SA Water

SOUTH AUSTRALIAN WATER CORPORATION

TG 10g

TECHNICAL GUIDELINE

GENERAL TECHNICAL INFORMATION FOR GEOTECHNICAL DESIGN

~ Part G ~
Materials

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No Changes Required In the January 2007 Edition

The following lists the major changes to the November 2004 edition of TG 10g:

1. Nil

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Section 2: Rock Riprap for Erosion Control Works in Watercourses

Typical Specification Clauses and Explanatory Notes

2.1 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. (Note 1)

The mean diameter (D_{50}) of the stone in the riprap shall be 400 mm (Note 2) and the riprap shall be well graded (Note 3) in the size range 150 mm minimum to 500 mm maximum. (Note 4) In the context of this specification (1) "mean diameter" means the diameter of a spherical stone of equal mass, and (2) "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. (Note 5)

2.2 Riprap Placement

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

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)

2.3 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 twice the maximum mean diameter of stone in the mix.

(7) Where the riprap is in a location where it is likely to be disturbed by children an additional clause may be required, eg: “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 by children.”

(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.”

This “Technical Note” was prepared by Ed Collingham, 29/04/2003
(Ex Principal Engineer Geotechnical)

Section 3: Rubble VS Waste

SA Water normally specifies PM2/20 (20 mm quarry rubble) for all pipe trench fill. The contractor proposes instead to use a PM3/40 (40 mm quarry waste) where the pipeline is in unsealed roads, and proposes also to use this material as the permanent road surface. In support of this proposal the contractor argues that the Council uses this same PM3/40 material to construct their unsealed road pavements and are happy that it form 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. A recommendation is then made on the proposed use of PM3/40 in this specific case.

3.1 Attributes for Trench Fill Material

The attributes we are looking for 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.

3.2 Reasons for Rubble (PM2/20) Over Waste (PM2/40)

- 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 are the characteristics of the material proposed by the contractor?

- It is definitely a Class 3 material (quarry waste) not a Class 2 (quarry rubble) because (a) its % fines is too high, (b) it is too sandy, (c) it has too big a gap in the grading up to the largest size of stone, and (d) the largest size of stone has poor shape.
- When used as road surfacing it displays the performance shortcomings discussed above as being expected of a 40 mm Class 3 material. (See photo below.)

Figure 3.1 - Illustration of Quarry Waste used as Road Surface.

3.3 Summary and Recommendations

The PM3/40 material proposed by the Contractor meets neither the SA Water specification for trench fill material nor the performance characteristics intended to be achieved by that specification. Nevertheless a simple hand-remoulding test in the laboratory indicates that it is not unduly sensitive to moisture content despite its appearance. Also if, as suggested, it is the same material that the Council use to construct their unsealed roads and they are happy for us to use it, then it could be given favourable consideration **in this case only**. It is recommended however that it be confirmed that this is the material that the Council uses, and also that the contractor achieves the specified density in the trench fill without risking damage to the pipe.

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(Ex Principal Engineer Geotechnical)

Section 4: Particle Size Distribution (PSD)

There are two spreadsheets available for Particle Size Distribution (PSD) Plots. The original was developed by Coffey and then altered by Collingham, they are a tool to aid in material specifications and general design, last revised, 21/12/2001. They are available in the database.