TECHNICAL NOTE

TECHNICAL INFORMATION FROM THE CONCRETE PIPE ASSOCIATION OF AUSTRALASIA

DESIGNING RIGID & FLEXIBLE PIPELINE SYSTEMS

In Australia and New Zealand the requirements for the design and installation of pipelines is specified in a number of Australian/New Zealand Standards that relate to the specific pipe type and material to be used. The pipe types predominantly used in Australia and New Zealand are rigid (i.e. steel reinforced concrete pipe) and flexible (i.e. plastic and metallic).

The structural performance and in-service life of pipelines is dependent on the specified design and installation requirements, appropriate to the selected pipe material and the available site conditions being achieved.

The design requirements for each pipe alternative vary markedly with properties such as the rigidity or stiffness of the pipe material selected, its need or ability to react with the embedment materials, and the shape and dimensions of the embedment. The 5 points below are the main design differences that should be considered when comparing rigid and flexible pipe.

1. Materials selection

- **Concrete is rigid, plastic is flexible** – Rigid pipe has sufficient strength to carry working loads on its own, flexible pipe deflects when under load and requires the interaction of the soil to have enough strength not to collapse.
- **Different materials need different Standards** – Concrete pipe has one product specific material Standard, AS/NZS 4058 "Precast concrete pipe (pressure and non-pressure)". AS/NZS 3725 "Design for installation of buried concrete pipe"is then used to determine the expected loads on the pipe.

  The various plastic pipe types, PVC, PE, GRP, all have a specific product Standard, whilst design is conducted in accordance with AS 2566.1 "Flexible plastic pipe – Design" and installation in accordance with AS 2566.2 "Flexible plastic pipe – Installation".
- **AS/NZS 4058 is the only pipe Standard that requires ALL product raw materials to comply with Australian and New Zealand Standards.** This is not the case for all flexible pipe raw materials. Refer to the relevant standards to understand what is required for each pipe material.

2. Product size and load class

- **There are big differences in size availability** – Concrete comes in 27 nominal sizes as per AS/NZS 4058, from 225mm to 4200mm diameter. Plastic is unregulated and the size depends on the supplier and type.
- **There is no comparison to load class** – Concrete load capability is high and increases with class and size. Plastic pipe's load carrying capability is dependent on the pipe stiffness and the soil interaction around it.

3. Structural design

- **The main load bearing section of rigid and flexible pipelines is very different** – For rigid concrete pipe it is the PIPE. For flexible plastic pipe it is the SOIL.
- **This means the design criteria is critical for flexible pipe** – Plastic has very low strength or stiffness, and as a result AS/NZS 2566.1 "Flexible plastic pipe – Design" requires the designer to calculate for the expected pipe deflection, stiffness and buckling, over its service life and determine what level of soil interaction is required to ensure it does not fail in the short or long term.

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- **Deflection limits?** – AS/NZS 2566.1 "Flexible plastic pipe – Design" nominates allowable short term deflection limits for most plastics as 5% and long term limits of 7.5%. This means the designer has to be sure that the soil envelope around the pipe will remain stable enough so that the pipe will not deflect greater than these limits. This is required as plastic pipe strength decreases over time.

Design Criteria	Concrete	Plastic
Main load bearing section of the pipeline	Pipe	Soil
Inherent strength/stiffness of pipe material	Very high	Very low
Required strength/stiffness of soil envelope	Minimal	Very high
Impact of soil movement on pipe strength	Nil to very low	Expect deflection
Acceptance testing requirements	Factory load test	Initial deflection

4. Product acceptance

- **The designer must nominate acceptance criteria for pipe** – Concrete pipe is accepted on the basis of its ability to meet performance tests in AS/NZS 4058. Plastic pipe should be accepted by (a) design calculation, which is assumed on the basis that the contractor will achieve the right installation to allow for the designed deflection, stiffness and buckling; and (b) by performance, which requires short term and long term deflection testing.

Pipe Materials	Allowable short-term deflection	Allowable long-term deflection
GRP	4.0 %	6.0%
ABS, PE, PP, PVC	5.0%	7.5%

Note: Table taken from AS 2566.1. Short term deflection should be measured at 14 days and long term deflection at 2 years.

5. Life expectancy

- **The service life of each type is different** – For concrete it is the 100 years (AS/NZS 4058) based on performance history, testing and serviceability. For plastic it is 50 years (AS 2566.1) based on expectations of a stable soil envelope for that period of time and no unexpected loads.

As can be seen that the same design criteria and calculations cannot be carried over from one material to the other. Rigid and flexible pipe offer very different material alternatives and must always be treated as such. Importantly however, designers and specifiers can use an appropriate Standard when designing for pipelines including different pipe materials to ensure they are implementing the specific requirements for that material.