MANAGEMENT OF WASTE GENERATED BY A GROUP OF CONCRETE PLANTS.

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ABSTRACT

This paper explains how to manage the waste generated by a group of concrete plants. These plants are located within a radius of 1000 metres in an environmentally protected area, which is situated on the outskirts of Oviedo (Spain).

These concrete plants produce around 45000 tons of waste every year. This waste comes from the specimens used in the test for quality control of manufactured products. It is also obtained after washing trucks mixers and from concrete returned to the plant because it does not meet the requirements.

Until 2001 the waste was stored in a common accumulation area for all concrete plants. The waste was left here a considerable time before being moved to a landfill. The transport and reception of wastes generated high costs. In 2001, when the First National Plan for Waste came into effect in Spain, the common accumulation areas were forbidden.

Concrete plants decided to join forces and set up a recycling plant for construction waste. It is located near the area. The products obtained are used as recycled aggregates for manufacturing backfill concrete, non-structural precast concrete and structural concrete.

1. INTRODUCTION

This project is the result of the hopes and dreams of a group of entrepreneurs from Asturias, Spain. They work in the ready-mix concrete and aggregates extracting industry and believe that the business activity doesn’t involve only the short-term profit. On the contrary, without neglecting this first aspect, which is otherwise the raison d’être of the business activity, they also give relevance to the sustainable development over time and to the promotion of a company social responsibility culture and a social and environmental mindset in their business relations and operations [1,2].

We have committed ourselves, as a company, to maintaining this responsible behaviour with Society by trying to reconcile our interests as entrepreneurs with Society’s values and demands.
Our intention, in line -concerning these issues- with the policies of both the Autonomous and National Governments and the European directives, is to commit ourselves, as business entities, to analysing in which way our activity has an impact on the environmental, economic and social dimensions of our Society and channelling this impact in order to generate equitable and sustainable benefits and cause the minimum possible prejudice to all the involved parts.

Our first contribution to this positioning, which is well in tune with our main objective, has been the foundation of the association “La Belonga Impulso Industrial Alternativo”. This entity, which has been conceived as a non-profit organization, has “a technological nature and a clear environmental vocation” in accordance with its bylaws. Among the scheduled goals, it is clearly specified that of “promoting –in the association’s territorial scope (township of La Belonga and neighbouring rural areas of Llagú and Latores, located in the council town of Oviedo)- an environment-friendly industrial development and seizing, if possible, new business opportunities”.

2. OBJECTIVES

1.- Add value to materials that are currently being dumped [3].

2.- Minimize the environmental impact of these waste materials by using them –once recycled- in new production processes [3].

3.- Vitalize the industrial fabric of our sphere of action and generate economic synergies to foster the creation of new job positions.

3. LOCATION

The Principality of Asturias (Figure 1) is located on the Northern coast of Spain, (Figure 2) covering an area of 10.600 km2. The total population amounts to 1.040.000 inhabitants, 75% of them live in the centre area, where the regional capital, Oviedo, is placed. Located 4 km from the capital, El Caleyo is a natural area highly representative of the autochthonous flora of Asturias. It is placed at only 4 minutes from the centre of Oviedo (the recycling plant is installed in a plot of 9000 m2 corresponding to the hollow left by the former quarry). The abovementioned features confer a significant industrial relevance to this place. The industrial history of this area began 30 years ago. Over these years, different industrial operations have coexisted in the area, all of them related to the primary (extraction industry) and the processing industries. The main obtained raw materials have been those extracted by the primary industry, together with the typical dairies of the Asturias region, the horreos1 for grain storage, the balagares y varas de hierba2 - traditional procedures for hay drying- and, of course, the typical Holstein-like huts of the Asturias region.

1 Translator’s note: An horreo is a typical stone or wood construction for grain storage, which is mainly used in the Spanish regions of Asturias and Galicia.
2 Translator’s note: Balagar and Vara de hierba are two different terms used in Asturias to refer to small piles of dry hay or straw used to feed animals.
4. INVESTMENTS AND FINANCING

This organization complies strictly with the purposes established in its bylaws and, in this regard, this project has been co-financed by the Ministry of Science and Technology and the Ministry of Environment, as well as by related companies, through non-refundable credits and credits at zero interest, together with a contribution of 1.500.000€ privately granted by the companies:

- Lafarge Aridos y Hormigones, S.A.U. Concrete plant/ Aggregates plant.
- Hormigones El Caleyo, S.A. Concrete plant
- Hormigones Áviles-Oviedo, S.A. Concrete plant
- Canteras La Belonga, S.A. Aggregates plant.
- El Caleyo Derivados del Cemento, S.A. Concrete prefabricated products

Based on the above premises, which were aimed at determining the aforementioned recycling actions, equipments and processes, it became clear that the solution to the prevailing problem had to be ambitious and, therefore, a high economic investment was required. The goal - which has already been achieved- was to recycle all the by-products generated by the companies belonging to the Association and other companies of the ready-mix concrete
industry that operate in the Asturias region and neighbouring areas with a view to their subsequent commercial exploitation. In order to carry out this operation, it was necessary to set up a crushing and classifying plant, to where all the surplus concrete of the associated companies is transported once the setting time has elapsed. In these conditions, the by-products can be completely recovered and subsequently co-processed. The location of the associated concrete plants and the recycling plant can be observed in the figure 3.

Figure 3. Concrete plants and recycling plant.

5. CO-PROCESSING OF WASTE MATERIALS

The co-processing of waste materials begins at the concrete manufacturing plant, with the concrete that is sent back to the plant by work centres due to one of the following reasons:

1.- An excessive volume of concrete that cannot be applied to the work.
2.- Concrete tanks that cannot be used due to problems caused by formworks, steel frameworks, etc.
3.- Concrete tanks that, when delivered on site, didn’t meet specific plasticity features or other parameters recorded in the list of the product requirements.

5.1. Operating procedure at the concrete plant.

When the concrete is sent back to the plant for one of the aforementioned reasons, the mixer truck driver informs the concrete plant manager so that this person can prepare the necessary space for the returned concrete amount. With the purpose of developing a control register, the truck is weighed before the unloading operations. The plants must have the minimum required unloading and storage infrastructures (drying beds and stockpiles).
The unloading process is carried out in small amounts -between 80 and 100 l of concrete-, which are poured in a cake-shaped pile with a diameter of c.80 cm and a height of 15 cm (Figure 4).

Figure 4. Unloading process.

The following day, once the concrete is set and hardened, the material is moved with a loading shovel in order to re-pile it and make room for new entries in the drying bed. After completing this process, the concrete amount that can be placed into an articulated lorry (25 t) is loaded and sent to the recycling plant (Figure 5).

Figure 5. Waste concrete.
5.2. Operating procedure in the recycling plant

Once the concrete truck arrives to the recycling plant, a visual monitoring process is performed and the materials are weighed using a scale, with capacity for 60 t, in order to control the materials at their entry to the plant.

When the materials are placed on the scale, a delivery note showing the entry date and time, the material involved, the recipient, the origin, the haulier, the operator, the weight – both gross and net- and the truck tare is issued, together with the approval document for the driver:

It is necessary to make 4 copies of the delivery note: one for the monitoring process in the processing plant, another one for the administrative control –the invoice for the recipient is made on this copy basis-, a third copy for the recipient so that this person can control the delivered materials and the last one for the driver.

Once the weighing process has been carried out, the material is tilted either directly into the receiving hopper or on a recycling pile. Materials with a size higher than the inlet tip of the crusher are set aside and broken using a hydraulic hammer.

This is a chain system, and, therefore, the size calibration process begins in the receiving hopper leading to a pre-screening feeder.

Currently, there are two processing lines according to the attached sketch.

Line 1: This first line is aimed at new materials brought into the plant with humidity over 15%. It consists of a hopper equipped with a grid of 100mm. The fine materials provide the humidity. The materials are led to a pre-screen equipped with diverging rods that separates those materials higher than 40 mm. The materials over this size return to the processing line No.2 and those under the size are moved by a conveyor belt to a ROLLIER screen with an elastic mesh, which classifies the material into three sizes, 0-10 mm, 10-25 mm and 25-40 mm, and discharges the material directly into the stockpiles.

Line 2: This second line is aimed at materials higher than 100 mm without apparent humidity. This line consists of one hopper that leads to a Muller jaw crusher [4]. The resulting materials are moved by a conveyor belt to a Triman rod mill, which crushes and breaks them into a maximum size of 40 mm. The materials are afterwards moved by another conveyor belt to an Extremadura 2000 screen with a metallic mesh, which further classifies the materials into three sizes, 0/10 mm, 10/25 mm and 25/40 mm, and discharges them, by means of a ribbed conveyor belt, into the stockpiles. At the same time, this production line receives the rejected materials over 40 mm coming from the fine line or line 1, which are further moved by a conveyor belt to the Triman grinding mill. The system is equipped with a by-pass that allows to discharge the materials -when dry- directly to the mill or to the Extremadura screen with a metallic mesh if they have an excess of humidity.

Both production lines are equipped with a belt electromagnet, manufactured by Triman, which prevents ferric products from being deposited in the final stockpile.

The 25/40 mm recycled aggregates, one of the three resulting products, are fed again in the grinding system and go through the production line 2 once more.

The 10/25 mm recycled aggregates -considered a finished product- are stored and sold in the market as artificial graded aggregates (ZA25), which are mainly used as backfill material for road sub-bases.
The 0/10 mm recycled aggregates are stored and sold in the market as sand. They are mainly used for prefabricated concrete products, such as curbs and flooring blocks, as well as for producing low strength concretes.

In the figure 6 a flow sheet of the plant can be observed.

The commercialization process of these products is similar to the entry at the plant: a truck is loaded using a front loader owned by the crushing plant. Afterwards, it is weighed using a scale and a delivery note –similar to the entry delivery note– is issued, together with four copies for the material control and invoicing processes.

![Flowsheet of the plant](image.png)

**Figure 6. Flowsheet of the plant.**

### 6. PRICES

The entry materials pending to be processed, which come from concrete plants, have a fixed price of 3,50 € per ton, providing that they meet the required shape, size, humidity and that they are free of wood, metal, land, plastic.

- Aggregates 10-25 mm in plant: 3,00 €/tn.
- Aggregates 0-10 mm in plant: 3,00 €/tn.

### 7. COMMERCIAL POLICY

In the new Spanish Code for Structural Concrete [5], there are some recommendations concerning the use of recycled aggregates, which means that the prevailing vacuum of standards related to this issue has been filled. Nevertheless, new specifications for particular
cases in which recycled aggregates are used are currently being developed to avoid the suspicion around the behaviour of these materials caused by ignorance. It’s a proven fact, indeed, that the use of recycled aggregates for both structural and non-structural concrete has clear peculiarities with respect to traditional concrete.

Although the recommendations set forth in the new Spanish Code for Structural Concrete [5] have left the door for the use of recycled aggregates in concrete open, we believe there is still a pressing need for conducting experimental researches that could be used as the scientific basis required to develop criteria and standards. It is also necessary to implement procedures of use that made possible to recycle these waste materials with enough technical guarantees, so that they could be systematically used, not only for the traditional applications, but also in the manufacturing of structural or resistant concrete.

The undertaken technical and commercial actions are aimed at:

1.- Developing Standards, along with engineering and architectural studies, in order to integrate these products in projects.

2.- Cooperating with the State, Autonomous and Local Public Authorities in order to make compulsory the use of recycled aggregates in public works.

3.- Promoting the consumption of these products in Civil Engineering works where the price is similar.

8. COSTS AND RESULTS 2007-2008

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<td>800</td>
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Taxes. | 0,27 | 8.200 | 0,16 | 8.800 
Telephone. | 0,05 | 1.350 | 0,03 | 1.760 
Workwear. | 0,02 | 680 | 0,01 | 725 
Overhead expenses. | 1,68 | 50.150 | 0,96 | 52.500 
**Total cost** | 6,48 | 196.925 | 5,54 | 303.463 

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<td><strong>NET PROFIT</strong></td>
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### 9. TECHNOLOGICAL PARTNER

In order to develop these actions, the Construction Engineering Department of the University of Oviedo is cooperating with us in this project as a participating institution. As a result of this contribution, the department is going to focus on one of its lines of research.

The researching team, which consists of company’s employees and university’s members, will have the opportunity of transferring to the market the investigations carried out over the project, thus conferring them a national dimension. This circumstance will benefit our region and contribute definitively to improve the technological level of our research centres.

### 10. ADMINISTRATIVE LICENCES

As of 14/02/2005, the Environment, Urban Planning and Infrastructure Department of the Regional Government of Asturias decided to grant a licence for Harmless Waste Treatment to our crushing and classification plant so that the concretes of La Belonga Impulso Industrial Alternativo could be co-processed.

The waste materials to be co-processed shall be only concrete waste materials, according to the code LER 17010, coming from concrete manufacturing plants.

### 11. CONCLUSIONS

Promote alliances between competitors in the industry of concrete prepared with clear common objectives within the framework of sustainable development.

Minorities the environmental impact that produces ready-mixed concrete industry in rural areas with special connotation landscaping.

Add value to waste with the minimum investment to be included in new processes of production through the assembly of crushing and sorting plants.

Encourage the creation of new jobs by the completion of the foundations of the alliance, reinvesting all profits in environmental and social projects within the environment.

Search for sustainable sensitivity in engineering and architecture projects where the central administration, regional and local acts as promoters of the works.
Partnerships with universities by providing experimental research teams getting a scientific basis and necessary to the development of rules to be transferred to the markets.

12. REFERENCES


