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Lampiran 1 Perhitungan Prediksi Jarak Lemparan *Richard and Moore*Tabel 1 Perhitungan Prediksi Jarak Lemparan *Flyrock Cratering*

No	Tanggal	Lokasi	Fd	ST	H	$\sqrt{m}$	$\left[\frac{\sqrt{m}}{ST}\right]^{2.6}$	K <sup>2</sup>	g	CRATERING	Error	SD	Loading Density
			(m)	(m)	(m)								
1	14/01/2023	PIT (E)	25	3.36	6.15	5.17	3.06	182.25	9.81	56.94	127.76	1020.22	26.72
2	16/01/2023	PIT (E)	24	3.58	7.18	5.17	2.60	182.25	9.81	48.28	101.19	589.75	26.72
3	18/01/2023	PIT (E)	23	3.87	6.22	5.17	2.12	182.25	9.81	39.43	71.45	270.04	26.72
4	20/01/2023	PIT (E)	22	4.21	8.10	5.17	1.71	182.25	9.81	31.68	44.00	93.69	26.72
5	23/01/2023	PIT (E)	25	3.43	6.88	5.17	2.90	182.25	9.81	53.97	115.87	839.18	26.72
6	24/01/2023	PIT (E)	23	3.73	7.68	5.17	2.34	182.25	9.81	43.40	88.68	416.05	26.72
7	26/01/2023	PIT (E)	19	4.94	6.94	5.17	1.13	182.25	9.81	20.90	10.02	3.62	26.72
8	27/01/2023	PIT (E)	19	4.95	7.83	5.17	1.12	182.25	9.81	20.79	9.44	3.22	26.72
9	30/01/2023	PIT (E)	31	3.19	6.69	5.17	3.51	182.25	9.81	65.17	110.23	1167.62	26.72
10	1/2/2023	PIT (E)	12	5.91	8.03	5.17	0.71	182.25	9.81	13.12	9.29	1.24	26.72
11	2/2/2023	PIT (E)	17	5.12	6.69	5.17	1.03	182.25	9.81	19.05	12.04	4.19	26.72
12	3/2/2023	PIT (E)	18	4.73	7.48	5.17	1.26	182.25	9.81	23.40	30.02	29.19	26.72
13	6/2/2023	PIT (E)	12	5.59	7.65	5.17	0.82	182.25	9.81	15.16	26.31	9.97	26.72
14	8/2/2023	PIT (E)	20	5.16	7.75	5.17	1.00	182.25	9.81	18.66	6.68	1.78	26.72
15	9/2/2023	PIT (E)	20	4.45	5.91	5.17	1.48	182.25	9.81	27.43	37.13	55.15	26.72
16	14/2/2023	PIT (E)	13	5.96	7.95	5.17	0.69	182.25	9.81	12.83	1.30	0.03	26.72
17	17/2/2023	PIT (E)	13	5.97	7.93	5.17	0.69	182.25	9.81	12.78	1.73	0.05	26.72
18	21/2/2023	PIT (E)	13	5.95	7.92	5.17	0.69	182.25	9.81	12.89	0.87	0.01	26.72
19	6/3/2023	PIT (E)	14	5.44	6.57	5.17	0.88	182.25	9.81	16.27	16.20	5.15	26.72
20	12/3/2023	PIT (E)	15	5.63	6.67	5.17	0.80	182.25	9.81	14.88	0.80	0.01	26.72
21	16/3/2023	PIT (E)	19	4.99	7.77	5.17	1.10	182.25	9.81	20.36	7.17	1.86	26.72
22	20/3/2023	PIT (E)	22	5.45	7.61	5.17	0.87	182.25	9.81	16.19	26.40	33.74	26.72
23	21/3/2023	PIT (E)	14	5.47	7.49	5.17	0.86	182.25	9.81	16.04	14.55	4.15	26.72
24	23/3/2023	PIT (E)	28	5.45	7.56	5.17	0.87	182.25	9.81	16.19	42.17	139.45	26.72
25	24/3/2023	PIT (E)	15	5.62	7.58	5.17	0.80	182.25	9.81	14.95	0.34	0.00	26.72

Tabel 2 Perhitungan Prediksi Jarak Lemparan *Flyrock Faceburst*

tanggal	lokasi	burden awal ke ff (m)	Fd	$\sqrt{m}$	$\left[\frac{\sqrt{m}}{B}\right]^{2.6}$	K <sup>2</sup>	G	FACEBURST	Error	SD	Loading Density
			(m)								
14/01/2023	PIT (E)	4	25	5.17	1.95	182.25	9.81	36.19	44.75	125.14	26.72
16/01/2023	PIT (E)	3.8	24	5.17	2.23	182.25	9.81	41.35	72.29	301.00	26.72
18/01/2023	PIT (E)	4	23	5.17	1.95	182.25	9.81	36.19	57.33	173.89	26.72
20/01/2023	PIT (E)	4	22	5.17	1.95	182.25	9.81	36.19	64.49	201.27	26.72
23/01/2023	PIT (E)	3.9	25	5.17	2.08	182.25	9.81	38.65	54.60	186.30	26.72
24/01/2023	PIT (E)	4	23	5.17	1.95	182.25	9.81	36.19	57.33	173.89	26.72
26/01/2023	PIT (E)	4.1	19	5.17	1.83	182.25	9.81	33.94	78.61	223.10	26.72
27/01/2023	PIT (E)	4.3	19	5.17	1.61	182.25	9.81	29.98	57.81	120.65	26.72
30/01/2023	PIT (E)	3.9	31	5.17	2.08	182.25	9.81	38.65	24.67	58.51	26.72
1/2/2023	PIT (E)	4.5	12	5.17	1.43	182.25	9.81	26.64	122.01	214.36	26.72
2/2/2023	PIT (E)	4.2	17	5.17	1.72	182.25	9.81	31.88	87.50	221.28	26.72
3/2/2023	PIT (E)	4.5	18	5.17	1.43	182.25	9.81	26.64	48.01	74.67	26.72
6/2/2023	PIT (E)	4.5	12	5.17	1.43	182.25	9.81	26.64	122.01	214.36	26.72
8/2/2023	PIT (E)	4	20	5.17	1.95	182.25	9.81	36.19	80.93	262.01	26.72
9/2/2023	PIT (E)	3.9	20	5.17	2.08	182.25	9.81	38.65	93.25	347.79	26.72
14/2/2023	PIT (E)	4.3	13	5.17	1.61	182.25	9.81	29.98	130.65	288.45	26.72
17/2/2023	PIT (E)	4.2	13	5.17	1.72	182.25	9.81	31.88	145.20	356.29	26.72
21/2/2023	PIT (E)	4.5	13	5.17	1.43	182.25	9.81	26.64	104.93	186.08	26.72
6/3/2023	PIT (E)	4.5	14	5.17	1.43	182.25	9.81	26.64	90.29	159.80	26.72
12/3/2023	PIT (E)	4.4	15	5.17	1.52	182.25	9.81	28.24	88.29	175.41	26.72
16/3/2023	PIT (E)	4.2	19	5.17	1.72	182.25	9.81	31.88	67.77	165.78	26.72
20/3/2023	PIT (E)	4	22	5.17	1.95	182.25	9.81	36.19	64.49	201.27	26.72
21/3/2023	PIT (E)	4.4	14	5.17	1.52	182.25	9.81	28.24	101.74	202.90	26.72
23/3/2023	PIT (E)	4.1	28	5.17	1.83	182.25	9.81	33.94	21.20	35.24	26.72
24/3/2023	PIT (E)	4	15	5.17	1.95	182.25	9.81	36.19	141.25	448.88	26.72

Lampiran 2 Parameter Lemparan *Flyrock* Rumus *Ebrahim Ghasemi*Tabel 3 Parameter lemparan metode *Ebrahim Ghasemi*

tanggal	lokasi	FD	B	S	St	H	D	Q	P
		(m)	(m)	(m)	(m)	(m)	(m)	(kg)	(kg/m <sup>3</sup> )
14/01/2023	PIT (E)	25	8.78	9.84	3.36	6.15	0.200025	65.35	0.12000
16/01/2023	PIT (E)	24	9.39	10.28	3.58	7.18	0.200025	53.68	0.08000
18/01/2023	PIT (E)	23	8.84	9.90	3.87	6.22	0.200025	59.62	0.11000
20/01/2023	PIT (E)	22	8.72	9.72	4.21	8.10	0.200025	68.35	0.10000
23/01/2023	PIT (E)	25	8.83	9.74	3.43	6.88	0.200025	56.01	0.09000
24/01/2023	PIT (E)	23	8.80	9.87	3.73	7.68	0.200025	58.86	0.09000
26/01/2023	PIT (E)	19	8.58	9.64	4.94	6.94	0.200025	72.16	0.12000
27/01/2023	PIT (E)	19	8.93	9.96	4.95	7.83	0.200025	86.92	0.12000
30/01/2023	PIT (E)	31	9.01	9.95	3.19	6.69	0.200025	54.57	0.09000
1/2/2023	PIT (E)	12	8.96	9.91	5.91	8.03	0.200025	59.97	0.08000
2/2/2023	PIT (E)	17	7.94	10.93	5.12	6.69	0.200025	34.66	0.05000
3/2/2023	PIT (E)	18	8.02	10.96	4.73	7.48	0.200025	34.08	0.05000
6/2/2023	PIT (E)	12	8.88	10.05	5.59	7.65	0.200025	53.97	0.07000
8/2/2023	PIT (E)	20	7.95	10.94	5.16	7.75	0.200025	34.09	0.05000
9/2/2023	PIT (E)	20	7.99	10.92	4.45	5.91	0.200025	26.94	0.05000
14/2/2023	PIT (E)	13	8.89	9.98	5.96	7.95	0.200025	55.19	0.07000
17/2/2023	PIT (E)	13	8.91	9.96	5.97	7.93	0.200025	54.44	0.08000
21/2/2023	PIT (E)	13	9.06	9.94	5.95	7.92	0.200025	54.88	0.08000
6/3/2023	PIT (E)	14	7.94	10.91	5.44	6.57	0.200025	29.98	0.05000
12/3/2023	PIT (E)	15	7.95	10.96	5.63	6.67	0.200025	31.63	0.05000
16/3/2023	PIT (E)	19	7.93	10.89	4.99	7.77	0.200025	33.74	0.05000
20/3/2023	PIT (E)	22	8.14	10.81	5.45	7.61	0.200025	43.85	0.06000
21/3/2023	PIT (E)	14	7.91	11.04	5.47	7.49	0.200025	43.42	0.07000
23/3/2023	PIT (E)	28	7.93	10.93	5.45	7.56	0.200025	44.63	0.07000
24/3/2023	PIT (E)	15	7.72	10.89	5.62	7.58	0.200025	43.93	0.07000

Tabel 4 Parameter Dimensional Untuk *Flyrock*

$(P/Q)$ (m <sup>-3</sup> )	$(P/Q)^{1/3}$ (m <sup>-1</sup> )	Y ( $(P/Q)^{1/3}$ )	X1( $(P/Q)^{1/3}$ )	X2( $(P/Q)^{1/3}$ )	X3( $(P/Q)^{1/3}$ )	X4( $(P/Q)^{1/3}$ )	X5( $(P/Q)^{1/3}$ )
0,0019	0,1235	2,0990	1,0838	1,2148	0,4146	0,7596	0,0247
0,0014	0,1130	1,9212	1,0607	1,1614	0,4049	0,8117	0,0226
0,0018	0,1225	2,8174	1,0825	1,2131	0,4745	0,7615	0,0245
0,0015	0,1133	2,9469	0,9888	1,1016	0,4771	0,9181	0,0227
0,0017	0,1191	1,9063	1,0517	1,1600	0,4087	0,8197	0,0238
0,0015	0,1145	3,0910	1,0069	1,1301	0,4269	0,8788	0,0229
0,0017	0,1203	2,6466	1,0327	1,1602	0,5945	0,8347	0,0241
0,0014	0,1128	0,9026	1,0078	1,1233	0,5588	0,8834	0,0226
0,0017	0,1185	3,6748	1,0686	1,1793	0,3776	0,7935	0,0237
0,0014	0,1120	1,2316	1,0026	1,1090	0,6617	0,8993	0,0224
0,0017	0,1199	0,7192	0,9514	1,3098	0,6139	0,8025	0,0240

$(P/Q)$ ( $m^{-3}$ )	$(P/Q)^{1/3}$ ( $m^{-1}$ )	Y ( $(P/Q)^{1/3}$ )	$X1((P/Q)^{1/3})$	$X2((P/Q)^{1/3})$	$X3((P/Q)^{1/3})$	$X4((P/Q)^{1/3})$	$X5((P/Q)^{1/3})$
0,0015	0,1150	2,8746	0,9220	1,2603	0,5439	0,8606	0,0230
0,0015	0,1136	1,3626	1,0083	1,1412	0,6347	0,8690	0,0227
0,0015	0,1141	3,1937	0,9068	1,2476	0,5885	0,8840	0,0228
0,0019	0,1247	1,7455	0,9966	1,3618	0,5548	0,7368	0,0249
0,0014	0,1123	1,6849	0,9990	1,1214	0,6695	0,8926	0,0225
0,0014	0,1124	1,0116	1,0018	1,1195	0,6714	0,8917	0,0225
0,0014	0,1119	2,4621	1,0137	1,1124	0,6664	0,8868	0,0224
0,0018	0,1206	1,6888	0,9583	1,3162	0,6561	0,7928	0,0241
0,0017	0,1198	1,7970	0,9527	1,3131	0,6739	0,7993	0,0240
0,0015	0,1142	1,8274	0,9062	1,2441	0,5698	0,8870	0,0228
0,0015	0,1143	2,5152	0,9309	1,2354	0,6235	0,8696	0,0229
0,0015	0,1152	1,0371	0,9115	1,2718	0,6299	0,8627	0,0230
0,0015	0,1151	3,2237	0,9132	1,2578	0,6277	0,8706	0,0230
0,0016	0,1162	2,4410	0,8971	1,2661	0,6535	0,8805	0,0233

Tabel 5 Hasil Parameter Dimensional untuk *Flyrock*

Y	X1	X2	X3	X4	X5
0,741473	0,080442	0,194584	-0,88038	-0,27503	-3,70105
0,652944	0,058919	0,149653	-0,90411	-0,20857	-3,78958
1,035819	0,079234	0,193207	-0,74556	-0,27244	-3,70899
1,080761	-0,01128	0,096752	-0,73999	-0,08547	-3,78665
0,645152	0,050435	0,148383	-0,89488	-0,19882	-3,73675
1,128511	0,006884	0,122318	-0,8513	-0,1292	-3,77664
0,973293	0,03215	0,148586	-0,51998	-0,18074	-3,72706
-0,10247	0,00777	0,116253	-0,58193	-0,12402	-3,79122
1,301489	0,066313	0,164931	-0,97382	-0,23124	-3,74181
0,208313	0,00263	0,103457	-0,41294	-0,10609	-3,7989

Y	X1	X2	X3	X4	X5
-0,32957	-0,04987	0,269891	-0,48789	-0,22002	-3,73064
1,055909	-0,08125	0,231341	-0,60898	-0,15009	-3,77228
0,309401	0,008296	0,132067	-0,45453	-0,14036	-3,78482
1,161171	-0,09786	0,221203	-0,5301	-0,12334	-3,78035
0,55704	-0,00341	0,308782	-0,58911	-0,30537	-3,69133
0,521726	-0,00102	0,114593	-0,40125	-0,11357	-3,79564
0,011492	0,001815	0,112844	-0,39843	-0,11466	-3,79505
0,901031	0,01359	0,106495	-0,40586	-0,12008	-3,79932
0,524022	-0,04256	0,274746	-0,42146	-0,23218	-3,72435
0,586108	-0,04842	0,272411	-0,39472	-0,22399	-3,73126
0,602907	-0,09849	0,218452	-0,56253	-0,11996	-3,77899
0,922351	-0,07166	0,21141	-0,47234	-0,13975	-3,778
0,0364	-0,0927	0,240398	-0,46216	-0,1477	-3,77014
1,170542	-0,09078	0,229391	-0,46563	-0,13861	-3,77098
0,892389	-0,10864	0,235923	-0,42536	-0,12728	-3,76145
16,58821	-0,38947	4,618072	-14,5852	-4,2286	-94,0232

YX1	YX2	YX3	YX4	YX5
0,059646	0,144279	-0,65277	-0,20392	-2,74423
0,038471	0,097715	-0,59033	-0,13619	-2,47438
0,082072	0,200128	-0,77227	-0,2822	-3,84184
-0,01219	0,104565	-0,79975	-0,09237	-4,09246
0,032538	0,09573	-0,57733	-0,12827	-2,41077
0,007769	0,138038	-0,9607	-0,14581	-4,26198
0,031292	0,144618	-0,50609	-0,17591	-3,62752
-0,0008	-0,01191	0,059629	0,012708	0,388482

YX1	YX2	YX3	YX4	YX5
0,086305	0,214656	-1,26742	-0,30096	-4,86993
0,000548	0,021551	-0,08602	-0,0221	-0,79136
0,016436	-0,08895	0,160794	0,072511	1,229496
-0,0858	0,244275	-0,64302	-0,15848	-3,98318
0,002567	0,040862	-0,14063	-0,04343	-1,17103
-0,11363	0,256854	-0,61553	-0,14322	-4,38963
-0,0019	0,172004	-0,32816	-0,1701	-2,05622
-0,00053	0,059786	-0,20934	-0,05925	-1,98028
2,09E-05	0,001297	-0,00458	-0,00132	-0,04361
0,012245	0,095955	-0,36569	-0,1082	-3,42331
-0,0223	0,143973	-0,22085	-0,12167	-1,95164
-0,02838	0,159662	-0,23135	-0,13128	-2,18692
-0,05938	0,131706	-0,33915	-0,07233	-2,27838
-0,06609	0,194994	-0,43567	-0,1289	-3,48465
-0,00337	0,00875	-0,01682	-0,00538	-0,13723
-0,10626	0,268512	-0,54504	-0,16225	-4,41409
-0,09695	0,210535	-0,37958	-0,11358	-3,35667
-0,22769	3,049586	-10,4677	-2,8219	-62,3533

X1X1	X1X2	X1X3	X1X4	X1X5
0,0064709	0,015653	-0,88038	-0,02212	-0,29772
0,0034715	0,008817	-0,90411	-0,01229	-0,22328
0,0062781	0,015309	-0,74556	-0,02159	-0,29388
0,0001272	-0,00109	-0,73999	0,000964	0,042713
0,0025437	0,007484	-0,89488	-0,01003	-0,18846
4,739E-05	0,000842	-0,8513	-0,00089	-0,026
0,0010336	0,004777	-0,51998	-0,00581	-0,11983
6,037E-05	0,000903	-0,58193	-0,00096	-0,02946

X1X1	X1X2	X1X3	X1X4	X1X5
0,0043974	0,010937	-0,97382	-0,01533	-0,24813
6,914E-06	0,000272	-0,41294	-0,00028	-0,00999
0,0024872	-0,01346	-0,48789	0,010973	0,186053
0,0066024	-0,0188	-0,60898	0,012195	0,306517
6,883E-05	0,001096	-0,45453	-0,00116	-0,0314
0,0095769	-0,02165	-0,5301	0,01207	0,369952
1,163E-05	-0,00105	-0,58911	0,001041	0,012587
1,044E-06	-0,00012	-0,40125	0,000116	0,003879
3,296E-06	0,000205	-0,39843	-0,00021	-0,00689
0,0001847	0,001447	-0,40586	-0,00163	-0,05163
0,0018116	-0,01169	-0,42146	0,009882	0,158518
0,0023446	-0,01319	-0,39472	0,010846	0,180672
0,0097	-0,02151	-0,56253	0,011815	0,372187
0,0051345	-0,01515	-0,47234	0,010014	0,270716
0,0085927	-0,02228	-0,46216	0,013691	0,349481
0,0082411	-0,02082	-0,46563	0,012583	0,34233
0,0118033	-0,02563	-0,42536	0,013828	0,408655
0,0910009	-0,11871	-14,5852	0,027711	1,477594

X2X2	X2X3	X2X4	X2X5	X3X3	X3X4	X3X5
0,037863	-0,17131	-0,05352	-0,72017	0,775061	0,242126	3,258317
0,022396	-0,1353	-0,03121	-0,56712	0,817413	0,188572	3,426195
0,037329	-0,14405	-0,05264	-0,7166	0,55586	0,203122	2,765274
0,009361	-0,07159	-0,00827	-0,36636	0,54758	0,063248	2,802069
0,022018	-0,13278	-0,0295	-0,55447	0,800804	0,177918	3,34393
0,014962	-0,10413	-0,0158	-0,46195	0,724713	0,10999	3,215057
0,022078	-0,07726	-0,02685	-0,55379	0,270379	0,093979	1,937997
0,013515	-0,06765	-0,01442	-0,44074	0,338641	0,072172	2,206222
0,027202	-0,16061	-0,03814	-0,61714	0,948328	0,22519	3,643856
0,010703	-0,04272	-0,01098	-0,39302	0,170517	0,043807	1,568703
0,072841	-0,13168	-0,05938	-1,00686	0,23804	0,107346	1,820154



X2X2	X2X3	X2X4	X2X5	X3X3	X3X4	X3X5
0,053519	-0,14088	-0,03472	-0,87268	0,370853	0,091399	2,297233
0,017442	-0,06003	-0,01854	-0,49985	0,206594	0,063799	1,720298
0,048931	-0,11726	-0,02728	-0,83622	0,281003	0,065383	2,003951
0,095346	-0,18191	-0,09429	-1,13982	0,347055	0,179899	2,174613
0,013132	-0,04598	-0,01301	-0,43495	0,161004	0,045571	1,523012
0,012734	-0,04496	-0,01294	-0,42825	0,158745	0,045684	1,512052
0,011341	-0,04322	-0,01279	-0,40461	0,16472	0,048737	1,541981
0,075485	-0,11579	-0,06379	-1,02325	0,177629	0,097856	1,569667
0,074208	-0,10753	-0,06102	-1,01644	0,155805	0,088414	1,472807
0,047721	-0,12289	-0,02621	-0,82553	0,316442	0,067483	2,125806
0,044694	-0,09986	-0,02955	-0,79871	0,223107	0,066012	1,784511
0,057791	-0,1111	-0,03551	-0,90633	0,213588	0,068261	1,742391
0,05262	-0,10681	-0,0318	-0,86503	0,216811	0,064541	1,755879
0,05566	-0,10035	-0,03003	-0,88741	0,180929	0,05414	1,599958

X4X4	X4X5	X5X5
0,075639	1,017886	13,6978
0,043502	0,790402	14,36093
0,074224	1,010483	13,7566
0,007305	0,323652	14,33871
0,039529	0,742934	13,9633
0,016693	0,487952	14,263
0,032666	0,673615	13,891
0,015382	0,470198	14,37337
0,053474	0,86527	14,00115
0,011254	0,403012	14,43161
0,048408	0,820812	13,91767
0,022526	0,566166	14,23009

X4X4	X4X5	X5X5
0,019702	0,531252	14,32485
0,015213	0,466272	14,29102
0,093252	1,127229	13,62592
0,012898	0,431075	14,40686
0,013147	0,435138	14,40237
0,01442	0,456241	14,43487
0,053909	0,864732	13,87077
0,050171	0,835763	13,92227
0,014391	0,453341	14,2808
0,019531	0,527992	14,27332
0,021816	0,556854	14,21394
0,019213	0,522699	14,22026
0,0162	0,478758	14,14848
<b>0,804468</b>	<b>15,85973</b>	<b>353,6409</b>

Perhitungan nilai X dan Y dimasukkan kedalam rumus determinan menggunakan rumus determinan :

$$A_0 = \begin{bmatrix} \sum(Y) & \sum X_1 & \sum X_2 & \sum X_3 \\ \sum(X_1.Y) & \sum(X_1.X_1) & \sum(X_1.X_2) & \sum(X_1.X_3) \\ \sum(X_2.Y) & \sum(X_2.X_1) & \sum(X_2.X_2) & \sum(X_2.X_3) \\ \sum(X_3.Y) & \sum(X_3.X_1) & \sum(X_3.X_2) & \sum(X_3.X_3) \end{bmatrix}$$

$$A_1 = \begin{bmatrix} N & \sum(Y) & \sum X_2 & \sum X_3 \\ \sum X_1 & \sum(X_1.Y) & \sum(X_1.X_2) & \sum(X_1.X_3) \\ \sum X_2 & \sum(X_2.Y) & \sum(X_2.X_2) & \sum(X_2.X_3) \\ \sum X_3 & \sum(X_3.Y) & \sum(X_3.X_2) & \sum(X_3.X_3) \end{bmatrix}$$

$$A_2 = \begin{bmatrix} N & \sum X_1 & \sum(Y) & \sum X_3 \\ \sum X_1 & \sum(X_1.X_1) & \sum(X_1.Y) & \sum(X_1.X_3) \\ \sum X_2 & \sum(X_2.X_1) & \sum(X_2.Y) & \sum(X_2.X_3) \\ \sum X_3 & \sum(X_3.X_1) & \sum(X_3.Y) & \sum(X_3.X_3) \end{bmatrix}$$

$$A_3 = \begin{bmatrix} N & \sum X_1 & \sum X_2 & \sum(Y) \\ \sum X_1 & \sum(X_1.X_1) & \sum(X_1.X_2) & \sum(X_1.Y) \\ \sum X_2 & \sum(X_2.X_1) & \sum(X_2.X_2) & \sum(X_2.Y) \\ \sum X_3 & \sum(X_3.X_1) & \sum(X_3.X_2) & \sum(X_3.Y) \end{bmatrix}$$

Keterangan :

$\Sigma Y$  : Jumlah data Y

$\Sigma X$  : Jumlah data X

$\Sigma X.Y$  : Jumlah data dari XY

$\Sigma X.X$  : Jumlah data dari XX

$\Sigma Y.Y$  : Jumlah data dari YY

Nilai a, b, c, d, e dan f didapat dengan rumus:

$$a = \frac{Det(A0)}{Det(A)}$$

$$b1 = \frac{Det(A1)}{Det(A)}$$

$$b2 = \frac{Det(A2)}{Det(A)}$$

$$b3 = \frac{Det(A3)}{Det(A)}$$

		15	-0,38947	4,618072	-14,5852	-4,2286	-94,0232
		-0,38947	0,091001	-0,11871	-14,5852	0,027711	1,477594
Det A		4,618072	-0,11871	0,950891	-2,63766	-0,83218	-17,3373
		-14,5852	-14,5852	-2,63766	9,361621	2,574648	54,81193
		-4,2286	0,027711	-0,83218	2,574648	0,804468	15,85973
		-94,0232	1,477594	-17,3373	54,81193	15,85973	353,6409

		16,58821	-0,38947	4,618072	-14,5852	-4,2286	-94,0232
		-0,22769	0,091001	-0,11871	-14,5852	0,027711	1,477594
Det A0		3,049586	-0,11871	0,950891	-2,63766	-0,83218	-17,3373
		-10,4677	-14,5852	-2,63766	9,361621	2,574648	54,81193
		-2,8219	0,027711	-0,83218	2,574648	0,804468	15,85973
		-62,3533	1,477594	-17,3373	54,81193	15,85973	353,6409

		15	16,58821	4,618072	-14,5852	-4,2286	-94,0232
		-0,38947	-0,22769	-0,11871	-14,5852	0,027711	1,477594
Det A1		4,618072	3,049586	0,950891	-2,63766	-0,83218	-17,3373
		-14,5852	-10,4677	-2,63766	9,361621	2,574648	54,81193
		-4,2286	-2,8219	-0,83218	2,574648	0,804468	15,85973
		-94,0232	-62,3533	-17,3373	54,81193	15,85973	353,6409

Det A4	15	-0,38947	4,618072	-14,5852	16,58821	-94,0232
	-0,38947	0,091001	-0,11871	-14,5852	-0,22769	1,477594
	4,618072	-0,11871	0,950891	-2,63766	3,049586	-17,3373
	-14,5852	-14,5852	-2,63766	9,361621	-10,4677	54,81193
	-4,2286	0,027711	-0,83218	2,574648	-2,8219	15,85973
	-94,0232	1,477594	-17,3373	54,81193	-62,3533	353,6409
Det A2	15	-0,38947	16,58821	-14,5852	-4,2286	-94,02324
	-0,38947	0,091001	-0,22769	-14,5852	0,027711	1,4775939
	4,618072	-0,11871	3,049586	-2,63766	-0,83218	-17,33732
	-14,5852	-14,5852	-10,4677	9,361621	2,574648	54,811931
	-4,2286	0,027711	-2,8219	2,574648	0,804468	15,859727
	-94,0232	1,477594	-62,3533	54,81193	15,85973	353,64095
Det A3	15	-0,38947	4,618072	16,58821	-4,2286	-94,02324
	-0,38947	0,091001	-0,11871	-0,22769	0,027711	1,4775939
	4,618072	-0,11871	0,950891	3,049586	-0,83218	-17,33732
	-14,5852	-14,5852	-2,63766	-10,4677	2,574648	54,811931
	-4,2286	0,027711	-0,83218	-2,8219	0,804468	15,859727
	-94,0232	1,477594	-17,3373	-62,3533	15,85973	353,64095
Det A5	15	-0,38947	4,618072	-14,5852	-4,2286	16,58821
	-0,38947	0,091001	-0,11871	-14,5852	0,027711	-0,22769
	4,618072	-0,11871	0,950891	-2,63766	-0,83218	3,049586
	-14,5852	-14,5852	-2,63766	9,361621	2,574648	-10,4677
	-4,2286	0,027711	-0,83218	2,574648	0,804468	-2,8219
	-94,0232	1,477594	-17,3373	54,81193	15,85973	-62,3533

Lampiran 3 Tabel Perhitungan Standar Deviasi Teori *Richard* dan *Moore* dan *Ebrahim Ghasemi*

Tabel 6 Perhitungan Standar Deviasi .

No	Lokasi	Standar Deviasi		
		Richard dan Moore		Ebrahim Ghasemi
		<i>Face burst</i>	<i>Cratering</i>	
14/01/2023	Pit E	125.14	1020.22	27.47
16/01/2023	Pit E	301.00	589.75	25.42
18/01/2023	Pit E	173.89	270.04	12.35
20/01/2023	Pit E	201.27	93.69	36.99
23/01/2023	Pit E	186.30	839.18	42.44
24/01/2023	Pit E	173.89	416.05	39.18
26/01/2023	Pit E	223.10	3.62	1.60
27/01/2023	Pit E	120.65	3.22	2.61
30/01/2023	Pit E	58.51	1167.62	141.20
1/2/2023	Pit E	214.36	1.24	26.15
2/2/2023	Pit E	221.28	4.19	20.31
3/2/2023	Pit E	74.67	29.19	0.42
6/2/2023	Pit E	214.36	9.97	43.51
8/2/2023	Pit E	262.01	1.78	4.74
9/2/2023	Pit E	347.79	55.15	0.52
14/2/2023	Pit E	288.45	0.03	23.91
17/2/2023	Pit E	356.29	0.05	12.18
21/2/2023	Pit E	186.08	0.01	12.88
6/3/2023	Pit E	159.80	5.15	38.64
12/3/2023	Pit E	175.41	0.01	30.35
16/3/2023	Pit E	165.78	1.86	1.91
20/3/2023	Pit E	201.27	33.74	9.98
21/3/2023	Pit E	202.90	4.15	13.58
23/3/2023	Pit E	35.24	139.45	106.89
24/3/2023	Pit E	448.88	0.00	5.65
		15.00	12.00	5.00

Lampiran 4 Tabel Perhitungan Persen Error Teori *Richard* dan *Moore* dan *Ebrahim Ghasemi*

Tabel 7 Perhitungan Persen Error.

No	Lokasi	% Error		
		Richard dan Moore		Ebrahim Ghasemi
		<i>Face burst</i>	<i>Cratering</i>	
14/01/2023	PIT E	44.75	127.76	21.0
16/01/2023	PIT E	72.29	101.19	21.0
18/01/2023	PIT E	57.33	71.45	15.3
20/01/2023	PIT E	64.49	44.00	27.6
23/01/2023	PIT E	54.60	115.87	26.1
24/01/2023	PIT E	57.33	88.68	27.2
26/01/2023	PIT E	78.61	10.02	6.6
27/01/2023	PIT E	57.81	9.44	8.5
30/01/2023	PIT E	24.67	110.23	38.3
1/2/2023	PIT E	122.01	9.29	42.6
2/2/2023	PIT E	87.50	12.04	26.5
3/2/2023	PIT E	48.01	30.02	3.6
6/2/2023	PIT E	122.01	26.31	55.0
8/2/2023	PIT E	80.93	6.68	10.9
9/2/2023	PIT E	93.25	37.13	3.6
14/2/2023	PIT E	130.65	1.30	37.6
17/2/2023	PIT E	145.20	1.73	26.8
21/2/2023	PIT E	104.93	0.87	27.6
6/3/2023	PIT E	90.29	16.20	44.4
12/3/2023	PIT E	88.29	0.80	36.7
16/3/2023	PIT E	67.77	7.17	7.3
20/3/2023	PIT E	64.49	26.40	14.4
21/3/2023	PIT E	101.74	14.55	26.3
23/3/2023	PIT E	21.20	42.17	36.9
24/3/2023	PIT E	141.25	0.34	15.8
		80.86	36.47	24.31