TECHNICAL INFORMATION ON BUILDING MATERIALS

TIBM - 27

FOR USE IN THE DESIGN OF LOW-COST HOUSING

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THE NATIONAL BUREAU OF STANDARDS
UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

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THE HARDENED WALL PLASTER

This is the third in a series of three sections of a digest of Circular C151, "Wall Plaster: Its Ingredients, Preparation and Properties", (January 9, 1924),[1] issued by the Bureau of Standards, dealing with the physical properties and defects of hardened plaster.

Properties

Fire Resistance: The fire resistance of plaster or plastered constructions is of importance chiefly where used in segregating portions of buildings, such as attached garages for dwellings. Plaster is of value as a fire resistive material only so long as it remains in place. The use of lime plaster is limited in this respect because it generally falls off on the side of the partition which is exposed to fire. In plastering to resist fire, the backing or plaster base is also important.

Acoustics: The transmission of sound through a wall depends not only upon the plastering, but also on the entire construction of the wall. Other things being equal, less sound will be transmitted by a heavy wall than by a lighter one. Of two walls of equal weight, the thicker will transmit less sound. In figuring either weight or thickness, the plastering should be included as part of the wall. A hollow wall, except for the bridging, is more effective than a solid wall in preventing transmission, provided the air space is introduced without sacrificing either weight or thickness of the solid material. The acoustical properties of a wall (or ceiling) are more complex than described above, but the subject is too broad to be covered in this digest.

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[1] Available from Superintendent of Documents, Washington, D. C. (Price 10 cents).

Volume Change: Plaster responds to changing atmospheric conditions by expansion or contraction, even after it has hardened. These "movements" of plaster are generally slight and not injurious unless cumulative. Extreme expansion will cause the plaster to bulge and finally to break away from the backing. Contraction may cause cracks in the plaster, resulting in separation of the coats.

Hardness: Wall plaster is frequently obliged to resist impact or abrasion. Its hardness may be considered from the standpoint of its ability to resist such forces. Resistance to impact is a function of the complete wall rather than that of the surface only. Resistance to abrasion may be considered as a function of the surface finish. Any of the usual cementitious materials should harden to a satisfactory degree, provided they are sufficiently compacted by troweling, and that atmospheric conditions do not interfere with their hardening.

Resistance to Water: The leakage of water, usually resulting from defective plumbing or flashing, is a kind of abuse to which plaster is frequently exposed. If the wood lath was not thoroughly saturated when plaster was applied, it may become so because of the leak, which will cause it to swell beyond its original dimensions and break the keys of the plaster.

Water standing in contact with metal lath may cause corrosion, particularly if stray electric currents are also present. This effect may be minimized by using painted or galvanized lath, and by using plaster of such a nature that the water forms an alkaline solution. This is the case with portland cement or lime plaster, and with gypsum plaster containing lime. Better protection is afforded if such lath is completely embedded in the plaster.

Continued seepage of water through plaster may cause failure due to the solution and disintegration of the cementitious material, or local expansion. Gypsum is somewhat soluble under these circumstances, while carbonated lime is little affected, and portland cement is improved by water. Water issuing from a leak usually saturates the plaster over a limited area only. The plaster within the area tends to expand, but is confined by the dry plaster surrounding it with the result that the wet plaster bulges out, cracks, and falls off.

Where continuously damp conditions are anticipated, portland cement plaster should be used.

Decorative Finishes: Whether the plaster is decorative of itself, or whether it acts merely as a base for the decorative paint or paper, its most important function is that of giving a pleasing appearance to the room.

Three-coat plaster should ordinarily be used where a smooth white finish is desired.

A sand float finish may be obtained with a two-coat plaster job, omitting the white finish coat. A wall finished in this way may be made structurally sound and is considerably cheaper than three-coat plaster. A large variety of finishes may be obtained with the use of various wood and steel floats, exposing such aggregates as colored sand, and mineral pigments, but care must be taken to select proper materials and use exact proportions. The use of textured finishes for a variety of decorative treatments has recently become a popular practice.

Painting:[1] Painting or papering a wall is the most general type of wall decoration, but certain conditions restrict and govern their use. Plaster which is in immediate contact with an exterior masonry wall should not be painted with an oil paint, as there is a strong probability that moisture will find its way through the wall and into the plaster and cause the paint to peel off. When plaster is applied on lath, rather than on masonry, it is safer to use oil paint. Plaster should be thoroughly dry when painted. If painted before the reactions involved in the hardening process are reasonably complete, free lime, will be likely to saponify the linseed oil, causing the paint film to become brittle. Free lime is usually present in all green plasters, whether lime, gypsum, or cement.

Papering: One distinct advantage in papering is that minor surface cracks affecting the appearance, but not the durability of the plaster, will not show through the paper. It is advocated, however, that when walls are to be re-papered, the old paper be entirely removed and the plaster scraped and pointed. The pointing of settlement cracks is a distinct aid in prolonging the life of plaster.

Types and Causes of Defects: Aside from failures caused by fire, or leaks, or by settlement of the building, well-made plaster should give satisfactory service indefinitely. When failure does occur, however, the important thing is to ascertain the reason for such failure in order that it may be effectively repaired.

Structural Cracks: A large prominent crack, extending across the surface and through the plaster, is probably a structural crack. It is caused by movement of the structural members of the building, and is not a fault of the plaster. Although possible to construct a building sufficiently massive and rigid so that this type of crack could not occur, the more practical expedient is to let the cracks form, and after the building has "found itself", point them up.

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[1] See TIM - 18

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Map Cracks: This type is less prominent than are structural cracks. They go through the plaster, but do not extend entirely across the surface. Instead, a system of cracks, running at various angles, form more or less geometric figures over the surface. These figures are usually large and well defined, and are repeated at various places on the surface. Hence the name, map cracks. They are usually caused by a lack of uniformity in the bond between the backing and the scratch coat, and may always be taken as an indication that the bond between the plaster and the backing is not uniform.

Shrinkage Cracks: Shrinkage cracks resemble map cracks, except that both the cracks themselves and the areas which they surround are much smaller. They do not run clear through the plaster, being confined usually to the finish coat. If the finish coat is sanded, shrinkage cracks indicate that the plaster was too rich, that it was permitted to dry too quickly, or that it was not troweled enough. Shrinkage cracks in a white finish indicate that it was troweled too soon. Shrinkage cracks have little effect on any of the properties of plaster except its appearance. A gloss paint should not be used to cover such a surface, as this type of paint will cause the shrinkage cracks to stand out in high relief.

Popping: Pops are small conical holes appearing on the plaster surface. They are caused by the hydration of individual particles in the plaster. Certain compounds of lime are not acted upon readily by water, but when exposed for an extended period of time will hydrate, this hydration being accompanied by excessive expansion. Whenever particles of such materials find their way into plaster, they remain apparently inert during the mixing, application, and hardening. Sometime later the hydration begins. The expansive force pushes the particle and everything in front of it out of the wall leaving the conical hole, called a "pop". If hydrated lime is used, the responsibility of failure rests with the manufacturer; if quick-lime is used, the responsibility rests either with the manufacturer or with the contractor who did the slaking; if no lime is used, the quality of sand should be investigated.

Expansion: It has been noted that map cracking is caused by a differential movement of the plaster and the backing. This movement may cause expansion as well as contraction. The effect is entirely different, however, If the bond between the scratch coat and the backing has been broken over a small area and the plaster is expanding, as a result of rising temperature or increasing humidity, compressive stresses will be concentrated in the plaster over this area. The first effect will be to cause the plaster to bulge out from the wall. As this movement is usually quite slow, considerable bulging may take place before failure actually occurs. Should the atmospheric conditions change and the plaster begin to contract, it may return to its original condition with no apparent damage. If expansion continues, however, it will eventually break the plaster. The break will not be a clean crack such as caused by contraction, but will be more in the nature of shattering.

Softness: Plaster should be hard enough to withstand reasonable abuse, and not rub off. If the plaster is soft, too little cementitious material has been used.

Blotches and Efflorescence: Blotches are often caused by certain salts in the plaster, which are soluble and hygroscopic. As the mixing water evaporates, these salts are brought to the surface and deposited. Their hygroscopic properties cause them to absorb water from the air, thus keeping the plaster damp. Calcium chloride is typical of this kind of salt. It is readily formed by interaction between lime and common salt, and is one reason why sea water or beach sand should not be used for plastering.

If the salt is soluble but not hygroscopic, it will be deposited on the surface of the plaster as a white crystalline substance which may easily be rubbed off.

Sometimes a white finish shows mottled gray and white, the areas of each color being so small that they are discernible only on close inspection. This condition is the result of using lime and gypsum of slightly different colors, which were not mixed as thoroughly as they should have been. These spots are permanent, but in no way affect the quality of the plaster.

Peeling of Paint: The peeling or blistering of paint is almost always due to the presence of water in the plaster.[1] If this occurs, the plaster may have been painted before it was thoroughly dry, or leaky water pipes may be the cause of the moisture in the plaster which is causing the paint to peel.

Recommended Selection of Materials: The choice of materials is usually a compromise between quality and cost, both initial and maintenance. Certain constructions predetermine the type of plaster backing required, but ordinarily the purchaser is free to select the backing and other plaster materials. To serve its full purpose, plaster should be as serviceable and durable as the rest of the construction.

Plastering is classified below as four types, A, B, C, and D, determined by the purposes to be served on the basis of the ratio of quality to cost. This information may be helpful in the selection of plastering materials.

A. Plaster used in public buildings, monumental work, etc., where quality is placed above cost, and appearance and durability are paramount:

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[1] See TIPS - 18.

Exterior masonry walls should be furred with tile or heavy metal lath on metal strips. Gauged lime or gypsum plaster should be used throughout, with three coat work 7/8 inch on lath, and two coat work 5/8 inch on masonry and tile. Partitions should be of tile or heavy metal lath on metal studs. Ceiling plaster should be put on in thin coats on heavy metal lath. On concrete the aggregate should be thoroughly exposed. If the masonry ceiling is of gypsum tile, gypsum plaster should be used. If the ceiling is of clay tile, either lime or gypsum may be used.

B. Plaster used in buildings of very good construction but designed to earn a reasonable return, such as office buildings, apartments, first class industrial buildings, etc.:

Plastering for these buildings should be practically the same as for class "A" except that medium weight metal lath may be used and, in some cases, 3/8 inch plasterboard on partitions. Class "A" plastering should be used for ceilings.

C. Plaster used for buildings where economy of first cost is the chief consideration and where maintenance costs are to be minimized:

This type is used in small office buildings, apartments, some factories and dwellings, and is probably the most commonly used type. Plastering is the same as for type "A" except that light weight metal lath, No. 1 wood lath, or 3/8 inch plasterboard may be used on all walls. For ceilings, medium weight metal lath should be used unless they are of masonry, in which case type "A" plastering should be used.

D. Plaster used for buildings where minimum quality with the maximum of satisfactory service is desired:

In this type, furring is unfortunately sometimes omitted, and plastering (two coats 5/8 inch thick) is applied directly to outside masonry walls. Inside masonry walls may be finished with a single heavy coat of plaster. A 3/4 inch three-coat or 5/8 inch two-coat plaster is recommended on light weight metal or wire lath, No. 2 wood lath, or 1/4 inch gypsum board on wood furring and studs. Ceilings should be of either medium weight metal lath or 3/8 inch plasterboard on joists or furring strips spaced not over 16 inches apart on centers, with plaster similar to that used for walls.

Lime and gypsum plasters represent a large percentage of the plaster generally used because the use of portland cement plaster is limited, being more particularly adapted to places constantly subjected to moisture. Portland cement plaster is not sufficiently plastic to be economical, and for finish coats, where a white coat is necessary, white portland cement should be used.