

Oblikovanje in izdelava polirne naprave ter polirni postopek z uporabo materiala Al 7075 T6

The Design and Manufacture of Burnishing Equipment and the Burnishing Process with Al 7075 T6 Material

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Polirni postopek je končna obdelava, ki jo lahko opišemo tudi kot postopek brez odrezkov. V pričujočem prispevku predstavimo polirno napravo, ki smo jo oblikovali in izdelali tako, da z njo lahko poliramo prizmatične elemente. Polirno napravo smo uporabili za poliranje prizmatično oblikovanih vzorcev Al 7075 T6, pri čemer smo upoštevali različne polirne parametre. Na koncu smo polirane površine opisali in razvrstili glede na njihovo hrapavost in trdoto.

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(Ključne besede: poliranje, prizmatični obdelovanci, hrapavost površin, površinska trdota)

The burnishing process is a final process that can also be described as a chipless process. In this paper, burnishing equipment that is designed and manufactured for the burnishing of prismatic parts is introduced. This burnishing equipment was then used to burnish prismatically manufactured Al 7075 T6 samples using different burnishing parameters. The burnished surfaces were characterized in terms of roughness and hardness.

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(Keywords: burnishing, prismatic parts, surface roughness, surface hardness)

0 UVOD

Poliranje je zelo natančna tehnika, ki se uporablja pri strojni obdelavi delovnih površin. Polirno tehniko uporabljamo že dolgo, saj z njo izboljšamo mehanske lastnosti in kakovost površine; poleg tega pa je zelo učinkovita tudi v serijski proizvodnji. Poliranje poveča tako kakovost površine kakor tudi mehansko trdnost. Zaradi naštetih razlogov je v večini primerov poliranje bolj primerno od brušenja [1].

Če v končno obdelavo vključimo polirni postopek, ta ponuja številne prednosti, na primer, povečanje trdote, večjo trajno nihajno trdnost in večjo odpornost proti obrabi. Kadar za poliranje uporabimo veliko silo, poliranje omogoči veliko odpornost proti poškodbam materiala. Razpoke zaradi utrujenosti se v materialu širijo od področij, na katerih se kopičijo dislokacije, ter točk, na katerih se je površina poškodovala. Zato so, z vidika širjenja razpok, značilnosti površine materiala zelo pomembne. Poškodbe površine oziroma razpoke

0 INTRODUCTION

Burnishing is a precise processing technique that is used in the machining of functional surfaces. The burnishing technique has been used for a long time because it can improve mechanical properties, surface quality and is very efficient in serial production. Burnishing increases the surface quality as well as the mechanical strength. For these reasons, the burnishing process is preferable to grinding for most applications [1].

When the burnishing process is used as a final treatment, there are a number of advantages, such as a hardness increase, higher fatigue strength and greater wear resistance. When burnishing is carried out with a great deal of force, the resistance to material defects also increases. Fatigue cracks in materials are propagated from regions of dislocation accumulation and defect points on the surfaces. For this reason, surface characteristics are very important from the crack-propagation point of view. These surface defects or surface cracks can be

lahko odpravimo prav s poliranjem. Ker poliranje zmanjša hrapavost površine, s tem zmanjša tudi možnost nastanka razpok [2].

Površine strojnih delov, ki jih izdelamo s stružnico ali frezalnim strojem, lahko obdelamo le do določene kakovostne stopnje. Za doseganje večje kakovosti pa moramo izdelke brusiti ali polirati. Izvedene in objavljene so bile že številne študije poliranja s stružnico ([2] in [3]), nismo pa še zasledili poročila o poliranju prizmatičnih obdelovancev.

Poliranje lahko spremeni značilnosti površine materiala. Vemo, da ta postopek zmanjša hrapavost površine ([4] do [6]) ter poveča njeno trdoto in odpornost proti obrabi ([7] do [11]). Poliranje lahko poveča tudi odpornost proti utrujenosti površine ([12] do [14]). Obstajajo tudi poročila o tem, da polirni parametri močno vplivajo na hrapavost in trdoto površine [15].

V prispevku smo med poliranjem materiala Al 7075 T6 spreminjali obdelovalne parametre – na primer število vrtljajev, hitrost poliranja in število prehodov polirne naprave – in material opisali glede na posledično hrapavost in trdoto površine. Določili smo vplive števila vrtljajev, hitrosti poliranja in števila prehodov naprave na hrapavost in trdoto površine.

1 OBLIKOVANJE IN IZDELAVA POLIRNE NAPRAVE

Polirno napravo smo oblikovali tako, da jo lahko uporabljamo za poliranje prizmatičnih obdelovancev (sl. 1). Na začetku oblikovalnega postopka smo se odločili, da bomo uporabljali napravo ne le v navpično delujoči osrednji frezalni enoti, ampak tudi tako, da bo lahko polirala prizmatične obdelovance. Da bi lahko polirali prizmatične obdelovance, smo kroglico namestili na končino naprave.

Za potrebe oblikovanja polirne naprave smo pregledali ustrezno literaturo, da bi se seznanili z načeli podobnih zasnov. Slika 1 prikazuje razstavljeno skico oblikovane in izdelane polirne naprave in s tem tudi prikaz njene sestave.

Ko poliranje izvajamo z veliko silo, se odpornost proti poškodbi materiala očitno poveča. Povečanje trdote površine in odpornosti proti obrabi ter zmanjšanje hrapavosti površine in širjenja razpok sta odvisni od polirnih parametrov, na primer, števila prehodov naprave, števila vrtljajev in hitrosti

removed by burnishing. Since the burnishing reduces the surface roughness, it also reduces the possibility of crack formation [2].

The surfaces of machine parts that are manufactured with a lathe or a milling machine can be machined up to a certain quality. If a better surface quality is required, they need to be ground or burnished. A number of burnishing studies involving a lathe were carried out and reported in the literature ([2] and [3]). However, the burnishing of prismatic parts has not been reported.

Burnishing can change the surface characteristics. The process is known to improve the surface roughness ([4] to [6]), and increase the surface hardness and wear resistance ([7] to [11]). Burnishing can also increase the fatigue resistance ([12] to [14]). It has also been reported that the burnishing parameters strongly affect the surface roughness and the hardness [15].

In this paper, Al 7075 T6 was burnished while varying the processing parameters – such as the number of revolutions, the feed rate and the number of passes – and characterized in terms of the surface roughness and hardness. The effect of the number of revolutions, the feed rate and the number of passes on the surface roughness and the hardness was determined.

1 DESIGN AND MANUFACTURE OF THE BURNISHING EQUIPMENT

The burnishing equipment was designed so that it can be used with prismatic parts (Figure 1). At the start of the design process it was decided to use the equipment not only in a vertical-processing centered milling unit but also so that it would be able to burnish prismatic parts. In order to burnish prismatic parts, a ball was placed at the end of the equipment.

For the design of the burnishing equipment, a literature review was made to check the principles of similar designs. An exploded view and installation drawing of the designed and manufactured burnishing equipment is shown in Figure 1.

When burnishing is applied under excessive force, the resistance to material defects definitely increases. The increases in the surface hardness, the wear resistance, and the reduction in the surface roughness and crack-propagation centers all depend on burnishing parameters, such as the number of passes, the number of revolutions, the applied force.

delovanja. Polirni postopek smo izvedli ob upoštevanju vseh teh parametrov.

Materiale potrebne za izdelavo polirne naprave, smo določili glede na položaj, ki ga ima posamezni del v celotni sestavi naprave. Za dele, ki so kritični z vidika trdnosti, smo izbrali C3425, za preostale dele pa SAE1050. Dele, ki so kritični z vidika trdnosti, smo pred montažo utrdili s toplotno obdelavo. Povprečna trdota ojačanih delov je bila med 55 in 65 HRc.

Ker je poliranje izvedeno s kroglico, ki je nameščena na končino naprave, je bilo treba izdelati kroglični ležaj z zelo natančnimi vrednostmi površine. V fazi oblikovanja smo zelo natančno načrtovali okrov, pri čemer smo upoštevali premo gibanje polirne palice, tako da je celotna naprava delovala brezhibno.

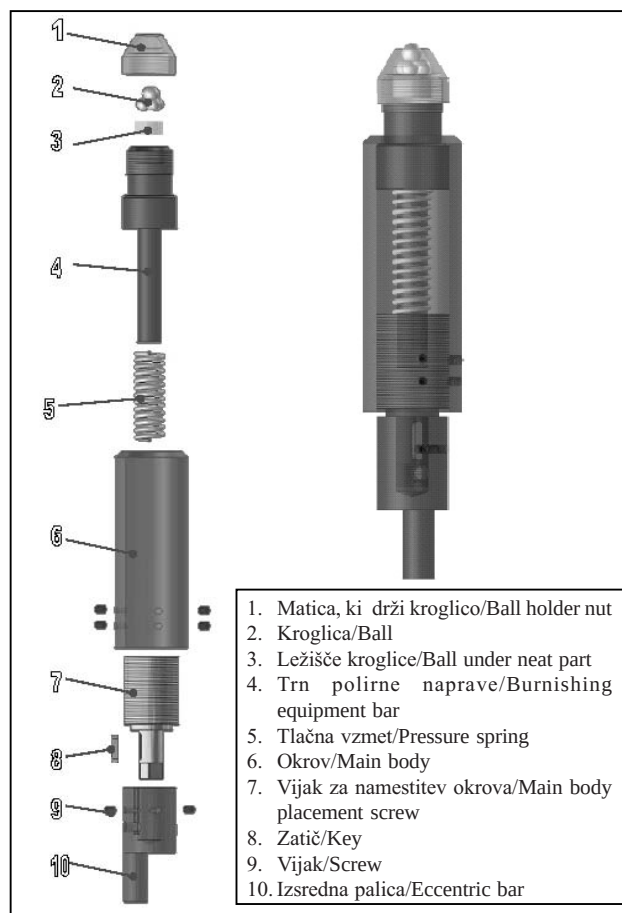
Sila poliranja je sorazmerna trdnosti tlačne vzmeti. Zato lahko to silo spremenimo z zamenjavo polirne vzmeti. Ker smo uporabili

The burnishing process was carried out, considering all these parameters.

Materials selection for the burnishing equipment was made after considering the positions of each part in the installed equipment. C3425 was used for the strength-critical parts and SAE1050 was used for the other parts. The strength-critical parts were hardened by heat treatments prior to installation. The mean hardness of the strengthened parts was measured to be between 55 and 65 HRc.

Since the burnishing is carried out by the ball placed at the end of the equipment, a ball bearing was manufactured with very precise surface values. At the design stage, the main body of the equipment was planned carefully by considering the linear movement of the equipment's bar and so that the whole system worked perfectly.

The burnishing force is proportional to the strength of the pressure spring. As a result, this force can be changed by changing the burnishing spring.



Sl.1. Razstavljena slika in prikaz sestave oblikovane in izdelane polirne naprave

Fig. 1. An exploded view and installation drawing of the designed and manufactured burnishing apparatus

vzmeti različnih trdnosti, smo to dejstvo upoštevali pri oblikovanju naprave. Zaradi izsrednega gibanja polirne palice smo napravo oblikovali tako, da vzdrži vibracije. Da bi odpravili napake, ki jih povzročajo vibracije, smo uporabili tlačno vzmet.

Since springs with different strengths were used, this fact was taken into account when designing the machine. Because of the eccentric movement of the equipment bar, the machine was designed to allow for the vibration. The pressure spring was used to remove the defects caused by this vibration.

2 PREIZKUŠANJE NAČINOV IN POGOJEV DELOVANJA

2 EXPERIMENTAL METHODS AND CONDITIONS

Polirni postopek smo izvedli ob upoštevanju parametrov, ki so podani v preglednici 1. Slika 2 prikazuje fotografijo poliranja.

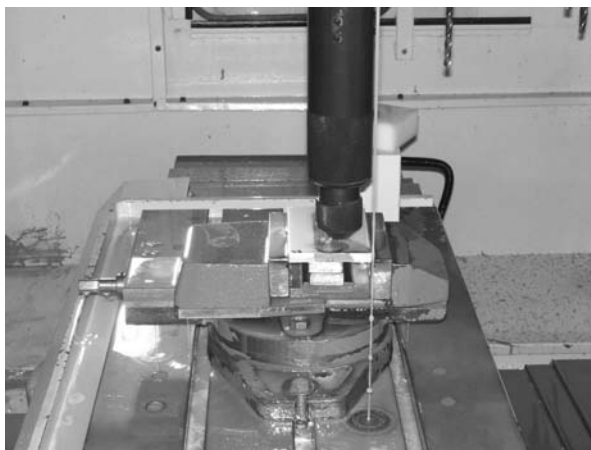
Poliranje smo izvedli ob upoštevanju parametrov iz preglednice 1. Pri tem smo ugotavljali

The burnishing process was carried out using the parameters given in Table 1. A photograph of the burnishing process is shown in Figure 2.

The burnishing was carried out using the parameters given in Table 1. The effect of the number

Preglednica 1
Table 1

Material	Aluminijeva zlitina (Al 7075 T6), 80×120 mm, prizmatični obdelovanec s povprečno hrapavostjo površine 1,780µm Aluminum alloy (Al 7075 T6) 80×120 mm prismatic part with a mean surface roughness of 1.780µm									
Kemična sestava aluminijeve zlitine Al 7075 (%) [16] The chemical composition of the Al 7075 aluminum alloy (%) [16]										
	Cu	Zn	Mg	Si	Mn	Fe	Cr	Ti	Drugo Other	Al
	1,20	5,10	2,10	0,40	0,30	0,50	0,18	0,20	0,15	drugo balance
	2,00	6,10	2,90	maks max	maks max	maks max	0,28	maks max		
Mehanske lastnosti aluminijeve zlitine Al 7075 [16] Mechanical properties of Al7075 aluminum alloy [16]										
	Odpornost proti zlomu Fracture strength [MPa]			Natezna trdnost Yield strength [MPa]		Raztegljivost Ductility [%]		Strižna trdnost Shear strength [MPa]		
	572			503		11		331		
Polirna naprava Burnishing equipment	Naprava je izdelana iz C3415 in SAE1050 ter ima kroglico s kakovostjo površine 0,15-µm. The equipment is manufactured from C3415, SAE1050 and with a ball that has a 0.15-µm surface quality.									
Polirni parametri Burnishing parameters	Hitrost poliranja [mm/rev], število vrtljajev [vrt/min], število prehodov naprave [n], tlačna sila [kN], premer kroglice [mm] Feed rate [mm/rev], number of revolutions [rev/min], number of passes [n], pressure force [kg], ball diameter [mm]									
	Sila/ Force [kN]								0,1–0,2–0,3–0,4	
	Hitrost/ Progress [mm/rev]								0,05–0,1–0,2–0,3	
	Število vrtljajev/ Number of revolution [vrt/min]								100–200–300–400	
	Število prehodov/ Number of passes								2–3–4–5	
Polirna miza Burnishing bench	Frezalna RK miza Taksan 40T1500 s pokončnim obdelovalnim središčem Taksan 40T1500 CNC milling bench with a vertical machining center									



Sl. 2. Polirni postopek

Fig. 2. The burnishing process

učinke števila prehodov, števila vrtljajev in hitrosti na hrapavost in trdoto površine. Dobljeni rezultati so prikazani v preglednicah 2 do 4. Rezultati so tudi grafično prikazani, in sicer na slikah 3 do 8.

2.1 Učinek delujoče sile in hitrosti poliranja na hrapavost površine

V štirih različnih permutacijah smo uporabili štiri različne sile in štiri različne hitrosti, da bi ugotovili učinke teh parametrov na hrapavost površine. Sto vrtljajev na minuto in dva prehoda

of passes, the number of revolutions, and the feed rate on the surface roughness and hardness were investigated. The results are tabulated in Table 2 to 4. The results were also presented graphically in Figure 3 to 8.

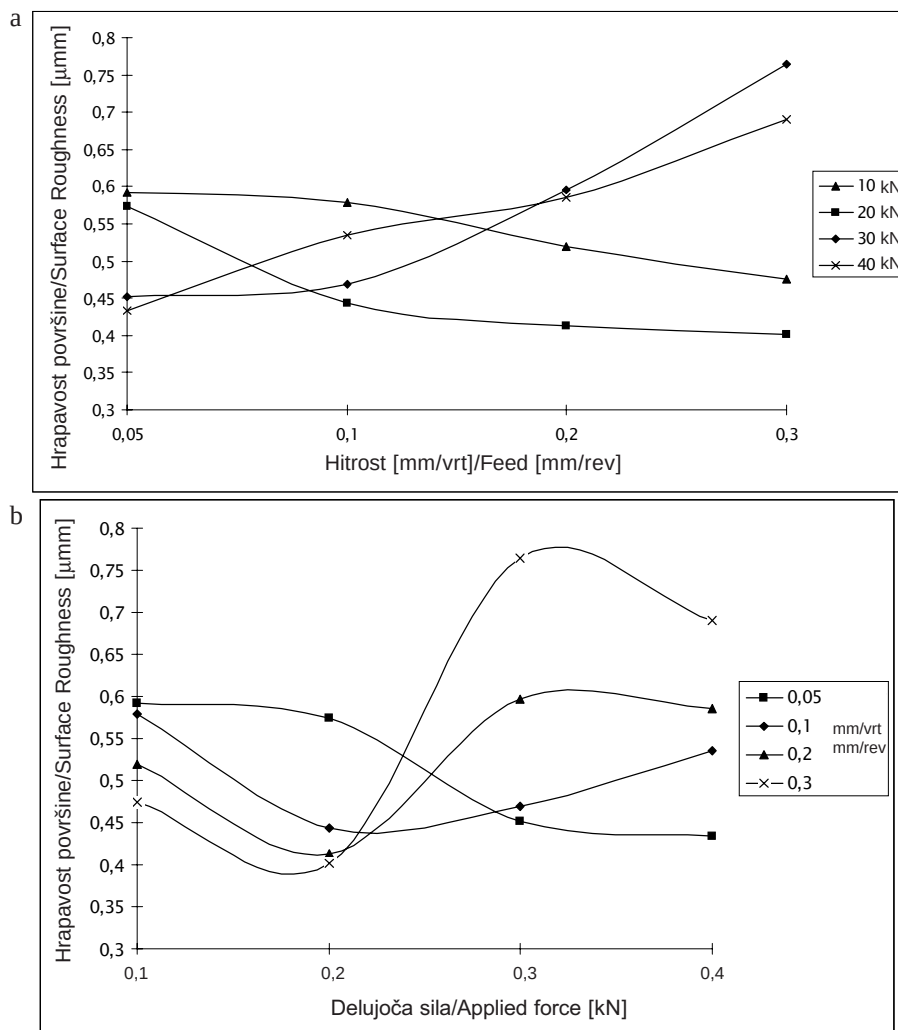
2.1 Effect of the applied force and the feed rate on the surface roughness

Four different applied forces and four different feed rates were used in different permutations to check the effect of these parameters on the surface roughness. One hundred rev/min and

Preglednica 2. Spreminjanje vrednosti hrapavosti in trdote površine materiala ob različnih hitrostih in delujočih silah ter stalnem številu vrtljajev na minuto (100) ter stalnem številu prehodov naprave (2)

Table 2. Variation of the surface-roughness and surface-hardness values for different feed rates and applied forces for a constant number of revolutions per minute (100) and number of passes (2)

Hitrost Progress [mm/s]	Delujoča sila/Applied force [kN]							
	0,1		0,2		0,3		0,4	
	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)
0,05	0,592	68	0,574	69	0,452	69,7	0,434	71,2
0,1	0,579	67	0,443	67	0,469	69	0,535	70,8
0,2	0,519	66,3	0,413	66,3	0,596	68,2	0,585	69
0,3	0,475	65,4	0,402	66	0,765	66,2	0,690	67,8



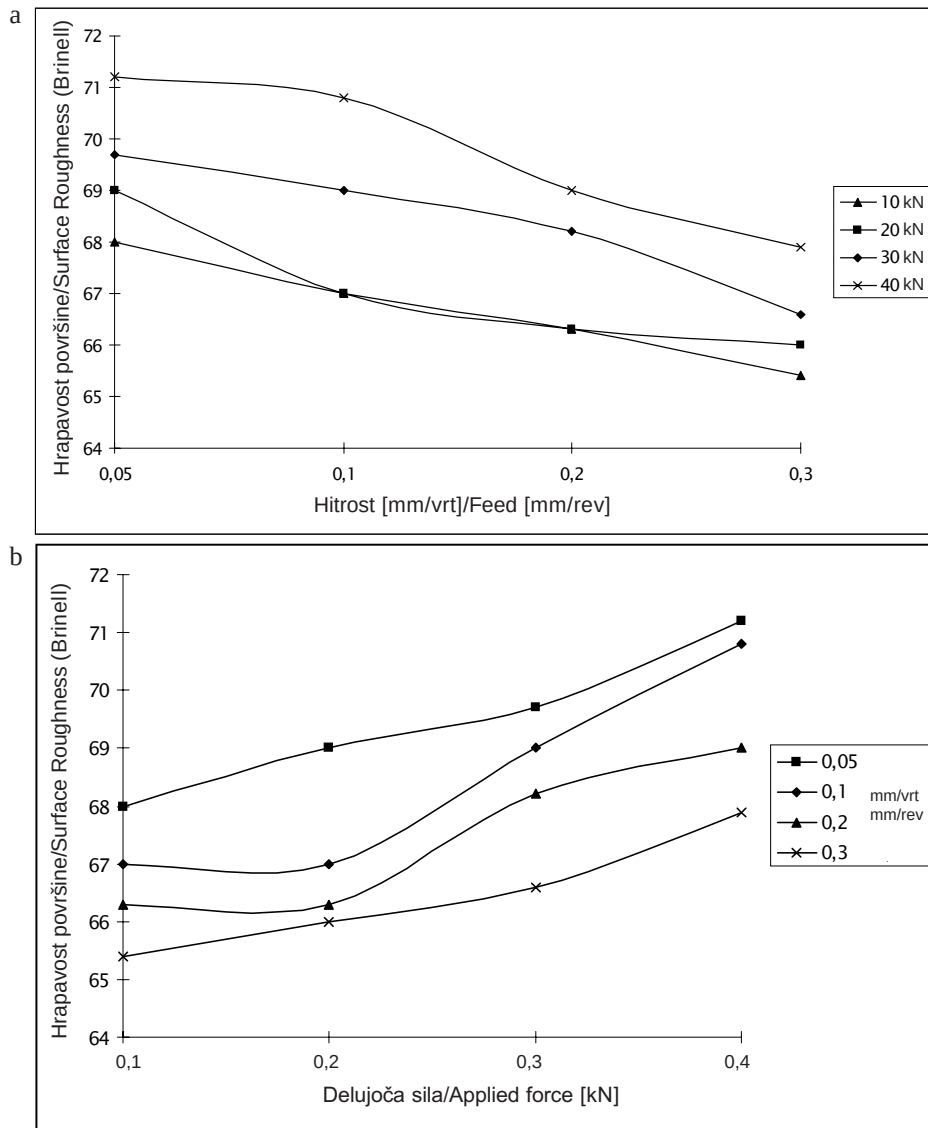
Sl. 3. Učinek hitrosti poliranja in delujoče sile na hrapavost površine (100 vrt/min in 2 prehoda naprave)
Fig. 3. The effect of feed rate and applied force on the surface roughness (100 rev/min and 2 passes)

polirne naprave sta bili vrednosti preostalih eksperimentalnih parametrov. Dobljene vrednosti hrapavosti in trdote površine so prikazane v preglednici 2 ter slikah 3 in 4.

Če preučimo diagrama slike 3, postane očitno, da povečevanje delujoče sile do določene vrednosti zmanjšuje hrapavost površine. Vrednost, ki presega 0,3 kN pa poveča hrapavost površine. Najbolj gladko površino smo dobili, ko smo delujočo silo in hitrost delovanja določili z vrednostima 0,2 kN in 0,3 mm/vrt. Druga najbolj gladka površina je nastala, ko sta bili vrednosti delujoče sile in hitrosti 0,2 kN in 0,2 mm/vrt. V teku naše raziskave smo najboljše rezultate hrapavosti površine dobili, ko je bila hitrost 0,2 ali 0,3 mm/vrt, delujoča sila pa 0,2 kN.

two passes were used as the other experimental parameters. The resulting surface-roughness and surface-hardness values are given in Table 2 and Figures 3 and 4.

When graphs a and b in Figure 3 are examined, it is clear that increasing the applied force reduces the surface roughness up to a certain value. More than 0.3 kN increases the surface roughness. The smoothest surface was obtained when 0.2 kN and 0.3 mm/rev were used as the applied force and the feed rate. The second smoothest surface was obtained when 0.2 kN and 0.2 mm/rev were used as the applied force and the feed rate. For this study, 0.2 or 0.3 mm/rev as the feed rate and 0.2 kN as the applied force gave the best surface-roughness values.



Sl. 4. Učinek hitrosti poliranja in delujoče sile na trdoto površine (100 vrt/min in 2 prehoda naprave)
Fig. 4. The effect of feed rate and applied force on the surface hardness (100 rev/min and 2 passes)

Ko smo preučili učinke delujoče sile in hitrosti poliranja na trdoto površine (sl. 4), smo ugotovili, da s povečevanjem hitrosti zmanjšujemo trdoto površine, medtem ko s povečevanjem delujoče sile povečujemo trdoto površine. Najboljšo vrednost trdote površine smo dobili pri hitrosti delovanja 0,05 mm/s in maksimalni delujoči sili.

2.2 Učinek števila vrtljajev in delujoče sile na hrapavost in trdoto površine

V štirih različnih permutacijah smo uporabili štiri različna števila vrtljajev in štiri različno delujoče

When the effects of the applied force and the feed rate on the surface hardness were examined (Figure 4), we found that increasing the feed rate reduces the surface hardness, while increasing the applied force increases the surface hardness. The best surface hardness value was obtained with a 0.05 mm/sec feed rate and the maximum applied force.

2.2 The effect of the number of revolutions and the applied force on the surface roughness and hardness

Four different numbers of revolutions and four different applied forces were used in different

sile, da bi ugotovili učinke teh parametrov na hrapavost površine. Hitrost 0,1 mm/vrt in dva prehoda polirne naprave sta bili vrednosti preostalih eksperimentalnih parametrov. Dobljene vrednosti hrapavosti in trdote površine so prikazane v preglednici 3 ter slikah 5 in 6.

Ko preučimo učinke števila vrtljajev in delujoče sile (sl. 5a, b), ugotovimo, da s povečevanjem števila vrtljajev pri delujoči sili 0,1 ali 0,2 kN povečujemo gladkost površine; ko pa silo povečamo nad 0,3 kN, se gladkost površine pri 200 vrt/min spet poslabša. Najbolj gladko površino smo dobili z uporabo sile 0,2 kN pri 400 vrt/min.

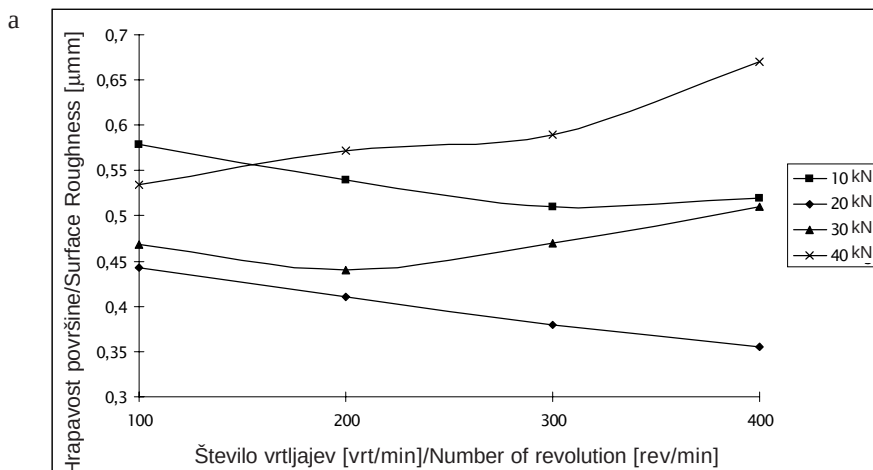
permutations to check the effect of these parameters on the surface roughness. A 0.1 mm/rev feed rate and two passes were used as the other experimental parameters. The obtained surface-roughness and surface-hardness values are shown in Table 3 and Figures 5 and 6.

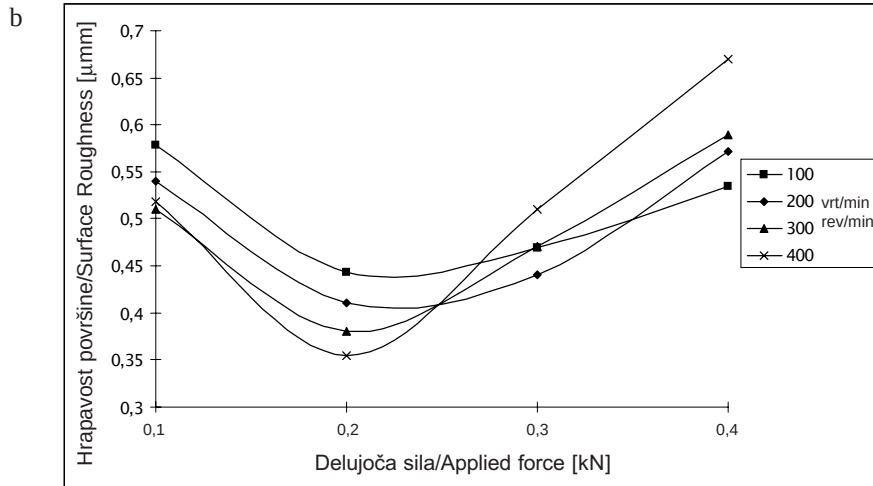
When the number of revolutions and the applied force are examined together (Figure 5 a and b), increasing the number of revolutions with 0.1 and 0.2 kN of applied force increases the smoothness of the surface; however, when more than 0.3 kN is applied, the burnished surface deteriorates after 200 rev/min. The smoothest surface was obtained with 0.2 kN of applied force at 400 rev/min.

Preglednica 3. Spreminjanje vrednosti trdote in hrapavosti površine materiala zaradi različnih števil vrtljajev in različnih delujočih sil (pri hitrosti 0,1 mm/vrt in dveh prehodih polirne naprave)

Table 3. The variation in the surface hardness and roughness with different numbers of revolutions and applied force (feed rate 0.1 mm/rev and number of passes 2)

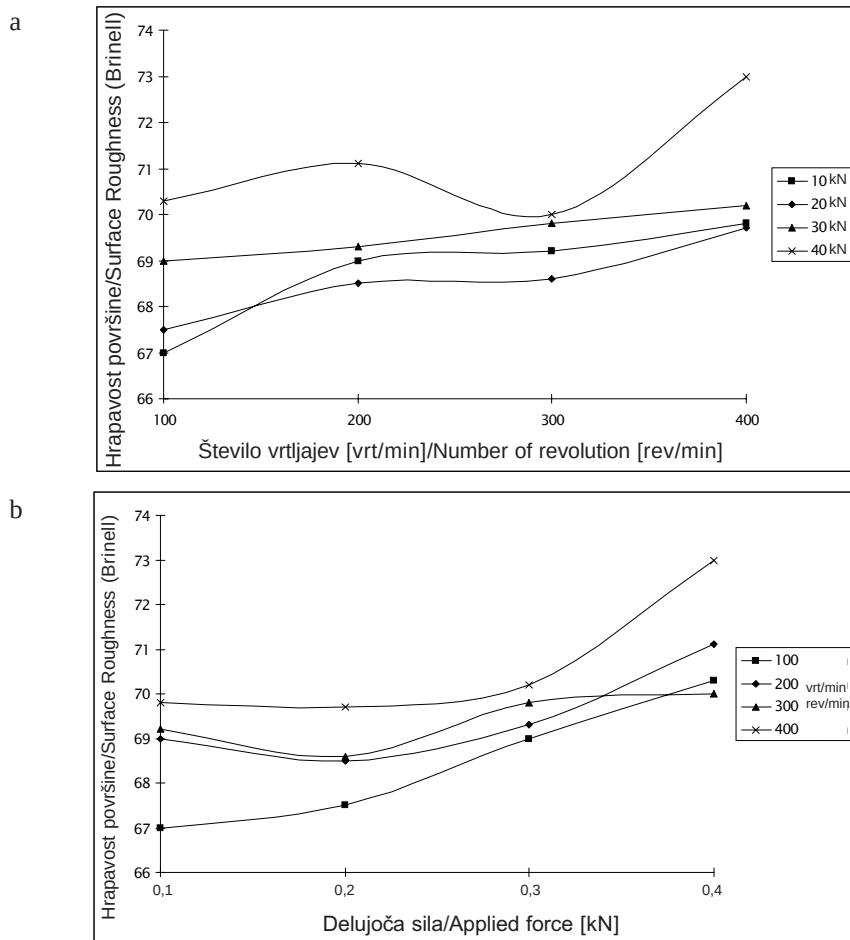
Število vrtljajev [vrt/min] Number of revolution [rev/min]	Delujoča sila/Applied force [kN]							
	0,1		0,2		0,3		0,4	
	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)
100	0,579	67	0,443	67,5	0,469	69	0,535	70,3
200	0,540	69	0,410	68,5	0,440	69,3	0,572	71,1
300	0,510	69,2	0,380	68,6	0,470	69,8	0,590	71,2
400	0,519	69,8	0,355	69,7	0,510	70,2	0,670	73





Sl. 5. Učinek števila vrtljajev in delujoče sile na hrapavost površine

Fig. 5. The effect of the number of revolutions and applied force on the surface roughness



Sl. 6. Učinek števila vrtljajev in delujoče sile na trdoto površine

Fig. 6. The effect of the number of revolutions and the applied force on the surface hardness

Ko preučimo razmerje med številom vrtljajev in trdoto površine ob upoštevanju različnih delujočih sil, ugotovimo, da se trdota površine povečuje s povečevanjem števila vrtljajev in s povečano delujočo silo. V tem primeru smo najbolj gladko površino dobili pri 400 vrt/min in delujočo silo 0,4 kN.

2.3 Učinek števila prehodov polirne naprave in delujoče sile na hrapavost in trdoto površine

V štirih različnih permutacijah smo uporabili štiri različna števila prehodov polirne naprave in štiri različno delujoče sile, da bi ugotovili učinke teh parametrov na hrapavost in trdoto površine. Hitrost 0,1 mm/s in 300 vrt/min sta bili vrednosti preostalih eksperimentalnih parametrov. Dobljene vrednosti hrapavosti in trdote površine so prikazane v preglednici 4 ter slikah 7 in 8.

S slike 7 lahko razberemo učinke števila prehodov polirne naprave in delujoče sile na hrapavost površine. Povečanje števila prehodov, posebej če gre za več ko 4 prehode, zmanjša gladkost površine. Ugotovili smo, da je tri najbolj primerno število prehodov. Najboljše rezultate dosežemo, če uporabimo silo 0,3 kN.

Diagrama a in b s slike 8 kažeta, da s povečanjem delujoče sile povečamo trdoto površine.

When the relationship between the number of revolutions and the surface hardness is examined by taking into account the different applied forces, the surface hardness increases with an increasing number of revolutions and larger applied forces. At this stage, the smoothest surface was obtained with 400 rev/min and 0.4 kN of applied force.

2.3 Effect of number of passes and applied force on the surface roughness and surface hardness

Four different numbers of passes and four different applied forces were used with different permutations to check the effect of these parameters on the surface roughness and the surface hardness. A 0.1 mm/sec feed rate and 300 rev/min were used as the other experimental parameters. The obtained surface-roughness and surface-hardness values are seen in Table 4 and Figures 7 and 8.

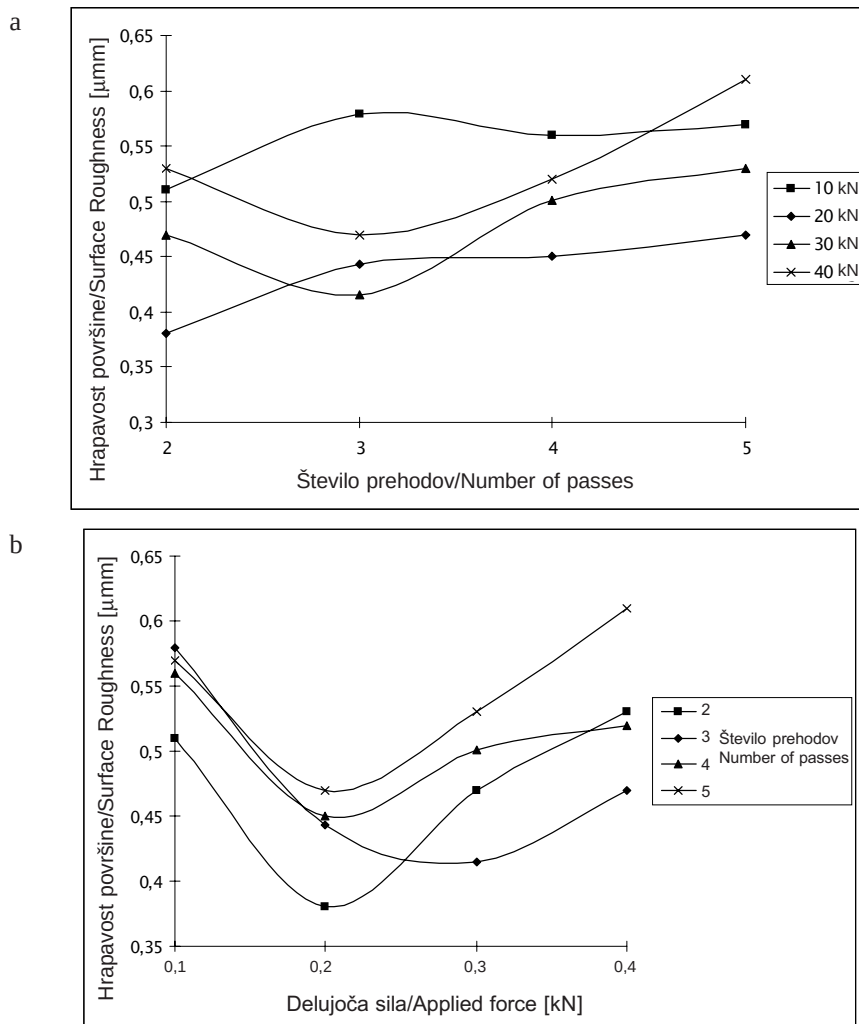
It is possible to see the effect of the number of passes and the applied force on the surface roughness from Figure 7. Increasing the number of passes, especially to more than 4, reduced the surface smoothness. The most suitable number of passes was found to be 3. The force that should be applied for the best result is 0.3 kN.

The graphs a and b in Figure 8 show that increasing the applied force increases the surface

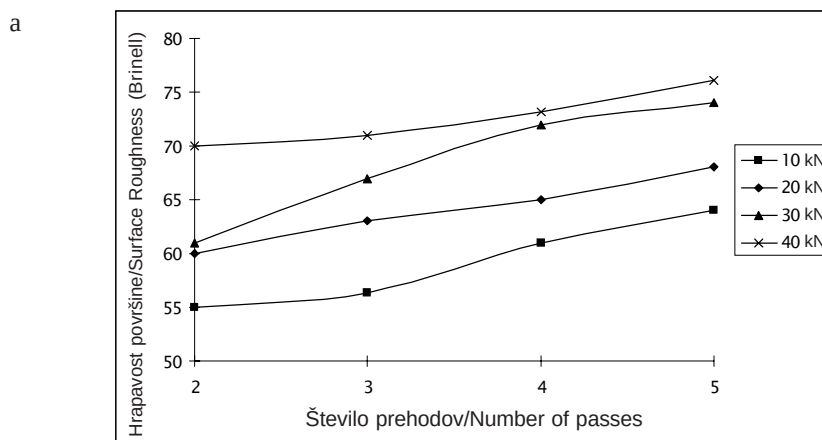
Preglednica 4. Spreminjanje vrednosti hrapavosti in trdote površine materiala pri različnih delujočih silah in različnem številu prehodov (300 vrt/min in hitrost 0,1 mm/s)

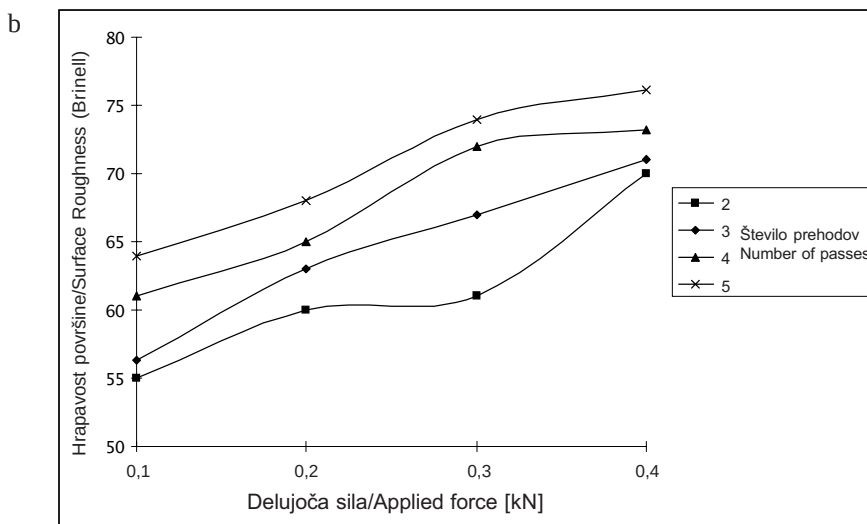
Table 4. Variation of the surface-roughness and surface-hardness values for different forces and number of passes (300 rev/min and feed rate 0.1 mm/sec)

Število prehodov Number of passes [n]	Delujoča sila/Applied force [kN]							
	0,1		0,2		0,3		0,4	
	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)	Hrapavost površine Surface roughness [μmm]	Trdota površine Surface hardness (Brinell)
2	0,51	55	0,38	58	0,47	61	0,53	62
3	0,579	56,3	0,443	62,5	0,415	67	0,47	68
4	0,56	61	0,45	65	0,501	72	0,52	73,2
5	0,57	64	0,47	68	0,53	74	0,61	76,1



Sl. 7. Učinek števila prehodov in delujoče sile na hrapavost površine
Fig. 7. Effect of the number of passes and the applied force on the surface roughness





Sl. 8. Učinek števila prehodov in delujoče sile na trdoto površine

Fig. 8. Effect of the number of passes and the applied force on the surface hardness

Površina je imela največjo trdoto pri petih prehodih in delujoči sili 0,4 kN.

hardness. The hardest surface was obtained with 5 passes and an applied force of 0.4 kN.

3 SKLEP

Na podlagi raziskave lahko naredimo naslednje sklepe:

- Očitno je, da s povečevanjem delujoče sile do določene vrednosti zmanjšujemo hrapavost površine. Ko pa sila preseže 0,3 kN, se hrapavost poveča. Najbolj gladko površino smo dobili, ko je delujoča sila znašala 0,2 kN, hitrost delovanja naprave pa je bila 0,3 mm/s. Lahko tudi rečemo, da s povečanjem hitrosti zmanjšamo trdoto površine. S povečanjem delujoče sile povečamo trdoto površine.
- S povečanjem števila vrtljajev pri sili 0,1 ali 0,2 kN povečamo gladkost površine; ko pa delujoča sila preseže 0,3 kN in število vrtljajev preseže 200 vrt/min, se kakovost polirane površine zmanjša. Najbolj gladko površino smo pridobili, ko je bila delujoča sila 0,2 kN in število vrtljajev 400 vrt/min. S povečanjem števila vrtljajev in delujoče sile povečamo trdoto površine.
- Ob povečanju števila prehodov polirne naprave, posebej ko imamo več kot štiri prehode, se gladkost površine zmanjša. V naši raziskavi se je izkazalo, da so najbolj primerni trije prehodi, najbolj primerna delujoča sila pa je 0,3 kN. Sila, ki jo moramo uporabiti za doseganje najboljših rezultatov, je 0,3 kN. S povečanjem števila prehodov in delujoče sile povečamo trdoto površine.

3 CONCLUSION

The following conclusions can be drawn from this study:

- It is clear that increasing the applied force reduces the surface roughness up to a certain value. More than 0.3 kN increases the surface roughness. The smoothest surface was obtained when 0.2 kN and 0.3 mm/sec were used as the applied force and the feed rate, respectively. It can also be said that increasing the feed rate reduces the surface hardness. Increasing the applied force increases the surface hardness.
- Increasing the number of revolutions with 0.1 and 0.2 kN of force increases the smoothness of the surface; however, when the force applied is more than 0.3 kN, the burnished surface deteriorates above 200 rev/min. The smoothest surface was obtained with 0.2 kN of force and 400 rev/min. Increasing the number of revolutions and the applied force increases the surface hardness.
- Increasing the number of passes, especially to more than 4, reduced the surface smoothness. The most suitable number of passes and applied force were determined to be 3 and 0.3 kN, respectively, for this study. The force that should be applied for the best result is 0.3 kN. Increasing the number of passes and the applied force increases the surface hardness.

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