CONCRETE BLOCK PAVING AS A PROGRAM OF GREAT SOCIAL IMPACT FOR DEVELOPING COUNTRIES. THE COLOMBIAN EXPERIENCE.

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SUMMARY

Concrete block paving acquires a special significance in underdeveloped or developing countries due to their social and economical conditions. The possibility of involving labor in the fabrication of the concrete pavers (small settings, with simple technology and nationally produced machinery) and in the construction of the pavement, makes concrete block paving the only alternative for many communities, in suburbs of the cities as well as in small villages; with many additional benefits in the social area because of the generation of employment and the creation of groups for communal work. This paper will show the process of assimilation of the concrete block paving in Colombia (see Appendix 1) and will present some experiences with special characteristics.

1. AN APPROXIMATION TO THE SOCIAL FUNCTION OF THE CONCRETE BLOCK PAVEMENTS.

1.1 The reason for the work of the community.

In underdeveloped or developing countries, the state is not able to satisfy the basic needs of the population.

Considering this situation the community faces the following dilemma: To wait for the intervention of the state, which may last longer than the proper existence of the citizen, or to execute the works which lead to satisfy such needs.

To get those works done it is necessary to count on a force of action and organization, almost always represented by non-governmental organizations for social work, associations of users, communal action, etc., which become the leader so that the communities be able to reach their purpose.

This situation occurs frequently in the low income neighborhoods, in big cities, and in the villages with small budgets and with deficient operative and service infraestructure. That is why, frequently, these projects have to be undertaken by stages, and with time they attain the required dimension.

Another fact that determines the technical or the economic scale of the project is the availability of cheap and plentiful labor (though not always qualifed(, which can substitute, in many cases and at least partially, the contributions in money.

In this framework of specific social as well as economical conditions, the need for the community work comes up.

1.2 The need of work in the road system.

The previously exposed facts can be applied directly to the system of roads and specifically to pavements.

The road infrastructure of the mentioned countries is quite below of that of a developed country, for its magnitude of for its technical characteristics.

The budgets of the Public Works entities, either national, state or municipal, only allow to attend partially to the construction of new roads as well as to the maintenance of the existing ones. Therefore the road system becomes, each time, more difficult to manage (see Appendix 2).

In big cities, an important percentage of the road system remains unpaved, specially in the illegally formed suburbs or in those of low income level and even in industrial areas (see Appendix 3).

In small villages, frequently only the main street has a good pavement. Very seldom they have a complete network of service (or they have a deteriorated one), which becomes an inconvenience for the construction of concrete pavements.

Most of these villages are on th mountains and far from the big cities, what makes it difficult to bring them the asphalt technology.

For both situations, in the city and in the small village, a solution is required with special characteristics, which must:

- Provide means of financing, with low interests and with suitable conditions of amortization, so that, given the social and economic characteristics, the obligations be met.

- It is a system which is flexible from the point of view of the amount of investment and the speed of progress of the work; and therefore the rhythm of contribution.

- Profit to the maximum the different means of resources, either official, from non-governmental agencies or communal, as well as the supply of material and available labor.

- Use simple and low cost technologies which can be easily assimilated and require not much machinery.

1.3 Concrete block paving as a plan of social interest.

It is within this context of social work where concrete block paving, with the participation the community, performs a different role to the one of the formal area of precasting and the official or private contracting.

Concrete block paving allows the use of simple technology to make the pavers and also for the construction of the pavement; with the possibility to adapt all the processes to a reduced scale by using simple machinery, basically of national production.

The posibility of the use of labor in larger scales and that of assuming different financial schemes (official, communal or mixed ones), and different payment programs, makes alternative the proper for the execution of easily profitable projects and with benefits for the communities that go beyond the ones of the projects.

For the block paving programs with the community it is necessary to:

- Count on a manager, being a person or an entity, who must evaluate the feasibility of the project and present it to the community.

- Have a supplier of pavers or to set up a plant for the production of them. If the last is done it must be verified the availability of adequate machinery for the scale of production, the permanent supply of basic materials and the existence of the necessary administrative and locative structure.

- Organize the constructive process of the pavement in a way that all the entities which take part in it be in coordination among themselves, and specially way when the work of one of them is a prerequisite for the others to develop their owns.

- Have sufficient technical support, in the manufacture of pavers, as well as in the construction of the pavement, because by allowing small scales and the participation of more labor, these programs are not technically inferior practices than those of other paving alternatives.

- Look for a clear financial scheme which could be managed directly or be turned over to a third party.

- Evaluate properly the alternatives, both for materials and for procedures and even the type of supply, because, despite of what has been said, not always a communal enterprise fulfills the conditions to obtain lower costs than the schemes of commercial production.

2. THE DEVELOPMENT OF CONCRETE BLOCK PAVING IN COLOMBIA.

2.1 the beginning of this activity.

Although in some rural areas the stone paver occupation still survives, this activity lost its force in Colombia during the first half of this century, and it never passed from using the stones in their natural state, to use the stone pavers. Therefore, in the whole country, the asphalt pavements are predominating, specially in the national road system. Only in the Atlantic Coast, which has a warm tropical climate all the year round, the concrete pavement is used in a broad way.

Already, since the end of the 60's, it was heard about the appearance of the concrete block paving. The ICPC was up to date of this development and in 1974 it coordinated the journey of a group of engineers, precasters and potential users of the system, in order to observe its application during the reconstruction of Managua, after the earthquake on December 1973.

This contact had as a result, the beginning of the production of pavers by Indural in Medellín and its use to pave the outer yard of the Centro de Exposiciones y Convenciones de Medellín (Medellín Conventions and Exhibitions Center).

Based on the compiled information, the ICPC issued a Pavers Handbook [20], published in 1975, which served as a guide for the construction of concrete block paving during the next seven years.

2.2 The promotional work.

The promotion of the system, started by the ICPC in 1974, which still continues, was focused on two specific fields: Commercial paving in cities, with pavers provided by local precasters, and the paving through communal programs or the ones in small towns.

The basic promotional work is developed in the cities, with engineers and architects, to whom the proposal is presented at the highest technical level. Within this group, the official entities always deserve special attention; to them conferences and courses, adapted to their needs and interests, are given since it is necessary modify the existing operative schemes, in which the alternative of block paving rarely exists.

Simultaneously, a program of lectures in the universities is developed; and it is suggested to each one that the block paving be included as

a subject in civil engineer, architecture, construction and technological related programs.

In order to develop these activities there has been, in several opportunities, a close collaboration with the local precasting industries.

The other field of activities which requires a specific work is that of the entities which have connection with programs of social or physical development, either urban or rural.

The financial institutions for development, community work and social service, and an endless number of non-governmental organizations belong to this group to which concrete block paving becomes attractive, because it fits within their programs of improvement of communities or because it represents additional sources of work and cooperation.

For these reasons, the promotion procedure has evolved along with the acceptability of this paving practice.

In the general promotional work it has been fundamental to be able to count on the information from abroad. But the work on social level has been adapted, technically as well as formally, to the cultural conditions of the medium. Very often the images are not enough; it becomes necessary to bring the interested people to visit the already developed programs which have obtained good results, and, in not a few cases to provide economic aid for the purchase of machinery, or special discounts on the cement, specially in those programs of great social content.

2.3 The technical support.

Due to the fast development of concrete block paving in Colombia, at the beginning of the 80s, in cities as well as in small villages, the ICPC considered necessary to develop an additional technical support, since it was the only institution in Colombia depository of sufficient information about the subject to do it.

Six "Technical Notes" [12,13,14,15,16,24] have been published, which cover the following subjects:

- Advantages and applications.
- Production of pavers in small plants.
- ICONTEC Standard 2 017 "Concrete Pavers".
- Thickness design.
- Specifications.
- Construction, maintenance and repair.

Those publications are refereed to the developments of well known international authors and researches but some systems have been adapted to the working conditions in the country, in the construction process and in the manufacture of pavers in small plants.

The development of the standards was achieved through graduation projects, directed by ICPC engineers, in local universities. The standard take into account the climatic conditions of the country (tropical), the physical ones of the pavers (shape and size) and the technical and economical conditions of tests (bending test).

The thickness design method is based on the fact that the behavior of concrete block paving is similar to the one of flexible pavements, which has been stated in many papers. Based on it, and using the Asphalt Institute thickness design method, a part of the asphalt thickness is substituted by the sand bedding and the pavers.

Furthermore there are a number of complementary documents [17,18,22,23], on the economical and production topics, which are useful to evaluate costs, efficiency and the feasibility of the programs.

2.4 Commercial concrete block paving.

This activity has increased since 1974 and is intimately connected to the commercial production of pavers by the precasters in the main cities. First in Medellín, then Cali, Bucaramanga, Bogotá and, in minor scale, in practically all the cities, the production of pavers appeared as an additional line to the one of the traditional concrete blocks and, since 1982, as the exclusive activity of some new precasters.



Figure 1. A street in Palermo, Antioquia, as they used to be.



Figure 2. Another street in Palermo, after the concrete block paving program.

Today there are about 25 producers which use imported machinery of medium and high performance (Columbia, Prensoland, Rosacometta, Fleming, etc.). Together they produce, annually, almost 500 000 m^2 of 60 or 80 mm pavers. The production of 100 mm pavers and the colored ones is made only by request.

Though the overall mentioned production does not appear to be much, compared with that of the developed countries, it is important since until now no work has exceeded 12 000 m^2.

All this consumption is due to private investment. The official organisms just started to develop programs in concrete block pavements. At present there is a bidding for the supply of pavers for the first harbor, in the Base Naval del Pacífico (Bahía Málaga), with approximately 2,5 ha of 100 mm pavers.

The average price in Colombia is \$1 400/m^2 for 80 mm pavers, and this allows to the concrete block paving to be competitive with asphaltic concrete, specially when there are low volumes of traffic; despite the tendency that exists in the medium to subdimension the latter and not consider the maintenance cost.

3. CONCRETE BLOCK PAVING WITH COMMUNAL OR SMALL SCALE PROGRAMS.

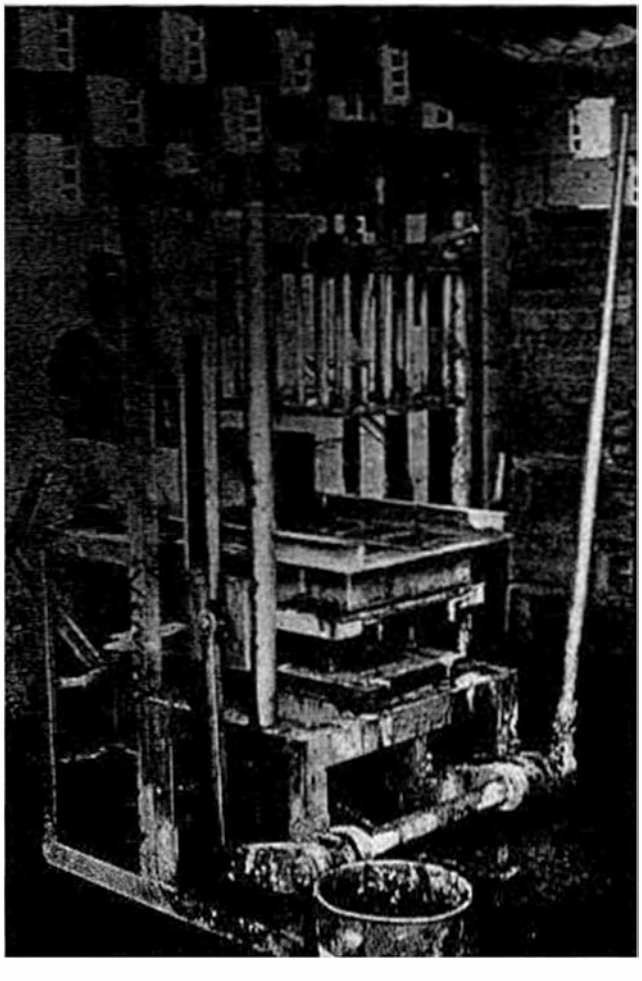


Figure The small machine for the production of concrete pavers.

3.1 Description of the small plants for the production of pavers.

The structure and fuctioning of small plants for pavers production are determined by the type of machinery in use.

3.1.1 Machinery for pavers production.

Its main characteristic is that of being of national production; it makes it almost immediately available and free of import taxes. the total cost of the machine is US \$1 927 and US \$212 for every additional mold.

At the present time there are seight machine producers, four of them making the same model of which 800 machines have being in installed since 1980. This model, produced with electric or gasoline motor, has a 0,16 m^2 mold and compacts the mix by vibration and presure. With the change of the mold the same machine can be used to produce standard concrete blocks (see Figures 3 and 4).

As it lacks of any automated system this machine requires a minimum of four people for its operation, including mixing and feeding. With this crew, the production reaches 24 m^2 /shift (150 cycles), which can go up to 56 m^2 (350 cycles) or to 80 m^2 (500 cycles) if the crew has six or eight workers.

With the medium efficiency 18 720 m^2 of pavers can be produced per year. It allows to pave 3 120 m of road, 6 m wide, what is eqivalent to the pavement for 720 houses (approx. 3 600 people, 18 blocks of houses).

As an exercise to evaluate the potential of this scale of production, taking the Department of Antioquia [1] with 3 888 067 inhabitants distributed as follows: 2 095 147 in the Metropolitan Area of Medellín (10 municipalities) and 1 792 920 in the other 116 municipalities in which 661 042 inhabitants live in their urban area. If all of the municipalities undertake the program simultaneously, using only one machine each one with the indicated average of efficiency, after one year the program will have

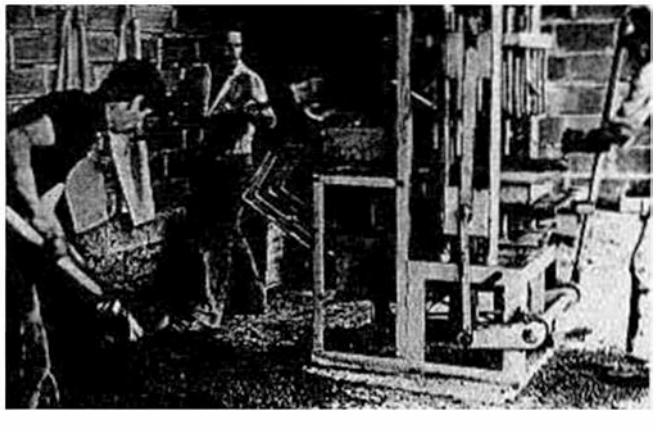


Figure 4. Concrete pavers production in one of the small plants, in Sabaneta, Antioquia.

paved 52 villages (41%); after two years 34 more (27% and 68% accumulated); after three years 14 more (11%, 79% accumulated). After 5 years it would achieve a coverage of 91% of the municipalities, and after 10 years 97%, leaving out only the Municipality of Medellín and the other biggest three of the Metropolitan Area.

It shows the potential of the use of small scale equipment in massive and continued programs.

3.1.2 The small production plants.

Figure 5 shows the scheme of a plant for the production of 80 m^2/shift, using only one machine. It requires a lot of 270 m^2, with 140 m^2 under roof for materials storage, production, cutting and curing of the pavers, workshop, office and services; additional space is provided for the storage of the produced pavers and the circulation of the vehicles. Lower volume productions can be installed in smaller areas.

This reduced space allows to place one of this plants in almost any lot, or under any structure available so the economye in the set up of the plant can be very important.

3.2 Recount of some experience with different schemes of work.

3.2.1 Development Bank - Municipality - Community scheme.

An important case in the promotion of concrete block paving has been sponsored by the Instituto de Desarrollo de Antioquia (Institute for the Development of Antioquia) IDEA which, though it is a development bank, not only has served to impel the paving, but encourages the use of concrete pavers in all those villages that have no complete service networks or have them in bad shape. Additionally, it gives assistance, through its technical department, about the installation of small plants for the production of pavers and in the construction of the pavement itself (see Figure 6).

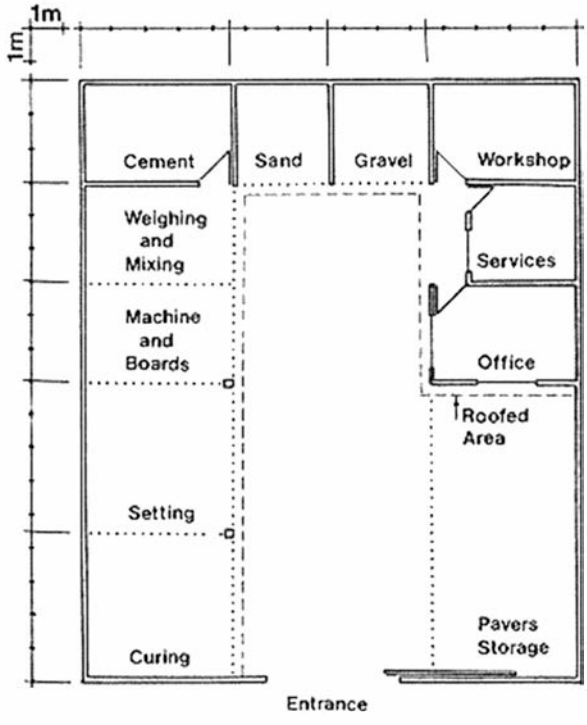


Figure 5. Scheme of a prototype plant for the production of concrete pavers.

Since 1979 concrete block pavements have been constructed in Antioquia for approximately US$ 1 348 332, through programs executed in 70 of its 126 municipalities, with an average of 5 000 m^2 per municipality at unit costs of approximately US$ 3,85/m^2.

In most of these municipalities, it is the municipal entity which produce the pavers, setting up plants of reduced size in its own plots and operating it with its own workers; using its vehicles for the transport of materials and the product. This has shown, as a result, a considerable reduction of costs, since part of the physical infrastructure, salaries, and transport are diluted together with other activities, because, in many cases, such costs are fixed, and otherwise they would remain idler.

Nevertheless, this has not been the only way of working that has been followed. Despite the fact that the IDEA finances the complete program, including the set up of the precasting plant, some municipalities receive assistance that they assign to street paving, and so reduce the debt they have to contract or complement the ordinary resources so they collect the total amount without the need of falling into debt.

Many of these programs work with the valuation scheme, distributing the cost of paving, total or partially, among the people more directly favored with it. Other programs receive a certain amount of materials from each dwelling. There are cases in which the production of pavers is not directly attended by the Municipality but it is in hands of the Society of Public Improvement, the parish, etc., whom the Municipality buys the pavers from, or receive them through donation of the citizen who get them from these other entities.



Figure 6. Ciudad Bolívar was the model for the block paving program in Antioquia.

3.2.2 Non-governmental organization - Community - Municipality scheme.

This has probably been the most complex program of the ones undertaken until now, due to the plurality and heterogeneity of the organizations and the intentions involved.

- The Carvajal Foundation (with resources which come from the biggest publishing industry in the country), works since 1961 in projects of social development in the city of Cali.

- The Community of El Poblado [11], a suburb of the district of Aguablanca with nearly total lack of services, living in slums or very deficient houses and lands which flooded seasonally. Its population is basically composed of immigrants from the country and workmen.

- The Municipality through the Secretary of Public Works.

- The Banco Central Hipotecario (Hypotecary Central Bank) BCH and its Fondo Financiero de Desarrollo Urbano (Financial Fund for Urban Development) FFDU.

This being an urban zone with a practically non-existing infrastructure, the Carvajal Foundation, after installing the programs of housing fitting, health, training, supply of food and construction materials, identified, in agreement with the community, the paving of the streets as a major need, in order to have the benefits of better systems of transport and a easier communications.

Once the different alternatives were studied, concrete block paving was adopted because of its advantages.

At the same time, there was the need of handling the problem of the garbage disposal which the Municipality was unable to solve. The Carvajal Foundation organized a recycling program (paper, metal, plastic) creating one committee in each block. Each one of them collects the materials and takes it to the communal center, where it is stored until there is enough to be sold to the industries.

The money received from the sale of the recycled material is kept in the common account of the program and, by means of internal accounting, they determine the moment when the dwellings of a committee reach the required amount for the construction of the block paving pen house (US$ 143).

To start the program the main cement distributor, DICENTE, donated a machine for the production of the pavers and supplies the cement with a 25% discount. The BCH donated another machine and US $38 550 for a fund to which the Foundation gave an equal amount. This capital produces approximately US $2 312 monthly, from which the material is bought and the workers of the plant are paid, all being inhabitants of the same suburb, who had no jobs before.

The municipality builds the base of the pavement in those street already provided with services. With the resources coming from the recycling, a part of the sidewalks, curbs and gullies are constructed and the necessary materials for the pavement finishing are bought. The construction is done by the community through previously selected trained groups.

Up to now about 2 000m of pavement have been constructed, and there are more than half a million pavers ready to be laid.

The effect of this program has been immediate. The appearance of the streets changes substantially and the community not only mends one of its main lacks, but also, by recycling the garbage, solves a problem and learns to work together to obtain common benefits. At present the program is organized in 21 committees and another 35 have been formed, waiting for the program to reach the area they live in.

3.2.3 Municipality - Community scheme.

The case of the zone of Moravia [6] in Medellín, is more dramatic because it was to the former garbage dump of the city; a zone of approximately 35 ha where the garbage was dispose without any treatment, and where about 14 600 people lived. Almost 1 759 depended, for their living, on the on site manual selection of garbage to sell it for recycling.

Once a technical sanitary filling was installed abroad, the Municipality intervened in Moravia to organize its inhabitants. After undertaking the urban re-ordering and the supply of services, the block paving of the streets was proposed, involving the community in the manufacture as well as in the laying of the pavers.

A small production plant was installed, with equipment and materials supplied by the Municipality and other official entities, and with free labor provided by the community. The construction of the first streets was completed with success; the Municipality supplied the bases and each dwelling the corresponding sidewalk (see Figure 7).

Unfortunately the program came down because of the irregularity in the supply of material and a change in the approach to the work in that zone. Only one thing became clear: The community always commits itself entirely and understands the benefits of this system of work but it cannot fulfill all the tasks simultaneously, specially when there are so few resources.

3.3 Notes on the results.

Examples like the here mentioned are plentiful in the country. Frequently the machine represents the principal burden for the start of the program and, therefore, it is donated by some development or communal work entity, and very

often by the cement industry. But despite the cost, its influence in the square meter of block paving is nearly insignificant since it is not superior to US$ 0,1, and will never surpasses 1% of its cost.

So enterprises constituted this way produce units at an average of US$ 3,1/m^2 total cost and for US$ 1,93/m^2 if free labor is provided for the job. This price is competitive with that of great precasters which buy their own machines in foreign currencym with 10% import tax and pay high fixed costs to guarantee supply to the demand they may have and, when of course, they wish will increase.

If labor is contributed to the work pavers can be produced at 50% of the commercial cost and even less, in those places far from the big cities where the supply of sand and granular material has lower prices to those of the big cities.

It has been fundamental for the programs account on sources of financing like the IDEA, the BCH and its FFDU which are convinced of its benefits. At the same time, the need of counting on national machinery, apportioned to the scale of the projects, is important to reduce the plants to a size that makes them possible and even profitable.

4. CONCLUSIONS

In general, the promotion has been effective. It cannot only be limited to the ICPC work but be a conjunction of wills. Without the connection achieved within the financing institutions and government and non-government organisms, it would have been impossible to promote the programs of great social content.

The programs of concrete block paving do not have just given to the community the pavement itself but also a source of employment, production plants and, above all, the improvement in life conditions and the regaining of the interest for the commnunal work as a development source.



Figure 7. A street, paved by the community in the zone of Moravia, Medellín.

APPENDIX 1.

COLOMBIA, BASIC INFORMATION [8,9,10].

Area (km^2): 1 141 748			
Population:	Total:	29 265 499	100,0%
	Urban:	19 666 415	67,2%
	Rural:	9 599 084	32,8%

PRINCIPAL CITIES: (Metropolitan Areas)

-Bogotá D.E.	3 982 941	(capital, industry)
-Medellín	2 095 147	(industry)
-Cali	1 400 828	(agriculture, ind.)
-Barranquilla	1 137 150	(seaport, industry)
-Bucaramanga	595 006	(industry)
-Cartagena	531 426	(seaport, tourism)
-Cúcuta	443 093	(frontier town)

ECONOMIC INDICATOR [2,3].

Currency: Peso	
Exchange Rate (Peso/US$)(Nov.25/87):	259,58
Income (US$/Hab. year) ('85):	1 420
Gross Internal Product (US$) ('85)	
Total :	34 400 000 000
Agriculture:	20%
Industry :	30%
External Debt (US$) ('86):	14 044 000 000
Production (ton)	
-Cement ('86):	6 399 395
--Internal Consumption :	5 234 768
--Export :	1 164 627
-Iron and Steel ('85):	438 746
Exports (US$) ('85):	
Coffee :	1 702 000 000
Oil :	409 000 000
Bananas :	156 000 000
Flowers :	132 000 000
Coal :	126 000 000
Constructed Area (m^2) ('85):	8 628 000

GROWTH INDICATORS ('86)

-Life expectancy (years)		64
-Birthrate		27/1 000
-Infantile deathrate		40/1 000
-Illiteracy deathrate	Total:	12,0
	-Urban:	6,8
	-Rural:	23,6
-Houses without basic services :		1 103 210
-Cement Consumption (kg/hab.year):		168

APPENDIX 2.

NATIONAL ROAD SYSTEM IN 1984 [7].

TYPE OF ROAD	LENGTH(km)	PAV.(%)	NON-PAV.(%)
TOTAL	121 374	28	72
-National	25 250	-	-
-Department	55 052	2	98
-Municipal	10 585	48	52
-Private	7 598	0	100
-Vicinity roads	22 889	68	32

1987 BUDGET FOR NATIONAL ROADS [5]. (US$)

-Construction and reconstruction:	47 881 120
-Conservation and improvement:	68 086 910

APPENDIX 3.

CONSTITUTION OF THE ROAD SYSTEM IN BOGOTA [4].

	(km)	(%)	(%)
TOTAL	: 10 000	100	
-Paved	: 6 000	60	100
--Bad shape	: 1 800		30
--Maintenance req.	: 1 800		30
--Good shape	: 2 400		40
-Base only	: 3 000	30	
-Subgrade	: 1 000	10	

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