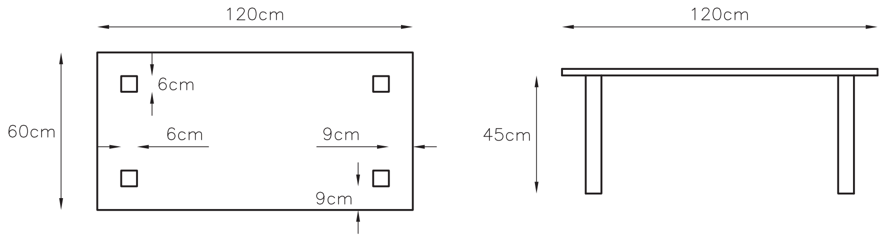
Assignment 03 – Solution of SOLID structures

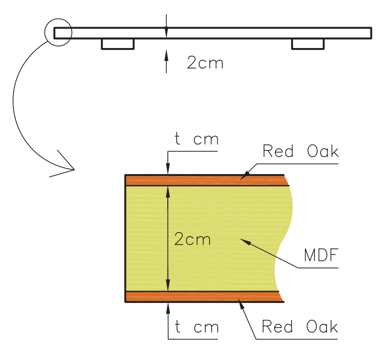
We want to construct a coffee table with a wood laminate. The table dimensions are the ones shown in the following figure:



We will construct the table as a wood laminate; with a lower and an upper layer of Red Oak wood and the core made of MDF. We already have the MDF board, which is 20mm thick, and we also have the table legs. The only piece missing are the boards of Red Oak.

In our trip to Lowe's, we find out that there are tens of red oak boards with different thicknesses, starting with a thickness of 0.5mm and varying it in multiples of 0.5mm. So we return home empty handed. We have to calculate the thickness required!

As we are not interested in the table legs, we will not model their whole length (2cm will be enough). Therefore, a close view to the model we have to make is:



Regarding the loads, we consider that the worst case scenario is to have four of our friends standing on it. This is approximately 350 kg, which can be applied as a distributed load of 5.0 kN/m^2.

The mechanical properties of the different materials involved in the simulation are:

Red Oak
- Density = 660 kg/m^3
- E (Young modulus) = 12.5 GPa
- ν (Poisson modulus) = 0.35

MDF (Medium Density Fibreboard)
Density = 750 kg/m^3
E (Young modulus) = 4.0 GPa
ν (Poisson modulus) = 0.25

In order to decide the thickness of the oak board required we will verify that the maximum stresses allowed by the materials are not exceeded and we will also verify that a maximum vertical deformation is not exceeded.

The strength of the different woods are:

Red Oak:

Max TENSILE strength, PARALLEL to grain	= 101 MPa
Max COMPRESSIVE strength, PARALLEL to grain	= 46.6 MPa
Max TENSILE strength, PERPENDICULAR to grain	= 7.0 MPa
Max COMPRESSIVE strength, PERPENDICULAR to grain	= 5.5 MPa

MDF:

Max TENSILE strength	= 18 MPa
Max COMPRESSIVE strength	= 10 MPa
Max SHEAR strength	= 7.0 MPa

Maximum deformation allowed = 2.0 mm

Notes:

a. The stress concentration effects in the red oak board close to the table legs can be ignored. In the simulation performed legs are stiffer than in reality (as we are only simulating 2cm of them) and this can lead to larger stress values.

b. The bond between the MDF and the oak board is considered to be stronger than the MDF. Therefore, the validation of the bond will be done verifying that in this area shear stresses are lower than the max. shear strength of the MDF.

In this assignment you must:

1. Find the minimum oak board thickness that fulfills all strength and deformation parameters. Which is the parameter that drives this dimension? Is this a critical parameter? (will the table break if we exceed it?)
2. What will happen if we cut the oak board wrong and fibers are placed with an orientation of 45º?

You will have to present a report describing the models developed and the results obtained.

This assignment is due on Monday August 6, 2012. You can handle me a paper copy after class or you can submit it as a pdf at x.martinez@upc.edu