

PAOLI, PENNSYLVANIA
March 28, 1966

TO: All Regional Managers
All Sales Managers
All Salesmen
Distribution Division Sales Personnel

CC: R. I. Fredericks, Paoli
K. A. McCaskill, Paoli

General Sales Bulletin #20-66

Subject: Firestop

By: C. E. Abbey - jp

C.E.A.

Forwarded herewith is a reprint of an article that appeared in the January 1966 issue of the Building Standards Monthly Magazine entitled "Type 'X' Wallboard, What It Is and Where and When It Originated." As indicated, this was prepared by C. E. Abbey and represents a complete story on the development of Firestop, which was an Industry First for our company when the gypsum facilities were under the company name of Certain-Teed Products Corporation. Remember, the same men who had so much to do with the development of this product and its promotion are still in the organization, other than the few who have retired.

Some of the older salesmen who were with the company at the time Firestop was introduced to the market may be aware of these facts. However, it is worth reviewing and is of particular interest to the newer salesmen. Firestop and its success is ample proof that the Bestwall Gypsum Division have amply qualified men in the gypsum field to give you a good share in leadership in this business.

Without using the tradename "FIRESTOP", there is sufficient reference in the article to tie in the fact that this is the history of Firestop. However, all of the statements are factual and the article was carefully reviewed by several people in management before it was released. If necessary, the facts may be proven by reviewing patents, company literature of the various gypsum manufacturers, and the Underwriters' Laboratories Building Material List which has been published in January each year for a long time.

This same article appeared in the May 1965 issue of the GDCI Magazine and, as indicated here, in the January 1966 issue of the Building Standards Monthly, and it has also appeared in the February 1966 issue of the Southern Building Magazine.

Thus, the story of Firestop has been brought to the attention of the drywall contractors and the building officials throughout the country.

Be sure you're getting your share of the growing market in fire rated gypsum wallboard. You have the best, and the original Type "X" gypsum wallboard.

TYPE "X" WALLBOARD

What It Is and Where and When It Originated

By
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Director, Technical Services
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Bestwall Gypsum Division

ALL THE major gypsum wallboard manufacturers market one or more fire-retardant gypsum wallboards under their own trade name. The term—Type "X"—is not the trade name of any specific company's fire-retardant gypsum wallboard. The following article is a concise history of the development of a particular Type "X" gypsum wallboard, by one company.—Editor.

IN ONE or another of its present forms, gypsum is used in 90 per cent of all buildings in the United States having finished interiors. Over 75 per cent of all residential construction today utilizes gypsum wallboard. Most of the remaining residential units have gypsum lath and plaster. In commercial and institutional work where, historically, lath and plaster were widely used, there has been a strong movement in the past few years to gypsum wallboard assemblies.

When gypsum wallboard first appeared in the early years of this century, it was relatively crude, consisting of several layers of roofing felt spaced with thin layers of cast gypsum. Over the years, a great many improvements have been made to achieve a stronger, yet lower cost, high quality, fireproof building material four feet (4') wide with a highly calendered, smooth-face paper, strong back paper and tapered longitudinal edges to facilitate finishing of the joints between panels.

A major factor contributing to the rapid increase in gypsum wallboard interiors in the past 10 years has been the development of a product with a core having greater fire resistance than conventional gypsum wallboard. In simple comparison, a five-eighths-inch (⅝") thick fire-rated board gives fire resistance in assemblies similar to the fire resistance of gypsum or metal lath and plaster which, for years, were considered as the only acceptable one-hour fire-resistive construction.

A.S.T.M. STANDARD C36

The present A.S.T.M. Standard C36 includes the definition of a product designated as "Type 'X'" gypsum wallboard. It reads: "Type 'X' (special fire retardant) designated gypsum wallboard, complying with these specifications, is one that provides at least: (1) one-hour fire-retardant ratings for five-eighths inch (⅝") thick; or (2) three-fourths-hour fire-retardant ratings for one-half-inch (½") thick gypsum wallboard applied in single layer nailed application on each face of load-bearing wood framing members, when tested in accordance with the requirements of Methods of Fire Test of Building Constructions and Materials (A.S.T.M. Designation: E119)." This is a refinement of the first definition for Type "X" which appeared in A.S.T.M. C36, 1955.

Much of the following information on the development of Type "X" gypsum wallboard was obtained by reviewing the U. S. Patents issued on gypsum and related materials in the past 20 years; by studying the Underwriters' Laboratories "Building Materials List" from 1945 to the present; by checking the literature on gypsum wallboard products of the various manufacturers, including their Sweets' Catalogue inserts, beginning in 1950.

EARLY HISTORY

In the early 1940's, chemists from the Bestwall division of Certain-teed Products Corporation began experimenting with various additives in the core of the gypsum wallboard in an effort to increase its fire resistance. Gypsum, by itself, or in combination with an aggregate, is a barrier to the passage of heat, fire and smoke for long periods of time, due to the chemical make-up of the material and its reactions under heat. Gypsum, or as it is technically known "hydrous calcium sulphate," is about 50 per cent water, by volume, or about 20 per cent water, by weight. When subjected to heat, the water of crystallization is separated from the calcium sulphate, changed into steam, and driven from the material. This requires heat at the surface and progressive action working from the surface exposed to the heat, back through the mass. As the water of crystallization is driven from the material, the material remains incombustible and offers good insulation to heat transfer. As shrinkage occurs, cracks develop because of the loss of half the material's volume. As the calcination proceeds through a gypsum wallboard, gypsum plaster, or gypsum block assembly, fissures commence to open up. These openings ultimately permit the passage of the fire and heat directly through the mass. If the material is in a ceiling installation, this would allow the material to drop.

IMPROVEMENT OF WALLBOARD

The primary reason for the success of metal lath and gypsum plaster assemblies as fireproofing, was the ability of the metal lath to reinforce the calcined material, holding it in place for a longer period of time. At the same time, such installation prevented the cracks from becoming large enough to allow the passage of heat, smoke, and flame. It was the aim of the Bestwall-Certain-teed chemists to incorporate characteristics in gypsum board that might accomplish the same result.

This research led to experiments in adding various incombustible fibers to the gypsum core, including asbestos fibers, mineral wool, glass wool, and fiberglass strands. The first patent issued October 17, 1950, to Michael Croce (No. 2526066) of Bestwall was based on material filed originally in 1943. Fire tests on full scale wall panels at Underwriters' Laboratories resulted in the first listing of one-half-inch (½") special fire-rated gypsum wallboard in 1946. This was the basis of the current Design No. 1—45-minuted, listed by U.L. Further laboratory work improved the product, resulting in a board which, when used in the ceiling, gave equal fire protection. Experimentation involved addition to the core of various materials which expanded when exposed to heat. It was found that vermiculite of proper grade appeared to be the most suitable. The purpose of the vermiculite was to offset the shrinkage of the core under heat. Fire tests of a floor and ceiling assembly with one-half-inch (½") board incorporating the unexpanded vermiculite and the incombustible fibers, developed a 45-minute fire resistance rating equal to that developed in the wall.

This was a major step forward. Up until then a partition surfaced on both sides with one-half-inch (½") regular gypsum wallboard would provide 40 minutes fire resistance, and a wood joist and floor assembly with one-half-inch (½") regular gypsum board as the ceiling, only 25 minutes. A wood floor-and-ceiling assembly with no fire protection, tested by the Bureau of Standards, withheld the passage of fire and heat and sustained the load for 15 minutes. One-half-inch (½") regular board, as the ceiling protection to this assembly, increased the fire resistance to 25 minutes thereby adding 10 minutes fire endurance to the assembly. Now the one-half-inch (½") fire-rated board newly developed by Bestwall produced 45

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He spent five years with the Gypsum Association as research engineer before his employment by Certain-teed Products Corporation as sales engineer. In this capacity he did promotional and building code work insofar as Certain-teed materials and assemblies were concerned, particularly with the fire-rated gypsum wallboard "Firestop."



C. E. ABBEY

Since the organization changed its name to "Georgia-Pacific Corporation — Bestwall Gypsum Division" Mr. Abbey has worked as merchandise manager, technical director and training director. In addition to his position as director of technical services, he is sales manager for tile products.

minutes fire resistance, or added 30 minutes of protection to the assembly—three times the protection offered previously by one-half-inch (½") gypsum wallboard!

WALLBOARD PRODUCTION CONTROL

At the time of the first test made at Underwriters' Laboratories, showing the improved fire resistance possible with the new special formulation in the core, there was a great deal of discussion as to how the production of such a product could be controlled to take care of variations in the amount (both maximum and minimum) of the special ingredients added to the core, variations in caliper of the board, and variations in the physical characteristics of gypsum from different deposits. Control is vital since gypsum wallboard is formed at speeds varying from sixty lineal feet (60 lin. ft.) to one hundred and fifty lineal feet (150 lin. ft.) per minute for a one-half-inch (½") thick board.

Before Underwriters' Laboratories would agree to listing the product, a series of full-scale tests was made to show the variations in the fire resistance possible with the minimums and maximums of ingredients, both as contemplated by patent descriptions and by manufacturing limitations. Also, checks were made to determine the consistency of fire resistance within the normal variation of the mechanical proportioning equipment customarily used in board manufacture. Furthermore, based on Underwriters' Laboratories' knowledge of the characteristics of gypsum from various deposits, tests were made of board produced from various grades of ore. As a result of this early work, Underwriters' Laboratories wrote their first "Manual of Procedure" which was to be their guide to check samples of material taken out of production runs or from dealer stocks, and also to check plant production of the special board. With refinements this has continued to be the basis for U.L. Listing and Labeling of all Type "X" gypsum wallboards.

Chemists continued to improve the core formulations to increase the performance of the board. This led to Patent No. 2,681,863 by Michael Croce and Clarence G. Shuttleworth, issued in June, 1954. It was based on original applications made in July, 1951, and represented the primary development insofar as the practical use of glass fibers in gypsum was concerned. It had been found from experiments that, while several incombustible fibers would perform satisfactorily to attain fire resistance of the product, all but one resulted in production difficulties.

The first test developing a one-hour fire-resistive wall assembly in a single layer application was of a five-eighths-inch (⅝") board with asbestos fibers and unexpanded vermiculite in the core. In the production of this material, due to the affinity of asbestos for water, there was difficulty in drying the board properly in the kilns. As a result, too much moisture remained in the wallboard and this created problems when shipments were made to northern destinations during below freezing weather.

INTRODUCTION OF GLASS FIBERS

Many types of glass fibers were checked before chemists found a satisfactory one. This one consisted of drawn, textile glass fibers formed into strands with a water-soluble binder. The binder was strong enough to hold the fibers together in the glass fiber manufacturing process during which the filaments were gathered into strands and rovings. When the strands were cut into short pieces and agitated in a wet plaster slurry, the binder softened and permitted the individual filaments to separate and disperse rapidly throughout the mix.

Further laboratory studies led to the third Patent No. 2,744,022 having to do with the use of additives in "Plaster Compositions and Products," issued again to Michael Croce and Clarence G. Shuttleworth in May, 1956.

During the early years of 1950, the Certain-teed Products Corporation was the only company producing a special fire-rated gypsum wallboard product, which it sold under the trade name "Bestwall Firestop." "Firestop" was tested and proved, first in a wall assembly over wood studs, then beneath a wood floor and ceiling assembly, later over steel studs, and finally beneath steel bar joists, all in single layer application for one-hour fire resistance.

When this product was introduced, the gypsum industry was not entirely convinced of its usefulness. Other gypsum manufacturers wanted to do their own experimentation and testing, and did not at that time take advantage of Certain-teed's development work. However, building officials and architects welcomed Firestop, as it enabled them to maintain one-hour fire-resistive requirements with a wider choice of assemblies, five-eighths-inch (⅝") Bestwall Firestop with its proved performance in full scale, official Underwriters' Laboratories fire tests, and the manufacture of the board under U.L. Re-examination Service, was accepted and approved under the Pacific Coast Uniform Building Code in 1951 (first Research Report No. 296, September, 1951). By 1955, there was acceptance in over 250 major cities throughout the United States. As the importance of Firestop developed, other gypsum manufacturers began to market competitive materials. However, in view of the acceptance of Bestwall Firestop, these manufacturers found it advisable to have their products also officially fire tested at Underwriters' Laboratories. Through the years, other first test facilities including those of Ohio State University, University of California (Berkeley), and the Fire Prevention Research Center (Gardena, California) have been used.

THE U.L. LABEL

The Underwriters' Laboratories annual publication, "Building Materials List," issued each January, indicates that Certain-teed Products Corporation was the only manufacturer listed for a special fire-rated gypsum wallboard as late as 1952. It was 1953 before any other manufacturer's fire-rated gypsum wallboard appeared in these Listings. As a result of several manufacturers producing a special fire-rated board, Underwriters' Laboratories insisted these manufacturers take Label Service. In consultation with the Bestwall officials, it was agreed that they would also use Label Service. Since that time, all the special fire-rated gypsum wallboards have been made under Underwriters' Label Service and carry an identifying mark, generally a "Manifest" or "Label" on the twin mounting (end bundling) tape.

Just what does the U.L. Label mean on Type "X" gypsum wallboard? Underwriters' Laboratories conduct a fire test on an assembly with a specific material, on the basis that the manufacturer will subscribe to Inspection Service and will properly label the product. Underwriters' Laboratories say in effect—the material when applied as listed will give the protection developed in the test. The manufacturer has the right not to so label the product. However, if the product is not labeled, Underwriters' Laboratories will say nothing of the product and its value for fire protection. On the other hand, by subscribing to Inspection Service, and manufacturing and shipping the material with the U.L. Label and Listing, the manufacturer gives assurance to the purchaser that it conforms to the rigid specifications set for the material on which the official fire test was made. Underwriters' Laboratories make periodic unannounced checks of manufacturing facilities, check material in process, in stock in the plant, and also check material purchased on the open market. Consequently, the U.L. Label Service gives the end user protection against changes in the product, which may adversely affect its fire-resistive performance.

When Bestwall Firestop is specified, it is only necessary for the building official, owner, architect, or contractor to examine the installation before it is decorated to make certain that the proper board has been used and that it has been correctly applied. To quickly identify the fire-rated gypsum wallboard pioneered by Certain-teed, face marking was adopted for Firestop in 1951 and Bestwall Firestop is still face marked down the center of the sheet every few feet with "⅝" Firestop" or "½" Firestop."

The cost of U.L. Inspection and Label Service, which insures that the product meets minimum standards and if properly installed, will give the fire protection specified, is absorbed by the manufacturer. The other testing organizations mentioned are well equipped and properly staffed to make fire tests equal to those made at Underwriters' Laboratories. None of them, however, does more than test and make a report on the assembly as tested with the materials furnished. There is no follow-up inspection to insure continuation of the performance in the future. Hence, when Building Code authorities approve materials in assemblies based on such acceptable fire tests, they rely completely upon the character and reputation of the manufacturer involved to assure them that the product continues to equal that tested. The U.L. Inspection and Label Service gives that continuing assurance!

INCREASES IN FIRE-RATINGS

In 1956 the Bestwall Gypsum Company was formed to take over the gypsum operations of Certain-teed. Bestwall has continued to test additional assemblies with five-eighths-inch (⅝") Bestwall Firestop. These tests proved two-hour and three-hour fire-resistive partition assemblies. Later, up to two-hour fire-resistive floor and ceiling assemblies with single layer applications, two-hour and three-hour column fireproofing, and other assemblies with metal framing, were tested successfully.

In 1962 and 1963, in further laboratory tests, in an effort to improve fire resistance, Bestwall made sufficient changes in formulation within the scope of the patent claims to require Underwriters' Laboratories to revise the "Manual of Procedure" on Firestop Bestwall literature and Underwriters' Laboratories "Building Materials List" (latest edition) demonstrate that Bestwall continues to manufacture only one fire-rated gypsum wallboard, Firestop, one-half inch (½") or five-eighths inch (⅝") thick, all of the improved type.

Going back again to the historical development of Type "X" wallboard, in all of the many patents which were reviewed and considered, there is one other issued to J. G. Jackson in August,

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TYPE "X" WALLBOARD

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1947, which mentioned fiber glass, reinforced gypsum wallboard. Based on work filed in 1941, it was covered by U. S. Patent No. 2,425,883. Comparison of the claims of the several patents which have been referred to would indicate the Jackson patent covered a different principle in the use of glass fiber reinforcement, directed primarily to portland cement construction, but broadened to include gypsum. The Jackson patent mentions the use of "concentrated reinforcement embedded therein" and reinforcing comprising "a consolidated group of fine glass filaments bonded together into a substantial rigid bar by a bonding medium which is substantially inelastic." The Jackson patent does not appear to describe use of textile glass fibers individually dispersed throughout a gypsum mass. The patents issued to the Croce-Shuttleworth team refer to glass fiber filaments individually dispersed throughout the product.

Certain-teed and Bestwall's literature has continually stressed the character of the core of Firestop as "thermally stabilized." Unexpanded vermiculite particles are well distributed in the core and expand on the application of heat, counter-balancing the shrinkage of the gypsum which occurs as it loses its water of crystallization, thus providing a core which is dimensionally stable under the action of fire. Glass fibers, well dispersed throughout the core, serve as a reinforcing network holding the wallboard core together.

LICENSE AGREEMENTS

Bestwall offers license agreements under its patents to other gypsum manufacturers. A number of companies have taken license agreements and make their products to the Bestwall's Firestop formulation. Underwriters' Laboratories Listing has been extended to their products after they have met the performance standards set for Firestop.

After several gypsum manufacturers had a fire-rated board on the market with proved performance in several standard assemblies, the Gypsum Association began to push for industry standards that would be acceptable to building code officials, testing organizations, and manufacturers.

In 1955, A.S.T.M. Committee C11 Gypsum finally added the new type gypsum board in A.S.T.M. Standard C36 on Gypsum Wallboard referring to it as "Type 'X'." The definition, as further refined, was given at the start of this article. The definition in C36 is the basis on which industry approvals of Type "X" board are requested. Effort has been made to establish that all Type "X" gypsum wallboards are equal and that performances developed with one are applicable to the others. Bestwall takes the position that a product with a "thermally stabilized" core has important characteristics not found in some other Type "X" gypsum wallboards.

In addition to its United States patents, Bestwall has obtained patent coverage in foreign countries including Canada, England, and Germany.

In the United States, the companies presently offering fire rated Type "X" gypsum wallboard and their trade names include:

American Gypsum Company.....Firebloc
Barrett Division of the Allied Chemical Corporation.....Firewall
Bestwall Gypsum Division, Georgia-Pacific Corporation..Firestop
Celotex Corporation .....Fi-Rok
Big Horn Gypsum Company Division of Celotex.....Firegard
Dierks Forests, Incorporated (Gypsum Division)....Flame Guard
Flintkote Company .....Fire-Ex
Blue Diamond Division of Flintkote Company.....Fire-Halt
Johns-Manville Sales Corporation.....Firetard
Kaiser Gypsum Company.....Null-A-Fire
National Gypsum Company.....Fireshield
Pabco Building Materials Division of
Fibreboard Paper Products.....Flame Curb
Republic.....Type "X" Gypsum Wallboard
Ruberoid Company.....Ruberoid Fire Rated Gypsum Wallboard
Texas Gypsum Company.....Fire-Stone
United States Gypsum Company.....Fire Code 45 and 60

Canadian Companies include:
Atlantic Gypsum Company.....Fire-Ex
Canadian Gypsum Company.....Fire Code 45 and 60
Domtar Construction Materials Limited.....Fireguard 60 - 120
Western Gypsum Company.....Westroc ⅝" - 60

U.L. RECOGNIZES OTHER TYPE "X" BRANDS

Underwriters' Listing for some of the gypsum manufacturers indicates other types of special fire-rated boards are being marketed.

In addition to proving the fire resistance of numerous assemblies, many years ago, Bestwall Gypsum Company ran Official Tests in Underwriters' Tunnel Furnace developing flame-spread ratings of 10 to 15 for both ivory face paper and gray back paper. Underwriters' have extended this to the paper for the special product used as a gypsum base for Bestwall's thin plaster veneer, and sold under the trade-name "Firestop Dens-Cote Gypsum Base."

As further proof of the advantages of Firestop and to give the contractors and building owners low cost constructions, Bestwall sponsored specific fire tests as outlined by Underwriters' in 1962, proving it was not necesary to cover joints between sheets of Firestop gypsum wallboard to develop the fire-resistive ratings of the various assemblies, either wall or ceiling. No Firestop assemblies fire tested since 1961 have had the joints treated. This provides the lowest cost assemblies which may be finished either with tape and compound for smooth surface, or left unfinished and covered with veneer finish, acoustical tile, or whatever else may be desired.

The proving of the fire ratings possible with assemblies using Firestop and the availability of Type "X" gypsum wallboard from all manufacturers has led to a great increase in the use of gypsum wallboard in multistory dwellings, and in institutional, commercial, and industrial buildings which formerly used other materials to provide the fire resistance required by Building Codes and Fire Insurance Rating Bureaus. The Bestwall Gypsum Company, which developed the *original* Type "X" fire-rated gypsum wallboard, has been first to prove most of the assemblies involving this material. There are likely to be additional assemblies proved by Bestwall as time goes on, including additional ratings with one-half-inch Firestop.