

Devotion School Area Geology and Civil Engineering Walking Tour Teacher's Guide

Materials:

1 Compass
Student Maps
Students Tables and Note Sheets (made in class before the tour)
Clipboards/something hard to take notes on
Pencils/Pens
Index Cards (premade)

Instructions:

There are 20 stops on this walking tour. Each stop has at least one index card to go along with it (there may be multiple index cards per stop). There are *concept* index cards that do not have stops assigned to them. The teacher should place them into the tour at his/her own discretion (we suggest either reading them before the tour starts or along streets where there are not many stops).

Before the tour begins, the teacher should distribute maps and index cards to students (students should already have their tables that they made in a previous class).

Students should follow the tour on their map and read their index card, when they arrive at the appropriate stop. After the card is read, the teacher may lead a small discussion about what was just read, and in some places perform a demonstration. Students should take notes at each stop on their maps and tables.

There should be at least one compass that is taken on the trip. During the tour, the students should pass the compass around, and during a free moment, they should locate north and plot it on their maps (this information will be used when they are divided into groups to make their big maps).

Stops and Their Index Cards:

1. Begin at the main entrance to school

Entrance

These steps are made of large blocks of granite connected to each other.

How do you think granite forms?

Why do you think the steps are made of multiple pieces as opposed to one big block?

Why do you think an engineer would choose granite for these steps?

Granite is an igneous rock. Granite forms when molten rock intrudes into the earth's crust and cools. Sometimes granite is coarse grained and you can see all the minerals in it; sometimes it is fine grained. Coarse grained granite occurs when the cooling is slow, and fine grained granite occurs when cooling occurs quickly. This is because slow cooling allows minerals to have time to rearrange and group together, where as if the rock is cooled quickly the minerals don't have time to rearrange; they become solidified in place without time for rearrangement (for example if the students were given 1 minute to line up alphabetically, at the end of 1 minute they probably wouldn't be very organized, but if they had 10 minutes, they could probably organize).

These steps are made of multiple pieces because this stone was quarried and transported.

Granite is more resistant to weathering than limestone or sandstone, so it makes a sturdier building material.

2. Cross the roadway and stop on the walkway to the Edward Devotion Museum.

Edward Devotion Museum Walkway

Looking at how the mudstone/sandstone/shale walkway is peeling.

Based on your observation, what can you say about how mudstone/sandstone forms?

Mudstone/Sandstone/Shale is a sedimentary rock. It is deposited in layers.

Some sandstones are resistant to weathering, yet are easy to work. This makes sandstone a common building and paving material.

Mudstone is a fine-grained sedimentary rock whose original constituents were clays or muds. Grain size is up to 0.0625 mm (0.0025 in) with individual grains too small to be distinguished without a microscope. With increased pressure and time the platy clay minerals may become aligned, with the appearance of fissility or parallel layering. This finely bedded material that splits readily into thin layers is called shale, as distinct from mudstone.

Edward Devotion Museum Building (1)

This building is 267 years old (from 1740). Over the years it has encountered many different seasons.

What parts of the house do you think help the building to deal with the rainfall and snowfall?

The siding of the house makes it so that water will roll off of the building instead of pooling up in the crevices. The gutters carry water away from the building to prevent flooding.

Edward Devotion Museum Building (2)

The school building is made of brick, while this building is wood and has been painted. Look for signs of weathering on this building.

Which building can stand up to the harsh weather better?

What do you think covering wood in paint does?

Brick is a more durable material than wood. Brick will not rot and does not need to be protected from the natural elements.

Paint makes the building aesthetically pleasing, but also protects the wood that is covers from weathering. Areas where the paint is peeling show more signs of weathering.

3. [Leave the Edward Devotion Museum and walk to the left past the inclined podium, and stop at the steps located slightly beyond the podium.](#)

Steps after Podium

Look at how the concrete pathway is no longer connected to the steps. The stuff that used to connect it is broken. What are some reasons that they would not be connected anymore?

There is an earth wall underneath the walkway that is pushing outwards (in the direction opposite Harvard St.) The brick retaining wall under the podium is embedded deeper within the ground, while the stairs are not. The pressure from the earth wall has pushed the stairs laterally away from the walkway. As the stairs move, the soil underneath moves as well, causing the walkway to sink.

When there is water buildup (after heavy rainfall or snowmelt), the situation is amplified. Water pressure is more forceful than earth pressure. This is why we need drainage holes in retaining walls.

4. Walk to the black railing that is bent and rusting.

Steel/Iron Railing (1)

This railing is made of steel which is a very strong material that withstands a lot of force. It must be welded and shaped in a factory before it is brought to the location where it will be used.

What are the advantages and disadvantages of using a flexible material like steel?

Advantages:

Steel is easy to form into any shape desired

Not as affected by frost as concrete

Lighter than most strong materials (i.e. concrete)

Can be fixed easily by welding

Disadvantages:

Will bend under a lot of pressure.

Will rust and/or corrode

Steel/Iron Railing (2)

Look at how the steel railing detached a little in the middle and broke off. This is most likely due to “rust smacking.” Rust is formed when iron (a main component of steel) mixes with water and oxygen. Since rust has higher volume than the originating amount of iron, when it builds up, it may force adjacent parts apart.

5. Walk on the sidewalk along the side of the school (along Stedman St.) towards the back fields. Stop at the huge rock jutting out next to the sidewalk.

Roxbury Conglomerate

This rock is known as Roxbury conglomerate, a rock formation found all over the Boston area that is about 560 million years old. This piece is likely an old piece of foundation.

What can you guess about the age of the rocks compared to the stuff that holds them together?

Roxbury Conglomerate also called the Roxbury puddingstone (because it looks like a Christmas pudding) is one of Boston’s few rock formations and Massachusetts’s official rock. It is around 560 m.y. old. Conglomerate is a sedimentary rock formed by the cementation of rounded rocks/pebbles together.

The pebbles that make up the conglomerate are older than the matrix that holds them together.

6. Continue down Stedman St., and stop at the parking garage.

Parking Garage (1)

How is the building above this garage supported?

Walk over to the concrete column. Remember that concrete has to be poured right on the building site. What could the holes in the sides be from? If that is true, how do you think this was made?

Columns and beams, going in both horizontal directions, support the building above the garage.

The concrete was poured onsite into a cylindrical frame. The holes are air bubbles from when the concrete was poured.

Parking Garage (2)

Look at the floor. Is it completely flat? Why would it be built like this?

Floor slopes down towards drains. Students can look for boundaries of an area where all the water would go to one specified drain. This also happens on a larger scale of parts of cities, states, or countries—known as a watershed.

7. Continue down Stedman St. until you reach the paved walkway beyond the baseball field. Turn right onto the “brick” walkway, and stop at the tree root that is breaking the walkway.

Walkway Beyond Fields (1)

Look at the roots uplifting the walkway. What can you conclude about the sequence of events? Which material was here first?

The tree was already planted when walkway was added, but the tree and roots have grown since that and are now breaking through the walkway.

Walkway Beyond Fields (2)

This walkway looks like it is made out of brick. It is actually made out of asphalt. What is a reason you would use asphalt instead?

Asphalt is much cheaper and faster to use than laying out brick. The brick imprinting is more aesthetically pleasing than asphalt.

8. Walk until the whole class has a view of the weathervane on top of the school.

Weathervane

The weathervane is made of copper. When copper reacts with oxygen, it turns from ashiny salmon color (imagine a penny) through various shades of bronze and then finally becomes green. This process can take 25-30 years.

Discuss oxidation.

Teacher's note: Pass around 2 pennies. One that has its copper color and one that has turned green.

9. Walk to the end of the paved walkway and stop at the concrete steps.

Concrete Steps

These steps are made of concrete.

What is different about these steps compared to the granite steps at the front of the school? How were these steps constructed?

These steps are one solid piece instead of blocks. Concrete must be poured at the site of construction. Notice the air holes and the shape of the side mold. With concrete you can pour any shape that you want.

10. Continue walking along the side of the field toward the school. Stop on the foursquare blacktop, and look at the building

Foursquare Blacktop

Notice the different colors of bricks on the wall of the school building.

Why are these bricks different colors?

Aesthetics or to fill a hole in the wall. Between the two glass windows perhaps used to be one big window, which was later filled. The smaller patch under the vent is to cover a hole caused by weathering or impact.

11. Walk towards the playground, and stop at the wooden wall.

Wooden Wall by Play Ground

Look at the beams coming out of the structure towards you. These beams are being used to reinforce the wood going in the opposite direction and holding up the soil

Where else have you seen this?

Beams in the parking garage. Retaining wall by the stairs at the beginning. Wood has natural drainage through cracks.

Steps with Steel Covering

These steps are made of concrete. The covering on the edges are made of steel.

Why is steel only used to cover part of the steps?

Steel is more resistant to weathering than concrete. However, concrete is much cheaper to use. Steel is often used in limited quantities to strengthen concrete.

12. Stop at the playground area with woodchips.

Playground materials

Much of the playground is covered in sand or woodchips in stead of the asphalt around it. Why would these materials be used? Imagine falling off the jungle gyms onto asphalt instead of a softer material.

Softer materials are used for safety reasons. When kids fall, these materials have more give than something harder such as stone.

13. Facing Harvard Street make a left. Stop at the wall right after the store Kabloom.

Kabloom Wall

The wall is made of limestone. You can tell limestone when you can see the shells in it. This is one way you can tell the difference between sandstone and limestone.

Where does limestone come from?
How is it formed?

Limestone is a sedimentary rock made from calcite (CaCO_3). When shellfish, crustaceans, and coral die, their shells fall to the bottom of the ocean and get compacted and cemented together, creating limestone. Limestone used in construction is often taken from places that used to be covered in water.

Limestone is often found in caves.

Teacher Demonstration: Another way to tell the difference is that limestone reacts with acid. Take acid in small container. Put a few drops onto limestone. Watch it fizz.

14. Continue down the same side of the road, stopping at 305 Harvard St. to look at the beam with peeling paint.

305 Harvard St.

Lead makes paint more opaque, more durable, and speeds the drying process. Paint in older buildings often has lead in it. Now we know that lead is poisonous and when it peels like the paint here, children can eat it or dust particles can give people diseases.

Recall that paint protects what is underneath. Metal is a strong building material, but corrodes easily.

15. Continue down Harvard St. until you reach the corner of Harvard St. and Beacon St. Look across Harvard St.

Corner of Harvard St. and Beacon St. (3)

Most houses here have shingles roofs. When you put shingles on a roof you start at the bottom and work your way up so that they overlap.

Why do you think they overlap like that?

To let the rain fall into the gutters.

Corner of Harvard St. and Beacon St. (4)

The shingles on this older building are made of slate. Most shingles are now made of asphalt and painted.

Why would you use asphalt instead of the natural slate material?

Slate is more expensive. Recall the asphalt walkway painted to look like brick.

16. Make a left on to Beacon St., follow by a left onto Pleasant St. Cross the street and stop in front of the library.

Library

Notice how the front wall of the library is made mostly of glass.

What do you notice that is different about the other building materials used here that you didn't see around the school?

The glass is supported by metal framing. Since glass is a weaker material, you need stronger metal framing to support large pieces of it.

17. Continue down Pleasant St. until you reach the entrance of 57/59 Pleasant St.

57 and 59 Pleasant St

What is one metal that this green pole made of?

These walls are made of marble. What is marble? How does it form?

The green pole is made with copper

Marble is metamorphic limestone.

Limestone that got buried deep down in the earth and metamorphosed due to pressure

18. Make a left onto Dwight St. Walk one block ,a dn stop athe driveway of the first house after you cross --- street.

Dwight St. House

What do you notice about the retaining walls for the driveway and the foundation of this house?

Made of stone. Talk about drainage. Point out where the soil is pushing out the wall. Compare to the first wall seen in stop #3, where the steps were pushed out.

19. Bear left on Dwight St. and stop at the Corner off Babcock St. and Devotion St. at the parking garage.

Devotion and Babcock Parking Garage

Notice the different shaped columns supporting the top of this parking garage. Count how many there are of each kind.

Why are there different numbers and shapes of columns?

Ones with bigger tops take more distributed load rather than concentrated. There are a larger amount of the smaller ones. More smaller ones to support the heavier load of the many-storied building above that part of the garage

Concept Cards:**Basements**

Look for houses that have basements. Buildings in places like Florida do not have basements.

Why do some areas have basements and not others?

Basement must be embedded for freezing

Foundations

What is the difference between a basement and a foundation?

There is no difference between a basement and a foundation. They are simply describing different things. A basement is a foundation

Aesthetics

Certain elements of houses are not necessary for the structure to stay together and be safe. Look for things that you think are unnecessary but make the building look nicer. Many times it is a design in the wood or sandstone.

Arches

The keystone is the stone placed at the very top of the arch. It is mostly used for decorative purposes but it is the last stone placed when the arch is made. Can you find the keystone of an arch?

Wood

Many older buildings are made of wood. It is a strong material that is also flexible which makes it great for homes. Larger structures are harder to build with it however.

Wood can be cut in 2 ways, with the grain or against the grain. Which do you think is stronger?

Wood also has a naturally round shape, and when you cut it in to a square shape it still tries to remain round. Look for columns of wood rounded at the edges.

Retaining walls

A retaining wall is a wall made to hold back soil to keep it from caving in onto the surface. They also prevent erosion. Stone, brick and concrete are the most common materials used. Drainage holes

Some made of stone.

Hold back the soil. Soil pressure increases the deeper you go.

Steel vs. Concrete

Concrete and steel have very different properties. Concrete is good at lasting through compression (a push) and steel is good at lasting through tension (a pull). Steel in general is a stronger building material, but it is much more expensive than concrete so often times concrete columns have steel reinforcements inside so that they can stand up