



EN1991 Biomechanics in Pulling-test

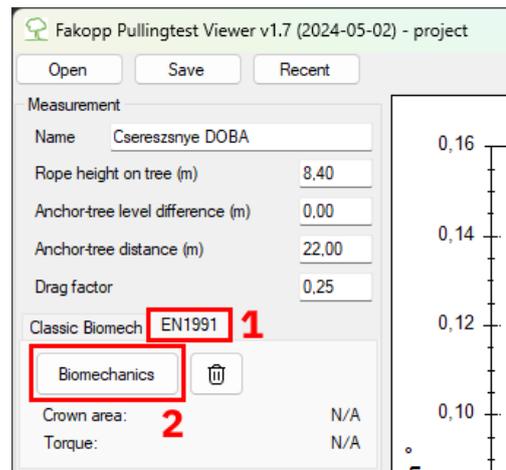
2024.05.07.

Guide to EN1991 Biomechanics

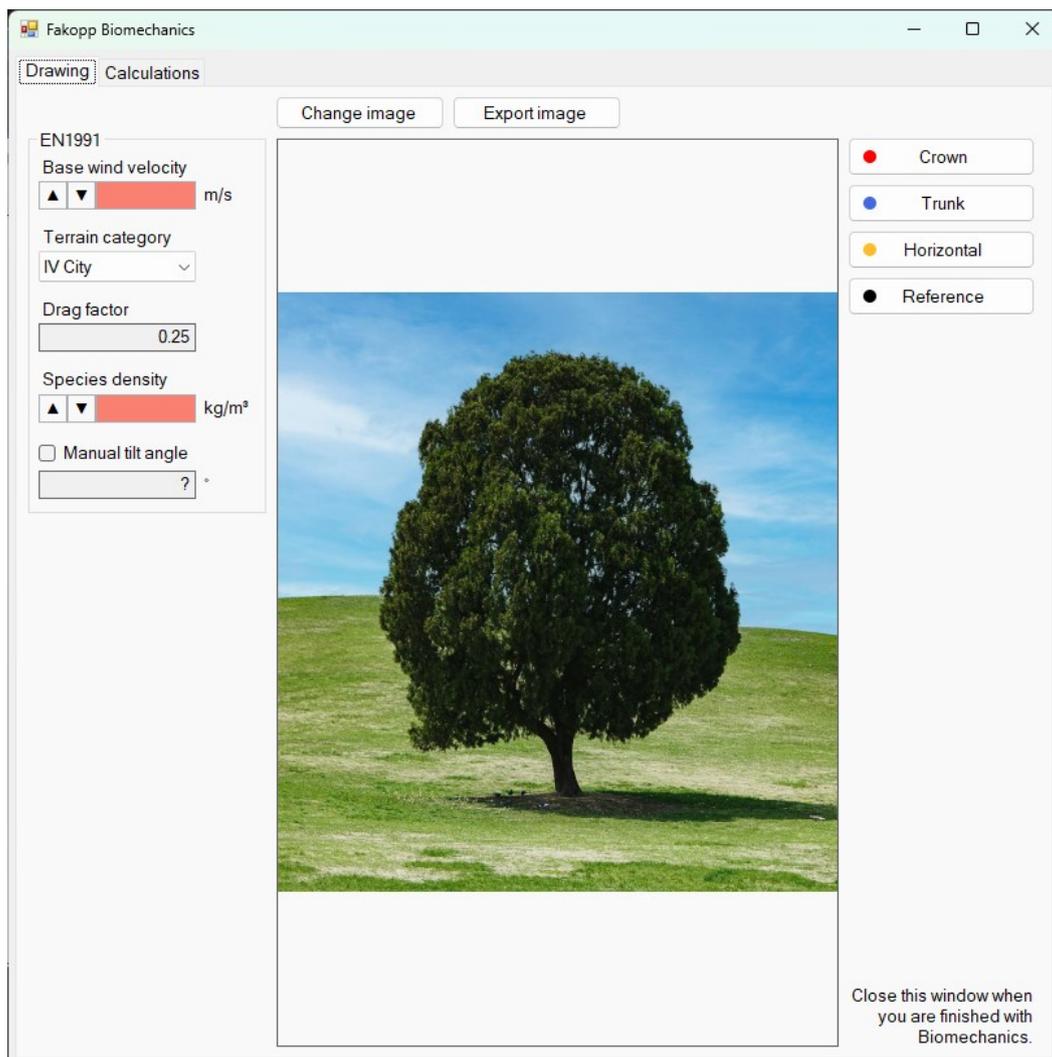
Start biomechanics

To start EN1991 based biomechanics:

1. Click on the “EN1991” tab
2. Click on the “Biomech” button



- Select an image of the tree being measured. (Make sure that the tree takes up most of the image.)
- The Biomechanics window will show the image:



Set EN1991 parameters

Start by entering the parameters of the model:

1. The base wind velocity: declared in section 4.2 of the EN1991-1-4 standard, and should be given in the National Annex.
2. Terrain category: defined in table 4.1 of section 4.3.2 of the EN1991-1-4 standard, and may be given in the National Annex.
3. The drag factor of the tree (can be specified in the main window, above the EN1991 tab).
4. The density of the tree species.
5. The tilt angle will be calculated automatically from the image once all lines have been drawn. Alternatively it can be entered by checking the “Manual tilt angle” box. (This is necessary when the tree tilt amount is not clearly visible on the image.)

EN1991

Base wind velocity m/s

Terrain category

Drag factor

Species density kg/m³

Manual tilt angle

°

Define tree dimensions

Start drawing on the image by clicking on one of the buttons to the right.

- Crown: draw the outline of the tree crown
- Trunk: draw the outline of the tree trunk
- Horizontal: draw a horizontal line representing the horizontal level of the image at the base of the tree
- Reference: draw a line representing a known length on the image (most commonly the height of the tree)

Crown

Trunk

Horizontal

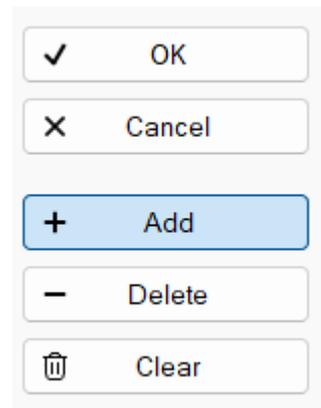
Reference

Add points

To add points to any line:

- Ensure the “Add” button is selected
- Click to add a new point to the end of the line
- You can also insert a point when the mouse cursor is close to the line

Points already place may also be moved by dragging them while the left mouse button is pressed.



Remove points

To remove a point:

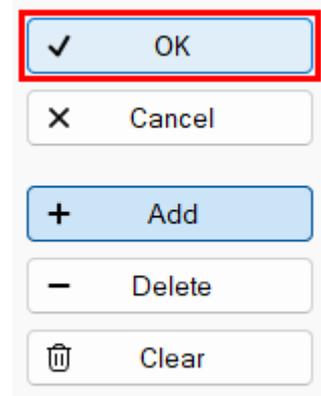
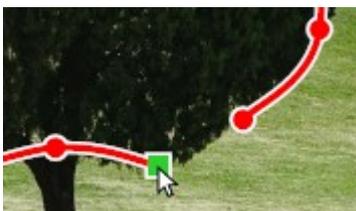
- In “Add” mode: Right click a point
- In “Delete” mode: simply click on a point
- “Clear” button: removes all points



Finish Drawing

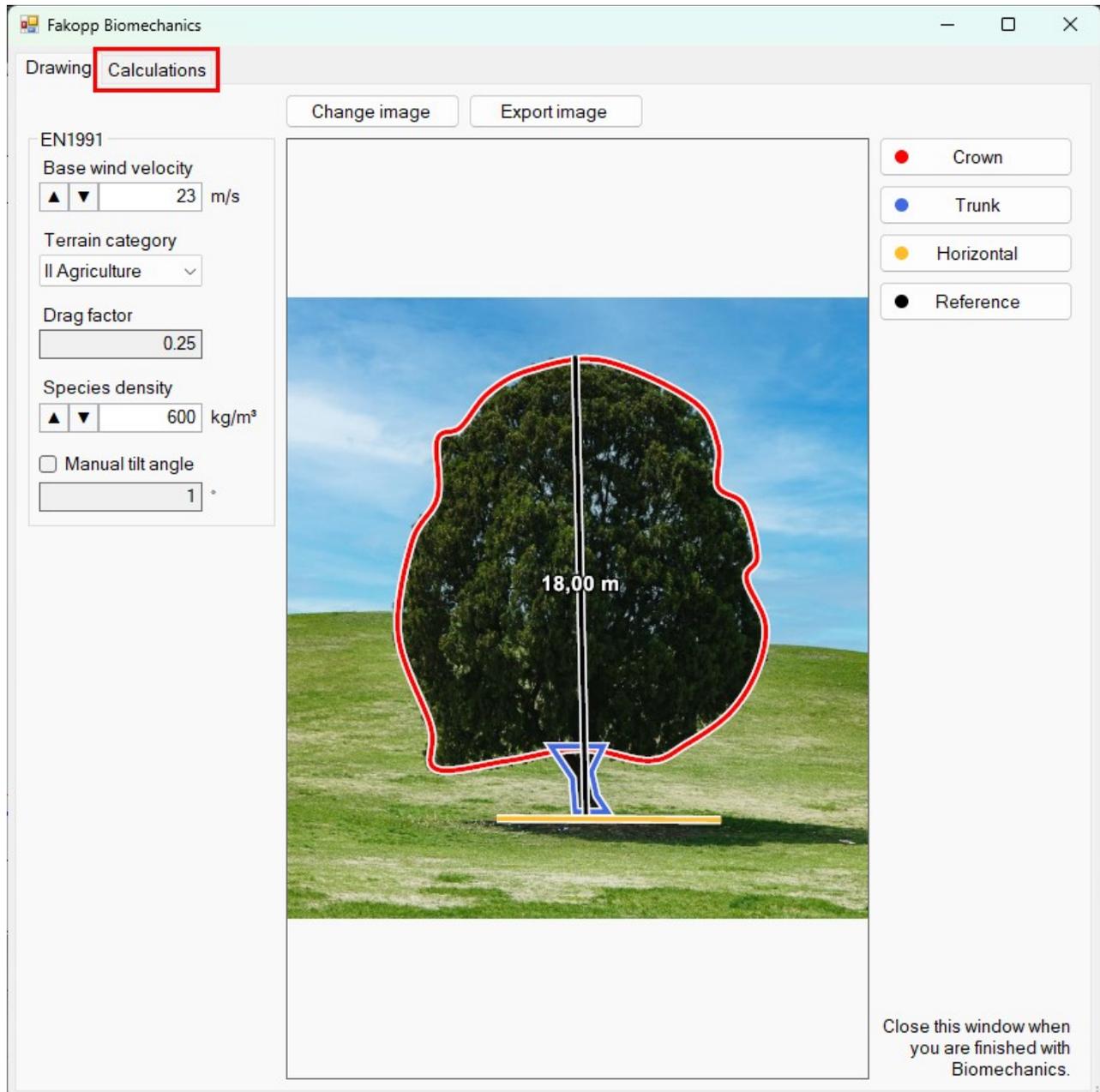
To finish drawing, you can either:

- Click on the OK button
- For the crown and trunk you can left click on the first point placed



Calculate results

- Once you finish drawing, ensure that all parameters and lines are correct.
- If everything looks correct, click the “Calculations” tab to calculate the model. (You can always return later to make corrections.)



Fakopp Biomechanics

Drawing **Calculations**

Change image Export image

EN1991

Base wind velocity
▲ ▼ 23 m/s

Terrain category
II Agriculture

Drag factor
0.25

Species density
▲ ▼ 600 kg/m³

Manual tilt angle
1 °

● Crown

● Trunk

● Horizontal

● Reference

18.00 m

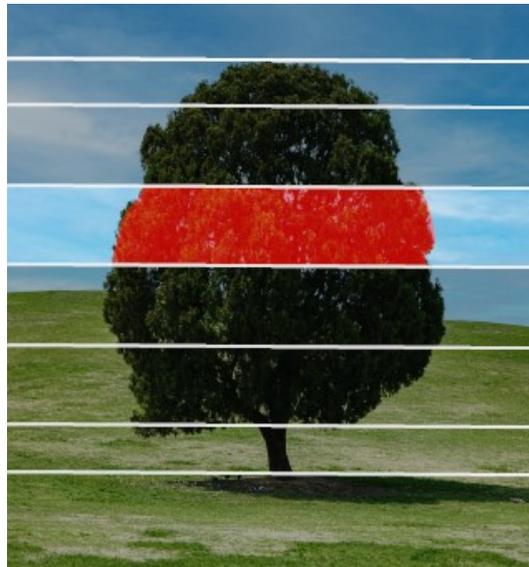
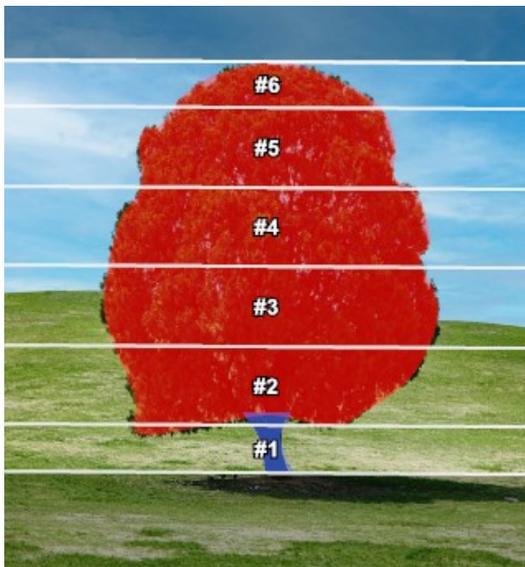
Close this window when you are finished with Biomechanics.

“Parts” table

The model divides the surface facing the wind into a number of “parts” based on the terrain category and tree height:

- Parts are numbered from the ground up, with #1 being the bottommost part.
- The “All parts” row at the top of the table represents the whole tree
- The “bottom” and “top” columns show the height of the bottom and top of each part relative to the ground.
- The “torque” column shows the total torque of each part.

part	bottom	top	torque
All parts	0.00 m	17.74 m	350 kNm
#6	15.74 m	17.74 m	46 kNm
#5	12.30 m	15.74 m	113 kNm
#4	8.87 m	12.30 m	98 kNm
#3	5.43 m	8.87 m	66 kNm
#2	2.00 m	5.43 m	26 kNm
#1	0.00 m	2.00 m	1 kNm



“Results” table

The results table summarizes the model result by displaying the trunk and crown areas as well as the total torque of the whole tree.

Crown area	179.75 m ²
Trunk area	2.94 m ²
Total torque	349 783 Nm

Model calculations

The bottom half of the “Calculations” tab details how the model results were calculated.

1. Formulas and brief explanations
2. The font sizes may be adjusted using the “A+” and “A-” buttons.
3. The “Explanations” check-box determines whether the formulas may be accompanied by brief explanations
4. The gray horizontal line is a draggable divider that allows resizing the contents of the window.

Note that internally the software uses 15 decimal digits internally.

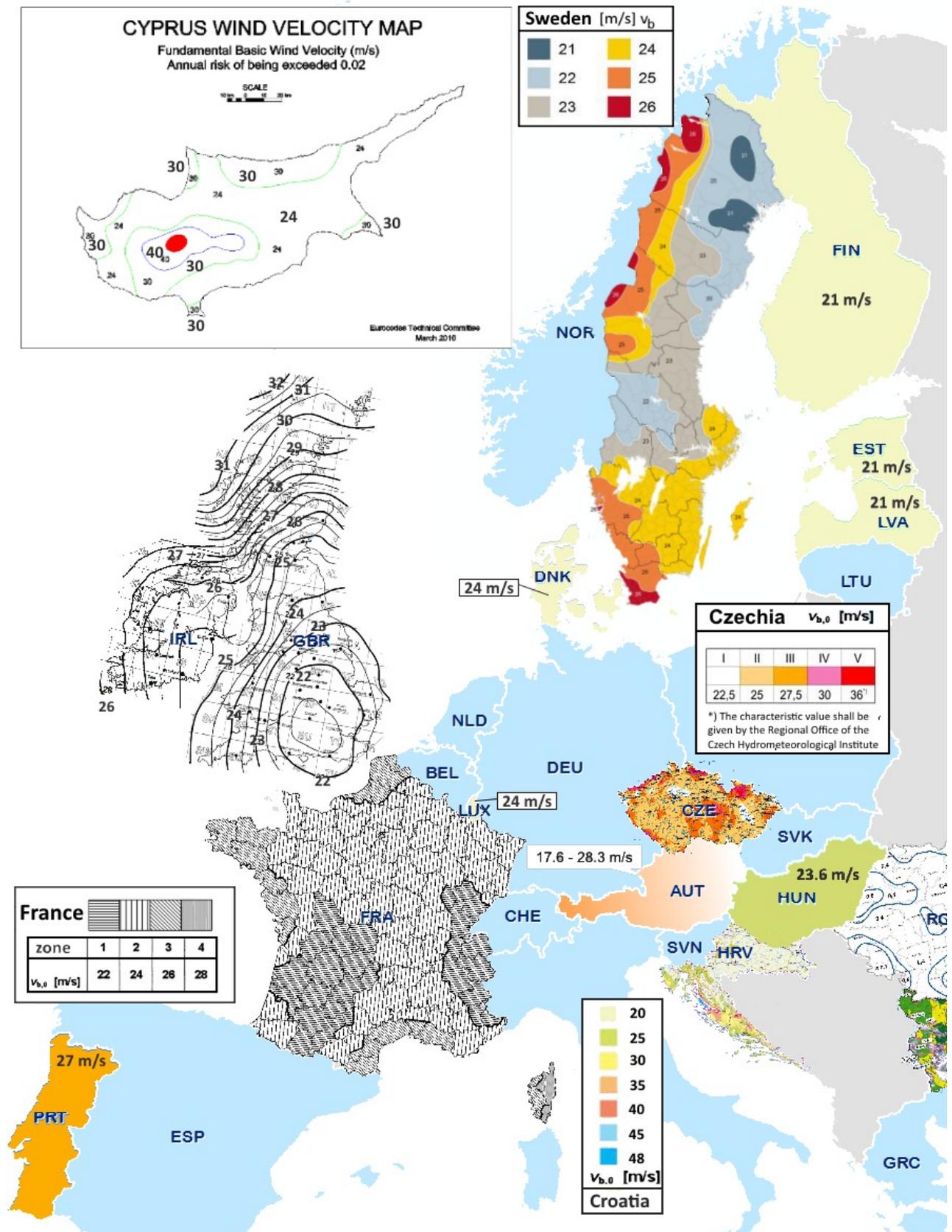
Exporting data

- You can copy the calculations using the copy button above them.
- The drawn image may be exported using the “Export image” button.

Leaving the Biomechanics editor

- Simply close the window once done.
- To store your work, save the project as usual (using the “Save” button in the top-left corner of the main window).

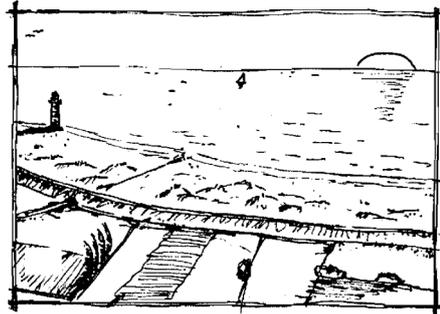
Annex A: wind maps



(source: State of harmonised use of the Eurocodes)

Annex B: Terrain categories

- 0 Sea or coastal area exposed to the open sea



- I Lakes or flat and horizontal area with negligible vegetation and without obstacles



- II Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights



- III Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)



- IV Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m

