
Tests of Iowa Building Stones

BY

A. MARSTON

TESTS OF IOWA BUILDING STONES.

The tests compiled in tables I to VI inclusive include those made during the present investigation and also those which appear in the earlier reports of the present Survey. In general the materials were collected by a member of the Survey, but the majority of the tests were made under the direction and supervision of Professor A. Marston, Dean of the Engineering division of the Iowa State College, Ames, Iowa. Tables I and II include the transverse tests made upon much larger blocks than are ordinarily used for the purpose. The dimensions and distances between supports are given in the tables. The crushing tests recorded in table III were made on cubes approximating two inches. The absorption tests of the present investigation were carried through a much longer period than is usually done although at the end of 700 hours the specimens had not yet reached a constant weight. Tables V and VI give the results of two investigations, neither of which was carried far enough to be conclusive. The only conclusion which can be drawn safely is that twenty freezings and thawings have no appreciable effect, either in decreasing the strength or in increasing the disintegration of the materials tested.

In several of the tables, tests of building stone from other states which enter the Iowa markets in competition with the Iowa products were included for comparison.

TABLE I.
TRANSVERSE TESTS* OF ORIGINAL SPECIMEN.

Number of specimen	Height	Width	Total Length	Distance of Fracture from Nearer Support	Description of Fracture	Breaking Load in Pounds	Lbs. Per Square Inch
	Inches	Inches	Inches	Inches			Modulus of rupture
1	4.78	6.08	24	9	Marked by crystals of calcite		
2	4.90	6.22	24	8.5	Fairly regular	3490	636
3	4.82	5.90	24	8.75	Fairly regular	3530	701
4	5.00	5.92	25	8.62	Very regular	5110	938
5	7.18	8.00	22.25	8.5	Very regular	11180	735
6	7.32	7.30	27	9	Very regular	6480	151
7	6.96	7.30	27.5	6.5	Fairly regular	5150	397
8	7.20	7.47	28.5	7.5	Fairly regular	6770	476
9	7.24	7.81	28	7.5	Fairly regular	5880	390
10	6.14	7.45	27.75	6	Fairly regular	4210	109
11	7.22	6.57	28	6.5	Regular	6400	508
12	7.24	7.65	27	8.75	Very regular	6730	157
13	6.86	7.32	28.75	7.5	Fairly regular	5130	406
14	6.71	7.52	26	8	Fairly regular	5910	475
15	6.50	7.30	26.5	8	Fairly regular	8560	754
16	6.50	7.42	26.5	7.75	Fairly regular	8000	693
17	6.48	7.34	28	8.5	Very regular	9110	802
18	6.40	7.03	27.5	8.5	Fairly regular	7470	705
19	6.40	8.17	27	8.75	Fairly regular	10480	850
20	6.06	6.86	24.5	8.25	Very regular	8840	952
21	6.15	6.48	25.5	8.75	Fairly regular	8210	909
22	7.09	6.90	25.5	8.5	Fairly regular	9090	711
23	6.08	6.94	25.5	8.75	Very regular	8850	936
24	7.13	7.30	25.5	8.5	Fairly regular	10940	800
25	6.00	6.00	24	7.7	Fairly regular	9390	1178
26	5.98	5.98	24	9	Fairly regular	8940	1133
27	5.98	5.98	24	8.5	Fairly regular	8620	1093
28	5.92	5.90	24	8.75	Fairly regular	2550	337
29	5.92	5.96	24	8.25	Fairly regular	2720	356
30	5.96	5.91	24	8.5	Fairly regular	5080	658
31	6.20	6.20	24	8	Fairly regular	8180	931
32	5.92	5.97	24	8.5	Fairly regular	6100	791

* 18 inch supports.

Numbers 1-5 are dolomites from the Wilkes Williams quarry about six miles south of Postville, Iowa.

Numbers 6-14 are from Senator J. A. Green's quarry, Stone City, Iowa.

Numbers 15-19 are from the quarry of Dearborn & Sons, Stone City, Iowa.

Numbers 20-24 were furnished by the LeClaire Stone Company, Davenport, Iowa.

Numbers 25 and 26 represent blue Bedford oolite and 27 and 31 buff Bedford stone.

Numbers 28-30 represent Lake Superior in red sandstone.

Number 32 is Cleveland sandstone.

The same numbers are used in tables II and VI.

TABLE II.

TRANSVERSE TESTS* OF LONGER PIECE OF SPECIMEN AFTER FIRST TEST.

Number of specimen	Height	Width	Length of Span	Fracture	Failure	Lbs. Per Square Inch
	Inches	Inches	Inches			Modulus of rupture
1	4.78	6.12	10	Marked by crystals of calcite.....	6540	702
2	4.88	6.22	10	Fairly regular.....	8000	811
3	4.82	5.88	10	Fairly regular.....	4800	527
4	5.00	5.92	10	Very regular.....	10600	1074
5	7.44	7.03	8	Very regular.....	21520	664
6	7.25	7.41	10	Very regular.....	17660	680
7	7.10	7.22	10	Regular.....	16440	677
8	7.26	7.32	10	Large calcite crystals, regular....	17740	690
9	7.16	7.80	10	Fairly regular.....	14000	525
10	6.10	7.59	10	Very regular.....	16290	867
11	6.60	6.81	10	Very regular.....	16200	809
12	7.14	7.31	10	Regular.....	18820	757
13	7.30	6.53	10	Very regular.....	12000	517
14	7.08	7.43	10	Very regular.....	18770	758
15	6.54	8.18	10	Very regular.....	18000	772
16	6.56	7.42	10	Very regular.....	21180	1003
17	6.54	7.58	10	Fairly regular.....	19180	887
18	6.52	7.19	10	Regular.....	17630	865
19	6.52	8.04	10	Fairly regular.....	21870	960
20	6.28	7.06	10	Very regular.....	17930	966
21	6.10	6.55	10	Fairly regular.....	21380	1312
22	6.81	7.00	10	Very regular.....	20000	924
23	6.12	7.00	10	Regular.....	22000	1260
24	7.13	6.54	10	Fairly regular.....	17140	773
25	6.20	6.00	10	Fairly regular.....	8000	1170
26	5.97	5.97	10	Fairly regular.....	14950	1054
27	5.98	5.98	10	Fairly regular.....	13470	942
28	5.90	5.86	10	Fairly regular.....	4420	325
29	5.94	5.95	10	Fairly regular.....	4920	351
30	5.94	5.88	10	Fairly regular.....	8980	649
31	6.20	6.20	10	Fairly regular.....	13550	853
32	5.93	5.98	10	Fairly regular.....	10000	713

*10 inch supports.

TABLE No. III.
CRUSHING TESTS OF IOWA BUILDING STONES.

County	Location of Quarry	Kind of Stone	Working area in inches	Load Per Square Inch		Authority	Remarks
				Spalling	Failure		
Dallas.....	Van Meter.....	Sandstone.....	4.14	10,800	11,700	C. E. Dept.	Seamy, Coal Measures
	Van Meter.....	Sandstone.....	4.04	12,200	13,900		do	Seamy, Coal Measures
Delaware....	Hopkinton.....	Limestone.....	4.14	3,600	5,500	do	
			4.18	3,650	4,600	do	
			4.14	6,377	6,377	do	
Des Moines..	Burlington ...	Limestone	3.01	6,500	6,600	do	John Loftus quarry
	Burlington ...	White limestone	4.00	6,800	8,500	do	John Loftus quarry
	Burlington ...	Gray limestone	4.28	6,700	13,100	do	John Loftus quarry
	Burlington ...	Blue limestone.....	3.50	6,700	11,400	do	John Loftus quarry
Fayette ...	Six miles south of Postville ..	Dolomite.....	4.01	2,392	4,520	do	} Wilkes Williams { All quarry sheared vertically
	Six miles south of Postville ..	Dolomite.....	3.86	3,625	4,620	do	
	Six miles south of Postville ..	Dolomite.....	3.93	4,270	5,810	do	
	Six miles south of Postville ..	Dolomite.....	3.98	1,207	3,252	do	
	Six miles south of Postville ..	Dolomite.....	4.05	1,198	2,470	do	
Humboldt...	Humboldt.....	Limestone.....	3.82	5,500	6,200	do	Saint Louis limestone

Jasper.....	Monroe.....	Sandstone.....	4.36	3,600	3,600	do	} Coal Measure sandstone } E. G. Kemper quarry
	Monroe.....	Sandstone.....	4.57	3,700	3,700	do	
Jones.....	Hale.....	Dolomite.....	4.00	2,887	2,887	do	Sheared conically
	Hale.....	Dolomite.....	3.60	2,937	2,937	do	Sheared conically
	Hale.....	Dolomite.....	3.33	3,067	4,375	do	Sheared conically
	Stone City.....	Dolomite.....	3.95	1,519	2,987	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.93	2,150	3,422	do	J. A. Green quarries
	Stone City.....	Dolomite.....	4.00	5,425	5,425	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.82	3,140	3,390	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.80	2,053	4,184	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.98	1,785	3,000	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.90	2,000	3,775	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.93	2,914	3,269	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.90	3,000	3,310	do	J. A. Green quarries
	Stone City.....	Dolomite.....	3.79	2,290	3,600	do	Dearborn & Sons
	Stone City.....	Dolomite.....	3.88	773	3,090	do	Dearborn & Sons
	Stone City.....	Dolomite.....	3.81	3,753	3,753	do	Dearborn & Sons
	Stone City.....	Dolomite.....	3.93	1,880	3,052	do	Dearborn & Sons
	Stone City.....	Dolomite.....	3.85	2,910	3,300	do	Dearborn & Sons
	Stone City.....	Dolomite.....	4.04	5,300	6,400	do	F. S. Brown & Co.
	Stone City.....	Dolomite.....	4.12	4,100	6,600	do	F. S. Brown & Co.
	Stone City.....	Dolomite.....	4.06	6,100	7,400	do	
	Stone City.....	Dolomite.....	4.08	5,600	7,500	do	
	Stone City.....	Dolomite.....	4.02	4,000	4,100	do	
	Stone City.....	Dolomite.....	4.08	5,400	5,400	do	J. A. Green { Strawboard bearings
	Stone City.....	Dolomite.....	4.12	5,300	5,700	do	
	Stone City.....	Dolomite.....	4.02	4,500	5,000	do	
	Stone City.....	Dolomite.....	3.92	4,800	4,800	do	
	Stone City.....	Dolomite.....	4.06	12,500	13,400	do	Dearborn & Sons "upper white"
Stone City.....	Dolomite.....	3.98	10,600	11,600	do	Dearborn & Sons "8-inch bed"	
Stone City.....	Dolomite.....	4.16	6,700	6,700	do	Dearborn & Sons "flag- ging layer"	
Stone City.....	Dolomite.....	4.10	12,200	13,200	C. E. Dept.....	Dearborn & Sons, "dinen- sion stone"	
Stone City.....	Dolomite.....	4.20	6,500	6,500	do	Dearborn & Sons, "bridge- stone"	

CRUSHING TESTS.

TABLE No. III—CONTINUED.

County	Location of Quarry	Kind of Stone	Working area in inches	Load Per Square Inch		Authority	Remarks								
				Spalling	Failure										
Jones	Stone City	Dolomite			5,917	Col. D. W. Flagler..	Dearborn & Sons, "bridge-stone" J. A. Green J. A. Green, cube placed on edge J. A. Green								
	Stone City	Dolomite			11,250	Dodge, Minn. Geol. and Nat. History Survey									
	Stone City	Dolomite			6,750	Dodge, Minn. Geol. and Nat. History Survey									
	Stone City	Dolomite			7,625	Lient. W. P. Butler.									
Lee	West Point	Brown sandstone	4.00	7,000	7,000	C. E. Dept.	<table border="0"> <tr> <td rowspan="2">Craig Quarry No. 1</td> <td rowspan="2">{</td> <td>Broke with slight report and exhibited conical shears</td> </tr> <tr> <td>Conical shear</td> </tr> <tr> <td rowspan="2">Craig Quarry No. 2</td> <td rowspan="2">{</td> <td>Slightly inclined shear</td> </tr> <tr> <td>Slightly inclined shear</td> </tr> </table>	Craig Quarry No. 1	{	Broke with slight report and exhibited conical shears	Conical shear	Craig Quarry No. 2	{	Slightly inclined shear	Slightly inclined shear
	Craig Quarry No. 1	{	Broke with slight report and exhibited conical shears												
			Conical shear												
	Craig Quarry No. 2	{	Slightly inclined shear												
			Slightly inclined shear												
	West Point	Brown sandstone	4.33	4,620	6,890	do									
West Point	Brown sandstone	3.80	5,660	5,800	do										
West Point	Gray sandstone	3.40	5,830	7,650	do										
West Point	Gray sandstone	3.80	4,740	6,530	do										
West Point	Gray sandstone	4.04	3,710	7,180	do										
Louisa	Morning Sun	Limestone	3.61	3,950	3,950	do	<table border="0"> <tr> <td rowspan="3">{</td> <td>Wilson quarry, all samples broke without report and reduced to a granular mass</td> </tr> </table>	{	Wilson quarry, all samples broke without report and reduced to a granular mass						
	{	Wilson quarry, all samples broke without report and reduced to a granular mass													
		Morning Sun	Limestone	3.72	3,360	3,360			do						
Morning Sun		Limestone	3.61	2,490	2,886	do									
Madison	Winterset	Limestone			4,588	Rock Island Arsenal	Bevington quarry								

Mahaska	Given	Limestone	3.70	8,500	12,500	C. E. Dept.	Saint Louis limestone
Marion	Red Rock	Red sandstone			4,434	L. Higgins	Coal Measure sandstone
	Tracy	Limestone	4.12	7,300	9,500	C. E. Dept.	Saint Louis limestone
	Tracy	Limestone	4.20	5,200	9,900	do	Saint Louis limestone
Marshall	Quarry	† Oölite	3.94		11,600	do	Failure, accompanied by much shattering { All samples of Iowa marble broke in such a way as to show much elasticity 63,000 lbs. applied, no effect 63,000 lbs. applied, no effect Sustained 65,800 lbs. with- out further rupture Beyond capacity of machine to crush Sustained 65,800 lbs. with- out further rupture
	Quarry	† Oölite	4.00	11,875	13,450	do	
	Quarry	† Oölite	3.96	13,636	14,900	do	
	Quarry	† Oölite	3.84	10,260	10,260	do	
	Quarry	Oölite	4.08	10,280	12,740	do	
	Quarry	Oölite	4.00	14,250	14,250	do	
	Quarry	Oölite	4.00	9,500	13,250	do	
	Quarry	† Iowa marble, plain	3.90		12,080	do	
	Quarry	† Iowa marble, plain	4.12	14,685	15,120	do	
	Quarry	† Iowa marble, colored	4.06		9,128	do	
	Quarry	Blue limestone	4.08			do	
	Quarry	Blue limestone	4.04			do	
	Quarry	Fossiliferous lime- stone	4.00	10,500		do	
	Quarry	Fossiliferous lime- stone	4.00	15,825		do	
	Quarry	Fossiliferous limestone	4.00	10,925		do	
Quarry	Fossiliferous lime- stone	4.04	14,430	16,435	do		
Quarry	Fossiliferous lime- stone	3.96	9,773	9,773	do		
Quarry	Blue limestone	3.96	7,070	8,712	do		
Quarry	Blue limestone	3.96	7,320	8,383	do		
Scott	LeClaire	Dolomite	4.16	11,100		do	Specimen from F. H. Thiel- man and stood 12,000 lbs. without crushing
	LeClaire	Dolomite	4.22	9,900		do	Specimen from F. H. Thiel- man and stood 13,300 lbs. without crushing
	LeClaire	Dolomite	3.85	2,920	7,630	do	LeClaire Stone Company
	LeClaire	Dolomite	3.80	1,965	5,720	do	LeClaire Stone Company, vertically sheared

CRUSHING TESTS.

† Tests made under the direction of Prof. G. W. Bissell, Dept. of Mechanical Engineering, I. S. C.

TABLE No. III—CONTINUED.

County	Location of Quarry	Kind of Stone	Working area in inches	Load Per Square Inch		Authority	Remarks
				Spalling	Failure		
Van Buren..	LeClaire.....	Dolomite.....	3.86	3,808	5,025	C. E. Dept.....	} LeClaire Stone { Sheared Co..... { vertically
	LeClaire.....	Dolomite.....	4.00	3,000	7,775	do	
	LeClaire.....	Dolomite.....	3.64	2,371	3,901	do	
	Chequest Creek	Gray sandstone.....	4.20	3,740	3,880	do	Price quarry
	Chequest Creek	Gray sandstone.....	4.20	5,740	5,740	do	Price quarry
	Chequest Creek	Gray sandstone.....	3.80	4,630	5,200	do	Price quarry
	Chequest Creek	Gray sandstone.....	4.18	6,030	6,030	do	Price quarry
	Chequest Creek	Gray limestone.....	3.50	8,140	11,430	do	Price quarry, "fossiliferous"
	Chequest Creek	Gray limestone.....	3.06	3,590	8,770	do	Price quarry, "fossiliferous"
	Chequest Creek	Gray limestone.....	3.43	6,850	7,320	do	Price quarry, "fossiliferous"
	Chequest Creek	Limestone.....	3.76	3,370	4,520	do	Price quarry, "dimension stone"
	Chequest Creek	Limestone.....	3.80	2,760	2,770	do	Price quarry, "dimension stone"
	Chequest Creek	Limestone.....	4.00	1,750	4,275	do	Price quarry, "dimension stone"

TABLE No. III—CONTINUED.—STONE FROM COMPETING LOCALITIES OUTSIDE OF IOWA.

County	Location of Quarry	Kind of Stone	Working area in inches	Load Per Square Inch		Authority	Remarks
				Spalling	Failure		
Illinois	Joliet	Dolomite . . . . .	.....	.....	14,775	Gilmore	Average of three tests
	Lemont	Dolomite	12,000			do
Indiana	Bedford	Blue oölite	4.07	3,439	4,373	C. E. Dept.	Stone from Fred Andrews
	Bedford	Blue oölite	3.91	5,626	5,626	do	Stone from Fred Andrews
	Bedford	Buff oölite	4.09	1,467	5,480	do	Stone from Fred Andrews
	Bedford	Buff oölite	4.12	6,050	6,050	do	Stone from Fred Andrews
Michigan	Lake Superior.	Red sandstone	3.89	5,527	5,887	do	
	Lake Superior.	Red sandstone	4.00	4,400	6,712	do	
	Lake Superior.	Red sandstone	4.08	8,700	9,450	do	
Minnesota	Kasota	Dolomite . . . . .	.....	.....	18,500	Gilmore	
	Winona	Dolomite	16,250		do
Ohio	Berea	Sandstone . . . . .	.....	.....	8,222	do	Average of four tests
	Cleveland	Sandstone	4.01	6,870	8,350	C. E. Dept.	Stone from Fred Andrews

CRUSHING TESTS.

TABLE
ABSORPTION TESTS SHOWING

County	Location of Quarry	Kind of Stone	Number of Hours in Water						
			1	8	24	48	72	144	
Dallas.....	Van Meter....	Sandstone.....							
Des Moines.	Burlington...	Gray limestone...							
	Burlington...	White limestone...							
Fayette....	Williams.....	Dolomite.....	4.32	4.80	5.12	5.41	5.70		
	Williams.....	Dolomite.....	4.71	5.22	5.52	5.82	6.12		
	Williams.....	Dolomite.....	5.18	5.70	5.98	6.31	6.68		
	Williams.....	Dolomite.....	4.53	5.08	5.33	5.62	5.92		
	Williams.....	Dolomite.....	4.44	4.88	5.26	5.42	5.84		
Humboldt..	Humboldt...	St. Louis limestone							
Jasper.....	Monroe.....	Sandstone.....							
Jones.....	Stone City....	Dolomite.....							
	Stone City....	Dolomite.....							
	Stone City....	Dolomite.....							
	Stone City....	Dolomite.....	10.20	10.64	11.28	11.67	12.17		
	Stone City....	Dolomite.....	8.94	9.38	9.84	10.20	10.69		
	Stone City....	Dolomite.....	7.62	8.28	8.72	9.10	9.54		
	Stone City....	Dolomite.....	10.06	10.55	11.07	11.50	12.00		
	Stone City....	Dolomite.....	8.73	9.08	9.66	9.98	10.40		
	Stone City....	Dolomite.....	9.30	9.72	10.22	10.62	11.10		
	Stone City....	Dolomite.....	9.49	9.84	10.42	10.92	11.37		
	Stone City....	Dolomite.....	9.32	9.83	10.32	10.83	11.28		
	Stone City....	Dolomite.....	9.20	9.58	10.15	10.67	10.93		
	Stone City....	Dolomite.....	6.02	6.38	6.81	7.34	7.55		
	Stone City....	Dolomite.....	6.62	6.92	7.30	7.90	8.08		
	Stone City....	Dolomite.....	7.58	7.95	8.46	8.88	9.32		
Stone City....	Dolomite.....	7.72	8.19	8.64	9.23	9.59			
Stone City....	Dolomite.....	7.72	8.36	8.82	9.61	9.73			
Madison...	Winterset....	Limestone.....							
Mahaska...	Oskaloosa....	Limestone.....							
Marion....	Tracy.....	Limestone.....							
	Red Rock....	Sandstone.....							
	Red Rock....	Sandstone.....							

No. IV.

INCREASE IN PERCENTAGE.

Number of Hours in Water							Authority	Remarks
168	264	336	432	510	700	Not known		
4.15	.....	.....	.....	.....	.....	.....	Murray.....	Coal Measures
1.87	.....	.....	.....	.....	.....	.....	do	John Loftus quarry
0.74	.....	.....	.....	.....	.....	.....	do	John Loftus quarry
6.10	6.45	6.53	6.68	6.81	6.88	.....	C. E. Dept.	
6.47	6.76	6.88	7.06	7.16	7.32	.....	do	
7.18	7.44	7.56	7.77	7.89	8.08	.....	do	
6.33	6.64	6.72	6.92	7.05	7.22	.....	do	
6.24	6.57	6.66	6.82	6.95	7.15	.....	do	
4.31	.....	.....	.....	.....	.....	.....	Murray.....	Mastin & Sterns
8.64	.....	.....	.....	.....	.....	.....	do	Kemper, Coal Measures
7.48	.....	.....	.....	.....	.....	.....	do	Champion quarry, spalls from crushing machine
9.37	.....	.....	.....	.....	.....	.....	do	Champion quarry
6.91	.....	.....	.....	.....	.....	.....	do	Champion-quarry, dressed cube
.....	.....	.....	.....	.....	.....	5.45	G. S. Morrison	Champion quarry
13.07	13.62	13.94	14.23	14.50	14.81	.....	C. E. Dept.....	J. A. Green
11.56	12.08	12.38	12.61	12.81	13.02	.....	do	J. A. Green
10.39	10.92	11.21	11.46	11.62	11.93	.....	do	J. A. Green
12.86	13.21	13.57	13.88	14.03	14.33	.....	do	J. A. Green
11.24	11.57	11.90	12.21	12.41	12.75	.....	do	J. A. Green
11.93	12.47	12.71	13.06	13.30	13.52	.....	do	J. A. Green
12.30	12.88	13.12	13.47	13.71	14.03	.....	do	J. A. Green
12.10	12.83	13.08	13.36	13.66	14.00	.....	do	J. A. Green
11.63	12.34	12.52	12.80	13.04	13.41	.....	do	J. A. Green
7.98	8.40	8.50	8.72	8.88	9.14	.....	do	Dearborn & Sons
8.43	9.29	9.40	9.49	9.70	10.06	.....	do	Dearborn & Sons
9.69	10.57	10.73	10.93	11.11	11.44	.....	do	Dearborn & Sons
10.02	10.82	11.01	11.27	11.50	11.83	.....	do	Dearborn & Sons
10.22	10.92	11.12	11.32	11.56	11.84	.....	do	Dearborn & Sons
.....	.....	.....	.....	.....	.....	0.42	Rock Island Arsenal.....	Bevington quarry
3.34	.....	.....	.....	.....	.....	.....	Murray.....	St. Louis limestone
3.27	.....	.....	.....	.....	.....	.....	do	Steel, a broken piece
10.82	.....	.....	.....	.....	.....	.....	do	Dunreith, Coal Measures
10.82	.....	.....	.....	.....	.....	.....	do	Dunreith, Coal Measures

TABLE No. IV--

County	Location of Quarry	Kind of Stone	Number of Hours in Water					
			1	8	24	48	72	144
Marshall ..	Quarry	Oölite	0.85	.....	2.66	.....	.....	2.75
	Quarry	Oölite	1.56	.....	3.95	.....	.....	4.05
	Quarry	Oölite	1.20	.....	2.50	.....	.....	2.61
	Quarry	Oölite	0.71	.....	2.11	.....	.....	2.20
	Quarry	Oölite	1.50	.....	2.55	.....	.....	2.64
	Quarry	Iowa marble	2.33	.....	3.60	.....	.....	3.87
	Quarry	Iowa marble	1.81	.....	3.31	.....	.....	3.57
	Quarry	Iowa marble	2.31	.....	3.97	.....	.....	4.37
	Quarry	Blue limestone	0.45	.....	1.86	.....	.....	2.02
	Quarry	Limestone	0.72	.....	1.72	.....	.....	1.79
	Quarry	Limestone	0.22	.....	0.70	.....	.....	0.77
	Quarry	Limestone	0.06	.....	1.65	.....	.....	1.79
	Quarry	Limestone	0.22	.....	1.64	.....	.....	1.79
	Quarry	Blue limestone	2.03	.....	3.17	.....	.....	3.36
Quarry	Blue limestone	4.00	.....	5.41	.....	.....	5.65	
Scott	LeClaire	Limestone . . . . .	.....	.....	.....	.....	.....	.....
	LeClaire	Limestone	6.33	6.62	6.93	7.33	7.52	.....
	LeClaire	Limestone	5.41	5.71	5.92	6.17	6.28	.....
	LeClaire	Limestone	7.08	7.31	7.62	8.03	8.28	.....
	LeClaire	Limestone	6.75	7.11	7.37	7.75	7.92	.....
LeClaire	Limestone	7.27	7.56	7.87	8.32	8.49	.....

STONE FROM COMPETING

Illinois	Joliet	Dolomite . . . . .	.....	.....	.....	.....	.....	.....
	Lemont	Limestone . . . . .	.....	.....	.....	.....	.....	.....
Indiana	Bedford	Oölite . . . . .	.....	.....	.....	.....	.....	.....
	Bedford	Blue Oölite	3.47	3.66	3.79	4.01	4.08	.....
	Bedford	Blue Oölite	3.53	3.68	3.85	4.07	4.09	.....
	Bedford	Buff Oölite	4.57	4.76	4.95	5.19	5.23	.....
Michigan	Bedford	Buff Oölite	4.72	4.90	5.16	5.25	5.34	.....
	Lake Superior	Red Sandstone	5.91	6.24	6.47	6.92	7.06	.....
	Lake Superior	Red Sandstone	6.13	6.46	6.68	7.06	7.28	.....
Minnesota	Lake Superior	Red Sandstone	4.79	4.94	5.26	5.67	5.70	.....
	Kasota	Dolomite . . . . .	.....	.....	.....	.....	.....	.....
	Winona	Dolomite . . . . .	.....	.....	.....	.....	.....	.....
Ohio	Pipestone	Quartzite . . . . .	.....	.....	.....	.....	.....	.....
	Berea	Sandstone . . . . .	.....	.....	.....	.....	.....	.....
	Cleveland	Sandstone	5.06	5.40	5.70	5.83	6.07	.....

CONTINUED.

Number of Hours in Water							Authority	Remarks
168	264	336	432	510	700	Not Known		
.....	.....	.....	.....	.....	.....	.....	C. E. Dept. ...	Fine grained, northeast quarry
.....	.....	.....	.....	.....	.....	.....	do	Fine grained, northeast quarry
.....	.....	.....	.....	.....	.....	.....	do	Southeast quarry
.....	.....	.....	.....	.....	.....	.....	do	Southeast quarry
.....	.....	.....	.....	.....	.....	.....	do	Southeast quarry
.....	.....	.....	.....	.....	.....	.....	do	West quarry
.....	.....	.....	.....	.....	.....	.....	do	West quarry
.....	.....	.....	.....	.....	.....	.....	do	West quarry
.....	.....	.....	.....	.....	.....	.....	C. E. Dept.	Northeast quarry
.....	.....	.....	.....	.....	.....	.....	do	Fossiliferous, N. E. quarry
.....	.....	.....	.....	.....	.....	.....	do	Fossiliferous, N. E. quarry
.....	.....	.....	.....	.....	.....	.....	do	Fossiliferous, west quarry
.....	.....	.....	.....	.....	.....	.....	do	Fossiliferous, west quarry
.....	.....	.....	.....	.....	.....	.....	do	Timber creek
.....	.....	.....	.....	.....	.....	.....	do	Timber creek
1.32	.....	.....	.....	.....	.....	.....	Murray	
7.84	8.29	8.43	8.69	8.83	8.98	.....	C. E. Dept.	
6.40	6.83	6.93	7.03	7.11	7.22	.....	do	
8.54	8.97	9.15	9.33	9.40	9.53	.....	do	
8.28	8.72	8.84	9.02	9.17	9.30	.....	do	
8.88	9.31	9.45	9.65	9.77	9.98	.....	do	

LOCALITIES OUTSIDE OF IOWA.

.....	.....	.....	.....	.....	.....	.....	1.08	Gilmore	
.....	.....	.....	.....	.....	.....	.....	1.12	Gilmore	
.....	.....	.....	.....	.....	.....	.....	4.34	Hopkins	
4.12	4.44	4.51	4.57	4.62	4.77	.....	.....	C. E. Dept.	
4.25	4.56	4.64	4.75	4.80	4.95	.....	.....	do	
5.51	5.81	5.88	6.03	6.07	6.24	.....	.....	do	
5.78	5.95	6.11	6.23	6.28	6.53	.....	.....	do	
7.55	8.13	8.30	8.53	8.66	8.89	.....	.....	do	
7.93	8.39	8.56	8.80	8.86	9.16	.....	.....	do	
6.43	6.85	6.99	7.17	7.31	7.63	.....	.....	do	
.....	.....	.....	.....	.....	.....	.....	3.57	Winchell	
.....	.....	.....	.....	.....	.....	.....	4.76	Winchell	
.....	.....	.....	.....	.....	.....	.....	.....	Gilmore	
.....	.....	.....	.....	.....	.....	.....	4.76	Gilmore	
6.89	7.08	7.52	7.63	7.79	8.01	.....	.....	C. E. Dept.	

TABLE No. V.
FREEZING TESTS.*
SAMPLES TAKEN FROM THE QUARRIES OF THE LE GRAND QUARRY CO.

Kind of Stone	Height of cube	Surface dimensions	Area	Breaking Load in Lbs.		Load Per Square Inch		Loss in weight in per cent	Remarks
				Spalling began	Failure	Spalling began	Failure		
Oölite, fine-grained, northeast quarry	2.05	2.00x2.08	4.16	55,700	56,400	13,390	13,558	0.0014	Loud report
do.....	2.08	2.00x2.08	4.16	26,000	.....	6,250	14,280	0.0013	Sustained 59,400 lbs. Very slight spall at 26,000 lbs
Oölite, fine-grained, southeast quarry	1.99	1.97x2.00	3.94	50,000	60,000	12,690	15,230	.....	Loud report and cube much shattered
do	2.00	2.00x1.96	3.92	34,000	55,700	8,673	14,210	.....	do
do	2.02	1.97x1.97	3.88	50,000	56,500	12,890	14,560	.....	do
Iowa marble, west quarry	1.96	2.02x2.02	4.08	50,000	56,500	12,255	13,850	0.0007	Broke with a loud report
do	1.92	2.00x2.00	4.00	42,600	52,700	10,650	13,175	0.0008	do
do	2.00	2.04x2.02	4.12	38,000	51,700	9,225	12,550	0.0009	do
Blue limestone, northeast quarry ...	2.00	1.98x1.97	3.90	.....	.....	.....	15,360†	.....	59,400 lbs. applied without effect
Fossiliferous limestone, N. E. quarry	2.00	2.00x2.02	4.08	.....	.....	.....	14,560†	.....	59,400 lbs. applied without effect
do	1.98	1.97x2.00	3.94	55,600	.....	14,035	14,900†	.....	59,400 lbs. sustained
Fossiliferous limestone, west quarry.	1.98	2.04x2.02	4.12	35,900	40,000	8,715	9,710	.....	Weak report
do	1.97	1.99x1.96	3.91	30,500	30,500	7,800	8,950	.....	Weak report
Blue limestone, Timber creek	2.00	2.04x2.01	4.10	28,000	36,300	6,830	8,850	.....	Slight report‡
do	1.96	1.98x1.96	3.88	32,700	32,700	.....	8,430	.....

*The cubes were placed in distilled water until completely saturated, after which the specimens were encased in cotton batting saturated with distilled water and placed in wooden trays, eight by eight inches and two inches deep, provided with wire bottoms. The trays after being securely packed were placed in the refrigerator and kept at a temperature of from 17° to 19° F. for forty-eight hours. Then they were removed from the refrigerator and subjected to a temperature of 70° F. for twenty-four hours. This process was repeated six times. The specimens were afterwards subjected to refrigeration and thawing ten times; but the conditions were less constant than in the first six. In the latter series the minimum temperatures ranged from 21° to 32° F.

†The above table shows that the blocks suffered no appreciable loss in weight or strength during the investigation. It is highly probable that lower temperatures would have given very different results.

‡In spite of the apparent weakness, low specific gravity and rather high percentage of absorption, the quarry face along natural fissures shows this stone to be one of the most durable quarried in the county.

TABLE No. VI.
FREEZING AND THAWING TESTS.

Number of specimen	Dry weight	Saturated weight	Number of Freezings		Remarks
			10	20	
1	39.80	42.54	42.45	42.39	Wilkes Williams quarry
2	39.09	41.95	41.84	41.81	Wilkes Williams quarry
3	42.47	45.90	45.76	45.79	Wilkes Williams quarry
4	44.12	47.30	47.15	47.13	Wilkes Williams quarry
5	45.06	48.28	48.02	47.96	Wilkes Williams quarry
6	31.53	36.20	35.69	35.74	J. A. Green quarry
7	34.35	38.82	38.24	38.23	J. A. Green quarry
8	31.76	35.55	35.05	35.11	J. A. Green quarry
9	32.49	37.15	36.74	36.71	J. A. Green quarry
10	34.35	38.60	38.20	38.05	J. A. Green quarry
11	33.85	38.43	37.83	37.71	J. A. Green quarry
12	34.14	38.93	38.33	38.26	J. A. Green quarry
13	33.51	38.20	37.48	37.70	J. A. Green quarry
14	32.81	37.21	36.63	36.82	J. A. Green quarry
15	41.98	45.82	45.39	45.37	Dearborn & Sons quarry
16	39.59	43.57	42.85	42.87	Dearborn & Sons quarry
17	35.11	39.13	38.44	38.57	Dearborn & Sons quarry
18	35.77	40.00	39.37	39.33	Dearborn & Sons quarry
19	34.45	38.53	37.90	37.74	Dearborn & Sons quarry
20	35.23	38.39	38.27	38.38	LeClaire Stone Company
21	39.22	42.05	42.04	42.18	LeClaire Stone Company
22	39.24	42.98	42.67	43.14	LeClaire Stone Company
23	39.26	42.91	42.75	42.58	LeClaire Stone Company
24	35.34	38.87	38.82	38.53	LeClaire Stone Company
25	46.13	48.33	48.05	48.03	Stone obtained from Fred Andrews
26	45.64	47.90	47.51	47.56	Stone obtained from Fred Andrews
27	46.45	49.35	49.02	49.03	Stone obtained from Fred Andrews
28	30.61	33.33	33.00	33.05	Stone obtained from Fred Andrews
29	36.70	40.06	39.60	39.74	Stone obtained from Fred Andrews
30	40.90	43.97	43.32	43.40	Stone obtained from Fred Andrews
31	43.02	45.40	45.15	44.37	Stone obtained from Fred Andrews
32	36.69	39.63	39.01	39.38	Stone obtained from Fred Andrews

