

Mellékletek jegyzéke

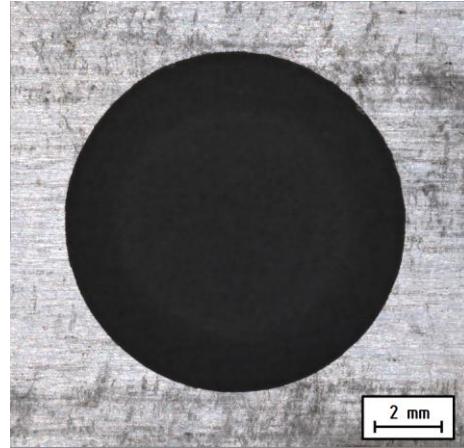
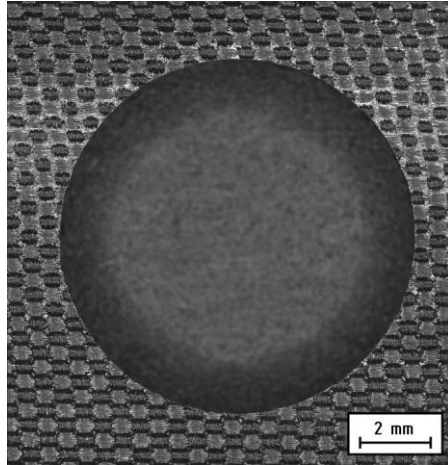
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1. sz. melléklet: Rétegekönben készült mikroszkópi képek

Az UD-CFRP és alumínium lemezekről készült mikroszkópi képek láthatóak.

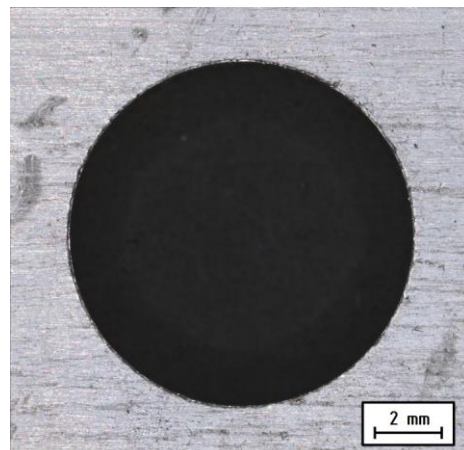
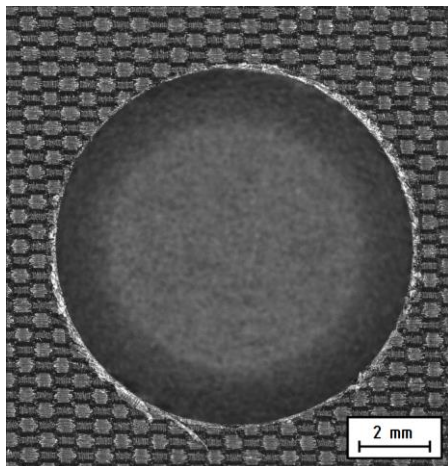
1. furat

$f_z = 0,05 \text{ mm}$; $v_c = 150 \text{ m/min}$; $S = \text{HS}$



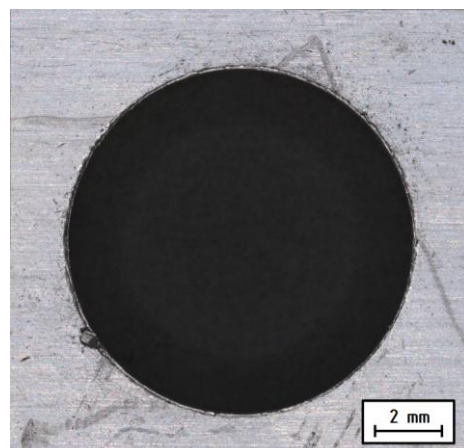
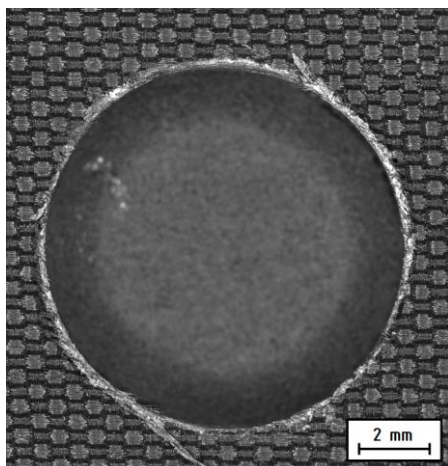
2. furat

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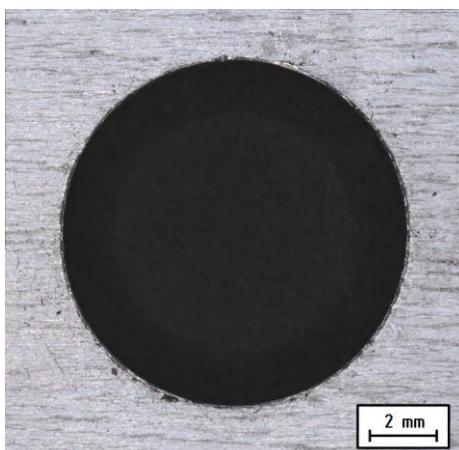
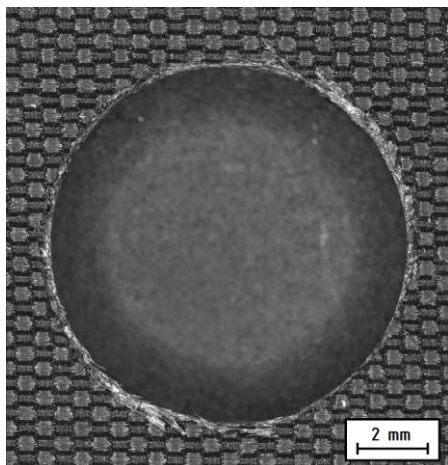
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$f_z = 0,025 \text{ mm}$; $v_c = 150 \text{ m/min}$; $S = \text{C}$



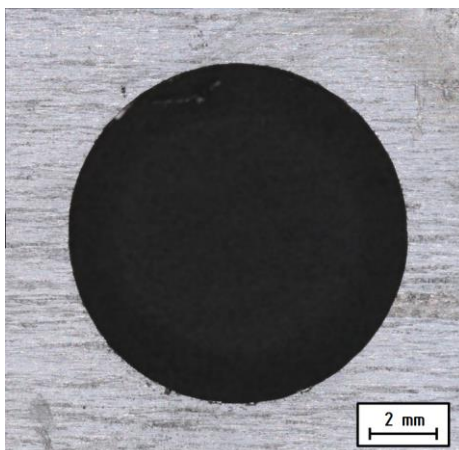
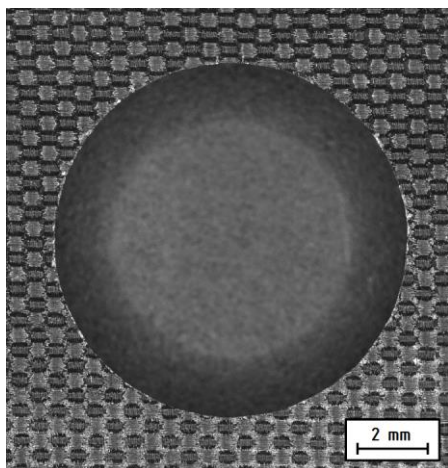
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$f_z = 0,05 \text{ mm}$; $v_c = 150 \text{ m/min}$; $S = C$



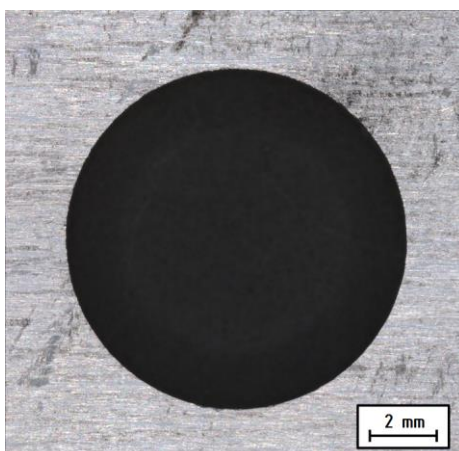
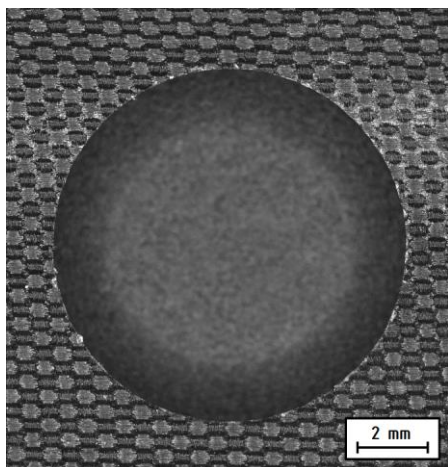
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$f_z = 0,05 \text{ mm}$; $v_c = 150 \text{ m/min}$; $S = HS$



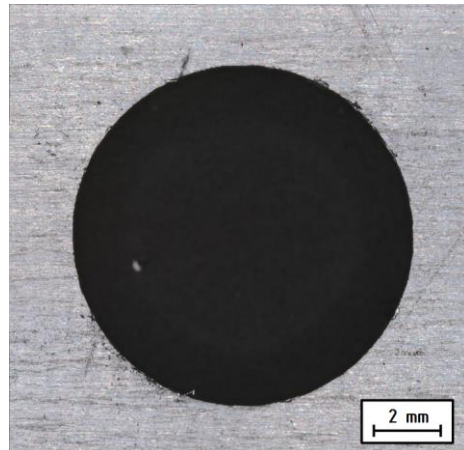
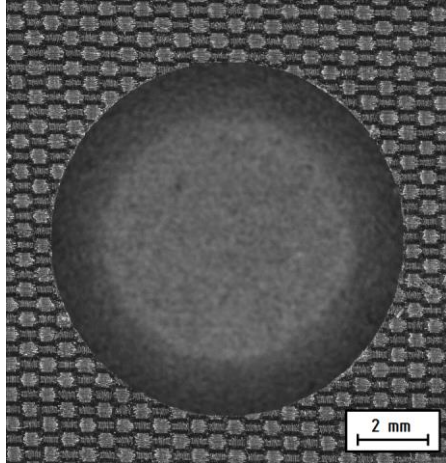
6. furat

$f_z = 0,033 \text{ mm}$; $v_c = 114,64 \text{ m/min}$; $S = HS$



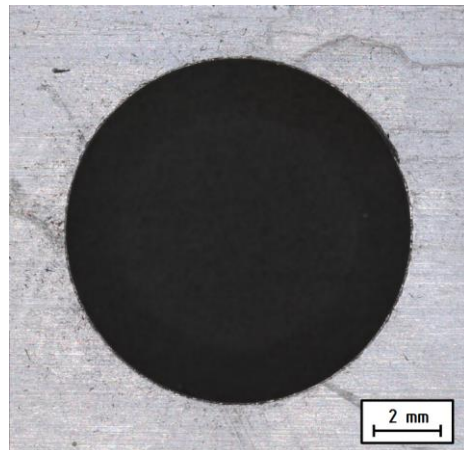
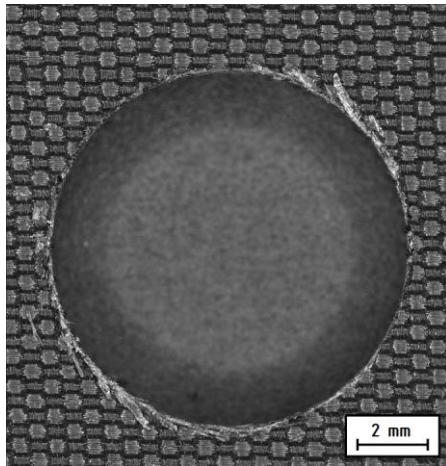
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$f_z = 0,05 \text{ mm}$; $v_c = 150 \text{ m/min}$; $S = \text{HS}$



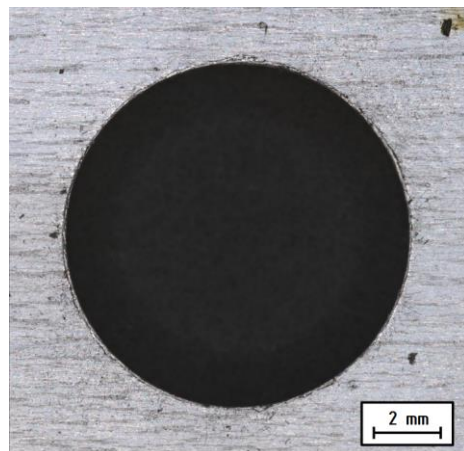
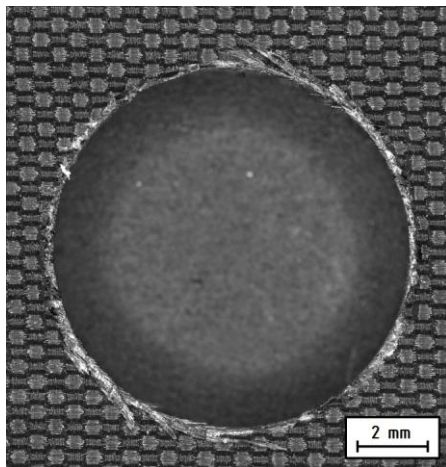
8. furat

$f_z = 0,075 \text{ mm}$; $v_c = 150 \text{ m/min}$; $S = \text{C}$



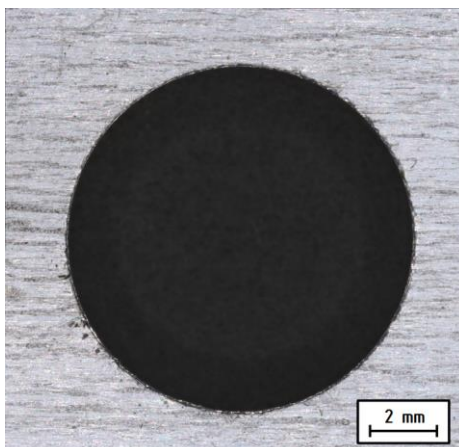
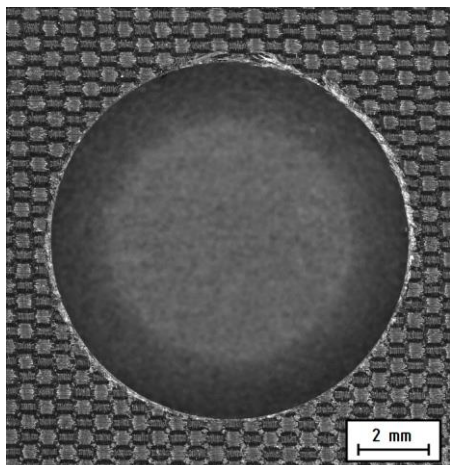
9. furat

$f_z = 0,033 \text{ mm}$; $v_c = 185,36 \text{ m/min}$; $S = \text{C}$



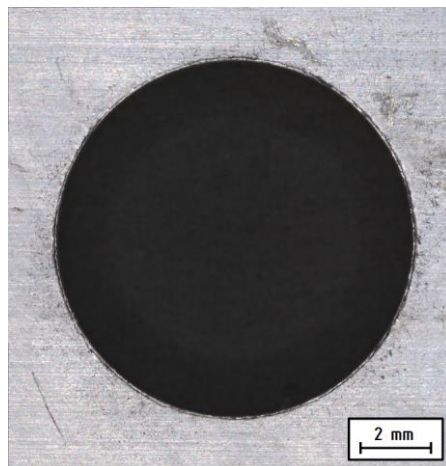
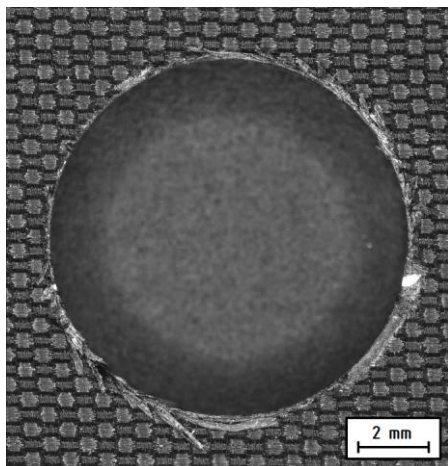
10. furat

$f_z = 0,068$ mm; $v_c = 114,64$ m/min; $S = C$



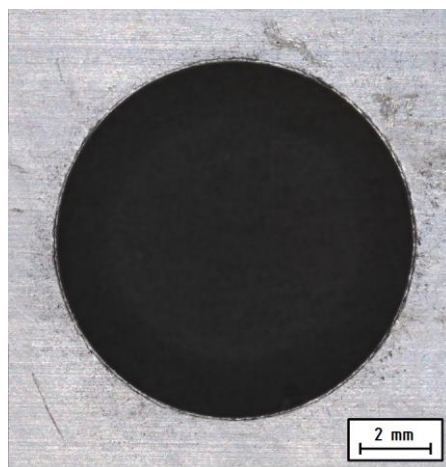
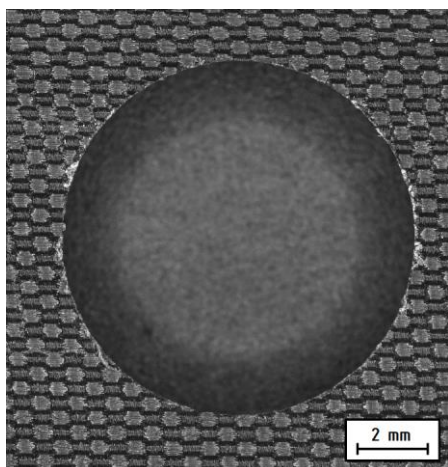
11. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = C$



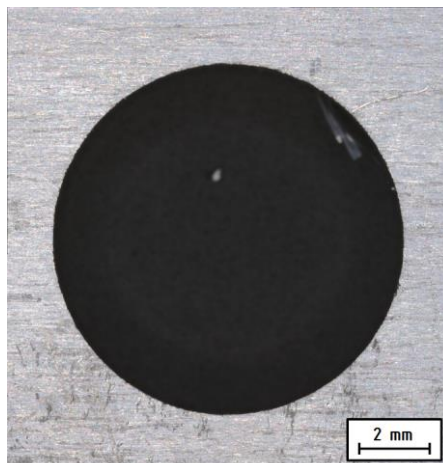
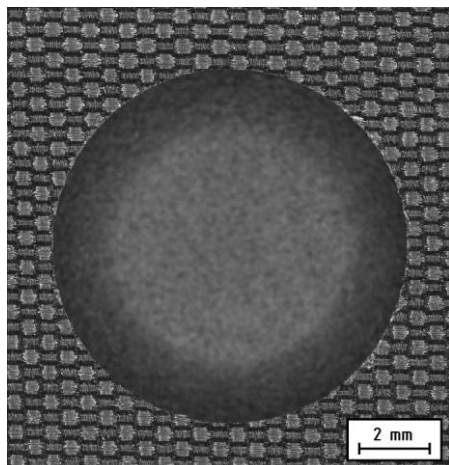
12. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = HS$



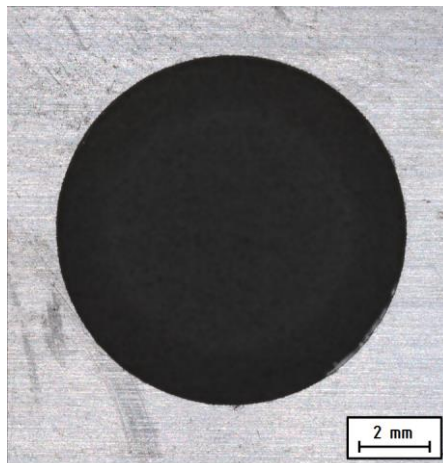
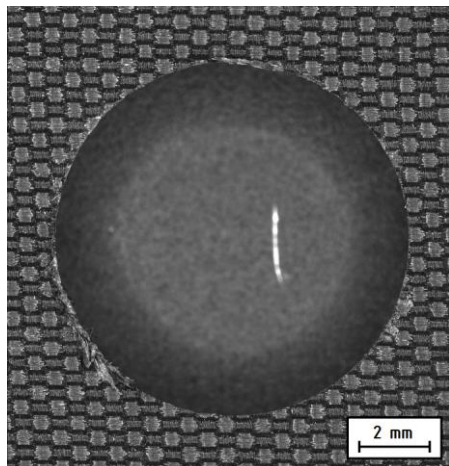
13. furat

$f_z = 0,068$ mm; $v_c = 114,64$ m/min; $S = HS$



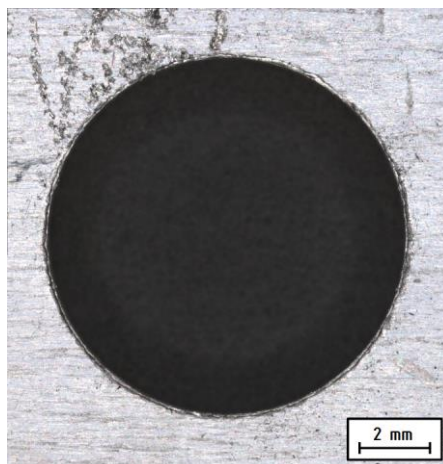
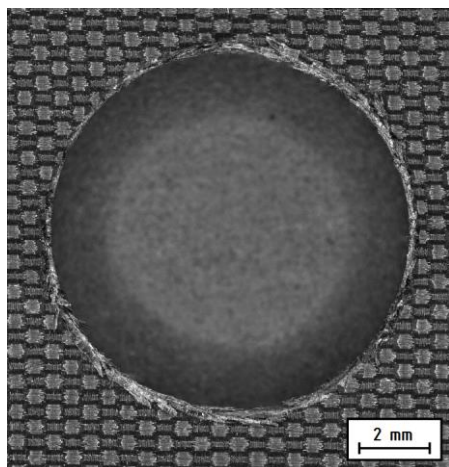
14. furat

$f_z = 0,05$ mm; $v_c = 100$ m/min; $S = H$



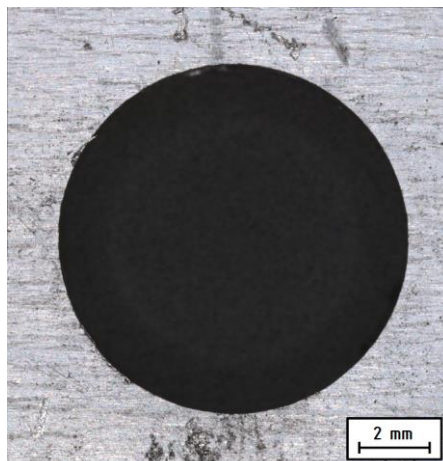
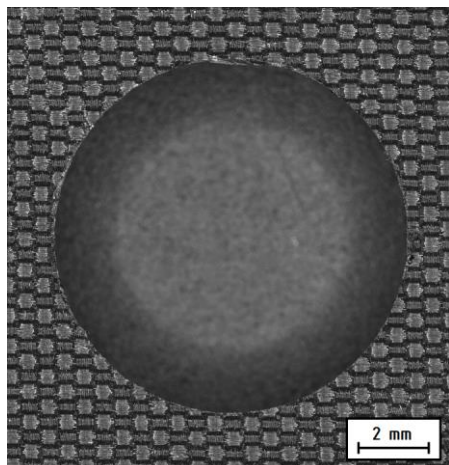
15. furat

$f_z = 0,05$ mm; $v_c = 100$ m/min; $S = C$



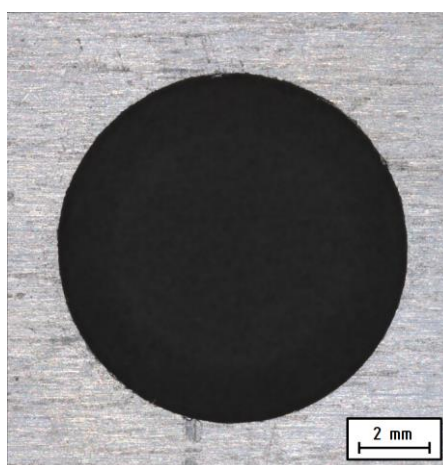
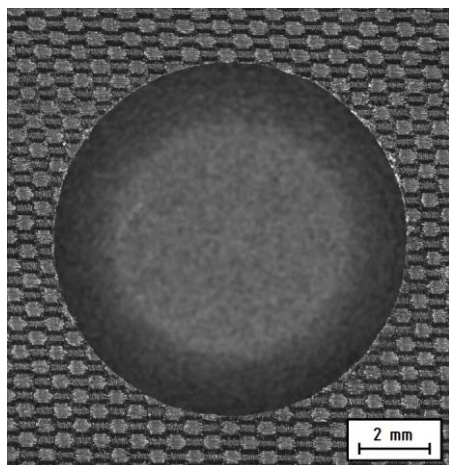
16. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = H$



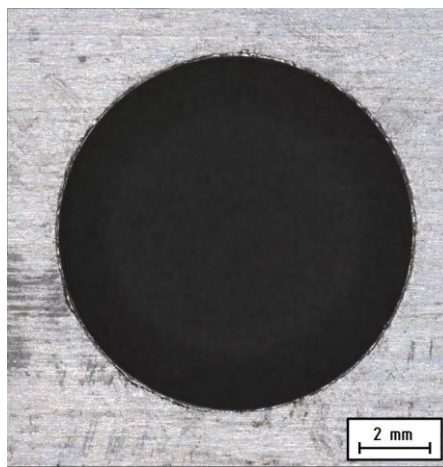
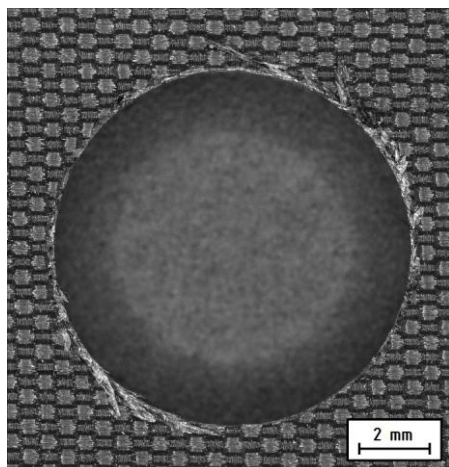
17. furat

$f_z = 0,068$ mm; $v_c = 185,36$ m/min; $S = HS$



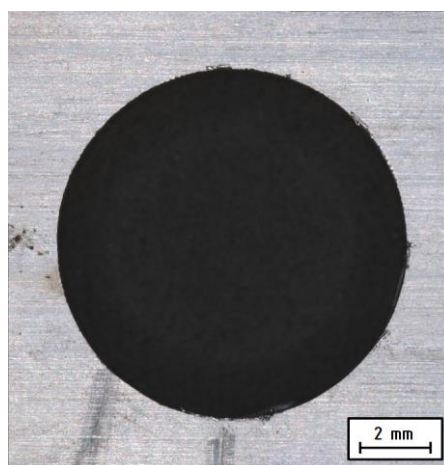
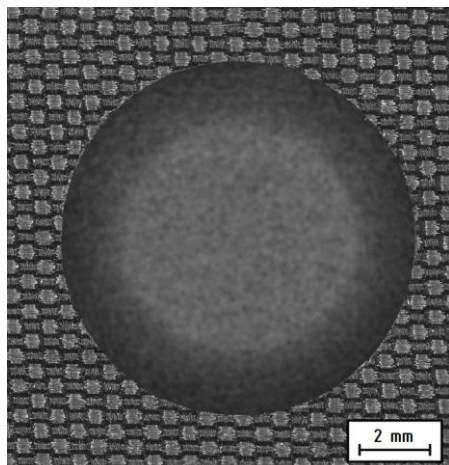
18. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = C$



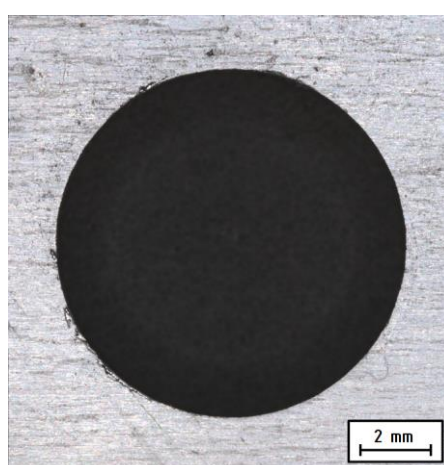
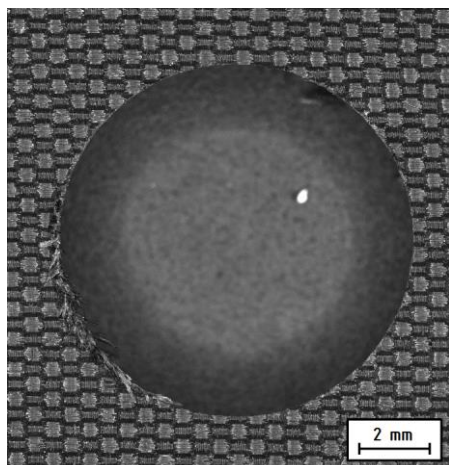
19. furat

$f_z = 0,075$ mm; $v_c = 150$ m/min; S= HS



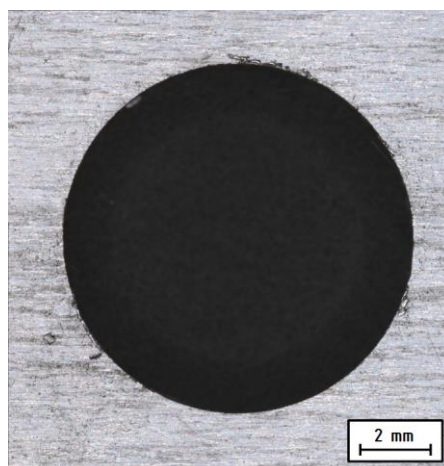
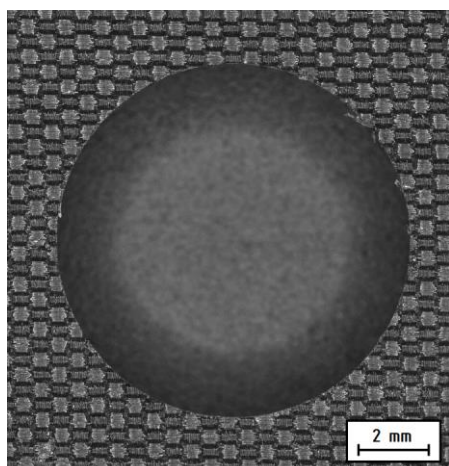
20. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; S= H



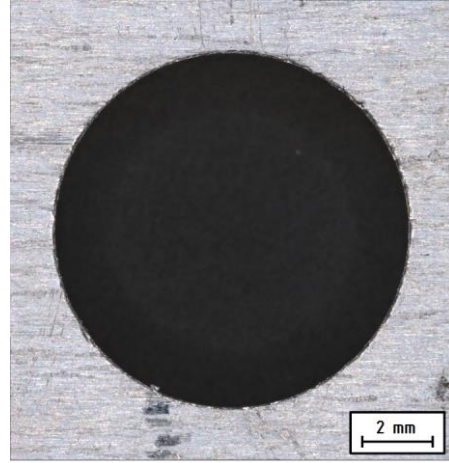
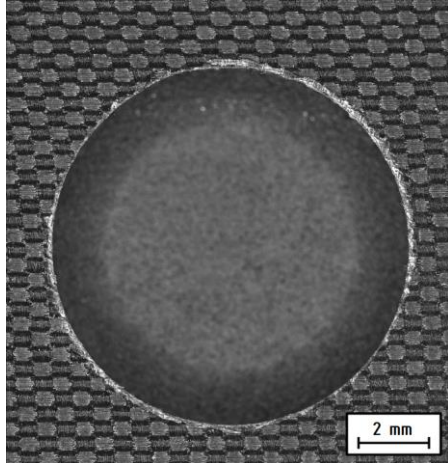
21. furat

$f_z = 0,05$ mm; $v_c = 100$ m/min; S= HS



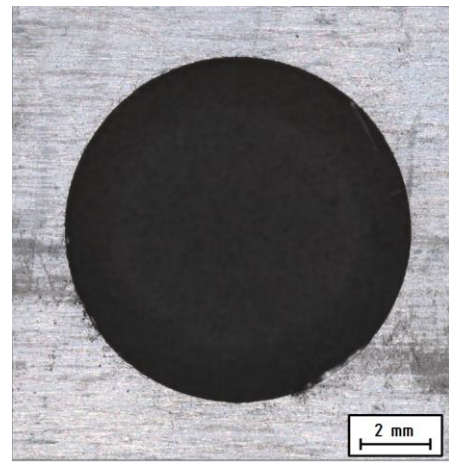
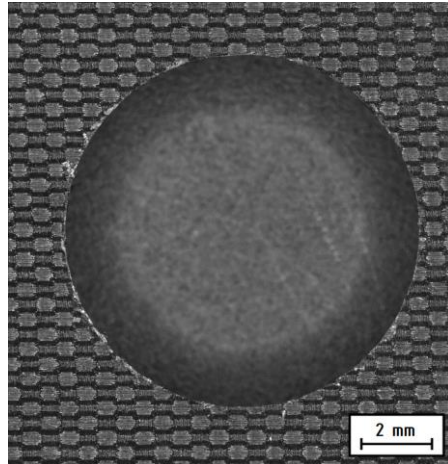
22. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = C$



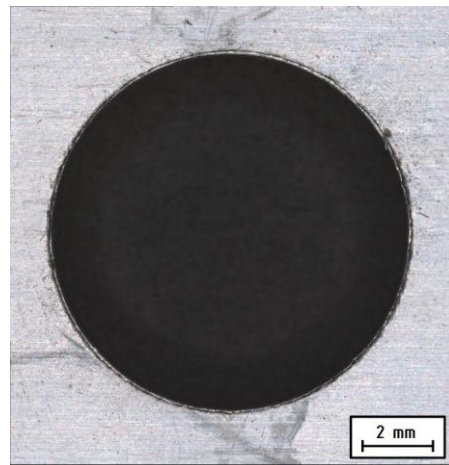
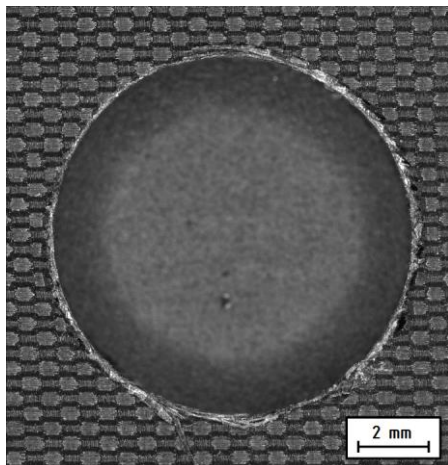
23. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = H$



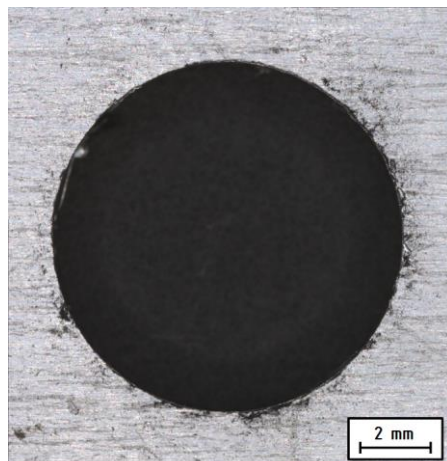
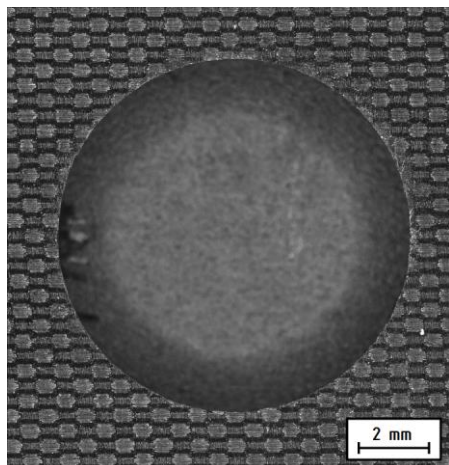
24. furat

$f_z = 0,033$ mm; $v_c = 114,64$ m/min; $S = C$



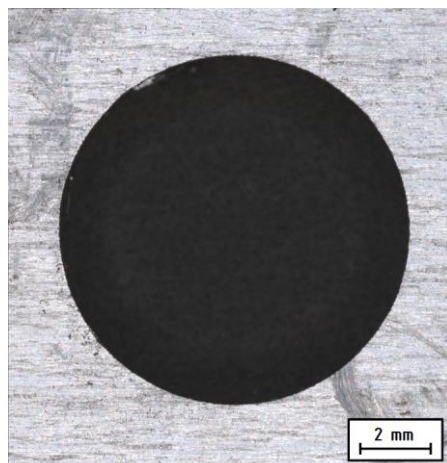
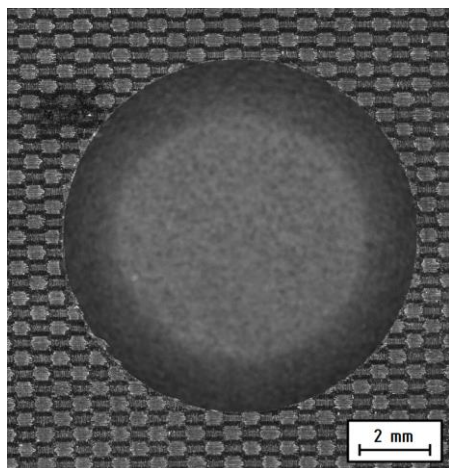
25. furat

$f_z = 0,025$ mm; $v_c = 150$ m/min; S= HS



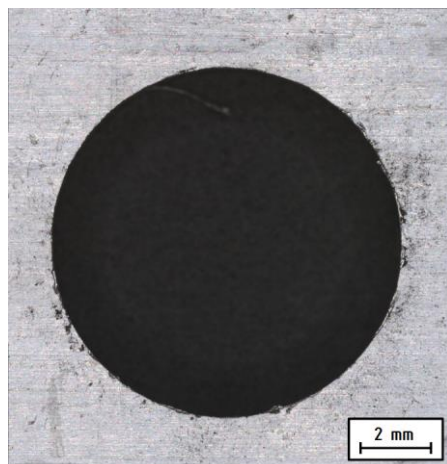
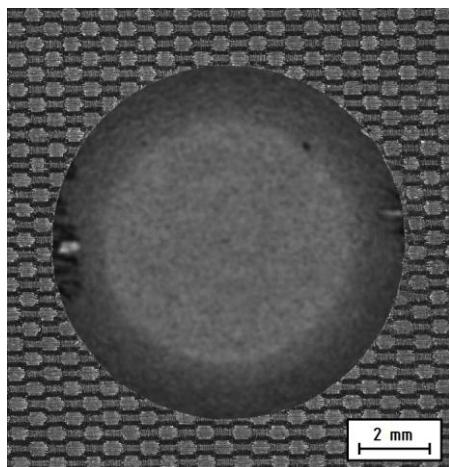
26. furat

$f_z = 0,068$ mm; $v_c = 114,64$ m/min; S= H



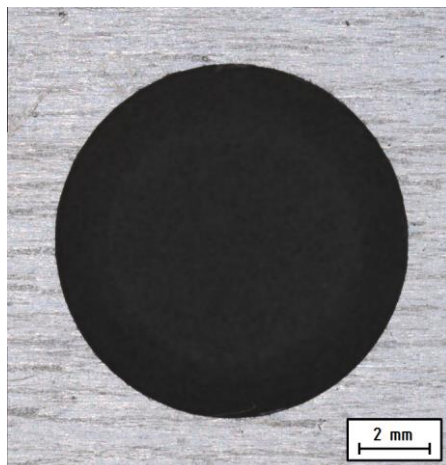
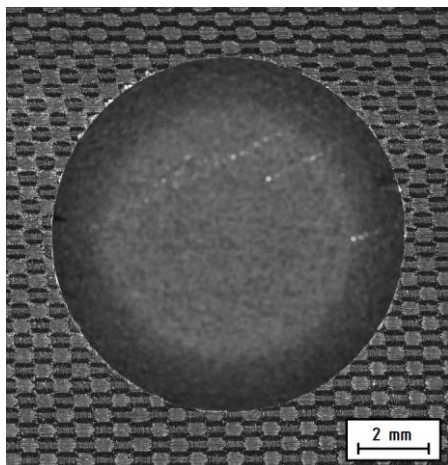
27. furat

$f_z = 0,033$ mm; $v_c = 185,36$ m/min; S= HS



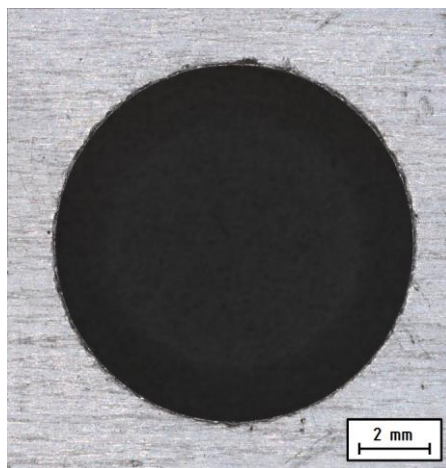
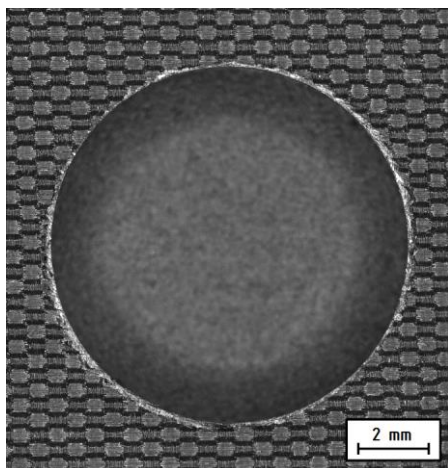
28. furat

$f_z = 0,033$ mm; $v_c = 185,36$ m/min; $S = H$



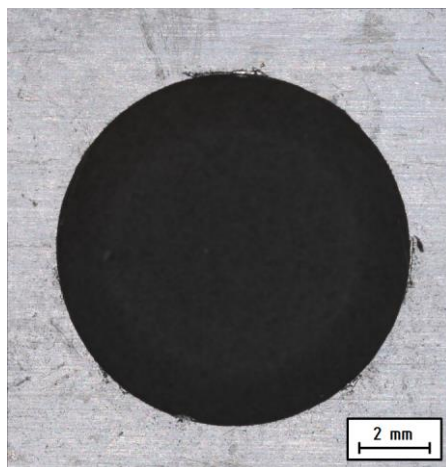
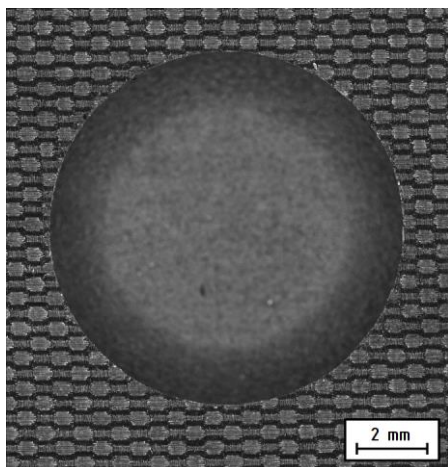
29. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = C$



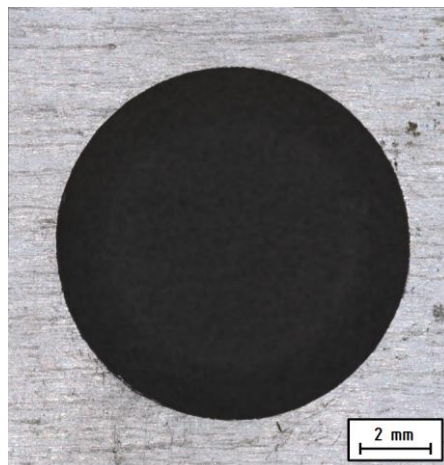
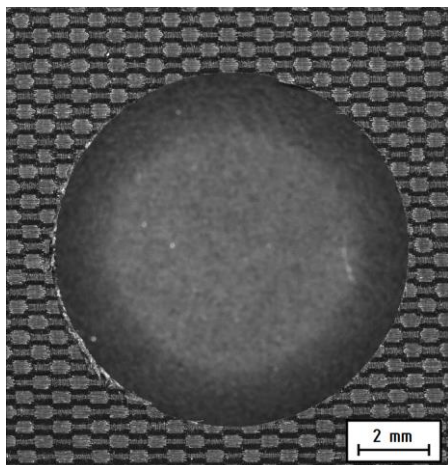
30. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; $S = HS$



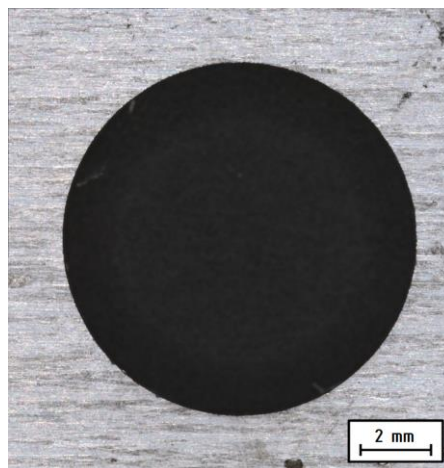
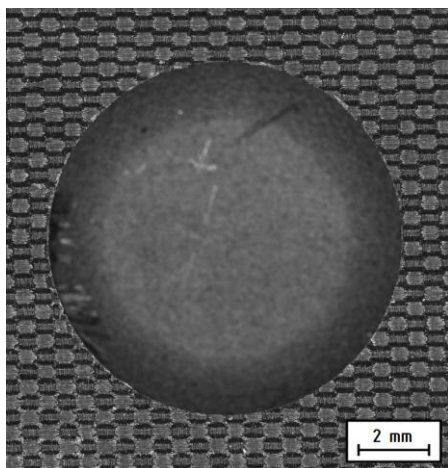
31. furat

$f_z = 0,075$ mm; $v_c = 150$ m/min; S= H



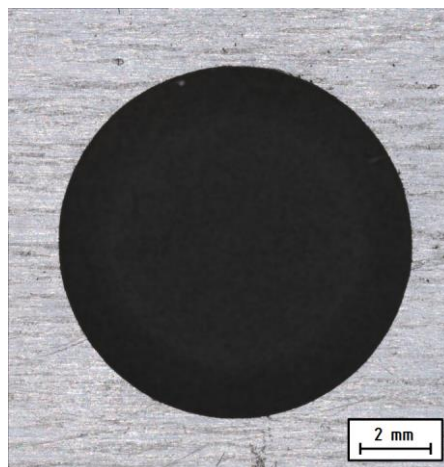
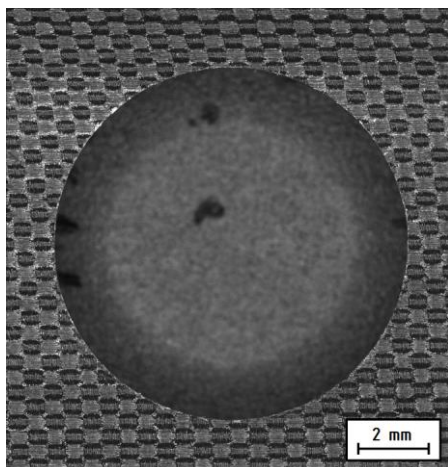
32. furat

$f_z = 0,033$ mm; $v_c = 114,64$ m/min; S= H



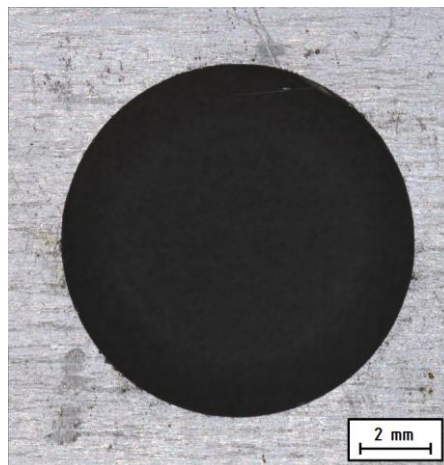
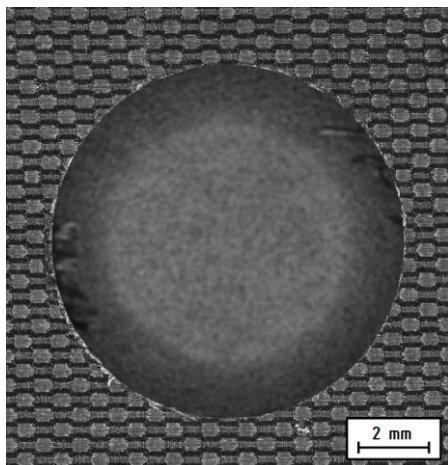
33. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; S= H



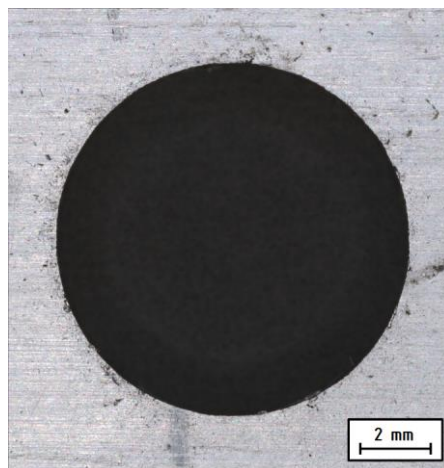
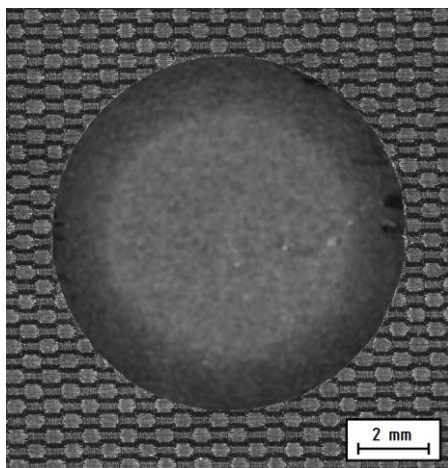
34. furat

$f_z = 0,025$ mm; $v_c = 150$ m/min; S= H



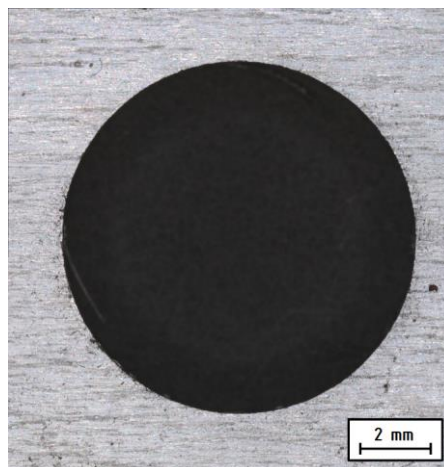
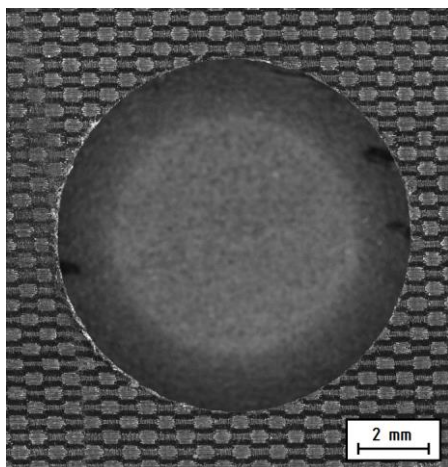
35. furat

$f_z = 0,05$ mm; $v_c = 200$ m/min; S= HS



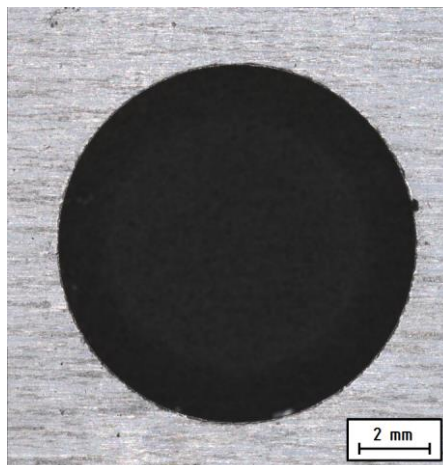
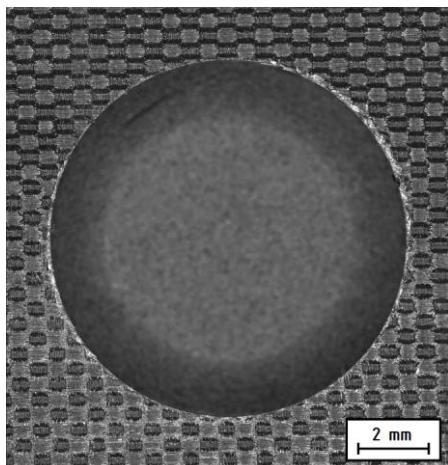
36. furat

$f_z = 0,05$ mm; $v_c = 150$ m/min; S= H



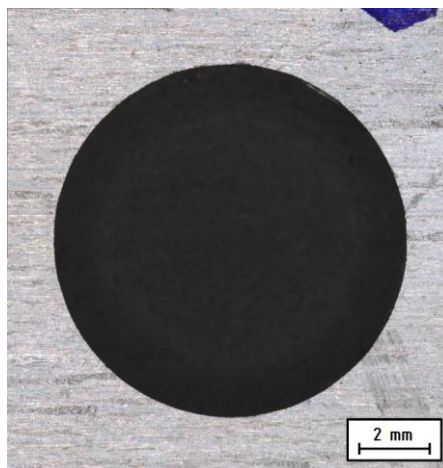
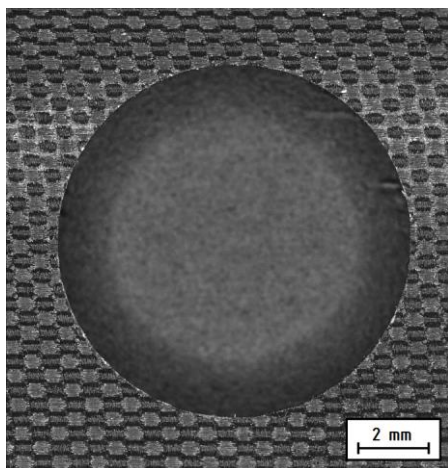
37. furat

$f_z = 0,068$ mm; $v_c = 185,36$ m/min; $S = C$



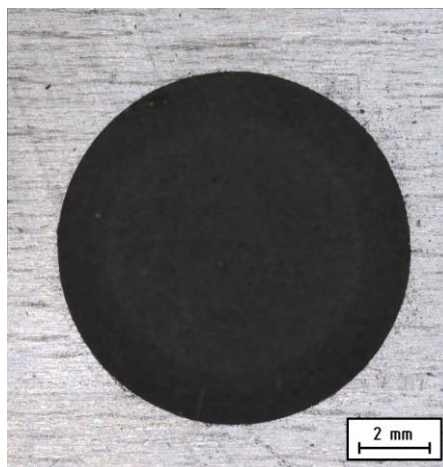
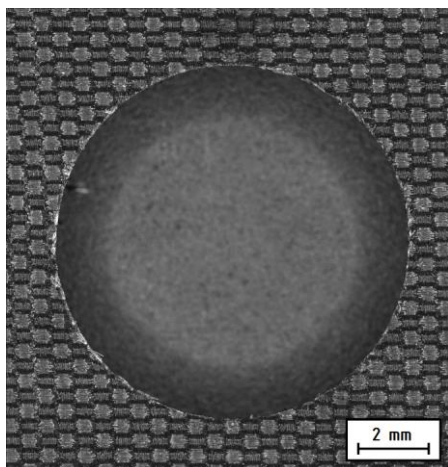
38. furat

$f_z = 0,05$ mm; $v_c = 200$ m/min; $S = H$



39. furat

$f_z = 0,068$ mm; $v_c = 185,36$ m/min; $S = H$



2. sz. melléklet: Kísérleti és mérési jegyzőkönyv

2.1. Kutatás célja

Al/UD-CFRP szendvicsszerkezetek forgácsolásindukált hibajelenségek (delamináció és sorja) kísérleti- és szimulációs vizsgálata.

2.2. Kísérleti környezet

2.2.1. Felhasznált gépek, szerszámok, műszerek és eszközök

- Nilfisk GB733 ipari porszívó
- Kondia B640 háromtengelyes CNC marógép
- TIVOLY 82402211000 Ø10 csigafúró
- TIVOLY 82402210800 Ø8 csigafúró
- THOMAS 23N12065 Ø6 maró
- Kistler 9257B erőmérő
- KISTLER 5070 jelerősítő
- National instrument USB-4431 adatgyűjtő
- Labwiev program
- F1 fúrókészülék
- UD-CFRP 5mm vastag vinilészter mátrix (Zoltek-től Farkas Balázson keresztül)
- Alumínium ötvözet 5mm vastag EN AW 6082 (AlMgSi1)

2.2.2. Rögzített paraméterek és körülmények

- Száraz megmunkálás
- Forgács elszívás
- Lemezsorrend: UD-CFRP/Al (UD-CFRP felül, Al alul)

Kutatási alapadatok

Környezet

Dátum: 2023. június. 26.
Helyszín: BME „G” épület
Hőmérséklet:
Nyomás:

Személyzet

Kísérletvezető: Markó Balázs (jegyzőkönyv)
Laboráns 1: Dr. Geier Norbert (gépkezelő)

2.2.3. Faktorok

Megnevezés	Jelölés	Mértékegység	Értelmezési tartomány		Szintek száma	Vizsgált szintek
			Legalsó szint	Legfelső szint		
Fogankénti előtolás	f_z	mm	0,025	0,075	5	0,025; 0,033; 0,05; 0,068; 0,075
Forgácsolási sebesség	v_c	m/min	100	200	5	100; 114,64; 150; 185,36; 200
Technológia	S	-	A	C	3	A, B, C

2.3. Kísérlettervezési mátrix

Ssz.	Furatpozíció F1 fúrókészülékben	Próbatest azonosító	Faktorok			CNC programhoz számolt adatok		Megjegyzés
			f_z (mm)	v_c (m/min)	T (-)	f (mm)	n (1/min)	
1	1	AL1 CFRP1	0,050	150	HS	0,100; 0,050		
2	2	AL1 CFRP1	0,050	200	C	0,100		
3	3	AL1 CFRP1	0,025	150	C	0,050		
4	4	AL1 CFRP1	0,050	150	C	0,100		
5	5	AL1 CFRP1	0,050	150	HS	0,100; 0,050		
6	6	AL1 CFRP1	0,033	114,64	HS	0,065; 0,033		
7	7	AL1 CFRP1	0,050	150	HS	0,100		
8	8	AL1 CFRP1	0,075	150	C	0,150		
9	9	AL1 CFRP1	0,033	185,36	C	0,065		
10	10	AL1 CFRP1	0,068	114,64	C	0,135		
11	11	AL1 CFRP1	0,050	150	C	0,100		
12	12	AL1 CFRP1	0,050	150	HS	0,100; 0,050		
13	13	AL1 CFRP1	0,068	114,64	HS	0,135; 0,068		
14	14	AL1 CFRP1	0,050	100	H	0,100; 0,050		
15	15	AL1 CFRP1	0,050	100	C	0,100		
16	16	AL1 CFRP1	0,050	150	H	0,100; 0,050		
17	17	AL1 CFRP1	0,068	185,36	HS	0,135; 0,068		
18	18	AL1 CFRP1	0,050	150	C	0,100		

19	19	AL1 CFRP1	0,075	150	HS	0,150; 0,075		
20	20	AL1 CFRP1	0,050	150	H	0,100; 0,050		
21	21	AL1 CFRP1	0,050	100	HS	0,100; 0,050		
22	22	AL1 CFRP1	0,050	150	C	0,100		
23	23	AL1 CFRP1	0,050	150	H	0,100; 0,050		
24	24	AL1 CFRP1	0,033	114,64	C	0,065		
25	25	AL1 CFRP1	0,025	150	HS	0,050; 0,025		
26	26	AL1 CFRP1	0,068	114,64	H	0,135; 0,068		
27	27	AL1 CFRP1	0,033	185,36	HS	0,065; 0,033		
28	28	AL1 CFRP1	0,033	185,36	H	0,065; 0,033		
29	29	AL1 CFRP1	0,050	150	C	0,100		
30	30	AL1 CFRP1	0,050	150	HS	0,100; 0,050		
31	31	AL1 CFRP1	0,075	150	H	0,150; 0,075		
32	32	AL1 CFRP1	0,033	114,64	H	0,065; 0,033		
33	33	AL1 CFRP1	0,050	150	H	0,100; 0,050		
34	34	AL1 CFRP1	0,025	150	H	0,050; 0,025		
35	35	AL1 CFRP1	0,050	200	HS	0,100; 0,050		
36	36	AL1 CFRP1	0,050	150	H	0,100; 0,050		
37	37	AL1 CFRP1	0,068	185,36	C	0,135		
38	1	AL2 CFRP2	0,050	200	H	0,100; 0,050		
39	2	AL2 CFRP2	0,068	185,36	H	0,135; 0,050		

C: Konvencionális fúrás Ø10 csigafúróval

H: Helikális marás Ø8 csigafúróval és Ø6 maróval

HS: Helikális marás spirális furatbővítéssel Ø8 csigafúróval és Ø6 maróval

További megjegyzések:

- Töltéserősítőn méréshatár 1000N
- Erősítési tényező 100 N/V
- Mérési frekvencia: $f=N_{\max}/60 \cdot (360/10)=6366 \text{ Hz} \approx 7000 \text{ Hz}$
- Fúrókészülék kiórázva rövidebbek oldala mentén: $\pm 0,02 \text{ mm}$
- G54-es munkadarab nullpont
- Alumínium lemezen „x” jelölés tetején a bal alsó sarokban
- Patronos szerszámbefogó
- Program indításkor potméter 100%-on van
- Egymás után vannak a furatok
- Új szerszámok lettek használva
- Az NC program futtatva volt: D/NCprograms/geier/20240626_markobalazs mappából

2.4. Mérési jegyzőkönyv

Mérés ideje: 2024.07.11. 8:30-12:00

Helyszín: BME „J” épület

Mérőeszköz: Keyence VR-5000 profilométer

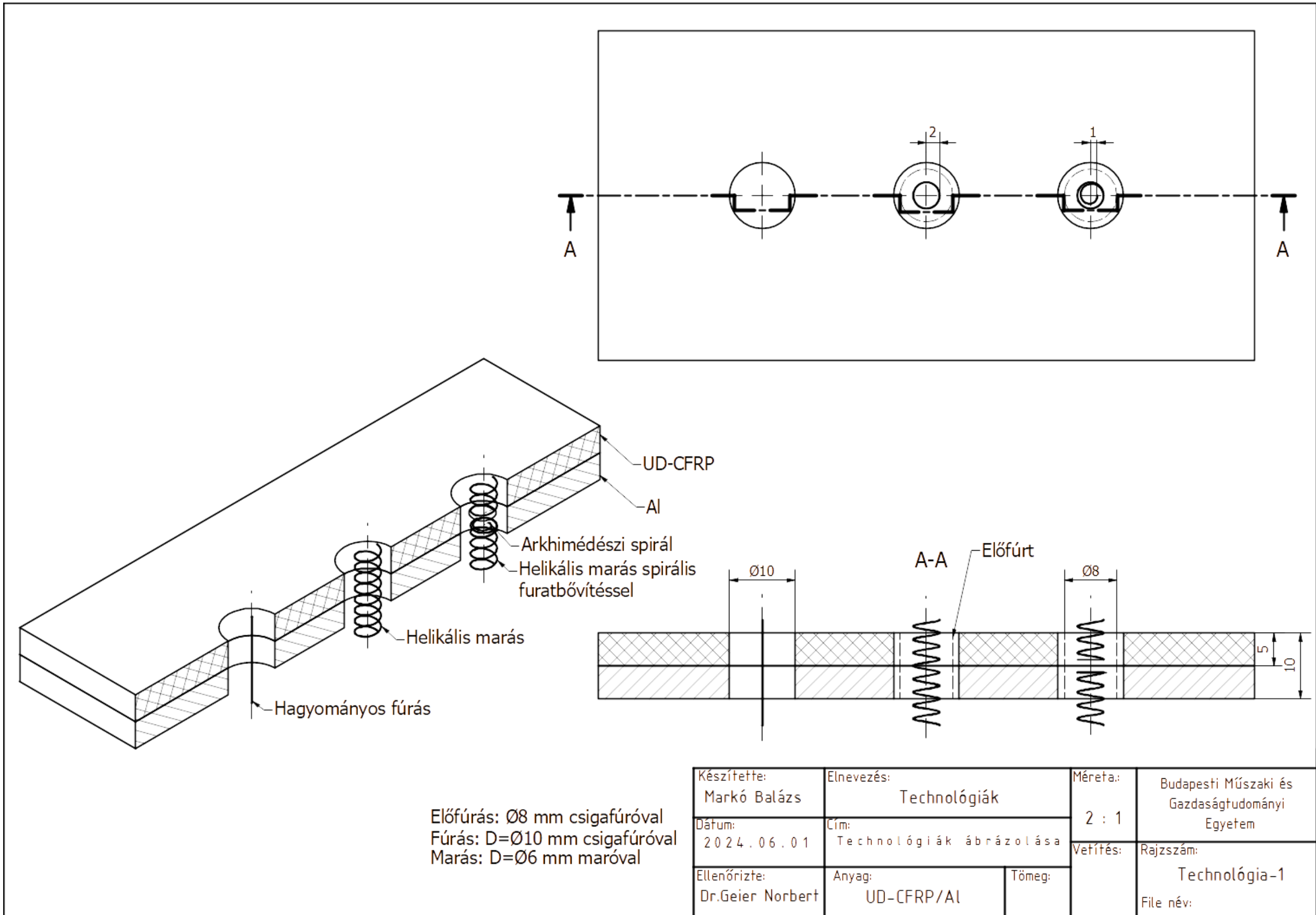
Mérést végezte: Markó Balázs

Mérési beállítások:

- A mérés mindkét esetben rétegeközben történt.
- Mérés sorrendje: alumínium lemez 1.-39. furat, majd UD-CFRP lemez 1.-39. furat.
- Nagyítás: 38x
- Minden furat mérése esetén a furat mellet automata referenciasíkot vettem fel.

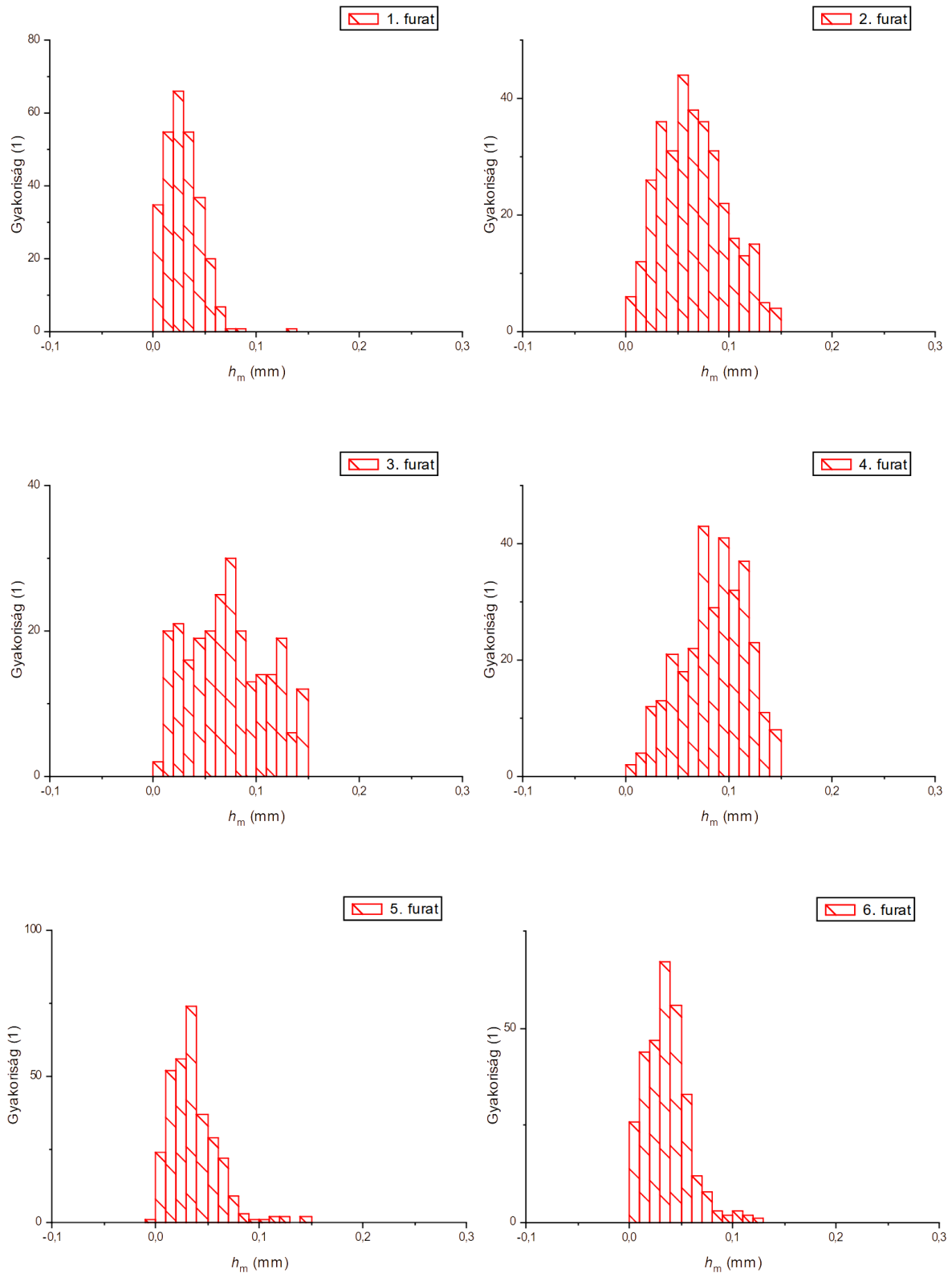
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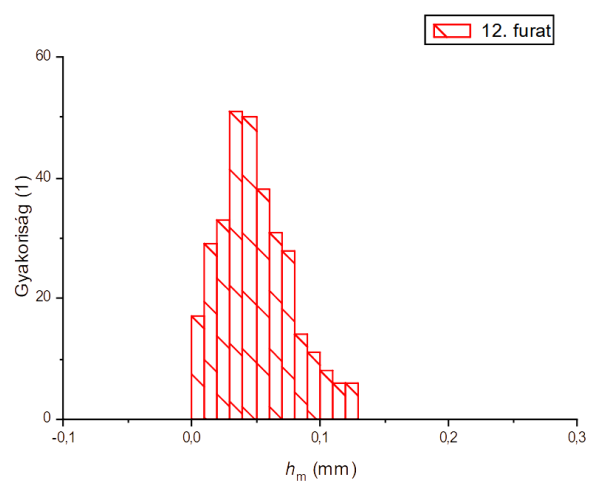
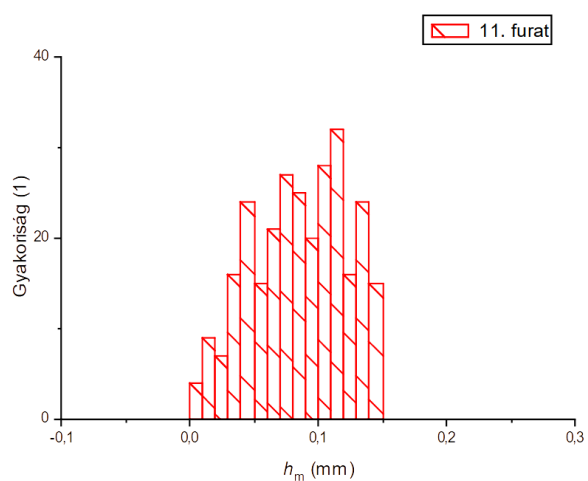
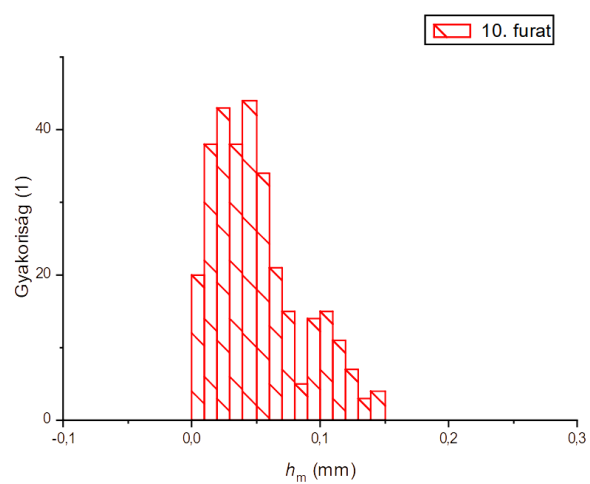
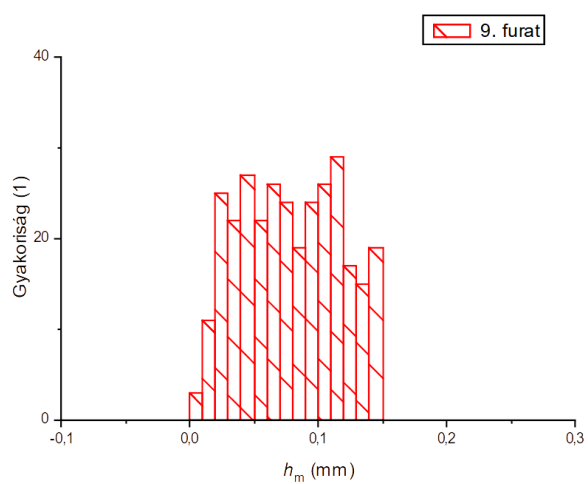
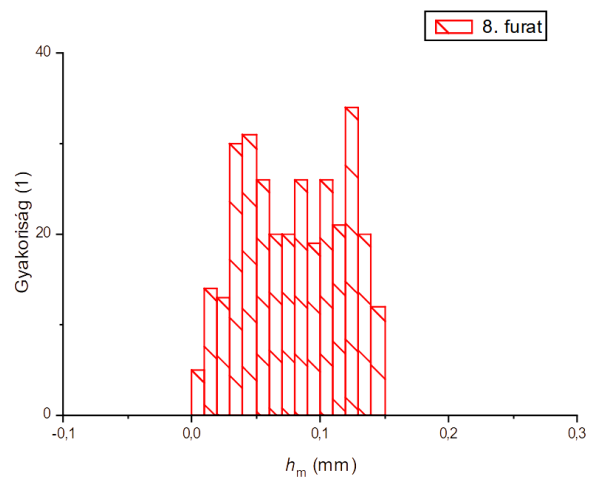
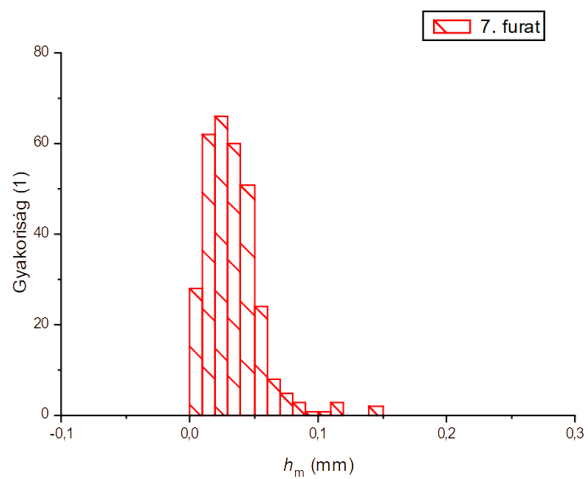
3. sz. melléklet: Műszaki rajz a technológiákról

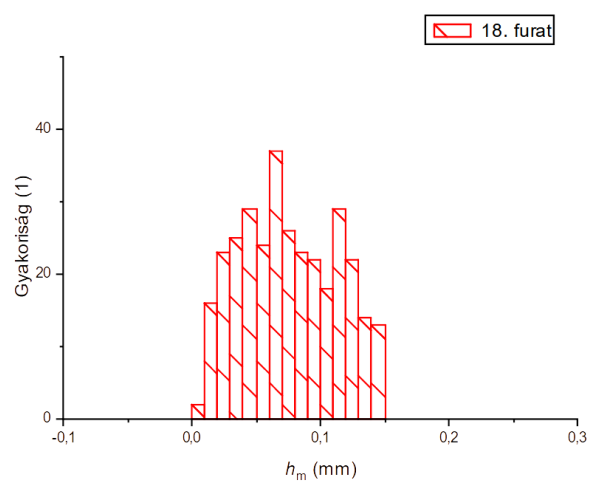
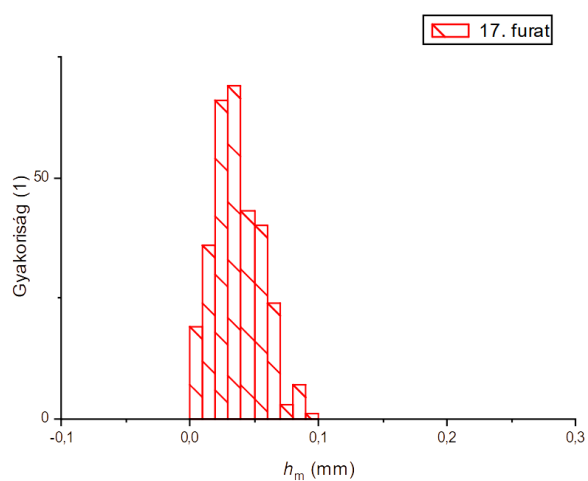
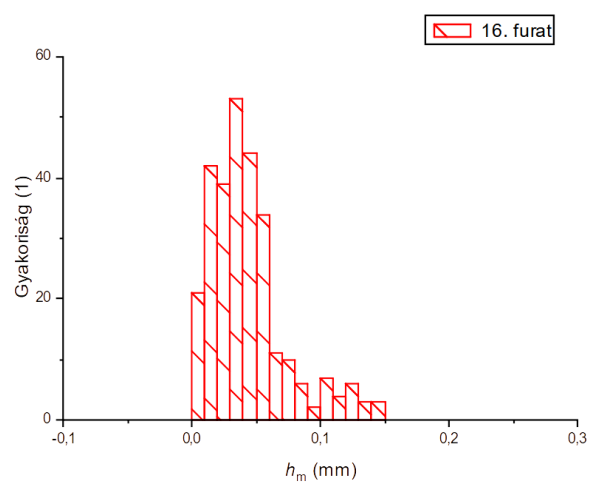
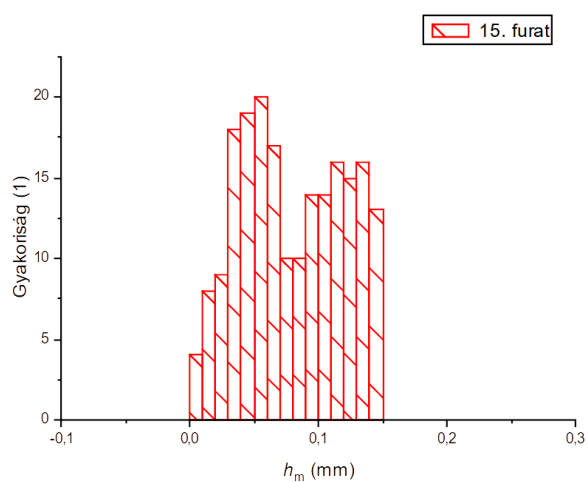
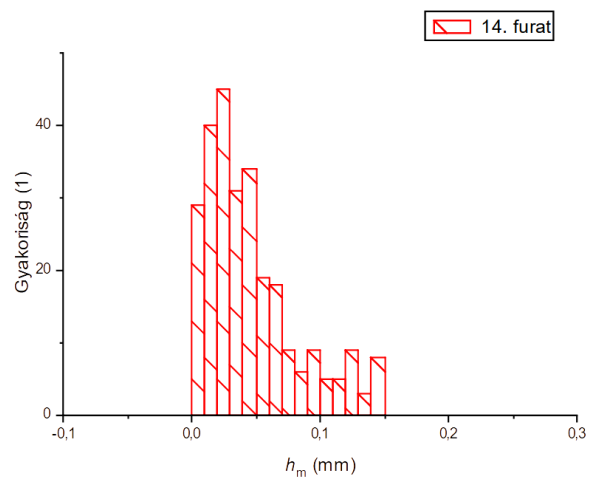
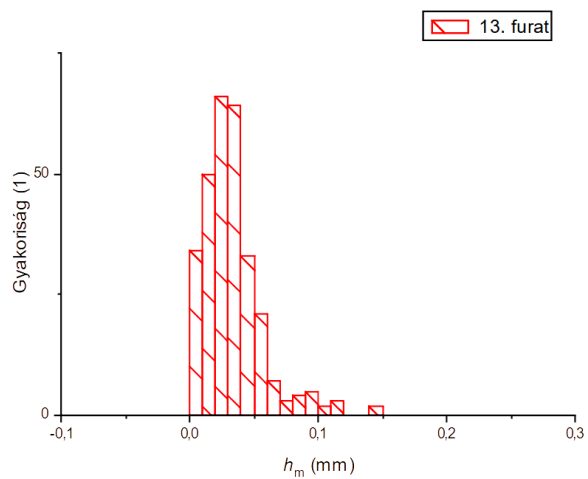


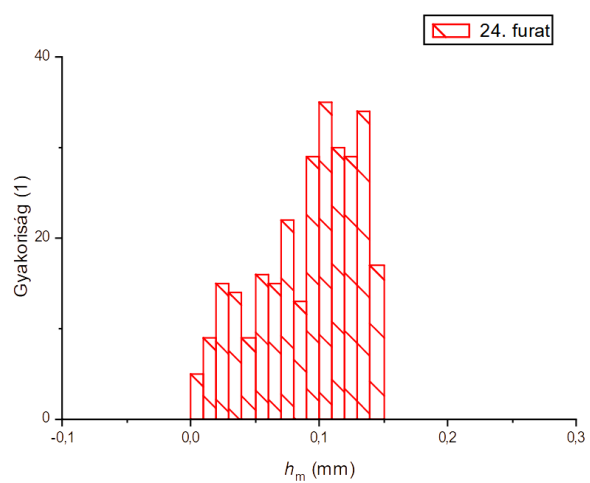
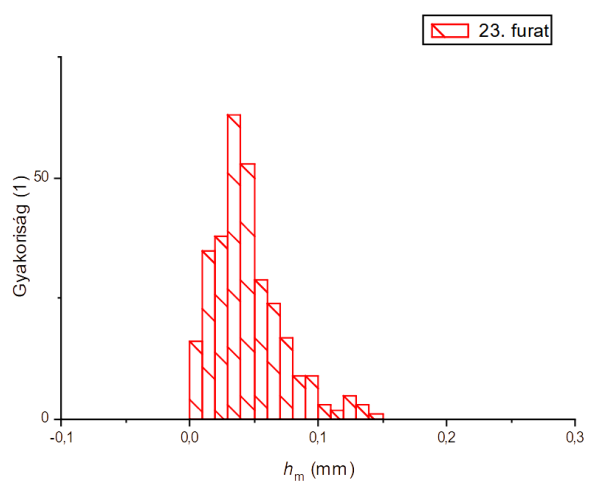
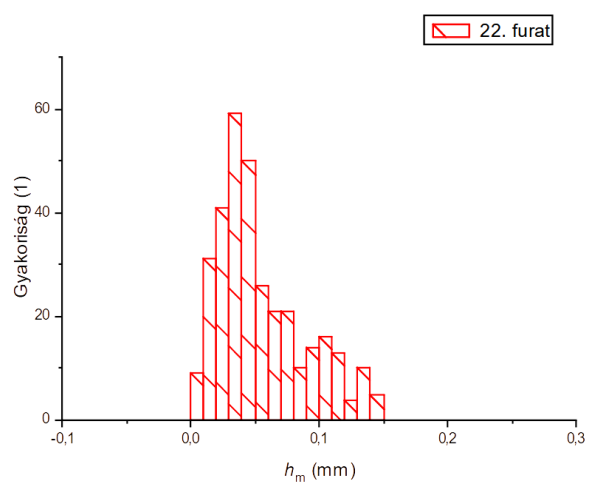
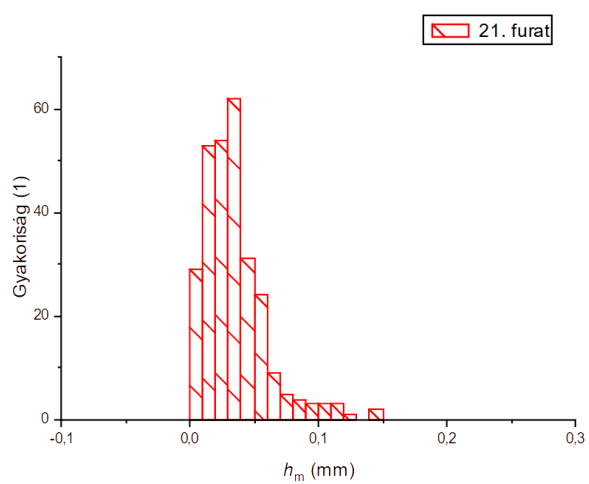
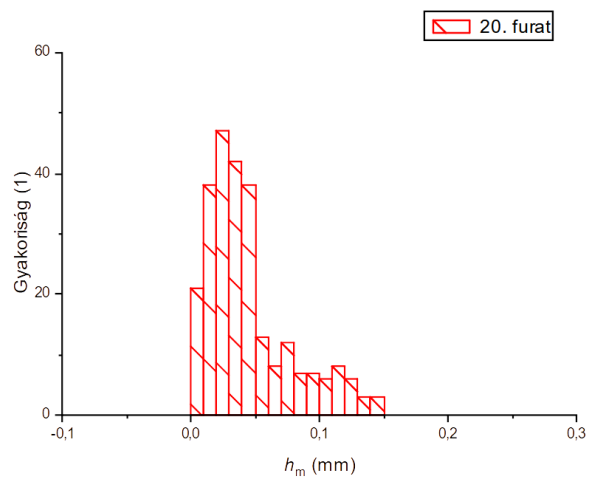
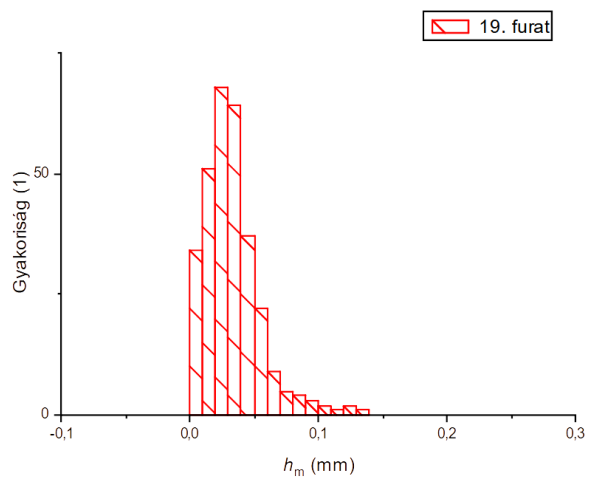
4. sz. melléklet: Maximális sorjamagasság eloszlások

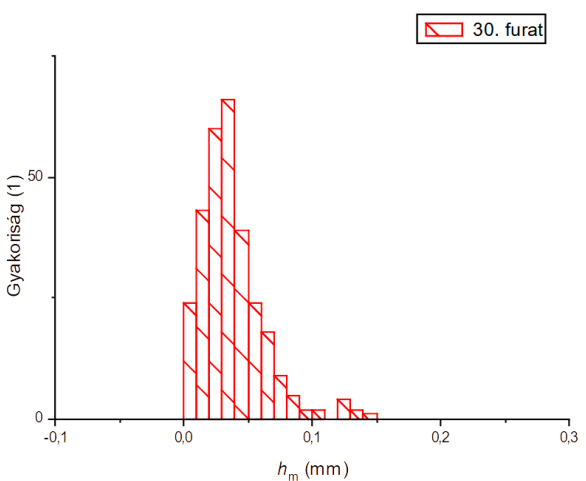
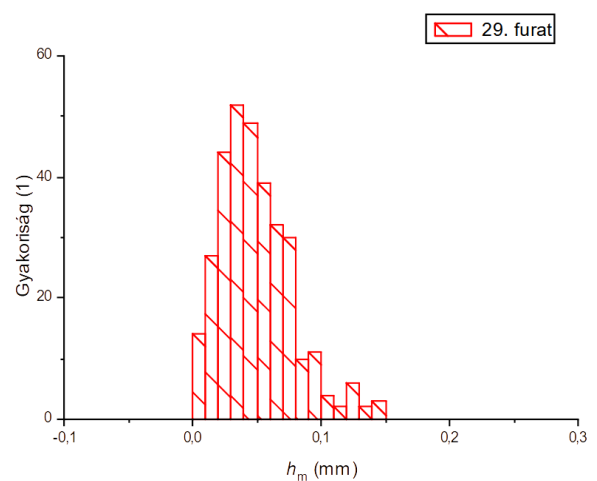
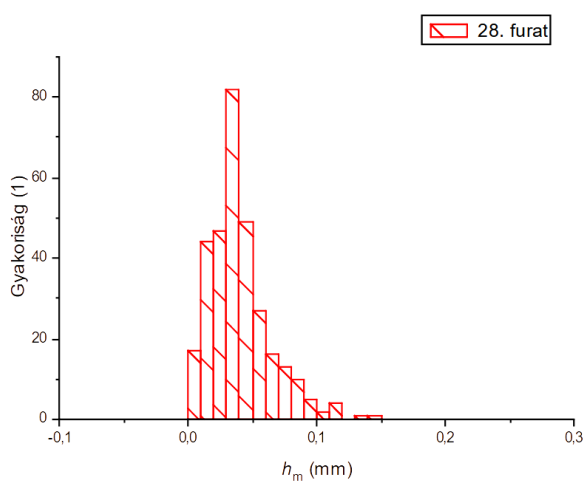
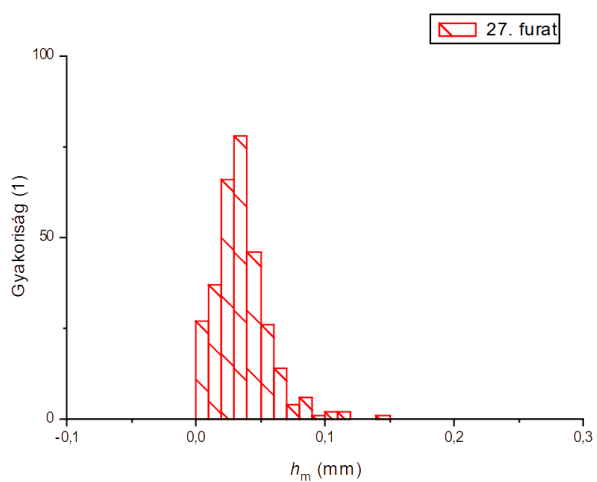
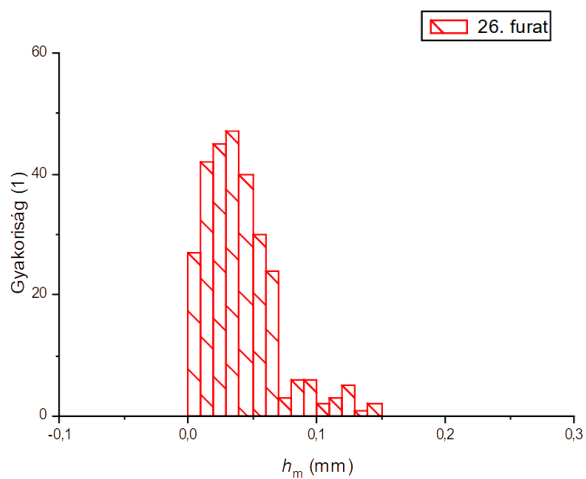
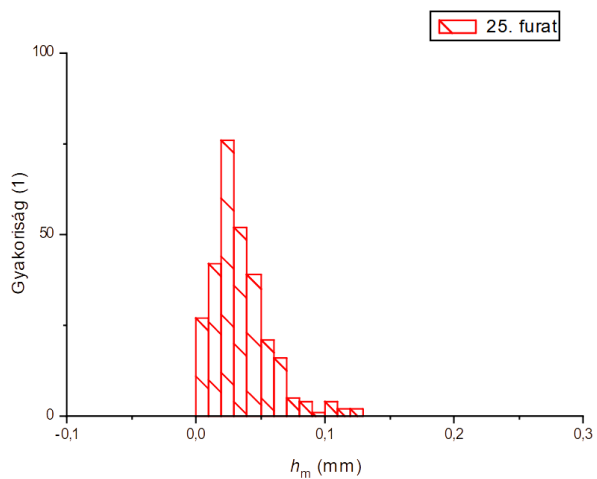
Az UD-CFRP furatok maximális sorjamagasság eloszlásai láthatóak az alábbiakban.

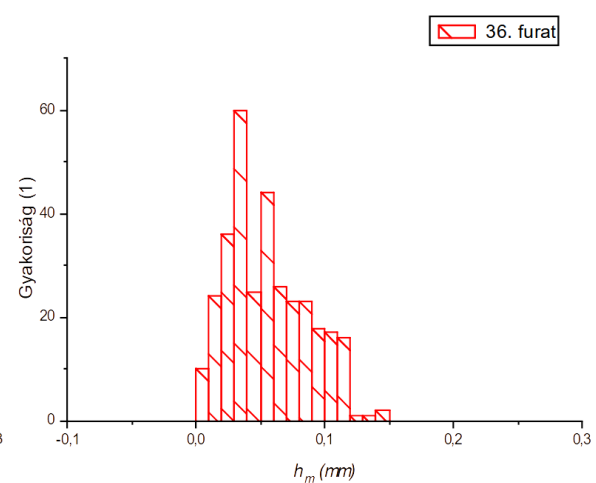
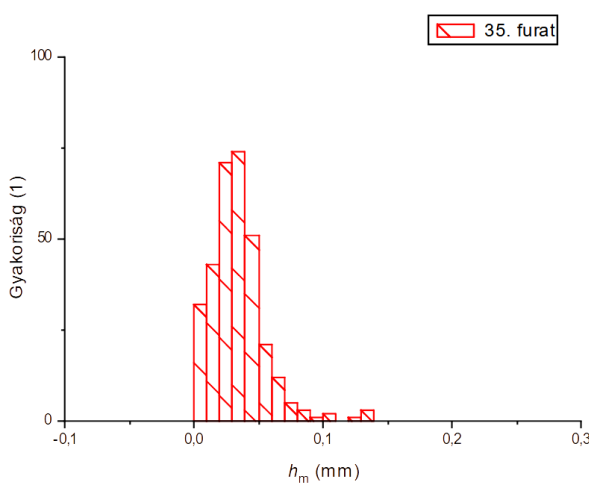
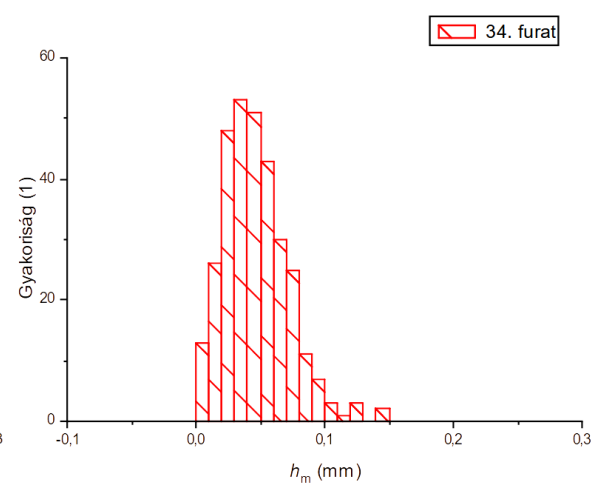
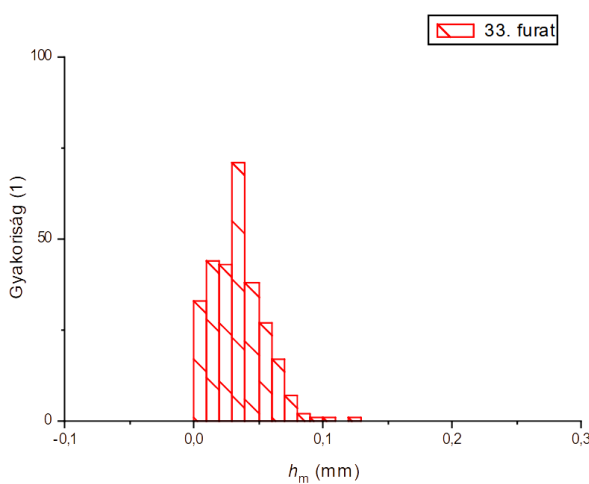
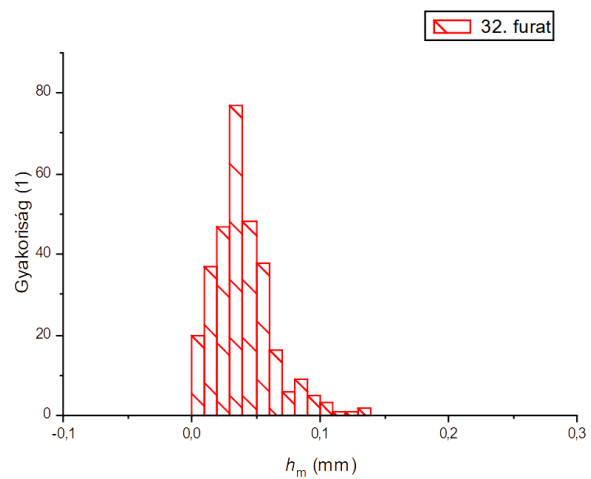
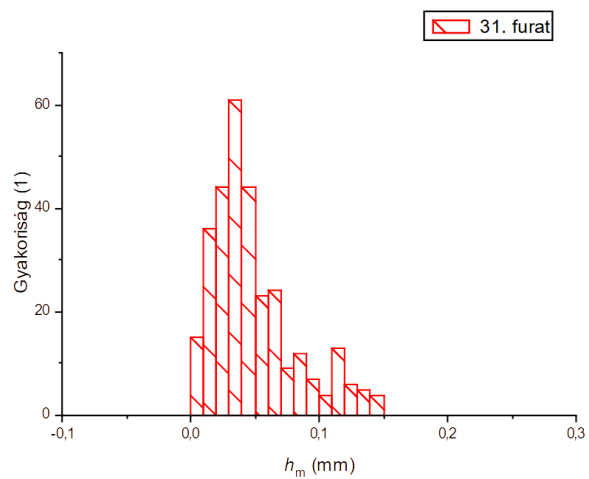


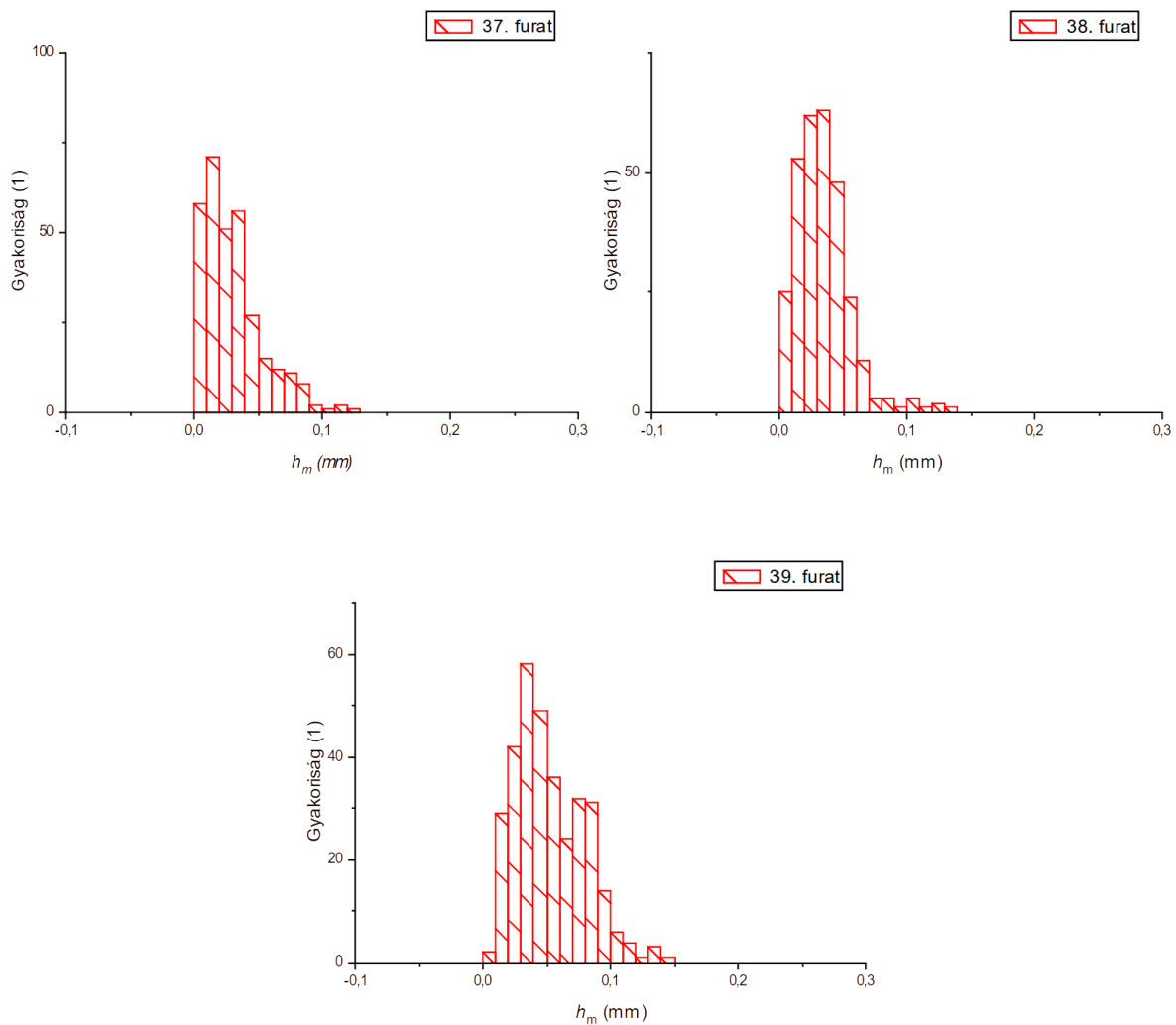




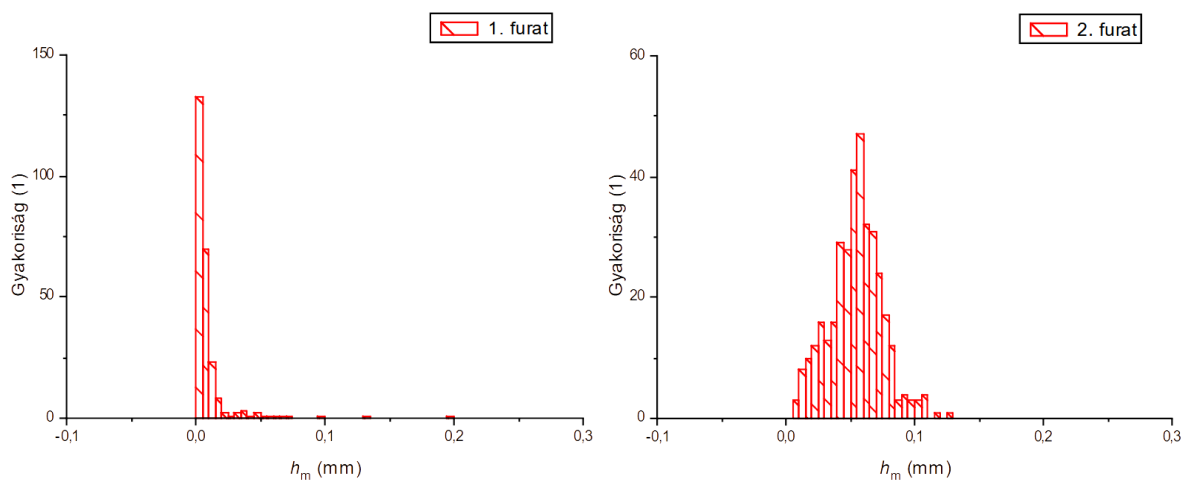


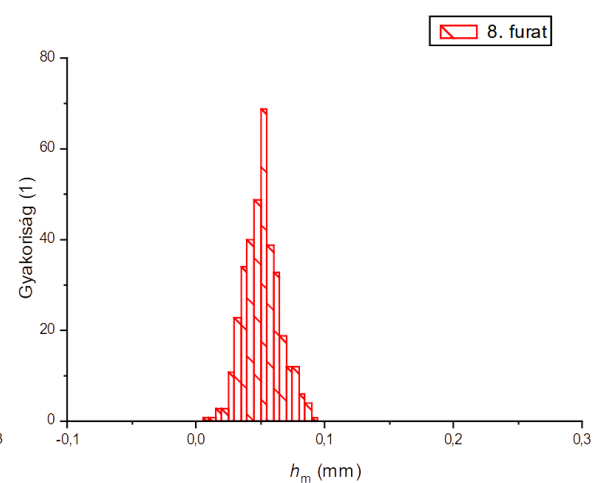
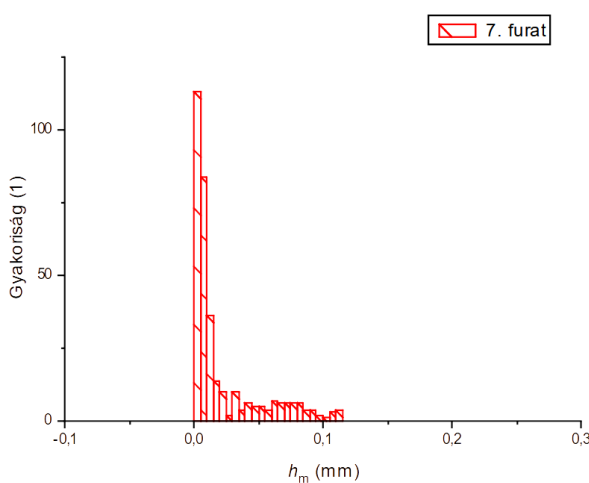
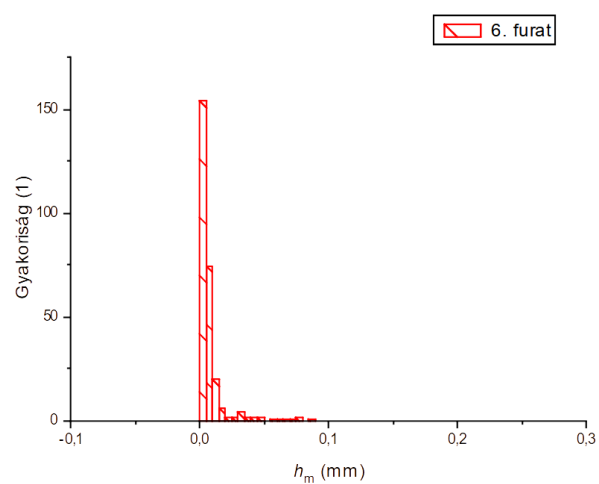
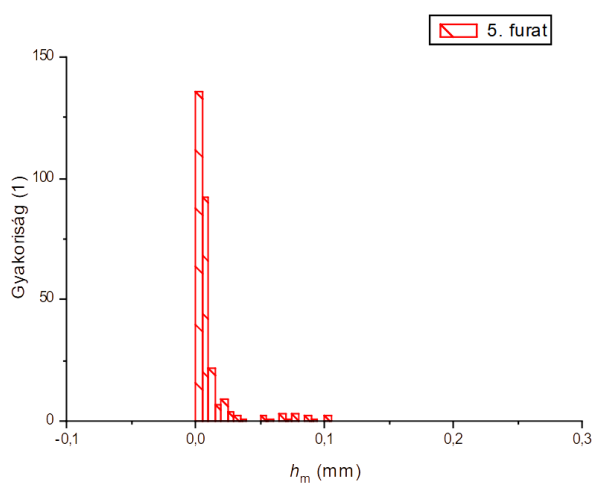
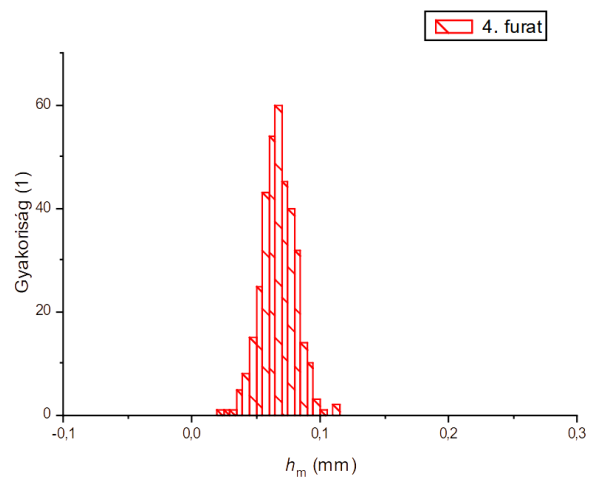
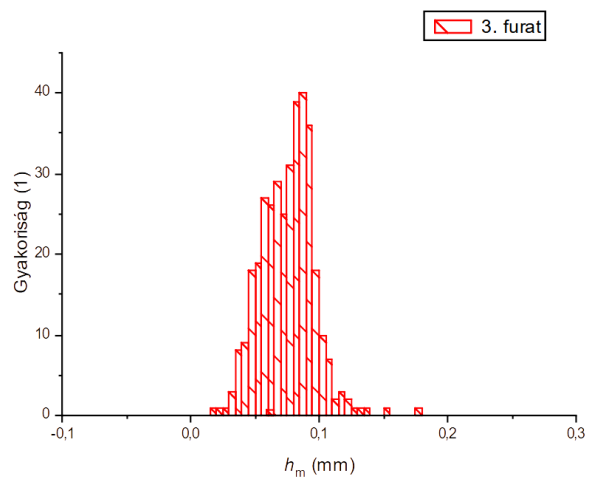


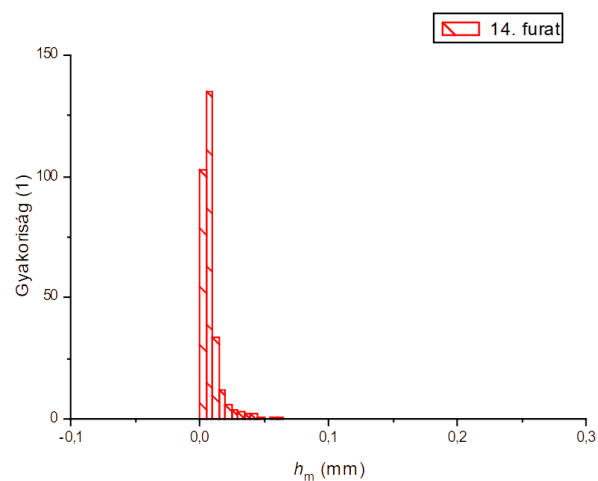
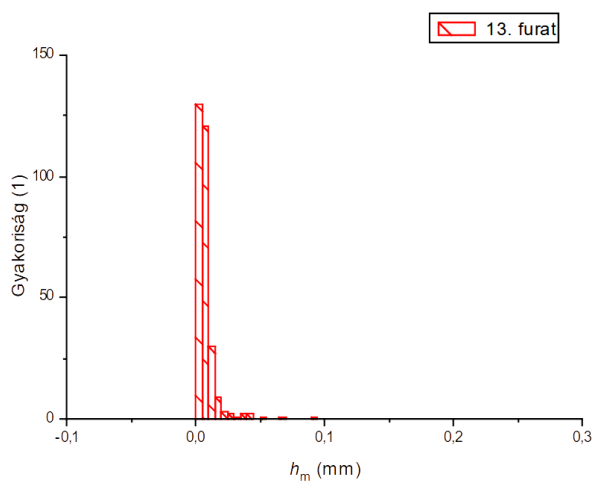
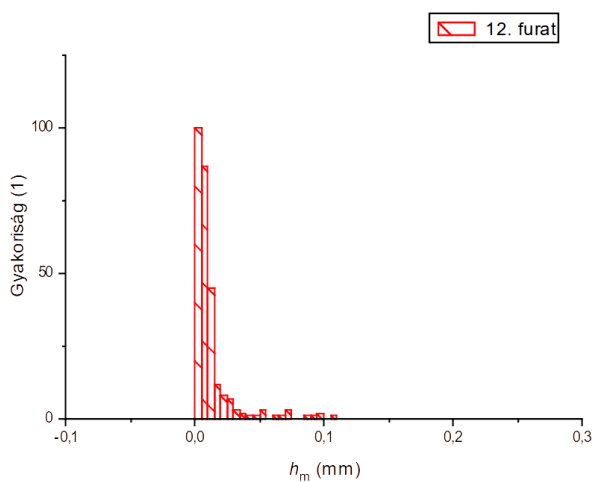
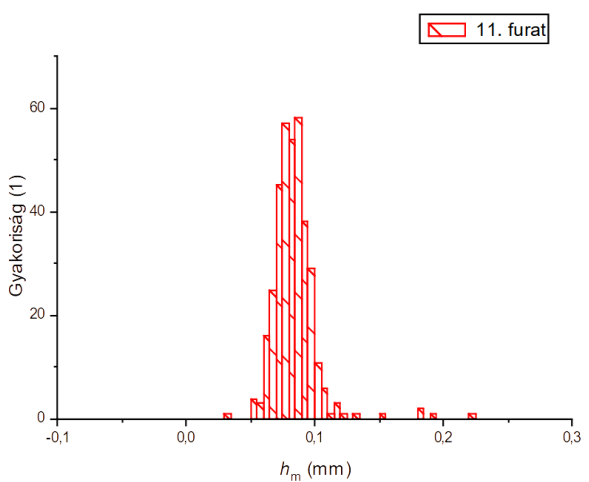
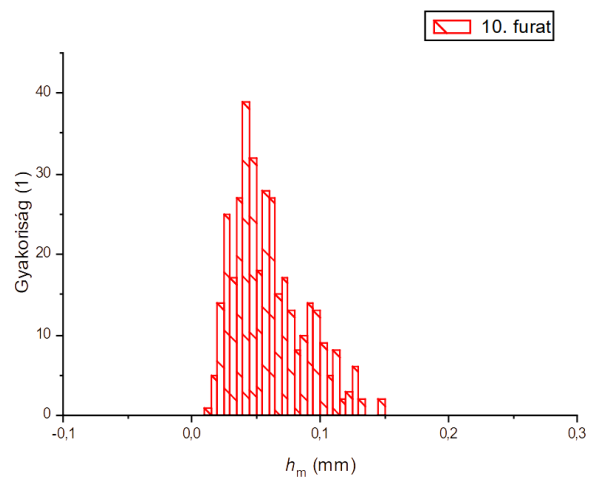
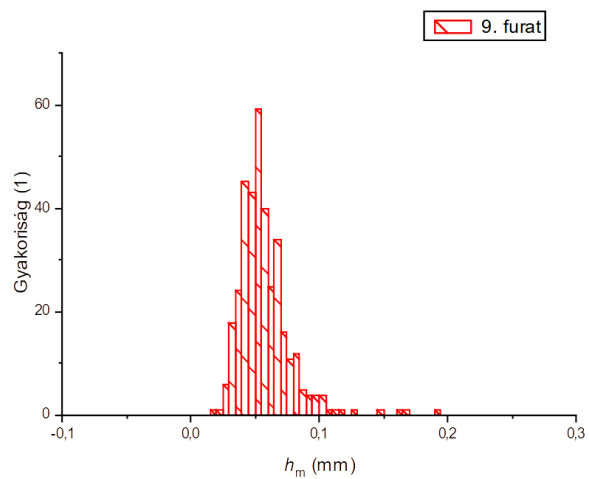


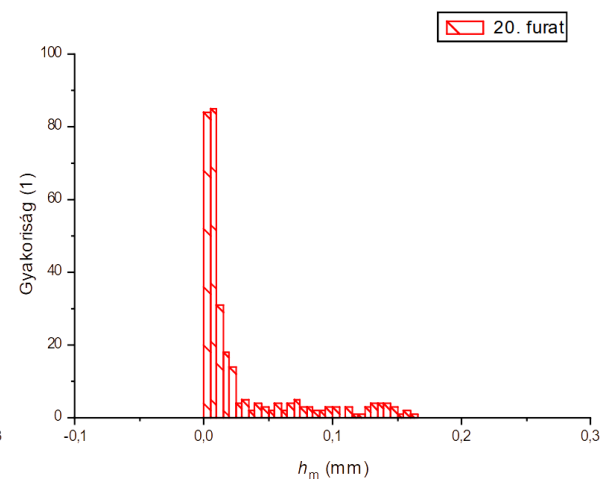
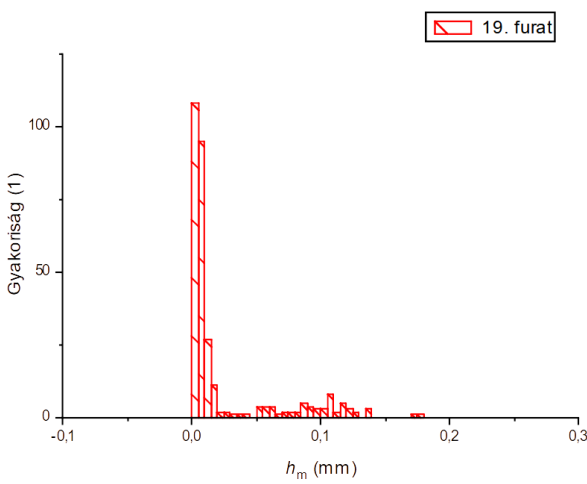
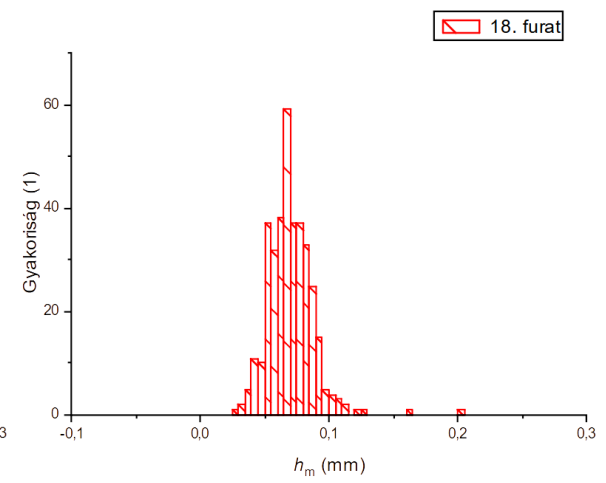
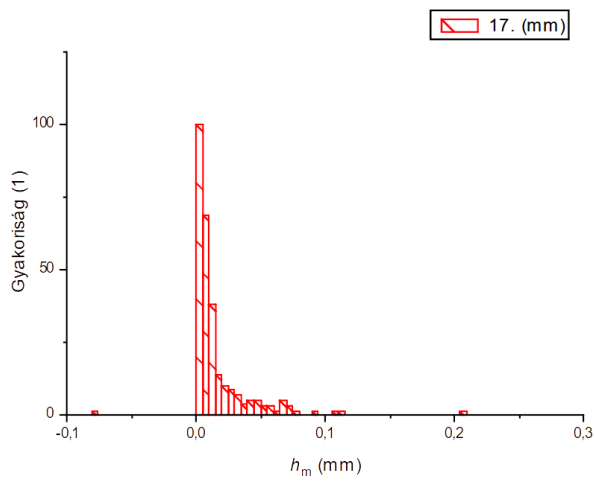
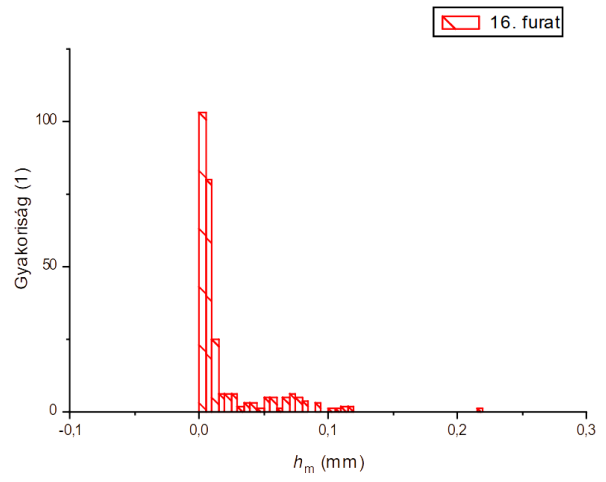
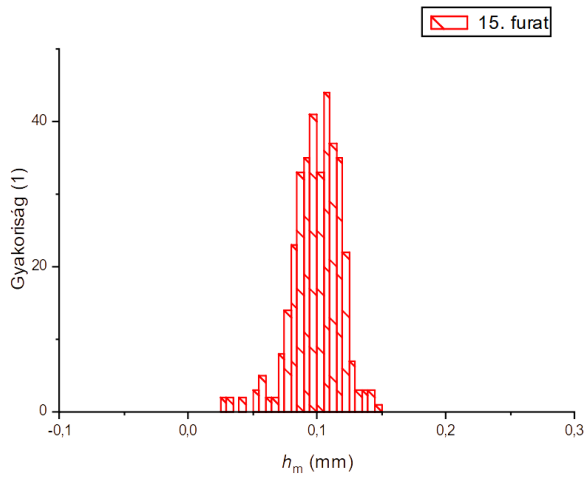


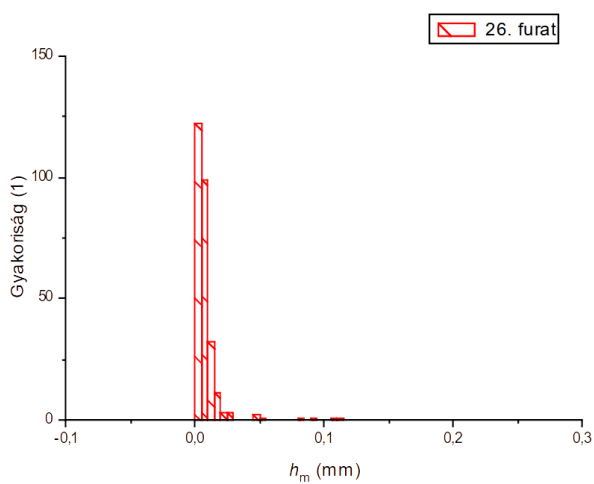
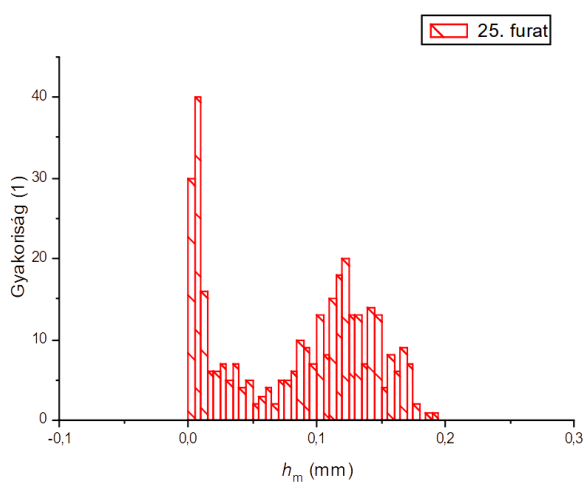
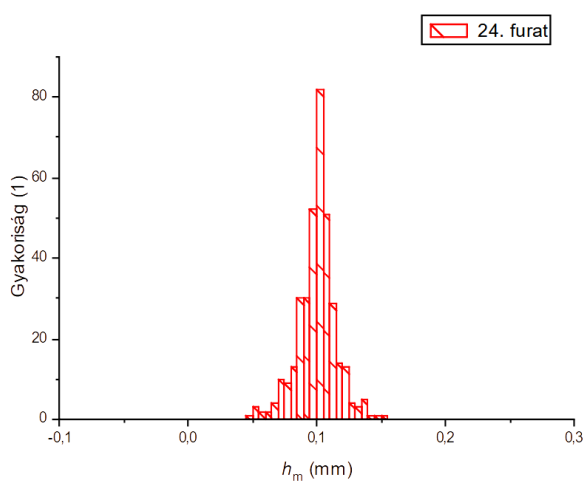
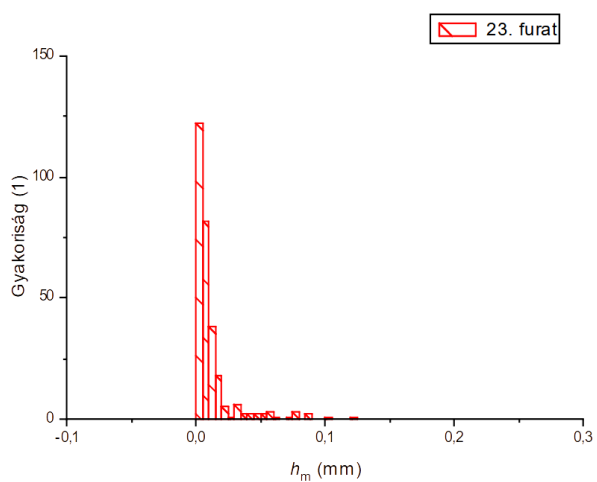
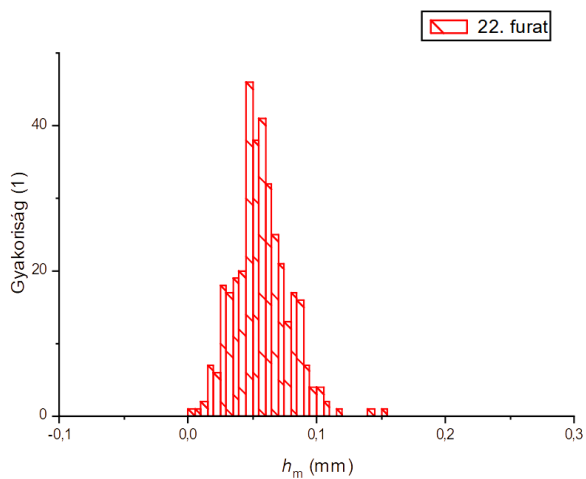
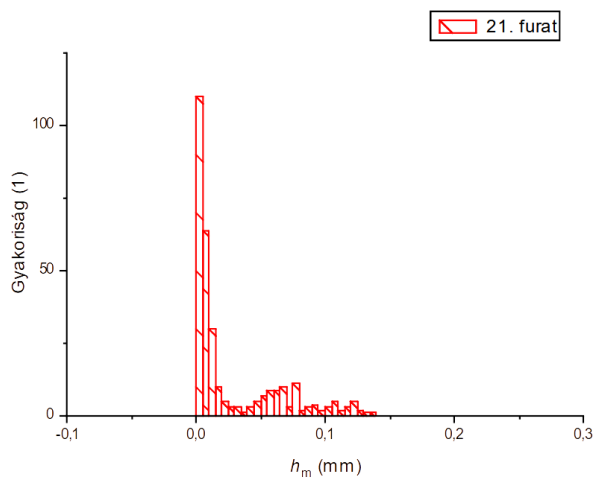
Az alumínium furatok maximális sorjagasság eloszlásai látatóak az alábbiakban.

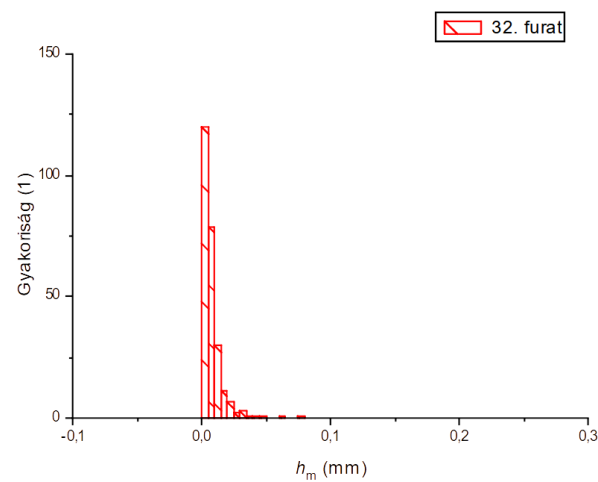
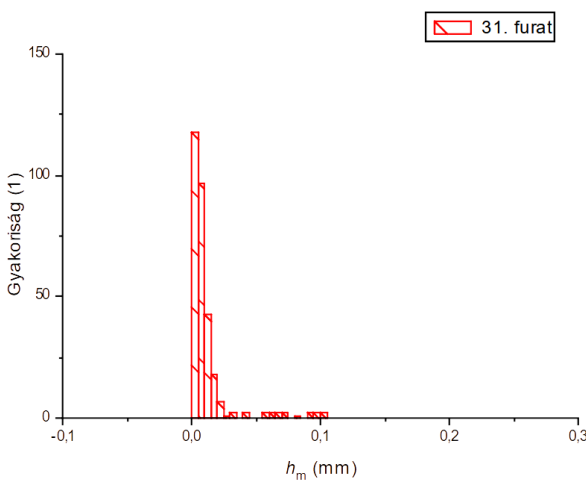
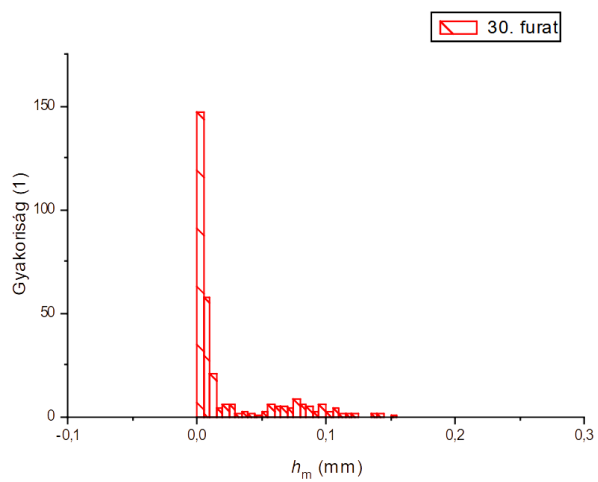
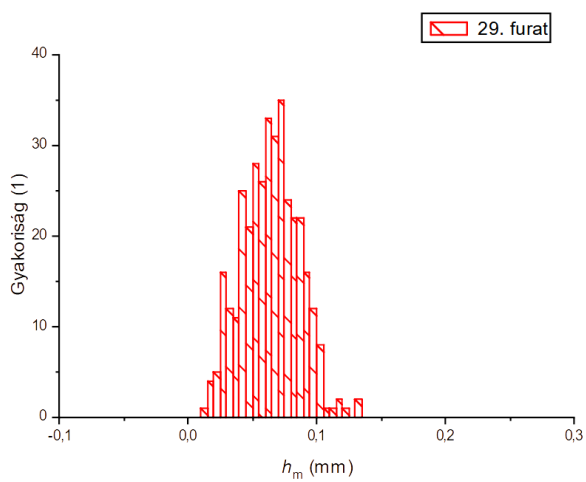
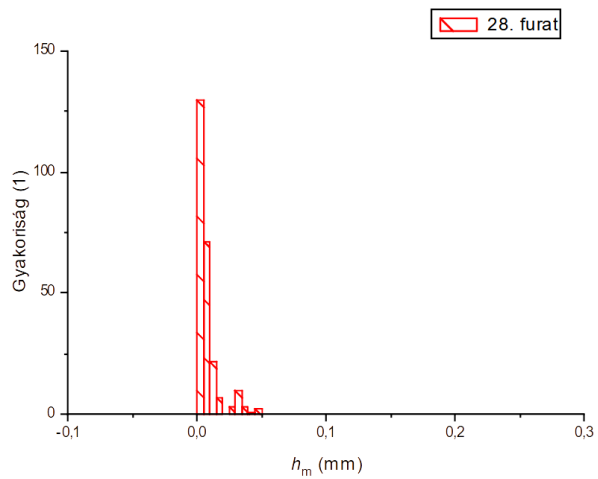
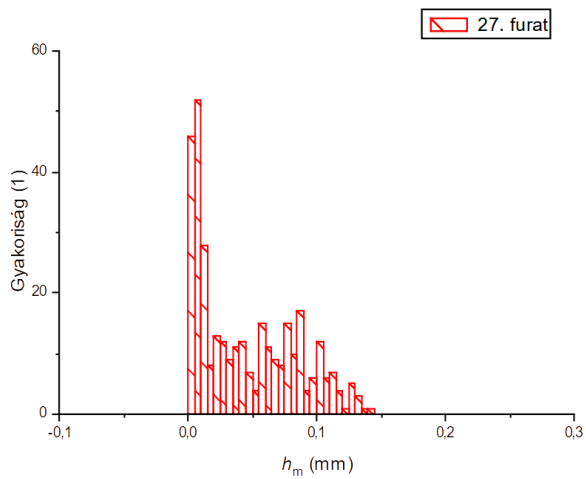


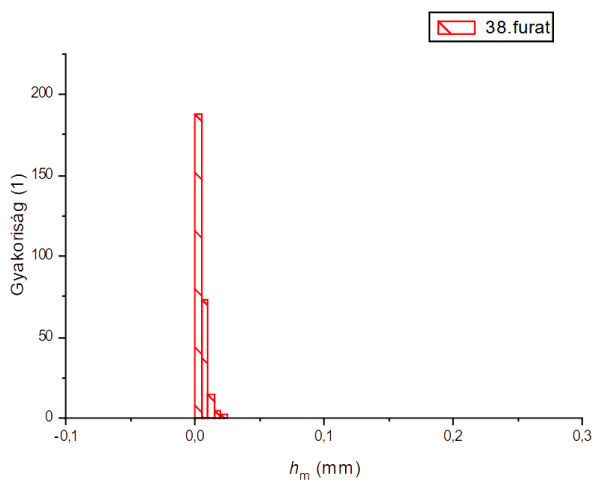
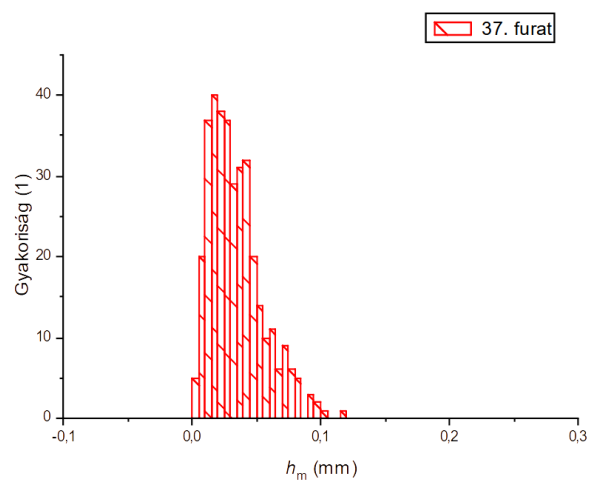
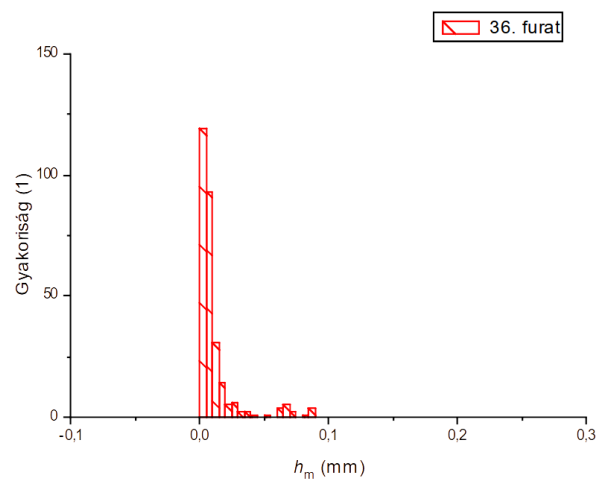
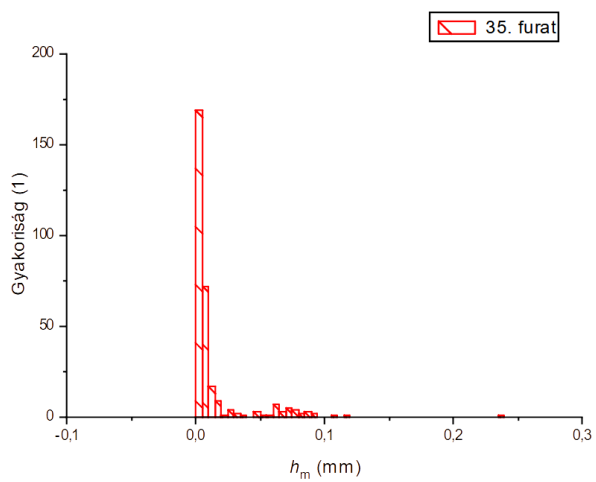
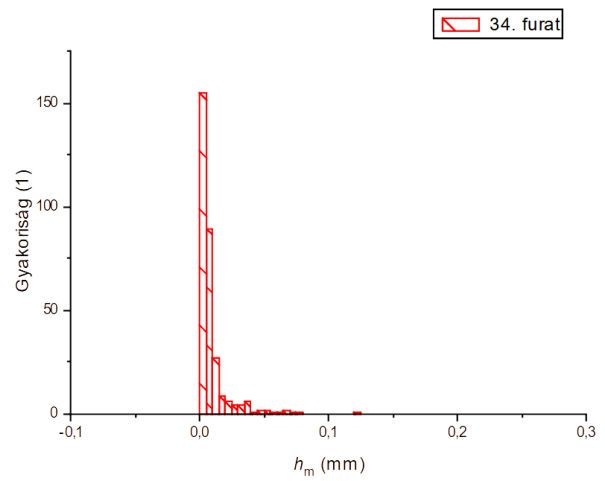
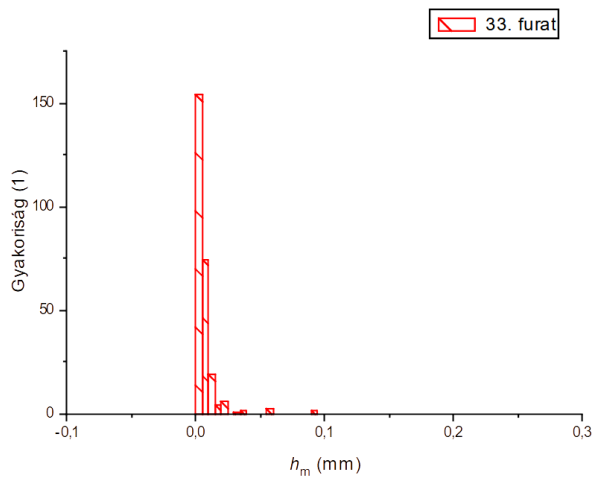


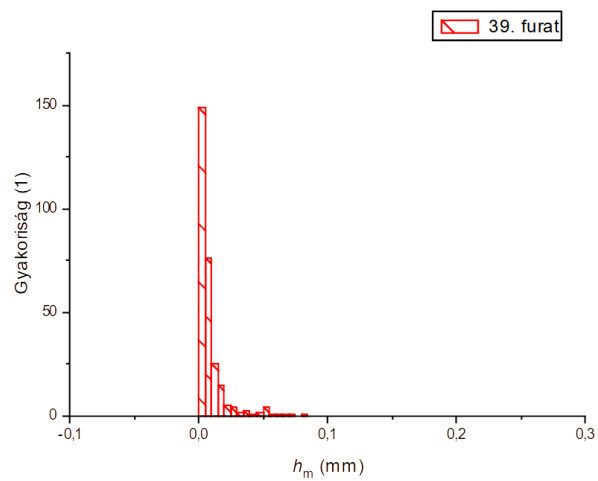












5. sz. melléklet: Cliff-féle hatásnagyság eredmények

A dolgozatban lévő Cliff-féle hatásnagyság vizsgálat eredményei vannak ebben a mellékletben, elsőként az UD-CFRP lemezek esetén.

Jelölés		[S (1); f_z (mm); v_c (m/min)]								
	Érték	[C; 0,025; 150]	[C; 0,033; 114,64]	[C; 0,033; 185,36]	[C; 0,05; 100]	[C; 0,05; 150]	[C; 0,05; 200]	[C; 0,068; 114,64]	[C; 0,068; 185,36]	[C; 0,075; 150]
[S (1); f_z (mm); v_c (m/min)]	[C; 0,025; 150]		-0,2470	-0,1471	-0,2956	-0,2173	0,1426	0,3563	0,6714	-0,1347
	[C; 0,033; 114,64]	0,2470		0,1123	-0,1404	0,1219	0,4371	0,5620	0,7861	0,1454
	[C; 0,033; 185,36]	0,1471	-0,1123		-0,1983	-0,0384	0,3219	0,5015	0,7827	0,0246
	[C; 0,05; 100]	0,2956	0,1404	0,1983		0,1532	0,4215	0,5625	0,7806	0,2054
	[C; 0,05; 150]	0,2173	-0,1219	0,0384	-0,1532		0,4186	0,5944	0,8671	0,0650
	[C; 0,05; 200]	-0,1426	-0,4371	-0,3219	-0,4215	-0,4186		0,2617	0,6464	-0,3117
	[C; 0,068; 114,64]	-0,3563	-0,5620	-0,5015	-0,5625	-0,5944	-0,2617		0,4141	-0,4994
	[C; 0,068; 185,36]	-0,6714	-0,7861	-0,7827	-0,7806	-0,8671	-0,6464	-0,4141		-0,7921
	[C; 0,075; 150,0]	0,1347	-0,1454	-0,0246	-0,2054	-0,0650	0,3117	0,4994	0,7921	
	[H; 0,025; 150,0]	-0,4228	-0,6233	-0,5738	-0,5964	-0,7134	-0,3497	-0,0365	0,4250	-0,5850
	[H; 0,033; 114,64]	-0,5364	-0,6965	-0,6812	-0,6861	-0,8046	-0,4904	-0,1846	0,3055	-0,6959
	[H; 0,033; 185,36]	-0,5312	-0,6896	-0,6713	-0,6825	-0,7907	-0,4831	-0,1856	0,2924	-0,6883
	[H; 0,05; 100]	-0,2055	-0,3463	-0,3131	-0,3965	-0,3864	-0,1346	0,0722	0,4083	-0,3165
	[H; 0,05; 150]	-0,4187	-0,5649	-0,5468	-0,5895	-0,6489	-0,3615	-0,0992	0,3335	-0,5583
	[H; 0,05; 200]	-0,6353	-0,7572	-0,7589	-0,7574	-0,8680	-0,6073	-0,3207	0,1579	-0,7778
	[H; 0,068; 114,64]	-0,5527	-0,7021	-0,6817	-0,6966	-0,7902	-0,5033	-0,2205	0,2337	-0,6939
	[H; 0,068; 185,36]	-0,3366	-0,5899	-0,5134	-0,5552	-0,6483	-0,2430	0,0612	0,5247	-0,5220
	[H; 0,075; 150]	-0,3284	-0,5121	-0,4681	-0,5370	-0,5640	-0,2470	0,0166	0,4363	-0,4736
	[HS; 0,025; 150]	-0,6288	-0,7587	-0,7538	-0,7554	-0,8602	-0,6005	-0,3174	0,1555	-0,7698
	[HS; 0,033; 114,64]	-0,5787	-0,7132	-0,7068	-0,7063	-0,8230	-0,5423	-0,2515	0,2244	-0,7246
	[HS; 0,033; 185,36]	-0,6077	-0,7361	-0,7379	-0,7372	-0,8485	-0,5800	-0,2920	0,1944	-0,7571
	[HS; 0,05; 100]	-0,6180	-0,7376	-0,7399	-0,7443	-0,8353	-0,5901	-0,3260	0,1315	-0,7539
	[HS; 0,05; 150]	-0,7142	-0,8140	-0,8275	-0,8141	-0,9297	-0,7035	-0,4287	0,0444	-0,8469
	[HS; 0,05; 200]	-0,6404	-0,7595	-0,7649	-0,7627	-0,8755	-0,6149	-0,3245	0,1623	-0,7853
	[HS; 0,068; 114,64]	-0,6226	-0,7409	-0,7442	-0,7485	-0,8403	-0,5968	-0,3316	0,1293	-0,7594
	[HS; 0,068; 185,36]	-0,6028	-0,7515	-0,7424	-0,7323	-0,8765	-0,5651	-0,2446	0,2547	-0,7594
	[HS; 0,075; 150]	-0,6552	-0,7740	-0,7768	-0,7747	-0,8780	-0,6318	-0,3576	0,1140	-0,7950

Jelölés		[S (1); f_z (mm); v_c (m/min)]								
	Érték	[H; 0,025; 150]	[H; 0,033; 114,64]	[H; 0,033; 185,36]	[H; 0,05; 100]	[H; 0,05; 150]	[H; 0,05; 200]	[H; 0,068; 114,64]	[H; 0,068; 185,36]	[H; 0,075; 150]
[S (1); f_z (mm); v_c (m/min)]	[C; 0,025; 150]	0,4228	0,5364	0,5312	0,2055	0,4187	0,6353	0,5527	0,3366	0,3284
	[C; 0,033; 114,64]	0,6233	0,6965	0,6896	0,3463	0,5649	0,7572	0,7021	0,5899	0,5121
	[C; 0,033; 185,36]	0,5738	0,6812	0,6713	0,3131	0,5468	0,7589	0,6817	0,5134	0,4681
	[C; 0,05; 100]	0,5964	0,6861	0,6825	0,3965	0,5895	0,7574	0,6966	0,5552	0,5370
	[C; 0,05; 150]	0,7134	0,8046	0,7907	0,3864	0,6489	0,8680	0,7902	0,6483	0,5640
	[C; 0,05; 200]	0,3497	0,4904	0,4831	0,1346	0,3615	0,6073	0,5033	0,2430	0,2470
	[C; 0,068; 114,64]	0,0365	0,1846	0,1856	-0,0722	0,0992	0,3207	0,2205	-0,0612	-0,0166
	[C; 0,068; 185,36]	-0,4250	-0,3055	-0,2924	-0,4083	-0,3335	-0,1579	-0,2337	-0,5247	-0,4363
	[C; 0,075; 150,0]	0,5850	0,6959	0,6883	0,3165	0,5583	0,7778	0,6939	0,5220	0,4736
	[H; 0,025; 150,0]		0,1775	0,1756	-0,0824	0,0929	0,3344	0,2158	-0,1236	-0,0413
	[H; 0,033; 114,64]	-0,1775		0,0087	-0,1975	-0,0626	0,1770	0,0590	-0,2892	-0,1895
	[H; 0,033; 185,36]	-0,1756	-0,0087		-0,2022	-0,0718	0,1626	0,0499	-0,2893	-0,1945
	[H; 0,05; 100]	0,0824	0,1975	0,2022		0,1372	0,3148	0,2397	0,0058	0,0485
	[H; 0,05; 150]	-0,0929	0,0626	0,0718	-0,1372		0,2157	0,1135	-0,1879	-0,1086
	[H; 0,05; 200]	-0,3344	-0,1770	-0,1626	-0,3148	-0,2157		-0,1034	-0,4433	-0,3373
	[H; 0,068; 114,64]	-0,2158	-0,0590	-0,0499	-0,2397	-0,1135	0,1034		-0,3260	-0,2353
	[H; 0,068; 185,36]	0,1236	0,2892	0,2893	-0,0058	0,1879	0,4433	0,3260		0,0573
	[H; 0,075; 150]	0,0413	0,1895	0,1945	-0,0485	0,1086	0,3373	0,2353	-0,0573	
	[HS; 0,025; 150]	-0,3315	-0,1823	-0,1691	-0,3155	-0,2189	-0,0110	-0,1074	-0,4441	-0,3381
	[HS; 0,033; 114,64]	-0,2551	-0,0863	-0,0747	-0,2533	-0,1367	0,0839	-0,0250	-0,3635	-0,2620
	[HS; 0,033; 185,36]	-0,3032	-0,1439	-0,1300	-0,2855	-0,1865	0,0371	-0,0699	-0,4139	-0,3044
	[HS; 0,05; 100]	-0,3397	-0,2008	-0,1843	-0,3229	-0,2349	-0,0310	-0,1224	-0,4439	-0,3462
	[HS; 0,05; 150]	-0,4575	-0,3098	-0,2932	-0,4057	-0,3338	-0,1369	-0,2295	-0,5643	-0,4484
	[HS; 0,05; 200]	-0,3417	-0,1801	-0,1662	-0,3164	-0,2171	-0,0018	-0,1067	-0,4505	-0,3383
	[HS; 0,068; 114,64]	-0,3472	-0,2040	-0,1908	-0,3260	-0,2387	-0,0350	-0,1290	-0,4486	-0,3497
	[HS; 0,068; 185,36]	-0,2422	-0,0609	-0,0546	-0,2461	-0,1186	0,1221	0,0031	-0,3668	-0,2511
	[HS; 0,075; 150]	-0,3764	-0,2313	-0,2169	-0,3477	-0,2620	-0,0581	-0,1531	-0,4830	-0,3792

Jelölés		[S (1); f_z (mm); v_c (m/min)]								
	Érték	[HS; 0,025; 150]	[HS; 0,033; 114,64]	[HS; 0,033; 185,36]	[HS; 0,05; 100]	[HS; 0,05; 150]	[HS; 0,05; 200]	[HS; 0,068; 114,64]	[HS; 0,068; 185,36]	[HS; 0,075; 150]
[S (1); f_z (mm); v_c (m/min)]	[C; 0,025; 150]	0,6288	0,5787	0,6077	0,6180	0,7142	0,6404	0,6226	0,6028	0,6552
	[C; 0,033; 114,64]	0,7587	0,7132	0,7361	0,7376	0,8140	0,7595	0,7409	0,7515	0,7740
	[C; 0,033; 185,36]	0,7538	0,7068	0,7379	0,7399	0,8275	0,7649	0,7442	0,7424	0,7768
	[C; 0,05; 100]	0,7554	0,7063	0,7372	0,7443	0,8141	0,7627	0,7485	0,7323	0,7747
	[C; 0,05; 150]	0,8602	0,8230	0,8485	0,8353	0,9297	0,8755	0,8403	0,8765	0,8780
	[C; 0,05; 200]	0,6005	0,5423	0,5800	0,5901	0,7035	0,6149	0,5968	0,5651	0,6318
	[C; 0,068; 114,64]	0,3174	0,2515	0,2920	0,3260	0,4287	0,3245	0,3316	0,2446	0,3576
	[C; 0,068; 185,36]	-0,1555	-0,2244	-0,1944	-0,1315	-0,0444	-0,1623	-0,1293	-0,2547	-0,1140
	[C; 0,075; 150,0]	0,7698	0,7246	0,7571	0,7539	0,8469	0,7853	0,7594	0,7594	0,7950
	[H; 0,025; 150,0]	0,3315	0,2551	0,3032	0,3397	0,4575	0,3417	0,3472	0,2422	0,3764
	[H; 0,033; 114,64]	0,1823	0,0863	0,1439	0,2008	0,3098	0,1801	0,2040	0,0609	0,2313
	[H; 0,033; 185,36]	0,1691	0,0747	0,1300	0,1843	0,2932	0,1662	0,1908	0,0546	0,2169
	[H; 0,05; 100]	0,3155	0,2533	0,2855	0,3229	0,4057	0,3164	0,3260	0,2461	0,3477
	[H; 0,05; 150]	0,2189	0,1367	0,1865	0,2349	0,3338	0,2171	0,2387	0,1186	0,2620
	[H; 0,05; 200]	0,0110	-0,0839	-0,0371	0,0310	0,1369	0,0018	0,0350	-0,1221	0,0581
	[H; 0,068; 114,64]	0,1074	0,0250	0,0699	0,1224	0,2295	0,1067	0,1290	-0,0031	0,1531
	[H; 0,068; 185,36]	0,4441	0,3635	0,4139	0,4439	0,5643	0,4505	0,4486	0,3668	0,4830
	[H; 0,075; 150]	0,3381	0,2620	0,3044	0,3462	0,4484	0,3383	0,3497	0,2511	0,3792
	[HS; 0,025; 150]		-0,0906	-0,0484	0,0204	0,1235	-0,0134	0,0237	-0,1280	0,0446
	[HS; 0,033; 114,64]	0,0906		0,0529	0,1100	0,2154	0,0905	0,1164	-0,0300	0,1405
	[HS; 0,033; 185,36]	0,0484	-0,0529		0,0681	0,1710	0,0332	0,0715	-0,0833	0,0928
	[HS; 0,05; 100]	-0,0204	-0,1100	-0,0681		0,0985	-0,0325	0,0029	-0,1453	0,0243
	[HS; 0,05; 150]	-0,1235	-0,2154	-0,1710	-0,0985		-0,1371	-0,0936	-0,2583	-0,0774
	[HS; 0,05; 200]	0,0134	-0,0905	-0,0332	0,0325	0,1371		0,0391	-0,1230	0,0588
	[HS; 0,068; 114,64]	-0,0237	-0,1164	-0,0715	-0,0029	0,0936	-0,0391		-0,1495	0,0196
	[HS; 0,068; 185,36]	0,1280	0,0300	0,0833	0,1453	0,2583	0,1230	0,1495		0,1748
	[HS; 0,075; 150]	-0,0446	-0,1405	-0,0928	-0,0243	0,0774	-0,0588	-0,0196	-0,1748	

Az alumínium lemeznél kapott Cliff-féle hatásnagyság vizsgálat eredményei a következők.

Jelölés		[S (1); f_z (mm); v_c (m/min)]								
	Érték	[C; 0,025; 150]	[C; 0,033; 114,64]	[C; 0,033; 185,36]	[C; 0,05; 100]	[C; 0,05; 150]	[C; 0,05; 200]	[C; 0,068; 114,64]	[C; 0,068; 185,36]	[C; 0,075; 150]
[S (1); f_z (mm); v_c (m/min)]	[C; 0,025; 150]		-0,7147	0,6761	-0,5066	0,5430	0,6893	0,6193	0,9403	0,8140
	[C; 0,033; 114,64]	0,7147		0,9005	0,1827	0,9204	0,9204	0,8436	0,9903	0,9745
	[C; 0,033; 185,36]	-0,6761	-0,9005		-0,8128	-0,3373	0,0113	0,1783	0,7789	0,1878
	[C; 0,05; 100]	0,5066	-0,1827	0,8128		0,8031	0,8365	0,7621	0,9644	0,9057
	[C; 0,05; 150]	-0,5430	-0,9204	0,3373	-0,8031		0,3273	0,3838	0,8541	0,5229
	[C; 0,05; 200]	-0,6893	-0,9204	-0,0113	-0,8365	-0,3273		0,1329	0,7248	0,1690
	[C; 0,068; 114,64]	-0,6193	-0,8436	-0,1783	-0,7621	-0,3838	-0,1329		0,6340	-0,0299
	[C; 0,068; 185,36]	-0,9403	-0,9903	-0,7789	-0,9644	-0,8541	-0,7248	-0,6340		-0,7086
	[C; 0,075; 150,0]	-0,8140	-0,9745	-0,1878	-0,9057	-0,5229	-0,1690	0,0299	0,7086	
	[H; 0,025; 150,0]	-0,9822	-0,9915	-0,9467	-0,9871	-0,9640	-0,9395	-0,9250	-0,7780	-0,9341
	[H; 0,033; 114,64]	-0,9966	-0,9996	-0,9863	-0,9979	-0,9907	-0,9811	-0,9753	-0,8550	-0,9813
	[H; 0,033; 185,36]	-0,9997	-1,0000	-0,9950	-0,9981	-0,9981	-0,9857	-0,9737	-0,8534	-0,9878
	[H; 0,05; 100]	-0,9986	-0,9998	-0,9889	-0,9987	-0,9952	-0,9860	-0,9809	-0,8799	-0,9845
	[H; 0,05; 150]	-0,8582	-0,9293	-0,7361	-0,9093	-0,7784	-0,7306	-0,7178	-0,5414	-0,7064
	[H; 0,05; 200]	-1,0000	-1,0000	-1,0000	-1,0000	-1,0000	-0,9995	-0,9996	-0,9509	-0,9999
	[H; 0,068; 114,64]	-0,9751	-0,9873	-0,9634	-0,9842	-0,9677	-0,9606	-0,9572	-0,8572	-0,9593
	[H; 0,068; 185,36]	-0,9905	-0,9988	-0,9547	-0,9946	-0,9744	-0,9499	-0,9354	-0,8004	-0,9423
	[H; 0,075; 150]	-0,9632	-0,9896	-0,9300	-0,9803	-0,9425	-0,9268	-0,9252	-0,7939	-0,9209
	[HS; 0,025; 150]	0,0370	-0,1369	0,1310	-0,0832	0,1236	0,1469	0,1525	0,3148	0,1724
	[HS; 0,033; 114,64]	-0,9847	-0,9978	-0,9515	-0,9929	-0,9651	-0,9466	-0,9374	-0,8283	-0,9409
	[HS; 0,033; 185,36]	-0,6162	-0,8078	-0,3975	-0,7516	-0,4600	-0,3790	-0,3648	-0,0718	-0,3363
	[HS; 0,05; 100]	-0,7513	-0,8840	-0,5475	-0,8447	-0,6208	-0,5431	-0,5264	-0,3181	-0,4980
	[HS; 0,05; 150]	-0,9720	-0,9815	-0,9481	-0,9768	-0,9604	-0,9436	-0,9340	-0,8256	-0,9383
	[HS; 0,05; 200]	-0,9484	-0,9874	-0,8887	-0,9765	-0,9054	-0,8852	-0,8828	-0,7795	-0,8762
	[HS; 0,068; 114,64]	-1,0000	-1,0000	-0,9997	-0,9998	-0,9999	-0,9982	-0,9970	-0,9210	-0,9990
	[HS; 0,068; 185,36]	-0,9583	-0,9849	-0,8822	-0,9746	-0,9183	-0,8690	-0,8405	-0,5999	-0,8566
	[HS; 0,075; 150]	-0,8893	-0,9571	-0,8443	-0,9366	-0,8512	-0,8400	-0,8443	-0,7296	-0,8325

Jelölés		[S (1); f_z (mm); v_c (m/min)]								
	Érték	[H; 0,025; 150]	[H; 0,033; 114,64]	[H; 0,033; 185,36]	[H; 0,05; 100]	[H; 0,05; 150]	[H; 0,05; 200]	[H; 0,068; 114,64]	[H; 0,068; 185,36]	[H; 0,075; 150]
[S (1); f_z (mm); v_c (m/min)]	[C; 0,025; 150]	0,9822	0,9966	0,9997	0,9986	0,8582	1,0000	0,9751	0,9905	0,9632
	[C; 0,033; 114,64]	0,9915	0,9996	1,0000	0,9998	0,9293	1,0000	0,9873	0,9988	0,9896
	[C; 0,033; 185,36]	0,9467	0,9863	0,9950	0,9889	0,7361	1,0000	0,9634	0,9547	0,9300
	[C; 0,05; 100]	0,9871	0,9979	0,9981	0,9987	0,9093	1,0000	0,9842	0,9946	0,9803
	[C; 0,05; 150]	0,9640	0,9907	0,9981	0,9952	0,7784	1,0000	0,9677	0,9744	0,9425
	[C; 0,05; 200]	0,9395	0,9811	0,9857	0,9860	0,7306	0,9995	0,9606	0,9499	0,9268
	[C; 0,068; 114,64]	0,9250	0,9753	0,9737	0,9809	0,7178	0,9996	0,9572	0,9354	0,9252
	[C; 0,068; 185,36]	0,7780	0,8550	0,8534	0,8799	0,5414	0,9509	0,8572	0,8004	0,7939
	[C; 0,075; 150,0]	0,9341	0,9813	0,9878	0,9845	0,7064	0,9999	0,9593	0,9423	0,9209
	[H; 0,025; 150,0]		0,0847	0,2057	-0,0052	-0,1426	0,3319	0,0664	0,0919	-0,0533
	[H; 0,033; 114,64]	-0,0847		0,1231	-0,0879	-0,2165	0,2444	-0,0168	0,0088	-0,1341
	[H; 0,033; 185,36]	-0,2057	-0,1231		-0,2193	-0,3190	0,0983	-0,1428	-0,1152	-0,2500
	[H; 0,05; 100]	0,0052	0,0879	0,2193		-0,1493	0,3707	0,0650	0,1001	-0,0577
	[H; 0,05; 150]	0,1426	0,2165	0,3190	0,1493		0,4246	0,1986	0,2174	0,0976
	[H; 0,05; 200]	-0,3319	-0,2444	-0,0983	-0,3707	-0,4246		-0,2667	-0,2246	-0,3866
	[H; 0,068; 114,64]	-0,0664	0,0168	0,1428	-0,0650	-0,1986	0,2667		0,0223	-0,1174
	[H; 0,068; 185,36]	-0,0919	-0,0088	0,1152	-0,1001	-0,2174	0,2246	-0,0223		-0,1422
	[H; 0,075; 150]	0,0533	0,1341	0,2500	0,0577	-0,0976	0,3866	0,1174	0,1422	
	[HS; 0,025; 150]	0,6932	0,7279	0,7657	0,7143	0,5867	0,8228	0,7200	0,7225	0,6733
	[HS; 0,033; 114,64]	-0,1578	-0,0725	0,0568	-0,1825	-0,2755	0,1639	-0,0942	-0,0585	-0,2114
	[HS; 0,033; 185,36]	0,5154	0,5732	0,6241	0,5541	0,3554	0,7081	0,5615	0,5563	0,4906
	[HS; 0,05; 100]	0,2657	0,3303	0,4150	0,2744	0,1239	0,5039	0,3154	0,3318	0,2265
	[HS; 0,05; 150]	-0,1617	-0,0799	0,0406	-0,1757	-0,2789	0,1438	-0,1004	-0,0741	-0,2099
	[HS; 0,05; 200]	-0,1440	-0,0651	0,0621	-0,1675	-0,2588	0,1649	-0,0854	-0,0489	-0,1966
	[HS; 0,068; 114,64]	-0,0712	0,0124	0,1528	-0,0845	-0,2141	0,2968	-0,0080	0,0301	-0,1383
	[HS; 0,068; 185,36]	0,1643	0,2436	0,3340	0,1950	0,0075	0,4456	0,2333	0,2361	0,1315
	[HS; 0,075; 150]	0,0456	0,1231	0,2379	0,0491	-0,0918	0,3610	0,1058	0,1289	-0,0101

Jelölés		[S (1); f_z (mm); v_c (m/min)]								
	Érték	[HS; 0,025; 150]	[HS; 0,033; 114,64]	[HS; 0,033; 185,36]	[HS; 0,05; 100]	[HS; 0,05; 150]	[HS; 0,05; 200]	[HS; 0,068; 114,64]	[HS; 0,068; 185,36]	[HS; 0,075; 150]
[S (1); f_z (mm); v_c (m/min)]	[C; 0,025; 150]	-0,0370	0,9847	0,6162	0,7513	0,9720	0,9484	1,0000	0,9583	0,8893
	[C; 0,033; 114,64]	0,1369	0,9978	0,8078	0,8840	0,9815	0,9874	1,0000	0,9849	0,9571
	[C; 0,033; 185,36]	-0,1310	0,9515	0,3975	0,5475	0,9481	0,8887	0,9997	0,8822	0,8443
	[C; 0,05; 100]	0,0832	0,9929	0,7516	0,8447	0,9768	0,9765	0,9998	0,9746	0,9366
	[C; 0,05; 150]	-0,1236	0,9651	0,4600	0,6208	0,9604	0,9054	0,9999	0,9183	0,8512
	[C; 0,05; 200]	-0,1469	0,9466	0,3790	0,5431	0,9436	0,8852	0,9982	0,8690	0,8400
	[C; 0,068; 114,64]	-0,1525	0,9374	0,3648	0,5264	0,9340	0,8828	0,9970	0,8405	0,8443
	[C; 0,068; 185,36]	-0,3148	0,8283	0,0718	0,3181	0,8256	0,7795	0,9210	0,5999	0,7296
	[C; 0,075; 150,0]	-0,1724	0,9409	0,3363	0,4980	0,9383	0,8762	0,9990	0,8566	0,8325
	[H; 0,025; 150,0]	-0,6932	0,1578	-0,5154	-0,2657	0,1617	0,1440	0,0712	-0,1643	-0,0456
	[H; 0,033; 114,64]	-0,7279	0,0725	-0,5732	-0,3303	0,0799	0,0651	-0,0124	-0,2436	-0,1231
	[H; 0,033; 185,36]	-0,7657	-0,0568	-0,6241	-0,4150	-0,0406	-0,0621	-0,1528	-0,3340	-0,2379
	[H; 0,05; 100]	-0,7143	0,1825	-0,5541	-0,2744	0,1757	0,1675	0,0845	-0,1950	-0,0491
	[H; 0,05; 150]	-0,5867	0,2755	-0,3554	-0,1239	0,2789	0,2588	0,2141	-0,0075	0,0918
	[H; 0,05; 200]	-0,8228	-0,1639	-0,7081	-0,5039	-0,1438	-0,1649	-0,2968	-0,4456	-0,3610
	[H; 0,068; 114,64]	-0,7200	0,0942	-0,5615	-0,3154	0,1004	0,0854	0,0080	-0,2333	-0,1058
	[H; 0,068; 185,36]	-0,7225	0,0585	-0,5563	-0,3318	0,0741	0,0489	-0,0301	-0,2361	-0,1289
	[H; 0,075; 150]	-0,6733	0,2114	-0,4906	-0,2265	0,2099	0,1966	0,1383	-0,1315	0,0101
	[HS; 0,025; 150]		0,7504	0,3711	0,5075	0,7410	0,7343	0,7441	0,6028	0,6574
	[HS; 0,033; 114,64]	-0,7504		-0,5974	-0,3764	0,0127	-0,0059	-0,1083	-0,2905	-0,1957
	[HS; 0,033; 185,36]	-0,3711	0,5974		0,2126	0,5926	0,5682	0,5998	0,3788	0,4586
	[HS; 0,05; 100]	-0,5075	0,3764	-0,2126		0,3772	0,3555	0,3303	0,1362	0,2160
	[HS; 0,05; 150]	-0,7410	-0,0127	-0,5926	-0,3772		-0,0187	-0,1046	-0,2944	-0,1985
	[HS; 0,05; 200]	-0,7343	0,0059	-0,5682	-0,3555	0,0187		-0,0960	-0,2733	-0,1825
	[HS; 0,068; 114,64]	-0,7441	0,1083	-0,5998	-0,3303	0,1046	0,0960		-0,2581	-0,1199
	[HS; 0,068; 185,36]	-0,6028	0,2905	-0,3788	-0,1362	0,2944	0,2733	0,2581		0,1234
	[HS; 0,075; 150]	-0,6574	0,1957	-0,4586	-0,2160	0,1985	0,1825	0,1199	-0,1234	