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In general, in the gravitropic reorientation process, compression wood is associated to gymnosperms and tension wood to angiosperm. Except for very few hardwood species where compression wood have been observed, such as for example *Pseudowintera colorata* (Kubera and Philipson 1978; Meylan 1981), *Hebe salicifolia* G. *Forst*. (Kojima et al. 2012), *Viburnum odoratissimum* var. *awabuki* (Wang et al. 2010), or *Buxus sempervirens* (Baillères et al. 1997) and *Buxus microphylla* var. *insularis* (Yoshizawa et al. 1999).

The presented research focused on the properties of *Buxus sempervirens* from biomechanical aspects on the tree to the mechanical and physical behaviour of the material. Indeed, there are virtually no scientific publications about the physical-mechanical properties of Boxwood although it is an interesting study case for uncommon re-orientation process.

A wide experimental plan (approx. 150 specimens for various types of tests) has been realized on a living « archetypal » tree of 110 years, which restored verticality in a steep mountain slope of South of France. External residual growth strains have been measured at 4 positions along the circumference and 2 heights. After growth stress measurement, hygrothermal recovery (HTR) test were performed. Then sampling of specimens has been realized regarding to those positions in order to compare the mechanical and physical behaviour of reaction wood, opposite wood and « normal » wood. Thus measurement have been performed, such as isotherms of sorption and associated shrinkage/swelling, ultrasonic velocities in the 3 principal directions, and dynamic Young's modulus and damping at audio-frequencies (for green wood and dry wood conditions). Concurrently Young's modulus and damping coefficient of air-dry wood have been measured on more than 100 samples from 3 different origins (6 trees in total) at different radial positions in the stem cross section. Samples for determination of microfibril angle were also cut along the radial position for the different studied trees.

Growth stress measurement confirmed high level of compression in the lower side of the curvature of the tree. Microfibril angle measurements also clearly highlighted the presence of compression wood. Similarities where found with the mechanical properties of compression wood in gymnosperms, such as, lower Young's modulus and higher longitudinal shrinkage. However it is interesting to note that, in this species with high wood specific gravity (around 1) the anisotropy was rather moderate and the difference in physical/mechanical properties between compression and normal wood were less extreme than in gymnosperms species. In the case of sorption isotherm, the differences were surprisingly small. On the contrary, compression wood and "normal" wood reacted very differently to hygrothermal recovery tests.

Generally the results confirmed that the reaction wood of *Buxus sempervirens* is indeed compression wood. They also asked the question of amplitude in difference of wood properties in the case of a wood which has normally a very high density and a moderate stiffness.

References

Baillères H, Castan M, Monties B, Pollet B, Lapierre C (1997) Lignin structure in *Buxus sempervirens* reaction wood. Phytochemistry 44:35–39

Meylan BA (1981) Reaction wood in *Pseudowintera colorata*—a vessel-less dicotyledon. Wood Sci Technol 15:81–92

Kojima M, Becker V K, Altaner C M (2012) An unusual form of reaction wood in Koromiko (*Hebe salicifolia* G. Forst. (Pennell)), a southern hemisphere angiosperm. Planta 235 :289-297

Kucera LJ, Philipson WR (1978) Growth eccentricity and reaction anatomy in branchwood of *Pseudowintera colorata*. Am J Bot 65:601–607

Wang Y, Gril J, Clair B, Minato K, Sugiyama J (2010) Wood properties and chemical composition of the eccentric growth branch of *Viburnum odoratissimum* var. awabuki. Trees Struct Funct 24:541–549

Yoshizawa N, Ohba H, Uchiyama J, Yokota S (1999) Deposition of lignin in differentiating xylem cell walls of normal and compression wood of *Buxus microphylla* var. insularis Nakai. Holzforschung 53:156–160