

Important points in making good filament tip:

1. Printer Tuning

Tuned printer makes everything easier, at the very least, tuned the e-steps, extrusion multiplier and temperature.

Temperature is the most important factor

Changing the temperature most likely means changing everything else. Use PID or MPC for stable temperature.

Print Temp Tower, choose the lowest possible temp. Usually, it's easier to make good filament tip on lower temp.

2. Pressure inside the nozzle

Traveling from print object to wipe tower reduce the pressure inside nozzle. The amount of pressure lost while traveling depends on the distance, ideally this information can be calculated and made into formula. I don't have the skill to do that.

Also, unless the printed model is very simple, most likely the distance/pressure lost varies even between layers on the same object.

Prusa Slicer attempts to address this with extruding some amount of filament to wipe tower, but sometimes it's not enough.

If necessary, make a straight line on the beginning of the ramming parameter.

3. Ramming

The purpose of ramming is to push filament into the nozzle in a way that the melting plastic inside the nozzle isn't carried away when unloading. Ramming usually requires larger volume than the volume to stabilize pressure.

In other words, we are trying to overwhelm the nozzle melting capabilities, which then, hopefully, when the unloading begins, only the un-melted part of the filament is pulled out.

4. Unloading

Speed plays a big role in making good filament tip. Too slow, the effect of ramming is lost. Too fast, the ramming result is not set yet. Both will not produce a good filament tip. Start with the default value first (100 mm/s), adjust if needed.

5. Cooling

Cooling means that the filament is moved up and down for sometimes, allowing it to cool down and become hard again. Some filament needs more time to become hard again than other filament.

This is important for Direct Drive system where the filament is parked before the extruder. Soft filament will be deformed by the extruder gear which then can cause jamming.

Cooling also gives shortening effect on the filament tip. This effect can help reducing string.

Troubleshooting:

- Thick string / Blunt tip
 - Not enough time to melt the filament
 - Volume too high
 - Temperature too low

Solution:

- Increase the time
- Lower the volumetric speed.
- Increase temperature

- Ripped tip
 - Unloading speed too fast
 - Volume too high

Solution:

- Lower unloading speed
- lower volumetric speed.

- Smooth, long tip
 - Not enough volume
 - Time is too long
 - Temperature too high

Solution:

- Increase volumetric speed
- Lower time
- Lower temperature
- Use cooling moves

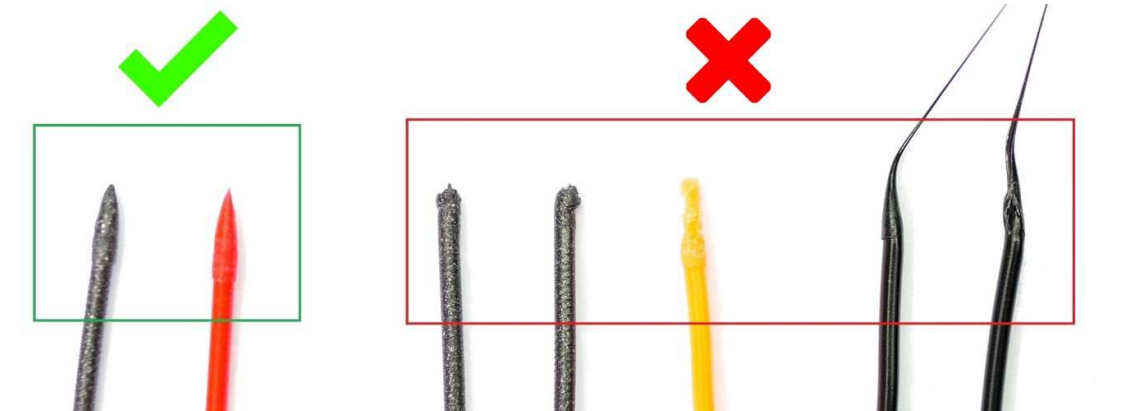
- Inconsistent filament tip
 - Extruder problem
 - Heat creep
 - Temperature too high
 - Wrong slicer setting

Solution:

- Tune the printer
- Check slicer settings

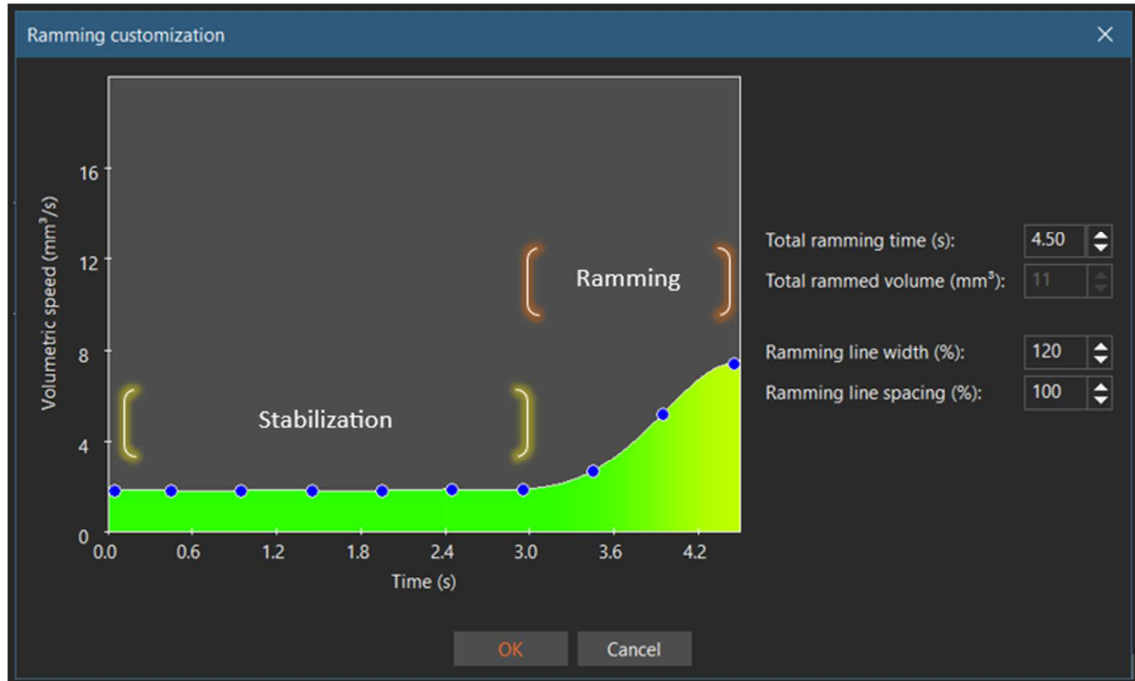
Examples:

1. Borrowing image from Prusa documentation, from the left:



#1, #2: good. #3, #4: blunt tip #5: thick string #6: smooth long tip #7: ripped tip

2. Ramming parameters with stabilization period:



3. Ramming parameters without stabilization period, from Prusa Slicer default setting. Pay attention to the increasing, which is not steep:

