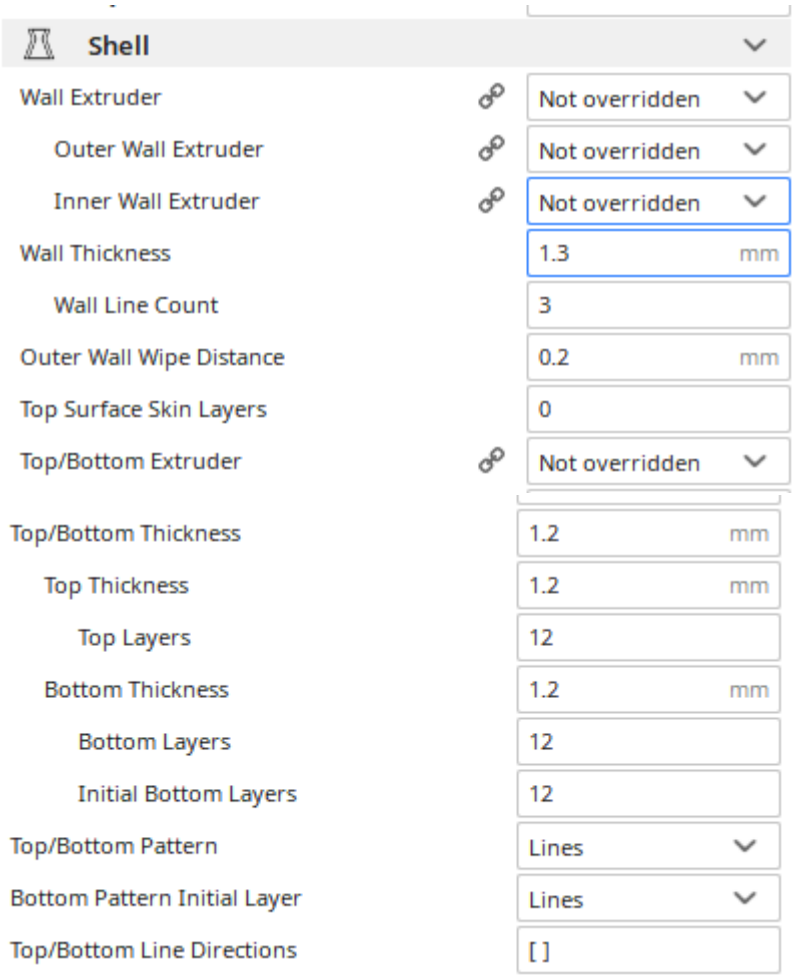
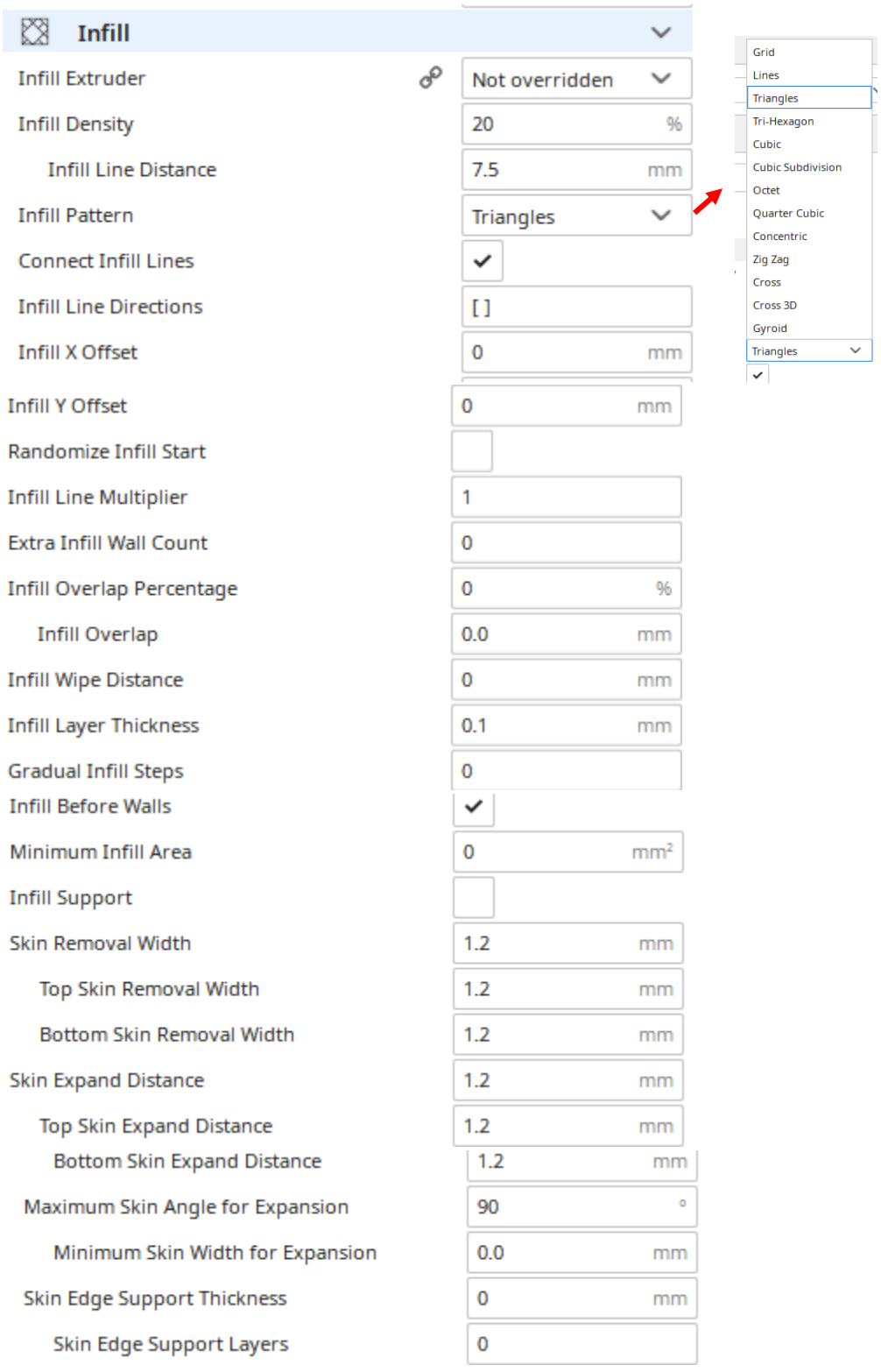
Supporting Materials

Attachment S1 (1-13 pages): Cura slicer's setting options

Settings of Cura software including options found from the dropdown menu ( ).


Shell
Wall Extruder
Not overridden
Outer Wall Extruder
Not overridden
Inner Wall Extruder
Not overridden
Wall Thickness
1.3
mm
Wall Line Count
3
Outer Wall Wipe Distance
0.2
mm
Top Surface Skin Layers
0
Top/Bottom Extruder
Not overridden
Top/Bottom Thickness
1.2
mm
Top Thickness
1.2
mm
Top Layers
12
Bottom Thickness
1.2
mm
Bottom Layers
12
Initial Bottom Layers
12
Top/Bottom Pattern
Lines
Bottom Pattern Initial Layer
Lines
Top/Bottom Line Directions
[ ]

Outer Wall Inset	0 mm
Optimize Wall Printing Order	✓
Outer Before Inner Walls	☐
Alternate Extra Wall	☐
Compensate Wall Overlaps	✓
Compensate Outer Wall Overlaps	✓
Compensate Inner Wall Overlaps	✓
Minimum Wall Flow	0 %
Fill Gaps Between Walls	Everywhere
Filter Out Tiny Gaps	✓
Print Thin Walls	☐
Horizontal Expansion	0 mm
Initial Layer Horizontal Expansion	0 mm
Hole Horizontal Expansion	0 mm
Z Seam Alignment	Sharpest Corner
Seam Corner Preference	Hide Seam
No Skin in Z Gaps	☐
Extra Skin Wall Count	1
Enable Ironing	☐
Skin Overlap Percentage	50 %
Skin Overlap	0.2 mm


Infill
Infill Extruder
Not overridden
Infill Density
20 %
Infill Line Distance
7.5 mm
Infill Pattern
Triangles
Connect Infill Lines
Infill Line Directions
[ ]
Infill X Offset
0 mm
Infill Y Offset
0 mm
Randomize Infill Start
Infill Line Multiplier
1
Extra Infill Wall Count
0
Infill Overlap Percentage
0 %
Infill Overlap
0.0 mm
Infill Wipe Distance
0 mm
Infill Layer Thickness
0.1 mm
Gradual Infill Steps
0
Infill Before Walls
Minimum Infill Area
0 mm²
Infill Support
Skin Removal Width
1.2 mm
Top Skin Removal Width
1.2 mm
Bottom Skin Removal Width
1.2 mm
Skin Expand Distance
1.2 mm
Top Skin Expand Distance
1.2 mm
Bottom Skin Expand Distance
1.2 mm
Maximum Skin Angle for Expansion
90 °
Minimum Skin Width for Expansion
0.0 mm
Skin Edge Support Thickness
0 mm
Skin Edge Support Layers
0
Grid
Lines
Triangles
Tri-Hexagon
Cubic
Cubic Subdivision
Octet
Quarter Cubic
Concentric
Zig Zag
Cross
Cross 3D
Gyroid
Triangles

Material

Build Volume Temperature	28	°C
Printing Temperature	245	°C
Printing Temperature Initial Layer	245	°C
Initial Printing Temperature	240	°C
Final Printing Temperature	235	°C
Extrusion Cool Down Speed Modifier	0.7	°C/s
Build Plate Temperature	70	°C
Build Plate Temperature Initial Layer	70	°C
Flow	100	%
Wall Flow	100	%
Outer Wall Flow	100	%
Inner Wall(s) Flow	100	%
Top/Bottom Flow	100	%
Infill Flow	100	%
Skirt/Brim Flow	100	%
Prime Tower Flow	100	%
Initial Layer Flow	100	%
Standby Temperature	100	°C

Speed

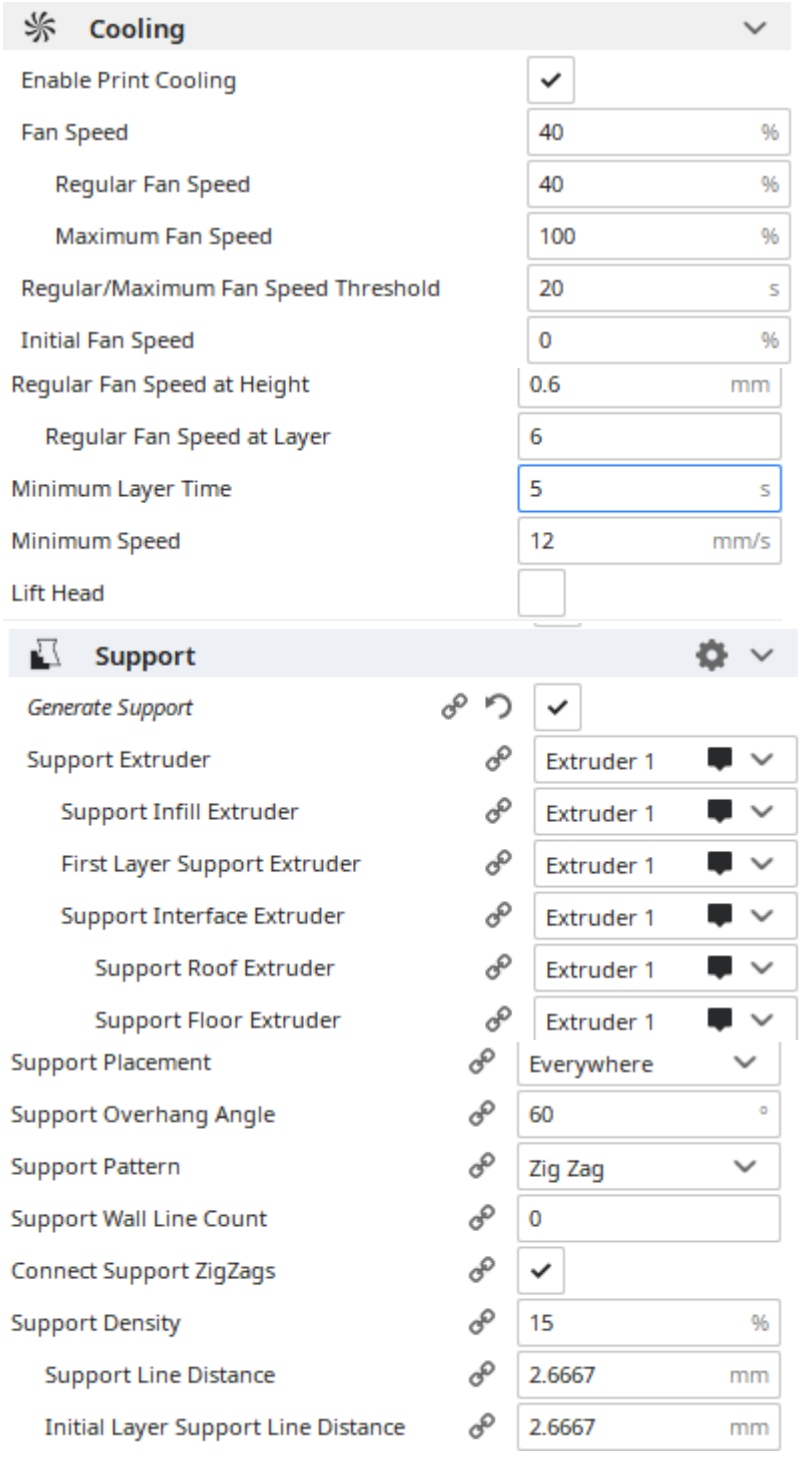
Print Speed	70	mm/s
Infill Speed	70	mm/s
Wall Speed	30	mm/s
Outer Wall Speed	20	mm/s
Inner Wall Speed	30	mm/s
Top/Bottom Speed	30	mm/s
Prime Tower Speed	30	mm/s

Travel Speed	150	mm/s
Initial Layer Speed	20	mm/s
Initial Layer Print Speed	20	mm/s
Initial Layer Travel Speed	42.8571	mm/s
Skirt/Brim Speed	20	mm/s
Z Hop Speed	10	mm/s
Number of Slower Layers	2	
Equalize Filament Flow	✓	
Maximum Speed for Flow Equalization	150	mm/s
Enable Acceleration Control	✓	
Print Acceleration	4000	mm/s^2
Infill Acceleration	4000	mm/s^2
Wall Acceleration	1000	mm/s^2
Outer Wall Acceleration	500	mm/s^2
Inner Wall Acceleration	1000	mm/s^2
Top/Bottom Acceleration	500	mm/s^2
Prime Tower Acceleration	2000	mm/s^2
Travel Acceleration	5000	mm/s^2
Initial Layer Acceleration	500	mm/s^2
Initial Layer Print Acceleration	500	mm/s^2
Initial Layer Travel Acceleration	625.0	mm/s^2
Skirt/Brim Acceleration	500	mm/s^2
Enable Jerk Control	✓	
Print Jerk	25	mm/s
Infill Jerk	25	mm/s
Wall Jerk	10	mm/s

Outer Wall Jerk	5	mm/s
Inner Wall Jerk	10	mm/s
Top/Bottom Jerk	5	mm/s
Prime Tower Jerk	15	mm/s
Travel Jerk	50	mm/s
Initial Layer Jerk	5	mm/s
Initial Layer Print Jerk	5	mm/s
Initial Layer Travel Jerk	10.0	mm/s
Skirt/Brim Jerk	5	mm/s

Travel

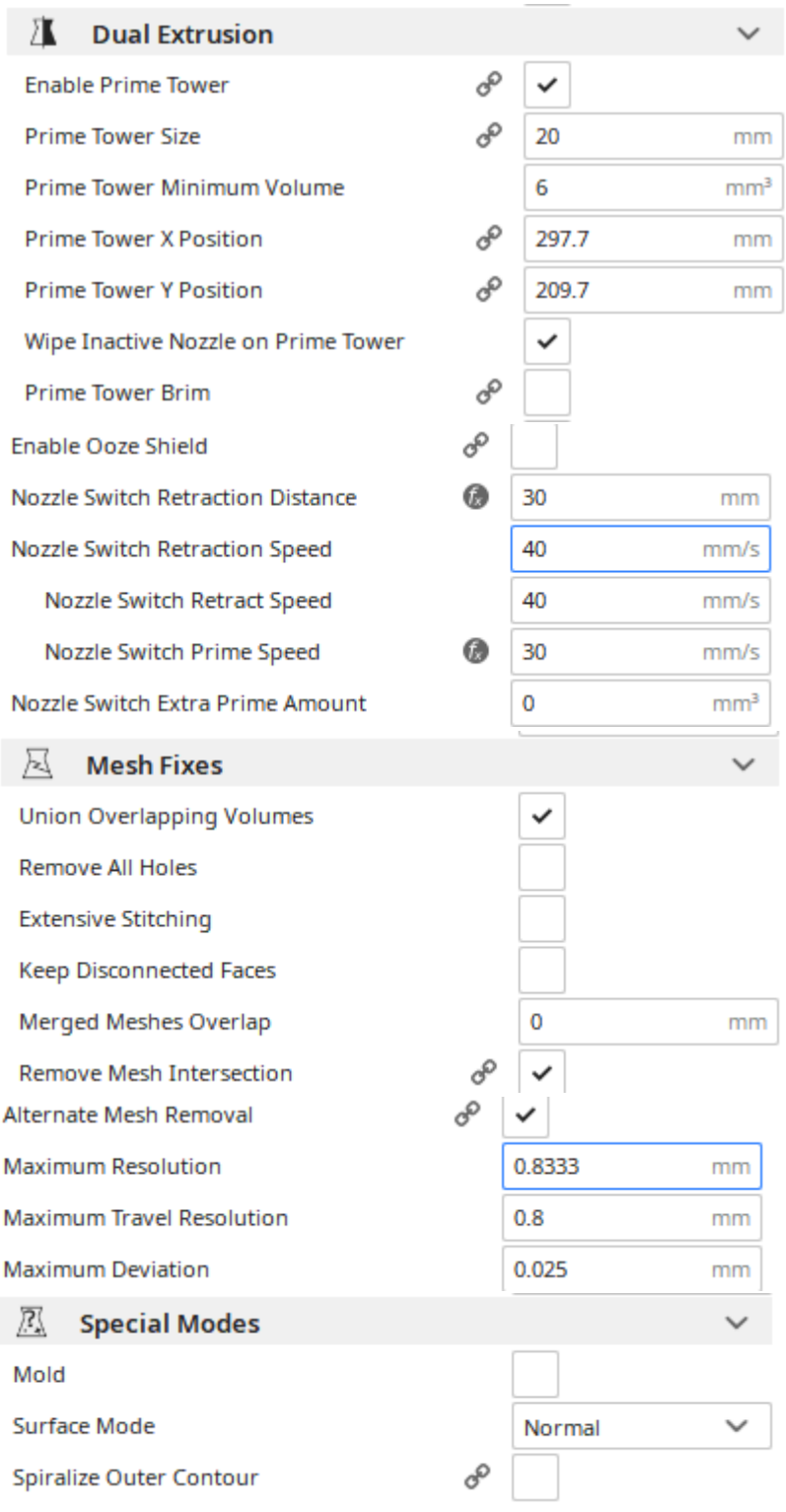
Enable Retraction	✓	
Retract at Layer Change		
Retraction Distance	8	mm
Retraction Speed	25	mm/s
Retraction Retract Speed	25	mm/s
Retraction Prime Speed	25	mm/s
Retraction Extra Prime Amount	0	mm^3
Retraction Minimum Travel	0.8	mm
Maximum Retraction Count	25	
Minimum Extrusion Distance Window	1	mm
Combing Mode	All	
Max Comb Distance With No Retract	0	mm
Retract Before Outer Wall		
Avoid Printed Parts When Traveling	✓	
Avoid Supports When Traveling	✓	
Travel Avoid Distance	3	mm
Layer Start X	330.0	mm
Layer Start Y	228.0	mm
Z Hop When Retracted	✓	
Z Hop Only Over Printed Parts	✓	
Z Hop Height	2	mm
Z Hop After Extruder Switch	✓	
Z Hop After Extruder Switch Height	2	mm

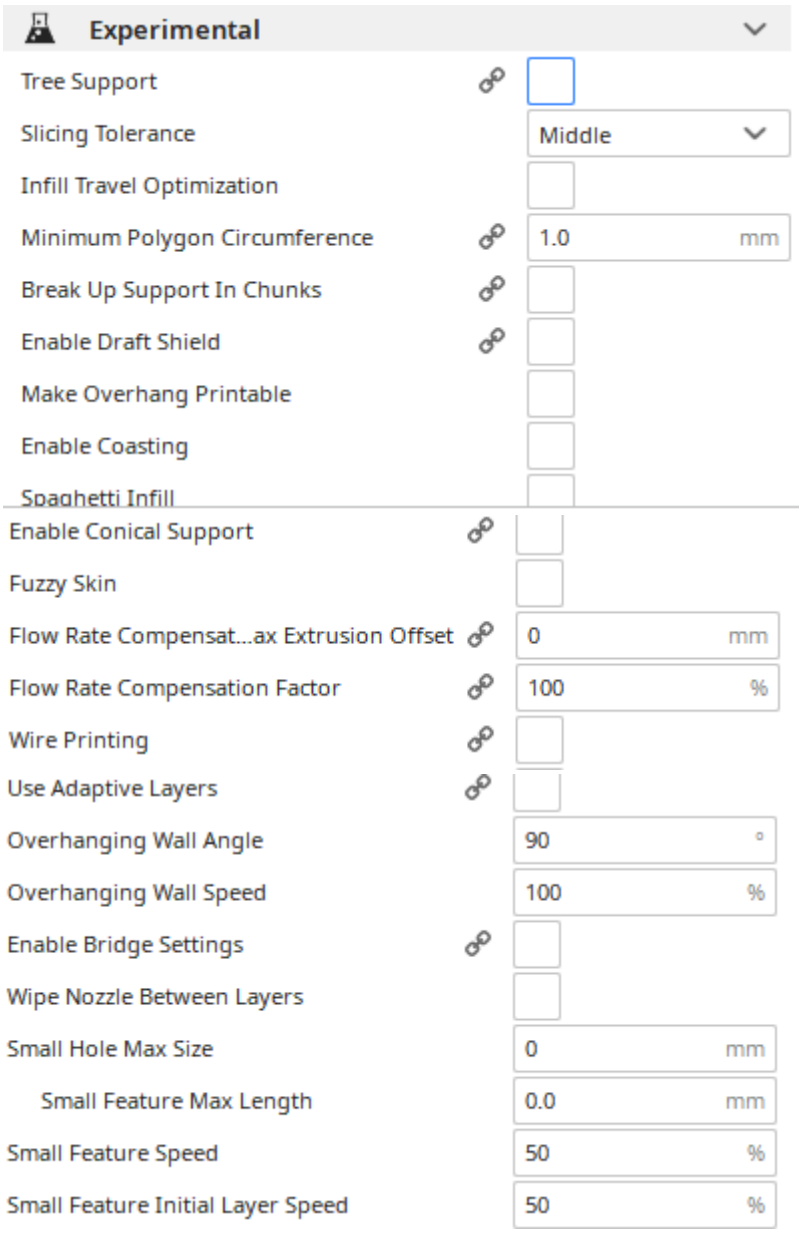

Cooling
Enable Print Cooling
Fan Speed
40 %
Regular Fan Speed
40 %
Maximum Fan Speed
100 %
Regular/Maximum Fan Speed Threshold
20 s
Initial Fan Speed
0 %
Regular Fan Speed at Height
0.6 mm
Regular Fan Speed at Layer
6
Minimum Layer Time
5 s
Minimum Speed
12 mm/s
Lift Head
Support
Generate Support
Support Extruder
Extruder 1
Support Infill Extruder
Extruder 1
First Layer Support Extruder
Extruder 1
Support Interface Extruder
Extruder 1
Support Roof Extruder
Extruder 1
Support Floor Extruder
Extruder 1
Support Placement
Everywhere
Support Overhang Angle
60 °
Support Pattern
Zig Zag
Support Wall Line Count
0
Connect Support ZigZags
Support Density
15 %
Support Line Distance
2.6667 mm
Initial Layer Support Line Distance
2.6667 mm

Support Infill Line Directions	[ ]
Enable Support Brim	☐
Support Z Distance	0.2 mm
Support Top Distance	0.2 mm
Support Bottom Distance	0.1 mm
Support X/Y Distance	1.0 mm
Support Distance Priority	Z overrides X/Y
Minimum Support X/Y Distance	0.4 mm
Support Stair Step Height	0.3 mm
Support Stair Step Maximum Width	5.0 mm
Support Join Distance	2.0 mm
Support Horizontal Expansion	0 mm
Support Infill Layer Thickness	0.1 mm
Gradual Support Infill Steps	0
Minimum Support Area	0.0 mm²
Enable Support Interface	☐
Enable Support Roof	☐
Enable Support Floor	☐
Fan Speed Override	☐
Use Towers	☑
Tower Diameter	3.0 mm
Maximum Tower-Supported Diameter	3.0 mm
Tower Roof Angle	65 °

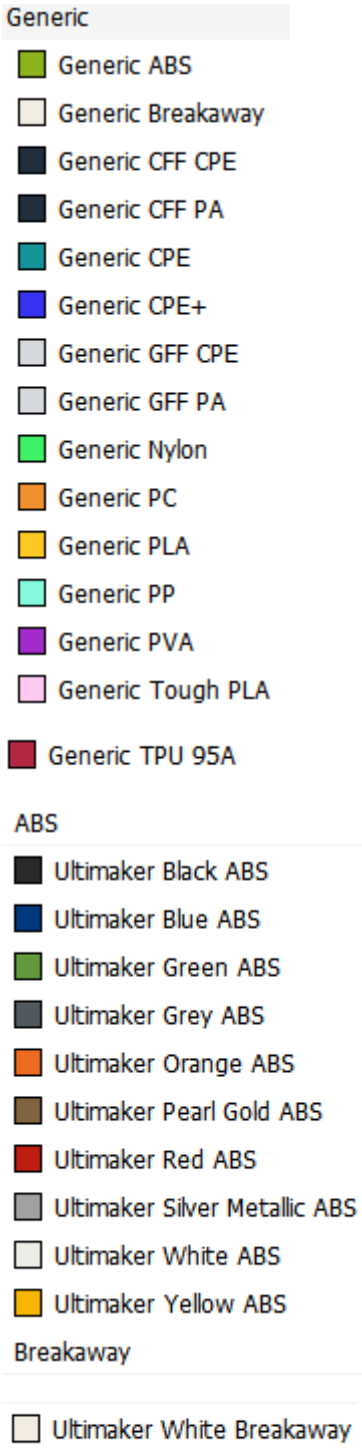
Build Plate Adhesion

Enable Prime Blob	☐
Build Plate Adhesion Type	Brim
Build Plate Adhesion Extruder	Extruder 1
Skirt/Brim Minimum Length	250 mm
Brim Width	7 mm
Brim Line Count	15
Brim Distance	0 mm
Brim Replaces Support	☑
Brim Only on Outside	☑


Dual Extrusion
Enable Prime Tower
Prime Tower Size
20 mm
Prime Tower Minimum Volume
6 mm³
Prime Tower X Position
297.7 mm
Prime Tower Y Position
209.7 mm
Wipe Inactive Nozzle on Prime Tower
Prime Tower Brim
Enable Ooze Shield
Nozzle Switch Retraction Distance
30 mm
Nozzle Switch Retraction Speed
40 mm/s
Nozzle Switch Retract Speed
40 mm/s
Nozzle Switch Prime Speed
30 mm/s
Nozzle Switch Extra Prime Amount
0 mm³
Mesh Fixes
Union Overlapping Volumes
Remove All Holes
Extensive Stitching
Keep Disconnected Faces
Merged Meshes Overlap
0 mm
Remove Mesh Intersection
Alternate Mesh Removal
Maximum Resolution
0.8333 mm
Maximum Travel Resolution
0.8 mm
Maximum Deviation
0.025 mm
Special Modes
Mold
Surface Mode
Normal
Spiralize Outer Contour


Experimental
Tree Support
Slicing Tolerance
Middle
Infill Travel Optimization
Minimum Polygon Circumference
1.0
mm
Break Up Support In Chunks
Enable Draft Shield
Make Overhang Printable
Enable Coasting
Spaghetti Infill
Enable Conical Support
Fuzzy Skin
Flow Rate Compensat...ax Extrusion Offset
0
mm
Flow Rate Compensation Factor
100
%
Wire Printing
Use Adaptive Layers
Overhanging Wall Angle
90
°
Overhanging Wall Speed
100
%
Enable Bridge Settings
Wipe Nozzle Between Layers
Small Hole Max Size
0
mm
Small Feature Max Length
0.0
mm
Small Feature Speed
50
%
Small Feature Initial Layer Speed
50
%

List materials

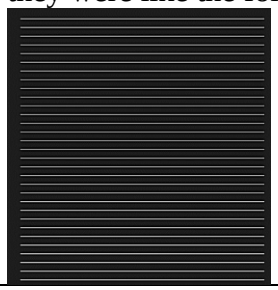



CPE
Ultimaker Black CPE
Ultimaker Blue CPE
Ultimaker Dark Grey CPE
Ultimaker Green CPE
Ultimaker Light Grey CPE
Ultimaker Red CPE
Ultimaker Transparent CPE
Ultimaker White CPE
Ultimaker Yellow CPE
PP
Ultimaker Transparent PP
PVA
Ultimaker Natural PVA
Tough PLA
Ultimaker Black Tough PLA
Ultimaker Green Tough PLA
Ultimaker Red Tough PLA
Ultimaker White Tough PLA
TPU 95A
Ultimaker Black TPU 95A
Ultimaker Blue TPU 95A
Ultimaker Red TPU 95A
Ultimaker White TPU 95A

Attachment S2: software limitation (pages 14-15)

The thickness of original model was 3 mm composed of 30 layers using 0.100 mm thickness option. Using ‘raise part’ option that uses 20 plastic layers (50 layers now) before it starts printing the main model to get better part quality (just in case, sometime if first few floor layers may not be of desired quality). Unfortunately, the following Figures demonstrate how the first two plastic layers experienced undesirable topology, which as not the part the model, and therefore, it negatively impacts the part quality.

Table S1: 2D layers view availed from the Eiger slicer

Category	Stacking of the layers	2D views from the slicing software
First 20 layers for ‘raise part’	Layers 1-16	
	Layers 17-18	Now these two layers are same as 1-16 layers. Previously, they were like the following image, 
	Layers 19-20	Previously it showed nothing, now it shows following, respectively 
Main part	Two undesirable layers, which was not planned to associate to the main part 1-21	

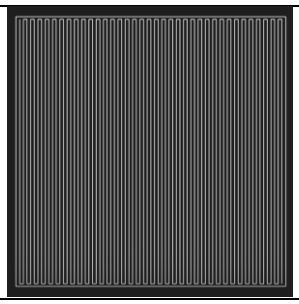
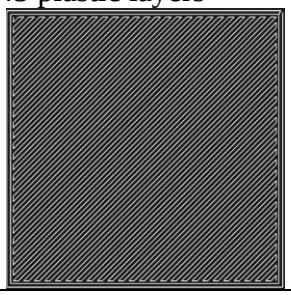
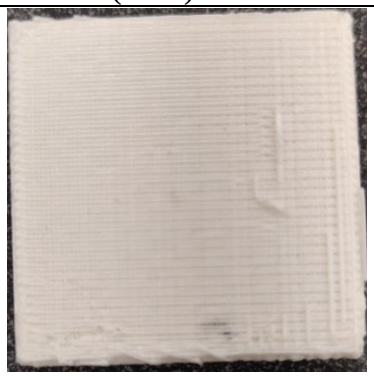
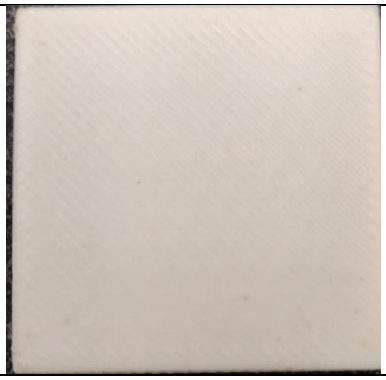
	(first two layers of the main part)	
	Rest are as planned (±45 ^{o} plastic layers and other planned fiber layer orientations)	45 plastic layers 

Table S2: Different views of the printed part using raise part option and regular part (without using ‘raise part’ option)

Category	Top (roof)	Bottom (floor)	Side
Using ‘raise part’ option			
Regular part, without ‘raise part’ option			

Attachment S3: importance of flatness of the print bed (pages 16-18)

Bed leveling knobs:

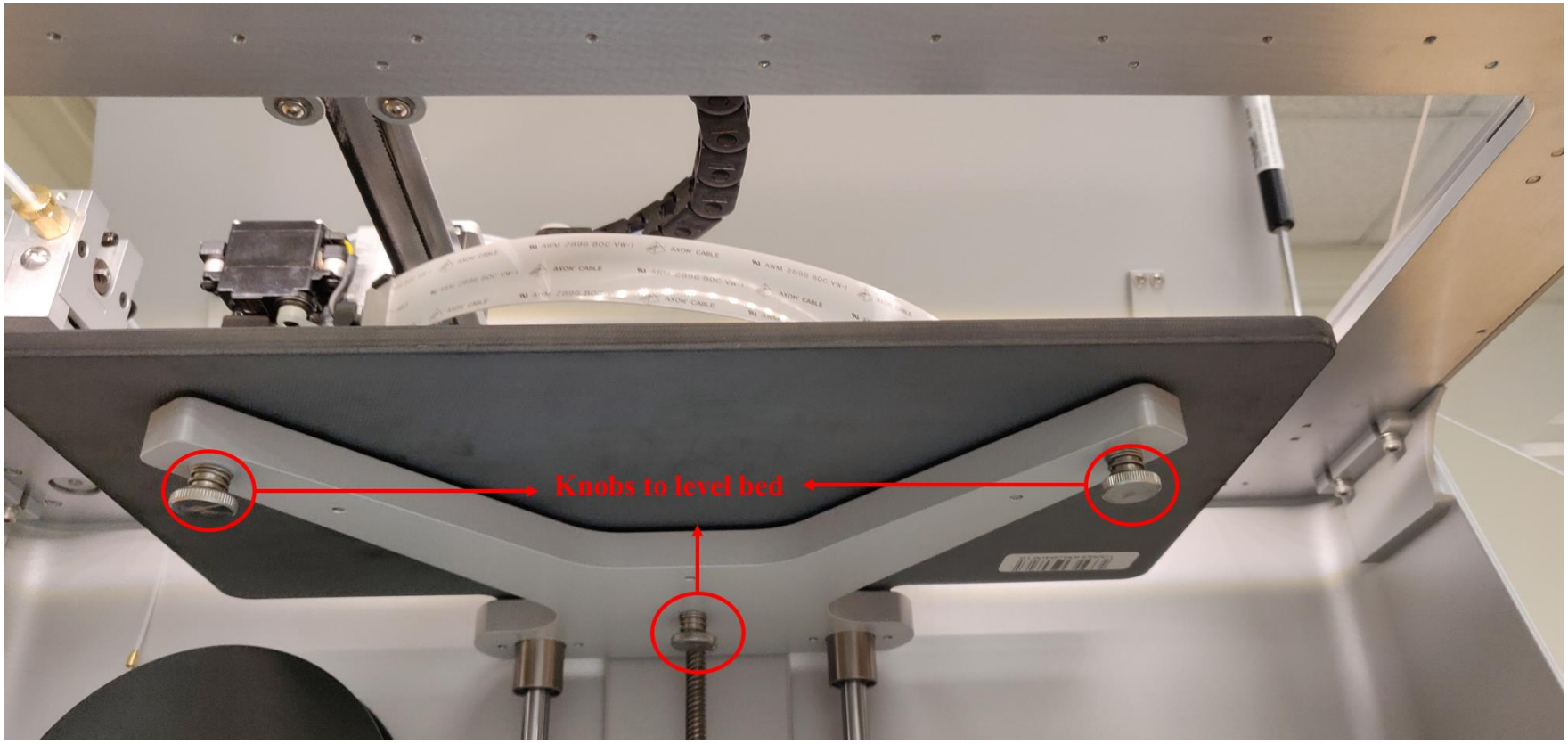


Figure S1: Three bed leveling knobs at three concerns, two at the front in either ends and one at the back in the middle

Bed level test print:

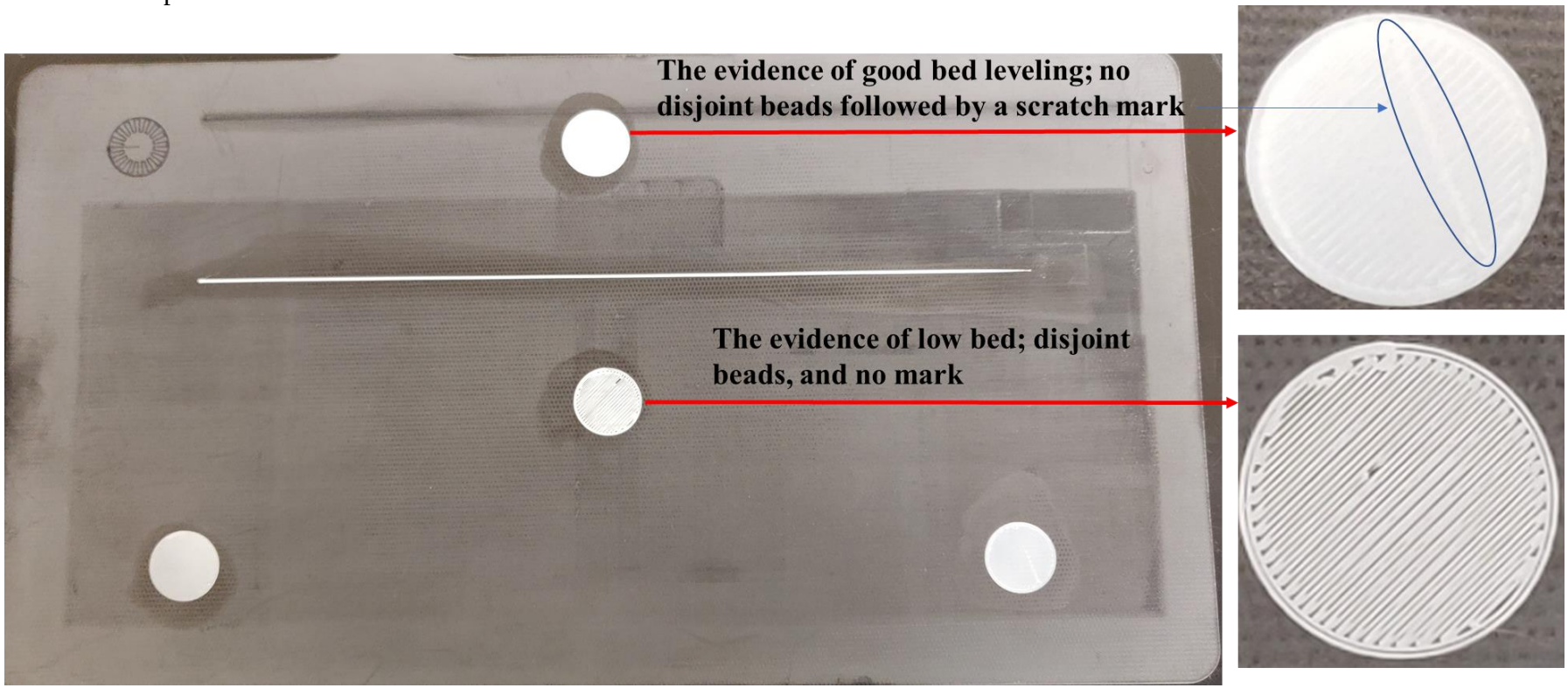


Figure S2: An example of uneven print bed. Although the bed level test at three corners shows good sign of leveling, the middle one suffers from low bed level that indicates imperfection in the flatness

Example of effect of uneven bed

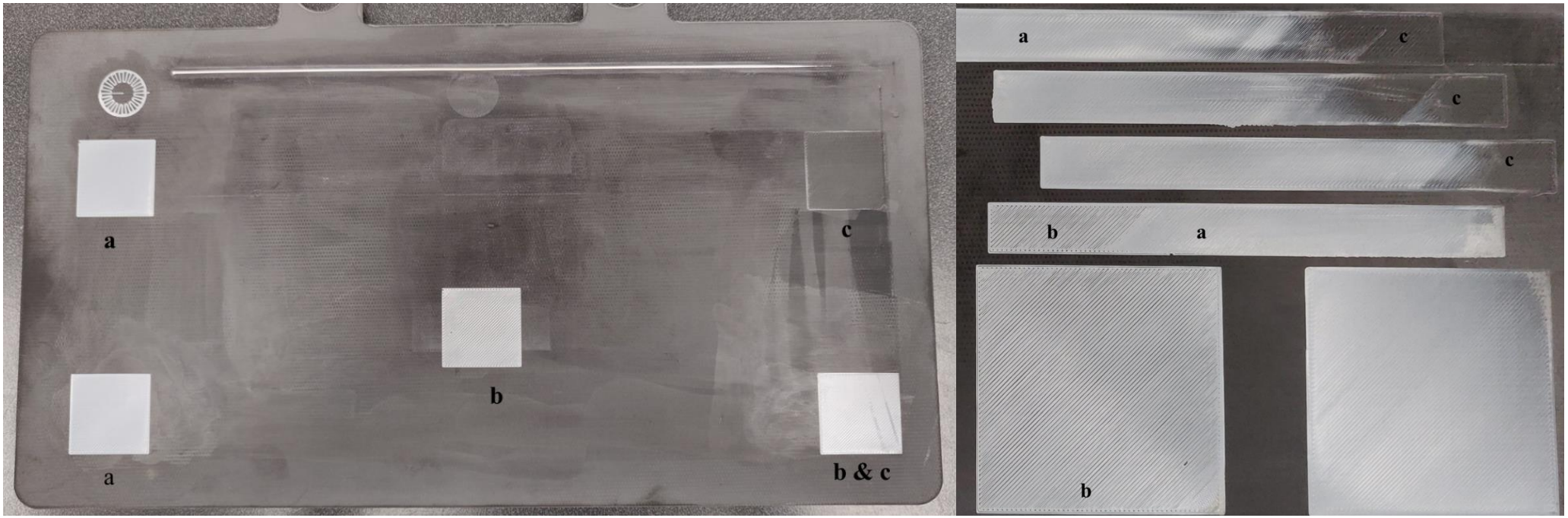


Figure S3: The effect of uneven bed (the images were taken after printing first layer, 0.1 mm thickness), printed good at some areas (a), with disjoint beads at some area (b) and with almost no materials at some area (c) (also a very good example of under extrusion due to printing with less material)

Attachment S4: print bead density for different materials layer heights (pages 19-20)

How is bead density; if the print layer height and using different materials affect the bead density so as the integrity of printed composites. Printed beads were counted by intentionally lowering the print bed so that it prints disconnected print beads

Table S3: Plastic layer bead density for 30 mm X 30 mm sample with 1 wall layer

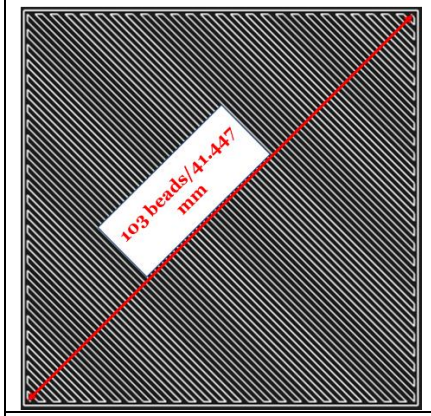
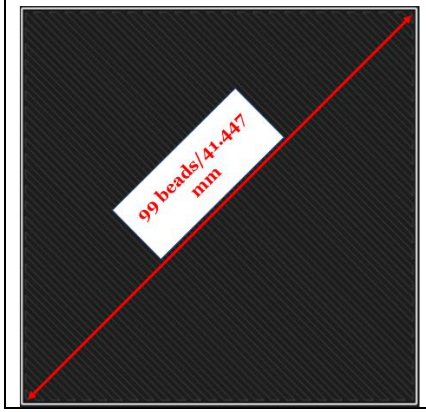
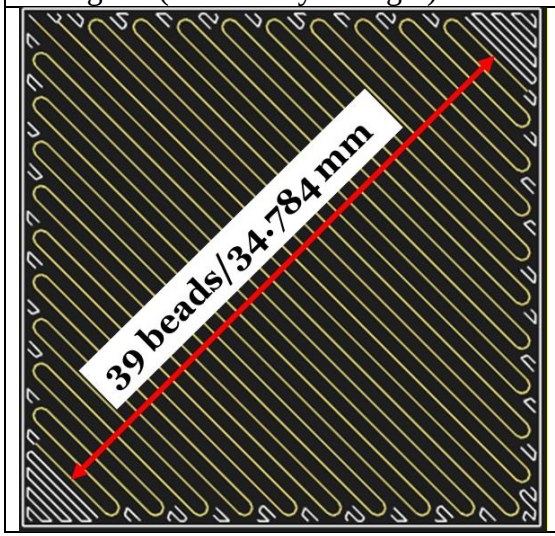
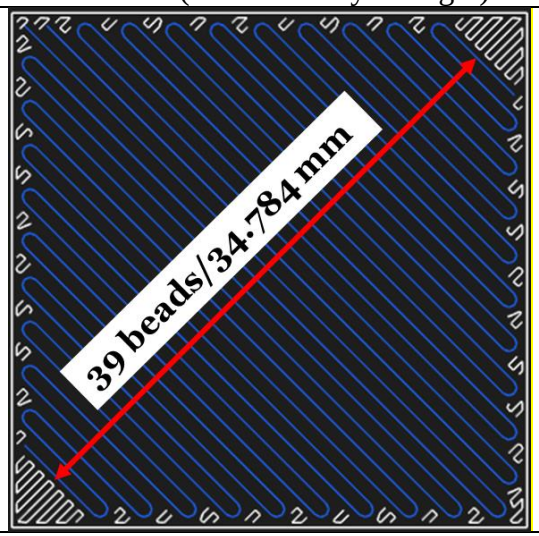
Views	Layer height (0.1, 0.125 and 0.2 mm)	
	Eiger software	Printed layer
For floor/roof 	For floor/roof layer 	
For infill 		

Table S4: Fiber layer bead density for 30 mm X 30 mm sample with 1 wall layer

Fiberglass (0.1 mm layer height)	Carbon fiber (0.125 mm layer height)
	

0.1 mm layer height

0.125 mm layer height

0.2 mm layer height

Figure S4: First layer views at different layer heights indicating relative increment of coverage of gaps at the same bed level