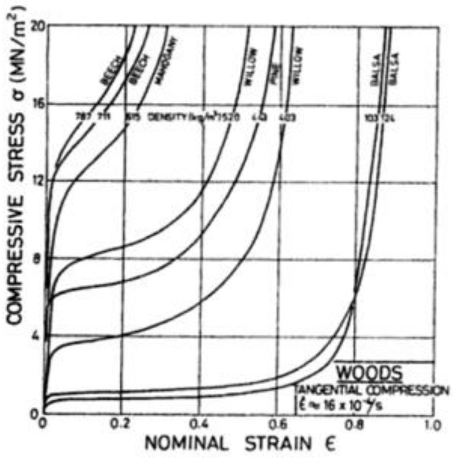
Abstract

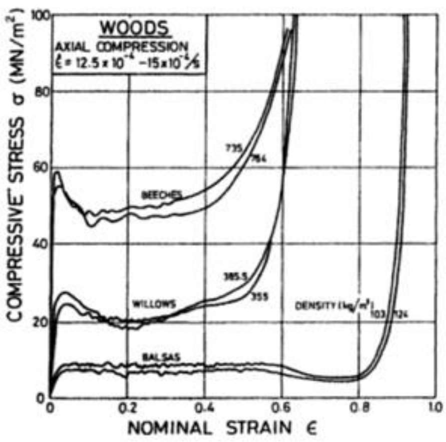
The present work tries to stablish some bases on the study of wood as material capable to absorb impacts. When thinking on wood, the first use that come to our mind is furniture (table, chairs…) or civil-construction uses as houses. Wood is one of the most ancient materials used first; in fact, its use is dated from the Paleolithic where it was used as material for utensils such as spears for hunting.

Nevertheless, this study tries to study wood as the solution of how to transport nuclear residues in a safety way. When transporting nuclear residues, by truck, it usually used some kind of rings that surround the cylinder, in order to protect it in case of impact.

These rings are usually made of materials capable to absorbed great amounts of energy before breaking. In this field, wood seems to be a good choice. Why? Because of his capacity to deform until values between 60% and 80% depending on the spice of wood. However, using wood has its cons due to the difference of the physical characteristics between the difference spices and the difficulty to find a proper physical model. The next graphics tries to show these facts:



Tangential Compression



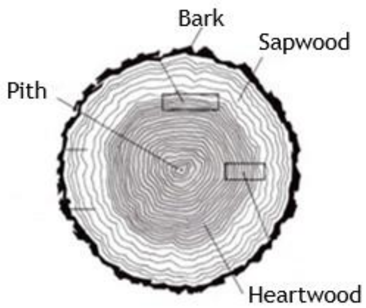
Axial Compression

First thing that one has to have in mind when using wood in a structural purpose is that there exists a lot of types of wood (pine, balsa…) and not each one is suitable for every objective.

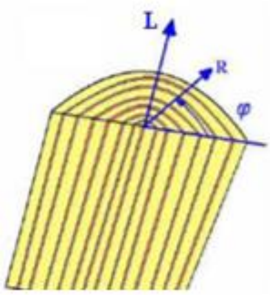
Related to that, is important to know that, due to the historical use of wood, for some purposes it is difficult to find in literature, for some spices, the physical values required.

Second important thing, is that wood properties are sensitive to humidity and temperature conditions.

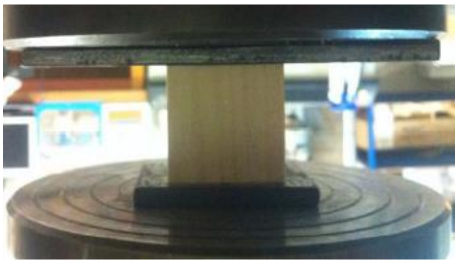
Wood's cellular structure (fibres) has a lot of importance in its mechanical behaviour; cellular materials have important plastic deformation dissipation to a load level almost constant in a large range of deformations. As it was said, mechanical properties of wood are characterized for a very high variability. This variability results from the differences observed on a macroscopic level but also on a microscopic level.

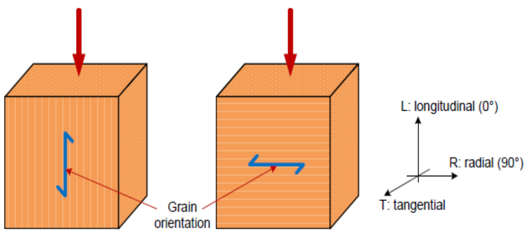


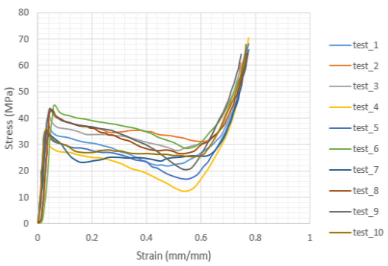
On wood we will define three different axes to define their mechanical properties. This axes are realted in the way that the loads can be applied on the fibres. So, we will have longitudinal (parallel), axial (perpendicular) or radial (tangent) direction.

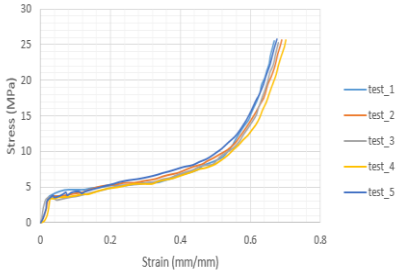


So, in this study, pine wood was experimentally tested. A cube was loaded in compression. First loaded parallel to the longitudinal axe and then, parallel to the radial one. In next figure, the experiment and the results are presented.









In the computations carried out in the work, some hypothesis to simplify the problem have been taken. The most important is that despite not all the fibres in wood follows the same direction; we have not taken into account that fact and assume that fibres are oriented in the same direction. It will be also covered the fact that not all the fibres will follow exactly the same direction so some hypothesis and simplifications will be taken.

Once the material and its mechanical behaviour has been described, a modelling of some load cases has done in order to be capable to find a model in LS-dyna software

So, the main objective of the present work is to deal with the elaboration of a material law within Ls-dyna software that will be able to reproduce the behaviour of wood under quasi-static compressive loads until large deformation, as observed physically in real experimental tests. For that, the software gives a lot of different models to choose. Despite a wood model is implemented, the present investigation starts working with some simple materials, as the MAT024 or MAT_PIECWISE_LINEAR_PLASTICITY. The aim of start using simple material models was to see if it was easy to get good results with this kind of models. Finally some orthotropic honeycombs materials such as MAT026 or MAT126 we're used.

The second important task of is to carry out a literature survey to study different constitutive material laws proposed by other researchers over the world such as: Hill`s criterion, which describe the nonlinear elasto-plastic behaviour when wood is under compressive loads at large deformations; The Tsaï criterion or Hoffman Failure criterion, both tries to explain how is the wood behaviour when failure or P. Mackenzie-Helnwein.

The results obtained using different models available in Ls-dyna (MAT024, MAT026, MAT063, MAT126 and MAT105) based on elastic and/or elasto-plastic behaviour, both isotropic and orthotropic, show that is possible to simulate adequately the wood behaviour under quasi-static compressive loads until large deformations.

A little definition of these material models is presented now in order to understand why these were the choose:

- MAT024/ MAT_PIECEWISE_LINEAR_PLASTICITY:
  Elasto-plastic material, isotropic and with VON MISES flow criterion.

- MAT026/ MAT_CRUSHABLEFOAM:
  This finite element model is based in MAT063. It is also an isotropic material but in this case, a multiplanar flow condition according to JOHANSON is used. Flowing occurs only as a function of the maximum amount of the principal stress.
- MAT063/ MAT_HONEYCOMB:
  This model is based on honeycomb models; it is an orthotropic model, which uses flow conditions according to JOHANSON.
- MAT126/ MAT_MODIFIED_HONEYCOMB:
  This model is based on honeycomb models; it is an orthotropic model, which uses flow conditions according to JOHANSON. The difference with material 026, is the used of differing expansion dimensions.

- MAT105/ MAT_DAMAGE-2
  This model is based on MAT105 which is an elastic viscoplastic material model combined with continuum damage mechanics.