Outline of “Rehabilitation for Prestressed Concrete Tendons in Incomplete Grouting Area Using $LiNO_2$ Solution — Repassive Method —”

「亜硝酸リチウム水溶液を用いたPCグラウト未充填部の補修 — リパッシブ工法 —」の概要


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1. Introduction

A factor that reduces the durability of existing prestressed concrete bridges is corrosion of their PC tendons due to incomplete PC grouting. In Japan, incomplete PC grouting is mainly observed in bridges constructed during the 1980s. In particular, for bridges built in cold or mountainous regions where antifreeze agents are sprayed during winter, rainwater containing chlorides or similar substances enters the incompletely grouted areas and significantly corrodes the PC tendons, as shown in **Fig.1**.

In Japan, areas of incomplete PC grouting are generally repaired by re-injecting PC grout with the same material as that of the new structure[1]. However, the corrosion-inhibiting performance of PC tendons corroded by chloride ions from antifreeze could be insufficient because there are chloride ions in the rust layer[1]. To repair such corroded PC tendons, the authors have developed a method of injecting a solution containing lithium nitrite (hereinafter referred to as the $LiNO_2$ solution) and applying grout with added nitrite[2].

This outline presents the developed rehabilitation technique and its use.

2. Rehabilitation Technique

(1) Outline of Technique

There are many Cl^--ions in the corrosion product that arises on PC tendons, making it difficult to mitigate steel corrosion using ordinary grouting material. Instead, the proposed technique involves using the $LiNO_2$ solution to introduce NO_2^--ions into the corrosion product. It has been reported that the steel corrosion is mitigated when the Cl^-/NO_2^- ratio is less than 1.25[3]. The solution can ingress into the small spaces between PC tendons or between a PC tendon and its sheath. Therefore, this technique provides corrosion-inhibiting performance to those small spaces. Along with injecting and grouting, gravity flow and vacuum are used to maintain high rehabilitation performance.

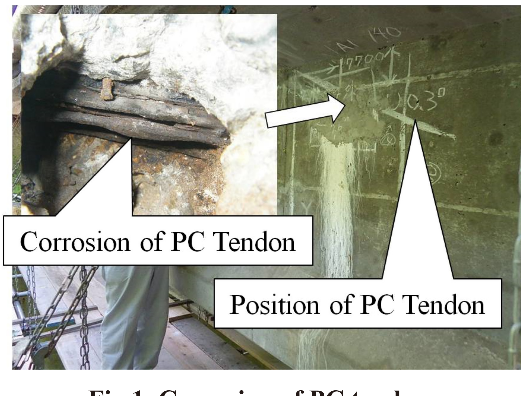

Fig.1 Corrosion of PC tendon

(2) Investigation

RC radar is used to locate and mark the positions of the reinforcing bars and PC tendons, and 25mm holes are drilled at the latter. A CCD camera captures images inside the sheath, allowing the areas of PC-tendon corrosion or incomplete grouting to be observed.

A 80mm core is drilled at the same position as a hole, allowing the rust layer on the PC-tendon surface to be swabbed and tested for Cl^--ions.

(3) Preparation for Injection

A core-sealing cap is placed on the core hole. The internal pressure of the sheath is reduced using a vacuum pump to allow cracks to be sought without the $LiNO_2$ solution leaking out. The cap is then removed temporarily, and a highly elastic tube with an inner diameter of 2mm is inserted through the core hole toward the existing grouted area and anchorage.

(4) Injection of $LiNO_2$ Solution

Fig.2 shows a 40% $LiNO_2$ solution being injected. The solution is injected from the injection via gravity flow and vacuumed with the pump 30 min to promote mitigation of steel corrosion. The solution is then removed from the sheath.

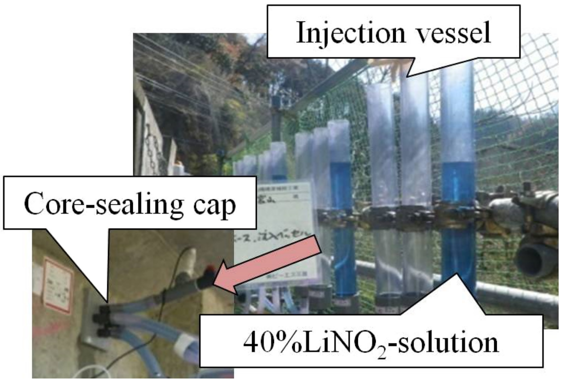

Fig.2 Injection of 40% $LiNO_2$ solution

(5) Grouting

The grouting material used for this technique has the following superior properties:

- contains 40% $LiNO_2$ solution to enhance repair performance;
- easily fills small spaces between PC tendons;
- can be used for prolonged durations to cope with unexpected problems;
- dose not separate underwater, thereby allowing the residual solution to rise and drain inside the sheath

This method has the following features:

- allows slow filling to better fill small spaces such as those between PC tendons is possible.
- the grouting progress can be monitored via the discharge of injected grout from the highly elastic tubes, as shown in **Fig.3**;
- the gravity flow of grouting provides a continuous head pressure to the injected grout to promote filling performance.

After grouting, the drilled cores are repaired.

3. Monitoring of Repair Performance

To confirm the long-time repair performance of this technique, the rest potential and polarization resistance of PC tendons in actual bridges to which it has been

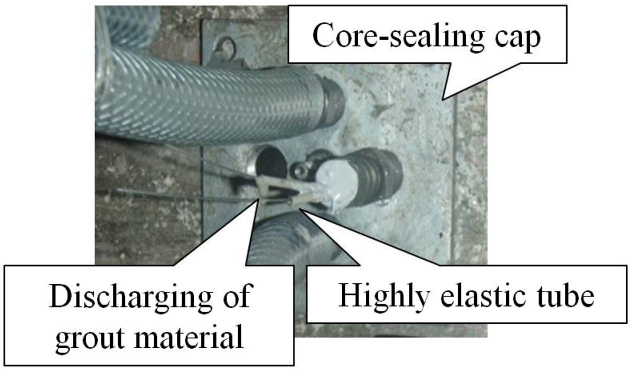

Fig.3 Discharge of injected grout material

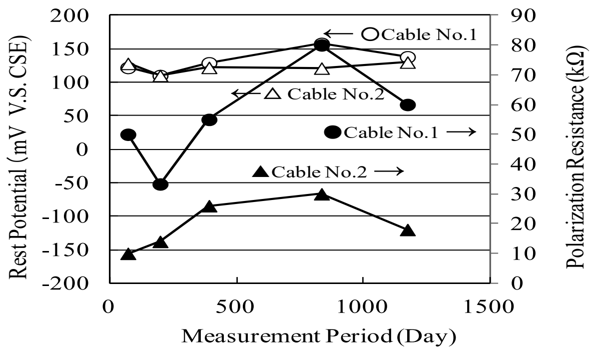

Fig.4 Example of monitoring data

applied are measured on a regular basis. An example of such results is shown in **Fig.4**. Both sets of data tend not to decrease during the measurement period, showing that this technique maintains good mitigation performance against corrosion.

4. Experience with Technique

This technique was developed in 2012, and has been used on 39 bridges in Japan for 5 years. The total grouting length to date is about roughly 5.3km.

5. Conclusion

A technique was developed for rehabilitating the PC tendons in existing PC bridges corroded by antifreeze agent because of incomplete grouting. To date, is this technique has been used on is 39 bridges in Japan, playing a vital role in extending their service lives.

References

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