TESTS ON NAILED JOINTS IN FIR AND HEMLOCK TIMBERS

Mr. Henry F. Blood, engineer of the Bureau of Buildings, Portland, Ore., has recently been conducting some tests on nailed joints using Douglas fir and western hemlock—two timbers most used on the Pacific Coast.

Report has now been made on these tests covering 110 joints, 87 of which were of Douglas fir and 23 of western hemlock, the tests all being designed to show the strength of nailed joints with wire nails used in single shear.

The tests were divided into two series, depending on the style of the joint. In the first, two sidepieces, each with the grain of wood vertical, were nailed to a centrepiece with the grain of wood horizontal. In the second, two sidepieces, each with the grain of the wood vertical, were nailed to a centrepiece with the grain of the wood also vertical. In both series both Douglas fir and western hemlock were tested, but in the second series only Douglas fir was used. The sizes of the sidepieces varied from 1 x 6 ins. to 3 x 8 ins., and those of the centrepieces from 4 x 6 ins. to 6 x 10 ins., the dimensions indicating commercial sizes which vary from 3/8 in. to 1/4 in. less than dimensions given. The nails were common wire nails ranging from 10d. to 60d. in size, and the number of nails used in each sidepiece varied from two to five. The sizes of the pieces were such that the nails had a penetration in the centrepiece of 30% to 80% of the length of the nail, but the nails were used in single shear, in no case passing through the centrepiece. All timbers were surfaced, so that contact in the joints was between planned surfaces only.

Tests were made by placing the blocks in a testing machine and forcing the sidepieces down and alongside of the centrepiece. Measurements were taken on the relative movement of the pieces by means of a scale screwed to the blocks. An effort was made to measure the elastic limit of the joints, but this could not be determined so it was not recorded. The ultimate loads carried in the series were as follow:

Results of Tests on Wood Joints to Determine Holding Power of Nails

	No. of tests.	Size of nail.	Ultimate load carried per nail, lb. per sq. in.
Series 1—Douglas Fir	14	10d.	525
	9	16d.	600
	10	20d.	749
	10	30d.	922
	5	40d.	1,183
	1	60d.	1,800
Series 2—Douglas Fir	5	10d.	407
	9	16d.	628
	12	20d.	751
	6	30d.	992
	4	40d.	1,023
	1	60d.	873
Series 2—Western Hemlock.	6	10d.	519
	4	16d.	588
	7	20d.	695
	6	30d.	979

This tabulation shows the irregularity and apparent unreliability of the single test made on the 50d. and 60d. nail joints.

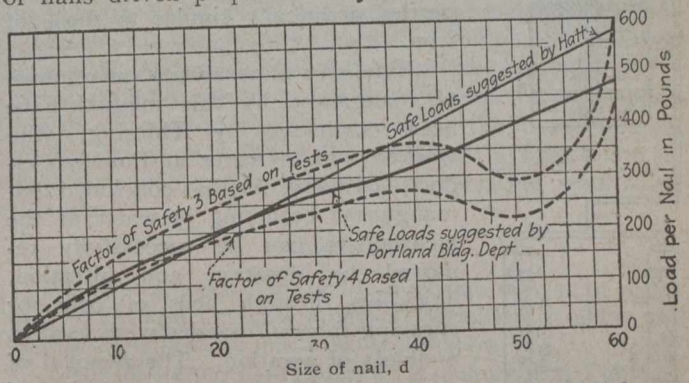
On the basis of these tests the department established safe values for nails driven in perpendicularly to the grain in either Douglas fir or western hemlock, with the load perpendicular to the length of the nail, as follow:

Penny nail.	Load value per nail, lb.	Penny nail.	Load value per nail, lb.
10	120	30	270
12	120	40	320
16	160	50	400
20	200	60	480

From the accompanying diagram of the loads based on two factors of safety and the suggested safe load, it will be seen that the suggested safe load is about according to the formula $W = 7d + 50$, where W is the safe working load, per nail in pounds and d is the penny designation of the nail. It is interesting to compare this value with the value suggested by previous experimenters of 9.6 d, the figure given by Prof. W. K. Hatt, of Purdue University, in a paper in the 1900 "Proceedings" of the Indiana Engineering Society.

For nails driven parallel with the grain of the wood the figures above should be reduced 25%. All of these values should be reduced if the penetration of the nail in the holding piece is less than 50% of its length.

Other conclusions in the report are that the resistance of nails driven perpendicularly in the timber with the grain of the wood parallel to the load is but little more than for nails driven similarly with the grain of the wood perpendicular to the load. It is also indicated that the standard nail heads are of proper proportions, there being no difficulty with the nail head pulling through the outside timber. The strength of the joint seems to be affected but little by the penetration of the nail in the centrepiece if that penetration is 40% or more of the length of the nail, but with less penetration the loads were reduced, and for a penetration of 30% the strength reduction amounted to about 25%. The examination showed that each nail in a joint seemed to support an equal proportion of the load.



Safe Loads for Nailed Joints of Oregon Fir and Western Hemlock

Nails driven perpendicular to grain. Load perpendicular to length of nail.

Two principal factors involved in the strength of nail joints are the resistance of timber to crushing and the nail to bending. The investigator reports that the resistance of the nailed joint, if depending solely on the resistance of the wood to crushing, varies with the diameter of the nail, other things being unchanged. On the other hand, the resistance of the joint, if depending solely on the resistance of the nail to bending, varies as the cube of the diameter of the nail. As the resistance of the joint depends on the combination of these two, various sized nails give varying degrees of resistance, but it is found that the variation of the resistance corresponds quite closely with the square of the diameter of the nail.