A Portland cement plaster wall system has many positive features, but one of the physical properties that it does not possess is flexural strength. It is because of the inability of the Portland cement plaster membrane to bend or flex that glass fiber strands were used in Portland cement-based plaster.

There are various types of synthetic fibers on the market that will provide flexural strength to the plaster matrix. The information in this article is focused on research and testing by the Northwest Wall & Ceiling Bureau as it pertains to chopped glass fiber strands in the base coats of Portland cement plaster.

There are two types of glass fiber strands; alkaline resistant (A/R) glass fiber and conventional E-glass fibers. Research completed by the concrete industry has shown that E-glass fibers in an alkaline medium will break down after a long period of time. Since the concrete industry was using glass fibers to increase structural properties, it was important to use A/R glass fiber. In our research with Portland cement plaster, we found that conventional E-glass fibers performed well for the purpose intended. Chopped E-glass fibers added to the scratch and brown coats for Portland cement plaster helped eliminate cracking. This is especially important during the early curing process.

The concept of adding chopped glass fiber strands began by going out to various job sites and adding handfuls of chopped fibers to the mix. Records were kept on various walls that had the glass fiber strands added to the Portland cement plaster mix and those that did not. The walls with three pounds of 1/2" chopped fiberglass strands per one sack of Portland cement plaster. The Portland cement plaster was hand applied. This testing showed the 400 sq. ft. wall with the glass fiber strands performed a great deal better regarding cracking as did the same comparable wall without glass fiber strands.

Testing was performed by Columbia Cement Corporation at their testing facility in Bellingham, Washington, in accordance with the ASTM flexural beam break test. The purpose of this testing was to determine the strength of beams when the percentage of glass fibers varied per sack of cement, and how the strength varied when the length of glass varied from 1/2" to 2" in length. Both A/R glass and conventional E-glass were used.

We worked with two basic mixes. Group A was type 1 regular cement in conjunction with type 1 masonry cement, and Group B was type 1 regular cement with type S lime. Approximately 50 samples were tested for strength at various time intervals of 14 days, 28 days, and 45 days, and a few tested at 90 days.

Testing showed that strength had increased in the flexural beams which had chopped fiberglass strands. The testing also indicated that there was not a great deal of difference in strength of the flexural beams when using 1/2" chopped glass fiber strands added to the mix had less cracking. Since this was not a scientific approach, we decided to do further research and controlled testing in both the field and in the laboratory.

Field testing was completed with 400 sq. ft. wall panels consisting of wood frame construction, 1/2" plywood sheathing, building paper, self furring lath, and 3-coat 7/8" Portland cement plaster. These walls were done with three pounds of 1/2" chopped fiberglass strands per one sack of Portland cement plaster. The Portland cement plaster was hand applied. This testing showed the 400 sq. ft. wall with the glass fiber strands performed a great deal better regarding cracking as did the same comparable wall without glass fiber strands.
conventional E-glass or A/R glass.

The mixing of the Portland cement plaster followed the standards set forth in ASTM C926, “Standard Specification for Application of Portland Cement-based Plaster.” Based on the testing, we concluded that E-glass fibers added to the matrix of base coats of Portland cement plaster would increase its flexural strength and reduce the possibility of cracking. Further field tests indicated that it was impractical to use fibers of greater than 1/2” in length. Chopped glass fiber strands longer than 1/2” were virtually impossible to apply through a plastering pump machine. Mixes with longer fibers, even applied by hand, were difficult and the glass fibers had a tendency not to mix well in the mixer. Thus, we concluded that 1/2” length fibers were more practical to use.

The amount of chopped fibers used in the mix is also affected by the means by which the Portland cement plaster is being applied. If pumping the material, one and a half to two pounds of 1/2” chopped glass fiber strands per sack of Portland cement is recommended. When applying the material by hand, a greater amount of chopped fiberglass strands can be added. The mixing process is very crucial. The individual filaments in the strands of chopped glass fiber have a tendency to unwind if they are in the mixer too long. Thus, it is recommended that the glass fiber strands be evenly spread in the plaster mixer just before the material is ready to be used. One or two minutes of mixing the fibers in the mixer is adequate.

Another problem occurs during the pumping operation. When the plaster is poured from mixer into the pump, some of the chopped fibers have a tendency to catch on the pumping machine’s screen. This cannot be avoided, and the hod carrier must have a board or some other device to scrape the screen periodically.

I feel that an additive of synthetic fibers in the scratch and brown coat of Portland cement plaster is an economical and a very effective means of eliminating or minimizing cracking.
It has also been a good promotional tool to show architects and others in the construction industry that we are continually trying to resolve the problem of cracking, and that this system with synthetic fibers is an effective method.

There are various types of synthetic fibers on the market today, and I am quite sure that almost all of these would perform the task of adding flexural strength. We are most familiar with the glass fiber strands, but I know that other fibers have come on the market and have been tested. Hill Brothers Chemical Company has a material called Hi-Fibe P Series Fiber, and there are others on the market. If a synthetic material is used in the Portland cement plaster process, I would strongly recommend that you first do some field work to see how it handles in gun and hand application. Some manufacturers have prepackaged the fibers in small plastic bags.

Portland cement plaster is brittle and weak in tension, but the development of fiber reinforced Portland cement plaster provides a technical basis for increasing strength and arresting the growth of cracking.

Reinforcing steel bars in concrete have the same beneficial effect. Tests have shown that adding fibers to a concrete mix increases its physical and mechanical properties when the fibers are uniformly distributed throughout the concrete. This same principle holds true with Portland cement plaster, even though we do not use nearly the amount that is used in the concrete industry.

The alkalinity content of the cement when mixed with water can affect the strength of synthetic fibers. That was the reason for the development of the alkaline resistant fiberglass strands. In Portland cement plaster, we are not looking for the same mechanical and physical properties as are required in structural concrete. It has been found that
conventional E-glass performs well. There is a big difference in cost between the A/R glass and E-glass, but if you are using a cement with high alkalinity and you are concerned about properties of the glass over a long period of time, then A/R glass is recommended.

The mixing and application of Portland cement varies a great deal. Each region does something a little different, and we all rely heavily on the person mixing the materials and the person applying the cement. Since Portland cement plaster work is not an exact science, it is essential that proper ingredients are used and measured out in the right amounts. Putting only a few 1/2" chopped fiberglass strands in the mix will not do the job. The minimum amount would be one and a half to two pounds per sack. The more you put in, the more tensile strength you add to the matrix.

Chopped glass fiber strands are not to be used in the finish coat. They are designed to be put in the scratch and brown coat only. The same amount of chopped glass fiber is added in each of the base coats. The chopped glass fiber strands are a physical additive that is dispersed through the cement plaster, and tests have shown that they work. The cost is minimal when compared to the results that one can achieve by using them.

About the Author:

Bob Drury has been Executive Director of the Northwest Wall and Ceiling Bureau for 14 years. His formal education consists of the University of Washington School of Architecture and San Jose University Engineering School. The Bureau is well recognized for its technical support and expertise in the construction community throughout western Canada and the Northwest United States.