Outline of "A Fundamental Study on Evaluation of Grouting Conditions in PC Grouted Tendon Ducts Using the Electromagnetic Response of the Sheath and PC Steel Bar Excited by Electromagnetic Impact"

「電磁的入力方法により励起されるシースおよび鋼棒の電磁場応答を用いた PC グラウト充填評価手法に関する基礎的検討」の概要


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1. Introduction

Incompletely grouted sheaths in post-tensioned prestressed concrete (PC) structures possibly cause corrosion of prestressing bars, adversely affecting their safety and durability. Therefore, early and quick detection of these defects correctly by a nondestructive method is strongly desired [1]. To solve this problem, especially for structures with large concrete cover thickness for sheaths with small diameters, the authors conducted a basic study of a method in which electromagnetic impacts are applied to the sheaths and prestressing bars to evaluate the grout filling level based on their electromagnetic responses. The results showed that the vibrations of the sheaths and prestressing bars are strongly correlated with the electromagnetic responses near the surfaces of the concrete. This suggests that nondestructive evaluation of the grouted condition of sheaths is possible without being affected by the quality of the cover concrete.

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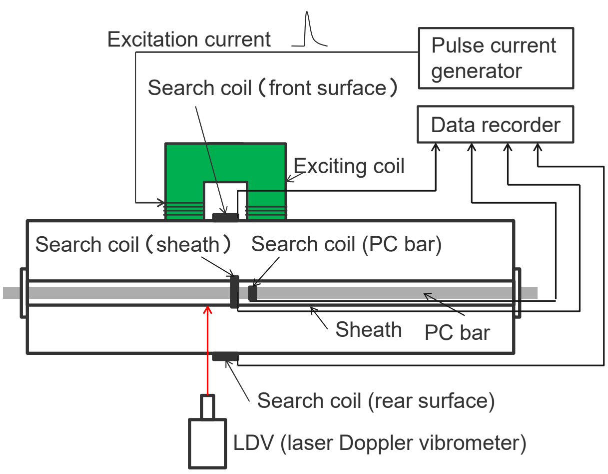
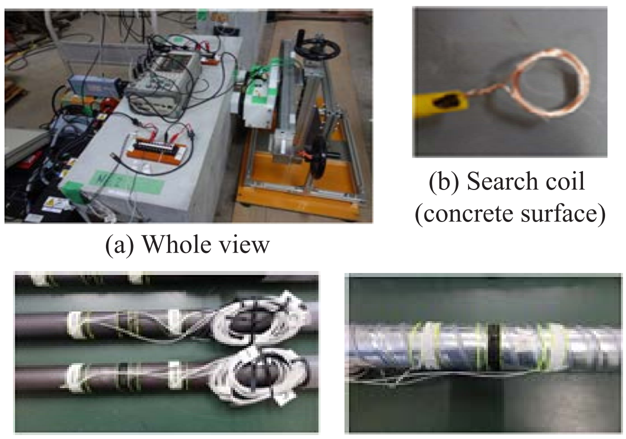


Fig. 1 Configuration of the measurement system



(a) Whole view
(b) Search coil (concrete surface)
(c) Search coil (PC bar)
(d) Search coil (sheath)

Fig. 2 Outline of the experiment

Sheath diameter	PC bar diameter	Cover
48 mm	32 mm	150 mm

(Unit: mm)

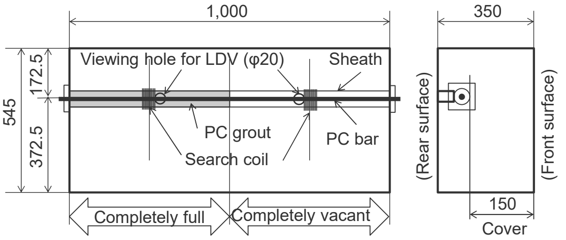


Fig. 3 Outline of the specimen

2. Scope of the Study

(1) Outline of the New Evaluation Method

Figs. 1 and **2** show the configuration of this evaluation method and its overall setup, respectively. By applying a large pulse current to the exciting coil, a pulsive magnetic field was generated around the sheath and the bar. To detect their electromagnetic responses, electric search coils were set on the sheaths and bars as shown in **Fig. 2(c)** and **(d)**. In addition, electromagnetic responses near the surfaces of the concrete were measured by electric search coils as shown in **Fig. 2(b)**. To observe the elastic response of the sheath directly by a laser Doppler vibrometer (LDV), specially designed specimens (**Fig. 3**) were prepared with holes drilled through the concrete to the sheaths.

(2) Experimental Study

The force acting on the sheath was estimated based on $\Delta i \times \Delta B$, where Δi is the deviation between the induced current values of the search coil on the concrete above the completely and incompletely grouted parts of the sheath, and ΔB is the deviation of the magnetic flux densities calculated from the induced currents measured at the concrete surface. Meanwhile, the elastic behavior of the sheath was estimated based on Δa, which is the deviation between the acceleration responses at the completely and incompletely grouted parts of the sheath. **Fig. 4** shows the measurements, revealing that the peak (F1) of Δa coincides with the peak (G1) of $\Delta i \times \Delta B$, and the peak (F2) of Δa coincides with the peak (G2) of $\Delta i \times \Delta B$. Therefore, a strong correlation is found between these peaks. In light of this, the grout-filling conditions of the sheaths were evaluated using the peak value of $\Delta i \times \Delta B$ as an evaluation index, as shown in **Fig. 5**. This figure demonstrates that incompletely grouted conditions (1-4, 1-5, and 1-6) are clearly distinguishable from completely grouted conditions (1-2, 1-3, and 2-3).

3. Conclusions

- There is a strong correlation between the vibration of a PC structure and the electromagnetic response measured on its concrete surfaces.
- The elastic responses of sheaths and prestressing bars in concrete can be estimated quantitatively from deviations in the electromagnetic responses on the concrete surfaces.

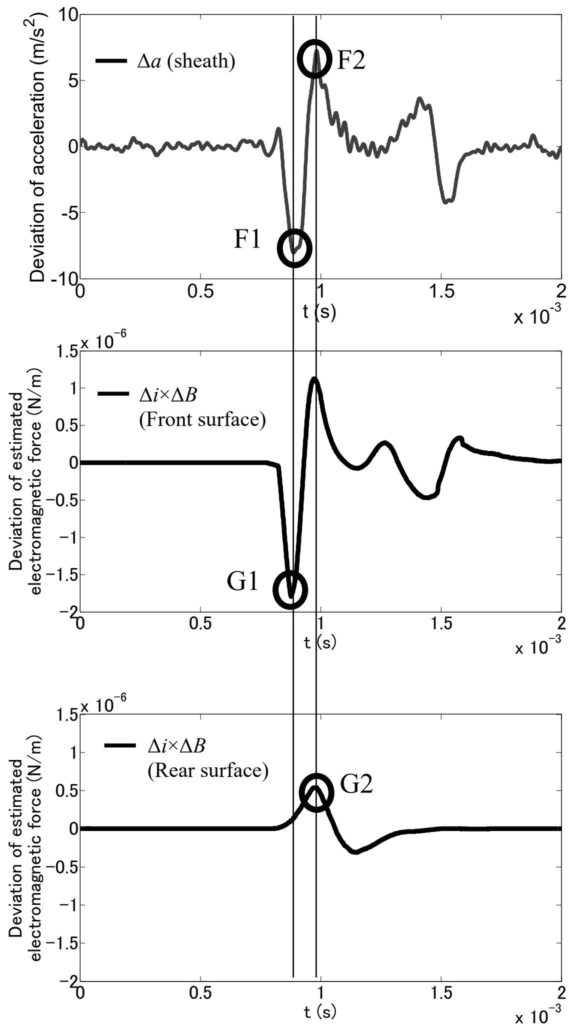


Fig. 4 Relation between elastic and electromagnetic responses of a sheath and PC bar

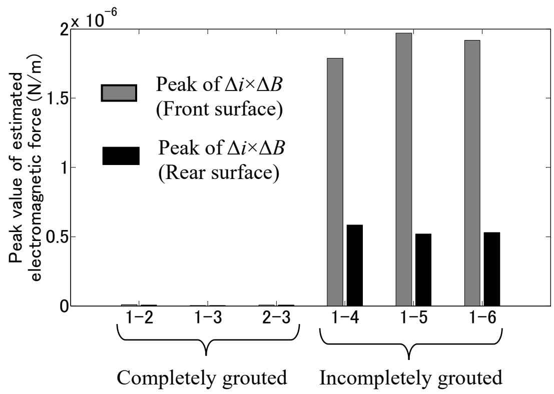


Fig. 5 Estimation results (peak value of estimated electromagnetic force)

Reference

[1] Hattori, S., Kamada, T., Uchida, S., Asakura, H., Terasawa, K.: *Basic study on the relation between elastic wave input methods and detection capability of imperfectly grouted part of tendon ducts in PC members*, Journal of Japan Society of Civil Engineers, Ser. E2, Vol. 73, No. 2, JSCE, Tokyo, pp. 239-250, 6. 2017 (in Japanese).
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