Characterization of compaction and CBR properties of recycled concrete aggregates with different fines contents for roadbed materials

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Keywords: recycled concrete aggregates (RCA), fines content, compaction, CBR, particle breakage

INTRODUCTION

Nowadays along with rapid urbanization, the pollution from construction and demolition waste (CDW) is becoming increasingly serious in Vietnam. Among of CDW, concrete waste is commonly recycled and used as roadbed materials after crushing and grading. Many studies have been done to characterize the mechanical properties of recycled concrete aggregates (RCA) such as compaction and CBR properties. However, limited studies are available to examine the effect of fines content (F_c; typically, the particle size of fines < 0.075 mm) on the mechanical properties though F_c controls the internal frictional resistance of graded RCA and particle breakage. This study, therefore, aims to carry out compaction and CBR tests of RCA with different F_c and to characterize the effect of F_c on the particle breakage.

MATERIALS AND METHODS

Concrete waste was collected from Thanh Tri CDW landfill in Hanoi, Vietnam. The concrete waste was crushed, sieved and graded in the laboratory to prepare samples for a series of laboratory tests. RCA samples used in this study were prepared with two different maximum diameters (D_{max}) of 25 and 37.5mm, and four different F_c of 0, 5, 10 and 20%. 22TCN333-06:2006 and 22TCN332-06:2006 were used to carry out compaction and CBR tests. For the CBR tests, samples were compacted at optimum water content (w_{opt}) that estimated from compaction test. In order to measure particle breakage, three different compaction energies, E_c = 580, 2631, 5262 kJ/m^3 were applied to compact samples. After the compaction test, the samples were sieved into each fraction to examine % increment/decrement (difference in mass % each fraction between before and after compaction) of each fraction.

RESULTS AND DISCUSSION

Figure 1 shows the tested results of compaction test. The maximum dry densities (MDD) of RCA appeared when F_c=5-10% and w_{opt} became around 9.5-10.5%. The "bulking" that gave a local minimum dry density can be observed for each test sample at the water content range from 6 to 7%.

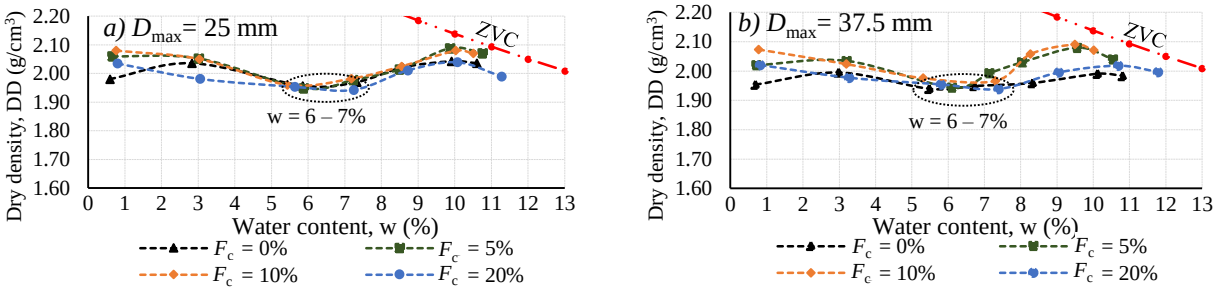

Figure 1 Compaction curves for tested materials

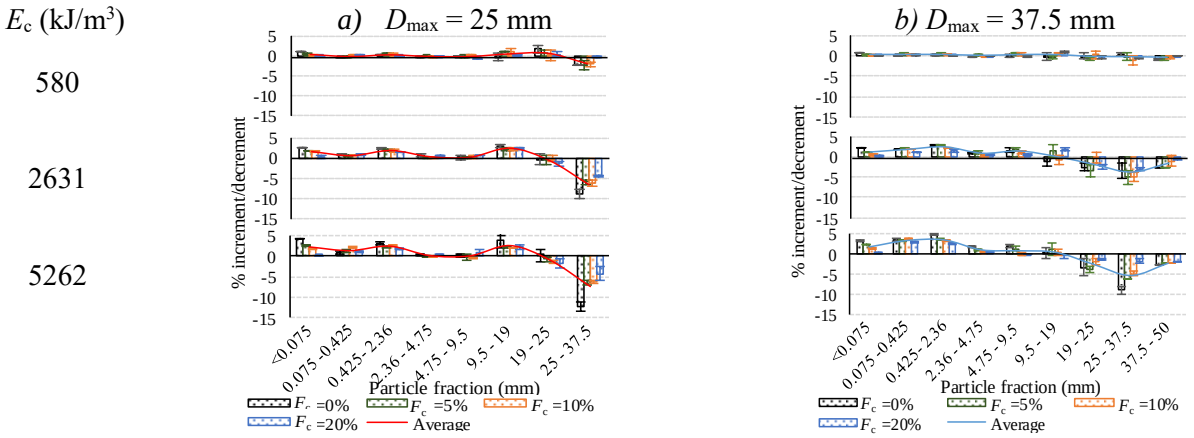

Figure 2 Particle breakage mode under different compaction energies

Figure 2 shows the % increment/decrement of each fraction after the compaction test. For both D_{max} of 25 and 37.5mm, the values of % increment/decrement increased with increasing of E_c. It was observed that almost no particle breakage for tested samples at the lowest E_c (= 580 kJ/m^3) condition. Regardless D_{max}, the fraction of 25-37.5 mm gave the highest % decrement (i.e., the most breakage) and the fraction of 0.475-2.36 mm gave the highest % increment. Measured CBR values as well as reported values in past studies were plotted against dry density (DD) and shown in Fig. 3. The CBR tended to increase linearly with increasing of DD, however, the measured values were scattered from the linear regression line especially at DD >1.95 g/cm^3 irrespective of F_c values.

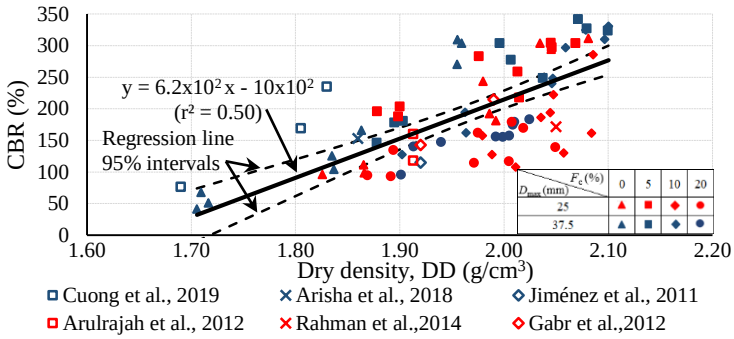

Figure 3 Relationship between CBR and DD

CONCLUSION

This study examined the effect of F_c on the compaction and CBR properties of RCA. The MDD became the highest for the samples with F_c=5-10%. The particle breakage became the most significant at the fraction of 25-37.5 mm, resulting in the highest % increment at the fraction of 0.475-2.36 mm. The CBR values gave a scatter increase with the increase of DD at high density condition.

ACKNOWLEDGEMENT

This research was supported by JST-JICA Science and Technology Research Partnership for Sustainable Development (SATREPS) project (No. JPMJSA1701).

REFERENCES

Arisha A.M., Gabr A.R. et al., Performance evaluation of construction and demolition waste materials for pavement construction in Egypt, J. Mater. Civ. Eng., 30, 2, 04017270, 2018.

Arulrajah A., Piratheepan J., et al., Geotechnical properties of recycled concrete aggregate in pavement sub-base applications, Geotech. Test. J., 35, 5, 1–9, 2012.