Drying Stress: Fundamentals

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As wood dries,
(below FSP, 30%MC),
it shrinks.

But remember, wood shrinks both
"as a material", and
as a "board".

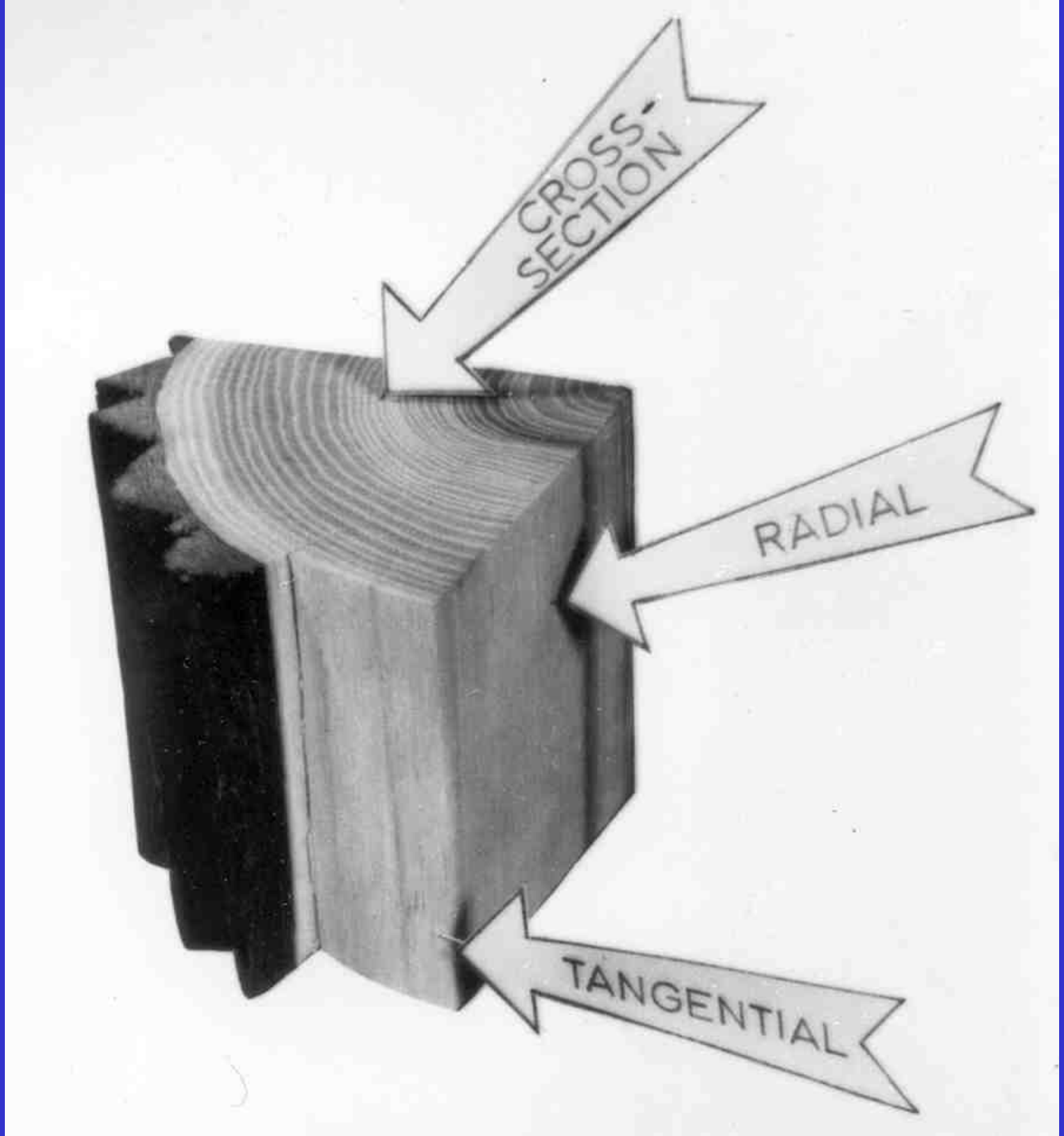
i.e.- when a “board” is at 40% MC, the “shell” is already below FSP, perhaps at 16% MC.

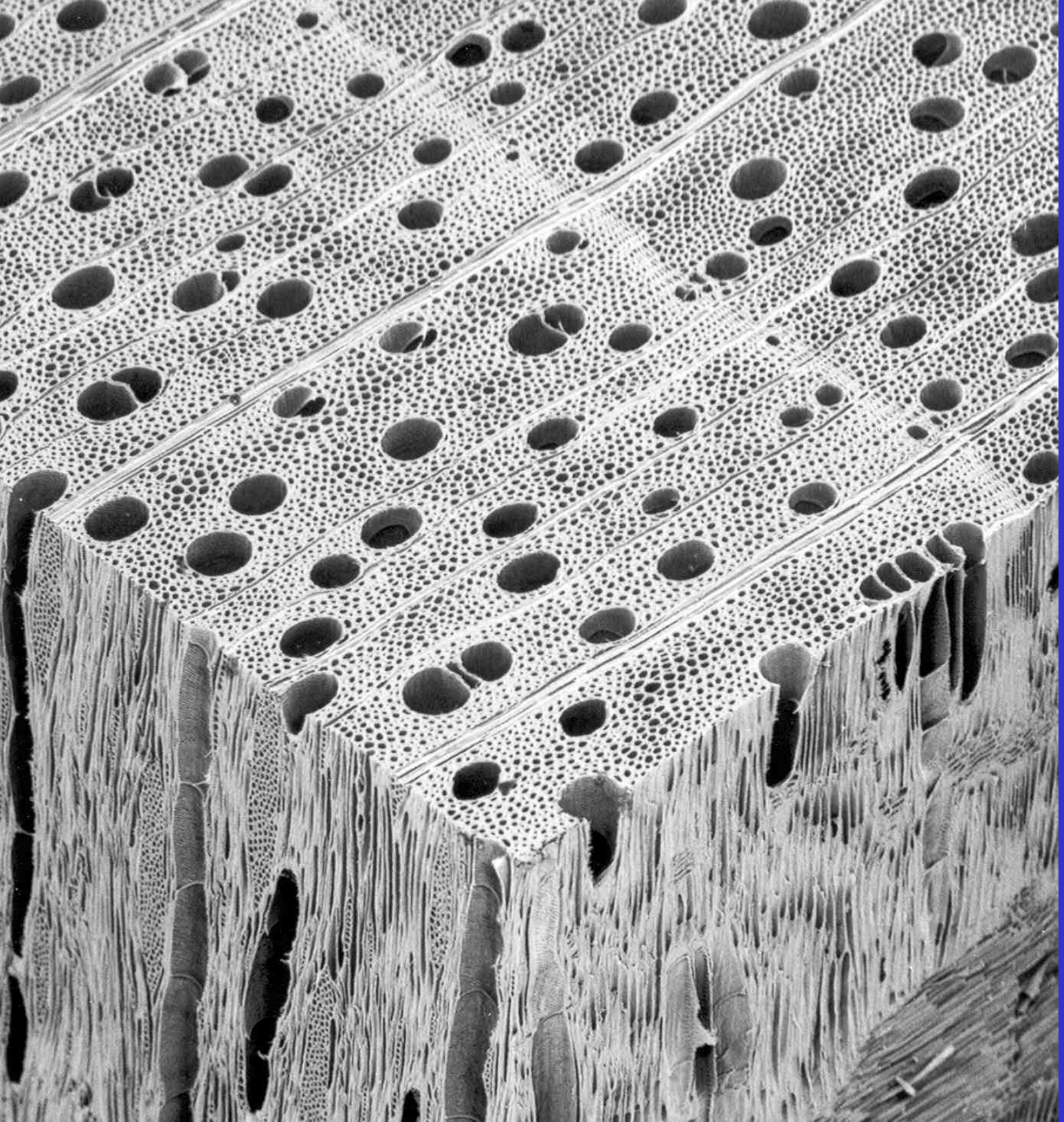
If shrinkage is “restrained”,
because the
“core” is still wet,
while the
“shell” is drying,
stresses develop.

So,
as wood dries it shrinks,
as wood shrinks,

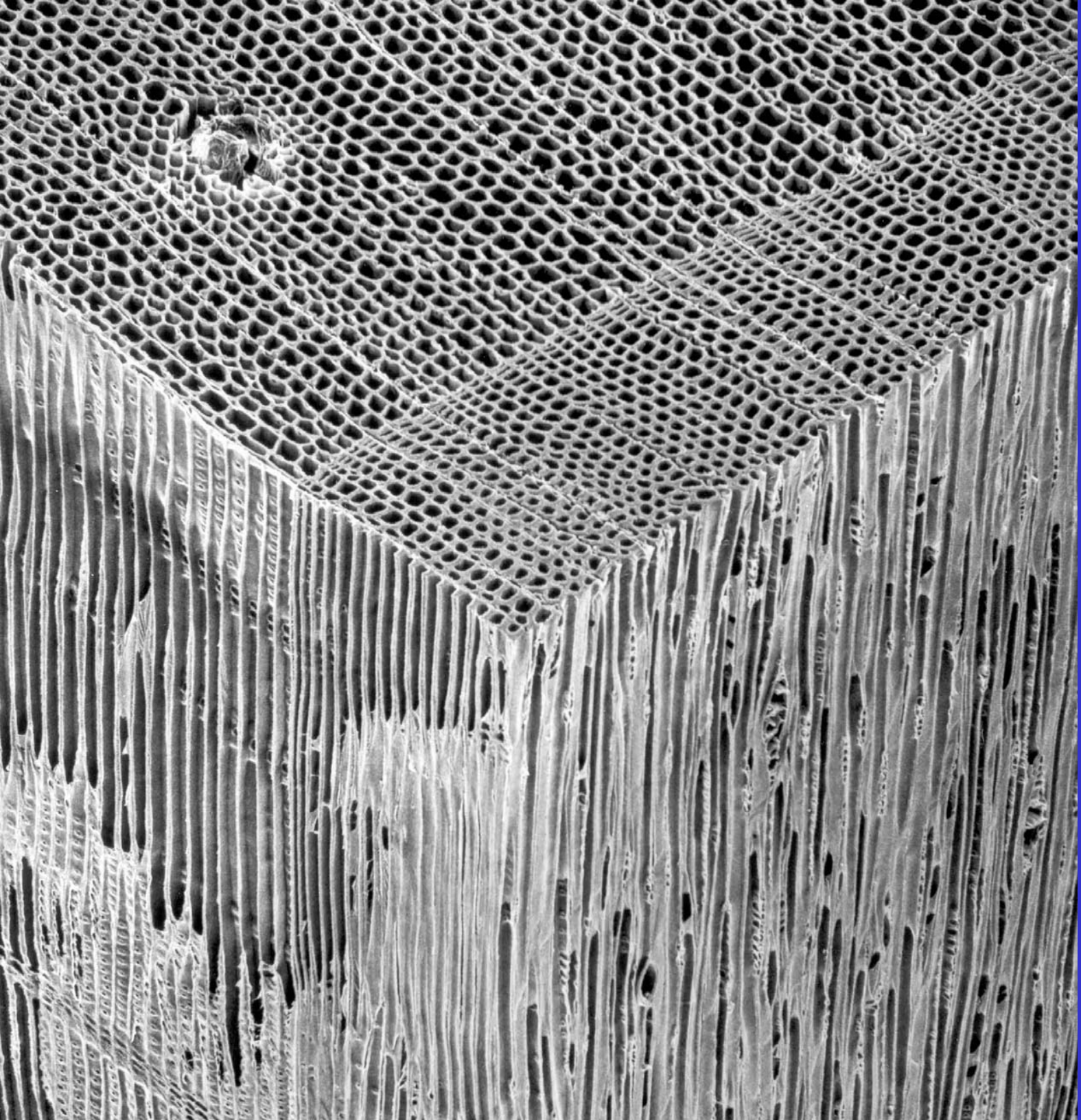
stresses develop.

Wood Shrinkage Varies with Orientation, Density, and Species.


CROSS-
SECTION
RADIAL
TANGENTIAL



Hard Maple



White Pine

Several “rules” about wood shrinkage:

- Dense wood shrinks more, because there is more wood material.
  - Latewood shrinks more than earlywood.
  - Maple and oak shrink more than pine.
- Shrinkage varies varies with orientation;
  - Longitudinal vs. transverse
  - Tangential vs. Radial
    - T/R ratio ~ 2/1

A good “general rule” about tangential shrinkage

- Softwoods, such as white pine shrink about 5 - 6 % from green to 0% -
  - ~ 1 % / 5.5% MC change
- Hardwoods, such as maple and oak shrink about 8 % from green to 0% -
  - ~ 1 % / 4% MC change

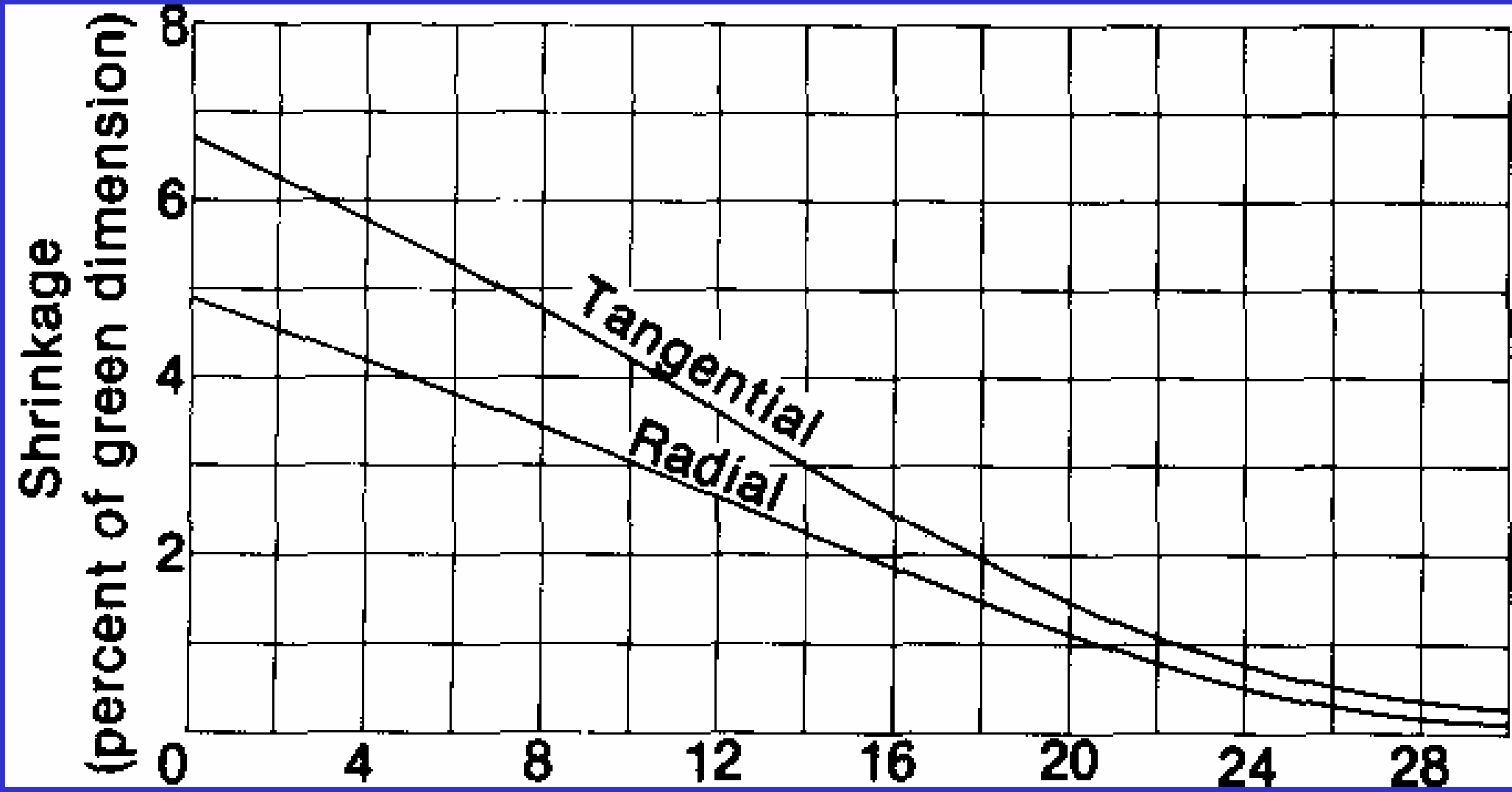
Longitudinal shrinkage of wood is very small, 0.1%

- Except for juvenile wood and reaction wood (compression and tension wood)

Longitudinal shrinkage of boards is very small.

- Except for -
  - boards with juvenile wood and reaction wood (compression and tension wood)
  - boards with sloped grain (which means there is a transverse component to the longitudinal orientation.

Wood Shrinkage



Strength and Stiffness
of wood depends primarily upon
Density and Moisture Content

Stiffness (bending // to grain)

	S.G.grn	Green	12%MC
		*1,000,000 psi	
White Pine	0.34	0.99	1.25
Hard Maple	0.56	1.55	1.83

*S.G.grn = dry weight (oven dry) / volume (green)

Strength (bending // to grain)

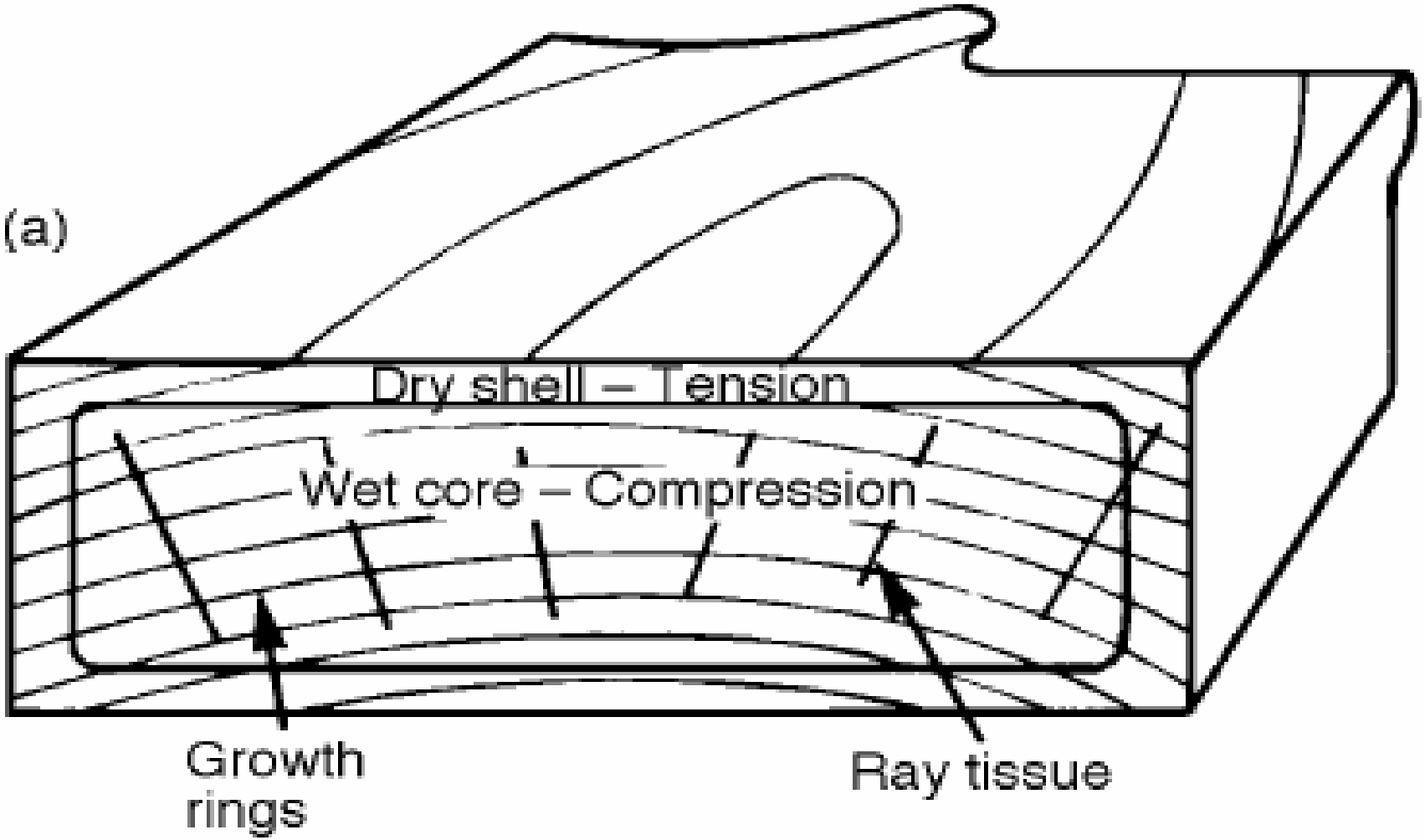
	S.G.grn	Green	12%MC
		psi	
White Pine	0.34	4,900	8,600
Hard Maple	0.56	9,400	15,800

*S.G.grn = dry weight (oven dry) / volume (green)

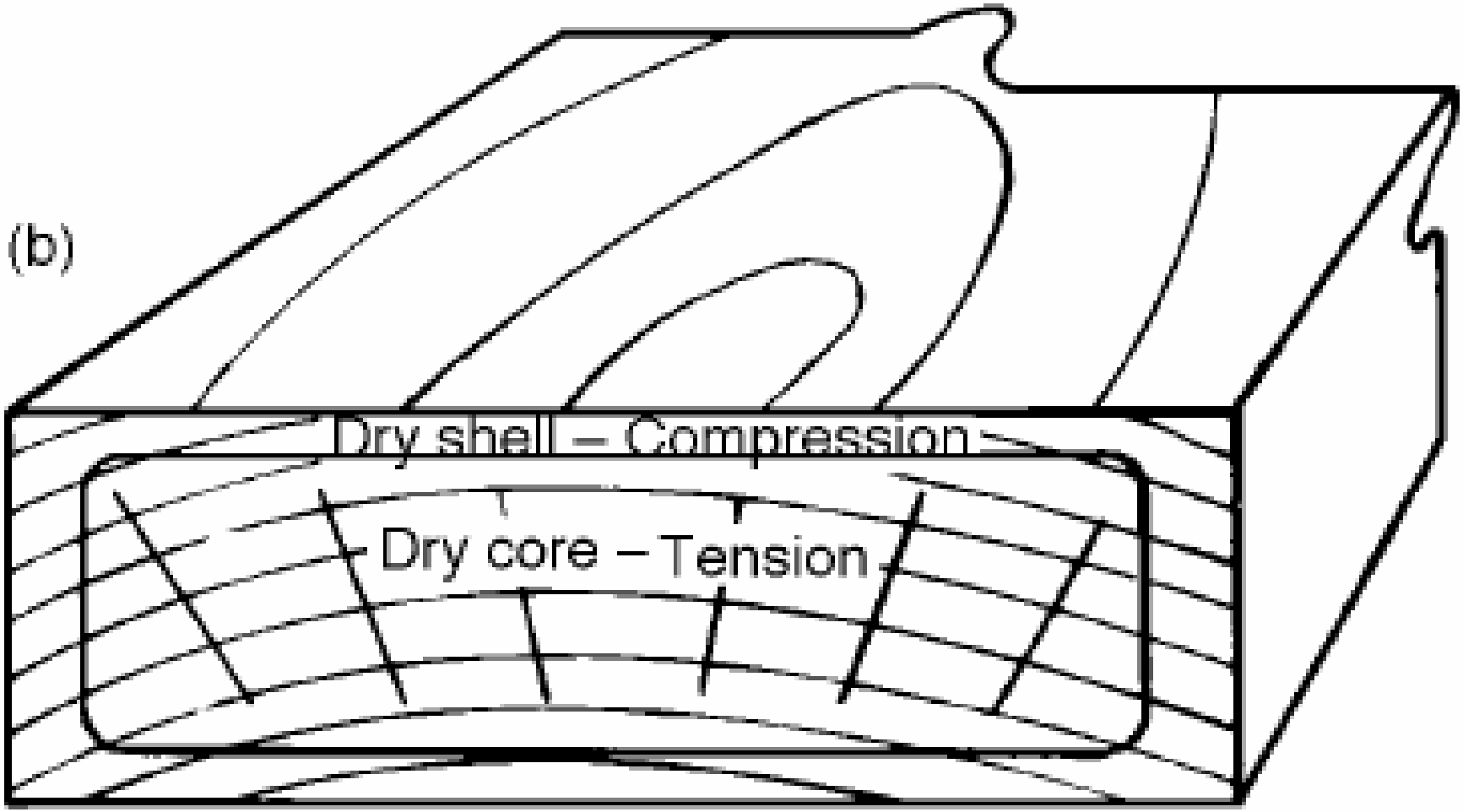
So,
as wood dries it shrinks,
as wood shrinks,

stresses develop.

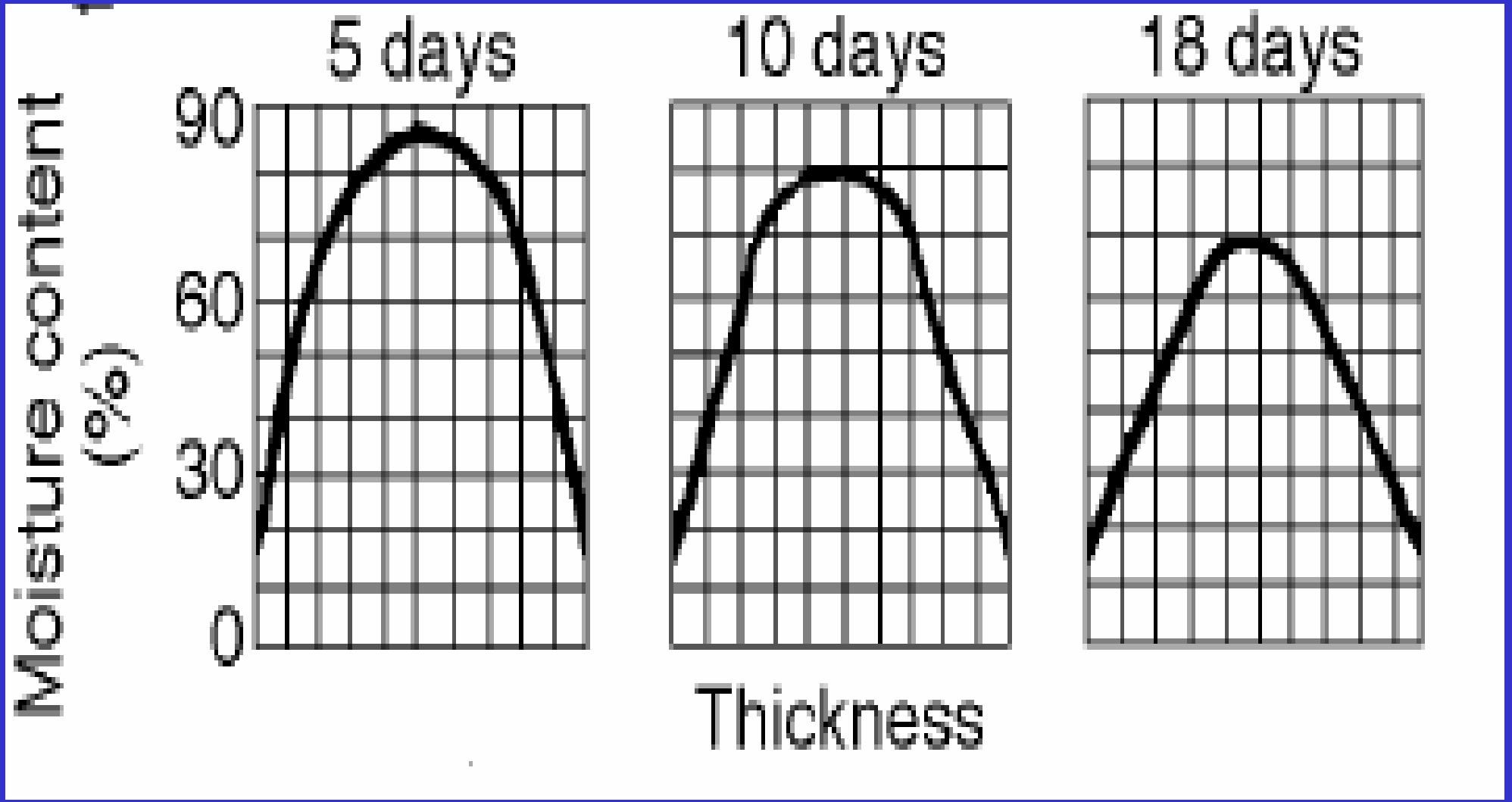
Development of Drying Stresses, Early in Drying



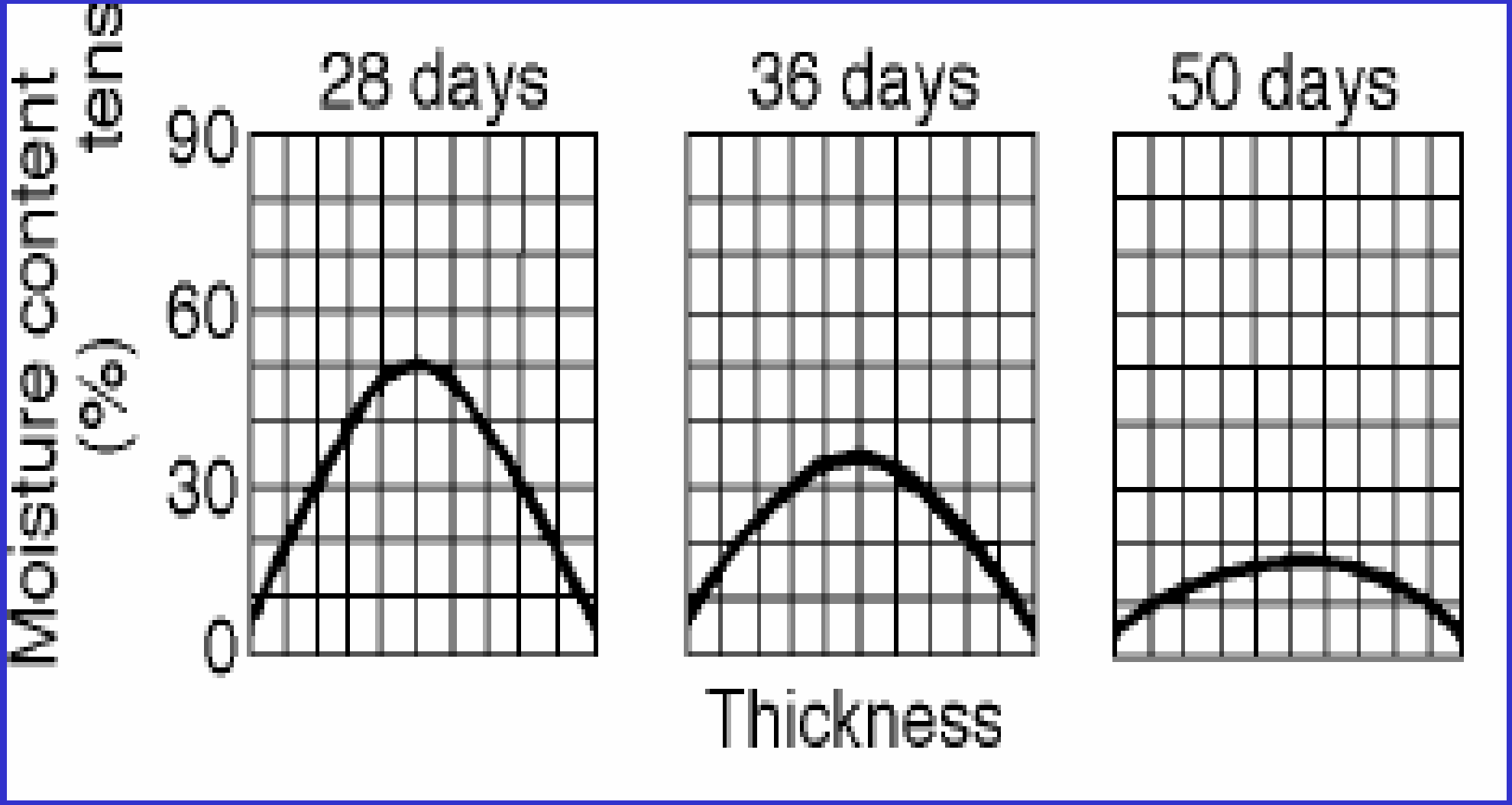
Development of Drying Stresses, Later in Drying



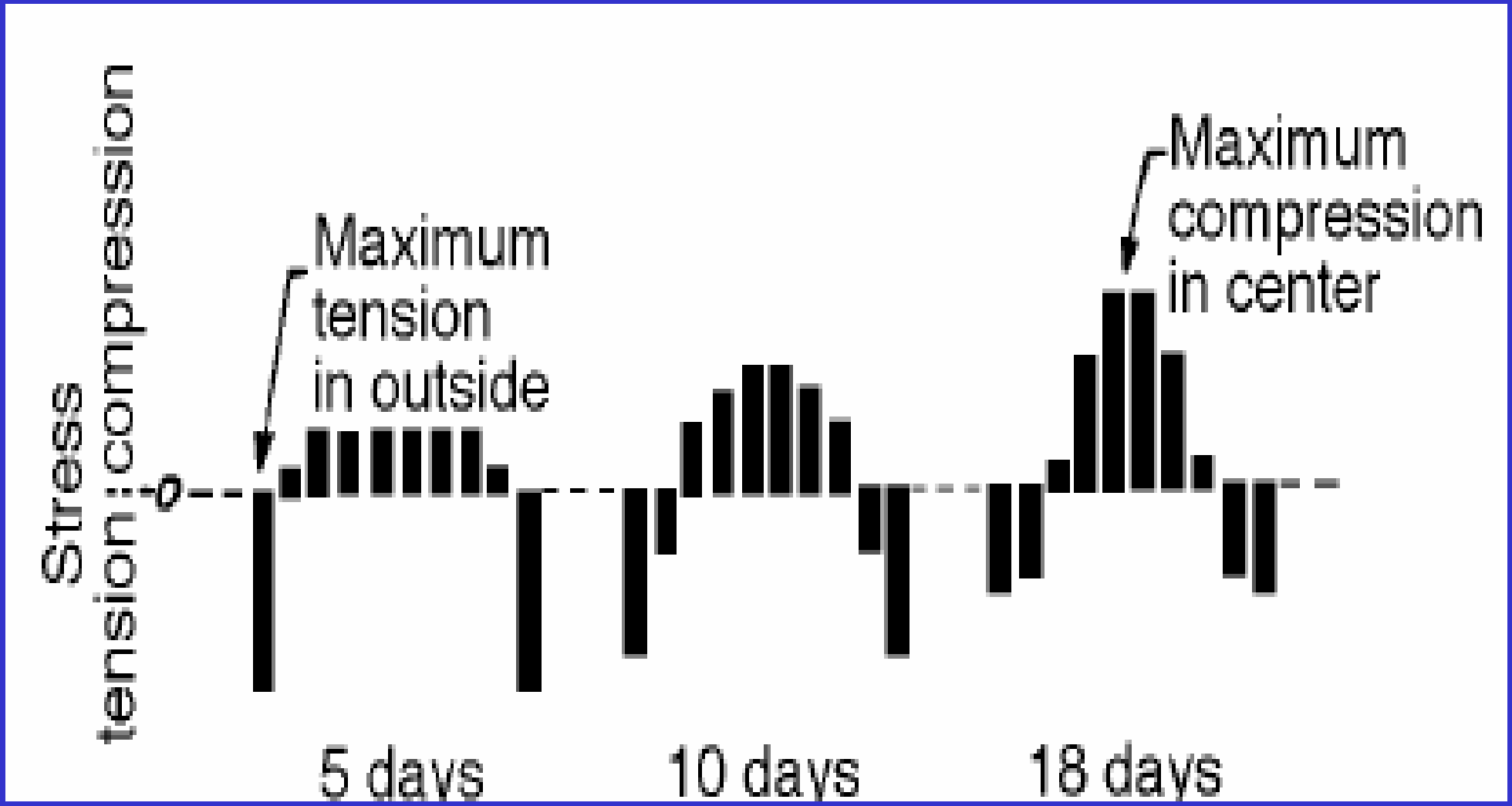
Moisture Gradient during Drying



Moisture Gradient during Drying



Stress Gradient during Drying



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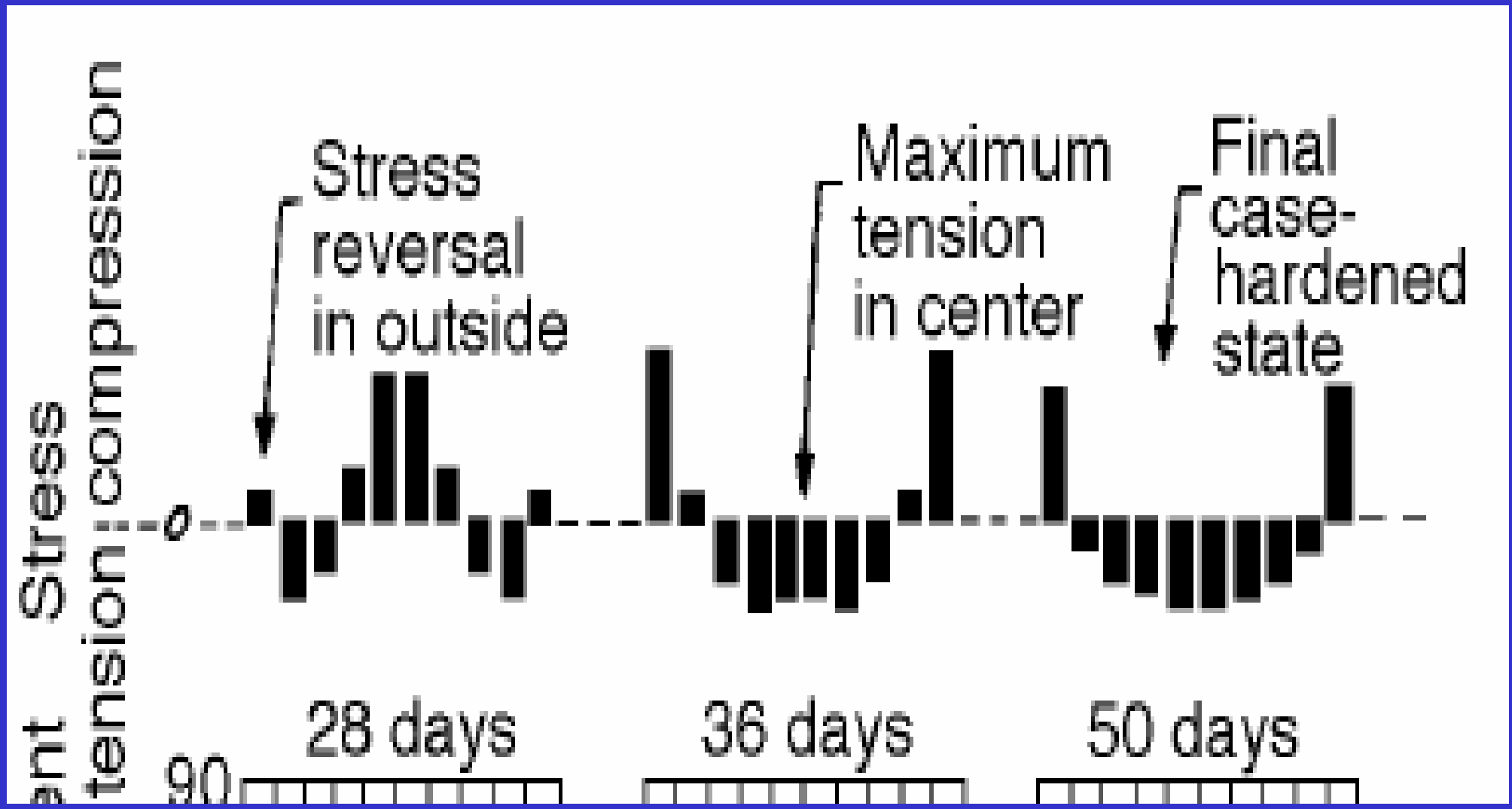
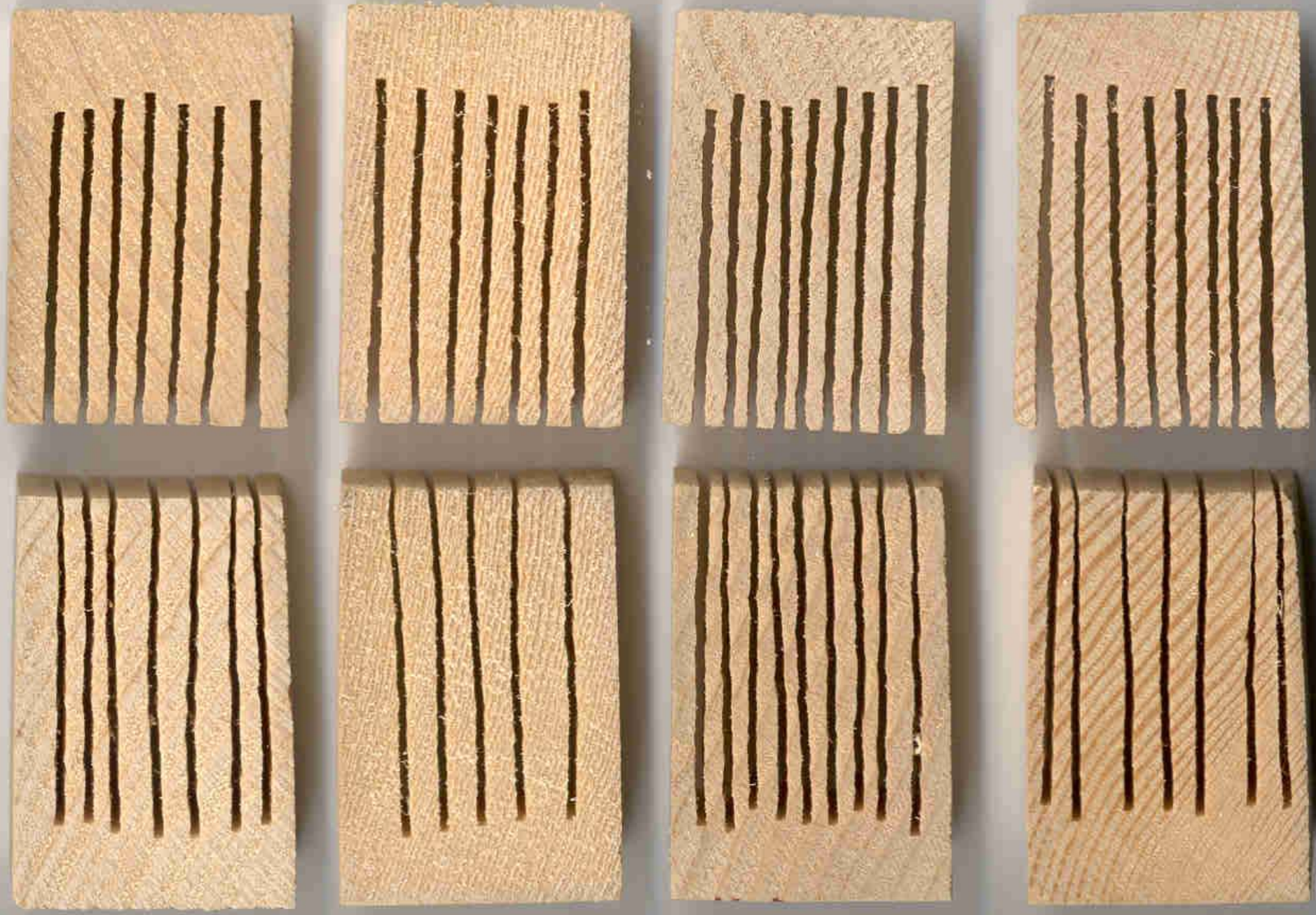


During “Stress Relief”,

- Moisture is added to the “shell” to cause it to try to swell against the core, relieving the stresses.

Stress Relief Conditioning

- High EMC and Temperature
  - Adds moisture
  - High temperature moves moisture faster
  - High temperature means wood is not as strong so stress relieve more readily.



Thank you!

Stress Relief, Application

- Equipment
- Lumber
- Millwork