An Analytical Study on Strain Distribution of Concrete Adjacent to Prestressed Joint

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1, INTRODUCTION

When we assemble precast RC members, in general, we put a rubber plate between the members. However, many unclear phenomena to be clarified exist with the interaction between rubber and concrete. In this study, we conducted an experiment to observe the interaction, and simulated the interaction phenomena analytically.

2. OUTLINE OF TEST AND TESTING RESULTS

Fig.1 shows the schematic figure of the test. Each concrete specimen was a 300mm length cylinder, which has a hole with a diameter of ϕ=18mm. The diameter of the specimen was 150 mm. The tension was introduced by a hydraulic pump. Fig.2 shows the location where the strains were measured.

Table 1 shows the average strain of the outer circumference concrete, at the time of the PC tension being P=30kN. The average strains were 1μ for t=0mm, -26μ for t=10mm, and -56μ for t=20mm. This indicates that the more thick the rubber is, the more the compressive strain of concrete generates.

3. ANALYTICAL MODEL

The material properties, which were used in analysis, were shown in Table 2. The concrete specimen was modeled by cylinder elements. Considering the symmetry, we analyzed 1/4 area. Fig.3 shows the finite element models of the specimen with rubber plate (t=20mm) and of it without rubber plate.

The analytical cases are shown in Table 3. In the table, the “concentrated load” cases are the analyses in which PC tension P=30kN is introduced at the center of the specimen, whereas the “distributed load” cases are the ones in which P=30kN is introduced at the end section of the specimen as the distributed load.

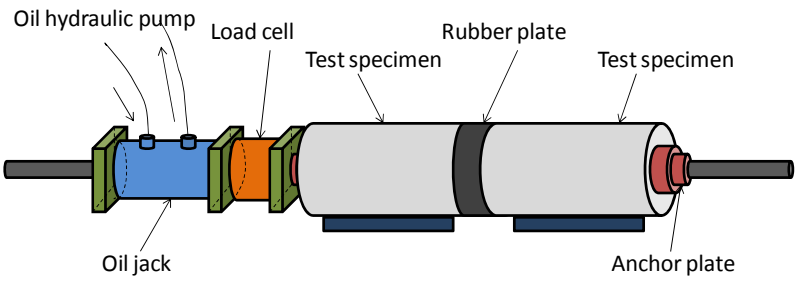

Fig.1 Schematic figure of the test

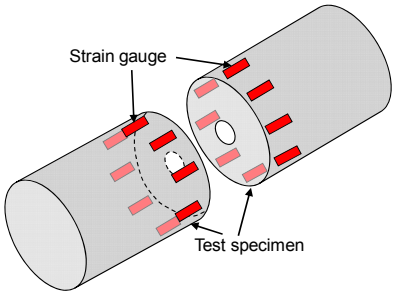

Fig.2 Measurement location

Table 1 Average strain of the outer circumference concrete

Rubber thickness	0mm	10mm	20mm
Average strain	1μ	-26 μ	-56 μ

Table 2 Material properties

	Concrete	Rubber
Elastic modulus	36 GPa	2.0MPa
Poisson’s ratio	0.20	0.49999

Keywords : Prestressed Joint, PC tension, Cylinder Element

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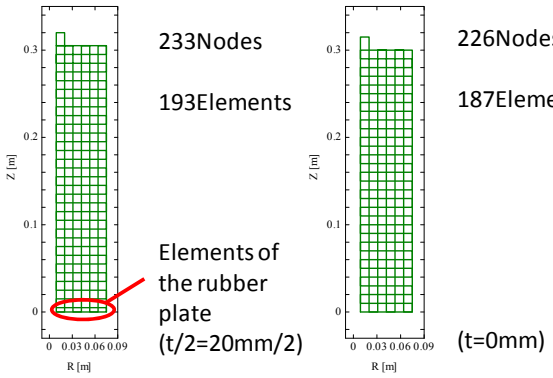

Fig.3 Analytical models

Table 3 Analytical cases

Loading Condition	t=00	t=10	t=20
Concentrated Load	C00	C10	C20
Distributed Load	D00	D10	D20

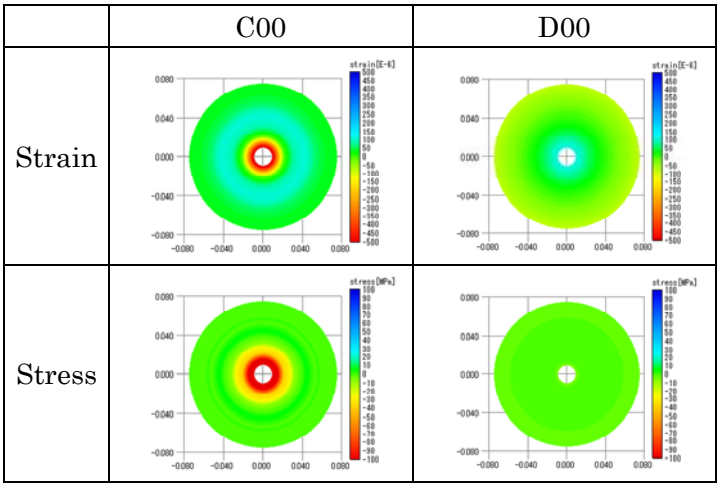

Fig.4 Analytical results (C00 and D00)

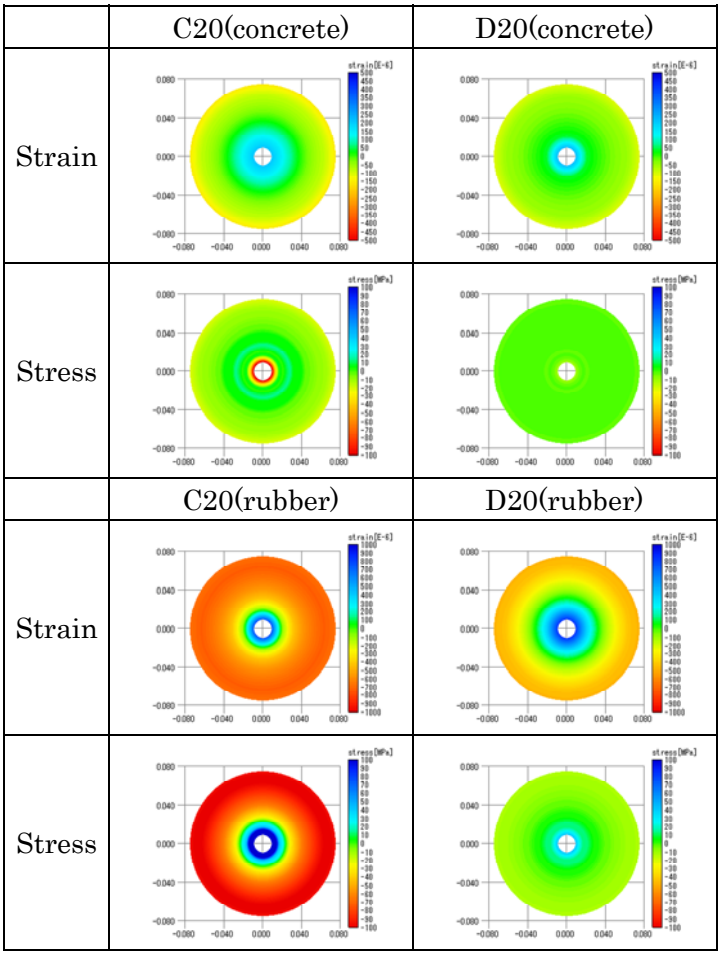

Fig.5 Analytical results (C20 and D20)

4. ANALYTICAL RESULTS

Fig.4 shows the analytical results of C00 and D00. In the case C00, the large compressive stress, in concrete side at intersection, generates in the center of the specimen. On the other hand, in the case D00, the stress seems to be substantially uniform.

Fig.5 shows the analytical results of C20 and D20. The concrete stress in C20 (Fig.5) shows that the stress at the center of the specimen reduced in comparison with that of C00. Meanwhile, in the case D20, the stress distributed almost uniformly. To sum up, the analytical results indicate that ;

1) If we consider PC tension as the concentrated load, though the center portion is compressed, the surrounding area of concrete section is hardly compressed.

2) If we consider PC tension as the distributed load, the stress in the concrete distributes almost uniformly throughout the interface.

3) When the PC tension is regarded as the concentrated load, the degree of ununiformity of the stress and/or strain distribution, in the sandwiched rubber, becomes large.

5. CONCLUSIONS

In the design, the PC tension is usually treated as the distributed load. However, the assumption (i.e. Bernoulli – Euler Assumption) might differ from the real mechanical behavior, and therefore, the mechanical behavior of pre-stressed joint should be clarified.

REFERENCES 1) T. Maruyama, J.Fukumuro, T.Kasai and T.Nakano : An experimental study on strain distribution in the press joint section due to prestress, Proc. of JCI, Vol.35, pp.481-486, 2013.7 (in Japanese)