# A guide to structural design of buried pipes - BS 9295: 2020

## Introduction

BS 9295 *Guide to the Structural Design of Buried Pipes* has been fully revised.

This follows on from the revision of the European Standard EN 1295-1 *Structural design of buried pipelines under various conditions of loading – Part 1: General requirements* (adopted in the UK as BS EN 1295-1: 2019) to remove the nationally established methods of design from its text.

Whereas BS 9295: 2010 provided supporting information to European Standard, BS 9295: 2020 is now the lead document for UK designers of buried pipelines. It includes design information for all buried pipelines: pressure and gravity pipes, rigid, semi-rigid and flexible materials. As a result, it is now is substantially more in depth than its predecessor.

The BPF Pipes Group and its members were actively involved in its preparation and welcome its publication.

**This BPF Pipes Group document helps designers to find their way round the updated standard and identifies the key changes, which include a new method for large diameter structured wall pipes.**

Good design principles, installation techniques and correct product specification ensure the long-term performance of a plastic piping system.

## General design principles

**Section 4** of BS 9295: 2020 explains the concepts used in the structural design of buried pipes, critically that the buried pipe system is a composite structure comprising the pipe, its jointing system and the surrounding soil. This section provides the underlying 'textbook' theory on how pipes behave in buried situations and distinguishes between the terms rigid, semi-rigid and flexible with respect to pipe design.

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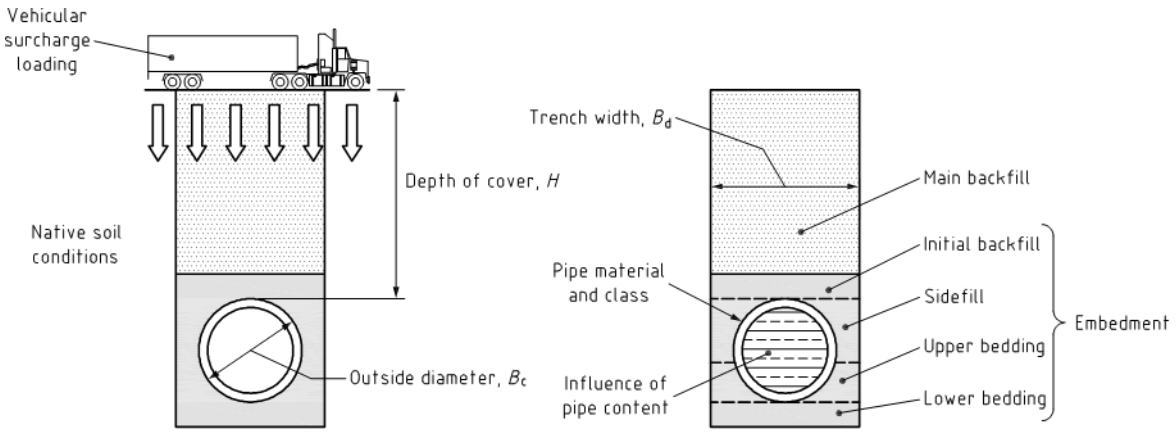
Note: The term polymeric pipe material in BS 9295 is used to cover thermoplastics (such as polypropylene, polyethylene, and PVC-U) and thermosets (GRP). Both use flexible pipe design, as do thin-walled steel and steel-reinforced thermoplastics. Table 1 of BS 9295: 2020 identifies which pipe materials are classified as rigid, semi-rigid and flexible.

Figure 1 (below) illustrates the factors that are influenced by the surrounding environment e.g. traffic loading, pipe depth, and those which might be controlled by the designer or installer e.g. type of backfill material and compaction, trench width and pipe material.




[Source: Figure 1: BS 9295: 2020]

**Section 4** describes the traditional design models, how they are used and their limitations. It explains the characteristics of polymeric pipe materials and their long term behaviour.

**Section 5** introduces and explains the type of loads to which a pipe in buried situations is subjected. It considers how to deal with the additional loads associated with construction sites and railway lines.

## Flexible pipe design

**Section 7 of BS 9295: 2020 sets out the design methods for flexible pipes, the most commonly used being thermoplastic pipes.** Importantly, a flexible pipe derives much of its load resistance from the soil surrounding the installed pipe.

For pressure pipes (all sizes) and non-pressure pipes up to 900mm

Figure 23C on page 47 clearly sets out the steps in designing a flexible pipe, based on the Marston-Spangler design method. The steps are detailed in clause 7.2. This method applies to all pressure pipes and non-pressure (gravity) pipes up to 900mm diameter. It has not changed from that in BS 9295: 2010 except for Table 14, Semi-rigid and Flexible pipe embedment properties:

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- Class S1 is now defined as self-compacting (single-sized granular capable of filling space under haunches of pipe with low compactive effort). It is, therefore, not relevant to provide a range of values for embedment soil modulus and deflection lag factor as shown for the other embedment classes.
- In Class S2, the highest compacted density value (modified Proctor density) of 95% has been removed.

For non-pressure pipes above 900mm

BS 9295: 2020 introduces a new design method (Gumbel method, clause 7.3) for large diameter thermoplastic pipes for non-pressure applications. The choice of the most suitable design method is dependent upon the size of the pipe and is therefore included in the Figure 23C flowchart.

This new method better reflects the structural behaviour of large diameter (greater than 900mm) structured-wall thermoplastic pipes.

In overview, the new method can be applied to:

- circular structured-wall pipes of thermoplastics conforming to BS EN 13476;
- solid-wall pipes of thermoplastics or other flexible homogeneous materials;
- non-pressure pipe systems subject to maximum surcharge of five metres;
- depth of cover which exceeds the greater of 0.6 metres (under rigidly-paved surfaces); 0.9 metres (under unpaved or flexibly paved surfaces); or half the pipe external diameter.

It assumes that construction of the pipe trench is carried out in accordance with BS EN 1610: 2015 *Construction and testing of drains and sewers*.

Whilst the new method has been developed for large diameter pipes (greater than 900mm), if the necessary data is available, it may also be used for small diameter non-pressure pipes instead of the Marston-Spangler method in clause 7.2.

## Your questions

Sewers for Adoption 7 says buried pipes should be designed in accordance with BS EN 1295-1. Can I use the new method in BS 9295?

The standards listed in clause B.6 are undated, therefore the most recent standard should be used. BS EN 1295-1: 2019 references BS 9295: 2020 so this can be used in your designs.

Sewers for Adoption 7 and Sewers for Scotland say that BS EN 1295-1 gives guidance on underground non-pressure PVC-U pipes. Does the standard now apply to all pipes?

BS EN 1295-1 and BS 9295 previously applied to all thermoplastic pipes (solid wall and structured wall of polypropylene, polyethylene and PVC-U) but the notes in SFA 7 (clause E.2.21) and SfS (clause 4.2.21) did not correctly reflect this. The latest versions can also be used for all plastic pipes.

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The Design and Construction Guidance for use in England from 1st April 2020 says buried pipes should be designed in accordance with BS EN 1295-1 and BS 9295. Which should I use?

The overarching principles of design are included in BS EN 1295-1: 2019 which points to the nationally established methods. The detailed method for designing pipes is set out in BS 9295: 2020.

Will the designs of large diameter structured wall pipe to the new method now included in BS 9295: 2020 give different results to previously? Do I need to change the way I design pipes or is it just a change of reference?

The new design method better reflects the structural behaviour of large diameter structured-wall thermoplastic pipes for non-pressure applications. However, additional data may be required to carry out the calculations. Where this is not yet available, the Marston-Spangler design method can still be used.

I am designing a large diameter pressure pipe. Should I use the new method for large diameter pipes now included in BS 9295: 2020?

The new design method is applicable only to non-pressure pipeline design.

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