Technology Development in the Hokuriku District of Japan for the Production and Distribution of Highly Durable Concrete Mixtures Using High Quality Fly Ash

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The Research Committee on the Promotion of Effective Utilization of Fly Ash Concrete in the Hokuriku District

1. Background of development

(1) Background of project

In the Hokuriku district, existing structures are showing signs of ASR (Alkali-Silica Reaction). ASR also is a concern for future structures. The fly ash available in the Hokuriku district has an ASR controlling effect, but due to fluctuations in quality and other reasons, it is not being effectively used. Limited aggregate resources must be used effectively to improve the durability of concrete in order to reduce environmental loads and life cycle costs, as well as promote local consumption of local products. These the district issues can be tackled through cooperation among relevant parties. In January 2011, "The Research Committee on the Promotion of Effective Utilization of Fly Ash Concrete in the Hokuriku District," , an industrial, academic, and governmental group, was founded with the aim of establishing a system for reducing quality variations in high quality fly ash and effectively using it in concrete mixtures. Figure 1 shows the committee's composition. Photo 1 shows a committee meeting that was held.

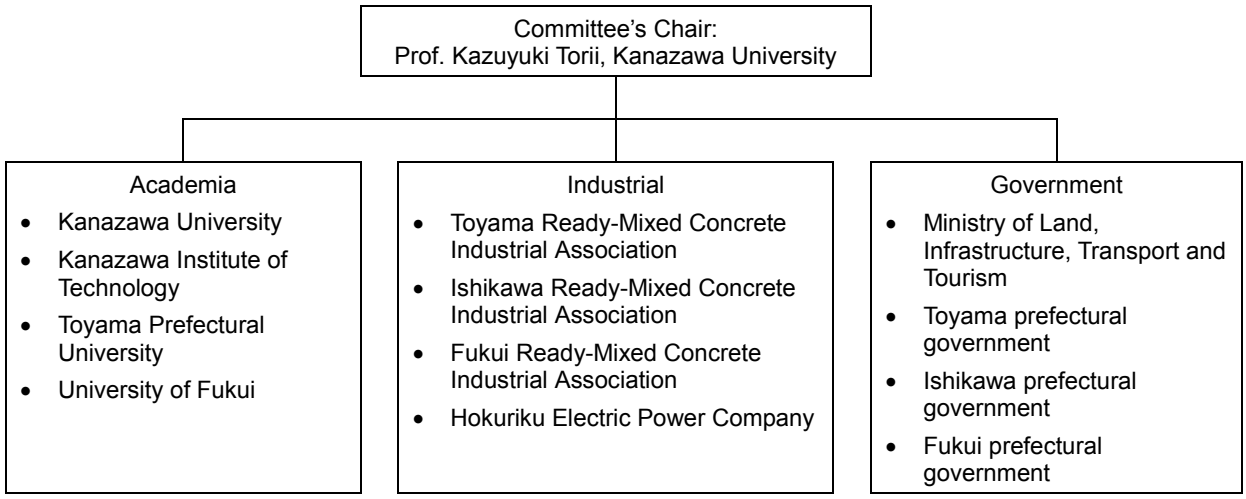

Figure 1. Composition of the Committee

Photo 1. Committee meeting

2. Summary of technology

(1) Descriptions of technology

The technologies to be developed for the system comprise a technology for classifying and managing the quality of fly ash and a technology for producing highly durable concrete using fly ash. The district's fly ash producers, concrete manufacturers, and clients are cooperating to establish a system to utilize classified fly ash in the district. Experts are also cooperating. Thus, in addition to solving specific issues, cooperation is being deeply incorporated. This differs from conventional technological development.

(2) Effects of technology

[1] Establishment of quality management and distribution systems for fly ash

At the Nanao-oota Thermal Power Plant in Ishikawa Prefecture and the Tsuruga Thermal Power Plant in Fukui prefecture, the classification of fly ash has begun, and a system to produce and distribute 30,000 tons shipment of high quality, low variability fly ash has been established.

[2] Preparation of standard mix proportion for fly ash concrete

A standard mix proportion for fly ash concrete containing aggregates typically used in the Hokuriku District was prepared.

Toyama prefecture: two aggregates
Ishikawa prefecture: two aggregates
Fukui prefecture: three aggregates

[3] Verification of the durability of concrete made with regional materials

The durability (calorific value, ASR, damage by chloride attack, frost damage, and carbonation control) of the standard fly ash concrete mixed in [2] was compared with concrete containing ordinary cement and concrete containing blast-furnace slag cement. The rresults demonstrated that concrete mixed with fly ash exhibited

improved durability that was equivalent to or higher than that of other types of concrete.

Table 1 lists the results of the quality comparison tests on concrete using fly ash.

Drawing on [1] to [3] above, by using concrete mixed with high quality fly ash, the practice of local consumption of local products can not only solve the district's ASR issue. The effect of reducing construction costs and CO_2 emissions can also be expected, thus contributing greatly to the district.

Table 1. Results of quality comparison tests on concrete using fly ash
(N: ordinary Portland cement, BB: blast-furnace slag cement Type B, N+F: 15% replaced with fly ash)

Comparison items		Toyama and Ishikawa Prefectures		Fukui Prefecture		Test items
		BB	N	BB	N	
	(1) Improved constructability	◎	◎	◎	◎	• 12-drive flow test • Bleeding test
	(2) Development of initial strength	☆	△	☆	△	• Compressive strength test
	(3) Increase in long-term strength	○	☆	○	☆	
	(4) Suppression of shrinkage	◎	◎	◎	◎	• Drying shrinkage test • Self-shrinkage test
	(5) Suppression of calorific value	☆	☆	☆	☆	• Simplified thermal insulation temperature rise test
	(6) Suppression of ASR	◎	☆	○	◎	• Mortar Bar Method (JIS A1146 and Danish Method)
(7) Improvement in durability	a. Permeable water suppression property	○	○	○	○	• Measurement of permeable water volume
	b. Chloride ion permeation suppression property	◎	☆	○	◎	• Penetration depth of chloride ions • Measurement of apparent diffusion coefficient
	c. Reinforcing steel corrosion suppression property	○	○	○	○	• State of corrosion of reinforcing steel
	d. Frost damage resistance	○	○	○	○	• Measurement of relative dynamic elastic coefficient • Measurement of mass reduction ratio
	e. Carbonation suppression property	◎	○	○	○	• Measurement of carbonation depth
	f. Porosity	○	○	○	○	• Pore volume ratio

Legend: The effect of N+F compared with BB or N was ☆: significantly observed, ◎: observed (partially equivalent), ○: equivalent, △: reduced (partially equivalent), and ×: significantly reduced.

(3) Records of technology application

Reconstruction work on the Kanazawatatsuruhama Line, a principal local road (conversion to four lanes, Uchinada Kaihin Bridge A1 and A2 abutment work) and 37 other projects.

(9,415m^3 of fly ash concrete was cast.)

Photo 2 shows construction work. Photo 3 shows the completed work.

Photo 2. Construction of fly-ash concrete abutments on a local road in Ishikawa prefecture.

Photo 3. Completed fly ash concrete box culvert on a national road in Ishikawa Prefecture.