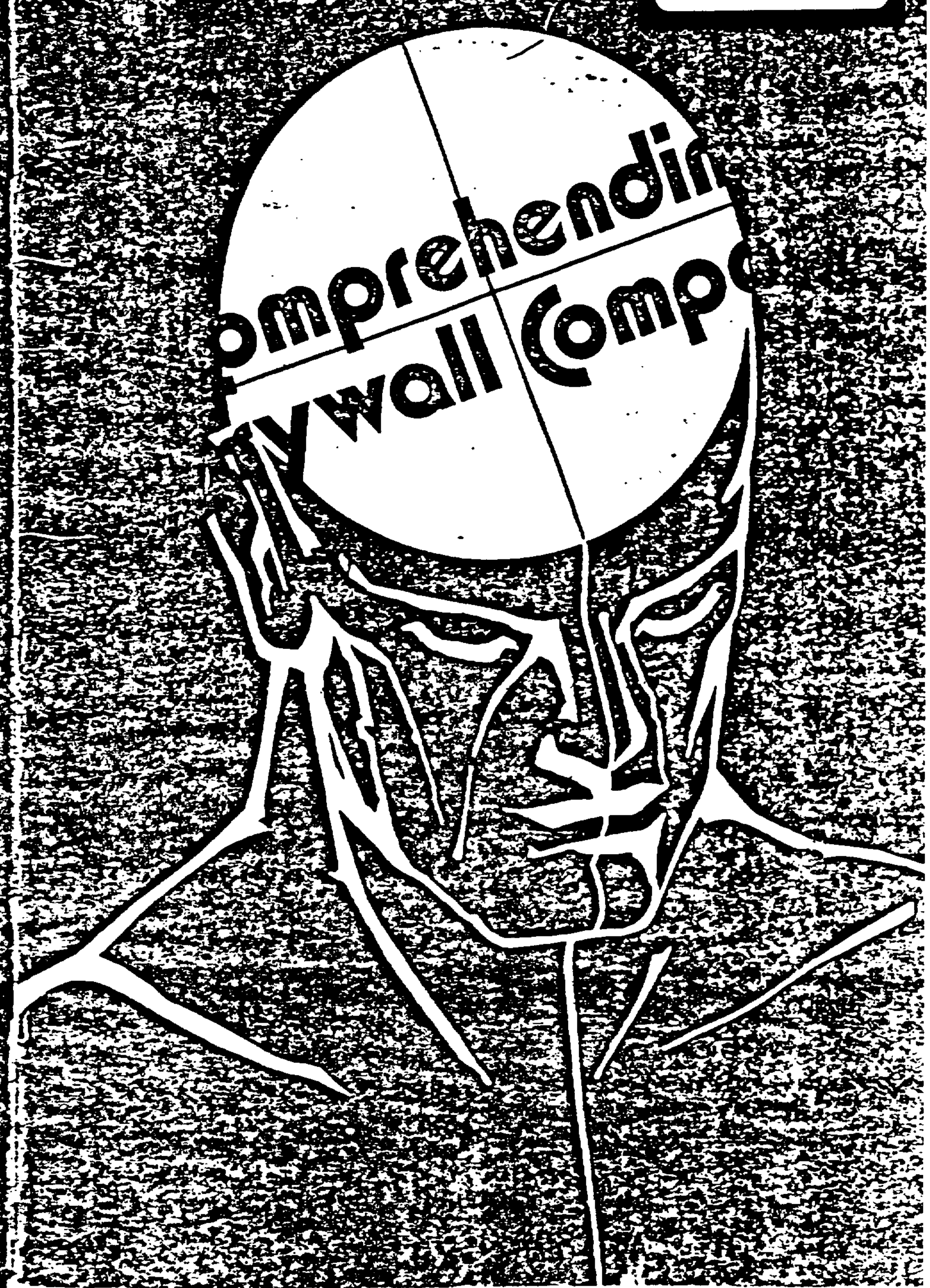
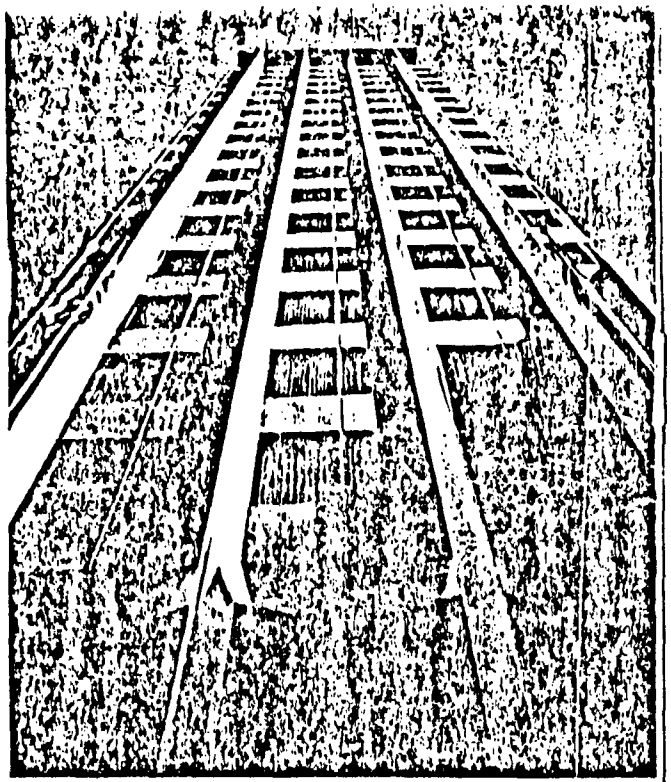
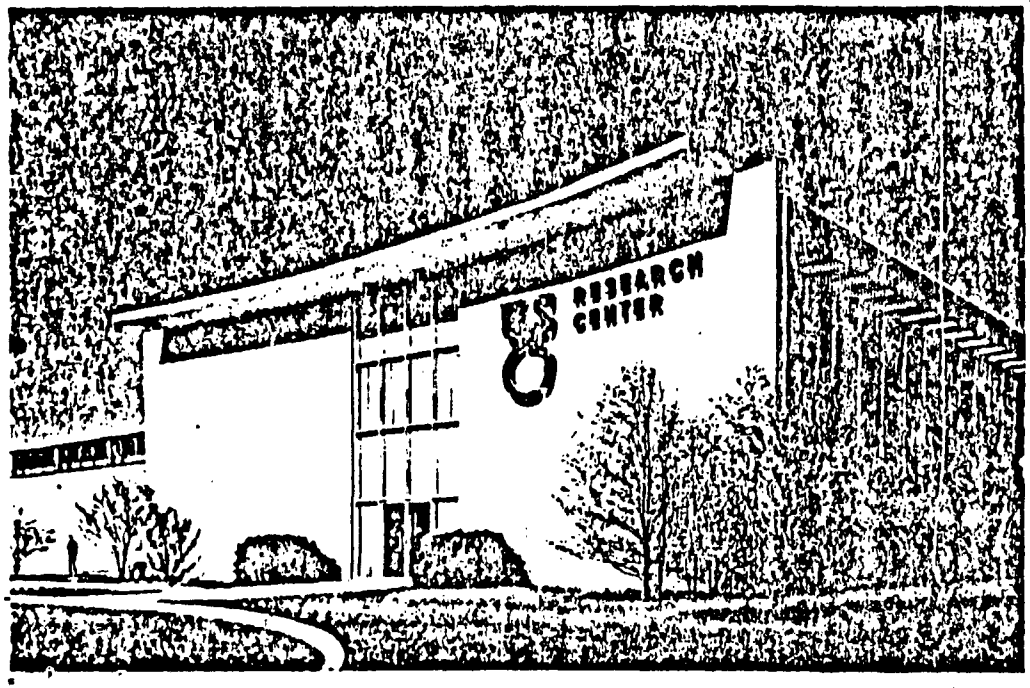
UNITED STATES GYPSUM





U.S.G. Corporate Headquarters Building in Chicago.

U.S.G. Research Center houses latest equipment.



Here's a penetrating look into drywall joint treatment products

...what's in them and how they work

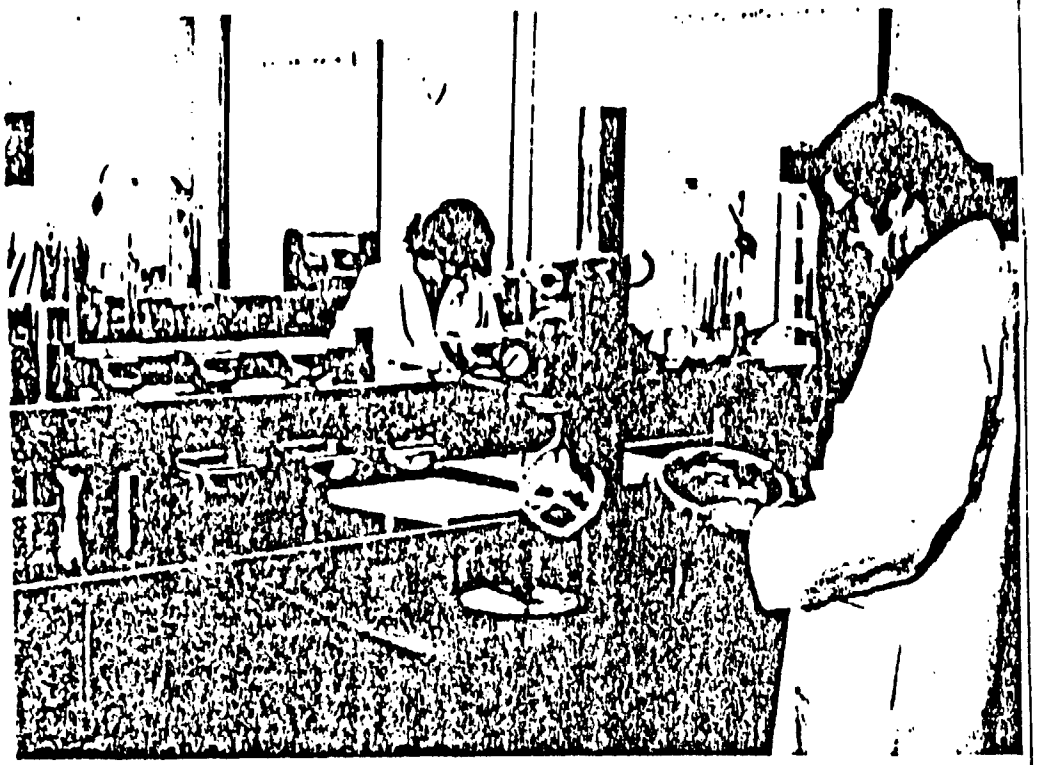
The story of joint compounds is in many ways the story of drywall construction. The use of gypsum panels has grown from a 10% share of market in 1940 to a point where today, virtually 95% of all single-family homes and apartments built have drywall interiors. Their use in commercial and institutional buildings is similarly widespread. The demand for drywall construction has multiplied for many reasons, but primarily because of its inherent fireproofing characteristic, speed and flexibility of construction, and relatively low cost. However, the feature of joining drywall panels to yield smooth, structurally sound walls and ceilings must be a key reason for this phenomenal market acceptance and growth. Joint compounds are the key element in providing this feature.

The market's appetite for joint compounds is enormous, and still growing. The industry's insatiable demand for ever-improving products makes the formulation and manufacture of joint compounds a challenging and important part of the construction process.

The production of joint treatment compounds requires careful selection and testing of raw materials plus the knowledge and experience required to make products that will meet rigid requirements. This procedure can be compared to the preparation of a gourmet dish by a master chef.

Famous chefs the world over use only the best ingredients, carefully measured and skillfully blended, to prepare their specialties. Success for these experts is the result of long experience in following carefully supervised procedures, while experimenting continually to improve existing recipes or develop new, exciting variations.

There are at least 100 manufacturers of joint treatment products located in 26 states, each using his own formulations involving a total of 70 to 75



A staff of research specialists carefully checks all formulations.

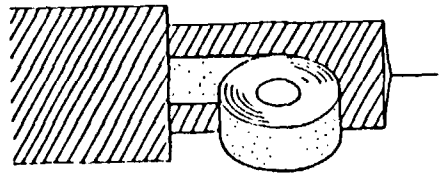
specific ingredients. All ingredients must be balanced carefully into a formula or recipe based on performance and cost. The joint compounds then are prepared in much the same manner as a master chef prepares his specialties—with finest materials, blended with skill acquired only after years of effort.

This booklet will explain briefly and simply how these joint compounds are [illegible] ...will help in selecting the appropriate product for the job at ...and, from the leading producer and originator of modern joint treatment—United States Gypsum.

Contents

Here are Compound Types...

Joint compounds are precise blends of adhesive binders, fillers, thickeners and additives. These special compounds are applied to drywall panel joints for bonding reinforcing tape to the panels and to further strengthen and conceal the joints. There are two basic compound forms: *powder products*, which are mixed with water on the job, and *paste products*, ready-mixed at the factory for immediate use on the job.



Powder Compounds—These are generally divided into two broad categories: products with casein or noncasein binders. Compounds with noncasein binders were developed to overcome disadvantages of those with casein binders. These improved compounds have water-dispersible adhesive binders and need no alkaline solvent or soaking time as required for casein binders. They are usable as soon as adequately mixed, and once mixed, noncasein products do not thin out or thicken—they remain at relatively the same consistency.

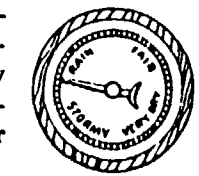
Ready-Mixed Compounds—The first improvement over casein compounds was ready-mixed paste compounds with vinyl binders. These provided easier working and sanding qualities and better crack resistance than their counterparts in powder compounds. Now further refined, these products are truly ready-to-use. Factory-mixed to smooth, lump-free consistency, they are ready for crater-free application at the job site. They normally require neither water nor mixing.

Here's How They Work...

Drying Compounds include noncasein powders and ready-mixed products, which dry by evaporation of water to become hard and develop adhesion. These compounds continue to shrink until completely dry.

Hardening Compounds are products which chemically harden in 4 hrs. or less. After hardening they will not shrink, even though not dry, have high strength, produce a superior bond and are virtually unaffected by high humidity or changes in humidity.

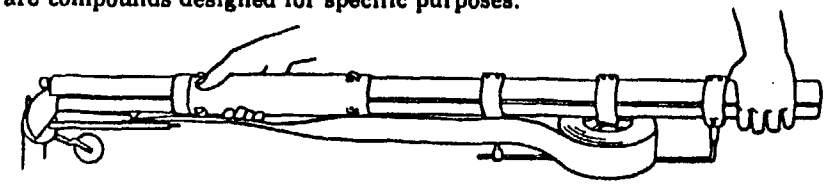
The main advantage of hardening compounds is the shorter time needed to finish joints. After taping compound has hardened—usually less than 4 hrs.—the fill coat can be applied without waiting for compound to dry. This feature is especially valuable in cold, damp weather where drying-type compounds may need days, or even weeks, before another coat may be applied.



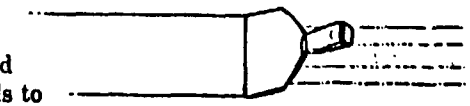
The high strength and hardness of these compounds make them excellent for taping and filling joints, metal corner beads, drywall trims and fasteners. Because they are usually more difficult to sand to the required smooth finish, they are not recommended for the finish coat on joints.

...and Here's How They're Used GP004 0443

Joint compounds today include three different product groups in paste or powder form, each with its own binder and solidifying method. Within each group are compounds designed for specific purposes.



Taping Compounds—for embedding tape and first coat over metal corner beads, drywall trims and fastener heads. They provide the strongest bond between tape and panel; also superior corner reinforcement. Their hardness makes them more difficult to sand—thus not as suitable for finishing coats.



Topping Compounds—for fill and finish coats over taping compounds to fully conceal joint area, fastener heads, drywall corner beads and trim. They offer least shrinkage, best workability and smoothest finish. Have less strength than taping compounds, but are easier to sand and finish.

All Purpose Compounds—for all joint compound applications: embedding, fill and finishing coats. Convenient to use, but they represent a compromise between the superior bonding quality of taping compounds and the excellent finishing and shrinkage properties of topping compounds.

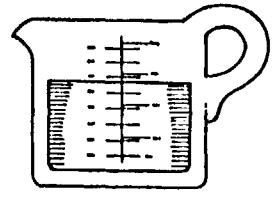
Requirements for a Good Product

A true joint compound should offer some 16 different properties, any one of which is all-important to the overall performance of the product. Since a joint compound is considered as simply a reinforcing and concealing material, the average person gives little thought to its specific properties. Yet when any one of these properties is lacking or not performing during application, the quality and end performance of the product are adversely affected.

There is scarcely a joint compound produced which will supply superior features in all of the performance properties. Each producer of joint compounds will, therefore, attempt to personalize his formulations by concentrating on certain properties which may be particularly noticeable to, or perhaps desired by, the customer. On some occasions a manufacturer may actually sacrifice important long-term properties to provide immediate ease of application; this can be dangerous and costly. The buyer's tastes will change depending on weather conditions and his adjustment to them, or a change in application crews may result in a demand for a different product. Here, then, are the properties to look for in a joint compound:

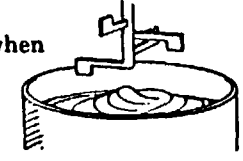
PROPERTIES	compound # 1	# 2	# 3	# 4	# 5
A	✓	✓	✗	✓	✓
B	✓	✗	✓	✓	✓
C	✗	✓	✓	✗	✗
D	✓	✓	✓	✗	✓
E	✓	✗	✓	✓	✗

Performance—This is a key requirement for a good joint compound. Includes compatibility with other products, adaptability to a wide variety of weather conditions, ease of mixing and application, and final performance on the wall. Each product has different uses and requirements, so each is designed for the best results in the shortest possible time. As a master chef selects special ingredients and prepares accurate recipes, so do chemists and research specialists select [illegible] materials for best performance of joint compounds.



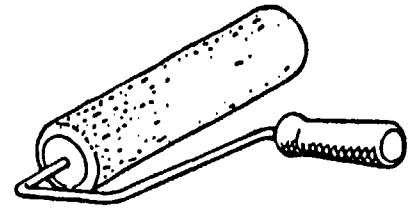
Compatibility—Ideally a joint compound should be compatible with all types of gypsum panels, metal corner beads, reinforcing tape and most drywall finishing products. Compounds should *not* be used with materials other than those for which they are specifically designed.

Mixability—Powder should wet down thoroughly when added to water and contain no lumps after mixing. Another important and desirable property is the speed with which the mixture combines uniformly



with water. When the correct amount of water has been added and the mixture stirred thoroughly, the compound should be ready for immediate use.

Color and Odor—Some joint compounds are used for decorative texturing purposes as well as for joint treatment, so their color—white—is an important formula consideration. But others are almost always painted, and color is not of importance. Actually some off-white compounds may have superior properties. However, the mix should be uniform and consistent in color when wet, and its odor should not be unpleasant.



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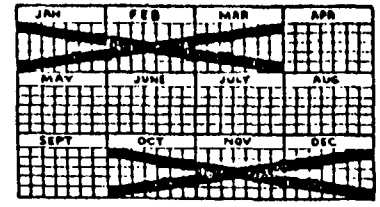
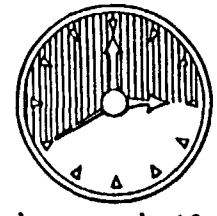
Shelf Life—Certain additives improve the shelf life of compounds for greater dependability. Powder compounds have a shelf life of about six months; ready-mixed products about a year. Lack of proper storage facilities and failure to rotate stock can cause compounds to deteriorate more rapidly. Old compounds can be spotted easily because they are mealy when mixed or applied and bond poorly.

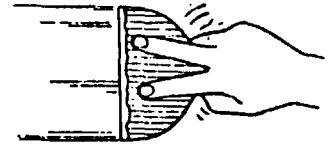


Mix Life—Also called "pot life", this is the length of time the powder compound is usable after being mixed. An ideal compound would be usable for an indefinite period after mixing; however, since most powder compounds usually are used the same day, length of mix life is not of concern except, of course, in the case of compounds which are formulated to harden in a specified time after mixing.



Stability—This term is used primarily with ready-mixed compounds. After they have been made, consistency should not change. This feature provides shelf life up to one year and assures the mechanic consistently good results when using the compound.

Slip—The ease with which a compound slides beneath or through the tools determines whether it is easy to apply. To the mechanic, this is probably the most important physical property of joint compounds since it directly affects his ability to do his job properly and



efficiently. However, there are some compounds offered in today's market which emphasize ease of application to the detriment of other properties.

Wet-Tack—Good wet-tack is important to the mechanic since this is the tendency for the compound to stick to both wall and tool while it is still wet. This property also holds tape to joint until compound dries or hardens—especially important when working on ceilings, particularly with the mechanical taping tools.

Freedom from Cratering—"Cratering", or pock marks, refers to small holes left in the joint surface after compound is applied with either hand or automatic tools. These are usually caused by air bubbles in the mixture and are extremely troublesome, being time-consuming and costly to remove.

Sandability Easy sanding is an important characteristic of joint compounds. With good sandability, a finer grade sandpaper can be used and the job finished more quickly and smoothly with less chance of scratching the finished job or damaging gypsum panel paper near the joint.

If binder content of a compound is increased, sanding becomes more difficult. As binder level is reduced, sanding becomes easier. For this reason, there is generally more binder content in taping compounds, less in all-purpose formulations, and still less in topping products.

Featherability—This characteristic permits joint compound to be smoothed out toward edges of joint into a tissue-thin coat that will blend evenly with the gypsum panel surfaces.

Coverage—The specific area that can be covered with a given amount of compound is affected by factors such as consistency, thickness of application [illegible]manship. For example, in the case of consistency, the more water added to a compound, the more coverage there will seem to be initially. However, final shrinkage of the applied compound is the important measure. Therefore [illegible]erage should not be confused with final yield of the applic[illegible] factors are depth of the board's tapered edge, depth of dimpling over fasteners, amount and type of bead used, number of butt-edged joints, and whether gypsum panels are applied horizontally or vertically.

Hardening and Drying Time—For compounds that set chemically, *hardening time* is the period required for an application of joint treatment to solidify. Hardening should always occur before the compounds dry. *Drying time* is the period required for all moisture to evaporate from the compound. The

drying process may be completed overnight with the help of added heat and good ventilation, or may require as much as six weeks or more where cold, damp conditions prevail. In drying-type compounds, full strength is developed *only* after complete drying has taken place.

In any case, applications of both hardening and drying compounds should be completely dry before being decorated in order to avoid discoloration of the finished surface.

Shrinkage—All drying-type compounds shrink. When the dry ingredients, or solids, are mixed with water and the joint compound is applied, the water evaporates and the volume of applied compound diminishes proportionately to the amount of water used. Shrinkage may amount to as much as 30% of a compound's wet volume, and most formulations shrink within a range of 20% to 30%. Shrinkage often is more noticeable over nailheads and metal corner beads than over joints. Several factors cause shrinkage of joint compounds:

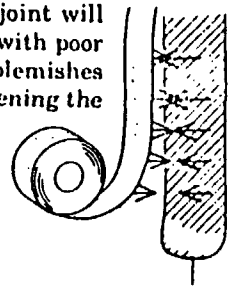
CP004 0045

- Variation among different *types* of compounds. Taping compounds often shrink most, all-purpose compounds less, and topping materials least. However, variations can result among the many different formulations of the same type of compound, but the amount of dilution by the mechanic has by far the greatest effect on shrinkage.

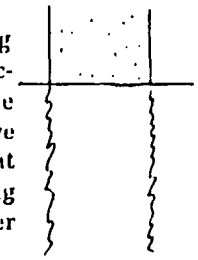
- Insufficient drying time between coats or applications of compound—particularly thick ones. Compound applications often can appear to be dry when actually only the surface may be dry. If subsequent coats of compound are applied at this stage, eventually the compound will shrink as it becomes completely dry and stable.

- Adding too much water in mixing results in more loss of volume in the areas filled with joint compound when the water evaporates. This is a major cause of excessive shrinkage.

Bond—This concerns the *dried* holding power of the compound to the tape, and in turn, to the adjacent surfaces. The amount of binder affects the degree of bonding power. When properly bonded, a finished joint will be as strong as the gypsum panel itself. A compound with poor bond will allow reinforcing tape to pull loose, causing blemishes and cracks in the finished application as well as weakening the entire joint system. Of equal importance is the bond to corner beads and trims.



Bond will depend on type of material, weather conditions during application, amount of water used in mixing and the workmanship of the tradesman. Cold weather or high humidity, for example, increase time necessary to achieve good bond, since maximum bond strength is achieved only when compound is completely dry.



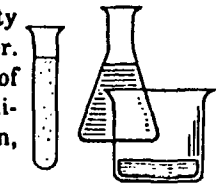
Edge-Crack Resistance—Cracking of joint compound along one or both sides of joint tape can be caused by poor job practices or unusual drying conditions. Poor job practices include too much or too little compound applied under tape, excessive water mixed into the compound, and failure to skim-coat tape immediately after embedding. Unfavorable drying conditions include taping in very humid or hot, dry weather or under freezing conditions.

Check-Crack Resistance—Random cracks may appear in joint compound, especially when used in deep fills or over metal corner beads. Usually caused by excess water in mix, thick fills or excessively fast drying of compound.

Joint Treatment Chemistry

Raw materials account for about 80% of joint compound production costs. Since there are well over 1,400 possible raw materials which can be considered in preparing a formulation, the complexity of compounding a joint material begins to come into perspective.

One element of the formula—a binder, for example—can have literally hundreds of variations as offered by dozens of chemical supply houses. Each of these elements in turn, is subject to variations in quality and may not be constant from one shipment to another. The formulator must not only consider the variable of raw materials, compensate for different climatic conditions and variations in tools and methods of application, but also must control the cost factor.



Formulating, then, is as much an art as it is a science...much as in the manufacture of paper or the preparation of a gourmet dish. Precision, like the production-line assembly of an automobile, is something to strive for but difficult to maintain.

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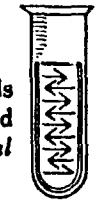
To obtain all the necessary features for easy-to-use, stable, long-lasting joint compounds, manufacturers formulate each type for its specific purpose. Only by a careful, scientific approach can quality performance be assured. And only by use of balanced amounts of the necessary ingredients can these results be maintained. Just as when following a special recipe in cooking, changing one ingredient or varying the amount used usually affects one or more properties of the finished product. These ingredients are carefully selected to obtain the properties necessary in a joint compound, accomplished only by painstaking experimenting in the laboratory and trial in the field. Production quality control must be rigidly maintained, as a mistake at this point can obviate the best of formulations. The dependability of proven products, at a fair price, is *the* reason why the large producers of joint treatment products, such as United States Gypsum Company, have predominated in the market.

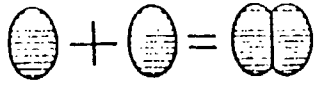
Joint compounds are composed of four major ingredients—binders, thickeners, fillers and additives. Following are types of each with their functions, sources and general uses.

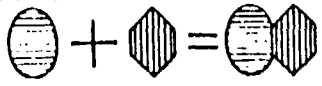
Binders



Binders are the "muscle" which, with the "bone" of the tape, welds the gypsum panels together and affects flexibility, hardness and stability of the finished joint. These are either *synthetic* or *natural* products.

Synthetic resins are organic materials, either liquid or solid, produced by polymerization of monomer molecules. Thus, ethylene molecules can be united with themselves to form polyethylene resin which is a polymer. A copolymer is derived from the polymerization or addition of two or more dissimilar monomers, as synthetic rubber from styrene and butadiene forms styrene-butadiene copolymer.



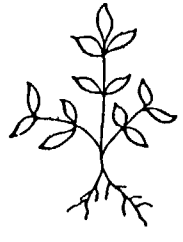


Examples of the important polymers most extensively used in industry are polyethylene, polyvinyl acetate, polystyrene, polyvinyl alcohol, polyvinyl chloride and polyacrylate:

Polyvinyl alcohol resin—A water-soluble, synthetic resin polymer, white to cream-colored, produced through a chemical change—hydrolysis—of polyvinyl acetate. It is used in the manufacture of joint compounds and water-resistant laminating adhesives; adhesives and binders for leather, cloth, fabric, and paper; size for paper and rayon and nylon knitting yarns; pigment binder; photosensitive film. Fully or partially hydrolyzed polyvinyl alcohols are compatible with a wide variety of natural and synthetic resins and other materials which are usually water-soluble and oil- and fat-resistant, and can be readily made water-resistant.

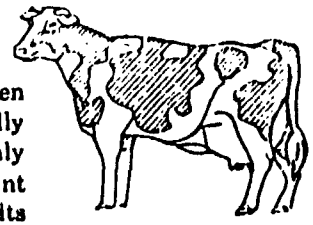
Polyvinyl acetate emulsion—A synthetic liquid-latex made from polyvinyl acetate resin which is odorless, tasteless and nontoxic. The emulsion is produced through the polymerization of vinyl acetate monomer with peroxide catalysts. These emulsions are used extensively in producing latex paints because of low cost, stability in weathering, self-priming, quick-drying and easy recoatability characteristics. Also used as a binder in nonwoven fabrics; as a strengthening agent for cements; in caulking compounds, lacquers, inks, wood putty, erasers and chewing gum. Other special forms are used in paints, upholstery backings, paper and paperboard coatings.

Industrial starch hybrids—Synthetic powdered resins representing [illegible] combinations of starch, polyvinyl alcohol and polyvinyl acetate resins.



Natural [illegible] produced from naturally occurring sources—such as plants and animal byproducts—in contrast to *synthetic binders* made from chemicals. Natural binders usually are less precise in their properties because they are dependent on the vagaries of nature. Examples of natural binder are:

Casein—The principal protein in milk (3%) and the main ingredient of cheese. It is white, tasteless and odorless. Precipitated by the addition of acid to milk, it is dried and often ground to granular powder. Casein is insoluble in water but dissolves in dilute alkalies; stable when kept dry but deteriorates rapidly when damp. *Industrial-grade* casein is used principally in production of paper coatings to render highly polished, enameled paper stock. Its use in joint compounds as a primary binder was probably its second largest market. Today, however, it has been largely replaced by synthetic binders. *Food-grade* casein is used in powdered milk, cottage cheese, diabetic flour, baking powder, gelatins and feeds. Certain other grades of casein are used in massage creams and pharmaceuticals, in wines and even fabric dyes.



Soybean flour—A vegetable protein obtained by crushing soya beans and extracting the oil. The residue is soybean flour. Refined soy protein was used in joint compounds for many years.

Starch—A white, tasteless powder made from corn, wheat or potatoes. The material is ground with water, the starch allowed to settle and then dried. Produced in grades such as commercial, laundry, technical, edible, etc. Used in the food industry; also for cosmetics and drugs. Special modified grades of starches have been used as binders in joint compounds.

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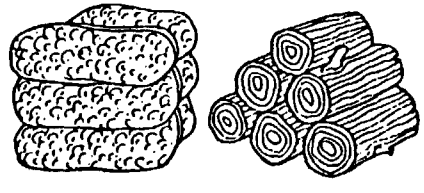
Thickeners

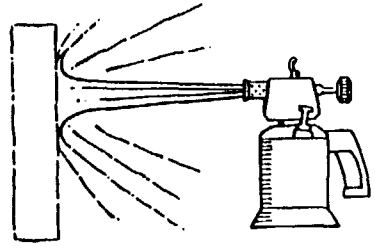
Thickeners are used in joint compounds to provide good working properties such as slip, and to reduce water separation from mixed compounds. Most thickeners are manufactured by chemical processing of cellulose, and include the following.

Cellulose is the preponderant and essential constituent of all vegetable tissues and fibers, especially cotton and wood. It is the "building block" of most thickeners and the basis of textiles and papermaking. In the form of cellulose acetate, it is used to manufacture acetate fiber, lacquers, photographic film, transparent sheeting and cigaret filters. In the form of nitrocellulose, or gun cotton, it is used in manufacture of smokeless powders. Chemical modification of cellulose produces hydroxyethylcellulose, carboxymethylcellulose and methylcellulose. These are used as thickening and suspending agents; as stabilizers for vinyl polymerization; as size for yarns; as an emulsion stabilizer for detergents and soaps; in latex paints, medicines, shampoos, creams, foods and adhesives.



Clay produces slip and other essential working properties in joint compounds—usually a fine grind of attapulgus clay. Widely used in paper coating, petroleum refining, adhesives, paints, plastics, liquid fertilizers, floor absorbents and fire extinguishers.

Asbestos, a magnesium silicate mineral which occurs in fiber form, is used in joint compounds to control liquid separation and shrinkage, to provide slip and prevent sagging of compounds. Fibers are identified as either amphibole or serpentine. The amphibole form is often used for chemical filters, electrical insulation and paint fillers. This type contains minerals such as tremolite and amosite which have received much publicity as possible links to lung cancer. The serpentine or mineral chrysotile is the type normally used in making joint compounds. This type also is used for fireproofing and insulating purposes, in automobile brake linings, and as a consistency stabilizer in cements.

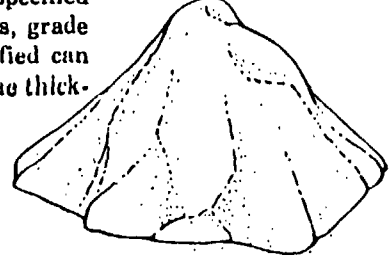


Natural gums are obtained from a great variety of plants. Rough groupings are water-soluble gums, resins and chicle. Generally, they are soluble in, and swell in water. Consist largely of carbohydrates—arabic, agar, tragacanth. Arabic gum, for example, is used in adhesives pharmaceuticals, inks, textile printing, cosmetics.

Marine algae derivatives are forms of thickeners obtained from special types of seaweeds. Used by the food industry in making gelatins, puddings and ice cream; also in cosmetics, pharmaceuticals, toothpaste.

Fillers or Extenders

Fillers are used to add bulk to and improve performance of joint compounds, and are selected for cost and general availability. They may account for 80% or more of the weight of a compound; are specified very precisely according to percent impurities, grade and color. The particle grade—or size—specified can be so minute that 100 particles would equal the thickness of a sheet of notebook paper. As the particle size increases, workability of the compound can become more difficult and gritty or grainy surfaces can result.



The grade of filler is especially important

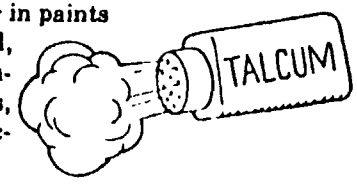
in that it controls workability, cracking, shrinking, texture and color of the compound. The overall smoothness of the dried joint is related directly to the grades and types of fillers used. The following fillers are used individually or as mixtures in joint compounds and many other products:

Limestone rock, composed mainly of calcium carbonate, is classified according to impurities contained. It is one of the most stable, common and widely found of minerals, available as powdered limestone, marble chips and various types of chalk. Used in pharmaceuticals, dentifrices, food processing, baking powder, agriculture, road ballast, portland cement.

Calcium sulphate is a natural hydrous mineral containing 20% water of crystallization. Found in many areas as alabaster, gypsite, satin spar, etc. Used in building materials, agriculture, and pharmaceutical and medical products.

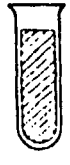
Mica is an ingredient that affects color, slip, shrinkage and crack resistance of joint compounds. Mica is a group of silicates of varying chemical composition that can be split into thin, flexible elastic sheets. As vermiculite, mica has the property of expanding 6 to 20 times its original volume when water is added.

Talc is a natural hydrous magnesium silicate, commonly known as soapstone. Readily available, used as an extender in paints and as a pigment in ceramics, gypsum board, asphalt shingles, cosmetics and pharmaceuticals; as a filler in rubber, soap, insecticides, putty and plaster; as a lubricant and as electrical insulation.



Additives

A very select and highly proprietary range of chemicals is added to refine and stabilize joint treatment products and give quality to their performance. These chemical ingredients act individually or in combination to affect properties such as shelf life, solution time, mixing, ease of application and odor. Examples of such additives follow.



Plasticizers are nonvolatile, organic liquids or low-melt solids produced from resins and added to joint compounds to improve flexibility and other properties. The terms "resin" and "plastic" are commonly used in the chemical industry. Outside the industry, however, they are often mistakenly interchanged. *Resin* is the starting material used in producing molded articles; *plastic* refers to the final product that could contain resin, fillers, plasticizers and pigment. Plasticizers are especially important in rubber and in vinyl and cellulosic plastics.

Reodorants are used in joint treatment products to destroy, mask or modify unpleasant odors.

Defoamers are sulfonated oils or silicones used in joint compounds to reduce foaming which often interferes with processing operations. Such foams may be caused by stirring air into the viscous mixture. Defoamers also are used in the brewing industry and in water-treatment plants.

Dispersing agents are materials added to a mixture to keep particles in suspension. Used especially with extremely fine particles of solids or liquids in finely divided form. Tetrasodium pyrophosphate, for example, *is a generic term for a water-soluble, colorless,* transparent crystal or white powder, used as a dispersing and emulsifying agent. These chemicals are used in latex paints, textiles, synthetic rubber, inks, pharmaceuticals, and detergents.

Pigments is a general term for substances and mixtures used to add color to many products including printing inks, floor coverings, leather, wax and cosmetics. Pigments are almost always insoluble, but wettable with water. *Iron oxide is a generic term for a red pigment,* occasionally used in joint compounds in certain areas to help match the color of treated joints to that of wall surfaces.

Preservatives is a general term applied to ingredients which act as fungicides, bactericides and mildewcides to prevent bacteria growth in organic materials. In joint compounds, bacterial decomposition can cause odors, changes in color and weakened bond. Among the types of commercial preservatives used are:

Zinc oxide (Chinese white)—An odorless, white to yellowish-white powder, insoluble in water and alcohol, lead-free in American processing. Used as a filler and accelerator in rubber and plastics; pigment and mold-growth inhibitor in paints; in ceramics, medi- feed additive, seed treatment and dietary supplements.

Mercury types—These are very effective against both mildew and bacteria. Only small amounts are needed to protect joint compounds.

Solvents is a term often applied to a substance such as water or alcohol, used to disperse or dissolve one or more other substances.

Emulsifying agents hold in suspension two or more liquids which do not normally dissolve or mix with each other—such as oil and water. Typical emulsifiers are egg yolk, casein, soap and gums such as acacia and algin. Used in pharmaceu-

ticals, prepared foods, drycleaning solvents, and mixtures used in the textile and leather industries.

Retarders are organic substances that delay or control the rate of hardening of joint compounds. Ground cattle hoofs or horns, which delay setting of gypsum products, are typical of commercial retarders used.

Accelerators are substances which speed the hardening of chemical ingredients of joint compounds. One of these is *potassium sulphate,* colorless or white, hard crystals or powder with bitter, salty taste. Used in analytical chemistry, medicine, fertilizer, aluminum and glass manufacture.

Vehicles are liquids which may be volatile such as water, or nonvolatiles which are used to carry and to insolubilize the compound ingredients.

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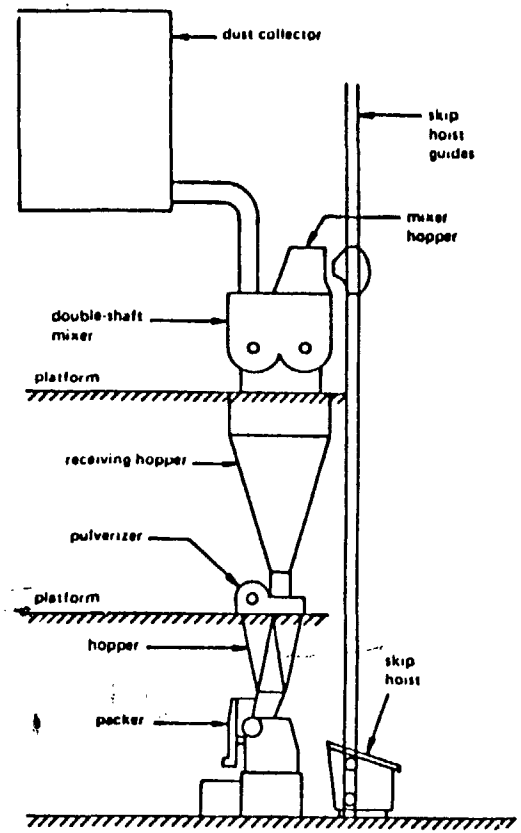
Joint Treatment Production

The production of both powder and ready-mixed compounds is a batch process, although two different types of equipment are used. When the equipment is changed over from the production of one type of compound to another, the inside of the equipment is carefully cleaned to remove all traces of the previous batch. This is necessary because of the incompatibility of some of the ingredients, and to maintain a "sterile" condition to prevent spoilage of the finished product. The same degree of care should be exercised on the job when mechanics change compounds. A small amount of one compound left on the tools can often contaminate another compound and produce unsatisfactory results.

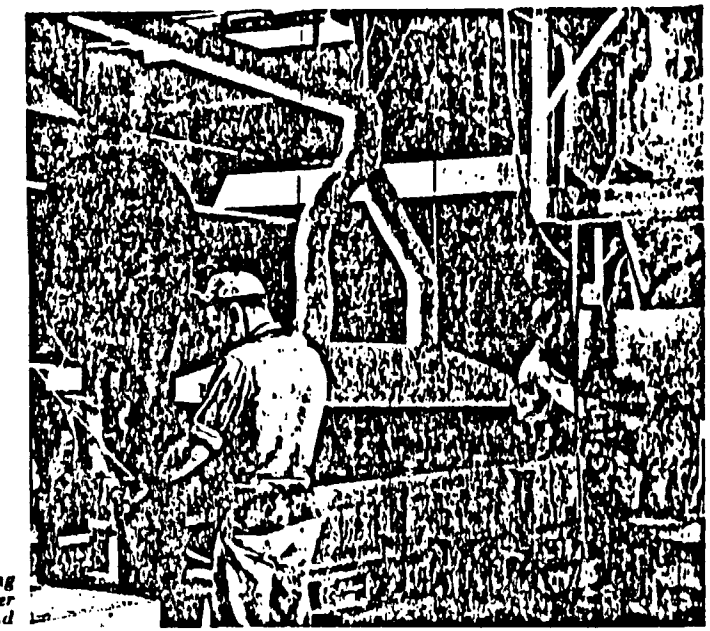
Powder Compound Manufacture

In the production of powder joint compounds, the fillers, bonding materials and other critical ingredients are weighed and placed in the skip hopper. The contents of the skip hopper are then dumped into the mixer.

The mixer is a double-shaft, horizontal blender which folds in the ingredients as the paddles rotate in opposite directions. When the ingredients are completely blended, gates on the bottom of the mixer open, dumping the contents into a receiving hopper which meters the material into the pulverizer. Here the powder is ground to uniform particle size. The pulverizer feeds into another hopper that supplies the packing equipment.



Typical mixing equipment for powder compounds



Packaging powder compound

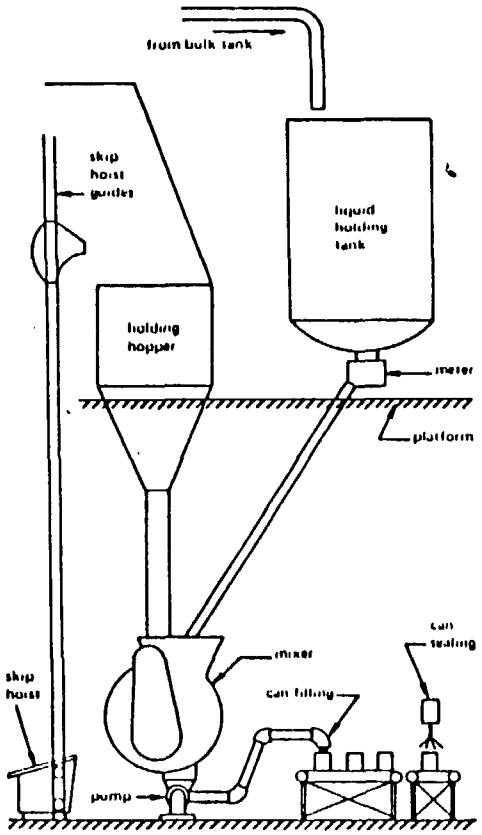
Packing joint compound powder is a difficult task since the material tends to fluff up in the bag. Several methods are used to compact and bag the compound, but in effect all shake, bump or vibrate the filled bags prior to closing the tops.

Because of the need to protect U.S.G.'s highly refined formulations from the effects of water vapor and to increase storage life, considerable attention has been given to the design of the package. The bag currently in use is manufactured by U.S.G. It consists of two plies of kraft paper with a film of polyethylene between. The film is unperforated, providing 8 to 10 times greater resistance to vapor penetration than bags used by some manufacturers for packaging joint treatment powders. This results in more uniformity in lots, mixing and application, as well as increased storage life. The bag also features a flat bottom for ease of handling.

Ready-Mixed Compound Manufacture

Ready-mixed joint compounds, like the powders, are produced in batches. The dry ingredients are placed in a skip hopper and dumped into a holding hopper in the same way as the powder compounds. Here the similarity ends. As the dry components sift into the mixer, special binders are added at this point. The mixing continues until all materials are thoroughly blended. A viscosity (flowability) test is made to assure the proper consistency before the batch is released for packaging.

From the mixer the compound is pumped into containers. Lids are applied (either manually or by semiautomatic equipment) and the process is complete.

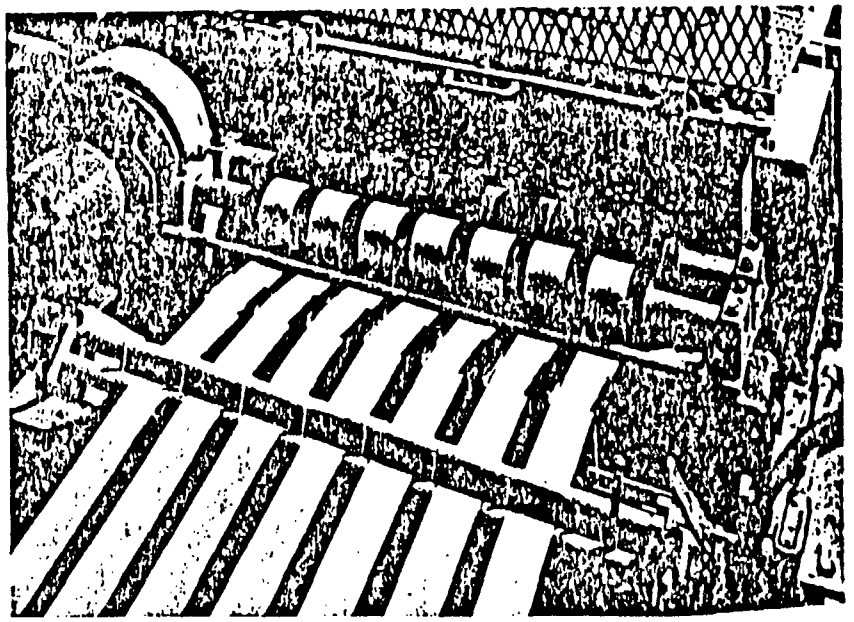


Typical production equipment for ready-mixed compounds

Tape Manufacture

The manufacture of PERF-A-TAPE Joint Reinforcing Tape, a patented process, is unique in the industry. PERF-A-TAPE is perforated by electric sparks to provide a clean hole (.002 to .02 in. dia.) that will allow entrapped air to escape but will not allow appreciable amounts of compound to pass. The perforating is performed in a continuous operation of a machine capable of handling several tapes at once.

The main innovation of the machine is two shafts carrying revolving, high-tension electrodes which align and produce a spark that passes through the tape to produce the holes. An intricate synchronization procedure aligns the electrodes at the exact instant of maximum electrical potential.



Bands of PERF-A-TAPE Reinforcing Tape emerge from spark-perforating machine

GP004 0451

U.S.G. products are developed to conform to the high standards necessary for foolproof results on the job. All raw materials are subject to extensive quality-control testing. During manufacture, samples of each batch are taken for immediate and future tests. As many as 16 individual tests are performed on each sample.

Here again, these procedures can be compared to those of a master chef who carefully measures and blends selected ingredients and follows each step of preparation to assure finest results.

When you buy and use U.S.G. Joint Treatment Products, you're getting the quality results of the finest materials and the most extensive research in the industry...from the people who pioneered drywall and joint treatment development.

Record of Development

As the originator of modern joint treatment, United States Gypsum has a history of industry "firsts". Here are research developments that have maintained U.S.G. products as leaders in the field:

Pre-1920—Plaster of Paris (first joint treatment material)

GP004 0452

1920—Sheetrock Finisher (first improved joint compound)

1924—USG Joint Compound (first true joint compound)

1925—Cloth Mesh Tape (first workable reinforcing tape)

1925—U.S.G. Reinforced Joint System (first true system—tape with compound)

1927 Metal "A" Tape (first effective reinforcing tape)

1937—Perf-A-Tape Joint System (first mechanically punched paper tape)

1947—Low-Alkaline Joint Compound (first formulation usable with modern paints)

1949—Spark-perforated Perf-A-Tape Reinforcing Tape (unique improvement)

1952—The Two-Compound Joint System (first use of two specialized joint compounds: Taping and Topping)

1953—Ready-Mixed All Purpose Compound (first factory-mixed joint compound)

1963—Durabond Joint Compound-Taping (first U.S.G. hardening-type compound)

1965—Ready-Mixed Topping Compound (first ready-mixed finishing compound)

1965—Cover Coat Concrete Finishing Compound (first for drywall trade)

1966—Durabond 90 Joint Compound (first multi-purpose hardening compound)

1967—USG Brand Joint Compounds (first major improvement in [illegible] compounds)

1971—Durabond XL Joint Compound (first joint compound formulated for use with exterior ceiling board)

1972—[illegible] pound (first tapeless joint system for pro[illegible] assembly of manufactured homes)

1973—Durabond Joint Compound-All Purpose (first hardening compound which can be used for finishing)

1974—USG Crater Free Ready-To-Use Joint Compounds (first major improvement in ready-mixed compounds)

1974—USG Ready-To-Use Compound-Taping (completes the first two-compound ready-mixed joint system)

And U.S.G. Joint Treatment Products Perform Best—by Design

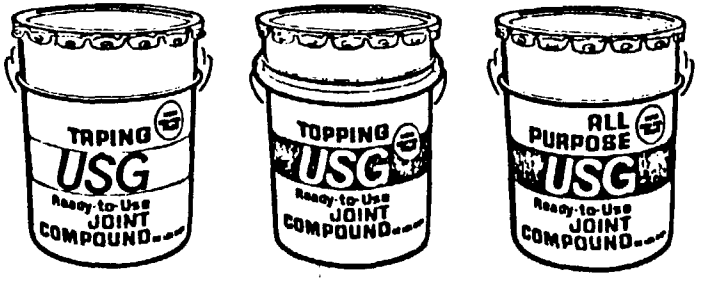
A full line of U.S.G. Joint Treatment Products embodies the desirable characteristics that science and field experience have proven most effective to meet any job requirement.

USG *Crater Free* Ready-To-Use Compounds —the key to quality joint treatment

One of the most annoying and costly characteristics of all ready-mixed joint compounds was the problem of cratering—small pits in the surface of the dried compound caused by air entrapped in the compound when produced. These craters required extra work and material to eliminate. In addition, many ready-mixed products were produced in standard consistencies which, in many cases, had to be diluted and remixed on the job, adding to the cost and delay as well as increasing the possibility of cratering.

To overcome these problems, United States Gypsum recently introduced its USG Crater Free Ready-To-Use Joint Compounds. These are the best-selling, fastest-growing joint compound products in the industry—factory-mixed to a smooth, crater-free, truly ready-to-use consistency. There is no need for additional water, or the use of electricity or mixing equipment at the job site.

Available in Taping, Topping and All-Purpose types and in hand- or machine-tool consistencies, Crater Free Compounds feature superior ease of handling and crack resistance plus excellent adhesion without excessive hardness for easy sanding. The material's vinyl-type binders provide many of these properties.



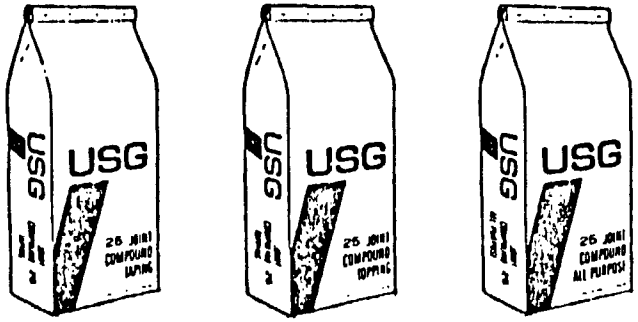
USG *Crater Free* Ready-To-Use Joint Compound-Taping is a ready-mixed product that can be used directly from the container with no time-wasting mixing or retempering. This creamy, smooth, vinyl-base compound handles easily and saves time; embeds tape, drywall corner beads and trim perfectly.

USG *Crater Free* Ready-To-Use Joint Compound-Topping is a vinyl-base finishing material with uniform high quality and working consistency; also may be used as a first coat over metal corners, drywall trims and fasteners. Produces smoother finish with less shrinkage and sanding than Ready-To-Use All Purpose Compound. Makes an excellent texturing material.

USG *Crater Free* Ready-To-Use Joint Compound All Purpose is a drying-type formulation widely used for embedding, finishing and texturing because of its uniform high quality. On-the-wall cost averages the same as, or less than, that of powder compounds. Also used with reinforcing tape for repairing cracks in interior plaster and masonry not subject to moisture.

USG Powder Joint Compounds —the ultimate in materials that mix faster, apply easier

These noncasein powder compounds offer outstanding performance characteristics, including shorter mixing time and stable consistency. While they are not compatible with casein-type joint compounds, they may be used with DURABOND Compounds and USG Crater Free Ready-To-Use Compounds.



USG Joint Compound-Taping is designed for embedding tape and for first fill coat on metal corner beads, drywall trims and fasteners; also used for patching plaster cracks. Offers outstanding bond and resistance to cracking.

USG Joint Compound-Topping is a smooth-sanding material for second and third coats over taping compound. Produces excellent feathering and superior finishing results.

USG Joint Compound-All Purpose incorporates good taping and topping characteristics in a single product, for use where finest results of the specialized compounds (above) are not necessary. Also has good texturing properties.

DURABOND Joint Compounds —the top selection with engineered performance

These hardening-type compounds provide faster finishing of drywall interiors even under slow drying conditions. Rapid hardening permits same-day joint finishing and usually next-day decoration. Low shrinkage and superior bond are outstanding features. All DURABOND Compounds are excellent for laminating gypsum panels to gypsum panels, to sound deadening boards or to existing above-grade, clean concrete surfaces.

When used with SHEETROCK SW Gypsum Panels, the system produces the strongest drywall joint ever developed. The exclusive eased-edge design of SHEETROCK SW Panels helps compensate for framing irregularities, damaged panel edges and extremes of temperature and humidity that can cause ridging and beading.

DURABOND Joint Compound-Taping is a hardening-type material for embedding tape, drywall fasteners and metal accessories. Also ideal for heavy fills because it chemically hardens in 3 to 4 hrs. Virtually unaffected by humidity.

DURABOND Joint Compound-All Purpose is a hardening-type material that can be used for *all* drywall joint treatment applications—taping, filling, patching *and finishing*—with the convenience of a single-package product. Offers satisfactory performance in all three stages of joint treatment with remarkable strength, bonding and humidity-resistance characteristics. Can be decorated with selected coatings while *still damp*, an exclusive feature among all joint compounds. A finish coat of Ready-To-Use Compound is not required.

DURABOND 90 Joint Compound is the required pre-fill material for SHEETROCK SW Panels to smooth and strengthen joints between panels. Its 1-to 2-hr. hardening time also makes it an ideal alternate for DURABOND Joint Compound-Taping in applications where faster finishing is desired. Also used extensively on the job for patching and touch-up work.

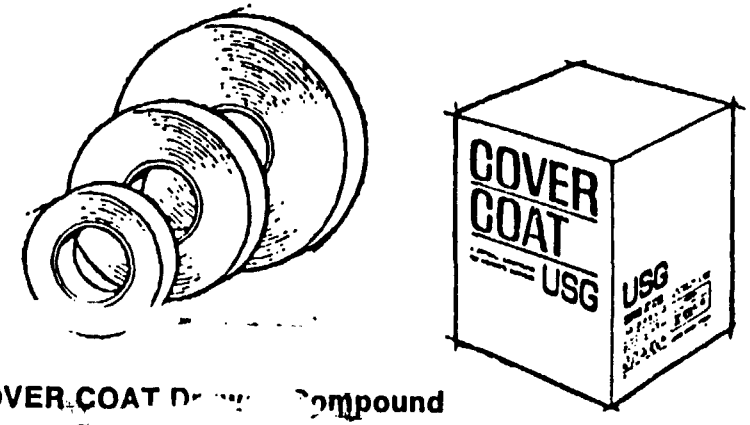
DURABOND XL Joint Compound is a distinctively superior product designed to treat joints, fasteners, drywall beads and trims and provide heavy fills in USG Exterior Gypsum Ceiling Board application. Hardens in 30 to 60 min.; offers outstanding properties of bond, moisture resistance, edge-crack resistance and low shrinkage.

PERF-A-TAPE Reinforcing Tape

The industry's No. 1 joint reinforcement tape is manufactured from special cross-fibered paper possessing great tensile strength, both with and across the paper grain. Average cross-tensile strength of PERF-A-TAPE exceeds 38 lbs. per in. width, producing joints as strong as the board itself. The tape also has exceptional wet strength...resists stretching, wrinkling and other distortions. Smooth, tapered edges lay flat and resist tearing under tools.

PERF-A-TAPE is spark-perforated to allow air to escape; perforations are too small to show through finished joint surfaces. A controlled taper from side to side and wafer-thin edges of 1/200 in. (thinner than a razor blade) reduce possibility of edge cracking.

PERF-A-TAPE is outstanding in all other characteristics. It is ironed for smoothness, and precisely center-creased for easy application to angles. Moisture content is controlled—longitudinal dimension change after being wetted and dried is less than 1%.



COVER COAT D[illegible] Compound

This vinyl-base product is designed for filling and smoothing interior monolithic concrete ceilings and columns located above grade—no extra bonding agent needed. Supplied in ready-mixed form (sand can be added), easily applied with drywall tools in two or more coats. Dries to a fine white surface usually making further decoration unnecessary.

Compliance with Recognized Standards

U.S.G. joint treatment products comply with ASTM Standard C475-64 and Federal Specifications SS-J-570a-Type I for joint compound only, Type II for tape only, and Type III for joint compound and tape.

Conclusion

GP004 0454

Now that the formulation and manufacture of various types of joint treatment products from U.S.G. have been described, it's easy to compare the careful selection and blending of ingredients with the preparation of gourmet dishes that have made outstanding chefs and restaurants famous the world over.

The balance of chemistry, like that of gourmet cooking, is an art that has been developed to a fine point. Constant experimentation and refinement have produced joint treatment products that meet the most exacting demands of the professional builder and homeowner alike.

Joint System Selector

First Coat: embedding tape; final coat over beads; spotting fasteners	Second Coat: filling over tape, beads and fasteners	Third Coat: finishing over tape, beads and fasteners
Interior Application		
1. DURABOND Compound-All Purpose	DURABOND Compound-All Purpose	DURABOND Compound-All Purpose
2. DURABOND Compound-Taping	DURABOND Compound-Taping	USG Ready-To-Use Compound-Topping or USG Compound-Topping
3. USG Crater Free Ready-To-Use Compound-Taping or All Purpose	USG Crater Free Ready-To-Use Compound-Topping or All Purpose	USG Crater Free Ready-To-Use Compound-Topping or All Purpose
4. USG Powder Compound-Taping	USG Powder Compound-Topping	USG Powder Compound-Topping
5. USG Powder Compound-All Purpose	USG Powder Compound-All Purpose	USG Powder Compound-All Purpose
6. DURABOND 90 Compound	DURABOND 90 Compound	USG Ready-To-Use Compound-Topping or USG Powder Compound-Topping
Exterior Application		
DURABOND XL Compound	DURABOND XL Compound	DURABOND XL Compound

To select the proper drywall joint system, the specific requirements (time allowed), drying conditions (temperature and humidity) and performance desired should be determined. After these factors are weighed, the proper system can then be selected from the table. Recommendations are listed in order of preference—No. 1 in each case can be expected to provide the highest-quality results.

Glossary of Terms

Additives—Special ingredients that refine and stabilize joint compound products.

Adhesion—Bond of joint compound and tape to surfaces.

All-Purpose Compounds—One-package products suitable for all joint compound applications.

Binders—Ingredients that hold joint compound materials together and provide bond or adhesion to surfaces.

Bond—Holding power of compound when dry.

Check Cracking—Random cracking in joint compound surfaces.

Cohesion—Ability of joint compound ingredients to hold together.

Compatibility—Feature of a joint compound that allows it to be used with other compounds and various types of gypsum panels.

Coverage—Surface area—including nailhead, bead and trim finishing—that can be completed with joint treatment.

Cratering—Pockmarks in surface of joint compound, usually caused by air bubbles in compound.

Drying time—Period required for *all* water to evaporate from applied joint compound.

Edge-Crack Resistance—Ability of finished joint to resist cracking along edges of reinforcing tape.

Feathering—Process of smoothing compound at edge of joint during application.

Fillers—Powdered materials used for body and bulk in formulation of joint compounds.

Hardening Time—Period required for chemically hardening-type compound to become hard.

Mix Life—Also "pot life". Length of usable life of powder-type compound after being mixed.

Mixability—Easy-mixing quality of powder compounds.

Powder Compounds—Dry products to be mixed with water for use.

Ready-To-Use Compounds—Factory-mixed products ready to use on the job.

Sandability—Ease of sanding to level surface.

Shelf Life—Length of time compound can be stored.

Shrinkage—Depressions occurring in surface of compound over joints, nailheads and trim as drying takes place.

Slip—Ease of application of compound.

Stability—Long-lasting uniform consistency of joint compounds.

Taping Compounds—For embedding tape and for first coat over reinforcement.

Topping Compounds—For fill and finish coats over tape and reinforcement.

Wet Tack—Ability of compound to stay in place on surface and tools during application.

For specific application instructions, see U.S.G. publications: DURABOND Joint Compounds—J-17; USG Powder Joint Compounds—J-47; USG Crater Free Ready-To-Use Joint Compounds—J-60; PERF-A-TAPE Reinforcing Tape—J-67; COVER COAT Drywall Compound—J-59; How to Install and Finish SHEETROCK Gypsum Panels—J-333.

Notes

Notes

Reference sources—The following companies have furnished material used as reference sources for this booklet: *Canadian Johns-Manville Asbestos, Ltd.*, "Johns-Manville Asbestos Fiber"; *Carey-Canadian Mines, Ltd.*, "Facts About Asbestos", "This is Asbestos"; *Charles Pfizer & Company*, "Technical Report—Marblewhite"; *Georgia Marble Company*, "Calcium Carbonate Pigments", "Calcium Carbonate, Natural", "The Powdered Marble with Myriad Uses"; *J.M. Huber Corporation*, "This is Huber Clay", "Kaolin Clays and their Industrial Uses"; *Troy Chemical Company*, "Troy Technical Quarterly"; *Union Carbide Corporation*, "Special Report on Binders"; *United States Gypsum Company*, "Mineral Facts and Problems".

UNITED STATES GYPSUM
BUILDING AMERICA
101 South Wacker Drive, Chicago, Illinois 60606

date_____

U.S.G.:

please send me____copies of each U.S.G. technical folder marked:

- ☐ USG® Ready-To-Use Joint Compounds—J-60
- ☐ DURABOND® Joint Compounds—J-17
- ☐ USG Powder Joint Compounds—J-47
- ☐ COVER COAT® Drywall Compound—J-59
- ☐ PERF-A-TAPE® Reinforcing Tape—J-67
- ☐ How to Install and Finish SHEETROCK® Gypsum Panels—J-333
- ☐ Please have your representative call to set up a

NAME _____ TITLE _____

COMPANY _____ PHONE _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____