GEAR PROJECT - AN AMBITIOUS PARTICIPATIVE PROJECT

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ABSTRACT

The project for the elaboration of the "Spanish Guide on Recycled Aggregates" (GEAR Project) is the major project of research in the sector of recycling of RCD and in the sector of construction materials nowadays in Spain.

Subsidized by the Ministerio de Medio Ambiente, y Medio Rural y Marino, of Gobierno de España, the GEAR Project is coordinated by the GERD (Spanish Association of the Recycling Industry) and possesses the direct participation of 24 recycling companies, three technological centers (AIDICO, AITEMIN and INTROMAC) and four universities (Universitat Politècnica de Catalunya, Universidad Politécnica de Valencia, Universidad de La Coruña y Universidad de Oviedo).

The project presents, for the first time in Spain, an exhaustive, systematic and complete study of the recycled aggregate production. It contemplates diverse phases of work for the duration of two years. The work is directed to the analysis of the recycled products made in Spain and the analysis of its behaviors "in situ", taking advantage of the existing practical experience.

Its principal aim is to normalize the recycled aggregate and its uses, by guaranteeing its quality and environmental safety. As a result, the GEAR Project tries to do an offer of values and tests to suggest a regulation for the Spanish market of recycled products, contributing to the specific and definitive recognition of these aggregates as materials of construction.

Keywords: recycled aggregate, CDW, recycling, normative, quality.

1 INTRODUCTION

The project for the elaboration of the "Spanish Guide on Recycled Aggregates" (GEAR Project) is a technical and scientific project, subsidized by the Ministerio de Medio Ambiente, y Medio Rural y Marino, of Gobierno de España, within the framework of the National Plan of Scientific Research, Development and Technological Innovation.

Coordinated by the GERD (Spanish Association of the Recycling Industry), the GEAR Project considers the participation of all agents of the construction sector, implicated with the CDW recycling market. The project has the direct involvement of 24 CDW recycling companies of Spain, 4 universities and 3 technological centers.

The main goal of the project is the elaboration of the “Spanish Guide on Recycled Aggregates”. This guidance will be, within the framework of this project, a limited set of
specific technical prescription proposals referring to main applications of CDW recycled aggregate. These prescriptions' function is to propose detailed specifications for the use of the recycled aggregate in recommended applications and to describe the conditions of its application and quality control.

To reach this general aim, the project contemplates several phases to be developed over 30 months. Works will be carried out making good use of all the hands-on experience of recycled aggregate applications in Spain and generating new knowledge derived from the complementary experimentation that will be done during the project. The project considers the Spanish technical specifications, as well as the other countries’ technical specifications.

As a consequence, the project expects to clarify uncertainties about the technical criteria of recycled aggregate use in the civil construction in Spain, in such a way that the use of the recycled products will be carried out in a more regimented way and insurance.

Definitely, it is the first step to create commercialization and verification instruments for recycled aggregate in Spain.

2 JUSTIFICATION OF THE PROJECT

The CDW constitute one of the more important waste residue flows of Europe, for its high rate per capita of production and for the technical and economic feasibility of its recycling.

The CDW recycling is currently a more and more stimulated activity for EU countries. European and Japanese experiences prove that the existing knowledge gives enough technological bases for the development of this industry.

In Spain, the Environment Ministry has published in the 2008 the Integrated National Plan of Residues (PNIR) 2008-2015. The primary goal of the Plan for the CDW residues is the controlled collect, correct environmental management, recycling and reuse of these residues. The Plan’s aim is to decrease near to 60% of the CDW elimination and to recycle a minimum of 25% of the CDW produced for the year 2012 [1].

According to the “Statistics per Year of the Sector Prices and Fares” elaborated each year by the GERD, the CDW production amount was 35 million tons in the year 2007. Approximately 15% of these waste residues were recycled and transformed in secondary materials for the construction.

As a recycled aggregate application study, it is relevant to mention the many research works developed by CEDEX and UPC for the application of recycled aggregates attendants for ministerial organisms and the technical support work fulfilled in 2005 by the GERD (Study on the Use of Recycled Aggregate in the Construction of Roads) for the CEDEX (Public Works Studies and Experimentation Center) of the Development Ministry and of the Environment Ministry.

However, despite the fact that Spain is developing important actions in the field of the CDW, it is necessary to do an ampler action to define specific technical prescriptions and criteria for the regulation and guidance of these materials' production for its currents general applications.
Regarding this, it is important to highlight the following documents:

General Technical Prescription for Road and Bridge Works (PG-3), Part 5th: firms and pavements, that presents the possibility of the recycled aggregate use as aggregates for heavy traffic categories T2 to T4, if they fulfill demanded specific technical prescriptions, and declared it origin [2];

Structural concrete's norm – EHE, which introduces the possibility of the recycled aggregate use in concrete with some restrictions [3].

The GEAR Project means to present for the first time in Spain an exhaustive, systematic and complete study of the recycled aggregate production and its use as construction materials. The project expects to:

Clarify all currently uncertainties regard to technical criteria of use the recycled aggregate in the civil construction;

Enable that the CDW recycling is carried out on a more regimented and directed way to the real and actual applications that are given for the recycled aggregate in Spain.

The project considers the current regulations in Spain referring to the use of conventional and recycled aggregate, as well as the good practices fulfilled in the sector (practical experience of CDW recycled aggregate use in Spain), and also the accepted technical specifications of other countries about CDW recycled aggregate. For that, this study adds norms and parameters currently in discussion in the national and international organisms of normalization.

The recent announcement of the European Framework Directive of Waste Residues 2008/98, will be an essential support to achieve the objectives posed by the project, due to its definite contribution to clarify basic concepts for recycling and elimination and to set the “end of the residue” criteria.

3 PROJECT PARTICIPANTS

The GEAR Project has the direct involvement of 24 CDW recycling companies from all over Spain, 4 universities and 3 technologic centers, in addition to the GERD, as the coordinating entity. The figure 1 points out the participating institutions and companies of the project and its interaction flows.

The GERD is the association that, since 1994, groups and represents the interests of the Spanish companies dedicated to the management and recycling of rubble and garbage dumps.

Currently, the GEAR Project is the main developed action carried out by the GERD in order to open the path towards the definite recognition of CDW recycled aggregate as a construction material and to create commercialization and quality control instruments for these materials in Spain.

The GERD, represented by it director, Alfons Güell, assumes the General Coordination of the project participants and the task works that will be carried out. The Scientific Coordination of the project, in charge of Prof. Dr. Enric Vázquez, coordinates all scientific studies that have been developed over the project in the Technology Centers and Universities.
participants. The Technical Coordination, in charge of Civil Eng. Elaine Varela, manages all technical activities that are developed in the participating recycling plants.

All recycling companies that participate on the project are members of the GERD. These companies mostly possess recycling plants with relevant seniority and experience in recycled aggregate production and represent the real-life situation of the existing plants in Spain and Europe.

The Technology Centers and Universities that participate in the project are research centers with a long experience in studies of building materials and, more specifically, recycled materials. They contribute, in addition to its knowledge, with facilities and equipments for the production of the proposed studies and with the recycling sector overview in its community respect to it specifies, difficulties and situation. They are as follows:

- Instituto Tecnológico de la Construcción - AIDICO
- Asociación para la Investigación y Desarrollo Industrial de los Recursos Naturales - AITEMIN
- Instituto Tecnológico de Rocos Ornamentales y Materiales de Construcción - INTROMAC
- Universidad de A Coruña
- Universidad de Oviedo - UNIOVI
- Universitat Politècnica de Catalunya - UPC
- Universidad Politècnica de Valencia – UPV

The direct involvement of the above-mentioned companies and organizations in the elaboration of the GEAR aims to:
- Guarantee that the produced document is in reality implementable and demanded by all wrapped sectors;
- Encourage the recycled aggregate producers and consumer sectors to fulfill the quality requirements offered by the GEAR;
- Facilitate the promotion of the GEAR between the wrapped sectors.

4 TASKS DESCRIPTION

Coordination:

The Coordination phase takes place over the entire Project. The activities of this phase covers the planning and coordination works; administrative providences; work meetings, management of materials and equipments provision; works and reports of quality control; and other management and information work tasks of which each participant is in charge within its specific area.

Computer Program Database:

The computer program database of the “Spanish Guide of Recycled Aggregate” is the main tool of the project in order to file and treat technically and statistically all information collected and created by the project about recycled aggregate production and its application. This tool is going to allow the statistical study of the quantitative and qualitative results obtained by the universities and technological centers.
This phase covers all the activities of creation and maintenance of the database and the software programs.

**Analysis of the current recycling situation in Spain**

The activities of this phase cover the technical characterization of the recycled products currently marketed in the Spanish recycling plants, as well as the classification of the fulfilled works done with these materials. The objective of this phase is to analyze, in a systematic and scientific way, the hands-on experience of manufacture and use of the recycled materials in Spain, with the aim of determining the current situation of CDW recycled aggregate’s technical and environmental quality.

**Induced Complementary investigation**

The induced complementary Investigation consists of the following works:

Specific scientific studies to complete the technical analysis of recycled aggregate and its possible applications in Spain. The application fields that are studied are: roller compacted concretes, no structural concretes, pre fabricated elements, fillings / drainages, aggregates for roads bases and gravel and soil cement.

Environmental impact analysis of recycled aggregate produced in Spain, in order to establish environmental quality control methods of recycled aggregates by leaching and to indicate suitable environmental indicators to these materials according to the Spanish reality.

**Experimental application of the knowledge**

In this phase, the project will carry out the experimental “in situ” work, to analyze the behavior of recycled aggregate and to check the feasibility of it use; and also to test the suitability of the proposed control quality and environmental indicators.

**Specific Technical prescription elaboration**

In this phase the set of specific prescription proposals of the “Spanish Guide of Aggregate Recycled” will be elaborated with the share of all participants and collaborators of the project, in different levels of action.

**GEAR Project Spreading**

The spreading phase is essential to contribute to the achievement of the diffusion of the GEAR and to promote the real application of the offered specifications. This activity will be carried out over the entire project, with the disclosure of the project's partial results, and also in the end, with the disclosure of the GEAR:

- The project results are spreading through the project website, which is gradually updated with information about the work, through the Techniques Disclosure Conferences that occurred during the project, and through the technical articles published in technical journals of the sector.
• The Guide Spreading will be the last project activity and consists of publishing and distributing the GEAR in CD and book format. Techniques Disclosure Conferences will be organized in Professional Associations and/or Commerce Chambers, with the collaboration and participation of public and private companies and authorities.

The Figure 1 presents the flow chart of the project activities.

5 COLLaborators Networks

The project have the premise that the adequate elaboration of a guidance for recycled aggregate use of a country should consider the working interest of the maximum of agents of the main wrapped sectors: the sector of the recycling, in charge of producing the material; the construction sector, in charge of its use; and the scientific sector, in charge of analyzing it.

Also, the massive incorporation of agents of all sectors related to the market of the recycled aggregate in the elaboration of the GEAR will contribute to the diffusion and application of the GEAR and increase of the use of recycled aggregate.

Regarding this, and considering the great interest of these sectors in Spain, the GEAR Project is open to all recycling companies, universities, research centers, building companies and public administrations that wish to collaborate in its elaboration. The Project has intended the creation and maintenance the following networks of collaborators:

• Recycling Companies (RC) Collaborators Network: created in the Phase 1 of the project, it is currently formed by 30 CDW recycling companies that collaborate with the project through the technical data exchange and the provision of recycled aggregate samples. They represent jointly with the CDW participant recycling companies, the producer sector of recycled aggregate, and therefore will present its impressions, expectations, doubts and
worries regarding its experiences in the production and commercialization of recycled aggregate.

- **Technologic Centers / Universities (TC/U) Collaborators Network**: this network should be consolidated in the Phase 2 of the project. Currently this Network is formed by a university. They represent, jointly with the participant Technology Centers and Universities, the scientific sector. They will contribute to the knowledge with regard to its experiences in the study and analysis of recycled aggregate and will exchange information with the scientific staff of the project through projects in agreement.

- **Construction Companies / Public Administrations (CC/PA) Collaborators Network**: This network will be formed during the phase of Experimental Application. Institutions and companies that will participate on this network will carry out recycled aggregate works controlled by the GEAR Project. They will represent the civil construction sector and, therefore, will present its impressions, expectations, doubts and worries with regard to its experiences in the use of recycled aggregate in its works. The creation of this network will allow reaching agreements with professional associations and contracting public administration and organisms for the use and confirmation of the offered prescriptions of the GEAR.

Finally, in the Phase 5 of the project, all participants and collaborators of the project will take part, in different levels of action, on the **General Network of the Project**, that will be in charge of the elaboration of the GEAR technical prescriptions.

The Figure 2 presents the structure of the Project Collaborators Networks and points out schematically the diffusion increase of the GEAR by its creation.

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*Figure 2. GEAR Project Structure Network.*
6 ORGANIZATIONAL STRUCTURE AND INFORMATION LEVELS

The Figure 3 points out the general flow chart of the participants and collaborators of the GEAR Project. The figure indicates the levels of actuation and information access of each participant and collaborator of the project.

Because of the great amount of dates and staff, the information exchange is carried out through a program of navigation that manages a selective and hierarchized access to the database of the project:

• **Information Level 1**: The coordination staff has access to all documents of the project's database. This staff is in charge of managing the production, revising and approving of all project reports.

• **Information Level 2**: The scientific staff has access to all database documents of the project related to its application field and region of action and to all internal reports of the ongoing project. This staff is in charge of carrying out and revising reports.

• **Information Level 3**: The technical staff has access to all internal reports of the project and all technical analysis generated from its own information. It participates on the project's reports revision.

• **Information Level 4**: The collaborative staff has access to all public reports of the project and all technical analysis generated from its own information. It has the possibility of doing suggestions in the project reports.

![Figure 3. Organizational structure and information levels of GEAR Project staff.](image-url)
7 EXPECTED RESULTS

The GEAR Project expects to:

- To prove, with technical and scientific severity, the recycled aggregate characteristics and possibilities of use, based on specific regulations on this regard.
- To consolidate the recycling and construction sector in Spain and the use of a practical and implementable guide, that:
  - defines and relates technical and environmental quality control indicators of recycled aggregate.
  - warrants the constant improvement of technical and environmental outcomes of these two sectors.
- To sensitize the recycling companies to normalize / standardize its products and production ways.
- To decrease the prejudice of the recycled materials' use in the civil construction sector.
- To reduce in a significant way the environmental impact derived from the companies' activity of civil construction sector.
- To spread the model in the territorial field object of the project as well as in other European regions.

The “Spanish Guide of Recycled Aggregate” that is posed in this project is an essential document, from which the recycling sector will be able to generate:

- a legal technical regulations proposal to be presented to the Spanish public organisms to be used as a key reference in the production, commercialization and use of CDW recycled aggregate in private and public works;
- a database, that should be increased with new applications and experience to consider the market changes of these new building materials.
- a technical, scientific and environmental knowledge base that will allow further research and development of new applications and materials with more added value.

The “Spanish Guide of Recycled Aggregate” will allow the characterization and validation of recycled aggregate by guaranteeing its quality. It will make possible the stable market development. Likewise, it will minimize the environmental impact produced by the CDW’s uncontrolled elimination and consolidate and improve the recycling market and the commercialization of recycled aggregate thought the quality implementation in these materials and the employment increase in the construction sector.

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REFERENCES

