Plastics Industry Pipe Association of Australia Limited ACN 086 511 686

Flexible Pipe Design

By Mark Heathcote, PIPA Executive General Manager
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Introduction:

The design of flexible pipe systems worldwide is covered by many national and local standards or accepted practices. The primary reference regarding the design of flexible pipe systems in Australia is Australian/New Zealand Standard AS/NZ2566 "Buried flexible pipelines – Structural Design and Installation".

Internationally the number of reference documents is extensive including EN1295, ATV A 127 (Germany), Fascicule 70 (France), ÖNORM B 5012 (Austria), VAV P70 (Sweden), PSSM (United Kingdom), GRP-draft (Germany), CalVis (The Netherlands), Bossen (The Netherlands) and most recently prCEN/TS 15223 "Plastics piping systems - Validated design parameters of buried thermoplastics piping systems" and ISO 21138-1-2007 Annex C- Structural Design.

These design approaches tend to be similar using a Spangler type formula to model the behaviour of the pipe with inputs like soil loads, traffic loads, pipe ring stiffness, soil stiffness etc. Using a mathematical approach, they aim to predict the pipe's response to design loads, including the potential for deflection of the pipe, wall strain, combined internal pressure and external soil loads and buckling.

In 1996 The European Plastics Pipe and Fittings Association (TEPPFA) and PlasticsEurope invested heavily in a project looking at the performance of flexible non-pressure pipes under various installation conditions and in doing so compared the measured result to that calculated theoretically from a range of design approaches. The TEPPFA work focused on only one parameter – pipe deflection.

The TEPPFA work highlighted the variability of different design approaches and the need to recognize that due mainly to the many parameters involved, no design method will give precise results.

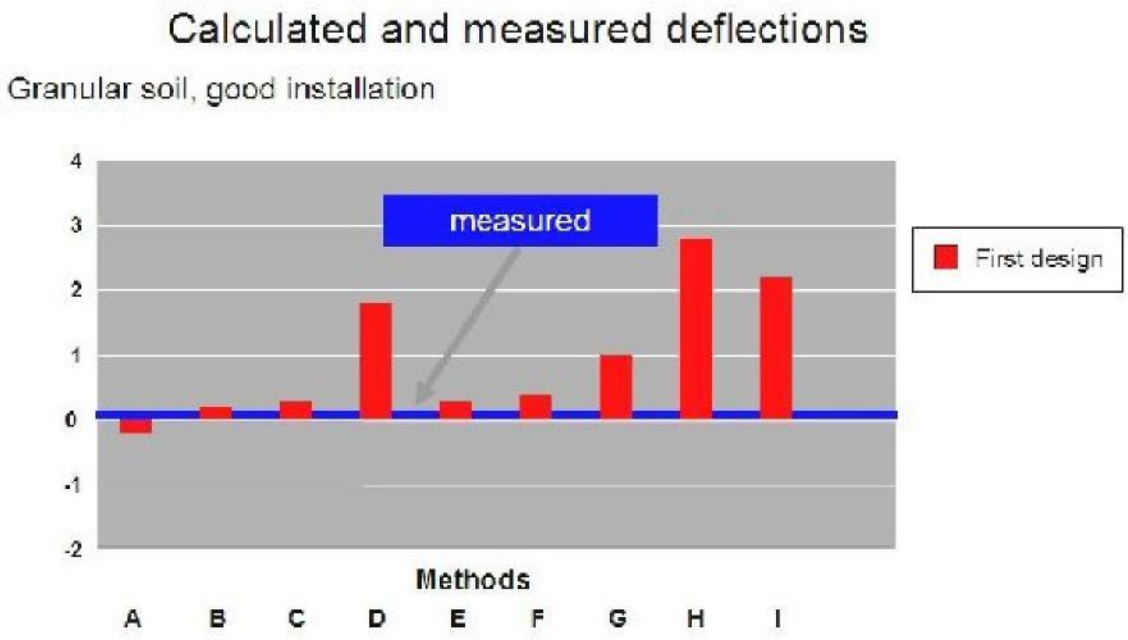

Figure 1

Figures 1 (granular soil, good installation) and 2 (granular soil, poor installation, with traffic load) illustrate the predicted results for a range of mathematical approaches, compared to the measured deflections. Generally the measured deflections were equal to or less than the predicted values. The results indicate that no two design options predicted exactly the same result and in most cases the predicted behaviour did not correspond with the measured behaviour.

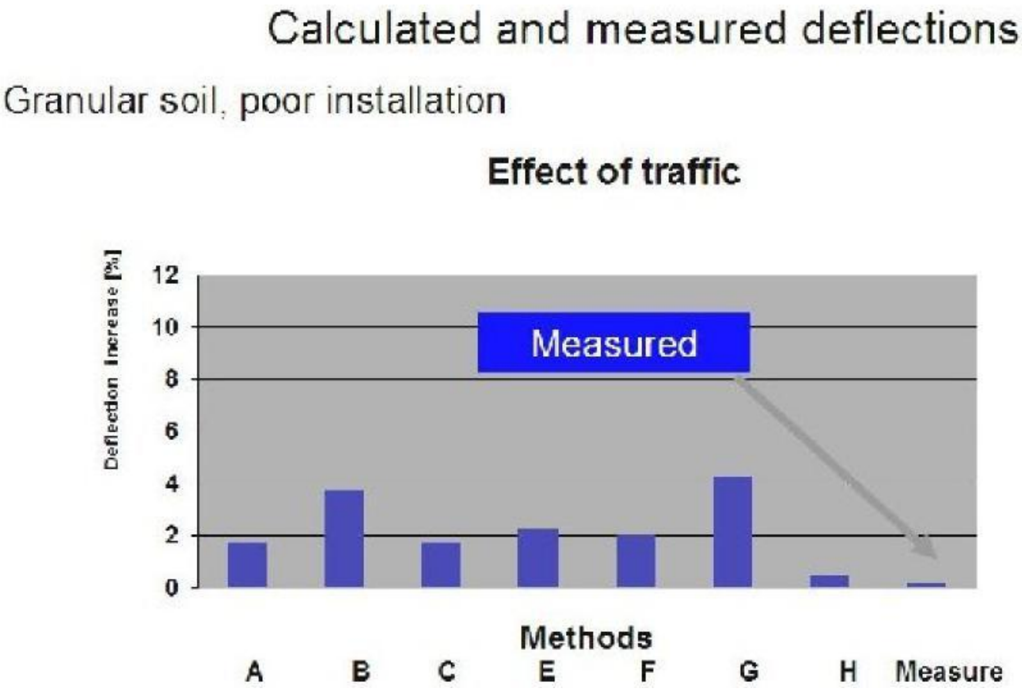

Figure 2

The TEPPFA work draws some positive conclusions in terms of the relative contribution of various elements of an installation to the deflection of a pipe; in particular highlighting the significant contribution of the quality of installation (Figure 3).

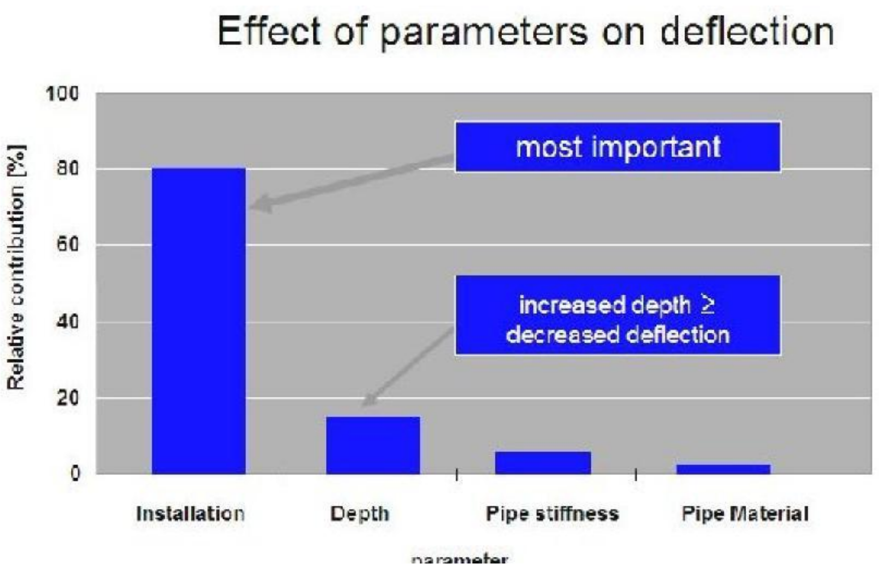

Figure 3

The TEPPFA work results in the generation of a chart (Figure 4) that shows the typical range of deflections that will occur in pipes of varying pipe stiffnesses depending on the degree of compaction that took place during installation – well compacted, moderate compaction or no compaction.

The design graph is applicable to situations where:

- The burial depth is between 0.8 m and 6 m.
- Pipe diameter is up to 1100 mm diameter
- Burial depth to diameter ratio is ≥ 2.0.
- Sheet piles or trench shields, if used, are removed before compaction. Otherwise the well or moderate compaction will be reduced to the “none” compaction level.
- The installation categories “well”, “moderate” and “none” reflect the level of compaction upon which the designer can rely.

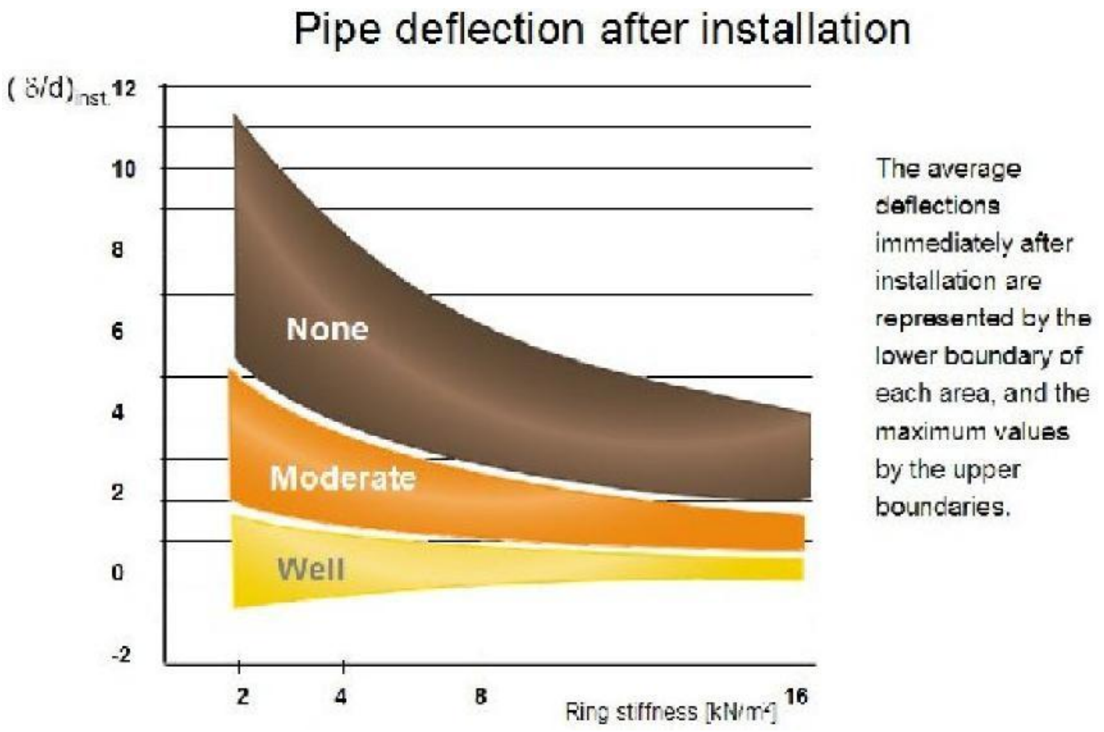

Figure 4

Calculations done in accordance with AS/NZ 2566 for SN2 & SN8 pipes and using the following Effective Combined Modulus values:

Well	7MPa
Moderate	2MPa
None	0.5MPa

give deflection values in agreement with the design chart, falling in the mid range of the graphs as shown.

The TEPPFA conclusions suggest that the mathematical approaches place undue emphasis on burial depth and traffic loads for the majority of typical installations.

Conclusions drawn by TEPPFA included:

- Traffic load has little effect on final deflection.
- Deflection depends more on installation quality than pipe stiffness.
- For “well” to “moderate’ installed pipe high pipe stiffness is not required to limit deflection.
- Limit state conditions are not likely to occur.
- The type of material and the creep ratio is not important with regards to deflection.

It is stressed that the TEPPFA approach is itself not a design alternative to AS/NZS2566 as it only considers deflection.

The TEPPFA project has been well scrutinised and accepted to the point where the results of this work are referenced in the latest European Standards for flexible pipe design - prCEN/TS 15223 “Plastics piping systems - Validated design parameters of buried thermoplastics piping systems” and ISO 21138-1-2007 Annex C- Structural Design and also referenced by the Water Services Association of Australia in the revised Australian PE Code.

The TEPPFA approach is valid for the majority of general pipe installation conditions for reticulation and common trunk pipeline sizes. Under these conditions detailed calculations predicting pipe performance are usually not necessary. TEPPFA concluded that final deflection of pipes was controlled by the settlement of the soil after installation. Where installation was controlled, or self-compacting granular material was used, pipe deflections were consistently low regardless of installation depth, and traffic or other loads.

Reiterating that the TEPPFA work is not a design alternative to AS/NZ2566 and that for unusual conditions including very poor native soils, large pipe sizes, high ground water conditions or where depths are greater than 6 metres, we recommend that design calculations be performed in accordance with AS/NZS 2566.1. Further information about the TEPPFA project is available from their website (www.teppfa.com).

For Further information please contact :
Plastics Industry Pipe Association of Australia Ltd
Suite 246, 813 Pacific Hwy, Chatswood NSW 2067
or email plasticspipe@pipa.com.au