

# Sewage collector made of Polycrete® tubing segments

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According to the general town drain plan for the city of Offenbach the hydraulical capacity of the 80 years old DN 900 and DN 1200 sewage collectors (brickwork and vitrified clay) had been proven insufficient. So they were renewed by driving a tunnel and installing DN 1300 and DN 2000 polymer concrete tubing tunnels using the Tauber tunneling system.

ESO, the Offenbach municipal waste disposal body and client of the project, decided to request functional

proposals for the project without specifying a certain repair or renewal method. Due to the space limitations in the inner city and the unfavorable location of numerous existing supply pipes and cables the most effective and cost-efficient solution for the total renewal of the sewage collector was trenchless work. Kocks Ingenieure, a Frankfurt engineering company, was commissioned with planning and organizing the request for proposals for the sewage collector renewal.

First the various potential methods (open cut renewal, pipe jacking, constructing segments of concrete tubbings with subsequent inliner installation) were investigated carefully. Then Offenbach decided in favor of shield driving and installing a tunnel made of polymer concrete tubbings.

Thus Offenbach has become the first place where a sewage collector is

made of polymer concrete tubbings. So far tubing sewers that were built using the Tauber tunnel method were often used as external protection pipes for the actual sewer pipes, which consisted of corrosion resistant material. The costly insertion of an inliner is no longer necessary now because polymer concrete material is being used. The pre-fabricated Polycrete® tubbings manufactured by Meyer Rohr + Schacht in Lueneburg feature material properties as specified in DIN 54815 that make the tubing sewer reliably corrosion-proof.

## Sewage collector made of segments

Tauber Rohrbau GmbH & Co. KG, the building company, has specialized in this method which was developed in England in the 70ies. The core of the system is made up of three identical concrete segments (tubbings) which are either 60 or 75 cm long (depending on the diameter, which may range from DN 1000 to DN 3000). The segments with groove and tongue in axial direction are joined together to make up a stable, load-bearing pipe ring structure. Groove and tongue along the radial face ensure a flush tight joint with the previous pipe ring. The ring gap is filled with filler gravel (2 - 8 mm), and later on injection grouting is injected into the outer void along the whole drive length. Thus the required test pressure of 5 m of water column is guaranteed. The combination of pre-fabricated elements and the surrounding grouting layer generated on-site makes up a high quality compound pipe with tight joints.



1 The world's first sewer made of polymer concrete tubbings is located in Offenbach / Main. (photo: tis)

The structure's strength and fitness for use are proven by structural evidence for the tubbing construction in every project. The evidence is provided in line with the rules for tunneling, taking the load and soil situation into account. The calculation system is the pipe ring in elastic bedding with the tubbing joints designed as mobile links. The soil situation around the tunnel is the basis for the load bearing capacity. In normal soils (stiffness modulus  $< 10\text{MN/m}^2$ ) the structural strength of non-reinforced tubbings is sufficient. For unfavorable soils one reinforcement layer may be required.

## Project design

According to the general town drain plan for the city of Offenbach the hydraulical capacity of the 80 years old DN 900 and DN 1200 sewage collectors (brickwork and vitrified clay) in Wilhelmstrasse had been proven insufficient. So they had to be renewed by DN 1300 and DN 2000 sewer systems.

The work ordered by ESO included the complete removal of the existing DN 900 sewer (brickwork and vitrified clay) over the whole length between the crossings with Bieberer Strasse and Bismarckstrasse including all manholes and the construction of the new DN 1300 sewer made of polymer concrete tubbings. Due to a slight shift



3 Pre-fabricated tubbings for the DN 1300 sewer (photo: Meyer Rohr+Schacht)

of the new sewer axis compared to the old one it was necessary to partly remove a larger cross-section. The space around the ring was filled with concrete later on.

In the section between the crossings with Bismarckstrasse and Friedensstrasse the existing DN 1300 brickwork sewer including all manholes had to be removed and replaced by a new DN 2000 sewer made of polymer concrete tubbings.

The 95 street water sink and house connections (DN 150 and DN 200) in the sewer section to be renewed have to be properly connected to the new sewer. ESO strictly ruled out the interruption of those connections for the building period.

## Construction activity

In Offenbach a total number of eight drives between 5.5 m and 105 m long were produced with an open-face driving shield. The Tauber tunneling system employed here is equivalent to the method used for building large tunnels. The complete machinery, i.e. drive hydraulics, control cockpit, transport equipment and excavation tools, is located in a metal pipe. The operator sitting in the front in the control cockpit operates the various pre-controlled valves.

The difference between other jacking systems employed in sewer construction and the Tauber tunneling system is that in the latter the pipes need not be jacked through the soil by large hydraulic pressure, so no counter-support is required. That is why drives can be executed in any desired length.

The soil and any existing obstacles are excavated right at the open face within the new cross-section. First the excavation tool loosens the soil and moves it to the belt conveyor, which follows the driving machine on rails. Then the machine pipe is driven straight into the open soil



2 During the driving phase the house connections are cut and transferred to a temporary auxiliary line (photo: Meyer Rohr+Schacht)

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The soil and any existing obstacles are excavated right at the open face within the new cross-section. First the excavation tool loosens the soil and moves it to the belt conveyor, which follows the driving machine on rails. Then the machine pipe is driven straight into the open soil by its internal hydraulic cylinders. The driving steps are either 60 or 75 cm, depending on the tubing length. During this the finished pipe acts as counter-support for the pressure ring. Then the hydraulic cylinders are drawn in, making room for the installation of the tubbings, which are transferred to the location by the trailing transfer system. Once the new pipe segment has been installed and the gap around it filled it can serve as a counter-support for the hydraulic cylinders which drive the shield further. This method is most advantageous in soils which are susceptible to large jacking pressure because only little pressure is required to overcome the friction on the machine shell. Another most suitable field of application are places where there is danger of soil settling.

The design of the new sewer in Offenbach did not require a curved drive. Some difficulty was introduced into the drive process because in certain sections there was too little space left above the new sewer. In order to avoid soil settling and damage to the road surface it was therefore



4 Inside view of the cockpit of the driving machine (photo: tis)

necessary to partly position the machine below the old sewer.

In a number of sections the demolition of the old sewer bottom presented additional difficulties. The use of the conventional excavation equipment would have caused excessive wear. The use of conventional explosives was ruled out in the densely built-up area, which is sensitive to shock waves. So Tauber Rohrbau GmbH & Co. KG used the Boulder Buster method, an alternative blasting method. The Boulder Buster is a non-exploding tool for breaking rocks. A cartridge contain-

ing an agent is inserted into a drill hole that is filled with water and then activated, generating a pressure pulse. Through a channel the pulse is introduced into an incompressible fluid column. The pressure pulse destroys the boulders with little shock waves. The use of the Boulder Buster method made it possible to easily remove part of the old sewer bottom in a very short time.

## Flow management

The Offenbach sewer system is very shallow, with extremely little gradient. In the event of heavy rainfall the situation becomes critical because then there is water backlog building up from the river Main. So flow management turned out to be problematic at times. Each length had to be blocked, and about 200 l/sec had to be pumped over to the sewers in the neighboring roads.

## House connections

One reason for selecting the Tauber tunneling method for renewing the sewer was the large number of house connections and sinks. Those 95 connections could not be closed

## Advantages of the mini-tunneling method:

- Due to the compact machine design the diameter of the start and receiving pits need no be bigger than 3.8 m.
- Effective work is also possible in areas which are sensitive to settling.
- Only lightweight equipment needs to be handled, which facilitates the supply of construction sites in the inner city.
- No counter-supports are required.
- No costs incurred to compensate for any damage due to high jacking pressure.
- House connections can be re-connected during the construction phase without problems.

down. That is where the special advantage of the Tauber method came in because the house connections could already be re-connected during the construction phase. The connections were simply cut during the driving process, and the ongoing discharge was transferred to a temporary auxiliary line. Upon completion of a length the house connections were properly re-connected to the new sewer in their old place.

### Manholes

All nine existing manholes in the sewer section had to be renewed, too. For renewing the manholes prefabricated rectangular polymer concrete profile slabs were used.



The connection with the sewer system is unproblematic. The tubings are inserted in the specially prepared profile slabs and bonded using epoxy resin. Thus a uniform, corrosion-proof system is generated.

The construction project with an overall volume of EUR 2.3 mill. was started in October, 2000, and is scheduled for completion by June, 2002.



#### POLYCRETE® Tubbing segments DN 1000 - DN 3000

Inner diameter mm	Outer diameter mm	Wall-thickness mm	Length mm	Weight kg/Ring
1000	1140	70	600	320
1300	1480	75	750	545
2000	2280	120	750	1385
2500	<i>Under construction</i>			
3000	<i>Under construction</i>			

#### Construction project:

Renewal of sewage collector, DN 1300 and DN 2000, in Wilhelmsstrasse, Offenbach / Main

**Client:** ESO (Offenbach city municipal utility and disposal company)

#### Builders:

Tauber Rohrbau GmbH u. Co. KG, Muenster

#### Tubbing manufacturers:

Meyer Rohr + Schacht GmbH

**Start of project:** October, 2000

**Scheduled project completion:** June, 2002

**Project volume:** EUR 2.3 Mio.

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