

COMPARATIVE TESTS OF MORTARS FOR USE IN MASONRY THESIS FOR THE DEGREE OF B. S. Francis J. Corr, Jr. 1930



Copy 2

÷ .

COMPARATIVE TESTS OF MORTARS FOR

USE IN MASONRY

A Thesis Submitted to

The Faculty of

MICHIGAN STATE COLLEGE

of

AGRICULTURE AND APPLIED SCIENCE

By

Francis J. Corr, Jr.

Candidates for the Degree of

.

Bachelor of Science

June 1930

crp Z

THESIS

•

•

.

These tests were to be run on Brixment, Medusa Mix, Utica, Line with fifteen percent Portland coment and Peerless Portland cement alone. All the tests were run according to the American Society of Testing Materials standards. The primary purpose of using Peerless Portland cement alone was to have a standard with which to compare the other mortars.

The writer has chosen these particular patented cements as they are the most popular cements used in this locality.

FINENESS TESTS

Samples of from 200 to 250 grams of each cement were taken and passed through a 20 mesh screen to remove any lumps or foreign materials that might have been in the cement. Three fifty gram samples, of each cement, were then put in the Ro-Tap machine and were shaken for a period of fiteen minutes. The samples were then taken from the Ro-Tap machine. The portions retained on the screen, and the portions passing the screens, were weighed seperately and recorded in the following tabulations. The averages of the three samples of each cement, and the percent of the totals of each cement passing the screens were also recorded in the tabulations.

94932

TABULATED RESULTS

Sample	On Screen	In Pan	Total	Lost
Brirment				
#1	12.0g	37.2g	49.2g	0.8g
# 2	11.9g	37.7g	49.6g	0 .4g
#3	<u>10.8</u> g	<u>38.5</u> g	<u>49.3</u>	<u>0.7</u> g
Average	12.2g	37.8g	49.4g	•6g
75	.6 Percent passed sc:	reen		
Sample				
Utica Cement				
# 1	11.0g	39. 0g	50.0g	0
#2	<u>10.3</u> g	<u>39.5</u> g	<u>49.8</u>	0.25
Lverag e	10.1g	39 . 2g	49.9g	.lg
78.	.5 Percent passed sci	reen		
Sample				
Medusa Mix C	ement			
#1	4.7g	45.0g	49.7g	0 .3 g
# 2	4.7g	45.0g	49.7g	0 .3g
f 3	4.6g	45.1g	49.7g	0.3g
Average	4.6 g	45.3g	49.7g	•3g
90	.6 Percent passed sc:	reen		
Sample				
Peerless Port	tland			
#1	3.5g	46 .4g	49.9g	.0g
#2	4.00g	46.0g	50.0g	.0g
# 3	<u>3.1g</u>	46.3g	<u>49.4</u>	1.28
Average	3 .5 g	46.2g	49.8 g	.4g

. · · · ·

. **.** . .

· · · · · · · ·

· · · · · · · ·

· · · ·

ŧ

X.

RANK OF CEMENTS FOR FINENESS TESTS

Peerless Portland	92.3%
Medusa Mix Cement	90.6 <u>%</u>
Utica Cement	78.5%
Brixment	75.6%

Medusa Mix, although nearly as fine as Peerless Portland cement, is not comparable as an equal for strength as will be shown later on in the Thesis. Utica cement and Brixment, although not as fine as Medusa Mix, are comparable with it as an equal as will also be shown in the Tension Tests.

NORMAL CONSISTENCY TEST BY VICAT NEEDLE

Samples of 500 grams each were weighed out and put upon a non-absorbent surface. Quantities of water were measured and mixed with the cement until a consistency was reached that would cause the needle of the Vicat Apparatus to sink a distance of 10 mm in 30 seconds. If the sample failed it was discarded and a new sample mixed. This was continued until the above stated consistency was reached. The conclusions reached are tabulated below:

Utica Cement	44.0 %
Medusa Mix	30 . 3%
Brixment	28.6%
Peerless Portland	23 .0%

Utica cement which has the lowest specific gravity of all the cements absorbed more water than any other. This cement seems to be stickier and of a pastier consistency than the others. The flexibility of Utica cement was noticed in breaking the cylinders.

SOUNDNESS TESTS

The same samples used to make the Normal Consistency tests were used for the Soundness tests. The cement was placed on glass plates 4" x 4" and pressed out with a trowel in round pats $\frac{1}{2}$ " thick at the center and tapering out to nothing at the edges. The pats were covered with a damp towel and cured for 24 hours. They were then exposed to steam for five hours.

The Portland cement was the only one of the cements that wholly withstood the test being very smooth and sound at the end of the 5 hours. The Medusa Mix, Utica and Brixment shrank and checked.

TENSION TESTS

The Tension tests on Utica Cement, Brixment, Medusa Mix and Peerless Portland cement were run by mixing one part cement to three parts of Standard Sand and necessary amount of water.

The amount of water to be used was determined by use of Table 1 of Standard Specifications and Tests for Portland Cement. This table is shown below. The normal consistency of some of the neat cements ran too high for this table so a curve was plotted with the data given and the percentages necessary for the mortars of those cements was found. The curve is shown on the next sheet.

One thousand grams of cement and 3,000 grams of sand were weighed out and mixed in a pan. The percentage of water computed was then added and the mass mixed thoroughly with the fingers. The mortar was then ready to be placed into the gang molds which were oiled to prevent sticking. A scale was used for pressing the mortar





in the molds to obtain a more uniform quality of briquettes. The amount of pressure used in thumbing the briquettes is very important and if it is varied it will cause the breaking strengths of the briquettes to vary.

After all the mortar was placed in the gang molds they were put in moist chambers for twenty four hours. After the twenty four hour had passed the molds were removed and the briquettes were immersed in water to further cure them.

Quantities of the materials is shown in the following tabulations:

			Wa	ter
Sample	Cement	Sand	%	CC
Brixment	1000g	3000g	11.1%	44 0cc
Medusa Mix	100 0g	5000g	11.6%	464cc
Portland	1000g	3 000g	10.7%	428cc
Utica	1000g	3 000g	13.4%	540cc

SEVEN DAY BRIQUETTES TESTS

B	rixment Me	dusa Mix	Peerless Portland	Utica
	60	130	225	85
	60	145	210	90
	65	130	230	95
	65	130	200	90
	60	135	240	85
	70	140	220	95
	80	130	2 10	90
	70	150	200	85
	60	140	225	95
	65	135	230	80
	70	145	205	90
	65	150	2 00	95
	70	145	220	85
	60	135	220	90
	70	140	205	85
	65	130	210	85
	70	150	230	95
	65	135	240	90
	75	145	235	85
	<u>65</u>	<u>130</u>	235	<u>95</u>
▲▼.	66#/ sq. in.	138#/sq. in.	220#/sq. in.	89 #/s q.in.

RANK OF CEMENTS AT 7 DAY TESTS

Peerless Portland Cement	2 2 0	168.	/ s q.	in.
Medusa Mix Cement	138	**	••	H
Utica Cement	8 9	Ħ	Ħ	Ħ
Brixment	66	**		n

Seven Day tests shows that the cements of higher rank are stronger cements or that they are quicker setting cements than those of lower rank.

The cement showing a low breaking strength at Seven Day Test is proven to be a slower setting cement as it has a higher breaking strength at Twenty Eight Day Test than has the cement just above it in the Seven Day Test.

B	rixment	Medusa Mix	Peerless Portland	Utica
	215	225	365	220
	240	210	400	220
	240	230	400	200
	200	225	3 90	200
	230	230	400	210
	210	215	395	205
	225	225	375	230
	235	220	39 0	220
	220	225	400	200
	225	230	385	205
	240	210	400	215
	240	215	39 5	220
	230	250	385	210
	220	220	380	200
	220	225	400	225
	225	215	390	205
	250	210	395	215
	225	220	3 90	220
	230	225	37 0	200
	<u>210</u>	235	<u>400</u>	205
Lv .	226#/sq.in.	221#/sq.in.	3 90 #/sq. in.	211#/sq.in.

RANK OF CEMENTS AT 28 DAY TESTS

Peerless Portland Cement	390
Brixment	226
Medusa Mix Cement	221
Utica Cement	211

Brixment which had the lowest rank in the Seven Day test now jumped to the highest rank of the Patented cements but was not to be compared with Peerless Portland Cement as an equal. Utica cement mortar seemed to be more elastic. This was noticed in the breaking by the long time taken in causing it to break.

COMPRESSION TESTS.

A three thousand pound concrete was designed by the Trial Method.

The proportion of water and cement was decided by use of the Water Cement Ratio Curve which is given in the Manual published by the Portland Cement Association.

It was decided to make the sample in a cylinder 3" in diameter and 6" in heighth as the heighth should be twice the diameter for such cylinders.

All the cement mortars were governed by the water cement ratio and the workability necessary for a mortar as it is used by a bricklayer in ordinary practice.

The cement and water were measured out and placed in the mixer. Sand was added to the cement, and water in portions which were weighed out as they were needed. The materials were allowed to mix for about five minutes. They were then poured into a pan and from there in the containers. A wet cloth was placed over the cylinders for the first 24 hours. The containers were then removed and the cement cylinders were placed in the wet chambers until breaking time.

At the end of the twenty four hour period the Utica cement was so green that it was necessary to leave it in the container until a later time.

All mixing was done in a 22 cu. ft. Smith mixer.

Quantities of Materials used are tabulated below:

Samples	Sand	Kater	Cement	Time
Brixmont	182 lbs	41 gal.	3/4 cu.ft.	
Line & Portland Coment	t 210 "	41 *	.625 * *	.125 cu. ft.
Nodusa Miz	198 -	41 "	3/4 • •	
Peerless Portland	200 "	41 m	5/4 • • .	
Utica Cement	184 "	41 "	3/4	

Lime and Postland Cement allows a larger batch of mortar te be made than does any other cement. This is one reason why many Contractors favor Lime mortar in preference to a Patented mortar. Bricklayers favor lime mortar for use as it is more workable than any other mortar - slips from the trowel easier.

.

SEVEN DAY COMPRESSION TESTS

]	Brixment	Lime & Portland	Medusa Mix	Peerless Portland	Utica
	4.25	8750	2412	12,675	365
	700	8350	26 00	13,550	350
	605	10800	2500	14,500	360
	490	9550	2600	12,525	325
	425	9350	2650	13,175	340
	700	8950	2550	13,000	395
	650	7800	21 00	12,800	410
	675	7350	2360	13,200	375
	570	8695	2510	11,950	270
	580	9200	2310	12,600	265
	500	8700	2400	13,200	290
	625	9315	2550	13,900	300
	570	8710	2500	12,700	380
	650	8250	2100	14,400	295
	675	10700	2360	12,900	340
	495	9600	2270	11,975	335
	<u>705</u>	7100	21 30	13,100	<u>395</u>
▲۳.	29 1	8704	2347	13,022	340
Av. per	85#/s g	." 1243#/sq	." 335#/sq.1	in. 1,860#/sq.in.	4 9#/ s q.in.

sq.in.

RANKING OF CEMENTS FOR SEVEN DAY COMPRESSION TEST

Peerless Portland Cement	1860 #/sq. in.
15% Lime with Peerless Portland Cement	1243#/sq. in.
Medusa Mix Cement	3 35#/sq. in.
Brizment	85#/sq. in.
Utica Cement	49#/sq. in.

Peerless Portland Cement as was expected was far superior to any of the Patented cements. Portland Cement guaged with 15% of lime was next in the rank. The Lime Portland Cement mixture seemed to set more slowly than Portland Cement alone due to the addition of lime. Medusa Mix was the best of the Patented Cements being four times as strong as the Brixment and six times as strong as the Utica Cement at the 7 day test. This cement seemed to set quicker than the other Patented cements.

If strength alone were to be considered Peerless Portland Cement would be the best cement. Flexibility is a favorable quality for the mortars to have and this quality is possessed by the Patented cements. They are considerably cheaper than Portland cements which is of great importance in building.

TWENTY EIGHT DAY COMPRESSION TEST

	Brixment	Lime & Portland	Medusa Mix	Peerless	Utica
	9 10	19,000	3,050	26,000	890
	860	18,200	3,750	23,000	870
]	1020	20,600	5,200	28,500	1015
	970	19,300	3,400	24,200	9 60
1	L 040	19,400	3,600	19,800	1040
	890	21,000	3,250	22,500	980
	880	20,600	3,340	27,000	99 0
	97 0	19,000	3,270	23,000	1060
	94 0	19,000	3,160	26,100	920
	895	21,100	3,640	24,650	900
	965	19,600	3,520	26,100	865
	980	21,300	3,810	22,600	79 0
	990	19,100	3,470	26,140	850
	945	19,200	3,640	26,200	90 5
	<u>930</u>	19,050	3.440	25.150	870
<u>ل</u> ۲.	870	19,660	3,436	24,730	927
Av.# per	125 #/sq.i :	n. 2,809#/sq.in	• 491#/sq.in	. 3,572#/sq.in	. 132#/sq.in.

8q."

RANK OF CEMENTS AT TWENTY EIGHT DAY COMPRESSION TEST

Peerless Portland Cement	3,572#/sq.in.		
15% Lime & Peerless Portland Cement	2,809#/sq.in.		
Medusa Mix Cement	4 91#/sq.in.		
Utica Cement	132#/sq.in.		
Brixmont	125#/sq.in.		

Peerless Portland Cement broke at the strength designed for in twenty eight days with a margin on the favorable side. Lime and Portland cement more than doubled in strength from seven days to twenty eight days. Medusa Mix gained a little more than one fourth its strength for the period, between seven days and twenty eight days. Utica cement jumped ahead of the Brixment and showed a tripling ef strength for the 21 day period between the tests. Brixment was almost on even rank with the Utica cement being only 7#/sq. in. lower.

SIXTY DAY COMPRESSION TEST

BI	ixment 15%	Lime & Portland	Medusa Mix P	eerless	Utica
	1700	19,100	4,430	27,000	2,200
	2230	19,200	4,100	24,000	1,850
	2165	21,600	4,100	28,500	1,500
	1600	19,500	4,350	25,200	1,930
	1900	19,800	4,900	19,900	1,920
	19 8 0	21,400	4,490	23,600	1,760
	1870	20,600	4,210	26,000	2,165
	1710	19,000	4,410	27,100	2,210
	23 10	19,100	4,190	25,000	1,510
	2220	21,500	4,100	27,100	1,920
	2175	19,700	4,250	25,100	1,910
	1610	21,400	4,900	23,500	1,750
	1990	20,600	4,490	27,000	2,150
	1960	19,100	4,220	24,900	2,200
	1830	19,200	4,430	27.000	1.500
Av .	1950	20,800	4,370	26,100	1,890
Av.# per Sq."	280#/sq.in.	2,900#/sq.in.	6 3 0 #/s q.in.	3,700#/8	q.in. 270#/sq.in.

RANKS OF CEMENTS FOR SIXTY DAY COMPRESSION TEST

Peerless Portland Cement	3,700#/sq.in.		
15% Lime & Peerless Portland Cement	2,900#/sq.in.		
Medusa Mix	630#/sq.in.		
Brixment	280 #/sq.in.		
Utica Cement	270#/sq.in.		

The Peerless Portland cement alone and Peerless Portland Cement guaged with 15% Lime showed a very small percentage of gain after 28 days being about 2 to 3%. Medusa Mix, Utica and Brixment showed a greater percentage of gain. All of these cements gained over 100#/sq.in. for the period between 28 day test and 60 day test.

CONCLUSIONS

Peerless Portland Cement and Peerless Portland cement guaged with 15% lime showed the strongest results being from 5 to 15 times stronger than the Patented mortars.

Portland cement mortar is more brittle than the Patented cement mortars which is not a favorable property. If the mortars are more elastic they will lend a helping hand to any settling that takes place in the foundation and cover up the cracks that would occur where Portland cement mortars were used.

	Tension		Compression		
Summary of Ranking	7 da.	28 da.	7 da.	28 da.	60 da.
Peerless Portland	1	1	1	1	1
" "15%Lime			la	la	la
Medusa Mix	2	2	2	2	2
Utica Cement	3	4	4	3	4
Brixment	4	2	3	4	3

Peerless Portland cement alone was 1st in all tests. Peerless Portland cement with 15% Lime was 2nd in all the tests given it.

Medusa Mix Cement took 2nd place in four places and was 3rd in only one place.

Brixment was second in one place, third in two places and fourth in two places.

Utica cement was third in two places and fourth in three places. This cement was lower than Brixment by a very small margin and for all practicable purposes could be said to be equal to Brixment. \$

Utica cement is different from all the other cements in that it is very pliable. It took about twice as long to break a cylinder of Utica cement as any other cement due to the gradual giving. The cement cylinder of Utica did not snap at its ultimate breaking point as did the others. They simply eased down and crumbled. ROOM USE ONLY





