

METHOD FOR CONTROLLING WORK PERFORMANCE OF FRESH CONCRETE BASED ON REGULATION AND CONTROL OF POURING CONSTRUCTION PERFORMANCE OBJECTIVE

TECHNICAL FIELD

The present invention relates to a method for controlling work performance of concrete, and in particular relates to a method for controlling work performance of fresh concrete based on regulation and control of a pouring construction performance objective.

BACKGROUND

During construction of a concrete structure, it is required that fresh concrete must have good work performance in order to ensure the compactness and uniformity of concrete construction and facilitate operations of mixing, transport, pouring, vibration, etc. For fresh concrete with poor work performance, the difficulty of construction will increase as it is too viscous on one hand, and segregation and bleeding will be caused as it is too thin on the other hand, thereby causing tube blockage of concrete pumping to affect the construction process and the compactness of a final concrete structure.

As a result, the performance of fresh concrete needs to be strictly controlled in order to ensure the quality of a project and the smooth progress of construction. There are several main control nodes for work performance of concrete during construction at a project site, mainly including a work performance control node for discharging concrete in a mixing station, and a work performance control node for transporting the concrete to the site for pouring construction. The work performance of the concrete is characterized by performing slump and expansion tests at each control node. A conventional method mainly controls work performance of concrete at a discharging node for the concrete to ensure that the

concrete discharged from a mixing station is in good condition. The work performance of the concrete transported to a pouring construction site is often far from the best work performance required for pouring construction, and the work performance needs to be re-adjusted by means of adding additional additives, etc., thereby increasing the operational difficulty of on-site personnel, and delaying construction time. Meanwhile, with the application of novel additives in concrete, it is more and more difficult to grasp a changing rule of work performance of concrete from a discharging node to a construction node.

According to factors such as environmental conditions, interval time between mixing and construction, etc., a time-dependent changing rule of work performance of concrete can be grasped to reasonably grasp a changing rule of the work performance of the concrete at different time, and the work performance of the concrete can be controlled to achieve the best construction performance during construction.

SUMMARY

In order to ensure the construction quality of concrete, the present invention provides a method for controlling work performance of fresh concrete based on regulation and control of pouring construction performance objective. A time-dependent changing rule of the work performance of the concrete under different environmental conditions is taken into account, and a construction node for the concrete is used as a work performance control base point. The method can grasp a changing rule of the work performance of the concrete under different interval time and environmental conditions, and control the work performance of the construction node for the concrete to be within a most suitable range for construction, thereby improving the construction quality, and guaranteeing the compactness of a final concrete structure.

In order to achieve the above objective, the present invention adopts the following technical solution: a method for controlling work performance of fresh

concrete based on regulation and control of a pouring construction performance objective, including the following steps:

step (1) carrying out a time-dependent test on work performance of fresh concrete under various working conditions to obtain time-varying data of the work performance of the concrete: preparing the concrete at a maximum daily temperature, a minimum daily temperature, and an average daily temperature corresponding to a location of a project, controlling initial expansion degrees of the concrete to be 650 mm, respectively, and performing the time-dependent test on the work performance of the concrete every 20 minutes to obtain expansion degrees of different time-dependent concrete under different conditions;

step (2) building a time-varying model for the work performance of the concrete based on different working conditions: performing least squares fitting on a time-dependent test result of the work performance of the concrete, and building the time-varying model for the work performance of the concrete based on the different working conditions, the time-varying model for the work performance of the concrete based on the different working conditions being as follows:

$$W(t) = (aT + b)t^2 + (cT + d)t + \lambda$$

wherein $W(t)$ is the expansion degree of the concrete corresponding to different time, and has a unit of mm; T is an environmental temperature under the different working conditions, and has a unit of °C; t is interval time between mixing and construction, and has a unit of min; λ is the expansion degree of the fresh concrete, and has a unit of mm; and a , b , c , and d are temperature correlation coefficients; and

step (3) according to the different working conditions and a work performance control indicator of a construction node, determining relevant parameters of the time-varying model for the work performance of the concrete, and calculating a work performance control indicator of the fresh concrete:

determining the temperature T of the current working condition, the interval time t between mixing and construction, and the expansion degree $w(t)$ corresponding to the best work performance of the concrete required for construction, substituting the environmental temperature of the current working condition, the interval time between mixing and construction, and the target expansion degree into the model, and calculating the expansion degree λ of the fresh concrete capable of making the concrete reach the target expansion degree during construction under the condition of the interval time.

The time-dependent changing rule of the work performance of the concrete under the different environmental conditions is taken into account, the construction node for the concrete is used as the work performance control base point, and according to interval time between discharging and construction of the concrete and a site environmental condition, a control requirement of the work performance of a discharging node for the fresh concrete capable of making the concrete achieve a control objective at the construction node under the working condition is calculated.

The present invention has the following outstanding advantages:

Compared with a conventional method for controlling work performance, the method for controlling work performance of fresh concrete based on regulation and control of a pouring construction performance objective reduces the operational difficulty of on-site construction personnel, lowers the risk of tube blockage of concrete pumping and poor pouring compactness, and has relatively high feasibility.

According to the environmental conditions, the interval time between mixing and construction, a time-dependent changing rule of the work performance of the concrete can be grasped, and the work performance of the concrete can be controlled to achieve the best construction performance during construction.

DETAILED DESCRIPTION OF EMBODIMENTS

The technical solution of the present invention is further described in detail below with reference to the embodiments.

Embodiment 1

The present invention provides a method for controlling work performance of fresh concrete based on regulation and control of a pouring construction performance objective, including the following steps:

step (1) A time-dependent test on work performance of fresh concrete under various working conditions is carried out to obtain time-varying data of the work performance of the concrete: the concrete is prepared at a maximum daily temperature, a minimum daily temperature, and an average daily temperature corresponding to a location of a project, initial expansion degrees of the concrete are controlled to be 650 mm, respectively, and the time-dependent test on the work performance of the concrete is performed every 20 minutes to obtain expansion degrees of different time-dependent concrete under different conditions. An environmental temperature of a test and a test result are as shown in Table 1:

Table 1 Environmental condition and time-dependent test result of work performance of concrete

Group	Temperature (°C)	Expansion degrees at different time (mm)									
		0	20	40	60	80	100	120	140	160	180
1	36.2	650	680	700	690	670	630	600	530	490	430
2	28.5	650	680	710	730	690	660	620	560	520	490
3	20.8	650	680	710	740	740	700	670	630	580	550

step (2) A time-varying model for the work performance of the concrete based on different working conditions is built: least squares fitting is performed on a time-dependent test result of the work performance of the concrete, and the

time-varying model for the work performance of the concrete based on the different working conditions is built. The time-varying model for the work performance of the concrete based on the different working conditions is as follows:

$$W(t) = (aT + b)t^2 + (cT + d)t + \lambda$$

wherein $W(t)$ is the expansion degree of the concrete corresponding to different time, and has a unit of mm; T is an environmental temperature under the different working conditions, and has a unit of °C; t is interval time between mixing and construction, and has a unit of min; λ is the expansion degree of the fresh concrete, and has a unit of mm; a , b , c , and d are temperature correlation coefficients; and a fitting result is as follows:

$$W(t) = (8 \times 10^{-5}T - 0.01671)t^2 + (-0.05807T + 3.202)t + \lambda$$

step (3) According to the different working conditions and a work performance control indicator of a construction node, relevant parameters of the time-varying model for the work performance of the concrete are determined, and a work performance control indicator of the fresh concrete is calculated: it is determined that the temperature T of the current working condition is 25.6°C, the interval time t between mixing and construction is 45 minutes, and the expansion degree $W(t)$ corresponding to the best work performance of the concrete required for construction is 680 mm. The environmental temperature of the current working condition is substituted, and an obtained calculation model is as follows:

$$W(t) = -1.47 \times 10^{-2}t^2 + 1.716t + \lambda$$

The interval time between mixing and construction, and the target expansion degree are substituted, and it is calculated that the expansion degree λ of the fresh concrete capable of making the concrete reach the target expansion degree during construction under the condition is 632 mm.

CLAIMS

1. A method for controlling work performance of fresh concrete based on regulation and control of a pouring construction performance objective, characterized in that, the method comprises the following steps:

step (1) carrying out a time-dependent test on work performance of fresh concrete under various working conditions to obtain time-varying data of the work performance of the concrete: preparing the concrete at a maximum daily temperature, a minimum daily temperature, and an average daily temperature corresponding to a location of a project, controlling initial expansion degrees of the concrete to be 650 mm, respectively, and performing the time-dependent test on the work performance of the concrete every 20 minutes to obtain expansion degrees of different time-dependent concrete under different conditions;

step (2) building a time-varying model for the work performance of the concrete based on different working conditions: performing least squares fitting on a time-dependent test result of the work performance of the concrete, and building the time-varying model for the work performance of the concrete based on the different working conditions, the time-varying model for the work performance of the concrete based on the different working conditions being as follows:

$$W(t) = (aT + b)t^2 + (cT + d)t + \lambda$$

wherein $W(t)$ is the expansion degree of the concrete corresponding to different time, and has a unit of mm; T is an environmental temperature under the different working conditions, and has a unit of °C; t is interval time between mixing and construction, which is an interval time from time when the concrete is poured out of a mixer to time when the concrete enters a pump truck for pumping or direct manual pouring, and has a unit of min; λ is the expansion degree of the fresh concrete, and has a unit of mm; and a , b , c , and d are temperature correlation coefficients; and

step (3) according to the different working conditions and a work performance control indicator of a construction node, determining relevant parameters of the time-varying model for the work performance of the concrete, and calculating a work performance control indicator of the fresh concrete: determining the temperature T of the current working condition, the interval time t between mixing and construction, and the expansion degree $W(t)$ corresponding to the best work performance of the concrete required for construction, substituting the environmental temperature of the current working condition, the interval time between mixing and construction, and the

target expansion degree into the model, and calculating the expansion degree λ of the fresh concrete capable of making the concrete reach the target expansion degree during construction under the condition of the interval time.

2. The method for controlling work performance of fresh concrete based on regulation and control of a pouring construction performance objective according to claim 1, wherein the construction node for the concrete is a time node when the concrete is transported to a construction platform and begins to be poured from a tank truck into a pump truck for pumping or direct manual pouring.

3. The method for controlling work performance of fresh concrete based on regulation and control of a pouring construction performance objective according to claim 1, wherein the environmental temperature under the different working conditions is the environmental temperature during concrete transportation, construction and other processes under different weather and sunshine conditions.

4. The method for controlling work performance of fresh concrete based on regulation and control of a pouring construction performance objective according to claim 1, wherein the work performance control indicator of the fresh concrete is a control requirement of the work performance of the concrete at concrete mixing completion time when the concrete can achieve reasonable work performance during construction in a time-varying manner under the action of the temperature.