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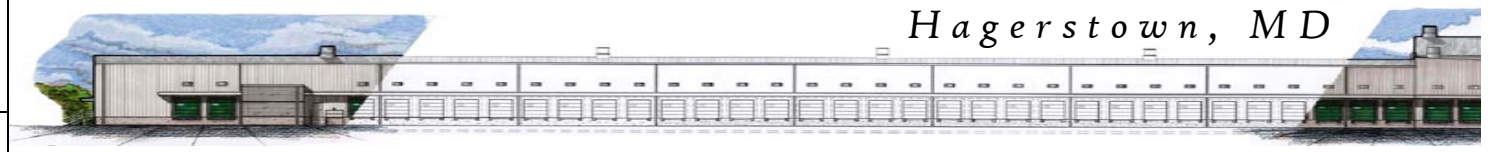
FedEx Ground Distribution Hub

Hagerstown, MD



Construction Management Senior Thesis Presentation 2005

by Lucas Klock

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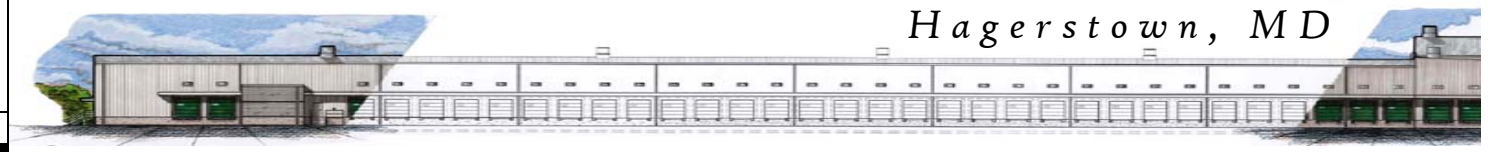

Presentation Overview

~ Project Background & Overview

~ Advanced Modeling

~ Tilt-Up Construction Analysis

~ Enclosure Comparison

~ Panel Lift Analysis

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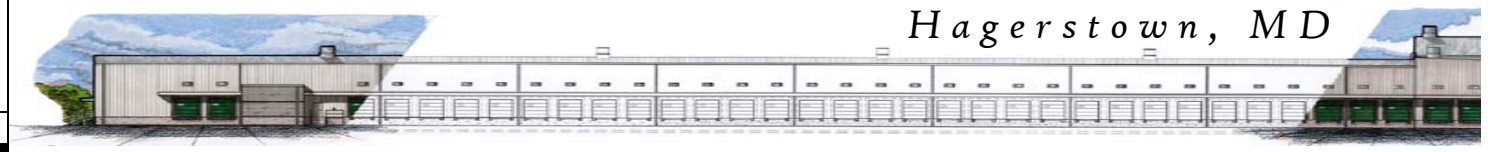

Key Project Players

Owner

FedEx Ground

Architect / Engineer

OSBORN

Prime Contractors

Gilbane

BUTLER CONSTRUCTION
A BlueScope Steel Company

HK SYSTEMS

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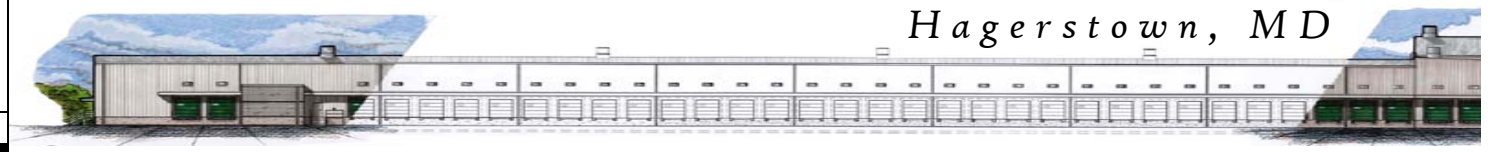

Project Statistics

~ **Function:**	Distribution Facility
~ **Lot Size:**	114 Acres
~ **Building Size:**	475,000 sq. ft.
~ **Estimated Cost:**	$100,000,000
~ **Project Start:**	October 2003
~ **Fully Operational:**	2006

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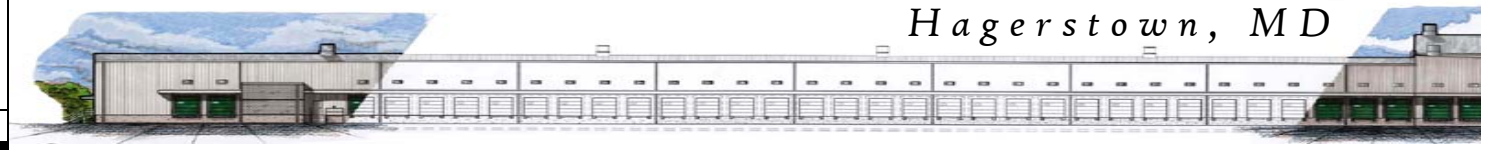

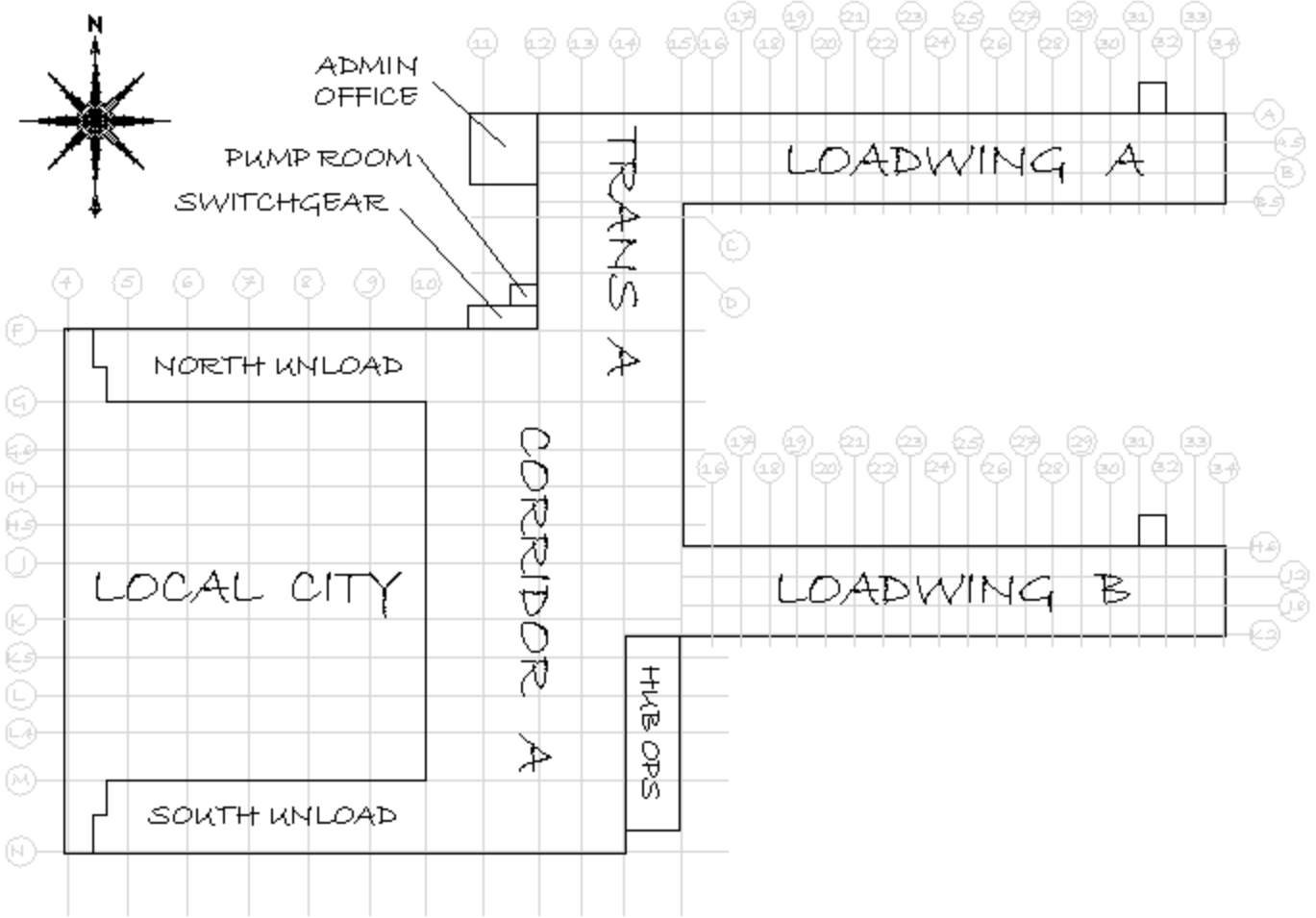

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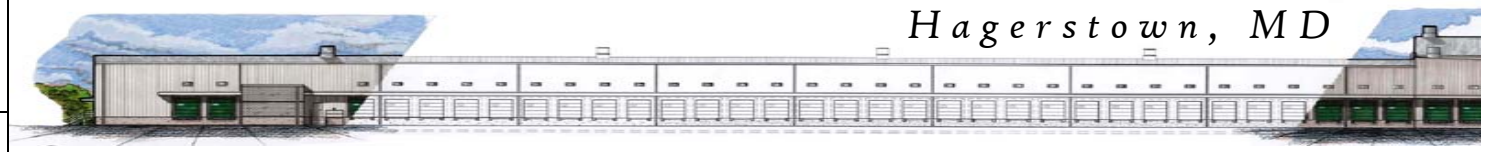

Advanced Modeling

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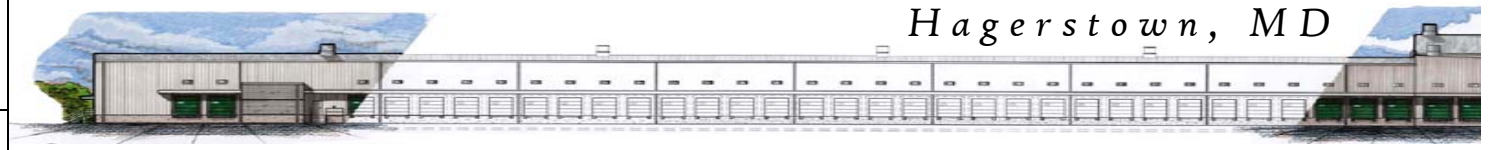

Benefits of Advanced Modeling

~ Visualize Construction Process

~ Increased Planning & Coordination

~ Improves Overall Communications

4D Model

Interior Walkthrough

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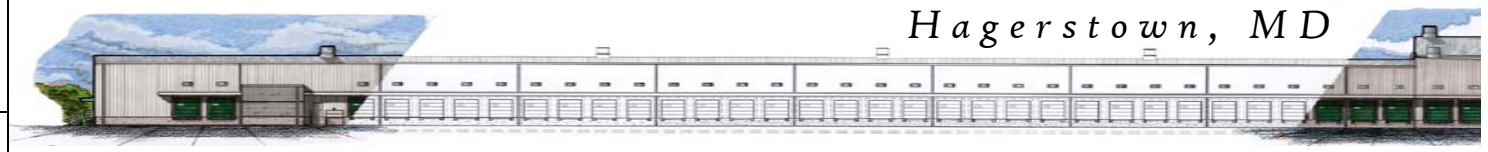

Tilt-Up Constructability Analysis

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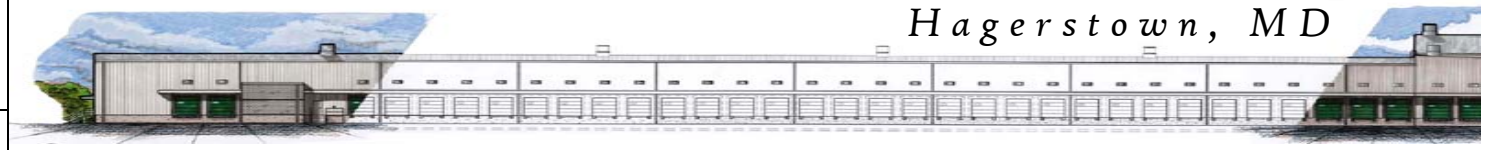
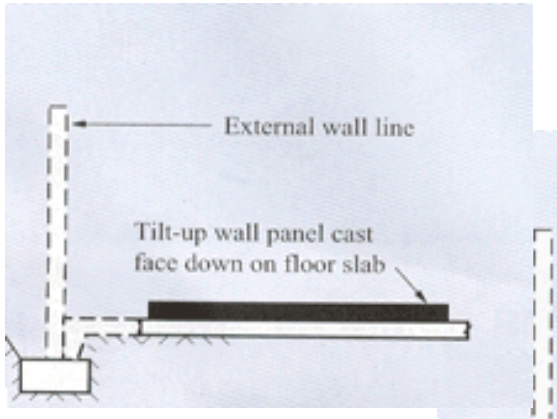
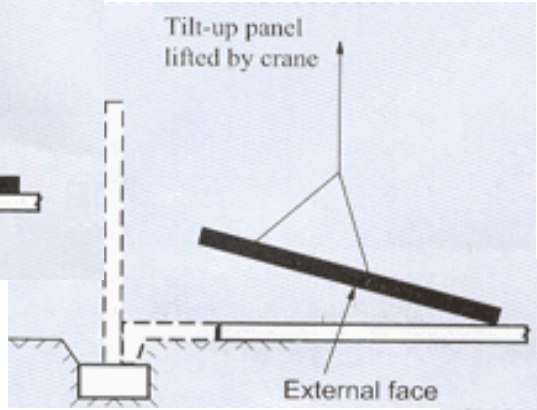


Overview of Tilt-Up Construction

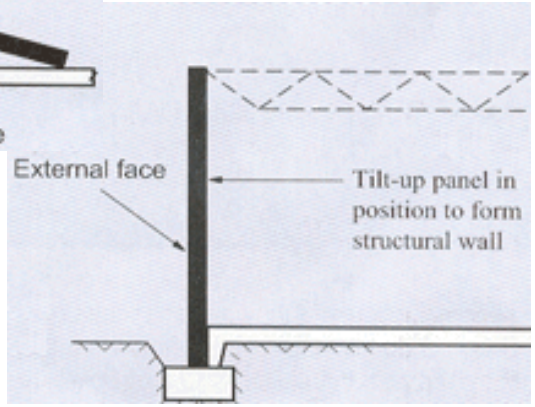
Step 1



Step 2



Step 3



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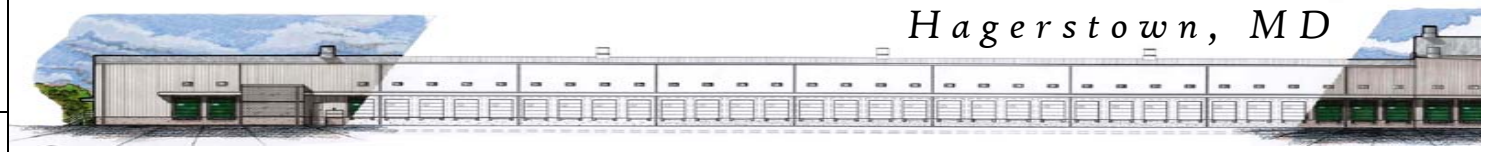

Benefits of Tilt-Up

~ Cost Competitive

~ Quick Erection

~ Highly Durable

~ Increased Level of Security

~ Low Maintenance Costs

~ Architecturally Appealing

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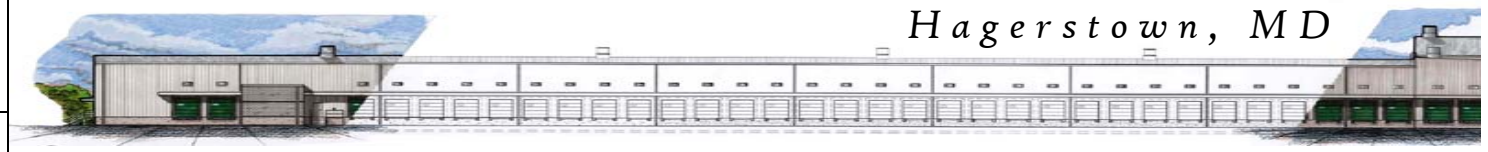

Constructability

	Yes	No
Are the exterior surfaces essentially flat?	X	
Do they make up at least 50% of the total wall surface?	X	
Will most of the wall panels rest on the foundation as opposed to elevated lintel panels?	X	
Will most of the wall panels overall height be less that 30 feet?		X
Can there be highly repeatable panels, in order to improve the efficiency of panel erection?	X	
Is there enough floor area available to provide a casting surface of the panels?	X	

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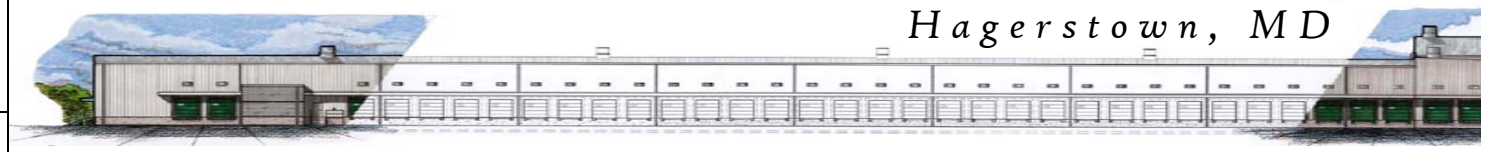

Current Design Adaptability

Building Element	Current Design	Analysis Recommendation
Site Conditions	Available area: 100 + acres Access: 4 lane private access No overhead utility restrictions No adjacent buildings	Site is adequate
Slabs	Interior: 6" steel reinf., 4000 psi conc. Exterior: 8" fiber reinf. 4,000 psi conc. Slope: 3.5% (allowable 0.5%) LC Only	Adequate to carry imposed crane loads, Slab slope needs reduced
Subgrade	6" of graded aggregate for 6" of concrete 8" of graded aggregate for 8" of concrete Subgrade compaction min. of 100%	Subgrade is adequate

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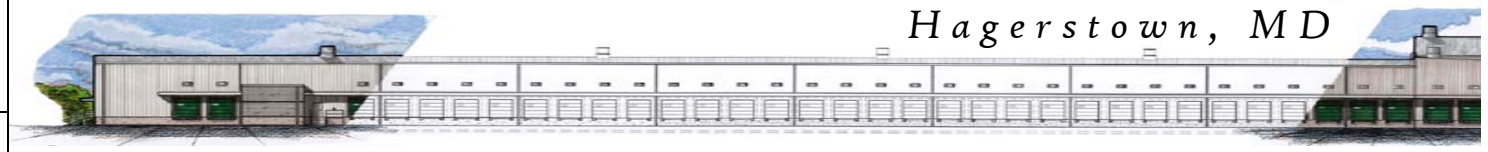

Current Design Adaptability

Building Element	Current Design	Analysis Recommendation
Foundations	Ext. wall ftgs: 7' x 1' reinforced (typ) Fdn. walls: 1' x 5.5' reinforced (typ)	Needs additional structural analysis, Modify walls to accept panels
Lateral Bracing System	Lateral bracing provided by horizontal purlins	Panel to Column connections need to be designed
Roof Structure	MR-24® Standing Seam Roof System	Roof to Panel connections need to be designed

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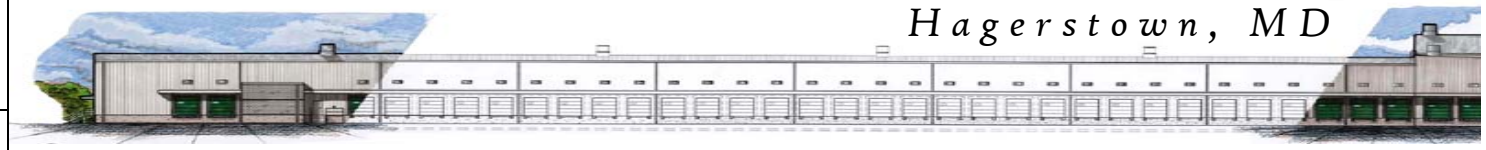
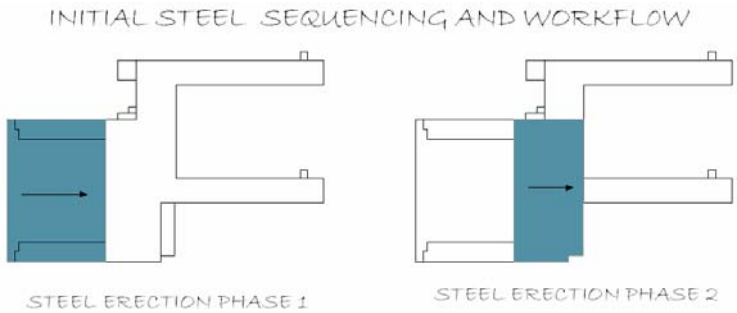
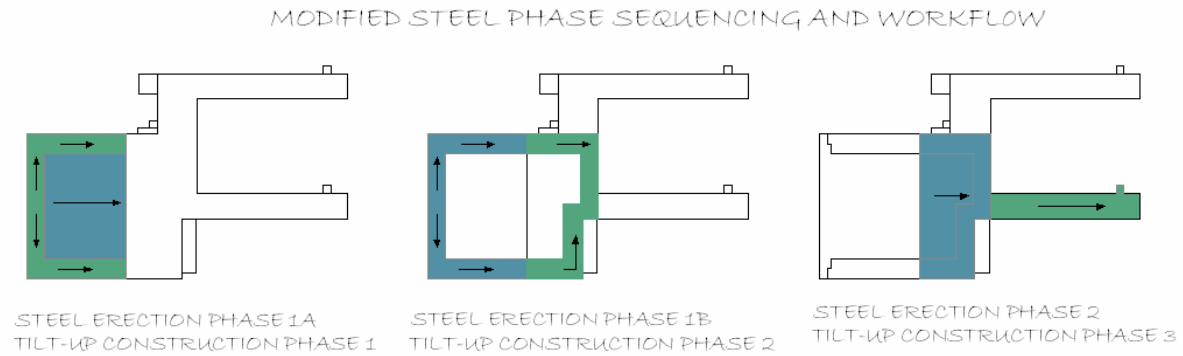


Panel Layout

- Panels should not occupy more than 75% - 80% floor area
- Panel sequencing requires increased planning





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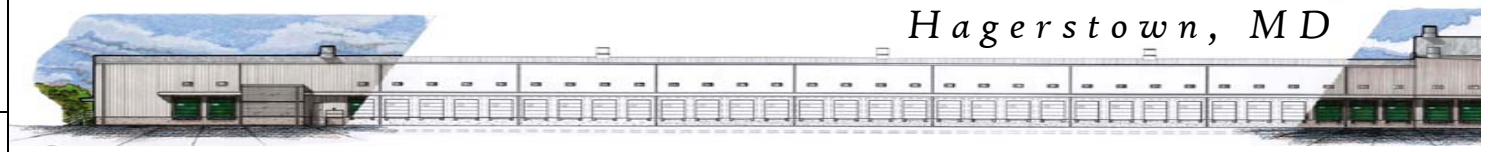

Enclosure Comparison

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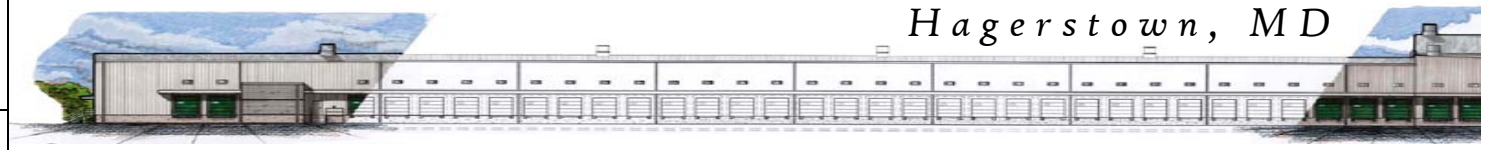
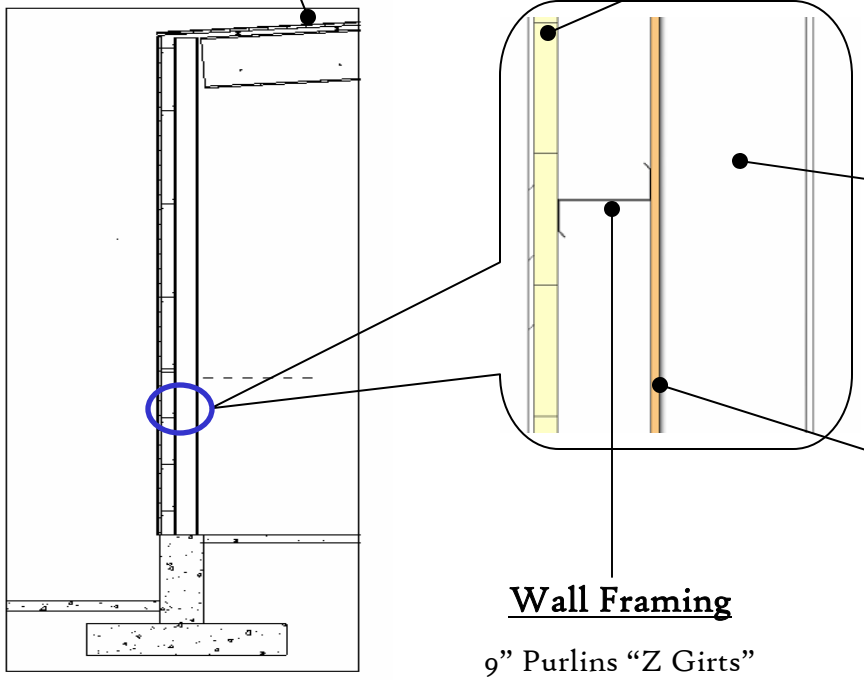


Pre-Engineered Enclosure System

Roof System

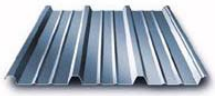
MR-24 ® Standing Seam Roof System



Wall Sheeting System

Butlerib® II Wall Sheeting

2" Blanket Insulation



Structural Members

W12 x 26, W14 x 43, W 14 x 61

Various Custom Shapes

Braced Frame

Interior Liner Panels

¾" CDX Fire Rated Plywood

Primed Both Sides

2 Coats of Paint on Exposed Face

Wall Framing

9" Purlins "Z Girts"

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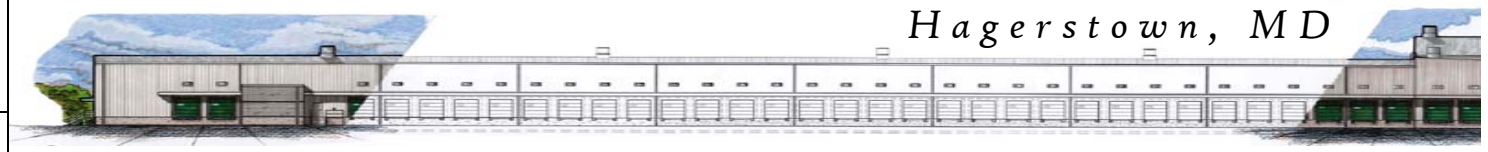

Pre-Engineered Cost Estimate

Activity Description / Area	Local City / Unload (4-10 / E-N)	Corridor (10-15 / E-N)	Loadwing A & Trans (15-34 / H.6-K.2)	Loadwing B (12-34 / A-E)	Loadwing Restrooms	Admin. Office	HUB Ops	Switchgear / Pump Room	Total
Concrete Footings	359.5	228.5	214.3	208.7	6.3	8.9	23.1	5.2	1,054.4
Concrete Foundation Walls / Piers	304.0	166.4	223.5	190.2	24.0	28.6	24.0	10.6	971.3
Structural Steel	69.4	23.0	82.9	55.0					230.3
Wall Sheeting System	217.7	44.2	207.8	152.6					622.3
Plywood Liner Panels	10.9	9.7	10.9	10.9					42.4
CMU Walls & Masonry Veneer					61.5	91.1	61.5	63.4	277.4
Total	**961.5**	**471.8**	**739.4**	**617.3**	**91.7**	**128.6**	**108.6**	**79.1**	**3,198.0**

* All costs are in thousands of dollars

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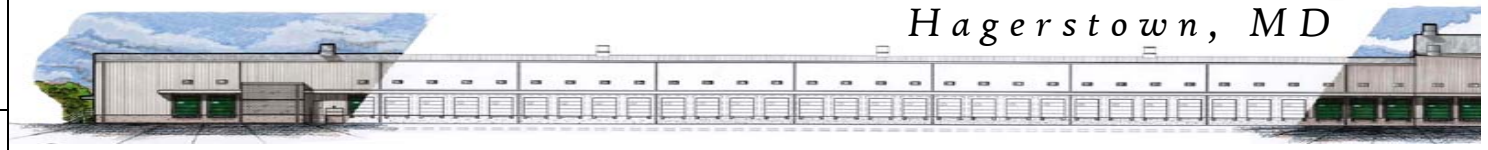
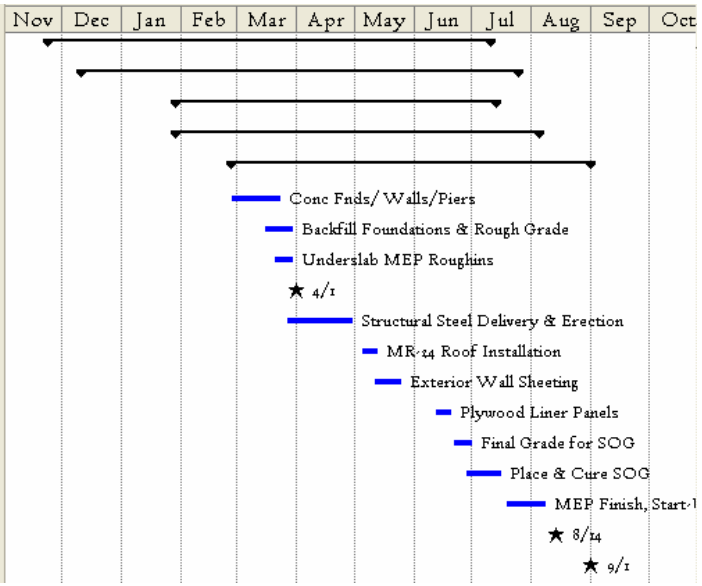


Pre-Engineered Steel Schedule

	Task Name	Duration	Start	Finish
1	**Local City / Unload (E-N / 4-10**	**229 d**	**11/24**	**7/10**
15	**Corridor (E-N / 10-15)**	**227 d**	**12/11**	**7/24**
29	**Load Wing 'B'**	**167 d**	**1/29**	**7/14**
43	**Load Wing 'A' Transition**	**189 d**	**1/29**	**8/5**
58	**Load Wing 'A'**	**187 d**	**2/27**	**9/1**
59	Conc Fnds/ Walls/Piers	25 d	2/27	3/22
60	Backfill Foundations & Rough Grade	15 d	3/15	3/29
61	Underslab MEP Roughins	10 d	3/20	3/29
62	Load Wing A Ready for Butler	0 d	4/1	4/1
63	Structural Steel Delivery & Erection	34 d	3/27	4/29
64	MR-24 Roof Installation	8 d	5/5	5/12
65	Exterior Wall Sheeting	14 d	5/11	5/24
66	Plywood Liner Panels	8 d	6/12	6/19
67	Final Grade for SOG	10 d	6/21	6/30
68	Place & Cure SOG	18 d	6/28	7/15
69	MEP Finish, Start-Up & Test	20 d	7/19	8/7
70	Load Wing A Complete	0 d	8/14	8/14
71	MS VI - Load Wing 'A' Ready for HK Syst	0 d	9/1	9/1



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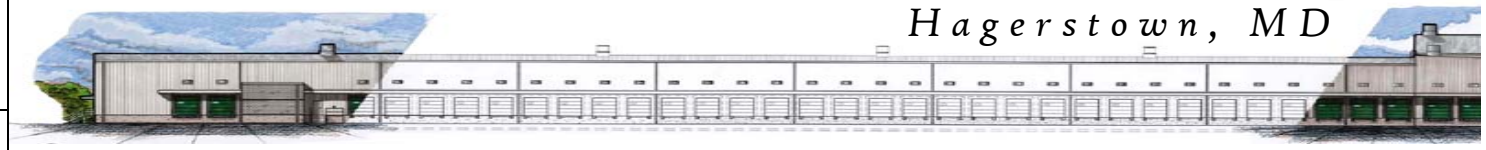


Tilt-Up Enclosure System

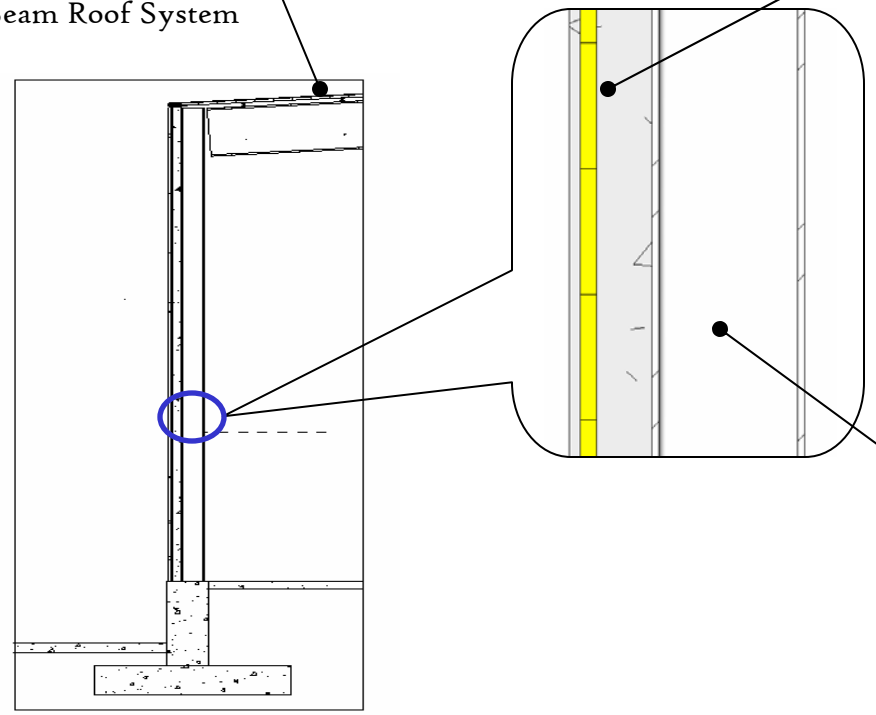
Roof System

MR-24® Standing Seam Roof System

Tilt-Up Panels

7 1/2" Insulated Panel with 1 ½" Rigid Insulation

Span from Dock Level to Roof



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W12 x 26, W14 x 43, W 14 x 61

Various Custom Shapes

Braced Frame

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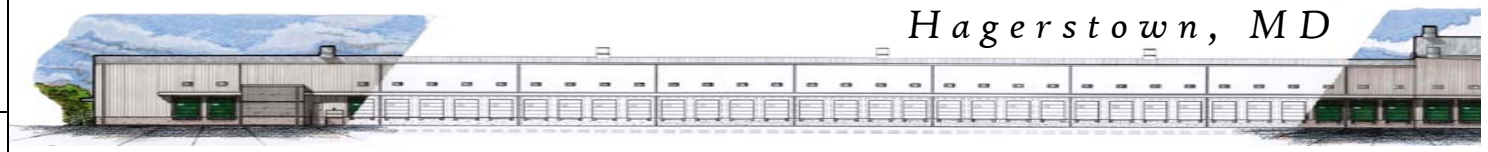

Tilt-Up Cost Estimate

Activity Description	Area: Local City / Unload (4-10 / E-N)	Corridor (10-15 / E-N)	Loadwing A & Trans A (15-34 / H.6-K.2)	Loadwing B (12-34 / A-E)	Loadwing Restrooms	Admin. Office	HUB Ops	Switchgear / Pump Room	Total
Concrete Footings	359.5	228.5	214.3	208.7	6.3	8.9	23.1	5.2	**1,054.4**
Concrete Foundation Walls / Piers	304.0	166.4	223.5	190.2	24.0	28.6	24.0	10.6	**971.3**
Tilt-Up Panels	544.3	110.7	519.3	381.5	54.9	63.5	68.8	44.7	**1,787.7**
Structural Steel	69.4	23.0	82.9	55.0					**230.3**
Wall Sheeting System									
Plywood Liner Panels									
Total	**1,277.2**	**528.6**	**1,040.0**	**835.4**	**85.2**	**101.0**	**115.9**	**60.5**	**4,043.7**

* All costs are in thousands of dollars

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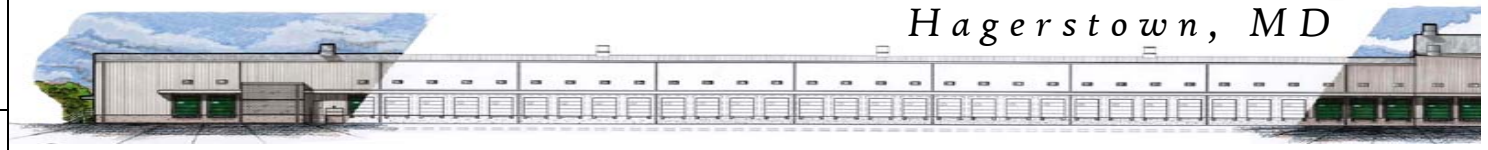
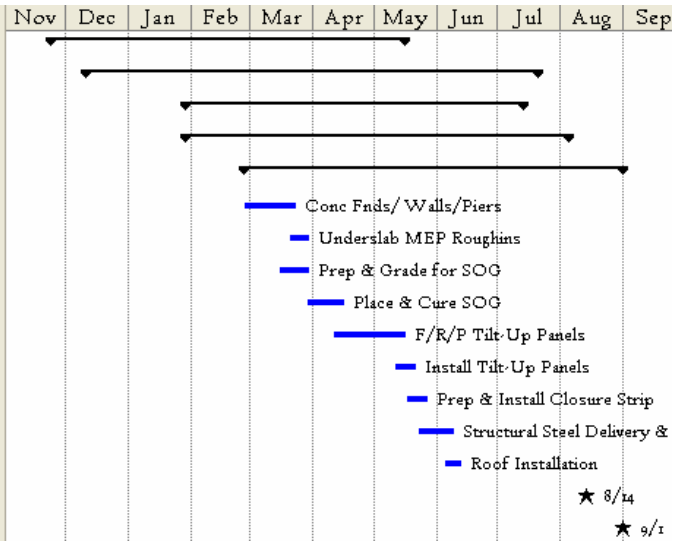


Tilt-Up Schedule

	Task Name	Duration	Start	Finish
1	**Local City / Unload (E-N / 4-10)**	**173 d**	**11/24**	**5/16**
13	**Corridor (E-N / 10-15)**	**223 d**	**12/11**	**7/21**
25	**Load Wing 'B'**	**167 d**	**1/29**	**7/14**
37	**Load Wing 'A' Transition**	**189 d**	**1/29**	**8/5**
49	**Load Wing 'A'**	**187 d**	**2/27**	**9/1**
50	Conc Fnds/ Walls/Piers	25 d	2/27	3/22
51	Underslab MEP Roughins	10 d	3/20	3/29
52	Prep & Grade for SOG	15 d	3/15	3/29
53	Place & Cure SOG	18 d	3/29	4/15
54	F/R/P Tilt-Up Panels	35 d	4/11	5/15
55	Install Tilt-Up Panels	10 d	5/11	5/20
56	Prep & Install Closure Strip	10 d	5/17	5/26
57	Structural Steel Delivery & Erection	17 d	5/23	6/8
58	Roof Installation	8 d	6/5	6/12
59	Load Wing A Complete	0 d	8/14	8/14
60	MS VI - Load Wing 'A' Ready for HK System:	0 d	9/1	9/1



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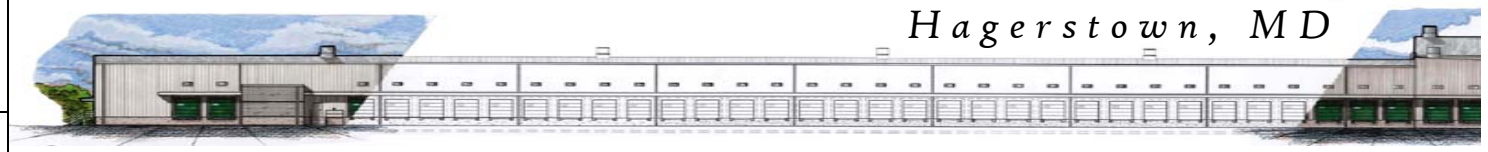

Pre-Engineered Steel vs Tilt-Up Concrete

	Pre-Engineered Steel	Tilt-Up Concrete
Cost	$3,198,000	$4,038,700
Schedule	12 Months	12 Months

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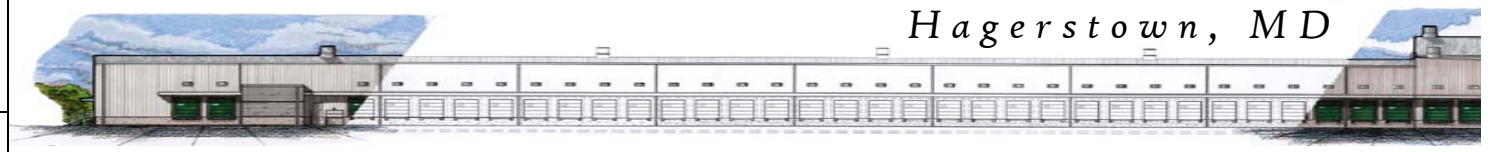

Lift Analysis

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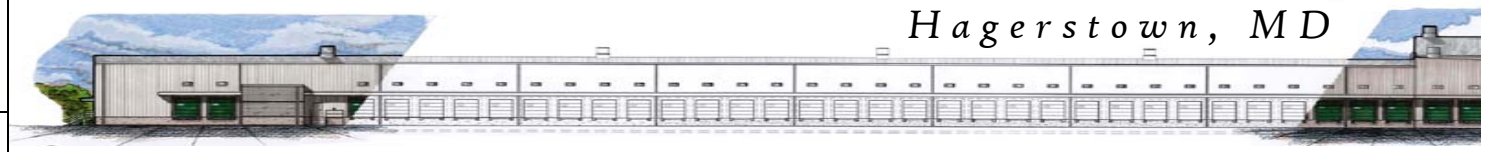
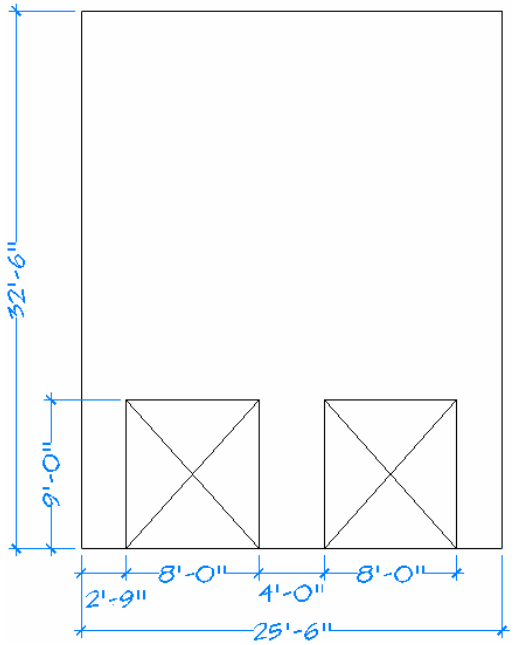


Initial Panel Design

Design Constraints

Panel Height	32' – 6"
Panel Width	25' – 6"
Total Panel Thickness	0' – 7 ½"
Insulation Thickness	0' – 1 ½"



Local City North & South
Initial Panel Sketch

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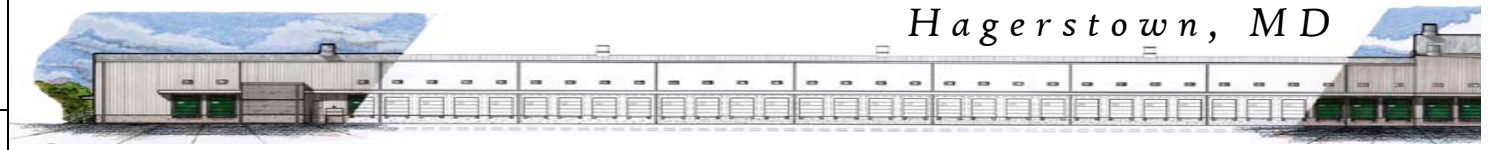
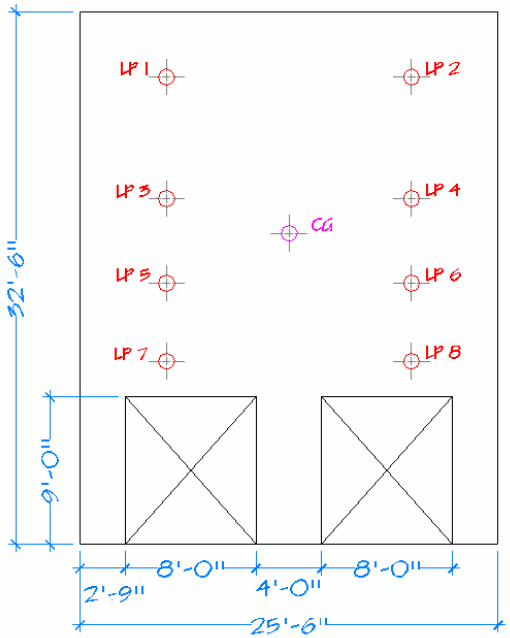


Panel Calculations

Design Calculations

Gross Panel Area	832.0 sq. ft.
Void Area	144.0 sq. ft.
Net Panel Area	688.0 sq. ft.
Panel Weight	51,600 lbs.



$$\#\text{ of lifting points} = \frac{\text{panel weight } (1.3)}{\text{insert capacity}}$$

$$\#\text{ of lifting points} = \frac{51{,}600 \text{ lbs. } (1.3)}{8{,}333 \text{ lbs}} = 8.05 \text{ inserts}$$

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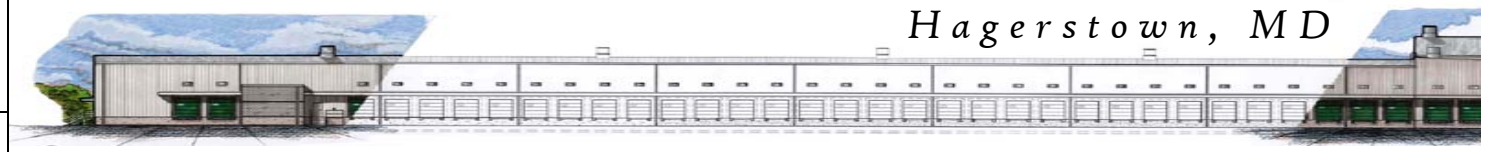
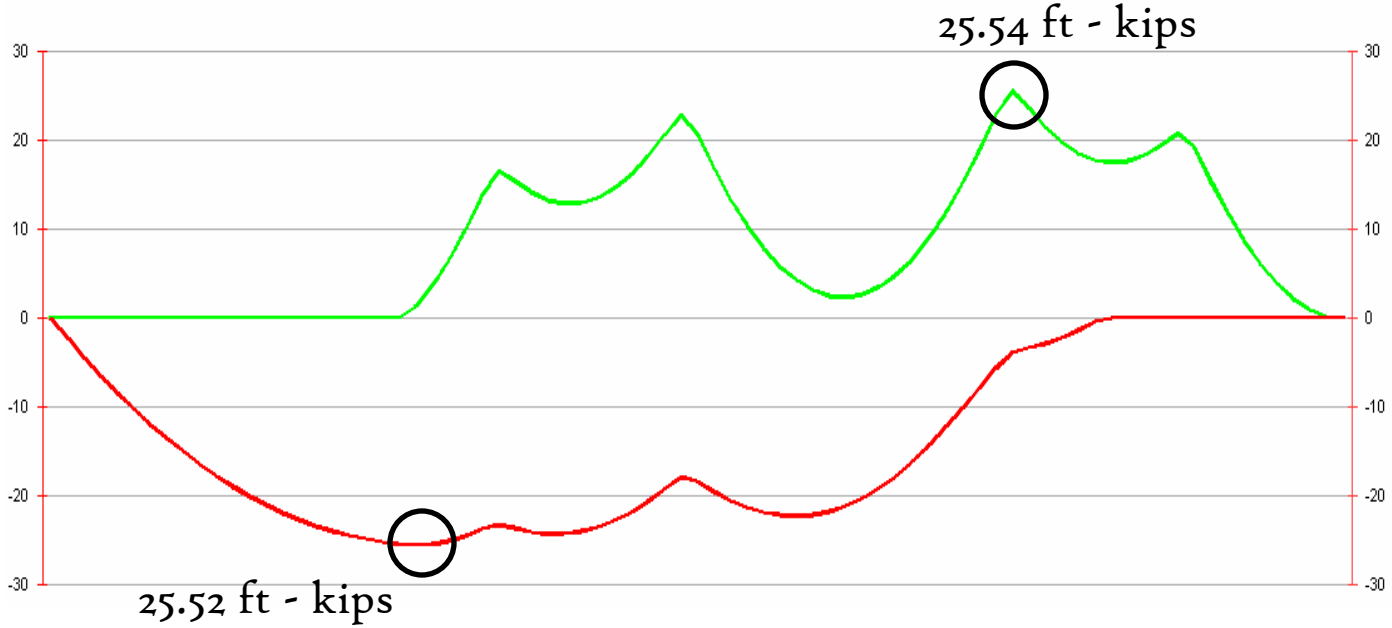


Panel Analysis



Bending Moment Envelope (ft – kips)

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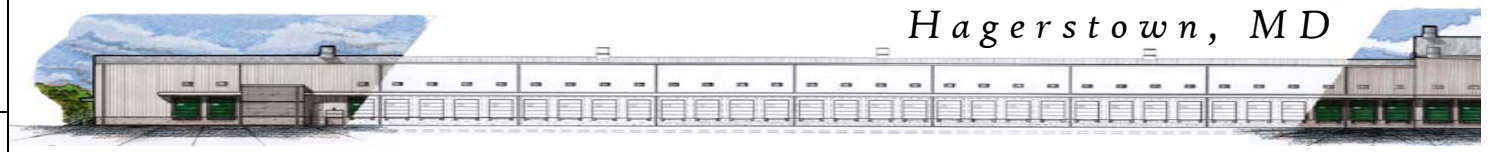
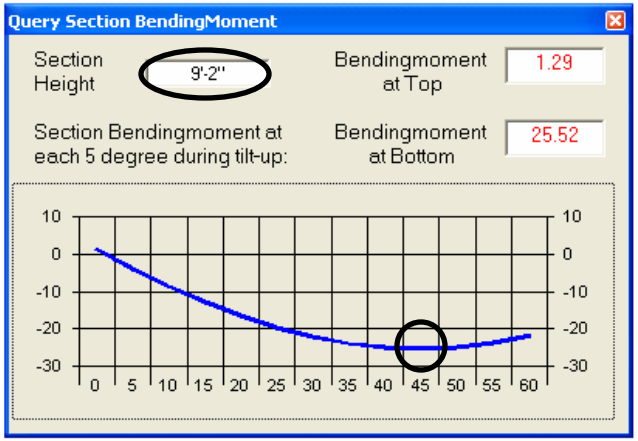
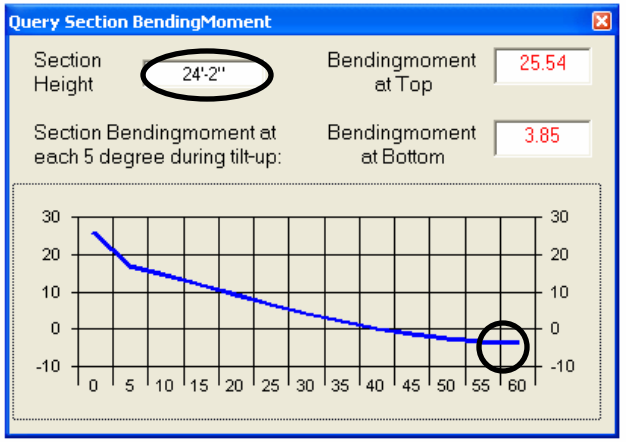


Panel Analysis





Allowable Bending Stress = 328 psi
Maximum Stress Imposed = 117.5 psi

328 psi < 117.5 psi ∴ OK for Lift

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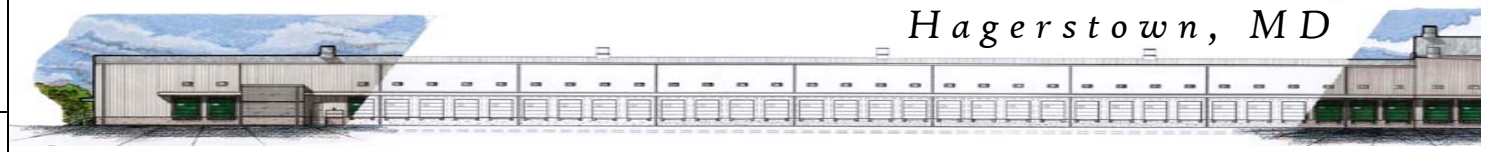

Conclusion

- Advanced models will be used as a communication tool for future projects

- Tilt-Up is feasible and compatible with FedEx Ground Distribution Facilities

- Tilt-up a viable alternative to a pre-engineered steel system

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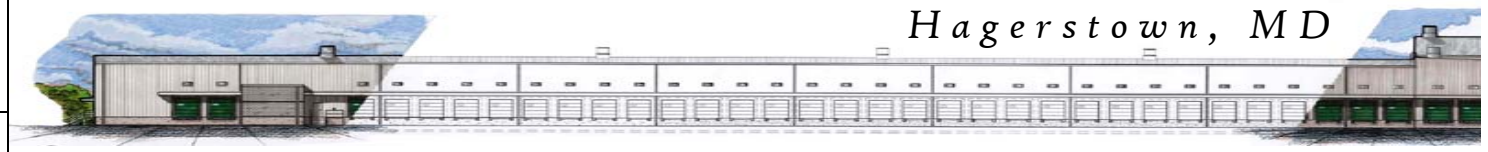

Acknowledgements

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Dr. John Messner

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Dr. Linda Hannagan

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John & Rebecca Klock

Elizabeth Schaut

Fellow AE students

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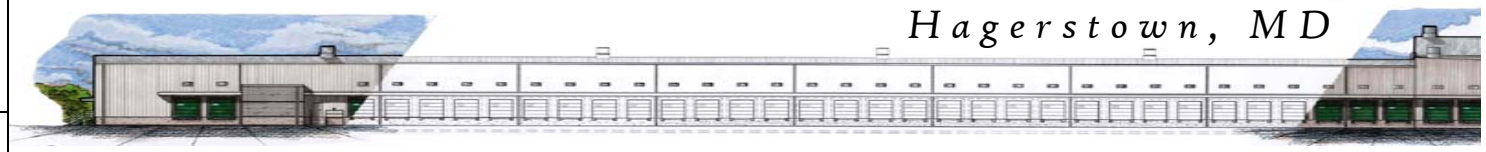
FedEx Ground Distribution Hub

Hagerstown, MD



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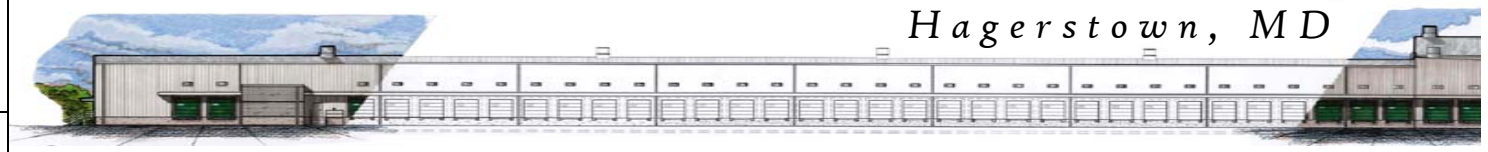
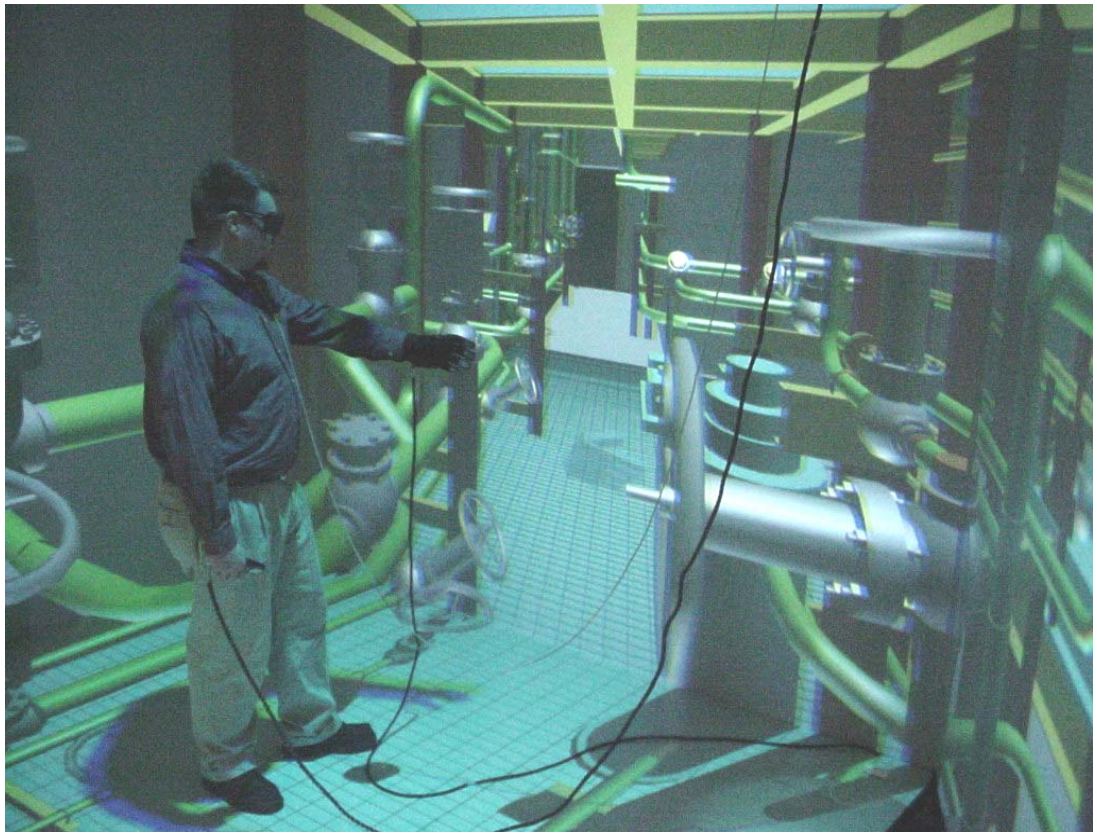


Virtual Prototyping



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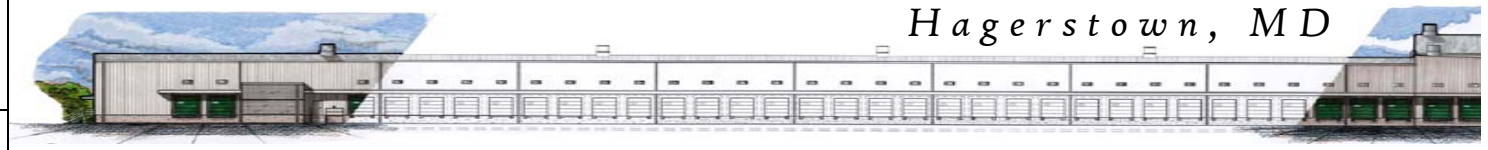
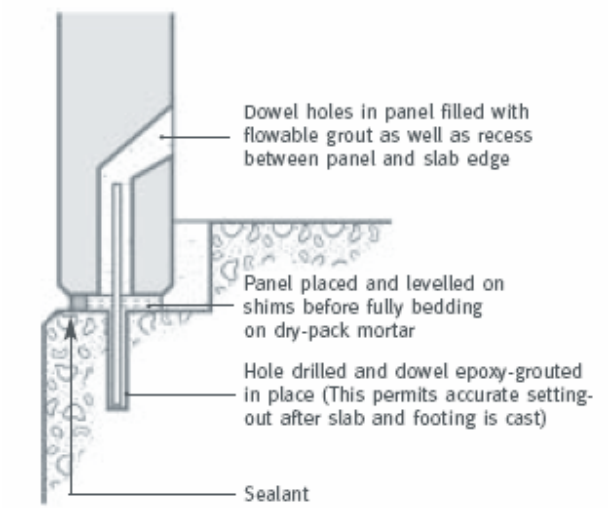
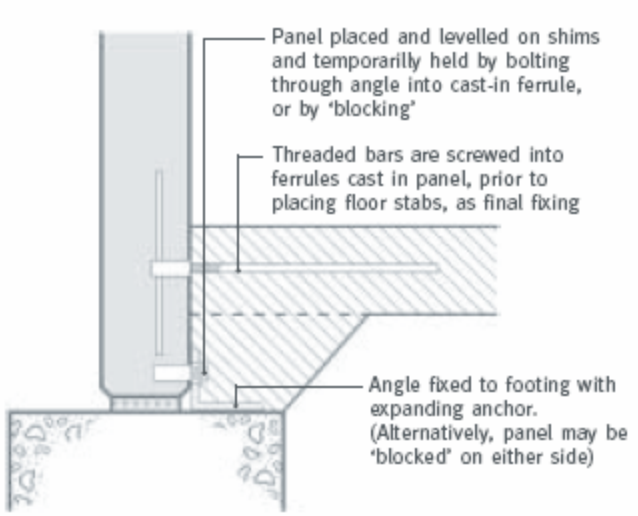


Foundation Modification



Panel to footing slab



Panel to strip/pad footing

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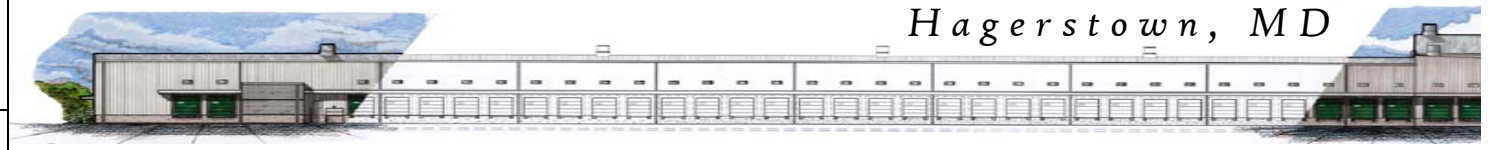
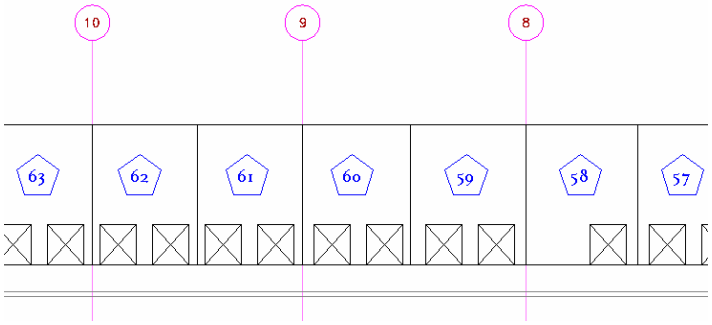


Panelizing the Building

Layout Constraints

- Locations where members frame into the panels
- Locations of openings
- At least 18" between openings
- Approximate panel weights



Local City - South Elevation (28 - 49)

Panel Number	Height (Ft.)	Width (Ft.)	Thickness (Ft.)	Area (Sq. Ft.)	Void Area (Sq. Ft.)	Net Area (Sq. Ft.)	Volume (Cu. Yds.)	Weight (Lbs.)	Weight (Tons)
28	32.50	17.25	0.50	560.6		560.6	10.4	42,047	21.0
29	32.50	23.25	0.50	755.6	100.3	655.3	12.1	49,151	24.6
30	32.50	25.50	0.50	828.8	152.8	676.0	12.5	50,698	25.3
31	32.50	25.25	0.50	820.6	76.4	744.2	13.8	55,818	27.9
32	32.50	25.67	0.50	834.2	152.8	681.4	12.6	51,104	25.6
33	32.50	25.25	0.50	820.6	152.8	667.8	12.4	50,089	25.0
34	32.50	25.67	0.50	834.2	152.8	681.4	12.6	51,104	25.6
35	32.50	25.25	0.50	820.6	152.8	667.8	12.4	50,089	25.0
36	32.50	25.25	0.50	820.6	76.4	744.2	13.8	55,818	27.9
37	"	"	"	"	"	"	"	"	"
38	32.50	25.75	0.50	836.9	152.8	684.1	12.7	51,307	25.7
39	32.50	24.75	0.50	804.4	152.8	651.6	12.1	48,870	24.4
40	32.50	24.00	0.50	780.0	152.8	627.2	11.6	47,042	23.5
41	32.50	24.00	0.50	780.0	152.8	627.2	11.6	47,042	23.5
42	32.50	24.00	0.50	780.0	152.8	627.2	11.6	47,042	23.5
43	32.50	24.00	0.50	780.0	152.8	627.2	11.6	47,042	23.5
44	32.50	24.00	0.50	780.0	152.8	627.2	11.6	47,042	23.5
45	32.50	24.00	0.50	780.0	152.8	627.2	11.6	47,042	23.5
46	32.50	26.08	0.50	847.7	100.3	747.4	13.8	56,057	28.0
47	32.50	24.00	0.50	780.0		780.0	14.4	58,500	29.3
48	32.50	24.00	0.50	780.0		780.0	14.4	58,500	29.3
49	32.50	11.08	0.50	360.2		360.2	6.7	27,016	13.5

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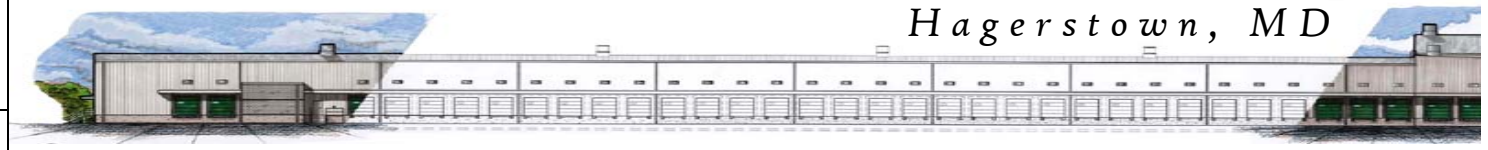
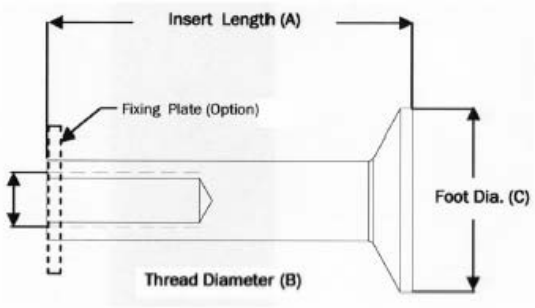


Panel Insert

DUCTILE FERRULE INSERT

- Designed to give additional load strength in concrete
- Anchors can be used for lifting/handling or fixing and mounting for structural purpose.
- Based of 4:1 Safety Factor, although it factor can be lowered to 3:1 (consult UFC).
- The large foot creates a large shear cone in concrete.



DUCTILE FERRULE INSERT

Bolt Diameter (B)	Insert Length (A)	Min. Ultimate Strength	SWL 4:1 (Steel)	Foot Dia. (C)	Safe Work Load* (Concrete 4:1)		Minimum Edge Distance	Part Number
					Tension	Shear		
in.	in.	lbs	lbs	in.	lbs.	lbs.	in.	
1/2	4.00	19000	4750	2.00	3750	4500	8.00	NCFFI12
5/8	4.50	28000	7000	2.25	6250	7500	8.50	NCFFI58
3/4	5.00	37600	9400	2.75	6000	7200	9.00	NCFFI34
3/4	10	37600	9400	1.80	9000	10800	12.00	NCFFI3410
3/4	12	37600	9400	1.80	9000	10800	12.00	NCFFI3412
7/8	6.00	54000	13500	3.15	9000	10800	10.50	NCFFI78
1	6.50	60000	15000	3.15	10000	12000	10.50	NCFFI1

*Based on 4:1 Safety Factor and minimum capacity strength of 3500 psi with a full shear cone. Concrete Material: 1522

For connecting, the bolt or rod connection must be equal to a Grade 8 or higher.