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ON AGENDA 21 FOR LATIN AMERICAN AND CARIBBEAN *CONSTRUBUSINESS* - A PERSPECTIVE FROM BRAZIL

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ABSTRACT

The subject of this paper is about an analysis of the challenges to make this complex sector more sustainable in the Latin American and Caribbean (LAC) region. The regional economic, social and environmental characteristics are presented. The relative size of the construbusiness in LAC economies is discussed. The relative importance of its environmental loads is discussed based on available CO_2 generation data as well as on some available local studies' results of construction wastage and construction and demolition waste generation rates.

Some items to be included in a regional Agenda 21 for the Construbusiness are presented based on the regional specificities as well as on the global Agenda 21 for Sustainable Construction proposed by CIB. Reducing building material wastage, increasing the use of recycling wastes to new building materials, energy efficiency in buildings, water conservation, indoor air quality, quality of products and processes, durability and maintenance, social aspects are treated amongst others as important issues to be in a regional Agenda 21. The regional vision on Sustainable Construction is accessed by the ongoing regional actions. Challenges for the research communities are identified.

1. INTRODUCTION

Construbusiness is a word in English (etymology: construction + business) created by Brazilian construction associations to describe the totality of the construction business related activities. It includes as role-players the building contractors, designers, materials producers, building systems producers, financial agents, researchers, governmental institutions, water, telephone, electricity and sewage suppliers, environmental organizations and consumers. It was created as an analogy with the agribusiness concept, conceived in the middle 1950's to represent all agricultural related business (MERRIAM WEBSTER'S, 2000). It is a systemic concept that implies a perception of the construction related challenges from a broader perspective, considering the interrelations between the various role-players in the construction process and products life cycle. It also implies building and sustaining a tight and, some times uneasy, partnership between all players in order to find new integrated solutions to old problems or new challenges. This kind of system thinking and acting has proved to be useful to help Brazil improve its construction industry in many aspects, including the environmental related ones.

In the opinion of the authors, *construbusiness* is a way of describing and approaching the building and construction sector that helps to successfully achieve a sustainable construction because of its systems approach and inherent democratic way of acting. There are many perceptions of the concept of sustainable construction but whichever view one takes, it implies holistic thinking with regards construction and management of the built environment with a life cycle perspective. It does not only imply new environmentally-orientated construction designs but also new, environmentally-friendly operation and maintenance procedures. The building materials must not only be produced in sustainable way, but also answered according to new requirements deriving from holistic environmental prerequisites. There is no sense in producing a cladding glass in a very environmentally-friendly and certified way if the glass sheet is going to be marketed in as a façade or a roof in a Brazilian temperate climate.

Construction is a very big and complex industry and services network according a total *construbusiness* perspective. The subject of this paper is about an analysis of the challenges to make this complex sector more sustainable in the Latin American and Caribbean (LAC) region. Latin America and the nearby region of Carib include 33 countries (ECLAC, 2000), ranging from small islands to large nations like Brazil and Mexico.

This paper takes primarily a Brazilian point of view, which certainly affects its contents. Brazil is by far the largest and certainly the most industrialized country in Latin America and Caribbean (LAC). Perhaps due to its unique Portuguese colonization it used to be the least integrated country in the otherwise Spanish colonized and speaking region. The paper is also a first approach on the theme, and builds on information that is far from exhaustive.

2. Construction and the Latin American and Caribbean (LAC) Societies

2.1 Introducing Latin America and Carib

Latin America and Carib (LAC) are the most urbanized among the developing regions of the world. In 1995 about 74% of LAC's 484,3 million inhabitants lived in cities (Mac Donald and Simione, 1999). In the year 2000, 174 million of those inhabitants are estimated to be living in one of the 59 cities larger than 750 thousand inhabitants located in the region (Mac Donald and Simione, 1999).

Table 1 presents World Bank comparative data of Latin America and Carib (LAC) versus developed countries. The LAC GNP is about 15% of the high-income countries. The GNP growth has been rough following the population growth during the last five years, which means that globalization is not improving life standards. If the average GNP is low, the income distribution makes it worse. According to the regional average, the 10% richest earn between 4 and 13 times more than the 40% poorest (ECLAC, 1999). As a direct result, in 1996, 36% of the households were below the poverty line in 18 of the LAC countries (ECLAC, 1999). In most countries of the region, a wealthy economic elite has developed consumption standards equal to those of the richer people in the developed world.

For most LAC citizens, with the possible exception of those from the socialist Cuba, their dream is to live in a first-world society, because they believe it is the kind of society that can assure its citizens better living standards. For these citizens, development means more industries, cars, highways, consumer goods and, of course, better security, health and education.

The average LAC citizen's life is poor and is also about 9 years shorter compared to those of the richest countries (Table 1). LAC exports mainly agricultural and mineral commodities. Manufactured products are mere 11% of the total exported goods (Table 1).

The region per capita total energy consumption is about one fifth of the higher-income countries (Table 1) and one-eighth of the North America (WRI, 2000).

Energy is obtained in a more sustainable way. About 66% of its electrical energy comes from hydroelectric or geothermal sources (ECLAC, 2000).

Despite having very high-polluted cities like Mexico City and São Paulo, the region does have a relatively low per capita contribution to the major global pollution problems, like global warming. The per capita total CO_2 release is well bellow the world average (Figure 1). It is about 6 times lower than USA and Canada and 4 times lower Germany. Considering the CO_2 fixation capacity of the forests, the LAC contribution of CO_2 concentration is even lower.

Table 1 – Comparative data between 23 countries of Latin America and the 43 countries with the highest income (adapted from original tables of WORLD BANK, 2000)

Data Profile	High income			Latin America and Carib		
	1995	1998	1999	1995	1998	1999
People						
Population, total (million)	870.3	886.6	890.9	477.7	501.3	509.2
Population growth (annual %)	0.6	0.6	0.5	1.7	1.6	1.6
Life expectancy at birth, total (years)		77.7			69.7	
Mortality rate, infant (per 1,000 live births)	6.3	5.8			30.9	
Environment						
Surface area (million sq km)	32.1			20.5		
Forest area (million sq. km)	6.4			9.1		
Forest area (%)	19.9			44.4		
Annual deforestation (% of change)	-0.2			0.6		
Commercial energy use (kg/oil eq. per capita)	5,244.5			1,109.3		
Electric power consumption (kwh)	7,967.1			1,296.5		
Economy						
GDP at market prices (current 10^{12} US$)	22.8	22.6	23.7	1.7	2	2.1
GDP growth (annual %)	2.4	1.9	2.7	1.4	2.0	-0.3
GNP per capita, Atlas method (current US$)	25,720	25,530	25,730	3,380	3,880	3,840
Agriculture, value added (% of GDP)	2.0			8.2	7.8	8.0
Industry, value added (% of GDP)	30.7			32.7	28.6	29.4
Services, etc., value added (% of GDP)	63.8			59.1	63.6	62.7
Technology and infrastructure						
Telephone mainlines (per 1,000 people)	526.9	567.2		91.7	122.8	
Personal computers (per 1,000 people)	205.2	311.2		19.8	33.9	
Roads, paved (%)	**90.0**	**94.0**		**24.2**		
Trade and finance						
Trade (% of GDP, PPP)	38.7	38.3		16.0	19.1	
Of manufactured exports(%)	20.6			8.2	11.7	

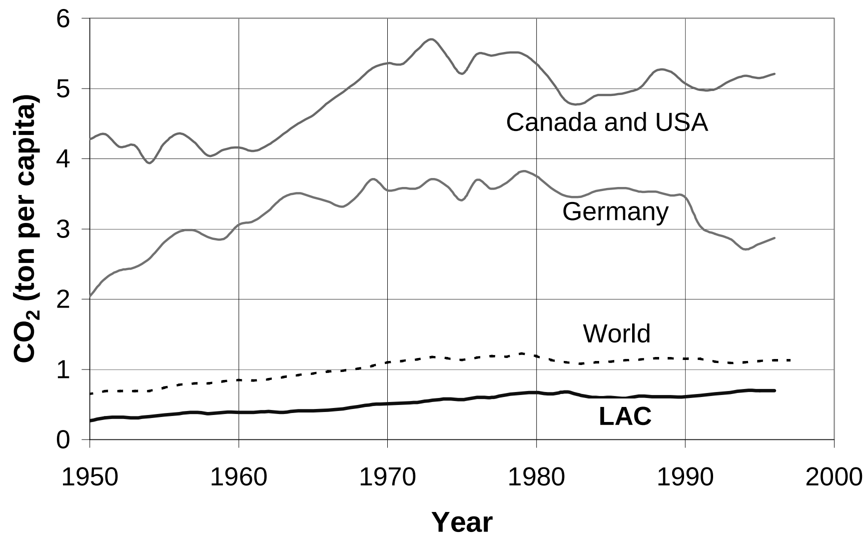

Figure 1 – CO_2 per capita of Latin America and Carib, World, Germany and USA and Canada (original data from MARLAND, BODEN & ANDRES, 2000).

The balance of payments is negative, with the current account of US \$ -90 10^6 in 1998, a figure more than double than in 1996 (ECLAC, 1999). As a consequence, the foreign debt rose to US \$736 10^9 (1998), 35 % of its total GNP times.

As a whole, LAC countries are becoming poorer. During the last decade most of the LAC countries were deeply committed to reducing their inflation rate. Nowadays, annual inflation rates are typically bellow 12% and the governments are still conducting a strict fiscal policy, reducing the public deficit, with significant reduction of social investment. The interest rate is, in general, much higher than in higher-income economies (CALCAGNO, MANUELITO & RYD, 2001).

LAC is one of the most forested regions of the world, with about 44% of their land covered by forest (see Table 1, WORLD BANK, 2000). This rate is double that observed in the higher-income nations. A major problem is that about 90% of LAC forest area is in the Amazon region. It covers 40% of Brazil's total area, and also parts of Bolivia, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela. It constitutes 70% of the world's rainforests and 20% of the world's fresh water (The Amazonian Parliament, 2001). The preservation of this enormous forest seems to guide most of the international efforts related to sustainability in LAC.

LAC also have abundant water resources (Table 2), despite the fact that water is a scarce resource in some regions, like in some inland areas of the Northeast of Brazil as well as in big cities, like São Paulo.

Table 2– Freshwater resources and withdrawals in LAC region in comparison with other regions and the world (WRI, 2001). Dom = domestic. Ind. = industry. Agr. – agriculture

Region	Availability per capita (m^3/year)	Withdrawals per capita (%)	Sectoral Withdrawals (%)			Year
			Agr..	**Ind.**	**Dom**	
World	7,045	9	67	19	9	1995
Europe	3,981	18	39	45	14	1995
South America	34,791	1	60	11	20	1995
Central America /Carib	6,290	10	X	X	X	1995
Costa Rica	27,936	5	80	7	13	1997
El Salvador	2,820	4	46	20	34	1992
Mexico	4,136	19	78	5	17	1998
Bolivia	37,941	0	87	3	10	1987
Chile	61,007	2	84	11	5	1987
Brazil	31,849	1	61	18	21	1992

2.2 CONSTRUBUSINESS IN LAC

In several ways, LAC is under construction. Somewhere between 76 and 84 % of the $3{,}1x10^6$ km of LAC roads are still unpaved (Table 1 and ECLAC, 2000). Traditional paving is known to use a great amount of natural resources. In higher income countries about 94% of the roads are already paved.

Shantytowns are part of the built environment in most of the countries. In 19 countries of the region there is a need to construct 17 million new houses (MAC DONALD & SIMIONI, 1999). In São Paulo and Rio about 20% of the population live in shantytowns (CLICHEVSKY, 2000).

Modern urban infrastructure, like piped water, electricity and sewage piping systems are relatively scarce in LAC (Table 3). Sewage treatment is even more rare because the piping systems are expanding faster than the treatment stations (ECLAC, 2000 b). In 1996, the Inter-American Development Bank's estimation was that only 5 to 10% of the wastewater undergoes proper treatment (FOSTER, 1996).

Table 3– Houses with services (% of total). Data from ECLAC (2000) from years 1990 and 1980 related to 19 LAC countries

	Max	**Median**	**Min**
Piped water	92.5	76.70	57.5
Sewage piping system	84.2	52.2	7.2
Electric lighting	99.4	85.3	39.6

The contribution of the construction sector to the GNP varies highly according to macroeconomic factors. Nevertheless, according to the Inter-American Development Bank the share of the construction industry to the LAC's GNP has been between 6,1% to 6,9% from 1991 to 1997 (IDB, 2001). The Inter-American Federation of Construction Chambers shows that the participation of the construction industry is responsible for 2,5 to 11.4% of the country formal jobs. But these figures represent only the formal portion of construction industry. In LAC a very significant portion of the houses is being built by the family members themselves, normally with the help of relatives and friends. In Bolivia, this kind of production scheme is responsible for 45 to 55% of the total urban houses produced every year (CLICHEVSKY, 2000). Even so this kind of construction is part of the *construbusiness*, because it uses industrial building materials most of the times. As a consequence, in Brazil, most of the Portland cement and paint is sold to these smaller consumers.

In LAC, small local companies produce very important portion of building materials, like red ceramic bricks. Consequently, it is difficult to obtain accurate data about its size and environmental impact. Table4 presents some data about the production of steel-related products and Portland cement in the region. Brazil is among the world five biggest producers of ceramic tiles, with a production of $428x10^6$ m^2. About 90% of this amount is consumed inside the country and 10% exported worldwide (ABC, 2001). The Brazilian Ceramic Society (ABC, 2001) estimates an annual production of $60x10^6$ ton of red ceramic components, like bricks and roof tiles. About 11,000 small companies are in this very traditional business and production losses (energy and material) are estimated to be around 30%.

The local production of building materials and self-construction scheme help make *construbusiness* bigger than the construction industry in most LAC countries. For example, in 1997 the construction industry itself was responsible for 9,8% of the Brazilian GNP. In the same year the *construbusiness* was 14,8% of the Brazilian GNP, with total revenue of US $ 128 million (FIESP, 1999). For comparison, *construbusiness* is estimated to be responsible for 11% of the European Union GNP (CIB, 1999).

Table 4 – Production of selected important building materials in LAC, Brazil and Mexico (ECLAC, 2000)

Product	Year	Production (Mton)			Number of countries
		LAC	Brazil	Mexico	
Pig iron	1998	33 457.0	25 257	4 454	8
Steel	1997	52 448.4	26 153	14 218	> 12
Non flat rolled steel products (1)	1997	16 004.0	5 815	5 059	> 11
Portland Cement (2)	1995	94 629.4	28 256	24 429	23

(1) Includes bars and light sections, wire rod, rails and heavy sections.
(2) does not include Haiti

2.3 ENVIRONMENTAL IMPACT OF CONSTRUCTION IN LAC

The global environmental impact of this sector, from raw materials extraction, materials production, transportation, construction, use, maintenance and demolition is important. As a result of being under construction and the high economic importance of the construction industry, it is possible to estimate that the *construbusiness* environmental impact is relatively higher in LAC than in developed countries.

Materials consumption by the LAC construction industry might well be higher than the 50% of total material consumption estimated in Japan (KASAI, 1998) and even higher than the 75% estimated for the USA (MATOS & WAGNER, 1999).

Construction demolition waste is a result of construction wastage, maintenance and demolition. Due to illegal deposition, it is very visible in most big cities of Latin America. Construction and demolition waste generation estimates vary worldwide from a mere 163 kg per capita to 3 658 per capita, with typical values above 400kg per capita (JOHN, 2000). This

great variation can be explained as result of:
(a) different definitions for construction and its waste;

(b) technological differences; and

(c) the different levels of construction activity, among others.

Estimations for LAC countries are scarce. PINTO (2000) has made estimates for the construction and demolition waste generation in 6 different Brazilian cities with populations ranging from 242 000 to 625 000 inhabitants. From this author's data it is possible to estimate that per capita generation rate varies from 330 to 630 kg/year, with a median of 486kg/year. This estimation includes informal construction but does not include residues from paving. The same author estimates that during the construction of a typical Brazilian building 150 kg of waste is generated per square metre. Overall, the amount of construction and demolition waste in Brazil is considered to be significantly higher than the domestic solid waste.

In Chile, The National Environmental Commission (CONAMA) estimates an annual generation of construction and demolition waste of $3.5x10^6$ ton/year (MEIER, 1998), which for a population of $14.8x10^6$ inhabitants (ECLAC, 2000), corresponds to a generation per capita of 236 kg/year. This amount is slightly higher than the domestic solid waste generated in the country. SUAREZ; MALAVÉ (2000) estimates 0.06 m^3 of construction waste for each square metre of building in Colombia.

Deposition of construction demolition waste is frequently illegal because there are no or few landfills that accept this waste in the region (UNEP, 2001), spoiling the landscape, and when dumped in watercourses can cause urban flooding.

The transportation of the waste can represent a significant cost for the building contractor (UNEP, 2001). In big cities of Brazil, transportation of one cubic metre of construction or demolition waste costs between US $4.5 to 8 (PINTO, 2000), and is a wealthy and growing business.

Materials consumption and construction waste rates are increasing due to high materials wastage rates at building sites. Material wastage rate can be defined as the amount of material consumed in addition to the planned amount (in percentage). Part of the wastage is actual waste as litter and part is unnecessarily incorporated in the building. A recent Brazilian national survey on building site material wastage was conducted by 17 Brazilian universities and investigated 80 building sites from 52 building contractors (AGOPYAN et al., 1998). The survey succeeded in showing that actual wastage rates (Table 5 shows some results), that are higher than the figures assumed by the companies.

Table 5 - Building material wastage during construction both as waste and over thickness (AGOPYAN et al., 1998). Values are expressed in percent of the planned material consumption.

	Portland Cement	**Steel rebar**	**Concrete and ceramic blocks**	**Sand**	**Ready-mix concrete**
Minimum	6	2	3	7	2
Maximum	638	23	48	311	23
Median	56	9	13	44	9

The impact of the production of Portland cement on CO_2 generation is very well documented. Figure 2 shows that the impact of the Portland clinker production is 4% of the total CO_2

released in the region. This value is much higher than that observed in developed countries and is even above the worldwide average of about 3%.

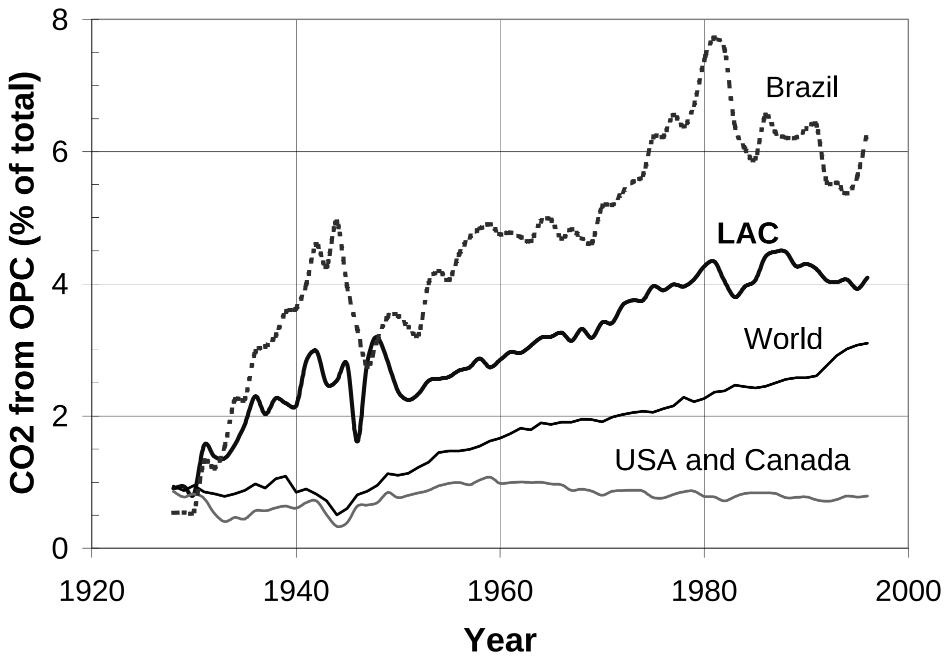

Figure 2 - Participation of clinker decomposition of limestone during clinker Portland production in the total CO_2 released in Latin America and Carib, Brazil, World, and USA and Canada (original data from MARLAND, BODEN & ANDRES, 2000). This figures does not include CO_2 due to combustion.

Buildings consume energy in all stages of its life, from the building materials production stage to the building demolition. **Table 6** from WRI (2000) shows the contribution of the use of buildings to the total consumption of energy. It varies over LAC from about 18% in Brazil up to 46% in the Dominican Republic, but the average is not very different from the higher income countries. Consequently, the average LAC house uses about one-fifth of the energy of a house located in one of the high-income nations (Table 1). The operation of buildings is responsible for consuming more than 50% of the Brazilian electric energy (LAMBERTS & WESTPHAL, 2000), and this share is growing. The main electricity uses in Brazilian houses are: refrigerators (33%); water heating (26%); and lighting (23%). Air conditioning use is growing but has still a low impact in this sector due to low saturation in the market (Geller 1991, LAMBERTS & WESTPHAL, 2000). In 1995, 40% of the Peruvian electricity was consumed by private houses and 69% in indoor illumination (CAMPODÓNICO, 1998). The contribution of *construbusiness* to global energy consumption is much higher, because these figures in Table 1 do not include either the production phase of building and its materials or its demolition.

Table 6 – Total energy consumption distribution for economical sectors (data from WRI, 2000)

Region/Country	**Residential**	**Commercial + Public**	**Agriculture**	**Transportation**	**Industry**	**Total**
World	27.1	7.4	2.8	24.8	32.2	94.3
Europe	27.1	7.3	4.0	23.0	32.9	94.3
North America	17.3	12.6	1.2	38.1	26.3	95.5
LAC	21.3	3.4	2.4	31.8	39.4	98.3
South America	16.8	5.0	4.8	32.7	37.3	96.6
Argentina	19.8	6.6	6.7	33.8	29.2	96.1
Bolivia	32.7	1.6	1.6	34.9	28.7	99.5
Brazil	13.5	4.8	5.2	32.3	41.4	97.2
Chile	25.4	0.8	1.3	29.2	36.8	93.5
Dominican Rep	46.3	0.0	1.0	29.9	20.5	97.7

In LAC, an average 50% of the treated water is wasted due to leakage of the pipe system (HUEB, 2000). As in the rest of the world, buildings are not the main consumers of water (Table 2) but concentration of both buildings and population can cause local water shortage.

Because it is under construction, and because of the regions relatively low degree of industrialization and despite the self-construction scheme, the environmental impact of c*onstrubusiness* tends to be even more important in LAC societies than it is in the high-income nations. And, it is important to note, that the infrastructure and housing construction are expected to grow in the following years, increasing the environmental impact of the *construbusiness*.

3. AGENDA 21 FOR CONSTRUCTION INDUSTRY IN LATIN AMERICA

In this first approach, the selection of items for the Agenda 21 for LAC *construbusiness* has been made considering the global Agenda 21 on Sustainable Construction, prepared by the CIB in 1999, as well as some society environmental, social and economic characteristics of the LAC region. Environmental aspects that are now under discussion in the region are also selected.

The CIB Agenda 21 on Sustainable Construction (CIB, 1999) describes the challenges that the construction sector has to overcome to collaborate in a sustainable development under the headings (1) management and organization; (2) product and building issues; (3) resource consumption; (4) impacts of construction on sustainable urban development; (5) environmental loads; (6) social, cultural and economic issues. In this paper, a different approach is adopted. The suggested items to take part of an Agenda 21 for LAC's construbusiness are hopefully more easily perceived by the construbusiness roleplayers as an action plan. Most of suggested items are related to more than one of the six cited CIB's Agenda 21 challenges.

It is necessary to mention that this chapter item is based on an original contribution of the Department of Civil Construction Engineering of Escola Politécnica, University of São Paulo.

This contribution is aimed at helping the discussion of the Brazilian local Agenda 21 for the *construbusiness* (see JOHN et all, 2000).

3.1 Reduction of building material wastage

Reducing material wastage has several environmental effects. It reduces the amount of construction waste and, in the long term, the amount of demolition waste. It also reduces the global material consumption and has an impact on construction costs, making houses more affordable, which is very important in a region where about 50% of consumers cannot afford a proper house.

The measured waste rates in Brazil reveal great differences in total wastage between building sites using the same technologies (Table 5). This reveals the great influence of management, design and culture practices on the wastage rates. Some improvement can be achieved by education, site planning, management and design practices, but the use of new technologies can be also important.

Waste reduction and management in building sites is also very important and has been investigated in Chile and Brazil (CCC, 1999, PINTO, 2000, GREGOLI, 2000).

3.2 Increasing the use of recycled wastes as building materials

When properly done, recycling wastes as building materials is a convenient way to reduce the environmental impact of the construction industry. It has several potential environmental advantages (Table 7): (a) helps reduce the consumption of natural resources; (b) reduces the deposition of landfill; (c) can reduce the energy consumption on the materials production and all its associated pollution; (d) can result in more durable materials (JOHN & ZORDAN, 2001).

The LAC's Portland cement industry recycles industrial wastes in countries like Mexico (CEMEX, 1999), Colombia, Chile, Argentina and Brazil. In Brazil the Portland cement industry is the biggest recycler processing more than $5x10^6$ ton/year of blast furnace slag and fly ash (JOHN, 2000). Depending on the availability, clinker Portland is blended with granulated blast furnace slag, fly ash or other pozolans, with important benefits in terms of energy, CO_2 generation among other impacts.

Most of Brazilian steel concrete rebar is produced on electric arc furnaces, using mainly steel scrap as raw material. The Latin America Iron and Steel Institute reports that the use of the electric arc furnaces is growing in LAC and on average, electric arc furnaces are responsible for about 40% of the steel produced in the region (ILAFA, 2001). But the environmental benefits of these activities are scarcely publicized to the consumers.

The Brazilian Ready-Mix Concrete Association is developing an Environmental Programme that will include recycling water and fresh concrete, which is returned to the plant (ABESC, 2001). In Colombia, CEMEX reports that water has been recycled in three operational concrete units, reducing the water consumption up to 30% (CEMEX, 1999).

Table 7 –Environmental benefits of recycling on producing some building materials (in % of the non recycling impact)

Environmental impact	**Steel**	**Glass**	**Cement**[2]
Energy consumption	74	6	~50
Natural resources consumption	90	54	50
Water	40	50	-
Atmospheric pollution	86	22	<50[2]
Water pollution	76		-
Wastes in general	105	54	
Mineral wastes	97	79	

Sources: JOHN (2000); (2) estimation considering replacement of 50% of the clinker with fly ash, and reduction on CO_2 production.

The major challenge in this area is the recycling of construction and demolition wastes. Up to now few Brazilian cities have recycling schemes, all of them controlled by the municipalities. There is no report of commercial recycling within Latin American, except for the use of this waste for land reclamation in coastal areas or quarries (UNEP, 2001). A major part of the C&DW generated goes to illegal dumping sites, frequently obstructing waterways and causing urban floods. Recycling construction and demolition waste as aggregate is reported as being commercially feasible in Colombia (SUAREZ; MALAVÉ, 2000) and Brazil (PINTO, 2000). It can be done in recycling plants as well as inside the building site (GREGOLIN, 2000 and PINTO, 2000)

In Colombia, the Ministry of Environment issued in 1994 a regulation about construction demolition waste. The Brazilian National Council in Environment (CONAMA) is discussing similar resolution nowadays. Waste taxation is not reported but Colombian regulation allows local authorities to tax construction demolition waste (MINAMBIENTE, 1994).

Additionally, all regions do have their own agricultural, industrial or mining residues that can be recycled locally. It is worth mentioning the significant production of more than 5 million tones of steel slag in LAC, of which the great part has not yet been properly recycled.

3.3 ENERGY EFFICIENCY IN BUILDINGS

It is considered possible to reduce the energy consumption of residential buildings in Argentina, by about 50% for heating and 30% for illumination. For commercial and public buildings the overall estimated possible reduction is 30% (BOUILLE, 1999).

LAMBERTS & WESPAHL (2000) point out several different possibilities for action to improve energy consumption during building use. It includes education, development of energy code, improvement of air conditioning systems, replacement of electric showers, improvement of roof insulation, use of solar energy to heat water and window improvements. It is obviously strongly related to building and services design practices.

The Brazilian PROCEL (National Electric Energy Efficiency Programme) is already taking actions for the improvement of the efficiency of some building appliances. The Mexican CONAE (National Commission of Energy Conservation) has been working on appliances as well as in the building itself to limit the maximum density of electrical power in illumination of non-residential buildings (CONAE, 1995)

Also, there is significant room for improvement of energy efficiency in the production of different building materials and equipments, especially in those produced by small companies.

3.4 WATER CONSERVATION

Despite the great water availability, water shortage is a problem in several areas of LAC. There is lack of detailed data on water consumption in buildings in Brazil (JOHN, 2000) and, probably, in LAC as a whole.

Brazil is structuring its National Water Conservation Plan (PNCDA, 2001), which includes specific actions for buildings. The Rational Use of Water Programme of State of São Paulo (PURA) succeeded in reducing water shortages in the LAC biggest city. The Mexican government has its Program on Efficient Use of Water in Public Buildings.

The reduction of water consumption in buildings results from a combination of education of the users with design and technical changes. Water metering systems, harvesting rain water, re-using served water, low volume WC, aerated and self-closing faucets, waterless technologies, can be mentioned. Most of these methodologies and technologies are already available in the Brazilian market (JOHN *et all*, 2000).

3.5 IMPROVING INDOOR AIR QUALITY

Nowadays, indoor air quality is considered to be a relevant subject in large Brazilian commercial buildings (BRICKUS *et all.* 1998).

In 1998 the Ministry of Health issued a directive on the indoor air quality (Portaria 3523, 28/08/1998) requiring specific procedures for maintenance and hygiene of air conditioning systems in large buildings (TROTTA & ARAÚJO, 2000). But with the increase on the use of air conditioning in houses (LAMBERTS & WESTPHAL, 2000) its importance will certainly grow in the near future to include almost every building.

In colder regions of LAC countries, mainly Argentina, Chile and the Andean Community, indoor air quality problem is probably more important, due to the heating of houses through burning biomass or fossil fuels without proper precautions.

3.6 IMPROVEMENT OF THE QUALITY OF CONSTRUCTION PROCESS AND PRODUCTS

There is no possible environmental action without a systemic and successful quality scheme, because the defects are an expensive form of wasting environmental resources. Then, the ongoing efforts for quality improvement within the *construbusiness* sector must be intensified.

In the last 10 years, Brazil developed the PBQP-Habitat (Brazilian National Programme for Quality and Productivity in the Habitat) aiming at solving the *construbusiness'* quality related problems. The steering Committees of PBQP-Habitat and its regional branches gather representatives of all *construbusiness*, from material producers associations, financing agents, governmental institutions, research and professional associations, building contractors associations. For each building product, activity or business a specific project is developed to improve its overall quality, environment, and productivity as well as voluntary certification schemes.

The Mercosur and Chilean Forum of Quality and Productivity in Housing was founded in 1999 and aims at improving quality and sustainability in housing within the region.

3.7 DURABILITY AND MAINTENANCE

Increasing the knowledge on the service life of the built environment, and the capability of generating and managing life data are certainly a major challenge for achieving a more sustainable construction industry (SJÖSTRÖM, 2000). This does not only concern the physical but also the functional durability of the constructed asset, and includes the optimization of the service life in all phases of the building process. This in turn requires from a building, the flexibility and capacity of being upgraded.

In Brazil, the research on durability is almost completely limited to reinforced concrete structures. As a result the last version of the Brazilian Design Concrete Structures Standard has made important advances in this field. This kind of approach must be extended to all other technologies and materials construction.

Maintenance is rarely a major concern during a construction design and some established building technologies require frequent and expensive maintenance activities. Durability and maintenance are also a relevant topic of discussion in public works. Concepts like life cycle costs should be implemented to select more competitive technologies.

3.8 OTHER ASPECTS

Hygiene and health in building sites are certainly a major problem in the region (CLARIN DIGITAL, 1997; CNC, 2000; SAURIN et all, 2000).

The recent ban of asbestos in Chile (LA TERCERA, 2001) and in some Brazilian cities with the discussion of a comprehensive asbestos ban in whole country – are connected with this subject but also raise the question of the use of environmentally safe building materials in general. Asbestos is used mainly as reinforcement in cement sheets, pipes and water tanks.

Environmental impacts of building sites – vegetation protection, dust (CCC, 1998B) and noise (CCC, 1998) generation are also relevant and important issues.

3.9 SOCIAL ASPECTS

An Agenda 21 for Sustainable Construction in LAC must include the ambition of a better life for the entire population. This will certainly require a significant improvement and enlargement of the built environment, including more environmentally sound houses and infrastructure.

To meet such a goal will require the sector to work closely with other social roleplayers interested in overcoming these problems. But the goal also introduces technical challenges, mainly those related to the development of new technological solutions that should have at the same time low financial cost and low environmental impact.

4. THE VISION OF SUSTAINABILITY OF CONSTRUCTION IN LAC'S

Several industrial associations and companies already have in their catalogues and/or their own environmental agenda far reaching environmental ambitions, including e.g. environmentally-friendly products. The Brazilian Ready Mix Concrete Association (ABESC, 2001) and the giant cement worldwide active Mexican company CEMEX (CEMEX, 1999) are examples. CEMEX and Votorantim, the biggest Brazilian cement producer, are active members of the international project "Toward a Sustainable Cement Industry", sponsored by the World Business Council for Sustainable Development (WBCSD, 2001). In Brazil there are a growing number of building projects that claim to be environmentally-friendly, mainly because they manage to preserve some of the native vegetation.

The Letter of San Salvador, issued as a conclusion of the FIIC's (Inter-American Federation of Construction Chambers) XXI Congress on Housing asks for official incentives for companies that adopt lean construction methods. The FIIC is promoting in 2001, its Second Latin American Contest on Sustainable Housing and Urban Development. The Construction Chamber of Chile does have a formal Environmental Policy. In 2001 the Chamber is promoting a national environmental contest, focused on building site noise and dust control, waste management as well as environmental management. The Chilean chamber is also distributing among its members the English version of CIB Agenda 21 on Sustainable Construction.

The Environmental Chamber for Construction of the State of São Paulo is taking several environmental actions, mainly those related to the protection of vegetation, noise pollution by highways, sewage treatment and CDW reduction and recycling. The Brazilian PBQP-Habitat and The Mercosur and Chilean Forum of Quality and Productivity in Housing are intended to act in sustainability issues, but very few activities have been carried out on the subject to improve the overall quality.

Chile, Argentina and Brazil are engaged in the Green Building Challenge. Recently the CIB Symposium on “Construction and Environment – from theory into practice” as well as the CIB W 62 Int. Symp. Water Supply and Drainage was held in Brazil. The CIB Agenda 21 on Sustainable Construction has been translated to Brazilian Portuguese. The Brazilian National Built Environment Researchers Association has several scientific committees working on Agenda 21 related aspects and one specifically devoted to Sustainability issues on construction. Its last National Congress was about Sustainability.

Despite all these activities, there is a lack of a more systemic approach towards sustainable construction and co-ordination among the different *construbusiness* roleplayers. Since the environmental impact of a construction facility depends on the environmental impact of each different component, co-ordination of activities seems to be important. From this point of view, the *construbusiness* approach adopted by the Brazilian PBQP-Habitat seems to be very interesting.

It will be very important to build synergistic networks capable of offering comprehensive environmental-friendly solutions for buildings and other construction products, increasing their marketing appeal. This kind of action will help consumers to easily realize the options available for protecting the environment when commissioning, buying or refurbishing buildings. Such networks must also help the development of building assessment methods to be used even during the design phase (SILVA, AGOPYAN & JOHN, 2000), making it possible to demonstrate the environmental benefits of the proposed solutions.

5. BARRIERS FOR SUSTAINABLE CONSTRUCTION

The conclusion of the UN LAC diagnosis on policies and governmental institutions for sustainability appointed two major barriers: (a) lack of effective power of the (governmental) environmental institutions; and (b) the low degree of environmental concern among the citizens (OCAMPO, 1999).

In a region greatly marked by poverty and economic problems, it is very difficult to establish the environment as a national priority. For example, in LAC the measurement of urban air quality is not a rule. Only Brazil, Mexico and Chile have good measurements networks (KORK; SAÉNZ, 1999). Also, there is a lack of basic legislation for waste, even most landfills do not comply with sanitary standards (ACURIO *et al.*, 1997).

Consequently, the sustainability actions are focused on poverty, democracy, human settlements and preservation of natural resources. Chile is probably the only country of LAC that is developing sustainability policies for the different industrial sectors.

Financing is a very important barrier to sustainability. Any technical solution that increases the total price of housing or infrastructure will probably face significant opposition especially if aimed at low cost housing.

6. CHALLENGES FOR THE RESEARCH COMMUNITY

The research community in LAC is relatively small, with the national investment in research below 0.8% of the GNP (HILL, 2000). Nevertheless, there are active research groups in the region covering most of the suggested Agenda 21 topics. Certainly research partnerships among different countries will reduce the cost and length of time required to solve the main technical problems.

There is an urgent need for benchmarking of different environmental aspects, like materials wastage, energy and water consumption, construction and demolition waste generation, and indoor quality. Good benchmarking will help to establish priorities for the Agenda 21 ambition and work and its related research needs. It will also allow the measurement of the results on every aspect of the Agenda 21 action.

In the region there is also a lack of comprehensive and reliable data about the different environmental loads of building materials production, building operation etc. Therefore, it is very difficult to establish and perform Life Cycle Assessment studies. It is, in addition, important to work on environmental assessment tools for buildings adapted to LAC needs.

The development of new and environmentally-friendly construction materials is a challenge. Recycling construction and demolition and other local wastes can be a valuable environmental tool in LAC.

Research and development on environment-related management aspects is essential because a organizational and managerial transformation is necessary to give support to the sustainability issues (CIB, 1999). One immediate goal in this research area for LAC *construbusiness* is to develop management techniques to reduce material wastage at building sites as well for quality management.

The investigation of the relationship between architectural design and sustainability in LAC must be clarified. Additionally, a more sustainable construction process will require design tools that allow the consideration of sustainability issues like energy, water and materials consumption at the design.

Improving the durability knowledge of construction is, as mentioned, a major challenge. There is a lack of regional data to support the service life design of buildings. The development of a LAC network on durability of building materials and buildings would be a major achievement.

The research community has already developed environment-related knowledge, like the passive and low energy architecture design tools and technologies, but most of this knowledge is not transferred to the market. Consequently, the creation of better mechanisms to allow the transference of knowledge from research institutions to the market is a key issue to be addressed. A common Agenda 21 on sustainable construction could help also in this subject.

Finally, a sustainable construction process will require professionals with better environmental knowledge. This, in turn, will require new, improved and environmentallyoriented education, technical handbooks in all fields, like building materials, building systems, etc.

7. CONCLUSIONS

The impact of construbusiness in the environment in Latin America and Carib is probably more important than it is in developed countries. This is due to the fact that LAC is still under construction and the regions have a relatively low degree of industrialization. The implementation of an Agenda 21 for Sustainable Construction in the region is considered to be very important.

Reducing building material wastage, increasing the use of recycling wastes as building materials, energy efficiency in buildings, water conservation, indoor air quality, quality of products and processes, durability and maintenance and social aspects among others, are important issues to be included in a regional Agenda 21.

There are several environmental initiatives being carried out by institutions connected to the construbusiness. Developing a better co-ordination among the different players of the construbusiness will help develop and implement a consistent Agenda 21 in the region. However, there are important barriers. The most important one is perhaps the low degree of environmental concern among the LAC citizens.

The relatively small regional research community will have to adjust to answer the new challenges. Co-operation between countries is important and has to be improved.

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