Surprising Masonry
THINGS THAT KEEP LIFE INTERESTING WITH MASONRY!

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For The Masonry Society

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Objectives / Outline

Masonry is being phased out...
Masonry saves money and time
  ◦ Cost Analyses
  ◦ Schedule Comparisons
Masonry spans long distances
  ◦ Walls
  ◦ Beams
Masonry carries the load
  ◦ Bearing
  ◦ Axial
  ◦ Flexure
  ◦ Shear
Fun stuff
Masonry is being phased out...?
MARTK PRESSURE AND LACK OF UNDERSTANDING AND LACK OF PLANNING...

Masonry Best Fit Archetypes
Places where people sleep
Primary education facilities
Secure/hardened facilities
Places you don’t want to burn...

Photo Credit: International Masonry Institute

Photo Credit: JDH Engineering

Photo Credit: Zaragon Place Website

Photo Credit: International Masonry Institute
Competitive Systems...

Places where people sleep?
Primary education facilities?
Secure/hardened facilities?
Places you don’t want to burn...?

Why???

Construction Erection Schedule
Innovation or marketed/perceived innovation
Finishes?

Let’s look at a couple things!
Masonry saves money and time...

TIME AND TIME AGAIN IT’S PROVEN... IF YOU LOOK AT THE FACTS!

Initial Cost, Life Cycle Cost, Construction Scheduling

Masonry IS Cost Competitive
Masonry IS Cost Competitive

Eliminate Steel Framing - Redundant Structural Cost

<table>
<thead>
<tr>
<th></th>
<th>Steel Frame/Stud 2” Rigid Insul.</th>
<th>CMU - 2” Rigid Insul.</th>
<th>CMU - 3” Spray Foam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Cost</td>
<td>$30,784</td>
<td>$24,537</td>
<td>$22,406</td>
</tr>
<tr>
<td>Present Worth</td>
<td>$35,798</td>
<td>$28,256</td>
<td>$25,119</td>
</tr>
<tr>
<td>Present Worth (/SF)</td>
<td>$45.52</td>
<td>$35.93</td>
<td>$31.94</td>
</tr>
</tbody>
</table>

Save Time with Masonry

Residence Halls
Hillcrest Hall - OU

Figure Credits: International Masonry Institute / Oakland University
Shorter Schedule - CC TEC

Schedule:
- They always design and build this way ‘because it goes up fast!’ – Bob Garrison, Sr.
- This project was a really tight schedule for 200,000 SF
- Broke ground in February 2015, started masonry in mid-April 2015, completed masonry in February 2016.
- Average Crew Size:
  - 26 bricklayers including 2 supervisors
  - 15 laborers
Shorter Schedule

Schedule:
- Steel frame may have shorter site construction time to get to roof membrane...
- Masonry gets to full enclosure faster so other trades can work
- Coordinate mechanical openings – often later design/fab...

Masonry Lintel Benefits

**Steel lintels cause delays...**
- add 6-8 weeks...
- as much as 12 weeks delay

Detailing / Review / ?Revision? / Fabrication / Galvanizing

**Masonry lintels are faster and less expensive!**

Some masons...?? still prefer steel lintels!!!!
Masonry Lintel Benefits

Which will be easier and faster to build in the field?
Which will perform better?

Masonry spans far! AND CARRIES THE LOAD!

Walls and beams can really reach...
Masonry walls can go tall!

Masonry can go tall:
- 8” CMU economical up to around 25 feet
- 12” CMU economical up to around 40 feet
- 16” CMU economical up to 50 feet or more
- Can go taller with double reinforcement
  - 62’ with 12” CMU
  - 80’ with 16” CMU

Masonry systems can go tall:
- 10-15 stories easily accommodated
- Can reach 20 or more stories even in seismic areas.

Masonry lintels span far!

Span large openings
Easier to achieve lower deflection

- 7 cs. CMU = 0.145”
- W16x36 = 0.376”
Masonry lintels span far!

Span large openings
Easier to achieve lower deflection

8 cs. CMU = 0.50”
W24x117 = 1.15”

Reinforced Veneer Lintels
Codified – IRC up to 18’-3”

Engineered could exceed 25’ – Thanks Mark McGinley!
BLUEWATER VIEW – PORT HURON, MI

0.1” PER FLOOR HORIZONTAL DEFLECTION
H/1400

Design and Figure Credit: Bergmann Associates/Phil Ledent

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BLUEWATER VIEW – PORT HURON, MI

Design and Figure Credit: Bergmann Associates/Phil Ledent

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Masonry carries the load!

USE THE ENVELOPE AND WALLS FOR STRUCTURE!

Bearing, Axial, Out-of-Plane, In-Plane

Bearing and Axial Load

You don’t need steel framing...

Masonry can carry the load...

Beam and girder bearing:
- Beam bearing: 8” x 8” at $f'_m = 2,000$ psi: 47,250# (ASD)
- Beam bearing: 8” x 8” at $f'_m = 2,500$ psi: 59,400# (ASD)
- (plate edge 1” in from face of 12” CMU)

Wall axial capacity:
- 23’-4” tall, hollow, 8” CMU with $f'_m = 2,500$ psi can carry 9,450 plf
Bearing and Axial Load

You don’t need steel framing...
Masonry can carry the load...

Joist bearing:
- 181’ clear span
- 112” deep SLH joists
- 11’ on center
- on 34’ tall 12” CMU walls

Masonry for Lateral Force Resistance

8” partially grouted
14’ long shear wall
16’ to diaphragm
41 kips of wind shear

With gravity...
With wind pressure...

#5’s at 24” o.c.
Masonry for Lateral Force Resistance

8” partially grouted
48’ long bearing and shear wall
16’ to diaphragm
8 kips of wind shear
With gravity...
With wind pressure...
With bolted lintels

#5’s at 48” o.c.

Use Masonry Lintels!

Trim openings!
Control joints better placed - better structural performance
Better Structural Performance

Control joints better placed for better wall structural performance

(See NCMA TEK 10-3 re. eliminating CJ’s)

Masonry Infill Panels

TMS 402 Appendix B

Bounding frame works with masonry panel

Steel or concrete frame

Frame movement creates diagonal corner contact and a ‘compression strut’

Figure 1—Concrete Masonry Infill as a Diagonal Strut
**Masonry Infill Panels**

Design Panel Length = 30’
Design Panel Height = 16’
Example Shear Load = 3,000#
Design Shear Capacity = 13,500#

Must design the frame for interactive loads/reactions

Up to 100k capacity for grouted 12” CMU!
Masonry Infill Panels

Out of plane load resistance:
NOT by simple vertical or horizontal span!!!
Employs arching action and strength design approach based on research

Example Design Pressure: 24 psf
Example Design Capacity: 25 psf – OK!

Fun stuff!

A COUPLE COOL THINGS...

Brick lintels and screen walls
Reinforced Veneer Lintels

Codified – IRC up to 18’-3”

Engineered could exceed 25’ – Thanks Mark McGinley!

Brick Screens

Crazy calcs

or... Phil -> Brian -> Mark
Australian Masonry Code Research Project(s)

Engineered applicability being evaluated – Thanks Mark Masia!

Conclusions

Some masonry surprises aren’t so good...
Most masonry surprises are good!
Masonry is INEXPENSIVE
Masonry is FAST
Masonry is STRONG
Masonry SPANS
Masonry can do COOL things

AS 3700 Eqn. 7.4.3.2(2)

\[
M_{ch} = 2.0 \times \Phi \times k_p \times (f'_{mt})^{0.5} \times (1 + f_d/f'_{mt}) \times Z_d
\]

- \( M_{ch} = 248001.0 \text{ N-mm per Meter} \)
- \( 248.001 \text{ N-M per Meter} \)
- \( \Phi = 0.6 \)
- \( k_p = 0.517 \)
- \( f'_{mt} = 0.69 \text{ Mpa (Type N PCL)} \)
- \( f_d = 0 \text{ MPa for Horiz. Bending (at panel top)} \)
- \( Z_d = 481010 \text{ mm}^3 \text{ per Meter} \)
- \( Z_d' = 67293 \text{ mm}^3 \text{ per bedded area} \)
- \( b = 47.625 \text{ for mortar joint for horiz. step analysis} \)
- \( d = 92.075 \text{ for mortar joint for horiz. step analysis} \)
- \( k_p(a) = 0.517 \)
- \( k_p(b) = 0.833 \)
- \( k_p(c) = 1.000 \)
- \( s_p = 47.625 \text{ mm} \)
- \( t_u = 92.075 \text{ mm} \)
- \( h_u = 57.15 \text{ mm} \)
- \( \text{Bedded Areas per Meter} = 7.12 \)
- \( \text{Allowable Pressure} = 0.4134 \text{ kN/m}^2 \text{ (kPA) (simple span, 5:1 conservative)} \)
- \( \text{Design span length} = \frac{2.19075}{5} \text{ (screen only width + half bedding on end)} \)
- \( \text{unit width} = 1.00 \text{ M} \)
- \( \text{Allowable Pressure} = 8.63 \text{ psf (on gross area, simple span, 5:1 conservative)} \)
- \( \text{Experiment Pressure} = 105.83 \text{ psf (solid surface, fixed end, adjusted for 5:1 ratio)} \)

Screen Area (gross) = 65.88 SF (per L&H)
Screen Area (openings) = 25.57 SF (per L&H)
Screen Area (solid) = 40.31 SF (calculated)
Questions and Discussion....

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