SURFACES ON SEVERN AND WYE BRIDGES

Revêtements sur les ponts Severn et Wye

Beläge auf der Severn- und Wye-Brücke

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1. Principles

The principles involved in the surfacing of these bridge decks were that

(a) The steel was metal sprayed and painted to provide an immediate protection

(b) A rubber bitumen waterproofing membrane was applied between the immediate protection to the steelwork and the running surface

(c) The running surface would be flexible enough to accommodate flexing of the orthotropic plate, but sufficiently rigid to resist deformation due to traffic and hot weather.

The supporting deck in both cases consisted of a 7/16"(11 mm) hightensile steel plate carried on 9" (229 mm) deep troughs 12" (305 mm) wide at 2' (610 mm) centres spanning between diaphragms 15' (4.57 m) apart.

2. Steel Protection

The deck sections were shot blasted, zinc sprayed to a minimum thickness of .003" (.076 mm) and given a coat of etch primer. Edges were masked for a width of 2" (51 mm) for subsequent welding. After all the seams had been welded they were shot blasted, metal sprayed and given a coat of etch primer so that the protection of the steel plate to be surfaced was uniform throughout.

3. Surfacing

To ensure maximum adhesion of the membrane, the etch primed surface was mechanically scrubbed with an industrial detergent and washed clean with water. As soon as the surface was dry, it was primed with a proprietary reclaimed rubber adhesive, Bostik 1255, which as soon as the solvents had evaporated, was covered by the 1/8" (3.2 mm) thick waterproof membrane spread over by means of squeegees. The mastic asphalt was immediately laid by hand to a thickness of 1 3/8" (35 mm) so that the process for a given area of deck was virtually continvous between the commencement of cleaning and the completion of the asphalting.

4. Facts and Figures

	Severn	Wye including Beachley Viaduct
Length of bridge	5240 ft (1597 m)	3783 ft (1153 m)
Area Area surfaced	37000 yd^{2*} (30936 m^2)	29700 yd^{2*} (24800 m^2)
Plant and Labour employed	One 2 1/2 ton (2.5 tonnes) mixer for rubber bitumen. Five 8 ton (8 tonnes) mixers for asphalt. Twenty eight men of whom 12 were engaged in laying the asphalt.	similar
Duration of work	Thirteen weeks	Eleven weeks
Cost (including priming and waterproofing membrane	37/- per yd^2 (44/- per m^2)	37/- per yd^2 (44/- per m^2)

The cost of waterproofing a concrete deck and machine laying base course and wearing course totalling 3" (76 mm) is approximately 32/- per sq. yd. (38/- per m^2).

* These figures are not proportional to the bridge lengths because there is a variation in width from 64' (19.5 m) on Severn to 69' (21 m) on Wye.

5. Specification

Extracts from the specification for workmanship and materials for the membrane, and asphalt surfacing are given in Appendix A.

6. Points to Note

The asphalt was laid at a temperature of over 200°C and in planning the programme for laying material at this temperature on steel decks, consideration should always be given to the thermal effects induced, as if too great an area of deck plate is subjected to a temperature of this order very large forces will be induced in the immediate locality.

In Wye Bridge the main webs join the deck plate near the centre of the slow lanes and it was expected that the surfacing at this point would be more susceptible to cracking. Successful control was achieved by cutting a groove in the surfacing 3/8" (9.5 mm) wide and 5/8" (16 mm) deep and filling it with a proprietary sealing compound. The groove was omitted from a limited length of deck to see how the surfacing would behave, but cracks soon formed and the groove was provided throughout.

7. Performance

The deck has now been in use for two years and its performance has generally been satisfactory. The volume and weight of commercial traffic on one lane has been recorded at intervals, and the number of axles related to their weights is given in the following Table.

Traffic Data

Total number of vehicles through tollgates since bridge opening on 8th September 1966 to 1st August 1968 = 11 022 282

Number of axles on Eastbound slow lane :-

Axle weight		Weekly average recorded between 8th July 1967 and 3rd August 1967
lb. x 10^{-3}	kg. x 10^{-3}	
0 - 4	0 - 1.81	85695
4 - 8	1.81 - 3.63	19083
8 - 12	3.63 - 5.44	7843
12 - 16	5.44 - 7.26	3733
16 - 20	7.26 - 9.07	2309
20 - 24	9.07 - 10.89	815
24 - 28	10.89 - 12.70	205
28 - 32	12.70 - 14.51	86
32 - 36	14.51 - 16.33	74
>36	> 16.33	35

The troubles which have been experienced can be summarised as :-

(a) In July 1968 an exceptional spell of hot weather led to the sudden appearance of a few blisters in the surfacing and these were generally pierced, heated and rolled flat though in some cases they were cut out and replaced with fresh material.

(b) Some flow of the mastic asphalt down the camber has occurred in one or two places and the maximum movement recorded is about 3" (76 mm). Consideration is being given to the provision of a 1 1/2" x 1 1/2" (38 mm x 38 mm) steel angle attached to the deck in order to restrain the tendency to flow.

(c) In one case a daywork joint in the mastic has opened into a crack which penetrates to the waterproofing membrane, this has been opened out and sealed with a proprietary sealer, Pliastic 164.

8. Conclusions

The problem of surfacing the orthotropic plate deck is difficult and a considerable amount of development work will be required before a completely satisfactory result can be achieved. It would be desirable to save some of the dead weight of the surfacing in long span bridges, in Severn it amounted to about 2,600 tons (2640 tonnes), but the thin resin carpets have not yet proved sufficiently durable. The hand laid mastic is expensive in labour and needs to be done in good weather, but apart from the penalty of weight, it appears to give the most dependable performance of materials presently available though the correct balance between flexibility and lack of deformation is difficult to achieve.

APPENDIX A

RUBBER BITUMEN COMPOUND (waterproofing membrane)

1. Materials

The compound shall be prepared by blending 90/100 Pen. bitumen with limestone powder, of which not less than 85% passes a 200 mesh sieve. The proportions shall be approximately :-

Bitumen	25 - 30%
Limestone	70 - 75%

The blend shall be adjusted to give a Softening Point (R. & B.) of 80 - 85°C.

Pulvatex rubber crumb shall be added to the extent of 1.3 - 1.5% of the whole by weight and the compound re-adjusted to a Softening Point of 90 - 100°C.

2. Application

The compound shall be re-melted on site and shall be spread onto the prepared base as speedily as possible, using squeegees or trowels, at a temperature not exceeding 205°C.

MASTIC ASPHALT

1. Materials

Gradings for high grade limestone containing not less than 85% of calcium carbonate :-

Passing 200 mesh sieve	45 - 55%
Passing 72 mesh sieve retained on 200 mesh	10 - 30%
Passing 25 mesh sieve retained on 72 mesh	10 - 30%
Passing 7 mesh sieve retained on 25 mesh	5 - 20%
Retained on 7 mesh sieve	Nil

(Sieve sizes are British Standard)

Trinidad Lake Asphaltic Cement :-

Specific Gravity at 25°C	1.17 - 1.25
Penetration at 25°C	20 - 30
Softening Point (R. & B.)	60 - 70°C
Mineral Matter (Ash)	17 - 19%
Loss on heating at 163°C for 5 hours	Max. 2%

As manufactured, the mastic asphalt shall have a soluble bitumen content of 14 - 15% exclusive of any coarse aggregate as hereinafter specified.

2. Preparation on Site

The mastic asphalt shall be delivered to the site in blocks of approximately 1/2 cwt. (25 kg) each. These shall be broken up and re-melted in mechanically agitated mixers and laid at a temperature not exceeding 240°C without the addition (save as hereinafter specified) of limestone dust, sand or any filler whatsoever.

3. Coarse Aggregate

During the process of re-melting, there shall be added to the mastic asphalt in the mixer 3/8" - 1/4" (9.5 mm - 6.4 mm) clean cubical granite chippings. The chippings shall be added in such proportions that it shall represent 40 - 45% by weight of the mixture as laid.

4. Hardness Number

The Hardness Number of the mastic asphalt as laid shall be 25 - 30 at 35°C.

5. Application

The mastic asphalt shall be laid to a thickness of 1 3/8 inch (35 mm) on to the steel plates wich have been cleaned, dried and primed with a special adhesive (Bostik 1255). On the adhesive shall be laid a special rubber / bitumen compound to approximately 1/8 inch (3.2 mm) thickness. The mode of spreading and finishing the mastic asphalt shall be in accordance with the requirements of British Standard 1447 : 1962, Clause 6.

6. Rubber Bitumen Seal to Vertical Steel Surfaces

At the junction of the asphalt surfacing with vertical steel surfaces, a 1/2 inch (12 mm) gap isto be left in the asphalt which is later to be filled by pouring in the hot rubber bitumen sealing compound equivalent to Dulastic "R".

7. Surfacing to the Asphalt

Except for a 9 inch (229 mm) wide strip at the edges and under the white marginal strips, pre-coated approved angular chippings, 1/2 inch (12 mm) size, conforming to B. S. 63 "Single-sized roadstone and chippings", shall be rolled into the asphalt whilst it is still warm, and in a plastic condition. The chippings shall be uniformly distributed at 100 to 150 sq. yds. per ton (85 - 127 m^2 per tonne).

8. Tolerances

The finished surface shall be such that when tested with a 10 ft. (3 m) straight edge the maximum departure from a true surface shall not exceed 1/4 inch (6.4 mm).

The maximum tolerance on the specified thickness shall be $\pm$ 1/8 inch ($\pm$ 3.2 mm).

Where these figures are exceeded, the surfacing shall be cut out and re-laid at the Contractor's expense.

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