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Abstract

CHARACTERIZATION OF ALKALI SILICA REACTIVITY OF XI JIANG RIVER SAND

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This thesis presented the investigation results on the Alkali Silica Reactivity (ASR) of Xi Jiang River Sand at Xio Cheng (XJRS) (肇慶西江河砂). The sand sample was spot collected in a batching plant in Macau Coloane. To perform this investigation, a series of tests were performed with testing methods following American Society for Testing and Materials (ASTM). Crushed granite rock sample from a quarry in Coloane (CCGR) (路環花崗碎石) was also collected for a comparison purpose.

Petrographic analysis was performed following ASTM C295 :1985 on XJRS by using stereomicroscope and polarized light microscope with modal point count analysis. A content of 13.0% reactive constituents (5.0% Claystone, 4.4% Silicolite/Chert, and 3.6% Graywacke) was found existing in XJRS. Those constituents consisted of microcrystalline quartz, cryptocrystalline silica and chalcedony which are prone to ASR. Petrographic analysis on CCGR was also performed. It was found that it contained only insignificant amount of strained quartz and trace amount of microcrystalline quartz. CCGR was considered as ASR innocuous.

Mortar bar expansion tests following ASTM C227:90 were performed on both XJRS and CCGR for ages up to 6 months. The expansions of mortar bars of both aggregates were 0.02% at 6th month showing that both aggregates were innocuous. The test results of XJRS did not support the petrographic results. The presence of graywacke (metamorphic sandstone) could mislead the test results. Thus, the mortar bar method ASTM C227:90 may not be suitable for XJRS.

Accelerated mortar bar tests following ASTM C1260:94 were performed on XJRS and CCGR for ages up to 1 month. The expansions of XJRS mortar bars were greater than 0.20%, 0.35% and 0.56% at 9th day, 14th day and 1st month respectively suggesting that XJRS was deleterious reactive aggregate with rapid expansion and long lasting reactivity. The non-suitability of ASTM C227:90 on XJRS was further confirmed by these test results. The expansions of CCGR mortar bars were 0.08% and 0.12% at 14th day and 1st month respectively showing that CCGR was innocuous and it was consistence to the results of petrographic analysis and mortar bar method ASTM C227:90.

To investigate any pessimum concept existing in XJRS, accelerated mortar bar tests were carried out on mixtures of XJRS + CCGR in different proportions for ages up to one month. It was found that as the XJRS content decreased, the expansion decreased. However, only the mixture down to 10% of XJRS + 90% CCGR could fall within innocuous range. Mortar bar expansion remained constant when reactive mineral content was between 9% to 13%. The reactive mineral content of XJRS is 13% which limited the testing with reactive mineral content beyond 13%. Hence, pessimum phenomenon could not be fully demonstrated in this study.

To confirm the occurrence of ASR in the XJRS mortar bars under the accelerated mortar bar test, and to verify if the reactive minerals took place in this chemical reaction, the mortar bars were examined by petrographic analysis following ASTM C856-95 by using stereomicroscope, polarized light microscope with modal point

count analysis, metallurgraphic microscope, and X-ray dispersion analsysis (EDX) under Scanning Electron Microscope (SEM). Cracks, gels, and attacked aggregates confirmed the ASR occurrence. Fresh alkali silica gels ($(Na_2O{\cdot}K_2O{\cdot}SiO_2)$) and calcium alkali silica gel ($Na_2O{\cdot}K_2O{\cdot}CaO{\cdot}SiO_2$) were found.

Discussion on the structural effects of ASR by using with Shunde River Sand (another location of Xi Jiang River) (順德河砂) was presented as an informative portion of this thesis. Concrete prisms 75x75x285mm, after cured for 28 days were soaked under 1M NaOH of 80°C for ages up to 3 months. Prism expansion, E-modulus, and compressive strength were determined according to ASTM C1293-01, CS1 :1990 Section 17 and Section 15 AMD 1201 respectively. It was found that the E-modulus and the compressive strength reduced along with the expansion of prisms. However, the reduction will become stable at certain ages. The total reduction on E-modulus and compressive strength were found to be approximately 60% and 23% respectively.