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Designing the separation of the combined sewer system in the Murcki district of Katowice.

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ABSTRACT: In 2019, design office SANKAT began designing the separation of the combined sewer system in the Murcki district of Katowice, the largest city in the Upper Silesian and Zagłębie metropolitan area. The scope of works covered the diameters in the range of DN300 – DN500mm. The condition of the existing sewer was very poor and caused many operational problems such as sedimentation and leaks.

The investment was designed using both traditional (open trench) and trenchless (pilot pipe jacking and microtunneling) technologies. The main reasons for using trenchless methods were the coverings of sewer sections above 4.5 m as well as road crossing locations. The extent of trenchless technologies amounted to:
DN400mm - 396m and DN500mm - 236m. The system was completed with DN1200 precast reinforced concrete manholes.

At the design stage four pipe materials were adopted, i.e. polymer concrete, stoneware clay, basalt or reinforced concrete pipes. Due to the fact that Katowice lies in a mining area, all materials had to be approved for use in mining damage areas up to and including category III (deformation up to 6 per mill). It forced the contractor to use pipes in shorter lengths, i.e. 1 m. The decision to use a particular material was left to the contractor.

The investment was carried out by the company Firma Handlowo-Usługowa INSTBUD and the trenchless works were the responsibility of the company PRI INKOP from Cracow, one of the largest companies in Poland specialized in the field of trenchless technologies. It was decided to use clay jacking pipes DN400mm and DN500mm on the entire scope of the investment, where the trenchless technologies were involved. The choice of clay jacking pipes was influenced by its high strength parameters, very long service life of well over 100 years, a positive opinion from the Central Mining Institute (Główny Instytut Górnictwa) for use in mining areas up to and including category III, short delivery times and the positive experience of the contractor and the investor from previous investments.
The contractor company PRI INKOP successfully performed the trenchless technologies from March to November 2022. Difficult ground conditions and rock interbeds forced the contractor to use the microtunneling machines Herrenknecht AVN400 and AVN500.

1. INTRODUCTION

Separation of the combined sewer system in the largest city of the Upper Silesian and Zagłębie metropolitan area requires a considerable amount of skills in finding the right technology as well as material suitable for the existing conditions. The best solution often combines the use of both trenchless and traditional technology for the construction and renovation of existing sewers.

2. GENERAL FRAMEWORK OF THE PROJECT

The project involving the separation of the combined sewer system in the Murcki district of Katowice is part of a major project co-funded by the European Union from the Cohesion Fund under the Infrastructure and Environment Operational Programme: “IMPROVEMENT OF WASTE MANAGEMENT IN THE CITY OF KATOWICE – STAGE III”.

The entire project consists of **89** investment tasks (including civil works, supplies and services).
Within the framework of the project, more than 90 kilometers of sewer networks have been or will be constructed and upgraded, using both traditional and trenchless technology.

The expected total cost of the Project is more than **PLN 345,235,154.06**.
Granted funding for the Project in the amount of **PLN 175,461,515.62**.

The aim of the entire task carried out by Katowickie Inwestycje Sp. z o.o. is to organize the sewage management in the city of Katowice and to adapt it to the requirements of Polish and EU law. The implementation of the project contributes to the improvement of the environment, including clean water and soil.

The main reasons for using trenchless methods were the coverings of sewer sections above 4.5 m as well as road crossing locations.

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3. DESCRIPTION OF THE TECHNOLOGY AND MATERIAL USED

The work was carried out using the microtunnelling method. Microtunnelling is a guided method using hydraulic presses: the pipe assembly – the tip of which is fitted with a jacking machine – is jacked from the starting shaft in the direction of the target shaft. Depending on the pipe diameter and the geological conditions, the distances that can be covered using this method can be as long as 200 m or even more. The removed soil is transported by an auger or an irrigation pipe.

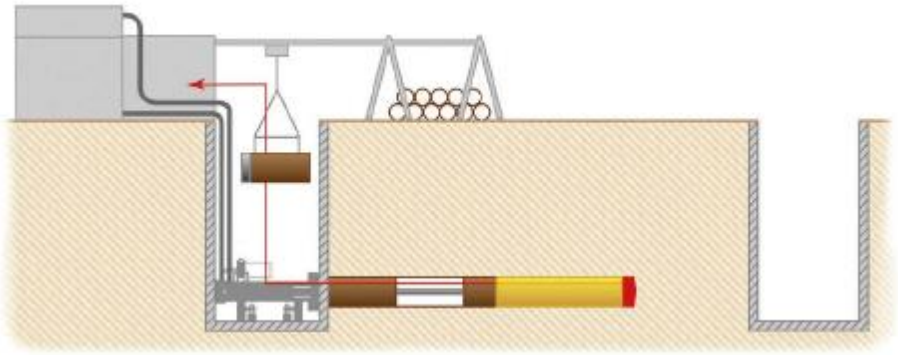

Figure 1. Microtunnelling method.

The installation process consists of the following steps:

- Insertion of the vitrified clay jacking pipes directly after the jacking machine
- Guidance of the jacking machine by the guidance cylinders in the cutting head
- Laser measurement with target board and geolaser
- Removal of the soil at the cutting face by the cutting wheel
- Removal of the spoil by slurry shields
- Separation of soil and water in the separation plant ..Recovery of the jacking machine in the target shaft

Waste water systems made of vitrified clay easily meet the extreme requirements and various properties of an economical and sustainable operation - for well over a hundred years. The features of material, joint, and component are excellent.

Table 1. Technical characteristic of vitrified clay jacking pipes

Technical characteristic	Value	units
Jacking forces	up to 2400	kN
Longitudinal pressure strength	100	N/mm^2
Wall thicknesses	up to 100	mm
Specific weight	22	kN/m^3
Bending tensile strength	min. 18	N/mm^2
Tensile strength	min. 10	N/mm^2
Modulus of elasticity	~ 50,000	N/mm^2
Tightness	up to 2.4 bar	bar
Corrosion resistance	given	
Chemical resistance	pH 0 - 14	
Frost resistance	given	
Hardness (acc. to Mohs)	~ 7	
Fatigue strength under cyclic load	given	
Reaction to fire	non-flammable	
Wall roughness	0,02	mm
Abrasion resistance	0,25	mm
Resistance against high-pressure cleaning	up to 280	bar
Service life	100 and more	years

4. DESCRIPTON OF THE PROJECT

The investment was aimed at separating wastewater through the construction of a new sanitary sewer network and the adaptation of the existing combined sewer system to a rainwater drainage system. The wastewater separation made it possible to solve the key problems of wastewater disposal and management in the area of the implemented project, such as excessive inflow of rainwater to the wastewater treatment plant or pollution of surface water by admixtures of sanitary sewage.

The investment area is located in the southern part of the city of Katowice, in the center of the Murckow Forest (Lasy Murckowskie).
The existing sewer system to be renovated and the designed sewers, including the accompanying construction facilities under the scope of the investment, are located in road lanes or their shoulders, on the properties owned by the City of Katowice.

Part of the sanitary, storm and combined sewer system is in a condition described as poor. The reason for this are the advanced age of the network and geological conditions. The existing sewer system caused many operational problems, related to the sewer leakages and the unreliable self-cleaning rate of the sewage – insufficient sewer slope.
Sewer failures mainly consist of clogs in the sewers and are removed on an ongoing basis by the technical staff of Katowickie Wodociągi S.A.

The planned investment, due to the adopted technologies and the way the work was performed, did not adversely affect groundwater. The facilities on the sewer network are designed with highly watertight materials that guarantee full watertightness.
The project's construction solutions assumed the construction of gravity sewers using the excavation method with GRP pipes or vitrified clay pipes, while sewers to properties were made of PVC-U pipes. Gravity sewers constructed using trenchless methods (drilling, jacking, microtunneling) were to be made of polymer concrete, vitrified clay, basalt or reinforced concrete pipes. The decision to use a particular material was left to the contractor.

The main reasons for using trenchless methods were the coverings of sewer sections above 4.5 m as well as road crossing locations.

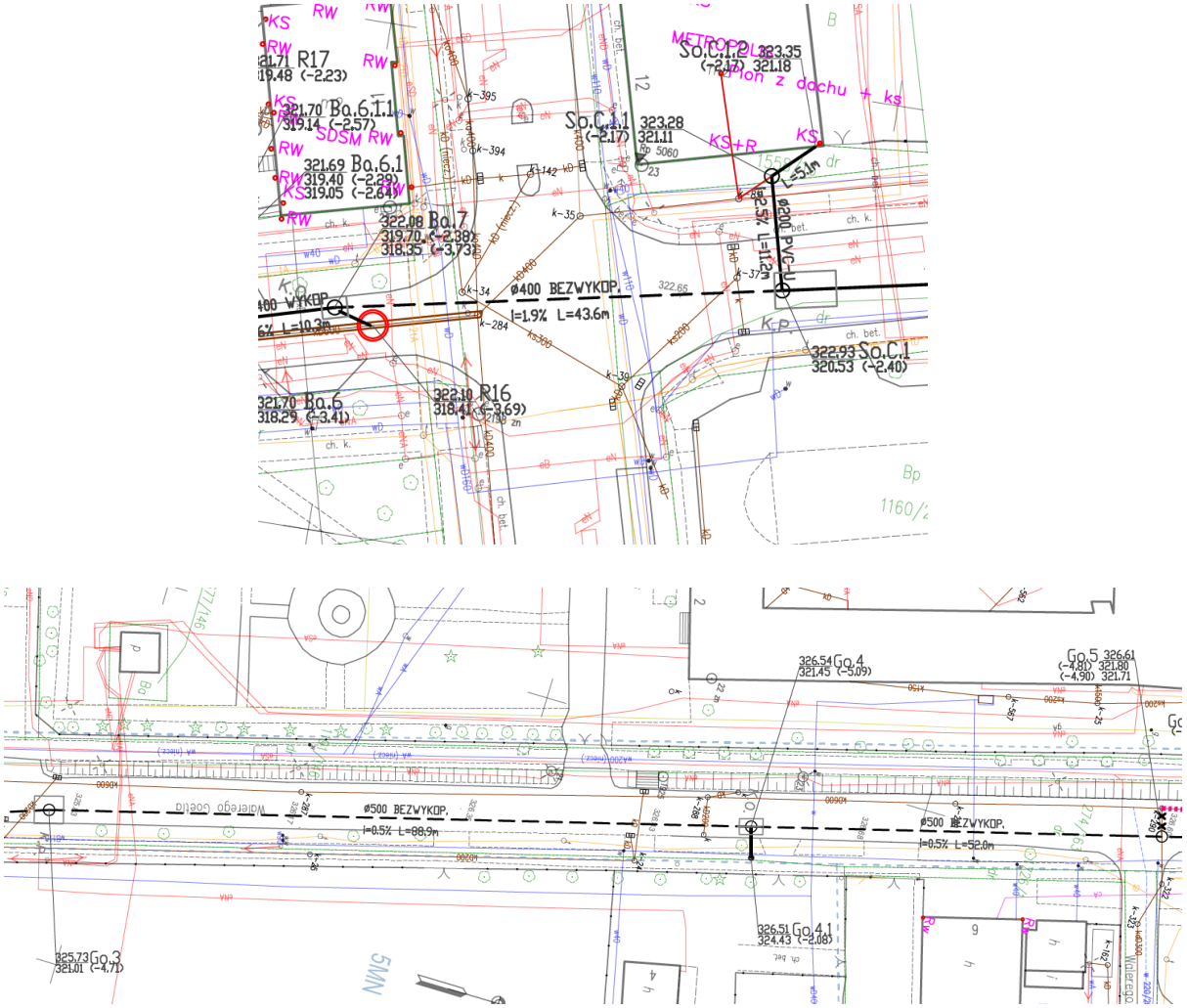

Figure 2. Trenchless technologies DN400mm and DN500mm planimetry

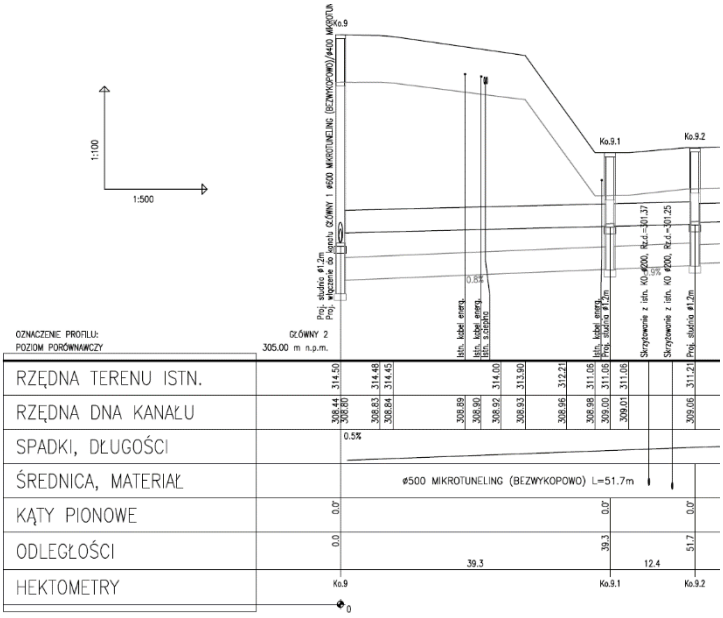

Figure 3. Profile DN500mm

The choice of clay jacking pipes was influenced by its high strength parameters, very long service life of well over 100 years and the positive experience of the contractor and the investor from previous investments.

Figure 4. Clay jacking pipes

The contractor company Inkop implemented the trenchless technologies from March to November 2022. Difficult ground conditions and rock interbeds forced the contractor to use microtunnelling machines Herrenknecht AVN400 and AVN500

5. CONCLUSION

The combination of different sewer construction technologies and materials at the design stage along with the experience of the contracting company is a key aspect to ensure the efficient and effective project implementation.