Storm/Roof Drainage

By:

Joseph V. Messina, CPD

CUH2A

A Division of HDR

American Society of Plumbing Engineers,
8614 W. Catalpa Ave., Suite 1007 Chicago, IL 60656

Site Drainage

- Rain water should be collected and discharged independently of sanitary sewer systems to prevent overloading treatment facilities. Which is a code requirement in most locations.
- The basis for design is the size of area drained, type of area surface and rainfall rates based on the geographical location.
- The rainfall rates which are available from the U.S. Department of Commerce and Weather Bureau. And also can be found in your ASPE Data Book under the Storm Drainage Chapter and in your local plumbing codes.

Site Drainage Formula

Flow Rate = Coefficient of Runoff x Intensity x Area

$Q=ACI$

where:
- Q = flow, cubic feet per second
- A = area in acres
- I = rainfall rate, inches per hour
- C = surface runoff factors:

Site Drainage Formula

Flow Rate = Coefficient of Runoff x Intensity x Area

Q=ACI

where: Q = flow, cubic feet per second

A = area in acres

(36,000 sq. ft.)

(36,000 sq. ft. ÷ 43,560 = 0.826 acres)

Site Drainage Formula (cont.)

I = rainfall rate, inches per hour (4.69")

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	USE NOAA ATLAS FOR DETAILED STATE PRECIPITATION MAP		[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table is taken for the ASPE Data Book

Site Drainage Formula (cont.)

C = surface runoff factors: (0.10, rough grass or undeveloped ground)

Runoff Coefficients

Type of Surface	Description	C
Grass	Rough grass or undeveloped ground	0.10
Grass	Average developed lawn	0.20
Grass	Sparse lawn on hard ground	0.25
Paved	Rough surface on flat slopes	0.60
Paved	Average pavement	0.85
Roof	Flat roof with provisions for standing water	0.85
Roof	All other roof surfaces	0.95
Composite	Average values for entire site area (Value depends upon relative amount of lawn area)	0.55 to 0.75

Table is taken for the ASPE Data Book

Site Drainage Formula (cont)

Flow Rate = Coefficient of Runoff x Intensity x Area

Q = ACI

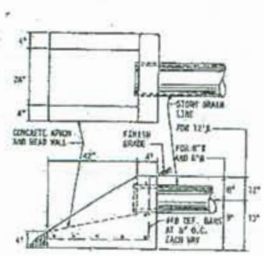
Q = 0.826 acres x 0.10 x 4.69 inches

Q = 0.387 cfs

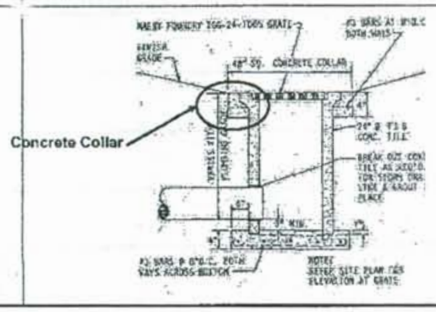
Use: 4" PVC-DWV or 6" CI

Components of Site Drainage

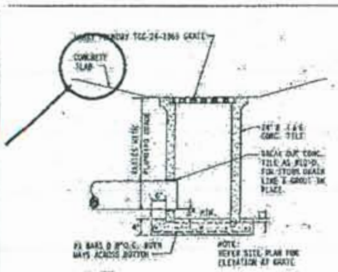
Drainage Headwall Detail



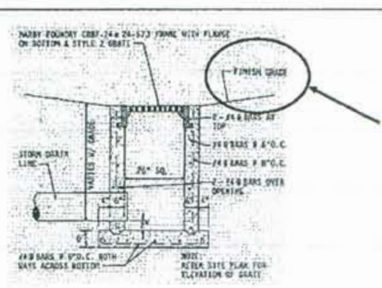
Catch Basin/Inlets



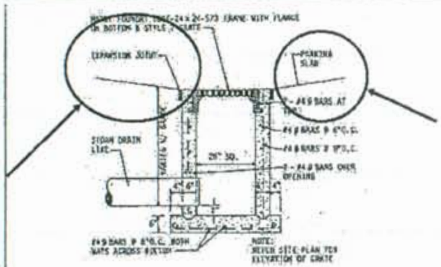
Catch Basin/Inlet



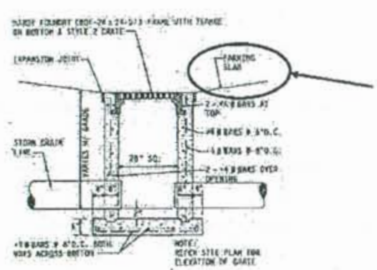
Catch Basin/Inlet



Catch Basin/Inlet



Catch Basin/Inlet

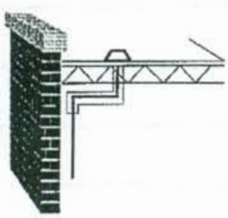


Questions on Site Drainage?

Roof Drainage

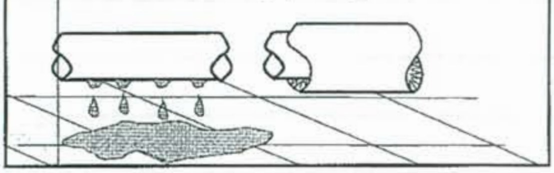
History of Roof Drainage

- → With the advent of flat roofs came Roof Drains with interior piping systems.



History of Roof Drainage (cont)

- → In the Early 1990's A Roof Collapse at a Department Store led to a Study of Roof Drain Flow Rates at Univ. of Minnesota . The report showed the problem was caused by the restriction of flow at the roof drain strainer.
- → Insulation was added to horizontal drains to prevent condensation from dripping on ceilings.

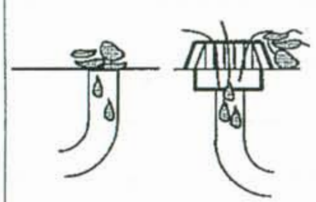


History of Roof Drainage (cont)

- 1961-63 PDI Conducted a study on Roof Drains.
- In 1964 ANSI ASME standard was created to establish standards on Roof Drains.
- Sizing charts based on square foot areas were developed for model codes based on rainfall weather data.
- Late 1980s Roof collapses caused Model Codes to adopt Overflow Drains language, but it was vague.
- Code language is still being updated on Overflow Drains.

History of Roof Drainage (cont)

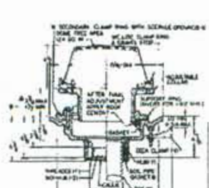
- Strainers were added to roof Drains to prevent blockages in the drain by leaves and debris.



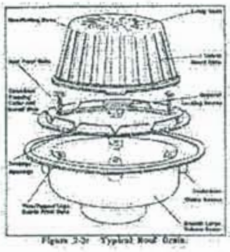
ANSI/ASME Roof Drain Standard

- ANSI/ASME Standard A112.21.2M 1983 Roof Drains. (Revised in 2001)
- Standard covers:
  1. Scope
  2. Definitions/Types,
  3. Nomenclature
  4. Outlet types & Connections
  5. Top size-Free Area
  6. Materials
  7. Finishes
  8. Accessories

  (Flow performance of the Roof Drain is NOT covered in the Standard)



Components of Roof Drains



This Figure is taken from the ASPE Data Book

Expansion Joints or Horizontal Offsets

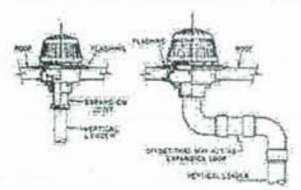
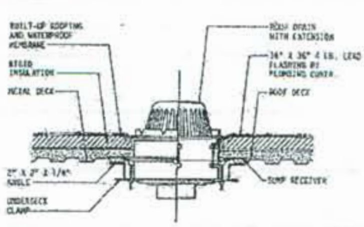


Figure 2-7: Typical Expansion Joint or Horizontal Offset.

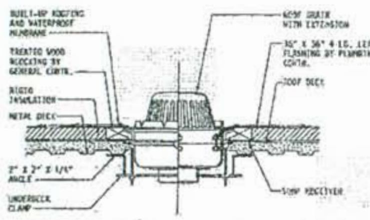
Figure taken from ASPE Data Book

Roof Drain Detail



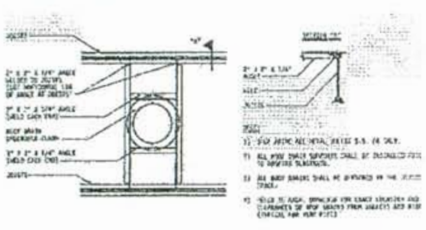
(Metal deck with light weight concrete, insulation and built-up roofing.)

Roof Drain Detail



(Metal deck with light weight concrete, insulation, built-up roofing and wood blocking for support)

Roof Drain Support



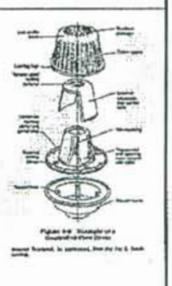
(A suggested way to support a roof drain when installed in a built-up roof with metal deck on steel framing.)

Controlled-Flow Drain

A Controlled-Flow Roof Drain has several components. The components are there to help control the amount of water that will enter the drainage system.

Advantage: the drainage piping can be sized smaller which is a cost and space savings.

Disadvantage: the roof has to be designed to hold a lot of water until it drains into the roof drain. Structural Engineers don't like to leave water on a roof, that is the worst thing to do.

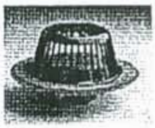


Siphonic Roof Drain

A Siphonic Roof Drain has several components. The components are there to help control the amount of water that will enter the drainage system to create the siphon.

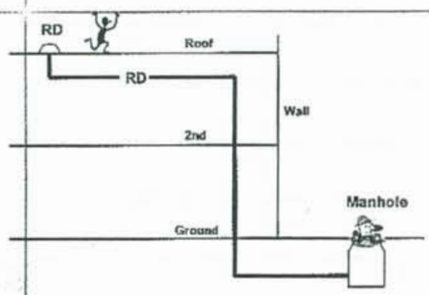
Advantage: the drainage piping can be sized smaller which is a cost and space savings.

Disadvantage: the roof has to be designed to hold a lot of water until it drains into the roof drain. Structural Engineers don't like to leave water on a roof, they feel that is the worst thing to do.



Siphonic Roof Drain Anatomy

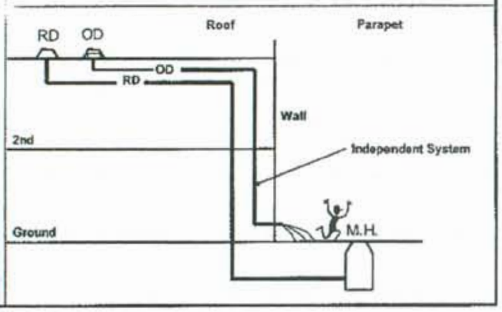
Roof Drainage



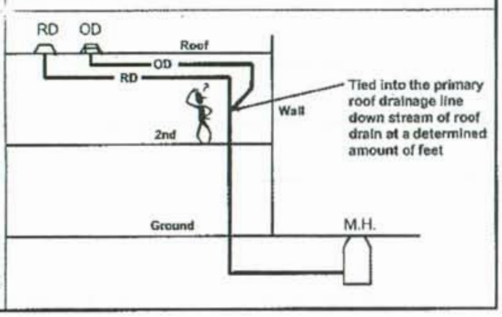
Secondary Roof Drain Methods

- Model Codes, Local Codes and Local Official vary on minimum requirements for secondary roof drainage (also referred to as overflow roof drains) piping and disposal point.
- Always check with the authorities having jurisdiction to determine Roof Drain/Overflow Drain piping requirements.

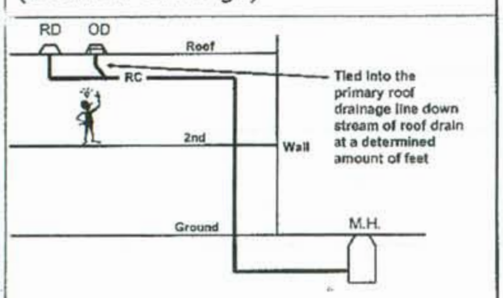
Secondary Roof Drainage
(Overflow Drainage)



Secondary Roof Drainage
(Overflow Drainage)



Secondary Roof Drainage
(Overflow Drainage)

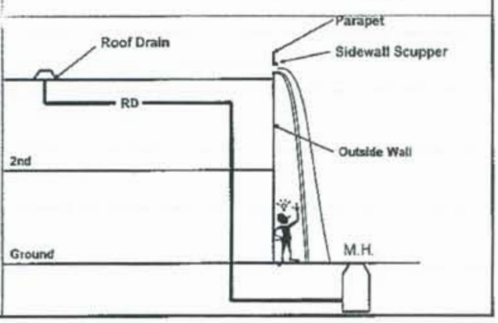


Secondary Roof Drainage
(Overflow Drainage By Scupper)

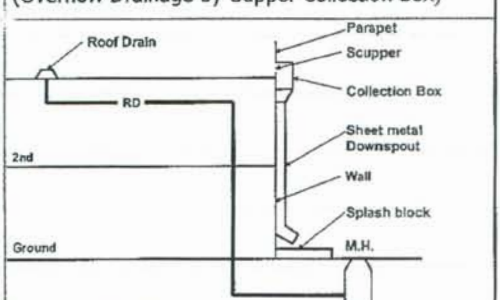
[illegible]

Table taken from ASPE Data Book Vol. 2 Chapter 4

Secondary Roof Drainage
(Overflow Drainage By Scupper)

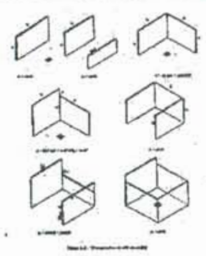


Secondary Roof Drainage
(Overflow Drainage by Supper Collection Box)

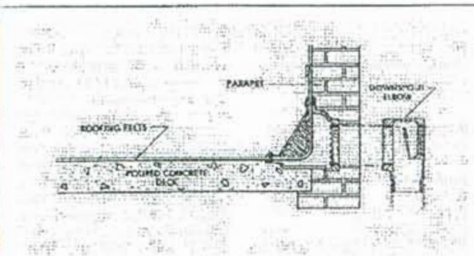


Calculation of Sidewalls Related to Roof Drain

These figures were taken from an older ASPE Data Book. It is a page of illustrations indicating different ways to figure sidewall area (rain water hitting the side of a building). These figures have been removed from the ASPE Data Book.



Scupper Drain



Selecting and Sizing Roof Drains

1. Calculate the total roof area.
2. Determine the maximum hourly rainfall in inches. See Table 2.1. (This figure can be acquired from your local weather bureau, ASPE Data Book and the local code authority).
3. Select leader size.
4. From Table 1106.6, determine the number of square feet that can be drained by one roof leader at the local maximum rainfall rate.
5. Divide the total roof area by the area that one leader will handle. The above result is the number of roof drains required for the building.

Selecting and Sizing Roof Drains

6. After the number so roof drains requires has been determined then it is a good idea to give this information to the Architect so he can lay out the drains to accommodate his roof slops, peaks and valleys and insulation thickness. Make sure that the Architects knows that the number you gave him is the minimum. He can put more drains on the roof if he wishes which is sometimes based on the thickness of his insulation and how he wants to taper it.
7. After the Architects has laid out drains then the Plumbing Engineer/Designer and start to figure out the accurate square footage per drain and design the piping system within the building.

Rain Fall Rate Table

Table 2-1: Maximum Rates of Rainfall for Various U. S. Cities, In Inches Per Hour (MM Per Hour). (Cont'd)

	100-Yr., 5 Min.	100-Yr., 15-Min.	100-Yr., 60-Min.	5-Yr., 5-Min.
Georgia:				
Atlanta	9.90 (251.5)	7.12 (180.9)	3.75 (95.3)	4.09 ([illegible])
Augusta	9.84 (249.5)	7.20 (182.9)	4.00 (101.6)	4.67 ([illegible])
Macon	10.08 (256.0)	7.40 (188.0)	3.75 (95.3)	4.78 (121.5)
Savannah	[illegible]	[illegible]	[illegible]	[illegible]
Thomasville	10.44 (265.2)	7.88 (200.2)	4.25 (108.0)	4.96 (125.9)
Hawaii: Honolulu	USE NOAA ATLAS FOR DETAILED STATE PRECIPITATION MAP		3.00 (76.2)	5.2 (132.1)
Idaho:				
Boise	USE NOAA ATLAS FOR DETAILED STATE PRECIPITATION MAP		0.90 (22.9)	2.7 (68.6)
Lewiston			1.10 (27.9)	3.1 (78.7)
Pocatello			1.20 (30.5)	3.7 (94.0)
Illinois:				
Cairo	9.84 (249.9)	6.96 (176.8)	3.40 (86.4)	4.65 (118.0)
Chicago	9.30 (236.2)	6.60 (167.6)	2.75 (69.9)	4.39 (111.5)
Peoria	9.72 (246.9)	6.88 (174.8)	3.35 (85.1)	4.59 (116.5)
Springfield	9.84 (249.9)	7.12 (180.9)	3.50 (88.9)	4.64 (117.9)

Table is taken for the ASPE Data Book

Selecting Size of Roof Drains

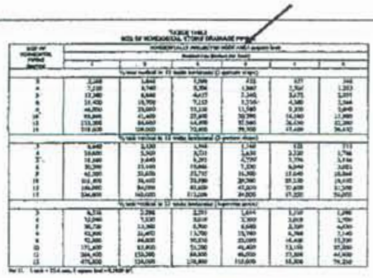


Table is taken for the 2000 International Plumbing Code

Sizing Roof Drains Leaders

TABLE 1106.2
SIZE OF VERTICAL CONDUCTORS AND LEADERS

DIAMETER OF LEADER (inches)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	1,440	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	17,300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,730	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table is taken for the 2000 International Plumbing Code

Converting Roof Square Footage Loads to GPM

→ Use the following formula to determine GPM.

GPM = .0104 x R x A

GPM = Gallons per minute

R = Rainfall intensity – Inches/hour

A = Roof Area – square feet

.0104 conversion factor is the GPM/sq. ft. for one (1) inch/hr. rainfall

Converting Roof Square Footage Loads to GPM

→ Use the following to determine GPM.

GPM = .0104 x R x A

R = Rainfall intensity – Inches/hour (4.69 inches)

A = Roof Area – square feet (4132 sq. ft.)

GPM = .0104 x 4.69 x 4132

GPM = 201.5

Combined Storm and Sanitary Sewer Systems

Recommended methods of converting sanitary fixture unit loads to equivalent square feet of the drained area is as follows.

1. When the total fixture unit load is 256 FU of less, use 1,000 square feet as a minimum.
2. When the total fixture unit load is greater 256 FU multiply the fixture units by 3.9 square feet to convert to equivalent drained area.
3. For continuous of intermittent flow, multiply each GPM of flow by 24 square feet to convert to equivalent drained area.

(The above conversion rules are based on 4" per hour rainfall. Multiply by the correct factor for other rainfall rates)

Find The Factor For Other Rainfall Rates

How to find the square foot factor of other rain fall rates.

For 6" rainfall rate:
6" rainfall rate x 3.9 sq. ft. ÷ 4" rainfall rate = 5.85 sq. ft.

For 8" rainfall rate:
8" rainfall rate x 3.9 sq. ft. ÷ 4" rainfall rate = 7.80 sq. ft.

Reference Material To Consider

- ASPE Data Book – Volume 2, Chapter 4, Storm Drainage Systems
- 2000 International Plumbing Code
- Atlanta Chapter of ASPE (For the building design)
- J.R. Smith
- Zurn Industries

Questions?