Notes to Structural Design of Buried Bosspipe Lines

Bosspipe lines are classified as flexible pipelines, structural design of which relies upon side support to resist vertical loads without excessive deformation. Detailed practice for the structural design of buried flexible pipelines is given in AS/NZS 2566.1 and its Supplement.

The structural performance of Bosspipe is dependent on pipe characteristics, properties of native soil and embedment material, external and internal loadings.

According to AS/NZS 2566.1, structural design of buried flexible pipelines is based on assurance that calculated vertical pipe deflection, ring strain, ring stress and buckling resistance do not exceed the allowable values. For polyethylene and polypropylene pipes, allowable long-term vertical deflection for non-pressure pipelines is 7.5%, allowable long-term ring-bending strain is 4.0%.

AS/NZS 2566.1 uses ring-bending stiffness as basis for structural design. Three classes of nominal stiffness of Bosspipe pipes are as follows:

- CivilBoss SN16 (“Civil 16”) - minimum nominal stiffness of 16000 N/m/m,
- CivilBoss SN8 (“Civil 8”) - minimum nominal stiffness of 8000 N/m/m,
- FarmBoss, typically SN6 - minimum nominal stiffness of 6000 N/m/m.

Typical embedment geometry is shown on Figure 1 and Table 1 (based on requirements of AS/NZS 2566.1).

Table 1. Minimum embedment zone dimensions

millimetres

Bosspipe size	Minimum dimension		
	l_b	l_c	l_o
DN225	100	150	100
DN300	100	200	150
DN375	100	200	150
DN450	150	300	150

B - trench width measured at springline of pipe.

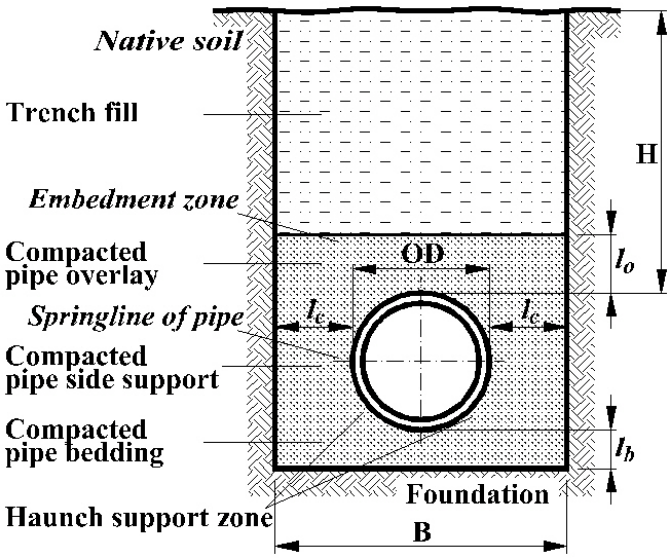

Figure 1. Typical installation in a trench

Trench width shall be sufficient for placement and compaction of embedment materials, and for making and inspection of joints. To minimise the load on the pipe, the trench width should be kept as close to the specified minimum as possible.

Typical embedment material is gravel or coarse aggregate. The embedment material shall be free of organic materials and of other materials that would be harmful to a pipe or rubber ring (e.g., mineral oils, fuels, etc.). The recommended maximum particle size is 14 mm, and it shall not be over 20 mm. For better compaction, we recommend that content of fines should not exceed 12%, preferably less than 5%.

In structural design of buried flexible pipelines, soil support is expressed in terms of combined soil modulus of embedment material and native soil. AS/NZS 2566.1, Table 3.2, gives typical values of embedment material modulus (E'_e) and native soil modulus (E'_n) for different types of soils and degrees of compaction of embedment material (see Table 2).

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Table 2. Embedment and native soil - materials and moduli*

Materials			Moduli E'_e and E'_n, MPa				
Description	Classification		Uncompacted	Dry density ratio R_D (%)			
				85	90	95	100
				Density index I_D (%)			
				50	60	70	80
	AS 1726†	AS 2758.1	Standard penetration test ‡ Number of blows				
			≤ 4	> 4 ≤ 14	>14 ≤ 24	>24 ≤ 50	> 50
Gravel-single size	-	} Coarse aggregate	5§	7§	7§	10§	14
Gravel-graded	GW		3§	5§	7§	10§	20
Sand and coarse-grained soil with less than 12% fines	GP, SW, SP and GM-GL, GC-SC, etc.	-	1	3§	5§	7§	14
Coarse-grained soil with more than 12% fines	GM, GC, SC SM and GM-SC, GC-SC	-	NR	1§	3§	5§	10
Fine-grained soil (LL<50%) with medium to no plasticity and containing more than 25% coarse-grained particles	CL, ML, mixtures ML-CL and ML-MH	-	NR	1§	3§	5§	10
Fine-grained soil (LL<50%) with medium to no plasticity and containing less than 25% coarse-grained particles	CI, CL, ML, mixtures ML-CL, CL-CH and ML-MH	-	NR	NR	1	3	7
Fine-grained soil (LL>50%) with medium to high plasticity	CH, MH and CH-MH	-	NR	NR	NR	NR	NR

* Values apply for covers to 10.0 m and are conservative for greater covers.

† See Appendix A of AS 2566.1 Supp 1.

‡ For native soils only. See AS 1289.6.3.2.

§ These values are the more commonly used and achieved in practice.

NR = No reliable modulus values for these materials. May be appropriate where external load is nominal or where evaluation permits its use.

NOTES:

1 Values are conservative as they contain a reduction in modulus, which occurs when the ground water is above the pip. Allowance can be made for dry ground conditions. (See AS/NZS 2566.1 Supp 1.)

2 Where appropriate, geotextile is to be placed between native soil and embedment material to prevent migration of fines.

3 Where stabilized materials are used the designer shall determine values E'_e for the specified material.

Source: AS/NZS 2566.1, Table 3.2.

Guide to the description and identification of soils is given in AS/NZS 2566.1 Supplement 1, Appendix A, or AS 1726. For example, ''SM'' group includes silty sands and sand-silt mixtures (particle size ~0.2 mm), ''SC'' group includes clayey sands, sand-clay mixtures (particle size ~0.075-0.1 mm), ''CL'' and ''CI'' groups include inorganic clays of low to medium plasticity and medium to high dry strength, and so on.

The flexible pipelines are installed at a depth exceeding the minimum pipeline cover *H* (see Fig. 1) given in Table 3 (requirements of AS/NZS 2566.2). Note that some pipes may not be suitable at the minimum cover given in Table 3 when buried in soil with low soil modulus in conditions of extensive traffic loading. Suitability of a pipe for the design cover and site conditions shall be evaluated based on AS/NZS 2566.1.

Table 3. Minimum cover (*H*)

Loading condition	***H**** , m
Not subject to vehicle loading	0.30
Land zoned for agricultural use	0.60
Subject to vehicular loading –	
(a) no carriageway;	0.45
(b) sealed carriageways; and	0.60
(c) unsealed carriageways	0.75
Pipelines in embankments or subject to construction equipment loads	0.75

* Under cultivated agricultural land ***H*** should not be less than 0.6 m. Railway crossings are covered by other requirements.

Maximum pipeline cover depends on soil type, embedment material, degree of compaction, as well as on pipe characteristics. Graphs on Figures 2 to 4 may serve as a guide (with increase of native soil modulus, the soil conditions change from unstable ground to rock). The graphs for Bosspipe lines are prepared based on recommendations of AS/NZS 2566.1 (construction equipment loads, external hydrostatic loads, superimposed dead loads, temperature effects, soil subsidence and differential settlement, are not taken into account; traffic loadings in shallow cover conditions may exceed buckling resistance).

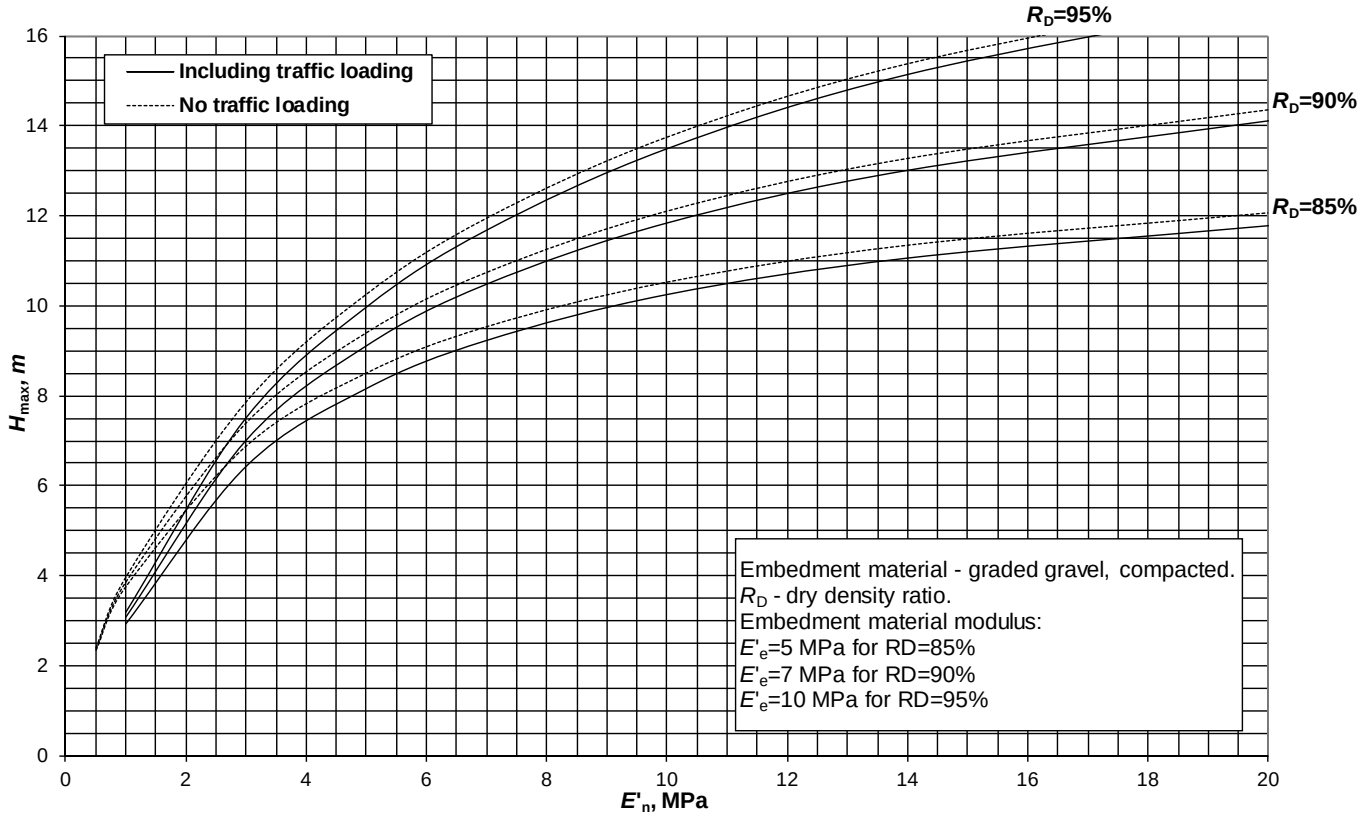

Figure 2. Typical maximum cover H_{max} for CivilBoss SN16 pipe (no internal pressure or vacuum) for different combinations of native soil modulus E'_n and embedment material compaction.

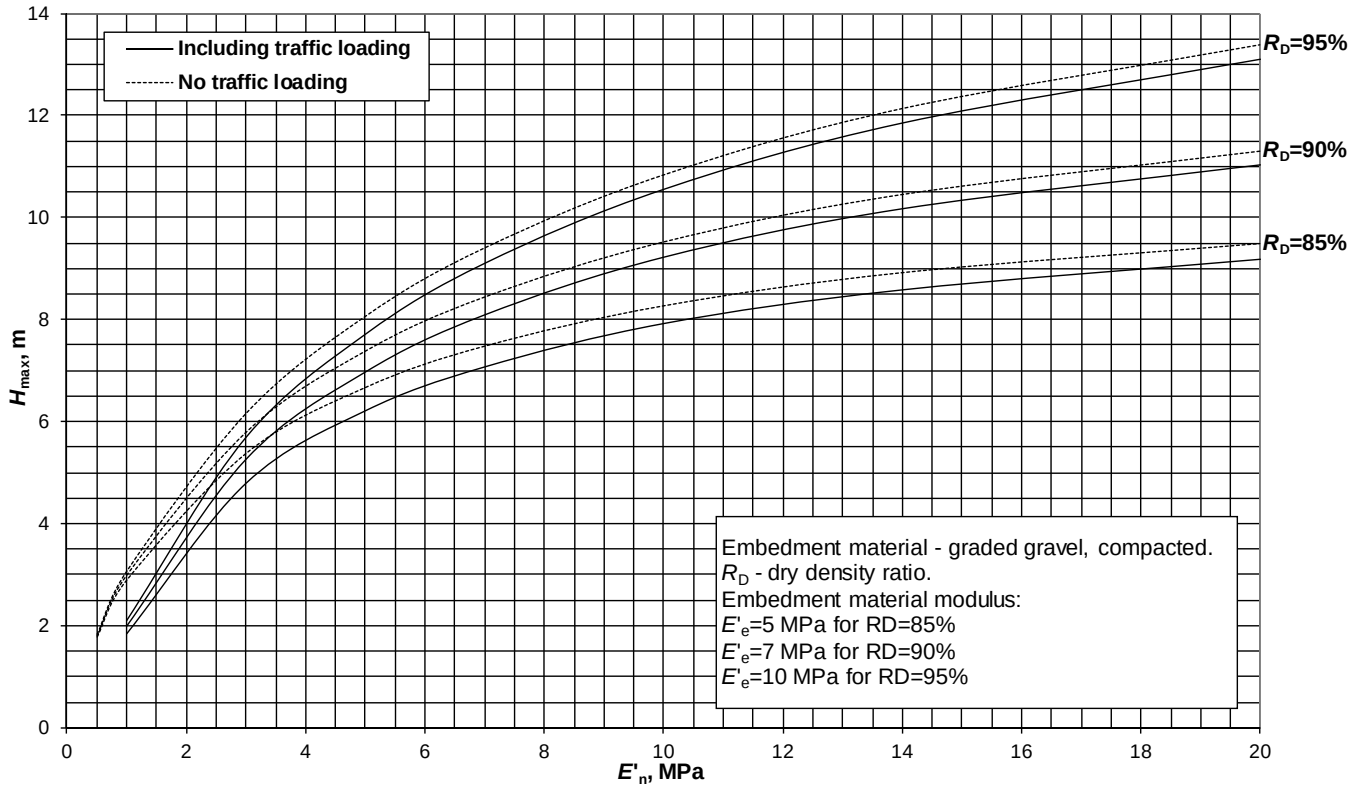

Figure 3. Typical maximum cover H_{max} for CivilBoss SN8 pipe (no internal pressure or vacuum) for different combinations of native soil modulus E'_n and embedment material compaction.

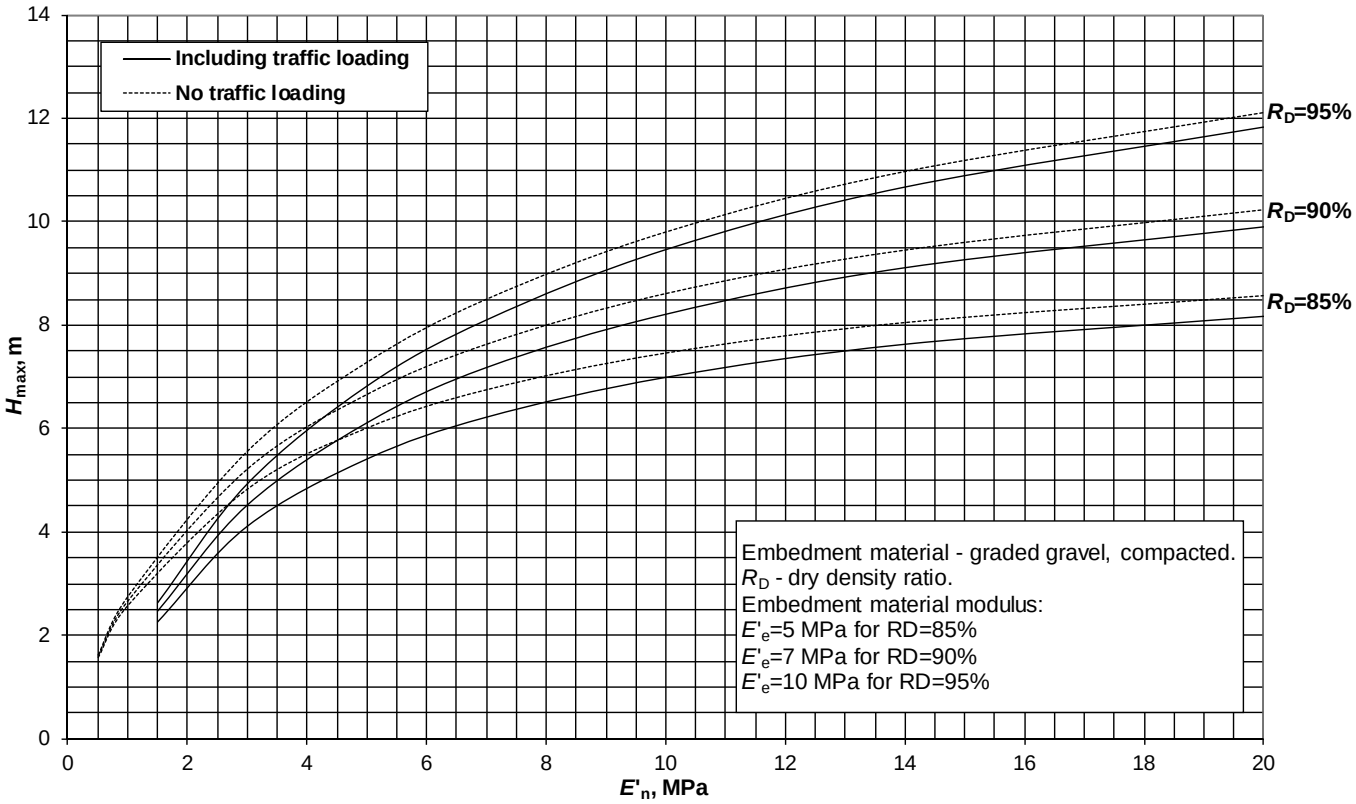

Figure 4. Typical maximum cover H_{max} for FarmBoss SN6 pipe (no internal pressure or vacuum) for different combinations of native soil modulus E'_n and embedment material compaction.