Can you print overhangs without supports?

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Abstract. Yes: up to 45° by most design guides (Prusa says 45 to 60°) and across bridges of 5 to 10 mm. Past that, use chamfers, teardrop holes, splits or a new orientation.

Keywords: supports, overhangs

1 Can you print overhangs without supports?

Yes, within limits. Protolabs Network, UltiMaker and Xometry put the self-supporting limit at 45°, and Prusa says printers manage 45 to 60°. Short bridges print in mid-air too: 5 mm by Protolabs Network's rule, 10 mm by UltiMaker's. Anything past those limits needs a design change: a chamfer, a teardrop hole, a split or a new orientation.

1.1 The number

Table 1. The number

Feature	Prints without support up to	Stated by
Overhang	45°	Protolabs Network, UltiMaker, Xometry
Overhang	45 to 60°, depending on nozzle diameter and settings; possibly under 45° with a 0.25 mm nozzle	Prusa
Overhang	75° on Prusa printers with the Nextruder and 360° cooling	Prusa
Bridge	5 mm	Protolabs Network, Xometry
Bridge	10 mm; 25 mm in Tough PLA with active cooling and tuned settings	UltiMaker
Round horizontal hole	8 mm diameter	MakerVerse
Teardrop horizontal hole	Almost any diameter, if the top angle stays within the 45° limit	MakerVerse
Diamond horizontal hole	Almost any size, with filleted corners	MakerVerse

Each row is the maker's own published rule, from Prusa's knowledge base article "Modeling with 3D printing in mind" and the fused deposition modeling (FDM) design guides of UltiMaker, Protolabs Network, Xometry and MakerVerse. 45° reads the same from vertical or from horizontal; Prusa does not say which way it counts its 60° and 75°.

1.2 Why do some overhangs print in mid-air and others need support?

Every new layer has to land on something. On a slope, each layer rests mostly on the layer below and only its outer edge hangs out: at 45° it steps out by one layer height. A flat ledge has nothing under it and is held at one end only. Bambu Lab's wiki calls that a cantilever and says it must be supported, however small.

A bridge is the exception. The slicer lays straight lines across the gap, and Bambu Lab's wiki says a short bridge prints well enough without support because both ends of every line are anchored. Its length is the limit, which is why the guides above cap it at 5 to 10 mm.

Every way of printing without supports does the same thing: it turns a flat overhang into a slope of 45° or less, a short bridge, or a face resting on the bed.

A round horizontal hole has both problems in one feature. Its sides are gentle slopes, but its roof flattens into a ceiling. Protolabs Network says horizontal holes are where bridges occur most often, and MakerVerse says round ones print without support up to 8 mm across. A teardrop swaps the flat roof for two straight slopes that meet in a point.

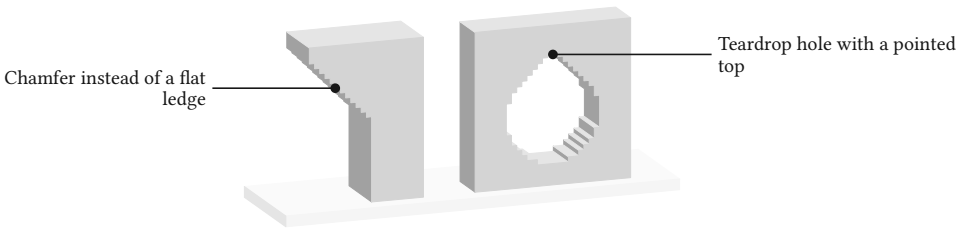


Figure 1. A chamfer under a ledge and a pointed teardrop top on a horizontal hole turn flat overhangs into slopes the printer can build without support.

1.3 Can you 3D print without supports?

Yes. Many models need none: any part whose downward-facing surfaces all rest on the bed, lean 45° or less, or span a short bridge. Shapes that usually print support-free:

- boxes and enclosures printed open side up;
- cylinders standing on their base, and cones or pyramids printed point up;
- brackets, plates and signs laid on their largest flat face, with any lettering raised on the top;
- parts designed with chamfers and teardrop holes, as below.

The cases that do need support are in what supports are and when you need them.

1.4 What overhang angle can you 3D print without support?

45° by every design guide in the table; Prusa allows up to 60°, or 75° on its Nextruder printers. Slicers set their own threshold, some counted from horizontal, so check yours in what overhang angle needs support.

1.5 How long a bridge can you print without support?

5 mm by Protolabs Network's and Xometry's rules, 10 mm by UltiMaker's. UltiMaker adds that it has printed 25 mm bridges in Tough PLA with active cooling and tuned settings. Protolabs Network warns that past 5 mm a bridge can sag or carry marks from support. For a longer span:

- chamfer both ends of the gap, so the flat part gets shorter;
- turn the part so the span stands vertical;
- split the part so the span prints flat on the bed.

1.6 How do you design parts that print without supports?

Five changes do most of the work, each from a maker's design guide:

- **Lay the flat face down.** Prusa says a surface printed on the bed comes out perfectly flat and smooth, and Protolabs Network notes that turning a hole's build direction by 90° removes its need for support. Check strength first: Prusa compares printed parts to wood, stronger in one direction than another (orientation for strong parts).
- **Chamfer downward-facing edges instead of filleting them.** Prusa says a fillet facing the bed makes a very steep overhang that spoils the surface, and recommends a chamfer when finish matters. Xometry's rule is to add a chamfer or fillet to any overhang past 45°.
- **Make horizontal holes teardrops or diamonds.** MakerVerse says a teardrop hole can be almost any diameter if its top angle stays within the 45° limit, and a diamond almost any size with filleted corners. Point the tip straight up. Where roundness matters, MakerVerse says to print the hole vertically instead.
- **Close counterbores with a sacrificial layer.** A counterbore (the wider recess for a screw head) printed opening-down leaves a ring hanging over the bore. Model a one-layer skin across it, or let the slicer add one, and break it through after printing. Printed opening-up, the counterbore has no overhang.
- **Split the model into flat-bottomed pieces.** Prusa says splitting a model minimizes the supports it needs and can improve its looks and strength. PrusaSlicer's Cut tool (C) names "a needlessly large amount of support material" as a reason to cut. It adds Plug, Dowel or Snap connectors and can lay each piece cut face down; join them afterward as in joining 3D printed parts.

1.7 How do you add chamfers instead of overhangs?

In CAD, select the edge where the overhang's underside meets the wall below it and apply a Chamfer with both distances equal to the overhang's depth. Equal distances give a 45° slope that runs from the wall out to the overhang's edge, so no layer hangs past the limit.

- **Why not a fillet:** a fillet's surface sweeps through every angle, so part of it is nearly flat. A chamfer holds one angle the whole way.
- **If the wall below is shorter than the ledge is deep,** a 45° chamfer cannot fit. Turn or split the part instead.
- **On the bottom edge that touches the bed,** UltiMaker suggests a small 45° chamfer against elephant's foot (first layers squashed outward).

1.8 How do you 3D print without supports?

Start in the slicer and edit the model only for what it cannot fix:

1. **Turn the part.** "Place on Face" in PrusaSlicer and "Lay on face" in Bambu Studio and OrcaSlicer put the face you click on the bed. The key is F in PrusaSlicer and Bambu Studio.
2. **Let the slicer reshape steep overhangs.** OrcaSlicer's "Make overhangs printable" (Process > Quality > Overhangs) and UltiMaker Cura's "Make Overhang Printable" (Experimental) fill under any overhang past a maximum angle so it becomes a slope. Both ship off. The angle defaults to 55° in OrcaSlicer and 50° in Cura, counted from vertical (90° leaves the model unchanged). OrcaSlicer warns that this changes the model's shape, so check any part that must fit an assembly.
3. **Bridge counterbores.** Set "Bridge counterbore holes" to "Partially bridged" or "Sacrificial layer" in Bambu Studio (Process > Quality > Advanced) or OrcaSlicer (Process > Quality > Bridging). It ships at None and shows in Advanced mode.

1.9 How to check it on your own print

1. **Slice with supports off** and step through the preview layer by layer. Every outer line should sit on the layer below, on a slope or a short bridge; a line drawn over empty space marks the feature to fix.

2. **Test the risky feature first.** Use the Cut tool to slice off a small section holding the chamfer, hole or bridge, and print the section by itself.
3. **If a slope droops or curls,** fix cooling before redesigning (why overhangs droop).
4. **If a hole's top sags,** make it a teardrop, or design it slightly small and drill it to size, as UltiMaker suggests.
5. **If a bridge sags,** shorten it with chamfers at both ends or stand the span upright.
6. **If one spot still fails,** support only that spot instead of the whole part (reduce support material).

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