EFFECT OF FRESH CONCRETE FREEZING IN STRUCTURE ON ITS QUALITY DETERMINED BY NON-DESTRUCTIVE METHODS

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The results of concrete strength investigations in foundation under the air-compressor which was realized in low minus temperatures are presented. As a composite testing method were used the ultrasonic and sclerometric tests. The detailed analysis of concrete quality by complex method showed that the use of two-parametrical quality characteristic of concrete is necessary for the proper estimation.

INTRODUCTION

The realization of the concrete monolithic constructions is subject often to the unfavourable influence of the atmospheric agents. As the most important of these agents one should regard the action of frost on the freshly shaped concrete construction, which causes the delay of cement hydration process in concrete mix, and also the series of destructive occurences, which reduce considerably the strength of hardened concrete. In building practice the necessity often exist of objective estimation of quality of concrete in construction, which in the realization phase uderwent the freezing in consequence a sudden decrease of air temperature below 0°C. Because of the purpose of a construction and its size it is not always possible to cut or bore samples from construction to test them on compression testing machine. In this situation, it is imperative to use of non-destructive technics of investigations with utilization of two non-destructive methods at least.

In this paper the analysis is presented of examination results of frame-foundation under the air-compressor, frozen to temperature -20°C in the concreting period. In the investigations two non-destructive methods - ultrasonic and sclerometric - were used as a composite unity.

EXAMINATIONS

The construction of frame-foundation under the air-compressor, which was realized of Polish mining towns, is presented in fig. 1 and 2. This foundation under the air-compressor was realized in the minus temperatures season, i.e. in November - December

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months. The complex non-destructive tests were carried out on the foundation columns only in consideration of no access to high foundation slab. The access to the slab was impossible because the assembly process of air-compressor was fairly advanced.

The sclerometric tests have been carried out by means Schmidt's hammer type N, whereas the ultrasonic tests - by means of material tester type UNIPAN-541 with the numeric reading. The elaboration (1), containing the general regression curve for ordinary constructional concretes, was used in determining the compressive strength of the concrete by sclerometric method. On account of the fact that at the moment of examination the con-crete had an age of about 200 days, it was necessary to apply suitable correction coefficients for regression curves in order to attain the determination of real quality concrete parameters, characterized by the average strength, coefficient of strength variability and the minimum strength of concrete. The following coefficients were accepted: in sclerometric method according to (1) - $s = 0,86$, in ultrasonic method according to (2) - $v = 1,16$. The concrete quality parameters in the foundations columns fixed by the each non-destructive method and the complex method (3) are presented in table 1.

RESULTS

The analysis of results presented in the table 1 indicates the fundamental differences between the data obtained by both non-destructive methods. Sclerometric method yields considerably higher values of strength variability coefficients and average strength than those obtained by ultrasonic method. None the less of the above differences, it is very characteristics and interesting that values of minimum strength obtained in both methods with the probability $P = 0,95$ are almost the same.

TABLE 1 - Concrete quality parameters in the foundation columns fixed by the each non-destructive method and the complex method (3).

	Sclerometric method			Ultrasonic method			Complex method	
Column No.	$\bar{R}$ MPa	υ_r %	R_{rnin} MPa	$\bar{R}$ MPa	υ_r %	R_{rnin} MPa	$\bar{R}$ MPa	R_{rnin} MPa
A1	15,2	34,5	6,6	12,4	7,5	10,8	13,8	8,7
A2	16,3	13,5	12,7	11,8	12,8	9,3	14,0	11,0
B1	18,0	26,1	10,3	12,3	10,9	10,2	15,1	10,2
B2	17,8	24,4	10,7	13,4	15,9	10,0	15,6	10,3
Designed compressive strength of concrete R = 20 MPa								

The observed phenomenon shows the various influence of the concreting of construction in conditions of minus temperatures on the results of concrete quality investigations by sclerometric and ultrasonic methods. Analysing this problem in detail, one can ascertain that fresh concrete freezing causes the considerably damages within the butt of concrete surface with the boarding. The space of this butt is most often subject to the creating ofice lentils, which cause a considerable nonuniformity of the hardness of

surface layer of concrete. This phenomenon strongly influences the strength variability coefficient of concrete as determined by Schmidt's hammer. The next stage of concrete hardening in plus temperatures conditions with the great content of carbon dioxide in air, results in the fast increase of surface layer hardness because of carbonization process. The effects of these phenomena were fully confirmed by sclerometric tests.

In case of determining the strength of concrete by ultrasonic method the results are strongly influenced by microscratches along the ultrasonic pulse path. The microscratches caused by the destructive action of ice on the cement gel with aggregate mixture, considerably increase the delay of ultrasonic pulse velocity as a result of the elongation of propagation distance. Besides, they cause the considerable damages of concrete structure homogeneity. With no possibility of a free moisture inflow into the internal volumes of concrete the phenomenon of so-called "healingself" does not take place. Thus, there is no possibility of improving the quality of the tested foundation with the passage of time. The low variability coefficients of concrete strength obtained by ultrasonic method, are the result of the sufficiently uniform amount of microscratches within the concrete along the height of foundation columns.

CONCLUSIONS

- The results of examination by both non-destructive methods presented in the table 1 show, that for fairly objective concrete quality estimation the application of complex method comprising two or more nondestructive methods is needed.

- For the estimation of strength parameters of concrete the usage of two-parametrical quality characteristic is necessary, comprising the strength variability coefficient as well as average strength.

SYMBOLS USED

s = correction coefficient for regression curve in sclerometric method
v = correction coefficient for regression curve in ultrasonic method
υ_r = coefficient of strength variability, (%)
R = average strength of concrete, (MPa)
R_{rnin} = minimum strength of concrete, (MPa)

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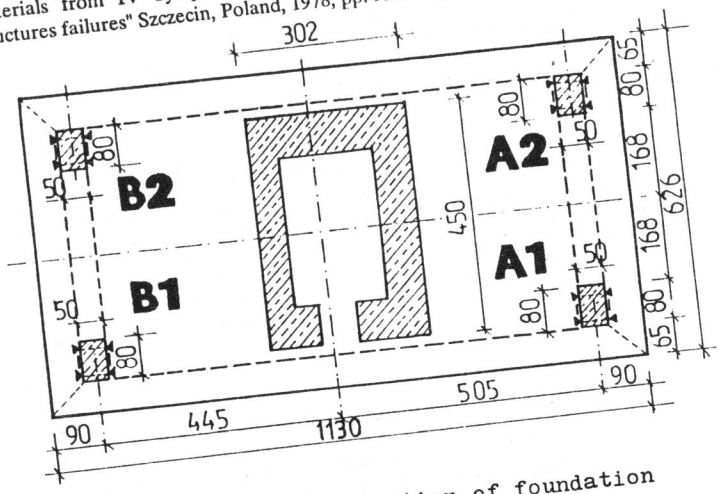

Figure 1 Horizontal section of foundation under air-compressor

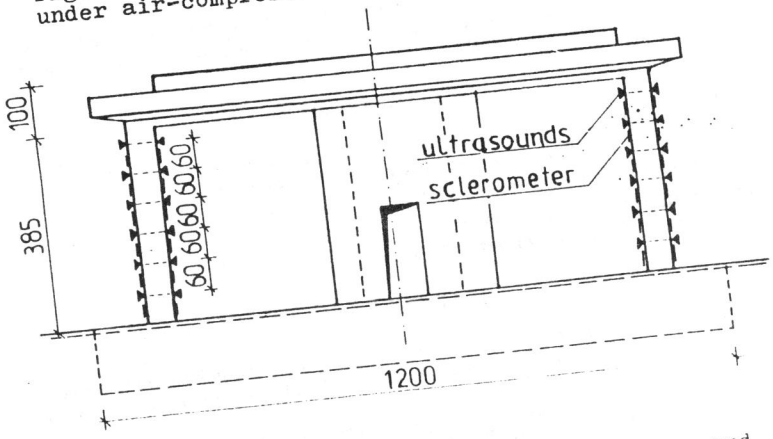

Figure 2 Vertical section of this foundation and measurement places to non-destructive testing