SA Water

Engineering

Technical Guideline TG0633

General Technical Information for Geotechnical Design - Coarse Geomaterials in Civil Works

Version: 2.0
Date: 16 September 2019
Status: ISSUED

Document ID: SAWG-ENG-0633

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Government of South Australia

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Significant/Major Changes Incorporated in This Edition

This is the first issue of this Technical Guideline under the new numbering format. The original version of the document was last published in 2007 with the name of General Technical Information for Geotechnical Design Part G – Materials (TG 10g). A full version history of this document is given in Document Controls. The major changes in this revision include the following items:

- Minor revision of Section 3 (formerly Section 2 in TG 10g)
- Minor revision of Section 4 (formerly Section 3 in TG 10g)
- Section 4 of TG 10g in not included in TG 0633.

Document Controls

Revision History

Revision	Date	Author	Comments
0	2004	Ed Collingham	First Issue of TG 10g
1	10/1/2007		Nil
2	16/9/2019	Moji Kan	Major Revision, Reformatting to TG 0633

Template: Technical Guideline Version 6.00, 10/05/2016

Approvers

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Contents

List of figures

1 Introduction

SA Water is responsible for operation and maintenance of an extensive amount of engineering infrastructure.

This guideline has been developed to assist in the design, maintenance, construction, and management of this infrastructure.

1.1 Purpose

The purpose of this guideline is to detail minimum requirements to ensure that assets covered by the scope of this guideline are constructed and maintained to consistent standards and attain the required asset life.

1.2 Glossary

The following glossary items are used in this document:

Term	Description
D_{50}	Mean diameter of the particles in particle size distribution chart
D_{100}	Maximum diameter of the particles in particle size distribution chart
PM2/20	20 mm quarry rubble, Class 2
PM3/40	40 mm quarry waste, Class 3
SA Water	South Australian Water Corporation
TG	SA Water Technical Guideline
TS	SA Water Technical Standard

1.3 References

1.3.1 Australian and International

The following table identifies Australian and International standards and other similar documents referenced in this document:

Number	Title
NA	

1.3.2 SA Water Documents

The following table identifies the SA Water standards and other similar documents referenced in this document:

Number	Title
NA	

1.4 Definitions

The following definitions are applicable to this document:

Term	Description
SA Water's Representative	The SA Water representative with delegated authority under a Contract or engagement, including (as applicable): • Superintendent's Representative (e.g. AS 4300 & AS 2124 etc.) • SA Water Project Manager • SA Water nominated contact person
Responsible Discipline Lead	The engineering discipline expert responsible for TG 0633 defined on page 3 (via SA Water's Representative)

2 Scope

The scope of this document is to provide guidelines for the selection of coarse granular geomaterials in design of the general civil works for SA Water infrastructure.

3 Rock Riprap for Erosion Control Works in Watercourses

This Section presents a general guideline on selection of riprap materials for protection of small watercourses against erosion. For erosion protection in large watercourses, e.g. for rivers revetment, a proper geotechnical engineering investigations and detailed design by a qualified engineer is required.

3.1 Riprap specification

Riprap shall consist wholly of hard, durable, dense natural rock. All stones in the riprap shall be well shaped, with no stone having a length more than 2.5 times its breadth or thickness (see Note 1 in Section 3.3).

The mean diameter (D_{50}) of the stone in the riprap shall be 400 mm (see Note 2 in Section 3.3) and the riprap shall be well graded (Note 3) in the size range of 150 mm minimum to 500 mm maximum (Note 4). In the context of this clause:

- "mean diameter" means the diameter of a spherical stone of equal mass, and
- "well graded" means a mix where any given size of stone fits comfortably in the voids between the next size up but does not keep them apart (also see Note 5 in Section 3.3).

3.2 Riprap placement

The minimum thickness of the riprap layer shall be not less than 1000 mm (see Note 6 in Section 3.3).

The riprap shall be placed such that all stones are well interlocked, no individual stones protrude out into the flow, and the voids between stones of any given size are filled with stones of progressively smaller size (Note 7).

3.3 Notes for Specifiers and Designers

1. Quartzite and dolomite riprap produced by most South Australian quarries usually has suitable durability, density and shape.

2. The mean diameter required is derived by engineering design for each application.

3. A "well graded" riprap for use in watercourse erosion control works (rock chutes or bank revetment) is a mix where any given size of stone fits comfortably in the voids between the next size up but does not keep them apart. Such a mix has good resistance to erosion and is "self-healing" in the event it is overstressed or undermined.

4. The size range required is derived by engineering design for each application.

5. With careful selection it is sometimes possible to use "shot rock" direct from the quarry floor. The cost savings can be considerable.

6. The minimum thickness of a layer of riprap should be not less than 2.5 times of D_{50}, or 1.25 times the maximum diameter of the stones in the mix (D_{100}).

7. Where the riprap is in a location where it is likely to be disturbed by children, an additional clause may be required, e.g.:

"The riprap shall be sorted with the smaller size stones underneath and the larger ones on the surface."

and/or

"The stones on the surface of the riprap shall be locked together by close-spaced spot grouting with concrete to the extent necessary to prevent them being plucked out."

8. Where stone of sufficiently large size is not available it may be appropriate to specify: "The effective maximum size of stone in the placed riprap shall be increased by spot grouting with concrete at one metre centres, using sufficient concrete at each spot to lock up the riprap over a diameter of 500 mm."

4 Rubble vs Waste in Trench Fills

SA Water normally specifies PM2/20 (20 mm quarry rubble) for the pipe trench fill. In 2003, in one of the SA Water projects, the contractor proposed to use a PM3/40 (40 mm quarry waste) instead, where the pipeline was in unsealed roads, and proposed also to use this material as the permanent road surface. In support of this proposal the contractor argued that the Council uses this same PM3/40 material to construct their unsealed road pavements and are happy that it forms the surface of our trench fill. There follows a discussion of the reasons why SA Water normally specifies PM2/20 (20 mm quarry rubble) and avoids 40 mm materials or quarry wastes.

4.1 Attributes for trench fill material

The desired attributes in a trench fill material (which are provided by the PM2/20 normally specified) are:

a. It must be easy to compact because:
   - In the confines of a trench, only fairly light compaction equipment **can be** used.
   - The pipe, which is only just below the trench fill, could be damaged or displaced by heavy compaction and so it is **desirable** that only light compaction equipment is used.

b. It must be fairly insensitive to moisture content because:
   - Stockpiles will be exposed to the weather for quite long periods and can easily become too wet or too dry for easy compaction.
   - An over-wet material will not dry out once in the trench because (a) a trench is a relatively sheltered environment, and (b) the layers of fill must be placed one immediately after the other so that the road can be put back in service at the end of each day. These restrictions do not apply in roadworks where, for example, a 100 mm layer of fill can be placed and then allowed to dry-back if necessary, before rolling.

c. If it is also required to form the final road surface, it must in addition:
   - Have enough clayey fines in it so that it binds and seals, but not so much that it becomes slick or sloppy when wet.
   - Be well graded over its whole size range so that it has good internal mechanical interlock between the particles and therefore resistance to rutting and unravelling.
   - Have well-shaped large size particles in it, not flat or elongated ones. If the large size particles are flat or elongated, they will often lie flat on the rolled surface rather than lock into it, and so will flick out easily under traffic.

4.2 Reasons for using rubble rather than quarry waste

The quarry rubble (PM2/20) is more favourable compared with quarry waste (PM2/40 or PM 3/40) because:

- Most 40 mm products (even Class 2 ones) often look like an otherwise well-graded 20 mm product with a few 40 mm particles thrown in.
- This is not a problem if the material is used only in the lower layers of the trench fill and then covered by a better material, but if it is brought right to the surface in an unsealed road the 40 mm particles can easily be flicked out by traffic.

Why class 2 material (quarry rubble) rather than class 3 (quarry waste)?

- Because the poorer grading of a Class 3 material makes it more difficult to compact.
- Because the higher % fines in a Class 3 material means that (a) compaction is likely to be more sensitive to moisture content, and (b) a road surface made of it is more likely to become slick or sloppy when wet.
- Because the large size particles in a Class 3 material can be poorly shaped (flat or elongated) and are therefore more likely to be flicked out of a road surface by traffic.

What were the characteristics of the material proposed by the contractor?

- It was a Class 3 material (quarry waste) not a Class 2 (quarry rubble) because (a) its % fines was too high, (b) it was too sandy, (c) it had too big a gap in the grading up to the largest size of stone, and (d) the largest size of stone had poor shape.
- If used as road surfacing it would display the performance shortcomings discussed above as being expected of a 40 mm Class 3 material (see Figure 1 below).

Figure 1: Illustration of Quarry Waste used as Road Surface.

4.3 Summary and recommendations

The PM3/40 material proposed by the Contractor did not meet neither the SA Water specification for trench fill material nor the performance characteristics intended to be achieved by that specification.