國立臺北科技大學
資源工程研究所

碩士學位論文

利用焚化底渣作為混凝土磚粗細骨材之研究

A Study on Municipal Solid Waste Incinerator Bottom Ashes Used as Fine/Coarse Aggregates of Concrete Block

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摘　要

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本研究以焚化底渣全取代天然粒料之粗細骨材，並在水灰比、粗粒料比、水泥對粒料比例、爐石粉取代水泥比、攪拌時間等操作參數下進行壓製混凝土磚的實驗，以研發垃圾焚化底渣多元之資源化用途。本研究之實驗係利用製磚廠現有之小台方型製壓金屬模具與震動馬達來壓製混凝土磚，並盡可能模擬工廠實際生產流程與措施，一次總共可以完成25塊 7cm ×7cm×4cm試體。本研究粒料使用來源分為天然砂石與焚化底渣，以水灰比、粗粒料比、水泥對粒料比例、爐石粉取代水泥比例及材料攪拌時間為操作參數，並透過田口式實驗設計法之L18及L9等直交表，依序進行製磚實驗。藉由抗壓強度、吸水率、孔隙率、單位重等工程性質，比較焚化底渣與天然粒料所製成之混凝土磚性質，以探討以垃圾焚化底渣作為粗細骨材製作混凝土磚之可行性。

由研究結果顯示最佳的實驗參數為水灰比0.3、粗粒料比30%、水泥粒料比0.25、爐石粉取代水泥比0%、攪拌時間3分鐘，製成試體之強度最佳達250kgf/cm^2，接近CNS 3930的規範標準，但其他組別試體強度則大多不超過150 kgf/cm^2，顯示研究所利用焚化底渣製成之混凝土磚有很多改善空間，而低水灰比下，天然粒料的製成效果未明顯好於焚化底渣，除了單一組配比強度最佳達到CNS 3930標準之外，其他組別強度均不超過100 kgf/cm^2。在得到第一階段實

驗結果後馬上規劃第二階段製磚實驗，第二階段實驗精簡了操作參數而更深入的探討水泥粒料比、粗粒料比與爐石額外添加量對磚體的影響。由結果顯示，磚體的單位重增加，而孔隙率與吸水率降低，意味著磚體結構更加密實而強度亦隨著增強，最佳操作參數為水泥粒料比0.3、粗粒料比40%、爐石粉額外添加量4%，各組試體28天抗壓強度最佳可達300kgf/cm^2 ，可滿足CNS 3930的規範。另外，對試體進行乾溼循環養護以測試其耐候性，研究結果亦證明了焚化底渣製成之混凝土磚試體在極端氣候狀態之下並不會有所損壞，反而藉由浸水使得試體能夠持續進行水化反應，進一步增強試體強度。綜合本研究結果顯示，在考慮垃圾焚化底渣全量資源化再利用之前提下，配合混凝土磚成型技術，以垃圾焚化底渣全量取代作為粗細骨材製成混凝土磚具有其可行性。

ABSTRACT

Title：A Study on Municipal Solid Waste Incinerator Bottom Ashes Used as Fine/Coarse Aggregates of Concrete Block

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In this study, the feasibility of MSWI bottom ashes fully substituting for natural sandy gravels as fine/coarse aggregates to produce concrete block is evaluated, and the experimental parameters such as water-cement ratio, coarse aggregate ratio , cement ratio, slag added ratio and stirring time are investigated. The experimental molding machine was used to produce concrete block specimens and the compressive strength test of concrete block is performed after 28 days of curing at room temperature. The types of aggregate are including natural sandy gravel and MSWI bottom ash. The ratio of water to cement is set to 0.22, 0.26 and 0.3 . The ratio of coarse aggregate is set to 0%, 15% and 30%, and the ratio of cement is set to 0.15, 0.2 and 0.25. In addition, the ratio of slag added is set to 0%, 15% and 30%, and the slurry mixing time is set to 2 minutes, 3minutes and 4minutes. All operating parameters were designed with Taguchi methods. By analyzing the engineering properties of concrete blocks such as compressive strength, water absorption, porosity and unit weight, it explored the feasibility of concrete blocks made from MSWI bottom ash aggregate.

The results indicated that the optimum experimental parameters were 0.3 of water-cement ratio, 30% of coarse aggregate ratio, 0.25 of cement ratio, 0% of slag added ratio and 3 minutes of slurry mixing time. The highest compressive strength of all specimens would reach to 250kgf/cm^2, it was close to the standards of CNS 3930. However under lower water-cement ratio, the compressive strength of concrete block made from natural sandy gravel aggregate was not significantly better than MSWI bottom ash. Based on the above results, the following experimental parameters such as cement ratio, coarse aggregate ratio and slag added ratio would be further investigated. By analyzing unit weight, porosity, water absorption and compressive strength of concrete blocks, the optimum parameters were 0.3 of cement ratio, 40% of coarse aggregate ratio and 4% of slag added. The highest compressive strength of concrete blocks would reach to 300kgf/cm^2, it complied with the standards of CNS 3930. Besides, the effects of weather resistance through wet-dry cycle test is evaluated, the results indicate that the higher compressive strength of concrete block is, the more wet-dry test cycle is. Based on the results of this study, it is feasible that MSWI bottom ashes could fully substitute for natural sandy gravels as fine/coarse aggregates to produce concrete blocks.

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