Research and Analysis on Quality Control of Concrete Raw Materials in Construction of Road and Bridge

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Abstract. By introducing the contradiction of concrete construction quality control, the main points of concrete construction quality control, concrete mix design considerations, concrete mixing, transportation, on-site acceptance quality control points, bridge concrete construction control key points, issues that need to be highlighted, etc. Eliminate or reduce common quality problems, identify quality hazards, use FMECA technology to analyze failure modes and impacts in all aspects of prestressed road and bridge construction process, after process combing, failure mode determination, failure cause analysis, failure mode for road bridge concrete, The impact of safety and other aspects of judgment, to remind engineering construction and technical personnel to start from the details, to do a good job in the quality of bridge engineering.

1. Research background
FMECA (Failure Mode, Effects and Criticality Analysis) is short for failure mode, impact and hazard analysis. It is a potential failure mode for each component (component or function block) of the product during the product design process. And its impact on product function, analysis of the degree of harm caused by the consequences, proposed a possible improvement measures to improve product reliability, a design analysis method. It mainly includes two contents, namely Failure Mode Impact Analysis (FMEA) and Hazard Analysis (CA) [1]. The former is a qualitative analysis, which can adopt either the "bottom-up" logic induction method or the "top-down" function method. The purpose is to analyze the fault conditions of key components that affect the system function. In order to take measures to improve the design. The quality of concrete construction is closely related to various aspects such as construction technology, vibration, maintenance, construction management, etc. Only by making every detail to ensure the quality of concrete structure. The test and test work involve the selection, design, preparation, adjustment, production, and casting of raw materials for concrete. Each process requires expertise and a high degree of professionalism to solve and control the problems that arise throughout the process.
2. FMECA fuzzy risk analysis of concrete construction quality

According to the hazard analysis, the traditional FMECA judges the risk by using the risk sequence number method, that is, the designer, the user and the maintenance personnel score the fault occurrence degree O, the severity S and the detection difficulty degree D to form three types. The score is obtained, and finally the multiplication is obtained by the risk order number RPN, and the prevention or improvement measures are taken on the basis of the RPN. The method is convenient, intuitive and easy to promote [2], and is a quantitative calculation of risk assessment. However, the collection of risk data involves a wide range of people, and the departments and positions that provide data personnel are different, and the opinions are different. For example, when assessing the severity of the consequences of a failure mode, different people have 7 points, 8 points, or 9 points for their evaluation, and the risk order number is calculated, and if a certain value is required, no matter which one is given, the fuzzy information of the other two scores is lost, and the calculation result is uncertain. In addition, in the actual project, the contributions of these three types of judges to the system risk assessment are not the same. If they are simply multiplying, they cannot reflect the specific contributions of each object. Therefore, the quantitative analysis of risk assessment of traditional FMECA is not objective and rigorous.

Aiming at this problem, this paper adopts the fuzzy (FUZZY) mathematical analysis method, and establishes the corresponding fuzzy set by collecting the risk data, and uses the weighted analysis of the contribution degree, severity and ease of detection to the risk to establish a fuzzy mathematical model is used to refer to this FMECA method in the sense of FUZZY, which is called fuzzy risk analysis [3].

3. The basic steps of fuzzy comprehensive evaluation of FMECA fuzzy risk comprehensive evaluation

3.1. Determine the factor set

In the fuzzy environment, considering all aspects of the influence on the object of judgment, and these factors are ambiguous, they constitute a set of factors $U$, ie $U= \{u_1, u_2,..., u_n\}$, where $u_i$ represents the judgement the $i$ influencing factor of the object ($i = 1, 2, ... n$).
3.2. Determine the judgment set
The evaluation set \( V = \{v_1, v_2, \ldots, v_m\} \), where \( v_j \) represents the \( j \) rank \((j = 1, 2, \ldots m)\) of the judgment, and is generally a set consisting of judgment languages [4].

3.3. Calculating the single factor evaluation matrix
A fuzzy map from the factor set \( U \) to the evaluation set \( V \) is given, and the degree of membership of each factor to each evaluation level is determined. That is, the single factor \( u_i \) is judged, and the fuzzy set \((r_{i1}, r_{i2}, \ldots, r_{im})\) on \( V \) is obtained, which is a fuzzy map \( f \) from \( U \) to \( V \), namely:

\[
f(U) \rightarrow F(V) \quad u_i \rightarrow f(u_i) = (r_{i1}, r_{i2}, \ldots, r_{im})
\]  

(1)

Where \( r_{im} \) represents the membership of \( u_i \) to \( v_m \).

The fuzzy relation \( R \) can be determined by the fuzzy mapping \( f \), and the fuzzy relation \( R \) is the evaluation matrix of the fuzzy comprehensive evaluation, that is,

\[
R = \left( \begin{array}{cccc}
R_{11} & \cdots & R_{1m} \\
\vdots & \ddots & \vdots \\
R_{n1} & \cdots & R_{nm}
\end{array} \right)
\]  

(2)

3.4. Establishing a weight distribution set
When conducting a comprehensive evaluation, each factor needs to be weighted because the contribution of each factor to the evaluation result is different. The weighting of each factor:

\[
A = (a_1, a_2, \ldots, a_n), \sum_{i=1}^{n} a_i = 1, 0 \leq a_i \leq 1, \text{ and } a_i \text{ represent the weight distribution of each factor, that is, the measure of the degree of influence of the factor concentration } u_i \text{ in the overall judgment. It can be determined according to a certain algorithm or according to the evaluation of the department expert [5].}
\]

3.5. Comprehensive evaluation model
By combining the weight set \( A \) and the evaluation matrix \( R \) according to the \( M \) model, a comprehensive evaluation of each factor can be obtained, namely:

\[
B = A \circ R = (b_1, b_2, \ldots, b_m)
\]  

(3)

Among them, \( b_j = \sum_{i=1}^{n} a_i r_{ij} (j = 1, 2, \ldots, m) \), \( b_j \) is a function of \( r_{j1}, r_{j2}, \ldots, r_{jm} \), that is, the evaluation function. Finally, according to the principle of maximum membership degree, the level \( v_i \) of \( b_j = \max (b_1, b_2, \ldots, b_m) \) is used to determine the degree of hazard of the failure mode.

The above is a first-level comprehensive evaluation. For complex systems, there are many factors related to the judgment object, and the weight distribution is difficult to determine, or even if the weight distribution is determined, the weight of each factor is small due to the normalization condition, and then the operator will be integrated. The result of value. Therefore, a multi-level risk fuzzy evaluation method can be adopted, that is, the \( u_j \) in the factor set \( U = \{u_1, u_2, u_m\} \) can be further divided into \( \{u_{j1}, u_{j2}, \ldots, u_{jn}\} \), and each factor is still ambiguous, then A two-level fuzzy evaluation can be used, and the evaluation comprehensive model is
\[ C = A \circ B = A \left[ \begin{array}{c} A_i \circ R_1 \\ A_2 \circ R_2 \\ \vdots \\ A_n \circ R_n \end{array} \right] = A \circ (b_{ij})_{n \times m} = (c_1, c_2, \ldots, c_m) \quad (4) \]

Where: \( A_i \) - the level weight set of the \( i \)-th factor, \( F \);
\( R_i \) - the ranking matrix of the \( i \)-th factor;
\( B_i \) - the first-order fuzzy evaluation result of the \( i \)-th factor;
\( C \) - the result of fuzzy comprehensive evaluation between various factors.

By analogy, it is also possible to use three levels, four levels and other levels to conduct fuzzy comprehensive evaluation of things.

The membership of \( V_j \).

\[ u_j(x) = \begin{cases} 1 & (x \leq 2) \\ 2 - 0.5x & (2 < x \leq 4) \end{cases} \quad (5) \]

And so on, for the membership degrees of \( V_2 \), \( V_3 \), \( V_4 \), and \( V_5 \), \( u_2(x) \), \( u_3(x) \), \( u_4(x) \), and \( u_5(x) \) respectively indicate the corresponding evaluation levels.

Fig. 2 Five-language membership function diagram

FMECA is an effective preventive method for quality pre-control. In this project, through the formulation of the process, the risk control table and the SIPOC chart, various pre-control measures are implemented, and the pre-fabricated box girder construction is carried out in strict accordance with the preset plan. Active and effective measures are taken to reduce the frequency of failure modes and increase the detectability of failure modes. By reducing the frequency of failure modes and increasing the detectability of failures \[6\], RPN is significantly reduced. In order to evaluate the control effect, after the construction of the prefabricated box girder is completed, the FMECA working group scores the four failure modes \( S \), \( O \), and \( D \) of the key monitoring, and calculates the risk coefficient. The current concrete quality risk factor is high, and the final RPN of the four failure modes monitored is greater than 65. The project quality risk is high, and it is necessary to impose supervision in daily work.
4. Analysis of key quality control of concrete raw materials

4.1. Cement
The control of cement quality must start from the cement production process. Different types of cement will appear depending on the type of clinker. At the same time, different types of cement will be used according to the construction requirements of road and bridge, and the quality requirements of cement higher, only in this way can ensure the quality of concrete meets the requirements of road and bridge construction design drawings. In addition, in general, the shelf life of cement is less than 3 months. Therefore, the construction personnel must strictly follow the relevant standards when testing the quality of cement, especially the date of cement production. Currently, there are two main types of cement on the market: packaged and unpackaged. For unpackaged cement, sampling must be carried out in a scientific and effective manner. The test items include cement stability, strength, initial setting and final setting time. The packaged cement should be carefully checked for the factory and production date to see if the packaged cement is damaged during transportation and whether it is damp.

4.2. Fly ash
1) Appearance and color can indirectly reflect the amount and fineness of carbon content. The change of chromaticity has great influence on the appearance quality of concrete. If the carbon content is too high, concrete tends to lag behind. 2) Density and bulk density the density of fly ash can vary greatly from 0.4 to 4 kg/m³. The density and bulk density can be determined to determine the uniformity, the thickness and the quality of the raw materials. Finely ground fly ash should be noted to incorporate other auxiliary materials during grinding, which will affect the performance of the concrete mixture (the phenomenon of delayed bleeding) and durability [7]. 3) The fluctuations of the two indexes, the loss on ignition and the water demand, have a great influence on the performance of the concrete mixture. Loss on ignition is an estimate of carbon content, high in carbon content and high in water demand. If the loss on ignition exceeds 7%, it will seriously affect the gas content of concrete.

4.3. Admixture Adaptability
In the construction, the adaptability of cementitious materials and admixtures should be completed before the concrete mix ratio design, so that the cement, admixture and admixture can be correctly selected and the optimal mix ratio can be determined. Poor adaptability: The cement or cement block in the aggregate is finer, the adsorbed water and the admixture are stronger than the cement, which results in poor performance of the mixture; the cement alkali and sulfur content in different places are different, and the polycarboxylic acid admixture Adaptability is quite different; fresh cement and temperature make the admixture poorly adaptable; when the grinding aid is added to the admixture, it is prone to discomfort; the naphthalene admixture has high alkali content and easily causes slump loss; sulfamate Admixtures tend to bleed the concrete mix.

4.4. Quality control of aggregates
Aggregate mainly refers to sand and stone in concrete raw materials. Sand can also be called fine aggregate. According to its diameter, it can be divided into three categories: coarse sand, medium sand and fine sand. According to the origin, it can be divided into mountain sand, river sand and sea sand. The quality control of sand is mainly to detect the texture of fine aggregate, the fineness modulus, the mud content and the content of harmful substances. The focus is on the amount of mud and harmful substances. The reason is mainly due to the 2 The content of the item will affect the strength of the concrete. The stone mainly refers to the pebbles and fine gravel. Because of its large diameter, it is also called coarse aggregate. According to the relevant standards of concrete production, it will be mixed according to the first ratio or the second ratio, but because of the stone There are differences in the size of the concrete. Therefore, when mixing, the stones with too large diameter must be treated to ensure the quality of the concrete.
5. Conclusion
1) Formulating a detailed and reasonable mass concrete construction plan is the key to ensuring the quality of the project. It must be constructed in strict accordance with the approved plan. It is strictly forbidden to change the plan at will. 2) The various processes of mass concrete construction should be closely connected, with high standards and strict requirements, to ensure that the project quality meets the requirements of current regulations and meet the excellent standards.

Acknowledgments
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References
[1] Zhu Wen, Xu Haijun, Kuang Shaoning, et al. Comparative Study on Detection Methods of Water-Soluble Chloride Ion Content in Concrete Quality Control Process. Concrete, Vol. 6 (2017) No.14, p. 148-151.
[2] CUI Xin, LI Yulin, LU Xiao-bo, et al. Quality control technology for fair-faced concrete production in rail transit engineering. Construction Technology, Vol. 1 (2017) No.20, p. 117-120+134.
[3] Fan Zaifa. Quality Control Measures for Concrete Construction of Back Piping of Xiangjiaba Hydropower Station. People's Yangtze River, Vol. 4 (2013) No.28, p. 103-105.
[4] Liu Guojun, Liang Rui, Yang Yuanbing. Blasting Demolition of Reinforced Concrete Simply Supported Beam Bridge in Complex Environment. Blasting, Vol. 4 (2017) No.34, p. 115-119.
[5] Wang Xiaojue, Zhong Shuxian, Meng Xianlei, et al. Influence of compression of super high-rise concrete on measurement control. Architecture Technology, Vol. 7 (2018) No.49, p. 95-97.
[6] Huang Guofu, Chen Mihang, Li Binghai, et al. Review of Research Status of Quality Control and Physical Strength Testing and Evaluation of Wet Shotcrete Construction. Tunnel Construction, Vol. 1 (2018) No.38, p. 32-36.
[7] Li Shanji, Feng Shenqiang, Wei Yingjie. Research on Grouting Sleeve Installation and Quality Control Technology for Prefabricated Concrete Structures. Sichuan Architectural Science Research, Vol. 1 (2017) No.43, p. 145-148.