# TRỘN CALCIUM CHLORIDE TRONG BÊ-TÔNG ĐỂ CHỐNG LẠNH

NKC

Để đóng góp cho lá-thư có thêm tài liệu về nghề nghiệp tôi xin soạn ra đây một ít tài liệu nghiên-cứu về sự trộn chất calcium chloride vào xi-măng để làm cho bê-tông mau cứng để chống lại các hư hại do thời tiết lạnh gây ra. Thấy dịch đi dịch lại có thể khó hiểu hơn và có thể làm sai lạc ý-nghĩa của tài-liệu nên tôi mạn phép trích nguyên văn những đoạn chính yếu. Tài liệu kỹ-thuật lúc nào cũng khô-khan, chỉ lưu-ý một số ít bạn muốn trao dồi nghề nghiệp, nên không hấp dẫn đối với đa số độc giả. Do đó tôi xin có lời kiểu lời trước với các bạn nào không thích đọc bài nầy. Tôi cũng mong các bạn nào hưởng ứng góp thêm ý kiến vào vấn đề nhứt là các bạn có kinh nghiệm "chiến-trường" ở các công trường xây cất mùa đông hay ở các labs đã có dịp đập bể nhiều ống bê-tông mẫu.

FIGURE 1.

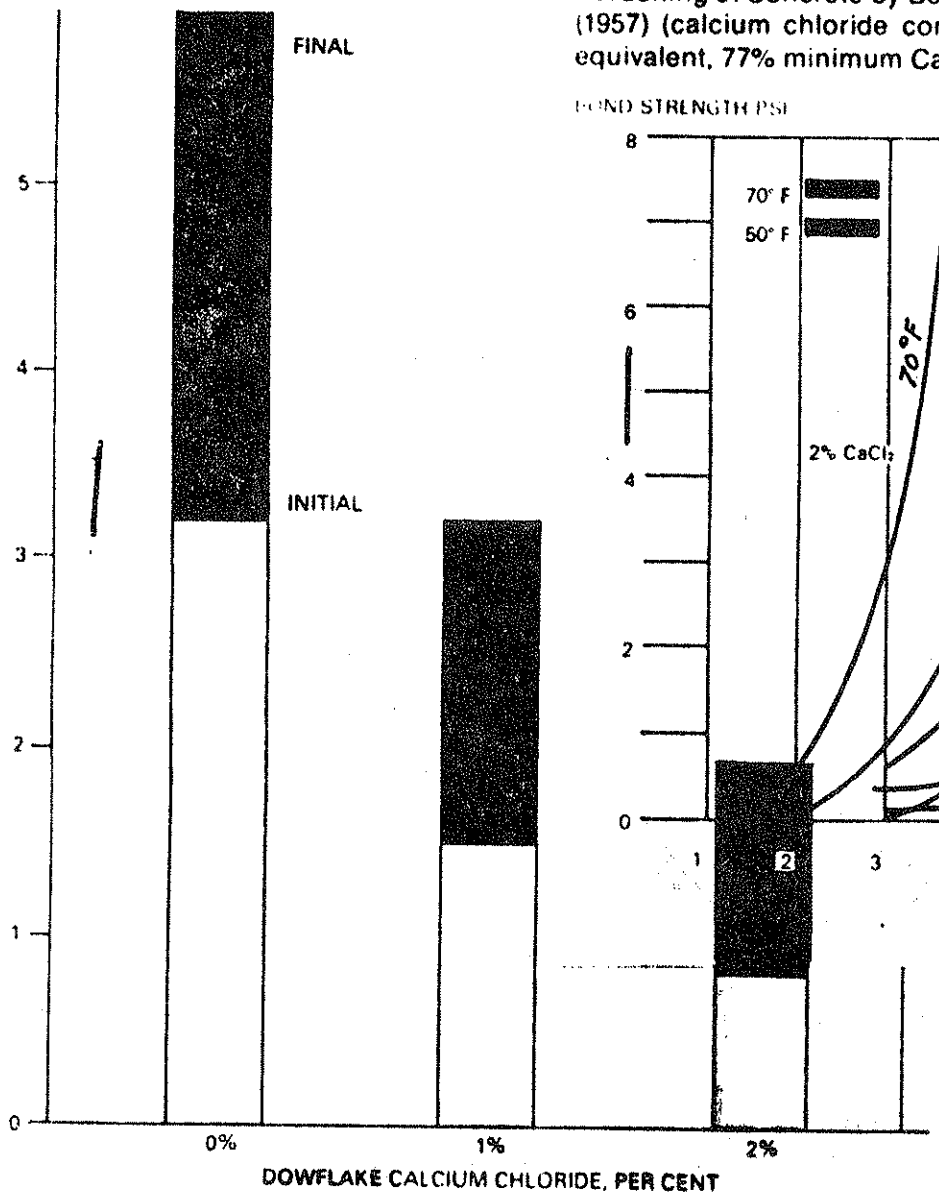



**FIGURE 2**—Setting time of concrete—with and without calcium chloride—as measured by pin pull out tests. Data from report of T. M. Kelly and D. E. Bryant, The Masters Builders Company, "Measuring the Rate of Hardening of Concrete by Bond Pullout Pins", *Proceedings*, ASTM, Vol. 57 (1957) (calcium chloride concentration expressed as DOWFLAKE $CaCl_2$ equivalent, 77% minimum $CaCl_2$).

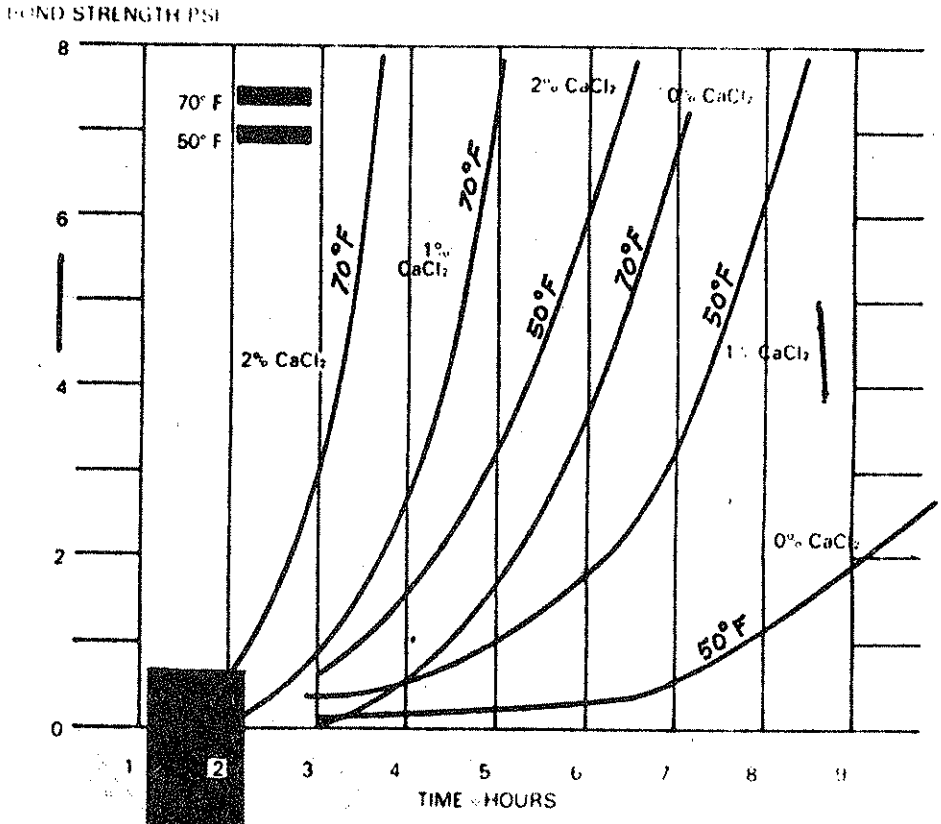
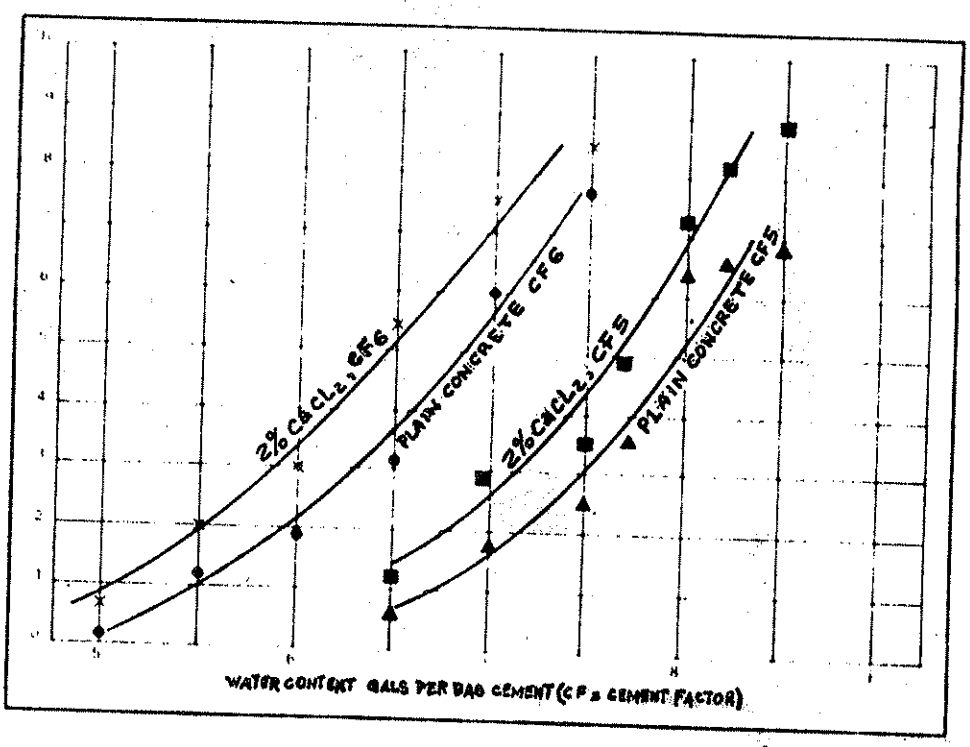


**TABLE III — Recommended Gallons of Calcium Chloride "Standard" Solution Bags Cement per Cubic Yard Concrete**

| Cubic Yards Per Batch | Calcium Chloride Admixture | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1% | 1 | 1.1 | 1.2 | 1.4 | 1.5 | 1.6 | 1.7 |
| | 2% | 2 | 2.2 | 2.5 | 2.7 | 3 | 3.2 | 3.5 |
| 1.5 | 1% | 1.5 | 1.7 | 1.9 | 2.1 | 2.2 | 2.4 | 2.6 |
| | 2% | 3 | 3.4 | 3.7 | 4.1 | 4.5 | 4.8 | 5.2 |
| 2 | 1% | 2 | 2.2 | 2.5 | 2.7 | 3 | 3.2 | 3.5 |
| | 2% | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 |
| 2.5 | 1% | 2.5 | 2.8 | 3.1 | 3.4 | 3.7 | 4.0 | 4.4 |
| | 2% | 5 | 5.6 | 6.2 | 6.8 | 7.5 | 8.1 | 8.7 |
| 3 | 1% | 3 | 3.4 | 3.7 | 4.1 | 4.5 | 4.8 | 5.2 |
| | 2% | 6 | 6.7 | 7.5 | 8.2 | 9 | 9.7 | 10.5 |
| 3.5 | 1% | 3.5 | 3.9 | 4.4 | 4.8 | 5.2 | 5.7 | 6.1 |
| | 2% | 7 | 7.8 | 8.7 | 9.6 | 10.5 | 11.4 | 12.2 |
| 4 | 1% | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 |
| | 2% | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 4.5 | 1% | 4.5 | 5 | 5.6 | 6.2 | 6.7 | 7.3 | 7.8 |
| | 2% | 9 | 10.1 | 11.2 | 12.4 | 13.5 | 14.6 | 15.7 |
| 5 | 1% | 5 | 5.6 | 6.2 | 6.8 | 7.5 | 8.1 | 8.7 |
| | 2% | 10 | 11.2 | 12.5 | 13.7 | 15 | 16.2 | 17.5 |
| 5.5 | 1% | 5.5 | 6.2 | 6.8 | 7.5 | 8.2 | 8.9 | 9.6 |
| | 2% | 11 | 12.4 | 13.7 | 15.1 | 16.5 | 17.8 | 19.2 |
| 6 | 1% | 6 | 6.7 | 7.5 | 8.2 | 9 | 9.7 | 10.5 |
| | 2% | 12 | 13.5 | 15 | 16.5 | 18 | 19.5 | 21 |
| 6.5 | 1% | 6.5 | 7.3 | 8.1 | 8.9 | 9.7 | 10.5 | 11.3 |
| | 2% | 13 | 14.6 | 16.2 | 17.8 | 19.4 | 21 | 22.6 |
| 7 | 1% | 7.0 | 7.9 | 8.8 | 9.6 | 10.5 | 11.4 | 12.2 |
| | 2% | 14 | 15.7 | 17.5 | 19.2 | 21 | 22.8 | 24.5 |

**FIGURE 3** — For equivalent water content, concrete treated with calcium chloride increases workability as measured by slump. Data from report of H. C. Vollmer, Pro. HRB, Vol. 23 (1943).



# USE OF CALCIUM CHLORIDE IN PORTLAND CEMENT CONCRETE

The principal result of adding calcium chloride to concrete is an accelerated rate of hydration for the cement. This faster rate of hydration, especially for concrete placed during low temperatures in cold weather produces three major beneficial effects:

1 - Reduction in time for set both initial and final.

2 - Attainment of early strength.

3 - Protection in cold weather for freshly placed concrete.

Along with these important contributions, investigations also indicate that calcium chloride has other beneficial effects. For instance, it will improve workability, reduce bleeding tendencies, and has beneficial effects on air-entrainment and ultimate strength.

For cold weather concreting, the following guidelines are recommended:

- Quality concrete, winter or summer, requires proper mix design, quality materials, adequate mixing, proper placing, finishing and curing.
- The use of calcium chloride in concreting should not be limited to the times in winter months when temperatures are in the 30° to 45° range or below. Anytime the temperature drops below 70° there is a reduction in the rate of cement hydration. In these upper cool temperature ranges of 50° to 65°F, benefits can be obtained by use of calcium chloride, 2% $CaCl_2$ equivalent addition of cement.
- Concrete should not be placed on frozen subgrade. Temperatures of forms, adjacent concrete and/or subgrade should be above freezing at time of fresh concrete placement.
- Where calcium Chloride is used concrete should be maintained at a temperature above 50°F for the first three days and above freezing for the following three days.
- After a six day protection period, protection may be removed if the temperature of the concrete is not permitted to drop more than 40° in 24 hours.
- All concrete should be protected from wind, rapid heat and/or moisture loss.
- Forms left in place during the curing period will help reduce heat and moisture loss.
- When used in recommended amounts, calcium chloride is not an anti-freeze, since it lowers the freezing point of the water in the concrete and insignificant amount.

In summary calcium chloride provides needed protection for concrete placed in cold weather. It protects against freeze damage by accelerating the rate of cement hydration and thus lowering the free-water content of concrete. It imparts the necessary early strength to offset the potentially damaging forces of freezing.

- Compressive strength of concrete is normally used for design purposes. However, flexural strength is also important in concrete where adequate flexural strength is necessary to resist the effects of loads that set up tensile stresses.

The advanges of calcium chloride for accelerating early flexural strength in concrete have been reported. It has also been reported that ultimate flexural strength of calcium chloride treated concrete exposed to the weather for periods up to eight years is not adversely affected.

- Calcium Chloride can be classed as a Type C accelerating chemical admixture for concrete. The specific effects produced by chemical admixtures may vary with the properties of the others ingredients in the concrete. If ASTM C494 must be met for a specific project, the actual materials to be used must be checked with the calcium chloride admixture to establish performance characteristics of the concrete as expressed in the statement from C494.
- Air-Entrained concrete is now universally recommended for practically all exposed surfaces, especially where freeze-thaw conditions prevail. Calcium Chloride can be used to advantage with air-entrained concrete made from air-entrained cement or with an air-entrained admixture. It is a well-known fact that air-entrainment tends to retard strength developement of higher cement factor concrete. The addition of calcium chloride compensates for this lag in strength gain.
- Most reports show that the higher early strength obtained with calcium chloride contributes greatly to the long-range durability that follows proper curing.
- Calcium chloride helps to assure that concrete will be durable against freeze and thaw cycles.
- Calcium chloride causes the heat to develop and to be released in one-half the normal time. This effect contributes much to the value of calcium chloride in winter concrete work.
- Calcium chloride should not be used in prestressed concrete because of its potential for augmenting stress corrosion.
- Where sulfate-resisting concrete is required, calcium chloride should not be used.
- Calcium chloride will increase expansion where cement alkali-agregate reaction is not controlled by the used of low-alkali cement or effective pozzolan.
- As calcium chloride precipitates most air-entraining agents and some water-reducing agents, when mixed in the same solution, it is important that the material be kept in separate solutions and introduced separately into the mixer.
- Calcium chloride in the mix in permissible amounts will not lower the freezing point of concrete to any significant degree. Any such attempt to protect concrete from freezing should not be permitted.
- Variation in color could be caused by using calcium chloride.

Trích đăng,

NGUYEN KIM CHI