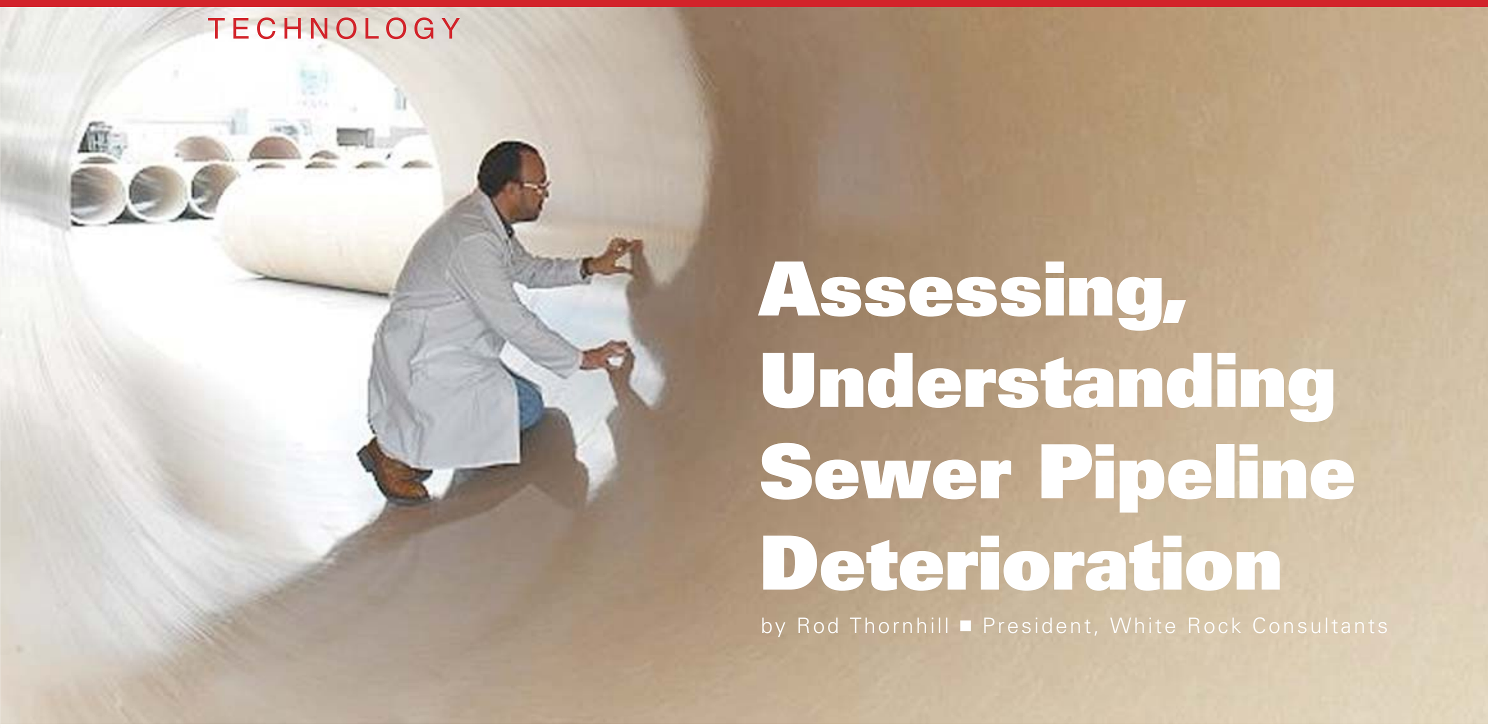

Assessing, Understanding Sewer Pipeline Deterioration

by Rod Thornhill ■ President, White Rock Consultants

As our ability to collect more detailed and versatile internal inspection data on sewers improves, new applications for the information are being developed. Particularly interesting is the use of the information for comparing multiple inspections of the same pipe segment over time to see what changes are occurring inside the pipe. This article discusses how this and other techniques can be used to better understand pipe deterioration and improve overall pipeline condition management.

Getting started – an assessment of the current pipe condition

A temporal comparison of pipeline condition requires that a common process for describing observations and defects be used for all current and subsequent inspections. Definitions for all conditions found during the internal inspection must be well established, including guidelines for assigning the clock position, severity, percentages, footage and grade. Also important is establishing how the data from each inspection will be stored in a database and the use of quality control to ensure accuracy of the coding.

Anyone who has tried to compare multiple TV inspections of the same pipe data collected from different coding systems can appreciate how unwieldy and unreliable that process can be. Commonly there are so many differences in code definitions and coding rules themselves that rather than using the coded data, it is more efficient to simply view the multiple inspections simultaneously and look for differences. Because this process would take so much time it is rarely conducted. The use of multiple coding processes and the unreliable comparison of data is the primary reason so little work in the United States has been done to better understand sewer pipeline deterioration.

To improve the accuracy and increase the use of internal TV inspection data, the trade organization NASSCO developed the Pipeline Assessment and Certification Program (PACP). The PACP is an industry standard for describing, coding, collecting and archiving defects and observations seen during TV inspections at different intervals. Implementation of PACP allows inspection data from different operators, engineers, contractors and software vendors to be used without translating the coding from one to the other. Standardization results in fewer resources needed for interpretation of the data so more resources can be directed toward utilization of the data.

NASSCO obtained the assistance of the Water Research Centre (WRc) in Swindon, England in developing the PACP. WRc established the Manual of Sewer Condition Classification (MSCC) for coding of sewer defects 30 years ago, and has conducted extensive research on pipe deterioration in the UK using the MSCC coding standards.

Many utilities have established their own excellent standards for defect coding. Regardless of whether it is a national standard or utility specific, a properly implemented process for consistently logging and storing data is an absolute requirement to detect pipe condition change. Each inspection will establish a benchmark of condition for monitoring changes throughout the life of each pipe.

Construction history

TV inspection is a relatively new technique for pipeline assessment, and only became a routine practice around 1980. Prior to the that, the ability to know the condition of pipes too small for man-entry was limited to what could be seen by lamping from the manholes. Correlating the construction history of sewers in the U.S. with the implementation of TV cameras shows that the majority of sewers were constructed in an era when the internal condition of a small diameter pipe was a mystery.

Leonard Metcalf and Harrison P. Eddy in 1914 wrote Sewerage Practice, Volume I; Design of Sewers. This remained a standard reference text on sewer systems for many decades and is now recognized as one of the greatest engineering achievements of the 20th Century.

Inadequate design and construction practices were of great concern to them. This view is no better illustrated than by the fact that they chose to make the following the first sentence of the book:

"American sewerage practice is noteworthy among the branches of engineering for the prepondering influence of experience rather than experiment upon the development of many of its features, apart from those concerned with treatment of sewerage."

Even in 1914, these two leading authorities recognized the tendency of sewer design engineers to use methods and materials in practice before those methods and materials had a proven track record.

They also wrote regarding the quality of concrete pipe in use at the time that:

"The amount of capital required to put up a small plant for making cement tile and pipe is so moderate that a large number of these little works have been built. Owing mainly to lack of skill, working capital, or both, much inferior pipe has been produced in these small plants, and this poor product has prejudiced many engineers against all cement pipe."

Col. George E. Waring, Jr., was a prominent engineer of the 1800s responsible for designing some of the earliest separate sewer systems in the United States. On the title page of his book, *Draining for Profit and Draining for Health*, published in 1867, he included the following quote:

"Every reported case of failure in drainage which we have investigated, has resolved itself into ignorance, blundering, bad management or bad execution." – William Gisborne, Minister of Public Works, New Zealand.

Inadequacies in the quality of sewer construction have been known to exist as long as sewers have been built. Only since the development of TV equipment have we been able to fully understand those construction related deficiencies. In 1969, we knew more about the dark side of the Moon than about the inside of small diameter sewer pipes.

Any investigation of sewer pipe deterioration should include a local perspective on past construction methods and materials. Some understanding of each era of construction should be developed and, where applicable, correlated to pipe condition. A good way to get started is browsing the map room or library where copies of out-of-date specifications are kept. Also useful is to discuss the type of materials and construction used with crews responsible for repairs, or experienced local contractors.

One important characteristic of construction that should be known is whether the pipes have manufactured joints. Most rigid pipe prior to 1960 was sealed with mortar, oakum, or a bitumastic material poured around the joint. These joints almost always leak and this leakage affects the ability for voids around the pipe to be created.

Also the strength of the existing pipe should be evaluated. We know many of the early rigid pipes were relatively low strength. By testing a few representative pipes, we would better understand why some areas of the collection system perform differently than others.

Mechanisms for change – factors that affect the rate of deterioration

Pipes constructed at the same time and with similar initial construction defects may have widely varying changes in condition over time. This is because certain factors are known to advance the deterioration of sewer pipes.

Perhaps the most obvious deterioration factor is concrete pipe exposed to H2S corrosion. The corrosion usually progresses at a steady rate and can be monitored by careful internal inspection. The PACP codes have several degrees of corrosion damage that, when combined with recording of clock positions and distance, can accurately describe corrosion damage and measure change in corrosion patterns over time.

Another powerful mechanism is surcharging of the sewer. During surcharge conditions, the sewer is pressurized with wastewater and the wastewater is forced out of the pipe through cracks, leaking joints, defective taps and other structural defects. The wastewater then saturates, softens and erodes the soil surrounding the pipe. Once the surcharge is relieved and the sewer is flowing freely, the wastewater leaks back into the sewer and may bring soil with it, leaving a void outside the pipe. If surcharging occurs again, the deterioration process is repeated. Surcharge is perhaps the most powerful yet often overlooked deterioration mechanism. It is not surprising that an area known to have a history of frequent surcharging will be in generally poor structural condition, since the correlation between surcharging and structural condition is so strong.

Groundwater infiltration, root intrusion and third party damage are other examples of factors that will contribute to the deterioration of the pipe.

Signs of H2S deterioration, root intrusion, groundwater infiltration and third party damage can usually be detected during internal inspection. Evidence of surcharge can be seen during an inspection of adjacent manholes or by a review of maintenance records or customer backup complaints.

Operational & maintenance activities

Much can be learned by knowing the previous operational and maintenance activities for each pipe. A pipe point repair may seem benign, but it probably indicates the pipe had previously failed. Many utilities have only recently began keeping repair history records; therefore knowing the existence and location of point repairs may only be possible as a result of internal inspection. Identifying the pipe repair material and knowing a little history of the utility will help to indicate how long ago the repair was completed.

Root intrusion is one of the most destructive deterioration mechanisms affecting sewers. It is no accident that roots find their way into sewers since they are naturally drawn to sewer pipes by the low levels of condensation produced by warm wastewater flowing through cool pipes. Roots find their way into pipes through initial defects such as cracks, holes, joints or defective taps. Once inside the pipes, roots flourish and in low flow conditions can grow hydroponically like tomatoes in a wire basket, with all the water, air and fertilizer they need. If the roots grow unabated they not only get more dense but they evolve from weak, fine roots, to thicker, woody tap roots that can make existing sewer defects worse.

Roots are most commonly removed by cutting them with a rodder or jet nozzle with a root cutter attached. However, root cutting does not remove the root, but merely cuts the root off at the pipe surface. More importantly, long term root cutting usually results in the root growing back with a denser pattern and spreading to other clock positions at the same location. Once the roots become established around the circumference of the pipe, they only need grow a few inches to begin causing reduction of flow and blockages.

Perhaps more troubling is the damage done to sewer pipes as a consequence of root cutting. Root saws spin inside the pipe at a high rate of speed and with considerable torque. The root saw is guided through the pipe by scraping against the inside surface of the pipe, therefore cutting the roots flush with the inside pipe surface. However, the inside surface of the pipe is often not smooth and can have protruding taps, uneven cracks and fractures and offset joints. While traveling through the pipe, the cutter can hit these features and cause further structural damage.

Changes in condition – retro-assessment of previous inspections

The use of a standard condition assessment procedure that has a high level of detail implemented for successive inspections provides the ability to detect any significant change in the severity of previous defects, and to identify when new defects are created. This gain in knowledge will result in a much greater understanding of each pipe segment. The practice of benchmarking using multiple inspections will quickly allow the rate of change for pipes to be estimated.

Use knowledge gained

Utilizing knowledge gained from research and investigation helps plan in a proactive management of pipes to alter pipe deterioration or plan replacement.

Better identification of deterioration factors affecting individual pipes will provide opportunities to improve the longevity of the pipe. For example, areas with history of frequent surcharge and accompanying structural failure can be targeted for more active backup abatement. Damage from aggressive root cutting may be reduced by changing equipment, better training or different root control strategies.

Summary

The understanding of pipe condition changes and the factors that influence pipe deterioration will be greatly enhanced by standard condition assessment practices. Application of common condition assessment for multiple inspections of the same pipe alone will provide a much greater knowledge of the behavior of that pipe. The construction methods and materials history will answer many questions regarding the significance of construction defects or pipe material longevity.

Using different and non-standard condition assessments during each inspection meant looking out a different portal each time a pipe was televised. Using a standard condition assessment approach means the industry is now able to use a time-lapsed picture window to see the entire landscape. As we begin to share what we have learned individually, we will be better able to embrace the concept of cradle-to-grave asset management and maintain each sewer pipe in perpetuity.

FOR MORE INFORMATION OR CONTINUED DISCUSSION:

Contact Rod Thornhill, White Rock Consultants, (214) 221-5474l, rodthorn@swbell.net