SailPowerCalc v1.1 ©WB-Sails 1996-2006

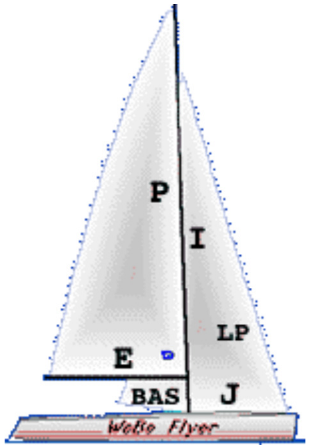
Revised 2/2006

This little JavaScript application calculates the sail areas, forces and moments, when given the rig measurements and wind conditions. It represents in a simplified manner the aerodynamic module of a VPP (Velocity Prediction Program), used to predict the sailboat's performance.

WIND & HEEL	RESULTS	INFO & THEORY	WB-NEWS

RIG MEASUREMENTS given in meters. You can change these ...

P main luff	5	m	**E** main foot	2	m
I jib hoist	5	m	**J** jib base	1	m
Not in use	0		**spinArea** spinnaker area	0.0	m^2
LP percent J	120% 110% 100% 90%	–	**BAS** boom height **RMC** righting moment	0.80 78	m – kgm/¡
P in feet	16.4	ft	**E** in feet	6.6	ft
I in feet	16.4	ft	**J** in feet	3.3	ft
Not used		ft	**spinArea** in feet^2	0	ft^2
BAS in feet	2.6	ft	**RMC** lb.ft/¡	564	lb. ft/¡



SailPowerCalc automatically recalculates when you change a value - TAB or click out of a field, to see the effects of the changes on the sail forces. All input is metric - the measurements in feet /knots are merely converted, and do not affect calculation.

WIND & BOAT ... and these ...					
AWS apparent wind speed	10	m/s	**AWA** apparent wind angle	90	deg
HEEL angle (given)	11	deg	**AWS** app. wind speed in knots	19	kn

SAIL AREAS, FORCES & MOMENTS ... to see the results down here.								
Mainsl area	5.9	m^2	**Jib** area	2.3	m^2	**Spinnaker** area	0	m^2
	63	sq ft		25	sq ft	Spinnaker up	0	sq ft
Heel angle (estimated)	2	deg	○ Auto depower ◉ Keep full power					
Sail Drive	74	kgf	**Sail Heel**	44	kgf	**Heeling Moment**	128	kgm
	164	lb		98	lb		690	lb ft

Update	Reset	**BACK TO INPUT**

Additional data

Leeway	2.3	deg	Center of effort height % of rig height	37	%	Rig aspect ratio	4.1
Drive to HM ratio	0.581		Depowering factor	1		Lift coefficient	1.393
Driving force coefficient	1.393		Heeling force coefficient	0.863		Drag coefficient	0.863

BACKGROUND INFO The sail force coefficients used by SailPowerCalc are based on *Personal VPP,* a velocity prediction program written by Mikko Brummer in -92.

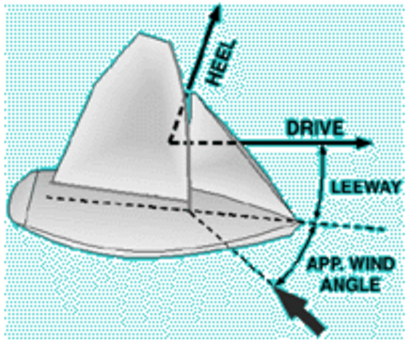
Sail areas

Sail areas are calculated from the basic rig measurements P, E, I and J. The boom height above sheerline BAS is needed for the calculation of the heeling moment. The righting moment RMC can be found, for instance, in an IMS-certificate. It is the moment needed to heel the boat over one degree.

Wind is apparent, not true

All the wind values are apparent wind, not true wind. VPPs usually base their data on true wind values, but since boatspeed is unknown, and sails work on apparent wind, SailPowerCalc has to rely on apparent wind.

Sail Drive & Heel



The sail drive is the actual force that is thrusting your boat forward. Drive is in the direction of the motion of the boat - it differs from the direction of the centerline of the boat by the amount of leeway, since a sailboat is always more or less "slipping sideways". Apparent wind angle is measured to the centerline of the boat.

The heeling force (Sail Heel) is, like the name suggests, the force that is heeling your boat over. It is perpendicular to the centerline of the boat and the mast. The heeling force acts at the height of the center of effort, given in the additional data as percentage of the rig height.

Heel angle & heeling moment

SailPowerCalc calculates the heeling moment about the mast foot (base I), and this heeling moment is not directly comparable to the righting moment (RMC) you can find in your IMS-certificate. Without knowledge of the hull and keel, you cannot calculate the true heeling moment, since part of the heeling arm lies under the water. The true heeling moment is approximately one third larger, pending on the freeboard height and the underwater hull shape.

However, given the RMC, SailPowerCalc can estimate the heel angle at a given wind. For this purpose, the calculated heeling moment is increased by 35%. Since sail forces depend on the boat heel, you must usually "iterate" to to get the given (input) heel and the estimated heel to match. Run SailPowerCalc once, change the given heel to match the estimated one, and re-run by pressing Update. When the two heel figures are the same, your results are accurate.

SailPowerCalc & IMS sail forces

The coefficients used in SailPowerCalc are more complete than those used by the IMS-rule in three respects:

- the drive available is a function of leeway - important in close hauled conditions

- sail forces are corrected for rig aspect ratio
- the genoa overlap factor is more realistic than the blanketing factor of IMS

SailPowerCalc's approach differs from that of the IMS. While IMS estimates mainsail & foresail force coefficients separately, and then puts the two sail together using a blanketing factor, SailPowerCalc looks at the sailplan as one, not attempting to discern the forces of the mainsail and the jib.

Leeway

When trying to pinch a boat, the leeway increases rapidly, decreasing the apparent wind angle (as measured to the centerline of the boat). Sail drive is lost at a steeper rate. SailPowerCalc allows for leeway in simplified manner, since there is no boat data to go with.

Aspect ratio

The rig aspect ratio affects the pointing ability of the boat. A taller rig produces more drive at a given wind angle and for the same sail area than a lower one. Try a very high aspect ratio P= 17.35 m E= 5.00 m, and compare with the default rig (Reset). There is a catch with high aspect ratio - heeling moment goes up - this puts a practical limit to the tallness of the rigs we use on contemporary boats. Low aspect ratio also performs better off wind.

The genoa overlap factor is based on a study with MacSail.

Depowering

As wind increases, you need to depower in order to avoid excessive heel. SailPowerCalc's Auto depower simulates this, by flattening & feathering the mainsail (jib power remains unchanged). Feathering also lowers the sail center of effort, helping to keep heeling moment under control. Keep full power is the default setting. Unlike for the number fields, you need to use the Update-button to validate a change in depower. Decrease the jib-LP to "depower" the foresail.

Depowering starts when apparent wind speeds exceeds 7 m/s (14 knots).

Additional data

Additional data shows some key parameters used in the calculation of sail forces. Leeway is a function of AWA, which is obviously a simplification - again, boat data is needed to compute real leeway. The sail drive to heeling moment ratio is an important parameter for sailboat performance. In light winds, you want to maximise drive, ignoring heeling moment, but as wind picks up, the drive to heeling moment ratio becomes more and more important.

The Reset-button clears calculated fields and sets input values back to default (a fractional rigged, modern 40-footer).

This is a beta-version that has not been extensively tested. There may be bugs (and probably is), so apply the results with appropriate caution.

To run JavaScript, you need Netscape Navigator (version 2.0 or newer), or Microsoft Internet Explorer 3+.

Changes

2/06 A change allowing to specify no spinnaker, as suggested by Reino Urala, was implemented, and coefficients were revised to better match wind tunnel tests.

7/98 A bug was fixed to make SailPowerCalc compatible with Navigator 4+. A problem associated with the setting of the spinnaker in harder winds (pointed out by several users) causing drive to become negative, still needs to be addressed.

3/97 35% was added to the heeling moment, to simulate the under water part of the heeling arm. Though mentioned in the Background info, this feature was never implemented in the code. The bug came out when comparing with SailTrimSim results. Heel angles are increased accordingely.

BACK TO SAILPOWERCALC

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