compound. Known weights of cement, sand, and water were used, and the volume of the mortar produced was measured; and then knowing the specific gravity of the several ingredients, the density of the resulting mortar was computed by a process not necessary to explain here. The voids in each disk are stated in the table, and ranged between 23.4 and 24.0 per cent. If the sand had not been well graded, the per cent. of voids would have been considerably greater, and also the individual voids would have been larger. A 1:2:4 concrete made of well-graded sand and stone would have only about 13 to 15 per cent. of voids.

The amount of water used in making each of the several disks is stated in the table. Knowing the percentage of alum and soap in the water and the amount of water used in mixing, it is easy to compute the amount of the precipitate in the mortar. The amount of precipitate in each disk is given in the table.

The percolation for each of several successive 24-hour periods is given in the table. The results show that the alum and soap precipitate is quite effective in decreasing the percolation. In the first series of experiments, Nos. 1 and 2, the alum and soap compound equal to 1.2 per cent. of the cement stopped a little over 76 per cent. of the percolation during the first twenty-four hours; and the corresponding results for the other series are 54 and 69 per cent., respectively. The variation in the several series is surprisingly large, but it is certain that the experiments were carefully made; and the range in the results probably indicates the effect of undetected inequalities in the materials, the proportions, and the mixing.

Somewhat similar results were obtained for each of the successive 24-hour periods. The decrease in percolation through the treated and also through the untreated disks is due to two causes, viz.: (1) The percolating water doubtless has in it some solid matter, which clogs the pores of the upper surface of the disk. However, the water employed was that in the city water mains, and was reasonably free from solids; (2) the percolating water takes up the soluble portions of the mortar from the upper part of the disk and carries them to the lower part. It is universal experience that all masonry becomes more nearly watertight after use. It is interesting to note that in this series of experiments the average percolation during the twelfth 24-hour period was only 2.6 per cent. of that during the first period.

The most interesting feature of these experiments is that the alum and soap compound equal to an average of 1.2 per cent. of the cement in a mortar containing an average of 23.7 per cent. voids, stopped 65 per cent. of the percolation; or, in other words, adding water-repelling void-filling material equal to approximately 5 per cent. of the voids reduced the percolation to one-third of that of untreated mortar. One can hardly conceive that an equal amount of a non-repelling, void-filling material would be equally effective. Apparently, then, the alum and soap compound in the concrete acts like oil on the wires of a sieve. The experiments are being continued to determine the effect of the alum and soap compound with less porous mortars.

The mixing of alum and soap in the concrete reduces its strength somewhat; but there are many situations in which strength is unimportant, or at least is less important than watertightness. The effect of the alum and soap upon the strength of the mortar varies a little with the method of storing the test samples. For example, the mean of six neat Portland cement briquettes mixed with 21 per cent. of water which contained ½ per cent. of alum and 1½ per cent. of new "Ivory" soap, when left in the moulds one day and stored in a moist chamber of six days, had a strength of 87 per cent. of that of similar briquettes made with water alone; and when left in the moulds one day and then stored six days in water had 84 per cent.; and when twice as much alum and soap were used, the strength was 83 and 71 per cent., respectively.

A Better Water-repelling Compound.

Instead of using alum and soap as above, it is better to substitute aluminum sulphate (sometimes, but improperly, called alum) for the alum. The aluminum sulphate is cheaper than alum, and only about two-thirds as much of it is required; and the compound formed is equally water-repelling. The best proportion, in round numbers, is: One part of aluminum sulphate to 3 parts of hard soap, both by weight. Aluminum sulphate equal to 1 per cent. of the water and hard soap equal to 3 per cent. of water will give a dry precipitate equal to 2.5 per cent. of the water.

As with the alum and the soap, an excess of either of these ingredients does no harm; but an excess of soap is better than an excess of aluminum sulphate, since the soap unites with any free lime in the cement and forms calcium soap, which is a better waterproofing material than the aluminum sulphate alone.

Apparently no attention, except possibly by the manufacturers of proprietary waterproof compounds, has been given to the relative effect of capillary repellent and capillary attractive compounds.

One of the best means of making mortar or concrete waterproof is to make a dense mixture, i.e., to use plenty of cement and well-graded sand and broken stone; but nevertheless there are circumstances in which it is desirable to use a waterproof wash or to make a moderately lean mixture impermeable by adding a waterproofing ingredient to the mortar or the concrete. Either pair of the above ingredients is excellent when used as a wash to make a wall waterproof, as, for example, a cistern. To use them for this purpose, make solutions of the alum or the aluminum sulphate and of the soap of the proportions stated above; and then apply one of the solutions to the wall, and when it has dried apply the other. Apply as many pairs of coatings as may be necessary, which will usually be only two or three. It is better to apply the solutions hot; and it is important that they should be well rubbed on, but it is vital that they shall not be rubbed to form a froth.

Table Showing Effect of Alum and Soap on Permeability of Cement Mortar.

Test No.	Water in per cent. of dry Mat.	Precipitate. Per cent. of cement.	Precipitate. Per cent. of voids.	Percolation, in Grams per 24 Hours. 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	10	0	23.4	945	155	94	61	51	34	30	26	18	14	14	12	....	....
2	10	1.2	23.6	224	37	21	12	10	6	5	4	2	2	2	2	12	6
.	..	...	....	......	.....	.....	.....	.....	.....	....	....	....	....	....	....	2	2
3	12	0	23.9	1,113.0	342.3	195.0	166.6	132.7	120.4	98.0	73.5	61.4	55.5	52.8	44.9	....	....
4	12	0	23.9	1,061.2	330.6	178.4	145.0	123.2	107.7	66.3	49.8	41.1	37.6	36.3	30.6	....	....
		mean		1,087.1	336.4	186.7	155.8	127.9	114.0	82.1	61.6	51.2	46.5	44.5	37.7	....	....
5	12	1.4	24.0	497.8	206.8	122.3	76.7	64.2	58.2	36.0	25.0	21.0	19.5	17.0	15.0	....	....
6	12	1.4	24.0	517.0	222.2	132.2	87.7	72.1	65.1	39.4	26.1	21.7	19.5	16.9	16.2	....	....
		mean		507.4	214.5	127.2	52.2	68.1	61.6	37.7	25.5	21.3	19.5	16.9	15.6	....	....
	12	0	23.9	1,101.1	324.0	150.9	108.4	84.8	79.2	56.6	59.1	48.9	35.5	31.0	20.2	47.3	21.5
	12	2.8	24.0	339.5	221.2	114.8	75.2	54.4	50.4	33.3	33.7	28.0	20.2	17.3	16.0	25.5	11.0
	12	2.8	24.0	333.8	213.4	113.6	74.9	52.2	47.6	31.5	32.0	25.4	18.0	16.3	14.3	22.3	10.2
		mean		336.6	217.3	114.2	75.0	53.3	49.0	32.4	32.8	26.7	19.1	16.8	15.1	23.9	10.6