George Mason University PE Building Renovation & Expansion

Fairfax, Virginia

Brenton Decker
The Pennsylvania State University
Construction Management

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George Mason PE Building

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Project Overview

Total Cost: $29 million

Size: 116,166 sf (2 stories) - 49,240 sf of renovation
66,926 sf of new construction

Dates of Construction: October 2007 – May 2009

Function: Multi-functional Recreational Facility

Building: 3-gymnasiums, squash/racquetball courts, strength-training facility, admin. Offices, juice bar & lounge area, locker rooms

Project Overview

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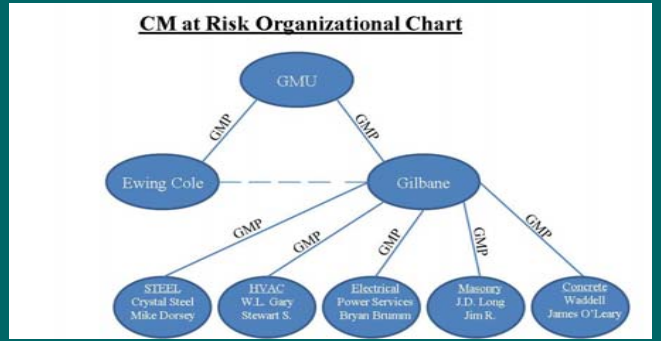
Project Overview

Project Overview

Project Team

Owner: George Mason University
Architect: Ewing Cole
CM: Gilbane Building Co.
Civil Engineer: Christopher Consultants
MEP Engineer: Ewing Cole
Landscape Architect: Lewis Scully Gionet
Audio/Visual Consultant: PMK Consultants

Project Delivery Method: CM @ Risk



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Project Overview

Structure: Shallow spread footings and strip footings, Structural Steel

Façade: Brick w/ CMU backup, Curtain wall, Storefront windows, and Metal panels

Architecture: Very Modern compared to rest of campus. Meant to be somewhat of a signature building

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Schedule Acceleration of Steel Erection

Problem:

- Project behind schedule

Goal:

- Make up some of the lost time
- Provide a more efficient work flow

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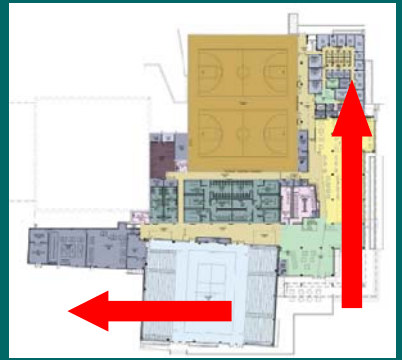
Schedule Acceleration of Steel Erection



Schedule Acceleration of Steel Erection

Original Schedule	86 days	Tue 3/11/08	Tue 7/8/08
New Gym Underground	8 days	Tue 3/11/08	Thu 3/20/08
Mech. Underground	15 days	Mon 3/17/08	Fri 4/4/08
New Gym SOG	5 days	Tue 3/25/08	Mon 3/31/08
East Wing Underground	20 days	Mon 3/31/08	Fri 4/25/08
New Gym Steel	25 days	Fri 4/4/08	Thu 5/8/08
Mech. Steel	15 days	Thu 4/17/08	Wed 5/7/08
East Wing SOG	15 days	Fri 4/18/08	Thu 5/8/08
East Wing Steel	40 days	Wed 5/14/08	Tue 7/8/08

Original Steel Erection Time: 65 work days

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Schedule Acceleration of Steel Erection

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New Gym Underground	8 days	Tue 3/11/08	Thu 3/20/08
Mech. Underground	15 days	Mon 3/17/08	Fri 4/4/08
New Gym SOG	5 days	Tue 3/25/08	Mon 3/31/08
East Wing Underground	20 days	Mon 3/31/08	Fri 4/25/08
New Gym Steel	25 days	Fri 4/4/08	Thu 5/8/08
Mech. Steel	15 days	Thu 4/17/08	Wed 5/7/08
East Wing SOG	15 days	Fri 4/18/08	Thu 5/8/08
East Wing Steel	40 days	Wed 5/14/08	Tue 7/8/08

Original Steel Erection Time: 65 work days

Schedule Acceleration of Steel Erection

Accelerated Schedule	77 days	Tue 3/11/08	Wed 6/25/08
New Gym Underground	8 days	Tue 3/11/08	Thu 3/20/08
Mech. Underground	15 days	Mon 3/17/08	Fri 4/4/08
New Gym SOG	5 days	Fri 3/21/08	Thu 3/27/08
East Wing Underground	10 days	Mon 3/31/08	Fri 4/11/08
New Gym Steel	25 days	Fri 4/4/08	Thu 5/8/08
Mech. Steel	15 days	Thu 4/17/08	Wed 5/7/08
East Wing SOG	15 days	Fri 4/4/08	Thu 4/24/08
East Wing Steel	40 days	Thu 5/1/08	Wed 6/25/08

Accelerated Steel Erection Time: 56 work days

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Schedule Acceleration of Steel Erection

Affected Work

- New East Wing Underground
- New East Wing SOG
- Gilbane's Office

Schedule Acceleration of Steel Erection

Steel Erection Crew

Crew E-7	Hr.	Daily
1 Structural Steel Foreman	$46.70	$373.60
4 Struc. Steel Workers	$44.70	$1,430.40
1 Equip. Operator	$42.55	$340.40
1 Equip. Operator Oiler	$36.80	$294.40
1 Welder Foreman	$46.70	$373.60
2 Welders	$44.70	$715.20
1 hydraulic Truck Crane, 80 Ton		$1,296.00
2 Welders, gas engine, 300 Amp		$268.40
80 L.H., Daily Totals		$5,092.00

Underground Work Crew

Crew B-17A	Hr.	Daily
2 Laborer Foremen	$33.60	$537.60
6 Laborers	$31.60	$1,516.80
1 Skilled Worker Foreman	$42.85	$342.80
1 Skilled Worker Foreman	$40.85	$326.80
80 L.H., Daily Totals		$2,724.00

Total Added Cost: $212,000

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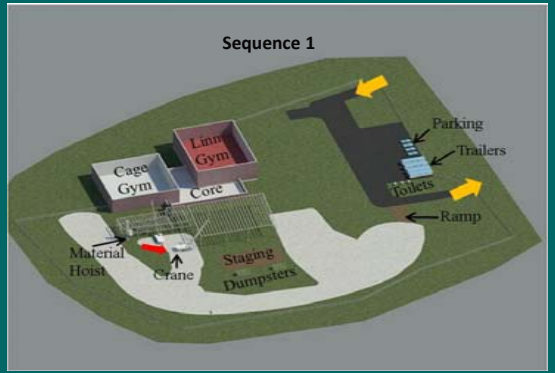
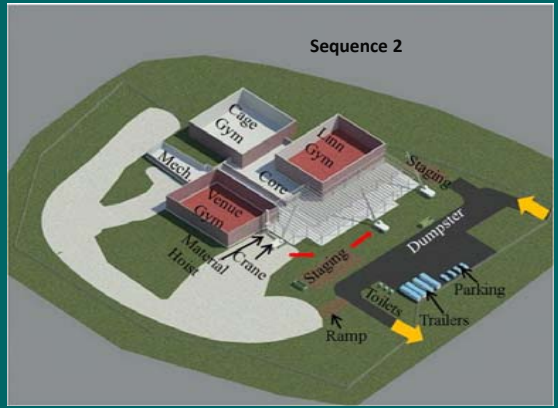
Schedule Acceleration of Steel Erection



Schedule Acceleration of Steel Erection



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Schedule Acceleration of Steel Erection

Conclusions:

- Acceleration of New East Wing Steel save 9 work days
- Added costs to accelerate schedule are $212,000
- Cost too high for small schedule savings, don't implement

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Mechanical Analysis: Fabric Duct System

Problem:

- Metal duct reduces aesthetics
- Costly when compared to other alternative
- Hard to keep clean

Goal:

- Provide a healthier and more aesthetically pleasing space
- Reduce cost and installation time

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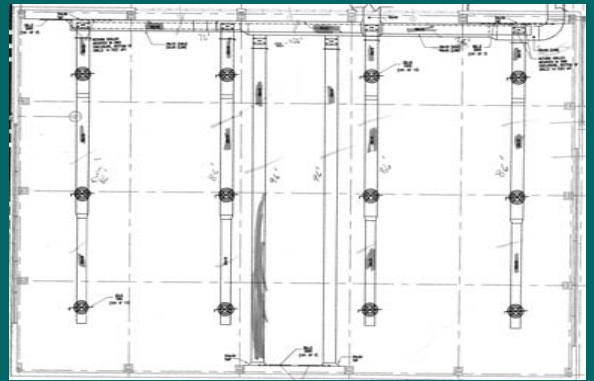
Mechanical Analysis: Fabric Duct System



Mechanical Analysis: Fabric Duct System

Design Conditions

- 24 ga. Galvanized steel
- 30 ft. above finished floor
- 23,000 cfm Rooftop AHU
- Minimum OA supplied @ 70%

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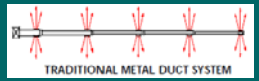
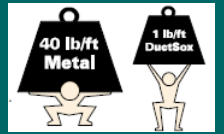
Mechanical Analysis: Fabric Duct System

- Aesthetics
- Superior Air Dispersion
- Little Balancing
- Easy Installation
- Hygienic
- Cleanable

Mechanical Analysis: Fabric Duct System





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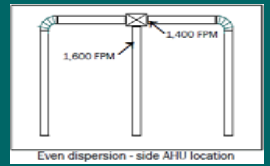
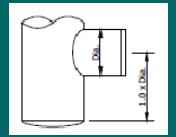
Mechanical Analysis: Fabric Duct System

Verona Fabric w/ Comfort Flow

Diameter	Inlet Velocity			
	1,000	1,200	1,400	1,600
54	15,904	19,085	22,266	25,447



Take off Tees



1.5 x Dia away from endcap = 6'9"

Mechanical Analysis: Fabric Duct System

Fabric Airflow

Q_{Fabric} = FP x SA x (AP/0.5)

=1.5x6579x(.5/.5)

= 9868 cfm

Throw – Directional Airflow

9&3 and 4&8 o'clock chosen

Throw required for 4&8 o'clock

(Height – 6) x 2.00 = Throw

(30 – 6) x 2.00 = 48 fpm

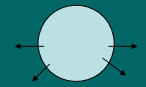
L-Vent Sizing

$$TVS = \left(\frac{Q_{vent}}{(Length) \times \sqrt{(AP/0.5)}}\right)$$

Q_{vent} = 5160 cfm

Vent Size	AP (in w.g.)	Airflow (CFM/ea)	Distance (ft) to Velocity (FPM)		
			150	100	50
15	0.25	10.6	8	12	18
	0.50	15.0	11	16	26
	0.75	18.4	13	20	32
	1.00	21.2	15	23	37

Vent Detail



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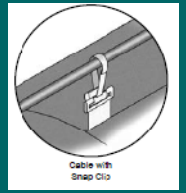
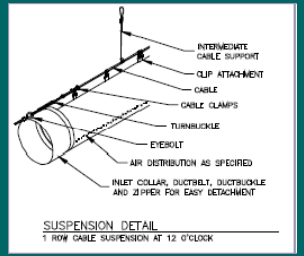
Mechanical Analysis:
Fabric Duct System

Suspension

- 2-row Tension Cables





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Mechanical Analysis: Fabric Duct System

Metal Duct	Cost	Fabric Duct	Cost
Supply	$35,990.47	Supply	$21,383.20
Return	$27,234.40	Return	$27,234.40
Total Cost	$63,224.87		$48,617.60
Savings			**$14,607.27**

Mechanical Analysis: Fabric Duct System

Fabric Duct Installation	
Activity	**Time (hrs)**
Inlet connection	1
Cable Suspension & hang duct	42.16
Add 20% for diameter 41-60"	8.43
Total	51

* Note installation time based on 2 man crew

Duct Installation Time	
Metal Supply Duct	12 days
Fabric Supply Duct	6.5 days
Savings	**5.5 days**

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Mechanical Analysis: Fabric Duct System

Conclusions:

- Fabric duct has many benefits over metal duct
- Cost savings of $14,607
- Schedule savings of 5.5 days

- Fabric duct is a feasible alternative

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Structural Analysis: Reducing Roof Beam Sizes

Problem:

- Roof overdesigned for mechanical loading

Goals:

- Reduce roof beam sizes
- save money due to the size reduction

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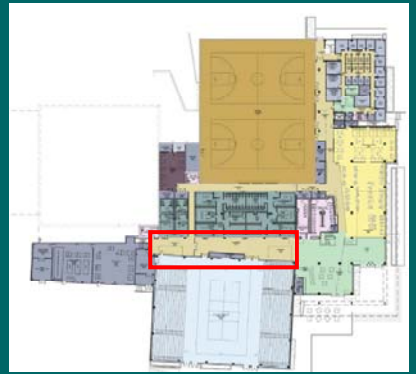
Structural Analysis: Reducing Roof Beam Sizes



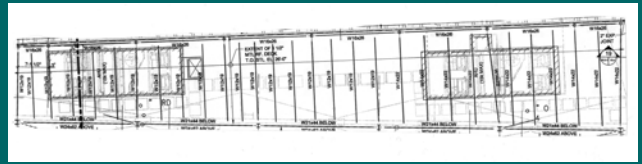
Structural Analysis: Reducing Roof Beam Sizes

W14 x 22 beams

W12 x 19 beams

(2) 8,000 lb AHU's

Mechanical design loading – 75psf



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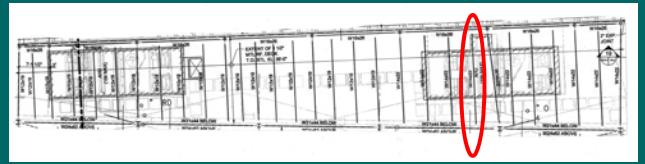
Structural Analysis: Reducing Roof Beam Sizes



Structural Analysis: Reducing Roof Beam Sizes

Dead Loads	Weight (psf)	Snow Loads	Weight (psf)
Misc. dead load	15	Snow load	30
AHU	6.4	Snow drift load	65
3-ply roofing	1		
Rigid Insulation	0.75		
20 ga. Metal deck	2.5		
ACT ceiling tile	1		

V_{max} = 11.5 kips

M_{max} = 48.6 ft-kips

From Steel Manual

W12 x 14 can be used

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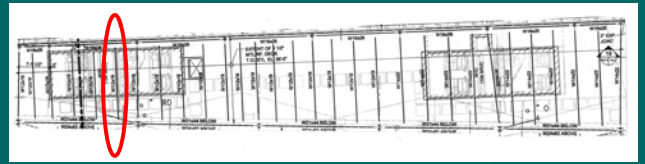
Structural Analysis: Reducing Roof Beam Sizes



Structural Analysis: Reducing Roof Beam Sizes

Dead Loads	Weight (psf)	Snow Loads	Weight (psf)
Misc. dead load	15	Snow load	30
AHU	8.6	Snow drift load	65
3-ply roofing	1		
Rigid Insulation	0.75		
20 ga. Metal deck	2.5		
ACT ceiling tile	1		

V_{max} = 9.25 kips

M_{max} = 30.8 ft-kips

From Steel Manual

W12 x 14 can be used

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Structural Analysis: Reducing Roof Beam Sizes

Cost comparison using MC²

- 30 beams total

Roof Beams	Cost
Original Roof Members	$70,071.69
Reduced Members	$54,486.42
Savings	**$15,585.27**

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Structural Analysis: Reducing Roof Beam Sizes

Conclusions:

- Mechanical loads on concerned roof don't exceed 29 psf
- Beams can all be reduced to W12 x 14's
- Cost savings of $15,585

Reducing these beam sizes is a feasible alternative

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Industry Research: BIM Implementation

Problem:

- Complex facades consisting of 9 different types
- Connection details and constructability not clearly defined
- Several change orders & many coordination meetings regarding issue

Goals:

- Show that BIM could have been beneficial to this process
- Determine cost of implementing BIM for GMU
- Determine why BIM isn't used more often in the industry

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Industry Research: BIM Implementation

Benefits
- Better Coordination between trades
- Find problems before built in field
- Reduce change orders

Cost of Implementing BIM
- .5 % of the overall construction cost
- Would cost $120,000 to implement

Why BIM is slow to catch on
- Struggle over who should pay for BIM on projects
- Recommend cost be divide equally amongst benefiting parties

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Industry Research: BIM Implementation

Conclusions:

- BIM provides many benefits that make it worth the investment
- Would cost $120,000 to implement on GMU
- Cost should be divided equally among benefiting parties

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Summary & Conclusions

Schedule Acceleration

-Would cost $212,000 to accelerate

- Saves 9 work days

- Site slightly more congested

Mechanical Analysis

-Fabric duct has many benefits over metal

- Cost savings of $14,607

- Schedule savings of 5.5 days

Summary & Conclusions

Structural Analysis

-Beams reduced to W12 x 14's

- Cost savings of $15, 585

Industry Research: BIM

-Would cost $120,000 to implement

- Cost should be divided between benefiting parties

- Benefits outweigh costs

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Acknowledgements

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AE Faculty & Staff

Family & Friends

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Questions

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