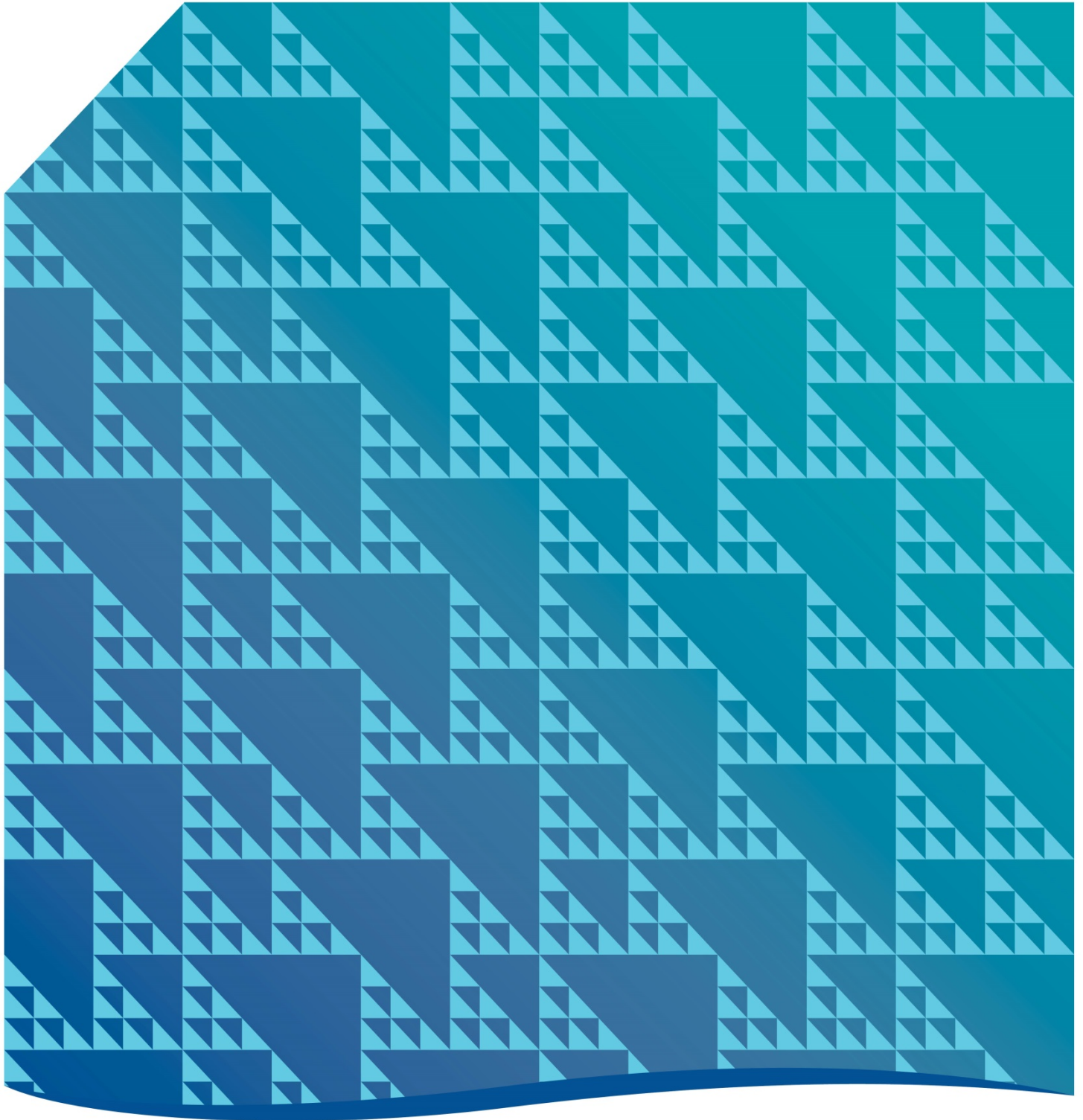


ENG6 Production of Aggregates and Rock
Products *Explanatory Notes*

Date: July 2014

Edition 1 / Revision 0

General Specification



REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1 / Rev 0	All	<i>'Department of State Growth'</i> replaces <i>'DIER'</i>	BW (MRA)	07.07.14
	Document	Formatting updated to current Specification template		
	ENG6.1	Secondary Mineral Content included in introduction to the Specification		
	ENG6.4.1	Durability descriptors expanded to include Secondary Mineral Content		
	ENG6.7	List of required control charts expanded to include Secondary Mineral Content		

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ENG6.1 INTRODUCTION

The intention of *Standard Specification G6* is to define an industry standard for the testing, monitoring and recording of quality at the material source. *Standard Specification G6* aims to ensure that aggregates and rock products supplied to work sites have the specified properties and that the quality is both uniform and verifiable. A further aim is that the evidence concerning quality is readily accessible. It is intended to provide contractors and supervisors with up to date, and easily interpreted information on the properties and variability of products delivered to a work site. The properties covered by the specification include:

- Durability including:
 - Wet Strength and Wet/Dry Strength Variation (WDSV)
 - Secondary Mineral Content (SMC)
- Resistance to polishing (PAFV)
- Aggregate shape including:
 - Flakiness Index (FI); and
 - Average Least Dimension (ALD)

The specification aims to ensure that the selection and production processes are under effective control and that this control can be readily demonstrated through systematically collated and readily available data. The underlying principle is that a well-managed quality control system provides the best insurance against defective products. It also provides the most effective means of tracking down the source of any non-compliance.

ENG6.2 SCOPE

These notes provide:

- The background, reasons and scope of *Standard Specification G6*.
- Explanation/expansion of the terms used in *Standard Specification G6*.
- Interpretation guidelines.

ENG6.3 BACKGROUND

This specification is the starting point in a chain of production testing and quality control. This chain is intended to extend from the examination and mapping of the quarry face and to continue through the extraction and processing of materials at the rock source to the delivery and placement of the materials into the pavement or other road structure.

In developing this specification it has been recognised that:

- (i) A robust, effective and visible quality control system is essential to the efficient management of operations within the source and to the supply of a reliable and consistent product. Such a system involves a combination of visual inspection, testing, control charts and analysis. The required system should expose trends in product quality and product variability.
- (ii) Consistent products allow consistent construction practices that in turn produce more uniform pavements. The oversight and minimisation of variability is fundamental to good pavement construction practice.
- (iii) Provided the above system is maintained and accessible, it is likely to give the customer more confidence in the quality of the supplied product than the same amount of quality assurance testing of the product on delivery.
- (iv) The system described above provides both the producer and customer with a diagnostic tool, one that can be used to locate the likely source of a non-compliance and with thoughtful scrutiny can be used to detect and eliminate problems before they surface.
- (v) It attempts to eliminate unnecessary testing, by tying the frequency of testing to the risk of non-compliance. Where the risk of non-compliance is low, the producer is rewarded by a lower frequency of testing.

- (vi) It attempts to eliminate repetition in the various Department of State Growth "Roadworks" and "Bridgeworks" specifications that have quality requirements for aggregates and rock products.

ENG6.4 MATERIAL PROPERTIES

The specification is primarily concerned with the intrinsic properties of the rock substance (i.e. the quality of the rock that goes into making the products.) Whereas the durability and polishing resistance are almost exclusively determined by the properties of the source rock, shape is significantly affected/determined by the crushing process and changes in this will affect shape. ALD is also significantly affected by the screening process. The following provides introductory comment on the various test criteria.

ENG6.4.1 Durability

It is generally recognised that there are two quite distinct aspects to what is called durability. These are strength and soundness. It is also generally recognised that there are no completely satisfactory test criteria that apply equally well to all material types and potential usages. Department of State Growth has settled on the following for pavement materials:

- (i) Strength. - This is concerned with the resistance to a loss of shape or degradation from physical forces such as crushing or abrasion. The Department of State Growth has adopted the measures of Wet Strength and Wet/Dry Strength Variation. The result is expressed in kiloNewtons (kN).
- (ii) Soundness. - This is concerned with resistance to degradation from environmental influences, particularly water, but including the action of temperature cycling, frosts, salts etc. The Department of State Growth has adopted the measure of Secondary Mineral Content (SMC) for basic igneous rock. The SMC is used to determine whether the stone is sound, marginal or unsound. No specific measures have been adopted for other rock sources at this stage.

NOTES:

1. *Where a product is blended, the aggregate strength and durability of the least durable component applies.*
2. *Tasmanian geology indicates that it is the basic igneous rocks (basalts and to a much lesser extent, dolerites), that are the more likely to have a soundness problem. This arises from the possible existence of compounds sensitive to water (mainly clay type materials). These materials will often exhibit high wet strengths. Sandstones and quartzites will normally have good soundness properties, but may suffer from low wet strength and abrasion resistance properties.*
3. *In general Specification G6 is a process specification, with the specific limits/maximums/minimums/targets covered by other Department of State Growth Specifications, as the value depends on the intended purpose. However G6 does use the SMC to define the stone as sound, marginal or unsound, as these definitions apply to all intended uses. Other Department of State Growth Specifications such as R40 Pavement Base and Subbase detail the composition limits for marginal and unsound stone.*
4. *In developing a project specification for other than conventional pavement uses, consideration should be given to the external and internal environments that might affect durability of the rock, for example exposure to sea water, sulphates etc, and the specification of other test methods such as sulphate soundness.*

ENG6.4.2 Resistance to Polishing

This test property applies only to wearing courses, those that may be subjected to the polishing action of truck and car tyres. Resistance to polishing is expressed as the Polished Aggregate Friction Value (PAFV). It is determined by subjecting aggregates to an artificial polishing environment. The friction value is measured with the British Pendulum Meter. There are two alternative polishing procedures:

- Horizontal Wheel, AS 1141.41
- Vertical Wheel, AS 1141.40

The latter is similar to the British Polished Stone Value (PSV), but is limited to 10mm aggregate. The former can accommodate both 10 and 14mm aggregate.

ENG6.4.3 Particle Shape

Shape is important with respect to ease of packing of particles. In Department of State Growth Standard Specifications shape is measured by the Flakiness Index Test (FI), AS 1141.15. A flaky particle basically is one that can be fitted through a slot whose width is 60% of the average of the nominal size of the sieve on which the particle was retained and the sieve next in size above. FI is the percentage by mass of the flaky particles to the total mass. FI provisions occur in a range of roadwork specifications, including *Standard Specifications R40, R51 and R55*.

Average Least Dimension (ALD), AS 1141.20, is a primary property in sprayed seal design.

ENG6.5 PRODUCTION CONTROL

The required process of production control includes:

- The examination and mapping of the quarry. The aim here should be to delineate source rocks according to their intrinsic properties and to identify and eliminate materials that are likely to have a detrimental effect on quality.
- The sampling and testing of representative samples from each class of material delineated.
- The production of reference samples. Reference samples provide an important link in the quality chain between the sample on which the assigned value is calculated and the product being processed at any particular time. For each material type identified in the quarry the producer is required to retain a reference sample. The method of production should be based on AS 1141-30. The reference samples have to be registered within the plant's quality system.
- The producer is required to maintain quality control charts.

ENG6.6 ASSIGNED VALUE AND FREQUENCY OF TESTING

It is important to understand that the assigned value applies to an essentially homogenous product, that is one without obvious changes in properties, whether or not these properties are directly related to the particular property in question. The results of noticeably different parts of a source should not be mixed. With respect to particle shape, any change in crushing or screening operations has the potential to affect shape and the effect of these changes on shape properties should be investigated before the change result is included in the calculation. The date of any change in operations or source material should be shown on the control charts.

With one exception (PAFV), the assigned value is essentially the lower or upper 16%ile (characteristic) value. The characteristic value approach includes variability in the estimate. It is calculated from the following equation:

$$\text{Assigned Value} = \bar{X} \pm s$$

Where:

- \bar{X} is the average of the five (5) most recent test results
- s is the sample standard deviation of the five (5) most recent test results

Because of inherent variability within a product and within test procedures there is always uncertainty as to the true quality of a product. Whilst testing based on a small number of samples might indicate that a product just complies with a specification, more extensive

testing might show that the product does not comply. This uncertainty about compliance is lessened when the gap between the assigned and specified values increases.

The specification offers a 50% reduction in the frequency of testing if the characteristic value, calculated from $x \pm 2.0s$ complies. The characteristic value calculated from this equation is essentially the upper or lower 2.5%ile value.

ENG6.7 PRESENTATION OF DATA

Control charts are required for all measured properties for every product type produced by the source. The charts must be readily available to the Contractor who in turn would supply them to the Supervisor on request.

Different qualities of materials should not be mixed in the charts or in the calculation of the assigned values.

The required charts include:

- Wet strength and Wet to Dry Strength Variation
- Secondary Mineral Content
- PAFV
- FI
- ALD

Other Department of State Growth Specifications have additional control chart requirements. These include particle size distribution, Atterberg Limits and maximum dry density. In addition to the specified information requirements, the charts should show any change in source rock or in the crushing and screening process.

Control charts provide a powerful tool to analyse the cause of product non-conformance. It is often possible to find at a glance a linkage between non-compliance in a particular property and a change in a source rock property. The significance of any unexpected change or trend in quality and any change in product variability evident in the chart should always be assessed. They should be sought at the "Nomination of Materials" stage.

The date of any change to the crushing and screening process must be shown on the charts.

ENG6.8 INTERPRETATION

The provisions of *Standard Specification G6* apply to all producers of all rocks and aggregates, except those where no aggregate strength or durability provisions apply (e.g. subbase 2 and selected subgrade). It applies to both small and large producers.

The intention of Specification G6 is to set an industry standard to which all suppliers shall meet. In consequence and in fairness to complying producers, deviations from the requirements and obligations will not be permitted.

The specification was originally developed in collaboration with the then Crushed Stone and Sand Association (CSSA), Tasmania, now CCA/Extractive Industries Tasmania (CAA/EIT). The CSSA has developed a companion document "Quarry Inspections, Source Rock Evaluation and Associated Production Control Procedures". Their document outlines, for the benefit of producers, how the requirements of this specification can be achieved.



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