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# IMPROVE OF TENSILE STRENGTH OF CONCRETE CYLINDERS WITH A HOLLOW CROSS SECTION BY USING VIBR-VACUUMIZING TECHNOLOGY

## ПІДВИЩЕННЯ МІЦНОСТІ БЕТОННИХ ЦИЛІНДРІВ З ПОРОЖНИСТИМ ПЕРЕРІЗОМ ПРИ РОЗТЯГУВАННІ ВІБРОВАКУУМІРОВАННЯМ

## ПОВЫШЕНИЕ ПРОЧНОСТИ БЕТОННЫХ ЦИЛИНДРОВ С ПОЛЫМ СЕЧЕНИЕМ ПРИ РАСТЯЖЕНИИ ВИБРОВАКУУМИРОВАНИЕМ

**Annotation.** investigated the effect of concrete tensile strength in by adjusting of forming methods .It was developed method for forming of a hollow concrete cylinders, which allows to extract up to 35% of the mixing water, reduce the W/C to 0,35…0,4, $R_t$ = 4,3-4,5 Mpa at Ku = 1.75.
**Keywords:** hollow concrete cylinders, vibration-vacuum, technology of compacting ,strength of concrete.
**Анотація.** Досліджено вплив міцності бетону при розтягуванні шляхом регулювання методів ущільнення. Розроблено технологію формувань бетонних циліндрів з порожнистим перерізом, яка дозволяє екстрагувати до 35% води змішування, зменшити В / Ц до 0,35…0,4, $R_{bt}$ = 6,5-6,8 Мпа при Ку = 1,35.
**Ключові слова:** бетонні циліндри з порожнистим перерізом, віброваккуміровання, технологія формування, міцність бетону.
**Аннотация.** Исследовано влияние прочности бетона при растяжении путём регулирования методов уплотнения. Разработана технология формования бетонных цилиндров с полым сечением, которая позволяет экстрагировать до 35% воды затворения, уменьшить В/Ц до 0,35…0,4, $R_{bt}$ = 4,3-4,6 Мпа при Ку=1,75.
**Ключевые слова:** бетонные цилиндры с полым сечением, вибровакуумирование, технология формования, прочность бетона.

**Introduction.** Concrete cylinders with hollow section of different purpose are characterized by the extensive application: in chemical and petrochemical industries for transporting highly corrosive and sterile environments; in construction; in urban public utility systems. Ensuring reliable operation of this type of structures throughout the entire lifetime is associated with maintaining their integrity under various load conditions, and depends on the accuracy of the methods of determining the strength taking into account manufacturing techniques.

As early as in the 30s of the previous century vacuum compaction of concrete mixes has been used successfully in the construction of buildings and structures of mass concrete [7, 8, 9, 10]. In practice, back at that time the advantages of vacuum compaction of concrete mixes in monolithic structures had already been convincingly proved. The main ones are the following:

increase in labor productivity; reduction of the period of construction of buildings or individual structures; significant reduction in metal consumption (material consumption) by formwork; energy savings; reduction of specific consumption of cement; significant improvement in concrete quality.

However, in the 1950s because of the overuse of harsh and even very harsh mixes, vacuum compaction method has been undeservedly forgotten. But it was soon discovered that the use of harsh concrete mixes in the construction of monolithic structures is associated with a number of major shortcomings of the technological and technical nature [5]. Therefore, back in the 1960s it has been argued [7] that this method of compaction of concrete mixes shall be resumed and applied in the areas, where it is technically feasible and economically beneficial.

**The aim of this study –** increased strength concrete cylinders with a hollow cross section in tension.

**Relevance of this study.** For the wide application of concrete cylinders with a hollow section with sufficient strength characteristics, it is necessary to develop technology and concrete compositions that ensure the production of the specified properties in concrete cylinders. According to the calculations carried out previously [1], for the material concrete cylinders with a hollow section We need to provide increased tensile strength ($R_t$) [2,3,4]. Experimentally, tensile strength Rt determined by the tensile test specimens of standard-eights shape (Fig.1). The reference composition C : G = 1: 3, W / C = 0.5; G – sifting gravel aggregate production $M_к$ = 2.7, С Э Portland cement grade 500. The effect of each factor is determined from the coefficient of efficiency $K_y$

$$K_y = \frac{R_{t\,(i)}}{R_{t\,(к)}}, \qquad (1)$$

wherein $R_{t\,(i)}$ – Results i – that test $R_{t\,(h)}$ – the strength of the reference sample (27 kg/cm²).

Vibr-vacuumizing technology provides intensive growing

Fig. 1. The developed device for compacting samples eights shape by vibr-vacuumizing technology.

strength in the initial period of hardening, reduction of time for the heat treatment of products, reduction of metal process equipment, etc. [6]. Owing to the depression created in the suction shield of concrete through the filter sucked air and water which are removed with a vacuum pump. cement particles in the filter material. Overpressure is created by injection of water between the rubber body and the stocking of the core, acting from within. Retaining overpressure rubber stocking onto the concrete, the form is sent to the heat treatment [5]. The degree of concrete mix compaction depends on the frequency and amplitude of vibrator, as well as on the duration of vibration. For compacting concrete mixes vibration amplitude is within 0.3 mm – 0.7 mm at a frequency of about 3000 vibrations per minute. For the vacuum treatment of laid concrete the stationary and mobile units are used, which consist of a vacuum pump and vacuum shield coated with filter medium.

**Results of the study.** The work was to study the effect of the concrete mix humidity and time for evacuating the tensile strength (Fig. 2).

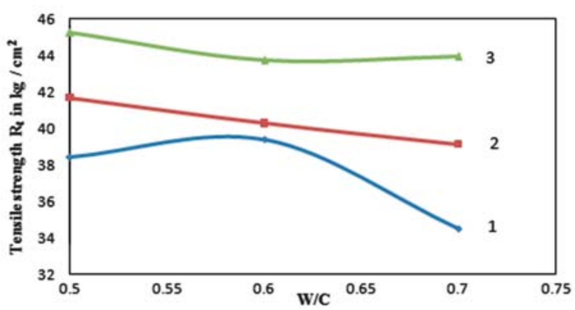


Fig. 2. Effect of humidity on the tensile strength of concrete samples compacted by vibr-vacuumizing technology.
1 – time-vacuum 1 minute, 2 – vacuum time 3 minutes, 3 – time-vacuum for 2 minutes.

As a result of laboratory research on the proposed laboratory setup (Fig. 4) using vibr-vacuumizing technology. method for compacting of concrete cylinders with hollow section were produced (Fig. 4).

Fig. 4. Concrete cylinders with a hollow section, compacted by vibr-vacuumizing technology.

Figure 5 shows the structure of cement paste obtained with different methods of sealing concrete mixture, photographs show that the samples of concrete compacted by compression (a) and vibr-vacuumizing technology. (b) provide a substantially uniform concrete structures with packing of all its components.

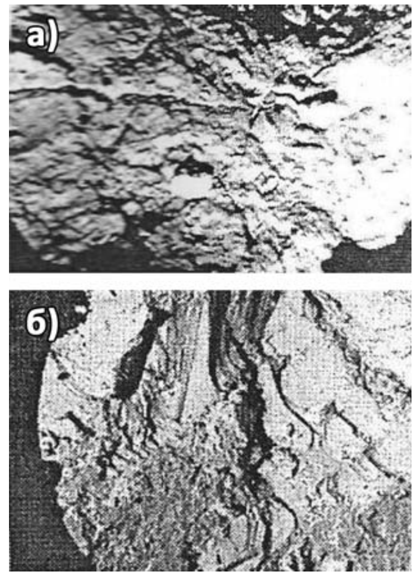


Fig. 5. Electron microscopy 5- cement stone grained concrete compacted:
a – reference;
b – vibr-vacuumizing technology.

Table 1.

Performance $R_{bt}$ concrete strength at stretching

| Measuring the number | Tensile strength, kg/cm$^2$ | | |
|---|---|---|---|
| | 1B | 2B | 3B |
| 1 | 45.23 | 41.67 | 38.41 |
| 2 | 43.72 | 40.25 | 39.38 |
| 3 | 43.93 | 39.11 | 34.50 |

Note: 1B, 2B, 3B samples sealing method vibr-vacuumizing technology to timeslot 1; 2; 3 min.

**Conclusion.** The effect of vibr-vacuumizing on the concrete tensile strength has been studied experimentally. The technology of molding concrete cylinders with a hollow section, including vibration and subsequent evacuation of the compacted mixture, has been developed. Investigation of the structure of concrete showed that evacuation allows extracting up to 35 % of the mixing water, reducing the initial W/C = 0.65 to W/C = 0.35 ... 0.4. The developed method makes it possible to obtain the strength of concrete when stretching in an article ($R_t$ = 4,3 -4,6 MPa). The increase in $R_t$ is determined by the coefficient of hardening (Ku). It has been experimentally established that for vibr-vacuumizing the index Ku = 1.75

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