TECHNICAL INFORMATION ON BUILDING MATERIALS

TIBM - 57

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.

December 3, 1937

WEATHERING PROPERTIES OF BUILDING BRICK

Freezing and thawing of saturated or partially saturated brick is the commonest cause of disintegration, dependent for its severity on the particular section of the country in which it occurs. Although other factors have an effect on the disintegration of brick, their consideration does not fall within the scope of this outline, which is based on tests conducted by J. W. McBurney.

For brick made from a specific clay or shale, molded by the same process into units of the same size and shape, there are a number of measureable properties, variation in which parallels variation in degree of burning and degree of resistance to weathering. Strength, porosity, density and color are among the properties, change in which is associated with, and dependent upon the degree of burning.

Limits of strength, porosity, color, etc., are, in general, unsuitable for specification control of weatherability, because of the differences in raw materials and methods of forming. For example, consider a clay that produced a dark red color when well-burned. A brick of salmon pink color made of such a clay would probably indicate an under-burned brick. Another clay, of differing chemical composition, may produce salmon colors in well-burned brick.

The ratio of easily filled pore space to total pore space is related to the resistance to disintegration by freezing and thawing. An example of such a ratio is Schurecht's ratio designated as C48/B5, which is the ratio of absorption by 48-hour cold-water immersion to absorption by 5-hour boiling. A modification of this ratio consists of the absorption by 24-hour cold-water immersion divided by absorption after 5-hour boiling, expressed as C24/B5. The current (1936) Tentative Specifications for Building Brick (made from clay or shale) of the American Society for Testing Materials, use the C24/B5 ratio, together with upper limits on water absorption and lower limits on compressive strength for the purpose of grading brick according to weatherability.

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METHODS USED

Comparable samples of selected bricks were subjected to a number of different methods of freezing and thawing. Among the comparisons were the effect of freezing in contact with water, compared with freezing in air; and the effect of different degrees of saturation of bricks at the time of freezing on speed and severity of disintegration.

Similar comparable samples were exposed to the action of weather by "planting" in a brick "cemetery", according to the practice followed by the Building Research Station in Watford, England. This method of exposure consists in standing bricks on end, half buried in soil. Panels of masonry also have been built and exposed, using different types of brick.

The ability of brick to withstand 51 cycles of freezing and thawing can be measured by the combination of the following factors: not less than 2500 lb/in^2 compressive strength with an absorption ratio of not more than 0.80, or a compressive strength of not less than 6000 lb/in^2 with an absorption ratio of not more than 0.85.

It was found (1) that the probability of particular bricks failing to pass 51 cycles of freezing and thawing increases with increase in C48/B5 ratio, and (2) if bricks exceeding 20 percent absorption by 5-hour boiling and less than 2500 lb/in^2 in compressive strength are eliminated, the ratio C48/B5 provides an excellent criterion for rating the residue.

Table 1 is a summary of results of exposure tests of 29 types of bricks. The grading of degree of disintegration used in the column "number of specimens" is as follows:

(a) No visible effect of weathering.

(b) An amount of dusting, chipping or spalling such that not more than one percent of the original weight of the brick is lost. In the inspection of masonry, such slight disintegration is usually recognized by noting that the brick in question is clean and bright compared with more resistant brick.

(c) Such a degree of spalling or structural cracking that the brick would be objectionable in masonry either on account of its appearance or on account of structural weakness. In general, a three percent loss in weight is taken as separating this grade from the next.

(d) The brick is unusable. The loss in weight exceeds three percent. Breaking of the brick into two or more pieces rates "d".

If the rule of rejecting all samples containing individual bricks with C24/B5 ratios above 0.80 and with water absorption by 5-hour boiling above 20 percent and with flat compressive strength below 2500 lb/in^2 be applied, all samples remaining except No. 28 rate "a". No 28 is a de-aired brick concerning which there is evidence that the "true" C24/35 ratio cannot be measured by the methods now employed.

Eighteen of the 29 types of bricks described in Table 1 were used in the construction of a series of small panels. The following conclusions are tentatively presented: (a) partial protection of panels (capping) reduces the degree of disintegration in comparison with unprotected panels; (b) less disintegration results from exposing a brick in the face of a panel than results from exposing a brick in the "cemetery" test for an equal interval of time. If the "cemetery" exposure test is reclassified into two grades, "no disintegration" and "slight to complete disintegration" there is excellent correlation between the results of the panel exposure test and the "cemetery" test.

It is recommended that when brick made in a certain neighborhood are to be used locally, the behavior of comparable brick in buildings at least thirty years old should be noted. Special attention should be given to the condition of foundation courses and parapets.

TABLE I

DATA ON BRICKS USED IN CEMETERY EXPOSURE TESTS
ARRANGED IN DESCENDING ORDER OF C24/B5 RATIOS.

CONSTRUCTION COMPLETED NOVEMBER 1, 1936
INSPECTION MADE MAY 22, 1937

NO.	DESCRIPTION[1] AND LOCALITY	C24/B5 RATIOS AVG.	MAX.	MIN.	AVERAGE COMPRESSIVE STRENGTH	AVERAGE WATER ABSORPTION, 24-HR COLD	NUMBER OF SPECIMENS DEGREE OF DISINTEGRATION[2] A	B	C	D	TOTAL
					LB/IN^2	PERCENT					
1	SM,C SALMON, HUDSON VALLEY	.900	.960	.850	2890	20.4	8	14	3	0	25
2	SC,C COMMON, WISCONSIN	.898	.920	.850	2180	31.1	5	16	0	4	25
3	DP,S COMMON, TEXAS	.887	.900	.875	7405	12.7	20	5	0	0	25
4	SC,C SALMON, BALTIMORE, MD.[3]	.876	.895	.845	6815	11.8	0	8	7	5	20
5	SC,S DE-AIRED, CENTRAL PENN.[4]	.865	.900	.835	6100	9.6	24	1	0	0	25
6	SM,C COMMON, DETROIT, MICH.	.859	.895	.820	3640	20.2	19	4	2	0	25
7	DP,C SALMON, D. C.[5]	.855	.875	.840	3000	15.9	20	0	0	0	20
8	SC,C LIGHT HARD, W. VA.[6]	.852	.885	.820	6010	11.6	25[7]	0	0	0	25
9	EC,C SALMON, EASTERN MD.	.844	.880	.815	2825	14.7	2	4	1	13	20
10	SM,C LIGHT HARD, NEW ENG.	.842	.900	.795	4450	15.5	15	10	0	0	25
11	SM,C LIGHT HARD, NEW ENG.	.842	.925	.735	8020	14.3	25	0	0	0	25
12	SC,S SALMON, WESTERN MD.	.829	.855	.800	1620	15.4	0	1	2	17	20
13	SM,C HARD, HUDSON VALLEY	.828	.920	.755	3725	17.4	24	1	0	0	25
14	SC,C SALMON, BALTIMORE, MD.[3]	.820	.905	.630	7095	9.9	13	6	4	1	24
15	DP,C COMMON, TEXAS	.807	.910	.720	3550	26.8	21	4	0	0	25
16	DP,C COMMON, D. C.[5]	.801	.855	.745	3990	12.0	24	1	0	0	25
17	SM,C SALMON, BALTIMORE, MD.	.751	.810	.670	1880	17.3	9	1	1	9	20
18	SM,C COMMON, CENTRAL PENN.	.729	.765	.645	5370	12.6	25	0	0	0	25
19	EC,C COMMON, CHICAGO, ILL.	.728	.870	.555	2500	11.6	17	5	3	0	25
20	SC,C HARD, D. C.	.707	.775	.515	3990	8.7	25	0	0	0	25
21	SAND-LIME, PHILA., PENN.	.703	.735	.675	3495	13.3	25	0	0	0	25
22	EC,C STRAIGHT HARD, PHILA., PA.	.698	.740	.665	6070	11.5	25	0	0	0	25
23	SM,C SALMON, S.E. PENN.[8]	.675	.710	.630	1285	16.2	25	0	0	0	25
24	SC,S FACE, ST. PAUL, MINN.[9]	.644	.830	.405	5220	10.5	20	0	0	0	20
25	SM,C HARD, NEW ENG.	.639	.830	.070	13020	5.8	25	0	0	0	25
26	SM,C HARD, NEW ENG.	.614	.755	.535	11675	4.4	25	0	0	0	25
27	SC,S HARD, W. VA.[6]	.548	.625	.400	13410	2.4	25	0	0	0	25
28	SC,S DE-AIRED, IOWA[4]	.509	.965	.155	12460	3.2	21	3	0	1	25
29	SC,FC FACE, WESTERN PENN.	.338	.370	.250	15400	0.8	25	0	0	0	25[10]

[1] SM – SOFT MUD DP – DRY PRESS SC – SIDE CUT
EC – END CUT C – CLAY S – SHALE FC – FIRE CLAY

[2] (A) NONE, (B) SLIGHT, (C) PARTIAL, (D) COMPLETE.

[3] NOS. 4 AND 14 CORRESPOND EXCEPT FOR DEGREE OF FIRING.

[4] IT IS QUESTIONABLE WHETHER C24/B5 RATIOS FOR DE-AIRED BRICKS OF THIS DEGREE OF BURNING ARE CORRECT.

[5] NOS. 7 AND 16 CORRESPOND EXCEPT FOR DEGREE OF FIRING. A DIFFERENT TYPE OF EXPOSURE CAUSED A CORRESPONDING SAMPLE TO RATE "D".

[6] NOS. 8 AND 27 CORRESPOND EXCEPT FOR DEGREE OF FIRING.

[7] QUESTIONABLE WHETHER RATING SHOULD BE "A" OR "B". THERE IS A SLIGHT CHIPPING ON EDGES OF ALL SPECIMENS.

[8] NOTE THE LOW COMPRESSIVE STRENGTH.

[9] NOT TYPICAL SHALE. A MIXTURE OF SPECIALLY TREATED FACE BRICK.

[10] CRAZING ON EXPOSED ENDS OF A NUMBER OF SPECIMENS.