CHAPTER 7

MODEL FOR PREDICTING COMPRESSIVE STRENGTH OF SPECIAL CONCRETES

In some occasions that conventional concrete has some limitation special concretes might be applied. To select concrete type depends on work condition and construction cost, for example, low-heat concrete (LHC) suits for massive construction such as dam and footing, roller-compacted concrete (RCC) suits for dam and pavement and self-compacting concrete is proper for the complicated or heavily reinforced structures.

The same concepts as conventional concrete are introduced in order to predict the compressive strength of the mentioned special concretes. Low-heat concrete is taken into consideration in the conventional concrete model in the case of low lime (CaO content) as shown in section 7.2. The prediction of compressive strength of roller-compacted concrete and self-compacting concrete will be discussed below.

7.1 Roller-Compacted Concrete (RCC) and Self-compacting Concrete (SCC)

To construct the models, the author collected data of various mix proportions, mostly from industrial laboratories and universities in Thailand. After applying the same concept as 28-day compressive strength model of conventional concrete, the models of both RCC and SCC were proposed as shown in section 7.1.1 and 7.1.2.

7.1.1 The 91-day compressive strength model of roller-compacted concrete

RCC differs from conventional concrete principally in aggregate grading, paste content and consistency. It is generally compacted by applying large compaction effort due to its extremely low consistency. Generally, the compressive strength of RCC is inspected at 91 days. Therefore, it is modeled based on 91days as expressed in Eq. (7.1).

$$f'_{RCC}(91) = (46.568\times(w/b)^{-0.54})(\log C-1.7)-37.153\times(w/b)+37.022 \qquad (7.1)$$

To predict compressive strength of RCC at other ages, the strength development function (ϕ) is introduced as a function of time (t), water to binder ratio (w/b) and glass to lime ratio (SiO2/CaO) which can be explained by the concept of pozzolanic reaction and hydration reaction. The computational function of strength development is expressed in Eq. (7.2). Finally, the compressive strength of RCC at any considered age t can be predicted by Eq. (7.3).

$$\phi(t)=((0.1473\times\exp(0.5443\times(w/b))\times\ln(SiO_2/CaO)+0.1482\times\ln(w/b)+0.5879) \times\log(t+1)+((0.2118\times(w/b)-0.4233)\times\ln(SiO_2/CaO)+(-0.4529\times\ln(w/b)-0.3438)) \qquad (7.2)$$

$$f'_{RCC}(t) = \frac{\phi(t) \times f_{RCC}(91)}{\phi(91)} \quad (7.3)$$

where

$f'_{RCC}(t)$: the compressive strength of RCC at any considered age t (Mpa)
$f'_{RCC}(91)$: the 91-day compressive strength of RCC (Mpa)
$\phi(t)$: strength development of RCC at any considered age t
$\phi(91)$: 91-day strength development of RCC
SiO_2 : total SiO2 content in both cement and fly ash, kg/m^3 of concrete
CaO : total CaO content in both cement and fly ash, kg/m^3 of concrete

7.1.2 The 28-day compressive strength model of self-compacting concrete

Since conventional concrete may not be capable of perfectly filling in some in congested reinforced formworks and complicated formwork, SCC had been introduced with its performance based on very high fillingability without segregation. Consequently, the vibration process is unnecessary. In order to flow freely, this concrete must has very high amount of paste by mixing concrete that has binder content more than 400 kg/m^3 of concrete. The model for predicting compressive strength of self-compacting of concrete is expressed in Eq. (7.4).

$$f'_{SCC}(28) = [56.041+\exp(16.66-44.322\times(w/b))] \times(\log C-2.15)+95.68\times\exp(-3.24\times(w/b)) \quad (7.4)$$

Due to the lack of available and accurate data, both models do not take into account the effect of γ. For more accuracy, this effect should be considered.