Recent experience on wearing surfaces for steel bridge decks of lightweight construction

Autor(en): **Best, K.H.**

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RECENT EXPERIENCE ON WEARING SURFACES FOR STEEL BRIDGE DECKS OF LIGHTWEIGHT CONSTRUCTION

Expériences récentes sur des revêtements de chaussée pour ponts à tablier extraléger

Die neuesten Erfahrungen mit Fahrbahnbelägen auf Leichtbrückendecken

K.H. BEST
Great Britain

This contribution describes some experience, including maintenance difficulties with asphalt surfacing on a series of movable bridges which were completed between 1961 and 1967.

Figure 1 illustrates the cross section of a swingbridge at Regents Canal Dock, London, designed in 1959. The deck plate is 9/16th in. (14. 3 mm.) thick with stiffeners at 12 in. (305 mm.) centres. At that time the British Road Research Laboratories were testing sample panels of steel battledeck to investigate alternative methods of construction and surfacing under heavy traffic.

After considering the interim results from these trials and other available information the surfacing was specified as shown in Figure 2 as follows.

As a matter of interest this bridge was fabricated at a shipyard on the north-east coast of England, launched and towed by tug down the coast to the Thames Estuary. It was therefore delivered unpainted so that shot blasting and metal spraying was carried out on site. The steel deck was primed by applying a rubber bitumen emulsion at the rate of 6 to 8 gallons per sq. yard (32. 6 to 43. 5 litres per sq. metre).

A 3/8th in. (9. 5 mm.) thick layer of mastic asphalt to B. S. 988, Table 1, Column 3, was then laid. This is an insulating and waterproofing layer of fairly flexible characteristics of the type used on the roofs of buildings.

Mastic asphalt to B.S. 1446, Table 1, Column 3, was then laid as a wearing course. This was specified to include 35% - 40% of coarse aggregate with a penetration of 25 - 35. Whilst the asphalt was still warm and plastic, hard $\frac{3}{4}$ in. (19 mm.) stone chippings, pre-coated with asphaltic cement were rolled into the surface.

This swingbridge is located at a dock entrance which is subject to very heavy commercial traffic. Immediately at one end of the bridge a sharp turn is required on one of the carriageways owing to a one-way traffic system on the approaches. As a result the bridge deck surfacing in this area is almost continuously subject to heavy braking forces.

Four years after the bridge was opened a series of transverse waves or corrugations at about 1. ft. 6 in. (0.457 m.) centres appeared in a section of the deck, coincident with wheel paths in the areas of heavy braking. This type of defect is illustrated in Figure 3. The defective areas were removed without difficulty and re-laid to the original specification. We found that the mastic insulating layer had been laid to a greater thickness than specified in this area and the Road Research Laboratories also made tests on samples. As a result it was recommended that for future work the stone content of the wearing course should be increased and a harder grade of asphalt cement adopted. Measurements of the rate of indentation during a wheel tracking test with a loaded wheel repeatedly running over specimens at 45°C. suggested that deformation was likely if heavy traffic was turning and braking hard, although the surfacing might be satisfactory for normal conditions.

Analysis of samples showed that the stone content was at the lower limit of the specified range, that is, about 35% and the penetration value of the recovered soluble bitumen was found to be rather low.

As a result of this experience and experiments, we modified the specification and deck details for surfacing the Woolwich ferry bridge ramps in London, and the Middlesbrough Dock swingbridge on the north-east coast. These were designed in 1964 and 1966 respectively.

This revised specification is illustrated in Figure 4 and you will notice the following improvements. A tack coat of Bostik C was applied to the zinc sprayed steel deck followed by a 1/8th in. (3.2 mm.) thick insulating layer of rubberised filled bitumen having a final softening point of 90 to 95°C. This material was obtained by mixing

75 parts of limestone filler with 25 parts of 80 - 100 penetration bitumen to which a sufficient quantity of unvulcanised rubber powder was added to give the required ring and ball softening point. The insulating layer was laid at about 180°C. by means of squeegees to give about 1/8th in. (3. 2 mm.) thickness.

The wearing course is $1\frac{1}{4}$ in. (32 mm.) thickness of mastic asphalt to B.S. 1447, Table 1, Column 3, having a penetration of 15/25 including 40 - 45% coarse aggregate. The surface was finished, as before, with $\frac{3}{4}$ in. (19 mm.) pre-coated chippings at the rate of 100 sq. yards per ton (82 sq. metres per tonne).

Thus the specification was improved from that adopted for the earlier swingbridges by replacing the relatively thick and soft insulating layer by the thinner and more resilient rubberised filled bitumen and the stone content and hardness of the wearing course was slightly increased.

The steel deck plates on the bridge ramps at Woolwich Ferry are stiffened by bent flats of trapezoidal section. They operate through a tidal range of 30 ft. (9. 1 m.) and because the heavy vehicles using these spans are either embarking or dis-embarking on steep gradients, up to 1 in 12, the road surface is subject to heavy shearing forces due to the inclination and to braking and traction.

At each end of the ramps, reinforcement in the form of steel strips $1\frac{1}{4}$ in. x $\frac{1}{4}$ in. (32 mm. x 6.4 mm.) were welded to the battledeck at 6 in. (152 mm.) pitch in a chevron pattern along the vehicle wheel tracks. This arrangement is shown in Figure 5 and although the ramps have been operating for two years and the traffic has been very heavy, there are no signs of trouble.

For medium span steel decks and heavily trafficked movable bridges of this type I prefer to adopt a relatively stiffer steel deck which not only reduces welding distortions but prolongs the life of the asphalt surfacing. The additional load arising from, say, an extra 1/16th in. (1. 6 mm.) thickness is not usually significant in these cases and because fabrication costs will be the same, increased capital costs are usually limited to the price of the extra material. For movable bridges subject to heavy traffic in dock areas we believe this small additional cost is more than offset by savings in maintenance.

Having said that, however, I would agree with the reporters' contention that more surfacing troubles have been caused by faulty specification and quality control than by the flexibility of the deck plates, and, of course, for long span bridges savings in dead weight become much more significant.

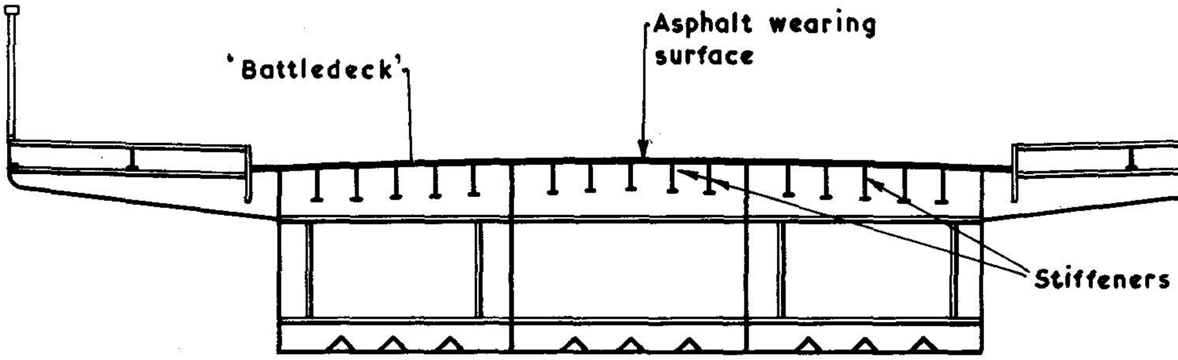

FIG. 1. CROSS SECTION OF SWING BRIDGE AT REGENTS CANAL DOCK. LONDON.

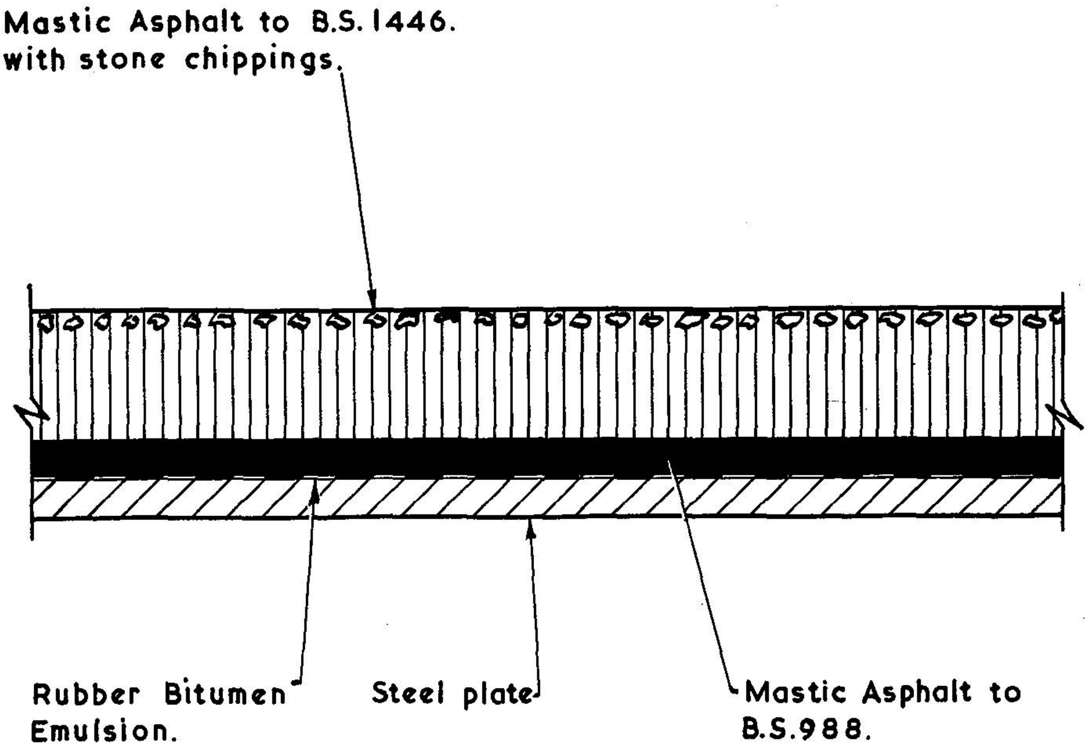

FIG. 2. SURFACING OF SWING BRIDGE AT REGENTS CANAL DOCK, LONDON.

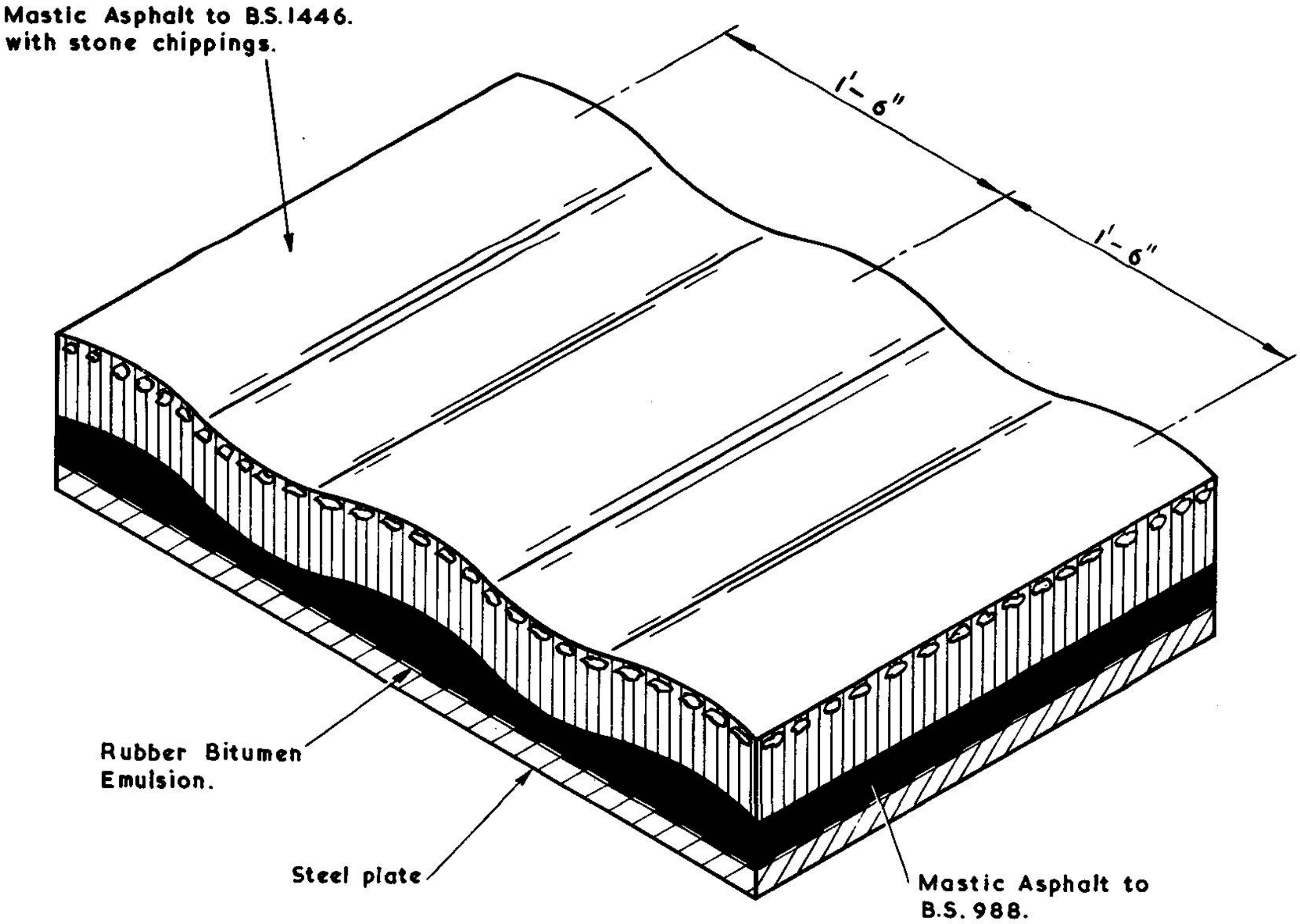

FIG. 3. DEFECT-TRANSVERSE WAVES IN ROAD SURFACE.

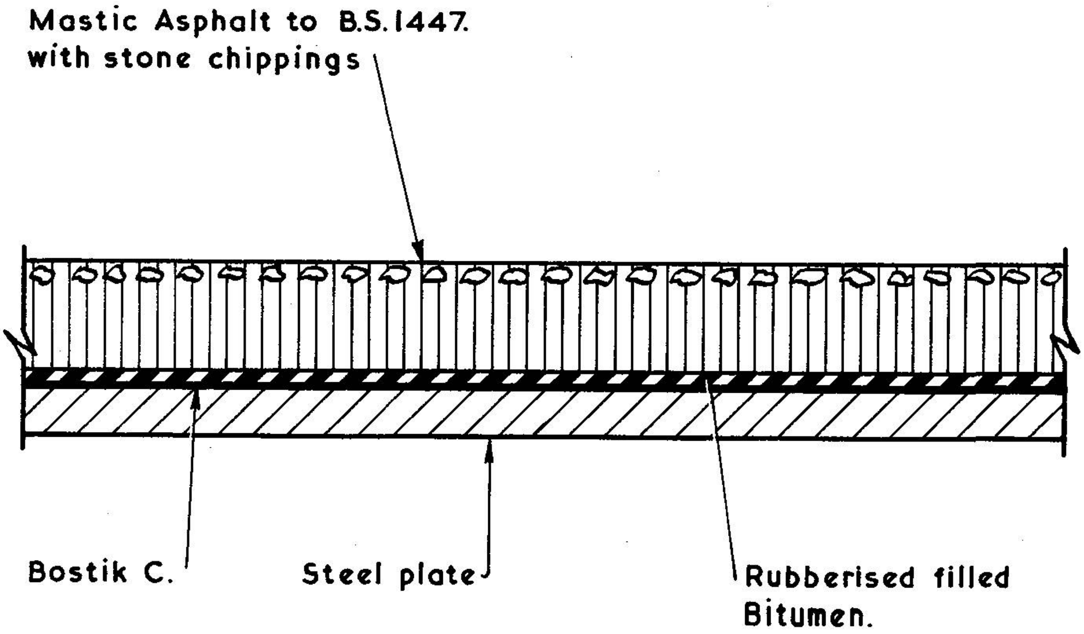

FIG. 4. NEW SPECIFICATION FOR SURFACING AT WOOLWICH AND MIDDLESBROUGH DOCK SWING BRIDGE.

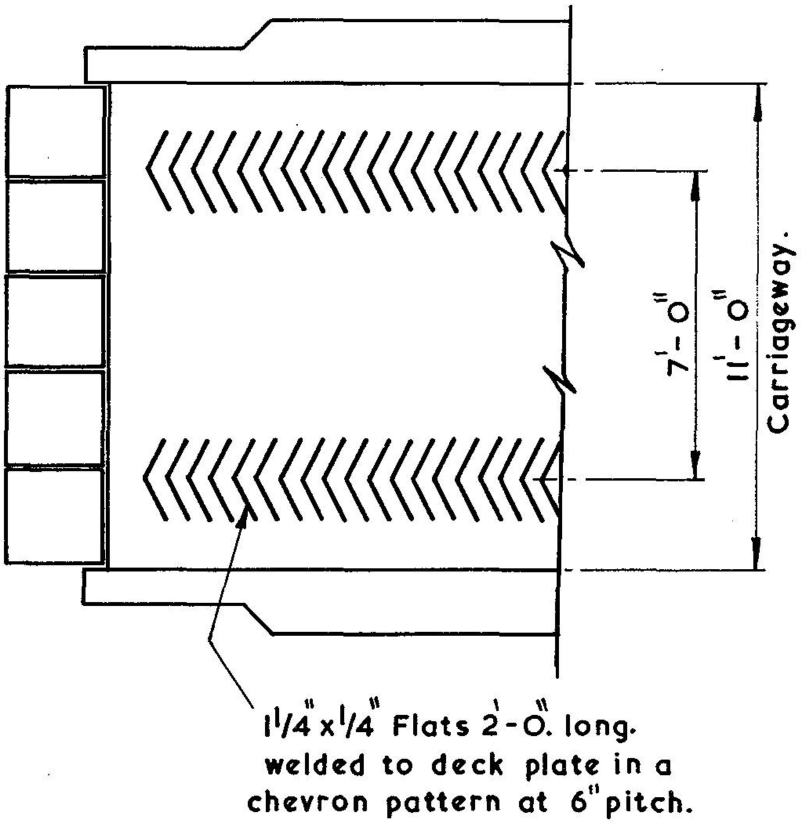

FIG. 5. REINFORCEMENT AT END OF RAMPS.

SUMMARY

Four years after completing a swing bridge in the London Docks a section of surfacing in a limited area subject to braking forces from heavy traffic had to be replaced.

As a result of this experience and tests on samples the specification for recent movable bridges has been modified. The insulating layer is reduced in thickness, the stone content and penetration of the mastic asphalt increased, and steel strips are welded to the deck plate to reinforce the surfacing in heavy duty areas.

RESUME

Déjà quatre années après l'ouverture d'un pont tournant dans les docks de Londres, on a été obligé de remplacer le revêtement dans une zone limitée, soumise aux efforts de freinage du trafic lourd.

A la suite de cette expérience et après des tests sur modèles, on a modifié les spécifications de revêtements pour les ponts mobiles récents. On a réduit l'épaisseur de la couche d'isolation et augmenté la part de gravier et la pénétration de l'asphalte coulé. Dans les sections les plus sollicitées, des bandes d'acier sont soudés sur la tôle pour renforcer le revêtement.

ZUSAMMENFASSUNG

Vier Jahre nach Eröffnung einer Drehbrücke in den Londoner Docks mußte ein Abschnitt, welcher den Bremskräften schweren Verkehrs ausgesetzt war, erneuert werden.

Als Ergebnis dieser Erfahrungen und Prüfungen ist die Spezifikation der Fahrbahnbeläge für neue, bewegliche Brücken abgeändert worden. Die Isolationsschicht ist in der Dicke vermindert, der Splittanteil und die Eindringtiefe des Gußasphaltes erhöht und Stahlsteifen sind zur Verstärkung der Oberfläche in schwerbeanspruchten Abschnitten angeschweißt worden.