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NATIONAL BUREAU OF STANDARDS REPORT

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Test of Precast Concrete Shower Receptors

by

James O. Bryson

Report to

Federal Housing Administration

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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Precast concrete shower receptors were tested to determine the flexural strength under a concentrated load, watertightness while under load, and the quality of the concrete. The tests were made with five different types of receptors, two of which were reinforced and the other three were plain. One of the three plain receptors contained a lightweight concrete.

The receptors were tested in duplicate and had average flexural strengths for the five different types ranging from 913 lb to 1255 lb. The reinforced receptors failed to show evidence that the reinforcement served to increase their strength. All receptors were watertight up to their maximum loads.

1. Introduction

At present there are no standard specifications for precast concrete shower receptors. In view of this, the Federal Housing Administration in a letter dated December 3, 1958, requested the National Bureau of Standards to perform tests to aid in determining the structural characteristics needed in a precast concrete shower receptor to allow its use without the added protection of a metal shower pan.

1.1 Scope

Data on the properties of the receptors were obtained by performing tests which fall into three categories. They are: a strength test of the receptors under a concentrated load, a water permeability determination during the load test, and miscellaneous tests to determine the quality of the concrete.

The concentrated load test was to represent the most severe load condition that could possibly be found in service, such as a heavy man standing in the center of a receptor supported at diagonally opposite corners. The water permeability test was to determine the point at which the receptor would cease being watertight under the applied load. Tests to determine the water absorption and the compressive strength of the concrete

fall in the miscellaneous tests category. An examination of the receptors in "as received" condition and determination of the location and type of reinforcement were also included among the miscellaneous tests.

2. Test Specimens

The precast concrete shower receptors were supplied by the Fiat Metal Manufacturing Company, Inc., of Long Island City, New York. They were 36 in. square receptors with a shoulder on the border approximately 1 1/4-in. wide and were bound with a sheet metal strip standing 4-in. high. All of the receptors received for testing were of the same model which was called "Sierra" by the manufacturer.

Five types of receptors were included in this test. The types were classified by material composition as follows:

1. Dense concrete, plain.
2. Dense concrete, reinforced.
3. Terrazzo surfacing on dense concrete base, plain.
4. Terrazzo surfacing on dense concrete base, reinforced.
5. Terrazzo surfacing on lightweight concrete base, plain.

The receptors were to be load tested at the age of 28 days and 2-in. cubes cast from the same batch of materials were to be tested to determine the compressive strength of the concrete. However, the shipping schedule followed by the manufacturer was such that the age of the receptors at the time of test varied from 27 to 31 days. Since the manufacturer did not supply cubes representing all the receptors tested, it became necessary to drill cores from the receptors to determine the compressive strength of the concrete.

4. Test Procedures

4.1 Concentrated load test

Several factors were given consideration in establishing the concentrated load test procedure. The specimens had to be supported above the lower platen of the testing machine high enough to allow observation of the underside throughout the test. The testing machine which had sufficient clearance to admit a 36- by 36-in. receptor was a 600,000 lb capacity machine which had a minimum load range of 0 - 30,000 lb. For this reason, a 5,000 lb capacity load cell was used to measure the applied load with a greater precision than could be attained with the indicator of the testing machine.

The receptors were supported on diagonally opposite corners, with the point of support at a distance 3 in. in from each corner. This provided a bearing length of 6 in. at each support. The flexural span, from center to center of the supports, was 44 7/8 in. Heavy steel frames supported the specimens approximately 30 in. above the platen of the testing machine with 3/4 in. square aluminum bearing bars set in plaster on the steel frames to serve as line reactions. Strips of leather were placed between the test specimens and the bearing bars to compensate for any uneveness along the bearing surface. The load was applied through a vertical steel pipe 5 3/4 in. in outside diameter and 1/4 in. in wall thickness. This pipe was set in plaster in the center of the specimen. The ends of the loading pipe were machined parallel to each other and perpendicular to the longitudinal axis. A 1/2 in. thick steel plate was placed on top of the loading pipe to support the load cell which made contact with the head of the testing machine.

The deflection of the specimen under load was measured with two 0.001 in. dial gages symmetrically located about the center of the span at a distance of 1 3/4 in. from the surface of the loading pipe. Figure 1 shows the over-all view of the test setup.

The load was applied to the specimens at a rate slow enough to allow dial gage readings to be made without interrupting the application of the load. The loading rate, in terms of the deflection of the specimen was 0.003 in. per min (or about 100 lb per min). Dial gage readings were made at loads of 250 lb, 500 lb and at 100 lb increments thereafter.

An exception to this was the first specimen tested (plain, dense concrete base with terrazzo surfacing) where the readings were made at 100 lb increments from zero load.

During the loading test the water permeability of the specimen was determined by filling it with water after applying a sealer at the base of the loading pipe which covered the drain opening. The load observed at the instant when the water penetrated the specimen and became visible on the underside was recorded, as was the load at first crack and the maximum load. Water did not become visible on the underside of the specimen at first crack in all cases. In all specimens but two, it became necessary to continue deflecting the specimen to permit leakage to occur, and during this process the load, having passed the maximum value, began to drop off. For this reason, the loads recorded in Table 1 as loads corresponding to the first leak are in most cases less than the loads at first crack.

4.2 Compressive strength test

Three small cores, approximately 1 in. in diameter, were drilled from each receptor after the completion of the load test to be used for determining the compressive strength of the concrete. The cores were drilled from the receptors near the shoulder where the thickness of the conrete was about 2 in., giving a height to diameter ratio of about 2. The ends of the cores were capped with a high strength gypsum plaster which was allowed to harden over night. The compressive load was applied to the cores at a rate that would cause failure within 1 to 2 minutes.

4.3 Water absorption test

Segments taken from the receptors subjected to the concentrated load test were used to determine the water absorption of the concrete. The specimens were approximately 25 sq in. in surface area with thicknesses equal to the depths of the respective receptors.

The specimens were dried in a ventilated oven at a temperature of 110° C for 72 hr after which they were cooled to room temperature and weighed. They were then submerged in a tank filled with clean tap water at room temperature and allowed to soak for 24 hr. At the end of the soaking period the specimens were taken from the tank, blotted with a damp towel and immediately weighed. The absorption is reported as a percentage of the dry weight.

4.4 Miscellaneous examinations

Upon receipt of the receptors, one of each type was visually examined for over-all general appearance and shrinkage cracks. In addition, one receptor with a terrazzo surface and one of plain concrete were stored in the laboratory and filled with water for one week. The two receptors were observed daily to detect any damp spots showing on the undersides.

Following the concentrated load test each receptor was broken up to determine: (1) the type and location of reinforcement (if any); (2) the depth of the receptor base at the shoulder and at the center; (3) the thicknesses of the materials in the composite units at the shoulder and at the center.

5. Results

The receptors were square and conformed to the specified dimensions within a very small tolerance. There were no surface defects or shrinkage cracks visible on any of the five types of receptors "as received." This was also indicated by the examination of those receptors which were permitted to hold water for one week. After one week's test, neither the terrazzo surfaced receptor nor the plain concrete receptor showed any dampness on their bottom surfaces.

The test results for the individual receptors are given in Table 1. In the concentrated load tests, the maximum loads varied from a low of 913 lb (average for the two plain dense concrete receptors) to a high of 1270 lb (average for the two plain terrazzo-dense concrete receptors). All of the receptors failed in the same manner which was characterized by a sudden drop-off of the load without warning with visible cracks appearing simultaneously. Two exceptions to this were the plain terrazzo-dense concrete receptor No. 2 and the reinforced terrazzo-dense concrete receptor No. 2. In these cases the cracks were detected just before the maximum loads were reached. In all cases the cracks first appeared in the center of the receptors at the edge of the drain and proceeded in the directions of the free corners of the specimens. The crack patterns on all the receptors were essentially the same and are illustrated by figures 2 and 3 which show the cracks in a plain (non reinforced) receptor and a reinforced receptor, respectively.

The relationship between the center deflection and the applied load for each receptor is illustrated by the curves in figure 4. Although the term center deflection is used, the points of measurements of the deflections were 4 5/8 in. from the center of the specimens. However, because of the proximity of the points at which the measurements were made to the center of the receptor, this approximation is believed to cause no serious error.

During the load tests the receptors developed leaks either at the maximum load or at some stage of loading beyond that producing the maximum load. That is, most of the receptors did not develop leaks immediately when the maximum load was reached, but only upon developing considerably larger deflections than those observed at the maximum loads. Thus, only the plain terrazzo-dense concrete receptors Nos. 1 and 2 allowed water penetration at the maximum loads, while all other receptors maintained their watertightness up to some stage of loading beyond the maximum load.

6. Discussion

An examination of the data indicates that there was no clearly defined relationship between the compressive strength of the cores removed from the receptors and the strengths of the receptors as tested. It is noted that while the compressive strengths of the cores ranged from 1990 to 6140 psi, the maximum loads supported by the receptors varied from 825 to 1375 lb.

It is believed that the sheet metal strip located around the edges of the receptors contributed greatly to the bending strength of the units. This belief is supported by the fact that the two plain receptors composed of lightweight concrete which showed relatively low compressive strengths, supported practically the same loads as the plain dense concrete receptors and the reinforced dense concrete receptors.

The failure of the reinforced receptors to support greater loads than the plain receptors might be due to the fact that the wires in the welded fabric made an angle of 45° with the direction of the flexural span, thereby reducing considerably the effectiveness of the fabric as structural reinforcement.

If we assume that the design load on the receptor is produced by an individual weighing 300 lb, then the ratios of the maximum load to the design load will be found to range from 2.8 to 4.6.

The receptors can be rated as watertight up to the maximum load. Only two receptors, the plain terrazzo-dense concrete receptors, developed leaks as soon as the maximum loads were reached. All other receptors developed leaks only upon reaching considerably larger deflections than those observed at the maximum loads.

Table 1. Properties of Shower Receptors

Description of receptors		Thickness of Slab: Location	Terrazzo topping	Concrete base	Total	Age of receptor when tested	Maximum concentrated load	Load at appearance of first crack	Load at appearance of first leak	Compressive strength of cores (avg. of 3)	Absorption 24 hr cold	Ratio of maximum load to design load **	Reinforcement
			in.	in.	in.	days	lb	lb	lb	psi	%, by weight		
Terrazzo surfacing on dense concrete base, plain	1	At center	1/2	1 1/16	1 9/16	28	1160	1160	1160	4300	6.0	3.9	None
		At shoulder	3/4	1 5/16	2 1/16								
	2	At center	1/2	1 1/4	1 3/4	30	1375	1350	1375	6140	6.6	4.6	None
		At shoulder	13/16	1 3/8	2 3/16								
Terrazzo surfacing on dense concrete base, reinforced	1	At center	1	11/16	1 11/16	28	1175	1175	800*	5130	8.8	3.9	2- by 2-in., 16- by 16-ga wire fabric, 1/2 in. from bottom surface
		At shoulder	1 3/8	5/8	2								
	2	At center	1 1/4	3/4	2	28	1270	1250	750*	4140	9.0	4.2	Same as above
		At shoulder	1 1/4	13/16	2 1/16								
Dense concrete, plain	1	At center		1 3/4	1 3/4	29	825	825	250*	5640	7.4	2.8	None
		At shoulder		2	2								
	2	At center		1 3/4	1 3/4	28	1000	1000	850*	3570	7.4	3.3	None
		At shoulder		2 1/16	2 1/16								
Dense concrete, reinforced	1	At center		1 13/16	1 13/16	28	1025	1025	425*	3850	8.6	3.4	2- by 2-in., 16- by 16-ga wire fabric, 5/8 in. from bottom surface
		At shoulder		2 3/16	2 3/16								
	2	At center		1 11/16	1 11/16	28	1000	1000	875*	4180	8.2	3.3	Same as above
		At shoulder		1 15/16	1 15/16								
Terrazzo surfacing on lightweight concrete base, plain	1	At center	1/2	1	1 1/2	27	880	880	350*	1990	10.8	2.9	None
		At shoulder	1/2	1 1/2	2								
	2	At center	1/2	1 1/16	1 9/16	31	1000	1000	350*	2130	10.6	3.3	None
		At shoulder	5/8	1 5/16	1 15/16								

* Value observed after the maximum load had been passed and the load started to drop off while the specimen continued to deflect.
** The design load is assumed to be an individual weighing 300 lb.

U. S. DEPARTMENT OF COMMERCE
Lewis L. Strauss, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

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Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

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- Office of Basic Instrumentation.
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