Coppin State University
Physical Education Complex

Baltimore, MD

Coppin State University
Physical Education Complex

Baltimore, MD

Todd Drager

Structural Option

Faculty Consultant: Lepage

Coppin State University
Physical Education Complex

Baltimore, MD

Topic Overview

Coppin State University Physical Education Complex

Topic Overview

Introduction

-Building Information

-Existing Systems

-Proposal

Structural Depth

-Lateral System redesign

-Gravity System Modifications

Architectural Breadth

CM Breadth

Conclusion

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Building Information

Owner: Maryland Stadium Authority

Architect: Conchran, Stephenson & Donkervoet, inc.

Associate Architect: Sasaki Associates, inc.

Structural Engineer: Hope Furrer, Associates, inc.

Mechanical Engineer: James Posey Associates, inc.

Electrical Engineer: Diversified Engineering, inc.

Civil Engineer: Site Resources, inc.

CM Firm: Gilbane Building Co

Coppin State University Physical Education Complex

Building Rendering

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Building Information

Owner: Maryland Stadium Authority

Location: North Baltimore (Baltimore City)

Height: Varies 30'-60'

Size: 155,200 Sqft.

Expected Completion: 2009

Project Delivery Method: Design-Bid Build

Estimated Cost: $102 million

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Building Information

Exterior: red brick, glass

-Exposed steel trusses over 4100 seat arena

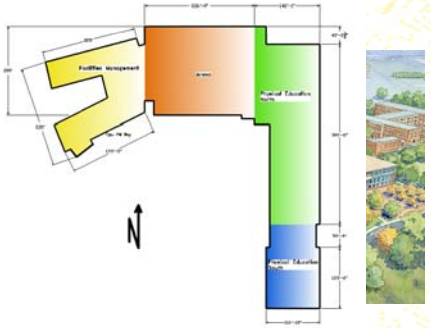
-Spaces Include basketball arena, 8-lane swimming pool, racquetball courts, gym, classrooms, management facilities

-Surrounds Soccer Field

-Structurally sub-divided by 3 expansion joints

Coppin State University Physical Education Complex

Building Rendering



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Coppin State University Physical Education Complex

Existing Structural Systems

-Composite Steel Floor System

-W-shapes widespread as Beams and Columns

-Typical Beam Spacing @10'

-Typical Girder Spacing @31'

-Concrete Strength f'c=4000psi

-Lateral System Composed of Braced Frames and Moment Frames

-Foundation Composed of Spread Footings

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Building Plan

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Existing Arena Structural Systems

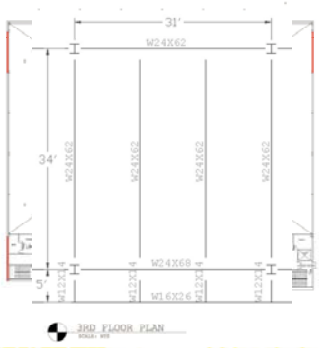
-Columns: W

-Floor Heigl

-Braced Fra

-Moment Fr

-Roof Truss



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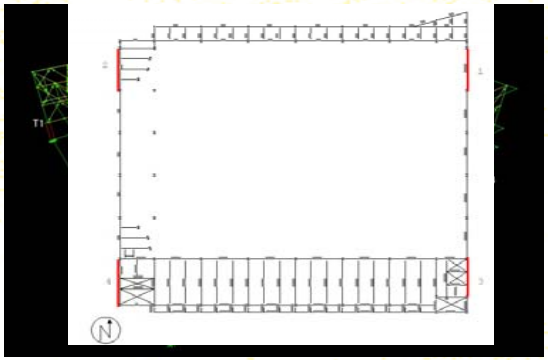
Building Plan



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Proposal

-Both Gravity and Lateral Systems proved successful

-Baltimore City has been underfunded and slow to update buildings

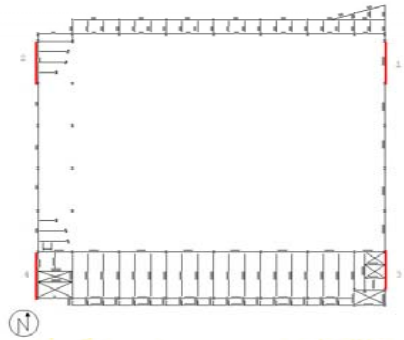
-Goal was to revitalize the area and improve architecture by changing structural elements

-Primary Focus: Arena Trusses

-Breadths: Architecture, Construction Management

Coppin State University Physical Education Complex

Building Plan



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Architectural Breadth Intro

-Goal: Make Arena more prominent

-Current Height: 60'

-Surrounding Building Heights: 30'-60'

-Current Arena Capacity: 4100

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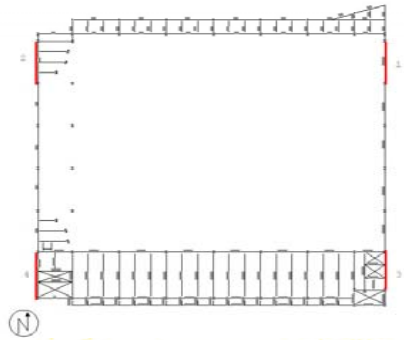
Building Plan



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Architectural Breadth Intro

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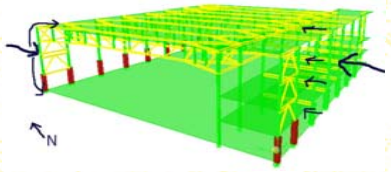
Lateral System Redesign

-Current Moment Frames(N-S) use heavy, expensive shapes

-Replacing with shear walls could save money



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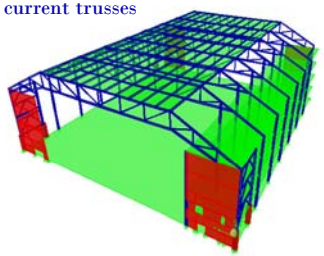
Lateral System Redesign

-Trusses use similar formation as current trusses

-Shear Walls at 4 corners

-Few openings due to doors

-Roof diaphragm shuffles load into shear walls



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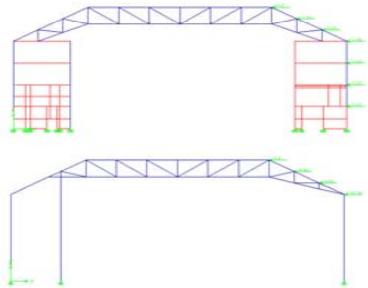
Lateral System Redesign



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Roof Trusses

-Trusses different for interior and exterior

-Sized using ETABS and SAP and checked by hand

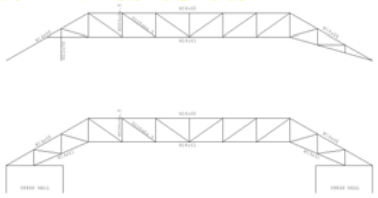
-Designed with both lateral and gravity load

-Typical Members:

W14x68

W14x61

HSS6x6x.5



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Shear Walls

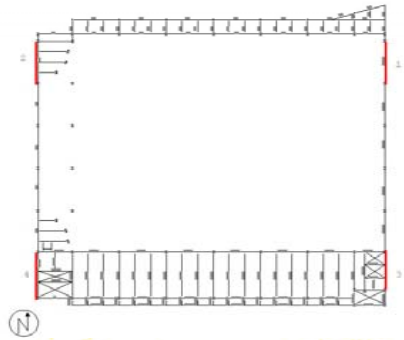
-Governing Load Combination: 0.9D +1.6W

Wind Load Paths (From North) Total Input Load=208.3k x 1.6= 333.3k				
Load Case	Wall Element	Shear(k)	Overturning Moment('k)	Drift
4	1	15	622	0.11
	2	9.3	139	0.09
	3	153.5	5413	0.23
	4	141.6	**7783**	0.27
	Total	319.4		

Wind Load Paths (From South) Total Input Load=281.9k x 1.6= 451k				
Load Case	Wall Element	Shear(k)	Overturning Moment('k)	Drift
11	1	**33.7**	5450	0.15
	2	**36.3**	1300	0.12
	3	**183.5**	5450	0.31
	4	**184.4**	6850	0.36
	Total	437.9		

Coppin State University Physical Education Complex

Structural Modifications



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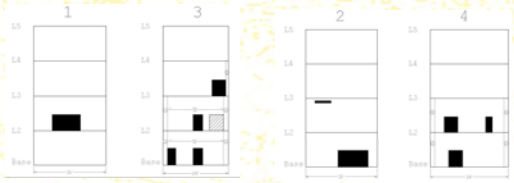
Shear Walls

-All Reinforcement #4 @ 20in. o.c. except where noted



*Area 1: Contains 2#7 at the end and 2 sets of 2#4 spaced at 10"

*Area 2: Contains 2#5 at 10in. o.c.

*Area 3: Contains #4 at 10in. o.c

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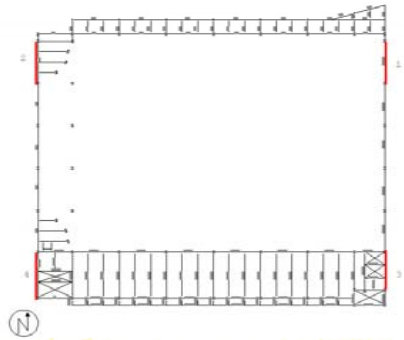
Structural Modifications



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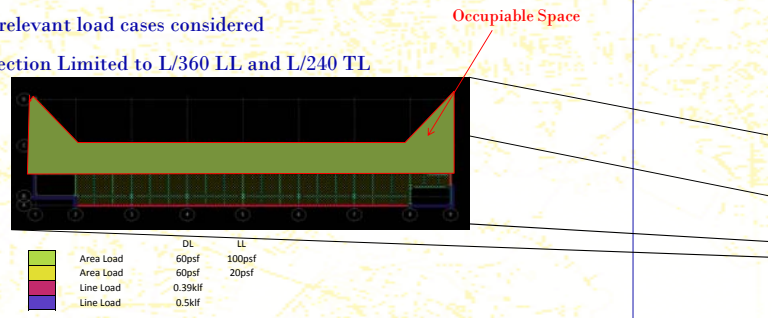
Additional 5th Floor

Use RAM Structural System to analyze new floor

-All relevant load cases considered

Deflection Limited to L/360 LL and L/240 TL



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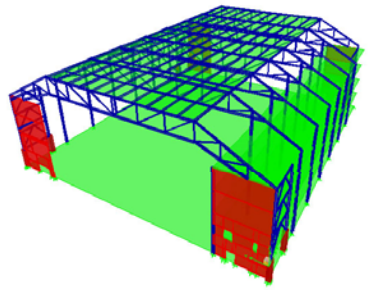
Typical Framing Plan



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Girder Optimization

Under the assumption that cost of 10lb. Of steel ~ 1 shear stud

5th Floor Girder Optimization

	Span	Moment('k)	Shear(k)	Section	# Studs	Total Equiv
G1	31'	346.24	33.63	~~W16x26~~	40	1206
				W18x35	16	1245
				W16x31	27	1231
G2	Span	Moment	Shear	Section	# Studs	Total Equiv
	38.3'	230.25	19.48	~~W16x26~~	16	1156
G3	Span	Moment	Shear	Section	# Studs	Total Equiv
	31'	180.36	24.4	W12x19	31	899
				W14x22	16	842
G4	Span	Moment	Shear	Section	# Studs	Total Equiv
	34'	292.75	31.33	**W18x40**	11	1470
G5	Span	Moment	Shear	Section	# Studs	Total Equiv
	34'	257.09	24.99	W14x22	36	1042
				~~W16x26~~	16	966
				W16x31	14	1101

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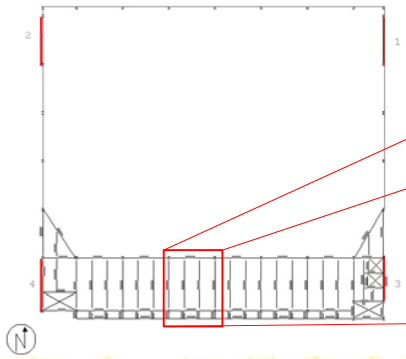
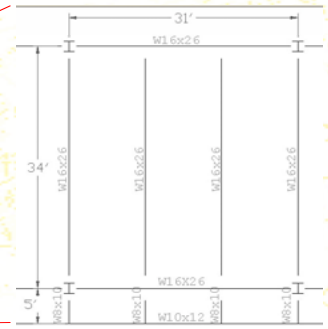
5th Floor Framing Plan



Coppin State University Physical Education Complex

Typical Framing Plan



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Architectural Breadth

USC - The Coliseum

Duke – Cameron Indoor Stadium

OSU – The Horseshoe

UNM - The Pit

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New Plans

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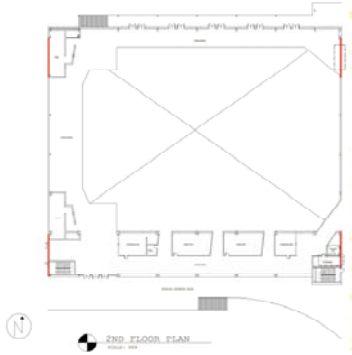

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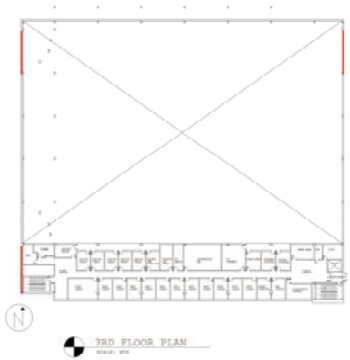

3RD FLOOR PLAN

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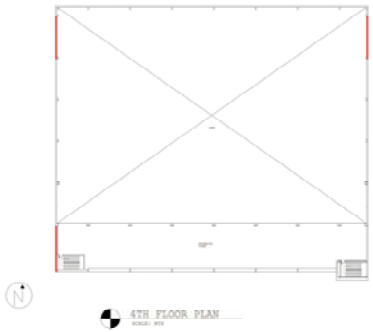

4TH FLOOR PLAN

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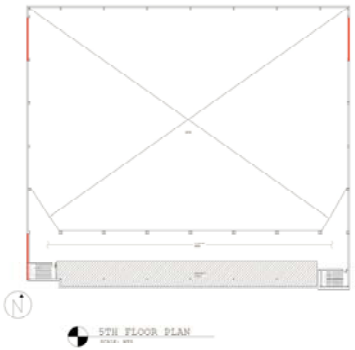
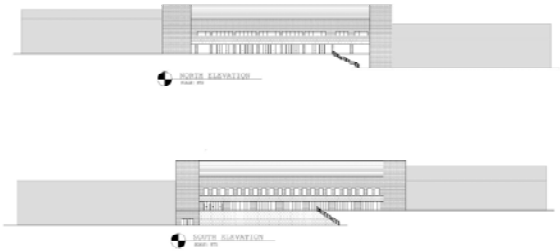


Coppin State University Physical Education Complex

Existing Elevations



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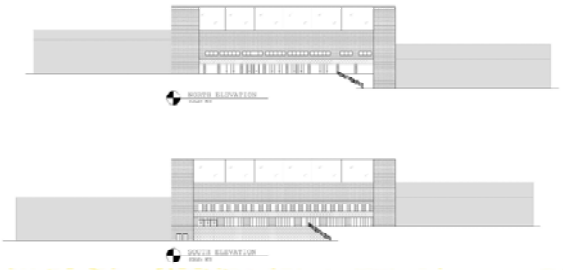

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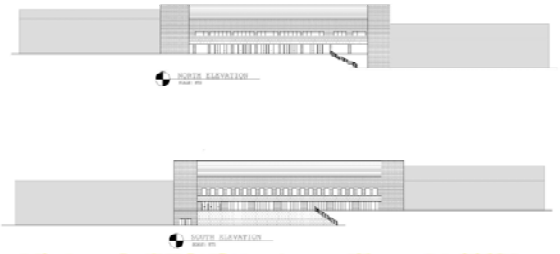

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Model

THIS IS WHERE THE 3D WALKTHROUGH BELONGS, BUT WILL NOT PLAY IN POWERPOINT. ☹ - SEE AVI VIDEO ON WEBSITE.

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Existing Rendering

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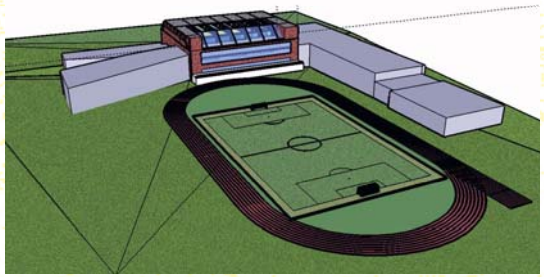

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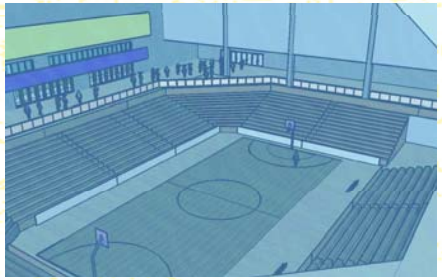
View From 5th Floor



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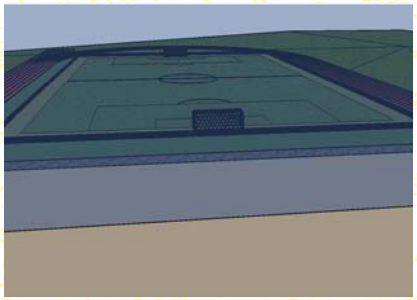

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Model on Map

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Construction Management Breadth

-Primary Focus: Cost, Scheduling Implications

-Considerations: Materials, Labor, Time

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Existing Rendering

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Cost Analysis

LATERAL CHANGES

STEEL	TRUSS			COLUMNS		FLOOR	
	W14x120	HSS8x8x.5	HSS6x6x.5	W14x257	W12x58	W27x84	W24x62
Old(ft.)	3984	3744	0	1080	0	310	0
New(ft.)	2705	0	2238	0	1152	0	310
Total weight(lb.)	-153480	-182408	78576	-277560	66816		
Length	-1279	-3744	2238	-1080	1152	-310	310
Cost/Length	168			320	72.5	132	89.5
Cost/Lb.		1.95	1.73				
Total piece cost($)	-214872	-355695.6	135936.48	-345600	83520	-40920	27745
Total cost($)		**-434631.12**			**-262080**		**-13175**

CONCRETE	SHEAR WALL
	Concrete(4000psi)
Old(CY)	0
New(CY)	184
Material Cost/CY	117
Placing Cost/CY	25.5
Total Cost/CY	142.5
Total Cost($)	26220
	26220

TOTAL LATERAL SYSTEM COST($) **-683666.12**

Coppin State University Physical Education Complex

Cost Analysis

GRAVITY CHANGES

STEEL	NEW FLOOR							
	W8x10	W10x12	W12x14	W12x19	W14x22	W16x26	W18x35	W18x40
Old(ft.)	0	0	0	0	0	0	0	0
New(ft.)	254	59	51	28	54	1047	30	34
Total weight(lb.)	2540	708	714	532	1188	27222	1050	1360
Length	254	59	51	28	54	1047	30	34
Cost/Length								
Cost/Lb.	22	31	25.5	33	39	40.5	55	61.5
Total piece cost($)	5588	1829	1300.5	924	2106	42403.5	1650	2091
Total cost($)				**57892**				

CONCRETE	NEW FLOOR	FOOTINGS	BRICK/EXTERIOR	NEW FLOOR
	Concrete (5000psi)	4000psi		Metal Stud Backup
Old(CY)	0	0	Old(ft^2)	0
New(CY)	197	36	New(ft^2)	21308
Material Cost/CY	113	117		
Placing Cost/CY	26.5	26.5		
Total Cost/CY	139.5	143.5	Total Cost/ft^2	22.1
Total Cost($)	26505	5166	Total Cost($)	470906.8
	26505	**5166**		**470906.8**

TOTAL GRAVITY SYSTEM COST($) **560469.8**

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Cost Analysis

Lateral Changes: -$680,000

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Gravity Changes: $560,000

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Total: -$120,000

.....$120,000 Savings

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Existing Rendering

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Scheduling Analysis

Schedule Modifications	Duration(days)
Formwork for Shear Walls Floor 1	1
Replace Moment Frames with Shear Walls Floor 1	2
Formwork for Shear Walls Floor 2	1
Replace Moment Frames with Shear Walls Floor 2	2
Formwork for Shear Walls Floor 3	1
Replace Moment Frames with Shear Walls Floor 3	2
Formwork for Shear Walls Floor 4	1
Replace Moment Frames with Shear Walls Floor 4	2
Modified Truss Installment	0
Additional Framing (5th floor)	2
Pour Additional Slab	2
Erection of Additional Columns	1
Building of extra 15' of exterior wall	14
Installment of roof glass panels	1
Modification to footing sizes	0
Total	**32**

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Existing Rendering

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Scheduling Analysis

Cost due to delayed schedule:

Assumption: General Conditions Fees ~ 1% through duration of project

$102 million project = $34,000/mo.

32 day delay => $50,000 additional cost

Material/Labor + Time = -$120,000 + $50,000 = $70,000 Savings

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Lateral System: N-S system from moment frames to shear walls

Modified Arena Trusses w/ less steel

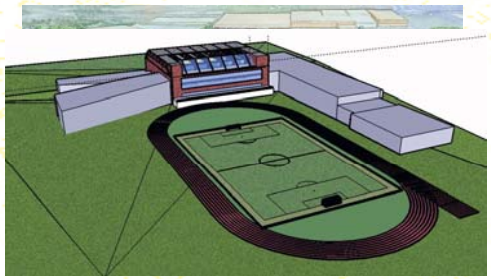
Gravity System: Additional 5th Floor

CM: Less Material Costs, Extended Schedule

Architecture: Arena more monumental

Coppin State University Physical Education Complex

Existing Rendering



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Questions?

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-My classmates, friends and family

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Foundation Changes

Spread Footings enlarged from 10' x 10' x 38" to 12' x 12' x 38"

See Appendix D in report for calculations

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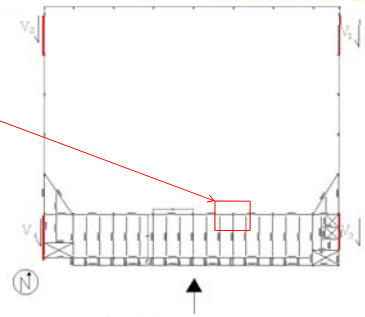
Structural Modifications



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Torsion

Torsion Shear	Direct Shear	Total Shear
W1: 4.8k	W1: 33.7k	W1: 38.5k
W2: 4.4k	W2: 36.3k	W2: 31.9k
W3: 4.4k	W3: 183.5k	W3: 187.9k
W4: 4.8k	W4: 184.4k	W4: 176.6k

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Structural Modifications