

Study on construction schedule optimization of bored pile based on genetic algorithm

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Abstract. The site construction management of traditional filling pile has some disadvantages such as redundancy of data, difficulty in finding data, low working efficiency and poor timeliness. Thus, combined with the actual needs of filling pile construction management, based on the Java language, the mobile phone client of filling pile construction information management system was developed, and the mobile client system framework, operating process and functional framework were designed and illustrated. The software provided an advanced management method for the filling pile construction, it had great value to guarantee the construction progress and improve the information level of construction management.

1. Introduction

Bored piles are widely used as the common pile foundation type. The traditional construction management of bored piles adopts the ways of manual preparation of progress reports and filling in the construction logs. This method has such disadvantages as data redundancy, data search difficulties, low work efficiency, poor timeliness, etc., therefore, it has always been a problem that must be solved by construction managers about how to use modern technical means to solve the problem of the construction schedule information management of bored piles.

The Internet industry is a hot spot in recent years. Applying Internet technology to the field of construction management can effectively improve the informatization management level of the bored piles construction, and further achieve the scientific integration and management of construction information. Through the connection of internet and construction information, real-time query of construction information on the mobile phone client can be realized, remote management of construction information can be realized, and the intelligent level of project management can be greatly improved. Besides, the database's powerful information storage and management capabilities can provide more advanced data storage management tools and more intuitive information display effects for construction information management [1].

Under the new situation of the transformation and development of the construction industry and the new round of scientific and technological changes, the Internet technology has been introduced into the construction management of bored piles, and the construction of bored piles has been managed in a combination of the Internet and the construction of bored piles, which is of practical significant to



ensuring the construction progress and improving intelligent construction management level. Through the research and application of this project, it can effectively solve the problem with the backward construction management level of the bored piles and promote the information management level of the construction project [2-3].

2. System structural design

2.1. System framework

According to the function demand analysis of the bored pile construction information management system. The framework of the system is divided into four layers: interface layer, application layer, data layer and support layer. Clear division and good coordination are made at all layers:

(1) The interface layer refers to the communication layer between the user and the system. At this layer, the system senses the user's operation through this layer, automatically calls the system to specify the function module, and complete the user instruction.

(2) The application layer is the function that the system needs to provide on the basis of the effective operation by the user. Such functions include managing pile-foundation information, progress information, and quality information. After the system receives the operation instruction input by the user, the related function is started according to the instruction, and is finally implemented in the system[4-6].

(3) Data layer is the database for storing various types of construction information, including various data interfaces involved in implementing data conversion processing. In the database, relevant information, data, and information can be stored in a long-term and effective manner. In the storage process, if there is a difference between the data type and the default data type, the system will make conversions through the matching data interface, and then store it again after successful conversion.

(4) The support layer enables the system to have a range of common service functions, such as the operating system. Its functions can better serve the bored pile construction information management system, making it more simplified in implementation and use.

2.2. Information management process

The construction management information system of bored piles provides functions such as record, inquiry, analysis and statistics etc. for the construction process of the pile foundation project. The operation flow of the system is shown in Fig.1.

The object of system operation is a specific bored pile construction project. After the user name is entered and the item to be managed is selected, the system is logged in, and then according to the input information, and various service functions related to the project management are displayed, as shown in Fig.1. In addition, the system can also provide effective technical support for the transformation of relationships between projects, mainly including the preservation of current projects, viewing of completed projects, and switching of projects currently being implemented etc.

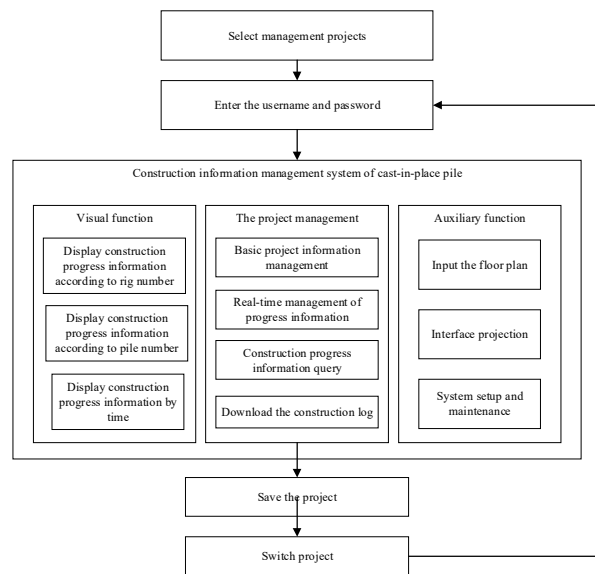


Fig 1. Function distribution and operation process of bored pile information management system

3. Optimization model of construction schedule

The formulation of the construction schedule directly affects the construction period and cost of the entire project. Therefore, it's the key for good bored construction project about how to formulate a scientific and reasonable construction schedule, save the cost and create a satisfactory economic benefit under the premise of ensuring the construction period and quality. According to the construction characteristics of the bored pile and the relationship between construction cost, period and cost, the construction progress optimization model of the pile was constructed and the improved genetic algorithm was used to solve the model.

3.1. Description of optimization model

The specific model is as follows:

Objective function:

$$\min C = \sum C(i) = \sum (a_i T(i) + b_i) + r \cdot (Q(i) - Q_{low}(i)) \quad (1)$$

Constraint conditions:

$$\begin{cases} T_E(i) \leq T(i) \leq T_L(i) \\ C_{\min}(i) \leq C(i) \leq C_{\max}(i) \\ Q(i) \geq Q_{low}(i) \end{cases} \quad (2)$$

a_i : the time-cost factor of the i process, $a_i = \frac{C_{\max}(i) - C(i)}{T_L(i) - T(i)}$; b_i : the process time (i)-cost constant, $b_i = \frac{C(i)T_L(i) - C_{\max}(i)T(i)}{T(i) - T_{\min}(i)}$; i : operation number, $i=1, 2, \dots, n$; n : the total number of operations; $T(i)$: normal construction time for process i ; $T_L(i)$: the latest completion time for process i ; $T_E(i)$: the earliest completion time of process i ; $C(i)$: the actual use fee for process i ; $C_{\max}(i)$: maximum operating cost for process i ; $C_{\min}(i)$: minimum use cost for process i without affecting quality; r : quality loss system,

$r = \frac{C(i)}{Q_n(i) - Q_{low}(i)}$; $Q_n(i)$ is the standard construction quality of i process, and $0 < Q_n(i) \leq 1$; $Q_{low}(i)$: Minimum construction quality under the premise of ensuring safety for the i process, $0 < Q_{low}(i) \leq 1$.

3.2. Optimization model solving

Genetic algorithm is a process of finding the optimal solution through genetics, variation, etc. according to the principle of human genetics. The main steps include:

(1) Generate feasible solution unit, in order to randomly select several sets of decimal solutions within the constraint range;

Pile NO.	Construction schedule
1#	Buried steel liners
2#	
3#	Measuring unreeling
4#	Buried steel liners into a hole
5#	A hole cleaning
6#	Lower steel cage
7#	The second hole cleaning
8#	Cast concrete complete
9#	
10#	

Fig 2. On-site recording function module

(2) The feasible solution conversion unit that converts several sets of decimal feasible solutions into a binary solution for crossover and mutation operations. Wherein: the crossover operation is used to cross-pair the binary feasible solutions and generate a new feasible solution; the mutation operation is used to randomly change certain code of the binary feasible solution to prevent the search from falling into a local optimal solution;

(3) The calculation unit of fitness value uses the objective function as the fitness function of the cyclic search, and brings each set of feasible solutions into the fitness function within the constraint condition, and finds the most suitable solution, that is, the temporary optimal solution;

(4) The loop unit is used for the cyclic cross unit, the mutation unit, and the fitness value calculation unit. When the difference between the temporary optimal solution by the current round search and the optimal solution by the previous round search is less than the allowable value, it's believed that the temporary optimal solution by the current-round search is the optimal solution of the objective function.

4. System function analysis

4.1. Layout of main interface

The main interface of the system is the implementation platform of the overall system function. During the actual application of the system software, most of the interaction between the user and the system is implemented through the main operation interface [7]. So, the design work of the main interface is very important, deciding the software appearance, and more importantly, but also determining the accessibility of the program itself. Therefore, the layout design of the main interface must be reasonable with clear interface, so as to ensure that the system functions are clear at a glance.

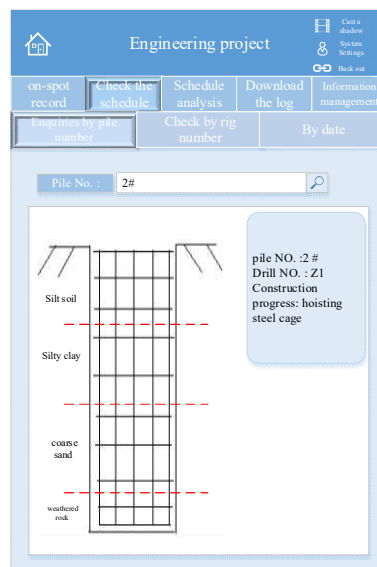


Fig 3. Query interface by pile number

The system interface developed in this paper is mainly divided into three parts: title bar, function bar and display column. The title bar is used to display the project name and place some general function buttons, such as return to home page, system settings, exit system, and projection functions etc. The main functions of the system are displayed in the function bar[8]. It is mainly divided into five parts: the on-site recording function is used to record the daily construction progress of each pile according to the actual construction progress and the construction status of the day; the progress query function is used to view the progress by three means such as the pile number, drilling rig number, and the date, and then the user can choose the appropriate query method based on his specific needs[9-12]; the schedule analysis function is used to compare the actual construction schedule with the planned one, and give each pile with the construction schedule analysis; the log download function is used to generate a standard construction log table, and automatically generate logs according to the construction progress of the day. The display column is used to display the construction progress of the pile with the function bar.

4.2. Bored pile construction information management

The main purpose of the bored pile construction information management system developed in this paper is to store and manage the construction schedule information in the on-site construction, and to realize the visualization of the construction status information. The specific functions are as follows:

(1) On- site recording function

This function is to record the construction status information of pile foundation, especially the progress information. It's used to effectively record the construction status of each pile and the construction situation of the day, and then store the record information in the database for centralized management, effectively avoiding the loss of data and ensuring the security of the data. The on-site recording function interface is shown in Fig.2.

(2) Progress query information module

The query function by pile number is to display the progress information and the geological information of the pile in the visualization window according to the pile number input by the user (Fig.3); the inquiry function by drilling rig number can display the relevant construction progress of all piles according to the drilling machine number input by the user, and different construction schedules are distinguished by different colours to ensure that the construction status is clear at a glance; clicking on the pile to be viewed, the specific information of the pile can also be displayed (Fig.4).

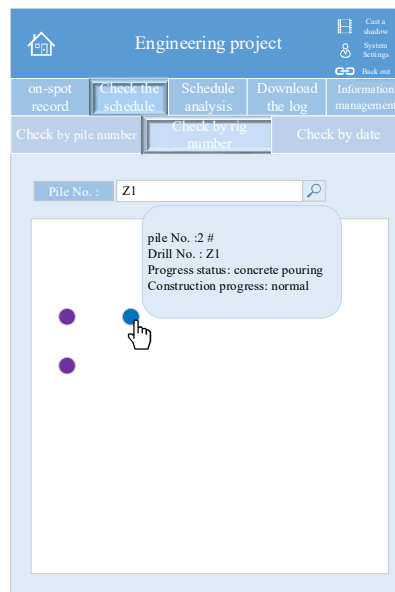


Fig 4. Query interface by drilling rig number

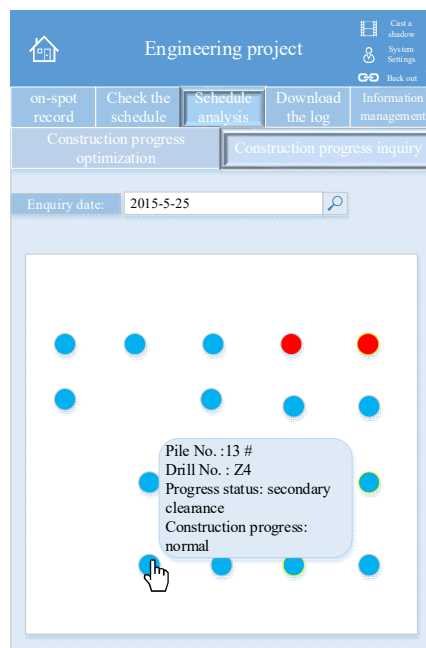


Fig 5. Schedule analysis function interface

(3) Construction schedule analysis module

The module displays the overall construction status through the visualization window by comparing the actual progress with the planned (Fig.5): the blue pile indicates the construction progress as scheduled, the red pile indicates that the actual construction schedule is slower than the planned one, and green pile indicates that the actual construction schedule is ahead of schedule.

5. Conclusion

In this paper, by selecting the project management of bored piles as the object of study, the related research on information and visualization was carried out. Then, based on the functional requirements and actual use requirements, Java language was adopted and the information management system of the cast-in-situ pile construction project was successfully constructed. The main advantages of the management system are reflected in the following aspects:

(1) The system has developed the visualization module. The manager can quickly view the construction progress at any time through the visualization window, and the construction schedule is clear at a glance, which is convenient for the manager to find problems and solve problems in time, and also provide effective technical support to ensure that the project is completed as planned.;

(2) The system has developed the interface projection function, which can project the mobile phone interface to the computer end, which is convenient for the construction personnel to report the construction progress, and also provides visual technical support for the manager to discuss and modify the next construction progress.

(3) The system development has changed the shortcomings of traditional bored pile construction schedule management such as data redundancy, difficulty in finding, and poor timeliness etc., so as to improve the management efficiency and information level of construction progress.

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