CICE 2012 Rome

EXPERIMENTAL INVESTIGATION ON BOND OF FRP/SRP APPLIED TO MASONRY PRISMS

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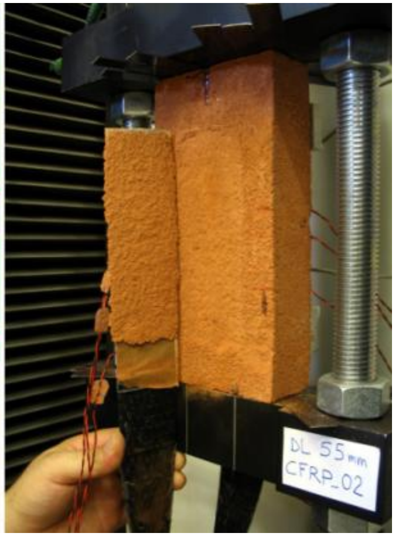
Background



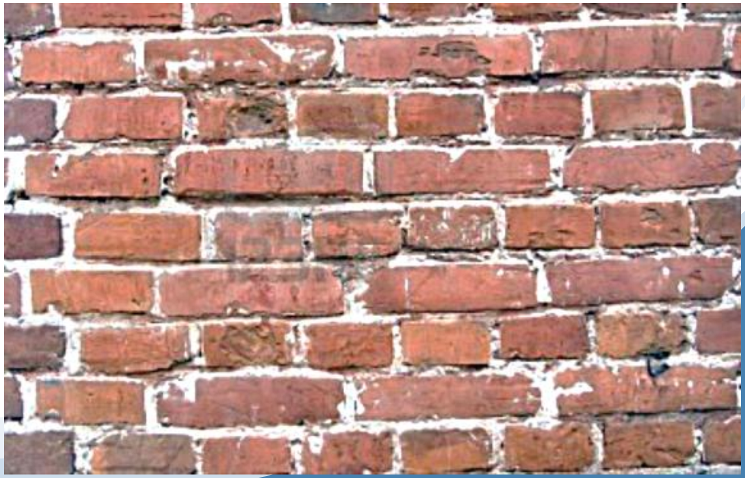
Investigations of bond behaviour on masonry elements (clay bricks, natural stones,…) are increasing.

Typical effective lengths for solid clay bricks may be about 80÷100mm (glass…), 120÷150mm (carbon…).

Height of solid clay bricks is commonly about 40÷60mm .

Joints of historic masonry are generally made of poor lime mortars.

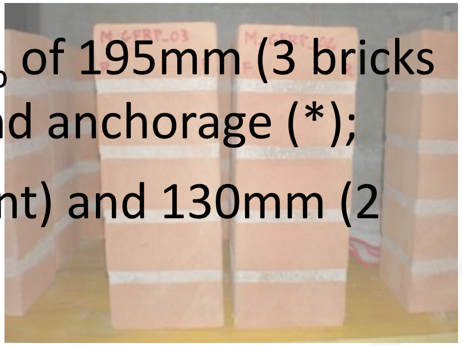
The role of mortar joints still needs to be deepened.



Experimental activity

Overall thirty Single-lap (SL) Shear Tests on five-course masonry prisms made of solid facing clay bricks and weak lime mortar:

- ❑ ***one type*** of masonry substrate;
- ❑ ***four types*** of epoxy-based reinforcement, GFRP (glass fibres), BFRP (basalt fibres), CFRP (carbon fibres) and SRP (steel fibres);
- ❑ ***two types*** of specimens, one having a bonded length L_b of 195mm (3 bricks and 3 joints) and the second having a reinforcement end anchorage (*);
- ❑ ***additional shorter L_b*** for GFRP, 65mm (1 brick and 1 joint) and 130mm (2 bricks and 2 joints).



TEST MATRIX

REINFORCEMENT	L_b = 65 mm	L_b = 130 mm	L_b = 195 mm	end-anchored
GFRP	3	3	3	3
BFRP			3	3
CFRP			3	3
SRP			3	3

(*) MAZZOTTI, C., SAVOIA, M., FERRACUTI, B. (2009) *A new single-shear set-up for stable debonding of FRP-concrete joints*

Materials characterization

Mortar Tassullo T30V:

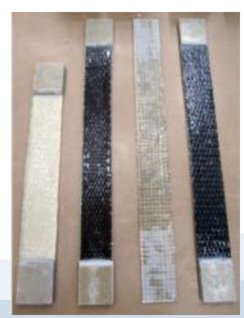
- ❑ $f_{c,T30V} = 2.6\ N/mm^2$
- ❑ $f_{sp,T30V} = 0.35\ N/mm^2$
- ❑ $E_{T30V} = 5490\ N/mm^2$

Bricks San Marco Rosso Vivo:

- ❑ $f_{c,b} = 19.8\ N/mm^2$
- ❑ $f_{sp,b} = 2.5\ N/mm^2$
- ❑ $E_{b} = 5760\ N/mm^2$

Masonry assemblage:

- ❑ $f_{c,m} = 8.2\ N/mm^2$
- ❑ $f_{sp,m} = 1.1\ N/mm^2$
- ❑ $E_{m} = 2060\ N/mm^2$



Impregnated composites (Fidia s.r.l.):

- ❑ $E_{GFRP} = 80 \cdot 10^3\ N/mm^2$
- ❑ $E_{BFRP} = 87 \cdot 10^3\ N/mm^2$
- ❑ $E_{CFRP} = 241 \cdot 10^3\ N/mm^2$
- ❑ $E_{SRP} = 200 \cdot 10^3\ N/mm^2$

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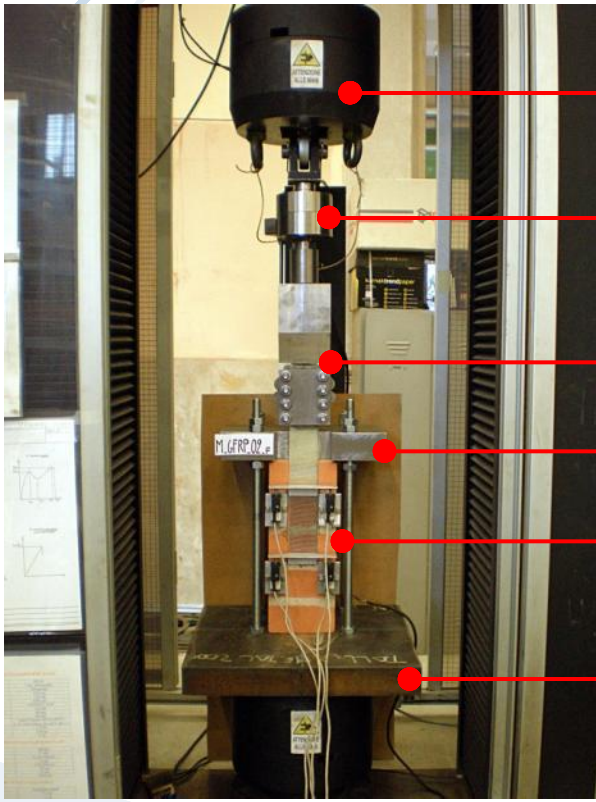
Test setup and instrumentation

Single-lap setup
disp. rate of 0.3 mm/min
acquisition rate of 10 Hz



movable transverse beam

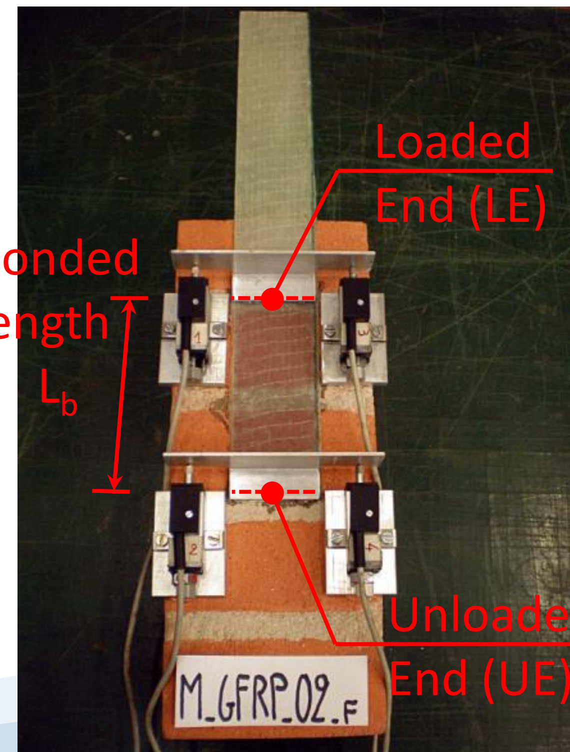
load cell

clamping system

upper steel plate

sample

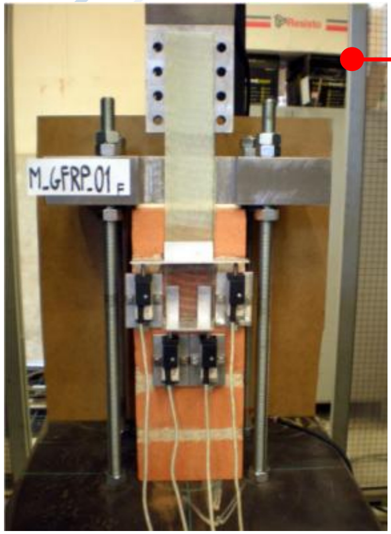
lower plate fixed to the machine's head



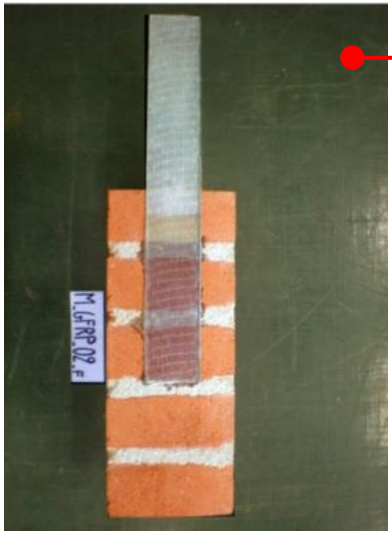
two potentiometers at LE and other two at UE

Specimens

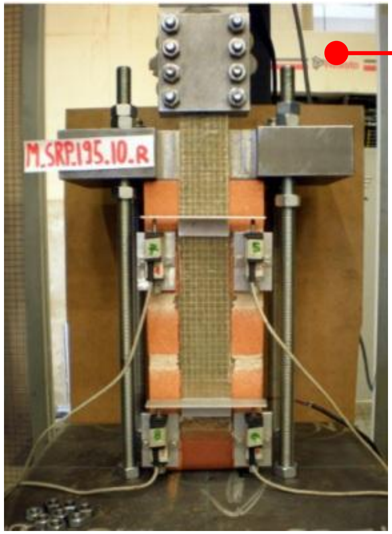
GFRP, with L_b = 65mm → 1 brick + 1 mortar joint



GFRP, with L_b = 130mm → 2bricks + 2 joints



SRP, L_b = 195mm ↓ 3 bricks + 3 joints



end-anchored CFRP → 3 bricks + 3 joints + anchorage

Typical failures

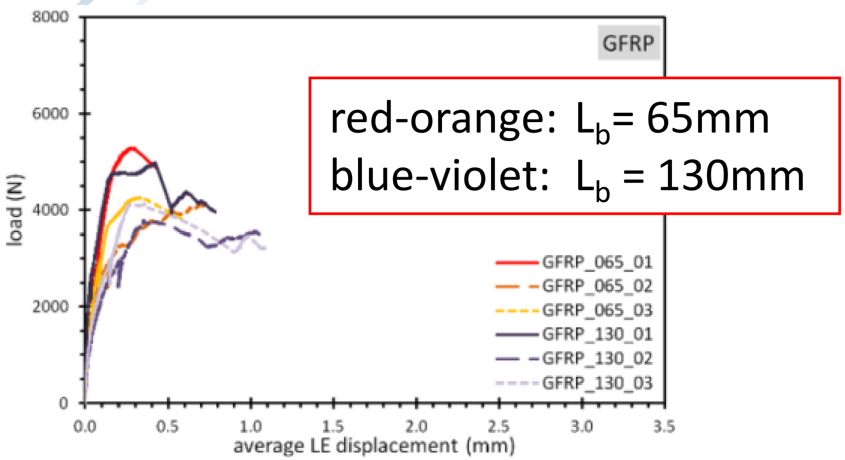
GFRP, with L_b = 65mm

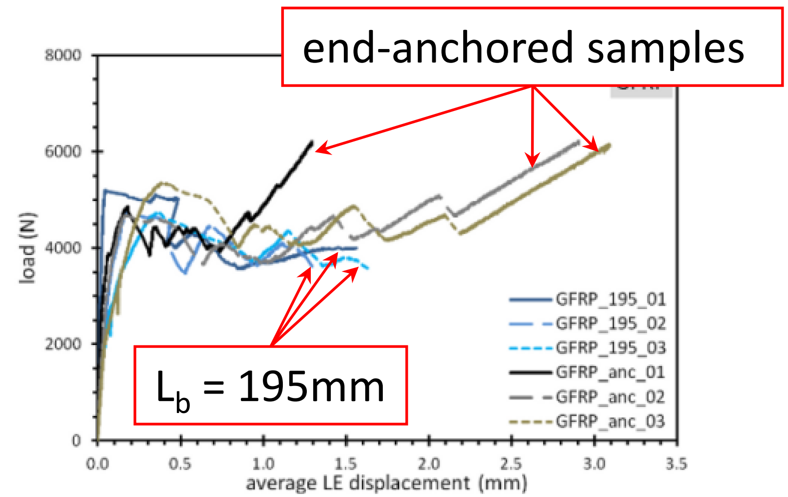
GFRP, with L_b = 130mm

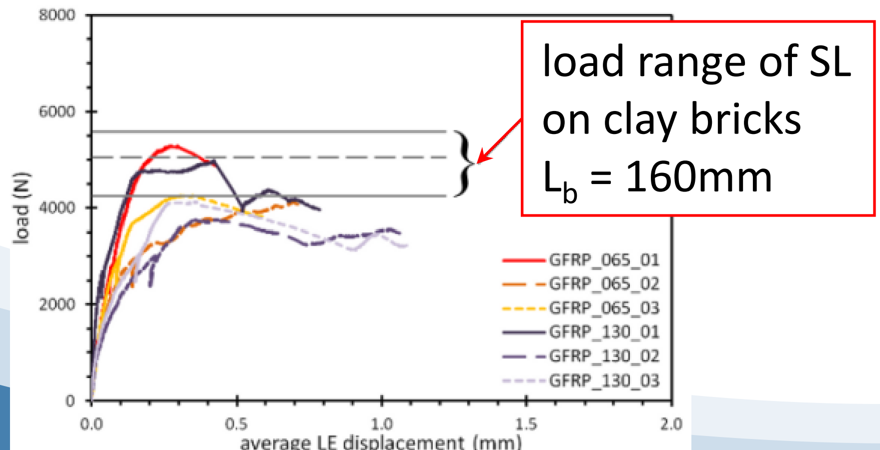
end-anchored CFRP

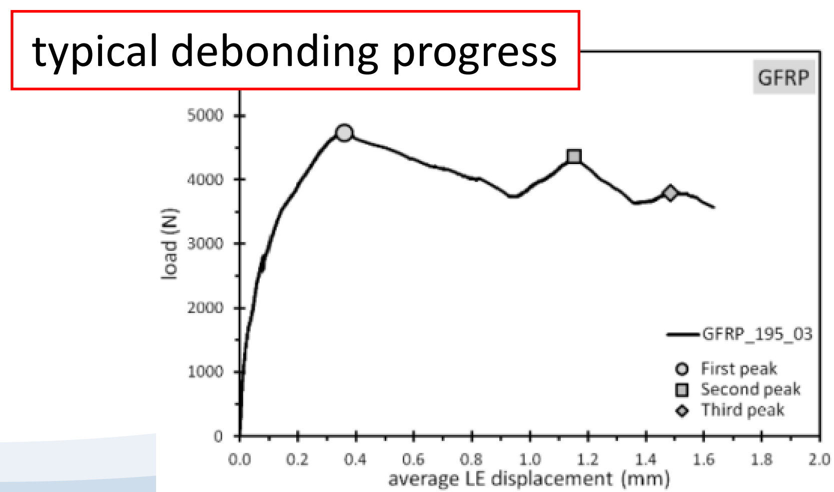
end-anchored SRP

Load results for GFRP (various L_b)



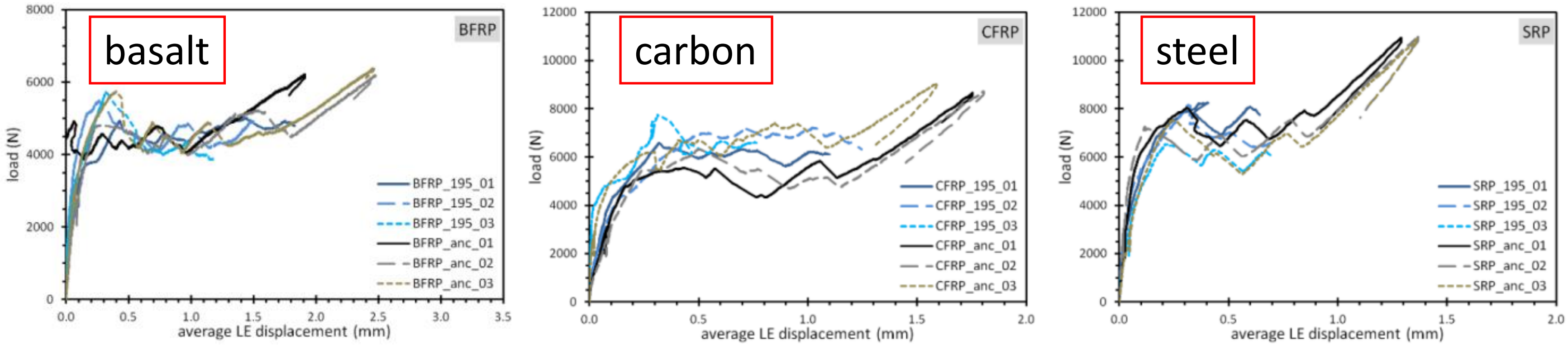




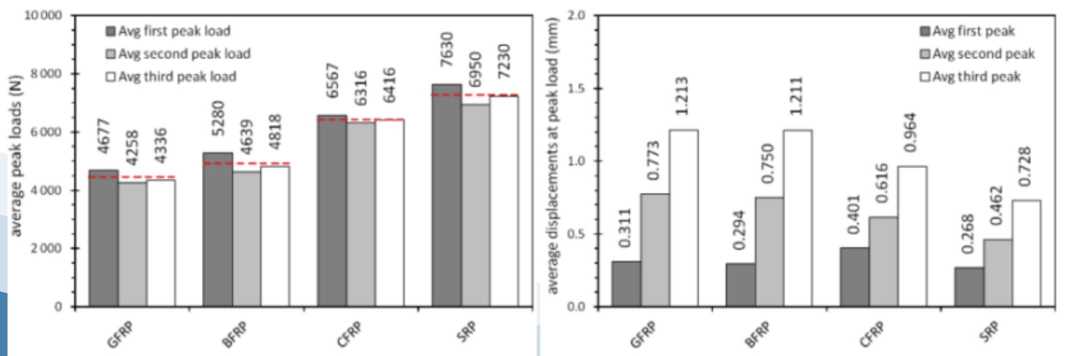


Results for BFRP, CFRP and SRP

load – LE displacement curves



peak loads and related LE displacements



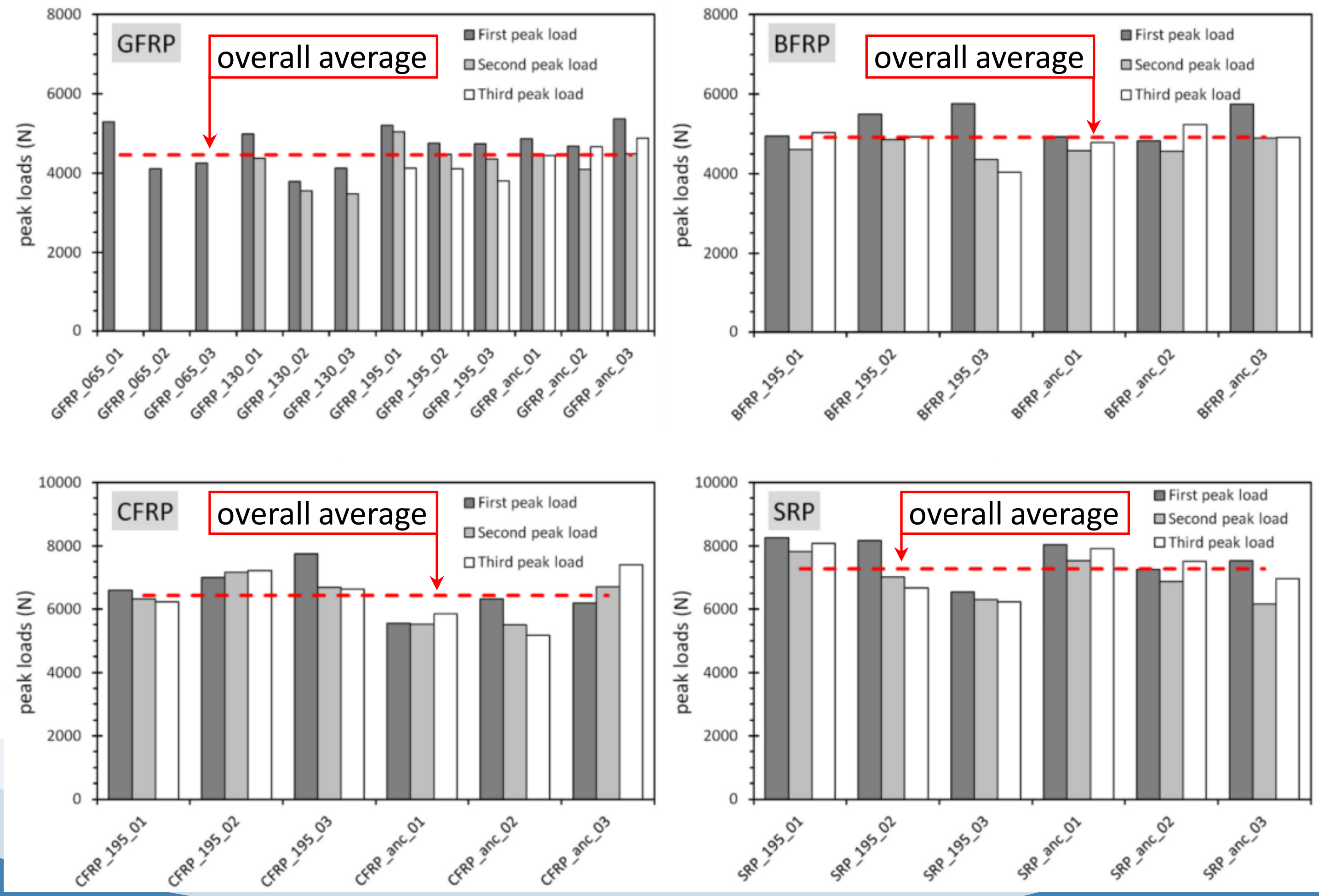
Peak loads:

- ❑ slight prevalence of the 1st one.

LE displacement:

- ❑ No significant difference for the 1st peak;
- ❑ consistent with different stiffness for subsequent ones

Recorded peak loads



Conclusions

- For *that combination* of clay bricks and weaker lime mortar (similar elastic modulus but rather different strength), the presence of mortar joints has a strong influence on the bond behaviour: it appears that higher bonded lengths do not provide higher strength, as if joints split the bonded area into segments one-brick long.
- strengths recorded with L_b of 65 mm were actually greater than expected (compared to results of SL-ST performed on single bricks bonded for 160 mm, granted that lateral brick's surfaces generally show a slightly higher strength), as if a certain contribute is given by a sort of interlocking of a mortar tooth;
- end-anchored specimens allowed for stable test progress, avoiding brittle detachments detrimental also for the applied instrumentation; this may be significant also toward a future standardization of bond tests;
- as expected, stiffer reinforcements (CFRP and SRP) showed higher strength, and equivalent composites (GFRP and BFRP) had similar results.

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THANKS

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