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CONSIDERATIONS ON PIPES LAYING FOR SEWERAGE

T. V. CHIRA[1]

Abstract: *The paper addresses some of the faults found in sewer networks related to the pipes laying technique and the "shortcuts" employed in some cases by contractors involved in sewerage network construction. In the final part of the paper some calculus elements for static loads are presented and conclusions are drawn.*

Key words: *sewerage, pipe, faults, loads.*

1. Introduction

During an extended study conducted on the sewerage networks in several counties situated in Transylvania a large number of sewer survey footage was analysed and a classification of faults was made. Some of these faults were presented in [1]. An important number of these faults occur as a result of an incorrect technique or improper tools used in the laying of the pipes. Gaskets can be expelled from their housings during pipe laying, leading to pipe joints that are not water tight from the start. The pipe bedding in the trenches is not correctly executed and singular stress points can appear on the bottom generator of the pipe – for example the pipe is laid on a pointy rock instead of a layer of sand etc. The earth filling is not done in a correct manner, with insufficient compaction of the earth layers above the pipe, leading to uneven stress later in the life of the sewer pipe. In the following pages some of the encountered faults are presented.

2. Faults Found in Sewer Pipes

During the study mentioned in the introduction, footage for 418 sewer sections was analysed, totalizing 21.4 km of sewer pipe also were analysed printed reports for 143 sewer sections totalizing 9.4 km. The pipe materials for the inspected sections were: PVC (polyvinyl chloride) – largest number of sections, reinforced concrete - second in number of inspected sections, GRP - glass reinforced polyester - third, respectively vitrified clay and asbestos on the four and five places with a very small number of sections. By watching the footage and by studying the printed reports, 649 faults or abnormalities were identified and classified. The classification was done as follows: sedimentation; cracks, breaches and pipe wall collapses; cross-section ovalization; incorrect joints; pipe movement in the soil due to insufficient soil compaction; lateral joints protruding in the main collector; roots penetration and stagnant used water. Many

[1] Faculty of Building Services, Technical University of Cluj-Napoca.

of these faults are caused by an incorrect laying of the pipe that can be the result of lack of training of the workers, haste during the pipe laying or lack of proper tools and equipment. To illustrate these faults some screen captures from the footage are presented. In Figure 1 it can be seen a sewer section with a degree of 15% sedimentation caused by insufficient slope of the pipe.

Fig. 1. *Sedimentation caused by insufficient slope of the sewer pipe [2]*

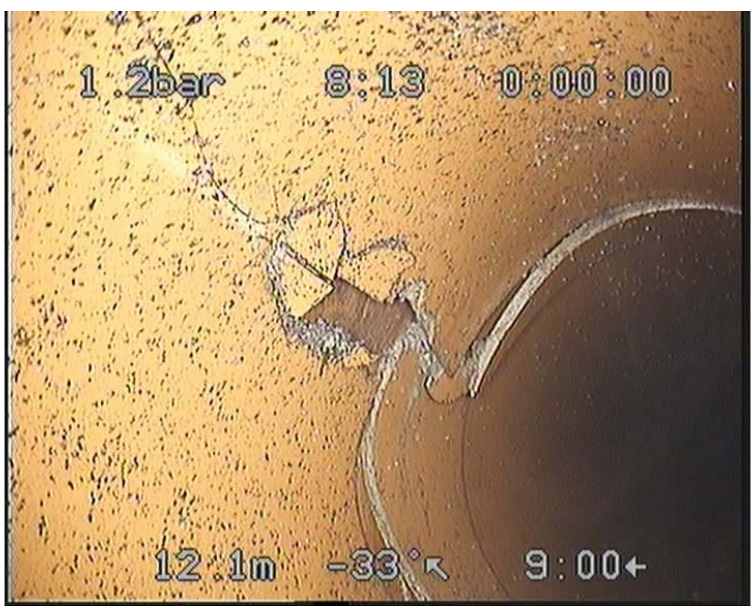

Fig. 2. M*ultiple cracks in the pipe wall and a portion of it is missing [2]*

In Figure 2 is presented a pipe with multiple cracks in the wall and a portion of the pipe wall is missing. It can be observed that the pipe was not laid in proper sand bedding but straight into the soil. In both cases the laying of the pipe was incorrect and causes supplemental maintenance costs to the sewer network administrator. In the first case the sediments must be washed more often than the usual cleaning activities scheduled for the sewer network – hence the additional costs. In the second case is necessary to repair the affected section immediately because collapse of the sewer pipe is imminent.

Fig. 3. *Cross-sectional deformation (ovalization) due to external overloads [2]*

Figure 3 presents the case of an ovalization of a PVC sewer pipe due to increase of external loads. The traffic intensity on the roads above the sewer lines has greatly increased in the recent years and sometimes heavy loads are carried on the streets during special transports and these can affect the sewer sections under the roads. In the particular case presented in Figure 3 the sealing of the joint was not affected but a small splinter from the pipe has broken. In Figure 4 it can be observed an incorrect pipe joint that has the gasket expulsed from its housing – hence, the sealing is compromised. In these cases, great attention must be exerted to position the gasket correctly in its housing and a special lubricant must be used on it. Also, the pressure exerted on the pipe inserted in the socket must be coaxial to the pipe and applied with constant force. This will permit the end of the pipe to travel through the gasket without expulsing it and a good sealing will be obtained. For big pipe diameters special jacks must be used for pushing the pipe in the socket of the previous one. Unfortunately, the contractors use, on site, the bucket of an excavator to push the pipes and this leads to the gasket expulsion because the pushing direction is not coaxial to the pipe.

Fig. 4. *Gasket expulsion at the joint due incorrect jointing technique [2]*

3. Calculus Elements for Loads Exerted on Sewer Pipes

Since understanding how the loads act on the sewer pipes is very important, some elements of calculus taken from [3] are presented in this chapter. The pipes are subjected to fundamental loads and accidental loads. The fundamental loads comprise permanent loads and overloads. Examples of permanent loads are: the pipe's own weight, the weight of the soil filling covering the pipe, the earth pushing without overloads, the internal and external water calculus pressure and the weight of the water inside the pipe. The overloads are generated by the traffic on the roads above the sewer pipe and possibly by materials temporarily deposited on the pipe (at the surface) during works. In gravitational sewers accidental loads are given by pressurisation of the sewer during heavy storms. The sewer section weight can be calculated knowing specific gravity of the pipe material and dimensions or using the pipe's datasheet from the producer. The weight of the earth filling above the pipe in conditions of good compaction can be calculated with formula (1) presented here:

$$G_1 = C \cdot \gamma \cdot H \frac{B_t + D_{ext}}{2} \quad (1)$$

where G_1 is the weight of soil filling, in kg, for sewer pipes laid in trenches like the ones presented in Figure 5; C represents a coefficient depending on the ratio *H*/B available in calculus diagrams, see [3]; γ is the specific gravity of earth filling, in kg.f/m^3, available in tables; *H* represents the depth of the upper generator of the pipe in relation to soil surface; *B*, B_t are the dimensions of the cross-section of the trenches as shown in Figure 5; D_{ext} – the external dimeter of the pipe.

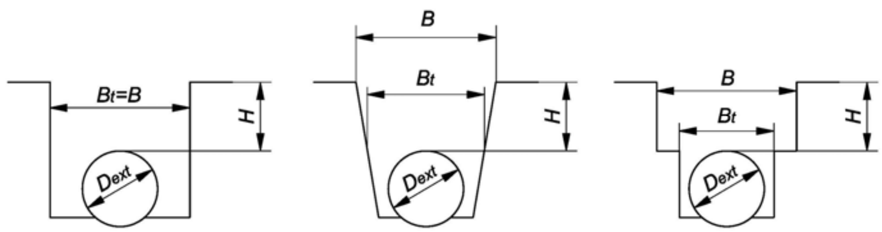

Fig. 5. *Types of tranches used in sewer pipe laying [3]*

If the width of the digging is bigger than of the trench we deal with a situation similar to embankments, in this case formula (2) is used:

$$G_2 = C_1 \cdot \gamma \cdot H \cdot D_{ext} \tag{2}$$

In this formula G_2 represents the vertical load given by earth filling for tranches with embankments; C_1 is a coefficient which depends on the ratio H/D_{ext} available on calculus diagrams presented in [3] and the meaning of rest of the terms was given above. Lateral pushing of the earth, *f*, expressed in kg.f/m^2 is calculated with the formula (3):

$$f = 2 \cdot \alpha \cdot \gamma \cdot H \tag{3}$$

where

$$\alpha = \frac{1}{2} tg^2 (45^\circ - \frac{\varphi}{2}) \tag{4}$$

and φ is the natural slope angle of the earth in which the trench was dug; H represents the depth of the middle of the channel in relation to the soil surface and γ was explained above. The vertical pressure from uniformly distributed load on soil surface for 1m of sewer pipe, G_4, in kg.f/m is:

$$G_4 = C_2 \cdot H \cdot p \tag{5}$$

In formula (5) C_2 is a coefficient available in calculus diagrams and is dependent of the ratio H/B; H – is the height of the earth filling above the upper generator of the sewer pipe, expressed in meters; B is the width of the trench at soil surface, in meters and p represents the uniformly distributed load at soil surface, in kg.f/m^2. Vertical pressure due to concentrated loads, like vehicles on wheels, is expressed in kg.f/m and is calculated with formula (6):

$$G_5 = f \cdot C_3 \cdot P \tag{6}$$

where *f* is a coefficient dependent on the depth *H* of the upper generator of the sewer pipe in relation to soil surface and is available in tables; C_3 is a coefficient available in calculus diagrams and is dependent of the depth *H* of the trench and the width *B* of the trench; *P* represents the concentrated load at the soil surface.

4. Conclusions

The most important conclusion is that greater care must be exerted in laying pipes for sewerage networks and the laying techniques must be applied to the letter of the book in order to obtain water tight sewer sections. Great attention must be payed to the compaction of the sand bedding and soil filling that surrounds the sewer pipe when the laying is done in open trenches or if possible, as alternative, trenchless laying techniques could be employed with minimal soil disturbance. As far as the sewer administrator is concerned, commissioning of sewer section should be done only and only after sewer CCTV survey with diagnostic equipment capable of determining the sewer section slope and the contractor should correct any inadequate slope cases because, otherwise, great expenses will be made with frequent pressure washes of those sewer sections. Faults like protruding laterals in the main collector even if are not affecting the sealing of the pipe are dangerous from another perspective: they become an obstacle in front of the sewer CCTV equipment and the surveys cannot be carried out properly.

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