Construction and Building Materials 140 (2017) 91–99

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Fal-G Binder Pervious Concrete

K.S. Elango *, V. Revathi

Dept. of Civil Engineering, K.S.R. College of Engineering, Tiruchengode, India

HIGHLIGHTS

- FaL-G binder in pervious concrete (PC) is an attempt to exploit its potential.
- The size of coarse aggregate has direct impact on various properties of PC.
- The aggregate size of 10 mm was found as optimum for FaL-G binder PC.

ARTICLE INFO

Article history:
Received 17 September 2016
Received in revised form 16 January 2017
Accepted 16 February 2017

Keywords:
Pervious concrete
OPC
FaL-G
Coarse aggregate
Compressive strength
Split tensile strength
Permeability
Porosity
Wetability

ABSTRACT

Pervious concrete can be described as a porous concrete which permits the penetration of water through the interconnected network of pores. In general, pervious concrete is produced using Ordinary Portland Cement (OPC) as binder, and being used for pedestrian path, parking lots and has many other applications. In this paper Fly ash-Lime-Gypsum (FaL-G) binder has been used as a binder and studies have been carried out for physical, mechanical and other relevant properties with various sizes of coarse aggregates. The results are compared with the pervious concrete made out of OPC binder. The test results are presented and discussed elaborately. It is found that FaL-G binder pervious concrete satisfies the requirements laid down by codal provisions.

1. Introduction

Pervious concrete is customarily acknowledged for rain water management system due to its enriched porosity. It is a special type of concrete with high pores connectivity and behaves as a storm water infiltration basin. It allows high volume of rain water to enter into the soil over a large area, thus helps in recharging of precious groundwater. Typically, it is used in parking areas, less traffic roadways, pedestrian pathways, swimming pool decks etc. By the way, use of separate storm water retention ponds may be avoided and smaller capacity storm sewers can be used. Since 1970, USA familiarizes the use of pervious concrete with respect to its merits for environmental protection [1,2].

Pervious concrete is a composite material made of the same materials used in concrete with little to no fine aggregates. In fact, interconnected network of pores are decisively incorporated into pervious concrete [3–6]. Permeability of pervious concrete is the significant criteria to ensure the penetration of water. Basically, pervious concrete has to increase the permeability without significantly reducing strength. Single graded coarse aggregate is very much preferable to provide greater permeability and porosity. Low porosity of pervious concrete can improve the compressive strength and with higher binder content, produces better strength properties. [7–10].

Several studies were carried out using Ordinary Portland Cement (OPC) and blended cement as binder and performance was demonstrated at laboratory and field level. These studies reported the strength properties, influence of aggregate sizes, effect of porosity, void ratio of aggregates and permeability characteristics of the pervious concrete [11–15]. Besides, abrasion and raveling resistance of conventional cement binder pervious concrete was also studied [16–18]. Ever since natural resources got

* Corresponding author at: Department of Civil Engineering, K.S.R. College of Engineering, K.S.R. Kalvi Nagar, Tiruchengode 637 215, Namakkal Dt., Tamilnadu, India.

E-mail addresses: kselango04@gmail.com (K.S. Elango), revthiru2002@yahoo.com (V. Revathi).

http://dx.doi.org/10.1016/j.conbuildmat.2017.02.086
0950-0618/

depleted day by day, it became imperative to find an alternative binder. Apart from conventional cement binder, FaL-G (Fly ash-Lime-Gypsum) technology has emerged and gained widespread acceptance across different parts of India. Bhanumathidas and Kalidas are the pioneers in promoting FaL-G as binder. Fly ash is a by-product obtained during the burning of coal in thermal power plant. Lime and gypsum are usually available either from mineral sources or may be procured from industrial wastes. FaL-G is a cement free green binder as it is made of recycled industrial waste. Inevitably, it curtails the CO_2 emission released during the manufacture of cement. Also, cement production involves over exploitation of the natural resources. FaL-G has the full potential to conserve natural resources and controls pollution. It is a low cost and less energy intensive construction material. Further, the durability of FaL-G binder is said to be good due to the enhanced hydration, matrix formation and densification.

Despite its advantages, it has few drawbacks such as increased setting time and relatively low strength. However, when comparing to OPC, FaL-G binder gains its full strength after a period of fifty days due to slow reaction between fly ash, lime and gypsum. Due to slow pick up of the strength, the major application of FaL-G is confined to brick production [19–21]. However, the higher grade FaL-G concrete has been adopted for various applications including mass housing projects, check dams, water tanks and pavements in India [22,23]. Also, it is found that addition of silica fume improved the strength of FaL-G binder [24].

While continuing the above applications, the present study aims to explore the use of FaL-G binder in pervious concrete which is a next step to extend its application. In this study, strength, permeability, porosity, abrasion resistance and chemical resistance of FaL-G binder pervious concrete were evaluated and the results are compared with conventional cement binder pervious concrete.

2. Experimental work

2.1. Materials

In the present work, Ordinary Portland Cement (OPC) of 53 grade conforming IS 12269-1987 was used. High calcium (class C) fly ash was collected from Neyveli Lignite Corporation India Limited, Neyveli, India. The specific gravity of fly ash was 2.62 and the X-ray diffraction (XRD) spectra illustrates that fly ash has huge scatter peak at about 20–30° (2θ max) as indicated in Fig. 1. It endorses the existence of crystalline phases of quartz, calcite, feldspar and mullite in matrix of alumino silicate glass. The SEM image of fly ash designates that nearly all the particles are spherical in shape (Fig. 2).

Lime powder with specific gravity of 2.43 was procured locally. The XRD pattern demonstrates that lime sample has huge scatter peak about 30–40° (2θ max) as indicated in Fig. 3. It confirms the crystalline phases of quartz and calcite. From the XRD results, it is evident that lime is mainly composed of calcite, aragonites, vaterite, quartz and feldspar. The SEM image of lime presented in Fig. 4 reveals that particles are crystalline.

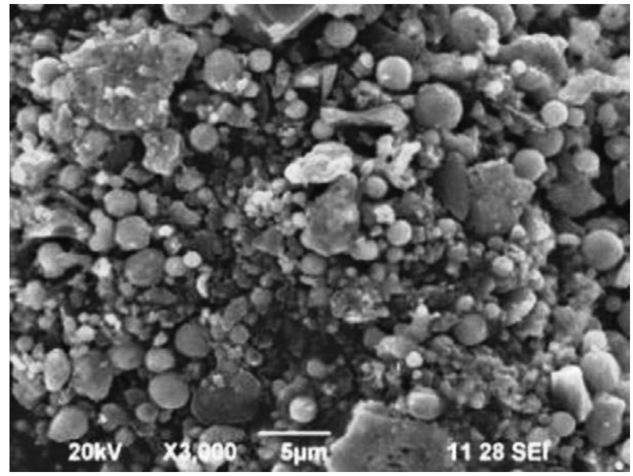

Fig. 2. SEM image of Fly Ash.

Gypsum, a by-product of fertilizer factory was gathered from Cuddalore, India. The specific gravity of gypsum was 2.31.The X-ray diffraction (XRD) spectra in Fig. 5 illustrates that gypsum samples has huge scatter peak at about 20–30° (2θ max). It has been identified that mineral compositions such as calcite and magnetite are present.

The SEM image of gypsum demonstrates the existence of larger and smaller prismatic crystal with smooth surface (Fig. 6). The morphology of gypsum identifies the calcium sulphate crystals in the SEM image.

The coarse aggregate used was crushed, angular blue granite stones of uniform size namely 6.3 mm, 8 mm, 10 mm and 12.5 mm. It has specific gravity of 2.76, 1% water absorption, 16.6% impact value, 18.38% crushing value and 27.4% abrasion value. Potable water available in KSRCE conforming to IS 456-2000 was used in this study for casting and curing of specimens.

2.2. FaL-G binder

Fly ash, lime and gypsum were blended in dry condition in the ratio of 50:40:10. Binder to water ratio was taken as 0.35. This dry blend was added with water and thoroughly mixed. The prepared paste was filled in 50 mm mould and kept in room temperature. After 24 h, specimens were demoulded and covered with gunny

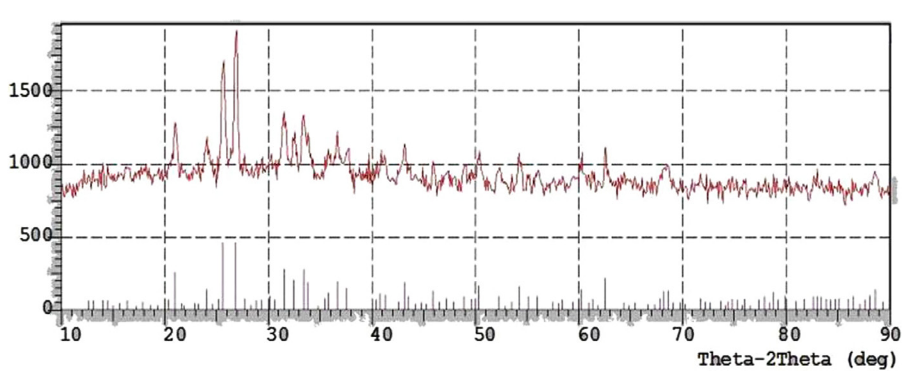

Fig. 1. X-ray Diffractogram of Fly ash.