RTRI Develops Acid-Resistant Geopolymer Mortar Emitting Less Carbon Dioxide

RTRI developed geopolymer mortar for plastering. The developed mortar emits less carbon dioxide and has excellent acid resistance. It can be used to plaster the spots where existing cement mortar is not suitable.

1. Background

In tunnels, acid underground water is likely to seep out or acid is produced by a chemical reaction of water and soot from diesel railcars. In such facilities, concrete walls might be sometimes lysed by acid and internal reinforcing steel might be corroded. The lysed part needs to be removed and repaired with mortar. However, since existing cement mortar is vulnerable to acid, the lysed concrete surface has to be repaired with acid-resistant polymer cement mortar. Cement also has a problem of carbon dioxide emission in the process of manufacturing.

Geopolymer has been expected to replace cement as the material that solves these problems. It is highly acid resistant and its carbon dioxide emission in the course of manufacturing is 60 to 80% less than cement. However, geopolymer also has weaknesses. It is not easy to handle in plastering work because it is highly viscous. The repaired part needs to be kept in temperatures 60 to 80℃ until it gets hardened, because it is liable to crack due to contraction, if it is kept in ordinary temperatures.

2. Strengths of the geopolymer mortar

RTRI developed geopolymer made with new materials and a new mixing ratio and solved the issue of viscosity (Patent 5091519 and 6058474), and using this geopolymer, developed geopolymer mortar for repair plastering jointly with Kadoya Kogyo Co., Ltd. and Takaboshi Co., Ltd. (patent pending).

- It can be used for plastering as easily as cement mortar. In test plastering, experienced plasterers have given good evaluations regarding its workability like smoothness and stickiness in trowel finishing.
- Heating is not required during the curing period. The mortar does not crack even if it is kept in ordinary temperatures of 5 to 30℃.
- Carbon dioxide emissions during manufacturing the geopolymer mortar can be reduced about 70% compared to cement mortar (Fig.1) . It means that the reduced emission amount per production of 1 ㎥ geopolymer is equivalent to the amount that 22 Japanese cedar trees absorb in a year[*3]. As the geopolymer is made of recycled industrial by-products such as fly ash generated in coal-fired power plants and blast furnace slag from steel plants, it contributes to reducing environmental load.
- Since the geopolymer is highly acid-resistant (Fig. 2 and 3), it is effective to repair the spots being exposed to acid water. In acid-proofness tests (soaked in 5% sulfuric-acid solution for 4 weeks), this geopolymer has shown the same level of acid resistance as the mortar made of acid-resistant polymer cement.
- The price is not expensive compared to the cement mortar made of acid-resistant polymer.
- Since this mortar has excellent heat and sugar resistance, it can be used to repair road tunnel where

fire may happen and kitchens where degradation might be caused by sugar.

- Since this mortar is prepared by kneading pre-mixed powder and attached solution with a handheld mixer, it is also available for repairing a small area (Fig. 4).

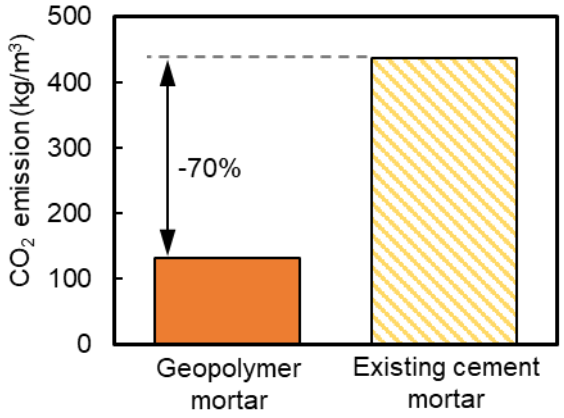

Fig. 1 CO_2 emission per 1 m³ in manufacturing plastering materials

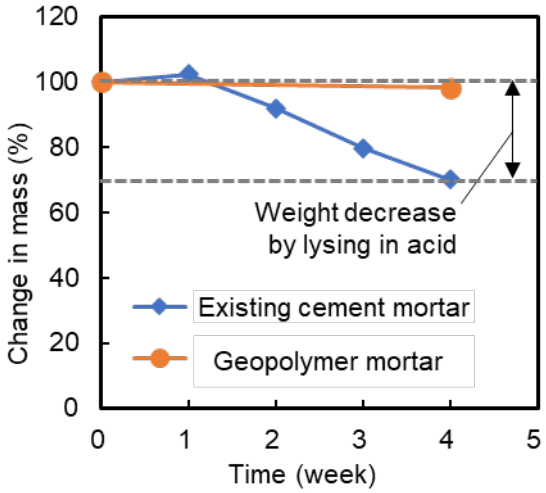

Fig. 2 Acid resistance of plastering materials (mass change when soaked in 5% sulfuric-acid solution)

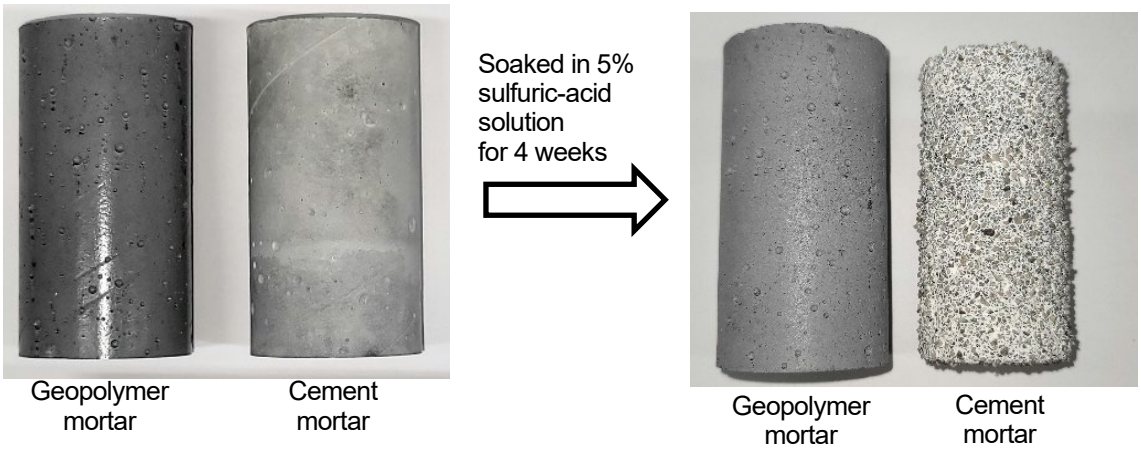

Fig. 3 Acid resistance of the geopolymer mortar (change after soaked in 5% sulfuric-acid solution)

Fig. 4 Preparing geopolymer mortar with handheld mixer

3. Date of Release

This Geopolymer Mortar was released on October 26, 2022 by Kadoya Kogyo Co., Ltd. and Takaboshi Co., Ltd.

*1 Geopolymer: Inorganic polymer prepared with amorphous pulverulent body containing silica and alumina and alkaline solution. It was named geopolymer combining “polymer” with “geo” which means earth, as it has molecular structure similar to minerals and rocks.

*2 Polymer cement: Cement mixed with organic polymer in order to improve strength, chemical resistance and adhesiveness.

*3 Calculated based on the assumption that one 50-year-old Japanese cedar tree absorbs 14kg carbon dioxide in a year.

*4 Acid resistance required in the “Standard performance for section repair materials” stated in the “Manual for concrete repair techniques” developed by the Tokyo Metropolitan Government Sewage Bureau.