EFFECT OF COARSE AGGREGATE ON BEHAVIORS OF CPC UNDER TENSION

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1. INTRODUCTION

Chemically prestressed concrete (CPC) has been well recognized for its cracking resistance [1]. It is considered that the ductile properties of restrained expansive concrete reported by previous research contribute to this cracking resistance [2]. However, cracking is not solely affected by the mechanical properties of concrete. The interaction between the reinforcement and the surrounding concrete also significantly influences cracking of RC and CPC. Yet, the interaction between the reinforcement and expansive concrete in CPC has hardly been scrutinized. This lack of information makes it impossible to clarify doubtful properties of CPC such as its crack spacing or its tension stiffening effect. This study is therefore an attempt to elucidate the interaction between the reinforcement and surrounding expansive concrete when CPC is subjected to pure tension.

2. EXPERIMENTAL PROGRAM

Table 1: List of specimens

Name	Type of Material	Expansive Agent (kg/m^3)	Cracking Load (kN)
N-10	RC	-	29.78
E60-10-1	CPC	60	59.86
E60-10-2	CPC	60	46.88
NM-10	RM	-	60.04
EM90-10	CPM	90	103.62

Table 2 Mix Proportions

	Unit Content (kg/m^3)					Strength (MPa)
	W	C	E	S	G	
N	165	330	0	860	956	37.20
E60	164	268	60	860	956	35.33
NM	254	507	0	1346	-	38.51
EM	252	411	90	1346	-	33.96

RC and CPC prisms were prepared. List of all specimens is given in Table 1. Specimens were composed of reinforced concrete (RC), CPC, reinforced mortar (RM) and chemically prestressed mortar (CPM), had a cross section of 100x100 mm^2. Total length of specimen is 600 mm. Mix proportions is given in Table 2. Profile of specimens is illustrated in Fig. 1. An unbonded zone of 100 mm was provided by inserting PVC pipe at the end of specimen to avoid free end of prisms from acting as pre-cracks. Spiral reinforcement was additionally inserted to prevent unwanted internal cracking. 30-mm thick plates and nuts were used to restrain the expansion of all specimens. Holes were created in the steel plate for fixing acrylic plates with specimens. These plates and nuts were removed just before loading. The demolding was conduced 24 hours after casting and the specimens were cured under moist condition afterwards. The monotonic tensile loading was conducted at the age of 28 days.

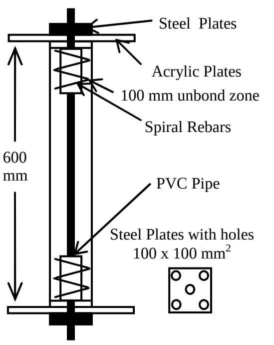

Fig1. Profile of specimens

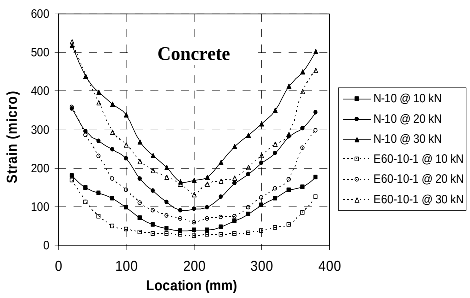

Fig 2 Strain distribution of reinforcement (N-10 and E60-10)

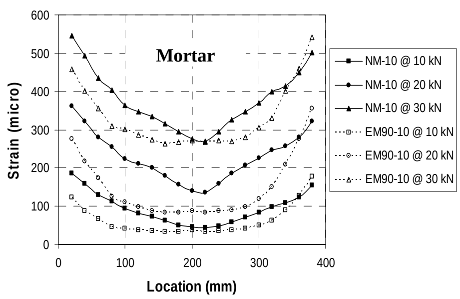

Fig 3 Strain distribution of reinforcement (NM-10 and EM90-10)

3. EXPERIMENTAL RESULTS

3.1 Strain Distribution of Reinforcement

Fig 2 and Fig 3 show the strain distribution of reinforcement in each specimen. The strain distribution between that of CPC is different from that of RC and the strain of reinforcement in CPC is less than that in RC in general. These smaller strains of the reinforcement indicate that the expansive concrete in CPC is capable to carry more load than ordinary concrete in RC.

3.2 Total Elongation of Reinforcement

From the strain distribution of reinforcement, the total elongation of the reinforcement can be calculated as the area under the strain distribution curves shown in Fig2 and Fig3. The elongation calculated by assuming that there is no slip at the middle of the specimen is shown in Fig 4 (Elongation of half of specimen).

Keywords: Expansive concrete, Strain distribution, Aggregate, Elongation
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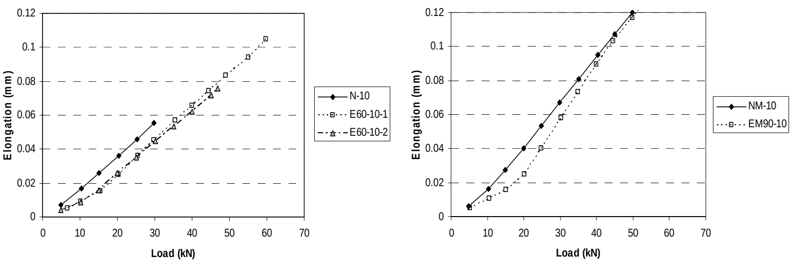

Fig 4 Relationship between load and elongation of reinforcement

In the case of concrete, elongation of reinforcement is shortened and this shorten elongation remained even after load increased. However, in the case of mortar, although the elongation of the reinforcement is reduced initially, the reduction of the elongation was gradually vanishing when the load increased.

3.3 Surface Concrete Strain

The strain of surface concrete is shown in Fig 5. For RC and CPC, the value and shape of the surface strain distribution are similar although the elongation of the reinforcement is not equal to each other. On the other hand, the surprising result could be observed in the case of CPM. The strain distribution of CPM is initially similar with that of RM. Nevertheless, the distribution of surface strain of CPM remained same when the load was increased from 20 kN to 30 kN although the strain elongation of reinforcement was considerably during that period. As the results, the average strain of surface mortar in CPM is smaller than that in RM at the cracking. [see Fig 5c and 5d].

4. DISCUSSION

According to aforementioned results, the presence of the coarse aggregate can significantly influence the interaction between the reinforcement and surrounding concrete in CPC. Without coarse aggregate, not only the elongation of reinforcement can be reduced just at the lower load but the strain of surface concrete is less when the load reaches cracking load.

Since the elongation of reinforcement and the average surface strain of concrete is highly related with the crack width of RC and CPC. The shorter elongation of reinforcement and larger average surface strain is preferable if the crack width is to be controlled. Therefore, CPM may not be efficient for solving cracking problems.

Mechanism of these behaviors of CPC and CPM is still under further investigation. Coarse aggregate may influence the internal restraining condition so that the mechanical properties of expansive concrete are well upgraded. Furthermore, the authors are expecting that not only the presence of coarse aggregate but the shape of steel bar may also significantly affects the behaviors of CPC.

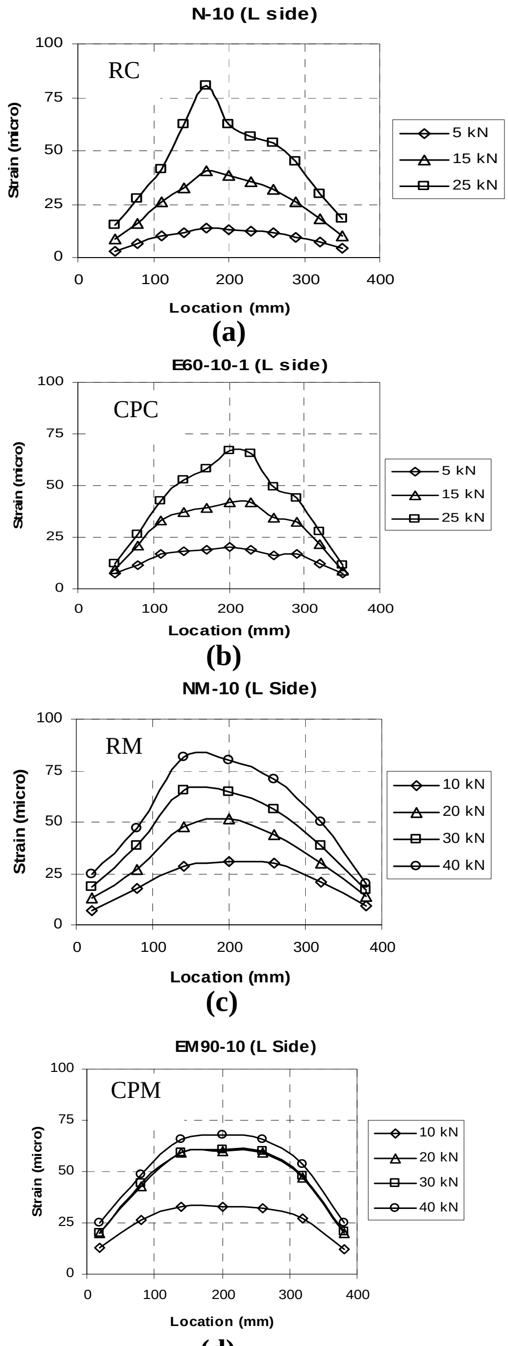

Fig 5 Strain distribution of surface concrete

5. CONCLUSION

Influence of coarse aggregate on the interaction between reinforcement and surrounding matrix in RC, CPC, RM and CPM were investigated. It was found that the merits of CPC may partly disappear if the coarse aggregate is not provided.

REFERENCE

1. Sahamitmongkol, R. and Kishi T., "The Effect of Restrained Level on Cracking Resistance for Chemically Prestressed Reinforced Concrete", JCI Conference, Vol. 25, No.2, pp.763-768, 2003
2. Hosoda, A. et al., "Behavior of Expansive Concrete Under Tensile Stress Including Tension Stiffening", the Eighth East Asia-Pacific Conference on Structural Engineering & Construction, 2001