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WATERPROOFING LAYER IN THE BRIDGE ROADWAY DESIGN AND IMPORTANCE OF MODERN WATERPROOFING MATERIALS IN THE BRIDGE CONSTRUCTION

Abstract: *Work describes history and importance of waterproofing in bridge construction and use of modern materials in different countries of the world. Importance of installation quality and components in order to protect carriageway is described. Examples are given of experience of USA, Europe and Russia. Work also considers future challenges in the field and different types of materials. Advantages and disadvantages of materials in terms of technical and economic parameters are discussed. One part of work describes importance of waterproofing layer for bridges and its history, while use of modern materials is discussed in another part. In conclusion, work describes how important it is to use modern materials in Georgia and how worth it is to spend more funds for above mentioned components.*
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Introduction

Bridge building holds a prominent place in engineering structures design and construction. Bridge is a highly complicated and interesting structure, which reliability and stability is very important for the country. Bridge building history has been started from the 2nd century BCE, when humans begun to construct arched bridges from a stone. Afterwards, a wooden bridge building technology has been introduced. From the late 18th century metal bridge constructions are found already, while since the early 20th century the reinforced-concrete bridges occur.

It is almost impossible to separate less important elements from the entire bridge structure, since all elements are essential for the structure, starting with piers' foundation and ending with the roadway structure.

Adoption of modern technologies in the bridge building caused the significant increase of superstructure (span) constructions length. Use of long spans is expedient in some cases in order to get rid of building of high, technologically complicated and expensive piers in certain situations that in its turn has a major impact on the total cost of bridge building. As of today, span length of girder bridges surpassed 330 m (Shibanpo Bridge, date of construction 2006). Span stability and strength is of great importance for bridge (as an expensive and strategically important structure) service life extension and for securing of safety and smooth traffic. The issue of span bearing capacity extension is significantly determined by water impermeability of the construction that is attained thanks to high concrete quality and full-fledged waterproofing. The problem is aggravated due to use of such chemical anti-freeze and anti-slip reagents during abundant snowfall on the roads, which activate concrete leaching and processes of metal corrosion. Under conditions of low-grade waterproofing water can penetrate into concrete pores, accumulate in concrete construction depth and freeze at below-freezing temperatures, as a consequence the concrete increases in volume and generates cracks. As a result, the reinforcement starts to corrode and causes damage of reinforced-concrete construction. Based on the above mentioned, we can boldly conclude that water withdrawal from the bridge roadway is an important factor of span durability preservation.

According to the work The Concrete Bridge Durability (NCHRP Synthesis of Highway Practice 4) issued in 1995 in USA, the roadway damage is the most frequent occurrence for bridges that is mainly caused by the roadway cracking, blow-up and demolition. Among the mentioned reasons, the roadway demolition is the most hazardous, since it causes intensive penetration of water and moisture into reinforcement grid, activates processes of leaching and corrosion that is followed by the construction break-down.

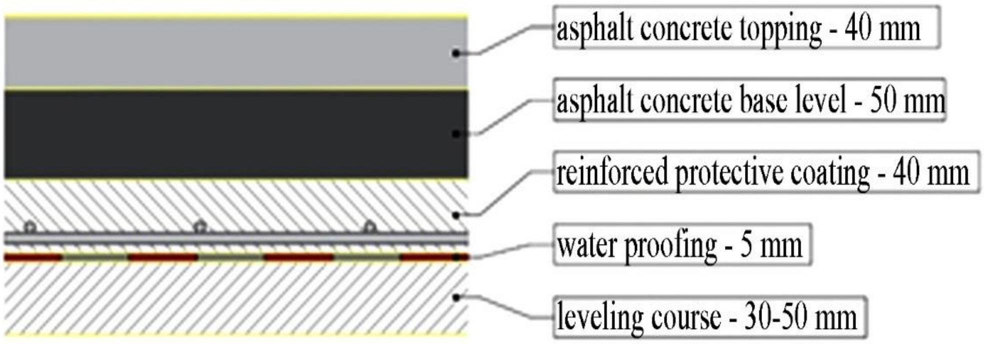
Protection of construction materials and structures from water and moisture rises from the ancient times. Since olden times, they used resin during construction, which was applied to the structural surface and this way protected them from dampness. Along with construction branch development waterproofing materials and their application technologies have been improved, as well. Today, there are many types of materials at the market and each manufacturer opts for its own production. Despite the hard work and researches conducted by specialists of the branch of the many countries worldwide, it is difficult to unequivocally give the preference to one or another material or technology, though the experience has showed the advantage of some of them compared to conventional technologies and materials.

Strange though it might sound, in some cases the materials used in the beginning of the last century have shown the unexpected results. For instance, in 2002, in Saint Petersburg there was reconstructed the Bolshoi Ilyinski Bridge situated at Okhta River, which had been built in 1912. It turned out during reconstruction that the waterproofing layer, which was installed using poured asphalt prepared on the bitumen basis, was in satisfactory conditions. The similar situation was created regarding railway bridge across the Neva built in 1913. The span structure over both rivers was remained in satisfactory conditions and their replacement was necessitated by the load growth only.

Waterproofing layer has to satisfy the following main requirements:

- water impermeability;
- sufficient adhesion to leveling course (structural surface);
- sufficient adhesion to protective coating (layer) or asphalt layer;
- elasticity against crack formation;
- stability to high and low temperatures;
- engineering process simplicity;
- less damage to the environment during execution and exploitation;
- long service life.

The roadway of reinforced-concrete bridge built according to conventional method in Georgia consists of a leveling course, arranged over superstructure beams, waterproofing layer, reinforced protective coating and 2 layers of asphalt concrete.



Picture 1.

Bridge building mainly uses 2 kinds of waterproofing:

- membrane waterproofing (insulating adhesive tapes);
- filling waterproofing.

According to tradition, a membrane waterproofing is mainly used for roadway structures. The mentioned method was introduced in the 20th century in the bridge building and has been widely used in both the entire Soviet Union, and some countries of America and Europe.

Despite its wide application, the membrane waterproofing installation had and still has several problems:

1. Insulating surface has to be plain, and no hollows and humps should exist on it (e.g. from the reinforcement). Frequently it is impossible to satisfy this requirement, since arrangement of reinforcement humps (free lengths) is necessary according to design.
2. Adhesive surfaces are heated up using naked flame (by means of propane hand torch), which generates temperature up to 1000 grades, while polymer self-ignition temperature is 300-400 grades, that as a consequence causes its burn-off and loss of bitumen elasticity, due to this fact cracks are formed at below-freezing ambient temperatures and bitumen starts to break.
3. It is impossible to keep an instrumental or other type of control over water impermeability; therefore, water penetrates into remained cavities, then freezes under below-freezing temperature conditions and insulation breakdown begins.

From here one can make conclusion that there is no full-fledged control over engineering process of membrane waterproofing installation, therefore we have no warranty of water impermeability into the structure.

Study of technical state of bridges constructed in Georgia in the last century showed that in most cases the water impermeability is not secured that becomes the main reason of their rehabilitation or superstructure replacement.

In the last years a membrane waterproofing based on polymeric materials has gained wide use. It is applied by brushes or via spraying method. Usually 1 or 2-component materials occur. In case of spraying, components mix each other and after air contact, they completely attach to the surface in the form of weldless membrane. The mentioned materials mainly represent polymeric substances and their use in the bridge building scales up from day to day.

Below are given the positive aspects of membrane waterproofing materials: installation simplicity, elasticity, absence of connecting welds, no necessity of protective layer on the bridge roadway structure.

Among the negative aspects are: high prices, insufficient test of time.

The key problem of the mentioned materials is their high price. Though, taking into account the fact that protective layer is no more needed and service life of the bridge is substantially longer compared to conventional membrane waterproofing, maybe it is reasonable to think about their use.

On the other hand, lots of modern options of membrane waterproofing materials have been produced in the last years, and as it alleged by their manufacturers, they don't need protective coating and are distinguished by high adhesion ability.

In order to respond to the future challenges of the bridge building branch, it is necessary to adopt new technologies and materials in our country, that should be expressed in study and assimilation of modern waterproofing materials, as well.

Based on the all abovementioned, one can conclude that the major part of branch specialists deems appropriate acceleration of adoption and implementation of modern waterproofing materials and corresponding technologies in Georgia. However, it should be noted that even such advanced countries, as USA, Great Britain, Russia and Canada, still are not ultimately confirmed their opinion regarding this issue. For instance, according to AASHTO, there is probably no necessity to use protective coating on the modern waterproofing layers, while upon Canadian regulations its application is necessary. Worth noticing that with the aim of thorough study of the issue and searching of foreign component analogues in Georgia, the united scientific team of Tbilisi State University and Georgian Technical University has started to take some steps in this direction on a voluntary basis.

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