
Shotcrete and it's Applications in Modern Civil Engineering Construction Projects

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ABSTRACT

During the early days of 20th century, a new method of concrete construction was introduced, whereby it enabled the application of sprayed concrete the introduction of this new method of concrete construction had brought a tremendous advancement in the concrete construction industry. The application of the sprayed concrete has been a significant change in the construction of underground works, where rock support and other construction activities were carried out with less difficulty. This paper examines concrete, different method of applications, quality control for site tests, and other construction ethics that should shotcrete operations for any construction activities.

Keywords: Shotcrete, Application, Civil Engineering Construction Projects.

INTRODUCTION

Concrete is usually known as the most versatile construction materials, which is used in construction industry and usually reinforcement. In its fluid state, concrete can be moulded into various structural and architectural shapes with the help of from work designed for the intended purpose. However, sometimes it is very difficult to mould concrete into various required shapes especially when the prepared from work has complicated shapes with limited access for powering concrete together with vibration in order to attain its compressive strength; durability and appearance.

It is for this purpose the term shotcrete came into being in the field of construction industry.

LITERATURE REVIEW

It was in 1895 at the field museum f natural science in Chicago, united

states of America (USA), and the curator known as Dr' carton Akeley was looking for some means of crating models of prehistoric animal. A skeleton frame had been manufactured but the body shapes of those animals could not be formed properly by the application of conventional trowelled mortars. As a result, Dr Akeley wanted to develop a device to enable the mortar mixture to be sprayed, which was successful as a single chamber pressure vessel in 1907. This enabled the spray of mixture of cement and sand through a delivery horse when pressurized with compressed air. The device was then named the cement – Gun, and the sprayed material was also named Gunite, which remained for sprayed mortar after then. After the invention of the cement Gun, the construction Industry later introduced the concept of sprayed concrete as then the alternative method of concrete

construction in places where cost of for work is very expensive or difficult to fix in position, and also in areas where access to the work place is very difficult. In addition the introduction of sprayed concrete was equally critically important when very thin layers or variable thicknesses are required and normal casting techniques cannot be applied. Today the advantages of sprayed concrete as a method of concrete construction and the improvement of construction

equipment, materials and application of know how have made the sprayed concrete construction type of various type of work. in the USA, the name shotcrete is widely used and known for sprayed concrete, while in united kingdom (U.K), it is reformed to as short concrete. In addition, sprayed concrete is also sometime referred to as short concrete. However, in these modern days, the name shotcrete is widely used all over the world.

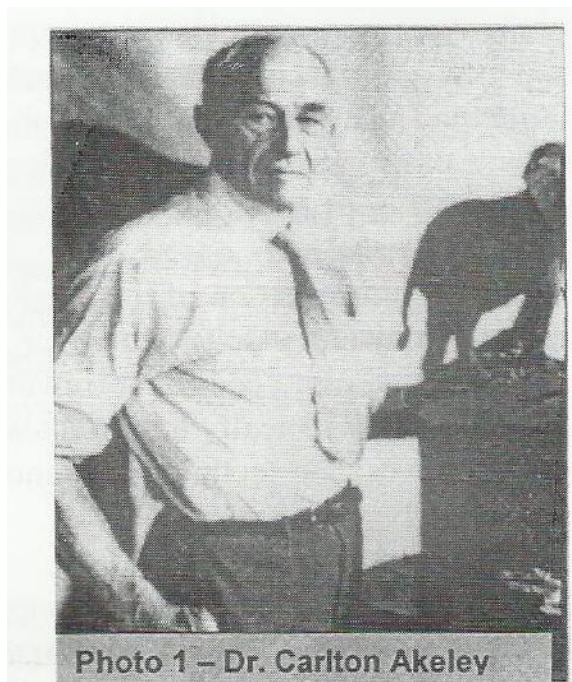


Figure 1

WHAT IS SHOTCRETE?

Shotcrete is a concrete shot into place by means of compressed air at high velocity, where the force of the jet impacting on the surface compacts the material, so that it can support itself without sagging even in a vertical and overhead faces.

Applications of Shotcrete

Shotcrete is generally used in rock stabilization works, such as underground tunnel linings, underground power house; cavern rock support works, surface excavated slope stability, thin concrete structures such as shells, and repairs of deteriorated concrete structures. In these modern days of

civil Engineering construction, more than 90 percent of the shotcrete produced is used for rock support works. Shotcrete therefore takes care of stability problems in tunnels and other underground construction works; and it is a key rock support mechanism in the following civil Engineering

Construction:-

- i. Underground Tunnel works

- ii. Mining operation and construction
- iii. Hydropower projects
- iv. Slope stabilization
- v. Pit curbing
- vi. Canal Lining
- vii. Reconstruction and Repair
- viii. Sea walls
- ix. Refractory
- x. Corrosion protection
- xi. Agricultural manure pits, etc

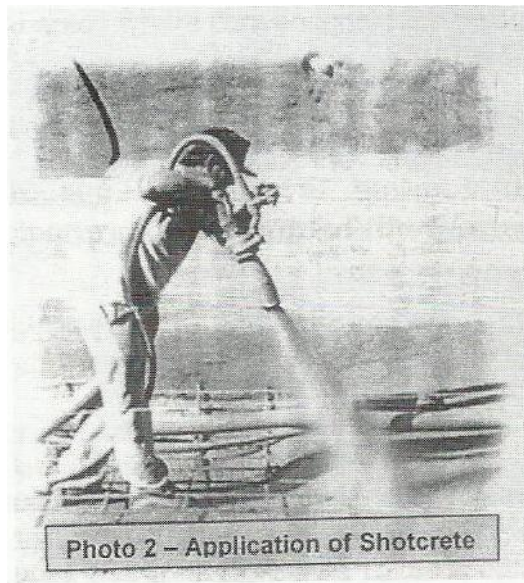


Figure 2

Methods of Shotcrete Application

There are basically two types of shotcrete application methods by which shotcrete can be applied. These are:-

- (i) **Dry – mix Method:-** In the dry method, cement and aggregates are usually mixed without adding water, while the dry-mix is usually fed into the pneumatically operated shotcrete machine which delivers a continuous flow of the material through the

delivery hose to the nozzle at a known rate through a flexible hose. Inside the nozzle is fitted a perforated manifold through which pressurized water is introduced for mixing with the dry mix ingredients, before the mixture is projected at high velocity and the mixture is placed in its proper position

- (ii) **Wet-mix method:-** In the wet-mix method cement aggregate, water and admixtures are thoroughly mixed as it would

be done for conventional concrete. The mixed material is later fed into the delivery equipments; such as a concrete pump which propels the mixture through the delivery hose by positive displacement or by compressed air.

Mix-Ingredients

With the usually normal concrete, the ingredients for shotcrete are usually the cement, aggregate, water and admixtures. The mixture proportion for shotcrete should generally be prepared following the specification in accordance practice for shotcreting.

Advantages of Wet-mix Method over dry-mix Method

As a result of Technological advancements, the wet-mix method has tremendous advantages as compared to the dry-mix method. These advantages are as follows:-

- (i) The wet-mix method usually increase the capacity of applying shotcrete per unit time with an average of 60 to 100m³, which can be achieved during normal working hours per day.
- (ii) A better quality concrete can be achieved due to the proper mix of the ingredients in the batching or mixing plants with control amount of water added. However, in the dry-mix method, the quality of concrete is mainly dependent on the

skill of the No33le operator, who is controlling the amount of water to be added.

- (iii) With the wet-mix method, not only higher compressive strength of the concrete is attained, but also the thick layers with improved bondage can be achieved
- (iv) The application of steel fibers and new advanced admixtures are possible with the application of wet-mix method.

Shortcomings of Wet-Mix Method

With the tremendous advantages of the wet-mix method into the construction industry, it has the following shortcomings:-

- (i) The Initial financial investment cost was very high, especially with the shotcrete machines.
- (ii) Wet-Mix method is not expected to be exposed to a lot of interruption during the operation. The end result of interruption is the blockage of flexible and rigid hoses of the system, which can shorten the life span of such an expensive equipment
- (iii) The wet-mix shotcrete equipment are larger in size than when compared to the dry-mix shotcrete equipments, which limits the applications of the wet-mix method in narrow and

confined working environment areas.

site during shotcrete construction application.

Quality control and Testing

Quality control and Testing should generally be carried out on a regular basis on the fresh mix-samples of sprayed concrete before applying it for any construction site. The site trails should be repeated to ensure the following:-

- (i) Workability
- (ii) Pump ability
- (iii) Spray ability
- (iv) Rebound
- (v) Slump
- (vi) Concrete destiny
- (vii) Admixtures dosage and compatibility with the cement type used.

Hardened Concrete Test

The test to be carried out on any hardened concrete includes the following:-

- (i) Compressive
- (ii) Concrete density
- (iii) Flexural strength
- (iv) Flore content
- (v) Bondage
- (vi) Permeability

- ❖ Adherence to other construction ethics, such as Health and safety observation during construction activities; control of hazardous substances, construction design and management regulations, working Environment, and waste disposals are to be strictly obeyed on any construction

CONCLUSION

Shotcrete is currently used in the construction of underground works where the rocks support is of primary concern or given due consideration. In addition, shotcrete is also used as an alternative for existing conventional method of concrete construction in the construction of different concrete structures. The other wide range applications of shotcrete are as follows:-

- (i) Underground power house
- (ii) Underground subway and access Tunnels
- (iii) Underground water way tunnels
- (iv) Mining works
- (v) High cut surface excavation slop stabilization
- (vi) Concrete repairs of marine structures
- (vii) Concrete lining works where the application if conventional concrete layers of concrete formula erection and placement is very difficult.

- ❖ The operation of shotcrete should generally be guided by nozzle men and other members of the construction team in order to be able to maintain proper quality of works and efficient utilization of resources that are available for the construction.

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