EFFECTS OF FRESH CONCRETE TEMPERATURE ON FRESH AND HARDENED PROPERTIES OF CONCRETE UNDER HOT WEATHER CONDITIONS

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Degree of Master of Science

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Prof. S. M. A. Nanayakkara Date

Abstract

Understanding and managing fresh concrete temperature is essential as it affects the properties of fresh and hardened concrete. Even though a maximum temperature is specified for mass concrete pouring, there is no proper guideline to control the temperature in normal concreting works.

Effects of fresh concrete temperature on fresh and hardened properties of concrete in normal concrete works under hot weather conditions were evaluated through an experimental investigation. This thesis reports the outcomes of the investigations carried out. A study was done on the past records of fresh concrete temperatures collected from concrete batching plants, where the temperature was not controlled in any manner during the batching process under hot weather conditions. For the experimental investigation, one mix proportion with Portland cement was selected. Test specimens were cast to check the temperature development of concrete, slump and slump variation with time, evaluation of plastic shrinkage cracking, evaporation rates throughout the experimental period, compressive strength development and splitting tensile strength. The fresh concrete temperature of the mixes was controlled at 30, 32, 34 and 36 °C by varying mixing water temperature under hot weather conditions where ambient temperature, humidity and wind conditions were monitored.

Slump and slump loss are directly related to the fresh concrete temperature as it showed considerable reduction when the fresh concrete temperature increased. Further, the test results revealed that the time taken to appear the first crack is lesser when the difference between the fresh concrete temperature and the ambient temperature increases and vise versa. Same time the evaporation rate is also higher when the difference between the fresh concrete temperature and the ambient temperature increases. When the evaporation rate is higher, the concrete mix tends to crack earlier. Hence, it can be concluded that it is beneficial to keep the fresh concrete temperature close to the ambient conditions to minimize the plastic shrinkage cracking. The highest test results for compressive strength and splitting tensile strength were also obtained when the fresh concrete temperature was close to the ambient conditions. Therefore, from the above analysis, it can be concluded that it is beneficial to keep the fresh concrete temperature close to the ambient conditions to get the optimum results in terms of plastic shrinkage cracking, compressive strength and tensile splitting strength.

Therefore, the recommendations given in the code of practices and project specification should be modified to reflect these findings along with the ambient conditions.

Keywords: fresh concrete temperature, concrete placing temperature, hot weather concreting, ambient temperature, plastic shrinkage, compressive strength development, splitting tensile strength

Specially dedicated to my supervisor Prof. S.M.A. Nanayakkara...

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LIST OF ABBREVIATIONS

Abbreviation	Description
°C	Celsius
°F	Fahrenheit
d	Cross-sectional dimension of the specimen (in mm)
D	Density (in kg/m^3)
F	Maximum load applied (in N)
FA/TA	Fine to total aggregate ratio
hr	Hours
l	Length of the specimen (in mm)
m	Mass of the concrete in the container (in kg)
T	Fresh concrete temperature
T_a	Temperature of aggregate
TA/C	Total aggregate to cement ratio
T_c	Temperature of cement
T_i	Temperature of ice
T_w	Temperature of batched mixing water from normal supply excluding ice
w/c	Water to c3ement ratio
W_a	Dry mass of aggregate
W_c	Mass of cement
W_i	Mass of ice
W_w	Mass of batched mixing water
W_{wa}	Mass of free and absorbed moisture in aggregate
Π	Pi
σ_{ct}	Splitting tensile strength (in N/m^2)

LIST OF APPENDICES