THESIS,

SHEAR STRENGTH OF WOODS FOR JOGGLES,

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The Shear Strength of Woods for Joggles.

In the history of early architecture, it was customary to construct buildings exceedingly massive, so that there could be no doubt in the mind of any one as regards their stability. Massiveness was the chief characteristic of the construction of that period.

Little was, for a long time, known about the principles of construction and the strength of materials. As different principles were discovered by observation and experience, they were applied and came gradually into use. For example, we find the heavy stone lintel used in Egypt and Greece at an early date. Later we find the arch used, in its various forms, circular, pointed and segmental. In these early times materials were plentiful and labor inexpensive, the work being mostly done by slaves superintended by skilled workmen.

Since the introduction of iron into building construction, the styles have changed, the construction being much lighter and less material used.

Cheapness and durability are the essential elements in the construction of to-day, when the features of construction not aesthetics enters the problem. No surplus material should be used. A building is, theoretically constructed, so that its strength and durability in one part is proportional to that in any other part. Where it is inconvenient or unadvisable to use a solid timber for a beam or girder, large enough to carry the required weight, two timbers are often used, one upon the other. These timbers, when loaded have a tendency to slip upon each other and bend, thus decreasing their ability to support the load. Pieces of wood are notched into the upper surface of the lower and the lower surface of the upper timber, which resist the force tending to slide them. These pieces so used are called joggler.

It is the purpose of this thesis to investigate the shearing strength of various kinds of woods, in two directions relative to the grain. One direction will be called longitudinal shear, that is, in the direction of the length of the tree; the usual term used to signify that direction. It will be understood by referring to Plate I Fig. 2

The other direction will be called cross-wise, not transverse. The direction may be understood by Fig. I Plate I.

The tests were made with the testing machine, manufactured by Richle Bros., Philadelphia, in the Testing Labratory of the U. of I. The force was compressive and applied upon two specimens at a time. The pressure is hydraulic, applied by pumping oil so that the pressure is increased gradually and with uniformity.

The pressure is indicated by means of a bar resting upon steel bearings, so that the slightest change may be readily recorded.

A vernier is used in reading so that it may be accurately read to ten lbs.

The capacity of the testing machine is 100,000 lbs.

The temporary device for holding the specimens is shown in Plate 2. It is made of hickory and held together with bolts. The piece marked A is 4"X 4" X 13". B and C are each $1\frac{1}{2}$"X 4"X$15\frac{1}{2}$". D is 2"X 4"X $4\frac{1}{8}$". The bolts are $\frac{1}{2}$"X 8".
Iron plates were used to strengthen the side pieces. The bolts b and c are in mortises in A so that they are free to move up and down enough to allow the specimens to shear. D is used to keep B and C apart so that the friction between B A and C A is decreased. Oil was used between B A and C A which greatly reduced the friction. A rested upon a ball and socket joint which caused an qqual distribution of the pressure. When the pressure was applied upon B and C they sprung out at the middle enough to relieve all friction except at the lower corners, thus making the friction so small in proportion to the pressure applied, that it would make no appreciable difference in the correctness of the results. The iron plates prevented springing enough to cause a revolving motion in the specimens.

Joggles are, in practice, used in shear crosswise, that is cut off of the side of a plank, but according to the results of the experiments it was found that in all but one case, namely, hickory, the shear strength was more than twice as much longitudinally.

The relative strength of the shear longitudinally and crosswise will be found in table 2.

The wood in the shear crosswise gives away gradually by crushing, while longitudinally the wood splits suddenly with a sharp report, specially walnut, the suddenness depending upon the readinesswith which the wood splits.

The facts just given above would indicate that a larger factor of safety would be necessary in case the wood was used in longitudinal shear than if used crosswise. The relative shearing strength is given in Table 2.

The shear strength in Table I was obtained by dividing the pressure in lbs. by the area in square inches.

The average shear given in Table 2 is taken from Table I.

The relative shear between the different woods is given in Table 2. Poplar, having the least strength in each direction of all the woods tested, is taken as unity and the strength of each of the others divided by it. For example; the average logitudinal shear of poplar is 927 which we call unity, that of white pine 1087. 1087 divided by 927 equals 1.17 the strength of pine compared with poplar? In the same manner the relative shear of the others is obtained.

In case a pine girder was used and it was not desirable to cut away the fibers enough to put in a large pinejoggle, a smaller one of a harder wood with a large shearing strength could be used, which would not necessitate so much weakening of the girder.

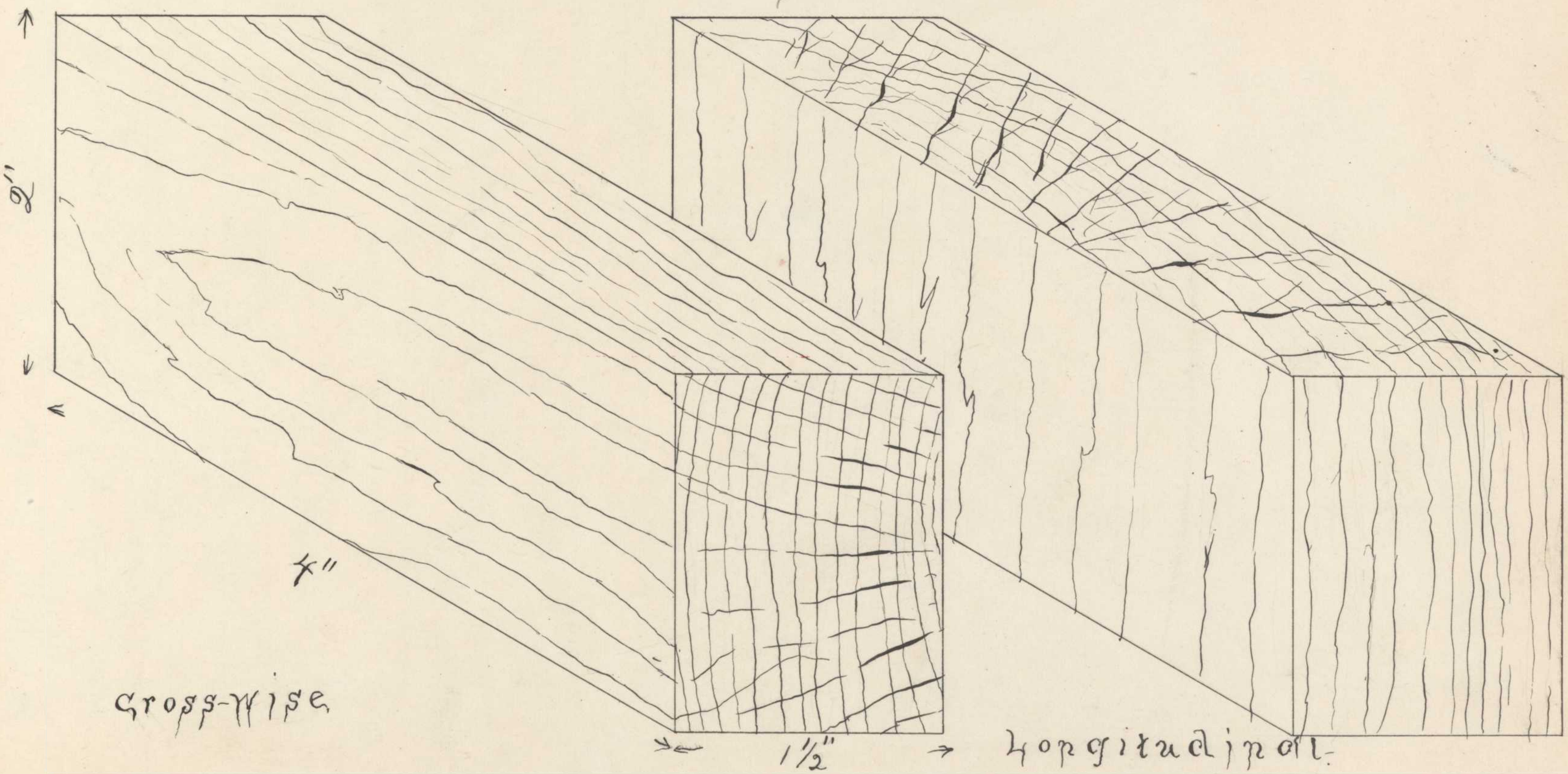
In case joggles were used in hard wood as girders as oak or hickory it might be advantageous to use a joggle of metal.

The results of the experiments show that the more difficult the wood is to split, the greater strength it has for joggles. Curly maple and elm would doubtless be very efficient, but no specimens were accessible at the time the experiments were made.

Plate I.

Fig. 1.

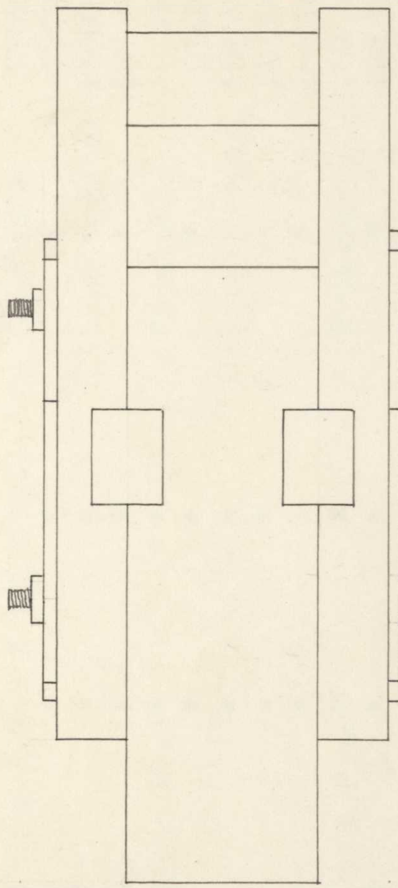
Fig. 2.

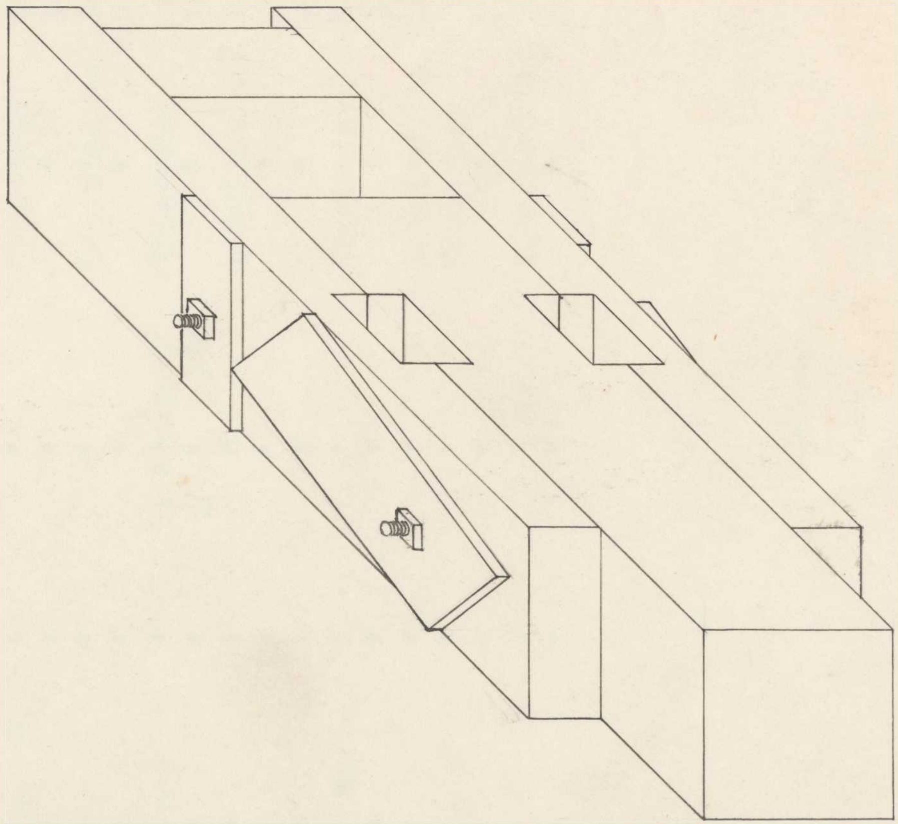


Cross-wise

Longitudinal.

Plate 2.





No	Material	Dimensions	Area	Direction	Presure	Shear Strength	Average
1	Poplar	I½X 2 X 4	2blks. I6"sq.	Crosswise	6700	4I9	
2	"	"	"	"	7340	459	439
3	"	"	"	Longitudinal	I4000	875	
4	"	"	"	"	I5750	984	929
5	White Pine	"	"	Crosswise	7350	459	
6	"	"	"	"	8I00	506	482
7	"	"	"	Longitudinal	I6950	I059	
8	"	"	"	"	I6850	I053	
9	"	"	"	"	I8290	II49	I087
I0	Georgia Pine	"	"	Crosswise	8050	503	
II	"	"	"	"	I0050	628	
I2	"	"	"	"	I0300	643	59I
I3	"	"	"	Longitudinal	20300	I268	
I4	"	"	"	"	22400	I400	
I5	"	"	"	"	24380	I524	I397
I6	Walnut B.	"	"	Crosswise	I0300	644	
I7	"	"	"	"	I0400	650	647
I8	"	"	"	Longitudinal	26480	I655	
I9	"	"	"	"	26840	I675	I666
20	Cherry	"	I block 8"	Crosswise	4500	562	
2I	"	"	2 " I6"	"	I0800	675	6I8
22	"	"	"	Longitudinal	25000	I562	
23	"	"	"	"	28700	I793	
24	"	"	"	"	29600	I850	I735
25	Oak White	"	"	Crosswise	I4000	875	
26	"	"	"	"	I5000	937	906
27	"	"	"	Longitudinal	29600	I850	I850
28	Hickory	"	"	Crosswise	2I550	I346	
29	"	"	"	"	23000	I43I	I388
30	"	"	"	Longitudinal	3I950	I997	
3I	"	"	"	"	37750	2359	2I78

Table I.

Material	Average Longitudinal Shear	Average Shear crosswise	Relative Shear Strength	Relative Shear Longitude	Relative Shear Crosswise
Poplar	927	439	2.11	I	I
White Pine	1087	482	2.25	1.17	1.09
Georgie "	1397	591	2.36	1.50	1.34
Cherry	1735	618	2.80	1.86	1.39
Walnut	1666	647	2.57	1.79	1.47
Oak White	1850	906	2.04	2.	2.06
Hickory	2178	1388	1.56	2.34	3.15

Table 2