*cg***Calc** - Center of Gravitiy (CG) Calculator

The *cg***Calc** of eCalc.ch not only calculates and evaluates the center of gravity (CG), neutral point (NP) and mean aerodynamic chord (MAC) but also visualizes your design of conventional aircraft, flying wing, delta or canard. Approximate complex wing design with **5 trapezoidal wing panels**. For further instructions see below...

Never ever exceed Center of Gravity on maiden flight!
Select a actual CG slightly in front of calculated CG for first flight.

Aircraft or Project Name: Zorro XXL

Units: mm

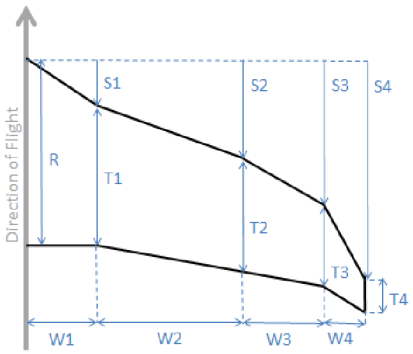
Deutsch

Wing:

Root Chord [R]:	240					mm
Tip Chord [T1-T5]:	160	0	0	0	0	mm
Sweep [S1 - S5]:	15	170	0	0	0	mm
Panel Span [W1 - W5]:	905	65	0	0	0	mm

Tail: Flying Wing (0%) (Tail Effectivness)

Root Chord [R]:	17.5					mm
Tip Chord [T1-T5]:	17.5	24.5	14	12.6	0	mm
Sweep [S1 - S5]:	0	0.75	3	4	0	mm
Panel Span [W1 - W5]:	4	7	24	1	0	mm



(if less than 5 half wing panels are required, define the panel span = 0 starting from the far right with W5)

Distance LE Wing to Tail [D]: 88 mm (use negative value for canard)

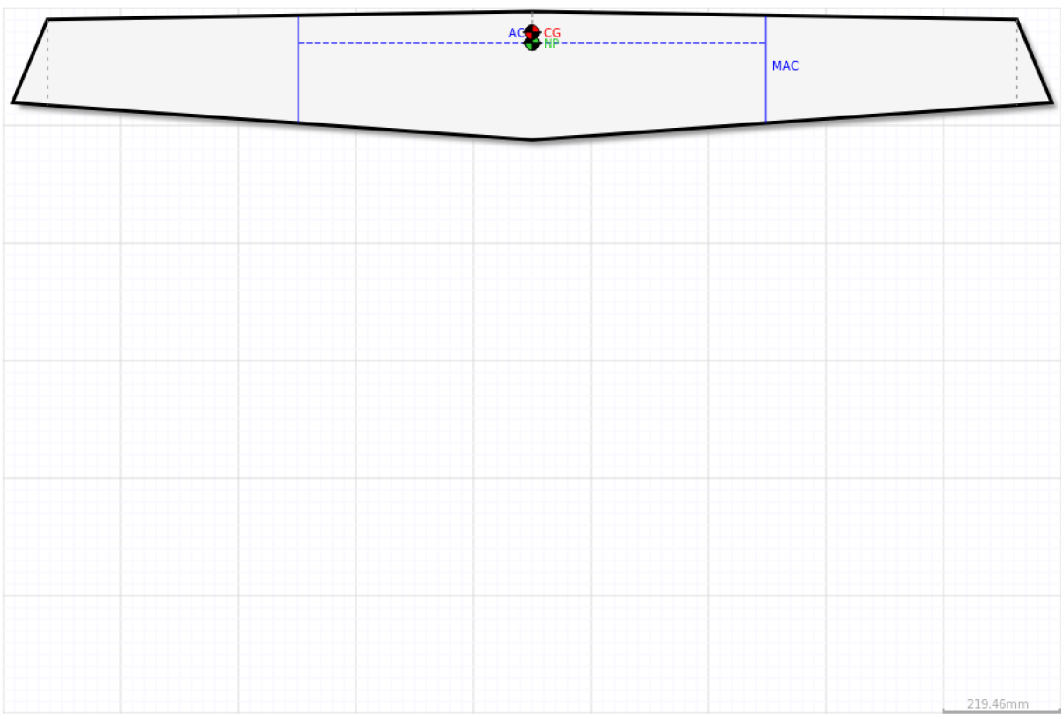
AC Position: 25 % of MAC (default: 25%)

Static Margin: 15.0 ... 10.0 % of MAC (advice: between 15 and 5%)

calculate

Results: Link to recall Zorro XXL

Aircraft CG range [●]:	**28.66 ... 38.66** mm (= 10.00 ... 15.00% of MAC)	Aircraft NP [●]:	58.66 mm (= 25.00% of MAC)
Wing AC [●]:	58.66 mm (= 25% of MAC)	Tail AC [●]:	0.00 mm (= 25% of MAC)
Wing MAC @ Distance	199.99 mm @ 436.42 mm	Tail MAC @ Distance	0.00 mm @ 0.00 mm
Wing Span:	1940.00 mm	Tail Span:	0.00 mm
Wing Area:	**372400.00** mm²	Tail Area:	**0.00** mm²
Wing Aspect Ratio:	10.11	Tail Aspect Ratio:	0.00
		Stabilizer Volume (V_{bar}):	0.00

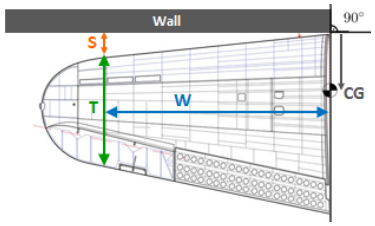


How to use:

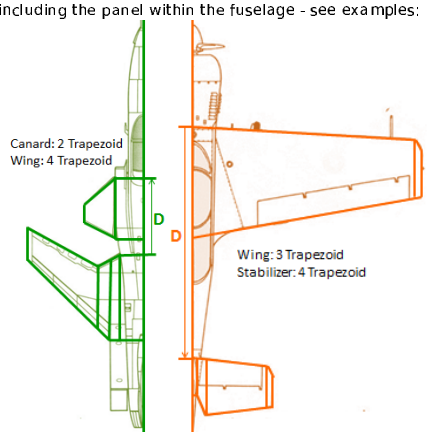
1. Select the units of measurements.

Explanation:
It has been found both experimentally and theoretically that, if the aerodynamic force is applied at a **location of 25%** of the

2. Take your wing or entire airplan and align it in a right angle to a wall.



3. Approximate your wing with max. 5 trapezoidal panel including the panel within the fuselage - see examples:



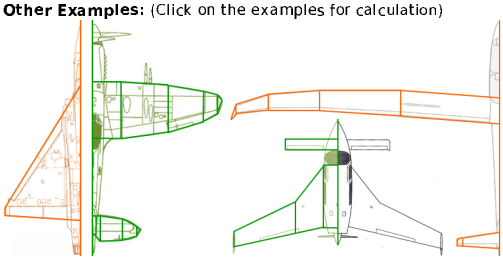
Grumman X-29 Sukhoi Su-29

4. accurately measure chord (R & T), sweep (S) and panel span (W) of each trapezoid according sketch on top.
   Remark[1]: for extreme wing dihedral (V-shape) or for all V-Tail use the planform dimensions projected onto the horizontal plane.
5. select the type of your tail (standard stabilizer, T- or V-tail, canard, flying wing or delta) and repeat 2. to 4. for your stabilizer.
6. measure the distance (D) from the leading edge (LE) of the main wing to the leading edge of the stabilizer (see abouve).
7. define the static margin.

Results:

- Verify the wing drawing does correspond to your airplane
- Verify the wing and tail span do match the span of your plane
- Verify the wing area corresponds to manufacturers information
- The Center of Gravity is measured in the middle of the fuselage from the leading edge (LE) of the main wing. Positive value are towards the back, negative towards the front of the aircraft.
- Use a rather conservative CG value for inflight evaluation and approch a lower static margin (decreased stability) in small steps.

Other Examples: (Click on the examples for calculation)



Mirage 2000 Spitfire Mk 47 Velocity XL
Arcus

Mean Aerodynamic Cord (MAC), the magnitude of the aerodynamic moment remains nearly constant even when the angle of attack changes. This location is called the wing's **Aerodynamic Centre (AC)**. The AC value is always measured from the **Leading Edge (LE)** in the center of the corresponding wing.

The **Neutral Point (NP)** of an aircraft is the point where the aerodynamic forces are balanced. Having two or more wings interacting on your aircraft (e.g. main wing and tail) they influence the aerodynamic forces to your aircraft. The NP value is always measured from the leading edge (LE) in the center of the main wing.
The **«tail effectivness»** influences the NP position and does not only depend on it's size, but also it's location relative to the main wing.
V-Tail[1]: project the V-Tail onto the horizontal plane and use the projected dimensions.
Flying Wings & Delta: Do not have a tail (second wing). Therefore Aerodynamic Center (AC) and Neutral Point (NP) are identical.
Canard: Although the stabilizer is in front of the main wing, the stabilizer has to be defined as «tail» wing. However, make sure the Distance between main wing and tail (stabilizer) is defined as a **negative value**.

The **Center of Gravity (CG)** is the point where the aircraft's weight is balanced. The CG value is always measured from the leading edge (LE) in the center of the main wing.
For longitudinal stability the CG is placed 5% to 15% of MAC in front of the NP. This margin for stability is called **Static Margin**. A lower static marging will result in less stability, a grater elevator authority (agility) and a more «tail heavy» aircraft. But any CG byond NP will lead to uncontrolable flight conditions and aircraft upset.
A higher static margin creates more stability, less elevator authoritiy (slugish pitch) and a more «nose heavy» aircraft. Too much static margin may lead to an elevator stall unable to pitch the aircraft for take-off or landing
For a **typical conventional aircraft design** the CG is between 25% to 38% of MAC.
The **Stabilizer Volume** (Vbar) is a value for maneuverability. The lower the more agile the aircraft gets. Typical values are:

0.5...0.9 Trainer
0.3...0.6 Aerobatic
0.5...0.8 Glider
0.5...1.1 High-lift Jet
0.3...0.5 Combat Jet
0.0 for Delta & Flying Wing (due missing Stabilizer)

The optimal Center of Gravity must be evaluated in flight. For safety reason start CG evaluation always in a conservative manner with a static margin of 15...5% for a good longitudinal stability. Optimize CG in small steps only! **Never ever exceed CG on maiden flight!**

Limitations - what does *cgCalc* NOT do:

- *cgCalc* does not provide aerodynamic performance analysis.
- Propulsion and aeroelasic effects on incidence and dynamic stability are not covered.
- *cgCalc* is not able to calulate NP of bi-planes.
- Canard: For canard configuration the stabilizer is significant smaller than the main wing. For tandem wings use the «std stabilizer» option.
- Fuselage: *cgCalc* does not take into account the lift effect of «fat» fuselage. Having a fat fuselage in front the main wing, use an additional 5% static margin (see Sukhoi example uses rather 15% than 10% static margin).
- Jets with intake below or ahead of the wing and twin aircraft with wide nacelles do have a significant destabilizing effect and is not taken into account by *cgCalc.*

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