Engineering Development on High-value Added Effective Utilization of Coal-gasification-slag
− Evaluation of Applicability to Lightweight-fine-aggregate for Concrete −

Background

Expected as one of the next-generation electric power generation methods, integrated coal gasification combined cycle (IGCC) system has been developed and demonstrated toward the practical use now in Japan (Fig.1). Coal-gasification-slag (CGS, Fig.3), which is obtained by water-granulating liquid slag (Fig.2), is discharged as a by-product from IGCC power generation. Not only for the effective utilization of resource and the protection of environment, but also for the spread of IGCC system, it is essential to develop utilization techniques of CGS. Focusing attention on the special heat-foaming property of CGS, CRIEPI has been developing the trimming weight techniques of CGS. It is important to develop an effective application method of the heat-foamed CGS at the present stage.

Objective

To evaluate the applicability of heat-foamed CGS to lightweight-fine-aggregate for concrete.

Principal Results

Conducting comparative typical tests with concrete specimens containing heat-foamed CGS, ordinary fine-aggregate and commercially available lightweight-fine-aggregate, respectively, we have evaluated the applicability of heat-foamed CGS to lightweight-fine-aggregate for concrete. The following results show that heat-foamed CGS can be applicable to lightweight-fine-aggregate for concrete; the test results indicate that concrete containing heat-foamed CGS can have a performance level equal to concrete containing commercially available lightweight-fine-aggregate.

1. Lightweight properties

Heat-foamed CGS was obtained, which has the lower density (1.46g/cm^3; saturated and surface-dry condition) despite its water absorption equal to that of commercially available lightweight-fine-aggregate (Fig.4 and 5).

2. Fresh concrete conditions

Fresh concrete containing heat-foamed CGS with required slump value [*1] could be produced by elementary mix proportion terms (water content and sand-total aggregate ratio) equal to that containing ordinary fine-aggregate and commercially available lightweight-fine-aggregate, respectively.

3. Strength

Heat-foamed CGS in hardened concrete was distributed uniformly without unevenness and condensation (Fig.6). Concrete containing heat-foamed CGS, with density of 90 percent of concrete containing ordinary fine-aggregate, performed the compressive strength equal to that of ordinary concrete. Compressive and splitting tensile strength, and Young's modulus of concrete containing heat-foamed CGS were approximately equal to concrete containing commercially available lightweight-fine-aggregate (Fig.7).

4. Durability

Resistance to carbonation [*2] of concrete containing heat-foamed CGS was same or more than that of concrete containing commercially available lightweight-fine-aggregate (Fig.8). Alkali-aggregate reaction [*3] of concrete containing heat-foamed CGS was confirmed harmless (Fig.9).

Future Developments

The applicability of heat-foamed CGS made from greater variety of coal to lightweight-fine-aggregate for concrete will be evaluated. Additionally, we will aim to asses the market competitive power of heat-foamed CGS.

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Reference

I. Kurashige et.al., 2006, "Engineering Development on High-value Added Effective Utilization of Coal-gasification-slag - Evaluation of Applicability to Lightweight-fine-aggregate for Concrete -", CRIEPI Report N05040 (in Japanese)

＊1：One of the indexes indicates tenderness of fresh concrete (ref. JIS A 1101)
＊2：The phenomenon when alkalinity of hardened concrete gradually reduces due to reaction with cabon dioxide in the atmosphere
＊3：The phenomenon where some sort of aggregate reacts with high alkaline pore water in concrete and expands to crack concrete

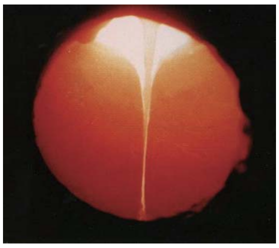


Fig.2 Discharging of liquid slag from CRIEPI test furnace

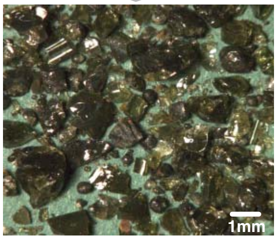
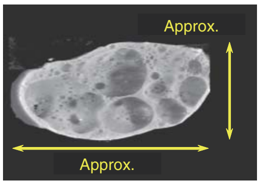


Fig.3 Water-granulated CGS example

Fig.4 Heat-foamed CGS example

; form rounded, produced by retaining for 5-7 min. at approx. 1000℃



Heat-foamed CGS with a large number of spherical pores is trimmed its weight

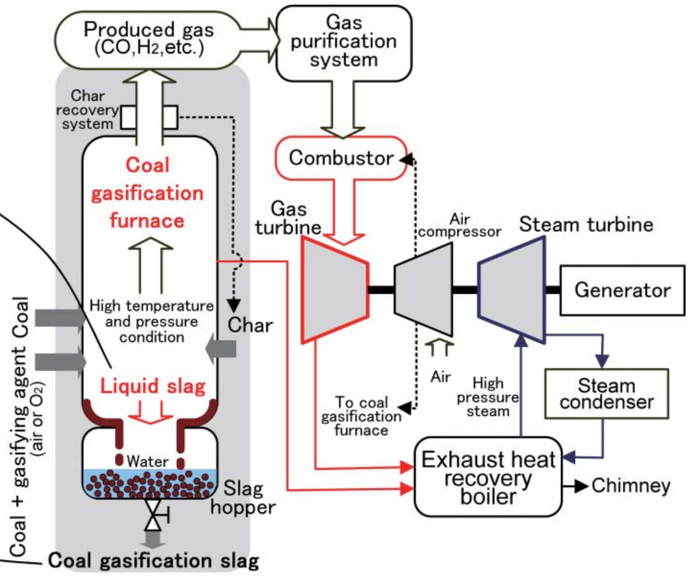
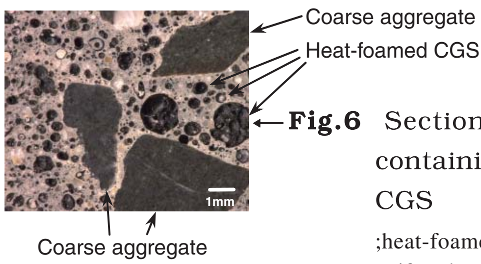


Fig.1 Examples of IGCC plant system and coal gasification furnace

←**Fig.5** Internal structure image of heat-foamed CGS



←**Fig.6** Section of concrete containing heat-foamed CGS

;heat-foamed CGS distributed uniformly

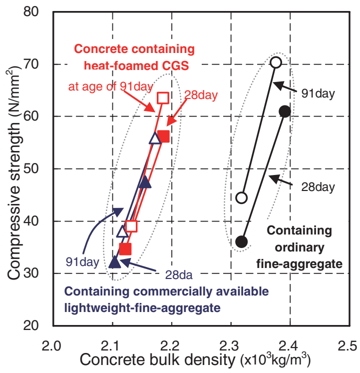


Fig.7 Compressive strength of concrete containing heat-foamed CGS

; obtained equal to concrete containing ordinary fine-aggregate with lower density equal to concrete commercially available lightweight-fine-aggregate

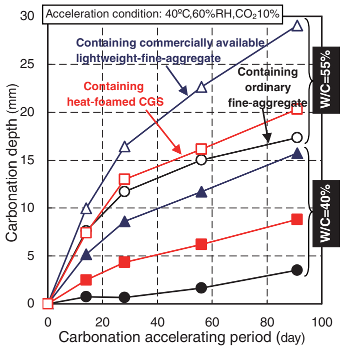


Fig.8 Carbonation resistance of concrete containing heat-foamed CGS

; indicates equal to concrete containing commercially available lightweight-fine-aggregate

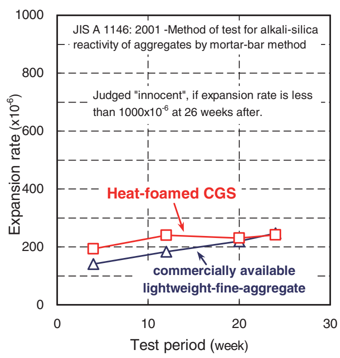


Fig.9 Alkali-aggregate reactivity of heat-foamed CGS

; confirmed innocent by JIS test