Urban Construction Waste Dumps

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Abstract. The development of mankind is inextricably linked with the transformation and change in the nature of the use of natural ecosystems, the expansion of the boundaries of nature use, the development of cities and the expansion of urban areas. At the same time, the construction of new buildings is often preceded by the dismantling or demolition of an old dilapidated or morally and/or physically outdated structure. Any construction work is accompanied by the formation of various waste dumps on construction sites. The article proposes a method for determining the depth of penetration of pollutants into the ground together with rainwater, and also analyzes the results of laboratory studies. According to the results of the research, graphs of the dependence of the depth of liquid penetration into the ground depending on the time and height of the column above the ground surface are presented. The obtained graphs allow us to determine the most likely depth of contamination penetration, depending on the size of the rain layer. Removing the polluted layer will allow you to carry out the most effective work on the improvement of the territory. Such measures will reduce the negative impact on the ecosystems of urban areas.

Keywords: Agro-ecology · Agriculture biotechnology · Food process engineering · Biotechnology in food · Construction of agricultural buildings

1 Introduction

In the process of urban development, there is a gradual change in its appearance, replacing outdated worn-out buildings and structures with newer and more modern ones. After the approval of the plan for the reconstruction of the city territory, dismantling works are carried out to demolish buildings and clean up the territory. All dismantled construction waste is temporarily stored on construction sites, and then taken to the landfill [1–4].

The period of waste accumulation varies and can reach several weeks. During this period, there is a partial decomposition or disintegration of waste and its spread over the surface of the soil, as well as penetration into the soil thickness during the rainy period of the year.

The bulk of construction waste consists of the battle of concrete products, the battle of bricks, metal waste, wood waste, plastic, glass, paper and cardboard [5–7], also on construction sites there are waste of bulk construction materials. The percentage of these wastes depends on the types of buildings and structures being demolished, as well as

A. Beskopylny et al. (Eds.): INTERAGROMASH 2022, LNNS 575, pp. 2491–2498, 2023.
https://doi.org/10.1007/978-3-031-21219-2_279

Fig. 1. Dismantling of buildings.

on the type of building material used in the construction of new buildings (Fig. 1). At the end of the work on construction sites, they carry out landscaping works: arrange courtyard roads, parking lots, playgrounds, arrange recreation areas, etc. [8–13].

The smallest particles of construction waste accumulated on the surface of the ground, pollute it. Polluted soil is an unfavorable material for house and children's playgrounds. Therefore, it is important to know the depth of penetration of pollutants to determine the optimal thickness of the soil replacement [14–19].

2 Materials and Methods

For the experiments in the laboratory, a physical model was made (Fig. 2), which allows you to record the depth of penetration of the liquid into the soil thickness. The physical model consists of several plastic pipes with a diameter of 8 cm and a length of 40 sm. The pipes in the lower part are closed and vertically attached to the wall. In each pipe, sand is placed in portions, the size of which corresponds to the average size of the soil of the studied construction sites. Periodically, when falling asleep in the pipe, the sand is compacted, which allows you to achieve a uniform density.

The studies used soil with a particle diameter d in the range of 0.630–0.315 mm and d = 0.315–0.140 mm, as well as sand consisting of a mixture of the abovementioned fractions in equal parts. The filtration coefficient was determined for each of the three types of laboratory soils used:

1. for laboratory soil with d = 0.630–0.315 mm, the filtration coefficient was 4.8 × 10–4 m/s or 4.8 × 10–2 cm/s,
2. for laboratory soil with d = 0.315–0.140 mm, the filtration coefficient was 1.7 × 10–4 m/s or 1.7 × 10–2 cm/s,
3. for laboratory soil with d = 0.630–0.140 mm, the filtration coefficient was 1.1 × 10–4 m/s or 1.1 × 10–2 cm/s.

Fig. 2. Physical model (for the experience).

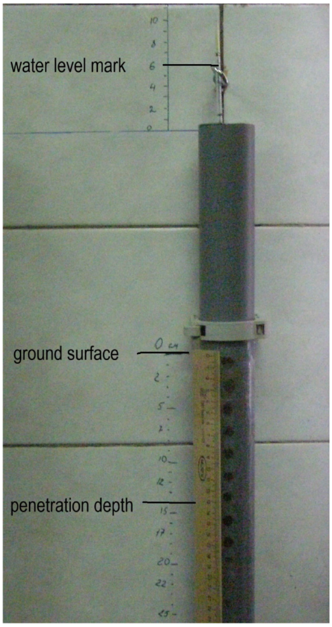

Fig. 3. Physical model (on the right-the final stage of the experience).

To fix the liquid level above the ground surface, a foam float was installed in the pipe with a glass tube inserted into it, on which the zero level was marked. During the studies, the time t of liquid penetration into the liquid at different depths y was determined at different liquid levels above the surface Δ. The experiments were carried out with a liquid layer above the sand equal to 5, 10 and 15 cm (Fig. 3).

3 Results

All data was recorded in the form of a table. Each experiment was conducted in a series (at least 5 times). According to the data, the arithmetic mean penetration depths and the arithmetic mean time were calculated for each series of experiments. The results are presented in Table 1.

Table 1. Average research results.

No. points	Height of the liquid column, cm	Arithmetic mean depth of liquid penetration, cm	Arithmeticmeantime, sec	Diameter of soil particles, mm	Water volume/liquid column height
0	10	0	0	0.63–0.315	200 ml/10 cm
1	9	−5.3	12		
2	8	−9.6	26.6		
3	7	−11.8	41.75		
4	6	−14.5	59.88		
5	5	−17.5	81.25		
6	4	−19.7	103.63		
7	3	−22.8	125.25		
8	2	−24.8	156.13		
9	1	−27.4	181.25		
10	0	−29.7	200.63		
1	5	0.00	0.00	0.315–0.14	100 ml/5 cm
2	4	−2.33	8.44		
3	3	−5.00	16.78		
4	2	−7.22	32.33		
5	1	−9.78	54.44		
6	0	−13.89	94.56		

After processing the results, graphs of the dependence of the penetration depth on the study time were obtained for all the studied $\Delta = 5$, 10 and 15 cm. An example of the obtained graphs for the first type of soil is shown in Fig. 4.

The duration of liquid penetration exceeded the duration of absorption by 30–35%, while the depth of soil wetting increased to 19%. Observations have shown that the higher the height of the layer above the ground, the longer the period of penetration of the liquid deep into the sand.

From the graphs corresponding to the first type of soil, it follows that the higher the height of the liquid layer above the ground, the more intense the initial process of liquid penetration. Thus, at $\Delta = 5$, 10, and 15 cm, the depth $y = 5$ cm was reached in

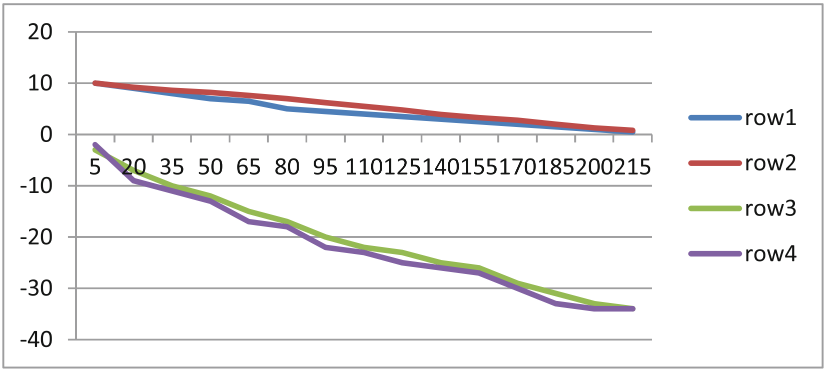

Fig. 4. Dependence of the depth of liquid penetration on time.

17, 12, and 5 s, respectively, and the depth of 10 cm was 47, 28, and 25 s, respectively. The maximum penetration of the liquid into the depth of the ground when the liquid layer above the ground surface is equal to zero for the same Δ was set to 14.6, 29.7 and 44.7 cm in 78, 201 and 332 s, respectively. The maximum penetration of the liquid into the soil thickness will be 14.6, 29.7 and 52.6 cm in 78, 201 and 431 s, respectively. After this time, no further penetration has been recorded.

From the obtained graphs, it follows that the maximum penetration depth increases with an increase in the liquid layer Δ above the ground. The obtained graphs of liquid penetration differ significantly (Fig. 5):

1. at Δ equal to 15 cm, the depth of penetration of the second type of soil is 5% greater than the depth of penetration of the first type, and the depth of penetration of the third type in comparison with the first type of soil - by 19%;
2. at Δ equal to 10 cm, the depth of penetration of the second type of soil is 5% greater than the depth of penetration of the first type, and the depth of penetration of the third type in comparison with the first type of soil - by 18%;
3. at Δ equal to 5 cm, the depth of penetration of the second type of soil is greater than the depth of penetration of the first type by 0.7%, and the depth of penetration of the third type compared to the first type of soil - by 18%.

4 Discussion

Within the framework of laboratory experiments, studies of the process of penetration of pollutants with liquid into the laboratory soil were conducted, which showed the following. The maximum penetration depth for laboratory soil of the first type (with a particle diameter from 0.63 to 0.315 mm) was: at Δ = 5, 10 and 15 cm, respectively, 14.6, 29.7 and 52.6 cm in 78, 201 and 431 s; for laboratory soil of the second type (with a particle diameter from 0.315 to 0.14 mm): at Δ = 5, 10 and 15 cm, respectively, 14.7, 33.3 and 55 cm in 95, 329 and 665 s; for laboratory soil of the third type (with a particle

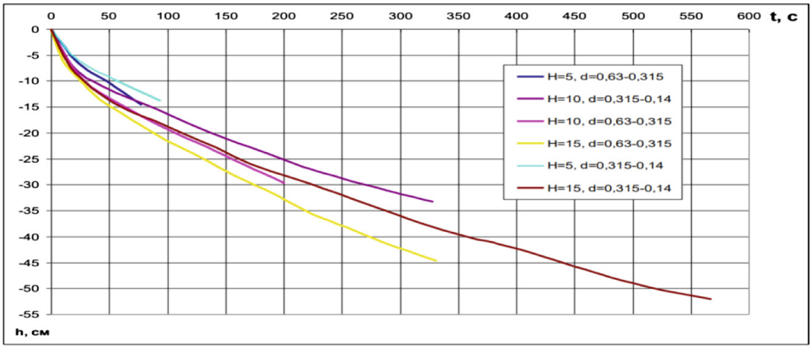

Fig. 5. Averaged graphs of the dependence of the depth of liquid penetration.

diameter from 0.63 to 0.14 mm): at $\Delta = 5$, 10 and 15 cm, respectively, 17.3, 45 and 61 cm in 108, 350 and 720 s.

It is revealed that the depth of liquid penetration depends on the initial liquid layer on the surface Δ and on the porosity of the soil m. The greater the Δ and the lower the m, the greater the depth of penetration of the liquid into the ground. The duration of liquid penetration exceeds the duration of absorption by 30–35%, and the depth of soil wetting increases to 19%.

5 Conclusions

Laboratory studies have shown that the depth of penetration of a liquid that simulates a liquid polluting the soil on a construction site depends on the height of the initial liquid layer on the soil surface and on the filtration coefficient. The maximum depth of liquid penetration corresponds to the soil with a particle diameter from 0.63 to 0.14 mm.

Based on the results of the presented studies, it is possible to determine the maximum depth of penetration of pollutants into the ground for a certain period of time, or to determine the time of penetration of pollutants to a certain depth of the ground, as well as the speed of movement of pollutants at any time. These data will allow us to take the most effective measures to achieve minimization of soil contamination on construction sites during the work, as well as to optimize the improvement of the territory after the work is completed.

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