ESTIMATION FOR EFFECTIVE PRESTRESS IN PC SLABS OF KANMON ROADWAY TUNNEL

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1. INTRODUCTION

Fig. 1 shows the cross-section of Kanmon Roadway Tunnel which connects Shimonoseki City to Kitakyushu City, PC slabs lie between traffic lanes and exhaust duct. Due to aging for 53 years, loss of prestress occurs. Then, compared with experiment, FEM analyses are conducted to estimate the effective prestress.

2. EXPERIMENTAL CONDITION

Fig. 2 also displays the bending shape of PC slab in maximum deflection (47mm). As Fig. 3 shows, 21 PC steel wires (diameter as 2.9mm) are fixed, with 5 in upside and 16 in downside. Strain gauges are attached in the upside of concrete (name begin as U) and the downside of PC steel wires (name begin as P). Crack condition until the ultimate stage is shown in Fig. 4. After the deflection of 32mm, only width of cracks increased with almost no new crack generated.

3. ESTIMATION OF EFFECTIVE PRESTRESS

In construction, initial pretensile stress of PC steel wires is 1372N/mm^2. As parameters, 100, 80 and 60 percent of it is applied to PC steel wire models of three analytical cases, which is respectively named as 1.0, 0.8 and 0.6 prestress case.

In Fig. 5, based on the cracking strain of concrete, by checking the corresponding load in each analytical case, the cracking load is obtained. Deflection of 10mm (approximate to the slope changing deflection in experimental curve) is treated as representative small deflection and four times of it as 40mm is treated as representative large deflection. Fig. 6 shows comparisons of strain distributions (changed values from initial states).

The maximum difference ratios between analyses in representative large deflection are all greater than those in representative small deflection (25% to 16% for load values, 86% to 19% for stress values in downside of concrete, 43% to 33% for stress values in PC steel wire, 9% to 0% for shift values of neutral axis). This infers the influence from different initial prestress is greater in large deflection point.

In small deflection point, member is mainly in elastic stage, where concrete plays major part in the property, as the initial

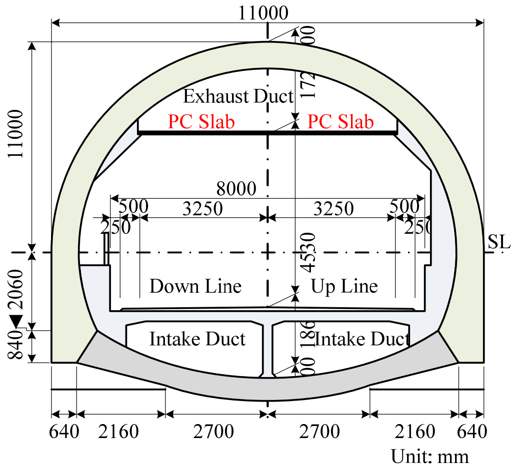

Fig.1 Section of Kanmon Roadway Tunnel

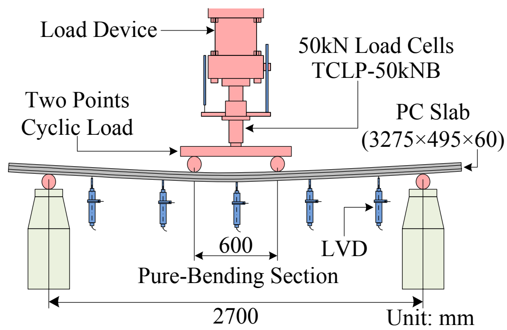

Fig. 2 Test Device

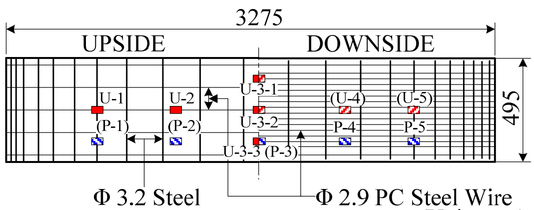

Fig. 3 Formation of PC Slab (Unit: mm)

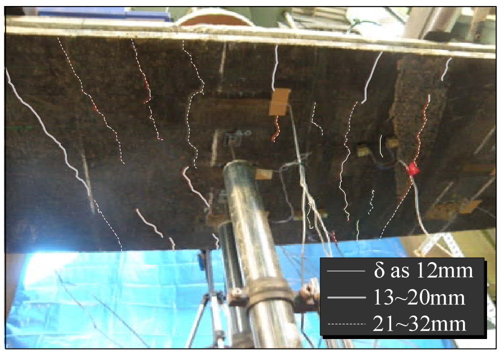

Fig. 4 Crack Condition

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stiffness, of members and then big difference does not occur. Afterward, as the different initial prestress, crack will firstly occur to the smallest prestress case. This causes the smaller prestress case has higher compression height in the cross section, and smaller stiffness, than the greater prestress case, as the applying load growing. So the difference and influence on the result as load-deflection curves due to different initial prestress in large deflection point are more obvious than that in small deflection point. Thus, estimating in large deflection point is better. By comparing load-deflection curves in large deflection point in Fig. 5, the effective prestress is between 1.0 and 0.8 times of initial prestress.

For load-strain curves, estimating in large strain point is also inferred better. We find the corresponding load in representative large deflection from load-deflection data of experiment, based on which the corresponding strain in load-strain data can be found and is defined as representative large strain.

$$\sigma_{effective} = \sigma_{smaller} + \frac{a}{b} \times 0.2 \qquad (1)$$

From Eq.1, estimated effective prestress can be obtained. Eq.1 is based on the method of interpolation. Estimation for P-3 strain gauge is shown in Fig. 7. (a, b and $\sigma_{smaller}$ is 0.7kN, 1.15kN and 0.8 times, $\sigma_{effective}$ equals 0.9 times). Considering precision, we only round to one decimal place for the calculated results.

Estimations for other main strain gauges are also conducted, of which results are summarized in Fig. 8. Combined with the result from load-deflection curve, estimated effective prestress for the No.1 specimen is thought to be 0.9 times generally.

Except No.1, estimations for No.2 and No.3 specimens are conducted by using the same methods as well. Both their load-deflection curves lie between the curves of 0.8 and 1.0 prestress case of analyses. Estimations for load-strain curves are summarized in Fig. 8. The average estimated results of them are also 0.9 times, although the estimated results of each single strain gauge are distinguished from gauge to gauge. Therefore, considering the effective prestress in all these three specimens are estimated as 0.9 times, we concluded that the general effective prestress in PC slabs of Kanmon Roadway Tunnel is 0.9 times of initial prestress.

4. CONCLUSIONS

(1) General effective prestress remained in PC slabs of Kanmon Roadway Tunnel is 0.9 times of initial prestress.

(2) Large deflection point can reflect influence from prestress better and estimating effective prestress in large deflection (similarly in large strain) point is considered to be better.

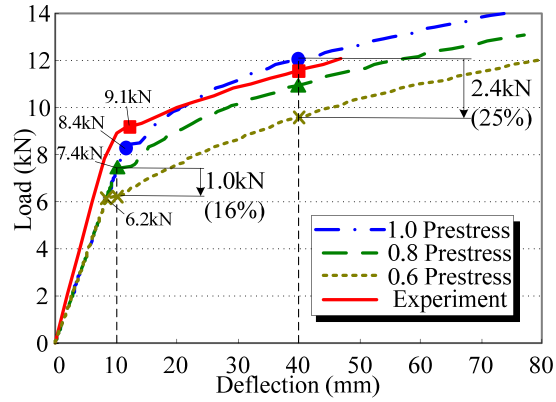

Fig. 5 Comparison of Load-deflection Curves

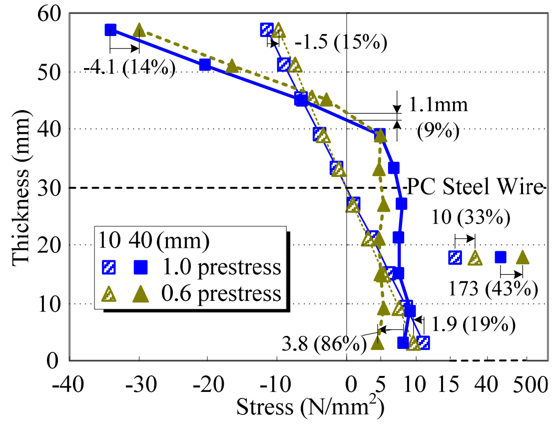

Fig.6 Stress Distribution

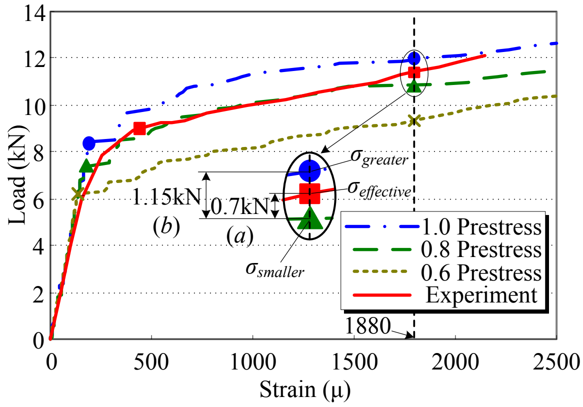

Fig. 7 Load-strain Curves (P-3 Strain Gauge)

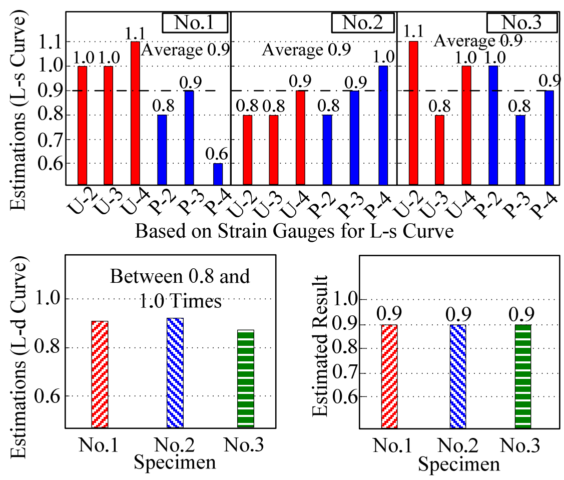

Fig. 8 Summary for Estimated Results