

# The History of Shotcrete

## Part II of a Three-Part Series

By George D. Yoggy

**T**he machine known throughout the world as the “Cement Gun” and its integral process *Gunite*, followed a curious route since its invention in 1909, originally for recreating animal skeletons, by naturalist Carl Akeley. Introduced at the Cement Show in New York in 1910, the machine and the process became an almost immediate success as a construction tool that was as unique as it was versatile. The first 5 years of its career saw several changes and improvements in the “gun,” as experience and testing begat modifications to suit the many uses in civil and industrial applications. Crossing the Atlantic in 1915, the *Gunite* process spread quickly throughout the world, and by 1922, the Cement Gun Company and the process was global, before the term was popular or even understood, *Gunite*, as a useful and important construction method, flourished through the 1920s, 30s and 40s in all of the industrial centers of the world. By 1950, nearly 5000 machines had been delivered to projects or contractors in every state and more than 120 countries.

The contracting activities of the Cement Gun Company provided nearly unlimited opportunities to prove the versatility and technical characteristics of pneumatically applied concrete. While it may seem that there is a great deal of emphasis on the company itself and its activities, one must remember that they were the only ones engaged in the production AND use of the machine for many years. Affiliate concerns were formed in Europe to service the countries of the world that had industrial and construction needs. A continuous effort of testing, comparing and communicating results and procedures was a mainstay of the global company’s activity. As independent contractors and franchises were started, standards established by the Cement Gun Company and recognized testing and specifying

authorities of the time prescribed strict procedures for the *Gunite* process. Gradation and proportioning of materials,

operating procedures, application and design specifications, finishing, and curing were clearly directed by the company through bulletins and technical papers. Quality was assured through clear communication of the prescribed and proven steps.

Throughout most of the period described, *Gunite* proved to be a technical process embraced by the engineering and contracting community. Refractory applications were also a prominent use for the process, since many combinations of cements, aggregate, and granular filler materials could be conveyed, wetted and applied to a substrate with predictable performance results. About half of all of the machines that went into service around the world did so in the melting shops of industry: smelters; mills; foundries; chimneys; boilers; refineries, etc. The other half were used to construct water storage and transport systems, protect steel structures, and to repair, construct, and support concrete and earth structures for countless industrial and commercial uses. History reveals that the *Gunite* industry and business was very successful, useful and respected in nearly every facet.

Then, a funny thing happened on the way to “prosperity.” In about 1950, (give or take a couple of years depending on where you look), changes began to occur! Considering the process was pushing 40 years, perhaps it was a “mid-life crisis.” Certainly the years following the war effort changed our culture and the way we lived and worked. Technology born out of necessity in the preceding years became available and useful in all phases of our lives. The world became “smaller” as the population became more mobile. While it may have seemed unusual that in 1920, *Gunite* found its way to Europe, India, and South Africa before it caught on in California, a glance at a globe reveals that the distance was the same (from Allentown), but there was a lot more going on in Europe than on the west coast, and many of the roots of industry were east rather than west, in those days. The mid-40s changed all of that forever!

Following World War II, change became the norm. New types of machines were developed, as well as the first equipment changes since the original invention. Some succeeded, and some faded away. Frank Reed developed a successful bowl-type machine that proved to be productive and simple to operate. The Jetcreter came out of Iowa and led to the Meynadier development of the Meyco rotor-style gun. Jack Ridley came up with a mixing and feeding system that combined a double tank gun and a trailer that is still referred to as a “Micon Rig”, no matter who built it. Aliva came into the foreign market shortly after Meyco with a rotor style machine, and there are still a few modified versions of the basic designs produced around the world. The so-called “continuous feed” guns were a significant change, and are still in use

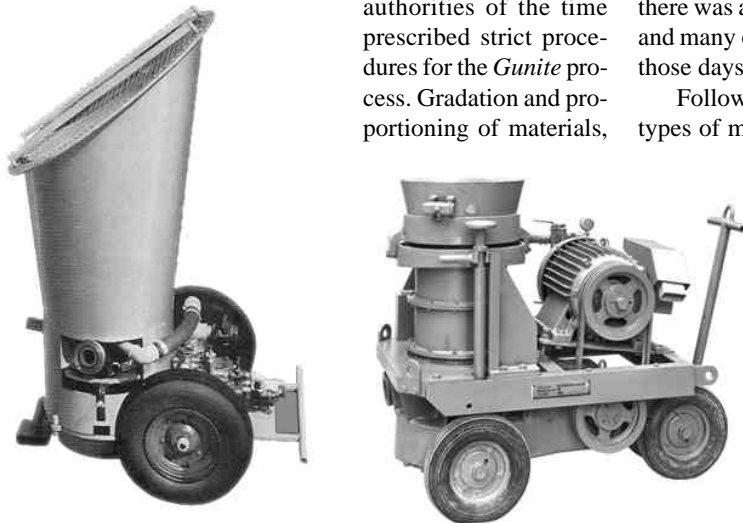


Figure 1 (left). Bowl type gun developed by Frank Reed.

Figure 2 (right). Meyco GM 57 rotor type machine.

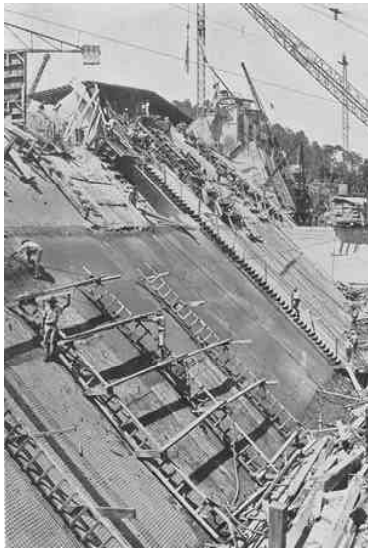


Figure 3. Guniting overlay for water proofing was done during construction of Chendorah Dam, Federated Malay States, c1930.

throughout the nation. Was there too much opportunity? Was it the west-coasters doing “their own thing” while some of the easterners shrouded their activity in mystery to protect their business? What happened to the assured quality that the carefully honed procedures established so well and shared for the first 40 years? What about the test and design data from Lehigh, UC, the Corps, and the Cement Gun Company? How did the love/hate attitude toward *Guniting* happen? And why did it happen only in the U.S?

There are likely as many opinions as there are people involved in the industry, and debate on the subject could fill more pages than are available. However, there is no question that the industry suffered, and its growth and acceptance was stifled for many years. Test data and project performance information that once flowed freely and orderly began to fade away. There was pitifully little documentation available to engineering schools, and the engineering community was reluctant to “gamble” on a process that it did not understand. If the decision maker had a good experience with *Guniting*, he would specify or approve it. If his experience or information was negative, *Guniting* was out—a situation experienced by too many gunners, too many times. Even the new term *Shotcrete*, along with its official ACI definition, failed to turn the heads of designers except in a few cases.



Figure 4. MiCon rig, introduced by Jack Ridley

today along with a variety of batching, mixing, and feeding devices. The wet process was yet to come. We’ll talk about that in Part III.

The real issue of the “mid-life crisis”, however, was the complete disconnection throughout the American *Guniting* industry that damaged the quality and credibility of the process. Perhaps it was that the new machines required less skill to operate, and the original company had no direction. Maybe it was the rapid spread of business and construction

throughout the nation. Was there too much opportunity? Was it the west-coasters doing “their own thing” while some of the easterners shrouded their activity in mystery to protect their business? What happened to the assured quality that the carefully honed procedures established so well and shared for the first 40 years? What about the test and design data from Lehigh, UC, the Corps, and the Cement Gun Company? How did the love/hate attitude toward *Guniting* happen? And why did it happen only in the U.S?

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There is no question that the *Guniting*, now called *Shotcrete*, industry lived through an extremely difficult period. There were many successful projects and companies that also lived through the same period. If we are now in the “reversal” period,

credit must be given to those that maintained the bridge of knowledge and dedication that spanned the chasm of confusion and carelessness. Names such as Crom, Maier, Fredericks, Reading, Moore, Carroll, Truman, Warner, Esposito, Rappa, Zynda, Lorman, Glassgold and a host of others were diligent in the work they performed and the procedures they advocated. Still, the free enterprise system that we all believe in also allowed many to do as they pleased, sometimes with little guidance, and too often, with much criticism and disagreement.

The 40 years from inception to outstanding growth and accomplishment could easily be called the period of “success”. The 40 years following should be called the period of “demise,” by comparison. However, there are clear signs of recovery all around us: sound technical procedures and a growing circulation of information that is valid; research and contract practices suitable to specification and design requirements; materials and equipment capability that incorporate the latest in concrete technology. Much has happened in the first decade of the third 40-year period. Are we truly in the age of “recovery”?

Consider this. The definition of shotcrete that our industry lives by, “...concrete or mortar applied to a surface at high velocity...” has been included in ASTM V. 04.02—*Concrete and Concrete Aggregates*, the majority of the past 40 years, and in all five volumes of the *ACI Manual of Concrete Practice*, yet we have struggled to make our case to the engineering community with only 45 pages of Volume 5 dedicated to shotcrete (ACI 506). That was not enough. “Shotcrete” is a method of placing concrete. All technology applies! Proper training, education, practice, research and communication are required. This is what Collier et al intended. This is the path forward, regardless of how we fell off the track.

We’ll assess the “recovery” in Part III.



George Yoggy has been directly involved in shotcrete and concrete applications in underground, heavy construction, and repair of concrete structures for more than 40 years. From 1967 to 1986, Mr. Yoggy owned and operated Concrete Equipment Corp. and Shotcrete Plus, Inc., both businesses engaged in the design, manufacture and supply of equipment for ground support,

shotcreting and concrete placing systems in the North American tunneling, repair and mining industry. In 1986, the company was acquired by Master Builders, Inc., and he established the Underground Construction group for MBT Americas.

As a director for MBT Americas, Mr. Yoggy is responsible for developing and managing the supply of products, equipment, and services for shotcrete applications in the underground and general construction markets. He has international experience in shotcrete for ground support technology employing NATM and similar techniques developed in Switzerland and Austria, as well as shotcrete for repair and refractory applications.

Mr. Yoggy serves on various committees including ACI Committee 506, Shotcrete, and is a member of the board of directors of ASA and President Elect of the American Underground Construction Association. He continues to be an active participant and respected leader in industry initiatives.