UDC 514.182

PECULIARITIES OF SOLVING POSITIONAL PROBLEMS OF DESCRIPTIVE GEOMETRY ON DRAWINGS WITH NUMERICAL MARKS

Sergey Zalevsky[1], PhD,
zalsergkpi@gmail.com, ORCID 0000-0002-7411-1462;
Oleksandra Boiko[2], Senior Lecturer,
o.boiko@zsi.slupsk.pl, ORCID: 0009-0001-0652-9074;
Valentina Savchuk[1], Assistant,
svs_sav@ukr.net, ORCID: 0009-0005-4776-7916;
Oleksii Vorobiov[1], Student gr. TA-33,
ta33.vorobiov.oleksii@gmail.com
[1]National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Ukraine, Kyiv)
[2] Unification of IT schools in Słupsk, Słupsk, Poland

Abstract *- In the training of mining engineers, it is necessary to master the means of developing projections with numerical marks that are most rational when depicting surfaces in which the height dimensions are much smaller than the horizontal ones. The absence of the usual coordinate system, namely the frontal and profile planes of projections, makes some adjustments to the methodology of depicting geometric elements and leads to the need to use specific notations and methods for solving geometric problems. The paper considers the peculiarities of solving a typical problem of descriptive geometry on a drawing with numerical markings. Also, the basic terms and concepts used in the development of surveying drawings are given.*

Keywords *- numerical marks, topographic drawing, intersection of a line with a plane, embedding, horizontal spacing, line of incidence, scale of embedding, lines of extension.*

Problem statement. For the training of mining engineers, a very important component is mastering the course of surveying and topographic drawing. This gives students the opportunity to master the necessary tools and skills to draw up surveying drawings, which are an integral part of the design of mining enterprises. Such drawings depict the shape and conditions of minerals, as well as the surface topography. The use of projections with numerical markings should be introduced into the professional training of students of mining specialties.

Analysis of recent research. The vast majority of works devoted to the development of numerical markings drawings consider in detail the principles of depicting geometric objects and surface relief, but insufficient attention is paid to covering methods for solving geometric problems. Paper [1] describes in detail

the features of depicting a line and a plane on a drawing with numerical marks, but does not provide features of solving geometric problems. Work [2] discusses some basic concepts of the relative position of two lines and a straight plane, but does not provide methods for solving practical problems related to the intersection of these geometric elements.

Formulation of goals (task setting). The method of using projections with numerical marks is the basis of graphic documents of mining enterprises (plans of mining operations; floor, horizontal, summary and other plans). knowledge of this method is a necessary component of the professional training of a mining engineer.

The main part. In descriptive geometry, three orthogonal projection planes are used to depict an object. But this is possible only when the vertical and horizontal dimensions of the object are approximately the same. If the height of the figure is much lower than its horizontal dimensions, it is inconvenient to use the system of three projection planes. In this case, instead of building frontal and profile projections, you use numerical marks that are placed near the projections of points on the horizontal plane. Numeric marks indicate the distance to the horizontal projection plane (Z coordinate of a conventional drawing book). They are positive (the point is above P_1) or negative (the point is below P_1). In surveying plans, the most common unit of measurement is the meter. To set points, you need to have a scale (Fig. 1).

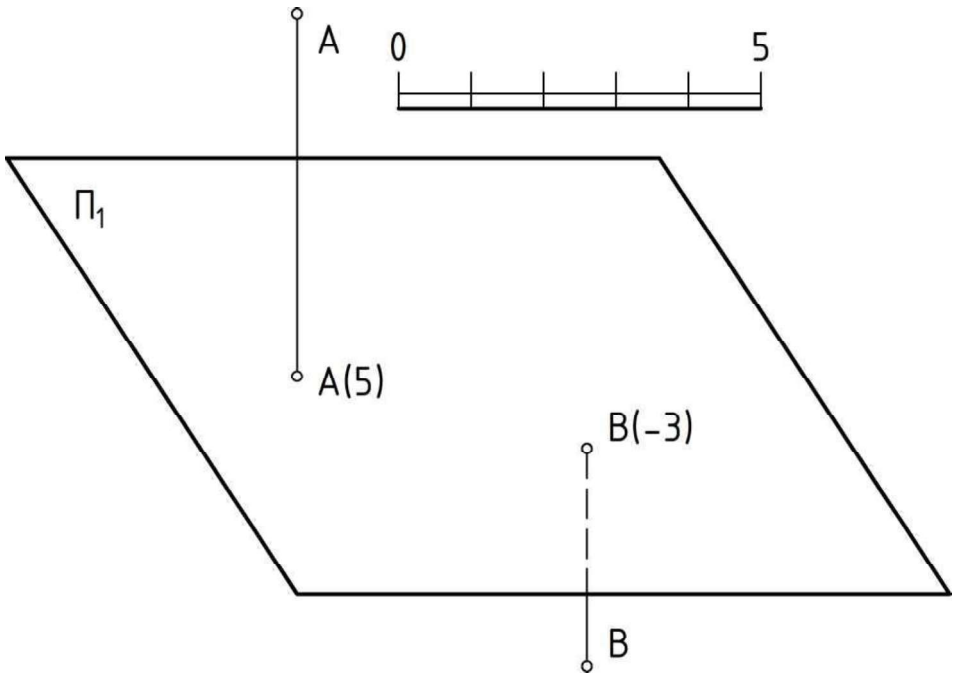

Figure 1. A point on a drawing with numerical marks

The position of a line in space can be determined by two points or by one point and a direction with a given slope angle (Figure 2), where i is the slope of the line. It is calculated as the ratio of the difference in the heights of the points to

the line's slope. The line's intercept is the length of the line's projection onto the plane P_1. The arrow indicates the direction of the line's slope.

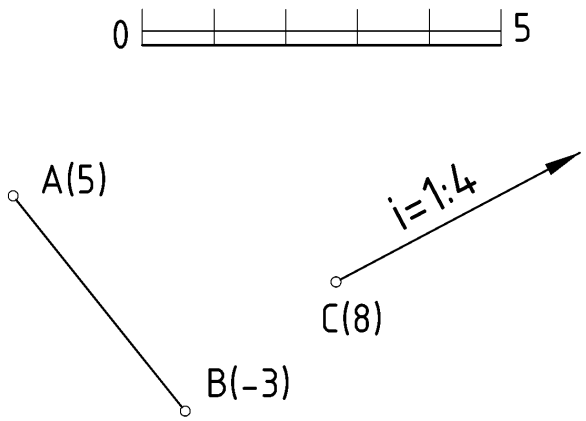

Figure 2. Image of a line on a drawing with numerical marks

The length of the embedding that corresponds to the unit of excess is called the line interval. To solve problems, it is convenient to use graduated lines, i.e. lines with integer numerical marks. The line is graduated using Thales' theorem (Fig. 3).

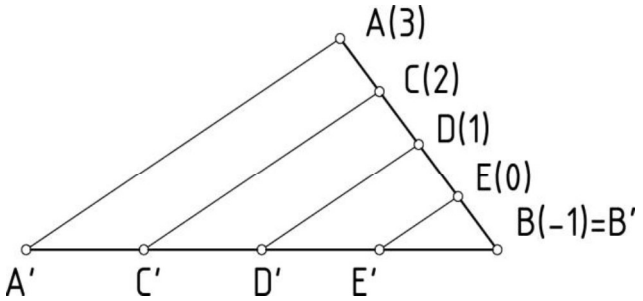

Fig. 3. Graduation of a straight line

A plane can be defined by three points that do not lie on the same line, two intersecting lines, two parallel lines, and so on. In drawings with numerical symbols, it is customary to define a plane using its characteristic lines: the horizontal and the plumb line (line of greatest inclination) of the plane. In mining, instead of the term "line of greatest inclination", the term "dip line" is used and instead of "horizontal" - "strike line". In the projection on P_1, α is indicated - the angle of extension of the plane, which is measured from the north direction (X coordinate) clockwise to the direction of projection of the extension line. The plan depicts the "embedding scale" - a graded projection of the dip line. It is depicted as a double line (thin and thick) with divisions that correspond to the elevation (Fig. 4)

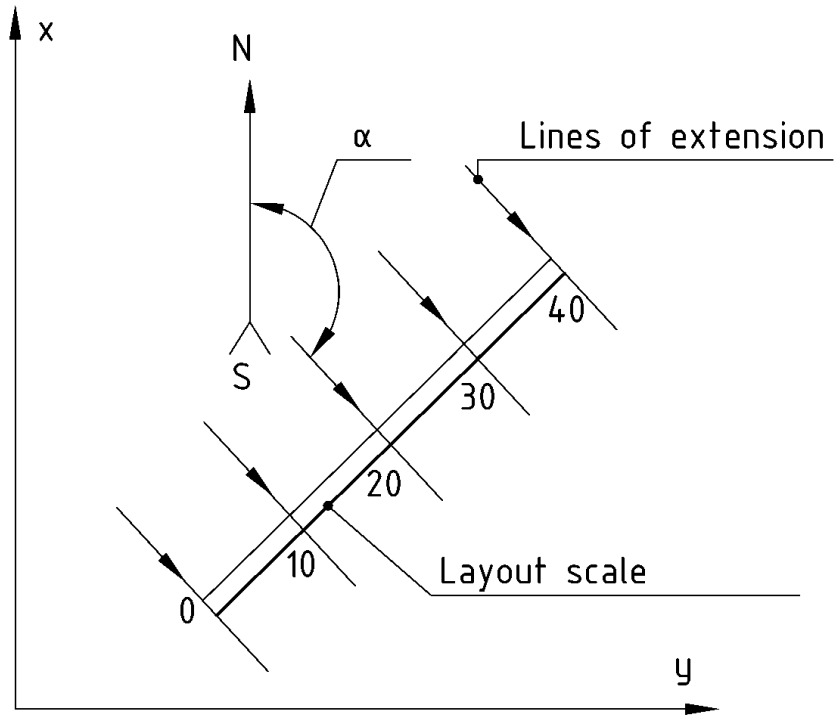

Figure 4. Image of a plane on a drawing with numerical marks

Let's consider solving the problem of intersection of a line with a plane on a drawing with numerical symbols. To do this, we include the line in the auxiliary plane-mediator of the general position (Fig. 5)

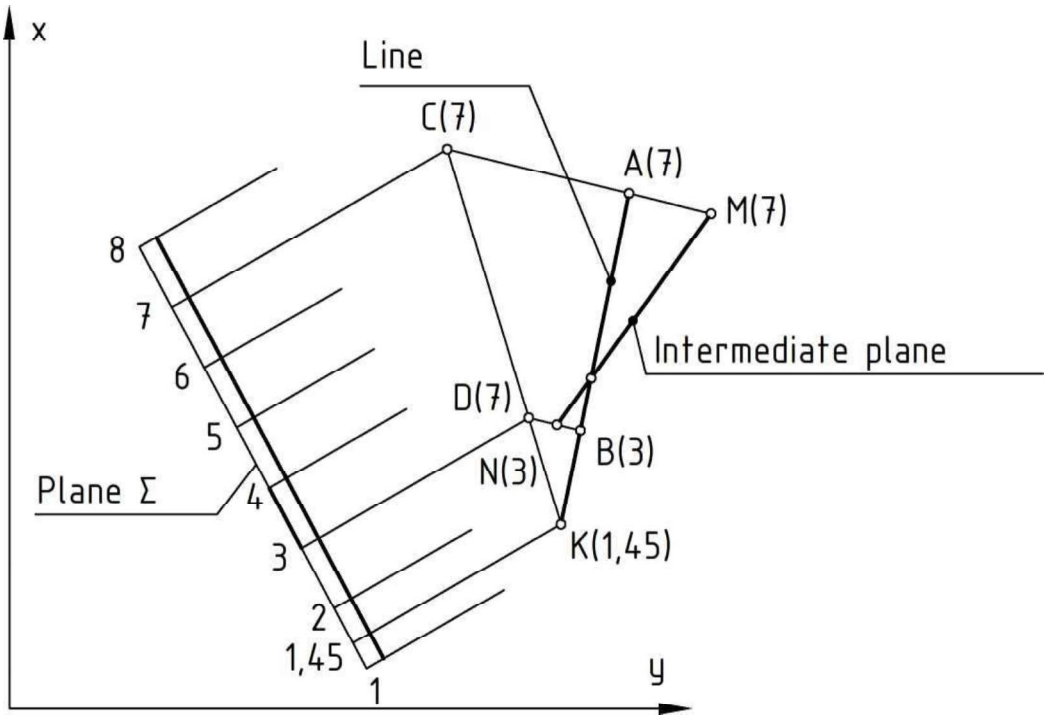

Figure 5. Intersection of a line with a plane

Next, we look for the line of intersection of the given plane∑ and the intermediary plane. To do this, draw a horizontal at the numerical mark of the line through point A(7). Using the rule of parallelism of plane horizontals, we get the line of extension at point B(3). The line C(7)D(3), drawn through the obtained intersection points of the horizontals with the same numerical values, is the line of intersection of the intermediary plane and the given plane∑ . Next, we define the desired point K as the point of intersection of the line of intersection of the planes with the given line. The numerical designation of the resulting point is sought by projecting it onto the slope scale line of the given plane∑ or by graduating the line A(7) B(3).

Conclusions. The paper considers the issues of creating drawings with numerical marks. The basic principles of creating images on topographic maps are presented. The application of general methods for solving problems of descriptive geometry when using images of objects with numerical marks is shown. An example of solving a typical problem of descriptive geometry is given.

References.

1. Mining computer graphics in projections with numerical marks. Methodical instructions for performing laboratory work for students of the direction 6.050301 Mining / O.I. Dodatko: NSU, 2012. - 49 p. [in Ukrainian].
2. Pik A.I., Kovbashin V.I., Rasskazov Y.S. Projections with numerical markings. Ternopil: Ivan Puluj TNTU Publishing House, 2010. 58 p. [in Ukrainian].
3. Sz. Chmielewski, T.J. Chmielewski, A. Mazur Publisher. Engineering graphics in environmental protection, landscape architecture and urban planning. Volume I. Lublin: Wydawnictwo Uniwersytetu Przyrodniczego , 2009. p. 231. [in Polish].
4. Robert Molasy . Inzynierska grafika: principles of projection and dimensioning. Kielce: Wydawnictwo Politechniki Swi^tokrzyskiej, 2012. p. 256. [in Polish].
5. Nikulina V. Descriptive geometry. Study guide / V. Nikulina - Lutsk: LNTU, 2008. - 134p. [in Ukrainian].
6. Section: descriptive geometry. A course of lectures for distance learning. Study guide - Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2021. 171 p. [in Ukrainian].
https://ela.kpi.ua/handle/123456789/39819
7. Vanin V.V., Bilytska N.V., Hetman O.G., Mikhlevska N.V. Educational tasks in descriptive geometry and engineering graphics for programmed learning of students of non-mechanical specialties - K.: NTUU “KPI”, 2013. - 60 p. [in Ukrainian]. https://ng-kg.kpi.ua/files/Vanin_Bilitska.pdf