Flattening of Bamboo by Thermo-Mechanical Treatment♪

Park, Choong-Nyeon, Prof.
School of Materials Sci & Eng.
Chonnam N. University
cnpark@jnu.ac.kr

1. Background of research♪

❖ **Need for development of environmental frien dly natural materials ♪**

- Sick House Syndrome

  - Atopic allergy from chemicals contained in the indoor materi als of new house

- Deficiency of raw materials

  - Drastic increase of raw material cost

- Weak points of woods

  - Low strength - chemical coating

❖ **Need for composites with** high strength-to-wei ght ratios **using natural(bamboo) fibers ♪**

2. Advantages & disadvantages of bamboo♪

❖ Advantages

- Rapid growth(2 months) and utilization(after 2-3 years), unnecessary o f planting except once, abundance in supply(Southeast Asia)
- Good mechanical strength, high thermal conductivity, natural elegant c olor, water resistance, unnecessary of chemical coating
- Natural fiber: fabrics, bamboo reinforced polymeric composites.
- Plentiful mineral elements

❖ Disadvantages

- Cylindrical shape
- Cracking easily upon drying (parallel to longitudinal direction)
- Getting musty easily when humid (due to plentiful organic nutritive elements)

☞ Bamboos have been used only for indoor materials and limited so much in their utilization. ♪

3. Flattening Methods of bamboo♪

Flattening of bamboo can overcome the cylindrical shape of ba mboo, consequently diversifies a use of bamboo. ♪

❖ Cutting and gluing ♪
- Cutting into many small rectangular shape pieces →removal of the outer and the inner surface parts → gluing♪

❖ Grooving and gluing♪
- V-shape grooves at the surface of bamboo →gluing ♪
  → removal of the outer and the inner surface parts ♪

⇒ sacrifice of strength and water resistance of bamboo surface♪

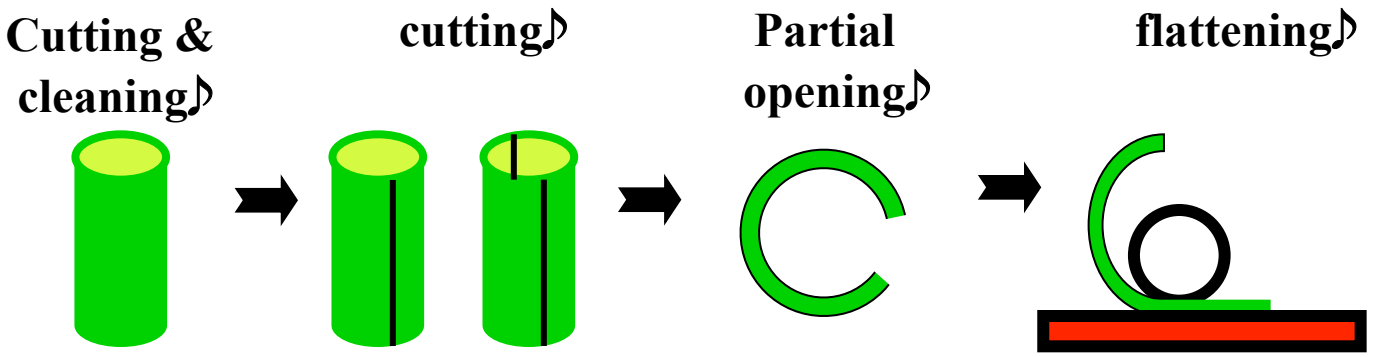
❖ Thermo mechanical treatment (this work)♪
- Flattening bamboo without cutting and gluing process♪
- Scratch and wear resistant due to original skin ♪

4. Flattening by thermo-mechanical treatment♪

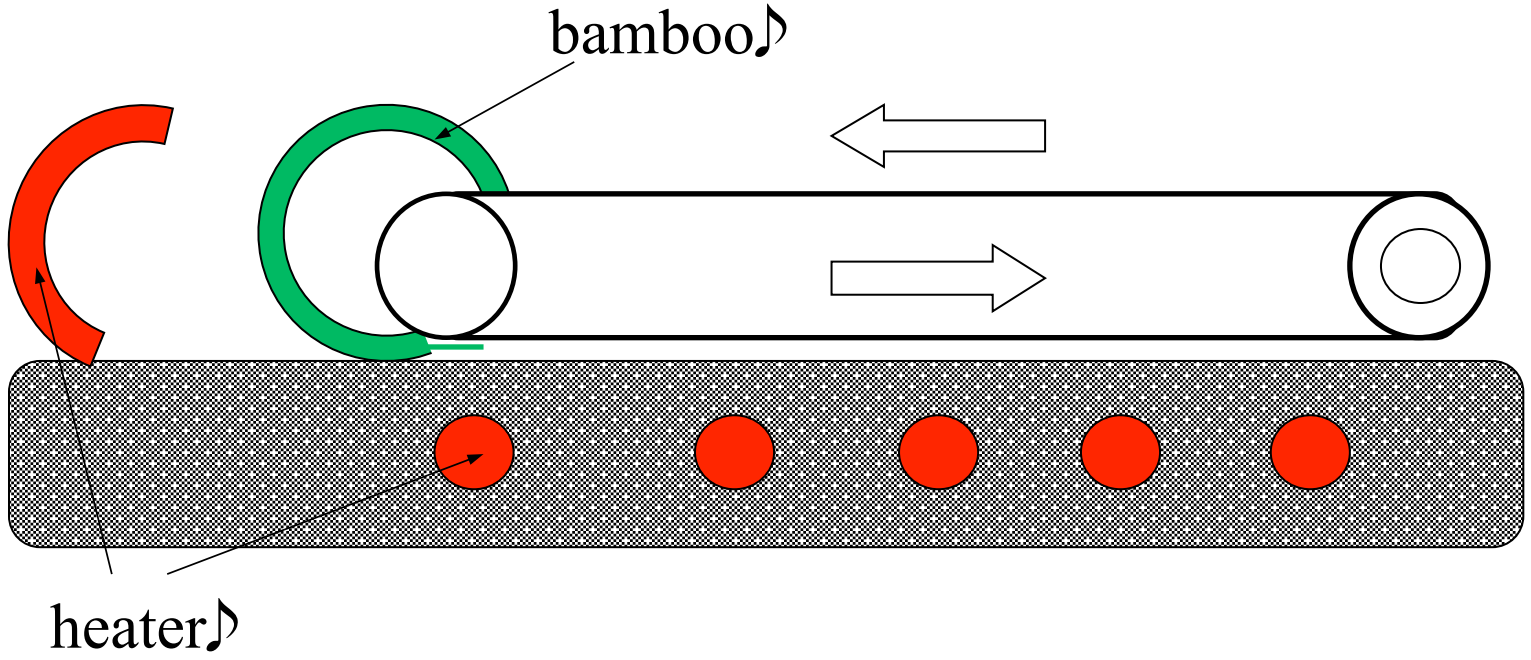
4.1 Flattening of cylindrical green bamboos without node ♪ ♪

- Cylindrical green bamboos (Korean king bamboo, O.D: about 80-100 mm, L:250-400mm, t:5-7mm (cutting and cleaning)♪
- Then the bamboos were placed in an oven at the temperature of about 200℃. (partial opening)♪
- After waiting for bamboo to be opened enough the bamboos were put into the flattening machine which could flatten bambo o gradually in transverse direction♪
- Temperature of flattening:150- 200℃, Flattening speed:10-20 cm/min♪

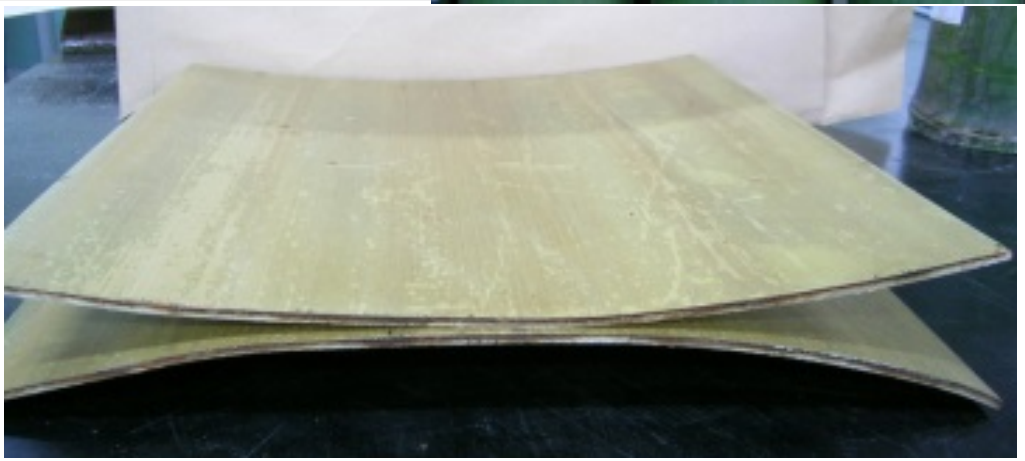
  ⇒The rectangular-shape bamboo plates without crack. ♪



4.2 Schematic diagram of the machine f or flattening cylindrical bamboos witho ut node♪

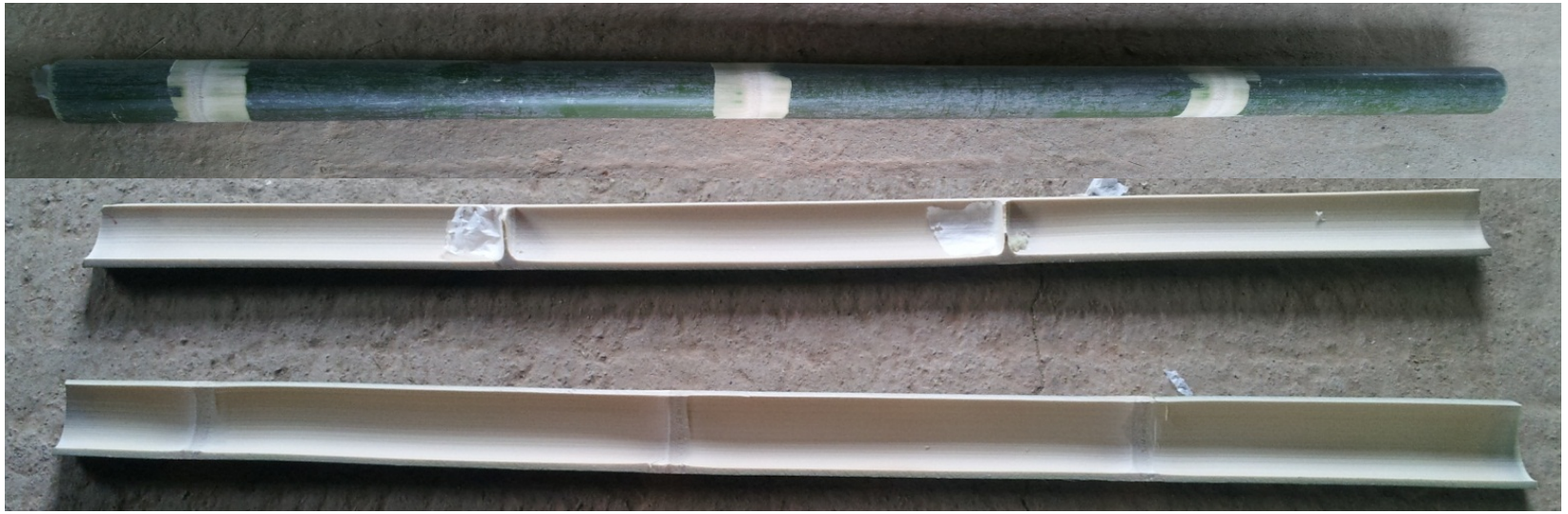


4.3 Flattened bamboos without node obtained by the thermo mechanical treatment

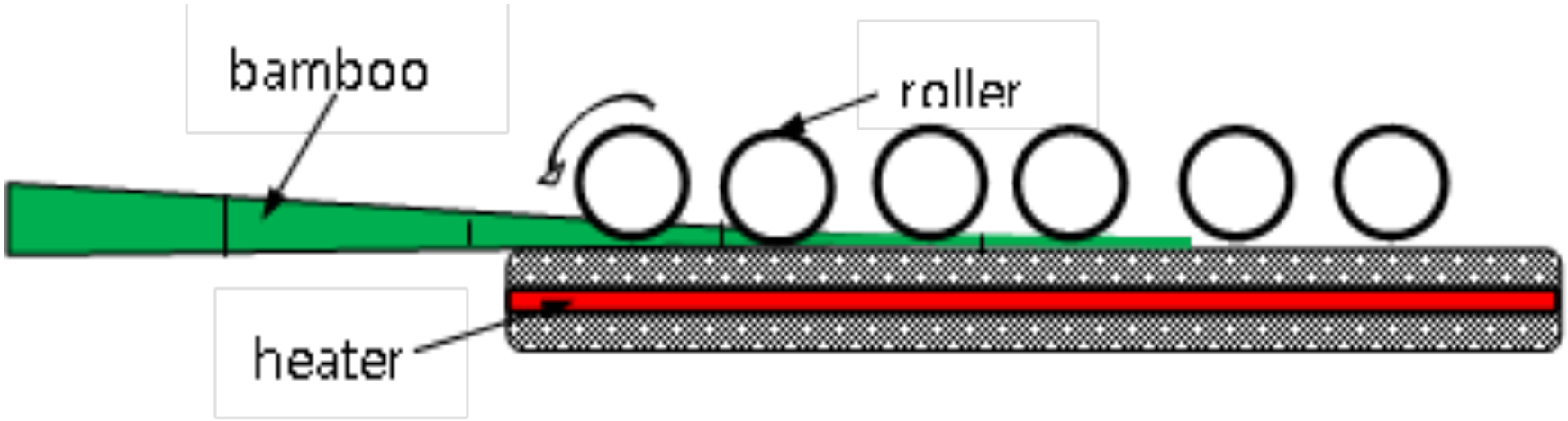


4.4 Flattening of cylindrical bamboos with no des ♪

- Cylindrical green bamboos (Korean king bamboo, O. D: about 80-100 mm, L:1250mm, t:5-7mm♪
- Removal of extruding parts of node out side♪
- cutting into 2 pieces♪
- Removal of internally extruding parts of nodes♪
- Flattening by machine♪

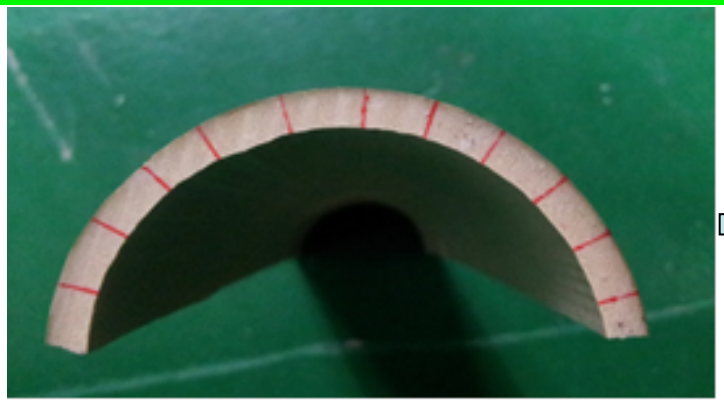


4.4 Schematic diagram of the machine for flattening hemi-cylindrical bamboos with nodes♪



- Temperature of flattening:150- 200℃♪
- Flattening speed: 30-100cm/min depending on the thickness, the moisture contained and the age of b amboo♪

4.5 Flattened bamboos with nodes obtained by the thermo mechanical treatment♪



(natural surface)♪

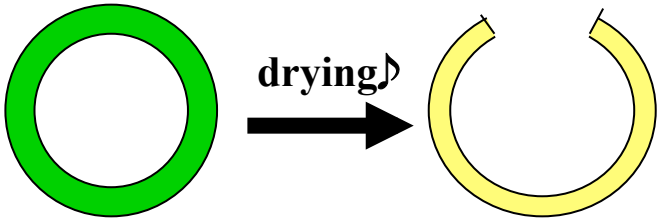
80mm

1200mm

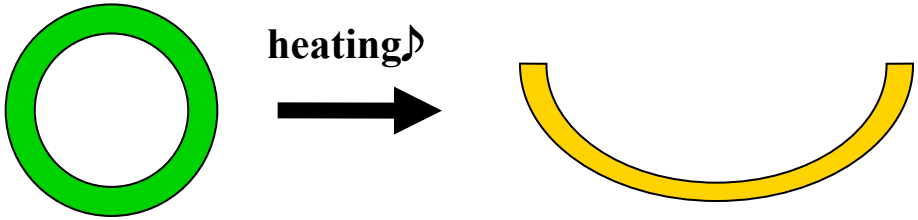
(abraded surface) ♪

5. Flattening of bamboo at various conditions♪

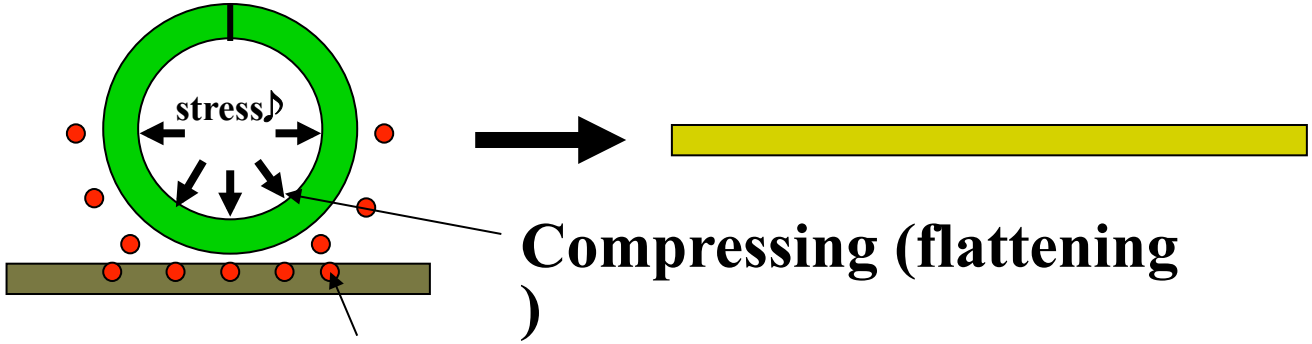
Flattening partially by natural drying♪



Flattening partially by heating♪

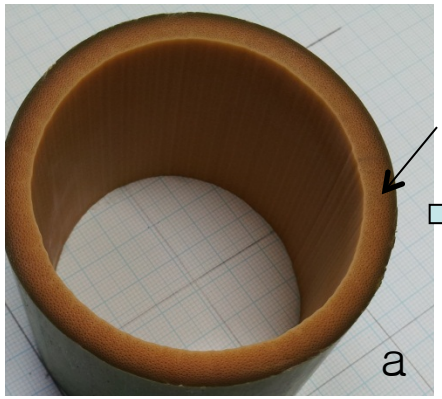


Flattening completely by thermo-mechanical treatment♪

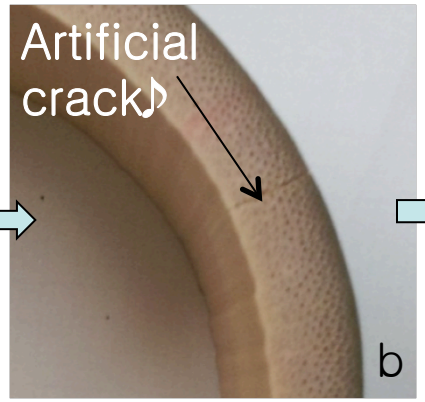


6. Mechanism of Partial Flattening by a Natural Drying

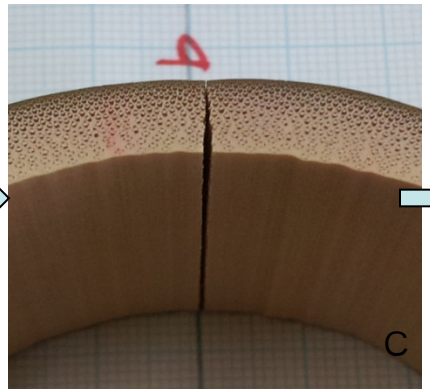
6.1 Shape Change of a crack in bamboo with drying at RT ♪



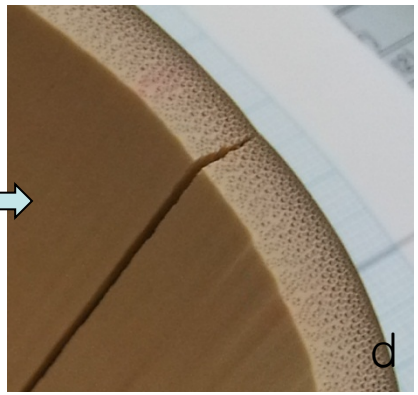
t=0, σ_c<0♪



t=0.7hrs, σ_c<0♪

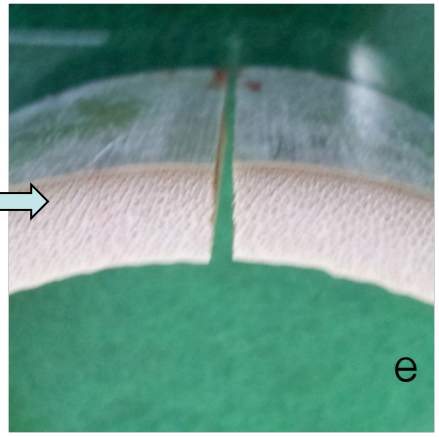


t=16.5hrs, σ_c<0♪



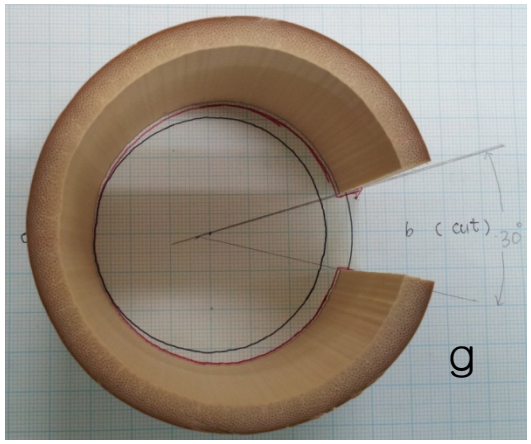
t=2days, σ_c<0♪

Cf: Tempered Glass ♪



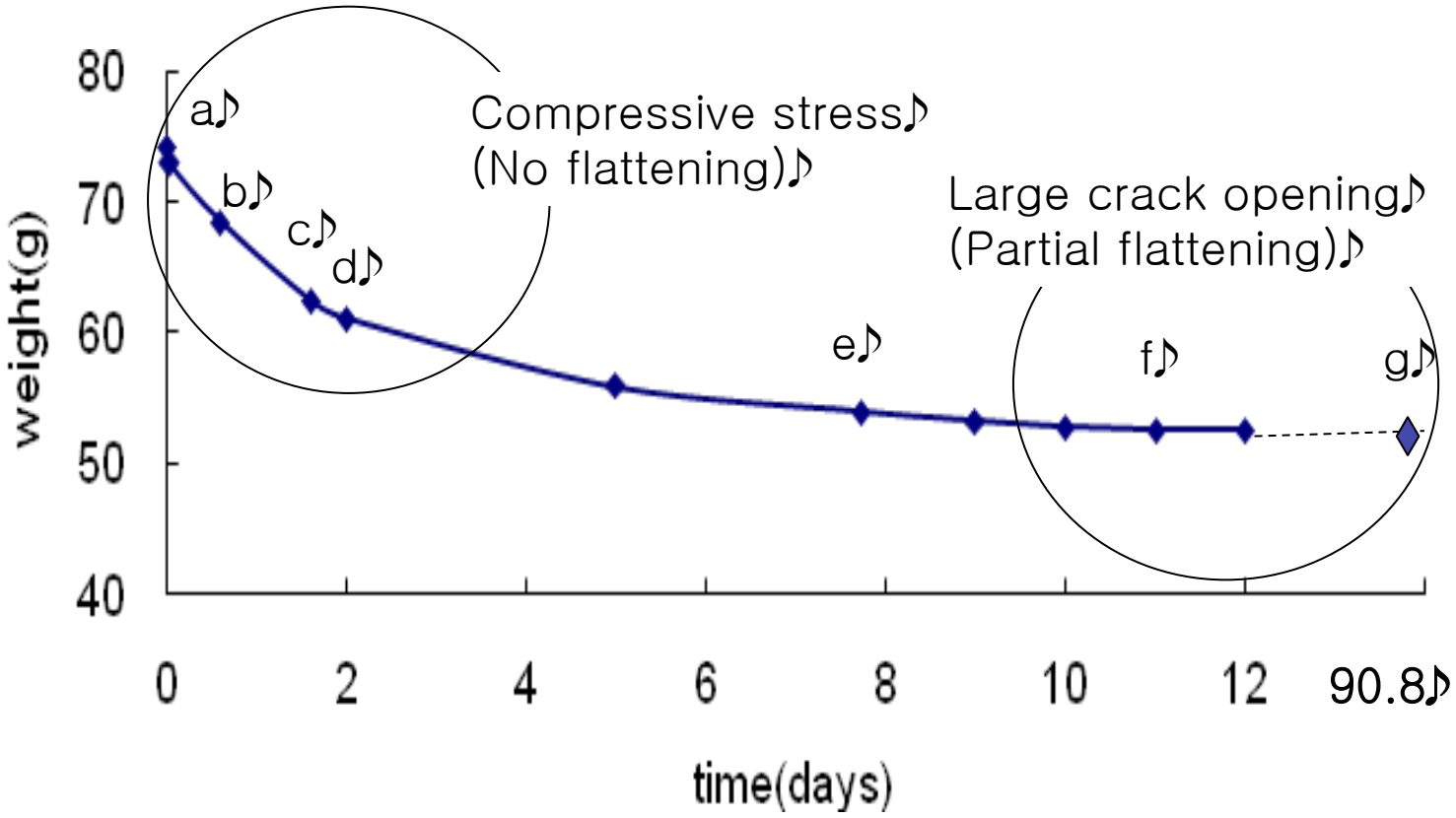
t=7.7days, σ_c=0♪

t=11days♪



t=90.8days♪

6. 2 The weight changes of a green bamboo♪ during drying at 25℃♪

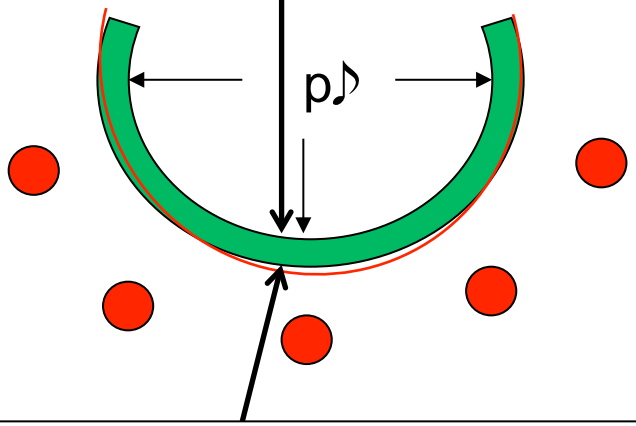


6.3 Flattening Mechanism of a Green Bamboo by Thermo-Mechanical Treatment♪

pressing♪ ⇒ Different strain♪ ⇒ Flattening & cracking♪

Heating ♪ ⇒ Thermal softening ↑→ prevention from cracking♪
Drying speed ↑→ contraction♪
Thermal expansion →Over flattening♪

Tensile stress(strain)♪
Low temp.: slow drying, smaller comp. strain ♪ ⇒ smaller contraction♪

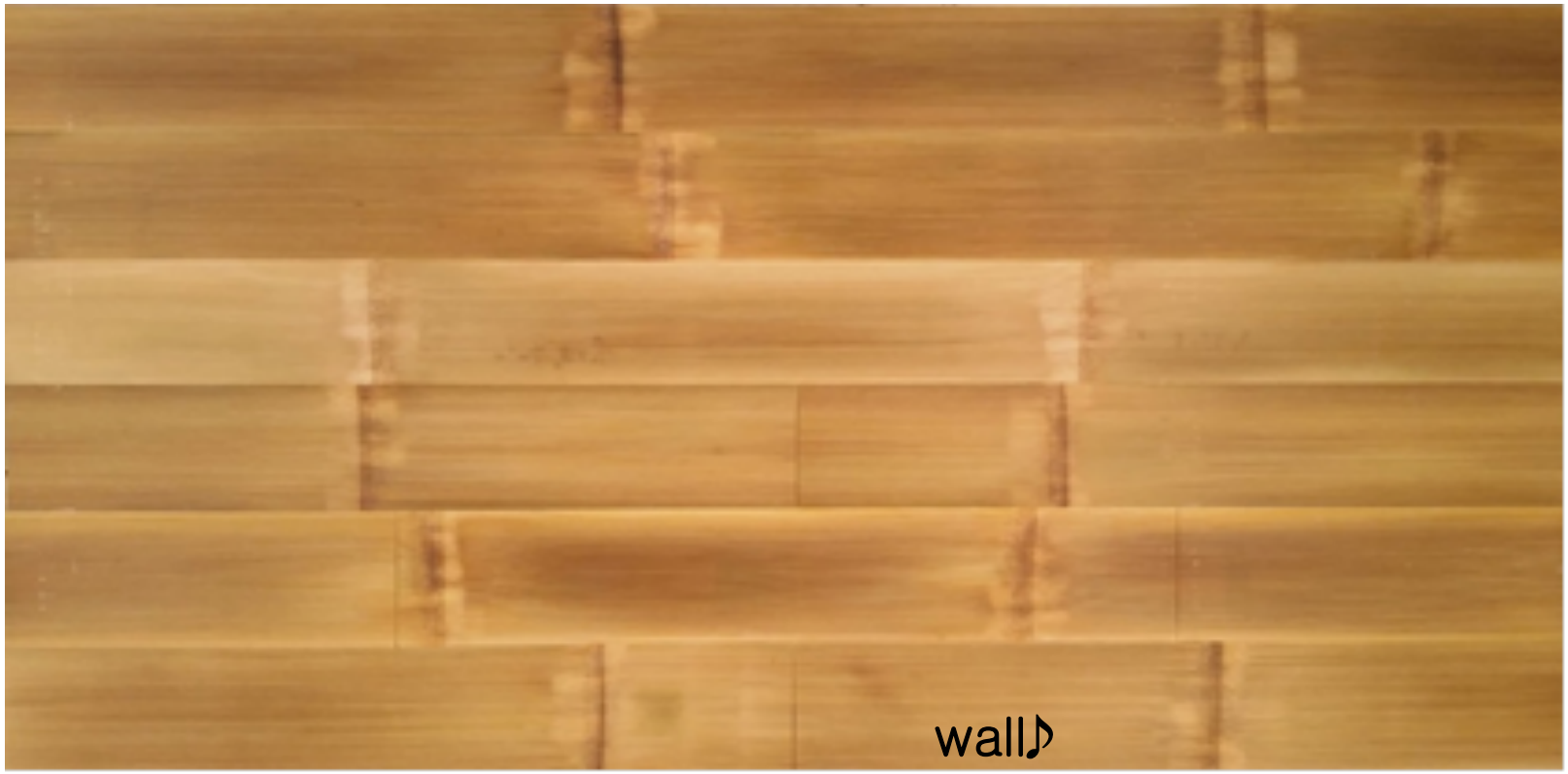


Flattening♪

Comp. stress(strain)♪
High temp.: Fast drying, larger comp. strain♪ ⇒ larger contraction♪

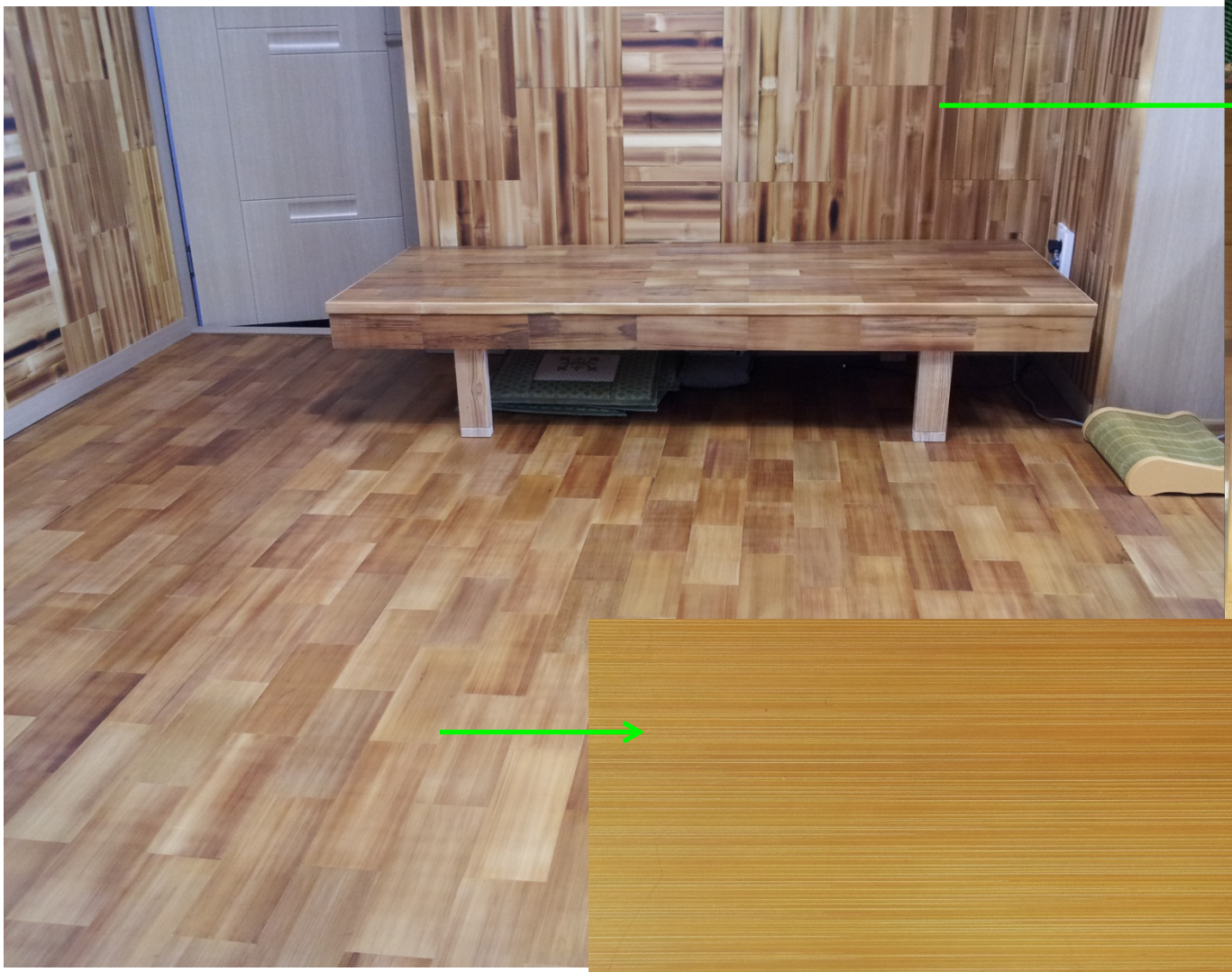
7. Applications of flattened bamboos♪

Floor and Wall♪



skate board♪

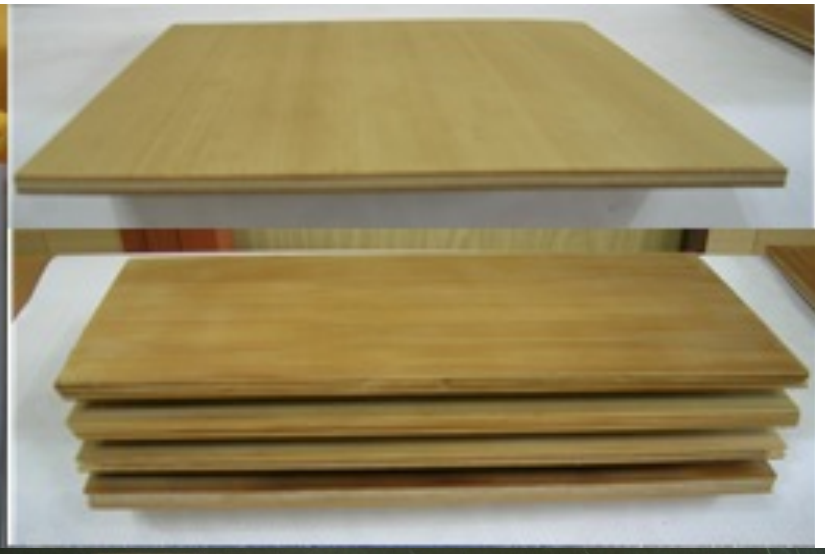
Bamboo floor, wall and tea table with ground skin




Bamboo floor with ground skin♪

Bamboo tables♪

Bamboo plates and veneer boards♪



Printed patterns on flattened bamboo plates ♪

Flattened bamboo plates with printed patterns ♪

Ink printing♪