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FAULTS FOUND IN SEWER PIPES, CAUSES AND REMEDIES

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Abstract: *In the contents of the paper, the author presents several photos extracted from footage obtained during CCTV (closed circuit television) sewer inspection activities in sewer mains. In these photos several types of faults found in sewer pipes can be observed. After a thorough analysis of the photos and additional data obtained during inspections the leading factors for the faults are identified. The analysis revealed that some of the faults are related to pipe material and others are due to disregard of pipe laying techniques. In the final of the paper some remedies are suggested for the presented cases of faults.*

Key words: *sewer pipes, faults, CCTV inspection, pipe rehabilitation.*

1. Introduction

The anthropic action on the environment is damaging because of the pollution it generates and it should be a permanent concern for society and most of all for specialists to minimise it. One of the pollution sources is the sewer network if the sewer sections are not perfectly sealed and exfiltration of waste water occurs in the adjacent soil and ground water [1]. Neither the infiltration of ground water in the sewer network is not a good thing because the waste water processing plant will be forced to process a bigger volume of water thus increasing the processing cost. A good way of assessing the technical condition of a sewer sections is by CCTV survey with specialised mobile inspection laboratories and this should be the first step in choosing the rehabilitation method for the sewer sections.

2. Preliminary data

During a research activity the author had access to the CCTV inspection footage archive of the local sewer service operator. The archive contains movies, photos and inspection reports generated during CCTV inspection activities conducted in sewer sections. The materials were produced with the two mobile CCTV inspection laboratories of the local sewer service operator. Both of these laboratories make use of remote controlled robots carrying CCTV cameras along the sewer section between two manholes. The first mobile laboratory is an older generation, the footage being recorded on VHS videotape and after that converted to digital format and recorded to DVD media for archiving purposes. The second mobile laboratory is a newer generation, uses greater resolution digital camera and the obtained footage is

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stored on hard disks or DVD media. The sewer sections were made from different pipe materials. Not only has the pipe material varied but also the age of the sewer sections, soil conditions and natural slope of the terrain. In regard of pipe material the surveyed pipe sections were made of PVC (polyvinyl chloride), reinforced concrete, GRP (glass reinforced polyester), vitrified clay and asbestos cement. The vitrified clay and asbestos cement sections were in small number while the most numerous sections were made from PVC followed by reinforced concrete and GRP.

3. Sewer pipe faults

In the studied materials were found several types of pipe faults commonly found in sewer networks. These were classified in several categories: cracks or breaches in the pipe wall, pipe collapses, faulty joints on the main sewer collector, faulty lateral joints, roots penetrations through the pipe wall, sediments and cross section deformations.

3.1. Cracks or breaches in the pipe wall

Cracks in the pipe wall occur more often in reinforced concrete and GRP pipes but are not totally absent in PVC pipes. There are several scenarios for appearance of the cracks. One possible cause, especially in the case of concrete pipes is the erosion of the pipe wall from inside by the waste water carrying sand and gravel.

As result of erosion the pipe wall is weakened and cannot withstand the loads exerted on it. In this case is highly probable to observe longitudinal cracks found usually in the lower part of the cross section of the sewer pipe. Chemical corrosion is another potential cause of weakening of the pipe wall. Another scenario for the occurrence of the cracks is the failure to follow the pipe laying technique especially the bedding conditions.

It is known that pipes should be laid on a sand bed and covered with sand in order to distribute loads as evenly as possible. If the pipe is laid on rocks the weight of the pipe combined with the weight of soil layers above it and other loads may cause the cracks to appear at the the contact point with the rock. Same thing is possible if the rock is above the pipe and is pressed against the pipe wall. In either case the cracks could be in any direction. A third possible scenario is to have different degrees of soil compaction along the pipe section.

This may lead to cross sectional shearing of the pipe when big loads are applied on the less compacted portion of the soil. Shearing is possible also in case of landslides. In other circumstances it’s possible to have less compacted soil on the sides of the sewer main and when the laterals are loaded heavily they could break the mains wall at the joint. Figure 1 presents such a case. Cracks or breaches could also be caused accidentally during interventions on other networks adjacent to sewer by digging machinery and equipment, especially when the sewer section is older and less well documented. By implementing modern tools for network mapping and documenting like GIS (geographic information system) we should be able to avoid in the future these incidents. Sometimes the cracks are caused by increasing loads combined with aging of sewer infrastructure. In most cases the sewer lines are underneath roads circulated by heavier and numerous vehicles. In these cases longitudinal cracks appear on the upper side of the pipe and if the reinforcing is exposed the pipe will collapse when it corrodes.

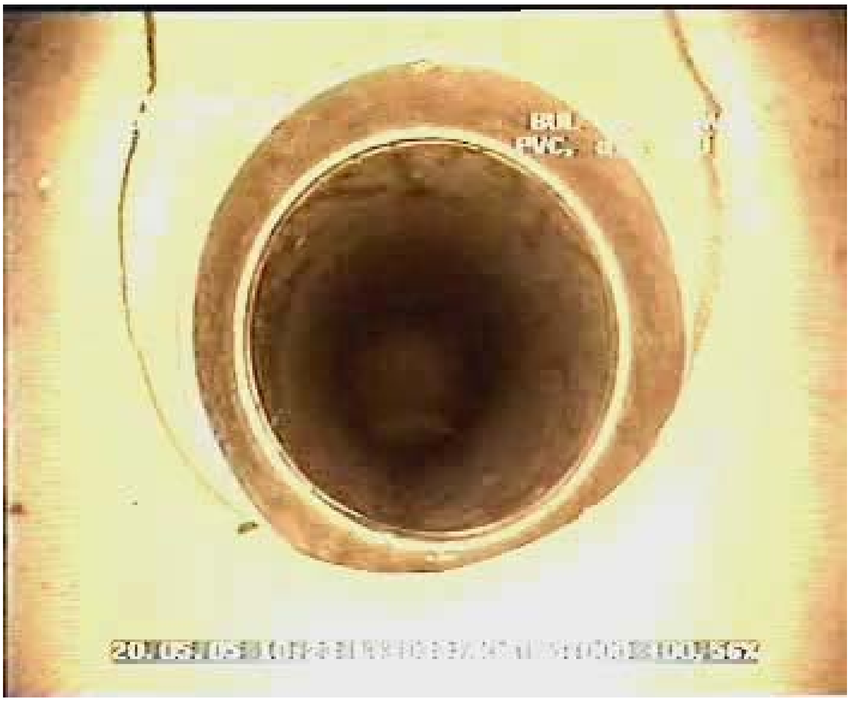

Fig. 1. *Cracks in the wall of a PVC sewer main at a lateral joint due to uneven soil compaction and the lateral acting as a lever*

3.2. Pipe collapses

Pipe collapses are very dangerous because not only contaminate the soil and the ground water but render the use of the sewer impossible. Collapses occur when cracks evolves into breaches and parts of the pipe wall are missing and thus the structural integrity of the pipe section is affected. In other cases the collapses are the result of landslides. Another mechanism for collapses is forming of cavities in the soil underneath or along the sewer pipe. Usually this cavities are the result of soil being washed away by underground water. Sometimes soil particles get inside the sewer pipe if wall breaches are present or faulty joints exist. Figure 2 exemplifies this kind of fault. Since the effects of these faults are very disturbing measures should be taken to prevent them.

3.3. Faulty joints

There are several types of faulty joints. In some cases, when the sealing is done with rubber gaskets the sealing is lost because when the pipes are connected they are not properly aligned and the gasket is expulsed from its groove. This mainly occurs in PVC and GRP sewer sections. Another reason for gasket expulsion is the lack of a proper lubricant on the entire length of the gasket. In other cases when the sealing is done with mortars or other compounds in time they fall from the joint and the sealing is lost. Obviously, these faulty joints are big sources of infiltration of ground water or exfiltration of waste water. In Figure 2 a faulty joint in a concrete pipe allows soil to get inside the pipe and in Figure 3 a

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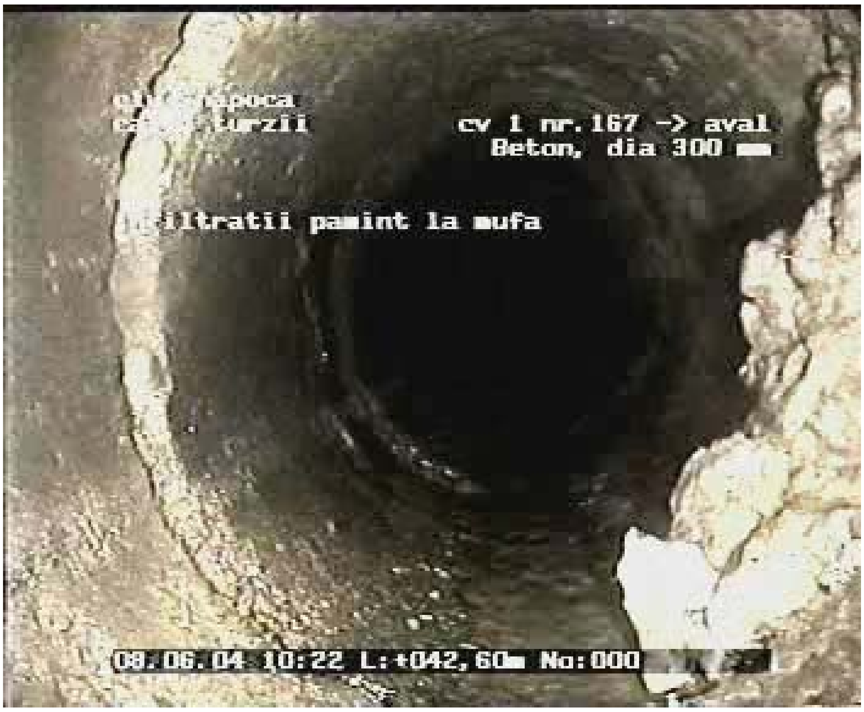

Fig. 2. *Faulty joint in a concrete sewer section allowing soil to enter inside the pipe (in the right side of the image)*

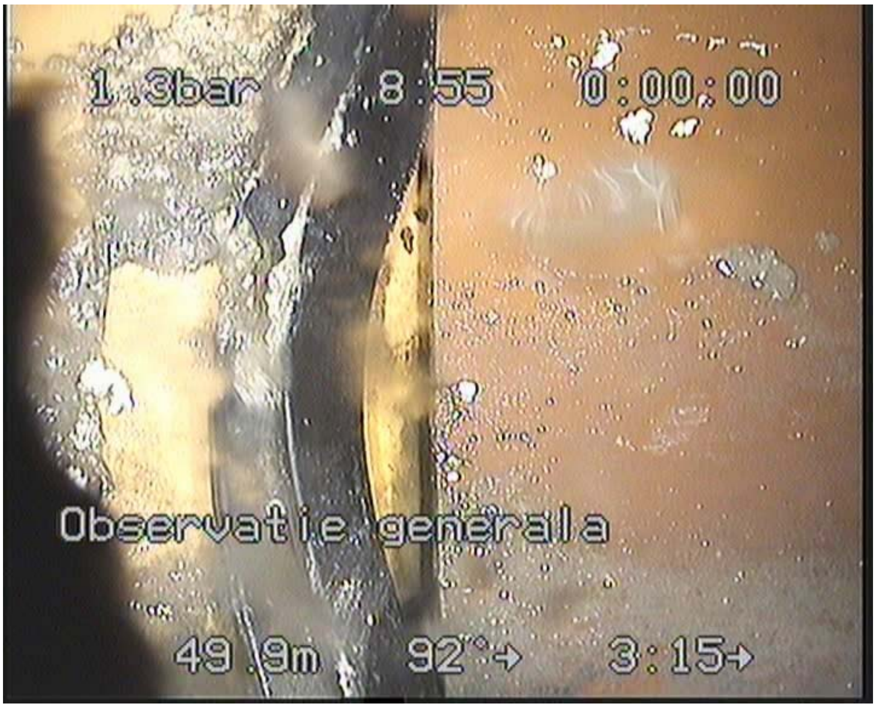

Fig. 3. *Rubber gasket expulsed from groove in a PVC pipe joint*

joint has the gasket expulsed and sealing compromised

The same problems may occur also at lateral joints but here there is one more situation worth mentioning, namely laterals protruding excessively inside the sewer main. In this particular case is not an issue of compromised sealing but an issue of creating an obstacle in the way of floating debris that may lead to creation of dams inside the sewer section. For example a wooden plank stuck against such a protruding lateral will quickly agglomerate sand and gravel thus creating a sediment deposit and diminish the usable cross section of the pipe. Another issue related to protruding laterals is the impediment of continuing the CCTV inspection when such a situation arises because it acts like a barrier in the way of the inspection robot, the only solution being to try to insert the robot from the other manhole and this is time consuming. This situation is exemplified in Figure 4. Even more, if we have two protruding laterals between two consecutive manholes the distance between them cannot be inspected.

3.4. Root penetrations

Root penetrations occur when trees exist in the vicinity of the pipe section. Sometimes the trees were planted after execution of sewer pipeline disregarding the minimum distance required by norms. In any case root penetrations inside the sewer pipe may lead even to the collapse of the pipe or complete obstruction of the cross section thus incapacitating the functioning of the sewer. Figure 5 shows a case of root penetrations at an early stage, the sewer section being still in function.

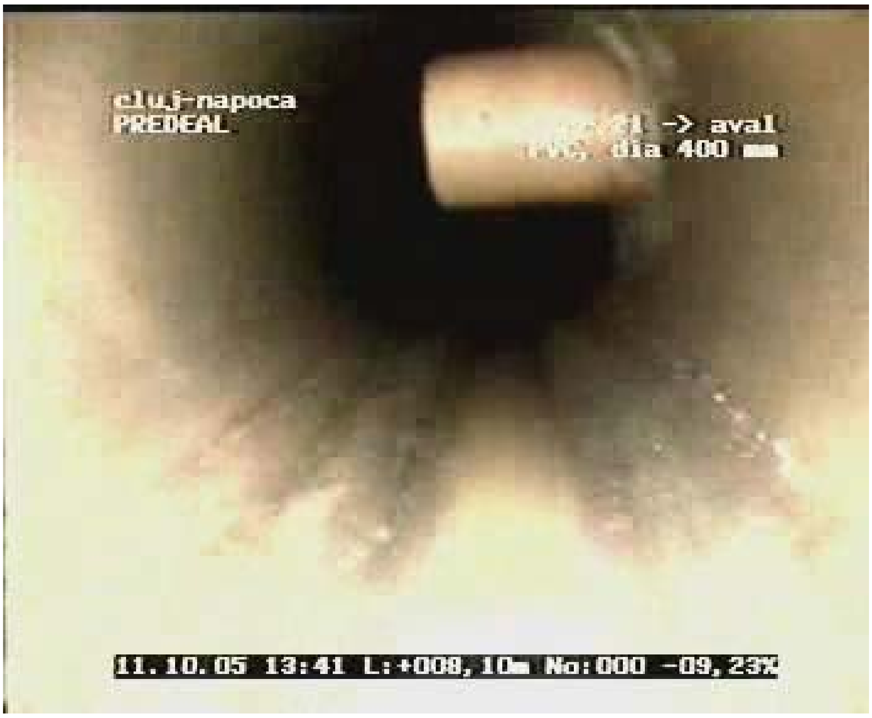

Fig. 4. *Protruding lateral inside sewer main prevents the camera robot to advance along the pipe* [2]

Fig. 5. *Early stage of roots penetrating inside concrete sewer pipe* [2]

3.5. Deposits of sediments

This type of fault has mainly two causes. The first and the most frequent is the lack of a proper pipe slope that leads to a waste water velocity lower than the self-cleaning velocity stipulated by norms. The second cause is the creation of artificial dams inside sewer pipe due to debris stuck across the section. The most problematic is the first case because it can be corrected only by remaking the sewer section and laying the pipe at the correct slope. The alternative, would be to make frequent washes of the sewer section which can be very costly in terms of money and resources. The second situation can be solved comparatively easy by removing the dam inside the pipe and performing a wash of the sewer section. In cases of counter slope the deposits of sediments ca reach such heights that render de sewer section unusable.

3.6. Cross section deformations

Cross section deformation is encountered most often in PVC sewer pipes because of the plasticity of the material. It is the effect of unequal forces or loads exerted on the cross section of the pipe. Frequently section deformations are observed as ovalities of the usually round cross section pipes.

While small ovalities do not affect the functioning of de sewer section as long as the sealing is still maintained severe deformation can go beyond ovality and the cross section of the pipe gets a U shape. In this case it is obvious that the good functioning of the sewer is prevented and the sealing is lost. Figure 6 shows a case of sediment deposit and Figure 7 presents a case of severe cross section deformation in a PVC pipe.

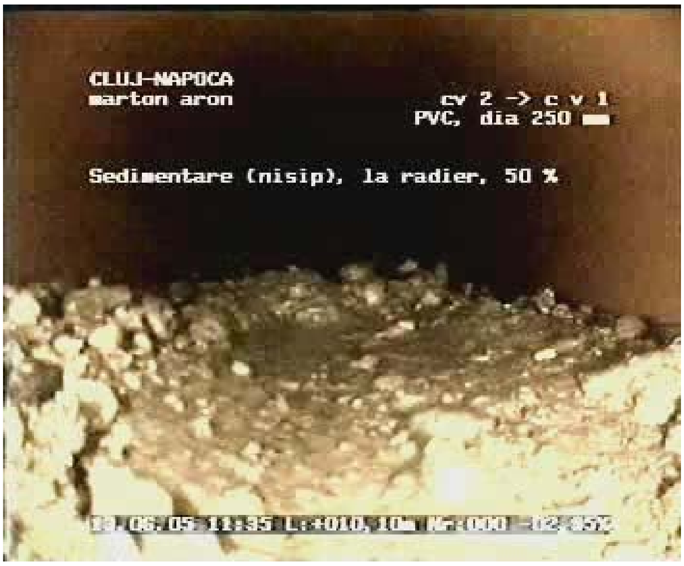

Fig. 6. *Deposits of sediments – 50% of the pipe cross sections is unusable due to sediments*

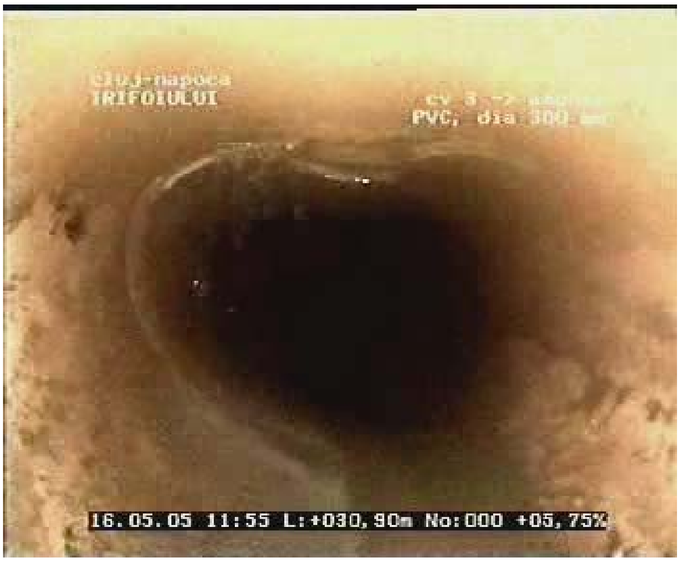

Fig. 7. *Severe deformation of the pipe cross section – the sealing is compromised*

4. Conclusions

The first and most important conclusion is that keeping a sewer network in top condition is a great way of reducing ground water and soil pollution because the sewer pipeline route goes across the entire city and may be even passing through agricultural fields before reaching the waste water treatment facility. Sewer service operators should schedule CCTV surveys on the entire network in order to assess as clearly as possible the technical condition of sewer sections. CCTV robots are a very useful way for this purpose but other means should be considered, for example SSET (sewer scanner and evaluation technology) or ultrasonic scanning [3]. SSET gives image of greater resolution and ultrasonic scanning gives information about the pipe wall condition beyond its inner surface being able to detect faults invisible from the inside of the pipe. It must be mentioned though that is not usable on all pipe materials. In regard of repairing the faults presented in this paper we have nowadays several technologies at our disposal. Some of the faults can be repaired only by replacing the affected section, like in case of pipe collapses. This implies excavating trenches, pretty often on roadways and streets, disturbing the traffic and necessitating remaking of the roadway surfaces which is costly. Clearly is better to prevent such faults than to confront them. In the case of cracks and faulty joints we have at our disposal several trenchless technologies for waterproofing the sewer section as long as it is statically stable. For example there are robotic grouting techniques and lining techniques. For lateral junctions sealing there is a robotic technique for applying top hat liners. Both for longitudinal liners and top hat liners after impregnation and insertion in place follows a polymerisation step that gives rigidity to the lining. Root penetrations should be removed as soon as possible because thickening of the roots may lead to pipe collapse. There are special cutting heads for removing roots inside the pipe but the tree should also be removed from the vicinity of the pipe line. Protruding laterals can be removed by remote controlled robots equipped with special cutting heads. Minor cross sectional deformation should be inspected on regular bases to see if the deformation is getting worse, in which case the pipe must be replaced. Sever deformation implies immediate replacement of the pipe.

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References

1. Chira, T.V.: *Diagnosticarea stării tehnice a conductelor de canalizare* (*Technical Condition Diagnosis of Sewer Systems),* PhD Thesis, Cluj-Napoca, 2012.
2. Chira, T.V., Safirescu, C., Moldovan, E.: *Câteva aspecte privind defecțiunile conductelor de canalizare* (*Several aspects regarding faults in sewer pipes),* In Proceedings of Conference Modern Science and energy SME2013, Cluj-N., p. 225-234.
3 Iyer, S., Sinha, S. Pedrick, M., Tittmann, B.: *Evaluation of ultrasonic inspection and imaging system for concrete pipes*, in journal: Automation in Construction, 22, 2012, Elsevier, p. 149-164.