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CONCRETE PAVING BLOCKS AS PROTAGONIST IN THE DEVELOPMENT URBAN RESIDENTIAL NEIGHBORHOODS

COTTI DE LA LASTRA, Leda, Engineer.

Director of Inspection and Certification, Municipality of Trelew, ARGENTINA.
Professor, National Patagonian University "Saint Juan Bosco".

HERRERA, Claudio, Civil Engineer.

Promotion and Technical Services Manager.
Petroquímica Comodoro Rivadavia S. A..
Barrio Don Bosco, km 8, (9003) Comodoro Rivadavia, Chubut, ARGENTINA.
Tel./Fax.: + 54-297-4535189, cherrera@pcr.com.ar

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

Summary

This paper describes the use of concrete block pavements in a residential neighborhood, where the added value of the system in an urban development project.

22 000 m^2 of pavement were built with a width of 2.4 m and an area for restricted movement 2.0 m wide on each side of the road. Because the width of designed road only allows the movement of a single vehicle, the restricted movement areas are used for parking. There are three possibilities to cover these parking areas: grass, loose stone material and brick dust.

The paves used were "Uni-stone", Type I according to IRAM Standard 11656, with a 28 d compressive strength greater than 45 MPa. They were installed in herringbone pattern confined with gutters and concrete curbs. The shape of the gutters allows the crossing of vehicles to the parking area, along the city block, without having to allocate specific ramps in front of the garages, with a lower profile.

The main reasons for the election of this solution, they were:

- The immediate opening to transit after laying the pavers, even partially, so as not to interrupt the transit at any time.
- The construction technology is simple and does not require highly trained labor, making it attractive for the generation of local labor.
- It requires very little maintenance
- The limited road width and the "texture" of the pavement act as "natural speed reducers".
- The combination "generated" by the pavers and the wide "sidewalks" with various cover materials, enhance the architecture of this residential neighborhood, something that cannot be achieved with other type of pavement.
- The possibility to "reuse" the pavers, in case of interventions and repairs, allows to qualify this pavement as "sustainable".

1. DESCRIPTION OF THE PROJECT

The present work discusses the use of concrete block pavements in a suburb where the advantages of this paving system were taken into account as a benefit for an urban development project.

The described work is a part of the so-called "Paving 400 blocks to complete the street network of the city of Trelew", and includes one of the residential neighborhoods located in the southern sector of the city, with particular characteristics like a closed neighborhood but without being so. Large empty lots characterize it, with no commercial activity so it was desirable to maintain low speed traffic and one-way streets.

1.1 Road project

To harmonize the road project with the characteristics of the neighborhood, the designers projected narrow streets in the inner neighborhood and two two-directon streets, Pellegrini and Captain Murga, linking this sector to the rest of the city a to the major roads going to other cities.

The decision was for the construction of a concrete block pavement, covering a 22 000 m^2 area, along a total of 55 city blocks.



Figure 1. Location of the Barrio San Benito and the block paved streets.

The width of road was designed to allow the movement a single vehicle, consists of a 3,8 m wide profile which includes 2.4 m of concrete block pavement contained by gutter-curbs with a width of 0.7 m wide and a "restricted circulation" area 2.0 m wide to each side of the road. Figure 2 shows the transverse profile for a standard street.

This so-called "restricted circulation" area has as purpose of allow parking and the vehicle surpass if necessary.

To achieve this purpose the traditional gutter-curb turned into a mountable gutter-curb, using a slight slope that allows accessing the area of "restricted circulation" across it, allowing the vehicle surpass and parking. The longitudinal heights enable the collection of the surface water towards the established collecting points.

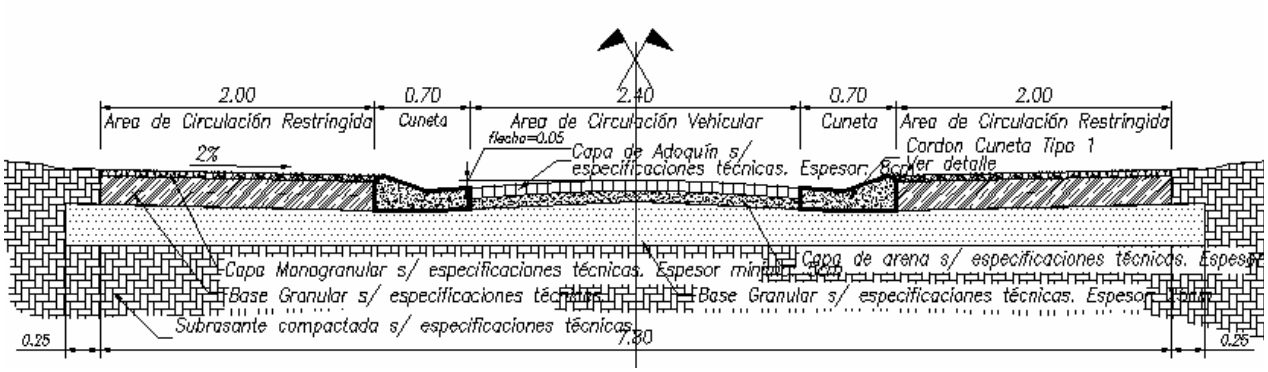

Figure 2. Pavement cross section.

1.2 Pluvial project

To ensure the rainfall runoff in times of rain, the road was projected with a cross slope of 4% so that water could easily drain towards the mountable gutter. Those curbs have a longitudinal slope of 1.5%, which allows to lead the water by surface towards the pre-established lowest points which are planned rain ducts that collect the water from this basin and its journey continue collecting water form neighbor basins (see Figure 3).

Sketch shows through arrows the surface runoff. The rain conducts, one that is now under construction, are built with 1.0 m diameter concrete ducts, increasing its section throughout its route. Collected waters are concentrated in pools from which is it pumped to the Chubut River.



Figure 3. Rainfall project.

2. GENERAL CHARACTERISTICS OF THE WORK.

2.1 Granular base

The pavements are located in an area of the city with soils with low support value.

The structural package includes the improvement of a thickness of 0.45 m below the level of the subgrade.

When the material of subgrade was not suitable, a first layer of 200 mm of selected granular soil from local quarries was placed; over it, a 250 mm tick granular base, compacted, to a minimum of 95% of the maximum density obtained in the compaction Proctor test T 180 (see Figures 4 and 5).



Figure 4. Opening of the box for the pavement.



Figure 5. Implementation of the granular base.

The base is composed of granular, non-plastic material, coming from a nearby site. In Figures 6 and 7 can be seen the exploitation and classification of the granular material in the quarry.



Figure 6. Extraction of the granular material in the quarry.



Figure 7. Classification of the granular material in the plant.

This material has a type A1b according with the universal soil classification.

The maximum dry density in the Proctor T 180 test showed a result of 2.117 g/cm^3, for a maximum 7.7% humidity.

Figure 8 shows the density / moisture curve for the base material.

The strength characteristics of the base material were evaluated through the support value test, whose graph is shown in Figure 8.

In figure 9 it can be seen that for the density corresponding to the maximum obtained in the Pórctor, the obtained support value is 65%, which implies it is an excellent quality material.

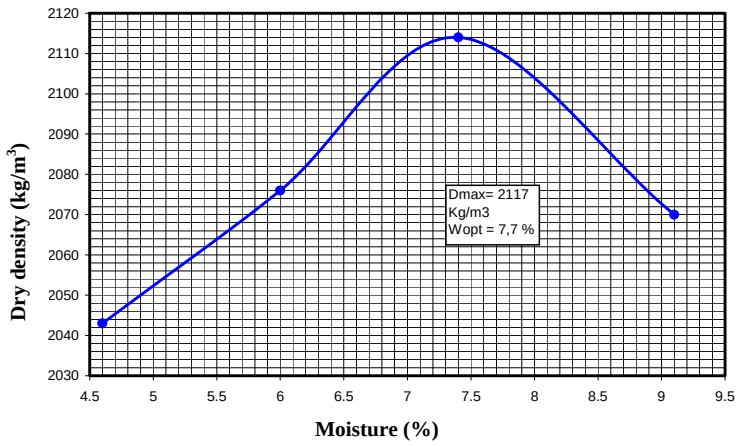

Figure 8. Density / Moisture curve.

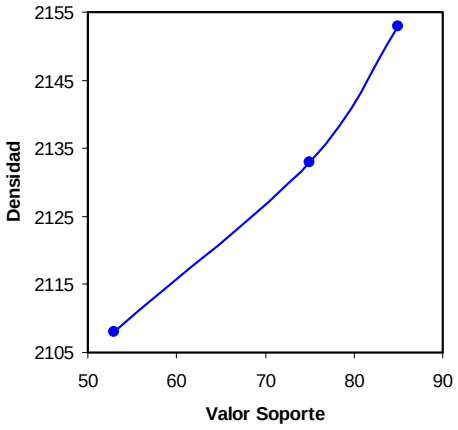

Figure 9. Density / Support value curve.

2.2 Confining mountable gutter-curb

Prior to the laying of pavers, a mountable gutter-curb was built, working as a confinement for the pavers and allowing the access to the area of *"restricted movement"*, in order allow the crossing of the vehicles and the parking in such area. Figure 10 shows the profile of the mountable gutter-curb.

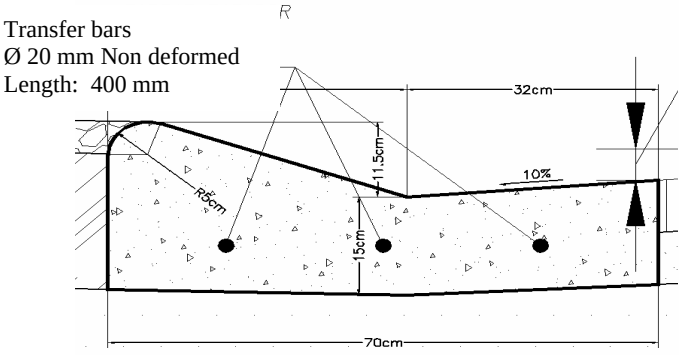

Figure 10. Mountable gutter-curb.

Construction of the mountable gutter-curb was made using plant precast H - 21 concrete, that means a 28 day characteristic compressive strength of 21 MPa.

Due to the adopted profile, it was adopted a constructive methodology making perforated steel sheet profiles. Using a lower cantilever devise, the joining the pins stay perfectly horizontal and parallel. These profiles were placed at distances established for contraction joints of such that the casting was made in a discontinuous pattern, first the odd portions and then the even ones.

Figures 11 and 14 shows the building process and the profiles in detail.

2.3 Concrete pavers

The used concrete pavers were grey, "Uni-stone", 80 mm thick units, Type I according to the IRAM Standard 11656, i.e. those for use in pavements for public roads, airports, ports, load courtyards, etc. To be Type I means having a compressive strength larger than 45 MPa as average of the sample, and no less than 40 MPa for individual values of the specimens.



Figure 11. Preparation for the construction of the gutter-curb.



Figure 12. Discontinue constructive methodology for the gutter-curb.



Figure 13. Metallic formwork, spacers and steel joint bars.



Figure 14. Detail of the steel joint bars.

The samples were regularly taken to verify the physical and mechanical characteristics of the pavers.

The selected laying pattern was herringbone, which provides a very good interlock to resist both horizontal and transversal relative displacement, and presents a good behavior under traffic.

Figure 15 shows the laying pattern used.



Figure 15. Used herringbone pattern.

2.3.1 Building methodology

The laying of pavers was made according to IRAM Standard 11657 and to the Particular Technical Specifications. The bedding sand layer was 40 mm, form a local origin. This was a coarse sand whose distribution responds to the one indicated in Table 1.

Table 1. Bedding sand.

Sample	**47/07**	**Specification**	
MATERIAL	**SAND**	**MINIMUM**	**MAXIMUM**
SIEVE No.	**% passing the sieve**		
"3/8"	100	100	100
4	100	90	100
8	82	75	100
16	60	50	95
30	28	25	60
50	19	10	30
100	4	0	15
200	0	0	5

After the pavers were laid, they were vibro-compacted with a plate with a surface of 0.5 m^2 with two orthogonal passes, overlapping 1/3 of one unit.

The cuts of pavers were made with a grinder with a cutting disk. Once they were adjusted against the gutter, the joints were sealed with dry sand (see figures 16 and 17). A screened sand was used, with a grading corresponding to the one in Table 2.

The work was done with a seven workers crew. The average yield per crew proved to be 150 m^2 /d (21.5 m^2 / worker x day).

Table 2. Joint-filling sand.

Sample	**47/07**	**Specification**	
MATERIAL	**SAND**	**MINIMUM**	**MAXIMUM**
SIEVE No.	**% passing the sieve**		
8	100	100	100
16	100	90	100
30	90	60	90
50	60	30	60
100	25	5	30
200	6	0	15

3. ADVANTAGES OF THE PAVING WORKS IN CONNECTION TO THE CHOSEN TYPE OF PAVEMENT

There are several benefits of this type of pavement for the characteristic of the neighborhood and its geographic location.

- In relation to this last point, it must be considered that in the Patagonian region, climate is a conditioning factor in the construction of pavements. There is trouble not only in winter due to low temperatures, but also in spring and summer, when strong winds force to suspend the concrete casting activities for several days. This type of pavement has the advantage of factory-

made precast concrete units, with all the required quality features. It allows independence from the prevailing weather conditions.

- Another advantage is that transit can be reinstated immediately since it is not necessary to wait for the curing and hardening of the concrete to occur. Additionally, the construction technology is simple because it does not require highly trained personnel, making it attractive to generate local employment.
- It requires very little maintenance and if it is necessary to do repairs in service lines under the road, the pavers can be withdrawn and re-laid without implying breakages in the case of traditional concrete, something that allows qualifying that pavement as "sustainable".
- The network generated by the pavers in combination with the spacious sidewalks and the various materials they were coated with, accentuate the residential architecture from the neighborhood, something that no other type of pavement can achieved (see Figures 20 and 21).

3.1 Comparative cost analysis

The analysis of the bids made by the bidding companies in this project, for the different types of pavements, generates the following comparative Table 3.



Figure 16. Adjustment of the details of the paves in the road.



Figure 17. Cutting of pieces of less than a complete paver.





Figures 18 and 19. Details of the laying of pavers.





Figures 20 and 21. Aspect of a street of the neighborhood before and after the intervention.

Table 3. Comparative values for initial cost of new pavements.

TYPE OF PAVEMENT	RELATIVE COST
Concrete, thickness = 150 mm.	100
Pavers, thickness = 80 mm.	125
Pavers, thickness = 60 mm.	110
Asphalt, thickness = 50 mm.	83

Concrete pavement was considered as the basis for the comparison, being the one with the greatest participation in the work referred to in (1). Consequently, it was given the relative value of 100.

In spite of being the "initial cost" of concrete block pavement higher in some sectors of the city with similar characteristics to the ones described in this work, it was selected over the other types of pavements for the advantages listed in paragraph 3. Additionally, it is the pavement with the greatest residual value, due to the "reusable" feature of the pavers, and the added value of the “aesthetic” aspect of them.

In addition, values were considered by m^2 of surface and in the case of the concrete block pavement, the surface was less. Its mixed surface was formed by a road of only 2.4 m and the two areas of *"restricted circulation"* 2.0 m wide each, which shall be conditioned by the neighbors choosing among three alternatives; lawn, dust brick, or natural ground with a "road gravel" layer.

The difference would have been even better if it they had used 60 mm thick pavers, perfectly feasible for the type of planned transit. However, the statement of technical specifications did not consider them, perhaps by the belief that still persists in places where the system is not yet highly developed of the 60 mm pavers are only suitable for pedestrian paths, squares, and others minor applications.



Figures 22 to 25. Different aspects of the finished streets.