of the expansion joint. This includes:

- Cleaning the joint from dirt, dust, old materials and moisture;
- checking the quality of the concrete or other base on which the gravel-mastic material will be laid. It is important that the surface is flat, free of cracks and defects;
- if necessary, special primers or primers can be applied to the base to improve the adhesion between the materials.

2. Preparation of crushed stone and mastic material.

Crushed stone mastic materials consist of a crushed stone base, mastic (usually bitumen-based) and special additives. It is important to mix these components properly to ensure the required elasticity, strength and waterproofing of the joint. Materials can be:

- crushed stone or gravel of a certain fraction;
- bitumen or polymer mastics;
- Special plasticizers to increase elasticity and frost resistance.

To achieve the desired characteristics, the material is mixed in accordance with technological standards and specifications.

3. Laying the material in the joint.

The crushed stone and mastic material is placed in a specially prepared joint between the parts of the bridge structure:

- first, a crushed stone base is placed on the bottom of the joint, evenly filling the cavities;
- then mastic is applied to fill the space between the crushed stone and form a sealed layer. The mastic should cover the crushed stone completely, ensuring even distribution and improving adhesion.

**Conclusions.**

Several important conclusions can be drawn from the analysis of the requirements for the construction of crushed stone and mastic expansion joints on bridges. Crushed stone and mastic joints are an effective and reliable solution for compensating for deformations in bridge structures, ensuring their strength, tightness and durability. The right choice of materials and precise adherence to the installation technology are key factors in achieving the desired results.

In particular, it is important to take into account the operating conditions of bridges, climatic factors and specific loads that can affect expansion joints throughout the entire service life of the structure. The choice of aggregate and mastic materials that meet quality standards guarantees the reliability of the joints and increases the overall safety of bridge structures.

Thus, to ensure the durability and efficient operation of bridges, it is necessary to carefully approach the design and installation of expansion joints, especially gravel-mastic ones, in compliance with the established technical requirements and taking into account all possible external influences. This will ensure not only the reliability and safety of bridge structures, but also significantly reduce the cost of their maintenance and repair in the future.

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