

**AIR ENTRAINMENT IN CEMENT AND CEMENT MORTARS
BY COLLOIDAL GAS APHRONS (CGAS) FOR
MANUFACTURE OF
AERATED CONCRETE**

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**DEPARTMENT OF CHEMICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY DELHI
MARCH 2016**

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AERATED CONCRETE**

by

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DEPARTMENT OF CHEMICAL ENGINEERING

*Submitted
in partial fulfillment of the requirement of the degree of*

DOCTOR OF PHILOSOPHY



Indian Institute of Technology Delhi
MARCH 2016

CERTIFICATE

This is to certify that the thesis entitled “Air entrainment in cement and cement mortars by Colloidal Gas Aphrons (CGAs) for manufacture of aerated concrete” presented by Mr. Narendra Kumar Tiwary, is worthy of consideration for the award of the Doctor of Philosophy and is a record of the original and bonafide research work carried out by him under my guidance and supervision and that the results contained in it have not been submitted in part or in full to any other university or institute for award of any degree or diploma.

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(Narendra Kumar Tiwary)

Air Entrainment in Cement and Cement Mortars by Colloidal Gas Aphrons (CGAs) for Manufacture of Aerated Concrete

Abstract

Aerated concrete is produced by incorporating air or an inert gas in cement or cement mortar matrix. It does not have coarse aggregates. The physical properties of aerated concrete are density dependent and those in turn depend upon total number of voids and their distribution in it. These voids are due to incorporated air or an inert gas in cement or cement mortar. Materials like flyash and slag have also been added to the mortar and have a marked influence on the physical properties of the aerated concrete. Methods of incorporating bubbles into the matrix have traditionally been based on chemical reactions in which a gas produced is entrapped in the matrix causing cellular structure and forming the aerated concrete. An alternative method is the addition of a special air-entraining admixture to the matrix or addition of a preformed stable foam made from air-entraining admixture in a separate foam generator. The entrainment of air bubbles in the matrix by these methods results in the formation of majority of air voids of big size and of limited surface area. The current methodologies of entraining bubbles of desired shape, size, and distribution in cement or cement mortar matrix are inadequate and pose limitations on the quality of aerated concrete produced. This necessitates an alternative method of production of air bubbles which have a more regular shape, smaller sizes, and a more uniform size distribution and which can be entrained in the matrix leading to better physical properties and consequently a better performance at lower costs.

Colloidal Gas Aphrons (CGAs) represent a system which contains finer sizes of air bubbles in the size range of $10\mu\text{m}$ - $25\mu\text{m}$. The surface area of air bubbles is about $5 \times 10^3 \text{ cm}^2/\text{cm}^3$ of liquid. In view of the smaller sizes and uniformity of air bubbles in CGAs, it is expected that the CGAs may produce aerated concrete with a more uniform and finer dispersion of air voids and a corresponding high surface area. The high surface areas will cause more linkages between air voids and the hydration products of cement resulting in a greater porosity of the product, and hence a lighter material but with better physical properties. With this objective, in the present study, CGAs have been used to entrain air in the matrix of cement and cement mortar for producing the aerated concrete. The material produced has been evaluated for its physical properties like dry density, compressive strength, drying shrinkage, water absorption, acoustic properties, and thermal conductivity. The material produced has properties comparable to those of aerated concrete manufactured by other methods of aeration, and the present process is more economical, and environment friendly. The produced material also has a significant potential for sequestration of pollutants like carbon-di-oxide and nitrogen oxides.

DECLARATION

I declare that the thesis entitled “Air Entrainment in Cement and Cement Mortars by Colloidal Gas Aphrons (CGAs) for Manufacture of Aerated Concrete” submitted in partial fulfillment of the degree of Doctor of Philosophy is a record of original work carried out by me under the supervision of Prof. (Dr) Ashok N. Bhaskarwar, and has not formed the basis for award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practices in reporting scientific information, due acknowledgment have been made wherever the findings of other have been cited.

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