A Quirky Look at the History of Concrete

This part of the CD contains several papers on the History of Concrete as seen by Luke and Billie Snell. Luke and Billie are members of the American Concrete Institute (ACI) and the History of Concrete Committee. Luke has served for several years as the chair for this committee while Billie served as the secretary.

Several of these papers resulted from being raised in upstate New York. As children we sang the Erie Canal Song – never realizing until later how much of an impact it had on the development of both New York State and the Midwest.

Since Luke served as a previous Chair of the American Concrete Institute's Chapter Activities Committee and the International Committee, Billie and I were able to work with several Engineers and Contractors in several countries to start ACI chapters. This gave us the opportunity to see both concrete monuments and construction practices from around the world.

These papers are the "fun" part of concrete. It represents topics that caught our interest as we traveled and/or relived our past. We do not present these as scholarly historical papers (Luke is an Emeritus Engineering Professor and Billie is a Retired School Teacher). What we hope is that we can share with you some observations of the most prevalent building material used in world - Concrete.

Other Construction Materials

Two papers are included in this session.

The first is a paper written by Murray D. Snell (Luke's Father). He was a major manufacturer of Canadian White Cedar products and a supplier of cedar leaf oils. This article summarizes a history of the Canadian White Cedar and a snapshot of this industry in the 1970s.

The second paper is a result of collaboration with an Adjunct Instructor (a retired Vice President of Granite City Steel) and Luke. He came into my office and suggested we do a paper on steel nails. Over the years, he had collected information on nails but never put it together. This proved to be an interesting challenge, as I had to learn about a material I did not know about.

As you read these papers, our hope is that you develop an appreciation of the materials most of us take for granted. They have a rich (and mostly hidden) history that has improved our lives! Enjoy!

Luke and Billie Snell

Unique regional technique grew out of Erie Canal construction

Cobblestone Masonry Construction

by Luke M. Snell

A unique construction technique called cobblestone masonry flourished in the United States between 1825 and 1865; several buildings still exist as testimony to the technique's durability. Approximately 800 cobblestone structures were built, most of them in the area of Rochester, New York. Others were built in Illinois, Michigan, and Wisconsin.

The cobblestone masonry era has been linked to the construction of the Erie Canal for which excavated stone was used to build canal locks and bridge abutments. The work required a large number of skilled stone masons, who were recruited to the relatively undeveloped frontier of western New York state from New England, Pennsylvania, eastern New York, and as far away as England.

When the canal was completed, western New York began to boom. For the first time, farmers could ship crops easily to the East Coast. The canal also spawned many allied businesses—restaurants, hotels, blacksmiths, stables, etc.—to support the shipping industry. Many of the masons from the Erie Canal construction stayed in the materially rich Fingerlake and Great Lakes areas as farmers and businessmen, and many of them did part-time cobblestone masonry work.

A cobblestone is defined as a stone from 2 to 10 in. (50 to 250 mm) in diameter. The early cobblestones were elongated, shaped like a loaf of bread. And they were abundant in the plowed fields and along the lakes and streams of western New York, providing a supply at no cost except for the time of gathering and sorting them.

Limes and natural cements were commonly used mortars during this time. Portland cement was patented in 1824 by the English builder Joseph Aspdin, but production techniques for it were not perfected until 1845, and even then the cost was high and availability was limited.

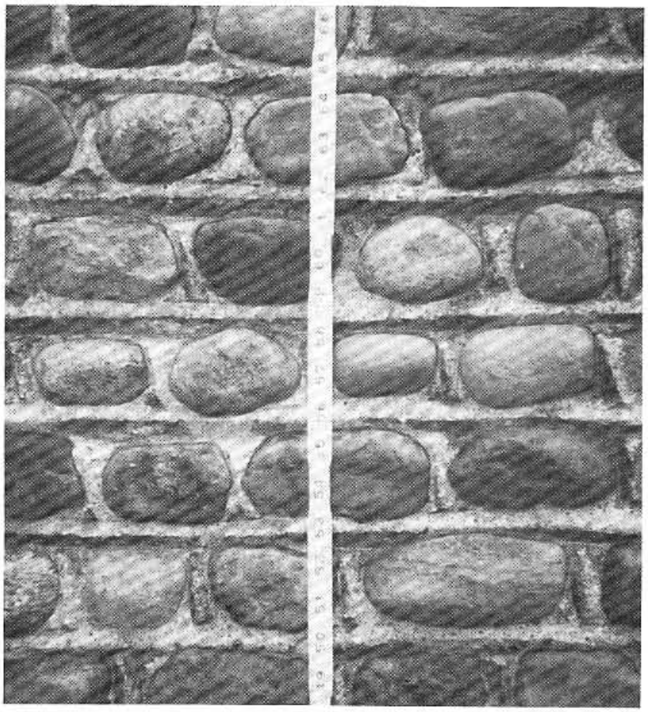
Limestone was abundant in western New York and making lime was relatively inexpensive. Lime had been locally manufactured for the Erie Canal construction and these facilities remained active, making lime available at a low cost.

The lime was produced by burning ground limestone (heating it to approximately 2000 F [3870 C]) to create quicklime. The quicklime was then converted or slaked to a usable lime product at the jobsite. The following is summarized from a cobblestone mason's notes describing the process of slaking the quicklime for use in mortar:[1]

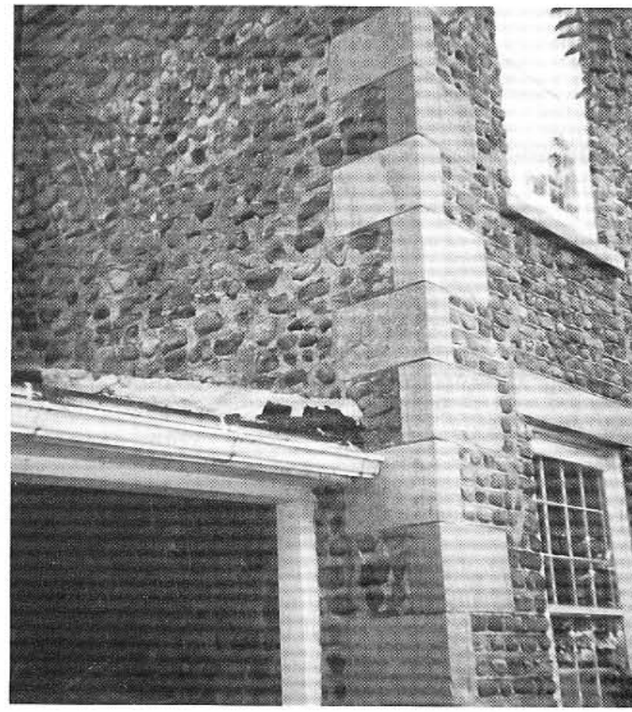
> (1) Quick lime to be slacked (is put) in a box. Then mix with equal parts of sand.
>
> (2) Pour in a pit dug in the ground and left for at least a year. Cover with at least two inches of sand.
>
> (3) Remove from pit and mix with two additional parts of sand.
>
> (4) A rule when mortar was ready for use: that mortar would not stick to a trowel when trowel was inserted into mortar, and trowel would pull out clean.

Unlike portland cement, lime mortar hardens by reacting with carbon dioxide in the air. The lime is protected from the air while it is in the pit, allowing ample time for the slaking process (changing the fresh quicklime to slaked lime) to be completed.

Cobblestone masonry construction emerged about 1825 when western New York was prosperous and growing. At the same time, a large number of part-time masons were available, cobblestones and lime were accessible, and homeowners and builders apparently were willing to try new construction techniques.



Sometimes the mortar was troweled to a "V" between the rows of cobblestones so that they would stand out distinctly.



Often, the side of a house that was visible from the road was cobblestone masonry, while the sides not seen were typical fieldstone construction.

Cobblestone masonry basically consists of uniform sized cobblestones placed in horizontal rows. Sometimes the mortar was troweled to a "V" between rows so that the cobblestones would stand out distinctly. These details were for visible exterior walls only. In some cases, the side of a house that was visible from the road was cobblestone masonry, while the back of the house was typical fieldstone construction.

Cobblestone walls were approximately 15 to 24 in. (380 to 610 mm) thick, with fieldstone being the majority of the wall. The cobblestone was placed as a facing veneer for the structure's exterior; the interior walls were plain fieldstone. The elongated cobblestones extended into the fieldstone (the fieldstone and the facing veneer were constructed at the same time) so that the elongated stone functioned as its own tie.

With this technique, a mason could lay about three courses of cobblestone (10 to 12 in. [250 to 305 mm] high) on a 40 ft (12 m) wall in a 12 hour work day. Obviously, the technique was extremely slow and would be cost effective only when skilled masons were available at a low cost and the cobblestones and fieldstone were plentiful.

As cobblestone masonry became more popular, methods were developed to improve the speed of construction. One procedure was to build the fieldstone wall first, then to add rounded cobblestone as a veneer afterward. Unlike the early construction, these cobblestones were not tied into the fieldstone walls, making these walls less durable.

Only a few masons built more than three cobblestone houses, so there were few improvements in the process. Several masons worked together on homes and learned the techniques from each other, but work would stop when there were visitors on the jobsite. The masons apparently did not want to share their trade secrets and risk competition for masonry work.

Little has been written about cobblestone construction.[2-6] Most of what we know is what a few owners wrote. One of their accounts is given in the following letter to the editor of "Cultivator" magazine:

Messrs Editors:

In 1835 I built me a house of cobblestone, of the following description: front 45 x 83 feet, 2 stories, forming an "L" in rear of 65 x 23 feet, single story for kitchen, washroom and wood shed. My plan for thickness of wall was: the cellar wall 20 inches thick to first floor, drop off two inches to second floor, then drop off two inches, and extend out to top. Sort your stones so as to have the outside course three or four inches, with straight lines for cement. Take the coarsest of sand for the stone, and a fine sand for brick. I used the common stone lime, one bushel of lime to seven of sand for stone, and the same kind of lime, one bushel to two of sand for brick. Furnished all materials on the ground, and paid my masons $3.75 per hundred feet. He furnished his own tenders and made his own mortar, built his own scaffolds and tended themselves. I boarded them. I think I have as good a house as can be made of the same materials. There is not a crack in the walls that you can stick a pin in as yet. The stone, I do not consider any expense as it frees the land of them. There is no painting to be done to it, as is required of brick or wood, it makes the strongest of walls, and I think the neatest and cheapest building that can be made. You may calculate the expense of the building at so much a perch, according to the size you wish to build. I did not keep an exact account of my building, as the stone, sand, and lime were bought at leisure spells.

P. P. Bonesteel
Victor-Ontario
County
New York
March 1842

The homeowner considered the cobblestones and the time to gather and sort them to be free. But if this cost were considered realistically, it would be considerably higher than most other materials.

The cobblestone masonry buildings in other parts of the United States appear to have been built by masons who learned the techniques in western New York and moved on. In most cases, only a few homes were built in any one area. The unique conditions that sustained its use in western New York and along the Erie Canal did not exist in other parts of the country, where cobblestone masonry was more of a novelty.

The era of cobblestone masonry construction ended about 1865, or after a single generation of masons. The technique was just too slow, and thus too expensive, to continue.

The durability and beauty of this type of construction is evident in the cobblestone structures that still stand, many of which are preserved as homes and stores, and as monuments to a unique era and to yesterday's craftsmen.

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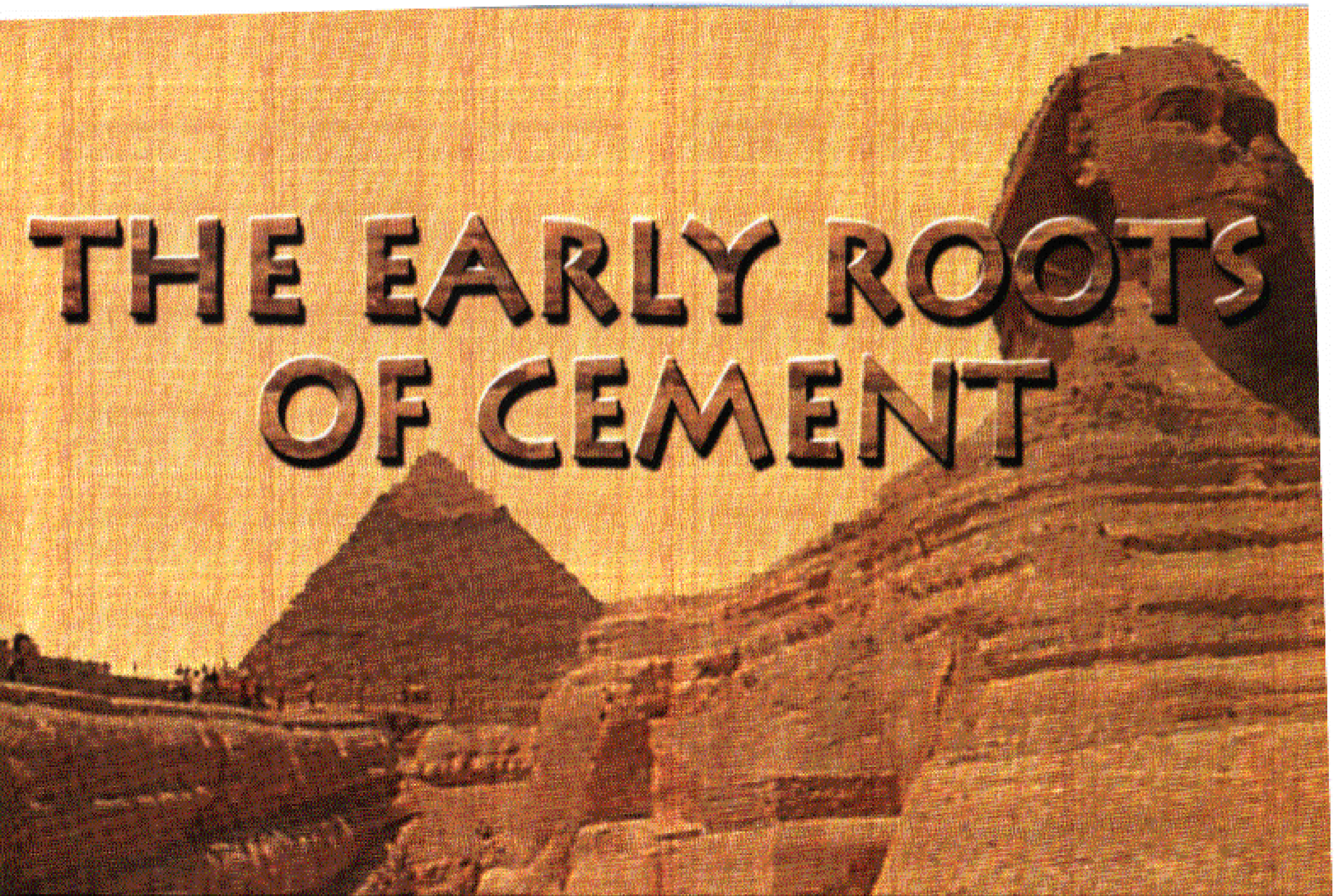

THE EARLY ROOTS OF CEMENT

by Luke M. Snell and Billie G. Snell

When most of us think of masonry construction, we envision a mason putting blocks or bricks into a bed of mortar. The mortar would be made from portland cement, lime, sand, and water that bonds the bricks or blocks together. The finished construction is a wall in a wide variety of structures.

The world's first major masonry project was very different from today's construction. Approximately 4500 years ago, Egyptian engineers and constructors built the pyramids. These are the only intact and remaining Ancient Wonders of the World, and they intrigue us as we speculate about how they were built.

It is obvious that the pyramids are not like most construction. The Great Pyramid is 3044 ft (928 m) at its base and its height is 484 ft (148 m). The blocks vary in size from 4000 to 100,000 lb (1800 to 45,000 kg). The constructors did not have block and tackle to handle these massive stones. Most historians are of the opinion that the equipment used to move these blocks into place included wedges, levers, incline planes, rollers, and sleds. The exterior blocks were cut so that when placed, the gap between the blocks would be 0.02 in. (0.5 mm).

The weight of the blocks and the shape of the pyramid made mortar unimportant for bonding the blocks together into a continuous mass. Gravity and the design of the pyramid basically held the structure together.

Use of mortar in pyramid construction

Several of the mortars used in the Great Pyramid have been analyzed and a typical analysis indicates:

Material	%
Gypsum	70 to 90
Carbonate of lime (limestone)	8 to 17
Sand	2 to 8

One researcher analyzed mortar samples from the Sphinx, and from Giza and Karnak. These results showed a wider variation:

Material	Maximum %	Minimum %
Gypsum	90	23
Carbonate of lime (limestone)	72	1
Sand	26	2

Most of the mortars appear to be basically a processed gypsum that had traces of sand and limestone when mined. Gypsum is plentiful in Egypt, and is available from two sources. It can be mined from rock formations (in several areas of the country) or can be found in scattered areas just below the surface. In each case, the gypsum has a small percentage of sand and limestone thus supporting the concept that gypsum was used as processed. The sand and limestone were not added but were "contaminants" of the processed gypsum.

"THE QUESTION THUS IS: WHY DID THE EGYPTIANS USE A RELATIVELY WEAK MORTAR THAT WILL DETERIORATE IN WET WEATHER?"

Properties of gypsum

Gypsum is not used today as a mortar. It has relatively low strength and deteriorates in wet weather. The authors made a mortar similar to those used in the pyramids, composed of 85% processed gypsum (plaster of Paris), 5% sand, 10% limestone, and a water-to-gypsum ratio of 0.6. The 7 day strength was 2650 psi (18 MPa); when cured under water (one day in mold, 6 days in wet cure), it was 1290 psi (9 MPa). These strengths would be much greater than those achieved by the Egyptians.

The authors used a fine-ground plaster of Paris, which is a pure form of gypsum that is processed to make it very reactive. The experiment does show that the mortar lost 49% of its strength in a 6 day water cure. This would indicate that gypsum mortar would not be acceptable as a mortar in a wet environment. For Egyptian construction, especially in the desert area, when the pyramids were built, gypsum mortar would obviously work.

Egypt had several limestone quarries and could have developed a much superior lime mortar, yet there is no evidence of lime mortar used in Egypt until the second century BC or approximately 2500 years after the pyramids were built. The question thus is: Why did the Egyptians use a relatively weak mortar that will deteriorate in wet weather? Although there are no written records that explain why gypsum mortar was used, several clues are available.

Gypsum is a relatively easily mined rock and is chemically known as hydrous calcium sulfate. When heated to approximately 265 F (130 C), part of the water is driven off, as shown

$$CaSO_4 \cdot 2H_2O \rightarrow CaSO_4 \cdot 1/2H_2O + 1\text{-}1/2H_2O$$

Δ Temperature: 275 to 345 F (135 to 175 C)

When recombined with water, an interlocking crystalline structure of hydrous calcium sulfate ($CaSO_4 \cdot 2H_2O$) is reestablished. This becomes the mortar that was used in the pyramids. Egypt has little available natural fuels. However, the 265 F (130 C) temperatures needed to process the gypsum can be easily achieved with an open fire. To make lime, temperatures in excess of 1800 F (1000 C) are needed. Many historians speculate this was one of the reasons lime manufacturing was not developed. The scarcity of fuel made lime mortar noneconomical, plus the fact that gypsum mortar apparently was successful.

Gypsum mortar reduces friction

As stated before, the mortar was not needed to bond the stone blocks together. However, the mortar played a critical part in the construction of the pyramids. The key reason mortar appears to have been used was to "butter" the joints and to reduce the friction as the blocks were maneuvered into place. A simple experiment performed by the authors showed that the force to move a block is reduced by approximately one half when gypsum mortar is used (see Fig. 1). Using a spring scale, the force was measured by pulling a concrete brick in position. The experiment was repeated by using a gypsum mortar between the bricks. The force was approximately half when the gypsum mortar was used. (It is possible that the force could be reduced further by varying the mixture.) The concept of using the gypsum mortar to "butter" the joint appears to be a sound engineering judgement.

One of the earliest uses of gypsum was as a mortar as part of the building of the Egyptian pyramids, one of the largest and oldest construction projects still in existence. The size and shape of these structures makes the mortar of little importance for the finished product. However, during the actual building of the pyramid, the mortar made the construction more feasible. The Egyptian engineers and constructors developed the ideal mortar for a lasting structural marvel that we continue to appreciate today.

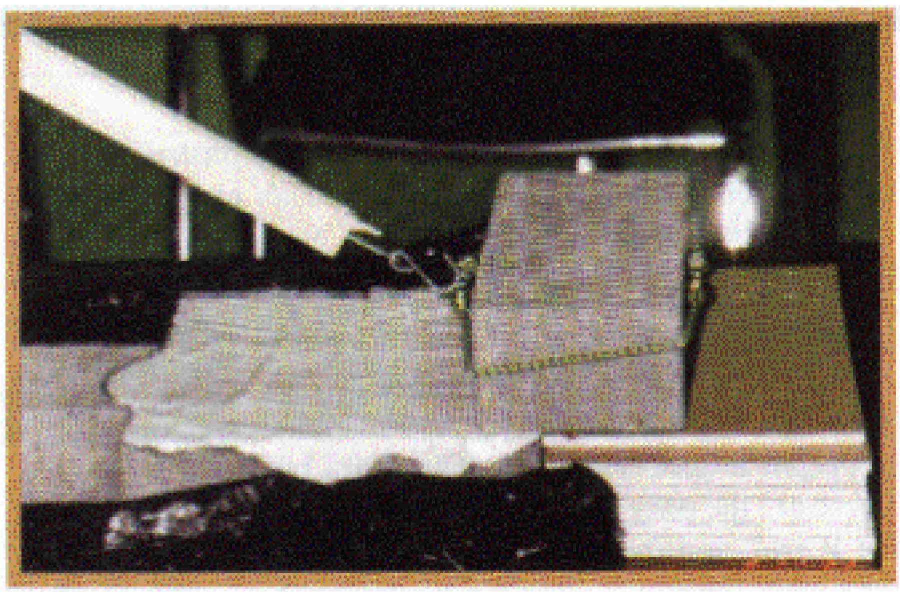

Fig.1 — A simple experiment that shows friction between concrete bricks is reduced by over 50% when a processed gypsum mortar is used.

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Photo — An 1858 picture that shows the timeless beauty of the pyramids.

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Graveyard Concrete

Cement use in the historic cemeteries of the French Quarter

BY BILLIE G. SNELL AND DEBBY L. AMON

Fig. 1: A large mausoleum within St. Louis Cemetery No. 1 in New Orleans. Mausoleums are typically constructed for use by individual families and for members of organizations, such as the Grange

This article had initially been scheduled for the October 2005 issue, just prior to the ACI Fall 2005 Convention that was to take place in New Orleans, LA. In the wake of the destruction caused by Hurricane Katrina and the subsequent relocation of the convention, the article was postponed. It is presented now in tribute to the historic legacy of New Orleans as the city's reconstruction continues.

Throughout our everyday lives, concrete surrounds us. We are born in concrete hospitals, attend concrete schools and churches, walk on concrete sidewalks, travel over concrete roads and bridges, and even reside in concrete homes. It really should be no surprise then, that in death, many families choose to have their loved ones interred in a concrete crypt or mausoleum (as shown in Fig. 1).

Although most concrete crypts and mausoleums are built in low-lying areas, where water could easily destroy a coffin, it's not entirely true for the city of New Orleans. Basically, the majority, if not all, of the crypts and mausoleums in the cemeteries of New Orleans were built along the lines of traditional European cemeteries and to represent the architecture of a French city. In fact, many visitors to New Orleans have stated that these cemeteries do look like a miniature city—a "city of the dead"[1] (Fig. 2 and 3).

Most of the crypts and mausoleums in New Orleans are constructed of brick covered with a cement plaster (see Fig. 4). Even when these crypts and mausoleums need repair work done, workers use a mixture of both lime and cement. This combination does not detract from the original structure.[2]

Venturing into any New Orleans cemetery is never quite complete unless one takes a walk down memory lane in St. Louis Cemetery No. 1 to view the most well known of all crypts—that of Marie Laveau, the notorious Voodoo Queen. Marie was a famous practitioner of voodoo, a mystic cult with African origins. As shown in Fig. 5 and 6, her crypt is constructed of lime and cement stucco over brick. Located in the front of St. Louis Cemetery No. 1, this crypt is definitely one of the many examples of New Orleans' rich history.

Fig. 2: A typical New Orleans cemetery resembles a small city—a "city of the dead"

Fig. 3: Another view of a "city of the dead" within a New Orleans cemetery. A concrete pump is being used for the repair of a cemetery wall

Fig. 4: This particular crypt shows the stucco of lime and cement over the brick structure

Fig. 5: This crypt also shows the stucco of lime and cement over the brick structure. Sometime in the 1960s, X marks or cross signs began showing up on crypts as part of supposed voodoo ritual. According to tradition, however, they have no connection to voodoo practice. Cemetery preservationists consider the marks acts of vandalism

Fig. 6: At the very front of St. Louis Cemetery No. 1 is located one of the most famous crypts, that of Marie Laveau, the Voodoo Queen. The X marks are clearly visible

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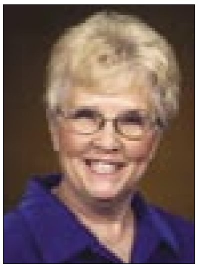

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Monumental Achievements

Readers respond with their favorite concrete monuments.

In the October 2006 issue of THE CONCRETE PRODUCER, we asked our readers to nominate their favorite "must-see" concrete monuments from across the country. Then at World of Concrete in January in Las Vegas, we asked attendees to vote for the favorites. The results are in. Below are the favorites.

Brown County Veterans Memorial, Green Bay, Wis.

This total precast concrete structure was dedicated in 2003 to the veterans of Brown County. It honors veterans from all branches of the armed forces: Army, Air Force, Coast Guard, Marines, and Navy. The monument was paid for by donations from the sale of Tribute Bricks, markers honoring individual veterans. The structure does not honor or glorify war, but shows appreciation to the common men and women who served to protect peace and freedom.

The Parthenon, Nashville, Tenn.

The Parthenon proudly stands as the centerpiece of Centennial Park in Nashville. The re-creation of the 42-foot statue Athena is the focus of the Parthenon, just as it was in ancient Greece. The building and Athena statue are full-scale replicas of the Athenian originals, which are made of marble. The Nashville version was created from structural reinforced concrete, cast concrete aggregate, brick, and stone. It was built between 1921–31.

American Stonehenge, Maryhill, Wash.

This replica of the famous Stonehenge in England is made of reinforced concrete. Sam Hill, a wealthy railroad executive, built the structure on a lonely bluff overlooking the Columbia River. In building the replica, Hill intended to memorialize the Klickitat County soldiers killed in World War I. He considered it a reminder that "humanity is still being sacrificed to the god of war."

Other nominees...

Cushman/Hewitt/Gifford Monument, Woodstock, Ohio

Cast and sculpted by Warren Cushman in the late 1890s, this monument is dedicated to the men who served in the Union Army during the Civil War. The structure is made of Buckeye Portland Cement, stands 22 feet tall, weighs 62 tons, and took three years to complete. In 1899, the Portland Cement Association placed a full-page picture of the monument in its magazine to publicize the versatility of its product.

High Family Gravestone, Bayham, Mich.

The monument dedicated to the High family, originally from Midland, Mich., and then Bayham Township near Straffordville, Ont., is a 5-foot-high obelisk. The earliest date on it is 1808.

— Special thanks to Luke Snell, director of the Concrete Industry Management program at the Del E. Webb School of Construction at Arizona State University, for compiling the information.

Here is the complete list of monuments, including those from our October issue, so that you can plan a "concrete vacation."

USS Arizona Memorial – Honolulu, Hawaii
International Peace Arch – Blaine, Wash.
American Stonehenge – Maryhill, Wash.
Peace Tower – Kelvin, N.D.
Brown County Veteran's Memorial – Green Bay, Wis.
Chief Black Hawk – Oregon, Ill.
The Lewis and Clark Confluence Tower – Hartford, Ill.
Jefferson Davis State Historical Site – Hopkinsville, Ky.
The Parthenon – Nashville, Tenn.
The High Family Gravestone – Bayham, Mich.
Woodstock Civil War Veteran's Memorial – Woodstock, Ohio
Remembrance Walk – Rochester, N.Y.
Eric Goodwin Passage – Charlottesville, Va.

The Erie Canal – America's First Concrete Classroom

by Luke M. Snell and Billie G. Snell

As the 19th Century dawned, the United States was still basically confined to the Atlantic coast. Although the new nation greatly enlarged its boundaries by the Louisiana Purchase of 1803, the Appalachian Mountains and the lack of an interior interconnected waterway made it difficult to penetrate the vast forested lands to the west of the 13 original colonies.

Albany, New York, was still a frontier town. The overland movement of goods was cost prohibitive. An eight-horse wagon took 15 to 45 days at $100 per ton (0.9 tonne) for the journey from Buffalo to Albany.[1] As a result of these circumstances, New York State officials saw an opportunity for the future development of the area and also to provide a major western route for the United States. This, coupled with salt deposits at Syracuse and the need to transport that salt to the east coast, stimulated interest in a canal system across upper New York.

Not everyone was interested in a canal system in New York. When President Jefferson was asked to fund construction of the canal, he had just signed a bill to start work on the National Road west from Baltimore. Jefferson's reply to the request: "It is a splendid project and may be executed a century hence...here is a canal of a few miles projected by General Washington (the Potomac Canal) which has languished for many years because of a small sum of $200,000...cannot be obtained...think of making a canal 350 miles long through a wilderness! It is a little short of madness to think about it."[2]

As a result of Jefferson's action, New York state legislators were no longer enthused with the construction of the canal since the state would now have to totally finance it. At the close of the war with England (War of 1812), a petition explaining the benefits of a canal system circulated throughout the state, especially through those counties in which the canal would pass. The legislation received appeals from more than 100,000 people to build the canal. Due to public pressure, the State of New York finally authorized $20,000 for a detailed survey, and construction of the canal system began July 4, 1817.

Although the people of New York were willing, several challenges became evident. The proposed canal was over twice as long as any previously constructed and, at this time, the United States had few engineers.[3] Several debates on whether to hire foreign engineers or "do it ourselves" were conducted in the New York Assembly. Many saw this as an opportunity to prove that Americans could handle their own destiny. The final decision was to design and build the canal system with United States personnel; thus, the Erie Canal would be the laboratory for America's "first school of engineering."

HISTORY OF CONCRETE

ACI Committee 120, History of Concrete, welcomes additional contributions related to concrete history from ACI members.

Such contributions should be brief, of three double-spaced pages of text with one or two illustrations, if possible. For information about such contributions, please contact Stella Marusin at Wiss, Janney, Elstner Associates, (708)272-7400.

In 1816, a young self-trained engineer, Canvass White, was hired as an assistant to the surveyor. Although his formal training consisted of some basic mathematics, science, and surveying, White's ability caught the eyes of the chief engineer, Benjamin Wright, and the governor, DeWitt Clinton. Since knowledge of canal construction was so limited, Clinton requested that White go to England and study the existing canals, locks, and buy improved surveying equipment. White journeyed to England, walked the canal system and sketched in great detail its construction.[3,4,5] Armed with these details and with the very latest surveying equipment, White stepped into a major technical challenge.

The canal was designed to go from Buffalo (another small settlement) to the Hudson River at Albany. To build this 363 mile (584 km) waterway, 83 locks were required. The ideal way to build the locks was to use stone and cement. Mortar made from this cement would become harder, relatively impermeable, and would be ideal for use on the Erie Canal system. Basically, the limestone rock used to make the cement must contain the right amounts of natural ingredients so that the natural hydraulic cement is a product rather than the lime. This cement was available only in Europe and had to be imported at great cost. Lime was manufactured in the United States but was not as durable as the natural hydraulic cements. Earlier, consideration had been given to building the locks out of wood due to the abundance of lumber but this idea was dropped due to the short service life of such material.[4]

The concept finally agreed upon was to build the locks out of stone and lime

Excerpts from "Directions for Using White's Patent Hydraulic Cement":[6]

"To every bushel of the powdered cement add one bushel of sand, mix them together and pass them through a sieve, then add a sufficient quantity of water to make it (by well mixing and working) about the consistency of a soft putty. It is then fit to use but should not be kept more than six or eight hours and should be thoroughly worked just before it is used."


Canal engineer White

"The valuable properties of this cement depend in a great measure on the mode of preparing it for use. The mixing should therefore be conducted with care in order to form a perfect union of the powdered cement, sand and water. This can be best accomplished by the use of the New England corn hoe on a board floor or by beating with a hand stamper; not much labour is required if properly applied. Mechanics can judge when the mixture is perfect by the appearance of the mortar, which, when properly prepared, very much resembles putty."

"The sand should be neither coarse nor fine but of a middling quality or about the size of the common pop(p)y seed. If the sand is too coarse the mortar will be short or brittle...If the sand is too fine the cement will shrink and crack after it has been used."

"This cement can be used in any situation and for any purpose to which any other mortar or hydraulic cement can be applied. It does not become perfectly hard within one or two months."

mortar with the outer edges of the mortar joints made with the imported natural hydraulic cements. This compromise used as much of the local resources as possible and would still provide a fairly durable lock system.

While traveling in England, White had witnessed the manufacture of the natural hydraulic cements. In 1818, he experimented with several local limestone sources that were near the Erie Canal. He found one deposit near Chittenango, southeast of Syracuse, that would form a natural hydraulic cement when correctly processed. (This process involved heating the limestone and reducing the end product to a powder.) This cement was used in canal construction as early as 1818 and in all face work of locks and arches. Some of this work still remains in place.

The plant at Chittenango produced many thousands of bushels of cement annually until at least 1840.[5] Although White patented his cement, he never trusted his patent. He wrote that the production of cement must be "a good and cheap article...As no reliance can be placed on a patent, our only protection will be in honesty and punctuality."[6] To insure that his cement was correctly used an instructional brochure was prepared.[7]

As the first concrete engineer of the United States, White was able to incorporate his natural hydraulic cement into several other American canal systems. The solution to the challenges presented by the Erie Canal enabled the country to expand at less expense, to develop young and bright engineers, and to manufacture America's own natural hydraulic cement. White's patented cement was now available for the young country to further American enterprise and to continue the development of the new nation.

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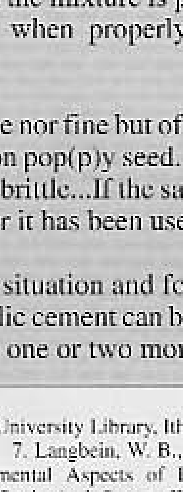
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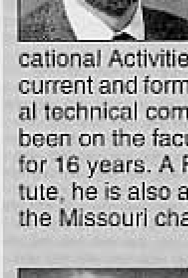
Billie G. Snell is an educator consultant and teacher as well as president and owner of Snell Educational Enterprises, Edwardsville, Ill., which develops science kits for children.

"Untoppled" Historic Tipple

BY LUKE M. SNELL AND BILLIE G. SNELL

As you enter Muddy, IL, your attention will be drawn to a sign announcing one of the small town's historical attractions (Fig. 1). The sign proclaims that Muddy has "The only mine tipple built of solid concrete existing anywhere in the world." This might be a stretch. Nonetheless, the structure is called the O'Gara (later the Sahara) #12 Muddy Mine Tipple, and the claim is also made by the townsfolk that the tipple is the first of its type built with reinforced concrete. There have since been many concrete tipples and most modern varieties are of reinforced concrete construction.

What is a tipple? A tipple, like the historic one described here, is a structure—or its location—at a mine where coal cars from the mine are upended physically—tipped as it were—and emptied of their contents. The coal can then be unloaded into a storage area, or directly into a loading chute. In earlier times, the tall tipple was the prominent structure at the surface of an underground mine. A large edifice, it housed a rotary dumper for emptying the loaded cars bringing mined coal and waste rock excavated underground.

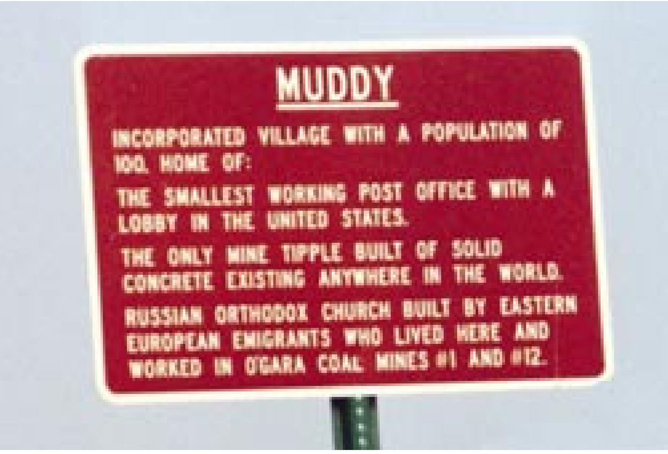

Fig. 1: The historical, reinforced concrete structure is a source of local pride

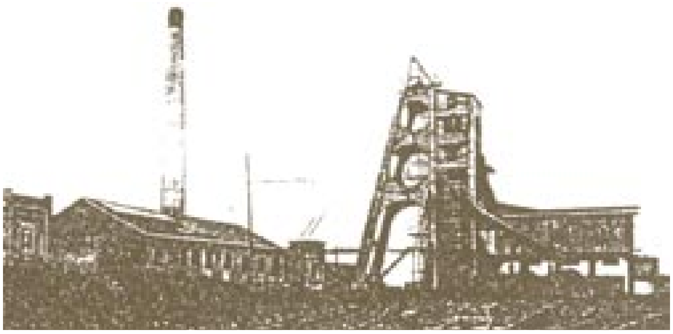

Fig. 2: The Muddy, IL, tipple at work in the 1920s

Fig. 3: After more than 80 years, the structure is still in excellent condition, having resisted decades of freezing and thawing

Conjecture in Muddy, IL, is that its tipple's back legs are set on an angle to function as a ground-mounted hoist, aiding also in raising the loaded cars up from the mine and lowering the empties. Once hoisted and tipped out, a car's pieces of excavated material were dumped into conveyors and carried on to screens for sorting according to size and quality—waste rock being removed at the same time. Also, a tipple served as a storage facility before the coal was transferred to another type of conveyance, such as truck or rail car (Fig. 2).

What makes Muddy's tipple so unique as a historical concrete structure is that before its time most tipples were constructed of wood, brick, or even concrete block, but not cast-in-place concrete. Such a structure was even unusual as late as the 1930s, yet the Muddy tipple was built in 1923 by the now defunct Allen and Garcia Co. for the O'Gara Coal Co. It closed operation in 1930 as the Great Depression of the time deepened.

Though much more information about this historical tipple has been lost, it still remains as a magnificent and unusual cast-in-place edifice that today is still in near perfect condition (Fig. 3).

Selected for reader interest by the editors.

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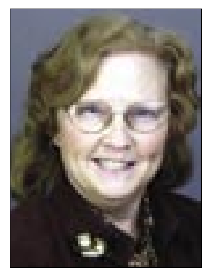

Billie G. Snell is a teacher, educational consultant, and a researcher in the Concrete Construction Resource Unit at SIUE. She is also an ACI Missouri Chapter member and the ACI Missouri Chapter newsletter editor.

Oldest Concrete Street in the United States

An experimental pavement proved successful, and is still in use today

BY LUKE M. SNELL AND BILLIE G. SNELL

Bellefontaine, Ohio, was like many small towns in the 1890s. It was a growing community and had traffic problems. (The traffic was basically buggies, wagons, and horses; cars would not start to appear for at least another 10 years.) Like many small towns, the street conditions depended on the weather. When raining, the streets were muddy, and when dry, they were hard and dusty. Unlike other towns, Bellefontaine had two visionary men, George Bartholomew and James C. Wonders, who were willing to try a new material called artificial stone, or concrete, to solve its problem.

George Bartholomew had moved to Bellefontaine, Ohio, in 1886 after having learned about cement production in Germany and at the San Antonio Cement Co. of Texas. He had found in mid-Ohio almost pure sources of limestone and clay, the main ingredients for the production of cement, and had hoped to bring cement and concrete technology to the Midwest.

After successful experiments in making cement, he started the Buckeye Portland Cement Co. and began promoting the use of artificial stone (concrete). An obvious solution to the muddy and dusty street problems was to use his cement and create a concrete pavement. The city council was skeptical about this concrete pavement. It was concerned that the pavement would not be durable and would abrade as a result of the heavy loads on steel-rimmed wagon wheels.

The city council could find no models of successful concrete pavements. New York City had used concrete as a base course with a wearing course of Macadam and cobblestone, but using concrete for the pavement and the wearing surface was unprecedented.

In 1891, the city council took the first steps in concrete paving to see if this new concept had any merit. It authorized the paving of a small section of a roadway: an 8-ft (2.5 m) strip next to the hitching posts. The experimental concrete pavement proved to be successful and provided a durable roadway free of mud and dust. Still skeptical about embracing this new concept of concrete pavement, the city council took an extremely conservative approach to its next step. It authorized the paving of the square around the courthouse, provided George Bartholomew was willing to donate the cement and post a $5000 bond that guaranteed the pavement would last 5 years.

The construction followed the same techniques that had been developed for sidewalk construction. The slabs were formed in 5-ft (1.5 m) squares with tar paper between adjacent slabs, and a two-layer pavement system was used. The bottom, or base course, was approximately 4 in. (100 mm) and had maximum-sized aggregate of 1-1/2 in. (40 mm) with a water-cement ratio of 0.60. The top, or wearing course, had maximum-sized aggregate of 1/2 in. (15 mm) and a water-cement ratio of 0.45.

The historical marker celebrating the 75th year of service

The mixing of the concrete was done without heavy equipment. The sand, stone, and cement were dumped into a pile, and after mixing the concrete with hand-powered screw mixers, the concrete was tamped into the forms. This mixing-and-placing method entrapped approximately 8% air. The concrete was cured by the continuous wetting of 2 in. (50 mm) of sand for one week; when finished, the strength of the concrete (measured by recent cores) was more than 5000 psi (34.5 MPa). When freezing weather was expected, 2 in. (50 mm) of sawdust was used as an insulating blanket.

This pavement was considered so revolutionary that the Chicago International Exposition of 1893 awarded George Bartholomew First Place for Engineering Technology Advancement in Paving Materials. This was a major accomplishment and helped to lend credibility to this new technique.

James C. Wonders, the Logan County engineer, designed the pavement and provided technical direction for the road construction. Although most of the credit for the first concrete street goes to George Bartholomew, Wonders provided the technical expertise and direction to make it a successful project. Wonders went on to additional successes, becoming the State Highway Commissioner (Ohio) and a road expert for the U.S. Bureau of Public Roads.

In 1991, Bellefontaine had a major celebration honoring George Bartholomew and his experimental pavement that is still in use. The street was later closed to traffic so the town could preserve this historical pavement. This became a political issue with many people who felt that closing this street to vehicles caused parking and traffic problems around the courthouse. After the next mayoral election, the street was opened once again to light vehicular traffic, and is still in use. The statue of George Bartholomew at the end of the street keeps truck traffic from using this pavement.


Monument to the 50th anniversary of the concrete pavement. Folklore states that the full-depth cross section on the sign shows the outline of the State of Ohio

The concrete pavement turned out to be a success. The overall materials and construction costs (excluding the cost of the donated cement and the bond) was $9000, and the maintenance and repair cost for the first 50 years was $1400. Obviously, the bond to guarantee the road for 5 years was really never needed. When you visit the

A piece from the Bellefontaine concrete pavement that shows the full depth (note the two layers of pavement)

The oldest concrete street in the United States as it appears now (the street is still in use)

Statue honoring George Bartholomew for his insight in using concrete pavement. This statue is at the end of the street and limits the use of the street to light vehicles

courthouse in Bellefontaine, Ohio, you can see some of the original concrete pavement still in place and in use, although the concrete pavement does show wear (what wouldn't after almost 110 years of service?). You can also see a statue of George Bartholomew that honors his vision of using concrete as a paving material.

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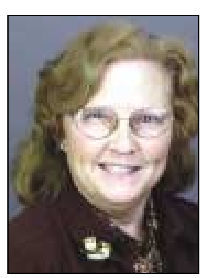

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Via the Video

Presenting "concrete" history to grade school children*

Since 1992, members of the Ohio Ready Mixed Concrete Association have worked with Ohio school teachers to present concrete in grade schools. These presentations were intended to show the children that concrete can be both challenging and also can be exciting.

Ohio is blessed with many historical events that involve the uses of concrete. To enhance the on-going concrete activities with these schools, a video has been developed to show a sample of this history. The video can become a part of a balanced educational approach that allows children to integrate history, math, science and technology in a single format.

Throughout the years the Ohio Ready Mixed Concrete Association (ORMCA) has developed several different higher educational programs to promote the successful use of concrete. These programs were designed for a wide variety of professionals, to show the correct procedure for concrete construction and design as well as to promote concrete awareness. In 1992, ORMCA started a new endeavor that was aimed at a younger audience. A program for grade school children was begun (*Concrete International*, March 1992).

The Concrete Kits for Kids program provides hands-on experience for grade school children as they learn about this basic building material. After the children physically make and cast a floating concrete sample, engineers and/or technicians talk to the classes about the concrete industry.

Most children have no idea of the role of concrete in the economic and historical development of Ohio. To illustrate the role of concrete in their lives and history, a video presentation was developed.

The video has two purposes: 1) to inform viewers that concrete has been an important part of civilized development beginning with the Roman era to modern time; and 2) to illustrate that concrete has been used and is still an integral part of the development of Ohio. This video connected historically significant concrete structures to other historical benchmarks which occurred at about the same time. Hopefully with this approach the students would see and understand the development of this industry. This can open up new opportunities with the students, such as doing science fair projects and/or developing special projects.

The value of this video to ORMCA members will be in the public's realization that they produce and deliver an important product which has long been substantive to people's activities.

Target audience

The intended audience is school age children of fourth through sixth grade levels. The video would predominantly be used in grade school classrooms. However, the video could be of interest to a wider audience (Rotary clubs, historical societies, and college classes).

Challenges and frustrations

A few challenges were encountered in producing the video. The major problem was keeping within a reasonable budget while locating structures that were significant enough to be included in a history of concrete video.

Outside expertise was necessary for taping most of the video footage. At the start of the project, the actual sites for many of the historical subjects were not decided; a good estimate of the travel and the videotaping time was not available. All of the "then known" taping locations were plotted on a map of the state. The travel route for the cameraman to follow was then marked on this same map. When possible, aerial photographs or video footage, taken by others, were purchased. By this planning, taping time and cost was minimized.

A primary source of information about existing significant concrete structures in Ohio was the Ohio Historical Society. This society provided slides and recommended certain concrete bridges to videotape. They also assisted in the reviewing of the Society's files for old concrete buildings in Ohio.

One frustration that turned into a success was with a house in Newark, Ohio. According to the Ohio Historical Society, the house was a concrete structure, constructed with forms designed by Thomas A. Edison.

The house turned out to be a brick and frame structure of Victorian architecture; it obviously was not the concrete house as reported in the files. Since the local historical society was closed on that day, the crew contacted the local Chamber of Commerce. The Chamber was not familiar with the structure and the local library's information was a duplicate of what was in the state historical society's files.

Fortunately, the resident of the house knew about local concrete houses and the relationship to her own house. From her, it was learned that a developer had lived in her house in the early 1900s. This developer had built seventeen concrete houses on lots near her own house. According to an old newspaper article, the developer had been an associate of Thomas Edison. The seventeen houses, near her property, were in fact the concrete houses made with the Edison forms. These houses provided excellent video footage.

Video production and distribution

Anticipating that the video would be used as part of a grade school class activity, the video needed to be brief. The running time of the final version is about 22 minutes.

Enough copies of the video have been produced to distribute to each of the ORMCA members and for the schools where the Concrete Kits for Kids program was presented. Additional copies of the video are available on an as needed basis.

If you would like more information on the video or details on how to produce this type of video, call (614) 891-0210 or mail your request to P.O Box 29190, Columbus, OH 43229-1090.

Assistance and contributions for this project were made by many concrete and historical specialists including the National Ready Mixed Concrete Association, Portland Cement Association, and The Aberdeen Group.

* This article was submitted by Warren P. Baas and Luke M. Snell.

Concrete In Mongolia — Big Changes

Source: THE CONCRETE PRODUCER News Service *Publication Date: July 17, 2012*

By Luke M. Snell, PE

In 2002, I was invited to go to Mongolia to help start the first Mongolian Concrete Conference and to inaugurate an American Concrete Institute (ACI) chapter in Mongolia. If you are like me, I only had a vague idea of where Mongolia is, so I had to get a world map out to locate it. I found Mongolia is north of China and south of the Siberian part of Russia. It is completely landlocked and has an extremely large desert, the Gobi.

After reviewing all the information and deciding to make the *"trip of a lifetime,"* we felt that in a small way we could make a difference in concrete technology in a developing country. When we arrived in Mongolia, my wife Billie and I saw several abandoned construction sites, and no ready-mix plants or trucks.

Our host took us to some precast plants that made concrete pavers, hollow core slabs, and some small precast units. We also visited some construction sites and saw that most of the concrete was being site batched. The mixture designs that were being used were basic (about 3000 psi) and no admixtures were available. Thus, this concrete had no air entrainment to withstand the bitter cold winters.

Mongolia is located south of Russia and north and west of China.

I began to think this trip would be unsuccessful. The start of a Mongolian Concrete Conference and an ACI chapter appeared to be premature and the people unable to make basic advancements in the concrete industry due to the remoteness of the country.

I soon found out this assessment was completely off base. The engineers, contractors and people working in the concrete industry had been keeping up with the latest developments in concrete and wanted to implement them in Mongolia. At the first Mongolian Concrete Conference about 100 people attended. Even with a language barrier, the questions were detailed and thoughtful. They wanted to learn how to improve their industry.

The meeting of the Mongolian ACI Chapter had 15 members. Their first order of business was to commit to doing the Mongolian Concrete Conference each year. I was overwhelmed by their enthusiasm for improving concrete.

One of 15 concrete trucks bearing the logo of Premium Concrete.

Over the next few years, I was able to go back to Mongolia on funded projects. Mongolia was still suffering from changes in government and economic policies. The price of copper had dropped and the country was in a recession. Roads were not being repaired, construction sites were still abandoned, engineering graduates were having trouble finding jobs, and the concrete industry appeared to be at the same stage as 2002.

At the ACI meeting in Dallas in spring 2012, a manager of a batch plant in Mongolia approached me and asked if I would be able to come to Mongolia and help train his people on concrete.

The economy in Mongolia is now booming. The price of copper has risen and new copper mines are being developed in the Gobi Desert, and construction in Ulaanbaatar is strong. His company, Premium Concrete, had just installed a central batch plant, purchased a quarry, was washing their aggregates, had 15 ready-mix concrete trucks and were now using admixtures in their concrete.

They are trying to establish themselves as the quality and service leaders in Mongolia. Thus, they wanted the training program to help them to provide “premium” concrete and service. They are planning to seek the National Ready-Mixed Concrete Certification for their plants. A cursory inspection of the plant indicates that this is a logical next step in their quality control process.

Technicians perform a slump test at the Premium Concrete batch plant.

After working with them for over a week, visiting several concrete projects, and attending this year’s Concrete Conference, I am optimistic about the concrete industry in Mongolia. They are making great strides and everyone is working together to make quality concrete.

Several people have worked to help in the development of Concrete Education in Mongolia including M.R. Hansen, professor from South Dakota School of Mines and Technology, the late Dick Stehly (American Engineering Testing and ACI president), Frank Kozeliski (formally president of Gallop Sand and Gravel, now consultant), Robert Ripley (marketing manager for Proceq) and John Clark (production manager for Country Materials).

The Premium Concrete batch plant located in Ulaanbaatar plans to seek the National Ready Mixed Concrete Certification.

We also want to thank Zircon, Kestrel, Fluke, Proceq, American Concrete Institute, several ACI Chapters and ACI members across North America and Hanley Wood for donating equipment, educational materials and money to make the Mongolian Concrete Industry a success.

Luke Snell *is Senior Materials Engineer at* ***Western Technologies Inc.*** *in Phoenix, Arizona serving the southwest United States and is chairman of the ACI 120 History of Concrete committee.*
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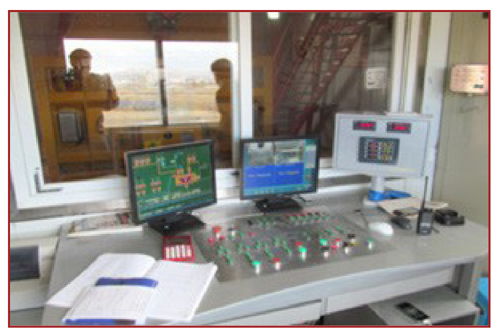
Mongolia Quick Facts:

- The Capital of Mongolia is Ulaanbaatar. Population: 1 million
- Ulaanbaatar is often called the world’s coldest capital city. Average temperature: 27.7°F
- Approximately 33% of Mongolians live in the capital
- Major producer of copper, gold, silver, coal and uranium.
- Formerly communist.
- Sometimes referred to as “Outer Mongolia”. “Inner Mongolia” is an autonomous region in China.
- The country is about the size of Alaska.
- Major trading partners are China, Russia and Korea.
- There are airports, hotels, restaurants, beer, and vodka named after Genghis Khan, a national hero.



The computer system used at the Premium Concrete batch plant.

How ACI's First Certification Program got its Start

A look back after 25 years of ACI certification

BY LUKE M. SNELL

Nowadays, everyone agrees that you can't have an effective quality control program without accurate and consistent testing procedures, and good testing procedures require knowledgeable technicians. But it wasn't always this way…

THE DARK AGES—BEFORE ACI CERTIFICATION

I was on a job site doing my weekly site visit, chatting with one of my best technicians. I commented on how well he knew his job of testing concrete—he laughed and told me that he had a really rocky start. After answering an ad in the newspaper and a brief interview, he was hired immediately and given 5 minutes of training (how to run a slump, how to make cylinders, forget air—it was too complicated of a test), and then sent off to the job site. Luckily, he survived his first experiences, left that company, and learned how to be a good concrete technician with another company.

This year, the American Concrete Institute is celebrating the 25th anniversary of its first certification program. As part of the celebration, we're honoring the individuals and committees who exhibited the foresight, fortitude, and conviction to develop and initiate the first ACI certification program. We've asked Luke Snell, as the Chair of the task group assigned to establish the first ACI Certification program, to recollect how the first program was developed—*John W. Nehasil, ACI Managing Director of Certification*

Unfortunately, his experience was common in the 1970s. ACI deliberated this issue for many years, trying to decide whether it was within the scope of ACI's mission to develop and administer knowledge and skills assessment programs.

In 1978, the issue reached critical mass when the ACI Board of Direction charged the Educational Activities Committee (EAC) with developing a proposal for a certification program. In developing the proposal, EAC adopted the approach that ACI would assume a leadership role in "establishing and maintaining such a program (Certification) for the purpose of improving and regulating the quality of concrete." In support of developing a certification program, then-ACI President John McLaughlin pointed out in his January 1980 *Concrete International* President's Memo, that though barbers must participate in a training and examination program to become qualified to a set of standards, "…I have no such assurance with respect to the qualifications of technicians who are, to a large extent, in day-to-day control of the quality of concrete construction or projects in many parts of the United States."

After much debate and compromise, the Board authorized the formation of ACI Committee E 902, Certification. The committee was chaired by Herman G. Protze III (of W.R. Grace), with ACI Director of Education Harold W. (Bud) Gilley serving as Secretary, and was populated by 14 members from universities, engineering, inspection and testing companies, associations, and admixture and cement manufacturers representing all regions of the U.S. This group began the task of determining the content, form, and delivery method of the first ACI certification program.

THE AGE OF ENLIGHTENMENT—DEVELOPMENT OF THE FIRST ACI CERTIFICATION PROGRAM

At the first ACI Committee E 902 meetings, several issues were quickly agreed upon:

1. The certification program would be national in approach, and would not address regional testing procedures.
2. Program participants would be required to demonstrate that they can use the equipment correctly to perform the procedures and tests.
3. The program would cover sampling concrete, making test cylinders, and performing the slump, unit weight, and air content tests (the temperature test was at first optional).
4. Program participants would need basic knowledge of concrete.
5. The examiners and proctors administering the certification program would be required to know the correct procedures and have a background in the concrete industry.
6. The tests and procedures would follow American Society for Testing and Materials (now, ASTM International) standards.

Following assembly of this framework, ACI Committee E 902 began to sweat the details:

Individuals certified as Concrete Field Testing Technician—Grade I have demonstrated the knowledge and ability to perform and record the results of basic field tests on freshly mixed concrete, including slump flow testing *(photo courtesy of the Ohio Ready Mixed Concrete Association)*

ACI certification training is conducted in Spanish throughout Latin America

Air content tests

With most of the U.S. using the pressure method to determine air content and few areas regularly using the volumetric method, the Committee agreed that many technicians might never see, much less perform, a volumetric air test. ACI Committee E 902 discussed whether it would be fair to require all participants to conduct the volumetric test. Some argued that the test should be optional, with areas routinely using porous or lightweight aggregates free to require it, while areas typically not using these types of aggregates would be free to eliminate it.

During the deliberations, it was observed that a technician with an ACI certification may move to another area where the volumetric air test is used. ACI Committee E 902 then decided that to be an effective national certification, ACI's certification program must include *both* air tests. It is interesting to note that after 25 years, this issue is still debated, particularly as the program continues to expand beyond the borders of the U.S.

Knowledge level of the technician

This proved to be one of the most hotly debated issues and took almost 2 years to resolve. Some ACI Committee E 902 members believed that an ACI-certified technician should possess knowledge of the principles of concrete technology to at least the level of the *Concrete Primer* (ACI Publication SP-1) or *Design and Control of Concrete Mixtures* (a Portland Cement Association publication). The opposing philosophy was that a certified technician needed only to correctly perform the designated concrete tests and report the results.

Many committee members employed technicians who were highly skilled and capable of performing nondestructive tests, mixture adjustments, reinforcement and forms inspections, and other concrete testing and inspection work. But many also had technicians just starting their careers, who knew very little about concrete and had no formal education in concrete technology. The question really centered on at what level ACI should certify:

technicians who demonstrate knowledge and ability to conduct the basic tests on fresh concrete and report the test results or expert technicians whose knowledge and skills extended beyond this level of competency.

Again, following much debate, this first certification program was established as an entry-level program, with the committee deciding that future opportunities to formulate higher-level programs would exist should this program prove successful. As an entry-level competency assessment, the ACI Concrete Field Testing Technician-Grade I (FTT) program was formulated to require technicians to know if they have the right equipment; be able to handle the concrete correctly before, during, and after the test; be able to run the test correctly; perform the test at the correct time and within the specified time limits; record the results correctly; and communicate those results to the appropriate people on the job site.

In deciding upon this approach, ACI Committee E 902 agreed that the FTT program would *not* test technicians on knowledge or ability related to issues such as adjusting the concrete so that slump would meet specifications, how changes in materials can influence slump, whether concrete with slumps outside of the limits of the specifications can be placed, and mitigation of other noncompliance issues.

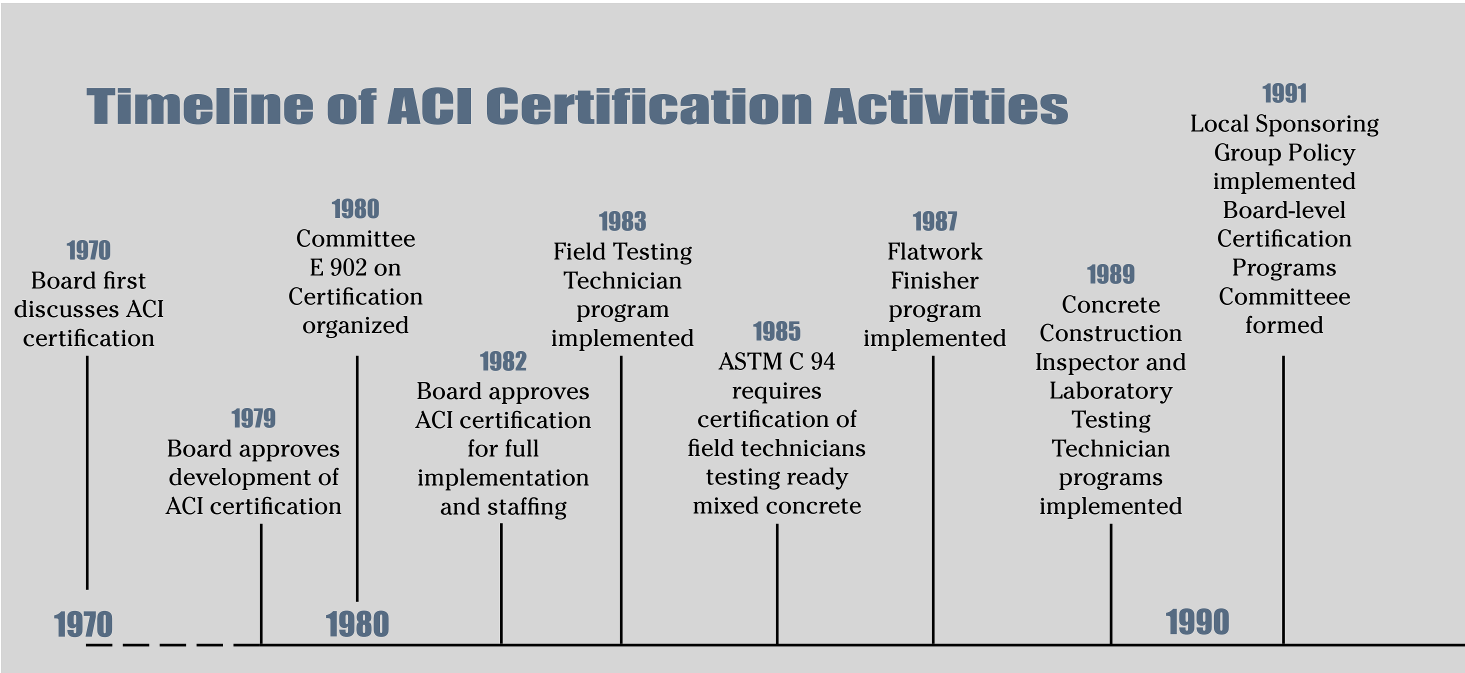
Students as far away as Mongolia have also benefited from ACI certification training

Training requirements

Once the committee agreed on the knowledge level expected of technicians, they then moved on to discuss the training level required to become certified. ACI Committee E 902 recognized that many testing laboratories, departments of transportation, ready mixed concrete associations, and other organizations already offered well-developed training programs that were suitable to prepare individuals for the ACI certification exams. ACI Committee E 902 further realized that establishing a standard training requirement could unnecessarily complicate the certification process and preclude a course of self-study. It was therefore decided that formal training would not be a certification requirement, but that it would be encouraged in recognition that training improves participants' chances of passing exams. This decision positioned ACI to focus on developing the certification test materials, policies and procedures, and allowed other organizations and individuals the flexibility to develop training programs to address not only the national program's scope, but also regional and local needs.

Training programs are now available from a variety of sources such as colleges/universities (some civil engineering programs require the ACI FTT Certification exam as part of their materials courses), highway departments, testing laboratories, materials suppliers, trade associations, ACI chapters, unions, and governmental agencies. Most ACI Local Sponsoring Groups

An ACI Shotcrete Nozzleman certification exam in progress



(LSGs—organizations formally authorized to conduct ACI certification exams) offer some form of training.

Although the ACI certification program does not require participants to complete training for certification, some LSGs have assessed their resources and determined that they cannot afford to allow unprepared participants to attend exam sessions. They have subsequently initiated local policies that require participants to complete and prove evidence of training before being allowed to take the exams. In addition to ACI's *Technician Workbook for Certification of Concrete Field Testing Technician—Grade I*, CP-1, other training CD-ROMs, DVDs, and videos are available from third-party developers to aid in either instructor-led training or self-study programs.

Training for certification has become very dynamic with many examples of successful programs that can be used as templates for new programs. Regional Certification Roundtable discussions for LSGs are held twice each year in conjunction with ACI Chapter Roundtables (the next one will be held in Houston, TX, on October 27-28, 2005) and are excellent opportunities to learn how training is being offered. If you're invited to one of these roundtables, I highly recommend that you attend!

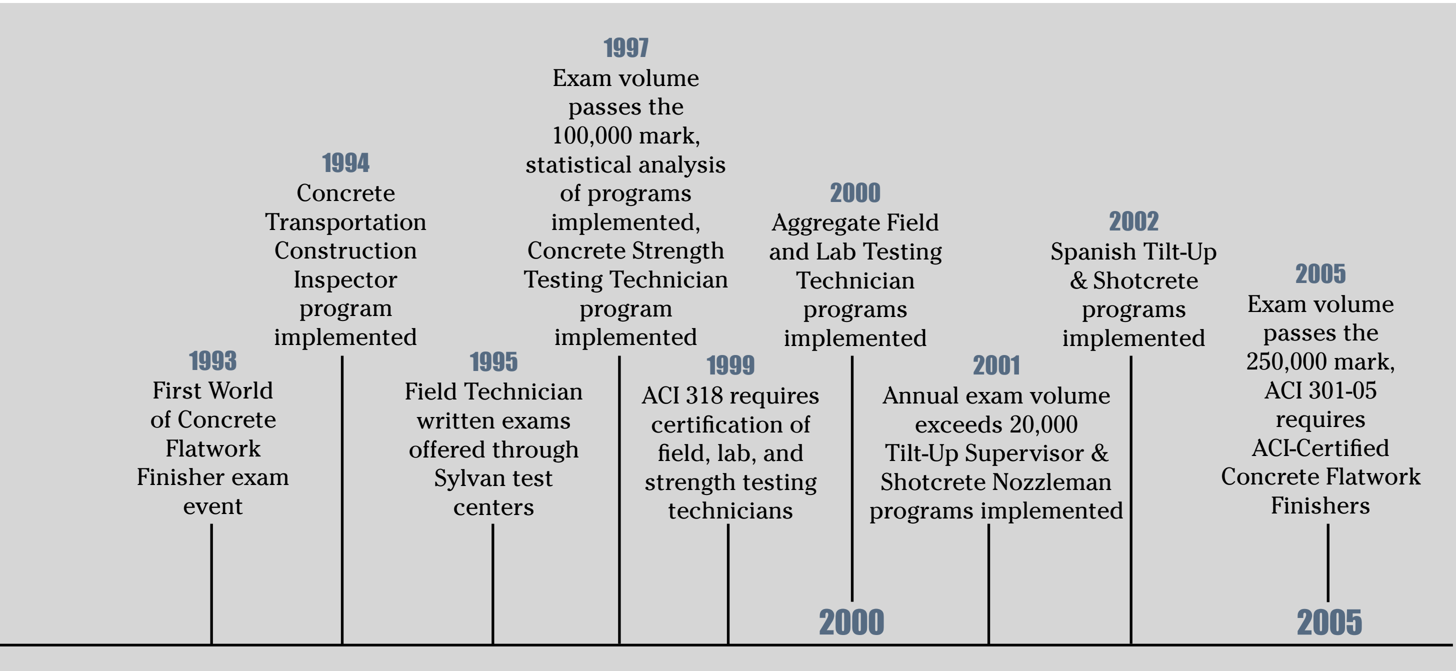
Responsibility for administering the certification exam

The committee agreed that a responsible person, knowledgeable in concrete technology, should administer the exam. However, ACI Committee E 902 had to spell out the minimum qualifications of the examiner to provide ACI certification staff with guidance on who to approve as examiners. Since the Professional Engineering license is necessary to sign engineering reports, and it is a requirement that a laboratory have a Professional Engineer (ASTM C 329), it was decided that one criteria for approval as an ACI examiner would be that the individual be a licensed Professional Engineer (PE). Additionally, a second requirement was that this PE also be knowledgeable in concrete technology. In adopting these requirements, the committee felt that a PE, being bound by a Code of Ethics and knowing that signing a document carries legal implications, would take the responsibility for administering the exam seriously.

Potential examiners must complete and submit to ACI an application documenting background (education and work experience), knowledge of concrete technology, and evidence of their status as a Professional Engineer. Once approved by ACI, individuals are then eligible to serve as examiners under the auspices of an ACI-approved LSG. Each time an examiner conducts a certification program, he or she must sign a report that assures the program was conducted according to the program policies. This care in selecting the examiner and requiring them to work through a local organization has helped contribute to the success of the ACI certification program.

Time limits

Testing procedures and standards change, equipment changes, and not all people certified will test concrete on a regular basis. For these reasons, ACI Committee E 902 recognized that a certification should not be valid for life, but should require that the certified individual periodically renew certification through retesting.



The committee, without dissent, selected 5 years as the reasonable length for the FTT certification. After 5 years, the technician must repeat the certification process based on the then-current technical resources.

After 2 years of meetings and a great deal of ACI staff time, the ACI certification program for FTT was ready. No one was quite sure if it would be a success or if it would be met with indifference.

The first few years were indeed filled with mixed reactions. ACI was threatened at one point with a lawsuit alleging restraint of trade, while testing laboratories and others in the cement and concrete industry used ACI certification as a way to differentiate their personnel from their competitors. These employers recognized the market potential and wanted to be able to advertise that their technicians met ACI standards. Within 2 years, ASTM C 94, Standard Specification for Ready Mixed Concrete, required that concrete be tested by an ACI-certified technician or approved equivalent. This, along with many designers requiring in their specifications that concrete technicians must be ACI-certified (or approved equivalent), guaranteed the success of the program.

THE RENAISSANCE—SUCCESS OF THE ACI PROGRAM

The ACI Concrete Field Testing Technician—Grade I certification program was only the start. As this program became well established, new programs were developed using the FTT program as the template. ACI now offers 14 different certification programs. We have processed over 250,000 exams administered through 100-plus LSGs operating internationally to participants residing in 44 different countries. It truly has become the standard way for field technicians, finishers, lab technicians, inspectors, and operators to prove their knowledge and ability to perform their jobs.

We must take our hats off to the individuals and committees in ACI who saw the need for concrete technicians to have a certification credential “like barbers” and to those who developed the first certification program. We must also take our hats off to the past ACI Boards of Direction who maintained support for the programs even when they weren’t sure it would be successful. We are especially proud of the ACI-certified personnel who work on our projects and provide high quality, state-of-the-art service to the concrete industry.

Selected for reader interest by the editors.

Luke M. Snell, FACI, is the Director of the Concrete Construction Resource Unit and a Professor of Construction Management at Southern Illinois University-Edwardsville (SIUE). He is Chair of ACI Committee 120, History of Concrete, and the International Committee. Snell is a member of the Chapter Activities Committee and several other ACI technical and educational committees. He has been on the SIUE faculty for more than 20 years.

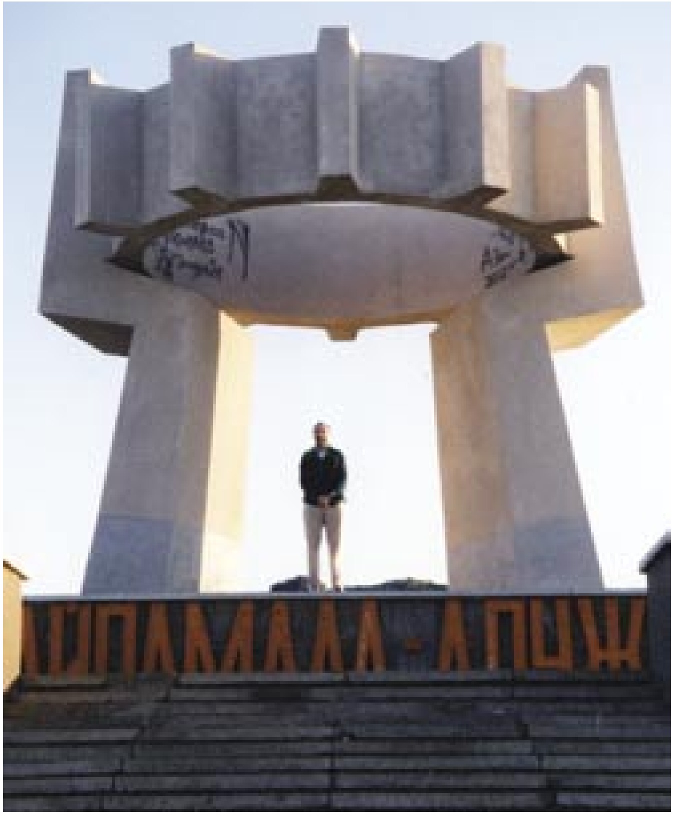
Concrete is Beautiful—Mongolian Style

BY BILLIE G. SNELL, LUKE M. SNELL, YAGAANBUYANT DUINKHERJAV, AND WILLIAM J. SEMIOLI

In many minds, Mongolia is a land shrouded within historical fable. The land from where, in the Middle Ages, fierce nomadic horsemen burst forth from their central Asian steppe, penetrating eastward as far as central Europe. The skilled Mongol warriors brought with them their conquering mastery of the bow, cunning military strategy and cavalry tactics, their families, and gers, traditional nomadic dwellings. But they were to retreat quickly back into the east—not because of worthy opposition, but on the death of their emperor, the Great Khan.

Much earlier still, during the latter part of the Roman Empire, and originally from Mongolia as well, came another tribe of nomadic horsemen-warriors—the Huns, or Hunnu. They, too, had surged into Europe, almost to the gates of Rome, under their renowned leader Attila. But the Mongolians of today are a gentler people, unlike their ancestors, much happier at staying put at home and looking inward toward developing their nation and building a better life for its people.

Modern Mongolia is a country of 1.6 million km^2 (600,000 mi^2), slightly smaller than Alaska, with a population of only 2.7 million people, slightly less than that of the city of Chicago, IL. A relatively poor nation in comparison to many, it is embarking on a road to greater modernity and prosperity. It has had horse breeding and agriculture at its traditional economic base, but has been industrializing and thrusting itself into greater urbanization. While Mongolia possesses great latent wealth in its natural resources, there is a downside as much of its terrain has suffered from the



Within the industrial city of Erdenet stands this tribute to the friendship between Mongolia and the former Soviet Union, which existed at the time of its construction. The precast concrete elements shown represent two hands holding aloft a manufactured gear, symbolizing both nations working together toward common economic goals

Near the center of the Mongolian capital city is this Air Force Memorial, a tribute to Mongolian airmen who served in World War II. Shapely curved and vertical precast elements and other segments are supported on a cast-in-place foundation

Mongolian cities erect these entranceways or gates. This one on the outskirts of Darkhan is formed from painted precast elevated elements supported upon a cast-in-place base

This functional apartment building, of rectilinear design and with decoratively painted exterior elements, is formed from accelerated-cure precast concrete. The precast was supplied by a plant in Ulaanbaatar, Mongolia's capital, a city of 600,000 and some 10 mi. (16 km) distant. The capital city has four precast plants

Sleek, aesthetically pleasing concrete bridges like this one will serve on the new trans-Mongolian Millennium Road, a two-lane highway that will link 80% of the country's population centers upon completion detrimental historical legacies of deforestation, overgrazing, and subsequent soil erosion. The impact of these blights is seen in Mongolia's often severe but beautiful steppe landscape. Then, too, there are climatic extremes that take a toll—the country borders Siberia and is home to the Gobi Desert.

As are other commodities in this independent nation, wood and steel are scarce. So as Mongolia builds its infrastructure for the future, concrete has been its structural material of choice. Concrete helps house its people, its seats of government, its places of worship, and, among others, commemorates the Mongolian people's long and rich history.

When viewed on site, each as the center of attention of the beholder, many examples of Mongolian architecture may at first strike the foreign onlooker, who will have different aesthetical perceptions, as being of austere simplicity, and often formed with bulky, basic geometric designs—though they are highly practical and functional for their purposes. It's only when the onlooker takes a step back and views these structures amid the stark beauty of their natural surroundings that he or she senses it—gets it. The structures fit, and they are beautiful in their special Mongolian way.

Surrounding the site of the old Mongol capital of Karakorum (now a monastic Buddhist enclosure) are old stone masonry walls atop which sit a series (144 in all) of modern-built concrete stupas. A stupa is a Buddhist shrine. This monastery site is more than 230 mi (370 km) from Ulaanbaatar

This precast bas relief is 8 ft (3 m) high, adorning the exterior of the Mongolian Museum of Natural History in Ulaanbaatar. It depicts charging Mongolian horse warriors of old—the one in the forefront is sounding a call to battle

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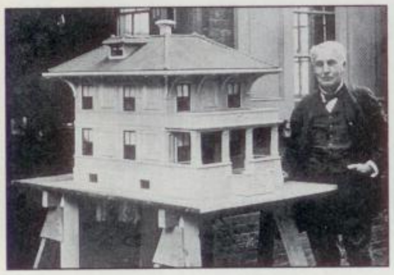
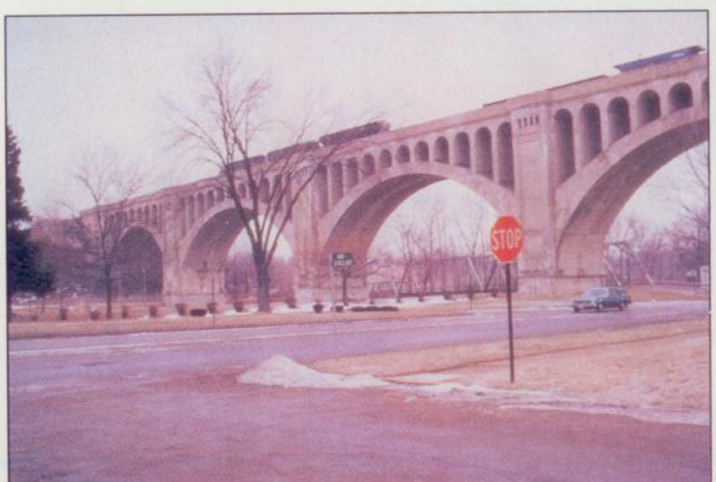
Concrete Beginnings—History of Material Set in Ohio*



Thomas Edison with his model of a concrete house. Forms were designed so that the entire house could be constructed of concrete. Seventeen of these houses were built in Newark, Ohio.

Statue of George Bartholomew. He spent two years trying to convince the community to try this new material called concrete. The city complied only after Bartholomew donated the paving material and posted a $5,000 bond guaranteeing that the pavement would last for five years. He was successful; the pavement has been in use for more than 100 years.

The first high-rise reinforced concrete skyscraper in the United States was built in Cincinnati, Ohio. This 16-story building was constructed in 1902 by Fero-Concrete Construction Company. It was built at a time when no buildings with more than 6 stories had been constructed of reinforced concrete. The building is still in use.



This bridge in Sidney, Ohio, was featured in the October 11, 1923 *Engineering News-Record* article. This structure "offered an excellent opportunity to experiment with the method proposed by Prof. Duff Abrams of the Structural Materials Research Laboratories, Lewis Institute, for the design of concrete mix." The bridge and new methods of specifying materials are still in use.

The first concrete house in Ohio, is undergoing restoration. Built in Spring Valley, Ohio in 1853 by the owner, Mr. George Barrett, an expert in designing and constructing innovative mills for woolen manufacturing.

A 1941 ready-mixed truck. The change from job-site batching to central mixing of concrete and delivery by ready-mixed concrete trucks provides a consistent, high-quality concrete.

**Editor's Note:* The title of this presentation that was given by Warren P. Baas and Luke M. Snell was "Presenting 'Concrete' History to Children Via the Video." It was featured in "Innovative Teaching Techniques" at the Wednesday morning session of the 1995 ACI Spring Convention in Salt Lake City, Utah. For further information about this presentation, please refer to pg 90 in the May 1995 issue of *CI*.

Site Batching of Concrete

Not all parts of the world have the luxury of relying on consultants to prepare organization plans to create a more efficient organization. In some parts of the world, just batching concrete is painstaking.

While in Algeria recently, we visited some jobsites and saw the batching procedures. Here, as in many parts of the world, site batching of concrete is the norm because ready-mixed concrete is not available.

In the United States, site batching of concrete also was common in areas which did not have access to ready-mixed concrete. Before World War II, much of the concrete used for farm buildings was made onsite. Many cement companies and the Portland Cement Association wrote pamphlets on how to make and place concrete on the farms.

Since it was not easy to weigh the cement, sand, and stone, batching was done by volume. To make batching easier, cement was put in 1-cubic-foot bags. This made measuring the volume of cement unnecessary. The farmer would simply determine how much concrete he needed and add the appropriate number of bags of cement. The sand and the rock would be measured in convenient-sized containers of a known volume so that they achieved the desired ratio of materials in their concrete.

A bag of cement in Algeria weighs 50 kilograms or 110 pounds. This is slightly larger than the U.S. cement bag of 94 pounds. They add the cement by the bag. The coarse and fine aggregates are added by volume into the hopper.

The Algerian procedure of site batching concrete for reinforced concrete structures is to use a ratio of cement: fine aggregates: coarse aggregates of 1:1.8:2.7. This is almost identical to the 1:2:3 mixture used in the United States.

They specify a slump of 4 inches, with strength of 3500 psi. Obviously, there are many mix designs used in Algeria. The one that we witnessed would be typical for structural concrete.

The material is put into a hopper and mechanically lifted into the mixers. The contractor blends the two coarser aggregates. The first is sized from 1/4 inch to 1/2 inch; the second from 1/2 inch to 1 inch. This blending of aggregates is recommended so they get a uniform distribution of aggregate and a more efficient mixture.

Concrete can be batched in many ways, requiring attention to details and a need for consistent procedures. Algerians have developed an improved way of site batching their concrete. By following a consistent procedure and using modern equipment, they produce good quality concrete.

— Luke M. Snell and Abdellatif Baghli

Snell is the director of the Concrete Industry Management Program at the Del E. Webb School of Construction at Arizona State University. Baghli is an assistant professor at the University of Aboubekr in Tlemcen, Algeria.

Above: Site batching is the norm in Algeria because ready-mix is not available. Above, right: Concrete is batched at a construction site in Algeria. Right: Site batched concrete has a 4-inch slump with strength of 3500 psi.

Tree Surgery and the Concrete Cure

BY BILLIE G. SNELL AND LUKE M. SNELL

It goes without saying that, historically, concrete has long been a building and repair material of choice. But what about for surgery? Well, "tree surgery," to be specific. Concrete had been somewhat popular in the practice of tree surgery in the earlier part of the 20th century. At the time, a number of arboreal experts made claims that repairing a badly decayed tree with concrete could extend its life significantly. Consider the alternative, as a sensitive, cement industry sage wrote at the beginning of the last century:

"Picture to yourself, a fine old shade tree into which insects have bored causing decay. Larger and larger becomes the hole, and unless prompt measures be taken, the weakened condition of the trunk will permit the first heavy windstorm to strike the tree to earth—a fallen monarch that cannot be replaced in less than a lifetime."[1]

BEGINNING THE CURE

Information published in the 1910s pointed out that most candidate trees for surgery already have visible holes. Once a tree was chosen for a cure with concrete, the first step required the removal of every last bit of decay (Fig. 1). Tools suggested for the purpose at the time were a hand axe, mallet, and chisel. The "surgeon" wielding these tools was reminded how important it was to remove all decayed matter, and "...to use the same thoroughness which a dentist uses when cleaning a tooth for filling. If all the decay is not removed, it will continue as if the filling had not been placed."[2]

Once the decay had been removed, the surgeon disinfected the tree's cavity. For this purpose, cleansing materials recommended at the time were creosote or crude petroleum oil. Over the prepared surfaces, the surgeon then applied a thick coat of heated coal tar or asphalt. This step, would help eliminate the formation of voids between the wood surface and the inserted concrete after completion of the surgery. One reference reassured its readers that procedures similar to the ones noted above had been used for several years by a Mr. G. E. Stone, of the Massachusetts Agricultural College.[3]

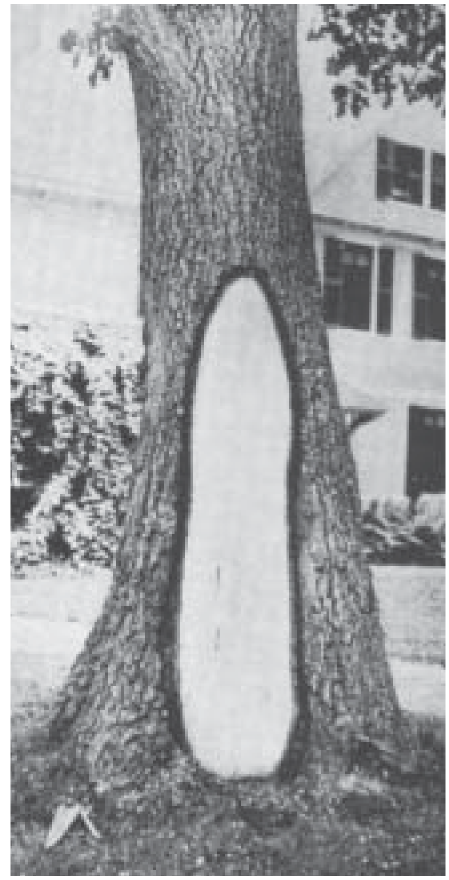
FILLING THE CAVITY

For a small cavity, other reference material states that nails should be driven into the wood surrounding the cavity to "better hold the concrete."[2] If the cavity was quite large, however, woven wire mesh or small steel rodding could be used.

In early concrete publications, suggested proportions for mixtures of protective concrete filler appeared. At the time, recommended proportions by volume were 1:3 cement to sand; or 1:2:4 cement, sand, screened gravel or stone, with a suggested mixture consistency similar to jelly. This concrete was then packed into the cavity (Fig. 2) and its exposed surface troweled smooth (Fig. 3).

Forms were used only when necessary to hold the inserted concrete in place. If needed, and after thorough greasing, forms fashioned with wood, zinc, or tin, were





(Left) Fig. 1: Tree “surgeon” removes decay from a parasite-gutted tree using hand axe, mallet, and chisel. All decay must be removed
(Center) Fig. 2: A tree surgeon fills a cleansed cavity in another tree with concrete
(Right) Fig 3: The patient is patched and remedied

tacked to the ailing tree. It was cautioned, however, that a portal hole had to be left in the forms so that concrete could be placed through and into the cavity. It was recommended that the forms be removed as soon as possible.

Post-surgical cosmetics come into play as well, because the concrete surface clashed in color and texture with the bark of the tree. A reference book recommended the concrete be painted the color of the bark.[1] Other experts called for trimming the edges of the bark once or twice a year. In some cases, however, the bark would grow over the exposed concrete without leaving a scar.[2]

There were, at the time, however, naysayers who felt that filling a tree’s decayed cavity with concrete was not a good idea.[3] They noted that concrete, upon setting, is too rigid a material, and, as such, would deter normal movement within the living tree. (Today, using concrete in tree surgery is, in fact, no longer considered the best approach. There are now other, more flexible and more suitable materials available for the process.)

Early on there were humorous—and some not so humorous—stories about attempts to cut down concreted trees. Some voices from history comment on giving ailing trees a concrete cure:

“Thanks to concrete it is now possible to save trees that appear to be almost beyond help...”[1] and,

“Nothing adds so much to the home-like appearance of a place as good shade. But trees are like teeth—they need attention...By means of concrete, many famous old trees, seemingly about gone, are now saved.”[5]

THE LIBERTY TREE

A famous tree once saved with concrete in 1907 was “The Liberty Tree,” in Annapolis, MD. This majestic Tulip Poplar (Fig. 4) eventually lived an estimated 400 years—100 to 150 years beyond the normal life span for the species. Unfortunately, damage from high wind forces exerted during recent Hurricane Floyd harmed the old tree too severely, requiring its removal in 1999. Taking out the concrete-filled arbor proved an arduous task—requiring a laborious day and a half. It was a sad ending to a natural monument that had withstood many assaults during its long life, including lightning strikes, fire set in one its hollows, and even a blast from 2 lb (0.9 kg) of gunpowder placed within a hollow in the old tree.

The Liberty Tree earned its name for events taking place under or near its once capacious, leafy awning

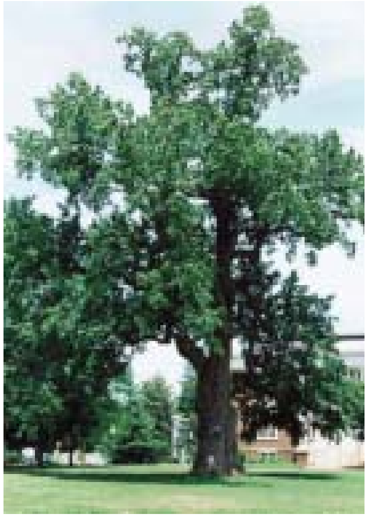


Fig. 4: The Liberty Tree of Annapolis, MD. Tree surgery and concrete filler permitted it to live another 90 years before a hurricane finally did it in

during the American Revolution in the 18th century. At the time, these events included meetings at which orators fomented revolution against the British Crown. One such speechmaker was Maryland's Samuel Chase, a founding father of the United States of America, and a signer of the Declaration of Independence.

Over the many subsequent decades, the tree and its environs hosted picnickers, religious sermonizers, sporting events, and even ceremonies for the graduating students of St. John's College, on the campus of which the Liberty Tree had resided. In the early part of the 20th century, however, the extent of the large cavity (due to parasites that had excavated into the tree) became quite serious. The damage had reached 56 ft (17 m) up the interior of the tree. Remedial surgery took place in 1907, when a landscape architect, forester, and tree surgeon, John T. Withers, cleaned out the tree's enormous void. He followed with antiseptic treatment and then filled the cavity with concrete, using sections of iron and steel for reinforcement. The Liberty Tree required 55 tons (50 tonnes) of concrete—reportedly the largest case of tree surgery ever performed.

Although the famous old tree did succumb finally, it has experienced a sort of metamorphosis. After being torn down, its sturdy wood was sold to a guitar manufacturer, who converted it to 400 "Liberty Guitars."

ANOTHER FAMOUS OLD TREE

A story is currently being told of another "famous old tree."[6] In 1970, an arboreal rescue team placed concrete within this tree "in the hopes that the additional fortification would preserve the tree." Unfortunately, the patient didn't survive long, and keen deliberations followed its demise on how to remove its firmly implanted timber carcass.

No one considered the use of a chain saw "to remove the towering hunk," since there was lack of confidence as to just where in the tree the concrete might be. Still, the tree removal team felt it could not leave the dead old tree in place because there was concern that a high wind would eventually blow it down, endangering anyone nearby. An attempt was thus made to pull it down with a tractor and rope. This effort proved fruitless, and a conclusion was quickly reached that no wind on this planet was going to topple *this* tree.

Other current options being considered are: concrete drilling, concrete sawing, and even dynamiting. Complicating matters a bit, the moribund tree is now home to a colony of lively bees. Someone then suggested leaving the old concrete-filled wood carcass as a totem pole. Not a bad idea if you are a romantic and think about it—the totem, a standing testament memorializing the once and forever sturdy old tree with its stout heart of concrete.

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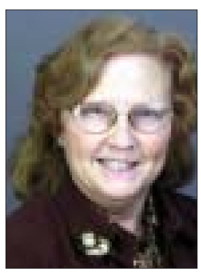

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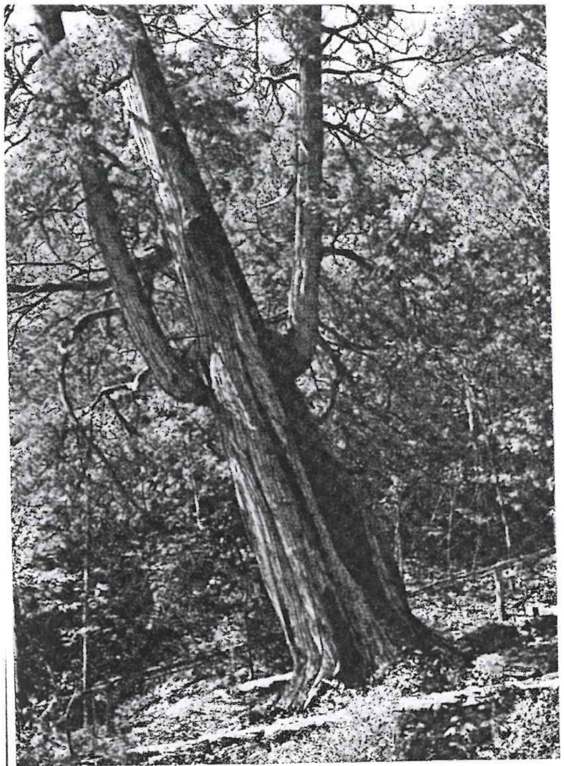

The world's largest and oldest northern white cedar grows in Natural Bridge, Va. It is allegedly 1600 years old.

Tree of Life

by Murray D. Snell
Snell's Cedar Products, Ltd.
Eganville, Ontario

Cartier's voyage had been successful to this point. He had found the mouth of the St. Lawrence and was on his way to find the fabled short route to the Orient. He reached the present site of Montreal, before he found his way blocked by a series of rapids. It was October, so there was nothing more to be done, but to prepare winter quarters in this strange and hostile land. A crude fort was built and the ships moored near by. Game was saited down and firewood cut. The winter of 1535-36 was especially cold. To add to their misery an epidemic of scurvy devastated the little group until there were only three or four men strong enough for sentry duty. Soon the ships were frozen in the ice and the Indians walked around them examining the strange vessels. Cartier tried as best he could to conceal the helpless plight of his crew while he asked the chief Domagaia, if he knew a cure. The chief sent two women to bring some branches of an evergreen tree. The bark and leaves were boiled together and the sick men drank of the tea every other day.

So occurred one of the most famous Indian cures of all times. As Cartier later wrote soon fighting broke out - "about who should be the first to take it, that they were ready to kill one another so that a tree as big as any oak in France was spoiled and looped bare and it wrought so well that if all the physicians of Montpelier and Lovaine had been there with all the drugs of Alexandria, they would not have done so much in one year as that tree did in six days.... "

It was named "Arbor Vitae," tree of life. As a result of this incident it was the first tree imported to Europe from North America. Jacques Rosseau, the eminent botanist, later identified it as thuja occidentalis, our northern white cedar.

Three hundred years later cedar tea was still a popular tonic in lumber camps. Thoreau in "The Main Woods" wrote -

"This night we had a dish of arbor vitae or cedar tea which the lumbermen sometimes use when other herbs fail - 'A quart of Arbor Vitae To make him strong and mighty.' But I had no wish to repeat the experiment. It had too medicinal a taste for my palate."

Internal use of cedar has recently been proved injurious. The Pure Food and Drug Administration has forbidden its use in cough syrup and other patent medicine, to be administered internally. Present day use of cedar in medicine is confined to liniments or ointments. The manufacturers of an ointment type cold remedy uses most of the world's production of cedar leaf oil.

This oil is made by steam distillation of small branches and leaves. Because of the work involved in gathering and processing the material and the large quantity required to produce a pound of oil, it is expensive. A ton of brush yields only ten pounds of oil. A far cheapter oil is made by distilling red cedar shavings and sawdust in Virginia and Texas. This is a salvage operation using sawmill waste and the cedar wood oil is used in floor and furniture polishes. Cedar leaf oil is too costly for such use. Besides its medical uses, it provides a base for perfumes. The present world production is somewhere near 250 barrels a year. The states of New York and Vermont as well as the provinces of Quebec and Ontario have produced nearly all of this oil. About five years ago a producer in Northern Michigan started making oil in significant amounts. It is a fragile market, dominated by one buyer. A slight over production often sends the price tumbling, driving marginal producers out of the business.

In addition to the use of cedar brush in the manufacture of oil, there is an active demand for selected cedar boughs by florists. Such boughs are used as fillers in floral arrangements. They must have a uniform dark green color without the common rusty tinges. The boughs must also have a pleasing shape. They are often packed in seven pound bundles. Cutters call this flat brush, to distinguish it from the oil brush which may be much rougher and less attractive. Naturally it commands a much higher price. In November and December the demand increases, as much of it is used in making Christmas wreaths. Buyers from the U.S. visit each little community throughout the cedar region of Ontario once a week. Through the summer months the return trip is usually made at night when it is cooler. The tightly packed truck loads of boughs will overheat and discolor if left too long, so they are rushed to florists in each metropolitan area.

The cutting of cedar brush is non-destructive unless the entire tree is cut. Many women and children as well as men earn extra income by clipping it. Two years after cutting, the brush may be clipped again. There are very few forest products that permit harvesting every two years.

The harvest of all cedar products lends itself particularly well to a part time operation with limited investment in machinery. Northern white cedar is the lightest in weight of any commercially important North American wood, so much of it is still loaded by hand. Farmers still supplement their income by delivering a load of cedar brush or posts on their pickup trucks when they come to town to shop.

It is its light weight as well as its resilience that makes cedar the preferred wood for canoe ribs and planking. Canoe stock must be selected knot-free lumber. One might think that fiberglass or aluminum would render the use of cedar obsolete; this is not the case however. Goods are still hauled in large freight canoes to remote outposts in the north cheaper than by air. With heavy loads, in white water, banging against rocks, the modern day voyageurs find cedar canoes superb. Of course many sporting canoes are made of cedar too.

By far the largest market for this unique tree is fence posts. Hundreds of thousands are used untreated in Canada for highway guide posts alone. This year (1977) the Province of Ontario will buy 87,200 eight foot cedar posts with six inch minimum top diameter, and 16,400 nine foot posts with eight inch top diameter. Millions more smaller sized posts are used for cattle fence and as vineyard posts.

It is usually not considered necessary to treat cedar. White cedar heartwood is one of North Americas most decay and termite resistant woods. This quality is attributed to certain substances called thujaplicins found in the heartwood. Besides being highly toxic to a variety of wood destroying fungi and termites, thujaplicins have been used in the treatment of human diseases. Unfortunately they are soluble in water, and eventually leach out of the wood leaving it less decay resistant. Tests by the University of Michigan show that an untreated cedar post with a four inch top diameter will last about sixteen years in the ground. An untreated jack pine post with the same diameter can be expected to last three years. There are instances of large cedar poles being in the ground for ninety years. When they were removed they were found to be still sound and would have given many more years of service.

White cedar lumber demands a premium price for building construction. It is not so aromatic as red cedar and so is not used in making moth repellant cedar chests and closets. It does not hold a nail as well as fir or spruce, nor is it as strong; however, it does have one superior quality, that is its dimensional stability. It will not shrink, warp, or twist as much as any of the other species.

Blocks as short as sixteen inches can be used as shingle bolts. The market for white cedar shingles was dormant for a long time. Now they are in good demand. They do not weather as dark as the western red cedar shingles and are preferred as siding by some home owners especially in the Cape Cod area.

Virtually no part of the tree goes to waste. Pieces cut from the tops can be used down to two inches in diameter. They are peeled, given a conical point, split, and nailed tightly together into stockade panels. This is privacy fence to be used around swimming pools, patios, or wherever a screening fence is desired. Cedar is particularly prized for rustic fencing, not only for its decay resistance, but also because it weathers naturally to a soft silver gray. Cedar fencing in the States is usually left unpainted. Manufacturing rustic fence in Canada is a multi-million dollar a year industry. Most of it is made for export and is trucked as far as Florida. Many styles are produced beside the stockade fencing. There is an annual trade show in Toronto sponsored by the Canadian Fence Industry Association, where the latest designs are shown each spring.

A northern white cedar reported to be the worlds largest and oldest, grows in Natural Bridge, Virginia. This scenic wonder is supposed to be over 1600 years old. It is merely a shell. Like so many of these ancient trees, decay has progressed to the point where almost the entire tree is hollow. Cedar trees 400 years old are common in swamps.

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A harvest of cedar posts and cedar oil brush. The value of cedar leaf oil produced in North America is nearly $1,000,000 a year.

A load of cedar fencing heads south, part of Canada's $14,000,000 rustic fence export business.

TREE OF LIFE

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Virginia is almost as far south as this cedar grows, although it can be found in mountainous areas of North Carolina and Tennessee. In Canada its range extends from New Brunswick to eastern Manitoba.

Early settlers made roofs for their cabins by splitting hollow cedar logs and laying them side by side from ridge to eaves, with the split sides up. Other half logs were inverted over the spaces between the logs. This was the first channel drain roofing. It is hard for us to imagine where they got so many hollow cedar logs until we consider that the cedar stands were over age in those days and hollow trees were common in those conditions.

Very little attention has been given to reforestation or conservation of this valuable tree in Canada. The State of New York started a cedar plantation about 50 years ago near Tully. Little was known about proper spacing and the trees were planted too far apart. The lower limbs were not shaded as they would have been in a dense natural stand, so the coarse branches and large knots reduced the value of the trees. Recently, a new cooperative study by the U.S. Forest Service's North Central Forest Experiment Station and the Michigan Dept. of Natural Resources was started. Some information is already available. Cedar produces a heavy crop of seeds depending on the weather, but often every two years. Some of the most successful stands have been obtained by clear cutting and direct seeding. Natural seeding can be achieved also by strip cutting, leaving mature trees on the side of the strips to reseed the bare areas.

The latest available reports from the State of Michigan are for the year of 1972. In that year, 5,300,000 cubic feet of northern white cedar were harvested from Michigan forests. Almost 80% of this came from the Upper Peninsula. Saw log production was 8,514,000 board feet and fence post production was 2,912,000 pieces. The value of the 5,300,000 cubic feet delivered to the fence plant, log cabin factory, or post and pole yards was $1,730,000. Processing at the plant into saleable products increases the value in the plant to $6,920,000. By the time it reached the customer, it was worth $13,840,000.

In Michigan small amounts of cedar are used in pulpwood, but it is usually considered too valuable for such use if fence plants are nearby.

In Canada little research has been done about propagation. In some areas cedar has been deliberately destroyed to reforest with "more valuable" species. In Ontario the Dept. of National Resources (formerly Lands and Forests) is especially concerned with maintaining cedar stands for deer yards. Cedar provides winter feed for deer and rabbits, also the dense cover that is needed for shelter of the game. The abundant seeds are eaten by squirrels and birds through the winter months. The name Arbor Vitae, tree of life, has a special meaning in supporting the lives of these forest dwellers.

Until thirty-five years ago, cedar was considered a scrub tree. It was zealously destroyed to provide better pasture and meadow land. There was a limited market for hand peeled posts having a five inch diameter. Smaller diameters were left in the brush piles to rot. Immediately after World War II, it was found that the smaller sizes could be sold successfully in the dairy sections of New York, New Jersey and Pennsylvania. Some of these smaller posts, or pickets as they were called, had to be hauled as far as 500 miles, so trucking costs were important. An average of 3000 posts six feet long with a three inch minimum top diameter can be hauled on a forty foot trailer. They are sold pointed ready for driving into the ground, and are used to support barbed wire cattle fence. This market peaked about 1969 with perhaps 35 trailer loads a week crossing into the U.S. over the Thousand Island Bridge. That year one dealer alone hauled 333 trailer loads. Since then the market has declined. Last year (1976) the value of fence posts exported from Canada was only $689,000. However, rustic fencing exports were $14,302,000. Not all of this was cedar, but much of it was. The value of cedar leaf oil produced in North America is now nearly $1,000,000 a year.

Research has been done on the curative value of cedar leaf oil in treatment of other diseases than the common cold. More study could be made of thujaplicins which are found in the wood. Perhaps some day there may be a very literal fulfillment of the words spoken by St. John in Revelation 22:2

> "In the midst of the street of it, and on either side of the river was there the tree of life, which bare twelve manner of fruits, and yielded her fruit every month, and the leaves of the tree were for the healing of the nations."

THE INDISPENSABLE, UBIQUITOUS, COMMON NAIL

*By Russell C. Solomon**
and
*Luke M. Snell**

It is difficult to overemphasize the importance of the evolution of ferrous nails and their technical development on the construction industry. The gradual technological transition from crude hand forged to machine-cut wrought iron nails and then subsequently to nails produced from steel wire has had a tremendous impact on construction methods.

The 1959 "Encyclopedia Americana" quotes Henry Wright the famous architect as having stated, "The technological development of the mass production of nails after 1800 cut from wire rather than forged of wrought iron helped to win acceptance for the typically American balloon frame house which used only nails to join light studs and sheathing."

In modern construction a bent or damaged nail is discarded rather than straightening it for reuse. In fact, it costs more for a carpenter to pick up a dropped nail than it does to use another nail. This has not always been the case. Nails were once considered so precious, that in Colonial America a moving family would burn down their homes to reclaim the nails. The Virginia legislature passed a law promising the owner an equal number of nails if they would not burn down their homes. Nails in the 1600s were considered precious because iron was expensive and each nail was individually crafted.

The nail is basically a piece of metal that is driven into two pieces of wood to hold them together. The point of the nail shears the wood fibers and forces the fibers downward as the nail is driven into the wood. The force that holds the wood together is the frictional forces of the wood fibers against the shaft of the nail. This force would be lower the first few days after the nail is driven into the wood. Eventually, the wood fiber returns to the original position and the friction between the shaft of the nail and the wood fiber increases.

The critical element of the successful use of nails thus becomes the:

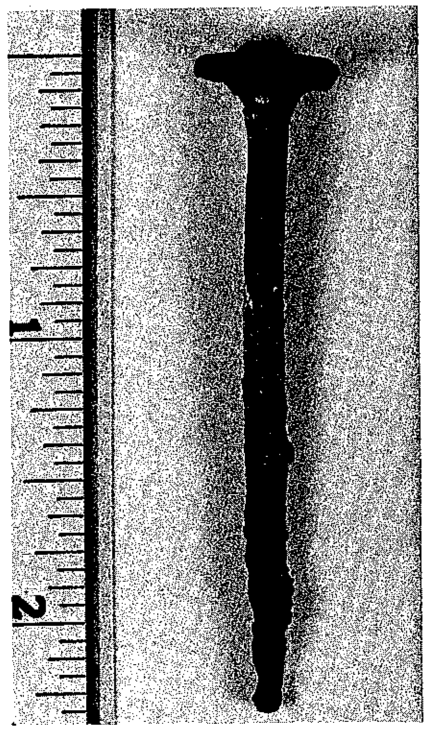

Figure 1: **A hand-forged nail from a Roman Legionary Fortress at Inchtuthil, Perth, Scotland. Buried by Romans in 87 A.D. and excavated in 1961.**

1. Strength and hardness of the metal. It must be strong enough to penetrate the wood and to resist the driving forces.
2. Surface texture of the nail. The smoother the nail, the less bond or frictional forces develop.
3. Cost. The cheaper the nail, the more techniques are developed.

Modern construction is not a simple endeavor but is complicated by many factors and some of these factors impact on the selection and use of nails. Ideally, one type of nail would serve all purposes but such is not the case. Indeed, one manufacturer has estimated that there are approximately 10,000 different types of nails with varying sizes, styles, shapes, finishes, etc. The proper selection of the right nail to be used for a given task is very important if optimum results are to be obtained.

Figure 2 shows a selection of old fashioned cut nails currently being manufactured and sold by the Tremont Nail Co. of Wareham, Mass. These nails from America's oldest nail manufacturer (1819), are available for use in restorative and antique work. Figure 3 shows a selection of some of the various types of modern nails available for use.

The Bible refers to King David's use of iron nails to build a Temple in approximately 1000 BC: "And David prepared in abundance iron for the nails of the gates, and for the closures and joinings . . .", I Chronicles 22:3, Old Testament. The techniques of making iron probably came from Central Asia and these techniques were then imported to the Middle East around 1200 BC. Early techniques utilized iron ore and burning charcoal in contact with each other. The heat of the charcoal was not hot enough to melt the iron, but it was hot enough to make a pasty mass of iron and slag. This could then be hammered, pressed, and worked into an acceptable wrought iron product.

The process of making nails did not significantly change for the next 2700 years. However, with the improved techniques of making iron, more tools and nails were made from this relatively strong and hard material.

In early America, farmers would make nails as a family wintertime activity around the fireplace. The farmer would take iron rods, heat them in the fire, and then form them into nails with hammer, anvil, and other tools. This technique, of making nails, continued into the late 1800s.

The next major step began in the early 1800s with machines that would make unfinished iron nails. In the beginning, the unfinished nails were completed by hand. Later nails were completely machine-produced. These

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> "And David prepared in abundance iron for the nails of the gates, and for the closures and joinings . . ."
> I Chronicles 22:3, Old Testament

nails were basically square nails, somewhat irregular and called cut nails. The use of steel caused nails to be much harder and stronger than any of the previous nails. Steel nails allowed the nailing of harder dense woods. (These nails slowly replaced the wrought iron nails because of the superiority of the product as well as the improved manufacturing techniques causing lower prices.)

The development of the wire nails followed the cut nails and resulted as a by-product of the Wire industry. Nails could be made from offsized wire that could not be sold as wire. The wire would be cut to length and nails completely made with automatic equipment. By the early 1900's, the wire nails had taken over 90% of the nail market.

The shafts of the wire nails were extremely smooth, thus the wire nails did not hold as well as the previous nails. These nails were stronger, more uniform, cost less and were much easier to use. The lower holding strength did not limit the use of wire nails; when needed, more nails were used to provide strength. Currently wire nails are made to tolerances and standards which were not achievable a few years ago. This is basically due to high speed automatic nailing machines which produce a superior quality product.

At the present time there are many persons who collect nails for a hobby. One retired contractor in Joliet, Illinois is reported to have a collection of over 20,000 nails from all parts of the world. His collection has nails from a 2700 year old ship from Venice as well as nails from 48 of the 50 states.

One of the co-authors of this paper has an extensive collection which contains a nail buried by the Romans in Perth, Scotland in 87 A.D. and excavated in 1961. The nail is handmade and is in remarkably good condition considering it had been buried for 1900 years! (Figure 1)

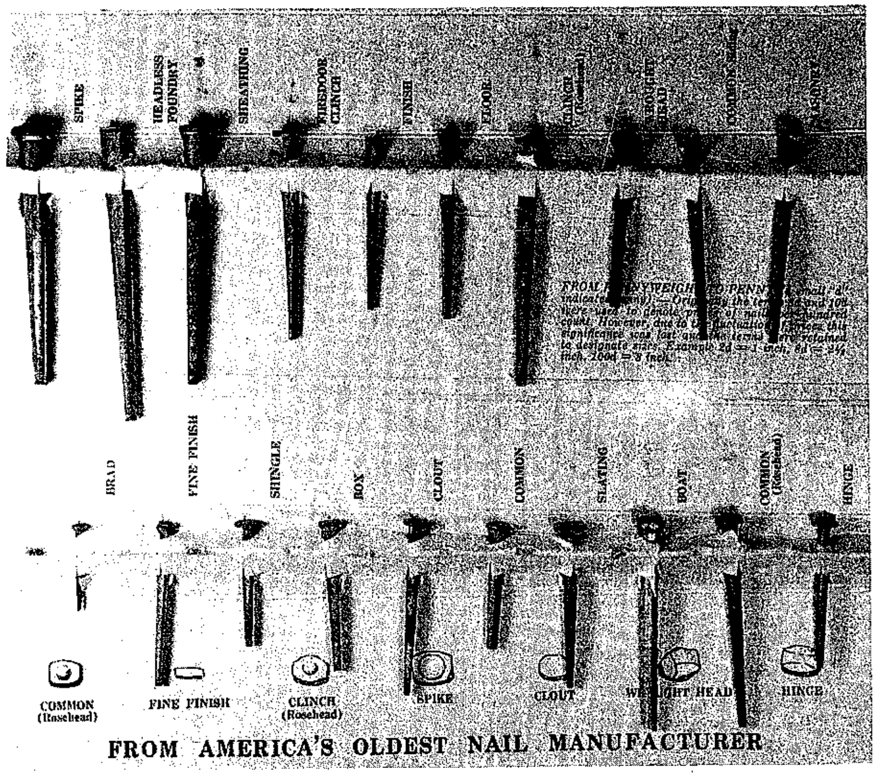

Figure 2: **Old fashioned cut nails from America's oldest nail manufacturer.**

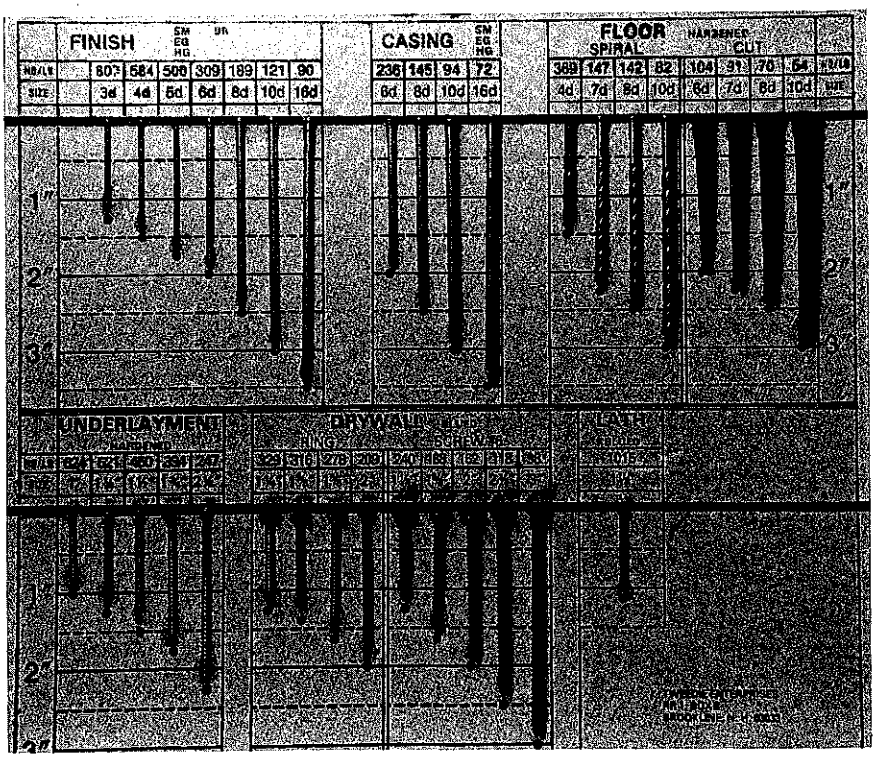

Figure 3: **Examples of Modern Nails.**

The nails used in today's construction are similar to the nails made 3500 years ago. The materials and the equipment used to make nails have

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NAILS (Cont. from page 27)

changed, however the basic concept of nails remains essentially unchanged. Luckily, the cost of nails has radically dropped so now we do not have to burn our homes to reclaim the nails! □

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