

# Aerofuselage

Objects from the `aerofuselage` class create lift and drag based on their geometry, coefficients, airspeed and attitude relative to the airflow direction. All larger objects in the Aerofly FS 2 Flight Simulator, that create significant amounts of lift and drag and each use their own `aerofuselage` object. Those larger aircraft parts could be the main fuselage, the closed engine cowlings like the ones in twin engine aircraft, but not the nacelles of turbofan engines. Nacelles can currently not be modeled due to their ring like shape.

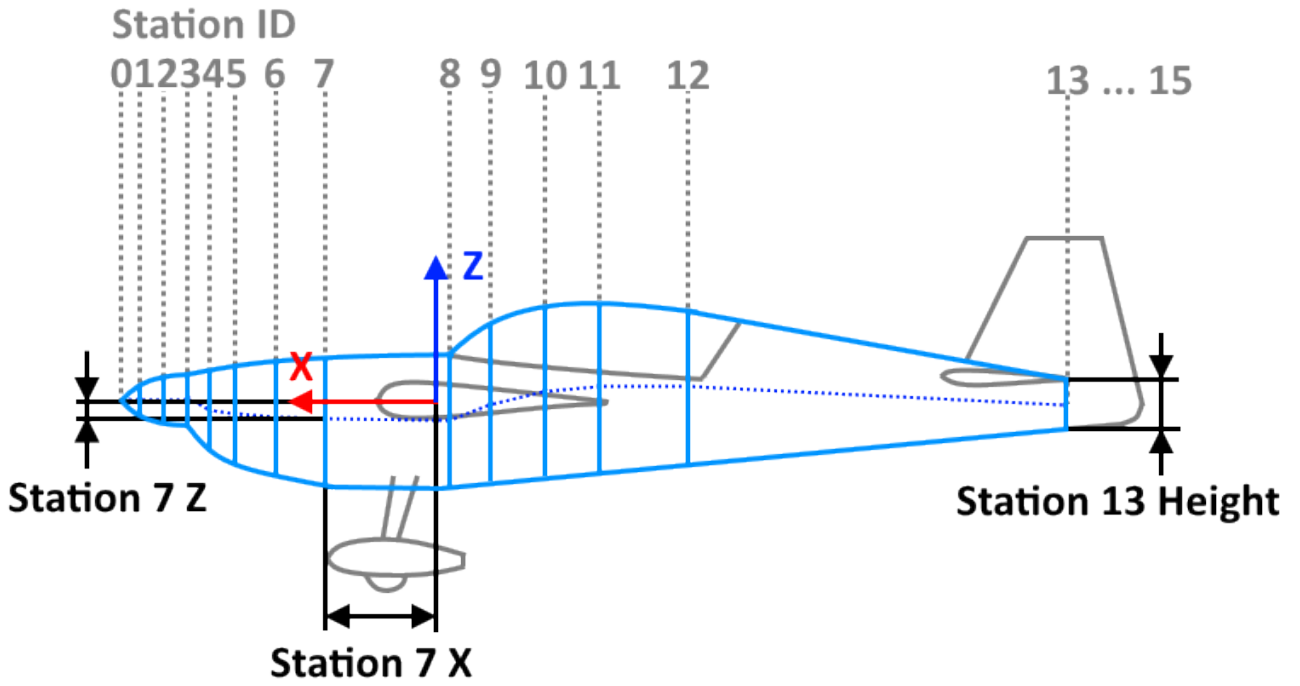
In knife edge flight or high angles of attack the `aerofuselage` creates the greatest amount of lift compared to all other aerodynamic objects. Like an airfoil the aerofuselage has a lift coefficient, in fact two even. One for the side forces (y-direction) and one for the up/down forces (z-axis). It also has a drag coefficient for each of the axis.

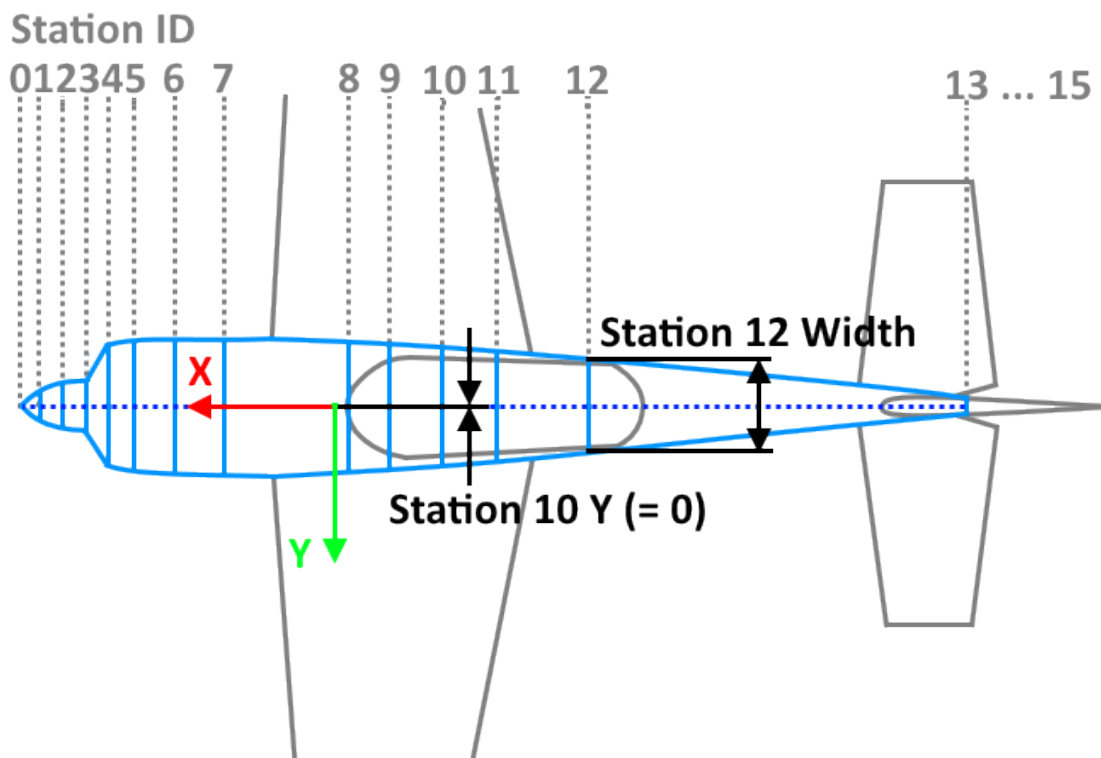
## Other aerodynamic classes

[aerowing](#), [airfoil](#), [airbrake](#), [propeller](#), [aerodrag](#)

## Stations

Like an [aerowing](#) an `aerofuselage` is divided into at least two sections with a maximum count of 16. Each section (station) has an X, Y and Z position, a height and width and a shape parameter assigned in the appropriate arrays: `StationX`, `StationY`, `StationZ`, `StationWidth`, `StationHeight` and `StationShape`. Each of these array must contain the same number of values. For readability it is recommended to align the sections values to form a grid pattern in the TMD code (example code below). The shape attribute is an approximation of the fuselages shape for a cross section at the given station x position. It can be either round 0 or rectangular 1. Round shapes will produce other flight behavior than rectangle shapes.





## Coefficients

An aerofuselage instance can have up to 6 different coefficients:

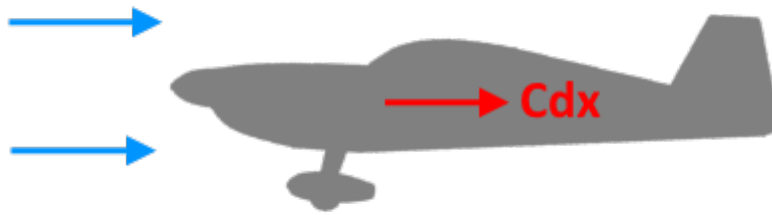
- 3 drag coefficients, one for each axis:  $C_{dx}$ ,  $C_{dy}$  and  $C_{dz}$
- 2 lift coefficients for y and z  $C_{ly}$  and  $C_{lz}$
- 1 moment coefficient  $C_m$

## Level flight

### $C_{dx}$

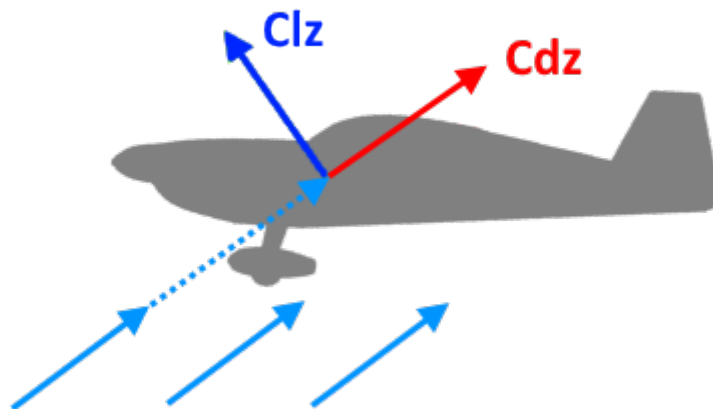
The  $C_{dx}$  parameter is the drag coefficient in flight direction. When the air only comes from the front this is the only coefficient that shows any influence on the flight behavior of the aircraft. A higher coefficient results in a higher drag produced by the fuselage and therefore reduces the distance the aircraft can glide. A higher value also affects the maximum velocity of the aircraft because the drag increases while the thrust remains the same. The  $C_{dx}$  value must be positive for a realistic physics simulation.

Typical values are between 0.3 and 0.05. Gliders have less, aircraft with rougher surfaces tend to have higher values.



## Flight in high angle of attack

At a great angle of attack the large geometry of a fuselage can create significant amounts of lift and drag. In the Aerofly FS 2 these affects are simulated and can be fine tuned using the  $C_{lz}$ ,  $C_{dz}$  and also the  $C_m$  value (see below).



### $C_{lz}$

The  $C_{lz}$  describes the lift of the fuselage created by the increase of the [angle of attack](#). With a larger value the fuselage contributes a significant amount of the total lift of an aircraft.

0.5 is a good value to start with

For aerobatic aircraft:  $C_{lz}$  should be set lower than the  $C_{ly}$  if the fuselage is taller than wide. Otherwise rolling circles or loops tend to oscillate upwards each time the wings are somewhat level compared to the knife edge attitude where the fuselage creates almost all of the lift.

This value greatly affects the rotation speed of the knife edge spin

## Cdz

The  $C_{dz}$  parameter serves a similar purpose as the  $C_{dy}$  for the z-axis. A greater value will increase the drag produced by the fuselage as the angle of attack is increased.

1.2 is a good value to start with

The amount of power in high angle of attack attitude (stall or even hover) is affected by this parameter. However the largest drag component comes from the induced drag of the [aerowings](#).

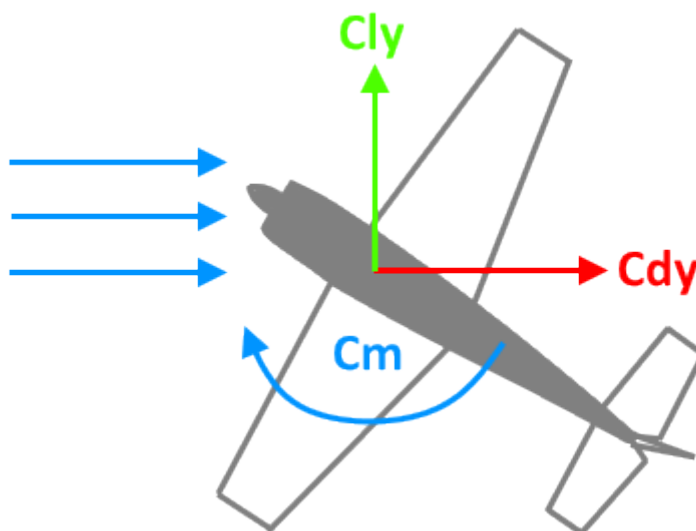
The nose-down attitude of the airplane while in a spin is affected by this value.

Lower values will increase the agility for aerobatics maneuvers such as tubles but also snap rolls.

A lower value increases a gliders performance at higher angle of attack, which is the case for tight turns in a thermal.

## Knife Edge flight

During a knife edge flight the fuselage of an aircraft is hit sideways at an angle and can act like an airfoil depending on its shape. In the Aerofly FS 2 this is modeled by the aerofuselage shape parameter, its geometry defined by the stations and fine-tuned by the values below.



## $C_{ly}$

$C_{ly}$  is the lift coefficient of the fuselage for sideways streams of air (side-slip, y-axis). The greater the value the more side force the fuselage produces at a given side slip angle.

0.6 is a good initial value.

With higher values the airplane requires less side slip angle to maintain altitude in the knife edge flight. Use a moderate value for aerobatic airplanes to make them more realistic and also more agile.

## Cdy

Cdy is the drag coefficient of the fuselage for a sideways stream of air (y-axis). The greater the value the more drag the fuselage creates when in a side-slip condition. With a higher value the required thrust or the sink rate increase while in side-slip. Its value must be positive for a realistic physics simulation.

1.0 to 1.5 is a good value to start with

The rate of a flat spin is greatly dependent on this value. Higher values will result in a much lower rate of turn while in a flat spin

Reducing the value for Cdy will increase the agility of the airplane. It will do snap rolls and other aerobatics more easily.

This attribute determines the amount of power needed for KnifeEdge flight.

## Cm

With a Cm value greater than 0.0 the aerofuselage destabilizes the aircraft around the y and z axis. With a value lower than 0.0 it stabilizes the flight path.

A Cm of 0.0 or slightly positive is the most realistic value because the majority of the moment of the fuselage is already calculated by the geometry described by the stations and its relative positioning to the [center of gravity](#) of the entire aircraft.

The Cm of the fuselage is not the ideal parameter to make an aircraft more agile around the pitch axis. Use [aerowing downwash](#) and the [airfoil CmAlpha](#) parameters.

## Propeller

The LateralForceCoefficient and LateralDragCoefficient of a [propeller](#) also have a large influence on the knife edge flight. (Please see main topic about the [propeller](#) class)

## Example Code

### Minimal

**Caution:** Requires a [rigidbody](#) with the name Fuselage

```
<[aerofuselage][FuselageAero][[
  <[string8][Body][Fuselage]>
  <[float64tmarray][StationX]      [ 1.0 -1.0 ]>
  <[float64tmarray][StationY]      [ 0.0  0.0 ]>
```

```

    <[float64tmarray][StationZ]      [ 0.0  0.0  ]>
    <[float64tmarray][StationWidth] [ 0.05 0.05 ]>
    <[float64tmarray][StationHeight][ 0.05 0.05 ]>
    <[uint32tmarray][StationShape]  [ 0    0    ]>
    <[float64][Cdx][0.05]>
    <[float64][Cdy][0.8]>
    <[float64][Cdz][0.8]>
    <[float64][Cly][0.6]>
    <[float64][Clz][0.6]>
    <[float64][Cm] [0.0]>
  >

```

## All

**Caution:** Requires a [rigidbody](#) with the name Fuselage

```

<[aerofuselage][FuselageAero][ ]
  <[string8][Body][Fuselage]>
  <[tmvector3d][R0][ 0.0 0.0 0.0 ]>
  <[tmvector3d][X0][ 1.0 0.0 0.0 ]>
  <[tmvector3d][Y0][ 0.0 1.0 0.0 ]>
  <[tmvector3d][Z0][ 0.0 0.0 1.0 ]>
  <[float64tmarray][StationX]      [ 1.0  0.5  -0.5  -2.0  ]>
  <[float64tmarray][StationY]      [ 0.0  0.0  0.0  0.0  ]>
  <[float64tmarray][StationZ]      [ 0.0  0.0  0.0  0.0  ]>
  <[float64tmarray][StationWidth] [ 0.0  0.2  0.1  0.05 ]>
  <[float64tmarray][StationHeight][ 0.0  0.25  0.125  0.05 ]>
  <[uint32tmarray][StationShape]  [ 0    1    1    0    ]>
  <[float64][Cdx][0.05]>
  <[float64][Cdy][0.8]>
  <[float64][Cdz][0.8]>
  <[float64][Cly][0.6]>
  <[float64][Clz][0.6]>
  <[float64][Cm] [0.0]>
  <[float64][Offset][0.0]>
  <[bool][HasSwimmer][false]>
>

```

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