Manhole inspection in the 'Building of the Year 2021' in Czechia

The entire interior of the over 35-metre-deep manhole was optically scanned with 4K resolution in a single vertical inspection. The operation was accompanied by two representatives of the Prague Municipal Sewage Authority.

The Prague Municipal Sewage Authority had imposing manhole structures, including an over 35-metre-deep manhole object, inspected with the Panoramo SI 4K inspection system in cooperation with Vodovody a kanalizace Jablonné nad Orlicí A.S., IBAK's sales and service partners for Czechia. IBAK used this particular practical application to create a digital twin on the basis of the Panoramo data.

Long-standing partner

Vodovody a kanalizace Jablonné nad Orlicí A.S. (VAK) has sold IBAK systems in Czechia for more than 30 years. The company was one of the first firms outside Germany to sell Panoramo systems for main sewers

and is therefore a committed pioneer of 360-degree camera technology. Accordingly, VAK is now also promoting this technology on the manhole sector with the Panoramo SI 4K. Tomáš Vymetálek and Vladimír Vokrál are part of the 10-strong VAK team and have advised the Prague Municipal Sewage Authority also to thoroughly scan complex manhole structures optically and to use the data for comprehensive condition assessment.

Proven function principle

The Panoramo SI 4K is a manhole inspection system that features 3D scanning technology and the possibilities of software-aided data processing. The system is equipped for this purpose with two high-re-

solution cameras with 185° fisheye lenses that look in opposite directions. During the inspection, the Panoramo SI 4K moves through the manhole and takes photos continuously. These are then put together to form an all-over 360-degree Panorama image. This method permits the complete mahole to be scanned in a single operation without any blind spots being created.

Award-winning structure

Among the structures that were to be inspected in Prague and the near vicinity were drop manholes, overflow structures and the award-winning combined waste-water collector in the ul. Nad Novou Libní. The last-named, which won an award as the 'Building of the Year 2021' in Czechia,

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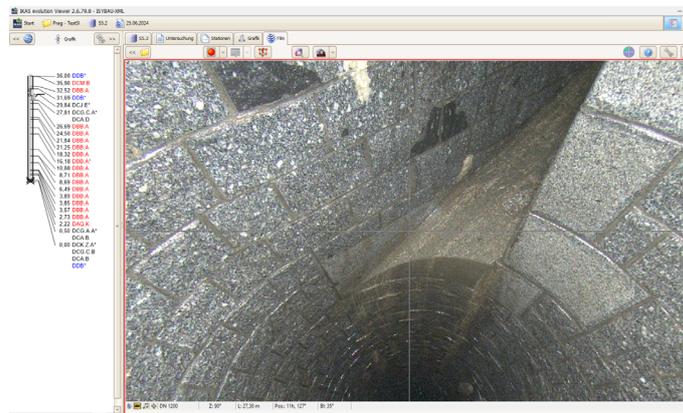marks a significant milestone in Czechia's modern sewer technology.

A central component of this structure is a circular slope with tangential inflow. The drop zone, which runs in the middle of a 1.2-metre-wide pipe, is of a particularly innovative design. Instead of the wastewater being guided along the vertical slope, it is led through a bypass channel. The drop zone is accessed via a spiral staircase. The bypass channel is located on a spiral plate next to the stairwell. The manhole itself is designed as a monolithic reinforced concrete pipe with an internal diameter of 5.25 metres and reaches a total depth of 35.50 metres.

This special construction method reduces the speed of the outflow, supports in this way the aeration of the water and therefore prevents the formation of harmful gases. Finally, erosion in the manhole is minimised, which contributes to assuring a long service life and the stability of the structure.

View of the scanned data in the IKAS evolution software at the position of the stormwater overflow.

Data evaluation with 3D measurement

The scanned data of the manhole in Prague was evaluated with the IBAK sewer analysis software IKAS evolution. From the image data, the software automatically generates a point cloud consisting of a large number of 3D measuring points. With these points, the geometric shape of the manhole is shown graphically. The software automatically identifies the diameter of the manhole rings. In the point cloud, any desired longitudinal or cross section can be generated to take measurements on them. Thus, in the point cloud, for example, the manhole depth can be measured or the dimensions of building components which were not previously documented, protruding connections or the pipe sizes of inflows and outflows can be determined.

After the 3D measurements have been captured, the geometrical shape of the measured object is shown both as a graphic in the scanned data and in the point cloud. Comprehensive evaluations on the basis of the data quality generated with the Panoramo SI have now been possible for 16 years. IBAK now used this specific practical application to investigate whether the data quality is sufficient to create a comprehensive digital twin of the over 35-metre-deep manhole structure. Basically, the familiar point cloud is already a digital twin. With this project, however, IBAK advanced a step further and aimed at producing a digital image that realistical-

ly reproduces both the geometry and the texture of the structure's surface.

3D reconstruction for visualisation

3D reconstruction is a process whereby three-dimensional digital models of physical objects or environments are created. This done by capturing and processing data, the source of which can be for instance stereo camera images, such as those from the Panoramo SI 4K. As the images are captured with this inspection system by two cameras positioned at a specific distance from each other, the same scene is scanned multiple times from different viewing angles. By evaluating the differences between the images, the depth information of the scene can be calculated using mathematical models. The result is a detailed 3D model that realistically represents the shape, the structure and also the texture of the original. For this purpose, a high-density point cloud is required. This is further processed into a surface network that shows the entire surface of the structure with a high degree of detail.

Such 3D reconstructions permit comprehensive, precise visualisation and analysis of physical objects and environments. They make it easier to understand the structure and the potential problems. This 3D model can be explored interactively, whereby problematic areas can be precisely analysed without requiring physical presence on site. In addition, the model enables precise measurement of cracks, deposits and other structural anomalies, thus permitting a rapid and exact assessment of the condition of the manhole.

The visualised representation of manholes in 3D helps to identify weak points, damage and wear at an early stage and to take targeted measures before major problems arise. This supports the decision-making process of engineers, urban planners and other stakeholders by providing clear and vivid data presentations.

Convincing results

The manhole is a decisive component of the sewer network because it forms the transition from the sewer system to the body of the road. It enables access for the operating personnel for cleaning, TV inspection, leak testing and the implementation of rehabilitation measures. For 16 years now, with the Panoramo SI inspection system, it has been possible to include manholes in the inspection and documentation of the entire sewer system.

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Above: First of all, IBAK generated from the Panoramo SI image data a high-density point cloud consisting of a large number of 3D measuring points (horizontally turned in the software).
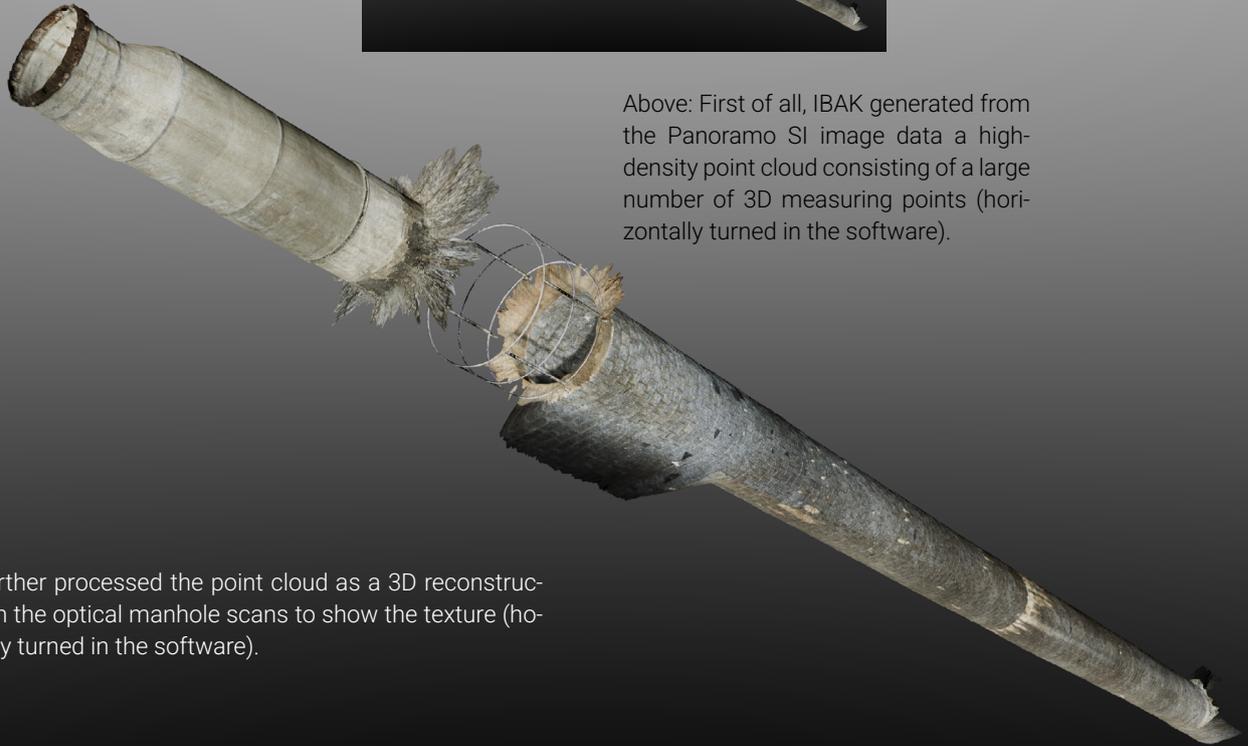
IBAK further processed the point cloud as a 3D reconstruction with the optical manhole scans to show the texture (horizontally turned in the software).

The inspection of the award-winning combined wastewater collector in Czechia impressively demonstrated the efficacy of the manhole inspection system. The rich-in-detail 3D scan provides the Prague Municipal Sewage Authority with valuable data for the evaluation of the condition of the manhole and supports them with the efficient and safe maintenance of their infrastructure. With the aid of this technology, potential problems can be identified at an early stage and remedied in a targeted way, which reduces the operating costs in the long run and prolongs the service life of the sewer system.

IBAK set themselves the task of using exactly this challenging structure to check whether the data quality of the Panoramo scan is sufficient to create a digital twin with a high degree of detail. The specific practical application with an exceptionally deep manhole offered an ideal opportunity to thoroughly investigate this question. The test was a complete success: A high-density point cloud could be generated from the Panoramo image data. It was demonstrated that the quality of the scans generated with Panoramo is sufficient to create a complex digital twin. The outstanding data quality that has now already been generated for 16 years with the Panoramo SI has proved its future viability and precision. With the

increasing significance of digital twins for the surveillance and analysis of structures, it was essential for the Kiel-based company to ensure that the technology used is capable of supplying the data basis for further mathematical calculations.

The Panoramo SI 4K has convincingly proved its capabilities in practical operation in the 'Building of the Year 2021' and will without doubt also play an important role in future for the maintenance and repair of manhole structures.

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