Toward a complete reemployment of aggregates from demolition work in situ

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Abstract

The recycled concrete aggregates (RCA) produced by the demolition of old buildings seem to be an option in order to construct new buildings and to preserve the environment by the reusing of inert materials, reducing the resort to the natural materials and the disposal in landfills. Numerous countries are multiplying studies concerning this subject and evolving their regulations consequently. These days, it seems fundamental to go further in the environmental protection by minimizing the impact of road transport through the implementation, on the same urban site, of the following process: in a first phase the demolition, then recycling, then storing and finally reconstructing the buildings. In fact, the increase of the recovery rates of recycled concrete aggregates seems globally meeting the current environmental constraints. However, the transportation of the demolition wastes from the site to the recycling plant and potentially their return are still problems, which are not correctly considered in environmental assessments. Research of the briefest possible short loop is not really developing in France. This study is devoted to understanding the stumbling blocks to this development. If the aim of the financial viability of the short loop is obvious, the study shows that the complexity of project building in urban refurbishment is the first block to remove. The role of the various operators of the project doesn’t comply with the global coherence provided by short loop circuits. The study highlights several technical blocks concerning the recycling organization in situ, the storing of recycled concrete aggregates and finally their reuse in order to produce new concretes.

Keywords: recycled concrete aggregate, urban refurbishment, road transport, short loop.

Introduction

In France, the analysis of the social housing real estate market is that it’s mostly ancient and doesn’t meet the modern criteria of comfort and energy efficiency. Most of the housing (70%) were built before 1980 (Statistical Data, USH 2011). Those housing have usually similar construction method, that is to say generally reinforced concrete frame building with masonry infill walls. In light of their construction methods, a complete renovation and an upgrade to standards is hardly conceivable from an economical point of view. The need in housing is growing in France, it’s necessary to build new housing and for that occupy either a new land on the outskirts of the cities or a land inside of the cities which were freed by the demolition work. Moreover, the concerns for the environmental questions became essential through the “Grenelles” lows and recently the ALUR low. A land resource and energetically efficient urbanism becomes an aim for the construction sector, simultaneously other objectives like the reduction of the personal vehicle usage are considered. Therefore, in order to solve the problems of the need in new housing, aging housing stock and the preservation of land, a simple solution is coming out: demolish the ancient buildings in order to free the land for the construction of new housing.
This solution represents a major challenge. Indeed, once demolished, the buildings form a source of not negligible and potentially reusable waste. Currently in France 58 million tons are sent in landfill whereas 26 to 49 million tons could be recycled, especially in the concrete ("Thème3", Recybéton 2015). One of the solutions would be the recycling of inert materials resulted from the demolition work. This solution fits in the environmental friendly approach, however it’s not always adapted to the urban constrains. Waste sorting centres and recycling plants are generally located on the outskirts of the cities, which implies after the demolition of a building, an increase of road transport to those facilities. On the other hand, the construction of new housing also implies an important road transport of construction materials. But it was demonstrated that the environmental impact of the recycled aggregate concrete could be substantially decreased if the quantity of the additional cement and the road transport were reduced. ("Evaluation environnementale du béton de granulats recycles, Recybéton 2015 and LCA of concrete made using recycled concrete or natural aggregates MARINKOVIC et al, 2014). So, an ideal solution comes out: the short loop that is the reuse of inert materials resulted from demolition of the previous building which will be used in order to produce the concrete of the new building and this, on the same or a nearby site. This solution answers to all the issues: preservation of the natural resources by the use of the recycled concrete aggregates, the decrease of disposal in landfill of inert wastes, preservation of the land resource through the demolition and the reconstruction on the same site, significant reduction of the heavy road transport in urban area and consequently the diminution of the environmental impact of the recycled aggregate concrete. However, recourse to the short loop in the production of concrete is not used in France. Different kinds of stumbling blocks prevent this approach.

The abundance of operators.

The operator’s interaction is a fundamental component in the demolition-reconstruction process in accordance with the short loop. Indeed, the deconstruction-construction process requires the intervention of numerous stakeholders who are appointed for their skills. The contracting authority, which is the client and the backer of the construction, is in principle interested by the short loop concept. For instance, the social housing landlords have the will to keep the demolished concrete on the site, yet they don’t have a 100% reuse target. A basic sorting is generally done on the site and the aggregates are recycled in the construction of platforms and in the road structure. By other means, the contracting authority only has a slight interest in the deconstruction of their buildings. We note that generally there is an important lack of information regarding the building to demolish: lack of plans, landfill vouchers, plan of sorting, inexistent waste audit. When asked about those pieces of information, the contracting authorities systematically send to the prime contractor, who often doesn’t have further details and is tasked only with the monitoring of the demolition work and the asbestos removing. The demolition-construction operations are always set up in a call for tenders procedures. This system of competing offers divides the project in numerous technical lots, demolition being part of those lots. When the project is significant, a prime contractor is appointed. This demolition prime contractor is always distinct from the construction one. He is generally in charge of the asbestos-removing program too and he’s genuinely not interested in the benefits of the short loop as long as it’s not imposed in the contract. He doesn’t have a vision of overall cost, which could reveal an economic gain.
Specialised design offices could take action in order to promote the short loops. However, there’re few of them currently. As a result, there is a lack of support for the decision making of the clients.

When we consult those design offices that support the contracting authority, we realise the extent of the compartmentalisation of the operators. The communication is very difficult between the different operators, especially due to the low interest in the demolition. We notice that in the costs, an increase of construction costs and a stabilisation, even a decrease of demolition costs. Moreover, this lack of added value for the contracting authority explains the low interest in this kind of operations.

A salvage reasoning of light work wastes by the specialised industries is noted whereas the recycled aggregates are often sent in landfill and in the best cases used in the road structure.

The building companies role is determining in the process, because they must provide technological solutions (crushing, sieving etc.) as a result, they have to invest.

The role of the regional authorities is essential too. They deliver the building permits and ensure that the project is in compliance with the public requirements (for example, the project must be in keep with the local urbanization plan). When we consult the town halls, we realise that each one of them have their own approach. Some of them are sensible to the short loop process; others don’t even suspect this option. As a result, it’s difficult to imagine a global master plan that could be used in a more important territorial scale. Nevertheless, the decrease of the urban truck traffic stills an excellent argument to convince the councillors.

In France, another operator is playing an important role: the public land institution (PLI). It’s an organization funded by the government. It manages the planning of public lands for the urban refurbishment operations and in case of social housing operations. Given the kind of operations, the PLI seems to be an important protagonist for the short loop process because he helps the local authorities to find, purchase, and restructure the lands. Once he completed his assignment, he returns the land to the local authorities in exchange for the commitment to build social housing. On a temporal scale, from the convention signature to the return of the land, on average 5 years could pass, this duration can be reduced or extended.

So, it’s understandable that the cooperation between all the operators is essential regarding the complexity as well as the duration of the urban refurbishment operations.

**Standard blockage.**

Despite the law reinforcement in the sector of waste management: the landfills are categorised since 2014 (Decree n° 2014-1501 of 12 December 2014), and the recycling targets of the construction sector wastes on the horizon 2020 is set to 70% (European directive 2008/98/C), the evolution of standards is cautious regarding the recycled concrete aggregate. The substitute rates cannot exceed 30% according to the concrete standard NF EN 206-1, which is shown in the Table 1

| Table 1: Substitution rate depending on the type of recycled aggregates |
|---------------------------------------------------|------------------|
| Type of aggregates | Exposure classes |
|                    | X0    | XC1, XC2 | XC3,XC4,XF1,XD1,XS1 | Other exposure classes |
| Type 1             | 60    | 30      | 20                  | 0                   |
| Type 2             | 40    | 15      | 0                   | 0                   |
| Type 3             | 30    | 5       | 0                   | 0                   |
| Sand               | 30    | 0       | 0                   | 0                   |
Recycled aggregates are not allowed in the prestressed concrete. The storing and the use of recycled aggregates are subjected to additional tests in order to guarantee the quality of the future concrete. Those tests are both temporal and qualitative, for example twice a month and also every 2000 tons.

**Conclusion and possible solutions.**

The public authorities and the contracting authorities awareness of the construction industry wastes, the conservation of lands and the necessity of an environmental-friendly approach pushes the use of recycling aggregates in the front row. However some stumbling blocks prevent the use of the short loop process in the demolition-reconstruction operations. The problems are interpersonal, standard and technical. In those three fields, solutions can be provided in those three fields.

Regarding the abundance of the stakeholders and the temporal scale a precise identification in the operators network of the decision-makers must be established. The intercession to those decision-makers must be done with convincing technical arguments including if possible some tangible examples in order to demonstrate the viability of the short loop system.

Regarding the standard blockage, the employ of the precast concrete seems to be the solution. Indeed, precast concrete products are not subjected to the concrete standard (EN 206-1) but they are subjected to the performance guarantee.

So, we could imagine a transportable precast concrete process, which arrives on the construction site, uses the demolished concrete in order to produce structural components of the future construction. It’s a new way of building that opens up some new perspectives in the use of the important deposit that represents recycled aggregates stemming from demolition work and which corresponds to the environmental friendly criteria.