INVESTIGATION OF TOPSOIL
OF THE HISTORICAL-CULTURAL LAND PARCEL
“JEWISH CEMETERY”

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1. Task of field investigations of soils of the historical-cultural land parcel "Jewish cemetery"

The studying of mutual relations of tree-bush vegetation and topsoil is a necessary condition of the most rational use of soil fertility for satisfaction of the needs in recreational functions of different objects.

In this connection the reasonable scientific planning and realization of economic measures require preliminary implementation of the complex of soil investigations.

Soil investigation is an inalienable part of park arrangement, planning of economic measures and works relating to reconstruction and preservation of historical objects, namely the ancient Jewish cemetery.

Main tasks of soil investigation implementation at this object are:

- laying and description of soil profiles;
- soil sampling;
- determination of physical-mechanical and chemical soil properties;
- determination of influence of edaphic factor and vegetation cover of the park;
- determination of degree of soil impairment caused by anthropogenic influence at the "Jewish cemetery".

2. Preparatory period of field investigations

Preparatory period of field investigations of the "Jewish cemetery" includes:

- getting to know the object of investigation, exising cartographic material,
- getting to know conditions of soil formation on the territory of the cemetery.

- studying of materials of investigation of geological structure and soil forming rocks;
- influence of human economic activity on topsoil of the cemetery;
- selection of place for soil trenches laying.

3. Methodology of soil profile laying

Since, according to the national traditions it is forbidden to dig on the territory of a cemetery deeper than 20 cm, we have confined our investigations only to upper strata.

Soil trenches have been made in the following directions: the north, the east, the south, the west, from the higher part of the cemetery to the lower part of the slopes.

Natural vegetation, character and degree of anthropogenic influence on the soil and erosion processes were considered.

The main wall of a trench has been oriented with consideration of free access to it and its lighting. The trench was 30-40 cm, wide 20 cm deep. Soil mass was thrown off only sideward with purpose of bedding preservation on the place of a profile section. For description of top stratum a profile was prepared by top-down cleanup of its main wall.

Description of a trench was implemented according to top genetic stratum and morphological criteria including the following:

- determination of name and indices of a stratum;
- measurement of a stratum thickness;
- morphological description of genetic stratum.

The taxonomic evaluation of genetic stratum was done on the base of the description of soil trenches of profile.

Description of genetic strata was implemented using data of description of bedding and top stratum.

Characteristic of bedding was described in the following order: composition (litter characteristic, of what and what types it is composed), colour, thickness, presence of fungi hyphaes, relation with moisture, and junction to mineral part of soil.

Description of mineral stratum includes: colour, structure, thickness, porosity, fissuring, mechanical composition, new formations, inclusions, relation with moisture, and junction to next stratum.

After morphological description of soil trench the samples of soil have been taken for the following laboratorial analysis. Sampling was made from the most typical parts of each genetic stratum selected during the description.

Sampling was implemented at the depth of up to 20 cm. Weight of selected sample was not less than 500 grams.

Type of soil was determined according to geographical location and phytometer spectrum.

4. Characteristic of litter and forest bedding of the "Jewish cemetery".

Exposition, slope gradient and soil conditions have direct influences on decomposition of litter and formation of bedding on the cemetery. Decomposition of litter and forest bedding causes creation of mineral compounds of nitrogen, phosphorus, potassium and other elements which are the basis of plant nutrition. In bedding as well as in soil the process of protein decomposition run out by ammonia-fixation i.e. creation of ammonia salines (in most cases they are accessible for plants) is noticeable and a whole range of microbiological processes of nitric metabolism is implemented.

Thickness of the bedding on the territory of the "Jewish cemetery" fluctuates from 1 till 5 cm that corresponds to 2-5-year quantity of litter according to the weight.

Characteristic of the park bedding is shown in table 4.1.

Table 4.1. Characteristic of the bedding on the territory of the “Jewish cemetery”

Number	Thickness	Characteristic
1	2 cm.	bedding, soft; consists of litter and remains of grass, wood kinds of maple, ash; friable, fresh; junction to mineral stratum is abrupt.
2	5 cm.	bedding, consists of litter and remains of kinds of maple, nut-tree, willow, elder, guelder-rose; grey-brown, friable, fresh; junction to mineral stratum is abrupt.
3	3 cm.	bedding, consists of litter of grasses; brown, friable, fresh; junction to mineral stratum is abrupt.
4	4 cm.	bedding, consists of litter and remains of trees and bushes of maple, pear-tree, hornbeam, elder; brown, friable, fresh; junction to mineral stratum is abrupt.
5	2 cm.	bedding, consists of litter and remains of trees and grasses of oak, apple tree, Norway maple; brown, friable, dry; junction to mineral stratum is abrupt.
6	4 cm.	bedding, consists of litter and remains of wood vegetation of maple, nut-tree, pear-tree, plum-tree, apple-tree; brown, friable, dry; junction to mineral stratum is abrupt.
7	4 cm.	bedding, swarding, consists of litter and remains of grasses Filipendula vugaris, Stenactis annua, common goldilocks, Hipericum perforatum, Enigeronica Canadensis; mink, fresh; junction to mineral stratum is abrupt.

8	4 cm.	bedding, consists of litter and remains of grasses Filipendula vugaris, Stenactis annua, common goldilocks, Hipericum perforatum, Enigeronica Canadensis; brown, friable, fresh; junction to mineral stratum is abrupt.
9	3 cm.	bedding, consists of litter and remains of grasses Filipendula vugaris, Stenactis annua, common goldilocks, Hypericum perforatum, Enigeronica Canadensis; brown, friable, fresh; junction to mineral stratum is abrupt.
10	2 cm.	bedding, consists of litter and remains of trees Norway maple, willow, hornbeam; brown, friable, fresh; junction to mineral stratum is abrupt.

5. Topsoil on territory of the cemetery

Research of topsoil on this territory was implemented on four transects: north, east, south and west.

The scheme of location of the soil trenches on the cemetery territory relatively to corners of the earth is shown on the fig. 1. In general 10 soil trenches, were created namely 3 soil profiles on the slope of the northern side, 1 on the slope of the eastern side, 3 on the slope of the southern side and 3 soil profiles on the slope of the west side.

Structure and morphology of soil profiles of the cemetery are presented in the tables 4.5.1, and detailed description of the litter and genetic mineral strata is shown in the figures 4.5.1.

Table 2. Morphology of soils of the “Jewish cemetery”

East direction
Thickness of the profile according to strata, cm.

	Profile numbers	
	1	10
Name and thickness of soil strata	H_0 (0-2)	H_0 (0-2)
	He (2-17)	He (2-20)
Name of soil	Light-grey forest soil	Grey forest soil

Sample 1

East slope of the “Jewish cemetery” territory.
Trees –
Bushes – elder.
Underbrush is absent.
Grass covering at the moment of research is practically absent.

H_0 (0-2) – bedding is soft, consists of litter and remains of trees, friable, fresh, junction to mineral stratum is abrupt.

He (2-17) – soil is humus with light features of scavenging, grey, granular, friable, thinly fissured, light loamy sand, roots of grasses and trees, fresh, junction to mineral stratum is gradual.

6. Methodology of soil samples investigation.

Soil density (volume weight)

Soil density was determined as a ratio of soil weight to its volume, determined in inviolate natural porosity (*Vi.n.p.*):

$$d1 = \frac{m}{Vi.n.p.} \text{ g/cm}^3; \qquad Vi.n.p. = Vs. + V p.;$$

where d_1 – soil density;

m – weight of the sample in absolutely dry state;

$Vp.$ – volume of pores;

$Vs.$ – volume of solids.

Soil density depends mainly on soil porosity and also on the following: vegetation kind; mechanical and mineralogical composition of soil; structuring; tillage degree.

Soil samplings for the following determination of density were implemented by using the appliance of the field laboratory of Litvinov.

Appliances and materials: weighting bottles, exsiccator, appliance of Litvinov, soil cutter, spade, drying oven, scales.

Density of solid phase of soil

We have determined the density of solid phase of soil (d_2) as a ratio of soil weight to total volume of solids. Value of density of soil solid phase depends on mineral composition and content of humus in genetic strata.

For density determination we used well-known method in physics - pycnometer method. This method makes it possible to determine the total volume of solids of soil according to the weight of water displaced by this volume from the pycnometer.

Density of solid phase of soil is determined as:

$$d_2 = \frac{P_1}{P_1 + P_2 - P_3} \quad (g/cm^3)$$

where, P_1 - batch of soil, g,

P_2 – weight of pycnometer with water, g,

P_3 - weight of pycnometer with water and soil, g.

Appliances and materials: pycnometers, funnel, scales, distilled water.

Field moisture

Field moisture of soil is the expression of provision of plants with water and it was determined in percentage terms as a ratio of water weight to the weight of absolutely dry soil.

$$W = \frac{A}{b} x100\%$$

where W – field moisture, %;

A – weight of evaporated water, g;

B – weight of dry soil, g.

Appliances and materials: weighting bottles, exsiccator, appliance of Litvinov, soil cutter, spade, drying oven, scales.

Hygroscopic moisture

Content of hygroscopic moisture (*Wh.*) in percentage terms in relation to the weight of air-dry soil was determined by the formula:

$$Wh = \frac{Pair.d.s - Pabs.d.s.}{Pabs.d.s.} x100\%$$

where, Pair.d.s. – weight of soil in air-dry state;

Pabs.d.s – weight of soil in absolutely dry state.

Content of hygroscopic water in soil depends on the quantity of humus and clay particles within soil and is an indirect characteristic of its mechanical and sometimes chemical composition as well.

Determination of hygroscopic moisture is implemented by thermo-weighting method.

Appliances and materials: weighting bottles, exsiccator, drying oven, scales, drying cups with plug stoppers.

Soil porosity

Total porosity of soil is expressed in percentage terms of its total volume in inviolate state.

Total porosity was calculated on the basis of soil density – d_1 and density of the solid phase of soil – d_2 by using the formula:

$$V = (1 - \frac{d_1}{d_2}) x 100\%$$

Appliances and materials: weighting bottles, exsiccator, appliance of Litvinov, drying oven, pycnometers, funnels, scales, distilled water.

Soil aeration

Methodology of determination of aeration is the action of subtracting volume of pores filled with water (Vw) from total soil porosity (V) and it is calculated according to the formula:

$$Vaer. = V\text{-}Vw. = V\text{-}Wf \cdot d_1$$

where, V – total porosity,

Wf – factual field moisture;

d_1 – soil density.

Aeration shows the ability of soil to retain some quantity of air in certain physical state. Aeration is changeable and passive as its dynamics depends on the mode of soil moisture; when moisture is increasing then aeration is decreasing and vice versa.

Together with aeration the aeration degree is determined in percentage terms in relation to total soil porosity. The egree of aeration is determined by using the formula:

$$Deg.aer. = \frac{Vaer.}{V} x100\%$$

Appliances and materials: weighting bottles, exsiccator, appliance of Litvinov, drying oven, pycnometers, funnels, scales, distilled water.

pH-metry

Principle of the method. Determination of pH of water extract (national standards 27753.3-88) is a top-priority stage of investigation of carbonate and neutral soils. This index is determined by measurements of pH of water suspension or water extract from soil. Actual acidity makes direct influence on development of plants and soil microorganisms. Total error of the method is 0,1 pH.

Apparatus, materials, reagents. For implementation of analysis the following are used:

Universal ion-meter;

Rotator for stirring of soil suspension with frequency of oscillations 75 cycles per minute;

Laboratorial scales of a second class of accuracy;

Metric laboratorial ware;

Conical flasks with volume 250 cm^3;

Chemical cups with volume 100 cm^3;

Distilled water according to national standards 6709-72;

Filter paper according to national standards 12026-76.

Determination of humus using the method of I.Tyurin.

The essence of the method (national standards 26213-91) lies in determination of content of humus substances in soil by means of their wet combustion in hard oxidant - solution of dichromate of potassium in sulfuric acid. Content of humus substances is determined according to the quantity of oxidant used for combustion process.

Apparatus, materials, reagents.

For implementation of analysis the following are used:

Analytical scales;

Sand bath;

Metric laboratorial ware;

Conical flasks with volume 100 cm^3;

Glass funnels according to national standards 25336-82;

Burettes of 2-nd class of accuracy according to national standards 20292-74;

Solution $K_2Cr_2O_7$, 0,4n. in diluted sulfuric acid;

Solution of Mor salt, 0,2n.;

Solution of phenyl-anthranilic acid $C_{13}H_{11}O_2N$.

Distilled water according to national standards 6709-72.

7. Physical-mechanical and chemical properties of soils of the park.

Physical-mechanical properties of topsoil of the cemetery territory are shown in the table 7.1.

Density of top layer of soil ranges within the bounds 0,98 – 1,32 g/cm^3. Type of soil according to density is normal, compacted and strongly compacted. Density of solid phase of soil is from 2,35 till 2,49 g/cm^3.

Field moisture of soil ranges within the bounds 16,01 – 24,12 % and depends on slope exposition and the altitude of sampling. Thus, the upper part of slopes is characterized by less field moisture than the bottom. In this way the obtained results show that samples №5 – 16,01%, №7 – 14,71%, №8 – 16,01% have less porosity in contrast to the west slope (sample №10 – 22,32%), and to the north slope (sample №9 is 22,32%).

General porosity of soil is changing from 43,8% till 59,55%. The least porosity has been fixed in the bottom part of the slope near the cemetery entrance, not far from the path. Aeration degree ranges within the bounds 40,41 – 73,50 %.

Chemical properties of topsoil of the cemetery territory are presented in the table 7.2.

Analysis of results has shown that pH of water extract of all the samples taken exceeds 7 units and ranges within the bounds 6,75-7,7 units. Soils are alkaline and alkalescent.

Percentage content of humus in topsoil of the park does not exceed 3,52% and is decreasing along the profile and in the places where erosion processes are observed. Maximum values of percentage content of humus are fixed in upper strata of soil profile of southern part of the cemetery (sample №4 – He – 3,53 % of humus; №4 – He – 3,49 % of humus). In these places there is grass covering with the most density.

On some slopes the thickness of strata is changing and extraction of parent material on the surface is observed in consequence of erosion processes.

Physical-mechanical properties of topsoil of territory of Jewish cemetery

Table 7.1.

No	d1, soil density, g/cm^3	Soil type according to density	d2, g/cm^3	Field moisture, W, %	Hygroscopic water, Wh	Soil porosity, V %	Soil aeration, Vaer.	Aeration degree, %	Crit. soil moisture, W wither	B, inaccessible
1	1,32	strongly compacted	2,35	18,22	0,125	43,80	19,76	45,11	0,187	4,95
2	1,24	compacted	2,39	16,69	0,227	48,20	27,51	57,08	0,342	8,48
3	1,29	strongly compacted	2,48	17,42	0,189	48,05	25,58	53,23	0,284	7,33
4	1,18	compacted	2,47	24,12	0,272	52,23	23,76	45,50	0,410	9,67
5	1,14	normal	2,42	16,01	0,233	52,83	34,58	65,46	0,351	7,99
6	1,2	compacted	2,47	23,76	0,164	51,37	22,86	44,50	0,247	5,92
7	1,12	normal	2,41	14,71	0,216	53,56	37,08	69,23	0,325	7,27
8	0,98	normal	2,42	16,10	0,319	59,55	43,77	73,50	0,480	9,41
9	1,24	compacted	2,49	22,41	0,208	50,20	22,41	44,64	0,313	7,77
10	1,28	strongly compacted	2,46	22,32	0,166	47,94	19,37	40,41	0,249	6,38

Table 7.2.

Chemical properties of topsoil of territory of Jewish cemetery

Northern direction

No	Stratum index	Stratum, thickness	pH (H_2O)	Humus, %
1	He	2-17	7,35	2,53
2	He	2-20	7,69	3,16
3	He	2-19	6,82	2,98
4	He	2-20	6,75	3,52
5	He	2-20	7,3	2,90
6	He	2-20	7,35	1,99
7	He	3-16	7,5	2,16
8	He	2-20	7,62	3,49
9	He	2-19	7,7	2,86
10	He	2-20	7,67	1,95

List of the questions that had to be elucidated in the report "Investigation of topsoil of the cemetery"

1. Accumulation of the forest bedding in the bottom part of the slope.
2. Anthropogenic influence on distribution of bedding of different parts (slopes) of the cemetery.
3. Even distribution of forest bedding on the inviolate slopes.
4. Initial erosion processes on the slopes.
5. Exposition of root system caused by soil washout. (In case of such an exposition).
6. Anthropogenic influence on distribution of bedding of the south slope.
7. Destruction of the bedding and soil compaction in consequence of intensive anthropogenic load on the slopes. (which slopes?)
8. Washout of genetic strata of topsoil of the cemetery.
9. Inclusions of carbonates and tree roots in mineral strata of soil.
10. Inclusions of remains of construction waste in man-made ground of the cemetery. (In case of such remains).