GUIDANCE ON

COLOURED SURFACINGS

(KRH)

Coloured Surfacing.

(1) Type and Location

So that there is clarity about the colouring of surfacing laid within the highway the following is recommended.

(a) **Red Surfacing**	Should only be laid in	**Bus Lanes** **Village Gateways** **Within ladder markings** **Advance warning sites**
(b) **Green Surfacing**	Should only be laid in	**Cycle Lanes**

The County Surveyors Society Accident Reduction Working Group has recently issued a document titled the Use of Coloured Road Surfaces which is useful background reading.

Some counties have reported accident's when motorists have wrongly assumed that some red surfacing has the same properties as anti skid material. Skid resistance therefore is an important consideration. Is there a need for high skid resistance or is it to match that of the existing surface? High skid resistant material laid in narrow widths could give rise to potential hazards associated with differential braking response.

(2) Choice of Aggregate

In order to define the long term performance of coloured surfacing the following should be specified.

(a) Aggregate Source
(b) Approximate B5 381c Colour
(c) Nominal Grade
(d) Nominal PSV
(e) Nominal AAV
(f) Overall Colour Change Index
(g) Resistance to Wear
(h) Resistance to Scuffing
(i) Resistance to Salt Spray

(a) **Aggregate Source – Red Surfacing.** In the past Chinese calcinated bauxite, dyed red, has been used with varying degrees of success in traffic calming schemes and on some bus lanes. As red is the colour most vulnerable to ultra violet radiation and general traffic wear it tends to fade in time. Where traffic does not pass over the surfacing, this colour fading is less of a problem.

However when a naturally occurring red coloured granite has been used, initially dyed or undyed (eg Abingdon Road bus lane) the colour has remained reasonably stable. Therefore two naturally occurring coloured granites are recommended.

(i) Harden Red Granite
(ii) Cloburn Granite

These granites should only be used where a PSV of 55 or less is required. Where a higher PSV is demanded (approaches to roundabouts, traffic signals, pedestrian crossings on bus lanes for example) a Chinese calcinated bauxite using the same initial dye should be considered, and is therefore recommended for these particular situations.

(iii) Dyed Chinese Calcinated Bauxite.

Aggregate Source – Green Surfacing Most of the green coloured surfacing has been laid in the cycle lanes in Oxford. In this case a naturally occurring green coloured granite has been used, dyed or undyed. Where a green dye was used the colour has remained reasonably stable. Therefore this naturally occurring coloured granite is recommended.

(i) Griggion Green Granite

(b) **Approximate BS 381c Colour.** If a dye is required to either enhance the natural colour of the granite or dye the chinese calcinated bauxite the following colours are recommended.

(i)	**Red**	**Colour 445 Venetian Red**	(granite/calcinated bauxite)
		Colour 564 Bold red	(calcinated bauxite)
		Colour 538 Cherry Red	(calcinated bauxite)
(ii)	**Green**	**Colour 262 Bold Green**	(granite)

(c) **Normal Grading.** From Clause 924 (SHW7) the grading of the aggregate shall be not more than 5% is retained on a 3.35mm BS sieve and not more passes a 1.18mm BS sieve. However the following standards are recommended

(i)	**Bus Lanes**	**2 – 5mm**
(ii)	**Traffic Calming Areas**	**1 – 3mm**
(iii)	**Cycle Lanes (on carriageways)**	**1 – 3mm.**
(iv)	**Cycle Lanes (on footways)**	**0.9 – 1.4mm**

(d) **Nominal Polished Stone Value (PSV)** (Resistance to Polishing) The necessary polished stone values of the coloured surface can be determined for all road locations using Table 2.1 – Minimum PSV of Chippings (or Coarse Aggregate for Unchipped Surfaces) for Flexible Surfacings on New or Resurfaced Roads. Source –Manual of Contract Documents for Highway Works, Volume 7, Section 3, Part 1, HD 28/94. The required P.S.V for each location is dependent on the amount of commercial vehicle traffic flows. For information a copy of this Table is included overleaf.

As long as the coloured surfacing meets this criteria then any possible ensuing legal claims can be adequately defended

The recommended aggregates should have the following minimum PSVs

	Aggregate	**PSV**
(i)	**Harden Red Granite**	**55**
(ii)	**Cloburn Granite**	**55**
(iii)	**Griggion Green Granite**	**63**
(iv)	**Dyed Chinese Calcunated Bauxite**	**73**

For bus lanes Harden Red Granite has been used successfully as part of OTS and is the recommended red aggregate. However when a higher PSV is demanded (approaches to roundabouts, traffic signals, pedestrian crossings on bus lanes), a Chinese calcinated bauxite having the same colour properties should be used (Required PSV should be 63 to 70 dependent on the number of commercial vehicles/lane/day).

(e) **Nominal Aggregate Abrasion Value.** Similarly from Table 2/2, which again can be found in MCDHW, Vol 7, Sect. 3, Part 1, HD 28/94, the maximum values for durability or resistance to abrasion of wearing cause chippings/aggregate have been determined according to commercial vehicle traffic flow. A copy of this table is reproduced below.

Table 2.2 Maximum AAV for Flexible Surfacings on New or Resurfaced Roads

Traffic (cv/lane/day) At design life (see 2.16)	< 250	251 – 100	1001 1750*	1751 – 250	2501 3250	>3250
Max AAV for chippings	14	12	12	10	10	10
Max AAV for aggregate In coated macadam Wearing course	16	16	14	14	12	12

- For roads carrying less than 1750 cv/lane/day, aggregate of higher AAV may be used where experience has shown that satisfactory performance is achieved by an aggregate from a particular source.

The selected granite and calcinated bauxite aggregates how AAV values much lower than the maximum permitted values and are more than satisfactory for the purpose. Recommended/Typical AAV values should be as follows:

Aggregate	**AAV**
(i) Harden Red Granite	**1.4**
(ii) Cloburn Granite	**1.4**
(iii) Griggion Green Granite	**4.9**
(iv) Dyed Chinese Calcunated Bauxite	**4.0**

Therefore the recommended aggregates should have a more than satisfactory AAV.

(f) **Overall Colour Change Index (ΔE)** This index measures the colours vulnerability to ultra violet radiation and general traffic wear. Generally speaking the bigger the value, the greater the overall colour change. The recommended target overall colour change index therefore should not be greater than the following values after 2000 hours of testing*

Colour	**Max ΔE.**
(i) Venetian Red (Colour 445)	**7.3**
(ii) Bold Red (Colour 564)	**7.5**
(iii) Cherry Red (Colour 538)	**7.4**
(iv) Bold Green (Colour 262)	**14.7**

*ΔE. In order to confirm these figures the aggregate shall have been assessed by the British Board of Agrement (BBA) for resistance to UV – A radiation.

The ASTM G53 – 96. Resistance to Accelerated Weathering Test shall be used which subjects the aggregate to a UV – A light/condensation cycle: four hours of UV – A light at 45°C followed by four hours condensation at 50°C for a total of 2000 hours using a QUV weatherometer. The colour retention of the aggregate is determined by spectrophotometer colour measurements using the CIE LAB method.

(g) **Resistance to Wear.** This is a different measure which simulates long term wear caused by turning traffic after 100,000 wheel passes. The recommended target values for the Resistance to Wear indices are listed below

Erosion Index	**0 (0 best – 30 worst)**
Final Texture Depth	**> 1mm**
Minimum Skid Resistance Value	**65**
Maximum Overall Colour Change Index	**13.0**

Again to confirm these figures, the aggregate shall have been assessed by the BBA. *The Wear Test (Appendix H Transport Research Laboratory Report 176) shall be used to determine the performance of the material following 100,000 wheel passes. The colour retention of the aggregate is determined by spectrophotometer colour measurements using the CIELAB method.*

(h) **Resistance to Scuffing** This measure simulates the turning action of traffic and identifies the potential for debonding**. Included in the indices are Resistance to Scuffing after 25 freeze/thaw cycles and Resistance to Scuffing after 24 hours of diesel exposure.** The recommended target values for Resistance to Scuffing indices are listed below.

Erosion Index	**0 (0 best – 30 worst)**
Final Texture Depth	**1.5mm**
Maximum Overall Colour Change Index	**16.0**

Again to confirm these figures, the aggregate shall have been assessed by the BBA. *The Scuffing Test (Appendix G, TRL Report 176) shall be used to determine the performance of the material, the actions of the scuffing tyre exposing the aggregate by abrasion of the coating. The Resistance to Scuffing after freeze/thaw conditioning (Appendix L, TRL Report 176) and exposure to diesel (Appendix M, TRL Report 176) will also be required part of the testing regime. The colour retention of the aggregate is determined by spectrophotometer colour measurement using the CIELAB method.*

(i) **Resistance to Salt Spray** This change in the colour index simulates exposure to the material of 500 hours of salt spray (winter maintenance). The recommended target value for overall colour change index should not be greater than the following value.

Overall Colour Change Index	**2.0**

To confirm this figure, the aggregate shall have been assessed by the BBA.
BS 3900: Part F12: 1985 (1991) shall be used to determine the performance of the material.

(3) Coloured Surfacing Aftercare

After the coloured surfacing has been laid, there may well be occasions when some reinstatement work may need to be carried out eg following a statutory undertakers excavation. Suppliers should be selected who can supply the aggregate/binder in small DIY kits to cover areas of up to 2.5 or 5.0 sq metres.

(4) Coloured Surfacing Rejuvenating Products

At the present time there are no benchmark specification for coloured surface rejuvenating products. An acrylic colour rejuvenator was tried on the Nuneham Courtenay gateways (Bimark) but it was unsuccessful. Not only did it turn pink, it was more costly than a new structional layer.

I have spoken to **Adbruf** who said that their product had been approved by the London Directorate and was used on the London Road Route. Their **Colourplus** range of acrylic based products can be roller, spray, squeeze or brush applied, supposedly has good colour retention with a degree of skid resistance. Perhaps some trial areas could be undertaken within the County to confirm its effectiveness. In the absence of any other sunder colour rejuvenator, **this product is therefore recommended.**

(5) Binders

As the laying of coloured surfacing is very similar to that of laying high skid resistant treatments, Clause 924 from the Manual of Contract Documents for Highway Works, Volume 1, Specification for Highway Works should be used as basis for this type of work. Under this Clause, a variety of binders can be used which include both thermosetting and thermoplastic binders.

For the purpose of simplicity I have divided the binder types into hand applied types and machine applied types for larger areas.

(a) Hand Applied Binders

Most small areas of coloured surfacing are hand applied for reduced costs and ease of application. Colour pigmented binders are preferred which are a similar shade to the aggregate being used so that maximum colour retention is retained. If any bleeding of the binder does occur through the aggregate it will not spoil its appearance. Likewise it will also form a barrier between the aggregate and the original road surface than preventing bituminous binder from the road staining the new surface.

There are four main types of binder that can be used:

(i) Epoxy resin extended binder
(ii) Polyurethane binder
(iii) Acrylic binder
(iv) Thermoplastic rosin ester binder

(i) **Epoxy Resin Extended Binder**

Can be pigmented to any required colour. Its main advantage is that it is more moisture tolerant than the other types of binder and works well during summer months. However it cannot be laid all the year round and the lower the temperature the longer the curing time e.g. Depending upon ambient temperature this may vary from 1.5 hours @ 25ºc to 5 hours @ 10ºc. There are no accelerators available which can be added to epoxy resin to reduce curing time and is more difficult to lay at lower temperatures. It also produces a strong odour when being laid and there are COSHH implications to this product as there is evidence that it may toxic by inhalation and may be carcegenic and mutagenic. When cured it can form a more brittle structure.

(ii) **Polyurethane Binders**

Can be pigmented to any required colour. Its main advantage is that it can be laid at lower temperatures so it can be used during summer and winter months providing the surface is dry and the minimum road temperature is 5ºC. Accelerators can be added to it to reduce the curing time and fillers can be used to extend the material. It main disadvantage is that it is not moisture tolerant. However it does not produce a strong odour when being laid and is more user friendly and easy to lay. When it has cured it is a more flexible material less prone to brittleness.

(iv) **Acrylic Binders**

Can be pigmented to any required colour. Its advantage is that, similar to polyurethane binders, it can be laid at low temperatures so that it can be laid at night or during the winter months providing the surface is dry and the minimum road temperature is 4º. The approximate curing time is 1½ hours. Fillers can be used to extend the material. When cured the systems retains good tensile and flexural properties. However this product is less robust, it can lead to colour retention and consistency problems and is comparatively very expensive.

(iv) **Thermoplastic Rosin Ester Binder**

This is a hot, hand laid treatment which is applied in a single layer on the road surface. It contains calcinated bauxite with a colour polymer modified resin. It is less weather sensitive during its application and has the advantage of being able to be used over existing road markings. It is quick to apply and can be trafficked as soon as the surface reaches ambient temperature allowing the system to be applied with minimum traffic disruption. However its disadvantages are that it forms a brittle finish and besides being uncomfortable to drive over it can fail at the screed joint interfaces.

All of these types of binders have their advantages and disadvantages but on balance apart from the whole life aspect of the finished product, the main considerations are curing time which affects the amount of time traffic is disrupted and the binders ease of use. Preferably an all year round product should be used with short curing times. Therefore the following binders for hand applied work are recommended in order of preference:

(i) Polyurethane binder
(ii) Thermoplastic rosin ester binder

(b) Machine Applied Binders

Binders for use in laying large areas of coloured surfacing such as bus lanes are normally two component between modified epoxy binders laid by special purpose built tanker sprayers. The system used should be similar to that specified in the Highways Authority Product Approval Scheme (HAPAS) for High Friction Surfacing. **The following binders are therefore recommended,** as it appears to be the only HAPAS approved material for this type of system to date. However there may be COSHH considerations and because of the odour present during after laying it may not be suitable for town centre use.

(i) Two component bitumen modified epoxy binder

The system is available in standard and winter grades. The winter grade material is used when ambient temperatures are between 5°c and 10°c. The maximum road temperature on which the binder can be laid is 35°c.

(6) Surfaces Unsuitable for Treatment

Surfaces not suitable for treatment include slurry surfacing, micro surfacing fatted and multilayer surface dressing and surface dressings over soft or unsound bases. Performance on concrete may not be as good as on bituminous surfacing.

Attention is required to ensure the surface is probably prepared. The surface to which resin is applied should be dry and free from dirt, oil, excess bitumen and other contaminant that may cause lack of adhesion.

Any potholes, cracks or surface defects should be prepared before anti skid treatment is applied and where necessary any road markings should be removed first if they are to be covered by the process, except where a thermoplastic modified resin binder is used.

High Friction Surfaces

(7) Type and Location.

High friction surfaces are easier to define as they have to comply to performance specification laid down in Clause 924. Volume 1 Specification for Highway Works.

However the colour of such surfacings are of concern as they can give the wrong message to certain drivers and can add to confusion. Of particular concern is laying of buff coloured anti skid material on bends. Some motorists see this as a signal that they can travel faster around the bend than they would have otherwise, creating accidents that the anti skid surfacing was laid to prevent. Buff coloured surfacing at pedestrian crossings can also detract from the adjacent road markings and in some areas be environmentally intrusive.

Three types of calcinated bauxite are available

(a) Chinese calcinated bauxite	(i) Buff
	(ii) Dark grey
(b) Guyanese bauxite	(iii) Darker grey

Therefore using these materials, the following coloured aggregate is recommended for the following situation:

Approaches to major junction (side roads)	**Buff**
Approaches to major junction (through route)	**Grey**
Bends	**Grey**
Roundabouts	**Buff**
Gradients > 10%	**Grey**
Approaches to roundabouts	**Buff**
Approach to traffic signals	**Grey**
Approach to pedestrian crossings	**Grey**
Approach to railway crossings	**Grey**

High friction surfacing should be applied strictly in accordance with the current system method statement provided in accordance with the British Board of Agrément HAPAS Roads and Bridges Certificate.

For information a copy of the current Clause 924 and Notes for Guidance NG 924 are enclosed from the Specification for Highway Works, Volume 1 and 2 respectively.

(8) Thermoplastic Rosin Ester Products – Zebraflex

There is concern about the thermoplastic rosin ester products (e.g. Zebraflex and E.S.S Systems) regarding their riding qualities and structural integrity at various sites within the County. Within a few months, after the material is laid, failures occur along the screed joints and in some cases small areas of the material just lift off. As well as providing a rough ride for motorists, some cyclists find it unpleasant to ride over.

There is another issue of reinstatement after their design life has expired. If the riding qualities of this material are poor now, what would the anti skid surface be like following the application of another similar layer.

This material has been used for many years and Zebraflex has applied for and successfully received a HAPAS certificate No99/H030 for the product(Zebragrip Standard High Friction Surfacing System). However it should be noted that this is for Type 3 use only (see Table NG 9/15 enclosed) and it should only be used for the lowest levels of commercial vehicle traffic. E.S.S. Systems have a similar HAPAS certificate No. 99/H029 for their Heavy Duty Friction Surface System.

Even prior to 1998, when only epoxy resins were allowed to be used under Clause 924, this material was used at several locations within the County. However since that time there are sites where it has been laid, even on trunk roads, where it does not comply to the type classification contained within Table NG 9/15.

Given for example that Zebragrip (or E.S.S System) should only be used at roundabout approaches where the maximum number of commercial vehicles/lane/day is only 100, no wonder the systems structural integrity is suspect and the expected service life of 5 to 10 years cannot be achieved. It is important that any anti skid treatment is fit for the purpose and whole life costs are considered.

Therefore due to the problems encountered with these particular products, I recommend suspension of its use for the time being. I gather from Zebraflex that a Mark II Zebragrip which meets the Type I requirements is due to receive a HAPAS certificate very soon but I suggest that sites in other counties are monitored first to confirm its effectiveness and riding quality before the product is considered for reintroduction here.

(7) HAPAS Approved High Friction Surface Systems.

At the time of writing there are currently six contractors who hold HAPAS Agrément Certificate for High Friction Surfacing.

a)	Colas Ltd -	98/H001	Spraygrip High Friction Surfacing System Tel 01342 711000 Type 1 Classification (Epoxy Binder System) (Machine lay)
b)	Zebraflex -	98/H002	Suregrip 924 High Friction Surfacing System Tel 0125 72 73225 Type 1 Classification (Epoxy Binder System) (Machine lay)
c)	Johnson Surfacing -	98/H003	Supergrip High Friction Surfacing System Tel 01737 242466 Type 1 Classification (Epoxy Binder System) (Machine lay)
d)	ESS System - **(Not recommended)**	99/H029	ESS Heavy Duty High Friction Surface System Tel 01273 597902 Type 3 Classification (Thermoplastic Rosin Ester System) (Hand lay)
e)	Zebraflex - **(Not recommended)**	99/H030	Zebragrip Standard High Friction System Tel 0125 72 73225 Type 3 Classification (Thermoplastic Rosin Ester System) (Hand lay)
f)	Jobling Purser -	99/H031	Rocbinda High Friction Surfacing System Tel 0191 273 2331 Type 1 Classification (Polyurethane Binder System) (Hand lay)