Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 55 (1987)

Artikel: A new concrete production method using small pieces of ice
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DOI: https://doi.org/10.5169/seals-42745

A New Concrete Production Method Using Small Pieces of Ice

Nouvelle méthode de confection de béton par utilisation de petits morceaux de glace

Ein neues Betonherstellungsverfahren unter Verwendung von Eisstücken

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SUMMARY

A new unique method has been developed for the production of concrete. This new method takes advantage of small pieces of ice and their melting process. The concrete is obtained by substituting small pieces of ice for the mixing water. Using this method, the various properties required of concrete during production are greatly improved.

RÉSUMÉ

Une nouvelle méthode unique a été mise au point pour la confection de béton. La nouvelle méthode tire avantage de petits morceaux de glace et de leur processus de fonte. Le béton est obtenu en substituant les petits morceaux de glace à l'eau de mélange. Les différentes propriétés de béton requises durant la confection sont considérablement améliorées.

ZUSAMMENFASSUNG

Es wurde eine neue Methode zur Betonherstellung entwickelt, welche den Schmelzprozess kleiner Eisstücke ausnützt. Bei der Betonherstellung wird das Mischwasser durch Eisstücke ersetzt. Die verschiedenen Eigenschaften des Betons während der Herstellung werden durch diese Methode wesentlich verbessert.

1. INTRODUCTION

This paper introduces the unique concrete production method based on a new concept. The new concept means that small pieces of ice and their melting process are effectively utilized for production of concrete. The concrete is obtained by substituting small ice pieces for the mixing water. The various required properties of concrete during production, including mixing efficiency, placement performance, consolidation ability and curing stability are greatly improved.

The concept of using small pieces of ice and fundamental characteristics of the concrete produced by this method are described in the previous papers [3] and [4], in detail. In the papers, the essential differences between this proposed method and former techniques using ice pieces described in [1] and [2] are also discussed.

This method of producing concrete was originally conceived by T. SUZUKI, primary author, and various experiments and examinations were undertaken jointly by T. SUZUKI and K. TAKIGUCHI.

2. METHOD OF PRODUCING CONCRETE USING SMALL ICE PIECES

The proposed concrete production method is distinguished by using small ice pieces substituted for the mixing water at the start of mixing. The small ice pieces should be perfectly melted at the finish of placing. The characteristics of this concrete production method are shown in Chart 1.

The advantages of this method are as follows.

(1) Mixing can be conveniently carried out almost irrespective of the mix proportions.

The difference between solid-liquid phase mixing and solid-solid phase mixing is shown in Photos. 1 and 2. These two photographs indicate the sections of wheat

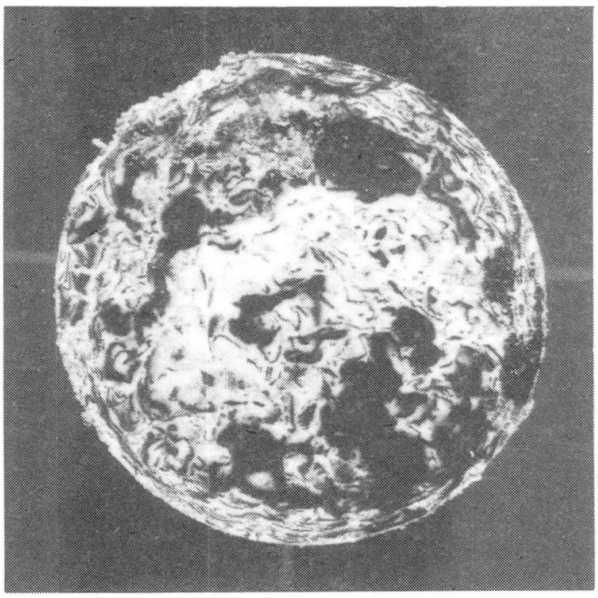

Photo.1 Section of wheat flour and red ink (liquid phase) mixture

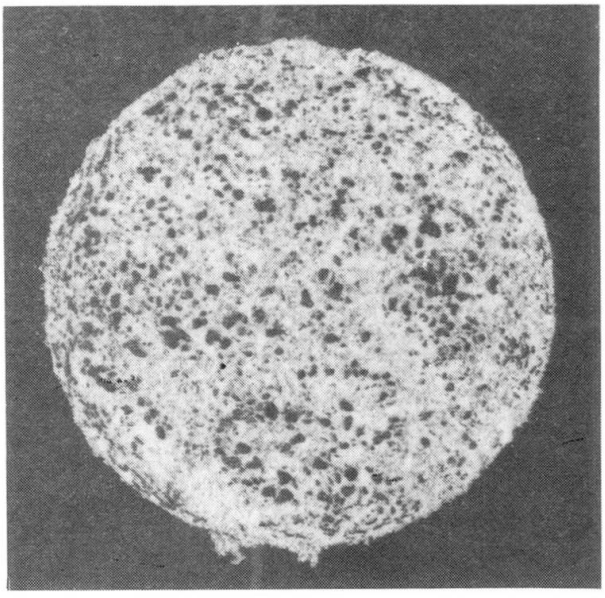

Photo.2 Section of wheat flour and red ink (frozen and sliced) mixture

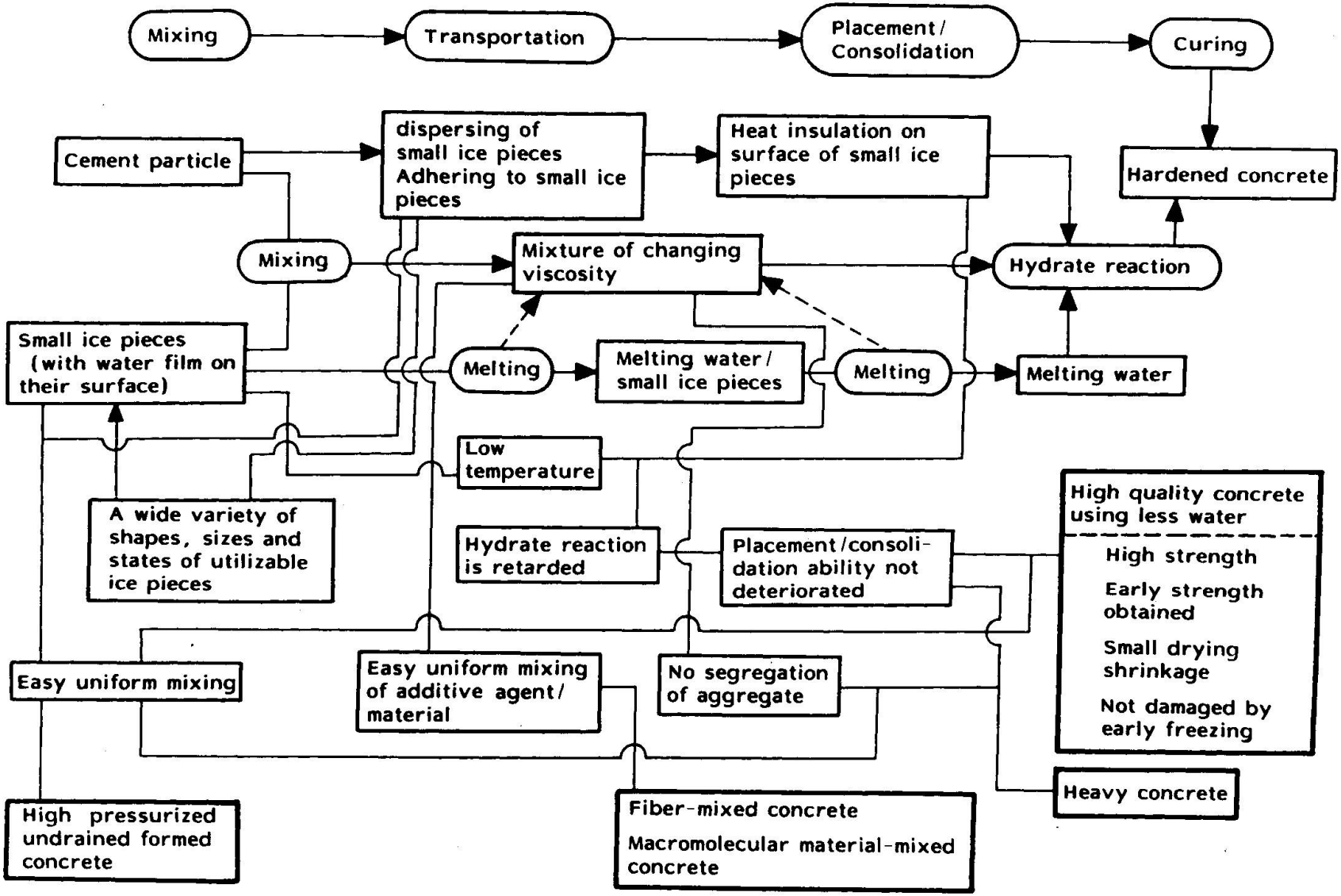

Chart 1 Characteristics of concrete production method utilizing small ice pieces and then melting process

flour and red ink mixture. Red ink in the liquid phase was used in the mixture shown in Photo.1. Red ink was frozen and flaked with an ice slicer for the mixture shown in Photo.2. All the conditions except the phase of red ink at the mixing were the same.

(2) Small ice pieces of a wide variety of shapes, sizes and states can be used.

Because the minute particles of cement have the effect of dispersing the pieces of ice, they can be separated and dispersed uniformly. This can be attained without hindrance even when macroscopic water film forms on the surface of the pieces of ice, or even when they are joined in a chain form.

Crushed ice of maximum particle size 3~5 mm, sliced ice of 1~2 mm, natural snow and very small ice pieces can be used.

(3) The viscosity changes as the small ice pieces melt, reaching an appropriate level for the uniform mixing of special additives, such as fibers.

(4) There is no aggregate segregation after uniform mixing because of the change in viscosity caused by the melting of the ice.

(5) The hydrate reaction is retarded throughout mixing until final placement.

The above characteristics are advantageous for production of the following types of concrete:

i) High quality concrete using less water
ii) Concrete with heavy aggregates
iii) Concrete mixed with fibers
iv) Concrete mixed with macromolecular materials
v) Pressured and undrained formed concrete
vi) Slow setting ready-mixed concrete

3. PROPERTIES OF CONCRETE OBTAINED USING THIS METHOD

The compressive strength of concrete produced by this method was examined comparing with that of conventional concrete. Two types of concrete compared were produced under the same conditions except the phase of mixing water. The

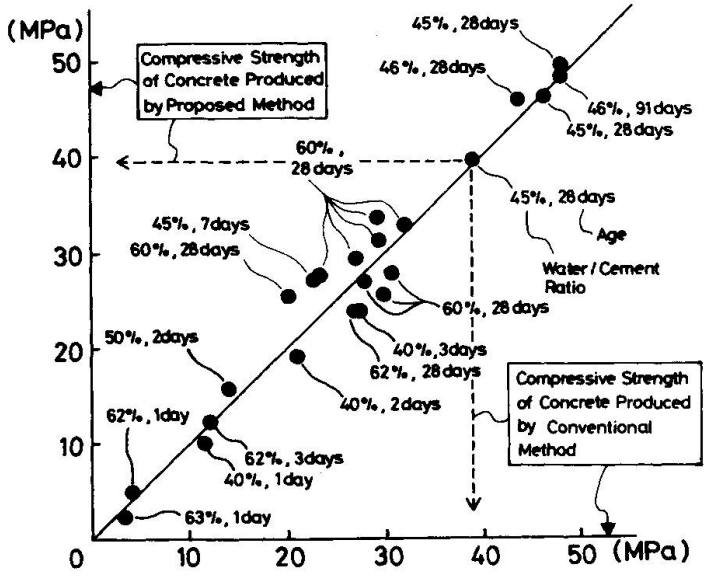

Fig.1
Compressive strength of the concrete produced by proposed method and of conventional concrete

curing period ranged from 1 day to 91 days. The experimental results are shown in Fig. 1. It can be concluded that the strength of the concrete produced by proposed method is equal to that of the conventional concrete.

The slump values of the concrete produced by this method are larger than those of conventional concrete as shown in Figs. 2 and 3. The mix proportion of the concrete shown in Fig. 2 is: Cement 264 kg/m^3, Water (Small ice pieces) 161 kg/m^3, Sand 851 kg/m^3, Gravel 1016 kg/m^3, Air entraining agent 2.8 kg/m^3. As for Fig. 3; Cement 305 kg/m^3, Water (Small ice pieces) 180 kg/m^3, Sand 777 kg/m^3, Gravel 992 kg/m^3, Air entraining agent 3.4 kg/m^3.

As shown in Figs. 2 and 3, the slump value of the concrete produced with small ice pieces became larger as time passed, though the ice pieces were perfectly melted when the concrete was mixed up. This is one of the distinctive properties of the concrete with small ice pieces.

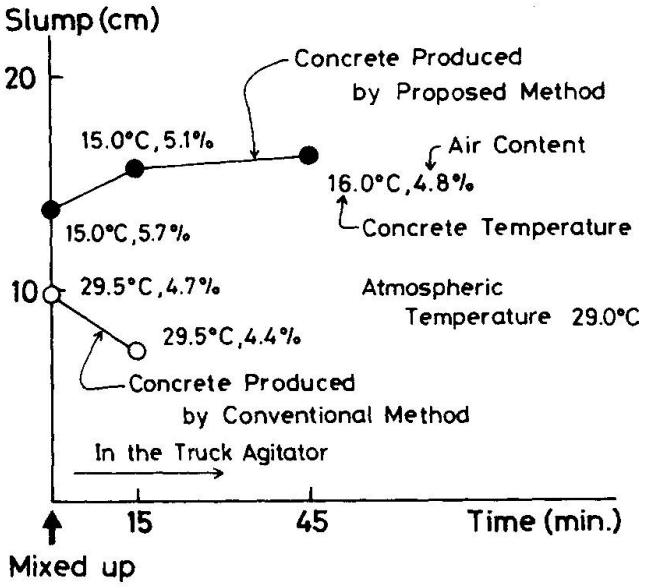

Fig.2 Slump of the concrete produced by proposed method and of conventional concrete

4. PRACTICAL USE AND ECONOMICAL ASSESSMENT

In several actual structures, the concrete produced by this method was practically used without any problem. The atmospheric temperatures at practical using of this method were about 30°C(hot weather), 20° C (mild weather), -5° C (cold weather) and so on.

The transportable plant suppying small ice pieces was designed as shown in Fig. 4, and the first experimental truck shown in Photo. 3 was made. The plant truck is working successfully according to the specifications shown in Fig. 4.

The cost of this proposed concrete depends on the price of ice and will be 3~15% higher than that of the conventional concrete. A rise in price by using small ice pieces is not so significant, because it should be evaluated together with the improved properties. To product high quality concrete using this method shall be economical in the final analysis.

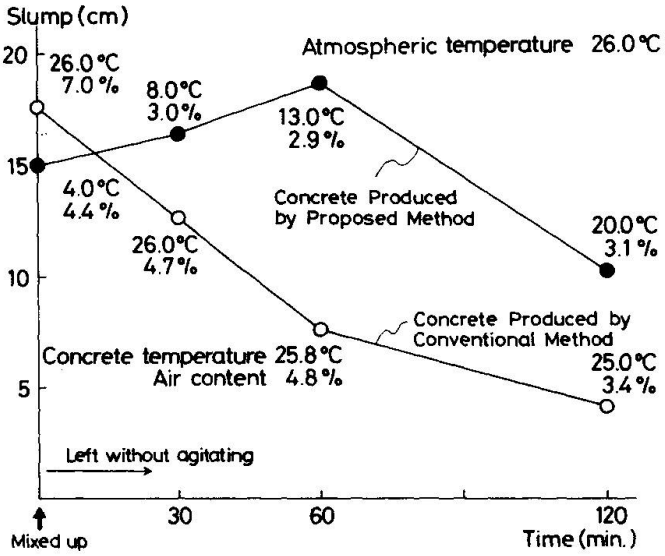

Fig.3 Slump of the concrete produced by proposed method and of conventional concrete

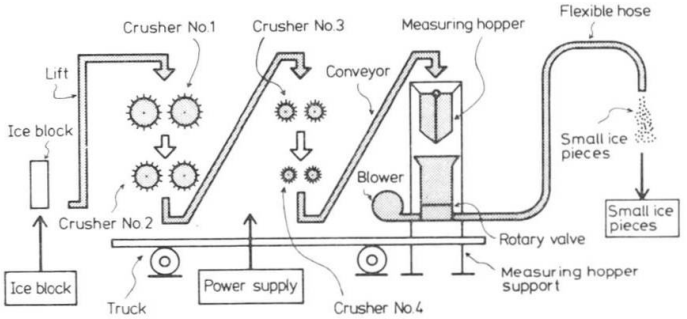

Fig.4
Transportable plant system supplying small ice pieces and the specifications of the plant

Specification	Maximum particle size of ice pieces	Continuously supplying capacity	Allowable measuring error
	3 ∿ 5 mm	180 ∿ 220 kg/min	1 kg/ 180 kg

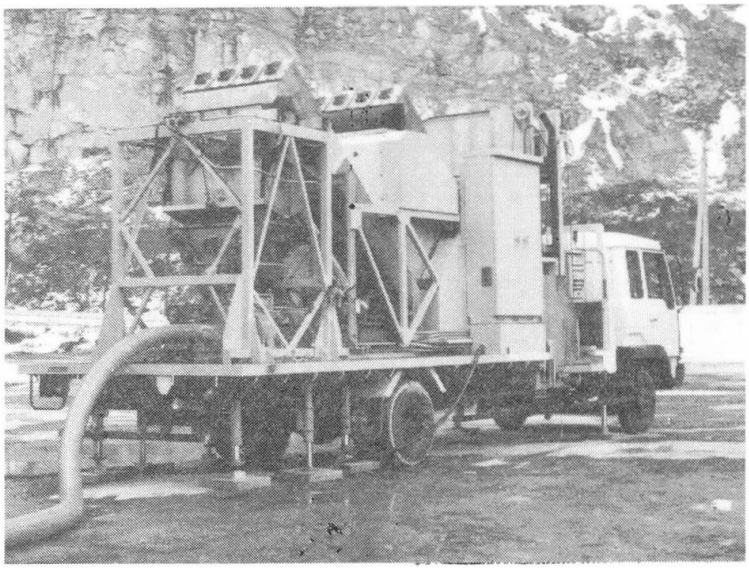

Photo.3
The first experimental plant truck

5. CONCLUSION

The various problems faced in the production process of concrete can be solved by the proposed method using small ice pieces instead of mixing water.

The concept of utilizing small ice pieces and their melting process has opened up new possibilities for the production of various types of concrete.

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