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a technique
for erecting
block walls
without mortar
joints

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CURRENT SERIAL RECORDS

SURFACE BONDING OF CONCRETE BLOCKS



J. W. Simons and B. C. Haynes, Jr., authors of this publication, are agricultural engineers with the Agricultural Research Service, USDA. Their research is being conducted at Athens, Georgia in cooperation with the Georgia Agricultural Experiment Stations.

The work contributes to the Southern Regional Housing Project, S-66, Physical, Social, and Economic Aspects of Functional Housing for Low-Income Families.

ARS research on surface bonding began in 1967 and is being continued at the College Station, The University of Georgia College of Agriculture Experiment Stations, Athens, Georgia. So far, this technique has been limited to one story construction. Even with one story height, long walls should be cross-braced with partitions or reinforced pilasters as required in conventional block walls. Because of relatively limited testing of the new process (2 1/2 years), no guarantee can be made as to the life and durability of the surface bonding. Testing is continuing. Even if some deterioration of the glass fiber should occur due to alkaline reaction of the cement, the walls will continue to be structurally sound if tied down with rods as indicated. USDA is working with industry toward the development of a non-reactive fiber that will assure high durability and life of the bonding mix.

This publication supersedes CA 42-57, "Surface Bonding - A Technique for Erecting Concrete Block Walls Without Mortar Joints."

SURFACE BONDING OF CONCRETE BLOCKS

A Technique for Erecting Block Walls Without Mortar Joints

Surface bonding is a construction technique in which concrete blocks are stacked without mortar to form walls that are then coated on both sides with a thin layer of cement-glass fiber mixture.

A cement bond formulation was first used in 1967 by the U. S. Army Corps of Engineers at their Ohio River Laboratories, Cincinnati. Further testing by the authors with a modified formulation at Athens, Georgia and at John's Island, South Carolina has demonstrated the usefulness of the material for block bonding and waterproofing.

The surface-bonding method of erecting concrete

block walls has these advantages over the conventional method of laying block:

- No mortar is used between blocks.
- Less time is required. An unskilled laborer with some experience can readily erect a concrete block wall with surface bonding.
- Wall joints are stronger.
- Bonding mixture adequately waterproofs walls in most locations.
- Walls can be colored without painting by adding mortar color or cement color to the bonding mixture.



BN-35070

Dry stacking of concrete block walls for migrant labor quarters at John's Island, South Carolina.

MAKING THE SURFACE BONDING

Selecting the Materials

Ingredients for the bonding mixture and amount of each ingredient you will need are as follows:

- Regular Type I gray portland cement, 78 parts, for most applications. White cement, 78 parts, is used if light colored tones desired. The mix should not be applied if temperature approaching freezing is expected

during 24 hours following application. Roof construction should not be started until the following day. Regular cement (94 lbs. per sack), is less expensive than white or Type III cement and is generally used for most surface bonding applications.

- Hydrated lime (50 lbs. per sack), 15 parts, which makes the mixture more workable and easier to apply.
- Calcium chloride, 2 parts, in flake or crystal form. This reduces the initial setting time of the mixture and

makes a harder surface. It usually comes in 100 pound sacks and is available from agricultural chemical dealers or distributors handling it for ice and snow removal from roads.

- Calcium stearate, 1 part, which improves the waterproofing quality of the mixture. It is generally available from chemical distributors in 25 or 50 lb. lots. Buy only a technical bulky wettable grade.

- Glass fiber Type E, 4 parts, that is coated with organic chrome binder or silane binder, and is chopped to 1/2 inch lengths. This acts as reinforcement in the mixture. It is available from plastic- and chemical-supply distributors in 40 or 50 lb. lots. Be on the lookout for a new non-reactive fiber when it becomes available on the market.

Calcium stearate and the glass fiber are the most expensive of the ingredients per pound. But you need only a small amount for surface bonding the walls of one house.

Small premixed packages are expected on the market in the near future and will carry mixing instructions. This would permit you to purchase only the quantity needed.

Tools

Eight tools needed for surface bonding are as follows:

Small tub or wheelbarrow—a boxlike body to mix and hold the bonding mix.

Bricklayer's trowel—needed for mixing the dry ingredients and the water.

Hawk—a small board or piece of square metal with a handle attached to the bottom, for carrying the bonding mix.

Plasterer's trowel—for spreading and smoothing the bonding mix.

Garden hose with fine spraying nozzle—needed for wetting down the block wall before applying the bonding mix and for spraying water onto the bonded wall to aid in curing the mix.

Carpenter's or mason's level—needed for checking the walls to be sure they are horizontal and vertical. Use the level as each course is laid.

Chalk line—tightly-braided cotton cord for checking wall alignment.

Rubber coated gloves—to protect hands.

Mixing the Materials

The bonding mix sets rapidly and must be mixed in small quantities. This is especially true in hot weather.

If one person is plastering, prepare only about 25 pounds of bonding mix at one time. The mix will become too stiff and difficult to trowel if it sets too long.

Weights of the ingredients needed to make a 25 pound batch of the bonding mix are as follows:

Cement—19 1/2 pounds

Lime—3 3/4 pounds

Calcium chloride—1/2 pound

Calcium stearate—1/4 pound

Glass fiber—1 pound

Water—about 1 1/2 gallons

Mix all of the ingredients thoroughly except the calcium chloride. Then mix the calcium chloride with one gallon of the water.

Add the calcium-chloride-water solution slowly to the dry ingredients and thoroughly mix. Water required for 25 pounds of dry mix is about 1 1/2 gallons, but this amount should be adjusted as necessary to produce a good troweling mix. The mix should be as thin as possible to handle with a trowel. If it is too stiff it will not bond properly.

Some water can be added to the mix to keep it workable. This should not be done, however, more than 30 minutes after the first mixing; otherwise, chemical action prevents satisfactory remixing.

If premixing of the dry ingredients in batches for future use is desired, the calcium chloride should be placed in separate moisture-proof containers. Do not mix it with the other dry ingredients.

Cost of Materials

The cost of ingredients for 25 pounds of uncolored dry mix containing regular cement is about \$1.25 or five cents per pound. Twenty-five pounds should cover about 44 square feet of wall when applied to both sides.

This amounts to about three cents per square foot of wall.

White cement costs about one cent more per square foot of wall than regular cement.

BUILDING THE WALLS

Foundation

A concrete block building, like any other building, needs a good foundation laid on undisturbed or well compacted soil. The concrete foundation or floor on which the walls are to be erected must be level and smooth. This is the most important step in starting the

first course of block and in saving time in erecting the wall.

Table 1 gives lengths of surface bonded walls to help in measuring the floor or foundation. Height of walls are also included to locate course heights of window and door openings.

Table 1

CONCRETE BLOCKS FOR SURFACE BONDED WALLS

Standard 16" (15 5/8" long x 7 5/8" high) Block

No. Block	Length of Wall	No. Courses	Height of Wall
1	1' - 3 5/8"	1	7 5/8"
2	2' - 7 1/4"	2	1' - 3 1/4"
3	3' - 10 7/8"	3	1' - 10 7/8"
4	5' - 2 1/2"	4	2' - 6 1/2"
5	6' - 6 1/8"	5	3' - 2 1/8"
6	7' - 9 3/4"	6	3' - 9 3/4"
7	9' - 1 3/8"	7	4' - 5 3/8"
8	10' - 5"	8	5' - 1"
9	11' - 3 5/8"	9	5' - 8 5/8"
10	13' - 0 1/4"	10	6' - 4 1/4"
11	14' - 3 7/8"	11	6' - 11 7/8"
12	15' - 7 1/2"	12	7' - 7 1/2"
13	16' - 11 1/8"	13	8' - 3 1/8"
14	18' - 2 3/4"	14	8' - 10 3/4"
15	19' - 6 3/8"	15	9' - 6 3/8"

Laying the Blocks

The bonding mixture will hold to the surface of lightweight porous blocks better than it does to smooth blocks.

Anchor the wooden plate through the cores of the walls to the floor at not more than 8 foot intervals and on both sides of door openings. One way to do this is to set 3/8-inch bolts in the concrete footing or floor as it is being poured.



Dry stacking of concrete block walls at a self-help project in Gainesville, Florida.

BN-35075



BN-35073

Dry stacking a concrete block column to fit between a door and a window or between two windows. A narrow column such as this one needs the additional strength provided by tie-down or reinforcing rods.

Fasten a 3/8-inch steel rod, threaded at both ends, to each bolt by means of a well-pump rod connector. Make the rod long enough to extend through the wooden plate at top of wall. Secure the rod with washer and nut. This procedure not only provides wind resistance, but also makes it easier to keep the wall aligned while applying surface bonding.

Hooked rods may be set in the concrete floor and rods with hooks on one end and threaded on the other end used to tie the plate and wall to the floor. This is similar to the method just described.

Insertion of tie rods after walls are stacked eliminates the difficulty of lifting blocks over the rods. Cores could be filled with concrete or mortar if extra strength is desired at this point. One disadvantage, however, of filling block cores with concrete or mortar is that heat loss is increased through that part of wall. Blocks at sides of door openings should also be tied down or reinforced. One disadvantage of filling block cores with concrete or mortar is that heat loss is increased through that part of wall. In cold weather, condensation might occur on the inside surface.

Make a trial laying of the first course of blocks. Place the blocks as closely together as possible. Where half blocks are used, spaces between blocks may be as wide

as 1/4 inch. This width can be safely filled with the bonding mixture but the number of such cracks should be held to a minimum.

If ends of blocks are uneven, turn some blocks over so they will match better and leave smaller cracks.

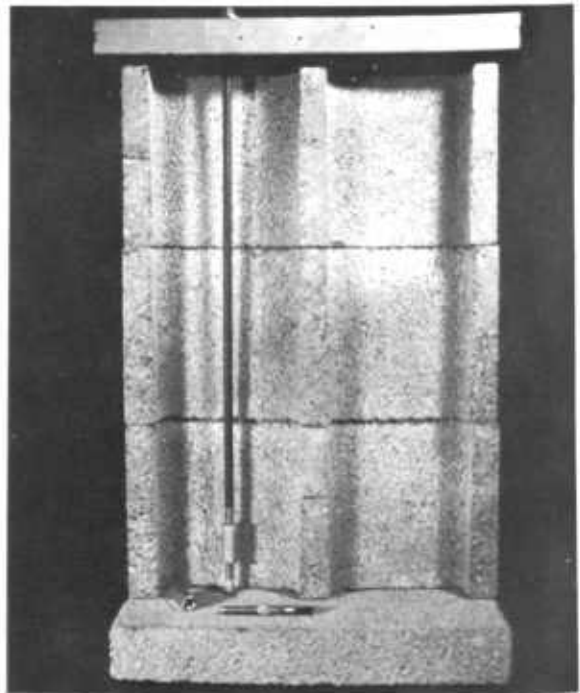
If blocks are slightly oversized and the floor or footing is too short, start laying blocks at the center of the wall and work out to the corners.

If blocks are slightly undersized or the floor is oversized, start at the corners and work toward the center of the wall. Allow a small crack between the ends of the blocks. The outside face of the blocks should be flush with outside edge of concrete floor if possible.

If the foundation or floor is level and smooth, so that mortar is not necessary to level the first course of block, the block should be set in bonding mix about 1/8 inch thick. This ties the block to the base and prevents rain from entering between the floor and wall. Place bonding mix in short sections at a time and level block accurately.

Sheet metal inserts, cut from scrap, may be placed in horizontal joints between blocks to level them or to adjust for differences in height.

Align walls occasionally. Use chalk line with corner hooks or fastened to small nails shoved into cracks between blocks at corner to align walls.



BN-35587

Concrete blocks tied down with rod, connector, and bolt in floor.

Finishing the Walls

Make window and door openings as you would in conventional concrete block construction.

For windows up to 2 feet, 8 inches in width, no reinforcing of the lintel other than surface bonding is needed. Wider openings must be reinforced with steel angles, precast concrete lintels, or lintel blocks filled with concrete and reinforced with rods.

If the lintel is made only with surface bonded block, or with reinforced lintel blocks, a temporary wood frame must be inserted to hold the block in place while the surface bonding is applied and when reinforced lintel blocks are filled with concrete. Let steel angles or precast concrete lintels extend about 8 inches beyond the jamb on each side of the opening.

Window sills can be made in several ways. Patio blocks may be used if you make a slot to hold the fins of metal windows. Cut the slot with a masonry saw blade. Two rows of concrete brick may be used if you leave a space between the rows for the window fins. Half size window blocks with slots on the upper side may also be used.

Shim up the metal window frame so that the surface bonding mix applied on the outside will slope enough to drain off rain.

The block wall should be clean and thoroughly wet by spraying or applying water with a large calcimine brush. The bonding mix will not stick if the block surface is covered with dust.

Apply the bonding mixture with a plasterer's trowel and work from a plasterer's hawk.

Trowel the bonding mixture on both sides of the wall in a thin coat—only about 1/16 inch thick. Trowel only enough to bond the mixture to the block. The finished surface should be reasonably smooth.

Too much troweling weakens the bond. Do not try to make the surface too smooth by applying heavy pressure or troweling too long.

Do not apply the bonding mixture when temperatures are 40° and falling or are above 90° F.

Twenty-five pounds of dry bonding mix, when properly prepared, should cover 40 to 50 square feet of wall on both sides. With some experience you should be able to apply the bonding mix on 50 to 75 square feet of wall on both sides per hour.

The bonding mix can be sprayed on with stucco spraying equipment. Trowel the sprayed mix before it



BN-35074

Surface bonding mix being applied to concrete block walls. Laborer applies mix with plasterer's trowel while holding a hawk.

sets to provide better bonding and help align the glass fibers more nearly parallel to the wall surface to give greater strength.

Curing the Walls

Proper curing is essential for good bonding. If the bonding mixture dries out too fast, it will crack.

After the bonding mix has set sufficiently to prevent a fine spray of water from washing it off, it should be dampened for a day or two to aid in curing. Use a hose with a fine spray nozzle or a pressure insecticide tank with a spray nozzle.

A surface bonded wall should be allowed to cure overnight or a minimum of 9 to 12 hours before any nailing is done particularly on a roof.

Fastening Objects to Walls

When fastening cabinets or other fixtures to surface bonded walls, drill holes in the wall and use expansion shields with screws. Other types of fasteners may also be used.



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Finished sleeping quarters.

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