FP1402

How will we plan and build in future?

J. Gamerro[1,3,*], J. F. Bocquet[2], and Y. Weinand[1,3]

[1]IBOIS EPFL, Lausanne, Switzerland
[2]LERMAB ENSTIB, Epinal, France
[3]National Centre of Competence in Research for Digital Fabrication, Switzerland
[*]julien.gamerro@epfl.ch

1 Introduction

A man who wants to act for the future cannot ignore two major facts. Firstly, the resources that made possible the transformation of today's world will be rarefied especially fossil energies. Secondly, these resources will contribute until their profitable depletion to the phenomenon of global warming because of their CO^2 emissions. The vision of a near future is therefore not "development" with an idea of growth but "sustainable reorganization". It will consist of storing CO^2 by any means, limiting the CO^2 emitted to achieve it, while transforming our environment to no longer need to emit: in short "decarbonize" our world. Actually, to create this world the energy that can be consumed is the sixth of what our parents had.

A colossal challenge awaits the construction field with the current population level. It will be necessary to deconstruct the less efficient structures, to build where it has been deconstructed by densifying the housing and to adapt today's buildings where it is possible. To make a successful transition, five reorganization areas should be implemented: one sociological and four technological.

2 Sociological Area

It is the most crucial part because people have to understand that instead of a world where everything is produced in order to be consumed, production must be focused on consuming less and in a smarter way. It is also true for the Architecture, Engineering and Construction (AEC) industry. Nowadays, people mentality begins to change progressively. Tools like digital technologies can help and should be efficiently implemented because as it has been mentioned in the introduction, the resource is limited and as a result the right to make mistakes too.

3 Technological Areas

3.1 Resources optimization

Resources optimization will inevitably involve to bring production sites closer to exploitation places by using the local resource. Territories with their production places and logistic networks should be seen as gigantic factories whose multi-constraint flows must be optimized. Territories, grouped into coherent life areas, should be modelled numerically to predict their optimal reorganizations. Digital tools such as Artificial Intelligence could possibly optimize such models.

3.2 Building Optimization

The digitalization of the existing heritage, thanks to Building Information Modelling (BIM) for example, is essential for establishing a picture, for modelling the deconstruction in order to predict the flows and lastly for predicting the reconstruction to minimize the waste of resources. Deconstruction and reconstruction should be organized by geographical area in order to select appropriate materials and also to facilitate the creation of recycling entities.

3.3 Low-tech and new construction methods

For reducing the amount of fossil resources and more polluting materials, the use of wood for construction systems is an excellent alternative. Moreover, it is indispensable to implement recycled materials for a better sustainability. It is also necessary to develop, for these construction systems, assembly solutions as simple as possible that can be easily produced by new technologies and recycled. As automation and robotic are increasingly present in

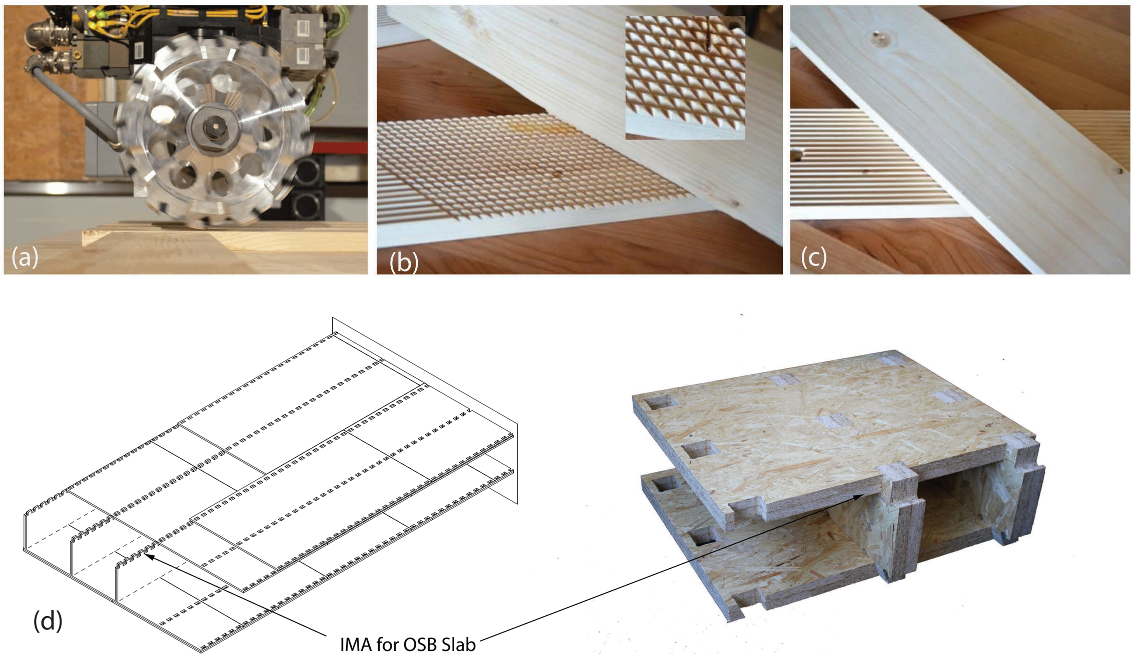

Figure 1. (a) Tool for mechanical preparation of wood interfaces on robot, (b) type of wood connection, (c) different angles possible, (d) IMA for slab made of OSB panels

the AEC industry, new ways of designing structural elements can be imagined and implemented for meeting the mentioned requirements. In this context, research institutes such as IBOIS and LERMAB have developed wood-wood connections. The first one, called Integral Mechanical Attachments (IMA), is for plate structures (see figure 1 (d), IBOIS) and the second one is for beam elements and use a specific mechanical preparation of the interfaces (see figure 1 (a,b,c), LERMAB). New connection methods for structural timber elements offer alternatives to structural bonding and metal fasteners. Fabrication processes and geometries are more flexible and can be used to design others timber construction products which is a great advantage for medium size timber companies (most common in this industry). A growing interest from timber industry in these connections has emerged and various projects have been realized like the new theatre of Vidy-Lausanne.

3.4 Regulation and Standards

Constraints and regulations related to new buildings are constantly evolving and all these changes, in our ways of thinking and producing, will have an impact on standards. For the policy field, contractual relationships, risk-allocation models and procedural flows should evolve if only for the implementation of BIM. Focusing on the technical side, research should be performed to characterize recycled materials for using them in new constructions. For timber construction there is only literature for assessing the semi rigidity of mechanical fasteners. The introduction of mechanical fastener stiffness, called K_{ser}, was a major advance in Eurocode 5 in order to solve problems of stability and large displacement which is usually the most critical point for timber structures (Serviceability Limit State). In order to be able to bring these new connection techniques into common practice, there are gaps to fill concerning their behaviours (slip modulus, failure modes, resistant capacity, long term) and that is why research is performed at IBOIS and LERMAB on this topic.

To conclude, there are many challenges for the world and therefore for the AEC industry. All the actors of the different fields (policy, construction, technology…) should work together toward the same goal: "decarbonize our industry".