RainSpace® Stormwater Management Detention Chamber

Structural Support Specification

The Environmental Protection Agency, under the Clean Water Act, has established the National Pollution Discharge Elimination System (NPDES) which requires site developers to install stormwater detention systems to capture or detain runoff water on site before its eventual infiltration or discharge. Low Impact Development Ordinances have been enacted by cities, counties and states in compliance with the Clean Water Act. On-site stormwater management and control and hydro-modification practices are integral to new development and redevelopment projects. Underground storage vessels, tanks or chambers are available for on-site water collection that eliminate the expense and loss of surface occupancy when ponds or swales are used for this purpose. The structure of the underground storage system must support the static and dynamic loads placed upon it by the weight of earth, pavement and vehicular traffic.

The RainSpace Stormwater Management Detention or Infiltration Chamber is an underground stormwater detention and/or infiltration void space. The structural support is composed of patented core bundles of corrugated high density polyethylene tubes laid and stacked horizontally within a permeable geotextile filter material. The size of the void space thus created determines the water detention capacity. Stormwater is directed into the RainSpace Clarifier and filter through the on-site storm drain system, then into the Chamber, and infiltrates into the sub-soils or is temporarily detained and passed at slower rates into down-line storm drains or surface spreading structures. The Structural Core Bundles also known as PTI Multipipe™ are custom manufactured for RainSpace by corrugated tubing manufacturer Plastic Tubing Industries, Inc.

For non-vehicular loading, the minimum top fill cover for the RainSpace chamber is 24” of compacted fill which may be composed of the excavated soil, sand or aggregate or combinations thereof and may be covered at the surface with pavers, flexible asphalt or concrete. The depth of any such surface finishes is included in determining the total cover depth of the top fill. The maximum top cover depth is 60”

Loading Applications

Applications without vehicular loading must support the dead weight of the top cover fill and finish surfaces placed above the RainSpace chamber. Vehicle loading standards are applicable in determining the load bearing strength of underground structures. When the RainSpace Chamber is placed under surfaces that will experience vehicle traffic and loading, the specification for top fill depth and cover material is set to conform with the appropriate vehicle loading requirement. The standards for vehicle loading have been established by the American Association of State Highway and Transportation Officials – LRFD Bridge Design Specifications, Customary U.S. Units (AASHTO LRFD Specifications). Loads are considered to be either a live load or a dead

load. Live loads change in position and magnitude and dead loads remain constant throughout the life of the underground system. Vehicular loads are the most commonly considered live loads, usually from trucks in this application. The soil and surface finish load is the dead load consideration. Vehicular loads are based on the primary AASHTO truck load configurations such as H-10 (16,000 pound axle weight), H-20 (32,000 pound axle weight) and H-25 (40,000 pound axle weight).

According to AASHTO LRFD Specifications – Customary U.S. Units (2007) the vertical pressure generated by a wheel load over a buried structure may be estimated by the formula:

Vertical Pressure (psi) = Wheel Load/(20+1.15H)(18.25+1.15H)

Where the Vertical Pressure is expressed in pounds per square inch, Wheel Load is expressed in pounds and H = the depth of the top cover in inches. The AASHTO values include a combined truck tire wheel contact area of approximately 20 inches by 18.25 inches for a tire pair on each end of the vehicle axle. The AASHTO method allows an assumption that the load spreads through the top cover fill depth by increasing the loading area's width and length by 15%.

Live Load Support

The Multi-pipe bundled product was tested by NSF International to the IAPMO Standard 63-99a to determine bearing strength under load. The load requirement of the Standard and the load applied in the test is the AASHTO H-10 load of 16,000 pounds axle weight (8,000 pounds wheel load). The top cover applied in the test was 12" of compacted fill. Applying the AASHTO vertical pressure wheel load formula, the **Vertical Pressure applied to the bundled Multipipe during the test at the H-10 load was 7.385 pounds per square inch, not considering the rolling vehicle impact factor. Including the impact factor of the rolling load over the bundled Multipipe, the vertical pressure applied was 10.35 PSI.** The NSF test indicated the Standard was met across a range of rolling test loads from axle weights of 2,000 pounds up to the H-10 16,000 pound standard. Weights above the H-10 16,000 pound axle weight were not tested.

Live loads (vehicle weight plus impact factor) are dispersed through the pavement, top cover fill and geogrid stiffeners when used and transferred to the "sub grade" which is the top of the RainSpace Chamber in this application. Live loads transferred to the sub grade decrease with increases in the depth of the top cover. Live loads up to H-25 can be sustained by the RainSpace structure up to 10.35 PSI calculated according to the standard AASHTO formula, **less the Dead Load** of the top cover, **less a margin of safety** of 40% -50%. Alternate load calculations derived from the AASHTO formula can also be made with similar relative results.

Dead Load Support

The dead load or earth load is the load applied by the weight of the top cover material. The weight of soils varies with composition and density. A conservative soil weight used in load bearing calculations is 130 pounds per cubic foot. Reinforced concrete is heavier than soils or asphalt at 145 pounds per cubic foot. Using a conservative approach and applying a top cover weight of 145 pounds per cubic foot as though the entire top cover fill were concrete, the following vertical pressures are applied to the underground structure at varying depths of top cover - (No consideration is given here to the further dispersion of load and stiffening of the top cover provided by pavement at the finish surface or use of geogrid material):

Top Cover Depth	Top Cover Weight/sf @145#/cf	Pressure on Underground Structure (PSI)
24”	290.0#	2.01 psi
30”	362.5#	2.52 psi
36”	435.0#	3.02 psi
48”	580.0#	4.03 psi

The dead weight loads placed on the RainSpace Chamber structure at these top fill cover depths are less than the non-rolling load of 7.385 PSI applied at the H-10 load standard and a substantial margin of safety is available at the indicated cover depths.

Combined Live Loads and Dead Loads Support

Applied loads to the structure of the RainSpace chamber can be calculated at various depth of top cover fill by calculating the Dead Load and the Live Load at various vehicle axle weights. For example, a live load weight at H-25, combined with a 30 inch top cover composed of soil and/or aggregate stiffened by geogrid applies a total load of 6.01 PSI to the Chamber, which is 58% of the tested load of 10.35 PSI. Increasing the top cover depth to 31 inches reduces the combined load to 5.57 PSI or 52% of the tested load.

Top cover fills with lighter densities than reinforced concrete (soil, aggregate, sand) reduce the dead load and thus reduce the combined applied load when vehicles are added. Pavements such as asphalt concrete six inches in thickness or greater will also reduce the applied load by dispersing surface loads over a wider area. Reinforced concrete pavement will typically disperse surface loads to such an extent that the live load becomes a relatively immaterial addition to the dead load and the combined applied load therefore is much less than when no concrete surface pavement is used.

Two variations of the AASHTO formula can also be used to compute the Live Load with Impact Factor at various depth of top cover. The Point Load variation assumes no load spread over a wheel set footprint and a wider spread factor as the cover depth increases; the Tensar version of the AASHTO formula applies wheel pressures in psi at the surface under the wheel footprint. Both variations produce calculated total load pressures on the top of the RainSpace Chamber that are similar to the standard AASHTO method. Rain Tech, Inc. employs all three methods in suggesting top cover specifications according to surface loading applications to engineers and contractors using RainSpace Chambers for their stormwater control and rainwater storage requirements.