A 30 YEAR CASE HISTORY OF POLYURETHANE THICK FILM COATINGS IN CIVIL ENGINEERING APPLICATIONS

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Abstract: Extreme temperatures, rain, and freeze thaw cycles can all attack structures causing corrosion and therefore high maintenance costs. The UK DOT ensures maintenance is kept to a minimum by protecting its bridge stock using an effective waterproof coating which meets the exacting standards specified in BD47. A number of polyurethane based waterproofing systems have now met this standard. The inherent properties, ease of installation and long term protection offered by polyurethane systems make them extremely popular amongst client authorities across the world.

INTRODUCTION

Structures throughout the world are at constant attack from environmental influences such as: water and airborne contaminants, extreme temperatures and freeze thaw cycles. These elements enter the structure through cracks and small holes. This process leads to premature degradation and untimely decay of concrete and steel structures. Without a suitable protective coating these cracks deepen over time which can eventually compromise the integrity of the structure.

The UK DOT recognises that corrosion of its bridge stock leads to constant, expensive repair and maintenance. In the UK the Highway Agency (part of the DOT) maintains 10,000 bridge structures on motorway and trunk roads. Throughout their service life all will require some repair and maintenance.

HISTORY OF WATERPROOFING IN THE UK

An excellent example of how a government agency has developed a particular standard can be seen in the UK DOT's attitude towards waterproofing coatings applied to bridge structures.

Back in the 1940s the UK DOT (at that time The Ministry of War Transport) addressed the need to protect its structures through bridge deck waterproofing. Over the next 30 years many different waterproofing systems were used including mastic asphalt products and various combinations of bituminous sheet. Many products were found to be ineffective due to: poor substrate bond, areas of blistering and pin holing, an inability to follow substrate contours and degradation of the finished product's components. By 1960 it was mandatory to waterproof all UK Highways Agency bridge structures and by the 1990s the DOT had collated a definitive list of requirements for waterproofing systems, standard BD47.

Devised by TRL (Transport Research Laboratory), the testing requirements for BD47 consist of a strict assessment programme. Once the standards are met the product is awarded a British Board of Agrément (BBA) certificate for roads and bridges. When BBA certification is obtained the product can be used on any bridge maintained in compliance with the specification for UK highways works (MCHW1).

To meet BD47 and gain BBA certification the waterproofing product

must undergo vigorous field testing throughout the installation process and be subjected to post-installation checks including resistance to: tensile adhesion, chloride ion penetration, heat aging, chisel impact, aggregate indentation, thermal shock, crack cycling as well as shear adhesion tests. The manufacturer is asked to submit details on the health and safety aspects of the product, the expected service life, quality assurance statements, material chemical makeup as well as system requirements such as the necessary surface preparation and bituminous overlay.

POLYURETHANE SYSTEMS

Since 1960 polyurethane waterproofing systems have excelled on a range of industrial applications where other types of waterproofing systems have failed. Where many systems proved ineffective due to lack of flexibility, an inability to spray vertically and poor bond between substrate and membrane, the polyurethane systems offered the client durable and strong protection. Polyurethane based products were initially created for corrosion protection on structures such as trawler's decks subject to the ambient conditions in the North Sea, but their versatility soon became apparent following successful applications on bridge, roof and tunnel structures. Through advances in production and application methods polyurethane system manufacturers were able to develop products and eliminate more of the defects found in previous systems.

The Versatility of Polyurethane Systems

Polyurethane membrane has now been applied to structures worldwide including road and rail bridges, basements, roofs and water containment facilities.

In the UK a number of high performance, polyurethane products hold a BBA roads and bridges certificate and meet the requirements of BD47. In addition certain systems also hold BBA certification for use as a damp-proof waterproofing membrane for application on underground structures and internal/external applied tanking. The approved systems, which meet BD47, provide a reliable, flexible and long-term waterproof seal and have the additional benefits of being resistant to tear, root and microbial attack, sound insulating as well as performing well under all forms of weather.

The effectiveness of polyurethane systems stems from the quality of the material components. Most systems are 100% solids, VOC free and contain no fillers. They are suitable for use in all ambient conditions. Polyurethane membrane retains its physical qualities through temperatures -42°C to 110°C with elongation not effected (1). The membrane is highly resilient with elongation at break greater than 250%, hardness of approximately 80 shore A and tensile strength of 1815 psi (2,3,4). More importantly the membrane is watertight, not fractured by substrate cracking and movement, resistant to aging and current service life for the majority of BBA approved membranes is at least 25 years.

Application

The effectiveness of polyurethane systems is enhanced by the innovative spray application techniques developed over recent years.

Manufacturers and applicators now invest heavily in research and development to optimize the efficiency and quality of application methods. Installation operations are now computer controlled and specially designed spray equipment at the forefront of waterproofing technology is used. This technologically advanced equipment now

allows for complete mobility, spraying vertical surfaces, overhead, behind pipe bays and over corners without problem. The computers carefully monitor the ratio and temperature of the material and measure output coverage rates.

The quality of the installed polyurethane system is assured. Quality tests on the membrane don't finish at application. Applicators insist that all installed the membrane is subject to a range tests including pin-hole surveys and pull-off tests. Furthermore membrane samples are sent to independent test laboratories to certify the integrity of the membrane, all in accordance with BBA certification.

CASE STUDIES

Figure I – The Severn Second Crossing, UK

The Second Severn Crossing, UK

Polyurethane waterproofing membranes have established a good reputation with client authorities throughout the world.

In 1996 a polyurethane waterproofing system was applied to the Second Severn Crossing. The original 'first' crossing was slowly disintegrating due to the ongoing increase in traffic loads together with the harsh conditions in this coastal environment.

To complete this contract within the required programme constraints the contractor used multiple spray machines and several teams of spray operatives, creating a potential output of 21,500ft_ per day.

Figure II – Anderton Boat Lift, UK

Anderton Boat Lift, UK

In 2001 a polyurethane membrane was applied to existing steel structures on this boat lift situated on the UK canal network. Built in 1875 the lift represented a prime example of Victorian civil engineering. By the 1960s canal use was infrequent and the lift slowly fell into disrepair. In 2001 a decision was made to renovate the lift back to its former glory for recreational use.

17,000 square feet of steel surfaces were coated with polyurethane membrane. Vertical and hard to reach areas proved easy to cover using a 165 feet hose attached to a mobile sprayer. The membrane adhered flawlessly to the steel substrate and gelled within seconds with no drips or curtaining. A UV resistant coating was applied to all the membrane above the waterline to maintain aesthetic appearance.

Figure III – Athens Concert Hall

Athens Concert Hall, Greece

Polyurethane membrane was selected for installation to the buried roof structure which was part of the major project to extend the prestigious Athens Concert Hall.

The client elected to use a polyurethane based system to coat the most difficult and irregular stepped elevations of the roof area which incorporated integral sub-surface drainage channels.

The installation of 32,000 feet square to buried concrete surfaces was completed during spring 2002 and the new, improved Concert Hall was showcased during the 2004 summer Olympics.

References

(1) BAM Test Certificate 2.33/23529
(2) Tested to DIN53504 test standard
(3) Tested to DIN53505 test standard
(4) Tested to DIN53504 test standard