Benha University

Shoubra Faculty of Engineering

Surveying Engineering Lecture 8: Levelling (Grid-Precise)

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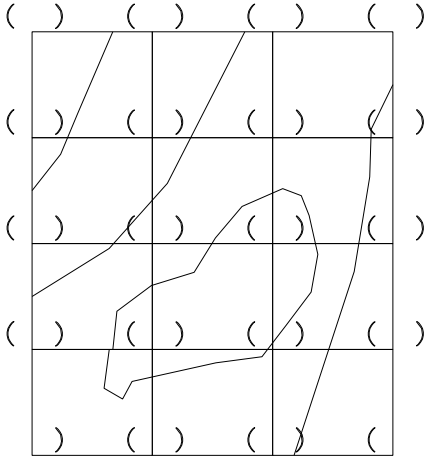
Basic Idea

One of the many applications of leveling

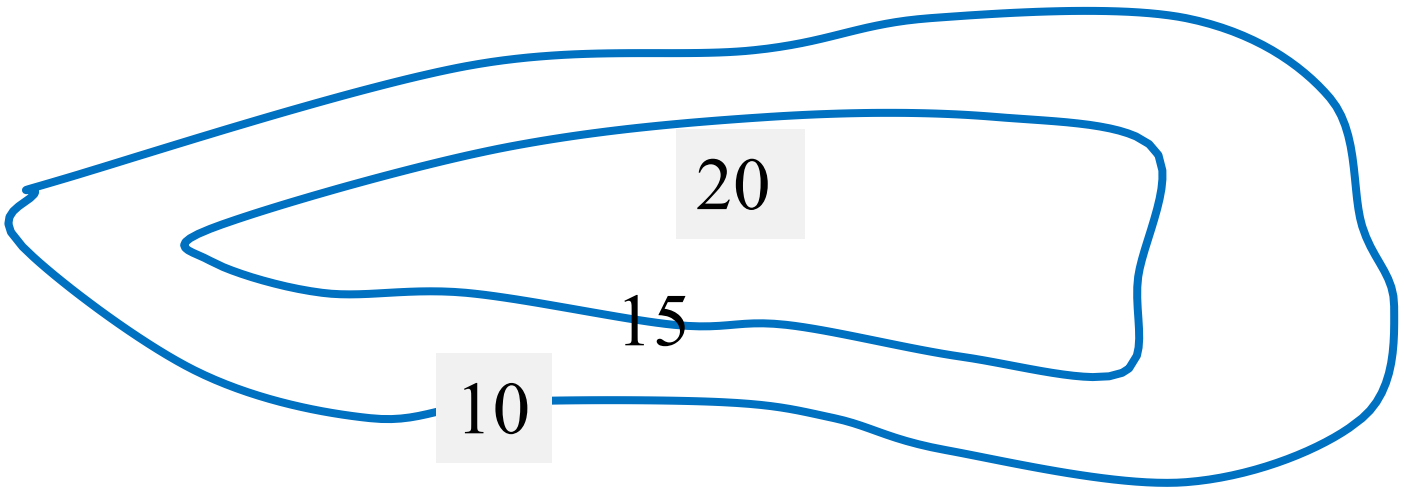
The main aim of grid leveling is to divide the ground by grid lines and determine the elevation of points of intersection of grid lines (nodes) in order to draw contour lines and produce contour maps.

The spacing between grid lines depends on the topography of the ground. The distance increases for uniform ground and vice versa.



Contour Lines

They are imaginary lines joining points of same elevations in which the spacing between them indicates the slope of the ground (e.g. If parallel, indicating uniform slope).



Contour Interval

It is the vertical spacing between successive contour lines depending on the topography, required accuracy and map scale **(usually multiples of 0.25m, 0.5m or 1m and constant all over the map).**

Choice of **Contour interval** depends on:

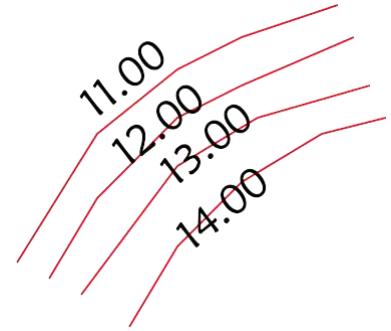
- The purpose and extend of the survey
- The Scale of the map
- The nature of the terrain (topography)

Contour Characteristics

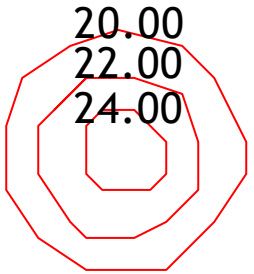
-Continuous

-Do not intersect
(only in special cases)

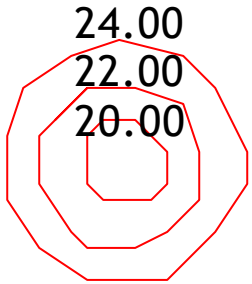
-Close on each other
or close on area edges



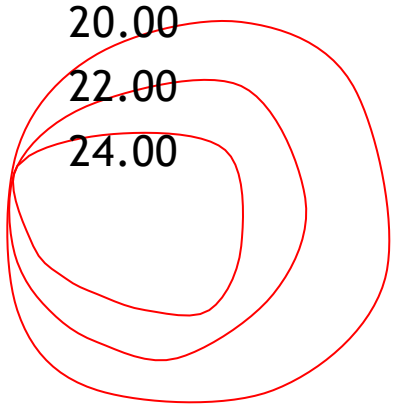
Uniform slope



Hill



Valley



Vertical cut

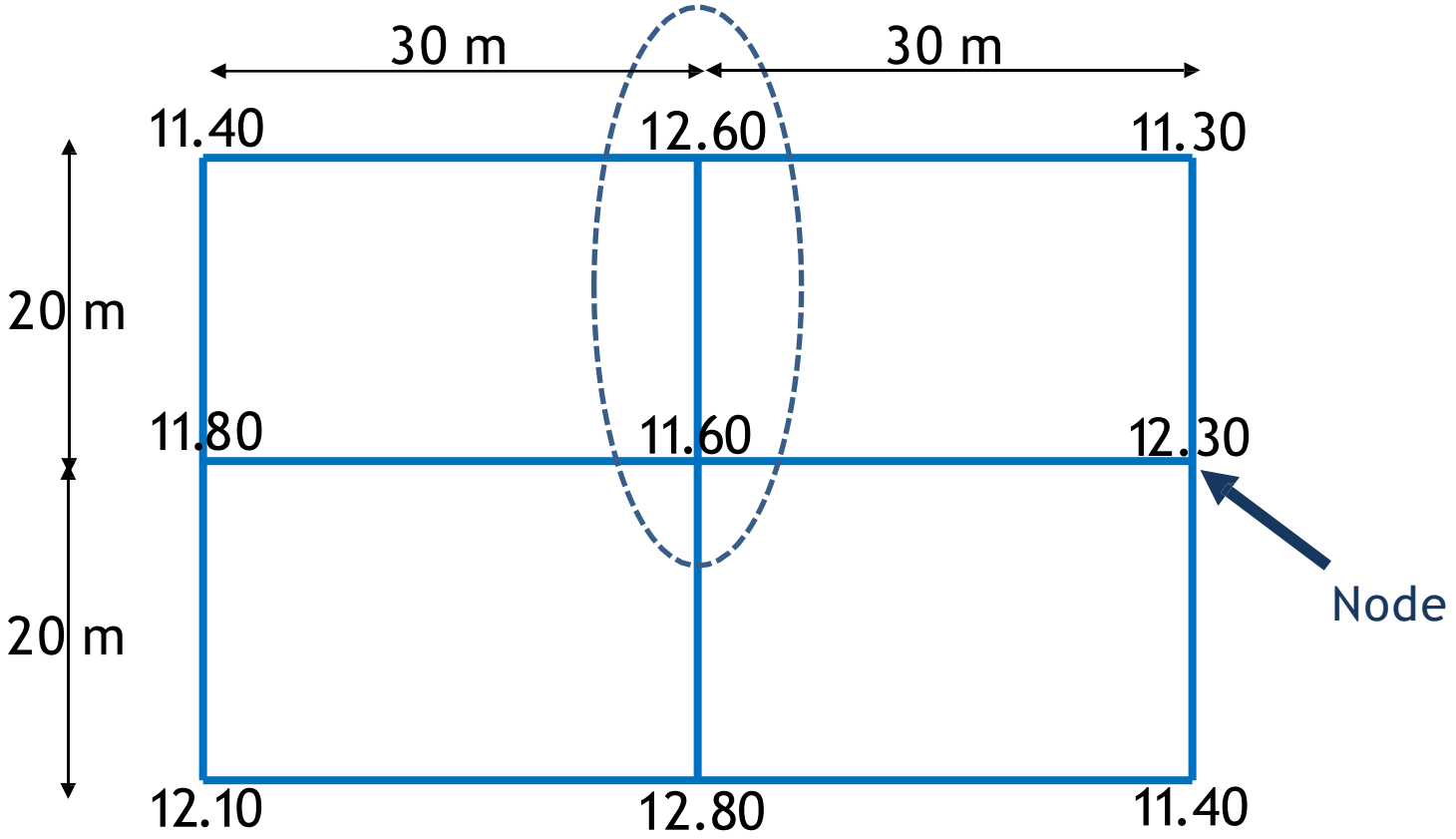
Importance

Contour lines: To know which contour line to draw with a certain contour interval, indicate first, **lowest and highest** elevation on the grid.

Cut and Fill Area: If it is required to level the ground on a certain elevation, then indicate (**shade**) the cut and fill areas. **We could calculate volume of cut and fill also**

Cross section: Sometimes it is required to extract a x-section at a certain direction. **This is drawn directly on the contour map.**

Formation of Grid



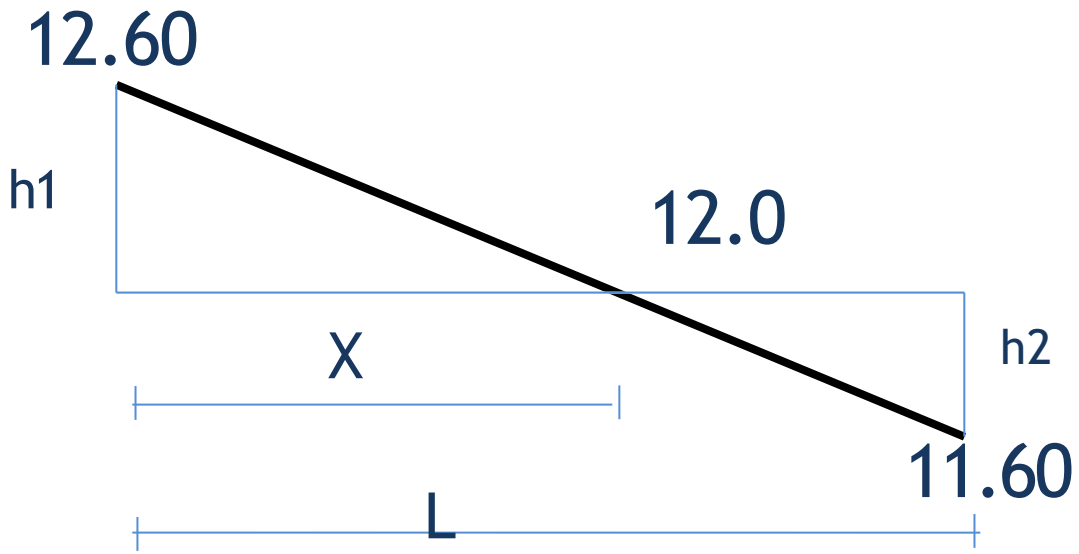
How to Interpolate Contours

Mathematically

L = 20.0 m

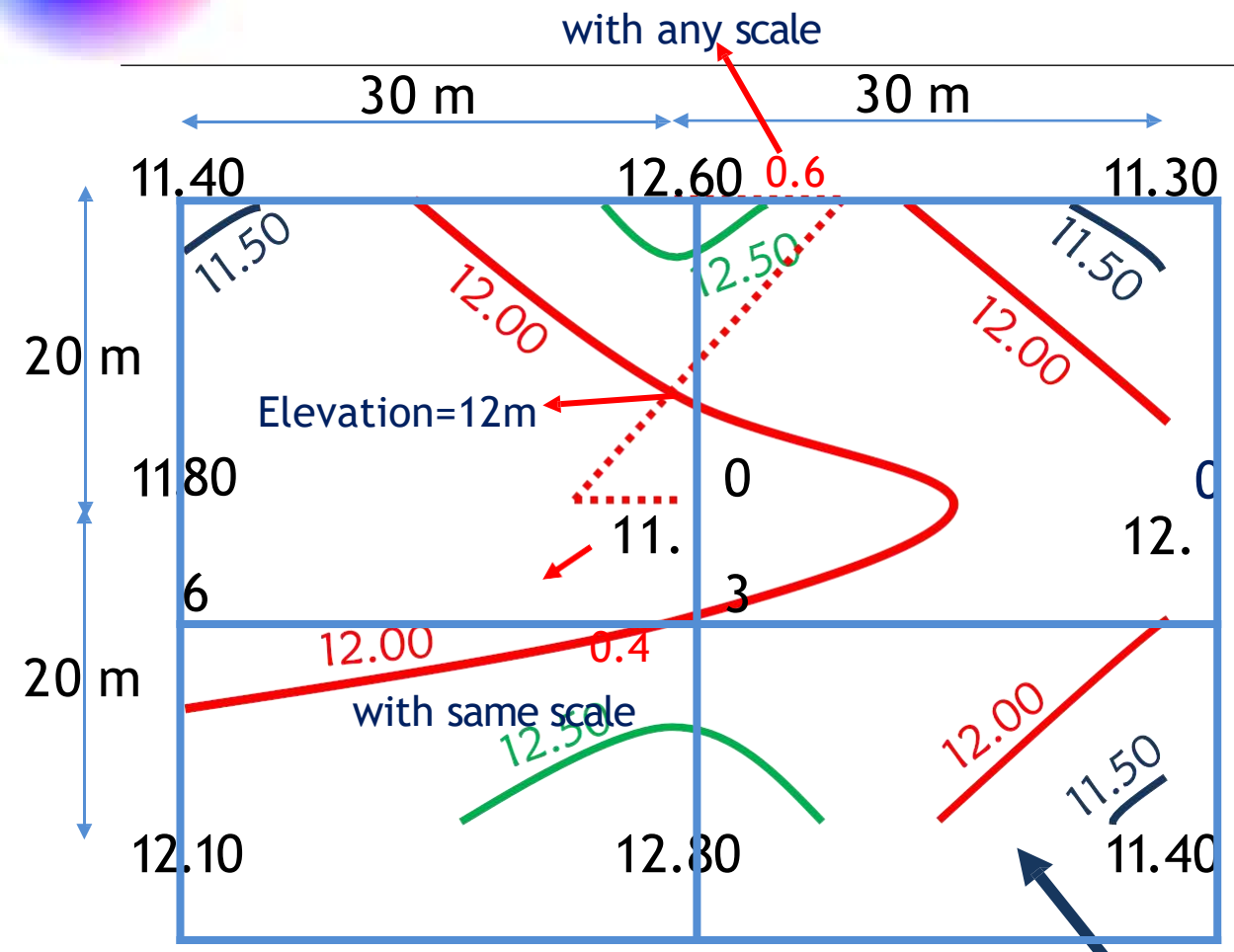
h1 = 12.6-12=0.6m

h2 = 12-11.6=0.4m



$$\frac{h1}{h2} = \frac{x}{L-x}$$ ⇨ Get X

How to Interpolate Contours



Say contour interval 0.5m

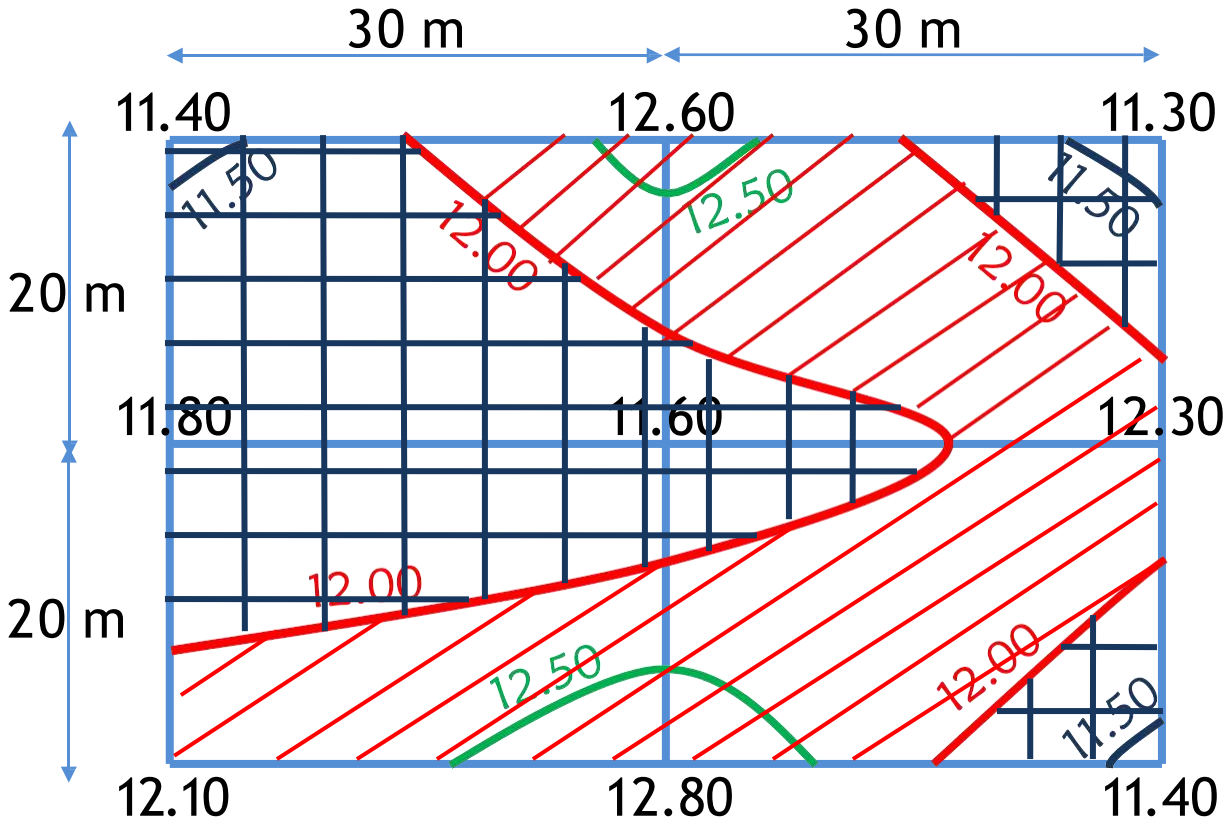
Min. height 11.30m

Max. height 12.80m

Then draw contour: 11.5m, 12m, 12.5m

This is drawn on a map with a certain scale

Finding Cut and Fill Areas

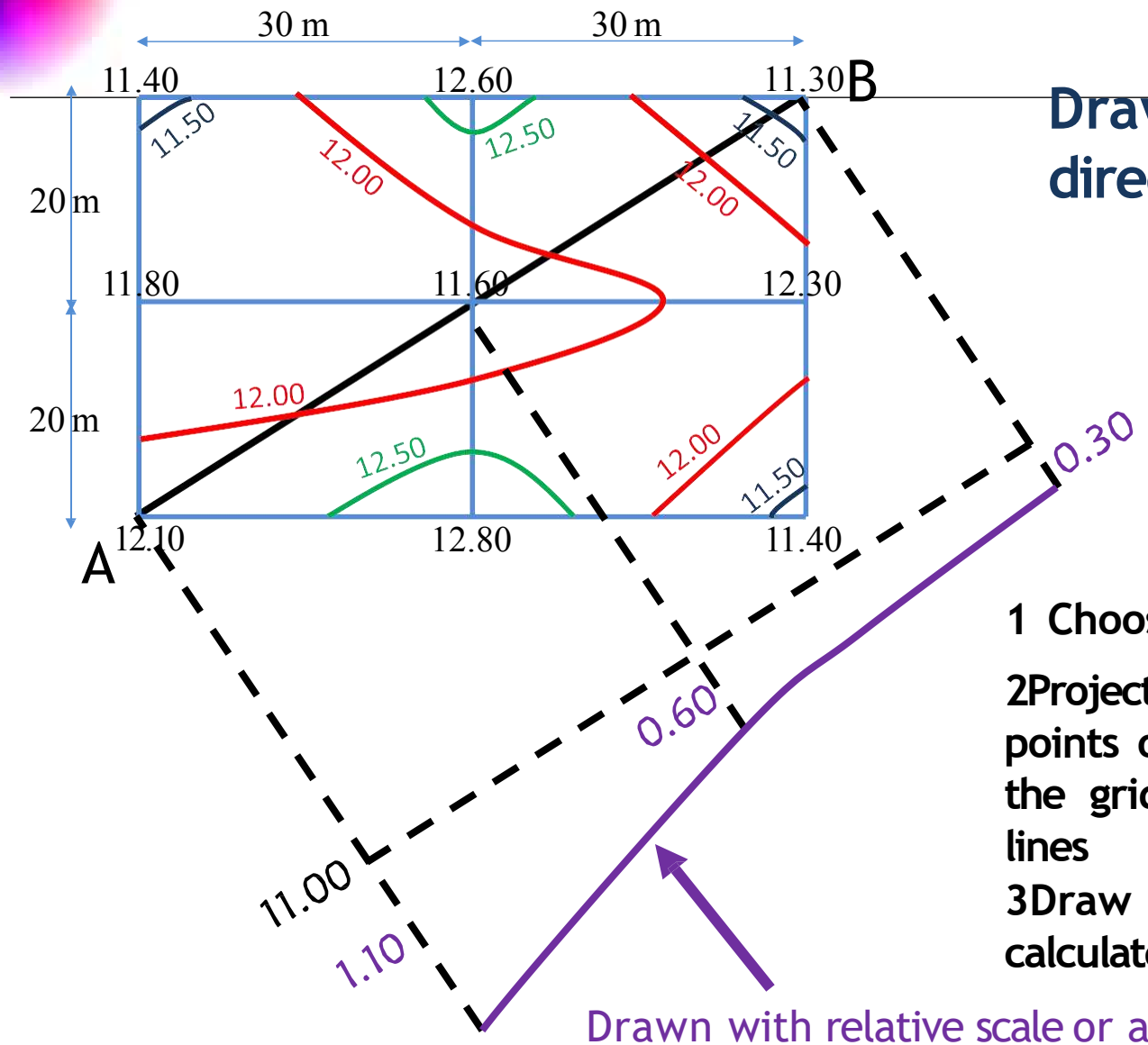


If it is required to level the ground at 12m

CUT

FILL

Drawing a Cross Section



Draw a x-section in direction AB

1 Choose a certain datum

2Project all intersection points of cross section with the grid only not contour lines

3Draw x-section with calculated heights

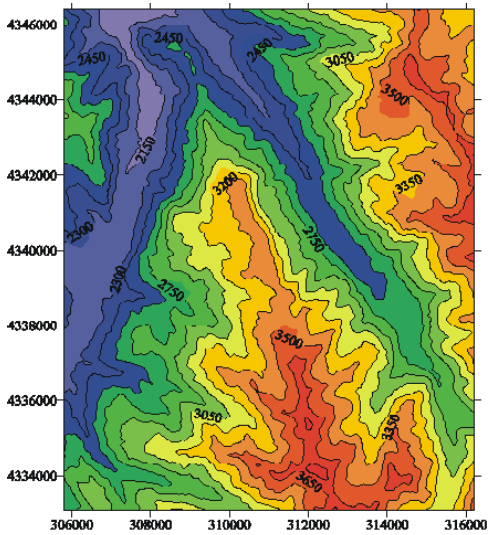
Drawn with relative scale or as given

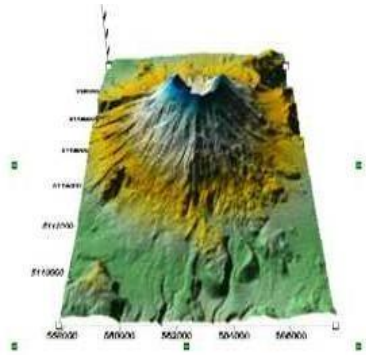
Current Software for Grid Levelling

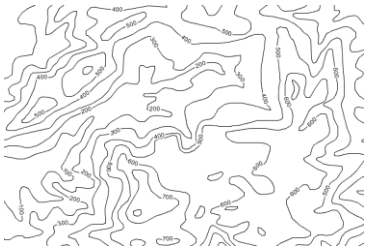
Surfer 8

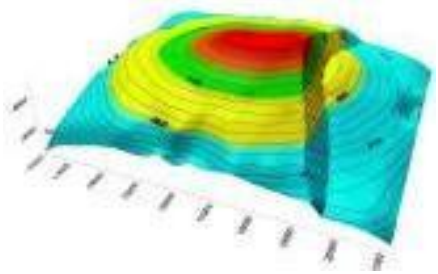
AUTODESK® CIVIL 3D®

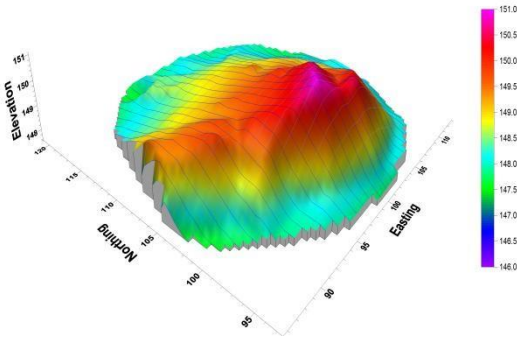
LISCAD™ SURVEYING & ENGINEERING SOFTWARE











Precise (Digital) Level

Precise Levelling

Precise Leveling is a branch of Spirit leveling used to determine the elevation of points with accuracy reaching to

0.05mm

Allowable Errors in Precise Levelling

- Where $$\Delta_{allowable}\,(\text{mm}) = c\sqrt{L\,(\text{km})}$$
- $\Delta_{allowable}$ is the allowable closing error in (mm)
- L is the length of leveling route (km) [Distance between level and BS's and FS's only] No Intermediate sights
- C is the leveling constant depends on the degree of leveling technique
- C = 0.8 - 1.2 for Precise leveling

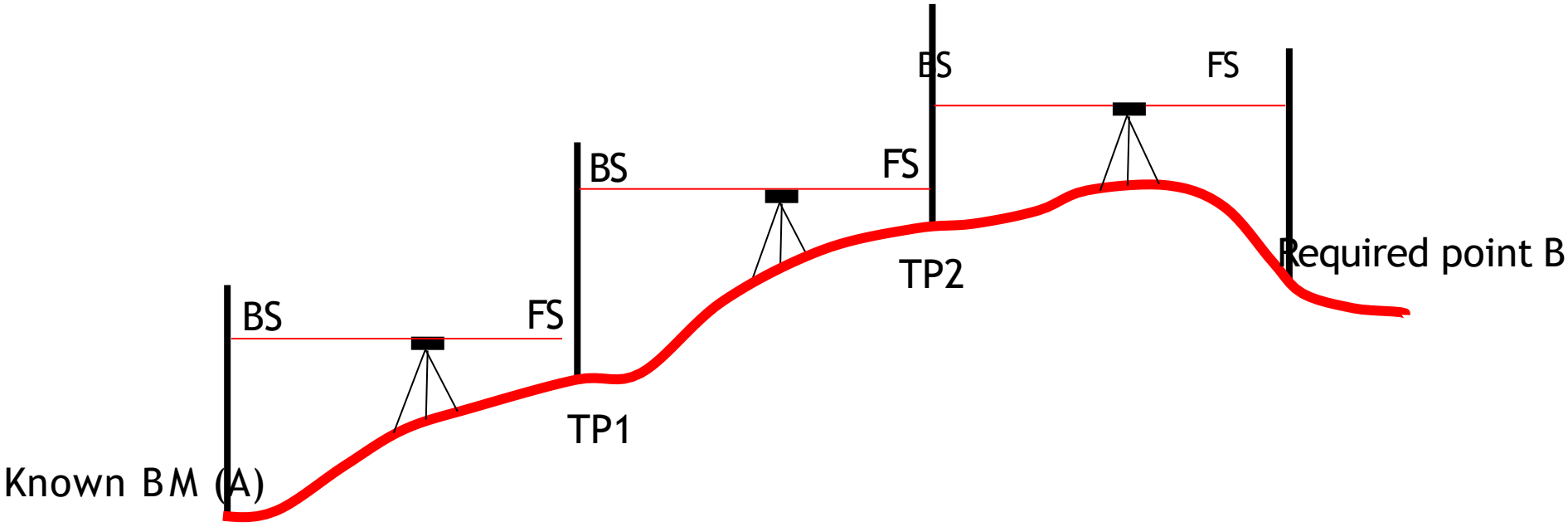
IF $\Delta \le \Delta_{allowable}$ ➡ leveling procedure accepted ➡ distribute error on no. of setups

IF $\Delta > \Delta_{allowable}$ ➡ leveling procedure rejected ➡ STOP ➡ repeat observations

Application of Precise Leveling

Benchmark Transfer

The required elevation of point (B) (within the desired project area) located at a far distance from a known Benchmark (A) is obtained through BS's and FS's only without the need to measure intermediate sights, in order to be accurate as possible by decreasing the number of observed points.



Supplementary files:

- https://www.youtube.com/watch?v=I1uPExz5QhU
- https://www.youtube.com/watch?v=v5Q1xag4_Yg
- https://wecivilengineers.wordpress.com/2018/09/02/features-advantages-of-digital-level-surveying/
- https://www.sccssurvey.co.uk/leica-ls15-digital-level.html

Thanks

Dr.Eng. Hassan Mohamed