DABEC DIGEST

volume 4, issue 1 january, 2005

SIZING STORM WATER SYSTEMS

I know you all have been anxiously awaiting our topic this month. You might recall our topic from November, 2004 which dealt with pipe materials and uses. During that newsletter I promised to spend some time talking about how engineers size pipes for various uses. This is that month....

PRIMARY VARIABLES

Unfortunately, I won't be able to turn you into a storm sewer expert in the two pages of our newsletter, but I should be able to educate you enough on the basics so you will be able to understand the engineering lingo that goes along with storm sewer systems.

The first piece of the puzzle when it comes to sizing storm pipes is known as a **Watershed**. The term watershed sounds like a small building used to house or supply water, but it isn't in this case. A watershed as it relates to storm systems is all that portion of a surface that contributes storm water to a given discharge point. Watersheds can be very large or very small. The size of the watershed is determined by the discharge point and the topography (surface variation) that drains to that point. For example, the watershed for the Mississippi River above its mouth in the Gulf of Mexico is very large and is approximately 1.2 million square miles, while the watershed for one of the downspouts on your house may only be a couple hundred square feet.

No matter how big or small the watershed for your pipe or discharge point is, it is a very important factor in sizing the pipe. Generally speaking, the peak flow rate that will be delivered to a given point is directly proportional to the area of the watershed contributing to that point. In other words, two watersheds with similar characteristics will deliver similar peak flows. If one watershed happens to have more area it will deliver more flow. Additionally, if watershed A has about twice the area of watershed B, it is likely to deliver about twice the peak flow.

Some factors that can alter this relationship are the physical characteristics of the watersheds. One such physical characteristic is the general slope of the watershed. Twenty acres on the side of a mountain will probably have a higher peak discharge than twenty acres of prime river bottom farm ground with almost no slope. Another physical characteristic that will impact the peak flow from a given watershed is the surface condition of that watershed. For instance, a watershed that is completely contained within an asphalt parking lot will have more runoff than a watershed that is completely made up of unconsolidated sand and gravel.

Which leads us into our next major variable when deciding what size pipe to use. That variable is the **Run-off Coefficient (Rc)**. The Rc is an approximation of how much rainfall will be caught by irregularities in the surface and "soak in" and how much rainfall will "run off." Not all the water that is caught by irregularities in the surface will soak in. Some of that water will sit there until it eventually evaporates (imagine a depression in a parking lot.) The Rc is generally dependent on the surface conditions (soil types, degree of saturation, compaction, surface irregularity, and ice) and the slope of the surface. For example, two soils with identical composition and different slopes will have different Rc. The soil with steeper slope will have a higher Rc.

The next major variable is called the **Time of Concentration (Tc)**. The Tc is the predicted time it will take a drop of water to travel from the furthest reaches of the watershed to the discharge point we are trying to analyze. The velocity of the water flow must be estimated (or calculated) for every step of the route and the length of the route must be measured. When you divide the length by the velocity you get the time it takes to travel that distance. (Remember the old "train travels from Philadelphia at 50 mph" word problems?) For example, if the total length is 2000 feet and the average velocity is 2 feet per second the time required is 1000 seconds or a little over 15 minutes.

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This Issue's Quiz:

1) True or False:

Watershed is defined as any shed which contains a water supply, water equipments, or other water-related items.

2) True or False:

Time of Concentration is defined as the maximum length of time I can concentrate when reading this newsletter.

3) True or False:

The peak flow at a discharge point is directly related to watershed size.

4) True or False

The "I" in the formula must be determined at the Tc.

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SIZING STORM WATER SYSTEMS (CONT.)

You might be wondering why we care about Tc. The reason is that at the Tc you have the earliest time in the storm at which all areas of the watershed are contributing run-off to the discharge point being analyzed. After the Tc, all areas continue to contribute run-off until the rain ends but it is the earliest time we are concerned about. The reason for that is because of the nature of rainfall. Most of the time, we approximate intense rainfalls with a model storm that dumps a bunch of water early in the event and then slowly tapers off to nothing. (Imagine a normal thunderstorm.) There are other ways to model rainfall, but I'm afraid you would all be asleep by the time I got through the second model (of many).

In any event, the Tc tells us the earliest time at which all areas of the watershed are contributing run-off to the discharge point. We will use the Tc with the other major variables to determine the peak discharge rate at the discharge point.

The last major variable to discuss is the **Rainfall Intensity (I)**. Anyone that has ever seen it rain knows that rain doesn't always fall at the same rate. When it is really pouring cats and dogs the intensity is high. A light drizzle represents a low rainfall intensity. The I that we are interested in is the I that occurs at the Tc. I have already mentioned modeled storms, but this is really where they come into play. The modeled intensity at the Tc is the number we pull out of the model to use when calculating the total discharge rate at the discharge point. The equation looks like this:

$$Q=Rc*I*A$$

I didn't tell you what Q is, but it is the volumetric flowrate at the discharge point and A is the area of the watershed. It is really important to make sure the units are managed when doing this calculation. It is very easy to miss minutes and seconds and inches and feet.

Well, that was an awful lot of work just to find Q. Now that we have it, what do we do with it?

Remember that Q is the modeled peak flowrate at the point you are measuring. The peak flowrate is very important, because if you size a pipe, inlet, ditch, swale or pond to handle some number less than the peak, water will begin to back up at that element. We usually refer to water backing up as a flood. Flooding is okay in some areas (detention basins), but is generally unwanted in others (basements).

Next month we'll get to pipe sizing criteria, I promise.

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DABEC DIGEST

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SIZING STORM WATER SYSTEMS-CONTINUED

Wow, has it been a month already? I suppose you guys feel like it's been way more than a month, because you have been dying to read this article I promised you in January about pipe sizing. Well, here's the article:

PIPE SIZING CRITERIA

Sizing storm water pipes tends to have a lot more variables than determining the peak discharge rate to the collection point (which we discussed last month.) The first aspect of sizing pipes we will discuss is the gravity-flow capacity of the pipe, itself.

The gravity-flow capacity of a pipe is the peak capacity capability of that pipe when there is still a little air in the pipe. In other words, if you drill a little hole in the crown of the pipe, no water will come out. Most of the time, engineers try to design storm system pipe networks to function in gravity conditions. There are several reasons for this, but the primary reason is probably to reduce the likelihood of leaking and sucking. If the gaskets between the pipes sections leak a little and the pipe is under pressure, some water will escape from the pipe and saturate the ground around the pipe. When the water level recedes, the saturated earth will tend to suck back into the pipe through the leak in the gasket and create a little void above the pipe. Over time, the little void can turn into a really big void and cars driving over the pipe can fall into the hole. Occasionally, you will see news footage of a giant hole in an intersection that just two hours before had traffic running over it. This mechanism is usually how these holes develop.

There is more than one model (or formula) to use when calculating the gravity capacity of a pipe. Most Civil Engineers will use something called "Manning's Formula" to calculate the estimated capacity of a real-world pipe. When using this formula (which we will be doing for the balance of this newsletter) the gravity capacity of a pipe is dependent on three primary variables. Those variables are: the **cross-sectional area** of the pipe, the **slope of the pipe**, and the **coefficient of friction** of the interior sides of the pipe.

The **cross-sectional area** of the pipe is simply the available flow area to the water (or other fluid). In other words, if you have a pipe with an interior diameter of 12", the cross-sectional area of the pipe is found by using your high-school geometry (who would have ever thought?) and taking the radius squared times pi (approx. 3.14). In case you don't have a calculator, it has an area of 113.1 square inches (0.785 sq ft). An interesting side-note about circles and pipes is that a 24" pipe does not have twice the area of a 12" pipe. Because area is a function of the radius squared, a pipe with twice the diameter always has four times the area. You can take that one home and impress your kids.

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The **slope of the pipe** is also simply defined as the amount of fall divided by the amount of run. It is important to always use the same units when measuring the fall and the run, but other than that, this calculation is relatively bullet-proof. For example, a pipe that is 200 feet long and falls 2 feet from the upper end to the lower end has a slope of 2/200 or 0.01, which is the same as 1%. Due to circumstances beyond our control, pipes usually have dips and rises in between the upper end and lower end and do not travel on a laser line between those two points. If those dips and rises become excessive the actual capacity of the pipe could be very much different from what we calculate. For the purposes of this newsletter, we will assume that all pipes have a straight and consistent invert that proceeds directly from their upper to lower ends.

The **coefficient of friction** for a pipe is the measure of how much resistance the pipe surface offers to the flow of water. Pipes with a very smooth interior (glass, plastic, etc.) have a lower coefficient of friction than pipes with a rough interior (concrete, cast iron, etc.). An interesting point about the coefficient of friction is this: the gravity flow of fluid in the pipe is directly proportional to the coefficient of friction. For example, a pipe with a coefficient of friction of 0.01 will carry twice as much fluid (every other variable being equal) as a pipe with a

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This Issue's Quiz:

1) True or False:

Manning's Equation can accurately predict how many touchdowns Peyton will throw this sunday.

2) True or False:

The coefficient of friction for a pipe material is an indicator of how much resistance the pipe gives water as it passes through.

3) True or False:

The slope of the pipe is calculated by dividing the fall of the pipe by the length of the pipe.

4) True or False

The Hydraulic Radius is how tightly a pipe can be bent with a hydraulic jack.

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SIZING STORM WATER SYSTEMS (CONT.)

coefficient of 0.02. *Warning: the advanced class of newsletter readers should continue to read here, everyone else skip to the next paragraph, this next section could be dangerous to your mental health*....Oddly enough, the standard values used for the friction coefficient in Manning's Equation are all metric. You would think that Manning (who was an Irish engineer and died in 1897) would have English units on his coefficient, but he doesn't. Conversion from SI friction coefficients to BG units for the pipe flow is easy, just multiply by 1.49. If you don't, all your pipes will be too big. One of the variables in Manning's Equation is the Hydraulic Radius. The Hydraulic Radius is the Area of flow divided by the Wetted Perimeter. The Wetted Perimeter is the measurement of the feet of the perimeter that the water is touching for a given cross-sectional area. (If a circular pipe is full it is simply the diameter.)

Just for posterity, here is Manning's Equation:
Flowrate=(1.49*(Hydraulic Radius)^2/3*(Slope)^1/2*(Area))/FrictionCoef.

So, if you know the cross-sectional area, slope, and coefficient of friction for a given pipe, the capacity of said pipe can be calculated using Manning's Equation listed above.

The last piece of the puzzle for sizing pipes in a storm sewer network involves the design criteria for your system. In engineering "storm water land" we usually design pipes against a theoretical rainfall model that is supposed to mimic what might happen in the real world. There are several models to choose from, but the general idea is that the rainfall intensities and durations are represented by the model and the peak flow rate that the pipe must handle can be calculated using these models. The interesting part of this design process is that engineers don't usually size pipes to handle the ultimate expected flow in a gravity flow condition. The main reason is cost of infrastructure. The ultimate peak flow only has about a 1% chance of occurring in a given year and the cost of building the system to meet that requirement is very high. As a compromise, engineer's make sure that the overall system (grading of the site, pavements, inlets, pipes, and over-flow paths) can handle that 1% chance storm without flooding houses and damaging property, even if all of the water doesn't escape the site in pipes.

This is so much fun, I think we might continue next month, be safe....

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DABEC DIGEST

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STORM WATER SYSTEMS-CONTINUED

We have spent the last couple of months talking about storm sewers. In January we discussed run-off calculations and how to determine the peak flow a storm sewer network would have to carry from a defined watershed area. In February we talked about how to calculate the capacity of certain pipe to make sure it will handle that given flow. In this newsletter, we will discuss Grading Plans, Overflow Paths, and Routing Storm Water through your system. I bet you can't wait, so here we go.....

GRADING PLANS

The Grading Plan for a developing site is simply defined as the three-dimensional plan for that site. In other words, the Site Plan shows the two-dimensional location of everything on the site, but the Grading Plan shows its' vertical location, as well. For example, if you just looked at a Site Plan, you would be able to tell that the proposed building is 25 feet from the property line, but you wouldn't be able to tell that it is also five feet higher than the property line without looking at a Grading Plan.

Many people believe the only true priority of the Grading Plan is to "balance the dirt". (Balancing the dirt means that no earthen material will be hauled into or off the site during the contruction process.) While it's true that balancing the site usually reduces the construction cost, there are always many "balance" points for every site. For example, the site is "balanced" before any construction work takes place. In that case no excavation work takes place (and no construction activity), which is the lowest cost of all. Another example would be to turn every hill on the site into a valley, and turn every valley into a hill. The dirt would still "balance", but the construction cost would be very high. We prefer to minimize the excavation and fill (while balancing the site), rather than just balancing the site. In other words, try to find the minimum amount of excavation and fill that will satisfy the requirements of the development and still result in no haul out or import of earthen materials. That is much harder to do than just "balancing the site".

Another function of the Grading Plan (and the one this newsletter is focusing on), is to provide **clear storm water flow** with the **lowest construction cost** and **lowest maintenance cost** after construction.

Clear storm water flow is extremely important. If there is a blockage to storm water on the site it is very likely that some of the improvements, parking lots, roads, or other areas will flood without warning. Flooding homes, garages, parked cars, or washing out road ways is very expensive and must be avoided at all times. Damage to property is very costly, but in extreme flooding conditions people can be injured or even killed and that is the worst case scenario for designers everywhere. You might recall from our last newsletter that engineers don't typically design pipes to handle the peak design storm event. Because it is likely that more water will fall than the pipes can handle alone, and because pipes and inlets plug with debris and ice, the site designer must provide overland flow paths that protect property and life along the way. These paths are usually referred to as "**Overflow Paths**" and they are the primary method for ensuring a clear storm water path downstream until the storm water reaches the ocean. Virtually every inlet, pipe, depressional area, and other storm collection point must have an Overflow Path to protect the site against catastrophe.

The **lowest construction cost** is also a major factor that must be addressed during the design of the storm water system. Since money doesn't grow on trees (at least around here), most developers and property owners prefer to get the biggest "bang for their buck" when building storm water systems. Installing unnecessary, redundant, or over-sized piping systems burns a lot of money, so efficient storm sewer systems are a must when trying to keep the cost down. The grading plan and the piping plan must work together to complete an efficient, low-cost solution for draining a site. Sometimes, however, the lowest construction cost can be very expensive over time in the form of maintenance.

Imagine building a house and keeping the construction cost down

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This Issue's Quiz:

1) True or False:

Balancing the dirt on a construction site always yields the lowest excavation cost.

2) True or False:

There is very little maintenance expense associated with a storm system.

3) True or False:

The Grading Plan is the three-dimensional plan for the site construction of a project.

4) True or False

I read the routing storm water section of the newsletter and I wish I hadn't, because now I have a head ache.

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STORM WATER SYSTEMS (CONT.)

by not installing insulation. The construction cost will be really low compared to the next-door neighbor's house, but over time that low construction cost will lead to an extremely high maintenance cost that will eventually result in a life cycle cost that is much higher than the neighbor's insulated house. You might be wondering how much maintenance there can be if the storm sewer system isn't designed or installed correctly. Here are some problems that can arise: un-mowable wet-spots, dead landscaping, pavements deteriorating due to flooded subgrade, wet basements, plugged pipes that need cleaning regularly, and un-predicted localized flooding damage. The old adage "an ounce of prevention is worth a pound of cure" is very true when it comes to storm water systems.

ROUTING STORM WATER THROUGH THE SYSTEM

This an another extra-credit section to the newsletter. The material in the next couple paragraphs will not be on the final exam, so don't bother reading this unless you want to.....

You might recall that time is a major factor in determining the required capacity of any storm water system. In particular, you might remember a key variable called the "Time of Concentration (Tc)" from earlier newsletters. The Tc coupled with the travel time of the storm water in the system gives us an indication of the longest time it takes a drop of run-off to travel from the furthest point in our development to the discharge point of our system. The routing factor comes into play at the intermediate pick-up points along the system route.

I believe the easiest way to understand this is to imagine the Mississippi River watershed. If the entire watershed had a consistent rainfall occur over it at the same time, the water that fell on New Orleans would already be in the Gulf by the time the water that fell on Minneapolis even got to the state line. Keeping this thought in mind, you should be able to see that all flows within the system are not purely additive. In other words, the water that is upstream in a system and the water that is downstream in a system do not have to be in the collection system at the same time because they are separated by travel time in the watershed. As sites get smaller, this factor becomes almost negligible. As they become very large, this factor becomes very important in the calculations.

As always, this has been fun. (At least for me....) If you have any questions you'd like to have answered, give me a call. Otherwise, we'll see you next month. Be safe.

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DABEC DIGEST
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CONCRETE MIXES AND DELIVERY-101

If you haven't seen a concrete delivery truck running on the roads lately, you haven't been on the roads lately. The big trucks with the spinning barrels on them run almost year-round in this area delivering batches of ready-mix concrete to construction sites for a wide variety of uses. In fact, the batch concrete in the trucks is also made up of a wide variety of mixes for those uses. We are going to spend some time talking about concrete over the next few issues. Buckle your safety belts and hang on.....

CONCRETE, OR CEMENT?

The first thing we have to do is a little vocabulary lesson. I'm sure you have all heard someone (or even yourself) refer to concrete as "cement". The truth of the matter is that cement is one of the ingredients in concrete. While we would never refer to bread as flour (or yeast), it is not unusual to hear someone call concrete "cement". Concrete is a mixture of several ingredients (which vary depending on the intended use and wearability of the final product). Generally speaking, all concrete will consist of: sand (fine aggregate), gravel (larger aggregate), cement, and water. It is not unusual to add components to this basic mix to generate a concrete that will perform properly for a specific function (called an admixture), but these other additives do not transform concrete into another material, they just enhance certain properties of concrete.

HOW DOES IT WORK?

Fluid, flexible concrete (in the truck or the mixer) becomes hard, inflexible concrete through a chemical reaction between the cement and the water in the mix. If the mix doesn't contain cement, you will only get wet sand and gravel. If the mix is completely dry, it will continue to be dry components forever. (Just like Sack-crete at the lumber yard.)

In essence, water turns cement into glue. When the "glue" comes into contact with clean aggregate it bonds to it. When the "glue" dries, a strong matrix is formed between the particles in the mix. That matrix is useful for all kinds of building projects.

WHAT MAKES CONCRETE SO STRONG?

Within concrete are large particles, medium particles, and small particles. If the mix of particles (aggregate) is correct, the air gap between the mixed particles will be very small. That air gap is where the cement/water mixture makes its home and binds the aggregate together. If the aggregate is clean and strong before it is mixed with the cement and water it will form a very strong bond with the cement. The strength of that bond and the strength of the aggregate is what makes concrete so durable.

Concrete does have a weakness, however. You have probably never seen a concrete rope, or a concrete chain. The main reason people don't use concrete ropes (aside from their lack of flexibility) is that concrete has very little tensile strength. Tensile strength is the ability of a material to resist breaking or stretching when a tensile load is applied to it. In other words, if you pull on concrete it will break.

On the other hand, concrete has an incredibly high compressive strength. Compressive strength is the ability of a material to resist breaking or deforming under a compressive load. In other words, concrete is very hard to smash or squeeze. Normal, every day concrete typically has a compressive strength in the neighborhood of 4,000 lbs per sq inch!

CONSTRUCTION SITE CONCRETE

Unless the concrete is mixed on site, the first step is to call a ready-mix plant with an order for the concrete. Mix specifications have to be given at the time of ordering. The mix specifications usually include the aggregate type and size to use, the type of cement (there are 5 types of Portland cement), and the ultimate strength requirement (or the amount of cement to include in the mix).

If you have never ordered concrete before, it might surprise you that there are so many options. Ordering concrete is a lot like ordering a pizza. You know you're going to get crust, pizza sauce, and cheese, but the rest of it can vary wildly. Similarly, if you called up the pizza joint and told them you wanted a

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This Issue's Quiz:

1) True or False:

A lot of people have a cement parking lot and sidewalk at their house.

2) True or False:

Concrete hardens through a chemical reaction.

3) True or False:

Concrete has excellent tensile strength properties, but poor compressive strength.

4) True or False

Slump is the technical definition for the posture of the person driving the concrete delivery truck.

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CONCRETE MIXES AND DELIVERY (CONT.)

couple pizzas delivered, they would probably ask a bunch of questions to find out exactly what you want (number and type). Another way ordering concrete is like ordering pizza is that most people around here order just a couple of variations on the main theme, and the people that order shrimp and pineapple are few and far between.

I think it's safe to say that the majority of slab-type concrete (parking lots, driveways, garage slabs, patios, and other visible slabs) construction in this area is composed of 4,000 psi limestone concrete. The limestone designation is for the type of aggregate in the mix. Around here you can typically order native stone or limestone. Most people order limestone for visible slabs because it is a pretty white color and it finishes well. Unfortunately, it costs a little more than native stone concrete, so native stone concrete is frequently used for foundations and un-seen slab work (under the carpet, tile, etc.). Additionally, native stone concrete it typically more porous than limestone concrete and can pop in the winter when absorbed water freezes.

Concrete is normally shipped in the truck with the bare minimum amount of water in the mix. It is important to place and work concrete with the minimum amount of water necessary for forming and finishing to maintain as much of the inherent strength of the mix as possible. Excess water in the mix sits inside the concrete matrix and evaporates over time leaving voids in the concrete. These voids create weaknesses and places for water to be transmitted through the concrete. Having too much water in the mix will also tend to create a sloppy surface condition and the fine aggregate in the mix will tend to float to the surface and create a weak, porous surface condition which will drastically reduce the wearability of the surface.

The amount of water in a batch of concrete is indicated by something called "slump". The higher the slump value, the wetter the mix. Slump is measured using an inverted cone (with 8" bottom diameter, 4" top diameter, and 12" height), a board or other flat surface, and a tamping rod. The inverted cone is placed on the board and filled with tamped concrete. Once filled, the cone is removed vertically and the concrete is allowed to slump. The height of the top of the pile of concrete is measured and subtracted from the initial height of 12". The result of that subtraction is known as the slump of that mixture (typically between 3 and 6 inches). A mixture with a slump of 3" would be 9" tall on the board.

Wow, this could take a while. Bring your yellow boots next month to keep the concrete off your jeans. See you then....

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DABEC DIGEST
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CONCRETE INSTALLATION-101

Wow, it's hard for me to believe it's been a month since the last newsletter. Frankly, it seems like a year or two to me. Anyway, it's time to get back in the groove and carry on with our study of concrete. This month (if you haven't guessed) we are going to talk about installing concrete on the job site. Here goes...

FOUNDATIONS

It only seems right to work from the bottom up, so we'll start with foundations. Appropriately named, foundations are designed to provide a solid base for the structure proposed for construction. Foundations need to be installed in such a way that freezing the ground around them will not cause them to move upward and settle later. They also must be heavy enough to resist uplift which occurs primarily from windloads on the structure. And lastly, they have to able to resist loading from the structure and the ground and not settle.

It is almost a cliche, but without a properly designed and installed foundation, the rest of the structure is at risk (along with everyone in it and around it). Since most foundations are out of sight (and out of mind), it is easy to not place as much emphasis on the proper construction of foundations as we should.

Typically, foundations in this area are called trench footings or spread footings. The idea behind both is the same. An excavator digs a trench (of appropriate width and depth) and the side walls and bottom of the trench actually become the forms for the foundation. We can do this around here because our clay type soils can maintain a vertical side wall (at least for a while). In sandy areas forms are frequently used because the side walls will collapse and mess up the job.

When excavating the trench special attention must be paid to the width of the trench, the depth of the trench, and the condition of the bottom of the trench. If the trench is too narrow, the strength will not be as required, if it is too wide money is wasted on concrete and excavation that isn't necessary. If the trench is too shallow, frost can heave the structure, if it is too deep, money is wasted again. And lastly, if the bottom of the trench is covered with uncompacted crumbs from the excavation, the foundation will settle (usually unevenly).

After the foundation is excavated, insulation is usually installed on the inside of the foundation to prevent as much heat loss as possible through the foundation. Most foundations also require re-inforcing steel, which is either tied into the trench in its appropriate location, or installed with the concrete. Additional reinforcing steel is also used to tie the foundation to the structure above. This steel is actually partially buried in the foundation and partially exposed above to be attached to the structure, whether it be block, wood, steel, or more concrete.

After all this preparatory work is complete and an inspector has come out to make sure the work is correct, the concrete is delivered on the batch truck.

Foundation concrete is usually the least labor-intensive of all concrete work. If the truck can drive up to the foundation, it will simply pull up and fill the trench to the appropriate elevation. The concrete crew will then vibrate or shake down the concrete to make sure there are no major voids in the foundation and minimally float the surface to make sure it is level and at the correct elevation for future work.

SPECIAL DELIVERY

Sometimes, the truck can't drive up to the area that needs concrete. In these cases there are several other methods for getting the concrete to the trench.

Most commonly, the concrete is carried from the truck and dumped in the area under construction. There are several ways to carry the concrete including: buckets, shovels, skid-steer loaders, and skip buckets on cranes. When dumping the concrete into the work area (including out of the truck) special care must be taken to not dump it too far. As you recall, the strength of concrete lies in its matrix construction, which occurs only when the fine aggregate and coarse aggregate are evenly distributed through the mix. If concrete drops too far, the larger aggregate tends to fall to the bottom and the smaller aggregate tends to rise to the top and some of the strength is lost.

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This Issue's Quiz:

1) True or False:

Since no one can see the foundation, it doesn't really matter how carefully it is constructed.

2) True or False:

There is usually more hand labor involved in installing foundations than slabs.

3) True or False:

Dumping concrete out of a truck several feet down into a foundation hole will reduce the structural properties of the mix.

4) True or False

Screeding is another term for scraping off to grade.

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CONCRETE INSTALLATION (CONT.)

Usually, if concrete is going to be dropped from a bucket or chute a long distance an "elephant trunk" called a tremie is attached to the bucket or chute to keep the batch together and reduce the effect of the fall.

Concrete can also be transported from the batch truck to the work site by a concrete pumping truck. These trucks are basically a large concrete pump with a long boom on wheels. The batch truck dumps the concrete into a hopper on the pumper and it pumps the concrete through the boom to the work site.

BASEMENT (OR FOUNDATION) WALLS

Concrete wall construction is very much like trenched foundation construction, except that the forms for the walls have to be installed in their correct location horizontally and vertically (and usually on top of the foundations poured earlier). Concrete mix is placed inside the forms, vibrated to reduce voids and to get a good bond with the reinforcing steel, and the top is floated to provide a smooth, level work surface. Usually, there will be steel sticking out of the top of the walls for connection to future construction, wood, block, steel, or more concrete.

CONCRETE FLATWORK

Flatwork is basically all slabs, sidewalks, etc. that are wider than they are deep. Flatwork usually is the most labor intensive of all concrete installation, because it requires the most attention after it leaves the truck. Forms are usually set up for the edges of the slab to maintain grade and thickness and steel is usually placed to hold the slab together. Concrete is placed within the forms by the truck driver and the crew "screeds" off the concrete to the top of the forms with a straight board or other method. After it is screeded (scraped) off, the surface is typically floated, which brings the fines to the surface and levels it even more. The edges then have to be worked to smooth them down and after an appropriate set time, a power trowel is frequently applied to the surface to smooth it even more and provide a denser surface finish to resist wear and water. Sometimes the surface of the concrete is brushed to make it less slippery when wet. Within about 24 hours of placing the concrete, the surface must be cut on regular intervals to prevent irregular cracking. The concrete will crack no matter what you do, so the cuts (at least 1/3 of the total thickness) provide a place for the cracks to be and keep the surface clean and presentable.

We'll hit concrete at least one more time next month, I think. Take care until then.

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DABEC DIGEST
volume 4, issue 6 june, 2005

CONCRETE INSTALLATION-201

We've spent a couple months on concrete basics, here is an issue that goes into more depth on some specialty concrete uses and installations. You will notice that the class title has been changed to "201" to reflect the advanced subject matter. Congratulations to everyone for graduating to this higher level study matter.

PRE-CAST CONCRETE

"Pre-cast concrete" is a generic term used by construction people to describe virtually every concrete product that is cast into a form somewhere other than the job-site. (Usually a factory environment.)

The idea to create masonry units offsite and ship the finished product to a construction site is an old idea. Bricks have been around for a really long time and may be considered to be the building blocks (forgive me) upon which modern pre-cast concrete was built.

Pre-cast concrete comes in many shapes and sizes. Perhaps the most common are CMUs (Concrete Masonry Units), which many people refer to as concrete blocks. These concrete blocks look a lot like really big white/gray bricks from the side, but when viewed from the top they are quite different.

SELECTED UTILITY USES

Pre-cast concrete is also widely used in the utility industry. Pre-cast concrete manholes and inlets are installed on almost every job-site to allow for underground pipe and conduit junctions and access for maintenance. Additionally, pre-cast concrete is used for a wide variety of underground tanks, including many septic tanks installed every day.

One of the advantages in using pre-cast concrete in these methods is reduced construction time. Not all that long ago, when pre-cast manholes weren't available, many manholes were built on site using bricks. You can imagine how much longer it would take to build a manhole from scratch on site with bricks than simply lowering some manhole sections into place.

Another advantage of using pre-cast concrete in this manner is consistency. Manhole dimensions can be specified by the engineer and each manhole should conform to those dimensions and match the manholes upstream and downstream to facilitate maintenance and replacement at a later date if necessary. Brick manholes are rarely the same size as each other which can make both of these tasks very difficult.

The last big advantage of using pre-cast concrete structures underground that we will discuss is infiltration. Infiltration means ground water seeping into the utility path. Every place a joint occurs in that utility is another place water can seep in. Consider how many joints there are in a brick manhole. Now, consider how few joints there are in a pre-cast concrete manhole.

Pre-cast concrete pipe is also used all over the country to convey storm water and waste water for various utility uses.

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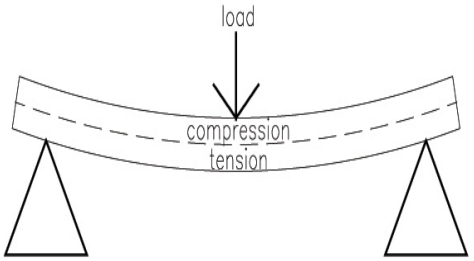
Concrete pipe is very strong and durable and tends to have a lower maintenance cost when used under the correct conditions. When concrete pipe is used for sanitary sewer systems it is usually lined with an agent that is resistant to certain kinds of corrosion to protect the concrete because some of the gases in sanitary sewerage can degrade the concrete and cause it to fail.

Pre-cast concrete pipe is generally not used for water supply, because pressure in the pipe causes the pipe to stretch (go into a tension loading area), and since concrete doesn't stretch well, it tends to break.

PRE-TENSIONED CONCRETE

Which leads us to our next topic. How can a material with virtually no tensile strength be used as a bridge material. When examining a typical "slab" bridge, approximately half of the slab is in tension, while the other half is in compression.



We all know by now that concrete is very good in compression and very bad in tension.

Sometimes bridges are designed with steel on the bottom (very good in tension) and concrete on the top (very good in compression). How-

potpourri

Congratulations go out to last month's winners. Get your answers in for your chance to win!!!!!

This Issue's Quiz:

1) True or False:

The idea of using pre-cast masonry for building purposes is a new one.

2) True or False:

Brick manholes are likely to have less infiltration than pre-cast concrete manholes.

3) True or False:

Concrete pipes are good conduits for municipal water supply due to their durable material properties.

4) True or False

Concrete has excellent tensile strength and very poor compressive strength.

Fax or email your answers to Brian at D. A. Brown Engineering Consultants by June 30, 2005 for a chance to win valuable DABEC Merchandise.

CONCRETE INSTALLATION (CONT.)

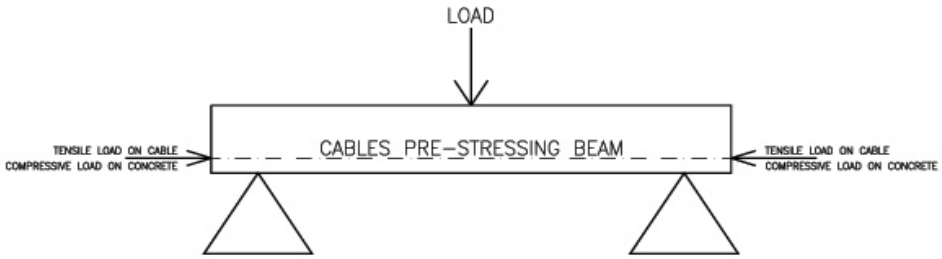
ever, there are also a huge number of bridges that don't appear to have any steel structural members at all. How do they do that?

Engineers to the rescue! Concrete has wonderful weatherability properties, which is very important when you're talking about bridges. I'm sure you've heard about lead paint and hazardous clean-up before. Most of the older bridges in the US are (or have been) painted with lead paint and it's a mess cleaning it up. Unfortunately, most of the alternative paints don't last as long as lead paint, so the maintenance cost is going up.

Concrete doesn't rust, but it doesn't support tensile loads, either. When you're designing a "slab" bridge, you're going to have tensile loads. Pre-tensioned, pre-cast concrete is how engineers got around that problem.

After a ton (pardon me again) of design work to determine the appropriate cross-sections, a form is built in which to pour the structural concrete member (aka, the beam that will support the bridge). These members usually have a "T" or "I" cross-section. This is where the fun part begins.

A pre-determined number of (usually steel) cables are run length-wise through the form and through the ends of the forms. Then the cables are stretched to a pre-determined load. After the cables are tight, high-strength concrete is poured into the form and vibrated appropriately to generate a good bond between the cables and the concrete. After the concrete has set, the ends of the cables are released. When the cables try to return to the natural length, the concrete resists and the end result is that the concrete is put into a compressed loading state. As long as the bridge loading doesn't exceed the pre-loaded compression state the concrete will remain in a compressed state. Here is a diagram to try to clear this up:



And, one final thought, similar loading can be done after the beam is poured if tubes are left in the concrete for the cables to be stretched in. That is called post-tensioning, rather than pre-tensioned (or stressed).

See you next month.

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DABEC DIGEST

volume 4, issue 7 july, 2004

HOW ABOUT SOME ASPHALT...

Well, we spent the last three months talking about concrete. In the traditions of the great debates, we are going to spend nearly equal time talking about asphalt. This month will be the beginner's course and next month we will start to go a little more in depth.

WHAT IS ASPHALT?

Asphalt is a flexible paving material. Flexible is a relative term, of course. Compared to a wet noodle, asphalt is quite rigid. The reason asphalt is considered to be a flexible paving material is that it has the inherent capability to conform to its support system over time without catastrophically failing. Some paving materials (like concrete) are rigid, which means that they break instead of bend.

Flexibility can be a very useful property in a paving material. Flexible pavement can "rebound" from loading situations and regain nearly its same shape while an inflexible pavement might break. Flexibility can also lead to some problems, such as rutting when tire loads push the pavement out and leave a trench in the pavement.

Asphalt has remarkably similar components to concrete. Just like concrete, the largest single component in asphalt pavement is aggregate. As you will recall, aggregate is the technical name for rocks, stone, sand and/or gravel.

Also just like concrete, asphalt has a "glue" that holds the aggregate matrix together. The glue in asphalt is "asphalt". Asphalt is a component of crude oil. After the other useful products are removed from crude oil in the fractional distillation process, asphalt remains. Asphalt is actually a solid at room temperature and becomes liquid only when heated. Thus, asphalt pavements are hot when applied to the road-bed.

Asphalt can also be referred to as: Asphalt Cement, Asphalt Binder, or just plain Binder. As you would imagine, all Asphalt is not created equal (just like you can get different grades of gasoline at the gas station). Binder is generally specified by a set of letters and numbers. The first letters in the specification are "PG", "AC", "PEN", or "AR". PG is the newer standard of the four and is the one generally used for specifying Binder at this time. "PG" stands for "Performance Grade" and is generally associated with Superpave Design Mix (which we will discuss later).

PG classifications indicate the temperature performance range for the binder. As we mentioned earlier, asphalt is temperature sensitive. As it heats up, it becomes liquid. Liquid pavements do not have the same resistance to tire loading that solid pavements have. In addition, as it cools down it becomes brittle. A brittle pavement will crack instead of deflect which also causes problems.

The beautiful thing about the PG system of classifying binder is that it gives the engineer, buyer, and/

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DABEC GOLF INVITATIONAL

Some of you probably thought I forgot about our tournament this year. I'm ashamed to admit that I have been too busy with work this year to focus much time on golf (is that even possible?). However, by popular demand, we will be hosting the Fifth Annual DABEC Invitational on Friday August 26, 2005 at 12:30 pm at Noble Hawk Golf Links in Kendallville, IN.

The format for the tournament will be 4 person Florida Scramble and it will cost $200 per team to enter. Team winners will be paid in cash, there will be proximity prizes all over the course and lunch and dinner will be provided at the tournament. Use the registration form below to register your team. Registrations and entry fees must be received by August 19, 2005.

TEAM MEMBERS

_____

_____

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_____

PHONE:_____

___ I am interested in sponsoring a hole for the tournament.

potpourri

Congratulations go out to last month's winners. Get your answers in for your chance to win!!!!!

This Issue's Quiz:

1) True or False:

Asphalt is a derivative of crude oil.

2) True or False:

Asphalt cement, asphalt, asphalt binder, and binder can all refer to the same thing.

3) True or False:

Asphalt is a runny liquid at room temperature.

4) True or False

Asphalt generally loses strength at higher temperature and becomes brittle at lower temperatures.

Fax or email your answers to Brian at D. A. Brown Engineering Consultants by July 31, 2005 for a chance to win valuable DABEC Merchandise.

HOW ABOUT SOME ASPHALT (CONT)

or contractor the ability to select a binder that is tailor-made to their particular climate, which brings us to the last part of the identification sequence-the numbers. Each Performance Graded binder classification ends in two numbers. The first one is the maximum expected seven-day average pavement temperature and the second one is the minimum expected seven-day average pavement temperature. For example, PG 58-28 has a performance range from 28 degrees Celsius to 58 degrees Celsius. As you would expect, pavements in Minnesota will require a lower operating range than pavements in Florida.

BASIC INSTALLATION

The first step in placing asphalt is ordering asphalt from the plant. The mix design of asphalt will vary depending on the intended use for the pavement. Home driveways and airport taxiways will likely require different asphalt mixes. We will talk about mix design next month.

After the order is placed and the trucks full of hot asphalt arrive it has to be placed on the sub-grade in proper thickness and location. The thickness of the individual lifts is very important. The reason for this is that the asphalt must be compacted to remove voids in the mix and provide for a good, solid matrix of stone joined by the binder. If the asphalt is dumped out of the back of the truck and rolled when it is too thick, the bottom layers of asphalt don't receive any compaction because the top "bridges" and protects it from the roller.

Asphalt paving machines are designed to prevent this from happening and to provide a smooth, consistent driving surface. The paving machine generally has a large hopper on the front that can be loaded directly from the truck or from another transfer machine. The hopper then discharges the asphalt mix onto the road-bed and the machine levels the surface and controls the depth of lift.

When the surface of the asphalt is the appropriate temperature, compacting rollers will roll over the surface. These rollers work the asphalt and smash it together to give it the appropriate strength and resistance to rutting from traffic (which also compacts the asphalt).

Well, believe me when I say we are just getting started with asphalt. Next month we'll go into more depth and continue this discussion. Don't forget to enter your golf teams in our tournament, which is introduced in the side-bar on page 1. See you next month....

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DABEC DIGEST

volume 4, issue 8 july, 2005

HOW ABOUT SOME MORE ASPHALT...

Buckle your seat belts, we're going to drive through this article about asphalt and compress as much information into these two pages as possible. (Multiple apologies for multiple puns...)

ASPHALT PAVEMENTS

You will recall from our concrete issues that concrete pavements are typically poured full-depth at one time. You will also note from the last article that asphalt pavements are generally installed in "lifts". This is a significant difference between these two pavement types. Concrete will generally have the same structural characteristics at the bottom of the slab as it does at the top of the slab. (Since it is all from the same mix.) Asphalt pavements can have a different mix, compaction, binder, or other factor for each lift of the pavement.

In other words, asphalt is like a layered cake. The bottom layer can be chocolate, the middle layer lemon, and the top layer vanilla. (With binding icing between each layer to hold it together.) Concrete is more like a very stiff jello. You mix it together, pour it in the mold and let it set up. The bottom of the jello will taste just like the top.

The ability to specify different pavement types for different depths is one of the strengths of asphalt. Larger stone typically provides an asphalt mix that is more resistant to rutting, but it also makes a rougher finish and is not conducive to being used as a driving surface. On the other hand, a mix that is largely made up of smaller aggregate provides a smoother surface and more resistance to water penetration, but it may lack resistance to rutting. A pavement cross-section that is completely one or the other will not function as well as a pavement cross-section that contains both.

Therefore, it is normal in the asphalt paving business to have at least two different mixes coming to the job-site for the same pavement. The majority of the pavement thickness is usually made up of a stronger mix that is resistant to rutting, but will have a rougher surface and the top of that layer is covered with a finish course that has a smoother finish but less resistance to rutting.

In fact, if we go back to our layer cake analysis, most asphalt pavements have at least two layers (while a good proportion will have three). The two-layer cakes will normally have a three-inch bottom layer and a one-inch top layer with a tack-coat in between. The three-layer cakes are typically used in higher stress situations and can vary widely. However, normally the bottom two layers will be the same material, placed at different times (lifts), and the top layer will look a lot like the two layer cakes above.

The bottom layers are typically referred to as "base" courses, or "binder" courses. The top layer is usually referred to as a "finish" or

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DABEC GOLF INVITATIONAL

This is your last reminder to enter a golf team in this year's Invitational.

If you have any questions, don't hesitate to give me (Brian) a call.

The format for the tournament will be 4 person Florida Scramble and it will cost $200 per team to enter. Team winners will be paid in cash, there will be proximity prizes all over the course and lunch and dinner will be provided at the tournament. Use the registration form below to register your team. Registrations and entry fees must be received by August 19, 2005.

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PHONE:_____

___ I am interested in sponsoring a hole for the tournament.

potpourri

Congratulations go out to last month's winners. Get your answers in for your chance to win!!!!!

This Issue's Quiz:

1) True or False:

Asphalt pavements always have the same mix from the top to the bottom.

2) True or False:

It is not unusual to have two layers of different composition asphalt in a pavement section.

3) True or False:

Superpave is a really strong type of asphalt used on highways.

4) True or False

Superpave is a standardized method of designing asphalt pavements to acheive the desired performance.

Fax or email your answers to Brian at D. A. Brown Engineering Consultants by Aug. 31, 2005 for a chance to win valuable DABEC Merchandise.

HOW ABOUT SOME MORE ASPHALT (CONT)

"surface" course.

MIX DESIGNS

Here is where asphalt gets really interesting, and we are going to go back to cake (I'm starting to get hungry). How many different kinds of cake are there? There are probably just as many kinds of asphalt mixes. No, I'm not kidding. In fact, new kinds of asphalt mixes are being developed everyday. You might have been driving on a section of asphalt pavement lately and noticed a sign that said something like "Test Section". Those sections of pavement are generally new mix designs that are going through final "real-world" tests before being implemented on a wider scale throughout the region where they are being tested.

We can't talk about mix design without talking about something called "Superpave". Superpave is the name for a specific method of designing asphalt mixes. It is not the name of a specific mix of asphalt pavement. Superpave method has made it possible to accomplish two major tasks in the asphalt construction world.

The first accomplishment is that Superpave has standardized design methods and provides for more consistent results in the asphalt pavement. Prior to Superpave, there were a lot of different mixes used in different areas that had more inconsistent properties when placed on the road projects. This led to some disappointment in the performance of the pavement (which caused the development of Superpave in the first place).

Another major value to the Superpave design method is that the laboratory testing results more closely mimics the traffic loading for the pavements. Superpave method requires specific compaction methods, temperatures, etc. in the laboratory to accurately reflect what happens to the pavement after it leaves the plant. The results are that those "Test Sections" you see on the highway are more likely to perform adequately after going through the Superpave process. That means that less time is required to bring a good mix design to the construction industry and that the pavements we are putting down today are much less likely to fail tomorrow.

Thanks for wading through that with me, we might do some more asphalt next month. Don't forget to enter your golf team in the Open, deadline is coming up fast. See you next month, I'm going to go find some cake :-))

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DABEC DIGEST

volume 4, issue 9 sept, 2005

WHY IS FLOODING A BIG DEAL?

In honor of Katrina, I thought it would be a good idea to talk about flooding damage, remediation efforts, and the wide-spread chaos a "little" water can cause.

OBVIOUS PROBLEMS

I am splitting this discussion into two parts. Clearly the first part is "Obvious Problems". This section will briefly discuss the major issues most of us would recognize immediately as problems with flooding, but may not think of all of them at once.

Drowning. All engineers must first consider risk to human life in the course of designing any system, machine, or product. In this case, the first and most immediate major consequence of flooding can be the loss of human life. Whenever water is introduced into areas that are normally dry, drowning can result. The flooding doesn't even have to be as major and widespread as we have seen in Katrina's wake. An unexpected inch of water over a highway next to a full ditch, stream, or lake can result in fatalities as cars hydroplane off the road and end up in the water.

Personal property damage. This category includes property outside the house as well as property inside the house, and the house itself. Cars, mowers, tools, etc. that spend any length of time under water are usually ruined. Inside the house, personal property like pictures, artwork, clothing, electronics, appliances and furniture are all likely to be completely destroyed by spending any length of time under water.

The house itself will also sustain major damage. Carpet, wall finishes and drywall (or plaster) will probably be the first to go. Next will be wood finishing products and cabinets and countertops. If the house spends enough time underwater, the structural elements of the house can be damaged. Mortar, wood joists, wood flooring, and insulation will all be destroyed.

There are two major problems with flood water that we don't usually consider when imagining the damage to personal property. The first issue is that flood water is not clean. When an area floods, small dirt particles are picked up in the water and deposited wherever the water goes. Bacteria, molds, and animals are also moved around in the water and deposited in other places. The second issue is that flood waters are rarely stagnant. In other words, as the water rises vertically, it is also usually moving horizontally. The ebb and flow of water against structures, through houses, and across property causes major damage by pushing homes off foundations, smashing floating debris into property, and carrying sediment into areas where sediment shouldn't be.

LESS OBVIOUS PROBLEMS

You will recall from previous issues that some soils shrink and swell depending on how much water

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DABEC GOLF INVITATIONAL RESULTS

On a lighter note, we had our golf invitational on August 26th, the weather was awesome, we played through in just over 4 hours, and the food was great. (All three major components to having a good time at a golf outing:-))

This year's victorious team was Fitch, Inc. whose players were:

Mike Fitch

Larry Fitch

Rick Fitch

Luke Fitch

In addition to winning the tournament, they also won two skins, including a double eagle on the par 5 Hole #16. (That's right, folks, they made a two on a par five.)

Thanks again to everyone that competed in our tournament. We really appreciate your partnership with us during the year and look forward to hosting you on the golf course again next year...

potpourri

Congratulations go out to last month's winners. Get your answers in for your chance to win!!!!!

This Issue's Quiz:

1) True or False:

Loss of human life is usually the first concern of engineers designing systems for human use.

2) True or False:

The sediment and microbes carried by flood water cause major problems.

3) True or False:

Flood-saturated soils can result in structural damage to improvements on the property.

4) True or False

Virtually all utility pipes will have to be cleaned to remove sediment from the lines.

Fax or email your answers to Brian at D. A. Brown Engineering Consultants by Sep. 30, 2005 for a chance to win valuable DABEC Merchandise.

WHY IS FLOODING A BIG DEAL? (CONT)

is in the soil. Since almost all permanent improvements in a town (houses, streets, water supply, sanitary sewer, storm pipes, etc.) touch the soil, if it moves it can negatively impact those improvements. Soil expansion can heave pavements, disconnect pipe segments underground, lift corners of houses, and cause other very nasty problems.

You will also recall that a soil's strength can be completely lost if it gets wet. Permeating the soils that are supporting the infrastructure of a city can cause unbelievable structural damage in roads, buildings, and utility services in the right conditions.

Utility services are especially sensitive to flooding problems. Water treatment plants (which provide drinking water to the population) have to be maintained almost like an operating room for cleanliness and functionality. Filling the treatment plant with bacteria and sediment-laden water causes huge problems and enormous clean-up costs to get the plant back into a functional state. The water mains themselves will also have to be cleaned out once the plant is functional again. Water mains rely on flow and internal pressure to keep the drinking water clean for drinking. When the internal pressure drops (which will inevitably happen when a town floods) water outside the pipe can get into the pipe. That water is dirty, which contaminates the system. The system has to be flushed and tested to make sure no dangerous bacteria are present before it is put back into service.

Sanitary sewer services will probably be harder to bring back on line. Waste water treatment plants are very delicate environments. Introduction of foreign material and flushing of the treatment system can cause the whole system to fail and require a significant length of time before the plant is fully functional again. Additionally, the flood will leave substantial amounts of sediment in the sewer lines (just like the houses). That sediment will prevent the lines from transporting the sewage from the homes to the plant. Most of the lines will have to be water-jet cleaned after the plant is back on line in order to remove the sediment (which will tax the treatment plant when treating all of the dirty water).

Storm pipes and pumping stations will also have significant sediment deposits in them that will have to be cleaned out as part of the renovation project. All that mud will make a mess wherever it ends up as part of the clean-up project.

Keep the people of Lousiana and Mississippi in your prayers. See you next month.....

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DABEC DIGEST

volume 4, issue 10 oct, 2005

EARTHQUAKE, ANYONE?

Wow, this has been the summer of natural disasters, hasn't it? Since the last newsletter (less than a month) Texas has been hit with a major hurricane (Rita), and this past weekend was the major earthquake (7.6 magnitude) that decimated Muzaffarabad, Pakistan.

EARTHQUAKE CLASSIFICATION

First of all, let's talk about the severity of earthquakes. We all hear the numbers on the radio and tv, but what do they really mean?

The "Richter Scale" is the generally accepted method of classifying the intensity (or magnitude) of an earthquake. In order to classify an earthquake with a certain Richter Scale number, measurements of the amplitude of the earth movement must be made by calibrated seismographs. Basically, these seismographs measure vibrations in the earth's crust. (Interestingly enough, a major earthquake on the other side of the world will likely be measured by seismographs on this side of the world, they are that sensitive.) Once the seismographs record the information, and adjustments are made for distance from the epicenter (the "center" of the earthquake) a Richter Scale number can be calculated for the event.

The Richter Scale is logarithmic, which means that a quake with a magnitude number of 4 actually has an amplitude 10 times higher than a quake with an amplitude of 3. (Amplitude is the vertical displacement of the earth's crust during the quake.) In other words, a quake classified with a Richter Scale magnitude of 7 has an amplitude 1000 times greater than a quake with a magnitude of 4.

Amplitude of the shock wave is not the only possible measure of earthquakes we can get from the Richter Scale number, however. It also turns out that with each whole number increase in Scale, the quake releases about 31 times more energy. (In other words, a "7" releases about 30,000 times more energy than a "4".)

The USGS website indicates that there are several thousand earthquakes every year world-wide that have a magnitude higher than 4.5.

WHAT'S THE BIG DEAL?

Major earthquakes (higher than 7.0) that occur in densely populated areas are vicious killers. The initial death toll for the quake in Pakistan may be as high as 40,000 people. The actual death toll within a year after the quake is hard to estimate. (To put that in perspective, approximately 70,000 people died within the year after the atomic bombing of Nagasaki near the end of WWII.) As always, engineers are most concerned with the preservation of human life. Therefore, we must design building and other systems in earthquake-prone areas to be as resilient to this kind of devastation as possible.

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WHAT EXACTLY DOES ACCELERATION HAVE TO DO WITH FORCE?

This will be a trip down memory lane for many of you, bringing back suppressed memories of your high school physics class.

Force is always equal to the mass times the acceleration:

F=mA

When you step on the scale in the bathroom, it measures the force of your mass at the acceleration rate of earth's gravity. If you moved the scale to the moon and stepped on it, it would indicate that you lost about 83% of your weight overnight. The normal acceleration of earth's gravitational pull (near the earth's surface) is about 32.2 ft/sec^2. So, if the scale says 200 lbf, your mass would be 6.21 slugs (or 200 lbm-which is weird, but a special thanks goes out to the english dude who named all this stuff).

If the earth moves horizontally with an acceleration rate of 40 ft/sec^2 and a building is attached to it, you should be able to see that the combination of the downward gravitational force and the sideways earthquake force will result in a huge loading on the building in a direction that it may not be designed for. In other words, bad things happen.

potpourri

Congratulations go out to last month's winners. Get your answers in for your chance to win!!!!!

This Issue's Quiz:

1) True or False:

Loss of human life is usually the first concern of engineers designing systems for human use.

2) True or False:

An earthquake with magnitude of 4 is twice as strong as a magnitude 2 earthquake.

3) True or False:

Falling into cracks in the earth is the most common way people die during an earthquake.

4) True or False

Masonry buildings have an inherent resistance to earthquake forces and are very safe.

Fax or email your answers to Brian at D. A. Brown Engineering Consultants by Oct. 31, 2005 for a chance to win valuable DABEC Merchandise.

EARTHQUAKE, ANYONE? (CONT)

STRUCTURAL DAMAGE

We've all seen fantastic movie footage of giant craters opening up during an earthquake and people falling into them, but that is not the usual cause of death during an earthquake for its victims. According to a study done by Snieder and Van Eck in 1996, a little more than 75% of all earthquake-related fatalities come from collapsing buildings. Landslides and fire accounted for about 15% of the fatalities and the other 10% came from other sources. The most common single-source of death came from the collapse of masonry (concrete block, brick, etc.) buildings. Masonry buildings are particulary susceptible to earthquakes because of the mechanism by which the energy of the earthquake travels through the ground. As the shock wave from the quake travels away from the epicenter at incredible speed, the earth moves. The movement of the earth can be measured as an acceleration forward and backward. Frequently, the acceleration of the earth exceeds the acceleration due to gravity. In other words, the base of the building for a brief moment will have forces exerted on it horizontally in excess of the force of gravity. Masonry joints really don't have any tensile strength. They rely on the force of gravity to hold them together. If somehow gravity turned sideways and the wall is vibrated (like it does in an earthquake), the wall will usually disintegrate and fall.

In order for the walls to stand (and therefore continue to hold up the floors and roofs), they must be able to withstand forces in several directions and also be able to handle vibratory forces. There is a fine line structural designers must walk between too rigid and not rigid enough. In other words, bend but not break.

There have been an incredible number of new structural inventions devised in recent years to help buildings stand during earthquakes. Buildings that are most vulnerable to earthquakes tend to be very tall and slender buildings (sky-scrapers), because the bottom moves horizontally and the top tends to stay in one place due to its inertia. Obviously, having sky scrapers fall during an earthquake in a heavily populated area is not desirable, so many safeguards and new connections are being used to prevent that from happening. Maybe we'll discuss some of those next month, if another major disaster doesn't happen. Let's all pray that it doesn't.

Be safe, see you in November....

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DABEC DIGEST

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TORNADO DAMAGE AND SAFETY

We spent the last two months talking about natural disasters. In September we discussed flooding from hurricanes and other sources in honor of Rita and Katrina. In October, we discussed earthquakes and damage associated with them in honor of the mid-east quake last month. Early Sunday morning, November 6, 2005, I was visiting some friends in Boonville, IN and almost got sucked up in a tornado. Many people in the area lost their lives. Many more had their homes destroyed, their personal property missing, and other tragic occurrences. In honor of the tornado that almost got me, I will spend one more month talking about natural disasters. If we have another major natural disaster this year, we will stop talking about them altogether.

TORNADO CLASSIFICATION

In a similar manner to hurricanes and earthquakes, tornadoes have a classification system to help identify the amount of damage that they can cause.

The "Fujita Scale" is the generally accepted method of classifying the destructive capability of a tornado. An interesting fact about the Fujita Scale is that the tornado is only assigned a scale number after the storm is gone and specialists from the National Weather Service can inspect the damage and assign a rating. This is mostly due to the fact that weather monitoring stations are rarely in the direct path of a tornado, and even if they were they would likely be destroyed.

The Fujita Scale has six currently used classification ranges. Each range starts with the letter "F" (in honor of T. Theodore Fujita-who invented the classification system.)

An F-0 tornado has the following characteristics: winds up to 72 mph, overall light damage, damage to some chimneys, shallow rooted trees and branches uprooted and blown off, and damage to signs.

An F-1 tornado will have the following signature: winds from 73 mph to 112 mph, moderate damage, peels surface of roofs, mobile homes pushed off foundations or overturned, moving autos pushed off roads, and attached garages may be destroyed.

An F-2 tornado will have winds 113 mph to 157 mph, considerable damage will occur, roofs torn off frame houses, mobile homes demolished, boxcars pushed over, large trees snapped or uprooted, and light object missiles will be generated.

An F-3 tornado will have winds 158 mph to 206 mph, severe damage, roofs and some walls torn off well-constructed homes, trains overturned, most trees in path up-rooted.

An F-4 tornado will have winds from 207 to 260 mph, devastating damage, well-constructed homes leveled, structures with weak foundations blown off some distance, cars thrown and large missiles generated.

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WHAT DO ALL THESE WARNINGS AND WATCHES ON TV MEAN?

We've all seen them. The nice-looking weather person stands up there, interrupting our favorite program on tv and tells us that "the National Weather Service has issued a Severe Thunderstorm Watch for the following counties...."

Sometimes, they follow that up with an explanation of what a "Severe Thunderstorm Watch" really means. Other times they don't. Here are two basic tips that will help you decifer what they are really saying.....

First of all, if they say the word "warning", you better pay attention. Warning means there already is one and it is headed somewhere. For instance, a Tornado Warning means there is some evidence (weather spotter or doppler radar) that there is a tornado already out there. That tornado might be headed your way, so pay attention.

Secondly, if they use the word "watch", that means that conditions are favorable, but there is no confirmed severe weather, yet. You still ought to pay attention since a Tornado Watch means they are looking for one to form. It just hasn't, yet.

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Congratulations go out to last month's winners. Get your answers in for your chance to win!!!!!

This Issue's Quiz:

1) True or False:

Tornado Watch means there is a tornado out there and they are watching it.

2) True or False:

The weather man in the studio can tell if the tornado is an F-2 or F-3 by looking at the radar.

3) True or False:

Flying debris is unlikely to cause injury during a tornado.

4) True or False

Tornadoes only happen in the spring and summer, so once fall comes around, we don't need our emergency shelter anymore.

Fax or email your answers to Brian at D. A. Brown Engineering Consultants by Nov. 30, 2005 for a chance to win valuable DABEC Merchandise.

TWISTER DAMAGE CONT

An F-5 tornado creates incredible damage. With winds over 261 mph it will lift strongly framed houses off their foundations and carry them considerable distances to disintegrate. Automobile sized missiles will fly through the air in excess of 100 meters. Trees will be de-barked and steel re-inforced concrete structures will be badly damaged.

As if that isn't bad enough, Fujita actually had an F-6 classification in his original scale, but it has been dropped since with the theory being that it isn't practically possible to generate a tornado with that much energy.

The tornado that occurred in southern Indiana last weekend has since been classified as an F-3 with winds around 200 mph. It was on the ground (or near the ground) for about 41 miles and was traveling at about 75 mph, which equates to about 35 minutes, killing about 22 people. Until this tornado, 10 deaths were reported nationwide this year. (Information in this section taken from USA Today's website.)

A TORNADO IS COMING, WHAT DO I DO?

First of all, you should prepare for severe weather (including tornadoes) before it occurs. Develop a plan at your home with your families so you know in advance what you can or will do when the tornado comes. Also, develop a plan at work for handling severe weather.

You also need to make sure you have a disaster kit stored at your house (or business) where you can get it in an emergency. A top-notch disaster kit will include: 3 gallons of water per person, 3 days of food that won't spoil, a change of clothes and footwear, one blanket or sleeping bag per person, a well-equipped first aid kit, a battery-powered weather radio and portable radio, flashlight and plenty of batteries, an extra set of car keys and credit card or cash, and special items for infants, elderly or disabled persons. I can't emphasize enough that whatever items you store for emergency need to be put where you are going to be when the emergency strikes. You won't have time to round this stuff up when you're trying to get your kids out of bed and into shelter.

Hopefully, you have a basement. If you do, that is a good spot to plan your emergency hide-out. If not, an interior room with no windows is the next best thing. If you don't have either of these, you might plan to vacate your home and head to a local shelter. But, you may not have time (we didn't). In that case, get away from the windows and doors as best you can, and keep your heads down. Flying debris is extremely dangerous, even if the tornado doesn't strike directly. Visit http://www.nws.noaa.gov/om/brochures/ttl.pdf (source for this information) to get more details on emergency action plans. Be safe, and see you next month....

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DABEC DIGEST

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IS IT DECEMBER ALREADY?

Can you believe it's December, 2005? In just a few short days we will be turning the calendar over again and heading into another year. Of course, we will have little time to consider that since we will all be running around like crazy people trying to finish off business responsibilities, family shopping, preparing for family gatherings, and shoveling snow every other day.

As is our custom, we will give all of your technical brains a rest this month and spend a little fun time together.

FUNNY QUOTES

"The statistics on sanity are that one out of every four Americans are suffering from some form of mental illness. Think of your three best friends. If they're okay, then it's you."
Rita Mae Brown.

"If your parents never had children, chances are you won't either."
Dick Cavett.

"I'm desperately trying to figure out why kamikaze pilots wore helmets."
Dave Edison.

"Now they show you how detergents take out bloodstains, a pretty violent image there. I think if you've got a T-shirt with a bloodstain all over it, maybe laundry isn't your biggest problem.Maybe you should get rid of the body before you do the wash."
Jerry Seinfeld.

"This is the sixth book I've written, which isn't bad for a guy who's only read two."
George Burns.

"Sure, luck means a lot in football. Not having a good quarterback is bad luck."
Don Schula.

"Show me a man who is a good loser and I'll show you a man who is playing golf with his boss."
Jim Murray.

"Sure, there have been deaths and injuries in boxing, but none of them serious."
Alan Winter.

"It took me seventeen years to get three thousand hits in baseball. I did it in one afternoon playing golf."
Henry Aaron.

"If you're playing a poker game and you look around the table and and can't tell who the sucker is, it's you."
Paul Newman.

"I haven't committed a crime. What I did was fail to comply with the law."
David Dinkins, NY Mayor.

"Outside of the killings, Washington has one of the lowest crime rates in the country."
Mayor Marion Barry

"I'm not going to have some reporters pawing through our papers. We are the president."

D. A. Brown
Engineering Consultants Inc.

JUST MARK TWAIN

"The report of my death was an exaggeration."

"They spell it Vinci and pronounce it Vinchy; foreigners always spell better than they pronounce."

"The holy passion of friendship is of so sweet and steady and loyal and enduring a nature that it will last through a whole lifetime, if not asked to lend money."

"Only one thing is impossible for God: To find any sense in any copyright law on the planet."

JUST GEORGE W. BUSH

"A low voter turnout is an indication of fewer people going to the polls."

"Rarely is the question asked: Is our children learning?"

"What I am against is quotas. I am against hard quotas, quotas they basically delineate based upon whatever. However they delineate, quotas, I think, vulcanize society. So I don't know how that fits into what everybody else is saying, their relative positions, but that's my position."

"It's clearly a budget. It's got a lot of numbers in it."
(sorry Mr. President-the editor)

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Congratulations go out to last month's winners. Get your answers in for your chance to win!!!!!

This Issue's Quiz:

1) True or False:

Santa's Sleigh has eight reindeer.

2) True or False:

The Christmas Tree tradition began in eastern europe.

3) True or False:

Jesus was born in a manger in Bethlehem.

4) True or False

After questioning the Wise Men, Herod had all male children in Bethlehem under the age of 2 killed to stop the "King of the Jews" (Jesus) from growing up and taking over.

Fax or email your answers to Brian at D. A. Brown Engineering Consultants by Dec. 31, 2005 for a chance to win valuable DABEC Merchandise.

DECEMBER...CONT

Hillary Clinton.

"It is wonderful to be here in the great state of Chicago."
Dan Quayle

Lady Astor to Churchill "Winston, if you were my husband I would flavour your coffee with poison."
Churchill: "Madam, if I were your husband, I should drink it"

Bessie Braddock to Churchill "Winston, your drunk!"
Churchill: "Bessie, you're ugly, and tomorrow morning I shall be sober"

"I am extraordinarily patient, provided I get my own way in the end."
Margaret Thatcher.

"Harold Wilson is going around the country stirring up apathy."
William Whitelaw.

"At every crisis the Kaiser crumpled. In defeat he fled; in revolution he abdicated; in exile he remarried."
Winston Churchill.

"The British Secret Service was staffed at one point almost entirely by alcoholic homosexuals working for the KGB."
Clive James.

"Insanity is hereditary: You can get it from your children."
Sam Levinson.

"In general my children refuse to eat anything that hasn't danced in television."
Erma Bombeck.

"I have a stepladder. It's a very nice stepladder but it's sad that I never knew my real ladder."
Craig Charles.

Have an extremely joyful Christmas and a Happy New Year. See you in 2006.....

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