

ExactFlat
For Rhino 3D

HOW TO
**CREATE EXACTFLAT FOR RHINO MATERIAL
FROM MEASURED DATA**

Quick Start Video Companion Guide For
“How to Create ExactFlat for Rhino
Material from Measured Data”

To access the companion video for this. document please visit:

<https://youtu.be/m5ycABOtIUM?feature=shared>

To talk to an expert, please call
+1 705-999-0901

To book a demo, please visit
<https://www.exactflat.com/webdemo>

ExactFlat Expert Pattern-Making Service

ExactFlat Expert Pattern-Making Services is an outsourced service providing a seamless solution for businesses seeking fast, accurate, and flexible pattern-making support. Leveraging our years of experience and deep industry knowledge, we offer a service tailored to meet your specific requirements:

- 1. Fast Turnaround:** We understand the urgency of your projects. Our team is equipped to deliver swift results, helping you meet deadlines and maintain productivity.
- 2. Precision and Accuracy:** ExactFlat's commitment to precision is unwavering. Our experts ensure that the patterns we create are crafted to fit your needs, resulting in consistently well-fitting solutions.
- 3. Flexibility:** We understand that each project is unique. Our service is designed to accommodate a diverse range of requests, providing you with tailored solutions that align with your industry and vision.

Whether you seek to optimize your digital pattern-making process or require a reliable partner to support your outsourcing needs, ExactFlat Expert Pattern-Making Services stands ready to assist.

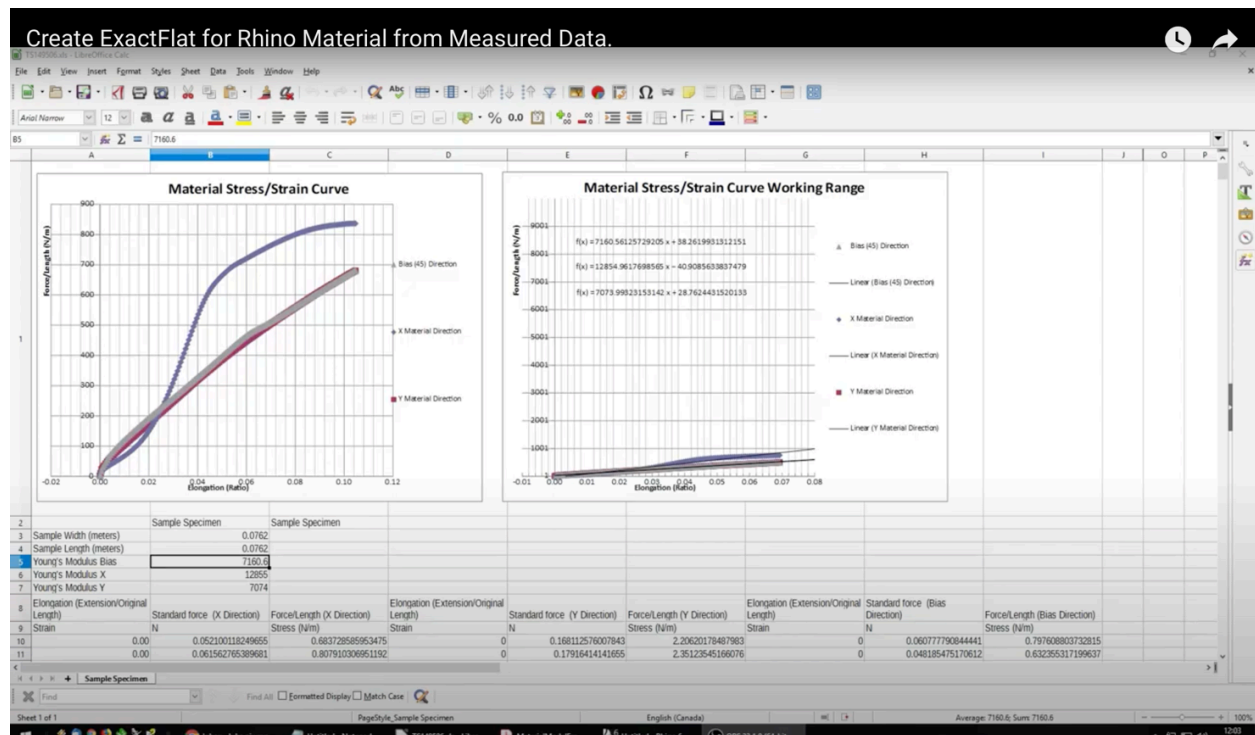
Table of Contents

1. Introduction.....	5
2. Measured Material Report.....	6
3. Create a New Material.....	7
4. Metrics.....	8
5. Create a New Material.....	9
6. Add Linear Isotropic Metric.....	10
7. Add Linear Orthotropic Metric.....	12
8. Add Linear Bias Metric.....	14
9. Save the Newly Created Material.....	15

1. Introduction

Video Time Code: 00:00 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=0s>

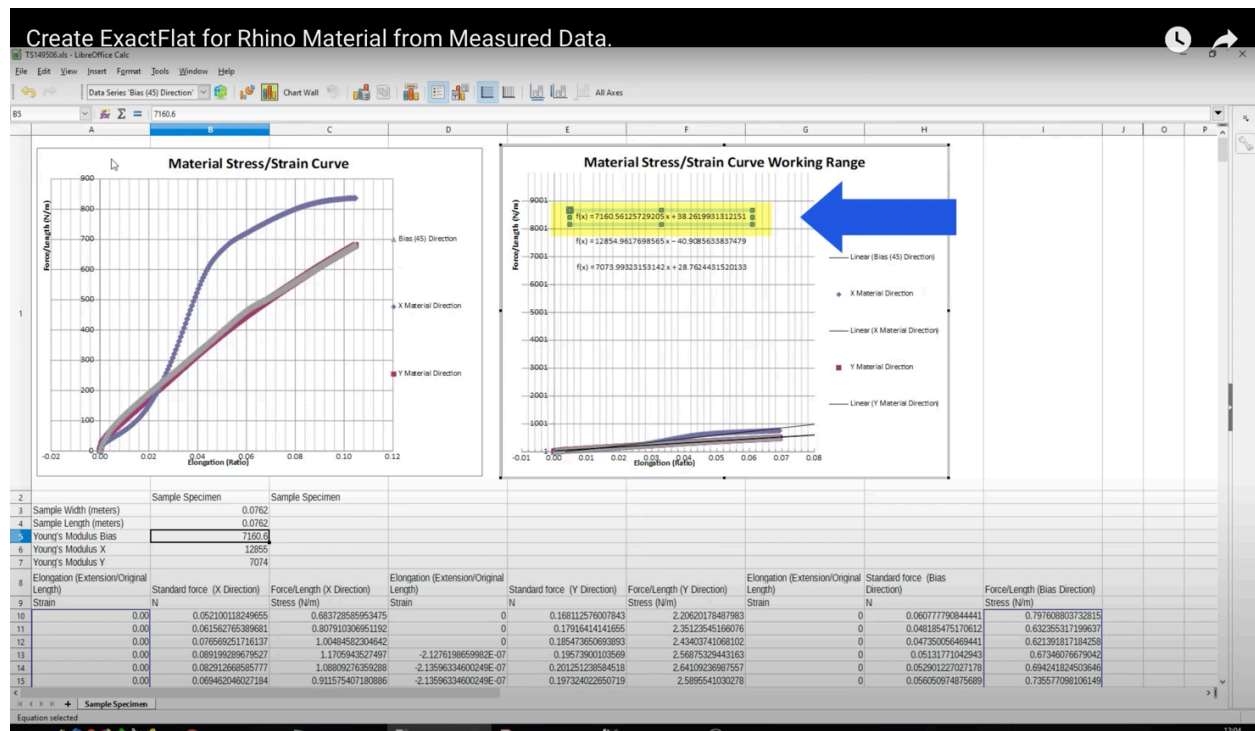
Hello, and welcome to this video. Today we are going to be talking about how to create a new material for use with ExactFlat for Rhino from measured material data. When you send your material out to be measured, you will receive a report that looks like this.



2. Measured Material Report

Video Time Code: 00:22 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=22s>

The three main points of data that we need from this report are the Young's modulus bias, the Young's modulus X and Young's modulus Y. Older versions of this report don't list the Young's modulus bias X or Y as data in the rows and columns here. However, they always have the different equations of best fit for our different material directions here. So, the Young's modulus bias X and Y, it's just the slope of the line of the equation of best fit. If you're missing these data points here or you're using an old version of the report that they're not present, we can look at the material stress strain curve working range graph. And we can just look at the different equations here. When we click on this one up here, we're looking at the bias graph. The Young's modulus for the bias direction is 7160.5. That corresponds with what we have down here.



Video Time Code: 01:42 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=102s>

The Young's modulus for the X direction is 12854.96. And again, that corresponds with what's down there. And finally, the Young's modulus for the Y direction is 7073.99, which again, corresponds with what we have in the report down here. In new versions of the report, the Young's modulus, they're already pulled off the graph for you. You can just literally take these values and plug them into the material editor. But old versions of the report, they're not here, so you must pull them off the graph yourself.

3. Create a New Material

Video Time Code: 02:32 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=152s>

Once we have these three values, we can combine them with this document here. And this describes in detail how to create a new material from the measured report, and it just describes how we pull the Young's modulus off the graphs, so it's what we just talked about. And then talks about guessing the Poisson ratio. In most cases, the Poisson ratio is just going to be zero and ExactFlat will determine the best way to handle Poisson ratio.

The screenshot shows a PDF document titled "How to Create a New Material from the Measured Material Report". The document is displayed in a viewer window with a green header. The main content is titled "Material Properties from The Excel Template".

Reading the Excel Template

The chart "Material Stress/Strain Curve Working Range" shows three curves along with their lines of best fit. The slopes of the lines give the Young's Moduli Y_b , Y_x and Y_y in N/m. Example data are shown in the table.

Curve	Colour	Equation	Young's Modulus
Bias (45) Direction	Green	$y=12x+3$	$Y_b = 12 \text{ N/m}$
X Material Direction	Blue	$y=45x+6$	$Y_x = 45 \text{ N/m}$
Y Material Direction	Red	$y=78x+9$	$Y_y = 78 \text{ N/m}$

Guessing the Poisson's Ratios

The Poisson's ratios ν_b , ν_x and ν_y are unitless quantities that lie between -1 and 1. They are typically small and positive, so zero is usually a reasonable guess. The exception to this rule is that the bias Poisson ratio is large for a material composed of rigid fibers. Such a material will have a bias Young's modulus that is much smaller than the other two Young's moduli.

$$\nu_b = \begin{cases} 1 & Y_b \ll Y_x \\ 0 & \text{otherwise} \end{cases}$$

Video Time Code: 03:00 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=180s>

The only exception is the Poisson ratio and the bias direction. If the Young's modulus is in the bias direction and is less than the Young's modulus in the X direction, then the Poisson ratio for the bias is going to be one. Otherwise, Poisson ratio is zero, only in the bias direction. Poisson ratio in the X and Y direction is always zero. Knowing that, from this measured data, we can formulate three different metrics.

4. Metrics

Video Time Code: 03:31 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=211s>

We can simulate the material in a linear bias metric. So that's using the data from all three different directions that the material is stretched. We can simulate the material in a linear orthotropic metric, so using X and Y, and we can simulate material in a linear isotropic metric. If the material behaves the same in all three directions, then we can use that.

Create ExactFlat for Rhino Material from Measured Data.

Linear Bias Metric

The six parameters Y_b , Y_x , Y_y , v_b , v_x and v_y are used as is.

Linear Orthotropic Metric

The parameters Y_x , Y_y and v_x are used as is. If the shear modulus is entered as zero, the program will estimate it internally using Huber's formula. A somewhat better formula based on the bias data is shown in the table.

Property	Value
Young's Modulus MD	Y_x (N/m)
Young's Modulus TD	Y_y (N/m)
Principal Poisson's Ratio	v_x
Shear Modulus	$\frac{1}{2} \frac{Y_x}{1+v_x}$ (N/m)

Linear Isotropic Metric

Let the Young's modulus be the average of the three Young's moduli and let the Poisson's ratio be zero.

Property	Value
Young's Modulus	$\frac{Y_x + Y_y + Y_b}{3}$ (N/m)
Poisson's Ratio	0

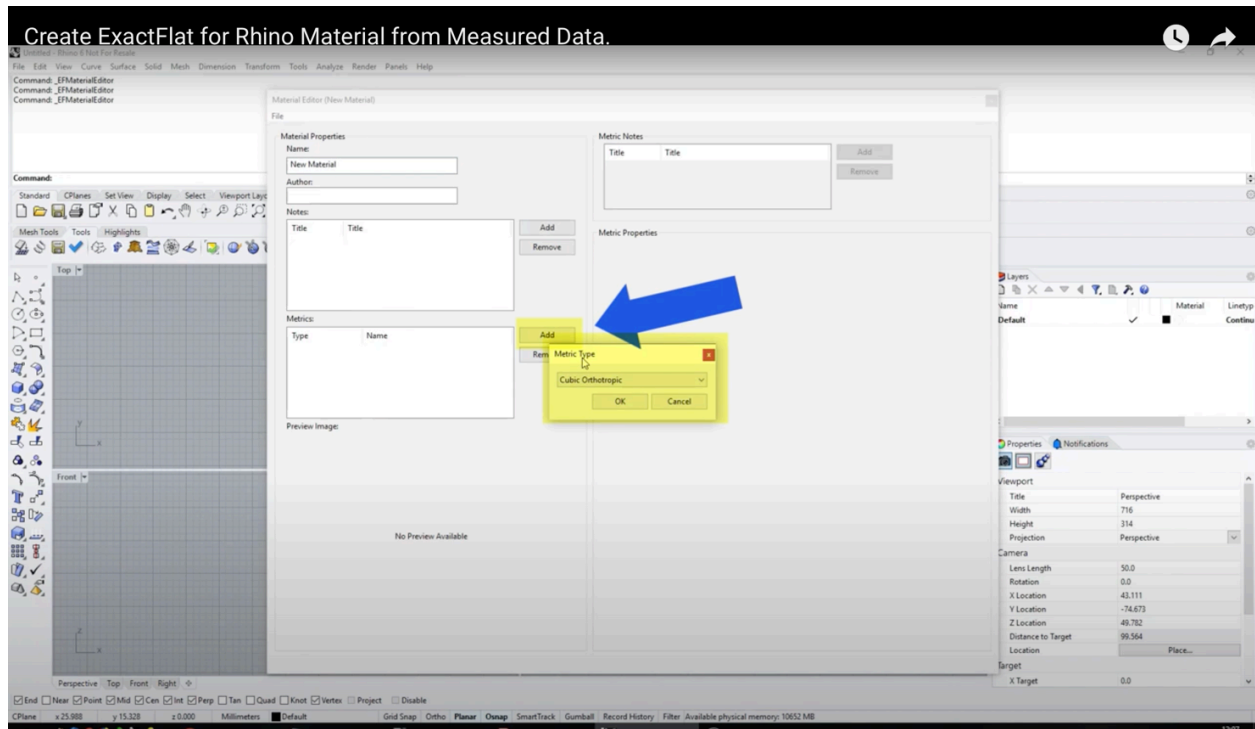
Video Time Code: 03:53 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=133s>

They're all formulated a little differently. Biggest thing to remember is with linear isotropic, we average all three Young's modulus, and that's what we use. With linear orthotropic, we're using the X and Y Young's modulus as is. And then we simulate the shear modulus based of the linear bias or the bias direction, the 45-degree direction. And then with linear bias, we just use all three or all six values rather, all three Young's modulus and all three Poisson ratio values as is

5. Create a New Material

Video Time Code: 04:39 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=279s>

To create a new material, we go to Rhino, we open up the material. We click this icon right here. It's the material swatch icon. We click that and it opens the material editor. It's always going to open to a new material. The first thing we're going to do is give our new material a name. We're going to call it New Material. So, we haven't added any metrics to this material yet. We do that down here in the metrics section. We click the Add button, and now we can choose a metric to add.



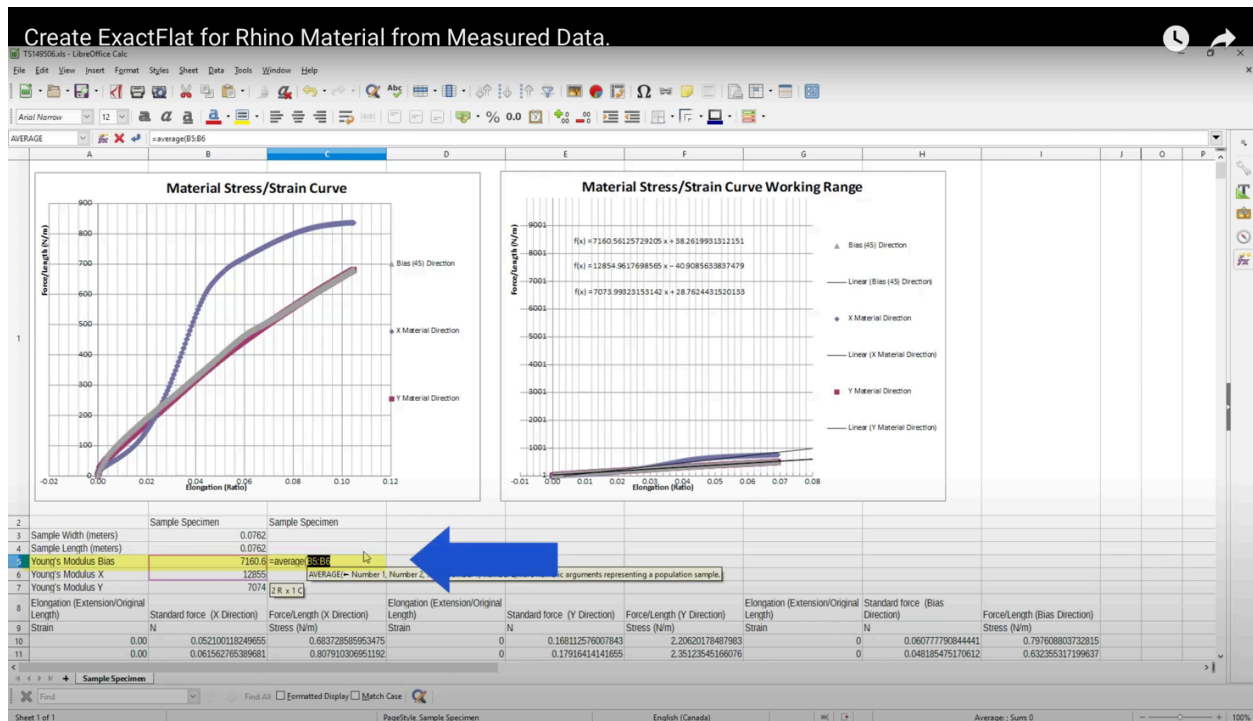
6. Add Linear Isotropic Metric

Video Time Code: 05:06 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=306s>

Using measured data, we can create linear bias, linearized tropic and linear orthotropic. This are the only three that we can create from the measured data. We're going to start with the easiest, linear isotropic. We'll select that from the list and click Okay. The only data point that we need that is not on the measured data set is the *material thickness*.

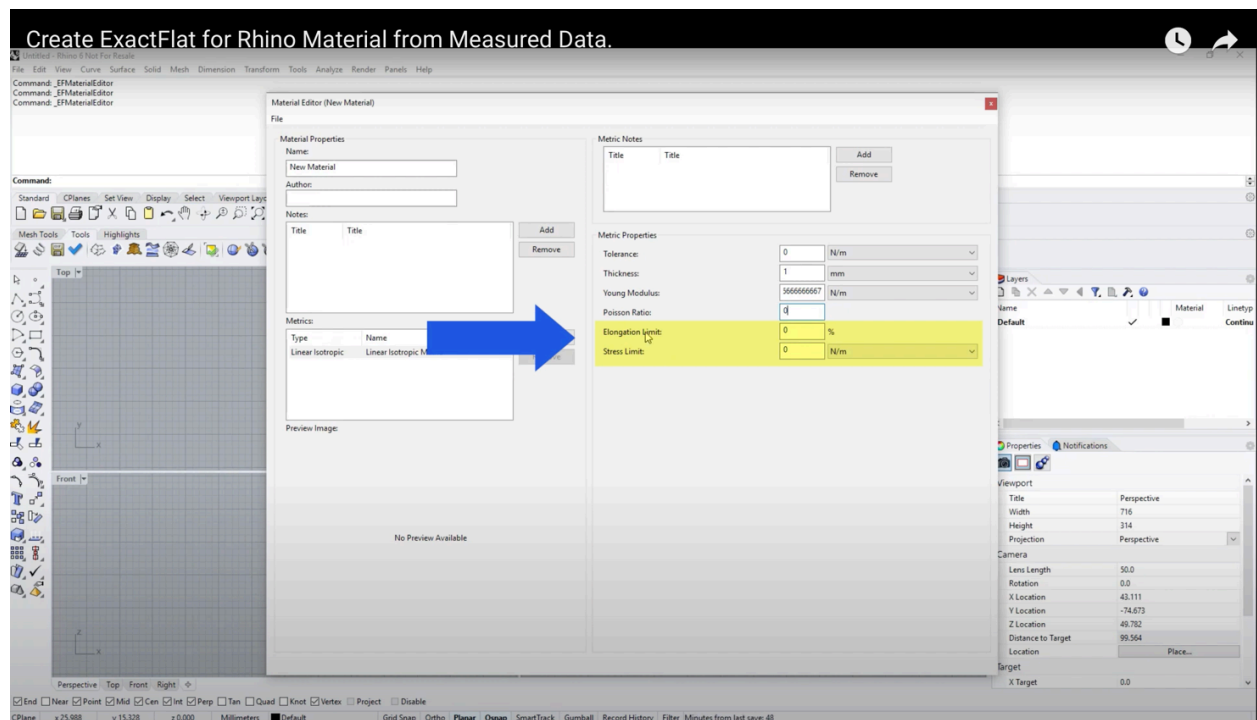
Video Time Code: 05:27 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=327s>

We really going to have to measure the material thickness yourself. Or in most cases, the material data sheet provided to you by your material supplier should have the thickness of the material on there. You can either pull it off the data sheet or you can measure it. As long as we have the thickness, we can enter that in. Tolerance is always going to be zero. This is more for reporting during optimization, but the tolerance does not have any effect on the shape or quality of the pattern. So, we're just going to leave that set to zero. And then for linear isotropic, we need the Young's modulus. When we look back at the sheet here, linear isotropic metric, Young's modulus is the average of the Young's modulus and the X, Y, and bias direction. We'll go back to our spreadsheet and we're just going to cheat here using excel commands. So equals average. And we're going to take the average of all three of those. We end up with this value here. We're just going to copy this right into the report here. We're always going to make sure that our units for these reports are always in Newton meters.



Video Time Code: 06:31 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=391s>

If ever there's any doubt these units are indicated on the material as well. Our stress is always measured in Newtons per meter. We just make sure that our units match what's written on the graph here. It should always be in Newtons meters. And so that's it for linear isotropic. Our Poisson ratio according to the document is always going to be zero. So, we've entered in the material thickness Young's modulus Poisson ratio and that's all we need to do. The elongation limit and stress limit, all metrics are going to have limits on them. And these are more for reporting during optimization. They have no effect on the shape or quality of the pattern. Any kind of limit value here, we're just going to leave that set to zero and we're not going to worry about that. We're going to click the Add button again. We're going to add another metric. We've already created our *linear isotropic*. We're going to once again click Add.



7. Add Linear Orthotropic Metric

Video Time Code: 07:32 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=452s>

We're going to select the *linear orthotropic* from the list. And now we're going to create a *linear orthotropic* model for this material. If we go back to our PDF document here to create a *linear orthotropic*, we need to use Young's modulus X and Y as is for the MD and TD value. And our principal Poisson ratio is going to be ν_X , which is always zero. And our shear modulus is either going to be half of or a quarter of the Young's modulus in the bias direction. This depends on the value of ν_B right here. ν_B is going to be one if the Young's modulus in the bias direction is less than the Young's modulus in the X direction or zero otherwise. In this case, when we look at our material data here the Young's modulus in the bias direction is most definitely less than the Young's modulus in the X direction. In this case, ν_B is going to be one.

Create ExactFlat for Rhino Material from Measured Data.

MaterialModelFromMeasuredData.pdf - Adobe Acrobat Reader DC

File Edit View Window Help

Home Tools Document

$\nu_y = 0$

Linear Bias Metric

The six parameters Y_b , Y_x , Y_y , ν_b , ν_x and ν_y are used as is.

Linear Orthotropic Metric

The parameters Y_x , Y_y and ν_x are used as is. If the shear modulus is entered as zero, the program will estimate it internally using Huber's formula. A somewhat better formula based on the bias data is shown in the table.

Property	Value
Young's Modulus MD	Y_x (N/m)
Young's Modulus TD	Y_y (N/m)
Principal Poisson's Ratio	ν_x
Shear Modulus	$\frac{1}{2} \frac{Y_b}{1+\nu_b}$ (N/m)

Linear Isotropic Metric

Let the Young's modulus be the average of the three Young's moduli and let the Poisson's ratio be zero.

Property	Value
Young's Modulus	$\frac{Y_x + Y_y + Y_b}{3}$ (N/m)
Poisson's Ratio	0

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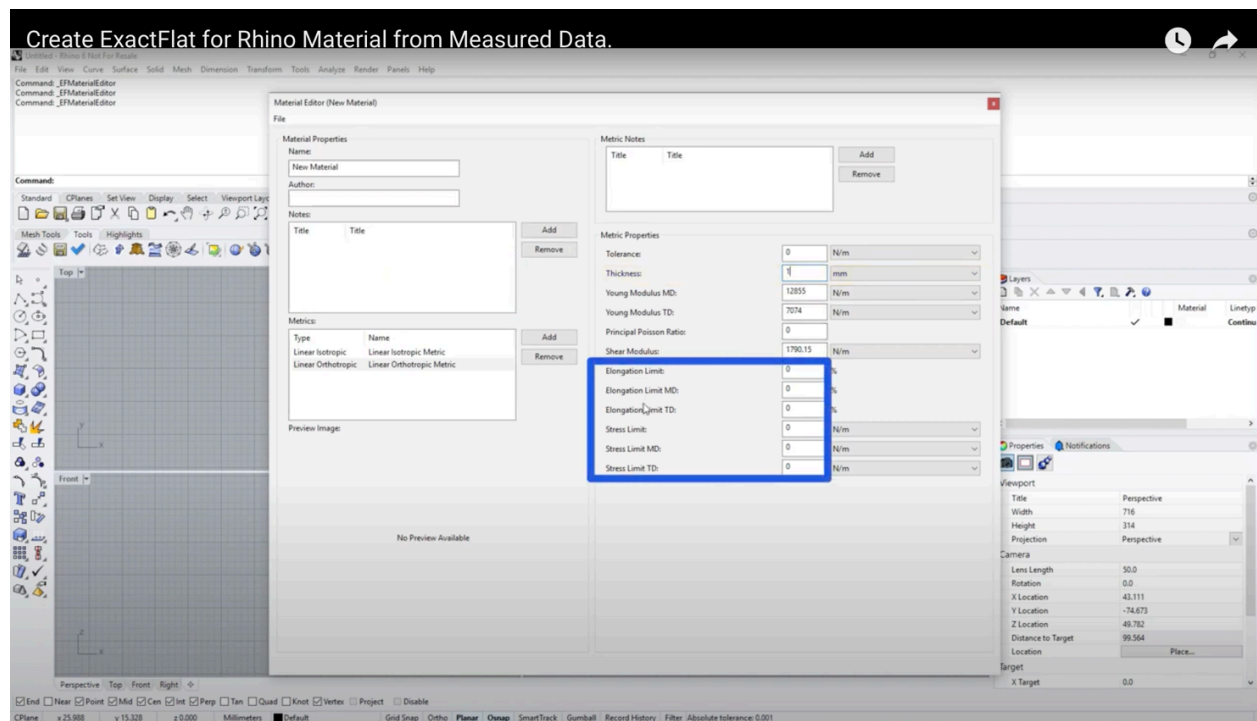
Video Time Code: 08:36 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=516s>

Knowing that, this is going to be half of Y_B over two so essentially a quarter of the Young's modulus in the bias direction. We have all we need to create a *linear orthotropic* model now. We're going to go back to our spreadsheet, we're going to take Young's modulus in the X direction we're going to copy this into the MD column. We're going to take the Young's modulus in the Y direction, we're going to copy this into the TD column. And then we're going to go back and we're going to cheat again. We're just going to use Excel commands, we're going to take a bias and we're going to divide it by four. We're going to take a quarter of the Young's modulus in the bias direction and we're going to copy this into our shear modulus value. And our Poisson ratio, again, is always going to be zero. So, we have everything we need. We've entered

everything. We're just going to update our thickness here change that to one, and that's all we do for *linear orthotropic*.

Video Time Code: 09:48 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=588s>

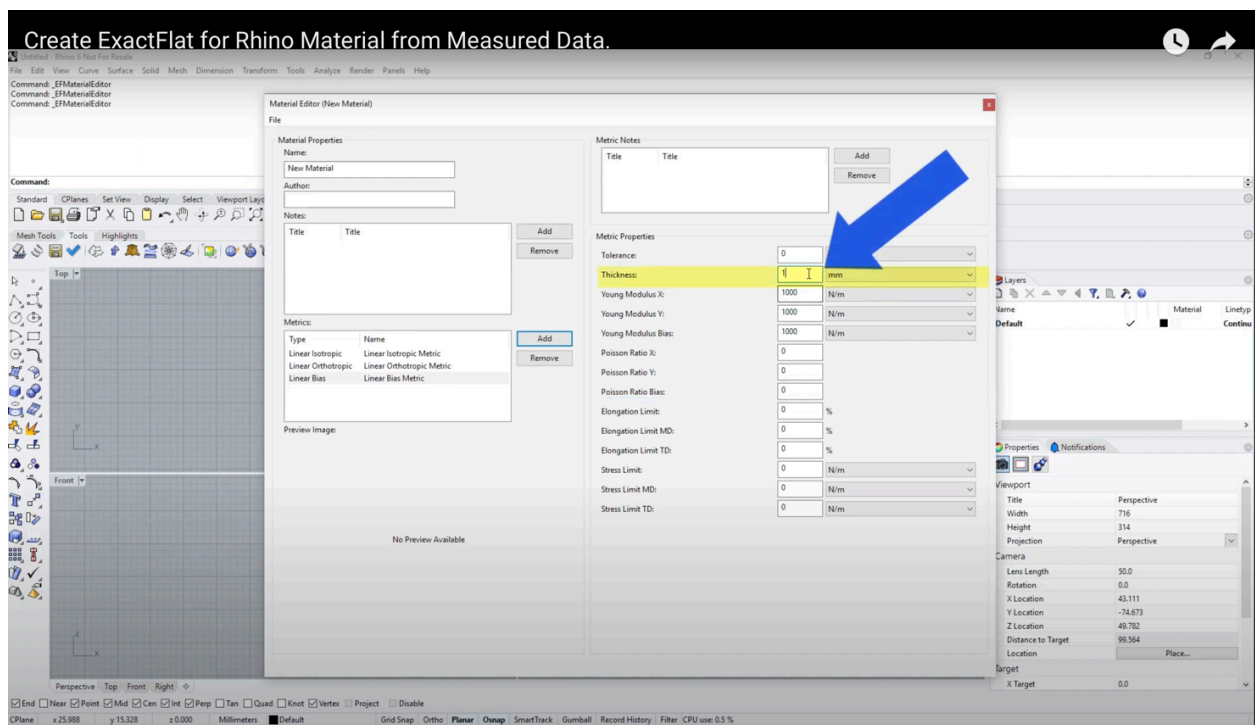
So again, we're not going to change any of our limits. We're just going to leave this at zero, we're going to leave the tolerance at zero and all we've done is we've entered the thickness Young's modulus X, Young's modulus Y, Poisson ratio is always zero. And in this case, the shear modulus is either going to be half of or a quarter of the Young's modulus in the bias direction, and that depends on whether the bias Young's modulus is less than the X Young's modulus or not. So lastly, we're going to create another new metric.



8. Add Linear Bias Metric

Video Time Code: 10:22 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=682s>

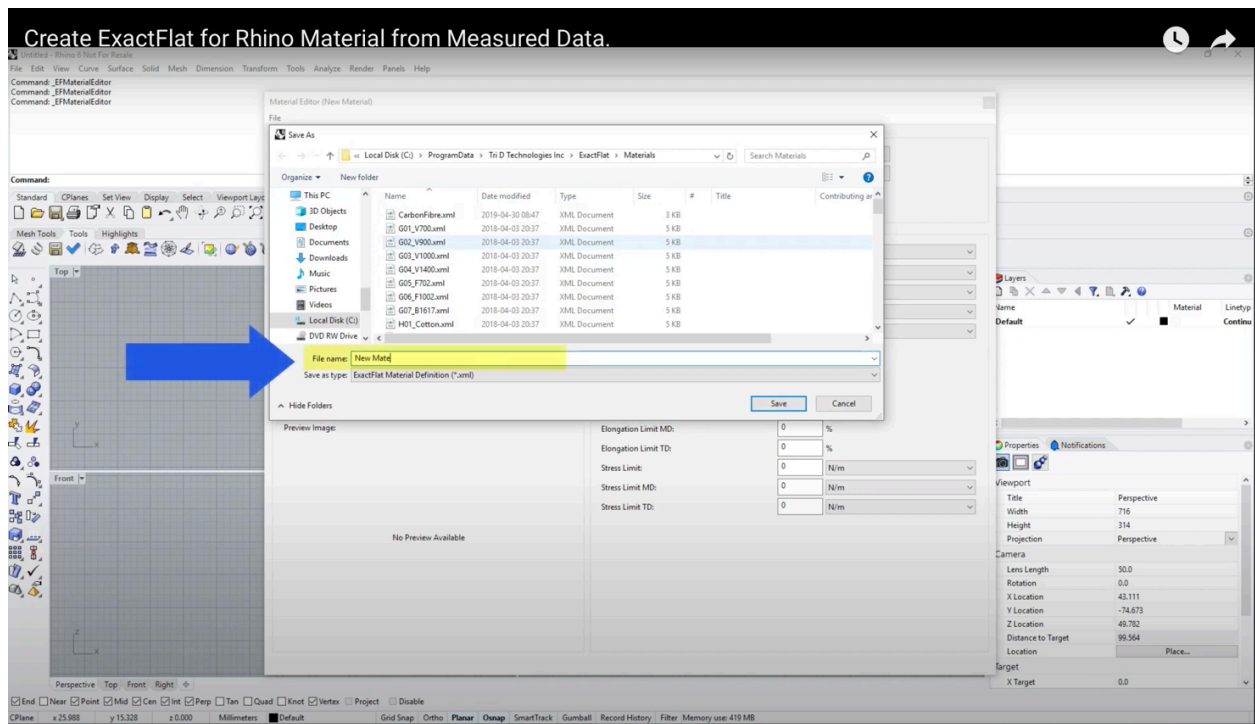
We're going to create linear isotropic, so we're going to select *linear bias* from the list, click Okay. And then we just use all six values as is. So again thickness, we're just going to use one millimeter. We'd enter in the thickness of our material. Let me go to our report here, Young's modulus X. Copy that into the editor Young's modulus Y. We'll copy that into the editor. And Young's modulus bias, we'll copy that into the editor. Poisson ratio X Y is always going to be zero. X and Y is always zero. And then VB, again this is based on whether YB is less than YX or not. We do know that the Young's modulus bias is less than Young's modulus X, so VB is going to be one. And lastly, we're going to leave all the limits at zero again and that's it, we're all done.



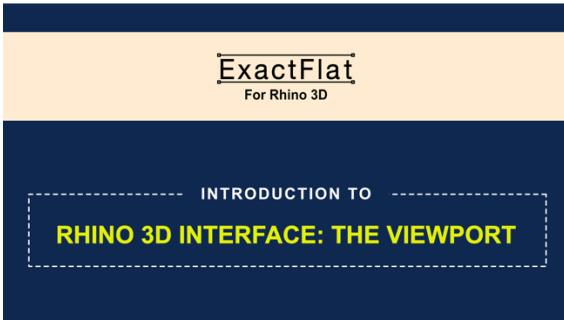
9. Save the Newly Created Material

Video Time Code: 11:35 <https://www.youtube.com/watch?v=m5ycABOtIUM&t=695s>

The last thing we're going to do is we're going to save our material definition so we can now use it with the ExactFlat for Rhino. We're just going to save this as New Material. And it's very important we want to make sure we're saving it to this location here. Program data is a hidden folder by default so you can either type this in explicitly so you can run C colon backslash program data, or we can use name shortcuts, so program data will bring you to that folder as well. And then we just navigate to Tri-D technologies without a dash, ExactFlat materials, and we can save it right in this folder here. When ExactFlat starts up it's going to automatically load every single material in this folder into the material database for use. So, saving your new material in this folder means that ExactFlat will load it every single time you want to use ExactFlat so you can use it in your projects.



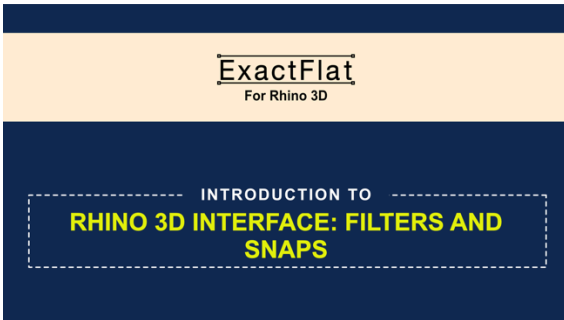
Additional Video Resources



<https://youtu.be/SW8iZfaD7tE?si=XpYCKNF1RXO0W-8>



https://youtu.be/TCkzyv6p1T0?si=NtULBO_z7Ail4xqo



<https://youtu.be/7V5GpQLwwQ4?si=bIGFzWu37LFLjCUn>



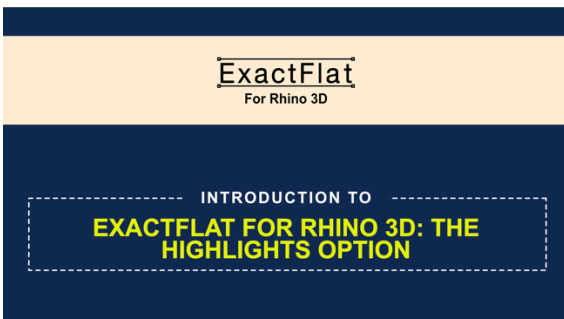
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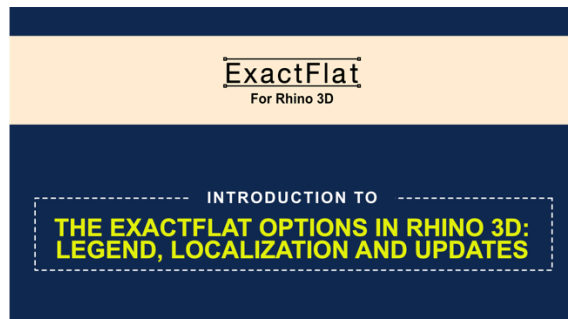
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<https://youtu.be/yTeAu2x4f7o?si=gNz67xqLHN0W0DC2>

1. A Comparison of Features: ExactFlat for Rhino vs. ExactFlat for SolidWorks

Feature	ExactFlat for Rhino 3D	ExactFlat for SOLIDWORKS 3D Standard	ExactFlat for SOLIDWORKS 3D Professional
3D CAD platform	Rhino 3D	SolidWorks 3D	SolidWorks 3D
3D CAD import	✓ (Via Rhino 3D)	✓ (Via SolidWorks 3D)	✓ (Via SolidWorks 3D)
Export	Unlimited DXF	Unlimited DXF	Unlimited DXF
Single user licensing	✓	✓	✓
Network licensing	✓	✓	✓
Hardware dongle license	✓	✓	✓
Cutter Profiles		✓	✓
Database support			
Database Driven		✓	✓
Database manager		✓	✓
Material properties		✓	✓
Marker lay-rules		✓	✓
Piece names		✓	✓
Piece labels		✓	✓
Edge labels		✓	✓
Notch Types		✓	✓
Edge Types		✓	✓
Piece Creation			
Join/delete faces	✓	✓	✓
Create pieces	✓	✓	✓
Piece names	✓	✓	✓
Custom piece names	✓	✓	✓
Mesh Optimization			
Uniform re-mesher	✓ (whole pattern)	✓ (per-piece only)	✓ (per-piece only)
Adaptive re-mesher	✓ (whole pattern)	✓ (per-piece only)	✓ (per-piece only)

Mesh Validation	✓	✓	✓
Mesh Decimation	✓		
Thin Triangle Removal	✓		
Disjoint Mesh Separation	✓		
Mesh Repair Tools	✓ (via Rhino 3D)		
Pre-Flatteners			
Fracture	✓	✓	✓
Smart Fracture	✓	✓	✓
Pelt	✓	✓	✓
CCM Initial	✓		
CCM Minimal	✓		
CCM Round	✓	✓	✓
LSCM	✓		
Relax Curvature	✓		
Press	✓		
Local target strain	✓		
Global target strain	✓		
Flipped triangle remove	✓	✓	✓
3D to 2D Optimizer			
Pattern fit optimizer	✓	✓	✓
Strain Map	✓	✓	✓
Linear Isotropic Material Modeling	✓	✓	✓
Linear Orthotropic Material Modeling	✓		
Bias Material Modeling	✓		
Preserve Boundary Length	✓ (whole pattern)	✓ (per-piece only)	✓ (per-piece only)
Whole Pattern Associative Optimization	✓		
3D to 2D Markings			
Marking	✓	✓	✓
Arrange			
Translate	✓ (precision)	✓ (limited)	✓ (limited)

Rotate	✓ (precision)	✓ (limited)	✓ (limited)
Align Horizontal	✓ (precision)	✓ (edge only)	✓ (edge only)
Align Vertical	✓ (precision)	✓ (edge only)	✓ (edge only)
Find Tool	✓	✓	✓
Edge Features			
Seams	✓ (Global seam offset)	✓ (Individual seam offset)	✓ (Individual seam offset)
Seam end conditions		✓	✓
Hem		✓	✓
Hardware & marking		✓	✓
Drill marking		✓	✓
Notch points	✓	✓	✓
Notch chains/arrays		✓	✓
Grain line	✓	✓	✓
Edge Labels		✓	✓
Marker Tools			
Manual markers		✓	✓
Marker sets		✓	✓
Automated nesting		✓	✓
Drawing Tools (applies to pieces, materials, notches, edges, and operations)			
Table features		✓	✓
Balloon features		✓	✓
Callout features		✓	✓

1. About Tri-D Technologies – Makers of ExactFlat

What do we do?

ExactFlat helps companies make better patterns faster

Our Vision

A 100% digital workflow from 3D design to 2D pattern to digital printer and automated cutter.

We seek to empower pattern makers with digital tools that replace slow manual process.

Our Mission

Make 3D to 2D digital patterning easy, automated, and fully integrated into industrial workflows for all segments.

Tri-D Company Background

- Founded 2008
- Privately held
- Headquartered in Toronto, Canada
- Leader in 3D to 2D pattern making
- SolidWorks Gold Solution Partner
- Customers in 22 countries
- Products integrated into SolidWorks, Rhino 3D, AutoDesk Fusion 360, Onshape

Innovation Firsts

- First FEA 3D to 2D flattening solver for textiles
- First Adaptive meshing algorithms for textiles
- First 3D to 2D texture flattening for solid materials
- First 3D to 2D texture flattening for textiles
- First 3D to 2D directional strain and sag removal
- First 3D to 2D graphic and image flattening
- First 3D to 2D digital smoothing pattern optimizer