DEVELOPMENT OF LANDS ON THE SLOPE THROUGH TERRACING FOR RECREATION AREAS

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Abstract

The terracing of sloping land provides multiple functional and aesthetic advantages. Landscaping on a slope is a complex work that requires a thorough analysis of the features of the relief, soil and vegetation. The adoption of an optimal terracing solution, in terms of dimensions, contributes to the quality of the result obtained, its maintenance over time and a minimal impact on the environment. In this work, for the dimensioning of the terraces and the optimal use of the natural elements, the topographic survey of the surface was carried out with the GPS. When determining the width of the leisure terraces, the slope of the land and microrelief were taken into account. To make the embankments more efficient, it was proposed to equalize the volume of excavation with that of filling. The achievement of this objective was achieved by covering the surface to be leveled with a network of squares, with a side of 17 m, the corners of the squares being materialized on the ground with wooden stakes. The absolute shares of all the points of the squares were determined, and depending on the weight of each point, the weighted average share of the two networks of squares was calculated. The calculation resulted in a value of the weighted average elevation on the first terrace, from the upstream side, of 148.789 m, and on the second terrace of 146.599 m. The values thus obtained were imposed quotas for the execution of the terrace platforms. Depending on the micro-relief of the land on the surface proposed for development and the neighboring areas, widths of the terraces of 15 and 17 m, with a length of 88 m, have resulted, which allow their use for the purpose proposed for development.

Key words: land terracing, soil erosion, land elevation

In some countries, terraces were originally developed to provide a larger area for cultivation on hillsides and to help long-term agricultural production. In addition, the variability of terracing methods has reduced the risk of erosion, especially in regions affected by uneven rainfall, both seasonally and annually.

Terraced landscapes have considerable ecological and aesthetic value. The terracing of sloping land has been used since ancient times, all over the world, for both aesthetic and productive purposes. Well-known examples are the Arab gardens of Spain and the agricultural terraces of Central and South America (Sandor J. A. et al., 1998; Gardner R. A. M. et al., 2003).

Terraced areas are distinctive features of the agricultural landscape in Europe. They represent a resource for agriculture and tourism, but also a challenge for land conservation and management (Stanchi S. et al., 2012).

The soils on the terraced surfaces are considered anthropogenic soils due to the human-induced characteristics and relief shape changes (Van Dijk A. I. J. M. et al., 2003; Zornoza R. et al., 2009).

Terraces, as a means of soil conservation, increase infiltration and reduce runoff. If agricultural terraces are well designed, constructed and properly maintained, they help protect the soil by increasing infiltration rates and decreasing runoff and sediment production. Under optimal conditions, these terraces form a state of hydraulic equilibrium between geomorphic settings and anthropogenic use (Schönbrodt-Stitt Sarah et al., 2013).

MATERIAL AND METHOD

The area proposed to be developed as a recreational area is located in the NE of Iaşi. It is the property of USV Iaşi, being adjacent to the student campus and the sports base (*figure 1*).

For the leveling of the two proposed leisure terraces, depending on their size and the degree of unevenness, the method of leveling the checkered surfaces with small squares was applied. The topographic elevation of the surface and the determination of the elevations of the corners of the squares was carried out with the GPS Stonex S7G4083040007.

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The weighted average elevation of each terrace was calculated using the formula:

$$Zmp = \frac{\sum p \cdot Z}{\sum p}$$

where: ∑p • Z – represents the sum of the products between the weights and the quotas of the points;

∑p – the sum of the weights of the points.

For the application to the field of the average weighted elevation, resulting from the calculation, the Leica GeoSystems DNA 10 digital precision level was used, the actual leveling being done with the bulldozer.

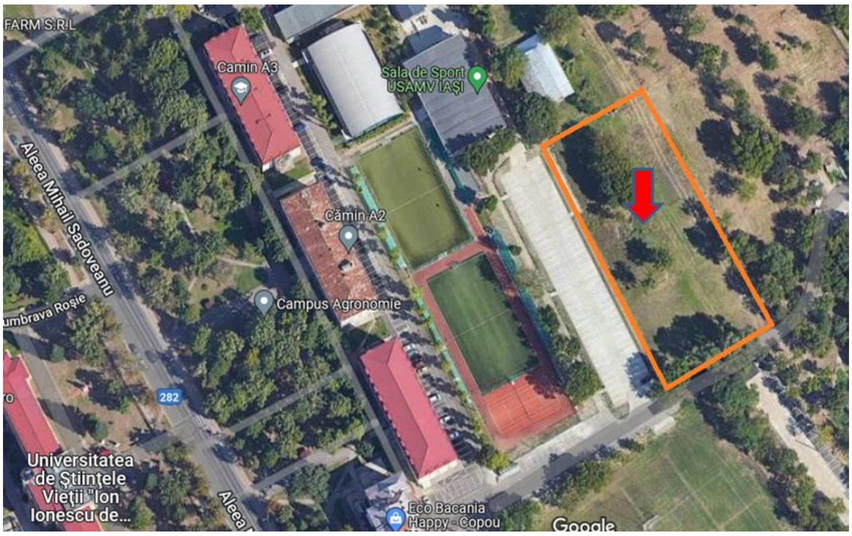

Figure 1 **Location of the landscaped area** (Google maps)

RESULTS AND DISCUSSIONS

Land preparation on slopes by terracing requires the recognition of the land, an important stage in the topographic survey. After recognizing the land and establishing its characteristic points, from a planimetric and level point of view, the topographic survey of the area to be developed was carried out. The topographic survey was carried out with the Stonex S7-G GPS and included a number of 91 topographic points. The amplitude of the elevations of the points on the surface to be developed is between 151.11 m and 137.07 m. The length of the slope is 114.00 m with an average slope of about 13%.

For the representation of the level curves, depending on the degree of inclination and the accuracy of the representation of the unevenness, the natural equidistance of the normal level curves of 0.25 m was chosen.

From the analysis of figure 2, the allure and the density of the level curves, a natural modeling of the land can be found, on the raised surface in the plan there are two initial incipient slopes.

In order to capitalize on the existing natural elements of the land, it was proposed to build, in the upstream part of the raised surface, two terraces with horizontal platforms, with a length of 92 m, a width of 17 m and spaced at 5.00 m (*figure 3*).

The leveling of the surfaces can be carried out either at a certain elevation imposed by the project, or in order to obtain an average elevation, in order to compensate for the earthworks, that is, to equalize the volume of excavation with that of filling. In order to reduce the execution costs, the option of compensating the earthworks was chosen.

In order to compensate for earthworks, it is necessary to calculate the weighted average elevation. In order to obtain the weighted average share, the leveling of the surfaces in a checkerboard with small squares was applied. Thus, two grids of squares with a side of 17 m were created on the surface to be developed, a size imposed by the orography of the land (*figure 4*). The corners of the squares were materialized on the ground with wooden stakes, and the elevations of the points of the grid of squares were determined, in the Black Sea Reference System, with the Stonex S7-G GPS.

Depending on the positions they occupy in the grid of squares, the points have different weights. Analyzing figure 4, it can be seen that out of the 12 points of each grid of squares, four points have a weight of 1 and eight points have a weight of 2.

Following the calculations, a weighted average elevation of 148.789 m and 146.599 m for the downstream terrace resulted for the upstream terrace. The weighted average quotas resulting from the calculation were imposed quotas for the execution of the leveling of the two terraces (*figure 5*). Due to the connection of the terraces with the neighboring areas, by sloping, two platforms with the length of 88 m and the upstream-downstream level difference of each platform of about 5 cm have resulted, to ensure the drainage of water. The width of the upstream terrace is smaller, with values between 14.00 and 15.00 m, due to the extension of the upstream slope and the utilization of the rainwater drain from the parking platform.

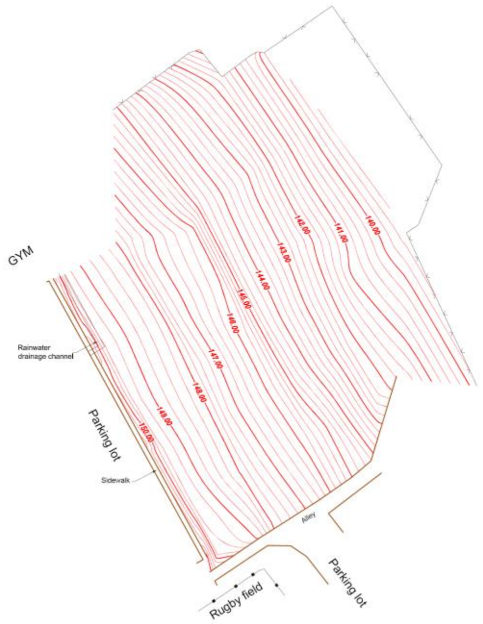

Figure 2 **Topographic plan with level curves**

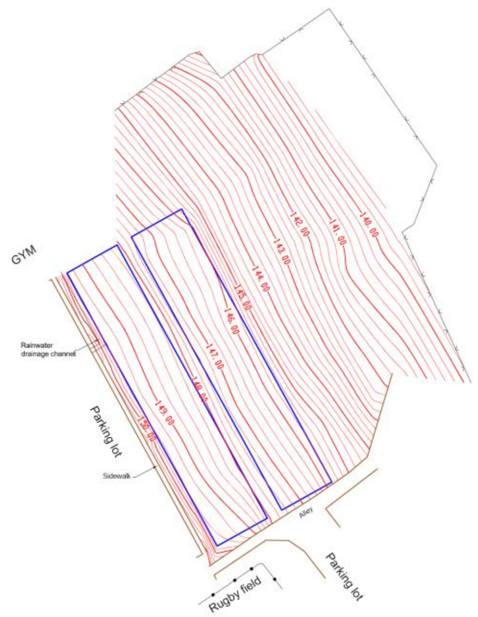

Figure 3 **Terraces proposed for development**

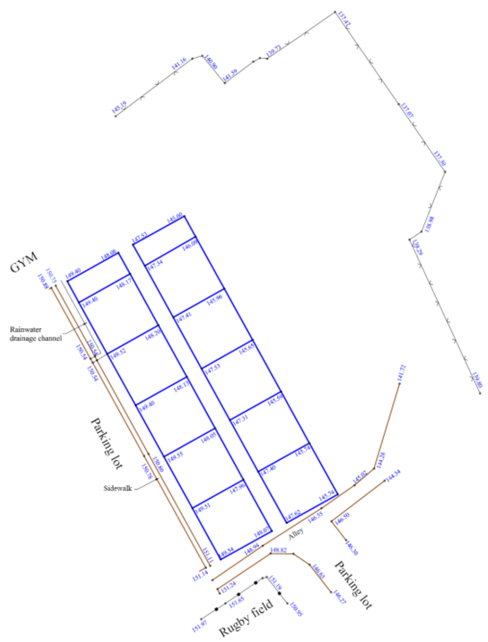

Figure 4 **Application of geometric leveling with small squares**

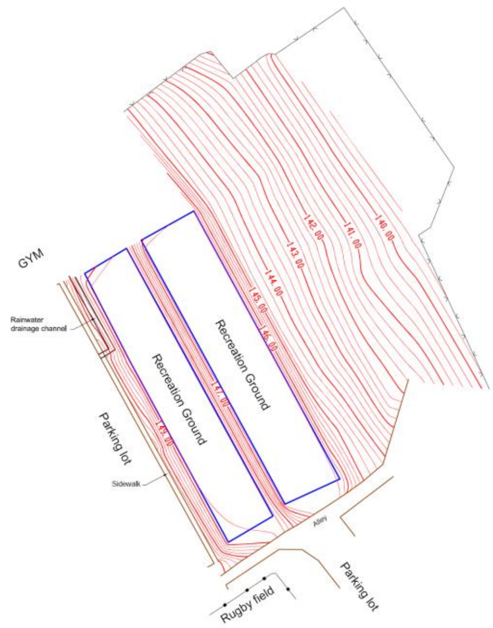

Figure 5 **Landscaped terraces**

During the actual execution of the two terraces, for as little impact as possible on the surrounding environment, the existing trees were kept, especially those on the slopes, and the fertile soil layer was uncovered (*figure 6*). The uncovering of the fertile soil layer is a mandatory requirement in earthworks, and by covering the landscaped surface with the exposed fertile soil, the creation of favorable conditions for the development of the vegetal carpet was ensured.

Figure 6 **Technical aspects of terracing**

CONCLUSIONS

In earthworks, in order to equalize the volume of excavation with that of filling, it is necessary to determine the weighted average elevation of the area to be developed.

When determining the size of the side of the grid of squares, for the leveling of the surfaces, the size of the irregularities of the land surface and their density must be taken into account.

In order to reduce the impact on the environment, when determining the width of the leisure terraces, the microrelief and the slope of the land and, last but not least, the existing woody vegetation must be taken into account.

Uncovering the fertile layer of soil and leveling it on the surface of the terraces, after execution, ensures favorable conditions for the development of a uniform vegetal carpet, contributing, together with the woody vegetation on the slopes, to the stability of the terraces and the reduction of soil erosion.

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