

**On roof construction and wall strength : non-linear structural integrity analysis of the Early Bronze Age Helike Corridor House**

KORMANN, Mariza, KATSAROU, Stella, KATSONOPOULOU, Dora and LOCK, Gary

Available from Sheffield Hallam University Research Archive (SHURA) at:

<http://shura.shu.ac.uk/11518/>

---

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

**Published version**

KORMANN, Mariza, KATSAROU, Stella, KATSONOPOULOU, Dora and LOCK, Gary (2016). On roof construction and wall strength : non-linear structural integrity analysis of the Early Bronze Age Helike Corridor House. In: CAA 2016 : 44th International Conference on Computer Applications and Quantitative Methods in Archaeology, Oslo, Norway, 29 March to 2 April 2016. (Unpublished)

---

**Copyright and re-use policy**

See <http://shura.shu.ac.uk/information.html>

# On Roof Construction and Wall Strength: Non-Linear Structural Integrity Analysis of the Early Bronze Age Helike Corridor House

Mariza Kormann<sup>1</sup>, Stella Katsarou<sup>2</sup>, Dora Katsonopoulou<sup>3</sup> and Gary Lock<sup>4</sup>

<sup>1</sup>Communication and Computing Research Centre, Sheffield Hallam University, Sheffield, UK

<sup>2</sup>Department of Palaeoanthropology-Spelaology, Athens, Greece

<sup>3</sup>The Helike Society and The Helike Project, Athens, Greece

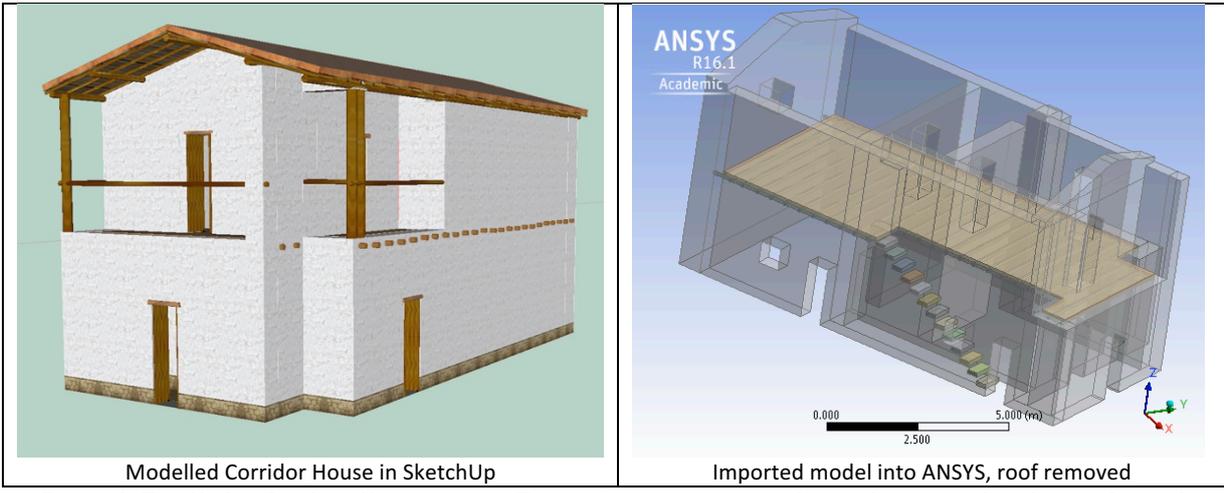
<sup>4</sup>The University of Oxford, UK

[m.kormann@shu.ac.uk](mailto:m.kormann@shu.ac.uk), [stella@stellakatsarou.gr](mailto:stella@stellakatsarou.gr), [eliki@otenet.gr](mailto:eliki@otenet.gr), [gary.lock@arch.ox.ac.uk](mailto:gary.lock@arch.ox.ac.uk)

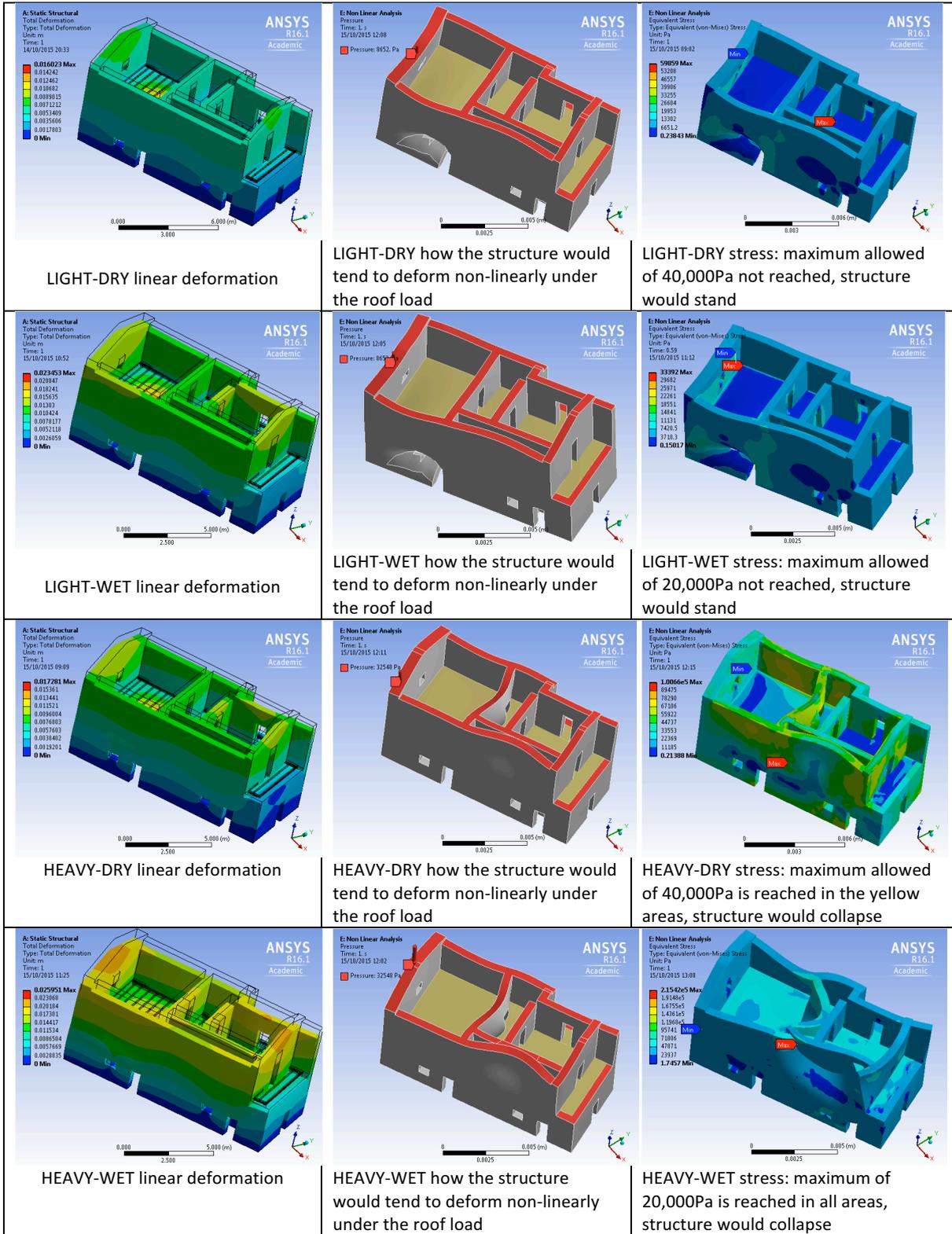
## Abstract

We have demonstrated [1] through Structural Integrity Analysis that the Adobe brick Early Helladic (EH II-III) Helike Corridor House design was sound and it was able to support a second floor. This paper furthers the research focusing on roof loads by performing non-linear and sensitivity analyses addressing two research questions: 1) Was the roof of a light tiled construction or was it heavy as described in [2] about four times heavier than a tiled roof; and 2) What would the behaviour of the structure be when subjected to adverse wet weather under light and heavy roof loads. Previous research has shown that Adobe bricks can absorb large quantities of water from 2 to 10kg/m<sup>2</sup> [3, 4]. Furthermore, if it absorbs 4kg/m<sup>2</sup> the overall strength of the wall is reduced by 50% [3]. Using mechanical properties of dry and wet Adobe bricks, we have performed non-linear analysis using ANSYS aimed at determining whether or not the structure would collapse under four conditions: LIGHT-DRY (light roof, dry Adobe), LIGHT-WET, HEAVY-DRY and HEAVY-WET. The results show that under a light roof the structure would stand. However, a heavy roof similar to early Minoan structures [2] would lead to total collapse of the house as the Yield Stress on the wall structure is greater than the maximum allowed for wet and for dry Adobe. This points to sophisticated construction techniques with tiled rooves and the possible use of stabilising materials such as lime, ash or organic to protect the tiles [5]. The theory that Helike builders were aware of such techniques could only be supported by planned forthcoming detailed soil analysis to identify possible stabilisers and this would raise further questions on wider interactions such as trade. This research offers new understandings of roof techniques and weight limitations for Adobe building Corridor Houses in a period where only scant evidence is available.

- [1] M. Kormann, S. Katsarou, D. Katsonopoulou and G. Lock (2015). Structural Integrity Modelling of an Early Bronze Age Corridor House in Helike of Achaea, NW Peloponnese, Greece. *CAA 2015 Siena*.
- [2] J. McEnroe (2010). *Constructing Identity in the Aegean Bronze Age*, University of Texas Press, 195pp.
- [3] H.G. Njau and E. Park (2015). Physical Properties of Unfired and Compressed Same Clay Brick Composites Reinforced with Natural Fiber from Tanzania, *Int J of Innovative Research in Advanced Eng*, Issue 4, Vol. 2 April 2015.
- [4] L.A. Palmer and D.A. Parsons (1934). A Study of the Properties of Mortars and Bricks and their Relation to Bond. *US Dept of Commerce Bureau of Standards* Vol. 12, 609—644.
- [5] R. Eires, A. Camoes and S. Jalali (2013). Earth Architecture: Ancient and New Methods for Durability Improvement. *Structures and Architecture: Concepts, Applications and Challenges – Cruz (ed)*, Taylor and Francis Group, London, 962—969.



**Figure 1:** The Helike Corridor House model. The roof was replaced by its equivalent weight in the simulation studies



**Figure 2:** Non-linear failure analysis. The limit for stress is 40,000Pa for dry Adobe, and 20,000Pa for wet. If these values were exceeded on the wall structure, it would collapse.