9th International Masonry Conference

July 7, 8, 9 2014
Guimarães, Portugal

IMS International Masonry Society

Universidade do Minho Escola de Engenharia

EuLA European Lime Association

IMC Students' Challenge

Maximum Compressive Load of Masonry Prisms

2nd Testing Report

April 2014

1 Introduction

The "**IMC Students' Challenge**" is an initiative of the Organizing Committee of the 9th International Masonry Conference, to be held in Guimarães, Portugal, during July 7-9, 2014. This competition is sponsored by EuLA - the European Lime Association.

The objective of this competition is **to predict the maximum compressive load** of two types of masonry prisms, as stated in the previous announcement. The present document provides information about the flexural and compressive strengths of the masonry units used for the two types of specimens: solid clay bricks (SCB) and hollow concrete blocks (HCB).

2 Flexural and compressive strengths of masonry units

Both tests were carried out under displacement control, in order to provide force-displacement curves including post-peak behaviour.

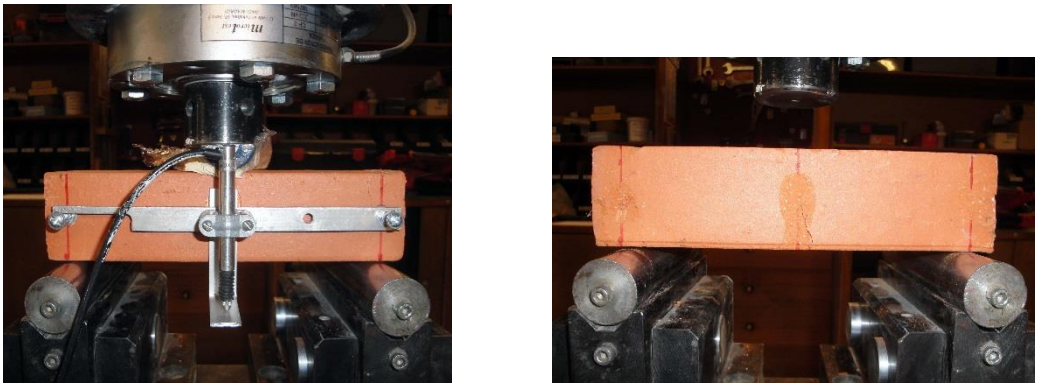
The masonry units were kept under the same curing conditions as the masonry specimens to be tested, which were 20 °C ± 2 °C of room temperature and 60% ± 5% of relative humidity.

2.1 Solid clay bricks

Five solid clay bricks were tested for flexural strength (see Figure 1) and other five for compressive strength (see Figure 3). General requirements of ASTM C67 - 13a [1] were followed to conduct the tests, and calculate flexural strength. Flexural failure was obtained without notching the bricks, and consequently the failure plan was not always at midspan. The average distance from the midspan to the plan of failure was 4 mm for the specimen SCB.F1 and 20 mm for the two remaining valid tests, SCB.F2 and SCB.F4. The distance between supports was 174 mm. In Figure 2 are shown the force-displacement curves for the flexural tests of the SCB specimens.

For the compression tests, both ASTM C67 - 13a [1] and EN 772-1 [2] were taken into consideration. Full length blocks were tested, to be consistent with the method adopted for the HCB specimens. The average gross area of the upper and lower bearing surfaces is 20000 mm^2. In Figure 4 are shown the stress-strain curves for the compression tests carried out on SCB specimens.

Flexural and compressive strength values, with respective Coefficients of Variation (CoV) of all specimens are presented in Table 1.



(a) (b)

Figure 1 Flexural test on SCB: (a) before; and (b) after.

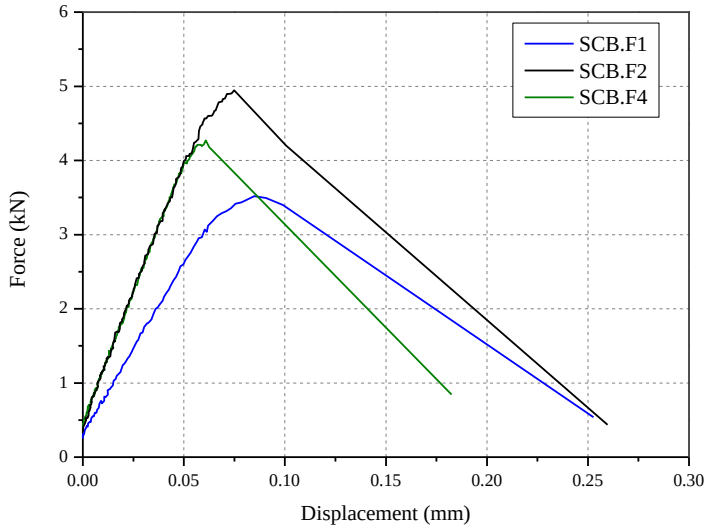
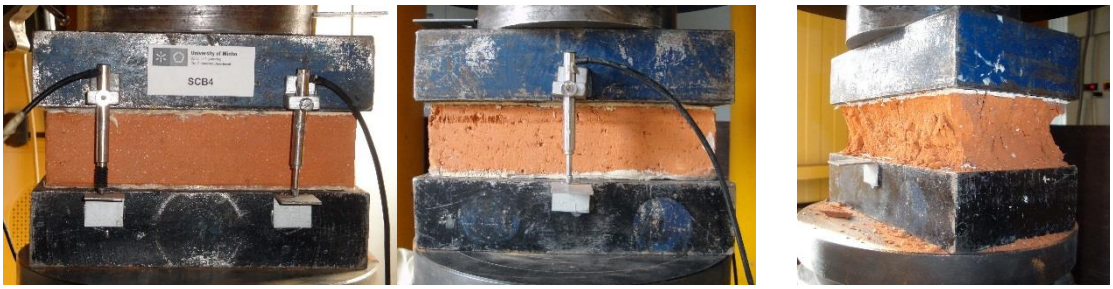


Figure 2 Force-displacement curves of flexure tests on SCB



(a) (b)

Figure 3 Compression test on SCB: (a) before; and (b) after.

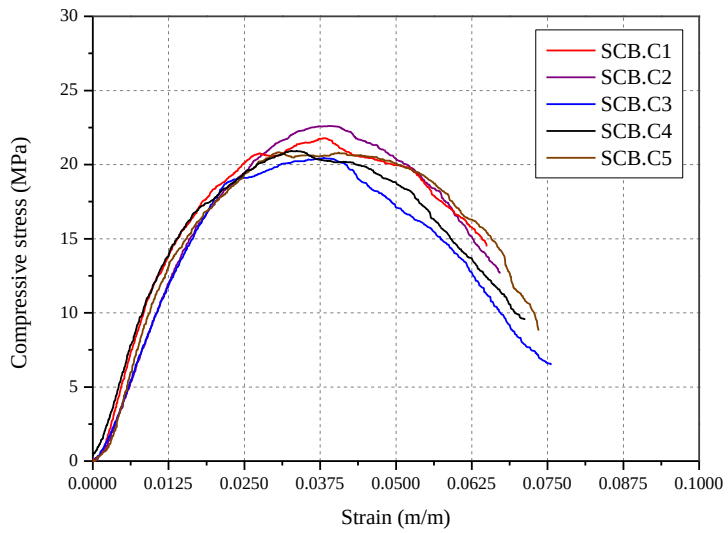


Figure 4 Stress-strain curves of compression tests on SCB.

Table 1 Maximum force and flexural strength for all SCB specimens

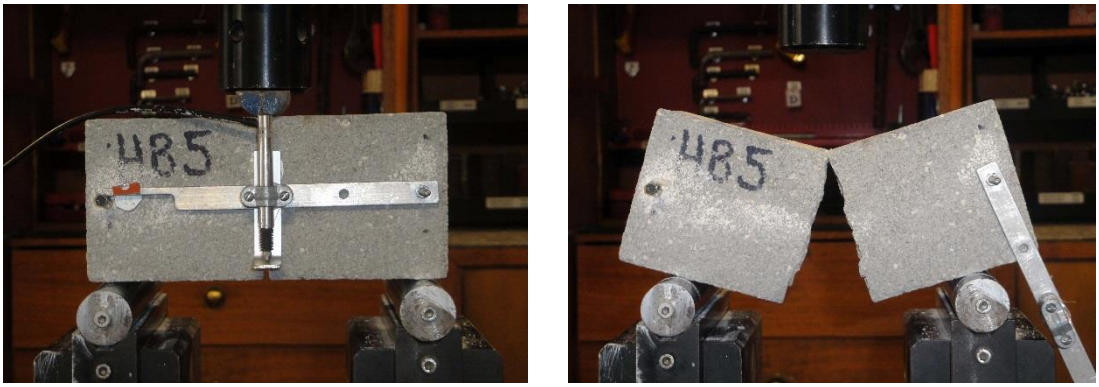
	Flexure tests			Compression tests	
	F (kN)	f_{xb} (MPa)		F (kN)	f_b (MPa)
SCB.F1	3.52	3.15	SCB.C1	439.2	22.0
SCB.F2	4.99	3.60	SCB.C2	457.3	22.9
SCB.F3	-	-	SCB.C3	412.4	20.6
SCB.F4	4.27	3.09	SCB.C4	423.1	21.2
SCB.F5	-	-	SCB.C5	423.9	21.2
Average	4.3	3.3		431.2	21.6
CoV (%)	14.1	7.0		3.6	3.6

2.2 Concrete hollow blocks

Five concrete hollow blocks (HCB) were tested for flexural strength (see Figure 5) and other five for compressive strength (see Figure 7). General requirements of ASTM C67 - 13a [1] were followed to conduct the tests and calculate flexural strength. In order to obtain flexural failure, the specimens were carefully notched through the width of the block at midspan, using dry sawing [3]. The width of the notches had an average of 3 mm and the blocks had an unnotched depth of approximately 79 mm. The distance between supports was 174 mm. In Figure 6 are shown the force-displacement curves for the flexural tests of the HCB specimens.

For the compression tests, both ASTM C67 - 13a [1] and EN 772-1 [2] were taken into consideration. Full length blocks were tested, to prevent damage caused by sawing. The average gross area of the upper and lower bearing surfaces is 9400 mm^2. In Figure 8 are shown the stress-strain curves for the compression tests carried out on HCB specimens.

Flexural and compressive strength values, with respective CoV of all specimens are presented in Table 2. Specimens HCB.F1 and HCB.C1 proved to be outliers so their results were excluded.



(a) (b)

Figure 5 Flexural test on HCB: (a) before; and (b) after.

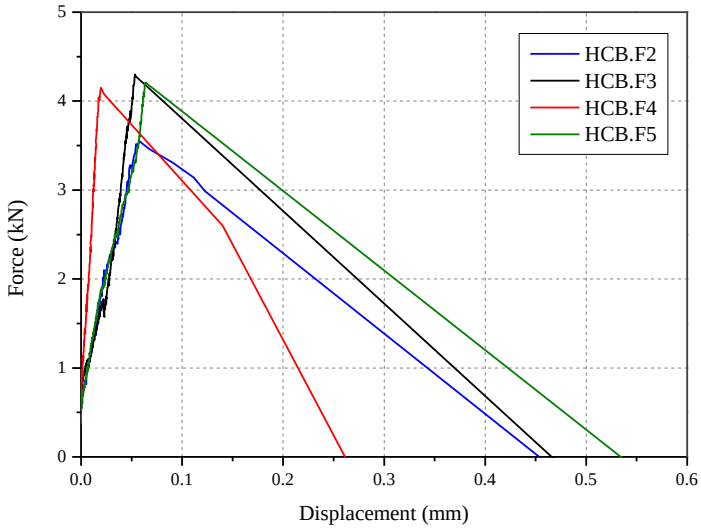
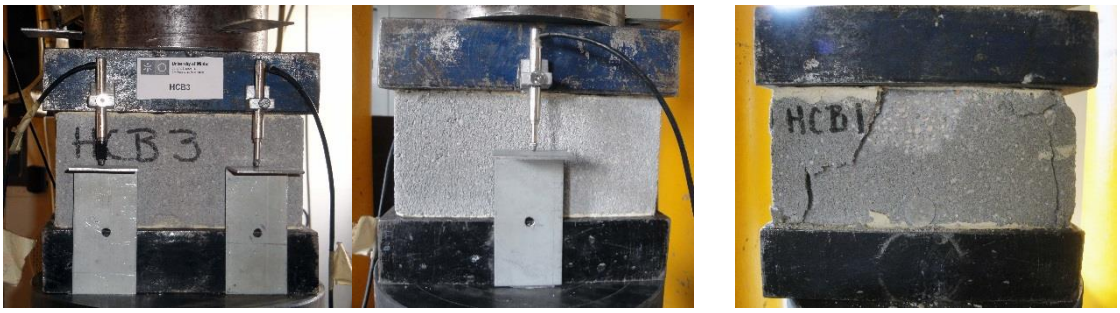


Figure 6 Force-displacement curves of flexure tests on HCB



(a) (b)

Figure 7 Compression test on HCB: (a) before; and (b) after.

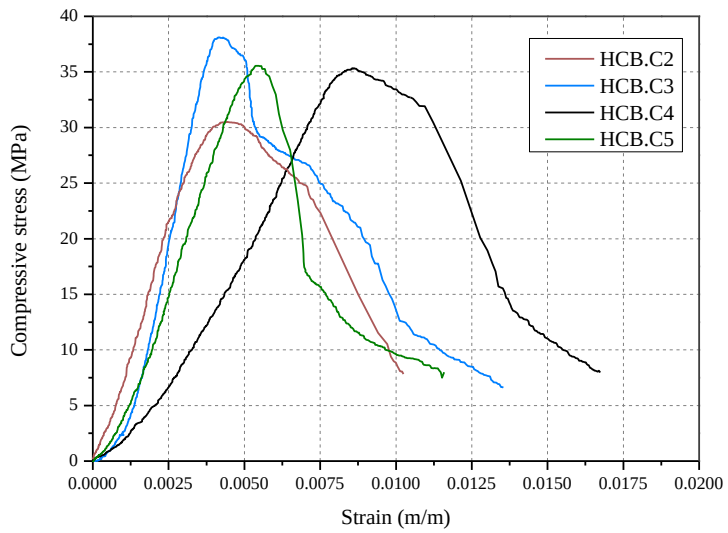


Figure 8 Stress-strain curve of compression tests on HCB.

Table 2 Maximum force and flexural strength for all HCB specimens

	Flexure tests			Compression tests	
	F (kN)	f_{xb} (MPa)		F (kN)	f_b (MPa)
HCB.F1	-	-	HCB.C1	-	-
HCB.F2	3.55	5.76	HCB.C2	294.4	31.3
HCB.F3	4.30	6.96	HCB.C3	368.1	39.2
HCB.F4	4.15	6.59	HCB.C4	337.6	35.9
HCB.F5	4.21	6.87	HCB.C5	344.7	36.7
Average	4.1	6.5		336.2	35.8
CoV (%)	7.3	7.2		7.9	7.9

3 Conclusions

The present document is the second and final testing report for the "**IMC Student's Challenge**", and it provides information about the flexural and compressive tests carried out on the masonry units.

Students have now to prepare their one final report (pdf format) and to prepare one A1 sized poster (59.4 x 84.1cm, 23.39 x 33.11 inches). Both final report and poster must be sent to the conference organization before the 15th of June, 2014. Templates for the documents are available in the conference webpage.

The tests on the masonry prims will be carried out on July 7, 2014 (during the 9th IMC), 216 days after the specimens' construction.

We remind that at least one team member designated to represent each team must be present at the IMC Students' Challenge. A 50% discount on the conference registration fees will be given to all team members. The first eight teams will receive the 500€ grant after their participation in the conference.

Students have now to do their individual registration on the conference website by choosing the option "Bona fide Student" and "Student Challenge".

Guimarães, April 2014

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References

[1] EN 772-1. Methods of test for masonry units -Part 1: Determination of compressive strength. 2002.

[2] ASTM C67 - 13a, 2013, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile ASTM International, West Conshohocken, PA, 2013, DOI: 10.1520/C0067, www.astm.org.

[3] RILEM TC 162-TDF: Test and design methods for steel fibre reinforced concrete. Materials and Structures 2002; 35:579-582.