flow through two rabbits arranged in series. The electrodes consist of tufts of absorbent cotton saturated with solutions of strychnine sulphate and sodium chloride and placed in contact with plates of metal attached to the conducting wires. The exterior electrodes through which the current enters the first and leaves the second rabbit are saturated with sodium chloride. The interior electrodes, through which and a short wire the current passes from one rabbit to the other, are saturated with strychnine sulphate. As strychnine is a cation it moves toward the cathode. Hence strychnine ions penetrate the body of the second rabbit which soon succumbs to convulsions. But the strychnine which is in contact with the first rabbit is already at a cathode. Consequently it does not enter the body of the animal, which remains unaffected.

These methods are applicable to the human subject and make it easy to introduce definite medicinal ions. Dr. Leduc has cured facial neuralgias in which repeated surgical operations had proved ineffective by the electrolytic introduction of salicylic acid into the diseased part.

One of the most regular therapeutic effects of electrolytic treatment is its resolvent action on hardened tissues and scars. For this purpose a solution of sodium chloride is employed as a cathode. Dr. Leduc cites the case of a young soldier whom an abscess in the hand had left with complete ankylosis or immobility of the fingers. In a military hospital the patient had received without benefit various treatments, including forcible working of the joints under chloroform, and had finally been discharged as incurable. He was then treated by electrolysis. The injured hand was immersed in a bath of salt water which served as the cathode, and a current of 0.03 ampere was applied for half an hour. Two such treatments effected a complete cure. The writers have also obtained remarkable and very rapid cures in cases of stiffness of the joints caused by wounds. Electrolytic medication is still in its infancy, but it seems destined to have a great future.

In the words of Prof. Leduc: "It is difficult to imagine how absurd will appear in the future our present practice of disseminating throughout the body, in order to act upon a very small region and a coarse tissue, substances which are particularly injurious to the most delicate and important tissues, such as those of the nervous centers. It should be one of the objects of medicine to substitute local for general treatment whenever it is possible to do so. Toward the attainment of this object the electro-ionic method offers means, not presented by any other system of medication. It enables us to introduce into cells impermeable to many drugs, the entire series of ions and to obtain the specific effect of each."—From the French of Drs. P. Desfosses and A. Martinet in *La Nature*.

PREVENTION OF FREEZING IN CONCRETE BY CALCIUM CHLORIDE.

By RICHARD K. MEADE.

PROBABLY each winter finds more and more concrete work being done. The importance of protecting such work from freezing and thawing is well understood, and it is now the general practice either to heat the sand, gravel and water used in making the concrete or else to add salt to it. Heating the water and aggregate hastens the setting of the mortar and staves off the freezing, by the initial heat of the mixture, until after the concrete has hardened. In the other case the salt being dissolved by the water used in the making of the mortar, forms a brine which freezes at a lower temperature than does pure water. The first method is expensive, troublesome and in large undertakings almost an impossibility. The second method is, therefore, the one usually resorted to for preventing freezing.

Now it is a well-known fact that solutions of calcium chloride freeze at a much lower temperature than do solutions of salt of the same degree of concentration. For instance, a 20 per cent solution of salt freezes at 7 deg. F., while a 20 per cent solution of calcium chloride does not freeze until the temperature falls 8 deg. lower, or to -1 deg. F.; calcium chloride should, therefore, be much more effective than salt in preventing the freezing of cement mortar. Additions of salt to concrete have no other beneficial effect than to prevent freezing, while calcium chloride in small percentages is known to often cause unsound cement to become sound and also to render cement mortar more impervious to water.

In view of these facts, it seemed an important matter to investigate the effect which calcium chloride exercises in preventing the freezing of mortar exposed to low temperatures. At the beginning of the cold weather of the present winter, therefore, the writer undertook a series of experiments along that line, the results of which follow:

Strength.—In order to investigate fully the strength of Portland cement mortars, with and without addition of calcium chloride, when exposed to cold weather, ten sets of sand briquettes of ten briquettes each were made up as follows:

Sets.	Cement.	Sand.	Calcium Chloride, Per Cent.
2	1	2	0
1	1	2	2
1	1	2	4
1	1	2	6
2	1	3	0
1	1	3	2
1	1	3	4
1	1	3	6

The sand used was standard crushed quartz and the cement was of a standard American brand, about two weeks old and normal in every respect. It passed both the steam and boiling tests and left a residue of 4 per cent on a No. 100 test sieve. It took its initial set in 2 hours and its final set in 5 hours and 15 minutes.

The calcium chloride used was obtained from the Carbondale Chemical Company, Carbondale, Pa., and was marked Solvay Process Company's Chloride of Calcium and guaranteed by them to contain 75 per cent anhydrous salt, CaCl₂.

Of the ten sets of briquettes, two, one 1:3 mortar and one 1:2 mortar, both containing no chloride, were tested in the ordinary standard manner, by leaving them in the laboratory for 24 hours under a damp cloth and then placing them in water for the balance of the 7 and 28-day periods, this being merely the standard test to determine the strength the cement was capable of developing under standard conditions.

The other eight sets were carried out of doors as soon as made. They were placed on a porch roof, on the northwest side of a building, and exposed to whatever the elements had in store for them. The morning after they were made they were covered with snow and this was cleared away to remove its protection from the wind. The range of temperature is shown in Table 1, for the entire 28 days. The "first day" is the day that the 1:3 sand briquettes were made and taken out of doors, and the temperature given as the maximum is that to which they were first exposed. The 7-day 1:3 briquettes were broken on the eighth day and the 28-day 1:3 briquettes on the 29th day. The 1:2 sand briquettes were made and exposed on the second day and broken on the ninth day and thirtieth day, respectively.

TABLE 1.—TEMPERATURES TO WHICH BRIQUETTES WERE EXPOSED.

Day.	Max.	Min.	Day.	Max.	Min.
1st	35		18th	24	14
2d	38		19th	25	13
3d	35		20th	17	5
4th	23		21st	29	-1
5th	31		22d	27	10
6th	12	-1	23d	27	3
7th	15	-4	24th	35	20
8th	26	8	25th	29	25
9th	25	22	26th	28	12
10th	18	6	27th	39	23
11th	23	8	28th	38	13
12th	30	5	29th	47	30
13th	34	22	30th	44	15
14th	23	5	31st	28	13
15th	38	12	32d	26	13
16th	43	30	33d	21	8
17th	23	17	34th	26	16

The 7-day 1:3 briquettes were exposed to temperatures as shown between the first and eighth days, and the 28-day 1:3 briquettes to the temperatures indicated between the first and twenty-ninth days, etc.

It will be seen that the effect of the addition of 2 per cent of calcium chloride was to make the cement mortar exposed to the cold as strong as that kept in a warm room, 60 deg. to 70 deg. F. This is no doubt due to the fact that calcium chloride prevents the freezing of water to which it is added and so, when it is mixed with the cement it is taken up by the water used to gage the mortar, preventing the freezing of this water and consequently allowing the processes of solution and crystallization, which constitute the hardening of cement mortar, to go on without hindrance by the freezing of the water.

The power which calcium chloride can exert to prevent the freezing of mortar may be understood from the following explanation. About 10 to 15 per cent of water is used in making concrete. If all the calcium chloride dissolves in this, and since it is very soluble there is reason to believe that most of it does, a 15 to 20 per cent solution of the salt will be formed and the freezing point of such a solution is 14 deg. to -1 deg. F.

The maximum effect seemed to be reached with 2 per cent calcium chloride, and this amount was sufficient to increase the strength of the mortar approximately one-third over that of mortar not protected from freezing. The larger proportions of chloride did not seem to exercise the same influence as 2 per cent. This was no doubt because additions of both 4 per cent and 6 per cent caused marked quickening of the setting time of the cement used. It is a well-known fact that quick-setting cement does not show as high strength as the slow-setting. It is a curious fact, although well known, that up to a certain point additions of calcium chloride retard the setting of cement, but beyond this amount they have the opposite effect.

TABLE 2.—TENSILE STRENGTH OF MORTAR WITH AND WITHOUT CALCIUM CHLORIDE UNDER DIFFERENT CONDITIONS.

Age of briquettes, days	Individual Breaks, 1:2 Mortar.										Average
	7	28	7	28	7	28	7	28	7	28	
No chloride, tested in laboratory	412	527	394	531	392	516	410	548	398	538	401
No chloride, outside exposure	314	409	323	402	318	387	307	400	303	391	313
2 per cent chloride, outside exposure	404	500	416	516	430	502	399	511	421	521	414
4 per cent chloride, outside exposure	338	432	315	401	327	406	317	421	323	420	324
6 per cent chloride, outside exposure	367	462	359	430	350	441	350	432	361	444	357
Individual Breaks, 1:3 Mortar.											
No chloride, tested in laboratory	280	360	278	364	292	372	290	360	287	352	285
No chloride, outside exposure	190	305	207	293	220	280	217	310	214	302	210
2 per cent chloride, outside exposure	404	500	416	516	430	502	399	511	421	521	414
4 per cent chloride, outside exposure	266	307	254	287	260	284	282	290	277	294	268
6 per cent chloride, outside exposure	284	287	284	297	271	281	264	306	262	280	273

About a week after the first lot of briquettes were made, a very cold spell of weather came and it was deemed advisable to make up a new lot of briquettes and expose to this extreme cold. Four sets were made up of 1:3 cement and sand mortar containing respectively 0 per cent, 2 per cent, 4 per cent, and 6 per cent calcium chloride. Sand, cement, and molds were all chilled to out-of-doors temperature and the water was drawn from the tap, in this experiment. The briquettes were then placed out doors as soon as made. The temperature at that time being 5 deg. F., or 27 deg. below the freezing point of water. The temperature dropped to -1 deg. F. that night. The temperatures to which these briquettes were subjected is shown in Table 1. They were placed out of doors on the fifth day and the seven-day and twenty-eight-day briquettes were broken on the twelfth and thirty-third days, respectively. The tensile strength of these briquettes is shown below in Table 3:

TABLE 3.—STRENGTH OF 1:3 MORTAR EXPOSED TO 5 DEG. TEMPERATURE AS SOON AS MADE.

Age	7 days				28 days			
	0%	2%	4%	6%	0%	2%	4%	6%
Chloride	139	225	218	192	236	408	325	258
	142	215	226	174	215	388	328	270
Individual	128	236	200	194	220	376	350	280
Breaks.	140	221	2	180	218	378	342	263
	121	229	196	202	236	385	347	266
Average	135	225	208	189	225	387	338	267

It will be seen that the briquettes to which 2 per cent calcium chloride had been added were more than two-thirds again as strong as those to which no calcium chloride had been added, showing that the colder the weather the greater the benefit that will be derived from the addition of calcium chloride.

In order to investigate the effect of alternate freezing and thawing upon the strength of cement mortars made with and without calcium chloride, four sets of cement mortar (1 of cement to 3 of sand) were made with 0 per cent, 2 per cent, 4 per cent, and 6 per cent calcium chloride, respectively. These were placed out of doors as soon as made and allowed to remain out over night. The thermometer fell as low as 4 deg. F. that night. In the morning they were brought into the laboratory and allowed to remain all day, the temperature reaching 72 deg. F. while they were in the room, or a change in temperature of 68 deg. F. Each night these briquettes were placed out of doors, and each morning they were brought in the house. In this manner they were exposed to alternate freezing and thawing daily for the whole of the first seven days and practically all of the 28 days. The strength of the briquettes so exposed is given in Table 4.

It will be seen that in this instance also the mortar containing 2 per cent calcium chloride had about one-third greater strength than the mortar to which no chloride had been added.

TABLE 4.—STRENGTH OF 1:3 MORTAR, ALTERNATELY FROZEN AND THAWED.

Age	7 days				28 days			
	0%	2%	4%	6%	0%	2%	4%	6%
Calcium chloride	247	318	325	302	313	379	359	351
	230	328	323	324	302	391	350	354
Individual	244	317	313	318	316	396	358	323
Breaks.	244	343	313	310	321	412	371	328
	231	340	306	304	290	414	362	352
Average	239	329	316	312	308	398	360	342

Color.—In order to determine the effect which calcium chloride would have on the color of the cement, and also to see if efflorescence occurred in concrete made with this, with a view to determining if calcium chloride could be used in making hollow concrete blocks during the winter time, small slabs of concrete 8 inches square were molded of 1:3 mortar. These blocks were allowed to dry out in the room, and also were alternately sprinkled and dried with a view to bringing out efflorescence. The slabs containing 4 per cent and 6 per cent calcium chloride, on drying out for the first time, showed considerable efflorescence; but this washed off when the slab was sprinkled and did not reappear. There were also apparent in the blocks small dark splotches with white borders, due no doubt to the caking of the chloride and consequently to its not having been thoroughly disseminated through the mortar. This was overcome by dissolving the calcium chloride in the water used for the mixture. When this was done the slab of mortar made by adding 2 per cent calcium chloride could not be distinguished from that containing none, after both had dried out. The slab containing calcium chloride, however, owing to its affinity for water, took longer to dry, and conse-

quently looked darker, for the first week or two, than did the other.

Waterproofing Properties.—Some time ago the writer discovered that additions of calcium chloride helped to make mortar more impervious to water. In order to test this the slabs mentioned above were dried in the air for two weeks and placed on edge in a vessel containing about an inch of water and allowed to remain in this 24 hours. The slabs were weighed before being placed in the vessel and after being taken out and the surface water wiped off. The block containing no calcium chloride had absorbed 7.5 per cent of its weight of water, while that containing 2 per cent only 3.7 per cent of its weight of water. This shows that calcium chloride lessens the permeability of mortar more than 50 per cent, or, in other words, that a block containing no calcium chloride will absorb twice as much water as one having 2 per cent calcium chloride.

In this particular test, at the end of 24 hours, the slab containing no calcium chloride was wet all over while those having 2 per cent and over had their upper edges still dry. The slab containing 4 per cent calcium chloride absorbed 3.42 per cent water and that containing 6 per cent 3.40 per cent.

is sometimes necessary to quicken the set of cement. When this is desired, calcium chloride, in the proportions of 4 or more per cent of the cement, can most safely be used since caustic soda and carbonate of soda both may cause cement mortar to expand and crack.—The Engineering Record.

THE DEMOLITION OF THE GREAT WHEEL AT EARL'S COURT, LONDON.*

THE demolition of the Great Wheel at Earl's Court, which for twelve years has formed so conspicuous a feature of the London landscape, is completed. The work has been one requiring the exercise of no little ingenuity in the devising of safe, yet reasonably economical, methods of procedure. The efficiency of the arrangements made is well shown by the fact that in spite of an unusually severe winter, and in spite of the fact that unexpected difficulties arose in taking apart joints and withdrawing bolts and pins, the whole gigantic structure has been razed to the ground in a period of less than four months' actual working time, and without the occurrence of any serious accident directly attributable to the operations in progress. There was,

The wheel was a pin-jointed structure 300 feet in diameter, weighing, with the cars in position, about 1,000 tons, while the two four-legged standards on which it was mounted weighed about 400 tons more. No detailed plans of the edifice were available, and all the data necessary for determining the proportions and positions of the temporary struts required in the demolition had to be measured from the structure itself. For its erection very heavy and expensive scaffolding extending up to the axle level had been employed, but considerations of time and expense made impracticable any similar plan of operations for taking it down. The difficulties were enhanced by the very restricted area of the site on which the wheel stood. This site was in an angle between two lines of railway, over one of which the outer edge of the wheel protruded. Heroic methods, such as destruction by dynamite, were accordingly out of the question, and the engineer had, therefore, to face the problem of a piece-by-piece process of demolition. In this, moreover, the greatest care had to be exercised to insure the safety of the ground staff. Every bolt and nut had accordingly to be lowered down in bags, since small articles dropped from a height of 300 feet or more cannot be depended on to fall verti-

HOW THE FORTY CARS WEIGHING 200 TONS WERE REMOVED SO THAT THE WHEEL WAS NEVER OUT OF BALANCE MORE THAN THE WEIGHT OF ONE CAR.

THE DEMOLITION OF THE GREAT WHEEL AT EARL'S COURT, LONDON.

Soundness.—It is a fact well known that additions of calcium chloride will often render unsound cement sound. To several samples of unsound cement 2 per cent calcium chloride were added and in each case the resulting mixture passed the steam and boiling tests perfectly.

Conclusions.—From the above tests and experiments the writer has come to the conclusion that additions of calcium chloride to mortar, which is to be exposed to cold weather, will prevent its freezing and allow it to develop its full strength. That mortar to which it has not been added, when so exposed, will not develop its full strength, and in some instances has even insufficient strength to admit of its being used in work of any importance or strength.

That it may be used in concrete blocks which are made in the winter time, adding to their strength and impermeability, without causing discoloration of, or efflorescence on, the blocks.

That the addition of 2 per cent of calcium chloride will cause quick-setting cements to become slow-setting and often unsound cement to become sound. It

is true, one fatality; but this occurred at a time when work had been suspended owing to the violence of the wind, and the incident well illustrates how such lamentable occurrences will take place in spite of the utmost care on the part of the engineer and the contractors. The unfortunate victim in passing under the tower with a friend was struck by a pin falling from a shackle 150 feet above ground level. The pin had been loosened by the action of the wind in banging the shackle against the steel work. By an extraordinary fatality the workman thus so haplessly struck down had taken part in all the really dangerous portion of the work—that is to say, in the removal of the uppermost segments of the wheel; but when progress had been carried down to axle level, feeling less certain of his nerve, he had asked for a job on ground level, a request which was immediately complied with. This change of occupation was undoubtedly the indirect cause of the unfortunate man's death, as, when hit by the falling bolt, he was taking his friend to see the work on which he had just been engaged.

* Engineering (London).

cally. The first process was the removal of the cars, which were forty in number, and weighed some 200 tons. These were hung from the main pins of the outer peripheries of the wheel, which, to this end, were extended cantilever fashion beyond the chords, of which they made the joints. This removal was effected in such fashion as never to allow the wheel to be more than the weight of one car out of balance. The procedure will be understood by reference to Fig. 1. The cars were, of course, taken off at the lowest point of the wheel. Car No. 1 being removed, the wheel was turned through 180 deg., and car No. 21 taken off. The next car to be removed was No. 11, and the fourth car No. 31. By proceeding step by step in this fashion the whole of the cars were, in the course of ten days' work, dismounted without, as already stated, the wheel being unbalanced during the process by more than the weight of one car.

In devising the plans for taking down the structure, the wheel was assumed to consist of two semicircular arches, the upper one of which rested on, and was supported by, the lower one, which, in turn, was suspended