ENGINEERING GUIDELINE

SELECTING MATERIALS FOR BEDDING STEEL REINFORCED CONCRETE PIPE

Concrete Pipe and Precast
Association of Australasia

INTRODUCTION

The Standard **AS/NZS 3725 – 2007 "Design for installation of buried concrete pipes"** includes details of the material (select fill) required to achieve minimum compaction levels that are aligned with the various support types recommended for steel reinforced concrete pipe. The document outlines some very strict grading requirements for the material required for the construction of bed and haunch zones (Table 6, AS/NZS 3725) and side zones (Table 7, AS/NZS 3725). It also nominates specific compaction levels that are needed to achieve the appropriate bedding factor for each support type.

Whilst it is expected that materials graded in accordance with the Standard are used on site so as to achieve the design requirements, often they may not be readily available or are difficult to source. As a result many concrete pipe drainage projects in Australia and New Zealand are being compromised or delayed due to the unavailability of material, the wrong material being used, and/or inappropriate compaction levels being achieved. This Engineering Guideline will provide industry with some alternatives to consider when the selected fill materials and corresponding grading limits outlined in AS/NZS 3725 cannot be sourced or achieved, without compromising the bedding factor associated with the designed support type.

BACKGROUND

The requirements for the material selection, or select fill, for bedding construction have been in place in AS/NZS 3725 since 1989. Select fill is defined in the Standard as:

"The material obtained from excavation of the pipe trench or elsewhere with a particle size not greater than 75 mm, and which conforms with the soil classes given in Table 1."

Table 1 of AS/NZS 3725 nominates the types of soils that can be utilised for bedding, which are taken from AS 1726 "Site Investigations". These are outlined in Table A below.

For concrete pipe installation it is envisaged that select fill is utilised in the construction of the bed, haunch and side support zones of any trench or embankment embedment condition. "AS/NZS 3725" nominates associated bedding factors with these zones, depending on the support type, and these are reliant on the contractor achieving the nominated compaction levels in the bed, haunch and side zones for that support. This is where the grading limits for the select fill AS/NZS 3725 must be considered. Any material outlined in Table A below that does not comply with the grading limits outlined in Table 6 (for bed and haunch zones) and Table 7 (for side zones) of AS/NZS 3725 are considered inappropriate to achieve these compaction levels.

ABBREVIATION	DESCRIPTION
SC	Clayey sands with fines of low plasticity
SP	Poorly graded sands
SW	Well-graded sands
GC	Clayey gravels with fines of low plasticity
GW	Well-graded sand and gravel mixtures with little or no plastic fines
GP	Poorly graded sand and gravel mixtures with little or no plastic fines

Table A: Table 1 from AS/NZS 3725: soil classes as defined in AS 1726

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In recent times it has become evident that industry is paying greater attention to the specification and installation of concrete pipe to AS/NZS 3725. As a result contractors have discovered that sourcing the fill materials required to meet these grading demands is not simple, or in many instances, not available. This can result in the wrong material being sourced or inappropriate blends being mixed, resulting in voids and gaps in the bedding, or incorrect compaction taking place. When this occurs there is a good chance that the designed bedding factors are not being achieved.

NOTE: For example, when mixing expensive blended fill materials to achieve the required grading levels, often this will result in a more difficult to compact fill compared to a good quality, readily available material that may not comply strictly with the grading limits in the Standard.

AS/NZS 3725 recognises that the nominated compaction levels outlined may not always be reached, or that different materials, where grading does not comply with the Standard, may be required to embed the pipe. In these instances the Standard permits a reduction of the bedding factor, as per Clause 9.3.2 AS/NZS 3725 which states:

- Where the fraction passing the 0.6 mm sieve is outside the limits, and is not cement stabilized, the bedding factors shall be 1.5.
- For material outside the limits of other sieve sizes, any maximum bedding factor shall be reduced by 15%.

However, this can be limiting to the designer, the contractor, and the manufacturer, particularly when other practical options may be available that may not compromise the bedding factor for the designed support type when compacted appropriately.

OTHER STANDARDS

Many Standards, both local and overseas, that reference bedding supports systems, acknowledge a preference for a well graded granular based material. However, unlike AS/NZS 3725, they do not limit the use of a wide range of materials with little or no plastic fines content. Such Standards recognise the importance of the support stiffness required by material type (typically measured by compaction), side fill support, voids in compacted material and the potential migration of fines into these voids (causing long term support degradation), and the need to carefully specify, detail, construct and test the installation to a level consistent with the material used and the geotechnical characteristics of the site.

IN PRACTICE

As noted, AS/NZS 3725 can be restrictive with regard to the selection of suitable materials for the construction of concrete pipe bedding support systems. Other relevant standards use a wide range of soil materials in bedding support systems, requiring different compaction standards and design, testing and quality control initiatives.

Anecdotal evidence would suggest that the use of "non-complying" materials, when installing concrete pipe, has always occurred. With modern procedures requiring formal "sign off' of installation to AS/NZS 3725, it has highlighted the restrictive use of materials within the stormwater drainage industry, but at what cost?

Complying materials can be very difficult to source and/or are more expensive than perfectly suitable alternatives that are often easier to compact. Appropriateness of these materials can be confirmed as suitable by:

- Implementing sound construction and quality control plans
- Conducting field trials to demonstrate required compaction standrds can be achieved
- Reviewing and preparing design to mitigate the potential migration of fines (i.e. including geotextiles)

BEDDING TYPE	HS3		HS2		HS1		H2		H1	
Bedding Material	I_D	R_D	I_D	R_D	I_D	R_D	I_D	R_D	I_D	R_D
SW, SP, GW, GP	70	95	60	90	50	85	60	90	50	85
SC, GC	n/a	n/a	70	95	60	90	70	95	60	90

Table B: Minumim compaction requirements for various bedding types and select fill soil classes

NOTES:
1. I_D refers to Density Index (%) and is for cohesionless materials (refer to Clause 8, AS/NZS 3725 for more information).
2. R_D refers to Dry Density Ratio (%) and is for cohesive materials (refer to Clause 8, AS/NZS 3725 for more information).

With sound construction and geotechnical input, an innovative and cost effective bedding support solution, consistent with the bedding factors outlined in AS/NZS 3725 to achieve design requirements, can be achieved.

RECOMMENDATION

In addition to the detailed requirements of AS/NZS 3725, the CPPAA provides the following guidelines for the selection of fill material to be utilised when selected fill in accordance to the Standard is difficult to source or work with:

General requirements for use of materials – Select fill complying with the generic soil classes as defined in AS 1726 and shown in Table 1 of AS/NZS 3725 (refer to Table A of this document), but not complying with the particle size distribution of Tables 6 and 7 of AS/NZS 3725 may be used in the bed, haunch, and side zone, provided that:

a) It can be demonstrated through construction plans, quality control plans, and field trials that the degree of compaction shown in Table B of this guideline, corresponding to the selected bedding type and material, can be achieved, and,

b) Methods to prevent migration of soil fines from or into the bedding material shall be provided when ground water movement or existing soil and bedding conditions are conducive to particle migration, and,

c) Long thin particles are not used (despite complying with the grading standards), due to their angular shape which increases the risk of stress on the pipe due to inadequate or non-uniform bedding, and,

d) Maximum particle size of select fill materials in bed, haunch, and side zones shall not be greater than the recommended limits given in Table C, or so selected to ensure uniform support around the pipes, and prevent concentrated point loading.

Alternatively, if a) to d) inclusive cannot be achieved, the bedding material must be cement stabilised.

PIPE DIAMETER	BEDDING ZONE	
DN	Bed and Haunch	Side
225 - 1350	20	40
1500 - 2250	40	75
> 2250	65	75

Table C: Recommended maximum particle size (mm)

NOTES: If the requirements for the above recommendations are met, the bedding factor reduction outlined in AS/NZS 3725 Clause 9.3.2will not apply. However, as in accordance with AS/NZS 3725 Clause 9.3.3, bedding factors will be reduced in line with the Standards recommendations if the conditions prescribed for the use of these materials cannot be demonstrated or achieved.

APPENDIX A

To assist in the reading of the and analysis Engineering Guideline, Tables 6 and 7 from AS/NZS 3725 – 2007 are found below:

SIEVE SIZE MM	WEIGHT PASSING %
19.0	100
2.36	100-50
0.60	90-20
0.30	60-10
0.15	25-0
0.075	10-0

Table AA: Table 6 - Grading limits for select fill in bed and haunch zone

NOTES: Acceptable material within the above grading limits would result in material that is well graded and free draining. Granular material that may exhibit these qualities but would break down when wetted, such as shale or gravely conglomerates, are not suitable materials and shall not be used.

SIEVE SIZE MM	WEIGHT PASSING %
75.0	100
9.5	100-50
2.36	100-30
0.60	50-15
0.075	25-0

Table AB: Table 7 - Grading limits for select fill in side zone

NOTES: Acceptable material within the above grading limits would result in material that is well graded and free draining. Granular material that may exhibit these qualities but would break down when wetted, such as shale or gravely conglomerates, are not suitable materials and shall not be used.

DISCLAIMER: The Concrete Pipe and Precast Association of Australasia believes the information given within this brochure is the most up-to-date and correct on the subject. Beyond this statement, no guarantee is given nor is any responsibility assumed by the Association and its members.