FACTORS AFFECTING THE DEVELOPMENT OF CONCRETE BLOCK PAVING IN DEVELOPING COUNTRIES, BASED ON THE LATIN-AMERICAN EXPERIENCE

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SYNOPSIS

Concrete Block Paving (CBP) follows very different growth and development patterns depending on the characteristics of the countries where it is introduced. The mentality and the technical and physical possibilities of a developed country are totally different of what can be found in a developing one. Therefore CBP has to be assimilated, better than transferred or imported to those countries, if a sustained progress is expected. What is shown through a recount of the way CBP has evolved in several Latin-American countries, is the need for an institution to be in charge of promotion of this technology, specially in order to assimilate it to the local conditions and to provide the required technical and organizational support.

1. INTRODUCTION

CBP is a very singular technology. An ancient idea, updated in Europe with a new basic material, concrete, and with enough technical research to compete in today's high-tech world. But the basic principles stay simple and adequate for low or medium-tech environments, in underdeveloped or developing countries.

Latin-America (countries from Mexico to Argentina, Figure 1) is a region that, despite a common origin (mostly Spanish colonization and language, with Portuguese ones in Brazil and some English, French and Dutch in the Caribbean), has a wide range of development stages, from Haiti, only comparable with the poorest countries in Africa and Asia, to Mexico, Brazil and Argentina, near to become developed countries. Those differences are further affected by geographical location and morphology, available resources, and by the political culture of each country. Though CBP has arisen from the same technical background, it has developed differently in every country.

CBP has been known since the late 60s or early 70s through out the continent. The development reached in each country had nothing to do with the size, economic strength or, even, previous use of stone paving. Instead it has depended on the decision, by governmental or private institutions to promote the technical aspectsof CBP and their ability to permeate, both private and governmental engineering offices in charge or specifications, design and construction of pavements, with adequate information for the technology not to be forgotten after the first trial projects; and continue being used on an ongoing basis and promoted at every possible application for paving materials.

CBP is a good case study to analyze how a foreign technology, coming from developed countries (Europe), have had such different results in different countries. What is really interesting is that it is not only applicable to countries but also to other areas like states, regions, cities or even small population areas, where the same unbalances could exist as will be presented in the next pages.

2. TECHNOLOGY IMPORTATION, TRANSFER AND ASSIMILATION

A new technology, when introduced to a country or region, can be imported, transferred or assimilated (adapted). The way it is done depends, to a very large extent, on the policies determined by governments and the actions taken by private institutions interested in such technology.

Those three introduction schemes could be considered a question of "semantics", if looked from the perspective of developed countries (a technology goes from here to there and start working); but the truth is that it is a question of "languages".

If a technology is introduced from one place to another, both with the same technical and economic "language", (i.e. approximately the same economic and technological level), there is no need for alterations. The technology is assimilated, as it can be done by any private, prosperous, avant-garde company, even in developing countries, no matter the existing scenario.

The conflict appears when most of the parameters are different (technical, financial, marketing, labor, etc.) and it is necessary to have different approaches in each case or place on how the technology is applied.

It could be considered that there is a **technology importation** when design and execution of projects are made by foreign companies, typically turn-key projects. If those

in charge of planning, have determined that a true technological evolution is a priority for the recipient country or region, a technology import will be justifiable only for high-tech and singular projects. In other ways, a recurrence of this type of projects could be seen, from the perspective of the recipient, as technological "colonialism".

Technological transfer implies the participation of local people in the execution of the projects. Most of the time they acquire the know-how for building but rarely for designing, and neither have the control of what to do nor the power to modify designs or technologies. This type of approach can be understood as local "paternalism"; but should be the minimum degree of participation for any project in developing countries.

In this respect there is an increasing feeling in the international technological community about the moral obligation for developed countries to provide developing or poor ones with technological know-how, specially in those aspects that could save lives. And the same is applicable to states or regions inside a country.

Technology assimilation or **adaptation** is considered to be a must step after technology transfer. Assimilation means to acquire the domain of what and how should be done, and should include:

- A revision of the purposes in order to adapt them to local points of view.
- An analysis of the technical procedures to include local ingenuity and knowledge in order to simplify, modify and adapt them, to make them cheaper and less conflictive with local culture and practices.
- An inventory of resources including:
  - Characteristics of local materials.
  - Availability and characteristics of equipment and processes. It is convenient to have nationally produced equipment, or easy and inexpensive imports of the right type and with simple technologies.
  - Provision of written guides to cover every single step involved in the technology, according to the required level and the existing background.
  - Evaluation and optimization of human resources, from designers to labor, including technicians, inspectors, administrators, etc.
  - Creation of specific financial schemes in which the paths to obtain resources be clearly defined, no matter if it comes from international aid, governmental, local, private or different combinations of sources. In other words, "where" and "how" could financing be obtained.

When those aspects are reviewed, a new structure or a set of structures becomes apparent, each one with a specific purpose. If the structures are clear, every program or project should be possible to be duplicated in other places, by simply adapting the basic constituent structures according to predetermined parameters.

But it is not enough to consider those three stages (importation, transfer, assimilation) for the introduction of a technology; it is fundamental to know "who" will be the recipient of the transfer or the assimilation processes. Although it is possible to bring a technology to governmental, private (industry) or communal levels, governmental offices, due to their sizes and structures, are difficult to be really aware of the wishes and needs of the people. Private companies often make fast technological transfer for their commercial purposes and adapt it to their needs in their own industrial enclaves. Assimilation comes only when communities are directly involved and the whole topic is imprinted with the foretold principles. And it does not mean that in every place there should be importation, transfer or assimilation. It depends of the way the technology is intended to evolve and the goals to reach.

A large number or very different examples can be seen in the following account of the evolution in Latin-American countries.

3. ORIGIN AND DEVELOPMENT OF CBP IN LATIN-AMERICAN COUNTRIES

There is CBP in almost every corner of the world. Latin-America is not the exception, and every one of these countries have CBP in very different extents but with very positive results in most, if not all, the cases.

One point to be noticed is the key role played by the Cement and Concrete Institutions in the technical promotion of CBP. This is specially so in the survival and growth of the technology, since the technical stage or tradition in Latin-American countries has not allowed the creation of Trade Associations for Concrete Masonry and/or Concrete Block Paving. These associations could bear the responsibility for the promotion and growth of CBP; at least, for their own benefit.

Due to the characteristics of the production of Concrete Paving Blocks (CPBs) and the construction of CBP, there is a huge potential for this type of pavement in numerous situations where the technical level is not the optimum for other types of pavements, or where there is the possibility to obtain a large input in free or cheap labor; a very frequent situation in developing and underdeveloped countries.

But this technology is not necessarily bound to this type of environment in Latin-America. There is a large spectrum of applications in several countries, with a first-class technical level, and a complete standardization in almost all the countries (14).

3.1 Argentina

The origin of CBP in Argentina goes back to 1958 with the use of blocks with keyed walls, a German technology marketed under the name Blokret for hexagonal blocks and Trief and Prefar for other shapes. This technology went further than simple transfer, and Eng. Juan F. Garcia Balado, from the Argentinean Portland Cement Institute - ICPA, developed a pavement design method for this type of block (8).

It is not possible to be totally true but it seems that those blocks crossed the border to Brazil and Bolivia. The fact is that the Brazilian Concrete Institute - IBRACON and the Brazilian Portland Cement Association - ABCP published, during the '60s and early '70s, several guides for the design and application of this type of pavement, that could be considered as CBP.

But those blocks are wet-cast with peripheral dismountable rings, making them more complicated to produce than extruded CPBs. This makes the technology more difficult to promote while avoiding its true assimilation. Right now, it survives in some places but with a no significant influence. There was a case in which it was used in Colombia to partially pave Tumaco, a small coastal village on the Pacific Ocean, under an international cooperation program.

Nowadays there are around 13 commercial paving block industries in the country, producing a full spectrum of block shapes and sizes; but there is not a widespread use of CBP. In this country ICPA has not put CBP in the first line for the promotion of cement, and they are just starting some promotional activities. Most of their work for communal promotion of cement consuming pavements have been oriented toward rigid concrete pavements with interesting financial and technical approaches.

3.2 Bolivia

This mediterranean country had a very strong tradition of old stone pavements and a wide use of keyed CPBs. Although there is no clear information, it is known that they have down-scaled plants for the use of CPBs for large and small towns.

3.3 Brazil

The size of the CPB industry in Brazil must be large as any other thing in this country, where there was also a considerable tradition of stone block paving in the oldest cities. It is known that besides the early use of keyed paving blocks and the actual large scale commercial industry for conventional ones, there are a lot of small plants, following very similar schemes to those found in Colombia, using small, nationally produced, block making equipment with hydraulic technology, contrary to the Colombian mechanical approach.

The Brazilian Portland Cement Association - ABCP has played an important role in the promotion of several different low-profile technologies for the use of cement, and CBP is one of them besides concrete and soil-cement pavements, soil-cement and concrete masonry, ferro-cement, etc.(1-5).

3.4 Chile

Chile has one of the oldest and more solid commercial concrete block industries in the continent. Late in the '70s the paving block producers and the Chilean Cement and Concrete Institute (ICH) produced a guide for the design of concrete block pavements (6), and from then on, a series of documents in order to update design and construction practices (7). There is an extensive use of concrete paving blocks in the main cities, competing mainly with concrete pavements. But the technology is still in the transfer level by private companies and no effort has been made to adapt it for a real widespread use.

3.5 Colombia

CBP came to Colombia from Nicaragua in 1974 during the reconstruction of Managua after the 1973 earthquake, with ICPC's conviction of its great potential to be adapted to simple technology; and a lot of labor be included in both block making and laying.

A good example of a technology assimilation is the program originated by PNUD (United Nations Development Plan) and the Urban Development Institute - IDU in Bogotá, with the technical support of ICPC. The basic purpose was to generate employment through small production plants of concrete products and the first one was set-up in Santa Cecilia, a quarter in the district of Usaquén, where the Communal Action Committee got the financing from another institution and set-up their plant to produce the blocks. They became contractors for IDU, selling and laying the CPBs over

the base course provided by the same institution. Later on, IDU charged the community with the cost of the pavement but it was lower than for any other type of pavement, and the committee got the income for selling and placing the CPBs.

This first experience continued with the paving of seven kilometers of pedestrian alleys and narrow streets using both commercial and community produced CPBs. A second phase is starting right now, financed by The World Bank to pave 15 km of access streets to poor quarters without rain drainage below their streets; and a third phase will start soon with 35 km more. Other programs like the ones promoted by the IDEA in more than 80 municipalities in the Department of Antioquia (Photos 1, 2), the Mayor's Offices in Cartagena and Medellín (Photo 3), and the Carvajal Foundation in Cali (Photo 4) are described in other papers (10, 12, 15).

Twenty years after the introduction from Nicaragua, there is a widespread use of concrete paving blocks in the whole country, specially for housing and industrial subdivisions and for small programs with a special social content (communal labor) in large cities as well as in small towns and villages (Photos 5-8). It implies two parallel approaches: The commercial CPB industry, following international standards and with a good technology transfer; and the social CPB and CBP programs, a true technology adaptation where nationally produced equipment is used to make satisfactory units, and a lot of labor for both production and laying (Photos 1, 2).

This parallel approach has been maintained by ICPC since that first contact with CBP in Nicaragua and the first CBP was built in Medellín later that year. But to maintain both alternatives working, it has been fundamental to count on the promotional activity and the technical documents produced by ICPC (11, 13, 16-19), and the responsible commercial production of the avant-garde technologies and the demonstrations projects for new applications, like that now under construction San Antonio Park, in Medellín, with 20.000 m^2 of high quality, full colored CPBs following very intricate designs, the first project of this size and quality in Latin-America.

3.6 Costa Rica

A clear example of technology Import and private transfer can be found in Costa Rica. Even though it is a small country, there are only two or three producers of CPBs and the use grows very slowly. Some pavements can be seen in San José and other cities, mainly for pedestrian and light-weight traffic (Photo 9). In comparison, they have two container terminals built by foreign companies, one in each ocean, as turn-key

projects and with the provision of CPBs by one of the producers to one of the projects. But in this case nothing more than the particular specifications for those blocks was left to increase the technological level in the country.

3.7 Ecuador

Ecuador had excellent stone paving blocks. Cities like Ibarra are good examples of superior craftsmanship. Although there is not a quantifying information about the size of the concrete block industry in the country, they have very good pavements like in the Amazons River Boulevard, in the modern part of Quito, in shopping centers and in a lot of small towns and villages, paved with concrete blocks, like Tulcán (Photo 13), near the Colombian border, and some others using even colored CPBs.

3.8 El Salvador

The path of CBP starts in Nicaragua and then crosses to El Salvador. Several main streets were paved in San Salvador during the early 70s and CPBs have been used mainly for subdivisions, parking lots and small villages (Photos 11, 12).

Due to the small size of the country, the two or three companies producing CPBs nowadays can reach every single corner or it; but until very recently the technology was dormant, using the same construction guides and block shape they have been using for 20 years.

3.9 Guatemala

There is not a total certainty if CBP went directly from Nicaragua to Guatemala or if they passed first through El Salvador. The fact is that, in Guatemala, CBP has been promoted by Government Offices, which have produced a series of documents with simple indications on how to build them.

3.10 Haiti

The experience in Haiti is very singular, due to the participation of an international financial institution like The World Bank and its idea of how things should be done in poor areas, specially in relation to the role that local engineers could or should play, and the no-consulting of some realities in the area.

Despite their troubled economic and politic situation, the concrete block paving technology has evolved from the first streets, paved following the technology proposed in

Central-American countries, to the international standard practice.

There is a very strong CPB production industry, with first-rate, large-scale equipment. Due to the total lack of maintenance of the streets, it was decided CBP to be the technology to be implemented by the Ministry of Public Works from now on in Port-Au-Prince and other cities (Photos 15, 16). The durability of this type of pavement has been much larger than the one of the asphalt alternatives, built simultaneously several years ago, and since CPBs consume, basically, national products, do not affect the already weakened trade balance.

3.11 Mexico

Mexico has a large concrete block paving industry grouped by the National Concrete Block Producers Association. There are very well known examples of CBP in Mexico City in Plaza Garibaldi, the Rose District and the streets near El Zócalo and some use in subdivisions. But despite the work made by the Mexican Cement and Concrete Institute - IMCYC with early translations of the C&CA (9), it has not been enough and nowadays Stamped Floors are gaining the market CPBs should have conquered since the early 70s when they were brought from El Salvador.

3.12 Nicaragua

Up to what we know, Nicaragua was the gate through which CBP entered Latin-America and, maybe, the whole America. It seems that during the late 60s, there was the first production of CPBs in Managua and soon it permeated to Guatemala, El Salvador and from there to Mexico. After the December 1973 earthquake hit Managua, most of the main streets of the city were paved with CPBs and this experience was assimilated by Colombia, Costa Rica and Honduras (Photo 14), the last two in a minor scale.

The Nicaraguan experience is a type of technology assimilation, with the National Government and International Development Institutions acting as the support for the technology to spread, becoming popular and be used everywhere (Photo 17).

3.13 Uruguay

The concrete paving block industry in Uruguay is not very large compared with the one in Brazil or Colombia, but there are interesting works like the container terminal in the port of Montevideo (Photo 18) and several streets. Nowadays the industry is

improving the basic infrastructure for a future development of CBP, starting with a standard on CPBs and some studies for the implementation of small programs. Up to now there has been a technology transfer but an assimilation seems to be the future goal.

3.14 Venezuela

The Venezuelan experience is different, since it is a newcomer to the business, but entered with a major work: The boulevards over the excavated tunnel for the Metro in Caracas were built during the '70s and '80s. The material was chosen by the French designers and the CPBs were made by Viposa (a non-profit company devoted to the production of precast low-cost houses) who set-up a plant with a Zenith machine and produced, as first contract, 75.000 m^2 of CPBs.

One interesting topic, from the marketing point of view, is that since there was only one producer, CPBs were sold as "vipoquines", a word made by Viposa and Adoquines, the Spanish word for paving blocks.

This is a clear case of technology Import. From that time there has been no significant increase in the national CPB market for several reasons. The first is that CPBs in this Metro first contract were placed directly over the roof slab of the tunnel, made engineers, architects and public works officials to believe CBP is good for architectural purposes only, not for street or heavy traffic situations (Photos 19, 20). Since there has not been a specific promotional campaign by any institution, besides one or two courses offered by the Venezuelan Cement Producers Association - AVPC, the market is almost dead, with a few cases where some small towns have hauled CPBs 200 to 300 km inside the country to pave their Central Squares in the same material the Metro Boulevard is paved in Caracas.

With such stable inner market it has been possible to export CPBs to the Islands of Aruba and now to Curaçao, a Dutch territory on the Caribbean (Photo 10), where CPBs used to be brought by ship from Holland.

It is interesting to establish a comparison with Colombia. Two neighbor countries with similar characteristics and with totally opposite approaches to the same technology.

4. FINAL CONSIDERATIONS

This attempt to put together some thoughts considerations about what should be the

development of CBP in a developing country, based on the recount of the Latin-American experiences, is aimed to show the importance of having an Institution, be it governmental or private, responsible for the promotion and support of the technology if it is aimed to grow, spread widely and reach higher technical levels. The experience has shown that the commercial CPB producers are not capable as yet to generate their own structure to market and develop CBP.

It is interesting to note how Nicaragua was the regional technical center during the 70s. But for the 80s and 90s Colombia is gaining such impulse that several other countries, including Costa Rica, El Salvador, Guatemala, Uruguay and Venezuela have asked for help to give CBP a new impulse under different perspectives. And in order to define those perspectives, it has been fundamental to have a lot of information, coming in and out of ICPC through international contacts with other institutions and individuals involved in the development and implementation of the technology. ICPC has a clear idea of the importance of this CBP technology for the people and the Country, no matter if it is or not the best way to increase the consumption of cement, and also has the feeling that the results must be openly shared with those interested in them, as a small contribution for their own well being.

5. FIGURES AND PHOTOGRAPHS



* Spanish speaking countries
Information taken from Almanaque Mundial, Ed. America, 1992.

#	Country	Population	Area (km^2)
24	Argentina	32.880.000	2.779.221
3	Belize	178.000	22.965
22	Bolivia	7.314.000	1.098.581
21	Brazil	150.368.000	8.511.996
14	Colombia	32.978.000	1.114.748
17	Costa Rica	3.015.000	51.100
9	Cuba	10.544.000	110.922
23	Chile	13.173.000	736.903
19	Ecuador	10.782.000	275.830
5	El Salvador	252.000	21.040
18	Frch.Guyana	114.000	90.000
2	Guatemala	257.000	108.889
16	Guyana	1.023.000	214.969
11	Haiti	5.609.000	27.750
6	Honduras	131.000	112.088
1	Mexico	88.598.000	1.958.201
4	Nicaragua	3.871.000	130.700
8	Panama	2.315.000	75.717
25	Paraguay	4.279.000	406.752
20	Peru	22.332.000	1.285.215
13	Puerto Rico	3.533.000	8.897
12	Rep. Dom.	7.170.000	48.308
17	Surinam	400.000	163.365
26	Uruguay	3.128.000	176.215
15	Venezuela	19.736.000	916.445
27	*South Africa*	*34.492.000*	*1.221.037*

Figure 1. Latin-American and Caribbean countries. Population and Area compared with South Africa.



Photo 1. Prototype plant for low-scale production of CPBs in Sabaneta (Ant.), Colombia.



Photo 2. CBP under the program financed by IDEA in the small town of Támesis (Ant.), Colombia (1985).



Photo 3. Second stage of CBP of the Moravia quarter near the old dumpsite in Medellín, Colombia (1989).



Photo 4. Soccer team resting on a CBP in El Poblado quarter in Aguablanca District in Cali, Colombia (1988).



Photo 5. "Callejón de la Purrututú", a restricted access street in Valledupar (Cesar), Colombia (1993).



Photo 6. Street network built prior of a multistory building program in El Salitre, Bogotá, Colombia (1993).



Photo 7. "Centro Comercial Automotriz", a shopping center for automobile items in Medellín, Colombia (1988).



Photo 8. "La Visitación" shopping center in Medellín, Colombia (1990).



Photo 9. CBP for pedestrian use in front of a hospital in San José, Costa Rica (1993).



Photo 10. A pedestrian street paved with colored CPBs in Aruba, imported from Venezuela.



Photo 11. CBP in the workshops of Saltex, a paving block plant near San Salvador, El Salvador (1993).



Photo 12. "Chiltiupán Avenue", the first street paved with CPBs in 1970 in San Salvador, El Salvador (1993).



Photo 13. Repair after laying new water pipes in Tulcán, Ecuador (1986).



Photo 14. Main Square paved with large paving blocks, in Tegucigalpa, Honduras (1974).



Photo 15. Main road connecting Port-au-Prince and Petion Ville in Haiti (1991).



Photo 16. Inner city street paved under the Urban Development Program in Port-au-Prince, Haiti (1991).



Photo 17. Concrete block paved street in a residential quarter in Managua, Nicaragua (1984).



Photo 18. Container terminal in the port of Montevideo, Uruguay (1990).



Photo 19. Access plaza in a station of the B Line of the Metro in Caracas, Venezuela (1989).



Photo 20. Boulevard in front of Chacaito Metro Station in Caracas, Venezuela (1989).

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