Industrial building in France: comparison of imported wood, local wood, steel and concrete

BENCH VALUE

Bioeconomy and wood construction in France

The market of wood construction in France

In the second half of the 20th century, wood construction did not develop strongly because the main construction materials used in France were concrete and, to a more limited extent, bricks and steel. For the last 20 years, wood construction has been either stable or slowly increased its market share on the construction market. This is because of the development of technical products such as glulam, wood frame walls and Cross Laminated Timber (CLT).

When considering specifically the companies constructing wood frame buildings, according to recently published enquiry results (CODIFAB - France Bois Forêt, Enquête Nationale de la construction Bois, 2019), in 2018, the market share of wood construction in the different sectors was as follows:

- Total new housing: 6.3% - individual houses: 9.4% - collective housing: 4.3%
- Housing extension and heightening: 27.5%
- Tertiary private and public buildings: 10.5%
- Agriculture buildings: 25.2%
- Industrial buildings: 18.8%

Political environment for wood construction

Since the late 1990's, some political initiatives support the development of the use of wood in construction, for example, an attempt to regulate on a minimum amount of wood in new buildings and the launch in 2012 of a public label for "Biosourced buildings" (Décret n° 2012-518 du 19 avril 2012 relatif au label «bâtiment biosourcé »). Since 2010, the ministry in charge of construction has supported R&D and actions in order to waive technical and regulatory barriers for the development wood construction. The wood industries and enterprises sector, together with the administration, have been setting up and implementing a strategy for this development.

A specific promotion and development action has been carried out through ADIVbois (https://www.adivbois.org/, last access 2019-29-08), an association dedicated to the development of multi-storey wood buildings. For the last 5 years, most of the big cities in France have seen a few projects of 7- to 8-storey buildings and even higher ones. Another important achievement of this promotion action is the fact that the developer of the Paris 2024 Olympic Games announced in 2019 their willingness to have a large majority of the buildings of the Olympic Village and press village to be wood constructed.

The law on green growth and energy transition adopted in 2016 has led to the creation of the E+C-label in France, which rewards new buildings with low environmental impacts. Its first objective is to reduce the use of non-renewable energy and encourage energy production during the use phase of the building. Its second objective is to reduce greenhouse gas emissions over the whole life cycle of the building. A test phase of the label is ongoing and will result in a new regulation by 2020. This foreseen regulation on energy and environmental performance of buildings may be a strong promoter of wood construction since it considers carbon footprint and possibly carbon storage of buildings.

The case study

The case study building is an industrial building of 2200 m^2 located in Pessac, Nouvelle Aquitaine. It was chosen because of its typical features, as it is a combined industrial building with dual function as storage room and office for a coffee roasting company.

The building is constructed using glulam made from Scandinavian spruce by the Arbonis company in Chemillé, Pays de Loire. The objective of the case study is to compare it with buildings made of local wood from the Limousin area as well as steel and concrete frame buildings (Table 1).

The steel and concrete building was modeling by the Limoges University to be equivalent to the existing building. Further detailed information on the technical features of the French case study can be obtained in Delivables 3.2. and 4.2. available at benchvalue.efi.int.

Table 1. Modeling results.

Material	Mass (t)					Volume (m^3)
	Frame	% frame	Roofing	% roofing	Total	Total
Timber	27.7	40	19.0	27	69.7	151.6
Steel	30.9	47	18.4.	28	66.2	8.5
Concrete	102.9	45	91.4	40	229.2	91.7

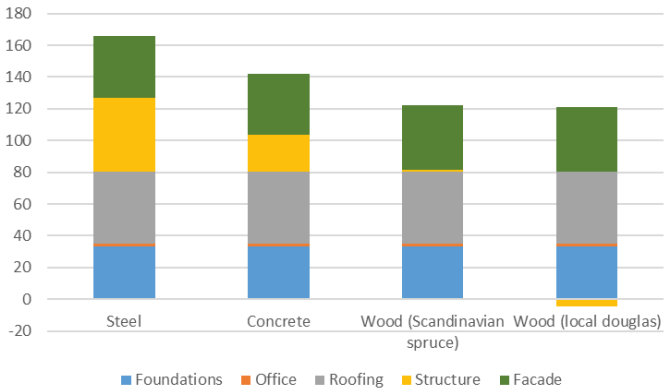
Results

The steel frame building has the highest emissions of kg CO_2 equivalent per square meter. The wooden building had the lowest emissions and the concrete building being in between. The non-renewable energy use is higher for the steel building and comparable for the wooden and concrete building. The wooden building stores 58 kg of CO_2 per m^2. By comparison, the CO_2 absorbed by carbonation of concrete according to the calculation of the industry is 5 kg CO_2 per m^2.

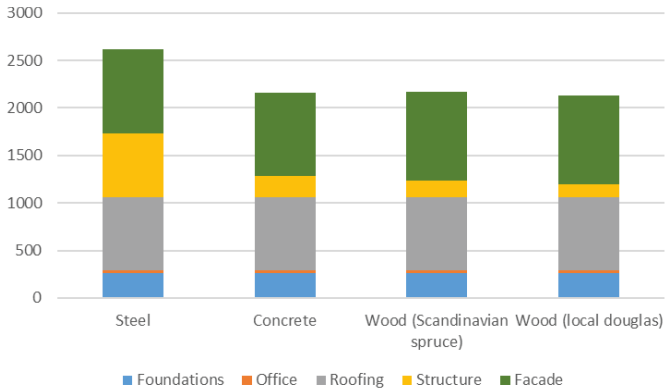
As far as the economic indicators are concerned, the production costs could not be compared due to a lack of data. The value added rate at national level is very similar for the three materials for building companies. For the upstream companies, the value added rate is lower for the wood industry and the steel industry and high for the cement industry.

The steel construction industry has the highest import rate and the Douglas fir based construction industry the lowest, with the concrete building in between. The Scandinavian spruce building has an import rate that is close to the wood sector average in France. The Scandinavian spruce building has a significant part of its production cost that stays in France (65%).

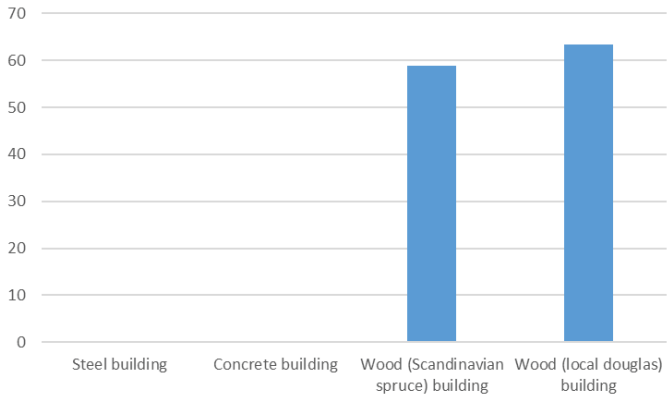
Concerning social indicators, it was not possible to collect the number of working hours needed for the steel and concrete buildings. The wages and accident rates are comparable for the three types of materials as far as the building phase is concerned. It should be noted that the Arbonis Company did not have any accident reported for the glulam manufacturing and building phases. The wages are much higher in the upstream industries (steel manufacturing, cement industry) due to the size of the companies involved. The accident rate is also lower in these industries considering national data. The forestry and sawmill sectors are mainly represented by small and medium enterprises located in rural areas. A possible consequence of this is that wages are lower and accident rates higher than in other industries. On the other hand, SME have a positive impact on the national industrial fabric and generate much-needed jobs in rural areas.



Results for the climate change indicator for the life cycle of the building including the benefits of recycling and energy recovery (A-D) in t eq. CO_2 per square meter of building



Results for the total use of non-renewable primary resources for the life cycle of the building including the benefits of recycling and energy recovery (A-D) in MJ per square meter of building



Results the biogenic carbon content of the building in t eq. CO_2 per m^2

Substitution factors

The substitution factor calculated based on the case study results is equal to 0.54 tC/tC in the glulam considering imported timber and 0.59 tC/tC considering local Douglas fir. If it is assumed that the consumption of glulam will raise from 156 000 m^3 in 2015 to 142 000 m^3 for the business as usual scenario and 452 000 m^3 for the strongly voluntarist scenario in 2035 (Etude Prospective de la Construction Bois 2019). The corresponding CO_2 savings are equal to 136 000 t CO_2 if Scandinavian spruce is used for glulam manufacturing and 160 000 tCO_2 if local douglas is used instead.

Considering the wood construction and furniture, a strongly voluntarist scenario envisions the growth of wood products starting from 4.2 Mm^3 in 2015 to 4.7 Mm^3 considering a business as usual scenario, 6.8 Mm^3 for the voluntarist scenario and 8.5 Mm^3 for the strongly voluntarist scenario (Etude Prospective de la Construction Bois 2019). The average substitution factor for construction and furniture in France is 0.9 tC/tC which makes a total of substitution differential of 1.8 Mt CO_2 per year in the voluntarist scenario and 3.3 Mt CO_2 per year in the strongly voluntarist scenario (Etude Prospective de la Construction Bois 2019).

Stakeholder interaction and results of discussions

A workshop was held in May 2019 in Limoges, together with French stakeholders and BenchValue partners. FCBA, University of Limoges and EFI had other interactions during the project in the two past years with stakeholders. From these meetings and discussions, the following results can be drawn:

- The French wood resources are renewable, abundant, local and sometimes difficult to mobilize: the characteristics of the main used softwood species are well known, the aesthetics of the material is a strong asset, as is the environmental image to the public.
- The main challenges that wood in construction is facing are the other lobby by competing industries, the difficulties to structure the sector, the construction market acceptance, and the risks of resource depletion in the future for softwood.
- In the future, it is foreseen that the construction market will be more open to wood, that the environmental issues will gain priority in society, that the other lobby from other material industries will be stronger, that new uses of wood will be developed and that the productivity of the French wood industry will increase.
- As for the main goals that the forestry-wood chain should aim at, they are the following:
  - Developing the resource by plantation policy, and (ii) considering the potential of hardwood species to be used in complement to softwood ones for construction;
  - Communication to the market on performances of wood construction and its sustainability assets, building on renewability for example;
  - Structuration of the forestry-wood chain French sector, and development of its production capacity to face the market development
  - Intensifying Employment, research, innovation and education in the forest and forest products sector.

National recommendations

The French Douglas value chain has many advantages over the Scandinavian imports: lower environmental impact, more added value redistributed and more jobs in France. However, the Douglas fir is still not fully competitive as compared to imported wood as far as glulam manufacturers are concerned but thanks to a good dialog between the first and the second transformation, this situation is in the process of being solved. This is partly associated with the cost of sawing which is higher than in Scandinavia. This can be explained by the size of sawmills in France: the 12th biggest sawmills in Sweden have a higher capacity than any sawmill in France. Investment must be made to make French wood more competitive. Sawmills have also invested in their own glulam manufacturing companies: as they have the knowledge on how to transform Douglas, they can provide Douglas glulam in a more profitable way.

Wood as a material has a lower environmental impact for industrial buildings. Public policies should favour low carbon building including biogenic carbon storage. The 2020 environmental regulation will include maximum levels for carbon footprint. The discussions about including carbon storage benefits are still active.

The wood industry should be attentive to the carbon footprint calculations done by other industries that are not compliant with relevant standards or that are questionable from an environmental point of view. These optimisations include for the concrete production: overestimated carbonatation, no impact considered for the use of slags and no accounting for waste combustion in cement production. The steel industry has also not accounted for the production of slags, use the avoided impact method where the standard forbids it etc. Indeed, the wood industry should be much more active in standardisation processes and as a lobby at the European commission.

Contributors:

Estelle Vial (firstname.lastname@fcba.fr), Tifenn Guennec, Guy Costa, Armand Clopeau

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