공항 활주로 포장용 친환경 콘크리트의 활용 방법

A Sustainable Concrete for Airfield Rigid Pavements

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Abstract

The use of recycled concrete aggregates (RCA) as a substitute for natural aggregates in new concrete produces both economic and environmental advantages. Most of the RCA applications for pavements have been primarily applied to support layers for roads and airfields. This paper summarizes a work completed at the University of Illinois in partnership with the O'Hare Modernization Program to examine the effect of coarse and fine RCA on the concrete's fresh and hardened properties for airfield rigid pavement applications. Ten different RCA concrete mixtures were prepared with the incorporation of different percentages of RCA fines as well as replacement of cement with high volume percentages of supplementary cementitious materials such as Class C fly ash and ground granulated blast furnace slag to improve the workability and long-term properties of RCA concrete. All the mixes on this stage included 100% recycled coarse aggregates and the Two-Stage Mixing Approach was used as a mixing procedure. Based on the results obtained in the research, mixes with high percentages of recycled fine and coarse aggregates could be used for construction of airfield concrete pavements in conjunction with supplementary cementitious materials

키 워 드 : 순환골재, 활주로, 콘크리트, 지속가능성
Keywords : recycled aggregate, airfield pavement, concrete, sustainability

1. 서 론

The ultimate objective of this study was to ascertain the viability of RCA concrete as a rigid pavement surface material for airfield applications.

2. 실험 개요

A study was conducted to evaluate the suitability of crushed airfield concrete as recycled concrete aggregates (RCA) for used in future airfield concrete pavement applications. Concrete mixtures were designed with the measured physical properties of the RCA including absorption capacity, specific gravity, and gradation. All concrete mixtures in this study had a total cementitious content of 517 lb/yd^3 and a water-to-cementitious ratio of 0.42. A minimum of 20% of Type C fly ash partially-replaced the Type I cement. During this study, two mixing procedures were evaluated to determine if the fresh and hardened properties of the RCA concrete could be improved: normal mixing procedure (NMP) stated in ASTM C192 (2007)[1)] and two-stage mixing approach (TSMA) proposed by Tam et al. (2008)[2)]. The TSMA enables the RCA to be initially coated with a cement slurry during the mixing in order to improve workability and fill voids and cracks in the RCA to enhance the bonding and properties of the new interfacial transition zone.

3. 실험 결과

The partial replacement of sand with RFA showed that there was an effect on the initial slump of the mixtures depending on the RFA replacement percentage and the concrete strength (compressive, split tensile, and flexural strength). RFA mixtures containing higher fly ash contents achieved mean flexural strength values less than typically required for concrete pavement acceptance at 28 days. The effects of RFA and high volumes of supplementary cementitious materials on the free shrinkage were not significantly different than the natural aggregate concrete at

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ages less than 28 days but were greater than the free shrinkage strains after 28 days for both the natural and RCA concrete.

The permeability and freeze-thaw resistance of concrete with coarse and fine RCA was found to be adequate as long as sufficient curing time and air void system existed. The results from the rapid chloride penetration test and an air permeability test revealed that the chloride penetrability and air permeability ratings were relatively low.

4. 결 론

Overall, RCA can be used as a replacement for natural coarse aggregate for airfield concrete pavement applications when looking at its effects on workability, strength, shrinkage, and durability. In this study with crushed airfield concrete, the replacement of virgin aggregates with coarse and fine RCA resulted in a slight strength reduction (compression, split tension, and flexural) as well as a reduction in fracture energy. Free shrinkage strains were similar up to 28 days but RCA concrete had increased shrinkage strains at longer drying times. The freeze-thaw durability and permeability of RCA concrete was found to be acceptable even for higher pozzolan RCA mixtures as long as sufficient curing time was allotted. By utilizing a different batching and mixing procedure, TSMA, and supplementary cementitious materials, the workability of coarse and fine RCA can be used successfully to cast concrete pavements with limited to no change in the long-term strength characteristics of the hardened concrete. The TSMA can provide a slight increase in strength properties over the NMP and maintaining the initial aggregate moisture state near to saturated conditions can also benefit workability and strength properties.

Workable concrete mixes with low cementitious content were obtained for all mixtures evaluated with the use of a superplasticizing agent. In general, the slump was reduced with the addition of RFA which increased the required superplasticizer dosage. As expected, increases in the fly ash content of the RCA mixtures increased the slump primarily due to the increase in the total paste content. An analysis of variance demonstrated that the compressive, split tensile, and flexural strengths were statistically affected by the RFA content and higher volumes of supplementary cementitious materials. Mixtures containing higher fly ash volumes (>30%) with addition of slag) achieved mean flexural strength values less than typically required for concrete pavement acceptance and thus mix adjustments and specifications would need to be implemented. In general, RFA and high volumes of supplementary cementitious materials had similar free shrinkage strains to virgin aggregate concrete (Stage III) at ages less than 28 days but were greater than the free shrinkage strains after 28 days relative to the virgin and RCA concrete in Stage III. Overall, the free shrinkage strain rates at 56 days especially for mixtures with higher pozzolan and RFA content were much higher than the virgin aggregate concrete (Stage III).

Acknowledgement

This research was supported by Brain Pool program funded by the Ministry of Science and ICT through the National Research Foundation of Korea (2020H1D3A2A01048216).

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