ditions of water and under different exposures, reference being particularly made to frost. All tests were made in quadruplicate :—

The 1st set was submerged, after 24 hours, in water of laboratory tanks ;

The 2nd set was kept on damp boards in a closed tank for the whole period, and never allowed to dry out ;

The 3rd set was allowed to set in the laboratory, and then exposed to the severe frost and left in open air for the whole period ;

The 4th set was exposed in from 8 to 10 minutes to the severe frost, and left there for the whole period, except to take them out of the moulds when they were set or frozen.

ocular evidence that their structure was injured, and the test-pieces broke most irregularly, while the other exposures at about 0° F. gave no evidence of any injury at all. Coming to the natural cement mortar in the 5th and 6th lines, we find much different results. The first one is decisive, and is that this particular cement mortar cannot be laid in zero weather. The first set were all blown to pieces (except the cube), which surprisingly stood 1,390 lbs., while the 2nd set, although not quite blown to pieces, all showed extreme injury.

The most peculiar result is that this same cement, neat, if given a few hours to set in the temperate air, will on exposure to the frost attain a strength highest of the 4 conditions ; this is quite remarkable, that while

Mixture.	Age.	Tensile Strength.				Compressive Strength.				Dates of Exposure.	Temp. of Exposure for 3.	Temp. of Exposure for 4.	Time from Mixing till Exposure	Natural time of set	No. of tests.	Remarks.
		Water test. (1)	Damp air test. (2)	Exposure after setting. (3)	Exposure before setting. (4)	1	2	3	4							
No. 11 Portland Neat.	2 mos.	602	471	282	334					Dec. 6 to Feb. 6	+23°F.	+22°F.	30′ (3) 12′ (4)	25′	16	
1 to 1.	"	377	276	194	233	3200	1780	1600	1900	Dec. 11 to Feb 11	+5.°F.	+3½°F.	40′ (3) 8′ (4)	35′	20	
2 to 1.	"	168	150	105	111	800	720	660	440	Dec. 12 to Feb. 12	−½°F.	0°F.	40′ (3) 10′ (4)	37′	24	
3 to 1.	"	104	86	92	97	300	520	230	300	Dec 13 to Feb. 13	−5°F.	−6°F.	1°27′ (3) 10′ (4)	1° 25′	24	Nos. 3 and 4 showed irregular and injured factures.
No. 1. Natural Neat.	"	226	221	349	0	1600	1500	2300	1390	Jan. 12 to Mar. 12	+2°F.	+5°F.	4°15′ (3) 11′ (4)	4° 15′	24	No. 4 tension completely blown in fragments.
1 to 1.	"	125	229	187	44			0	800	Feb. 5 to April 5	+18°F.	+1°F.	8° 0′ (3) 10′ (4)	8° 00′	22	Some of No 4 tension and all of No. 3 compression injured.
Neat.	"	250	281	159	94	2800	2000	3300	1390	Feb. 13 to April 13	+13°F.	+5°F.	6° 0′ (3) 10′ (4)	6° 0′	24	Mixed with water at temp. 122° F.
1 to 1.	"	129	170	80	117					Feb. 14 to April 14	+9°F.	0°F.	3° 0′ (3) 8′ (4)	2° 50′	20	Mixed with water at temp. 118° F.
Neat.	1 m.	155	278	217	249					Feb. 26 to Mar. 26	+17°F.	+7½°F.	7° 0′ (3) 9′ (4)	7° 0′	20	Mixed with 2 per cent. brine.

It will be noticed that these tests were purposely made in cold snaps, so as to make the tests as severe as possible.

It would appear improbable that mortar immediately exposed to severe frost would become stronger than that allowed to set in a warm atmosphere, but the results of all the Portland cement tests, both in tension and compression (with one exception) assert it ; and also that those allowed to set in the laboratory, and then exposed continually, are the weakest of all the four conditions treated of. This would go far to dispute the advisability of covering up mortar laid in frosty weather.

The next deduction from the Portland cement tests is that laboratory tests made with briquettes submerged give higher results than can be expected in open air work, and therefore that engineers should add to this the various other degenerating contingencies, such as bad mixing, dirty sand, etc. A deduction not much evidenced in the table is that it is not safe to lay Portland cement mortar below 0° F., because the 3rd and 4th series of 3 to 1 Portland exposed at —6° F. gave the Portland cement was strongest when submerged, the natural cement was stronger in damp air and strongest in frost. Indeed, the Portland cement, in air, for 1 to 1 mixtures, was very little stronger than the 1 to 1 natural.

All of the natural cement specimens exposed to frost showed a disintegrated layer on the outside about $\frac{1}{8}$" thick ; underneath this the structure was quite sound, and doubtless much of the variations in tests is due not so much to a weakening through the whole mass as to a reduced sectional area.

The last series made with 2 per cent. brine in mild weather for 1 month (exposed at +7½° F.) showed that salt increased the strength, making them as strong as others were at 2 months, when mixed with fresh water, and also again emphasized the advantage to this natural cement of open air tests. It would seem that either hot water or salt are therefore very strengthening in their effect.

This series of experiments was carried out with a view of obtaining more information on the shearing