第V部門 **Study on Bonding Shear Strength at Interface between New and Old Concrete- Part 2**

Osaka University Fellow M Shigeyuki Matsui
Osaka University Student M ○ Maisarah Ali
Sho-Bond Corporation Member Shinsuke Kurihara

1 Introduction

One of the most important requirements of repair works for concrete structures is the achievement of a satisfactory bond between the repair material and the substrate. A number of testing methods have been proposed to measure bond strength such as slant shear test, direct tensile test, compression shear test, etc. but they are mainly laboratory tests and mainly used as material testing to satisfy material specifications. Only a few are suitable for testing on site. Consequently many repair works have been carried out without effective monitoring of their quality. Therefore there is a need for testing method to measure bonding strength on site.

The objective of the study is to develop a testing method to measure bonding strength between new and old concrete and to study factors governing bonding strength. In the first part of this study, a new testing method to measure bonding shear strength at the interface between new and old concrete has been developed by using torque instrument. In the second part, beam tests are carried out to confirm the validity of this method.

2 Specimen and Test Method

The specimen for torque test are13 concrete prisms of size 1300 x 1100 x 100 made from ready mix concrete of specified strength of 240 kgf/cm^2. After curing, each prism was divided into 2 sections and different surface treatments were carried out on each section as shown in Table 1. Then new concrete of 50mm thickness was poured on the prisms. After curing, partial cores of 100mm dia. and 60mm depth were done on the prisms. Steel disks were attached to the surface of the cores with epoxy. After a few days the torque instrument was attached to the steel disk and force was applied by the torque wrench until failure occurred. The torque instrument and layout of specimen are shown in Fig.1 The equilibrium equation between the maximum shear strength can be obtained by the following equation:

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

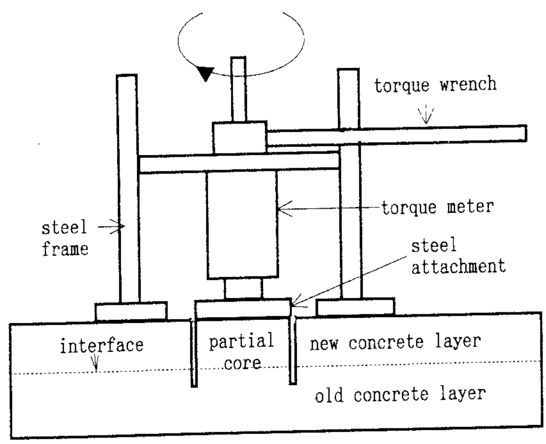

Fig 1. Torque Instrument and Specimen

The specimens for the beam test were beams of size 530 x 120 x 150 (new concrete layer thickness is 50 mm). First the beam substrates were made with concrete of the same mix and 2 D13 reinforcements at the bottom of the beam. After curing, surface treatments were carried out on the top surface of the beams (substrates). Then new concrete of 50mm thickness was poured on the substrate with 2D10 reinforcements in the new concrete layer. After curing the beams are tested in static loading as shown in Fig 2. Load was applied with every 1 ton increment to permit measurements of data until failure occurred.

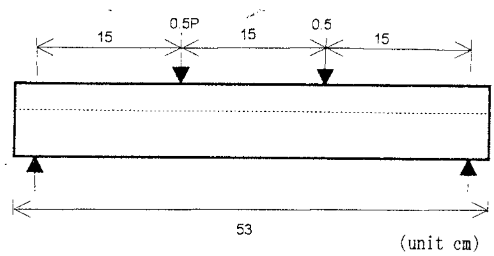

Fig 2. Layout of Beam Test

Shigeyuki MATSUI, Maisarah ALI, Shinsuke KURIHARA

3 Test Results and Discussion

From Table 1, in the case without the usage of bonding agent, sand blast treatment developed the highest bonding shear strength as compared to dry ice blast and no surface treatment as expected, because it had the highest degree of surface roughness. However the failure modes these specimens were shear failure at the interface between the new and old layers.

Specimens using polymer mortar as bonding agents, most of the specimens did not fail mostly at interface but at the new and/or old concrete. This indicate that the bonding strength between the two layers were strong. In this category chipping treated surface had the low shear value and most of the failures occurred at the old layers. This may be due to micro cracking occurring in the old layer while chipping.

Using epoxy on no treatment surface improved the bonding strength greatly and failure did not occur at the interface.

Table 1. Torque Test Results

Specimen Type	Bonding Agent	Surface Treatment	τ_{max} (kgf/cm^2)
3nd	no	dry ice blast	34.70
3nn	no	no	26.94
3nb	no	sand blast	39.34
3sf	polymer mortar	fine grind	41.97
3sg	polymer mortar	course grind	40.35
3sd	polymer mortar	dry ice blast	33.37
3sb	polymer mortar	sand blast	40.74
3sc	polymer mortar	chipping	37.39
3en	epoxy	no	35.40
3eb	epoxy	sand blast	33.68
lef	epoxy	fine grind	40.58
leg	epoxy	course grind	41.14
led	epoxy	dry ice blast	45.93
len	epoxy	no	38.00
leb	epoxy	sand blast	37.20

For beam specimens, under the loading flexure cracking first occurred in the center followed by diagonal tension cracks near the support propagating towards the loading point. For specimens with epoxy + short blast and polymer + shot blast and dry ice failed by crushing of the compression zone. However the beams with no bonding agent + no surface treatment, polymer mortar + course grind and dry ice blast, cracks occurred at interface as shown in Fig.3. From Table 2, it is found that the shear capacity of these beams were 24% lower that those which did not cracks at the interface. This mean that if bonding is not done properly, the new layer does not act as a composite beam and this reduce the overall capacity of the beam.

Table 2. Beam Tests Results

Specimen No	Bonding Agent	Surface Treatment	Cracks at Interface	Max Shear Stress (kgf/cm^2)
3eb1	epoxy	sand blast	no	70.35
3eb2	epoxy	sand blast	no	67.81
3sb1	polymer mortar	sand blast	no	71.45
y3sd	polymer mortar	dry ice blast	no	67.48
3sg1	polymer mortar	course grind	yes	54.87
y3sg	polymer mortar	course grind	yes	57.26
y3nn	no	no	yes	56.88
3sd1	polymer mortar	dry ice blast	yes	53.53

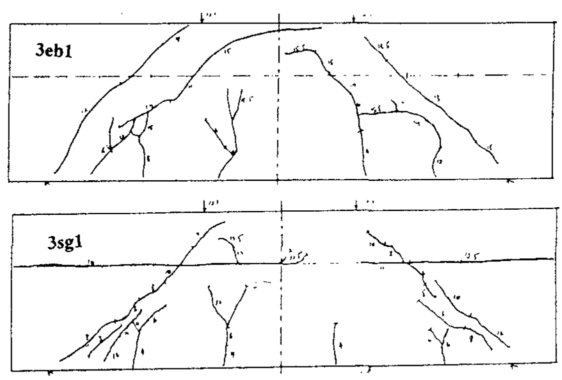

Fig 3. Crack Patterns in Beams

The results between the two tests method cannot be compared directly due to different loading methods and stress condition along the interface. However generally looking at these two results it is found that without the usage of bonding agent and any surface treatment, the bonding strength at the interface is very weak.

4 Conclusion

In this study a new testing method to measure bonding shear strength by using torque has been developed. The higher the degree of roughness of old concrete surface the higher the bonding shear strength. Applying bonding agent such as polymer mortar or epoxy helps to increase greatly the bonding strength at the interface between new and old concrete. The shear capacities of beams which cracks occurred at the interface were about 24% lower than those in which cracks did not occur at the interface.