

DECONSTRUCTION CASE STUDY IN SOUTHERN ITALY: ECONOMIC AND ENVIRONMENTAL ASSESSMENT

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ABSTRACT

The paper will analyse how context affects the real possibilities of building materials' reuse and recycling. A deconstruction Case Study in Southern Italy of some big residential buildings gives the opportunity to verify the deconstruction thesis in a real context, to study alternative scenarios to assess the most advantageous one in economic and environmental terms, and to define the profiles of every scenario.

The scenarios' definitions will take into account alternative dismantling techniques and the possibilities of managing C&D materials in relation to the operators and the presence of landfills, surface quarries, and recycling centres in the territory.

KEYWORDS: Recycling; Reuse; Unauthorised Buildings

INTRODUCTION

The ideas on building materials' recycling with appropriate techniques for selective and controlled demolition can be verified in relation to their real applicability only when we face real case studies. The economic, social, and environmental characteristics of the context can significantly influence the technical-economic feasibility of an intervention, based on the CDW materials' recycling.

At the macro-context level, the national laws and the different awarenesses of environmental issues influence the possibility to manage and recover CDW. There is a big difference of opinion on CDW recycling in different countries of the EU. The main aspects regarding these differences are natural resources, transport distances, economic and technologic situation, and population density [1].

Moreover, the real feasibility requires a micro-context assessment, due to the existence of regional or local laws and specific context characteristics. For example, for the inert debris from CD, we have to concentrate our analysis within a radius of few kilometres [2], that is about 30 km, in relation to transport costs and inert debris value.

The economic definition of an intervention aimed to recycle and reuse materials/components can be based on the following evaluations:

- costs of different possible demolitions (controlled or selective demolition, deconstruction, cherry-picking of materials);
- costs for transport of CDW;
- waste disposal fees and waste treatment centres' fees;
- eco-taxes, e.g. in Italy there is a different eco-tax in each region;
- costs for treatment of CDW in the construction site;
- incomes from the reuse of materials/components (salvage value).

All these costs depend on the context characteristics, such as the presence of local qualified companies specialised in controlled and selective demolition and appropriately equipped (laser systems, special diamond blades, and water-demolition techniques, etc.).

The deconstruction of a whole building or of its parts is more labor-intensive than a mechanical demolition [3] in terms of working hours, specific skills, and safety measures for workers. That causes about a 20% increase in costs (according to Italian cases studies), compared to traditional demolition. These costs have to be put into the balance-sheet with the incomes from resale of recovered materials and components.

Regarding transport costs, they depend, almost in a linear way, on the distance between the construction site and the CDW treatment installation, and on the dimensions of dump trucks in relation to the surrounding places (streets dimensions, the closeness of schools and hospitals etc.). According to Italian cases studies, the transport costs, loading and unloading included, can affect the total cost of demolition by 40% in relation to the kind of demolition and related costs. As a consequence, after the valuation of the waste quality that makes the reuse more or less advantageous, the presence of a treatment installation near the construction site is an indispensable condition in assessing the opportunities of waste transport into places that are different from landfills. The census of the CDW recycling installations made by ANPAR (National Association of Recycled Aggregates Producers) shows that most of the installations are concentrated in the North Italy, with the number of installations decreasing in the Middle and becoming very low in the South and in the islands (Figure 1).

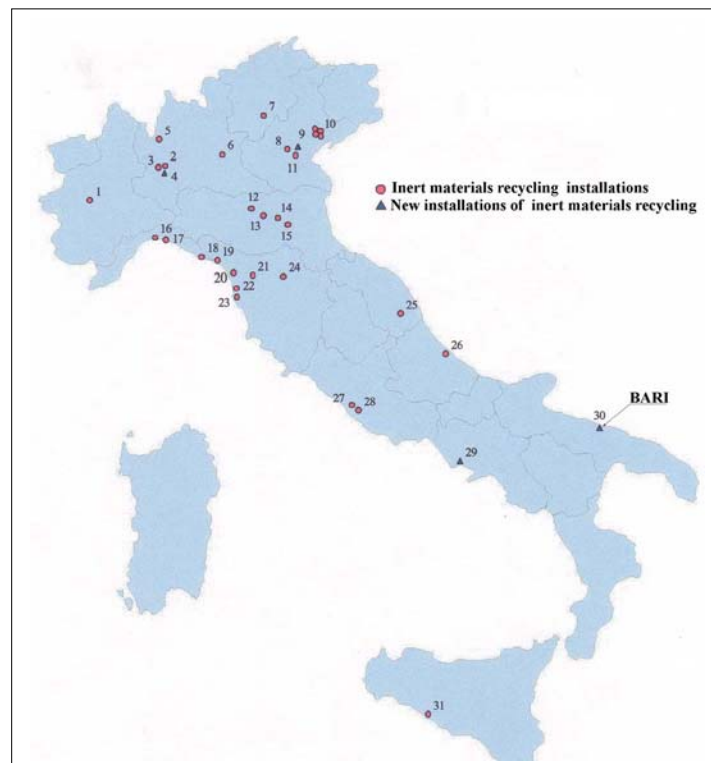


Figure 1 ANPAR (National Association of Recycled Aggregates Producers) census of inert materials recycling installations.

Lacking fixed installations for CDW treatment, an alternative solution may be the use of mobile crushing plants. But, the quality of recycled materials is lower, as these plants are usually not equipped to eliminate the possible present light fractions. In any case, the produced recycled materials for their granulometric (0-70 mm) and geometric characteristics (more edges than in the natural aggregates) can be used with very good results for road embankments and subgrades.

There are different kinds of mobile treatment plants for construction sites, from the smallest ones, useful only for the fragmentation of stones, marbles, granites and CD waste, to the ones with the complete cycle, equipped with magnetic separator and screens for the differentiated selection of granulates. The problem is, again, the context characteristics. The use of mobile equipment with a close cycle requires the availability on the construction site of wide space (about 10.000 square metres) to accumulate recyclable materials. It is also necessary to assess dust and noise level that can be tolerated and allowed in relation to the activities in the surrounding area. The advantage of mobile plants' use is not in the treatment costs, but especially in the cutting down of transport costs. In fact, a fixed treatment installation asks fees comparable to the necessary costs for the use of mobile plants. Moreover, the fee can also be reduced if the quality of CDW is good.

The further positive aspect is that the customer or company, according to a previous contract, can remain the owner of recycling materials that can be used directly for other building works. Moreover, if the customer is a public organisation, such as a Municipality, the time intersection of two different public works can be planned in advance, or at least some Municipality's stoking areas of CDW materials can be predisposed to tend to a complete close-cycle of those materials.

A particular subject is the eco-tax. In Italy, a special tax (called "eco-tax") was introduced for the disposal into landfills according to the national law n.549/95 art. 3, to promote the decrease of CDW production and their recycling and recovery of energy and raw materials. In particular, every region has to fix the amount of the tax between 1,03 Euro and 10,30 Euro per ton of CDW. As a consequence, the eco-tax that can be saved with CDW recovery is different in each region, according to the regional political aims and the awareness of environmental issues (e.g. it is 4 Euro per ton in Apulia, 7,75 Euro per ton in Emilia Romagna and 1,33 Euro in Tuscany).

Regarding the salvage value, the more materials that are selected, the higher the salvage value that can be obtained. Also, the energy quantity contained in the materials is important. For example, the iron obtained from crushing reinforced concrete structure and performing magnetic separation can be sold to the ferrous materials collecting centres. This represents a sure income in the balance sheet for materials recycling. Instead, the wood recovered from CDW can be income, or a further expenditure, in relation to the kind of treatment installation and selection methods.

The revaluation of the recovery materials market would positively influence the net income for selective demolition, but certainly the increase in disposal fees would have a more direct and immediate effect on the choice of the most advantageous demolition method. The local disposal fees in a geographic area are an important "indicator" of deconstruction potential, and will encourage more "whole house" deconstruction in lieu of selective "cherry-picking" of materials [3]. In fact, in Italy, disposal fees are lower than in other countries (especially in

North Europe), and the eco-tax changes in each region. The eco-tax in the Southern Italian regions is the lowest.

In addition to the economic issues, some environmental indicators must be taken into account. Therefore, it can be useful to consider different scenarios that have to be assessed, according to economic and environmental parameters. The definition of environmental balance can be based on the indicators connected with the following issues:

- load of the CDW on the environment;
- consumption/safeguard of the natural resources;
- availability of raw materials;
- availability of secondary raw materials;
- impacts connected with the transport of CDW materials, in terms of consumption and harmful emissions;
- acoustic impacts and pollution from dusts connected to the different solutions of demolition.

The assessment of the real advantages of materials' recovery can be achieved, thanks to a multiple criteria analysis of costs/benefits for the different scenarios in relation to the characteristics of context. Based on these considerations, a case study of possible demolition and CDW recycling is presented.

THE CASE STUDY

The aim of the study is to delineate some alternative scenarios for the demolition of three unauthorised buildings in Bari (a city of the Apulia region in Southern Italy), and to assess the most advantageous scenario in economic and environmental terms.

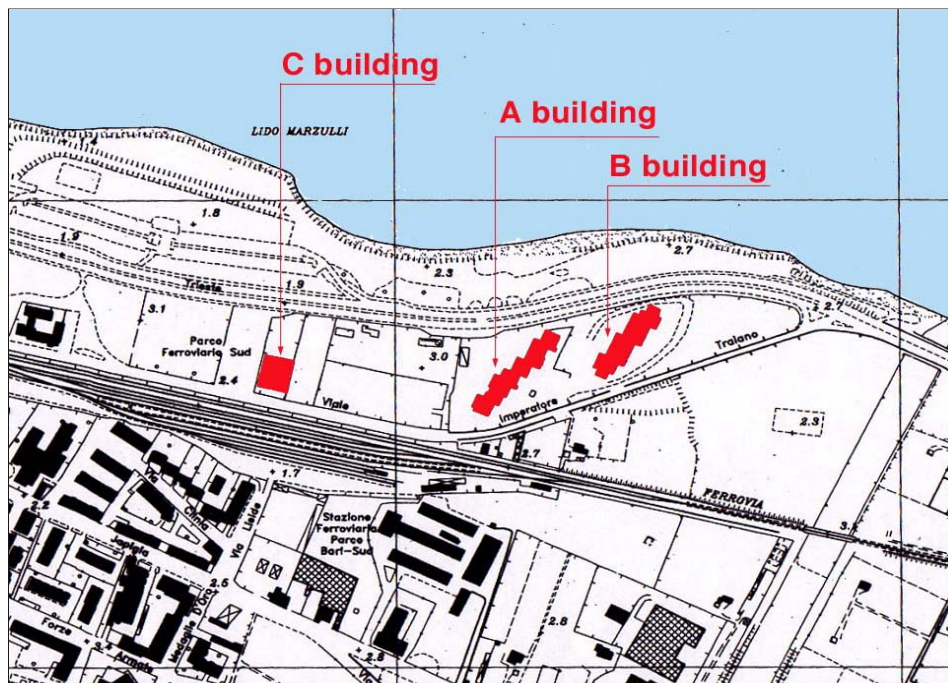


Figure 2 Location plan of the three unauthorised buildings

The three buildings are part of an unauthorised dwellings and offices unit, built along the coast within the town limits. Work was stopped in 1997, but judicial procedures have not yet identified the competence for the demolition - the Bari Municipality or the Magistrate's Court.

The three buildings have a strong environmental impact on that area, in that they are near a beach, a strategic point in environmental terms. The buildings are visible as a long barrier (called by environmental movements a "sluice-gate") from almost all the Bari waterfront for their location and shape. But at the same time, the question involves strong local, socio-economic interests.



Figure 3: View from the beach



Figure 4: View from the street

The three buildings (indicated as A, B, and C) have volumes of about 78.000, 68.000 and 24.000 cubic meters, respectively, and their height is of about 45 meters.

The works are not complete:

- reinforced concrete structures consisting of pillars, beams, reinforced concrete/ hollow tiles mixed floors) in B building;
- reinforced concrete structures and hollow tiles curtain walls in A building, and in a part of C building.

Table 1 Debris percentage on the buildings volume.

BUILDING	A	B	C	Tot.
VOLUME (cubic metres)	78.000	68.000	24.000	170.000
MATERIALS VOLUME (cubic metres)	14.000	8.400	3.900	26.300
DEBRIS PERCENTAGE ON THE BUILDINGS VOLUME	18%	12%	16%	16%
DEBRIS VOLUME AFTER DEMOLITION (cubic metres)				80.000

Table 2 Materials and quantities

BUILDING	A	B	C	Tot
REINFORCED CONCRETE (cubic metres)	7.400	5.700	2.700	15.800
HOLLOW TILES (cubic metres)	6.600	2.700	1.200	10.500
TOTAL DEBRIS AFTER DEMOLITION (cubic metres)	14.000	8.400	3.900	26.300

Table 3 Composition of materials

BUILDING	A	B	C	Tot
REINFORCED CONCRETE	53%	68%	70%	60%
HOLLOW TILES	47%	32%	30%	40%

As our analysis shows, the buildings are made almost exclusively of “basis materials”(concrete, iron, and hollow tiles) that can be easily reused. There are no finishes, plants, windows, and doors. Therefore, it is not necessary to use expensive techniques of selective demolition or deconstruction in order to separate those components from the concrete structures. The CDW are already partly selected. Therefore, different scenarios can be outlined in relation to the possible demolition techniques and real recycling opportunities. In particular, the definition of scenarios has to take into account:

- the technical and operative possibilities for the different types of demolition;
- the real possibilities to manage the demolition materials in relation to the operators (companies, Customers, users, politicians);
- the presence of landfills, surface quarries, and recycling centres in Municipality territory.



Figure 5 A Building



Figure 6 B Building

The economic definition can be based on the following evaluations:

- local costs for the use of different demolition techniques;
- costs for transport of CDW;
- waste disposal fees and waste treatment centres' fees;
- eco-taxes in Apulia region;
- costs for treatment of CDW in the construction site;
- incomes from the reuse of materials/components (salvage value), according to the local market.

The definition of “environmental balance” can be based on the indicators connected with the following issues:

- load of the CDW on the environment;
- consumption/safeguard of the natural resources;
- availability of raw materials;
- availability of secondary raw materials;

- impacts connected with the transport of CDW materials (consumption and harmful emissions);
- acoustic impacts and pollution from dust, connected to the different solutions of demolition.

After a preliminary study, other more specific indicators can be introduced, thanks to a citizen's participation process, to define specific profiles of the environmental impact for each scenario.

At the present stage, the following scenarios have been built:

Scenario 1: Traditional demolition and dumping of the CDW in landfills.

This represents a reference scenario, "witness scenario", since it is generally the most adopted in these cases. Considering dimensional and typological characteristics of the buildings and the surrounding context, the scenario is based on the demolition with mines and the dumping of CDW in the nearest landfills that have to be chosen among those with an adequate receptivity.

Scenario 2: Controlled demolition and dumping of the CDW in a fixed treatment installation.

This scenario is based on the use of demolition techniques that allow the production of two principal homogeneous fractions of materials: reinforced concrete and mixed concrete-hollow tiles. These fractions can be treated in fixed fittings and then used to make reusable aggregates for no-structural concrete, road subgrade, and fillings.

The scenario assessment should also consider different opportunities for these materials' management in relation to possible conventions between the Municipality and the other operators in the sector.

Scenario 3: Traditional or controlled demolition and crushing of the materials in the construction site with mobile plants of treatment.

This scenario is based on the demolition with mines, or in a controlled way, and a subsequent use of a treatment plant in the construction site. This equipment can produce usable aggregates for subgrade and fillings. The assessment of the scenario should verify the opportunities of making the recycled materials available for new public works of the Municipality or of other public local Agencies (e.g., for the projects that have been introduced into the "Investment program of the public works- years 2002-2004"). The scenario also allows assessment of the option of CDW reuse, after the treatment of the materials, for improvement works in the same area.

After a preliminary assessment, the results are as follows:

Scenario 1.

It is possible to use demolition with micro-mines, as there is an area almost completely free from buildings within a range of about 100 kilometres. The presence of railway does not necessarily represent a problem if, during the explosion, the trains are stopped and some devices are used for the protection of the railway-tracks. The dimensions and the typological characteristics (number and dimension of pillars, beams span, number of floors, the lack of finishes, plants, windows, and doors) make the use of the micro-mines demolition method quite easy. There are landfills within a range of 7 kilometres from the construction site and the disposal fee is quite low, about 9,50 Euro per CDW ton (5,50 Euro for waste management

and dumping costs plus 4 Euro for eco-tax). The total costs for the demolition and dumping of the CDW in landfills are about 1.014.738 Euro (plus VAT). But in environmental terms, this scenario is not good, as there is considerable production of dust during the explosion, and the 26 tons of CDW are not reused.

Scenario 2.

It is possible to use excavators equipped with hydraulic pincers on a 50 metres long arm, to separate the concrete pieces from the mixed concrete-hollow tiles debris. There is only one inert materials recycling centre near the construction site. The treatment fee is about 4 Euro per ton. There are not other recycling centres in the surrounding area. It is also possible to use big dump trucks, as the area is easily accessible. In environmental term, it is a very good scenario; but in economic terms, it is not so advantageous, because the demolition process is more expensive than the traditional one (about 19%) and the treatment costs (4 Euro per ton) are comparable with waste management and dumping costs (5,50 Euro per ton) of landfills. But, we can save eco-tax (4 Euro per ton) by dumping the CDW in a fixed treatment installation.

Scenario 3.

The third scenario results the most advantageous in economic terms for the following reasons:

- there is a free area of about 10.000 square metres in the construction site;
- the transport costs from the construction site to a fixed recycling installation can be saved;
- the near quarries are not a problem, as the recycled produced aggregates have a competitive price;
- the Municipality is still the owner of the aggregates and iron (salvage value = 412.611 €);
- the Municipality can use the aggregates for other public works or in the same construction site for area improvement.

In environmental terms, the only problems may be the dust and noise produced during the materials' treatment by mobile plants. But, there are not particular activities in the area that could be damaged or annoyed by dust and noise, especially during autumn and winter.

Table 4 Demolition Costs for the three Scenarios

Scenario 1				
	Unit	Unit Cost	Quantity	Cost
Demolition with mines. To evaluate for the total volume (empty spaces included).	€/m3	1,65	170.000	280.500
Load on dump tracks	€/m3	1,59	78.999	125.608
Transport with dump tracks for 50 quintals to CDW treatment installation	€/q	0,08	585.221	46.818
Landfills: Waste management and dumping costs	€/ton	5,60	58.522	327.725
Eco-tax	€/ton	4,00	58.522	234.088
TOTAL				1.014.738

Scenario 2				
	Unit	Unit Cost	Quantity	Cost
Demolition with excavators equipped with hydraulic pincers on a 50 metres long arm, including the primary crashing (40/50x40/50 centimetres blocks) and iron separation. To evaluate for the total volume (empty spaces included).	€/m3	6,20	170.000	1.054.000
Load on dump tracks	€/m3	1,59	78.999	125.608
Transport with dump tracks for 50 quintals to CDW treatment installation	€/q	0,08	585.221	46.818
Dumping of the CDW in a fixed treatment installation	€/ton	4,00	58.522	234.088
TOTAL				1.334.906

Scenario 3				
	Unit	Unit Cost	Quantity	Cost
Demolition with excavators equipped with hydraulic pincers on a 50 metres long arm, including the primary crashing (40/50x40/50 centimetres blocks) and iron separation. To evaluate for the total volume (empty spaces included)	€/m3	6,20	170.000	1.054.000
Secondary crashing to 0,70mm	€/m3	12,91	26.333	339.959
TOTAL				1.393.959
Salvage value				
Inert materials value and Iron value	€			-412.611

THE UNAUTHORISED BUILDINGS AND THE MATERIALS RECYCLING

As illegal buildings are often in a places with environmental value (by the sea, by the rivers, in the countryside etc.), the demolition of unauthorised constructions and the recycling of their materials offer the possibilities to give back to nature the territory and materials. Moreover, the unauthorised buildings are often not completed, and therefore it is easier to recycle their materials. The phenomenon of illegal buildings has spread throughout Italy, but half of the unauthorised constructions are in the Southern Region of the nation. In particular, according to CRESME (Centre for Economic, Sociologic Researches and of Building Market) data, the Southern regions of Campania, Apulia, and Sicily share the supremacy of the illegal buildings. According to the same data, during 2002, among the new 162.407 buildings, almost 19.000 were illegal, equal to 11,7%. The materials recycled from unauthorised buildings can reach a considerable proportion, therefore it should be taken into account in relation to the necessity to pull down illegal constructions.

CONCLUSION

The study of the demolition and the materials' recycling of the three buildings in the city of Bari, called "Punta Perotti" buildings, is still at a preliminary stage because of the complex legal procedures that have already lasted for about 6 years. As this preliminary study shows, Scenario 3 results the most advantageous in economic terms and in environmental terms for the context characteristics, but the economic advantage is not so evident. Therefore, the

Government should introduce further incentives in order to increase the number of materials recycling centres, especially in Southern Italy and in the islands [4], at the same time increasing the disposal fees or the eco-taxes. In fact, a material recycling is considered within sustainable development strategies, as it allows decreased waste, use of natural resources, CO2 emissions, energy consumption, and the number of surface quarries on the territory.

Regarding the case study, we hope that it will soon be possible to pass to the executive project and to the real materials recycling. As the events of “Punta Perotti” buildings catch the attention of newspapers and TV, an operation of this kind can have great social relevance because it can influence the public opinion about recycling practices. In other words, it can promote other positive actions in environmental and economic terms.

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