RELATION OF WATER TO TENSILE STRENGTH IN SUPER CEMENT MORTARS

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EARL L. CLARK

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Relation of Water to Tensile Strength in Super Cement Mortars

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By

Earl L. Clark

Candidate for the Degree of Bachelor of Science

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Super Cement was first made in England by an English investigator. It was successfully used in Great Britain for a number of years, prior its introduction into Canada in 1920. Now it is freely used in both countries in every kind of work where cement is used.

After thorough investigation and determination of some of the merits of Super Cement, the Peerless Portland Cement Company, has secured the right to manufacture this product. At present the Peerless Portland Cement Company has two factories, one at Detroit, and one at Union City, Michigan.

Super Cement is a more efficient form of Portland Cement, rendered so by the incorporation of a substance known as catacoll during the manufacturing process.

Catacoll, itself has no more cementing qualities than the raw Gypsum, which is ordinarily used in the manufacture of Portland Cement, a portion of which it replaces. Catacoll occupies no greater volume and it is anything but a water repellant.

The strength and impermeability developed in Super Cement concrete are derived from the reactions which occur between the mixing water and the constituents of the clinker. The function which catacoll accomplishes is to facilitate these reactions, and thus ensure that they will be more complete than is the case in Portland Cement.

Super Cement hydrates more thoroughly than Portland Cement, that is to say a greater portion of it combines chemically with the mixing water to form the cementing medium on which concrete depends for its qualities of cohesive and adhesive strength and stable density. Consequently greater strength in tension, compression and adhesion are obtained with Super Cement.

Super Cement combines the forgoing features to produce concrete of

great denseness. This tendency is further promoted by the action of the catacoal in influencing the constituents of the cement to form a hydrate of a more colloidal nature than that produced by the union of ordinary Portland Cement and water. As a final result, Super Cement produces a concrete which is impervious to liquids, that is water proof.

Super Cement is made in the same manner as Portland Cement, in fact the same grinding processes and the same machinery is used for both cements. Super Cement is not finer ground than ordinary Portland Cement, and it is nothing more or less than improved Portland Cement. The foregoing has been quoted from pamphlets published by the Peerless Portland Cement Company.

This experiment, the effect of water on the tensile strength of Super Cement mortars was performed in the laboratory. All specimens were made under like conditions, using the same quantities of Super Cement and sand, the one to three was used, but with different percentage of water.

The sand used in the mix was somewhat graded in that what was used passed a number twenty sieve. The sand was very dry and fairly clean.

All mixing was done according to the specifications of the American Society of Testing Materials.

The standard gang mold was used for all specimens, there being four to a gang and each test for a certain day was made of four specimens, also the mix for one complete test for each percentage of water used was all mixed at the same time and immediately placed in the moulds.

The specimens were placed one day in moist air and the remainder of the time in water until tested.

Four briquettes were tested at the end of the first day, four the second day, four the third day, and four on the fifth, seventh, fourteenth, twenty-first and twenty-eighth days. All specimens were tested in the Rheile tension testing machine. The four briquettes were tested for

each day and each test recorded. If for any reason a briquette tested low or high according to the others of that same group, it was discarded. However, the tests of each group ran very uniform and there were only a very small percentage of the tests disregarded. The strength for each period was taken as the average of that particular group.

The different percentages of water used in the mix were from ten, and increasing by one per cent to, and including, nineteen per cent.

With the ten and eleven percentages of water mixes the strength increased rapidly for the first week, then more gradually thereafter. Of all the specimens tested the ten and eleven percentage of water mixes give the least strength at twenty-eight days. There was another element very noticeable in these mixtures that were low in water. The quantities with exception of water, that were used for all mixes were the same and the same number of moulds were filled with each, but with these two percentages of water mixes there was more mortar left over that was not needed than with the other mixes. This was due to the sand bulking, consequently more volume and less material per given volume, and so less strength could be expected.

With the twelve and thirteen per cent mixes, the strength the first week was very much the same as for the dryer mixes. But the second and third weeks there was a decided change, even a decrease in strength with the twelve per cent water mix. Perhaps the chemical action had ceased for a time. Then again the fourth week the tensile strength increased very rapidly, as shown by the curve.

The fourteen and fifteen percentages of water mixes are about normal consistency and they seem to give the best results. However, with the fifteen percent of water mix there is a period in which the strength does not increase. This period is during the third week, and is, without doubt, due to an excess of water, because this same period

occurs in the sixteen percent of water mix but is much more noticeable by comparison of the curves. Then too, with the fourteen percent of water mix, this period does not occur at all.

The wetter mixes of seventeen, eighteen and nineteen, percentages of water had the higher strengths at twenty-eight days. With the nineteen percent of water mix, the strength was highest of all specimens at twenty-eight days. This mix also increased in strength uniformily throughout the test. However with all of these apparently good results these higher percentages of water mixes should not be considered because when the mortar was placed in the moulds the mix was so wet that some of the water ran out of the mortar on the curing pan. This water escaping from the briquette would lower the percentage of water in the mix considerably.

The results obtained indicate that fourteen percent of water gives the highest and most nearly uniform strength as far as tensile strength is concerned.

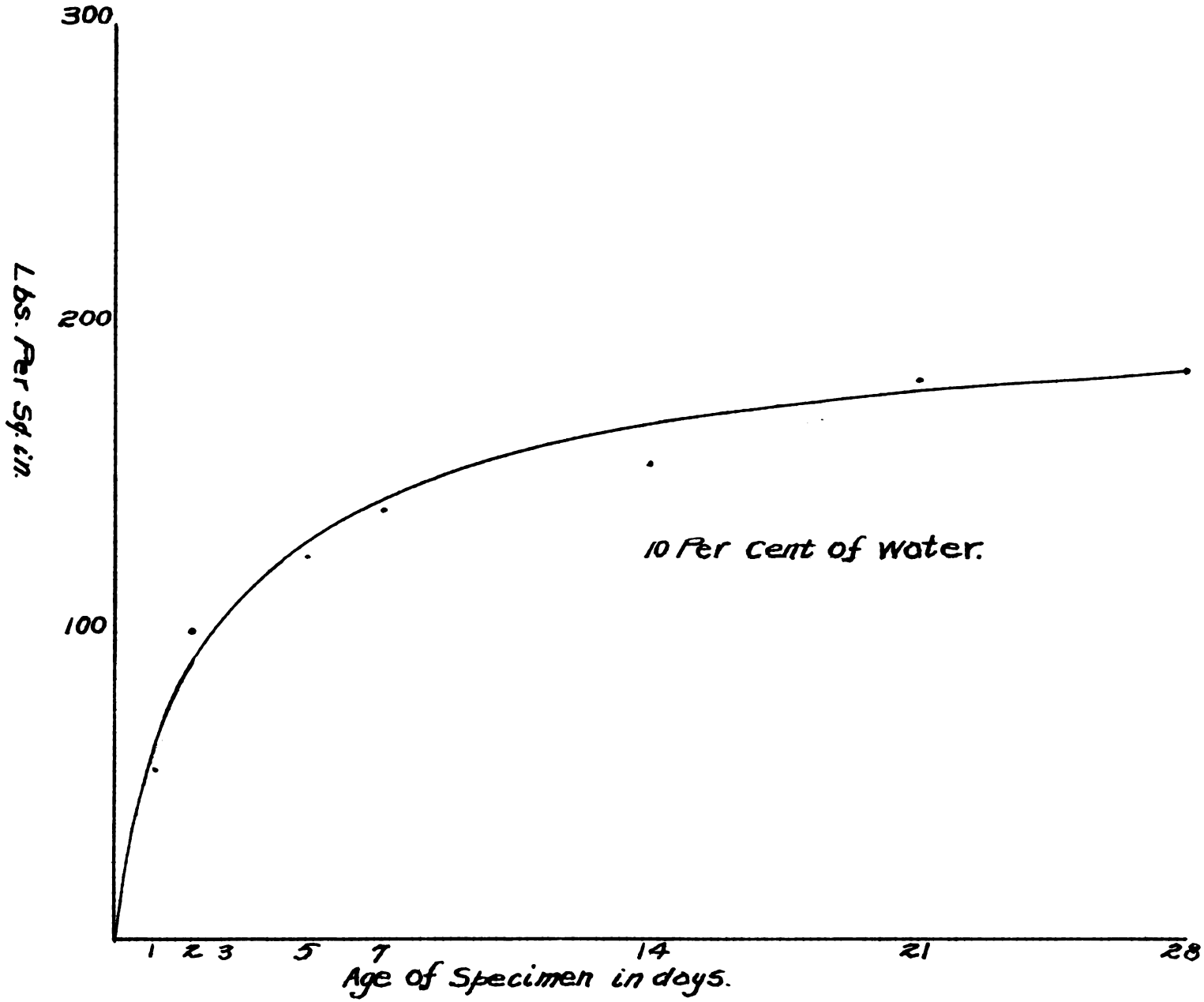
Results of Specimens Tested

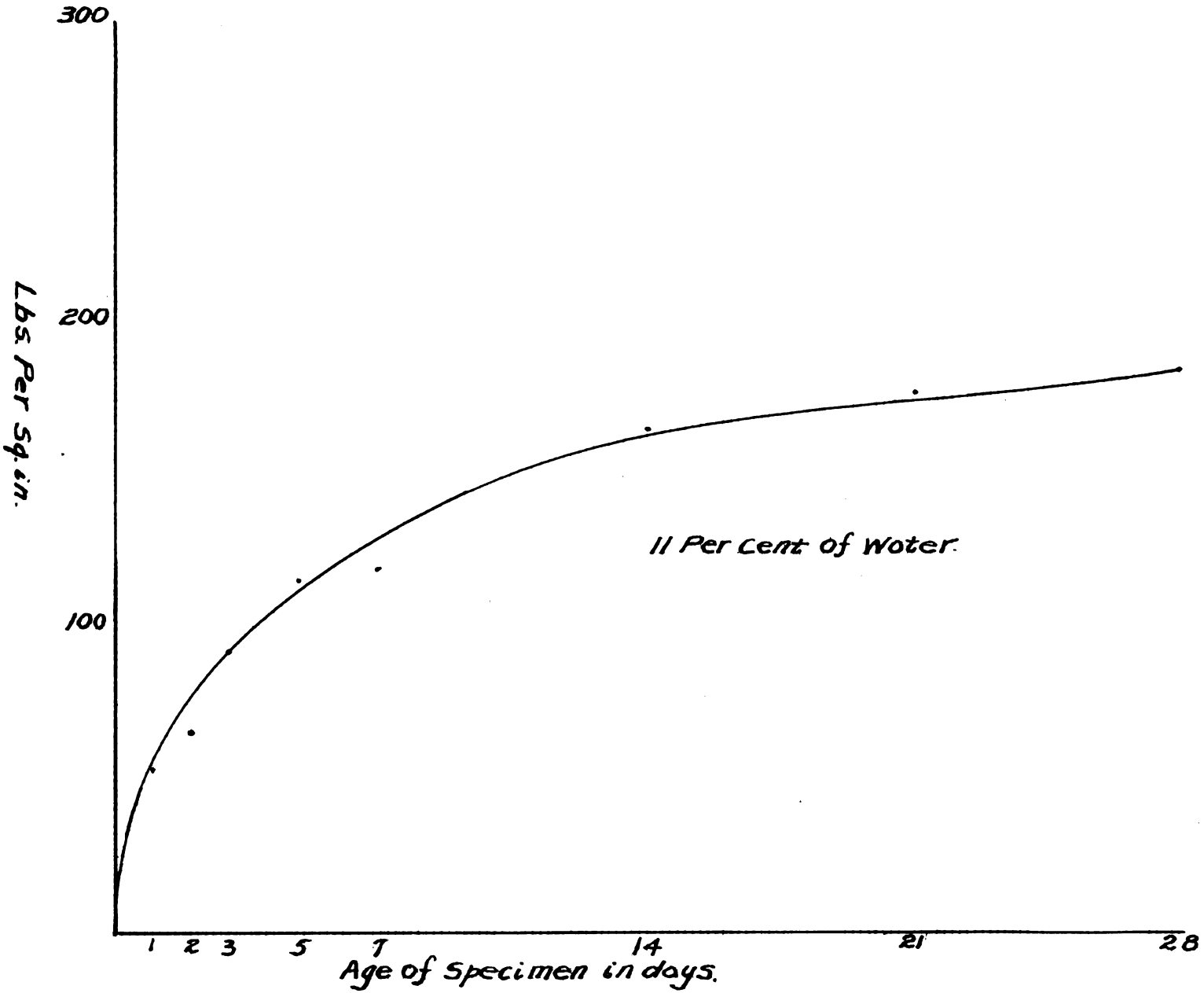
Percentage of water	1 day	2 days	3 days	5 days	7 days	14 days	21 days	28 days
10	60	100	70	140	160	160	160	165
	60	100	120	110	150	160	170	130
	60	100	120	120	100	150	180	160
	60	100	130	130	150	150	200	*
Average	60	100	110	125	140	155	177	152
11	50	65	90	120	120	170	200	200
	50	70	90	90	130	150	160	-240-
	65	60	100	140	110	140	160	170
	55	70	90	115	120	195	180	185
Average	55	66	92	116	120	164	175	185
12	50	55	65	145	155	170	165	190
	50	60	60	120	170	140	135	210
	45	60	90	105	200	175	180	200
	45	60	70	110	130	155	*	*
Average	47	59	71	120	163	160	160	200
13	50	90	120	110	130	190	235	-170-
	50	85	120	135	145	190	210	240
	70	110	110	120	155	230	220	260
	50	95	-70-	-80-	190	210	*	250
Average	55	92	117	122	155	205	221	250
14	50	110	120	185	180	250	310	290
	60	110	125	165	185	250	270	300
	80	100	125	170	185	270	320	300
	60	-70-	105	170	190	240	270	290
Average	50	106	119	172	184	252	292	295
15		80	115	150	165	250	235	280
		100	105	175	200	235	255	270
		80	105	170	205	250	245	275
		90	-70-	160	195	260	*	*
Average		88	108	163	191	249	245	275
16	60	60	125	110	190	315	245	300
	70	70	125	140	150	240	240	270
	60	65	100	170	165	255	255	300
	70	75	120	150	135	285	240	*
Average	65	68	117	140	160	249	245	290

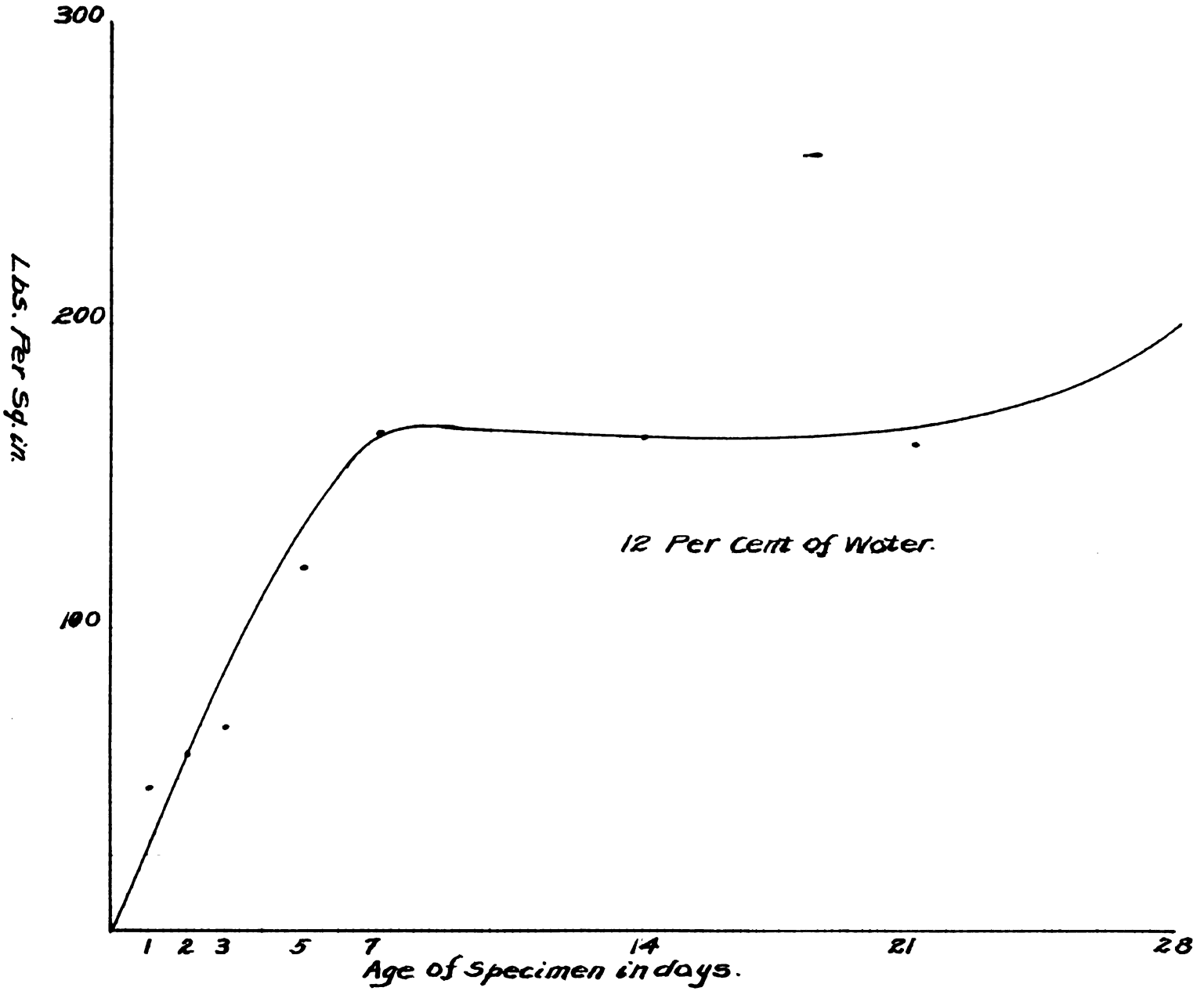
Results of Specimens Tested

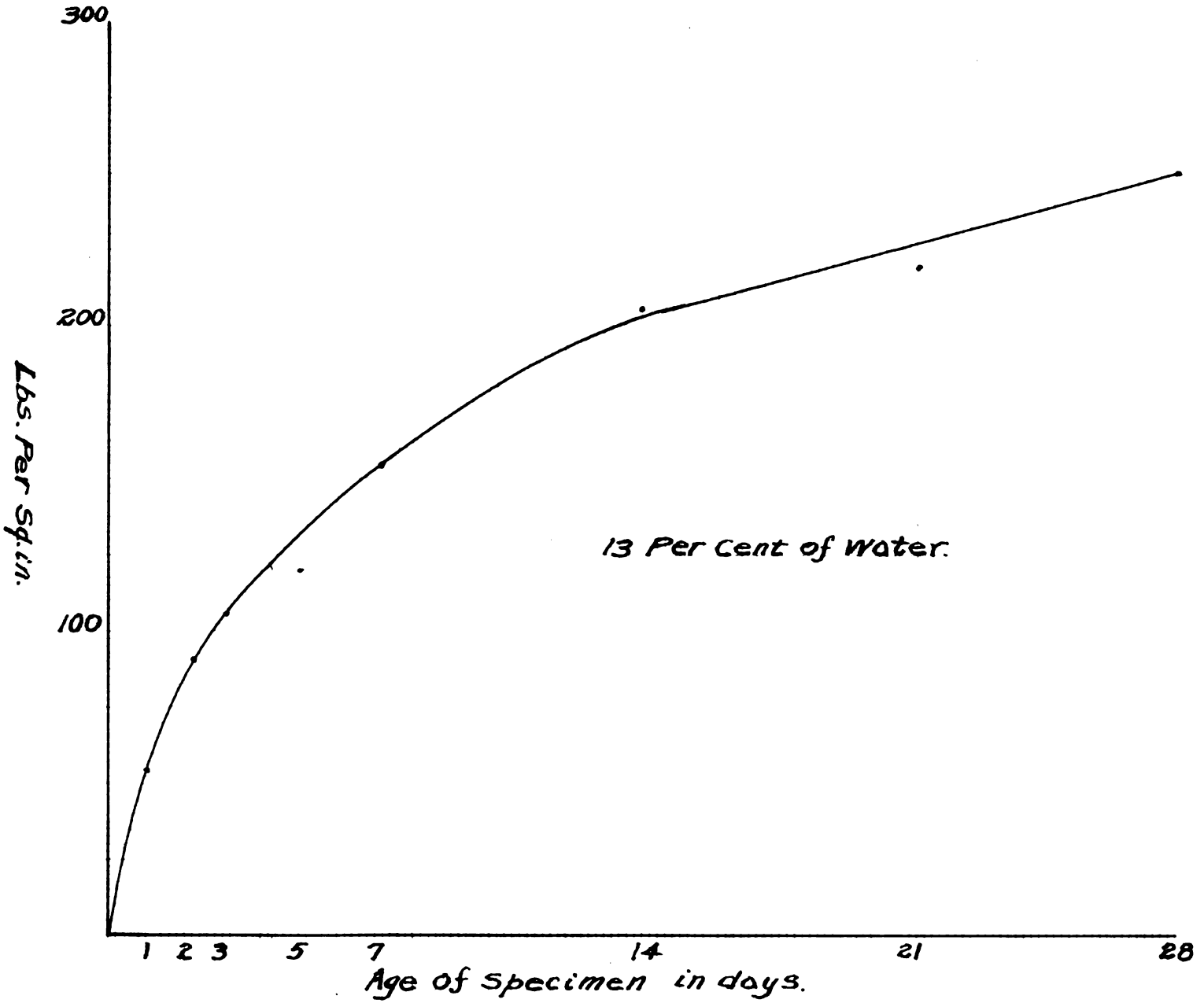
Percentage of water	1 day	2 days	3 days	5 days	7 days	14 days	21 days	28 days
17	50	55	115	160	180	285	250	330
	60	60	115	120	155	220	260	300
	60	65	140	130	180	255	300	300
	50	55	135	-99-	175	260	275	280
Average	55	58	126	133	172	255	272	303
18		55	70	130	180	245	225	290
		90	100	150	190	250	210	300
		55	95	120	170	255	235	330
		70	60	135	170	240	225	280
Average		66	81	144	177	247	224	300
19		80	60	140	175	255	270	310
		80	110	140	140	300	300	260
		60	100	135	155	290	305	280
		70	70	140	165	315	290	330
Average *		72	85	139	159	290	291	295

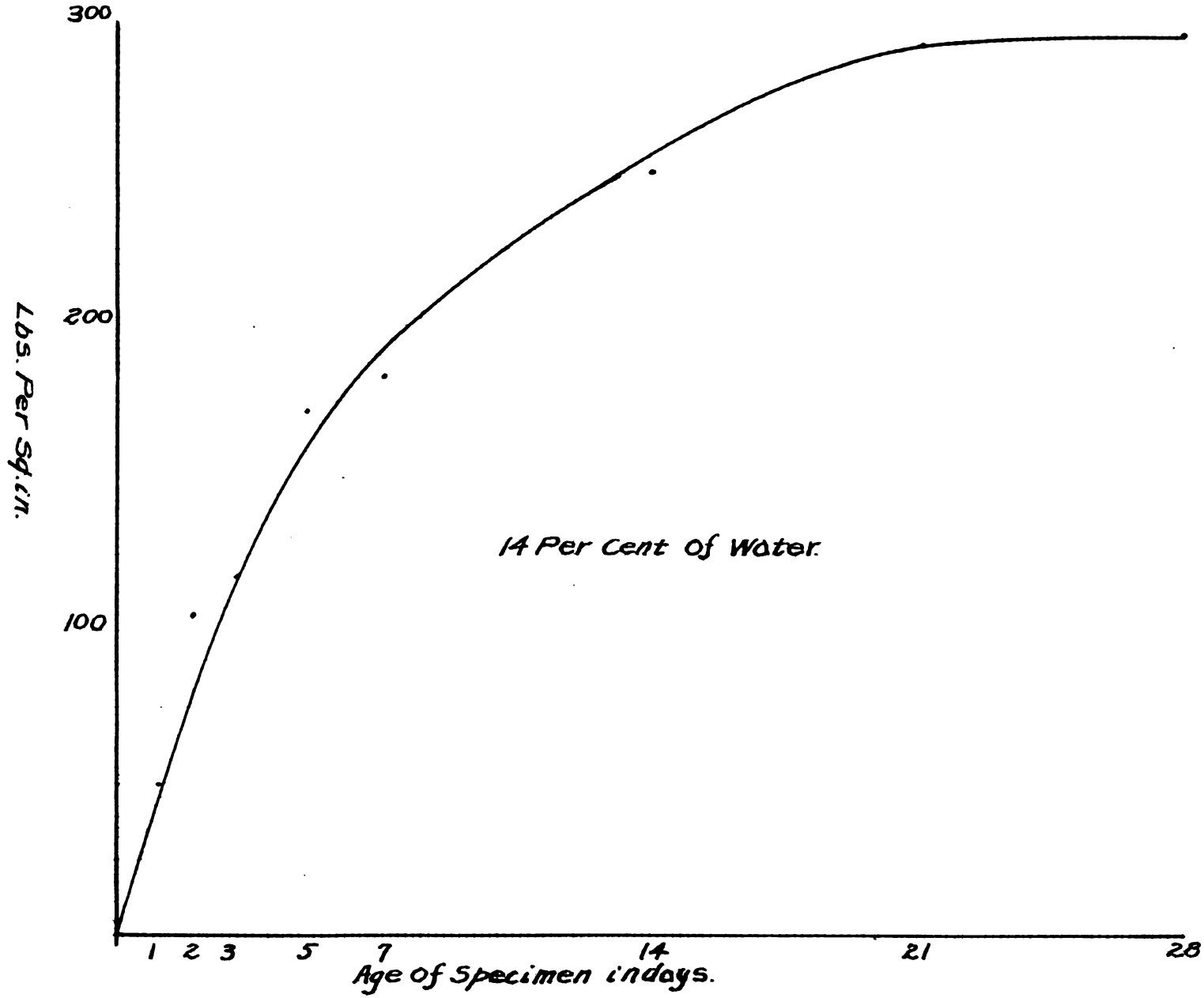
* Only three specimens tested.

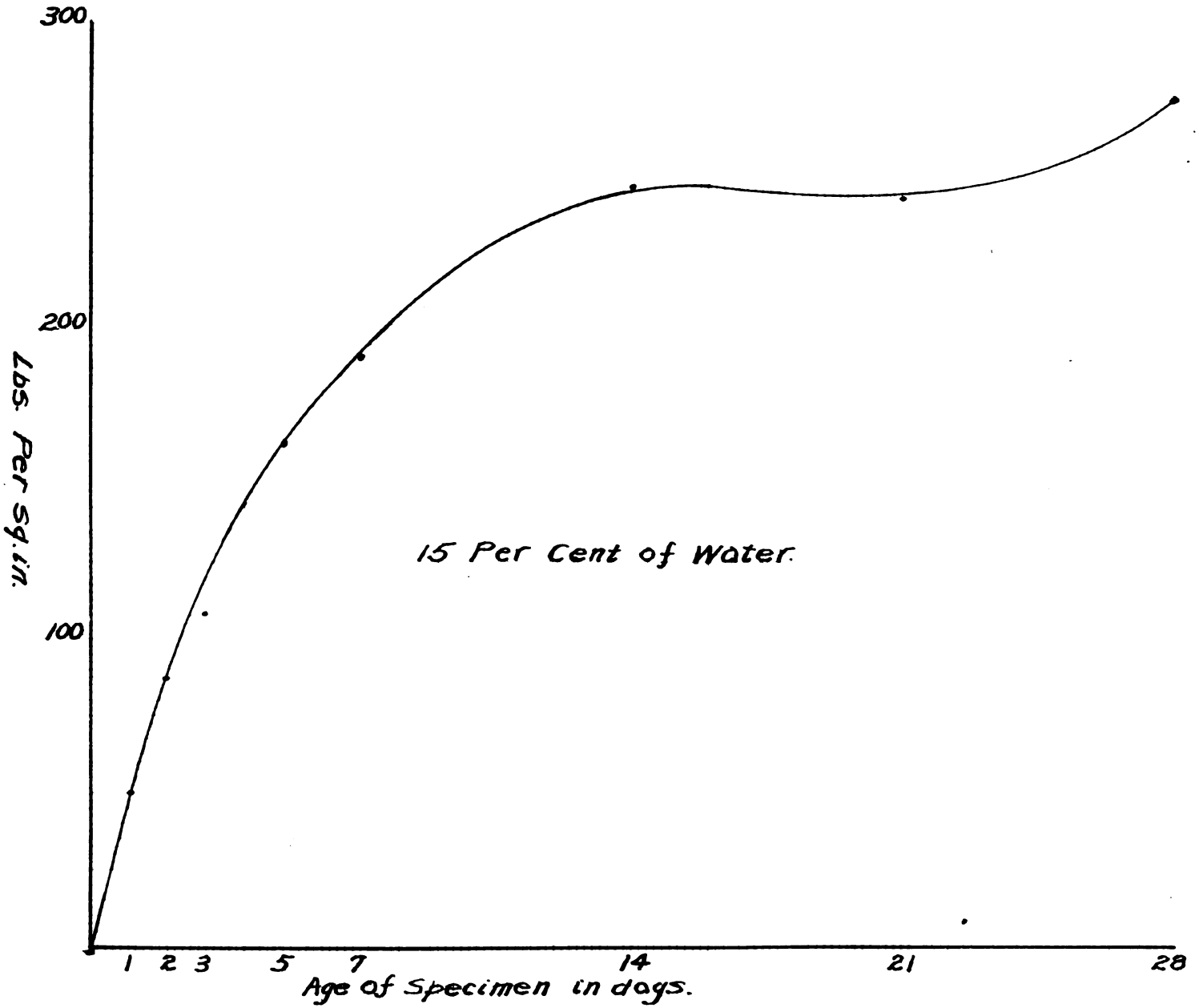

300
200
100
Lbs. Per Sq. in.
10 Per Cent of Water.
1
2
3
5
7
14
21
28
Age of Specimen in days.

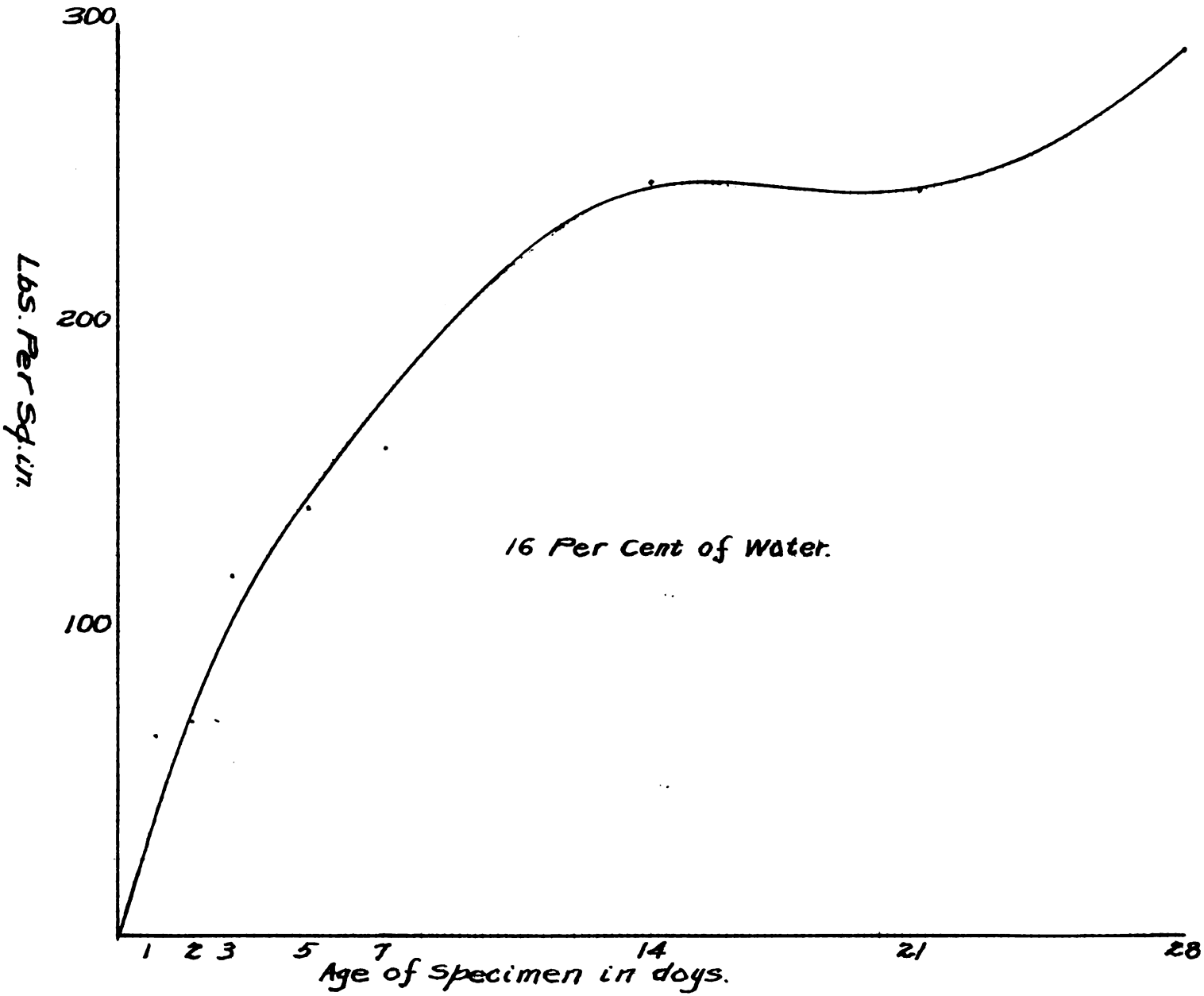

300
200
100
Lbs. Per Sq. in.
11 Per Cent of Water
1
2
3
5
7
14
21
28
Age of Specimen in days.

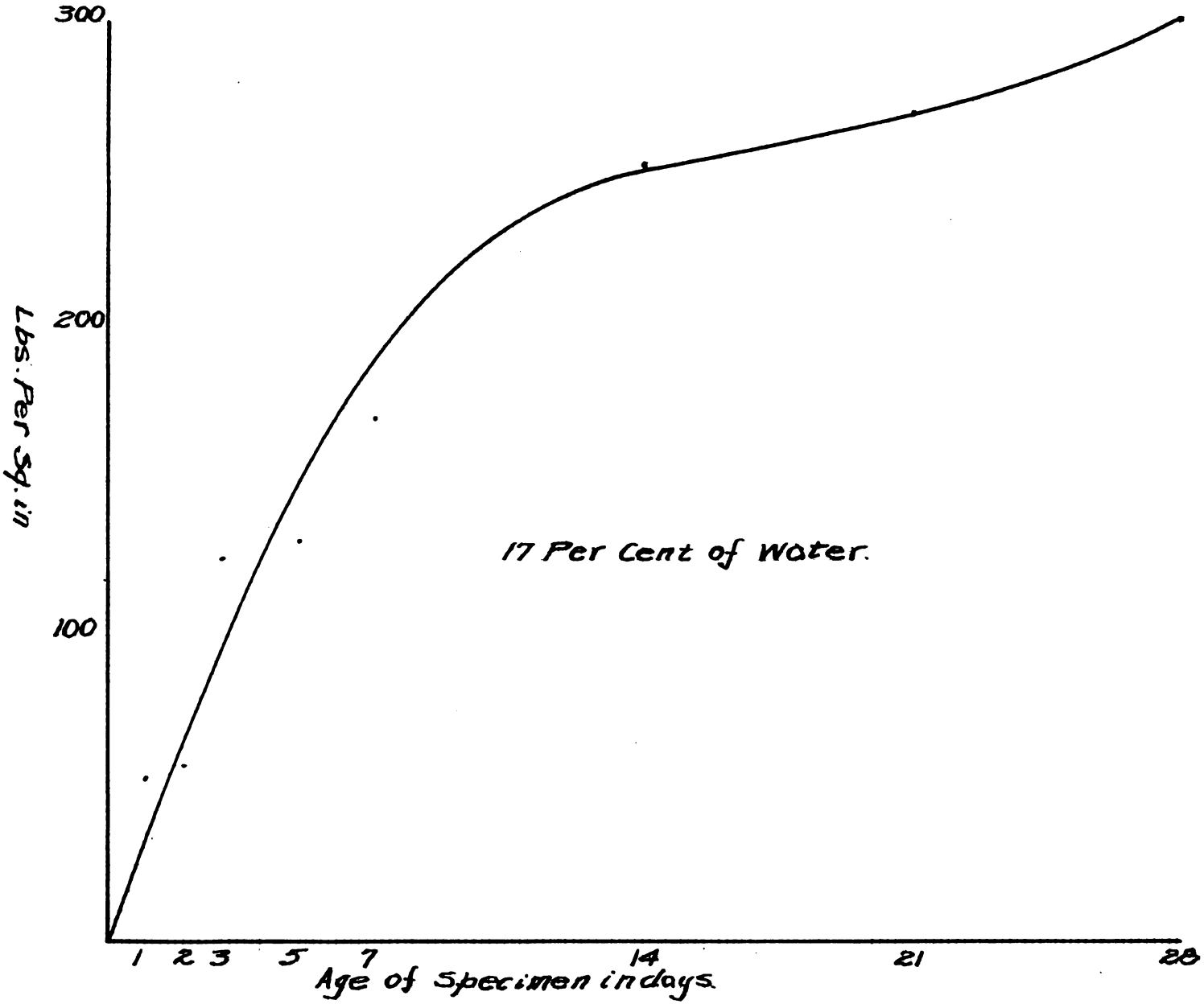

300
200
100
Lbs. Per Sq. in.
12 Per Cent of Water.
1 2 3 5 7 14 21 28
Age of Specimen in days.

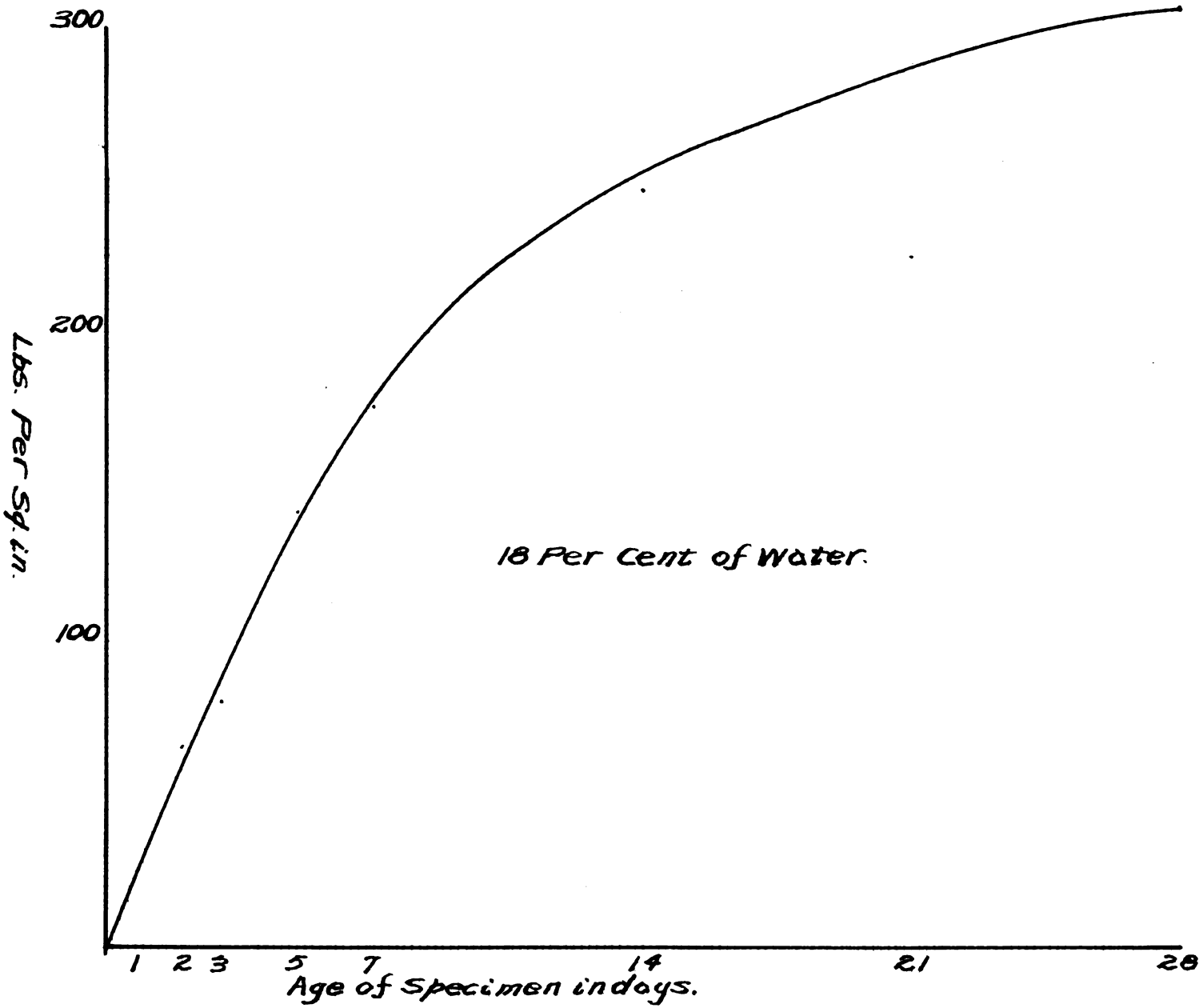

300
200
100
Lbs. Per Sq. in.
13 Per Cent of Water.
1 2 3 5 7 14 21 28
Age of Specimen in days.

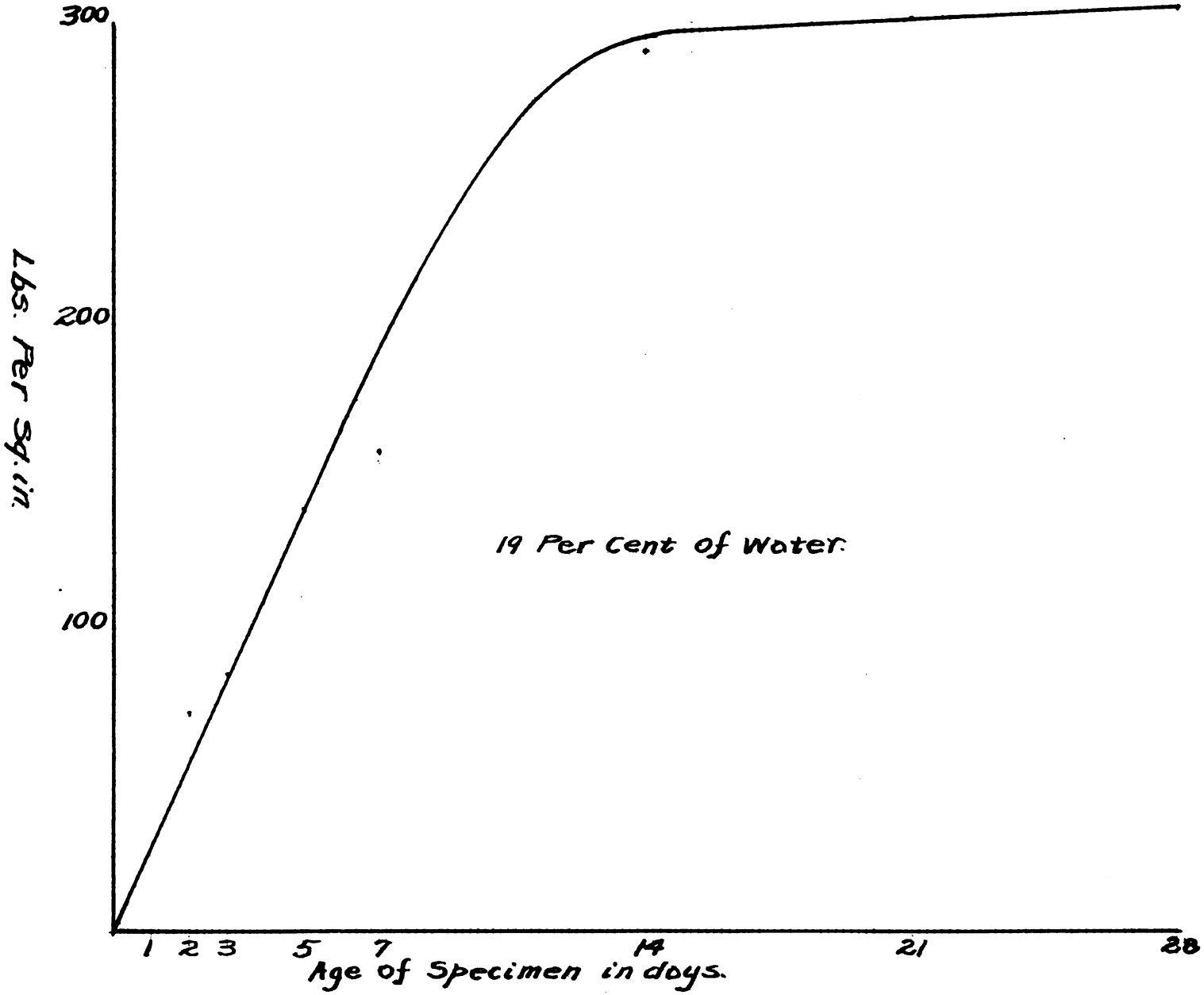

300
200
100
Lbs. Per Sq. in.
14 Per Cent Of Water.
1 2 3 5 7 14 21 28
Age of Specimen in days.


300
200
100
Lbs. Per Sq. in.
15 Per Cent of Water.
1 2 3 5 7 14 21 28
Age of Specimen in days.


300
200
100
Lbs. Per Sq. in.
16 Per Cent of Water.
1
2
3
5
7
14
21
28
Age of Specimen in days.


300
200
100
Lbs. Per Sq. in
17 Per Cent of Water.
1 2 3 5 7 14 21 28
Age of Specimen in days.


300
200
100
Lbs. Per Sq. in.
18 Per Cent of Water.
1 2 3 5 7 14 21 28
Age of Specimen in days.


300
200
100
Lbs. Per Sq. in.
19 Per Cent of Water.
1 2 3 5 7 14 21 28
Age of Specimen in days.