# Cutting a New Deal for Lumber Drying

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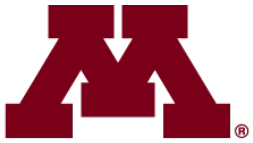


UNIVERSITY OF MINNESOTA

# The Contemporary Deal

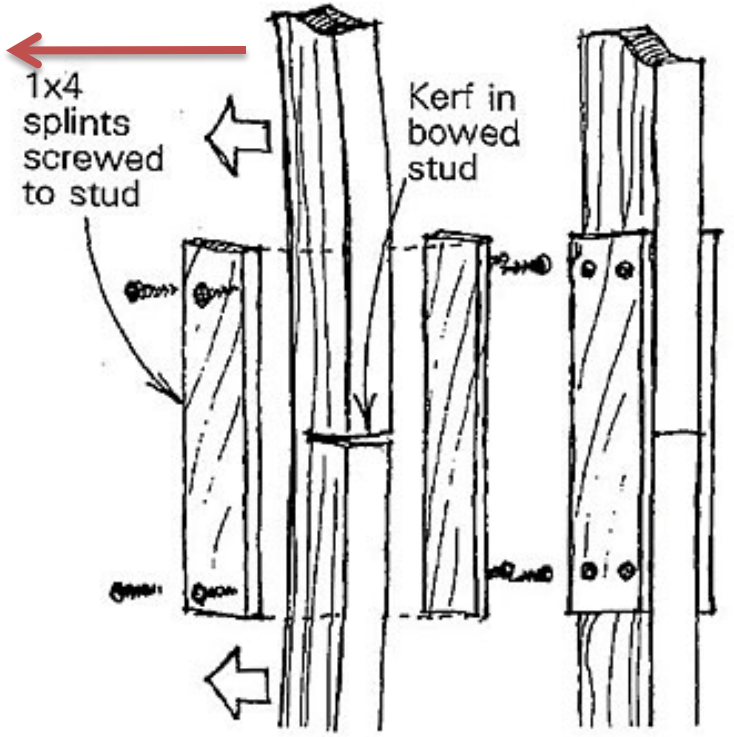
The bad

The good

From: Measures for improving quality and shape stability of sawn softwood timber during drying and under service conditions. Best Practice Manual to improve straightness of sawn timber. Edited by Veikko Tarvainen. Espoo 2005. VTT Publications 584. 149 p.

# The Contemporary Deal

…and the ugly




Tore J. Wubbenhorst, Lindenhurst, NY
From Fine Homebuilding 65, pp. 32 January 1, 1900

# The Contemporary Deal

Western Lumber Grading Rules – 2005

| Nominal Width | At Edge Wide Face | Centerline Wide Face | Holes (Any Causes) |
|---|---|---|---|
| 4” | 1 ¾” | 2 ½” | 1 ½” |

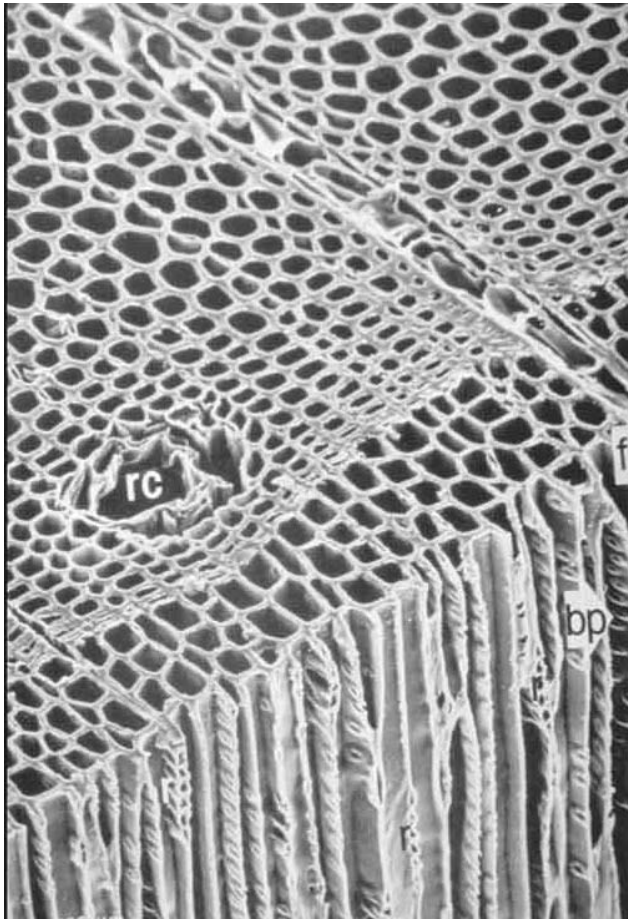
One hole or equivalent smaller hole per 1 lineal foot

At 8 holes per board, it still qualifies as the “Neighborhood Stud”

# Dealing From a “Stacked Deck”

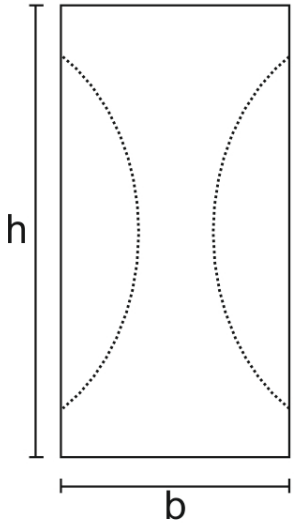
Tracheids of mature white pine range from 3 to 4 millimeters in length and are 90 to 100 times as long as they are wide.

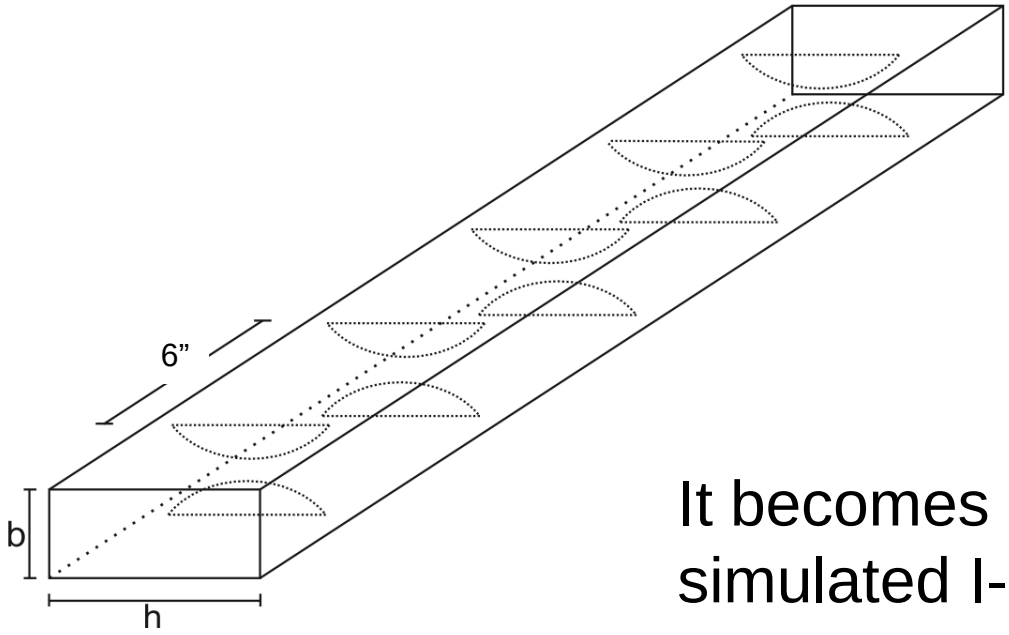
Take the “freeway,” but where are the exits?



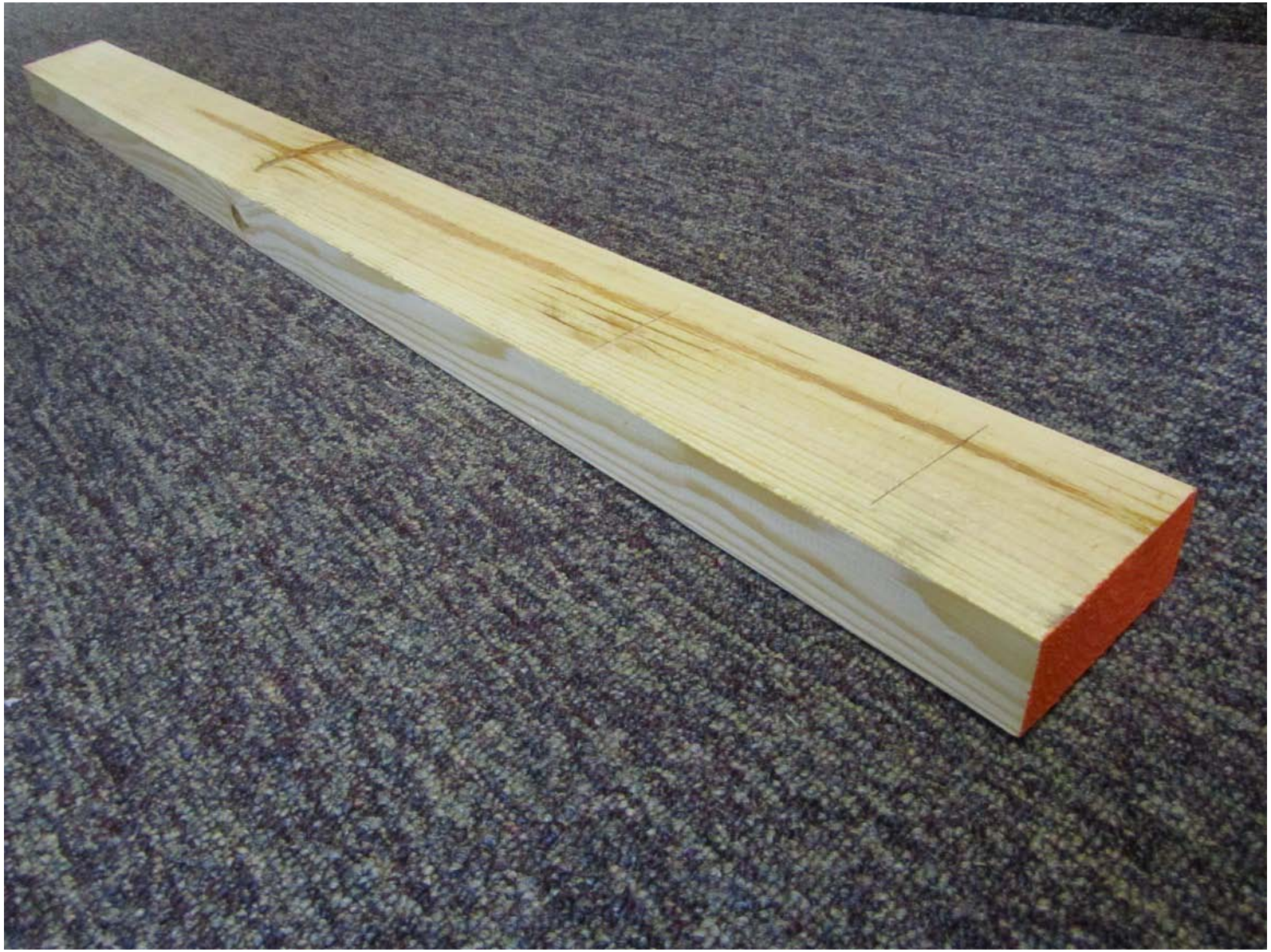
# Showing a Pair of 6's for the "Game Opener"

Longitudinal diffusion is about 10 to 15 times faster than is lateral diffusion (USDA Dry Kiln Operator's Manual)



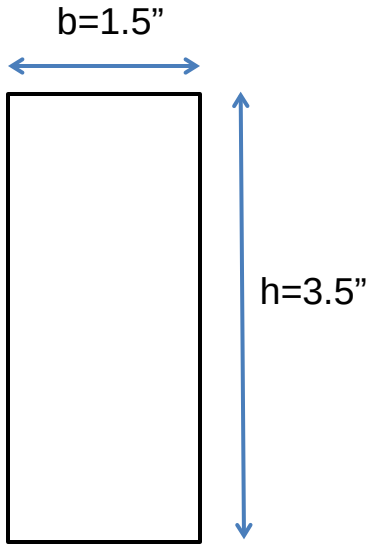

It becomes a simulated I-Joist



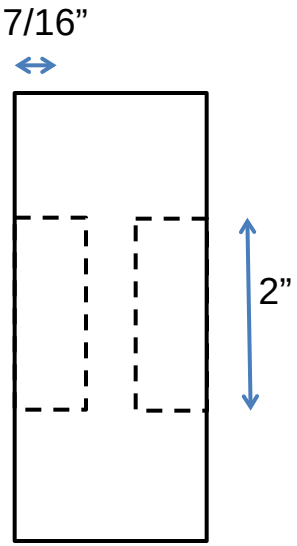
# Having a "Wild Card" in the Game

The moment of inertia (I), for a homogeneous wood beam equals:

$$I = \frac{b \times h^3}{12}$$




$I = 5.36in^4$




$I = 4.78in^4$ (90% of control)

$$The\ bending\ stress = \frac{M \times C}{I}$$

# Change in Properties with MC

| Property | Relative change in property from 12% MC | | |
|---|---|---|---|
| Bending Strength | At 6% MC: 1.30X | At 12% MC: X | At 20% MC: 0.75X |

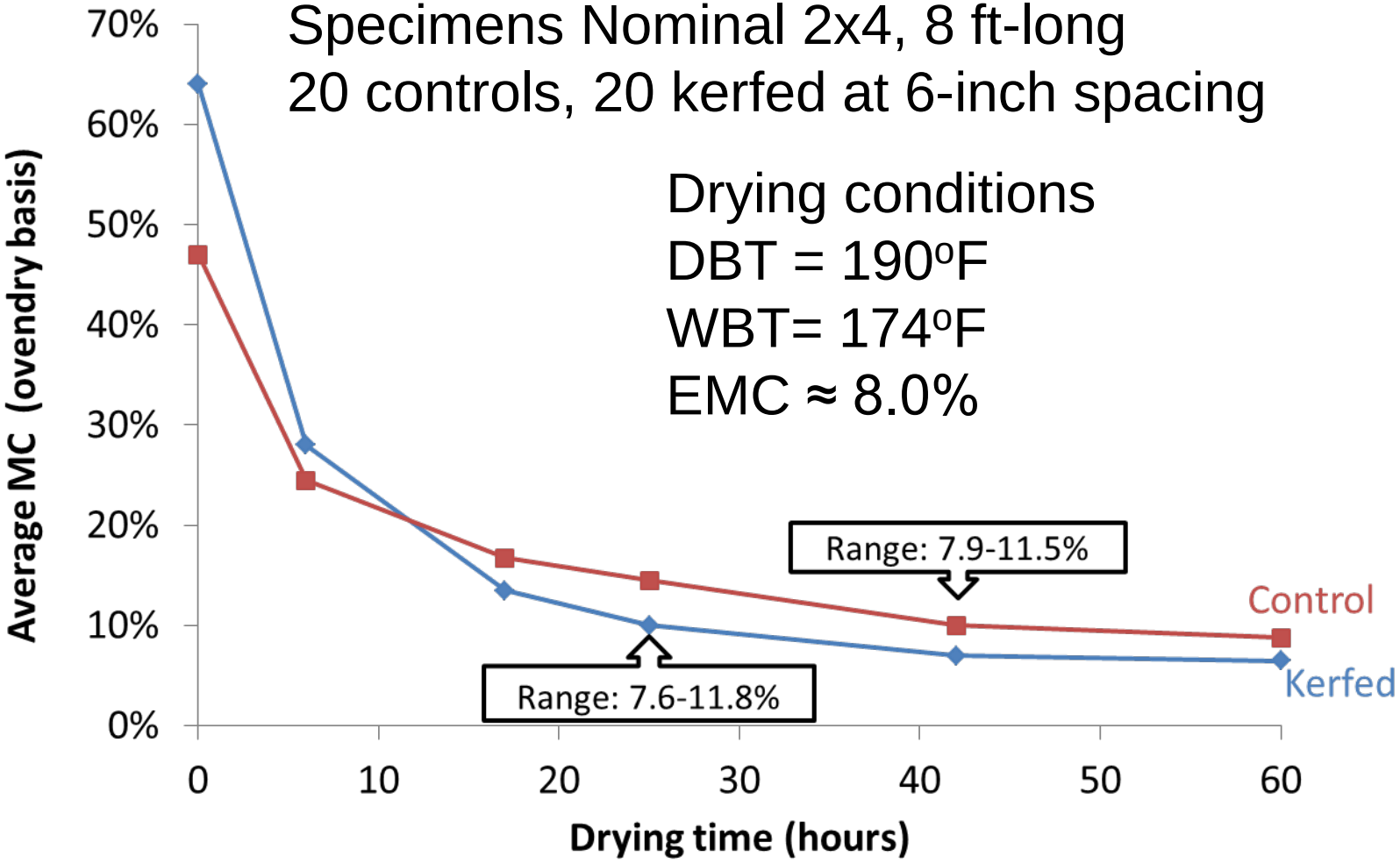
*(Wood Handbook, USDA 1987)*

"If you want to know wood, know its MC"

# Some Winning Hands for the "New Deal"

Specimens Nominal 2x4, 8 ft-long
20 controls, 20 kerfed at 6-inch spacing

Drying conditions
DBT = 190°F
WBT= 174°F
EMC ≈ 8.0%



# Tabular Comparisons for Warp and Strength Factors

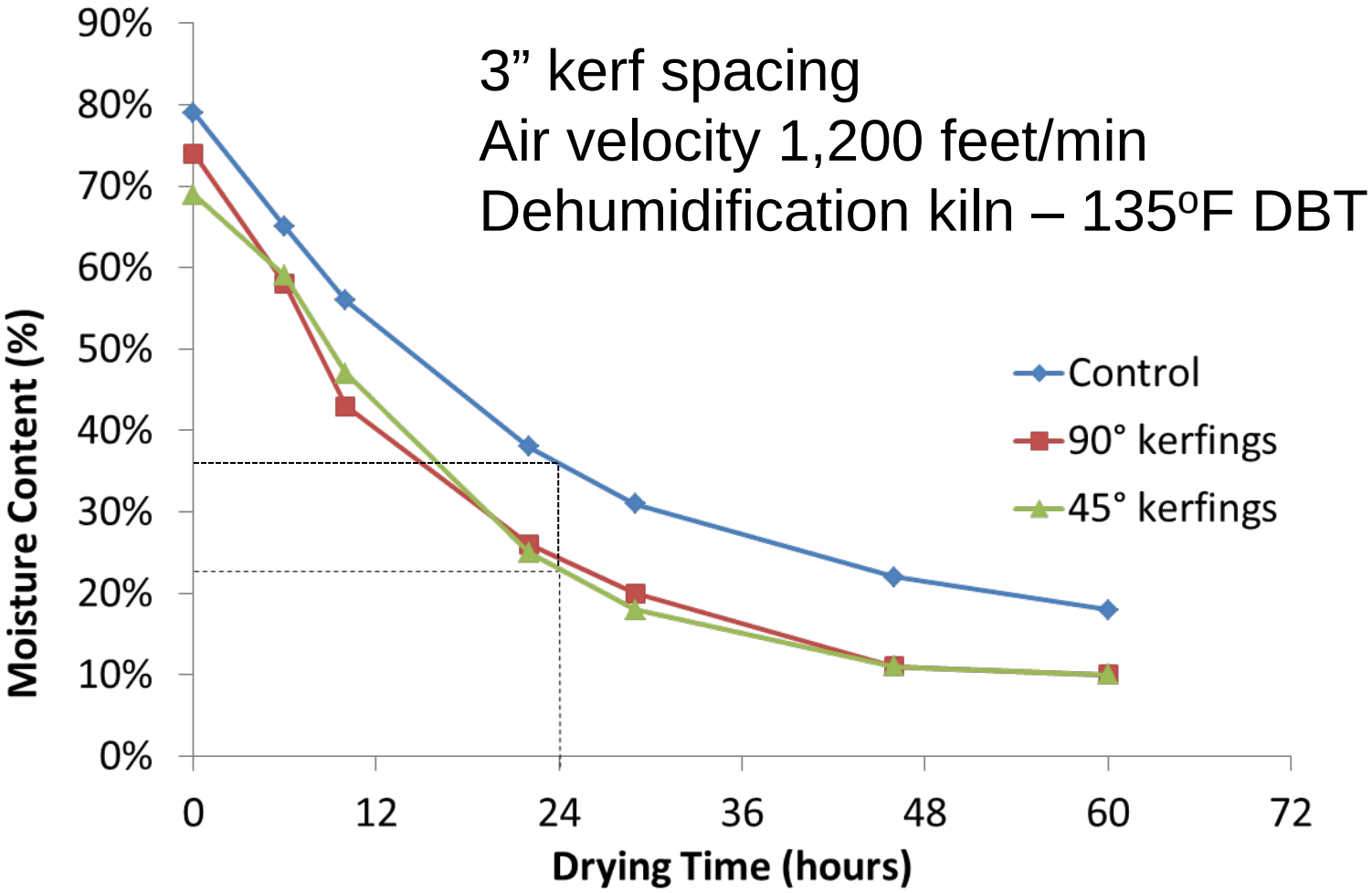
| 20 studs of each | MOR (psi) | MOE (1,000 psi) | Number in Stud Grade | | | Avg. MC |
|---|---|---|---|---|---|---|
| | | | Crook | Bow | Twist | |
| Controls | 4,989 | 823 | 12/20 | 20/20 | 4/20 | 9.7% |
| Kerfed | 4,743 | 949 | 17/20 | 20/20 | 8/20 | 9.0% |

$$\frac{\mathrm{MOR}_{\mathrm{kerfed}}}{\mathrm{MOR}_{\mathrm{controls}}} = 95\%$$

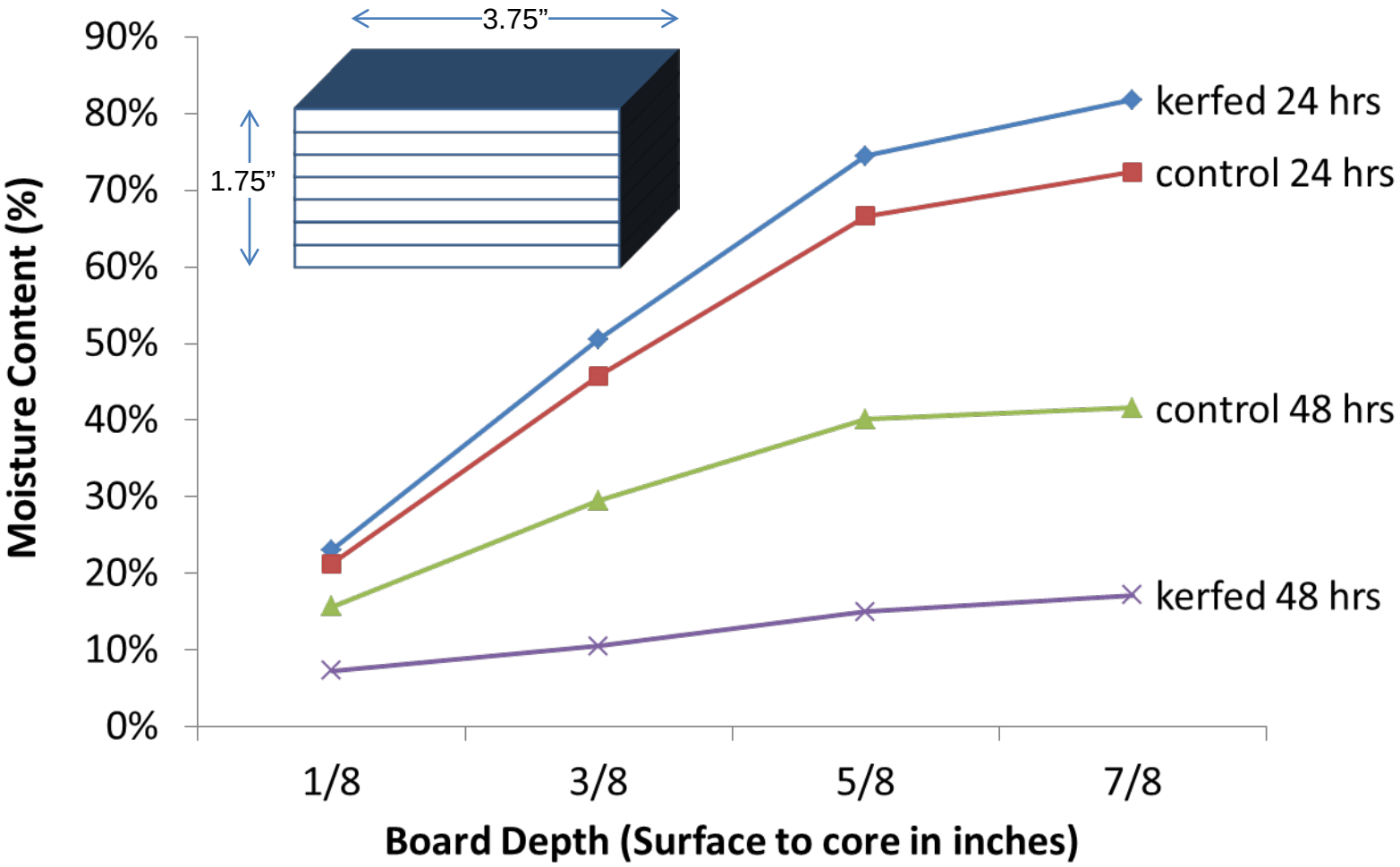
$$\frac{\mathrm{MOE}_{\mathrm{kerfed}}}{\mathrm{MOE}_{\mathrm{controls}}} = 115\%$$

The increase in MOE now appears due to a decrease in horizontal shear.

# Comparative Drying Rates



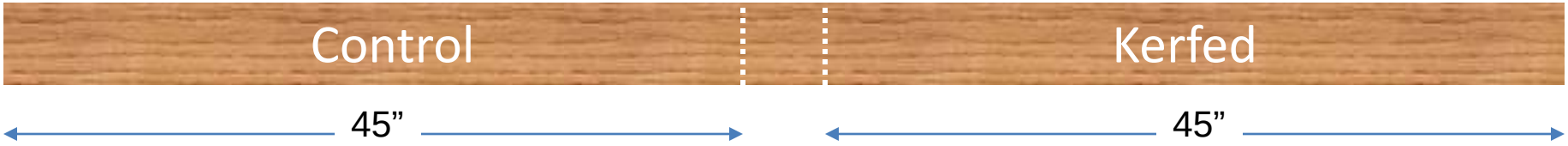
# Comparison of Moisture Content Gradients – DH Kiln – 3” Kerf Spacing



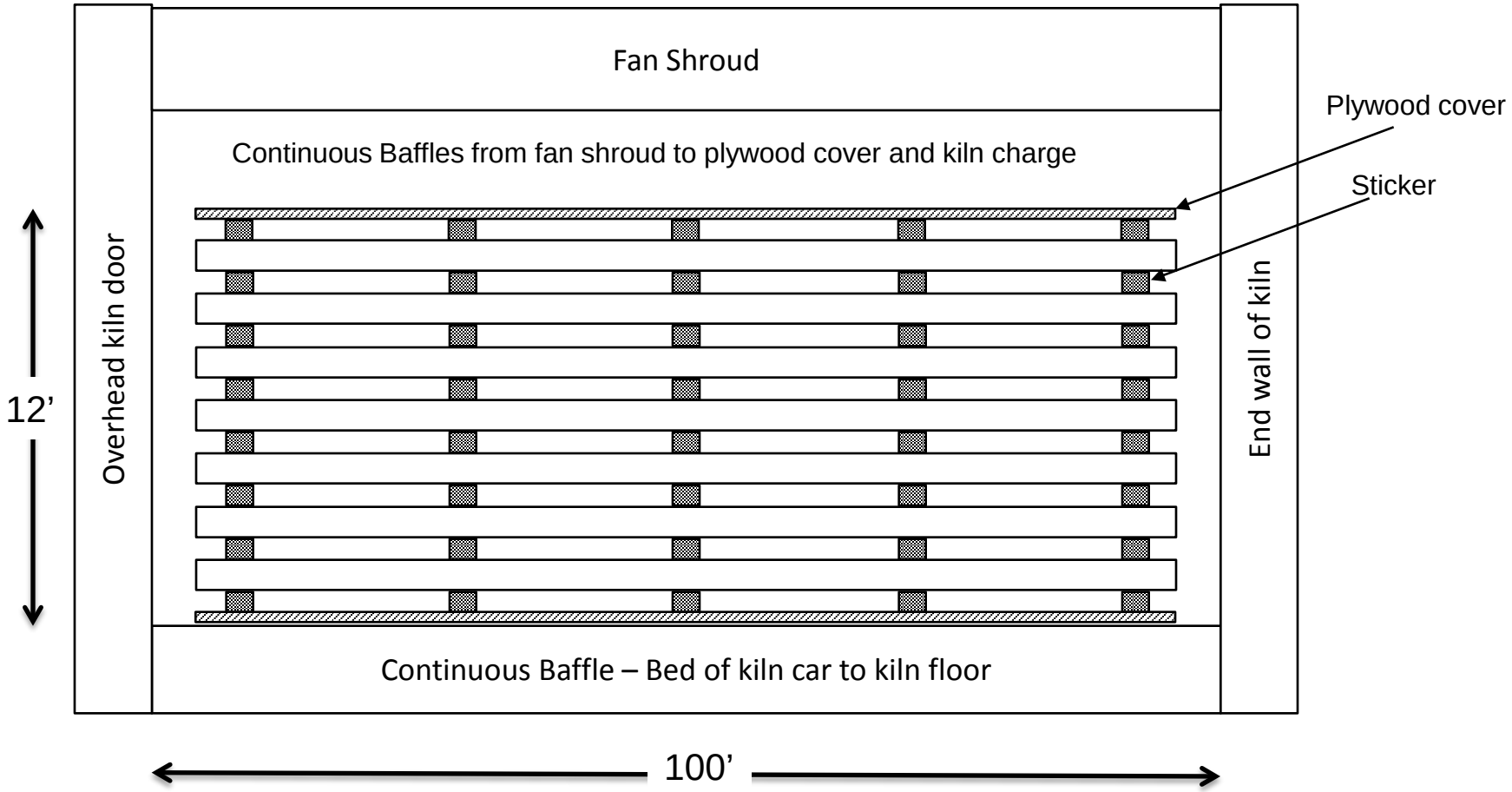
# Moisture Content After 48 Hours of Dehumidification Drying

Moisture content measured by resistance meter

| Sample Type | Board MC's | | Core MC's | | MC Std. Dev. | N |
|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | | |
| Controls | 19.3% | 9.5-29.0% | 22.1% | 9.5-33% | 5.81% | 31 |
| Kerfed | 8.0% | 6.0-11.5% | 9.2% | 7.0-14.0% | 1.77% | 31 |



# Shuffling the Deck for a Pretend Kiln Charge



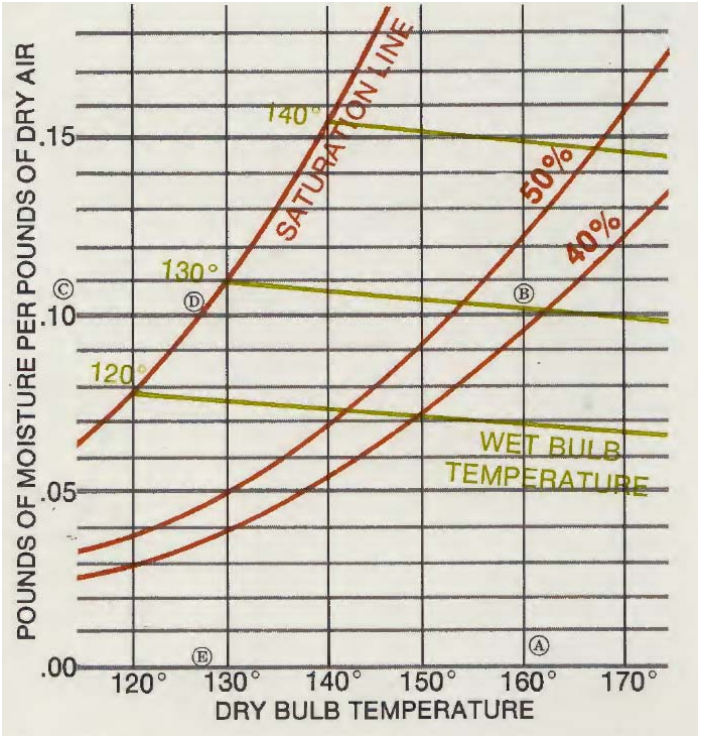

Lumber 1.75” thick, stickers 0.75” thick

$$12' \times 100' \times \frac{0.75}{2.50} = 1{,}200\text{ft}^2 \times 0.30 = 360\text{ft}^2$$

# An Abbreviated Analysis for the Common Sized Kiln Charge

- Assume a kiln charge of 100,000 bdf.
- Estimated water to be removed: 164,000 lbs.
- Air velocity of 2,000 feet/minute through area of 360 $ft^2$=720,000 $ft^3$/minute.
- $$\text{Pounds of dry air per min} = \frac{\frac{720{,}000 \text{ft}^3 \text{of air}}{\text{min}}}{14 \text{ft}^3 \text{of air per pound of dry air}}$$
- $$\text{Pounds of dry air per min} = 51{,}428 \text{ pounds of dry air/min}$$
- Critical question: “So what?”

# Glad you asked, whereby a visit to Doctor Dallas Dedrick's chart for psychrometric calculations




- Entering air at 160°F DBT and 130°F WBT (approx. 42% RH).
- DBT cools to 130°F at constant WBT of 130°F.
- Absolute humidity (lbs. water vapor per lbs. of dry air) increases from about 0.102 to 0.110, i.e. 0.008lb.

$$51{,}000\,\frac{lb\ of\ dry\ air}{min} \times 0.008\,\frac{lb\ of\ mositure}{lb\ dry\ air} \cong 400\ lb/min$$

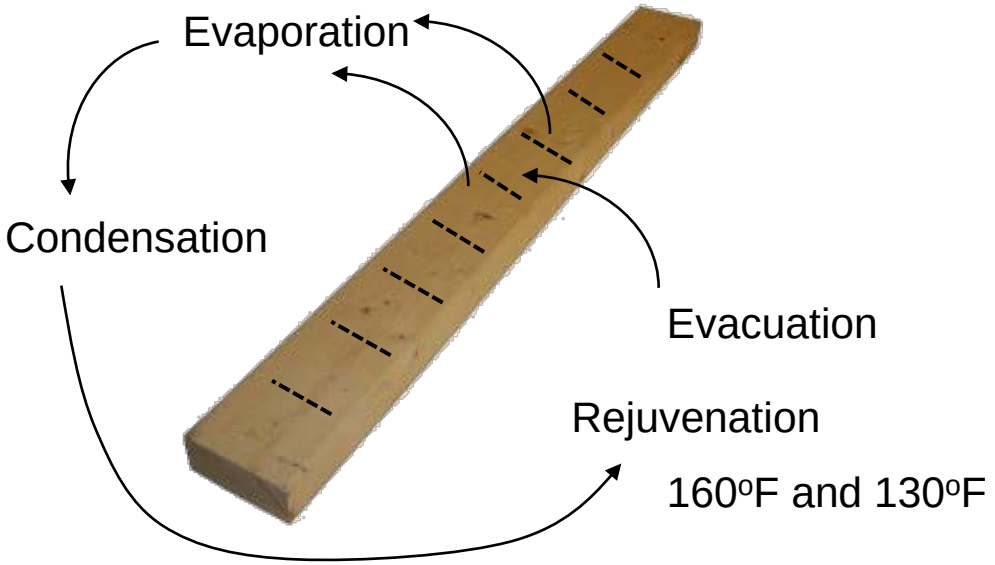
$$\frac{164{,}000\ lb\ of\ water}{400\ \ lb/min} = 410\ minutes = 6.8\ hours$$

- A psychopathic outcome from psychrometric input!

# The Drying of Kerfed Lumber as an Inside Job

An integrating approach in the drying of kerfed lumber in a non-vented, or slightly vented, dehumidification kiln.

How about a “down-to-earth” 24 hours?



# Cards Face Up – Time for the Showdown!

1. Energy savings and lower drying costs
2. Less warp
3. Higher grade recovery
4. Minor post-drying and associated warp
5. Overall improvement in structural performance
6. Elimination of VOCs
7. Recovery of valuable water.

A real-life 7-card straight?

# Or, does the “New Deal” contain one or more jokers?

Thanks for hearing me out!

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To this audience and to those who have contributed a guiding influence to the green kerfing effort:

THANK YOU!