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León, Spain, September 8th- 10th

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

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SUMMARY

SUMMARY

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.

Main biological agents

SERVICE LIFE

- **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

PROJECT

- The project "***Durability of exterior wood works in real conditions of use***" leaded by FCBA, aims to improve the knowledge about the **degradation in exterior applications** of different **9 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 **9 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**.

BACKGROUND

- 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.**

SUMMARY

EXTERIOR WOOD COMMODITIES

- 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**.

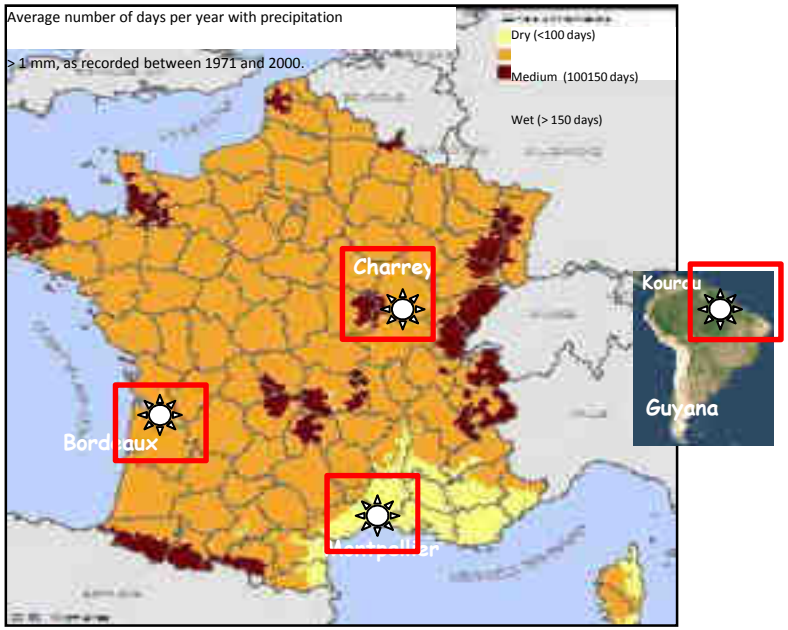
Experimental Set up in Bordeaux, France

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**).



Location of experimental sites

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**.

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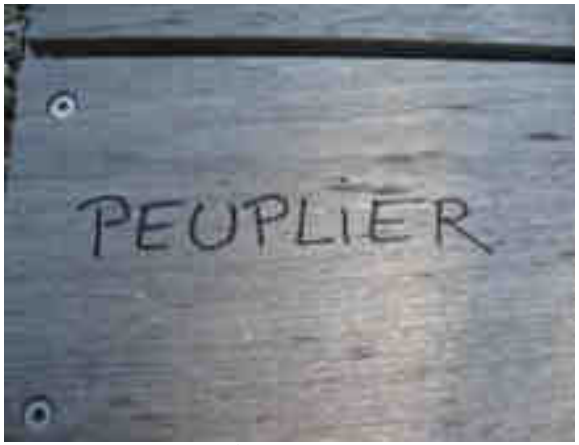
- Including a **non-durable species** as **Poplar** in the test will allow evaluating the impact of design on fungal decay's kinetics after a short period of time (<10 years).
- It should be noted that in reality **poplar** for **exterior applications** is rarely used **without any preservative treatment**.

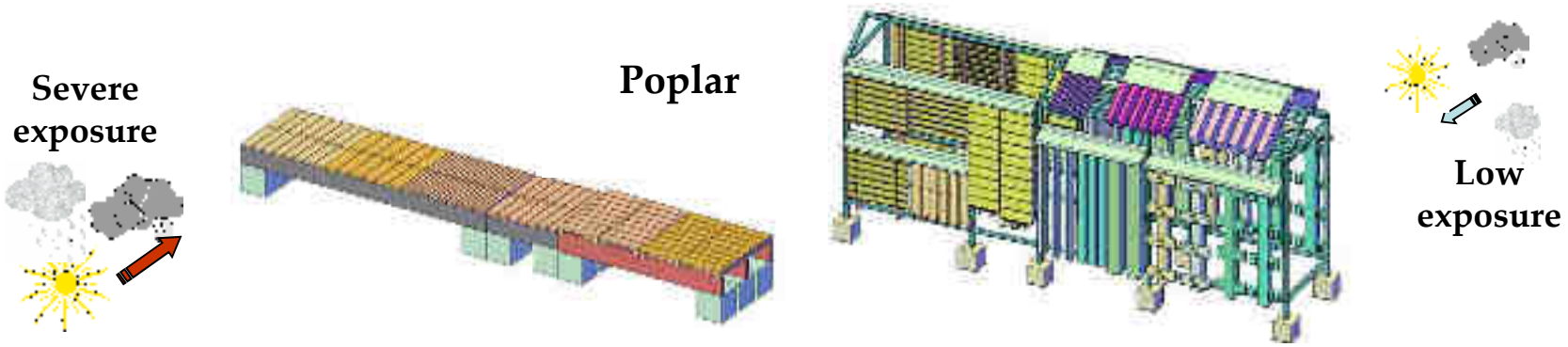


Poplar from France

TEST SETS

- To estimate the **decay** potential of **Poplar** under various **exposure situations**, **various Test Sets** typically meant for **Use Class 3** were installed.

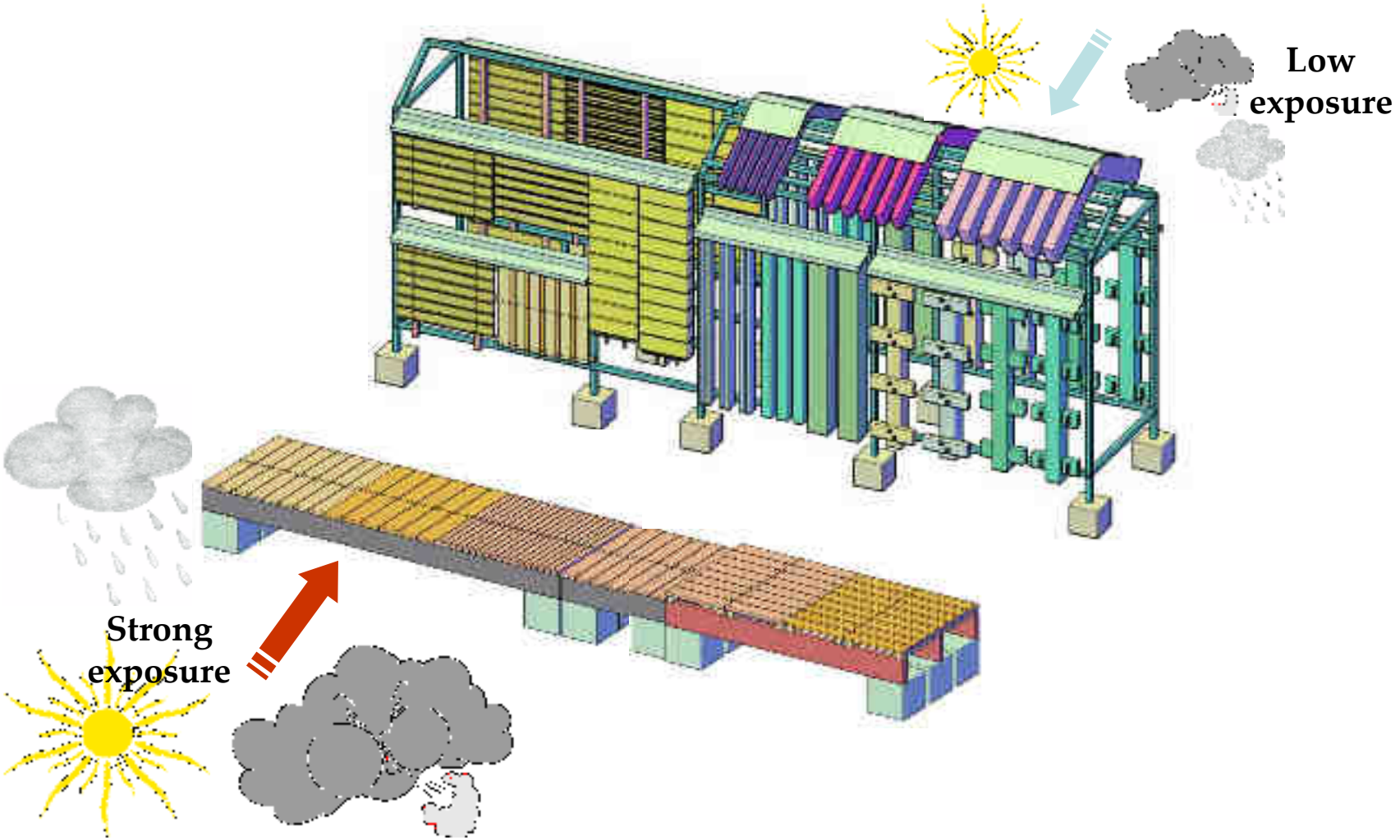
- **Test Sets** were made with **Poplar** include:
  - **Deckings:** Made of 6 horizontal designs fixed on concrete blocks.
  - **House-like metallic structure:** Vertical elements(**clads**, **logs**, **posts**) and inclined elements (**posts**). The orientation of the two facades of the structure is 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.

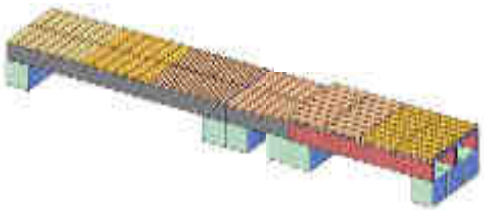
TEST SETS

Set of commodities N°1 (Poplar)

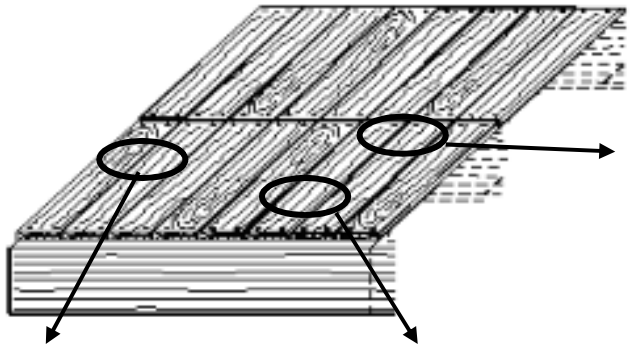


DECKINGS

- **Decks** are regarded as the most severely **wood exterior elements** affected by **weathering** due the possibility of **rain-water accumulation** on the wood' 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.



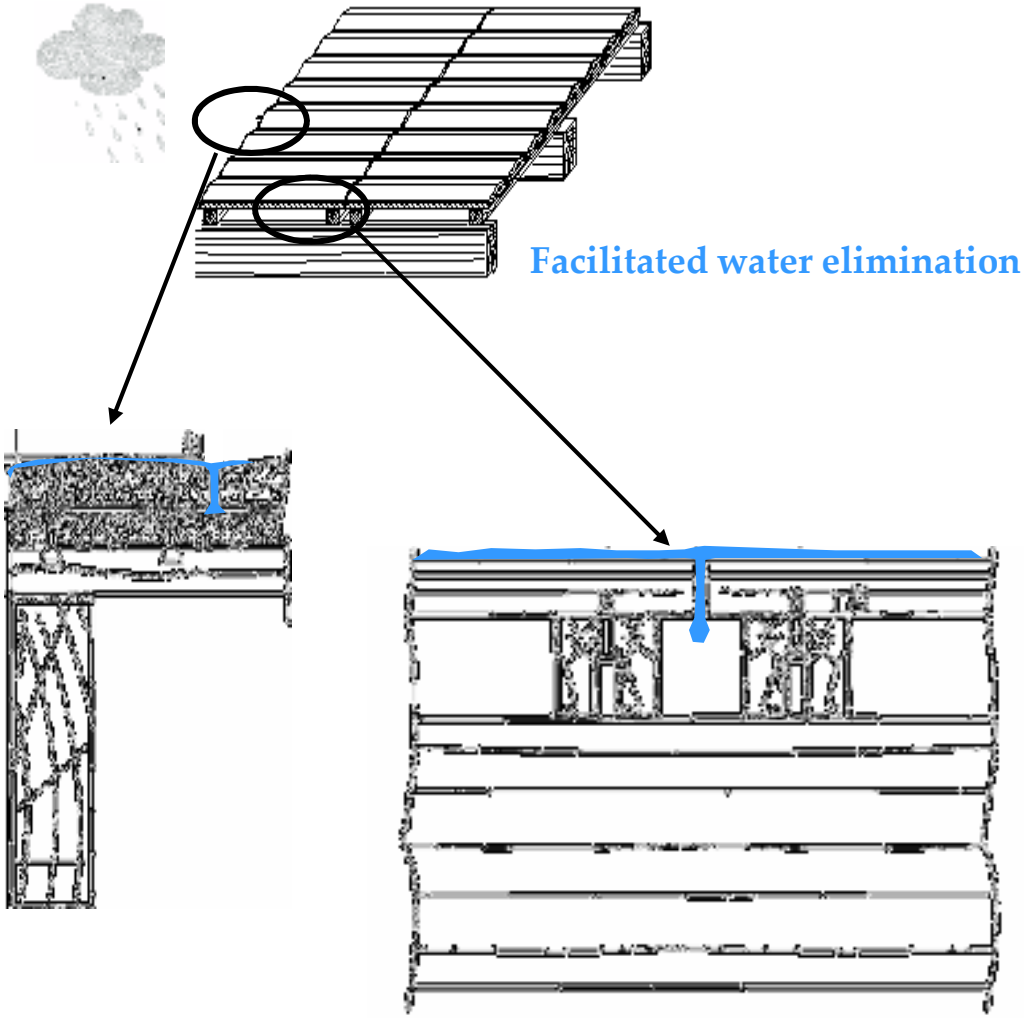
Traditional design (1)



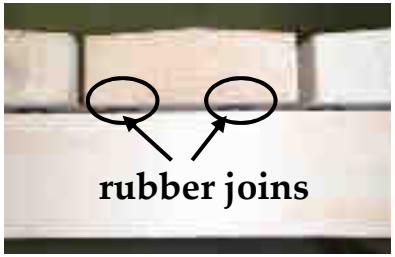
Water accumulation on the surface & water-traps

DECKINGS

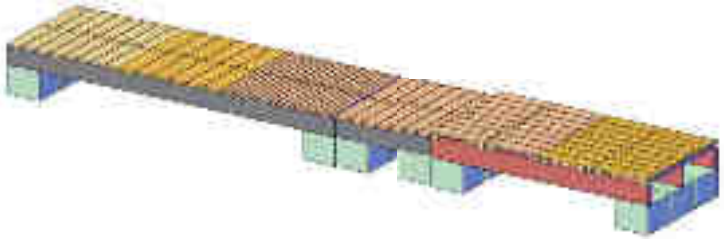
Improved design (6)



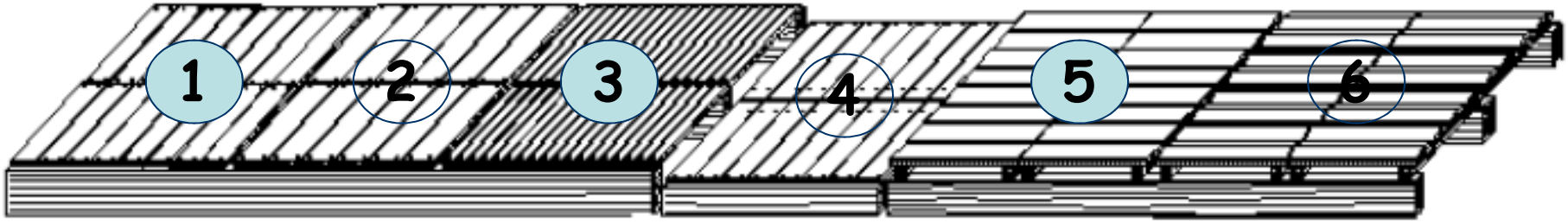
Facilitated water elimination



DECKINGS



6 designs

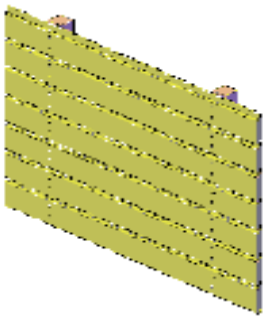


MOISTURE RETENTION

« Use Class 4 – like » → « Use Class 3 – like »

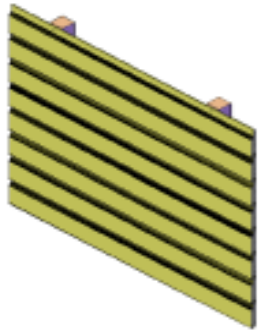
CLADDINGS

- **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).



Thin boards
Tongue + Groove

Thick boards
Tongue + Groove



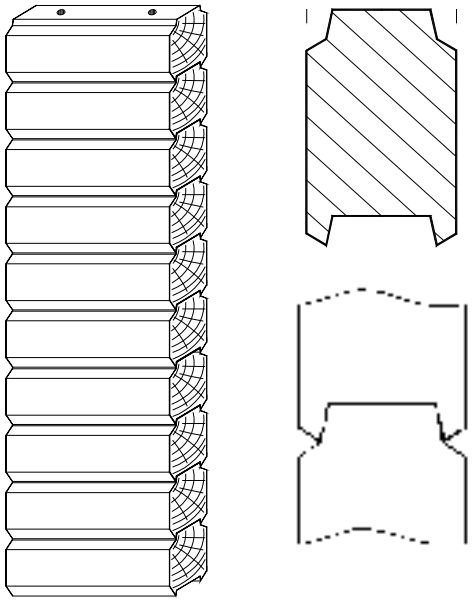
Thin boards
Hidden nails

expected durability

LOG WALLS

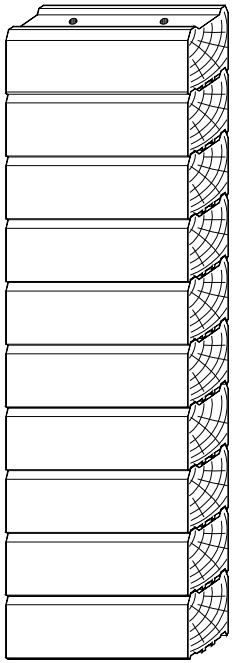
- **2** different designs were chosen. The main differences are the **shape** of the logs and their **ability to facilitate water drainage**. Identical sets of log walls were installed in situations that either allow or prevent their direct exposure to driven rain.
- Two different walls 2 meters high and 50 cm wide were made with **poplar**.

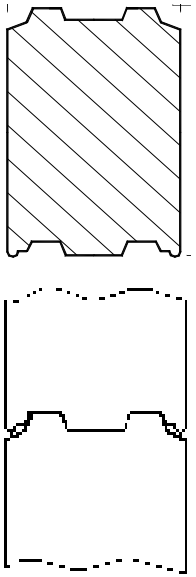
Current commercial



Water penetration by capillarity

Improved design



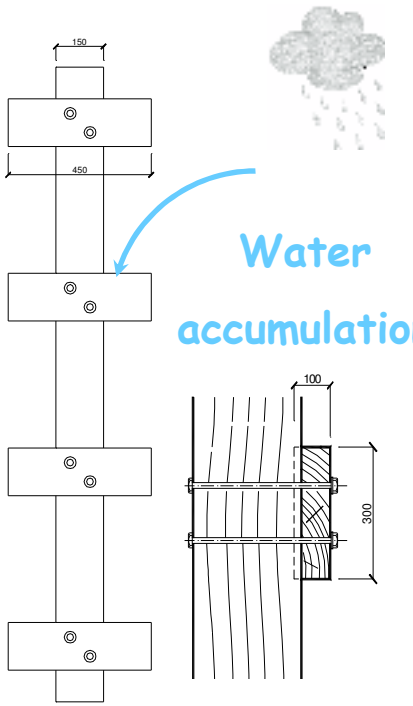


Water deflection

POSTS

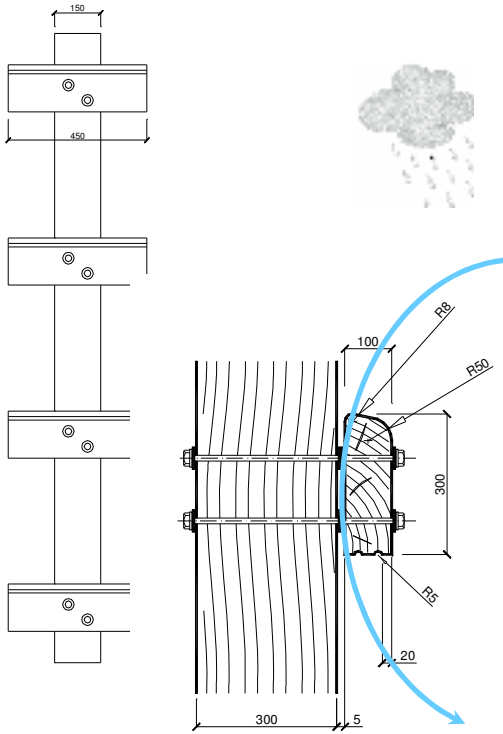
- The durability of **posts** is being tested along their **incline** (vertical or semi-horizontal with a 10% slope) and their **thickness** (from 3 to 25 cm).
- **2** different designs were chosen. The end-grain of the posts was protected from rainwater by stainless steel sheets.

Current commercial design



Water accumulation

Improved design

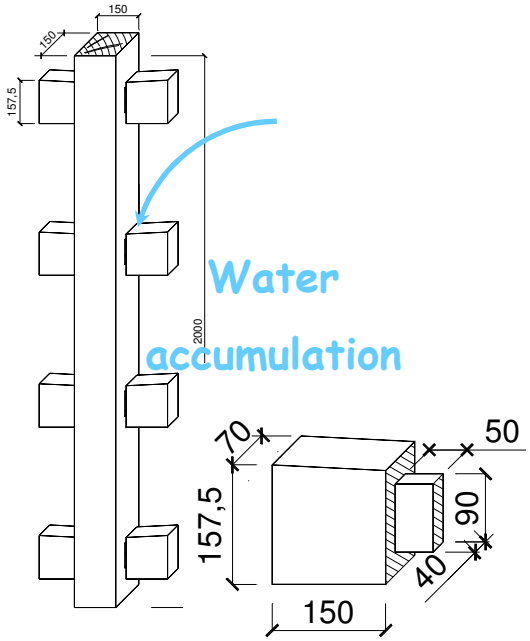


Water drain-off

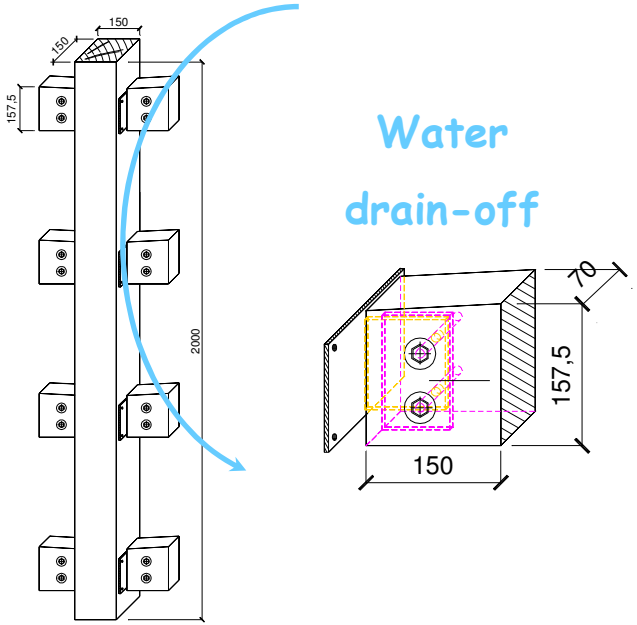
POSTS CONNECTED TO BEAMS

- **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



SUMMARY

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)
- Regard to 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).

RESULTS

- 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.




SUMMARY

CONCLUSIONS

- 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 year of exposure**, the results need to be considered as preliminary.

ACKNOWLEDGEMENTS

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THANK YOU VERY MUCH FOR YOUR KIND ATTENTION