PHYSICAL PERFORMANCE AND DURABILITY EVALUATION OF RUBBERIZED CONCRETE

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論 文 名　：PHYSICAL PERFORMANCE AND DURABILITY EVALUATION OF RUBBERIZED CONCRETE
(ゴムチップを混入したコンクリートの物理特性および耐久性評価に関する研究)

区　　分　：甲

論 文 内 容 の 要 旨

The main objective of this research is to develop rubberized concrete with achievable structural strength using simple mix design. Simple mix design is a description by using the crumb rubber, used as in condition just received from the plant without any washing or pre-treating procedure. Then, three types of durability test were conducted namely, 1) Abrasion wear resistance test, 2) Chloride ion diffusion test, and 3) Freezing and thawing test. Up-to-date, many successful achievements were reported by researchers around the world. However, in Asian cases, very rare information on the use of wasted as a mixture component is gathered. By conducting this study, it could provide useful and valuable knowledge for construction technology especially for Asian industry.
This dissertation consists mainly of the seven chapters.

In **Chapter 1**, the background, problem statement, significance, research contribution and novelty of this study are listed out.

In **Chapter 2**, research review on previous researchers work on the application of waste tire rubber in mortar/concrete and durability are described. Several important properties related to this study were viewed and discussed. High reduction in strength properties was observed by previous researchers and many suggestions were proposed either by washing the rubber or the use of suitable treatment on the rubber surface in order to enhance the bonding of the matrix. However, in my research, by using conventional mixing method, it was proposed that to use the rubber without any treatment (use directly as received) with maximum 20% sand replacement in volume is a method to use crumb rubber effectively. As a result, each rubberized mixture showed an acceptable structural strength value.

In **Chapter 3**, three step-by-step stages of mix design were conducted and discussed. The *first stage* was the preliminary study to determine the suitable waste tire rubber size and percentage replacement that can be used in rubberized mortar. Three rubber size group were received from the industry plant which where combination of 1mm-3mm, combination of 0.71mm-1.7mm and 0.425mm. Size of 1mm – 3mm with 10% of sand replacement was chosen in terms of acceptable fresh and hardened mortar properties. In *second stage,* suitable water-to-cement ratio (w/c) and required additional binder was determined before proceeding to concrete mix. Results shows that w/c = 0.35 gave reliable mortar physical properties. Finally, rubberized concrete with w/c =0.35 was carried out and specimens were prepared for mechanical test and durability test. Along these three stages, air content was carefully studied and controlled.

In **Chapter 4**, experimental work and discussion on chloride ion diffusion in rubberized concrete tested by migration test and by immersion in salt water was described. Effective diffusion coefficient, D_e test was conducted according to JSCE-G571-2003. Meanwhile, immersion test in salt water was conducted according to JSCE-G572-2003. Additional concrete specimen with w/c = 0.50 was prepared to study the effectiveness of CR in high w/c in comparison with w/c = 0.35. Results showed that chloride transport characteristics were improved by increasing the amount of CR due to the fact that CR has the ability to repel water. Meanwhile, rubberized concrete with w/c = 0.35 gave better resistance against chloride ion compared to w/c = 0.50.

In **Chapter 5**, discussion on the effectiveness of crumb rubber to improve wear resistance tested by surface abrasion test were described. An experimental study on abrasion wear resistance was conducted on mortar (w/c = 0.35, 0.30 and 0.25) and concrete (w/c = 0.35) specimen containing CR with and without silica fume. From test results, it was clearly seen that 10% crumb rubber addition as sand replacement provide good resistance against abrasion. Meanwhile, compressive strength was the most important factor affecting the abrasion resistance, where abrasion resistance was increased with an increase in compressive strength. However, abrasion resistance was found to be slightly decreased when compressive strength exceeds $50N/mm^2$.

In **Chapter 6**, the role of crumb rubber as air void under freezing and thawing was studied. Specimen was prepared in three groups; first group was the specimen without silica fume with air content ranging between 4% to 5%, second group was the specimen without silica fume with air content ranging between 0% to 1.5% and third group was the specimen with silica fume with air content ranging between 4% to 5%. These rubberized concrete were tested on freezing and thawing resistance to understand this behavior. The temperature for freezing and thawing was set to 15°C ±5°C for thawing temperature and -18°C±5°C for freezing. This test was continued until 300 cycles according to ASTM C666. Results show that up to 300 freeze-thaw cycle, there was no minus effect observed for all specimen.

In **Chapter 7**, conclusion from (1) to (4) were drawn based on Chapter 4 to Chapter 6 and recommendations for future works is presented.

(1) Even though the strength was reduced with the inclusion of crumb rubber, the reduction was less than 50% and it achieved acceptable structural strength.

(2) Chloride transport characteristics were improved by increasing amount of CR due to the fact that CR has the ability to repel water. Similar positive behavior was also observed in porosity test with the replacement of crumb rubber in concrete.

(3) Rubberized concrete showed good resistance against abrasion load where the depth loss were decreased with the increasing of crumb rubber in the mixture.

(4) There were no minus effect of crumb rubber on concrete resistance against freezing and thawing.