Influence of the climatic changes on wood structures behaviour

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Abstract

The mechanical and physical properties of wood structural elements and of wood structures are strongly affected by the combination of humidity, temperature variation and biological attack.

The aim of this study is to develop a design model able to estimate timber elements decay function of the exploitation climatic conditions (temperature and humidity).

The deterioration program may be applied on any type of wood element and is indicating the necessity of increasing the cross section dimensions if and when the specific humidity and temperature become of significant influence.

The results of this study are of great importance as the behavior of a non-treated timber element can be surveyed when directly influenced by changes in climatic conditions (relative humidity and temperature).

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1. Introduction

The variations of humidity and temperature have a great influence on the behavior of construction materials and mostly on the wood itself, on which we are interested in this study.

To improve the behavior of wood influenced by these variations, we will try to better analyze the results. We will analyze the records of temperature and humidity during a few years with values taken at different moments during the day: at sunrise, at noon, when the temperature has the highest value and at sunset; then, we will divide the results in one deterministic part and other stochastic.

For some years, researchers have been making studies on the developments of performances for the fungal decay and their impact on wood and also on the augmentation of mold. The studies have been based on multiple strategies and on different variables of wood such as: mass loss, loss of resistance, influence of moisture, life expectancy of wood, appearance.

In order to see how climate change can affect the regions of Marseille and Saint-Nazaire from France, we will use a French program CNRM-CM5 which is an Earth System model based on climate simulation that can generate climate scenarios for the two villages.

It is necessary to have complete models of deterioration to have a big picture of the influence of climate on wooden elements. The climate factors: temperature and humidity have to be integrated in these models of deterioration to see exactly the way in which the climate influences the properties of the material.

This model, that is function of time, temperature and humidity, has to be integrated in the decay models in order to evaluate climate effects that will change over a period of time. However, because of the difficult integration between the two models, it is necessary to make a simplified approach that will be analyzed in this study. It will depend on the influence of climate change during seasons and the random change in temperature during one season.[3]

For the estimation of temperature values, we have to measure the maximum and minimum temperature to see the trends of the diurnal temperatures. This is made even if when measuring time, one has a high accuracy for estimating values of degree days. [4]

The calculation is made with the Matlab software, with some verification in the Excel software.

2. The model created for the temperature

For the temperature series, it is necessary to make a model that will be rely on known representations taken from data calculated by the French model of national circulation CNRM-CM5, explained above. The temperature variations are considered on each hour and the components of this series are deterministic and stochastic.

The temperature on a certain time $t$ (calculated in hours) is analyzed as following:

$$ T(t) = T_{\text{mean}} + T_{\text{sin}}(t) + T_{\text{day}}(t) + T_{\text{stoch}}(t) $$

(1)

where:

- $T_{\text{mean}}$ represents the mean temperature of the time series
- $T_{\text{sin}}(t)$ is simply analyzed as a sinusoidal variation (fig.1.a)
- $T_{\text{day}}(t)$ and $T_{\text{stoch}}(t)$ are functions that represent the temperature variations of an year, of every day and the stochastic part of the model.

2.1 The analysis of the deterministic part

$T_{\text{mean}}$ is calculated as a mean between the temperatures of the series of time:

$$ T_{\text{mean}} = \frac{1}{n_h} \sum_{i=1}^{n_h} T_i $$

(2)

$n_h$ represents the total number of hours for the time series and $\overline{T}_i$ represents the temperature recorded at a certain moment $i$;

$T_{\text{stoch}}(t)$ is simply analyzed as a sinusoidal variation (fig.1.a):

where:
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