UDC 504.062

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IMPROVING TECHNOLOGIES FOR PREPARING ROCK SPOIL HEAP SLOPES FOR PLANTING OF GREENERY

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Kolesnikova V. V. **Improving technologies for preparing rock spoil heap slopes for planting of greenery.** – This paper proposes a new method of stabilization of rock spoil heap slopes, which results in savings during the technical stage of revegetation, in particular, during flattening and terracing of slopes in order to achieve stabilization. This method is unique due to its economy, low environmental impact, long-term sustainability and ease of construction.

Key words: stabilization of rock, revegetation, flattening, terracing, achieve stabilization.

Introduction

For over 200 years underground coal extraction has been a common practice in the Donbass region. During the development of deposits, waste rock gets brought up to the surface along with coal. The waste is then stored on the surface as rock-disposal piles of different shape. There are 1185 such sites covering over 7 thousand acres and containing approximately 1.7 billion cubic meters of waste [1].

All this time existed and especially sharply the problem of harmful influence of pedigree dumps costs now on a natural environment, and all this time scientists tried to find the optimal decision of this problem. The evolution of forms of pedigree dumps appeared one of consequences of decision of this question from conical sharp waste banks through the flat benched dumps to landscape building (fig. 1).

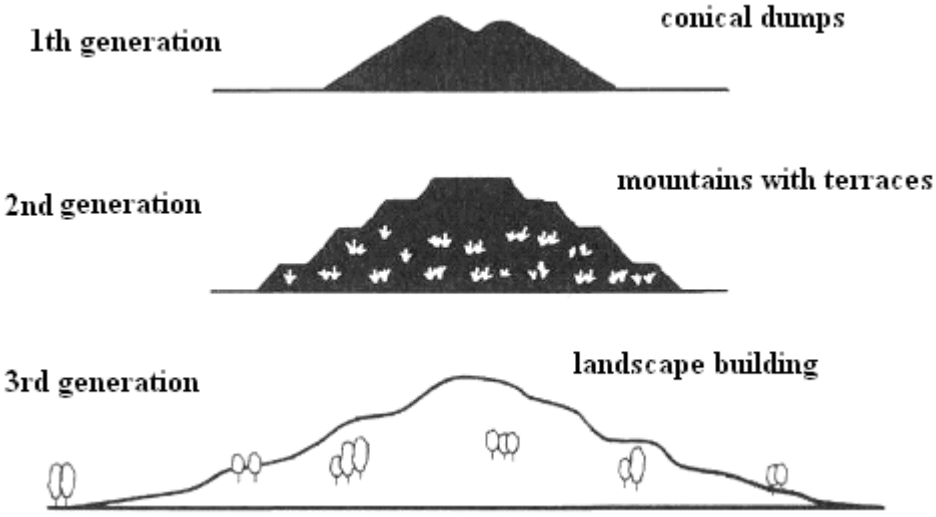

Fig. 1. Evolution of form of dump.

On the first stage of development of the coal mining dumps which have cone-shaped forms caught up on one's the sleep in the world. Through the magnificent pouring they did not hinder to penetration of oxygen inward and that is why felt like spontaneous combustion. Contamination of the inhabited districts smoke, instability of waste banks in time and difficulty of their planting of greenery through the high steepness of slopes, and also erosion is related to it under the action of wind and rain, led to that which was in future from pouring out of such dumps to refuse. Majority from these waste banks were afterwards taken apart in connection with that the burned completely mountain breed found application as building material, and some of them – re-formed in flat pedigree dumps. The rules of pouring out, registrations of steepness of slopes and planting of greenery, were worked out, body of dump described as a

mountain with terraces with strict lines and strict contour. An order pursued in relation to the certain form of dump, first of all, the exception of changes and mobility of the mountain masses.

In Ukraine and flat pedigree dumps catch up on one's the sleep to this day. However in Germany went farther and already at the end of 70th for taking title on further exploitation to the dump decision role, next to the ground of necessary areas under dumps, the consent of mountain enterprise to convert these dumps into landscape building by means of new principles of registration and planting of greenery [2].

In order to restore the environment in mining districts, the Ukrainian Cabinet of Ministers passed Resolution No. 1606 on August 31, 1999, which approved a Framework for improving the ecological condition of said districts. One of the goals of the Framework is the determination of optimal ways and methods of rehabilitating territories where intensive use of subsurface resources took place.

According the Framework and taking into consideration the low tree density of the region, the most advantageous solution to the problem of dust-spreading terricones is phytooptimization (planting of greenery) of the rock spoil heaps.

In recent years the optimization of the rehabilitation of terricones has become much more relevant in connection with restructuring of the coal industry, which is accompanied by closing of unprofitable mines. This process demands implementing of nature protecting arrangements, which are focused on increasing of ecological safety and planting of greenery on mine dumps, in particular.

Furthermore, because of a shortage of available land in the overpopulated region called Donbass an important issue of purposeful use of land, taken for carrying rock spoil heap**,** arouses. Therefore, including of the rock spoil heap territories in composition of natural landscape has to become the main purpose of recultivation of rock spoil heap as soon as possible.

Similar methods are widely used in Germany [2]. Many rock spoil heaps, for example, Grose Holc near Bergkamen or Pattberk in Moerse that is located in a lower course of Rein, are resting places for many residents of that area. One could get rested there, enjoy clean nature, it’s a good place for children to play. The landscape facilities were engineered along with landscape architectures. Some were very skeptical about this project, but there are many supporters among residents nowadays. Before being built by decorators, the «landscaped» mountains have to be born on paper. There are many variables, such as: dump places, steepness of inclinations, drops, and sinuosity of roads. Next step is a modeling. During this process dry and wet biotops are being planned, because they are desirable and essential no less than others. Therefore, not only decoration of landscapes needs to be taken under the consideration, but an environmental protection as well.

It’s well known that recultivation is very expensive and time-consuming process. Based on the information received from the Ministry of Finance, there was increase up to 9 billiard hryvnia in investing in coil mining industry in 2013, which is 3 billiard hryvnia more than was received the previous year. However, only 16% from this amount was spent on restructuring of coal mining industry. The rest of the money was distributed between different expenditures, such as environmental protection services and works, preparation of coalmines for liquidation, actual extermination of mining plants, and etc.

Underfinancing doesn’t allow performing quick and quality measures for recultivation of increasing amount of waste heaps. Target function of effectiveness of recultivation is [3]:

$$\sum M_T + \sum M_B + \sum M_C = \sum\sum M_R \to \min \quad (1)$$

$$\sum E - \sum\sum M_R \to \max \quad (2)$$

where $\sum M_T$ – money spent on technical stage of recultivation, hryvnia; $\sum M_B$ – money spent on biological recultivation, hryvnia; $\sum M_C$ – money spent on building industrial, civil and other

facilities on spoil dump, hryvnia; $\sum \sum M_R$ – total amount spent on recultivation, hryvnia; $\sum E$ – complete public and economic outcome from the recultivation of waste dump, hryvnia.

Amount of expenses in expressions 1 and 2 could be obtained by simple calculation or using the principle of integrated exponents.

Compliance with principle of minimum of combined cost allows increase of some elements (expenses) for the cost of others. Based on this principle, decreasing of at least one expense leads to decreasing of amount of expenses on recultivation, which ideally should tend to a minimum.

The cutting down of expenses on technical stage of recultivation was proposed, on process of flattening and terracing of slops for their stability in particular.

It is well known that unsteadiness of upper level of soil on inclinations of heaps is the main impediment for growth and development of plants. As a result of episodical movement of dump mass under the change of temperature, humidity, and under the influence of wind, destruction of root system of sprouts and adult plants takes place. The surface level of soil has to be locked in order to provide good conditions for growth of plants and to preserve the root system.

Presentation of materials and results

At present, in order to implement the adopted recultivation techniques, in keeping with requirements of the biological stage, there are ongoing efforts to create terraces and microterraces, flatten slopes of a given size, create ditches for planting trees and shrubbery, create drainage systems and lay down of topsoil.

During the process of reforming cone shaped pile into flat level the inclinations of 35–40° steepness form and they are equal to the steepness of natural slope of waste mass. Changes in temperature, humidity, and air slake of waste are responsible for instability of slops. The erosion processes, rockslides and soil slips are very often happen on inclinations. To increase stability of the surfaces of wastes slope flattening is performed. This is the most complex and expensive process in recultivation of soil.

Earthmoving machines are used for slope flattening. The borders of base area get transferred onto the flat top of reformed pile and they are calculated in order to insure the necessary steepness of inclinations and proper arrangement of terraces. The research of great number of slopes made possible to determine the maximum allowed steepness. It has to be no more than 30° in slopes of coal mines and 27° in slopes of enriching plants (since the waste and traces of enrichment get collected together). Starting from the borders of platform, the earthmoving machine transfers the waste layer by layer in radial direction from center to the periphery of slope and dumps it under the slope. The borders of each new layer move from the center to the rim on the distance that equal the double depth of the layer of transferring waste.

Due to limited territory, most of the time, slope flattening is performed on slopes of up to 30°, with terrace heights of 10 m. In this case, the area of rock spoil heaps increased by about 40%.

Terraces and microterraces are cut into rock spoil heap slopes in order to prevent the onset of erosion processes, to fortify the slopes through planting of brush and trees, and to collect and divert atmospheric precipitation. However, the process of terracing, is very labor intensive and expensive.

As an alternative to the described method of stabilizing soil on the surface of the rock pile, as well as a way to prevent development of erosion processes, we are proposing to use elastic systems of slope stabilization.

Examples of such elastic systems of slope stabilization include TECCO (Germany) [4] and Tensar (England) [5], with Tensar being more dominant on the Ukrainian market.

The system offered by TECCO consists of a high-tensile steel mesh constructed of 3 mm wire, covered with a 150 g/m^2-thick aluminum zinc alloy. The mesh has a tensile strength of over 1770 N/mm^2 and a mesh size of 83 x 143 mm. These high strength and corrosion resistive properties, together with the three dimensional cell structure, allow wide-ranging applications in slope stabilization, while making the mesh an effective and reliable way to implement hydro and dry seeding.

Natural vegetation creates protection against erosion, however, on steep slopes it may be necessary to implement additional measures to combat erosion.

In these cases, it is necessary to use low-visibility materials, which would create the desired erosion protection with the help of a vegetation layer.

Another solution is the three-dimensional Tensar Mat, which is a special meshing with a high degree of flexibility, tensile strength, and resistance to microbiological decomposition processes. This material is available in rolls and is designed to be laid directly onto the soil or foundation area. Tensar Mat is first used to stabilize the surface until a thin layer of vegetation develops, and then continues to provide long-term reinforcement to the root system.

Tensar Mat is made out of polyethylene, which makes it chemically inert and, consequently, not subject to corrosion. Mats are made from two highly elastic flat base layers, connected with two more upper layers that have a wave-like surface. The shape of the upper layers provides good adhesion with the soil. These mats provide long-lasting reinforcement and anchoring for the room systems of plants.

Advantages of the given method of slope stabilization consist of the following: economy; sustainability; long-lasting solutions; ease of installation.

Conclusions

In order to successfully conduct revegetation, it is necessary to prepare the rock spoil heap surface in such a way, that will prevent displacement of the upper layers of soil along the slopes of the heap.

As an alternative to the discussed operations, we propose the use of elastic slope stabilization systems, such as TECCO (Germany) or Tensar (England). Advantages of these systems consists of economy, sustainability, long-lasting solutions, and ease of installation.

In addition, the Tensar system is capable of controlling slope angles that are much higher than those on existing rock spoil heaps, which can lead to more economical land use and an increase in deposited rock material per unit area.

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Received: 19.11.2013 Accepted: 13.12.2013

Колесникова В. В. **Совершенствование технологий подготовки склонов породных отвалов к озеленению. –** Предложен новый метод стабилизации склонов породных отвалов, позволяющий экономить на техническом этапе рекультивации, в частности на операциях выполаживания и террасирования откосов с целью достижения их устойчивости. Метод отличается своей экономичностью, экологичностью, долговременностью решения, легкостью возведения.

Ключевые слова: стабилизация откосов, рекультивация, выполаживание, террасирование, устойчивость склонов.

Колеснікова В. В. **Вдосконалення технологій підготовки схилів породних відвалів до озеленення. –** Запропоновано новий метод стабілізації схилів порідних відвалів, що дозволяє економити на технічному етапі рекультивації, зокрема на операціях виположування та терасування укосів з метою досягнення їх стійкості. Метод відрізняється своєю економічністю, екологічністю, довготривалістю рішення, легкістю зведення.

Ключові слова: стабілізація укосів, рекультивація, виположування, терасування, стійкість схилів.

Надійшла до редакції 19.11.2013 Прийнята до друку 13.12.13