How long do 3D printed parts last?

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Abstract. PLA showed no strength loss after a year at 25 °C, but 24 h of lab UV-B cut clear PETG's strength 36% and a hot soak halved carbon-fiber nylon's.

Keywords: replacement-parts, part-strength, pla, asa

1 How long do 3D printed parts last?

There is no fixed lifespan. A part kept cool, dry, shaded and lightly loaded barely ages: PLA (polylactic acid) lost no strength in a year of 25 °C water. Heat, sun, moisture and load each shorten its life. PLA softens above 60 °C (140 °F), and clear PETG lost 36 percent of its strength after 24 hours of lab UV-B.

1.1 What ends a printed part's life

Figures from the studies and Bambu Lab and Polymaker data sheets named in the last column. Each study tested its own specimens, so read a row as a measured case, not a guaranteed lifetime for your part.

1.2 Why each one shortens the clock

Room conditions do almost nothing. PLA is sold as biodegradable, but NatureWorks, the maker of Ingeo PLA,

Table 1. What ends a printed part's life

Condition	What fails	Material most affected	Measured figure	Source
Indoors, room temperature, no load	Nothing measurable	PLA (the most studied)	No change in tensile strength or molecular weight after 1 year in 25 °C water; no significant mass loss after 1 year in 25 °C fresh or sea water	Karamanlioglu and Robson, 2013; Bagheri et al., 2017
Heat	The part softens and sags	PLA	Heat deflection temperature (HDT) at 0.45 MPa: 57 °C (135 °F) for PLA Basic, 71 °C (160 °F) for PETG Basic, 100 °C (212 °F) for ASA, 112 °C (234 °F) for polycarbonate (PC)	Bambu Lab data sheets
Sunlight and ultraviolet (UV) light	Embrittlement, yellowing, strength loss	Clear, unpigmented PETG (glycol-modified PET)	Tensile strength down 36 percent (31.3 to 20.0 MPa) after 24 h of UV-B with condensation; blue PLA down 5.3 percent	Amza et al., 2021
Warm humidity	Hydrolysis: water cuts the polymer chains	PLA	Two of three PLA brands lost 23 and 28 percent of tensile strength after 100 h at 55 °C (131 °F) and 100 percent humidity; the third lost 2 percent	Sedlak et al., 2023
Water	The plastic absorbs it, swells and softens	Nylon (PA)	PA6-CF takes up 2.35 percent water against 0.43 percent for PLA Basic; Polymaker PA6-CF20 fell from 109.3 to 54.7 MPa after 48 h in 60 °C water	Bambu Lab and Polymaker data sheets
Repeated load	A fatigue crack grows until the part snaps	Every material; the design rule exists for PLA	Endurance limit at 2 million cycles is about 10 percent of ultimate tensile strength, which is 3.5 MPa for PLA Basic's 35 MPa	Ezeh and Susmel, 2019; Bambu Lab PLA Basic data sheet
Constant load	Creep: slow stretching, then rupture	PLA	Printed PLA under 10 MPa at 60 °C ruptured within a 3-hour test; PC did not rupture at 60 °C and 20 MPa	Dogan, 2022

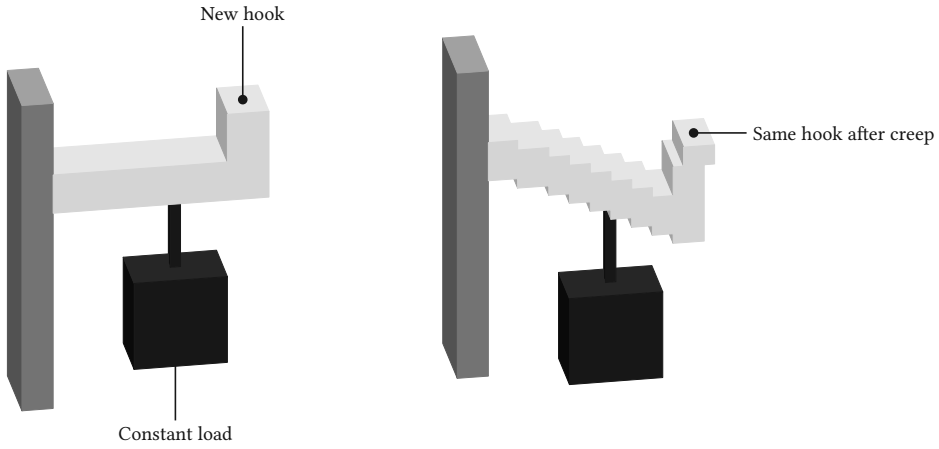


Figure 1. Printed PLA under a constant load slowly stretches, so a loaded hook in a warm room sags long before it breaks.

ties its breakdown to the heat and moisture of an industrial compost pile. Karamanlioglu and Robson saw PLA hold its strength at 25 and 37 °C for a year, start losing it at 45 °C and lose it fastest at 55 °C. A shelf bracket or a cable clip in a living room never gets that warm.

Heat works fast and sets the ceiling. Near its HDT a loaded part bends. The Prusa Knowledge Base says PLA gets soft and deforms above 60 °C, so a sunny dashboard or a dishwasher can ruin a PLA part on the first exposure.

UV results vary from test to test. Amza's clear PETG lost a third of its strength in 24 hours of UV-B and condensation, and the authors point to its lack of pigment. Sedlak's PETG gained strength after 100 hours under a mercury lamp.

Sedlak's samples also spent 98 winter days outdoors under cover, and every material's strength moved 7 percent or less. ASA (acrylonitrile styrene acrylate) was the least affected across all of Sedlak's tests, and ABS (acrylonitrile butadiene styrene) yellowed under the lamp. The Prusa Knowledge Base rates ASA as highly UV resistant and says PLA degrades under UV light.

Warm water breaks PLA from the inside. Bergaliyeva's PLA bars lost 33 percent of their strength after 56 days at 50 °C (122 °F) and 70 percent humidity. Nylon fails differently: it soaks up water and stays softer and weaker until it dries.

Load is the slow killer. Ezeh and Susmel's design curve for printed PLA puts the stress it can take for 2 million cycles at about a tenth of its tensile strength. Dogan ranked printed PLA worst for creep among six materials and limited it to room temperature with no load or very low constant loads. Creep speeds up with temperature, so a loaded PLA hook in a warm room sags long before it breaks.

1.3 How to make a printed part last longer

1. **Swap the material for the condition that will end the part.** Heat calls for PETG, ASA or PC. Sun calls for ASA, and a constant load for PC. Avoid nylon where it stays wet and has to hold its size. The full decision table is in which filament to use for a replacement part, and hot water is covered in which filament survives a dishwasher.
2. **Lower the stress.** Fatigue and creep life depend on stress, so a thicker section, more perimeters or a wider footprint add life no material swap can.
3. **Orient the part so the load runs along the layers.** Bambu Lab's PLA Basic pulls 35 MPa in XY and 31 MPa in Z, so a part loaded across its layers starts from the weaker figure. The method is in which print orientation makes a replacement part strongest.
4. **Keep PLA out of warm water.** Room-temperature water is fine for a year or more; the limits are on how long PLA lasts in water.

1.4 How to check it on your own part

- **Look for color change.** Light-colored ABS yellowed slightly after 20 hours of lamp UV in Sedlak's test, and Amza's clear PETG turned yellow. On a sun-facing part, yellowing is a sign of UV damage.
- **Look for whitening.** Malone's printed PLA fibers in 50 °C fluid turned white within 30 days as the polymer broke down. Whitening on a part that sits in warm water means hydrolysis has started.
- **Check for sag or a changed fit.** A hook that droops, a clip that no longer snaps tight or a bracket that has twisted is creeping. Replace it in a stiffer material before it ruptures.
- **Do not trust looks alone.** Malone's PLA at 37 °C stayed clear and intact for 180 days yet turned brittle. For a part that carries load in heat, water or sun, print a spare with it and flex the spare every few months. Replace the part when the spare cracks instead of bending.

The replacement parts guide covers the layer-strength table and where printing stops making sense.

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