Nirma University
Institute of Technology

Declaration

I, **Ashokkumar Ashwinikumar Tiwari** , registered as Research Scholar, bearing Registration No.**13EXTPHDE116** for Doctoral Programme under the Faculty of Technology Engineering of Nirma University do hereby declare that I have completed the course work, pre-synopsis seminar and my research work as prescribed under R. Ph.D. 3.5.

I do hereby declare that the thesis submitted is original and is the outcome of the independent investigations / research carried out by me and contains no plagiarism. The research is leading to the discovery of new facts / techniques / correlation of scientific facts already known. This work has not been submitted to any other University or Body in quest of a degree, diploma or any other kind of academic award.

I do hereby further declare that the text, diagrams or any other material taken from other sources (including but not limited to books, journals and web) have been acknowledged, referred and cited to the best of my knowledge and understanding.

Date:

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I endorse the above declaration made by the student.

Date: 07/11/2019

Dr. U. V. Dave

Abstract

With the advent of high-performance concrete and adoption of newer technologies for transportation and placement of concrete, such as pumping, the concrete flow properties in the fresh state have become very crucial in concrete making. The traditional method of determining workability of concrete by slump cone test grossly falls short in predicting the behaviour of fresh concrete in modern construction practices. Hence, in the last two decades, the measurement of rheological properties of concrete has emerged as a subject of extensive study. It was revealed from the published literature that the data on rheological properties of cement pastes and concrete containing relatively high volumes of supplementary cementitious materials (SCMs) were limited and often at variance. Further, concretes containing SCM, such as fly ash and ground granulated blast furnace slag, display different rheological behaviour during transportation and placement. Such observations in practice provided the prime motivation for the present study. The present research work was aimed at addressing some of the above observations. The scope of the research work covered, inter alia, the effects of cement replacement levels, the fineness and average particle size of SCMs, and the water-binder ratio (w/b). For this purpose, more than one hundred paste samples were prepared by using four different fly ashes and one slag at four replacement levels. A limited number of concretes were prepared with one fly ash and one slag and their rheology was studied with the help of a concrete rheometer. It was observed that the effect of addition of both fly ash and slag to cement was more pronounced for the yield stress than for the viscosity in the paste rheology. Further, there was a sharp increase in flow resistance, when the w/b was brought down below 0.40. The flow resistance was governed more by fineness than by the levels of replacement. Two different methods employed for the study, e.g., the rheometric measurement and mini slump cone test, showed similar trends for the pastes, although no correlation could be established, perhaps due to the intrinsic difference in the principles of assessment. In case of concrete, yield stress and viscosity of concrete decreased sharply with increase in cement replacement levels apparently due to increase in paste volume and decrease in paste density. For the same replacement level, fly ash reduced the yield stress and viscosity more as compared to the slag used. The present study has unfolded further directions for research as detailed in the thesis.

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List of Tables

Abbreviation, Notation and Nomenclature

OPC .... Ordinary Portland Cement
GGBS .... Ground Granulated Blast furnace Slag
FA .... Fly Ash
SCMs .... Supplementry Cementitious Materials
PSD .... Particle Size Distribution
PD .... Particle Diameter
w/c .... Water-Cement ratio
w/b .... Water-binder ratio
HRWR .... High Range Water Reducer
PCE .... Polycarboxylate Ether
COV .... Co-efficient of Variation
τ .... *Shear stress*
τ_0 .... *Yield stress*
μ .... *Plastic viscosity*
γ .... *Shear strain rate* (1/s)
LOI .... *Loss of Ignition*
IR .... *Insoluble Residue*