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Design & Construction Guide - Technical Briefing on Change Request - Uniformity between clauses E2.21 and E2.22

1. Introduction

The Sewer Adoption Panel has received a change request from John Davidson Pipes Ltd. requesting uniformity between clauses E2.21 and E2.22.

1.1 The current text:

E2.21 Thermoplastics Solid Wall Pipes and Fittings for Gravity Sewers

1. Thermoplastics pipes, joints and fittings for gravity sewers shall comply with the relevant provisions of BS EN 1401-1 (PVC-U), BS EN 1852-1 (PP), or BS EN 12666-1 (PE) as appropriate.

2. Ancillary drainage fittings shall comply with BS EN 13598-1 or BS 4660, as appropriate.

E2.22 Thermoplastics Structured Wall Pipe

1. Thermoplastics structured wall sewer pipe shall comply with the relevant provisions of BS EN 13476-1 and WIS 4-35-01, and BS EN 13476-2 or BS EN 13476-3. Pipes shall be BSI Kitemarked or have equivalent third party certification.

2. Pipes less than or equal to 500 mm in diameter shall have nominal short-term ring stiffness not less than 8 kN per m2 (SN 8) or be subject to a quality system for storage and embedment.

3. Nominal short-term ring stiffness of 2 kN per m2 (SN 2) is acceptable for pipes greater than 500 mm in diameter, subject to structural design load calculations in accordance with BS 9295:2019 which shall be provided to support this.

4. Maximum length of pipe for laying is 3 m or 10 x DN, whichever is the greater.

1.2 CESWI 8th Edition

The equivalent clauses in the Civil Engineering Specification for the Water Industry 8th Edition (CESWI 8) are as follows.

2.19.2 UNPLASTICISED PVC PIPES AND FITTINGS

3. PVC pipes, joints and fittings for gravity sewers and drains shall conform to BS EN 1401-1. Ancillary drainage fittings shall conform to BS EN 13598-1 or BS 4660, as appropriate.

4. PVC structured wall sewer pipe for gravity sewerage and drainage shall conform to the relevant provisions of BS EN 13476-1 and WIS 4-35-01 and BS EN 13476-2 or BS EN 13476-3.

1.3 The proposal

The request for change is:

"Please can we request that parts E2.21 and E2.22 of the DCG are amended to show uniformity regarding SN rating, Kitemark Certification, Maximum Pipe Length and WIS."

The reasons stated are:

"The wording under E2.21 leaves Utilities open to lower strength un-kitemarked systems being used in adoptable sewer applications."

"The wording in E2.21 is ambiguous and lacks detail."

Although not explicitly stated, the proposer implies that their preferred solution is to add the requirements of E2.22.2 to E2.22.4 to E2.21.

2. Technical Background

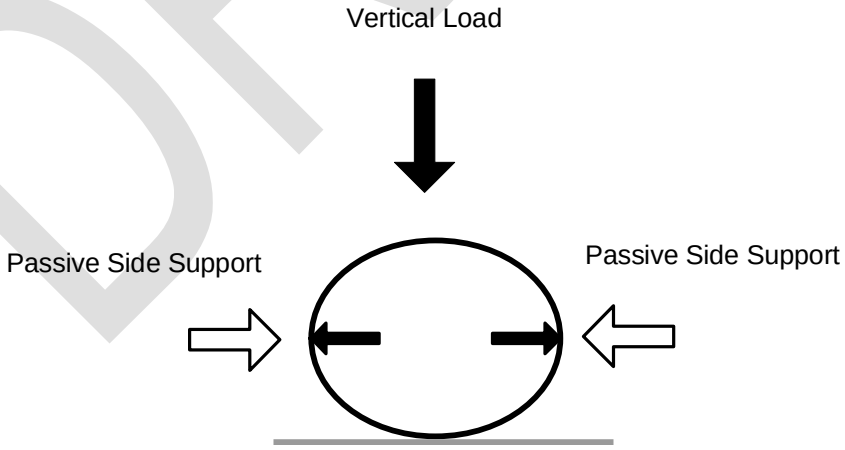
There are two technical issues:

- The ring stiffness of the pipes; and
- The length of the pipes.

2.1 Ring stiffness

The ring stiffness of a pipe is a measure of the flexibility of the pipe in cross section. It is expressed as a stiffness class (SN). Values of ring stiffness are measured in kN/m^2. The most commonly used ring stiffness classes are SN 2 (2 kN/m^2), SN 4 (4 kN/m^2), SN 8 (8 kN/m^2) and SN 16 (16 kN/m^2).

Unlike a rigid pipe, a flexible pipe relies on the side support of the soil around the sides of the pipe for its vertical strength. As a vertical load is applied it deforms the top of the pipe downwards, forcing it into an oval shape pushing the sides outwards. If the soil around is correctly compacted it resists this pressure with a corresponding opposing force called passive side support, and the pipe remains stable. If there is no passive side support, then the pipe is likely to buckle and collapse under the vertical load.



During construction the granular fill around the pipe must be properly compacted to provide the side support. Unfortunately, if the pipe is not very stiff the it can deform during the process of filling and compacting the fill around the pipe and this deformation is then fixed. A deformed pipe will not perform as well as a circular one. Width larger pipes the fill is laid more gradually

in courses, and it is easier to adjust compaction of the fill to limit the deformation as the pipe is buried.

2.2 Pipe Length

It is important that pipes are laid to a constant gradient. If they are not, then then it is possible that sections of pipe will have too low a gradient (too flat) or even reverse gradient (backfall). This can cause build-up of solids or sediments in the pipe.

With long lengths of pipe, if the pipes are not very stiff longitudinally, then pipes can bend during storage or installation, and it becomes very difficult to lay then to a consistent gradient. The pipes are not very heavy and as the pipe surround material is placed, they can easily rise. This is especially the case where the pipes have bent during storage. As an illustration, consider how easy it would be to lay a garden hose pipe to a constant gradient.

As pipes get larger the wall thickness must be increased to meet a desired ring stiffness. Since the polymer is expensive the price can become uncompetitive at large diameters. For this reason, manufacturers started making ribbed or cellular pipe walls to increase the ring stiffness without using as much polymer. These are called structured wall pipes.

Although the structure of the pipe increases the ring stiffness for a given volume of polymer, it does not have the same effect on the longitudinal stiffness and so these become more difficult to lay to a constant grade. To overcome these problems the pipe unit lengths are limited to 3 m. (The pipes are typically supplied in 3 m or 6 m lengths).

The other concern about some structured wall pipe products was that the inner wall could be so thin that it could be easily punctured by rods or jetting during maintenance activities.

3. Relevant Standards

3.1 BS EN 1401:2019

BS EN 1401:2019 Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly(vinyl chloride) (PVC-U) Part 1: Specifications for pipes, fittings and the system is the product standard for solid walled PVC drainage pipes.

Wall thicknesses are specified for pipes from DN/OD 110 mm to DN/OD 1000 mm for ring stiffnesses of SN2, SN4, SN8 and SN16. The are no requirements limiting the length of each pipe unit, so this is for the manufacturer to decide.

The national foreword to EN 1401:1998 contains the following statement.

"This document specifies three classes of pipes and fittings of differing stiffness, designated SN 8, SN 4 and SN 2 (See Table 4 and Table 6).

From the viewpoint of installation, the SN 8 or SN 4 classes have to be used if the system is to be installed in accordance with BS 8301 or BS 5955-6 in order to achieve the intended resistance to long term deformation.

If it is intended to use the other, less stiff (SN 2), class of pipe or fitting, the installation should first be subject to a structural design soil load calculation and the installation technique modified to suit the results of that calculation."

3.2 BS EN 13476

BS EN 13476 Plastics piping systems for non-pressure underground drainage and sewerage. Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) is the product standard for structured wall thermoplastics drainage pipes. There are three parts to this standard:

Part 1 - General requirements and performance characteristics (2018)

Part 2 - Specifications for pipes and fittings with smooth internal and external surface and the system, Type A (2020)

Part 3 - Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B (2020)

Essentially Part 2 covers pipes with a cellular construction and Part 3 covers ribbed pipes.

Parts 2 & 3 both permit pipes less than DN 500 mm to be SN4, SN8 or SN16 and pipes larger than DN 500 mm to be SN2, SN4 SN8 or SN16.

They also include an impact requirement based on a test using a striker dropped from height of 1.6m (for DN 110 mm pipes) or 2.0m (for larger diameters). The striker has a mass of between 0.5 kg to 3.2 kg depending on the diameter of the pipe and a hemispherical tip with a radius of 50 mm. This is a similar striker to that specified in the impact test in BS EN 1401 which is based on BS EN ISO 11173.

3.3 WIS 4-35-01

WIS 4-35-01 Specification For Thermoplastics Structured Wall Pipes – Supplementary Test Requirements (2008) sets out three supplementary requirements for structured wall pipes.

- Resistance to internal puncture

- Resistance to internal water jetting (only for pipes ≤ DN 300)
- Longitudinal bending

The internal puncture test seems to have a similar function to the impact test now included in BS EN 13476 Parts 2 & 3 though the striker has a lower mass (only 250g) but a much smaller diameter tip (2.5 mm radius). It is therefore not clear whether the two tests are comparable.

The longitudinal bending test measures the deflection under its own self-weight for a pipe of the maximum length supplied supported so that the span is 500mm less than the length of the pipe. The maximum permitted deflection is 5% of the pipe length.

4. Products available on the UK Market

The fact that a standard permits a product to have a particular diameter or ring stiffness does not mean that product is available on the UK market.

Most manufacturers only sell solid wall pipes at DN/OD 110 mm and 160 mm, though at least one manufacturer produces solid wall pipes up to DN400. The DN/OD 110 mm pipes mostly seem to be SN 8 but the DN/OD 160 mm and above are SN 4.

For structured wall pipes many manufacturers have the BSI kitemark though only some include the requirements of both BS EN 13476 and WIS 4-35-01. Many also have BBA certification.

For Solid Walled Pipes almost all manufacturers have the BSI Kitemark for their products.

5. Discussion

5.1 Ring Stiffness (SN rating)

Addition of a clause similar to E2.22.2 into E2.21 would be problematic as solid wall PVC sewer pipes greater than DN/OD 110 do not seem to be available on the UK market. Without evidence of a problem with DN/OD 160 pipes rated at SN4 it would be difficult to argue for such a requirement.

Although both BS 8301 and BS 5955-6 have been superseded, installation techniques have not changed since then so the comment in the foreword to BS EN 1401-1:1998 is still valid. This is also consistent with E2.22.3.

As solid wall pipes DN/OD 160 and larger, of stiffness class SN 4, have been in use without problem for many years, consideration might be given to easing the requirement in E2.22.2 to 4 kN/m^2 (SN 4) perhaps with SN 8 retained for DN/OD 110 pipes.

If the requirement is retained, uniformity could be achieved by its inclusion in E2.21.

It is noted that this requirement does not appear in CESWI 8.

5.2 Maximum length

Given the longitudinal bending requirement in WIS 4-35-01, and assuming that the pipes are stored in accordance with E2.1, it is difficult to support this as a separate requirement in E2.22.2 and without evidence it would be difficult to justify its addition to E2.21. It is noted that this requirement does not appear in CESWI 8.

5.3 WIS

The requirement for compliance with WIS 4-35-01 for structured wall pipes is included in CESWI 8.

The scope of the WIS is purely for structured-wall pipes and this would preclude its being included as an additional requirement in E2.21. While a case might be made to remove the impact test on the grounds that BS EN 13476 already includes such a test, the two tests are different and comparison testing would be required to establish whether they are indeed comparable.

5.4 Third party certification

The requirement in E2.22 is one of only two specific requirements for third party certification in the DCG. The other is in clauses E4.5 (Ready Mixed Concrete).

The requirement for third party certification of structured-wall pipes is not included in CESWI 8.

There is also a statement on page 95, which is identical to a paragraph in CESWI and reads as follows:

> *"Additional quality assurance requirements, including third party certification, may be sought by the sewerage company as a cost-effective means of ensuring compliance with Standards. BSI Kitemarking is an example of third party certification."*

This seems to stop short of a general requirement for third party certification.

Extending third party certification to solid wall plastic pipes is likely to lead to questions about why that was chosen when other products are not subject to the same requirement. There needs to be a clear rationale for inclusion of such requirements.

It is understood that the rationale for including this requirement was that a number of the structured-wall products were innovative, and that this requirement offered additional assurance about the new product.

Since the solid-wall products on the market do seem to have third party certification of some type, adding this requirement to E2,21 would have no practical effect. The fact that many of the certificates for certified structured wall products do not mention conformity to WIS 4-31-01, is perhaps evidence that this requirement is still relevant.

5.5 Ambiguity

Although E2.21 is shorter than E2.22 the direct reference to standards is clear and unambiguous. If there is any ambiguity it might be due to the statement about third party certification on page 95.

6. Possible draft text

Depending on the outcome, it is suggested that the text should be based on the CESWI text. It should be noted that the requirements for polyethylene and polypropylene structured wall pipes are in a similar separate clause. This could be added if required.

E2.21 UNPLASTICISED PVC PIPES AND FITTINGS

X. PVC pipes, joints and fittings for gravity sewers and drains shall conform to BS EN 1401-1. Ancillary drainage fittings shall conform to BS EN 13598-1 or BS 4660, as appropriate.

X. PVC structured wall sewer pipe for gravity sewerage and drainage shall conform to the relevant provisions of BS EN 13476-1 and WIS 4-35-01 and BS EN 13476-2 or BS EN 13476-3.

Depending on the decision the panel makes regarding the various issues, a minimum ring stiffness requirement could be added as follows:

X. Pipes and fittings for gravity sewers less than or equal to 500 mm in diameter shall have nominal short-term ring stiffness not less than 4 kN per m^2 (SN 4) or be subject to a quality system for storage and embedment. Pipes and fittings for gravity sewers greater than 500 mm in diameter may have a nominal short-term ring stiffness of 2 kN

per m^2 (SN 2), subject to structural design load calculations in accordance with BS 9295:2019 which shall be provided to support this.

Depending on the decision the panel makes, a requirement for third party certification could be added as follows.

X. The conformity of structured wall pipes and fittings for gravity sewers to the standards in <> above shall be certified by a third party certification body.

7. Conclusions

1. There is a technical rationale for inclusion of the additional requirements for structured-wall pipes that are not specified for solid walled pipes.

2. Although clauses E2.21.1& 2 and E.2.22.1 are not identical to the equivalent clauses in CESWI 8, the technical differences include the minimum requirement for ring stiffness and the maximum pipe length requirement. Whatever changes are agreed, if a version different to that in CESWI 8 is agreed, it could be updated in CESWI in the next annual update.

3. Inclusion of a minimum ring stiffness requirement of 8 kN/m^2 (SN 8) would preclude the use of almost all solid wall pipe products of DN/OD 160 mm and above as these are manufactured with a ring stiffness of 4 kN/m^2 (SN 4). The author is not aware of any evidence that there is a problem with the 4 kN/m^2 (SN 4) ring stiffness of these pipes.

4. If uniformity is desired, then consideration might be given to reducing the ring stiffness requirement in E2.22.2 to 4 kN/m^2 (SN 4) at least for pipes of DN/OD 160 mm and above. This would then align with the market for solid wall pipes and for uniformity a similar requirement could be added to E2.21. If this is agreed it could be added to CESWI 8.

5. The maximum length requirement in clause E2.22.4 is included as the wall structure of structured-wall pipes only increases the ring stiffness not necessarily the longitudinal stiffness of the pipe. However, since WIS-4-35-01 includes a requirement for longitudinal stiffness additional requirement is a duplication.

6. Inclusion of a reference to the requirements of WIS 4-35-01 into E2.21 is not feasible as the scope of this WIS is limited to structured-wall pipes.

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