

Introduction

HydroStor chambers are injection molded, subsurface stormwater management structures that support soil and surface loads through an arching structural form. Loads from overlying soil and applied surcharges are transferred through the chamber system to the foundation interface and the areas between adjacent chambers. A crushed stone foundation is incorporated as part of the system design to distribute these loads to the underlying soils in a manner consistent with allowable bearing conditions. The design professional is responsible for evaluating site-specific loading and soil properties and establishing the appropriate foundation stone thickness for each HydroStor chamber installation.

Loads applied above a HydroStor system are transferred through the surrounding soil and crushed stone foundation to the underlying subgrade, which provides the primary resistance to these loads. The crushed stone foundation layer beneath the chambers serves to distribute loading over a larger effective area, reducing bearing pressures at the subgrade interface and maintaining stress within allowable limits. Prinsco provides minimum foundation depth tables (Ref. 4 & 5) to assist in selecting crushed stone thicknesses based on cover height and typical loading assumptions; however, these tables are based on simplified bearing evaluations and do not address all site conditions or chamber configurations. For applications outside the table assumptions, ASTM F2787 provides an accepted methodology for evaluating bearing pressures and effective load distribution. This technical note is intended to support consulting engineers in applying ASTM F2787 principles to site-specific conditions and in determining appropriate allowable subgrade bearing pressures and foundation stone depths for HydroStor chamber systems.

Subsurface Loading

Loads originating from live loads, pavement structure, soil cover, and crushed stone embedment are distributed through the foundation layer to the underlying soils. **Figure 1** illustrates a representative HydroStor chamber installation cross section. The arched geometry of HydroStor chambers influences load distribution, resulting in concentrated pressure zones beneath the chamber feet and between adjacent chamber rows.

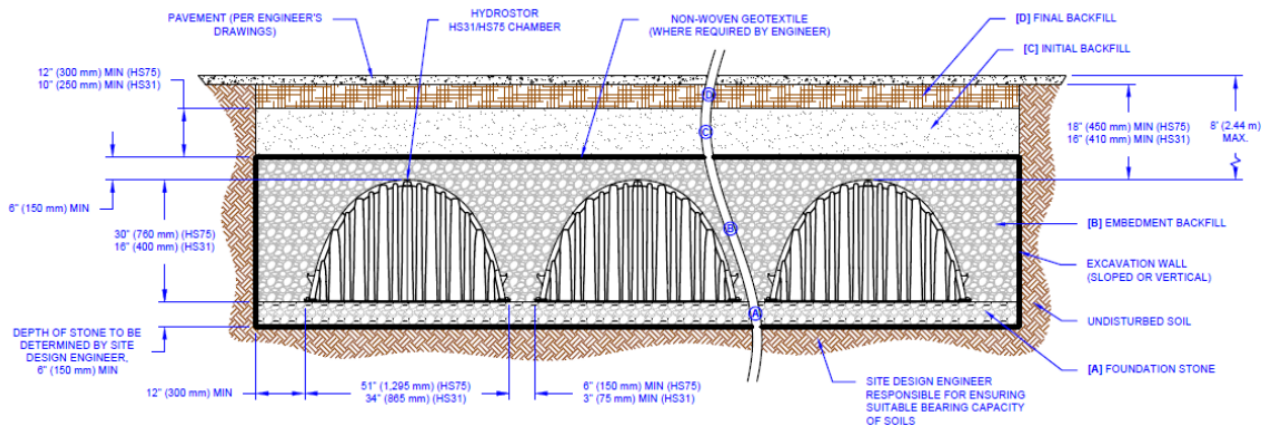


Figure 1: Standard Hydrostor Installed Cross-Section



The interaction between a HydroStor chamber system, the foundation stone, and the supporting subgrade involves complex load distribution mechanisms. For development of Prinsco's minimum foundation depth tables (Ref. 4 & 5), this behavior is represented using a simplified loading model that assumes surface and soil loads act as uniform pressures that linearly reduce with depth below the chamber feet. **Figure 2** illustrates the conceptual loading approach used for these tables. At the elevation of the chamber base, loads are combined and represented as a uniform strip pressure acting over a width defined by the chamber row spacing and the effective foot width of the chamber feet. Surficial live loads (typically assessed as the AASHTO Design Truck per Ref. 2) are assumed to spread through the crushed stone foundation layer until a uniform bearing pressure is applied at the subgrade interface. The simplified load distributions shown in **Figure 2** may not capture localized increases in pressure and therefore may not be appropriate for detailed geotechnical analysis. However, the approach is consistent with AASHTO (Ref. 2 & 3) and is considered reasonable when used with an appropriate factor of safety applied to the allowable subgrade bearing capacity, as described in ASTM F2787.

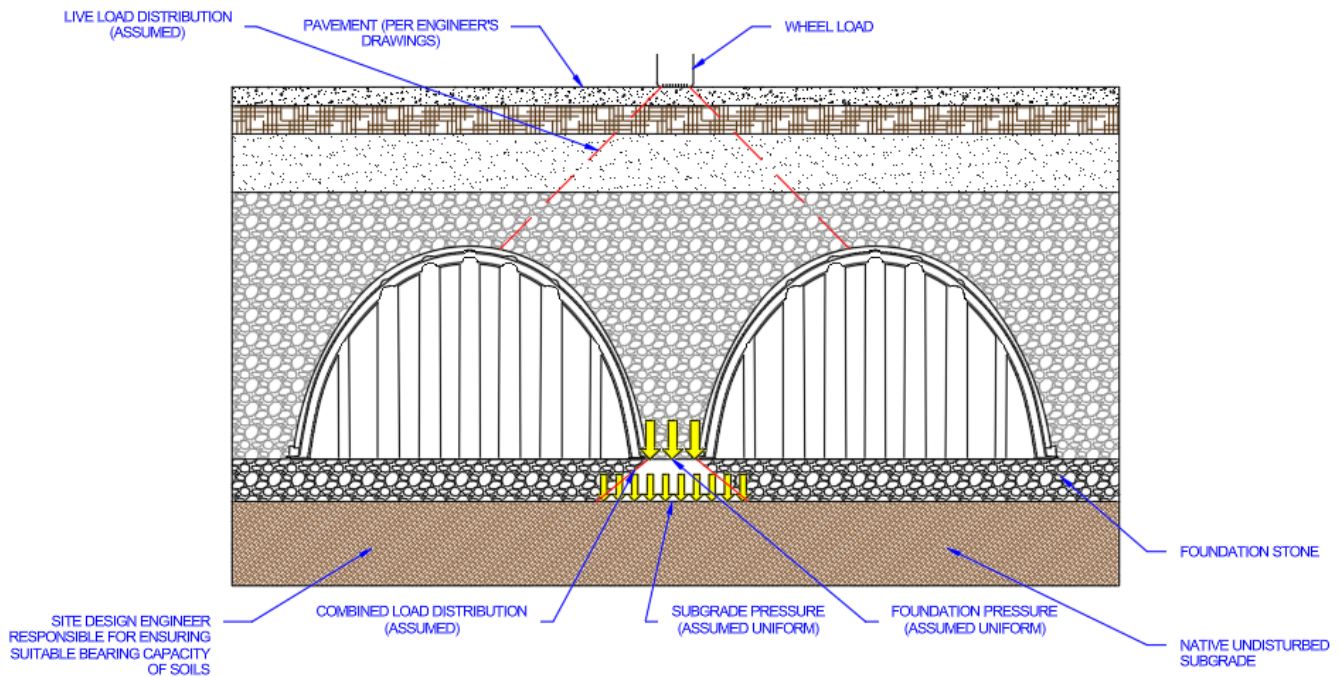


Figure 2: Conceptual Subgrade Loading Diagram of a Hydrostor Chamber (N.T.S.)

Subgrade bearing pressure is influenced by the chamber row spacing, the depth of soil cover above the system, and the thickness of the foundation stone beneath the chambers. While increased row spacing may be used in some layouts, HydroStor chambers have defined minimum spacings by product type: 3 in. (75 mm) for HS31, 6 in. (150 mm) for HS75, 5 in. (127 mm) for HS180, and 8.5 in. (216 mm) for HS290. Cover height is typically governed by site grading, pavement section requirements, and hydraulic design constraints. As a result, foundation stone thickness becomes the primary variable available to the designer for managing subgrade bearing pressures. Prinsco's minimum foundation depth tables (Ref. 4 & 5) provide guidance on foundation stone depth for varying cover heights and subgrade bearing capacity combinations based on the standard chamber spacing shown in Figure 1. Product-specific dimensions and corresponding foundation design table references are provided in Table 1.



Hydrostor Subgrade Performance Considerations

Establishing an allowable subgrade bearing pressure is standard geotechnical practice and typically considers ultimate capacity (shear failure), settlement behavior, local experience, and other project-specific conditions. For HydroStor installations, the intent of this discussion is to highlight subgrade behaviors that can influence foundation performance beneath chamber systems; it is not an exhaustive list. The supporting soils beneath a HydroStor system should provide a stable bearing surface and maintain adequate support under anticipated in-service conditions, including moisture variations associated with open-bottom chamber applications.

Bearing Capacity

Bearing failure is not acceptable for chamber foundations. Subgrade evaluation should address the governing bearing limit state for the foundation/subgrade interface and consider whether localized bearing effects may control the chamber layout being used.

Settlement

HydroStor systems can accommodate some settlement; however, differential settlement should remain lower than 1" across the structural span of the chamber. Where settlement limits are critical, geotechnical recommendations should be coordinated with the selected chamber configuration and foundation section.

Subgrade Moisture/Saturation

For open-bottom chamber systems, the native soils should be capable of maintaining adequate bearing support when water infiltrates into the subsurface system. Where infiltration is undesirable (e.g., sensitive soils, karst, contaminated groundwater, or other constraints), an impermeable liner option may be used to limit infiltration into the underlying soils.

Depth Tables & LRFD

Prinsco provides minimum foundation depth tables within HydroStor design guides to help designers select foundation stone thicknesses for common chamber configurations. These bearing capacity tables are calculated in accordance with ASTM F2787 and may not be appropriate for all site conditions; when soils with bearing capacity below 2.0 ksf (96 kPa) are encountered, a geotechnical engineer should evaluate the site and recommend appropriate foundation preparation (which may include increased foundation stone thickness or other remedial measures).

The published minimum foundation depth tables are formatted for direct use with an allowable bearing pressure approach. If a project's geotechnical recommendations are provided in an LRFD format (separate service and strength limit state values with associated factors), additional interpretation may be needed so that the table inputs and the geotechnical capacities are being compared on a consistent basis.

ASD vs. LRFD (General Overview)

Shallow foundation design generally addresses two objectives: (1) limiting settlement to tolerable levels (service limit state) and (2) preventing bearing capacity failure (strength/ultimate limit state). Under an allowable stress design (ASD) framework, unfactored foundation pressures are compared directly to an allowable bearing pressure recommendation. In an LRFD framework, load and resistance factors are applied and the service and strength checks are treated separately, often resulting in distinct geotechnical capacities for each limit state. When geotechnical reports provide LRFD capacities, designers should confirm whether the values include resistance factors and ensure the bearing pressures being checked are expressed on a consistent basis with the reported capacities.



Applying LRFD Recommendations to HydroStor Foundation Tables

The HydroStor minimum foundation depth tables provide foundation stone thickness guidance as a function of cover height, chamber configuration, and subgrade bearing capacity. When using ASD recommendations, the table bearing capacity headings may be compared directly to the allowable bearing pressure recommended by the geotechnical engineer. When using LRFD recommendations, the service-level capacity should be compared to service-level bearing pressures, and the strength-level capacity should be compared to strength-level bearing pressures using a consistent factoring convention (i.e., confirming whether the reported strength capacity is already reduced by a resistance factor). Project settlement tolerances should be established by the site design engineer; HydroStor guidance is intended to support selection of foundation thickness but does not replace site-specific geotechnical design judgment.

Table 1: HydroStor Product References (Row Spacing & Foundation Tables)

HydroStor Model	Minimum Row Spacing	Effective Foot Width	Soil Column Width	Structural Span	Minimum Foundation Depth Table <small>(Ref. 4 & 5)</small>
HS31	3 in (75 mm)	2.9" (74 mm)	8.7" (221 mm)	28.2" (715 mm)	Table 1a - HS31 Minimum Required Stone Foundation Depth
HS75	6 in (150 mm)	2.8" (71 mm)	11.6" (295 mm)	45.4" (1153 mm)	Table 2b - HS75 Minimum Required Stone Foundation Depth
HS180	5 in (130 mm)	3" (76 mm)	11" (279 mm)	71.8" (1825 mm)	Table 1a - HS180 Minimum Required Stone Foundation Depth
HS290	8.5 in (216 mm)	6.2" (157 mm)	20.9" (531 mm)	88.1" (2238 mm)	Table 2b - HS290 Minimum Required Stone Foundation Depth

Notes:

- a. Row spacing is measured from the outside edges of chamber feet. Additional spacing is acceptable and may be used to mitigate weaker subgrade conditions or reduce required foundation stone thickness.
- b. The effective chamber foot width is defined as the horizontal distance from the exterior edge of the chamber foot to the centroid of the corrugation.
- c. Soil column width = (Row Space) + 2*(Effective Chamber Foot Width).
- d. The chamber structural span is the distance between the centroids of opposing corrugations measured at the chamber foot elevation. The differential settlement tolerance for each product type is based on the structural span.

References

1. ASTM F2787 – “Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers”
2. AASHTO Bridge Design Specifications, Section 3 – “Loads and Load Factors”
3. AASHTO Bridge Design Specifications, Section 12 – “Buried Structures and Tunnel Liners”
4. Hydrostor HS31-HS75 Design Guide, Section 4.1 – “Subsurface Foundation Requirements”
5. Hydrostor HS180-HS290 Design Guide, Section 4.1 – “Subsurface Foundation Requirements”