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Fenko O., PhD, Associate Professor
Krupchenko O., PhD, Associate Professor
Yurko I., PhD, Associate Professor
Poltava National Technical Yuri Kondratyuk University

THE INFLUENCE OF ITS OWN STRESSES ON CONCRETE STRENGTH UNDER COMPRESSING

The results of experimental studies of the impact own stress unevenly distributed over the cross section, for strength of brittle materials were presented. Changes in the distribution of stresses in own cross-section caused by uneven shrinkage of concrete samples were analyzed. The reasons for own impact stresses are unevenly distributed over the cross-sectional sample for strength of concrete compressive were justified.

Also the effects of stress on its own strength of concrete at its moisture were considered. Described impact on own stress compressive strength is confirmed by experimental results obtained by other authors. Shows the distribution of stresses in its own cross section at its water saturation and drying is not only concrete and also other porous materials.

Keywords: *own stresses, strength of concrete, water saturated concrete, shrinkage, creep.*

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Фенко О.Г., к.т.н., доцент
Крупченко О.А., к.т.н., доцент
Юрко І.А., к.т.н., доцент
Полтавський національний технічний університет імені Юрія Кондратюка

ВПЛИВ ВЛАСНИХ НАПРУЖЕНЬ НА МІЦНІСТЬ БЕТОНУ ПРИ СТИСКУ

Наведено результати експериментальних досліджень впливу власних напружень, нерівномірно розподілених по перерізу, на міцність крихких матеріалів. Проаналізовано зміни розподілу власних напружень у поперечному перерізі, викликані нерівномірною усадкою бетонних зразків. Обґрунтовано причини впливу власних напружень, нерівномірно розподілених по поперечному перерізу, на міцність бетонних зразків при стиску.

Також розглянуто результати впливу власних напружень на міцність бетону при його зволоженні. Описаний вплив власних напружень на міцність при стиску підтверджується результатами експериментальних досліджень, отриманими іншими авторами. Наведений розподіл власних напружень по поперечному перерізу при водонасиченні та висушуванні стосується не лише бетонів, а й інших пористих матеріалів.

Ключові слова: *власні напруження, міцність бетону, водонасичення бетону, усадка, повзучість.*

Introduction. The strength of the concrete varies over time and depends on the storage conditions, moisture, drying and from their own stress caused by shrinkage, swelling, creep during prolonged load.

The influence own structural stresses on the strength of concrete, caused by long compression or tension continued, was investigated in many experiments. The influence unevenly distributed over the cross-section of own stresses on the strength of concrete hasn't been studied, although it is advisable to consider a factor that determines the strength of concrete.

Review of recent sources of research and publications. The strength of concrete depends on many factors, which primarily include the composition of concrete and conditions of its hardening [1, 2], the age of concrete [3], the temperature and moisture of the environment [4 - 8], and therefore identify separately impact their own stress on the strength of concrete is difficult. To identify impact of their stresses that are distributed unevenly over the cross-section of the strength of the material, is logical to do experiments on ageless and nonporous material. Metal can be regarded as such material. [9].

Commonly known sequence of destruction metallic (fragile) samples. Destruction compressive samples begins with external layers, while a tensile - with internal. This sequence can be explained by the destruction of their own stresses that appear during casting (rolling) metal. During hardening metal samples when they are casting, cooling starts from external layers, so their temperature lower than internal. The external layers are compressed and the internal layers are stretched when aligning temperature. During the testing such samples by compression stresses in their external layers and stress from external loads (one sign) will be added, so the destruction of the sample will start with external layers. Destruction will start from the middle of the sample when tested in tension and internal layers are overwhelmed.

To confirm the given conclusions, it is expedient to make and test samples from the field opposite in field of sign their stress compared with the tension that arises when «natural» cooling. So that external layers are stretched and d internal layers are compressed.

These experiments were conducted on samples of fragile (silica) aluminum. Samples with a diameter of 30 mm and height 60 mm within the limits each party were cast of one melt. Samples of "natural" production were cast as steel cylinders and cooled with external layers. Other samples are spilled in the same cylindrical form with steel installed in the center of steel tubes.

Forms were installed in the electric heating device. Before bottling duralumin forms is heated to the melting temperature of duralumin, and the tube was served water at room temperature. Therefore, cooling the sample passed starting from the internal layers during its solidification. This created its own tensions field opposite in sign to the previous.

The test results confirmed previous conclusions about the impact own stress on strength: samples with opposite "natural" field of its own tensions were stronger than samples "natural" production on average by 20% [9], that impact own stress unevenly distributed over the cross-section in an average of 10%.

Parts of the common problems that earlier unsolved. Bold still unsolved aspects of the problem. The influence stress on own compressive strength of concrete and other porous materials were remained unexplored.

Problem statement. Determining the impact unevenly distributed over the own section stresses on strength of concrete in compression.

Main material and results. Difficulty its own experiments on the impact of stresses caused by shrinkage, on strength of concrete consists in that the intensity and distribution of shrinkage in cross section depends on the concrete storage conditions of samples.

Shrinkage begins and proceeds more intensively on surface of the sample and gradually passes to the internal layers during storage samples in air-dry environment. On the surface of the sample occur shrinkage stretching stress during reducing its size (due to shrinkage). They will compress the concrete in the nucleus (center) of the sample, namely they create conditions for the appearance of cracks on the surface of the sample. At the beginning of sample loading force compression external layers are not compressed to the load that can compensate them own stretching tension.

The interior of the sample which is compressed own stresses to the application of external force under load compression force will have larger (total) strain than external layers, and therefore should determine the strength of the entire sample. However, internal part, though overloaded, but is in the holder, which was created under loaded outer layers. As a result of this sample as a whole has to withstand the external load more than the sample without its own tensions.

Is well known and the effect of increasing the strength of concrete on drying (it is confirmed by numerous experiments). Continuing analysis of the impact of shrinkage (unevenly distributed over the section) stress we can predict possible reduction of concrete strength in time.

In the above state of stress creep of concrete in the outer layers arises from a tensile, and in internal - from compression. Parallel to this shrinkage is moving to the internal layers and eventually reaches the center of the sample. During this period, the intensity of the shrinkage in the outer layers decreased concrete has increased size due to a tensile creep his own stresses.

Internal layers (core sample) being reduced from shrinking in size, compress external layers themselves being in stretched condition. Characteristically, this process amplifies reduction obtained by an internal part of the creep of compressive shrinkage in the initial period.

When you load such a sample will be overwhelmed by the force of the compression outer layers, which are without a holder, and, of course, like the be destroyed at a lower load than the sample without its own tensions. Based on the above it can be concluded about the possible reduction of the strength of concrete in time. This conclusion is confirmed by the change in time diagrams of concrete strength in Fig. 1.

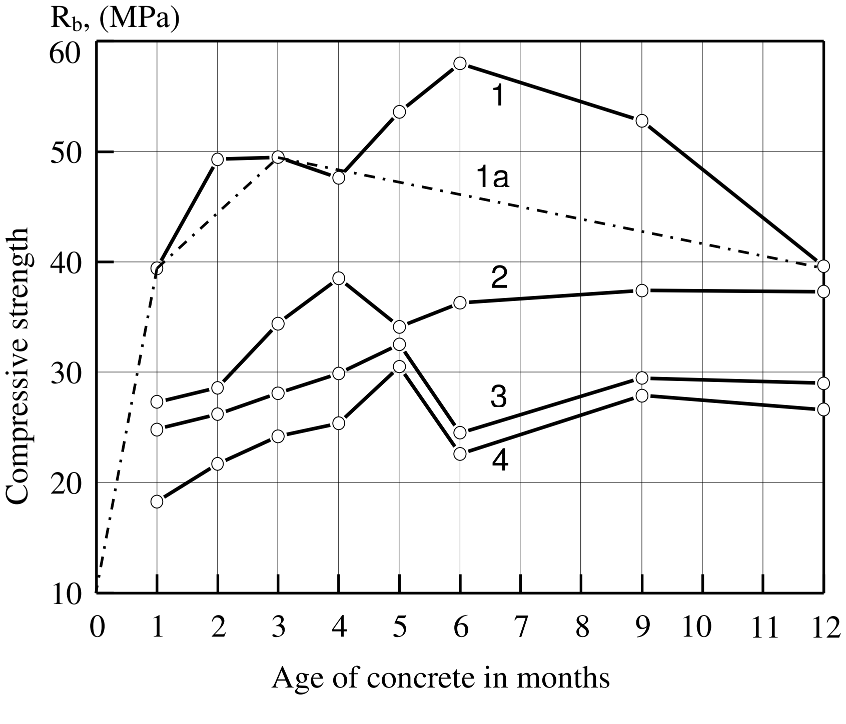

Figure 1 – Diagram of changes over time concrete strength (by S. Mironov)

There is a temporary reduction in the strength of concrete in the experiments carried by S. Mironov [1] out in all concretes (and natural hardening, and steaming).

After a while shrinkage of concrete attenuated, appears relaxation of its own tensile stresses in the middle (core) sample and stress compression in external layers, that reduces difference stress in the external and internal layers, and thus decreasing their negative impact on strength of concrete in compression. There is a kind of "recovery" (increase) the strength of concrete.

In Figure 1 shows the diagram changes cube compressive strength of concrete some samples. Repeated reducing its strength can be further structural relaxation caused its own stress [3]. This reduction can't be based on concrete properties (size gravel, water-cement ratio, hardening conditions, etc.) and storage conditions.

Summarizing the analysis of the impact of shrinkage stress (unevenly distributed over the cross section) on strength concrete in compression, it can be concluded that the strength of the concrete should first increase, then there may be a temporary decrease in strength, and then again an increase in compressive strength. These conclusions are fully confirmed experiments conducted by S. Mironov and others.

Diagrams would be different depending on the method of conducting experiments. For example, if you construct diagrams by three points, the second increase concrete strength will not happen (Fig. 1). These results were obtained in experiments of V. Sytnyk and Y. Ivanov [2], where the strength of concrete determined in four stages (Fig. 2, Fig. 1), and not eight as in experiments S. Mironov.

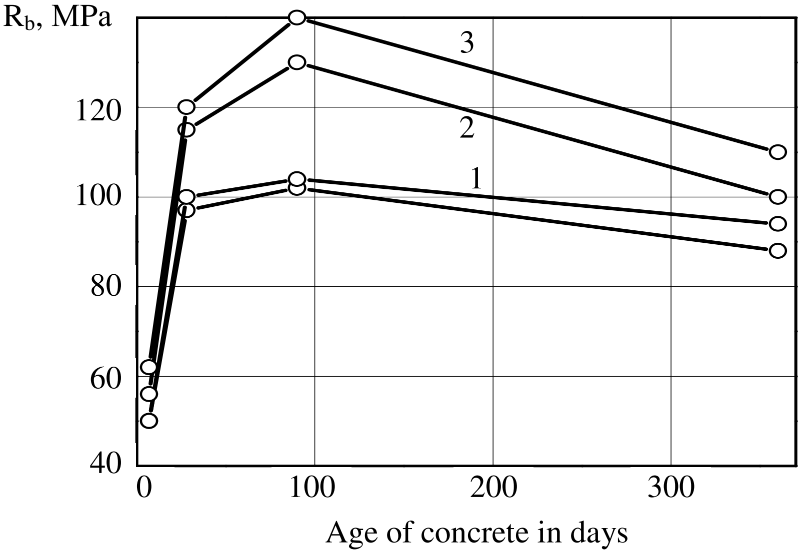

Figure 2 – Chart changing concrete strength (1), mortar (2) and cement (3) in time (based on the results of experiments V. Sytnyk, Yu. Ivanova)

In the water saturation of concrete samples will be shown the opposite effect. The process begins with moistening external layers. Concrete swells (increase in size), cause the own stress in the outer layers of compression and stretching in internal (central). When compression of the sample overwhelmed are external layers, but they are in a holder (intrinsic) because the sample begins with destruction of external layers, and as a result, the strength of sample will be less than the strength of the same sample without its own tensions caused by swelling.

In such a state of stress appears in concrete creep compressed and stretched external layers in the interior of the sample, this leads to a partial relaxation its own stresses. Reducing own stress reduces their negative influence and strength of concrete after a temporary recession increased.

Further swelling the central process (internal) of the sample field creates own stresses opposite to described previously. The emergence of the field own stress due to the fact what concrete creep at the beginning of water saturation led to reducing the size of compressed concrete in the outer layers and to increase its size in an internal part the sample.

Swelling of the internal layers sample (which is later on external) continues to increase its size by stretching at the same time reduced in size outer layers. This leads to more increase the strength of concrete.

Creep of concrete (compressed in the core section and stretched in the outer layers) and the stress relaxation reduces own positive effect, because the strength of concrete will gradually decrease. Depending on the technology production and storage conditions of samples reducing the strength can occur in very different terms. Reproduced character changes compressive strength of concrete in his water saturation confirmed by experiments of various authors [4, 5] analyzed Z. Tsilosani [6].

Invokes the interest that describes the impact of water saturation on compressive strength is not only concrete and other porous materials. In Figure 3 shows the results of experiments Russellya [7]. He studied the effect moistening gypsum on its compressive strength.

As shown in Figure 3 sequence of changes in strength gypsum while water saturation by compression coincides with the rationale described own impact stresses. Similar results were obtained in experiments of E. Shchukin, M. Dukarevycha and others [10], who studied the changes in strength magnesium hydroxide at saturation with water and ethyl alcohol (Fig. 4).

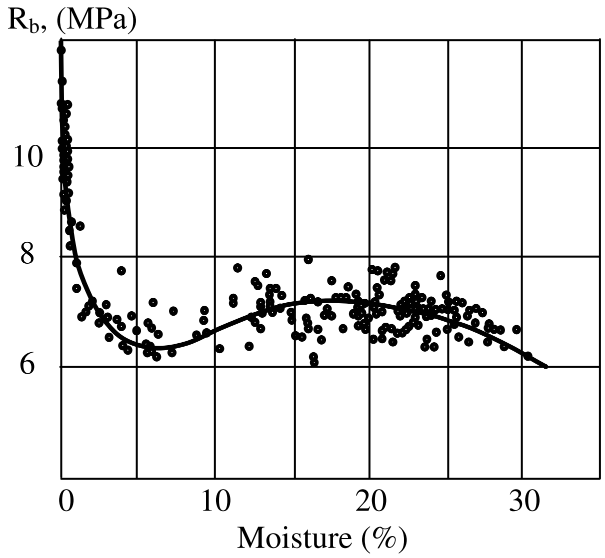

Figure 3 – Diagram of changing strength gypsum sample compression depending on moisture (based on experiments Russellya [7])

Reasons water saturation influence on strength porous materials using experimental results of various researchers [6] analyzed in the research Z. Tsilosani. Reasons impact were limited mainly to adsorption and capillary compression, but such factors influence on strength of water does not exhaust all possible cases of its action on concrete.

It is no accident in the 60 - 70s of XX century in the press there were conclusions of some researchers (V. Gorokhov, M. Elbakidze and others) about own involvement to stress the impact of water saturation and drying on strength of concrete in compression. It is also necessary to note research S. Shestoperova and T. Lyubimov [11] about the impact of water saturation and drying of concrete on his compressive strength. The authors have concluded experiments «change strength and drying moisture samples infinitely negotiable», which excludes the effect of additional hydration of cement.

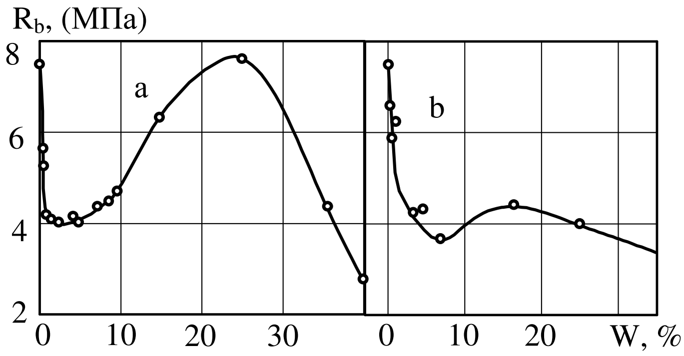

Figure 4 – Diagram of impact of water saturation (a) and ethyl alcohol (b) magnesium hydroxide on its compressive strength

Similar results were obtained in experiments of K. Mileykovskoyi [12], who investigated the «moistening effect on the strength of concrete air-dry hardening».

The influence moistening on the strength of concrete author relates with the development of strains swelling. It is noted also that with the termination of volume decrease swelling strains concrete strength is terminated, and prolonged water saturation strength is fully restored.

From this, we can conclude that the recovery of compressive concrete strength is own relaxation after the stress (as discussed earlier).

It is necessary to also be noted that in experiments of various authors own physical mechanical impact stresses on the strength of concrete is not provided, and for the final solution of this issue required as an experimental and further theoretical research.

Conclusions. The above analysis own stresses in the concrete, unevenly distributed over the cross section (caused by shrinkage or swelling), confirms and justifies their impact on the strength of concrete in compression. Described distribution of own stress in cross-section while water saturation and drying does not concern only concrete but also other porous materials.

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Fenko O.G., Krupchenko O.A., Yurko I.A.
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