Structural Integrity Modelling of an Early Bronze Age “Corridor House” in Helike of Achaea, NW Peloponnese

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

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Structural Integrity Modelling of an Early Bronze Age “Corridor House” in Helike of Achaea, NW Peloponnese

Mariza Kormann, Stella Katsarou, Dora Katsonopoulou and Gary Lock

Sheffield Hallam University, Paloe Dept, The Helike Project, Oxford University
Early Helladic II/III site

The Helike Delta
The Helike Corridor House (HCH)

- The Corridor feature
- Its function
HCH within Early Helladic Settlement

• The HCH within the proto-urban settlement
• The socio-economic importance of the HCH
Aims and Objectives

• **Aims**
  – Explore materials and plan alterations on the Helike Corridor House (HCH) through structural integrity studies

• **Objectives**
  1. What is the structural value of the added corridors
  2. Whether the geometry of the house would support a second floor
  3. To study the effects of redesigned geometry from earlier phase

• **Methodology**
  – Determine the mechanical properties of building materials
  – Perform structural integrity based on finite element modelling
  – Comparative analysis and validation with Lerna’s House of the Tiles
Related Previous Work

• Interpretation of corridor houses
  – The House of the Tiles at Lerna
• Structural analysis in cultural heritage
  – Seismic vulnerability of ancient buildings
  – Restoration of monastic buildings
  – Historical reconstructions
  – Durability of materials
Geometry Modelling of HCH
The Reconstructed HCH

View from the North East

Stairway to upper floor

Large room at the back

View from the North West

Small room with external access only
• Roof
  – Wooden structure, reeds, rammed earth, tiles
• Upstairs floor
  – Wooden structure, reeds, mud
• Staircase
  – Wooden structure
Materials Characterisation

- Structural analyses with ANSYS require for each material:
  - Density
  - Compressive strength
  - Tensile strength
  - Young’s modulus of elasticity
  - Poison ratio

- Other properties such as bulk and shear modulus are derived from these
# Mechanical Properties

<table>
<thead>
<tr>
<th>Material</th>
<th>Density $\text{kg.m}^{-3}$</th>
<th>Young’s Modulus MPa</th>
<th>Poisson Ratio</th>
<th>Compressive Strength MPa</th>
<th>Tensile Strength MPa</th>
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<tbody>
<tr>
<td>Adobe Brick</td>
<td>1737</td>
<td>54.7</td>
<td>0.17</td>
<td>1.2</td>
<td>0.04</td>
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<tr>
<td><em>Pinus halepensis</em></td>
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<td>10,770</td>
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<td>61</td>
<td>81.6</td>
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<tr>
<td><em>Olea spp</em></td>
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<td>17,770</td>
<td>0.25</td>
<td>62</td>
<td>31</td>
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<tr>
<td>Reed <em>Arundo donax</em></td>
<td>234</td>
<td>9,000</td>
<td>0.25</td>
<td>665</td>
<td>321.7</td>
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# ANSYS Simulation Settings

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<th>B</th>
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<tbody>
<tr>
<td><strong>1</strong></td>
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<tr>
<td>Static Structural</td>
<td>Linear Buckling</td>
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<td>Engineering Data ✓</td>
<td>Engineering Data ✓</td>
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<td>Geometry ✓</td>
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<td>Solution ✓</td>
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<td><strong>7</strong></td>
<td><strong>7</strong></td>
</tr>
<tr>
<td>Results ✓</td>
<td>Results ✓</td>
</tr>
</tbody>
</table>
Importing Geometry
Setting up External Loads

A: Static Structural
Static Structural
Time: 1 s
11/03/2015 14:18

- **A**: Force: 2.6224e+005 N
- **B**: Fixed Support
- **C**: Standard Earth Gravity: 9.8066 m/s²
Results: Static Structural Analysis Total Deformation

A: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
Time: 1
11/03/2015 14:22

- 0.016216 Max
- 0.014414
- 0.012612
- 0.010811
- 0.0090088
- 0.007207
- 0.0054053
- 0.0036035
- 0.0018018
- 0.0 Min
Results: Linear Buckling

No floors
No stairs

With floors
No stairs

With floors
With stairs
 Interpretation

- Design and materials capable of supporting second floor
- Wall more susceptible to buckling is the outer wall to the stairs
- Adding first floor and staircase makes that wall less susceptible to buckling
- Transversal walls at 90 degrees on the corridor on the west side of the house makes the structure more rigid
Conclusions

• Modifications of early house structure into the Helike Corridor House achieved the required space and monumental height
• Structural analysis using finite element methods show that structure would be able to support second floor
• Architectural design similarities suggest re-use of prescribed plans
• The function of the house within pre-urban society suggests an administrative seat, assembly hall, kin group or communal storage space
• Further work involves non-linear structural integrity analyses
Tour of the Helike Corridor House