



Shotcrete, Airplanes, and Automobiles

By George D. Yogy "Giving structural steel a protective rust-proof and fireproof coating, without the use of forms...Lining tunnels, dry earth walls, irrigation ditches, etc. with a waterproof protective coating...Coating wood piles to protect them from destructive sea insects...Waterproofing concrete dams and reservoirs...Repairing defective concrete sea walls...And, coating frame houses, factory curtain and inclosing walls, waterproofing, etc."

An overview of the shotcrete industry? Yes! As printed in the March 12, 1911 issue of *Engineering News Record*. Add refractory applications around

1913, commercial swimming pools about the same time, and you have a good cross-section of the most versatile and effective method of placing concrete that has been available to the construction industry for 90 years.

The early years of this century produced a number of inventions that have benefited mankind, yet only a few had a singular beginning and continued in their "original" form for nearly the entire 100 years. While airplanes and automobiles have improved dramatically with materials development, functionally, they are much the same as Orville, Wilbur, and Henry conceived them. Shotcrete, as the method for placing concrete pneumatically, is comparable. A contractor can still purchase a "gunite" machine based on the original double chamber design (it even looks the same). While rotary machines came on the scene in the 50s and con-



Historic bridge
repair/restoration.



crete pumps that were practical for wet application followed some years later, the "projection of mortar and concrete onto a surface at high velocity" remains very much the same as Carl Akeley developed it just after the turn of the century.

Has there been any improvement in 90 years? Of course! As materials technology has changed the airplane and the automobile, concrete technology has brought about change in this multipurpose construction tool, particularly for the wet-mix shotcrete application method. Both the wet and dry processes, however, continue to play a major role in concrete repair, ground support, and new construction around the world.

Repairs of concrete structures such as bridges, sewer and water conduits and their processing facilities, parking structures, industrial facilities, and commercial buildings will be among the top shotcrete applications as we close this century. Underground support systems for tunnels and mines will follow closely. Advancements in admixture technology, as well as equipment developments in pumping and robotics, have made wet shotcrete a fast growing choice for ground support and tunnel lining. The higher volume output capabilities of wet-mix shotcrete systems will move that method into the lead in total yd^3/m^3 placed. The ratio of the total number of shotcrete applications is approximately 70%-30% in favor of the dry-mix process, with a five to seven year projection of change to 60% wet-40% dry, representing the growth in the wet process.

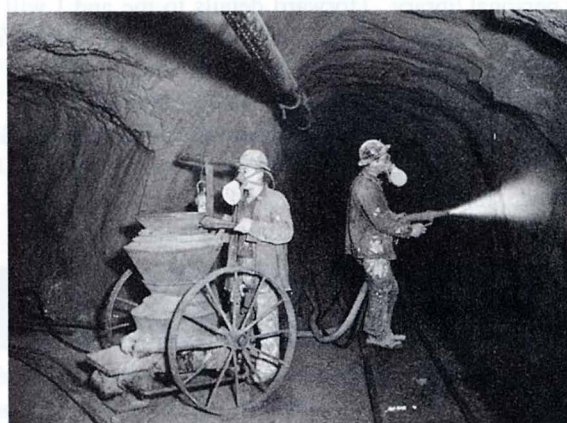
The swimming pool, slope protection, canal lining, and related applications comprise a third major segment of the shotcrete industry. The fourth is the placement of refractory materials in the metals, cement, glass, and petrochemical markets. The flexibility of shotcrete as a method of placing concrete makes it suitable for nearly any application from coal bunkers, concrete ships, railway, road and water tunnels to dams, reservoirs, Disney characters, theme parks, bridges, animal habitats, and gold mines. All of these have been constructed or reconstructed with concrete applied by the shotcreting method.

History has given us many examples of the strength, flexibility, and durability of concrete placed pneumatically. Our aging infrastructure will continue to benefit by using shotcrete as a primary repair tool. Underground construction, in some cases, is possible only because of shotcrete. Advancements in shotcrete materials knowledge and technology confirm what many within the industry have always known and provide even greater incentive and opportunity for education and growth for use of shotcrete as a construction solution.

The list of construction applications in the 1911 issue of ENR is still valid today, and has, in fact, expanded. Like the airplane and automobile, the



Shooting a bridge abutment in Philadelphia.



Shooting of a railroad tunnel in Pennsylvania circa 1921.

process we now call shotcrete is functionally the same as it was over 90 years ago. Technologically, however, it is at the high end of the concrete spectrum and a significant part of our future. ■



George Yogy, Director of Allentown Equipment Division of Master Builders and current Vice President of ASA, has been involved in shotcrete and concrete application for underground and heavy construction for over 40 years. George joined Master Builders Technologies in 1986 as part of an acquisition program and formed the Underground Construction group. His work has taken him across the U.S. as well as abroad. Some of his projects include the New York Water Tunnel, Mt. Lebanon, and the Lehigh and Cumberland Gap Tunnels. George is also a member of ACI 506 and 506 Underground, ASTM shotcrete committees, and the International Tunnel Association (U.S. Representative to Shotcrete Working Group 12).