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Project Report

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Chapter 1. Introduction

1.1 Preliminary Discussion

In general, flexible pipes rely upon their deformation from imposed loads to mobilize the support of embedment material on both sides of the pipe. Their primary structural function is distributing the imposed vertical loads to the surrounding soil. Only a small portion of the imposed loads are actually carried by the flexible pipe itself. Instead, load is transferred to the surrounding bedding material.

On the other hand, in a case of a rigid pipe all the loads have to be resisted by the pipe. This simply means that in case of overloading the flexible pipe simply deforms further whilst the rigid pipe fractures (see **Figure 1**).

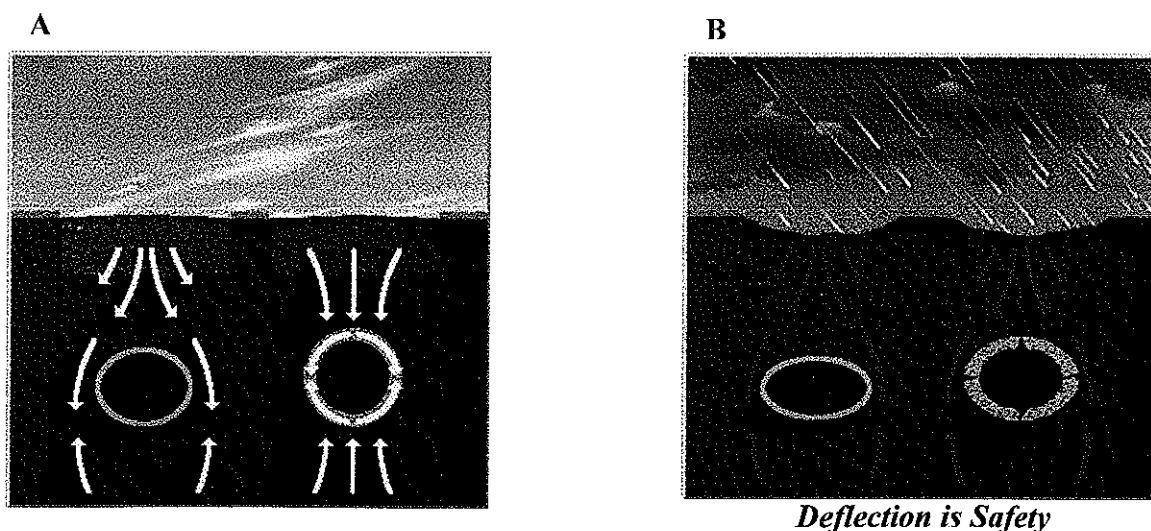


Figure 1-1: Flexible pipes are shown on the left of illustration A and B, with rigid pipes shown on the right. Illustration B demonstrates the effects of overloading in which flexible pipe simply deforms further whilst the rigid pipe fractures.

The Weholite pipe and the enveloping soil mass, working in tandem as a composite unit, is one of the most remarkably synergistic systems in engineering. When the soil is properly compacted around the pipe, the load-carrying capacity of the pipe-soil system far exceeds the individual capacity of either component by itself.

1.1.1 Chemical Resistance

Few materials offer better over-all resistance to corrosive acids, bases and salts. In addition polyethylene is unaffected by bacteria, fungi or even aggressive naturally occurring soils. It has good resistance to many organic substances, such as solvents and fuels. Polyethylene piping does not rust, rot or corrode like traditional metal or concrete piping. It is not subject to galvanic or hydrogen sulfide corrosion.

1.1.2 Life of Weholite

Weholite pipe is a HDPE pipe (high density polyethylene pipe). HDPE is a very durable material with a long history of use for water and gas pipelines amongst many other applications. Long term studies over two years have so far shown no brittle behaviour for HDPE 80 material (production material for Asset). On the basis of these results a minimum service life over 100 years at operating temperatures of 20 ° C to 40 ° C can be predicted from pipes made of this material. Bearing in mind that the temperature of a buried pipe is around 4 ° C, the design life of the pipe can be easily predicted over 120 years.

1.2 Abrasion of Weholite

In the so-called Darmstadt abrasion test (DIN v. 19534, part 2), samples of commonly used pipe materials were filled with a mixture of sand and water, and then subjected to a specified number of rocking cycles. The amount of abraded material was measured at regular intervals. The result indicates that high density polyethylene has the highest abrasion resistance properties of all the common pipe materials.

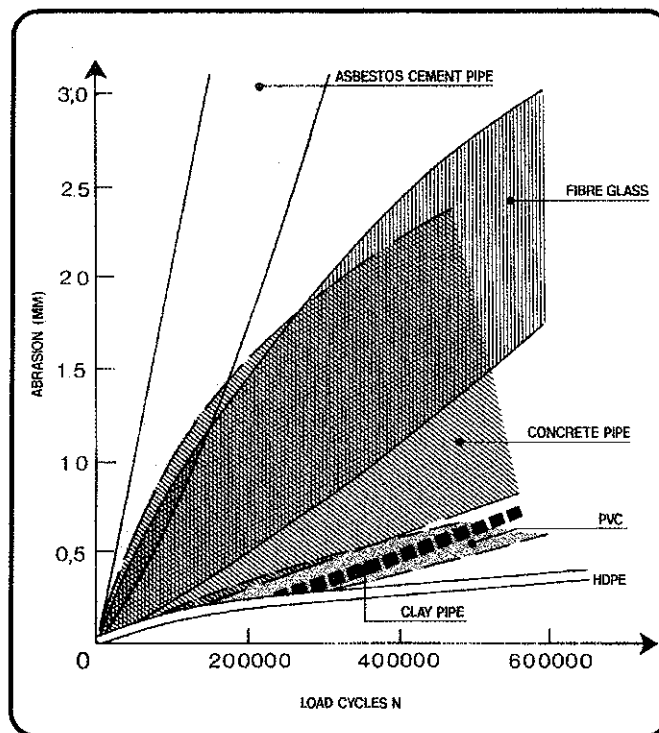


Figure 1-2: HDPE abrasion resistance.

As it is indicated in the above figure, HDPE pipe has the best abrasion resistance in comparison with the rest of typical materials that are commonly used for pipelines.

1.3 Hydraulic Design

Weholite pipes are suitable for gravity and low pressure applications. The corrosive and abrasion resistant properties of HDPE provide a very durable pipe. Polyethylene does not readily bond with or adhere to other materials. Siltation and sliming do not occur in the way they do in other materials such as concrete and GRP, and long term flow characteristics remain constant. The Roughness Coefficient (k_s) for the Colebrook formula of 0.03mm and the Manning's value (n) of 0.01 has been obtained by full scale field hydraulic measurements.

1.4 Temperature Range

Polyethylene has very good characteristics, such as impact strength, at low temperatures. It is the preferred material for operating temperatures below -40°C. The highest permissible service temperature for a polyethylene pipe depends upon the duration and magnitude of stresses upon the pipe. Generally, 60°C is the typical maximum service temperature. However, some non-pressure applications can be used up to 80°C.

1.5 Biological Resistance

Biological attack can be described as degradation caused by the action of microorganisms such as bacteria and fungi. Virtually all plastics are resistant to this type of attack. Once installed, polyethylene pipe will not be affected by microorganisms, such as those found in normal sewer and water systems. Polyethylene is not a nutrient medium for bacteria, fungi, spores, etc.

1.6 Project Objectives

The main objective of this report is to summarize the theoretical calculations for the proposed Weholite. The particular project consists of a multi leg 1200mm I/D Weholite pipeline with approximate cover of 0.835 m on top.

The main scope of the present report is to demonstrate that the Weholite pipe is suitable for the given application.

1.7 Project Outline

The present chapter presents a preliminary discussion about the Weholite pipe and its main characteristics such the design life and the chemical resistance as well as soil-pipe interaction.

Chapter 2 aims to provide the reader with an overview of the BS EN 1295 : 1998 calculations.

Chapter 3 provides the flotation calculations for the proposed Weholite scheme.

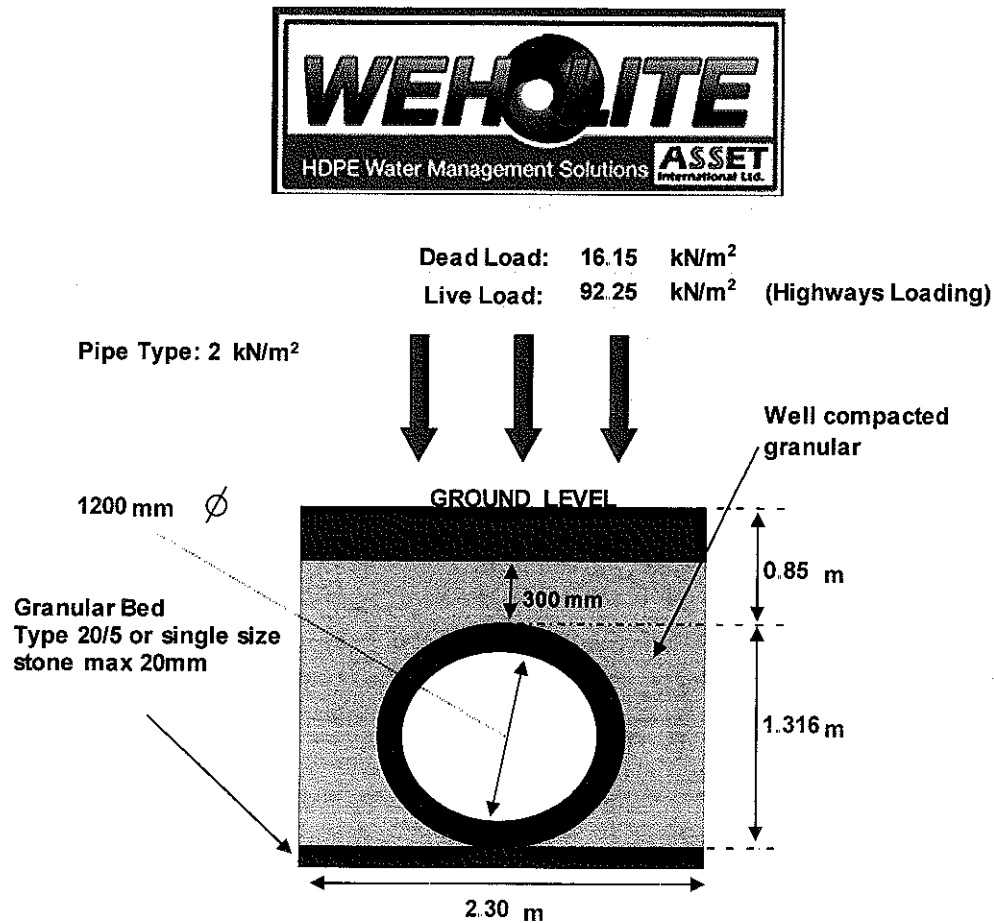
Chapter 2. BS EN 1295 : 1998 Calculations

2.1 Introduction

In the present chapter, calculations according to BS EN 1295 will be presented. This BS includes calculation for the pipe deflection and buckling stability. They based on Spangler formula similar to all the international standards that refer to plastic pipes. The BS set as maximum limit for deflection the 6% and the F.O.S against buckling is 2. The corresponding Finnish standard allow maximum deflection up to 8% and extensive tests has proved that buckling occur in deformations more than 25%.

2.2 Calculations

The calculations for the particular scheme are presented below



Calculations according to BS EN 1295 - 1 : 1998

Pipe Zone - From Table NA.6 [E' 2] :	10000	kN/m ²	
Guide Values of Modulus for Native Soil [E' 3] :	5000	kN/m ²	
Soil Type as in Table NA.1			
Overall Soil Modulus [E'] :	6197	kN/m ²	{ Equation 16 }
C _L :	0.619681		{ Equation 17 }
Initial Deflection:	2.28%		{ Equation 23 }
Long Term Deflection:	2.36%		Note: Initial Deflection using DL set at 1.0 < 6% O.K
Total vertical external pressure:	108.404	kN/m ²	{ Equation 15 }
Long term critical pressure:	165.792	kN/m ²	
Short term critical pressure:	261.965	kN/m ²	
F.O.S against buckling:	2.224	{ Equation 21 }	> 2 O.K
Deflection Test:	PASSED		
Buckling Test:	PASSED		

To the best of our knowledge, information and belief, based on the information provided, we believe that Weholite Pipe is suitable for the intended application. As Asset International Ltd has no control over the design, installation and application of Weholite Products, we would remind you that it remains the responsibility of the customer to ensure that products are suitable for a given application.

COMMENTS FOR STRUCTURAL CALCULATIONS

The above calculations demonstrate that the Weholite pipe is suitable for the particular applications since the deflections and the F.O.S are well inside the acceptable limits.

Chapter 3. Flotation Calculations

3.1 Introduction

A buried pipe may be subjected to flotation from high groundwater levels around the pipe. Flotation may occur when the ground water around the pipe produces a buoyant force greater than the download force of the soil prism above the pipe plus the weight of the pipe and its contents.

In general, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be of significant concern. A quick rule of thumb is that when buried in common saturated soil with at least one and one half pipe diameters of cover, pipe is generally not subject to groundwater flotation

3.2 Flotation Calculations for the Proposed Scheme

Although the water table is very low and therefore flotation is not an issue, in the present section we have attached flotation calculations for the minimum cover (0.45 m) with the level of underground water table at the crown of the 1350 mm I/D Weholite pipe.



FLOTATION CALCULATIONS

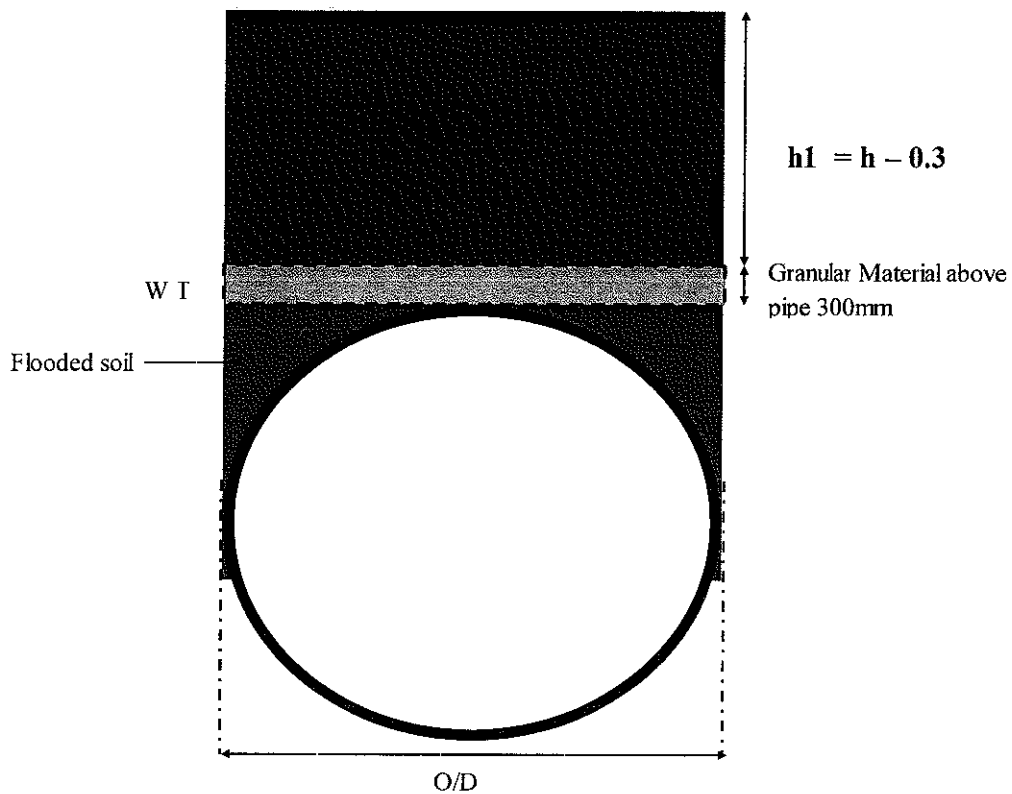
Pipe Characteristics

Ring Stiffness Class: 2 kN/m²

Pipe I/D: 1.200 m

Pipe O/D: 1.316 m

Depth of cover h: 1.000 m



Assumed values:

w_d : Specific weight of dry soil: 1800 kg/m³

w_G : Specific weight of ground water: 1000 kg/m³

w_{gm} : Specific weight of granular material: 2000 kg/m³

Note: The calculations based on the assumption that the pipe is empty

Theory:

The uplift force of the pipe can be calculated as

$$F_{up} = W_G \frac{\pi}{4} OD^2 \quad (1)$$

The downforce can be calculated as

$$F_{down} = W_p + W_l + W_f + W_d \quad (2)$$

W_d : Weight of dry soil

W_l : Weight of liquid (0 in the present case)

W_f : Weight of flooded soil

W_p : pipe weight

$$F.O.S = \frac{F_{down}}{F_{up}} \quad (3)$$

Calculations:

$$(1) \rightarrow F_{up} = 1360.2 \text{ kg / m}$$

$$\left. \begin{aligned} W_f &= A_{flooded_soil} * w_G \quad (4) \\ A_{flooded_soil} &= \left[OD^2 - \pi \left(\frac{OD}{2} \right)^2 \right] / 2 \quad (5) \end{aligned} \right\} W_f = 185.85 \text{ kg / m}$$

$$W_d = W_{Dry_soil} + W_{Granular_material} \quad (6)$$

$$W_{Granular_material} = A_{granular} * w_{gm} = (OD * 0.3) * 2000 \Rightarrow W_{Granular_material} = 789.6 \text{ kg / m} \quad (7)$$

$$W_{Dry_soil} = A_{dry_soil} * w_d = (OD * h_1) * 1800 \Rightarrow W_{Dry_soil} = 1658.16 \text{ kg / m} \quad (8)$$

$$\left. \begin{aligned} (7) \\ (8) \end{aligned} \right\} (6) \rightarrow W_d = 2447.76 \text{ kg / m}$$

$$W_p = 67 \text{ kg / m } \textcircled{9}$$

$$\textcircled{2} \xrightarrow{\textcircled{4} \text{ } \textcircled{6} \text{ } \textcircled{9}} F_{\text{down}} = 2700.61 \text{ kg / m}$$

$$\textcircled{3} \longrightarrow \text{F O S} = \underline{1.99}$$

To the best of our knowledge, information and belief, based on the information provided, we believe that Weholite Pipe is suitable for the intended application. As Asset International Ltd has no control over the design, installation and application of Weholite Products, we would remind you that it remains the responsibility of the customer to ensure that products are suitable for a given application.

COMMENTS FOR FLOTATION CALCULATION

3.3 Concluding Remarks

During this report every possible effort has been made to ensure that the information is comprehensive and accurate. In Asset's opinion, efficient work has been done in order to provide a complete picture of the theoretical calculations for the proposed Weholite scheme. The floatation report above as calculated the water table at the crown of the pipe however your SI report shows the ground water level at just 180mm below ground level, this will reduce the F.O.S to just 0.8. By increasing the cover to 1.0 meter will counter act the floatation issues as shown in the floatation calculation above.

Asset International Ltd

