REPLACEMENT OF STEEL STRUCTURE FOR WOODEN STRUCTURE IN ENVIRONMENT EXPOSED TO MARINE AGGRESSIVENESS

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**ABSTRACT:** One described in this work, the challenges and solutions for the design of a timber structure used to replace another of steel that collapsed. The choice by wood is due to the fact that is a material better suited to environments with high salinity and, in this context, to reduce maintenance costs.

**KEYWORDS:** Aggressive environment, Wooden structures, Steel structures, Maintenance.

1 INTRODUCTION

The city of Salvador is located in Northeastern Brazil and constitutes one of the main entry points of the country. It was the first capital, established by the Portuguese after arriving in the new territory on April 22, 1500. Salvador is inserted into the extensive coast of Brazil which is bathed by the Atlantic Ocean. It is located eight meters above sea level and has one of the highest degrees of salinity of Brazil.

Due to the climate and the proximity to the sea, the city environment creates a condition very unfavorable to the metallic components of every order in function of oxidation processes that may develop. Furthermore, the air blowing from the sea makes the oxidation process even more corrosive because the oxidation is enhanced by wind currents carrying the droplets of water and salt. In this context, the structures require special maintenance condition, aiming not only extend the life of the building, but also ensure the structural safety. The wooden structures are attractive option for aggressive environments due the fact that the conditions of inspection and maintenance are easier to be performed and are less costly because are restricted to connecting components.

2 PRESENTATION OF THE PROBLEM

This paper describes the design of a structure of wood used to replace another of metal that collapsed. The collapsed structure was situated in environmental conditions of high level of aggressiveness.

The structure that collapsed was built in front of the building, staying away about 100 meters from the seaside. The roof in ceramic tile had a total area of $285.36 \, \text{m}^2$ and was supported by steel frame, except the columns that were in reinforced concrete. The columns possessed an architectural finish that kept them hidden by a coating of clay bricks.

The original steel structure collapsed in May 2013, after 07 years of use, destroying completely the superstructure and the columns. The remaining metallic structure was also replaced considering the high costs of maintenance. The builders called to rebuild the roofing chosen by the use of wooden structure, whose design solutions provide the basis of this discussion. The main facade of the building and the roofing analyzed can be seen in Figure 1.

3 STRUCTURAL DESIGN

3.1 COMPUTACIONAL MODELING

The computational model was constructed using the finite element method, with plate elements to simulate roof tiles, common rafters, battens and purlins and bar elements to simulate trusses, beams, hip rafters, ridge broad and columns. The support basic structure is constituted by plane frame that support the scissors from roofing whose combination gives the assembly tridimensional shape.
In the computational model the bars were considered joint ringed on the start and end of element and the roofing plates were discretized in order to make its nodes coincide with the scissors points which support hip rafters. The Figure 2 shows the mathematical model used to obtain structural efforts. More details about Finite Element Method are presented by Bucalem [1].

**Figure 2: 3D Frame and Kind of elements on MEF Model**

### 3.2 STRUCTURAL DIMENSIONING

The design of structural pieces was performed assuming a wood resistance class of 60 MPa and sought to meet the recommendations of the NBR 7190 – Design of wooden structures of Brazilian Association of Technical Standards (ABNT) [2]. Efforts in structural elements were extracted from the computational model presented in the previous section and the cross sections were calculated by observing the guarantees resistance and stability. Special challenges relate to the design of the support columns, made to meet the pined condition as well as beans and columns, whose cross sections found particular solution. Another limitation is the availability of laminated timber and the amount of wood from one species to suit the mounting of the roofing, with the necessary mechanical composition and the use of structural elements of different tropical species.

### 3.3 FINAL ARRANGEMENT

The geometric modeling with the final arrangement can be seen in Figure 3. The project was presented to the builders with the graphical representation of the structural elements, with plans, views and sections, as well as the detailing of connections. The geometric modeling also collaborated with the production and assembly of structural components.

**Figure 3: Final arrangement**

### 4 CONCLUSIONS

In aggressive environments wooden structures show up naturally more advantageous than steel structures considering maintenance tasks to which they are subject. It should be noted that the geometric modeling of the structure contributed to the implementation of complex solutions required, as well as numerical modeling allows evaluation of efforts and the "as-built" of the structure. It is important to highlight that the design of a wooden structure requires knowledge and creativity to overcome the challenges of design and detailing own this material.

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### REFERENCES
