Relining standards – benefits and limitations

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In the second of a two part series, Interflow's Ian Bateman considers the application of AS/NZ2566.1 in the relining sector.

LARGE DIAMETERS LINING – AS/NZ2566.1 OVERLY CONSERVATIVE?

The diameter of pipes that are now being lined in the trenchless industry continues to increase. It recent times, pipe liners in excess of 3 m have been installed. Again, the default design standard has been based on the approach taken in AS/NZ2566.1.

In these diameter ranges, a couple of the assumptions extracted from the standard begin to severely limit what is practically and economically possible. Each of these will be separately discussed.

EARTH LOADING SILO REDUCTION FACTORS

AS/NZ2566.1 permits the use of earth loading silo reduction factors once the soil depth is greater than ten times the diameter of the pipe being relined. In a 150 mm pipe this translates to 1.5 m depth, but in the case of a 3 m pipe it translates to 30 m. Clearly in larger diameter pipes the full prism weight of soil is not borne by the host pipe (up to 10 x D), in fact in many cases, if it was, the original host pipe would not have been able to withstand the loads. As such, it seems reasonable to have a less conservative way of treating soil loads as the diameter increases. Potential methods could be:

1. Use the 10 x diameter relationship up to a certain depth and then use silo reduction factors beyond that point.
2. Use the 10 x diameter relationship up to a certain depth and then assume it is a constant beyond this point.
3. Use the 10 x diameter relationship for certain diameters (say up to 750 mm) and permit the use of silo reduction factors for larger diameters.
4. Use the 10 x diameter relationships, but allow the modulus of soil reactivity to increase with depth.

Any of these methods would seem reasonable. The fourth option alludes to a related issue that will be discussed below.

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SELECTION OF E', THE MODULUS OF SOIL REACTIVITY

AS/NZ2566.1 presents a table to assist selecting a value for E'. The values in the table range from 1 — 20 depending on the nature of the embedment material and the degree of compaction. The trenchless industry has adopted the use of E' values of between two and five, on the basis that the condition of the surrounding soil is not known (indeed it could be missing), it is not economically viable to individually assess the soil in every case, and using a low value of E' helps impose an overall degree of conservatism to the design in recognition that the use in the trenchless relining application is a little different to the original intent of the standard.

For the vast majority of circumstances the approach taken to date has served the industry well. Practical and cost effective solutions have been offered to clients and installed products have performed to expectations.

However as diameters of pipes and culverts needing rehabilitation get larger, the inherent conservatism of using an E' of between 2 and 5 becomes very restrictive, and the costs of providing a solution become prohibitive. As such it may represent better value to attempt to quantify the actual E' on the project and then design a solution rather than taking a blanket conservative approach.

There are a variety of methods that can be used to estimate E' and they can involve some geotechnical surveying or empirical modelling or referring to tables in standards such as the one presented in AS/NZ2566.1.

Interestingly one of the approaches (Jeyapelan 2004) recognises that the E' can be considered to be a function of soil depth. That is, as the depth increases, the effective E' also increases. Specifically it is recommended to increase the value of E' by between 0.17 MPa and 0.7 MPa (depending on degree of compaction) for each 0.3 m of soil depth above 1.5 m.

Hence there are two issues (silo reduction factors and estimates of E') related to depth of soil that significantly

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affect the design and viability of rehabilitation solutions for large diameter pipelines. The current default approach by the trenchless industry to adopt a constant value of E' and not allow silo reduction until depths greater than ten times the diameter will tend to become very restrictive and overly conservative as diameters increase.

An approach to addressing this may be as follows:

1. Apply the existing default approach for diameters up to (say) 1,200 mm, i.e. the diameter range in which the vast majority of work currently occurs.
2. For larger diameters, establish more information about the condition of the surrounding soil so that a more accurate value of E' can be specified before designing the rehabilitation solution.
3. For larger diameters at deeper depths ensure that either the E' value takes into account the depth or allow the use of silo reduction factors at depths, less than ten times diameter.

SUMMARY

The design equations borrowed from AS/NZ2566.1 have served the Australian and New Zealand pipeline rehabilitation industry well over the last two decades. However as products have developed and the industry has taken on new challenges, some limitations have presented themselves. Two examples have been presented in this paper and it is recommended that as the industry continues to develop that the default design approach be enhanced with guidelines on how to treat specific applications and products.

REFERENCE

1. Jeyapalan, J. and Watkins, R., 'Modulus Of Soil Reaction (E') Values For Pipeline Design', *Journal of Transportation Engineering,* January/February 2004.

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