The radial distribution of material constituting the bamboo stem is found to be similar to the optmal for the given constraints of max stress and bending moment that are applicable for bamboo under loading condition. Radial distribution of material along the height obtained also follows the pattern observed in bamboo. Predictions made of extreme cases of bamboo, i.e., one with large radius and thin cross section, and another with small radius and solid cross section, can also be verified.

Note 1

First->Look at all graphs

->Find the range of parameters relevant to the paper and plot varying between the extremes can be useful.

Bending Moment - 400N-m for Tapered graded/homogenous

1000N-m for Straight homogenous

Max Stress -6 Mpa Tapered Homogenous

-12 Mpa Tapered graded

-23 Mpa Straight Homogenous

->FInd useful graphs

->Figure out the pattern on parameters

->Determine which graphs needed to be created

->Create need graphs

->Take graphs from mannans thesis

->Write the line defining the work

Note 2

>Overall density (1d,2d)

Distribution of stress

Bending Moment

The radial distribution of material constituting the bamboo stem is optmal for the constraints of max stress and bending moment that are applicable for bamboo under loading condition. Radial distribution of material along the height obtained also follow the pattern observed in bamboo. Predictions made of extreme cases of bamboo, i.e., one with large radius and thin cross section, and another with small radius and solid cross section, can also be verified

Assuming axisymmetry, the radial distribution of constituent materials of bamboo is optimal for the constraints of maximum stress and bending moment that are applicable for bamboo under loading condition.

Note 3

Bamboo is natural composite which is composed of fibres embedded in a matrix of parenchyma cells. Bamboo fibres are mainly composed of cellulose, hemi-cellulose and lignin [L.Y.Mwaikambo et. al.]. Fibres are spread out across the cross section in graded manner with higher density towards the periphery. Also the size of parenchyma cells decreases along the radially outward direction as the air content reduces. This results in axisymmetric density variation in the radial direction. [Plot showing distribution of fibres.]

This can be modelled as the distribution of two materials, and air(capture in parenchyma cells). First material being the denser and stiffer fibres and second material being the parenchyma cellular material excluding air. The properties of fibres and parenchyma are taken from [Mannan et. al, L.Y.Mwaikambo et.al].

Bamboo like any other living organism is a result of evolutionary process . Survival of the fitest means that bamboo species is nature's best solution for some natural condition lead to existence of bamboo. Bamboo grows tall upto 20m to rise above the other competiting plantation. With such a slender structure, bending load due to high speed tropical winds are a major constraint which the evolution had overcome. Bamboo has very high specific strength, which is also a desired attribute in industrial applications. It desired to develop composites with high stiffness and lower weight.

Therefore, we frame it as a maximization probblem, with the objective function being specific strength, optimizing the radial distribution of fibres and parenchyma with same inner and outer radius similar to the bamboo.