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Issue Article

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SAFETY MARGIN OF BRITTLE MATERIALS DURING COMPRESSION DEFORMATION

***Abstract**: The degree of safety margin of tool steel, gray cast iron, wood, concrete, glass, brick under the influence of various compressive loads was analyzed in the article.*

***Key words**: compression, safety margin factor, load, sample.*
***Language**: English*

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Introduction

The strength of brittle materials is determined by applying a compressive load and fixing the degree of deformation of the material. The compression test protocol is described in [1]. Since various brittle materials are subjected to loading in this study, the following documents are used to perform compression tests [2-10]. The aim of the study is to determine the safety margin for some metallic and non-metallic brittle materials in the form of a factor to predict the degree of deformation of the material and its destruction when a given force is applied.

Materials and methods

The calculation of the safety factor values was carried out by computer modeling in a special program. A series of compression tests of the cylindrical sample model was performed (the diameter and height of the sample were assumed to be 15 mm each). The samples were given the properties of the following brittle materials: ceramic brick (GOST 530-2012), K1 cobalt (GOST 123-2008), modified wood (GOST 9629-81), M1 glass (GOST R 54170-2010), G51320 tool steel, EN-GJL-200 (GOST 1412-85) and D1000 cellular concrete (GOST 25485-89). The following loads were applied to the sample model: 1000 N, 10000 N, 25000 N, 50000 N and 100000 N.

Results and discussion

After the experiment, the minimum calculated values of the safety margin factor of material of the deformed samples were analyzed. The calculated values of the factors were processed and presented graphically in the Fig. 1.

The range of values of the calculated safety margin factor was from 0 to 10, where 10 characterizes the maximum strength of the deformed material. According to the results of the experiment, it can be noted that the margin of safety of the considered brittle materials decreases with an increase in the applied load. At the same time, ceramic bricks have the least margin of safety, which can be destructed under low compressive loads. K1 cobalt has a high safety factor. When loading a sample made of K1 cobalt with a compressive force of up to 20000 N, the material is not subjected to irreversible deformations. Metal alloys (G51320 tool steel and EN-GJL-200) have the same safety factor values. Wood and cellular concrete have small safety margin factor. In the load range from 1000 to 15000 N, the safety margin of these materials decreases from 10 to 1.

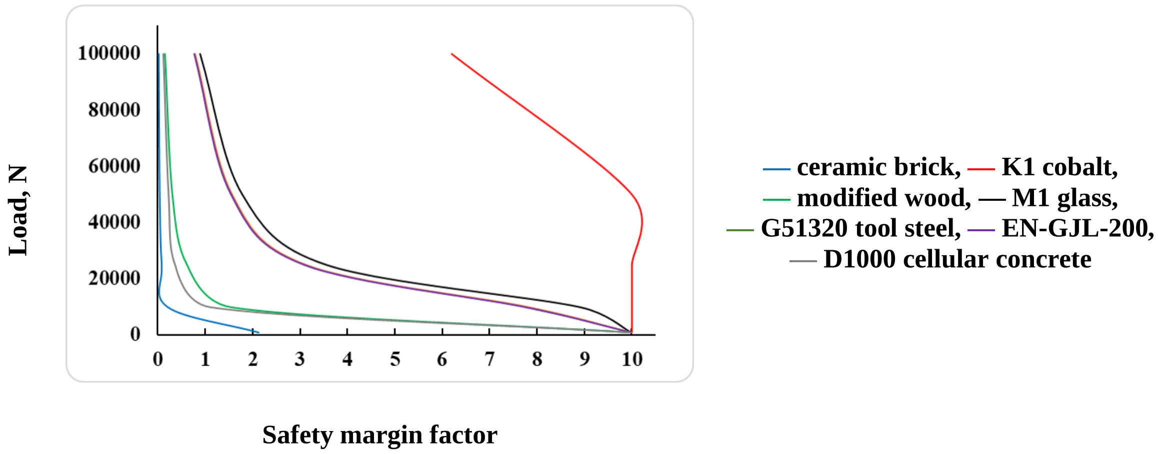

Figure 1. The dependence of the change in the value of the safety margin factor of various materials on the value of the applied load in the conditions of testing samples for compression.

Conclusion

Thus, on the basis of computer compression tests of brittle materials, calculated values of the safety margin factor were obtained. Under various scenarios of material loading, the deformation characteristics of the samples are graphically displayed. K1 cobalt has a high compressive strength (the safety margin factor is 6 at a load of 100000 N). On the other hand, materials such as ceramic bricks, modified wood and D1000 cellular concrete will undergo predicted partial destruction under low compressive loads.

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