INTEGRATED DECONTAMINATION AND REHABILITATION OF BUILDINGS, STRUCTURES AND MATERIALS IN URBAN RENEWAL
- A EUROPEAN PROJECT FOR A SUSTAINABLE CITY CONCEPT

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Abstract

A project called “Integrated Decontamination and Rehabilitation of Buildings, Structures and Materials in Urban Renewal” (IRMA) is being conducted within the European Commission’s Fifth Framework Programme “Energy, Environment and Sustainable Development”. This international initiative involves seventeen partners from nine European countries, representing important stakeholders with interests in urban development.

The primary objective of the project is the development and implementation of a general “City Concept” comprising a toolbox of improved technologies and processes together with decision-making and management tools for sustainable urban renewal, focusing on contaminated buildings, in order to protect the environment from hazardous compounds and save reusable buildings and materials.

The paper presents the main focal points of the project, including risk management, health and safety of construction and demolition workers, reduction of waste and preservation of buildings and resources. The holistic purpose of the project is to respond to some of the most important challenges of urban development, such as rehabilitation of old buildings, minimisation of waste and recycling of materials.

Within this general context, focus will be placed on environmental aspects of demolition and reuse of the waste materials produced thereof. Firstly, cleaner techniques for selective demolition are developed, concentrating on the environmental aspects of the process in order to ensure optimal working conditions. Secondly, decontamination procedures of demolition waste are investigated so as to ensure an environmentally optimal reuse of those materials and prevent negative impacts during the re-use of the materials.
1. INTRODUCTION

Most buildings and structures contain substances potentially dangerous for the environment and human health. Some buildings have been constructed with materials containing substances considered harmful today, e.g. asbestos, PCB, heavy metals, certain paints, etc., which can constitute a problem both during the “normal” use and the renewal operations of the buildings.

At the same time, some of the most important challenges of urban development are the rehabilitation of old buildings, minimisation of waste and the recycling of materials. The identification and management of contaminated structures and buildings are thus important prerequisites for an innovative 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.

IRMA stands for “Integrated Decontamination and Rehabilitation of Buildings, Structures and Materials in urban renewal” and it is a project carried out within the European Commission’s Fifth Framework Programme “Energy, Environment and Sustainable Development”, Key Action 4: City of Tomorrow and Cultural Heritage.

The contract no. EVK4-CT-2002-00092 contains the legal terms of the project. The Contract was signed in July 2003, the actual project’s commencement date was August 2003, and it has a duration of 42 months, i.e. until February 2007.

The project total cost is estimated to be 5,110,728 Euro, being half of it financed by the European Commission and the other half by the involved organisations.

2. ABOUT THE PROJECT

2.1 Project objectives

The major problems encountered in the current context of urban renewal are that:

− very little practical applicable knowledge on the decontamination of buildings and materials is available
− there are no accepted technologies or guidelines for the decontamination of polluted buildings and materials
− there are no standards for the classification of decontaminated buildings and materials as “clean”
− the means of classification of polluted soil cannot be applied to recycled materials
− a considerable amount of vandalism (graffiti) results in the need for decontamination
− the health and safety of personnel carrying out work on contaminated buildings is insufficiently regulated

The main objective of the IRMA project is to develop and implement a general “City Concept” comprising 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. This includes:

− Minimisation of risk to occupants of buildings
− Health and safety of construction and demolition workers
− Reduction of waste
− Preservation of buildings and resources
2.2 Project participants

The project consortium consists of seventeen (17) partners from eight (8) 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.

Table 1 includes the partners participating in the project, the type of organisation they are and the country they are established at.

Table 1. Information on project partners

<table>
<thead>
<tr>
<th>PARTNER NAME</th>
<th>TYPE OF ORGANISATION</th>
<th>COUNTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demex</td>
<td>Consulting engineers</td>
<td>Denmark</td>
</tr>
<tr>
<td>Dansk Beton Teknik</td>
<td>Concrete testing and R&amp;D center</td>
<td>Denmark</td>
</tr>
<tr>
<td>Intron</td>
<td>Technical consultancy and laboratory</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>Demoliciones Técnicas</td>
<td>Demolition contractor</td>
<td>Spain</td>
</tr>
<tr>
<td>Belgian Building Research Institute</td>
<td>Research institute</td>
<td>Belgium</td>
</tr>
<tr>
<td>Brandis</td>
<td>Demolition contractor</td>
<td>Denmark</td>
</tr>
<tr>
<td>Enviro Challenge</td>
<td>Recycling contractor</td>
<td>Belgium</td>
</tr>
<tr>
<td>Contento Trade</td>
<td>Research and technology center</td>
<td>Italy</td>
</tr>
<tr>
<td>SBS Byfornyelse</td>
<td>Urban renewal and consultancy</td>
<td>Denmark</td>
</tr>
<tr>
<td>Hochschule Bremen</td>
<td>University</td>
<td>Germany</td>
</tr>
<tr>
<td>Delft University of Technology</td>
<td>University</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>Brussels Institute for Management of Environment</td>
<td>Public administration</td>
<td>Belgium</td>
</tr>
<tr>
<td>Amarsul</td>
<td>Municipality waste management company</td>
<td>Portugal</td>
</tr>
<tr>
<td>Rotterdam Public Works Engineering</td>
<td>Public administration</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>Dr. Tech. Olav Olsen</td>
<td>Consultant engineers</td>
<td>Norway</td>
</tr>
<tr>
<td>Meldgaard</td>
<td>Recycling equipment suppliers</td>
<td>Denmark</td>
</tr>
<tr>
<td>Federal State of Bremen</td>
<td>Public administration</td>
<td>Germany</td>
</tr>
</tbody>
</table>

2.3 Project contents

The project is organised following a modular scheme, addressing each of the main objectives in separate Work Packages (WP). Table 2 presents the contents addressed in each of the work packages.

Table 2. Structure of the project into Work Packages and their contents

<table>
<thead>
<tr>
<th>WP 1. Compilation of data on building contamination and development of database</th>
</tr>
</thead>
<tbody>
<tr>
<td>− Development of a database to be used as information tool</td>
</tr>
<tr>
<td>− Compilation of the relevant baseline information</td>
</tr>
<tr>
<td>− Description of the state-of-the art on decontamination of buildings, structures and materials</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WP 2. Assessment of contaminated buildings and structures</th>
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</thead>
<tbody>
<tr>
<td>− Identification of existing contamination and assessment of the related risk for human health and environment based on their behaviour with respect to emissions</td>
</tr>
</tbody>
</table>
Environmental impact and risk assessment of selected urban development scenarios comprising large groups of buildings, including contaminated buildings and structures

WP 3. Development of cleansing and demolition methods
- Improvement or further development of clean processes for the removal of surface contamination in buildings and structures
- Improvement or further development of clean processes for the selective (partial) demolition of structures

WP 4. Cleansing of waste materials
- Development of techniques for eco-efficient cleansing processes of demolition waste
- Development of techniques for maximum recovery and reuse of building waste materials

WP 5. Development of “City Concept” for decontamination and rehabilitation of buildings, structures and materials
- Development of a model and a computer program for an integrated management system called “City Concept” for activities and processes related to decontamination and rehabilitation of urban structures and buildings:
  · Demolition (partial and total)
  · Cleansing of surfaces and materials
  · Recycling and reuse of recycled materials

WP 6. Evaluation of “City Concept” for European cities
- Feasibility study and evaluation of the “City Concept” in the following European cities and urban areas: Bremen (D), Brussels (B), Copenhagen (DK), Aarhus (DK), five municipalities on the Setubal Peninsula (P) and Rotterdam (NL)
- Demonstration of the “City Concept” during a test project in connection with an actual rehabilitation plan

WP 7. Implementation and exploitation – Reporting, recommendation and guidelines
- Development of a "Code of Good Practice for Works on Contaminated Buildings" including:
  · Guidelines for sampling and analysis procedures for contaminated building surfaces, presentation of criteria for the emission behaviour of pollutants; and guidelines and input data for risk assessment
  · Proposed decontamination methods for construction waste on an industrial scale with related environmental impact analysis and socio-economic optimisation
  · Guidelines for project management, including decision making, planning, supervision and administration

WP 8. Project management
- Project coordination and administration in accordance with the contract requirements and pursuing the highest quality of the project’s outcome

Despite of the presented division of work, necessary for the realisation of the project in praxis, the whole project is conceived as a unitary working process aiming at the final objective: the development and evaluation of the City Concept to be used for urban renewal processes at European level. The interrelation among the different Work Packages described in table 2 is depicted in figure 1.

2.4 Project outcome
The main outputs of the project suitable for exploitation follow the objectives of the individual work packages. 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.

The results of the project will be materialised in the following deliverables, all pieces of an integrated management system for decontamination and rehabilitation of buildings, structures and materials in urban renewal, i.e. the City Concept.

− Final Report. Descriptive document about the development and findings of the specific work packages and the project in general.
− Database. Database of pollutants appearing in buildings and related materials, their physico-chemical properties and their possible interactions with building materials, preferential disposition sites, methods for their quantification and efficiency of appropriate cleaning techniques among others.
− Code of Good Practice for Works on Contaminated Structures. Guideline providing a structured approach for the identification and safe and efficient handling of contaminated structures and leading to maximum recovery of materials and minimum consumption of resources.
− Dissemination material. Demonstration material – including video documentation of different activities – for training and further education of engineers and skilled workers in clean construction, refurbishment and demolition procedures.

Figure 1. Interrelations among Work Packages
3. CITY CONCEPT

3.1 Description of the model

Developing an integrated management approach to urban renewal is the main objective of IRMA project. This approach is compiled within a model called City Concept, which is described in this section. Figure 2 represents the conceptual model for the holistic process of urban renewal described by the City Concept.

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

Figure 2. Conceptual model of the City Concept

The decisions about the renewal strategy are based on many factors, being the contamination of structures and materials a determinant one. 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
− important volumes of polluted demolition waste materials (primarily concrete and masonry rubble) can be recycled
− the volume of contaminated building waste will be reduced
− materials can be recovered upon complete or selective demolition to save natural resources and to avoid the need to dispose off waste
− open spaces at the urban rehabilitation sites are used for the establishment of crushing and sorting machinery in order to allow all recycling to be carried out on site. Only contaminated waste and other non-recyclable materials are to be transported from the site
3.2 Elements of the City Concept

Figure 3 presents the elements of the City Concept model; each of them is shortly described below.

1. The Old City comprises a number of structures. Based on the assessment of the structures and depending on the city development master plan and on the existing conditions, the structures are divided in two main categories: obsolete and reusable.

2. The obsolete structures comprise all kind of structures. The structures are assessed with respect to demolition and waste management. A general master plan for demolition contamination, recycling and waste management is prepared.

3. The decontamination comprises asbestos removal, collection of hazardous waste, removal of polluted substances and structures, cleansing of surfaces. A part of the decontamination will take place during the demolition work.

4. The demolition will be performed as selective demolition in order to sort all fractions of building waste materials on the site. Contaminated structures will be classified into clean and contaminated materials in order to minimise the overall volumes of contaminated materials.

5. The site clearance will take place after completion of the demolition. Polluted soil will be removed from the site, and replaced by natural materials or recycled materials. The site clearance depends on the master plan for the new city.

6. New structures will be constructed on the cleared sites with the maximum use of recycled materials for aggregate in concrete, sub-base materials or fill. Recycled materials might also be used in construction of temporary roads and structures.

Figure 3. Diagram showing the elements of the City Concept

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6. New structures will be constructed on the cleared sites with the maximum use of recycled materials for aggregate in concrete, sub-base materials or fill. Recycled materials might also be used in construction of temporary roads and structures.
7. The new structures comprise new buildings, roads, open spaces and gardens.
8. The reusable structures, including buildings, roads and various installations are assessed with respect to their function in the new city.
9. The decontamination comprises asbestos removal, collection of hazardous waste, removal of polluted substances and structures and cleansing of surfaces. A part of the decontamination will take place during the following rehabilitation work.
10. The rehabilitation of the structure depends on the need for changes of the building and the building conditions. An important part of the rehabilitation work implies removal of installations and partial demolition of the structure. The decontamination will partly take place during the rehabilitation work.
11. The site clearance around and inside the structure will take place after completion of the partial demolition. Polluted soil will be removed from the site, and replaced by natural materials or recycled materials.
12. The reconstruction of the reused structures will take place according to the public requirements of new structures and the design of the reused structures. Recycled materials will be used to the widest extend as possible.
13. The reused structures shall comply with the public requirements for buildings and other structures, and the lifetime is expected to be the same as that of new buildings.
14. The rubbles generated during demolition and rehabilitation are collected and transported to a building waste recycling plant on site or transported to an external plant according to the demolition waste recycling plan. Clean materials and contaminated materials are stored separately.
15. The non-contaminated rubble materials are sorted in different fractions in function of the material, e.g. steel, wood, etc.
16. The rubble materials contaminated by oil, chemicals and heavy metals for example, are to be cleaned or reused for special purposes.
17. Crushing of rubble materials takes place in mobile crushing plants and sieves on-site or in stationary crushing plant outside the city area.
18. The recycled materials are intended to be used as aggregates, sub-base materials or filling materials.
19. The hazardous waste materials are to be incinerated, disposed off at controlled landfills or subjected to special treatment.
20. Those waste materials that are not recycled will be disposed off at landfills or incinerated in accordance to national and local regulations.
21. Polluted soil is removed according to national/local regulations and the intended future use of the site. The polluted soil might be treated and returned to the site.
22. Natural materials or virgin materials are transported from quarries or riverbeds from outside the city.
23. The New City will contain a mix of new and reused structures. The infrastructure will also be new or reused structures.

3.2 Economic perspective of the City Concept

The diagram showing the elements of the City Concept - Figure 3 - indicates processes and streams of materials. An 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. This is schematically represented in figure 4 below.
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.

4. CONCLUSIONS

A research & development project is being performed within the European Commission’s Fifth Framework Programme “Energy, Environment and Sustainable Development”. The project is called IRMA, which stands for “Integrated Decontamination and Rehabilitation of Buildings, Structures and Materials in urban renewal”. The project - which is in its early stages - addresses some of the most important challenges of urban development, such as rehabilitation of old buildings, minimisation of waste and recycling of materials. Within the project, the identification and management of the contamination of structures and buildings are common prerequisites for the development of an innovative environmentally-oriented approach to urban renewal.

A model called City Concept is the core and main objective of the project, consisting of an integrated management system, where rehabilitation, demolition and recycling techniques are combined into a common approach to urban renewal. The City Concept comprises a toolbox of improved technologies and processes, focusing on contaminated buildings in order to minimise risk to environment and people from hazardous compounds and to save reusable buildings and materials. The City Concept consists of decision-making and management tools for sustainable urban renewal, including:
- Minimisation of risk to the occupants of buildings
- Health and safety of construction and demolition workers
- Preservation of buildings and resources
- Reduction of waste

This model - to be used among the city planners and construction & demolition practitioners - will guide towards a sustainable approach to urban renewal, providing the managerial and information tools necessary to integrate environment and health & safety
considerations as important factors within the decision-making process related to urban renewal.

The project is still at its early stages. At this moment Work Package 1 has been completed and the baseline study contained herein provides a valuable basis for further work towards the development of the City Concept. Maximum interaction with relevant stakeholders around Europe is desirable for an optimal project outcome and in order to ensure its future usability.

REFERENCES