Estendendo A Vida Útil Das Estruturas De Concreto Armado Em Obras De Arte Especiais

Extending the Service Life of Concrete Structures

Mario Baggio[1], Leonardo Coutinho[2]
1 Alchemco United States / mario@alchemco.com
2 Alchemco Brasil leonardo.coutinho@alchemco.com.br

Summary / Resumo
O objetivo dessa apresentação é mostrar a história e a filosofia da preservação das estruturas de concreto armado em obras de artes especiais. O foco é mostrar como é feito atualmente nos Estados Unidos, apresentar a AASTHO TSP-2 ITD - Transportation System Preservation Technical Services Program – Innovative Technology Demonstration, onde as tecnologias mais avançadas são testadas pelos diferentes estados e também as principais soluções disponiveis para esse tipo de construção.

The objective of this presentation is to show the history and philosophy of preserving reinforced concrete structures in special works of art. The focus is on showing how this is currently done in the United States, presenting the AASTHO TSP-2 ITD - Transportation System Preservation Technical Services Program - Innovative Technology Demonstration, where the most advanced technologies are tested by different states, and also the main solutions available for this type of construction.

Palavras-chave / Keywords
Impermeabilização proteção corrosão, AASTHO TSP-2 ITD;
Waterproofing, Protection, Corrosion, AASTHO TSP-2 ITD

1. Introduction

Infrastructure is a vital component of any modern society, enabling the smooth flow of people, goods, and services. Bridges, in particular, are critical to the transportation network in the United States, connecting communities, facilitating commerce, and providing essential access to emergency services. However, the current state of US infrastructure, including bridges, has been a cause for concern in recent years.

The American Society of Civil Engineers' (ASCE) Infrastructure Report Card, published in 2021, gave the US infrastructure an overall grade of C-. The report revealed that the country's infrastructure was in desperate need of investment and modernization to address the challenges of aging and increasing demand.

Bridges, in particular, were a significant area of concern, with the report card assigning them a grade of C. The report noted that one in three bridges in the US was in need of repair or replacement, with the backlog of repair work estimated at over $125 billion.

The condition of US bridges has a direct impact on the safety and efficiency of the transportation network. Bridges that are in poor condition are at risk of failure, resulting in closures, detours, and disruptions to the flow of goods and services. These closures can result in significant economic losses, particularly for industries that rely on just-in-time delivery schedules.

Furthermore, bridges that are not adequately maintained can also pose safety hazards, increasing the risk of accidents and fatalities. Ensuring the safety of bridges is crucial to guarantee the safety of the traveling public and the efficient movement of goods and services.

In this article, we will explore the current state of US infrastructure, with a particular focus on bridges. We will examine the challenges facing the US infrastructure, the impact of aging infrastructure on bridges, and the potential solutions that can be implemented to address these challenges. We will also examine the role of technology in bridge preservation and maintenance, and the potential impact of the recently passed infrastructure bill on the future of US infrastructure.

2. Challenges Facing US Infrastructure

The United States infrastructure has been facing several challenges that have impacted its condition over the years. One of the significant challenges is the aging infrastructure, with many bridges, roads, and other critical infrastructure assets built several decades ago. The ASCE report card noted that most US infrastructure assets were designed to last for only 50 years, and many have exceeded their intended lifespan.

The growing population and increasing demand for transportation services have also put pressure on the country's infrastructure, resulting in congestion, delays, and higher maintenance costs. Additionally, extreme weather conditions, such as floods, hurricanes, and wildfires, have caused significant damage to infrastructure assets, including bridges.

Aging Infrastructure and Bridges

The aging infrastructure has been a significant challenge for US bridges, with many of them built several decades ago and reaching the end of their intended lifespan. The ASCE report card revealed that over 231,000 US bridges were at least 50 years old, and the average age of US bridges was over 44 years. The report also noted that the average lifespan of a US bridge was 50 years, and many bridges have exceeded their intended lifespan.

The impact of aging infrastructure on bridges can result in a range of issues, including structural deficiencies, deterioration, and wear and tear. Bridges that are not adequately maintained can become structurally deficient, meaning they can no longer support their intended loads, resulting in weight restrictions, closures, and detours. Furthermore, bridges that are not adequately maintained can also become prone to corrosion, erosion, and fatigue, resulting in the need for expensive repairs and replacements.

Potential Solutions for Addressing Bridge Infrastructure Challenges

Several solutions are available to address the challenges facing US bridges and infrastructure. The ASCE report card recommended several measures, including increasing funding for maintenance and repair work, investing in new technologies and materials, and implementing sustainable infrastructure solutions.

One potential solution is to increase funding for bridge maintenance and repair work. The recent infrastructure bill passed by the US Congress includes $110 billion in new funding for bridge and highway repair work. This funding will go a long way in addressing the backlog of repair work and ensuring the continued safety and reliability of US bridges.

Another potential solution is to invest in new technologies and materials to enhance the durability and longevity of US bridges. Advanced materials, such as fiber-reinforced polymers (FRPs), offer a lightweight, durable, and corrosion-resistant alternative to traditional construction materials. These materials can be used to construct new bridges or retrofit existing ones, extending their service life and reducing maintenance costs.

Moreover, technology can play a significant role in bridge preservation and maintenance. The use of sensors, drones, and other monitoring technologies can provide real-time information on the condition of bridge structures, allowing for early detection of potential issues before they become major problems. This technology can enable more efficient and effective maintenance and repair work, reducing downtime and increasing the safety and reliability of US bridges.

Reasons for the premature deterioration of the US Infrastructure

Infrastructure deterioration refers to the degradation of public infrastructure assets over time, leading to decreased performance, safety, and reliability. This deterioration can result from various factors, including environmental factors, aging, and inadequate maintenance. In this article, we will explore the main reasons for infrastructure deterioration and their impact on infrastructure assets.

Environmental Factors

Environmental factors such as water, humidity, wind, temperature, and sunlight can have a significant impact on infrastructure assets. For example, water can cause corrosion, erosion, and weathering of infrastructure components, such as steel and concrete. Wind and temperature can also cause fatigue, cracking, and deformation in infrastructure components. Sunlight exposure can cause discoloration and surface cracking, leading to structural damage.

Aging Infrastructure

Another primary reason for infrastructure deterioration is the aging of infrastructure assets. Many infrastructure assets such as bridges, tunnels, and buildings were constructed several decades ago and have exceeded their intended lifespan. As infrastructure ages, it becomes more vulnerable to wear and tear, leading to deterioration.

Inadequate Maintenance

A lack of regular maintenance and repairs can also contribute to premature deterioration of infrastructure. Infrastructure that is not adequately maintained is more prone to corrosion, erosion, and other forms of deterioration. For example, a bridge that is not regularly inspected and repaired may suffer from fatigue, corrosion, and other forms of deterioration, leading to structural deficiencies and the need for costly repairs or replacement.

Overuse

Infrastructure assets that are overused, such as highways and bridges, can also suffer from premature deterioration. Overuse can lead to increased wear and tear, resulting in structural deficiencies and other forms of deterioration. For example, highways that experience high traffic volumes are subject to increased stress, leading to cracking and deformation in the roadway surface.

Design Flaws

Infrastructure assets with design flaws can also suffer from premature deterioration. Design flaws can lead to stress concentrations, fatigue, and other forms of damage, resulting in premature deterioration and the need for repairs or replacement. For example, a bridge with inadequate design specifications may suffer from excessive vibration, leading to fatigue and eventual structural failure.

Natural Disasters

Natural disasters such as earthquakes, hurricanes, and floods can also cause significant damage to infrastructure assets, leading to premature deterioration and the need for repairs or replacement. For example, a bridge that suffers damage from a flood or earthquake may require extensive repairs or replacement, depending on the extent of the damage.

3. Innovation and the Infrastructure Bill

The Infrastructure Bill represents a significant investment in infrastructure assets in the United States, with a focus on improving the safety, reliability, and sustainability of transportation and other infrastructure systems. The bill includes provisions for funding infrastructure maintenance, repair, and replacement projects, as well as for the development of innovative technologies and solutions to address infrastructure challenges.

One of the key innovations included in the Infrastructure Bill is the establishment of a new Infrastructure Financing Authority. This authority will provide loans and other financing tools to support infrastructure projects across the country, including in rural and underserved communities. By providing access to low-cost capital and other financial resources, the Infrastructure Financing Authority aims to accelerate the pace of infrastructure investment and drive economic growth.

In addition to the Infrastructure Financing Authority, the bill also includes provisions for the development and deployment of innovative infrastructure technologies and solutions. This includes funding for research and development of new materials, construction techniques, and other innovations that can enhance the durability, safety, and sustainability of infrastructure assets.

One such innovative technology is the use of advanced sensors and monitoring systems to detect and diagnose infrastructure issues in real-time. These systems can provide early warning of potential infrastructure failures, enabling proactive maintenance and repairs that can prevent costly and dangerous failures. Additionally, the use of digital technologies and data analytics can improve the efficiency and effectiveness of infrastructure management, reducing costs and enhancing performance.

Another innovative solution included in the Infrastructure Bill is the development of sustainable infrastructure projects that promote energy efficiency, environmental sustainability, and resilience. This includes investments in renewable energy, electric vehicle infrastructure, and green infrastructure projects that can help mitigate the impacts of climate change and support long-term sustainability.

Overall, the innovation included in the Infrastructure Bill represents a significant step forward in addressing the infrastructure challenges facing the United States. By investing in innovative technologies and solutions, we can enhance the safety, reliability, and sustainability of our infrastructure systems, while driving economic growth and job creation.

However, the success of these innovations ultimately depends on sustained investment, collaboration between infrastructure stakeholders, and effective implementation. To ensure that these innovations are deployed effectively and achieve their intended outcomes, it is essential to develop a comprehensive infrastructure strategy that prioritizes maintenance and preservation, leverages new technologies, and addresses the underlying causes of infrastructure deterioration.

In conclusion, the innovation included in the Infrastructure Bill represents a significant opportunity to address the infrastructure challenges facing the United States and to promote economic growth and job creation. By investing in innovative technologies and solutions, we can extend the lifespan of existing infrastructure assets, reduce the need for costly replacement projects, and ensure that infrastructure remains safe and reliable for public use. The success of these innovations ultimately depends on sustained investment, collaboration, and effective implementation, and the development of a comprehensive infrastructure strategy that prioritizes maintenance and preservation and addresses the underlying causes of infrastructure deterioration.

4. Current Solutions to protect and Preserve Bridges

Bridges are critical components of our transportation infrastructure, providing safe and efficient passage for millions of people and goods every day. However, these structures are subject to deterioration over time, which can compromise their safety and functionality. One of the main threats to bridge durability is water penetration, which can cause corrosion of steel reinforcement and deterioration of the concrete. Therefore, waterproofing and protecting bridges from water penetration are crucial to ensure the continued safe and reliable operation of our transportation networks. In this article, we will explore the various solutions available to waterproof and protect bridges.

Protective Coatings

Protective coatings are one of the most common solutions used to waterproof and protect bridges.

These coatings can be applied to the surface of the bridge to prevent water penetration, as well as to protect the concrete from exposure to environmental factors such as ultraviolet radiation and chemicals. There are various types of protective coatings available, including acrylic, epoxy, and polyurethane coatings.

Acrylic coatings are often used for their ability to resist ultraviolet radiation, which can cause fading and degradation of the surface. These coatings can also provide some protection against water penetration, although they are not as effective as other types of coatings.

Epoxy coatings are known for their ability to adhere well to concrete and provide excellent protection against water penetration. They are often used for bridges that are exposed to harsh environments such as saltwater, and they can be applied in thick layers for added durability.

Polyurethane coatings are similar to epoxy coatings in their ability to resist water penetration, but they are more flexible and can better accommodate the natural movement of the bridge caused by temperature changes and other factors. They are often used for bridges that are subject to significant movement, such as those with expansion joints.

Waterproof Membranes

Another solution for waterproofing and protecting bridges is the use of waterproof membranes. These membranes are typically made from materials such as bitumen or polyurethane and are applied to the surface of the bridge to create a barrier against water penetration.

Bituminous membranes are one of the most common types of waterproof membranes used for bridge protection. These membranes are made from a combination of bitumen and various fillers and are applied in several layers to create a thick, durable barrier against water penetration.

Polyurethane membranes are also used for bridge protection, especially in areas where the bridge is subject to movement. These membranes are flexible and can better accommodate the natural movement of the bridge without cracking or breaking.

Corrosion Inhibitors

Corrosion inhibitors are another solution for protecting bridges from deterioration caused by water penetration. These inhibitors are typically added to the concrete mix during construction or applied to the surface of the bridge after construction to prevent the corrosion of steel reinforcement.

There are several types of corrosion inhibitors available, including calcium nitrite, organic inhibitors, and surface-applied inhibitors. Calcium nitrite is one of the most common types of corrosion inhibitors used for bridge protection, and it can be added to the concrete mix in small quantities to prevent the corrosion of steel reinforcement.

Organic inhibitors are another type of corrosion inhibitor that can be added to the concrete mix. These inhibitors are typically made from organic compounds and work by forming a protective layer on the surface of the steel reinforcement.

Surface-applied inhibitors are applied to the surface of the bridge after construction to create a barrier against water penetration and to prevent the corrosion of steel reinforcement. These inhibitors can be applied in various forms, including sprays, paints, or impregnations.

Cathodic Protection

Cathodic protection is a technique used to protect bridges from corrosion caused by water penetration. This technique involves creating an electrical current that flows through the bridge to prevent the corrosion of steel reinforcement.

There are two types of cathodic protection available for bridge protection: sacrificial anode and impressed current. Sacrificial anode cathodic protection involves attaching a metal anode to the bridge, which corrodes instead of the steel reinforcement. This sacrificial anode can be made from materials such as zinc, aluminum, or magnesium, and it must be periodically replaced.

Impressed current cathodic protection involves the use of an external power source to create an electrical current that flows through the bridge. This current helps to prevent the corrosion of steel reinforcement and can be adjusted to meet the specific needs of the bridge.

Joint Sealants

Joint sealants are another solution for waterproofing and protecting bridges. These sealants are typically applied to the joints between the bridge deck and other structural elements to prevent water penetration and to protect the underlying concrete from damage.

There are several types of joint sealants available, including silicone, polyurethane, and hot-applied sealants. Silicone sealants are often used for their ability to resist ultraviolet radiation, which can cause degradation of the surface. Polyurethane sealants are flexible and can better accommodate the natural movement of the bridge without cracking or breaking. Hot-applied sealants are typically made from a combination of asphalt and rubber and can provide excellent protection against water penetration.

5. The Innovative Technology Demonstration Working Group and the new Approach to Bridge Maintenance

The Innovative Technology Demonstration (ITD) Work Group for bridges is a collaborative effort between the Federal Highway Administration (FHWA) and state transportation departments to evaluate and promote innovative technologies for bridge construction, repair, and maintenance. The ITD Work Group was established in 1999 as part of the FHWA's Technology Partnership Program, which aims to promote the use of new technologies to improve the performance, safety, and efficiency of the transportation system.

The ITD Work Group is made up of representatives from state transportation departments, the FHWA, and other stakeholders, such as industry associations and academic institutions. The Work Group evaluates new technologies based on their potential benefits, cost-effectiveness, and feasibility for implementation in bridge construction, repair, and maintenance projects.

The ITD Work Group evaluates technologies in several ways, including conducting field demonstrations, developing technical guidance documents, and providing training and outreach to promote the use of innovative technologies. The Work Group also collaborates with other FHWA technology programs and initiatives to share knowledge and best practices.

The ITD Work Group has evaluated a range of innovative technologies for bridge construction, repair, and maintenance, including advanced materials, sensors, inspection technologies, and software tools. The Work Group has also developed guidance documents and best practices for the use of these technologies, which have been widely adopted by state transportation departments and industry stakeholders.

In conclusion, the Innovative Technology Demonstration Work Group for bridges is an important initiative that promotes the use of innovative technologies to improve the performance, safety, and efficiency of bridge construction, repair, and maintenance. The Work Group plays a vital role in evaluating and promoting new technologies, providing guidance and training to stakeholders, and advancing the state of the art in bridge engineering.

6. How the Bio-Based Enzymatically Modified Waterproofing Technology is helping to preserve the US Infrastructure

The Bio-based Enzymatically modified sodium silicate technology is a promising option for waterproofing concrete structures because it offers several advantages over traditional waterproofing solutions. Here are some reasons why enzymatically modified sodium silicate technology is a good option to waterproof concrete structures:

Long-lasting protection: enzymatically modified sodium silicate technology offers long-lasting protection against water penetration, even in harsh environments. This technology can penetrate deeply into the concrete and form a gel-like substance that fills the pores and capillaries of the concrete. This gel-like substance can resist the ingress of water and other harmful substances, providing long-lasting protection to the concrete structure.

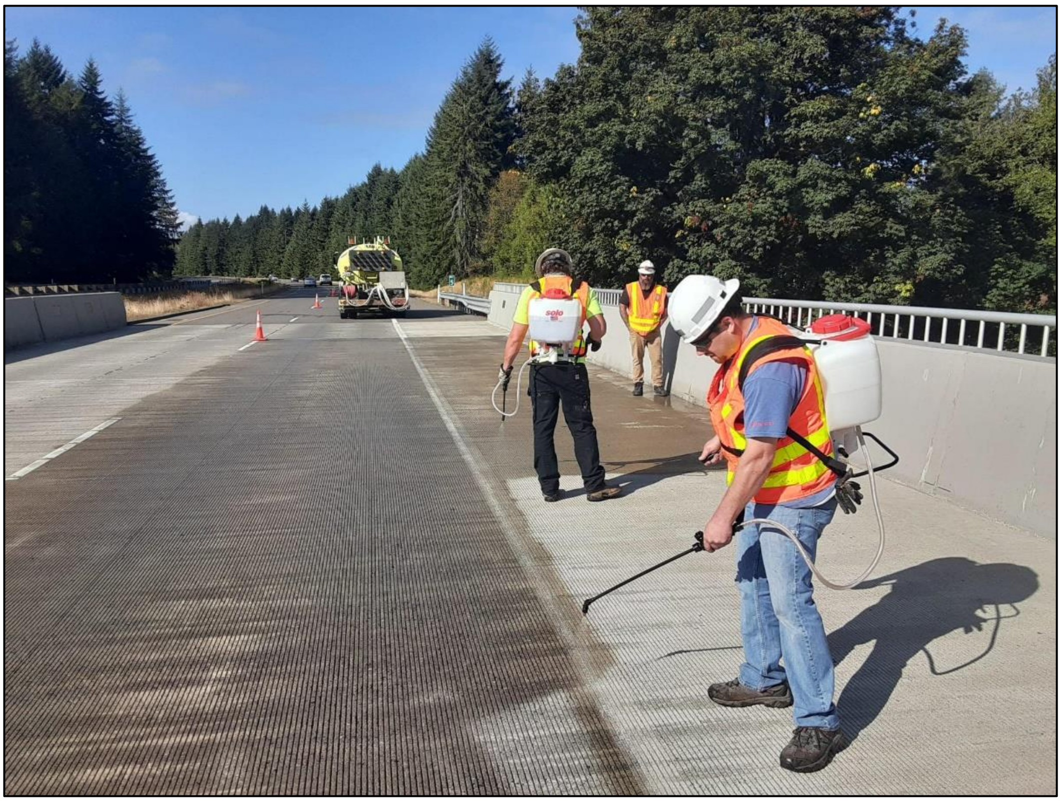
Environmentally friendly: Enzymatically modified sodium silicate technology is an environmentally friendly solution to waterproofing concrete structures. It is made from natural, renewable materials and does not contain any harmful chemicals or volatile organic compounds. This technology is also non-toxic, which means it is safe for workers and the environment.

Easy to apply: Enzymatically modified sodium silicate technology is easy to apply, requiring no specialized equipment or expertise. It can be applied by spray, brush, or roller, and it dries quickly, allowing for fast and efficient waterproofing of concrete structures.

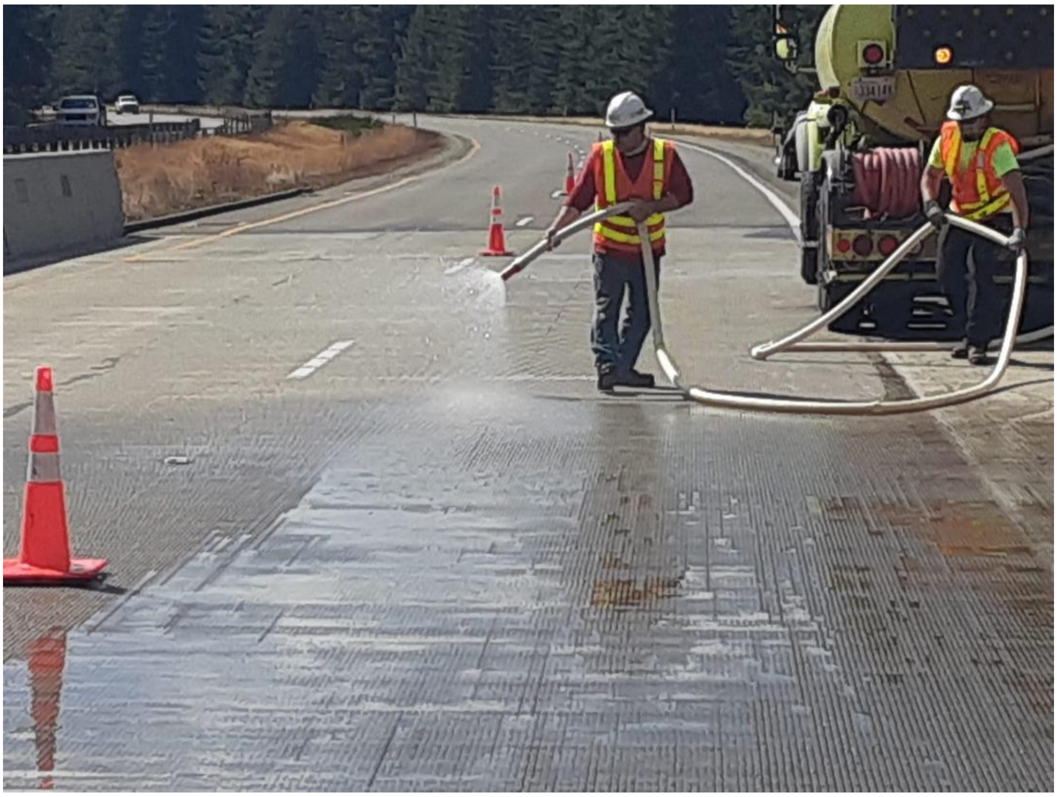
Cost-effective: Enzymatically modified sodium silicate technology is a cost-effective solution to waterproofing concrete structures. It requires less labor and fewer materials than traditional waterproofing solutions, and it can be applied quickly, reducing downtime and disruption to transportation networks.

Improves durability: Enzymatically modified sodium silicate technology can improve the durability of concrete structures by strengthening the concrete and reducing the risk of cracking, spalling, and other forms of deterioration. This technology can also reduce the risk of corrosion of steel reinforcement, which can compromise the structural integrity of the concrete.

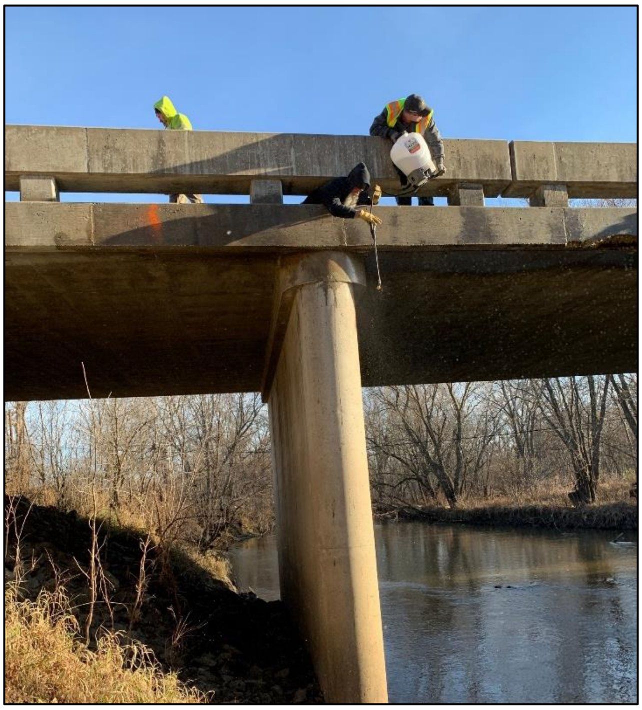
In conclusion, enzymatically modified sodium silicate technology is a good option to waterproof concrete structures because it offers long-lasting protection, is environmentally friendly, easy to apply, cost-effective, and can improve the durability of the concrete structure. This technology is a promising solution to address the challenges of waterproofing and protecting concrete structures, and it is worth considering for future infrastructure projects.



Picture 1 – Application of Bio-based Enzymatically Modified Silicate



Picture 2 – Activation of Bio-based Modified Waterproofing with water



Picture 3 – Vertical Application of Bio-based Waterproofing

7. Conclusion

In conclusion, protecting and waterproofing bridges and infrastructure is critical to ensuring the safety, reliability, and longevity of these assets. The deterioration of infrastructure assets can result from various factors, including environmental factors, aging, inadequate maintenance, overuse, design flaws, natural disasters, lack of funding, deferred maintenance, lack of innovation, and poor planning and execution. By addressing these challenges through preventive maintenance, regular inspections, and the development and implementation of sustainable infrastructure solutions, we can extend the lifespan of infrastructure assets, reduce the need for costly replacement projects, and ensure that infrastructure remains safe and reliable for public use.

Bio-based Enzymatically modified sodium silicate technology is an innovative solution for protecting and waterproofing concrete structures, providing several benefits over traditional solutions. This technology offers superior durability, resistance to abrasion and chemicals, and increased adhesion to concrete surfaces. Furthermore, it is environmentally friendly, easy to apply, and cost-effective, making it an attractive option for infrastructure owners and managers.

The Infrastructure Bill represents a significant investment in infrastructure assets, including bridges, and provides funding for their maintenance, repair, and replacement. This bill acknowledges the importance of infrastructure to the functioning of modern society and the need for sustained investment in its preservation and maintenance. With the implementation of the Infrastructure Bill, we can expect increased emphasis on the preservation and maintenance of infrastructure assets, including bridges, and the development of sustainable infrastructure solutions.

However, it is essential to recognize that protecting and waterproofing bridges and infrastructure is an ongoing process that requires sustained investment and attention. Infrastructure assets are subject to wear and tear over time, requiring regular maintenance and repairs to ensure their continued safety and reliability. By prioritizing infrastructure maintenance and preservation, we can extend the lifespan of existing infrastructure assets, reduce the need for costly replacement projects, and ensure that infrastructure remains safe and reliable for public use.

In conclusion, protecting and waterproofing bridges and infrastructure is a critical component of ensuring the safety, reliability, and longevity of these assets. By investing in preventive maintenance, regular inspections, and sustainable infrastructure solutions, we can extend the lifespan of existing infrastructure assets, reduce the need for costly replacement projects, and ensure that infrastructure remains safe and reliable for public use. The Infrastructure Bill provides a significant opportunity to invest in the preservation and maintenance of infrastructure assets, including bridges, and to develop sustainable infrastructure solutions that meet the needs of modern society. However, the success of these efforts ultimately depends on sustained investment, innovation, and collaboration between infrastructure stakeholders. By prioritizing infrastructure maintenance and preservation, we can ensure that our infrastructure assets remain safe, reliable, and sustainable for future generations.

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