

ANALYSIS OF THE CORRELATION BETWEEN MODIFIED SECONDARY AND PRIMARY COMPRESSION INDEX ON THE EXAMPLE OF OLD MUNICIPAL WASTE IN SERBIA



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INTRODUCTION

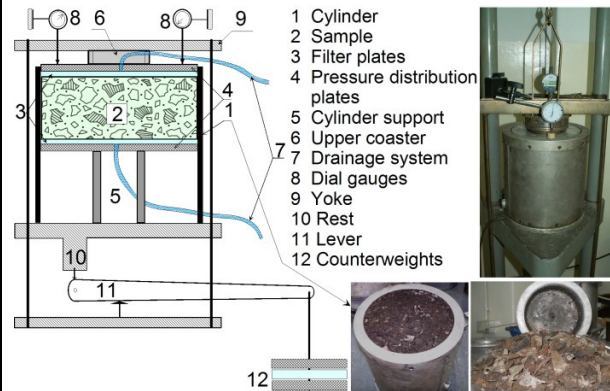
Determining numerical indicators of mechanical behaviour of municipal waste is quite complex, and the main reasons for this are: variable and heterogeneous composition of waste which is porous and mostly unsaturated, difficult taking and testing of representative samples, lack of generally accepted sampling and testing methodology, pronounced changes in properties depending on time i.e. stage of waste decomposition, etc. For the determination of compressibility parameters of municipal solid waste, the most usually used laboratory test is the one-dimensional test with oedometer apparatus, or the monitoring of waste settlements is performed at landfills. Test results are usually presented according to the compressibility parameters: primary compression index C_c and secondary compression index C_{α} , apropos the modified index of primary C_c' and the modified index of secondary compression C_{α}' .

SAMPLE SELECTION

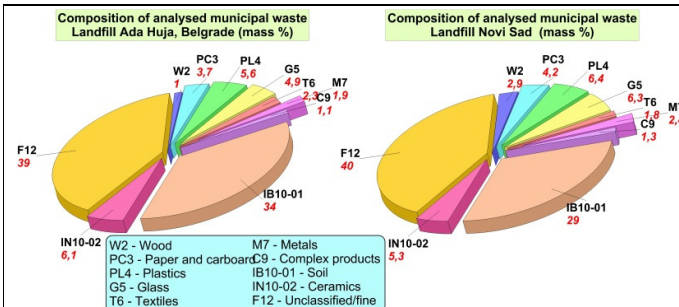
Laboratory tests were performed on municipal solid wastes of different ages, which were taken from two landfills in Serbia (active landfill in Novi Sad and closed landfill Ada Huja in Belgrade) by exploratory drilling and by digging of exploratory pits. After defining the composition, sorting of waste was performed according to the partially modified procedure. Tests were performed on artificially prepared samples, taking into account humidity, compaction, percentage content and form of individual waste components. The material was previously homogenised, mixed and fragmented to ensure an adequate ratio of particle size distribution, i.e. ratio of the characteristic apparatus dimension (L) and size of fractions (d), $L/d \geq 5$. According to these conditions and characteristics of municipal solid waste, tests were carried out using an oedometer apparatus with diameter of $\varnothing 20$ cm and height of 20 cm. Samples with height of 8 cm were installed in it, by raising the support in the cylinder, i.e. moving the lower surface for the load. In this way samples were formed in three series (A, B and C). The waste from the landfill Ada Huja (age over 40 years) was used for the series A (4 samples), and the waste from the landfill in Novi Sad (age about 20 years) was used for the series B (4 samples). One sample was formed for the series C from mixed waste from two landfills (Ada Huja and Novi Sad). For all three series, samples were formed with different unit weights γ and with natural moistures w (Table), which are typical for most landfills which contain a higher percentage of soil.



The applied procedure of municipal waste classification



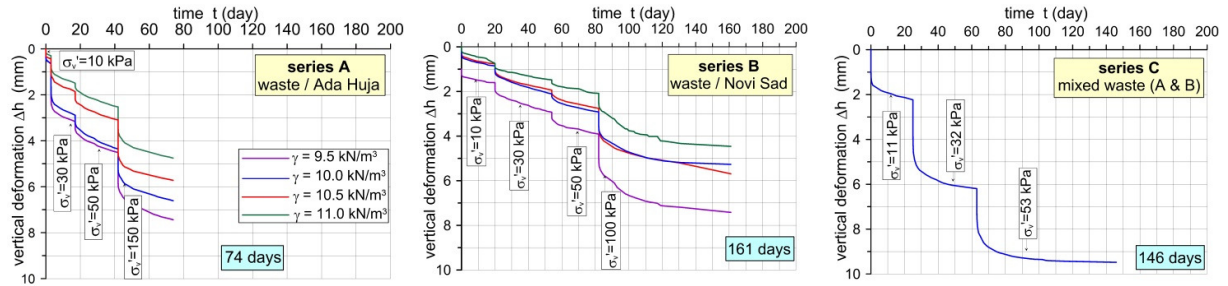
Construction of oedometer apparatus



Series	Sample labels	w (%)	γ (kN/m ³)	G_s	e_0
A	U-1	27.5	9.5	2.20	1.952
	U-2	39.1	10.0		2.060
	U-3	37.5	10.5		1.882
	U-4	30.7	11.0		1.614
B	U-5	39.9	9.5	2.00	1.944
	U-6	39.9	10.0		1.798
	U-7	42.9	10.5		1.722
	U-8	40.7	11.0		1.559
C	U-9	30.8	10.0	2.05	1.676

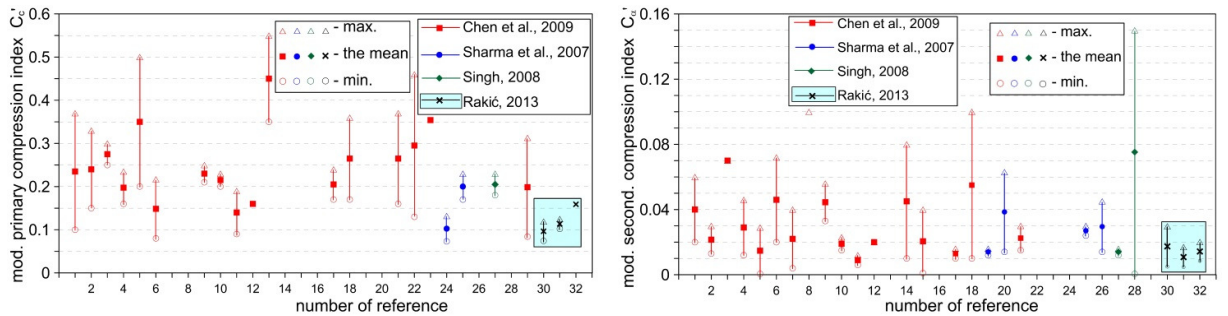
TESTING PROCEDURE

For the determination of the void ratio e_0 , the specific gravities G_s were adopted which were determined by using the expression which contains content of organic substances. Also, specific gravity was determined by laboratory test using completely automated pycnometer AccuPyc 1330. The obtained specific gravity values ranged from $G_s=1.977$ to 2.390 , and the highest values were obtained for waste samples with the highest soil material content, and the average values were adopted depending on the location. For all samples, loads were applied stepwise and the following values of vertical stresses were selected: 10-30-50-150 kPa (100 kPa for series B) which were constantly maintained. Total duration of the test for samples of the series A was 74 days, for samples of the series B was 161 days, and series C 146 days. Load durations differed from grade to grade and from sample to sample, and ranged from a minimum of 3 days for the series A ($\sigma'_v=10$ kPa), to a maximum of 83 days for the sample of the series C ($\sigma'_v=53$ kPa). At the end of the last load level, short-term unloading were performed for 10 min, as follows: 50-30-10-0 kPa, or: 32-11-0 kPa for sample of the series C.

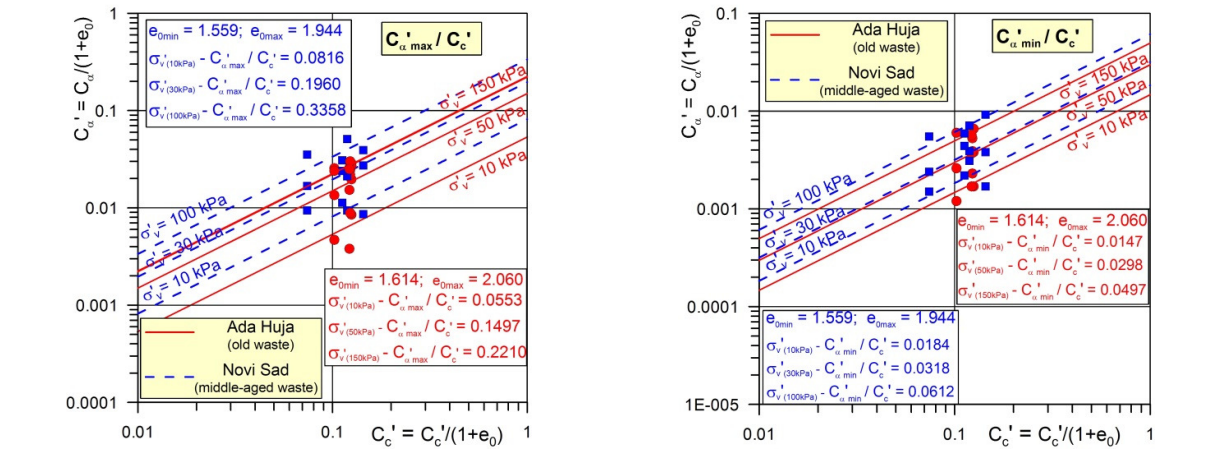


TEST RESULTS

Index and modified index of secondary compression were determined for all load steps, particularly for less steep and steeper parts of the curve. Considering the nature of deformations, its minimal values $C_{\alpha \min}$ and $C_{\alpha' \min}$ were determined from the less steep part of the diagram, while from the steeper part of the diagram, the maximal values $C_{\alpha \max}$ and $C_{\alpha' \max}$ were determined.



Determining the compressibility parameters of municipal waste requires long-term laboratory tests. Since the primary compression in municipal waste lasts significantly shorter, compared to the secondary, by establishing the relationship between these two parameters, the test time could be significantly shortened. As the values of the modified primary compression index C'_c were determined for all tested samples, it made it possible to establish their correlation depending on the applied vertical stresses ($\sigma'_v = 30, 50, 100-150$ kPa).



CONCLUSION

The tests presented in the paper (performed in a period of 74 - 161 days depending on the series of tests), allowed to establish a correlation between the modified index of primary and min and max modified secondary compression indices. The results are presented graphically in the form of logarithmic diagrams, which can be useful for obtaining the approximate values of the indices $C'_{\alpha \min}$ and $C'_{\alpha \max}$, for a significantly shorter duration of the experiment.