GNSS Ellipsoid Height to Orthometric Height (Geoid)

Orthometric heights from GNSS ellipsoid heights and geoid undulations at two points, the height difference, and the error if geoid change is ignored.

Method: Ellipsoid; geoid and orthometric heights

Input parameters

Unit system: SI

Parameter	Value	Unit
Ellipsoid height, point 1	132.62	m
Geoid undulation, point 1	-31.425	m
Ellipsoid height, point 2	158.20	m
Geoid undulation, point 2	-31.318	m

Calculated results

Parameter	Value	Unit
Orthometric height, point 1	164.04	m
Orthometric height, point 2	189.52	m
Orthometric height difference	25.479	m
Error if the geoid slope were ignored	107.00	mm

Notes for this case

• GNSS gives heights above the ellipsoid (h). Heights above the geoid (orthometric H, close to mean sea level) follow from H = h − N, with the geoid undulation N from a geoid model (for example GEOID18, EGM2008) at each point. N is negative where the geoid lies below the ellipsoid (most of the US, India). Over short distances the change in N matters more than its value; ignoring it gives the error shown.

Formula and method

$$H = h - N, \quad \Delta H = (h_2 - h_1) - (N_2 - N_1)$$

Variables

h_1	Ellipsoid height, point 1	m
N_1	Geoid undulation, point 1	m
h_2	Ellipsoid height, point 2	m
N_2	Geoid undulation, point 2	m
H_1	Orthometric height, point 1	m
H_2	Orthometric height, point 2	m
ΔH	Orthometric height difference	m
$\Delta h - \Delta H$	Error if the geoid slope were ignored	m

Method and standards

Geoid heights.

Assumptions and limits

- Geoid undulations from a consistent model; deflection of the vertical neglected.

References

Ellipsoid, geoid and orthometric heights

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/civil/surveying/gnss-orthometric-height

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Reopens the calculator with the inputs of this report.