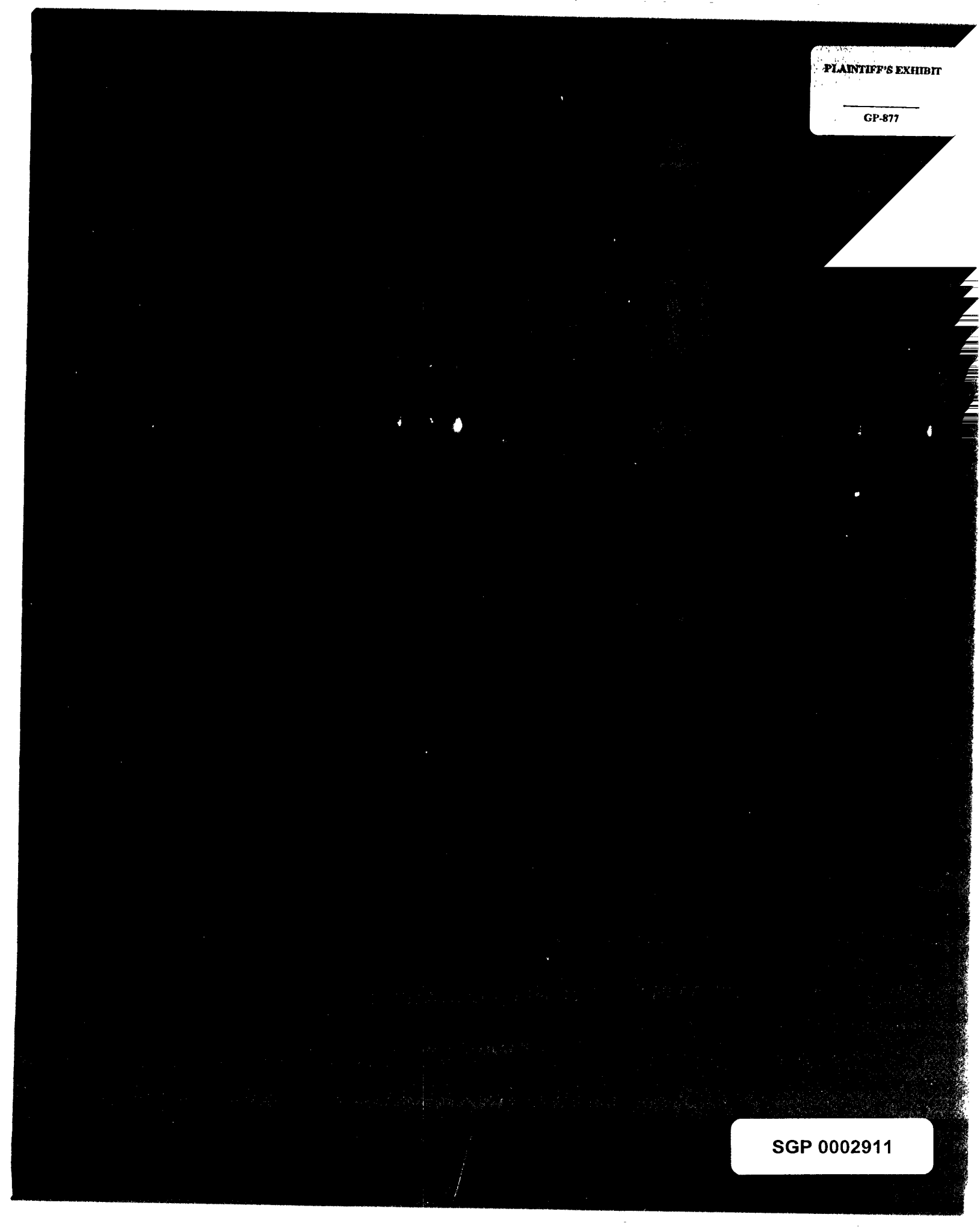
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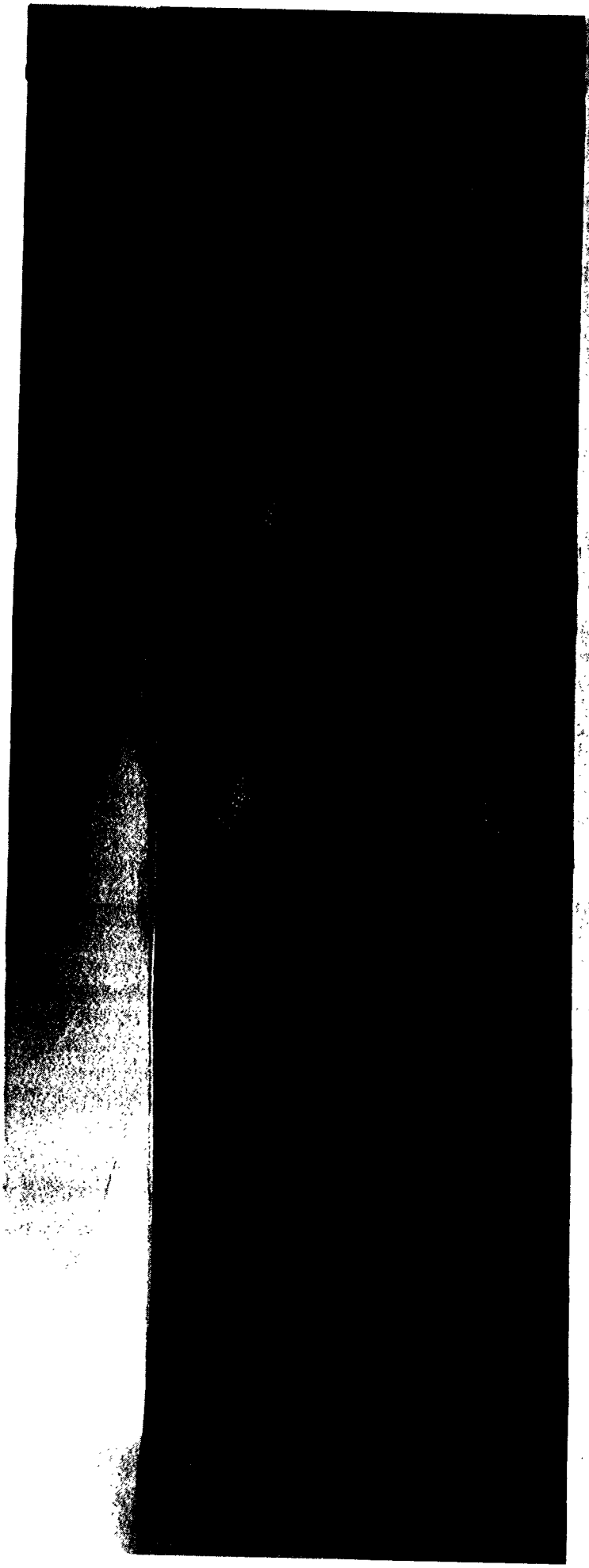

BESTWALL CERTAIN-TEED SALES CORPORATION

GYPSUM PRODUCTS MANUAL

1959 EDITION

NOTE

This Manual No. 81 is the property of Bestwall Certain-teed Sales Corporation for the exclusive use of the sales representatives or other employee to whom it has been issued. It may not be transferred to another employee without permission of the District Sales Manager and, under no circumstances, may it be given or loaned to persons outside the Bestwall Certain-teed organization. Upon request, it must be returned to Bestwall Certain-teed in good condition excepting normal wear and tear. If it is lost or stolen, notify the District Sales Manager immediately.

Receipt of Manual acknowledged.

Date _____ Signature of Salesman _____

August 15, 1959

SGP 0002913

BESTWALL CERTAIN-TEED SALES CORPORATION

GYPSUM PRODUCTS MANUAL

1959 EDITION

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August 15, 1959

SGP 0002914

GYPSUM PRODUCTS MANUAL

PREFACE

1959 Edition

This manual is a technical presentation of Gypsum, including general geological facts, chemical and physical properties, mining and processing of rock, calcination process, manufacture of all gypsum products, and detailed discussions of each product.

The Gypsum Products Manual is for the information of Bestwall Certain-teed Sales Corporation personnel only. It contains competitive product information developed in Bestwall and Certain-teed laboratories, observed in the field, and other miscellaneous sources. Each manual is numbered and registered. It is not to be given or loaned to people outside of the Bestwall Certain-teed Sales organization. This includes a 100% Bestwall Certain-teed account.

This manual gives you technical background of gypsum products. The proper use of all these references will aid you in selling and reduce the amount of inquiries you need to make to the District Sales Office, the Plant, and/or the General Sales Office.

An appendix is included in the manual giving miscellaneous general information involving assemblies and uses of gypsum products particularly as it might pertain to a number of gypsum products.

Throughout the manual and the appendix references are made to standard text books, manuals, or trade journals, which generally are available from public libraries. The salesman who would know all he can about the items he sells would find it of value to be acquainted with some of these books. Use this manual to make yourself self-reliant. It will be particularly helpful in selling architects. The manual will give you background for selling a customer of any class on buying Bestwall.

Notice the mechanical arrangement of the book. It is sectionalized and pages are numbered in a decimal system that will permit new sheets to be added anywhere in the book. Product literature is included. With this edition, technical information in past General Sales Bulletins and Product Information Bulletins have been included. You may discard those dealing with Gypsum Products, Lime and Roof Decks prior to October, 1958.

In the future no technical information or reference material on gypsum products will be covered in the General Sales Bulletins or in Product Information Bulletins. You will be given revised sheets or new sheets for the gypsum products manual numbered, dated, and properly indexed. Read them and put them in place in your manual. Thus, the Gypsum Products Manual becomes an automatic self-perpetuating reference book.

While it may be repetitous, the manual is complete in product information. Printed material in addition to literature is included as reference standards and listings.

GYPSUM PRODUCTS MANUAL

Preface (Cont'd.)

Your Sales Help Book should be used and kept up-to-date. This has all the literature as well as advertisements, give away items available for distribution to the trade. Your Salesman's Manual of Procedure gives you necessary instructions to carry out your sales functions.

Read the new sheets when you get them and file them!!!

Keep your manual up-to-date!!!!

Keep your mind and ideas of gypsum up-to-date!!!!

GYPSUM PRODUCTS MANUAL

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GYPSUM PRODUCTS MANUAL

Chapter I - Generalities

Gypsum Rock

Gypsum is a naturally occurring mineral of a definite chemical composition. Its chemical composition is $CaSO_4 2H_2O$ and when 100% pure it contains 46.5% SO_3, 32.6% CaO and 20.9% combined water of crystallization (by weight). However, no commercial deposits are 100% pure gypsum but the mineral as mined is mixed with varying amounts of limestone, sand, shale, anhydrite, and sometimes a minute amount of rock salt and organic matter.

Geologically, gypsum is classified as a stratified or sedimentary or a secondary rock -- that is, it has been formed under water either by evaporation of sea water, or by the concentration and deposition of the gypsum leached out of limestone and shale by circulating waters.

Varieties:

"Rock Gypsum" is the type usually mined. It is soft granular or compact rock, usually white to gray in color, containing from a trace of impurities up to 30 or 40 per cent. "Selenite" is a pure crystalline variety of gypsum occurring in transparent monoclinic crystals or cleavable masses. "Alabaster" is a white, compact, fine grained variety of rock gypsum which is used to some extent for carving, especially in Europe. "Satin Spar" is a fine translucent fibrous variety of gypsum with a beautiful silky sheen.

"Gypsite" is an impure, earthy variety of gypsum which occurs on the surface of the earth in layers or pockets. It bears the same relation to rock gypsum as sand does to sandstone, in that it has been formed by the disintegration of exposed rock gypsum and spread over the surface of the ground by wind and water. It is usually intimately mixed with clay, sand, limestone or organic matter and is an important source of gypsum wall plaster.

Where Found

There are numerous deposits of gypsum of commercial importance in the United States. They are found in New York, Ohio, Michigan, Iowa, Kansas, Texas, Oklahoma, California, Colorado, Montana, New Mexico, Virginia and Utah from which thousands of tons of gypsum products are shipped each year. Valuable deposits are found in Nova Scotia, New Brunswick and Ontario, Canada. Large tonnages of Nova Scotia and New Brunswick rock are shipped to United States cities on the Atlantic seaboard where they are made into plaster and plaster products. San Marcos Island off the coast of Lower California (Mexico) is a source of gypsum rock for some of the West Coast producers of gypsum products. The purity of gypsum rock varies rather widely and, to be commercially practical, the gypsum content should be at least 75% and preferably 85%. For white specialty plasters such as many industrial plasters, rock of at least 98% and preferably 99% purity or higher is required.

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Chapter I

Characteristics

Gypsum is crystalline calcium sulphate which consists of 79.1% calcium sulphate and 20.9% water (by weight). It has the property of releasing three-fourths of its water of crystallization when heated to about 335° F., most of the water being released at 250° F., to form calcined gypsum. Crystalline gypsum has vapor pressure just like water. As long as the vapor pressure of the gypsum is lower than the surrounding medium, it will not calcine, but when the gypsum is heated, its vapor pressure rises and when it passes the vapor pressure of the surrounding medium, the gypsum will give up its moisture. In saturated air, this point is 212° F. To actively promote calcination, however, it is necessary to heat the gypsum to about 250° F. When heated to 420° F., practically all of the water of crystallization is released to form soluble anhydrite or second settle stucco.

These products have the property of reuniting with water and recrystallizing (setting) to form the original crystalline hydrated calcium sulphate. Since it is a simple recrystallization process, the set (recrystallization) can be speeded up (by use of accelerators) or slowed down (by use of retarders). Ordinary calcined gypsum neither accelerated nor retarded usually will set in from 30 to 60 minutes depending upon purity and method of calcination. As gypsum hardens in setting, it increases in volume slightly which is the reason that it takes such good detail in casting operations. When crystallization is complete, the set gypsum has only to be dried to reach its maximum strength.

The Changes Involved in the Setting of Calcined Gypsum

(a) Chemical Reaction

When calcined gypsum is mixed with water an interlocking mass of gypsum crystals is formed according to the following reaction:

$$2\ CaSO_4{:}\tfrac{1}{2}H_2O + 3\ H_2O = 2\ CaSO_4{:}2H_2O$$

Heat is generated during this reaction which is exactly the reverse of the calcining operation where three-quarters of the water of crystallization is driven off forming a new crystal. Calcined gypsum added to water chemically combines with about 18% of its weight of the mixing water forming the original gypsum crystal and setting to a firm, hard mass, the density and strength of which are controlled by the amount of mixing water used.

(b) Thermal Change:

Theoretically, when water is added to a pound of calcined gypsum about 50 B.T.U.'s of heat are given off in setting. This heat generation is of considerable importance in the casting of molding plaster in glue molds. If the heat is generated too quickly as might be the case of a very quick-setting molding plaster and the temperature of the cast runs over 110° F., the glue or gelatin molds may be melted or softened. In casting a 2" x 4" cylinder of pure molding plaster using 70 parts

of water to 100 parts of plaster by weight with the initial temperature of the slurry about 70° F., the rise in heat in the cast as it is setting will be from 35 to 40° F. An impure gypsum will, of course, generate less heat. The temperature used in setting of gypsum also is valuable in applications such as poured-in-place gypsum fibered concrete in the winter time, as the heat generated often prevents the slurry from freezing before set.

(c) Volume Changes:

A plaster cast will expand in setting, the amount of expansion depending on the purity of the plaster and the amount of mixing water used. At a plastering consistency using 50% water the linear expansion of a pure plaster will be about 0.18%. If used at a pouring consistency with 70% water, the expansion will be about 0.16%. The setting expansion of a molding plaster is a valuable property as it insures the filling out of every fine detail of the mold. The volume of a set plaster case changes slightly as temperature and humidity conditions change. We have no exact figures on expansion due to changes in moisture content, but the thermal expansion of sanded plaster is said to be .0000092 of an inch per degree Fahrenheit - only slightly more than concrete or steel. The setting expansion of gypsum can be decreased to as low as 0.04% by the addition of certain chemicals.

Chapter I

Comparison with Lime

Gypsum differs markedly in its characteristics from lime and Portland Cement. Limestone is calcined carbonate ($CaCO_3$) or a mixture of calcium carbonate and magnesium carbonate ($CaMgCO_3$). When heated to high temperatures (1525° F. or higher) carbon dioxide (CO_2) is released and calcium oxide and magnesium oxide are formed (quick lime). The quick lime is usually reacted with water to form calcium and magnesium hydroxides (hydrated lime). When the hydrated lime is exposed to the air in the presence of moisture, the carbon dioxide in the air reacts with the hydroxide to produce the original carbonates and water. This reaction causes the mass to harden, but it is a very slow process and often is not completed for many years. This slow hardening was one of the primary reasons lime plaster was superseded by the faster setting gypsum plaster as basecoat plastering. It also is the prime reason why lime is completely unsatisfactory as a casting medium.

Comparison with Portland Cement

Portland Cement is made from a mixture of limestone and shale or clay with a small amount of gypsum to regulate the setting time. The proportions of the limestone and clay or shale are carefully controlled so as to produce the proper proportions of lime, silica, and alumina which are necessary to make good Portland Cement. The raw materials are crushed so that most all will pass a 100 mesh screen and they are then heated, usually in a rotary kiln, to a maximum temperature of about 2500° to 2600° F., where they react together chemically to form complex silicates and aluminates, losing carbon dioxide and water in the process.

These complex silicates and aluminates react together when mixed with water to form other complex chemical compounds. These reactions require considerable periods of time except under very special conditions, which is why cements and concretes are normally kept wet for at least seven days and do not develop full strength until about 28 to 30 days. Portland Cement does not expand upon setting which, combined with its slow setting properties, makes it noncompetitive with gypsum for most casting purposes or for plastering, except under certain limited conditions.

The chief advantages of Portland Cement over gypsum are in strength and water resistance. These characteristics are the principal reasons for the use of Portland Cement for structural purposes especially for exterior work such as building, roads, sidewalks, dams, etc. Only the high strength gypsums such as Densite and Hydrocal exceed Portland Cement in strength.



Chapter II

U. S. TRADE MARK REGISTRATIONS - BESTWALL GYPSUM COMPANY

TRADE MARK	GOODS
* Acme	Gypsum Wallplaster, plaster of Paris, calcined gypsum and stucco
* Agatite	Cement Plaster (Gypsum)
* Beaver	Gypsum Wallboard, lath, Gypsum Plaster, Dental plaster of Paris (other - roofing, fiber board)
* Beaver BB and Device Consisting of animal over shield	Dental Plaster of Paris
* Beaver BB animal over shield	Gypsum Wallboard and Lath (others)
Bestwall	Composite board or panel made for the most part from Calcined Gypsum
* Certain-teed	Land Plaster (Fertilizers) Dental Plaster and surgical plaster of Paris.
* Certacoustic	Acoustical tile made from gypsum
Certrock	Plaster of calcined gypsum for making casts and molds in production of ornaments, statuary, moldings and the like.
* Climax	Cement Plaster (Gypsum)
Densite	Plaster of calcined gypsum for making casts and molds for dental purpose; molded and formed objects and structures in the construction, building and industrial arts; high strength calcined gypsum.
Densflor	Flooring compound including a high proportion of calcined gypsum plaster (Densite)
Denswall	Calcined gypsum plaster (high strength wall plaster)
Firestop Bestwall	Plaster board (Gypsum wallboard special core)

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Gypsteel	Gypsum precast slabs for gypsum roof and floors.
Kalite	Acoustical Plaster
Lite-Mix	Prepared mixture of calcined gypsum plaster and light weight aggregate (wall plaster)
Perfolath	Gypsum wallboard and gypsum lath (perforated)
* Pure Wite	Gypsum wall plaster - calcined gypsum finishing plaster.
Fig. of Plasterer plasterized plaster	Gypsum plaster (Wall plaster)
Satin Spar	Finishing plaster (White gauging)
Sunflower	Plaster (molding and casting)
Tufcast	Molding or casting plaster of calcined gypsum (mixture - not pure gypsum).

* Trade marks discontinued in use with change of Certain-teed to Bestwall.

3. MANUFACTURE

GYPSUM PRODUCTS MANUAL

Chapter III

Production and Manufacture

Production

Mining:

(a) Method, Room and Entry System

The so-called "Room and Entry" system is used to develop most of our mines. In making plans for development a main haulage entry is driven well ahead. Side entries are turned off at intervals and from these rooms, usually paralleling the main entry, are developed. From these side entries and rooms about three-quarters of the available rock is removed, leaving one-quarter as pillars to support the roof.

In making a plan of development for a mine, the principal objectives from an engineering standpoint are as follows:

1. To maintain proper haulage tracks with favorable grades.

2. To provide adequate ventilation which means furnishing approximately 100 cubic feet of fresh air per man per minute.

3. To lay out the work so that natural drainage will keep any water present away from working places as much as possible.

(b) Drilling & Blasting

Drilling is accomplished in our mines by electrically-driven augers. In most localities gypsum is fairly soft and easily drilled by this method. Holes up to 12 feet in length are used and from $\frac{1}{2}$ to 1 pound of dynamite per ton of rock is required. Occasionally it is necessary to do secondary blasting or breaking of the large chunks occurring in the primary blast.

(c) Loading & Selection

Most of our mines are now "mechanized". By this term we mean the loading is accomplished by means of machines which have largely displaced old hand loading methods. Joy loaders are used in our mines. Such a machine is caterpillar mounted. Its front end has gathering arms that pull the rock back on to a conveyor and thence to a special transfer or "shuttle car" behind. During operation the loader is worked into the rock pile gradually, picking up the material as it goes.

The "Shuttle Cars", as their name implies, shuttle back and forth between loader and transfer point where material is transferred to mine cars. In most cases, narrow gage mine cars transport the gypsum from transfer point, near loading operation, to the crushing plant. At one of our mines where the highest of purity must be maintained, hand selection is still used.

(d) Control of Quality

Most of our gypsum deposits run fairly uniform in quality. Local skill has been developed to the point that any substandard material is easily detected and promptly eliminated as a source of supply. Periodic analyses are made of the rock supply as well as finished product. In the case of original exploration of a deposit, numerous core drill tests are made and the samples from these tests are thoroughly analyzed.

(e) Hauling & Hoisting

As mentioned in subdivision "c" above, the rock is transfered from "Shuttle Cars" to mine cars near the working face. These mine cars are then hauled to hoist or crusher by an electric locomotive. In several instances, our crushing plants are located within the mine and the crushed rock is brought to the surface by means of belt conveyors or bucket elevators.

Quarrying

The quarrying of gypsum rock is carried on somewhat similarly to other quarrying. Usually, it is necessary to strip the overburden which may sometimes be as much as 50 feet in depth. At our Fort Dodge Plant a hugh dragline, capable of handling a 5 cubic yard bite, is used for this purpose. The exposed surface of the rock is thoroughly cleaned prior to drilling and blasting.

(a) Drilling & Blasting

In our quarries wagon drills are used. These are large pneumatically-operated drills mounted on a suitable portable support. Blasting is done by dynamite and electric caps, very similar to underground methods. In quarrying, however, the drill holes are usually vertical whereas in mining they are horizontal.

(b) Loading

Large mechanical shovels are used to load the blasted rock into Deisel trucks. These trucks transport the material to the crushing plant where it is reduced to usable sizes. The operation from that point is similar to that in mining.

Gypsite

(a) This material occurs near the surface and is recovered by means of a dragline excavator. The digging is conducted to give a uniform blend of the material from top to bottom of the deposit, thus insuring uniformity of product.

(b) Purity

The purity standards for this material are largely maintained through periodic checks at source. Constant checks of the material being processed also serve as a means of quality control.

(c) Transportation

The gypsite is loaded into narrow gauge railway cars which transport it to mill storage. It is unnecessary to crush this material as it occurs in a finely divided state somewhat similar to clays. It is fed directly to calcining kettles from the storage by suitable conveying equipment.

Crushing

The gypsum rock is recieved from the mine in large chunks which are crushed to a size about 2" and under by either a gyratory crusher, roll crusher or jaw crusher. This rock is then elevated and conveyed to bins or tanks from which the rock is taken for rock drying.

Rock Dryers used in drying gypsum rock are usually a cylinderical drum about 6 feet in diameter and 40 feet or over in length. The drum is installed horizontally and revolves slowly, the rock being conveyed through the drum by metal flights. The direct heat of coke or gas is used as there must not be any smoke or soot to contaminate the plaster. The free moisture only is dryed out of the rock, thereby making the rock dry for pulverizing and calcining.

Grinding

Different types of grinders are used as follows:

1. Hammer Mill:

The hammers are placed on a roter which resolves rapidly. The gypsum rock is thrown by the hammers against a breaker plate. Cage bars are in the bottom of the mills. The force of the hammers drives the gypsum rock through the cage bars. The speed of the rotor and spacing of the cage bars determine the fineness of

grind. The gypsum rock is then conveyed to the Raymond Mills. In some plants the hammer mill product is screened, the fines thus removed being put through air separators, the coarse material being conveyed to the Raymond Mills. The air separators remove the particles which are fine enough for land plaster and the coarser particles are conveyed to the Raymond Mills for further grinding.

2. Raymond Mill:

The gypsum rock is ground between driven rollers and a stationery grinding ring. These mills have either 4 or 5 rollers. A high speed fan lifts up the pulverized gypsum rock when it is ground to the fineness for which the mill is set. Certain special types of Raymond Mills called Raymond Kiln Mills are equipped with a heating device which flash dries the rock as it is being ground. Previous drying of the rock is not required when kiln mills are used for grinding.

The Raymond Mills can be adjusted to regulate particle size of the ground raw gypsum depending upon the end use to which it will be put. Coarse ground material is used in certain products such as gauging plaster, where lack of plasticity and easy soaking and mixing with lime putty for finish coat plastering are beneficial. Medium ground material is used for most other products except certain specialties made at plants not having buhrstones for regrinding. The ground gypsum (land plaster) is elevated to bins over the kettles, ready for calcining.

Samples of the ground gypsum are taken periodically and tested for fineness in the plant laboratory to see that it is as specified.

Calcining

Kettle

This process is used at all our mills and is the process most generally used in the industry. The kettle consists of a steel shell enclosed in brick work and is so constructed that heat can be directed against the bottom and sides of the shell as well as through two or four flues that run through the kettle and are in direct contact with the calcining gypsum. It is heated by either coal, gas or oil. Each kettle is equipped with a stirring device so that the boiling contents are kept in constant agitation. After calcination is completed, a port hole or gate just above the bottom of the kettle is opened allowing the contents to flow out into the hot pit below from whence it is conveyed to various storage bins. The bulb of a recording thermometer is placed in the interior of the kettle with the time-temperature chart located in front of the kettle where it can be easily seen by the operator.

The ground gypsum (land plaster) from the Raymond Mills is placed in bins over the kettles. The land plaster is gradually added to the heated kettle over a period of 15 to 30 minutes. As soon as the land plaster strikes the hot kettle, water begins to be released as steam which in effect causes the mixture to boil almost like water. The rate of filling and heat applied are regulated so that the mixture never ceases to boil. After the kettle is filled, it actively boils at about 250° F. until substantially three-quarters of the water of crystallization are released and then the temperature rises fairly rapidly to 335° F., at which time the heat is nearly shut off and the batch dumped, preparatory to refilling. The chemistry of this reaction is very simple.

$$2CaSO_4 \cdot 2H_2O \text{ plus Heat } 252 \text{ B.T.U.'s per pound} = 2CaSO_4H_2O \text{ plus } 3\ H_2O$$

$$79.1\ CaSO_4 - 20.9\ H_2O \qquad\qquad 93.8\ CaSO_4\tfrac{1}{2}\ H_2O - 6.2\ H_2O$$

$$32.6\ CaO \quad 46.5\ SO_3 \qquad\qquad 38.65\ CaO \quad 55.15\ SO_3$$

The dumping temperature of 335° F. is the point at which calcination to first settle stucco is complete. This temperature was established by analyzing many samples of stucco calcined at various temperatures. This material is now regular calcined gypsum or first settle stucco. Each batch consists of 12 to 17 tons depending upon the size of the kettle. Time of calcination is usually 1½ to 2 hours.

By continuing heating of the gypsum to about 420° F., substantially all of the water of crystallization is released and second settle stucco is produced. Years ago this product was widely used but now has very limited use and our principal market is as a dessicant for certain types of insecticides.

Samples of each kettle batch are taken for determination of water carrying capacity, setting time, and fineness in the plant laboratory. Results of these tests enable the quality supervisor to control these products within the limits specified.

Various chemicals added in minute amounts to the stucco while it is being calcined greatly affect the physical properties. By such treatment it is possible to reduce the water carrying capacity (T.C.) of calcined gypsum from 74% to 50 to 52%. If lower water carrying capacity is required, the time of calcination can be extended to 3 to 3½ hours by using a low fire under the kettle, which, in combination with the chemical treatment, will reduce the water carrying capacity (T.C.) to as low as 46%.

Typical uses of low carrying capacity plasters are for pottery molds and all kinds of statuary casts where it is necessary to have strength in the finish molds or casts which can only be obtained by proper low water to plaster ratios. Most all industrial uses require low water carrying capacity plaster. In our own plants, low water carrying capacity stucco is used to make wallboard and lath so as to reduce the water in drying.

Rotary

In some gypsum plants, gypsum is crushed and sized to small pieces from 1" in diameter down and fed into a rotary cylindrical calciner similar in construction to a small rotary cement kiln. Hot gases at a temperature of around 400° F. pass into the kiln in a direction opposite to that of the rock. After passing through the kiln the hot and steaming rock is transferred to a ventilated calcining bin where the residual heat in the material completes the calcination. The calcined rock is then reground and made into wall plaster, etc. This process is a continuous one and is said to be more economical in fuel than the batch kettle process. On the other hand, it is not easy to control the setting time of calcined gypsum so made as erratic sets are obtained due to possible incomplete calcination of the interior of the larger pieces and over calcination or dead burning of the small fragments. Calcined gypsum obtained by the rotary kiln is somewhat more plastic than calcined gypsum made in a kettle but is not nearly as plastic as the product obtained by tube milling.

Effects of Variations in Processing

(a) Effect of Particle Size on the Product Obtained

If gypsum is ground to a very fine powder the calcined product is light and fluffy and due to its requiring greater amounts of mixing water to obtain a given consistency a weaker, softer cast will result. Such a product is more plastic and sticky than is the case when calcining a coarsely ground raw gypsum, which will result in a material that will carry less water which results in a stronger set cast.

(b) Effect of Duration of Calcining Time

The properties of a calcined gypsum can be altered by changing the length of time of the calcining operation. By utilizing a low fire under the kettle the calcining time can be dragged out to three or three and one-half hours resulting in a product that has a decidely lower water carrying capacity and consequent higher strength and density of set and dry cast.

(c) Effect of Chemical Treatment

Various chemicals added in minute amounts to gypsum as it is being calcined greatly affect the physical properties. By such a treatment it is possible to reduce the water carrying capacity of a calcined gypsum from 74% down to 48% resulting in an increase of strength of the set and dry cast of nearly 100%. By adding very small amounts of certain chemicals, not more than an ounce or two per ton of gypsum, it is also possible to greatly alter the void structure of the plaster cast. For instance, a treatment of this sort is made on our Sunflower Molding Plaster which results in casts made from this plaster being unusually free from voids or pinholes which tend to weaken the cast and cause uneven wear for certain industrial purposes. The processes which we use to reduce the water carrying capacity and improve the void structure are protected by patents, numbers 1,960,538 and 1,995,963 owned by Bestwall.

(d) First and Second Settle

As outlined before first settle calcined gypsum or stucco is made by calcining to 335° F. which drives off 3/4 of the water of crystallization of the gypsum crystal. About 20 years ago it was common practice to calcine to from 400° F. and thus dry off practically all of the water of crystallization which resulted in a somewhat quicker set and lower water carrying capacity than ordinary first settle. This second settle stucco made a somewhat stronger cast and was used to some extent for various industrial purposes. If the calcination was carried to much higher temperatures, dead burned calcined gypsum would result; in other words, such a plaster would not set. Very little second settle plaster is made today as modern methods of chemical treatment result in calcined gypsum of a much lower water carrying capacity and resulting higher strength.

Chapter III

The Properties of Calcined Gypsum

(a) Setting Time

The setting time of calcined gypsum as it comes from the kettle varies from about 30 to 60 minutes depending on the purity of the rock and the treatment during calcination. The setting time test as made in our laboratories is called a clean test and is made by adding a weighed amount of the calcined plaster to a measured amount of water and allowing it to soak exactly 30 seconds in a clean cup. It is mixed vigorously for exactly 30 seconds more and is then transferred in the form of a pat to a clean glass plate. The pat is said to have reached its initial set when a 1/4 pound Gilmore needle will make a barely visible impression and its final set when a 1 pound Gilmore needle will make the same slight impression, this test is usually made at what we call testing consistency (T.C.). A weighed amount of plaster, usually 100 grams is added to sufficient water to result in a definite measurable consistency which is about the consistency that a plasterer applies mortar to a wall.

(b) Fineness of Grind

A coarse ground kettle stucco without further treatment is used for certain purposes such as a gauging plaster where the lack of plasticity is advantageous when mixing with lime putty for a white finish. A medium grind kettle stucco is used for making board, lath and plank. for regrinding in the tube mill for making wall plasters or for regrinding in the buhr stone mill after calcination for making molding and various industrial plasters.

A fine ground kettle stucco has various industrial uses such as common molding plaster, terra cotta stucco, polishing plaster and marble setting stucco. The fineness of grind of the lar[illegible] plaster or powdered gypsum is varied, depending on the use to which the kettle stucco is to be put.

(c) Effect of the Water Carrying Capacity (or T.C.) on Strength.

Other things such as purity of the rock, the amount of retarder used, and the completeness of the drying operation being equal, the strength of the gypsum plaster cast depends on the amount of mixing water used. A certain untreated plaster, we will say, has a testing consistency of 70 -- that is, it takes 70 parts of water to 100 parts of plaster by weight to form a mortar of about plastering consistency. To get this same plaster to form a pouring consistency such as is used in most casing operations will require 90 parts of water to 100 parts of plaster by weight. Take the same plaster that has been treated to produce a calcined gypsum of a low water carrying capacity we can obtain a T.C. of 50 and a pouring consistency of 70. The relative strengths obtained by testing the set and dried casts are about as follows:

	Treated Plaster T.C.50 (Pouring Consistency 70)	Non-Treated Plaster T.C. 70 (Pouring Consistency 90)
Tensile strength dry cast lbs. per sq. in casts made at T.C.	About 500 lbs.	About 300 lbs.

(c) Effect of Water Carrying Capacity (or T.C.) on Strength (Cont'd.)

	Treated Plaster T.C. 50 (Pouring Consistency 70)	Non-Treated Plaster T. C. 70 (Pouring Consistency 90)
Compressive strength dry cast lbs. per sq. in. casts made at T.C.	About 3000 lbs.	About 2000 lbs.
Tensile strength dry cast lbs. per sq. in. casts made at pouring consistency	About 300 lbs.	About 150 lbs.
Compressive strength dry cast lbs. per sq. in. casts made at pouring consistency.	About 2200 lbs.	About 1000 lbs.

Using a plaster that will pour with a minimum amount of mixing water is especially important in many industries such as potteries, casting shops, statuary shops, etc., where strength and density of the casts are important.

(d) Plasticity:

Calcined gypsum as it comes from the kettles is ordinarily not a very plastic material. By plastic we mean substance that when mixed with water is soft, buttery, spreads easily and retains its water to a marked extent when the mortar is placed against a highly absorptive backing. For instance, a mixture of fine sand and water is not plastic and cannot be spread with a spatula on a blotter, whereas butter is very plastic at room temperatures and can be spread back and forth very easily on a blotter. Calcined gypsum made from some rock gypsum is considerably more plastic than others. Ft. Dodge rock makes a comparatively highly plastic gypsum whereas that made at some of our other plants is not as plastic. This is probably due to differences in amount and kind of impurities as well as possible differences in crystalline structure. Other things being equal, a fine ground land plaster will produce a more plastic calcined gypsum than a coarse grind. However, it should be noted that no calcined gypsum as it comes from the kettle at any mill will make a completely satisfactory wall plaster to be used with sand as calcined gypsums are not sufficiently plastic and also upon aging very quickly lose most of the plasticity that they originally possessed. It is therefore, necessary to treat or process the kettle stucco further to develop a satisfactory wall plaster.

SGP 0002938

Regrinding Calcined Gypsum:

(a) The Tube Mill

1. Description:

Tube mills used for grinding calcined gypsum are revolving cylindrical drums, (some are 6' in diameter and 20' long), lined with a special hard metal or silex stone and filled slightly more than half full with 1-1/2" steel balls as a grinding medium. Warm calcined gypsum is fed at a constant rate into one end of the revolving mill and is discharged at the other end, the degree of grinding due to the balls cascading over and over and plasticity of the resultant product depending on the rate at which the stucco passes through. A minimum amount of air passes through the mill.

2. Theory in Making Plastic Calcined Gypsum:

The plaster going through the tube mill is ground and rubbed between the balls and the metal shell. It has been suggested that the heat generated in grinding the plaster releases some of the combined water. Due to the construction of the tube mill this water cannot escape in any quantity but is reabsorbed on the surface of the individual crystals. This produces a highly plastic plaster which cannot be duplicated by any other practical method. This process was patented in 1921 by the United States Bureau of Standards and can be used by anyone in this country.

3. Uses of Plastic Calcined Gypsum:

The main use for calcined gypsum made plastic in the tube mill is for the manufacture of wall plaster that is applied to the wall when mixed with sand. Such plasters are neat fibered plaster, unfibered plaster, wood fibered plaster to be used with sand, ready sanded plaster and mixing plant stucco which is shipped to mixing plants for the manufacture of neat and sanded plasters. Plastic calcined gypsum is also used to some extent in the manufacture of sand float finish and prepared trowel finish and is one of the ingredients of Certrock.

4. Control of Degree of Plasticity:

The use of tube milled calcined gypsum is only one of the steps used in the manufacture of our Plastisized Plaster. Another most important step is the control of the degree of plasticity. If the plasticity of a neat plaster is too low it will be deficient in sand carrying capacity, more difficult to work and will not have satisfactory aging properties. If the plasticity is too high, the plaster will be more difficult to mix and will be sticky or gummy working when mixed with normal amounts of sand. When using such plaster the mechanics are quite likely to use too much sand in order to obtain mortar that will work freely enough and in so doing may produce soft, weak plastering.

(b) The Buhr Stone Mill

1. Description:

These mills consist of two very hard circular stones enclosed in metal caps. Through a hole in the center of one stone which is stationary is fed calcined gypsum for further grinding. The other stone revolves at a high rate of speed and the gypsum or plaster is ground between the two stones. The distance the two stones are set apart determines the fineness of the ground.

Keenes Cement:

Keenes Cement is made by calcining a pure rock gypsum at a red heat in a so-called "Bee Hive" kiln so that all the water of crystallization is driven off. This is ground and mixed with an accelerator or catalyzer such as potassium sulphate which accelerates the setting time. Keenes Cement produces a harder, stronger cast than ordinary calcined gypsum as the water carrying capacity is considerably lower. It differs from gypsum molding plaster in that it cannot be satisfactorily accelerated to as quick a set and the wet strength develops more slowly. Keenes Cement is, therefore, not used to any extent for making pottery molds, statuary made in glue molds, quick set dental plasters, etc., where a quick set and quick hardening are desired. Keenes Cement can be retempered; that is, after it has set, it can be reground, mixed with water and will again set up. This is because the process of setting or crystallization takes place around each particle near the presence of the catalyzer or accelerating chemical. The entire particle does not hydrate or form a new crystal as is the case with ordinary calcined gypsum. Keenes Cement has a low plasticity and when used as a plastering material is usually mixed with lime for easier application. It can be stored for years without deterioration or appreciable loss of strength as it does not have the affinity for atmospheric water as does ordinary gypsum plaster.

Keenes Cement can be used, usually mixed with lime, for scratch and brown coat plastering and is frequently used as a gauging plaster with finishing lime for a finish white coat and for colored finishes. A common use is for wainscotings in kitchens and bathrooms where its hardness and moisture resistance are an advantage. While Keenes Cement is not waterproof, it withstands moisture better than ordinary gypsum plastering. It is also used in the manufacture of artificial marble (Scagliola) Caen Stone, Travertine finish, etc., and is frequently used in making colored and textured finishes and in making slow setting dental stones.

Chapter III

Densite Calcination

If you will refer to the paragraph on characteristics of gypsum found on page 1.002 you will find an explanation of the theory of the calcination of gypsum. In the ordinary kettle process, water is released at about 250° F. and at that temperature the water, of course, instantly turns to steam. This has the effect of exploding the gypsum crystals and creates porous particles of calcined gypsum which absorb a good deal of the mixing water in the manner of a sponge, which increases the water carrying capacity.

It has been known for many years that if the water could be released from the gypsum in liquid form the crystals would not be disrupted, but would remain as solid particles and, therefore, would not require so much mixing water. In the Hoggatt Patent No. 2,616,789, the Densite process is disclosed. Essentially this consists of heating lump gypsum in a boiling solution of calcium chloride at 225° to 228° F. This temperature is high enough to cause the gypsum to slowly calcine and release its water in liquid form. About 3½ tons of graded rock are placed in a basket and calcined for 3½ to 4 hours. The basket is then raised out of the calcining solution and washed substantially free of calcium chloride with boiling water, then dried and ground.

Hydro-Cal

Hydro-cal is the product of a process patented by Randel & Dailey and assigned to the United States Gypsum Company. This patent has now expired.

This process essentially consists of heating lumps of gypsum in an autoclave under 15 to 17 lbs. steam pressure over a period of 5 to 6 hours, at which pressure and temperature, the water of crystallization is released as liquid water. The crystals are similar to Densite, but not as low in water carrying capacity.

A modification of this process is capable of matching Densite in water carrying capacity and strength. This is called Low Consistency Hydro-Cal.

When calcination is complete, the steam pressure in the autoclave is released, the calcined lumps emptied out and then dried and ground to required fineness.

Chapter III

Plaster Products

Wall Plaster

All plasticized plasters are made from plasticized stucco which is produced by grinding stucco in the tube mill. This particular type of grinding markedly increases the plasticity of the stucco which results in much better working properties under the plasterers' tools, and also causes the plasticity to remain over reasonable periods of time when stored in customers' warehouses prior to use. Once the proper rate of stucco feed is established to produce the plasticity desired, it is not changed. The stucco is tested periodically for plasticity by the plant laboratory to see that it is correct.

If plasticity is allowed to get too low, the plaster will be deficient in sand carrying capacity, short working, and have poor keeping properties. If plasticity is permitted to get too high, the plaster will be difficult to mix, sticky and gummy working with normal amounts of sand. This often causes the plasterer to add too much sand in order to make mortar that will work freely enough under the tools. This results in soft, weak plastering.

Careful control of plasticity must, therefore, be maintained and our years of experience in this process dictates the proper amount of plasticity.

Neat - Fibered, Unfibered, Extra-Fibered, Wood Fibered

Conform to A.S.T.M. Specification C28-55

Fibered Plaster is sometimes referred to as Neat Fibered Plaster - the word "Neat" implying that the product as shipped by the manufacturer does not contain aggregate; the aggregate necessary being added on the job. This is made by mixing weighed amounts of plasticized calcined gypsum with weighed amounts of manila or textile glass fiber, and sufficient commercial retarder and set stablizer to contol the setting time to the desired degree. After being thoroughly mixed a definite length of time, it is sacked, usually in multiwall bags. On the job it should be mixed with aggregate (sand, perlite, or vermiculite) for scratch or first coat plastering on the various lath backings on gypsum block, on brick or tile, and also for the second or brown coat on all types of backing. Extra fibered or double extra fibered plaster, which contains a larger amount of fiber, is often supplied to be used for the scratch coat on metal lath. See pages in Chapter IV for proper mixing and application specifications.

Gypsum Unfibered Plaster is made in the same way as fibered plaster except that the fiber is omitted and is to be mixed with the same amounts of aggregate. It can be used for first coat plastering with aggregate (sand, perlite, or vermiculite) on gypsum lath, brick, tile or gypsum block, and for the second coat on all types of backings. The only application where Fibered plaster must be used and unfibered

plaster cannot be used, is for the first coat on metal lath, wire lath or wood lath. (All laths where keys are formed) Unfibered plaster can be used for the second coats on all kinds of backings.

In certain sections of the country unfibered plaster is used to a large extent; in other sections fibered is universally used - partically because the dealer dislikes to stock both fibered and unfibered when the former can be used for both scratch and brown coats on all plaster bases except concrete.

Gypsum Wood Fibered Plaster is made from medium plasticity calcined gypsum with the addition of a non-staining wood fiber and the necessary amount of retarder in the same manner as described under fibered plaster. It is used on the job without the addition of aggregate when applied on wood lath, lath, or gypsum lath, and on fiber insulation lath. When used on brick, clay tile and gypsum tile it shall be mixed with one part of sand by weight or 1 cu. ft. of perlite or vermiculite to 100 lbs. of plaster, in order to reduce shrinkage. It will make a harder, stronger wall than neat plaster with aggregate and will provide a more fire resistant construction. It is frequently used for patch work and in localities where a good grade of plastering sand is not available.

Wood Fibered Plaster is used improperly in many parts of the country as plasterers will add two or more parts of sand. When it is known that a shipment is to be so misused, a special formula made of plasticized plaster which will carry the extra sand is shipped. In doing this trouble may be encountered with other users of the shipment who attempt to use the plaster properly.

SGP 0002944

Gypsite Plaster and Artificial Gypsite Plaster:

Acme, Texas Plant formerly produced all the various wall plasters made from plastisized calcined gypsite. This type of plaster is characterized by its darker color and its ability to age for long periods of time without much deterioration. It has been used for many years by many plasterers in the south and southwest who are so accustomed to work with this material that they prefer it to rock plaster. Because of this demand, artificial gypsite plasters were made at Fort Dodge and Grand Rapids Plants which were an excellent match in color and working properties.

The demand for dark plaster has decreased as competition with their source of natural gypsite exhausted, promoted white plaster. Bestwall no longer makes artificial brown plaster at Ft. Dodge and Grand Rapids, but continues to supply the working characteristics in that type material to those customers who prefer it.

The demand for brown plaster at Acme has decreased greatly and that plant is now shipping more white plaster than brown.

Mill Mixed Plaster

Lite Mix, a Mill Mixed Plaster, is plasticized calcined gypsum plus textile glass fiber (no fiber in unfibered), retarder, set stabilizer, and proper amounts of expanded perlite. All ingredients are carefully weighed except the perlite, which is added by volume, and then thoroughly blended before sacking. No sisal fiber is used in making Lite Mix. Perlite is a volcanic glass containing a small amount of combined water. When heated to a high temperature, the glass softens and the water is released with explosive violence which puffs the perlite up like popcorn. Good expanded perlite will weigh about 8 lbs. per cu. ft. and have good strength so that it will not break up to any extent in mixing. Perlite is expanded in our own plants at Akron, Grand Rapids, Ft. Dodge, and Sigurd. Acme uses perlite expanded at Ft. Dodge. Bestwall does not make a sanded base coat plaster nor a vermiculited base coat plaster.

Concrete Bond Plaster

An especially prepared plaster that will bond perfectly to concrete and which should always be used over monolithic concrete surfaces. In its preparation, ingredients are added which change the expansion of ordinary plaster to that of concrete so that the two materials will not delaminate due to unequal expansion. Ordinary sanded plaster is sometimes used but bond failure may occur. Water only should be added to bond plaster, the addition of aggregate not being permitted.

Chapter III

THE CONTROL OF SETTING TIME

Calcined gypsum has a natural setting time as it comes from the kettles of from 30 to 60 minutes tested at testing consistency under clean conditions. By the addition of small amounts of accelerator or retarder, the set can be varied from as quick as two minutes to as slow as a week or longer.

(a) Retarders:

In general, organic substances such as glue, tartaric acid, citric acid are retarders. Commercial retarder such as is used at our plants is made by digesting hog hair, cattle hair, horns and hoofs in caustic soda solution to which is added a certain amount of lime. This is dried and ground to a fine powder forming an effective retarder. Only a few pounds of this material per ton of plaster is necessary to retard wall plasters to the proper degree.

(b) Accelerators:

Raw ground gypsum, ground set gypsum plaster, potassium sulphate, alum and any number of other cyrstalline inorganic salts will accelerate the setting time of calcined gypsum. A set quicker than the normal set of kettle stucco is necessary in the manufacture of plate glass stucco, some dental plasters and for some uses of molding plaster. A mixture of fresh raw or uncalcined gypsum and potassium sulphate is the most effective accelerator that we know and only a small amount of this mixture is necessary to cause a very quick set. Most plastering sand accelerate the setting time of plaster although occasionally a sand is encountered high in organic matter that will retard the set. Small percentages of lime or Portland Cement will effectively accelerate the setting time of wall plasters and are often used to accelerate the set of retarded wall plasters on the job.

THE CHANGES INVOLVED IN THE SETTING TIME OF CALCINED GYPSUM

(a) Chemical Reaction:

When calcined gypsum is mixed with water an interlocking mass of gypsum crystals is formed according to the following reaction:

$$2\ CaSO_4{:}\tfrac{1}{2}H_2O \text{ plus } 3\ H_2O = 2\ CaSO_4{:}2H_2O$$

Heat is generated during this reaction which is exactly the reverse of the calcining operation where three quarters of the water of crystallization is driven off forming a new crystal. Calcined gypsum added to water chemically combines with about 18% of its weight of the mixing water forming the original gypsum crystal and setting to a firm, hard mass, the density and strength of which are controlled by the amount of mixing water used.

(b) Thermal Change:

SGP 0002946

Theoretically, when water is added to a pound of calcined gypsum 252 B.T.U.'s of heat are given off. This heat generation is of considerable importance in

(b) Thermal Change (Cont'd.)

the casting of molding plaster in glue molds for if the heat is generated too quickly as might be the case of a very quick setting molding and the temperature of the cast runs over 110° F. the glue or gelatin molds may be melted or softened. In casting a 2" x 4" cylinder of pure molding plaster using 70 parts of water to 100 parts of plaster by weight with the initial temperature of the slurry about 70° F. the rise in heat in the cast as it is setting will be from 35° to 40° F. An impure gypsum plaster will, of course, generate less heat.

(c) Volume Changes:

In setting, a plaster cast will expand, the amount of expansion depending on the purity of the plaster and the amount of mixing water used. At a plastering consistency using 50% water the linear expansion of a pure plaster will be about 0.18%. If used at a pouring consistency with 70% water, the expansion will be about 0.16%. The setting expansion of a molding plaster is a valuable property as it insures the filling out of every fine detail of the mold. The volume of a set plaster cast changes slightly as temperature and humidity conditions change. We have no exact figures on expansion due to changes in moisture content but the thermal expansion of sanded plaster is said to be .0000092 of an inch per degree Fahrenheit - only slightly more than concrete or steel.

THE WAREHOUSE

This department is used for the mixing, sacking, shipping and storage of the finished plaster products. The various kinds of products manufactured are prepared and the various ingredients added such as retarder, or accelerator, to govern the setting time, sand for sanded plaster, wood fiber for wood fibered plaster, and manila fiber for fibered plasters.

(a) Conveyors:

Conveyors are used to distribute the plaster to the various storage bins - also to remove the plaster from the bins to the mixers for sacking. They may be the revolving screw type, or drag chain type.

(b) Bins:

Bins are used for the storage of the different kinds of plaster such as tubed stucco, regular stucco, and the special grades. Bins may be wood or steel construction and hold from 10 to 250 tons. They are generally hoppered so that material will flow out of the bottom.

(c) Cooling Devices:

Cooling devices are used for the purpose of reducing the temperature of the plaster before or after it is placed in the bins. These devices help to make the plaster uniform when ingredients are added in the mixer. Tubes passing through the bins

(c) Cooling Devices (Cont'd.)

to allow cold air to pass inside the tubes are one type. Revolving discs that spread the plaster, screw conveyors which are open at the top are some of the other devices used to cool stucco.

(d) Weighing Hoppers:

The calcined gypsum, retarder, fiber, etc., are accurately weighed into a large hopper above the mixer. As soon as the charge is m ie up, it is dropped through a gate in the bottom of the hopper directly into the mixer.

(e) Mixers:

Mixers are used for the proper blending of the stucco, retarder, fiber and sand and other ingredients used in the manufacture of the various plasters. The mixer consists of two shafts with paddles that agitate the plaster as they revolve. Generally mixers hold from 1/2 ton of material. The plaster is mixed for a predetermined length of time and then gates are opened to allow material to flow out of the mixers to the packers.

(f) Fiber:

Fiber is used for the purpose of holding the keys in place until the plaster sets when plastering on wood lath, perforated lath or metal lath. Formerly goat or cow hair was used. A type more generally used is Manila which is made from rope or the same material as rope. This fiber is then put through a machine known as a picker which has one stationary disc containing a number of teeth. A revolving disc in contact with the stationary disc also has teeth so that the matted fiber as it passes through the picker is torn apart in order to produce fiber that can be uniformly mixed with the plaster in the mixer. Sisal fiber through the same means is also widely used. Bestwall now uses textile glass filaments in lieu of the various organic matters used.

(g) Packers:

Bates packers are used for the filling of the bags. The packer has a hopper or bin over it which will hold slightly more than the mixer. This hopper is V-shaped and has in the mixer below a shaft with small paddles which revolve at a high rate of speed. These paddles are arranged at the proper place to force the plaster through tubes on the front of the packer. These tubes are about 8" long and are open on the bottom. The bag has a flap or valve in one corner and the plaster is forced by the paddles through the tube into the bag similar to the action of a centrifugal pump. The packer has an automatic weighing device which shuts off the flow of the plaster when the bag reaches the correct weight.

(h) Bags:

Various types of bags are used. Some are open as a store bag and are known as open mouth bags. These must be tied after they are filled. The valve bag is completely tied in the case of the cloth type and pasted or sewed in the paper type. Some bags are made of a single sheet of Kraft paper, while the more modern types are made up of three to five layers of paper and are known as the multi-wall bag. The advantage of this bag over the single paper construction is that it is much more sturdy in construction even though the combined layers of paper are not as heavy as the single sheet. Many of our products are packed in special moisture resisting bags, which have one layer treated with a moisture resisting composition. Scutan and Navy-D are trade names for asphalt lined bags. Multi-wall bags can have pasted ends or sewn ends. The type bag will be indicated with each product.

(i) Loading into Car:

The sacks are placed on two-wheeled hand trucks and trucked into the cars for shipment. The cars are lined with paper and all protruding nails, trash, etc. are removed before the cars are loaded. In cars containing only one brand the tonnage to be placed in the car is so arranged that the sacks are at a uniform height throughout the car and kept away from the sides to prevent chafing in shipment. When more than one brand is loaded, they are separated by paper, but are placed as tightly together as possible to prevent movement. All cars are carefully inspected to make sure that rain cannot enter to cause lumpy and quick setting plaster.

SGP 0002949

Chapter III

Prepared Finishes

Sand Float Finish

A prepared Sand Float Finish, which is used with only the addition of water, is made of properly plastic plaster with just the right amount of a uniform sized white silica sand.

Trowel Finish

Prepared Trowel Finish is a white or light gray finishing plaster used in many localitites specially in the Middle West, for a finish plaster in place of the usual gypsum-lime putty finish. Mixed with water only, it is ready for use thus saving considerable time in soaking lime putty and mixing with gauging plaster. Since it contains no lime this finish can be painted as soon as it is dry. It makes a harder finish with a more definite setting time. It is processed to have exactly the right degree of plasticity for application to a nearly dry base coat.

Gauging Plaster

The finish coat on plastering usually consists of hydrated lime putty and gauging plaster. The hydrated lime provides workability and smoothness, but due to its slow hardening properties, it would shrink or check crack if applied by itself. Gauging plaster (calcined gypsum) is therefore blended with the lime putty to cause the finish coat to harden within a reasonable length of time, usually an hour or less. When the gauging plaster sets, it rigidifies the finish coat and prevents it from shrinking thereafter, and also hardens the finish so that it can withstand abrasion. It also improves adhesion to the base (brown) coat. Gauging plaster does not add to the plasticity of the finish, the hydrated lime is added for that purpose. Sufficient gauging plaster should always be used (one volume of gauging plaster to not more than three volumes of lime putty) in order to prevent check cracks, map cracks, or craze cracks.

Quick Set

Common Gauging Plaster Quick Set is produced at all of our gypsum plants. It is relatively coarsely ground unretarded calcium gypsum with a setting time of about 40 minutes. Its color varies somewhat depending on the rock from which it is produced. When mixed with lime putty it will make a good finish, but with occasional small dark specks caused by the limestone and shale impurities in the rock.

Satin Spar Gauging Plaster, Quick Set, is made from pure white rock obtained at our Blue Rapids, Kansas; Acme, Texas; and Sigurd, Utah mills. When mixed with lime putty a pure white finish is obtained free from dark specks. When the highest quality work is desired, one of these products should be specified. Their properties such as setting time, fineness of grind, ease of mixing, etc., are the same as common gauging.

These quick set gauging plasters are mixed with lime putty to counteract the shrinkage of the lime, to make a harder finish and to reduce the stickiness of the mortar. Ordinarily it is necessary to retard such mixtures of gauging and lime putty if a setting time slower than 10 to 15 minutes is desired. This is usually done by adding commercial retarder to the water or by replacing a certain amount of the quick set gauging with unfibered plaster (retarded) or screened neat fibered plaster. Plasterers in certain sections

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Chapter III

Industrial Plasters

Sunflower Molding

This well known and popular brand is made from gypsum rock of over 99% purity at Blue Rapids, Kansas and is also made at Acme, Texas and Sigurd, Utah, from rock of over 98% purity. It is made by a special process which lowers the water carrying capacity to a minimum so that this plaster when mixed at plastering consistency with 50% water will give a tensile strength of over 500 lbs. per square inch and a compressive strength of over 3,000 lbs. per square inch on the set and dry casts. At pouring consistency when mixed with 70% water a tensile strength of over 300 lbs. and a compressive strength of over 2200 lbs. results. It contains no abrasive material.

After calcination and treatment in the kettle this plaster is reground to a fineness of 99.9% through a 50 mesh screen and 98.0% through a 100 mesh screen insuring a uniform fine texture and easy soaking and mixing properties. Its color is white. The setting time of this product is held within rigid specification limits at the plant so that it will set on the job in from 15 to 25 minutes depending on mixing conditions. For special uses the setting time can be made quicker or slower as desired. The heat developed as the plaster sets, is generated slowly, resulting in a cool working plaster that will not injure gelatin molds. The setting expansion when mixed with 50% water is 0.18% and when mixed with 70% water is 0.16%. Sunflower Molding is as good a molding plaster as can be made from gypsum and is unexcelled in quality the world over.

NOTE: A special fine grind (99% through a 100 mesh) is also available in limited quantities.

Common Molding Plaster of high quality is also made at the Fort Dodge, Iowa, plant in limited quantities.

The regrinding of molding plaster is done in buhrstone mills. These mills consist of two very hard circular stones enclosed in metal caps. Calcined gypsum is fed through a hole in the center of one stone which is stationary for further grinding. The other stone revolves at a high rate of speed and the gypsum or plaster is ground between the two stones. The distance the two stones are set apart determines the fineness of grind. Small grooves or channels are cut in the stones leading towards the outer edges. As the material is ground it is forced out of the mill through these channels by centrifugal force.

The Plasticity of the Reground Product:

The object of regrinding calcined gypsum through a buhrstone mill is to obtain a finely ground product without greatly increasing the plasticity. This type of mill accomplishes this purpose as a very fine powder of relatively low plasticity results.

A requirement for plasters such as Sunflower Molding is that it shall mix easily to a smooth, pourable slurry with a minimum amount of mixing water. If the calcined gypsum is highly plastic it requires long mixing to obtain a desired pouring consistency, both properties highly undesirable in a casting plaster. The regrind in the buhr mills gives us the desired properties of fine grind, easy mixing with water with some decrease in the water carrying capacity.

Statuary Casting

This plaster differs from regular molding or casting plaster in that it contains a special ingredient which "case hardens" the finished cast. Objects cast with this plaster will have an extremely hard surface, resistant to marring and dense enough to be painted without preliminary sizing. Bestwall Gypsum Company's Statuary Plaster is made by blending a carefully selected amount of the case hardening ingredient with regular molding or casting plaster.

Plate Glass Stucco

For bedding the glass on continuous line machines, a pure, strong fast set, grit free calcined gypsum is used to which is added 2% to 5% hydrated lime. The lime causes the plaster to adhere more firmly to the glass. It is particularly important that the plaster used for the second side bedding shall be grit free, so that the polished glass will not be scratched as it is bedded or if it slips under the grinders or polishers. A special patented formula of plate glass stucco is also available for plants that do not want to go to the expense and uncertainty of adding lime. This formula is now used successfully in several of the largest plate glass plants in the country. A rather coarse ground low water carrying stucco is usually preferable as it releases from the glass better when the glass is taken from the table. The setting time is normally very quick and most customers request that the setting time regulated at our plants although one large customer does his own accelerating.

Plate glass stucco as made at our Blue Rapids Plant is unexcelled for this purpose. It is grit free, exceptionally strong and of a very uniform set. Although it is not necessary to use this grade of plaster for first bedding, some large concerns use it for both sides due to its strength and uniformity of performance. As soon as the proper setting time is determined for a particular operation no trouble is experienced with Blue Rapids plate glass stucco.

Stucco of somewhat lower purity, such as produced at our Fort Dodge plant is used for first bedding or "first side" purposes, however, it is not sufficiently grit free for use as second side stucco.

Impression Plaster

A fine ground, white, pure, quick setting plaster made from carefully selected rock, impression plaster is mixed by the dentist to a rather thick consistency and

placed in a small tray about the size of a jaw which is inserted in the patient's mouth. It hardens very quickly leaving a perfect impression of the entire upper or lower part of the mouth. Bestwall Impression Plaster is made by carefully blending fine ground, low water carrying capacity white stucco with accelerators to a 3 to 5 minute setting time. It may be further accelerated by the dentist with potassium sulphate or other accelerator.

Laboratory Plaster

This is the same high grade fine ground white plaster as Impression Plaster. The main difference is that it possesses a slower set of 10 to 20 minutes. The dentist uses this plaster for general laboratory work and for making models or casts over which vulcanizing can be done immediately. As considerable strength is desired the plaster should be mixed as thick as possible, so both sections of the mold between which the rubber plate is vulcanized are subjected to considerable pressure.

Orthopedic Plaster

A fine ground white plaster that will make a strong rigid cast. Ordinarily it is accelerated to set in from 10 to 15 minutes but a quicker or slower set may be desired according to the particular technique employed. It is used to make a rigid cast over a broken bone by immersing bandages in a rather thin plaster mix and wrapping the bandage tightly around the injured part. Very often the bandage is impregnated with dry plaster after which the roll may be immersed in water and wound around the injury. If a quicker set is desired powdered potassium sulphate can be added to the water. Bestwall Orthopedic Plaster is produced at both Acme and Blue Rapids.

Pottery Plaster

Pottery Plaster is made normally in three formulations, regular pottery plaster (K-55), a low water carrying and finer grind pottery plaster (K-59), and a high strength, thermal shock resistant, fine grind pottery plaster (K-61). Regular Pottery Plaster (K-55) is made in exactly the same manner as Sunflower Molding Plaster. It is white, pure, fine ground, low water carrying capacity stucco mainly produced at our Blue Rapids Plant under carefully controlled conditions. Fine ground extra low water carrying capacity pottery plaster (K-59) is a blend of slightly finer ground regular pottery plaster and Densite, the latter added to lower the water carrying capacity so that pottery molds can be cast at a lower water to plaster ratio to give improved hardness and mold life. K-61 is a blend of the finer ground regular pottery plaster, fine ground Densite and other ingredients.

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Densite

Densite is made by a patented process described on page . It is a very low water carrying, fine ground product producing smooth casts of very great hardness and strength. It has a T.C. of 22, a pouring consistency of 33, and a fineness of 92% to 95% through a 200 mesh sieve.

After the rock is calcined and dried, the lumps are broken up into particles, most of which will pass a 100 mesh screen in a swing hammer mill. At this stage it is gritty and harsh and looks and feels like fine, white sand. This material then is passed through a four-stage operation in a continuous stream for the following purposes:

1. Reground in a tube mill to reduce the particle size and increase the plasticity.

2. Reground through a buhrstone to break up any coarse flakes formed in the tube mill.

3. Passed through a reheater to remove any traces of free water or raw gypsum in order to make a more uniform set.

4. Passed through a fine screen to remove any extraneous matter present. The finished Densite is elevated into a bin over a mixer and a packer where all of the many added ingredients may be carefully proportioned and blended ready for sacking. Straight Densite is also packed without additives.

The whole Densite operation is under very close laboratory supervision.

With various additives the characteristics of a finished product can be controlled as:

(a) Setting Time

(b) Setting Expansion

(c) Strength

(d) Color

(e)

By this means, products are tailored to meet the requirements of a specific user.

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Crushed Rock

Crushed Rock for use in the manufacture of Portland Cement may be either crusher run rock including all fines or it may be graded rock to meet certain size specification. In the latter case, the crushed rock is passed over a series of vibrating screens which separate out the desired size for shipment. It is available for sale at Acme, Blue Rapids, and Sigurd.

Agricultural Gypsum

Rock gypsum ground to a powder is commonly called land plaster. This material is usually ground in Raymond mills so that 85% - 90% will pass a 100 mesh screen and is bagged without added ingredients. Agricultural Gypsum is available from Sigurd, Utah; Acme, Texas; and Fort Dodge, Iowa.

Terra Alba

Terra Alba is a very fine uncalcined gypsum processed so that at least 95% will pass a 325 mesh screen. It is normally made from pure white gypsum by fine grinding and air separating to the desired degree of fineness. It is not made by the Bestwall Gypsum Company.

Industrial Stucco

This product is made from light gray lower purity rock gypsums. It is usually treated to produce strong durable casts. Its setting time is about the same as Sunflower Molding Plaster.

Industrial Stucco is more or less a tailor-made material manufactured to suit the requirements of the purchaser so that no specifications can be given as to its set, grind and water carrying capacity.

Polishing Stucco

A fine ground, regular set calcined gypsum is used in large amounts for filling the spaces between blocks or slabs of granite and marble while they are being ground and polished with steel shot, emery and rouge. To give best results a fine ground grit-free plaster should be used. For bedding slabs to be cut, a coarse ground calcined gypsum may be used. The plaster slurry, usually mixed with sawdust, is poured between the slabs to present a solid mass through which the saw can cut and to prevent the loss of the sawing shot in the crevices.

Certrock

An extremely dense, hard, strong, calcined gypsum plaster that when mixed with only 40% water will readily pour, filling the most minute details of a mold. When set and dry, casts made from Certrock will have a tensile strength of over 600 lbs. per square inch and a compressive strength of over 5,000 lbs. per square inch. This is

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greater strength than is possessed by concrete as ordinarily made (high grade concrete is usually designed for compression strength of 5,000 lbs. per sq. inch).

Certrock is made by blending carefully weighed amounts of plasticized stucco and other ingredients which reduce the water carrying capacity of the stucco, olimi-nates air voids, and case hardens the surface of the cast as it dries. It is tested carefully for water carrying capacity and setting time by the plant laboratory.

Fill fo Safe Cabinets

Large amounts of calcined gypsum are used in the lining of safes and safe cabinets as a protection against fire. Stucco for this purpose is processed in manufacture to lower the amount of mixing water required and increase the density of the cast. Setting time is regulated to customer requirements.

Shell Loading Filler

Chapter III

Board Products

Gypsum Wallboard, Lath and Sheathing are composed of a core of fibered, hydrated calcined gypsum and other ingredients surfaced on both sides with smooth, uniform, specially-prepared paper forming the finished surfaces and serving as a reinforcement.

Each raw material used in the manufacture of these products is for a specific purpose, and only those that meet our rigid specifications are used. The quality and structural value of each board product depends upon its composition and fabricating during manufacture. To thoroughly understand the quality, properties, uses, etc., of each product, its composition and manufacture should be known. Therefore, the manufacturing may best be followed by starting with the raw materials and following their course, step by step, through the process.

1. RAW MATERIALS

(a) Paper:

Bestwall manufactures in its own paper plants much of the special paper used for surfacing wallboard, lath and sheathing. A different kind of paper is used for each finished product.

Due to high freight costs for shipping paper from our Thorold, Canada, Plant to our western wallboard plants, it is to our advantage to purchase some paper from outside manufacturers. This outside purchased paper is manufactured according to our own formulae and specifications.

The papers are manufactured on seven cylinder paper machines, which means that there are seven separate layers of paper stock felted together to form the solid finished sheet. The finished sheet as formed consists of 3 parts which are known as the face liner, filler, and bond liner. By building up the solid sheet in this manner, the composition of each part of the sheet can be controlled so as to produce a paper which will have the properties required by the finished gypsum board products.

All papers used for wallboard, lath and sheathing have certain properties in common:

1. The bond liner in all cases is made from unsized stock and is designed to produce perfect bond to the gypsum core. The bond to the gypsum core is accomplished by the bond liner absorbing the saturated gypsum solution from the gypsum slurry used for forming the core. Gypsum crystals grow in this saturated solution that has been absorbed by the bond liner and interlace into the crystals of the core, thereby producing the bond.

2. The filler of all our paper is made from a specially-sized paper stock to render it water resistant. The water resistance of the filler is very important. It is one of the features of the paper which we use for all types of board, lath, and sheathing. The filler is designed to prevent the free water present in the slurry and core from percolating through the face and back papers to the surfaces while the board is being manufactured. If this water filtered through the face and back papers, it would cause unsightly water marks, stains, etc. on the finished sheet.

   The water resistant filler also prevents the passage of free water present in gypsum plaster mortar when it is applied on the surface of gypsum lath, from passing through the covering paper into the core of the lath. If the water from the plaster mortar were not prevented from reaching the gypsum core in the lath, it would dissolve a sufficient number of the crystals which bond the paper to the core. This might cause the paper to loosen from the core.

3. The face liner used for wallboards is made from a special paper stock which is colored, highly sized, and treated to render it water resistant and scuff-proof. The finished surface is smooth, uniform, and non-absorptive. The face liner of lath paper is water absorbent exactly the same as the bond liner (as explained in 1 above), because its surface must have the properties of bonding to the gypsum plaster applied to the lath.

   The face liner of gray wallboard back paper is made from stock that is slightly sized so as to render it scuff-proof. The face liner of the paper used on sheathing is made from paper stock which is colored, highly sized, and treated to render it water resistant, scuff-proof. The finished surface is smooth, uniform and non-absorptive.

(b) Stucco:

The stucco used for manufacturing the core is designed especially for this purpose. It is of proper fineness and is low in water carrying capacity. This produces a core which has the proper hardness and strength.

(c) Glass Fiber:

The glass fiber used in Bestwall gypsum wallboards is the continuous textile grade which is soft and non-irritating to the skin. It has a very high tensile strength, being stronger than many steels. It is obtained in multiple strands wound in spools, and is cut to proper length continuously in synchronization with the belt speed of the board machine. The glass fiber is used under Bestwall Gypsum Company's Patent No. 2,681,863.

(d) Paper Fiber:

Paper Fiber is used in lath. It is also used along with glass fiber in all other board products except Firestop Bestwall, which contains only glass fiber. The paper fiber is scrap paper purchased from outside sources or waste paper from the wallboard operation. The paper is beaten up in water in a hydro-pulper in either a $2\frac{1}{2}$ or 3 percent concentration. It is pumped to the mixer by a variable speed pump which proportions the proper amount of paper pulp, depending upon the type of product being made and the speed of operation.

The glass fiber and paper pulp are added to the core for the following reasons:

1. To give proper nailing properties to the core and to eliminate chipping and shattering of the core at open edges of the board.

2. To reduce the brittleness of the core.

3. To produce a wallboard that has the required flexibility and which can be handled without breakage.

4. To reduce the weight of the board.

(e) Adhesives:

The gypsum crystals which form the core and bond it to the bond liner of the paper used are very fine and brittle. To protect these crystals, and to add to the bond between the core and the bond liner of the paper, a special adhesive is used. This adhesive is mixed into the ingredients in the core. It is water soluble and, therefore, concentrates between the gypsum crystals where the core is in contact with the bond liner. This

reinforces the crystalline structure and adds to the bond between the core and the paper covering. This concentration of the adhesive at the surfaces of the core is somewhat similar to the action of the soluble gum added to produce the case-hardened surfaces of statuary casting plaster.

(f) Accelerator:

The gypsum core must be set hard by the time the board reaches the cut-off knife, which is near the end of the board machine, so that the board can be cut into the required lengths. This makes it necessary to use an accelerator to regulate the setting time of the slurry. The accelerator which we use is ordinary pulverized gypsum rock. Chemical accelerators such as potassium sulphate, ammonium sulphate, etc. may also be used.

(g) Foam:

The foam added to the slurry used for producing the core is made from a solution of rosin soap. This solution is passed through special equipment that beats it into a stable, uniform-structured, small-bubble foam. The foam produces microscopic air voids throughout the gypsum core. The soap solution reacts with the gypsum to form insoluble calcium salts which further reinforce the void structure of the gypsum core. Foam is added to the slurry to:

1. Increase the thermal insulation value of the board.
2. Reduce the brittleness of the core.
3. Add to the flexibility of the board.
4. Reduce the weight of the board.

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PROCESS OF MANUFACTURE:

Each step in the process of manufacture is carefully controlled to produce quality and uniformity in the board, lath or sheathing. Quality depends upon the combination of the face and back paper used and the structure of the core, (the paper has been described above). The paper and the structure of the core controls rigidity, structural strength and durability of the finished product. The required hardness and strength of the core can be achieved by proper formulation of the dry ingredients and control of the water-plaster ratio.

The proper mixing of the dry ingredients, the addition of the foam, paper and pulp, glass fibers and the proper wet mixing before the slurry is poured onto the paper covering are all very important. A very rigid system of inspection, testing and control is maintained at all of our plants to make sure that the proper percentage of each raw material is used, and that the mixture is thoroughly dry mixed and wet mixed before it is used for forming the core.

The experience of some of our dealers in Pittsburgh and Johnstown, Pa., who had Bestwall gypsum wallboard in stock during the 1936 flood, illustrates what quality means in the composition of the core of gypsum board. Bestwall and competitive wallboards stocked in these dealers' warehouses were covered by the flood water for several days. After the water receded, the Bestwall was dried out and, except for being somewhat soiled, was still usable. The competitive wallboard disintegrated to such a degree that it was worthless.

(a) Dry Mixing:

It is absolutely necessary to thoroughly mix the glass fiber, accelerator and adhesive into the dry stucco so that a uniform mixture is obtained. Dry mixing is accomplished in the conveying equipment as the material is delivered to the wet end of the machine.

(b) Wet Mixing:

The dry ingredients are fed into a high-speed centrifugal mixer and are blended with mixing water, paper pulp and foam. The consistency of the slurry is accurately controlled by regulating the mixing water through the use of a recording water meter. The weight of the slurry is controlled by varying the foam content as required to produce a slurry of a definite density. Slurry from the mixer is discharged in three streams so that these streams of gypsum lath may be made at one time. For other boards, the streams all blend together at the forming rolls except where two streams of sheathing are made in which case only two streams are used.

(c) Edge Formation:

Square Edge, Tapered Edge, Tongue and Groove Edge, and Beveled Edge Boards are made by cutting grooves along the edges of the face paper after it leaves the paper race. The inside grooves regulate the width of the finished product. As the grooved paper approaches the forming rolls, it is folded into the various shapes along the grooves which are required for the particular type of edge being made by means of edge folding devices. Spaces between grooves are set depending upon the type of product being made and its thickness. Gypsum lath paper is not grooved along its edges but is passed through edge forming devices which fold the paper in a semi-circle on each side.

As the papers pass through the forming rolls, adhesive is applied at each edge which servesto stick the edges of the top paper to the folded edges of the bottom paper.

(d) Thickness:

Thickness of the various products is controlled by the spacing of the forming rolls.

(e) Length of the Machine:

As the gypsum board or lath leaves the forming section it is carried on wide rubber belts and carrier rolls to allow time for the gypsum core to harden (set). The total length of the machine depends to a considerable degree upon the speed operated. Our shortest machine is at Akron where the distance from forming rolls to cut-off knife is 525 ft. Our longest machine is at Fort Dodge where this distance is 884 ft.

(f) Cut-Off Knife:

Akron uses a reciprocating guillotine-type knife; all other plants use rotary knives for cutting the board into various lengths. The drive for the cutting mechanism is adjustable so that lengths can be varied as needed for various products.

(g) Transfer Table:

After the boards are cut to length, they are picked up by a transfer table and carried sideways to a tipple table which feeds the boards into the dryer. The dryer runs parallel with and alongside of the board machine. As 48" wide wallboards are transferred, they are inverted so that the ivory face is turned up. This preserves the finish of the ivory paper from blemishes, slick spots, etc. which may occur when the paper is in contact with the kiln rolls.

(h) Drying:

The board from the transfer is fed by the tipple table into the dryer which has 6 or 8 decks, and is wide enough to take 2 streams of board 4' wide, 3 streams 32" wide, 4 streams 24" wide, and 6 streams 16" wide. Our dryers are heated either by steam coils or by direct combustion of natural gas. The temperature is carefully controlled in the various zones into which the dryer is divided so as to dry the products properly. Large circulating fans blow the hot gases over the boards and laths and the moisture which is evaporated is blown out through exhaust stacks.

(j) Take-off:

(k) Perforated Lath:

In one plant lath is perforated after bundling. This is done by placing the bundle into a gang perforating machine which drills the holes. In other plants, the perforating is done by a punching machine at the end of the board machine; the operation being performed on the wet lath before it is cut into 48" lengths. The perforations in either case are 3/4" in diameter and spaced 4" apart.

(l) Reclaiming Department:

In this department, re-cutting equipment is available so that the damaged goods can be cut into smaller sizes and reclaimed for shipment to the trade.

(m) Loading Cars:

Loading cars of wallboard, lath and sheathing is done under close supervision. All possible precautions are taken to insure delivery of board in good condition. To illustrate the precautions which are taken, here is the routine which is followed in loading cars:

All cars are carefully inspected before they are accepted for loading wallboard, lath and sheathing. Any cars with leaky roofs, broken or unusually dirty floors, etc., are rejected. All loose nails are pulled from the floors and sides. Any loose boards are fastened to prevent damage to the load. After the cars have been cleaned and prepared, the floors are covered with dunnage board and the walls covered with paper. Only then does loading start. While loading the cars paper pads are attached to the side of the cars to protect the ends and edges of the piles of board, lath, or sheathing. Special care is used to brace, tie and protect the piles, and to prevent shifting or damage enroute.

Wherever possible, gypsum board products are now loaded into box cars or on flat cars by fork lift trucks. By this method whole units are set in place at one time. Spacers are placed between each unit so that the forks of the lift truck can be easily inserted and withdrawn.

INSPECTION:

All raw materials and entire process of manufacture are under the supervision of competent inspectors. An inspector is on duty at all times and on all shifts and is responsible for the quality of the products produced on that shift. Every step in the process is checked hourly or at fixed intervals as a matter of control. Finished boards are tested hourly or more often for thickness, width, length, bond, nailing properties, flexibility, strength, weight, appearance, resistance to moisture, etc. All tests and inspections are recorded on standard report forms which are made up in duplicate. These reports are watched by the board plant superintendent as the entries are made throughout the day. The reports when completed are signed by the inspectors and turned over to the board plant superintendent and plant manager for approval. One copy of the report is sent to the Paoli Laboratory. These reports are carefully analyzed by all concerned and then filed for reference.

SAMPLES:

All samples of wallboard, lath and sheathing are cut from standard production at Fort Dodge where the sample department is located.

Chapter III

WALLBOARD PRODUCTS:

(a) Bestwall gypsum wallboard is available in square edge, tapered edge, or beveled edge in 1/4", 3/8", 1/2" and 5/8" thickness, and 48" width. Tapered edge differs from square edge in that in manufacture tapered edge tapes 1½" wide by slightly over 1/32" thick in the center are inserted halfway under the edges of the board. This holds up the edges of the board until the core hardens and produces a taper on the face side of the board. Beveled edge board is made by making three score grooves on each edge of the paper and then forming each edge one half perpendicular and the other half at a 45° angle.

Three-eights and 1/2" board are bundled two pieces to the bundle. One-quarter inch board is usually bundled three pieces to the bundle, but has two pieces to the bundle for some markets.

(d) Insulating Bestwall wallboard is made by laminating thin aluminum foil to the back of regular gypsum wallboard.

(e) Bestwall Wood Grain Board is made by laminating wood grain (printed) paper to the face of regular gypsum wallboard.

(f) Firestop Bestwall is made in the same manner as regular Bestwall except that special ingredients (textile glass fiber and raw vermiculite unexpanded) are added to the core in carefully controlled amounts so that Firestop Bestwall lends increased fire resistance to constructions in which it is used. This product is manufactured under Bestwall Gypsum Company's Patent Nos. 2,681,863 and 2,744,022. It is made in 1/2" and 5/8" thickness.

(g) Firestop gypsum backer is 5/8" thick and is made in the same manner as Firestop Bestwall except that it is 24" wide and has tongue and groove edges.

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(h) Bestwall Fireproof Gypsum sheathing is 1/2" thick and 24" wide and is made with treated and untreated core. It is made in the same manner as gypsum wallboard except that 3 grooves are cut along each edge of the face paper, and then one edge is formed into a tongue and the other into a groove. Treated core sheathing differes from untreated core sheathing in that wax and asphalt emulsion are added to the core ingredients to impart water resistance to the core. The paper is also treated to give it water-repellent properties so that when exposed to rain, moisture, etc., it does not wet easily. Treated core sheathing is manufactured under patent No. 2,681,863 and licensed under patent Nos. 2,198,776; 2,432,963; 2,464,759; and 2,526,537. The cover papers on gypsum sheathing are colored black.

(i) Bestwall gypsum formboard is made 1/2" thick and 32" wide for use as a support for poured-in-place gypsum roof decks. Both cover papers on formboard are heavy and strong to lend strength and rigidity during pouring of the gypsum fibered concrete. The face paper is treated in manufacture with a fungicide so that mold growth will not occur during the relatively long drying period required for poured-in-place decks. The back paper has a soft absorbent face liner to promote good adhesion between it and the gypsum concrete. The formboard then acts as the tension member of the roof deck which insures high strength.

(j) Laminated Constructions:

Panels for Bestwall Hummer "C" studless walls are made in some gypsum plants and come in the following sizes:

(a) 16" wide rounded edge laminated panel, 1-1/8" thick and 8 ft. long.

(b) 24" wide beveled edge laminated panel, 1-1/8" thick and 8 ft. long.

The round-edge panels have a lath-type edge. Both rounded edge and beveled edge panels are made with ivory paper on the face side. Each panel consists of two full sheets of 3/8" board either 16" or 24" wide. These two sheets are laminated at the plant with a water-resistant-type glue. The edge of one sheet overhangs the edge of the second sheet 1" in a ship lap relationship. Strip (rib) of 3/8" x 4" wide gypsum board is then laminated along each edge of the two-ply panel. These strips are so arranged as to form tongue and groove edges on each side of the panel. The panels are erected in pairs back-to-back by means of No. 16 - 1-1/2" Phillips type flat-head wood screws, producing a finished panel 2-1/4" thick. Full details of this construction are found in a booklet entitled Bestwall Hummer Systems of Laminated Gypsum Wallboard Constructions (Form No. 5531).

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Chapter III

Joint System Products

All Bestwall Joint System products are made at the Acme, Texas plant in specially designed equipment just for this purpose.

All raw materials are purchased on rigid specifications and are carefully tested by the plant laboratory before use. Those not up to standard are rejected.

All ingredients are weighed accurately and then blended together in a batch mixer to a uniform mixture. The blended products are passed through a disintegrator which effectively disperses all ingredients to a lump-free mixture. They are then processed through a second mixer to be certain that an absolutely uniform mixture results. Then they are packaged into various containers on an automatic packaging machine. All joint system products are compounded to have low alkalinity and will not burn subsequent applications of paint or other decoration. Every batch is tested in the plant laboratory to be certain that it meets specifications.

Various products compounded are as follows:

A. Bedding Compound is a light gray colored material carefully compounded to provide maximum adhesion to the joints. It spreads smoothly and easily and has low shrinkage.

B. Topping Compound is ivory colored to match the ivory paper on Bestwall gypsum board. It is compounded for covering the taped joints and for spotting nail heads, and has very low shrinkage. It spreads smoothly and easily and can be sheared to form perfect feathered edges. It resists loss of water by suction and can be feathered to perfect edges without roughening up due to loss of water.

C. Joint System Cement is ivory colored to match the ivory paper Bestwall gypsum board. It is designed to be used to stick the tape to the joints and to cover the joints and spot the nail heads. It spreads smoothly and easily and can be sheared to feather edges without roughening up. It has low shrinkage, but not quite as low as topping compound.

D. All-Purpose Joint Cement is colored to an off-white shade. It is a low cost product designed to be used for for bedding, topping, and texturing. Since an all-purpose product such as this cannot have all of the desirable properties of a bedding compound, a topping compound and a texture paint, this product is compounded as a compromise on all three. This product is not available in all markets.

E. Certex Texture is compounded with carefully selected special ingredients to give clean, sharp textures. It contains special water retention agents which permit formation of uniform textures of fine design when required.

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F. Laminating Compound is a casein base designed for laminating gypsum board. It is not to be used for bedding tape or other finished board work.

G. Spakling Compound is compounded from molding plaster and other carefully selected ingredients to give it smooth working properties. It is designed primarily as a painter's plaster for repairing fine cracks and small blemishes. It has a long wet-mixed life and normally does not set by hydraulic action, but hardens when dried due to the presence of cementitious ingredients.

H. Patching Plaster is a specially compounded plaster made from molding plaster and other carefully proportioned ingredients. It is designed for the repair of larger areas than spackling compound. It has a short wet life, about 20 to 30 minutes, and sets hydraulically to form hard, strong patches. It may, of course, be used for the repair of small cracks and blemishes, but is not as good for this purpose as Spackling Compound.

Building Products

Plastering Machines

In order to obtain maximum efficiency and economy when applying plaster with a machine, it is necessary to plan the job and to know what corrective measures to take when the machine is not functioning properly. Following are suggestions for efficient application of plaster with a machine. Most machines pump the plaster by one of two means; either a Moyno pump or cylinder pump. The information below is applicable to both except when noted.

Mixers for use with Plastering Machines

1. It is very important that the mixer be kept clean. If set plaster builds up on the blades and falls off it will clog the spray nozzle.

2. The mixer should be large enough to keep the plastering machine supplied. If spraying as much as two cubic feet of mortar per minute a 6 cubic foot mixer will be necessary. This will allow three minutes for mixing each batch.

3. A mixer with rubber blades that wipe the drum clean is preferable. While the initial cost is more, the savings in prevention of build-up of set plaster resulting in clogged nozzle can easily pay for the difference in a short time.

4. Mixer should run at 35 to 40 revolutions per minute in order to obtain thorough mixing in a short period of time. If mixer is of ample capacity to keep up with the plastering machine and still do a good mixing job at a slower speed, 25 to 30 rpm is satisfactory.

Mixing Plaster for Use in Machine

In mixing mortar for machine application it is very important that it be lump free to prevent clogging the nozzle.

1. Add water to mixer using slightly less than the total amount required.

2. Add plaster and allow to mix until lump free.

3. Slowly add aggregate.

4. Add additional water to obtain proper consistency.

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Consistency of Mortar

Contol of consistency within fairly close limits is necessary for best results. It should be stiff enough that it will not sag on the wall and be difficult to darby, yet it must not be too stiff. Too stiff mix results in high pressure which in some cases means reduced capacity and in the case of Moyno Pump machines causes excessive

Consistency of Mortar (Cont'd.)

maintenance due to wear on rotor and stator. Consistency for most machines should be slightly softer than the consistency used for hand application. One company states that in 80% of the cases where best results were not obtained with their machine (Moyno Pump type), too stiff a mix was being used.

Plaster for Machine Application

At each of our plants we have special formulas for machine (gun) application plaste In some areas it is referred to as gun application while in others it is machine application. At each plant it is available either glass fibered or unfibered. Bestwall glass fibered machine (gun) plaster works well in all types machines while other fibers, used by competition, continually cause trouble due to balling up and clogging the nozzle. In many instances where an architect has specified fiber plaster and plaster was to be machine applied, only Bestwall was considered because it was the fibered plaster which could be applied without trouble and machine delay Generally plasters for machine application have low water carrying capacity, contai an air entraining agent to reduce hose pressure and have moderate or medium plastic These plasters are suitable for hand application, but usually are not quite as rich working as regular hand application formulas.

Aggregates

All above information refers to neat plaster. Very little Lite-Mix is sold for machine application. However, in one or two instances where Lite-Mix was used we did furnish a special formula. Generally the perlite necessary for a good ready mi plaster for hand application is considered too abrasive for machine application and results in more pump wear. This is true of competition's ready mixed plaster as well as our Lite-Mix. As a result a softer, less abrasive perlite is generally purchased and mixing is done on the job. Pump wear due to abrasive perlite is more of a problem with Moyno Pump machines than with Cylinder type machines.

Plaster mortar containing perlite aggregate usually comes out of the nozzle at very near the same consistency as when dumped in the hopper of the machine.

Vermiculite mortar stiffens considerably while going through a machine, hence a softer mix (thinner consistency) must be used to get the desired consistency out of the nozzle. Generally vermiculite plaster mortar pumps good in all type machines provided proper proportions are used, consistency is right and a good machine application plaster is used.

Sand mortar also comes out of a machine at about the same consistency as when put in the machine. Sand should be a good grade of plastering sand and must not contai any large particles which will not pass through the nozzle. Use of excessive sand aggregate will result in the sand settling out and it will not pump. Generally, the proportions of all aggregates recommended for hand application are satisfactory for machine application. Better results and less machine wear are usually obtained with sand-plaster mortars when used in the cylinder type machines. However, sanded mortars can be pumped through the Moyno Pump machines.

Factors Affecting Hose Pressure

Using a plaster especially formulated for machine application and maintaining proper mortar consistency are necessary to keep hose pressure at a minimum, but there are also several other important factors.

1. Hose length - Pressure varies nearly directly with length of hose used. A pump (cylinder or Moyno) will develop approximately twice as much pressure with a 60' hose as it will with 30' of the same hose.

2. Hose size - Diameter of hose is definitely a factor. If pressure for 60' of 2" hose is 90 psi, pressure required for 60' of 1½" hose would be about 165 psi.

3. Effect of height - In addition to pressure developed with an length of hose, about one-half pound per sq. inch must be added for every foot the plaster is elevated. For example, if the machine is on the ground and the hose is run up to second floor, which is 30' above ground, there will be an extra 15 psi hose pressure..

4. Proportion of Aggregate - A rich mix (2 to 1) will usually result in more pressure than a leaner mix (3 to 1). The richer mix will usually have to be slightly thinner than the lean one in order to get same capacity from the machine.

5. Mortars containing vermiculite aggregate normally pump with considerably less pressure than those containing either perlite or sand.

Remember, high hose pressure results in lower capacity and more machine wear. Bestwall gun plasters are formulated to pump with as low pressure as possible and at the same time work good under the tools after being sprayed on the wall or ceiling.

Spraying Acoustical Plaster

Bestwall Light Acoustical plaster was formulated especially for machine application. It works well in all type machines. Hose pressure is not normally a problem with this type plaster as it pumps easily with a low pressure.

The Nozzle

The nozzle of all plaster machines are basically the same. The mortar goes through an orifice, most have several interchangeable orifices varying in diameter from 1/4" to 5/8". Compressed air is fed to the nozzle. The amount of air, consistency and type of mix, volume of mix and size of orifice determine the spray pattern. The nozzle operates by emitting a globule of mortar, then air, then mortar. Low frequency of the cycle results in large globules of mortar while high frequency results in very small globules.

To lower frequency:
(1) Use lower air pressure
(2) Use larger orifice
(3) If air stem is adjustable, use greater distance from air stem to orifice.

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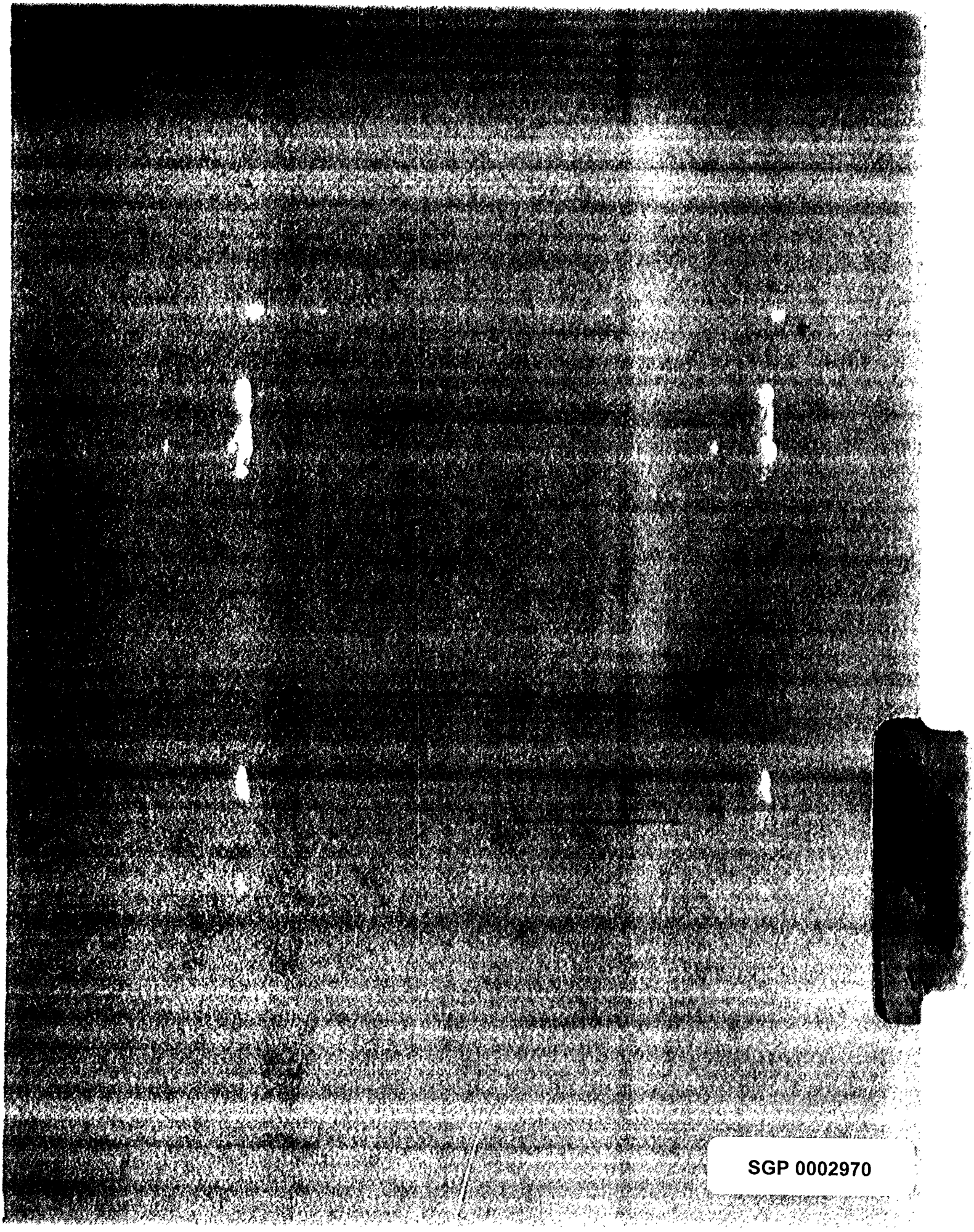
To increase frequency, resulting in finer spray pattern, reverse above procedure.

PLASTERING MACHINES

What To Do When Trouble Occurs With Machine Application

Trouble	Cause or Remedy
Plaster volume is too low	Too much hose being used or pump w.
Nozzle clogged with lumps	Buildup of fibers, set plaster or foreign matters.
Plaster rebounds from wall in operator's face	Lower air pressure. If spray patter is lost use larger orfice.
Hose pressure too high	Mix too stiff, hose too long or small diameter, fittings clogged or aggregate being used requires too high pressure to pump.
Plaster comes out in stream when browning	Increase air pressure. If this does not remedy trouble, use smaller orifice, or use thinner consistency mortar.
Nozzle spray too narrow	The air pressure is too low or orifice too large for plaster volume.
Aggregate tends to separate out	Using too much aggregate. Happens more frequently when using sand aggregate.
Plaster slumps on wall	Usually due either to too thin a mix or too much aggregate.



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