Technical condition of sewer networks in the Czech Republic

P Hlustik[1] and V Singrova[1]

[1]Institute of municipal water management, Brno University of Technology, Faculty of Civil Engineering, Žižkova 17, 602 00 Brno, Czech Republic

Abstract. This article offers a comparison of the detected defects in sewerage systems operated by water companies and by self-operators, determines their quantity and classifies them into individual categories. The determination of the number of the defects at self-operators is evaluated on the basis of performed camera inspections and compared with data provided by the water company.

1. Introduction

The owner of the sewer networks is obliged to ensure their trouble-free and safe operation, to create financial reserves for their replacement and document their use for these purposes. Municipalities with independent competence ensure development of sewers corresponding to the needs of the municipality by developing mandatory parts of the spatial planning documentation of the relevant municipality in accordance with the water supply and sewerage development plan [1].

The Water Supply and Sewerage Act No. 274/2001 Sb. specifies an obligation for the operators to generate reserve funds for the refurbishment of sewerage and to document how these funds are used [1]. The survey of sewer networks, that is carried out at present, most often consists of a visual inspection and a CCTV inspection depending on the dimensions of the specific sewer. Results of the survey are evaluated on the basis of pre-set diagnostic criteria. A detailed survey of all parts of the sewer system is costly and time-consuming and for this reason it is possible to focus on sewer sections with expected technical problems when surveying the sewer network.

Data necessary for the technical assessment of the sewer network condition can be obtained from visual inspection. The visual inspection of the sewer network (including drains) and classification of defects can be performed according to:

- ČSN EN 13508 Conditions of drain and sewer systems outside buildings,
- ATV - 143 Inspection, repair, rehabilitation and renovation of sewer networks, drains and plumbing systems (note: there are various translations in the Czech Republic),
- simplified coding system - individually designed.

In the Czech Republic, the duty to inspect the structural and technical condition of the sewerage systems is laid down in Act No. 183/2006 Sb. on town planning and the building code (the Building Code) as amended, under which the owners of buildings and water-related structures are obliged to use and operate them in accordance with decisions issued by construction and water authority and keep them in a good condition [2].

The situation is similar in the European Union. Each Member State has a legislative document (usually a law) that mandates an inspection of the technical condition of sewer networks [3].

Water companies that operate sewer networks are obliged to perform camera inspections of the sewerage system and evaluate its construction and technical condition. These documents are used for future planning of renovation of sewer networks and buildings [3,4].

2. Sewer network operators

Mutual comparison of evaluated data is performed for two different entities operating sewers. These are the self-operator (joint owner and operator of the sewer network) and the water company (different owner and operator of the sewer network). The evaluation of faults in the construction and technical condition was only for gravity sewers, the resulting values include faults in sewer connections.

The evaluation of faults was converted to the number of faults that occur per 10 km of sewer network. The comparison of statistical data was performed for water companies and for self-operators.

The types of faults were monitored only for the gravity sewer network, drains and sewage and rainwater facilities.

As regards water companies, data from 2019 was evaluated for 9000 km of sewer network, the summary data was provided for the purposes of the article.

As regards the self-operators, CCTV inspections covering a length of 40 km from 2018-2019 in selected municipalities were performed and evaluated. The CCTV inspections were carried out as part of research conducted by the Brno University of Technology, Faculty of Civil Engineering. The evaluation of CCTV inspections was performed by the research team itself.

The major part of the sewerage network was probably built in the 1970s - it is combined sewerage consisting mainly of concrete or reinforced concrete pipes.

3. Evaluated sewer networks faults

The statistical number of faults included defects of the sewers, drains and civil structures.

The evaluated structural defects of the sewers, drains and civil structures include:

- sewer deformation,
- cracks,
- missing covers,
- damage to the inner material of the pipeline,
- pipe joint failures,
- mechanical damage to pipe material,
- damage to the lining,
- damage to the inserts,
- pipe destruction,
- glands,
- other defects.

The evaluation of faults was performed for self-operators of sewer networks according to CZN EN 13508-2 Evaluation of condition of outside sewer network system and sewer connection Part 2: Coding system for visual inspection [5].

3.1.   Comparison of evaluated faults, water company

Sewerage failures were evaluated by 13 large water companies. Sewer faults were evaluated by employees of companies who keep long-term records of faults.

Camera inspections were performed on the sewer network in a percentage of different proportions of the following materials: concrete, stoneware, plastics, laminate and other materials different profiles.

Each company evaluated the same types of materials for the same time period in 2019.

It can be stated that from the structural point of view the most common problem is pipe destruction, pipeline deformation, missing pipeline parts and cracks.

In operational terms, the most serious problem is deflection of pipe joints, sedimentation and related to the surface damage caused by sulphuric acid corrosion and the related loss of material on the upper surface of the body.

The evaluation of faults for water companies is shown in Figure 1.
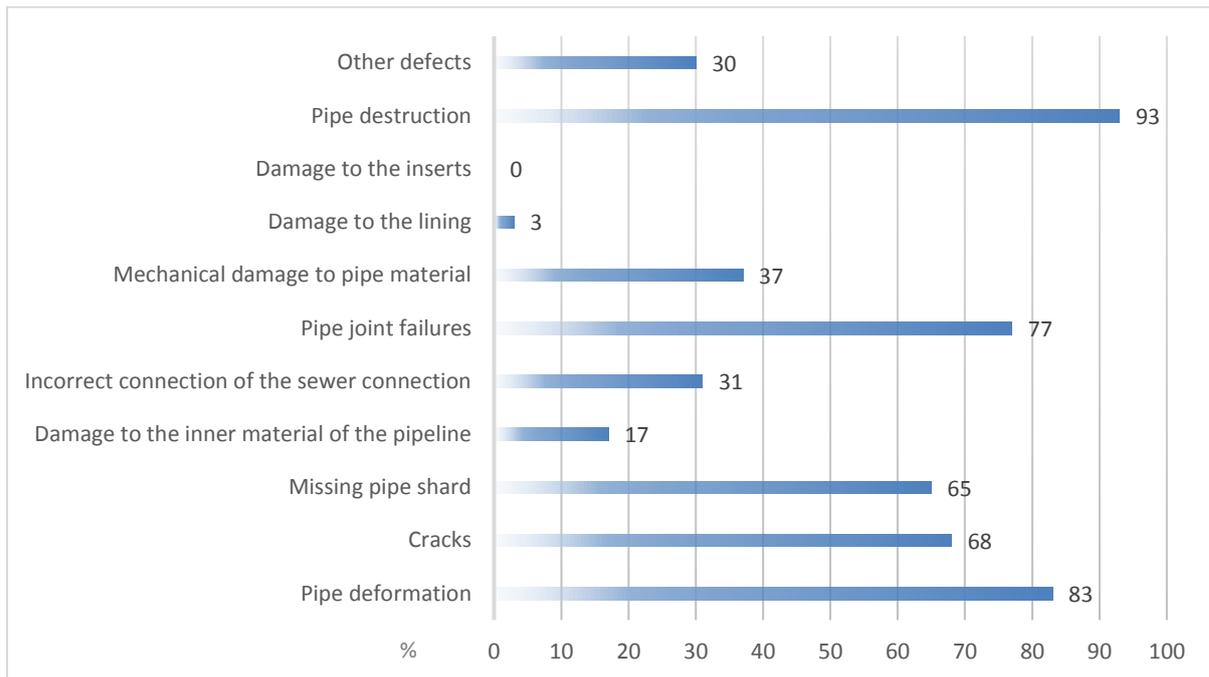
Figure 1. Types of defects and their occurrence in sewerage, Water company.

The numbers of detected sewer network and percentage, sewer connections and sewer objects failures by the water company is shown in Figure 2.
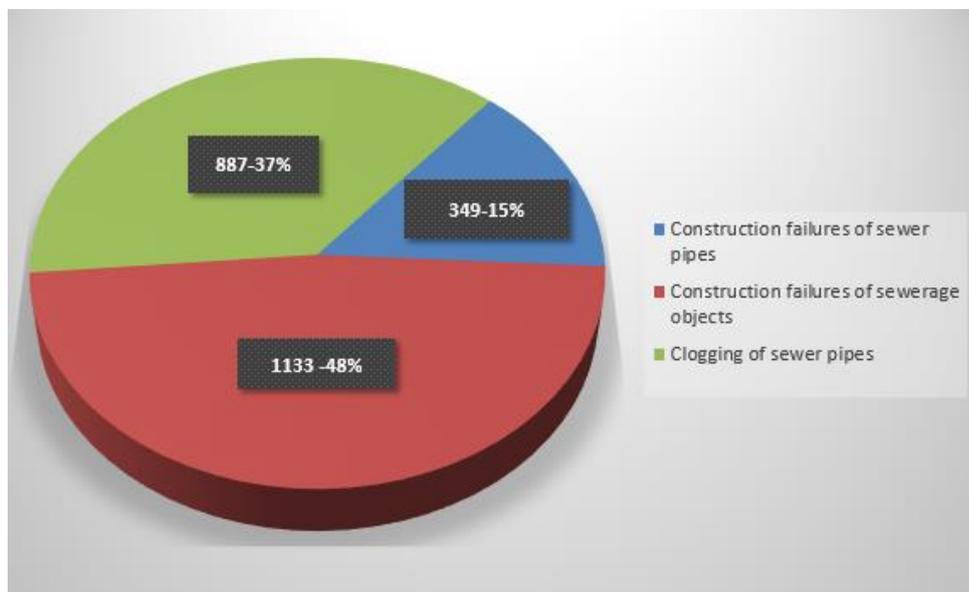

Figure 2. Number of defects of sewer system, sewer connection and objects, Water company.

A total of 95% sewer connection defects were caused by glands. Other structural defects included deformations, destructions and cracks in the sewer connection. The largest proportion of faults was reported in sewerage objects and sewerage pipes, which were clogged and impassable. Cleaning of clogged sewer connections must be handled by property owners. The owners are responsible for the construction and technical condition of the sewer connections and their smooth operation.

3.2.   *Comparison of evaluated faults, self-operators*

Camera inspections of the sewer network in selected municipalities were personally performed and evaluated by a team of colleagues at the Brno University of Technology, Faculty of Civil Engineering. Camera inspections were performed on the sewer network in a percentage of different proportions of the following materials: concrete, stoneware, plastics and other materials different profiles.

It can be stated that from the structural point of view the most common problem is pipe destruction, pipe deformation, missing pipeline parts and cracks.

In operational terms, the most serious problem is deflection of pipe joints, sedimentation and related to the surface damage caused by sulphuric acid corrosion and the related loss of material on the upper surface of the body.

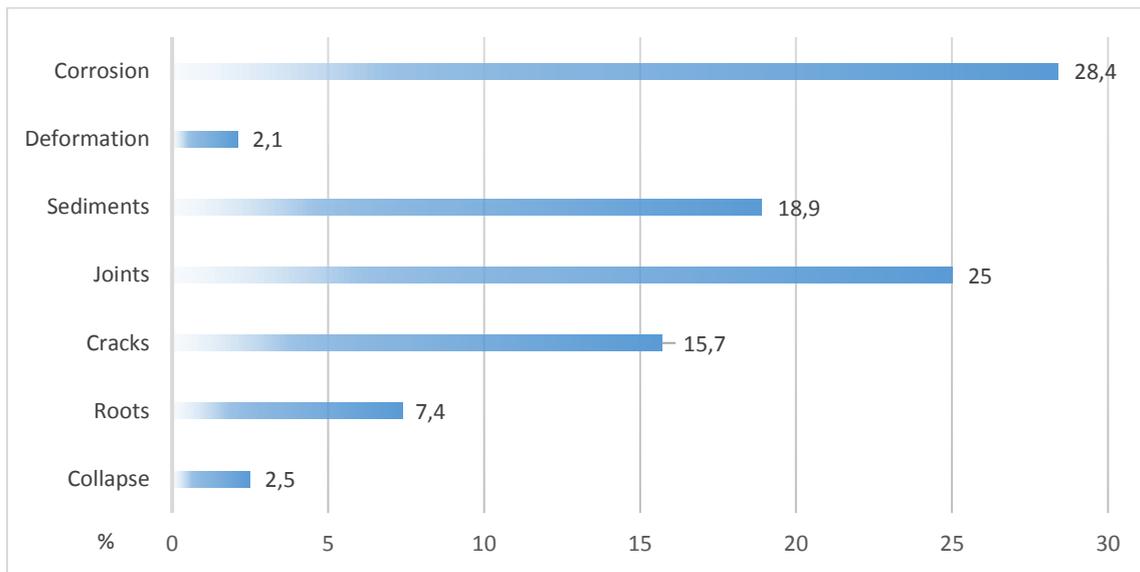The evaluation of faults for self-operators is shown in Figure 3.

Figure 3. Types of defects and their occurrence in sewerage, self-operators.

The numbers of detected sewer network and percentage, sewer connections and sewer objects failures by self-operator is shown in Figure 4.
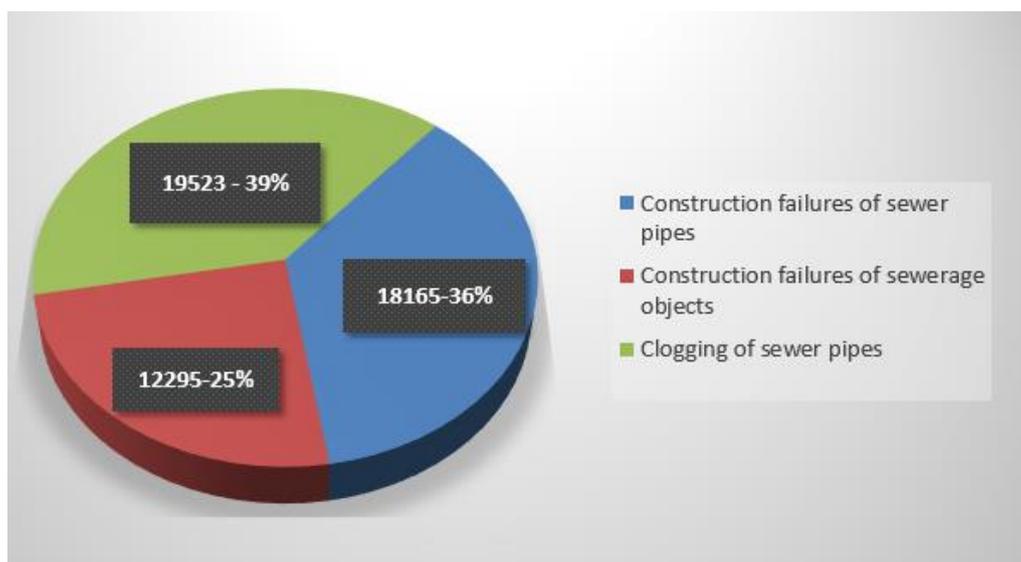

Figure 4. Number of defects of sewer system, sewer connection and objects, self-operators.

A total of 87 % sewer connection defects were caused by glands. Other structural defects included deformations, destructions and cracks in the sewer connection.

For sewer operators, the biggest problem is the wear of the material surface and misalignment the joints of the sewer pipeline. Wear of the material surface is accompanied by biogenic sulphate corrosion. The main reason is the covering of sewer manholes on private land, the sewer network then does not have a natural air draft and anaerobic conditions occur inside the sewer network [7].

The misalignment the joints of the sewer pipeline is due to the construction of a sewer network in the 1970s, when the sewerage system was built by the citizens themselves. The construction of the sewer network took place without the technical supervision of the construction investor, without meeting the requirements of technical standards, which are commonly used today.

Table 1 shows the resulting comparison of the number of defects per 10 km of sewers of the individual companies and independent operators of the sewer systems. Currently, no statistical data providing a comprehensive comparison of the number of defects and their percentage is available in the Czech Republic.

Table 1. Comparison of sewerage defect rates – number of defects/10 km/year.

Operator	Water company	Self-operators
Sewer system	4.6	50.6
Sewer connection	0.2	8.9

The main goal of the article is to compare the number of failures transferred to 10 km of sewer network per year for water companies and self-operators. From the result of the recalculation of failures/10 km/year we can define the following conclusions for self-operating sewer networks:

- invest less money in the renewal of the sewer network;
- do less regular inspections of the sewer network;
- usually no sewerage recovery plans have been drawn up;
- usually solves only currently necessary faults in the sewer network.

Self-operators are not well informed about the current legislative conditions in this area, regular actions and the necessary documents for the operation of sewer networks. Many self-operators with the construction of new water management infrastructure then contractually switch to water companies [8]. Water companies, on the other hand, have a realistic assessment of operational efficiency (cost), a public and transparent comparison of the functioning of individual groups of entities within the company's market. These activities are reflected in the subsequent price of services, information on the efficiency of the use of generated resources and investments [9].

When comparing the defect rates of the individual types of piping materials in company and self-operators we also take into account the time factor, i.e. comparison of the defect rate of sewers of the same age. Defects of the sewerage system were caused by lack of qualification in constructing the sewerage systems involving local residents, the age of the sewerage system and use of lower quality materials during construction conducted in the past. Experience shows that the assessed selected municipalities do not carry out regular inspections and maintenance of sewers, i.e. CCTV inspections nor physical visual inspection of the structural and technical condition. The average defect rate of the sewerage systems in water company with the subsidiaries and self-operators is up to 11 times higher and by sewer connection is up 45 times higher totaling an average defects per 10 km.

The conducted analysis has determined the average defect rate of sewerage systems for selected municipalities operating their sewerage networks themselves and the data was compared with water company. The empirical experience is not recorded and is usually included in internal company's documents.

4. Conclusions

The ownership and operation of water management infrastructure entails considerable responsibility with a number of legal obligations. It is necessary to have the relevant knowledge of one's rights and obligations, quality technology and equipment and, above all, professional staff. However, this does not correspond to the water and sewage tariffs, as the lack of funds for renewal and maintenance results in more frequent network failures and resulting higher sewer failure rates.

As the results of the survey conducted by the Ministry of Agriculture of the Czech Republic show, another relatively widespread practice is inadequate creation of funds intended for repair and renewal of the infrastructure, or even subsidised water tater taroffs paid by the municipal budgets through a cost item as a negative profit. This problem mainly concerns small and very small municipalities. People do pay a lower tariff per cubic meter but the municipality generates lower revenues from the operation of water management assets and therefore does not have sufficient funds for its maintenance and renewal. This condition then results in frequent sewer faults.

The conducted analysis has determined the average defect rate of sewerage systems for selected municipalities operating their sewerage networks themselves and the data was compared with water company. The empirical experience is not recorded and is usually included in internal company's documents.

The collection and assessment of all relevant information on the sewerage system and its inspection rank amongst the essential components of operating the sewerage system and form a necessary operation in drawing up sewerage system renewal plans. In the Czech Republic, the information about the sewerage system renewal plans are defined under Act No. 274/2001 Sb. on Water Mains and Sewers, as amended.

Acknowledgements

References
[1]   Act No 274/2001 Coll Act on Water Supply and Sewerage for Public Use and on Amendments to Certain Acts (Water Supply and Sewerage Act) In year 2001 number 274
[2]   Act No Act No 183/2006 Sb. on town planning and the building code (the Building Code) In year 2006 number 183
[3]   Directive No 91/271 / EEC of the European Parliament and of the Council on waste water treatment 1991
[4]   Directive No 60/2000 / EEC of the European Parliament and of the Council on a framework for Community action in the field of water policy 2000
[5]   CZN EN 13508-2 Evaluation of condition of outside sewer network system and sewer connection Part 2: Coding system for visual inspection CEN 2012
[6]   Hluštík P and Novotný J 2018 Water **10** 2073-4441
[7]   Vaclavik V, Dvorsky T and Bendova M 2013 SGEM **1** pp 1033-1044.
[8]   Handbook of the sewer network operator *Team of experts from the commission of sewerage operation at SOVAK ČR 2018*
[9]   Nepovím J and col 2011 Transfer of infrastructure assets of water mains or sewers SOVAK