EUCLID CHEMICAL

TECHNICAL BULLETIN AD-07

OFFSETTING POTENTIAL CORROSIVE EFFECTS OF CHLORIDES USING EUCON CIA/EUCON BCN

EUCON CIA is a corrosion inhibiting admixture containing a minimum of 30% Calcium Nitrite, which is added to the concrete during the batching process. EUCON CIA is designed to inhibit the corrosion of steel reinforcement in concrete.

Chloride ions are present at different levels in almost all aggregate and water sources. The alkalinity (high pH) of the pore solution in concrete promotes the development of a corrosion resistant film called the passivating layer on the reinforcing steel. In non-aggressive environments this film composed of ferric oxides and ferrous oxides (defects) is insoluble but in presence of chlorides, those defects form complexes that destabilize the passivating layer. The American Concrete Institute has established levels of acceptable chloride ions as shown in the Table 1 below for different concrete conditions.

The Federal Highway Administration (FHWA) recommends a chloride to nitrite ratio of 0.90 when using chloride bearing materials. These limits may also be used in very severe corrosive environments for enhanced protection, as needed (Table 2).

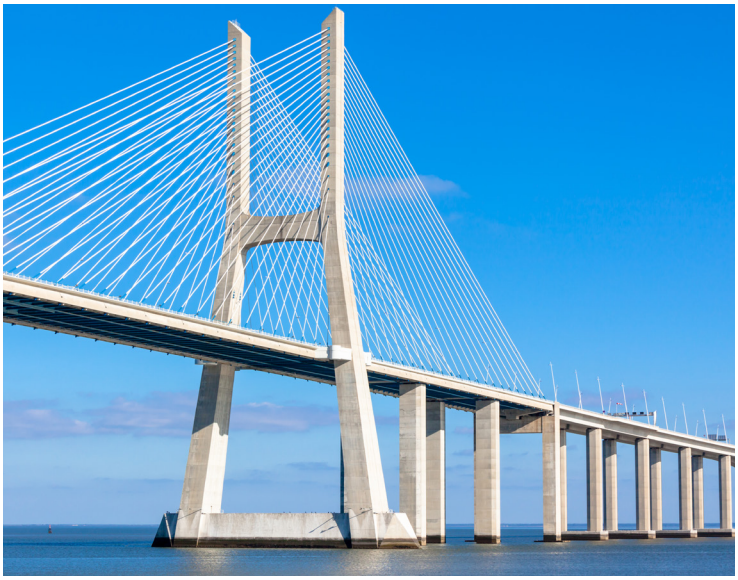
Table 1

ACI 318 BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE		Percent by weight of cement for water soluble chloride ion (Cl^-) limits in concrete	
Exposure Class	**Class meaning**	**Non-prestressed Concrete**	**Prestressed Concrete**
C0	Concrete dry or protected from moisture	1.00%	0.06%
C1	Concrete exposed to moisture but not to an external source of chlorides	0.30%	0.06%
C2	Concrete exposed to moisture and an external chlorides from deicing chemicals, salt, brackish water, seawater, or spray from these sources	0.15%	0.06%

Limits in Table 1 are to be applied to chlorides contributed over the lifespan of the structure.

Table 2

Eucon CIA gal/yd³ (L/m³)	Chloride-Bearing Materials lbs/yd³ (kg/m³)
1.0 (5.0)	2.1 (1.2)
2.0 (10.0)	4.1 (2.4)
2.5 (12.5)	5.1 (3.0)
3.0 (15.0)	6.1 (3.6)
3.5 (17.5)	7.1 (4.2)
4.0 (20.0)	8.1 (4.8)
4.5 (22.5)	9.1 (5.4)
5.0 (25.0)	10.1 (6.0)
6.0 (30.0)	12.1 (7.2)



In certain cases, concrete mix components, such as aggregates or mix water will contribute levels of chloride ions to concrete that will make it exceed the ACI limits. Therefore, it is always good practice to measure the chloride contents of the raw materials used in the mix. EUCON CIA can be added to the concrete mix to counteract the negative effects of the chloride ions. Using EUCON CIA may be far less expensive to the concrete producer than finding alternate sources of raw materials. The producer may still be in violation of ACI maximum chloride limits, but EUCON CIA will counteract the corrosive effects of chlorides so the engineer or producer can allow its usage.

In order to determine how much of EUCON CIA to use, concrete must be tested for water soluble chloride ion content. Once chloride content is determined, the dosage rates from Table 2 may be used.

Example 1: A prestressed concrete producer using a 650 lb cement factor tests for chloride content of a prestressed concrete member. Tests show the mix has a total chloride ion content of 0.655 lb/yd^3, or 0.1% by weight of cement. The chloride content exceeds ACI limits of prestressed concrete and the producer decides to use EUCON CIA to help protect the reinforcing steel from corrosion. By looking for 0.655 lb/yd^3 on the Eucon CIA data sheet, the producer can use the recommended dose of 1 gal/yd^3 to counter the chloride content of the concrete. The calculation of total chloride ion content of 0.655 lb/yd^3 can be found in Table 3.

To determine the amount of chloride ions contributed by each component, perform the following calculation as shown in Table 3 which is the **weight** x **chloride ion content** of each component. This will give the contributed chloride ion content % by weight for each component of the mix.

Table 3

Concrete Component	Amount (lb/yd^3)	Chloride Ion Content (%)	Calculation	Chloride Ions Contributed (lb/yd^3)
Cement	650	0.0035	650 x 0.0035%	= 0.023
Coarse Aggregate	1800	0.022	1800 x 0.022%	= 0.396
Fine Aggregate	1230	0.0139	1230 x 0.0139%	= 0.171
Water	260	250 ppm	260 x 250 x 10^{-6}	= 0.065

TOTAL = 0.655 (lb/yd^3)

Total chloride content by weight of cement:

$$\frac{\text{Total Contributed Chloride (lb/yd}^3\text{)}}{\text{Cement Factor}} \times 100 \rightarrow \frac{0.655 \text{ (lb/yd}^3\text{)}}{650 \text{ (lb/yd}^3\text{)}} \times 100 = 0.1\%$$

Chlorides contributed by the admixture (lb/yd^3) calculation:

$$\frac{\text{Dosage Rate (oz)}}{100 \text{ lb}} \times \text{Cement Factor lb/yd}^3 \times \frac{\text{Admixture Density lb/gal}}{128 \text{ oz/gal}} \times \text{Chloride Ion Content of Admixture \% Cl}^-$$

Example 2: Plain concrete + Admixtures containing 0.5% Cl$^-$

HRWA: $\frac{15 \text{ fl oz}}{100 \text{ lb}} \times 650 \text{ lb/yd}^3 \times \frac{10.7 \text{ lb/gal}}{128 \text{ oz/gal}} \times 0.50\% \text{ Cl}^- = 0.041 \text{ lb Cl}^-/\text{ yd}^3$

AEA: $\frac{2 \text{ fl oz}}{100 \text{ lb}} \times 650 \text{ lb/yd}^3 \times \frac{10.7 \text{ lb/gal}}{128 \text{ oz/gal}} \times 0.50\% \text{ Cl}^- = 0.0005 \text{ lb Cl}^-/\text{ yd}^3$

For more information on how to select the appropriate dosage of Eucon CIA to inhibit corrosion of reinforcing steel, please refer to the technical data sheet or contact your local sales representative or technical services.