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(54) Title: METHOD OF PRODUCING COOLED UNSET CONCRETE

(57) Abstract: The invention relates to a method of producing cooled unset concrete, in which the concrete starting materials such as binder, aggregates and make-up water are cooled by means of gaseous nitrogen during storage or transport or mixing to produce unset concrete. The cooling according to the invention makes production of quality concrete which is technically simple and inexpensive and largely independent of process and ambient conditions possible.



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Method of producing cooled unset concrete

The invention relates to a method of producing cooled unset concrete having the features of the preamble of Claim 1.

Cooled unset concrete is used to avoid temperature stress cracks in concrete constructions, for example retaining walls, bridge bearings, pylons, sluices, bunkers and power station buildings. Cooling of the concrete enables the heat liberated during hydration of the cement in the concrete to be compensated better and removed more uniformly and thus enables stress differences, which can lead to a lower resistance to carbonation, to chemical attack by chloride intrusions and to freezing and thus to a reduction in the strength of the component, to be avoided.

There are many possible ways of influencing the maximum concrete temperatures. Cooled unset concrete can be produced by cooling the binder which has the greatest heating potential present in the unset concrete, for instance cement, but also the aggregates such as gravel, sand, fly ash and the like, and also the added water.

Coolants used are, inter alia, crushed ice or very cold liquid nitrogen. The most advantageous way of cooling the concrete depends on the respective boundary conditions.

The liquid nitrogen used for cooling concrete is conveyed from a pressurized container, for example a storage tank or gas bottle, via a line by means of an addition device, e.g. a lance, in relatively large amounts and in a relatively short time into the mixer which mixes the concrete starting materials (binder, aggregates, water) to produce unset concrete. As a result of the introduction of liquid nitrogen, large

volumes of gas are liberated in the mixer, and these can lead to local critical undercooling of the unset concrete with adverse effects on the concrete quality (e.g. damage caused by freezing). In addition, thermal stresses can occur in the introduction region in the mixer, or mixer parts can become brittle due to the low temperatures and thus lead to mechanical damage, e.g. fracture of the mixer arms, which impairs mixer function. A further significant disadvantage of the cooling of unset concrete by means of liquid nitrogen is that the cooling effect achieved is unsatisfactory in proportion to the amount of coolant used, since only the heat of vaporization of the liquid nitrogen is utilized for cooling. In addition, the handling of relatively large amounts of coolant within short cooling times presents practical problems. Depressurization losses, which additionally reduce the cooling effect, also occur as a result of the cooling liquid which is used at a relatively high operating pressure and thus represents a continual hazard potential also occur. In addition, evaporation losses occur in the storage container in which the liquid nitrogen is stored in the event of prolonged downtimes, and these restrict the availability of liquid nitrogen for quick use in large amounts.

From production-related and thermodynamic points of view, cooling of the cement which is used as binder in concrete production and is delivered at temperatures of from +70°C to +90°C to the building site and is pneumatically introduced into hoppers is particularly advantageous. For example DE 40 10 045 C2 discloses a method and an apparatus for cooling a pulverulent substance, for instance cement used for concrete production, in which liquid nitrogen is injected into the pulverulent substance which is pneumatically transported through a transport line by means of a mixing tube of a Venturi nozzle installed in the

transport line and is thus brought into direct thermal contact with the pulverulent substance. In this method of cooling, the material to be cooled is cooled only while it is being transported through a transport line, i.e. only during the transport time. In addition, the plant components (transport lines) exposed to the very cold cooling liquid have to have a specific construction and be provided with low temperature insulation. Local undercooling of the material to be cooled or the temperature going below the dew point and thus a reduction in quality of the material to be cooled (cement) can also not be ruled out and there is the additional risk that (atmospheric) moisture will be introduced into the cooled plant complex, as a result of which the quality of the material being cooled is reduced or the material to be cooled becomes impossible to use. There is also the risk of pressurized gas hammering in the plant components in which the very cold cooling liquid is present, which adversely affects production safety.

It is therefore an object of the present invention to provide a method of producing cooled unset concrete which avoids the disadvantages of the known cooling methods and, in particular, makes economical use of the coolant used with simultaneously improved cooling performance possible.

This object is achieved by a method having the features of Claim 1.

Further embodiments of the invention are described in the subordinate claims.

In the method of the invention, the binder, e.g. cement, and/or the aggregates, e.g. gravel, sand, fly ash and the like, and/or the make-up water transported through lines and/or stored in a storage container

within the plant used for concrete production are thus cooled by means of gaseous nitrogen produced from liquid nitrogen by means of heat energy internal to the process.

The binder, the aggregates and the make-up water can also be cooled advantageously by means of the nitrogen cooling gas during mixing to produce unset concrete.

To achieve this, the liquid nitrogen stored in a pressurized storage container, e.g. a storage tank or a gas bottle, is vaporized by means of process heat taken from concrete production to produce gaseous nitrogen and the nitrogen gas is introduced into the binder, e.g. cement, or aggregates, e.g. sand, gravel, fly ash and the like, or the make-up water transported through the transport lines or stored in the storage container or mixed in a mixer to produce unset concrete.

The nitrogen cooling gas is advantageously introduced via the pneumatic devices present for loosening the cement or aggregate stored as bulk material in the storage container, with the nitrogen cooling gas being introduced into the bulk material stored in the lower storage region. As a result of the introduction of cooling gas in countercurrent, the thermal conditions in the storage container and the physical properties of the nitrogen are optimally utilized, as a function of the coolant temperature.

The cooling temperature is selected so that the temperatures necessary for the respective concrete quality are adhered to and, in addition, damage to the storage container, e.g. brittle fracture, resulting from the action of excessive cold is ruled out.

The nitrogen cooling gas is introduced either continuously or at various time intervals in differing

amounts and at variable temperatures as a function of the requirements in terms of concrete quality, the respective cooling requirement and the process and ambient conditions (influences of weather).

The very cold liquid nitrogen which is stored in a pressurized storage container and is used for producing the gaseous nitrogen is, for example, fed to a heat-exchange apparatus and while passing through this gives up its enthalpy of vaporization to the process medium flowing around the heat-exchange apparatus, advantageously to the make-up water stored in the stock tank or storage container or to the water used for sprinkling the aggregates. The gaseous nitrogen present at the outlet from the heat-exchange apparatus is used, in the manner indicated above, for cooling the binder (cement) or the aggregates (gravel, sand and the like) or the make-up water.

Instead of the nitrogen cooling gas, it is also possible to use any other cooling gas which is suitable for cooling concrete and is produced according to the invention from a liquefied gas.

As heat-exchange apparatus, it is possible to use all conventional heat exchangers, for example plate heat exchangers, shell-and-tube heat exchangers, in any number and arrangement with a performance corresponding to the respective requirements.

The invention makes thermodynamically efficient and economical utilization of the mass-specific refrigeration potential present in the liquid nitrogen and thus a significantly improved cooling effect compared to previous cooling methods possible.

The production of cooled unset concrete according to the invention has the following significant advantages

over the conventional production of cooled unset concrete:

- adherence to the parameters which are critical for the required concrete quality, e.g. the pH
- no pressure pulses as in the case of cooling by means of liquid nitrogen
- cooling power can be varied
- no undesirable influences on the gravimetric technique of the metering device(s) upstream of the mixer
- no icing of the outlet air filter on the concrete mixer
- no "bubble effect" in the unset concrete
- steady and satisfactory availability of the liquefied gas used for cooling gas production in all plant components
- no evaporation losses
- use of liquefied gas from gas bottles is possible
- no risk of freezing/icing in the inlet region of the plant components
- no low-temperature insulation of the transport lines
- technically simple and economical cooling of unset concrete.

Claims

1. Method of producing cooled unset concrete, in which the concrete starting materials such as binder, aggregates and make-up water are cooled by means of a cooling liquid, characterized in that the concrete starting materials are cooled by means of a cooling gas.
2. Method according to Claim 1, characterized in that the binder, for instance cement, is cooled by means of a cooling gas during transport and/or storage.
3. Method according to Claim 1, characterized in that the aggregates such as gravel, sand, fly ash and the like are cooled by means of a cooling gas during transport and/or storage.
4. Method according to Claim 1, characterized in that the make-up water is cooled by means of a cooling gas during transport and/or storage.
5. Method according to any of the preceding claims, characterized in that the binder and the aggregates and also the make-up water are cooled by means of a cooling gas while they are being mixed to produce unset concrete.
6. Method according to any of the preceding claims, characterized in that gaseous nitrogen is used as cooling gas.
7. Method according to any of the preceding claims, characterized in that the gaseous nitrogen is produced by vaporization of liquid nitrogen.

8. Method according to any of the preceding claims, characterized in that the liquid nitrogen is vaporized by means of process heat energy to produce gaseous nitrogen.
9. Method according to any of the preceding claims, characterized in that the gaseous nitrogen is introduced continuously or at various time intervals.
10. Method according to any of the preceding claims, characterized in that the gaseous nitrogen is introduced in various amounts and with variable temperatures.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 013, no. 415 (M-870), 13 September 1989 (1989-09-13) & JP 01 152012 A (TODA CONSTR CO LTD; others: 01), 14 June 1989 (1989-06-14)	1,3,6,7, 9
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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