

レポートの解答例

Sample Answer (7)

1.

$$C(x, t) = C_0 \left(1 - \operatorname{erf} \frac{x}{2\sqrt{D_{ap}t}} \right) + C_{initial}$$

上記の塩化物イオン濃度の予測式を C_0 について解くと, By solving the above equation for predicting chloride ion concentration for C_0 ,

$$C_0 = \frac{C(x, t) - C_{initial}}{1 - \operatorname{erf} \frac{x}{2\sqrt{D_{ap}t}}}$$

使用する単位をm, kg, yearsとして以下の値を上式に代入して, By unifying the used units as m, kg and years and substituting the values below to the above equation,

$$x = 0.03m, \quad C(0.03m, 10years) = 1.0 \text{ kg/m}^3, \quad C_{initial} = 0,$$

$$D_{ap} = 0.5 \times 10^{-4} \text{ m}^2/\text{year}, \quad t = 10years$$

$$C_0 \approx 2.92 \text{ kg/m}^3$$

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2.

鉄筋位置の塩化物イオン濃度が腐食発生限界濃度に達するとき、以下の関係が成り立つ。When chloride ion concentration at the location of rebar reaches to the critical chloride ion concentration, the following equation is satisfied.

$$x = 0.05m, \quad C = C_{lim} = 1.2 \text{ kg/m}^3, \quad C_{initial} = 0, \\ D_{ap} = 0.5 \times 10^{-4} \text{ m}^2/\text{year}, \quad C_0 = 2.92 \text{ kg/m}^3$$

$$1.2 = 2.92 \times \left(1 - \operatorname{erf} \frac{0.05}{2\sqrt{0.5 \times 10^{-4} \times t}} \right)$$

$$\therefore \operatorname{erf} \left(\frac{3.54}{\sqrt{t}} \right) = 0.59 = \beta$$

t の値を次々に仮定して、収束計算を行う。ここでは、二分法を用いる。Iteration process is conducted by assuming the value of t again and again. Here, the bi-section method is used.



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二分法で用いる t の初期値を $t_1 = 1 \text{ years}$, $t_2 = 50 \text{ years}$ とし, 以下の収束条件を用いる. Iteration process is conducted by assuming the value of t again and again. Here, the bi-section method is used.

$$\frac{\left| \beta - \operatorname{erf}\left(\frac{3.54}{\sqrt{t}}\right) \right|}{\beta} \times 100 < 0.1$$

(β の誤差が0.1%以下 Error of the value of β is less than 0.1%)

繰返し数9回目で上記の収束条件を満たし, $t = 36.9 \text{ years}$ を得る. The above condition is satisfied at the 9th iteration and $t = 36.9 \text{ years}$ is obtained.

10年目の現在から「あと何年で C_{lim} に達するか」という問いなので, 余寿命は $36.9 - 10 = 26.9$ 年である. Since the question is how many years it takes until it reaches to C_{lim} from the present, which 10 years have already passed, the remaining life is $36.9 - 10 = 26.9 \text{ years}$.

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なお、現時点（建設後10年目）と、さらに26.9年経過後の塩化物イオン濃度の分布は、以下のようなになる。The chloride ion distribution at present (10 years after the construction) and that after 26.9 years more become as the graph below.

