RECYCLING IN GREATER DEMOLITION PROJECTS AND EXPLOITATION OF THE IRMA CITY CONCEPT

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ABSTRACT

The EU financed project "Integrated Decontamination and Rehabilitation of Buildings, Structures and Materials in Urban Renewal" (IRMA) was completed in 2007. The result of the IRMA project comprised development of the City Concept, - an integrated management system for optimization of the recycling opportunities in major urban rehabilitation & development projects.

The paper presents a brief introduction of IRMA and the City Concept and the experiences of exploitation during the past years, including seven demonstrations projects in Europe and clearance of a 0.2 km2 totally destroyed Palestinian refuge camp, The Naher el Bared Camp (NBC) North of Tripoli in Lebanon.

The presentation of clearance of the destroyed NBC will focus on the planning, clearance, recycling and disposal of 500,000 m3 concrete rubbles and other building waste materials heavily contaminated by dangerous unexploded ordnance (UXO).

Finally the lessons learnt will be summarized and the way ahead of recycling concrete in demolition project will be indicated.

Keywords: Demolition, recycling, crushing, explosive ordnance disposal, waste management, project management.

1. IRMA PROJECT

The reuse1 of buildings and building materials is an important part of the construction industry and urban development. The challenges of reuse of buildings and materials are dominated by a very high potential of building waste and a growing demand for reusable materials in order to substitute natural resources. The opportunities for reuse of buildings and materials are based on overall economics and logistic management of resources of urban development projects.

However, most buildings and structures contain substances potentially dangerous for the environment and human health, which establish barriers to the reuse of buildings and materials. Some buildings have been constructed with materials containing substances

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1 In general the term ”reuse” covers all three terms: Reuse, Recovery and Recycling (abbreviated R3).
considered harmful today, e.g. asbestos, polychlorinated biphenyls (PCB), heavy metals, certain paints, etc., which can constitute a problem both during the “normal” use and the renewal operations of the buildings.

The identification and management of contaminated structures and buildings are thus important prerequisites for an innovative economical viable and sustainable environmentally-oriented approach to urban renewal.

In this context, the development of measures to identify and manage the contamination of buildings and structures, and the integration of rehabilitation, demolition and recycling techniques into a common approach to urban renewal called CITY CONCEPT are the main objectives of a research & development project called IRMA[1].

The project consortium consists of sixteen (16) partners from seven (7) European countries. They represent important stakeholders with interests in the decontamination of buildings in urban development: housing and civil contractors, demolition contractors, recycling specialists, consultants, universities, research institutes and municipal administrators. The list of participants is presented in the IRMA brochure [2].

The outcome of the project concentrates on the introduction of cleaner processes and maximum waste recycling in the construction and demolition industry focusing on urban rehabilitation and supporting safe and extended lives of buildings.

2. CITY CONCEPT

The results of IRMA and the outcome of the projects address the opportunities of reuse of buildings and materials in major urban development and renewal.

The CITY CONCEPT model is a holistic way of thinking and a specific way of doing with respect to the management of buildings and building materials in urban renewal. The model consists of:

- A description of the generic processes that constitute a urban development project
- Related tools for supporting some of these processes

The generic City Concept processes are defined as the chain of processes that have to be executed from the start of an urban development project - named “Old City” - to the completion of the development project - named “New City”.

The CITY CONCEPT toolbox is an electronic handbook containing guidelines, assessment tools and other relevant information - including improved technologies, processes and decision-making tools - to be used for the management of large urban renewal projects.

The electronic handbook is an open tool, which can be customised to specific projects with respect to geographical differences.

The CITY CONCEPT has been developed as the main objective of IRMA in order to provide a toolbox of improved technologies and processes together with decision-making and management tools for sustainable urban renewal. This managerial model focuses on contaminated buildings, in order to protect the environment and the people from hazardous compounds and optimise the reusability buildings and materials.

The CITY CONCEPT is a strong tool for all stakeholders, especially architects, planners and managers to exploit the opportunities and overcome the barriers.
2.1 Basic Philosophy

The basic philosophy of the CITY CONCEPT is to organise and manage the metamorphosis of the “old city” to the “new city” with respect to all processes concerning total and partial demolition, cleansing of polluted buildings and materials, recycling and logistic management of materials. An urban renewal project can be sketched as the generic chain of processes shown in figure 1.

![Figure 1. Sketch of the idea of the holistic process of urban renewal and basis of the CITY CONCEPT.](image)

The development of an old urban area, e.g. industrial area or harbour area, towards new purposes, e.g. housing or business, includes two complementary approaches:

Demolition of buildings and clearance of old infrastructure - which are condemnable or not useful for the new purposes - and management of building waste materials with respect to maximum reuse.

Rehabilitation of existing buildings and infrastructure, and reuse of these structures for new purposes.

The CITY CONCEPT is most applicable to major urban renewal projects with a certain volume of buildings and structures representing a big potential of reusable buildings and materials:

1 ha (10,000 m2) total site area and/or
10,000 m2 total floor area and/or
10,000 t total reusable building materials

A sequence of measures to identify and manage contamination will be designed within the first stages of the project. These measures will be implemented into the integrated management system with the following consequences for the urban renewal process:
hazardous substances in buildings and structures are identified and classified
toxic emissions during demolition activities are prevented
the lifetime of a structure can be extended
existing polluted building and structures can be rehabilitated and reused
polluted demolition waste materials can be recycled and the volume of contaminated
building waste will be reduced

2.2 Economic perspective of the CITY CONCEPT

The objective of the CITY CONCEPT is to optimise the material flow with respect to
economy and environment. It means that the amount of generated waste materials and the
consumption of natural materials must be reduced to a minimum, which requires maximum
recycling. Reducing waste and substituting natural resources with recycled materials is a win-
win situation. This is illustrated in figure 2.

A crucial barrier to recycling is the contamination of buildings to be demolished or
rehabilitated. Hazardous waste is very expensive to dispose off on controlled landfill, to
incinerate or to receive special treatment. Therefore, it is necessary firstly to separate the
contaminated materials from clean materials, in order to minimise their volume and
concentrate the pollution, and secondly to develop and implement appropriate cleansing
techniques for buildings, structures and materials.
2.3 Description of toolbox

The City Concept toolbox is developed as a software system to support project management. The toolbox is an electronic handbook that guides through all the phases of an urban renewal project, providing both the overview of the whole process and the information, tools and functionalities necessary at each individual step. See figure 3.

The backbone of the electronic handbook is a workflow containing the principle main phases of an urban renewal project. Each phase is composed of a series of processes to be executed and concludes on a milestone. When a milestone is achieved, the system returns to the main flow, where the next phase can then be addressed and a new sequence of processes can be opened.

These process flows are accessed by clicking on the concerned phase. Each process may also contain a flow of sub-processes.

2.4 Demonstration projects

Six demonstration projects have been performed for the evaluation of the CITY CONCEPT, which are presented in table 2. According to the latest information (2009) from Rotterdam, the CITY CONCEPT has been introduced as a general planning tool for demolition and recycling in urban renewal of the Rotterdam harbour areas.

<table>
<thead>
<tr>
<th>City and Country</th>
<th>Demonstration Project</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas work</td>
<td>Planning of decontamination and demolition of former gas work site.</td>
<td>After cleansing of surfaces more than 70% of the building materials can be reused.</td>
</tr>
<tr>
<td>Aarhus, Denmark</td>
<td>Decontamination and selective demolition of a foundry, a cool storage and a wool washing plant.</td>
<td>Practical experiences, discussion of and contribution to the CITY CONCEPT and guidelines were gained.</td>
</tr>
<tr>
<td>Industry</td>
<td>Demolition and recycling of old barracks including 60 buildings and 200,000 tonnes of rubbles.</td>
<td>Economical benefit documented. Saving up to 150,000 tonnes virgin materials and reduction of transportation with 350,000 km road traffic.</td>
</tr>
<tr>
<td>Bremen, Germany</td>
<td>Feasibility study of the recycling of concrete and masonry during the development of the area after closing the brewery.</td>
<td>The recycling potential has been assessed to 210,000 t of a total amount of 500,000 tonnes buildings materials. More than 6.7 million € can be saved by recycling.</td>
</tr>
<tr>
<td>New NATO HQ</td>
<td>Demolition and recycling of old barracks including 60 buildings and 200,000 tonnes of rubbles.</td>
<td>Economical benefit documented. Saving up to 150,000 tonnes virgin materials and reduction of transportation with 350,000 km road traffic.</td>
</tr>
<tr>
<td>Brussels, Belgium</td>
<td>Selective demolition of former factory.</td>
<td>In-situ recycling of 45% of the building materials and cost reduction around 58% compared to traditional demolition.</td>
</tr>
<tr>
<td>Carlsberg</td>
<td>Pre-demolition assessments of buildings focusing on environment and decontamination of structures.</td>
<td>Valuable experiences and input to the development of the CITY CONCEPT and electronic handbook.</td>
</tr>
<tr>
<td>Copenhagen, Denmark</td>
<td>Studies of four recycling scenarios: 1. off-site crushing / off-site reuse, 2. on-site crushing / on-site reuse; 3. on-site crushing / one-site, 4. on-site crushing / reuse on-site in construction.</td>
<td>Potential of 225,000 t rubbles available for recycling. On-site crushing and on-site reuse proved cheaper than off-site crushing and off-site reuse by an order of magnitude of 3 million EURO. Saving of 35% CO2.</td>
</tr>
</tbody>
</table>
3. RUBBLE REMOVAL AND RECYCLING IN LEBANON

In the summer of 2007, a brutal conflict broke out between the militant group Fatah al Islam and the Lebanese Armed Forces, resulting in the displacement of the 27,000 residents of Nahr el-Bared Palestine refugee camp (NBC) and parts of the adjacent areas. The conflict disrupted the lives of tens of thousands and destroyed their livelihoods and their homes comprising an urban area of approximately 20 ha and 500,000 cubic meter of rubbles mixed with unexploded ammunition.

Figure 4. Photos above show the destroyed NBC camp in Lebanon. Photo down left shows marking of explosive item, photo down right shows construction of new road by reused materials.
In October 2008 the clearance of the destroyed camp started. The overall challenge of the rubble removal project was to integrate and optimise the work processes of demolition and removal of rubbles and the clearance of mines and unexploded ordnance. The quality and success criteria of the rubble removal project can be summarized in the following:

The rubble removal will be completed in such a way that the respective areas are cleared and ready for construction works in accordance to the time plan of the Reconstruction Project.

Neighbours must be satisfied, and the number of neighbour claims must be low.

No serious accidents occur.

Highest possible amount of the rubble material will be recycled and reused for the benefit of the NBC reconstruction project, and lowest possible amount the materials will be disposed to the public landfill.

Table 2. Status of rubble management, NBC Rubble Removal project by June 2009

<table>
<thead>
<tr>
<th>Site for use</th>
<th>Cubic meter</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tripoli Harbour</td>
<td>217,000</td>
<td>Extension of the harbour area. Fill by crushed materials maximum size 200 mm.</td>
</tr>
<tr>
<td>Lebanon Armed Forces</td>
<td>70,000</td>
<td>Development of facilities and roads</td>
</tr>
<tr>
<td>Road reinforcement</td>
<td>45,000</td>
<td>Construction of new roads using major blocks for marine protection and other sizes for base course materials.</td>
</tr>
<tr>
<td>UNRWA</td>
<td>15,000</td>
<td>Repair of internal roads on site, and fill materials for temporary camp</td>
</tr>
<tr>
<td>Crushed materials stockpiled</td>
<td>3,000</td>
<td>Fill material for the construction of new houses on the site.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>350,000</strong></td>
<td>Approximately 80% of the total amount</td>
</tr>
</tbody>
</table>

The rubble removal project has been completed late in 2009. The status of the recycling and reuse of rubbles are presented in table 3.

The opportunities for a higher value of recycling for instance reuse the crushed materials for backfilling on site as a part of the following reconstruction project, have been discussed. Unfortunately, the timing of the availability of rubbles and the economical conditions were not making other opportunities feasible.

7. CONCLUSIONS

The major lessons learnt from the IRMA project and the seven demonstration projects in Europe are

- that the CITY CONCEPT and the integrated management tool box are feasible for all kinds of major demolition projects in urban removal,
that the opportunities for optimisation of recycling of building materials need to be addressed from the very beginning of the planning process, and

The major lessons learnt from the rubble removal project in Lebanon are

- that more focus should have been put on high value recycling from the very start of the project planning,
- that the rubble removal and clearance of unexploded ordnance must be carried out as an integrated contract, and
- that specific requirements with respect to production of high-value materials meeting the international/national standards of backfill materials must be included in the terms of recycling.

The seven European demonstration projects and the rubble removal of the destroyed refugee camp in Lebanon are very different projects with respect to the scenario and the context of the projects. However, the exploitation of the CITY CONCEPT was highly relevant to all of them, addressing the need for selective demolition and the opportunities for reuse of building materials as integrated parts of the projects.

The way ahead includes following steps:

- Architects and urban planners must be aware of opportunities of the possible reuse of buildings and building materials.
- The opportunities for recycling must be analysed very early in the project design phase.
- Requirements to materials and material standards must be reviewed carefully with respect to the use of recycled materials.
- Consultants and contractors must be economically encouraged to exploit all opportunities for recycling.
- Reuse of buildings and building materials provides an important contribution to the overall protection of the global environment.

REFERENCES

