第Ⅴ部門 **Study on Bonding Shear Strength at Interface between New and Old Concrete**

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1 Introduction

The key factor in repair and strengthening of existing reinforced concrete structures by increasing concrete layer is the bond strength at the interface between new and old concrete. Until now the bond strength is evaluated by bonding tensile strength obtained from pull-out test. In many structures such as bride deck overlay, however, the main stress acting on the interface is shearing stress. So, it is necessary to know and to control the bonding shear strength. The aim of this study is to develop a measuring method and to study bonding shear strength at the interface between new and old concrete. This report describes the experimental results on bonding shear strength by changing surface treatment between new and old concrete.

2 Specimen and Test Method

In this study, torque test is developed as a new testing method to measure bonding shear strength at the interface between new and old concrete. The main instrumentation are torque meter and an analyzer for recording of torque moment as shown in Fig.1. Two rectangular prisms made from cement mortar with mix characteristic ratio of cement to sand of 1:3 and w/c ratio of 0.65 were arranged as the old concrete. The surface of each prism was divided into 4 parts and different surface treatment was applied to each part as shown in Table 1. Then new layer cement mortar was casted on the prisms and cured. Partial cores were cored on the prisms until they reached to the bonded surface. Steel disks were attached to the cores' surface with epoxy. Torque instrument was attached to the steel disk and force was applied through the torque wrench until failure occurred. The failure occurred at the weakest part which could be at the old concrete, new concrete, bonded surface or the combination of these as shown in Fig 2. The maximum torque moment Mt was recorded by the analyzer. The equilibrium equation between maximum shear strength can be obtained by the following equation:

$$\tau_{max} = \frac{16M_t}{\pi d^3}$$ where d = diameter of core

Pull-out tests were also conducted on the same prisms.

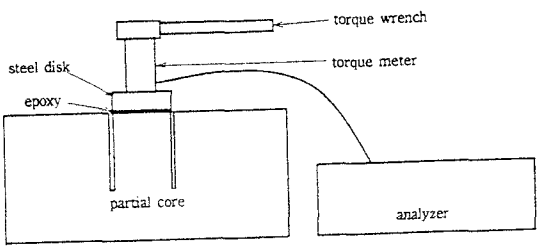

Fig.1 - Torque Test Instrument

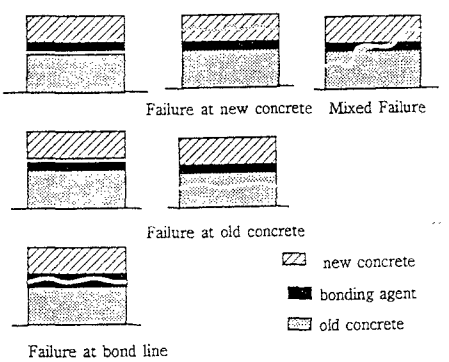

Fig.2 - Type of Failure Modes

3 Test Results and Discussion

From Table 1, in the case without usage of bonding agent(water was used instead), the chipping treated cores had developed the highest bonding shear strength as compared to hydrodemolition and grinding treated cores as expected because chipping treated cores had the highest degree of surface roughness. Failure modes of chipping treated cores were mixed failures while the other two were bonded surface failures. This indicates that the higher the degree of surface roughness the higher the bonding shear strength.

Table 1 - Result of Torque and Pull-out Tests on Various Surface Treatments (kgf/cm^2)

Surface Treatment	Bonding Shear Strength	Bonding Tension Strength
Chipping + water	31.22	16.88
Hydrodemolition + water	14.25	1.81
Grinding + water	9.42	3.49
Hydrodemo+cement slurry	38.57	6.42
Grinding + epoxy	41.35	15.32
Shot blast + cement slurry	42.52	18.9
Shot blast +epoxy	38.44	21.74

Comparing the result of hydrodemolition treated cores without bonding agent and with cement slurry as bonding agent, the bonding shear strength of the later increased over 2 times. For grinding treated cores, the usage of epoxy as bonding agent had increased the bonding shear strength by 4 times. Failure mode of cores using bonding agents were mixed failures as shown in Fig 3. This indicates that bonding agents help to increase bonding shear strength at the interface between new and old concrete.

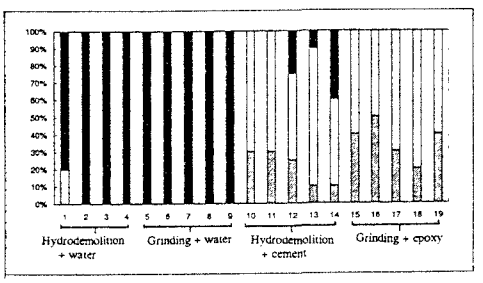

Fig. 3 - Failure Mode of Cores with/without Bonding Agent

Looking at the result of shot blast treated cores using cement slurry and epoxy as boding agents, it was found that the values of bonding shear strength were about the same. This indicates that using epoxy as bonding agent does not necessarily give better bonding strength compared to cement slurry although the price of epoxy is generally higher.

The result of pull-out tests showed the same trend as in torque tests as shown in Table 1.

From Fig 4, there is a linear relationship between bonding shear strength and bonding tensile strength.

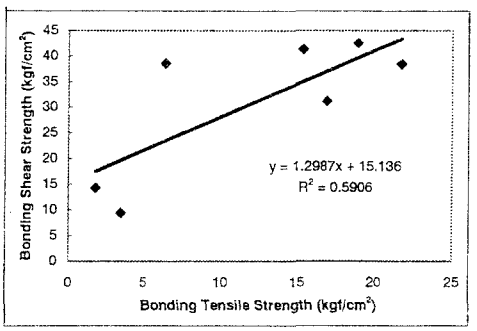

Fig.4 - Bonding Tensile Strength Vs Bonding Shear Strength

4 Conclusion

In this study a new testing method to measure bonding shear strength by using torque test has been developed. There is a linear relationship between bonding shear strength and bonding tensile strength. The higher the degree of roughness of old concrete surface the higher the bonding shear strength. Applying bonding agent such as cement slurry and epoxy help to increase greatly the bonding shear strength. There is not much advantage of using epoxy as bonding agent compared to cement slurry as the price of epoxy is generally higher.