Wood Bend Test

Engr 45 - Fall 2013 - SRJC

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Theory

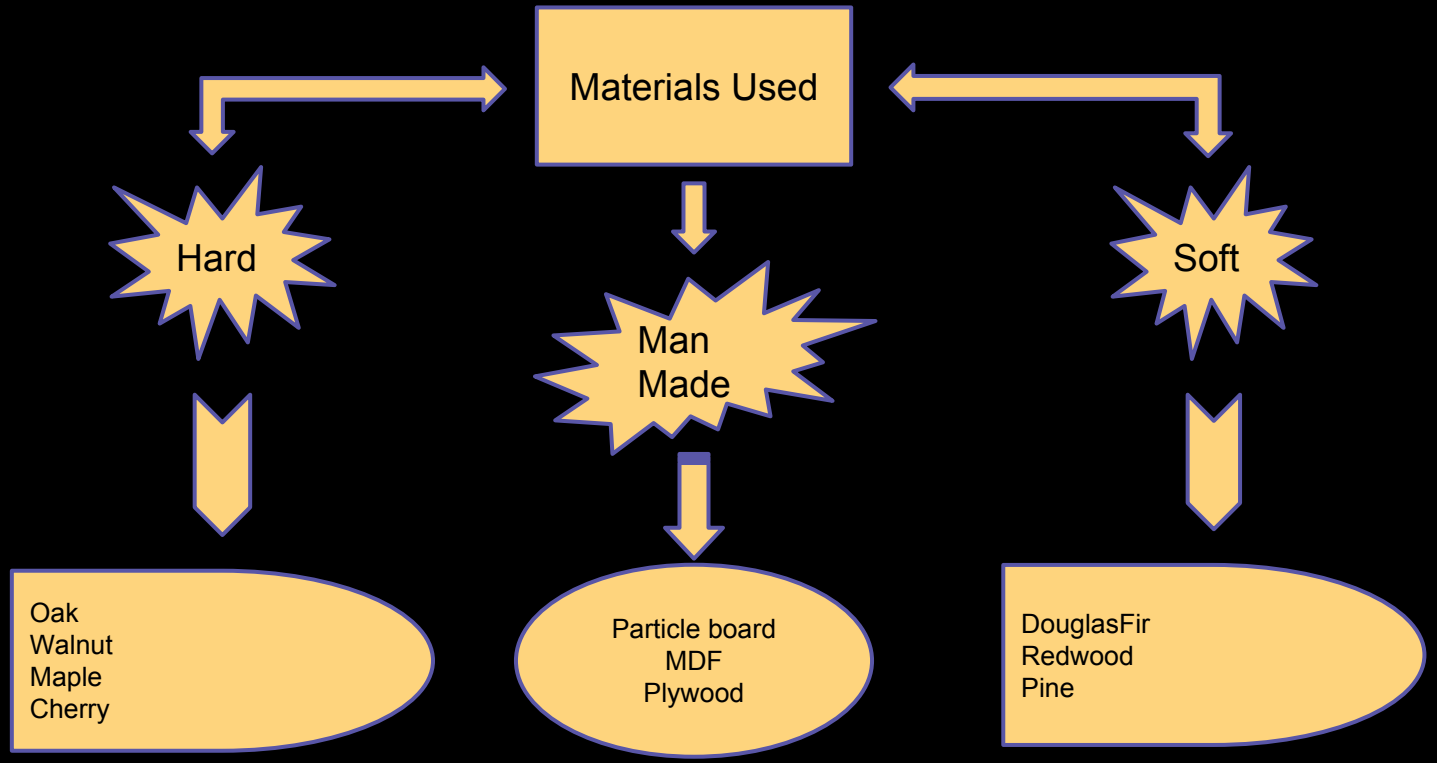
Bend Test (Three point flexural test)

- The Flexural test measures the force required to bend a beam under 3 point loading conditions. The data is often used to select materials for parts that will support loads without flexing.
- The test provides values for the modulus of elasticity in bending, flexural stress, flexural strain and the flexural stress-strain response of the material.
- The main advantage of a three point flexural test is the ease of the specimen preparation and testing.
- The flexural modulus is used as an indication of a material’s stiffness when flexed.
- However, this method also has some disadvantages: the results of this method are sensitive to specimen and loading geometry and strain rate.

Objectives

- Bend ten different types of wood and compare the stress/strain plots.
- Determine the stress/strain plot of the each type of wood when soaked with water vs. when completely dry.
- Calculate the modulus of elasticity.

The Masterful Set-Up



Material Specs

Material Dimensions, Weight and Density:

Material	Partical Dry	Partical Wet	Walnut Dry	Walnut Wet	Maple Dry	Maple Wet	Cherry Dry	Cherry Wet	MDF Dry	MDF Wet	Ceder Dry	Ceder Wet	Plywood Dry	Plywood Wet	Doug Fir Dry	Doug Fir Wet	Pine Dry	Pine Wet	Oak Dry	Oak Wet
Weight (g)	351	561	329	373	421	629	342	404	415	591	214	303	304	410	372	468	221	306	504	566
Length (mm)	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591
Width (mm)	50.63	57.25	50.75	50.81	50.70	51.12	50.76	52.22	51.52	56.25	51.46	52.36	51.77	52.27	51.10	52.95	51.41	52.21	50.80	51.17
Height (mm)	15.73	17.71	18.03	18.12	19.80	20.03	17.43	17.97	19.52	21.09	19.43	19.88	16.06	18.29	20.50	20.79	19.14	19.86	20.93	21.16
Cross Area (mm^2)	796	1014	915	921	1004	1024	885	938	1006	1186	1000	1041	831	956	1048	1101	984	1037	1063	1083
Volume (mm^3)	470280	598706	540321	543660	592779	604633	522443	554121	593848	700518	590422	614661	490957	564529	618578	650040	581045	612284	627846	639368
Density (kg/m^3)	747	937	609	686	710	1040	655	729	699	844	362	493	619	726	601	720	380	500	803	885

* Wet samples had identical specs as dry samples before being soaked for 5 days

Photos

How We Did It!

The Weights We Used:

10 lbs. = 44.5 N
20 lbs. = 89.0 N
35 lbs. = 155.7 N
45 lbs. = 200.2 N
55 lbs. = 244.7 N
70 lbs. = 311.4 N
80 lbs. = 355.9 N
90 lbs. = 400.3 N

The Data

Amount each board deflected (in mm):

Weight (lbs.)	Partical Dry	Partical Wet	Walnut Dry	Walnut Wet	Maple Dry	Maple Wet	Cherry Dry	Cherry Wet	MDF Dry	MDF Wet	Ceder Dry	Ceder Wet	Plywood Dry	Plywood Wet	Doug Fir Dry	Doug Fir Wet	Pine Dry	Pine Wet	Oak Dry	Oak Wet
10.00	7.24	13.80	0.80	1.56	0.40	0.20	1.20	1.00	2.49	7.06	3.51	2.97	2.01	2.40	0.05	0.60	1.36	1.99	0.01	0.40
20.00	14.20	-	1.70	1.74	0.80	0.40	1.72	1.65	4.47	13.66	4.50	4.21	3.84	4.76	0.80	0.80	2.04	3.30	0.10	0.90
35.00	-	-	2.35	2.87	1.60	1.00	3.02	2.97	7.76	35.12	6.10	5.84	6.99	7.73	1.70	1.20	3.24	4.97	0.60	1.78
45.00	-	-	3.13	3.49	2.01	1.30	3.82	4.31	9.94	49.20	7.10	7.07	8.93	10.43	2.18	1.23	4.08	5.84	1.00	2.13
55.00	-	-	3.50	4.42	2.43	1.61	4.65	5.35	12.43	-	8.30	8.16	10.80	13.23	2.70	1.40	4.86	7.48	1.17	2.40
70.00	-	-	4.22	5.44	2.98	2.22	5.84	7.25	15.64	-	9.96	9.96	13.33	19.45	3.36	1.99	6.11	8.87	1.87	2.95
80.00	-	-	5.03	6.14	3.32	2.52	6.73	8.55	18.41	-	11.10	11.23	15.84	27.54	3.82	2.15	6.87	10.10	2.18	3.24
90.00	-	-	5.39	6.85	3.76	2.86	7.70	9.90	21.36	-	12.20	12.71	17.69	-	4.36	2.52	7.56	13.50	2.52	3.49
200.00	-	-	11.25	29.39	6.29	7.48	13.11	24.04	-	-	-	-	37.02	-	8.88	5.25	13.53	-	5.20	7.18

The Math

$$Stress = \sigma = \frac{3Fl}{2wh^2}$$

$$Strain = \epsilon = \frac{6dh}{l^2}$$

$$Modulus\ of\ Elasticity = E = \frac{\sigma}{\epsilon}$$

$\sigma = Stress\ (Pa)$

$\epsilon = Strain\ \left(\frac{mm}{mm}\right)$

$E = Modulus\ of\ Elasticity\ (Pa)$

$F = Force\ (N)$

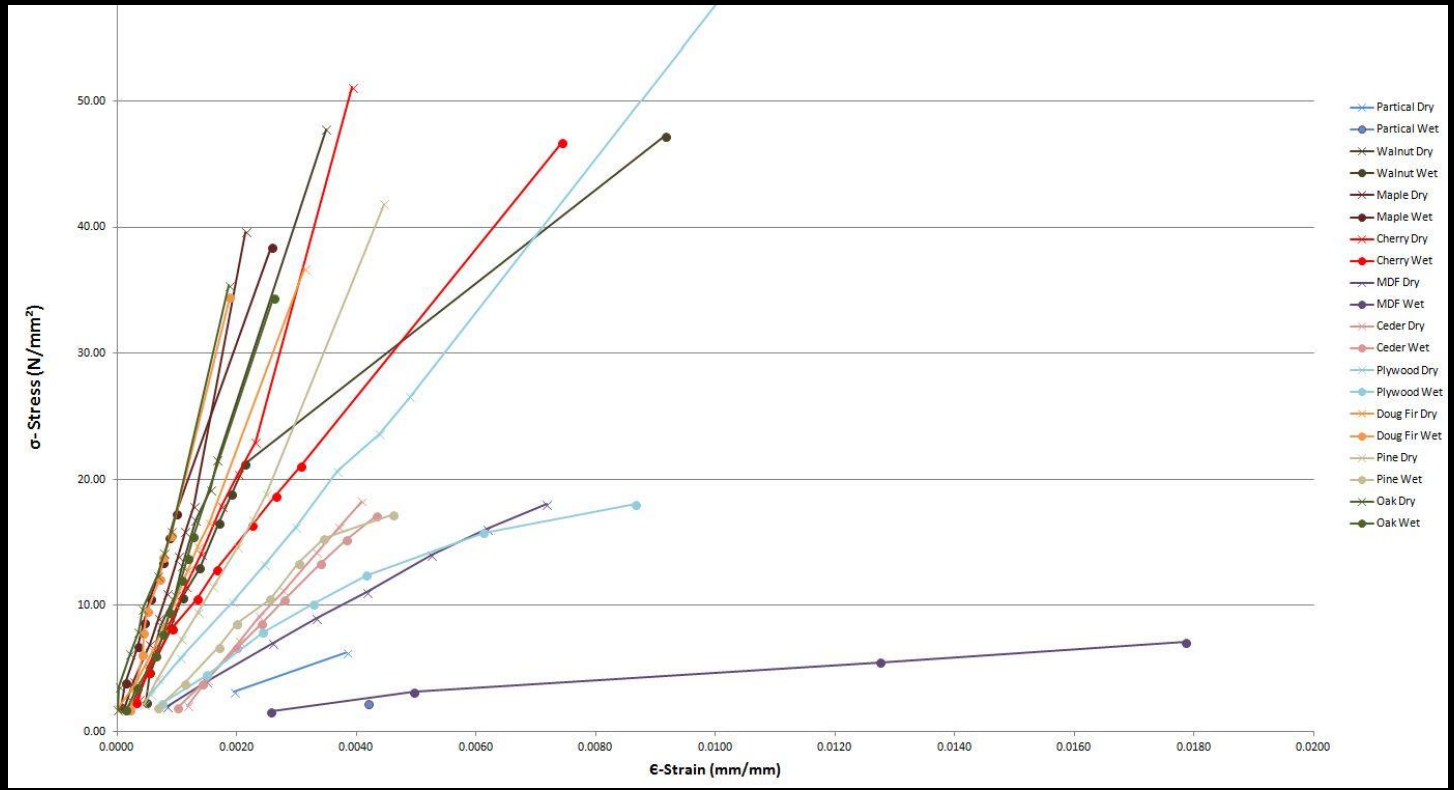
$l = Span\ length\ (mm)$

$w = Board\ width\ (mm)$

$h = Board\ height\ (mm)$

$d = deflection\ height\ (mm)$

The Graph


σ- Stress (N/mm²)
50.00
40.00
30.00
20.00
10.00
0.00
0.0000
0.0020
0.0040
0.0060
0.0080
0.0100
0.0120
0.0140
0.0160
0.0180
0.0200
Є-Strain (mm/mm)
Partical Dry
Partical Wet
Walnut Dry
Walnut Wet
Maple Dry
Maple Wet
Cherry Dry
Cherry Wet
MDF Dry
MDF Wet
Ceder Dry
Ceder Wet
Plywood Dry
Plywood Wet
Doug Fir Dry
Doug Fir Wet
Pine Dry
Pine Wet
Oak Dry
Oak Wet

The Results

Modulus of Elasticity (Pa) :

	Dry	Wet
Partical	1626	522
Walnut	12462	7403
Maple	14921	17214
Cherry	10784	7031
MDF	2616	454
Ceder	3914	3627
Plywood	5547	2637
Doug Fir	11299	16986
Pine	7740	4046
Oak	20302	11677
Average	9121	7160

What We Found!

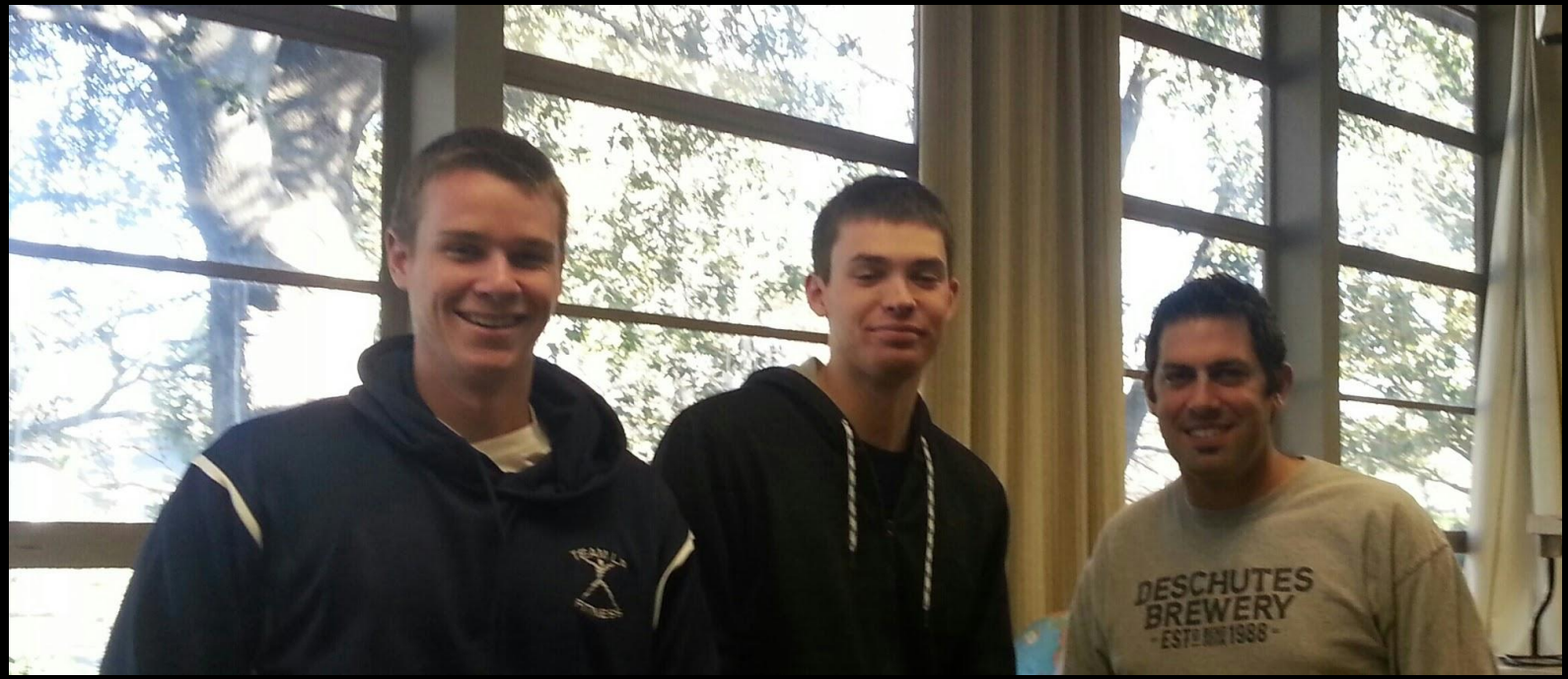
Moisture Content ↑

Modulus of Elasticity ↓

Sources

- http://en.wikipedia.org/wiki/Three_point_flexural_test
- Wiley Plus Virtual Simulation Software
- Younes Ataiiyan and Vince Bertsch

All Research Provided By:



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