Outline of "Special Filling Material Applied to Remediation Works of Contaminated Water Stagnating in Seawater Piping Trenches at Fukushima Daiichi Nuclear Power Plant"

「福島第一原子力発電所 海水配管トレンチに滞留した汚染水の除去に活用された特殊充填材」の概要


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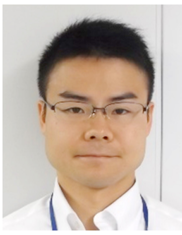
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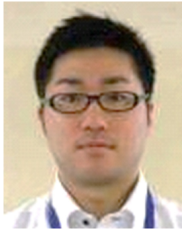
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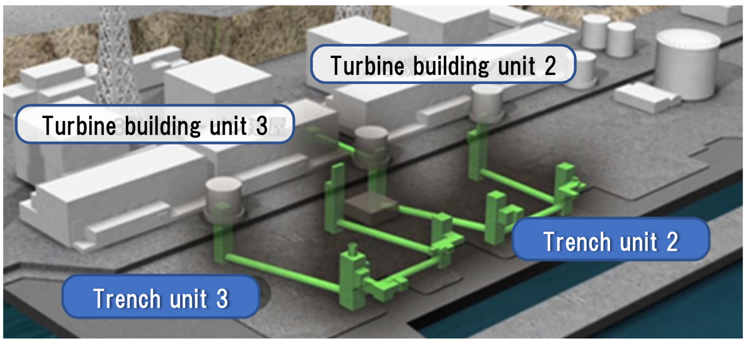
1. Introduction

After it was damaged in the tsunami disaster of March 2011, the Fukushima Daiichi Nuclear Power Plant attracted considerable concern regarding the possibility that contaminated areas could expand because of inflow and stagnation of highly contaminated water in seawater piping trenches. As an immediate countermeasure, a special filling material was developed that could flow as far as 85m in water and fill trenches densely without material segregation. It was applied to the actual filling work, and the work was succeeded in a short period. This eliminated the risk of contaminated water flowing out to sea and prevented radioactive contamination expanding across the site. Also it helped to minimize the radiation dose to workers on the site.

2. Development of Special Filling Material

(1) Background

From the viewpoint of long-term safety and stability, the method of replacing contaminated water with cement-based filler was adopted (**Fig.1**). In addition, to minimize the radiation dose to workers, a plan was developed to use the existing vertical shaft as a placing route instead of digging new vertical shafts for the purpose. To realize this, a special filling material was required that could flow underwater as far as 85m.



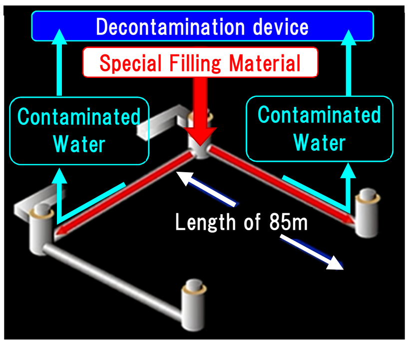


Fig.1 Structure of seawater piping trench (left) and remediation plan for contaminated water (right)

(2) Features of Special Filling Material

A special filling material comprising water, cement, fly ash, and special chemical admixtures was developed through various laboratory tests (**Photo 1**). Its performance was verified by a long-distance underwater flow experiment using an 85-m-long waterway (**Photo 2**) [1]. The features of this material are listed below.

- Excellent fluidity (a Japan Industrial Standard (JIS) mortar flow test gave 370–450mm, even after 12h)
- Even after flowing 85m underwater, the properties of the flowing tip do not degrade (**Fig.2**)
- Self-compactability to wrap reliably around cables and piping installed inside the trench (**Photo 3**)
- Non-bleeding property (zero bleeding rate)
- Low permeability (1×10^{-7}cm/s) and compressive strength (5.0N/mm^2), equivalent to soft rock
- Low shrinkage (an autogenous shrinkage of 50μ)

3. Actual Work on Site

The actual filling material was manufactured in the dedicated batch plant installed on the site. Agitator cars transported the filling material to the placing point in the existing shaft, and a concrete pump poured it into the contaminated water (**Photo 4**) [2]. On the other side of the shaft, the condition of the filling material on arrival and the launch height were managed, and it was confirmed that there was no flow gradient. This confirmation work was also done after hardening. The daily construction volume was approximately 200m^3. Approximately 11,000m^3 of contaminated water stagnating in the seawater piping trenches was removed in around 19 months. By harnessing the performance of this filling material, the labor was saved and the radiation dose to workers was reduced by around 70%.

4. Conclusion

This special filling material, which has excellent flowability, self-compactability, and workability in water, is expected to be used in various fields. For example, it could be used as filling material for pre-packed concrete, filling old supply/sewage water pipes, filling closed mine tunnels, and filling to improve the permeability of gravel layers.

This Technology won the Award of the Japan Concrete Institute in 2017.

References

[1] S. Yanai, Y. Hibi, K. Nishikouri, K. Sato: *Study on Filling Materials Suitable for Seawater Piping Trench Closure Work at Fukushima Daiichi Nuclear Power Plant*, Concrete Journal, Vol.54, No.4, pp. 362-370, April 2016. (in Japanese)

[2] Y. Hibi, S. Yanai, K. Nishikouri, Y. Soma: *The construction for Remediation Work of contaminated Water at Fukushima Daiichi Nuclear Power Plant –Closure Work of Seawater Piping Trench and Screen Pump Chamber–*, Concrete Journal, Vol.54, No.6, pp. 628-634, June 2016. (in Japanese)

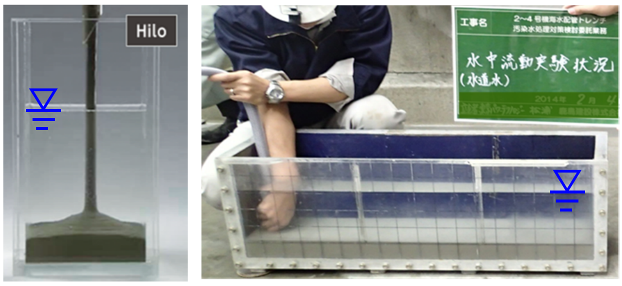


Photo 1. Laboratory test of material properties

Photo 2. Waterway test of material properties

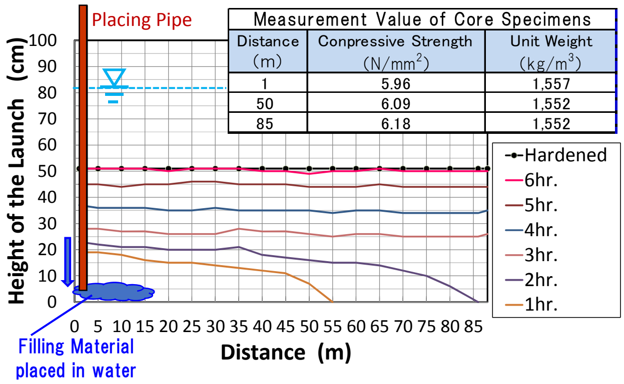


Fig.2 Waterway test of material properties

Photo 3. Filling around buried objects

Photo 4. Placing material on site