

Development of Sleeper Gripper with Fastening Mechanism for Pandrol Fastclip



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Abstract

As a measure for saving labor with aged PC sleepers, replacement to TC-type resilient sleepers for ballasted track and Pandrol Fastclips is scheduled. However since the replacement volume is enormous, it is necessary to make construction more efficient. Therefore, as a construction efficiency improvement, we developed a new gripper with a fastening mechanism, and herein we report on the details of that.

●**Keywords:** Excavator, Road-rail vehicle, Gripper attachment, Fastclip, Resilient sleeper

1. Introduction

More than 50 years has passed since prestressed concrete (PC) sleepers in the JR East operating area were laid, and future deterioration of those due to aging is becoming a concern. For that reason, the Research and Development Center of JR EAST Group has developed a PC sleeper with under sleeper pad¹⁾ that uses the Fastclip system in order to extend the maintenance cycle and be compatible with future mechanized construction in ballasted sections, and we plan to gradually replace sleepers in applicable sections with these resilient sleepers.

This paper gives an overview of the new sleeper gripper attachment with fastening mechanism for Pandrol Fastclip (hereinafter, gripper attachment referred to as “gripper”) newly developed in order to perform sleeper replacement efficiently. Note that Fastclip is a rail fastening system handled by Sumitomo Corporation in Japan.

2. Current Sleeper Replacement Work and Issues

Current mechanical PC sleeper replacement is done by attaching a gripper to a road-rail vehicle backhoe (BH) and performing work by steps 1 to 5 below (Table 1). Fig. 1 shows the positional relationship of rail and sleepers in steps 3 and 4 schematically.

Table 1 Sleeper Replacement Work Procedures

	Work details
Step 1	Release fastening system (manual work)
Step 2	Excavate ballast (mechanical work)
Step 3	Remove old sleeper (mechanical work)
Step 4	Insert new sleeper (mechanical work)
Step 5	Secure fastening system (manual work)

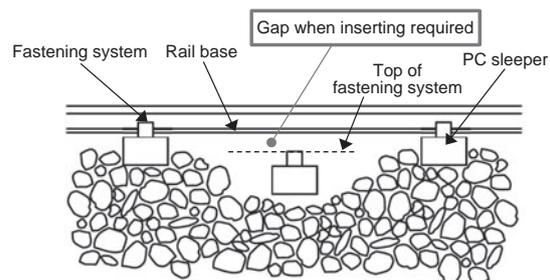


Fig. 1 Positional Relationship of Parts when Inserting Sleeper

In order that the rail base and the top of the fastening system are not obstructions when removing the old sleeper by a gripper (step 3) and inserting a new sleeper (step 4), the ballast under the sleeper is excavated so the top of the fastening system is slightly lower than the bottom of the rail. Therefore, when a new sleeper is inserted, the height of the top surface

of the sleeper is lower than the rail base position, so the sleeper needs to be manually hoisted when fastening the fastening system to the rail (step 5), and this required much labor (Fig. 2).

We thus decided to equip the gripper with a mechanism where rail fastening is possible with the new sleeper lifted by a gripper and developed a machine that enables the work of ballast excavation, sleeper removal/insertion, and rail fastening to be done together in order to reduce labor and make work more efficient (Fig. 3).

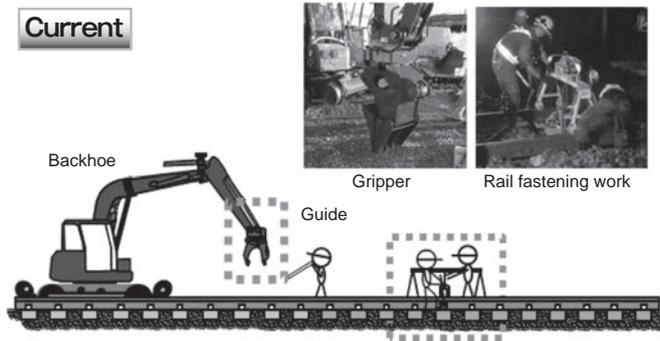


Fig. 2 Image of Current Sleeper Replacement Work (mechanical work)

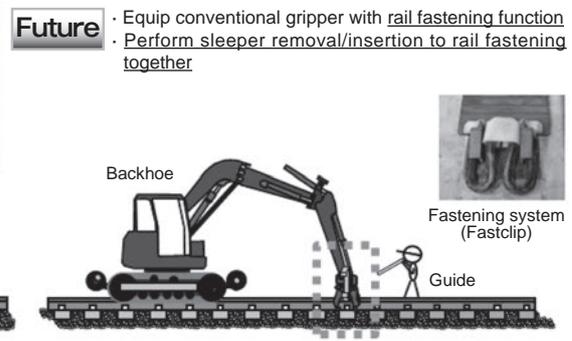


Fig. 3 Image of Replacement Work when Using Developed Gripper

3. Development of Sleeper Gripper with Fastening Mechanism for Pandrol Fastclip

3.1 Overview of Development

Fastclip-type fastening system sleepers are already in use in other countries, and specialized machinery with rail fastening mechanisms for sleeper replacement (rail fastening mechanism hereinafter referred to as “fastening mechanism”) too have been introduced (Fig. 4).

Meanwhile, sleeper replacement (mechanical work) in Japan has for a long time been done by gripper attached to BH due to various conditions and restrictions, and speed of mechanical work differs by heavy machinery operator experience and skill in mechanical operation. Therefore, development is needed to make use of operator skill and the like accumulated up to now.

Thus, the concept in this development was to be compatible with domestic BH conventionally used and equip a fastening mechanism while maintaining conventional gripper performance.

Table 2 show a comparison of the specifications of a mechanism produced overseas (SB60) and the specifications requested in development this time.



Fig. 4 Dedicated Machine Used Outside Japan (SB60) Source: Sumitomo Corporation website

Table 2 Comparison of Attachment Made Overseas (SB60) and specifications requested

	Specifications of overseas model (SB60)	Specifications requested
Rails supported	Standard gauge (1,435 mm)	Narrow gauge (1,067 mm)
Insulation	Narrow gauge (shunt when fastening)	Insulation (maintain insulated condition even in fastening work)
Dimensions	Large (blade, grip, fastening system separate)	Same as current gripper
Weight	Heavy (specs of heavy equipment used large)	Light (can be used by road-rail vehicle BH)
Replacement method	Remove and insert inside gauge (for continuous construction)	Remove and insert from ballast shoulder side (independent work possible)

3.2 Developed Gripper

(1) Development specifications

- A. Rail supported: Narrow gauge (1,067 mm)
- B. Construction heavy machinery supported: BH mainly used in JR East area
- C. Power: Ability to operate on BY power alone
- D. Weight: 700 kg or less
- E. Mechanism: Add fastening mechanism with conventional gripper function
- F. Insulation: Insulation structure that can be used even in sections where shunting is prohibited

(2) Developed gripper

Fig. 5 shows the mechanism of the prototype sleeper gripper with fastening mechanism for Pandrol Fastclip and Fig. 6 shows an exterior view. In this development, a prototype was made with specifications enabling attachment to a Komatsu BH (PC78UUT).

Table 3 shows a comparison of dimensions and weight of the developed gripper and current gripper.

Table 3 Comparison of Dimensions and Weight of Developed and Current Grippers

	Developed gripper	Current gripper
Height (mm)	1,466	1,270
Width (mm)	1,020 * 1,865 at fastening work	630
Weight (kg)	685	530

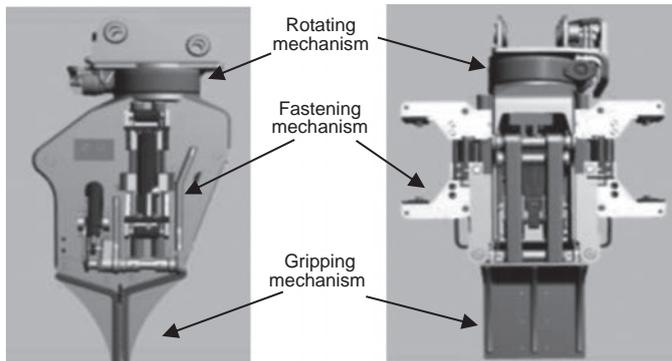


Fig. 5 Configuration of Mechanism of Developed Gripper

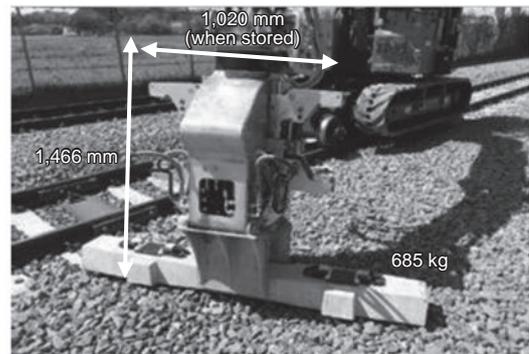


Fig. 6 Exterior View of Developed Gripper

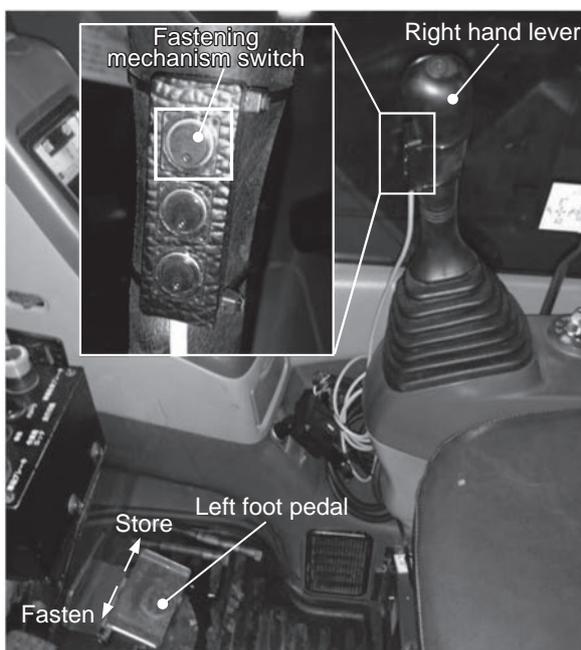


Fig. 7 Exterior View of Operator's Seat (Operation Switches)

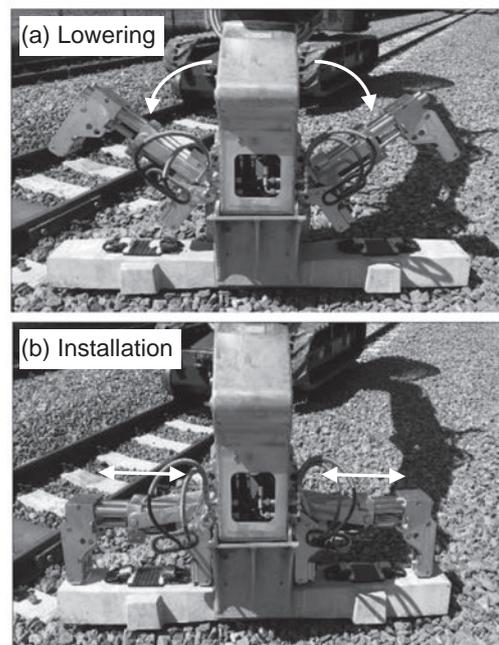


Fig. 8 Rail Fastening Mechanism in Operation

The same operating method as conventional grippers used in Japan was adopted for BH actions. The operating method of the fastening mechanism is as shown below.

- Operating method: Depress left side of right foot pedal while operating switch on top of right hand lever. [Fig. 7]
- Mechanism action: (1) Put support point of bottom of fastening mechanism in the center and lower while performing swinging actions. [Fig. 8 (a)]
(2) When fastening mechanism reaches top surface of sleeper, fasten the Fastclip. [Fig. 8 (b)]

Release and storage actions are done by depressing right side of right foot pedal while operating same switch as fastening work.

Action time of fastening mechanism is about 15 seconds from start to completion of storage. Manual rail fastening time is about 45 seconds including sleeper slinging work and the like, so the number of workers needed for fastening work can be reduced by introducing the developed gripper, and this is thought to lead to reduction in time for sleeper replacement work.

3.3 Performance Confirmation Tests at Depot Line

We conducted performance confirmation tests in a maintenance depot for purposes such as confirming the operability of the developed gripper (Fig. 9).

As a result, we confirmed that there are no problems in fastening mechanism actions and that the gripper mechanism itself can be used the same way as with the current one (ballast excavation, sleeper removal/insertion, etc.). And while the new gripper has larger dimensions and weight than the conventional one, replacement work can be done smoothly, and we believe that it can be put into practical use.

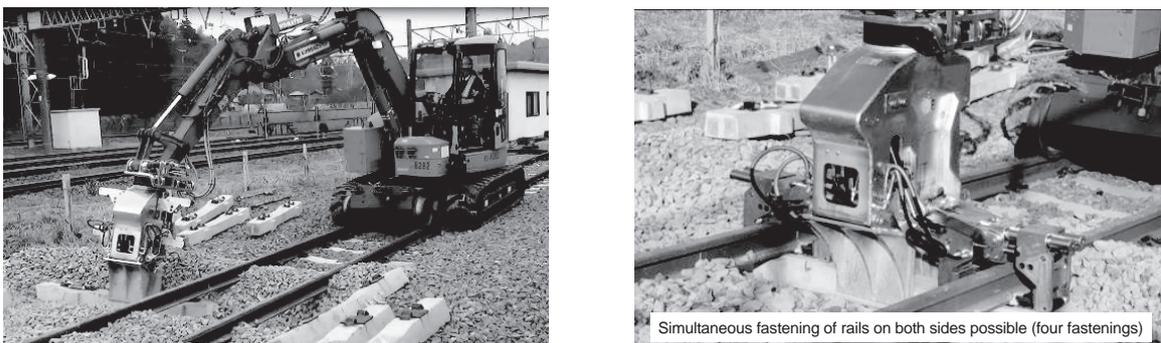


Fig. 9 Performance Check by Depot Line

4. Conclusion

We have developed a dedicated gripper that can perform Fastclip-type PC sleeper replacement, which will be done in the future with deterioration of PC sleepers due to aging, and we confirmed that it has sufficient performance. Into the future, we are aiming to introduce that upon confirming durability of the prototype developed and workability on commercial lines.

Acknowledgements

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Reference:

- 1) Akitoshi Omodaka, Takao Kumakura, and Toshiyuki Konishi, "TC-gata Yuudoushou Dansei Makuragi no Kaihatsu to Dounyuu" [in Japanese], *Shinsenso* Vol. 71, No. 8 (August 2017).