



Assessment of Angerlehner's MCS Sewer Renovation System - schedule

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1. Scope

To assess the performance of the MCS Sewer Renovation System developed and installed by Angerlehner, which consists of:

- the reaming of the host sewer to a suitable depth, so as to maintain the sewer's flow capacity after relining whilst sustaining structural integrity during installation. Reaming also removes the contaminated surface layer of the sewer and improves bonding of the grout.
- a GRP lining that provides a watertight and hydraulically smooth flow path and can be designed as a self-bearing structural component of the installed system.
- a grout that fills the void between the GRP lining and the reamed sewer, thereby preventing point loading of the lining and imparting additional load bearing capacity to the installed system.

This assessment considers the generic renovation system using any GRP lining that meets the requirements of the purchaser, including the MCS lining when appropriate.

2. Assessment schedule

The assessment will cover the following aspects of the renovation system.

- 2.1 A technical audit of the design methodology;
- 2.2 A technical audit of material properties, including type testing, quality control, and test results;

- 2.3 A technical audit and review of procedures, including written statements and on-site installation.

3. Design Methodology

Finite element analysis can be used for all aspects of the structural design of the Angerlehner MCS system.

The MCS system can also be designed as a Type I or Type II lining, according to the methodology developed by WRc⁽¹⁾. However, when this design approach is used, finite element analysis is still necessary to confirm that the host sewer is suitable for reaming.

The use of an established finite element analysis package (such as FINAL) by an experienced operative is an essential requirement of the design process. In addition, the following aspects of the finite element analysis will be reviewed as part of a technical audit.

- The appropriateness of assumptions made in the structural analysis (including materials properties and loading);
- The suitability of data collection (for example, that required for constraining ground parameters);
- The selection and application of factors of safety;
- The specification of a suitable minimum wall thickness to be maintained after reaming.

4. Review of materials properties

Properties of grout:



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- Bleeding of the grout must be sufficiently low to prevent excessive segregation and settlement of the grout materials. Bleeding after 3 hours shall be less than 2%, when tested in accordance with the method given in EN 445;
- Cube crushing strength ≥ 30 MPa when tested in accordance with the method given in ÖNORM B 3303;
- Permitted volume change between -0% and +2.5% when tested in accordance with the method given in EN 445.

Properties of GRP lining:

This assessment considers the generic Angerlehner MCS Renovation System using any GRP lining that meets the requirements of the purchaser, including the MCS lining when appropriate.

For installations where a Type I design approach is adopted ⁽¹⁾, the grout-lining must have a minimum shear bond strength of 1.0 MPa, when tested in accordance with the method given in RVS 11065 or equivalent.

5. Review of procedures

In addition to the properties of the materials, the following procedures will be reviewed:

- Material control (QC, delivery, storage, and stacking);
- Reaming;
- GRP lining installation;
- Hand laminations;
- Grouting (including mixing and metering of grout, control and use of admixtures in grout, and the decision support for determining

the quantity of grout to be laid in each layer);

- Post-installation inspection.

The accuracy of the reaming process is important to the integrity of the installed system. The following factors will be reviewed:

- The criteria used for checking that the host sewer is suitable for reaming;
- The pre-reaming data collection through coring of the host sewer (adequate sampling period and measurement techniques);
- The minimum wall thickness of the reamed sewer, which must be in accordance with the requirements of the structural analysis;
- The accuracy of the reaming, which shall be such that the reamed sewer is within -0% and +5% of the intended dimensions;
- The line and level of the reamed sewer – the reaming shall maintain the line and level of the host sewer or modify it in accordance with the design specifications;
- The QC procedures for reaming considering the depth of cut, wear of reaming tool, changes in line and level, and remedial actions for any unforeseen structural problems.



6. Audit of On-Site Installation.

Installation will be witnessed at one site to review on-site procedures. The quality of the reaming will be assessed at two sites.

A check will be made at two sites to ensure that the installed system is fit for purpose, considering that:

- The installed lining shall be watertight and have a smooth internal surface that is free from cracks and other surface defects;
- Lateral connections and hand laminations shall be watertight and of good quality;
- There shall be no significant voids in the grout of the installed system.

7. Reference documents

1. Sewerage Rehabilitation Manual
Published by WRc. plc. 3rd Edition.