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A NEW TYPE OF CONSTRUCTION OF THE CARRIAGEWAY OF ROAD BRIDGES USING NON-TRADITIONAL WATERPROOFING MATERIALS

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Abstract. *The article is devoted to a brief review of the design of the bridge deck of bridges with the device of traditional types of waterproofing, the advantages and disadvantages of using one or another material as insulation, the development of a new type of carriageway for road bridges using modern advanced materials. The design of the carriageway of the driving deck is proposed, where an aluminum sheet is used as a waterproofing, combined into a single structure by a roofing method. 3 options for such waterproofing are considered and the approximate economic effect of using the design of the carriageway of road bridges with waterproofing from aluminum sheets is calculated.*

Key words: *bridge, superstructure, bridge deck, roadway, pavement, protective layer, waterproofing, leveling layer, aluminum sheets, main beams of the superstructure, bearing capacity.*

НОВЫЙ ТИП КОНСТРУКЦИИ ПРОЕЗЖЕЙ ЧАСТИ АВТОДОРОЖНЫХ МОСТОВ С ПРИМЕНЕНИЕМ НЕТРАДИЦИОННЫХ ГИДРОИЗОЛЯЦИОННЫХ МАТЕРИАЛО

Аннотация. *Статья посвящена краткому обзору конструкции мостового полотна мостов с устройством традиционных типов гидроизоляции, преимуществ и недостатков применения того или иного материала в качестве изоляции, разработке нового типа проезжей части автодорожных мостов с применением современных перспективных материалов. Предложена конструкция проезжей части ездового полотна, где в качестве гидроизоляции применен алюминиевый лист, объединенный в единую конструкцию кровельным способом. Рассмотрены 3 варианта устройства такой гидроизоляции и подсчитан примерный экономический эффект применения конструкции проезжей части автодорожных мостов с гидроизоляцией из алюминиевых листов.*

Ключевые слова: *мост, пролетное строение, мостовое полотно, проезжая часть, покрытие, защитный слой, гидроизоляция, выравнивающий слой, алюминиевые листы, главные балки пролетного строения, несущая способность.*

INTRODUCTION

Reinforced concrete, which has existed as a material for about 150 years and is widely used in the construction of bridge structures, has brought to life the need for measures to protect concrete and reinforcement.

The most high-quality for their protection can be considered the use of molten lead as a waterproofing of the roadway of road bridges, which covers the entire surface of the leveling layer of the bridge deck. But, due to the high cost of lead in the modern world, this method of protecting bridge structures is not economically justified.

OBJECT OF RESEARCH

In recent years, in connection with the development of the industry of new synthetic materials, new insulating materials have also appeared. The main requirement for modern waterproofing materials of any kind and purpose is high adhesion or penetration ability (i.e., the ability of a waterproofing material to penetrate into the surface pores and microcracks of the insulated material (concrete). This group of materials is combined under the name of the Penetrant trademark).

Among the advanced materials used to insulate reinforced concrete spans are rolled bitumen-polymer welded waterproofing materials: isoplast, isoelastic, mostoplast (and its modifications - mostoplast-lit and techno-elastmost C). The foreign analogue of these materials is ergobit produced by the German company HEIDELBERG Bauchemie GMBH.

The waterproofing device from the listed roll materials is made by sticking them on a concrete (reinforced concrete) surface with melting the lower surface of the roll with the flame of an air-gas burner and simultaneously heating the base surface, slowly unrolling the roll and pressing it to the base. This is how the adhesion of the waterproofing material is achieved.

In any case, it is important that the waterproofing material on which the hot asphalt is directly laid is sufficiently heat-resistant (up to 2000C) and durable. Modern waterproofing materials do not always meet these requirements due to their low strength and deformation characteristics.

One of the world leaders in the production of waterproof materials and technologies for waterproofing bridges is the ICOPAL industrial group. The Brabant bitumen-polymer material developed by her with an integrated polypropylene geotextile is used for waterproofing reinforced concrete superstructures of railway bridges. The geotextile lining protects the waterproofing coating from damage and allows (by analogy with the technologies described above) laying of the crushed stone of the ballast prism (with its thickness of 350 mm or more) directly on the Brabant. Brabant is laid freely on the supporting base with welding by a gas burner and protection by strips of non-woven polypropylene overlaps and abutments to vertical surfaces.

SUBJECT OF RESEARCH

It should be noted that all of the above types of bitumen-based waterproofing do not protect the underlying structural elements from moisture penetration, because. the same bitumen is the destroyer of the layer designed to protect against water in one form or another. It goes something like this. After laying a waterproofing layer based on bitumen and its hardening, under the influence of temperature deformations, as well as deformations of the span structure of bridges under temporary load, the bitumen layer breaks due to its fragility, forming sharp edges that cut pasted rolled or other insulation.

This picture occurs in full measure, especially in the cool and cold periods of the year.

Summing up what has been said and analyzing the state of the issue under consideration of the device for waterproofing the bridge deck of reinforced concrete bridges, we can say that at this stage of its study, there is no 100% guarantee of water tightness of the considered types, and those that inspire confidence are very expensive or the technology of their device is very complicated.

THE PURPOSE OF THE RESEARCH

We will consider the traditional type of bridge deck construction, which is widely used in bridge building practice. The main function of this design of the bridge deck, consisting of leveling, waterproofing and protective layers (Fig. 1), is to protect the main load-bearing elements from water penetration. This design separates the overlying layers from the main load-bearing beams of the superstructures and these layers do not work together with them. As a result, the own weight of this "pie" is a forced constant load that acts on the main bearing elements and requires the consumption of additional reinforcement to absorb the forces arising from this load.

The rationality of the design of the bridge deck could be achieved by installing a single layer of mesh-reinforced self-stressed concrete, which performs the functions of a leveling, waterproofing and protective layer (Fig. 2), which, due to the occurrence of compressive stresses in concrete, will not let water through.

This solution provides for the laying of a layer of tension concrete with a thickness of at least 10 cm across the entire width of the span in accordance with the requirements of the “Technical Guidelines for the Design and Construction of Superstructures of Road and Urban Bridges with a Reinforced Concrete Slab of the Roadway without Pasting Waterproofing VSN 85-68”.

The bridge deck using self-stressed concrete, having advantages over the traditional waterproofing design, is labor-intensive in the device, because there is a need for watering or wetting self-stressed concrete for several days.

In this regard, a new type of bridge deck construction is proposed with the use of aluminum sheets as waterproofing, which covers the entire protected surface (Fig. 3). The strength, deformation, waterproofing and anti-corrosion characteristics of aluminum material are known and beyond doubt.

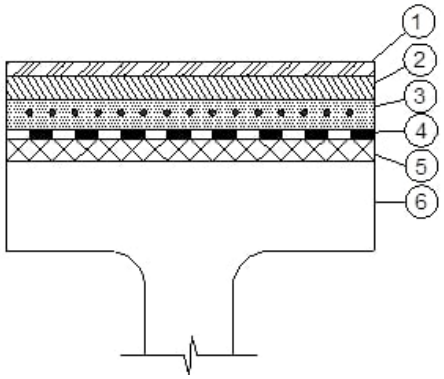

Fig.1. The traditional design of the bridge deck of the carriageway with the device of gluing or coating waterproofing: 1-top layer of asphalt concrete pavement; 2 - lower layer of

asphalt concrete pavement; 3-protective reinforced concrete layer; 4-waterproofing; 5-leveling layer; 6-slab main beam

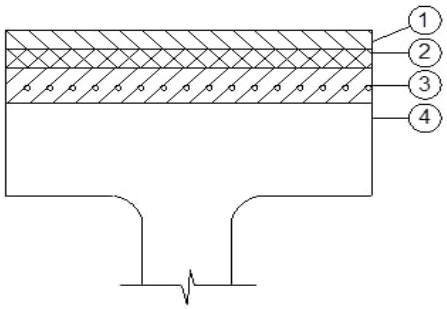

Fig. 2. Construction of the roadway using self-stressed concrete: 1-top layer of asphalt concrete pavement; 2-lower layer of asphalt concrete pavement; 3-ten cm reinforced layer of self-stressed concrete; 4-plate main beam

At the same time, the design of the roadbed of bridges with the use of waterproofing from aluminum sheets can be different. The options may be: 1) the aluminum sheet is laid directly on the leveling layer laid on the slabs of the main beams of the superstructure (Fig. 3); 2) an aluminum sheet is placed between two (lower and upper) layers of asphalt concrete pavement (Fig. 4); 3) an aluminum sheet is laid on a 10 cm layer of mesh-reinforced concrete laid instead of the previous "protective layer" (Fig. 5).

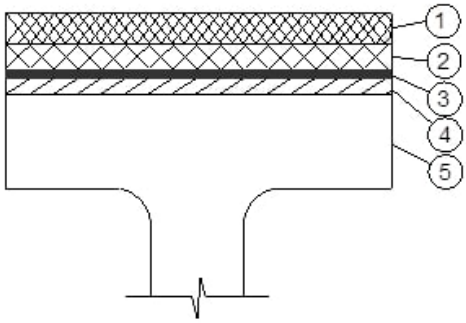

Fig. 3. The proposed design of the roadway with the laying of aluminum sheet on the leveling layer (option 1): 1-top layer of asphalt concrete pavement; 2-lower layer of asphalt concrete pavement; 3-waterproofing (aluminum sheet); 4-leveling layer; 5-plate main beam

The proposed options for the design of the carriageway of road bridges can be applied in new construction, and the third option can also be used in the repair, reconstruction and strengthening of the main load-bearing beams of spans of operated structures.

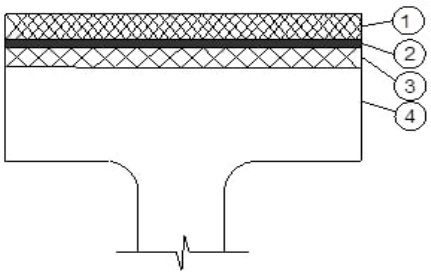

Fig.4. The proposed design of the roadway with the laying of an aluminum sheet between the layers of asphalt concrete pavement (option 2): 1-top layer of asphalt concrete pavement; 2-waterproofing (aluminum sheet); 3-lower layer of asphalt concrete pavement; 4-plate main beam

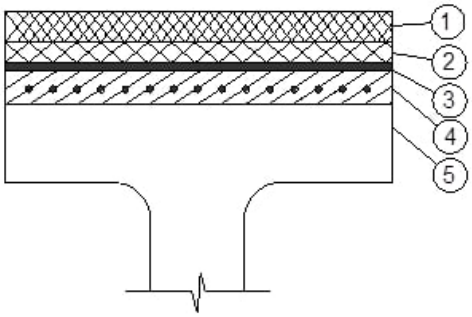

Fig.5. The proposed design of the roadway with the laying of an aluminum sheet on an additional layer of ordinary concrete (option 3): 1-top layer of asphalt concrete pavement; 2-lower layer of asphalt concrete pavement; 3- waterproofing (aluminum sheet); 4-ten-centimeter reinforced layer of ordinary concrete; 5-plate main beam

In the first and second versions of the carriageway design, there is no reinforced protective layer, which largely unloads the span structure. Due to the reduction of the constant load, the forces arising in the sections of the main beams are also reduced, as a result of which it is possible to reduce the number of working reinforcements of the main bearing elements of the bridge.

It is known that recently there has been an increase in the values of temporary loads of road bridges. So, since 2012, in our country, for newly designed bridges, instead of the temporary load A-11, the load A-14 is used, and instead of the wheel load NK-80, NK-100 is used. In this regard, the problem of the operational reliability of bridges designed and built taking into account the previous temporary loads and increasing their carrying capacity, taking into account the increased loads, becomes relevant.

The proposed third option for the design of the carriageway of road bridges using waterproofing from aluminum sheets will help solve this problem, because. when installing a 10-cm layer of concrete reinforced with meshes, working together with the main beams of the superstructure, it is possible to increase the bearing capacity of the atter by 10-15%. In this case, the value of the constant load does not increase, because. this layer of concrete is laid instead of the former "protective" layer.

A roofing sheet of aluminum sheets joined together by a roofing method is laid on a 10 cm layer of concrete reinforced with meshes, the ends of the sheets are tucked into the holes of the drainage pipes, which ensures reliable concrete insulation and prevents the appearance of drips and leaching of concrete. The road surface is laid directly on the surface of the aluminum sheets. When using this design of the bridge deck, hot processes and environmental pollution are completely excluded.

CONCLUSIONS

The use of aluminum sheet as a waterproofing of the bridge deck is also expedient from an economic point of view. According to the data obtained from practice, at present, the minimum direct costs (when using the traditional type, and not expensive foreign ones) for installing 1 m2

of a waterproofing structure from rolled materials are about 110 thousand sums (about 10 US dollars). At the same time, the waterproofing device from rolled materials is produced by 3 or 4 times their sticking on a layer of hot bitumen, which is a technologically complex hot process. In addition, the melting of bitumen at the construction site produces black tarry smoke, which is not welcome from an environmental point of view.

According to market data presented in numerous trading websites, the average cost of 1 m2 of 1.0 mm thick aluminum corrugated sheet is 40,000 sums (about 3.7 US dollars). The cost of laying 1 m2 of waterproofing from aluminum sheets by roofing in the labor market varies between 30-40 thousand sums (about 2.7-3.7 US dollars). Then the total cost of 1 m2 of waterproofing from aluminum sheets will be 70-80 thousand sums (about 6.4-7.4 US dollars).

The direct economic effect (without taking into account the reduction of construction time, labor costs, labor, obtaining waterproofing with a 100% guarantee and other factors) from the use of the above construction of the bridge deck using aluminum sheets as a waterproofing layer per 100 m2 of the surface area of the reinforced concrete bridge structure is about 300-400 USD.

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