

## SULPHIDE-BEARING SOURCE ROCK

### INTRODUCTION

Some sedimentary and metamorphic source rocks used for the production of crushed rock and aggregates may contain significant proportions of sulphide mineralisation. These sulphides oxidise (aided by bacterial action) when exposed to the atmosphere and water to form deleterious and highly soluble acid salts (sulphates). These acid salts have caused extensive rust-staining of sprayed bituminous surfacing as well as cracking and blistering of thin asphalt surfacing at a number of sites. Aggregate from certain sources exceed the specified limits for sulphide/sulphate content as described in the appropriate Australian Standards for concrete and concrete aggregate. This Technical Note provides guidance as to the use of such mineralised source rock.

### USE OF SULPHIDE/SULPHATE-BEARING CRUSHED ROCK BASE AND SUBBASE

If crushed rock from significantly mineralised sources is used as pavement base or subbase in asphalt surfaced pavements, dissolved acid salts tend to migrate to the interface of the crushed rock base and the asphalt surfacing. Pressure produced by hydration and crystallisation of the salts then causes debonding of the asphalt from the crushed rock base, resulting in cracking and blistering of the surfacing. The effect is most pronounced with thin asphalt surfacing, say up to 40 mm thick, and particularly for pavements which are lightly trafficked. Water can enter these lightly trafficked pavements, and significant damage can occur within the first few weeks of placement.



Acid salt induced damage to untrafficked pavement edge

For sprayed bituminous surfacing, damage is less frequently observed in the early life of the surfacing. Damage may become noticeable later when defects make the surfacing permeable thus allowing ingress of moisture and migration of the acid salts.

The following procedural and specification requirements are appropriate where the current quarry investigation report indicates the presence of sulphide mineralisation in the source rock. Testing for pH & conductivity is carried out regularly as a part of the VicRoads Quarry Accreditation process.

### Approval of the Source

The advice of the Manager GeoPave should be sought before approval of a supply of sulphide/sulphate-bearing material. This will ensure that appropriate inspections and testing of the source rock and crushed products can be carried out and advice provided as to whether lime stabilisation is required.

### Specification Requirements

VicRoads Standard Specification Section 812, Table 812.054, limits the amount of deleterious, soluble acid salt present in the crushed rock by the application of pH and conductivity limits as shown in Table 1.

Table 1 pH and Conductivity Test Requirements

Test	Test Value
pH (units)	6.0 (min)
Conductivity (µS/cm)	1500 (max)

If the Contractor proposes to use a crushed rock base or subbase material which does not comply with the specified requirements, the material may be accepted for use subject to the written approval of the Superintendent, but only after the Contractor specifies the method and amount of hydrated or quick lime to be combined with the product so that the requirement of Table 2 is met.

Table 2 pH of Material after addition of Lime

Test	Test Value
pH (units)	10.0 (min)

### Addition of Lime

To allow use of significantly mineralised crushed rock in the construction of thin asphalt or sprayed seal surfaced pavements, the application of calcium hydroxide  $\text{Ca(OH)}_2$  in the form of hydrated lime or quick lime is required. This renders the salts relatively insoluble by causing a reduction in the acidity of the pavement environment i.e. the material is stabilised.

Where initial testing indicates that lime is required, lime should be added to all material produced for that job even though subsequent test values for pH recorded for the unmodified product sometimes may fall within the acceptance limits given in Table 812.054 of the specification.

### Stockpiling of Crushed Rock

Sulphide/sulphate-bearing base and/or subbase materials may be stockpiled. The stockpiles should not be adjacent to waterways or drainage lines. Where testing has indicated the need to add hydrated lime or quick lime as a stabilising agent, this should be added at the time of production of the crushed rock and before stockpiling. Addition of the stabilising agent at this time is intended to prevent migration and concentration of deleterious salts within the surface layers or toward the base of the stockpile, and to prevent any potential environmental damage due to the runoff of acid solution.

### SEALING AGGREGATE

Aggregate containing sulphide/sulphate mineralisation which is used in sprayed bituminous surfacing applications may cause localised rust staining of the pavement surface together with disintegration of some of the sulphide-rich aggregate particles. In some instances the rusting (which appears to be transient, lasting perhaps for 2 to 3 years) has been observed to discolour and partly obliterate painted pavement markings. Rust stains may also affect adjacent concrete kerb and channel which can be an aesthetic problem in urban areas. In other cases, general discolouration of stockpiles and pavement surfaces occurs.

No limitation on the use of source rock containing moderate quantities of sulphide minerals for bituminous surfacing aggregate production is required except for instances where the transient rusting or discolouring of the pavement surface is undesirable.

### Stockpiling of Sealing Aggregate

When sealing aggregates containing acid salts are stockpiled, evidence of salt concentrations at the base of the stockpiles may be present as well as discolouration of the aggregate due to the precipitation of ferrous salts. These effects do not impact on the performance of the aggregate.

### CONSTRUCTION PRACTICE

When unstabilised crushed or ripped rock containing minor amounts of acid salts is to be used as base or subbase in sprayed bituminous surfaced pavements, it is necessary to ensure that rapid construction techniques are used. This will ensure that unsealed pavements or individual pavement layers are not allowed to remain open to the atmosphere for extensive periods of time as the presence of a free evaporative surface encourages the concentration and crystallisation of salts in the near-surface zone. Such concentrations may lead to loss of compaction density in the upper few centimetres of the exposed pavement layer.

### ASPHALT AGGREGATE

When used in hot mix asphalt, aggregate particles containing high levels of sulphide mineralisation may disintegrate leaving pits in the surface of the wearing course. These defects do not generally reduce the service life of the surfacing but can be a problem in specialised work such as sporting surfaces or shared path ways, particularly in the case where coloured epoxy or painted surfacing is applied.

### CONCRETE AGGREGATE

Aggregates for structural concrete must conform to the limits contained in AS 2758.1. This Standard requires that aggregates containing sulphide or sulphate salts (expressed as acid-soluble  $\text{SO}_3$ ) in proportions that result in the sulphate content of concrete exceeding 5% by mass of cement should not be used. These requirements are included in VicRoads Standard Specification Section 610.

### REFERENCES

- VicRoads Standard Specification Section 812 - Crushed Rock for Base and Subbase Pavement.
- AS2758.1 Aggregates and rock for engineering purposes - Concrete aggregates.
- VicRoads Standard Specifications Section 610 - Structural Concrete.

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