ZONOLITE DIVISION

CONFIDENTIAL

TO: Arnold Rosenberg

March 6, 1972

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FROM: James A. Berry

RE: Dry Hose Application of MONO-KOTE(R), Updating and Project Status.

PROGRESS REPORT No. 1641

cc: R. Caneer
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WRG 000928

PLAINTIFF'S EXHIBIT WRG-654

Objective: To develop a method of applying cementitious lightweight material; namely, MONO-KOTE(R) fireproofing insulation, conveyed by air through a dry hose system and to provide adequate amount of water for hydration of conveyed material, by either cold water vapor or saturated steam vapor, forming a slurry within the application nozzle barrel immediately prior to material being propelled from nozzle orifice and providing a uniformly hydrated spray of material from orifice opening.

The air conveyer blowing machine should have ease of mobility so as to be easily moved on construction sites.

The dry hose system and application nozzle should provide ease of workability and control of sprayed material.

History: Zonolite Dry Hose Research.

April 1964 MONO-KOTE dry hose tests at Zonolite Blue Island Plant, Illinois, conducted by Ralph J. Bragg. The original project objective was the same as our 1972 reinstigated dry hose study, to develop a method of application for lightweight insulating fill and fireproofing coatings of a cementitious nature which will result in increased performance, product workability and lower overall costs. Also to broaden the market for MONO-KOTE and insitu placed insulation materials.

Pilot work on the original Zonolite dry hose project was conducted during June and July of 1963 which led to our disclosure No. 262 and to a working rapport with Meyers Bros. Equipment Co.

The principle involved with the Meyers machine consists of conveying a dry blended cementitious mix by air through a suitable hose and effecting binder activation by cold water hydration at the instant the material passes through the application nozzle.

GRACE

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TO: Arnold Rosenberg
FROM: [redacted] Berry
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March [redacted], 1972

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Attempts to place type M.K. fireproofing with Meyers prototype machine [redacted] the final cured density to be in the range of 29 to 31 lbs./ft.^{3}, too high to be practical.

Reformulation of the product led to the composition known as MK-6, wherein vermiculite content was nearly doubled, and the air entrainment ingredient was omitted. The type of binder used in MK-6 was chemically identical to that in Type M.K., but set time was 30 minutes for MK-6, compared to 5-7 hours for Type M.K.

The MK-6 composition was tried under field conditions at Zonolite Blue Island Plant, Illinois on April 8, 1964. After preliminary trials, the Meyers machine was set at maximum output of productivity equaling 80 lbs. of MK-6 in 6 minutes and 2.3 g.p.m. of water at 110 lbs./in.^{2}; the ratio of MK-6 to water was 5.9 lbs. per gallon of water, at that period Type M.K. in a wet hose system required a ratio of 4.55 lbs. of M.K. per gallon of water. It amounted to a 23% reduction in water over Type M.K.; whereas MK-6 formulation at that time actually demanded more water per pound than Type M.K. in a conventional wet hose plaster pump.

Dry density of the tested MK-6 was 21.1 lbs./ft.^{3}. It was calculated that 19.6 lbs. of MK-6 and 1.5 lbs. of chemically combined water constitute the volume of 1 ft.^{3} of cured MK-6. Therefore, a board foot of MK-6 equals $\frac{19.6}{12}$ or 1.55 lbs.

Based on that particular volume, 32.25 board ft. of MK-6 was obtained per 50 lbs. bag.

Surface hardness of dry hosed MK-6 was found to be twice as great as wet hosed Type M.K. at the same density.

An Acme penetrometer No. 149 with a 1 in.^{2} piston gave a penetration resistance reading of 116 lb./in.^{2} for MK-6 and 59 lbs./in.^{2} for Type M.K.

The 1964 dry hose project was eventually stopped owing to an unacceptable dust problem in the system. Several approaches at various modifications were made, such as dampening the dry material at the blower machine outlet with a water atomizer.

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This helped to control the dusting problem, but added resistance to the material flowability causing the dry hose to block up at varying intervals. Regulation of the water regulator required constant attention, causing it to be impractical for actual field use. The application nozzle used in the 1964 project, was manufactured by Universal Machine Co., Winter Haven, Florida; nozzle designation A264 was made especially for Zonolite dry hose project, to be used in unison with the Meyers blowing machine. Universal now sells this particular nozzle as a standard stock item for wetting dry blown cementitious materials.

Model A264 nozzle consists of a straight through metal barrel with a 1.5 inch inside diameter, a capillary groove is located in the center of 6 inch long barrel, which feeds water to a jet ring with 20 mil holes set at 30° angle, confluent to the flow of dry material. The water jet ring provides a spray curtain of water in a vortex motion; hydrated material then passes through a choked (1.5" to 1.25") nylon nozzle 3 inches in length. As previously stated, the dusting problem was never really solved, to make the process suitable for field use.

MONO-KOTE(R) formulation designations mentioned in this report will be more clearly understood by the reader after noting the following:

Type M.K. was the Vermiculite Institute name for what is presently called MK-3, consisting of 100 lb. of Z.O.U. Gypsum to 7.88 ft.^{3} of vermiculite plus asbestos and air entraining agents.

MK-6 had double the amount of vermiculite by ratio to Type M.K. or 100 lbs. Z.O.U. to 15.76 ft.^{3} of vermiculite, air entraining agents were omitted from the MK-6 formulation

MK-4 formulation is almost the same as Type M.K. or MK-3; the asbestos bulking agent is replaced by celluflock in MK-4.

Dry Hose Project Reinstatement: November 1971.

Several tests were made with the existing equipment from the 1964 project, consisting of Meyers Bros. blower maching, water pump and Universal nozzle A264. All test material in this series is MK-4. A moderate and unacceptable amount of dusting resulted from the A264 and the water jet holes became repeatedly clogged with MONO-KOTE slurry. After widening the water jet holes from 20 mil. to 32 mil, several more tests were conducted, resulting in the same amount of dusting.

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The only significant change from widening the water jets, was decreasing the incidance of clogging. Further tests were made using a Therm-O-Flake gun manufactured by I.C.F.C.O., Joliet, Illinois; this type of nozzle was used by Cafco at one time, Cafco now use a Universal nozzle specially engineered for handling fibers. Asbestospray Co. also uses the new Universal nozzle which incorporates atomized water by compressed air energy. The Therm-O-Flake gun and cold water tests resulted in severe and unacceptable amounts of dusting with poor direction control of propelled hydrated material.

Dry Hose Using Saturated Steam for Hydration: November 22, 1971:

After some deliberation as to ways of preventing the dusting problem, it was reasoned that the easiest way to atomize or vaporize water and also to reduce surface tension, would be to generate steam.

We established early in the test series that a fine vaporized spray of water vapor did a much better job of hydrating the fine material particles and also arrested the dusting problem, as opposed to using a solid water jet.

The first approach with steam was made with the Thermo-O-Flake gun which was designed for blowing fiberous mixtures; material enters the gun at the rear and underside, then turns a 90 degree angle. Compressed air from an internal stem located in the center of the gun, propells the material to the open orifice, and becomes hydrated as it passes through a water curtain at the diverging cone shaped opening.

Orifice opening on the Therm-O-Flake measures 3 inches inside diameter.

The first thought was to use steam as a dampening medium introduced through the internal compressed air stem and to complete hydration with the existing water curtain at the nozzle. However, upon conducting the first test run, it was noted that the cold water curtain could be completely omitted; saturated steam provided adequate hydration, resulting in a minor amount of dusting.

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The large aluminum cast body of the Thermo-O-Flake gun was very cumbersome to manipulate and also became to hot to handle. Since it was found that steam would provide adequate hydration and also serve as a propellent, it appeared that the small and simple EZ-On type nozzle would be more suitable with steam. The EZ-On design of nozzle is the one most commonly used for wet hose MONO-KOTE spraying; it consists of an obtuse 5 inch long aluminum pipe 1.5 inch inside diameter, with an internal compressed air stem 0.25 inch inside diameter. Steam from a portable steam generator using 1.5 gallons of water per hour was connected to the external fitting of the compressed air stem. Several adjustments were made to the distance of the internal stem end and the nozzle opening, also several orifice diameters were tried to produce an acceptable hydrated slurry which could be applied to a metal test deck with a very minor and insignificant dusting situation.

This work led eventually to the writers invention disclosure No. 1025 in February 1972.

The first steam and dry hose sprayed pilot deck, was fire tested in January 1972.

Fire endurance time was 44 minutes, MK-4 was used. It was noted during the fire test, that a moderate amount of delamination was occuring at the interface of the first and second applied MONO-KOTE thicknesses; this apparently was due to a delay in thickness build up during application. The 10 minute delay was caused by a blockage in the dry hose system.

A surface skin had apparently formed on the first coat and the delayed second coat did not properly bond or knit at the interface. It is now realized the MK build up must take place within a short period of time between layers, probably no longer than five minutes interval between passes, when using the steam system with minimum hydration.

The amount of water converted to steam for hydration in this first pilot fire specimen, was 0.89 lbs. steam/1 lb. MK-4; The two maximum parameters found in this steam and MK-4 ratio are: 0.28 to 1.2 lbs. steam per 1 lb. MK-4.

The maximum delay in time between passes of MONO-KOTE build up is in actual fact, related to a certain degree, to the amount of steam used for hydration.

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mean workable ratio as a guide for further research should be approximately 0.9 lbs. steam/1 lb. MK-4. It should be noted that MK-4 in a wet hose system requires approximately 1.8 lbs. water per 1 lb. MK-4.

After minor adjustment to the EZ-On nozzle internal stem, setting stem end 1.5 inches from orifice opening, a second pilot test deck was sprayed. This particular spraying project, progressed with minor incidence of trouble or interruption. Oven dry density of MK-4 sprayed in this second test was 20.1 lbs/ft.^{3}.

Underwriters' Laboratory minimum oven dry density specification is 18 lbs./ft.^{3}, I understand no maximum density has been set by U.L. for our MK products.

Pilot (steam sprayed) Deck No. 2 was fire tested during the first week of March 1972, fire endurance time was one hour and twenty-two minutes (1:22).

The longest time/fire endurance for wet hose applied MK-4 pilot deck to date is 53 minutes, TR-8 (228).

Walt Payment did correlation research between fire endurance time and oven dry density. It was found that pilot fire test decks invariably failed within the first 30 minutes, if the oven dry specimen density ranged above 23.3 lbs./ft.^{3}.

Density of Wet Hose TR-8 was 20.3 lbs./ft.^{3}. One of the main difficulties with the Meyers Bros. blower machine appears to be in the feed gate system. The revolving segmented air lock, is charged with material from the hopper by screw feed and gravity. It revolves 180 degrees to the inverted position and becomes discharged by gravity.

The discharged material falls into an air Venturi and is carried by air down the dry hose. This particular system gives an irregular flow rate and causes problems with controlling hydration. A field trip was made to observe a competitor using a Universal machine for blowing Asbestospray. The Universal machine appears to have a superior air lock arrangement. Each segment of the revolving air lock is positively discharged by air as it rotates 180 degrees to the inverted position.