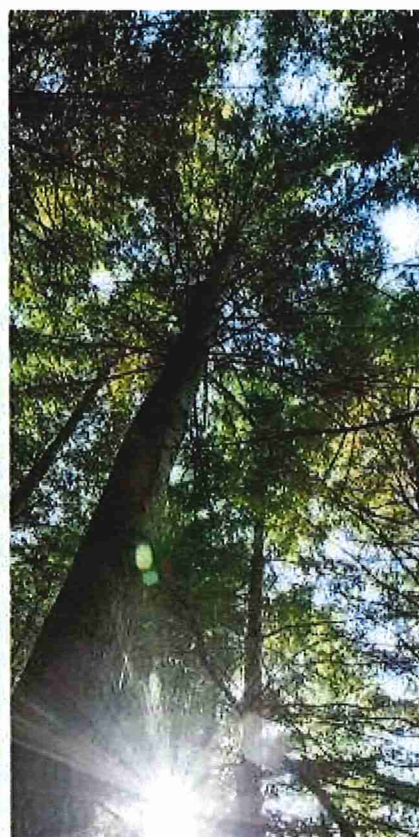


## LVL Stiffness Calculator User Guide

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## Introduction

This software is only intended to be used as a decision tool that enables questions to be asked about the potential suitability of a wood resource being able to supply a range of LVL grades. The output of the model indicates possible LVL layup grades and options, Scion accepts no responsibility as to whether or not these layup options will deliver the required LVL performance. The quality of the software output is heavily dependent on the quality and representative nature of the input data.

## Installation

LVL Stiffness Calculator is a Windows desktop application. It requires Windows .NET Framework 4.5.2 or later which is included by default with Windows 10. The application can be installed in Windows Vista SP2 or later. To install LVL Stiffness Calculator execute the installer. The installer will create a menu entry within a Scion menu folder and an optional desktop icon.

To uninstall the application use the standard Windows uninstall process.

## Menu Options

### *File*

**New** – Clear any existing calculation data

**Open** – Open a previously saved set of inputs.

**Save** – Replace input file with set of modified inputs.

**Save as...** - Save current inputs to a new or existing file (extension of file is .xml)

**Print** – Print current page to printer.

**Save as PDF...** - Create a PDF of the current page.

### *Peel Logs*

**Peel Logs** – Create an input veneer dataset by simulating the log peeling process. See [Peel logs](#) section for details.

### *Help*

**View Help** – View this user guide

**About** – Details about program.

## User Inputs

There are a number of pieces of information required to be entered into the calculator. These include:

- One or more veneer datasets
- The number of veneers in an LVL billet
- A set of grading definitions
- An order book containing one or more orders.
- A recipe



LVL Stiffness Calculator

File Peel Logs Help

Veneer Datasets

Name	Filename	# measured	Percent
Euc	C:\Datasets\Euc.txt	406	40
Radiata	C:\Datasets\Radiata.txt	693	60

Number of veneers in LVL billet:

Set Percentages

Veneer Grades					
	Grade 1	Grade 2	Grade 3	Grade 4	Totals
Stiffness ranges	≥15	12-15	10-12	<10	4.6 - 20.3
Available					
Euc	9%	22%	8%	1%	40%
Radiata	1%	8%	24%	27%	60%
Total	10%	30%	33%	28%	100%
Mean Stiffness	16	13	11	8	11.4

Order Book		Recipes						
Required Mean Stiffness	Percent	Grade 1	Grade 2	Grade 3	Grade 4	Sum	Mean Stiffness	
15.0	10%	Euc: 9				9	95%: 16.9	
		Radiata: 1				10	16.2	
							5%: 15.0	
13.0	30%	Euc: 7				7	95%: 14.2	
		Radiata: 3				10	13.2	
							5%: 12.3	
11.0	30%	Euc: 3				3	95%: 11.7	
		Radiata: 7				10	11.0	
							5%: 10.4	
8.0	30%	Euc: 0				0	95%: 11.1	
		Radiata: 1			9	10	8.6	
							5%: 6.4	
11.1	100%						11.5	

Add any notes here

Calculate

Figure 1: Main calculation page

These will be described in more detail below.

Note that when closing the application the current set of inputs will be retained so that when the application is next opened the same inputs will be loaded. You can also explicitly **Save** and **Open** previously saved inputs using the **File** menu options.

### Veneer datasets

A veneer dataset is a set of stiffness measurements that are used to describe the available resource. The dataset is loaded from a text file which should contain a list of positive numeric values each on a separate line. The order of the values is unimportant. The stiffnesses provided should be representative of the stiffnesses found in the resource available.

```

9.42
9.83
9.88
9.90
9.93
10.10
10.11
10.12
10.28
10.30
10.32

```

Figure 2: Example veneer dataset file content

The veneers from each dataset are graded and the percentage of veneers within each grade and dataset are displayed. In the recipe, the user must then enter the number of veneers to be used from each veneer dataset to make up each order. The calculation will determine whether the required percentages of veneers are available from the resource provided and indicate what the difference from required to available is.

Veneer Datasets				
Name	Filename	# measured	Percent	
Euc	C:\VDatasets\Euc.txt	406	40	Set Percentages
Radiata	C:\VDatasets\Radiata.txt	693	60	

Figure 3: Veneer datasets

To add a dataset click the Add dataset icon (+).

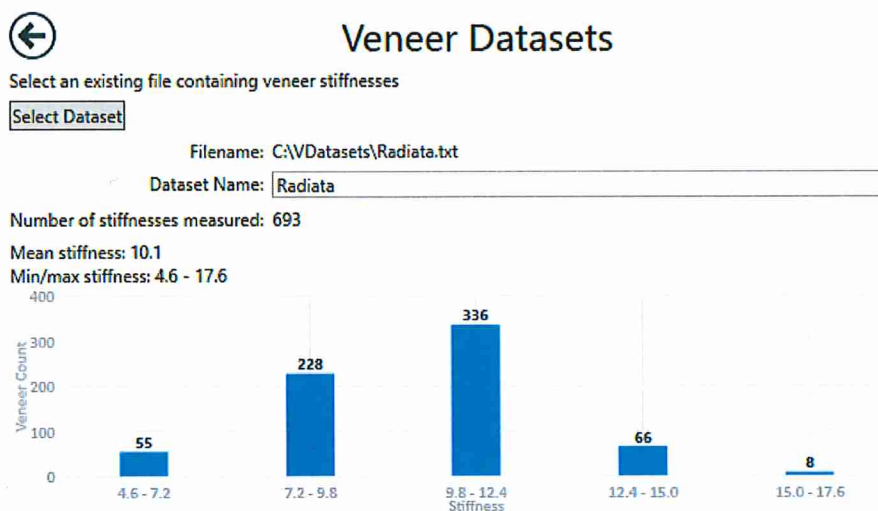


Figure 4: Add a veneer dataset

From the page that is displayed click the "Select Dataset" button to select an existing file containing veneer stiffnesses (format as described above). Once a file is selected some information about that dataset is presented (number of stiffnesses, mean stiffness, min and max stiffness) together with a histogram. The name of the dataset will be chosen to match the name of the file but this can be changed at this point (or later from the main calculator page). Click the back arrow (←) to add the chosen dataset to the set of veneer datasets and return to the main calculation page.

When more than one dataset is included the percentage of veneers available that are represented by each veneer dataset must be set. For one veneer dataset, the percent should be set to 100%. For two veneer datasets, by default, the percentage is set to match the percentage of veneers in each dataset.

For example, if dataset 1 has 100 stiffnesses, and dataset 2 has 300 stiffnesses then dataset 1 will be assigned a percentage of 25% (being 100 of 400 veneers measured), while dataset2 will be set to 75% (300 of 400). For three or more veneer datasets, no default percentage will be assigned.

These percentages can be overridden by entering a new percentage next to each veneer dataset. When there are two datasets, the percentage of the other dataset will be adjusted to keep the total at 100%. For 3 or more datasets, it is the user's responsibility to ensure that the total sums to 100%.

An alternate method for setting veneer dataset percentages is to adjust the percentages based on log percentages and expected veneer output. This method will simulate the peeling of logs to determine number of veneers from the mean diameter log from each dataset and then use the percentage of logs in the resource to calculate the percentage of veneers produced. To use this method click the

button

←

### Veneer Dataset Percentages

Dry veneer width (mm)

	Euc	Radiata
Enter the percentage of logs that a dataset represents	<input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Enter the mean diameter of logs represented by each dataset (cm)	<input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Peeler core diameter (mm)	<input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Veneer thickness (mm)	<input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Roundup diameter loss (%)	<input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Width Shrinkage (%)	<input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Mean Veneers per log		
Veneer Percentages		

Figure 5: Adjust veneer dataset percentages based on log percentages and expected veneer output

From the page that is displayed enter the values needed to simulate log peeling and calculate mean veneers per log and veneer percentages. Click the back button to use these percentages and return to the main calculation page.

### Veneer grades

Using the veneer datasets supplied, the calculator will grade the veneers into user-defined grades.

Veneer Grades					<input type="button" value="Edit"/>
	Grade 1	Grade 2	Grade 3	Grade 4	Totals
Stiffness ranges	≥15	12-15	10-12	<10	4.6 - 20.3
Available					
Euc	9%	22%	8%	1%	40%
Radiata	1%	8%	24%	27%	60%
Total	10%	30%	33%	28%	100%
Mean Stiffness	16	13	11	8	11.4

Figure 6: Summary of veneer datasets by grade

Grades are entered or edited using the  button.



## Veneer Grades

Grade	From Stiffness	To Stiffness		
1	<input type="text" value="15"/>	<input type="text"/>	<input type="button" value="⊖"/>	<input type="button" value="⊕"/>
2	<input type="text" value="12"/>	<input type="text" value="15"/>		
3	<input type="text" value="10"/>	<input type="text" value="12"/>		
4	<input type="text"/>	<input type="text" value="10"/>		

Figure 7: Edit veneer grades

Any number of grades can be added. Grade 1 is assumed to be the highest grade. A grade can be added below any current grade by click the  $\oplus$  next to the grade. A grade can be removed by clicking the  $\ominus$  button. Either the *From Stiffness* or the *To Stiffness* stiffness can be edited; the corresponding stiffness of the grade above or below will be adjusted automatically to match. The top grade (Grade 1) can have an empty *To Stiffness*; this indicates that all stiffnesses above the *From Stiffness* will be included in this grade. Similarly, the bottom grade can have an empty *From Stiffness* indicating that all stiffnesses below the *To Stiffness* will be included in that grade. To return to the calculation and use the modified grades click the back button.

### Order book

An order book is a set of orders that need to be filled. Each order has a required mean stiffness and a percent required.

Order Book		Edit
Required Mean Stiffness	Percent	
15.0	10%	
13.0	30%	
11.0	30%	
8.0	30%	
11.1	100%	

Figure 8: Order book

To edit the orders click the  button.





## Orders

Stiffness	Percent		
<input type="text" value="15"/>	<input type="text" value="10"/>	⊖	⊕
<input type="text" value="13"/>	<input type="text" value="30"/>		
<input type="text" value="11"/>	<input type="text" value="30"/>		
<input type="text" value="8"/>	<input type="text" value="30"/>		
100			

Figure 9: Edit order book

Any number of orders can be added. Order is unimportant. A new order can be added using the ⊕ button and an existing order can be removed using the ⊖ button. It is the user's responsibility to ensure that the total of all orders sums to 100%. To return to the calculation and used the modified orders click the back button.

### Recipes

Once a set of veneer datasets, a set of grades, a set of orders, and a number of veneers in an LVL billet have been defined the user can now begin the process of constructing a recipe.

Recipes							Clear
	Grade 1	Grade 2	Grade 3	Grade 4	Sum	Mean Stiffness	
Euc	<input type="text" value="9"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	9	95%: 17.7	
Radiata	<input type="text" value="1"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	10	16.2	5%: 15.1
Euc	<input type="text"/>	<input type="text" value="7"/>	<input type="text"/>	<input type="text"/>	7	95%: 14.6	
Radiata	<input type="text"/>	<input type="text" value="3"/>	<input type="text"/>	<input type="text"/>	10	13.2	5%: 12.2
Euc	<input type="text"/>	<input type="text"/>	<input type="text" value="3"/>	<input type="text"/>	3	95%: 11.8	
Radiata	<input type="text"/>	<input type="text"/>	<input type="text" value="7"/>	<input type="text"/>	10	11.0	5%: 10.1
Euc	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	95%: 11.7	
Radiata	<input type="text"/>	<input type="text"/>	<input type="text" value="1"/>	<input type="text" value="9"/>	10	8.6	5%: 7.1
						11.5	

Figure 10: Recipes

A recipe for each order needs to be constructed by selecting a specific number of veneers from each graded dataset. The sum of all veneers for an order should total the number of veneers in an LVL billet. As changes are made to the recipe the veneer sum and recipe stiffness are recalculated. The recipe stiffness is calculated by selecting at random the given number of veneers from the datasets supplied. This is done 1000 times and the mean plus the 5% and 95% confidence interval are displayed. The mean stiffness of each recipe should be at least equal to the required mean stiffness of the corresponding order.

The current set of recipes can be cleared using the **Clear** button.

### Calculate

Having entered a recipe the calculator can determine whether the available veneers can be used to satisfy the order with the recipe defined. Click the **Calculate** button to check.



**Calculate**

	Grade 1	Grade 2	Grade 3	Grade 4	Totals
Euc	9%	21%	9%	0%	39%
Radiata	1%	9%	24%	27%	61%
<b>Total Required</b>	<b>10%</b>	<b>30%</b>	<b>33%</b>	<b>27%</b>	<b>100%</b>
Euc	0%	1%	-1%	1%	1%
Radiata	0%	-1%	0%	0%	-1%
<b>Total Difference</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>1%</b>	<b>0%</b>


Figure 11: Available vs required percentages

The results shown convert the numbers of veneers for each graded dataset into a percentage (by using the relevant order percentage) giving the *Required* veneers as a percentage. It then subtracts the available percentages from this to give a percentage difference. Ideally, all percent differences will be 0%. A positive percentage difference indicates that there would be unused veneers, while a negative percent difference indicates that there would be a shortage of veneers for some orders.

Typically, the user will need to iteratively adjust the recipes and recalculate in order to use less of over-used veneers (negative percent) and more of under-used veneers (positive percentage) (while maintaining the current number of veneers per order and the correct mean stiffness per order).

## Peel logs

One method for generating veneer stiffness datasets is to simulate the peeling of a representative log. The menu option Peel Logs can be used at any time to create a veneer dataset file that can be added to the set of veneer datasets used in the LVL calculation.

 **Generate veneers from pith to bark stiffness**

Peeler core diameter (mm)

Veneer thickness (mm)

Dry veneer width (mm)

Width shrinkage (%)

Round up diameter loss (%)

Select file containing pith to bark dry wood stiffness profile

Figure 12: Peel Logs

The menu option will display the above form. The pith to bark dry wood stiffness profile is a csv file with the following format:

DistanceFromPith_mm	MOE_GPa
0	3
10	3.3
20	3.6
30	3.9
40	4.2
50	4.5
60	4.8
70	5.1
80	5.4
90	5.7

Figure 13: Pith to bark profile file format

Note that the names assigned to the two columns (*DistanceFromPith\_mm* and *MOE\_GPa*) and the distances are in increasing order from 0 up to the under-bark radius of the log (the last measurement is assumed to be the radius of the log). Measurements can be included at any distance (the more measurements the more accurate the simulation will be).

When a profile csv is loaded the peel log page gives some summary statistics about the data and graphs the profile.

Select file containing pith to bark dry wood stiffness profile

C:\VDatasets\Profile.csv

Log diameter (mm): 540

Stiffness range (GPa): 3 - 11.1

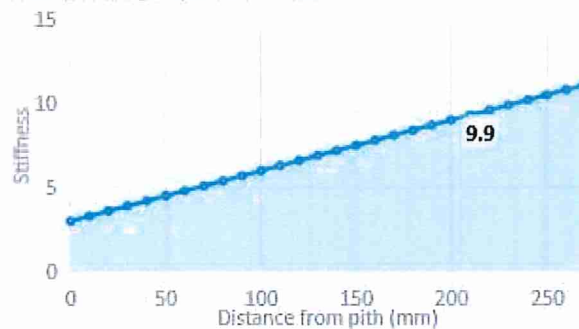


Figure 14: Stiffness profile

When all fields have been entered and a profile has been selected the log can be peeled using the

button. This will generate a histogram and summary statistics of the veneers that have been

peeled. The set of veneer stiffnesses can be saved to a text file by clicking the

button. This file is suitable for adding as a veneer dataset in the main calculation.

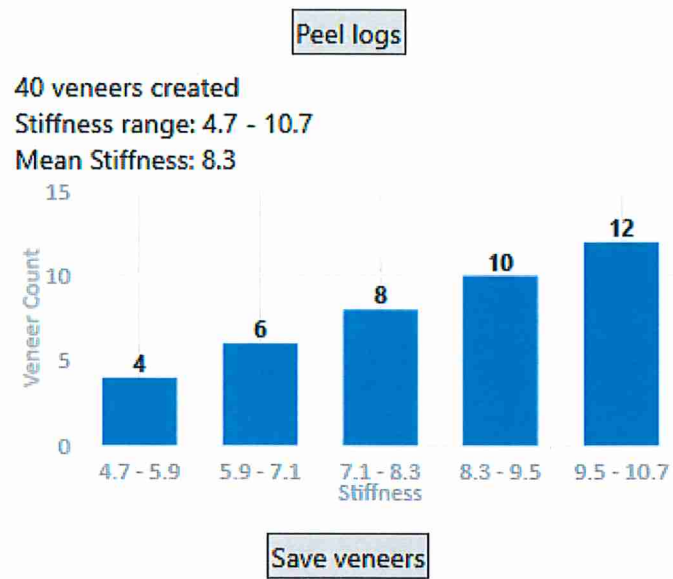


Figure 15: Veneers peeled by simulation