10th International Conference on Concrete Block Paving
Shanghai, Peoples Republic of China, November 24-26, 2012

The Performance of Colored Concrete Block Paver in Relation to Abrasion

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Summary

The technical department of Construction Pathology, which is part of INTI-Constructions, is in charge of attending queries related to pathologies affecting concrete paving blocks. Our department analyzes the components of the system and the conditions of its laying by inspecting the sites and carrying out laboratory tests. Our 30 year experience and the collaborative work with other institutions, such as AABH (Argentine Association of Concrete Blocks) and ICPA (Argentine Institute of Portland Cement), have resulted in the development of the Certification Program for concrete paving blocks. The aim of this program is to ensure the quality of the product and reduce the possible deficiencies.

The queries we receive come from local and national organizations and private individuals who are either producers or consumers indistinctively (concrete blocks manufactures, road constructors, constructing companies, etc). The geographical area, the building system or the workforce seem to have no impact on the failures, according to these inquiries. The most recurrent pathology we have identified has to do with the abrasion of the blocks due to pedestrian and vehicle traffic. In response to this pathology, the Abrasion Test has been used. This test is part of the IRAM (Argentine Institute of Normalization and Certification) norm 11656 “Concrete paving blocks, Requirements and Methods”. Through the study of this pathology we have become acquainted with the performance of grey concrete paving blocks, which are the most commonly produced in our country.

The use of these blocks for both pedestrian and vehicle paving – new and recovered - has recently increased in our country, including colored blocks (black and yellow). This study aims at anticipating the possible performance differences between grey and colored blocks. Conventional colored and grey paving blocks have been used in this test.

This paper compares the behavior of gray and colored pavers blocks in absorption and wear tests. For this evaluation were used conventional gray colored paving blocks (black, yellow, red).

Keywords: abrasion resistance, color stability

Introduction

Our institution receives requests for quality control of materials and services to study pathologies in the construction from different areas, such as, National establishments, provincial, municipal, private users, producer of precast concrete, road companies, construction companies, apartment complexes, in over every geographical areas.

In recent years, there has been a significant increase in the use of concrete paving blocks in different parts of Argentina. The use of this type of blocks not only is for pedestrian spaces but also for new spaces like streets, vehicle parking lots and spaces such as port container lots. This growth is due to the important development of the construction with private funds, plus a heavy investment from the public area, in regard to paving, recovery and enhancement of historic buildings, squares, walks, etc.

Because of the increasing blocks market, different areas emerged in this market; from technology companies to cooperative almost craft that also reach the final product, to this we should add that it is a product that when it is placed is very labor utilized. Under the above and with a comprehensive group work, our institution with other like the AABH and the ICPA has developed the Program of Voluntary Certification Blocks and concrete blocks where the manufacturing facilities of this kind of precast get voluntarily join to the seal of quality reaffirming that the quality of your finished product and also ensuring the control of its system of quality management.

This context had an impact on our Technical Unit with an increase in queries regarding to the quality of the blocks from different factories, as well as from different manufacturers interested in learning and improving their products. Under this is that we focus this subject on the intensive evaluation and behavior of the blocks in two important items, such as water absorption and wastage by abrasion. Basically evaluating the behavior of the blocks with pigments (colored) and the others commonly known as "gray" incorporating also the variant of using ‘fluidifying’ additives as appropriate or not.

Theoretical Framework

Having focused on the studies of blocks and basically on the followings assays, we have done a bibliographic research, we have talk with different manufacturers and we have asked them to give as some samples of their blocks so we can be able to do the followings assays. Knowing that, with in the dosages are several variables like the type of aggregate to be used, the granulometry, the type of cement, the use or not of additive, the manufacturing system and when it was done. We place as a parameter of fulfillment the IRAM Norm 11656-2010 Concrete paving blocks, requirements and test methods for the assays.

Experimental Framework

Laboratory tests - Starting from explained above, we began a study based in a series of assays to characterize the concrete blocks.

Over a representative sample of concrete blocks, we have done assays of dimensions, such as length, width, thickness, bevel´s projection; absorption, density, abrasion, breaking strength by bending in concrete blocks. All of them according to methods of fulfillment the IRAM Norm 11656-2010 Concrete paving blocks. The sample to be study was composed by ten different types of concrete blocks from two different factories, with different qualities which are expressed in the following table.

Table 1: Blocks Identification

COMPANY	IDENTIFICATION	BLOCKS´TYPE	CEMENT kg.	ADDED kg.	PIGMENT %c/100kg.Cto.	ADDITIVE
1	1-U-GR-06	Type 1" rectangular Angled (Uni Stone)", bezel, grey monolayer with separators, enom= 60mm	100	417	3	SI
	1-U-NE-06	Type 1" rectangular Angled (Uni Stone)", bezel, black monolayer with separators, enom= 60mm	100	417	3	SI
	1-U-AM-06	Type 1" rectangular Angled (Uni Stone)", bezel, yellow monolayer with separators, enom= 60mm	100	417	3	SI
	1-U-AM-08	Type 1" rectangular Angled (Uni Stone)", bezel, yellow monolayer with separators, enom= 80mm	100	364	3	SI
2	2-U-GR-S/AD	Type 1" rectangular Angled (Uni Stone)", bezel, grey monolayer without separators, enom= 60mm	100	406	5	NO
	2-U-GR-C/AD	Type 1" rectangular Angled (Uni Stone)", bezel, grey monolayer without separators, enom= 60mm	100	406	5	SI
	2-U-R-S/AD	Type 1" rectangular Angled (Uni Stone)", bezel, red monolayer without separators, enom= 60mm	100	406	5	NO

	2-U-R-C/AD	Type 1" rectangular Angled (Uni Stone)", bezel, red monolayer without separators, enom= 60mm	100	406	5	SI
	2-U-NE-S/AD	Type 1" rectangular Angled (Uni Stone)", bezel, black monolayer without separators, enom= 60mm	100	406	5	NO
	2-U-NE-C/AD	Type 1" rectangular Angled (Uni Stone)", bezel, black monolayer without separators, enom= 60mm	100	406	5	SI



Figure 1: Received blocks

Table 2: Results of test for measurement of length, width and thickness.

IDENTIFICATION	Average true length (mm)	Average true width (mm)	Average true thickness (mm)
1-U-GR-06	209,47	105,61	59,99
1-U-NE-06	207,77	104,18	60,61
1-U-AM-06	208,34	104,04	60,32
1-U-AM-08	208,22	104,52	77,65
2-U-GR-S/AD	219,16	110,25	82,21
2-U-GR-C/AD	215,83	108,05	78,18

2-U-R-S/AD	219,27	110,32	81,73
2-U-R-C/AD	200,01	111,66	82,55
2-U-NE-S/AD	218,84	111,91	81,52
2-U-NE-C/AD	229,87	120,16	93,28

Note: Following the IRAM Norm 11656:

- The nominal length (ln) of the blocks does not have to be less than 50mm or more than 250mm.
- The nominal width (an) of the blocks, must be at least 50mm.
- The standard thickness (ee) of the blocks, must be at least 60mm.

Table 3: Results of test for measurement of bezel.

IDENTIFICATION	Horizontal Projection			Vertical projection		
	Max (mm)	Min (mm)	Difference (mm)	Max (mm)	Min (mm)	Difference (mm)
1-U-GR-06	9,1	8,1	1,0	3,1	2,6	0,5
1-U-NE-06	7,7	6,5	1,2	3,7	2,2	1,5
1-U-AM-06	8,3	7,7	0,6	2,6	1,5	1,2
1-U-AM-08	9,1	8	1,1	3,8	3,0	0,8
2-U-GR-S/AD	9,2	7,5	1,7	4,9	4,3	0,6
2-U-GR-C/AD	8,9	6,4	2,5	3,9	3,0	1,2
2-U-R-S/AD	9,2	7,5	1,7	3,1	2,4	0,6
2-U-R-C/AD	8,4	7,4	1,0	4,4	3,3	1,4
2-U-NE-S/AD	8,2	6,9	1,3	6,6	5,2	1,4
2-U-NE-C/AD	8,5	6,5	2,0	6,1	5,1	1,0

Note: Following IRAM Norm 11656 : the bezel must have the same shape or side face throughout its length, both in the horizontal projection (phb) as in the vertical projection (pvb), the side face of the bezel must be at least 3mm and at maximum 7mm, and the difference between the highest and lowest of the four measurements of the horizontal projection of bezel (phb) and of the vertical projection (pvb), taken for each sample, do not have to be more than 1,5mm.

Table 4: Test results of water absorption

IDENTIFICATION	Average water absorption in mass %	Water Absorption Average Volume (kg/m³)
1-U-GR-06	5,12	109,62
1-U-NE-06	2,88	63,36
1-U-AM-06	3,11	69,17

1-U-AM-08	2,68	59,67
2-U-GR-S/AD	7,68	157,11
2-U-GR-C/AD	6,12	129,32
2-U-R-S/AD	7,50	154,94
2-U-R-C/AD	6,19	131,24
2-U-NE-S/AD	9,03	189,72
2-U-NE-C/AD	8,84	174,22

Note: Following IRAM Norm 11656 the concrete blocks should have a total water absorption (Aa%) (for all the volume of the sample) no more than 5% for the average or less or equal than a 7% for the individual value, referred to the dry mass of the blocks.

Table 5: Test results of flexural modulus of rupture.

IDENTIFICATION	Modulus of rupture to the Average Flexural (MPa)
1-U-GR-06	6,7
1-U-NE-06	6,9
1-U-AM-06	7,6
1-U-AM-08	6,6
2-U-GR-S/AD	4,2
2-U-GR-C/AD	4,9
2-U-R-S/AD	4,1
2-U-R-C/AD	5,4
2-U-NE-S/AD	4,0
2-U-NE-C/AD	4,1

Requirements as IRAM Norm 11656:2010 – Inc. 5.4
Minimum average of Modulus of rupture at the age of 28 days : 4,2 MPa
Minimum individual of Modulus of rupture at the age of 28 days : 3,6 MPa.

Resistance to abrasion test - Test Procedure:
The sample is subjected to abrasion, through a mechanical device composed of a steel disc, of hardness Brinell of (200±20)HB, an abrasive consisting of rounded silica sand grain with a predetermined flow rate. The essay consists of expose the sample to the rotation of the disc and the fall of the abrasive during a period of 1 (un) minute. The following is a photographic sequence of the test.



Figure 2: Sample´s Preparation

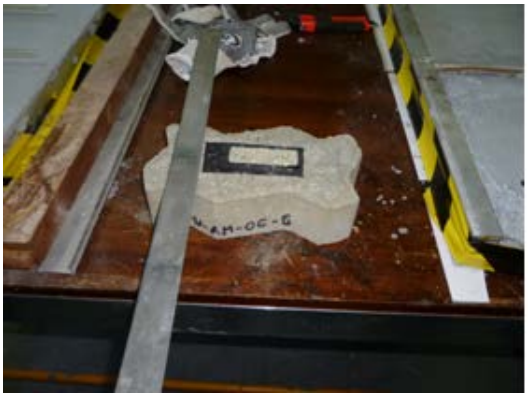


Figure 3: Placement on the test device





Figures 4 and 5: Carrying out the experiment





Figures 6 and 7: Measurement of the trace after the test

Table 6: Abrasion resistance test results

IDENTIFICATION	SAMPLE	Footprint long (mm)	
1-U-GR-06	2	25	27
	4	28	
	6	27	
	8	27	
	10	28	
1-U-NE-06	2	25	24
	4	22	
	6	23	
	8	23	
	10	25	
1-U-AM-06	2	25	24
	4	25	
	6	24	
	8	21	
	10	23	
1-U-AM-08	2	25	25
	4	25	
	6	26	
	8	25	
	10	24	
2-U-GR-S/AD	2	28	28
	4	28	
	6	27	
2-U-GR-C/AD	2	28	28
	4	27	
	6	29	
2-U-R-S/AD	2	28	28
	4	29	
	6	28	
2-U-R-C/AD	2	29	29
	4	28	
	6	29	
2-U-NE-S/AD	2	29	29
	4	29	
	6	28	
2-U-NE-C/AD	2	29	28
	4	28	
	6	28	

Note: Following IRAM Norm 11656, the value of the footprint long of the average of three samples subjected to the test method has to be less or equal of 23mm.

Conclusions

The following conclusions can be expressed according to the tests performed.

- The samples received in our laboratories are from companies that provide a high volume of blocks to the Argentinian market and they do not respond to requirements norms.
- In order to abrasion´s resistance, the evaluated blocks do not change significantly between gray and colored blocks, in proportions of 3 to 5% of pigment in relation to the cement.
- In some samples, the additive used, did not produce significant changes in the resistance to abrasion.
- During the test process, has been observed changes in the color of the pigmented blocks.
- Has been observed that the blocks without additives, have uniform color on all sides of it.
- Has been observed that the blocks with additives, have more differences in color between the upper surface and sides.

Current Research

Considering that abrasion does not present significant changes:

- The tested blocks are being exposed to outdoors to study the color conservation.
- As well we selected the red and yellow blocks, have more difference in colors,
- The yellow and red blocks have been the ones with more significant color changes. That's why we selected them to do new studies of colors in those blocks. Some of them will be studied exposing them to the outdoor and the others will be placed in the UV camera.

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