

## 第V部門

# Preliminary Test for Application of Half-Cell Potential On Long Concrete Specimen Attached with Conductive CFRP Layer

Kyoto University Student Member O Phanuphan PIBOONSAK  
Member Takashi YAMAMOTO, Atsushi HATTORI Fellow Toyoaki MIYAGAWA

## 1. INTRODUCTION

In the previous research (1), the readings of half-cell potential, HCP of the RC specimens with the dimension of 400 x 100 x 50mm, on the conductively strengthening layers, both with hole and without hole, were quite the same as the readings obtained on concrete surface without attaching. However, the problem arises that the obtained values present the average value of the whole specimen, or just present the local values. This research aimed to study the distribution of HCP reading on longer concrete specimens attached with conductively strengthening layers as before.

## 2. METHODOLOGY

Three concrete specimens with the dimension of 1200 x 100 x 50mm with a D10 steel bar placing at the center were cast. The specimens' details are shown in Fig.1. The conductive strengthening layer used in this test is the CFRP sheet bonded by the conductive epoxy resin, epoxy resin mixed with carbon black powder. The details of two mix proportions of concrete are shown in Table1.

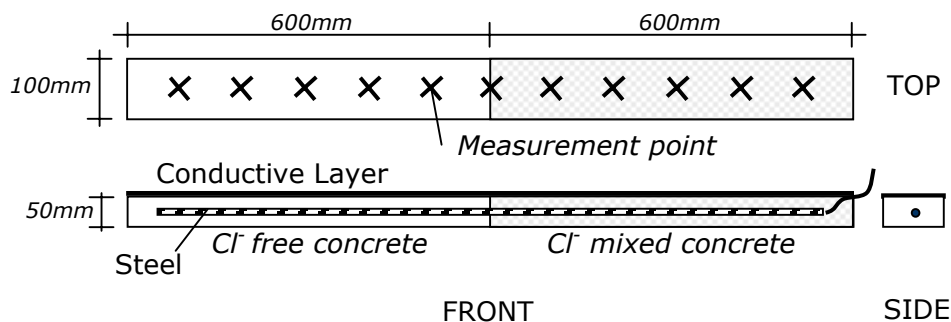


Fig.1: Test specimen

Table 1: Mix proportions of Concrete

Concrete Mixes	Unit (kg/m <sup>3</sup> )					Unit (cc/m <sup>3</sup> )	
	W	C	S	G	NaCl	WRA	AEA
Cl free concrete	188	314	897	889	-	785	1256
Cl mixed concrete	188	314	897	889	0.5	785	1256

The considered factor in this preliminary test is chloride ion content in concrete. Two types of 0.6 w/c and 51% s/a concrete mixes were used, which were Cl<sup>-</sup> free concrete and Cl<sup>-</sup> pre-mixed concrete, in order to make steel's corrosion in these two regions different. Therefore, the HCP reading from these two regions may come out differently. The 5% NaCl solution was sprayed only on Cl<sup>-</sup> mixed region from the concrete surface in order to accelerate corrosion and let the HCP readings different between two regions of the concrete specimens. The specimens were placed in room temperature.

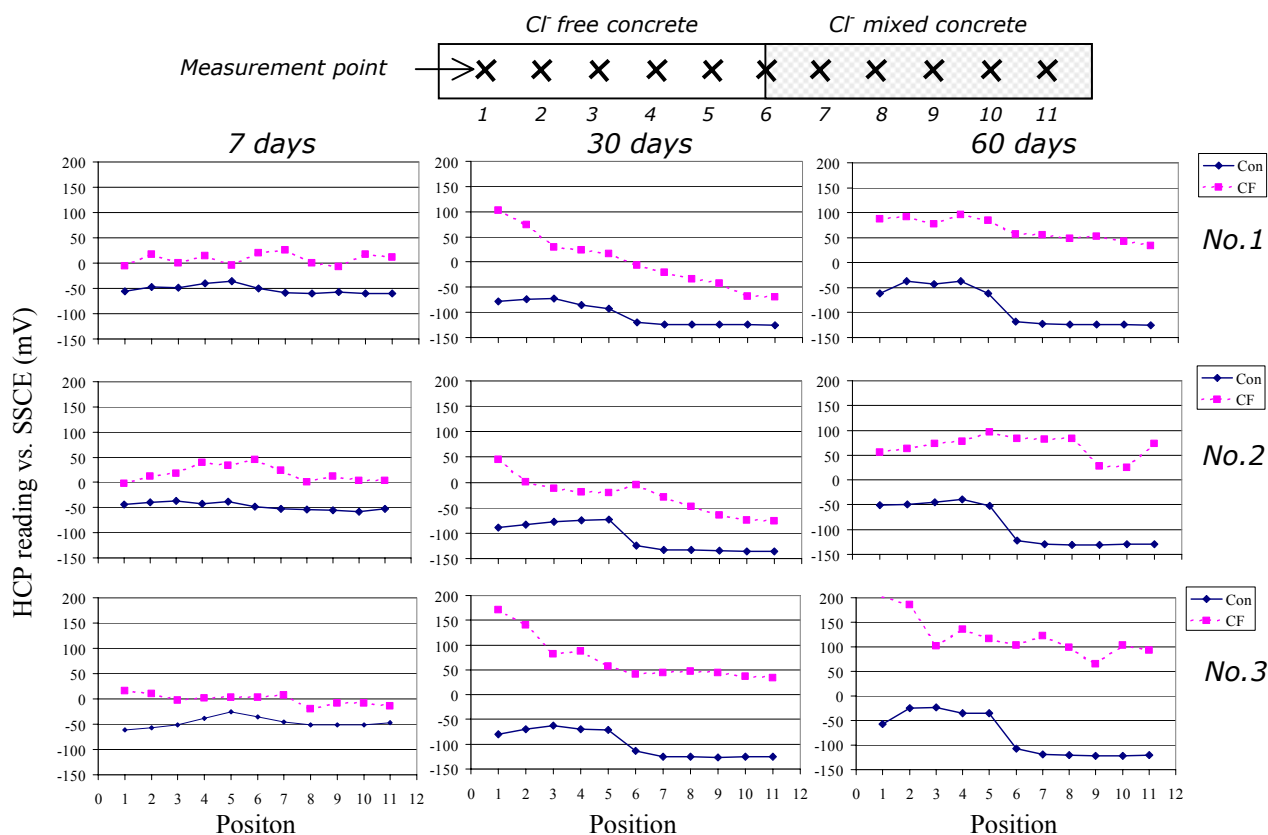
The measured item was the HCP in addition to the visual observation. The measurement times are set to be 1 week, 1, 2 and 3 months. The measurement will be done at every 10cm as shown in Fig 1.

## 3. EXPERIMENTAL RESULTS

The experimental results are shown in Fig.2. The HCP readings obtained at 7 days on both sides of the specimen, i.e. on concrete surface and on conductive CFRP layer, are in the same range in both Cl<sup>-</sup> free and Cl<sup>-</sup> mixed regions in all specimens (No.1 – No.3) as shown on the left hand side. Corrosion of the steel bar was not significant yet in this period.

For the reading obtained at 30 and 60 days, the values obtained on concrete surface are in the step shape; nobler in Cl<sup>-</sup> free region and sharply change to be poorer in Cl<sup>-</sup> mixed region, in all specimens,

because of the effect of the different  $\text{Cl}^-$  content and spray condition between those two regions. The values obtained on the conductive CFRP layer also are in the same tendency, but gradually decrease from left to right ( $\text{Cl}^-$  free region to  $\text{Cl}^-$  mixed region), not in the step shape, except in specimen No.2 at 60 days. Moreover, their magnitudes are also different from those obtained on concrete surface.



**Fig.2:** Experimental results

Refer to the experimental result in the previous research (1), HCP reading obtained on various types of conductive layers are quite equal to those obtained from concrete surface. The difference that obtained in this preliminary test may be explained in 2 ways. Firstly, the difference of moisture condition under the conductive CFRP layer on test specimen due to the difference in exposing methods. The wet and dry cycle was employed in the previous work, but spraying of 5% NaCl solution from concrete surface was used in this test. Secondly, the corrosion may be more severe on the steel surface that located close to 5% NaCl solution sprayed on concrete surface.

#### 4. CONCLUSIONS

The HCP reading is in the step shape, nobler in  $\text{Cl}^-$  free region and sharply changes to be poorer in  $\text{Cl}^-$  mixed region, when obtained on concrete surface. The HCP reading obtained on conductive CFRP layer is in the same tendency and gradually decreases from left to right, but it is not in the step shape as one obtained on concrete surface.

#### 5. FURTHER WORKS

The other types of strengthening material will be applied to this test in order to gain more experimental results, and find out the effect of the conductively strengthening layer to HCP reading. The curing method may be improved in order to make the moisture condition to be the same for the whole specimen. Moreover, the test may be developed in order to measure on the cylindrical column's surface.

**Reference:** (1) Piboonsak, P., Yamamoto, T., Hattori, A., Miyagawa, T., *Electrochemical Corrosion Monitoring of Steel in Reinforced Concrete Member bonded with Conductive Layer*, Proceeding of JSCE Conference, V-096, pp 189-190, 2004.