

Abstract

**Nirma University  
Institute of Technology**

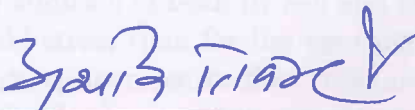
**Declaration**

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.

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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.

## Acknowledgment

I would like to thank my guide **Prof. Urmil V. Dave**, Professor and Head, Civil Engineering Department at School of Engineering, Institute of Technology. His constant support and guidance during research work equipped me with a great understanding of different aspects of the work. He has shown keen interest in this work right from beginning and has been a great motivating factor in outlining the flow of my work. I would like to thank Nirma University for supporting my research activities. I would like to thank almighty for providing me such an enthusiastic guide.

I would like to thank **Dr. Subrato Chowdhury**, Head – Central RD (Now Retired) at Aditya Birla Group's Cement Business whose keen interest and knowledge base helped me to carry out this research at company's premises. I am thankful to him for their continual kind words of encouragement and motivation throughout the this work. He continued to support me after retirement and worked tirelessly so that the thesis is completed.

I sincerely wish to express my deep gratitude for the enormous amount of help, guidance, constant encouragement and moral support rendered by **Dr. Anjan Kumar Chatterjee**, Ex. Wholetime Director, ACC limited. I owe my industrial research career to him. His regular encouragements and support was the reason I could submit this work.

My heartfelt thanks to **Dr. P. V. Patel**, former Head of Civil Engineering Department, Nirma University, for his support during the process of this work.

Further I would like to thank Central RD team at Taloja and Khor, without whose support the work could not have been completed. Special mentions are to **Dr. Mohan Medhe, Dr. Suresh Krishnamoorthy, Dr. Rattanlal Sharma, Manish Kuchya, Dr. Narendra Kumar, Sandeep Keskar, Bhavik Patel, Swapnil Narkar** and entire team for their support.

I am grateful to my students, **Maulik Panseriya, Bharath Naik, Rakesh Ravula and Sushank Bansal** who worked with me at Central RD Taloja on their Masters dissertations on various subjects connected with this work.

I express my sincere thanks to my family, who has always stood by me in sweet and sour situations. Thanks to my father, who has reviewed my thesis work and helped me to keep focus. I would like to express my gratitude to all friends, family and people who have provided moral support and help throughout my studies.

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# Abbreviation, Notation and Nomenclature

OPC	.....	Ordinary Portland Cement
GGBS	.....	Ground Granulated Blast furnace Slag
FA	.....	Fly Ash
SCMs	.....	Supplementary 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
$\tau$	.....	<i>Shear stress</i>
$\tau_0$	.....	<i>Yield stress</i>
$\mu$	.....	<i>Plastic viscosity</i>
$\gamma$	.....	<i>Shear strain rate (1/s)</i>
LOI	.....	<i>Loss of Ignition</i>
IR	.....	<i>Insoluble Residue</i>