



3D Printed Industrial Die Using Case Hardened L-40

CHALLENGE

Tooling for Production of Threading Bolts

Fasteners that loosen when used in high vibration environments, such as heavy equipment engine compartments or bridge structures, increase maintenance costs, jeopardize safety, and increase risk liability. Perfect Lock Bolt America, Inc. has designed new structural bolts with an intricate thread design that alleviate these concerns by resisting self-loosening.

To cost effectively produce these innovative bolts, the compression dies required a complex profile to form the threads. The conventional solution to machine the dies from D2 or M2 tool steel was unsuccessful because of the extreme difficulty in machining the complex die surface profile required to form the intricate thread design. Furthermore, experience obtained from machined profiles with lower complexity indicated an uneconomical die life given the low ductility of standard materials, producing a limited quantity of bolts per die.

Perfect Lock Bolt recognized the need to look at additive manufacturing as an alternate solution. However, their questions were two-fold: 1) Was there a material available that provided the necessary combination of hardness and toughness to extend the die life or serial bolt production and 2) Could that material be 3D printed to produce the geometrically and dimensionally challenging thread design?

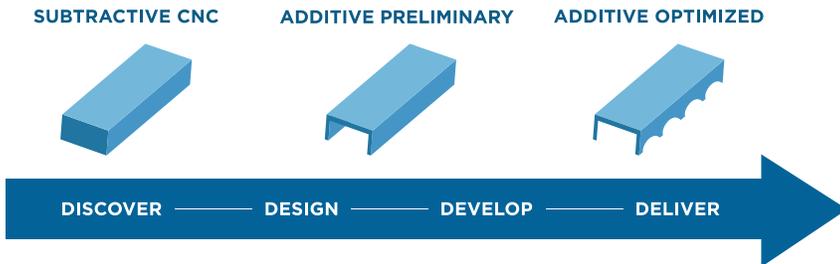


High Hardness, Compression Die
for Bolt Threading

SOLUTION

Formetrix Powder Bed Fusion 3D Printed Dies

Perfect Lock Bolt partnered with Formetrix from the conception of the problem to the final solution. In the alloy selection phase, Formetrix's L-40 steel powder was proven to demonstrate the needed performance in hardness and durability. In cooperation with production partner CFK GmbH in Kriftel, Germany, the team optimized the printing process and parameters to meet dimensional and surface tolerances. Achieving the best economics required that the dies, measuring approximately 20 cm (8in), be redesigned for additive manufacturing. In addition, Formetrix implemented post-production printing processes to achieve a surface finish of 2-3 micron Ra.



RESULTS

Successful Testing in a Production Environment

Formetrix recognized the opportunity to create what may be the first-of-its-kind — a 3D printed compression die set. The resulting L-40 prototype dies outperformed dies machined from D2 and M2 tool steels, and the powder bed fusion printing process was able to successfully produce the complex die thread design.

“We tried nearly every combination of material and conventional CNC machining process to create our dual-thread die sets, none of which could cut or grind the complicated dual-thread geometry of our thread form,” said Mark Doll, President and CEO of Perfect Lock Bolt America Inc. “The Formetrix solution delivered exactly what we are looking for, including excellent surface finish, flexibility, as well as strength and hardness for maximum die life. This is a welcomed technological innovation to the fastener industry. We have been pleased with our testing and are moving to production.”



Optimized Die Set After Printing



Dual-Thread Bolt From Validation Trial

BENEFITS OF 3D PRINTING

AM Advantages and Manufacturing Freedom

- Full Customization Capability
- On Demand Production
- Rapid Design Iteration
- Enable Parts Consolidation

Benefits of L-40

- Case Hardenable: Up to 70 HRC
- Excellent Core Properties:
 - Hard: >50 HRC
 - Ductile: >10% Elongation
 - Exceptional Toughness
- Easy to Print, Crack-Free (room temperature to 200°C)
- High Corrosion Resistance
- Safe: Low Toxicity (Cobalt Free)

