Construction Quality Control of Highway’s Civil Engineering

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Abstract. In order to improve the construction quality of highway’s civil engineering, a construction quality control model based on self-adaptive equilibrium game is proposed to improve the construction quality of highway’s civil engineering. The constraint parameter model of construction quality control is constructed, and the fuzzy decision function of construction quality control of highway’s civil engineering is established by combining the game equilibrium method of cost control and quality control. The optimal control of the construction quality of highway’s civil engineering is realized by using the method of correlation constraint and autocorrelation game. The simulation results show that the model can effectively predict and control the quality of highway’s civil engineering, the precision is high, the construction cost is reduced and the construction quality is improved.

Keywords: Highway, Traffic, Civil Engineering Construction, Quality, Control

1. Introduction
The construction materials, equipment and technology of highway’s civil engineering are complex, so it is necessary to carry out optimal management and quality control of civil engineering construction, so as to ensure the construction schedule and engineering quality. In order to strengthen the quality control and management of highway construction, it is necessary to carry out the whole process quality control in the construction of highway’s civil engineering [1]. The civil engineering project of highway needs to estimate the risk of construction quality well, realize the optimal control for construction quality of highway’s civil engineering, and complete the omnidirectional dynamic control of the construction process, thus it can promote the development of the construction process. Efficiency and quality optimization of engineering management are studied to effectively reduce unnecessary material overhead. It has great significance to study the construction quality control scheme of highway’s civil engineering, so as to improve the construction energy saving effect and construction quality and reduce the construction cost [2].

The construction quality control of highway’s civil engineering is systematic, extensive and dynamic. Due to the complexity of the construction process of highway’s civil engineering, it is necessary to carry out optimal management and quality control of civil engineering construction [3]. To ensure construction schedule and engineering quality, engineering construction quality control is the basis of quality control and safety management. It is necessary to maintain high construction quality in order to ensure the smooth progress of construction, and the smooth running of the work.
order to realize the quantitative control of the construction quality of highway’s civil engineering, this paper presents a construction quality control model based on self-adaptive equilibrium game, and the construction quality control model is constructed. The constraint parameters model is constructed, combined with the game equilibrium method of cost control and quality control, the optimal design of the control model is realized. Finally, the experiment simulation is carried out, which shows that the method in this paper used to improve the highway’s civil construction has superior performance in improve the construction quality [4].

2. Construction Quality Control Constraint Parameters and Decision Function Construction

The constraint parameter model of construction quality control is constructed, and the optimal decision is made by combining the method of cost and game equilibrium of quality control. The constraint parameters of construction quality control are composed of artificial factors, material factors and policy factors, respectively [5]. The parameters of nonlinear finite element model for highway’s civil engineering construction are set as $C_i=1$, $S_i=10$, $S_2=100$, $T_i=0.6$, $w_i=0.5$, and the quality control of highway’s civil engineering construction is analyzed by using benefit quantity standardization function and cost quantity standardization function. The standardized quantification function of the benefit of highway’s civil construction is obtained as follows:

$$V_i = \frac{X^i_{\text{max}} - X^i}{X^i_{\text{max}} - X^i_{\text{min}}}$$  \hspace{1cm} (1)$$

Under the quality constraint, the optimal fuzzy decision function for the quality control of highway’s civil engineering construction is obtained. Where, $X'$ is the cost distribution value of construction quality control for highway’s civil engineering, $X^i_{\text{max}}$ and $X^i_{\text{min}}$ are the maximum and minimum value of quality control under global convergence condition respectively. Under the constraint of total utility function, the load capacity $g(S)$ of construction quality control is a vector expressed as:

$$\begin{align*}
\min \quad & \sum_{b \in B}^{} z^w_b K^w_b (S) + \sum_{d \in D}^{} z^p_d K^p_d (S) + \sum_{a \in A}^{} z^{d\alpha}_{a,p} D_{a,p} + \sum_{a \in A}^{} \sum_{b \in B}^{} \sum_{p \in P}^{} z^{p\alpha}_{a,b,p} M \alpha_{a,b} + \sum_{a \in A}^{} \sum_{b \in B}^{} \sum_{p \in P}^{} z^{p\beta}_{a,b,d,p} M \beta_{a,b,d,p} \\
\text{s.t.} \quad & z^w_b R^w_p + z^p_d R^p_p + z^{d\alpha}_{a,p} + z^{p\alpha}_{a,b,p} \geq V_p, \quad a \in A, b \in B, d \in D, p \in P, \\
& z^w_b, z^p_d, z^{d\alpha}_{a,p}, z^{p\alpha}_{a,b,p}, z^{p\beta}_{a,b,d,p} \geq 0, \quad a \in A, b \in B, d \in D, p \in P. 
\end{align*}$$  \hspace{1cm} (2)$$

The benefit cost function of highway’s civil engineering construction is described as a nonlinear incremental function. In order to maximize the construction benefit of highway’s civil engineering and minimize the cost load, the optimal matching appears [6]. The dual benefit of highway’s civil engineering construction benefits is regarded as a linear game process, and the process function is expressed as follows:

$$Q_i(P) = \frac{(e_i - P_i)[\rho(N - 2) + 1] - \rho \sum_{i \neq j} (e_j - P_j)}{(1 - \rho)[\rho(N - 1) + 1]}$$  \hspace{1cm} (5)$$

The optimal decision function can be obtained by solving the joint solution $Q_i$ ( $i=1,2,\ldots, N$ ). The first order partial derivative of $P_j$ is obtained for U(Q) and then set to 0:
\[ \frac{\partial U(Q)}{\partial Q_i} = e_i - Q_i - \rho \sum_{i \neq j} Q_j - P_i = 0 \] (6)

Wherein, \( z_{bw} \), \( z_{d} \), \( z_{a,p} \), \( z_{a,b} \), \( z_{a,d,p} \) are the dual variable obtained from the cooperation of transportation cost and consumption cost of the construction materials during the construction process [7]. The dual equation of cost quality and the construction efficiency of highway’s civil engineering is expressed as:

\[ \mu_{1}(v(s)) = \sum_{bch} z_{bw} K_{bw}^b(S) + \sum_{d} z_{d} K_{d}^b(S) + \sum_{a,b} z_{a,b} D_{a,b} + \sum_{a, b, p} z_{a,b} M_{a,b} + \sum_{a, d, p} z_{a,d,p} M_{a,d,p} \] (7)

Based on the game equilibrium control, the fuzzy decision function of the quality control for the highway’s civil engineering construction of is constructed, and the adaptive regression analysis is carried out according to the fuzzy decision variable to improve the global stability of the construction quality control [8].

3. Optimization of Control Model

The fuzzy decision function of construction quality control for highway’s civil engineering is established. The adaptive equilibrium game is carried out by using the method of correlation constraint and autocorrelation game, and the quality quantization function is used to analyze the global quality control [9]. It can get that \( s \in \infty \) can be expressed as \( \mu_{1}(v(s)) \). The decision variables of cost and quality control in engineering construction is determined. The cost control requirement of highway’s civil engineering depends on the minimum cost of material on the \( w \) path of this OD. The production efficiency is satisfied when the scale of the construction site of highway’s civil engineering is:

\[ \delta \cdot (p_1 - \rho_1 A_1) \leq p_2 - \rho_2 A_2 \leq p_1 - \rho_1 A_1 \cdot Q(1 - \delta) \] (8)

It is impossible to provide accurate materials and market cost information for highway’s civil engineering construction. For this reason, it is necessary to carry out the construction cost of highway’s civil engineering to the above inequality. The breakdown of the forecast expenditure is expressed as follows:

\[ Z = B \sum_{w \in w} q_w - \sum_{a \in a} x_a \left[ t_a(x_a) + \beta v_x \right], \quad \forall \ v_{min} \leq v_x \leq v_{max} \] (9)

On the basis of the construction of the cost quality and the construction efficiency constraint function of highway’s civil engineering, in order to improve the production efficiency. It is necessary to consider the site in the construction process of highway’s civil engineering. Management factors are determined, so as to achieve the highway’s construction quality of the game balance prediction [10]. The transfer function of the construction quality control of highway’s civil engineering is established by using Smith prediction model:

\[ \begin{align*}
Q_1(s) &= M_{-1}^{-1}(s)f_1(s) \\
Q_2(s) &= M_{-1}^{-1}(s)f_2(s)
\end{align*} \] (10)

Wherein, \( f_1(s) \) and \( f_2(s) \) are regression coefficient and transfer coefficient, adaptive learning and nonlinear weighting control for system object and prediction model are obtained as:

\[ \begin{align*}
f_1(s) &= \frac{1}{\lambda_1 s + 1} \\
f_2(s) &= \frac{1}{\lambda_2 s + 1}
\end{align*} \] (11)
The game process of quality control is carried out by fuzzy weighted constraint method, and the game function of the control model is described as follows:

\[
Y(s) = \frac{C_1(s)C_2(s)P(s)}{1 + C_2(s)P(s)}R(s) + \frac{1}{1 + C_2(s)P(s)}D(s)
\]  

(12)

The model error of construction quality control point is studied by adaptive weighted learning, and the characteristic parameters are obtained as follows:

\[
\begin{cases}
C_1(s) = \frac{Q(s)}{Q_s(s)} \\
C_2(s) = \frac{Q_s(s)}{1 - M(s)Q_s(s)}
\end{cases}
\]  

(13)

The optimal game function of the construction quality control of highway’s civil engineering is obtained as:

\[
R_i(P) = (1 - \alpha)P \left( e_i^* - P \right)F_1 - \sum_{i \neq j} (e_j - P_j)F_2
\]  

(14)

Where, the optimal solutions output of quality control and cost control are expressed as follows:

\[
F_1 = \frac{\rho(N-2)+1}{(1 - \rho)[\rho(N-1)+1]}
\]  

(15)

\[
F_2 = \frac{\rho}{(1 - \rho)[\rho(N-1)+1]}
\]  

(16)

By means of statistical regression analysis, \( P_i \) is derived and equals 0:

\[
\frac{\partial R_i(P)}{\partial P_i} = (1 - \alpha)e_iF_1 - \sum_{i \neq j} (1 - \alpha)(e_j - P_j)F_2 - 2(1 - \alpha)P_iF_1 = 0
\]  

(17)

Organized as follows:

\[
P_i^* = \frac{e_iF_1 - \sum_{i \neq j} (e_j - P_j)F_2}{2F_1}
\]  

(18)

Combined with the best quality control and the minimum cost control, the correlation constraint and the self-correlation game method are adopted, so that the \( P_i^*, ..., P_n^* \) can be calculated by analogy, and the optimal design of the quality control model for the construction of the highway’s civil engineering is realized.

4. Simulation Experiment and Performance Analysis

In order to test the superior performance of this model in the construction quality control of highway’s civil engineering, the simulation experiment is carried out. The parameters of the experiment are set as follows: \( N=2, \ k=2, \ \alpha=0.1, \ 0.3 \leq e_i \leq 0.8, \ 0.3 \leq \rho \leq 0.6, \ i=1,2, \) and the quantitative evaluation parameters of engineering construction quality are \( \lambda_2 = 2, \ \lambda_i = 1.3. \) According to the above simulation parameters, the engineering quality control is carried out, and the control performance distribution of highway construction is obtained as shown in figure 1.
Evaluation gain of Construction quality / dB
Assumption / minion yuan
Time / day

Figure 1. Distribution of construction quality control.
Figure 1 shows that the construction quality control of highway’s civil engineering by using this method has good performance, the control revenue is test, and the result is shown in figure 2.

Figure 2. Revenue comparison of construction quality control.
Figure 2 shows that the proposed model can effectively predict and control the quality of highway’s civil engineering with high accuracy, which reduces the construction cost and improves the construction quality.

5. Conclusions
In this paper, a construction quality control model based on self-adaptive equilibrium game is proposed to improve the construction quality of highway’s civil engineering. The constraint parameter model of construction quality control is constructed, and the fuzzy decision function of construction quality control for highway’s civil engineering is established by combining the game equilibrium method of cost control and quality control. The optimal control of the construction quality for highway’s civil engineering is realized by using the method of correlation constraint and autocorrelation game. The simulation results show that the model can effectively predict and control the quality of highway’s civil engineering, the precision is high, the construction cost is reduced and the construction quality is improved. This method has good application value in construction quality control.

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