Surveying Laboratory

By:
Dr. Ghazi Al-Khateeb

Jordan University of Science and Technology
Department of Civil Engineering
1. Length of Pace Using Tape and Odometer

By Dr. Ghazi Al-Khateeb
Length of Pace Using Tape and Odometer

Objective

- The main objective of this exercise is to determine the length of pace using distance-measuring equipment (tools).
Length of Pace Using Tape and Odometer

Description of the Exercise

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The perimeter (circumference) of a reasonable rectangular area inside the university campus will be measured using tape and odometer.

Each side of the area will be measured in forward and backward (opposite) directions and recorded. The average of the two measurements will be calculated.
Each student in each group is required to contribute in fieldwork and measurements.

To measure the length of pace, each student in the group will be required to walk around the specified area to count the number of his/her paces along each side. The number of paces will be recorded.
Length of Pace Using Tape and Odometer

Description of the Exercise…

- The average (mean) length of pace will be calculated by dividing the average length of perimeter by the number of paces for each student in the group.

- The measurements in both directions for each side should agree to within a few centimeters. Neglect (discard) measurements that are outside this range.

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Each student in each group is required to submit a separate laboratory report done according to the criteria and formatting requirements discussed previously and documented in the course syllabus and policies.

Laboratory reports are due one week from the date of the exercise/project.

By Dr. Ghazi Al-Khateeb
Thank You

By Dr. Ghazi Al-Khateeb
2. Measurement of an Obstructed Distance

By Dr. Ghazi Al-Khateeb
Measurement of an Obstructed Distance

Objective

- The main objective of this project is to determine the distance between two points when direct measurement is difficult or not possible due to an obstruction between the two points such as a river, lake, building, tower, ... etc.
Measurement of an Obstructed Distance

Description of the Exercise

[Diagram showing a lake obstructing a direct path between points A and B, with points D and E used to measure the distance around the lake.]
Measurement of an Obstructed Distance

Description of the Exercise...

- Required is to compute the distance between two points without direct measurement.
- The surveying instruments and tools to be used in this project are tape, ranging rods (three), and prismatic square.

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Assume that the required distance is that between the two points A and B shown in the figure below.

The first step is to select a point such as C facing the line AB as shown in the figure.
Measurement of an Obstructed Distance

Description of the Exercise...

- From point C, a straight line CEB is constructed using three ranging rods located at these three points (a prismatic square is also used for this purpose). The visual line from point C to point B has to pass through point E for a straight line to be constructed. By eye, this can be checked when looking at the three rods located at the three points C, E, and B from point C. Check that with a prismatic square, too.
Measurement of an Obstructed Distance

Description of the Exercise…

- The distances CB and CE are measured using a tape.

- Using the tape, the distance between point C and point A (CA) is also measured.
**Measurement of an Obstructed Distance**

**Description of the Exercise…**

- Using the trigonometry, the point D between the two points C and A is located and the distance between point C and point D (CD) is calculated:

\[
\frac{CE}{CB} = \frac{CD}{CA}
\]
Measurement of an Obstructed Distance

Description of the Exercise…

- And therefore:

\[ CD = CA \times \left( \frac{CE}{CB} \right) \]
Measurement of an Obstructed Distance

Description of the Exercise…

- The distance between points D and E (DE) is measured.

- Using the trigonometry again, the required distance between A and B (AB) is computed as shown below:

\[
\frac{CE}{CB} = \frac{DE}{AB}
\]
Measurement of an Obstructed Distance

Description of the Exercise…

Thus:

$$AB = DE \left( \frac{CB}{CE} \right)$$
Therefore, the distance AB is measured using the trigonometry by constructing two triangles CDE and CAB using simple surveying instruments and methods as shown in the previous figure.
Measurement of an Obstructed Distance

Laboratory Report

- Each student in each group is required to submit a separate laboratory report done according to the criteria and formatting requirements discussed previously and documented in the course syllabus and policies that were handed to students at the beginning of the semester.

- Laboratory reports are due one week from the date of this project.
Thank You

By Dr. Ghazi Al-Khateeb
3. Chain Surveying Project

By Dr. Ghazi Al-Khateeb
Chain Surveying Project

Objective

- The main objective of this project is to obtain a horizontal plan of a building by chain surveying.
Chain Surveying Project

Description of the Project

By Dr. Ghazi Al-Khateeb
**Chain Surveying Project**

**Description of the Project…**

- Required is to obtain and draw a horizontal plan of a building as this shown in the figure above by chain surveying.

- The method that will be used to obtain the plan of the building is the traverse method.

- A closed traverse is constructed around the building as shown in the above figure.

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Chain Surveying Project

Description of the Project...

- All the corners of the building are located with reference to the traverse lines in the four sides using any of *four basic methods* (pair of ties method, offset method, polar method, and intersection method).

- The pair of ties method depends on taking the measurement of two distances from the point to be surveyed to a traverse line (base line).

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Chain Surveying Project

Description of the Project...

- The offset method is based on taking a perpendicular distance from the point to the survey line (base line).

- The polar method depends on taking the measurement of a distance from the point and an angle with reference to a traverse line (base line).

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Chain Surveying Project

Description of the Project…

- The intersection method depends on the measurement of two angles.

- The equipment and tools that are typically used in chain surveying are: chaining pins, poles, plumb bobs, thermometer, tape, prismatic square, staffs, and tension handles.

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Chain Surveying Project
Description of the Project…

- **Note #1:** Try to tie most of the corner points of the building to the base lines of the traverse.

- **Note #2:** The theodolite equipment will not be used in this project to measure the angles. Therefore, not all of the four methods described above can be used here. Only two of the methods that require distance measurement (the pair of ties method and the offset method) can be used.
Each student in each group is required to submit a separate laboratory report done according to the criteria and formatting requirements discussed previously and documented in the course syllabus and policies.

A horizontal map should be plotted on an A3 paper sheet. Each student in the group is required to submit a separate map.
Chain Surveying Project

Laboratory Report…

- Laboratory reports are due one week from the date of the exercise/project.
Thank You

By Dr. Ghazi Al-Khateeb
4. Construction of a Contour Map

By Dr. Ghazi Al-Khateeb
Construction of a Contour Map

Objectives

- To get enough training and practice on the level instrument.
- To learn how to conduct the different calculations and analysis from a leveling session including elevations.
- To learn how to draw a contour map for an area using leveling techniques.

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Construction of a Contour Map

Description of the Project
Construction of a Contour Map

Description of the Project...

- Required is to draw a contour map of a selected area as shown in the figure above.

- The first step is to divide the area into smaller squares (blocks) to look like a grid system. Each square is about $10 \times 10$ m in area.

- The elevation at each corner of the grid is determined.
Construction of a Contour Map

Description of the Project…

- The following example shows the calculations from a leveling session.

- A contour line is a line joining points of equal elevations (altitudes).

- The contour interval is the difference in elevation between two successive contour lines.

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### Construction of a Contour Map

**Description of the Project…**

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<th>Station</th>
<th>BS</th>
<th>HI</th>
<th>IS</th>
<th>FS</th>
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</table>
In this project, a contour interval will be selected as the maximum elevation minus the minimum elevation divided by 10.

Points with the same elevations will be joined to construct a contour line.
Contour lines coincide with the corners of the grid system are easy to plot since the elevations of the corners are measured.
The location of a contour line between two grid corners with known elevations is determined using trigonometry, for example: if the contour line (415) between 411 and 417 is to be located, the distance between the two ends is 10 m, then using trigonometry the distance X shown in the figure below is calculated.
Construction of a Contour Map

Description of the Project…
Construction of a Contour Map

Description of the Project...

\[ X = 10 \left( \frac{415 - 411}{417 - 411} \right) = 6.67m \]
Construction of a Contour Map

Description of the Project…

- Using the above procedure, all contour lines on the map will be located and plotted.

- Finally, a contour map will be constructed for the entire area.

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Construction of a Contour Map

Laboratory Report

- Each student in each group is required to submit a separate laboratory report done according to the criteria and formatting requirements discussed previously and documented in the course syllabus and policies.

- A contour map should be plotted on an A3 paper sheet. Contour values should be shown as in the figure above.
Laboratory reports are due one week from the date of the exercise/project.
Thank You

By Dr. Ghazi Al-Khateeb
5. Measurement of the Length (Width) of an Obstructed Building Using the Theodolite

By Dr. Ghazi Al-Khateeb
The main objective of this project is to obtain the length of a building without direct measurement of the dimension due to an obstruction in the way of measurement.
The Theodolite Project

Description of the Project

Building

\[ \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6 \]

\[ d_1 \]
Required is to obtain the length of a building without direct measurement using the theodolite.

The horizontal angle between the two ends of the targeted building side (C and D) is measured from a fixed point A as shown in the above figure (angle $\alpha_1$).
The Theodolite Project

Description of the Project...

- The horizontal angle between C and B (angle $\alpha_2$) is also measured.

- The horizontal angle between the two ends of the building side (C and D) from point B (angle $\alpha_3$) is measured.
From point B (another point outside the building area), another horizontal angle is also measured using the theodolite between the other end of the building side (point D in the figure above) and the first selected fixed point, A (angle $\alpha_4$).

The length between A and B is measured ($d_1$).
Using these angle measurements, the other angles can be calculated as shown below:

\[ \alpha_5 = 180^\circ - (\alpha_1 + \alpha_2 + \alpha_4) \]  
and  
\[ \alpha_6 = 180^\circ - (\alpha_2 + \alpha_3 + \alpha_4). \]

Using the sine law, the distances AC and AD can be computed as follows:

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The Theodolite Project

Description of the Project...

\[
\frac{\overline{AC}}{\sin(\alpha_3 + \alpha_4)} = \frac{\overline{AB}}{\sin(\alpha_6)}
\]

\[
\overline{AC} = \overline{AB} \frac{\sin(\alpha_3 + \alpha_4)}{\sin(\alpha_6)}
\]
The Theodolite Project

Description of the Project...

\[
\frac{AD}{\sin(\alpha_4)} = \frac{AB}{\sin(\alpha_5)}
\]

\[
AD = AB \frac{\sin(\alpha_4)}{\sin(\alpha_5)}
\]
The distance between C and D (length CD) can now be calculated using the cosine law as shown below:

\[ CD^2 = AC^2 + AD^2 - 2(AC)(AD)\cos(\alpha_1) \]
The Theodolite Project

Description of the Project...

\[ CD = \sqrt{AC^2 + AD^2 - 2(AC)(AD)\cos(\alpha_1)} \]

= The required length of the building.

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Laboratory reports are due one week from the date of the exercise/project.
Thank You

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