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Research Article

The Comprehensive Assessment Method of Concrete Damage after Disastrous Fire Based on Game Theory-Normal Cloud Model

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Rapidly and correctly assessing the extent of the damage to a concrete structure after a disastrous fire has great engineering significance. In this paper, an assessment method is proposed based on the game theory-normal cloud model. The surface colors of concrete, exfoliation, cracks, and hammering responses are chosen as the comprehensive assessment indices of concrete damage after fire to establish the corresponding assessment criteria. The normal cloud generator is used to calculate the certainty degree of the grading assessment index of concrete damage after fire. By adopting game theory, the objective weight obtained by the information entropy method and the subjective weight obtained by precedence chart are combined into a comprehensive weight. The comprehensive certainty degree value of concrete damage after fire is then calculated by certainty and weight matrices. The project case analysis shows the assessment results are both intuitive and realistic. This method provides a new approach to the assessment of concrete damage after fire which is more efficient and easier to apply than existing methods.

1. Introduction

The fire resistance performance of buildings has been widely researched [1]; however, there is little work on safety assessment, maintenance, and reinforcement of buildings following a disastrous fire. Safety inspection and appraisal should be made of the building after any such fire. Maintenance and reinforcement are also likely to be needed before the building can be used again, and buildings that cannot be appropriately repaired should be condemned and demolished. Therefore, the assessment of the damage grade of buildings after a disastrous fire has great engineering significance.

Currently, researchers generally adopt methods such as the numerical simulation method [2], ultrasonic testing [3, 4], colorimetric analysis [5, 6], the drilling resistance test [6, 7], and petrographic examination [8] to assess the damage grade of concrete after a disastrous fire. These methods have both advantages and disadvantages. For example, the numerical simulation method can calculate the damage extent and remaining bearing capacities, but the stringent professional requirements of the necessary assessors have limited the popularity and application of this method to a certain extent. The ultrasonic testing method has good sensitivity; even slight damage can be detected. However, there are still some disadvantages: it is time-consuming, cracks and defects in the concrete may greatly influence the results, and the detecting surface must be flat (the method is not suitable for sprayed concrete or concrete with exfoliation). The colorimetric analysis method is simple and fast and can be easily performed without expertise. Its only shortcoming is that cutting and sampling are needed, which limits the application in thin-walled structural members. The drilling resistance test method is a promising technology with advantages including rapid testing speed, easy operation, reliable test results, and not being affected by cracks, roughness of surface, or exfoliation of the concrete. However, it may be affected by drill parameters (type, shape, size, rigidity) and thrust force applied by users, etc. The damage depth of concrete after a disastrous fire can be detected accurately by petrographic examination technology, but this method has high requirements in terms of inspectors and equipment.

In general, most of the methods and technologies available are unsatisfactory, offering either speed or accuracy, never both. Therefore, a more effective method is urgently required to approach the challenge from a new angle.

Taking the macroscopic damage characteristics of concrete after a disastrous fire as assessment indices, an assessment model (cloud model) is built with mathematical tools (fuzzy mathematics theory and probability theory) to carry out pure mathematical calculations that provide reliable results rapidly and accurately.

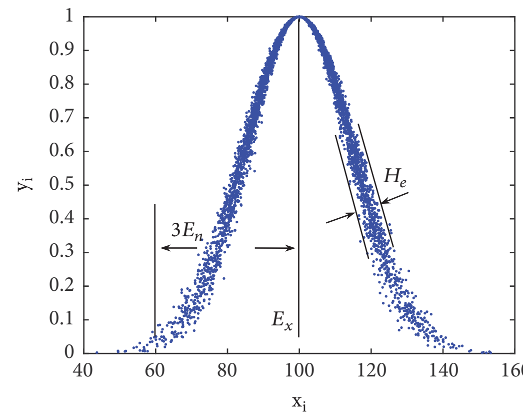


Figure 1: Sketch map of the cloud's digital characteristics.

2. Method

Academician Li Deyi proposed the cloud model theory in 1995 based on research into probability theory and fuzzy set theory [9, 10]. The cloud model can describe the inner relationship between fuzziness and randomness and realize the conversion between qualitative concepts and quantitative characteristics. Nowadays, the cloud model is widely used in fields such as environmental assessment [11], image processing [12], intelligent control [13], and geological forecasting [14].

2.1. Basic Theory of the Cloud Model. The cloud model is defined as follows. Let U be a domain of discourse represented by quantitative values and C be the qualitative concept on U. If the qualitative value is $x \in U$ and x is a random implementation of the qualitative concept C, the certainty degree $U(x) \in [0, 1]$ of x with regard to C is the random number with steady tendency [15], that is,

$$\mu := A \longrightarrow [0,1], \quad \forall x \in A, \; x \longrightarrow \mu(x) \tag{1}$$

Then the distribution of x on domain U is called the cloud, and every (x, y) is called a cloud droplet.

The cloud model is represented by three basic cloud digital eigenvalues $(\mathrm{E_X},\mathrm{E_n},\mathrm{H_e})$. Here, E_X is the expected value as well as the central value of cloud droplets in spatial distribution. E_n is the entropy as well as the measurement of qualitative degree of each index which is determined by the randomness and fuzziness of the qualitative concept; it not only reflects the dispersion degree of the cloud droplets, but also reflects the value range of the cloud droplet that is acceptable by the qualitative concept in domain space. H_e is the entropy of entropy, called hyperentropy. It is the measurement of entropy's fuzziness and randomness; the greater the value of hyperentropy, the greater the degree of membership, and the greater the thickness of the cloud. Figure 1 is a sketch map of cloud digital eigenvalues (where the expected value E_X=100, the entropy E_n=15, the hyperentropy H_e=1, and the number of cloud droplets N=5000).

2.2. Cloud Model and Generation Steps Based on Forward Cloud Generation. The cloud generator is the arithmetic that is necessary to realize the transformation of quantitative data and qualitative concepts into the cloud model. It can be divided into two types: a forward cloud generator and a backward cloud generator. Forward cloud generation is the process from qualitative description to quantitative representation [16]. The arithmetical steps of forward cloud generation are as follows:

Step 1. Determine E_x, E_n, H_e.

Step 2. Take E_n as the excepted value and ${H_e}^2$ as the variance to generate a normal random number E_{nn}.

Step 3. Take E_x as the excepted value and ${E_{nn}}^2$ as the variance to generate a normal random number x_i.

Step 4. Calculate the degree of certainty y_i by

$$y_i = \exp\left[-\frac{\left(x_i - E_x\right)^2}{2E_{nn}^2}\right] \tag{2}$$

Let (x_i, y_i) be a cloud droplet, which is a concrete quantitative realization of linguistic terms represented by this cloud. Where, this time, x_i is the corresponding value of qualitative concept in the domain of discourse, y_i is the measurement of the degree of belonging to these linguistic terms.

Step 5. Repeat Steps 2~4 until enough cloud droplets are generated.

2.3. Comprehensive Weight Based on Game Theory. Weight can be divided into objective weight and subjective weight, and each is assigned differently. Subjective weight reflects the willingness and preference of decision makers, while objective weight reflects the degree of contribution of concrete data to decision making in the scheme set. It is beneficial to improve the reliability of assessment results when combining the two kinds of weights. Subjective weight and objective weight can be combined into a comprehensive weight by game theory. In this paper, the objective weight is obtained by

	P_1	P_2	P_3	…	P_n
P_1		1	1	0.5	0.5
P_2	0		0	1	0.5
P_3	0	1		0.5	1
…	0.5	0	0.5		1
P_n	0.5	0.5	0	0	

Figure 2: The format of the precedence chart.

the information entropy method and the subjective weight is obtained by precedence chart.

2.3.1. Information Entropy Method. The information entropy method [17] is an objective assignment method which uses measured objective data for assignment. Entropy is an uncertainty measurement based on probability theory; the greater the amount of information, the smaller the corresponding uncertainty, and the smaller the entropy value. It makes the assessment more objective because it can eliminate human disturbance when calculating the weight of each index. The specific calculation method is shown in formulae (3)~(5):

$$P_{ij} = \frac{b_{ij}}{\sum_j b_{ij}} \tag{3}$$

where P_{ij} is the weight assignment of an index and b_{ij} is the value of the jth assessment grade of the ith assessment index.

$$e_i = -K \sum_j P_{ij} \ln P_{ij} \tag{4}$$

where $K = 1/\ln(\mathrm{n})$, if $P_{ij} = 0$, then $P_{ij} \ln P_{ij} = 0$.

$$a_i = \frac{1 - e_i}{\sum_i (1 - e_i)} \tag{5}$$

where $\sum a_i = 1$. As indicated by formula (5), the greater the entropy, the smaller the entropy weight, and the smaller the contribution to assessment results, and vice versa.

2.3.2. Precedence Chart. The precedence chart, a subjective weight assignment method, was initially proposed by Moody in 1983 [18]. It is a checkerboard chart (as shown in Figure 2) comprised of $n \times n$ blanks. The left column of the chart represents the comparison objects, and the top row of the chart represents the objects that are being compared. The blanks of the diagonal represent self-comparisons; these are meaningless, so they do not need to be filled out. There is a wealth of literature describing the calculation points and steps of the precedence chart, so they will not be repeated here [19, 20].

2.3.3. Determining the Comprehensive Weight by Game Theory. When seeking consistency or compromise between different weights, the deviation between possible weights and basic weights can be minimized by game theory, further improving the reliability of assessment results [21]. Calculation steps are as follows:

Step 1 (consistency examination). When n=2, the consistency can be examined by (6) [22].

$$d\left[w^{(1)} \quad w^{(2)}\right] = \left\{ \frac{1}{n} \sum_{i=1}^{n} \left[w^{(1)} - w^{(2)}\right]^2 \right\}^{1/2} \tag{6}$$

where $w^{(1)}$ and $w^{(2)}$ are two groups of weights involved in the game; n is the number of index vectors obtained in each weight group. The smaller $d\left[w^{(1)} \quad w^{(2)}\right]$ is, the closer the two groups of weights are. The consistency examination is considered to have been passed when $d\left[w^{(1)} \quad w^{(2)}\right] < 0.3$, and the weights can be coupled [23].

Step 2. Seek the most satisfied weight vector.

Seeking the most satisfied W^* in all possible vector sets, that is looking for the most satisfied weight coefficient a_k to minimize the deviation between W and each W_k,

$$\min = \left\| \sum_{j=1}^{n} \alpha_j W_j^T - W_i \right\|_2 \quad (i = 1, 2, \ldots, n) \tag{7}$$

The optimized first derivative condition of (7) can be obtained according to the differential properties of the matrix:

$$\begin{bmatrix} w_1 \cdot w_1^T & w_1 \cdot w_2^T & \ldots & w_1 \cdot w_L^T \\ w_2 \cdot w_1^T & w_2 \cdot w_2^T & \ldots & w_2 \cdot w_L^T \\ \ldots & \ldots & \ldots & \ldots \\ w_L \cdot w_1^T & w_L \cdot w_2^T & \ldots & w_L \cdot w_L^T \end{bmatrix} \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \ldots \\ \alpha_L \end{bmatrix} = \begin{bmatrix} w_1 \cdot w_1^T \\ w_2 \cdot w_2^T \\ \ldots \\ w_L \cdot w_L^T \end{bmatrix} \tag{8}$$

Step 3. Normalize the combination coefficient set. Here, a_k^* can be obtained by normalizing the combination coefficient sets $\alpha_1, \alpha_2, \ldots, \alpha_n$.

Step 4. Calculate the comprehensive weight by (9).

$$W^* = \sum_{k=1}^{L} a_k^* W_k^T \tag{9}$$

3. Establishing the Assessment Index System

3.1. Assessment Index. The results of assessing concrete after a disastrous fire are closely related to the selection of the assessment index. Selecting the assessment index correctly is the precondition to ensure the assessment results are reasonable and reliable. Based on widely used specifications and previous experiences [2, 24, 25], 4 representative assessment indices, specifically the surface colors of concrete (c_1), exfoliation (c_2), cracks (c_3), and hammering responses (c_4) are chosen to be the indices for the assessment of concrete damage after fire, so as to establish the assessment index system.

Table 1: The correspondence between assessment grades and damage state, plus maintenance measures.

Grades	Damage state and maintenance measures
I	Minor, not directly burned, the structural material and performance are uncompromised; no measures need to be taken.
II	Mild, the structural material and performance are compromised slightly; only measures to improve durability need to be taken.
III	Moderate, the structural material and performance are obviously compromised, but the structural safety is not compromised. Measures for improving durability and local processing, as well as appearance restoration measures, need to be taken immediately.
IV	Serious, although not yet destroyed; the structural material and performance are obviously compromised, and clear deformations or cracks appear. Damage adversely affects structural safety or normal working conditions, and reinforcement and local replacement measures should be taken.
V	Destroyed, structure or member collapse during or after the fire; structure is seriously burned, deformed, and cracked. The structure loses or mostly loses bearing capacity, and structural safety is imperiled, as well as safety support. Thorough reinforcement and replacement measures should be taken immediately.

Table 2: Grading and valuing standards of assessment index c_1.

Grades	c_1 Value	Damage state
I	0.0~0.1	Basically unchanged
II	0.1~0.25	Covered by black
III	0.25~0.4	Pink or red
IV	0.4~0.75	Off-white
V	0.75~1.0	Pale yellow

Table 3: Grading and valuing standards of assessment index c_2.

Grades	c_2 Value	Damage state
I	0.0~0.1	None
II	0.1~0.2	Local mortar cover exfoliate
III	0.2~0.45	Corner concrete exfoliate
IV	0.45~0.8	Large area of concrete exfoliate
V	0.8~1.0	Large area of concrete exfoliate and loose

Table 4: Grading and valuing standards of assessment index c_3.

Grades	c_3 Value	Damage state
I	0.0~0.1	None
II	0.1~0.2	Minor cracks
III	0.2~0.45	Cracks appear at the corner concrete
IV	0.45~0.75	Many cracks
V	0.75~1.0	Penetrating cracks

3.2. Grade Division Standard of the Assessment Indices. The damage to concrete after a disastrous fire ranges over 5 grades: minor damage (grade I), mild damage (grade II), moderate damage (grade III), serious damage (grade IV), and destroyed (grade V) according to literature [25]. The corresponding relationship between assessment grades and damage state, as well as maintenance measures of concrete after a disastrous fire, is listed in Table 1. With reference to literature [2, 25], in combination with fire investigation and expert experience, each assessment index is graded and valued. The grading and valuing standards are listed in Tables 2–5.

4. Research Case Fire Disaster

4.1. The Disastrous Fire. The disastrous fire in the study was caused by gas leakage in the ground floor of a commercial and residential building in Nanjiang (hereinafter referred to as "the building"), in Sichuan province at around 13:40 on

Table 5: Grading and valuing standards of assessment index c_4.

Grades	c_4 Value	Damage state
I	0.0~0.1	Loud sound, hammer leaves no trace on the surface.
II	0.1~0.25	Loud sound, hammer leaves obvious traces on the surface.
III	0.25~0.5	Dull sound, the concrete is smashed, and traces are left on the surface.
IV	0.5~0.8	Dull sound, the concrete is smashed and dented.
V	0.8~1.0	The sound is weak; the concrete exfoliates significantly.

Table 6: Summary sheet of the reinforced concrete floor plate surface after the disastrous fire.

Member number	Damage characteristics			
	c_1	c_2	c_3	c_4
P-1	0.16	0.08	0.33	0.29
P-2	0.77	0.83	0.69	0.95
P-3	0.27	0.61	0.31	0.43
P-4	0.81	0.93	0.66	0.85
P-5	0.82	0.91	0.57	0.88
P-6	0.24	0.18	0.28	0.25
P-7	0.83	0.85	0.67	0.74
P-8	0.79	0.91	0.62	0.82
P-9	0.25	0.13	0.42	0.29
P-10	0.20	0.15	0.39	0.24
P-11	0.38	0.41	0.24	0.45
P-12	0.17	0.15	0.27	0.22
P-13	0.24	0.28	0.21	0.32
P-14	0.23	0.11	0.18	0.43
P-15	0.16	0.13	0.14	0.10
P-16	0.21	0.18	0.39	0.22
P-17	0.22	0.15	0.25	0.30

Notes: $P - x$ represents the reinforced concrete floor plate numbered x. The average value of three independent field assessors is used as the final value of the index $c_1 \sim c_4$ of concrete floor plate.

Figure 3: External façade of the building after the fire was extinguished.

August 2, 2012. The fire was extinguished at approximately 14:10 that day; a photo of the building taken thereafter is shown in Figure 3.

4.2. Extent and Characteristics of the Fire Damage. The bottom three floors of the building have a frame structure (commercial use) and the upper six floors have a masonry-concrete structure (residential use). A comprehensive inspection of the building's fire area was carried out the day after the fire was extinguished. The results showed that only part of the ground floor where the fire took place was damaged, and the other areas of the ground floor, as well as the rooms on and over the second floor, were unaffected by the fire. In order to explain the problem briefly, only the damage grades of the reinforced concrete floor plates of the building after the disastrous fire are calculated (details of the damage characteristics are given in Table 6, and members' locations are shown in Figure 4). After the fire, the concrete surfaces of the plates of members P-4 and P-5 appear off-white, a large area of concrete is cracked, loosened, and exfoliated, and the rebar at the bottom of the plate is exposed. The plates are all 100mm thick, and the maximum depths of the loose concrete are 41mm and 43mm, as shown in Figures 5(a) and 5(b), respectively.

5. Comprehensive Assessment Analysis of Concrete Damage after Fire

5.1. Characteristic Parameters of the Cloud Model. The expected value E_X of the comprehensive assessment index of concrete damage after fire can be calculated according to

$$E_X = \frac{\left(b_{ij} + a_{ij}\right)}{2} \quad (10)$$

Table 7: Characteristic parameters of the graded cloud model of concrete damage after fire.

Grade	Assessment index (%)			
	c_1	c_2	c_3	c_4
I	(5,4.25,0.01)	(5,4.25,0.01)	(5,4.25,0.01)	(5,4.25,0.01)
II	(17.5,6.37,0.01)	(15,4.25,0.01)	(15,4.25,0.01)	(17.5,6.37,0.01)
III	(32.5, 6.37,0.01)	(32.5,10.62,0.01)	(32.5,10.62,0.01)	(37.5,10.62,0.01)
IV	(57.5,14.86,0.01)	(62.5,14.86,0.01)	(60,12.74,0.01)	(65,12.74,0.01)
V	(87.5,10.62,0.01)	(90,8.49,0.01)	(87.5,10.62,0.01)	(90,8.49,0.01)

Table 8: Weight $w^{(1)}$,$w^{(2)}$ and comprehensive weight w^*.

Indices	c_1	c_2	c_3	c_4
$w^{(1)}$	0.2450	0.2625	0.2586	0.2339
$w^{(2)}$	0.2500	0.3333	0.2500	0.1667
Consistency test		$\mathrm{d}\left[\mathrm{w}^{(1)}\quad \mathrm{w}^{(2)}\right]=0.049<0.3$		
w^*	0.2510	0.3475	0.2483	0.1532

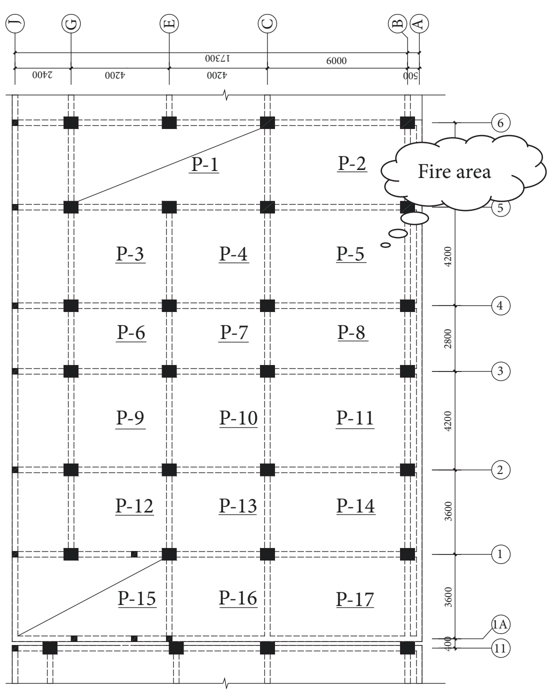


Figure 4: Schematic diagram of members' locations.

where a_{ij} and b_{ij} respectively are the interval boundary values of the comprehensive assessment standard of concrete damage after fire.

The interval boundary values are the transition state of two grades, so they may be affiliated with either of the two grades; thus, the certainty degree of the interval boundary values affiliated with both grades is exactly the same, and

$$\exp\left[-\frac{\left(b_{ij}-a_{ij}\right)^2}{8E_n^2}\right]=0.5 \tag{11}$$

The entropy E_n of the cloud model can be calculated by (11), as shown in (12):

$$E_n=\frac{b_{ij}-a_{ij}}{2.355} \tag{12}$$

The hyperentropy H_e is a constant which reflects the dispersion degree of the cloud model. The values can be adjusted according to the cloud chart of the comprehensive assessment index of concrete damage after fire.

The characteristic parameters (E_X, E_n, H_e) of the graded cloud model of concrete damage after fire can be obtained by calculating the data in Tables 2–5 according to (10) and (12). Each H_e value is 0.01%, as given in Table 7.

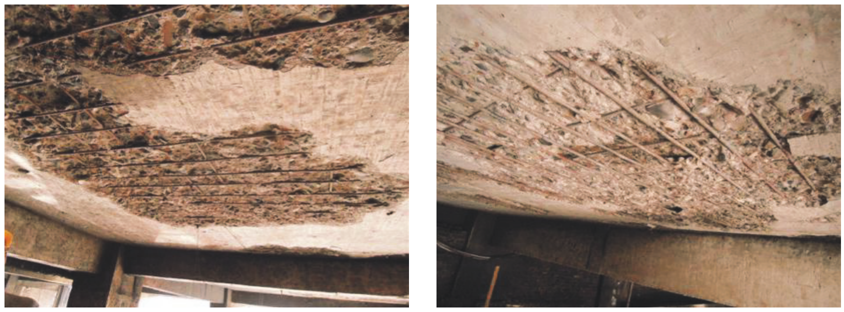
On the basis of the cloud model eigenvalues of the graded comprehensive assessment of concrete damage after fire in Table 7, using the forward cloud generator, 5000 cloud droplets are generated with MATLAB, and the graded cloud chart of the concrete surface color (c_1) can be generated (shown in Figure 6). The graded cloud charts of the exfoliation (c_2), cracks (c_3), and hammering responses (c_4) are similar and are not explained here.

5.2. Determining the Index Weight. The objective weight $w^{(1)}$ of each assessment index can be obtained by calculating the data in Tables 2–5 using (3)~(5); the subjective weight $w^{(2)}$ can be obtained by the precedence chart method. Then, α_k can be calculated by substituting $w^{(1)}$ and $w^{(2)}$ into (8), normalizing α_k, and obtaining the comprehensive weight W^* by substituting the normalized α_k into (9), as listed in Table 8.

5.3. Comprehensive Certainty Degree of the Cloud Model. The comprehensive certainty degree of the damage grades of concrete after fire can be calculated by

$$U_j(p)=\sum_i a_i\cdot y_{ij} \tag{13}$$

where $U_j(p)$ is the comprehensive certainty degree of corresponding grade j of the concrete member p, a_i is the



(a) Member P-4 (b) Member P-5

FIGURE 5: Concrete of the plate bottom cracked, loosened, and exfoliated, and rebar exposed.

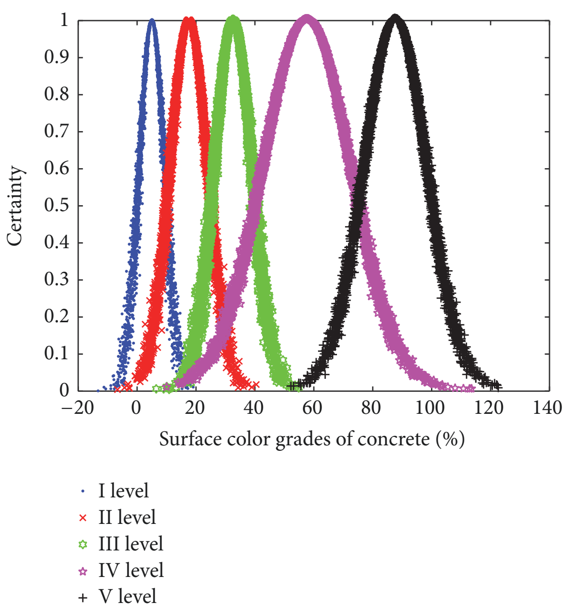


FIGURE 6: Grades of concrete surface color.

comprehensive weight of the ith assessment index of concrete member p, and y_{ij} is the jth assessment grade's average certainty degree of the ith assessment index. The damage assessment grade K of the concrete member p after fire can be calculated according to

$$K = \max \{U_1, U_2, U_3, U_4\} \quad (14)$$

6. Results and Discussion

The procedure of forward cloud generation written by MATLAB calculated the data in Table 6 5000 times, and the comprehensive certainty degree $U_j(p)$ was calculated according to the average value of certainty degree y_{ij}. The fire damage grades of the reinforced concrete floor plate can be obtained and compared with the results of the traditional method [24] (as listed in Table 9).

(1) The results produced by the proposed method for P-2, P-4, P-5, P-7, P-8, P-11, P-13, and P-15 are completely realistic and consistent with the results of the traditional method.

(2) The results produced by the proposed method for P-3, P-10, P-12, P-14, P-16, and P-17 have slightly lower values than those from the traditional method. The traditional method is more conservative than the method in this paper, and the method in this paper is more realistic, accounting for the difference.

(3) The results produced by the proposed method for P-1, P-6, and P-9 indicate that the fire damage of the above members is between grade II and III, biased towards grade III. The results are consistent with the traditional method, but results of the method in this paper are more intuitive.

7. Conclusions

This paper proposed a comprehensive assessment method for concrete damage after fire based on game theory-normal cloud model theory. The specific application of this method was explained in detail with reference to a practical engineering case, and the damage grades of reinforced concrete floor plates after fire were assessed. Then the following main conclusions were drawn.

(1) For the damaged members, the assessment results of this method are completely realistic and consistent with the results of the traditional method; for the members with moderate damage, the assessment results of this method are more objective. Overall, the assessment results of this method are intuitive and reasonable.

(2) Each assessment factor in this method (concrete surface color, exfoliation, cracks, and hammering responses) is easily obtainable; the assessment requirements are not too high; no numerical simulation is required; defects of the inspection surface and concrete have no effect on the results; cutting and sampling on assessment objects is not needed and not affected by the wall thickness of the structural member. In summary, this method is more applicable.

(3) In general, there may be a large number of concrete members damaged in the fire. The common method not only has a high workload but is also inefficient. This method takes full account of the uncertainty and fuzziness of the assessment factors. It is not only simple, but also easy to calculate digitally, making it more efficient.

(4) It must be emphasized that this method only considers the ultimate structural safety of the assessment object, but

Table 9: Comprehensive certainty degree.

Member No.	Comprehensive certainty degree value					Comprehensive assessment	Traditional method
	I	II	III	IV	V		
P-1	0.2796	0.3633	0.3921	0.0345	0.0000	III	III
P-2	0.0000	0.0000	0.0007	0.4433	0.5848	V	V
P-3	0.0000	0.0829	0.5623	0.4293	0.0010	III	IV
P-4	0.0000	0.0000	0.0017	0.3814	0.6954	V	V
P-5	0.0000	0.0000	0.0174	0.3912	0.7176	V	V
P-6	0.0033	0.4990	0.5435	0.0354	0.0000	III	III
P-7	0.0000	0.0000	0.0017	0.5007	0.5857	V	V
P-8	0.0000	0.0000	0.0053	0.4515	0.6395	V	V
P-9	0.0588	0.4672	0.4675	0.1187	0.0000	III	III
P-10	0.0224	0.6709	0.4000	0.0773	0.0000	II	III
P-11	0.0000	0.0277	0.7250	0.2774	0.0000	III	III
P-12	0.0261	0.7216	0.3721	0.0175	0.0000	II	III
P-13	0.0002	0.2544	0.6926	0.0509	0.0000	III	III
P-14	0.1302	0.5898	0.3592	0.0534	0.0000	II	III
P-15	0.1706	0.8734	0.1334	0.0068	0.0000	II	II
P-16	0.0036	0.6060	0.4443	0.0807	0.0000	II	III
P-17	0.0220	0.5808	0.4676	0.0257	0.0000	II	III

ignores the displacement and deflection of members that may affect the serviceability (applicability and durability) of the building.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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