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SERVICEABILITY ASSESSMENT OF A REINFORCED CONCRETE ONE-WAY SLAB USING PROBABILISTIC SBRA METHOD

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1. Introduction

The study, which is shortly described in the following paragraphs, demonstrates potential of the SBRA (Simulation-Based Reliability Assessment) method (see e.g. [1], [2]) in probabilistic serviceability assessment of a simply supported reinforced concrete one-way slab (see Fig. 1). Acting loads, consisted of dead load and imposed load, are causing vertical deflection of the slab. The goal is to assess vertical deflections of the slab.

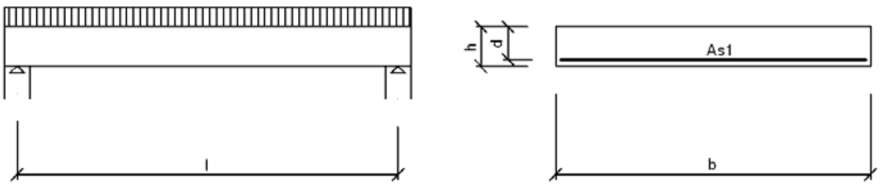

Fig. 1 Scheme of simply supported reinforced concrete one-way slab

2. Solved study

2. 1. Input data

Dimensions of the slab were considered as deterministic values. Concrete cover, reinforcement cross-section area and material characteristics were considered as random variable quantities. Bounded histograms of applied loads are shown in Fig. 2.

2. 2. Applied mathematical model

The mathematical model is based on the model contained in the Eurocode 2 [3]. The model respects influence of cracks on the stiffness of considered structure (for more details see [3]-[6]). Creep of the concrete, due to dead and long-lasting loads, is introduced using the creep factor ϕ_c (see Fig. 3). Shrinkage of the concrete is taken into account by shrinkage factor ϕ_{cs} (see Fig. 3). Those two factors were also determined according to the model contained in the Eurocode 2 [3].

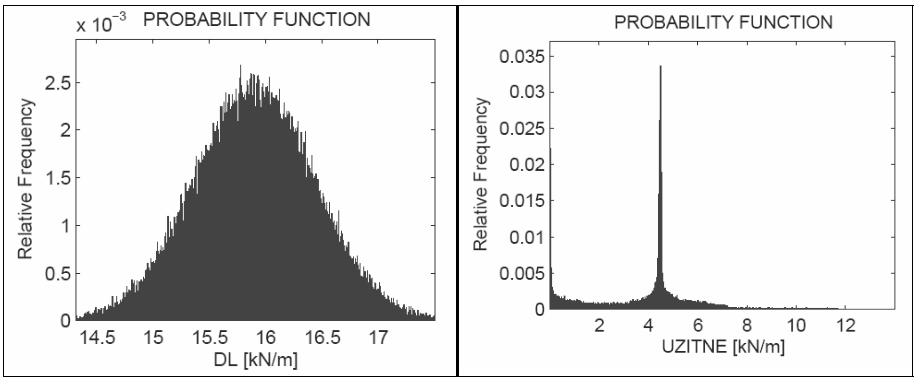

Fig. 2 Bounded histograms of (a) dead load and (b) imposed load

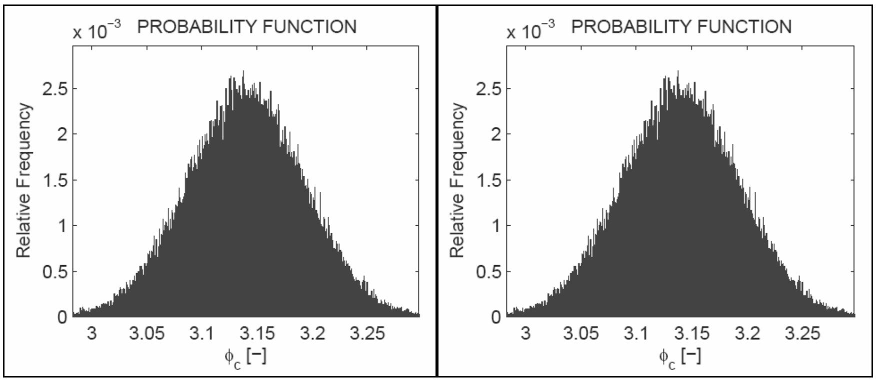

Fig. 3 Factors of (a) concrete creep ϕ_c and (b) concrete shrinkage ϕ_{cs}

2. 3. Calculation

The target probability, corresponding to the serviceability assessment, is considered $P_d = 0.07$ (according to the recommendation in the code [7]). Probability of failure P_f is calculated from the reliability function $RF = R\text{-}E$, where E is the vertical deflection due to the acting loads and R is the limit value. There were used two limiting values. The first limiting value corresponds to the case, when only dead and long-lasting loads are acting and its value equals to 1/250 of the slab span. In the second case, all loads are considered to be acting and the limiting value equals to 1/200 of the slab span. The resulting probabilistic funtions corresponding to these two cases are shown in Fig. 6. The resulting probabilities of failure are $P_{f,lt} = 0.22485$ and $P_{f,st,a} = 0.00455$. In the first case, there is not met the serviceability criterion $P_f < P_d$. This criterion can be satisfied e.g. by increasing of the member stiffness.

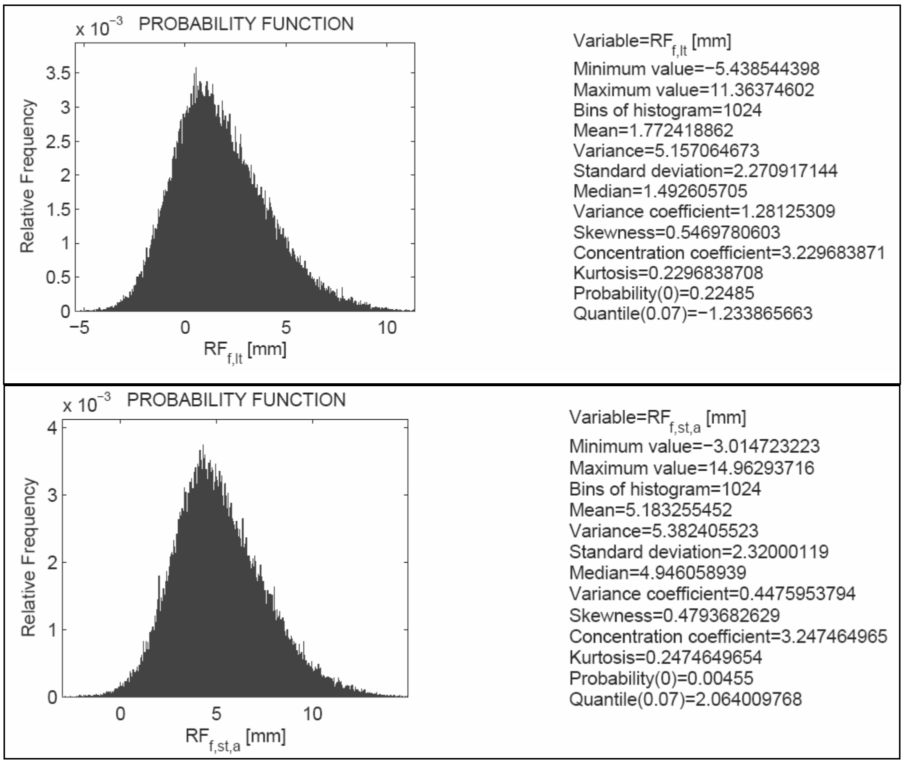

Fig. 4 Serviceability functions: (a) only dead and long-lasting loads are acting and $R = l/250$, (b) all loads are acting and $R = l/200$

3. Conclusion

The paper indicates the efficient application of the SBRA method in evaluation of serviceability criterion of reinforced concrete member. Randomness of individual input quantities can be easilly taken into account using bounded histograms better expressing real scatter then the parametric ones. The potential of this probabilistic approach can be also exploited in cases, when a structure is exposed to various time-dependent effects, such as carbonation of concrete, corrosion of reinforcements, etc. Then, the probability of failure is variable in time and reliability assessment can be easily performed by a curve of probability of failure (see eg. [8], [9]).

Acknowledgements

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Anotace

Cílem příspěvku je posudek použitelnosti prostě podepřené železobetonové nosníkové desky z hlediska svislých průhybů. Deska je namáhaná rovnoměrně rozděleným spojitým zatížením stálým a užitným. Většina vstupních veličin je uvažována jako náhodně proměnná, včetně zatížení, a jsou popsána ohraničenými histogramy. Posudek spolehlivosti je proveden na základě plně pravděpodobnostní metody SBRA (Simulation-Based Reliability Assessment).