

# Definition of the operated reinforced concrete structures condition

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**Abstract – A method is developed, which allows to determine category of the technical condition of bending reinforced concrete structures based on a probabilistic interpretation of the actual values of strength, based on the actual load level.**

Key words – diagnostics, monitoring, technical condition, probabilistic calculation, numerical analysis, approximation.

## I. Introduction

At diagnostics of the operated load-carrying reinforced concrete structures it is relevant to determine their current technical condition.

In modern construction practice reinforced concrete structures categorization of technical condition is based on visual examination, instrumental examination, usage of nondestructive control methods, verifying calculations.

This approach has a significant disadvantage: it can not accurately determine the actual strength of structures, which eventually affects the final assessment of the technical condition.

Similar problems are solved during the reinforced concrete structures monitoring.

Monitoring means observation of an object's (structures) state, to determine and predict the moment of its transition to the limit state.

The result of an object's (structures) monitoring is an array of diagnoses (values) of its constituent subjects (characteristics) obtained on inseparably adjoining time intervals during which the condition of the object (structure) does not change substantially.

During monitoring, the appointment of structures condition depends on the actual characteristics, in which zone they are located. It is therefore necessary to define the boundary values of the characteristics for each zone.

The values of strength boundary characteristics of the operated structures are defined in the project or during the diagnostics, where, as mentioned earlier, applied approaches do not provide accurate results.

## II. Main provisions of the developed method

We have developed a method that allows determining of the technical condition category of bending reinforced concrete structures, based on a probabilistic interpretation of the strength actual values, taking into account actual load level.

Determination of actual values of the reinforced concrete structures strength is performed by a test load

with further processing of the results by numerical methods. Thus the structure remains operably usable [1].

The actual load level of the structure is determined with reasonable accuracy during the technical examination.

## III. Usage of the developed method for diagnostics

According to [2], there are five categories of the reinforced concrete structures technical condition:

1. serviceable;
2. operable;
3. boundedly operable;
4. not operable;
5. emergency.

Each category is characterized by certain quantitative indicators, such as the probability of failure-free operation (P) and the safety characteristic ( $\gamma$ ), which are presented in Table 1.

TABLE 1  
QUANTITATIVE INDICATORS OF THE REINFORCED  
CONCRETE STRUCTURES TECHNICAL CONDITION  
CATEGORIES

Category of the technical condition	P	$\gamma$
1	$\geq 0,99865$	$\geq 3,0$
2	$0,99865 - 0,99$	$3,0 - 2,33$
3	$0,99 - 0,95$	$2,33 - 1,64$
4	$0,95 - 0,5$	$1,64 - 0$
5	$\leq 0,5$	$\leq 0$

Category of technical condition of the diagnosed concrete structure using the developed method is defined as follows:

1. during the diagnostics the actual level of the load acting on the structure at a given moment and the values of geometric and strength parameters are determined;
2. quantitative indicators of the structures condition (the probability of failure-free operation and the safety characteristic) are calculated;
3. structures test loading is conducted, in order to determine strength parameters;
4. by approximating the conclusion of the final value of the structures strength carried out;
5. graph of the structures strength characteristics distribution carried out;
6. technical condition categorization is carried out taking into account data given in Table 1.

## IV. Usage of the developed method for monitoring

The main issues that are being worked out while monitoring include:

- determination of the structures number for which observation is set;
- determination of the controlled characteristics (selection of the structures changing condition indicators);

SUMMARY TABLE

Categories (diagnostics)	States (zones) (monitoring)	P
1	1	$\geq 0,99865$
2	2	$0,99865 - 0,99$
3		$0,99 - 0,95$
4	3	$0,95 - 0,5$
5		$\leq 0,5$

### Conclusion

In such a way the developed method allows:

- to determine the actual value of bending reinforced concrete structures strength;
- to determine the category of the bending reinforced concrete structures technical condition during the diagnosis;
- to determine boundary values of bending reinforced concrete structures strength characteristics (normal, subcritical and critical) for appointment of normal operation, pre-emergency and emergency zones;
- to determine bending reinforced concrete structures state during monitoring.

### References

- [1] A. N. Savytskyi, "Determination of reinforced concrete bending structures strength by test load," Science and education a new dimension: Natural and technical science., Budapest., Vol. 8, 2013, pp. 117–127.
- [2] Rekomendatsyi po obespecheniu nadezhnosti i dolgovechnosti zhelezobetonnyh konstruktsyi promyshlennyh zdaniy i sooruzheniy pri ih rekonstruktsyi i vosstanovlenii [Recommendations on maintenance of reliability and durability of the reinforced concrete structures of industrial buildings and constructions in their reconstruction and restoration], Stroyizdat, 1990.

– selection of control areas (places or points on a structure, where the characteristics maximum values of selected indicators manifestation is typical);

– determination of the characteristics boundary values for each of the selected control areas.

When using the developed method for the structures strength characteristics boundary values determination, activities specified from article 1 to article 4 (see previous section) are performed.

The obtained values of the strength characteristics structures is an array of data that can later be used to establish zones of normal operation, the onset of pre-emergency and emergency state structures.

When using this methodology for assigning structures condition, activities specified from article 1 to article 5 (see previous section) are performed.

The direct appointment of structures condition, activities specified in article 6 (see previous section) is made depending on the zone in which the structures strength characteristic values are obtained Fig. 1:

– state 1: zone of normal operation (normal values of characteristics);

– state 2: pre-emergency zone (subcritical values of characteristics);

– state 3: emergency zone (critical values of characteristics).

For the developed method ease of use during diagnostics and monitoring, categories of the reinforced concrete structures technical condition used in diagnostics and states (zones) used in monitoring were brought into line Table 2.

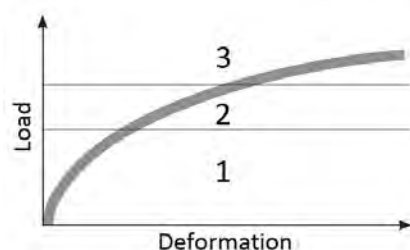


Fig. 1 A schematic graph of zones: 1 – normal values of characteristics; 2 – subcritical values of characteristics; 3 – critical values of characteristics