Structural Design From Reclaimed Material – Sauvabelin, The Never-Ending Story

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Introduction

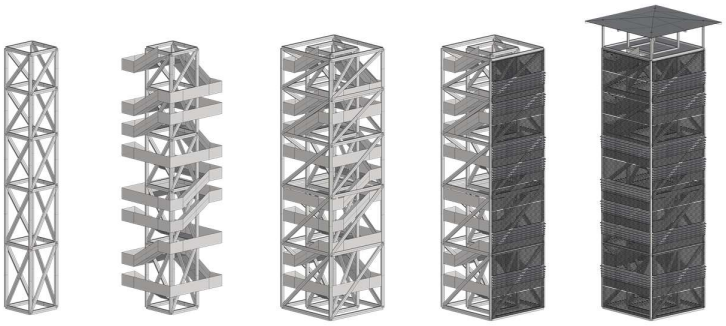
The timber lookout tower of Sauvabelin – by Bernard Bolli and Julius Natterer – was erected in 2003 to demonstrate the potential of solid wood construction. Due to its exposure to rainwater, the tower had an expected service life of about 20 years which was extended to 30 years thanks to important rehabilitation work performed between 2015 and 2017.
It is then expected that the tower will have to be dismantled by around 2030, but is this really the end of the story for the tower and its materials ?
The project aims to explore the reconstruction of the Sauvabelin Tower following a *structural design from reclaimed material* approach. The goal is to reuse as much material as possible from the existing tower in the design of the new tower.

Method

The project makes use of the decision support tool *Phoenix 3D* developed at the Structural Xploration Lab in Fribourg. *Phoenix 3D* is a user-interactive Rhino-Grasshopper tool that allows to design optimum truss structures made of new and reused components. It furthermore allows to obtain almost real time feedback that helps reaching the most efficient design out of a given subset of stock elements.
From quantities provided by the tool, the project aims to optimize the geometry of the load bearing structure taking environmental, architectural, structural and economic concerns into account.

Conceptual Design

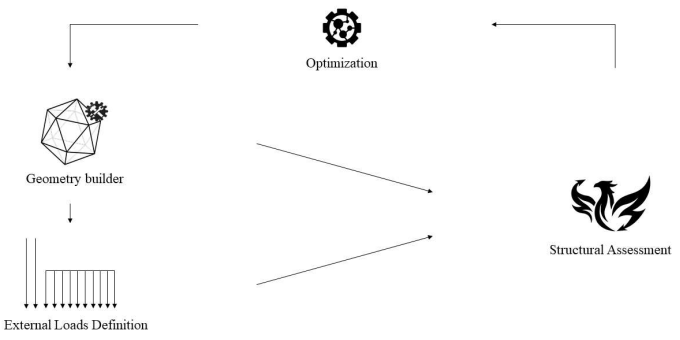
The conceptual design obtained from material, site and method considerations is illustrated in the following scheme,



The load bearing structure is intended to be constituted of an inner and an outer truss built from the reclaimed elements of the existing tower. These trusses confer stiffness to the tower, provide support to the staircase and to the cladded facades. Larger openings are performed in the facades at the level of the intermediate platforms to offer viewpoint to the visitors. The height of the top platform is chosen to offer a 360° view over the treetop.

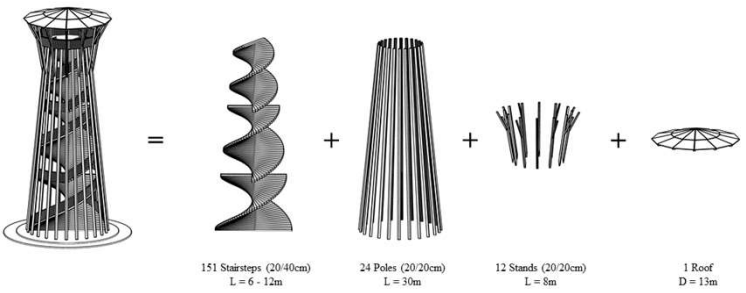
Optimization Process

The project aims to optimize the geometry of the load bearing structure i.e. the inner and outer truss. To do so, the whole structure and the definition of the external loads are parametrized in the grasshopper environment. The related external loads are calculated at each iteration and allows *Phoenix 3D* to proceed to the structural assessment. Some optimization can then be performed according to the quantities provided by the structural assessment. The optimization process is illustrated in the following scheme,

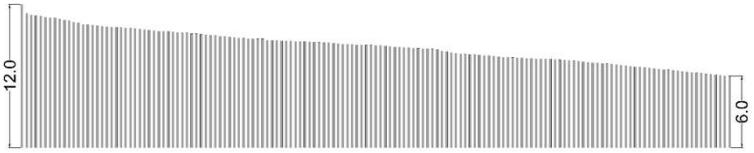


Resource Diagnostic

Since the goal of the project is to rebuild a structure at the same place, fulfilling the same purpose, from the material of the current tower, the first step is to assess what materials can actually be reclaimed; this is the so-called *Resource Diagnostic*.
Putting secondary and non-load bearing elements apart, the materials that can theoretically be retrieved from the existing tower are the following,



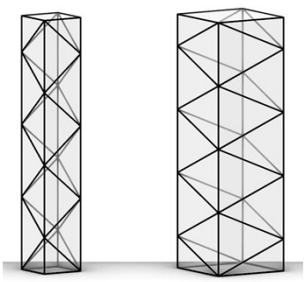
The 20/40cm douglas stairsteps are intended to be reused as load bearing elements and constitute the main source of materials. The poles are assumed to be reusable but for non-load bearing purpose due to the presence of numerous steel pins in the section. The stands can be used to build the roof frame of the new tower. The old roof can be reused as it is in another project.
Assuming initial grading of the sections reduced by the length replaced during the rehabilitation work of 2017, the stock distribution assumed is the following,



Results

The iterative process oriented to minimize the environmental impact while maximizing the stock use results in a 9x9 meter square tower. The optimization process allowed to find a geometry where the entire load bearing structure could potentially be built from reclaimed material. Moreover, it reuses 92% of the assumed stock of elements. Further information is provided.

Phoenix 3D - Outputs		
Stock Mass	[kg]	53906
Structure Mass	[kg]	49540
Reuse Mass	[kg]	49540
New Mass	[kg]	0
Waste	[kg]	4366
Reused Members	[-]	160
New Members	[-]	0
Total Members	[-]	160
Reuse Rate Mass	[-]	1
Reuse Rate Members	[-]	1
Environmental Impact	[$kgCO_{2eq}$]	24564
Max Utilization	[-]	0.42



Rendered View