UTILIZATION OF 'BALCRETE' FOAMING AGENT

Part IV.—Production of Lightweight Cellular Plaster Boards

S. Tehzibul Hasan

Building Materials Research Division

AND

M. Aslam and Hasan Imam

Chemical Research Division,
Central Laboratories, Pakistan Council of Scientific and Industrial Research, Karachi

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This paper describes the use of 'Balcrete' for the production of lightweight cellular plaster boards. It is possible to make these boards having a density ranging from 20 to 60 lbs. per cubic foot using 0.1-0.2 percent of 'Balcrete' by weight of plaster and with water: plaster ratio of 0.5-0.7. The flexural strength of these boards is about the same as cellulur concrete or clay bricks, but the compressive strength is comparatively less. The thermal conductivity rises sharply in the density range of 20-40 lbs. per cubic foot and gradually thereafter. Treatment of these boards with sodium silicate makes them water resistant.

Introduction

There are several processes which are used for the production of cellular plaster boards, but the general procedure for their manufacture comprises(1) mixing plaster of paris with water to form a slurry, (2) forming a foam by means of water and foaming agent in a foam cell or other mixing device and stabilising this foam by means of boiled starch which has the additional property of causing the paper liners to adhere to the plaster boards, (3) mixing the foam and plaster slurry and (4) processing the finished slurry by sandwiching between paper liners, cutting to length and drying the product. Foaming agents commonly used for the manufacture of these boards are potassium or sodium salts of a series of prepared rosins or alkyl sulphates by themselves or blended with water soluble lower aliphatic alcohols. The present investigations were undertaken with a view to use 'Balcrete',[1] a foaming agent developed at these laboratories for the manufacture of foam concrete for plaster boards by a two-step process: (1) preparatian of boards and (2) manual application of paper liners, using starch adhesives.

One of the primary conditions that a foaming agent hasto fulfil is that it should not prolong the time required for setting of the plaster. Foaming agents of the type of 'Balcrete' which are based on hydrolysed proteins have the property of retarding the setting time of plaster, but it has been found that such compositions can be satisfactorily used for manufacture of plaster boards by incorporating sodium sulphate.

Preparation of Boards

'Balcrete' and sodium sulphate were added to water in a vessel equipped with a high-speed agitator and the mixture stirred to generate the maximum foam. This took about three minutes. Plaster of paris was then gradually introduced into the foam, and the mixing continued after complete addition of the plaster, till a uniform slurry was obtained. This slurry was poured into moulds for preparation of boards.

The density of the finished product depends on several factors such as water: plaster ratio, quantity of foaming agent and sodium sulphate used. The relevant data is presented in Table 1, which shows that it is possible to make cellular plaster boards having a density, ranging from 20 to 60 pounds per cubic foot. The data shows that boards having a density range of 20-25 pounds per cubic foot can be made with 0.2 percent 'Balcrete' and water: plaster ratio of 0.7. The setting time can be reduced further by increasing the quantity of sodium sulphate. The boards in the density range of 30-60 pounds per cubic foot can be prepared by selecting any set of variables to get the desired density. It may be mentioned, however, that use of higher water: plaster ratio is not desirable, because the boards take a longer time to dry. It is preferable to use water: plaster ratio of 0.6, keep the quantity of foaming agent low and rely more on sodium sulphate to control the density of the final product. The influence of sodium sulphate on setting time and density is specifically shown in Table 2.

TABLE 1.—CONTROL OF DENSITY OF CELLULAR GYPSUM BOARDS.

S. No.	'Balcrete' % by weight of plaster	Water: plaster ratio	Sodium sulphate % by weight of plaster	Density lbs./cu.ft.	Setting time in minutes
1.	0.10	0.50	0.6	72	
2.	0.10	0.50	1.0	70	5-30
3.	0.10	0.60	1.0	47	
4.	0.10	0.70	1.0	45	
5.	0.15	0.60	0.6	60	
6.	0.15	0.60	1.5	43	15-45
7.	0.15	0.66	1.2	37	
8.	0.15	0.66	1.5	35	
9.	0.15	0.80	1.2	29	
10.	0.20	0.50	0.5	41	
11.	0.20	0.60	0.5	37	60-100
12.	0.20	0.70	0.5	21	

TABLE 2.—INFLUENCE OF SODIUM SULPHATE ON SETTING TIME AND DENSITY OF PRODUCT.

'Balcrete' % by weight	Water: plaster ratio	Sodium sulphate % by weight of plaster	Density lbs./cu. ft.	Setting time
0.3	0.6	nil	52	1 hr. 15 min.
0.3	0.6	0.3	43	54 min.
0.3	0.6	0.5	37	33 min.
0.15	0.6	0.6	60	16 min.
0.15	0.6	1.5	43	15 min.

Physical Properties

As the density of the cellular plaster boards is changed by varying the air content, the physical properties also undergo a change. Significant physical properties such as compressive strength, flexural strength and thermal conductivity over a wide range of densities were therefore determined. Compressive strength was measured on one-inch cubes, flexural strength on 7 × 1 cm. bars at a span of 3.92 cm. and thermal conductivity by the method described by Chotani *et al.*[2] The test results are shown in Figs. 1(a, 1b and c) which

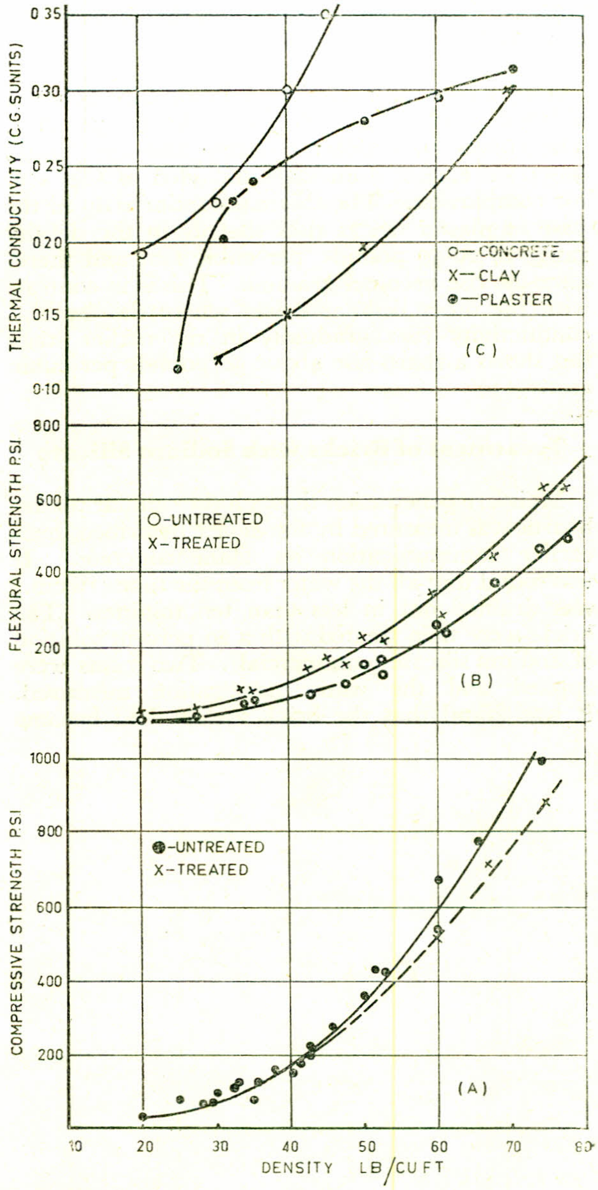

Fig. 1. (A, B and C)—Showing relationship between density and (A) Compressive strength, (B) Flexural strength and (C) Thermal conductivity.

show the variation of these values with density of boards.

The compressive strength of these boards is considerably lower than cellular concrete and clay bricks; for example, in the density range of 20-40 pounds per cubic foot, this value is 20-180 psi as against 80-550 for neat cement cellular concrete[3] and 150-700 for clay bricks.[4] The flexural strength in the density range of 30-40 pounds per cubic foot is about the same as the corresponding concrete bricks, but considerably lower than the clay bricks.

The curve representing relationship between thermal conductivity versus density is peculiar. The curves for cellular concrete and clay bricks based on earlier studies are included in Fig. 1(c) for comparison. The thermal conductivity in the case of plaster bricks rises sharply in the density range of 20-40 pounds per cubic foot and thereafter the rise becomes gradual. This is in contrast with the other cellular bricks where the thermal conductivity rises gradually in the earlier stage but shows a sharp rise above 50 pounds per cubic foot.

Treatment of Bricks with Sodium Silicate

Moisture penetration through the cellular plaster boards was measured by the device described in an earlier communication on foam concrete.[5] It was found that all the water from the tube (16 cm.) was drained out in less than ten minutes. The bricks were then treated with a 20 percent solution of sodium silicate (commercial). Two coats were applied and the water penetration measured. It was found that the brick surface had become highly water-resistant, the time taken for the water level to drop by 2 cm. being about 24 hours. It was further found that sodium silicate treatment also affected the physical properties, and the results are presented in Fig. 1 (a and b). The flexural strength was considerably increased while on the other hand compressive strength was slightly reduced above the density of 40 pounds per cubic foot.

Conclusions

The present studies have shown that 'Balcrete' can be satisfactorily used for the production of cellular plaster boards over a wide range of densities. Paper liners can be applied manually with the help of starch-based adhesives. The principal advantage in the manufacture of these plaster boards is, that moulds in which the plaster is cast can be removed in about thirty minutes, whereas in the case of cellular concrete and clay bricks, this period is of the order of 24 hours. Furthermore, these bricks are known to possess good acoustic properties. Their porosity can be reduced to a minimum by treatment with sodium silicate.

References

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