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STATUS OF PAVEMENTS REHABILITATED WITH PAVER OVERLAYS, AFTER SEVEN YEARS IN SERVICE

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Note: The following is the notation used in this presentation: (.) for decimals, and ( ) for thousands.

Summary

This paper evaluates the status of two overlay works using concrete pavers after more than seven years in service.

In 2001, some severely damaged pavements were rehabilitated, using thin coatings with concrete pavers, in an area of approximately 24 500 m^2. The works were located in the cities of El Calafate and Puerto Santa Cruz, 300 km and 200 km respectively from Rio Gallegos, the capital city of the province of Santa Cruz, Argentina.

The overlays consisted of 60 mm, "Uni-stone" pavers in herringbone pattern, over the sand layer and the existing pavements, some of them with up to 28 years old.

Because these works were the first of this type in the country, they are evaluated after seven years in service, to check the successes and failures. This knowledge will be useful in order to "apply" it in future projects and to "refine" this solution, aiming to extend the service life of the pavements and the cost / benefit ratio of this application.

In addition, the following characteristic of the pavements: to be able to be built by stages, not to require neither specialized labor nor specialized machinery, makes them particularly suitable for partial repair of spoiled old pavement (one or several blocks), adding extra value to the pavement´s service life, without requiring a large amount of resources. This is an appealing solution for a large number mid and small size cities, scattered throughout the Patagonia in Argentina and Chile.

1. BACKGROUND

The main access avenues of the cities of El Calafate and Port Santa Cruz, were rehabilitated using overlays with concrete pavers. They are 300 km and 200 km respectively far from the capital city of River Gallegos, in the province of Santa Cruz.

These works were made during year 2000 (El Calafate) and 2001 (Puerto Santa Cruz). The total rehabilitated surface was 28 400 m^2 and the overlays were made on concrete and asphalt pavements. In some cases, they are severely damaged, after 26 and 28 years in use, respectively (see Figures 1 to 3).



Figure 1. State of the asphalt pavement before the overlay with pavers in El Calafate.



Figure 2. State of the concrete pavement before the overlay with pavers in El Calafate..

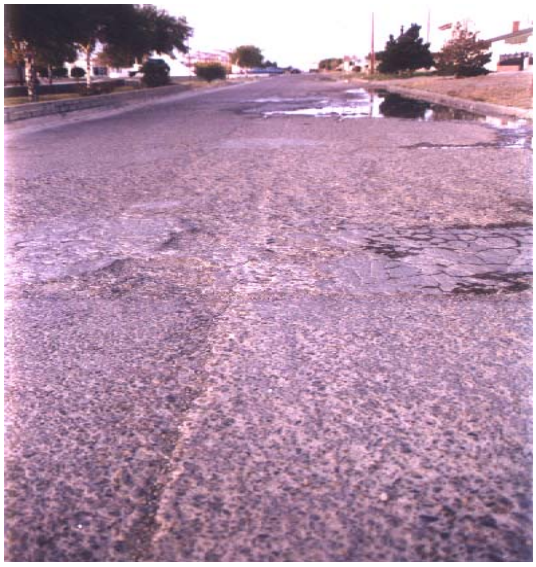

Figure 3. State of the pavement before the overlay with pavers in Port Santa Cruz.

1.1 Considerations about the adopted solution

In both cities, the existing pavements presented areas with significant damages. Those damages in the concrete pavements were loss several centimeters of thickness, exposed aggregates, spalling and breakages in the areas near the joints. In the cases of existing asphalt pavements, they presented, pronounced rutting, wear, loss of the asphalt surface and potholes.

The importance of these deteriorated routes, as the only entrance routes to the above-mentioned locations, led to consider the need to rebuild them, at least in some sectors, or its refurbishment to restore their original trafficking conditions.

The possibilities considered at that time included:

- To build a new pavement after demolishing the old one.
- To refurbish and strengthen the existing pavement with and overlay. In this case the presented alternatives were:

- A thin concrete overlay.
- An asphalt overlay.
- A concrete paver overlay.

Given that the existing pavement had a residual value as resistant structure, the adopted solution was to recondition the existing pavements rather than building new pavements.

To recondition the existing pavement, the concrete pavers overlay was chosen. This alternative was technical and economically more beneficial due to following facts:

- It uses precast concrete units allowing the works to be done even with inclement weather due to location and the time of year the work had to be developed. It shortened the "winter ban" usually of several months in these areas. This they allows contractors companies continue certifying units of work, what that dims fixed costs.
- It enables the generation of the need for a significant amount of local non-trained labor.
- It permits to build the pavement by parts, with an immediate traffic opening after placement of the pavers, without causing a great disorder to the movement of vehicles.
- It does not require large equipment for their construction.
- Since pavers do not conform a continuous layer, the thin or wide existing cracks in the base pavements, are not reflected in the surface.
- It has a high residual value with the possible reuse the pavers used for the intervention.
- Its high aesthetic value allows the combination of pavers of different colors to mark different areas, such as pedestrian crossings, parking areas and even the generation of figures.
- The minimum required maintenance can be made in small areas generating minimum interference to transit.
- Since its surface is made of small segments, the concrete block pavement acts as natural speed reducer, something very desirable in the residential areas. This type of surface improves the safety against pedestrian sliding and vehicle skating, especially in wintertime due to the presence of ice.

The pavements to rehabilitate did not have deformations (slabs collapses) or significant cracking. The distress was mostly due to spalling and erosion of the surfaces, increased by successive cycles of freezing and thawing and the lack of maintenance. These conditions allowed to consider the existing material as a good base, in structural terms, for the future overlay.

1.2 Construction of the overlays

A micro-concrete overlay (10 mm (3/8”) maximum size aggregate) was placed on the existing pavement to restore the original drainage slopes, to repair the batches and to fill the joints between slabs. This filling was made to avoid the bedding sand to get lost through the joints.

Once the surface was reconditioned and the original slopes were rebuilt, the process continued with the typical construction of a block pavement, i.e. distribution and leveling of the bedding sand, the laying of the concrete pavers and the sealing with sand and final cleaning.

Since the new pavements had “waterproof” bases, scarce slopes and limitations for the final thickness of the coating, the alternative was to decrease the height of the sand from 40 mm or 30 mm loose, to 20 mm after compaction.

The use of 60 mm pavers was according to the need of not losing the curb-gully, with just a 70 mm height curb after the overlay.

Concrete pavers were Type I according to standard IRAM 11656, i.e. those for use in public streets, airports, ports, freight courtyards, etc. Belonging to Type I means having a compression strength of more than 45 MPa as average and no less than 40 MPa for individual values.

In Port Santa Cruz it was necessary to maintain the lowest level of the gullies by using metallic confinement, made by "L" shaped profiles (3" x 3" x 4 mm), anchored to the existing pavement with metal anchors. In the city of El Calafate this was not necessary since there was no gullies.

Since a difference in level of, approximately, 80 mm that was generated in relation to existing pavements in surrounding areas to the overlays, it was decided to use transition ramps in the following ways:

- Scarifying and trimming with a pneumatic hammer along an one meter wide strip, with a variable thickness from 0 to 70 mm. It sought to match the end of the ramp with a slab of the existing pavement (see Figure 4).
- Leveling and rebuilding the slopes with soil-cement.
- Building the overlay of concrete pavers.



Figure 4. Construction or a transition ramp.

Figure 5 indicates the features of a transition ramp as it was built in Port Santa Cruz. In El Calafate, apart from building a smaller amount of ramps, they were resolved fixing a metal rail to the existing pavement, to confine the pavers, and the gap was filled with adhered asphalt.

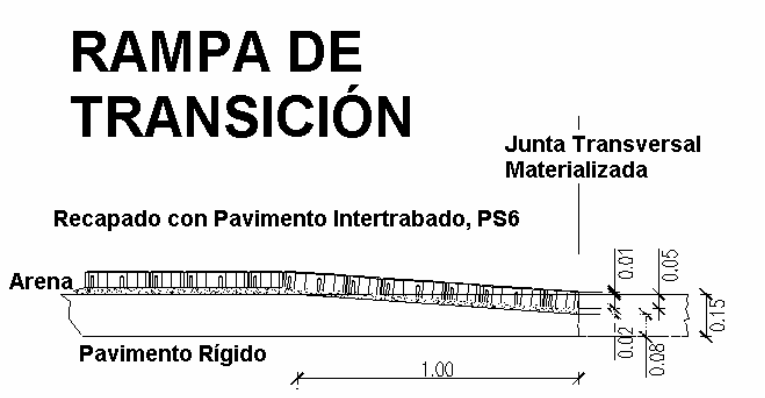

Figure 5. Outline of the "type" transition structure "ramp" against the existing pavements.

In the work of Port Santa Cruz, transversal slopes were, in some cases, extremely small (less than 0.5 %), less than the recommended minimum. As a result, water was flowing very slowly, generating small water accumulations that often ended disappearing by evaporation.

When placing the concrete paver overlay it was not possible to increase these transversal slopes, but it was possible to fix the depressions where water use to get stagnant. To improve the capture of water, vertical ducts were built additionally to the existent rain boxes (see figures 6 and 7).



Figure 6. Capture of surface water through a tube, built with the overlay.



Figure 7. Original rain boxes..

2. CURRENT SITUATION

Regarding the actual transit over the paver overlay, in the case of Puerto Santa Cruz it has been practically the same after the rehabilitation, about 1 000 vehicles of less than 1.2 t, 300 units between 1.2 t and 4 t, and some 50 with more than 7 t.

In El Calafate, in contrast, during high season (October to May), approximately 70 000 people enters the city, in addition to its 7 000 inhabitants, a number that grows year to year with the consequent commercial and vehicular movement associated to satisfy that growth.

After more than seven years in service, the current situation is as follows:

2.1 Pavers

The paver surfaces remain virtually with no superficial wear, except those in contact with unpaved streets and loose gravel, which have wore-out in some millimeters. In these cases, due to the stones swept away by vehicles, there is a wear greater than for the rest of the pavers (see Figure 8).

In Figure 9 it can be seen the contrast between the general surface of pavers and one embodied confinement made with a on-site cast concrete beam.

Pavers of colors different to gray were used to signal the pedestrian crossing places. After several years of service, the dark colors are the best preserved ones. The clear color have been disappearing confusing with the original gray pavers from the rest of the pavement, fundamentally because of the wear of the tires and the environmental dust “bury” them (See Figure 10).



Figure 8. Entrance area of "stones" swept away by vehicles



Figure 9. Beam State of embodied confinement with concrete "in situ" and pavers.



Figure 10. Signaling of the pedestrian road crossing, with colors different to gray.

2.2 Bedding sand and bases

There is neither visible evidence of horizontal displacement of the pavers nor unevenness of them, caused by the movement of the bedding sand, either by water that could infiltrate or by sand degradation (see Figures 11 and 12).

In principle, this would make evident the good operation of the vertical drains and a good "seal" of the pavement, despite the little transversal slopes, in some cases, and the impermeability of the bases (existing concrete and asphalt).

It should be noted that even though the Argentinean Patagonia has very little rains, some 200 mm annually, during the winter season, snow accumulates and the thaw brings water to the pavement (see Figure 13).



Figure 11. Current aspect of the screeds rehabilitated coated pavers.



Figure 12. Current aspect of the screeds rehabilitated coated pavers.



Figure 13. Rehabilitated pavement in the Calafate in presence of snow.

In the case of El Calafate suitable sands came from nearby sites on the coast of Lake Argentino.

For Puerto Santa Cruz, the bedding sand had to be transported from the city of Rio Gallegos, 200 km far; it was necessary because in the area there was no suitable sands for this purpose. The sealing sand was found in the area, but prior to its use had to be subjected to intense screening and drying.

Although the transport of the sand from such a distance increased the initial costs of the pavement, with the passage of time the good "behavior" of, marked a correct decision in due course.

2.3 Transition structures “Ramps"

Transition structures (ramps) have failed in the following cases:

2.3.1 Rebuilt pavements in El Calafate.

In the case of the ramps, they were built fixing a metal rail to the existing pavement, as a confining method for the pavers. The gap between both levels was filed with adhered asphalt. To date the asphalt material has virtually disappeared (see Figure 14).



Figure 14. The structure of transition "ramp" has virtually disappeared.

2.3.2 Screeds rehabilitated in Port Santa Cruz

In this case, the ramps were built as shown in Figure 1.

Those with slopes less than 6%, are in very good condition, as shown in Figure 15 .

Those who had slopes greater than 6%, usually up to 8% failed, showing vertical displacement and rupture of pavers (see Figures 16 and 17).

They are currently under repair, replacing with concrete the part of the breakage of zone of the change of slope.



Figura 15. Estado actual de las estructuras de transición “rampas”.

2.4 Speed reducers or "donkey loins" .

In general, they have kept in good conditions, except small breakage of the arrises. The most appropriate have been those where the raised pavers are parallel to the axis of the street.

The ones with pavers perpendicular to the axis of the street, a little time after construction, showed simple breakage in halves, but did not separate. It was probably due to the greatest area exposed surface to the "tires" of the vehicles (see Figures 18 and 19).



Figure 16. Current status of the structures of the transition "ramps".



Figure 17. Current status of the structures of the transition "ramps".



Figures 17. Speed reducers with pavers parallel to the axis of the street.



Figures 18. Speed reducers with pavers perpendicular to the axis of the street.

These profiles have failed, due to the weight of vehicles. The "wings" folded causing loss of interlock and rupture of some pavers in contact with the profiles, apart from being prone to the accumulation of rubbish by its low width in relation to its depth (see Figure 20).

3. considerations final

Overlays with pavers provide an economic alternative to improve the strength and appearance of deteriorated pavements.

The cost of these overlays is often much lower than to remove and rebuild the pavement, mainly for the reasons listed in paragraph 1.1, that describe the techno-economic benefits of this choice, additionally to not requiring large equipment and to the use of non-specialized local labor.

The overlays with concrete pavers can be built both on concrete or asphalt pavement.

In relation to the problems and/or failures that were found after more than 7 years in operation, it can be advised:



Figure 20. Confinement with metallic profiles.

- Use pavers with a high strength (> 45 MPa) near the unpaved streets. The adequate strength for this purpose or any other alternative solution could be determined once the new version of IRAM 11656 Argentinean standard for pavers, with the new abrasion testing method.
- Use "strongly" colored pavers for horizontal markings on the streets.
- In case to have to build ramps with more than a 6% slope, as a transition with existing built pavement, they must be done with a variable thickness concrete slab. If the slope can be maintained with less than a 6% slope, the transition with pavers works well.
- The speed reducers made with pavers, build them with risen units parallel to the axis of the street.
- Replace the small gullies made with metal profiles with concrete with grater width.