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# EXPERIMENTAL ASSESSMENT OF CONCRETE STATE UNDER COMPRESSION CONDITIONS

***Abstract**: This article presents the changes in the concrete state under compressive loads of varying intensity. The dependencies of concrete damage on the pressure generated in the sample has been constructed. Measurements* *were made along the entire height of the deformed sample, from the axial line to the outer diameter, which allows for a prediction of the critical state of material that leads to damage.*

***Key words****: sample, concrete, damage, pressure, compression.*
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## 1. Introduction

Building safety is an important issue in civil engineering, as the main material (concrete) is subjected to various forces that can cause residual deformation and partial destruction of the concrete [1]. The intensity of concrete deformation will depend on the material properties and the value of load.

Concrete consists of the following components: cement paste, aggregates, and water. The water ratio is crucial for the strength of concrete.

Depending on the intensity of load, concrete can undergo various deformation mechanisms. For example, when concrete is initially loaded, it develops microcracks, and when subjected to high loads, it crumples, leading to material failure [2-5]. At the same time, the strength of concrete is tested using standardized tests in laboratory conditions or by simulating a compression test in special software products. Finite element analysis allows for a more accurate assessment of concrete's state under compressive loads [6-10].

The practical value of this research is to determine the dependence of the intensity of concrete damage on the pressure in the material under various compressive loads. Various measurement schemes for deformed concrete allow us to conclude about the material state based on the radius of sample.

## 2. Materials and methods

An axisymmetric two-dimensional model of a 100 mm diameter and 100 mm high sample was created to conduct a series of tests to assess the state of concrete under compression. The model type allows you to generate a volumetric model for 3D visualization of the calculation results. The sample model was assigned properties typical of concrete: density of 2300 kg/m$^3$, Young's modulus of 25 GPa, Poisson's ratio of 0.2, tensile strength of 0.005 GPa, compressive strength of 0.05 GPa, and biaxial compressive strength of 0.07 GPa. Concrete damage was calculated using the Mazars damage model with a shear exponent of 1.06. The tensile damage evolution of concrete model was analyzed based on exponential strain softening. The fracture energy per area was assumed to be 200 J/m$^2$, taking into account a maximum damage coefficient of 0.99999. A variable force was applied to the concrete sample, causing the material to compress.

The quality of the computational mesh on the concrete model is shown in the Figure 1. The average mesh quality of the model allowed for an optimal balance between the accuracy of results and duration of the computer calculation.

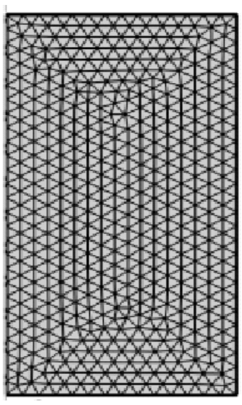
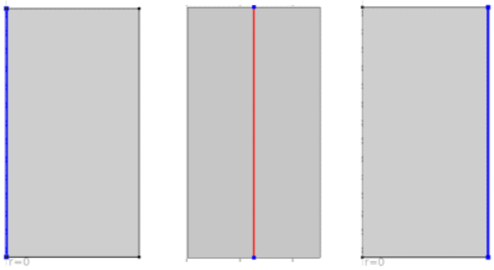


**Figure 1. The mesh on the concrete model.**

## 3. Results and discussion

The calculation results were obtained by recording the data on the material's damage intensity and pressure along the longitudinal section of the sample using three measurement schemes. The line originating from the point r=0 corresponded to the axial line of the sample model. The measurement schemes of the model state for the longitudinal section of concrete samples are shown in the Figure 2. These schemes provided data for analyzing the dependencies of damage on pressure under various loads applied to the concrete sample (the Figures 3-7).



A B C

**Figure 2. Measurement schemes for the state of concrete sample models in the longitudinal section. A is the first scheme, B is the second scheme and C is the third scheme.**

The presentation of the concrete sample's state is shown in a three-dimensional view with a 120-degree volume cutout for detailed visualization of internal volumes. Voids in the sample model define the undeformed volumes. All of the tests under consideration exhibit intense deformation in the upper part of the sample. The value of the damage coefficient increases towards the axial line. At the same time, pressure accumulates in the lower part of the sample.

The dependencies of damage on pressure, constructed according to the data of measurement schemes No. 1 and No. 2, are practically identical in a specific test. As the pressure in the material increases, the damage coefficient decreases. When a small value of force is applied, the damage coefficient decreases sharply along the axial line of the concrete sample. At higher loads on the sample, a proportional decrease in the damage coefficient was observed with increasing pressure in the material.

The calculated pressure in the material, obtained using measurement scheme No. 3, has maximum values. The minimum force on the sample leads to a decrease in the damage coefficient as the pressure in the concrete increases. However, under significant forces, the value of the concrete damage coefficient changes according to increasing and decreasing functions and has the form of a loop, which indicates variable pressure in the surface layers of the concrete sample, which will cause local cracks and damage of the material.

A

B

C

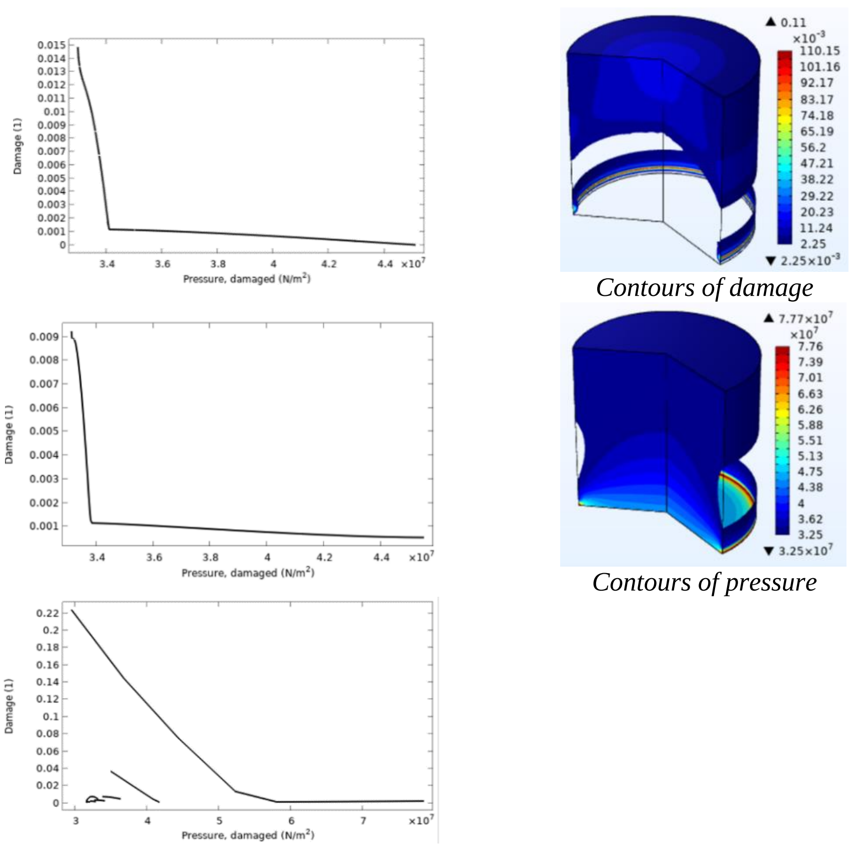



**Figure 3. Graphs of the dependence of damage on pressure under a load on the sample of 0.1 MPa: A-C – measurement schemes.**

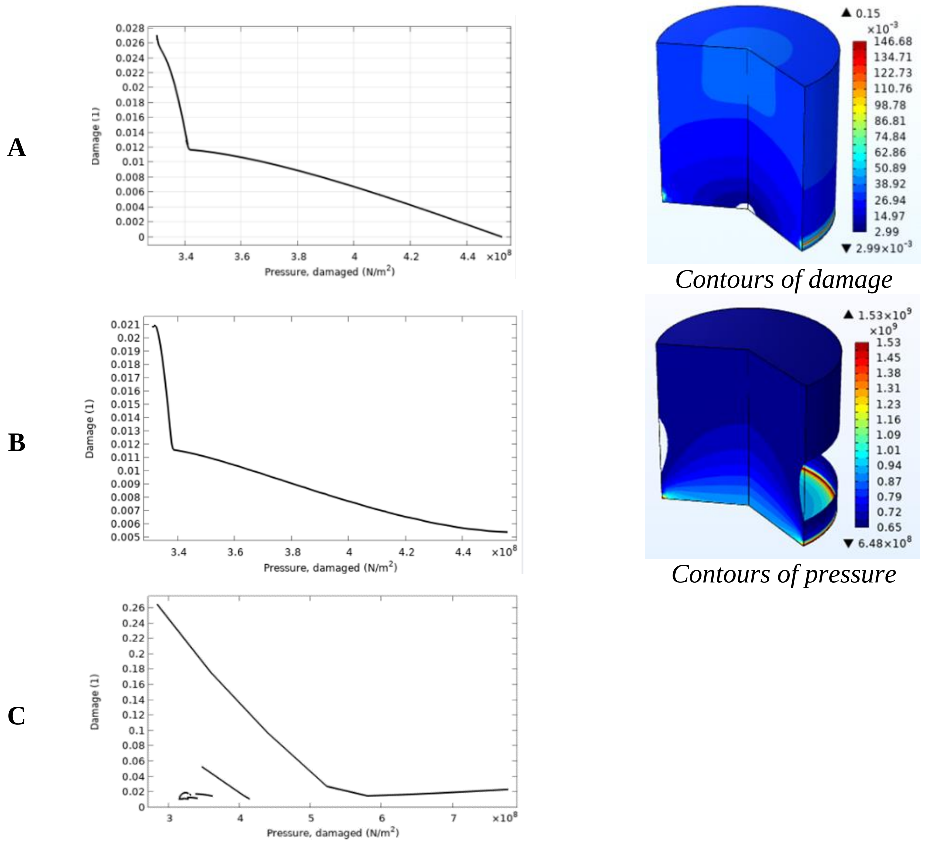



**Figure 4. Graphs of the dependence of damage on pressure under a load on the sample of 2 MPa: A-C – measurement schemes.**

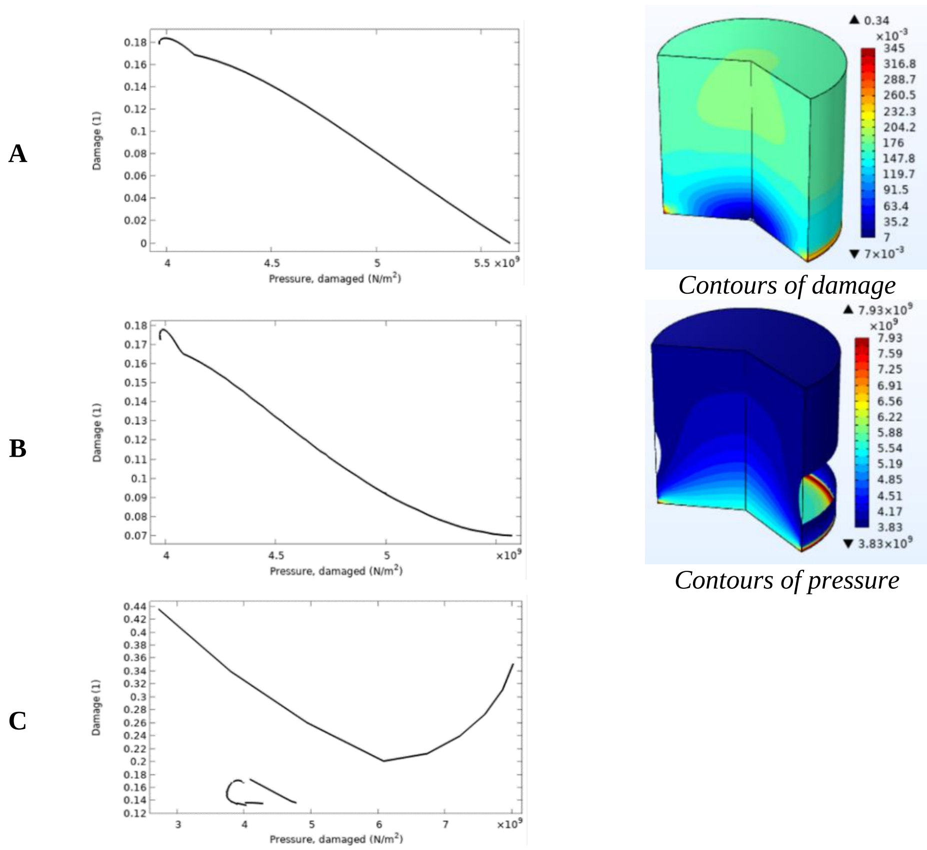



**Figure 5. Graphs of the dependence of damage on pressure under a load on the sample of 12 MPa: A-C – measurement schemes.**

A

B

C

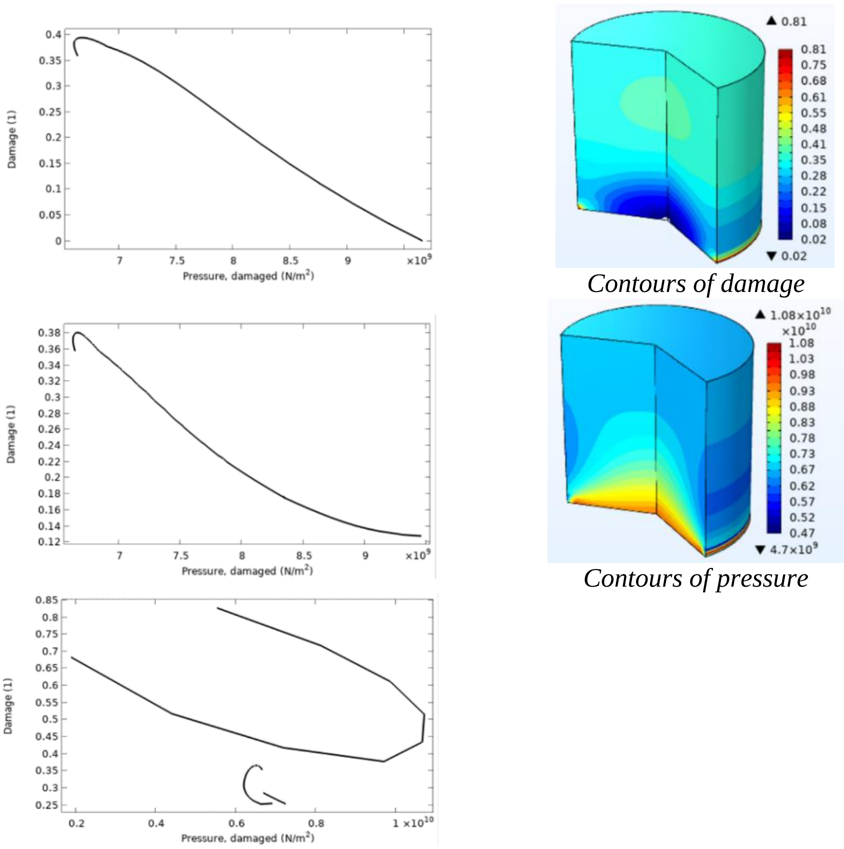



**Figure 6. Graphs of the dependence of damage on pressure under a load on the sample of 20 MPa: A-C – measurement schemes.**

A

B

C

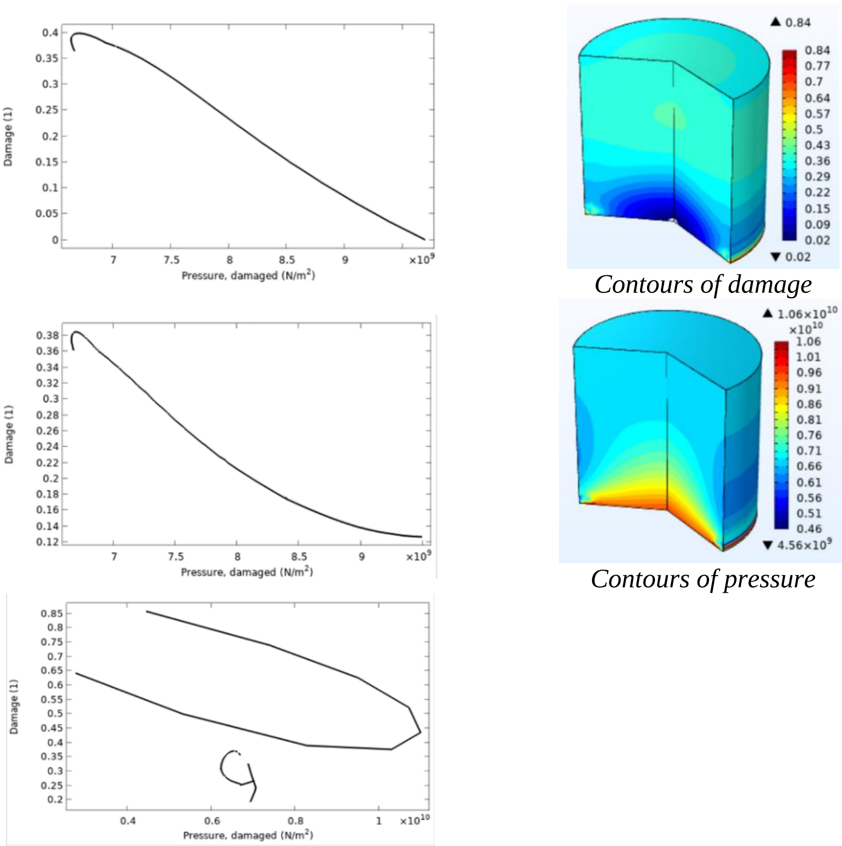



**Figure 7. Graphs of the dependence of damage on pressure under a load on the sample of 20.1 MPa: A-C – measurement schemes.**

**4. Conclusion**

Thus, based on the analysis of the computer modeling results, the following conclusions can be drawn:

1. The greatest deformation of concrete is observed in the area of surface layers of the loaded sample. The measured volume of concrete along the axial line of the sample and according to scheme No. 2 is subject to less deformation (approximately two times, relative to the data obtained according to the third measurement scheme).

2. Based on the color contours on the concrete model, it was determined that the greatest intensity of damage of materials was noted in the volume located in the upper part of the sample along the axial line. Pressure in the material increases at the lower part of the sample.

3. According to the constructed dependencies, it was noted that in concrete volumes (the first and second measurement schemes), the value of the damage coefficient decreases with increasing pressure. According to the third measurement scheme and with significant compressive forces on the sample, the damage coefficient can reach high values at lower pressure values in the material.

**References:**


1. Talaat, A., Emad, A., Tarek, A., Masbouba, M., Essam, A., & Kohail, M. (2021). Factors affecting the results of concrete compression testing: A review. *Ain Shams Engineering Journal*, Volume 12, Issue 1, 205-221.
2. Yiqiang, L. I., Xinmin, W., & Shitong, C. (2005). Comparison of stress-strain curves for concrete under uniaxial stresses. *Journal of Highway and Transportation Research and Development*, 22(10), 75-78.
3. Bongers, H. (1998). Multilevel analysis of concrete in multiaxial compression. *Computational Modelling of Concrete Structures*, 347-354.
4. Kampmann, R. (2012). The influence of the compression interface on the failure behavior and size effect of concrete. *Florida State Univ*., 53 (95), 45-52.
5. Haeri, H. (2015). Propagation mechanism of neighboring cracks in rock-like cylindrical specimens under uniaxial compression. *Journal of Mining Science*, 51(3), 487-496.
6. Lian, C. Q., Yan, Z. G., & Beecham, S. (2011a). Modelling pervious concrete under compression loading a discrete element approach. *Advanced Materials Research*, 168-170, 1590-1600.
7. Lian, C., Zhuge, Y., & Beecham, S. (2011b). Numerical simulation of the mechanical behaviour of porous concrete. *Engineering Computations*, 28(8), 984-1002.
8. Brara, A., Camborde, F., Klepaczko, J. R., & Mariotti, C. (2001). Experimental and numerical study of concrete at high strain rates in tension. *Mechanics of Materials*, 33(1), 33-45.
9. Ren, J., Tian, Z., & Bu, J. (2018). Simulating Tensile and Compressive Failure Process of Concrete with a User-defined Bonded-Particle Model. *Int. J. Concr. Struct. Mater*., 12, 56.
10. Azevedo, N. M., Lemos, J. V., & Almeida, J. R. (2010). A discrete particle model for reinforced concrete fracture analysis. *Structural Engineering and Mechanics*, 36, 343-361.