Most of the Water Taken Out of Wood Changes Neither Its Size Nor Its Strength

— of the water removed from 80 % to 12 %, a share of 0.735294 changes neither size nor strength, and the remaining 0.264706 brings the shrinkage and the gain in strength — the separator is whether the water leaving is free water in the cell cavities or bound water held in the cell walls — [Paper 748]

Yuuki YAMAGISHI (山岸 勇輝)
Yamagishi Complexity Torus Lab, Japan
September 2026

— From thinking to syncing. —

Abstract

Drying wood makes it shrink and grow stronger. Yet it does not shrink in proportion to the water removed.Which water changes what is counted through shrinkage and strength at each moisture content.No new theorem or law is claimed. First, above the fibre saturation point nothing changes——at 80, 50 and 30 % moisture, shrinkage 0.000000 % and strength 50.000000 MPa (Section 2). **Second, only below it does wood shrink and strengthen——4.800000 % and 100.000000 MPa at 12 %, 8.000000 % and 158.740105 MPa oven-dry** (Section 2). **Third, and this is the core. Most of the water removed changes nothing——of the water removed from 80 % to 12 %, 0.735294 alters neither size nor strength** (Section 3). **Fourth, the small remainder does everything——the remaining 0.264706 brings 4.800000 % shrinkage and 2.000000 times the strength** (Section 3). **Fifth, below the threshold, shrinkage is uniform——0.266667 % per 1 % of moisture** (Section 2). **Sixth, the separator is whether the water leaving is free water in the cell cavities or bound water held in the cell walls——"how much water was removed" does not say what changed** (Section 4). **Keywords**: moisture content, fibre saturation point, wood shrinkage, free and bound water, strength and moisture, effect of drying.

> **Scope of this paper (scope note)**: **No new theorem or law is claimed——the fibre saturation point, shrinkage roughly proportional to moisture below it, and strength rising as moisture falls are all known (Forest Products Laboratory 2010, Siau 1984).Species and direction are not distinguished——shrinkage differs greatly between tangential, radial and longitudinal directions, but a total shrinkage of 8.0 % is used as one representative value.The strength curve is a model——below the fibre saturation point strength is taken as exponential in moisture, fixed by 50 MPa green and 100 MPa at 12 %.One fibre saturation point——30 % is representative; in fact it moves with species and temperature.The drying process is not treated——drying rate, checking, warping and moisture gradients are not treated.No real timber is claimed——these are not measurements of any particular wood.Relation to earlier papers**: **Paper 455 showed that how dry one wants it decides which drying stage limits the rate——its scope note stated that the material was not limited to wood and that cracking from overdrying was not the subject. There the stage that sets the drying rate swapped. Here what the leaving water changes swaps at the fibre saturation point. The threshold of drying speed, and the threshold of the result of drying.**What is added is **tabulating shrinkage and strength by moisture and showing that neither moves above the fibre saturation point**, **dividing the removed water into water that changes nothing and water that changes the wood, 0.735294 and 0.264706**, **confirming that shrinkage and strength are continuous at the threshold**, and **placing the separator on free against bound water**.

1. Notation and the Question

Setting: **moisture content M is the mass of water as a share of oven-dry mass. Above the fibre saturation point M_f, water sits in the cell cavities; below it, water bound in the cell walls begins to leave. Shrinkage S and strength P are taken as follows.**

$$S(M) = S_T \, \frac{M_f - M}{M_f} \quad (M < M_f), \qquad \ln P(M) = \ln P_g + \frac{M_f - M}{M_f - 12} \ln \frac{P_{12}}{P_g} \quad (M < M_f)$$

Above M_f, $S = 0$ and $P = P_g$. Take $M_f = 30$ %, $S_T = 8.0$ %, $P_g = 50$ MPa and $P_{12} = 100$ MPa.

Question: **does every bit of water removed change the wood equally?**

2. Above the Threshold, Nothing Changes

Computation 2.1: **shrinkage and strength were derived at each moisture content.**

moisture	shrinkage	strength
80 %	0.000000 %	50.000000 MPa
50 %	0.000000 %	50.000000 MPa
30 %	0.000000 %	50.000000 MPa
20 %	2.666667 %	73.486725 MPa
12 %	4.800000 %	100.000000 MPa
0 %	8.000000 %	158.740105 MPa

> **Observation 2.2**
>
> **from 80 % down to 30 %, neither shrinkage nor strength moves.Just above and below the threshold, shrinkage is 0.000000 on both sides and strength 50.000000 against 50.000002 MPa——the threshold is not a jump in the model but the point where effects begin.**

> **Observation 2.3**
>
> **below the threshold, shrinkage is uniform.0.266667 % per 1 % of moisture, reaching the total 8.000000 % oven-dry——strength rises to 100.000000 MPa at 12 % and 158.740105 MPa oven-dry.**

3. Most of the Water Removed Changes Nothing

Computation 3.1: **per unit oven-dry mass, the water removed from 80 % to 12 % was split at the threshold.**

interval	water removed	share of all water removed
80 % to 30 %	0.500000	0.735294
30 % to 12 %	0.180000	0.264706

Observation 3.2

this is the core: a share of 0.735294 of the water removed changes neither size nor strength.While it leaves, shrinkage stays 0.000000 % and strength 50.000000 MPa——the amount of water removed and the amount the wood changed are different numbers.

Observation 3.3

the remaining 0.264706 does everything.Removing it brings 4.800000 % shrinkage and 2.000000 times the strength——all of the change is packed into little more than a quarter of the water.

4. The Separator

Observation 4.1

the separator is whether the water leaving is free water in the cell cavities or bound water held in the cell walls.Removing free water leaves the cell walls as they were; removing bound water shrinks and tightens the walls themselves——“how much water was removed” does not say what changed.

Observation 4.2

beside Paper 455.Paper 455 showed that how dry one wants it decides which drying stage limits the rate, not limiting the material to wood and setting cracking aside——there the stage setting the drying speed swapped; here the water setting the result swaps at the fibre saturation point.

Observation 4.3

what is not said.Species and direction are not distinguished, the strength curve is a model, and neither the drying process nor cracking is treated——what is shown is that the water removed divides in two, and only one part changes the wood.

5. Roll Call and Closing

1. **shrinkage 0.000000 % at 80 %** (Computation 2.1): **above the threshold.**
2. **strength 50.000000 MPa** (Computation 2.1): **unmoved.**
3. **4.800000 % at 12 %** (Computation 2.1): **below the threshold.**
4. **158.740105 MPa oven-dry** (Computation 2.1): **stronger.**
5. **0.266667 % per 1 %** (Observation 2.3): **uniform shrinkage.**
6. **water that changes nothing 0.735294** (Computation 3.1): **the core.**
7. **water that changes the wood 0.264706** (Computation 3.1): **does everything.**
8. **strength 2.000000 times** (Observation 3.3): **from that water.**
9. **50.000000 against 50.000002 at the threshold** (Observation 2.2): **continuous.**
10. **free or bound water** (Observation 4.1): **the separator; Paper 455.**

Closing: **Most of the water taken out of wood changes neither its size nor its strength.With the fibre saturation point at 30 %, from 80 % to 30 % moisture shrinkage stays 0.000000 % and strength 50.000000 MPa; below it they reach 4.800000 % and 100.000000 MPa at 12 % and 8.000000 % and 158.740105 MPa oven-dry——below the threshold shrinkage runs uniformly at 0.266667 % per 1 % of moisture.Of the water removed from 80 % to 12 %, 0.735294 changes nothing and the remaining 0.264706 brings 4.800000 % shrinkage and 2.000000 times the strength——the amount of water removed and the amount the wood changed are different numbers.The separator is whether the water leaving is free water in the cell cavities or bound water held in the cell walls——"how much water was removed" does not say what changed.Placed among the earlier papers——Paper 455 showed the threshold of drying speed and set cracking aside; this counts the threshold of the result.To be honest——species and direction are not distinguished, the strength curve is a two-point model, and the drying process is not treated.**

References

1. Forest Products Laboratory. (2010). *Wood Handbook: Wood as an Engineering Material*. USDA Forest Service.
2. Siau, J. F. (1984). *Transport Processes in Wood*. Springer.
3. Yamagishi, Y. (2026). *How Dry You Want It Decides Which Stage Is Rate-Limiting* [Paper 455]. Zenodo. 10.5281/zenodo.22733024

— From thinking to syncing. —

Yuuki YAMAGISHI (山岸 勇輝)

© 2026 Yamagishi Complexity Torus Lab, Japan · Licensed under Creative Commons Attribution 4.0 International (CC BY 4.0)