Fort Warren, Georges Island, Boston Harbor
Quarried Stone Report

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July 2, 2021
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Flat Wedge Holes

The "flat wedge method" is a modern term for a stone splitting technique whose original name was not recorded in the historical records. It is identified by its distinctive flat wedge holes. From the top the holes are elongated slots in the rock (see fig. 4). When the holes are split and viewed from the side they are trapezoid in shape (see figs. 7 & 8) The holes were cut with a cape chisel. (fig.1) The flat wedge has been hard dated to the year 1800 (foundation of Unitarian Church in Newburyport, MA). It likely predates that building by a year or more. The method predates the more familiar plug n' feather method which used finger length round holes spaced every 6-7 inches part. Both methods split the stone by placing a metal wedge ("plug") between two shims ("feathers"). The plug and feathers used in the flat method were wide and flat. (fig. 1) Please see *The Art of Splitting Stone* for the history of both holes.

Two short retaining walls contain examples of the flat wedge holes. Please see enclosed hand drawn map of their locations (no. 1 & no. 4). One wall (location no. 4) is part of the bridge abutment and the other (no.1) is a short distance in front (west) along an access road heading down to the picnic area today. This retaining wall attaches to the demi-lune. There is a third retaining wall on the opposite of the access road. The access road was built after 1900 and before 1945.[1] It was likely built in conjunction with the hospital (built after the Spanish American War & before WWI) and other buildings which stood where the picnic area is today.

All three retaining walls are similar in construction and appear to have been built around the same time as each other. The short retaining walls were constructed using small, irregularly sized blocks of unfinished stone. A third retaining wall (not recorded) on the opposite side of the access road has a partially finished stone block. The retaining walls were built using cement. In comparison no cement was used in the building of the original fort. These three retaining walls are out of character with all other Civil War era walls including retaining walls of the coverface earthworks which are of much better quality workmanship. All three were repointed (new cement) probably when the bridge was rebuilt by the state. The stones used to build the retaining walls were recycled or were split off larger rejected blocks.

Two different types of *Flat Wedge Holes* were found: (1) Machine cut (i.e. cape chisel mounted on a pneumatic drill) which are extremely rare (location no. 1). Only one block of stone contained the machine cut holes, still intact. The two holes are smaller than hand cut holes and more uniform. (see figs. 3-5) They have divots in the bottom (wave like bottom with ups and downs) from the cape chisel proving they are flat wedge holes and not the later (1868) rock hammer hole with a flat bottom. (2) Hand cut which are common (location no. 4). Three hand cut holes were found in a single stone in the bridge's retaining wall (see figs. 6-8). These have half the hole showing they were used to split the stone.

The flat wedge method predates the plug and feather method (i.e. round holes) by about twenty years. The flat wedge continued to be used after the introduction of plug and feather method in the commercial quarries in the early 1820s and is seen on stonework as late as 1870. It stops being used after about 1870. The machine cut flat wedge holes date from the 1860s or 1870s. Pneumatic (compressed air) and steam power drills didn't come into commercial use until the 1860s.

[1] Based upon maps of the fort shown in *History and Master Plan: Georges Island and Fort Warren Boston Harbor* (1960).

One other use was found for the flat wedge hole as a “dog hole”. A dog hole is a shallow hole usually round placed on opposite ends of a large block of stone. There are always only two dog holes per block. Please see our write up in the book, *The Art of Splitting Stone.* They had a specific use to lift large blocks of stone. Several examples were found at location no.5 the exterior wall of a bunker in the coverface near Bastion C. It appears the dog holes were used on the blocks to set them in place in the wall. What’s unusual is they were not erased. Figure 9, middle row has a flat wedge dog hole in the middle and a round hole on its right side used to split the stone. A second shallower flat wedge hole is above that appears to have been a mistake it is too high on the block.

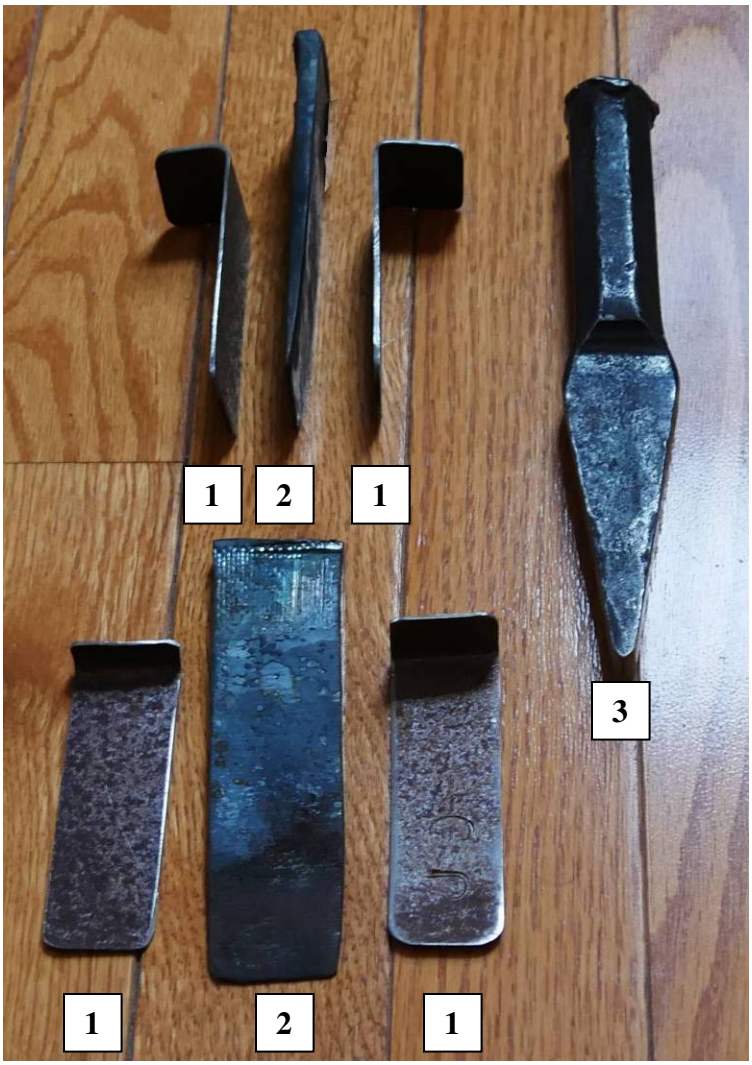

Figure 1 – The flat wedge method used a set of flattened “plug and feathers” inserted into each hole.
(1) Shims
(2) Wedge
(3) Cape Chisel

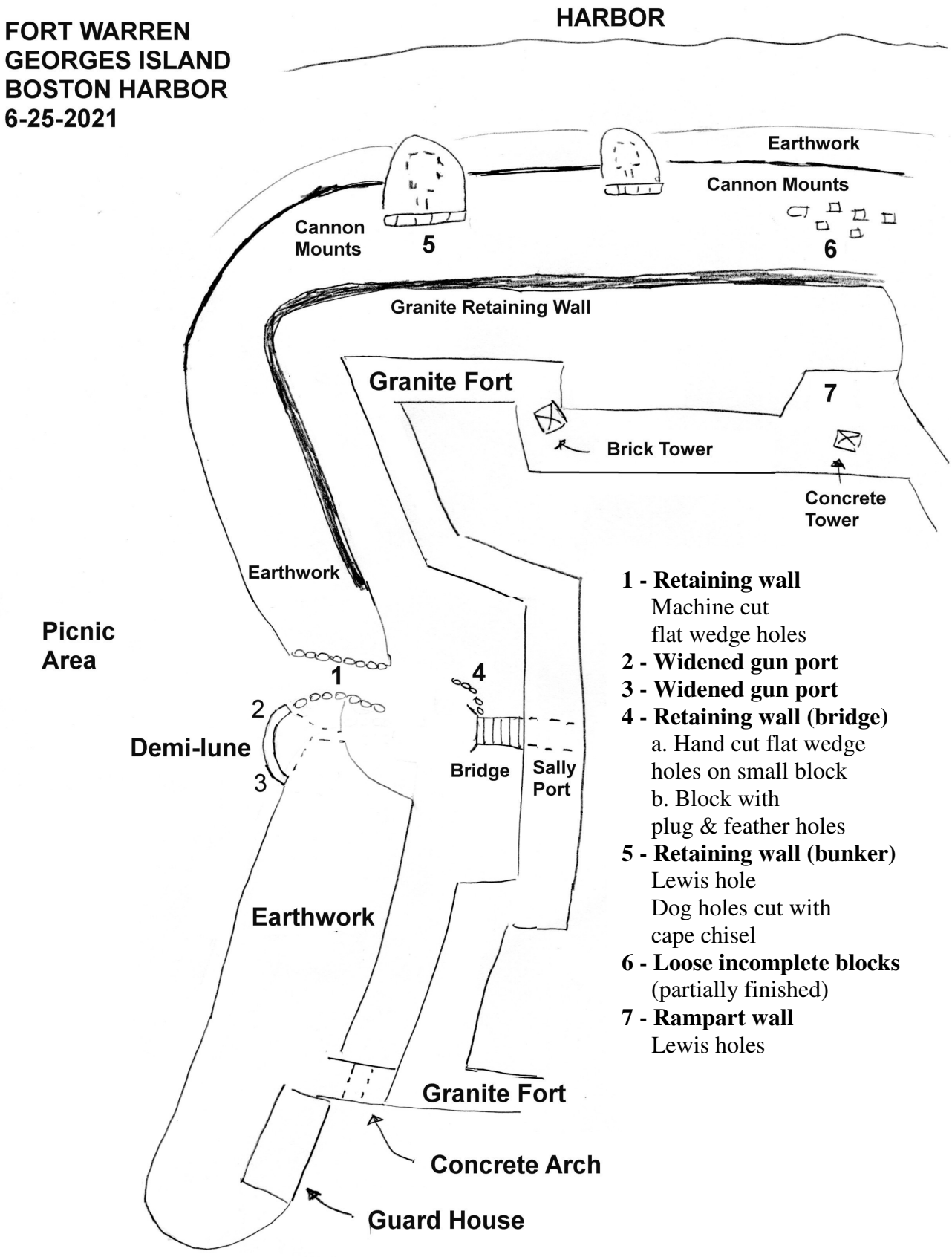

Figure 2 – Field sketch map showing locations of various quarry marks

Figure 3 – Location of machine cut flat wedge holes in the retaining wall of the access road to picnic area near the demi-lune.

Figure 4- Close-up of two machine-cut flat wedge holes

Figure 5 – Close-up of one of the above machine-cut flat wedge holes

Figure 6 – The hand cut flat wedge holes were found on a single block in the sally port bridge retaining wall

Figure 7 – Hand cut flat wedge holes as seen after the block was split in half. (Holes 1 & 2)

Figure 8 – Hand cut flat wedge holes as seen after the block was split in half. (Holes 2 & 3)

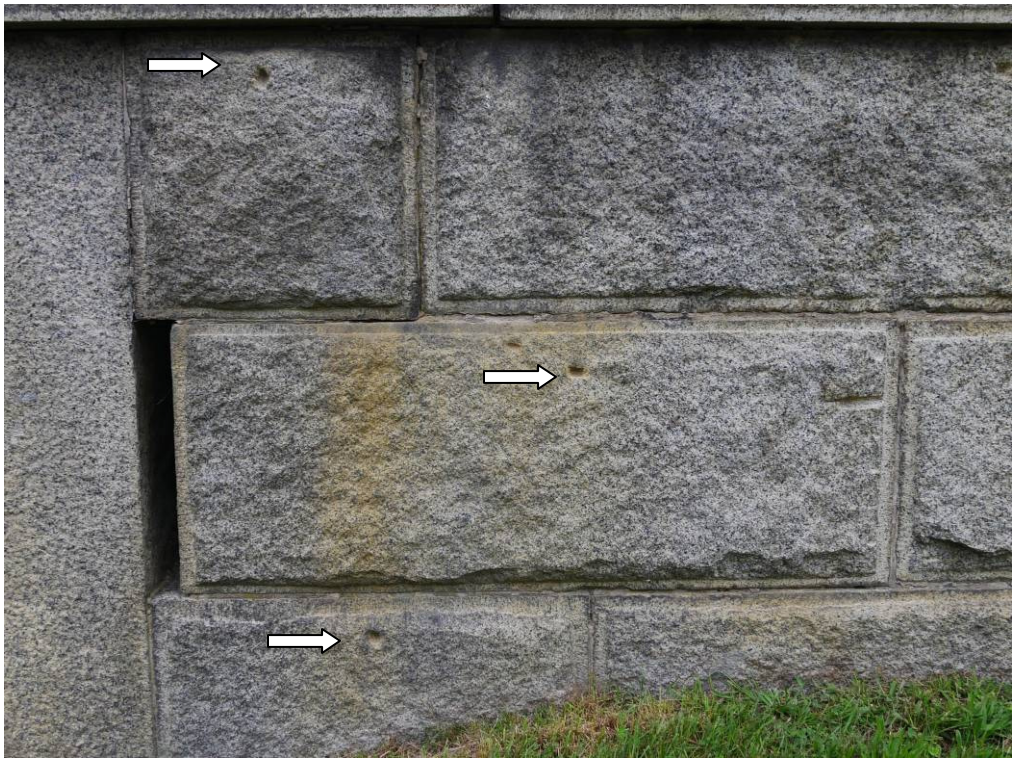

Figure 9 – Three of the blocks in this wall have dog holes near the top center of each block. Location #5 on map (Dog holes indicated by arrows)

Figure 10 – More examples of dog holes in the same wall

Figure 11 – A shallow flat wedge hole cut with a cape chisel and used as “dog hole” for lifting the block into place.

Extra Wide Gun Ports

A placard is between the prisoner widened gun port and an extra wide gun port. It is actually confusing as the prisoner's crudely and only slightly widened bottom section of the gun port is hard to find (it would benefit from an arrow pointed to the widened bottom section) and furthermore it is next to another gun port widened to the point a person can easily go in and out of the interior room (no. 2 on map). A second extra wide gun port actually has an exterior step and several interior steps (added by DCR) for that purpose (no. 3 on map).

I do not recall any information on the placard about the two extra wide gun ports. What caught my attention were the double, semi-circular lines of round plug n' feather holes on the interior side of the stone blocks forming the opening along with the extra wide size. (fig.14) An effort was made to erase all evidence of the unsightly industrial quarry marks used to split the stone blocks on the exterior the fort. This is seen throughout the entire fort. It includes the exposed interior sides of the narrow gun ports. This made the raw quarry marks stand out. The question is why were they left?

The narrow gun ports have several features: flared-out sides with a narrow seven inch wide opening and about a twenty-one inch wide front opening. Note the floor of the gun port's bottom front edge was cutout slightly below the top edge of the stone block, has curved corners, a flat bottom, and angles inward with a triangular shape as seen in figure 12. In comparison the bottom of the roof stone is straight across with no architectural feature. The outward appearance is the interior wall is flush against the narrow opening. Appearances can be deceiving. An interesting observation was made at the extra wide gun port as seen figure 13. The triangular feature in the floor actually has a counterpart on the interior creating an hourglass shape. That made the wall twice as thick. It would be interesting to know more about the gun port and its design.

The extra wide gun ports have straight sides from front to back forming a square boxed opening. The semi-circular lines of round holes are evidence of the stone blocks having parts of their sides removed to widen the opening. But this generation was not so focused on appearances as they left the exposed quarry holes. (Fig.14) Two small rectangular chipped out shape features are found on the front on one side of each of the extra wide gun ports. They were for heavy iron hinges of which one is still in place. The hourglass hollowed out floor feature was filled with cement to bring it up to the height of the top of stone block and create a level floor. The cemented floor was smooth but takes away from the workmanship of the original stone masonry. To the credit of those who remodeled the opening they did put a narrow edge finish on the front face of the stone block keeping with its original finish.

These extra wide openings show a shift in attitudes regarding military fortresses. The Civil War era's focus was on outward appearances, think about the decorative Victorian era houses often called Gingerbread Houses built during that time period. In comparison, the raw quarry holes were left exposed and cement was used to fill in the hourglass feature. The smooth texture of the cement suggests WW II era. A historian with expert knowledge in cement construction should be able to answer the age question.

The extra wide gun port (if that is what it is) could benefit from a second placard with an explanation. Is there documented information on its purpose? They are a small part of a much greater whole but are highly visible to the visitor and to me a way to show how things changed over time.

Every stone with an exposed surface was "finished". None were left in their raw state as they came from the quarry. A review of our photos indicates several different finishes were used on the exterior of the stones. Identification of the finishes would be a great historian or historic archaeology grad-student project. As a guide a reference book was published by the National Trust/Columbia University *Introduction to Early American Masonry, Stone, Brick, Mortar and Plaster* (1973, 1980).

Figure 12 – Standard gun port for rifles

Figure 13 – The standard size gun port was widened by splitting off and chiseling the angled out sections of the stone blocks on both sides. Hourglass area (outlined) was filled with cement.

Figure 14 – Drill holes from the process of widening the gun port. No effort was made to erase the marks.

Stone Blocks Finished on Site

"On arrival, the stones were fitted and finished by stone workers who lived on the island during construction." (*Study Guide* page 8) This was a common practice. At no. 6 on our map there are numerous unfinished blocks of stone lying on the ground see figure 15. Figures 16 & 17 show a block in the process of being completed. It has a narrow finished edge on one end (bottom center). One side has a rough and thicker section showing this block was in the process of being reduced to size. So why was it abandoned? A large flake of stone accidentally separated from the main block causing it to be rejected (right side). The flake was caused by a flaw in the granite. Here is proof the stone blocks were completed on site.

The group of unfinished stone blocks have examples of large round blast holes (fig.18), and small finger length round holes across the whole stone called the plug n' feather method (fig.19).

Figure 15 – Numerous unfinished blocks of stone.

Figure 16 – Block in the process of being finished but abandoned after a large stone flake broke off (arrow)

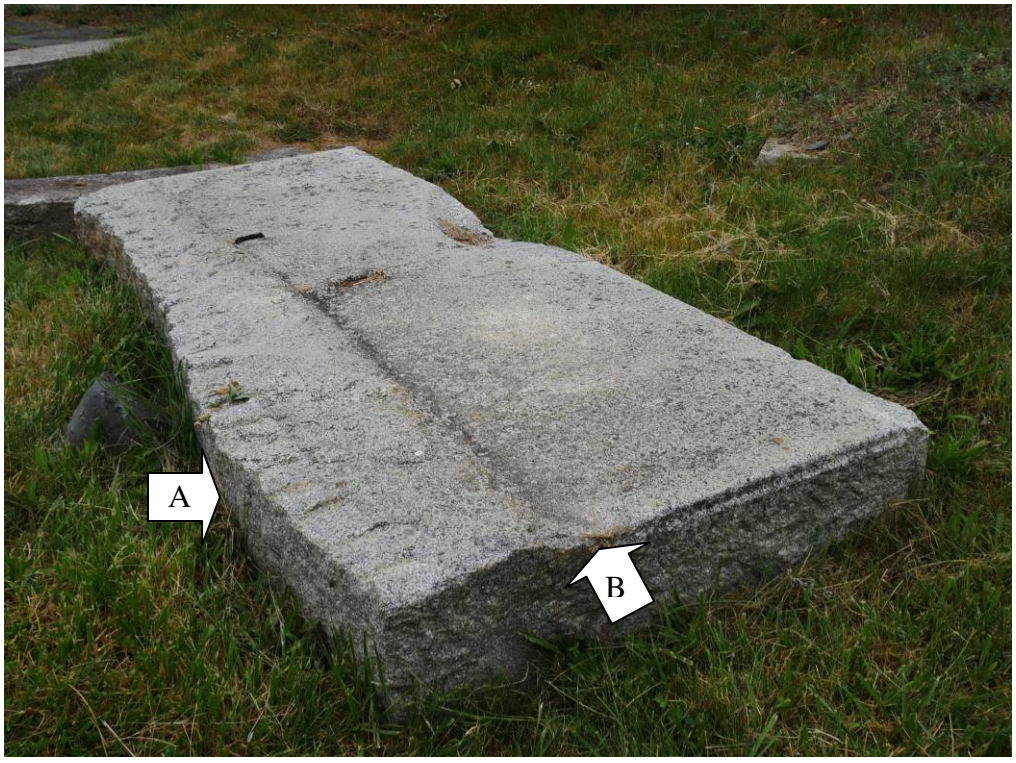

Figure 17 – Note the quarry tool marks (“A”) are on the uneven side of the block. Opposite side has a straight edge (see above photo). A rough line below the quarry marks shows where the block was to be reduced to its finished size. (“B”) The rough line coincides with the finished edge on the narrow side.

Figure 18 – Blast hole

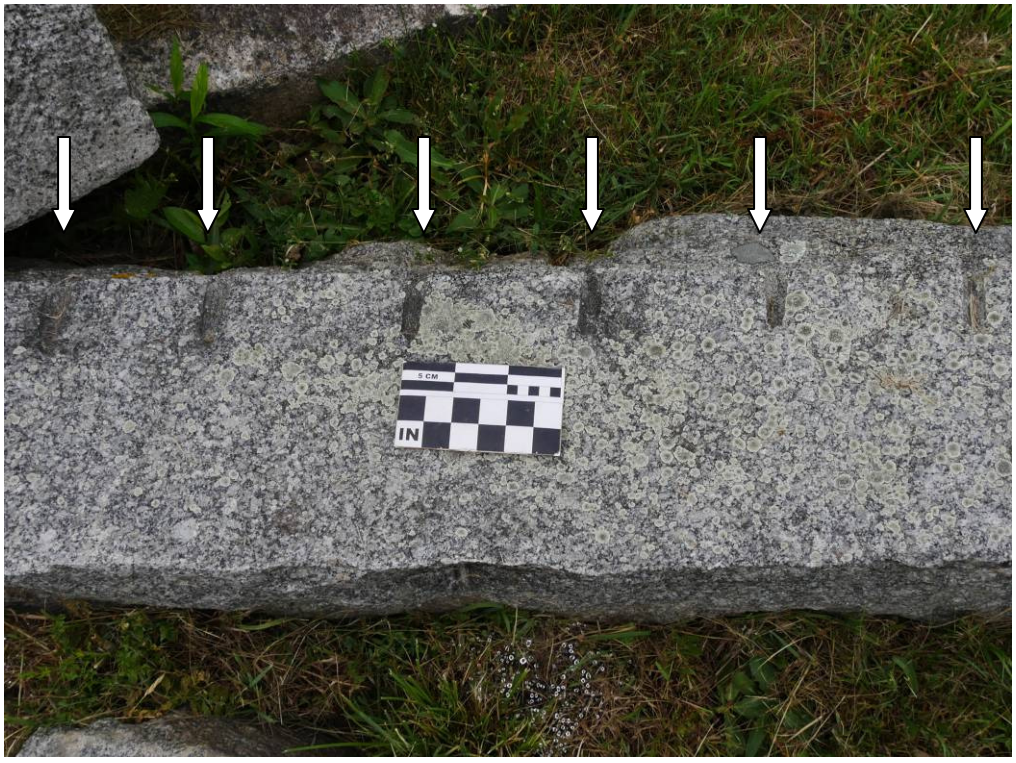

Figure 19 – Plug and feather drill holes

Figure 20 – Tools used for the plug and feather method of splitting stone

(1) Plug drill
(2) “Plug” (wedge)
(3) “Feathers” (shims)

Lewis (Lifting Device) and Lewis Hole[2]

The *lewis* is an ancient lifting device used as part of a system for lifting and lowering large stone blocks into position. It was used primarily in building construction in circumstances where other lifting methods were not practical. (One common example was the need to position a block in a tight space in a masonry wall.) This method utilized a specialized hole chiseled into the stone block called a *lewis hole*. The lewis hole was time consuming to cut and needed to be cut to specific dimensions so the metal lewis inserted into the hole fit correctly. When possible other lifting methods like dog hooks & chains or lifting tongs were used because they were much faster.

Description

From the top, lewis holes are elongated narrow slots in the stone block. If you were to split the block in half and see a side profile of the hole it would have the shape of a dovetail joint (upside down trapezoid.) The hole was placed in the top center of the stone block. The hole was positioned at the center of gravity for the block so that the stone would be balanced when lifted. There are no descriptions in the historical literature as to how the lewis holes were cut in the stone. Examples of lewis holes found at Fort Warren (constructed between 1833-1851) on Georges Island in Boston Harbor were slightly rounded at both ends of the slot which suggests the hole was initially started by drilling several round holes to approximate the size of the slot and establish the angle of the sides at either end. The stone between the holes would have been chiseled out.

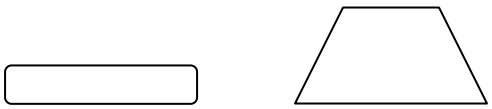

Figure 21 – Top down and side views of a lewis hole

The lewis device has three metal pieces placed into the lewis hole. Two of the pieces (A1 & A2 in figure 23) each have one straight side and one angled side which matches the angled side of the hole. These are placed in the hole first and each is fitted up against the angled side of the hole. Then a third piece (B) which is a straight metal spacer bar is placed between the other two pieces. This piece insures the two angle pieces are snug in the hole. All three pieces project above the top of the hole and have an eye hole through them. A U-shaped shackle is attached to the lewis by means of a round bolt placed in the eyeholes. This connects all the pieces together into a single lifting device. The chain is attached to the shackle. The block is then lifted and positioned on the building. The lewis is removed by reversing the order used for assembling it.

Note: At the Visitor Center there is interpretative panel on how the fort was constructed. The illustration shows a derrick (i.e. crane) lifting a block using a lewis.

[2] Not to be confused with the lewis blasting system which used a specialized lewis blast hole (shortened to "lewis hole" in much of the late 19th century quarry literature).

Figure 22 – Lewis Hole (Location no.5 on map)

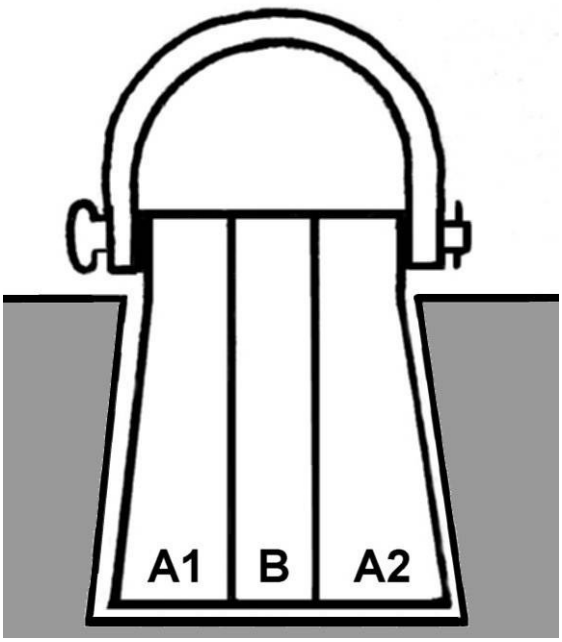

Figure 23 – A lewis consists of three pieces placed in the hole. Pieces A1 & A2 have one straight side and one angled side and are placed in the hole first. Piece B is then place between them to fit them snugly against the angled sides of the hole. A shackle is attached to them by means of a pin inserted through an eye hole in the top of each piece.

History

The lewis lift system dates back to Roman times. The Romans used a three piece lewis conceptually similar to the modern lewis but with some design differences in how the lift chain was attached to it (fig. 24).[3] Parts A1 and A2 of the lewis had a hook at the top of them instead of a bolt and shackle, metal rings were looped around the hooked ends. Examples of lewis holes have been found on Roman built structures in Great Britain.[4] It has generally been assumed the lewis was used in Medieval Europe for the construction of churches, castles bridges and other major stonework projects. However, there is a surprising lack of evidence to for its use. Illustrations from this time period show other types of lifting devices being used. In modern history, the lewis shows up in the 1700s. Several examples of lewis holes were document in harbor stonework dating to 1750 at Seaton Sluice in Southeast Northumberland (UK).[5] Diderot illustrated an example of a lewis in his encyclopedia published as a series of volumes between 1751 and 1765. (fig. 25)

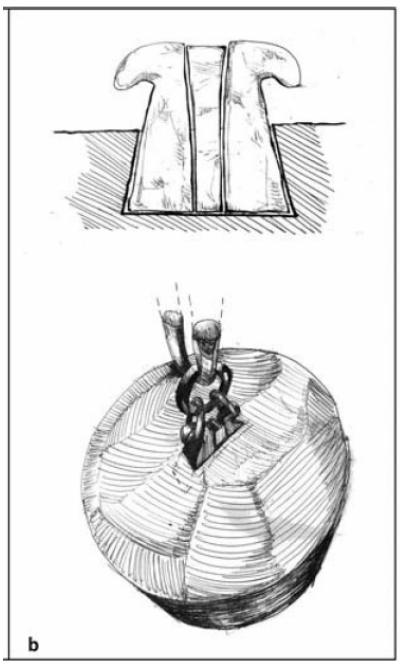

Figure 24 – Roman Lewis (Reprinted from Rababeh 2015 page 1029 for educational purposes only)

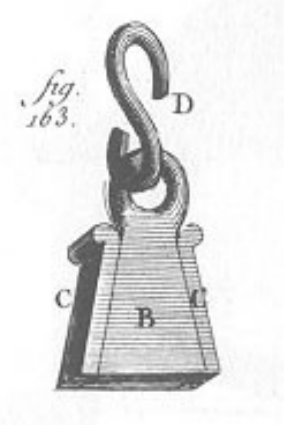

Figure 25 – Lewis device from Diderot's Encyclopedia (1751-1765)

[3] Rababeh, 2015: 1029.
[4] Morgan, 2002.
[5] Morgan ,2002.

When the modern design of the three piece lewis (fig. 23) emerged is unclear but numerous descriptions of it appear in 19th century sources. A few examples are given below:

Brees, S. C., 1852, *The Illustrated Glossary of Practical Architecture and Civil Engineering*. London: Savill and Edwards Printers.

> LEWIS, a contrivance for lifting and lowering stones. A wedge-shaped hole is first cut in the top of the stone to receive the lewis, which usually consists of three loose keys, which upon being raised extend outwards, and hold tight in the hole. A chain is connected with the lewis which is put in motion by a crane.

Knight, Edward, 1884, *Knights American Mechanical Dictionary*. Boston: Houghton, Mifflin & Co.

> Lewis. 1. A device for lifting stones which was used many centuries back but received its name from a Frenchman who brought it to its present form. He was architect on the works of Louis XIV., and gave it the name it bears in compliment to his master. It consists of two dovetail tenons, which are expanded by a key in a dovetail mortise in the stone, and shackled to the hoisting-chain. The dovetail pieces are first inserted and then forced apart in them middle key, so as to occupy the undercut portion of the mortise. All three are then shackled to the lifting-chain.

Anonymous, 1880, *Library of Universal Knowledge*. New York: American Book Exchange.

> LEWIS, or LEWISSON, a device for securing heavy blocks of stone to the tackle for hoisting. It is supposed to be named from Louis XIV of France, but there is evidence that it was used long before his time. In the stone is a quadrangular cavity, widened at the bottom on two opposite sides as in dovetailing. Into this cavity are thrust two wedge-shaped pieces of iron, heads downward and then a third piece, perfectly straight, is inserted between them to hold in place. The ends projecting above the stone present each and eye for a bolt, which passes through the whole and forms a handle for lifting the stone. After the stone is raised to its place, the bolt is first taken out; then the center-piece, which has held the wedge-shaped outer pieces firmly in place, is withdrawn, setting the latter free.

Foreman, A. (ed.), 1888, *Lockwood's Dictionary of Terms Used in the Practice of Mechanical Engineering*. London: Crosby Lockwood & Son.

> Lewis. – A contrivance for lifting stone and concrete blocks by means of a dove-tailed irons attached to a shackle piece. These fit into an undercut dove-tail in the stone, and are tightened by means of a wedge.

When the lewis was first used in United States is unclear. The lewis was one of the lifting devices used during the construction of the Bunker Hill Monument (1825-1835).[6] Several examples of lewis holes have been found on the stonework of Fort Warren (1833-1851). Examples of lewis holes are rare in New England. This is likely due in part to the lewis holes being covered up during the building's construction. All of the examples at Fort Warren occurred on blocks that were turned with the top of the block becoming the side of the block which faced outward. Some of these blocks seem to have been rejected originally and recycled at a later date. One of the lewis holes (locartion no .5) was near the edge of the block and off center and had a dog hole cut just above it. The position of the lewis hole suggests the block was larger at one point and was either split in half or trimmed down. The original block was likely damaged and recycled for a different part of the fort. (fig. 26)

[6] Willard, 1843: 30.

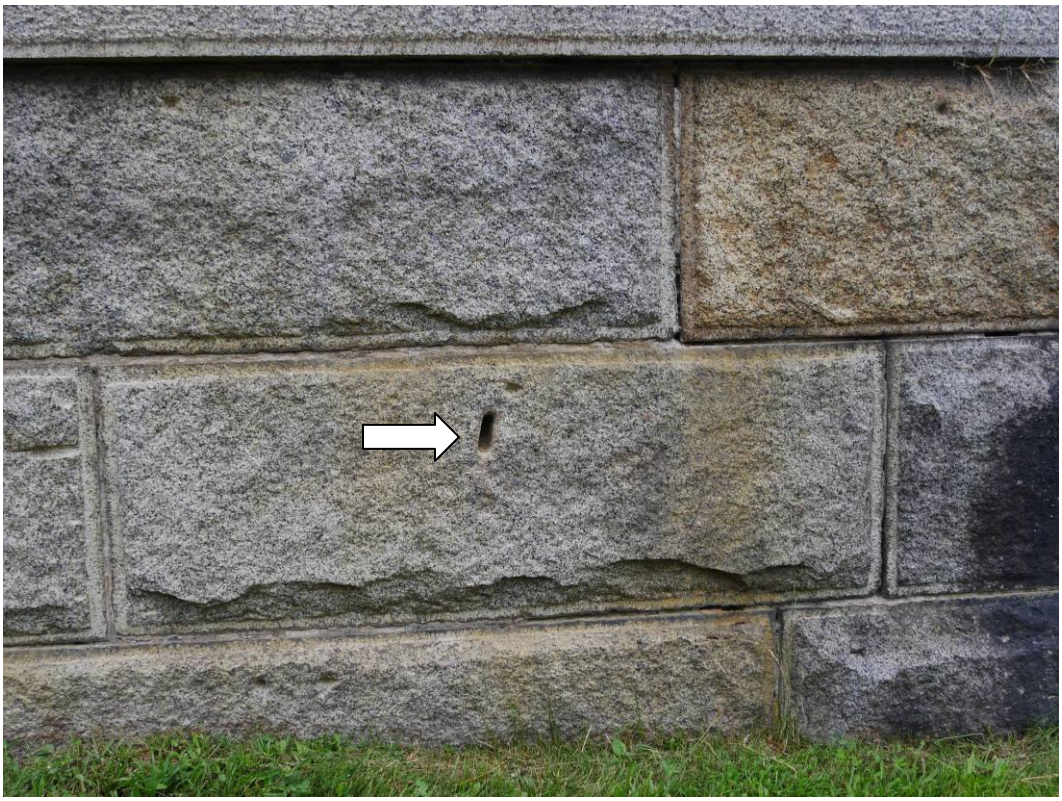

Figure 26 – This lewis is not in the center of the block. This suggests the block was split and half and recycled for use in this wall of Fort Warren.

Figure 27 – Lewis holes at location No. 7 on map are also not in the center of the block either/

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