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# GEOTEXTILES IN HIGHWAY SURFACE DRESSING
# GEOTEXTILES DANS LE REVETEMENT DE CHAUSSEE
# EINSATZ VON GEOTEXTILIEN IN DER STRASSENBELAGSERNEUERUNG

The paper will describe the road trials carried out in Kent, England, in 1984 and 1985, using a polypropylene Geotextile membrane as part of the Surface Dressing System. The purpose was to seal cracks in the surface, and reduce the variations in the hardness of the surface which would affect the effectiveness of the surface dressing.

**Dieser Bericht beschreibt die Versuche, die 1984 und 1985 in Kent (GB) mit der Verwendung von Geotextilien aus Polypropylen in Verbindung mit Folien als Teil von Belagserneuerungssystemen gemacht wurden.**

**Das Ziel war es, Risse in der Oberflaeche abzudichten und die Unterschiede in der Staerke der Oberflaeche, die die Wirksamkeit der Belagserneuerung beeintraechtigen wuerden, zu reduzieren.**

## 1. INTRODUCTION.

1.1 Surface dressing consists in spraying the road surface with a film of binder followed by the application of stone chippings which is then rolled. Surface dressing has three main purposes :-

(1) to seal the road surface against water.

(2) to arrest disintegration.

(3) to provide a non-skid surface.

The last purpose is of the greatest importance on major roads.

1.2 The chippings are held on the road surface and resist the plucking and tearing effects of vehicle tyres by a combination of two factors, (a) the adhesive effect of the binder and (b) the embedment of the chippings caused partly by the initial rolling but mainly by the effect of the traffic itself. The first factor applies immediately the dressing is laid but the second factor takes some time to be fully effective and depends upon the softness of the existing road surface (the substrate) or the geotextile in fabric surface dressing, the traffic intensity and the size of chipping.

1.3 Incorrect selection of rate of spread of binder and chip size for a given road may lead to premature chip loss, bleeding through of surplus binder or complete embedment of the chippings into the surface in the warm summer months. Such failures leave a very smooth road surface and nullify the skid resistance function of the dressing.

1.4 Unfortunately variations in the softness of the substrate frequently exist; across the width of a lane, because of traffic loadings; along the length to be treated, because of shading by trees or buildings; and intermittently or randomly, because of the different materials used in the surface, particularly by public utilities reinstating the holes after repair works.

1.5 Variations across and along the road can be accommodated by the most modern binder distributors; however, these are not always available. Even so, intermittent local variations cannot be accommodated and may need individual pre-treatment to 'normalise' the surface. This is expensive.

1.6 Where the road is porous; heavily crazed; where there is a significant amount of alligator cracking and where the cracks are wide (greater than 1 mm): the binder which flows into the cracks may be insufficient to seal them and arrest disintegration. The surface, if it is porous, absorbs bitumen. In such cases there may be insufficient binder left on the surface to properly hold the chippings.

1.7 The joints in surfacing, particularly round public utilities patches, are typically those which are too wide to be sealed by a single surface dressing and are prone to premature failure by water ingress.

1.8 Whilst such problems may be overcome by a double application of binder and chippings, it was decided to investigate the possibility of incorporating a geotextile in the surface dressing system to seal and bridge cracks, arrest disintegration and 'normalise' surface.

1.9 It was known, from experience in the USA, (1) that a non-woven polypropylene fabric had been used in combination with bitumen binder to seal highways before being covered with a suitable asphalt wearing surface. It was therefore decided to investigate whether this system could be used, not with an asphalt wearing surface, but simply with a covering binder and chippings.

1.10 It was hoped that the bitumen saturated fabric would cover and seal any cracks not fully sealed by the initial bitumen application, would hold together alligator cracking and would provide a completely uniform substrate on which to apply the binder and chippings necessary for a skid resistant surface.

1.11 Recent work in Berkshire (2) has indicated that cracks in bituminous overlays to cement bound roadbases may start at the road surface. If this is confirmed then the application of a geotextile to the road surface may not only seal the existing cracks, but also slow down the incidence of crack propagation.

## 2. FABRIC CHARACTERISTICS AND SELECTION.

2.1 The fabric selected should have the appropriate physical characteristics for the purpose:

(a) it should readily absorb the bitumen in order to form a strong waterproof membrane.

(b) it should be durable and resilient under both the vertical traffic loading and the longitudinal forces imposed by the opening and closing of the cracks in the substrate.

(c) it should be able to withstand temperatures of up to 150°F (300°C) imposed by the hot bitumen binder.

(d) it should be sufficiently robust to withstand the construction process and traffic.

2.2 Since a pavement moves in several directions under mechanical and thermal stresses and cracks are randomly orientated, the multi-directional physical properties of a non-woven fabric would seem to provide advantages over the directional properties of woven material.

2.3 The amount of binder absorbed to saturate the fabric and produce a good seal should be compatible with current spraying technology and not excessive as this would unnecessarily increase costs.

2.3 The fabric must be light-weight for ease of manhandling and resistant to degradation by spilled chemicals, the air, sunlight and bio-degradation.

2.4 Several different kinds of fabric have been evaluated in the USA including nylon, glass fibre, polyester and polypropylene. From use particularly in the states of Illinois and California and by US Army Corps of Engineers (1) a non-woven, 100% polypropylene, heat melded needle-punched fabric has been found to have a suitable combination of characteristics and it was two examples of such a fabric that were used in these trials. Two weights of fabric were assessed.

weight 140 g/m$^2$ thickness 1.5 mm
weight 110 g/m$^2$ thickness 1.1 mm

## 3. BINDER CHARACTERISTICS AND SELECTION.

3.1 The binder for surface dressing must have low viscosity during construction for sprayability, wetting and adhering to the road and coating the chippings, but high viscosity soon after to hold the chippings. It must also be temperature stable, reasonably flexible, durable and able to be used safely by operatives with low pollution risk.

3.2 Binders available in the U.K. to satisfy these somewhat conflicting requirements are almost exclusively bitumen based, some with polymer additives, and applied emulsified with water or mixed (cut-back) with volatile oils (flux).

3.3 In these trials a hot sprayed cut-back bitumen was used. For improved adhesion a rubberised cut-back bitumen was also assessed.

3.4 The viscosity of the grade of binder is dependent upon the normal temperatures in the U.K. for the time of year and, if very heavily trafficked roads are involved, a higher viscosity binder may be required.

3.5 The binder was selected in accordance with the Recommendations for road surface dressing (Road Note 39) (3). Two types of binder were used, 200 sec cut-back bitumen to B.S. 3690 Table 2 (4) and the same incorporating rubber.

3.6 The amount of binder to be sprayed in conventional surface dressing is dependent upon the shape and size of chippings, the traffic intensity, the nature of the old road surface and the expected degree of embedment under traffic. Where the geotextile was used, the last two factors were unknown quantities. Similarly the amount of binder required to adhere the geotextile to the road was also unknown. The work done in 1984 helped to clarify these unknowns and this was further investigated in 1985.

## 4. CHIPPING CHARACTERISTICS AND SELECTION.

4.1 The important characteristics for chippings are (a) that they should be capable of being spread at a uniform rate on the surface, (b) binder should readily adhere to them, (c) they should be sufficiently hard and durable to withstand the forces of the roller and subsequent traffic (d) they must provide adequate skid resistance.

4.2 In the U.K., single sized chippings are used complying with B.S. 63 (5), their size selected in accordance with the procedure set down in Road Note 39 (3). In this case, the hardness of the substrate provided by a geotextile was unknown, therefore the trials took place with differing chip sizes and traffic intensities.

4.3 The minimum skid resistance properties of the aggregate (Polished Stone Value) were calculated using the procedure outlined in Technical Memorandum H16/76 (6) which supplements the Department of Transport's Specification for Road and Bridge Works (7) and A Guide to Levels of Skidding Resistance for Bituminous Roads in Kent (8). In the case of the two minor road trial locationa a higher PSV stone was chosen because of local availability

## 5. DESCRIPTION OF 1984 TRIALS.

The location of the trials is given in Fig. 1.

### 5.1 Trial Area 84/1.

5.1.1 The work took place on 13th August, 1984, on the westbound lane of the A25 just west of the A21/A25 junction at Sundridge, near Sevenoaks. The road is a level fast road 10 m wide with a gradual bend at one end and a separate service road adjacent. Latest traffic figures for the section are 550 commercial vehicles per day in a total flow of 5000 vehicles.

5.1.2 The existing surface was well worn 10 mm surface dressing overlying hot rolled asphalt. Using the method described in Appendix 1 of Road Note 39 the surface was classified as 'soft' with a hardness probe penetration of 6 mm at 22°C. There were no signs of serious structural failure, but some slight rutting in the wheel tracks and one diagonal services trench. Drainage is by gulley with a grass edge kerb. The weather was overcast and dry, air temperature 18°C.

5.1.3 Details of the fabric, binder and chippings are given in Table 1.

5.1.4 In order to accommodate the 4 m width of the roll with the standard spray bar, two passes of the spray tanker were required. The roll of geotextile was then manhandled into position across the end of the sprayed area and rolled forward. It proved to be rather difficult to keep it in line with the road edge because of the weight of the roll and the instant bonding with the binder; it was also impossible to apply any tension to the fabric. As a result a number of creases and folds developed every time the roll was readjusted for line. Several of the large folds were later cut with a knife and overlapped. It was noted that whilst walking on the fabric some binder did appear through the membrane under the footmarks.

5.1.5 The tanker reversed over the laid fabric without difficulty and sprayed the second application, followed immediately by the Phoenix chipping machine laying the chippings. Compaction was by a Dynapac vibrating roller with rubber coated drum. Slow moving traffic was then allowed on the area.

5.1.6 As a control the eastbound side of the road was surface dressed in the conventional way using the same binder and chipping.

Observations During Construction.

5.1.7 The material bonded well to the surface of the road and at the spray rate the fabric appeared just filled with bitumen but there was not a great surplus of binder before chippings were applied. The heat of the binder did not seem to affect the fabric.

5.1.8 The tanker could run on the fabric without binder stringing or it sticking to or pulling the fabric. The edge fully bonded to the road.

5.1.9 The extensive creases in the fabric caused by the rolling out procedure became filled with bitumen and were not visible after chipping.

5.1.10 The current method of rolling the fabric out by hand was very slow and could, with advantage, be mechanised especially if the roll width and spray width could be rationalised.

5.2 Trial Area 84/2.

5.2.1 The work took place on the 22nd August, 1984, on Dalton Road, Crockenhill, Swanley. This is a 6 m wide carriageway on the edge of a village with kerb on one side and a hedge on the other. It forms the access to the Golf Course and the countryside beyond. The first 168 m were surfaced starting from the bellmouth at the northern end, using a different surface dressing crew to the one for trial 84/1.

5.2.2 The existing surface was badly cracked hot rolled asphalt classified as 'hard' with a hardness probe penetration of 1 - 2 mm at 20°C. Drainage is by gulleys on one side. The weather was overcast with air temperature 18°C.

5.2.3 Details of the fabric, binder and chippings are given in Table 1.

5.2.4 The roll of fabric 4 m wide was rolled out on the sprayed surface 3.66 m wide by hand with about 150 mm overlap on to the unsprayed road. It, again, proved to be difficult to roll out the fabric along the designated line without creases occurring at obligatory adjustments in direction. A small number of cars used the surface of the fabric temporarily during the operation. These did not damage the fabric nor pick up binder on their wheels as their weight did not seem sufficient to cause binder to penetrate the membrane.

5.2.5 The tanker reversed over the laid mat, marking it slightly, and sprayed the second application, followed immediately by the Phoenix chipping machine laying the chippings. Compaction was by a Dynapac vibrating roller with rubber coated drum. Slow moving traffic was then allowed on the area.

In the vicinity of the bellmouth the fabric was glued down by spreading bitumen and applying chips both by hand. The area was vacuum swept the next day.

5.2.6 The area beyond and to the sides of the trial length acted as a control.

## 6. OBSERVATIONS DURING CONSTRUCTION

6.1 The fabric bonded very well to the existing road even with the light first application and the hot bitumen of the second spray application did not seem to affect the heavier fabric. However the curling unbonded thinner fabric on the second trial would suggest a shrinkage of the material occurs. Provided this does not affect the fabric's properties it may be of advantage in removing minor creases.

6.2 The fabric width must be narrower than the sprayed width, and in order not to delay the works this means the roll width must be slightly less than the sprayed width.

6.3 A method to lay the fabric speedily and incorporating a slight tensioning device is necessary if the method is to be used on all except a very small scale.

6.4 Traffic including the tanker and cars could run on the fabric without the binder stringing or the tyres sticking to or pulling the fabric.

## 7. OBSERVATIONS IN-SERVICE

7.1 In March 1985, after 7 months' traffic and a winter with several weeks very cold weather and some snow ploughing, the fabric had still adhered well to the old road surface with no signs of lifting or tearing.

7.2 However on both trial sites extensive loss of chippings was apparent. Chippings were completely lost from specific areas, i.e. adjacent to the highway centre line in Trial 1 and in patches from Trial 2, so that about 10% of the road surface was bald on Trial 1 and 25% on Trial 2.

7.3 The reasons for why chippings were lost from some areas and not others was not capable of being definitively identified. It was not related to the variation in substrate nor the chippings, nor was it always in or out of the wheel tracks. It is known, however, that British spray tankers are prone to variations in binder distribution both transversely and longitudinally and accurate measurements of this parameter are difficult. It was in the second run of the sprayer required by the width of the road that the main chip loss occurred.

7.4 It was postulated that insufficient binder was the probable cause of chipping loss and this is partly confirmed on Site 84/2 where excess binder was used in the handwork areas and chippings were retained.

7.5 The slight improvement at Site 84/1 may have been the result of the slightly improved adhesion afforded by the rubberised bitumen. The use of the smaller chipping and thinner fabric, with theoretically smaller binder demand at Site 84/2 has not resulted in improved performance; however this may be slightly offset by the greater binder demand of about 0.1 $l/m^2$ for 10mm vs. 14mm chippings.

7.6 During 1985 only a little further chip loss took place, indicating that the effect of frost and snow-ploughing were significant.

7.7 Observation of the areas with chips still present showed that the small creases had no effect on the dressing performance and were often difficult to detect. The cubical chippings were orientated generally all in the same direction with a plane surface upwards, unlike the more random orientation of chippings on the control section. They had embedded themselves in the fabric without puncturing it.

7.8 Observation of the bald areas and where cracks in the substrate were present showed that even with traffic running on the bitumen impregnated fabric, the water-proofing function was excellent and no cracks in the fabric were visible. In many cases the "pockets" formed by the chippings now lost were still visible after many months' traffic.

7.9 The fabric appears to produce a uniform surface on which to surface dress, fulfilling the "normalisation" function.

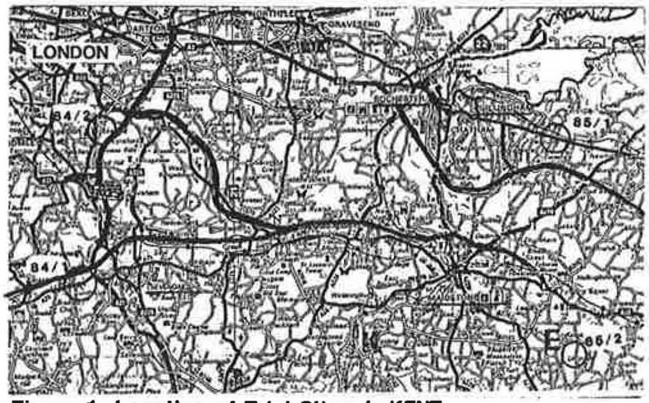


**Figure 1 Location of Trial Sites in KENT.**

## 8. LESSONS FROM 1984 TRIALS

8.1 The amount of binder available to hold the chippings must be adequate. This is a function of the binder from beneath, which soaks into or through the fabric and that added secondly which soaks into the fabric. Only that residual to the saturation process is available to hold chippings.

8.2 The volume of bitumen required to saturate the 140 $g/m^2$ fabric was subsequently ascertained and found to be 0.97 $l/m^2$. If the saturation volume is proportional to thickness, this equates to 0.72 $l/m^2$ for the 110 $g/m^2$ fabric. Therefore for the 1985 trials the amount of binder laid first was increased and the fabric was rolled before the second spray to press the fabric into the binder film and help binder uptake. The amount of binder on the second application was also to be increased and different rates of spray tried.

## 9. DESCRIPTION OF 1985 TRIALS

The location of the trials is given in Fig. 1.

9.1 Trial area 85/1.

9.1.1 The work took place on 18th July 1985 on the A2, westbound carriageway close to the turning to Upchurch. The road is a slight upgrade 7.3m wide and had a petrol service station halfway along the length. Traffic figures are about 700 commercial vehicles per day in a total flow of 9,000 vehicles in each direction.

9.1.2 The existing surface was worn hot rolled asphalt wearing course incorporating precoated chippings, with an extensive trench reinstatement along part of the road. The road had transverse cracking and wide cracks round the reinstatement. The air temperature was 16°C., and the road surface classified as 'normal'. The weather was overcast and dry.

9.1.3 Details of the fabric type, binder and chippings are given in Table 1.

9.1.4 The road was sprayed with binder 2.3m wide and the 2m wide fabric rolled out by hand. As before several large and some small creases occurred. The nearside of the fabric was given two passes of the Dynapac vibrating roller, with rubber coated drum. Whilst this marked the fabric it did not bring the binder through sufficiently for the fabric to be significantly blackened on the surface.

9.1.5 The second application was sprayed at different rates for each of the 3 sections, each approximately 60m long. The rate of spray recommended by Road Note 39 (3.) for this traffic, and assuming little embedment, is 1.1 $l/m^2$. It proved difficult to get the driver to obtain the correct speed over the short trial lengths.

9.1.6 Three trays were laid on the road in each section and then cut-out after the dressing for laboratory analysis if possible.

9.2 Trial Area 85/2

9.2.1 The work took place on the 2nd August 1985 on the C85 access road to Ulcombe Village, just south of the church and up a hill of gradient 15% approximately, with a bend one-third of the way up. The road width was 4m closely bounded by hedges. Traffic figures are about 700 vehicles per day, of which 10% will be commercial vehicles.

9.2.2 The existing surface was well worn surface dressing using slag aggregate, and hardness probe tests indicated a normal/soft surface with some very soft patches. There were numerous transverse and longitudinal cracks and crazed areas. The air temperature was 18°C.

9.2.3 Details of the fabric type, binder and chippings are given in Table 1.

9.2.4 The road was sprayed with binder 2.44m wide with the tanker travelling up the hill, and the 2m wide fabric rolled by hand. Because of the flimsiness of the fabric and the bends in the road, a number of very large creases occurred, which were left untreated. The fabric was rolled with a pneumatic tyred roller which pressed the fabric into the underlying spray, but not enough for complete saturation despite the excess binder.

9.2.5 The second application was sprayed at different rates for each of the 3 sections, the bend being at the end of the first section. The rate of spray recommended by Road Note 39 (3.) for this traffic is 1.1 $l/m^2$.

9.2.6 Three trays were laid on the road in each section and then cut out after dressing, for laboratory analysis if possible.

## 10. OBSERVATIONS DURING CONSTRUCTION

10.1 On these trials the fabric was always narrower than the sprayed width on the road and the overspray had no noticeable effect even on the lightest fabric.

10.2 Again the clumsiness and extreme difficulty of laying the fabric in the required line without creasing delayed the surfacing programme.

10.3 Despite the known, better compaction effort of the vibrating roller, the pneumatic tyred roller was more capable of bringing up the underlying binder.

10.4 With the available British Ashurst sprayers it was not possible to reduce the rate of spray below 0.8 $l/m^2$ on these trials.

10.5 Where the tanker pulled away sharply on the hill during the second application on Trial 85/2, wheel spin tore the fabric locally.

10.6 No difficulty was found in removing the fabric and chippings from ironwork which had previously been masked.

## 11. OBSERVATIONS IN SERVICE

11.1 In January 1985, i.e. after 5 months' traffic, two frostly spells but no snow, and considerable rain, parts of each trial had suffered chipping loss.

11.2 Trial 85/1 had chip loss in the centre section at the entrances to the filling station, not in the main road wheel path. This was particularly true where people turned in from the opposite carriageway. Some small chip loss was also observable not in the wheel path; elsewhere in the centre section, which may be caused by the shade of the garage awning; and to a very small degree in the first section, which has the least application of binder. There is no evidence of chipping loss in the last section.

11.3 Trial 85/2 had extensive loss of chippings on the first section at the bend, both in and outside the wheel track, on the outside of the bend. There is no evidence of chip loss in the middle and last section.

11.4 On both trials the ability of the saturated fabric to bridge cracks, and waterproof the surface is already apparent, as cracks outside the fabric treated areas were already clearly visible.

## 12. CONCLUSIONS

12.1 The 100% polypropylene continuous fibre, heat-melded needle-punched fabric was capable of being attached to a highway surface using hot bitumen, without observable degradation, and was capable of allowing traffic to run on it for a short period.

12.2 The amount of bitumen required to achieve adhesion was less than is normally possible to be distributed by typical British Ashurst tankers, but 0.63 $l/m^2$ was adequate. There is no evidence yet that where the fabric was rolled before the spray and chip application, that chipping adhesion has been improved. However, pressing the fabric into the first binder application, as happens with the USA mechanical fabric dispenser, is clearly advantageous. The second spray should ensure enough free binder is available for chip retention after absorption by the fabric. The trials carried out to date indicate that a second spray of 1.4 $l/m^2$ or 1.6 $l/m^2$, depending upon whether 110 $g/m^2$ or 140 $g/m^2$ fabric is used, is likely to provide adequate binder for chip adhesion.

| Trial No. | Location | Fabric Code | Fabric Weight g/m² | Binder: Cut - back Bitumen 200 sec. Nominal — Viscosity actual | Spray rate 1st (nominal) actual l/m² | Spray rate 2nd (nominal) actual l/m² | Temp. °C | Chippings Size mm | Coat % | Type | PSV | Spread Rate kg/m² |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 84/1 | A25 at Sundridge | 500 | 140 | 320 + rubber | (0.8) 0.63 | (1.2) 1.25 | 171 | 14 | 0.9 | Gritstone | 63 | 15 |
| 84/2 | Dalton Road Swanley | 022T | 110 | 260 | (0.8) 0.98 | (1.30 1.20 | 170 | 10 | 0.85 | Granite | 55 | 8 |
| 85/1 | A2 Upchurch Junction | 500 | 140 | 180 + rubber | (0.8) 0.98 | (1.2) 1.36 (1.4) 1.46 (1.6) 1.65 | 162 | 14 | 1.1 | Quartzite | 61 | 15 |
| 85/2 | C85 Ulcombe Hill | 022T | 110 | 200 | (0.8) 0.98 | (1.0) 1.15 (1.2) 1.2 (1.4) 1.4 | 166 | 10 | 1.0 | Gritstone | 67 | 9 |

TABLE 1. SUMMARY OF MATERIALS IN TRIAL AREAS

12.3 The performance of the two grades of fabric with respect to their long-term waterproofing and crack-bridging properties can only be assessed over a number of years. The thickness and hence binder demand should be the minimum possible to keep costs down, but both the 110 $g/m^2$ and the 140 $g/m^2$ are still performing well. Some cracks outside the trial areas are already visible on the surface after only 5 months, showing that the surface dressing is already ineffective as a seal. No cracks were visible through the fabric dressings after 16 months.

12.4 Chippings are retained better in the wheelpath than outside it. This is also true with conventional dressing but fabric dressing seems more sensitive to the lack of compaction by traffic. Vibrating rollers provide better compactive effort but bridge local depressions in the road. In these areas chip loss has been more observable. The best combination would appear to be a rubber drum vibrating roller with 4 pneumatic tyres on the other axle. More roller passes should be given than normal, particularly outside the wheeltracks.

12.5 Fabric dressing is far less tolerant of lateral forces on the surface caused by braking or turning traffic than conventional surface dressing. It would appear that the thicker fabric (140 $g/m^2$) is more tolerant as it provides a greater contact areas with the chipping. However, where such forces are likely, the use of a fabric dressing system needs further investigation. It may require more binder, more cohesive binder, more compaction or more careful traffic control.

## 13. ACKNOWLEDGEMENTS

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Trial Site 84/1

Rolling out the Fabric

Trial Site 84/1

Overspray and Chipping

Trial Site 84/2

Rolling out the Fabric

Trial Site 84/2

Applying Chippings

Trial Site 85/1

Fabric before Spraying

Trial Site 85/2

Fabric before Spraying