THE EPIDEMIC MAKES THE SUSTAINABILITY OF SEWAGE PIPES MORE URGENT

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Abstract: Problems such as aging and leakage of sewers became more acute during the COVID-19 outbreak than before. In this paper, we first introduce the two most serious problems (leakage and blockage) of sewage pipeline during the epidemic, and their harm to environment and health. Secondly, we describe the countermeasures of relevant departments from two aspects (during and after the outbreak). During the outbreak, some of China's experience can be learned and acted upon from now on. Some inspection, monitoring, and repair technologies may set off a boom after the outbreak and promote the sustainability of sewage pipes. Finally, we put forward the development direction of the sewage pipeline in the future, and the related computer technology has great application potential. The purpose of this article is to call on relevant industries and departments to carry out the sustainable development of sewage pipes as soon as possible.

Keywords: COVID-19; sustainability; sewage pipe; inspection; repair

1. Introduction

Sewage pipe is an indispensable project in people's livelihood, and it is also a key component of modern cities and economic prosperity. Its function is to transport the polluted water of each household to the main pipeline and finally flow into the sewage treatment plant. Among the 17 sustainable development goals established by the United Nations, goals 6 (clean water and sanitation), 9 (industry, innovation and infrastructure), and 11 (sustainable cities and communities) are all related to the sustainable development of sewage pipes[1]. The status of sewage pipes in many countries is not optimistic, even the United States, one of the most developed countries in the world. According to the wastewater infrastructure condition for the United States in 2017 (see Fig.1(a)) evaluated by American Society of Civil Engineers (ASCE), although the data for some states are not available, it is not difficult to see that the condition of wastewater infrastructure in most states is C (mediocre, requires attention) or D (poor, at risk)[2]. In 2017, the overall rating of wastewater facilities in the United States is D+, looking back at the rating of C in 1988[3], it shows that the condition of the infrastructures has declined dramatically in about 30 years. Thus, ASCE also estimated the investment needed for each state's wastewater facilities over the next 20 years based on the condition and scale. Fig.1(b) reveals that the required investment is high in densely populated and economically developed areas, such as New York, California, and New Jersey.

The outbreak of COVID-19 in early 2020 has severely affected everyone in the world, and the current situation in the United States is still not optimistic. According to the COVID-19 statistics system of Johns Hopkins University, as of June 18, more than 2.17 million people have been infected in the United States. In this context, the wastewater pipes in the United States are facing new challenges. Therefore, although the sustainable development of sewage pipes has been put on the agenda in the past few years, COVID-19 may make this demand even more urgent. Globally, some existing and developing technologies are valuable in improving the sustainability of sewage pipes.

2. New challenges for sewage pipes during the epidemic

Leakage and blockage of sewage pipes are two common problems, and these two problems have brought new challenges to public health during the pandemic.

Leakage. The leakage of sewage pipes during the epidemic will threaten public health and increase the probability of residents becoming infected. Studies have shown that leaks in sewage pipes can prevent residents' sewer systems from stopping airborne diseases. Moreover, once the sewage pipeline leaks, it will also seriously affect groundwater, soil, and the surrounding environment, especially hospital sewage during the epidemic[4]. Similar conclusions have been drawn from the 2003 SARS outbreak. On the other hand, some research groups have confirmed that the number of infected people in the community can be estimated by detecting the amount of virus in the sewage[5]. It can be used as an early warning method for the virus to make a comeback. Apparently, the leakage of sewage pipes will affect the detection results and lead to misjudgment.


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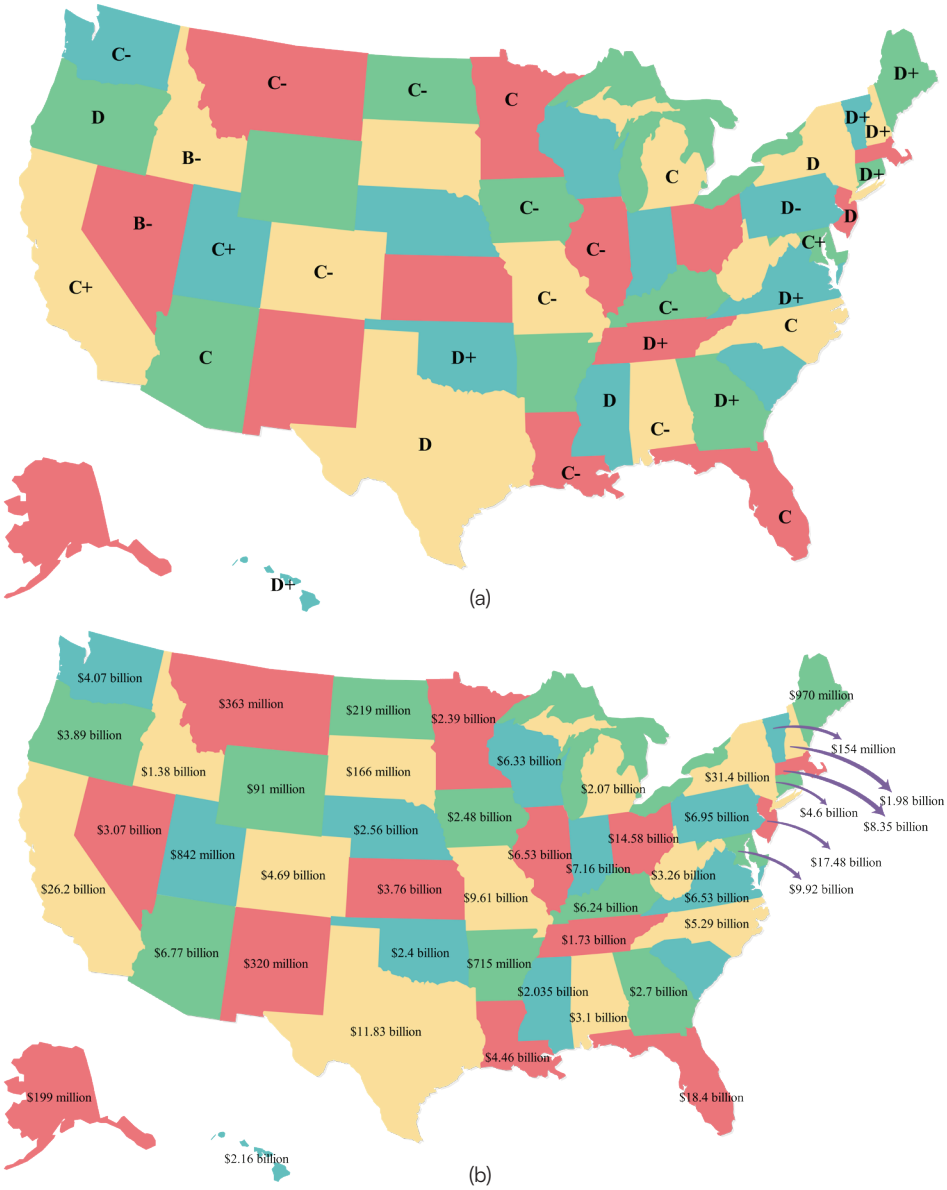

Fig. 1. Conditions and investments needed for wastewater infrastructure in the United States. **(a)** Wastewater infrastructure conditions for different states (data for ten states are not available). **(b)** Investment required for wastewater infrastructure in the next 20 years (data for South Carolina is not available). Source: ASCE Infrastructure Report Card.

Blockage. The blockage caused by the accumulation of residues in the sewage pipe often occurs. It will not only overflow the upstream sewage to pollute the soil and groundwater, but also corrode the pipe or cause leakage at the connections, and even lead to the backflow of sewage[6]. Especially during the epidemic period, if the sewage pipe is blocked, it will seriously pollute people's living environment and increase the risk of infection when there are few maintenance personnel available.

3. What to do now?

Due to the lockdown, the available staff is very limited. Therefore, it is challenging to start the sustainable development of sewage pipes now. However, there are still some feasible actions. China is the country with the earliest outbreak and the first country to respond[7]. Some experience has been proved to be effective and can provide some reference for other countries. Although these actions cannot fundamentally solve the problem of sewage pipe, they can reduce the impact of the hidden health problems caused by the sewage pipe defects to a certain extent.

Water quality monitoring. Strengthen the frequency and intensity of water quality monitoring, and accurately judge whether there is an infection in the area. Strictly ensure that the discharge of medical sewage and domestic sewage meets the standards.

Put disinfectant. Strengthen the use of disinfectants, ozone, and other agents, to control the spread of the virus.

Strengthen classified management. Act according to circumstances. Accurately classify medical sewage and non-medical sewage, or sewage in the infected area and sewage in the uninfected area, and then formulate different countermeasures.

Strengthen the protection of drinking water sources. Strengthen the protection and monitoring of drinking water sources, and strengthen sewage management in critical places such as farmers markets, supermarkets, and airports, investigate and deal with illegal sewage discharge in accordance with the law, and strictly prevent pollution accidents.

4. Sewage pipe inspection, monitoring, and repair in post-pandemic

COVID-19 reminded the entire wastewater industry to promote the sustainable development of the pipe as soon as possible. To meet this demand, some inspection, monitoring, and repair technologies can be more widely used.

Inspection. Sewage pipe inspection is to put the device into the pipe and collect data to determine whether there is defect, blockage, or damage. Some mature or emerging technologies have been successfully applied to sewage pipes[8]. For example, closed circuit television (CCTV), a visual technique, can clearly see the actual situation in the pipeline (see Fig.2(a)). Some sensor-based techniques with different shapes can move and collect data in the pipe, and later signal analysis can be used to determine defects that are difficult to identify with the naked eye (see Figs.2(b)-(c)). The detector based on sonar technology can also carry out online detection when the pipe is filled with liquid (see Fig.2(d)). By increasing the frequency and scope of inspections, managers can assess the condition of the pipe and decide whether replacement and maintenance are required.

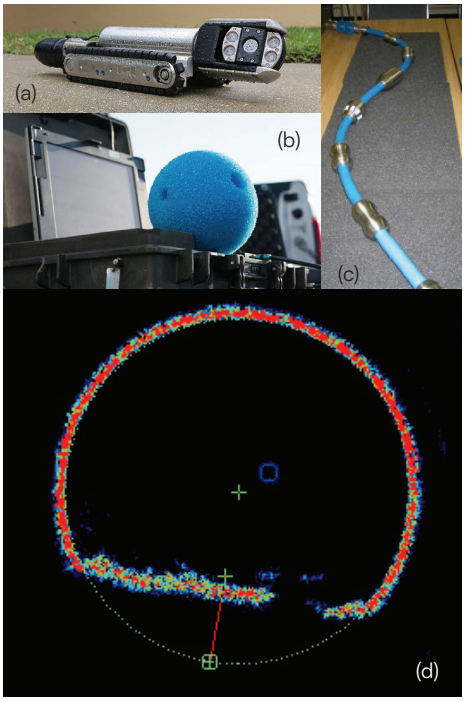

Fig.2. Some inspection methods suitable for sewage pipes. **(a)** CCTV. **(b)** SmartBall. **(c)** See Snake tool, **(d)** Sonar inspection tool.

Monitoring. The monitoring technology is mainly realized by sensors, which can monitor the leakage or rupture of the pipe in real-time[9]. When an abnormal signal is collected at the far end, it means that the pipeline is not operating normally. Monitoring technology can be used as an early warning or emergency alarm measures in management, which can avoid or reduce the failure probability of pipes.

Repair. When the sewage pipe is defective or has been damaged, it needs to be replaced or repaired[10]. In recent years, managers are more willing to adopt the repair scheme to save investment, especially in European and American countries. Trenchless technology is widely considered to be able to repair pipes more rapidly with low carbon in densely populated areas. Some techniques, such as curved in place pipe (CIPP), sliplining, and inserted hose method (see Fig.3), have been proved to significantly improve the corrosion resistance of the pipe and increase the service life of the pipeline for up to 50 years.

5. Outlook for interdisciplinary applications

With the rapid development of digital technologies such as artificial intelligence, big data, and virtual reality in recent years, traditional fields will also benefit from them. In the sustainable development of sewage pipeline, some scholars have applied big data and deep learning for intelligent pipe inspection[11] and pipe remaining life prediction[12]. Moreover, a technique named "digital twin"[13] in the "Industry 4.0" system may be able to monitor more intelligently in the future. It can not only capture data to realize the sewage pipe monitoring, but also predict and analyze the pipe status. Although these applications are still in their infancy or just an idea, there is no doubt that some interdisciplinary applications will be more widely used soon.

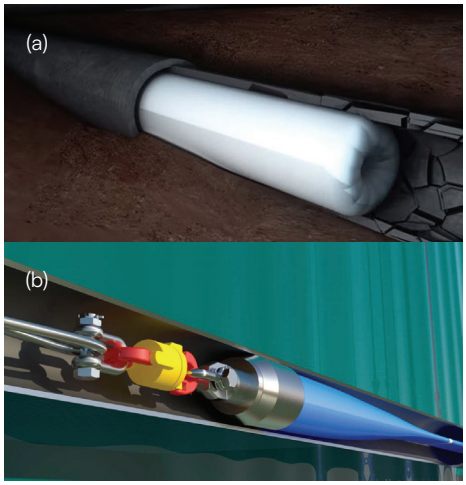

Fig.3. Some trenchless repair methods suitable for sewage pipes. **(a)** CIPP. **(b)** Inserted hose method.

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