Stanton Elementary School

Washington, D.C.

Ryan DeJesso

Advisor: Dr. Somayeh Asadi

Introduction

Ryan DeJesso Thesis Presentation: Stanton Elementary School, Washington D.C.
Construction Management
Advisor: Dr. Somayeh Asadi

Occupancy: Educational

Size: 83,700 square feet

Number of Stories: 3 above grade + Basement

Owner: Department of General Services (DGS)

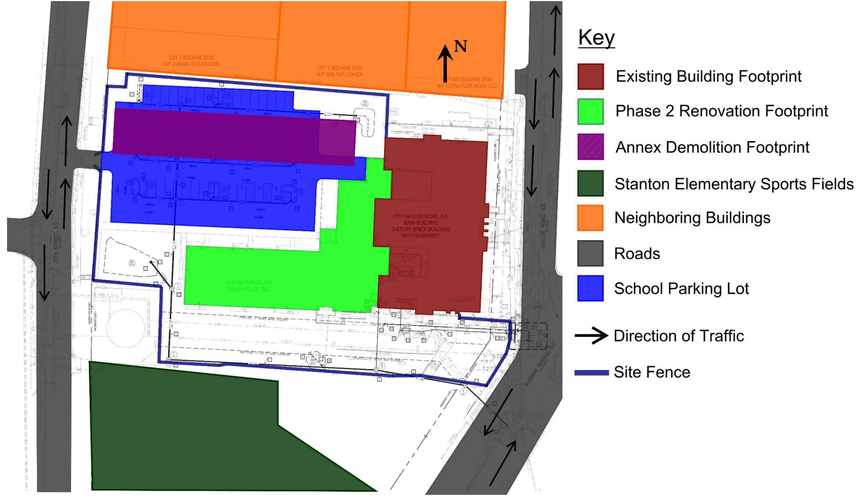
Construction Manager: Tompkins Builders

Project Cost: $32 million

Delivery Method: Design-Build with GMP

Phase 1 Construction: June 20, 2014 – October 24, 2014

Phase 2 Construction: March 31, 2015 – April 18, 2016



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Depth Topic 1: Short Interval Production Scheduling

Depth Topic 2: Project Re-phasing

Depth Topic 3: Piping Value Engineering

Acoustical Breadth: Classroom Acoustics Analysis

Structural Breadth: Foundation Redesign

Research Topic: BIM on Smaller Projects

Image Source: https://ms-dc.s3.amazonaws.com/img/school_img_2015/108.jpg

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Depth Topic 1: Short-interval Production Scheduling

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Construction Depth:
Piping Value Engineering

Piping Value Engineering

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Reasons for Analysis:

- Project financing issues throughout project
- Construction manager advised by owner to identify potential value engineering solutions
- PVC piping cheaper material and installation costs than copper piping

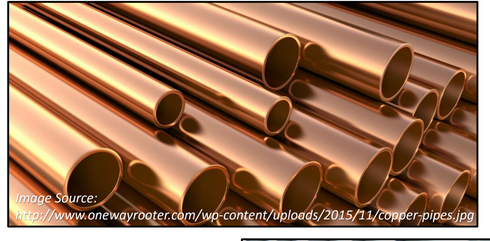

Image Source: http://www.onewayrooter.com/wp-content/uploads/2015/11/copper-pipes.jpg

Image Source: http://www.wc3design.com/wp-content/uploads/2014/08/DSCF0030.jpg

Cost Comparison: Initial Costs

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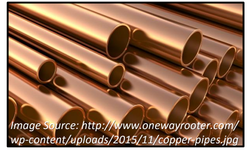
Detailed Estimate Process

- Assumptions
  - Copper Tubing – Type L
  - PVC Piping – Schedule 40
- Perform takeoffs for all pipe lengths, fittings, and valves
- Use RS Means cost data to perform estimate

Initial Cost Comparison



Copper Piping

$191,600

PVC Piping

$141,340

Cost Comparison: Maintenance Costs

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Maintenance Costs

- Inconsistencies in RS Means maintenance cost data for:
  - Pipe sizes
  - Comparable data between PVC and copper piping
- Durations for maintenance and replacement were similar for PVC and copper piping
- PVC typically cheaper to replace for unit cost data for similar items within RS Means

RS Means No.	System Description	Frequency (Years)	Crew
Copper Piping			
D2023 110 0010	Resolder Joint *Measure, cut & ream both ends* *Solder fitting*	10	1 PLUM
D2023 110 0020	Replace 3/4"copper pipe and fittings *Remove old pipe* *Install copper tube with couplings and hangers*	20	2 PLUM
D2023 110 0030 – D2023 110 0080	Replace (1" – 8") copper pipe and fittings *Remove old pipe* *Install (1" – 8") copper tube with couplings and hangers*	25	2 PLUM
PVC Piping			
D2023 130 0210	Reglue joint, install 1-1/2" Tee *Cut existing pipe, install tee 1-1/2"* *Inspect joints*	10	1 PLUM
D2023 130 0310	Reglue joint, install 2" Tee *Cut existing pipe, install tee 2"* *Inspect joints*	10	Q-1
D2023 130 2030 – D2023 130 2230	Replace 1000' PVC pipe (1" – 1-1/2") diameter *Remover broken pipe* *Install 1000' new PVC pipe 2" diameter* *Inspect joints*	30	1 PLUM
D2023 130 2330	Replace 1000' PVC pipe 2" diameter *Remover broken pipe* *Install 1000' new PVC pipe 2" diameter* *Inspect joints*	30	Q-1

Cost Comparison: Recycling Costs

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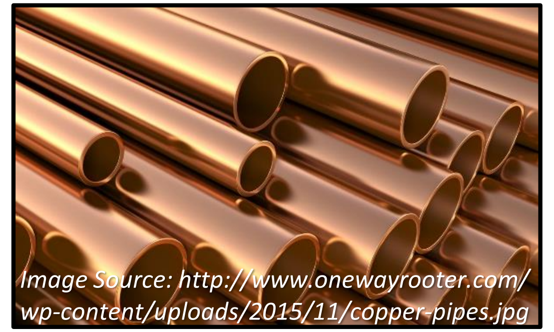
Copper Recycling Payback

Pipe Size	Total Pipe Length (LF)	Weight (lbs/ft)	Total Weight (lbs)
1/2"	756	0.285	215.5
3/4"	556.2	0.455	253.1
1"	1140.5	0.655	747.0
1-1/4"	52.8	0.884	46.7
1-1/2"	88.8	1.14	101.2
2"	552.5	1.75	966.9
3"	389.6	3.33	1297.4
4"	297.2	5.38	1598.9
Total Copper Weight (lbs)			5226.64

Total Weight (lbs)	Cost Per Pound	Total Scrap Cost
5226.64	$1.968/lb	***$10,286.04***

Scheduling Comparison



Copper Piping

1334 labor hours

PVC Piping

1228 labor hours

PVC Time Savings

106 hours
(13 construction days)

Structural Breadth: Pre-kindergarten Wing Foundation Redesign

Structural Breadth

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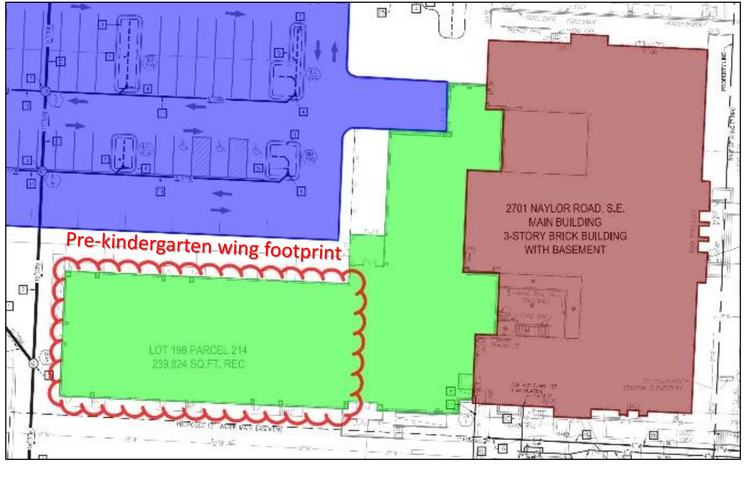
Reasons for Analysis:

- Plan for potential future building addition
- Site is fairly small, best option for addition would be vertically
- Determine if existing foundations can support loading conditions for two additional floors



Foundation System

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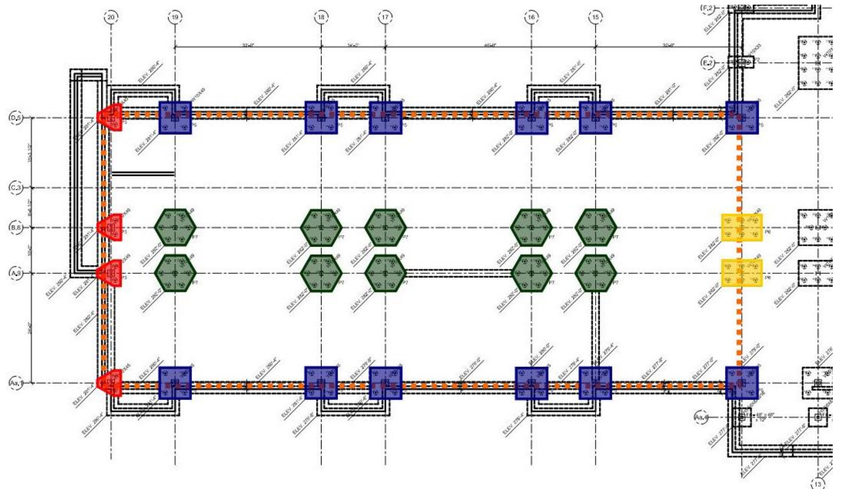
Existing Foundation System

Helical piles and pile cap system

Pre-kindergarten wing uses a variety of 28 pile caps spread over approximately

Pile cap sizes use 3, 5, 6, or 7 helical piles based on column loading conditions



Foundation System

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Acoustical Breadth

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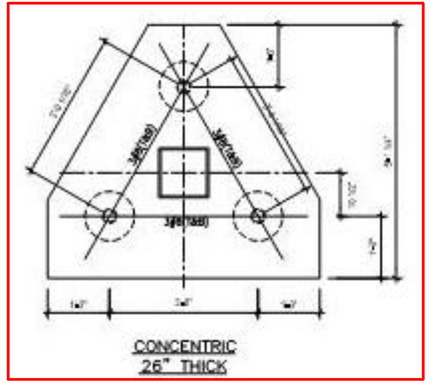
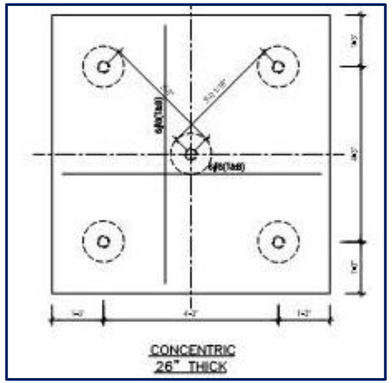
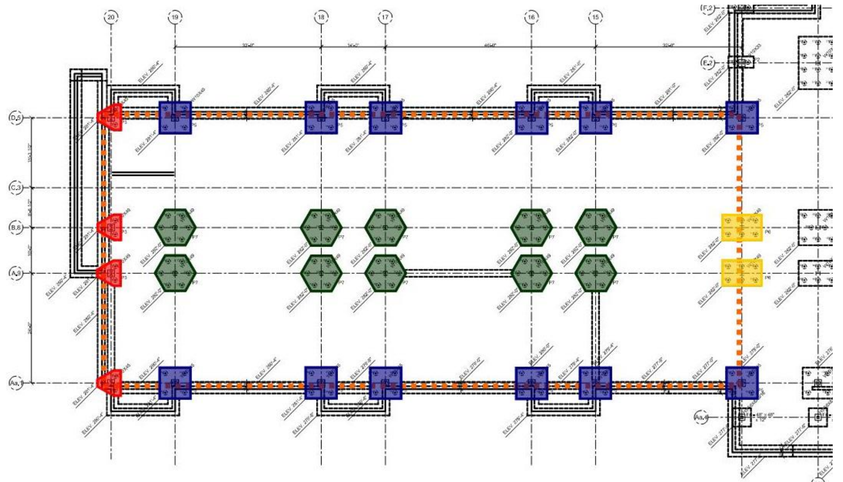


Pile Cap P3
- 3 Piles
- 20.95 ft^2 area



Pile Cap P5
- 5 Piles
- 6’ - 9” x 6’ - 9“ (45.56 ft^2 area)



Foundation System

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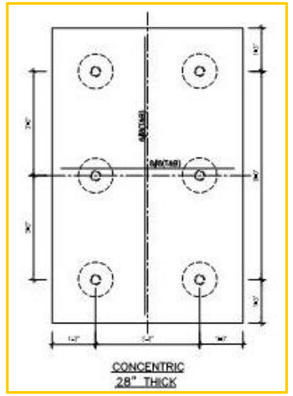
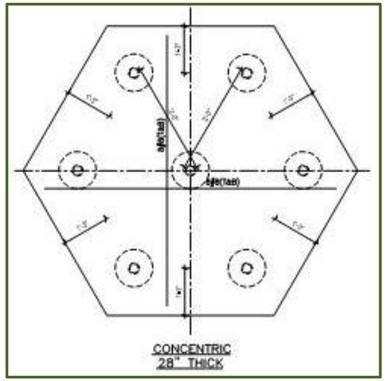
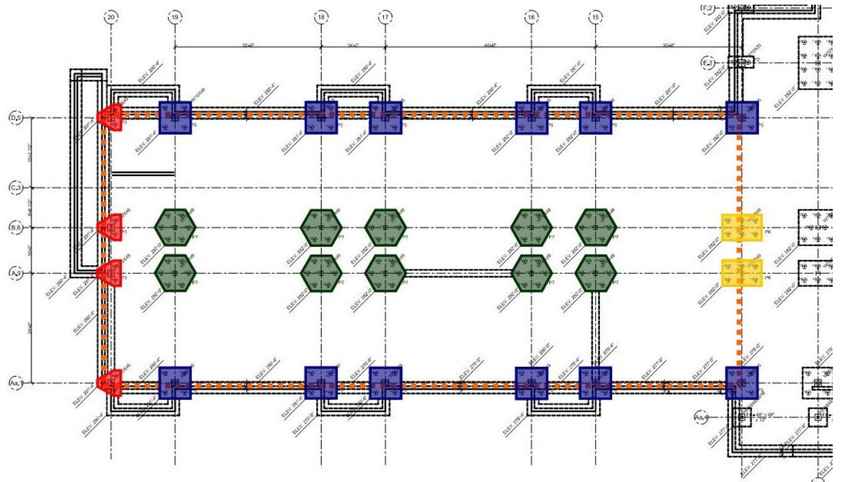


Pile Cap P6
- 6 Piles
- 5’ - 6” x 8’ - 6” (38.35 ft^2 area)



Pile Cap P7
- 7 Piles
- 51.65 ft^2 area



Foundation Loading

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Column Loading Conditions

Classroom Live Loads: 55 psf + 10 psf for partitions

Hallway Live Loads (Floor 1): 100 psf

Hallway Live Loads (Floors 2+): 80 psf

Roof Live Loads: 20 psf

Dead Loads: 40 psf

Snow Loads: 30 psf

Column Sizing

- Column Sizing determined from AISC Steel Construction Manual, 14th ed.
- Columns determined to be W8x33 on 2nd and 3rd floors.
- Existing columns are capable of transferring additional loading

Foundation Sizing

- Use ASD loading + column self weight

Structural Breadth

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Findings:

At pile cap locations B.8-14 and A.9-14, calculated loading was determined to be greater than the maximum loading condition on the pile cap.

Recommendation:

Keep all pile cap designs the ***except*** columns B.8-14 and A.9-14. Redesign these pile caps as P7 pile caps.

Column	Total Load on Footing (kip)	Existing Loading (kip)	Existing Design	# of Piles	Existing Loading Potential (kip)	Is Existing Design Sufficient?	Recommended Design
D.5-20	50.6	65	P3	3	120	YES	Remain the Same
D.5-19	162.7	175	P5	5	200	YES	Remain the Same
D.5-18	162.7	175	P5	5	200	YES	Remain the Same
D.5-17	162.7	175	P5	5	200	YES	Remain the Same
D.5-16	162.7	175	P5	5	200	YES	Remain the Same
D.5-15	162.7	175	P5	5	200	YES	Remain the Same
D.5-14	172.0	175	P5	5	200	YES	Remain the Same
B.8-20	74.7	85	P3	3	120	YES	Remain the Same
B.8-19	241.9	225	P7	7	280	YES	Remain the Same
B.8-18	241.9	225	P7	7	280	YES	Remain the Same
B.8-17	241.9	225	P7	7	280	YES	Remain the Same
B.8-16	241.9	225	P7	7	280	YES	Remain the Same
B.8-15	241.9	225	P7	7	280	YES	Remain the Same
B.8-14	261.9	210	P6	6	240	NO	Change to P7
Aa.1-20	50.6	65	P3	3	120	YES	Remain the Same
Aa.1-19	162.7	175	P5	5	200	YES	Remain the Same
Aa.1-18	162.7	175	P5	5	200	YES	Remain the Same
Aa.1-17	162.7	175	P5	5	200	YES	Remain the Same
Aa.1-16	162.7	175	P5	5	200	YES	Remain the Same
Aa.1-15	162.7	175	P5	5	200	YES	Remain the Same
Aa.1-14	172.0	175	P5	5	200	YES	Remain the Same
A.9-20	74.7	85	P3	3	120	YES	Remain the Same
A.9-19	241.9	225	P7	7	280	YES	Remain the Same
A.9-18	241.9	225	P7	7	280	YES	Remain the Same
A.9-17	241.9	225	P7	7	280	YES	Remain the Same
A.9-16	241.9	225	P7	7	280	YES	Remain the Same
A.9-15	241.9	225	P7	7	280	YES	Remain the Same
A.9-14	261.9	225	P6	6	240	NO	Change to P7

Cost Comparison

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Existing Pile Cap Foundation Costs

Item	Qty.	Unit	Material	Material Total	Labor	Labor Total	Equipment	Equipment Total	Total
3000 psi concrete	101.00	CY	207	$ 20,907.00	120	$ 12,120.00	0.73	$ 73.73	$ 33,100.73
Concrete Placement	101.00	CY			34.5	$ 3,484.50	1.15	$ 116.15	$ 3,600.65
Formwork	1604	SFCA	2.85	$ 4,570.61	5.05	$ 8,098.80			$ 12,669.41
#8 Rebar	6.79	TON	960	$ 6,520.78	470	$ 3,192.47			$ 9,713.25
Helical Piles	154	EA	N/A		N/A		N/A		$ 174,730.77
Total with Location Factor									***$ 230,307.58***

Existing Pile Cap Costs: ***$230,408***

Proposed Pile Cap Foundation Costs

Item	Qty.	Unit	Material	Material Total	Labor	Labor Total	Equipment	Equipment Total	Total
3000 PSI Concrete	103.12	CY	207	$ 21,346.41	120	$ 12,374.73	0.73	$ 75.28	$ 33,796.42
Concrete Placement	103.12	CY			34.5	$ 3,557.73	1.15	$ 118.59	$ 3,676.33
Formwork	1607	SFCA	2.85	$ 4,579.48	5.05	$ 8,114.51			$ 12,693.98
#8 Rebar	6.86	TON	960	$ 6,582.30	470	$ 3,222.58			$ 9,804.88
Helical Piles	156	EA	N/A		N/A		N/A		$ 177,000.00
Total with Location Factor									***$ 233,417.03***

Proposed Pile Cap Costs: ***$233,417***

Cost Difference: ***additional $3,423 to project cost (1.46% increase)***

Effects on Schedule

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Schedule Implications

- Time added for
  - Increased concrete, rebar and formwork: ***0.1 days***
  - 2 additional helical piles: ***0.5 days***

Total time added to schedule: *0.6 days*

Proposed Pile Cap Foundation Costs

Item	Qty.	Unit	Material	Material Total	Labor	Labor Total	Equipment	Equipment Total	Total
3000 PSI Concrete	103.12	CY	207	$ 21,346.41	120	$ 12,374.73	0.73	$ 75.28	$ 33,796.42
Concrete Placement	103.12	CY			34.5	$ 3,557.73	1.15	$ 118.59	$ 3,676.33
Formwork	1607	SFCA	2.85	$ 4,579.48	5.05	$ 8,114.51			$ 12,693.98
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Helical Piles	156	EA	N/A		N/A		N/A		$ 177,000.00
Total with Location Factor									***$ 233,417.03***

Proposed Pile Cap Costs: *$233,417*

Cost Difference: *additional $3,423 to project cost*
(1.46% increase)

Acoustical Breadth: Classroom Acoustical Analysis

Acoustical Breadth Introduction

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Reasons for Analysis:

- Owner wants best possible learning environment for students
- Good design creates quieter rooms and could limit distractions
- Variety of background noise sources such as
  - Naylor Road
  - School athletic fields
  - Hallways
  - Adjacent classrooms
  - Music room

Image Source: https://ms-dc.s3.amazonaws.com/img/school_img_2015/108.jpg


Image Source: https://upload.wikimedia.org/wikipedia/commons/3/3c/Peak_hour_traffic_in_melbourne.jpg


Image Source: http://www.rand.org/content/rand/pubs/research_briefs/RB9766/jcr:content/par/teaser_0.spectfit.0x1200.jpg/1395922659626.jpg

Library Acoustical Analysis

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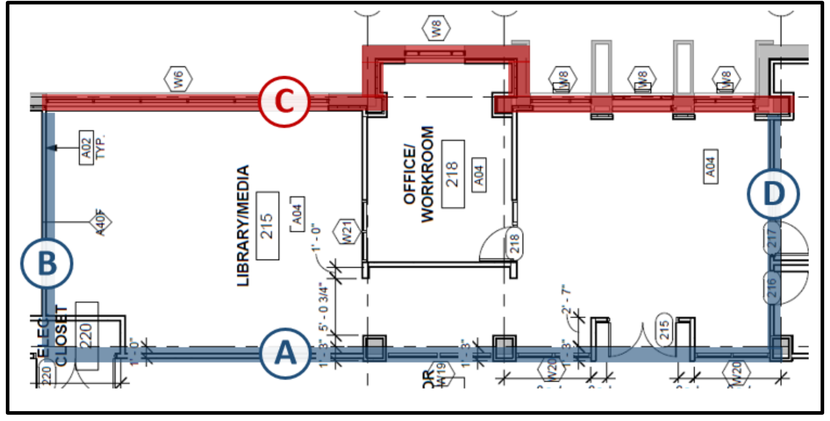

Potential Background Noise

Wall A: Hallway

Wall C: Naylor Road

Wall D: Classroom

Floor-Ceiling Assembly: Art Room with Kiln

Library Acoustical Analysis

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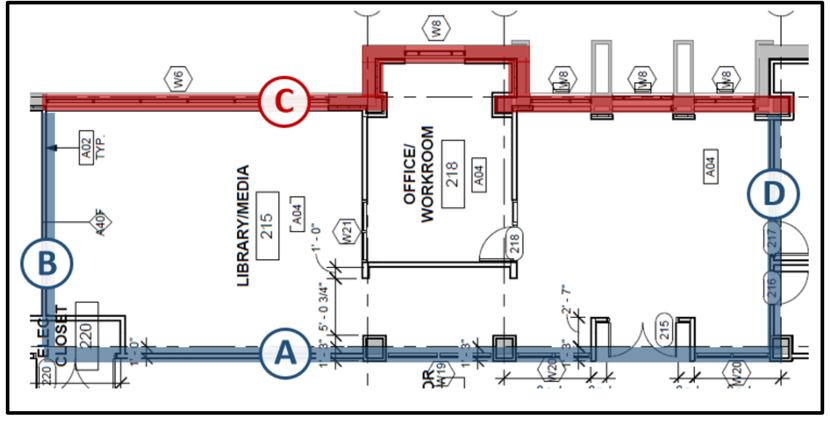

Partition	Wall/Material Type (Actual)	Adjacent Rooms	Recommended STC	Actual STC	Meets RQMT?
WALL A					
Wall	A42A	Hallway	45	56	YES
WALL B					
Wall	A40F	Closet	45	49	YES
WALL C					
Wall	A40F	Personal Toilet Rm	53	49	NO
WALL D					
Wall	A40F	Records/ Mailroom	45	49	YES
WALL E (COMPOSITE)					
Composite STC Rating		Naylor Rd	40	36	NO
Wall	F30E		N/A	45	
Window	W6		N/A	35	
WALL F					
Wall	A42A	Naylor Rd	40	56	YES
CEILING/FLOORING ASSEMBLY					
Ceiling	N/A	Visual Arts, Kiln	60	53	NO
Flooring	N/A	Storage Rm	45	53	YES

Library Acoustical Analysis

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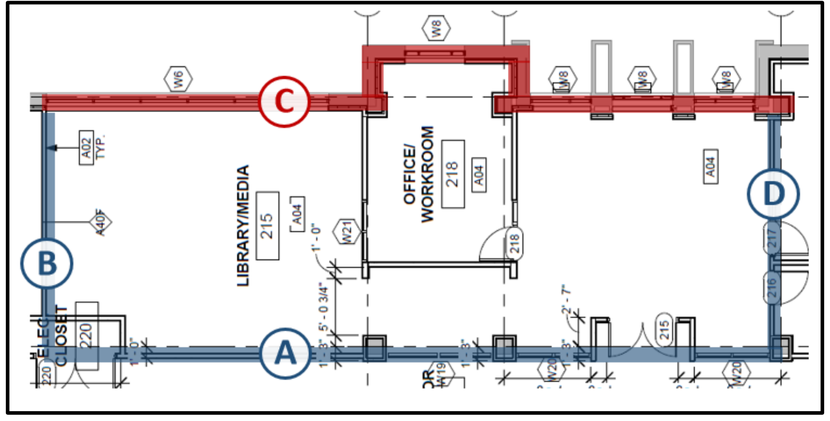

Does Design Meet Recommendations?

Wall A: Yes

Wall B: No, needs to meet STC-49

Wall C: No, needs to meet STC-53

Wall D: Yes

Floor-Ceiling Above: No, needs to meet STC-60

Floor-Ceiling Below: Yes

Library Cost Analysis

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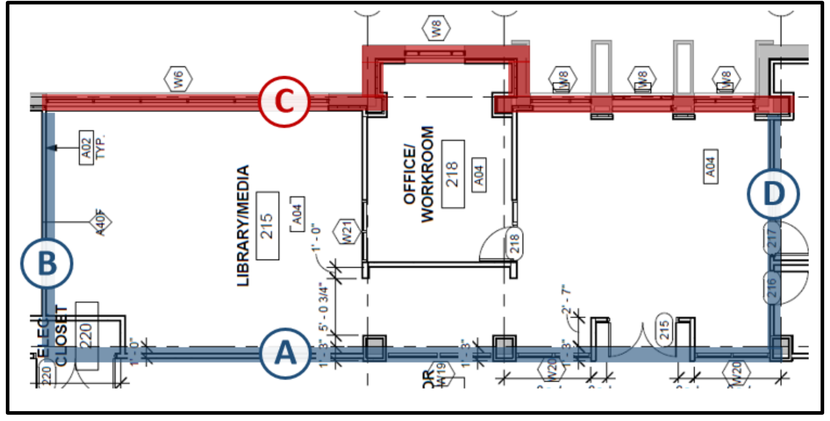

Cost Analysis

Location	Partition Type	Existing Design		Recommended Design		Cost Increase
		Design	Cost	Design	Cost	
Wall A	Glazing	STC-35 Rated Window, 1/4" thick	$ 2,552.14	STC-45 Windows, add 2" Air space and 3/16" thick pane	$ 1,343.66	$ (1,208.48)
Wall B	Wall	5/8" GWB, Sound Attenuation Batts between Metal Studs 24" OC - 3.5" thick, 5/8" GWB		Add 1/2" gypsum layer on each side of wall	$ 222.36	$ 222.36
Wall C	Glazing	STC-35 Rated Window, 1/4" thick	$ 4,567.60	STC-45 Windows, add 2" Air space and 3/16" thick pane	$ 8,300.00	$ 3,732.40
Wall D	Wall	5/8" GWB, Sound Attenuation Batts between Metal Studs 24" OC - 3.5" thick, 5/8" GWB	$ -	Add 1/2" gypsum layer on each side of wall	$ 252.96	$ 252.96
Total Cost Added						***$ 2,999.24***

Remaining Rooms Cost Analyses

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Room 108: Pre-kindergarten Classroom

Deficiencies

- Wall adjacent to bathrooms is below recommended STC-53
- Composite exterior wall adjacent to Naylor Rd is below recommended STC-40
- Floor-ceiling assembly adjacent to art room with kiln is below recommended STC-60

Cost Analysis

Location	Partition Type	Existing Design		Recommended Design		Cost Increase
		Design	Cost	Design	Cost	
Wall C	Wall	5/8" GWB, Sound Attenuation Batts between Metal Studs 24" OC - 3.5" thick, 5/8" GWB	$ -	Add 1/2" gypsum layer on each side of wall	$ 211.14	$ 211.14
Wall E	Glazing	STC-35 Rated Window, 1/4" thick	$ 5,460.00	STC-45 Windows, add 2" Air space and 3/16" thick pane	$ 9,800.00	$ 4,340.00
Ceiling-Floor Assembly	Floor Assembly	Carpeting, Composite Decking with 4" concrete, 1'-9" plenum, acoustical ceiling tile	$ -	Add 3" fiberglass insulation within plenum space	$ 64.00	$ 64.00
Total Cost Added						***$ 4,615.14***

Remaining Rooms Cost Analyses

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Room 319: Music Room

Deficiencies

- Walls adjacent to elevator shaft is below recommended STC-45
- Floor-ceiling assembly adjacent to art room with kiln is below recommended STC-60

Cost Analysis

Location	Partition Type	Existing Design		Recommended Design		Cost Increase
		Design	Cost	Design	Cost	
Wall B	Wall	3/4" GWB on Interior Side, "CH Type Studs - Metal Studs 24" OC, 1" GWB on Shaft Side	$ -	Add 1/2" gypsum layer on each side of wall	$ 111.60	$ 111.60
Ceiling-Floor Assembly	Floor Assembly	Carpeting, Composite Decking with 4" concrete, 1'-9" plenum, acoustical ceiling tile	$ -	Add 3" fiberglass insulation within plenum space	$ 384.00	$ 384.00
Total Cost Added						***$ 495.60***

Remaining Rooms Cost Analyses

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Room 1017: Pre-kindergarten Classroom

Deficiencies

- Wall adjacent to bathrooms is below recommended STC-53
- Wall adjacent to classroom is below recommended STC-53
- Composite exterior wall adjacent to athletic fields is below recommended STC-40

Cost Analysis

Location	Partition Type	Existing Design		Recommended Design		Cost Increase
		Design	Cost	Design	Cost	
Wall C	Glazing	STC-35 Rated Window, 1/4" thick	$ 2,479.40	STC-45 Windows, add 2" Air space and 3/16" thick pane	$ 3,911.60	$ 1,432.20
Wall D	Wall	5/8" GWB, Sound Attenuation Batts between Metal Studs 24" OC - 3.5" thick, 5/8" GWB	$ -	Add 1/2" gypsum layer on each side of wall	$ 104.04	$ 104.04
Wall E	Wall	5/8" GWB, Sound Attenuation Batts between Metal Studs 24" OC - 3.5" thick, 5/8" GWB	$ -	Add 1/2" gypsum layer on each side of wall	$ 278.46	$ 278.46
Total Cost Added						***$ 1,814.70***

Research Topic
BIM Use on Small Projects

BIM on Small Projects

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Construction Management
Advisor: Dr. Somayeh Asadi

Reasons for Analysis:

- Tompkins Builders used BIM on a limited basis for this project because of its size.
- There is a general misconception in the construction field that BIM is not beneficial for small projects.

Image Source: http://4.bp.blogspot.com/-rnYUwnUZ4Pk/U3Bxx7C7nkI/AAAAAAAAAJQ/pGUzy-Kw-Tg/s1600/bim-article-wordle.png

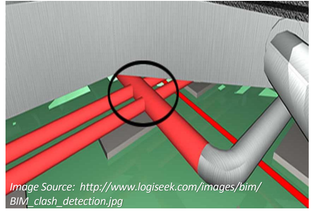

Image Source: http://www.logiseek.com/images/bim/BIM_clash_detection.jpg

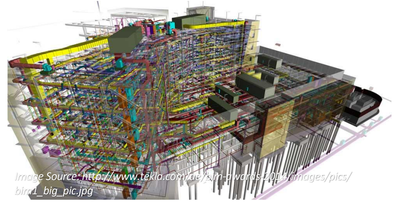

Image Source: http://www.tekla.com/sites/default/files/images/pics/bim_big_pic.jpg

BIM on Small Projects

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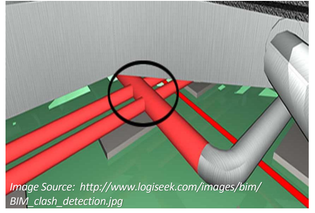
Analysis Included:

- Analyzing case studies for small projects using BIM
- Analyzing case studies for small firms using BIM
- Professional articles about BIM on small projects and project managers' experiences
- Analyzing survey-based research that occurred for BIM use on K-12 educational buildings

Image Source: http://4.bp.blogspot.com/-rnYUwnUZ4Pk/U3Bxx7C7nkI/AAAAAAAAAJQ/pGUzy-Kw-Tg/s1600/bim-article-wordle.png



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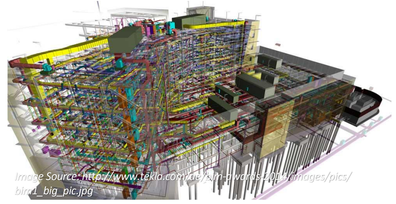

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Conclusions

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Recommended Minimum Requirements for BIM Use on Small projects

Building Systems Analysis
Site Utilization Planning
Construction System Design (Virtual Mock-up)
3D Control and Planning (Digital Layout)
3D Coordination
Sustainability (LEED) Evaluation
Design Reviews
Phase Planning
Cost Estimation
Existing Conditions Modeling

BIM Uses less essential on small projects

Maintenance Planning/Scheduling
Spatial Program Validation
Building Code Checking
Laser Scanning
Digital Fabrication
Planning for Future Renovations
Monitoring Building Performance
Energy Modeling
5D Modeling/Cost Estimate

Final Recommendations

Final Recommendations

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Piping Value Engineering Depth

- Initial cost and maintenance cost savings
- Schedule time savings

Recommendation: Use PVC Piping for the domestic water piping system

Structural Breath

- Existing pile cap design nearly is capable of supporting additional loads
- Limited added costs and time

Recommendation: Implement proposed foundation design

Acoustical Breadth

- Costs of acoustical redesign would be high
- Consider added costs of acoustical consultant
- Potential added time to an already very busy schedule

Recommendation: Implement necessary acoustical redesign

Conclusion

I would like to take the opportunity to thank the following people for their contributions to my thesis.

- Dr. Somayeh Asadi
- Dr. Michelle Vigeant
- Tompkins Builders; especially Jessica Marine, Pete Kapsidelis, Patrick Bynum, and Denzel Golden

In addition, thank you to Professor Bowers and Professor Parfitt for your guidance throughout the past two semesters.

Conclusion

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Questions?

Final Recommendations Recap:

Value Engineering Recommendation:
Use PVC Piping for the domestic water piping system

Structural Breath Recommendation:
Implement proposed foundation design

Acoustical Breath Recommendation
Implement acoustical changes