A STUDY ON ASR EXPANSION MITIGATION BY MINERAL ADMIXTURES AND LiOH・H2O

イスネイニ, モハマド

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氏　　名　: Mohd Isneini (モハマド イスネイニ)

論 文 名　: A STUDY ON ASR EXPANSION MITIGATION BY MINERAL ADMIXTURES AND LiOH・H_2O
(鉱物質混和材および LiOH・H_2O による ASR 膨張の抑制に関する研究)

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論 文 内 容 の 要 旨

Nowadays, concrete deterioration has become a major problem throughout the world. One of factors that contribute to the deterioration of concrete is Alkali-silica reaction (ASR). ASR will occur when these components such as reactive silica, alkalis and sufficient moisture are present in concrete. Several ways, such as 1) use of blended cement, 2) use of cement with low alkali content, 3) use of innocuous aggregate and 4) control of total alkali content in concrete have been applied to control or even to stop ASR in concrete. Currently, it is generally accepted that supplementary cementitious materials (SCM) such as fly ash (FA), silica fume (SF) or blast furnace slag (BFS) are widely used in concrete to prevent ASR.

This experimental study was carried out in the laboratory to investigate the effectiveness of mineral and chemical admixtures on reduction in ASR expansion. In this study, mortar and concrete specimens were made with reactive aggregate to test ASR expansion. The pessimum proportion of aggregate is used as 30% (reactive) and 70% (non-reactive). Concrete prism specimens were made according to RILEM AAR-3, and mortar prism specimens were made based on JIS A 1146. Specimens were cured and kept under 40ºC and R.H. 100% for expansion test. In this study, laboratory test was performed, therefore, strictly controlled condition could be arranged. This dissertation consists of seven chapters. The content of each chapter is as following.

In **Chapter 1**, research background, objectives of the research and thesis arrangement are explained, as well as the general framework.

In **Chapter 2**, brief introduction, theoretical background is explained. Also, aggregates used in this study and main methodology of this study is explained. Description on the supplementary cementitious materials (SCM) such as, silica fume (SF), fly ash (FA), expanded perlite powder (EPP) and chemical admixture, that is, LiOH H_2O are also included in this chapter.

In **Chapter 3**, based on previous studies showing the advantage of SF, FA, BFS on the ASR suppression, supplementary cementitious materials (SCM), silica fume (SF), fly ash (FA) and expanded perlite powder (EPP) were experimentally tested. Test results show SF 10%, FA 25%, EPP 15% added in cement could successfully suppress the ASR expansion in concrete. And, the results clarified that FA10%+SF5%, FA15%+SF10%, FA15%+EPP10% could also suppress the ASR expansion. As a result, mixture usage of FA and SF, FA and EPP are very good combination in mitigating ASR.

In **Chapter 4**, mechanism of ASR suppression by the single use and the combined use of minerals of FA,

SF and EPP are discussed. From discussion of the test results, a clear relationship between ASR expansion and total silica (SiO_2) content was found both for mortar and concrete. The relationship is expressed by the quadratic curve with correlation coefficient 0.69 for mortar and 0.85 for concrete. From this finding, as a parameter for ASR prevention by mineral admixture, total silica content can be adopted.

In **Chapter 5**, based on previous research showing that 4M LiOH H_2O solution could change reactive aggregate to passivated (non-reactive) aggregates. In the experiment described in this chapter, the 4M LiOH H_2O solution treatment of reactive aggregate was tried not only for mortar bar but also concrete bar. The results show that treatment in the 4M LiOH H_2O solution in 80°C for 5 days is effective to reduce ASR expansion of andesite containing crystbalite, however, for andesite containing opal, the treatment in 80°C for 10 days is necessary to obtain enough effectiveness. On the other hand, the paste covering method, that is, covering reactive aggregate with LiOH H_2O mixed paste before making mortar and concrete, could not reduce the ASR expansion. For both aggregates, 3M LiOH H_2O solution in 80°C for 5 days is not effective to reduce ASR expansion

In **Chapter 6**, a test on the combination of mineral admixture and LiOH H_2O was performed by using mortar bar specimens. As shown in Chapter 3, in order to reduce ASR expansion by FA, the FA replacement ratio should be at least 25%. In the experiment described in this chapter, FA at level of 10% and 15% is tested with 2M or 3M L_iOH H_2O treatment. From experimental results, mortar bar with aggregates treated with 2M or 3M L_iOH H_2O solution and with FA 10% or 15% was not expanded due to ASR. From this results, it can be estimated that by combing FA and L_iOH H_2O effects, the ASR prevention effect could be obtained with smaller amount of FA and L_iOH H_2O. Unfortunately, the minimum amount for FA and L_iOH H_2O could not be derived in this study.

In **Chapter 7**, conclusions, recommendations and future works are presented.

From this study, several new findings could be obtained on ASR prevention by mineral and chemical admixtures, as followings.

1) FA, SF and EPP has a potential to reduce ASR expansion. Effectiveness of these admixtures on ASR prevention, can be successfully designed by using the total silica (SiO_2) content in concrete.

2) Combination of FA, SF and EPP can also have a potential to reduce ASR expansion. The effectiveness can be estimated by same parameter.

3) The LiOH H_2O solution treatment was effective in reducing ASR expansion. In this study, 3M was not enough, but 4M was effective.

4) Combined use of FA and LiOH H_2O could also reduce ASR expansion. By combining them, FA could be reduced from 25% to 15% or 10%, and LiOH H_2O could be reduced from 4M to 2M or 3M as minimum requirement for ASR prevention.