Technical paper

Purpose of a High-Rise Drainage and Ventilation system

The fundamentals

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Abstract

The fundamental purpose of a high-rise drainage system is the removal of fluid and solid waste to the sewer while protecting the inhabitants of the building from cross contamination from sewer gases and pathogens from within the drainage system by ensuring water trap seals are maintained. The system should require minimal maintenance, should be as quiet as possible so as not to disturb the occupants from noise from discharges above and below them. Ideally the system should only require minimal resources to do this, in the terms of water usage as well as materials, to achieve the aim of sustainable (green buildings). Single stack drainage systems such stack-aerators or active drainage ventilation achieve this.

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Research | **Relevance** | Design | Solutions | Materials | Installation | Terminology | Standards

High-rise building solutions

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Introduction

Since the late 1700s water trap seals were seen as a solution, using a U-tube as a solution that would separate the drainage system from the building interior.

The industrial revolution in the UK from 1760-1840 lead to the first mass migration and urbanisation. The mass of people overcrowding living in towns and cities lead to increase in disease and deaths to which the poor sanitation of these population centres played a major part.

In the late 1800s this lead to the foundation of what we have as today'sdrainage and ventilation systems, using water to remove the waste water and solids and the use of water trap seals to protect the occupants of the buildings reducing the infections and deaths with good sanitation. In the 1950 -1960 further research was carried out to give the bases for the national codes in use today, but based on steady state discharge and for low rise buildings.

Today in the world we are living in a modern urbanisation with predictions that 80% of the world's population will become urbanised by 2050 and to meet this many cities are building high-rise buildings.

To ensure that with this new urbanization and that the mistakes of the past do not happen again, the high-rise drainage and ventilation must be designed so that the waste and solids are moved to the sewer and that the water trap seals are maintained to protect from cross-contamination.

The outbreak of the SARS virus at Amoy Gardens in Hong Kong back in 2003, high-lights the risk when the system fails, with 53 deaths and the forensic investigation proving that the infection was transmitted through the depleted water trap seals, poor design and lack of maintenance.

Requirements

The requirements of the drainage system have not changed from what was required back in the late 1800s, the core principles are the same these being:

- Remove waste from the habitable space via the sanitary appliance
- Retain a physical protection between the drainage pipework and the habitable space

In modern high-rise drainage and ventilation systems with with high-occupancy and increased loadings and longer pipe lengths involved in building the 30, 50 and 100+ storey tall buildings, the requirement to ensure that not only the waste is removed quickly to the sewer but also that the habitable space and the occupants in the building are protected from cross contamination by ensuring good design principles, so that the water traps seals are maintained.

Through research institutes such as Heriot Watt University, Drainage Research Group, evaluation of current national guidance has been undertaken, focusing on high-rise building drainage recommendation using simulation tools such as AIRNET as well as empirical testing. One of its key findings is that national code guidances undersize the venting requirements as well as unsteady flows condition for tall buildings.

In partnership with manufacturers and research institutes, together they developed solutions to meet the requirements of high-rise drainage systems. Guidance and data is available for national code bodies to re-evaluate their guidance for high-rise drainage and ventilation.

Testing on high-rise drainage test facilities, such as the NTL test tower in the UK and the HDEC in Holland ensure validation of the research as well as ensuring that products developed meet the demand and functionality required for tall buildings. They are also used to support the industry through live interactive technical demonstrations; seeing the operation of how a high-rise drainage system works "seeing is believing".

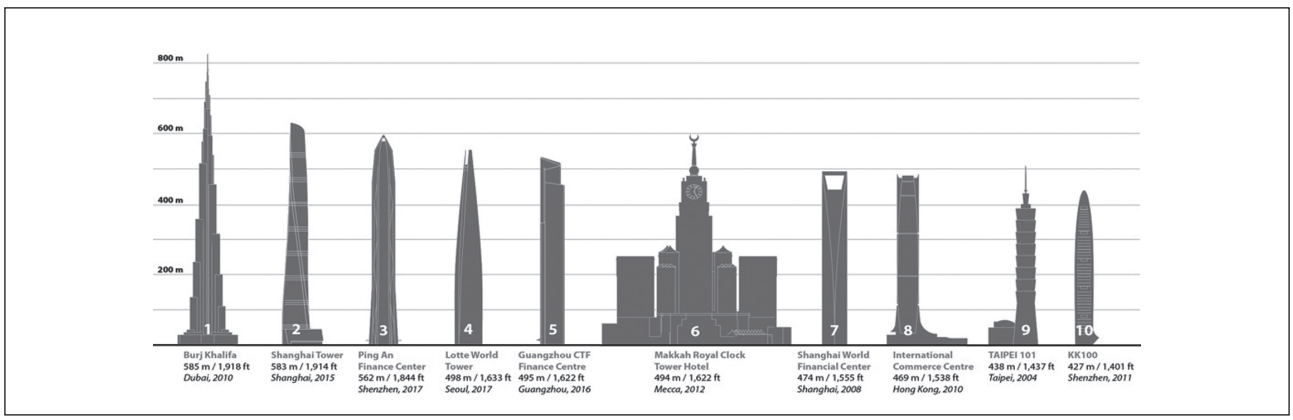

Figure 1.
Top 10 tallest high-rise buildings

Single stack solutions

Not only have these systems been developed for high-rise buildings, the research and testing has and is focused to meet the demands and operation for tall buildings, not only based on current loadings guidance, but focusing on water saving appliance, where less water is required to carry the waste and solids to the sewer and the impact on the function of the system.

They also meet the requirement of modern buildings to be sustainable, helping these building reach the green sustainability approvals, by removing the vent pipes from the building, saving in tall buildings 20-40 Km of pipe work that was required to vent the system.

They are tested to ensure the protection of the water trap seals barrier is maintained when air pressure transients are generated by the unsteady flow conditions, or in the case of stack attractors ensure that the pressure fluctuations are kept to a minimum.

Active Drainage Ventilation solution

With substantial research and completed projects, Active Drainage Ventilation, utilizing air admittance valves and P.A.P.A. provides:

- Reduced system complexity
- Reduced time of installation and labour
- Reduced material used in the system, bringing sustainability to the design
- Increased predictability of the system operation
- Ability to place suppression between transient source and appliances' trap seals to be protected
- Interception of transients prior to propagation throughout the network and impact on all connected appliance trap seals
- Single stack system
- Suitable for buildings of over 100 floors
- System pressures kept in the region +-100Pa, well below +-400Pa that affect trap seals in the system

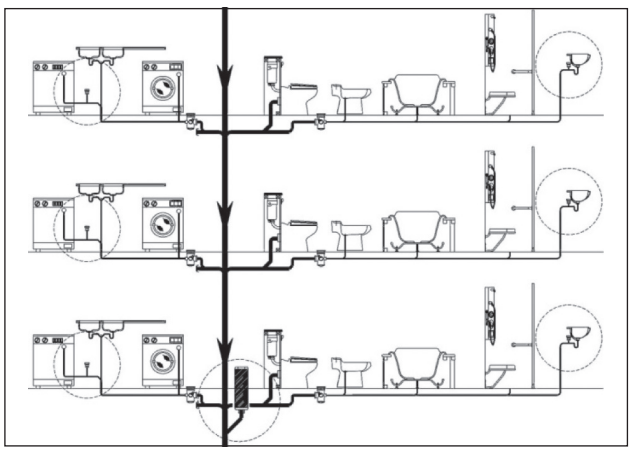

Figure 2.
Active drainage ventilation solution

Stack-aerators solution

- Slows the downward flow of water to prevent the formation of hydraulic plugs.
- Prevents waste water from branch lines mixing with other waste water until below the junction point.
- Has only one outlet pipe, replacing the need for a conventional two-pipe fully-vented or a fully ventilated modified stack system for multi-storey buildings.
- Provides significant cost savings through reduced pipe work and associated construction increasing flexibility for architects and designers of multi-storey buildings
- A single pipe stack, eliminating all additional pipe work required for relief venting
  - Increased design flexibility with longer unvented branch drains, to a maximum of up to 10 metres
  - Space-saving through the elimination of bulkheads
  - Installation and construction cost savings through the elimination of venting pipe work.

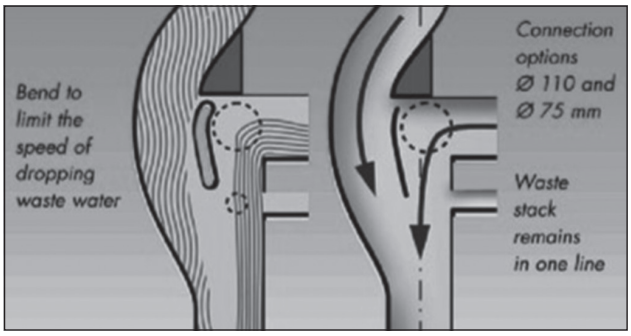

Figure 3.
Stack-aerator solution

Conclusion

The purpose of high-rise drainage and ventilation remains the same as low –rise drainage and ventilation, namely to remove the waste from the building to the sewer and ensure that the occupancies of the building are protected from cross-commination from the gases and pathogens from within the system.

Current national code guidance was based on steady state, low rise testing. To ensure that the drainage system for high-rise buildings is fit for purpose, the guidance within the codes needs to be revaluated and tested. Active drainage ventilation and stack-aerators are two systems that have been tested and researched for use in high-rise buildings and ensure that the system are fit for purpose.

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3. Swaffield J. A. and Galowin L.S., (1992) *'The engineered design of building drainage systems'*, Ashgate Publishing Limited, England

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