Durability of exterior wood works in poplar from France in real conditions of use.

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SUMMARY

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2.- EXPERIMENTAL SET UP
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NATURAL DURABILITY TO BIOLOGICAL AGENTS

- **Wood** is a material susceptible to **biological degradation**.

- **Natural durability** of wood depends on: **wood species, geographical origin, age, growth conditions** and the presence of **heartwood** or **sapwood**.
THE MAIN BIOLOGICAL AGENTS

- The main **biological agents** that may damage wood in exterior conditions above ground **Use Class 3** (European standard EN 335) are:

  - **Moulds and stains**: Cause aesthetically damage.
  - **Decay fungi**: Brown rot, white rot and soft rot fungi, which cause severe mass and strength losses to wood.
  - **Wood boring insects and termites**: cause significant damage.
● **Service life of exterior wood** (How long a wood product is expected to perform) depends on many factors: material's inherent characteristics and environmental factors.

● Exposing wood to exterior conditions (rain, sun, wind,...) highly increases the risks of the material being damaged by biological organisms such as wood-destroying fungi and wood-boring insects.

● Proper **design and protection** of wood products for exterior uses are crucial to ensure the best **service life** for them.

Exterior structures in Spain
The project "Durability of exterior wood works in real conditions of use" led by FCBA, aims to improve the knowledge about the degradation in exterior applications of different wood species from France (including poplar).

This research project arose from the desire of the French public authorities and wood industry to optimize the current systematic use of biocidal preservatives for exterior wood products due mainly to the general bad knowledge regarding correct design.

Experimental test devices related to use class 3 were installed to study the degradation exterior applications of different wood species related to “durability by design”.
PROJECT (POPLAR)

- Poplar Test specimens are exposed in different situations producing a decay risk corresponding to Use Class 3.

- The progress of moulds, blue stain, fungal decay, insect attacks, as well as cracks, shrinks, swelling and mechanical defects is monitored once a year.

- The aim of this project is to improve the performance and life expectancy of commodities made with untreated poplar in exterior applications under different conditions of exposure and weathering.

- Results will provide inputs for the development of a model of poplar degradation in exterior applications (data on biological degradation of wood, use conditions, climate and design).

- The applications of these researchers are to poplar industry, architects, builders and end users.
● Trees4Future Transnational Access Program allows to visit FCBA facilities (Biology laboratory and test devices) for 5 working days in February 2016 in order to work in the project "Durability of exterior wood works in real conditions of use" and to study the degradation of different wood species from France (including poplar) in exterior applications in test devices located at FCBA, Bordeaux.
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Bad practices in the design exterior wood commodities often result excessive moisture content in the wood. Wood products can contain zones where rainwater may accumulate, which are generally places where fungal attacks occur.

Mistakes made in the design often lead that a wood element initially meant for Use Class 3 are finally exposed to a level of biological risk that is higher than expected in this Use Class 3.

As a result, in situations where exterior wood components are not in ground contact may permanently accumulate water due to their design.
EXPERIMENTAL SET UP

- The current test used to evaluate the natural durability of wood species don’t very well correspond with the ways of evaluating durability, performance and service life of wood exterior commodities.

- The aim of the experimental test is to work out a protocol which will make it possible to estimate durability, performance and service life, in real situations of different 9 wood species from France (in this case focusing in poplar).

- This will involve quantifying the impact of material, climate, exposure, and design of selected exterior wood components of poplar.

Experimental Set up in Bordeaux, France
**EXPERIMENTAL SITES**

- **Climatic parameters** (rain, wind and UV radiation) strongly affect the esthetic and susceptibility to **fungal decay** of wood used for **exterior applications**.

- In order to compare **durability**, **performance** and **service life** of **wooden commodities** under different climatic conditions, **4 experimental sites** were selected in France:
  - **Bordeaux** (Oceanic)
  - **Charrey sur Saône** (Continental)
  - **Montpellier** (Mediterranean)
  - **Kourou-French Guyana** (Tropical).
WOOD SPECIES

- **Poplar** (Populus sp.) is a wood species which is of economic importance for the construction industry in France.
- It was also chose because it’s a **non-durable fungal decay** (Durability class 5 according to the European Standard EN 350) and subject to attacks by insects.
- Including a **non-durable species** as Poplar in the test will allow evaluating the impact of design on fungal decay’s kinetics after a short period of time (<10 years).
- It should be noted that in reality **poplar for exterior applications** is rarely used **without any preservative treatment**.
To estimate the decay potential of Poplar under various exposure situations, various Test Sets typically meant for Use Class 3 were installed.

- Test Sets were made with Poplar include:
  - Deckings: Made of 6 horizontal designs fixed on concrete blocks.
  - House-like metallic structure: Vertical elements (clads, logs, posts) and inclined elements (posts). The orientation of the two facades of the structure is to have one side severely exposed (to sun, wind and driven rain) and one side with less severe exposure.

Identical sets devices were installed on each of the 4 selected experimental fields: Bordeaux, Charrey sur Saône, Montpellier and Guyana.
Set of commodities N°1 (Poplar)
Decks are regarded as the most severely **wood exterior elements** affected by weathering due to the possibility of **rain-water accumulation** on the wood’s surface.

6 different **designs** were chosen, the main differences are:
- **Thickness** (22 or 30 mm).
- **Width** (5 or 12 cm) of the boards.
- **Shape** (plain or slope-shaped).
- **Way of screwing** them.
- **Number of wood-to-wood contact zone.**

**Traditional design (1)**

Water accumulation on the surface & water-traps
DECKINGS

Improved design (6)

Facilitated water elimination

rubber joins

bottom screwing

Durability of exterior wood works in Poplar from France in real conditions of use
DECKINGS

6 designs

MOISTURE RETENTION

« Use Class 4 – like » ─ « Use Class 3 – like »
8 claddings elements were made of poplar (4 elements was installed in situations that either allow or prevent their direct exposure to driven rain). The end-grain of the vertically exposed boards was protected from rainwater by stainless steel sheets.

Facades were built after choosing 4 different designs. The main differences between them are:
- **Thickness** (20 or 30 mm).
- **Way of assembling and screwing** them.
- **Orientation** of the fibers (three horizontal and one vertical cladding).

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**CLADDINGS**

- Thin boards
  - Tongue + Groove
- Thick boards
  - Tongue + Groove
- Thin boards
  - Hidden nails

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2 different designs were chosen. The main differences are the shape of the logs and their ability to facilitate water drainage. Identical sets of log walls were installed in situations that either allow or prevent their direct exposure to driven rain.

Two different walls 2 meters high and 50 cm wide were made with poplar.
The durability of posts is being tested along their incline (vertical or semi-horizontal with a 10% slope) and their thickness (from 3 to 25 cm).

2 different designs were chosen. The end-grain of the posts was protected from rainwater by stainless steel sheets.

Current commercial design

Improved design
Different kinds of joinery are being tested which are representative of traditional carpentry.

2 innovative types of joint are also being tested (use of stainless steel connectors) which reduce the wood-to-wood contact zones and allow for efficient water drainage from the two connected elements.

Their end-grain was protected from rainwater by stainless steel sheets.

Current commercial design

Improved design

Water accumulation

Water drain-off
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RESULTS

- The progress of moulds, blue stain, fungal decay, insects as well as cracks, shrinks, swelling and mechanical defects is monitored once a year, starting in 2010.
- Due differences among exposure sites and different designs the experiment will be conducted over a period of ten years (2020).
- The study is focus in Poplar, Bordeaux site and six years of exposure (2016)
- The poplar test specimens are evaluated by rating the extent and distribution of decay according to EN 252 (1989) as: 0 (sound), 1 (slight attack), 2 (moderate attack), 3 (severe attack) or 4 (failure).
- The mechanical behaviour and physical degradation of the exposed wood (cracks, swelling, shrinking, wooden movements) were evaluated visually.
RESULTS

In the set of commodities No. 1, all poplar test specimens were rated a minimum of 1 (slight attack) for decay. The most common is rating 2 (moderate attack), in some cases rating 3 (severe attack) and depending of design even is possible to find in some test specimens in the severe exposure rating 4 (failure).

Regarding the mechanical behaviour, in the set of commodities No. 1 big differences were reported with poplar test specimens exposed to severe exposure (South-West) where cracking, UV aging, swelling and shrinking strongly affecting the wooden poplar elements in comparison with low exposure facade (North-East).

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In the case of deckings, significant differences in terms of durability were found among the different designs. In best design decking the majority of poplar test specimens were evaluated by rating 1 (slight attack) and 2 (moderate attack). In the case of worst design the majority of poplar test specimens were evaluated by rating 2 (moderate attack) and 3 (severe attack), and there are some test specimens with rating 4 (failure).

Regarding in deckings to the mechanical behaviour and physical degradation no big differences were reported of the exposed poplar test specimens.
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● In the set of commodities No. 1, significant differences in terms of durability, and mechanical behaviour were reported in poplar test specimens exposed to severe exposure in comparison with low exposure (with better results) and also depending on different designs.

● In the case of deckings, significant differences in terms of durability were found between the different designs but not in mechanical behaviour.

● The research project presented here contributes to the knowledge of how to extend the durability, performance and service life of commodities made with untreated poplar and increase the value of poplar wood.

● However, after only six years of exposure, the results need to be considered as preliminary.
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