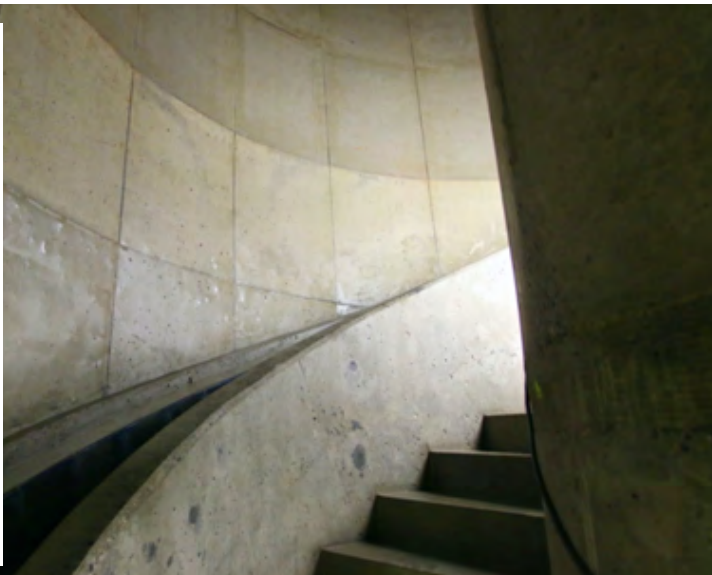




Prague Sewer Protection

Ďáblice, Czech Republic



General Contractor
ČERMÁK A HRACHOVEC A.S.

Owner
CITY OF PRAGUE

Engineer
KO-KA S.R.O.

Applicator
NEKAP S.R.O.

Products
CONCENTRATE, MODIFIED

Project Type
SEWERAGE TRANSPORT SYSTEM

Fig 1 -- Xypex Concentrate and Modified were combined to provide waterproofing and protection for two large shafts at the heart of a new sewage collection and transport system in the Ďáblice district of Prague, Czech Republic. Inset: large drop shaft (shown above) is 118 feet (36 m) tall and 20 ft (6 m) in diameter and features a spiral sewage channel and maintenance staircase.

Ďáblice ("she-devil") is a small enclave in District 8 (Fig 2) of the Czech Republic's capital Prague. Aside from its intriguing name, the community is known for its many sightseeing wonders, including the Ďáblice Observatory (Fig 3) on Ládví mountain, Prague's highest point at 1,178 ft (359 m) above sea level.



Fig 2 -- Ďáblice is located in northern Prague. Sewerage must be transferred from this elevated district down to the main wastewater treatment plant located on an island in the Vltava River.

While the area's elevation provides excellent views of the sky and surrounding lands, it also presents a challenge for municipal services such as sewer and water. One of Ďáblice's old-

est sewer lines was built in the 1970s and featured a series of short tunnels connected by six narrow drop shafts connecting each tunnel, forming a staircase-like structure descending down the steep hillside (Fig 4).



Fig 3 -- Ďáblice Observatory on Ládví mountain, Prague's highest point at 1,178 ft (359 m) above sea level.

Unfortunately, this configuration resulted in frequent drop-shaft clogging and constant maintenance. Eventually, the structure began to experience accelerated deterioration brought on by abrasion and microbiologically induced corrosion (MIC).

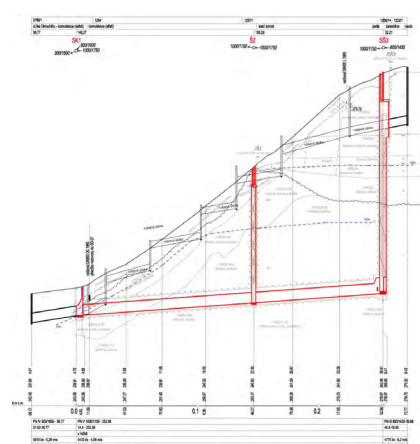


Fig 4 -- Side view of the new Ďáblice sewer connector system (in red). Tallest drop shaft (right) is 20 ft (6 m) O.D. x 17.2 ft (5.2 m) I.D. x 118 feet (36 m) tall. Center maintenance shaft is 13.8 ft (4.2 m) O.D. and 11.8 (3.6 m) O.D. x 72.5 ft (22.1 m) tall. The new connector tunnel at the base is about 820 ft (250 m) and cast-in-place concrete of an egg-shaped profile, lined with stone tiles. Old system shown in yellow. Blue lines show two distinct water tables due to bedrock formations.

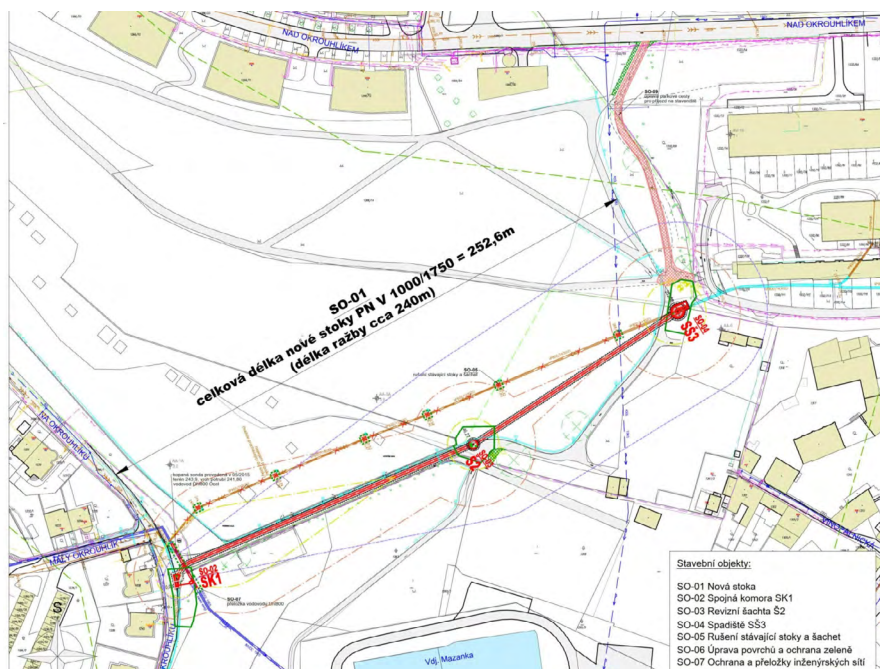


Fig 5 -- View of new wastewater collection and transfer system (red line), featuring two large cast-in-place shafts that are protected by Xypex Concentrate and Xypex Modified. Old sewer line (shown in blue) has 6 narrow drop shafts, which were prone to clogging.



Fig 6 -- The large shaft in the system is 20 ft (6 m) O.D. x 17.2 ft (5.2 m) I.D. x 118 feet (36 m) tall. Shown here under construction, the drop shaft will eventually have a spiral staircase and sewage chute that will allow wastewater to flow in a controlled way to the new transfer tunnel.

Replacement Required

In 2013, Prague-based KO-KA s.r.o. engineering firm was engaged by the city to design an alternative structure capable of providing a more controlled and maintenance-free descent for wastewater flow from the elevated community (Fig 5). The resulting design, features a main 20-foot (6 m) diameter drop shaft at the highest point connecting to a new transfer tunnel at nearly 120 feet (37 m) below the surface.

The main drop shaft (Fig 6) features both a spiral chute for controlled day-to-day wastewater descent and an overflow system for storm water acceptance (Fig 7). Storm water is redirected to a central drop shaft, which temporarily allows the overflow to freefall to the transfer tunnel (Fig 8).

The new 820-foot (250 m) long transfer tunnel connects with the pre-existing tunnel in order to continue the journey to the city's main wastewater treatment plant located on an island in the Vltava River. The new 1.45% inclined transfer tunnel provides a less aggressive wastewater flow than the previous system, resulting in lower emission of hydrogen sulfide (H₂S) gas and less abrasion.

Extra Protection Specified

One design challenge was the protection of the interior of both of the new shafts. The continual spray and splashing that occurs within the wastewater spiral chute and the extreme spray that takes place during storm overflow can cause MIC and other forms of infrastructure degradation.

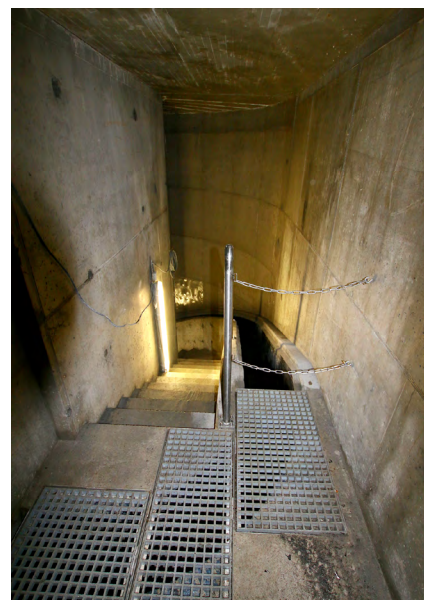


Fig 7 -- Large drop shaft features access/maintenance stairs on left and spiral wastewater chute on right to ease descent of sewage down to transfer tunnel at about 120 ft (37 m) in depth. Xypex Concentrate and Modified were used to coat all interior surfaces of both sewer shafts.

To protect the new cast-in-place main drop shaft and smaller (13.8 ft/4.2 m diameter) maintenance shaft (Fig 9), KO-KA specified that the structures should receive a coating of Xypex Concentrate (Fig 10) for deep-penetrating crystalline waterproofing and protection.

According to KO-KA project engineer Petra Bařinová, "Extra protection was needed due to the aggressive environment caused by sulphate and sulphuric acid attack. We chose Xypex Concentrate and Modified for long-term protection of the concrete without the risk of peeling or other imperfections that can occur with membranes and conventional coatings."

KO-KA has specified Xypex products on many other challenging projects throughout the Czech Republic, including utility tunnels and wastewater system construction/rehabilitation. In fact, KO-KA specified a special concrete-based injectable mix that was used to stabilize many Prague sewers (Fig 11) that were damaged by historic 2002 flooding in the city. Xypex Admix C-1000 NF was a key part of the sewer rehabilitation mix.

M 1:100

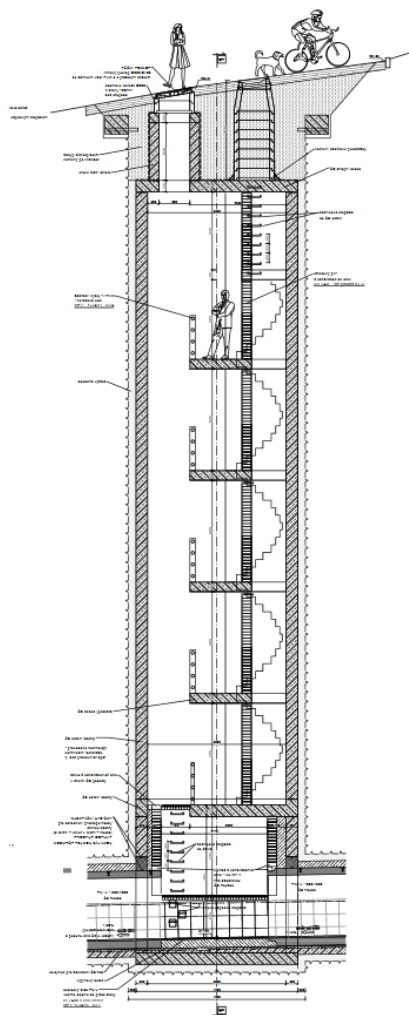


Fig 9 -- Middle maintenance shaft (shown above) in the Ďáblice sewer connector system is 11 feet 10 inches O.D. and 9 feet 10 inches I.D.

Fig 8 -- Drop shaft areas treated with Xypex Concentrate crystalline waterproofing and Xypex Modified hardener are shown in red above. These areas need additional protection due to the continual exposure to water, sulfates, sulfuric acid, varying pH levels and other harsh substances.

In this way, water and other liquids are prevented from penetrating the concrete from any direction. Laboratory studies have shown that

An additional coating of Xypex Modified was also specified to reinforce Xypex Concentrate. Xypex Modified chemically reinforces Concentrate to produce a harder finish that resists even extreme hydrostatic pressure, seals hair-line cracks up to 0.4 mm, resists aggressive chemicals, and cannot be punctured or torn.

Construction of the new wastewater collection and transfer system for Ďáblice was carried out from 2016 through August 2020. The application of Xypex Concentrate and Modified took place in early 2020 and was conducted by Nekap s.r.o., the Xypex distributor and a registered applicator for the Czech Republic.



Fig 10 -- Xypex Concentrate in 60 lb (27.2 kg) pails await spray application at a staging area near the Ďáblice sewer system shafts. Both Xypex Concentrate and Modified were used in the project to waterproof and protect the cast-in-place concrete.

Both Xypex Concentrate and Modified can be applied by brush or sprayer to saturated surface dry (SDD) concrete. The products were applied primarily by sprayer (Fig 12) in the Ďáblice project. According to Nekap director and Xypex regional representative Jan Mandelik, the firm's crew applied Xypex Concentrate and Modified over a four-day period using sprayers mounted on a 20-ft (6 m) extension poles (Fig 13).

The specially-designed spray tools helped save approximately two weeks of labor had the job been done using scaffolding and brushes and conventional sprayers. Approximately 20,000 ft² (1,900 m²) were treated with Xypex products, protecting the two shafts from internal wastewater spray and external groundwater intrusion. A total of 3,329 lbs (1,510 kg) of Xypex Concentrate and 2,513 lbs (1,140 kg) of Xypex Modified were applied.

"These structures are designed to last 100 years," Mandelik notes. "Xypex Crystalline Technology has been in use for more than 50 years on projects like this around the world. Engineers, contractors, architects and applicators specify Xypex because it can enhance the longevity of almost any project involving concrete structures."



Fig 11 -- Egg-shaped sewer lines are commonly used throughout the city of Prague, the capital of the Czech Republic. A new 820 ft (250 m) long wastewater transfer tunnel was built as part of the new sewerage project for the enclave of Ďáblice.



Fig 12 -- Here, a worker sprays Xypex Concentrate to the interior surface of the large drop shaft in the new sewer system serving District 8 in Prague.



Fig 13 -- A unique pole-mounted sprayer was devised to enable applicators to reach up to 20 ft (6 m) up to apply Xypex Concentrate and Xypex Modified to the saturated surface dry (SDD) concrete of both the large drop shaft and smaller maintenance shaft.