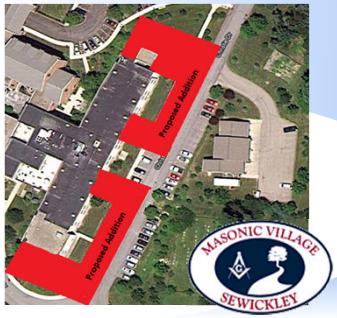
MASONIC VILLAGE AT SEWICKLEY

PENN STATE AE SENIOR CAPSTONE
JASON DRAKE | CONSTRUCTION OPTION
ADVISOR: JIM FAUST

OUTLINE

PROJECT OVERVIEW

- Masonic Villages of Pennsylvania
- Valley Care Association in 1999
  - 60 personal care apartments
  - 227 unit retirement living building
- Increase occupancy to 128 beds
  - 66,000 SF of New Construction
  - 40,000 SF of Renovations
- Importance of masonry



- Courtesy of Google Maps

OUTLINE

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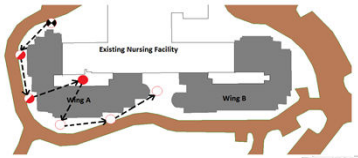

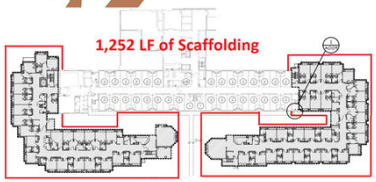

MASONRY ACCELERATION

- Mortar Mixing Procedures
- Freestanding vs. Hydro-Mobile Scaffolding

OUTLINE

Project Overview
Analysis #1: Masonry Acceleration
- **Adjusting the Critical Path**
- Savings Potential

Analysis #2: Façade Dimensioning
- Evenly Sized Elements
- Analyzing Dimensional Mismatches
- Material Waste, Time, and Manpower

Analysis #3: Value Engineered Façade
- Net Savings of the New Façade System

Mechanical Breadth
Analysis #4: Masonry Sustainability
Analyses Summary
Acknowledgements

ANALYSIS #1:

- Courtesy of WMF, Inc.

MASONRY ACCELERATION

- Mortar Mixing Procedures
- Freestanding vs. Hydro-Mobile Scaffolding
- **Adjusting Critical Path Elements!!!**

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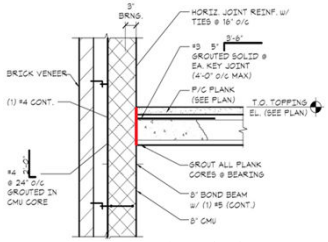


- Courtesy of RLPS, LTD.

MASONRY ACCELERATION

- **Adjusting Critical Path Elements!!!**

OUTLINE

ANALYSIS #1:

	Wing A	Wing B	Total
Floor 1	0 Days	-	0 Days
Floor 2	6 Days	0 Days	6 Days
Floor 3	10 Days	10 Days	20 Days
Total	16 Days	10 Days	**26 Days**

MASONRY ACCELERATION

26 Days!

OUTLINE

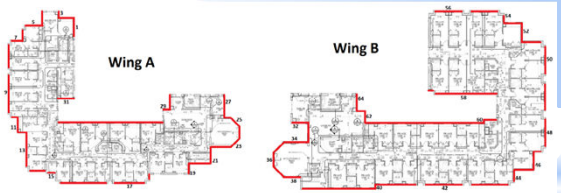
ANALYSIS #2:

- **Not Designed for Masonry Construction!!!**

- 116 Different Dimensional Components
- 64 Do Not Match up in Desirable Increments

- Analyzed Savings:
  - Material Waste
  - Time
  - Manpower

FAÇADE DIMENSIONING



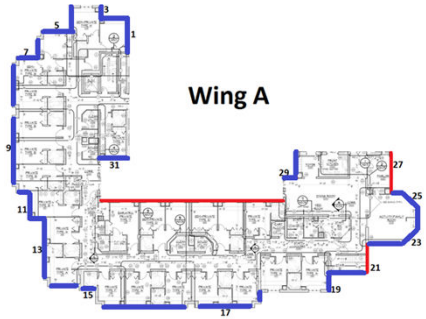
ANALYSIS #2:

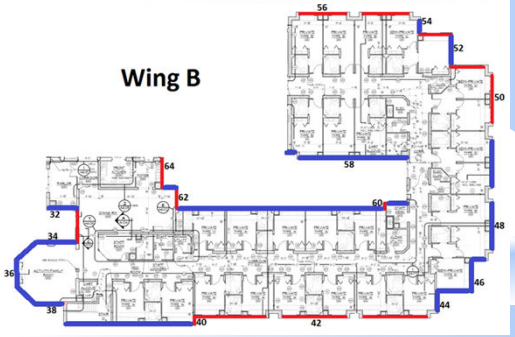
FAÇADE DIMENSIONING

Evenly Matching Units

1,3	2,39	4,16	5,18
6,22	7,11	8,15	9,13
10,32	12,14	17,61	19,44
20,34	23,24	25,26	28,57
29,63	31,35	36,37	38,45
46,47	48,52	49,59	54,58

- **1 Cut / CMU**





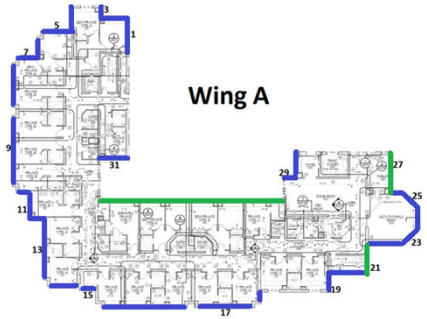
ANALYSIS #2:

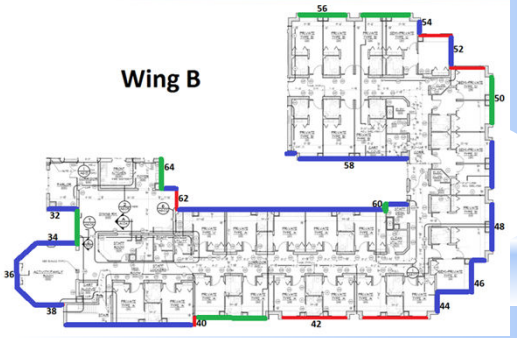
FAÇADE DIMENSIONING

Walls With Usable Scraps

Wall #	Length of Scrap		Wall #	Length of Cut Block	Total Waste of CMU/row
21	9	=>	60	8	1”
27	5	=>	50	3	2”
30	9	=>	55	3	6”
33	5	=>	56	2	3”
40	4	=>	64	2	2”
				Total:	14”

- 1 Cut / CMU
- 2 Cuts / CMU + Waste





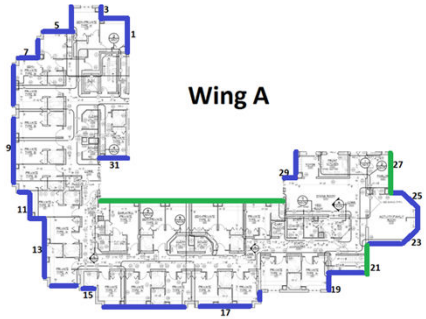
ANALYSIS #2:

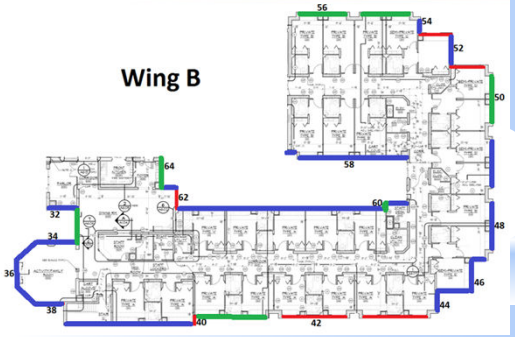
FAÇADE DIMENSIONING

Walls With Usable Scraps

Wall #	Length of Cut Block	Total Waste of CMU/row
41	12	4”
42	12	4”
43	12	4”
51	12	4”
53	10	6”
62	10	6”
	Total:	36”

- 1 Cut / CMU
- 2 Cuts / CMU + Waste
- 1 Cut / CMU + Waste





OUTLINE

ANALYSIS #2:

FAÇADE DIMENSIONING

Cost of Material Waste:

- Summed up the total inches of waste
- Multiplied by the number of CMU courses
- Computed an equivalent number of "wasted" CMU's
- Found a final dollar value of material

$1,031

OUTLINE

ANALYSIS #2:

Cost of Time:

- Calculated the total amount of cuts
- Assumed:
  - 4 min cycle
  - Labor rate of $28 / hr.
- Schedule delay of 24.4 hours
- 30 man crew

Cost of Manpower:

- 4 additional laborers

FAÇADE DIMENSIONING

Labor cost of 24.4 hour activity delay:

$20,496

Cost of additional manpower for a 59 day duration:

$52,864

OUTLINE

ANALYSIS #2: FAÇADE DIMENSIONING

Total Cost Reduction

$74,394

OUTLINE

ANALYSIS #3:

- Façade Redesign
- Embossed Brick-Faced CMU's
- Eliminates the need for brick veneer

- Veneer:
    - 39,047 SF
    - **$453,800**

VALUE ENGINEERED FAÇADE

- Courtesy of Westbrook Block

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ANALYSIS #3:

Added Project Costs:

- Brick Block CMU's
- Dyed Masonry
- Spray Foam Insulation

VALUE ENGINEERED FAÇADE

VE Changes	Cost / SF	Total Cost	Cost Difference
No Brick Veneer	$0.00	$0	+$453,800
Brick Block CMU's	$9.51	$371,300	-$58,900
Dyed Masonry	$0.41	$16,000	-$16,000
Spray Foam Insulation	$4.32	$168,700	-$129,700
Total Savings:			+$249,200

- Cost Data Extracted From RS Means Facilities Construction Cost Data 2011

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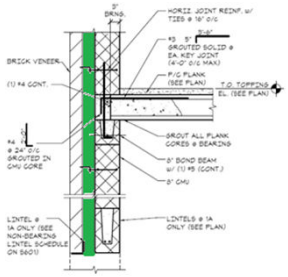
MECHANICAL BREADTH

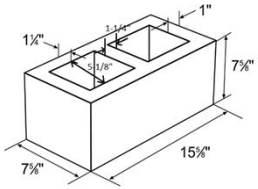


R-Value of Current Façade

Brick Veneer	=	R-3.2
2” Rigid Insulation	=	R-10
Mass Enhanced	=	R-0.5
Total R-Value	=	**R-13.7**

OUTLINE

MECHANICAL BREADTH



- Courtesy of Apple Gate

Spray Foam Insulation:
R-3.8/in x 5-1/8 in = R-19.5

CMU: = R-2.5

Average Total R-Value:
(19.5 x 79.7%) + (2.5 x 20.3%) = R-16.0

R-16.0 > R-13.7

OUTLINE

ANALYSIS #4:

- LEED 2009 for Healthcare:
  New Construction and Major Renovations
- LEED Silver
  - 55 Points
- LEED Gold (60 – 79 Points)

MASONRY SUSTAINABILITY

3 Categories:

- Sustainable Sites
- Energy and Atmosphere
- Materials and Resources

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ANALYSIS #4:

- **Points to be Pursued**
- **Points Already Earned / Not Practical**

Sustainable Sites:
- Credit 6.1: Stormwater Management – Quantity
- Credit 6.2: Stormwater Management – Quality
- Credit 7.1: Heat Island Effect (Non-Roof) **+1**

Energy and Atmosphere:
- Credit 1: Optimize Energy Performance **+1**

MASONRY SUSTAINABILITY

Materials and Resources:
- Credit 1: Building Wall Reuse **+1**
- Credit 2: Waste Management **+2**
- Credit 3: Resource Reuse
- Credit 4: Recycled Content
- Credit 5: Regional Materials

+5 LEED Points

OUTLINE

ANALYSES SUMMARY

Analysis #1: Masonry Acceleration
- Remove Floor Planks From Critical Path
- 26 Day Savings

Analysis #2: Façade Dimensioning
- Adjust Perimeter Dimensions on a Scale of Inches
- Cost Reduction:
  - Material Waste $1,031
  - Time $20,496
  - Manpower $52,864
- Total Savings: **$74,394**

Analysis #3: Value Engineered Façade
- Embossed Brick-Faced CMU's
- Additional Expenses
- Net Savings: **$249,200**

Analysis #4: Masonry Sustainability
- 5 Points From LEED Gold
- 3 Categories:
  - Sustainable Sites
  - Energy and Atmosphere
  - Materials and Resources

ACKNOWLEDGEMENTS

Industry

- Weber Murphy Fox, Inc.
- Masonic Villages of Pennsylvania

Academic

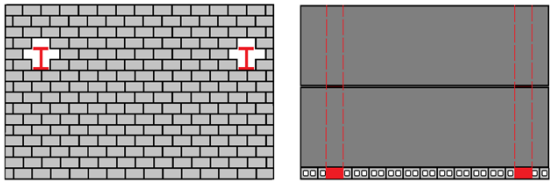
- Penn State AE Faculty
- Dr. Craig Dubler
- Professor Jim Faust

Special Thanks

- Tony Grace, Project Manager
- Kim Jeffreys, Project Executive
- Patty Downey, Project Coordinator
- Steve Burdick, Site Superintendent

OUTLINE

APPENDIX



Elevation View

Plan View

STRUCTURAL CALCULATIONS

Design Criteria:

Hollow Core Floor Plank:	50 psf.
Beam Self-Weight:	3 psf.
Resident Room Live Load:	40 psf.

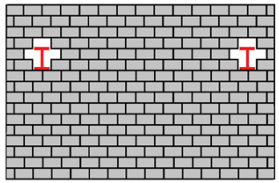
Factored Load = [1.2(50 psf.+3 psf.)] + (1.6 x 40 psf.) = 127.6 psf.
Tributary Area (A_t) = 25.5 ft. x 15 ft. = 382.5 ft^2
P_u = 127.6 psf. x 382.5 ft^2 = 48.8 Kip
V_u = 48.8 Kip/2 = 24.4 Kip
M_u = 48.8 Kip x 10 ft. = 488 K-ft.

No Brace Points: C_b = 1.14

$M_u' = M_u/C_b$ = 488/1.14 = 428.1
W14x90 most efficient
(See Figure 42)
Shape exceed limit for flexure
Use W16x89

OUTLINE

APPENDIX



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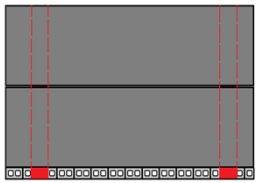

Plan View

FLEXURE:

WLB (Web Local Buckling):
E = 29,000 ksi
Fy = 50 ksi
h/t_w = 27.0

$\lambda_{pw} > \lambda_w$
$\lambda_{pw} = 3.76\sqrt{E/fy} > \lambda_w = h/t_w$
$3.76\sqrt{29{,}000/50} > 27.0$
90.6 > 27.0 OK

FLB (Flange Local Buckling):
$b_f/2t_f$ = 5.92

$\lambda_{pf} > \lambda_f$
$\lambda_{pf} = 0.38\sqrt{E/fy} > \lambda_f = b_f/2t_f$
9.15 > 5.92
Therefore $\phi M_n = \phi M_p$ = 656 K-ft
$\phi M_n > M_u$
656 K-ft > 488 K-ft OK

LTB (Lateral Torsional Buckling):
L_B = 25.5 ft.
L_P = 8.8 ft, L_R = 30.2 ft, ϕB_f = 11.6

$L_B < L_R$
Therefore $\phi M_n = C_b[\phi M_p - \phi B_f (L_B - L_P)]$
$\phi M_n = 1.14[656 - 11.6(25.5 - 8.8)] = 527$ K-ft

ϕM_n = 527 K-ft < ϕM_p = 656, Therefore use ϕM_n
$\phi M_n > M_u$
527 K-ft > 488 K-ft OK

Live Load Deflection:
w = 40 psf. x 15 = 600 plf = 0.05 k/in
L = 25.5 ft. x 12 in/ft. = 306 in
I_x = 1,300 in⁴

$\Delta_{MAX} < 5wL/384EI$
$\Delta_{MAX} = [5(0.05\ k/in)(306\ in)^4] / [384(29{,}000\ ksi)(1{,}300\ in^4)] = 0.15$
L/360 = 306 in/360 = 0.85
$\Delta_{MAX} < L/360$
0.15 < 0.85 OK

SHEAR:
a = ∞ (distance between web stiffeners)
a/h < 3 , Therefore Kv = 5

$h/t_w < 1.1\sqrt{(Kv * E)/fy}$
27.0 < 59.0 , Therefore C_v = 1.0
$h/t_w < 2.24\sqrt{E/fy}$
27.0 < 53.7 , Therefore ϕ = 1.0

Area of Web (A_w) = 16.5 in. x 0.525 in. = 8.82 in²
$\phi V_n = 0.6\phi F_y A_w C_v$
$\phi V_n = 0.6(1.0)(50\ ksi)(\ 8.82\ in^2)(1.0) = 264.6$ kip

$\phi V_n > V_u$
264.6 kip > 24.4 kip OK