A Review on Use of Crushed Brick Powder as a Supplementary Cementitious Material

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Introduction

In India, it is estimated that 250 billion bricks are produced annually in about 100,000 kilns present all over the country (Rajarathnam et. al. 2014). Mainly due to inefficient production processes, most of the bricks manufactured are of inferior quality which ultimately becomes a major source of waste production. The characteristics of Construction and Demolition wastes (C&D) are difficult to predict, but a major composition of this type of solid waste comprises of bricks in masonry work. Annually, India produces 10-12 million tons of Construction, Demolition, and Excavation waste material (Banerjee, 2019). As more and more civil structures are nearing the end of their expected lifespan, proper management and disposal of C&D wastes is necessary to obtain a sustainable environment.

Ground waste clay brick is a prospective pozzolanic material due to dehydroxylation of clay minerals during its manufacturing process at temperatures between 450˚C and 700˚C, leading to disintegration of crystalline phases and formation of reactive anhydrous amorphous phases which bring about its pozzolanicity (Navrátilová et. al. 2016). In the present framework, there is an urgent requirement for sustainable use of waste bricks in cement -based composite materials as its appropriate reuse can bring about significant social and economic benefit. Unless a systematic effort is made to correctly incorporate these types of waste materials into sustainable construction practices, dire wastage of finite natural resources will continue to occur. Keeping these views in perspective, a review of the existing literature regarding use of crushed brick powder (CBP) from waste bricks as well as demolition debris as a supplementary cementitious material has been conducted.

Materials and Methods

CBP is commonly used in conjunction with cement or lime to form mortar, which is then used as a construction material. It is also used as a partial replacement for cement and has been widely reported to provide better long term mechanical and durability properties. Pozzolanic nature of CBP comes from the calcining temperature of clay. When the crystal structure of clay is disintegrated, pozzolanicity of that clay is activated. This takes place at an optimum temperature for each type of clay (He et. al. 1995).

A review of the influence of CBP replacement on the properties of concrete in different areas is briefly summarized below:

Table 1. Summary of influence of CBP on different concrete properties

Parameters	Authors	Remarks
Microstructural Behaviour	Aliabdo et. al. 2013	Observations from SEM images indicates that sample having highest amount of CBP displayed the best pore structure
	Bektas et. al. 2007	Decrease in amount of CH for pastes containing CBP during 28 – 91 days was observed using TGA
	Bediako et. al. 2018	Using calorimetry, it was determined that reduced heat liberation occurs in the early periods in CBP blended pastes, which can be useful in the construction of mass concrete structures
	Afshinnia et. al. 2015	XRD analysis of mortar specimens with varying CBP percentages after a period of 1 year revealed that portlandite peaks decreased or even disappeared in the samples replaced with CBP owing to its pozzolanic nature
Mechanical Behaviour	Afshinnia et. al. 2015	28 days SAI of mortar cubes containing10%, 25% and 50% CBP at 90 days was reported as 92%, 86% and 59% respectively
	Zheng et. al. 2011	For varying levels of cement replacement and different average particle sizes, the flexural strength was not significantly affected
	Olofinnade	Increase in 28 days compressive and tensile strength of CBP replaced concrete upto

	et. al. 2016	10% replacement
Durability Characteristics	O'Farell et. al. 2006	Increasing CBP replacement levels in mortar gives increasing resistance to expansion caused by sulphate attack
	Filho et. al. 2007	Pore refinement due to pozzolanic activity retarded chloride ion transport in the matrix
	O'Farell et. al. 2000	Chemical composition of CBP used is responsible for controlling expansion of mortar for resistance to synthetic seawater

Results and Concluding Remarks

Traditional brick making processes employing inefficient technology creates bricks of inferior quality in addition to generating environmental pollution. These solid wastes generated must be utilized in the construction industry. Pozzolanic character of clay used for making brick comes from calcining it at a optimum temperature, which is different for different clays. Cement replacement by CBP in concrete mostly causes increased compressive, flexural and split – tensile strength at 28 and 90 days indicating good pozzolanic behaviour. 10 – 25% replacement by CBP gives acceptable values of Strength Activity Index (SAI) at 7 and 28 days. Pore refinement causing formation of additional hydration products due to pozzolanic reaction as well as filler effect of CBP are the primary factors causing improved durability of concrete.

Limited research has been done on the effect of chemical composition of raw clay on the pozzolanic potential of CBP is available. Future scope in this area remains in the investigation of parameters for enhancement of pozzolanicity in CBP, study of high volume replacement of CBP in concrete and effect of CBP replacement on corrosion of rebar.

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