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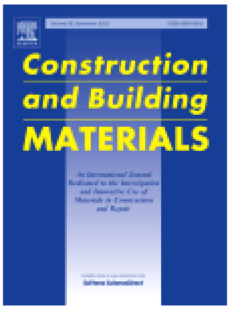

Mechanical behavior of an assembly of wood–geopolymer–earth bricks

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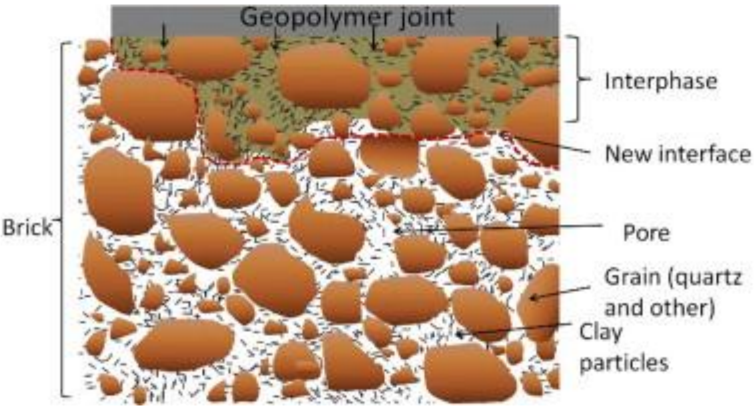
Abstract

Timber frame construction with earth brick infill is a sustainable design that is promising in the building construction field. However, cracks form at the interfaces of the bricks and frame with temperature and humidity fluctuations. A geopolymer binder can create stronger bonds between these two materials than traditional mortar, potentially preventing crack formation. This study focuses on the pull-out and shear mechanical behavior of laboratory assemblies of wood, geomaterial binder and two different types of earth brick. The full-field displacements of double-shear test samples were also obtained by digital image correlation (DIC) to better describe and understand the mechanical behavior of the system. The results show that the geopolymer binder provides good adhesion of approximately 1.5 MPa or 2 MPa, depending on the type of brick. Failure localization is also different for each assembly, occurring inside the brick and binder or only inside the binder. This result is confirmed by DIC analysis. The microstructure of the brick has been correlated with the mechanical behavior of the assembly. First results show that the geopolymer binder can be used as a joint in wood and earth masonry.

Graphical abstract



Highlights

► Geopolymer binder gives good adhesion between wood and earth. ► Shear results are similar to thus obtained on fired brick with cement mortar masonry. ► The Brick nature has an important effect on the mechanical behavior of masonry samples. ► The binder penetrates inside the earth creating a new phase.

Keywords

Masonry; Geopolymer; Double shear test; Pull-out test; Extruded brick; Earth

Figures and tables from this article

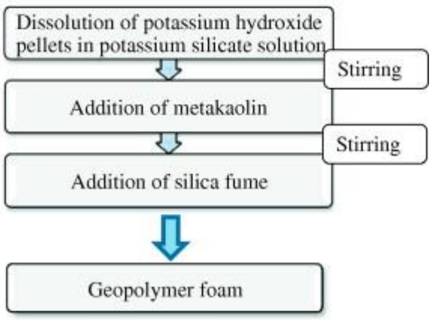


Fig. 1 Synthesis protocol of geo-material foams.

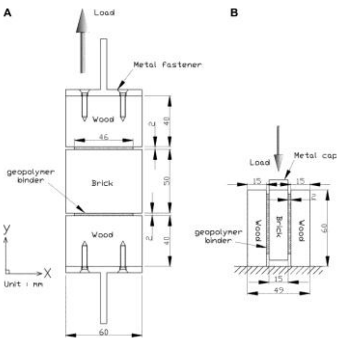


Fig. 2 Scheme of (A) pull-out test sample and (B) double shear test sample.

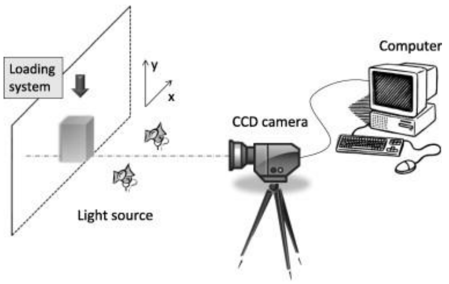


Fig. 3 Schematic illustration of the experimental setup for the DIC method.

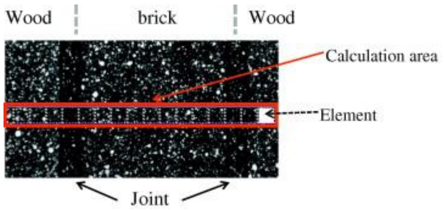


Fig. 4 Typical painted assembly with the calculation area in red and several element of calculation (white grid square). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).

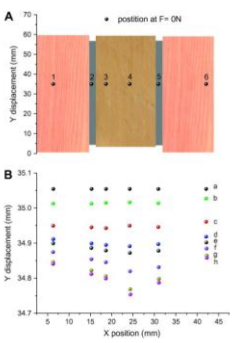


Fig. 5 Displacement analysis of SB1-6 sample (A) initial position of the tracking elements of the calculation area. (B) Displacement evolution of tracking element with respect to the load (a) 0 N, (b) 585 N, (c) 1664 N, (d) 2409 N, (e) 2642 N, (f) 3193, (g) 3699 N and (h) 3852 N.

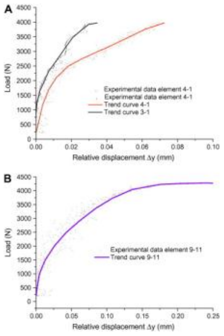


Fig. 6 Relative displacement curve in Δ*y* direction with respect to the load for (A) SB1-6 sample between no. 1 and no. 3 and no. 1 and no. 4 elements and (B) SB2-1 sample between no. 9 and no. 11 elements.

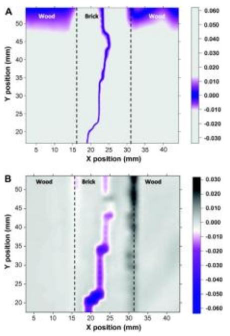


Fig. 7 Mapping of SB1-6 specimen (A) full field displacement Δ*X* under *F* = 2643 N and (B) full field deformation *εXY* for SB1-6 under *F* = 3971 N.

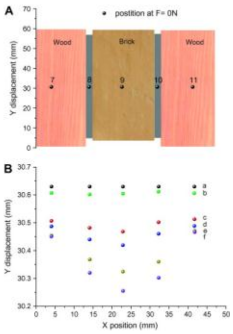


Fig. 8. Displacement analysis (A) initial position of the tracking elements of the calculation area for SB2-1 sample and (B) displacement evolution of tracking element at different load value for SB2-1: (a) 0 N, (b) 648 N, (c) 2662 N, (d) 3246 N, (e) 4094 N and (f) 4281 N.

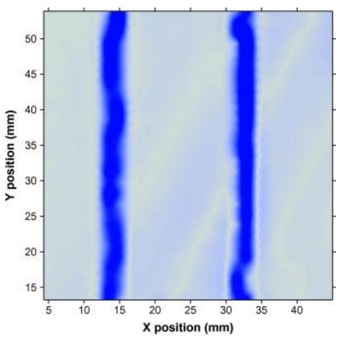


Fig. 9 Mapping of SB2-1 specimen, full field displacement *εXY* under *F* = 4281 N.

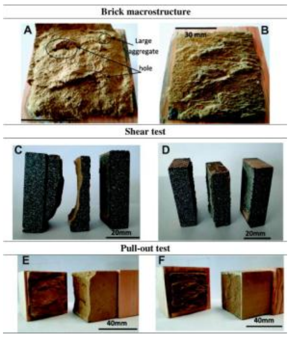


Fig. 10. Macrostructure of (A) B1 brick (B) B2 brick, picture of sample after failure (C) SB1-6, (D) SB2-1, (E) AB1 and (F) AB2.

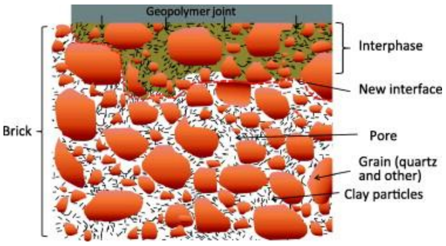


Fig. 11 Scheme of penetration of geopolymer binder inside brick.

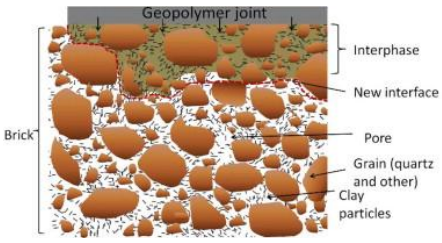


Table 1 Details of samples studied.

Table 2 Values of double shear test results for SB1 and SB2 assemblies.

Table 3 Pull-out test results for POB1 and POB2 assemblies.

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