



POLITECNICO
DI TORINO

Honors thesis

Architecture for the Sustainable Project Master course

Abstract

**Straw bale house construction at different latitudes.
Analysis of some constructive systems.**

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This thesis is proposed as an investigation on the characteristics and potential of straw as an effective alternative construction material compared to other more conventional techniques and subject to various climatic stress. The analysis undertaken focusses mainly on evaluating energy, sustainability and costs of the same building hypothetically constructed in three variants - wood and straw, concrete and masonry and X-lam – which will then be compared. The aim is to answer some question:

- Can you build in wood-straw at any latitude?
- Can the wood-straw system be compared in terms of efficiency with a masonry and concrete system?
- Can a building in natural materials be more economic compared to one in masonry and concrete?

Once we had identified an existing building to use as a case study, the stratigraphy of the wood and straw (main structure in laminated wood plugged up with straw-bales) was carried out so as to make up the elements of the covering. The building was analysed in the climatic conditions of Sestriere, climatic zone F, so as to evaluate its performance in “extreme” winter conditions. The thermal conditions of each straw component (determined by low transmittance) were then studied allowing us to understand the stratigraphy of the other two construction systems - X-lam and concrete and masonry - maintaining the same winter energy consumption levels in all three cases. By using ProCasaClima simulation, we were able to determine energy needs, environmental impact and building costs for each technique. This procedure allowed us to compare the results obtained and consequently determine that the construction system with the best features from the ecological and economical points of view was that in wood and straw.

After having elaborated new construction elements that were more suitable for a warm climate and maintaining the heating demand, we set up the new site in Porto Empedocle (climatic zone A) so as to have the highest summertime temperature. The cooling demand data software determined an equal level of efficiency in all three cases, as we investigated the factors that help determine a comfortable summer temperature and some improvements were proposed regarding the thickness of the plaster of the interior walls, the screening systems and colour of the plaster on the exterior façade.

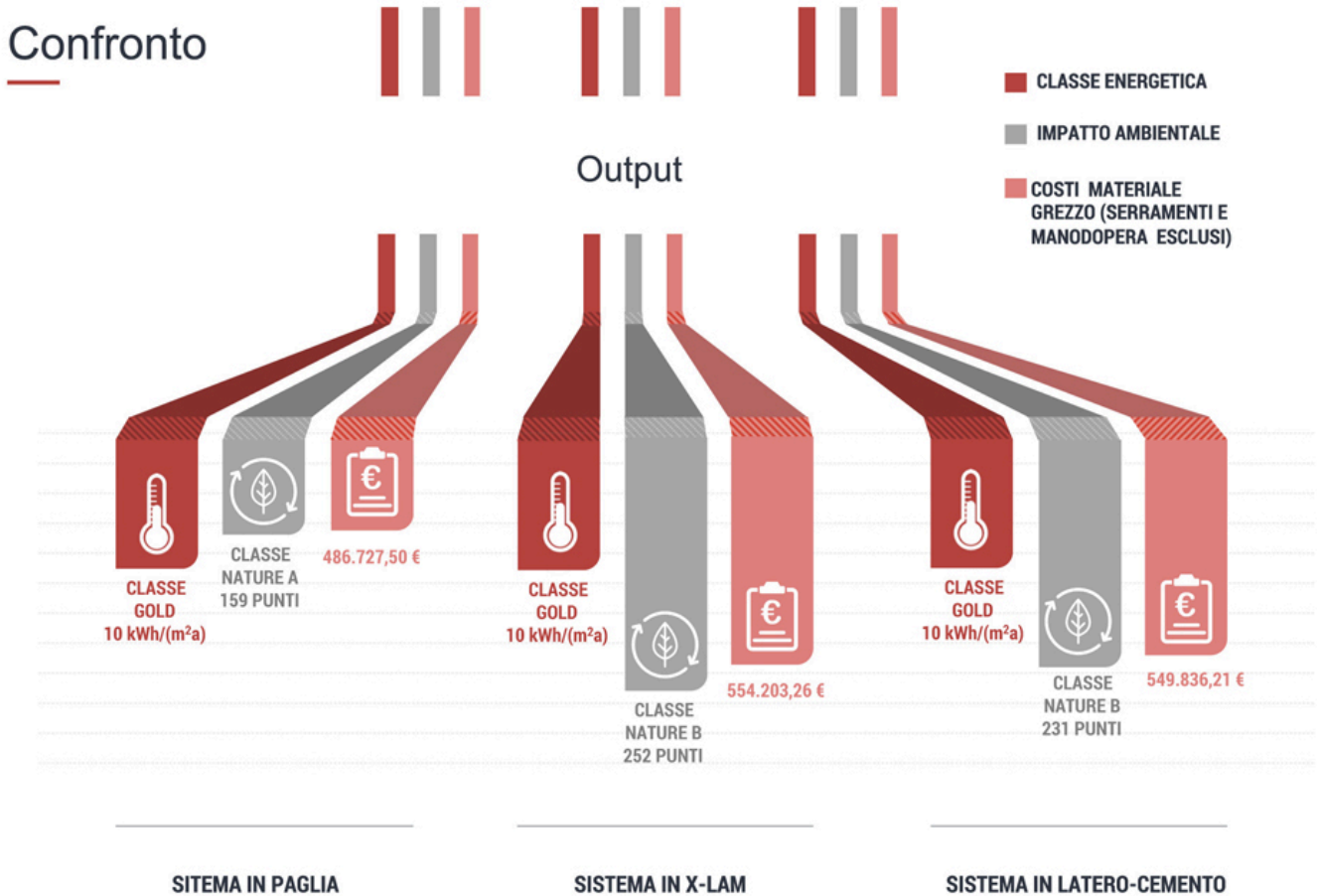
Having obtained the Sestriere and Porto Empedocle models, our research dealt with comparing the three construction systems in six different climatic zones. We used the Sestriere model for the comparison between the D, E, F zones and the Porto Empedocle model for the A, B, C zones.

Through the investigations carried out on behaviour in opposing climatic conditions, we witnessed the high performance of a wood and straw construction, which has been found to be superior in many cases compared to the other systems, thereby highlighting the validity of this technological solution. In all the cases analysed, from Sestriere to Porto Empedocle, a building in straw bales and wooden structure requires smaller heating and air conditioning systems thanks to the increased level of insulation and thermal capacity compared to a construction of more mass.

Cost analysis has also highlighted an effective benefit of the wood-straw technique over other construction systems.

From the ecological viewpoint, it has emerged that straw allows comfortable buildings to be constructed using a reduced amount of grey energy, and meaning that less energy is also used to maintain them.

This means that being able to choose an alternative to traditional construction systems, wood-straw technology is the perfect solution both during the winter and summer, surpassing all other systems studied in this thesis regarding sustainability and economy.



Picture 1: table giving a overview of ProCasaClima outputs about energy evaluation, sustainability and prices of three different constructive systems (wood and straw, concrete and masonry and X-lam) designed for the climatic area F and compared.

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