Siphonic Roof Drainage & Design Process
Presentation by

MIFAB®

Hydromax
Leaders In Siphonic Drainage

Siphonic Roof Drainage Systems
What is Siphonic Roof Drainage?

Siphonic Roof Drainage is an innovative solution which utilises the power of a natural siphon to create a high-performance roof drainage solution.
Why use Siphonic Roof Drainage?

Siphonic Roof Drainage is an Engineered Solution which provides many Technical Benefits

Siphonic Roof Drainage offers cost savings ranging from 25% to 45%!
Siphonic Roof Drainage
Only 1000 feet Pipe
Diameters 3” to 8”

Traditional Gravity System
1600 feet Pipework
Diameters 6” to 18”
What’s wrong with Traditional Gravity Drainage Systems?

Traditional Gravity drainage systems work but they are inefficient and have a number of factors restricting performance.
Restrictive Factors of Gravity Drainage

1. The water flow-rate is **dictated by ¼” pitch** when hanging the pipe, this decline also **limits the distance a pipe can travel**.

2. Multiple rainwater pipes have **location of discharge largely dictated by the gravity hydraulics** rather than design team choice of where to route.

3. Vortex formation at the gravity roof drain results in the **water being transported in an inefficient spiral motion** rather than straight into the pipe below.

4. Gravity drains/pipes require **⅔ air to transport ⅓ water** = bigger diameters required to properly flow.

5. The **driving force** is directly correlated to the **depth of ponding** (‘head’ of water above the roof drain).

6. **No Test Standards** currently in place to test ponding flow graphs for **Gravity Drains** = **unidentified** ponding on roof.
System Comparison

Traditional Gravity

½ water in annular flow
½ air core

Siphonic

No Air
Principles of Siphonic Drainage

• The Siphonic Roof Drain eliminates air entering the pipe promoting water filled pipework

• The full bore of the pipework carries the rainwater

• Water, without air, accelerates down the vertical downpipe, creating negative pressure and naturally generating a high performance siphonic flow

• The full height of the building provides the energy for this highly efficient Rainwater Drainage Solution
Rainwater falling down the vertical pipe accelerates, creating negative pressure. The negative pressure is given by the formula $-\rho gh$. More height results in greater negative pressure, which in turn leads to higher flow rates.
Top Technical Benefits
Siphonic Roof Drainage

- **Smaller Diameter** pipe required – approx. half the size of gravity diameter pipe size.
- Horizontal pipes are installed **without** PITCH – Flat Level.
- A significant **Reduction in Below Grade Drainage** (common range is from 20% to 60%).
- Pipes run full-bore with **self-scouring properties**.
### 4 Stages of Flow – Self-Cleaning System

#### Four Flow Patterns of Siphonic Drainage

**Stage 1 - Light Rainfall - Wavy or Gravity flow**
- Air above water
- Gravity flow in pipework

**Stage 2 - Plug flow**
- Plug of water filling whole pipe at high velocities which achieves self-cleansing.
- Air pockets driven down pipework

**Stage 3 - Bubble flow**
- Water filling whole pipe
- Air bubbles in suspension carried at high velocity

**Stage 4 - Full-bore flow**
- No more air entry – Air within pipe now fully purged

---

*Siphonic Roof Drainage Systems*
Top Technical Benefits (continued)

- Rainwater down pipes **routed to the Engineer’s Preferred Locations** - This frees up valuable building space.

- Routing of rainwater down pipes to the perimeter of buildings **Eliminates Below Grade Excavation Under the Building Floor**.

- Fewer pipes = **Reduced construction time and cost**.
Top Technical Benefits (continued)

- Ability to route rainwater pipes to **Retention Ponds** or **Detention Basins** or **Rainwater Harvesting**.

- **Easy co-ordination** of services for BIM modeling due to pipe work running flat

- Makes **rainwater harvesting** more cost effective

- **Reduced Ponding** on the roof compared to traditional gravity drains due to efficient water discharge
Smaller Diameter Pipes running Flat Level allows for Easy Co-ordination with structure and zoning of services

Siphonic Roof Drainage Systems
Top Technical Benefits

- **IPC 2015 Code Compliance** – Siphonic roof drains have performance graphs from testing to siphonic roof drains standard ASME A112.6.9
Gravity Drain
ASPE Research Foundation Recommendation

To develop a new and proper method for sizing storm drainage based on capacity of roof drain and maximum ponding

Sizing Method Recommendation

Based on the results of the testing, the plumbing engineering profession must establish a new and proper method for sizing storm drainage systems. The new sizing method must be based on the capacity of the roof drain, the maximum amount of ponding under various storm conditions at the roof drain, and the maximum capacity of the piping system.

The archaic method of using roof area needs to be abandoned. The roof area method does not address the pitch and roughness of the roof, resulting in ponding at the roof drain. The method also does not consider the flow rate through the roof drain.

The ASME A112.6.4 standard regulates the design and construction of roof drains. An important part of this standard should include the performance of the roof drain. This would include the flow rate through the roof drain at various ponding heights.
Pipe sizing is based on tables with design rainfall rates and roof areas. The roof area x rainfall rate equates to GPM flow.

<table>
<thead>
<tr>
<th>SIZE OF HORIZONTAL PIPING (INCHES)</th>
<th>HORIZONTALLY PROJECTED ROOF AREA (SQUARE FEET)</th>
<th>RAINFALL RATE (INCHES PER HOUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3,288</td>
<td>1,644</td>
</tr>
<tr>
<td>4</td>
<td>7,520</td>
<td>3,760</td>
</tr>
<tr>
<td>5</td>
<td>13,360</td>
<td>6,680</td>
</tr>
<tr>
<td>6</td>
<td>21,400</td>
<td>10,700</td>
</tr>
<tr>
<td>8</td>
<td>46,000</td>
<td>23,000</td>
</tr>
<tr>
<td>10</td>
<td>82,800</td>
<td>41,400</td>
</tr>
<tr>
<td>12</td>
<td>133,200</td>
<td>66,600</td>
</tr>
<tr>
<td>15</td>
<td>218,000</td>
<td>109,000</td>
</tr>
</tbody>
</table>

1/6 unit vertical in 12 units horizontal (1-percent slope)

3                                 | 4,640                                        | 2,320                         | 1,546| 1,160| 928  | 773  |
4                                 | 10,600                                       | 5,300                         | 3,533| 2,650| 2,120| 1,766|
5                                 | 18,880                                       | 9,440                         | 6,293| 4,720| 3,776| 3,146|
6                                 | 30,200                                       | 15,100                        | 10,066| 7,550| 6,040| 5,033|
8                                 | 65,200                                       | 32,600                        | 21,733| 16,300| 13,040|10,866|
10                                | 107,200                                      | 53,600                        | 39,133| 30,100| 24,080|19,590|

1/4 unit vertical in 12 units horizontal (2-percent slope)

10,066 sq. ft. at 3” per hour rainfall = 314 GPM

Effectively, the table says a 6” leader at ¼” per foot can take 314 GPM

Siphonic Roof Drainage Systems
Run-Off From Catchment Area

\[ q_i = \frac{1}{43200} \times I_d \times A_i \]

- \( q_i \) = Volume in Cubic feet per second
  (multiply by 448.83 to convert to Gallons per Minute)
- \( I_d \) = Design rainfall in inches per hour as per code
- \( A_i \) = Tributary Catchment Area running to the drain
The roof area x rainfall rate equates to a GPM flow

**GPM Calculator**

**Insert Rainfall Rate Below**

| Inches per Hour Rainfall | 3.0 |

<table>
<thead>
<tr>
<th>ROOF AREA #</th>
<th>SQ. FEET</th>
<th>Q</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>10066</td>
<td>0.70</td>
<td>314</td>
</tr>
<tr>
<td>A2</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>A3</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

10,066 sq. ft. at 3” per hour rainfall = 314 GPM

Effectively, the table says a 6” leader at ¼” per foot can take 314 GPM
Gravity 6” Drain at Ponding Depth = 2” can only Discharge 185 GPM

Target Flow for the 6” Leader is to Discharge 314 GPM

<table>
<thead>
<tr>
<th>Manufacturer, Model</th>
<th>Head</th>
<th>1”</th>
<th>2”</th>
<th>3”</th>
<th>4”</th>
<th>5”</th>
<th>6”</th>
</tr>
</thead>
<tbody>
<tr>
<td>6” Cast Iron Drain with Cast Iron Dome</td>
<td>GPM</td>
<td>10</td>
<td>185</td>
<td>199</td>
<td>238</td>
<td>267</td>
<td>218</td>
</tr>
</tbody>
</table>

Gravity 6” Drain at Ponding Depth = 2” can only Discharge 185 GPM

Even at 6” ponding this 6” Gravity drain can only Discharge 218 GPM

Effectively you would need 2 x 6” Gravity drains to obtain the target flow
Gravity Drain
ASPE Research Foundation Recommendation

“The archaic method of using roof areas needs to be abandoned........method does not consider flow rate through the roof drain”

Sizing Method Recommendation

Based on the results of the testing, the plumbing engineering profession must establish a new and proper method for sizing storm drainage systems. The new sizing method must be based on the capacity of the roof drain, the maximum amount of ponding under various storm conditions at the roof drain, and the maximum capacity of the piping system.

The archaic method of using roof area needs to be abandoned. The roof area method does not address the pitch and roughness of the roof, resulting in ponding at the roof drain. The method also does not consider the flow rate through the roof drain.

The ASME A112.6.4 standard regulations the design and construction of roof drains. An important part of this standard should include the performance of the roof drain. This would include the flow rate through the roof drain at various ponding heights.
Gravity Drain
ASPE Research Foundation Recommendation

Sizing Method Recommendation

Based on the results of the testing, the plumbing engineering profession must establish a new and proper method for sizing storm drainage systems. The new sizing method must be based on the capacity of the roof drain, the maximum amount of ponding under various storm conditions at the roof drain, and the maximum capacity of the piping system.

The archaic method of using roof area needs to be abandoned. The roof area method does not address the pitch and roughness of the roof, resulting in ponding at the roof drain. The method also does not consider the flow rate through the roof drain.

The ASME A112.6.4 standard regulates the design and construction of roof drains. An important part of this standard should include the performance of the roof drain. This would include the flow rate through the roof drain at various ponding heights.

ASME A112.6.4 needs to add a test for flow rate through a roof drain. The testing for flow rate should utilize the test setup developed by ASPE RF. This test setup has proven to be an accurate method of testing the flow rate through roof drains.
USA Siphonic Standards

ASPE Technical Standard #45
Published in 2007 and reviewed 2012.
(HydroMax’s Bill Ross was on committee)

In October 2013, having gained American National Standards Institute approval this revision was published as

ASPE/ANSI 45-2013: Siphonic Roof Drainage

Siphonic Roof Drainage Systems
## Applications

- Warehouses
- Distribution Centers
- Box Stores/Malls
- Parking Decks
- Podium/Promenade Decks

- Office Buildings
- Hotels
- Hospitals
- Airports/Rail Stations

### Siphonic Roof Drainage Systems

[Image of Siphonic Roof Drainage Systems]
Retail & Strip Malls

Commercial Offices

Malls & Multi Deck Parking

Siphonic Roof Drainage Systems
Apartment Blocks

Schools & Colleges

Siphonic Roof Drainage Systems
Airports

Manufacturing

Unusual Architecture

Siphonic Roof Drainage Systems
Understanding Savings
Warehousing & Distribution Centres

1,100,000 ft² Distribution Center Roof

Siphonic Roof Drainage Systems
Original Gravity Option
144 x 6” Roof Drains
72no. 8” Downpipe (Every 45ft)
2,600 ft. of 8” Pipe

Siphonic Solution
Only 36 x 5” Roof Drains
36no. 5” Downpipes (Every 90ft)
1300 ft. of 5” Pipe

SAVINGS
108 x 6” Roof Drains & penetrations
36no. Downpipes & MH connections
1300 ft. of Pipe and reduced diameter
60% the labor cost
Siphonic System

600,000 ft² Roof

Only 4 Rainwater Downpipes draining the Main Roof
Siphonic horizontal Collector Pipe at High Level

No Pitch
Completely FLAT

Siphonic Roof Drainage Systems
2, 3”, 4”, 5” and 6” Primary Siphonic Roof Drains
All Drains should be tested to ASME/ANSI A112.6.9:2005
With IAPMO listing

Lower ‘K’ Factors =
Higher Efficiency
and
Lower Ponding Depths

Example Performance chart – K factor and min/max GPM

<table>
<thead>
<tr>
<th>C.I. No-Hub Outlet</th>
<th>K factor</th>
<th>Minimum GPM Inflow</th>
<th>Maximum GPM Inflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td>0.12</td>
<td>23</td>
<td>400</td>
</tr>
<tr>
<td>4”</td>
<td>0.08</td>
<td>75</td>
<td>800</td>
</tr>
<tr>
<td>5”</td>
<td>0.04</td>
<td>120</td>
<td>1300</td>
</tr>
<tr>
<td>6”</td>
<td>0.04</td>
<td>160</td>
<td>2000</td>
</tr>
</tbody>
</table>

Siphonic Roof Drainage Systems
**K-Factor**

The fittings, such as elbows, tees, strainers, valves, etc., have all been tested and assigned "K" factors based on the head loss measured through them.

**Factors that Affect Head Loss**

1. Flow Rate
2. Inside Diameter of Pipe
3. Roughness of the Pipe Wall
4. Corrosion and Scale Deposits
5. Viscosity of the Liquid
6. Length of the Pipe
7. Fittings
8. Straightness of the Pipe
2, 3”, 4”, 5” and 6” Siphonic Overflow Roof Drains
All Drains should be tested to ASME/ANSI A112.6.9:2005
With IAPMO listing

Overflow drains will have a dam to raise water inlet level.

Overflow Systems must be kept separate from Primary Systems.

If they do connect together, the downstream pipework should be gravity design and vented

Siphonic Roof Drainage Systems
Podium/Promenade/Parking Deck Drains

Using cast iron frame and grates to house the Siphonic Roof Drain
Siphonic System to Top level of Parking Deck

Pipework Installed Absolutely Flat Level at High level
Siphonic Roof Drains can be combined with Trench Drains on Promenade Decks

Podium Decks
Design Process

- Siphonic Drainage is an Engineered Solution
- A Hydraulic analytical design calculation program provides the tool required for sizing pipework
- The design program should be independently tested to comply with all aspects of ASPE/ANSI 45:2013
Design Process

To calculate for compliance with ASPE/ANSI 45 standard you must first:

• Select Roof Drain placement

• Calculate GPM inflows to roof drains
  (code rainfall rate x roof area for primary and overflow)

• Select pipe material
  (commonly PVC solid wall schedule 40 or Cast Iron no-hub)

• Identify Interface with civils and determine if civils are designed to surcharge

• Provide AutoCAD or DWG Pipe layouts

• Draw schematic isometric drawing and input into calculation program
With this program, the Engineer ‘Draws’ the piping system into the calculation program.

**ALL** components to be installed **MUST** be included in the drawing. If any change is required to the drawing design— it **MUST** be recalculated.

---

**Siphonic Roof Drainage Systems**

[Logo: ASPE (American Society of Plumbing Engineers) and PHCC (Plumbing-Heating-Cooling Contractors Association)]
All Hydraulic Parameters must be met.

Pipe diameters are edited to find the ‘PASS’ solution to meet all hydraulic parameters within ASPE/ANSI 45

<table>
<thead>
<tr>
<th>Hydraulic Calculation Summary</th>
<th>Previous</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out of Balance</td>
<td>1.899 ft</td>
<td>0.999 ft</td>
</tr>
<tr>
<td>Minimum Pressure</td>
<td>-18.901 ft</td>
<td>-18.901 ft</td>
</tr>
<tr>
<td>Maximum Pressure</td>
<td>1.605 ft</td>
<td>1.605 ft</td>
</tr>
<tr>
<td>Minimum Velocity</td>
<td>2.699 ft/sec</td>
<td>5.63 ft/sec</td>
</tr>
<tr>
<td>Minimum Vertical Velocity</td>
<td>10.98 ft/sec</td>
<td>10.98 ft/sec</td>
</tr>
<tr>
<td>Maximum Velocity</td>
<td>25.241 ft/sec</td>
<td>25.241 ft/sec</td>
</tr>
<tr>
<td>Discharge Velocity</td>
<td>13.848 ft/sec</td>
<td>13.848 ft/sec</td>
</tr>
<tr>
<td>Fill Time</td>
<td>20 seconds</td>
<td>20 seconds</td>
</tr>
<tr>
<td>Pass / Fail</td>
<td>FAIL</td>
<td>PASS</td>
</tr>
</tbody>
</table>

| Tail Pressures | 1 | -1.142 ft | 1 | -1.142 ft |
|               | 2 | -1.639 ft | 2 | -2.103 ft |
|               | 3 | -0.809 ft | 3 | -1.273 ft |
|               | 4 | -0.778 ft | 4 | -1.241 ft |
|               | 5 | 0.259 ft  | 5 | -2.141 ft |

Siphonic Roof Drainage Systems
Roofs at different elevations may be affected by wind driven rain.

There is a risk that Roofs A and C will be affected by wind driven rain.

This vertical surface run-off will contribute more flow to roof A and provide less flow to Roof C.

Where roofs at different elevations may be affected by wind driven rain, The Design should incorporate separate piping systems to each roof.
Piping Details

Horizontal Pipework –
No DECREASE in diameter in direction of flow

Flow
no reduction in diameter in direction of flow

Flow
Not Permitted - reduction in diameter in direction of flow

Piping Details

Vertical Pipework –
No INCREASE in diameter in direction of flow

Flow
no Increase in diameter in direction of flow

Flow
Increase in diameter in direction of flow is Not Permitted

Siphonic Roof Drainage Systems
A 90° bend creates turbulence forcing the vertical tailpipe to prime and create suction early on in the rainfall event.
Piping Details

Must use Long 90’s, Knuckle Bends not permitted; Bends can be 45°

No Clean Outs

Only 45° WYE’s; no double branches permitted
ASPE/ANSI 45 Recommended Termination Details (Siphon Break)

Siphonic Roof Drainage Systems
Mifab HydroMax™ Siphonic Drainage Termination Details (Siphon Break)

- Ventilated to Atmosphere
- Siphonic flow
- Break to Gravity flow

Recommended Vent size being Two-Thirds Gravity Pipe size
($\frac{2}{3}$ air to $\frac{1}{3}$ water in the gravity flow)
Bracket Supports and Bracing

Recommendation – supports at each side of each change of direction

Sway Bracing at Maximum 30 ft Intervals

Recommendation – 2 supports at a bend; 3 supports at Wye Branch.

Intermediate Pipe Hangers at Code requirements
For PVC - Maximum 4ft Intervals
For Cast Iron - Maximum 10ft Intervals

Pipe Support Brace

Wall Clamp

Siphonic Roof Drainage Systems
OVER 8,000 Siphonic Roof Drain Systems SUCCESSFULLY designed by HydroTechnic™

100% SUCCESS RATE
ZERO System Design Failures

TRIED - TESTED - PROVEN

Siphonic Roof Drainage Systems
OVER 8,000 Siphonic Roof Drain Systems SUCCESSFULLY designed by HydroTechnic™

100% SUCCESS RATE
ZERO System Design Failures

TRIED - TESTED - PROVEN

Siphonic Roof Drainage Systems