c.c. to Dr Frank Day
Dick Shannon

J. H. Thomas - Toledo

M. Hardwick - Berlin

KAYLO R & D

November 1, 1966

R. S. Grant - Toledo
R. J. McEvoy - Granville
Wayne Johnson - New York

PLAINTIFF'S EXHIBIT K188

The attached article was taken from the Chemical and Engineering News magazine, October 24, 1966 edition.

I thought you would be interested in this article in relation to our conversation at Sunnybrook of several weeks back.

I thought it particularly interesting that glass compositions containing no boron were actually alkali resistant enough to contribute the modulus of rupture and strength characteristics in lime/silica compounds equivalent to 10% approximately of asbestos fibers. As they state in the article, such glass fibers in slabs after a month have shown no signs of deterioration.

Apparently this article has received some attention in the Granville area, inasmuch as Bob McEvoy mentioned it to me.

I have also covered Wayne Johnson with a copy of this memo since in a recent discussion he has indicated that the Marketing Division would be most interested in supporting a program whereby a substitute for asbestos in Kaylo could be found to give them an alternate solution to the current asbestosis problem in the insulation industry. Wayne also indicated that if a program could be developed, the I & C Marketing Division would be interested in supporting same.

As I indicated to you, I am convinced beyond a shadow of any doubt that this program is a must in the long range plans of marketing our calcium silicates. Costs, health hazards, market-ability, etc., are all prime considerations.

I would appreciate your comments.

MH/jmw

M. Hardwick

Pg 54 - C + E
Oct 24, 1966

Glass fibers reinforce concrete structures

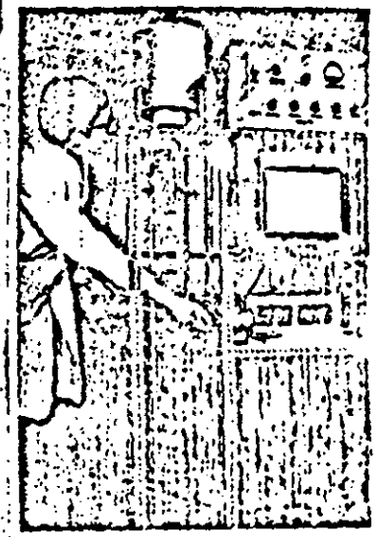
A highly alkali-resistant glass composition developed in the U.K. may allow architects still more freedom in precast concrete design. Glass fiber-reinforced concrete would make possible thinner high-strength structural shapes and piping than are now in use. A complex silicate of calcium, aluminum, and magnesium under study by the Ministry of Technology's building research station may fill the bill as a practical reinforcing glass—it's easily spun into fiber and it's compatible with portland cement.

Thinness limit. Corrosion protection sets a limit to the thinness of steel-reinforced concrete shapes. Reinforcing wires or rods must be covered by at least $^1/_2$ inch of concrete on all sides to prevent rusting. A fiber-concrete composite is an alternative, and asbestos fiber is already used to reinforce concrete planking and the like. In theory, glass fiber is better since its tensile strength is markedly higher than that of asbestos and it can be cut to the optimal length for making a strong composite with concrete. (Asbestos fibers are shorter than this optimum.)

The chemistry of hardening concrete defeated most previous attempts to reinforce it with glass fiber. Portland cement is about three quarters calcium silicate, which is converted during hardening into a calcium silicate hydrate—the main binding agent in concrete. The by-product is slaked lime, which attacks the low-soda borosilicate glass generally used for fiber making. As the concrete continues to harden, the glass gradually disintegrates and the composite loses its strength.

One way around the problem is to use a cement containing anhydrous calcium aluminate instead of calcium silicate. On hardening, it forms no slaked lime and thus doesn't harm ordinary glass fiber. But alumina cement is more expensive than portland cement.

Dr. R. W. B. Nurse, head of silicate research at BRS's Garston laboratory, near London, took the opposite tack. His group went after glass compositions that resist alkali attack. The glass now being tested, for which BRS has filed a patent application, was first formulated during a study of controlled crystallization of glass fibers. Unlike the usual fiber-making compositions, this glass contains no boron. It was found to resist alkali attack better than any other glass known, Dr. Nurse says, although its acid resistance isn't particularly outstanding.



PILOT PLANT. BRS's experimental setup produces glass fiber 10 microns in diameter which may be used to strengthen concrete shapes. Fiber is drawn in a single filament from the resistance furnace to a drum at the base of the rig

Testing has been limited to thin cement slabs containing about 5% fiber of what seems to be optimal dimensions for composite strength. Produced as a continuous filament 10 microns in diameter, the fiber is fed through a chopper and placed in the mold as a more or less parallel distribution of 2- to 3-inch lengths. Cement mix, overmoist to ensure thorough fiber wetting, is then added. The fibers remain partly oriented in their cement matrix, adding further strength to the composite. These slabs show a modulus of rupture of 15,000 p.s.i. after a month's hardening. This is more than three times the value for slabs containing 10% asbestos fibers. The latter can't easily be oriented in a mold. Glass fibers in slabs broken for examination after a month show no signs of deterioration. Nor has exposure to boiling caustic shown a significant effect on the glass.

In these thin slabs the fibers are distributed fairly evenly throughout the slab cross section. Thicker structural members might be reinforced by adding glass fiber to a thin layer at the surface of the tension side. Production methods for incorporating the fiber into slabs and into more complex shapes have still to be worked out. One approach is to blow chopped fibers into the mold to retain their parallel orientation. A detailed study is also planned of how well glass fiber adheres to cement particles in the composite.

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