ASSET
International Ltd.

Stephenson Street, Newport, Gwent. NP19 4XH
Web Site www.weholite.co.uk E-mail paul.oregan@weholite.co.uk
Direct Tel: 01633 637509 Fax: 01633 290519
Our Ref: POR-2353 29/01/2010

BSP Consulting

Tel: 0116 204 7766
Fax: 0116 204 7769

For the attention of :- Paul Garton

Gorby Road

Further to your recent enquiry, we now have the pleasure in forwarding our quotation as hereunder.

DEVELOPMENT SERVICES
11 FEB 2010
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Weholite HDPE Pipe Class: 2 kN/m²

Qty	Internal Diameter
87.5m	1200mm Dia Weholite Pipe
11No	1200mm Dia Tee Kay Couplers
3No	1200mm Dia 90Deg Bends
3No	1200mm Dia Access Shafts
4No	1200mm Dia Tee Sections
2No	1200mm HDPE Puddle Flanges
1No	675mm Dia Stub
4m	GRP Ladders

Total Material Cost: £23,842.00

Carriage Cost: £1,098.00

Extra Over

150mm stubs	£209.00ea
225mm stubs	£209.00ea
300mm stubs	£241.00ea
400mm stubs	£298.00ea
450mm stubs	£298.00ea
GRP Ladders	£80.00mtr

Pipe Lengths

The quotation is based on the use of **14mtr pipe lengths**. Should the pipe length or any other details change, we reserve the rights to revise our price.

ASSET

Delivery
Pipes are available in any length up to 14 m. Prices include for delivery by road to the nearest hard site or depot. The contractor shall be responsible for handling and offloading at site.

Installation
The contractor will be responsible for installing the pipes in accordance with Asset's installation guidelines provided on the working drawing.
The pipes are fixed together using the Flexseal Coupling Bands supplied.

Additional Works
Additional Works requiring site fabrication will be charged at £675.00 per day

Delays and Non-Conformance
Our price is based on pipes installed in accordance with Asset's installation guidelines, and assumes unhindered access into the pipes for our welding team.

Delays to the welding operation caused by the contractor may be subject to a charge of £84.00 per hour.

General
The prices quoted are those currently in effect. The prices invoiced will be those ruling at the time of despatch from our works.

PRICES VALID FOR 30 DAYS

VAT:
Prices shown do not include United Kingdom VAT., which will be charged separately on our invoice.

Terms of Payment:
Nett cash 30 days from date of invoice for approved accounts. Our full terms and conditions are attached.

Please do not hesitate to contact us again if you have any further queries.

Yours faithfully

Paul O'Regan
Technical Sales Enginer

DEVELOPMENT
SERVICES
11 FEB 2010
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WEHOLITE
HDPE Water Management Solutions
ASSET International Ltd.

Project Report

Groby Rd - Leicestershire

Stephenson Street
Newport
South Wales
NP19 4XH

01/02/2010

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**).

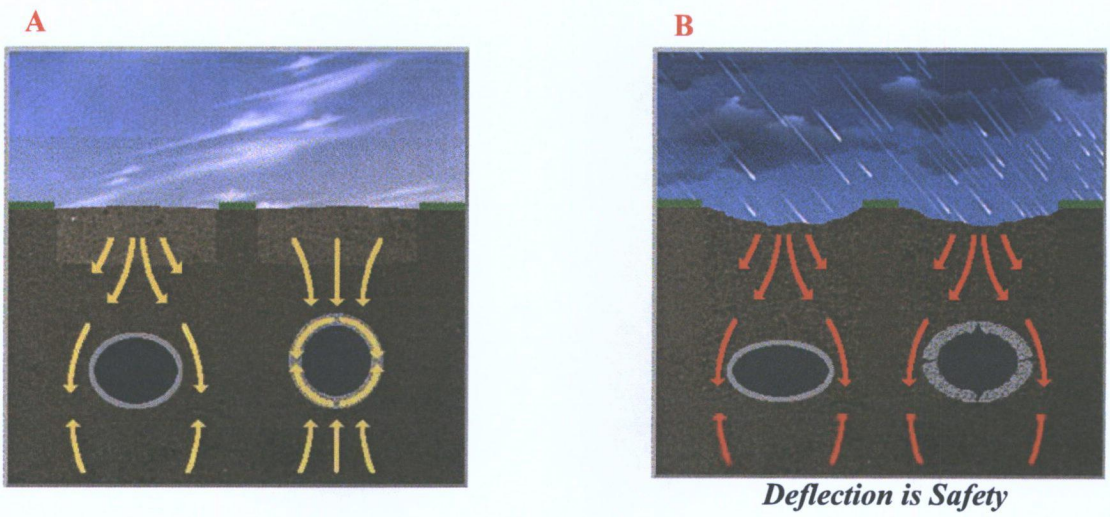


Figure 1-1: Flexible pipes are shown on the left of illustration A and B, with rigid pipes shown on the right. Illustration B demonstrates the effects of overloading in which flexible pipe simply deforms further whilst the rigid pipe fractures.

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.

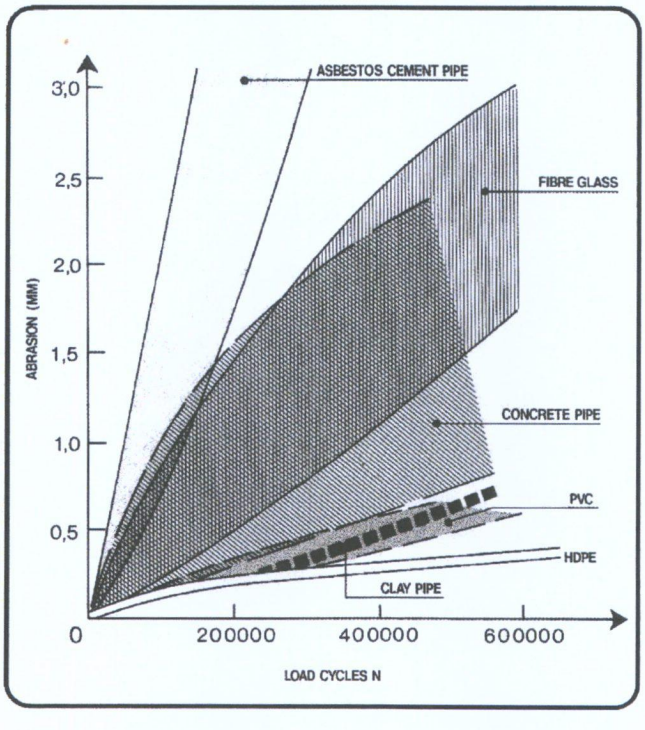


Figure 1-2: HDPE abrasion resistance.

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 micro-organisms, 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 tank of 1200mm I/D Weholite pipe with an approximate cover of 1 m cover on the 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

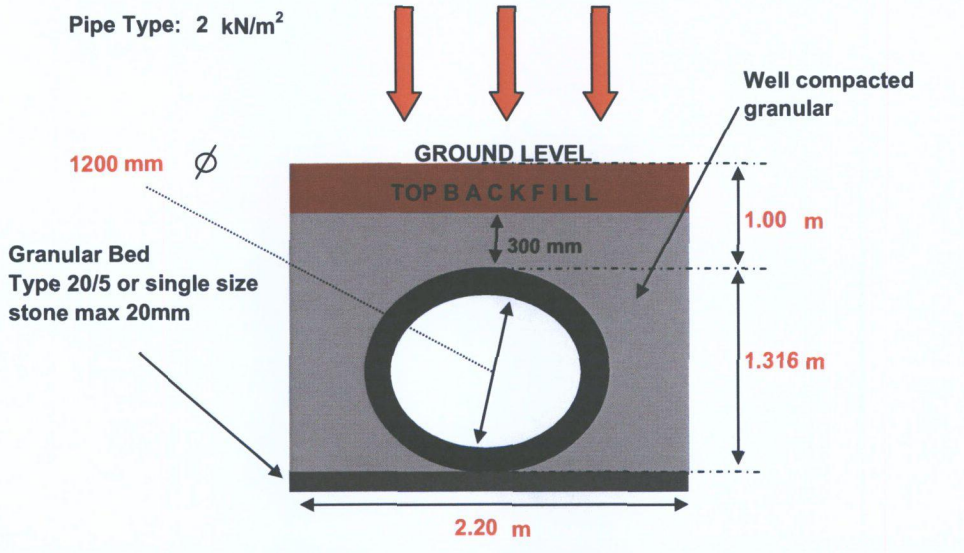
2.1 Introduction

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. In all calculations highways loading have been assumed.

Dead Load: 19 kN/m²
Live Load: 78.93 kN/m² (Highways Loading)



Calculations according to BS EN 1295 - 1 : 1998

Pipe Zone - From Table NA.6 [E'_2] :	10000	kN/m²	
Guide Values of Modulus for Native Soil [E' 3] :	6000	kN/m²	
Soil Type as in Table NA.1			
Overall Soil Modulus [E'] :	6992	kN/m²	{ Equation 16 }
C_L :	0.699165		{ Equation 17 }
Initial Deflection:	1.84%	{ Equation 23 }	< 6% O.K
Long Term Deflection:	1.89%	Note: Initial Deflection using D_L set at 1.0	
Total vertical external pressure:	97.930	kN/m²	{ Equation 15 }
Long term critical pressure:	179.755	kN/m²	
Short term critical pressure:	284.027	kN/m²	
F.O.S against buckling:	2.607	{ 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.

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.

In the present case highways loadings have been assumed and the value of deflections is less than 2.0%.

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

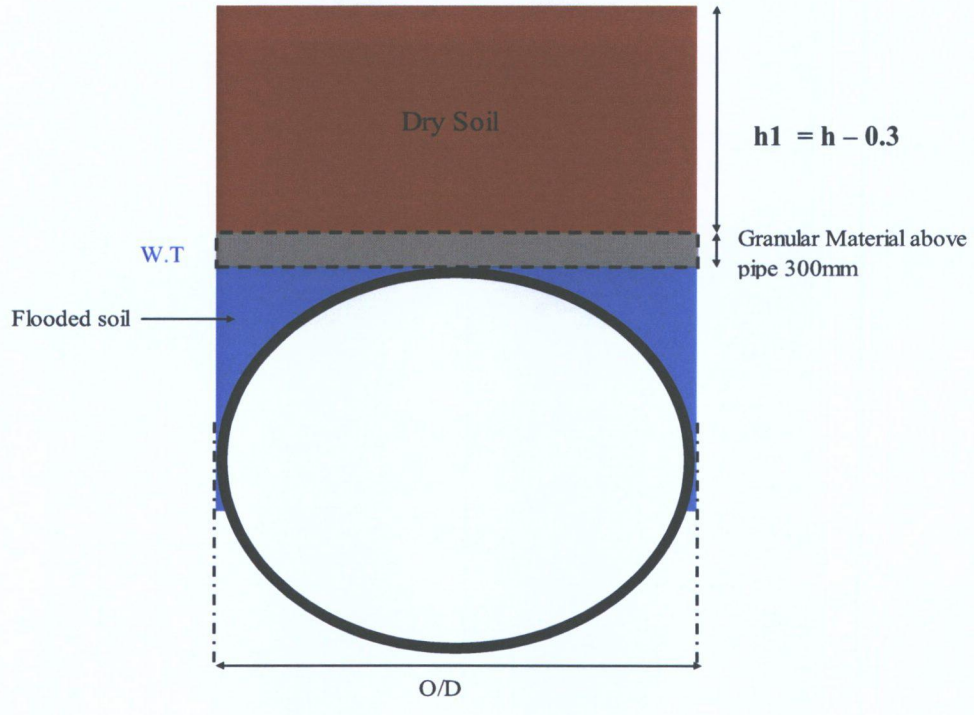
3.2 Floatation Calculations for the Proposed Scheme

Although there are no sign of water table in the area, in the present section we have attached flotation calculations for the minimum cover (1m) and with the level of underground water table at the crown of the 1200mm 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/m^3

w_G: Specific weight of ground water: 1000 kg/m^3

$w_{g.m}$: Specific weight of granular material: 2000 kg/m^3

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

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

$\mathbf{W_d}$: Weight of dry soil

$\mathbf{W_l}$: Weight of liquid (0 in the present case)

$\mathbf{W_f}$: Weight of flooded soil

$\mathbf{W_p}$: pipe weight

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

Calculations:

(1) ⟶ F_{up} = 1360.2 kg / m

$$W_f = A_{flooded_soil} * w_G \quad (4)$$

$$A_{flooded_soil} = \left[OD^2 - \pi \left(\frac{OD}{2} \right)^2 \right] \Big/ 2 \quad (5)$$

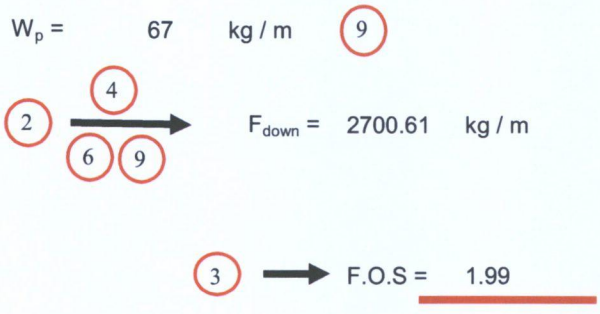
W_f = 185.85 kg / m

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

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

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

(6) ⟶ (7), (8) ⟶ W_d = 2447.76 kg / m



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.

The flotation calculations indicate that the pipe will not be subject to flotation even if the water table reaches the crown of the pipe.

Furthermore Asset International Ltd will provide a design certificate in order to verify that

1. **The Weholite pipe is suitable for the proposed application.**
2. **All deflections are within the acceptable limits.**
3. **The Weholite pipes will not be subject to flotation, buckling or other damage due to inadequate backfill restraint.**

Asset International Ltd will also guarantee the structural integrity of the pipe and the fabrication parts as well as the watertightness of the welded joints.

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.

Asset International Ltd.

References

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5. Pipe stiffness and how it affects the construction and quality of buried pipelines. I. Bjorklund, KWH Pipe.

6. ROR User Manual, KWH Pipe, Vaasa Finland, 2001.

7. www.kwhpipe.com