

NON-COMPLIANCE WITH PLUMBING CODES IN CHINA: THE CRISIS OF SEWER GAS LEAKAGE

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ABSTRACT

Sewer gas leakage in China is a pervasive public health issue caused by widespread non-compliance with building codes requiring water traps and proper toilet installation. Despite the existence of national standards, the lack of enforcement and oversight has resulted in hazardous conditions in residential and commercial buildings. This study examines the plumbing deficiencies in the Dinis Hotel in Luoyang and the Anhui Tower Hotel in Beijing following major renovations in 2023. Findings reveal improperly sealed toilets, absence of water traps in drains, and reliance on inadequate air valves, contributing to persistent sewer gas leakage. Sewer gas exposure poses significant health risks, including respiratory illnesses and toxicity from hydrogen sulfide. Addressing this issue requires strict enforcement of building codes, public education on the risks, mandatory training for construction professionals, and adoption of international best practices. Resolving these deficiencies is critical to safeguarding public health and ensuring the effectiveness of China's construction standards.

Keywords: China, plumbing code, sewage, drains, sewer gas, water trap, public health.

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1. Introduction

The problem of sewer gas leakage in China has persisted for decades [1]. The main causes are exposed sewer pipes due to non-compliance with building codes, failure to install water traps, and improper installation of vertical outlet toilets. For various reasons, the Chinese population has largely ignored these issues. Sewer gases are hazardous to human health [2], and in high concentrations, they can be fatal [3]. Long-term exposure to low concentrations of sewer gases can lead to symptoms such as fatigue, headaches, loss of appetite, irritability, dizziness, and even pneumonia [4]. Sewer gas contains harmful substances, including hydrogen sulfide, ammonia, carbon dioxide, methane, nitrogen oxides, and sulfur dioxide, some of which are flammable. Hydrogen sulfide in sewer gas also dulls the sense of smell, making it difficult for a person to detect its presence. At concentrations above 300 ppm, hydrogen sulfide can cause unconsciousness, and at concentrations greater than 1,000 ppm, it can lead to collapse [3]. Since sewer gas is heavier than air, it tends to accumulate in basements and on ground floors of buildings. This is why many underground garages in Chinese supermarkets often have a strong, unpleasant odor, which can be hazardous.

The author has been regularly visiting various cities in China since 2007 and has been consistently struck by the pervasive problem of sewer gas odors in buildings, apartments, hotel rooms, and underground garages. The source of these odors is unsealed sewer pipes, caused by improper toilet installations and other plumbing fixtures that are installed without water traps. In the summer of 2024, the author visited China once again and observed that the issue of sewer gas leaks persists, even in newly constructed buildings. This paper presents the results of major renovations of hotels in Luoyang and Beijing, where, despite the renovations, sewer gas leaks continue due to improper installation of plumbing fixtures and non-compliance with relevant building codes and regulations in China.

2. Dinis Hotel Renovation

The author has been visiting Luoyang since 2010 and stayed at the Dinis Business Hotel, Kaiyuan Branch, located at 1009 Zhou Shan Da Dao, Luoyang 471023, China. In 2023, the hotel underwent a major renovation of its third floor, including the installation of new tiles and plumbing fixtures in the bathrooms. The rooms were re-carpeted, and new furniture was added. The hallway was also refurbished, with modern carpeting and new doors to the rooms. However, during a visit in the summer of 2024, the author noticed a strong smell of sewer gas in both the hallway and the rooms of the hotel.

A previous publication highlighted the shortcomings of sewer and ventilation systems in China, as well as methods for temporarily stopping sewer gas leaks using plastic bags filled with water [1]. However, these measures did not yield the desired results, which were documented on video [5]. The other remaining source of sewer gas leakage in the room was the toilet. The hotel management was cooperative, and the building maintenance staff removed the toilet in the newly remodeled room 8326. It became clear that the seal between the toilet and the sewer pipe was missing in Figure 1(a). The plumber installed the gasket under the toilet, but this did not resolve the issue. The standard gasket was not thick enough to create a proper seal between the toilet and the drainpipe.

To the author's knowledge, there is no requirement in China to use a flange on a sewer pipe when installing a vertical outlet toilet, as specified in the building code [6]. Figure 1(b) illustrates that, during installation in room 8623, the toilet was positioned more than 5 cm to the right of the pipe center. While it is possible to install a vertical outlet toilet without a flange, this requires extra effort and the expertise of a qualified plumber to ensure the toilet is properly centered over the sewer pipe and that a tight seal is formed between the toilet and the flange. Like other construction professionals, plumbers in China must obtain a license, which requires

proper training and periodic testing. Sewer gas leaks are unacceptable in any hotel room, as these gases can spread throughout the whole building.



Figure 1. (a) Floor drainpipe under a vertical outlet toilet in remodeled room 8326 showing signs of leakage and poor seal; (b) Improperly installed toilet off the drainpipe center in room 8623 at Dinis Hotel.

3. Anhui Tower Hotel Renovation

The Anhui Tower Hotel in Beijing, located at No. 1 West Huixin Street, Chaoyang District, Beijing 100029, China, underwent a major renovation in 2023. The author stayed at this hotel in the summer of 2024. Unlike the Dinis Hotel, where only one floor was renovated, the Anhui Tower Hotel underwent a complete remodel, including a full replacement of its plumbing. The bathroom shower and floor drains had air valves installed, as shown in Figure 2(a). However, these devices allow sewer gases to escape, particularly when there are pressure fluctuations in the sewer pipes, such as when a toilet or sink is flushed. A video shows gas bubbles escaping from beneath a plastic bag filled with water placed over a floor drain while the sink is being drained [7].

The top of Figure 2(a) shows an old drain insert with an air valve that is stuck in the open position due to metal corrosion. Unlike a water trap, an air valve cannot provide full protection against sewer gas leakage [8]. If there is no water trap built into the drainpipe, an insert with a water seal can be used, as shown in Figure 2(b). The dimensions of the water trap insert must comply with the relevant building codes to ensure proper water drainage, prevent clogging, and prevent the water in the trap from drying out.



Figure 2. (a) New drain insert with an air valve and magnetic flap. Above is the old drain insert with the air valve stuck in the open position due to metal corrosion; (b) Inserts with water trap for floor or shower drains.

4. Discussion

In developed countries, building codes, regulations, and laws are in place, along with government agencies and organizations, to ensure that sewer pipes are properly sealed and that sewer gases do not leak, thereby protecting public health [6,9]. These laws are typically enforced by local government authorities. Construction professionals undergo specialized training to obtain a license and are periodically tested. Their work is also inspected to ensure compliance with building codes.

Similar laws exist in China. For example, the Chinese national standard GB 50015-2019 (Standard for Design of Building Water Supply and Drainage) specifies in Section 4, "Drainage," that building sewer systems must prevent backflow, pollution, and the spread of odors [10]. Each plumbing fixture is required to have an appropriate trap to prevent the escape of odors. The standard also mandates the installation of floor drains in rooms with plumbing, such as bathrooms and kitchens, and specifies a minimum water seal depth of 50 mm.

The China Professional Standard CJ/T 186-2018 (Floor Drain) outlines the design, installation, and maintenance of floor drains in residential and commercial buildings to ensure proper drainage and prevent odors [11]. Drains must include anti-backflow mechanisms to prevent sewage backup, and anti-odor seals must be used to block unwanted smells from entering the building. Interestingly, these standards do not specifically use the term "sewer gas," instead referring to "odor" and "smell," which is not entirely accurate.

The Chinese national standard GB 6952-2015 (Sanitary Wares) specifies the dimensions and design of sanitary fixture openings but does not provide guidelines on their proper installation [12]. The author was unable to find any Chinese standard that mandates the use of a flange on the sewer pipe when installing vertical outlet toilets.

In the US, toilets are installed on top of the waste pipe using a flange and a wax ring. Two brass bolts are used to center the toilet over the waste pipe and secure it in place, as shown in Figure 3(a). The wax ring creates a tight seal between the toilet and the flange. Experienced plumbers know that, in many cases, two wax rings may be required to ensure a proper seal.

According to plumbing codes, toilets must be securely attached to the floor using a flange. The flange should be made of corrosion-resistant material and must be firmly fastened to the sewer

pipe. The toilet drain and gasket must meet the ASME A112.4.3 joint leak test and be installed in accordance with the manufacturer's instructions. The flange should be securely attached to the drain and pipe structure, and the toilet must be fastened to the flange using corrosion-resistant bolts or screws. All joints must be sealed with an approved elastomeric gasket that complies with ASME A112.4.3, or with an approved curing compound.



Figure 3. (a) Flange with gasket and bolts for installing toilet onto a sewer pipe in the USA; (b) Flexible collar for connecting a sewer pipe outside the horizontal outlet toilet in Europe.

In Europe, toilets typically have horizontal outlets that discharge from the back of the toilet, connected to the sewer pipe via a sealed collar, as shown in Figure 3(b). Since the connection is external, any damage or installation flaws are visible without the need to remove the toilet.

As shown in Figure 4(a), the shower drainpipe lacks a water trap. A typical bathroom includes a bathtub or shower, a sink, and a toilet. According to China's national standards, a floor drain must be installed in the bathroom. The siphon is integrated into the toilet and sink drains, so additional water traps in the sewer pipes are not required. However, the bathtub or shower drain, and the bathroom floor drain do not have a trap, so it is built as a part of the sewer pipe in Figure 4(b). The absence of a water trap in the shower drain, as seen in Figure 4(a), violates China's national standard GB 50015-2019. As a result, sewer gases enter the bathroom through the shower and floor drains, even though air valves are installed in both drains.

The Florida Building Code requires that all plumbing fixtures be equipped with a trap [10]. The most common trap is a p-trap, and there are several installation rules. Traps must be self-cleaning and not rely on movable parts to maintain the water seal. Trap outlets cannot be larger than the fixture drain they connect to. The water seal should be between 2 and 4 inches. Traps must be installed level in relation to their water seal. Fixtures cannot be double trapped. The vertical distance from the fixture outlet to the trap weir should not exceed 24 inches, and the horizontal distance should not exceed 30 inches. Additionally, there are specifications for the maximum slope of horizontal sewer pipes to prevent the water from leaving the siphon due to inertia when draining large volumes of water, such as from a filled bathtub. These requirements are designed to ensure the proper operation of sewer systems and prevent the leakage of sewer gases.

In the United States, building codes are periodically updated, published, and made freely available to the public. Failure to comply with these codes can result in administrative penalties or even criminal liability. Compliance with building codes and regulations is enforced by local authorities, typically through inspectors from the construction department of each city. Before construction or remodeling work begins, approvals must be obtained from the construction

department, which then monitors the quality of the work through regular inspections. Construction professionals must undergo special training to obtain and maintain a license.

Construction projects in China are approved by local government authorities, and architectural plans are prepared according to national standards. Quality control takes place during construction, including materials, technologies and on-site quality of work inspections. Completed projects are inspected to confirm their compliance with all standards and requirements. Quality control systems in China include strict penalties for violations of safety and quality standards. Companies, contractors, and workers who fail to meet these requirements may be fined, lose their licenses, or even face criminal charges. In addition to national standards, China aims to comply with international construction standards. This includes adherence to ISO standards, as well as cooperation with international organizations to improve construction quality and safety. In theory, everything looks good, but in practice, it's a different story. At the time of writing this paper, certain construction standards are not being followed, otherwise, there would be no issues with the leakage of sewage gases.

The reasons why certain construction standards are not followed in China remain unclear. The Ministry of Housing and Urban-Rural Development (MOHURD) is responsible for developing building codes and regulations, but it does not directly oversee their implementation. In China, residential apartments are typically sold with bare walls, and owners hire contractors to complete the interior work. Quality control for these finishing works is not enforced by the government. It seems that many Chinese people have become accustomed to the presence of sewer gas and may not even notice its smell. This is a phenomenon that would be unthinkable in other developed countries. For example, if a hotel emitted the odor of sewage, customers would complain, and the hotel would be forced to address the issue. Similarly, the foul odor of sewage gases in the parking garages of supermarkets in China is a significant problem, especially since these projects are planned, built, and operated by professional organizations that are legally required to comply with building codes and regulations. China should consider studying and adapting international best practices in the areas of ventilation and sewerage systems for both industrial and residential buildings. Plumbers must be properly trained and instructed to adhere to the building code. The sooner this happens, the better it will be for supporting the country's massive construction efforts while safeguarding public health.

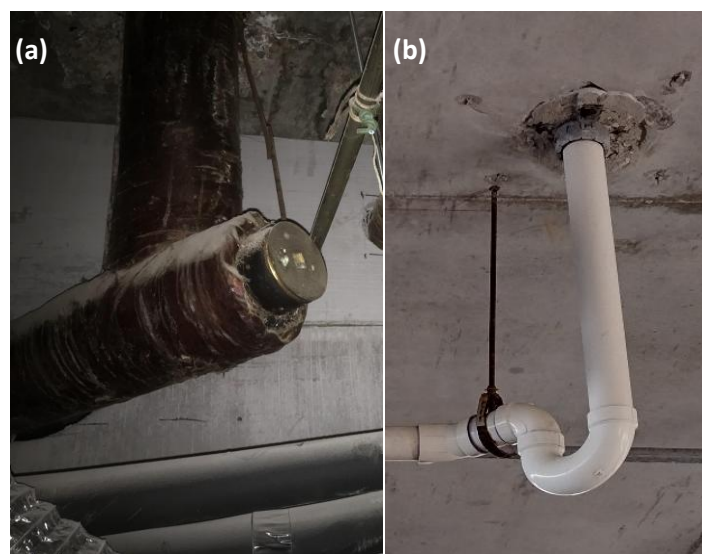


Figure 4. (a) Shower drain sewer pipe in Anhui Tower Hotel without a water trap; (b) Sewer pipe with a built-in p-trap.

Timely recommendations for the construction of energy-efficient buildings [13] led to the adoption of the national standard GB 55015-2021 (General Code for Building Energy Efficiency and Renewable Energy Utilization) [14]. However, as of 2024, regulations regarding the use of water traps in industrial and civil construction in China have not been fully implemented. As a result, new buildings in China continue to face issues with sewer gas leakage.

According to the Health Aspects of Plumbing published jointly by the World Health Organization and World Plumbing Council [15]: “Each fixture, or group of fixtures, connected to the drainage system should be equipped with a liquid seal trap. The depth of liquid in each seal must be adequate to prevent the emission of odours and gases, and must prevent access by insects or rodents from the sewer to the premises. Self-sealing waste valves are a possible alternative to liquid seal traps in some situations.” And “It is imperative that individuals installing and monitoring plumbing systems have access to adequate continuing education and training. An accreditation system should be developed to ensure that all such individuals have achieved and demonstrated appropriate levels of competency.”

5. Recommendations

To mitigate the issue of sewer gas leakage in China, the following steps are recommended:

1. **Enforce Existing Building Codes:** Government agencies must monitor compliance with national standards such as GB 50015-2019 and CJ/T 186-2018.
2. **Mandate Flange Usage:** Update standards to explicitly require the use of flanges for vertical outlet toilets.
3. **Enhance Public Awareness:** Educate the public about the health risks associated with sewer gas leakage.
4. **Train Construction Professionals:** Establish mandatory training and certification programs for plumbers and construction workers.
5. **Adopt International Best Practices:** Collaborate with international organizations to benchmark and implement proven solutions.

6. Conclusions

This study highlights the widespread issue of sewer gas leakage in China, driven by non-compliance with building codes, inadequate plumbing practices, and insufficient enforcement mechanisms. Despite the existence of national standards, the continued prevalence of improperly installed plumbing fixtures in new and renovated buildings underscores systemic gaps in implementation and oversight. The health risks associated with sewer gas exposure, including toxicity and respiratory illnesses, further amplify the urgency of addressing these shortcomings.

To mitigate these issues, it is imperative for government agencies to enforce compliance with existing building codes rigorously, mandate the use of critical components like water traps and flanges, and establish mandatory training and certification programs for plumbing professionals. Additionally, public awareness campaigns and the adoption of international best practices in plumbing and ventilation are essential for long-term improvement.

Resolving these challenges is vital to safeguarding public health, enhancing construction quality, and aligning China’s building practices with global standards. Without immediate action, the continued neglect of these critical issues risks undermining public confidence in infrastructure and jeopardizing the well-being of residents across the country.

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CONFLICT OF INTEREST STATEMENT

The author declares that there are no conflicts of interest.

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