# SUSTAINABLE ARCHITECTURE IN MACAU: THE GREEN CASINO

DESIGN STRATEGIES FOR A SUSTAINABLE APPROACH

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EXTENDED ABSTRACT

## Abstract

Nowadays the requirements for an architectural approach focused on sustainability of buildings are increasing.

With just over 30 km2 of total area, Macau is a very dense city where natural resources are scarce, subjecting themselves to imports, including materials, energy and water. The lack of policy and sustainable practices are also factors that emerge insecurely in the Macanese daily driver.

This research aims to analyse the environmental performance of buildings in casinos, which represent the major architectural typology and also economic supremacy in the region. However, these high-rise buildings reveal great environmental negativity, during the building phase as well as the maintenance phase.

The first part of the dissertation proceeds with a review of a historical background, following the evolution of urban morphology and architecture. Next, a Life Cycle Assessment (LCA) analysis of a building, in a quantitative manner, is performed, with the help of information acquired at the university Katholieke Universiteit Leuven, in Belgium, within the workshop Wienerberger Sustainable Building Academy 2014 (WISBA 2014).

Later, a theoretical framework of sustainable architecture and environmental comfort is proceeded, presenting examples of various passive design strategies and design recommendations.

In global terms, it is intended that the observations resulting from this research constitute a valid contribution to the systematisation of information applicable to buildings, not only in Macau, but also in other regions with similar climate and economy context.

**Keywords:** Sustainable Architecture, Bioclimatic Design, Life Cycle Assessment, Macau, Casino.

## Objectives

The term *Sustainability* is not a new topic. It just gained a lot of conscious, mostly because of the noticeable global warming, the constant condemning about the topic in the news and also franchising mass-media attention (ALLACKER, 2010). The world itself and the active role of the mankind are already facing dramatic climatic changes. These changes have a precursor to human activity, namely 40% of $CO_2$ emissions being responsible for buildings (SMITH, 2005), consequently, the need for greater caution has becoming mandatory.

Although *Sustainable Building* and *Green Building* are still not consensus, having different definitions within each supporter, a Green Building, in its essence, is a concern to reduce its environmental impact, such as $CO_2$ emission. On the other hand, a Sustainable Building is not only a concept facing the environmental issues, but also aims to improving the economy, resources usage, human and social status: It should also be a tool to rise the awareness of people of environmental protection.

The thesis investigates how changes of Macau's construction sector can be done to credit into a more sustainable way. It will mainly focus on design strategies of sustainable casino resorts, following the needs of the city and applying green design tactics to the scope.

It will follow the model of the principles of sustainable building, aimed not only to respond to environmental impact in Macau in constructions, but also to achieve the standard level of living in a demanding tropical humid weather.

It is intended to seek essential bioclimatic design strategies, with influences of the existing architecture typology in Macau like colonial, vernacular, contemporary architecture, not forgetting the ambitious Macanese way of land reclamations to expand the area of this small city.

This dissertation is divided into five main groups, preceded by the Introduction and Conclusions:

- *Introduction*
- *Macau: An Overview*
- *Sustainability*
- *Passive and Bioclimatic Design*
- *Design Project Strategies*
- *Project Recommendations*
- *Conclusions*

## Macau: An Overview

This chapter will provide a brief description about general characteristics about Macau. It is essential to understand the context of the city before starting the analyses the topic of the thesis. It is also important to examine Macau's lifestyle before and after the handover, and thus, influences of what Portuguese settlers had done will also be uncovered. From precolonial to postcolonial period, a summary about the architecture practiced in Macau will be made in order to understand the typology of construction that exists and its evolution. It will display the reasons

which led to the rising of casinos, giving the city economic prosperity. An overview of physical conditions like geology and natural resources will be studied, to understand what typology will be suitable for an optimal approach of a sustainable design.

Macau's urban planning and architecture are facing challenges in how to preserve its distinct cultural heritages, and to manage with the rapid growth in population and tourism activities. The old city of Macau has very rich and distinct cultural heritages, mixing Asian roots and the European legacy in buildings, architecture, and sightseeing on the streets. Heavy urban development pressure makes heritage conservation extremely difficult and challenging.

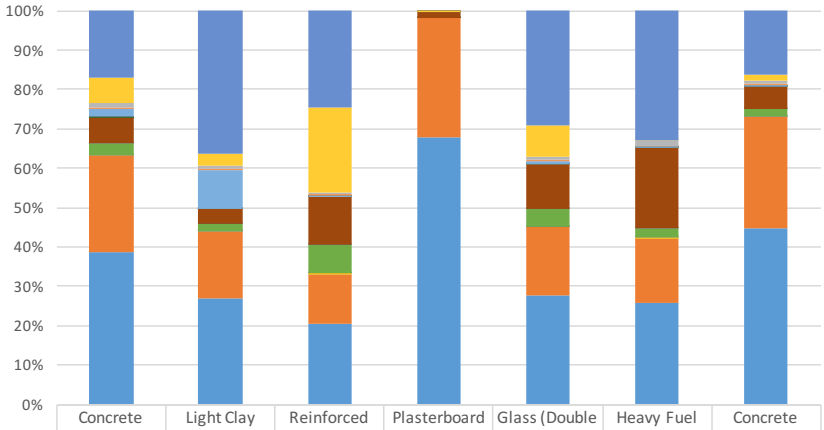
The chapter will finish stating that, not only implementing a recycle system in Macau, the city needs to adapt new regulations to decrease the consumption of energy, waster management and creating other means for water treatment and energy. Enhancing the educational system at the institutions is also necessary, in order to have cooperation between citizens, tourists and the city itself.

## Sustainability

This chapter will start to introduce the concept of *Sustainable* building. It will start to define the idea of it, based in official publications. It will compare major issues of building performance in a green and sustainable building, based in the idea of United Nations Environment Programme. A brief description about the set of workshops of WISBA 2014 will be made and a short conclusion concerning its report will be disclosed. *Life Cycle Thinking, Life Cycle Assessment, Nearly Zero Energy Building* will be uncovered in this chapter and a brief analysis of a case study of its appliance will be done. In the second part, analysis of the sustainability in Macau will be taken, based on papers published, regarding Ecological Footprint and Macau *Biocapacity*, especially in the tourism sector, due to the fact it is one of the main sectors which is flourishing Macau. A report of local analysis taken in February 2015 will be disclosed by interviewing Macau citizens, plus, a screening estimation of impacts in a chosen casino, namely *The Venetian*, with *LCA analysis* lectured in WISBA 2014 workshops.

With the help of local photos, directory maps and visual analysis, a brief screening of material impact assessment was carried out, using *EcoInvent* data *SimaPro* Software. Five materials were carrying out: concrete, glass, bricks, plasterboard and reinforced steel. The reason why these materials were chosen is because they are the most prominent and visible in the building, thus the most used and possibly the most impactful.

According to the charts, climate change for *Human Health*, *Climate Change* for *Ecosystem, Particulate Matter* formation are the most harmed impact categories during Production Stage in all five materials, as well as the energy spent. In exception for plasterboard, all materials uncover high value for *Fossil Depletion*, *Human Toxicity* and *Metal Depletion*.




| | Concrete Block 1kg | Light Clay Brick 1kg | Reinforced Steel 1kg | Plasterboard 1kg | Glass (Double glazing) 1m2 | Heavy Fuel Oil 1MJ | Concrete 1m3 |
|---|---|---|---|---|---|---|---|
| Fossil depletion | 17% | 36% | 25% | 0% | 29% | 33% | 16% |
| Metal depletion | 7% | 3% | 21% | 0% | 8% | 0% | 1% |
| Natural land transformation | 1% | 1% | 0% | 0% | 1% | 2% | 1% |
| Urban land occupation | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| Agricultural land occupation | 2% | 10% | 0% | 0% | 1% | 0% | 0% |
| Ionising radiation | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Marine ecotoxicity | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Freshwater ecotoxicity | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Terrestrial ecotoxicity | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Particulate matter formation | 7% | 4% | 12% | 1% | 11% | 21% | 6% |
| Photochemical oxidant formation | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Human toxicity | 3% | 2% | 7% | 0% | 4% | 2% | 2% |
| Freshwater eutrophication | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Terrestrial acidification | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Ozone depletion | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Climate change Ecosystems | 24% | 17% | 13% | 27% | 17% | 16% | 28% |
| Climate change Human Health | 39% | 27% | 20% | 59% | 28% | 26% | 45% |

Table 1: Distribution and comparison of weighted values of the impact categories for each material

The level of Ecological Footprint in Macau is leading into a serious disruption in supply chains and stiff competition for resources. This global threat is greatest for countries and cities like Macau that have large biocapacity deficits: which should be concerned for investors.

From a city where does have high monetary income, essential system and installations to improve the environment like recycle system, are still not implemented. Everyday, the waste collections are incinerated. The local people also suggest to emphasise the environmental protection through the present education system.

Unlike the surrounding cities like Hong Kong and Mainland China, Macau still has not a green building label regulation, relying on adapting from other countries. This demonstrates that Macau still has not a solid methodology to a greener future approach. Economic incentives, urban design, public campaigns, regulations and charges are all additional drivers which can be employed to boost Macau's flexibility in a resource-constrained future.

## Passive and Bioclimatic Design

This chapter will firstly introduce the concepts of Passive and Bioclimatic Design by reporting environmental impact throughout the world, especially in the building sector. An analysis of the climatic context of Macau based on temperature, humidity, tropical storm and wind will be made to complement the next chapter.

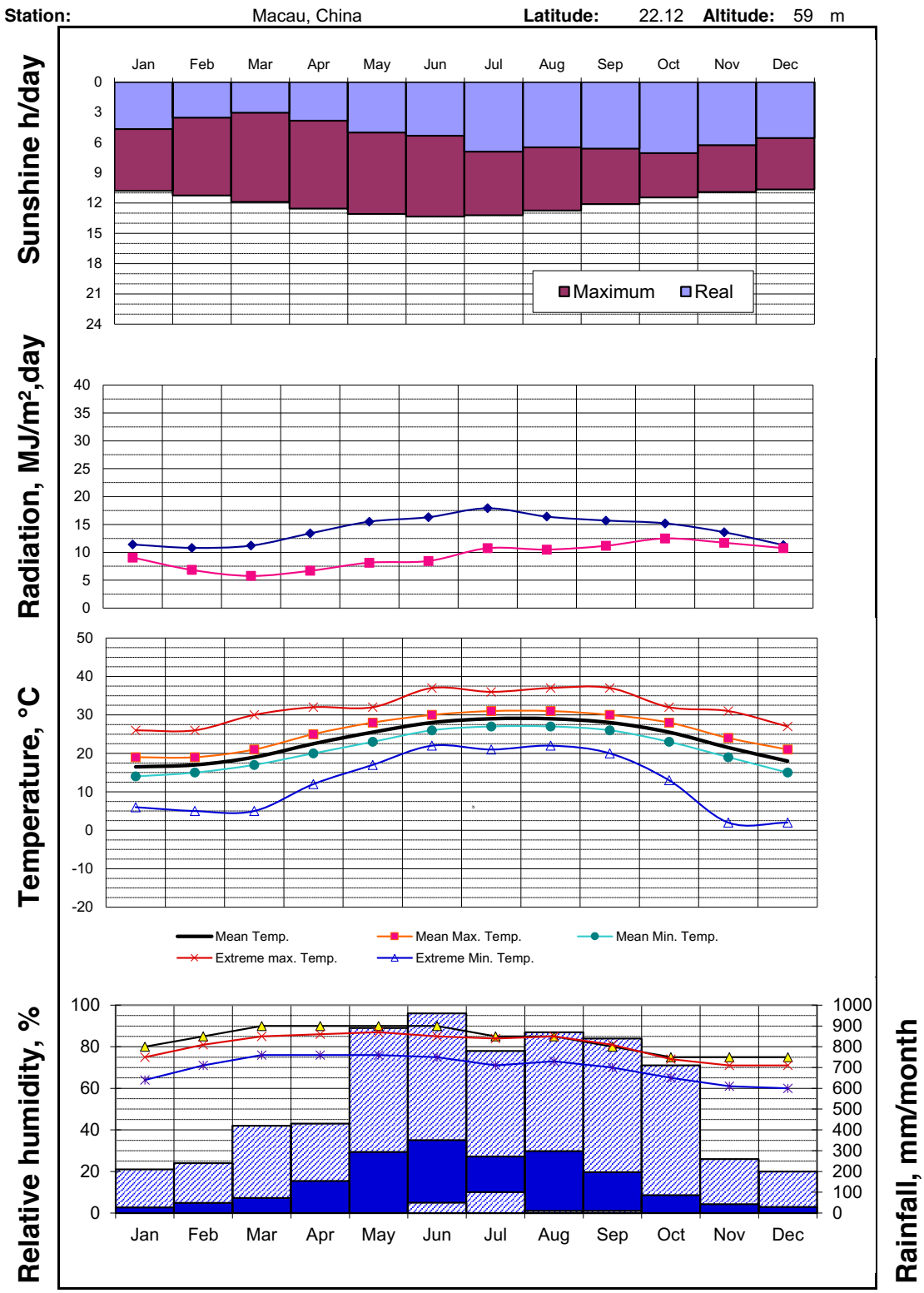



Table 2: Basic climate parameters in Macau (1981 – 2010) (ASHRAE, n.d.)

After the subsequent step, a brief description of design strategies and energy efficiency building design will be uncovered, based on the climatic context of Macau. As the results of the climatic analysis, through the Psychometric Charts using an energy design software tool Climate Consultant 6 BETA6, they portrait as focusing on shading and natural ventilation techniques (CORREIA GUEDES, 2015).

## Design Project Strategies

In recent years, the city of Macau has been experiencing a rapid unprecedented development, with a sudden increase in population and, in turn, shortage of space assets, thus making the city spaces into something extremely precious. Consequently, other than suggesting the construction of new building, refurbishing old buildings are also great solutions for Macau context. Not only because they can be a sustainable approach to preserve heritage, but also due to the fact the city has a lot of abandoned buildings. So based on all provided information, the next and last step, a conceptual design will be suggested, focusing on the material bamboo, suitable for the climate.

Figure 1: New conceptual proposal for the revitalisation of Hotel Estoril

Figure 2: New conceptual proposal of a new sustainable casino skyscraper

## Project Recommendations

Headed to the last chapter, a brief overview will be taken in this chapter, to collect the main ideas of optimal design strategies recommendations for the projects. Covering up the recommendations based on Macau climatic context, some practices can be implemented: Locating buildings close to hillsides or raise above the ground to increase the airflow; elongating blocks east-west making indoor and outdoor areas breezy and keeping them open to warmer season breezes, and if possible protected from storm and cool season winds; high ceilings let hot air rise above the people so the rooms feel cooler to its occupant; using white or light colours that stay cooler on sunny walls, roof and pavement; using tall trees that can shade roofs and reduce temperatures, and plants also cool by evaporating moisture as well as shading, like natural air conditioners; using insulation at the base of masonry walls to stop them being cooled by the soil below, which causes condensation; using lightweight or well-insulated materials so the building will not feel hot and not absorb humidity; using humidity friendly materials like wood, bamboo (like the proposed buildings), mud, earth, etc.; having very sloping ceiling to drain the rainwater and opening balconies and/or galleries to protect the rain are only few of the recommendations, not exclusively in Macau, but also in several hot-humid climate contextual cities.

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