9th. International Conference on Concrete Block Paving. Buenos Aires, Argentina, 2009/10/18-21
Argentinean Concrete Block Association (AABH) - Argentinean Portland Cement Institute (ICPA)
Small Element Paving Technologists (SEPT)

IMPROVEMENT OF RURAL AND MARGINAL URBAN AREAS THROUGH CONCRETE BLOCK PAVING, IN NORTHERN PERU

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Note: The following is the notation used in this document: (...) to decimal places and for the thousands.

Summary

Concrete block paving is not a widespread technique in Peru, so when deciding on the type of surface layer for a project, it is done between concrete slabs and asphalt. The curriculum for building professionals in universities, in the roads or pavements courses, only includes the design of the concrete and asphalt pavements.

For more than 40 years, Peruvian precast concrete companies have been dedicated to the production of precast concrete, mostly in Lima (the Capital), with very little or almost no production of concrete pavers. They produce other types of concrete precast elements such as blocks, tubes, poles, boxes etc.

It is therefore interesting to consider the experience gained in Northern Peru, by one of the most important cement producing companies (Cementos Pacasmayo), where they had a clear idea, to concentrate and specialize in the production and marketing of concrete pavers. For this purpose, they formulated a training plan for both, the beneficiary population and the local governments (through their public works engineers).

Those training sessions have helped to disseminate the benefits of this product in the region, and to generate a great consumption of pavers, using local workforce for these projects. In some cases, this workforce has been women, who assumed the laying of pavers.

This massive dissemination of the use of concrete paving blocks, has improved the rural and marginal urban areas in many districts, provinces and regions of Northern Peru like Tumbes, Piura, Lambayeque, Cajamarca, and La Libertad, and has solved the lack of good roads. The success is so big that the demand for pavers exceeds the capacity of the plants in the area, generating opportunity even for private investment.

1. INTRODUCTION

Peru is a mid-size South American country, bordered by Ecuador and Colombia to the North, Brazil, and Bolivia to the East, and Chile to the South. With 1 250 000 km^2, it is a little larger than Colombia and Venezuela, and has three (3) natural areas:

- **Costa (coast),** where Lima (the capital city) is located; it is a narrow coastal plain, mainly desert but crossed by fertile valleys.
- **Sierra (mountain),** part of the Andes mountain range, with peaks over 6 000 m high. It has the mineral resources of the country as silver, zinc, lead, copper, and gold, and most of the livestock.

- **Selva (jungle),** to the East, has large natural resources, but the lack of communication and transport infrastructure made that this region was unexploited until the 1970s.

Peru has a mixed ethnic composition made of indigenous, mixed and descendants of Spanish colonizers, with some communities of Chinese and African origin, totaling some 28 million inhabitants, with an index of 23 inhabitants/km^2. The annual growth is of 2.6%. 68% of the population is rural and 32% is urban, located in Lima, Arequipa, Callao, Piura (coast), Chiclayo, Chimbote, Trujillo Cuzco (mountain) and Iquitos (jungle). 52% of the population lives in the coast, 37% in the mountains, and 11% in the jungle. The per capita income is approximately US$ 4 450 per year (US$ 370/month) the seventh in South America after Venezuela, Chile, Uruguay, Argentina, Brazil and Colombia.



Figure 1. Map of Peru and the Northern areas, with major cities concerning this paper..

In Peru, there is not a rapid development of the precast concrete industry. However, there are companies that, for years, have produced pavers, blocks, poles, tubes, cement, and terrazzo flooring

tiles, precast structures, etc. This industry consumes 2% of the national cement consumption of +5 million t/year, hence there is a great potential to be exploited for the development of this industry. Consequently, some cement companies led the creation of precast concrete plants during the last 10 years, opening producing plants for precasting concrete products.

This paper focuses on the development of the North of Peru, whose annual cement consumption is 1.5 million t/year. There are now 25 precast concrete producing companies, distributed in the main cities of the region. Twelve of them only produce blocks, and thirteen make blocks and pavers. The equipment for the production is mostly Columbia, Poyatos and small locally crafted plants in companies with small production.

In 1998, Cementos Pacasmayo SAA, a cement producer, through its commercial subsidiary Distribuidora North Pacasmayo SRL (DINO SRL), began a program to increase the market size in the Northern provinces. One of the strategies was the promotion of concrete paving blocks.

Apart from the promotion of the work with the commercial precasting industry, there was the goal of developing actions with programs of self-build, self-help or communal work, with the communities or as joint projects with local, state, or national governments.

2. SITUATION OF PAVEMENTS IN NORTHERN PERU

The marginal-urban and rural areas share 65% of the inhabitable territory of the country, making it necessary to build works that contribute to improve the infrastructure for sanitation, health, education, and recreation, in order to raise the standards of living for all the population and in all aspects.

The sequenced in several towns have been that, after the sanitation system is built, the process for paving the internal routes starts, using concrete pavers to improve both the by-land communication and the environmental, socio-economic, and architectural conditions.





Figures 2 and 3. Concrete block paved streets in the city of Sechura (urban area).

Northern Peru has a problem with respect to the diversity of paving projects from the technological point of view, since it is used to consider solutions only with concrete slabs or concrete asphalt (without considering technologies or costs) (see Table 1). This is even an academic issue because universities do not disseminate the use of concrete block paving, leaving a lack of knowledge

among professionals. That also signals a big task to perform with the academy by the cement and precast concrete industries.

Table 1. Cost/m^2 of surface layer.

CONCRETE SLAB (US$ /m^2)	ASPHALT CONCRETE (US$/m^2)	CONCRETE PAVERS (US$/m^2)
29	14	19

Today, concrete paving blocks have a boom and are accepted in large urban paving projects, developed by regional and municipal governmental offices through works developed by direct management and/or contracts, with versatile solutions.

It can be said today that in Northern Peru, for each ten municipal urban road projects, about five use concrete pavers. This has been achieved in only nine (9) years and has made possible to solve many problems in areas where this type of pavement is used.

3. TECHNICAL PROBLEMS IN THE NORTH OF PERU

Some of the problems occurring in Northern Peru are:

3.1 Presence of water table

It is the product of the cyclical presence of the “El Niño” phenomenon and the proximity of some cities to the coast or rivers. The water table is almost at the base level in many cases, so the designers have to consider alternatives for subbase and base materials, and for the surface course.

In the past 50 years, "El Niño" has caused heavy economic losses in road infrastructure. Roads built with slabs of concrete or asphalt have collapsed one after another, due to heavy rains and the consequent weakening of the base. After experimenting in some areas with the experiences in other latitudes, it was noted that concrete block pavements tend to get impermeable and the rain water passes over it (as if it were a drainage channel). In case of damage or loss of the base and subbase materials, there is the possibility of recovering the surface layer made with pavers.

3.2 Access to health and/or electrical installations

It is quite important to choose the really best economic proposal due to the frequent problems with the systems of water collectors and the electricity and communications networks. Even in many cases, these systems are reaching the end of its useful life, so it is necessary to access these facilities for reconstruction and there is nothing better than having a concrete paving block surface.

An example is the city of Piura, where the change and enlargement of all sewerage networks would cost the City Administration approximately US $ 20 million, something difficult to do when the annual budget of the city is only US$ 15 million. That is why, whenever there is a possibility of a change or to start any street paving, the solution is immediately done with concrete pavers, not only when a full paving is needed but also for patching with pavers in areas with concrete slabs or asphalt, previously cut to access pipes for change or repair. Since it is expected that such pipes fail in the future, concrete pavers are installed to allow a new access to them.



Figure 4. Water table or overflow rivers.



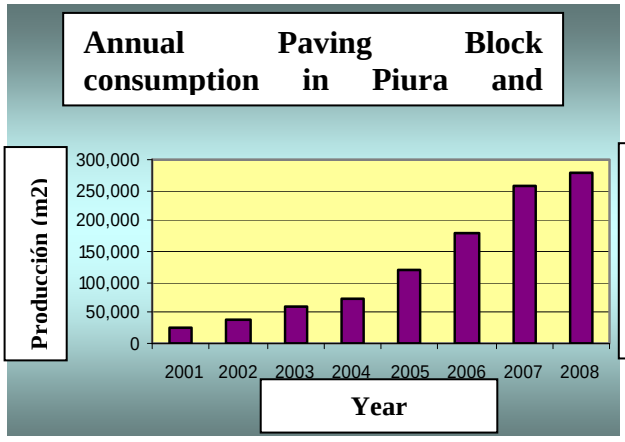
Figure 5. Access to sewage facilities.

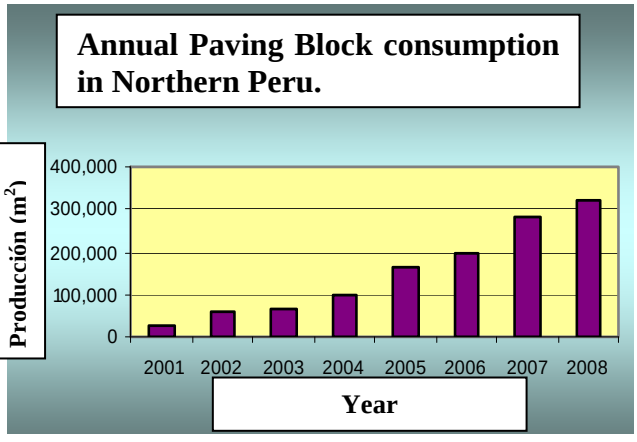
3.3 Salty and expansive soils

Salt and expansive soils are a common denominator of the foundation of some soils in cities. The pavements built during the last years, with asphalt or concrete slabs, are completely lost due to cracking or lifting of the surface layer. This is notorious in Paita and Huancabamba, where the bases and subbases have to be changed frequently. Consequently, with a surface layer made of pavers, the investment in the structural layers can be increased.

4. CHANGING THE FLOORING WITH PAVERS

A progressive growth can be observed for the last eight (8) years (2001-2008) in Figures 6 and 7, when the installation of the industrial block producing plants was started in Northern Peru. Figure 6 gives consumption in Piura-Tumbes, close to 70% of the one of Northern Peru; Figure 7 presents the total area of pavers of Northern Peru, with other departments like Cajamarca, Lambayeque, La Libertad, Ancash.





Figures 6 and 7. Pavers layed in Piura and Tumbes and in Northern Peru. (DINO SRL).

It is well known that concrete block paving generates two important facts in the area residents:

- The socio-economic benefits, since they allow the local people to get involved in laying the pavers, since it is an easy task that generates income for their families and enhance the value of their property through the improvement of urban streets or avenues where they are located.
- The architectural aspect coming from a street paved with concrete pavers, whose patterns, colors, and shapes generate bright finishes, and a completely different perception compared to the ones of the asphalt or the concrete slabs, which have a monotonous look. The same improvement occurs in areas for parks and gardens, when concrete block pavements are used.

It is unbelievable to see the great acceptance concrete block pavements have had in these areas, where it is the most asked-for way to pave by the inhabitants of urban streets. It is possible to find pavers in subnormal urban areas, villages and human settlements; inside the urban area of cities in streets, main streets an even in the most exclusive areas where high-cost projects are developed.

5. PARTICIPATION OF WOMEN AS SKILLED LABOR

In the last decade, the Peruvian Government carried out projects in infrastructure, sanitation, roads, and urban streets, through the implementation of social programs, looking for the creation of the largest number of jobs, with a great impact on the other economic activity in the country. One of those social programs is the so-called Building Peru.



Figure 7. Employment of local labor.



Figure 8. In the headquarters of the army, soldiers were the labor.



Figure 9. Paving in farmhouse Miraflores, Urban-marginal zone.



Figure 10. Concrete block paving in a private condominium.

Building Peru works with local and regional Governments, and with the civil society, generating technical dossiers for the implementation of mid-size projects within poor areas of inner districts and surrounding districts (farmhouses, human settlements, etc.), generating job opportunities for people of low resources that do not necessarily have knowledge and/or experience in construction.

As far as the Northern Peru, projects funded by this program are mostly, paving programs for roads and urban streets in poor urban areas, which are developed now thanks to the increasing ease for funding. Concrete block paving projects are the ones with the greatest acceptance, due to its advantages compared with the other types pavements (slab of concrete or asphalt) like: economy, durability, versatility, and enormous ease for the installation, not requiting, in many cases, the use of qualified workforce for laying them.



Figure 11. Inauguration of a park by Building Peru.



Figure 12. Training for women (DINO Plant - Piura).



Figure 13. Training sessions for women (City of Talara).

For this and other architectural reasons, the concrete block pavements have penetrated the Northern Peru to an extent that 90% of all districts in this region already have, at least, one block paved street. This activity has required a larger amount of labor since it is the type of pavement that generates (requires) the largest amount of labor for the construction.

To do this it, a training program has been run in different municipalities of the region, directed toward beneficiaries of the streets where the paving project uses concrete pavers. It has been done together with state agencies and private companies. The purpose is to train these people in different trades of construction, to enable them to participate in the execution of this type of works. After the training, they may have increased their future employment opportunities and access to work in similar projects.

The primary responsible for the training has been North Distributer of Pacasmayo SRL (DINO SRL), a commercial subsidiary of Cementos Pacasmayo, through its technical area of professionals and technicians, coordinates with the Chiefs of Infrastructure and Urban Development of the institutions or state programs, developing the skills for the beneficiary population and construction workers. These skills are divided into two parts:

- The first is theoretical, supported in written and audiovisual material provided entirety by DINO SRL. It explains to the students, the characteristics of concrete paving blocks (shapes, colors, standards, etc.), the benefits of their urban and architectural uses, the development of this type

of surface at a national and global levels and all the constructive process involved in the laying of concrete pavers. This training is usually done at a 4 h meeting.

- The second is practical, where the materials, equipment, and tools provided by the Organization and/or the Contractor responsible for the execution of the work, are used in the course by those who are to be trained in a construction site for one day. After of this process, those who are chosen from the trained group are suitable to start working immediately.



Figure 14. Block paving a street in Caserío Chepito (Cura Mori).



Figure 15. Concrete paver surfaced Street in Bernal.

However, the topic that has drawn more attention, after the training programs, is the participation of women as qualified labor for laying concrete pavers. They work now in different paving works in various sites of the Department of Piura, and specifically in the Low Piura districts, be it as contractors or by direct administration agreements, what becomes a great example of self-growth.

So far, during the last four years, some 100 lectures have been given in an equal number of localities (districts, villages, human settlements, etc.). In each of these, an average of 20 women has participated, totaling more than 2 000 skilled women in the laying process. The areas of Low Piura and a little less in Paita, Sullana and Talara cities are the ones where this program has reflected in the most conspicuous manner, the participation of women as skilled labor. They have installed more than 100 000 m^2 in the last four (4) years.

Many of these women trained in laying pavers, are at present and in some cases, the main source of income in their homes. This has not been a temporary training program, but in this case, women are steadily working in block paving in several works.

Today, there is a very well organized group, with a workforce capable of block pave hundreds of m^2 in a little time and that are running paving works with pavers in several Low Piura districts: Piura, Castilla, Bernal, Vice, Sechura, La Unión, Catacaos, La Arena, Bellavista, etc., with very good results and performance.

In many cities and areas mentioned above the Heads of Works in the Municipalities and the contractor's engineers, prefer working now with women, since they recognize in this group the best-qualified labor due to the learned skills and because they are better than men are for details and finishes.

While it is true that women receive less pay than men do, some 70% (see Table 2), this is because the daily rate of installation is smaller, but it still is above the specified average used for the calculation of the unit cost analysis. On the other hand, areas paved by women rarely get observations from the supervisors of the works, compared with areas paved by men, on alignments and cuttings. It actually affects the work completion times, which also ends in an increase in overhead and other costs when made by men.

Table 2. The pavement construction costs of adoquines (m^2).

CITY	COSTS (US$/$m^2$)				
	PAVERS	SURFACE LAYER	COMMERCIAL LABOR	COMMUNITY LABOR MEN	COMMUNITY LABOR WOMEN
Lima	8	15.5	3	---	---
Piura	12	19	2.5	1.8	1.25 (70%)

6. CONCLUDING COMMENTS

It is incredible to see the great acceptance of concrete block paving in Northern Peru where it is the most ordered pavement surface option for inner streets, demanded by the neighbors, in such a way that concrete block pavements can be found in all geographical, urban, and socio-economic places.

Thus, there is a great task yet: to make the integration of women to works, a massive program, an activity formerly reserved exclusively for men. If this is achieved, it could be said that the public authorities and Private sector would have the option to generate paving projects with greater physical goals (construction of larger areas of paving) and to generate more local labor, thereby would have low costs, when recruiting women for block laying. These women are now integrated and economically active with the population and contribute to the improvement of their family income.

When added together, these variables generate greater consumption of concrete precast units, which have a greater value when they replace roads that were not designed with cement products, and generate a great opportunity for cement producers, to extend and protect their market. Cements Pacasmayo initiated this process in the North of the Peru, and now other cement producers of Peru have followed the leader.

The best contribution of this paper would be to bring this experience to other countries in Latin America or the developing world, specially to the companies engaged in the manufacture of prefabricated elements, in this case, pavers, for which there is great market potential when it involves the beneficiary population of projects with the local government, through the training of skills. Above all it is important the generation of local labor, and especially of women, who were never accustomed to receive money for working and which are now an interesting labor source, for any concrete block pavement project.