A COMMERCIAL TEST

--of--

FOUR HYDRAULIC CEMENTS.

by

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CLASS OF 1900.

OUTLINE.

1. Description of Cements.
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A COMMERCIAL TEST OF FOUR HYDRAULIC CEMENTS.

It was the intention of the writer to make a test of cements made only in Kansas; but being able to secure but two Kansas Cements, two other leading commercial brands were secured with which to make comparison.

The cements that were put under test are as follows:

Germania, a Portland Cement.
Iola, " " "
Louisville, a natural cement.
Fort Scott, " " "

The Germania is a Portland cement, made in Germany near the border of Belgium. It is classed as one of the leading Portland cements. Its color is a light grayish blue and it is a fine grain cement, working easily under the trowel.

The Iola is a Portland cement, made by a plant just lately erected at Iola, Kansas, where natural gas is used as a fuel in calcining. The sample tested was made from the rock at Iola, which was shipped to the Company's plant in Michigan, and made there in order to find out what quality cement could be made from the material at Iola. The plant not being in operation when this test was begun, a sample of this cement was secured. The color of this cement is a little darker gray than the Germania and seems to be coarser as it works harder under the trowel and scratches more.

The Louisville is a natural cement made mostly on the Indiana side of the Ohio River, near Louisville, Kentucky.

The Fort Scott is a natural cement, made at Fort Scott, Kansas. It is very much like the Louisville. Both have a reddish brown color before mixing; but after setting the Louisville turns to a whiter color than the Fort Scott.

Test for Tensile Strength.

In all the tests only neat cement has been used. In this test eight briquettes of each kind were made every Monday. Only four briquettes for the 24 hr. test of ~~which~~ each were made. As soon as the briquettes were made, they were placed in moist air and kept there for 24 hrs. while setting.

The method used for keeping the air saturated is very simple. The briquettes were placed in a dry pan, over which was laid a damp coarse woven sack cloth, the cloth being supported so that it would not touch the briquettes, but the ends of the cloth rested in other pans, filled with water and capillary action kept the cloth moist.

The cements were mixed with a certain percentage of water for each cement determined before hand by ascertaining at what percentage it would work the best.

In the first set, each briquette was mixed separately, but in all the rest of the sets four were mixed at a time, except with the Louisville which set too fast to allow the mixing of more than one briquette.

The cement mortar was mixed on a large, heavy, plate glass, and all briquettes were given as nearly the same treatment in moulding as could be done with the apparatus at hand. They were worked with a trowel, and compressed in the mould till water appeared at the surface of the comparatively dry cement mortar.

The English-American form of briquette having a minimum cross section of one square inch was used.

The breaking of the tensile specimens was done with the Fairbanks Cement Testing Machine. The briquettes were broken so that the ages would be 1 day 1-2-3-4-5 & 6 weeks. The following tables show the record of the tests for tensile strength of each cement tabled separately.

Number	Cement	Water	Made	Age	Tensile Strength per. sq. inch	av. ten. str. per. sq. inch	Remarks
G 1-1	5 oz.	1 1/8 oz.	4/9/00	42 da.	698 lbs.		
G 1-2	" "	1 oz.	"	" "	706 "		
G 1-3	" "	" "	"	" "	560 "		
G 1-4	" "	" "	"	" "	761 "	677.1 lbs.	
G 1-5	" "	" "	"	" "	717 "		
G 1-6	" "	" "	"	" "	675 "		
G 1-7	" "	" "	"	" "	817 "		
G 1-8	" "	" "	"	" "	483 "		**
G 2-1	5 oz.	1 oz.	4/16/00	35 da.	768 "		
G 2-2	" "	" "	"	" "	713 "		
G 2-3	" "	" "	"	" "	760 "		
G 2-4	" "	" "	"	" "	758 "	723.5 lbs.	
G 2-5	" "	" "	"	" "	700 "		
G 2-6	" "	" "	"	" "	678 "		
G 2-7	" "	" "	"	" "	645 "		**
G 2-8	" "	" "	"	" "	766 "		
G 3-1	5 oz.	1 oz.	4/23/00	28 da.	681 "		
G 3-2	" "	" "	"	" "	653 "		
G 3-3	" "	" "	"	" "	551 "		**
G 3-4	" "	" "	"	" "	703 "	617.1 lbs.	
G 3-5	" "	" "	"	" "	650 "		
G 3-6	" "	" "	"	" "	745 "		
G 3-7	" "	" "	"	" "	570 "		**
G 3-8	" "	" "	"	" "	584 "		
G 4-1	5 oz.	1 oz.	5/3/00	21 da.	655 "		
G 4-2	" "	" "	"	" "	547 "		
G 4-3	" "	" "	"	" "	639 "		
G 4-4	" "	" "	"	" "	624 "	597.5 lbs.	
G 4-5	" "	" "	"	" "	542 "		

** Broke in lower clip

					per sq. inch	per sq. inch	
G 4-6	5 oz.	1 oz.	5/3/00	21 da.	579 lbs.		
G 4-7	" "	" "	"	" "	593 "		
G 4-8	" "	" "	"	" "	591 "		
G 5-1	5 oz.	1 oz.	5/7/00	14 da.	483 "		**
G 5-2	" "	" "	"	" "	531 "		
G 5-3	" "	" "	"	" "	597 "		
G 5-4	" "	" "	"	" "	605 "	521.7 lbs.	
G 5-5	" "	" "	"	" "	443 "		**
G 5-6	" "	" "	"	" "	583 "		
G 5-7	" "	" "	"	" "	415 "		**
G 5-8	" "	" "	"	" "	517 "		
G 6-1	5 oz.	1 oz.	5/14/00	7 da.	448 "		
G 6-2	" "	" "	"	" "	392 "		
G 6-3	" "	" "	"	" "	484 "		
G 6-4	" "	" "	"	" "	240 "	403.8 lbs.	
G 6-5	" "	" "	"	" "	529 "		
G 6-6	" "	" "	"	" "	367 "		
G 6-7	" "	" "	"	" "	452 "		
G 6-8	" "	" "	"	" "	319 "		**
G 7-1	5 oz.	1 oz.	5/15/00	24 da.	166 "		
G 7-2	" "	" "	"	" "	156 "	149.8 lbs.	
G 7-3	" "	" "	"	" "	126 "		
G 7-4	" "	" "	"	" "	151.5"		

IOLA--Kansas Portland.

Number	Cement	Water	Made	Age	Tensile strength per sq. inch	av. ten. str. per sq. inch.	Remarks
I 1-1	5 oz.	1 oz.	4/9/00	42 da.	660 lbs.		**
I 1-2	" "	7/8 oz.	"	" "	672 "		
I 1-3	" "	" "	"	" "	566 "		

** Broke in lower clip.

Number	Cement	Water	Made	Age	Tensile Strength per sq. inch	av. ten. str. per sq. inch	Remarks
1-4	5 oz.	7/8 oz.	4/9/00	42 da.	875 lbs.	699.15 lbs.	
I 1-5	" "	" "	"	" "	864 "		
I 1-6	" "	" "	"	" "	616 "		
I 1-7	" "	" "	"	" "	588 "		
I 1-8	" "	" "	"	" "	752 "		
I 2-1	5 oz.	7/8 oz.	4/16/00	35 da.	915 "		
I 2-2	" "	" "	"	" "	719 "		
I 2-3	" "	" "	"	" "	958 "		
I 2-4	" "	" "	"	" "	870 "	833.5 lbs.	
I 2-5	" "	" "	"	" "	788 "		
I 2-6	" "	" "	"	" "	876 "		
I 2-7	" "	" "	"	" "	764 "		
I 2-8	" "	" "	"	" "	779 "		
I 3-1	5 oz.	7/8 oz.	4/23/00	28 da.	796 "		
I 3-2	" "	" "	"	" "	761 "		
I 3-3	" "	" "	"	" "	397 "		**
I 3-4	" "	" "	"	" "	593 "	637.5 lbs.	
I 3-5	" "	" "	"	" "	837 "		
I 3-6	" "	" "	"	" "	813 "		
I 3-7	" "	" "	"	" "	424 "		
I 3-8	" "	" "	"	" "	479 "		
I 4-1	5 oz.	7/8 oz.	5/5/00	21 da.	925 "		
I 4-2	" "	" "	"	" "	890 "		**
I 4-3	" "	" "	"	" "	689 "		#
I 4-4	" "	" "	"	" "	611 "	798.3 lbs	°
I 4-5	" "	" "	"	" "	734 "		
I 4-6	" "	" "	"	" "	917 "		
I 4-7	" "	" "	"	" "	775 "		
I 4-8	" "	" "	"	" "	846 "		

** Broke in lower clip. # Shattered in lower clip. ° Broke lower clip and shattered in lower end.

					per sq. inch	per sq. inch	
I 5-1	5 oz.	7/8 oz.	5/7/00	14 da.	698 lbs.		
I 5-2	" "	" "	"	" "	796 "		
I 5-3	" "	" "	"	" "	646 "		
I 5-4	" "	" "	"	" "	815 "	676 lbs.	
I 5-5	" "	" "	"	" "	423 "		**
I 5-6	" "	" "	"	" "	673 "		
I 5-7	" "	" "	"	" "	694 "		
I 5-8	" "	" "	"	" "	663 "		
I 6-1	5 oz.	7/8 oz.	5/14/00	7 da.	576 "		
I 6-2	" "	" "	"	" "	607 "		
I 6-3	" "	" "	"	" "			#
I 6-4	" "	" "	"	" "	576 "	600 lbs.	
I 6-5	" "	" "	"	" "	536 "		
I 6-6	" "	" "	"	" "	714 "		
I 6-7	" "	" "	"	" "	593 "		
I 6-8	" "	" "	"	" "	655 "		
I 7-1	5 oz.	7/8 oz.	5/15/00	24 hrs.	221 "		
I 7-2	" "	" "	"	" "	225 "	241.2 lbs.	
I 7-3	" "	" "	"	" "	275 "		
I 7-4	" "	" "	"	" "	244 "		

LOUISVILLE--Natural Cement.

Number	Cement	Water	Made	Age	Tensile strength per sq. inch	av. ten. str. per sq. inch	Remarks.
1-1	4 oz.	1 1/4 oz.	4/9/00	42 da.	301 lbs.		
L 1-2	" "	" "	"	" "	310 "		
L 1-3	" "	1 3/8 "	"	" "	250 "	291 lbs.	
L 1-4	" "	" "	"	" "	299 "		
L 1-5	" "	" "	"	" "	286 "		
L 1-6	" "	1 1/2 "	"	" "	263 "		

** Broke in lower clip.

Broke while putting it in clip.

					per sq. inch	per sq. inch
L 1-7	4 oz.	1 1/2 oz.	4/9/00	42 da.	330 lbs.	
L 1-8	" "	" "	"	" "	289 "	
L 2-1	4 oz.	1 1/2 oz.	4/17/00	35 da.	228 "	
L 2-2	" "	1 3/8 "	"	" "	258 "	
L 2-3	" "	1 1/4 "	"	" "	272 "	
L 2-4	" "	" "	"	" "	284 "	257.25 lbs.
L 2-5	" "	" "	"	" "	217 "	
L 2-6	" "	" "	"	" "	255 "	
L 2-7	" "	" "	"	" "	257 "	
L 2-8	" "	" "	"	" "	287 "	
L 3-1	4 oz.	1 1/4 oz.	4/23/00	28 da.	281 "	
L 3-2	" "	" "	"	" "	237 "	
L 3-3	" "	" "	"	" "	201 "	
L 3-4	" "	" "	"	" "	249.5"	236.25 lbs.
L 3-5	" "	" "	"	" "	224 "	
L 3-6	" "	" "	"	" "	202 "	
L 3-7	" "	" "	"	" "	235 "	
L 3-8	" "	" "	"	" "	260 "	
L 4-1	4 oz.	1 1/4 oz.	5/5/00	21 da.	271 "	
L 4-2	" "	" "	"	" "	252 "	
L 4-3	" "	" "	"	" "	217 "	
L 4-4	" "	" "	"	" "	247 "	242.1 lbs.
L 4-5	" "	" "	"	" "	236 "	
L 4-6	" "	" "	"	" "	264 "	
L 4-7	" "	" "	"	" "	201 "	
L 4-8	" "	" "	"	" "	249 "	
L 5-1	4 oz.	1 1/4 oz.	5/7/00	14 da.	174 "	
L 5-2	" "	" "	"	" "	215 "	
L 5-3	" "	" "	"	" "	180 "	
L 5-4	" "	" "	"	" "	145 "	181.25 lbs.

					per sq. inch	per. sq. inch	
L 5-5	4 oz.	11/4 oz.	5/7/00	14 da.	183 lbs.		**
L 5-6	" "	" "	"	" "	189 "		
L 5-7	" "	" "	"	" "	175 "		
L 5-8	" "	" "	"	" "	184 "		**
L 6-1	4 oz.	1 1/4 oz.	5/14/00	7 da.	130 "		
L 6-2	" "	" "	"	" "	180 "		
L 6-3	" "	" "	"	" "	170 "		
L 6-4	" "	" "	"	" "	146 "	162.2 lbs.	
L 6-5	" "	" "	"	" "	174 "		
L 6-6	" "	" "	"	" "	166 "		
L 6-7	" "	" "	"	" "	164 "		
L 6-8	" "	" "	"	" "	168 "		
L 7-1	4 oz.	1 1/4 oz.	5/16/00	24 hrs.	198 "		
L 7-2	" "	" "	"	" "	194 "	182 lbs	
L 7-3	" "	" "	"	" "	141 "		
L 7-4	" "	" "	"	" "	198 "		

FORT SCOTT--Kansas Natural Cement.

Number	Cement	Water	Made	Age	Tensile strength per sq. inch	av. ten. str. per sq. inch	Remarks
F 1-1	4 oz.	1 1/4 oz.	4/9/00	42 da.	323 lbs.		
F 1-2	" "	" "	"	" "	300 "		
F 1-3	" "	" "	"	" "	302 "		
F 1-4	" "	" "	"	" "	284 "	308.7 lbs.	
F 1-5	" "	" "	"	" "	314 "		
F 1-6	" "	" "	"	" "	333 "		
F 1-7	" "	" "	"	" "	279 "		
F 1-8	" "	" "	"	" "	335 "		
F 2-1	4 oz.	1 1/4 oz.	4/17/00	35 da.	250 "		
F 2-2	" "	" "	"	" "	269 "		

**

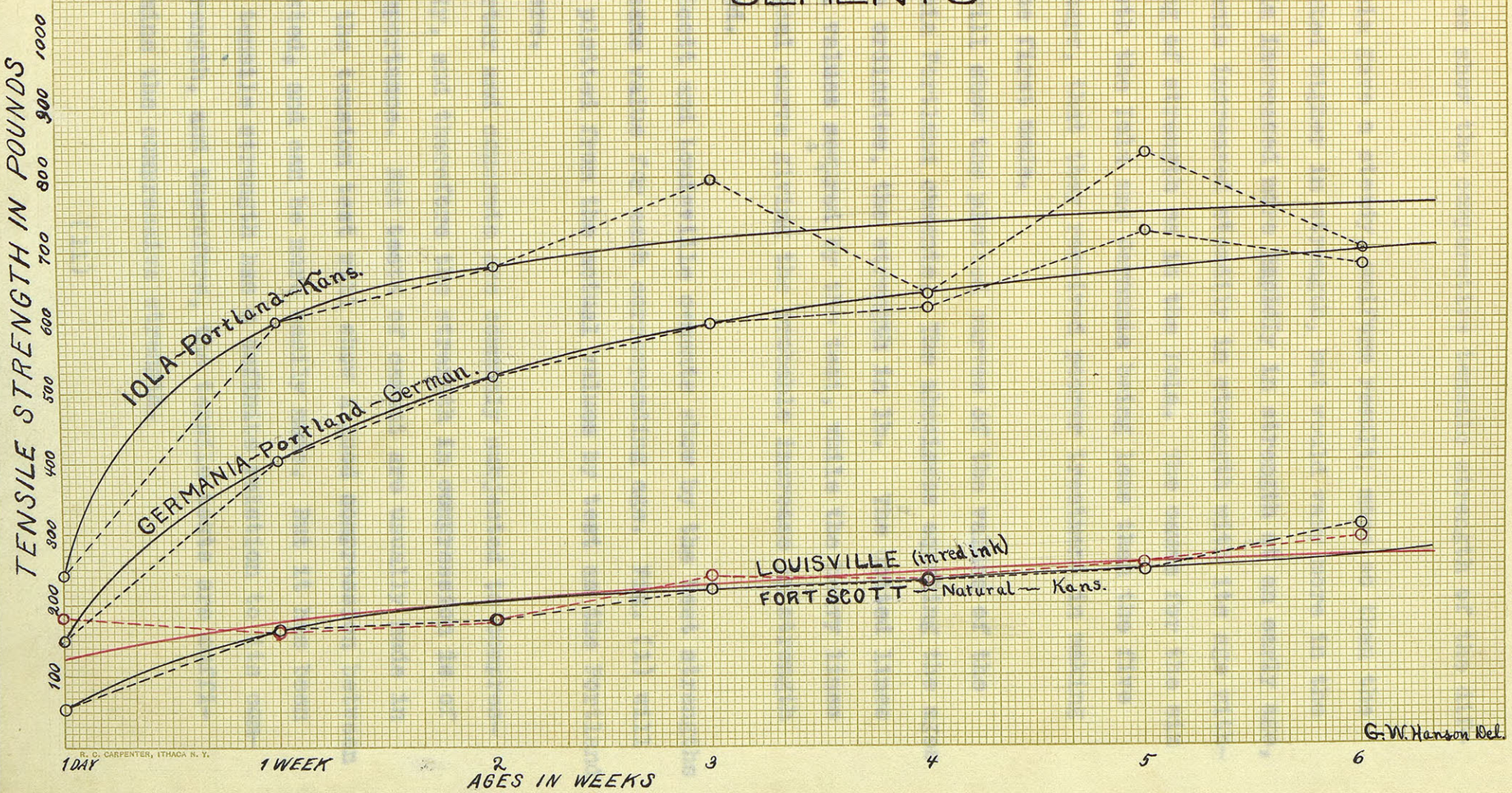
Number	Cement	Water	Made	Age	Tensile strength per sq. inch	av. ten. str. per sq. inch	Remarks
F 2-3	4 oz.	1 1/4 oz.	4/17/00	35 da.	226 lbs.		
F 2-4	" "	" "	"	" "	263 "	247.5 lbs.	
F 2-5	" "	" "	"	" "	215 "		
F 2-6	" "	" "	"	" "	263 "		
F 2-7	" "	" "	"	" "	221 "		
F 2-8	" "	" "	"	" "	283 "		
F 3-1	4 oz.	1 1/4 oz.	4/23/00	28 da.	180 "		
F 3-2	" "	" "	"	" "	291 "		
F 3-3	" "	" "	"	" "	254 "		
F 3-4	" "	" "	"	" "	270 "	233.5 lbs.	
F 3-5	" "	" "	"	" "	214 "		
F 3-6	" "	" "	"	" "	220 "		
F 3-7	" "	" "	"	" "	197 "		
F 3-8	" "	" "	"	" "	242 "		
F 4-1	4 oz.	1 1/4 oz.	5/5/00	21 da.	257 "		
F 4-2	" "	" "	"	" "	202 "		
F 4-3	" "	" "	"	" "	227 "		
F 4-4	" "	" "	"	" "	200	222.6 lbs.	
F 4-5	" "	" "	"	" "	226 "		
F 4-6	" "	" "	"	" "	227 "		
F 4-7	" "	" "	"	" "	220 "		
F 4-8	" "	" "	"	" "	223 "		
F 5-1	4 oz.	1 1/4 oz.	5/7/00	14 da.	193 "		
F 5-2	" "	" "	"	" "	182 "		
F 5-3	" "	" "	"	" "	171 "		
F 5-4	" "	" "	"	" "	200 "	181.3 lbs.	
F 5-5	" "	" "	"	" "	221 "		
F 5-6	" "	" "	"	" "	186 "		
F 5-7	" "	" "	"	" "	140 "		

Number	Cement	Water	Made	Age	Tensile Strength per sq. inch	av. ten. str. per sq. inch	Remarks
F 5-8	4 oz.	1 1/4 oz.	5/7/00	14 da.	158 lbs.		
F 6-1	4 oz.	1 1/4 oz.	5/14/00	7 da.	156 "		
F 6-2	" "	" "	"	" "	168 "		
F 6-3	" "	" "	"	" "	169 "		
F 6-4	" "	" "	"	" "	157 "	166.1	
F 6-5	" "	" "	"	" "	150 "		
F 6-6	" "	" "	"	" "	180 "		
F 6-7	" "	" "	"	" "	170 "		
F 6-8	" "	" "	"	" "	179 "		
F 7-1	4 oz.	1 1/4 oz.	5/16/00	24 hrs.	49 "		
F 7-2	" "	" "	"	" "	58 "	54 lbs.	
F 7-3	" "	" "	"	" "	60 "		
F 7-4	" "	" "	"	" "			°

° Broke while placing in position.

Fig.(1)

COMPARATIVE TENSILE STRENGTH OF CEMENTS



These tables show the comparative tensile strength of the different cements.

The Germania gave a steady, uniform result; more so than the Iola, which ranked higher in strength, but would vary more in the tests. The Iola increased more rapidly in strength at an early age, while the Germania increased steadily in strength with its age without any lowering of strength as in the Iola. The cause for the six weeks set in both the Iola and Germania being less than the five weeks, is, perhaps, that they received poorer treatment in making as they were the first made.

Fig. (1) will show the plotted curves of the values of the Iola and Germania Portland cements. The abscissas equaling the ages in days and the ordinates, the strength in lb. The dotted lines show the actual values secured by the test, while the heavy lines show a theoretical curve giving the probable increase in strength as age increased.

The Fort Scott and Louisville cements show by the test strengths of nearly the same value for each corresponding age. Fig. (1) will show the curve plotted from the actual values by test as the Portland and Germania were.

Cement mortar and concrete are commonly subjected to compressive stress only, and therefore the strength in compression is of the greatest importance. But tests of cement are usually made in tension, since the tension test will show a good compression between the cements tested, and can be more easily made. But it has been found that the tensile strength has a definite relation to its com- compressive strength, and therefore, the tensile tests are sufficient to determine the compressive strength.

The equation $\frac{\text{compressive str.}}{\text{tensile str.}} = 8.64 + 1.8 \log A$ in which A is the age in months, will give the approximate values for the compressive strength of the cemdnt. This equation was taken from Johnson's Materials of Construction and was developed by Prof. Tetmajer.

In order to see how nearly the actual compressive strength would coincide with the calculated strength, tests by compression of soild blocks of neat cement 2" x 2" x 4" and two weeks old, were made and the actual results compared with computed strengths.

The following table is the record of the compressive tests made on the blocks of cement by end bearing.

Test by compression neat cement blocks 2"X2"X4".

Number	Brand	Cement	Water	Made	Age	Total compression strength	comp. str. per sq. inch	av. com str. per sq
G 1-1	Germania	5 oz. to	1 oz	May 14	14 days	12350 lbs.	3087.5	2728 lb
G 1-2	"	" " "	" "	" "	" "	9475 "	2368.7	
I 1-1	Iola	5 oz. to	7/8 oz.	" "	" "	18700 "	4675	4987.5
I 1-2	"	" " "	" "	" "	" "	21200 "	5300	
L 1-1	Louisville	4 oz. to	1 1/4"	" "	" "	2370 "	592.5	851.2
L 1-2	"	" " "	" "	" "	" "	4440 "	1110	
F 1-1	Fort Scott	" " "	" "	" "	" "	2960 "	740	785.6
F 1-2	" "	" " "	" "	" "	" "	3325 "	831.2	

* Not very well packed.

Applying the equation $\frac{\text{comp. strength}}{\text{tensile strength}} = 8.64 + 1.8 \log A$

Here A = .5 tensile strength from table of Germania test for two weeks = 522 lb. Let Comp. str. = C.

substituting in above equation

$$\frac{\text{comp. strength}}{522} = 8.64 + 1.8 \log .5$$

$$\frac{C}{522} = 8.64 + 1.8 (\bar{1}.69897)$$

$$\frac{C}{522} = 8.64 + (\bar{3}.05814)$$

$$\frac{C}{522} = 5.582 \text{ lb.}$$

$$C = 2914 \text{ lb.}$$

For Iola cement A = .5 and ten. strength =676 lb.

The second member of the equation will equal 5.582 for all of the age of two weeks.

Hence,

$$\frac{C}{676} = 5.582 \text{ lb.}$$

$$C = 3773 \text{ lb.}$$

For Louisville cement ten. strength = 181 lb. A = .5

then

$$\frac{C}{181} = 5.582$$

$$C = 1000 \text{ lb.}$$

For Fort Scott C = 1000 lb. as the tensile strength = 181

Table showing the comparison between calculated compressive strength and actual.

Brand	Actual compressive strength.	Calculated comp. str.
Iola	4987. lb.	3773. lb.
Germania	2728. "	2914. "
Louisville	851 "	1000. "
Fort Scott	785. "	1000. "

This table shows that the calculated strength is approximately near the actual. The only cement that showed any considerable variation from this rule is the Iola whose actual comp. strength exceeded the calculated by 1214 lb. The rule may be considered sufficiently correct for an approximate determination of compressive strength from the tensile strength.

The following table shows the tensile strength of the cements and the calculated compressive strength.

Age	Iola. Port. cement		Germania. Port cement		Louisville. Cement.		Fort Scott. Natural Cement	
	ten. str.	Calculated comp. str.	ten. str	calculated comp. str.	ten. str.	calculated comp. str.	ten. str.	calcu com. s
1 day	241 lbs.		150 lbs.		182 lbs.		54 lbs.	
1 wk.	600 lbs.	3672.	404 lbs.	2472 lbs.	162 lbs.	991 lbs.	166 lbs.	1015
2 wk.	676 lbs.	3373 lbs.	522 lbs.	2914 lbs.	181 lbs.	1000 lbs.	181 lbs.	1000
3 wk.	798 lbs.	5195 lbs.	597 lbs.	3113 lbs.	242 lbs.	1250 lbs.	223 lbs.	1061
4 wk.	638 lbs.	5572 lbs.	617 lbs.	5331 lbs.	236 lbs.	2039 lbs.	234 lbs.	2012
5 wk.	834 lbs.	7826 lbs.	724 lbs.	6360 lbs.	257 lbs.	2256 lbs.	248 lbs.	2178
6 wk.	699 lbs.	6361 lbs.	677 lbs.	6064 lbs.	291 lbs.	2605 lbs.	309 lbs.	2768

Test for Soundness.

The test for soundness was made by boiling, following the rules laid down by the leading experts of Europe at the Fifth International Convention for unifying methods for testing construction materials held in Zurich Sept. 1895.

The test consisted of mixing neat cement with enough water to bring it to a plastic state after proper working, then forming with the hands twoballs of each kind from 1 1/2 ro 2 inches in diameter. These were kept in moist air until set had taken place, leaving them there for 24 hours. They were then taken and put in a dish of distilled water, and then slowly brought to a temperature of boiling point, consuming not less than thirty minutes in so doing. The dish was then put in a heating oven with a device for regulating the heat in the oven so it could be kept at a constant temperature. Here it was kept for three hours, at a constant temperature of 212° F.

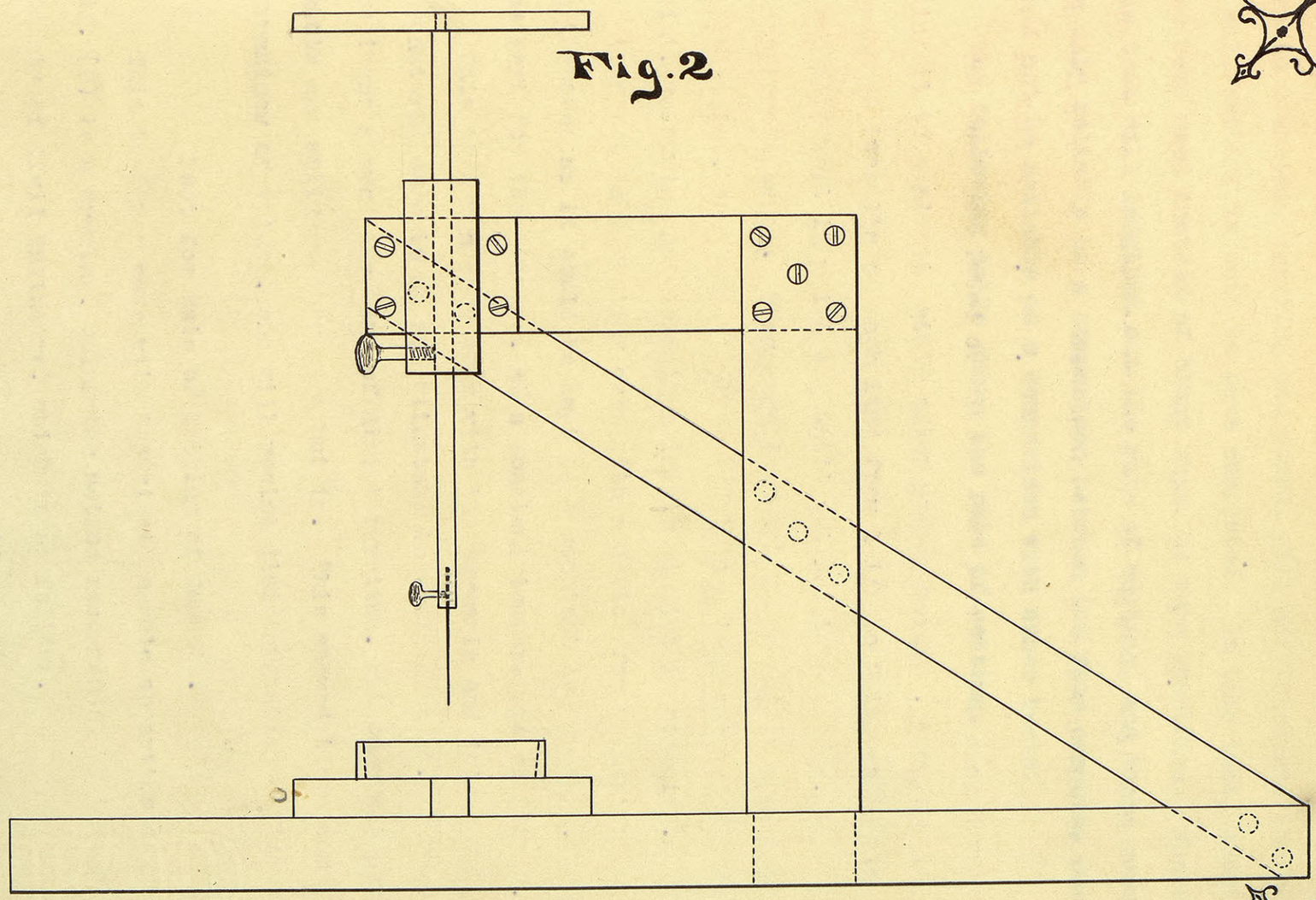
This test wam made only with the Germania and Iola cement, as the natural cements do not withstand the boiling test. None of the specimens showed any kind of disintergration, but came out perfectly smooth and solid as they were put in. This showed these cements have permanincy of volume, and will resist disintergrating influences.

Test for Rate of Setting of Cements.

This test was made with the vicat needle apparatus of which Fig. (2) is a drawing, using the method recommended by the American Society of Civil Engineers, which is as follows.

A neat cement mortar, having a stiff, plastic consistency is placed in a form two or three inches in diameter and one half inch thick, When a needle one-twelfth of an inch in diameter weighted with one-fourth of a pound, ceases to penetrate the entire mass, setting is said to have begun; when a needle one-twentyfourth of an

Fig. 2



The Vicat Needle Apparatus half size

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inch in diameter, carrying one pound, will not penetrate the mass at all, setting is said to have completed. In this test, sharp needles were used instead of blunt ones, as were specified. Therefore, this test will lengthen out the rate of setting, and these results are only reliable as a comparison between the four cements, but would not be reliable as a comparison with other tests.

The following table shows the rate of setting.

Test for rate of setting of cements.

Brand	Time when mixed.	Time when setting begins	Time consumed till set. begun	Time when set. is done	Time consumed from mixing to finish.
Germania	7:45 a.m.	8:15 a.m.	30 min.	5 p.m.	9 hr. 15 min.
Iola	7:50 a.m.	8:55 a.m.	1 hr. 5 min.	5:30 p.m.	9 hr. 40 min.
Louisville			4 min. 45 sec.		10 min. 12 se
Fort Scott	7:45 a.m.	8:30 a.m.	45 min.	10 p.m.	14 hrs. 15 mi

Test for rise of temperature during setting of Louisville cement.

While making briquettes of Louisville cement, they would heat and become quite warm while setting. This was perhaps on account of the presence of an excess of lime, or on account of the rapid setting that takes place in this cement.

In order to find what the variation of temperature was, this cement was mixed and formed in a ball around the bulb of a centigrade thermometer graded to tenths of degrees, and readings taken every half minute, of the temperature from the time water was mixed with the cement. The first minute was occupied in mixing and placing the ball in place so no readings were made then.

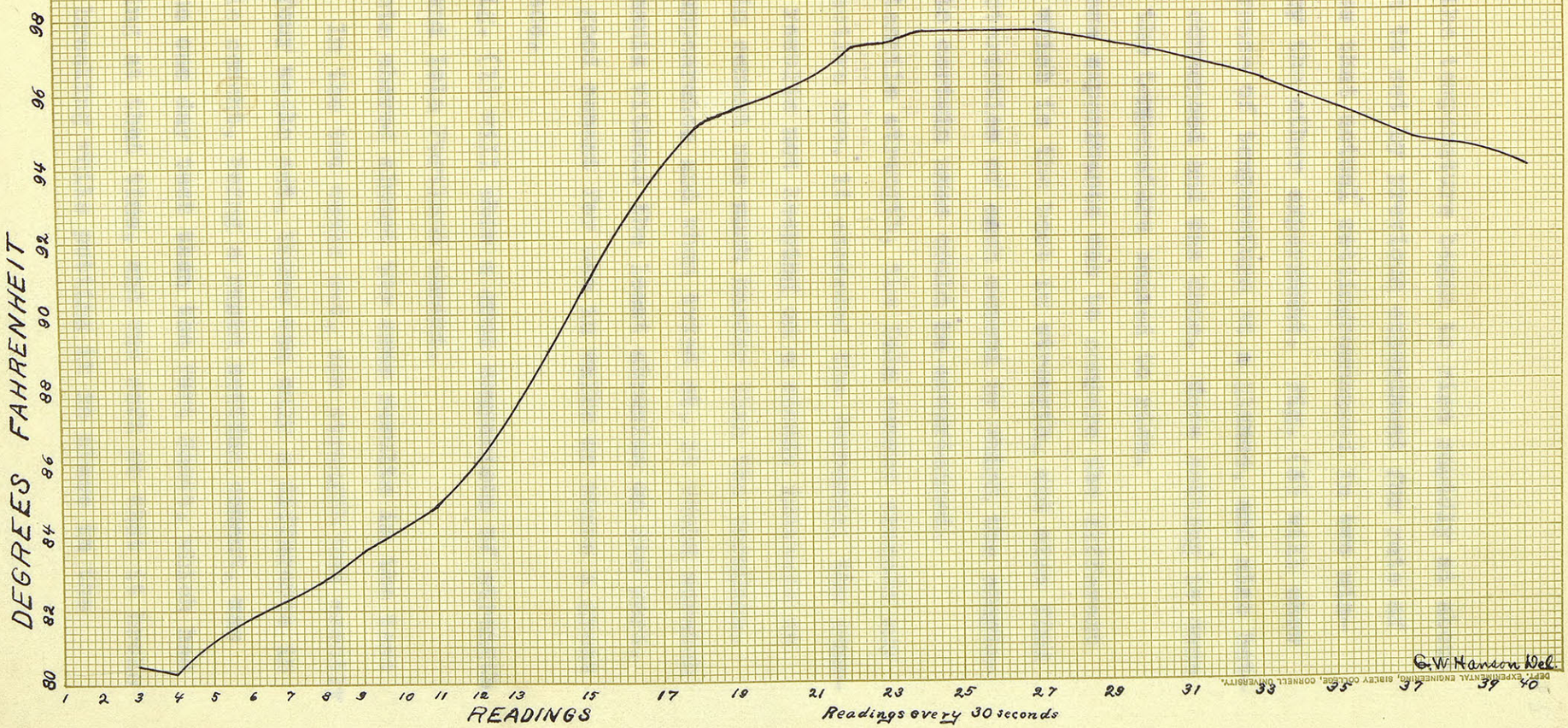
The following table shows the rise and fall of temperature every half minute for 20 minutes.

Test for rise of temperate during setting.

Reading	Degrees Cent.	Degrees F.	Reading	Degrees Cent.	Degrees F.
1			21	35.8	96.2
2			22	36.1	97.8
3	27	80.5	23	36.2	97.2
4	26.9	80.3	24	36.4	97.5
5	27.3	80.2	25	36.4	97.5
6	27.7	81.8	26	36.4	97.5
7	28.1	82.3	27	36.4	97.5
8	28.4	82.8	28	36.3	97.3
9	28.7	83.6	29	36.2	97.2
10	29	84.2	30	36.1	97
11	29.5	84.8	31	36	96.7
12	30.	86	32	35.9	96.5
13	30.8	87.3	33	35.8	96.2
14	31.7	89.	34	35.4	95.7
15	32.7	90.8	35	35.2	95.4
16	33.5	92.4	36	35.	95.
17	34.3	93.8	37	34.8	94.6
18	35	95	38	34.6	94.4
19	35.3	95.4	39	34.5	94.2
20	35.5	95.8	40	34.3	93.8

Fig (3)

RISE OF TEMPERATURE DURING SETTING OF LOUISVILLE CEMENT



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This shows that the temperature began to rise rapidly at about the time that it began to set by previous experiment for rate of setting. It also shows that actual settingcommenced in two minutes, much less than by the other experiment. Fig. (3) will show by the curve, the increase of temperature at a glance, and also better where the setting commenced and was done. Here setting is done in 12 minutes as then the temperature ceased to rise.

The object of these experiments was to compare the different cements and determine which is the best in strength, and also find out some of the characteristics of each cement by which the adaptability of the cement to certain uses could be ascertained.

In the test for tensile strength, the Iola cement exceeds any other, for every respective age, it exceeded the Germania, tho somewhat irregular in the results not keeping on a steady increase as the Germania. The Iola cement was much harder than the Germania. It had a sharp flint appearance and when tried at, it would scratch and wear away the Germania without the least abrasion on its part. This would indicate a good cement for use in walks or where a great deal of wear takes place.

The diagram on Fig. (1) will show a good comparison of strength between the Germania and Iola Portland cement.

The natural cements showed almost the same results in the test for tensile strength. In the two weeks set, the strength was exactly the same, and in the four weeks set, there was only a difference in two lb. The Louisville cement, being a rapid setting cement, was much stronger in in the one day test than the Fort Scott, which had just barely done setting at that time, and was soft so that it broke easily, one briquette breaking while putting it in place in the clamps.

Fig. (1) also shows the diagram that will give a good comparison of the strengths of these cements. These two cements are very nearly the same in strength, but could not both be put to the same uses, as the Louisville cement will complete setting in twelve minutes while it takes the Fort Scott about 14 hours. to completely set. This rapid setting would make it impossible to use when the cement is not used just as soon as mixed.

The following table will give a summary of all the tests that all the four cements were subjected to.

A commercial test of hydraulic cement.

Age	Iola Portland	Germania Portland	Louisville Natural	Fort Scott Natural
		Test for tensile strength per sq. inch.		
1 day	241 lbs.	150 lbs.	182 lbs.	54 lbs.
1 wk.	600 "	404 "	162 "	166 "
2 wk.	676 "	522 "	181 ""	181 "
3 wk.	798 "	597 "	242 "	223 "
4 wk.	638 "	617 "	236 "	234 "
5 wk.	834 "	724 "	257 "	248 "
6 wk.	699 "	677 "	291 "	309 "
	Test for compressive strength per sq. inch end bearing on blocks 2"X2"X4"			
2 wk.	4987 lbs.	2728 lbs.	851 lbs.	785 lbs.
		Test for rate of setting.		
Time till set. begins	1 hr. 15 min.	30 min.	4 min. 45 sec.	45 min.
Time till set. is done	9 hrs. 40 min.	9 hrs. 15 min.	10 min. 12 sec.	14 hrs. 15 min.