Introduction

In the building trade, for the majority of those involved, organic materials are still considered to be mere accessories, as products of secondary importance. However, they have proved to be omnipresent and therefore essential to the trade. This vision also explains why these organic materials have only been of interest to those authors of science and technology in the application's restricted framework, in the trade where each one of these materials is needed. Experience in the civil engineering domain has shown us that the "plastics", sometimes called *soft materials*, have many characteristics in common. All taken together, these characteristics may be interesting to compare, with the aim both to teach, and to stimulate research. Out of this aim, the 2003 work entitled *Matériaux organiques pour le génie civil – Approche physico-chimique* [MOU 03] was created and later translated into English as *Organic Materials in Civil Engineering* [MOU 06].

In this book we tried to define the field represented by these materials, which are characterized as:

– on the one hand, organic materials;

– on the other hand, construction materials.

In order to approach *organic materials*, we chose the physicochemical approach, meaning that we start by looking for what (in their molecular structure) characterizes these materials, and what exactly characterizes them as being part of the same category, regardless of their use. The intrinsic properties of these materials, namely their mechanical behavior, clearly depend on this structural data. Conversely, we were able to find all kinds of coherences between products with completely different uses, and we were then able to justify the *tranversality* hypothesis which guides our work.

Introduction written by Yves MOUTON.

Here, we should be precise. Although they are largely in the majority, the compounds which chemists call polymers – which will be greatly discussed in this book – are not the only existing organic materials, particularly in construction. This is why bitumen[1] used for road engineering and sealing various types of constructions, has an "organic" structure but cannot be qualified as polymers. In the same way, lumber is not strictly a polymer. Therefore our subject exceeds the strict framework of polymer applications in construction.

The world of *construction materials* is so vast that we chose to limit ourselves to the civil engineering field, where we felt more at ease, taking into account our own professional experience. Works were carried out to the field of building construction, but primarily for extrapolation reasons.

This initial work could not be left in this condition. The interest it generated made us take up its cause again, and develop it on two points.

First of all, it was presented as a summary, an introduction to organic construction materials as seen by a generalist. To go a bit further, it seemed necessary to let various specialists in the field concerned have their say, the people of art and science, as well as practitioners, each one of them also having to worry about sustainable development. The transversality hypothesis expressed in the first work was then transposed to the level of the whole book and its organization.

Secondly, the initial work was limited to civil engineering; opening up the subject to the whole of the construction domain seemed essential.

The book we are now proposing is therefore a more in-depth extension of this initial work, presented by specialists in each field discussed. The authors were not asked to approach their subject in an exhaustive manner. Some did, whereas others developed parts of the subject which seemed the most important to them. This means that this book is not intended "to cancel and replace" the previous work but to recreate it in more depth, to show new aspects of it and to update it.

Let us finally add that, written by teachers, researchers, experts and French entrepreneurs, this book is presented, in a certain manner, as a reflection of the French technique of organic material construction.

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1 It may be noted that the French word "bitumen" is "bitumen" in English and "asphalt cement" in American English. We must note here that "bitumen" has a more accurate sense than "asphalt" which often appears as ambiguous. This is why we will use the European terminology concerning bitumen technology.

In addition the concept of sustainable development was already taken into account in 2003 [MOU 03], but it was only really explicit in the final chapter. The procedure which is proposed today appears as follows.

The book is presented in 8 parts.

Part 1. Problems Regarding Organic Materials and Sustainable Development: a successive approach to define the concerned field of materials, the requirements of sustainable development, the health and environmental impacts of these materials used in construction. Chapter 1 presents these materials and classifies them into three categories which are detailed in Parts 3 to 6 of this book. Chapter 2, the most detailed chapter of Part 1, establishes the problems concerned with organic materials in a sustainable development context. This will be taken up again in Chapters 3 and 4, which are intended to be used for reference purposes in future works. On this subject, it must be noted that referenced literature is relatively poor in these fields. It is not the same as "gray literature", i.e. internal work in companies or research laboratories, but it is still difficult to bring it out into broad daylight. Asking this of the authors was still more difficult.

Part 2. *Organic Polymers as Building Materials*: starts with a thorough scientific presentation of these compounds.

As previously stated, *there is no identity between organic materials and polymers,* but road bitumens, for example, manifest properties which bring them closer to polymers and put them in this category of *soft materials*, which we mentioned at the beginning of the introduction.

With the concept of the polymer being defined, Part 2 follows by developing the way in which plastic manufacturers use polymer based products. Both the theorist's (discussed in the first chapter) and the plastic manufacturer's points of view respond to each other. Then, three phenomena which are at the core of many questions from users are discussed: first of all, the ageing and the durability of organic polymers, then, fire-proofing products containing organic polymers, and finally, processing the waste which is generated at the end of their life.

The first phenomenon is the subject of an important development, because it corresponds to a field where it is necessary to bypass the molecular scale if we want to understand these phenomena, and therefore be able to control the processes. The two others correspond to very widespread interrogations on the relevance of using organic materials when we speak about sustainable development. Here, there are ideas on eminently significant subjects ready to be put into place. Thus fire-proofing is the first response by producers to the anxious users of fire-sensitive organic materials, its balance being the definition of adequate constructive provisions. As for

the problem of waste management, it must be correctly replaced in its context to be dealt with, without *a priori*.

Part 3. Manufactured Products: meaning products which are to be implemented as they are.

First comes geosynthetics, which is used to carry out waterproofing or all kinds of work concerned with geosynthetics. "Waterproofing" is obviously the field of excellence for polymers which are, in their great majority, hydrophobic, and thus perfectly adapted to this use. This is initially dealt with thoroughly within a civil engineering framework. Then, as for plastic formulation, it is looked at in its daily use by the expert, within a general construction framework.

Their hydrophobic characteristic aside, certain polymers manifest particular elastic properties, more specifically elastomeric, which makes them very useful in several domains, particularly for manufacturing expansion or waterproof sealing, or expansion bearings or works of art. The study of these *elastomers* and *rubbers* also deserves to be widely developed.

Part 4. Composite Materials, Tensile Structures, Textile Architecture and Timber: is devoted to emblematic materials as particularly representing the original feature of organic materials: composites, architectural textiles and industrial wood.

Chapter 13 relates to organic matrix *composite materials*, some of which are real manufactured goods and others are implemented in situ. It is initially a question of presenting the pallet offered by these truly innovating products, while considering more particularly new constructions. Repair and strengthening structures will be discussed thoroughly in Part 7 as a specific application of binding.

Then materials for *tensile structures* arrived, which gave way to the practice now known as *textile architecture*, based on new mechanical concepts, particularly tensegrity.

Finally we should not forget *timber*, the oldest organic material, which has become an industrial material with masterful performances, and yet so unknown that it deserves to be developed further.

Part 5. Organic Binder-based Materials: concerns bitumen and other related products, paints and protective systems, products for repair and industrial mortars.

Bitumen, the first binder to appear in the field of construction and the most used organic binder today, is a complex product. Its colloidal structure expresses physical and mechanical properties, similar to polymers but more specific, which require

very interesting and considerable work on behalf of the researchers, to get closer to the work of polymerists. It must also be noted that significant results were obtained from this material with regard to research on the prevention of the industrial risks (see Chapter 3, Part 1).

For *paints* as well as *repair products and industrial mortars*, the last 20 years has seen spectacular transformations occurring in formulation concepts and implementation practices to fulfill the medical and environmental requirements which were to be part of the new standard. Those different domains had to take stock of the situation.

Part 6. Organic Compounds Built-in into Cement Matrices: particularly insists on hydraulic mortar and concrete admixtures. In the same spirit as for polymers in Part 2, the researcher is given a voice followed by the entrepreneur who lists the attributes of organic admixtures in construction processes. Chapter 21 takes stock of incorporating *organic fibers in cementitous materials* into the field of civil engineering.

Part 7. Problems Specific to Organic Materials: Adhesive Bonding: particularly illustrates the field opened by organic materials in the research domain, an essential assembly method for this type of material, and *characterization methods* which are also specific. These are two distinct domains. Bonding is a difficult phenomenon to pinpoint, which still opens the door to a lot of research, but which intervenes in a direct or indirect way as soon as an organic material is brought into play. *Strengthening of concrete structures* is the most important application of that technique in the field of civil engineering. Here the *durability of specimens under accelerated ageing* is used to qualify the materials.

Finally, for the *specific characterization methods of organic materials*, it is interesting to follow their evolution, both in terms of scientific knowledge and European and international norms. Bitumen, paints and concrete admixtures are particularly concerned.

Part 8. Organic Materials, Construction, Architecture, Creation and Sustainable Development: takes a step back. Firstly, the architect's point of view followed by that of the theoretical and applied mechanics' expert. This is then followed by setting up a perspective for the construction materials of tomorrow, when organic materials will play an important role but will not be exclusive. It will reflect the role of research and its pitfalls, before a conclusive article on the possible future of organic construction materials in a sustainable developmental perspective.

Hence, today we can say that organic construction materials are at the very heart of the awakening to the concept of sustainable development. Such an assertion

already passed for a pure provocation, five or ten years ago. Now it is becoming relevant, and today we turn our attention specifically to those who might have felt prompted yesterday.

Bibliography

[MOU 03] MOUTON Y., *Matériaux organiques pour le génie civil – approche physico chimique*, Hermès, Paris, 2003.

[MOU 06] MOUTON Y., *Organic Materials in Civil Engineering*, ISTE, London, 2006.