JUNE 2017 | VOLUME 30 | ISSUE 2

THE StressPoint®

FOR EXPERTS | BY EXPERTS

The Municipal Water Cycle

RETAINING WALLS
HOLDING SOMETHING BACK

LIFE VEST? CHECK!
BOAT SAFETY APP?
CHECK IT OUT!

BURBO BANK EXTENSION
WIND FARM

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Engineering Design & Testing Corp. is an association of forensic engineers dedicated to the study, interpretation and resolution of loss.

A Message from the President

Dear Friends,

Within this issue of *The Stress Point,* we present articles on retaining walls and water supply and disposal systems. Both are plentiful and sometimes easy to take for granted. Still, the convenience provided merits a lot more appreciation for what is required to give reliable, safe water and for various ground-based structures that stay where we want them.

So, holding things back or letting it flow, we need some of both in the right measure. An apt micro-study of much in life. Enjoy.

Until next time,

Mark D. Russell

Mark D. Russell, Ph.D., P.E.
President and Chief Engineer

THE StressPoint®

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Clean water: where does it come from, and where does it go?

FEATURE

IN THIS ISSUE

DEPARTMENTS

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"Give me a fulcrum and a place on which to stand, and I will move the world."
—Archimedes, Greek Inventor and Mathematician

Friends, Not Food

Image: SharkBanz

Never fear being a yummy shark snack again with the help of SharkBanz. Using magnetic technology, this bracelet disrupts the electronic receptors on the shark's nose, known as the Ampullae of Lorenzini. "Since the shark is tuned to be looking for very weak (faint) electromagnetic signals from its prey (heartbeats, muscle movements), this organ is highly sensitive," says Dr. Eric Stroud. "When you present a SharkBanz, it is a very unnatural and distressful level of signal. It tells the shark 'this is definitely not food.'" With no batteries or charging required, the band can withstand depths up to 330 feet (100 meters) of water. For more information and purchasing options, visit *www.sharkbanz.com.*

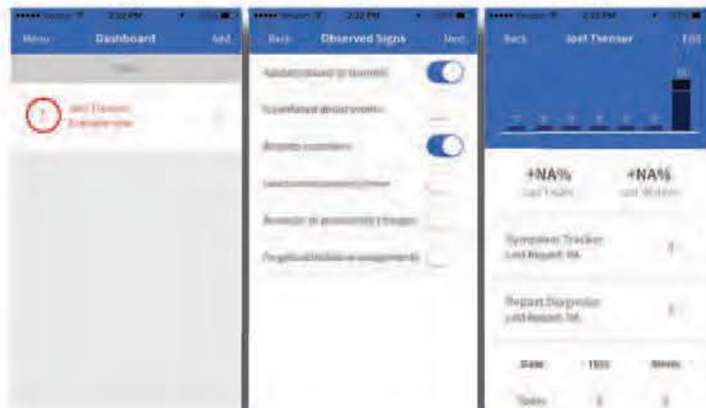
Goggles to Guide You

Open water swimmers have a tendency to veer from the finish line. With OnCourse Goggles, LED indicators light up green to indicate staying in a straight path, or turn yellow and red to warn when veering from the course. To set the course, the goggles have a point-and-click technology with an electronic compass to make it easy to set your path. According to OnCourse, when using the goggles, swimmers experienced an average of 5.7 minutes trimmed from their 1,500 meter (4,921 feet) swim. The goggles have a rechargeable battery, polarized and anti-fog lenses, and UV protection. For more information and purchasing options, visit *www.oncoursegoogles.com.*

Image: OnCourse

Head Injury Sensor

Athletic injuries are on the rise, and the Jolt Sensor was created to monitor the severity of the head injuries sustained by athletes. The Jolt Sensor can be clipped to any type of headgear: helmets, headbands, goggles, and more. The Sensor connects to an app and will continuously send information on the athlete's head injury and recovery. The app allows you to track symptoms and know when an althete suffers a hit and a potential concussion. The Jolt cannot diagnose a concussion, but it will help by informing how severely an athlete was hit. No need to worry about being on the field with a Sensor; the Sensor can send information up to 200 yards (600 feet). For more information and purchasing options, visit *www.joltsensor.com*.

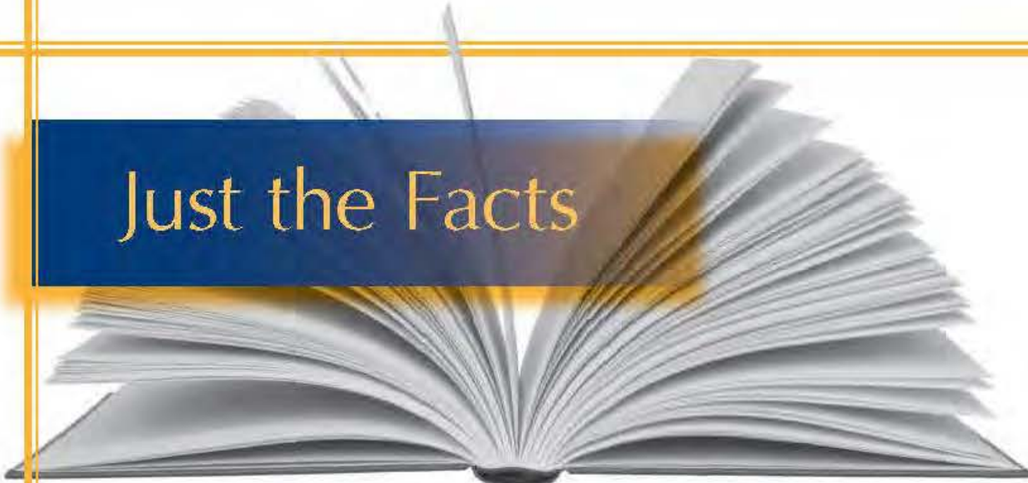


Images: Jolt Sensor

Small But Mighty

Bring the movie theater home with this cinema quality projector. The MobileCinema i70 is 3.3 inches long and weighs less than one pound, making it a small but mighty projector for all of your favorite videos and movies. Project onto any blank surface for 80 inches of viewing pleasure. The projector connects to Apple Play and Android Miracast, as well as other wireless devices and any HDMI-compatible device. It can also charge other electronics with its various ports. For more information and purchasing options, visit *www.aiptek.de*.

Images: Aiptek



Just the Facts

LIFE VEST? CHECK! BOAT SAFETY APP? CHECK IT OUT!

On May 16, 2015, the United States Coast Guard (USCG) launched a boating safety app. "Our boating safety program involves public education programs, regulation of boat design and construction, approval of boating safety equipment, and vessel safety checks for compliance with federal and state safety requirements," according to the USCG. "The Coast Guard Mobile App supports these missions by providing the essential services and information most commonly requested by boaters."

The USCG Boating Safety App includes information about a number of boating needs: find the latest safety regulations, request vessel safety check, check lists for safety equipment, float plans, navigation rules, the nearest NOAA buoy, hazard and pollution reporting, suspicious activity reports, and emergency assistance requests.

For those who find themselves in distress while on the water, the app also features an Emergency Assistance button that will call the closest Coast Guard command center.

Images: USCG

Photo Gallery

Burbo Bank Extension WIND FARM

Burbo Bank Extension is a windfarm currently in construction in the United Kingdom (UK), approximately 7 kilometers (4 miles) off the coast of Liverpool Bay. At full power the project can generate 258MW of electricity, enough green energy to meet the annual electricity demands of well over 230,000 UK homes. The project, a joint venture between DONG Energy (50%) and its partners PKA (25%) and KIRKBI A/S (25%), is the first offshore wind project to use MHI Vestas 8MW turbines – the largest in the world. At 195 meters (640 feet) from sea level to blade tip, each turbine is taller than the Gherkin building in London (over twice the height of the Statue of Liberty) and has a swept area larger than the London Eye. Using bigger turbines helps to reduce the cost of energy by capturing more wind. As a result, fewer are needed to generate large amounts of electricity. DONG Energy currently operates 17 offshore windfarms across the UK, Germany and Denmark, and was recently the world's first developer to reach installation of 1,000 offshore wind turbines.

"Modern wind turbines are a good example of how technology can be both simple and complex at the same time. From a distance, wind turbine blades spinning in the wind are akin to a child simply blowing on a pinwheel. Up close and inside the workings of a wind turbine, it becomes apparent that there are thousands of interconnected parts. Yet still, a wind turbine's purpose remains simple: to turn wind energy into electrical energy."

By: David J. Shamrell, M.E., P.E., CFEI
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Source: DONG Energy

The municipal WATER CYCLE

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Water for showers. Water for toilets. Water for shaving. Water for brushing teeth. Water for cooking and eating. Water for coffee and tea. Water for cleaning. And let's not forget water just for drinking water!

That's a lot of water, and it's just the start of the daily water consumption for one person. Where does all this water come from? How does it get to our faucets? What happens to water such that we consider it safe to drink? Finally, what happens to water on its way out the pipe?

Consider the Source

Water makes up over 70% of the Earth's surface. While it is plentiful, not all water is suitable for drinking. There are two basic types of drinking water sources: ground water and surface water.

When rain falls, water either seeps into the ground or runs along the surface and collects in rivers and lakes. Water absorbed into the ground collects below the surface to form underground rivers known as aquifers. Several aquifers may be located below a single location and span thousands of feet. The aquifer near the surface forms the water table and is most readily affected by rainfall. This water, also known as ground water, is extracted by digging holes (wells) in the ground and pumping the water out. The practice of digging wells in search of fresh water has been going on for over 10,000 years. Many of today's municipal wells are monitored to make sure that water is not pumped out faster than it is being replenished.

As implied, surface water comes from rivers, lakes, and reservoirs. Although surface water only accounts for 0.3% percent of Earth's freshwater, it's easier to extract and therefore provides for most of the drinking water supply, particularly within larger cities. Surface water is extracted with the help of pumps located along the edges of the water surface or, better yet, is simply fed by gravity to nearby water treatment plants.

Star Treatment

The most basic water supply system consists of private wells owned and operated by homeowners. Approximately 15 million United States households (or 15% of Americans) rely on private wells for their water supply. In a private water well system, homeowners have their own well and pump to bring water to their home. Home water filters and other treatment methods remove contaminants found within the well water before it is used for consumption.

The remainder of the population relies on a local water utility to supply drinking water. Depending on the location, water utilities may use a combination of ground and surface water to meet demand. Treatment for utility water is similar to private well water but on a much larger scale. Treatment plants are designed and operated in conjunction with regulatory agencies to ensure water is safe for consumption. Testing establishes the quality of the source water and the necessary treatment methods. Some sources may need little to no treatment, while other sources require several methods. For example, of particular concern would be surface water sources containing pesticides and other chemicals.

Sedimentation and filters are used to remove large and fine particles. To eliminate bacteria in the water, chlorine is a common additive. Other treatment methods are employed to address specific contaminants identified during testing. In addition, while not necessarily a treatment method, fluoride is added to prevent tooth decay in the general population. Once water has been treated, it is ready to enter the distribution system.


Water Treatment Plant


Centrifugal Water Pump

Pumps, Pipes, and People

Fans of the *Rocky* movies probably don't know that a famous scene from the first movie takes place above the remnants of a historically important municipal water system. In 1815, the United States' first major urban pumping station, known as the Fairmount Water Works, was commissioned in Philadelphia, Pennsylvania. This pumping station, located on the bank of the Schuylkill River, was used to supply clean drinking water to the city. Water extracted from the river was pumped to a reservoir atop a nearby hill. The reservoir provided water to the city below. At the time, pipes were made of wood from hollowed-out tree trunks. Piston pumps located next to the river were first powered by steam and then by the river water itself through the use of a turbine. For over 90 years, clean water was provided to the growing city in this fashion. In the early 1900s, however, industrialization led to contamination of the Schuylkill River and subsequent closing of the Fairmount Water Works. At the same time, newer technology was employed to create some of the modern treatment and piping systems used today. The Fairmount Water Works remains in place as a National Historic Landmark. On top of the former reservoir site sits the Philadelphia Museum of Art, known for the many steps leading to its entrance—the same steps ascended by Rocky Balboa.


Repairing a water line break

Water utilities of today use lots of pumps. Centrifugal pumps are the most common. Centrifugal pumps use a rotating impeller spun by a shaft connected to an electric motor. Pump and motor sizes range from five to several hundred horsepower. Centrifugal pumps offer efficiency, reliability, and safety compared to other pump designs. Plus, centrifugal pumps allow water systems to convey large volumes of water while maintaining pressure.

Upon leaving the water treatment plant, water is often sent to an elevated water storage tank. Water storage tanks are the most noticeable part of a water distribution system, and are often painted with the name of the local town. Elevated storage tanks can store hundreds of thousands of gallons of water for use during high-demand periods. Due to their height, they also help maintain pressure in the system.

Pumps located deep within wells or along the source water's edge push water to the treatment plant. Pumps at the treatment plant send pressurized water into the distribution system. Due to friction losses from water flowing through piping, booster pumps may be placed in the distribution system to increase pressure in piping systems located further away from the plant.

Reverse Osmosis Water Treatment Plant

Pressurized water delivered to your home ensures continuous water supply and operation of plumbing fixtures without the need for electricity. In addition, since piping systems incur leaks from aging pipes or at connections, having sufficient pressure within the piping ensures water leaks travel outward, as opposed to dirt and other contamination leaking inward into the piping.

A network of pipes branch out from the water treatment plant, eventually reaching homes and businesses nearby. A variety of piping materials make up this distribution system. Depending on when and where they were installed, piping materials include metals such as cast iron, ductile iron, steel and copper, or plastics such as polyvinyl chloride (PVC) and high-density polyethylene (HDPE). Each material has its advantages and disadvantages, all of which are considered by the water utility when installed. Metals may be stronger but are more expensive and are susceptible to corrosion. On the other hand, plastic piping is less expensive but is susceptible to physical damage.

At the end of the line, water utilities expect the user to receive water in essentially the same condition as when it left the plant. Still, there are times when the piping materials both in the distribution system and inside a structure affect water quality. Some older piping or fittings in both municipal and home installations contain lead that will leach into drinking water if not addressed. Frequent water quality testing is performed by water authorities to determine if lead or any other contaminant is present within vulnerable homes. In addition, chemicals may be added to the water to prevent corrosion of lead materials. Overall, the water utility is required to provide a safe water supply with insignificant amounts of lead and other contaminants. Additional information regarding water contaminants can be found in local water quality reports, issued to water utility customers every year.

Water Treatment Plant

Back You Go

Once the water comes out of a faucet, its journey is only half complete. The used water, or wastewater, still has a long way to go to return to its source. The route back follows a similar path.

If you have your own well, chances are you will also have your own means of disposing the wastewater via a septic system. A septic system distributes wastewater into the soil or to a sand-mound around the property. Homes with utility water service but without access to a utility wastewater system also have a septic system. Today, approximately 25% of homes use septic systems as the means of wastewater disposal. The rest send wastewater to a utility sewer system for disposal. The management and discharge of wastewater is governed by federal regulations under the Clean Water Act (CWA). The purpose of the CWA is to ensure that wastewater doesn't pollute clean water sources.

Mostly Natural Wastewater Treatment

Water naturally purifies while flowing through lakes, rivers, and streams. When populations were smaller and contaminants were fewer, wastewater was discharged directly into these bodies of water, and nature's purifying processes took care of the treatment of the wastewater. However, as populations grew and cities became more industrialized, wastewater treatment plants proved necessary to prevent pollution from contaminating the water source and causing disease.

The purpose of wastewater treatment plants is to use similar natural processes but at a much quicker pace. Early wastewater collection systems conveyed both wastewater and storm water to treatment facilities for processing. During heavy rains, such combined systems became overloaded, and overflow discharged directly into the water sources.

To circumvent this problem, modern systems now separate wastewater and storm water systems. However, many of the combined systems continue to operate in older, larger cities.

In separated systems, wastewater leaves our homes and travels through piping—by gravity—to the nearest collection point, referred to as a lift station. Piping can only go so far before the piping becomes too deep. At the lift station, pumps lift the wastewater up to another set of piping at a higher level, where gravity again guides flow towards the next lift station. As wastewater travels closer to the wastewater treatment plant, piping systems merge and there are fewer pumps, with each system handling larger volumes. Wastewater treatment plants are often located near bodies of water since these natural low points help reduce the number of lift stations.

Once at the treatment plant, the wastewater is turned into a fluid that can be sent to a water source without polluting the environment. One of the first treatment methods is to settle out solids within the wastewater. The wastewater is slowed down and passed over settling tanks, resulting in solids or sediment falling to the bottom. The resulting sludge at the bottom of the settling tanks is removed and disposed of separately. In another stage of treatment, the wastewater is passed through a bed of biological organisms, which consume most of the remaining organic material. After a round of disinfection to remove any pathogens, the wastewater is ready to be discharged. Still, some advanced treatment takes place to reduce the impact on the environment. One advanced process is the removal of excess nitrogen and phosphorus (elements that promote algae growth in water sources). Upon completion of treatment, wastewater may be discharged back to rivers, lakes, oceans, and even wells to help refill drinking water aquifers.

What's Coming Down the Pipe?

At its time, the Fairmont Water Works introduced items of value to any growing metropolitan city: pumps, piping systems, reservoirs, and clean water. As hoped for, population grew and industry prospered, yet with these changes came new challenges. For the sake of clean water, technical innovation of the process was as vital then as it is now.

For example, almost all of the drinking water in our country is derived from freshwater as it requires less treatment to be ready for human consumption. However, as treatment becomes more intense and freshwater supplies become harder to reach, especially during times of drought, the costs of supplying clean drinking water rise. At the same time, technological advances have reduced costs for desalination. In this process, saltwater is forced through a membrane filter, removing salt and most other contaminants. With desalination plants, the largest water source on the planet—our oceans—becomes a drinking water source. Already popular in the dry Middle East, desalination is on the rise in the United States, mainly in California, Florida, and Texas. In December 2015, a new desalination plant was opened near San Diego, California. This plant has been used to offset some of the unreliability of freshwater sources during drought conditions common in this area. Some 50 million gallons of water per day are produced from this plant. More desalination plants are already under construction in California.

Since electricity makes up a significant portion of the cost to deliver water, effort is being given to reduce energy costs of water and wastewater systems. One method is the use of variable frequency drives. In the past, water utilities used control valves to maintain a precise water pressure throughout the system. However, increased use of variable frequency drives has enabled pump motors to change speed in response to changing water demand, thereby reducing energy costs.

Like Philadelphia, communities around the world benefit from clean water and sanitation. The United Nations identifies access to clean water as a human right. Water makes life on earth possible, in more ways than one.

RETAINING WALLS

HOLDING SOMETHING BACK

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One of the oldest forms of an engineering structure is the retaining wall. Whether used to create a basement wall, keep a hillside from encroaching on a roadway, or hold up a runway so airplanes can land, the general principle is the same: to keep one material separate from an adjacent space.

Retaining walls are more than just stacks of heavy concrete blocks. Rather, they are engineered systems that follow specific design methods and come in a variety of configurations. Starting with the obvious is the geometry of a wall: how high and how long? Then, are there any limitations that might influence how much space the entire retaining wall system can take up? For example, if a retaining wall is needed next to a roadway, there may be a right-of-way distance required between the wall and an adjacent property line. Since soils are not the same from one area to the next, soils are examined to document their properties. Another important consideration is the anticipated external loads on the retaining wall. Will there be a parking lot behind the wall? A pond? Should we expect a 400-ton dump truck to be driving back and forth? Based on the answers to these questions and a few others, it is time to choose a wall type, select materials, and start designing.

Depending on the type of retaining wall system selected, there will be loads influencing that type of system. And where there are loads, there are often equations. Equations for interpreting loads on retaining walls date back to the late 1700s and 1800s. Two scientists, Rankine and Coulomb, and for the sake of innate scientific curiosity, studied earth pressure distribution of retaining walls. Thanks to the results of their work, engineers have equations for computing the equivalent horizontal stress of a soil based on the stress history and movement of a soil.

UNDER PRESSURE

Earth-pressure distributions are determined per one of three conditions. The three conditions are called active earth pressure, passive earth pressure, and at-rest earth pressure. Active earth pressure can be thought of as the lateral pressure from soil on the wall as the wall moves or tilts <u>away</u> from the backfill. Passive earth pressure can be thought of as the lateral pressure from soil on the wall as the wall moves or tilts <u>towards</u> the backfill. At-rest earth pressure can be thought of as the lateral pressure from soil on the wall that is not moving toward or away from the backfill. So, even though we think of retaining walls as not moving, the loads acting on retaining walls may come from a "moving" condition.

In addition to understanding the pressures on different types of retaining walls, and even which forces apply for each wall type, it is also important to know the soil properties of the foundation soil, the retained soil, and the fill or reinforced soil. Unlike other building materials, soil properties can vary from one foot to the next. For long retaining walls, minor changes in the soil over short distances can mean major changes from one end of the wall to the other.

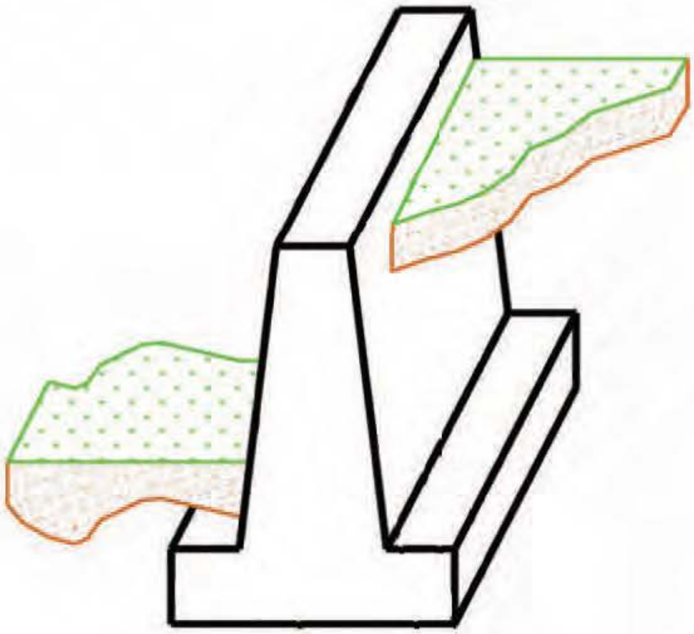
This could mean that multiple types of retaining walls are needed over the full length of the wall. On large publicly-funded projects, it would not be unusual to collect foundation and retained soil data every 50 feet (15.2 meters) along the length of a wall. On smaller projects and on private projects, it would not be unusual to collect that same soil data every 500 feet (152 meters) or sometimes not at all. Because of the variability of soil data and the high probability of unknowns, geotechnical engineers are conservative in their conclusions and use larger factors of safety or load factors (depending on the design methodology) than in other areas of civil/structural design. The benefit is that, because of these steps, retaining wall designs are often very robust.

THE WEDGE OF WEAKNESS

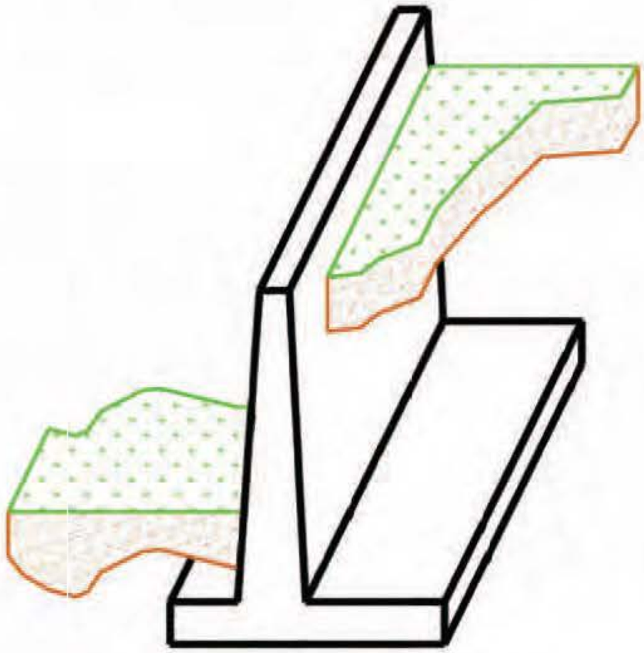
Based on the type of retaining wall selected and the properties of the various soil types, a designer identifies the area known as the "failure wedge." A failure wedge is a weak area in the retaining wall system where the stability of the retaining wall system is calculated. Determining the wedge helps the designer select structural methods to counteract the weak area. The failure wedge is a mass of soil that is expected to move under extreme conditions. The line between the "moving" and "non-moving" soil is called the failure plane. A failure plane can be classified as either internal or external depending on its location.

Retaining walls come in a variety of shapes, sizes, and types, but generally fall into two categories: externally stabilized or internally stabilized. Externally stabilized walls use structural components external to the retained soils' internal failure plane to resist movement. The oldest form of an externally stabilized retaining wall is called a "gravity wall." Gravity walls are built using large volumes of heavy materials; think boulders mortared together, or large concrete shapes. The weight and stiffness of these structures resists the lateral and overturning forces from the retained soil. Newer modifications of this design include the concrete cantilever wall and concrete counterfort wall. By utilizing the weight of soil over a cantilever footing to resist movement, these walls use less concrete then a traditional gravity wall. When a concrete counterfort wall is installed with the counterforts on the open side (not the soil side), it is called a buttress wall. Gravity, counterfort, and cantilever walls are typically used for permanent conditions due to the large volume of materials and concrete formwork required to build them. Other forms of externally stabilized walls are braced walls and tieback walls. In a braced wall, a series of horizontal, vertical, and angled structural members (struts, wales, and rakers) are installed on the front face of the wall and provide the required resistance. In a tieback wall, a series of tiebacks (commonly called nails or anchors) are installed through the face of the wall, and the ends are grouted into the soil behind the failure plane. Braced walls and tieback walls are typically found in excavations and used for temporary conditions.

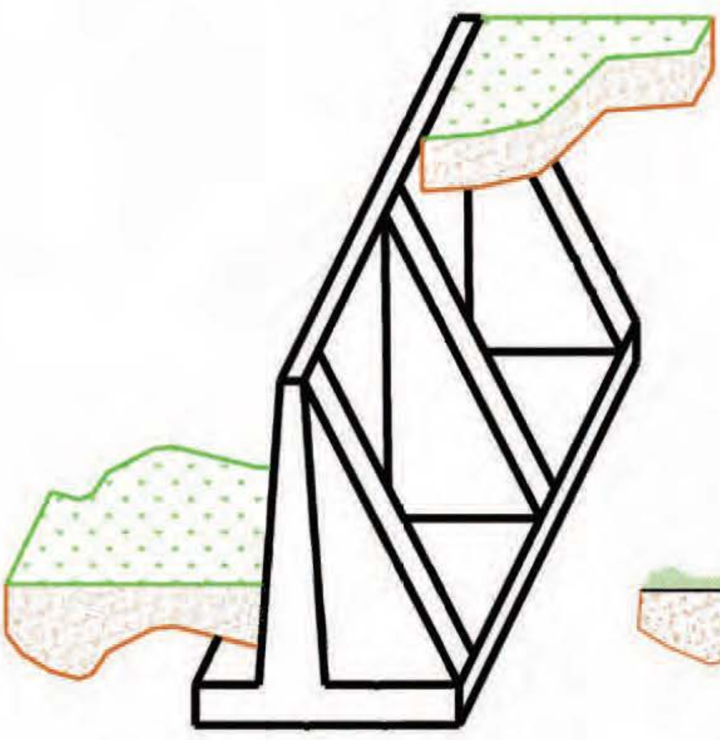
Internally stabilized walls use structural components in the potential failure wedge that cross beyond the internal failure plane to resist movement. The facing of the wall is a non-structural component utilized to prevent soil erosion and wall deterioration. Mechanically stabilized earth (MSE) retaining walls (sometimes called block walls) and soil-nail walls are both internally stabilized systems. MSE walls utilize either metal or geosynthetic strips or grids (also known as the reinforcement) layered with a compacted structural backfill soil to create a "reinforced soil mass." This mass works as a block to resist lateral and overturning forces from the retained backfill. The reinforcements also prevent movement of the potential failure wedge by reinforcing the internal failure plane. A soil-nail wall works in a similar fashion; however, since the soil nails are spaced further apart, a reinforced soil mass is not created, and lateral and overturning forces are resisted by the pullout capacity of the individual nails. Movement of the potential failure wedge is prevented by the shear of the individual nails. Unlike tieback walls, these soil nails are not grouted in place. MSE and soil-nail walls can be designed to either temporary or permenant conditions.



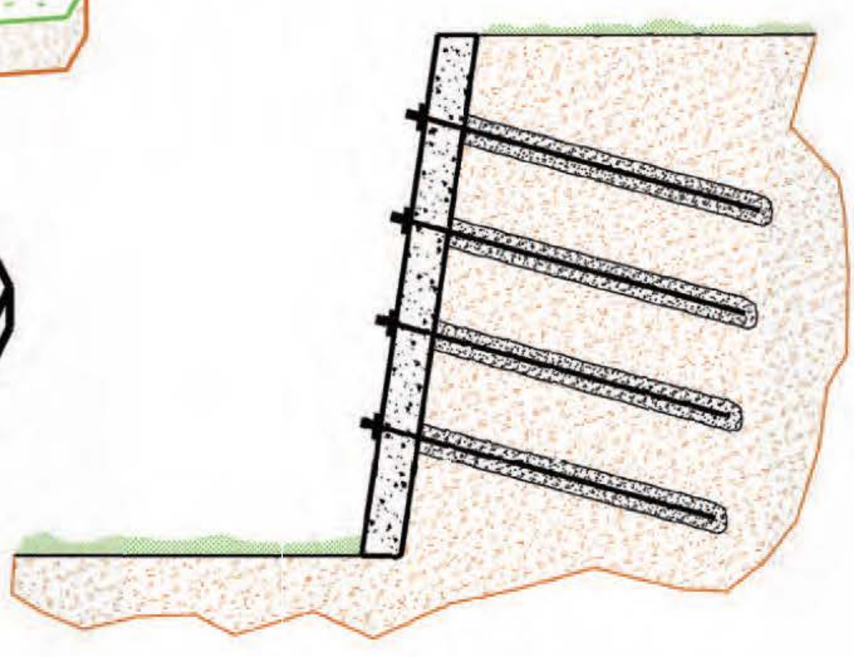
GRAVITY WALL



CANTILEVER WALL



COUNTERFORT WALL



SOIL-NAIL WALL

WALL SLIPS AND FALLS

Although most retaining walls are designed by engineers and the soil properties are known, retaining walls from time to time do come down. One cause of damage to retaining walls is unexpected hydrostatic pressure (the constant pressure from water). When hydrostatic pressures build up and exert excessive force on a wall, the wall can move outward (a sliding failure) or rotate (an overturning failure) as a block, the structural wall face may fracture, the modular block face may come apart, or the foundation soils may wash out and the wall may partially collapse (excessive deformation). Most wall systems have a method for draining water from the fill or retained soils. Methods include the installation of a drainage system (perforated pipes surrounded by gravel that drain through the wall face), the use of an impermeable membrane at the top surface of the wall, the use of a drainage column (typically a 1-2 foot wide column of gravel directly behind the wall face), a controlled fill soil-gradation that allows moisture to freely pass through the soil, or a combination of the above. The purpose of these systems is to divert water, preventing it from building up behind the wall and exerting undue force on the wall face. Over time, the natural movement of water through soil will result in a realignment of the soil particles. This realignment can result in fine particles clogging a drain, resulting in a buildup of hydrostatic pressure. It is therefore important to allow for a method to clean out the drainage system, especially if the backfill utilized has a high content of fine particles. It is equally important to actually clean out the system on a routine basis.

Another cause of damage to retaining walls is the growth of trees and other deep rooted vegetation behind the wall face. Large roots can exert a tremendous amount of pressure on the surrounding soil and have been known to fracture concrete and/or cause a wall to rotate. Large root systems also create channels for moisture to follow and can lead to excessive hydrostatic pressure. With MSE walls that are reinforced with geosynthetic soil reinforcements, growing tree/shrub roots can damage the soil reinforcement, reducing the strength of the wall. It is therefore important to prevent trees and deep rooted vegetation from growing near the back of a retaining wall.

Unfortunately, with retaining walls, it is often not possible to restore them to a pre-damage condition without disassembling them. Such a process can be time or cost-prohibitive due to the extensive amount of repair work. An alternative solution to stabilize a wall is to install soil-nails through the wall face. This will prevent further wall movement if the underlying cause of the movement is also dealt with. The design of such a repair should involve a licensed professional engineer with knowledge and experience in soil-nail walls.

While retaining walls may come in a variety of types, the design requirements and common problems that they encounter are quite similar. Diagnosing a problem with a retaining wall involves more than just looking at the damage. Analysis should also include a review of pre-construction and in-situ (as built) soil tests. Know that there are different test methods, and these results call for engineering interpretation to answer questions.

So that's the dirt behind retaining wall systems... structures often with stone faces working hard to hold it all back.

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LONG STORY SHORT

A Thing to Read

Thing Explainer
Author: Randall Munroe

Just when you thought you had exhausted your collection of books by former NASA scientists, along comes another must-read entitled *Thing Explainer*. Hold on to your quest for impressive words, as there is no place in this book for that kind of talk. Recognizing that so many of us want to know how things work, this book strips out the clutter of fancy words, complicated explanations, and boring "computer assisted drawings," replacing them with simple language, entertaining details, and cartoon drawings. Why? Because no matter how young or old we are, it should be fun to learn about a food-heating radio box (microwaves), the pieces everything is made of (the periodic table), sky touchers (skyscrapers), a big tiny thing hitter (the large Haldron Collider), and other cool stuff.

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