WATERPROOFING ASPHALT SYSTEM ON ROSE FITZGERALD KENNEDY BRIDGE, IRELAND

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ABSTRACT

The Rose Fitzgerald Kennedy bridge, Co. Wexford, Ireland was completed in January 2020 as part of the N25 Bypass project by the New Ross Joint Venture (BAM & Dragados).

The original asphalt pavement design over the concrete deck required a layer of mastic asphalt produced and machine laid by a specialist sub contractor as a secondary waterproofing layer to the concrete bridge deck.

The contractor New Ross Joint Venture (BAM & Dragados) together with Ooms Producten, Material Edge Ltd and surfacing contractor Lagan Asphalt developed an alternative design. The waterproofing system was based on past experiences of Ooms Producten in The Netherlands, including the 2015 Botlek bridge, A15 MaVa project (Maasvlakte-Vaanplein), which consisted of waterproofing four concrete approach ramps having a total surface area of 24,000 m2.

The asphalt pavement design proposal facilitated a much improved completion time for the asphalt deck as it provided for outputs of greater than 10,000m2 per day of waterproofing using specialist hot spray equipment of sub contractors Ooms Producten and Asphalt Reinforcement Services of the UK.

The original secondary waterproofing design was for a 60mm layer of machine laid mastic asphalt over asphalt regulating layers. This was replaced in the new design with asphalt regulating onto which the waterproofing (Sealoflex® SC-4) was machine sprayed, followed by layers of polymer modified SMA binder and surface course (55mm + 30mm). The entire waterproofing system was laid to a tight schedule during naturally short weather windows throughout the last 2 weeks of November and early December 2019.

1. Introduction

The Rose Fitzgerald Kennedy bridge is an Extrados type bridge, which at almost 900 meters is the longest bridge in Ireland and has the longest span of its kind in the world. It forms part of the € 230 Million, N25 New Ross Bypass PPP Project which comprises of 14km of dual carriageway road including new sections of both the N25 and N30 National Primary Routes and was carried out by a joint venture of The Royal BAM Group and ACS Group.

Waterproofing of the concrete bridge deck took place as usual using a spray applied MMA hand sprayed system. Due to the method of construction and final tensioning of the concrete deck itself there was a requirement to provide a secondary waterproofing over a considerable quantity of regulating with asphalt which was used to level the surface before a final running layer could be applied. In order to avoid water being able to sit in any low spots on the deck beneath and within the regulating a secondary water proofing was installed as part of the final surfacing layers. As a solution to these preconditions, a special asphalt system based on polymer modified asphalt regulating and surface course and a 3mm thick waterproofing hot-sprayed heavily polymer modified bituminous membrane was installed.

2. Secondary waterproofing redesign

The original design called for a 60mm machine laid mastic asphalt binder and surface layer combined. The mastic asphalt specified was to be machine laid to an area of 16,000m2. The anticipated timescale for completion of the mastic asphalt was 4-6 weeks.

After consultation with the supply chain an alternative solution was decided upon, one which would reduce the timescale to install and comply with contract requirements for the pavement which were:

- Contract outlines “special requirements” for wheel track testing which in turn requires a specific aggregate grading.
- Pavement was to be fit for purpose (i.e. adequate performance for rutting, skid resistance, IRI etc.)

- Limitations of small scale of mastic asphalt industry in Ireland expected to include production volumes not exceeding 35t/day, was therefore not considered a viable option.

The alternative waterproofing asphalt system (excluding filling/levelling layers) was made up of a 3mm thick layer of hot Polymer Modified Binder (Sealoflex® SC-4) sprayed by machine over which 10mm aggregate chippings were lightly scattered to allow restricted numbers of vehicles to travel across it prior to and during surfacing operations. Over the sprayed and chipped PMB waterproofing layer, 55 mm of Clause 906 AC Dense binder course 40/60 followed by 30mm of SMA 10 Surface course PMB 65/105-60 was applied without exceeding the maximum thickness of 100mm.

Drawing from experience with waterproof asphalt systems on previous concrete deck projects (Ir. C.P. Plug et al 2016), a system involving a hot sprayed highly viscous bituminous membrane with Polymer Modified Bitumen (PMB) was applied to the final layer of regulating. Due to the unevenness of the bare concrete system of the bridges, it would not have been wise to apply the bituminous membrane at the bottom layer on the concrete. By first applying a levelling course, the performance of the secondary waterproofing has been improved.

3. Product development testing

The membrane was previously tested in the laboratory using an asphalt mix, details of which are in Table 1.

Table 1: Asphalt layers without filling and levelling layer as produced in the laboratory.

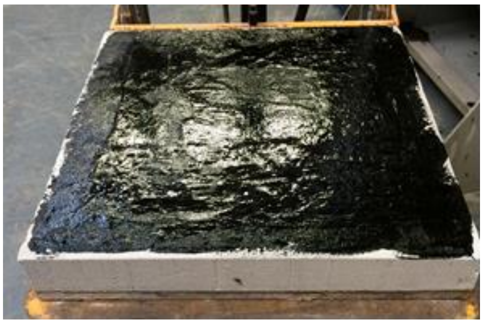
Layers	From top to bottom
Asphalt	AC 8 base/bind/surf Multiflex 100 S_LT
Crushed stone chippings	8/11 6-7 kg/m^2
Membrane	3.0 kg/m^2 Sealoflex® SC-6
Crusher sand	0.6 kg/m^2
Primer	1.0 kg/m^2 Emuflex N
Concrete	Porous concrete

Sealoflex® SC-6 was the product selected for testing as the waterproof bituminous membrane. (SC-4 has a lower softening point of >/= 85°C well suited to the conditions on New Ross Bridge)

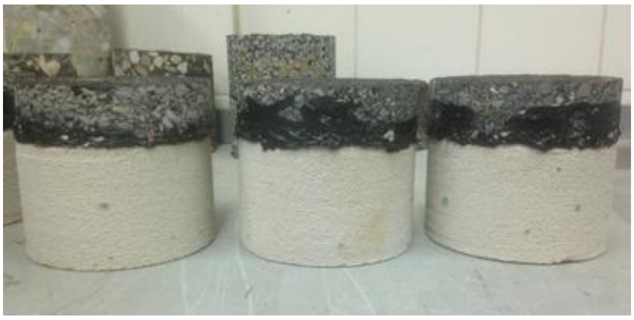
The production steps taken in the laboratory are shown visually in figures 1 to 6. The permeability of the cores (Ø 100 mm) from the system was then tested by KOAC-NPC. From KOAC-NPC’s results, the conclusion could be drawn that the system is not permeable. The permeability coefficient (k) at 5 and 7 bar water pressure was 0 m/s.

Figures 1 and 2: Concrete slab 3 weeks after production, with primer coat applied

Figures 3 and 4: Bituminous membrane system before and after scattering of crushed stone chippings.

Figures 5 and 6: Specimens after drilling and specimen after testing at KOAC-NPC

4. Laboratory outdoor confirmation trial

Subsequently, a large scale outdoor confirmation trial during which the laying conditions were established was created. The Sealoflex SC-6 was sprayed over an existing section of asphalt pavement which had been cleaned. The bituminous membrane (3 kg/m2) was then scattered with crushed stone 8/11mm (50% covering) and a thin binder course was applied to it.

Checks were made to ascertain the optimum timing of the application of the crushed stone was applied (before and after 1 night of curing of the membrane) and the use of the road roller.


Figures 7 and 8: Applying the binder course preparation section and cross-section of thin binder course

The best result for the compaction of the AC8 binder course was achieved by starting the compaction of the base/bind/surf Multiflex 100 S_LT at an external temperature of 130 °C with a small tandem roller (3-4 tonnes) up to an external temperature of 90 °C in up to three rolling passes (back and forth; six passes in total). After reaching an external temperature of approx. 90 °C, further compaction is possible with a large tandem roller (7 tons) up to the maximum density at a temperature of approx. 60 °C.

Drilled cores revealed that it is important for adhesion that the crushed stones are scattered on the membrane after rather than before it has cured. If scattering is done too soon, there is less adhesion between the asphalt layers (the applied binder course was see to come loose when drilling the cores).

The above lessons learnt were implemented in the work instructions on the Rose Fitzgerald Kennedy bridge waterproofing asphalt system.

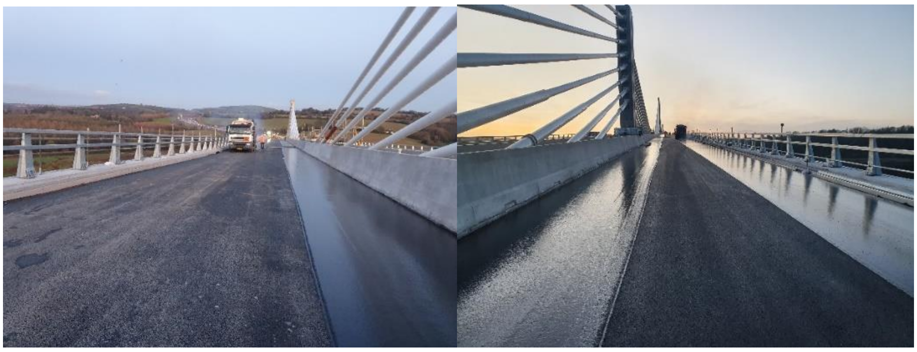
5. Levelling & regulating course

With the exception of a few locations, a levelling and regulating course of 20 to 140mm of a combination of SMA 10 PMB asphalt was laid over the entire surface of the previously waterproofed (MMA) concrete deck (in several layers) so that the intermediate and top layers could be laid in a uniform thickness.

6. Installation

The entire Rose Fitzgerald Kennedy bridge asphalt waterproofing system was laid to a tight schedule between periods of high rainfall at the end of November and beginning of December 2019.

After the regulating courses were laid the surface was either sprayed almost immediately and before any traffic had been allowed on it, or when spraying took place at a later stage, the regulating was cleaned, allowed to dry and tack coated prior to the application of SC-4. This was done to ensure proper adhesion between the top of the regulating layer and sprayed PMB membrane.



Figures 9, 10, 11: Applying sprayed Sealoflex® SC-4 membrane to clean, dry and prepared surfaces.

6.1 Special arrangements for protection of kerbs and concrete structure

Due to frequent high winds on the exposed bridge deck there was a high risk of cobwebs of SBS modified membrane spray being blown onto adjacent white integrated drainage kerbs. An innovative solution was put in place by the operatives from Ooms Producten to overcome this challenge. A wrap around the spray bar was installed using chicken wire, thus all the cobwebbing which normally occurs and can be whipped up by the wind was contained by the chicken wire structure. Following this the areas requiring cleaning were kept to an absolute minimum.

Where cobwebs did come in contact with the concrete it was observed that if caught very early on (within 1 hour) it could be swept away simply using a brush. Additionally during the application of the membrane, some of the most sensitive areas were kept clean by shielding using a self-propelled shield or masked off with tape.

Figure 12: Applying adhesive layer and protection method for removal of cobwebbing effect resulting from high winds on site.

6.2 Bituminous membrane

The Sealoflex SC-4 membrane was sprayed over the filling and levelling layer using 3.0 ± 0.2 kg/m^2 without the need to (re)apply an adhesive layer (tack coat) as long as it was soon after the levelling course had been laid. In this way the retained heat of the asphalt helps retain a dry surface (even after light rain) as long as site traffic is not allowed to drive over the leveling layer surface before spraying of the membrane. After application, the membrane was scattered with approximately 8 kg/m^2 of stone chippings 10mm unwashed or single washed surface dressing chippings (50% covering) using a forward self-propelled Phoenix chipper.

It was essential to ensure that traffic on the completed cured and chipped membrane was kept to a minimum and that pavers and delivery trucks with hot tyres (from travelling to site from local quarries) were warned of the potential to damage to the surface membrane as it can soften and get torn under turning traffic and static hot paver wheels.

In spite of the instructions to apply water to tyres and be aware of the above potential for damage, on the first occasion of paving the paver was left on the chipped membrane warming before the first delivery of asphalt was made. This resulted in a couple of small (100x200mm) areas receiving some damage. These areas were removed, resprayed and chippings were replaced. Following this early lesson the problem did not re occur as vigilance and precautionary measures were improved.

The only alteration to normal practice in paving was to set a maximum speed of 6m/min and that roller drivers should refrain from sudden changes in direction and not stop or park for any period on the finished mat but either on adjacent lanes of preferably off the deck completely.

Figures 13 and 14: A Phoenix forward spreader was used to apply 10mm chippings to the PMB bitumen membrane once curing had taken place (within 30 minutes to 1 hour after spraying).

6.3 Applying the binder course

The membrane was overlaid with a binder course consisting of AC 20 dense binder course 40/60. The layer was compacted using the method set up as per the procedure used on the preparation trial section.

Pavement Course	Clause/Standard	Mix designation/Material	Minimum thickness (mm)
Surface course	**Clause 942**	**SMA 10 surf PMB 65/105-60 des PSV 70**	**30**
Binder course	**Tii Series 900 Cl 3.1.4**	**AC 20 dense bin 40/60 des**	**50**
Waterproofing interlayer	**N/A**	**Ooms Sealoflex SC-4 (3kg.m2)**	**3**
Regulating layer	**EN 13108-5 Tii Series 900 Cl 5.1.10**	**SMA 10 bin PMB 65/105-60 des**	**20**
Total Pavement Min Thickness (excluding subbase):			**100**
Sand Asphalt protective layer	**Tii Series 900 Cl 4.1.5**	**HRA 0/2 F surf 40/60 specialist**	**20**

Figure 15: Pavement Build for RFK bridge.

Until the final surface course was applied, the binder course acted as a temporary covering layer on which a restricted amount of construction traffic was permitted.

Figures 16 and 17: Applying and rolling the binder course- Botlek Bridge, The Netherlands

7. Conclusion

By using a hot sprayed bituminous membrane capable of being sprayed 3mm thick, a secondary waterproofing system can be applied effectively and quickly to an asphalt or concrete substrate. However, it is important that the preparation and planning are well addressed in advance of spraying and the process including overlaying the membrane is carried out in accordance with the manufacturers established procedures.

A bituminous membrane can also be used where there is limited height (thickness) provided an easy-to-handle polymer modified asphalt is used as an overlay. In the project carried out, applying an average of 55mm of binder course asphalt at a temperature of between 140 and 160 °C over the bituminous membrane proved not to be a problem; i.e. there were no shearing or bleeding issues experienced.

Thanks to the flexible and expert commitment of all parties involved, it was possible to design and achieve a complex, waterproofing asphalt system within a short period of time to the satisfaction of the clients Tii (Transport Infrastructure Ireland).

8. References

Ooms Nederland Holding report 460013-08; Permeability of bituminous membrane project at Haringvliet locks; July 2007

Ir. C.P. Plug Ooms Civiel, Dr. A.H. de Bondt Ooms Civiel, Ir. R.H. Khedoe OomsCiviel Complex waterproofing asphalt system on Botlek Bridge ramps CROW Infradagen 2016

YouTube video: Applying waterproofing system Botlek bridge (Dutch)