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ScienceDirect

Procedia Environmental Sciences 31 (2016) 218 – 226

Procedia Environmental Sciences

The Tenth International Conference on Waste Management and Technology (ICWMT)

Reuse research progress on waste clay brick

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Abstract

Waste clay brick (WCB) is silicate solid waste, its recycling has great environmental and social significance. The application of WCB as recyclable coarce and fine aggregate in concrete and mortar, wall materials, as well as raw material or addition in the production of recyclable cement, has been briefly introduced. The following aspects were emphasized: the research progress of the impact of WCB as supplementary cementitious material on physical mechanics, deformation and durability of cementitious materials; the progress of the function of WCB as environmental materials on eliminating fluorine, ammonia nitrogen and phosphate in waste water; the current research status of the impact of WCB as recyclable aggregate on the mechanics, durability of GRC; the current status of WCB as filler in decorative paints, as filler in rubber plastic materials after being organically modified, as well as in the production of recyclable ancient architectural brick in recent years. The problems in recycling of WCB has also been summarized.

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific

Keywords: waste clay brick, recycling, research progress.

1 Introduction

With the speeding up of urban construction and improvement, a large amount of Waste Clay Brick (WCB) from the demolition of old buildings has been produced. According to statistics, WCB account for 50%-70% of the construction waste produced by urban redevelopment, and 30%-50% by building operations [1]. Quite a lot of brick not up to standard were also produced during the production of clay brick. In the past, WCB were often transported to suburban areas and countryside, and were treated with open-air piling up or being buried underground, which spent a large sum of requisition fees, and the issues like dispersing rubbish also caused serious second environmental pollution.

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Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific
doi:10.1016/j.proenv.2016.02.029

According to the literature[2], in the past five decades, at least 20 billion meters cubed of clay brick products have been produced in China, which will mostly be transformed into solid waste in the next five decades, approximately accounting for 50% of the total amount of construction garbage. Whether WCB surface with cement mortar or not, they're typical silicate solid waste, consisting of SiO_2 and AI_2O_3 in majority, the amount of the two accounting for no less than 80% of the total, other compounds are Fe_2O_3, TiO_2, CaO, MgO and so on. The mineral components are mainly quartz, feldspar and hematite, but clay mines and carbonate will also exist if not fully sintered[3].

Since the surface of WCB is rough, porous, and there are lots of corner angles and the micro cracks caused by disintegration and crush on it, WCB aggregate possess characters as low strength and high hygroscopicity compared to natural aggregate. Though it's unfavourable for working ability and strength of concrete and mortar, the character of rough surface and high hygroscopicity will form a microtubule or micropore system similar to light aggregate, which is advantageous for improving the cohesiveness between aggregate and cement, as well as increasing the compactness of hardened cement near the surface of aggregate, and also improving the interface structure of aggregate and cement paste [4-5], thus, the properties of concrete will be improved. Through adjusting the proportion, adding admixture and modifying the aggregate with organic compound, the strength, dry-shrinkage, freezing and thawing resistance, and chloride ion penetration resistance of recyclable concrete and mortar will be improved in different extents with WCB as coarce or fine aggregate [6-10].

With small apparent density than dinas aggregate, and sharing some characters of lightweight aggregate, WCB aggregate were often used to produce wall materials, the influence on physical mechanics, durability and thermal insulation of wall materials were researched with WCB as coarce or fine aggregate partly or totally, or supplementary cementitious materials [11-14]. In order to improve one or several characters mentioned above, the meatures often being taken is to add admixture (like fly ash), lightweight aggregate (like waste polystyrene particles), foamer, activator and so on, in those ways, products meeting the demands of some standard could be produced[15-19], the thermal insulation effect of produced lightweight wall materials has yet to be improved due to relevant high thermal conductivity of WCB itself.

As silicon-aluminum materials, WCB has the character of pozzolanic activity, there was documents recording masonry cement without clinker produced by WCB in the early 1970s [20]. When WCB was used to produce cement, it mainly serve as raw materials or admixture, and via activated technology or proper proportion of different raw materials, cement meeting a certain demand of strength grade could be produced [21-25].

Since there are already comprehensive documents [26-27] regarding application research of WCB in concrete, mortar, wall materials, road materials as well as recycle cement, an elaborate account will not be given in the text. The applications of WCB in the following aspects are summarized: 1)as supplementary cementitious materials, with particle size less than cement, WCB was used in cementitious materials directly or after being grinded or alkali activated; 2) Used in environmental materials; 3) Used in GRC materials, decorative materials, as filler in rubber plastic materials, as well as in recyclable ancient architectural bricks.

2 WCB used as supplementary cementitious materials in cementitious materials

2.1 The influence of WCB on physical mechanics, mechanical property, workability and deformability of cementitious materials

According to document [28], the physicochemical property of cement mortar specimen were researched ,which cement clinker partly replaced by WCB accounting for 0%,5%,10%,15 and 20% respectively of the total mass, as well as mechanical property in 7d, 28d and 90d. The microscopic structure of mortar was examined via SEM, while mineral components with XRD, and particle distribution analyzed with LG., the results show that WCB, an artificial pozzolanic material, could increase the time of grinding and setting of cement. When cement was replaced 10% by WCB, the strength of mortar could be increased.

According to document[29], the relationship between the mixing amount (0-50%) of WCB powder, which pozzolanic activity index is 107%, and the pozzolanic reaction was researched. The results show that when cement was replaced with 10%,20%,30%,40%,50% by WCB powder respectively, the setting time of the mixing system increased and the compressive strength accelerated more slowly in the early stage, but the strength increased sharply in the later stage. According to microscopic analysis, $Ca(OH)_2$ (CH) and CSH gel of the mixed phase have the same