Service Life of Concrete Pipeline Systems

Introduction

The UK has one of the largest sewerage networks in Europe, with an asset value of £108.8 billion [1]. It is also known to be one of the oldest sewerage systems in the world, with more than 40% of its networks constructed prior to 1945 [2]. The current state of the country's sewer network has been a major concern in the last three decades, OFWAT estimates that the cost of replacing this entire infrastructure requires £200 billion [3]. With such high stakes, the service/design life of sewer pipelines is a major requirement. OFWAT conducted a consultation in 2006 to investigate asset durability requirements as part of sustainability efforts in the sector, service life was identified by most participants as a main aspect that should affect assets' selection criteria [4].

Service life is already one of the main competitive advantages of concrete pipeline systems, as its performance is already supported by a long track record dating back for over a hundred years[(1)]:

- A 30 inch diameter concrete sewer pipe laid in 1903 in Norwich was excavated and tested. The pipe was found to be compliant with current strength requirements.
- More recent estimations also offer long service life. The BRE Special Digest – 1 (SD-1) offers an estimate of a maximum exceeding 100 years if necessary [5].
- The Highway Agency specifications (including the HA Design Manual for Roads and Bridges) offer a 100 years service life in normal conditions subject to extension if the pipe is not Damaged [6].
- A similar span is also being recognised in other countries, all US states specifications approve a 100 year life for concrete pipes. The same applies to the US Army Corps of Engineers' Engineering and Design Manual for Conduits, Culverts and Pipes. The new concrete pipe standard for New Zealand and Australia *AS/NZS4058: 2007* states that the manufacture, design, and installation of reinforced concrete pipe should be completed to achieve a long, durable, 100-year service life.

Therefore it is reasonable to expect a correctly designed, installed and maintained pipeline system to achieve a 100 to 120 years if not more. Indeed studies at Manchester and Surrey Universities in the late 1990s offer a 400 to 500 service life for concrete pipes [7].

Factors affecting the service life of concrete pipes

There are factors that can affect the service life of concrete pipes, however these can be successfully managed. They include the following:

- **Product Quality:** All CPSA products are produced in accordance with BS EN 1916, BS EN 1917, BS 5911 parts 1, 3, 4, and 6 and are third party certified.
- **Chemical Resistance:** Concrete made in accordance with BRE SD-1 to typically chemical class DC-4, can withstand thaumasite sulphate attacks from most types of aggressive ground in the UK, including class AC-3 [8].
- **Product Strength:** Concrete pipeline systems are profound structures with inherent strength, and therefore the effects of poor installation are not as critical on service life as in other materials. Under the requirement of product standards, routine strength tests are required.
- **Design:** It is important with any pipeline system design that proper attention is paid to hydraulic design as this will help negate chemical attacks.
- **Poor Installation:** Good supervision is essential as the most common cause for sewers to collapse is poor pipe laying techniques, Martin Jones [9] specifically identifies sewers laid in the 1920s-60s. The most common faults include failing to remove temporary laying supports, poor connections, problems with bedding, consolidation, third party damage, faults with pressure testing, and other engineering and workmanship faults.
- **Maintenance:** As with any structure, routine maintenance is essential to maintain the system's longevity.

[(1)]The earliest reference made about concrete pipes production was in Portland cement its Manufacture and uses by Henry Reid, published by Spoon in 1877. The book offered a description of concrete pipe production with two images showing production operations.

- **Sealing Systems:** EU Standards specify durability requirements for sealing systems. In addition, accelerated ageing tests on synthetic sealing systems found that seals are not detrimentally affected by bad workmanship or environmental factors, modern joints may be expected to function in excess of 120 years.

Conclusion

With modern manufacturing techniques and robust quality control standards it is reasonable to expect a service life in excess of 100 to 120 years for concrete pipeline systems.

For advice on achieving service life in excess of 100 years please contact the Concrete Pipeline Systems Association (CPSA).

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