

Study on risk prevention and control of third-party construction damage of underground pressure pipelines

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Abstract: The utilization scale of underground pressure pipelines such as gas, heat and water supply pipelines is increasing, and pipeline accidents occur frequently, among which the third-party construction damage has become one of the main factors, so it is crucial to prevent and control the risk of third-party construction damage. This paper probes into the risk prevention and control measures for the third-party construction damage of underground pressure pipelines from four aspects of management, laws and regulations, science and technology and culture. The research results show that only by taking into account the standardized management, restriction of laws and regulations, scientific and technological support, and cultural publicity, can the third-party construction damage risks of underground pressure pipelines be effectively prevented and controlled.

1. Introduction

With the continuous acceleration of urbanization, the utilization scale of underground pressure pipelines such as gas, heat and water supply pipelines is increasing. The normal operation of underground pressure pipelines is a solid foundation to ensure the continuous and orderly operation of residents' production and life, but pipelines often suffer from various disturbances and damages, of which the third-party construction damage is an important factor. Taking the gas network as an example, it can be seen from the National Gas Accident Analysis Report issued by the China Gas Association that the

third-party construction damage accidents account for 56.90%, 60.23%, 63.54%, 56.70%, 23.29%, 65.91% and 70.21% of the gas network accidents in the four quarters of 2021 and the first three quarters of 2022, respectively (see Table 1). It can be seen that the third-party construction damage is one of the main reasons for the gas network accidents. Therefore, risk prevention and control of third-party construction damage is very important. Through literature research and case analysis, it is found that management, laws and regulations, science and technology and culture can be taken into consideration.

Table 1. Statistics of gas network accidents caused by third-party construction damage

Order number	Time	Total number of accidents	Number of accidents with clear causes	Number of third-party construction damage accidents	Proportion of third-party construction damage accidents
1	The first quarter of 2021	58	42	33	56.90%
2	The second quarter of 2021	88	74	53	60.23%
3	The third quarter of 2021	96	75	61	63.54%
4	The fourth quarter of 2021	97	66	55	56.70%
5	The first quarter of 2022	73	39	17	23.29%
6	The second quarter of 2022	44	37	29	65.91%
7	The third quarter of 2022	47	41	33	70.21%

2. Standardized management

The main body responsible for the damage of underground pressure pipelines mainly involves pipeline

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enterprises and construction enterprises. For pipeline enterprises, it mainly exists that (1) The pipelines are not constructed according to the drawings during construction, and the drawings and data are not timely corrected after construction; (2) The accurate pipeline distribution drawings are not provided to the personnel of the construction enterprise; (3) Protective devices and warning signs are not set for pipelines as required; (4) The patrol inspection is not strong, and problems are not handled in time [1-4].

For construction enterprises, it mainly exists that (1) The construction enterprise did not check the accurate drawings before construction, and carry out blind construction; (2) The safety awareness of the personnel of the construction enterprise is weak, and the construction is against the rules [1-4].

In order to standardize the management of the construction process, it is required that (1) the pipeline enterprise should set up protective devices and safety warning signs during construction, and modify the drawings and file them according to the actual situation; (2) Before construction, the pipeline enterprise shall provide accurate drawings to the construction enterprise for reference; (3) Before construction, the construction enterprise must negotiate with the pipeline enterprise to formulate the protection scheme of pipeline facility, construction scheme, emergency plan, etc; (4) Before construction, the construction enterprise shall strengthen the safety technical disclosure and skill training for construction personnel; (5) During construction, the pipeline enterprise shall send professionals to the site for guidance; (6) Pipeline enterprises shall arrange personnel to strengthen daily inspection and deal with emergencies quickly and efficiently; (7) The corresponding supervision department is also required to supervise the

whole construction process [1-4]. In the process of standardized management, the relationship among the pipeline enterprise, construction enterprise and supervision department is shown in Fig. 1.

3. Restriction of laws and regulations

To prevent the third-party construction damage of underground pressure pipelines, it is far from enough to rely only on standardized management. It also requires the restriction of laws and regulations, and the punishment of barbaric construction, illegal occupation and other acts should be strengthened. Although relevant laws and regulations have taken shape, for example, Chapter III "Protection in Pipeline Operation" and Chapter V "Legal Liability" of the Oil and Natural Gas Pipeline Protection Law of the People's Republic of China, Chapter V "Protection of Gas Facilities" and Chapter VII "Legal Liability" of the Regulation on the Administration of Urban Gas regulate the construction requirements of pipeline enterprises and construction enterprises, and impose penalties on illegal acts of pipeline enterprises and construction enterprises, but do not provide detailed regulations on the later supervision of approved construction, and no specific implementation rules are specified in the punishment measures [5-7]. Therefore, it is also necessary to improve relevant laws and regulations, clarify the responsibilities of pipeline enterprises, construction enterprises, supervision departments and other parties in the whole construction process, increase penalties for illegal operations, and support the prevention and control of third-party construction damage of underground pressure pipelines through a sound legal system.

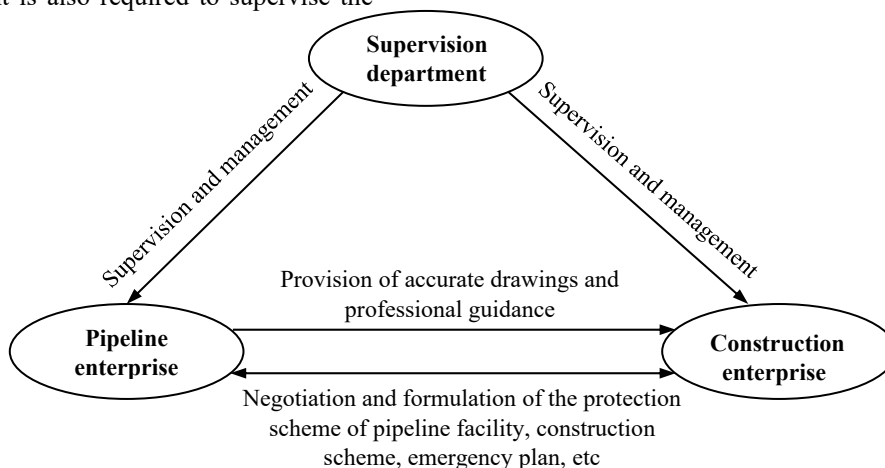


Fig. 1. Process of standardized management

4. Scientific and technological support

Informatization, intelligence and other scientific and technological means have always been important ways to prevent accidents. Hefei, Anhui Province, relying on Hefei Institute for Public Safety Research, Tsinghua University, has independently developed a system for safety operation monitoring of urban lifeline engineering, which has achieved dynamic risk monitoring of various

types of urban infrastructure, such as underground pipe networks and bridges based on the integrated technology of "perception, transmission, know and application" (see Fig. 2). It has achieved remarkable results and is known as the "Tsinghua Plan and Hefei Model". At present, the "Hefei Model" of urban lifeline safety engineering has been fully promoted in Anhui Province, and a monitoring network for urban lifeline safety engineering has been initially established, which has achieved initial success. Major urban safety accidents, such as gas explosion,

water supply pipe explosion, road collapse, urban waterlogging, heating pipe explosion, bridge collapse, have been well prevented.

For the third-party construction damage of the underground pressure pipelines, although the pipeline enterprise has patrol inspectors to inspect the pipeline regularly, the workload of manual patrol inspection is large, and the patrol inspection efficiency is low, which can not prevent the third-party construction damage accident of the underground pressure pipeline in a timely and efficient manner. Therefore, it is necessary to use information means to conduct real-time online monitoring of the construction damage of the underground pressure pipeline, so as to achieve early warning, reduce the risk of pipeline damage, and move the risk prevention gateway forward. At present, there is not much overall research on online monitoring technology of underground pressure pipeline, mainly including video monitoring, satellite monitoring, optical fiber sensing monitoring, acoustic signal/vibration signal monitoring and so on. Among them, video monitoring[8] is to build a visual system to achieve video monitoring, video scheduling, video consultation, and timely deal with third-party construction violations. Satellite monitoring[9] is based on high-resolution optical imaging, radar, laser altimetry and infrared technology to identify abnormal features around the pipeline. Optical fiber sensing monitoring technology[10] is to identify abnormal behaviors such as construction damage by

analyzing and processing the collected signals when light wave propagates in optical fiber and its characteristic parameters will change under external influence. Acoustic signal/vibration signal monitoring[11-12] refers to laying sound sensor or vibration sensor on the pipeline, and identifying the pipeline damage characteristics through signal processing methods such as filtering technology for the collected acoustic signal/vibration signal. In these methods, although the video monitoring can identify abnormal behavior through AI (Artificial Intelligence) technology, the video imaging quality is sometimes affected by the environment. The application of satellite monitoring in China's underground pressure pipelines is still in its infancy, and the price is relatively expensive[13-14]; Although the optical fiber sensing monitoring technology has high sensitivity and positioning accuracy, it needs to lay optical fibers in the same trench along the pipeline, and the cost is also high[15]. Acoustic signal/vibration signal monitoring requires more sensors to be laid on the pipeline, and is vulnerable to noise interference when identifying characteristic signals[16-17]. Therefore, it is urgent to break through the key technologies of underground pressure pipeline monitoring, and integrate cloud computing, big data, artificial intelligence and other emerging technologies to ensure the safe operation of underground pressure pipelines with scientific and technological innovation.

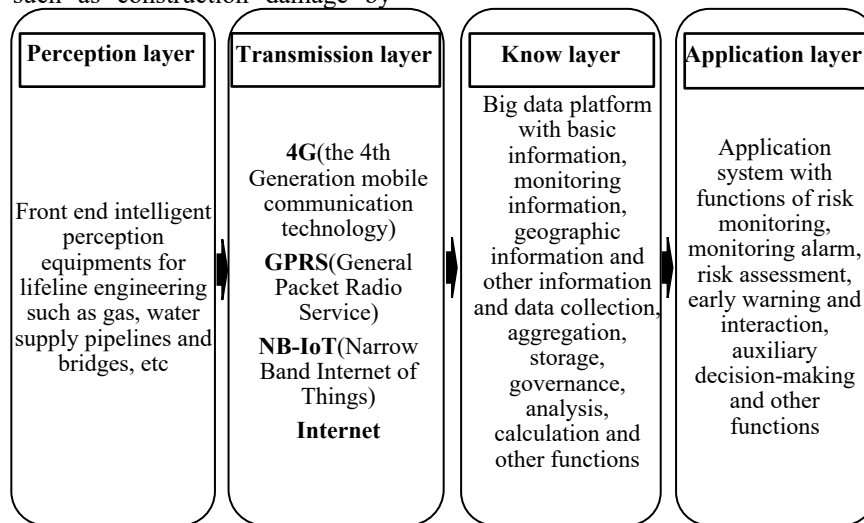


Fig. 2. System framework of "perception, transmission, know and application"

5.Cultural publicity

Safety culture plays a very important role in the process of enterprise safety management. Professor Fu Gui and other scholars put forward the 24Model to clarify the internal factors of accidents from two levels (organizational level and individual level) and four phases (directing behaviors, operational behavior, habitual behavior and one-time behaviors and state of objects), of which the root causes are the deficiencies of safety culture (see Fig. 3) [18], and studied the key elements of safety culture[19-20]. Therefore, in the protection of underground pressure pipelines, the

publicity objects of safety culture should not be limited to the internal employees of pipeline enterprises and construction enterprises. The publicity of safety culture should go into schools, communities, families and the masses, and use brochures, safety display boards, online videos and other ways to publicize the importance of pipeline protection, relevant laws and regulations, protection plans, emergency response and other knowledge, mobilize the people's strength, and enable the whole people to participate in the protection of underground pressure pipelines[21-22]. Among them, different publicity methods can be adopted for different areas such as urban and rural areas[21-22]. Only when all the people are aware of the importance of underground

pipeline protection and the importance of their participation in this activity can they actively participate

and prevent the third-party construction damage accidents to the greatest extent.

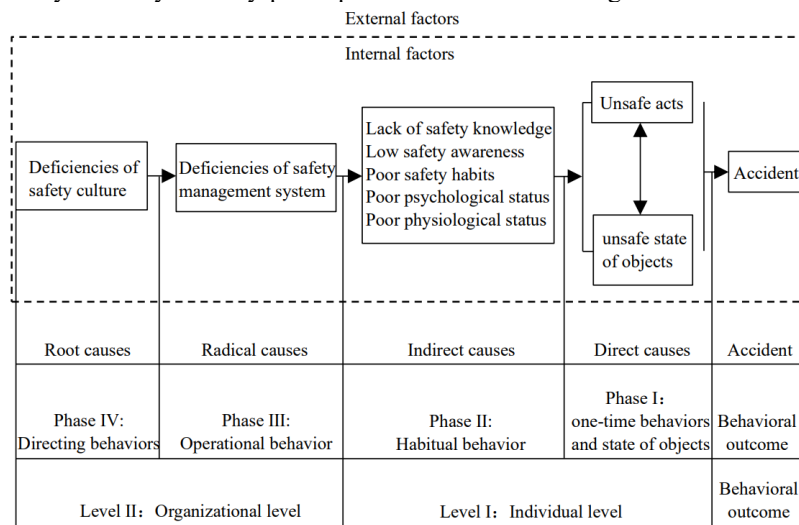


Fig. 3. 24Model[18]

6. Conclusion

In the risk prevention and control of third-party construction damage of underground pressure pipelines, standardized management, restriction of laws and regulations, scientific and technological support and cultural publicity are indispensable. Only by taking the new four-wheel drive path of "management + laws and regulations + science and technology + culture", can the risk prevention and control level of third-party construction damage of underground pressure pipelines be significantly improved, and the happiness index of residents' lives be improved.

Acknowledgments

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