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Advantages of mortar-based design for coloured self-compacting concrete

A. López [a], J.M. Tobes [b], G. Giaccio [c], R. Zerbino [d,*]

[a] CONICET-GINTEMAC, Faculty of Engineering, UTNFRC, Argentina
[b] Faculty of Engineering, La Plata University, Argentina
[c] CIC-LEMIT, Faculty of Engineering, La Plata, Argentina
[d] CONICET-LEMIT, Faculty of Engineering, La Plata University, Argentina

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ABSTRACT

The development of coloured self-compacting concrete (C-SCC) opens new fields of application, since it adds attractive alternatives for challenging architectural designs in terms of shapes and colour, to the already versatile aesthetic characteristics of traditional coloured concrete. The benefits of using cement paste or mortar tests as a previous step in SCC design to optimize mixture proportions have been recognized. This paper shows the advantages of using a mortar-based mix design methodology for C-SCC. In addition to rapid and easy determination of the proportions of the mixtures including different types of pigments, cements, mineral additions, and chemical admixtures, the mortar approach enables observation of the effect of pigments on the viscosity of C-SCC and evaluation of specific aspects as the colorimetric parameters, the colour homogeneity and the surface finishing.

1. Introduction

The development of coloured self-compacting concrete (C-SCC) seems to open new fields of application of SCC. In addition to the advantages of fluidity and filling capacity of SCC, the C-SCC extends the aesthetic aspects from a variety of colour and surface textures. Some recent applications of C-SCC can be found in the literature [1,2].

As it is well known the design of SCC requires a careful combination of the multiple material components of the mixture. A SCC must achieve high workability and flow into the formwork under its own weight without compaction and with no segregation. In rheological terms it is accepted that SCC has a low yield stress while the plastic viscosity can vary significantly. An appropriate combination of the two parameters is required to obtain a concrete with adequate fluidity and stability [3].

The same as other powder components, the addition of pigments will modify the flowability and the cohesion of the mixture. Changes on materials proportions must be considered to optimize the rheological properties. It was observed that pigments can increase the cohesion of the mortars [4] and therefore filler contents in concrete can also be reduced when pigments are incorporated [5].

The advantages of using cement paste or mortar tests as a previous step in SCC design, to select component materials and superplasticizer requirements in order to optimize mixture proportions, have been recognized mainly due to the simple experimental work involved [6]. Mortar tests can also show the influence of finer particles of the sand that should affect the properties of fresh mortar and the optimum paste volume, or to estimate the strength evolution. In addition mortar tests can be applied to observe effects produced by the changes in environmental conditions on fresh concrete [7,8].

The optimization in mixture proportions, and the characterization and control of the properties in the fresh state are critical for SCC, even more than in vibrated concrete, since the integrity of the structure will be governed by these properties. In C-SCC additional aesthetic aspects must be considered as the colour properties, the presence of stains or bubbles, and the surface textures for different types of moulds.

An extensive research program was developed on C-SCC; the effect of pigments on the rheological properties, the steps for C-SCC design, specific aspects as the pigment dispersion or the air incorporation, and the factors affecting colour and surface texture were studied.

This work discusses the advantages of mortar-based design for C-SCC. The effect of pigments on fresh properties of mixtures, the optimization of mixture proportions, the estimation of the desired strength and particular topics as the evaluation of aesthetic characteristics like the homogeneity of the colour and the surface texture properties are considered.

2. Experimental

2.1. Materials

Along the experimental program many mortars and coloured SCC were prepared including pigments of different shape and

* Corresponding author. Address: LEMIT, 52 e/ 121 y 122, 1900 La Plata, Argentina. Tel.: +54 221 4831144; fax: +54 221 4250471.
E-mail address: zerbino@ing.unlp.edu.ar (R. Zerbino).

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fineness. Synthetic pigments are extensively used as colour agents in cement based materials, their requirements are included in many sources [9–11]. Three iron oxides yellow (y), red (r) and black (b), carbon black (c), and two copper phthalocyanines blue (phb) and green (phg) were used (see Table 1). Yellow iron oxides have defined elongated – needle shaped particles, while red and black iron oxides usually show spheroidal shapes. On the other hand, carbon black and copper phthalocyanines are organic pigments, their shape is variable and, usually susceptible to flocculation.

Ordinary "grey" portland cement (G) or white portland cement (W) and calcareous filler (F), shown in Table 2, combined with two ether policarboxylated based superplasticizers (S1: solid content 35%, S2: solid content 18%) were used. A 12 mm maximum size granite crushed stone (density 2.75) and siliceous natural sand (fineness modulus 2.39, specific density 2.60) were used as aggregates.

2.2. C-SCC design

It has been recognized the advantages of using a step-by-step approach from the cement paste to the SCC to select component materials and superplasticizer requirements in order to optimize the mixture proportions. In C-SCC the fluidity and viscosity of the matrix can modify the dispersion of pigment particles; in addition requirements of colour homogeneity and surface finishability lead to attend the selection of moulds and demoulding agents.

The mortar test design assumes that the compatibility between the selected cement, mineral additions and chemical admixtures was verified before from previous experiences or based in cement paste tests. The main purpose of studies on mortars is to obtain the volume of paste and the superplasticizer dosage required to achieve self-compacting properties for a selected fine aggregate, and in the case of C-SCC, for a type and dosage of pigment [7]. Usually the pigment content is adopted based on colour requirements. Another advantage of mortars tests is that the loss of the flowability along time can be evaluated.

The procedure for C-SCC design fixes, as an initial step, the w/c ratio as a reference of the desired concrete strength and the pigment/cement ratio as a function of the colour intensity. Pigments contents are usually up to 5% of cement weight. After that, series of mortars are prepared with the aim to obtain the dosage of superplasticizer, the filler/cement and the sand/cement proportions. As pigments are fine powders when they are incorporated in SCC the calcareous filler content can be reduced.

The optimum proportions of component materials are selected mainly based on the evaluation of mortar fresh properties through the slump-flow and the V-funnel tests. The slump spread diameter (SF) and the flow time (FT) are measured, and the relative flow time (Rm) and the relative flow area (Γm) are usually calculated for the analysis as:

Table 2
Properties of used cements and calcareous filler.

Identification	Description	Specific gravity (g/cm^3)	Specific surface Blaine (m^2/kg)
W	White cement	3.06	410
G	Grey cement	3.11	337
F	Calcareous filler	2.80	380

$$\mathrm{Rm} = 10/\mathrm{FT} \quad (1)$$

$$\Gamma\mathrm{m} = (\mathrm{SF}/100)^2 - 1 \quad (2)$$

where FT is expressed in seconds and SF is expressed in mm [6].

Many authors suggested Rm and Γm values for making SCC; however it has been recognized that the recommendations are limited to the employed materials in each study [12–14]. The EFNARC guidelines indicate SF: 240–260 mm and FT: 7–11 s [12]. In previous experiences with similar materials without pigment incorporation, values of Rm between 2.5 and 2.8 and Γm between 8 and 9 were found apt for a matrix of a SCC.

To evaluate the evolution of the rheological properties with time, tests can be carried out immediately after the end of mixing and also some time later (i.e. after 45 min). In the last case the mortar is usually remixed 30 s before performing the evaluation.

Once the mortar has been selected, the last step is the adjustment of coarse aggregate content in concrete; the fresh C-SCC properties can be evaluated through the widely known procedures as the slump-flow (D_f and t_{50}), the V-funnel (T_V) or the J-ring (D_j) tests [15].

This methodology has been successfully applied for SCC design with different component materials, showing that only small adjustments of superplasticizer dosages were needed in concrete [7,16]. Regarding C-SCC, as it will be seen ahead, the use of mortars leads to other advantages as the evaluation of hue and saturation of the colour.

2.3. Colour evaluation

Colour can be evaluated by measures of tristimulus values L^*, a^* and b^*, represented in the chromatic space CIELAB (see Fig. 1). Three factors are considered L^*, h^* and C^* that represent lightness, hue and saturation respectively. L^* shows the variation between white (top), grey (centre of the sphere) and black (bottom). The parameter C^*, related with the colour purity, is represented by a vector from the centre to a point in the plane a^*–b^*. This parameter can adopt any position in accordance with the hue angle (h^*), which indicates that the colour varies from red, yellow, green or blue (0°, 90°, 180° and 270° respectively) or intermediate values. Another parameter is the difference in total colour ΔE^* related with the human perception capability [9,17].

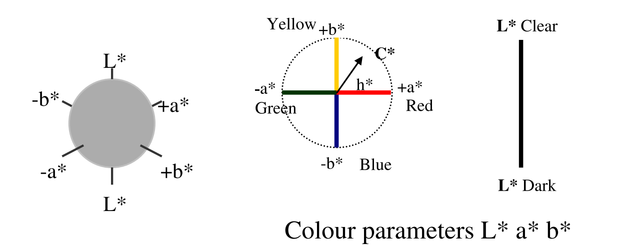
Measurements on mortars are useful for colour estimation. Although it is evident that there are limitations imposed by the small size of the specimens (35 × 35 × 350 mm) for the evaluation

Table 1
Pigment characteristics.

Description	Colour	Pigment identification	Specific gravity (g/cm^3)	Mean size (μm)	Maximum size (μm)
Iron oxides	Yellow	y	3.8	1	8
	Red	r	4.8	0.1–0.5	1
	Black	b	4.7	0.5–1	4
Carbon black	Black	c	1.9	0.001–0.01	≪0.1
Copper phthalocyanines	Blue	phb	2.0	<20[a]	40[a]
	Green	phg	2.0	5–25[a]	50[a]

[a] Particles agglomeration.

The CIELAB colour system or CIELAB colour space



Colour parameters

Lightness	Saturation	Hue
L*	$C^* = \sqrt{a^{*2} + b^{*2}}$	$h^* = \operatorname{arctg}\dfrac{b^*}{a^*}$

Hue	0º: red 90º: yellow 180º: green 270º: blue
Total colour difference [9]	$\Delta E^* = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$
Visual assessment of ΔE* [17]	0.5-1.5: slight 1.5-3.0: obvious 3-6: very obvious 6-12: large

Fig. 1. CIELAB colour system and definitions of colour parameters.

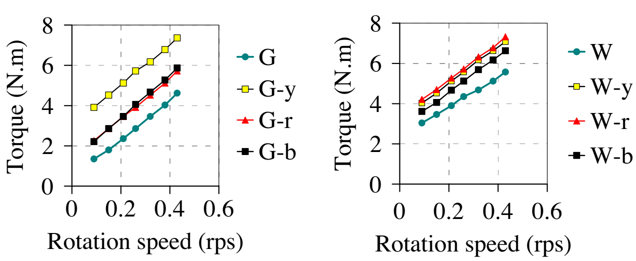


Fig. 2. Rheological tests on mortars.

of stains, bubbles or other surface characteristics, mortar specimens enable to show the effects of moulds of different materials and the demoulding agents used.

3. Particular aspects of coloured concretes

3.1. Effect of pigments on the rheological behaviour of fresh mortars

As the pigment has particles with sizes similar or smaller than cement and filler particles, it is not difficult to assume that as pigment is incorporated the viscosity of the paste and the water or chemical admixtures demand could be affected. A correct mixture design can improve the paste performance taken in consideration the effects of pigments on the material cohesion. As expected, these effects depend on the pigment characteristics [18,19].

Fig. 2 presents the torque vs. rotation speed curves obtained through a BML Viscometer 3 in mortars replacing the same volume of filler by iron oxide pigments red, yellow or black (r, y, b). Table 3 shows the yield stress (τ_0) and the plastic viscosity (μ) calculated assuming that the mortars behave like a Bingham fluid. The relative flow area (Γm) from the slump-flow test is also included. There was found an increase in cohesion when pigments were incorporated, which depends on the used pigment and cement type. It is interesting to note that although all mortars had similar plastic viscosity, the incorporation of pigments increases τ_0. The highest values were found in yellow mortars; it can be assumed that the elongated shape of the pigment particles has some role on the observed behaviour.

3.2. Effect of pigments on air content

Some pigments can strongly increase air incorporation in fresh concrete, as in the case of the cupric phthalocyanines [20]. Mortar tests are also effective to detect this fact. Table 4 shows the V-funnel (FT) and the slump-flow (SF) test results, and the air content measured immediately after mixing on fresh mortars prepared with cement W combined with pigments y, r, phb and phg. The superplasticizer dosage was adopted to achieve a spread diameter of 300 ± 20 mm. It can be seen a significant increase in air content appears when phthalocyanine pigments were used; as a consequence notable reductions in strength must be expected.

3.3. Effect of component material on colour properties

Factors affecting colour properties were analyzed. As it is known the colour properties are mainly affected by the finer materials. An advantage of the use of mortar tests is that the effects of sand on colour properties can be evaluated. The type of coarse aggregate does usually not affect the aesthetic aspects with the exception of architectural concrete with exposed aggregates finished surfaces.

With the aim to observe the effect of the cement type, filler content and the dosage of superplasticizer, series of pastes (P) and their corresponding series of mortars (M) were prepared with cements G and W without pigment incorporation.

Fig. 3 compares the colour parameters measured in cement pastes and mortars prepared with cements G and W. With these materials no differences were found in the chromatic coordinates between cement pastes and mortars. It can be seen that the lightness increased 10 units when cement W is used, but it was not affected by the chemical admixture content. This fact will be of

Table 4
Effect of pigments on air content in mortars with cement W.

Pigment	Dosage[a] (%)	S[b] (%)	FT (s)	SF (mm)	Air (%)
None	0	0.45	3.8	280	3.0
y	5.1	0.45	4.3	275	2.2
r	5.1	0.45	4.0	302	4.1
phb	2.5	0.60	4.4	302	14.1
phg	2.5	0.60	6.8	285	17.6

[a] Pigment, as percentage of cement weight.
[b] Superplasticizer dosage, solid content as percentage of cement weight.

Table 3
Effect of pigment incorporation on the rheological behaviour of mortars.

Pigment	Cement	τ_0 (Pa)	μ (Pa. s)	Γm	Cement	τ_0 (Pa)	μ (Pa. s)	Γm
None	G	4	18	5.9	W	26	11	3.4
y		43	18	2.5		42	14	2.8
r		15	19	4.3		40	13	2.8
b		13	19	3.9		30	13	3.2

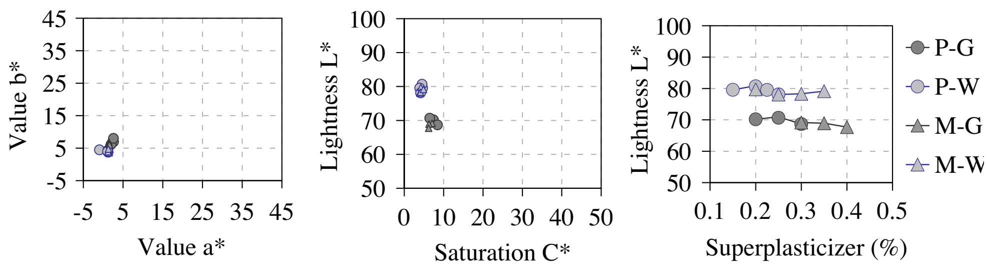


Fig. 3. Colour parameters in cement pastes (P) and mortars (M) prepared with cements G and W.

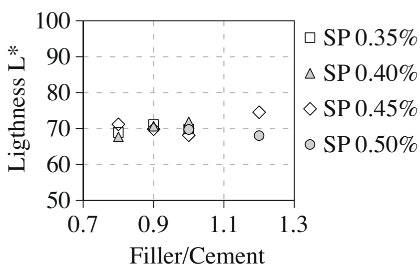


Fig. 4. Variation of lightness in mortars prepared with cement G and different filler contents.

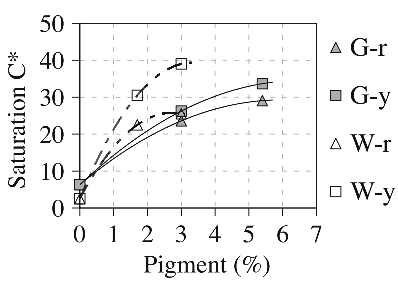


Fig. 5. Saturation curves of pigments red and yellow combined with cements G and W. (For interpretation of the references in colour in this figure legend, the reader is referred to the web version of this article.)

interest if small corrections in the superplasticizer contents of C-SCC are needed in practice.

Fig. 4 shows the effect of filler content on the lightness in mixtures prepared with the same type and content of superplasticizer and filler/cement ratios from 0.80 to 1.20. It can be seen a small variability in the lightness values (70 ± 5 units). In these experiences the surfaces of concrete in contact with the mould and the casting surfaces were evaluated; it was found that the presence of calcareous filler also minimizes the differences between both surfaces of concrete.

Finally, as it is known**,** the saturation values depend on the pigment content. Fig. 5 presents the saturation curves measured on mortars prepared with pigments r and y combined with cements G and W; it confirms that, as it is indicated in the literature, the saturation tends to remain constant after a certain pigment content [21].

4. Design of colour self-compacting concretes

4.1. C-SCC with cement G and pigments y, r, b, and c

An example of C-SCC mixture design is presented in this section. Three pigments of iron oxides – yellow (y), red (r) and black (b) – and of carbon black (c), were used in combination with grey cement (G), calcareous filler (F) and S1 superplasticizer. Series of mortars with water:cement:filler:sand proportions of 0.50:1:0.80:2.35 were prepared varying the S1 content to obtain appropriate values of Rm and Γm.

Based on the range of Rm and Γm previously indicated, high viscosity mortars with SF and FT near to 300 mm (Γm = 8) and 4.0 s (Rm = 2.5) respectively were adopted. The base mortars for C-SCC were selected considering not only the fluidity but also the visual appearance and the loss of fluidity along time.

Fig. 6 shows fresh mortar test results; it includes a reference mortar without pigment (G). The series are identified by the cement and pigment used. The dosages of pigment were 3% by cement weight for mortars with y and c, and 5% for mortars with r and b. It is interesting to note that significant effects on the viscosity and superplasticizer demand were found when black carbon was incorporated; as a consequence, the mortar with pigment c was optimized by reducing the paste volume (series Gc*) and the superplasticizer content. In series Gc* water: cement: filler: sand proportions were 0.50:1:0.36:2.71.

Based on the selected mortars C-SCC were prepared. C-SCC incorporating 330 kg/m^3 of cement G were made adjusting the coarse aggregate content (CAC) to obtain the desired self compacting characteristics (D_f = 650 ± 50 mm, typical SCC for walls and piles [15]). A reference SCC without pigments was also done. Con-

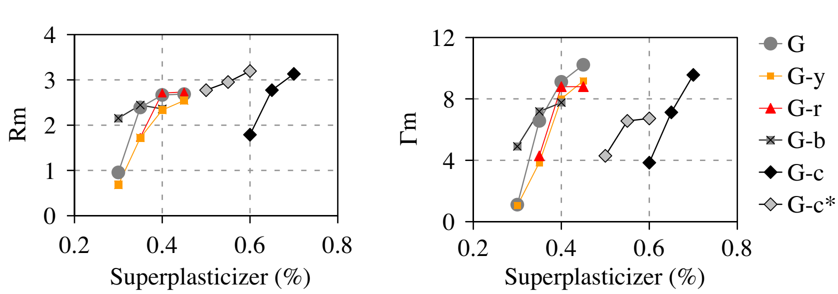


Fig. 6. Variation of fresh mortar parameters with the dosage of superplasticizer.

Table 5
C-SCC with cement G.

Pigment	S1 content (%)		SCC	CAC (%)	D_f (mm)	t_{50} (s)	T_V (s)	D_j (mm)	$D_f - D_j$ (mm)	Air (%)	fc (MPa)
	In mortar	In SCC									
None	0.40	0.40	G	30	625	3.5	8.9	615	10	2.5	42.0
y	0.40	0.45	G-y	30	690	4.0	14.7	690	0	2.3	48.4
r	0.40	0.40	G-r	31	630	3.8	14.5	615	15	2.8	43.6
b	0.35	0.35	G-b	30	660	4.0	12.6	655	5	3.4	44.0
c	0.65	0.65	G-c	27	695	2.8	14.7	690	5	5.7	41.4

crete properties and CAC are given in Table 5. As it can be seen the superplasticizer content used in mortars and C-SCC were very similar. The slump-flow diameter (D_f) and the time t_{50}, the passing time from the V-funnel (T_V), and the J-ring diameter (D_j) are presented. The difference $D_f - D_j$ indicates no blocking in the mixtures [22]. It must be noted that while the D_f values were similar or higher in C-SCC than in SCC without pigment, the V-funnel times were always higher. This behaviour can be related with an increase in viscosity due to the presence of pigments.

Fig. 7 shows the aspect of the C-SCC after the slump-flow test; no signs of aggregate segregation were found. In concrete G-c some concentration of coarse aggregate at the centre of the spread concrete was observed. In concrete G-b there was observed a lack of dispersion of the pigment b, the same was previously observed in the corresponding mortar. The ability of mortar tests to detect the dispersion capacity of pigments represents another benefit of the use of mortar tests.

Fig. 8 compares the colour parameters measured on mortars (M, empty symbols) and C-SCC (C, filled symbols). The chromatic coordinates b^* vs. a^*, and the lightness vs. saturation values are plotted. It can be clearly seen the correspondence of the values of each C-SCC with its matrix. The lightness remained constant, the saturation in the mortars was lightly higher; nevertheless these variations are not important, and this indicates that the studies on mortars enable to estimate these properties in concrete.

The possibility to evaluate the colour characteristics represents a particular advantage of the use of mortar tests in C-SCC design. The variation of hue and lightness using moulds of different materials or the effects of aging in different environments can also be analyzed.

4.2. C-SCC with cement W and pigments y, r, phb, phg

Following the above described procedure, C-SCC with cement W and pigments y, r, phb, phg were designed. Concretes were prepared with 340 kg/m^3 of white cement (W), calcareous filler, siliceous sand, granite crushed coarse aggregate of 12 mm maximum size, superplasticizer S2, and pigments y, r, phb and phg. The CAC was adjusted to obtain a $D_f = 750 \pm 50$ mm. The dosages of pigments were 5% of r and y and in the case of phb and phg

Fig. 7. Slump-flow tests of C-SCC with cement G.

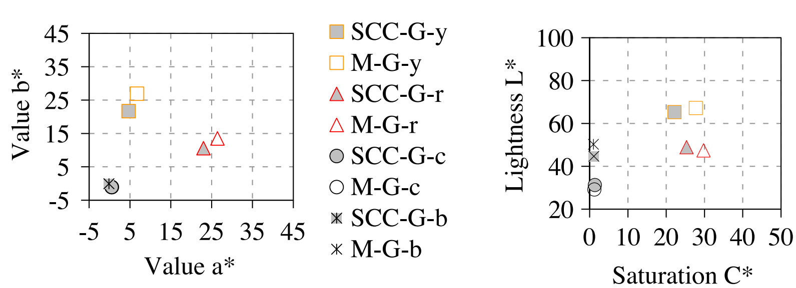


Fig. 8. Colour parameters measured on C-SCC prepared with cement G and the corresponding mortars.

Table 6
C-SCC with cement W.

Pigment	S2 content (%)		SCC	CAC (%)	D_f (mm)	t_{50} (s)	T_V (s)	D_j (mm)	$D_f - D_j$ (mm)	Air (%)		f′c (MPa)
	Mortar	SCC								Mortar	SCC	
None	0.45	0.40	W	29	770	2.6	8.9	680	90	3.0	1.5	60.6
y	0.45	0.40	W-y	29	780	2.3	9.3	680	100	2.2	1.5	53.7
r	0.45	0.50	W-r	29	800	1.5	9.1	690	110	4.1	1.5	57.6
0.8% phb	0.50	0.40	W-phb1	28	745	2.3	8.9	710	35	14.2	6.0	50.6
0.8% phg	0.50	0.40	W-phb2	27	760	1.8	5.6	710	50	17.1	8.5	43.6
2.5% phb	0.60	0.50	W-phg1	28	700	1.9	5.7	680	20	14.1	9.0	42.7
2.5% phg	0.60	0.40	W-phg2	27	700	1.9	5.3	700	0	17.6	14.0	35.4

two dosages were incorporated; 2.5 (the same as with grey cement) and 0.8% of copper phthalocyanines were used. The content of this pigment was reduced to 0.8% with the aim of analyzing its effects on the air incorporation.

Table 6 shows the dosage of S2 and air content of mortars and concretes, the properties of fresh concrete and the compressive strength. It can be seen a significant increase in air content when small percentages of phthalocyanine pigments were used. As a consequence of the air increase, the superplasticizer demand decreased in concrete, but notable reductions in strength took place. In these concretes the admixture content estimated from the mortar tests was notably higher than the actual dosage of admixture required in concrete. Again, when mortar tests were performed significant air incorporation had been measured, however there were not differences when the pigment content changed. When pigments produce secondary effects as air incorporation, the estimations of superplasticizer dosages and air content made on mortars must be used with care.

The capacity of pigment dispersion into the cement matrix is a particular aspect to be observed in C-SCC. Fig. 9 shows the aspect of the C-SCC after the slump-flow test. A lack of pigment dispersion was observed with the pigment phb, as well as occurred in previous tests with iron oxide b.

5. Mortar studies for surface colour design

5.1. Robustness of mortar-based C-SCC design for colour selection

As it was expected different tonalities can be obtained for a specific pigment varying its content up to the saturation point (see Fig. 5). Although pigment contents are usually small, it is interesting to analyse the effects produced by variations in pigment dosage on the self-compacting properties of C-SCC, in order to provide some guidelines for colour adjustment.

Table 7 presents the results of experiences performed with the aim of evaluating the variation of some properties of fresh mixtures and colour parameters of a base mortar (G) when different pigment contents are incorporated. Three iron oxide pigments (r, y and b) were included in dosages of 3%, 5% and 7% in replacement of cement weight (p/c). The dosage of superplasticizer remained constant in each Series. In addition to the colour parameters, the flow time (FT), the spread diameter (SF), and the air content were measured. The mixtures were repeated (batches A and B) observ-

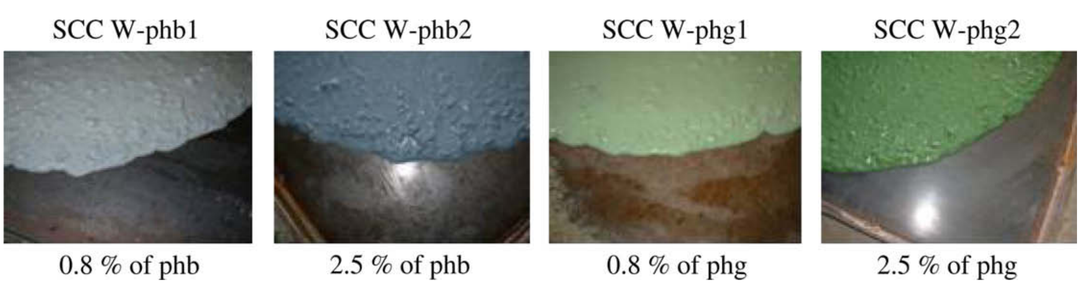


Fig. 9. Slump-flow test for C-SCC with cement W.

Table 7
Colour parameters, flow time (FT), slump flow spread diameter (SF) and air content in mortars incorporating different contents of pigments r, y and b. S2 solid content 0.30%.

Series	Dosage[a] (%)	FT (s)		SF (mm)		Air content (%)		Colour parameters		
		A	B	A	B	A	B	L^*	C^*	h^*
G	0	3.9	4.1	323	313	10.3	10.5	71.7	4.1	80
3 r	3	3.8	3.7	328	323	8.6	9.4	50.7	21.8	30
5 r	5	3.9	4.5	330	310	8.9	8.1	45.8	31.4	35
7 r	7	3.9	4.1	320	305	9.1	9.2	45.4	33.3	35
3 y	3	4.7	4.2	319	310	9.3	9.8	68.6	25.9	81
5 y	5	4.4	4.6	290	293	8.7	7.9	68.4	32.8	78
7 y	7	5.0	5.6	270	260	8.2	8.3	59.4	37.1	73
3 b	3	5.2	5.5	320	320	12.0	12.0	54.2	0.9	101
5 b	5	5.4	5.7	294	290	11.0	10.0	57.2	1.2	244
7 b	7	6.4	6.6	270	260	11.0	10.0	49.6	2.1	251

A, B: different batches.
[a] Pigment, as percentage of cement weight.

ing a good repeatability of test results. Although dosage of superplasticizer was the same, there were not significant variations in the flow properties of mortars.

Regarding colour properties, Table 7 shows that the parameters L^*, C^* and h^* change in accordance with the colour and content of pigment introduced. It can be seen that a wide range of colours can be obtained from the same base mortar. As the self compacting ability of the mortar remains mainly unchanged, the colorimetric parameters for a desired C-SCC can be adjusted without numerous trial works.

5.2. Use of mortars to evaluate the surface appearance

Aesthetics aspects as the texture, presence of bubbles, stains, and other surface properties became particularly significant for colour concrete applications. The surface texture, colour homogeneity are mainly affected by the cement and chemical admixtures, moulds quality and demoulding agents used. The casting procedure can also affect these characteristics. Although most of them must be considered in large scale probes at concrete level, mortar tests can also be useful especially to evaluate colorimetric parameters.

To compare the colour parameters of mixtures in contact with moulds of different texture and absorption, small U-shape elements with walls of three different materials (steel, wood and glass) were filled with mortars prepared with cement G and different contents of pigment y. Fig. 10 shows the aspect of the different surfaces of each mortar, the variation of the slump-flow diameter mortars and the measures of the colour parameters are also indicated. The surfaces of the specimens were homogeneous and no stains were detected. Some colorimetric parameters change in accordance with the surface material. The lightness (L^*) was smaller when wood moulds were used, the saturation (C^*) varies very much with pigment content and tends to be higher using steel moulds and the hue (h^*) remained the same for all materials used.

6. Conclusions

The incorporation of pigments opens new fields for SCC application, since it adds attractive alternatives for challenging architectural designs in terms of shapes and colour, to the already versatile aesthetic characteristics of traditional coloured concrete. This paper summarized an extensive experimental program on coloured self-compacting concrete (C-SCC), and discussed the advantages of using a step-by-step procedure for C-SCC design, focusing on the mortar approach.

The mortar approach leads to a rapid and easy optimization of proportions of mixtures that can include different types of pigments, cements, mineral additions and chemical admixtures. The method allows, among other possibilities, to define the superplast-

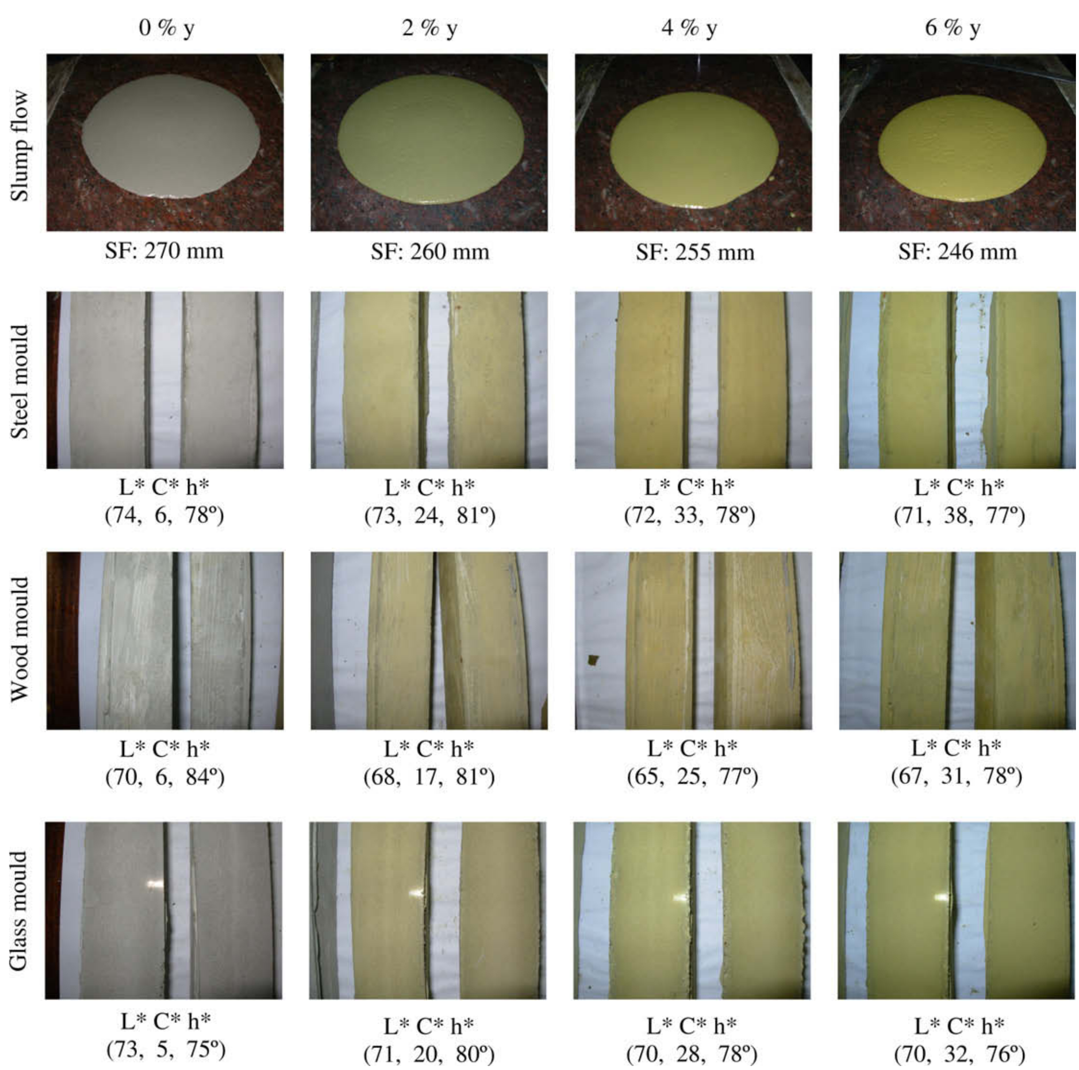


Fig. 10. Slump flow spread diameter and colour parameters measured on mortars prepared with cement G and different contents of pigment y.

icizer dosage for different pigment/cement/filler combinations, as well as to verify the effect of pigments on the viscosity of SCC and its variation along time.

The use of mortars makes possible to evaluate specific aspects required for C-SCC as the colorimetric parameters, the colour homogeneity and the surface finishing for different types of moulds. It was found that the self compacting ability of the mortar remains almost unaffected when there are small changes in the pigment content. The methodology of mixture design enables to obtain the desired colour properties without numerous trials.

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