Design and Construction Guidelines for Dry-Stack Concrete Masonry

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Dry Stack = Mortarless

• Used internationally.

• Uses
  – Buildings
  – Utility structures
  – Retaining walls
  – Residential
  – Storm shelters

• Benefits
  - Speed and ease of installation.
  - Reduced labor expenses.
  - Requires fewer skilled masons directed by experienced masons.
Dry Stack in the IBC

(Fiber-reinforced surface bonding cement parged onto both sides)

(Dry-stack concrete masonry units)

(Running bond)

(Mortar leveling course)
IBC Design Limitations

- Not for essential facilities.
- Not for nominal wind speed $V_{asd} > 110$ mph
- Empirical design for shear walls for SDC A only
- Empirical design for other walls for SDC A, B and C.

Purpose of Design Guidelines

- Develop a base for future code introduction.
- Address limitations using engineered masonry.
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Chapter 1 – Introduction

• History and Background.

• Since not code, options for use:
  ✓ Apply to code official as special structure per IBC Section 104.10 Modifications or IBC Section 104.11 Alternative materials, design and methods of construction and equipment.
  ✓ Obtain ICC-ES system approval.
Building

https://theconstructor.org/building/dry-stacked-interlocking-masonry-system-mortarless/9029/
Building
Building
Arizona home


Tanzania home

https://warwick.ac.uk/fac/sci/eng/elith/publications/all_publications/elith-w01.pdf
Highway Sound Barriers

Little mortar!  Low maintenance.  Control CMU efflorescence!
Interior Storm Shelter
Site Walls

Trash Enclosures

WALLS


Courtesy of Weldcraft Iron Works
Chapter 2 – Materials

• CMU only. (Limited testing available for clay units.)
• Uses standard ASTM CMU. Proprietary possible too.
• Mortar (setting bed), grout, reinforcement same as TMS 602.

• Compressive strength, $f'_{dm}$
  ✓ Prism strength
  ✓ Unit strength
# Unit Strength Method

<table>
<thead>
<tr>
<th>Net Area Compressive Strength of Concrete Masonry Units, psi (MPa)</th>
<th>Net Area Compressive Strength of Concrete Masonry Assembly, $f'_{dm}$, psi (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unground Interface</td>
<td>Ground Interface</td>
</tr>
<tr>
<td>2,000 (13.8)</td>
<td>1,300 (9.0)</td>
</tr>
<tr>
<td>2,800 (19.3)</td>
<td>1,400 (9.7)</td>
</tr>
<tr>
<td>3,150 (21.7)</td>
<td>1,600 (11.0)</td>
</tr>
<tr>
<td>3,500 (24.1)</td>
<td>1,800 (12.4)</td>
</tr>
<tr>
<td>3,850 (26.5)</td>
<td>2,000 (13.8)</td>
</tr>
</tbody>
</table>

Derived from research at Clemson University
Bed joint interface important

Units ground or unground for bearing.
Chapter 3
Dry-Stack Masonry Systems

• Two systems:
  – Reinforced …partial or full grouting.
  – Prestressed…..can use surface bonding for shear.

• Single wythe or cavity wall; running bond only.

• Does not include: veneers, SRWs or mechanically stabilized walls.
Reinforced Dry Stack
(partial or full grouting)
Prestressed Dry Stack

Surface-bonding mortar each side, if required

Steel prestressing tendon or steel rod

Mortar leveling bed

Steel bearing plate

Nut or tendon bearing

Bond beam with reinforcement

Nut or tendon bearing

Steel bearing plate

Dry-stacked running bond

Coupler and/or restrainer, if required

Footing reinforcement

Ground units only!
Dry Stack Buildings with Cavity Walls

• Reinforced or Prestress CMU back-up

• Low seismic.

• Air and moisture barriers.

• Anchor veneer to units rather than joint reinforcement.
Single Wythe Buildings

• Might require proprietary systems that are more resistant to water penetration.

• Fully grouted mass barrier wall.

• No mortar, but possibly an adhesive.
Chapter 4
Seismic Design Recommendations

• Use TMS 402 prescriptive detailing for shear walls.

• If ground units, use R & $C_d$ for mortared systems.

• If unground units, reduce one level.
Chapter 5
Performance and Serviceability

• Fire Resistance

• Air and Water Penetration Resistance

• Sound

• Aesthetics

• Drift and Deflection

• Movement Joints
Residence
Texas
First Course Alignment
Drill Tendon Locations
Set Anchor
Stress Anchor
Mortar Set First Course
First Course Level
Remaining Courses Dry Stack
Completed Walls Before Tensioning
Prior to Surface Bonding for weathertightness and shear value.
Completed

- Surface bonded exterior
- Trussed roof
- Anchored stone veneer
Thank you!