

## 32nd WEDC International Conference, Colombo, Sri Lanka, 2006

## SUSTAINABLE DEVELOPMENT OF WATER RESOURCES, WATER SUPPLY AND ENVIRONMENTAL SANITATION

## Colombo Sewerage Rehabilitation Project

M.R. Andersen, Denmark

*This paper describes an ongoing project in Colombo. The aim of the project is rehabilitation of the most critical part of the existing sewerage system in the city and construction of a new pumping station, which will replace the largest existing pumping station. Upgrading of a smaller existing pumping station by replacing all electrical and mechanical equipment is also part of the project. The benefits of the project will ensure the foundation for further development of the city, without overloading the sewerage system. In addition, ground water reserves will no longer be drained due to the condition for the sewerage system, which also will reduce operational costs of the connected pumping stations.*

**Colombo sewerage rehabilitation project**

The ongoing project was awarded to the Danish contracting company, Per Aarsleff A/S, in November 2004. The client, National Water Supply & Drainage Board (NWS&DB) invited the bids for the project in February 2004 after ensuring a soft loan from the Danish Government through DANIDA. The project value is approx. 22 million €.

**Background of the project**

The necessity for the rehabilitation of existing pipelines in Colombo was determined in 1997 during a study performed by the consulting company WS Atkins. In addition, collapses for the roads, due to collapsed sewerage pipelines had proven the need.

The main sewerage pipelines were built more than 80 years ago and their structural condition have since then deteriorated considerably.

During the above mentioned study, it was also proved that, massive infiltration of groundwater into the sewerage pipelines was occurring. In the report, the infiltration of groundwater was described as significant and is estimated to be 20 – 40 % of the total flow by NWS&DB.

**Scope of Work in the project (CSRP)**

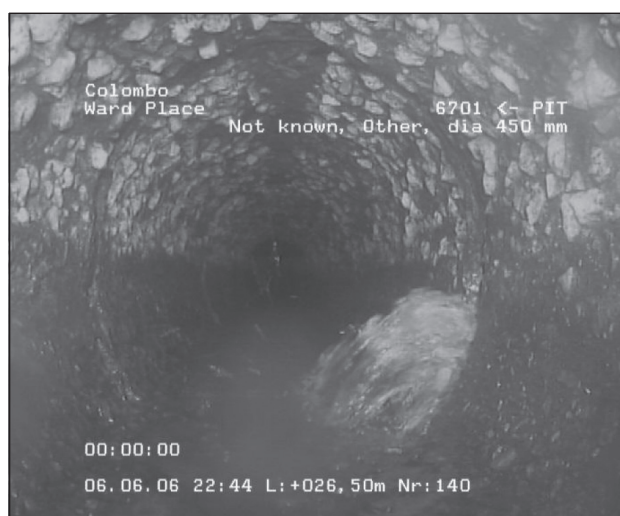
The scopes of work in the project consist of the most critical sewerage pipelines in the Northern catchment of Colombo and the largest pumping station in the city as well as rehabilitation of one pumping station in the southern catchment.

The scope of works included in the project is selected based on the earlier classification of pipelines as being critical, and according to the severer impact failure or collapses will have on the entire sewerage system in the city.

The commencement date of the project was the 9th of March 2005 and the project period is 32 months.



**Figure 1. Road collapse in T. B. Jayah Mw in Colombo, September 2005**



**Figure 2. Photo from inside the existing pipeline**

**Table 1. Scopes of Work in CSR**

| Description   |
|---|
| New pumping Station with a capacity of 2,900 l / sec. Madampitiya Pumping Station.  |
| Rehabilitation of approx. 9300 meter of existing sewer pipelines, ranging from circular 450mm to egg shaped 1830 x 1220 mm. |
| Rehabilitation of an existing pumping station up to a capacity of 1,700 l / sec. S8 Pumping Station.                        |

**Madampitiya Pumping Station**

The construction of new pumping station at Madampitiya is made difficult by the hard gneiss rock in the area and depth of the existing main sewerage pipeline. The construction of the pumping station is therefore made inside a cofferdam constructed by secant pile walls and heavy steel shoring.

The new pumping station will be equipped with coarse screen, automatic fine screens and vortex for removal of sand. The new pumps will transport the sewerage to an existing collection chamber, from where it is discharged into the sea.



**Figure 3. Established cofferdam for construction of the new pumping station**

**S8 Pumping Station**

In this existing pumping station, electrical and mechanical equipment will be replaced to accommodate the projected incoming flow for year 2020.

Both pumping stations will be equipped with frequency converters and a SCADA system to optimize the pump efficiency and thereby reduce running costs for the pumping stations.

**Rehabilitation of sewer pipelines**

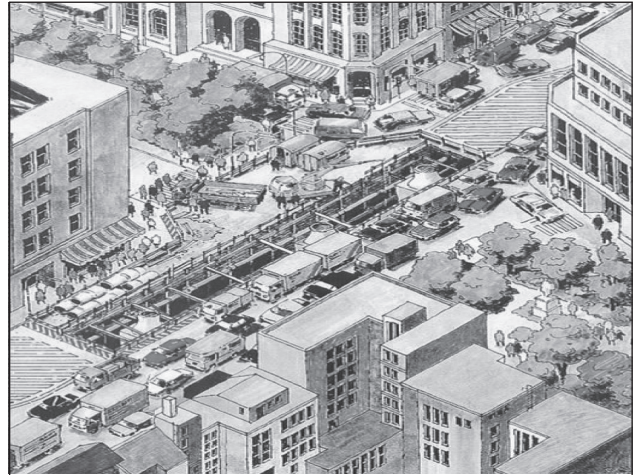
The most critical sewer pipeline in Colombo was established from 1906 and located under the main roads of the city. The topography of Colombo is the reason for a small slope of the pipelines and also the reason for the main critical sewers at a depth of 5 – 10 meters.

Combined with a high ground water table, the depth of the sewers make replacement by conventional excavation difficult and costly. The location of the sewers would also

disturb traffic to an unacceptable level, if excavations were to be made. Based on these arguments it was decided to use trench less technology, popularly called No-Dig methods.

**No-Dig methods versus Excavation**

As illustrated by the drawing below, the necessary working area is limited using No-Dig methods.



**Figure 4. Replacement of sewerage pipelines by excavation**



**Figure 5. Rehabilitation of sewerage pipelines using No-Dig method**

The difficult soil conditions and high ground water table will extend the excavation period considerably, and comparing the execution period on site, No-Dig methods will be approx. 7- 15 times quicker then replacement by excavation.

**Requirements to No-Dig methods**

Based on the surveys made in 1997 the requirements for the acceptable No-Dig methods were decided:

- Self sustaining rehabilitation, new products shall be able to sustain all external and internal loads on their own.
- Product life expectancy of minimum 50 years.
- The flow capacity of the existing pipelines must not be reduced.

**No-Dig methods used in CSR**

After cleaning and CCTV investigation of the existing sewer pipelines, two methods were selected for rehabilitation of the sewer pipelines, Aarsleff CIPP and Aarsleff GRP.

**Aarsleff CIPP**

CIPP is an abbreviation for Cured In Place Pipe and the name describes the principal well. The principle is to tailor make a liner to a certain section of sewer system. The flexible liner is first impregnated with resin, taken to the installation site, installed and cured on site. A new pipe is thus installed inside the existing pipeline.

In this project this method is used for the smaller pipelines ranging from circular 450mm to egg shaped 1050 x 710 mm. The total lengths for each dimension are shown below.

**Table 2. Length of CIPP rehabilitation**

| Dimension [mm] | Length [m]   |
|----------------|--------------|
| 450            | 1,110        |
| 525            | 1,217        |
| 600            | 506          |
| 825 (Siphons)  | 56           |
| 900 x 600      | 682          |
| 1050 x 710     | 469          |
| <b>TOTAL</b>   | <b>4,040</b> |

**Benefits for the client**

The advantages of this method are:

- Fewer disturbances to traffic and other public areas.
- Shorter execution period per meter of pipeline.
- Lower cost compared to traditional methods.

**Impregnation and installation of Aarsleff CIPP**

The dry liner is made of polyester felt and impregnated with polyester resin while being under vacuum.

Installation of the CIPP has a total duration of 3 – 4 days depending on the dimension and length of the rehabilitated section. The duration covers setting up of necessary installation equipment, inversion of the liner, curing, cooling and reopening of the rehabilitated section.

Photos from inside the existing and rehabilitated pipeline are shown opposite.

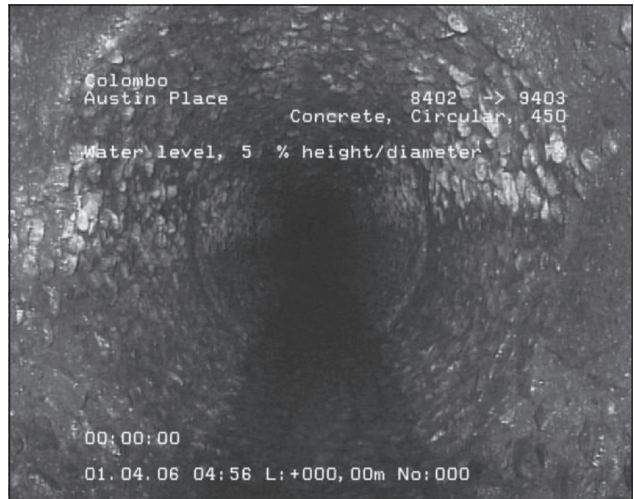
**Technical improvements**

Technically the improvements to the sewer system are:

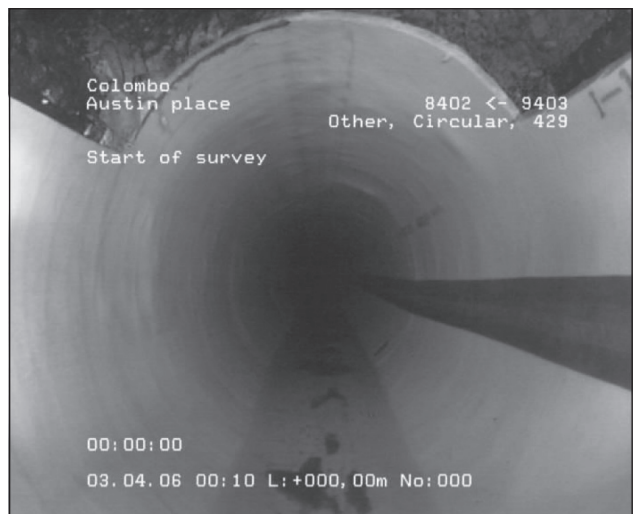
- New self sustained pipeline, with an expected life period of more than 100 years.
- Elimination of ground water infiltration.
- Increase of flow capacity by approx. 10%.
- Reduced siltation due to improved self cleaning effect.



**Figure 6. Installation equipment**



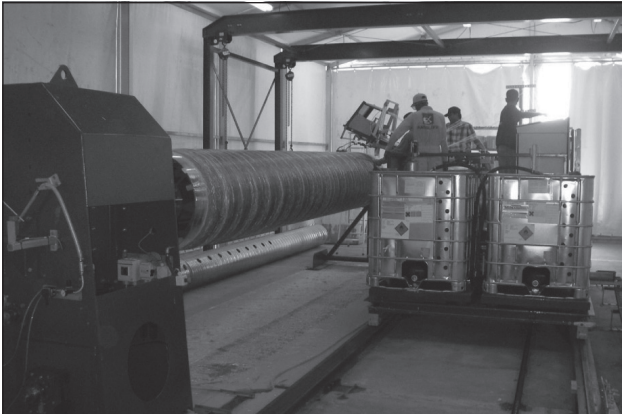
**Figure 7. Pipeline after cleaning, but before rehabilitation.**



**Figure 8. Pipeline after rehabilitation.**

**Aarsleff GRP**

The second No-Dig method that is used in the project is Aarsleff GRP, the benefits of which are similar to the benefits mentioned earlier. GRP is an abbreviation for Glass-fiber Reinforced Plastic pipes. The Aarsleff GRP is made using filament winding technology. The pipes are produced close to the installation site for this project, at a factory. The pipes can be produced in all lengths up to 6 meters, but the limitation in length is determined by the physical conditions inside the existing pipeline.



**Figure 9. Aarsleff GRP production factory**

**GRP Production**

Production of the GRP pipes is performed under a computerized filament winding machine. After initial curing the 6 meter pipe is cut into smaller pipes and the socket and spigot ends are grinded. The specially produced socket is installed in the socket end of the pipe and a special gasket is mounted in the spigot end.

**GRP Installation**

The pipes are lifted into the existing sewer pipeline, transported to the correct location, placed and jointed with the other GRP pipes. In principal it is construction of a new pipeline inside the existing one. The annular space between the existing and new pipeline is filled with grout after placement of GRP in the entire section.

The GRP pipes are transported inside the existing pipeline using a specially constructed trolley, which is also used to connect the GRP socket and spigot ends.

This method reduces the cross sectional area of the existing pipeline by about 10 – 15 %. Due to a much lower friction in the new pipeline, the flow capacity is not reduced and in fact is increased by up to 5 %.

**Technical improvements**

Technically the improvements to the sewer system are:

- New self sustained pipeline, with an expected life period of more than 50 years.
- Elimination of infiltrating ground water.
- Reduced siltation due to improved self cleaning effect.



**Figure 10. Transportation of GRP inside existing pipeline**

**Table 3. Length of GRP rehabilitation**

| Dimension [mm] | Length [m]   |
|----------------|--------------|
| 1370 x 900     | 1,178        |
| 1450 x 960     | 1,547        |
| 1830 x 1220    | 2,528        |
| <b>TOTAL</b>   | <b>5,253</b> |

**Environmental benefits**

- No future road collapses and continuous repair work of the sewerage system.
- Lower operation costs of the pumping stations, due to reduction of infiltrating ground water.
- Lower rate of contamination of surface water by sewerage, due to overload for the capacity in the sewerage system.

**References**

Sewerage rehabilitation proposals for Colombo, WS Atkins International Ltd., April 1999.  
 Colombo Sewerage Rehabilitation Project, National Water Supply & Drainage Board, 2004.  
 Sewerage Rehabilitation Manual, WRc plc, March 1994.  
 Static dimensioning in the rehabilitation of sewer pipelines (gravitation lines), 2nd edition, The pipe centre, Danish Technological Institute, December 2001.  
 Documentation of Calculation of flow capacity, Aarsleff, May 2004.

**Contact addresses**

Martin Rye Andersen  
 Project Manager  
 108 Nawala Road, Narahenpita  
 Colombo 05, Sri Lanka