Precast SuDS

Precast concrete SuDS solutions

Assessing long term serviceability and maintenance factors for different underground attenuation tanks

Last year, a new sewers' adoption code came into force, making underground stormwater attenuation tanks adoptable by water authorities. One of the adoption requirements for such attenuation systems is access for cleaning and maintenance throughout the service life of the asset. This factsheet looks at a wide range of factors associated with this adoption requirement and assesses the ability of several underground attenuation tank options to meet such requirements.

Adoption of attenuation tank systems

The new sewers adoption Design and Construction Guidance (DCG) came into force in April 2020, replacing Sewers for Adoption 7. For the first time, many Sustainable Drainage Systems (SuDS) can now be adopted by water authorities. Natural blue/ green applications such as retention ponds, swales and wetlands are usually used for SuDS attenuation. But where these solutions are unfeasible, proprietary underground attenuation tanks are used instead. The DCG notes that such underground tanks will need to have "… *provision for access for inspection and cleaning*". The DCG also requires means for the removal of sediment without allowing it to be washed downstream during maintenance and cleaning.

To put these requirements into context, adoptable attenuation tanks should be designed **with full accessibility** to enable the removal of any sediment which makes its way into the underground storage space. Such sediment will need to be **fully removable**, and the attenuation system will be expected to **withstand cleaning operations** where water jetting may be needed **throughout its service life**.

Achieving these requirements is crucial for asset undertakers. It is expected that there will be a significant rise in underground attenuation tanks constructed and maintained over the next few decades. Even if a small proportion of these tanks fail due to maintenance issues, the financial implications could be considerable. The ability of different attenuation tank options to fulfil these maintenance requirements may vary significantly as explained below.

Full accessibility

With the rising threat of flooding due to Climate Change, significant amounts of sediment is likely to enter attenuation tanks despite silt traps. Some recorded CCTV footages from inside some installed geocellular tank systems already show debris floating inside tanks (Figure 1). Footages show sediment, debris and even tree leaves settling and accumulating inside tanks. With an increase in flooding incidents and persistent rain over the next decades, the amount of sediment and debris finding its way through sediment traps will only rise.

Removal of such sediment is necessary as the continuous build-up of sediment can significantly reduce storage capacity and the efficiency of a tank to hold and release stormwater. It is not clear how attenuation tanks such as the ones identified in Figure 1 will serve for another four or five decades and continue to function without full access and a mechanism to retrieve the sediment.

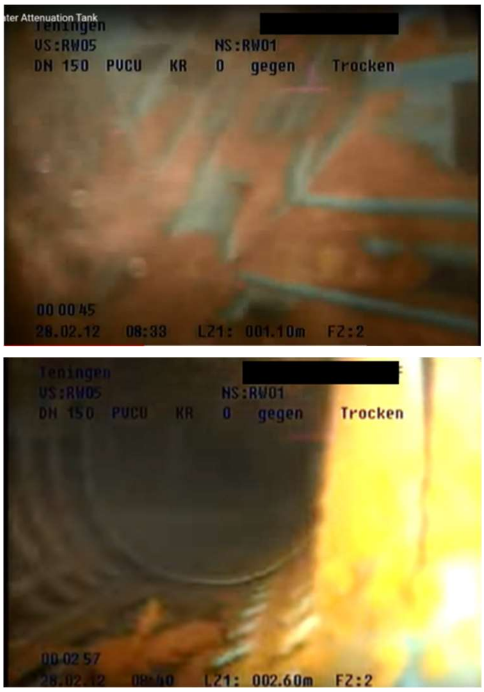

Figure 1. Footage from inside a stormwater attenuation tank, Sept 2013.

The process of retrieving that sediment and removing it from inside the tank could be a major challenge for some attenuation tank systems. Some geocellular tank suppliers seem to acknowledge that fact by stating that their units, once installed, cannot be visually inspected and maintenance will be based on reducing the rate of loss in performance over the life of the installation. There seems to be an acceptance that the storage volume will indivertibly be reduced over the life of the tank due to that inaccessibility problem. We identified at least one brochure by a stormwater box manufacturer which notes that most suppliers adopt this approach (gradual loss of capacity due to inaccessibility).

However, it is understood that some systems are accessible via CCTV and remote-controlled maintenance equipment: such systems may be cleanable internally. However, even such systems do not offer a guarantee of 100% access to the entire tank space. It is also unclear how sediment trapped inside such tank systems can be retrieved.

Conventional attenuation tank systems, such as piped systems, have an advantage over geocellular tanks. These systems can be accessible by larger equipment and visual inspection for the system is always possible.

Large diameter Pipes are even better in terms of accessibility as man-entry for inspection and maintenance is possible. Large tanks are usually supplied with entry points to enable this, making it significantly easier and more convenient to clean the units and retrieve any silt and oil from inside the tank. The same applies to attenuation tank systems made of box culvert units or precast modular tank systems.

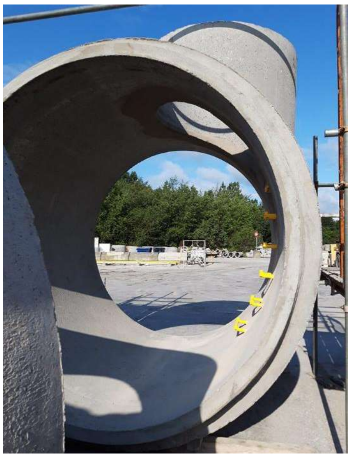

Figure 2. Side entry unit used as part of a concrete attenuation tank.

Withstanding jetting and cleaning operations

Cleaning of attenuation tanks will almost certainly utilise high-pressure water jetting. Higher pressure in jetting will enable different types of contaminants to be removed from the tank's structure. EN 14654-3: 2021 states that "*Maximum working pressures to avoid damage will vary according to the material of the pipe, condition of the pipe and type of nozzle*" as not all tank systems are the same when it comes to resistance to damage due to water jetting. The UK's Drain & Sewer Cleaning Manual (published in 2020) offers limitations on jetting pressures used for different types of drainage and sewer materials. These can be found in Table 1.

Jetting Pressure (MAX)	Concrete	Clay	Plastic	Bricks/ Fibre
PSI	5000	5000	2600	1500
BAR	345	345	180	103

Table 1. Water jetting pressure maximum limits in the Manual for Drain & Sewer Cleaning (WRc, 2020).

This clearly shows that for most plastic products, including plastic pipes and geocellular tank boxes, the jetting pressure should not exceed 2600 psi. The impact of this on the ability to remove some persistent types of contaminants, such as fat, oil, and grease, is unknown. Some geocellular tank systems made of virgin plastics claim to have jetting resistance of up to 2,800 psi. However, the ability of geocellular tanks made of recycled plastic to resist high-pressure jetting is largely unknown. Apart from one geocellular tank type, it was not possible to find any reports or literature confirming if the currently available range of geocellular tanks can meet the current jetting pressure designated for plastic pipes in the code, which is 2600 psi. The ability of the geocellular tank's membrane to resist jetting damage is also unknown. This is a major concern as retrieving and fixing any units or membrane damaged by jetting and maintenance is not possible once installed. On the other hand, precast concrete attenuation tank systems, including concrete pipes, box culverts, and modular tank systems, have proven high-pressure water jetting resistance of 5000 psi. Even in the extremely unlikely case of damage, concrete tanks' full accessibility enables asset owners to fix the units and restore them to their original state.

Maintenance against long-term damage and deterioration

Attenuation tanks should be designed to last for decades. The geocellular tank European standard EN 17152-1 suggests a design life of 50 years. For concrete attenuation tanks, series 1700 of the Specification for Highway Works in England (NG 1704) suggests that concrete pipes and box culverts, as highway structures, can fulfil a design life of 120 years. The main difference between precast concrete structures and different types of thermoplastic structures, such as plastic pipes and attenuation tanks, is the mode of deterioration during service life. The ring stiffness of a plastic pipe deteriorates over time (e.g. from 2kN/m^2 to 1kN/m^2 in the long term). The compressive strength of the geocellular stormwater boxes also deteriorates over time. All thermoplastic structures are subject to bathtub behaviour where the physical and chemical characteristics change over time (Farshad, 2006).

Concrete structures are different as their main compressive strength continues to grow as the structure gets older. Concrete may spall after decades of service. But if its steel reinforcement is protected by sufficient cover against any deteriorating elements, concrete structures can last for hundreds of years, growing stronger over time. This can make a significant difference when accessibility is considered. A 70 or 80-year-old attenuation tank structure with man access can be easily accessed and fixed where spalling or joint damage may have occurred, helping prolong the structure's life by a further 40 or 50 years. On the other hand, within a geocellular tank system if some of the 10 or 20-year-old geocellular units are damaged then the entire system can be compromised and may need to be replaced.

There is a significant difference in how various attenuation tank systems perform in terms of accessibility for cleaning and maintenance. Some systems are completely inaccessible, while others offer limited accessibility with no clear means on how to retrieve and remove sediment. Accessibility is also associated with long-term maintenance and the ability to mend accidental damage or age-related deterioration. Specifiers need to take these factors into account to avoid non-adoption. Asset undertakers need to assess the sustainability of the installation and adopt a Whole Life Costing approach when assessing systems with limited accessibility as long-term implications and risks exist.

References

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