Using the obtained results we are able to derive the chart of stress σ_1 [MPa] as a function of strain ε_1 [%]. Maximum stress was measured at approximately ε=2%, while the test was finished in the moment when total strain exceeded 5%. Simultaneously, it was easy to observe sharp increase of strains with almost steady stress factor. To paraphrase, deformation rises significantly without changes of force acting on a specimen. In the first phase of the uniaxial compressive test we can witness an almost-linear relation between stress and strain. That enables us to use approximation between two points and obtain linear modulus (also known as a Young's modulus) *E* [MPa] by means of the relation (1):

$$E = \frac{\Delta\sigma_1}{\Delta\varepsilon_1} \tag{1}$$

where: $\Delta\sigma_1$ – difference between stresses for two subsequent points [MPa]

$\Delta\varepsilon_1$ – associated difference in strains for the same points [%]

2.1 Succession of soil and soil-cement composite testing procedures

Preliminary tests were focused on proper control of soil parameters before its mixing with cement binder. The water content (Figure 1) and amount of organic parts in dry mass (Figure 2) were examined for proper classification of soil.

Fig. 1. Control of sample moisture content

Fig. 2. Testing of organic parts amount

The results of soil testing were juxtaposed in Table 2.

Table 2. Basic geotechnical information about the ground under study.

Soil Type	Natural Peat	
Amount of organic parts in dry mass [%]	5.5% – 8.3%	Average: 6,5%
Water content [%]	37.4% – 56.2 %	Average: 47,7 %

A typical specimen for that kind of testing is cubic: 15×15×15 cm. The area of the compressed edge is then 0,0225 m^2. The whole process of forming a specimen consists of several steps. We have to prepare necessary equipment which is: a large bucket, scales, empty forms and a mixing machine. Components of the mixture are: mixed soil and cement. Having scaled the ingredients, we put them into the bucket. All components are to be mechanically mixed to ensure a clear and uniform structure of final soil-cement material. According to former experience [6,7], the mixing process should take roughly from five up to ten minutes.

It is important that after adding the binder we must finish the whole process within 20-30 minutes, so as not to let the soil-cement mixture to harden too much. Having reached the aimed uniform structure and properties of the material, we start filling the previously prepared standard forms. These are made of plastic forms of internal size 15×15×15 cm. The upper surface of the material is leveled by means of a trowel. This activity is needed to ensure a flat surface of all sides. It is essential that every test specimen is prepared in the same way (with regard to the expected cement content) so the final results are reliable and comparable. Over 150 cubic samples were prepared altogether for UCT procedures, 148 samples were successfully tested. The binder used for the production of all DSM dry composite was standard cement CEM IIIA 32.5 N/LH/HSR/NA that exhibits the strength circa 22.0 MPa only after 7 days. After completion of sample preparation it is just the matter of time to use them in the uniaxial compressive test.

2.2 Methodology of uniaxial compression test (UCT)

The tests were conducted for a constant displacement with the velocity of 0.01 mm/s, in a controlled temperature of 20°C ± 3°C. The uniaxial compression strength tests of the cubic cement-soil samples were carried out in the PROETI mechanic press Figure 3 and Figure 4, synchronized with a computer recording: the time elapsed since test beginning, the axial force loading the sample, the axial displacement of the press piston (the reduction of the sample's length in the axial direction). Strain-stress charts for exemplary samples with determining compression strength and elastic modulus, are given on Figure 5 and Figure 6.

Fig. 3. and **Fig. 4.** Observed modes of failure mechanism in compression testing

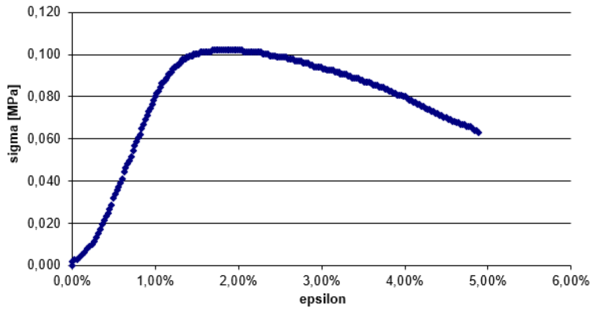

Fig. 5. Strain-stress chart. Sample from group 1, stored for 7 days. Derived uniaxial compression strength is, $R_c = 0{,}102$ MPa.

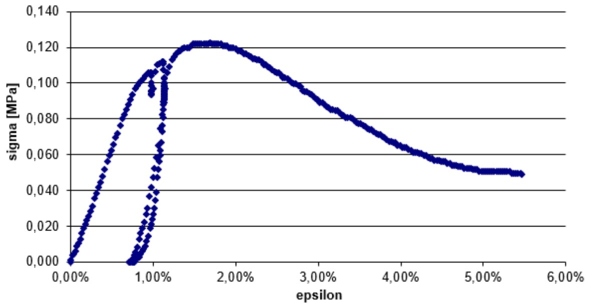

Fig.6. Strain-stress chart Sample from group 1, stored for 14 days. Derived uniaxial compression strength is, $R_c = 0{,}122$ MPa. Derived elastic modulus is,
$E_2 = 30{,}08$ MPa.

3. Uniaxial compression testing results on cubic samples for subsequent groups of samples

Low strength measurements of soil-cement formed in peats confirms the tests previously conducted by Jendrysik [4] and Kiecana [5]. The long time necessary to attain the maximum strength proves that it is desirable to take into consideration the plan of quality control of the material from which the columns are formed. The test carried out after 28 days may be unreliable (the results may be significantly underrated). The observed decreases in the samples' strength examined after 3 months are also alarming. They point to the degradation of the cement-organic material even if there are no external corrosive factors. The test samples were stored in a humid environment, humus-acid free, which would be the situation of an actual column formed in hydrated peats.

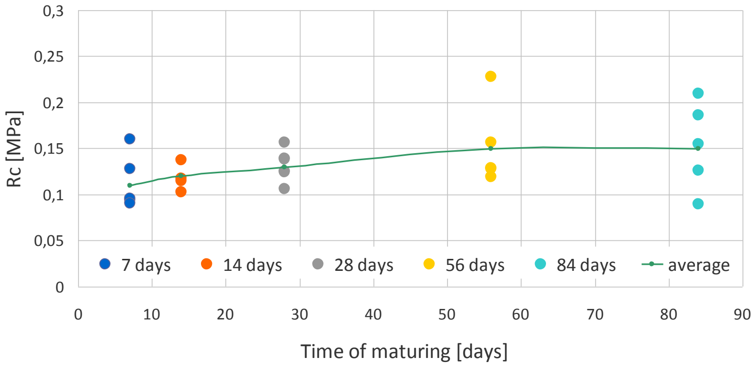

Fig. 7. Increase of measured compressive strength in time throughout testing program – group 1

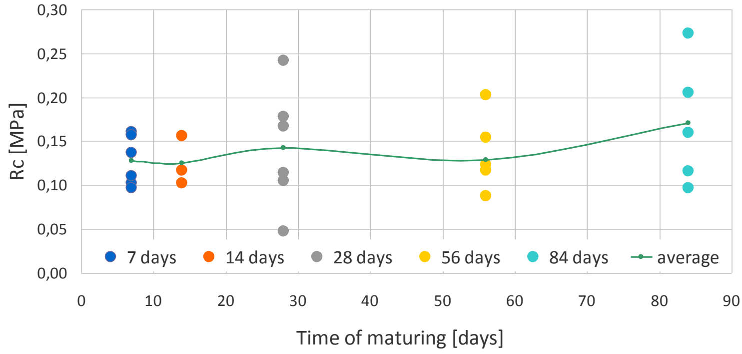

Fig. 8. Increase of measured compressive strength in time throughout testing program – group 2

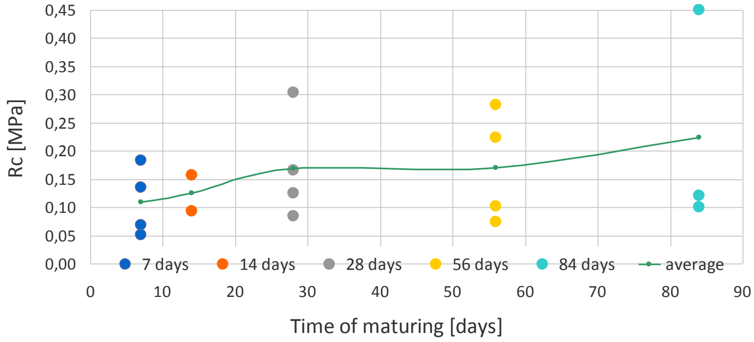

Fig. 9. Increase of measured compressive strength in time throughout testing program – group 3

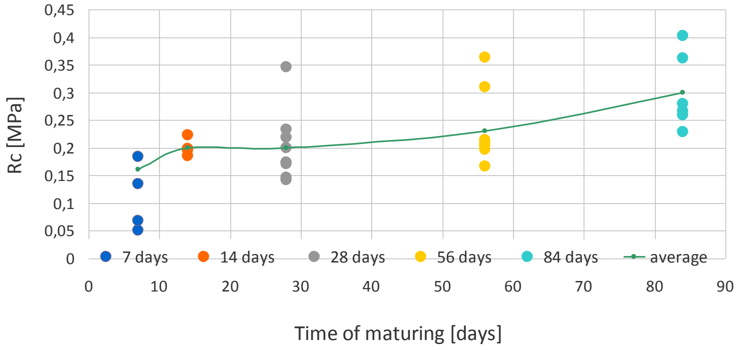

Fig. 10. Increase of measured compressive strength in time throughout testing program – group 4

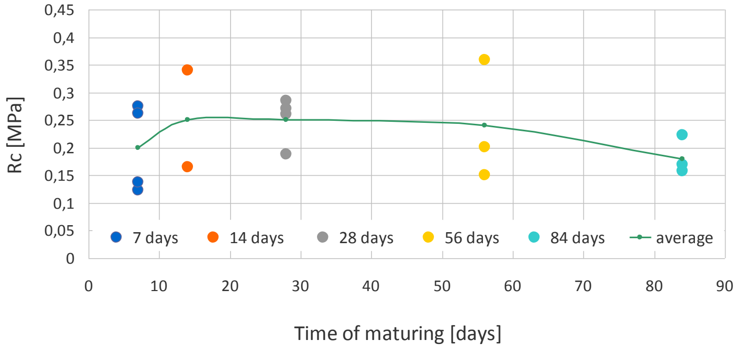

Fig. 11. Increase of measured compressive strength in time throughout testing program – group 5

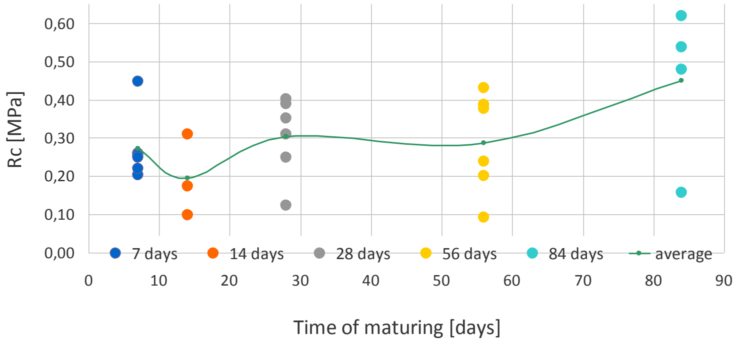

Fig. 12. Increase of measured compressive strength in time throughout testing program – group 6

4. Statistic analyses of obtained results

As the numbers of samples were similar for all the groups, it was possible to check whether the histogram of the obtained compressive strength results would fit into the well-known shape of normal (Gaussian) distribution. Standard deviation of results σ for each group was computed. On the basis of those results it was possible to state that 64% of the results are within $\pm 1\sigma$ margin around the mean value. No less than 87% is fitted within $\pm 2\sigma$ margin around the mean value. Theoretical values are 66% and 95%, respectively.

Histogram of compressive strength distribution is given on Figure 13 below.

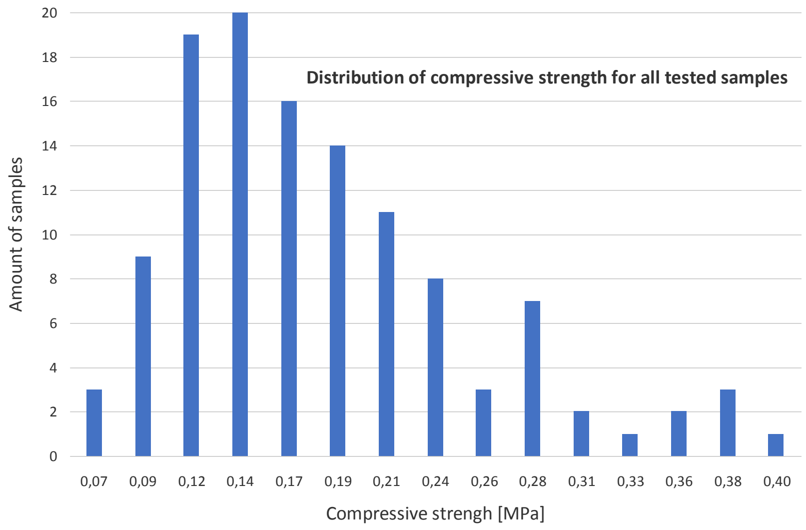

Fig. 13. Histogram of compressive strength distribution for the tested samples

The above presented analysis confirms that, at least for the range of performed test, the results should not be represented by means of normal distribution. Topolnicki in work [2] suggests to use the lognormal distribution. Previous studies with the DSM wet methods confirmed relatively uniform structure of samples and very law number of outliers between results. Large diversity of current study results was probably caused by a relatively law uniformity of manufactured samples due to their various weight – the average weight of the samples was 5kg ± 0,7kg. The weight of the samples varied 14% from the mean value. The heavier samples tend to be stronger and provide higher stiffness for all of performed test.

The values of the mode of destruction, presented on Figure 3 and Figure 4, do not differ much from each other and from the ones found in formerly reported studies [8-13].

5. Conclusions and final remarks

Maximum capacities in most of the cases were gained after 56 days since the composite production. The strength gain should be tested for a longer time period, because the impact of environmental conditions might be diminishing for the composite capacity. The optimal way of improving the reliability of DSM dry method would be the compaction at early stage of setting (increasing density), early over-consolidation and possible inclusions of granular mineral material – preferably sand, gravel or thin particles from demolition works [17].

The increasing amount of cementitious binder may also solve the problem; however current need for sustainable constructions [18] poses serious questions over that solution due to high carbon dioxide footprint.

Results of the current study formed the basis for Eng. diploma thesis of the author - special thanks are addressed to dr Jarosław Rybak who supervised it. The current study is a part of research grant no. 45WB/0001/17 – “Industrialized construction process (construction 4.0)”

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