

Designing with bio-based building materials – Challenges and opportunities



The problem of exterior structures built in Northern Spain climate in *Picea abies* due wood destroying fungi attacks. The example of a wood exterior structure in Pontevedra, Spain and the importance of design in the performance

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■ SUMMARY

1.- INTRODUCTION.

2.- EXAMPLE OF EXTERIOR STRUCTURE IN NORTH SPAIN.

3.- CONCLUSIONS

1.- INTRODUCTION

- **Spruce** and **fir** have been abundantly used in **exterior structures**: bridges, houses, facades,...) in overall Spain, especially during the last 10-20 years.
- Spruce and fir are generally from Central and Northern European countries with “treatment” for improving artificially their low natural durability(4).
- **Designs** of exterior structures have been copied(“copy-paste”)from Central and Northern European countries but without good results in all situations ...



Spruce Bridges in North Spain

- **Durability** of wood species(spruce, fir, larch,...), “**treatments**” and **designs**, combined with the variability of **climate** and **microclimate** conditions (exposure to weathering) in northern Spain, have caused serious damage to the exterior structures.
- Major problems are related to **decays** (brown rot an white rot) and wood destroying insects in lesser extent (wood boring insects and termites).



Spruce Bridges in North Spain with severe decays (12 years)

2.- EXAMPLE OF EXTERIOR STRUCTURE IN NORTH SPAIN

- Object: Covered bridge Pavement(Roof)
- Place: North-West coast of Spain
- Construction: 1995 (20 years)
- Porticos, pillars and beams
- Wood specie: Spruce.
- Wood type: sawn and glue lam
- Use classes: 2 (Under roof), 3.1 (vertical) and 3.2 (horizontal)
- Good Details design: Sheltering, distance from ground, etc.



■ USE CLASSES (EN 335:2013)



- Roof and sheltering protection (2)
- Horizontal elements (3.2)
- Vertical elements (3.1)

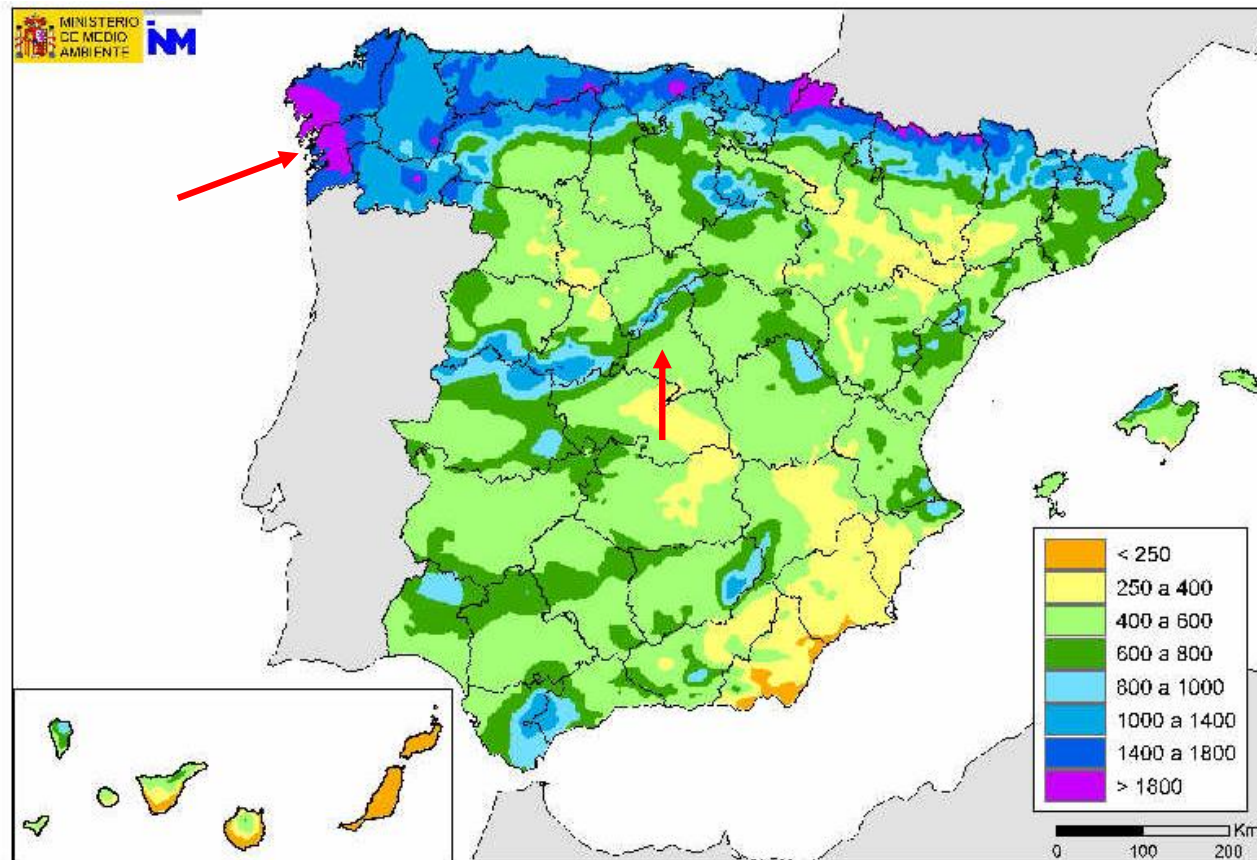
■ CURRENT SITUATION (20 years)

- After twenty years of service life in a first view the structure shows some **severe decay degradations**.
- In a detailed diagnosis **not all elements of the structure shows the same level of decay degradation**.
- The case study is aimed at understanding the **cause/s** of different level of decay degradation.



GEOGRAPHICAL LOCATION: CLIMATE

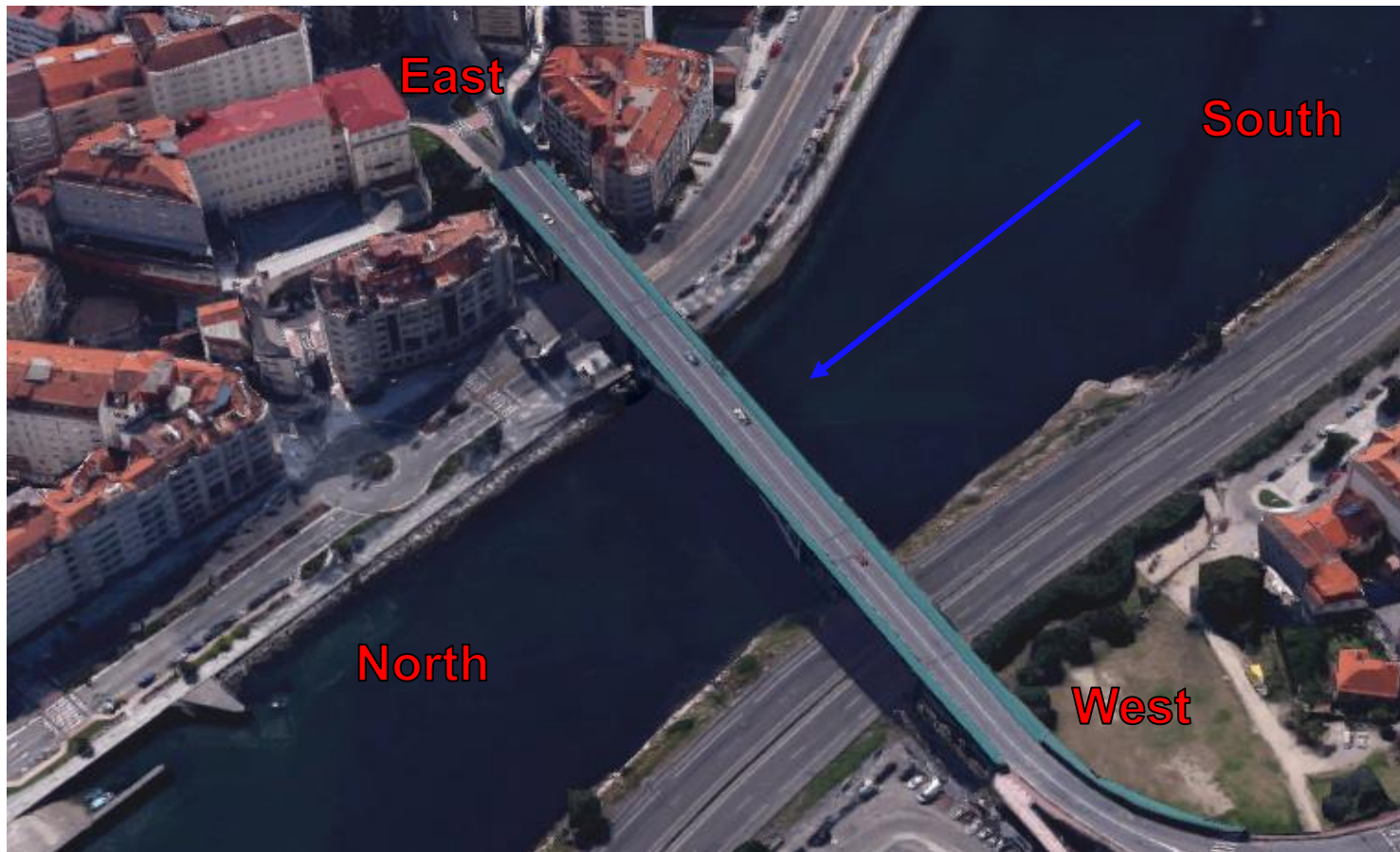
- North-West coast of Spain.
- Climatic conditions: Rainy (wet), warm, high RH.
- Sea level: Coast (South-West strong winds).



The example of a wood exterior structure in Pontevedra, Spain

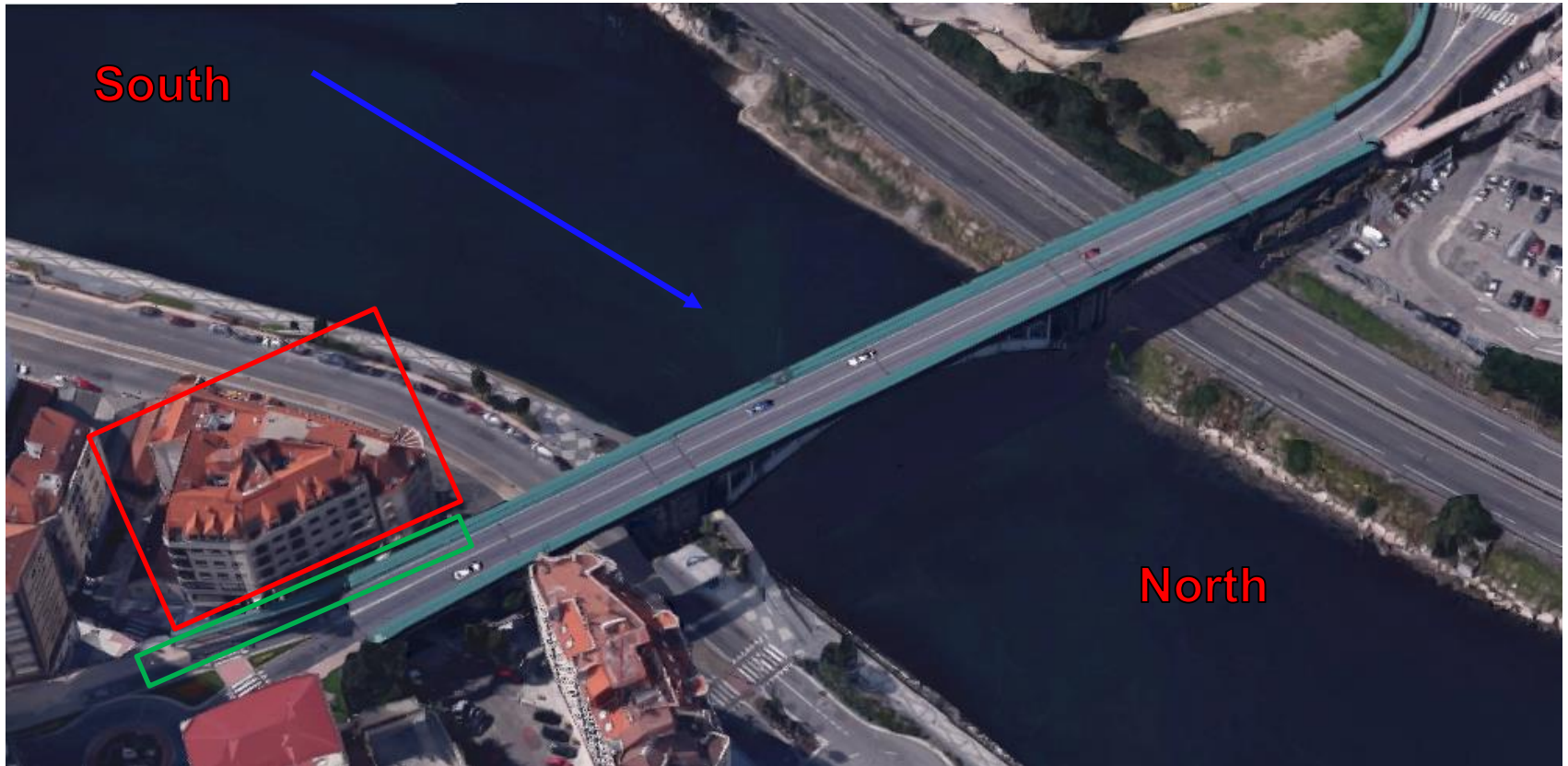
LOCAL CLIMATE: MICROCLIMATE

- Orientation of bridge: E-W.
- Driven rain: From South-West, rain exposure (moisture content).



The example of a wood exterior structure in Pontevedra, Spain

■ BUILDING PROTECTION: South

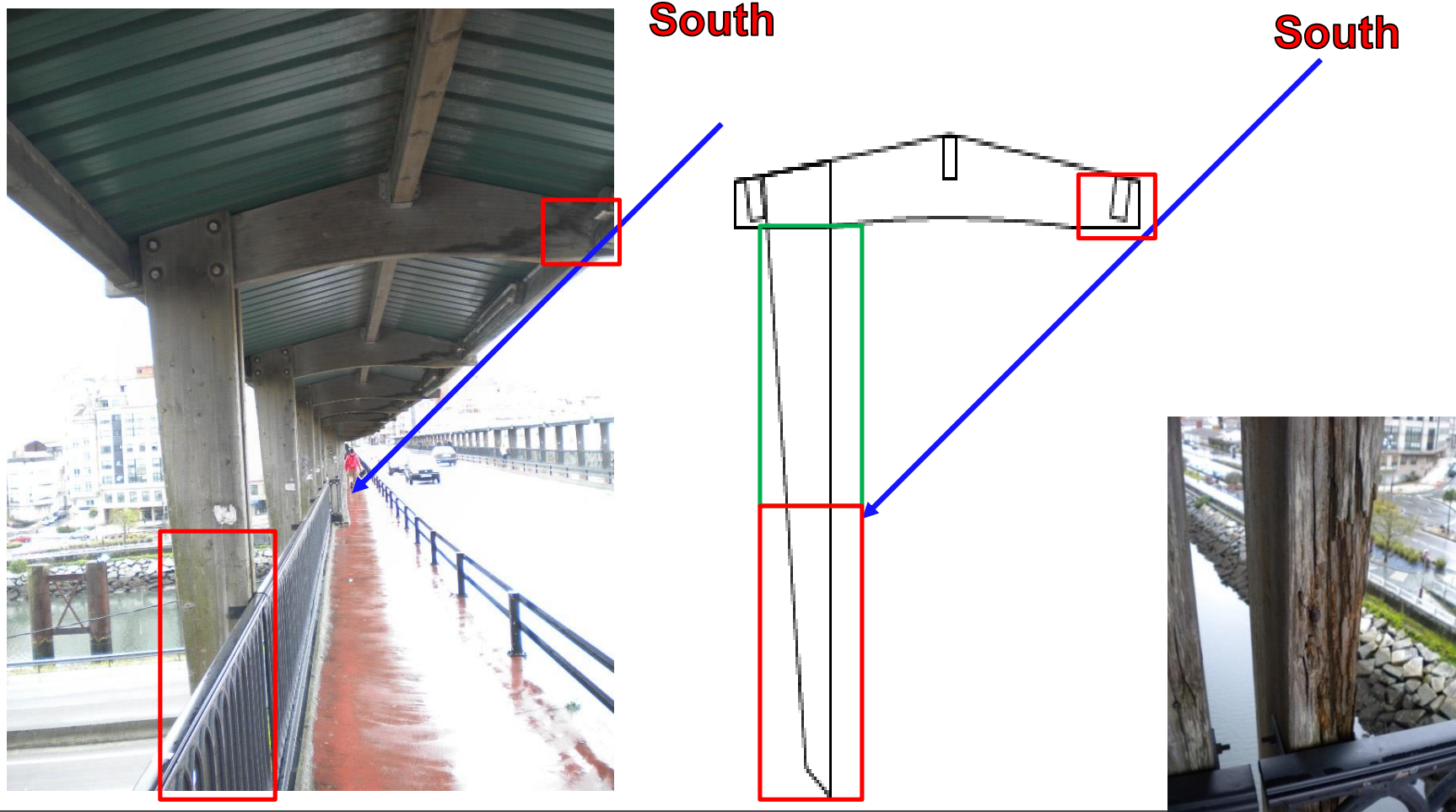


The example of a wood exterior structure in Pontevedra, Spain

■ ROOF PROTECTION NORTH STRUCTURE: South Orientation

- Roof: Physical protection.
- Sheltering: Yes in North, Not in South Driven rain.

Major part of North structure **not exposed** to weather



The example of a wood exterior structure in Pontevedra, Spain

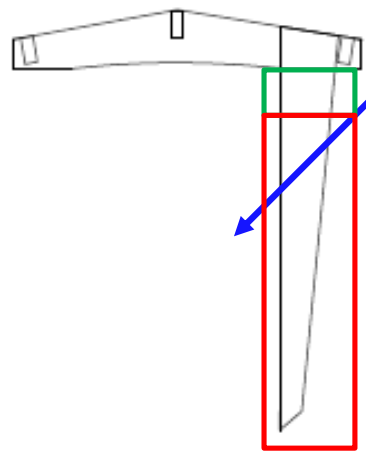
ROOF PROTECTION SOUTH STRUCTURE: South Orientation

- Roof: Physical protection.
- Sheltering: Driven rain.

Major part of South structure exposed to weather



South



The example of a wood exterior structure in Pontevedra, Spain

■ DETAILS DESIGN N.E: South Orientation

- Sheltering: No protection due strong South winds
- Lights: Protection



Directly exposed to rain (no protection sheltering)
End grain (unsealed) severe decay
Side grain

■ DETAILS DESIGN SOUTH STRUCTURE: North Orientation

No directly exposed to South rain



Sheltering: Protection South winds

Sheltering end grain protection beam



Lights: Driven rain water traps

3.- CONCLUSIONS

- There is a general **decay** of **exterior structures** built in **spruce** in Northern Spanish climates due different factors:
 - Durability (low 4)
 - Treatment
 - Use class
 - Climate
 - Microclimate (IMPORTANT!)
 - Conception of the work
 - Dimensions “massivité”
 - Design details
 - Maintenance
 - ...
- The problem is to evaluate the influence of each one parameter in the global degradation and if we change a little one parameter how is the influence in the final degradation

3.- CONCLUSIONS

- In this exterior structure there are important **decays** degradation after 20 years and the question is if we change one or more parameters (climate, dimensions,...) how will be change the final performance of this structure.
- This exterior structure in the same site but with **another orientation** (North-South) would performance better.



- This exterior structure in another site and same orientation (for example without strong South winds) would performance better



THANK YOU VERY MUCH FOR YOUR KIND ATTENTION

