**Highlights:**

* Laser surface hardening of cylindrical AISI 4340 steel specimens was studied using experimental and DOE approach.
* Laser power, laser feed speed and sample rotation speed were selected as input variables.
* Geometry of the hardened area, micro hardness and microstructure are investigated as output responses.
* Microhardness measurements revealed three distinct regions in the heat-affected zone (HAZ) of all samples.