A few words about history of concrete and sustainability

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The relation between construction and environment can be considered of, at least, three manners. 1. Any construction being an artifice, it is "naturally" an aggression on a former "state of nature". 2. Any construction however is an answer for human needs, which form part of our human nature. It thus belongs to nature. 3. Any construction exploits natural resources. It belongs to the man, animal responsible, to ensure the reproductiveness of them.

The history of architecture can be regarded as the history of the management of these resources. Until the 19th century, there is no problem, the exploitation of these resources (the stone, wood, earth) representing only a negligible part of their availability. After the industrial revolution, all change. It is what I would like to illustrate with the example of the concrete.

The concrete was the material of modernity, of the modern architecture in the 20th century. Will be the material of the future? In the next fifty years at least, certainly. Afterwards, no one doesn't know. But a thing is sure, it is that the world, in the next hundred years, will have to live probably with an immense inheritance of reinforced concrete. History is useful to understand a number of things. The concrete neither was never "invented", nor "discovered". The reinforced concrete either, or more exactly, it was many times invented.

The concrete is a mixture of cement, sand, and gravels, brewed with water. Sand, gravel, water, can be find everywhere. It is cement which must be manufactured, produced in an artificial way. The Romans used the concrete on a large scale. Their cement was composed of hydraulic lime and "pozzolana", kind of additive hardener then produced from reduced volcanic powder lava, of the area of Pouzzole (Sicily). How is lime obtained? By the calcination (burn to ashes) of limestone. The white powder obtained, called lime, is "extinct" with water. The resulting product (extinct lime) is preserved and handled easily. You mix sand and water there : mortar is obtained. Stones are added: concrete is obtained. You run the concrete in formwork provided with metal reinforcement : reinforced concrete is obtained.

After the Roman time, the concrete ceased being used, being replaced in construction by the stonework. Indeed, until the 18th century, the techniques of construction used primarily wood and stone, in accordance with an art of building particularly developed which left splendid monuments. The mortar, of unequal quality (according to the nature of limestone being used to produce it) was used only as complement, of assistance to the solidity, which was ensured by the quality of masonry.

But in the 18th century precisely, certain builders start to be interested in the Roman concrete, which hardness fascinated them. Some experimenters seek the "secrecy" of this concrete.

It is the beginning of an intense research which will succeed, with the discovery of Vicat in 1817, with the possibility of producing cement of quality artificially.

It should be noted that the production of cement is closely related to the principle of combustion of the calcareous stone, and thus with the type of combustible used. Precisely, thanks to the coal which replaces wood, we can await temperatures of 1200°, allowing to obtain the "clinker", i.e. cement which we know today. Thus, to obtain a ton of cement, it is necessary to burn a ton of coal, more or less. This is important for the question which interests us: sustainability.

The first cement factories appear in the middle of the XIXth century. It is an important stage in the history of the techniques of construction. For the first time, a material is produced in an artificial way, in factories specifically designed for that. Cement is "conditioned" and distributed like goods, everywhere where you can convey it. The development of the railroads of course will support the commercial expansion of cement, and its use soon will compete with that of the stone.

We have to await the end of the 19th century and the exploitation of many reinforced concrete patents to attend a true technical revolution, comparable with that of metal, the material king of the engineers in the 19th century.

The use of this new material remains however confined in a particular sector, dependent on the industrial expansion, sector which I would call the industrial installation (facilities). Indeed, the architects refuse this material, without expression, without image, of liquid origin. The categories of architectural aesthetics, conveyed by the academy, are not yet ready to accommodate new material. But on the level of the industrial installation, there is an extraordinary development, which will be used as

formal and constructive laboratory for the generation of the young architects in the beginning of 20th century.

It is necessary to retain the name of Hennebique. Contractor, it is him and his company which will develop a gigantic market for the use of the reinforced concrete. Here some images related to some of its achievements.

(...)

The concrete at the beginning of the 20th century is not regarded as a problem of environment. Moreover, people are not yet concerned with it. But I insist over this period, because it is the true beginning of the large wave of concrete which will be spread everywhere in the world, especially after the Second World War.

In the beginning of the 20th century, the reinforced concrete was known only by industrial equipment suppliers and by some contractors. The engineers, for the majority, rejected it, and the architects were unaware of it. Hennebique made an exceptional object of promotion of it, contributing largely to its diffusion. But it was necessary to wait the following days of the First World War, and especially those of the second, to attend a deployment economically significant.

Basically, the history of the reinforced concrete can be divided into three periods. The first is that of the industrial installation (tanks, pipes, silos, channels, pools, manufactures...), which covers around twenty years (1895-1915).

The second is that of the architects "pioneers" on the matter, the modern ones (Corbusier, Gropius, Mies van der Rohe...), who perceive in material an unequalled potential of creation and development (1920-1940). The third is that which starts with the “Reconstruction” (Rebuilding), continues during les “trente glorieuses" and goes on still today.

Today, i.e. in the beginning of the 21st century. From now on, it is known of everybody, infused the vocabulary (in a relatively dépréciative way: we "concrete" the countryside, the littoral...) and feeds a major sector of the economy (building, civil engineering) and industry (cement factories).

At these three periods, we would like to add a fourth, of which we do not know the limits but which apparently already makes us large signs: that of the future. This future which worries, so much on the level of planet than to that of the human societies. Where we will live when we will be ten billion? But especially perhaps, what will be like our built-up areas, urbanized, arranged?

We would like to recall that according to the economists, approximately 70% of what is built was at the twentieth century, and which the same proportion about (2/3) of the annual weight of delivered construction (in France at least), all combined programs, is out of concrete or reinforced concrete... That means that a new dimension qualifies from now on the question of the concrete : that of the quantity.

We do not speak any more but per million or billion tons, by million or billion cubic meters, by hundreds of thousands of residences and equipments. The concrete has certainly something to do with proportioning, with quality of aggregates, but above all it has something to do with quality of life, with city, with landscape. Million "hard points" was spread on the surface of the planet, constituting an immense armour monolith, which utility we do not call into question, but of which we know almost nothing as regards future, or sustainability.

Here besides what frightens : promoted from the origin like a material lasting, indestructible, definitively solid, the concrete (which is only hundred years old!) offer the worst ruins than we can imagine, has a potential of recyclability quasi non existent and, more over, arrives almost at the head of the classification as regards the pollutant emissions (a ton of clinker produced emits 850 kg of carbon dioxide)

November 16, 1944, in France, was created the MRU (Ministry for the Rebuilding and Town planning). It preceded the centralist manners of planning including the establishment of the projects of installation and construction, as well as the direction and the control of all the companies of the building sector. That will have important consequences, the economic sector of cement being of start privileged to the detriment of that of wood or steel. Not for technical or architectural reasons, but for economic reasons : at the time, producing one ton of cement burns about one ton of coal, that then made it possible to start again the mining activities of France.

The figuring of the needs: three million residences at the following day of the war, lead to a rather abrupt scaling on the level of the means under consideration for their implementation. The French Minister for the Rebuilding Eugene Claudius Petit wished to multiply by five the output of residences, which as well implied modifications on the level of territorial balances (where to rebuild?) as possible systems of capitalization (how to release from the funds?) and of the capacity of production (which technique to use?)

That gave place to a specifically French invention, well-known under the name of "prefabrication lourde". Conceived like a manner of building pieces of architecture from workshops sheltered and organized rationally, as in industry, the technique proved to be unsuited to the level of the reality of the building sites (open at air by definition),

inadequate as constructive system (weighty elements no adapted with the manufacturing specifications of the execution), and especially catastrophic on the level of architecture and town planning. It was thus the beginning of statistical architecture : only one type of floor, only one standard of window, only one exterior wall panel... Per thousands of tons, the concrete ran in standardized formwork, sometimes mechanized, obeying the new cycle of material, 24 hours between running of concrete and taking down formworks. Architectonic thousands of fragments circulated on barges or in trucks.

"Grands Ensembles", "prefabrication lourde", "industrialization of the building" are the major terms qualifying this era of the quantity as regards use of the concrete in the construction industry. It would also be necessary to evoke great contemporary work requesting of full capacity the capacities the cement factories. The equipment of all the alpine arc in hydroelectric dams, until the seventies, as well as the great works of infrastructure (roads, motorways, bridge, tunnels...) which is printed on whole Europe, contribute to the expansion of a technique from now on impossible to circumvent. Label, make of the twentieth century, the reinforced concrete will certainly sign some remarkable works, but he will be the operator essential of a true change in building art in general.

The major problem of this generalization of concrete and reinforced concrete, is that it is spontaneously badly accepted by the immense majority of the public. But the true problem induced by this material expansion, it is not so much its supposed ugliness (quite debatable) that the problem of its maintenance. In 1996; association for the protection of modern inheritance DOCOMO organized in Le Havre, the town of Auguste Perret, a conference devoted to this subject. It mentioned the technical problems related to its conservation or its repair, but especially, the congress underlined the problems of a society (our society) which was to take care of an immense, recent concrete inheritance (hardly a few decades of age), and already ill. A building owner asked if our society would accept, in the decades to come, to devote a share of budget equivalent or higher than that of health or education, for the only maintenance of this inheritance, already strongly corrupted. The question is still today very relevant and always current..

Here we are inside the question of sustainability. Of this immense legacy, what shall we do? To illustrate in a metaphorical way this important question (which of course I could not answer), I would like to introduce a figure, or rather a concept, a term, which reveals more or less the nature of the problem. This concept is a French word : “l’éclat” (the glare). This word accepts two significations : the matter fragment which burst (crack, piece), and the light intensity, the character shining, splendid of the object, its glare. Besides the glare of the concrete illustrates rather well the paradox of its aesthetics. The concrete seems being able to last beyond the life expectancy of any other material... but it cannot age.

A frequently mentioned problem of the concrete, indeed, is that it ages badly. It takes dust, it fixes pollution, it get damaged. The seasons pass and do nothing but damage it, to make it ugly. Thus : it fades, he looses its glare. We admire certainly the concrete of Tadao Ando or the Suisse school. They are young, nothing does not disfigure them yet. But what will it be in 50 years, 100 years and more? With this question, we cannot answer. We do not have the retreat to appreciate.

But it is this other dimension of the crack, of the wear which I would like to evoke. How "breakages" concrete? How ruins concrete? It is all the problem of this material which does not produce beautiful ruins. It is necessary to agree, to get on such a term, that of "beautiful" ruin. M. Mostafavi and D. Leatherbarrow report these difficulties, material and conceptual, and in a more general way, the difficulties of the modern architecture in front of the problem of physical ageing, in front of the problem of decrepitude, in its literal sense.

Today (2007), the figures of destruction or ruin related to the contemporary built legacy are, usually, images of catastrophes: war, earthquakes, floods... The destruction is a catastrophe, that can be measured in the precise (exact) time of annihilation obliteration, which is not any more that of slow wear or the simple lapse of memory, but that of disintegration, of the deflagration. Admittedly, Pompéi was a catastrophe, just like the fall of city of Troy undoubtedly. In certain way, the fall of the two towers of the World Trade Center of NY is more or less of the same type. But as regards trace, of ruin precisely?

Curiously, it is the obliteration which prevails in these situations. Kobe (Japan) recovered, at least physically, of the earthquake which had destroyed a part of the city in January 1995. Here is, allegorically expressed undoubtedly, the procedure by which today we assume the ruin of the concrete : by obliteration, the dissolution of the tracks. This posture, we will say, is a choice, a decision of society (as could be to it this other form of obliteration-rebirth : recycling). But what will occur of our own environment built in the decades to come?

Between the incommensurable quantity of concrete constructions which cover planet and the quasi instantaneous effect of their obliteration by the way of dynamite or the war, it is all the question of the inheritance which is asked. As long as we will not have invented adequate and credible receipts of recycling (others that re-employment of the concrete crushed as under layer for the construction of the roads), we will have to live with and maintain this immense park, increasingly harder,

increasingly heavier. Here is the challenge of the architects and the manufacturers of the future. What to make of this millions of tons built of reinforced concrete, whereas we cannot almost recycle them?