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► **To cite this version:**

Agnès Jullien, François de Larrard. An overview of recycling in road infrastructure in France from the OFRIR project. Wasteeng 05, Sep 2005, France. hal-00614123

HAL Id: hal-00614123

<https://hal.science/hal-00614123>

Submitted on 9 Aug 2011

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An overview of recycling in road infrastructure in France from the OFRIR project

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Abstract: This paper presents an overview of recycling in road infrastructure based on the OFRIR project, OFRIR being the acronym of "Observatoire Français du Recyclage dans les Infrastructures Routières". The OFRIR project has been based on a literature review of recycling in road framework in France since 1980, considering both environmental, geotechnical road building and service requirements. The review is presented in an internet site (<http://ofrir.lcpc.fr>, mail : ofrir@lcpc.fr) for road national actors aiming at proposing classified, summarized and validated information in order to help recycling decisions. Besides, part of the delivered information is attached to a geographical presentation in order to highlight local resources and practice.

Besides, LCPC and French technical network of road public ministry, BRGM (French Geological and mining organism) and INERIS (French Institute for risk assessment) also significantly contributed to this project supported by METLTM/DRAST and DR (Ministry of Transport and Construction/Scientific office and Road direction), by MEDD/DPPR (Ministry of environment and sustainable development/ Pollution and risk direction), by ADEME (Energy and Environment Agency) and finally by SETRA (Road and highway technical studies office).

The Internet site opened at the beginning of August 2003 and is currently being implemented with new data until 2006. Actually about fifteen products are presented, among which civil engineering by-products and other industrial by-products have been considered. A network of a hundred club members has also been developed. These members exchange data and documents that can be proposed on-line within the site. The club members are at present mainly French actors although some European actors have already decided to join the club members to contribute to this common knowledge.

This paper gives a general presentation of the actual available data. Then, a discussion based on a global analysis of collected data is presented. In particular, product peculiarities depending on their origin, that is, either natural materials with low characteristics, road waste or industrial waste, are examined.

Keywords: recycling-roads-product-internet-waste-

1. Introduction

LCPC (Central Laboratory for Roads and Bridges, a French public research institution) mainly used to deal with the construction of new infrastructure involving materials and structures. More recently attention has been focused on better management of the existing stock of infrastructures. The aim is to maintain and to adapt the existing structures to the evolution of requirements dealing with environment and safety. Therefore, it has obviously become important to optimise maintenance policies, to control natural risks and environmental impacts of infrastructures over their whole life cycle. Besides, recycling has to increase, especially in road pavement because of increasing care about environment and in order to meet the 2002 French legislation, which greatly limits landfill. Hence, only final waste products that is, products which cannot be recycled or reused with the available technology, will be allowed in waste disposals.

Therefore a national project began in 2002, aiming at developing a database about materials that are recyclable in road infrastructures. Hence, in order to improve recycling development, it is relevant to bring reliable information to those - owners, site engineers, construction companies and material suppliers - who contribute to

building. Environmental questions, usually considered as the most critical ones, are those for which transparency is the most necessary.

As for recycling in roads, nobody has at once the full knowledge in the field of geotechnic, pavement technology, environment, economy, and legal issues necessary for an optimal use of material resources. It is only by gathering the various specialists, with the view of favouring exchange and discussions that relevant collective work can be carried out and sustainable long term policies can emerge. Besides, road always imposed real size experiments, using road sections, testing materials or new techniques. Unfortunately, road section monitoring with time is not always possible for many years, especially if local actors change. Hence, when the topic concerns materials environmental assessment and associated impacts, which may arise either at medium or long term, such a turnover is very regrettable.

The **OFRIR** project (“Observatoire Français du Recyclage dans les Infrastructures Routières”) started on the above considerations, after about one year before getting ready. It is an internet site (<http://ofrir.lcpc.fr>) for road national actors aiming at proposing classified, summarized and validated information in order to help recycling decisions, while noticing the different obstacles, especially the geotechnical and environmental ones.

Besides, LCPC and French technical network of road public ministry, BRGM (Bureau de Recherche Géologique et Minière) and INERIS (Institut National de l’Environnement Industriel et des Risques) also significantly contributed to this project supported by METLTM/DRAST and DR (Ministère de l’Equipement, des Transports, du Logement, du Tourisme et de la Mer/Direction des Affaires Scientifiques et Techniques et Direction des routes), by MEDD/DPPR (Ministère de l’Ecologie et du Développement Durable/Direction de la Prévention des Pollutions et des Risques), by ADEME (Agence De l’Environnement et de la Maîtrise de l’Energie) and finally by SETRA (Service d’Etudes Techniques des Routes et Autoroutes).

This paper thus presents some elements about (i) the general data of the site, (ii) the data gathered to present a state of the art for fifteen products over eighteen, and (iii) the data associated with local practice either concerning products sources at the local scale or products used in road infrastructure from in-situ experiments or road works.

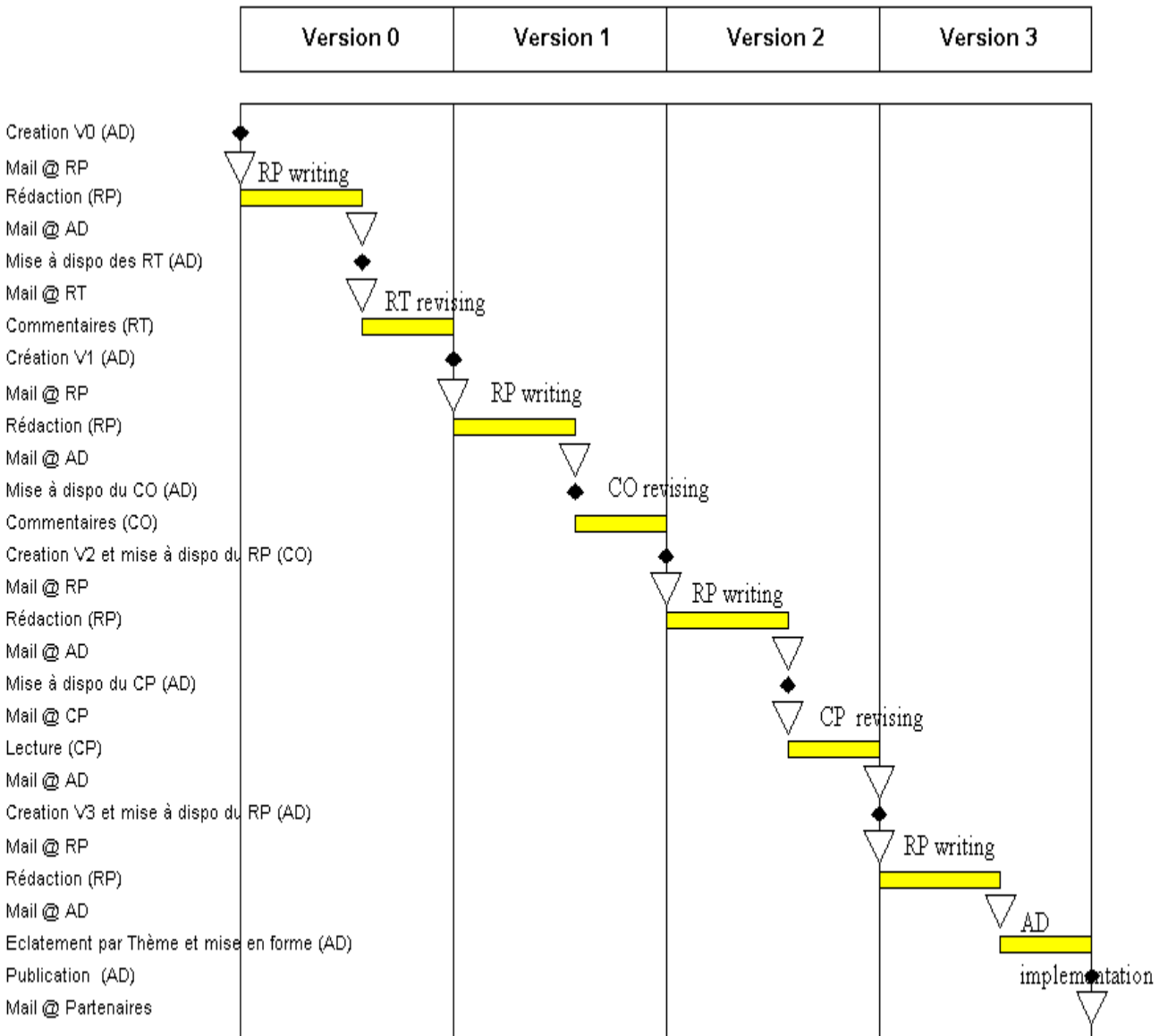
2. Presentation of the project and data implementation principles

The aim was to realise a database in the framework of an Internet site, focused on products usable in road infrastructure (SETRA and LCPC, 1998). Indeed, it is still important to give validated information to those who contribute to building in the framework of various industrial domains. Environmental questions, often found to be the most difficult ones besides economical problems, are those for which objectivity is necessary. The OFRIR site (<http://ofrir.lcpc.fr>) opened the 4th august 2003 for public connexion (anonymous). As for the private site area, only for club members (see menu connexion / charte du club on the first page), it was available since the 1st September 2003. At present LCPC is going on implementing the database with new data at last until 2006. Such an implementation implies to go on collecting data, either from literature or from new contributors registered to the OFRIR club.

The database was developed as follows. Several teams of experts were created: the group of products specialists, the group of thematic specialists and the group of local coordinators. A steering committee including the project coordinators, the site development responsible as well as the site Webmaster was also designed. Part of the work was initially devoted to create a state of the art for each product and required a very wide literature data survey. For that purpose, the local coordinators sent data to the products experts. Besides, products experts were asked to use as numerous pertinent documents as possible. Then, once the state of the art writing period started, both the thematic experts and the site coordinators successively revised the documents in order to reach a rather homogenous content from one product to the other.

Then, during a first phase, all texts giving state of the art for each product have been created, the texts being about 20 pages long. At the same time, the Internet site was developed and tested. Then a semi-automatic implementation method, including a workflow (Figure 1) for text revision process, especially realised to work with Internet tools has been developed. First of all, in order to obtain easy navigation conditions, the presentation of products state of the art has been proposed considering standard sections. This presentation has also another advantage, that is, once the text has already been fully implemented in the site, the procedure applied for its revision consists in changing only the section of interest.

Figure 1 : schematic view of the workflow process, with AD the site administrator, RP the product expert, RT the thematic experts (the whole), CO the co-ordinators, CP the steering committee, V0, V1, V2 and V3 the successive text version to be implemented.



RP : Responsable Produit
 RT : Responsable Thématique
 CO : Coordinateur de l'observatoire
 CP : Comité de Pilotage
 AD : Administrateur

The site ergonomics is such that (see figure 2) :

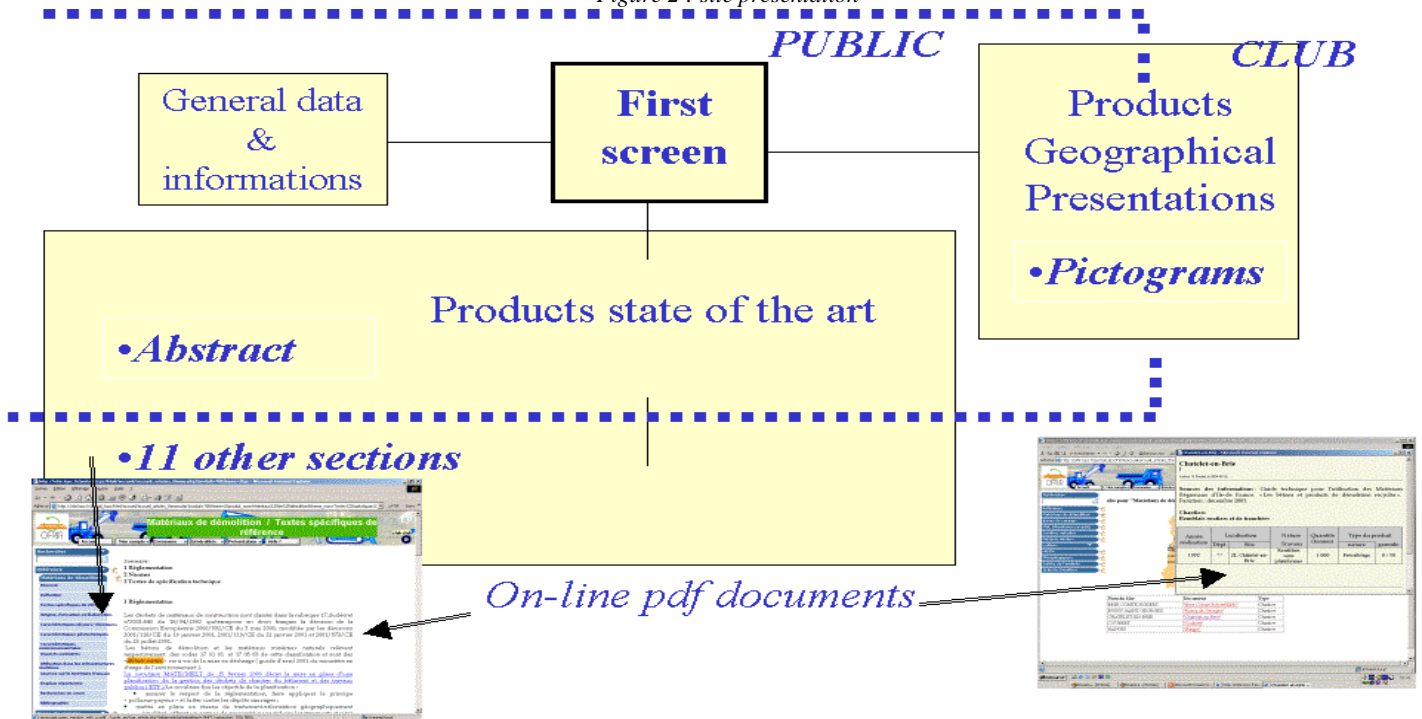
- general data and information are provided in the various fields such as juridical, waste, mechanics, environment, health and of course road construction,
- the states of the art are presented on the left screen side. Besides recycling products, there is also a state of the art called "reference". This specific state of the art focuses on natural classical materials used for roads infrastructure construction, in order to describe the standard of practice in public works, and then to remind usual rules for both materials and classical aggregates that conform to standards and specifications (SETRA and LCPC, 2000);
- the local data are attached to each product and are proposed using pictograms presented on a map of France at the administrative scale of departments.

Since the site opening, the revision has been done because of documents proposed to be on line whatever who made the proposal (any member of the club, products or thematic experts, anybody involved). Such changes arose because of changes of standards, changes of laws as it has been shown concerning aggregates and leaching characterisation. In all cases, each author who is a given product specialist, proposes a new version. Then all thematic referees revise this new version, that is:

- waste treatment expert,
- geotechnics expert,
- environment expert,
- road works expert,
- health expert,
- road upper layers expert,
- earthwork expert.

The on-line documents are to be proposed by each product expert and are then examined if necessary by thematic expert. The necessity of reviewing by expert referees of OFRIR partners in this context is mainly dependent upon data and text sources. Then, the published documents like journal publications, already revised by scientific or technical specialists did not follow any revision procedure, whereas reports including industrial reports, research reports or any other report have been submitted to the review cycle.

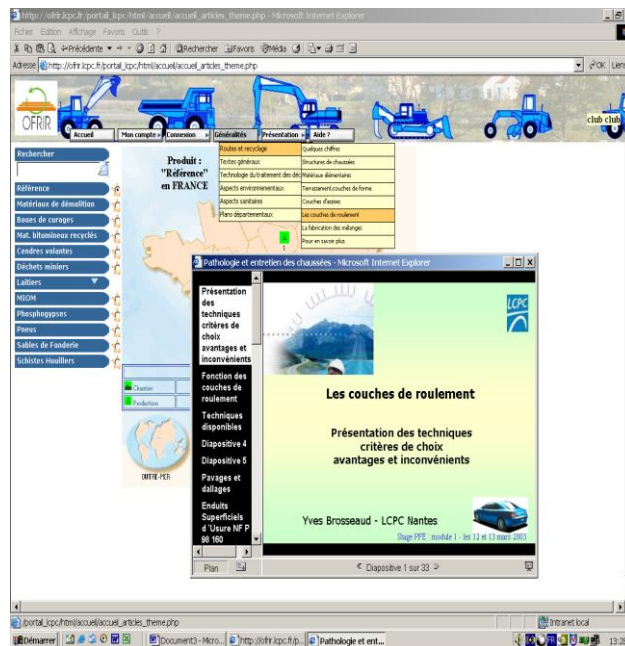
Figure 2 : site presentation



3. OFRIR available data

At the beginning of the project the purpose of the writing step of the site was to prepare state of the art for different products suitable for road infrastructure use. At the same time, general features have been collected to explain rules and practice in the various fields involved for materials recycling in roads (figure 3). The total number of products to consider was eighteen, at first. The list of already available products is as follows (French name): Reference (Référence), Reclaimed concrete (matériaux de démolition), Sludge (boues de curage), Reclaimed Asphalt Pavement/RAP (matériaux bitumineux recyclés), Coal fly ashes (cendres volantes), Mining wastes (déchets miniers), Blast furnace slags (laitiers de haut-fourneaux), Steel slags (laitiers d'aciérie), Nonferrous slags (laitiers non ferreux), MSWI bottom ash (MIOM), Phosphogypsum (Phosphogypses), Tires (pneus), Foundry sands (sables de fonderie), Shale (schistes).

Figure 3 : site general data.



3.1 Products state of the art and Local data

It is well known that damage phenomena under traffic cyclic loading depend upon material intrinsic mechanical properties. Therefore, once traffic is defined as the main parameter for road design, different initial thickness layers have to be used for road construction. The deepest layers are designed to remain mechanically stable during the infrastructure life and then have permanent thickness, while the upper layers are regularly removed and rebuilt with possible thickness changes, during roads life cycle. Maintenance operations, linked to traffic amplitude, are usually defined by guidelines or standards. Anyway, to obtain as homogeneous data as possible, for each product, the state of the art has been written considering data in relation with the points as follows.

- product definition, in order to precisely identify the industry from which it comes from, laying from public works to other industrial sectors such as steel industry for instance;
- specific literature texts in the field such as, laws, circulars standards and technical guides;
- products origin and the way it was processed to fulfil the required properties for road use;
- physico-chemical characteristics of the products components, including elementary compounds and mineralogical composition, such details allows to be aware of possible leaching elements, as well as possible swelling ability, both able to change macroscopic environmental and mechanical performances;

- Environmental characteristics studied through dust sampling (airborne emissions) or laboratory leaching tests on the product after elaboration, or compacted; environmental road scale experiments to characterise the infrastructure aqueous release,
- geotechnical properties, including the main resources characteristics depending upon the kind of use to be considered (aggregates, soils or binders),
- health aspects, providing if any a piece of those information about risks and dangers, for instance linked to asbestos or tar containing products,
- use in road construction, which details the type of use according to the classification (wearing course, binding course...).

Besides, local supply on the French territory, gives an overview of the available produced masses but it is only reported in some cases. Finally, in France, some of the products have already been used since 25 years, whereas some others have not been extensively recycled or reused.

As a first analysis of the collected data, it is obvious that the recent changes are mainly driven by the European standards changes that are for aggregates and leaching characterisation. Finally, among secondary raw materials, some of them (i.e. MSWI bottom ash) have been used as road sub-base and sub-grade for several decades. However road performances back analysis has not been systematically performed because there was no legal obligation for it. Hence, such use was due to either a lack of classical local materials, or with the objective of decreasing ultimate waste. Classical tests have thus been performed (Los Angeles, Micro-Deval, bearing capacity...) to compare those products properties to the usually required properties for natural materials according to standards, and to classify them (AFNOR, 1992). Hence it seemed interesting to propose, besides the state of the art for each a local presentation of the products sources and roadwork to allow data gathering for a wide range of places.

The road structure code of practice is still going on changing in order to add missing guidelines for by-products use to classical constitutive raw materials.

3.2 Club life and site implementation

Table 1 gives the number of references already available on-line for the club members both in the state of the art area and in the geographical presentation area either for production or for local road works experiments. As for the club members, among 113 members it is composed of 81 external members who do not belong to the administration financing the project. European members who have signed the “charte” of the club reach 8%. In the future other external members are expected to provide data, the principle for registration being to propose data for on-line use.

Table 1 : some indicators on-line documents and club life.

Product	State of the art	Local production	Local road works
Reference (Référence)	8	Not required	Not required
Reclaimed concrete (matériaux de démolition)	3	0	12
Sludge (boues de curage)	14	0	0
RAP (matériaux bitumineux recyclés)	13	0	0
Coal fly ashes (cendres volantes)	1	0	0
Mining wastes (déchets miniers)	11	0	0
Blast furnace slag (laitiers de haut-fourneaux)	3	4	0
Steel slag (laitiers d'aciérie)	9	0	0
Nonferrous slag (laitiers non ferreux)	6	0	0
MSWI bottom ash (MIOM)	15	59	16
Phosphogypsum (Phosphogypses)	38	1	0
Tires (pneus)		0	0
Foundry sands (sables de fonderie)	3	14	0
Shale (schistes)	8	21	0
TOTAL	132	99	28

4. Conclusion

At the beginning of the project, a network of various experts was created to write state of the art of products usable in road infrastructures, from materials definition, chemical and mineralogical characteristics, environmental properties, geotechnical properties, health aspects, use specifications and practical knowledge. Local resource availability as well as road works data is the part of the site to concentrate on for future implementation.

During the OFRIR Internet site implementation period, this project aimed at gathering all motivated people, through the exchange data club. It will be a precious tool for literature surveying and for research results diffusion in the field of recycling. Transversal good governance, gathering all actors into a common consensus, has been expected from this project. Hence, the results of this collective work lead to contribute to sustainable development in the framework of roads infrastructure.

Acknowledgments

The authors thank Michel BERCOVICI and Christian JOBIC of LCPC –Service informatique for the site development and installation as well as Laurence LUMIERE of LCPC, Section Développement Durable for site implementation.

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