BRITFORGE3D
3D PRINTING SERVICES

Technical guide

A Technical Guide – Part Three

Heat Resistance, Load, and Long-Term Durability in 3D Printed Parts

A common assumption in 3D printing is that if a part feels strong when it comes off the printer, it will remain strong in use. In reality, many printed parts fail not because they were overloaded, but because they were exposed to heat or stress over time. Understanding durability means thinking beyond initial strength and considering how materials behave in real-world conditions.

Heat plays a critical role in plastic performance. Most plastics do not need to reach their melting point to fail. Instead, they gradually soften as they approach their heat deflection temperature. At this point, a part may still look intact but can no longer support load without deforming.

PLA is a good example. While it is stiff and strong at room temperature, it softens at relatively low heat. This is why PLA parts often warp inside cars, near electronics, or in warm environments. The part has not melted; it has simply lost its ability to resist deformation.

Load introduces another dimension to durability. When a part carries weight continuously, it experiences stress even if that stress is well below its breaking strength. Over time, this can lead to creep, which is slow, permanent deformation. PLA is particularly prone to creep, which is why it is unsuitable for long-term load-bearing parts.

PETG behaves differently. Its slight flexibility allows it to absorb stress rather than concentrating it in one place. This makes PETG far more resistant to cracking and long-term deformation under moderate loads. However, this flexibility can also be a disadvantage where rigidity is required.

ABS and ASA are designed for harsher conditions. They maintain their shape at higher temperatures and resist impact better than PLA or PETG. ASA adds UV resistance, making it suitable for outdoor use where sunlight would otherwise degrade the material.

Nylon takes durability further still. It excels under repeated stress, vibration, and impact. Nylon parts often bend rather than break, making them ideal for mechanical components. However, nylon's performance depends heavily on moisture control, as absorbed water changes its mechanical behaviour.

Durability is also influenced by geometry. Sharp corners concentrate stress, while smooth transitions distribute it. Thin sections heat and cool faster than thick ones, which can introduce internal stress. These factors all affect how a part ages over time.

Print orientation plays a major role as well. Loads applied across layer lines exploit the weakest direction in FDM printing. Orienting parts so that stress runs along the layers dramatically improves durability without changing material or settings.

Environmental exposure must also be considered. UV light, moisture, chemicals, and temperature cycling all degrade plastics differently. A part designed for indoor use may fail quickly outdoors if material choice is not adjusted.

Durability, therefore, is not a single property. It is the result of material choice, geometry, orientation, and environment working together. Ignoring any one of these factors invites failure.

Professional printing workflows consider durability from the start. At BritForge3D, parts are evaluated not just for print success, but for how they will perform weeks, months, and years after installation.

Understanding long-term behaviour allows designers to avoid surprises and create parts that remain reliable throughout their service life.

Guide 3 Summary – Tolerances and Dimensional Accuracy

This guide explained why printed parts are never exact replicas of their digital designs and why this is not a flaw, but a characteristic of the process. By understanding tolerances, shrinkage, and orientation-related accuracy, you can design parts that fit reliably instead of relying on trial and error.

You learned that dimensional accuracy is about predictability, not perfection. Once variation is understood and planned for, assembly issues become far less common.

In the next guide, we move beyond fit and focus on how printed parts behave over time, exploring heat resistance, load, and long-term durability.