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Discussion of Paper, "INITIAL RATE OF ABSORPTION OF CLAY BRICK"

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The discussion is authored by
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1. INTRODUCTION

IRA is considered significant to mortar bonding, but scant attention has been given to the variation of IRA within brick prior to this work by Bailey et al. Instead, emphasis has been placed on average values obtained from a designated sample. Mortar bonds to individual units and not to an average. An acceptable average may include individual brick with unacceptably high or low values and thus produce a segment of poor bonding within a structure.

Test results from our laboratories confirm the results of Bailey et al. In addition, other sources of IRA variation have been examined and these may make an appropriate addendum to assist in interpretation of IRA data.

2. SOURCE OF SIDE TO SIDE VARIATION

The major sources of bed surface to bed surface variation are the kiln setting pattern, fuel, and firing schedule. Molding practice is an added source for molded brick.

Two brick may be pushed together with their bed surfaces forming an interface and leaving the opposite faces exposed to the kiln atmosphere. The heating exposure will differ between interface and exposed faces and produce a difference in porosity and IRA. The slower the heating rate, the lower the difference.

Solid fuels may increase the difference because of less uniform heating and localized atmospheres. Flashing may be applied to produce desired colors. It also produces greater fusion and thus lowers the porosity of the brick. The joined interface may be shielded from the time limited flashing environment and thus increase IRA difference. This difference can be observed end to end in a brick as well as bed surface to bed surface. The IRA difference from these sources is usually minimal, but will change from kiln to kiln. It is possible to find brick which will show a high IRA difference particularly in flashed brick but the population of these samples is small.

3. VARIATION BRICK TO BRICK

The change in IRA from one brick to another probably is more significant than the side-to-side variation. This is illustrated in Table 1. Two samples of five brick each and one sample of ten brick were obtained from a single shipment. Notice that the individual brick IRA spread from 14.9 to 39.4. A mortar compatible with the 14.9 brick will produce a leaky wall when a few 39.4 IRA brick are included even though the average may be acceptable.

Comparing averages of the three samples showed a change of 28 to 21 grams or a larger change than the side-to-side variation for most extruded brick of the Bailey et al report. It would appear that the testing of one side is adequate for indicating the spread of IRA values for extruded brick; however, neither ASTM C-64 or C-67 specify the number of brick to be tested and useful information depends on an adequate sample size and sampling procedure. Furthermore it is suggested that the spread between maximum and minimum IRA is as significant as the level of IRA in predicting the quality of mortar bonding.

4. TEST PROCEDURE

The same brick were sequentially tested by three different laboratories with results identified by individual brick numbers. The results of Table 1 show the maximum of 3 grams difference between mean values from the different laboratories. Individual values differed by as much as 5.4 grams. The laboratories used room dried specimens (labeled 'as received'). The time intervals between testing are indicated by the dates of testing listed in Table 2. Laboratory A repeated the measurement but this time drying the specimen as instructed by C-67. This increased the difference in IRA from the original measurement. Then laboratory A repeated the 'as received' measurement and found still higher differences. The results in Table 2 show differences as high as 9.3 grams with mean values for the three samples of 6.5, 4.6, and 5.8.

A comparison of dried with 'as received' brick was made by laboratory A for the test made one after the other. This showed a difference of less than 4 grams for all specimens and suggests minimal differences between the two procedures. However, mortar bonding of brick depends on the remnant IRA at the time of mortar application. Any moisture pickup at the job site will influence this IRA and so IRA should be determined on brick as conditioned for laying in order to predict mortar bonding.

5. INFLUENCE OF REPEATED RUNS

It was noticed that each successive laboratory determination produced progressively lower IRAs. There were three exceptions to this trend among the twenty brick tested by laboratory B and one for laboratory C. It was suspected that the brick were changing rather than laboratory identity causing the change. Laboratory A continued the repetition of measurements for three additional weekly trials. A comparison of the seventh run with the original run shows a marked change in IRA. The mean difference of the three samples was 12.0, 9.3, and 10.4. This amounted to a 50% reduction in IRA for many of the samples. Bailey et al showed a similar trend in their Table 5. Twelve out of 15 brick showed a progressive decrease in IRA with the third test versus the first test.

The reason for the change is not known. One possibility may be attributed to the presence of soluble salts. There are small quantities of soluble salts in brick usually in the amount between 0.01 and 0.07%. Also there are soluble salts in municipal water supplies and distilled water is not specified for the IRA tests, although it was used in this series. Repeated solution and evaporation may concentrate the salts in the surface pores and reduce IRA. Another possibility centers on the unusually strong attraction for water by the smallest pores. The water may not be removed by room temperature conditioning in a seven day period. The residue of water would reduce the apparent IRA of the brick. The results suggest that IRA changes with repeated wetting and aging.

6. SURFACE TEXTURE

The exposed faces of extruded brick may be decorated with sand coatings or may be textured. The coatings or textures may cause pronounced changes in IRA. The influence of sand coating on a commercial machine molded brick was evaluated by determining the IRA with the coating in place and then redetermining the IRA after sawing off the coated surfaces. The IRA was 61 before and 4 after removal of the coated surfaces. A less dramatic, but still significant change, occurs in extruded brick. A coated brick may show a high IRA around the perimeter of the bed surface and low IRA over most of the interior. This gives differential bonding between a narrow band around the perimeter compared to the interior surface.

7. MOLDED BRICK

Molded brick are shaped in such a way as to encourage difference in IRA between bedding surfaces. One bed surface may be sanded while the opposite face may be struck to produce a shaggy surface. Again the other surface may be smooth. The difference in texture can produce large differences in IRA. This is shown by the work of Bailey et al Tables 3 and 4. The average difference for all molded brick was 7.7 to 8.8 between bed surfaces. This compares to a value below 3 for extruded brick. Examination of the results for machine molded brick in their Table 3 shows an average of 17.4 for the maximum differences. It would have been helpful for the authors to have listed the IRA level of the brick since a difference of 17.4 grams in a 60 gram IRA brick would be of little concern. The same difference in a 20 gram brick would be of major significance. The results do suggest that it is important to identify the IRA of both bed surfaces of molded brick.

Answer (J. H. Matthys, University of Texas at Arlington):

The authors appreciate the discussion of Mr. Lauersdorf and Professor Robinson that not only supports the findings of the authors' paper, but also contributes to the understanding of the behavior observed. Your perceptive comments supported by your data add significantly to the value of this paper for the masonry industry with respect to the IRA performance of clay brick.

TABLE I

A COMPARISON OF IRA RESEARCH
FROM LABORATORIES A, B AND C

SAMPLE	LAB A			LAB B			LAB C		
No.	x	s	v	x	s	v	x	s	v
A	25.8	5.9	23	23.9	5.7	24	22.8	4.2	18
B	28.2	7.9	28	28.2	8.3	29	25.8	7.5	29
C	20.7	4.6	22	19.7	4.2	21	17.7	4.2	24

x = Mean IRA, g/min. 194cm^2

s = Standard Deviation, g/min 194 cm^2

v = Coefficient of variation, %

TABLE 2
THE INFLUENCE OF LABORATORY SELECTION
AND REPEATED RUNS ON IRA

SAMPLE LOT	IRA* AS RCVD LAB A	DIFFERENCE IN IRA* FROM LABORATORY A AS RCVD LAB B	AS RCVD LAB C	AS RCVD REPEAT RUN LAB A	DRIED LAB A	DIFFERENCE IN IRA* AT LAB A AS RCVD FROM DRIED	7TH RUN FROM FIRST
	8/22 9/27	10/17	11/7	11/15	11/13	11/15 11/13	12/4
A	26.1	-1.7	-3.1	-7.4	-5/5	-1.9	-13.0
	16.6	-1.3	-1.1	-3.3	-3.7	-0.2	- 7.8
	26.5	-3.3	-4.6	-6.1	-4.9	-1.2	-12.3
	33.2	-1.9	-3.2	-6.4	-5.3	-1.1	-11.6
	26.7	-1.5	-3.2	-9.3	-5.4	-3.9	-15.3
MEAN	25.82	1.94	3.04	6.50	4.96	1.66	12.00
B	25.4	-2.0	-3.9	-6.3	-4.8	-1.5	-11.8
	29.1	3.7	2.3	-2.5	-0.2	-2.3	- 6.6
	29.6	-0.8	-3.2	-4.5	-3.2	-1.2	- 7.7
	17.6	-0.2	-2.1	-3.7	-2.6	-1.1	- 8.8
	39.4	-0.6	-5.4	-5.9	-3.8	-2.1	-11.4
MEAN	28.22	1.46	3.38	4.58	2.92	1.66	9.26
C	23.7	-0.7	3.3	7.0	4.9	2.1	10.2
	21.2	-2.9	3.9	7.3	4.9	1.4	10.4
	31.7	-1.6	4.7	5.1	3.8	1.3	8.6
	19.0	-1.8	2.9	4.3	4.1	0.2	9.6
	19.7	0.6	2.6	4.7	3.7	1.0	8.6
	20.0	-0.6	2.4	7.2	4.0	3.2	11.6
	21.5	-1.4	3.7	7.5	4.4	3.1	13.7
	16.9	-1.1	4.3	6.4	4.2	2.2	11.5
	14.9	1.1	1.7	3.6	2.4	1.2	7.2
	18.2	-0.6	----	4.9	4.1	0.8	12.9
MEAN	20.68	1.24	3.24	5.80	4.05	1.65	10.43

* INITIAL RATE OF ABSORPTION IN g/min/ 194 cm^2

EXTRUDED 3 HOLE BRICK FLASHED