Road Emulsion Association Limited

Technical Data Sheet No.8

Patching, Grouting and Spray Injection Patching

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1. Introduction

Patching and Grouting are two important construction and maintenance techniques, applicable to carriageways and footways, which capitalise on the versatility of bitumen emulsion. The particular properties of emulsions that are exploited in these techniques are their ability to be used cold, to penetrate substrates and to coat dry or damp aggregate in depth. After curing, the residual bitumen binder provides excellent cohesive strength.

Patching refers to the repair of cracks, crazing, potholes and depressions, and is an effective treatment prior to surface dressing. Bitumen emulsion is used as a bond coat when conventional macadams are involved. Proprietary brushing grades can be used as a replacement for hot bitumen as an edge sealant.

Grouting is a process involving the construction or stabilisation of road surfacings and footways whereby emulsion is applied to compacted dry or damp aggregate. The low viscosity of the emulsion permits in-depth penetration through the interstices of the aggregate. This technique involves the construction of a combined base/wearing course surfacing from a thickness of 50mm to 75mm in one course or up to 100mm in two courses, as may be specified.

2. Patching

2.1 Preparation - The failed area should be cut cleanly to a regular shape with vertical or slightly undercut sides. A diamond shaped cut is preferred for heavily trafficked roads. It is important that the extent of the cut is such that the edges of the repair material will be in contact with good quality existing material. All loose and unstable material should be removed.

Bond coat emulsion Class C40B3, C60B3, or a polymer modified grade is applied, either by spraying or by pouring and brushing around the sides and base of the prepared area. Where dry surfaces are experienced, these may be moistened with water to permit deeper penetration of the emulsion.

2.2 Application - For heavily trafficked roads the patching material is frequently a hot bituminous mix, either asphalt concrete or hot rolled asphalt. If the depth of the repair area is more than 100mm the opening should be filled with successive layers of these materials which are levelled and compacted. The final layer should be suitably profiled. The patching material should contain a nominal size of aggregate which is no more than half the depth of the layer. A vibratory plate compactor is suitable for the consolidation of lower layers and small surfaces, whilst a roller is more practical for larger surface areas. If the repair has an open texture, it can be sealed with emulsion class C60B3 or C60BF3 at a rate of spread of 0.8 to 1.0 l/m^2 and blinded with grit or a pre-prepared slurry surfacing. (See REA Technical Data Sheet No. 12 – Miscellaneous uses of Bitumen Emulsions)

On less heavily trafficked roads alternative patching materials and procedures are available.

a) **Deferred Set Macadams** - Particular attention needs to be paid to providing vertical edges to the patches so that edge support is obtained.
b) **Emulsion/Aggregate Mixes -** Several permanent cold lay surfacing materials are available. In the past HAUC certification gave assurance of the proven performance of permanent cold lay materials; however, this process is now within the scope of the BBA/HAPAS Guidelines Document for the Assessment and Certification of Permanent Cold Surfacing Material for the Reinstatement of Openings in Highways or equivalent product acceptance schemes.
c) **In-Situ Patching -** Clean aggregate which should be 20/31.5mm nominal size, or no larger than about two-thirds of the depth of the hole, is placed in the prepared site to a thickness slightly greater than its depth. At this stage the minimum amount of emulsion required to coat the stone is poured on, followed by good compaction. The emulsion should be class C60B3 or C60BF3 C69B3 or C69BP3 and it is important that only the minimum quantity be used in order to avoid 'fat' spots on the road. The open textured patch should then be sealed by covering with clean 6.3/10mm or 2.8/6.3mm chippings and again well rolled.

2.3 Surface Dressing - If it is considered that the patch needs to be surface dressed in order to provide a matching texture to the rest of the road, then the following procedure should be followed. Brush sharp grit (preferably bitumen coated) into the pores of the macadam and vigorously sweep off any excess. Brush or spray apply C69B3 or C69BP3 or a proprietary brushing grade emulsion over the surface to a depth of approximately 50% of the height of the chippings to be used (approx. 1 - 2 l/m^2 depending on the macadam texture and chipping size). Immediately apply the chippings and protect the patch from fast moving traffic until the surface is cured and stable. (Technical Data Sheet No. 4 – Surface Dressing with Bitumen Emulsion or Road Note 39 [1] provide general guidance). The following day remove any loose chippings.

3. Grouting

Both full and semi-grouted works are recognised methods. In the former the quantity of emulsion used should be sufficient to coat the aggregate to the full depth of the construction; for a semi-grout, a lower water bound layer is formed during the aggregate compaction stage and then the emulsion is applied in sufficient quantity to completely coat the aggregate above this water bound layer. Semi-grouted work is particularly suitable for footway construction.

3.1 Preparation of Base - After ensuring that the foundations and drainage are satisfactory, the base may be scarified or, alternatively, clean sand or quarry fines should be applied to a total thickness not exceeding 13mm.

3.2 Application of Aggregate

(a) Selection

Any clean, angular aggregate can be used, provided that its crushing strength is sufficiently high to withstand the traffic to be carried. The grading should be selected with reference to the character of the aggregate and the depth of each compacted layer. Typical gradings might be:

For 50mm compacted thickness

60% 20/40mm nominal single sized material
30% 20/31.5mm nominal single sized material
10% 14/20mm nominal single sized material

For 65 - 75mm compacted thickness

60% 50mm nominal single sized material
30% 20/40mm nominal single sized material
10% 14/20mm nominal single sized material

The various sizes should be thoroughly mixed or alternatively the 14/20mm material should be spread over the larger aggregate, after the latter has been placed in position, and vibrated into the interstices.

(b) Spreading and Compacting

For finished thickness up to 75mm the aggregate should be spread to the required contour such that, after rolling, the minimum thickness is not less than specified. The aggregate should be stockpiled outside the area upon which it is to be spread and protected from contamination. Spreading may be carried out manually using shovels, and not forks, care being taken to avoid segregation during the operation. It may also be spread by mechanical means, such as a spreader box, when it is advisable firstly to spread the coarse aggregate and then to superimpose 14/20mm material as a separate operation.

Compaction should be carried out with a vibrating roller. Rolling should be longitudinal and progress from the sides towards the centre of the road or footway until there is no appreciable movement of the aggregate under the roller. If required, 14/20mm chippings can be added at this stage in order to correct any deficiencies there may be in the quality of the surface. For semi-grouted work, a quantity of water should be applied during rolling to form a uniform water bound layer. This lower layer should not exceed two-thirds of the total thickness of the compacted aggregate.

3.3 Application of Emulsion for thicknesses up to 75mm

For a full grout the quantity of the emulsion should be sufficient to penetrate the full depth of the course; it is advantageous to apply the emulsion in two stages. For semi-grouted work the quantity of emulsion used should be sufficient to coat the aggregate to the full depth of the layer above the non-bituminous layer. Typical rates of application for grouting are given in the following table:

Table 1 - Typical rates of application for grouting

Thickness of Course (mm)	Nominal Size of Aggregate	Full Grout (l/m^2)	Semi-grout (l/m^2)
50	40 mm down	5.5 - 7.0	3.0 - 5.5
65	50 mm down	7.0 - 9.5	4.0 - 7.0
75	50 mm down	9.5 - 11.0	5.5 - 8.0

The emulsion used is usually class C60B3, C60BF3, C69B3, or C69BP3 but other grades of emulsion may be used by agreement between purchaser and supplier. Immediately after application of emulsion, clean 2.8/6.3mm or 6.3/10mm chippings should be spread uniformly over the surface to fill the interstices.

3.4 Application of Emulsion for thicknesses above 75mm

Should a finished thickness of over 75mm be specified the aggregate should be spread, compacted and grouted with emulsion in two separate layers. The bottom layer should not have a thickness less than that of the top layer and the size of the aggregate should be appropriate to the thickness of each course. After the bottom course has been grouted the second layer of aggregate should be spread immediately, followed by compaction and grouting. The surface interstices of the second layer are only filled with chippings as in the case of a single course grout.

Work which is subsequently jointed should be finished off by layering and rolling a feathered edge not less than 300mm in width. Later this is cut back to a clean vertical face immediately before laying new material.

3.5 Surface Dressing

After a stabilisation period of several days, the surface should be swept and sealed with a surface dressing of bitumen emulsion selected from classes C60B3, C60BF3, C69B3, C69BP3 or other grades of emulsion by agreement between purchaser and supplier at an application rate of 0.9 to 1.4 l/m^2 with 6.3/10mm or 8/14mm chippings. For heavily trafficked roads, a second surface dressing of emulsion of the same class and rate of application, and 8/14mm chippings should be applied about two or three months after the first application, to provide a non-skid surface.

4. Spray Injection Patching

Spray Injection Patching (formerly referred to as Velocity Patching) is the term used to describe a process utilizing specialist proprietary machines that provide an in-situ patching repair as an alternative to conventional patching. The process is generally restricted to less heavily trafficked roads, mainly in rural locations, although it is also used for emergency repairs and semi-permanent repairs on strategic roads, hard shoulders and motorways in suitable circumstances. Guidance for the use of Spray Injection Patching is given in BS 10947 [2].

The process utilizes plant which provides a stream of high volume, low pressure air to remove unsound material and clean the defective area. Bitumen emulsion is then fed into the airstream to prime the exposed surfaces of the defective area before clean aggregate is also added to the airstream, simultaneously with emulsion. This results in bitumen emulsion coated aggregate being forced into the base of the defective area/pothole, building and consolidating simultaneously up to a finished level. The repair may be completed with a surface coating of clean aggregate if required, and the repair can normally be trafficked immediately after laying. In areas subjected to turning or heavier traffic, or for surface dressing pre-patching, additional compaction of the repair by pedestrian roller or vibrating plate may be utilized before trafficking.

The bitumen emulsion used will be a proprietary formulation conforming to BS EN 13808 to suit the individual machine and time of year, with a binder content typically in the range of 60-70% and formulated to give optimum coating and breaking characteristics. Both unmodified and modified grades are available, depending on the site application.

Clean washed surface dressing grade chippings complying with BS EN 13043 are used, typically 2.8/6.3 mm grading. Aggregates must be assessed to ensure they are compatible with the emulsion being used to ensure full coating and applied into the repair without premature breaking. Assessment includes determination of adhesivity with BS EN 13614 [3] and use of the Snowball Test described in Annex A of BS 10947 to demonstrate the chipping can form a cohesive mixture. The use of dirty or dusty chippings – e.g. surface dressing sweepings – is NOT advised, as it can result in poor coating of the aggregate and likely failure of the repair.

Original guidance in BS 434-2 [4] noted that Spray Injection Patching is a seasonal process in a similar way to Surface Dressing, and for best results the Spray Injection Patching season could generally be considered to start 4-6 weeks before the Surface Dressing season, and finish around the same time. That guidance is still valid for maximum productivity and success, however development of seasonal grades of emulsions has enabled the season to be extended for emergency and temporary repairs, and in suitable conditions for semi-permanent repairs. Some seasonal conditions, however, will be outside the scope of possible or practical variations to the emulsion. Conditions that should be avoided include:-

- Existing or predicted frost or snow
- Road and / or air temperatures too low
- Prolonged wet periods
- Poorly drained sites
- Areas of heavy shade – e.g. trees, tall hedges

It is good practice to carry out the Snowball Test before commencing work each day, which will give a good indication that the prevailing conditions and current materials are compatible for a cohesive repair mixture.

References

[1] Road Note 39: Design Guide for Road Surface Dressing – published by Transport Research Laboratory

[2] BS 10947:2019 Spray injection patching for highways and other paved areas. Specification

[3] BS 434-2:2006 Bitumen road emulsions. Code of practice for the use of cationic bitumen emulsions on roads and other paved areas (withdrawn)

[4] BS EN 13614:2021: Bitumen and bituminous binders. Determination of adhesivity of bituminous emulsions by water immersion test

For further information on all REA Technical Data sheets please look on the "Technical Datasheets" webpage on www.rea.org.uk

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