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**A Study for Reinforced Clinker-Free Concrete Elements Comprising By-Product Additives and Recycled Cement Produced from Wasted Fresh Ready-Mixed Concrete**

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“Waste ready-mixed fresh concrete” refers to surplus concrete unused at construction sites and returned to the ready-mixed concrete plant. Most of it has been treated as an industrial waste. In this research, we have established a revolutionary concrete manufacturing technology for developing recycled cement using waste ready-mixed fresh concrete (SR cement, hereafter) as raw material, and reusing it as concrete to achieve ultimate resource recycling (R-CF concrete). SR cement undergoes considerable quality degradation as the hydration reactions of waste fresh concrete progress. The newly introduced production line enables processing before the hydration reactions of the waste ready-mixed fresh concrete advance, and with the simultaneous use of a set-retarding agent, it has become possible to manufacture high quality recycled cement (Fig. 1).

R-CF concrete contains SR cement and a by-product mineral admixture. As a result, virgin Portland cement usage can be minimized, less than 5% of binder mass at most. For R-CF concrete, an outdoor exposure test was conducted with precast elements (PCa), solving important issues for commercialization such as durability. Commercialization of a PCa product that can be standardized and implementation of executive plans for application to actual construction have been initiated.

In addition, application of SR cement concrete in which ordinary cement has been partially replaced with SR cement to PCa products and ready-mixed concrete products was examined for general use. In preparing for practical application of these products, we confirmed stable quality through various experiments and obtained JIS conformity certification. In addition, 300 m<sup>3</sup> of ready-mixed concrete was applied for the first time in actual construction, confirming practical level competitiveness in terms of quality and cost. Currently, other construction work has started with full-scale application at a 5000 m<sup>3</sup> scale. As mentioned above, the social implementation of this technology has been realized by commercializing more than two competitive products that combine environmental performance, high quality and superior economic efficiency, and establishing an advanced “local production for local consumption” model of the recycling system in Kanagawa Prefecture where the operator, Sanwa Sekisan Co. Ltd., has its base (Fig. 2).

In addition, we had this technology evaluated as an admixture in conformity with Japan Industrial Standards through its building technology performance evaluation system using a third-party evaluation agency. This enables application of this technology to construction as a concrete or precast product with the JIS mark. We will continue to develop recycled cement concrete, contributing to establishment of a Resource Recycling Society.

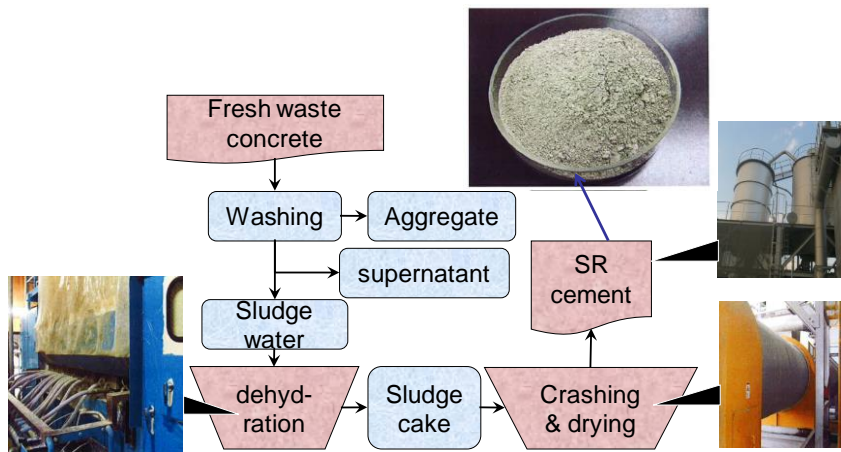


Fig. 1 Recycled cement production process.

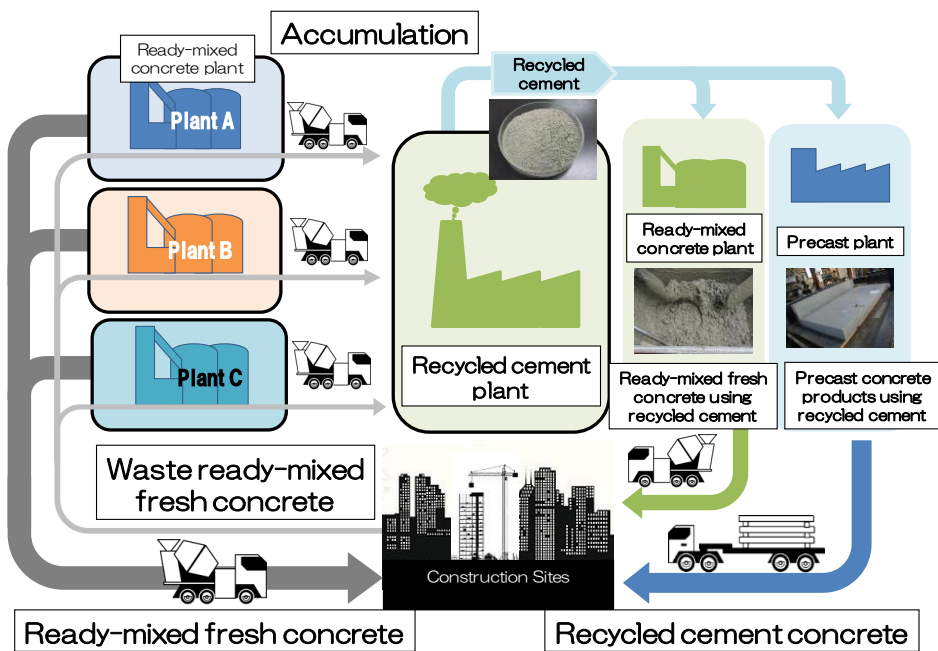


Fig.2 Local production for local consumption model in this research.