Survey Error Propagation: Sums, Series and Areas

Standard error of a sum of two measured quantities, of a distance taped in a series of equal segments, and of a rectangular area, with 95 % values.

Method: Propagation of random errors

Input parameters

Unit system: SI

Parameter	Value	Unit
Quantity a (length)	250.00	m
Standard error of a	15.000	mm
Quantity b (length)	120.00	m
Standard error of b	10.000	mm
Number of segments in a series	10.000	
Standard error per segment	5.0000	mm

Calculated results

Parameter	Value	Unit
Error of the sum a + b	18.028	mm
Area a × b	30,000	m²
Error of the area	3.0806	m²
Error of the series total	15.811	mm
95 % error of the sum	35.334	mm

Notes for this case

• Random, independent errors add as the square root of the sum of their squares. A sum: σ = √(σ_a² + σ_b²). A series of n equal segments each with σ_s: σ = σ_s√n (errors grow with the square root of the number of segments, not linearly). A product such as an area: σ_A = √(b²σ_a² + a²σ_b²). The 95 % error is 1.96σ. Systematic errors (wrong tape length, temperature) do not cancel this way and must be corrected first.

Formula and method

$$\sigma_{a+b} = \sqrt{\sigma_a^2 + \sigma_b^2}, \quad \sigma_{series} = \sigma_s \sqrt{n}, \quad \sigma_A = \sqrt{b^2\sigma_a^2 + a^2\sigma_b^2}$$

Variables

a	Quantity a (length)	m
σ_a	Standard error of a	m
b	Quantity b (length)	m
σ_b	Standard error of b	m
n	Number of segments in a series	-
σ_s	Standard error per segment	m
σ_{a+b}	Error of the sum a + b	m
A	Area a × b	m²
σ_A	Error of the area	m²
σ_{series}	Error of the series total	m
E_{95}	95 % error of the sum	m

Method and standards

Error propagation.

Assumptions and limits

- Independent random errors; small errors relative to values.

References

Propagation of random errors

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/survey-error-propagation

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Reopens the calculator with the inputs of this report.