PAVEMENT REHABILITATION WITH CONCRETE PAVERS

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ABSTRACT

This paper presents details of two projects where existing pavements were badly distressed. Concrete pavers overlay was chosen rather than asphalt or concrete paving. The works were done in the Patagonian region of, Argentina, specifically bellow the 42nd Parallel, where the extremely cold winters reduce the number of productive working days.

The projects covered a total area of 32,550 m^2, and were located in the Province of Santa Cruz. They involved the main streets of Calafate and Puerto Santa Cruz, the traffic could not be interrupted both ways.

The solution consisted of a concrete layer (maximum size of aggregate 10 mm) placed over the existing pavement to fill the joints and to ensure the definitive surface profile the street would have. 60-mm thick pavers of different colours were used, with a compressive strength over 45 Mpa.

The concrete pavers are performing well after two winters despite the hard weather conditions.

1. INTRODUCTION

These days in Argentina, one of the major applications of interlocking concrete pavements is for city streets. They are being strongly promoted by municipal governments for city streets because of the technical, economical and aesthetical advantages, and also because the construction of concrete block pavements allows the employment of more people (with little working skills) compared with other paving alternatives.

In Patagonia the times of construction depend greatly on the climate, and during the cold and wet season many workdays are lost. Concrete block pavements can still be constructed during very cold weather.

This is because the concrete paver is precast, and delivered ready to be placed. Moreover its structural properties (strength, low absorption, etc.) are maintained despite low temperatures and high humidity.

This paper presents the experiences obtained in two projects where pavements were distressed and concrete paver overlays were chosen as a suitable rehabilitation option. These works, the first of this kind in the country, were located at El Calafate and Puerto Santa Cruz, in the province of Santa Cruz.

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In El Calafate City, about 8,400 m^2 of the main street were rehabilitated whilst, in Santa Cruz City, about 16,000 m^2 of the main street and about 4,000 m^2 of other streets were rehabilitated using a concrete paver overlay. The traffic in Puerto Santa Cruz is not very heavy, but 70,000 people visit El Calafate (which has a population of 7,000) during the tourist season, October to May.

2. DETAILS OF REHABILITATED PAVEMENTS

In both cities, the existing pavements were severely damaged. The main problems of the concrete pavements were severe loss of thickness, exposed aggregates, spalling and broken joints. The problems of the existing asphalt pavements were associated with rutting, loss of abrasion, potholes and loss of asphalt.

As the works had to be done on the main streets in the cities, it was not possible to close the streets without causing severe disruption to traffic.

In both cases the alternatives were:

- Construction of a new pavement.
- Rehabilitation of existing pavement using either a thin concrete, asphalt or concrete paver overlay.

Usually the least expensive alternative is to rehabilitate the pavement rather than reconstruct it. This is especially the case when there is no need to realign the pavement, when structural damage is not severe and the concrete slabs have not collapsed. In the last case, expensive underpinning would be required.

In this case the best option was to rehabilitate the pavements rather than to reconstruct them.

The decision to rehabilitate the old concrete pavements with pavers resulted in the following technical and economical benefits:

- The use of precast concrete elements allowed work to be undertaken under adverse climate conditions and during the close season, which usually lasts several months. This resulted in a reduced cost of the project because contractors were working during a period when little work usually takes place.
- Use could be made of a large number of workers that had no specialized skills.
- Tasks could be done in stages, and the streets could be re-opened to traffic as soon as the pavers had been placed, resulting in very little disruption to traffic.
- Specialized road construction equipment was not required.
- Cracks in the existing pavement would not reflect through to the new pavement because the overlay was not a continuous surface.
- High remaining value, because the pavers are reusable if repairs have to be carried out.
- High aesthetic value, including the option to place coloured pavers to delimit footpaths and parking lots.
- Low maintenance, and any maintenance required can be carried out in small areas with little or no disruption to traffic.
- Since the surface is composed of small segments, speed of traffic is generally lower than that on conventional pavements, which is appreciated in residential zones. The surface also provides improved slip and skid resistance, particularly in winter.

2.1 Construction

Before constructing the overlay, detailed surveys were made so as to evaluate the pavement condition.

This was a necessary step to ensure that some structural life remained in the existing pavements in order to evaluate its contribution to the overall life of the new pavements.

Factors, which determine the condition of a pavement, are: cracking, spalling and settlement (rigid pavements), and rutting (flexible pavements).

The pavements to be repaired had not collapsed and neither was there any significant cracking. The main type of damage was spalling and erosion, present mostly next to joints caused by freezing, thawing cycles and inadequate maintenance. Considering the damages it presented the existing pavement was, from a structural point of view, suitable to be used as a sub-base.

To restore or modify the original transverse slope, and for patching and joint resealing between slabs, a 10-mm maximum size aggregate grout was poured. Joint resealing was done in order to retain bedding sand.

Once the surface and slope were restored, the typical construction process for an interlocking pavement continued, i.e. bedding sand distribution and levelling, placement of pavers, sealing with sand and final sweeping of the excess sealing sand.

The thickness of the bedding sand layer was reduced from 40 or 30 mm (loose condition) to 20 mm after consolidation because of the presence of impermeable bases, insufficient slopes and the limits imposed on the final thickness of the overlay.

Bedding and sealing sands used at El Calafate came from the lake coast, and no special treatment was required. The bedding sand used at Puerto Santa Cruz had to be transported from Rio Gallegos City, about 200 km away, because the local sand was too fine and did not meet the recommended gradation limits. It was possible to use local sealing sand but it had to be screened and dried before use. As sealing is one of the key factors for satisfactory performance of interlocking pavements, it was necessary to dry the sand due to scattered showers and the high humidity in the region during the project.

The 60 mm thick concrete pavers were laid in a herringbone pattern. This pattern is considered the most suitable for city streets and industrial pavements because it resists relative displacements in both the longitudinal and transversal directions. The 60 mm thick concrete pavers were selected in order to achieve a 70 mm height curb. (see Figure 1).

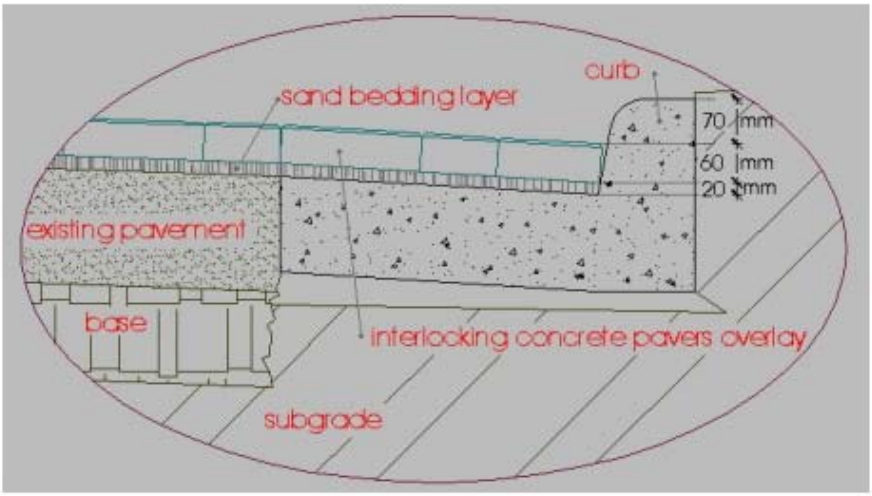


Figure 1. Cross sections. Overlay with concrete pavers.

The concrete pavers used complied with the Type I IRAM 11656 Standard, which is appropriate for use in city streets, airports, loading yards, etc. This classification requires that the average compressive strengths is 45 MPa, with no individual values less than 40 MPa

The edge restraint mainly consisted of the existing curb, but more than 1,000 lineal meters of deteriorated curb had to be replaced before the pavers could be placed. A metallic edge restraint was also used; it consisted of a 3"x 3" (75 mm x 75 mm) wing steel angles 4-mm thick, and fixed to the existing pavement by nails.

This kind of confinement was used for two different applications:

- opening to traffic street intersections in both cities; and
- to avoid the possible collapse of gullies in Puerto Santa Cruz
- An 80 mm thick over-level was generated between the existing pavements adjacent to the overlay

This problem was solved using transition ramps constructed as follows:

- a 1 meter width of scarification and trimming using jackhammers, with a variable thickness from 0 to 70 mm, in order to produce a soft joint between the end of the ramp and the existing pavement.
- Levelling of the transverse slope and restoration using soil-cement.
- Overlay with concrete pavers.

Figure 2 shows a typical transition ramp constructed at Puerto Santa Cruz. Only few ramps were generated at El Calafate. The problems there were solved using an anchored steel beam fixed to the existing pavement to confine the pavers, and bonded asphalt material used to compensate for the difference in levels.

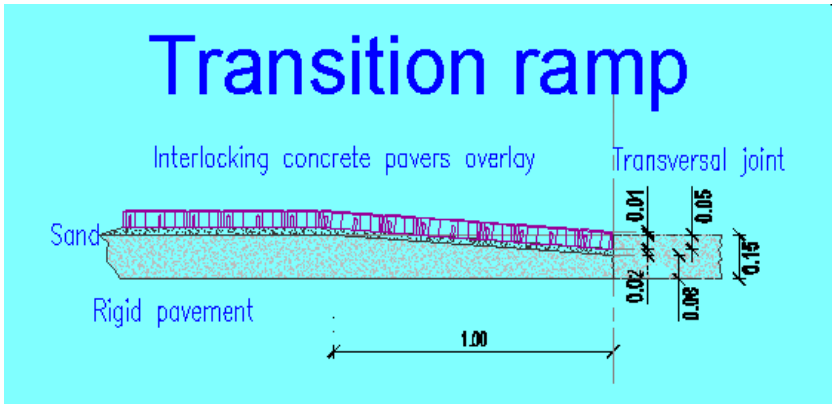


Figure 2. Rehabilitated pavement – existing pavement transition.

Since the rehabilitation involved main streets in both projects, it was important that the work be conducted with minimum disruption to traffic. In order to achieve this, the following strategy was adopted:

- El Calafate: the overlay was first constructed in one direction, after which it was re-opened to traffic while work proceeded in the other direction. In areas between boulevards, metallic profiles were placed as confining beams to allow traffic in and out of the rehabilitated zone.
- Puerto Santa Cruz: construction was carried out in both directions at the same time, including intersections; a similar procedure continued for the next block and so on.

Figure 3 shows the construction stages.

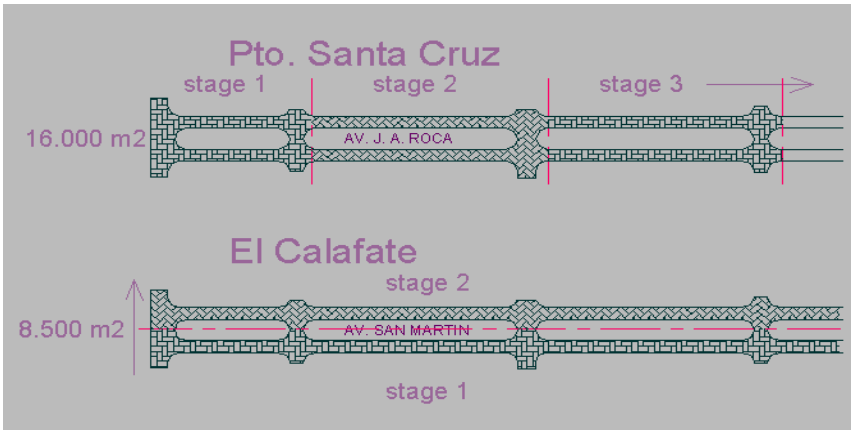


Figure 3. Construction stages.

In some cases temporary ramps were materialized confining them with steel beams and soil cement was used to compensate difference of levels accessing in and out the rehabilitated zones, without touching the existing pavement (see Figure 4).



Figure 4. Metallic confining beam: steel angle fixed to the pavement.

In Puerto Santa Cruz the slopes of the existing pavement were extremely low and under the minimum recommendations (0.5% and less). This led to ponding of water on the surface that remained until it evaporated. The solution found was to construct three or four vertical drainages on the sidewalks of each block.

Architectural value of this pavement was obtained from the patterns and colour arranges used to materialise footpaths and rumble areas.



Figure 5. General view of a completed segment of pavement.

Figure 5 shows a typical view of a completed segment of pavement.

3. COST COMPARISONS

The cost of overlays is frequently less than the cost of reconstruction and concrete pavers provide an economical alternative to improve the strength and aesthetics of deteriorated pavements.

Table 1 shows the relative cost of new pavements constructed using concrete, asphalt and concrete pavers.

It must be noted that the removal of the existing structure can represent about 30% of the cost of a new pavement.

Table 1. Relative Costs for New Pavement.

Type of Pavement (* thickness)	Relative Cost
150 mm* concrete	100
60 mm* concrete pavers	78
80 mm* concrete pavers	87
50 mm* asphalt	79

4. CONCLUDING COMMENTS

The condition of the rehabilitated pavement at El Calafate is still satisfactory after 3 years. There is some surface erosion at transition zones between the overlay and soil streets, due to stones being carried by vehicles entering the overlay (Figure 6). Possible solutions for this early erosion could be:

- Use of higher strength pavers (> 45 MPa).
- Production of double-layer pavers, with harder sands on the upper layer. This alternative depends on the availability of harder sands near the plant.



Figure 6. Eroded transition zone.

Contractors, project owners and the community have accepted the rehabilitation with concrete paver overlays very well. More than 75,000 m^2 interlocking concrete pavements are planned to be installed over the next few months; about 50% of this will involve rehabilitation by paver overlay.

It is noted that, in the Patagonian region between 1998 and 2001, the interlocking concrete pavements market share has grown rapidly from 0% to 20%.

Data from the Asociación Argentina del Bloque de Hormigón (AABH – Argentine Concrete Block Society) suggests that there is the capacity to produce about 3.300.000 m^2 high quality concrete pavers per year.

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Biography

Federico Pereyra-Iraola is an Engineer partner and founder of Concrete Solutions, a firm with offices in Buenos Aires and Comodoro Rivadavia, Argentina, rendering commercial consultancy services to the building industry.

He was member of the board of the following associations related to the industry:
Asociacion de Fabricantes de Cemento Portland Instituto del Cemento Portland
Asociacion Argentina del Bloque de Hormigon (President)
Consejo Portuario de Comodoro Rivadavia

In many occasions has been part -and chairman- of work teams representing the Argentina Cement before international organizations, such as CEMENSUR, FICEM (Ibero-American Cement Federation), PCA (Portland Cement Association),

NCMA (National Concrete Masonry Association), and other private and public entities.