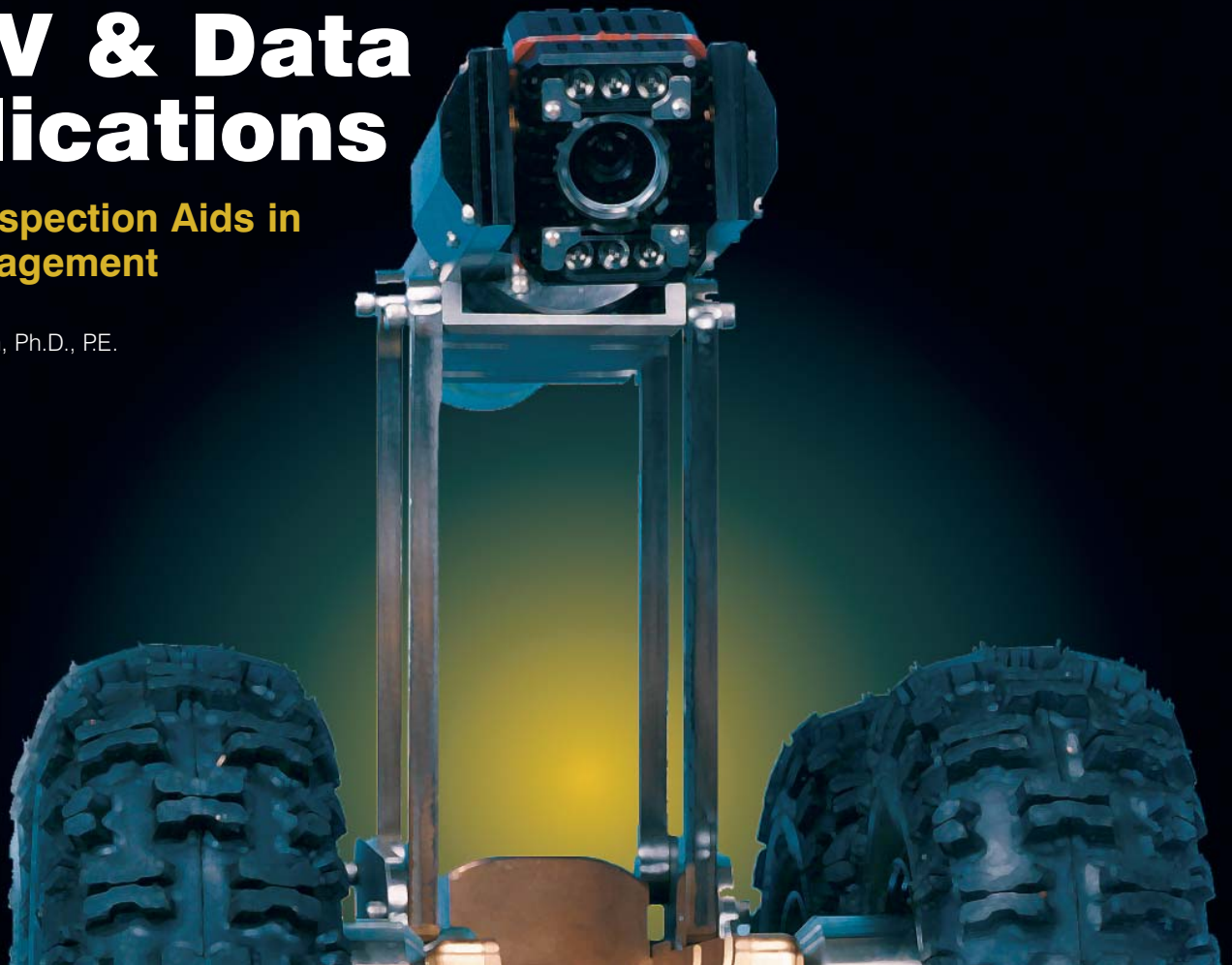


CCTV & Data Applications

Pipeline Inspection Aids in Asset Management

By Ahmad Habibian, Ph.D., PE.



CCTV cameras have been used for more than 40 years as a tool for inspecting small diameter sewer pipes. From black and white cameras with low resolution to today's cameras with the capability of generating high-resolution digital color videos, significant improvements have been made in the technologies to capture, store and assess video images. The migration to digital format of both the inspection images and the defect logs has made the analysis of CCTV easier and more efficient. The progress in the development of analytical tools to assist with the analysis and interpretation of CCTV data has been remarkable.

Application of CCTV Inspection

The CCTV inspection of sewer lines may be performed for a number of reasons including:

- Preventive maintenance
- I/I source identification
- Structural condition assessment
- Pre-rehab survey of sewer lines
- Quality control (acceptance) of rehabilitation pipe work
- Quality control of cleaning and other maintenance activities
- Complying with requirements of GASB34 modified (preservation) approach
- Collecting asset condition data for asset management plans
- Troubleshooting investigations for backups and overflows

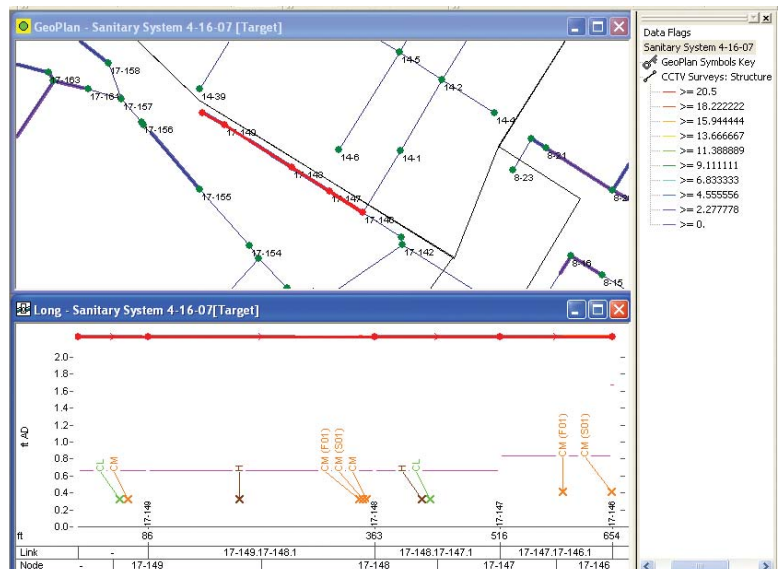


Figure 1. Graphical Depiction of CCTV Results

A survey performed for a research study for the American Society of Civil Engineers (ASCE) indicated wastewater utilities, on average, use CCTV to inspect approximately 7 percent of their system every year. Deciding which portions of the system to inspect is a challenge. Several factors should

be considered in crafting CCTV inspection programs.

Some wastewater agencies focus their limited resources on older and more problematic parts of their system. The new trend in developing inspection programs is moving toward the concept of criticality and risk. In this approach, the utility makes an assessment of risk associated with each sewer line and prioritizes its system based on the level of risk or criticality. The results of such an assessment are then used to develop an inspection program to manage the risk and keep it below an acceptable level.

Data Storage & Manipulation

For many years, CCTV images were stored on reel or cassette. A shortcoming of such media was the gradual degradation of the video quality over time. Additionally, the size of the physical space required for storing the video tapes was an issue for larger utilities with a large volume of CCTV data. With the advent of digital storage, the use of video tapes has now become almost obsolete. The digital data is stored on DVDs or large capacity hard drives. This not only reduces the physical storage requirements, but also significantly enhances the process of accessing the data. Many utilities have started building and developing asset management software with GIS interface capabilities that allow easy and efficient access to the CCTV data. In a typical application, a sewer segment of interest is selected in the GIS environment and with a few clicks of the mouse button, a graphical presentation of CCTV observations is generated, see Figure 1. The data for each observation, including video clips and still photo images, can be viewed by simply selecting the observation of interest in the graphical presentation of observations.

Data Analysis

The traditional approach to the analysis of CCTV included the review of CCTV observation logs and video images by an experienced person. This approach involved many hours of watching CCTV video tapes and assessing the severity of observed defects. While this process can provide reliable results, it is rather cumbersome and the results are heavily influenced by the level of experience of the person performing the analysis.

An alternative approach that has gained acceptance is to utilize a standardized defect coding system that can be utilized by the field crew to characterize the defects. NASSCO's Pipeline Assessment and Certification Program (PACP) was developed with this concept in mind. PACP not only standardizes the defect codes, but also provides rigorous training to operators to properly characterize the defects. This program has significantly advanced the analysis processes of CCTV data.

The PACP-compliant data collected in the field can easily be imported into a data analysis or asset management framework. With the availability of GIS data for the sewer system, color-coded maps of the collection system condition can be readily made, see Figure 2. Such a map would readily show the parts of the system that may have significant dete-

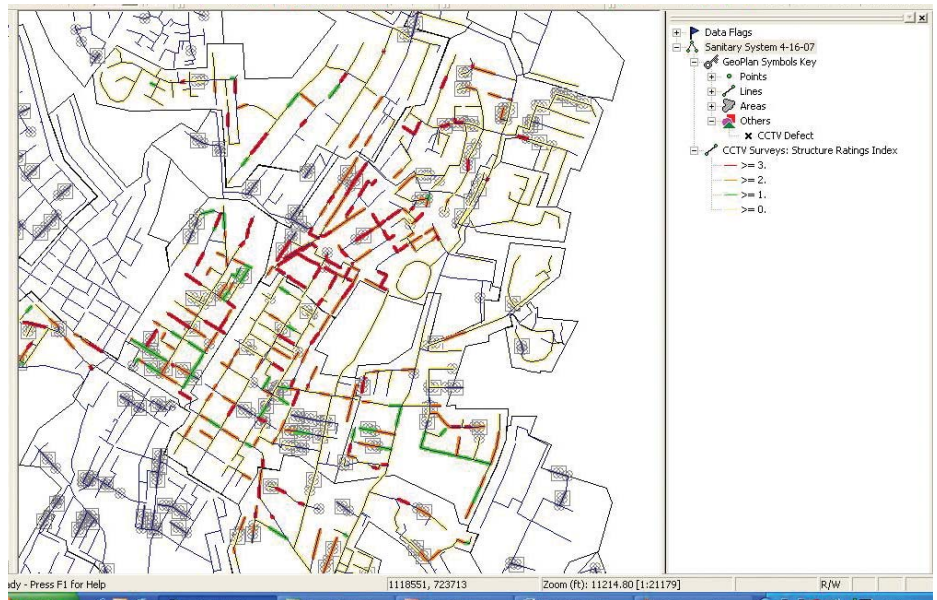






Figure 2. Graphical Representation of Sewer Pipe Conditions

rioration or have operation and maintenance implications. The information can further be analyzed to develop planning level costs for repair and rehabilitation.

Engineering level analysis can also be performed in areas with significant level of deterioration. The analyst would focus on such areas and perform a more thorough investigation of the sewer pipes including a review of the video images and still photos of the defects. The thorough analysis forms the basis for developing detailed rehabilitation options.


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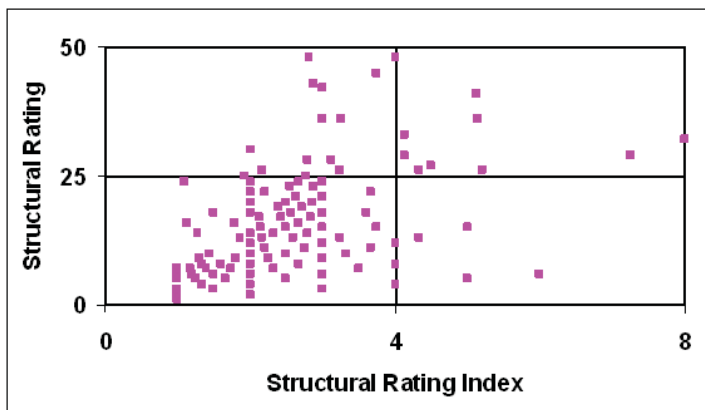


Figure 3. Analysis of CCTV Structural Ratings

PACP Coding System

The PACP defect codes are classified under three broad categories of 1- Structural, 2- Maintenance, and 3 – Construction. Each defect is uniquely defined and has a grade associated with it. The grading scale varies from one to five. The grades associated with all the structural defects observed in a reach of a sewer line (from manhole to manhole) are added together to arrive at a total grade score for that reach, which is referred to as Structural Rating. An average defect score, referred to as the Structural Rating Index, is calculated by dividing the Structural Rating by the total number of observed structural defects. The Structural Rating and the Structural Rating Index are used as a basis for prioritizing the structural condition of the sewer lines.

A chart of the Structural Rating vs. the Structural Rating Index is also a useful tool for gaining an understanding of the severity and distribution of the defects, see Figure 3. Each point on the chart represents one sewer line segment (from manhole to manhole). The results depicted in Figure 3 are from actual CCTV inspection of sewer system in the mid-Atlantic region. The top right hand corner of the chart (1st quadrant) is indicative of sewer line segments with a few concentrated defects of high severity. The best course of action for such sewer line segments may be surgical point repairs to eliminate such defects. On the other hand, the upper left hand corner of the chart (4th quadrant) is indicative of sewer pipes with a large number of small defects along the length of the line segment. The rehabilitation of the pipe by lining may be the best course of action for such a line segment. Quadrant 3 is indicative of a number of minor defects distributed over the length of the sewer line segment and quadrant 2 is indicative of a few moderate to minor defects in the sewer line segment. While it may be cost-effective to fix the defects for quadrant 2 by performing point repairs, it often is not cost effective to fix the defects for the sewer lines in quadrant 3. These defects, which are often minor, usually do not have a significant negative impact on the performance of the sewer line and can be placed on a watch list for future inspection and monitoring.

Similar to the analysis of the structural defects, the maintenance defects can also be processed and the results evaluated for developing preventive and routine maintenance recommendations

I/I Source Identification

As was mentioned earlier, CCTV may be utilized for iden-

tifying I/I sources. For identifying infiltration sources, CCTV inspection is performed during high groundwater conditions. The CCTV results would show all active sources of infiltration at joints, connections, and other defects. For identifying inflow sources, CCTV inspection is used in conjunction with dye testing. The inspection results would identify the point of entry into the sewer pipe of inflow sources that would have been identified during the smoke testing program.

Meeting the Requirements of GASB34 Modified Approach

An element of GASB34 modified approach is to perform an assessment of the condition of the system every three years. GASB34 allows wastewater agencies to utilize statistical approaches to extrapolate the overall condition of their system from a limited amount of inspection. At a CCTV inspection rate of 7 percent a year, approximately 20 percent of the system would be inspected in a three year period which can be used as a basis for extrapolating the overall condition of the sewer system. For the statistical approach to be valid, the limited inspection should be performed on a random sampling of the system.

Application of CCTV for Asset Management

A major component of an asset management program is condition assessment of assets. Any wastewater agency that utilizes asset management has to rely heavily on CCTV inspection for this purpose. Over time, the results of consecutive CCTV inspections of the same line can be used to develop deterioration rates associated with each class of sewer lines. Such deterioration rates would in turn be beneficial in developing estimates of remaining useful life of assets.

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Summary

After several decades of development, CCTV has established itself as a standard technique for inspection of sewer pipes. The advances in technologies for electronic capturing of the data, standardization of defect code descriptions, and development of analytical tools for data analysis have transformed CCTV inspection into a “must have tool” for wastewater agencies. The current state of deteriorating sewer infrastructure along with the strong interest in adopting asset management programs at wastewater agencies serve as major drivers for growth of CCTV industry in the 21st century.

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