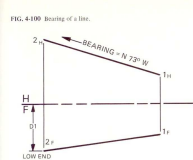


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TOPOGRAPHIC PROJECTION IN AMERICAN DESCRIPTIVE GEOMETRY WORKBOOKS

The term *topographic projection* corresponding to Polish *rzut cechowany*, Russian *проекция с числовой отметкой*, German *Kotierte Projektion*, Italian *proiezioni quotate* or French *géométrie cotée* cannot be found in American workbooks and in the internet. Formally, American authors do not introduce and distinguish the projection in question and its basic terminology. However, it is not completely true. Why?



4.48 BEARING OF A LINE

The angle that a line makes with a north-south line in the horizontal view is the bearing of that line. The bearing can only be measured in the horizontal view. Since the bearing of a line is the angle that the line makes with the north-south meridian, it is measured from the north or south towards the east or west. The bearing in the map direction of a line and measured in degrees with a compass from the north or south. The bearing indicates the quadrant that the line lies in and is always measured from the north or south.

Normally the originating point is the lowest numerical value or sequential letter, such as line 1-2 (A-B), which will start at point 1 (A). The low end is the lowest point on a line as seen in a frontal or elevation view. In some cases, the bearing is measured from the high end of the line toward the low end as for a sloping cross-country pipeline.

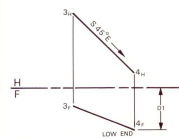


FIG. 4-101 Bearing.

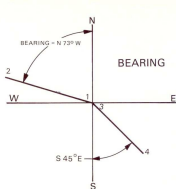


FIG. 4-102 Bearing measurements.

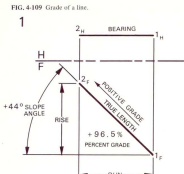
Lines that fall on a meridian have a bearing of due north, due south, due east, or due west.

The horizontal angle that a line makes with the north-south line is the bearing and is always an acute angle measured from the north or south. In Fig. 4-100, line 1-2 has a bearing of N 73° W, measured from the north, 73° toward the west. The bearing is measured from the north towards the west, from point 1 towards point 2.

Figure 4-102 shows the horizontal view of line 1-2, located in relation to the compass meridians. Line 1-2 lies in the second quadrant. Therefore it is measured from the north towards the west. In Fig. 4-101, the bearing of the pipeline, line 3-4, is S 45° E. This means that line 3₁-4₁ forms a 45-degree angle with the north-south meridian and is measured from the south toward east. Here the concept of low end has been applied. The low end is always determined in the frontal view where the elevation of the line is shown. In Fig. 4-102 line 2-4 is located in relation to the meridians and lies in the fourth quadrant since it is measured from the south towards the east.

The bearing of a line is used in engineering work to locate lines by compass directions. The bearing of a road, etc., would be measured on a map, normally from the north. Note that, in surveying, the concept of low end is useless, since the elevation may not be known or needed in regard to the bearing.

Chapter 8, Mining and Geology, discusses specific applications of the bearing of a line.



4.51 GRADE OF A LINE

Another way of stating a line's slope is to give the grade of the line. The grade or percent grade is the ratio of its rise (vertical height) to its run (horizontal distance). The percent grade is calculated in a view where the line appears as true length and the horizontal plane is an edge.

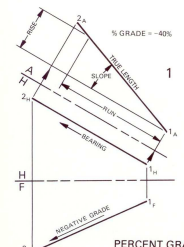
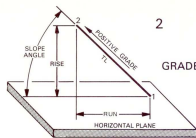


FIG. 4-110 Slope, grade, and bearing of a line.



In Fig. 4-109, line 1-2 is a frontal view. The slope angle and grade can be calculated in the F view since the line is true length and the horizontal plane shows as an edge. Note that the percent grade can also be calculated by changing the tangent of the slope angle into a percent. In this figure, line 1-2 has a slope angle of 44 degrees.

The tangent of 44 degrees equals .9656. Multiply the tangent .9656 by 100 in order to convert it to a percent. $.9656 \times 100 = 96.56\%$. Line 1-2 has a $+96.56\%$ grade since it slopes upward from point 1. The bearing of line 1-2 would be due west if taken from point 1.

When calculating the percent grade using the ratio of rise to run, always use 100 units for the run and measure the rise with the same type of units. This method will yield the percent grade. In Fig. 4-110 line 1-2 is oblique. Auxiliary view A is projected parallel to line 1₁-2₁ (1). Line 1₂-2₂ is true length and the grade can be calculated in this view. In (2), line 1-2 has been drawn so as to illustrate this procedure better. Note that a true length diagram could have been used.

One hundred units are set off along the run and the rise has been measured at 40 units (the type of units is irrelevant). The percent grade equals 40 divided by 100 multiplied by 100 (40%). The grade of line 1-2 is -40% since it slopes downward from point 1. The tangent of the slope angle is equal to the percent grade divided by 100; -40% divided by 100 equals $-.4$. Converting tangent $-.4$ to an angle gives the slope angle of -21.48° .

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Figure 1: The azimuth bearing and slope of a line defined by the orthographic projection (two-sheet Monge method) explained on pages 113 and 114 of the Luis G. Lamit workbook [3]

The entity of topographic projection and its application in American workbooks is introduced at the beginning of the orthographic projection onto two projective planes (Monge projection). Luis G. Lamit [3] already introduces the terms *azimuth bearing of a line* and *slope of a line*

(*grade of a line*) on page 113 of his 450-page monograph. Steve M. Slaby [4] makes this reference even earlier, because these terms appear on page 29 of his 350-page workbook. Similarly, F.W. Warner and M. McNearly [5], apart from the basic types of line projection: *horizontal*, *frontal*, *profile*, use the terms: the mapping of *contour lines* of a surface and meaning of azimuth bearing of a line on page 20. of their 250-page monograph devoted to the application of Descriptive Geometry. However, the latter book is devoted to the application of Descriptive Geometry, but we do not find there the basic terminology concerning the topographic projection from the traditional European view point.

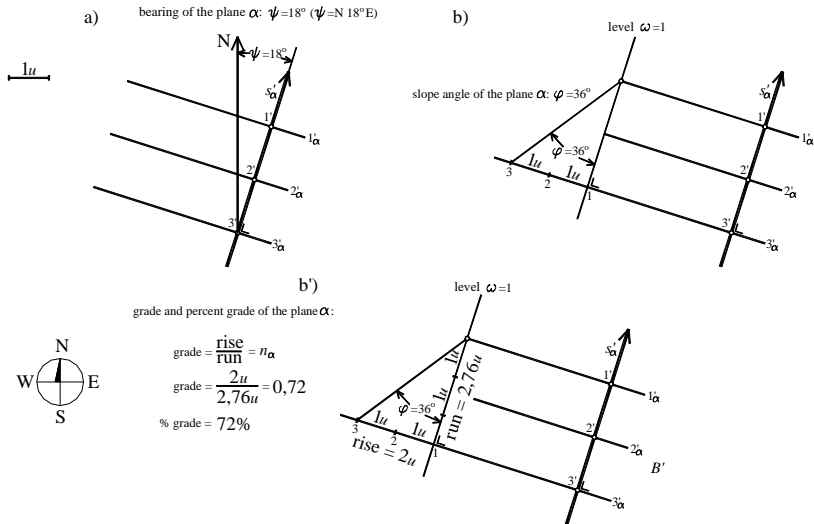


Figure 2: The description of the azimuth bearing and slope of a line defined in the author's lecture for the ERASMUS students [2]

In particular, the American authors in their workbooks do not mention the so called interval of a line and a plane. Such a term cannot be found. Searching for any equivalent of the interval we can find the term *run* (*horizontal distance*). Therefore the *grade* or *percent grade* of the line is the ratio of its *rise* (*vertical height*) to its *run*. The percent grade is calculated in a view where the line appears as true length and the horizontal plane is an edge (Fig. 1, p. 116, top, left side – third angle projection). If the line is in another position (not frontal), then the author [3] uses transformation into primary auxiliary view (Fig. 1, p. 116, bottom, left side – third angle projection).

This paper discusses the American proposition of a lecture of the theory and application of the section, which is equivalent to the topographic projection and its application.

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