

New Embankment Repair Method Developed

RTRI Developed an early repair method and aseismic reinforcement method for the embankment damaged by rainfalls and earthquakes. By applying these methods, the performance of embankments will be improved, while work period and repair costs will be reduced.

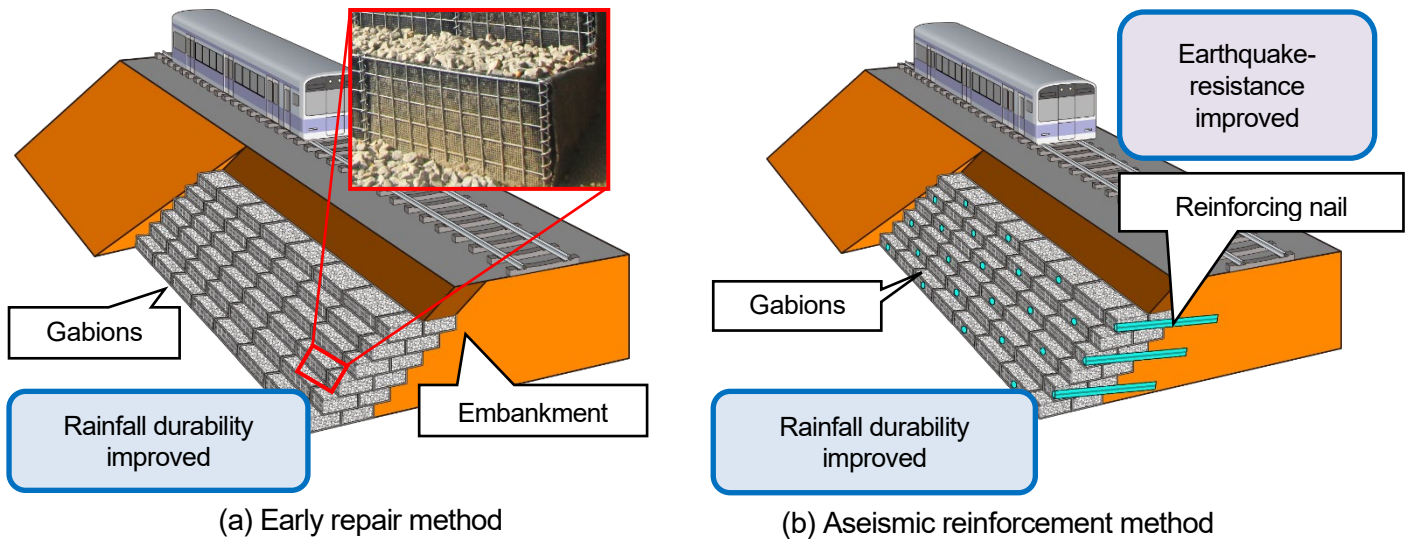


Fig. 1 Early repair and aseismic reinforcement method for damaged embankment

【Outline of the methods】

Previously, the embankment damaged by rainfalls and earthquakes (Supplementary fig. (a)) was temporarily sandbagged and train operation was resumed at slow speeds (supplementary figure (b)), then temporary retaining walls were installed (Supplementary figure (c)), sandbags were later removed and the embankment was reconstructed. (Supplementary figure (d)). This complicated process required long construction periods and high costs. (Table1). Since the repair work with the early repair method uses gabions instead of sandbags, it does not require such complicated work. It will reduce the construction period and cost, and at the same time, durability against rainfalls is improved.

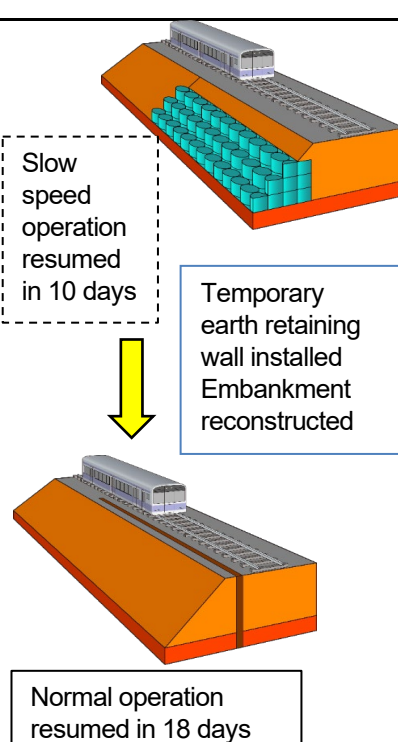
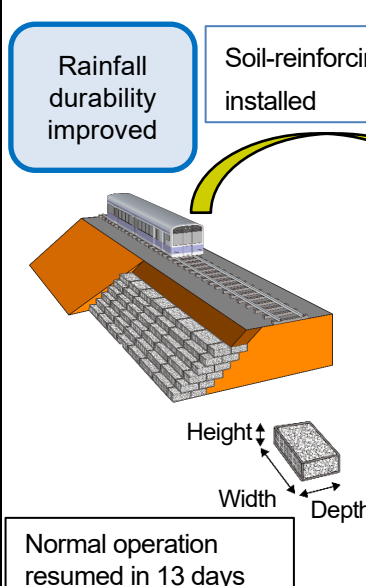
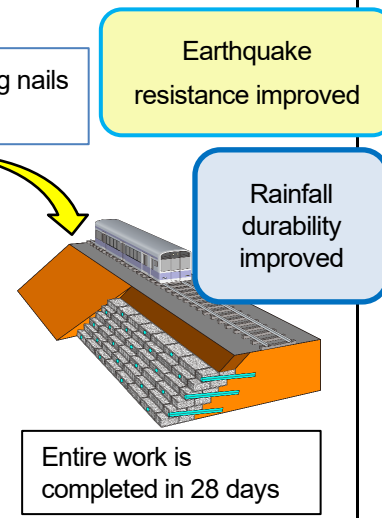
In the aseismic reinforcement method, in addition to the work of the early repair method, the embankment is reinforced with soil reinforcing nails made of steel and soil cement. This method improves earthquake resistance as well as durability against rainfalls.

【Effects and characteristics】

- In the early repair method, gabions are installed to the damaged section. Since the gabions are built with wire mesh sheets on site, the repair work can be done quickly and flexibly and the embankment can be repaired earlier.
- Since the gabions improve stability of embankments, it is confirmed by analysis that durability against rainfalls improves by about 70% compared to the existing repair method.

- With this method, train operation cannot be resumed at the stage of the temporary repair unlike the repair work with the existing method. However, the entire work period and cost are reduced by 30% and 60% respectively. (Table 1)
- In the aseismic reinforcement method, reinforcing nails are added to the early repair method. It is confirmed in model experiments that the embankment repaired with this method is capable of enduring 50%-stronger earthquakes compared to the one with the early repair method and the cost can be 30 % lower than the existing method. (Table 1)

Table 1 Comparison with the existing method and newly-developed methods
(5-meter high and 10-meter long embankment)

	Existing method using sandbags	Repair method using gabions	
		Early repair method	Aseismic reinforcement method
Images of the repair work			
Details	250 Large sandbags 50 type-III earth retaining walls	320 Gabions Width: 1.0 m Depth: 1.0 m Height: 0.5 m	320 Gabions Width: 1.0 m Depth: 1.0 m Height: 0.5 m 15 soil-reinforcing nails Diameter: 133 mm Length: 7.0 m
Repair cost ratio	1.0	0.4	0.7

【Embankment reinforced with aseismic reinforcement method】

This method was used to repair the embankment of Sanriku Railways Rias Line damaged by the typhoon which hit the eastern part of Japan in 2019. (Fig. 2)

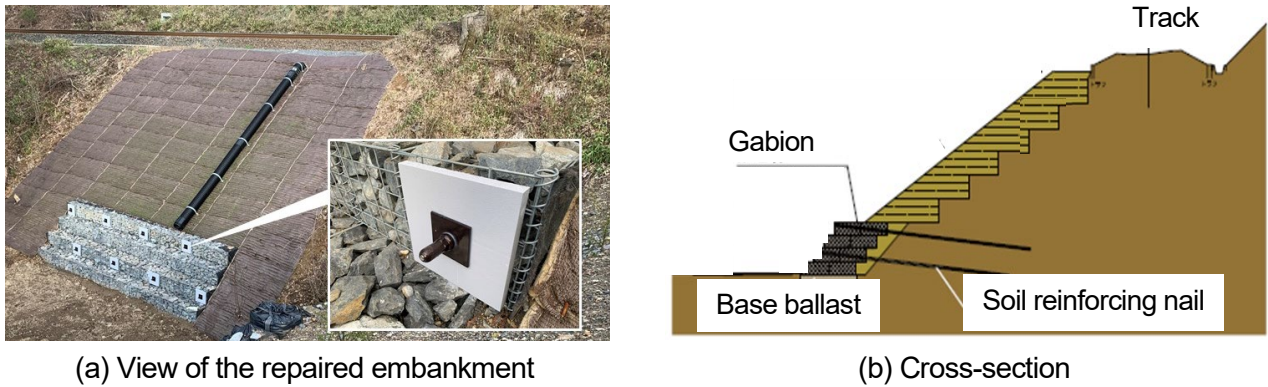
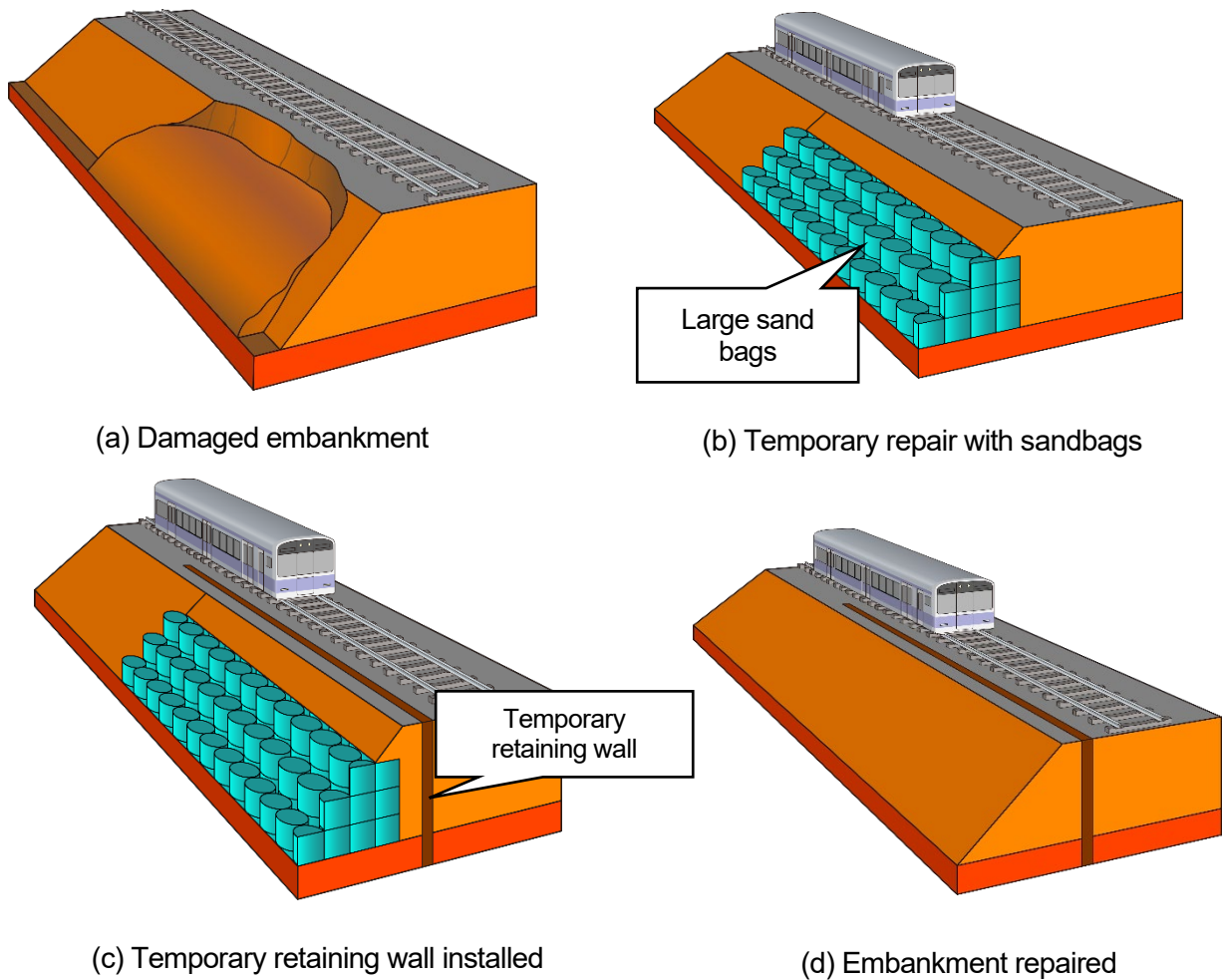


Fig. 2 The embankment repaired with the aseismic reinforcement method

The development of these methods is the outcome of the joint research with Okasanlivic Co., Ltd, Koiwa Kanaami Co., Ltd. and Raito Kogyo Co., Ltd.



Supplementary fig. The existing embankment repair method