

RESULTS

Three sizes of cement block were tried, these being $\frac{1}{2}$ " , $\frac{3}{4}$ " and 1" diameter. It was found that the 1" diameter blocks gave the smoothest movement and so these were used for all the tests.

When the trough was tilted, the block started to move downward at an angle of about 14 degrees, giving a value of 0.25 for the coefficient of friction between the block and the trough surface.

The velocities of the block travelling along the trough at five different angles of inclination are tabulated in Tables I to V, and the corresponding theoretical values in Tables VI to X. These values are plotted against the trough frequencies for comparison, shown in Figs. 6 to 10. It should be noted that the velocities when travelling in a series of jumps are not shown because the direction of the block movement could not be controlled during tests. The crank speeds where the block starts to leave the trough surface are shown in Table XI.

For the sand tests, the specific gravity of sand is found to be 1.3. Table XII shows the values of sand thickness, rate of discharge and mean velocity at six different hopper openings and four frequencies of trough vibration, and the relationship between the mean velocity and the rate of discharge is illustrated in Fig. 11.

TABLE I

Mean Velocities of Cement Block

at Angle of Inclination of 10 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	-	0.064	0.099	0.167	0.266	0.356
0.050	-	-	-	-	0.066	0.150	0.251	0.369	0.548	0.717	0.862	0.932
0.075	-	-	-	0.101	0.197	0.402	0.644	0.898	1.243	1.508	1.751	1.859
0.100	-	-	-	0.231	0.463	0.793	1.113	1.470	1.875	2.402	2.670	3.007
0.125	-	-	0.171	0.364	0.738	1.154	1.613	1.980	2.643	3.191	3.301	3.647
0.150	-	-	0.240	0.570	0.924	1.243	1.576	2.180	2.765	3.256	3.692	4.293

TABLE II

Mean Velocities of Cement Block
at Angle of Inclination of 20 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	0.092	0.196	0.267	0.314	0.368	0.395
0.050	-	-	-	-	0.156	0.306	0.498	0.655	0.730	0.928	1.185	1.577
0.075	-	-	-	0.185	0.354	0.742	1.105	1.359	1.736	1.998	2.327	2.694
0.100	-	-	-	0.361	0.630	0.972	1.253	1.595	1.805	2.222	2.805	3.690
0.125	-	-	0.158	0.600	1.033	1.536	2.237	2.820	3.610	4.145	5.618	8.000
0.150	-	-	0.341	0.878	1.554	2.138	2.839	3.507	3.650	4.662	9.428	10.909

TABLE III

Mean Velocities of Cement Block

at Angle of Inclination of 30 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	0.172	0.307	0.425	0.608	0.745	0.944
0.050	-	-	-	-	-	0.429	0.732	0.948	1.223	1.357	1.548	1.675
0.075	-	-	-	0.233	0.588	1.011	1.423	1.684	1.987	2.510	3.275	4.038
0.100	-	-	0.107	0.525	1.076	1.549	1.986	2.270	3.419	4.098	5.762	7.218
0.125	-	-	0.344	0.880	1.767	2.562	3.051	3.456	4.398	6.870	8.054	9.207
0.150	-	-	0.472	1.415	2.217	2.905	3.487	4.401	7.965	9.266	9.690	10.242

TABLE IV

Mean Velocities of Cement Block
at Angle of Inclination of 40 Degrees, in in./sec.

Amplitude a in..	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	0.200	0.383	0.639	0.878	1.136	1.405
0.050	-	-	-	-	-	0.388	0.830	1.282	1.748	2.276	2.753	3.154
0.075	-	-	-	-	0.440	1.283	1.894	2.483	3.103	3.564	4.306	4.901
0.100	-	-	-	0.465	1.199	2.133	2.910	3.945	4.414	5.176	5.737	6.630
0.125	-	-	-	0.677	1.815	3.147	4.188	4.506	5.746	6.207	6.936	8.027
0.150	-	-	-	1.068	2.437	3.846	5.252	5.901	6.799	7.273	8.081	9.430

TABLE VMean Velocities of Cement Blockat Angle of Inclination of 50 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	-	0.366	0.563	0.846	1.204	1.502
0.050	-	-	-	-	-	0.265	0.805	1.321	1.856	2.400	3.130	3.249
0.075	-	-	-	-	0.365	1.121	1.966	2.759	3.030	3.493	4.027	4.615
0.100	-	-	-	-	0.814	1.951	3.179	4.121	4.423	5.106	5.530	5.921
0.125	-	-	-	0.703	1.444	3.117	4.278	4.775	5.455	6.102	6.642	7.207
0.150	-	-	-	1.048	2.374	4.377	4.979	5.526	6.294	6.963	8.072	8.664

TABLE VI

Theoretical Velocities of Cement Block
at Angle of Inclination of 10 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	0.033	0.058	0.078	0.095	0.111	0.125
0.050	-	-	-	-	0.048	0.097	0.133	0.163	0.191	0.217	0.242	0.267
0.075	-	-	-	0.054	0.124	0.176	0.220	0.260	0.298	0.333	0.370	0.405
0.100	-	-	-	0.166	0.190	0.251	0.304	0.354	0.402	0.449	0.496	0.542
0.125	-	-	0.055	0.172	0.254	0.323	0.386	0.447	0.506	0.564	0.622	0.679
0.150	-	-	0.083	0.225	0.315	0.394	0.467	0.539	0.609	0.678	0.747	0.791*

* Velocity of the block at the crank speed where the block starts to leave the trough surface. Also see Table XI.

TABLE VII

Theoretical Velocities of Cement Block
at Angle of Inclination of 20 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	0.058	0.108	0.145	0.184	0.216	0.245
0.050	-	-	-	-	0.110	0.213	0.256	0.318	0.374	0.426	0.476	0.525
0.075	-	-	-	0.092	0.236	0.342	0.429	0.510	0.585	0.657	0.727	0.778*
0.100	-	-	-	0.216	0.369	0.489	0.596	0.695	0.791	0.884	0.898*	...
0.125	-	-	0.089	0.329	0.494	0.632	0.758	0.878	0.995	1.003*	...	...
0.150	-	-	0.238	0.435	0.616	0.772	0.919	1.060	1.099*	...	...	...

* Velocity of the block at the crank speed where the block starts to leave the trough surface. Also see Table XI.

TABLE VIII

Theoretical Velocities of Cement Block
at Angle of Inclination of 30 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	0.060	0.141	0.205	0.260	0.307	0.351
0.050	-	-	-	-	0.094	0.245	0.360	0.455	0.539	0.617	0.691	0.754*
0.075	-	-	-	0.093	0.320	0.483	0.617	0.737	0.849	0.923*	...	...
0.100	-	-	-	0.281	0.519	0.702	0.862	1.010	1.066*	...	...	...
0.125	-	-	-	0.452	0.706	0.914	1.101	1.193*	...	...	...	...
0.150	-	-	0.222	0.610	0.868	1.120	1.305*	...	...	...	...	...

* Velocity of the block at the crank speed where the block starts to leave the trough surface. Also see Table XI.

TABLE IX

Theoretical Velocities of Cement Block
at Angle of Inclination of 40 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	-	0.139	0.233	0.310	0.376	0.436
0.050	-	-	-	-	-	0.265	0.427	0.560	0.675	0.780	0.827*	...
0.075	-	-	-	-	0.352	0.583	0.768	0.929	1.012*	...	...	...
0.100	-	-	-	0.279	0.619	0.873	1.089	1.169*	...	...	...	...
0.125	-	-	-	0.509	0.867	1.149	1.307*	...	...	...	...	...
0.150	-	-	-	0.722	1.104	1.418	1.430*	...	...	...	...	...

* Velocity of the block at the crank speed where the block starts to leave the trough surface. Also see Table XI.

TABLE X

Theoretical Velocities of Cement Block
at Angle of Inclination of 50 Degrees, in in./sec.

Amplitude a in.	Crank speed, rpm.											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
0.025	-	-	-	-	-	-	-	-	0.205	0.313	0.404	0.484
0.050	-	-	-	-	-	-	0.428	0.608	0.761	0.842*	...	...
0.075	-	-	-	-	-	0.606	0.855	1.031*	...	...	...	...
0.100	-	-	-	-	0.625	0.969	1.191*	...	...	...	...	...
0.125	-	-	-	0.443	0.938	1.310	1.331*	...	...	...	...	...
0.150	-	-	-	0.716	1.232	1.459*	...	...	...	...	...	...

* Velocity of the block at the crank speed where the block starts to leave the trough surface. Also see Table XI.

TABLE XICrank Speeds Where the Block Starting to Leave the Trough.

Amplitude a in.		Angle of Inclination, Degrees.				
		10	20	30	40	50
0.025	Experiment	....	....	....	....	1130
	Theory	2848	2029	1678	1480	1356
0.050	Experiment	....	....	1170	1040	960
	Theory	2014	1435	1187	1047	959
0.075	Experiment	....	1180	970	850	800
	Theory	1644	1172	969	855	783
0.100	Experiment	....	1020	840	740	660
	Theory	1424	1015	839	740	678
0.125	Experiment	....	910	760	650	560
	Theory	1273	907	751	662	606
0.150	Experiment	1160	820	700	600	510
	Theory	1163	828	685	604	554



TABLE XII

Mean Velocities and Rates of Discharge of Sand Conveying

Angle of inclination 30 deg.
 Amplitude of vibration 0.100 in.
 Specific gravity of sand 1.3

Crank speed rpm.	Feeder opening No.	Sand thickness cm.	Rate of discharge lb/sec.	Mean velocity ft/sec.
1200	1	0.014	0.007	0.802
	2	0.040	0.023	0.853
	3	0.084	0.043	0.776
	4	0.127	0.070	0.822
	5	0.207	0.098	0.709
	6	0.265	0.129	0.732
1000	1	0.022	0.007	0.473
	2	0.064	0.022	0.525
	3	0.133	0.043	0.484
	4	0.207	0.067	0.490
	5	0.303	0.098	0.486
	6	0.403	0.130	0.486
800	1	0.032	0.007	0.331
	2	0.108	0.023	0.315
	3	0.191	0.043	0.335
	4	0.317	0.068	0.324
	5	0.477	0.096	0.303
	6	0.665	0.129	0.292
600	1	0.042	0.006	0.222
	2	0.186	0.022	0.176
	3	0.428	0.043	0.150
	4	0.664	0.070	0.159
	5	1.060	0.097	0.138
	6	1.492	0.129	0.130

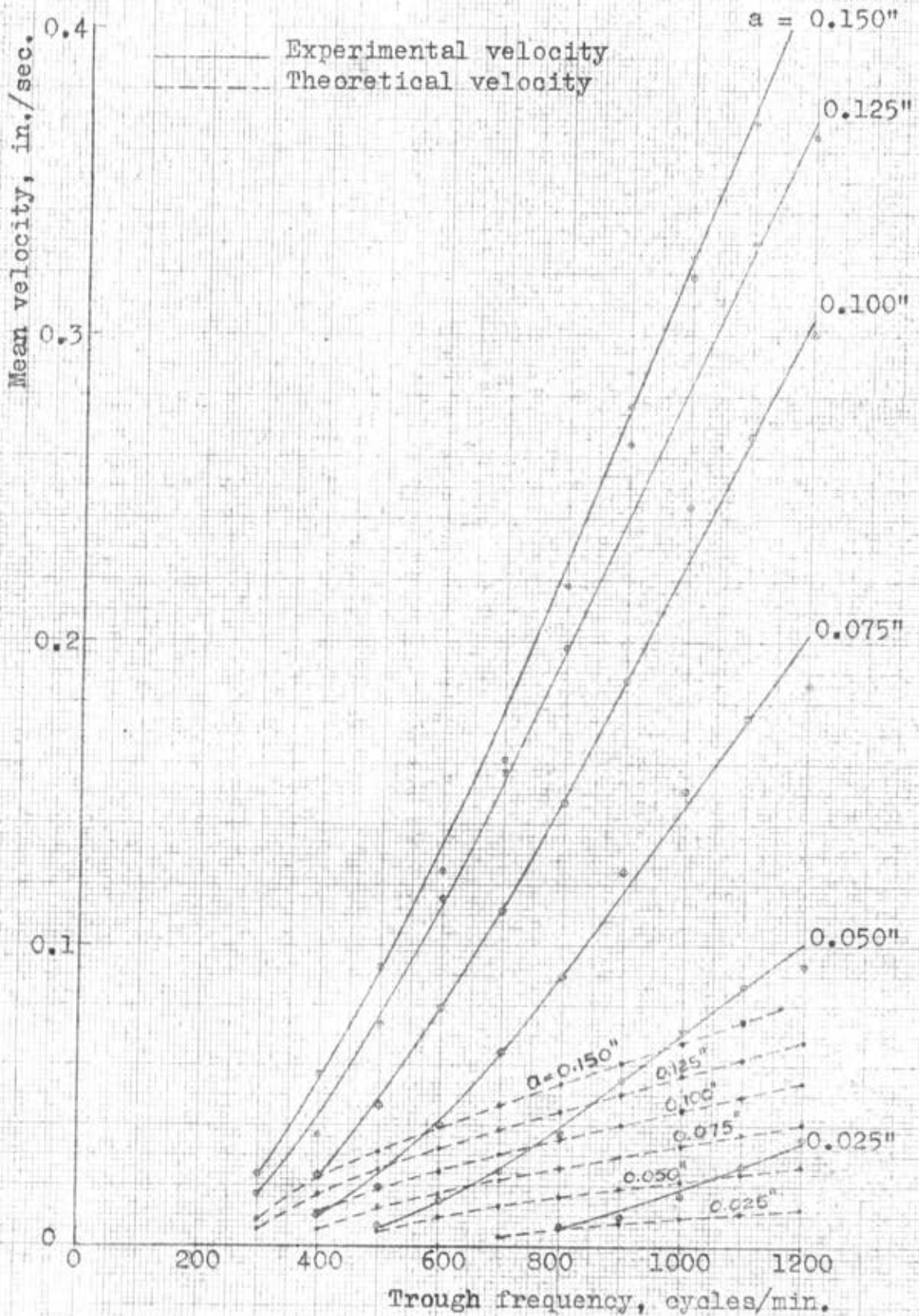


Fig. 6. Mean velocities of cement block at $\alpha = 10$ deg.

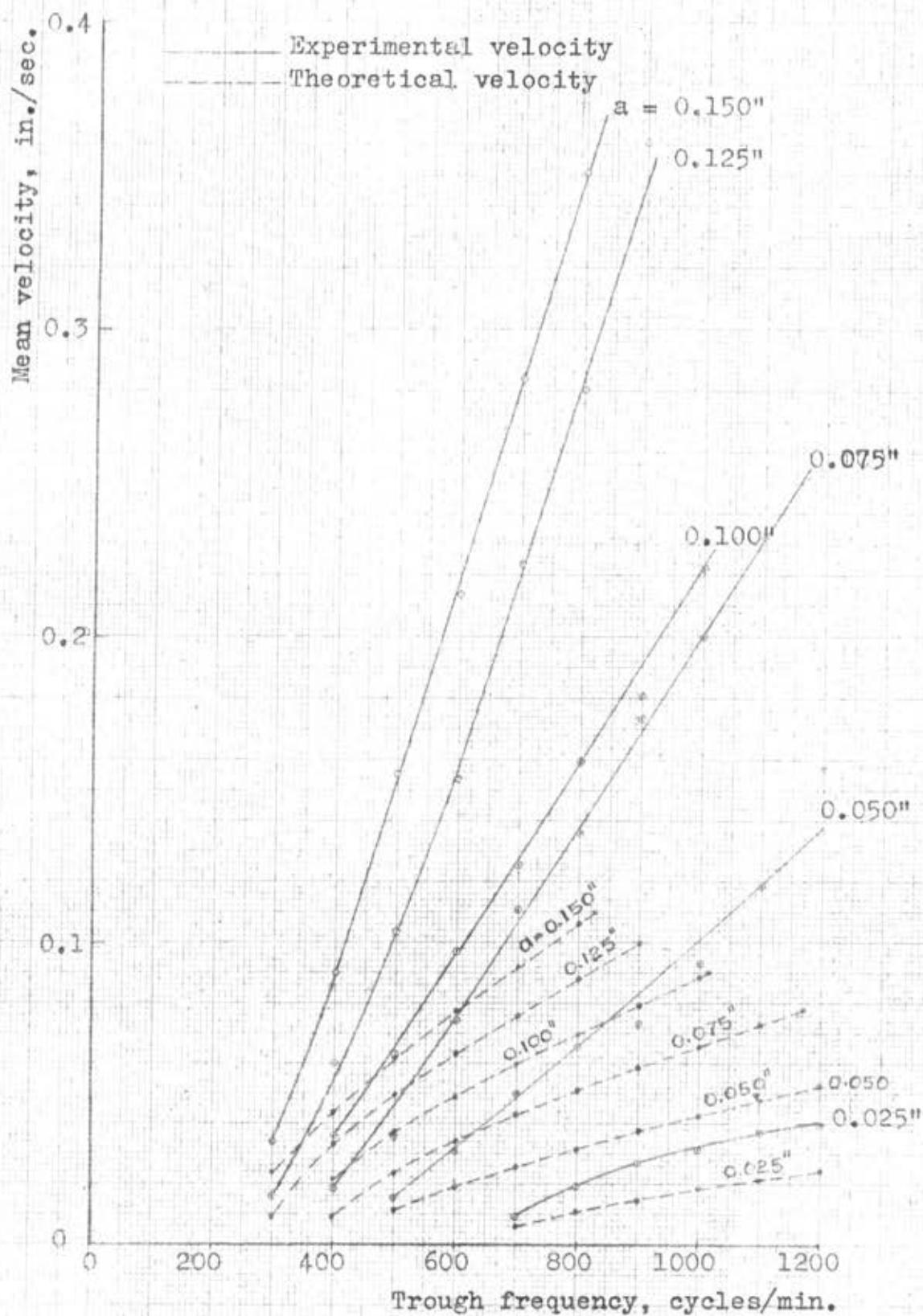


Fig. 7 Mean velocities of cement block at $\alpha = 20$ deg.

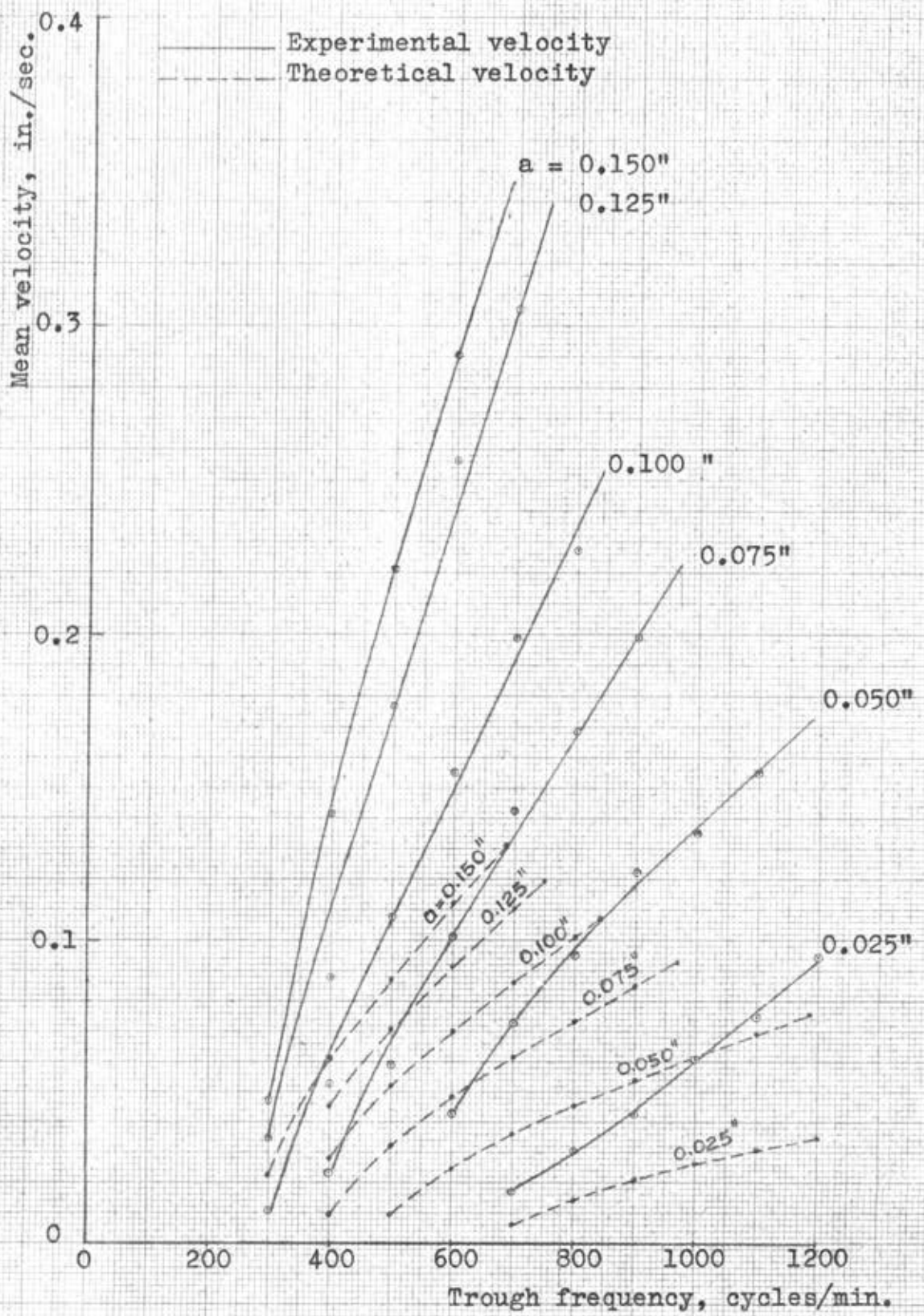


Fig. 8 Mean velocities of cement block at $\alpha = 30$ deg.

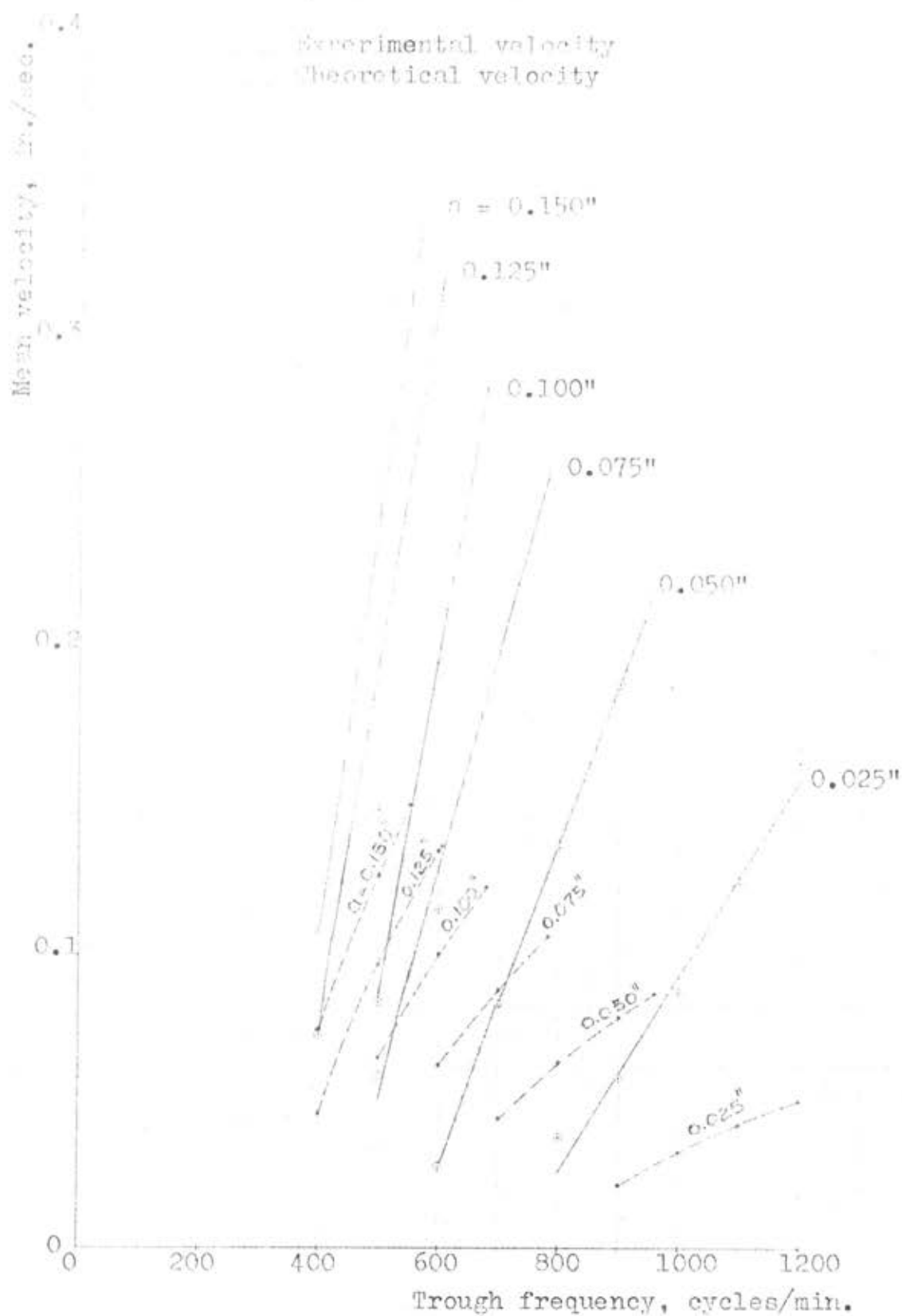


Fig. 10 Mean velocities of cement block at $\alpha = 50$ deg.

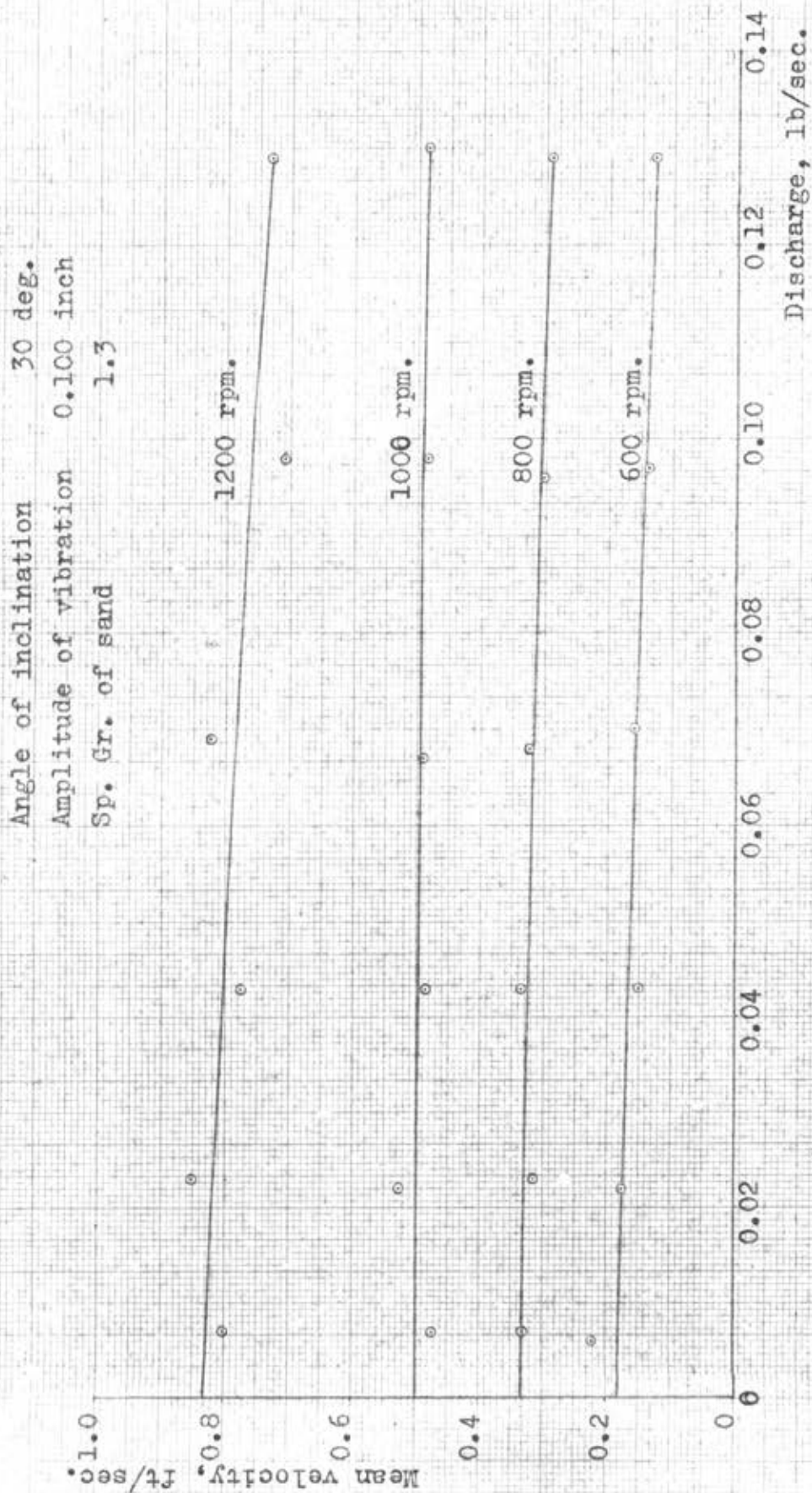


Fig. 11 Relationship between mean velocities and rates of discharge of sand conveying.