CHARACTERISATION OF HYDRATED CEMENT TREADED CRUSH ROCK BASE FOR BASECOURSE MATERIAL IN WESTERN AUSTRALIA PAVEMENT

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1. INTRODUCTION

Hydrated Cement Treaded Crushed Rock Base (HCTCRB) is a unique road base in Western Australia (WA), and made by blending standard crushed rock base (CRB) (Main Roads Western Australia 2008) with 2% General Purpose Portland cement (Standards Australia 1997). It is mixed and stockpiled at the optimum amount of water for a specific hydration period. Unlike the traditional cement treated base material, as after the hydration period it is retreated in order to break cementitous bonds, which generate during a hydration period, to maintain the properties of an unbound material. HCTCRB is expected to provide higher strength and lower moisture sensitivity than those of CRB, while avoiding the fully bound characteristics and fatigue cracking problems in cement treated material (Butkus 2004). This paper aims to present the mechanical characteristics of HCTCRB in terms of the resilient modulus using repeated load triaxial tests. The experiment works were conducted to study the influences of various factors during production process (i.e. cement content, mixing moisture content and hydration period) on HCTCRB properties.

2. LABORATORY WORKS

To examine the impact of cement content, test specimens were prepared using cement content of 1%, 2% and 3% by dry mass of CRB at the individual optimum moisture content (OMC). The effects of hydration period and moisture content were studied by producing HCTCRB with 2% cement content which is the typical amount of cement used in WA for HCTCRB. The hydration periods used in this study ranged from 7, 14 and 28 days. The amount of water used for crushed rock-cement mixtures at the initial stage (the first mix of cement, water, and CRB) of HCTCRB manufacture were varied from 100%, 110% and 120% of the OMC resulted from the moisture and dry density relationship of CRB-cement mixtures. These amounts of mixing water were specified to provide extra (enough) water for hydration reaction and prevent the mixture too dry at completion of a given hydration period. After completion of hydration and retreated processes, the test specimens were made using a modified compaction method, WA 133.1 (Main Roads Western Australia 2007), in the standard mold of 100 mm in diameter and 200 mm in height. The repeated load triaxial (RLT) tests to determine the test material resilient modulus following the standard test method, AG: PT/T053 (Austroads 2007) of which the drained triaxial conditions were conducted on the tested specimens and the suctions were not measured. The repeated vertical force waveform has a period of 3.0 s with rise and fall times of up to 0.3 s, and a load pulse width of 1.0 s. The resilient modulus tests were performed using 66 stress stages of various confining and deviator stresses to simulate the complex traffic loadings. The stress ratios between deviator stress and confining stress varies from 2 at the first stage to 25 at the final stage. The test specimens were subjected one thousand cycles of preconditioning stage and two hundred cycle-loadings at each stress stage.

3. RESULTS

3.1 Effect of cement content on the resilient modulus of HCTCRB

The resilient modulus test results plotted against bulk stresses are shown in Figure 1. All test samples exhibit the stress-dependent behavior. The test results can prove that the HCTCRB technique greatly improves the strength of the original material, CRB. HCTCRB samples with 3% cement provided the poorest performance even though it contained the greatest cement content amongst these three cement contents. This occurrence was a consequence of water consumption during hydration reaction. At the end of hydration time and prior making this specimen, its moisture content dropped to about 83% of its OMC. Thus, the material was considerably dry and the specimen could not be compacted properly as a result of insufficient water to lubricate the material grains during compaction. The moisture content after hydration completion of 1% and 2% cement samples were approximately 91% and 89 % of their OMCs, respectively. These two samples could be compacted and made the more qualified specimens than that of 3%cement content. It could be interpreted that those two samples (1% and 2% cement contents) still contained suitable amount of water for compacting the specimen.

3.2 Effect of hydration periods and amount of mixing water on the resilient modulus of HCTCRB

The resilient modulus test results of all HCTCRB samples with various hydration periods and moisture contents are illustrated in Figure 2.The results revealed those hydration periods and moisture contents affect the mechanical properties of HCTCRB. However, the related trends correspond to the different hydration periods and moisture contents were inconclusive. For normal cement treated base, the higher cement content and lower moisture content induce the higher modulus. The retreated process to break the cementitous bonds of the hydrated mixture is supplemented to produce HCTCRB. It is assumed that this breaking process mainly caused the uncertainty properties of HCTCRB.

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4. CONCLUSIONS

All HCTCRB samples showed considerably superior performances to those of CRB. In terms of cement contents, HCTCRB samples with 2% cement showed the highest strength whilst the 3% cement samples provided the poorest performance even though it contained the greatest cement content amongst other test samples. Thus 2% cement content would be still suitable for making HCTCRB. The results also reveal that hydration periods and moisture contents affect the mechanical properties of HCTCRB. However, the related trends correspond to the different hydration periods and moisture contents still cannot be clearly concluded. It is assumed that the retreated process to break the cementitous bonds of the hydrated mixtures would mainly cause some uncertainty of HCTCRB properties.

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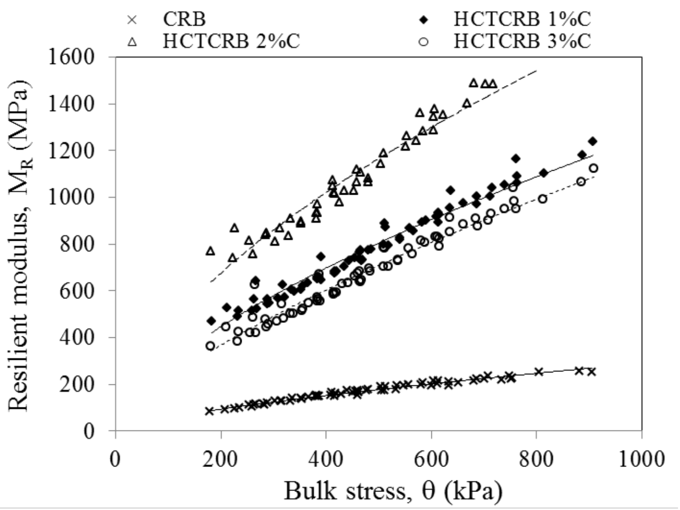

Fig. 1 Resilient modulus test results over the range of cement content

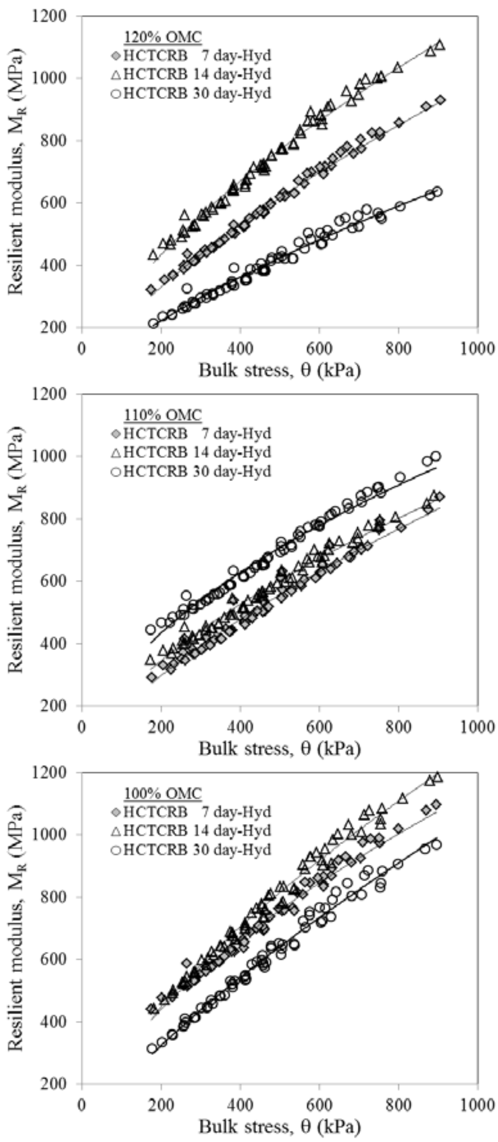

Fig. 2 Resilient modulus test results with variation of hydration periods and moisture content