TESTS ON THE EFFECT OF SHAPE ON THE STRENGTH OF CASTINGS.

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TABLE NO.5

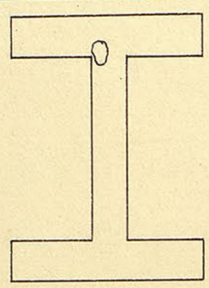
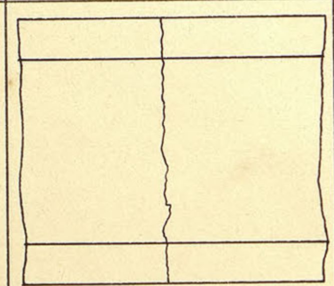
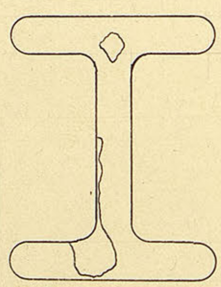
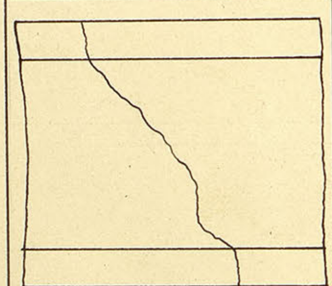
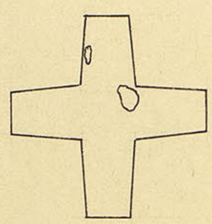
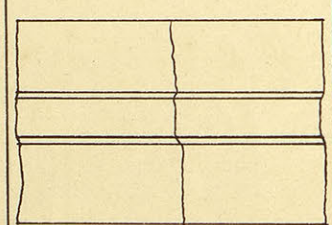
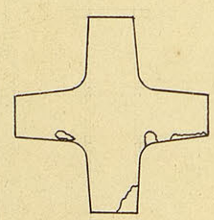
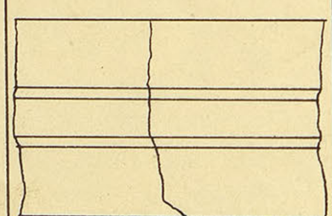
NO.	AREA OF CROSS-SECTION	BREAKING LOAD	MODULUS OF RUPTURE	CROSS-SECTION WITH FLAWS	FAILURE	REMARKS
1	.9	.78970 #	139900			FLAW ON COMPRESSION SIDE
2	.9	68510	121390			FLAWS CHIEFLY ON TENSION SIDE.
3	5.3	27050	154610			FLAWS ON COMPRESSION SIDE
4.	5.3	19440	110410			FLAWS CHIEFLY ON TENSION SIDE

TABLE NO. 4 CON.

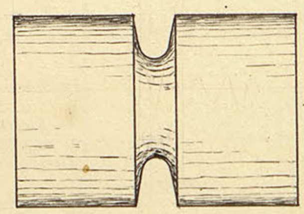
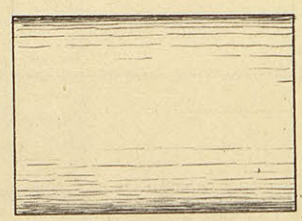
NO.	SMALLEST DIAM.	AREA	BREAKING LOAD	BREAKING LOAD #'s PER SQ. INCH	SHAPE OF SPECIMEN
1	.5	.1964	34210	191297	
2	"	"	37570	182125	
3	"	"	35770	192360	
4	"	"	37780	125970	
5	"	"	24740	174385	FIG. 4.
AV.	.5	.1964	34014	173227	
1	1.	.7854	84700	102385	
2	"	"	80640	102490	
3	"	"	80120	101990	
AV.	1.	.7854	80410	102288	FIG. 5.

TABLE NO.4

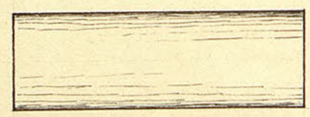
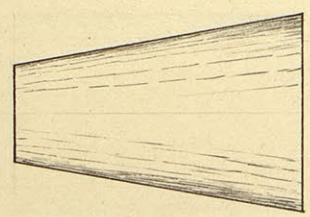
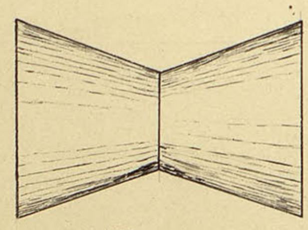
NO.	SMALLEST DIAM.	AREA	BREAKING LOAD	BREAKING LOAD #'s PER SQ. INCH	SHAPE OF SPECIMEN.
1	.5	.1964	28500#	106180	
2	"	"	21050	107185	
3	"	"	18140	92236	FIG 1.
4	"	"	19600	99797	
5	"	"	20680	105290	
AV.	.5	.1964	20064	102139	
1	.5	.1964	23020	117210	
2	"	"	32770	166830	
3.	"	"	25590	130295	
4.	"	"	29720	151310	
5	"	"	25510	129890	FIG. 2.
AV.	.5	.1964	26322	139107	
1	.5	.1964	27670	141885	
2	"	"	27180	138410	
3.	"	"	28270	143940	
4	"	"	28050	142820	
5	"	"	27220	138600	FIG. 3.
AV.	.5	.1964	27678	141131	

TABLE NO. 3.

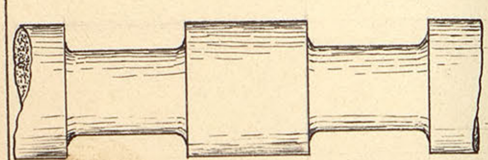
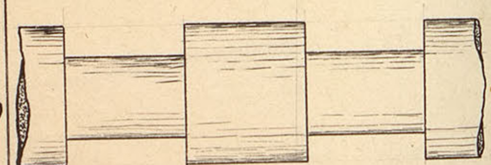
No.	Diam.	Area	Correction for Flaws	Area Corrected	Breaking Load	Breaking Load #s Per. Sq. Inch.	Shape of Specimen.
1.	.970	.73900	.023	.71600	# 17060	23827	
2.	.885	.61513		.61513	14170	23036	
3.	.982	.75734	.09	.66734	16000	23970	
4.	.957	.71930		.71930	18810	26150	Fig. 1.
AV.	.948	.70769	.028	.67934	16510	24246	
1	1.	.7854		.7854	15250	19417	
2.	.970	.7390	.08	.6590	14510	22018	
3	.907	.6461		.6461	15360	23770	
4	.974	.7451		.7451	17110	22960	Fig. 2.
AV.	.963	.7539	.02	.7339	15557	22041	

TABLE NO. 2.

NO.	DIAM.	AREA.	CORRECTED FOR FLAWS	AREA CORR'CTD FOR FLAWS	BREAK. LOAD.	BREAK. LOAD. #'s PER SQ. INCH.	SHAPE OF SPECIMEN
1.	1."	.7854	.05	.7354	15150#	20602.	Fig. 1.
2.	.993	.77435	.0225	.75185	17550	23355	
3.	.972	.74205	.045	.69705	14390	20644	
4.	.997	.74966		.74966	13360	17822	
5.	1.012	80436	.04	.76436	10340	11815	
6.	1.015	80915	.08	.72915	16300	22355	
AV.	.9915	.77749	.039	.73789	14515	19432	
1.	.983	.75891		.75891	15580	20530	Fig. 2
2.	.885	.61513		.61513	11450	18641	
3.	.887	.61790		.61790	9400	15212	
4.	.887	.61790		.65246	7450	12570	
AV.	.9105	.6524		.65246	10970	16610	
1	1.021	.81875	.095	.72375	14440	19951	Fig. 3.
2	.870	.59447		.5944	10210	17179	
3.	.875	.60133	.100	.50133	7680	15318	
AV.	.922	.67152	.097	.60652	10777	17483	
1.	.995	.77739	.03	.74739	16030	21448	Fig. 4.
2.	.999	.78375	.025	.75875	11580	15261	
3.	1.	.7854		.7854	15940	16121	
AV.	.998	.78218	.018	.76485	14513	17613	

FIG. 1.

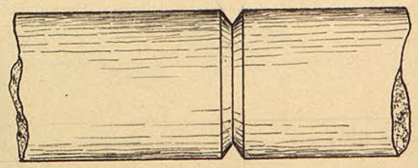


FIG. 2

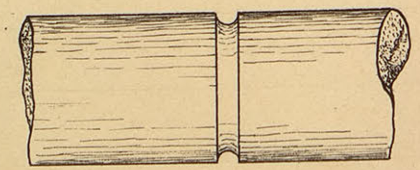


FIG. 3.

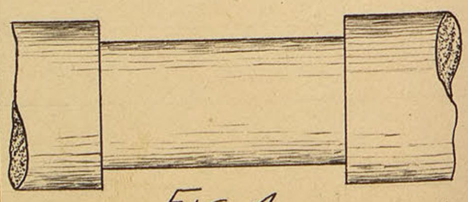


FIG. 4.

TABLE NO 1.
TENSION TEST

NO.	DIAM.	AREA.	BREAK. LOAD.	BREAK LOAD #'s Pr. Sq. In.	SHAPE OF SPECIMEN.
1.	.75"	.44179	8890#	20123	
2.	,,	,,	7750	17542	
3.	,,	,,	13330	30173	
4.	,,	,,	9960	22545	
5.	,,	,,	8340	18877	
AV.	.75	.44179	9654	21852	

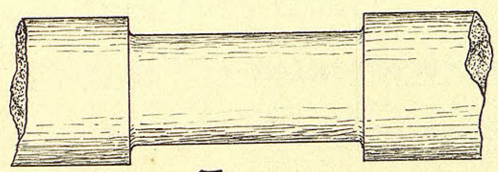


FIG. 1.

COMPRESSION TEST.

NO.	DIAM.	AREA.	BREAK. LOAD.	BREAK. LOAD. #'s Pr. Sq. In.	SHAPE OF SPECIMEN.
1.	.75	.44179	48340	125580	
2.	,,	,,	55480	92986	
3.	,,	,,	41080	129470	
4.	,,	,,	57200	107400	
5.	,,	,,	47240	106930	
AV.	.75	.44179	49870	112475	

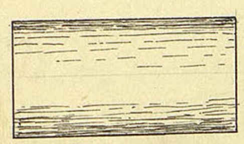


FIG. 2.

It was our intention upon taking up this subject for a thesis, to deal mainly with beams of various cross-section; to ascertain their transverse strength and the effect of the shape of the sections chosen upon this strength, but owing to unforseen difficulties which prevented the foundry from maintaining their usual supply of iron, it was impossible to cast the specimens and so we were limited almost entirely to tests in compression and tension, using the common test bars on hand and those specimens that we could turn from them.

The first test made was that of finding the relative strength of cast iron, in tension and compression. For this purpose specimens were turned three-fourths of an inch in diameter and one and a half inches long, five specimens being tested in compression and five in tension. The average breaking load of the specimens tested in tension was 21,852 pounds per square inch, and for those in compression 112,473 pounds per square inch, this giving the ratio of the breaking load in tension to the breaking load in compression as 1 is to 5.147. Results of this test are shown in table number one.

The second test (results shown in table number two) was made with turned bars in tension, sixteen specimens being broken in all; six of the shape shown by figure one, four like figure two, three like figure three and three like figure four.

The first specimen was simply a turned bar, the finished surface being of no specified length and the shoulders left round.

In the second a V shaped cut was made in the surface of the bar with a diamond nose lathe tool.

The third specimen was treated the same as the second except that in place of the diamond nose a round nose tool was used, cutting a U shaped groove.

The fourth is the same as number one with the exception that the shoulders in four are square, instead of round as in number one.

The average breaking loads are for the first- 19,432 pounds per square inch, for the second 16,610 pounds per square inch, for the third 17,483 pounds per square inch and for the fourth 17,613 pounds per square inch.

This shows that those specimens whose area of cross section changed gradually had the highest breaking load. While those whose area of cross section changed more abruptly broke at a lower load.

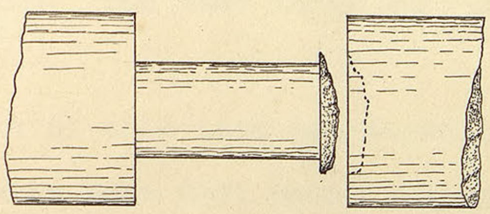
Number one had the highest breaking load, while number two had the lowest.

The specimens shown in figure four broke, in all cases at the change in section, along the line of shoulder.

In figure two the break was along the line of the sharp cut. These specimens broke at low loads on account of the very abrupt change in section.

Corrections in cross sectional area were made in some specimens on account of flaws. This was done by drawing the cross section and carefully measuring and locating the flaws thereon. The area of the flaws was then taken by a planimeter and this area deducted from the area of the cross-section.

The third test (results shown in table number three) was a tension test of bars which alternated in diameter from one and a half inches to one inch the section changing in size for every inch and a half of linear measure. This test was made for the purpose of noting the effect of abrupt changes of section in, and the effect of fillets on, castings. The data of the first four specimens (Table three) are of the filleted bars, the last four are not filleted. It is interesting to note that the average breaking load in pounds per square inch of the filleted bars is 2205 pounds greater than that of the bars not filleted. The filleted bars broke where the cross section was the smallest but those without fillets failed as shown in the figure.



The break occurred not at the smallest section but at the point where the sections changed, the smaller section tearing out a sort of mushroom shaped cap from the larger section, showing that the specimen was probably weakened by the part having the greater diameter cooling slower than the other part and causing internal strains at this place. The breaking load in pounds per square inch as shown in table number three is obtained by using the smallest cross section of the specimen in calculating the pounds per square inch.

If the actual area of the section where the break accurred had been used the ratio between the breaking loads of the specimens having fillets and those without would have been much greater.

The fourth test was a compression test with specimens of different shapes. There were twenty-three of these specimens in all the first five were one-half inch in diameter and one and one-half inches long. The second five were in the form of a truncated cone one end being one-half inch in diameter and the other end one inch in diameter and one and one-half inches long. The form of the next five specimens was that of two equal truncated cones, with the two smaller bases together. The diameter of the specimens at the ends being one inch and at the middle one-half inch and the length was one and a half inches. The next five specimens were cylinders one inch in diameter and one and a half inches long and there was a cut made in the middle of the specimen with a small round-nose lathe tool, making the smallest diameter one-half inch. The last three were cylinders and one and one-half inches long.

The results of this test are shown in table number four.

These results show that where the area of the cross-section was uniform as in the first and last shapes, the breaking load per square inch was the same. But where the area of the cross-section varied the breaking load in pounds per square inch (calculated by using the smallest area of the specimen) was greater than where the cross-section was uniform and the faster the cross-section increased in size from the smallest diameter the greater was the breaking load.

Thus with the specimen shaped as in figure two where the taper was least the breaking load was least, except in number one and four.

Specimens shaped like figure three gave greater breaking loads than for number two, and the specimens shaped like figure four, whose area of cross-section increased very rapidly from the smallest area to the largest, gave the greatest breaking load per square inch of any of the specimens in this test.

These tests, with the turned specimens in tension and in compression show that in tension where the smaller cross-section is of very short length the strength of the specimen is less than where the small cross-section is continued for a considerable length. But in compression where the small cross-section is of a short length the strength of the specimen is greater than where it is of greater length and the shorter the length of the small cross-section the greater will be the breaking load.

The fifth test was a beam test. There were four beams tested. The object of the test was to determine the effect of fillets on the strength of cast iron beams. The shapes of these specimens are shown in table number five; they were tested by placing their ends on knife edges two feet apart and the load applied centrally.

This test was not a satisfactory one on account of poor iron used in the castings and possibly poor workmanship.

The beams had many flaws and "blow holes." In the first specimen tested the flaws were in the compression flange which probably did not effect the strength of the beam. In the second, which was similar to the first except that it had fillets and rounded corners, there were more flaws and they were mostly in the tension flange which greatly lessened its strength.

The third and fourth specimens for this test were similar, except that the fourth one had fillets while the third one had the corners square.

The results of the tests of these two were very much like number one and number two for the flaws in number three were on the compression side while in number four they were principally on the tension side.

The flaws were of such irregular shape and the specimens broke in such a manner that it was impossible to make any correction for flaws.

Drawings and patterns for beams of the same size but with the size of the flanges in different ratios from those tested, had been made but the foundry was not able to make the castings and the test could not be continued further.