The syphonic roof drainage system

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Abstract

The Geberit Pluvia® roof drainage system is based on the ingenious gravity-induced vacuum principle. Consisting of HDPE roof outlets, pipes and fittings an engineered fastening system and a professional support package, Geberit Pluvia® allows the complete drainage of a roof without the requirement of a slope in the pipework, saving space, set-up time and expenses.

The symphonic roof system is widely used in the industrial and commercial sectors for roofs large than 100m2（1000 sq ft）. These include flat roofs, shed-type or normal pitch roofs as well as dome-shaped and arched roofs with various curvatures.

1. General principle

Geberit Pluvia system is the application of syphonic roof drainage system with advanced technology, high quality; economical, safe and reliable.

Syphonic roof drainage system is composed of symphonic outlet, piping system (hanged pipes, vertical pipes and pipes going out of building), fittings and fixing parts. Each component must accord with its own product standard and meet the specific requirement of system working pressure, fire protection, noise isolation and heat isolation.
The design parameter of outlet, pipe material and pipe accessories must be verified by hydraulic test.

The designed life expectancy of symphonic roof drainage system should be as long as the required life expectancy of the building.

The installation of syphonic roof drainage system must be fully in accordance with system design and installation drawing. Any change during installation must be approved by designer in advance.

2. Technical terms

2.1 Syphonic roof drainage system

The system will realize separation of air and water by separation of air and water by syphonic roof outlets when the water-level in the gutter reaches a certain height.

When rainfall intensity reaches the designed rainfall intensity, inside the whole pipe system will be full flow of water. Together with fat dropping velocity of water in vertical pipe, syphonic effect will happen. Because of this syphonic function, rain water can be drained out rapidly and efficiently.

Normally this system includes syphonic roof outlet, gutter, roof gutter, piping system and manhole.

2.2 Roof outlet

The facility located on the roof for collecting rain water. It includes grid cover (plain or gap-shaped), disc plate and connection pipe. Its function includes water drainage, water flow rectification, reducing the air volume entering the pipe, blocking dirt for easy cleaning.

2.3 Syphonic roof outlet

The outlet must be designed in a way that for the calculated drainage capacity and a certain controlled water level the air is cut off.

2.4 Hanged rain water pipe

The horizontal pipes that are hanged under the roof and beam connected with the vertical pipe and outlets

2.5 Overflow

It is the additional drainage hole for water drainage, when water (depth or velocity) exceed the design volume. Normally it is located on the end-gutter wall or parapet with a certain height over the roof. It is used for draining out rain water that exceeds the recurrence interval or water that accumulates because the outlet, gutter and pipe were blocked by sundries.

2.6 Fastening system

The main function is to fasten the pipes. Beside it also can absorb the pipe vibration, limit the pipe elongation caused by temperature change, avoid the pipe deformation caused by

hanging stress and absorb the horizontal stress of pipe. Fastening system should include anchor bracket, guiding clip, frame, connection accessories, hanging accessories, guiding steel (rail), fixation accessories etc.

2.7Rainfall quantity

It is the absolute volume of rain water and snow water falling onto the earth. It is presented by water depth (m) or the water volume of unit area.

2.8 Roof catchments area

It is the horizontal project area of the roof. For side walls that are higher than the roof should be calculated by 1/2 of their actual area.

2.9 Recurrence interval

It is the reciprocal of rainstorm occurring frequency. That is, the average interval time which the storm equal or bigger than certain rainstorm intensity happened within a certain statistical period.

2.10 Transition section

It starts from the ending point of hydraulic calculation of syphonic roof drainage system. Normally in transition section, the pipe diameter is enlarged and water flow change from syphonic flow to gravity flow. The transition section should better locate on the pipes going out of the building, and should make full use of system kinetic energy.

2.11 Calculation point

It is the hydraulic calculation point of syphonic roof drainage system. Normally it is an outlet, connection point of branch pipe, the point where pipe diameter changing, bending point (where water flow direction is changed) and other specific points which require hydraulic calculation.

3. System design

3.1 General Requirement

The calculation of rainfall duration, quality, roof catchments area and designed drainage capacity should meet the requirement of nation standard GB50015-2003 ‘Designing regulation of house water supply and drainage system.’

The recurrence interval of syphonic roof drainage system should be decided by the

importance of the building, the property of roof catchments area and meteorological factors. The recurrence interval for normal building should better be no less than 10 years. The recurrence interval for important building should better be no less than 30 – 50 years, based on the importance of the building and potential danger caused by overflow.

The outlets used in syphonic roof drainage system should pass hydraulic test.

For the roof whose catchments area is bigger than 5000m^2 should better install no less than 2 independent syphonic roof drainage systems.

Each catchments area should have overflow or overflow system. The drainage capacity of syphonic drainage system together with that of overflow or overflow system should better be no less than 5 minutes rain fall quantity with 100 years recurrence interval.

3.2 Pipe layout and design

The pipes of other non-syphonic roof drainage system should not be connected into syphonic roof drainage system.

Hanged pipes should better be installed horizontally, and negative slope installation is not allowed.

Each vertical pipe should better drain water out independently.

Water from different roof structure should better be drained out through independent drainage systems.

The checking well connected with pipes going out of the building, should better be built by concrete structure.

Pipes should not be built in loading structure of the building.

Pipes are not allowed to go through rooms with high requirement on noise. If have to, special noise isolation measurement should be taken.

If condensation could happen on the surface of pipe, special anti-condensation measurement should be taken.

The transition section between syphonic and conventional drainage system should not be on vertical pipes. The position of transition section should be decided by calculation, on condition that the kinetic energy of the system is fully used by the system.

The pipes on the lower part of transition section, should meet the requirement of Nation

Standard GB50015-2003 ‘Designing regulation of house water supply and drainage system’

Dimension of drainage pipes used in syphonic roof drainage system should no less than DN50.

The position overflow or overflow system should ensure that water can flow between outlets and overflow or overflow system.

The height of overflow or overflow system should be decided by the largest allowed water level for different roof structure, but the lower part of overflow should be 50mm higher that the roof or the top of outlet (when the roof is flat, with no gutter).

The height of all roof edge should not be lower than the height of overflow or overflow system.

3.3 Hydraulic calculation

Syphonic drainage system requires accurate calculation of hydraulic status of each section on pipe layout. Calculation result should include pipe dimension, pipe length, flow quantity, flow rate and pressure.

The designed drainage capacity of outlets should be decided by the hydraulic test of these outlets, and should not be higher than their biggest tested drainage capacity.

The dimension of vertical pipe should be confirmed by calculation, and can be smaller than the dimension of upper hanged pipe.

The calculation of the system is done by the Geberit ProPlanner Software.

4. System components

4.1 Outlet

Syphonic roof drainage system should use outlets tested by hydraulic method. The water damming height around the outlet should be controlled through accurate calculation of drainage capacity and pipe dimension, which should better be no more than 55mm.
Syphonic outlet should have anti-vortex function.
Syphonic outlet should locate in the lowest part of roof or gutter. Each water catchments

area should at least have 2 outlets. The distance between two outlets should not be more than 20m. The distance between outlets and roof edge should between 1m and 10m.

Generally, the body material of syphonic outlet can be cast iron, stainless steel, HDPE, or PP.

Syphonic outlet should be reliably connected with roof or gutter, and pipe system.

The material of connecting sheets of syphonic outlets that locate on the roof should be the same as that of water-proof material used on the roof.

For roofs that use bitumen as water-proof material, stainless steel sheet can be used.

The outlets that installed inside gutter, should also install connecting sheets whose material should be the same as that of the gutter.

Syphonic outlets should be equipped with grids, the shape of which can be small hole or slot. The dimension of grid should be no less than 6mm and no more than 15mm.

Syphonic outlets should better be symmetrically placed according to the position of vertical pipe.

Syphonic roof outlets should be connected with hanged pipes, and must not be connected directly with vertical pipe.

The syphonic outlets that connected with the same hanged pipe should better be installed at the same height.

Depth of gutter should be decided by the water damming height of roof outlet. Gutter's slope should better be no less than 0.003.

4.2 Pipes and fittings

Pipes used in syphonic roof drainage system must be able to endure negative pressure and vibration caused by high speed water flow. There is high requirement on pipes, fittings and the connections.

It should better use the same material of pipes and fittings in the same system.

The choice of pipes should be based on the features of different buildings, considering working pressure, fire protection, noise, easy installation, economical condition and the other factors.

a. Pipe and fittings should be made of materials no lower than PE80 class.

b. HDPE pipe thermal elongation should be no more than 3%.
c. Surface inside and outside pipe and fittings should be smooth, plane. Pipe thickness should be even. The surface color is black, blue.
d. Surface of pipe edge must be smooth, and be vertical to the axial surface of pipe.
e. Connection between pipes and fittings should be butt welding or by electronic sleeve.

4.3 Fixing parts

Fixing parts are necessary for pipe installation. All fixing parts must be able to bear the weight of pipes with full-flow water, and endure stress coming from high speed water flow. For HDPE pipe system, fixing parts should also be able to absorb the axial stress caused by thermal elongation of pipes.

Fixing parts should be designed according to different pipe materials and dimensions. Fixing parts should be exactly positioned, smoothly installed, tightly connected with pipes, but not scrap the surface of pipes.

Life expectancy of fixing parts should be no less than the life expectancy of syphonic roof drainage system.

It should better use proprietary fastening systems for syphonic roof drainage system.

5. System installation

5.1 General principle

Follow conditions should be fulfilled before installation:

a. Complete installation drawings and other technical documents that have been checked by different parties.
b. Approved installation plan and procedure that have been transferred to installer.
c. Materials, tools and manpower are ready, to ensure normal installation.
d. Building structure should be well understood before installation. Coordinating measurements should be made based on design, installation plan, structure construction procedure and other construction work.

5.2 Material checking

a. Specification, type, and function of pipe, fittings, outlets and other materials should accord with design requirements, and should be with documents of quality certification. The require materials will be calculated by Geberit ProPlanner Software.
b. Surface of pipe, fitting and the other materials should be flawless. For HDPE pipe and fitting, no crack, concave, air bubble and so on can appear on surface.

5.3 Material storage and delivery

a. Pipes, fittings, outlets and the other material should be stored by classification. Pipes should be stored horizontally on the plane floor, fittings, outlets should be stored layer by layer, and the height should better not be too high.
b. During loading and unloading the HDPE pipe, it is forbidden to impact, throw, break, drag etc.
c. HDPE pipes should not be exposed under sunshine for long time, and be isolated from fire and heat source.

5.4 Pipe layout

a. Rainwater drainage pipes should be installed on right position according to design. Hanged pipe can have no slope.
b. Access entry should be installed on vertical pipe. Distance between ground and center of access entry is 1.0m.
c. Connection between hanged pipe and vertical pipe should use 45° branch or 90° gradient tee.
d. Connection between hanged pipe and vertical pipe, vertical pipe and pipes going out of the building, should better use two 45° bends or one 90° bend with $R \geq 4D$. Access cleaning cover should be installed at the bottom of vertical pipe.
e. In high rise building, when HDPE pipes go through wall or floor, fire stopper of fire protection sleeve should be install according to design.
f. Rainwater pipes should go through the wall and floor covered with metal or plastic sleeves.

   For sleeves partly installed inside floor structure, upper part should be 20mm higher than decoration level; lower part should be the same level as floor bottom.

   For sleeves installed inside wall structure, both sides of sleeve should be level with the decoration surface.

Gaps between sleeves and pipes should be filled by fire protection material.

g. During installation, opening of pipes and outlets should be blocked.
h. When pipes go through building dilatation joint or expansion joint, system supplier should provide detailed technical documents and solution based on features and flections situation of different material of pipes.

5.5 Outlets installation

For flat roof, it should better use DN50 outlets; for roof with gutters and gully, it should better use DN50, DN75, or DN100 outlets.

Outlets that are belongs to the same syphonic drainage system should better be installed at the same horizontal level.

Inlet-water-height of outlets should ensure that the rainwater in the gutter can be drained out.

Outlets installation should be done according to the products guide manual.

During roof structure construction, installation hole for outlets should be reserved in advance.

Connection between the edge of outlet and roof should be tight and no leakage after installation.

During installation, rectifier, guided cover and the other special parts of outlets cannot be installed until the completion of roof waterproof treatment, rainwater pipe cleaning, and elimination of sealant that flows into the short pipe.

For outlets installed on steel panel or stainless steel gutter (gully), can use Argon welding for connection.

If materials of outlets and rainwater pipes are different, flange can be applied for connection.

5.6 Pipe installation

a. HDPE pipes should be connected by butt welding and electro welding.
b. HDPE pipes can be cut by pipe cutting machine. Cutting edge should be vertical to the axes of pipe.
c. The length of HDPE prefabricated pipe should not be longer than 10m. Connection between prefabricated pipes can be made by electronic sleeve.

The connection joint of metal pipe should fulfill the air hermetic requirements.

5.7 Installation of pipes going out of the building

a. Pipes going out of the building should be HDPE pipe.
b. Depth of underground rainwater pipes should be below the freezing line, and load above the pipes should be considered.
c. When burying HDPE pipes, grit layer with thickness is no less than 100mm should be laid in the normal terrene pipe channel.
d. The end part of underground rainwater pipes that go through the manhole and touch the surface of shaft should be coated two times adhesive, and grit, afterwards insert the cement plaster to avoid water leakage.

5.8 Installation of fixing parts

HDPE hanged pipes should be fixed by square steel profile. Square steel profile should be suspended on the structure of building along with suspending HDPE pipes. HDPE suspending pipes should be connected on the square steel profile by guide brackets and anchor brackets. The distance of square steel profile suspending points, and the distance between the guide brackets and anchor brackets should accord with the regulation of table below.

The anchor brackets of HDPE hanged pipes are normally set at the beginning, terminal, both sides of tee, and the position of branch pipe. If dimension of HDPE hanged pipe is more than or equal to DN250, there should be applied two anchor brackets in each fixation point.

The maximum of distance of anchor brackets which are applied in the HDPE vertical pipe is 5m, the maximum of distance of guide brackets is 15 x Dimension

At the bottom of vertical pipe, specific supporting and fastening measurements should be taken to support the bending point.

6. Checking

6.1 General regulation

Syphonic roof drainage system should be jointly checked by main constructor, system

supplier, and other relevant parts. People who check the system should have technical qualification.

Following documents are necessary for checking:

a. Installation drawing（Final version）and documents registering design & installing change.
b. Quality documents for outlets, pipe, fittings, and fixing parts.
c. Application manual for materials and installation.
d. Checking records during installation for mid-term tests and concealed sections that cannot be checked when project completed.

6.2 Checking of system components

Outlet:

a. Outlet installation should meet design requirement. Connection between outlets and roof should sealed and ensure no leakage.
b. No waste materials such as filling material, package, or other construction wastes are left around outlets, so that avoid outlet jam.
c. If the roof is concrete, the outlet should be protected by 1m2 and 5cm thick of washed stones whose dimension is bigger than 12cm.

Pipes:

a. The dimension, diameter and quality of pipes should meet the requirement of design. All pipes should meet relevant product standard.
b. The allowed deflection of pipe installation should be limited within the requirement of national standard GB50242-2002 ‘Checking regulation for the installation quality of piping work’
c. The distance between checking fittings or flanged-tees on hanged pipe, should meet the requirement of national standard GB50242-2002 ‘Checking regulation for the installation quality of piping work’

Fixing parts:

a. The installation of fixing parts for hanged pipe, vertical pipe should accord with the requirement in chapter 5.4.
b. Fixing parts should be firmly fixed on the loading structure of the building.

Overflows or overflow system:

a. No dirt, filling materials and waste construction staff can be left around the over flow.

b. The position of overflow or overflow system should ensure that water can flow between outlets and overflow or overflow system.

6.3 Hermetic checking

Jam all the outlets, fill water into roof or gutters of roof. Water should submerge the outlets for at least 1 hour, and no leakage should happen around outlet.
For pipes installed inside the building, should also tested by filling water inside the pipe till outlet for at least 1 hour, and no leakage should happen around pipes and all connection points.

6.4 Final checking

Roof and gutters should be clean and no dirt is left.
Each water catchments area should have overflow or overflow system that are installed in accordance with design.
Main horizontal and vertical pipes should pass water-filling test. Water should go through smoothly and no jam.