

REPORT 1

**SUSTAINABLE CONSTRUCTION
IN BELGIUM**

**F. HENDERIECKS
B. SIMONS
J. DESMYTER**

BELGIUM BUILDING RESEARCH INSTITUTE
Lozenberg I, 7
1932 Sint-Stevens-Woluwe - BELGIUM
Tel : +32 2 7164211 - Fax : +32 2 7253212

NATIONAL REPORT

CONTENTS

1. THE FRAMEWORK: THE POLITICAL AND SOCIAL SITUATION IN BELGIUM.....	3
2. THE CONSTRUCTION INDUSTRY IN BELGIUM.....	4
3. SUSTAINABLE CONSTRUCTION IN BELGIUM: ACTUAL SITUATION AND PERSPECTIVES	4
3.1 Town and country planning - Urban development	4
3.2 Mobility and infrastructure	9
3.3 Quality of dwellings.....	9
3.4 Environmental management planning.....	10
3.5 Soil remediation	11
3.6 Energy	12
3.7 Construction and demolition waste : State of the art	12
3.8 RTD initiatives.....	19
3.9 Information and training	20
4. DEMONSTRATION PROJECTS / CASE STUDIES	21
4.1 The centre for Sustainable Construction (Heusden-Zolder).....	21
4.2 The mobility plan of the city of Hasselt.....	21
4.3 Pleiade.....	22
4.4 The recycled house	23
5. THE HORIZON OF THE YEAR 2000 : THE CONSEQUENCES FOR THE CONSTRUCTION INDUSTRY BY 2010	23
5.1 City planners and the built environment.....	23
5.2 Initiating, designing, constructing and demolishing	24
5.3 Components, materials, services and assembly	24
5.4 Human resources and skills.....	24
6. CONCLUSIONS.....	25

1. THE FRAMEWORK: THE POLITICAL AND SOCIAL SITUATION IN BELGIUM

Belgium became a real federal state in July 1993, divided in three regions, Flanders, Wallonia and the City of Brussels. However, the regions have been responsible for their own environmental and building policy and legislation, since the eighties. Due to different political accents and due to distinct geographical difference the demand and supply of recycled materials varies from one region to the other.

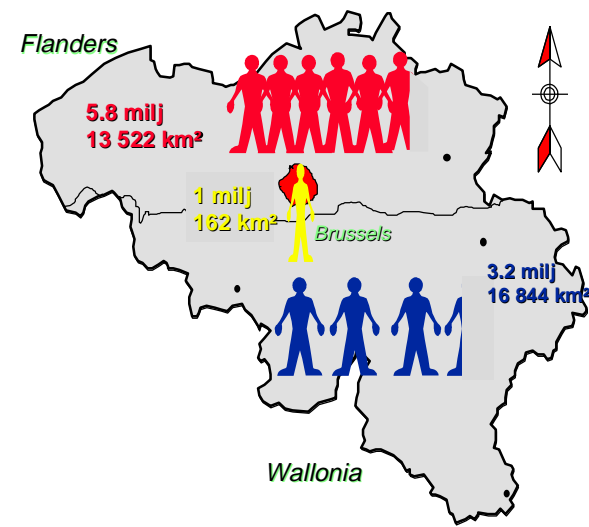


Figure 1: Map of Belgium

Flanders (13,512 km²), which is situated in the North of Belgium, has a very high population density of 422 inhabitants per square kilometre. Nearly no natural aggregates are available.

Brussels, i.e. the urban region of the city of Brussels, is the smallest (161 km²) of the three regions and counts 6025 inhabitants per square kilometre. No quarries and dump sites whatsoever are available.

The third region, Wallonia, is situated in the south of Belgium and has a population density of 190 inhabitants per square kilometre. A large number of quarries are dispersed over the territory.

2. THE CONSTRUCTION INDUSTRY IN BELGIUM

In Belgium the construction industry contains mainly SME's. On a population of 10 milj. people, there are 67 000 construction companies. 80% of them have less than 10 collaborators. They have an over all turn-over of 940 bilj. BEF (24 000 milj. ECU). Yearly some 40 000 residential buildings are constructed; 6 000 non residential.

A very typical phenomenon is that private construction is very predominant in Belgium: only 5% is social housing; 75 % of the buildings are inhabited by the owners.

The construction industry in Belgium has a collective research centre (BBRI, Belgian Building Research Institute), offering the technical support for the sector. Every construction company is a member of the BBRI.

3. SUSTAINABLE CONSTRUCTION IN BELGIUM: ACTUAL SITUATION AND PERSPECTIVES

3.1 Town and country planning - Urban development

3.1.1 Introduction : the historical context

The authority concerning town and country planning is nowadays a regional one. The three regions Flanders, Brussels and Wallonia have therefore developed, or are in the process of developing their own policy and legal instruments.

The legal basis for urban and country planning was in most regions until recently the national law of 1962 on urban development and country planning. In the seventies 48 sector plans ("gewestplannen-plans de secteur") were installed in which regulatory aspects of town and country planning are described. The division of the Belgian territory into 48 sectors was based upon regional, socio-economical and geographical data. In the sector plans (25 for Flanders, 22 for Wallonia and 1 for Brussels) zoning schemes for land allocation were defined taking into account the economical and social needs of the different sectors and considering the necessity of transport infrastructure. A difference was made between residential areas, green areas and areas for agriculture, industry, etc.

On a more local level municipal general plans and special plans for construction ("algemene en bijzondere plannen van aanleg - plans particuliers d'aménagement") were defined. A general plan for construction should describe in detail the land allocation of the total territory of the municipality. The special plans for construction contain the urban development and technical prescriptions for the different zones of the municipality.

3.1.2 Regional developments

Most of the principles of the former national town and country planning legislation have remained current in the regional policies. However in the near future some important changes are expected.

3.1.2.1 Wallonia

The Walloon code for town and country planning, urban development and the patrimony (the CWATUP, i.e. the “Code wallon d’aménagement du territoire, d’urbanisme et du patrimoine”) is at this moment being reviewed. This code, which was based upon the national legislation, allows the regional government to edit urban development regulation in order to safeguard the health requirements, the structural stability, the beauty and the safety of buildings, installations, infrastructure and their accessories. At the same time this code makes it possible to take measures which affect unoccupied dwellings, the thermal and acoustic qualities of buildings, the energy use and energy recuperation.

A very important order implementing these possibilities relates to the regulation concerning the thermal isolation and ventilation of buildings. The measures which were originally defined in art. 322/1 to 8 of the Code, were recently modified by the Walloon Government order of February, 15th, 1996 and the Ministerial Order of February, 15th, 1996. In these documents the thermal isolation coefficient was reconsidered for new dwellings. At the same time the scope of this regulation was broadened from new constructions to transformations and reconstruction’s of dwellings and offices and to school buildings and accommodation buildings in general. Requirements concerning ventilation were also indicated. A summary of the requirements is indicated in table 1.

<i>Real estate</i>	<i>New construction</i>	<i>Transformation of a construction with a change of use</i>	<i>Transformation of a construction without a change of use</i>
<i>Houses and dwelling buildings</i>	K55 or Be 450 + k_{max} values	K65 + k_{max} values	k_{max} values
<i>School buildings and offices</i>	K65 + k_{max} values	K70 + k_{max} values	k_{max} values for windows and renovated opaque facades

Table 1: Thermal isolation and ventilation in Wallonia (since 1996)

(*K* value indicates the global thermal insulation quality of buildings as defined in NBN B62-301, the *Be* value is an estimate of the net energy needs for heating taking into account the solar and internal heat gains and is calculated by a regulated method published in the *Moniteur Belge* of April 30th 1996, k_{max} must be calculated following NBN B62-002)

The Code CWATUP is now under revision. The draft Order modifying the CWATUP, approved by the Walloon government in April 1997 and currently under investigation at the Walloon parliament, states that the public authorities should manage the Walloon territory in order to meet in a *sustainable* way the social and economic needs of the collectivity “*par la gestion qualitative du cadre de vie, par l’utilisation parcimonieuse du sol et de ses ressources et par la conservation et le développement du patrimoine culturel, naturel et paysager*”. This general goal can afterwards be realised by adapting amongst others the sector plans, the municipal (general and special) construction plans and the allotment prescriptions. The introduction of a regional Walloon plan for town and country organisation, formerly known under the name “Plan Régional d’Aménagement du Territoire pour la Région Wallonne (PRATW)” and now entitled “Schéma de Développement de l’Espace régional (SDER)”, is considered as another interesting tool for implementing these objectives.

Interesting to note is that measures are foreseen to counteract linear infrastructure and uncontrolled urbanisation. In future a new urban or residential area would only be accepted in sector planning if it is situated besides an existing urban or residential area already under development. To develop linear urban or residential zones along road infrastructure would become impossible. It would also be very difficult to institute urban or residential zones in areas which have been identified as crucial regarding the protection of the patrimony, nature or ground or surface water or where there is a danger of flooding, landslide, etc.

3.1.2.2 Brussels Capital Region

The sector plan for Brussels, realised in 1979, was originally intended to protect the weaker activities (housing, workshops, trade and equipment) and the architectural and urban characteristics of the different areas and divided Brussels into different areas. In this sector plan a distinction was made between typical residential areas, mixed residential and company areas, administrative areas, company areas with an urban character, industrial areas, green and rural areas and areas for equipment for the common good or for public services.

The Regional Development Plan (“Plan Régional de Développement (PRD)”) and the Regional Zoning Plan (“Plan Régional pour l’Affectation des Sol (PRAS)”) are two important tools used by the Brussels Capital Region to realise a sustainable development of the city. In the first plan, i.e. the PRD, the objectives of the political majority concerning town and country planning are described. The second one, i.e. the PRAS, which still has to be finalised, will become the regulatory reference for land occupation and will therefore replace the sector plan of 1979.

The PRD and the PRAS were installed in order to assure a well balanced development of the capital area in terms of population growth, economic growth and industrial and administrative activities. The objectives of the PRD are “*to design a pleasant city, in which it is good to live and to work, where the socially weak are protected, and where the ambitions of the economic strong are encouraged and managed*”. One of the

instruments used is the definition of areas, called perimeters, where certain activities like housing, industry, trade and transport activities are promoted or protected.

Regarding urban development the Brussels Capital Region is drafting a regional regulation, called “Projet de Règlement Régional d’Urbanisme”. At the moment 5 parts of this regulation are prepared and discussed :

- *Part I : Characteristics of the constructions and their immediate surroundings*
- *Part II : Standard necessities for dwellings in terms of surface, hygiene, equipment, etc.*
- *Part III : Nuisance due to the realisation of works and conditions for running construction sites*
- *Part IV : Accessibility of buildings for disabled persons*
- *Part V : The thermal isolation of buildings*

With respect to the thermal isolation of buildings a distinction is made between buildings used for housing (dwellings) and office and school buildings. Different requirements are placed upon new construction activities and renovation or transformation activities. The requirements, based upon the NBN B62 series, are summarised in the following table 2.

<i>Real estate</i>	<i>New construction</i>	<i>Transformation or renovation</i>
<i>Houses and dwelling buildings</i>	K55	$K 55 + 10 A_r/s$
<i>School buildings and offices</i>	K65	$K 60 + 10 A_r/s$

Table 2: Thermal isolation in Brussels (under preparation)

(K value as defined in NBN B62-301, A_r is defined as the heat loss surface of the building and s is defined as the sum of the surfaces through which heat loss can take place and which are transformed or renovated)

3.1.2.3 Flanders

The country planning in Flanders is also based on the National Law of Urban and Country Planning of 1962 and has combined with national planning laws originally created in the 70's. Both these lawful means are limited until a passive support comes from the administration. A request for a building permission is given on the basis of the marked zones, or the destination, or delivery, or refused.

In the near future the phases will change and must come via the realisation of the Country Planning. On 24 July 1996 the structural planning in Flanders announced the basis for the inspection of the so named planning decree. The structure planning has therefore stated the whole ground territory of what must occur for the three existing government levels, the Region, the Province and the Community. Following the decree, country structural planning falls into three divisions (one informative, one

directive and one for binding the authorities) which together give a communal vision of the SPATIAL future of an area. It is important that they have a direction and do not give up therefore producing no immediate arguments which could inhibit the delivery of the permission. They have one forceful ability to cast over the authorities, and that is that their direction lies fixed in expert conclusions.

The project of Country Structural planning in Flanders is working together with the planning decrees of the Flemish Government approved from the 1 December 1996 until 28 February 1997 on a Public Research Submission. The plan is for the intended spatial structure of Flanders containing the vision of this structure over a period of 10 years (till the year 2007). The basic principles are :

- concentrated bundling, this is selectively concentrated on the growth of living, working and social functions in the cities and centres.
- the protection of open spaces
- the revaluation/preservation of the city texture/fabric

One essential difference between the four structural components is the definition of the city areas, the outer areas, the areas for economic activity and the line infrastructure. For each of these components there is a basic target which is aimed to consistently achieve durability and quality:

- First and foremost is the striving towards a selective *out building* in city areas. This means that the optimal use is made of the existing city structures.
- Secondly the outer areas are strengthened against further subdivision through the combination of living and working in the villages.
- Thirdly is the aim to selectively concentrate economic activity
- And finally the existing traffic and transport infrastructure should be optimized so that the use of community transport can be maximized and increased

In September 18, 1991, a decision on minimal requirements on thermal insulation for habitations and Flemish public buildings was taken. This regulation is based on the specification NBN B62-301(table 3).

<i>Real estate</i>	<i>New construction</i>	<i>Transformation of a construction with a change of use</i>	<i>Transformation of a construction without a change of use</i>
<i>Houses and dwelling buildings</i>	K55 k _{max} values	k _{max} values	k _{max} values

Table 3: Thermal isolation and ventilation in Flanders (since 1992)

(K value indicates the global thermal insulation quality of buildings as defined in NBN B62-301, k_{max} must be calculated following NBN B62-002)

3.2 Mobility and infrastructure

The high population density and a dense road network, especially in Flanders and Brussels, did put mobility to a high priority for public authorities. In Flanders, this resulted in the start of a mobility policy. The Brussels region is, in mobility matters dependent on Flanders, as Brussels is completely surrounded by Flanders. An important part of the Brussels ring is situated in Flanders.

April 96, a mobility agreement was approved by the Flemish government. From that moment, Flanders possess a framework for a mobility policy, where the responsibility is shared between the Flemish authority, the community and the exploitation company for buses. This framework concerns the construction of new roads, the improvement of the public transport, etc.

The exit point from the mobility covenant is the planning and multi modal hold of the Flemish mobility problem. Such covenants hinder the financing of particular projects of the Flemish Authorities, where no existing initiative and engagements of the community interfere (for example location, administration, remnants of old past ways, take-over of an old past way, through streaming facilities and so on). For the advantages of modular build-up to be seen, the local authorities are obliged to be held to a particular term after the signing of the “mother covenant”, a proposed mobility plan. The mobility plan, within the set framework, will result in action, and then different “export agreements” can be taken up.

3.3 Quality of dwellings

Outside the isolation and ventilation regimentation in the framework of the city buildings, expert planning exists, and recently initiative has been taken to define a minimal quality for sections of buildings. On 6 April 1995 a decree in Wallonia was created wherein a permission to rent was created and where a number of quality norms were defined, though only applicable to particular types of buildings. In fact, it was envisaged that small units (less than 28 m²) would occur where in the three living functions (cooking, living and sleeping) occur. The decree applies only to buildings older than 20 years and has no reference to student quarters.

Also in Flanders in the beginning of 1997, a design for the Flemish Living Code was created. A few minimal qualities for living were defined, with the intention of giving everyone the chance to have a safe, healthy and affordable dwelling, in decent living surrounds. Dwellings not within the minimal quality norms are declared unsuitable or unliveable. Dwellings for rent will be gradually required to complete a “conformity attest.” This means that the living code will be regulated and a number of social dwellings will be improved. In this framework the Flemish Government has already begun to develop a strategy for addressing abandoned buildings and hovels in 1996.

3.4 Environmental management planning

3.4.1 Wallonia

The Wallonian Region targets sustainable development through a large number of regulations and laws. A short explanation is given in table 4 below :

Subject	Objectives	Plans	Information
<i>Environment</i>	“Plan d’Environnement pour le Développement Durable (PEDD)”	<ul style="list-style-type: none"> • Walloon Waste Plan “Horizon 2010” • Water • Nature • Air • Soil 	§ 3.4.1. § 3.6.4.2.
<i>Landscaping</i>	“Schéma de développement de l’espace régional (SDER)”	Sectorial plans	§ 3.2.2.1.
<i>Energy</i>	“Programme de réduction des émissions de CO ₂ ,”	Political declaration on energy	

Table 4: Planification in Wallonia

The “Plan d’Environnement pour le Développement Durable (PEDD)” is dated 9 March 1995 and is intended to clarify and implement the Action Plan Agenda 21. In June 1992 it was introduced and affirmed by the Conference of the United Nations of Environment and Development. Therefore the PEDD will direct the activities, influencing the quality of the environment.

In the PEDD there is thus a long term vision to carry out the development of environmental politics. The foremost intention of the PEDD is to form on a coordinated realisation between the different objectives, actions and mediums that have a relationship with the different environment compartments. Then together, specific action plans can be formulated. The stimulation of a preventative movement is evolving from the concerned parties such as authorities, industry and so on. The polluter pays principle is also emerging.

The PEDD has formulated a number of aims, with over 257 proposed actions. They can be broken down into **sector** dominations (agriculture, industry, transport, energy) and **thematic** dominations (water, waste, etc.).

3.4.2 Flanders

In Flanders, similar plans are being and have been instigated. The first of these was the MINA-plan of 1989, followed by the Environmental Administration Plan and the Nature Development Plan for Flanders, intended for 1990-1995. The 1996 Environmental Projects Administration Plan 1997-2001 (in short MINA-2) undertook to see that a durable sustainable environment and nature administration was developed.

In 1996 it was intended that the Environmental Administration was precisely and unequivocally confirmed in a decree. In particular the Flemish Parliament is involved in the environmental administration in Flanders with three targets : the management of the environment, the protection of the environment, nature preservation and ordering of the biological and landscape diversity. Precise definitions are :

- the management of the environment through the protection of ground cover and nature
- the protection of people and the environment against pollution; and in the special case of the ecosystem which is important for the working of the biosphere and the relationship of food provision, health and other aspects of human life
- the average quality of the environment in the surrounding lands
- loss of nature and environmental damage

Important environmental problems, such as the thinning of the ozone layer and the greenhouse effect, function as themes. Targets are proposed, the administration forms a strategy and intended actions are confirmed and carried out. An important new element in the environmental administration is equal relationships with a specific **target group administration**, that the authorities in the future will work out. The group is one of the 9 target groups where an agenda exists. The agenda point currently being considered which has not been achieved yet is the increase of environmental effects following construction activities.

3.5 Soil remediation

Previously, it was only in **Flanders** who had specific rulings in relation to ground sanitation. The ground sanitation decree of 22 February 1995 and the following detailed conclusion "VLAREBO3 (the Flemish ruling concerned with ground sanitation) have unmistakably had a great impact, also in the construction sector. In many construction enlistments people are frequently confronted with ground resistance, that otherwise only occurs in a risk free situation with ground pollution.

The decree is divided between historical, new and mixed ground pollution. *Historical ground pollution* is that which occurred before 29 October of 1995 , the date of the establishment of the decree. *New pollution* is dated after and the date for mixed pollution is after and before 29 October 1995. The jurisdiction of this authority is most important, as seen from the new ground pollution, automatic sanitation would then become a sanitation norm. Historical ground pollution will continue until sanitation is standard, indeed the pollution is a serious problem formed for the people concerned with the environment and indeed for the authorities. In conclusion it is clear that a definition must be made between sanitation and those answerable for the costs incurred in further sanitation.

In the **Brussels Region** in recent times there has been the intention of creating a specific legal framework for the protection of the soil. Momentarily people here must appeal to the law makers for advancement until the environmental permission (Ordinance of 30 July 1992 and within a short time the ordinance of 5 July 1997) is

instigated. This will state that the permission borrowing authority has the absolute power to return the terrain in the city back to its original state. The Brussel's Waste Law has this power also in a particular number of cases, for example in the disposal of contaminated ground.

Like in Brussels, the people in **Wallonia** have recently begun with defining law establishment. Until now they worked very much with clauses from the regimentation concerning the exploitation permission (see ARAB-RGPT, an integrated environment permission not yet standing in Wallonia; awaiting work with apart exploitation and dump permission) and out of the waste disposal law establishment. Important to mention is the existence of a law concerning "la renovation des sites d'activité économique désaffectés." This law establishment is in fact a fill in under CWATUP (See §3.2.2.1.) and consists of a number of rules concerning sanitation of almost collapsing or abandoned industrial buildings. The sanitation is here greater defined to the sanitation of the ground only, and meaning the possible later use of the reintegration of the site in the built area.

3.6 Energy

Energy troubles are more related nowadays with environmental aspects than the economical arguments of the 70's and 80's. The European CO₂ guiding principal forces all countries to go ahead with further measures in the area of rational energy use. This is a more applicable form of energy use winning more and more thought as an alternative. In Belgium, the European agreements were made concrete in the "Nationaal Belgisch Programma ter Vermindering van de CO₂ -uitstoot-Programme National Belge de réduction des émissions de CO₂" , that was approved in June 1994 by the federal and the regional authorities. The goal was to reduce the national CO₂ -emissions in 2000 by 5% compared with 1990.

The Interministerial Environment Conference of June 1996 decided it acceptable to extend the goal also after the year 2000 under the same conditions and proposed that before the end of 1999 a national leading program with additional measures should be started.

3.7 Construction and demolition waste : State of the art

3.7.1 Introduction

The first construction and demolition waste recycling plant in Belgium started to operate in the 50's. However, the recycling industry was only developed on a broader scale from the seventies onward amongst others due to scientific and technical research. This lead in the beginning of the eighties to one of the most important pilot projects in Belgium, i.e. the construction of the "Berendrecht" lock nearby the Antwerp harbour with recycled concrete produced with recycled aggregates coming from the demolition of the old "Zandvliet" lock (2).

Since then, recycling became more and more a “hot” topic. Nowadays about 90 recycling plants are operating all over the country and can be classified into fixed plants, mobile installations with a fixed location and mobile installations. About 75 % of all the installations belong to the two first categories. The most advanced installations are generally composed of the following elements: a weighing bridge, equipment's for pre-processing (bull, crane, ...), a preliminary sieve to eliminate earth, sand and gypsum (finest materials), a primary crusher, electrical magnet systems, a sieve installation to separate the materials in accordance with the size of the obtained materials, an air sieve or a washing installation and a secondary crusher and sieve installation.

Far the largest part of the recycled aggregates are used in road construction. In addition to the re-use of crushed asphalt this sector takes the crushed concrete and mixed aggregates for use as unbound base-course and sub-base material. The mix material, and to a lesser degree the sieve and crusher sand, is also used in earthworks and raising. These materials are already for some years used as aggregates for treated or stabilised sand and lean concrete produced at mixing installations situated besides the recycling plant. Albeit the processing of masonry rubble is relatively cheap, the market for crushed masonry aggregates remains limited. Therefore, recycling plants may refuse to accept masonry rubble, which leads to the inevitable low-grade, unprocessed application of this inert material.

3.7.2 Amounts of waste materials and recycled products (3)

The production of C&D waste in Belgium is estimated at 8 million tons per year of which about 3.6 million tons/year are processed (i.e. 45 % recovery of C&D waste). This represents approximately 6 % of primary aggregate consumption. However, there are some slight differences between the regions in terms of composition of C&D waste and recycling level (4)(5)(6).

3.7.2.1 Flanders Region (3)(4)

In Flanders, the production of C&D waste was estimated in 1990 at 4.6 million tons per year. A study has shown that approximately 41 % of the waste consists of concrete, about 40 % of masonry and the remaining 20 % is a mixture of bituminous materials (12 %), ceramics (3.4 %) and various other types of waste. In 1990 it was estimated that about 2 million tons C&D waste (43 %) were being recycled a year. At the moment, the level of recycling increased already up to 65 % which represents 3 million tons a year. For 2000, 75 % recycling is expected.

These relatively high figures can be expected taking into account the lack of natural resources. For the moment there are about 80 recycling installations (crushing facilities) for C&D waste in operation in Flanders with a total capacity estimated at 5 million tons per year. At the same time, the high population density, i.e. 425 inhabitants per km², limits the capacity for dumpsites.

3.7.2.2 *Brussels Capital Region (3)(7)*

In Brussels, the production of C&D waste was estimated at 850,000 tons per year. In comparison with Flanders, a larger part of masonry rubble is present in the stony materials fraction. Selective demolition has the priority in the Capital Region since there is no landfilling capacities or recycling plants. Although the purpose was to reach a recycling level of 70 % back in 1996, currently only 50 % is processed in Flemish recycling plants in the neighbourhood of Brussels. The remaining 50 % is reused without processing as on-site fill or for landfill engineering.

Private investors are however planning to start up a brand new recycling facility on the Brussels Capital territory. This should in the near future lead to higher quantities of “real” recycling.

3.7.2.3 *Walloon Region (3)(5)*

In Wallonia, the production of C&D waste is estimated at 2.6 million tons per year. As the Walloon Region has a relatively low population density of 190 inhabitants per km² and a large number of quarries, the interest for recycling was until recently rather limited. However the environmental concerns motivated the Walloon Government to take some initiatives in the beginning of the nineties in order to develop the recycling industry. At the moment this has resulted in the creation of 30 special dumping sites, called “Centres d’Enfouissement Techniques” or CET, and 10 recycling plants, which process about 650.000 tonnes of C&D waste a year.

3.7.3 Information about the recycling industry

The average cost for a demolition contractor for waste disposal at class III dumpsites varies from about 5.75 to 16 ECU/ton, this is excluding transportation costs (see Table 5).

- In Flanders tipping costs for construction and demolition waste are 6.5 ECU/ton upon which an environmental tax of 9.5 ECU per ton has to be added.
- For the evacuation of its waste Brussels has for the moment to rely totally on the recycling and dumping possibilities offered in Flanders and in Wallonia. As already indicated, the Brussels Region doesn’t dump the mineral C&D rubble anymore.
- In Wallonia tipping costs are typically in the range of 2 to 7.5 ECU per ton. An environmental tax of 3.75 ECU per ton adds on to this.

In contrast with this, the recycling plants try to promote selective demolition by using different delivery tariff’s for mixed and clean material. Average prices for delivery at recycling plants are given in following Table 6.

Tax for landfill	<i>Flanders (1995)</i>	<i>Brussels</i>	<i>Wallonia (1994)</i>
Tipping costs class III (1995)	6.5 ECU/ton		2-7.5 ECU/ton
Environmental tax (1995)	9.5 ECU/ton	no dumpsites	3.75 ECU/ton
Sum	16 ECU/ton		5.75-11.25 ECU/ton

These prices are transportation excluded

Table 5: Tax for landfill in the three Belgian Regions

Average prices for delivery at recycling plants	
concrete	free of charge
reinforced concrete	1.25 - 2.5 ECU/ton
heavily reinforced concrete	6.25 - 12.5 ECU/ton
masonry	2.5 - 6.25 ECU/ton
mixed rubble containing plastics, wood	2.5 - 12.5 ECU/ton

Table 6: Average prices for delivery of C&D waste in recycling plants

Most of the C&D waste is processed by the recycling companies into secondary aggregates. The market for secondary aggregates can be summarised as follows:

- Concrete aggregates 80/200 find their application in hydraulic works as filling material for river embankment protection (limited market).
- Concrete aggregates 0/80, 0/56, 0/40, (4/32) with a continuous particle size distribution are the bulk of the production and are mainly used in road construction applications (as sub-base and base material). They are also used for landfilling and for the realisation of unhardened parking areas. In some instances, the material is split in a 0/20 and a 20/40 fraction for example and may be recycled as aggregates in lean concrete. A limited number of recycling plants have a concrete mixing installation using typically a 4/32 fraction for their concrete production (a 100 % substitution of the coarse aggregates by recycled aggregates is in this case of application). The market price of this kind of aggregates is about 5.75 to 6.5 ECU/ton (i.e. about 2.5 ECU/ton below the price of natural aggregates).
- Sieve and crushed sand is mainly sold as sand for pavement sub-bases or for the construction of embankments. Recycling plants having their own mixing installation produce also cement treated or stabilised sand with these products. The market price for this product ranges from about 1.25 to 2.5 ECU/ton.
- In some areas, crushed masonry 0/56 can be used in the private sector for landfilling and unhardened parking areas. The market price lies then around 3.75 ECU/ton. In most cases, however, mixed aggregates consisting of crushed masonry and concrete are used in unbound or bound applications as sub base or base materials. The

market price for these mixed aggregates is slightly lower than the price for crushed concrete and amounts to 5.25 ECU/ton.

- Recycled asphalt aggregates are recycled as base materials for roads and parking areas and reused in new asphalt. The market price is in the range of 3.75 to 5.75 ECU/ton.

As clearly illustrated, it is at the moment the road sector who gives the greatest outlet for recycled aggregates. However, as Belgium has already one of the most developed road infrastructures in the world, roads are mainly renovated and none are constructed. As a result of this the consumption of recycled aggregates in this market is stagnating. Therefore, the recycling industry has a clear need to develop new products or applications for the recycled aggregates in general.

3.7.4 Policy

As a result of the constitutional changes in the three regions, Flanders, Wallonia and Brussels, are taking into account some exceptions, entirely responsible for the formulation of the waste disposal policy. In particular the responsibility to draw up waste management plans has fallen under the authority of the regional administrations "Openbare Vlaamse Afvalstoffen Maatschappij (OVAM)" for Flanders, "Institut Bruxellois pour la Gestion de l'Environnement/Brussels Instituut voor Milieubeheer (IBGE/BIM)" for Brussels and "Office Wallon des Déchets (OWAD)" for Wallonia.

3.7.4.1 Flanders

The Flemish public institute OVAM was founded in 1981 and is responsible for the stimulation of prevention and recycling of waste. The management of C&D waste is based upon:

- the Waste Decree of April, 20th, 1994, in particular article 11 in which the definition of a clear regulation for the utilisation of secondary materials is made possible;
- the application order of this decree concerning hazardous waste for the hazardous fraction of C&D waste;
- the application order of the waste decree "VLAREA" concerning the prevention and the management of waste, approved in June 1997 by the Flemish Government and regulating the use of waste as secondary materials (8). This document is particularly relevant for the construction industry, as it contains a list of waste materials (C&D rubble, etc.) which are recognised as secondary aggregates if they fulfil certain requirements in terms of composition, lixiviation and conditions of use.
- the "Flemish Strategic Waste Action Plan 1991-1995", which is completed by the "Implementation Strategy Plan of Construction and Demolition Waste". The main objective of the latter plan is to realise a level of 75 % recycling of C&D waste for the year 2000. The remaining 25 % should be landfilled within effective and environmental by hygienic conditions.

- the decree of January, 21st, 1997, which approves the inter-regional collaboration agreement for the prevention and management of packaging;
- the technical specifications for public works, developed by the technical services of the Flemish Government. These documents, although not having a regulating character, have a particularly important example function. Since the beginning of the nineties amendments have been published in the form of circulars, which cover the use of recycled concrete and masonry aggregates for the construction of road sub-bases and bases, the use of secondary materials for embankment protection, the use of broken asphalt in lower road layers and the use of "hot recycled" asphalt in upper road layers. These circulars have been recently (January 1997) integrated in the Standard Specifications 250 ("Standaardbestek 250") of the Flemish Government.

A draft proposal in relation to the use of concrete and masonry rubble aggregates in recycled concrete in buildings and civil engineering works (foundations, inner walls,...) was under discussion in 1993, but was not accepted, this was mainly due to the uncertainty about the alkali aggregate reaction with recycled aggregates.

3.7.4.2 Wallonia

The OWAD which was founded in 1991 is the responsible organism for the management of waste in general. The management of C&D waste is based on the following legislative acts and documents:

- the Waste Decree of July, 5th, 1985 and the different application orders;
- the Decree of July, 25th, 1991 relating to the waste taxation in Wallonia and the application orders;
- the Waste Decree of June, 27th, 1996 of which one of the main purposes is to regulate the production of secondary products from waste (9). At the same time, the establishment and exploitation of special dumping sites (CET) is defined.
- the Walloon Waste Management Plan 1991-1995 which considered the prevention of waste and tried at the same time to limit the burden caused by the treatment or disposal of waste. The plan considered all existing technologies such as recycling, waste minimisation, incineration, pre-treatment and landfilling, but didn't specify a clear target level of recycling for C&D waste.

In accordance with this plan and in order to realise a better control of the C&D waste stream, the following initiatives were undertaken by the Government :

- ◊ about 30 special class III dumpsites, called "Centres d'Enfouissement Techniques", were created and managed by the company *Tradecowall* (in which the Government and the construction and demolition sector are represented).
- ◊ Following the conclusions of a study realised by *Tradecowall*, the Walloon Government decided on July, 7th, 1994 to invest through the public company *Spaque* 140 million BEF in the creation of 7 recycling plants.
- ◊ Besides this financial participation, a collaboration agreement between the Government and the Walloon Construction Confederation was signed on July, 14th, 1994 in order to improve the recovery of C&D waste. The main

tools identified were to sensitise and to inform the public and private sector about ways to prevent the arising of waste and to orient the C&D waste stream towards C.E.T.'s and recycling plants.

- The new Walloon Waste Management Plan, called "Horizon 2010" published in June 1997 and at the moment under public inquiry. C&D waste targets for recycling are defined, i.e. 60 % of recycling in 2000, 65 % in 2005 and 75 % in 2010. At the same time disposal of C&D waste at C.E.T.'s should be decreased to a level of 10 % in 2010.
- With respect to the technical specifications for public works, reference can be made to the circular AWA/178-95/150 which deals with the reuse of secondary materials within road works. This circular has already been integrated in the General Technical Specifications CCT 300 of the Walloon Government. In future, the circular will also be integrated in the Technical Specification Document W10 for road infrastructure (9).
- The last important initiative relates to the circular of February, 23rd, 1995 concerning the management and disposal of C&D waste at public works. This circular was published to stimulate the Walloon Administration to dispose of C&D waste in appropriate dumpsites or recycling plants and to promote the recycling efforts in general at public works. Amongst other issues, the Walloon Administration is forced to use transport forms on which the type and quantity of all the waste materials leaving the construction or demolition site must be specified.

3.7.4.3 Brussels

In the Brussels Region, environmental issues in general, and therefore also the waste problem, fall under the competence of the IBGE/BIM, which was created in 1989. The waste management rests on the following documents :

- the Decree of March, 7th, 1991, regarding the prevention and management of waste,
- the Brussels Waste Management Plan of 1992-1995 of which the aim was to realise 70 % recycling of C&D waste by 1996. In order to achieve this goal, major attention was directed towards the promotion of selective demolition.
- the order of March, 16th, 1995 regarding the obligatory recycling of certain types of construction and demolition waste (representing some 95 % of the C&D waste arisings in Brussels) in private and public works. This order forces the contractors to bring this particular waste to appropriate recycling plants situated in the neighbourhood of Brussels.
- the circular of May, 9th, 1995 regarding the reuse of C&D waste in public road and infrastructure works, which is in fact an annex to the General Technical Specification Document 150.

3.7.5 Development of recommendations and regulations

In relation to the initiative of the recycling association V.V.S. and the regional government technical authorities, a voluntary certification scheme for recycled aggregates for use in unbound applications, cement treated sand and gravel and lean

concrete was developed. COPRO is the responsible party for the certification of these aggregates.

At the moment a technical prescription for recycled concrete, masonry and mixed aggregates is being drafted in order to enable to grant a BENOR quality label to these aggregates. It is made by a CRIC¹-working group reporting towards the National Management Committee for the Certification of Aggregates.

3.7.6 References

1. CUR, CSTC, Eerland Recycling services, Brite-Euram Contract BRRT-CT-0048, "Use of Recycled Materials as Aggregates in the Construction Industry : State-of-the-Art in Europe", August 1997.
2. D. Morlion, J. Venstermans and J. Vyncke, "Demolition waste of the Zandvliet Lock as aggregates for concrete, Proceedings of the second international RILEM Symposium, Tokyo, Japan, 1988.
3. J. Desmyter et al., "Towards sustainability with construction and demolition waste in Belgium", in Environmental Aspects of Construction with Waste Materials, J.J.J.M. Goumans et al., Elsevier Science, 1994.
4. "Uitvoeringsplan bouw- en sloopafval", OVAM, 1995.
5. Plan Wallon des Déchets, Horizon 2000, Namur, June 1997.
6. "Guide de gestion des déchets de construction et de démolition", IBGE-BIM, 1995.
7. "Bilan après trois ans de plan déchets", Construction, Brussels, March 1996.
8. "Vlarea legt gebruikscertificaat op voor hergebruik bouw- en sloopafval", Bouwkroniek, July 1997.
9. "Recyclage des déchets inertes issus de la construction et de la démolition", Journée d'étude, Office Wallon des Déchets, Namur, November 1996.

3.8 RTD initiatives

3.8.1 Use of energy

In December 1991 the Flemish Government started an impulse program for Energy Technology between 1992 and 1995, the VLIET-program. For this there was 800 million Belgian Francs available. Before the continuation of this program there was more than 277 million Belgian francs extra available, so that further support could be given to research programs in the subject of energy and energy economy and renewable energy sources.

Interesting to mention is that the previous VLIET-program spent about 20% of the resources concerning heating and ventilation of buildings. About 35% of the support

¹ CRIC : Certification organism for cement, aggregates, concrete, fly ash and additives.

was orientated with research concerning renewable energy forms, for example wind, water, solar cells, bio-mass, storage and management.

During this year the Flemish Institution for Rational Energy Use will be opened, which, in the future, will play a co-ordinated role in the area of rational energy use.

3.8.2 Environmental programmes

In 1990, the Flemish government also started a 4 year impulse programme for research in the environmental field "VLIM" (Vlaams Impulsprogramma Milieutechnologie). In this programme, feasibility studies, research programmes and demonstration programmes were granted as well as more sociological studies.

3.8.3 Other

The Belgian construction industry has its collective research centre, the Belgian Building Research Institute (BBRI). Research was carried-out on several environmental themes, such as:

- the inner climate of buildings
- the recycling of construction and demolition waste
- new recycled materials for construction
- isolation (thermic and acoustic)

3.9 Information and training

3.9.1 Technological guidance

Within the BBRI, new technological developments are transferred to the industry by technological guidance. The task of technological guidance is to inform and train professionals in the construction industry to deal with new developments.

New guidance was created in 1994 in order to stimulate recycling and to help companies to minimise waste generation.

3.9.2 Presti-Projects : Programs for waste disposal in business

In 1994 the first subsidy program was started for the prevention of rubbish in Flemish businesses - the PRESTI-programme. Due to such great demand the Flemish government has the PRESTI-2 and PRESTI-3 programs approved. They shall both run until the end of 1998.

The PRESTI-2 program has the goal of encouraging the federation to work together with a minimum of two businesses from the sector testing prevention. Following this will be the application in business of the expansion campaign, specially directed towards middle sized businesses. The goal is of course to achieve results as examples to give in this manner to other businesses, and to continue until the adaptation of the

same measures. The PRESTI-3 program encourages businesses to take on the available existing knowledge in waste prevention to try out and therefore to begin a prevention plan.

4. DEMONSTRATION PROJECTS / CASE STUDIES

4.1 The centre for Sustainable Construction (Heusden-Zolder)

The new project Centre for sustainable construction, is planned for a renovated ancient mine building. The renovation will be carried-out as a large demonstration project in the field. It will contain conference- and meeting rooms, demonstration facilities, space for starting companies a child museum etc. In the neighbourhood of the centre, there is space for demonstration buildings and for new companies, operating within the framework of sustainable construction.

The centre is a joint initiative between the Construction sector (BBRI, Federation of construction industry, ...), the Energy sector and Public authorities (Flemish Waste Administration, Water supply administration ,...)

The centre will co-ordinate different initiatives in Belgium and in the Euregio in the field of sustainable construction, stimulate application, demonstrate new technologies and show concrete products and services.

The development of vision will be the task of the “creative cell”, an autonomous think-tank, steered by an independent scientific committee.

The information for the public will be organised by answering services, exhibitions, conferences, special demonstrations, etc. These will be organised within 6 monthly themes, such as “the circle of construction materials”, “energy a limited resource”, “the man and the water”, “Made from recycled”.

4.2 The mobility plan of the city of Hasselt

Several cities have implemented a mobility plan within the framework, described in § 3.2. Examples are the public transport plan in Brugge (parkings around the city and busses, bringing visitors into the centre) and the traffic plan of Gent (a channelling of the car traffic).

An interesting case study is the city of Hasselt, where an overall mobility plan is implemented. Elements of this plan are:

- traffic black points were inventorised and as much as possible adapted
- a “speed reduction plan”: 30 and 50km/hr in inhabited areas; 70 and 90 for other roads
- the inner ring of the city is completely reorganized:
 - ◊ reduction of a 4 lane-road to a 2 lane one
 - ◊ traffic is only admitted in 1 direction

- ◊ the new space is used for “slow traffic” (walking and biking) and trees
- a complete network of bike-lanes
- public traffic:
 - ◊ increase of the bus traffic by a factor 4
 - ◊ all buses are free within the city
- large parking areas outside town, free bus-shuttles to the centre

The first monitored results of this plan are expected in December '97, however, the first months of the new public transport plan showed an increase of the use of buses by a factor 10 and a considerable decrease of car traffic within the centre of town.

4.3 Pleiade

The PLEIADE (Passive Low Energy Innovative Architectural DEsign) dwelling is the Belgian contribution in the framework of the Task XIII project of the International Energy Agency (IEA). IEA Task XIII started in 1989. In total, 12 countries participate in the project : Austria, Belgium, Canada, Denmark, Finland, Germany, Japan, The Netherlands, Norway, Sweden, Switzerland, and the United States. The aim is to build in all participating countries a dwelling which should be for the period 2000-2010 a realistic low energy solar dwelling. It means that an important boundary condition is that the techniques to be used should be cost effective within 5 to 10 years.

For Belgium, the Belgian Building Research Institute together with Architecture et Climat of the University of Louvain-La-Neuve take part in IEA Task XIII. The Belgian participation is financed by the Walloon Region. Besides these 2 teams, a large number of other organisations are involved in the project :

- Electrabel which is the Belgian electricity and gas company. Electrabel acts as owner of the dwelling. Moreover, two of its laboratories, Laborelec (for all electrical applications) and A.R.G.B. (for all gas applications) are fully involved in the project and are responsible for the heating systems to be used in the dwelling. A gas system as well as an electrical heating system are installed in order to allow a comparison between different systems;
- a professional architectural office, led by Ph. Jaspard;
- COMITA which is the association of all Belgian thermal insulation associations. The major role of COMITA is related to the choice and installation related aspects of the thermal insulation and glazing systems;
- Belgian Centre for Domotics (BCD), which is the Belgian association of organisations involved in domotics;
- a whole range of sponsors.

The “Pleiade“ building is in fact a two-storey row house of about 240m² net floor area (including the attic which is part of the inhabited space) located in the new city of Louvain-la-Neuve. Special attention is given to the integration of the bioclimatic architectural concepts, the achievement of good thermal comfort in winter and summer, and good indoor air quality. Accordingly the design of the envelope was

important. Daylighting the central part of this 10 m deep row house was another objective.

A balanced ventilation system with heat recovery supplies fresh air to the bedrooms and recirculated air to the living rooms. During hot periods shading of the south-facing glazing and night-time natural ventilation reduces or eliminates overheating. Two heating systems, a gas air heating system with a four-zone control system, and an electrical heating system were installed for experimental purposes. A home control system ensures optimal energy use and thermal comfort. The system is also used for other functions, such as home security.

Other interesting technical aspects of the dwelling can be summarised as follows :

- the concrete blocks internal walls constitute the dwelling structure while the facades are made of light prefabricated highly insulated panels (up to 25 cm insulation). This option consequently guarantee a high thermal inertia which plays an important role in the prevention of overheating;
- the dwelling is equipped with improved double glazing (Argon filling and double low-emissivity coating);

4.4 The recycled house

This demonstration project concerns the construction of a demonstration building incorporating a significant proportion of new materials derived from recycling building debris and from the reuse of waste or by-products from other industrial sectors. The goal is to demonstrate that it is possible in the construction sector to make use of a high proportion of recycled materials without harming in any way the functional properties of the building or without increasing the construction costs. The project covers all the traditional phases of construction. It begins with the planning stage and includes materials selection, specifications, etc. until completion of the building and the access routes. It will be built on CSTC's experimental station site at Limelette (Ottignies - Louvain-la-Neuve) and will consequently be accessible at all times.

5. THE HORIZON OF THE YEAR 2000 : THE CONSEQUENCES FOR THE CONSTRUCTION INDUSTRY BY 2010

5.1 City planners and the built environment

Belgium is a very fragmented country, with a lot of construction along roads (“ribbon construction”). This results in a lack of open space. There is a high population and road density. As a consequence, tendencies in city and country planning are

- the use of the space is more and more regulated with
 - ◊ respect for open space and green areas

- ◊ discourage fragmentation
- stimulation of renovation
- other type of city planning (better planning of mobility, traffic reduction etc.)

5.2 Initiating, designing, constructing and demolishing

The main points of attention in these fields are:

- prevention of waste
 - ◊ separation during demolition
 - ◊ stimulation of the use of recycled material
 - ◊ stimulation of renovation
 - ◊ more standardisation
- energy saving
- water saving
- acoustic insulation

5.3 Components, materials, services and assembly

As in Belgium most construction of houses is carried-out for private families, tendencies are strongly initiated in a “market pull” situation. Therefore sensibilisation is extremely important. However sustainability and environmental soundness is more and more a commercial issue.

On the level of technical and scientific development, following issues are important :

- Combination of characteristics
 - ◊ energy (insulation & energy content)
 - ◊ waste
 - ◊ impact on environment
- Life-cycle analysis
- Environmental standards
 - ◊ Composition
 - ◊ Leaching

5.4 Human resources and skills

On the level of human resources and skills to be developed, there are tendencies toward

- More specialisation in the environmental field
- But also the need for more multidisciplinary skills
- Sensibilisation and information of the public (see § 5.3) is done by different instruments:
 - ◊ Changing economic environment : environmental costs are put on products. An example is the tipping fees on waste. (see § 3.7)
 - ◊ "Presti" projects are an instrument to promote sensibilisation actions, organised by industrial sectors
 - ◊ Sensibilisation campaigns are organised by the public authorities

6. CONCLUSIONS

As in other countries, quite some initiatives are taken in Belgium to implement principles of sustainable construction.

Specific to Belgium is:

- the regionalization of the country gave autonomy to the regions, which develop their own policy and put their own accents in issues, related to sustainable construction
- the importance of construction by private people requires an own approach of sensibilisation actions.
- the high population density and fragmentation of the space

For the future (horizon 2010), this means:

- an increased regulation on the use of land with more respect for open space and green areas
- stimulation of renovation of existing buildings
- more mobility planning and new concepts for city planning within these frameworks
- more waste prevention and recycling and
- increasing environmental costs (waste treatment, emissions, ...)
- attention for saving resources (energy, water, primary materials)
- on the scientific level: higher importance on global studies such as:
 - ◊ life cycle analysis
 - ◊ multi-criteria evaluation of materials, services, constructions,...