Bal-Last Interlocking Systems

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Flood Level Challenges for Lake Huron Community

Pressure Sewers in Flood Waters

As suppliers for interlocking ballast systems we are often asked to explain why ballast is needed. The Bal-Last® Interlocking system recently provided a solution to unique challenges at a project located on the shores of Lake Huron.

The designer is planning to install pump chambers with raised accessways in areas that often flood to a foot or more above finished grade. This wastewater collection project is needed to eliminate failing septic systems that are often submerged by flood water. A pressure sewer system will solve this issue.

The pump chambers will need to be able to withstand significant buoyant forces under flood conditions. The pump manufacturer requires the addition of ballast to assure the client that these lightweight, HDPE basins, designed to be water-tight, will also stay in place.

Natural Soil Burial Falls Short

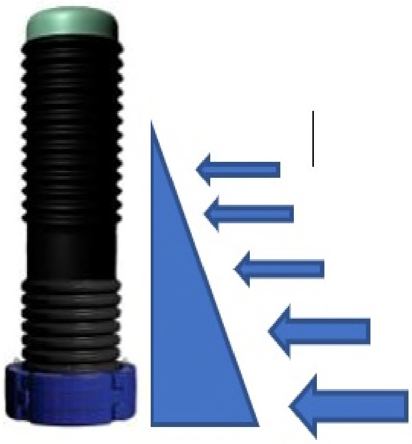
When tanks are buried there is a lateral soil load much like the load against a retaining wall. Under proper soil conditions, these loads can be adequate to secure a pump chamber under moderate groundwater conditions. During flooding or fully saturated soil conditions, the soil density is reduced as a result of the uplift forces of water. Under low groundwater conditions the soil may offset these upward forces and nothing happens to the tank.

As the water level rises, the lateral soil loads will not be enough to keep the tanks from floating out of the ground.

Inside this issue

Special points of interest

- Bal-Last has been the ballast solution for light weight wastewater grinder pumps since 2020
- Thousands of successful installations



Natural Soil Lateral Forces

The lateral forces are based on the soil area that is calculated as the area of a triangle using ½ the base times the height. This is because the forces are greater at the bottom of thank and non-existent at the very top.

The base of this triangle is determined by the sine of the soil's friction angle. The friction angle is related to the soil's cohesion properties. These friction angles can be seen from the Unified Soil Classification System table.

The pump manufacturer recommends Class I or Class II backfill soils that are the GW and GP soil classes seen on the next page. Should an installer elect to not use these materials, the use of more silty soils will result in a lower friction angle and lower lateral force.

These silty materials may have other properties that can be detrimental to the installation.

For the purpose of this article we are looking at the forces and weights needed to offset buoyancy from groundwater.

The lateral force is determined by the volume of backfilled soil that is pressed against the wall of the buried tank. In retaining wall design this is expressed as the force per foot of wall. With a circular tank, this force will be applied evenly around the circumference of the tank.

> *"The lateral force is determined by the volume and density of backfilled soil that is pressed against the wall of the buried tank"*

Lake Huron

This community will be replacing failed septic system for 236 homes. A pressure sewer system will be used to collect and convey wastewater for final treatment.

The homes are located in flood areas prone to standing water that will be on the surface around the grinder pump stations.

Bal-Last is proposed to provide the necessary ballast against these difficult conditions.

"Make your next E/One® installation an easy one with Bal-Last Interlocking Ballast Systems."

Lake Huron Project Solution

With a 26-inch diameter tank that stands close to 9 feet tall, the designer asked that the tanks extend out of the ground for access of 14-inches above grade. This exposed area will not be retained by soil. The tank will see uplift forces in flood conditions of 2,266 pounds.

For the purpose of this article we are looking at the forces and weights needed to offset buoyancy from groundwater. The lateral force is determined by the volume of backfilled soil that is pressed against the wall of the buried tank. In retaining wall design this is expressed as the force per foot of wall. With a circular tank, this force will be applied evenly around the circumference of the tank.

The station density, in this example, is determined by the weight in relation to the cubic feet of the tank. Our station has an empty tank weight of 279 pounds and displaces 36.33 cubic feet. Resulting in a density of 7.68 pounds/cubic foot. This will certainly float in water that has an uplift of 62.4 pounds/cubic foot. The uplift force becomes 2,266 pounds against a weight of 279 pounds.

Lateral forces of soil will be applied to counteract this lifting force. In our installation, the tank is buried to a depth of 7.5 feet. There will be 14 inches exposed above grade that will not have the benefit of lateral soil forces. Using the USCS soil classifications we can determine the lateral forces available to counteract the buoyancy. (Cont'd page 3)

USCS Soil-class	Description	Cohesion (kPa)	Friction angle (°)
GW	well-graded gravel, fine to coarse gravel	0	40
GP	poorly graded gravel	0	38
GM	silty gravel	0	36
GC	clayey gravel	0	34
GM-GL	silty gravel	0	35
GC-CL	clayey gravel with many fines	3	29
SW	well-graded sand, fine to coarse sand	0	38
SP	poorly graded sand	0	36
SM	silty sand	0	34
SC	clayey sand	0	32
SM-SL	silty sand with many fines	0	34
SC-CL	clayey sand with many fines	5	28
ML	silt	0	33
CL	clay of low plasticity, lean clay	20	27
CH	clay of high plasticity, fat clay	25	22
OL	organic silt, organic clay	10	25
OH	organic clay, organic silt	10	22
MH	silt of high plasticity, elastic silt	5	24

Unified Soil Classification System (USCS)
http://en.wikipedia.org/wiki/Unified_Soil_Classification_System

Lake Huron

From the USCS table above, gravel soil with soil friction angle of 38 degrees has a Sine of 0.6156. Clay soils with an angle of 29 degrees will have a Sine of 0.484. The area of the soil angle based on (½ B X Height). The base (B) is the Sine x Height.

- Gravel Soil: will result in: 0.6156(7.5) X 0.5 X 7.5 =17.3 cubic feet per foot of tank wall.
- Clay Soil will result in: 0.484(7.5) X 0.5 X 7.5 =13.6 cubic feet per foot of tank wall.

The weight is based on the density of the soil when fully saturated with ground water. We will use a soil density of 70 pounds/ cubic foot.

- Gravel Soil friction force: 17.3 Cubic Feet X 70 Pounds/ Cubic Foot = 1,211 pounds of force.
- Clay Soil friction force: 13.6 Cubic Feet X 70 Pounds/ Cubic Foot = 952 pounds of force.

Neither of these forces will fully offset the uplift of 2,266 pounds. We therefor need to counteract the 1,055 to 1,314 pounds of remaining uplift force.

Bal-Last® interlocking ring is called into action to add needed weight in two ways. The pre-cast, concrete filled blocks add weight of 375 pounds and has the shape and structural ability to anchor to the tank wall and support the vertical weight of soil that surrounds the pump chamber.

(*Page 4 lists the results of these calculations*)

Definitions

an·gle of re·pose

noun
the steepest angle at which a sloping surface formed of a particular loose material is stable.
"the angle of repose will vary locally according to the mechanics of shape and strength"

The **angle of internal friction** is a physical property of earth materials or the slope of a linear representation of the shear strength of earth materials. Earth materials that are unconsolidated and uncemented typically are called **soil** by engineers and geologist and may be called sediment by geologists.

Angle of friction: It is the **angle** which the resultant of the limiting **friction** and the normal reaction makes with the normal reaction. **Angle of repose**: It is the minimum **angle** that an inclined plane makes with the horizontal when a body placed on it just begin to slide down.

Find out more:
www.interlockingballast.com

Bal-Last is Locally Represented by:

Dubois-Cooper Associates, Inc.

905 Penniman Ave.
PO Box 6161
Plymouth, MI
48170-0161

Phone:
(734) 455-6700

sales@duboiscooper.com

Manufacturer's Representatives
Since 1950

Bal-Last Solution

As we mentioned; the Bal-Last® interlocking ring is called into action to add needed weight in two ways.

The pre-cast, concrete filled blocks add weight of 375 pounds and has the shape and structural ability to anchor to the tank wall and support the vertical weight of soil that surrounds the pump chamber.

The added surface area of the Bal-Last® ring supports 22.8 cubic feet of soil. Using the same density as above, we add 1,596 pounds of weight from the soil.

Our combined weights become:

Tank Weight = 279 pounds *
Bal-Last Weight =375 pounds**
Soil Weight =1,596 Pounds
Gravel Lateral Force = 1,211 pounds

TOTAL = 3,461 pounds

Uplift force: 2,266 pounds results in a net condition of 1,195 pounds and a bal-last safety factor of 153%

* *The tank at "OFF" level will hold 24 gallons and add another 200 pounds to this condition when in use.*
***The Bal-Last® weight used is in air and will be displaced by water as well. The volume of the Bal-Last® ring was included in the tank volume above and has been included in the uplift calculation*

For this project there are two pump station sizes proposed. Below are the specific results for each of these models.

	Lateral Force	Vertical Force	Uplift Force	NET Downward	Safety Factor Empty	Safety Factor "OFF' Level
DH071-104	1022.94	2250.53	-2266.80	3273.47	144%	153%
DH071-152	2366.56	3220.34	-3197.83	5586.91	175%	181%

The Bal-Last Interlocking system works with all heights of basins and can provide greater ballast support with deeper tanks that capture a taller soil column.

Bal-Last at Work

This picture came from one of our distributors demonstrating that while the station was engulfed by spring floodwater, all was stable and nothing moved.

Stations with flood covers and lateral venting continue to function well. This project used Bal-Last on all of the stations without an issue.

Image courtesy of:

Steven Garlicki at TEPCO, Trombold Equipment Company, Mars, PA

Reach out to Casey Garlicki @ CGarlicki@tepco.io

Flood waters are no match to stations installed with Bal-Last interlocking Systems.

Sea Coast Installation

These new basins were installed to function in tidal flood and velocity zone conditions.

This new project in **Salisbury, MA** demonstrate that even new basins that are empty and did not have the benefit of the pump weight, remain in place in silty sand that is fully saturated.

The occupied living spaces will be 8-feet above the pump chambers under coastal building requirements.

Albro Photo

41 Bayberry Hill Road

West Townsend, MA 01474

WWW.interlockingballast.com

The Bal-Last System

The **Bal-Last IBS** system is designed to hold *fast* or to *fix* to the tank wall with specially designed ribs that conform to the exterior of the pump chamber. Each block is designed to interlock with adjoining blocks to form a full circle (4 blocks) around the pump chamber. As the blocks are aligned, a locking pin secures each block in place providing a complete ballast ring. This process is *fast* and takes only a few moments to install on a pump.

The concrete filled **Bal-Last®** ring provides a benefit of adding weight or bal-last to the station and provides a solid, structural bond to the tank that ac-cepts the load of backfilled soil on the top to provide the balance of the bal-last weight needed to hold the station in place; even in fully saturated soil conditions.

The concrete filled blocks are provided with lifting inserts and lifting eye bolts to facilitate the off-loading and placement of the pump and ballast assembly. Backfilling of the station can immediately follow.

Bal-Last Interlocking Systems

41 Bayberry Hill Road
West Townsend, MA 01474

1417 Oakridge Drive
Birmingham, AL 35242

Phone: 978-808-4986

E-henry@interlockingballast.com

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INTERLOCKING BAL-LAST SYSTEM™