Senior Thesis Evaluation of the Sears Centre:

- ***Integrated Delivery Systems***
- ***Cast-In-Place Cost/ Benefit Analysis***
- ***Ice Rink (VEA) – Value Engineering Assessment***
- ***Footing Adjustments (via) Envelope Load Re-distribution***

Arnon L. Bazemore
Construction Management
Spring 2006
Dr. Messner

RYAN®
BUILDING LASTING RELATIONSHIPS

Prairie Stone Business Park • 5353 Prairie Stone Parkway • Hoffman Estates, IL

THE SEARS CENTRE

Primary Project Team

OWNER:
Madkatstep LLC
Sears, Roebuck Company
ARCHITECT:
Walsh Bishop Inc; Minneapolis, MN
www.walshbishop.com
CIVIL ENGINEERING/ SURVEYOR:
V3 Consultants; Woodridge, IL
www.v3consultants.com
STRUCTURAL CONSULTANT:
Needham & Associates
Overland Park, KS
www.needhamassoc.com
HVAC-PLUMBING CONSULTANT:
Belle Engineering; Elmhurst, IL
ELECTRICAL CONSULTANT:
Hyre Electric; Chicago, IL
GENERAL CONTRACTOR:
Ryan Companies, US Inc.
(Minneapolis, MN)
www.ryancompanies.com

Project Information

FUNCTION-PURPOSE:
- *Arena Facility*
- *Concerts and Sporting Events*

PROJECT COST:
$ 50,708,000

Building Cost:	*$ 35,030,000*
Site Construction:	*$ 7,241,000*
Soft Cost, etc:	*$ 8,437,000*

PROJECT SIZE:
240,000 SQ FT./ 4 Levels
CONSTRUCTION DURATION
315 Total Work Days

Construction Start:	*7/15/2005*
Project Turnover:	*9/18/05*

Building Architecture

The Arena consists of (4) levels which contain:
Event/ Mechanical Level
Main Concourses
Bridge Level
Suite Level
Dynamic Features:
40'-2" Glass Curtain wall surrounded by an epoxy aggregate concrete walk
Building Envelope:
1. *26 gauge Type 1,2,3 foam in-place insulated metal panels*
2. *ACI/ PCI Architectural Pre-cast panels*

Building Systems

STRUCTURAL SYSTEM

SHORING SYSTEM:
Shoring System integrated with foundation. System uses (100 kip) 55'-0" steel tie-backs @ 15°
FOUNDATION SYSTEM:
24'-0" Foundation Wall
4,000 psi concrete:
Continuous, Strip Footings, Grade Beams, Piers and Column Footings
SUPERSTRUCTURE:
Pre-cast Raker beams & columns, W14 – W30 I-beams 10" hollow core floor planks with 2" concrete topping for elevated floors

HVAC-PLUMBING SYSTEM

HVAC SYSTEM:
Features 240,000 CFM 70/30 VAV system for the arena bowl. Main supply ducts consist of 66" Ø un-insulated spiral duct, which services 40/20 diffusers
(6) 40,000 CFM Relief Vents are used for the return air system
(2) 10,000 MBH-gas-fired boilers
(2) 600 ton centrifugal chillers
PLUMBING SYSTEM:
(2) 1,500 gal ~ 3,000 GPH Water Heaters
Triplex Booster pump system

POWER DISTRIBUTION & LIGHTING SYSTEM

POWER DISTRIBUTION:
277/ 480 V 3Ø 4 wire supply
120/ 208 V alternate service
3,000 Amp Building Service
(8) Transformers that provide power distribution for mechanical, electrical and EMS systems are sized for 30 – 500 KVA load
LIGHTING SYSTEM:
- *Fluorescent Lighting*
- *3W LED illuminated hand rail*
- *Quartz Flood Lighting*
- *Recessed Fluorescent Lighting*

ARNON BAZEMORE
CONSTRUCTION MANAGEMENT – http://www.arche.psu.edu/thesis/eportfolio/current/portfolios/alb278

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Thesis Executive Summary

This thesis report will address (4) topics directly related to the Sears Centre construction and maintenance operations. Each topic evaluated will a unique impact on the building systems and project delivery method selected for this project. As a project delivery recommendation, integrated delivery is proposed to be used due in part to the leading construction entities experience with Design Build Operations. Success of the proposed delivery method will be interdependent on the value assessed to ice-rink operations, footing reduction via redesign and "cost re-capture recovery" by CIP installation.

Integrated Delivery Research

- Identifying construction costs
- Evaluating Payment Method
- Selecting the primary construction delivery method
- Selecting the appropriate contract
- Melding selecting Construction PDS with integrated delivery
- Identifying Integrated Delivery benefits via cost and time assessment
- Drafting Maintenance and Operations Budget

Cast In Place "Cost-Recapture" Costs/ Benefit validation

- Labor Rate identification
- Alternative Concrete System
- Financial Cost to system implementation
- Schedule Comparisons
- Pre-caster(1)/Pre-caster(2) and CIP Installer comparison

Ice Rink (VEA) – Value Engineering Assessment for facilities operations

- Identifying Design Capacities
- Understanding Refrigeration Operations
- Proposed (VEA) suggestions

Envelope Load Redistribution via Footing Size Reduction

- Identifying current loading condition
- Current Envelope Cladding Members
- Calculating current kip/ ft
- Footing Redesign-Column Check
- Cost/ Savings Analysis

Integrated Project delivery will successfully merge cost recapturing strategies, with financial alternatives to successfully achieve fluent project delivery. It is the goal of this thesis to translate all perceived adjustments into fiscal benefits for the owner and contractor.

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Cedric Bazemore
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Barnabas Bazemore II

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General Project Information

The Sears Centre Arena is a 9,000 to 11,000 seat sports/ event facility. Its primary purpose/ function will be to provide an indoor venue for multi-faceted concerts, entertainment performances and trade shows in the Hoffman Estates/ Northwest suburban Chicago area. In addition to housing large scale events, the Sears Centre will serve as home to several minor league professional hockey, lacrosse and arena football teams. Land development will include provision for 9,000 to 12,000 multipurpose arena, light infrastructure and landscaping with provision for 2,500 parking spaces.

The Sears Centre will serve as one of several planned project prototypes that will be constructed and owned by CCO throughout the country. Local marketing trends and expanding residential developments have created a demand for family and large scale entertainment in the Northwest Chicago area.

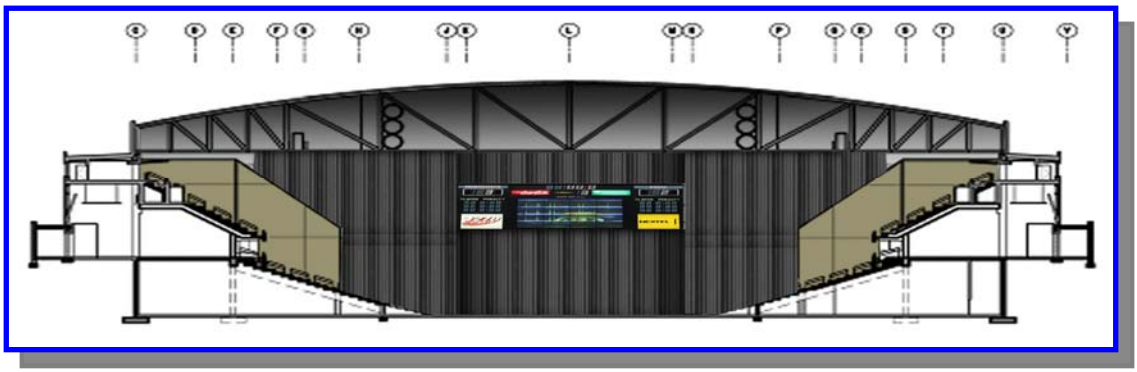
Building Profile:

- Event Level/ Mechanical Level
- Concourse Level/ Lobby/ Restroom/ Common Area
- Bridge Level
- SuiteLevel

(∑ Total of levels) = 4 Levels

This 4-storey arena features 3 different layout schemes for the lower level, mid level and upper level. The lower level consist of the event floor, team affiliation spaces, folding/ telescoping seating, commissary spaces, ice plant, communication, electrical spaces, storage in addition to all of the day to facility management operations.

The mid level, which houses both concourses and the bridge level, is the first level that aesthetic meets function. A 40'-2" slopped curtain wall terminates on the lower concourse level.



(Grand Vomitory/ Immediately Inside 40'-2" High Sloped Curtain Wall)

48 - 70% of arena seating is contained between the lower and the mid level. Additional arena amenities housed in this area are the main lobby, "grand vomitory "- entry concourse, concessions, arena ownership staff and administration, ticket sales and advertising, main public restrooms, VIP reception and arena audio/ video control room.

The upper level contains the area responsible for generating the largest sector for revenue, the suites. As previously mentioned Sears Center has a total of 42 suites. Each suite comes equipped with an upper and lower suite viewing aisle and all plumbing, electrical and telecommunication conveniences typically found in most state of the art facilities.

Executive Summary

This report will focus on the analysis of integrated project delivery for the Sears Centre project. Currently, the Sears Centre is using a Design-Build approach provided by Ryan Companies *(Minneapolis Based DB-Contractor).* As projects become more complex, owner-contract requirements continue to expand, resulting in an increase need for construction entities to become versatile in design, construction and financing processes. Equally important to the constructability of complex projects is the approach to delivery, which is inclusive to Operations and Maintenance concepts. However, majority of project prototypes that employee known methods of integrated delivery are government properties, infrastructure and public consortiums. Due to the fact that the private industry is experiencing an increase in business, related to complex scopes, an evaluation of integrated delivery for non-governmental projects can be resource effective overtime.

Thesis research will involve a detailed analysis of the project delivery system selected for the Sears Centre. Proposed method of evaluating this condition will include:

- Documentation of alternative project delivery systems
- Appropriate contract selection
- Predecessor PDS Selection Summary
- Construction Contract Selection Summary
- Integrated Delivery Documentation:
    1. *P^3 Validity of Public Private Partnerships*
    2. *Validity of BOT-Build Operate Transfer Model*
    3. *Validity of DBOM-Design Build Operate Maintain Model*

The recommendation to pursue an integrated delivery system for the Sears Centre will be validated by the results outlined in this accompanying report. Underlying conditions affecting the selection of the proposed integrated delivery system are (1) Time Reduction Assessment (2) Project Costs/ Budget Compatibility (3) Maintenance/ Operations budget identification and (4) Payback contributions with time durations. Integrated delivery systems selected will incorporate all of the benefits of using the Design Build approach (Construction) with FSM (Facility Service Management). In addition to the required project services outlined in this document, an evaluation of the construction entities procurement network will have to be referenced to determine internal feasibility of proposed delivery systems. Four out of Five construction entities have validity request for research in this proposed area. Each surveyed entity has different methods for pursuing integrated delivery systems. One important aspect to consider is the level of competence an organization has in (1) Internal Accounting-Cost Recapturing Strategies, (2) Property Management via "In-House/ Joint-Venture and (3) Financial procurement strategies. When these strategies are incorporated into Full program delivery, projects can be delivered with smooth adherence to time and budget constraints.

Integrated Delivery Systems Study for the Sears Centre

Project Origin at "Glance":

The village of Hoffman Estates is seeking to generate revenue from a highly competitive arena entertainment market. The plan will require physical provision for family shows, concerts and moderate to large sporting events. In addition to basic event requirements, the village has recognized the need to provide a building of high quality, patron comfort and accessibility capable of representing the surround Northwest "Chicago-land" Region.

Program Requirements & Fixed Constraints

- *Fixed Date*
- *Fixed Budget*
- *Quality Patron Suites*
- *Grade Level Parking*

Scope Background

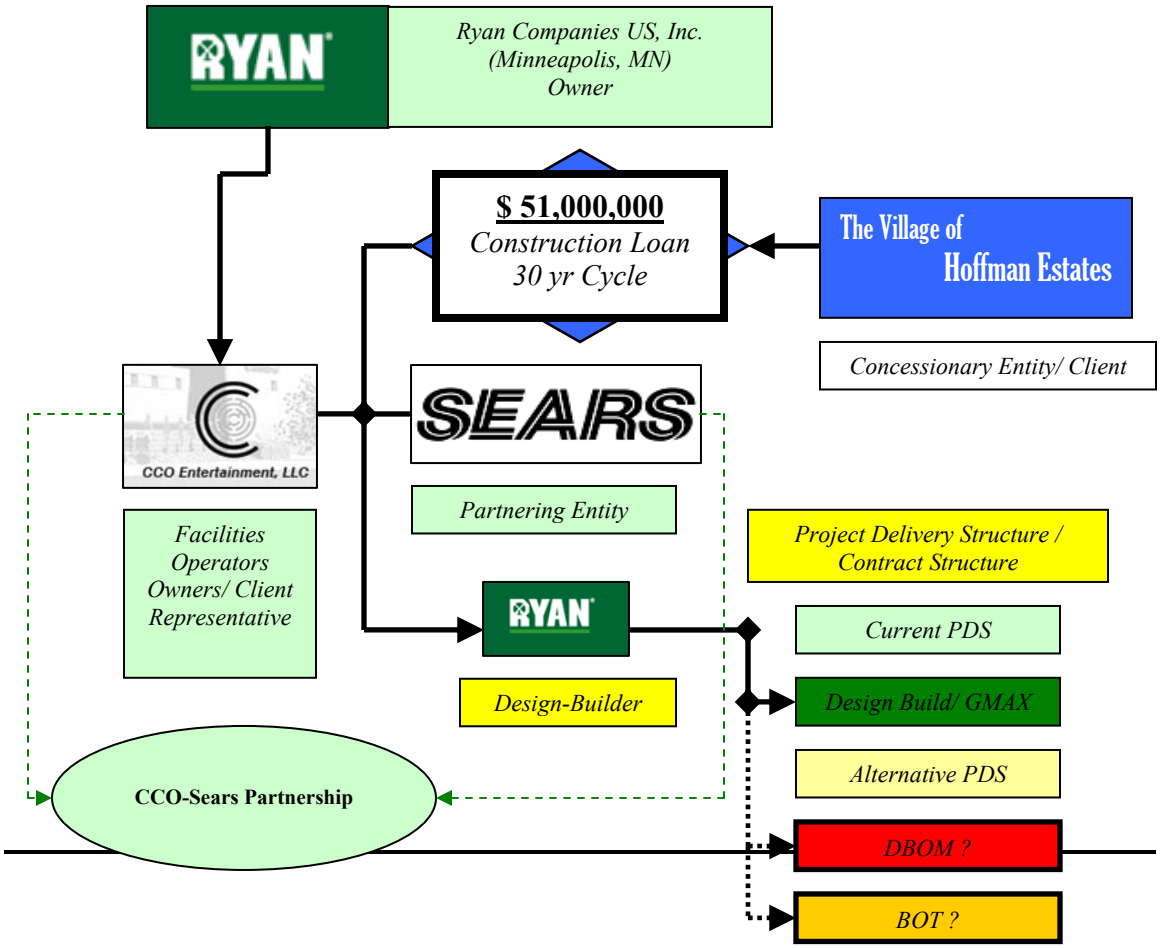
The Sears Centre is a landmark project, design and constructed by Ryan Companies US, Inc. The project will primarily consist of an 11,000 seat sports and recreation facility, 2,500 + spaces for patron parking and approximately 42 acres of landscaping and infrastructure. Ownership for this project will be shared between two parties *(Sears & Roebuck Company and CCO Entertainment)*. Like most high profile project, a partnership is present and essential for program and project structure.

Programming framework was structured to secure the fixed turnover date. As a result CCO Entertainment, LLC *(Limited Liability Corporation)* was formed from members of the design-build company and a newly acquired arena entertainment management firm. The second component of the project delivery systems is obtaining a high profile project participant as a partner in land acquisition, obtaining financial backing via notoriety and regional publicity. The Prairie Stone Business Park offered the greatest opportunity for business ventures which supports this type of arrangement. In addition to providing nearly 780-acres of undeveloped land, an ease of access has been create from sources of close proximity such as Sears & Roebuck Headquarters, Marriott Hotel and Conference Center *(Northwest)* and O'Hare International Airport.

After acquiring a partner and securing land rights, CCO Entertainment and Sears & Roebuck Company secured a $ 51,000,000 bond from the Village of Hoffman Estates. Ryan Companies has been selected to design and construct an arena facility capable of providing all amenities. Part of the agreement is provision for a facilities pay back period of 30-years. Since a special relationship exist between construction entity and owners, pre-construction services have been requested to include but are limited to the following:

- Value Engineering
- Best practices/ Design and Construction
- Procurement Services
- Integrated Design and Delivery

Program Delivery Structure:



Key Project Constraints:

- Project Budget-"Fixed Budget"
- Commercial Loan Pay-back Duration
- Building Maintenance/ Facilities Operations Cost
- Project Turnover Date

Project (Scope) Complexity:

In order to successfully evaluate optimum delivery methods of this project, several factors had to be determined post initial conception. Factors included but not limited to the project are arranged in order of precedence.

1. "Just-in-time" Facilities Delivery *(Must be met to counteract any liquidated damage clauses between facilities management/operations and entertainment clients/ sports franchises.)*
2. Cost Incursions *(Additional design and construction cost beyond commercial loan)*
3. Facility quality implementation measures which fits within the prescribed budget but exceeds that of the neighboring All-State Arena *(Rosemont, IL).*
4. Arena Maintenance and Operation Costs
5. Commercial Loan Repayments
6. Project Delivery Scheme (*How to merge Design-Delivery-Operations?)*

These three items will be used to determine the organization of the project delivery system, client-contractor contract and subcontracts for the Sears Centre project.

Existing Contract Types:

Project Participant Agreement	Contract Type	$ Contract Value
The Village of Hoffman Estates-CCO Entertainment	*Commercial Loan*	*$ 50,000,000*
CCO Entertainment-Ryan Companies	*GMAX*	*$ 50,000,000 (less FFE Budget)*
Ryan Companies-Walsh Bishop Architects	*Lump Sum*	*(3%-6%) Construction Budget*
Ryan Companies-Needham & Associates	*Lump Sum*	*(3%-6%) Construction Budget*
Ryan Companies-Bell Land Improvements (Excavation)	*Lump Sum*	*$ 1,610,566*
Ryan Companies-Lejeune Steel	*Lump Sum*	*$ 4,524,000*
Ryan Companies-Spancrete (Pre-cast Superstructure)	*Lump Sum*	*$ 4,318,537*
Ryan Companies-Elliot Concrete (Foundation/ Substructure)	*Lump Sum/ Unit Price*	*$ 2,105,760* *(add) Unit Price Contract for Composite Tie-backs $ 364,000* *$ 2,469,760*
Ryan Companies-Sebert (Land Development)	*Lump Sum*	*$ 560,539*
Ryan Companies-Oakbrook Mechanical	*Lump Sum*	*$ 4,258,000* *(less "VE") ($ 585,900)* ***$ 3,672,100***
Ryan Companies-Hyre Electric	*Lump Sum*	*$ 4,567,627*
Ryan Companies-Ewing Doherty	*Lump Sum*	*$ 921,455*

(Plumbing)		
CCO-RYAN -Southern Bleacher Company	*Lump Sum*	*"Tabulated from Cumulated Arena Data"*
Ryan Companies-CIMCO	*Lump Sum*	*$ 800,000*
CCO-RYAN-Arena Concessions	*D/B Allowance*	*"Tabulated from Cumulated Arena Data"*
CCO-RYAN-Arena Systems	*D/B Allowance*	*"Tabulated from Cumulated Arena Data"*
Total Arrangement		*Running Total Construction Building Cost (∑) $ 47,600,000*

Construction Cost:
(Probable Operations)* and Building Maintenance Cost: *(Arena Bowl HVAC Units)
Budget Comparisons (Current Budget vs. Budget with Life Cycle Upgrades)

Construction Budget		
Tasks	*Budget*	*"VE" Costs Add effects*
Demolition	*$ 0*	
Utilities	*$ 8,000*	
Excavation/ Found.	***$ 2,545,000***	***($ 28,893)***
~~Superstructure~~	*~~$ 7,855,000~~*	
~~Roofing Waterproof.~~	*~~$ 430,000~~*	
Envelope Sys.	***$ 2,246,000***	***($ 19,042)***
Int. Finishes	*$ 5,970,000*	
FF&E	*$ 577,000*	
~~Scoreboard~~	*~~$ 1,258,000~~*	
Ice Floor Package	***$ 803,000***	***($ 26,000)***
Equipment	*$ 721,000*	
Food Svc.	*$ 1,605,000*	
Seating	*$ 1,103,000*	
Vert. Transportation	*$ 598,000*	
Plumbing	*$ 1,148,000*	
Fire Protection	*$ 368,000*	
HVAC	***$ 3,325,000***	
Elect.	*$ 3,777,000*	
Audio/ Visual Sys.	*$ 779,000*	
Plaza and Site	*$ 549,000*	
∑Total w/ Soft Costs	***$ 47,420,000***	*Less ($ 73,935) =* ***$ 47,346,065***

Project Sourcing:

Project Sourcing for large scale sports recreation and concert facilities can be provided from a myriad of sources. However three sources that have been successful in recently arena development are (1) "P^3" Public-Private-Partnerships, (2) Private Donor Funding *(Typical of an Association/ Endowment Fund)* and (3) Commercial Construction Loans *(Lender to Designee Relationship)*. Funding for the Sears Centre is provided by Option # 3, which is a commercial loan structure that is fairly similar to a mortgage. This arrangement is widely used for construction projects ranging from sports facilities and other commercial properties. However alternative project funding is available for projects that can be classified as potential assets and incentives to local municipalities. Ultimately the goal of the CCO entertainment is to provide this type of development to townships and municipalities throughout the US. The irony exists in the classification of the property. CCO will endeavor to keep the property as a private asset using the delivery principals typically seen on fully or partially funded gov't projects. As a result an incentive structure program will be difficult to implement. One other inherent difficulty in project funding is the ability to obtain an inexpensive loan for a plan proto-type. Prototypes contain elevated risks associated with process inexperience. To counter act risks, increased interest rates will be used in annuity payments for the duration of the loan payback/ leaseback period.

Payment Methods:

Commercial Construction Loan Payment Terms

Most Commercial construction loans have a 20-30 yr payback period, valued at 70% - 100% of construction cost.

Cost Method Assessment – Mortgage/Commercial Loan Repayment Calculator:

(Loan & Financing Terms)

Key Terms to Commercial Construction Loan and Financial Sources	
$/r Interest Rate	*Interest is the amount paid for the use of money for a certain time. Although interest rate is typically quoted as a yearly figure, the actual amount of interest paid per year can be more, depending on the compounding period*
(t) Compounding	*Compounding is about interest on interest. When the interest is added to the principal to generate further interest, the interest is said to be compounded and the frequency this happens is called the compounding period. Interest can be compounded yearly, monthly, weekly, or even continuously.*
Points	*Points are one of the ways for lenders to cover the costs of processing the loan. Quoted as a percentage number, this is the amount added to the principal of the loan. For example,* ***if you borrow $100,000 with 2 points, you owe $102,000 the moment you receive your $100,000 loan.*** *This is generally accepted in return for a*

	favorable interest rate.
$/r APR	Loans sometimes involve additional cost such as points and other fees, which vary from lender to lender. In order to compares loans, one should use the ***A***nnual ***P***ercentage ***R***ate, the equivalent interest rate after all the added cost being considered.
$/r Annuity	A fixed annuity is a fixed amount paid at regular intervals. In spite of its name, this interval does not have to be a year. Also the amounts may be variable, in which case it is called a variable annuity.
$ Money Value	A term not typically used in commercial/ land development loaning. Under typical leasing terms, the interest rate can be approximated by the money factor multiplied by 24. When a dealer quotes a money factor ***k***, the customer should have the confidence of knowing that they are receiving a rate slightly ***better*** (lower) than 2400 ***k*** %.
(LIBOR) Interest Rate	*Libor is short for the London International Bank Offered Rate, the interest rate offered for US dollar deposits by a group of large London Banks. Rates are quoted for (1-month), (6-month) and (12-month deposits) Drawback is that a LIBOR Rate is an (AMR) – Adjustable Mortgage Rate, for this example LIBOR rates will be used as fixed rates during the course of the commercial loan, however for ideal situations commercial loans with interest rate evaluation longer than the (1), (3), (6) or (12) month durations will be used.*
"T-Note/ T-Bond" Treasury Note	***Treasury notes**, sometimes called T-Notes, earn a fixed rate of interest every six months until maturity. Notes are issued in terms of 2, 3, 5, and 10 years.* ***Treasury bills**, or T-bills, are sold in terms ranging from a few days to 26 weeks. Bills are sold at a discount from their face value. For instance, you might pay $970 for a $1,000 bill. When the bill matures, you would be paid $1,000. The difference between the purchase price and face value is interest.* *The U.S. Treasury resumed issuance of **Treasury bonds** with a 30-year bond auctioned in February 2006. The next auction is scheduled for August 2006.* 1. *Treasury Bills have maturities of one year or less.* 2. *Treasury Notes have maturities of two to ten years.* 3. *Treasury Bonds have maturities greater than ten years.*

Note: (bps = BPP is 0.01% of 1 percentage point) "237 bps/ 100 = 2.37% or 0.0237

Mortgage Rate(s) provide by Bankrate.com (Bloomberg Finance)					
Rates given as percentages (%)	Current(includes BPP)	(1) Month Prior	(3) Month Prior	(6) Month Prior	(1) Year Prior
15-Yr Mortgage	5.57	5.46	5.34	4.90	5.10
30-Yr Mortgage	5.88	5.81	5.74	5.34	5.52
1-Year ARM	4.89	4.61	4.52	3.95	3.82

Current Value of $ Money	
Indicator	*Interest Value*
Prime Rate	*7.50*
30 Year T-Bond	*4.70*
10-Yr Note	*4.66*
91 Day T-Bill	*4.53*
Fed Funds	*4.55*
12 Month LIBOR	*4.94*
30 Yr Mortgage	*6.24*

Loan Program: Executive (II) Program

Loan Use:

(1) Most Commercial Acquisition
(2) Commercial Refinance

Loan Value:
- $ 5,000,000 to $ 50,000,000(1)

Loan (%) Up to:
Up to (80%) of Costs

Interest Rate:
10-Yr T-Note + [114 – 237 BPP(s)](2)

Index Type:
Treasury Note 10 (yrs)

Index Rate:
4.66 % + (114-237)/100

Loan Term:
15, 20 & 25 year period

Amortization Schedule:
15 to 30 years

Loan Program: Large Private Placement Program

Loan Use:

(1) Commercial Acquisition
(2) Commercial Refinance
(3) Commercial Development

Loan Value:
$ 20,000,000 to unlimited(7)

Loan (%) Up to:
(70 %) to (100 %) of Costs

Interest Rate:
30-Yr T-Note + [150 – 300 BPP(s)](4)

Index Type:
Treasury Note 30 (yrs)

Index Rate:
4.70 % + (150-300)/100

Loan Term:
10 year period(6)

Amortization Schedule:
15 to 30 years

Reference Notes:

(1) Maximum loan amount based upon appraised value established by approved MAI appraisal, which will be at owner's or buyer's expense, and/or the DSCR.
(2) Fixed and Floating Rate Loans are available. Spread will vary with Loan Program. Rates are effective at the time of rate lock-in.
(3) Appraisal and DSCR can affect whether the maximum loan available.
(4) Low Fixed Rate depending on market conditions at time of rate lock-in.
(5) Mortgagor required to prepay first year's mortgage insurance at closing. Gross loan amount will be predicated upon 90% of cost or 1.10 DSCR as established by Insurer.
(6) The loan has a balloon payment due at the end of the term.
(7) The loan amount can be lower with a conventional amortization schedule and will be determined on a case-by-case basis.
(8) An Interest Only Loan, Valuation of Property, Paid in Cash Equity, and Rent Roll are prime determining factors for loan.
(9) The Combined Loan to Value (CLTV=First Lien and Mezzanine Loan) cannot exceed as indicated. The Mezzanine Loan may require backend payments, and lockout period.

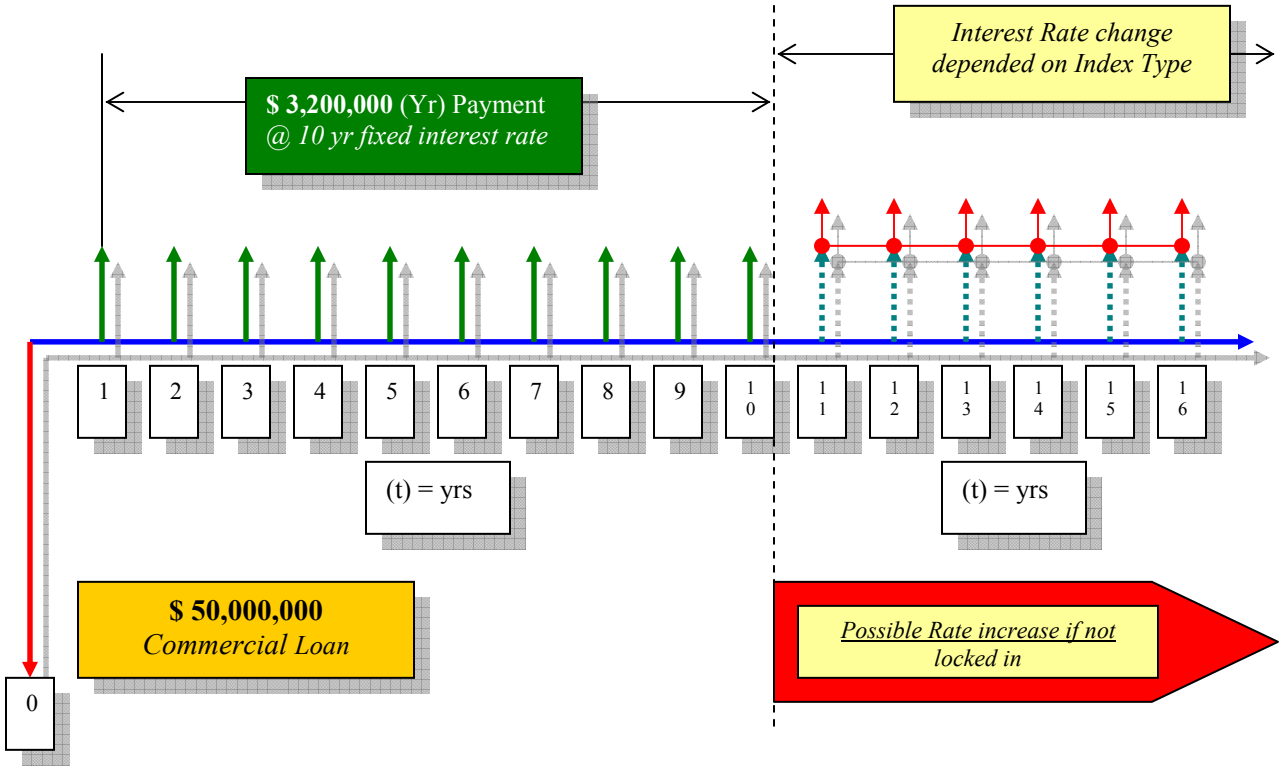
Rate Repayment = $\frac{(PLA')*[1-(IR+BPP)^{(NPS)}]*(IR+BPP)}{[1-(IR+BPP)^{(NPS)}]-1}$

(t) = time cycle

Using a rate calculation with a 30-yr mortgage 5.88% interest rate generated the following loan repayment rate for the Sears Centre property:

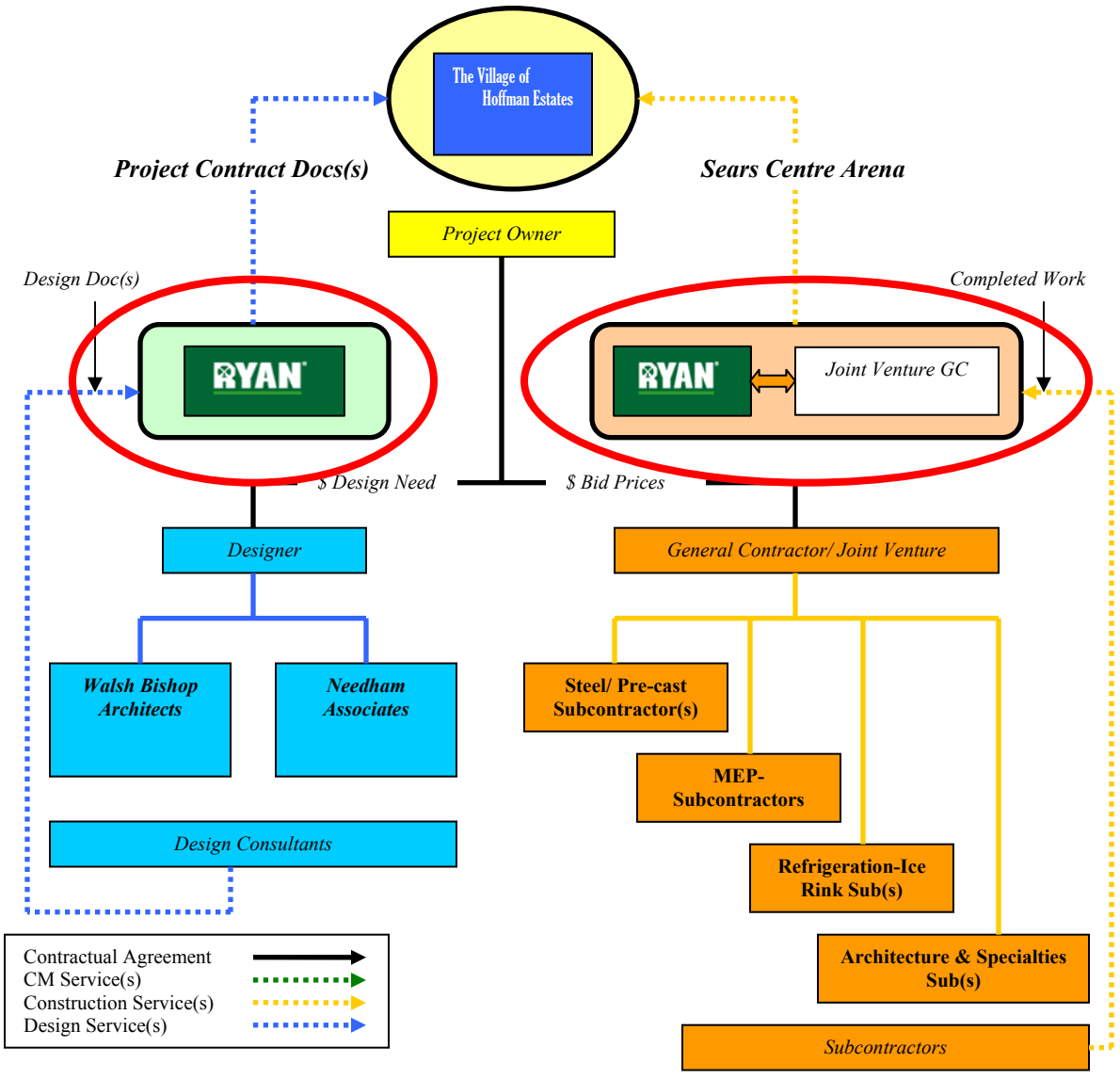
- $ 258,779.12 / mo. ⇒ **$ 260,000 / month**
- $ 3,119,206.73/ yr. **$ 3,200,000 / yr.**

Fixed Annuity Re-payment curve @ one 10-yr cycle:



Brief Summarization of PDS Alternatives

Traditional-Design/Bid/Build (TRAD/DBB) / *Alternative #1 (20% of Ryan Companies PDS)*



Analysis of Delivery for Sears Centre Project

- The traditional delivery method or Design-Bid-Build method typically involves (3) primary project participants. (1) Project Owner (2) A-E (Designer) and (3) General Contractor. The frame work for this arrangement is centered heavily on owner/ designer relationships. Design Entities are typically brought to the project at a relatively early stage of the project. Through this project development stage, a

building program is first established based on owner's needs and wants. Owners will hold (1) of the (2) primary contracts with the (A-E). This contract will cover all design development fees prior to any project construction or contractor selection. Design fees typically fall in one of three categories:

Typical Design fee payment types:

- *-$ (%)-of-anticipated Construction Cost*
- *-$ Designer's Lump Sum*
- *-$ Negotiated Reimbursement Rate typically (4% to 15%)*

Typical Design Services Provided in Arrangement:

- *Building Programming*
- *Conceptual Design*
- *Design Progression Services*
- *Base Project Estimate and*
- *Complete Drawings w/ Specifications*
- *Contractor Recommendations/ Hard Bid Situation*
- *Legal Commitment to owner's Risk*

When complete drawings are produced a General Contractor is selected to administer all construction directives based on complete drawing documents. The arrangement consist of the (2) project contract between the owner and the general contractor. No formal contract exists between contractor and designer, dispite encouragement by the owner for "project cohesion".

Typical design fee payment types:

- *-$ Payment consistent with contract type- typically 'Unit Prices' work best for this arrangement since known quantities are expected*
- *-$ Construction cost percentage of total units installed at an established rate.*

Typical Design Services Provided in Arrangement:

- *Building Permitting Acquisition & Cost*
- *Builders Risk and other pertinent insurance provisions*
- *Appropriate Bonding Capacities*

(Sears Centre) Advantage(s) for using PDS on Project:

Advantage for Contractor:

- *Level of complexity due to insufficient information directly related to incomplete design. Established quantities create ease of procurement and coordination from information standpoint.*

Advantage for Owner:

- *Village has direct control and input in the design schemes. (A-E) Firm will offer direct assistance in contractor selection via legal contract for consultation services.*

(Sears Centre) Disadvantage(s) for using PDS on Project:

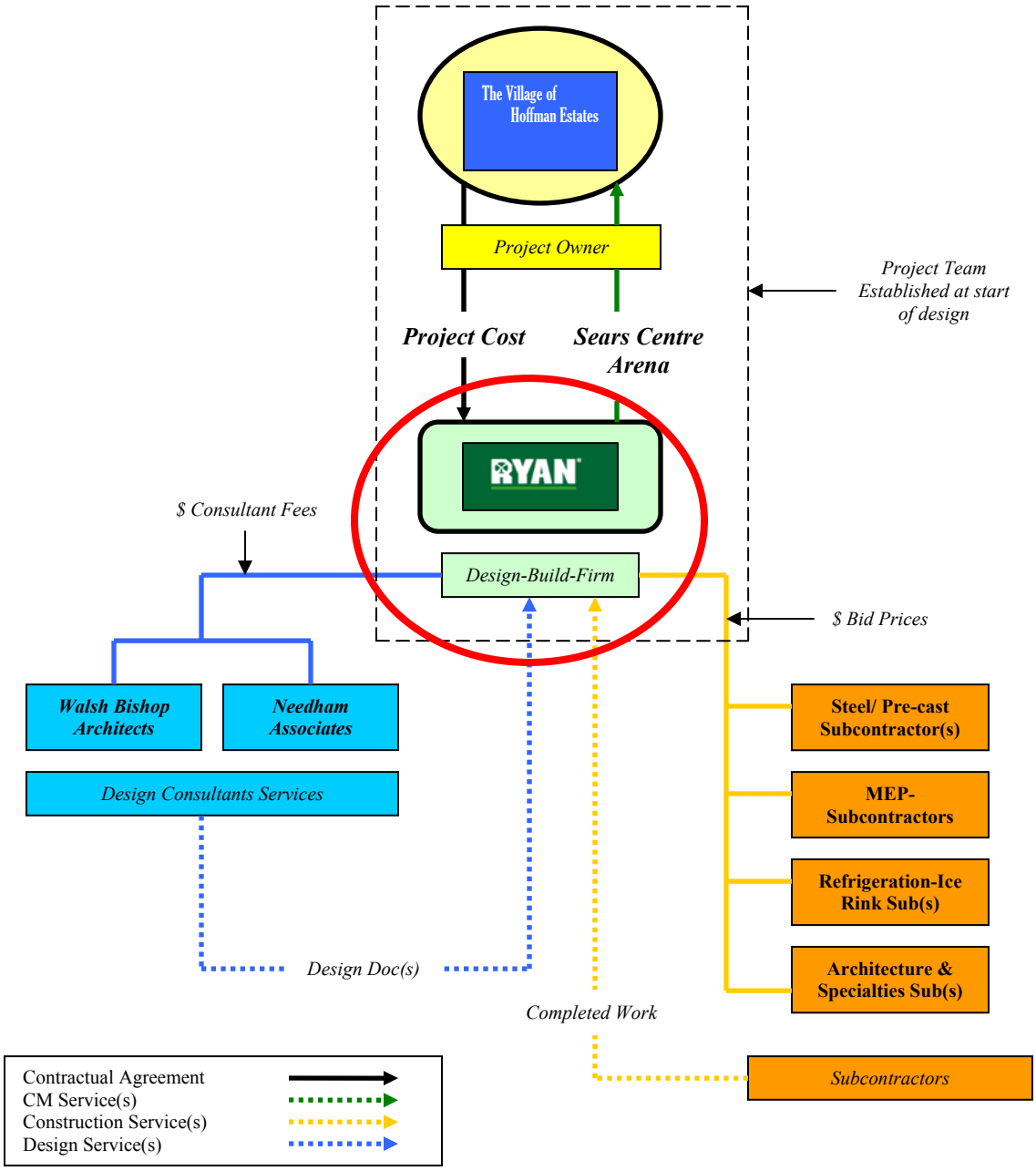
Disadvantage for Contractor:

- *Contractor must be "well-versed" in handling a project of this type since reputation will be depended on how well contractor can adjust to prices and time frames set forth by the owner strictly from (A-E) in-put. Price tends to be expected to be met with (A-E/ Owner) related calculations not local escalation which can be costly on a job of this type and size. "Possible adversarial relationships with Contractor and (A-E) professional. "Turnkey" operations, operations which meld design with construction, are the major premise for this delivery system.*

Disadvantage for Owner:

- *Although owner is solely responsible for the Design and General Construction contracts, design and construction collaboration may be time consuming and "One-sided" on a project of this type and size. Due to the importance of time and cost constructability concerns will have a substantial impact on meeting the required date within the fixed budget. Traditional method doesn't adhere well to inherent project constraints.*

Design Build (DB) – (*"Current Project PDS"***) / *Current Option accounts for 80% of Ryan Companies projects preferred method***



Analysis of Delivery for Sears Centre Project

- Design-build relationships are well suited for entities who have gained experience in the local market via-(Design/Construction) process and subcontractor reputation. Essentially the owner will issue a "master contract" with a firm which specializes in design development and construction in "niche-markets." The major

point behind the arrangement is the internal emphasis on "fast-tracking", inside constructability review and procurement acceleration. "Turnkey" operations, operations which meld design with construction, are the major premise for this delivery system. Design Build entity may exist as a single form or" Joint Venture" collaboration strictly for the purpose of completing the project.

Typical (DB) Design-Build contract payment types:

- *-$ GMAX, GMP Guaranteed Maximum Price*
- *-$ Negotiated Contract Reimbursable*

Typical Design-Build Services Provided in Arrangement:

Once Source Entity for the following:

- *Pre-construction Services*
- *Feasibility Studies*
- *Reality Checks*
- *Project Financing*
- *Land Procurement and acquisition/ Long Lead Item Identification and procurement*
- *Plan Conception and Design*
- *Cost Estimating and Cost Accountability*
- *In-house constructability reviews*
- *Construction Process Management and Contractor Selection*

(Sears Centre) Advantage(s) for using PDS on Project:

Advantage for Design-Build Entity:

- *(DB) Entity is in partnership with owner for project profitability, a "client-based relationship exists." Since this method is preferred for complex projects with strict specifications, the method is a probable PDS for this situation. Entity will have more control and persuasion in conceptualized designs. Constructability issues can be merged with design concerns and remedied up front rather than later.*

Advantage for Owner:

- *Fast-tracking is typically embedded in project delivery. Due to entity specialization, project design, construction and subcontractor collaboration are handled by one-source. Like most projects with this PDS, the (DB) is legally bound to provide the project at the agreed upon cost despite errors, omissions and unforeseen conditions. (If escalation isn't brought to the negotiating table early individual cost increases become the responsibility of the DB-Entity w/o debate.)*

(Sears Centre) Disadvantage(s) for using PDS on Project:

Disadvantage for Design-Build Entity:

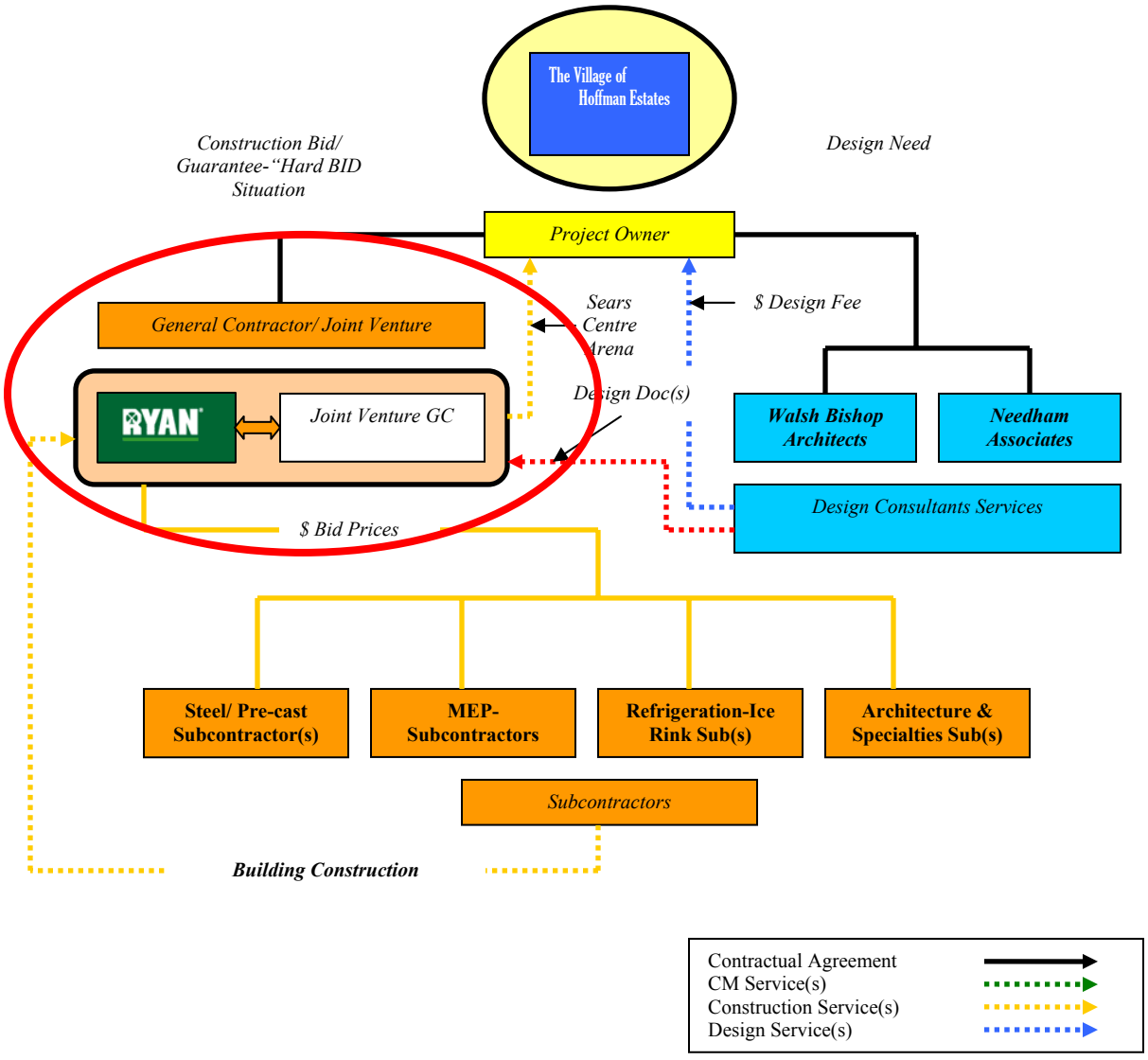
- *(DB) entity assumes all responsibilities related to design and construction. Since firm or joint venture is hired before the design is complete real pricing is difficult to establish. In addition to the pre-construction services provided by the entity, design-cost proposal are typically asked up front. One of the inherent difficult with the Sears Centre is that during the competitive bidding portion of subcontractor selection unit prices weren't finalize which made accurate unit prices difficult to obtain. Lump Sum Contracts were issued to major structural steel and concrete subcontractors without direct unit prices. Issues similar to these make fast tracking and best value prices difficult but not impossible to obtain.*

Disadvantage for Owner:

- *Lack of firm pricing can lead to sacrifice of quality for the sake of budgeting. Since one source provides pre-con/ construction and design, an accurate system of checks and balances may not exist, as consultation for construction and design come from one source or opinion.*

(However for this project since Ryan Companies has focused its business on 80% Design Build; this method by default was selected for the establishment of this planned prototype.)

Construction Manager at Risk CM@R / *Alternative #3*



Analysis of Delivery for Sears Centre Project

- Similar to Design Build in its approach to project cohesion with design and construction, this method specifies responsibility to each party for their respected area of expertise. A general contractor/ construction manager is bought into the project early to offer constructability with design reviews. Once constructability issues have been resolve with designs, plans are finalized for firm pricing and project management. Design and Construction contracts are held by the owner, in this case the Village of Hoffman Estates. Master cont
- Three "tiered" difference from Design-Build Approach

1. Management of construction process w/ inclusion of sub-contractor selection (GC/CM) holds performance contracts with sub(s) and vendors
2. Design and construction overlapping with emphasis on expediting the delivery process (Incorporation of constructability review)
3. *(QC)-Quality Control, Construction Cost Estimation for GMAX potential and project scheduling.*

Typical Design fee payment types:

- *Similar to that of a Design-Bid-Build/ Traditional Delivery Module*

Typical GC/CM contract suitable for PDS types:

- *-$ GMP*
- *-$ Reimbursable Contract at Negotiate Rate*

Typical Design-Build Services Provided in Arrangement:

Two Source Entities for the following:

- *Pre-construction Services*
- *Feasibility Studies*
- *Reality Checks*
- *Project Financing*
- *Land Procurement and acquisition/ Long Lead Item Identification and procurement*
- *Plan Conception and Design*
- *Cost Estimating and Cost Accountability*
- *In-house constructability reviews*
- *Construction Process Management and Contractor Selection*

(Sears Centre) Advantage(s) for using PDS on Project:

Advantage for Builder in CM @ Risk Arrangement:

- *Builders who specialize in this arrange are privy to a level of knowledge obtained via past experienced on specialized projects. Like Design-Build, entities have developed a niche market for complex projects that require this method as a preferred PDS. In this arrangement the builder will have ample opportunity to shape the project constructability in design. Arrangement may encourage value engineering suggestions and cost realizations since emphasis on pre-construction services are treated with equal importance as actual construction. A project of this type and complexity will require the CM/GC to have an intricate network of procurement strategies not only for long lead items but large scale common quantities as well.*
- *Overall GC/CM benefit – project unknowns brought to forefront via design-constructability reviews and active CM quantity pricing.*

Advantage for Builder in CM @ Risk Arrangement:

- *Project owner has the benefit of collaborative analyses from design and construction professional. The structure of the system has inherent checks and balancing. (CM) and (A-E) professional have an opportunity for direct contact prior to construction start and design document finalization.*
- *In most cases the owner has a representative with intense construction, schedule and cost accounting knowledge especially for procurement concerns. When cost is the precedent over time for complex project this is a viable solution.*

(Direction of Checks and Balance)

- *(CM) Accurate Pricing/ Design Specified Material*
- *(CM) Project Time-Frame Analysis with up to date information*
- *Best Value Assessment*

(Direction of Checks and Balance)

- *(A-E) CM/GC Specialization Qualification If requested by owner*

(Sears Centre) Disadvantage(s) for using PDS on Project:

Disadvantage for Builder in CM @ Risk Arrangement:

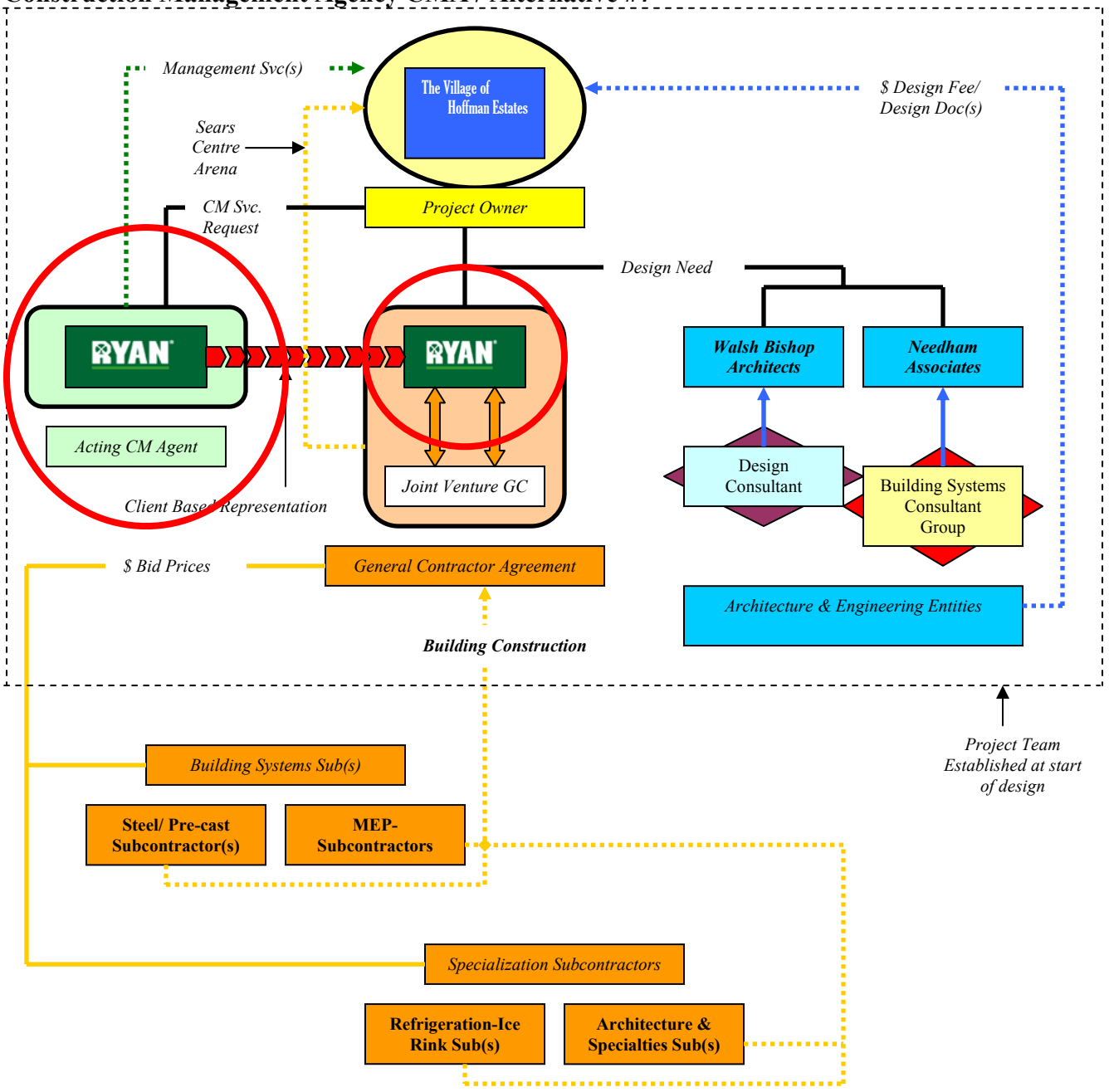
- *Success of this PDS depends on the level of knowledge owner has in detailed project workings. Premise of delivery system is (1) communication (2) owner involvement and (3) coordination during the pre-construction and construction stage. Unlike the Design-Build, meshing constructability and design changes can be time consuming and cumbersome, due to the fact that two independent sources are involved in the construction design process. Potential for adversarial relationship may develop when a product or process of equivalent/ compatible*

quality can be provided at a lower cost via CM-GC knowledge contrary to content specified in design documents.

Disadvantage for Owner in CM @ Risk Arrangement:

- *Although a valid system of "Checks & Balances" is established here to fill the void contain in the Design-Build delivery method, time factored changes can cause substantial delays if not communicated properly from Owner. Owner has to assume more responsibility in managing primary project relationships between (A-E) and CM.*
- *"Value Engineering = Cost Cutting/ Profit Protection" can be slightly difficult to detect in this setting.*

Construction Management Agency CMA / Alternative #4



Analysis of Delivery for Sears Centre Project

Delivery system has Construction Management entity acting in the order of the owner's representative and cost control function for project. Owner will handle multiple contracts (1) Contract with Architect and Design Services (2) General Construction Contract and (3) Construction Management Contract for owner representation. Interesting aspects to note are: project complexity and builder experienced Contract (2) and Contract (3) can be rolled into one package delivery to create a system similar to CM@R. Experienced owners have utilized this system to obtain "Best Value" processes. A trade off for consultation fee(s) and staffing overhead is usually present in this arrangement to help experienced owners manage GC(s). Project team is initialized during the conceptual, design or procurement phase of the project. CMA will most likely help projects with critical procurement issues.

"Related entities typically do not specialize in above method. All though method reduces procurement issues and preserves inherent checks and balances, potential of cost increase to project is high in addition to ownership-(Village of Hoffman Estates) is limited for managing construction and design contracts of this type."

Typical Design fee payment types:

- *-$ (%)-of-anticipated Construction Cost*

Typical GC/CM contract suitable for PDS types:

- *-$ Unit Cost*
- *-$ Lump Sum/ Fixed Price*

Typical Design-Build Services Provided in Arrangement:

- *Cost Checks*
- *Plan Check Services*
- *General Contractor(s) and Trade Management Services*
- *Project Scheduling*
- *Submittal Reviews*
- *Procurement Solutions*

(Sears Centre) Advantage(s) for using PDS on Project:

Advantage(s) to Sears Centre Pre-construction/ Construction Process:

- *"Fewer Quantity Bust"*
- *Clear Roles Widely Accepted*
- *Process is well established and universally understood; responsibility of project communication is taken off of the "shoulders" of the owner and taken up by the CM Agent.*

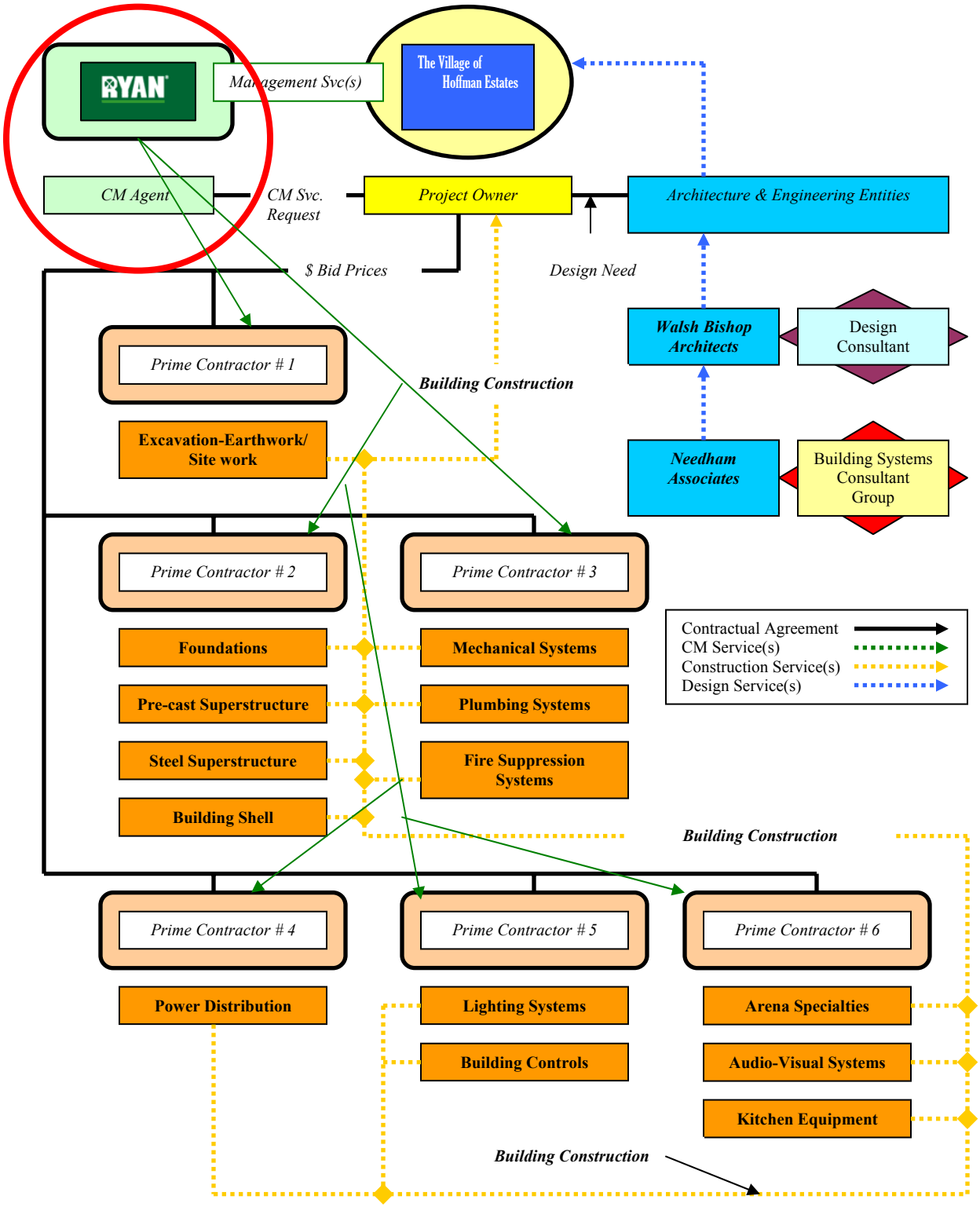
- *Owner specifies define requirement and has some knowledge of the desired construction process*
- *Fixed Price Changes/ Potential Reduction in Change Orders*
- *Fiduciary Responsibility of Agent lies with owner for project and process advancement*
- *Joint collaboration between (1) or (2) experienced Prime Contractors who specialize in services*

(Sears Centre) Disadvantage(s) for using PDS on Project:

Disadvantage(s) to Sears Centre Pre-construction/ Construction Process:

- *Cost of change order(s) increase due to time frame and previously implied cost controls*
- *Unforeseen adjustments and late scope changes can add to elevated design and overhead cost*
- *Construction typically starts after design is completed*
- *Design may lack constructability due to lack of contractor input*
- *Since cost is the precedent quality may be sacrificed for delivery*

Multiple Prime (MP)/ Multiple Prime w/ CM Agency/ Alternative #5



Analysis of Delivery for Sears Centre Project

Project structure for this delivery method is complex and relies on interactive owners who have experience in process management. A multi-prime (separate prime) arrangement involves multiple contracts between and owner and the major project participants. Like the (DB), (CM@R), (CMA) method the owner hires design and construction entities separately. Method is extremely useful where "phase occupancy" is a requirement and prescribed building and systems costs are elevated. To reiterate, the success of this method depends solely on owner's expertise in process management and communication flow. Large scale jobs or high profile projects, contract management directly impacts cost controls and overruns, as a result the multiple-prime with CM Agent arrangement has been introduced to the industry. Projects that are owned by large corporations or depend on agency funding typically use this arrangement to reach the most inexpensive $ cost per building system package.

"Although many universities, hospital systems use the MPA hybrid (Multiple Prime-CM Agent arrangement) for facilities, approach typically doesn't work in arena construction due to lack of coordination among primes. Phase occupancy is a non-existing requirement for Sports Facilities and Concert Centers."

Typical Design fee payment types:

- *-$ (%)-of-anticipated Construction Cost*

Typical GC/CM contract suitable for PDS types:

- *-$ Contract types should be uniform unless approved by owner for cost savings or time benefits*
- *-$ Unit Price contracts may work best in this arrangement due to known quantities for separate packages*

Typical Design-Build Services Provided in Arrangement:

- *Provided by owner / architect or acquired agent since owner assumes the responsibility of the "Master-Contractor"*
- *Multiple Primes follow a "Plan & Spec" method for building systems delivery*

(Sears Centre) Advantage(s) for using PDS on Project:

Advantage(s) to Sears Centre Pre-construction/ Construction Process:

- *Reduction or elimination of GC market-up*
- *Can obtain best price for unit cost structure*
- *Can be lucrative for Owner Controlled Insurance Policy (OCIP(s))*

(Sears Centre) Disadvantage(s) for using PDS on Project:

Disadvantage(s) to Sears Centre Pre-construction/ Construction Process:

- *Additional responsibility placed on owner for contract coordination and risk obligations*
- *Bonded Prices for project may cause some concern for owner*
- *Ambiguity of Final Construction Cost of Project*
- *Minimum incentive for increase in construction management fee (Owner Related)*
- *Third party liable a concern with multiple contractors*

Brief Summarization of Contract Alternatives

Cost-Plus-Fee/ Reimbursable Contract Structure:

The predecessor of a GMP/ GMAX structure, when a Cost-Plus-Fee arrangement is used the owner determines a fixed sum which may not be appropriate or desirable for project. Contract is usually administer between owner and contractor, although designer may be reimbursed in a similar manner for rendered services. Majority of contracts issued in this structure are open-ended based on preliminary documents and specifications solely for the purpose of arriving at a "targeted estimate." Once produced, a scope contract is executed between owner and general contractor. Although the contract structure affords the (GC) the opportunity to (1) impact the shape and depth of the scope with little input from design (2) In list the possibility of (GC) to generate extra profit for additional pre-construction services and (3) grants fast-tracking and value engineering opportunities for project, attention must be paid to exactly what reimbursements the (GC) and designer are entitled to. Any service provided beyond contract stipulations is at cost to designer/ (GC).

Key Concerns issues and factors with contract:

- Experience of (GC) relied on heavily to provide assume ceiling and reimbursement
- Owner must be careful that services render warrant costs on the account of both design and construction

Guaranteed Maximum Price/ GMP Contract Structure:

Contract is a variation of a 'Cost plus Fee Arrangement'. Occurrence which warrant contract use are projects with complex scopes which have budgets that can not accurately be determine pre-construction completion. A price ceiling or maximum price is established to counter-act and control upfront costs. Commonly referred as the "upset cost" the maximum price is one of the conditions which separate this arrangement from a Lump Sum structure. Flexibility for project completion and scope resolution only exist beneath the GMP. When determining "contractor upset costs", owners must be careful not to solely base expectations on in house estimates, drawings and specifications. In order to accurately estimate a complex project with this method, owners must jointly reference complete drawings and specifications, consultative intuition and cost escalation, which may be considerable for high profile projects such as recreational

facilities. Any incurred overage beyond the established price is the responsibility of the contractor dispute level of scope complexity.

Key Concerns issues and factors with contract:

- "Iron cladding a contract establishes a maximum cost ceiling that doesn't entitled contractor reimbursement if breached."
- ∑ $ Total Construction Cost $_{(Max\ Cost)}$ < $ Owner imposed "Upset Cost" $_{(GMAX/GMP)}$
- Incentive dispersions to contractor ,owner or % split
- Costs "caps" may influence sacrifice of scope and quality
- With GMP- Watch for "cost cap" can be inversely effective to overall quality of scope
- Without GMP- Watch for schedule increases in low of quality schedules

Lump Sum/ "Fixed Price" Contract Structure:

This particular contract is a relative straight forward "fixed cost arrangement." Unlike the previous contract, project unknowns are reduced to a minimum before contract implementation. Arrangement is popular with projects of defined scopes. As a side note "fixed price" agreements are usually used for contractors/ subcontractors who have very little influence on project design and have agreed to the terms of the owner for provision of scope within the contract.

Key Concerns issues and factors with contract:

- Fixed sum for performance of stipulated job – (Very little chance for contractor cost incentives)
- Construction difficulties/ costs overruns can only be addressed via relief(s) and remedies in contract clauses
- Contract as "master contract" is suitable for building construction
- Contract as "master contract" not suitable for operational components

Unit Cost/Price Contract Structure:

Basis behind contract forms the basis for an estimate completed before any contract release. Designer initially performs an estimated scope with typical quantity costs [$ / SF, $ / LF, $ / CY, $ / ton(s)]. Once defined costs are conveyed to owner, bid documents are released in a "hard bid" situation. Contract works best for typical projects which have been completed on repetitive bases, also for subsystems on jobs where know quantities are essential, such as foundation systems, scaffolding and shoring components. When executed properly, with some flexibility for direct contractor influence (i.e. reasonable bid floor adjustment), contract can be bid and implemented electronic via pro-log or expedition.

Key Concern issues and factors with contract:

- Owner must account for escalation, local taxes and market available as a baseline for accurate accounting even if bidders don't specify cost measures have already been included in bid

For a project of this type and size incentive contracts should be evaluated to be merge with the selective PDS used. This will provide a "fail-safe" for scheduled delivery and quality.

Types of incentive structures to be considered on project:

(1) Cost-Plus-Percentage-of-Cost-Contracts (Not recommended for planned complex projects with cost control issues)

Premise of Incentive:

- *Incentive structure is used under extreme circumstance of poorly defined scope at the start of project operations.*
- *Emergency repair work as the result of a natural disaster or un-predicted condition*
- *Implementation time frame so aggressive that the level of difficult for scope completion or eventual costs cannot be accurately estimated.*

Key Concern:

- *Method depends on good faith of contractor not to "overcharge" percentage of contract*
- *"Cost-plus-percentage fee doesn't provide direct incentive for contractor to minimize construction cost."*

(2) Cost-Plus-Fixed-Fee Contracts

Premise of Incentive Based on:

- *Fairly well defined projects of typically similar to projects performed in the past by subcontractor*
- *Sufficient Estimate*
- *Field Incentive based on the following conditions:*
  - *(1) Project size*
  - *(2) Estimated construction time*
  - *(3) Nature of complexity*
  - *(4) Perceived hazards*
  - *(5) Project Location*
  - *(6) Equipment and Manpower need for accelerated completion*

Key Concern:

- *Contractors fee/ incentive is fixed upon owner-contractor negotiation and eliminates future fluctuation*

(3) Incentive Contracts (Strongly encouraged on BOT & DBOM jobs)

Premise of Incentive:

- *Incentive contracts are two fold, contract incentive can apply to either cost or time adherence.*
- *Incentive structure - contractor and owner agree to target estimates of cost and time for construction and/or design-maintenance portion of the project.*
- *Bonus or penalties are directly tied to target estimates and are non-negotiable once agreed to.*
- *To stimulate costs savings, bonus clauses can be written into contract to provide shared savings, in addition to base fees stated as percentages of contract amount when* ***[actual costs < targeted estimate]***

Key Concern:

- *Incentive contracts adhere well to Cost-Plus-Fee/ GMAX arrangement*
- *Arrangement must applied to defined work with drawings and specifications sufficiently completed for project development*
- *Bonus-Penalty arranged should not be considered as liquidated damages since arrangement is accessed as a direct penalty or incentive*
- *~ 25% is used to calculate shared GC savings in arrangement*

Table 3: A PDSS Risk/ Organizational Structure Decision Table

Risk Factors/Org. Structure	Traditional (TD)	Design/Build (D/B)	CM (General Contractor) (CMGC)	CM (Agency) (CMA)	Risk Factor Range Organization
Project Characteristics (scope, complexity)	*Well defined scope; better suited for industry and standard jobs*	*Well defined projects; industry standard as well as slightly complex jobs*	*Fairly well defined, relative complex*	*Poorly defined, highly complex jobs*	Well defined [TD] [D/B] [CMGC] Poorly defined [CMA]
Time	*Not of the Essence*	*Better when time is of the essence*	*Time is generally critical*	*o.k. for both – slightly better when time is of the essence*	Of the essence [D/B] [CMGC] [CMA] Not of the essence [TD]
Owner Experience	*o.k. for both- better suited for inexperienced owners (relies on a/e)*	*Inexperienced owner, owner losses "checks and balances"*	*Critical that the owner be experienced*	*o.k. for both – better for an inexperienced owner*	Experienced [CMGC] [CMA] Inexperienced [TD, D/B]
Team Experience	*o.k. for both-better suited for inexperienced team*	*Better for experienced team*	*Critical that an experienced team be in-place*	*o.k. for both slightly better for an inexperienced owner*	Experienced [CMGC, D/B] [CMA] Inexperienced [TD]
Quality	*Industry standard as well as "monuments"*	*Industry standard jobs with a little higher quality requirement*	*o.k. for both – better for industry standard jobs*	*o.k. for both - better for higher quality projects*	Above Standard [CMA] [D/B] [CMGC] Industry Standard [TD]
Cost	*Better when cost is important but not critical*	*o.k. for both – better when cost is critical*	*Better when cost is critical*	*Not critical*	Critical [D/B] [CMGC] [TD] Not Critical [CMA]
(Project) Composite Risk	*Low Risk*	*Low – Medium Risk*	*High Risk*	*High Risk*	Low [TD] [D/B] [CMGC] High [CMA]

Table 4: A PDSS Risk/ Contract Type Decision Table

Risk Factors/Contract Type	Lump Sum (LS)	Unit Price (UP)	Guaranteed Maximum Price (GMP)	Cost-Plus Fee (CFP) Reimbursement + Agreed Fee	Risk Factor Range	Contract
Project Characteristics (scope, complexity)	*Well defined scope; Complexity not an issue as long as scope remains defined*	*Well defined scope but final quantities not known; complex or non-complex jobs*	*scope fairly well defined, higher complex projects;*	*Poorly defined, complex jobs*	Well defined Poorly defined	[LS] [UP] [GMP] [CPF]
Time	*Not of the Essence*	*Not of the Essence*	*o.k. for both, better when time is of the essence*	*of the essence*	Of the essence Not of the essence	[CPF] [GMP] [LS] [UP]
Owner Experience	*Better for inexperienced owner*	*Better for inexperienced owner*	*o.k. for both; better for an experienced owner*	*Experienced Owner*	Experienced Inexperienced	[CPF] [GMP] [UP] [LS]
Team Experience	*o.k. for both-better for an inexperienced team*	*o.k. for both- slightly better for an experienced team*	*Experienced Project Team*	*Experienced Project Team*	Experienced Inexperienced	[CPF] [GMP] [UP] [LS]
Quality	*Industry standard and "monuments"*	*Industry standard jobs*	*o.k. for both; slightly better for industry standard jobs*	*Higher than industry standard*	Above Standard Industry Standard	[CPF] [GMP] [LS/D/B]
Cost	*Better when cost is important but not critical*	*Generally critical with some flexibility to account for unknown quantities*	*o.k. for both; slightly better when cost is not crucial*	*Not critical*	Critical Not Critical	[LS] [UP] [GMP] [CPF]
(Project) Composite Risk	*Low Risk*	*Low – Medium Risk*	*Medium – High Risk*	*High Risk*	Low High	[LS] [UP] [GMP] [CPF]

Construction PDS Summary:

According to the results given through table 3 (PDS Selection) & table 4 (Contract type), coupled with the specializations of the general contractor the most probable PDS used to delivery the Sears Centre job is as follows:

Project Delivery Method Summary Probability					
Traditional Method (TD/ DBB)	*Design/Build (D/B)*	*CM General Contractor (CMGC)*	*CM Agency (CMA)*	*Total Results (%)*	*Probable PDS for Project*
0 %	***57 %***	*29 %*	*14 %*	*100 %*	***D/B***

Most Probable PDS used for Project should be: ***Design-Build***

Master Contract Delivery Probability					
Lump Sum (LS)	*Unit Price (UP)*	*Guaranteed Maximum Price (GMP)*	*Cost Plus Fee (CPF)*	*Total Results (%)*	*Probable Master Contract*
0 %	*14 %*	***86 %***	*0 %*	*100 %*	***GMP***

Most Probable Master Contract Delivery used for Project should be: ***GMP***

What happens if your organization is seeking to enter a market where they want to introduce a prototype while retaining it's assets for future development and profitability?

Why Integrated Delivery Systems for Sears Centre Project

Integrated delivery systems can be used as a tool to analyze present and future profitability in assets management. Equally important is its affect on procurement strategies. There are (3) basic integrated delivery systems that have emerged recently from successful project prototypes. These methods are as follows:

Integrated Delivery Systems:

(1) **[P^3] Public Private Partnership Initiative** *(Viewed as integrative procurement for report)*

Models used under [P^3] application

- *DBO-Design Build Finance*
- *DB-Design Build*
- *BOO-Build Own Operate*
- *BOOT-Build Own Operate Transfer*
- *BBO-Buy Build Operate*
- *Finance Only*
- *Separate O & M*
- *Operation License*

(2) [BOT] Build Operate Transfer System

- *BTO-Build Transfer Operate*
- *BO-Build Operate*
- *BOOT-Build Own Operate Transfer*

(3) [DBOM] Design Build Operate Maintain System

- *DBO-Design Build Operate*
- DBFO-*Design Build Finance Operate*

(Due to time constraints a pre-evaluation of the method will only be performed on the summary structured indicated above)

Note: BOT has been implemented as a strategy of Public Private Partnerships

A project of this complexity and type would be sufficient for a design build arrangement. However, do to two key conditions (1) municipality (Village of Hoffman Estates) to secure a venue with limited owner responsibility and (2) Ryan Companies/ CCO Entertainment to secure a re-occurring asset on the long term strategic plan for entry in the sports construction market, have given consideration for an integrated delivery system. The first step to an analysis of this type is two compute the maintenance and operations cost during the life time of the facility. As an arrangement, maintenance and operations costs can amount to nearly 3 x (construction costs) even if properly maintained. Cost of this type will only increase with concert and sports recreation type of

venues. The inherent condition is "ripe" for the institution of an integrated delivery system.

Successful systems have been implemented on:

- Healthcare projects (equipment procurement & maintenance strategies)
- Heavy Industrial Construction via Manufacturing, Chemical and Desalination Plants
- Infrastructure
  (1) (FDOT)-Federal Department of Transportation
  (2) Roadways (FHWA)
  (3) Railroads (FRA)
  (4) FAA-Airport Infrastructure (Northern Virginia's Dulles Int'l toll road and metro-rail expansion)
- Recently Industrial Business Parks *(Southwestern United States)*

With the implementation of an integrated design and delivery come inherent constraints that depend on owner need, driven by culture and economic cycles. Contrary to belief, integrated delivery systems have been used in oversees markets since the 1800's and beyond. A recent interview with an international construction company revealed the approach behind integrated delivery system is in fact procurement delivery paid and multi-facet currencies. Specifically developed for use in "third world" countries that have the need but lack the monetary or societal resources, integrated delivery has welcomed the opportunity for non-tradition payment for render services over a longer time frame. It should be advised that the success of this particular "industry depends on the political and socio-culture of a region." Due to material shortages, the rise of plan-check services, third party accounting cost control *(Ernst & Young/ Merrill Lynch)*, financial cost controls provided by accounting firms, owners now have financial obligations and options that were not part of development and construction 10 or 20 years ago.
One of the leading catalysts in the development of integrated delivery is the federal government. Like most owners both fed and state governments are endeavoring to achieve this best quality and process possible by:

(1) Merging design-construction with long term cost reduction decisions and
(2) Process Delivery with Assets management.

Although a private owner may not have the fiscal resources of a local government or municipality, similar results can be achieved by more conventional methods.
One such case is the use of Public Private Partnership for the development of NBA facilities. Two arenas have been developed using this method. The predecessor, the Rose Garden *(Portland, OR)* was developed on the premise of city recognition and homage to other noteworthy facilities (Boston Garden-*Boston, MA*/ Madison Square Garden-*New York, NY*). Spear headed by one single entity, the Rose Garden was a land mark venture for the public-private-partnership for commercial use. The frame work consisted of a

[TIAA-CREF/ Prudential Insurance/ Farmer's Insurance] loan consortium, Paul Allen-(Trail Blazers owner and principal representative), and the city of Portland tax payers' base. Construction costs were partially funded by a $ 155,000,000 commercial loan, of similar type and conditions used for the Hoffman Estates' Sears Centre. Overall construction cost amounted to $ 262,000,000 which was met via a joint arrangement (40 % / 60 %) split between tax payers and Paul Allen-Global Spectrum. Public private partnerships are effective when a city or local government desires to develop a specific area into an "Arena-Entertainment" zone to include hotel, restaurants, retail shops and other attractions. The other project to us a P^3 arrangement was the, American Airlines Center (*Dallas, TX*), which also has created a management entity similar to COO entertainment to main its operation for new facility (American Airlines Arena) and aging asset (Reunion Arena). (AA Public/ Private Development Split ($ 125,000,000/ $ 105,000,000 ≈ 54 % / 46 % split)

Basic Concept behind [P^3] Public Private Partnership(s):

Government led interdependence on private sector for adequate procurement of construction services:

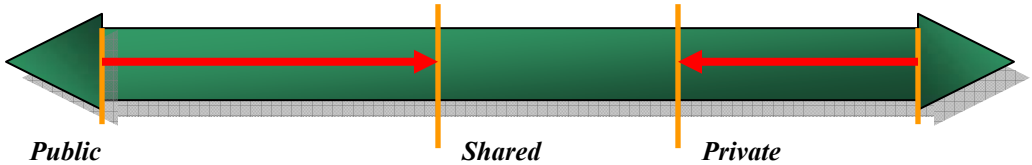
Addition of project value:

Appropriate allocation of Risks	+	*Innovative Competition of Risk*	=	*Value for Money -$-*
Private /Public Participant Uses network to procure mat'ls from network based on standards from area of expertise's		*Competition between contractors who can provide the most interactive services*		*Money can be saved by allowing contractor to use existing procurement channels instead of forcing entity to create new ones*

(Allowing qualified contractor to have specification re-adjusted if qualified engineering components in service procurement network).

Appropriate Allocation of Risks:

- ***Intent to minimize costs***
- ***Intent to provide greater financial certainty to public sector***



Public	***Shared***	***Private***
Legislative changes	*Inflation*	*Design*
Changes to project Scope	*Taxation*	*Construction Costs*

Land Acquisition	*Permitting*	*O & M Costs*
Governance	*Catastrophic Evt(s)*	*Operation Performance*
Sustainable political support		*Technological obsolescence*
		Financing Commissioning

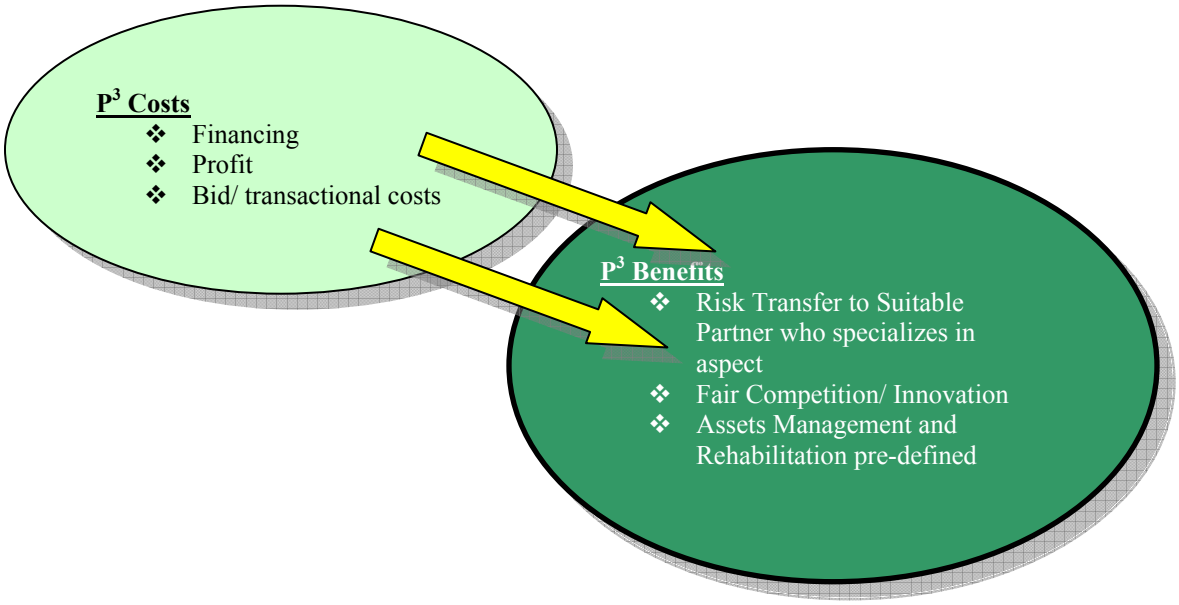
Innovative Competition of Risks:

- *Approach to private sector has proven to be fair and open*
- *Innovative solutions market life cycle costs as oppose to design and construction costs*
- *Increase long-term value for public money*
- *Reduction of tradition restrictions imposed by previous out-of-date specifications*
- ***B**est product provided at **B**est price reflected in **B**est process* **[B^3] analysis.**
- *Strict adherence to operating efficiency to avoid:*
  - *(1) Duplication*
  - *(2) Waste*
  - *(3) Cost Overruns*
  - *(4) Project Delays beyond conveyed procurement durations for products to reduce long term cost*

Value for Money:

Upfront Costs analysis, reduction is cost due to familiar procurement networks and project incentives

"Value for money is assessed by comparing P3 applicant against (PSC) public sector comparator (PSC) Construction Costs < (P3) Construction costs, (P3) Long Term Cost < (PSC) Operations Costs

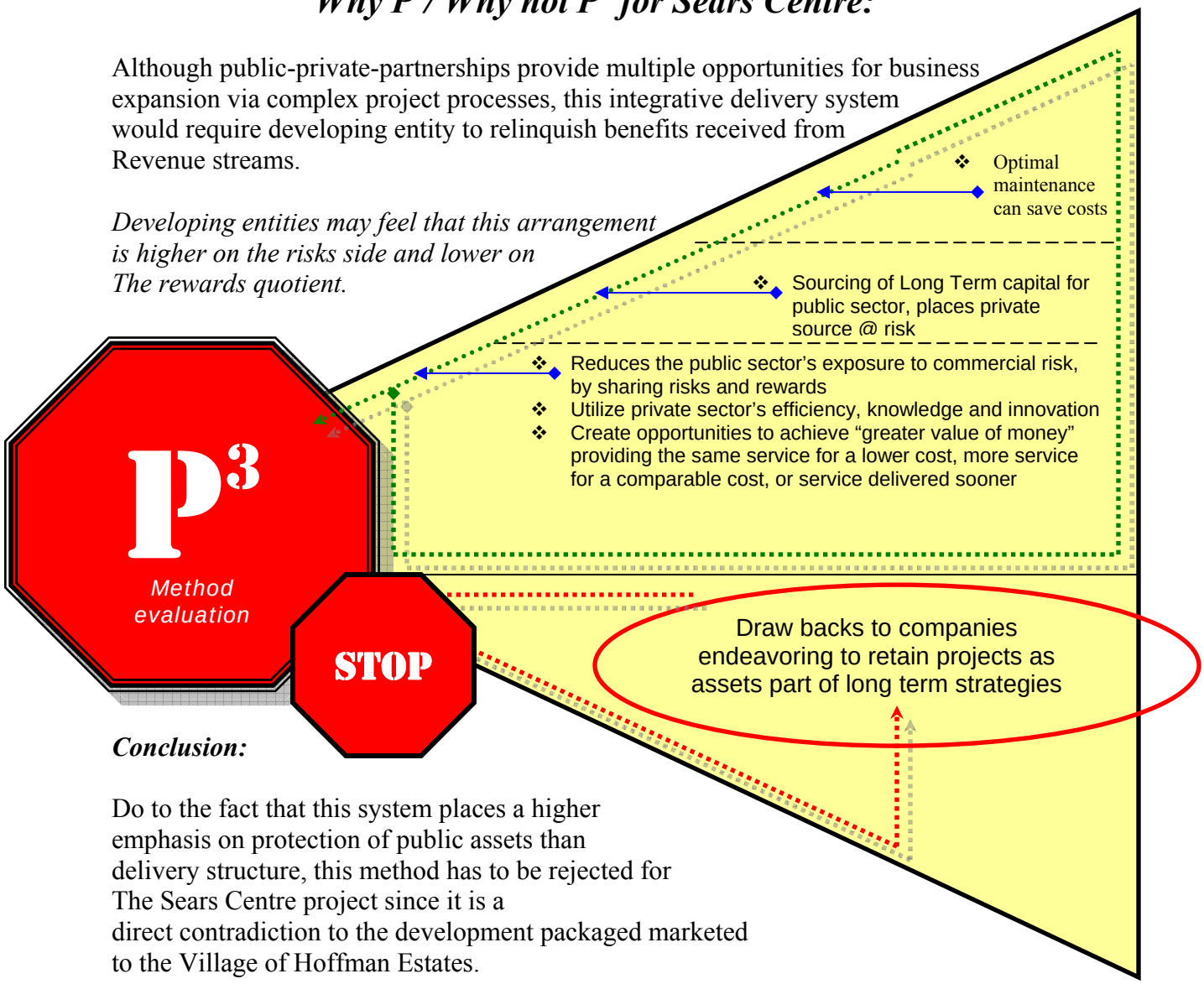


Long term benefits outweigh implementation costs for large projects of high complexity.

Why P³/ Why not P³ for Sears Centre:

Although public-private-partnerships provide multiple opportunities for business expansion via complex project processes, this integrative delivery system would require developing entity to relinquish benefits received from Revenue streams.

Developing entities may feel that this arrangement is higher on the risks side and lower on The rewards quotient.



Conclusion:

Do to the fact that this system places a higher emphasis on protection of public assets than delivery structure, this method has to be rejected for The Sears Centre project since it is a direct contradiction to the development packaged marketed to the Village of Hoffman Estates.

Premise of Development Package:

- ❖ Facility to be provided @ a minimum financial and responsibility cost to village
- ❖ Adherence to financing terms that are nearly guaranteed w/ risks and benefits the contractual arrangement undertaking by the development team

As a result a different integrated delivery system will should be selected which:

- ❖ Maximizes and protects both private and public funds equal with growth incentive
- ❖ Provides indirect compensation for contractor initiated feasibility studies
- ❖ Permits higher potential for incentive if adherence to strict penalties are required

Finalizing the appropriate Integrated Delivery Systems for Sears Centre Project

Inherent project constraints have validated the remaining two integrated delivery methods as probably project delivery systems. The major premise behind these two remaining PDS(s) is the private owner/ private contractor(s) approach to integrated delivery management. As a preference to future arena development, it is important to determine early what conditions would warrant an integrated delivery system for the non-governmental commercial construction industry. Issues that may warrant system use are concise and cover a broad range of topics

Conditions which should consider warranting integrated delivery in private industry:

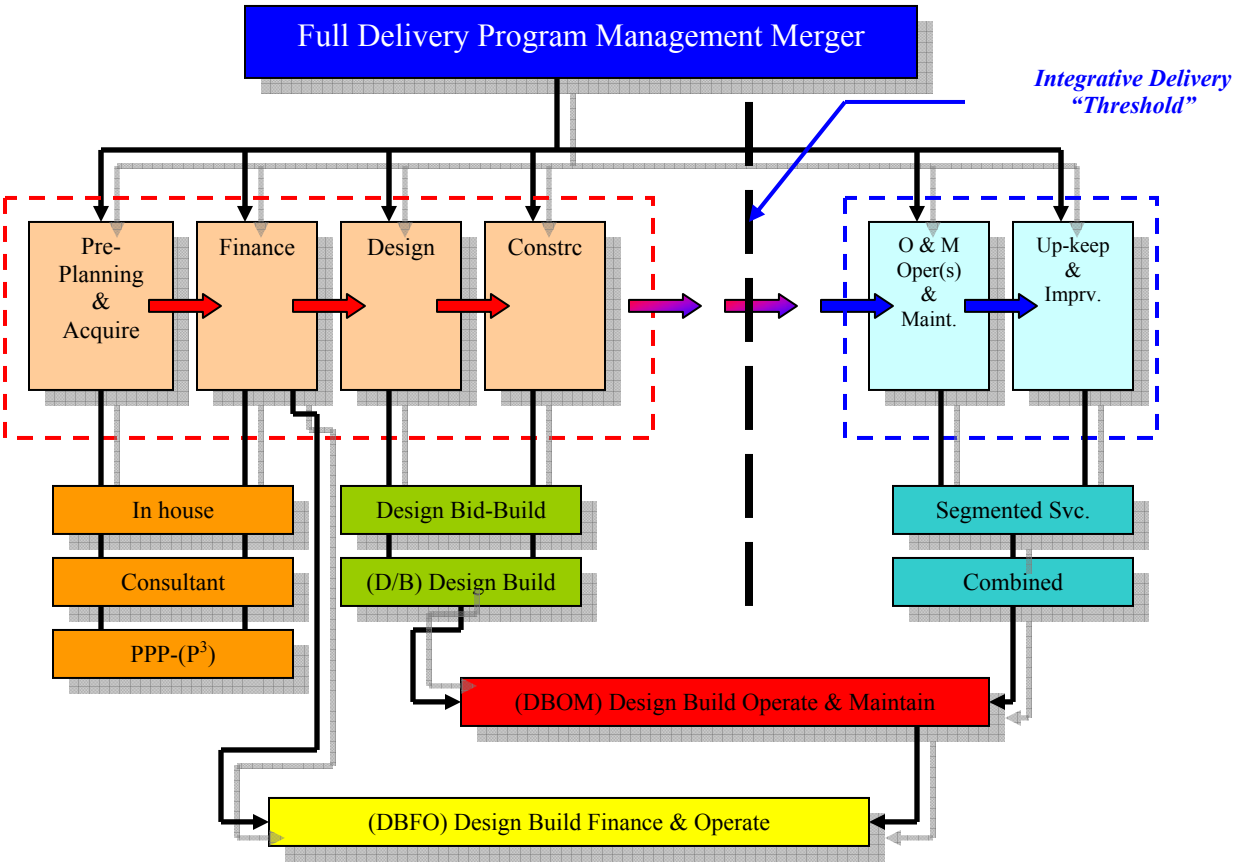
- Aggressive schedule on complex project driven largely by "Liquidated Damage Clauses"
- When building and operations costs have a substantial impact on decision to pursue project
- Overly sensitive time delivery for projects above the $ 40,000,000 cost threshold
- Projects which have significant implication of forecasting the financial future of a region via direct or indirect surrounding development
- Market Forces
- Corporate Strategic Plan forecast
- Growth Opportunities

Strategies used for defining the selection:

- Decide early whether project needs to merge Full Delivery Method with Program Management *(Can be crucial when selected either DBFO or DBOM method)*
- Determine three primary precedence in successive order of importance:

Primary Precedent	*Ascertained Level of Importance*
Time-(Fixed Date Delivery) Proposed Strategy:	☐ (5)-Paramount Importance Flexibility Non-negotiable
	☐ (4)-Strictly adhere to crucial lateral impacts on PDS
	☐ (3)-Important please evaluated for owners approval
	☐ (2)-Equal Precedence
	☐ (1)-Probable for flex adjustment
Quality (Best-Value Products (Best Value Process) Proposed Strategy:	☐ (5)-Paramount Importance Flexibility Non-negotiable
	☐ (4)-Strictly adhere to crucial lateral impacts on PDS
	☐ (3)-Important please evaluated for owners approval
	☐ (2)-Equal Precedence
	☐ (1)-Probable for flex adjustment
Costs-(Fixed Budget) Proposed Strategy:	☐ (5)-Paramount Importance Flexibility Non-negotiable
	☐ (4)-Strictly adhere to crucial lateral impacts on PDS
	☐ (3)-Important please evaluated for owners approval
	☐ (2)-Equal Precedence
	☐ (1)-Probable for flex adjustment

- Determine estimated maintenance and operations costs of project
- Evaluate the condition of in-house facilities management if applicable, other wise compute the costs benefit of joint venturing or purchasing O&M firm who specializes in potential project
- Embed "VE" with cost reduction initiatives
- Evaluated contractor/ construction entity procurement network
- As a side note reference "Lean and 6σ" Strategies in process improvement
- Evaluate Contractor/ Subcontractor incentives for time/ or costs reduction measures
- Determine optimum owner-client/design entity payment structure
- Compute project life-cycle
- Determine maintenance duration
- Analyze possible revenue streams on project
- Calculated initial investment loss if it to be reimbursed by owner at owners expense



Selecting the preferred method:

Premise of [BOT]-Build Operate Transfer Model: "Private Finance"

The 'BOT' approach enlist the duties of a private party (concessionary) retained as a concession for a fixed period from a public party or client (principal). The concessionaire(1) will assume the responsibilities for the development and operations of the proposed facility. Development consists of (1) Financing, (2) Design and Construction of facility, (3) Adequately managing and maintaining facility per agreed upon standards and (4) creating a profitable property during and beyond concession period. Return on investments is secured by the concessionaire while operating property pre principal turnover. At the end of the 'concession period' the facility is successful handed to the principal free of liens and at now costs to client. During the arrangement construction costs incurred for project are reimbursed prior to turnover date.

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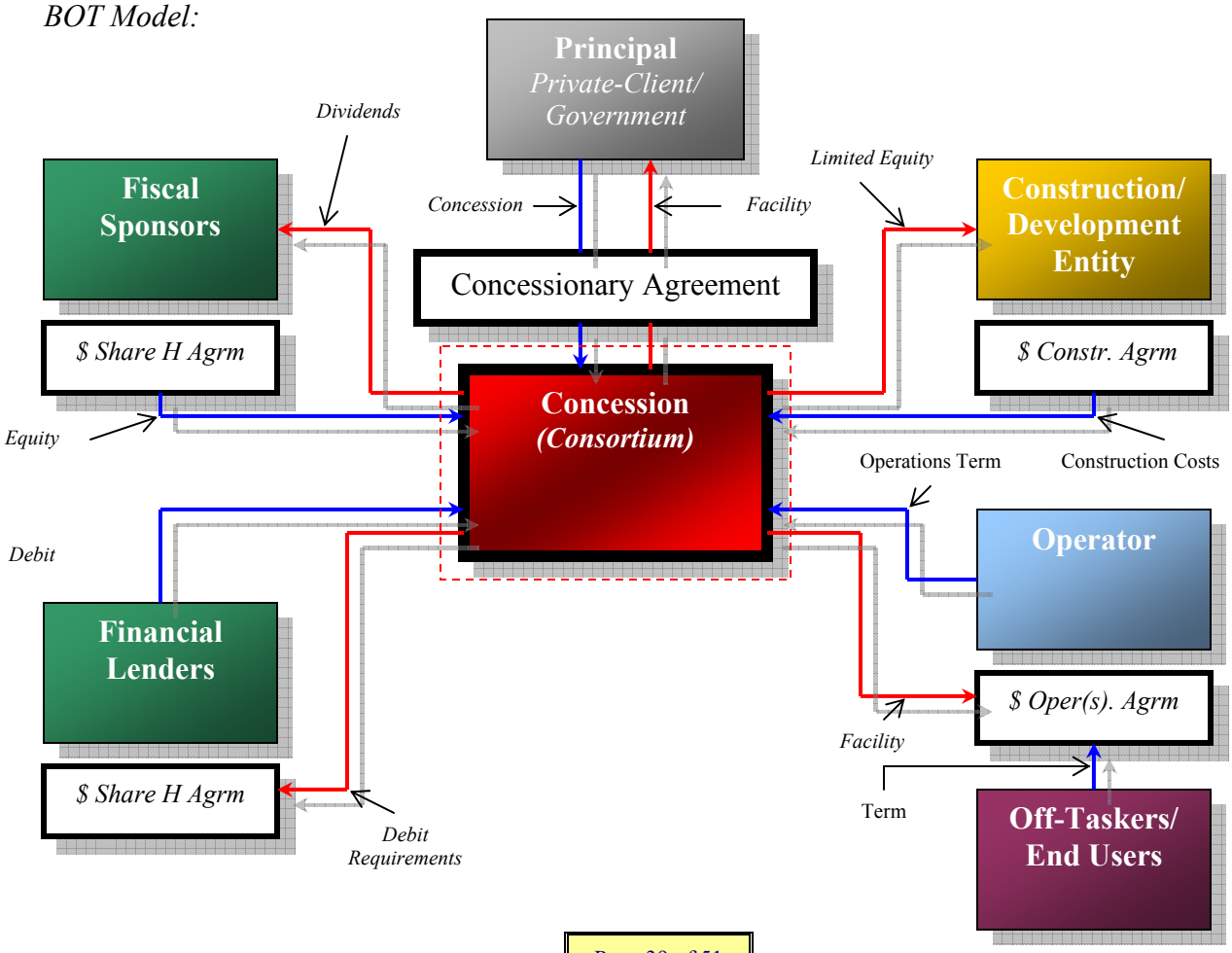
(1) Concessionary – an entity whom enters a contractual agreement to profit from performance of rendered services to a client for a specified duration. During this duration the concessionary asks as the "pseudo-owner" and operates all functions of the property

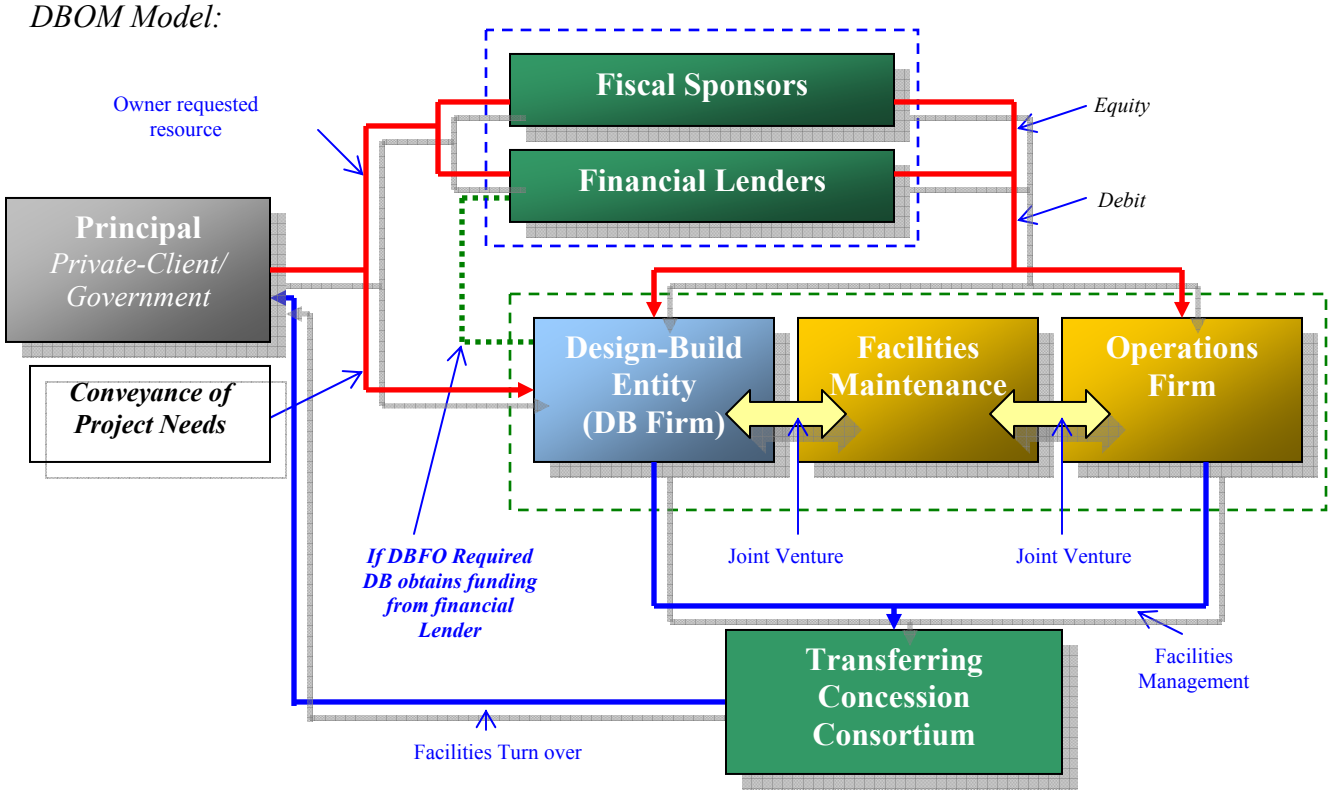
BOT Model:



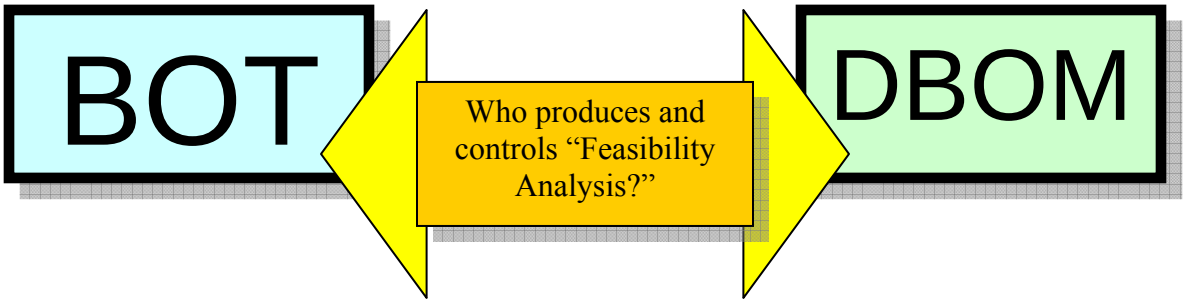
Premise of [DBOM]-Design Build Operate Maintain Model: Long Term Asset(s) management

Construction entity performs the role of facility operator in addition to the (1) pre-construction services, (2) design and (3) actual construction of project. The construction entity will enter a "joint-venture" and/ or absorb a design build firm and operations management company. Similar to a design-build contract, one master contract is distributed to client to cover the costs of facilities development = construction + operations. When financing becomes part of the scope requested by the client services are melded to create a hybrid (DBFO)- *"Design Build Finance and Operate"* approach. Typically the prescribed O & M contract duration is between 10 to 15 years, however for complex projects of large scale use longer durations should be evaluated *(20 to 30 year time frame)*. The introduction of an O & M team allows designers and contractors to reference necessary procedures and O & M knowledge bases for accurate life cycle costs. Upon contract award, client negotiates a construction costs needs and O & M contract requests for a specified period. If actual costs for facilities and maintenance operations exceed the "CM" fee, costs will be absorbed by the construction entity. As a result, this method is most suitable for a GMP/ GMAX/ Reimbursable structure. Equally important to this delivery method are the incentive/ dis-incentive (penalties) used for project completion.

DBOM Model:



Primary Difference between BOT & DBOM:



Feasibility Study
Initiated by Construction Entity *(Contractor control)*

Feasibility Study
Initiated by Owner *(Owner control)*

Finalizing which integrated delivery method to pursue largely depends on the delivery method selected in the above PDS. Under normal conditions, the owner is defined as a client who doesn't influence the workings of business strategies internally. Since a joint internal relationship exist between Ryan Companies and CCO Entertainment, in order to reconcile this difference, both entities will assume a client base relationship where CCO (Owner) contracts services from Ryan Companies (Construction Entity).
Decisions base on assumed decision from selection criteria chart:

Preferred PDS Selected		Preferred PDS Selected
CMA / CM@ Risk	BOT Track	DB
Master Contract Arrangement (Assumed)	DBOM Track	Master Contract Arrangement (Assumed)
☐ Unit Price (Not Valid) ☒ Lump Sum ☐ Cost Plus ☐ GMAX ☐ Added Incentives?		☐ Unit Price (Not Valid) ☐ Lump Sum ☐ Cost Plus ☒ GMAX ☒ Added Incentives?
Maintenance Options		Maintenance Options
Maintenance Option via: ☐ In house ☒ Joint-Venture ☐ Firm Buyout	*Question to Finalize Delivery Method Used*	Maintenance Option via: ☒ In house ☐ Joint-Venture ☒ Firm Buyout
Commissioning Experience: ☒ Experienced ☐ Intermediate ☐ Will need to acquire	**Feasibility Assess Studies provided for owner?** **( ) Yes ( ) No**	Commissioning Experience: ☒ Experienced ☐ Intermediate ☐ Will need to acquire
Level pre-construction services offered	Use BOT / Use DBOM	Level pre-construction services offered
☐ Design/ Constr. Review ☒ VE Analysis		☒ Design/ Constr. Review ☐ VE Analysis

☐ Procurement Solutions ☒ Financing Alternates ☐ Substantial Bond Cap. ☐ Develop Solutions		☒ Procurement Solutions ☒ Financing Alternates ☐ Substantial Bond Cap. ☒ Develop Solutions

Staying consistent with the PDS network at this point the recommended Integrated Delivery System to be used on the Sears Centre Project is DBOM. Implementing integrated delivery systems are a healthy way to develop a procurement network to maximize profits when incentives are specified.

Substantiating the decision to use DBOM for (Sears Centre):

- DBOM acts a quality baseline for design and construction of private projects similar to quality assurance guidelines of a P3 model less the inappropriate protection of private funds.
- DBOM diminishes the challenges of start-up problems, claims and system integration
- Reduces opportunity for cost growth while simultaneously increasing likelihood of achieved financial targets ($ 50,000,000 contract limit imposed by master contract negotiation)
- Accelerates completion schedule by providing scheduling certainty upfront
- Providing Sustainability:
  - Using inherent contract incentive structure (typically established as high as 25% of subcontract amount for meeting condition)
  - Reduction in risks related to system integration by requiring (DBS) Design-Build –Supplier to work together on solutions
  - Cost savings can be used to fund cost of higher performing products for building systems ($Costs implements appear nearly invisible to owner)
  - Reduction in energy usage/ fractional implementation life cycle analysis for project regardless of “Green Status”
- Financial Benefits:
  - Baseline cost of O & M of building can be distributed as set amount to reduce an flocculation
  - Reduction in the owners capital costs/ long term budget savings
- Commissioning Responsibilities:
  - Third party commissioning to reduce bias assessment in the evaluation and calibration of building system components
  - Commission moved to contractor controlled service as part of project delivery package
- Project Processing:
  - & M firm to be integrated in design and construction panel for project during pre-construction phase
  - Establishment of effective communication and electronic database log
- Elimination of “Profit Protection”:

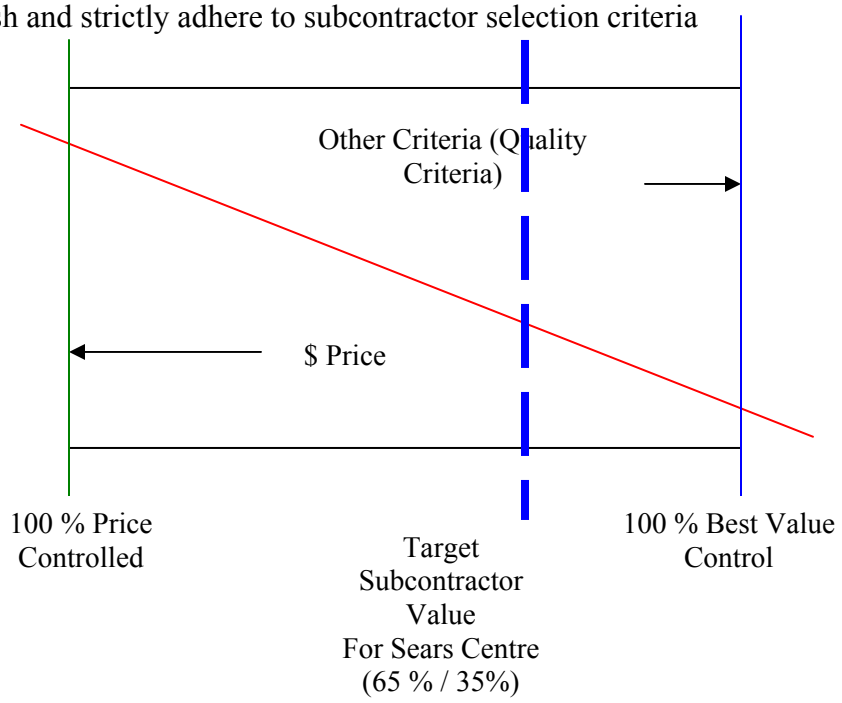
- ❖ DBOM established incentive make obtaining a profit impossible without assurance of product and process quality

Extended Maintenance Contract (Project Plus):

- ❖ Extended Maintenance Contract (10-15 Yr(s) < 20-30 Yr(s)) reduction in long term system costs

Key Concern:

- ❖ DBOM will have a lengthy RFP process. All proposal should be viewed based on best value intent, not price
- ❖ Establish and strictly adhere to subcontractor selection criteria



- ❖ Require all participants to submit RFI *(Request for Intent)* prior to life cycle costs analysis.
- ❖ Be careful not to set incentive or penalty schedule too high, may have an adverse affect on project subcontractors performance or willingness to bid project

Inherent benefits and drawbacks to DBOM delivery for Sears Centre by comparison:

Delivery Method	Advantages	Disadvantages
D-B-B	• Long History of Acceptance • Open Competition • Distinct Roles are Clear • Owner Flexibility • Easy to Tender	• Innovation Not Optimized • Usually results in cost overruns • Disputes between parties • Client Retains Most Risks

		• Usually Low Bid – Incentive for Change Orders • Owner Responsible for Errors & Omissions • Linear Process
D-B	• Reduced Administration • Single Sourced Responsibility • Quality Equal or Better than D-B-B • Innovative • Costs Savings • Project Completed Faster • Improved Risk Management • Early Knowledge of Total Costs • Accountability • Constructability Optimized • Early Partnering Potential & Trust Building • Integrating Design & Construction • Most Risks Transferred to the Design-Builder • Design Reflects Contractor Strengths & Ability • More Rewards/ Profit for Contractors • GMAX Preferred	• Limited Competition • High Tendering Costs • New Method & Unfamiliar with process • Client needs to make quicker decisions • Clients Bringing Design Requirements > 30% • (Reduces innovation)
CM @ Fee **CM @ Risk**	• Provides a Managing and Administering for all phases of a project • Treats Planning, Design Construction as an Integrated Tasks • Some Costs and Schedule Control • Good for Clients with insufficient staff • Owner Flexibility • Response for Time & Costs overruns • Holds & Manages the Trade Contractors • Constructability Design Review • Same Legal Position as a General Contractor • Provides a GMAX • Works Closely as a Teaming Effort for	• No Contractual Relationships with Trade contractors • No Contractual Responsibility for outcomes of project • Client Retains the Risks • Duplication of Administration & Additional paper work • Fast Tracking Difficult to Control with Designer & CM • Sometimes difficult to manage all phased packages with costs, changes & schedule

	• Partnership • Owner Flexibility	
DBOM	• Integrates the Process of Design, Construction, and Maintenance • One Contract for All Services and Products • Maintenance & Any Operations Aspects can be considered during design • Projects Completed Faster • Better Life Cycle Costs • Similar Benefits Earlier Mentioned in D-B	• Longer Tendering Process • Costly Tendering • Similar disadvantages as earlier mentioned in D-B
DBFO	• Complete projects that could not normally be accomplished wit internal funding • Integrates the process of design, construction and maintenance • Maintenance & Any Operations Aspects can be considered during design • Projects completed faster • Better Life Cycle Costs • Better Net Present Value (NPV) • Similar Benefits Earlier mentioned in D-B • Private Financing with no revenue Risk	• Costs more in the Long Run • Longer Tendering Process • Costly Tendering • Similar Disadvantages as earlier mentioned in D-B • Difficulty with Long Term Relationships • Future Political Changes May not accept/ agree with prior agreements/ commitments
FD or PM	• Shorter Time to Project Completion • Fully Integrated Process From Project Inception • Maximizes Planning & Reduces Problems during execution • Knowledgeable Alternative Funding Sources • Good for Large & Complex Projects • Single Source of Expertise • Quality should be greater	• Difficult to tender and not knowing costs • Compatibility issues with client • Quality Based Selection Process (Negotiated) • Client Needs to make decisions quicker
BOT & BOOT	• Same Benefits as DBFO • Usually for Toll Roads • Includes the Operations Aspects • Ownership is Transferred	• Same Disadvantages as DBFO • Difficulty with Long Term Relationships • Future Political Changes may not accept or agree

Feasibility of Proposed Integrated Delivery System

Criteria used in evaluating the validity of proposed PDS for Sears Centre:

- *On Time Delivery*
- *Delivery Under budget*
- *Break Even Analysis time frame duration*
- *Excellence in Design*
- *Remaining True to corporate identity through accountability measures*
- *MBE/ WBE participation*
- *Adherence to appropriate trade wages*

Analysis of Capital Costs merger and profitability of project:

- *Computing Maintenance Costs*
- *Computing Operations Costs:*
- *Computing Yearly Profit and Overall Profit of Deficient for yearly operation*
- *Arena Depreciation*
- *Depreciation Basis of an asset using straight line depreciation*

Preliminary Fiscal Analysis

Depreciation Basis of an asset = $C - S_n$
Initial Assets Cost [C]
Assumed salvage value of asset = [S_n] = $25,000,000
(Assuming Arena asset will be worth half its value 50 years from completion)

Straight Line Depreciation = $D_i = (C - S_n) / N$
N = 50 Yr(s)

$D_{(Sears\ Centre)}$ = [$ 50,000,000 - $ 25,000,000] / 50 = $ 500,000 annual depreciation

Yearly Operations Costs (Based on time, location factors to San Diego Convention Center & San Diego, CA → Chicago, IL CPI indices)

Assumed Sears Centre yearly Operations Costs = $ 4,479,000

Yearly Maintenance Costs (Based on location and size factor to Bryce Jordan Center)

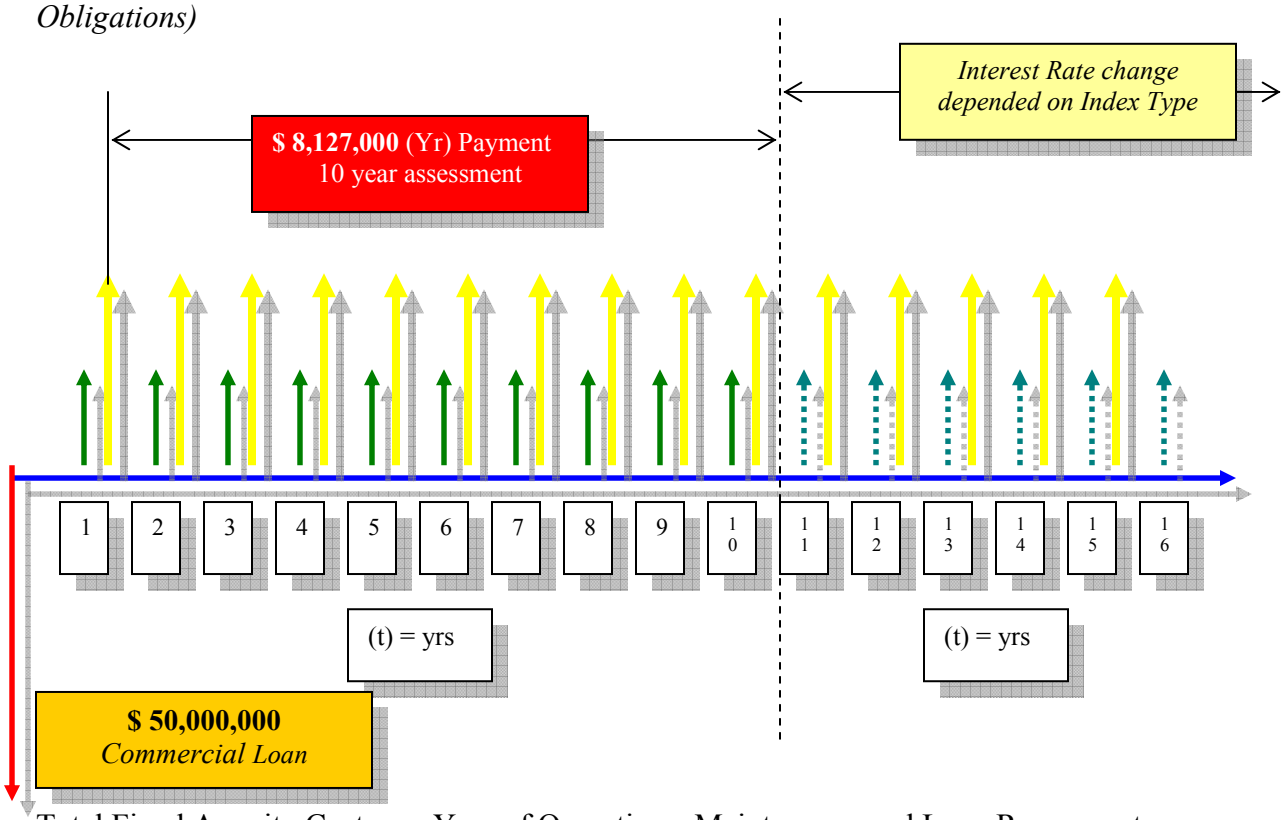
Assumed Sears Centre yearly Operations Costs = $ 448,000$_{(less\ ME\ VE)}$ = $ 422,200

GOAL	DBOM	DB w/ Outsourced O & M	DB w/ In-House O & M
On Time Delivery			
• Early certainty reschedule	Yes	Yes	Yes
• Delivery within schedule	High probability	High probability Note: additional interfaces increase risk of delayed opening	High probability Note: additional interfaces increase risk of delayed opening
Delivery Under Budget			
• Early certainty of re-construction costs	Yes	Yes, Note: Price likely to be higher than for DBOM approach due to Contractor uncertainty of operations via 3rd party O & M procedures for Arena	Yes, Note: Price likely to be higher than for DBOM approach due to Contractor uncertainty of operations via 3rd party O & M procedures for Arena
• Avoidance of construction of cost growth	Highly Probable	Probable	Probable
Break Even-On Operations by Specified Date			
• Early certainty re O & M costs, thus facilitating planning to achieve goal	Base O&M cost provided on a percentage base, long term goal to be fixed for a 30 yr duration evaluated every 10 yr(s) of operations	O & M costs must be estimated for planning purposes; actual amount will be determined only when the contract is awarded; contract will probably be long-term, increasing value of information for planning purposes	O & M costs must be estimated for planning purposes; Long Term information requested
Excellence Design			
• High quality design/ construction • Addressing life cycle cost	Probable—DBOM provides incentives for contractor to address O & M issues during design and construction	Since there is no built-in incentive to improve design to reduce life cycle costs, the owner should consider alternative means of achieving that goal.	Since there is no built-in incentive to improve design to reduce life cycle costs, the owner should consider alternative means of achieving that goal.
• Efficiently managing systems	Due to the complexity of the system and likelihood of glitches during the initial operations period, the system	This approach would require owner to manage interface between design/	This approach would require owner to manage interface between design/

integration into operations phase	designer and supplier is the best qualified to correct start-up challenges, achieve reliability most quickly and avoid claims and disputes between multiple contractors or contractor and owner	construction and O & M personal, creating opportunity for contractor claims and allowing arguments that O & M caused problem. Also owner would need to hire O & M staff/ consultants to provide input into design and construction Note: Third party probably will not be able to perform as well as the system supplier during the initial operations phase. If problems arise during O & M period, contractor may claim they are due to faulty maintenance or operator error	construction and O & M personal, creating opportunity for contractor claims and allowing arguments that O & M caused problem. Also owner would need to hire O & M staff/ consultants to provide input into design and construction Note: Owner probably will not be able to perform as well as the system supplier during the initial operations phase. If problems arise during O & M period, contractor may claim they are due to faulty maintenance or operator error
• Environmental Sustainability	Yes (Contract performance standards compliance mechanisms required.)	Yes (Contract performance standards compliance mechanisms required.)	Yes (Contract performance standards compliance mechanisms required during DB phase; direct owner control during O & M phase)
Remain True to corporate identity as a EOE DB			
• Social sustainability (family wages/ benefits)	Yes (O & M contract performance standards and compliance mechanism required.)	Yes (O & M contract performance standards and compliance mechanism required.)	Yes (Direct control by owner)
• Diversity (during Construction and O & M) • MBE & WBE Solicitation • Adherence to Trade Wages (Equal Comp. Process)	Yes (O & M contract performance standards and compliance mechanism required.) Note: DBOM offers long-term opportunity to strategize and collaborate with contractor. RFP/ RFI requirement to include "up-front" proposal for MBE/ WBE solicitation during Construction and O & M stage during project life span	Yes (O & M contract performance standards and compliance mechanism required.)	Yes (Direct control by owner)

Financial Verification of proposed Method
(Cash Flow Cost/ Benefits Assessment)

Assumed Cast Flow Curve Strictly for ∑ (DB Services, Maintenance and Operations Obligations)



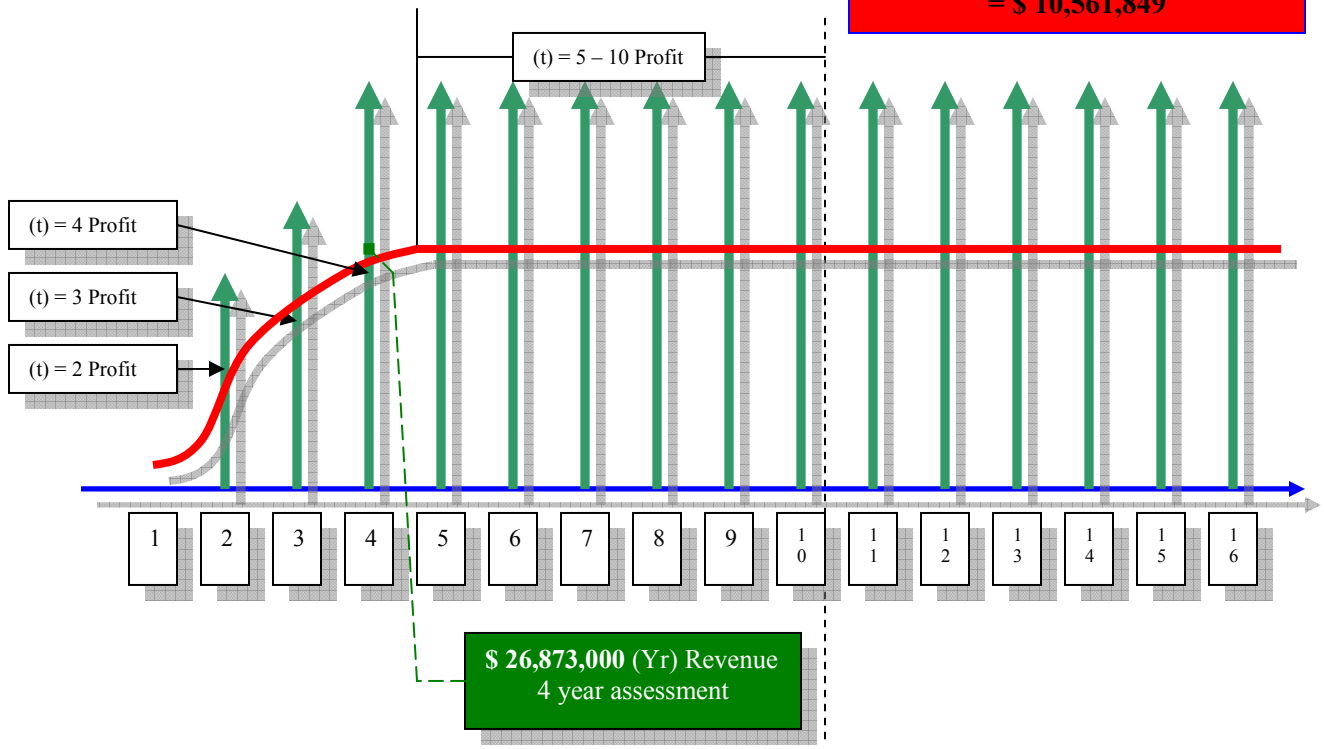
Total Fixed Annuity Costs per Year of Operations, Maintenance and Loan Repayment

	10 yr Annuity Loan Payment		$ 3,200,000	
(Capital Cost incl.) →	Annual Maintenance		$ 448,000	*($ 422,200)*
	Operations (Yearly)	+	$ 4,479,000	
	Total Annuity Payment		$ 8,127,000	*($ 8,101,200)*

Project Costs during a 10-yr operations cycle will amount to $ 81,270,000, which is roughly (2) times the amount of the construction cost. This further validates the use of an integrated delivery system for the Sears Centre project. With a contingency plan for purchasing a critical HVAC Unit, Electrical Component and absorbing a maintenance operation a 10-yr arena costs could easily approach $ 90,000,000. Equally important to the decision to pursue this type of delivery is computation of the project profitability. Profitability come from several sources, the Sears Centre plan, as with most sports facilities is to generate revenue from (1) Suite Sales, (2) Ticketing and (3) Event booking. Galliard, LLC (A leading sports facility and entertainment consultant) has calculated that the current project will yield annual revenues, directly attributed to Sears Centre operations at an estimated $35,000,000 an additional $ 37,000,000 million attributed to indirect sales, via enticed developments of the region.

Assume total yearly costs with taxes:
$ 8,127,000 x ∑ (1, 20%, 9.964%)
= $ 10,561,849

Perceived Cash Flow for 10 yr revenue source:



Perceived Yearly Revenues		$ 35,000,000
Total Yearly Costs	(less)	$ 11,000,000 (Misc. Svc.& Tax)
Yearly Income		$ 24,000,000

Costs/ Benefit Analysis:

Year	Costs	Yearly Income
1	($ 3,100,000)	$ 3,900,000
2	($ 11,000,000)	$ 5,300,000
3	($ 11,000,000)	$ 7,655,000
4	($ 11,000,000)	$ 15,873,000
5	($ 11,000,000)	$ 24,000,000
6	($ 11,000,000)	$ 24,000,000
7	($ 11,000,000)	$ 24,000,000
8	($ 11,000,000)	$ 24,000,000
9	($ 11,000,000)	$ 24,000,000
10	($ 11,000,000)	$ 24,000,000
(∑ Sum Total) =	**($ 102,100,000)**	**$ 176,728,000**

Benefit Analysis

Using the DBOM approach, a DBOM consortium (CCO-Entertainment-Ryan Companies) would be responsible for incurring ($ 3,100,000 @ yr (1) and $ 11,000,000 @ 9 yrs) a cumulative debt of $ 102,000,000 for a 10 yr span. The same PDS will intern generate $ 24,000,000 of income, starting at year (5), to return a 10 year profit of $ 176,628,000, nearly 4 *(353 %) times* the amount of the entire construction cost. The arrangement if worked properly will pay for itself within 5 yrs of the Sears Centre Operations.

Five Year Analysis:

$ 3,900,000 $_{(t = 1)}$ + $ 5,300,000 $_{(t = 2)}$ + $ 7,655,000 $_{(t = 3)}$ + $ 15,873,000 $_{(t = 4)}$ + $ 24,000,000 $_{(t = 5)}$ = [$ 56,728,000$_{(\text{Five Year Profit})}$ + $ 5,000,000$_{(10\% \text{ Fee})}$]

Total Five Year Profit = $ 61,728,000

Measurable Benefit = $ 61,728,000 - $ 50,000,00 = $ 11,728,000

Integrated Delivery System Conclusion

Final recommendation for the Sears Centre Delivery is to employ the use of a hybrid integrated delivery systems that merges third part financing using a concessionary arrangement similar to a Design-Build-Operate-Finance approach. Since the master construction contract was executed as a Design-Build GMAX/ this arrangement should carry over for administration of all O & M services. Project procurement should follow the requirements out line in a DBOM approach which were adopted from a P^3 arrangement.

PDS Recap

- Financing
- Procurement & Contracting
- O & M Services

Delivery System Structure

Use DBFO Approach
Use BOT Strategy
Use (GMAX) incentive

By revisiting the initial selecting criteria, it was determined that since Ryan Companies will assume the General Contracting/ CM Agency role for producing a product for internal transfer, the most probable delivery model most suited for this project is……

Build Operate Transfer

- If MVE *(Mechanical Value Engineering)* measures are implemented Sears Centre could save $ 25,800 annual, over a 10-yr period amount saved is $ 258,000. (10 yr total payback ➡ $ 176,986,000)

Executive Summary

This construction management supplement deals directly with evaluation of cost recapture for using Cast in Placement concrete instead of the present Pre-cast system. Over the past 30 years arena construction has used pre-cast installation for time sensitive projects: Note worthy projects which have employed the use of Pre-cast Concrete for building superstructure is listed below.

1. **Great American Ball Park** — *Cincinnati, OH*
2. **Jacobs Field** — *Cleveland, OH*
3. **Quicken Loans Arena *(Gund Arena)*** — *Cleveland, OH*
4. **Pacific Bell Park** — *San Francisco, CA*
5. **Palace of Auburn Hills** — *Detroit, MI*
6. **Erickson Stadium** — *Charlotte, NC*

According to industry sources, the costs of pre-cast installation is less expensive than a cast-in-place concrete method when Chicago, labor rates are factored in costs. An evaluation was completed to determine the costs and time analysis for constructing the Sears Centre concrete superstructure from CIP instead of Pre-cast concrete. The overall cost differences between the two methods, assuming comparable crew sizes were computed to be:

	Concrete Placement Method		***Associated Costs***
	Pre-cast	→	***$ 989,966***
(less)	*Cast-in-Place*	*(less)*	***$ 615,947***
	Cost Difference		***$ 373,919***

Unfortunately the saving presented for using a CIP alternative cannot be realized as benefit due to a conservative project overrun of 35 Days beyond the negotiated, penalty enforce turn over date. If time were not an issue with the fixed turnover date, Cast-in-place concrete would be a lucrative method of cost recovery, assuming time frame has at least 1 to 2-months of flexibility.

CIP/ Pre-cast Costs Comparison

An analysis was performed to determine the cost and time associated with using a CIP method for the Sears Centre superstructure, in lieu of the current Pre-cast concrete placement. Due to inherent project constraints, the Sears Centre project is mandated to adhere to all implications specified by Chicago-land unions. One of the dominate entities of Chicago unions is the Carpenter's local. This will have an apparent effect on the constructability of the Sears Center. Nearly 70% of the building superstructure is composed of pre-cast concrete. The decision to pursue cost recapturing via CIP analysis will be based on three determinants:

Pre-cast ⇨ CIP Determinants:

- Union Factored Labor Costs
- Formwork Costs (Bent Raker Form Costs)
- Time Durations

The purpose of the analysis is to determine the magnitude of the costs which can be recaptured via a CIP installation system. If the desired trade off is substantial, condition will warrant further evaluation. The current pre-cast system was chosen for the specific purpose of obtaining the negotiated deadline between Ryan Companies (Design-Builder and CCO Entertainment, September 18, 2006. In order to efficiently compare the two concrete placement method a trade of costs benefit analysis will have to be determined to calculated the costs/ day of overrun will have to be computed.

Superstructure Systems comparisons:

Benefits of Pre-cast construction (Chicago Market)

- Benefits of Pre-cast
- Ease of physical procurement
- Erection can take place in any temperature climate ("All weather erection")
- Curing time eliminated
- Union Labor Manufacturing Costs Eliminated
- Reliability of Pre-cast suppliers
- Industry movement in resent years has employed the use of pre-cast concrete for arena and stadium superstructure
- Bent Form costs eliminated
- Less labor intensive

Drawbacks of CIP (Chicago Market)

- Increase Labor prices due to union locals
- Longer Cure times and project durations
- Weather dependent/ Project duration delays can only be estimated "At best scenarios"

- Steel pricing for rebar also affected by labor installation costs, as opposed to mat'l costs

Key Labor Constraints for CIP Construction

Carpenter Hourly Rates:

- *R.S. Means* — *$ 35.55/ HR*
- *Chi Labor Factor Costs* — ***$ 47.52/ HR***

Δ (Hourly Cost Difference) = ($ 11.97/ HR)

Structural Steel Workers:

- *R.S. Means* — *$ 39.95/ HR*
- *Chi Labor Factor Costs* — ***$ 49.45/ HR***

Δ (Hourly Cost Difference) = ($ 9.50/ HR)

Concrete Workers:

- *R.S. Means* — *$ 34.40/ HR*
- *Chi Labor Factor Costs* — ***$ 47.86/ HR***

Δ (Hourly Cost Difference) = ($ 13.46/ HR)

Machine Operator:

- *R.S. Means* — *$ 38.10/ HR*
- *Chi Labor Factor Costs* — ***$ 53.78/ HR***

Δ (Hourly Cost Difference) = ($ 15.68/ HR)

- Increase completion time duration (attributed to concrete installation and curing time)

Drawbacks of Pre-cast construction (Chicago Market)

- More expense up front costs
- Lengthier procurement cycle
- Requires increase time for logistical analysis "Shake down" Area similar to steel construction

Benefits of CIP (Chicago Market)

- Less expensive to install
- Elimination of "Shake down" Area

Cost Recapture Strategy:

- *"What is the cost difference between a CIP and Pre-cast Installation?"*
- *"How valid is the upfront decision to use pre-cast over CIP for this project?"*
- *"What is the cost vs. time duration pay off?"*

Identify Member(s) under CIP Evaluation:

- *Please reference accompanying appendix section*

SEARS CENTRE

Construction Management Supplement

Time Impacts: *(Current method – Pre-cast Concrete Superstructure)*

ID	Task Name	Duration	Start	Finish	Predecessors
45	F/R/P bowl column pads	6 days	Wed 9/7/05	Wed 9/14/05	44
46	F/R/P wall T-8 to U-10	5 days	Tue 9/13/05	Mon 9/19/05	43
47	F/R/P wall U-10 to U-14	5 days	Tue 9/20/05	Mon 9/26/05	46
48	F/R/P wall U-14 to U-18	5 days	Tue 9/27/05	Mon 10/3/05	47
49	F/R/P wall U-18 to L-18	5 days	Tue 10/4/05	Mon 10/10/05	48
50	Backfill walls @ west end halfway	2 days	Tue 9/20/05	Wed 9/21/05	46
51	Install Tie-backs @ west end	5 days	Thu 9/22/05	Wed 9/28/05	50
52	Backfill west end to top	3 days	Thu 9/29/05	Mon 10/3/05	51
53	Backfill wall line U half way	2 days	Tue 10/11/05	Wed 10/12/05	49
54	Install Tie-backs @ wall line U	6 days	Thu 10/13/05	Thu 10/20/05	53
55	Backfill wall line U to top	2 days	Fri 10/21/05	Mon 10/24/05	54
56	Backfill wall line 18 half way	1 day	Wed 10/19/05	Wed 10/19/05	54FS-2 days
57	Install tie backs @ wall line 18	3 days	Thu 10/20/05	Mon 10/24/05	56
58	Backfill wall line 18 to top	2 days	Tue 10/25/05	Wed 10/26/05	57
59	Dig piers @ column line B.4	1 day	Thu 9/15/05	Thu 9/15/05	45
60	F/R/P Piers line B.4	1 day	Fri 9/16/05	Fri 9/16/05	59
61	Dig foundation @ column line B (North wall)	1 day	Mon 9/19/05	Mon 9/19/05	60
62	F/R/P Foundation Wall column line B	2 days	Tue 9/20/05	Wed 9/21/05	61
63	Dig Piers in west saddle bag area, near Column line 2	1 day	Tue 10/4/05	Tue 10/4/05	61,52
64	F/R/P Piers in west saddle bag area	1 day	Wed 10/5/05	Wed 10/5/05	63,62
65	Dig/ trench west saddle bag foundation walls	1 day	Wed 10/5/05	Wed 10/5/05	63
66	F/R/P west saddle bag foundation walls	2 days	Thu 10/6/05	Fri 10/7/05	65,64
67	Dig/ trench Piers @ column line V (South saddle bag area)	1 day	Thu 10/6/05	Thu 10/6/05	65
68	F/R/P piers at column line V (South saddle bag area)	1 day	Fri 10/7/05	Fri 10/7/05	67
69	Dig/ Trench south saddle bag foundation wall	1 day	Fri 10/7/05	Fri 10/7/05	67
70	F/R/P south saddle bag foundation wall	2 days	Mon 10/10/05	Tue 10/11/05	69,68
71	Masonry North side	10 days	Tue 9/20/05	Mon 10/3/05	61
72	Masonry West end	10 days	Mon 10/10/05	Fri 10/21/05	66
73	Masonry South & East end	14 days	Wed 10/12/05	Mon 10/31/05	70
74	(Masonry complete Exterior)	0 days	Mon 10/31/05	Mon 10/31/05	71,72,73
75	Pre-cast Erection	96 days	Tue 10/4/05	Tue 2/14/06	
76	Pre-cast Erection North side complete (Columns, Rakers,	20 days	Tue 10/4/05	Mon 10/31/05	52,45
77	Pre-cast Erection West side complete	26 days	Tue 11/1/05	Tue 12/6/05	76,52
78	Pre-cast Erection South side complete	20 days	Wed 12/7/05	Tue 1/3/06	77,55
79	Pre-cast set from outside bowl	30 days	Wed 1/4/06	Tue 2/14/06	78,74
80	Steel Erection & Misc.	132 days	Wed 12/7/05	Thu 6/8/06	
81	Steel Assembly	20 days	Wed 12/7/05	Tue 1/3/06	78FS-20 days
82	Erection of the Main Roof Trusses	50 days	Wed 1/4/06	Tue 3/14/06	78,81FS-15 days
83	Erection of Sway Trusses	50 days	Thu 1/5/06	Wed 3/15/06	82FS-49 days
84	Erection of Joists	50 days	Fri 1/6/06	Thu 3/16/06	83FS-49 days
85	Misc. Steel Detailing	50 days	Mon 1/9/06	Fri 3/17/06	84FS-49 days
86	Erect Mechanical Catwalk	15 days	Fri 2/17/06	Thu 3/9/06	84FS-20 days
87	Erection of West 1/3 of Deck	5 days	Fri 2/3/06	Thu 2/9/06	84FS-30 days
88	Erection of Middle Deck	5 days	Fri 2/17/06	Thu 2/23/06	84FS-20 days,87

SEARS CENTRE

Construction Management Supplement

Time Impacts: ***(Alternative Method Cast-In-Place Concrete Placement)***

ID	Task Name	Duration	Start	Finish	Predecessors
45	F/R/P bowl column pads	6 days	Wed 9/7/05	Wed 9/14/05	44
46	F/R/P wall T-8 to U-10	5 days	Tue 9/13/05	Mon 9/19/05	43
47	F/R/P wall U-10 to U-14	5 days	Tue 9/20/05	Mon 9/26/05	46
48	F/R/P wall U-14 to U-18	5 days	Tue 9/27/05	Mon 10/3/05	47
49	F/R/P wall U-18 to L-18	5 days	Tue 10/4/05	Mon 10/10/05	48
50	Backfill walls @ west end halfway	2 days	Tue 9/20/05	Wed 9/21/05	46
51	Install Tie-backs @ west end	5 days	Thu 9/22/05	Wed 9/28/05	50
52	Backfill west end to top	3 days	Thu 9/29/05	Mon 10/3/05	51
53	Backfill wall line U half way	2 days	Tue 10/11/05	Wed 10/12/05	49
54	Install Tie-backs @ wall line U	6 days	Thu 10/13/05	Thu 10/20/05	53
55	Backfill wall line U to top	2 days	Fri 10/21/05	Mon 10/24/05	54
56	Backfill wall line 18 half way	1 day	Wed 10/19/05	Wed 10/19/05	54FS-2 days
57	Install tie backs @ wall line 18	3 days	Thu 10/20/05	Mon 10/24/05	56
58	Backfill wall line 18 to top	2 days	Tue 10/25/05	Wed 10/26/05	57
59	Dig piers @ column line B.4	1 day	Thu 9/15/05	Thu 9/15/05	45
60	F/R/P Piers line B.4	1 day	Fri 9/16/05	Fri 9/16/05	59
61	Dig foundation @ column line B (North wall)	1 day	Mon 9/19/05	Mon 9/19/05	60
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64	F/R/P Piers in west saddle bag area	1 day	Wed 10/5/05	Wed 10/5/05	63,62
65	Dig/ trench west saddle bag foundation walls	1 day	Wed 10/5/05	Wed 10/5/05	63
66	F/R/P west saddle bag foundation walls	2 days	Thu 10/6/05	Fri 10/7/05	65,64
67	Dig/ trench Piers @ column line V (South saddle bag area)	1 day	Thu 10/6/05	Thu 10/6/05	65
68	F/R/P piers at column line V (South saddle bag area)	1 day	Fri 10/7/05	Fri 10/7/05	67
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73	Masonry South & East end	14 days	Wed 10/12/05	Mon 10/31/05	70
74	(Masonry complete Exterior)	0 days	Mon 10/31/05	Mon 10/31/05	71,72,73
75	**Cast In Place Erection**	**131 days**	**Tue 10/4/05**	**Tue 4/4/06**	
76	Cast In Place Erection North side complete (Columns,	28 days	Tue 10/4/05	Thu 11/10/05	52,45
77	Cast In Place Erection West side complete	34 days	Fri 11/11/05	Wed 12/28/05	76,52
78	Cast In Place Erection South side complete	30 days	Thu 12/29/05	Wed 2/8/06	77,55
79	Cast In Place set from outside bowl	39 days	Thu 2/9/06	Tue 4/4/06	78,74
80	**Steel Erection & Misc.**	**132 days**	**Thu 1/12/06**	**Fri 7/14/06**	
81	Steel Assembly	20 days	Thu 1/12/06	Wed 2/8/06	78FS-20 days
82	Erection of the Main Roof Trusses	50 days	Thu 2/9/06	Wed 4/19/06	78,81FS-15 days
83	Erection of Sway Trusses	50 days	Fri 2/10/06	Thu 4/20/06	82FS-49 days
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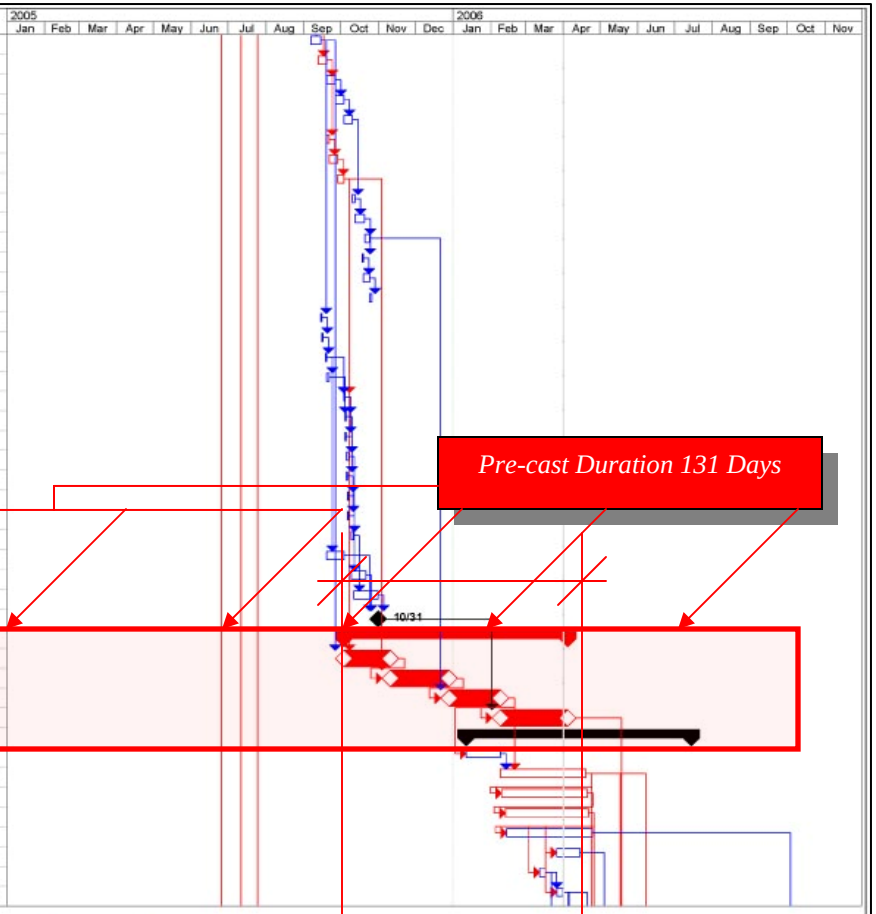
86	Erect Mechanical Catwalk	15 days	Mon 3/27/06	Fri 4/14/06	84FS-20 days
87	Erection of West 1/3 of Deck	5 days	Mon 3/13/06	Fri 3/17/06	84FS-30 days
88	Erection of Middle Deck	5 days	Mon 3/27/06	Fri 3/31/06	84FS-20 days,87



Project: Sears Centre Detail Sch (W) (
Date: Sat 4/1/06

Task | Milestone | Rolled Up Critical Task | Split | Group By Summary
Critical Task | Summary | Rolled Up Milestone | External Tasks | Deadline
Progress | Rolled Up Task | Rolled Up Progress | Project Summary

Page 2

The time assessment analysis has yielded a project duration overrun of 35 crew days for CIP construction of major structural elements. As a result the original project turnover date of **9/18/06** will have to be re-adjusted to **10/24/06**. Since inherent project conditions specify "Liquidated" damages beyond the negotiated completion date, CIP may not be a viable solution used on the Sears Centre. This condition will be evaluated further to determine the costs impacts versus Pre-cast installation.

Cost and Installation Comparison

Pre-cast Concrete Construction Cost:

The current production rate of Spancrete (Current project pre-caster is 20 pieces of pre-cast per day). As a cost comparative analysis, one additional pre-caster (High Concrete) was asked to provide installation production rates for critical columns, beams and rakers. Based on current project information conveyed, realistic durations for pre-cast assemblies were 15 pieces/ day.

Pre-caster	Daily Production	Project Duration	Project Costs
Spancrete	20 Pieces / Day	96 Days	$ 989,866
High Concrete	15 Pieces / Day	107 Days	$ 921,022

High Concrete/ Spancrete Costs Difference → = $ 68,844 (Savings for :)
High Concrete/ Spancrete Time Difference → = (11) day deficit
Deficit Time/ Costs Trade off = $ 6,259 per day

CIP Construction Cost:

Aside from labor costs, the most crucial cost encountered for Cast-In-Place construction is formwork rental costs. Standard Beams and Columns can easily be determined from RS. Means or ICE MC^2 software, however bent form work rental costs can escalate the price of cast-in-place concrete installation. Two leading formwork contractors whom specialize in raker bent form rental are Symons and Shockey Brothers Concrete. Bent raker form rental costs were obtained from Symons Baltimore office. Raker form rental costs for this project were determined by applying a location factor to a MD cost quote.

Standard 18 Riser/ Raker Bent Form Cost Quote $_{[Baltimore, MD]}$ = $ 3,500 / 28 Day Rental
Baltimore, MD $_{CPI\ Index}$ = 126.3
Chicago, IL $_{CPI\ Index}$ = 198
Adjusted Raker Bent Form Cost Quote:
[CPI $_{Chicago}$/ CPI $_{Baltimore}$] x $ 3,500 = $ 5,464.90 / 28 Day Rental

CPI Cost Break Down:

Material & Equipment	**46 %**	of Total CIP Costs
Formwork Costs	**37 %**	of Total CIP Costs
Labor	**17 %**	of Total CIP Costs
Total (Percentage)	**100 %**	of Total CIP Costs

Concrete Method	Daily Production	Project Duration	Project Costs
Pre-cast	**20 Pieces / Day**	**96 Days**	**$ 989,866**
CIP	**8.40 CY / Day**	**131 Days**	**$ 615,947**

CIP / Pre-cast Costs Difference → = $ 373,939 (Savings for :)
High Concrete/ Spancrete Time Difference → = (35) day deficit
Deficit Time/ Costs Trade off = $ 17,598 per day

Conclusion:

Although selecting pre-cast generates a costs trade off of $ 17,598 per day, the resulting reduction in duration, coupled with the elimination of any penalties assessed via liquidated damage clauses is enough refute any costs benefits with using a cast-in-place concrete method.

Executive Summary

This report is intended to analyze the workings of the NHL regulation rink to be installed in the Sears Centre. Ice-rink operation measures are a critical portion of this facilities operations cost. Value engineering suggestions will be supplied to aid CCO Entertainment in the day to day up keep of the arena facility.

Report Sections include:

- **Ice-System Overview**
  - *System Design Conditions*
  - *Typical Slab placement Construction*
- **Ice-System Operations**
  - *Brief review of Refrigeration principals for Cold and Warm Brine Refrigerant Solution*
  - *Ice-Surface Formation Procedure*
- **Ice-System Value Engineering Assessments**
  - *Cost Reduction Measures proposed for facilities operations*

The system will be installed by a leading ice-rink contractor (CIMCO) in conjunction with an ice-demineralizer supplier (Jet Ice). CIMCO-Jet Ice has produced over 20 projects for indoor ice sports facilities. Basic installation processes require substantial completion of building enclosure before initial testing. A key aspect to note is that heating of the underslab rink condition is necessary for preservation of the floor base. If this condition isn't obtain, substantial heaving produced by a pseudo "Freeze-Thaw" cycle could permanent damage the slab beyond recovery. A costly replacement could hamper arena operations and impact facilities operations and minimize revenues produced by leased events.

Highlighted Suggestions for operations reduction include:

- *Operations and Maintenance Improvements*
- *Lighting Improvements*
- *Ice-Resurfacing Improvements*
- *Refrigeration Systems Improvements*
- *Heating, Dehumidification and Ventilation Improvements*

If used appropriately, the proposed suggestions will reduce the annual operations budget by $ 25,800. Operations reduction have a potential to have a direct impact on the facilities payback period, in addition to reducing the time required for recapturing full building construction costs.

Ice-Rink Analysis for Value Engineering suggestion in Sears Centre Facilities Operations & Energy Costs Reduction

Ice-System Overview:

Ice construction is the most important aspect of the Sears Centre. The ice-rink could be viewed as the primary purpose for building construction. Part of the arena construction package is adherence to ice-distribution installation procedure typically used on National Hockey League ice rink and ice surfaces. Plans call for installation of (1) 85'-0" x 200'-0" NHL/ NCAA regulation ice rink with R 28'-0" Radii. This system can be classified as a mix use Ammonium (NH_3), 35 % $_{(by\ volume)}$ Ethylene Glycol/ Calcium Carbonate, closed loop brine system. (2) Brine circuits form the primary rink freeze and melt operations. Similar to typical sports facilities, the ArenaPak refrigerant supply and distribution system is located in the Northeast Event level mechanical room. (1) 4'-6" Under slab trench is used to distribute (2) 10" diameter cold brine supply and return headers and (2) 3" diameter warm brine supply and return headers. Trench extends to (1) 6' x 6' valve box on the north border of the ice-rink and (1) 3' x 3' trench box on the south terminus ice-rink.

Equally important to the analysis of rink operations is value engineering procedures in rink maintenance which can potentially reduce facilities energy use and operations cost. Specific measures will be made referenced to with proposed costs savings.

Identify needs of system

System Design:

❖ *Refrigeration capacity*	*160 tons of refrigeration*
❖ *Design Capacity*	*17° F to 15° F*
❖ *Saturated evaporator temperature*	*5° F*
❖ *Condensing Temperature*	*95° F*
❖ *Primary Refrigerant*	*Ammonium NH_3*
❖ *Secondary Refrigerant*	*35 % $_{(by\ volume)}$ Ethylene Glycol*
❖ *Water Deminarilizer*	*Jet-Ice Dimineralizer (20 gpm)*

System Design Pressures:	*System Design Pressures:*
High	*Low*
250 [psig*]	***250 [psig]***
System Operating Pressures:	*System Operating Pressures:*
High	*Low*
181.1[psig] @ 95° F	***19.6 [psig] @ 5° F***

Ice-Rink Analysis

How an ice-distribution system works

Identify system components

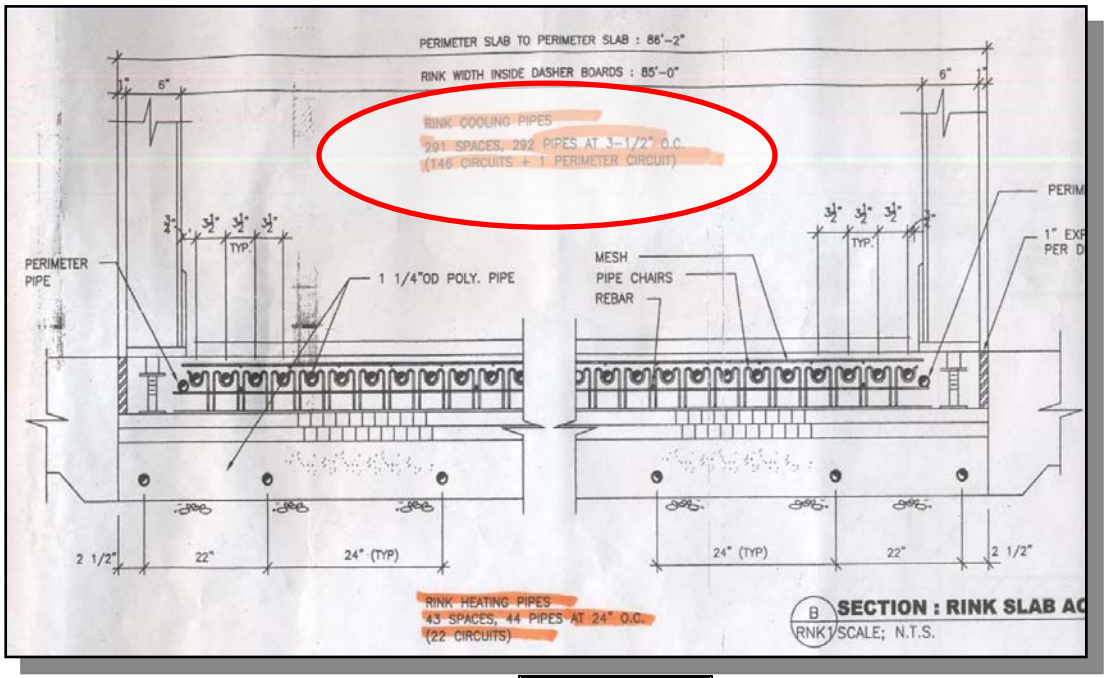
Equipment Schedule

- (2) Mycom N8WB compressors
- CIMCO CB0604 Shell & Tube Heat Exchanger *(Warm Brine Heat Exchanger)*
- CIMCO 24" Ø x 10'-0" Chiller w/ 24" Ø x 9'-0" Surge Drum *(Cold Brine Chiller)*
- EVAPCO ATC-280 *(Evaporative Condenser Unit)*
- Armstrong 4030 8x6x10 Cold Brine Pumps
- Armstrong 4030 3x2x6 Warm Brine Pump
- Armstrong Jacket Glycol Cooling Pump
- 937 US gallon Ammonium Absorption Water Tank
- 130 US gallon Cold Brine Expansion Tank
- 80 US gallon Warm Brine Expansion Tank
- 10 US gallon Glycol Expansion Tank
- 53 US gallon Refrigerant Mixing Tank

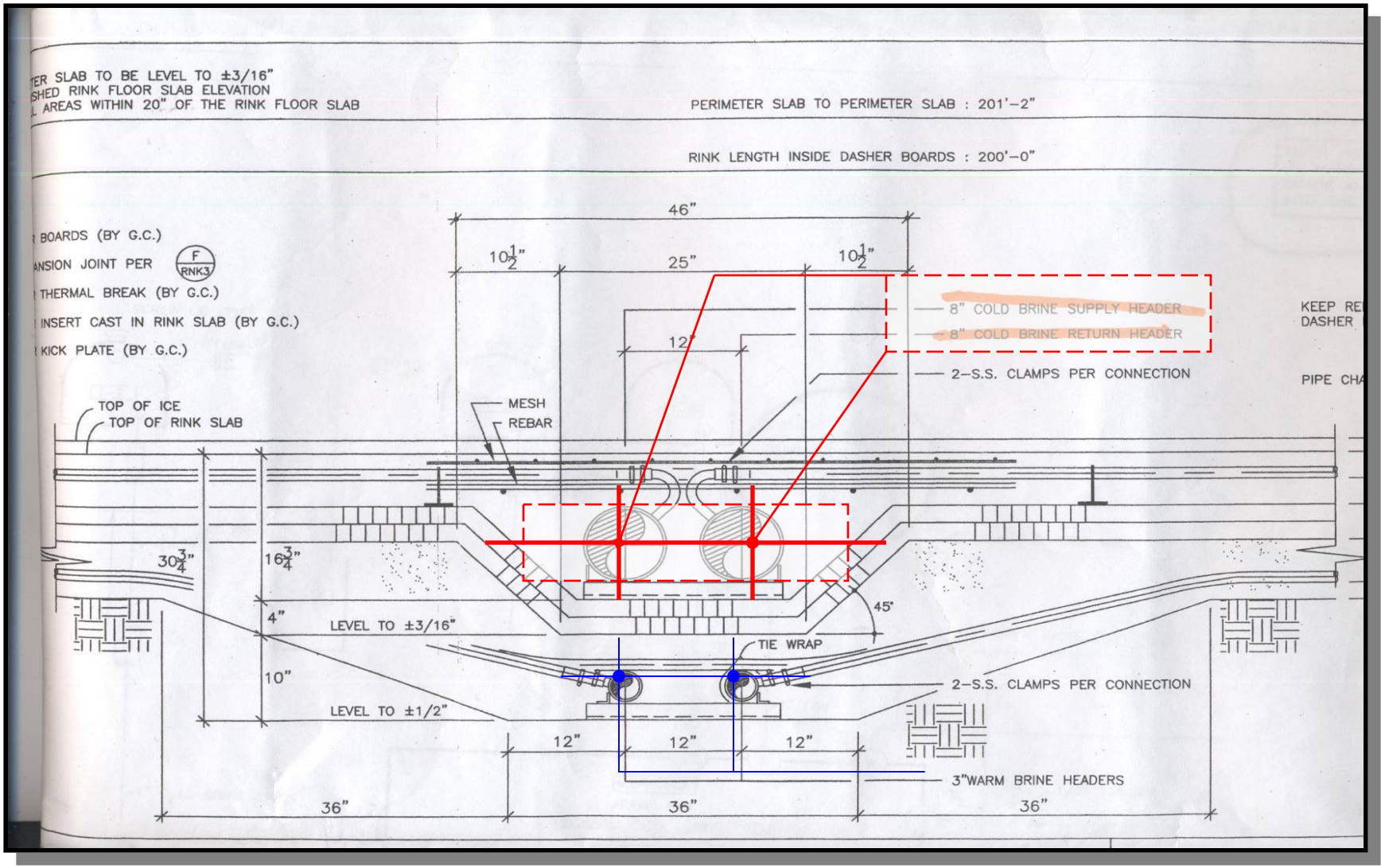
System Distribution:

Brine Piping via Schedule 40/ ASTM 53B ERW Steel varying diameter

Brine Type	*Main/Header Material*	*Main Diameter (inches)*	*Header Diameter (inches)*	*Number of Circuits*	*Distribution Material*	*Diameter Size (inches)*
Cold S.R	*SCH 40 Stl.*	*10*	*8*	*147*	*Poly Pipe*	*1-1/4"*
Warm S.R	*SCH 40 Stl.*	*3*	*3*	*22*	*Poly Pipe*	*1-1/4"*



Ice-Rink Floor Profile:



Ice-Rink Floor Construction (Sequence from bottom up):

- 1-1/2" Thick Ice Surface
- 6" 5,000 psi Thick Reinforced Concrete Rink Slab level to +/- 3/16" c/w
- 6x6 W2.9x2.9 Weld wire mesh above rink pip with 6" overlaps
- 1-1/4" OD Polyethylene rink pipes space @ 3-1/2" o.c.
- #4 Rebar at 12" (Bottom Layer) and 10-1/2" (Top Layer) on center each way. Below rink pipes with 15" overlaps tied together with loop-type wires at every intersection along the diagonal starting at every third rebar intersection along the length of the rink with bottom layer parallel to rink chairs (installed prior to floor pipe) and top layer parallel to pipe and top loaded into pipe chairs (installed after floor pipe)
- Mesh wired to pipe chairs every 12" along pipe chairs and around perimeter of each mesh sheet and to rebar below as required to hold all reinforcing in place, all tie wires to be bent away from rink pipe
- To loaded pipe chairs with base plate spaced at 3'-0" o.c. Overlap chairs by one pipe at the end of each chair
- 6 mil poly vapor barrier with 12" overlapping joints
- 4" DOW HI-60 Insulation or equivalent to be installed (2 Layers of 2" insulation with 6" staggered and overlapping joints)
- 7" thick (1'-2" and 1-5" lift) clean sand or screening compacted to 95% standard density and level to +/- 3/16"
- 1-1/4" OD Polyethylene heating pips spaced 24" o.c.
- Adequately drained subgrade and/ or 95% standard density granular backfill, level to +/- 1"

Purpose of (Two-Brine Paths):

- *Brine Path #1*

"Brine Path # 1" consist of the super-cooled refrigerant mixture (Ammonium (NH_3), 35 % (by volume) Ethylene Glycol/ Brine mixture) which is used to provide a cooled base for ice formation on the event slab. Circuited network is embedded in the concrete base slab and runs clockwise to provide required cooling distribution.

- *Brine Path # 2*

"Brine Path # 2" consist of a warmed brine mixture medium that is distributed beneath the insulation providing a warming condition which will protect the concrete slab against a frost-thaw, ground heave occurrence. Circuited network is embedded in the sand-lifts beneath the ground insulation and runs a counter-clockwise path to prevent heat neutralization of the incremented area.

Brine Path Graphic:

Cold Brine Path (CW) @ 147 Circuits
3-1/2" o.c.

Slab/ DOW Insulation

12" Depth

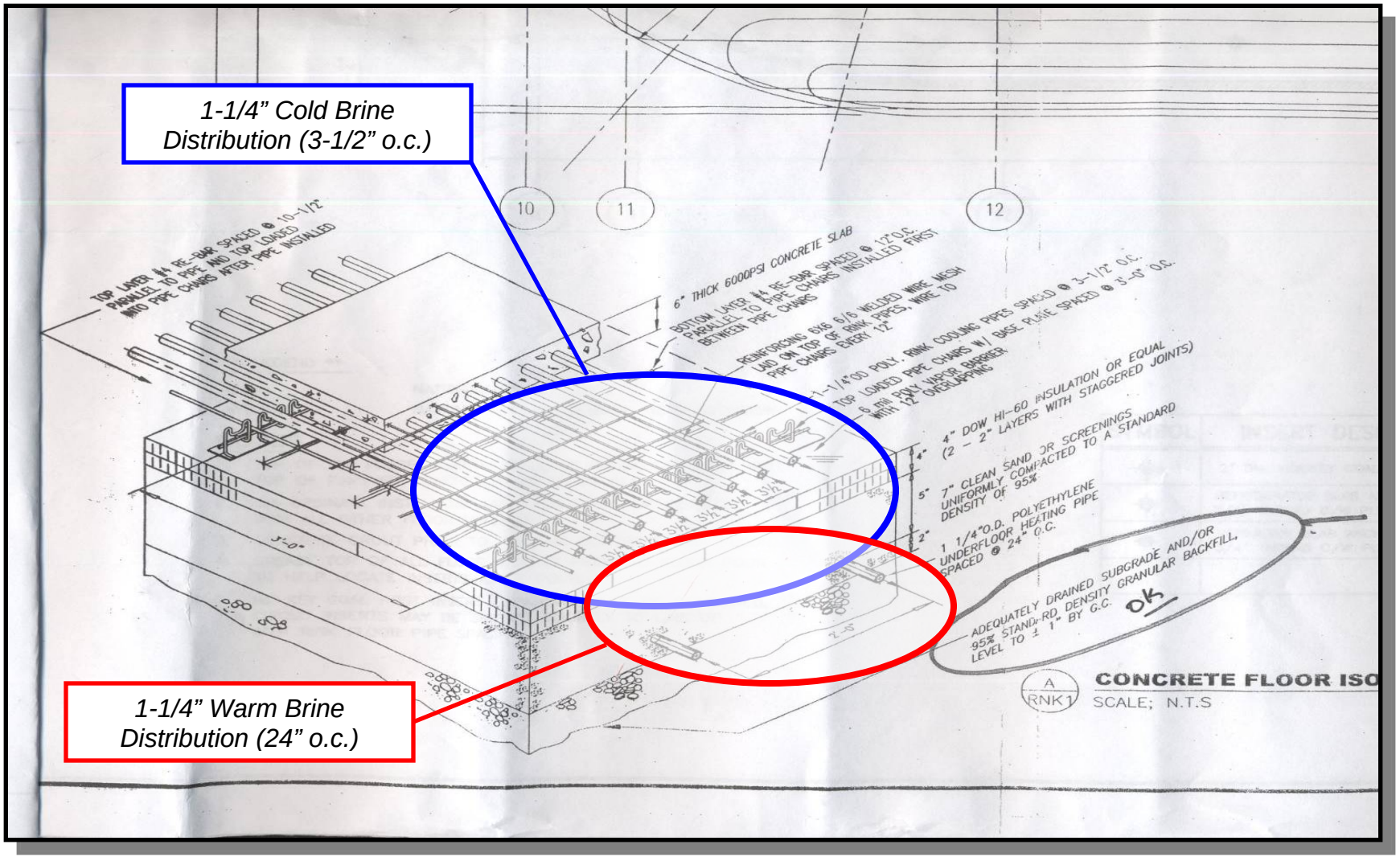
Sand Lifts

Cold Medium Propagation

Warm Medium Propagation

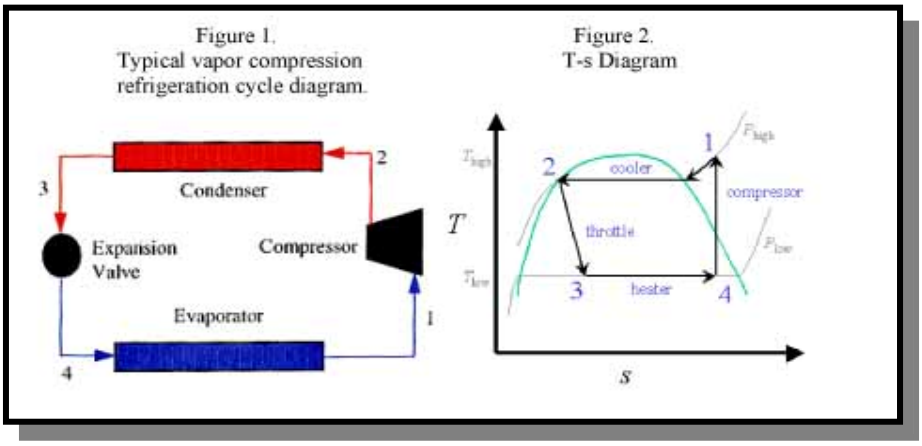
Warm Brine Path (CCW) @ 22 Circuits
24" o.c

Ice-Floor Schematic:



How an ice-distribution system works

Ice-System Operations: *Review Basic Refrigeration Cycle*
Flow Diagram –"Basic Refrigeration Cycle"/ Cold and Warm Brine Path



*Brief Summary of **"Cold Brine"** Refrigeration Principle:*

Defined as "the transfer of heat from a lower temperature region to a higher temperature in adjacent surrounding", refrigeration is the basic principle to ice-rink operations. An ideal vapor-compression cycle uses a working refrigerant (*Ammonium (NH_3), 35 % (by volume) Ethylene Glycol)* as a working fluid to absorb and reject heat. Referring to the previous diagram: (It is important to note that the cold and warm brine solution cycles operate

(Inlet 1/ Start of Refrigeration Circuit)

- *(Ammonium (NH_3), 35 % (by volume) Ethylene Glycol/ Brine mixture) Ammonium solution leaves water absorption tank to mix with glycol solution from expansion tank. Once two mixtures mix, combination mixture will interact with "cold brine" solution. Composite solution enters (2) MYCOM N8W8 compressors as a saturated vapor*

(During Compression/ Point 1 – 2)

- *(Ammonium (NH_3), 35 % (by volume) Ethylene Glycol/ Brine mixture)-Q_{in} increases in temperature by absorbing heat from surroundings that will be cooled and becomes a saturated vapor at "peak" heat (To improved absorption characteristics of refrigerant)*

(Point 2 - 3)

- *(Ammonium (NH_3), 35 % (by volume) Ethylene Glycol/ Brine mixture)-Q_{out} as a heated vapor passes through the EVAPCO ATC-280 unit condenser section of the closed circuit and exchanges heat with the surrounding, thus re-cooling the refrigerant solution as a saturated liquid. [Potential for heat re-use]* ➡

[Possible heat transfer to warm brine mixture beneath floor insulation/ embedded in sand layers]

(Refrigerant Expansion/ Point 3 – 4)

- *(Ammonium (NH_3), 35 % (by volume) Ethylene Glycol/ Brine mixture)-$Q_{out\ passes}$ through an expansion valve causing a decrease in temperature and pressure of refrigerant solution. (Chilled liquid)*

(Point 4 – 1/ Complete Refrigeration Circuit)

- *(Ammonium (NH_3), 35 % (by volume) Ethylene Glycol/ Brine mixture)-Q_L re-enters EVAPCO ATC-280 unit after absorbing heat from the ice-floor slab while creating a cooled slab condition necessary for freezing of water layers (sheet ice) (completing one closed circuit run embedded in (6") 5,000 psi concrete ice slab) as a saturated vapor before re-entering (2) MYCOM N8W8 compressors to began the process anew.*

*Brief Summary of **"Warm Brine"** = Refrigeration Principle in reverse:*

(Point 1 – 4 Start of Warm Brine Circuit)

- *"Warm" Brine solution leaves Compressor unit as a heated vapor, prior to being pumped through distribution network beneath rink insulation embedded in sand layers*

(Re-warming of Brine Solution)

- *"Warm" Brine solution absorbs cool medium transferred through 4" DOW HI-60 insulation later, resulting in a lower temperature*
- *"Warm" Brine solution enters EVAPCO ATC-280 Unit after absorbing cooled medium from slab and rink floor insulation*

(Warm Brine Expansion/ Point 4 – 3)

- *"Warm" Brine solution passes through expansion valve at reversed setting as a saturated liquid to increase in temperature and pressure*

(Point 3 – 2)

- *"Warm" Brine solution – Q_{in} receives heat from surrounding environment, re-heating brine solution to a saturated vapor (in purest form) [Possible Heat Transference from Cold Brine operations]*

(Point 2 – 1)

- *"Warm" Brine solution" enters Evaporative condenser to condense into liquid form at slightly lower temperature*

(Point 4 – 1/ Completion of "Warm" Brine Cycle)

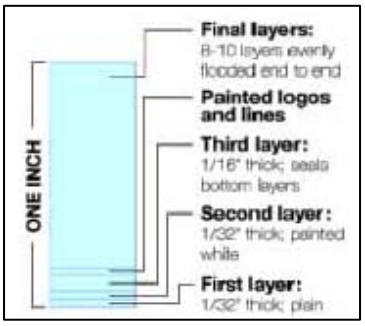
- *"Warm" Brine solution enters compressor at reverse setting to become super-heated as a vapor before beginning the process anew.*

The formation and placement of an Ice-Surface:

Floor Preparation:

Chiller cools the brine refrigerant to 15°F
System supplies 9,000 gal of cold brine to freeze an NHL regulation rink surface
Cold brine is pumped into embedded pipes in the bearing slab
Cold brine is used to maintain a floor prep temperature just below Fahrenheit freezing 32°F

Ice Surface Formation:



(1) It takes 12,000 – 15,000 gallons to form a Hockey rink surface
(2) Crew spays first and second layers on using a spray truck (Layer 1 = 1/32" Thick & Layer 2 = 1/32" Thick/ Second layer applied after freezing of first layer
(3) Crew paints the frozen second layer
(4) Crew spay applies third layer (Layer 3 = 1/16") as a sealant for the first two painted layers
(5) Crew supplies the remaining layers (10.5" / 10,000 galloons) @ rates 8.33 gpm to 10 gpm
(6) Complete freezing occurs before application of new layer
(7) Suggested Ice surface 24°F to 26°F

Ice-Resurfacing:

Standard Ice Resurfacing Rates

(#) Resurfacers	Bucket Capacity *(1 Bucket = 2,600 lbs of snow or 3 gallons)*	MPH	Time of (1) complete Rink Resurface (min)
1	3	9 to 10	[6 to 7] / 8 Passes
2	6	9 to 10	3/ 8 Passes

Typically a bucket is filled to ¾ capacity during resurfacing
(80 to 100 gallons of water) used for rink surfaces between periods
Life expectancy of propane powered ice-resurfacers:

5 seasons x (8 months / season) = 40 months
Propane resurfacer costs: $55,000 per unit

Value Engineering Operations Suggestions:

Operation and Maintenance Improvements

Increase Ice Temperature

- Sheet ice constantly absorbs heat from its surroundings. Heat absorption naturally decreases as the temperature in the ice goes up. As a result the refrigeration system must work to remove the heat that the ice sheet absorbs, its energy use also decreases proportionately when the ice sheet temperature can be slightly increased

- Ice sheet integrity is the case that governs the temperature controls in a sports facility. Temperature controls are typically set conservatively low values as a measure to preserve the condition of the ice sheet. Depending on a refrigeration systems schedule practical measures of increasing the temperature of the ice surface during facility down time may reduce yearly operations costs. Annual energy costs savings from increasing average temperature 1°F range from $ 800 to $1,600 for facilities of similar type and use

Reduce Ice Sheet Thickness

- Control and reduction of ice thickness can also reduce energy cost while providing consistent ice quality. Reducing ice sheet thickness for main sheets by ¼" will maintain an adequate surface support during re-surfacing procedures.

- Increasing coolant and slab temperatures will save energy through efficient use of refrigeration systems. Typical annual costs savings of a ½" surface reduction are between $ 145 - $ 300.

Reduce Refrigeration System Head Pressure Controls

- The refrigeration system keeps ice sheet cold by re-circulating refrigerant in a closed loop network. Once used in system, refrigerants absorb heat from under ice sheet and deposits heat medium to external source via condensation. In order for heat to flow from the refrigerant in the condenser, refrigerant must have a high temperature and pressure. This condition is known as head pressure, and is generated in the systems (2) compressors. Compressors use significant electrical energy during operations, if head pressure was reduced, energy usage and system wear on compressor components could be minimized. Refrigeration systems with expansion valves can operate properly at a pressure of 175 psig. The current operating pressure is 181.5 psig, by reducing 6.5 psig annual savings generated can reached between $ 292.50 and $ 468.00 annually

Lighting Improvements

Ice Sheet Lighting Recommendations

The level of illumination required for sports lighting depends on the following tasks:

- General Nature of Tasks
- Speed of action
- Skill of Players
- Number of Spectators
- Field of Distance

Recommended values from the Illuminating Engineering Society can be used for deciding the amount of foot candles or lux to apply to an ice surface

Activity	Foot candles
Pro Hockey	100
Amateur Hockey	50
Recreational Hockey	20
Figure Skating	15
Curling	10 – 20
Recreational Skating	10

The current requested foot candle value for the Sears Centre ice surface is 300 foot candles, for television purposes. If the present foot candle requirement could be reduced by 5% a significant reduction in the arena's power bill will result in kwH savings.

Resurfacing Improvements

De-mineralized Flood Water Treatment

A moderately busy ice rink with an average of 6-resurfacings a day will use approximately 1,000 gallons of water per day. Only heated city water can be used in the construction of the standard ice-surface. If dematerialized flood water is introduced in the refrigeration system, the hot water requirement is eliminated.

Water De-mineralization can be achieved two ways

(1) Ion-Exchange
(2) Reverse Osmosis

Current Demineralization System used in refrigeration Operations for Sears Centre:

- Jet-Ice Ion-Exchange system with a design capacity of 250,000 grains at a 20 gpm flow rate

Demineralization System Comparisons:

Demineralizers	Installation Costs	Operations Cost/ 1000 gal.
Ion-Exchange	$ 24,000	$ 12 - $ 15
Reverse Osmosis Filtration	$ 18,000	$ 3 - $ 5

If either system is installed the temperature of the ice sheet can be slightly raised to accommodate the reduction of energy needed to freeze pure water when compared to water with dissolve solids and heavier densities.

Electric Ice Resurfacer Analysis

Resurfacer	Purchase Costs	Operational Cost
Propane Powered	$ 55,000	$ 1,620/ yr (propane)
Electric Tethered	$ 72,000	$ 420/ yr (electric)
Electric Battery	$ 75,000	$ 420/ yr (electric)

Cost Comparisons over 40 months

Propane: $ 55,000 + [$1,620 (40/12)] = $ 109,000
Elect.(T) $ 72,000 + [$ 420(40/12)] = $ 73,400
Elect.(B) $ 75,000 + [$ 420(40/12)] = $ 76,400
Savings with Electric Tether: $ 35,600
Savings with Electric Battery: $ 32,600

- *Additional benefit of electric powered ice-resurfacer, reduction in CO & CO_2 deposits in facility*

Automatic Flood Water Full Shut-off Nozzle

- Arenas can conserve water and energy by installing a simple, inexpensive automatic shut off nozzle to the end of a flood hose.
- Measure can save excess H_2O spillage on ice-surface filling

Refrigeration Systems Improvements

Reclaiming Waste Heat from the Refrigeration System

- Waste heat generated by ice sheet refrigeration is a cost effective method of energy use reduction if captured.
- Re-used heat can be stored in heating apparatus/ Heating Tower for later use
- Reclaimed heat can be used to heat water or air to a temperature of 90°F ≤ Temp
  (1) Reclaimed heat uses:
  (2) Heating Arena air
  (3) Heating Hot water service
  (4) Melting Snow in snow melt pit (from ice re-surfacing operations), which can be distilled before using in irrigation system during summer seasons
  (5) Additionally warming brine in frost heave prevention operations

Heating, Dehumidification and Ventilation Improvements

Low Emissivity Reflective Ceiling

Reducing the amount of heat that ice sheet surface absorbs will result in lower energy bills in addition to improved ice quality.

Infrared radiation can account for more than 35% of the total cooling load of an ice sheet.
Refrigeration system workings varies from day to day depending on outdoor temperatures
Installation of a barrier between the ceiling and the ice sheet can effectively stop infrared radiation
Two methods of barrier installation
Low emissivity paints
Low emisivity fabrics

Infrared Reduction Method	Installation Costs	Year Pay back
Low Emissivity Paint	$ 22,000 - $ 100,000	$ 4,000
Low Emissivity Fabric	$ 23,000 - $ 28,000	$ 11,500

Conclusions:

By utilizing the value engineering suggestions the yearly operational savings achieved are:

Operations & Maintenance Improvements	**$ 1,237.50**
Increase Ice Temperature	$ 800.00
Reduced Ice-Thickness	$ 145.00
Reduction in Head Pressure	$ 292.50
Resurfacing Improvements	**$ 20,562.00**
Reverse Osmosis Deminarilizer	$ 9,882.00
Electric Resurfacer	$ 10,680.00
Ventilation Improvements	**$ 4000.00**
Low Emissivity Paints	$ 4,000.00

Total Savings Annual (O&M, Resurface Impv., Vent Impv.) = $ 25,800

Over a 10 (yr) period VE savings = $ 257,995

Executive Summary

One of the problems currently present on the Sears Centre project is the relatively light building weight. The current system is a complex envelope system composed of (1) 8' x 8' Architectural Pre-cast Panels, (2) 8" x 16" x 12" Split Face CMU(s) and (3) Type 1, 2, 3 CIM panels. CIM panels have an average weight distribution of 4.9036 lb/ ft^3.

Panel Designation	Panel Density lb/ft^3
Type (1) CIM Panel (2" thickness)	4.7147
Type (2) CIM Panel (4-1/2" thickness)	5.2814
Type (3) CIM Panel (2" thickness)	4.7147

Since the member distribution of CIM panels accounts for nearly 50% of the buildings cladding envelope, and analysis of a heavier alternative envelope member will be conducted in an effort to reduce over-turning in the strip footing, will at the same time reducing over sizing of footing weight by redistributing envelope loads to enclosure material.

Selection Criteria for Alternative Envelope Member(s):

1. ***Option #1***
   - ❖ Use pre-manufactured masonry panels in lieu of
     Pre-cast Form Liner
     Type (1) – Type (3) Metal Panels
     Type (1) – Type (3) Architectural CMU(s)
   - ❖ Alternative System Option # 1 – 100 % Pre-finished masonry
2. ***Option #2***
   - ❖ Use pre-manufactured masonry panels in lieu of
     Type (1) – Type (3) Metal Panels
     Type (1) – Type (3) Architectural CMU(s)
   - ❖ Alternative System Option # 2 – Pre-finished masonry w/ Pre-cast Form Liner
3. ***Option #3***
   - ❖ Use pre-manufactured masonry panels in lieu of
     Type (1) – Type (3) Metal Panels
   - ❖ Alternative System Option # 3 – Pre-finished masonry or Pre-cast panels with Brick Veneer w/ Pre-cast Form Liner & Arch CMU units

4. ***Option #4***
   - ❖ Use EZ-Wall System with thin briquettes in lieu of
     Type (1) – Type (3) Metal Panels
   - ❖ Alternative System Option # 3 – Pre-finished masonry or Pre-cast panels with Brick Veneer w/ Pre-cast Form Liner & Arch CMU units

Analysis of Footing Size Reduction (via) Remediation of the Complex Envelope System

Purpose for Analysis:

- The purpose of this structural pre-analysis is to determine if an overturning condition can be reduced by footing redesign or apply an additional klf loading to exterior strip footings and kips to column footings

The Sears Centre is a 240,000 SF sports facility with a complex envelope system composed of (8' x 8') Architectural Pre-cast Panels, 8" x 18" x 12" Split faced CMU(s), (2) Types of 2"- 4" thick CIM-*(Cored Insulated Metal Panels)* VersaWall Panels and (1) Type of 2" thick CIM-*(Cored Insulated Metal Panels)* Foam Wall Panel. Although the system is extremely affective in supplying insulation for large square foot areas, an inherent problem exist for relatively light weight envelope components.

As a result, strip and column footings have been oversized to limit the over turning condition. Additional loading will be utilized to add weight to the composite envelope.
The goals of the analysis:

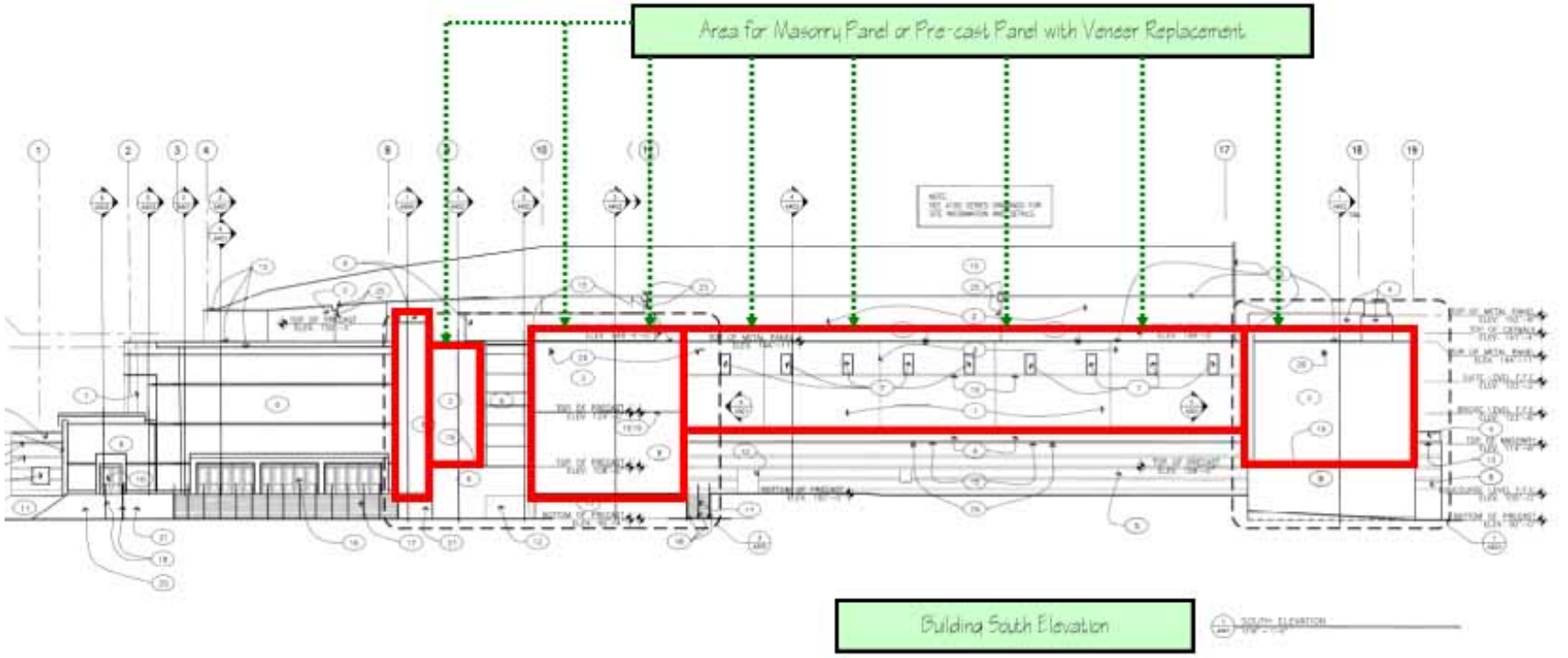
- Identify the region on the current envelope system for new member installation
- Identify the affected foundation areas
- Selecting an appropriate alternative for current envelope system of equal aesthetic *(Important for Arena appearance)*
- Determine a klf load which will safely reduce overturning occurrence
- Check current footings designs via redesign in an effort to reduce material, time and money associated with foundation installation costs. (Basic equation used/ Assumptions -Pleased see appendix for full hand calculations)

Identify complex envelope system elements

System Component	***Weight per linear foot (klf)***	***Percentage of Envelope***
8' x 8' Arch. Pre-cast Panels	*4.3291 klf*	*26 %*
8" x 16" x 12" Split CMU(s)	*0.0847 klf*	*24 %*
Type (1) 2"thick CIM panels	*0.0132 klf*	*13 %*
Type (2) 4-1/2"thick CIM panels	*0.0251 klf*	*15 %*
Type (3) 2"thick CIM panels	*0.0140 klf*	*22 %*
Total	***4.4661 klf***	***100 %***

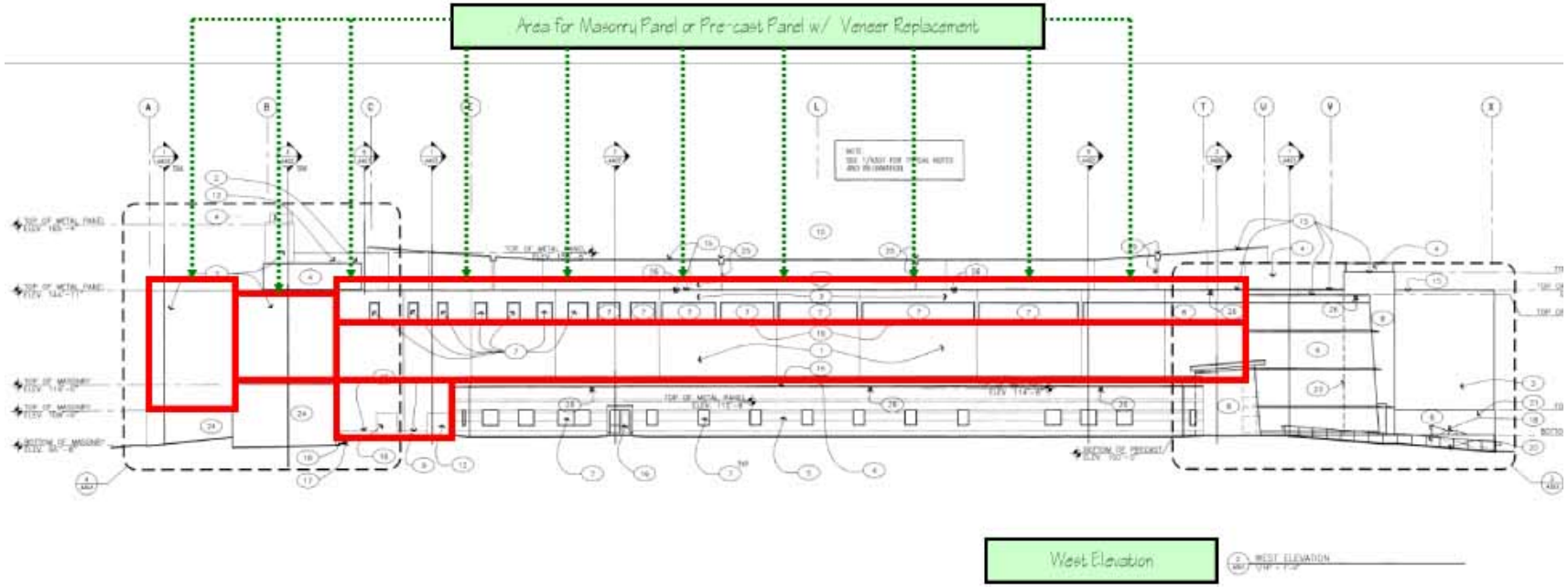
Identified Building Envelope Regions for Alternative Element Placement

South Elevation with proposed area of remediation highlighted



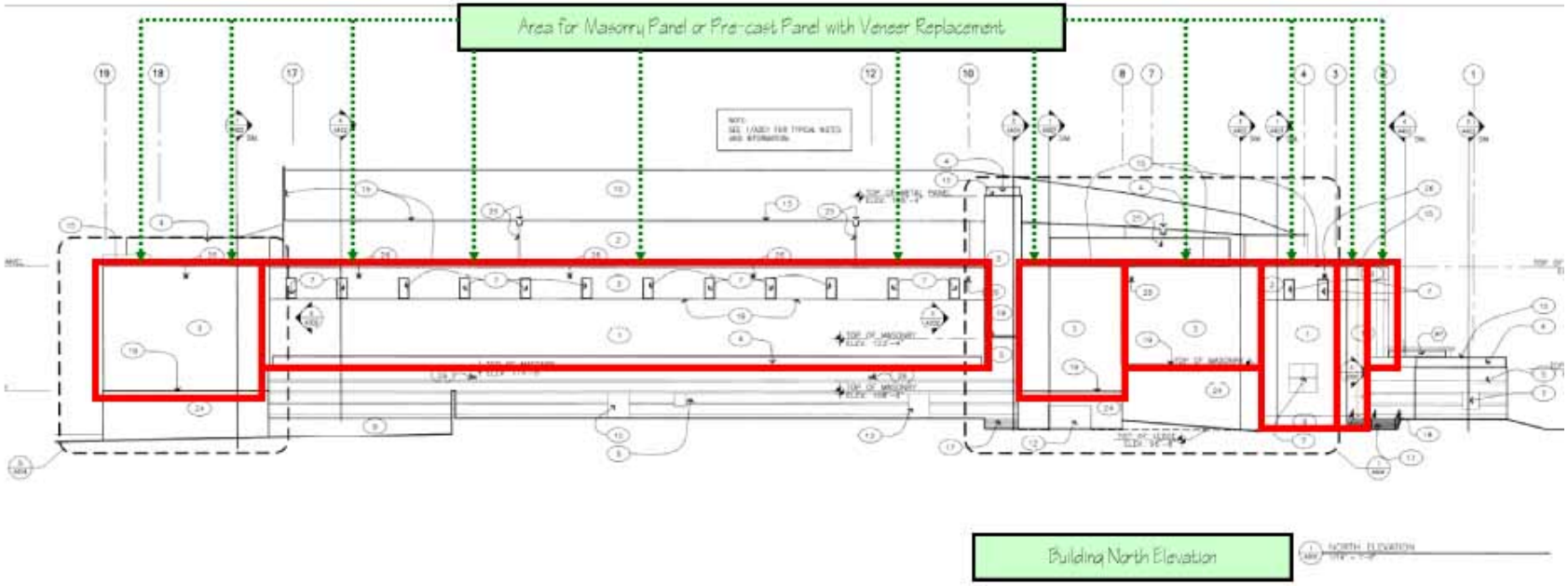
Current Assessment:
Proposed Change to: (South Elevation)
7,092 lbs → 7.092^{k} @ 8,743 SF

West Elevation with proposed area of remediation highlighted



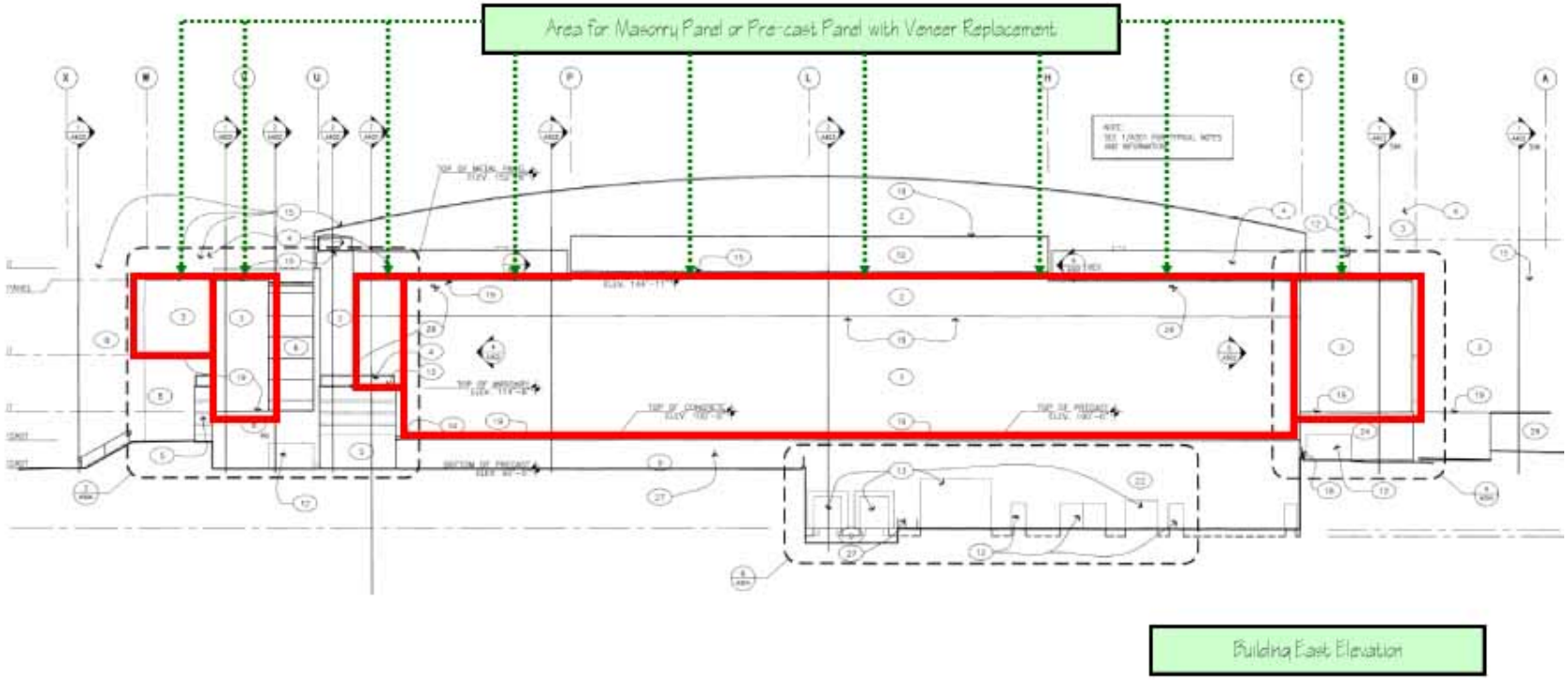
Current Assessment:
Proposed Change to: (West Elevation)
10,050 lbs → 10.050^{k} @ 13,112 SF

North Elevation with proposed area of remediation highlighted



Current Assessment:
Proposed Change to: (North Elevation)
13,240 lbs → 13.240^{k} @ 16,670 SF

East Elevation with proposed area of remediation highlighted



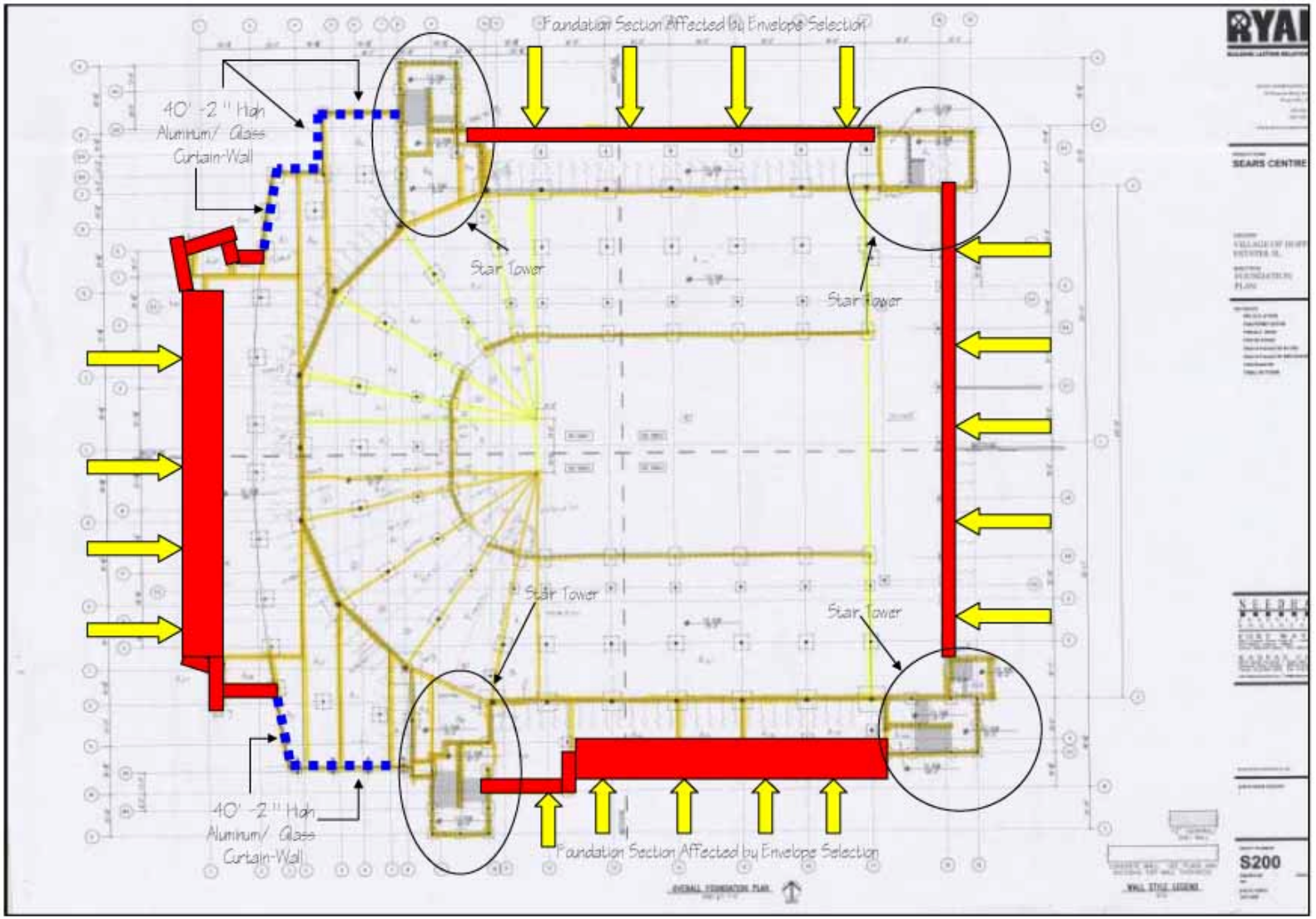
Current Assessment:

Proposed Change to: (East Elevation)

11,160 lbs → 11.160^{k} @ 13,938 SF

SEARS CENTRE

Footing Analysis via Redesign



Decide alternative envelope scheme:

Scheme Selection Summary

1. ***Option #1***
   - ❖ Use pre-manufactured masonry panels in lieu of
     Pre-cast Form Liner
     Type (1) – Type (3) Metal Panels
     Type (1) – Type (3) Architectural CMU(s)
   - ❖ Alternative System Option # 1 – 100 % Pre-finished masonry

   Reason for Rejection: Cost per cubic foot well beyond budget scope
   Reason for Rejection: Imposed Panel Weight per Area via 8' x 8' Panel or 8' x 30' could increase the size and costs of strip footing

2. ***Option #2***
   - ❖ Use pre-manufactured masonry panels in lieu of
     Type (1) – Type (3) Metal Panels
     Type (1) – Type (3) Architectural CMU(s)
   - ❖ Alternative System Option # 2 – Pre-finished masonry w/ Pre-cast Form Liner

   Reason for Rejection: Depended on size of unit a full sized masonry unit may also increase the size and bearing capacity of strip footing

3. ***Option #3***
   - ❖ Use pre-manufactured masonry panels in lieu of
     Type (1) – Type (3) Metal Panels
   - ❖ Alternative System Option # 3 – Pre-finished masonry or Pre-cast panels with Brick Veneer w/ Pre-cast Form Liner & Arch CMU units

   Reason for Rejection: Mentioned in previous option

4. ***Option #4 [Probable System to be used]***
   - ❖ Use EZ-Wall System with thin brackets in lieu of
     Type (1) – Type (3) Metal Panels
   - ❖ Alternative System Option # 3 – Pre-finished masonry or Pre-cast panels with Brick Veneer w/ Pre-cast Form Liner & Arch CMU units

   1. *Reason for Selection: To stay on the safe side this method was chosen do to reasonable load increase per linear foot, in addition to the relatively short installation time similar to the current CIM system.*
   2. *Reason for Selection: Similar to the overall selection criteria this method provides all season, installation method independent on outdoor temperature.*
   3. *Reason for Selection: Comparable Panel Sizes*

System selected: *Summitville Thin Brick / Installed in EZ-Wall Stud System*

- The proposed system to be used for the replacement of Type (1) & Type (3) CIM panels is the Summitville Thin Brick / Installed in an EZ-Wall Stud System.

Brick Veneer Panel Support System:

- 18 ga. Architectural Grade steel
- Hot dip Galvanized G-90
- Adjusted to support a 16" x 48" veneer/ insulated composite panel
- (Comparable to 1/3 size of the standard 48" x 48" Panel used for system)
- *** Custom Sizes interchangeable with system ***
- Maximum Wall Stud framing 24" o.c. / Sears Centre requirement 16" metal stud spacing for veneer construction
- Maximum Stud spacing from Girts 30" o.c

Thin Brick Unit Dimensions/ Adhesive Strength (etc):

- 7-5/8" x 2-1/4" x 3-5/8" with thickness = 9/16" Briquette
- *Comparable to the EZ-Wall supplied Ambrico, Inc. economy masonry unit of same type and size*
- Veneer Bonding adhesive rate for 150 psi
- Gypsum board classification

Determine impact on structural systems (Resultant Load in klf)

System Component	*Weight per linear foot (klf)*	*Percentage of Envelope*
8' x 8' Arch. Pre-cast Panels	*4.3291 klf*	*26 %*
8" x 16" x 12" Split CMU(s)	*0.0847 klf*	*24 %*
Type (2) 4-1/2"thick CIM panels	*0.0251 klf*	*15 %*
7-5/8" x 2-1/4"x 3-5/8" Thickness = 9/16" Thin Brick Assembly	*0.1267 klf*	*36 %*
Total	***4.5656 klf***	***100 %***
Loading Increase (klf) = 0.0995 klf		

Elevation	Load Increase (k)	Revised Envelop Load (k)
South Elevation	58.67^{k}	$2{,}163.60^{k}$
West Elevation	88.60^{k}	882.99^{k}
North Elevation	112.11^{k}	672.86^{k}
East Elevation	93.67^{k}	734.25^{k}

Total Envelope Load Increase (∑) = 353.05^{k}
Total Revised Envelope Load (∑) = 4,453.70^{k}

Structural Summary:

Condition:

- ❖ Strip Footing Re-design
- ❖ Column Size Verification via Re-design checks

(Full Hand calculations can be referenced in thesis appendix)
(Summitville Panelized Brick system data can be referenced in thesis appendix)

A composite wall composed of 8" x 16" x 12" Split Face/ Burnished Finish concrete masonry units, 8' x 8' Architectural Pre-cast panels, 4-1/2" thick 'CIM' panels and 4-3/4" and 7-5/8" x 2-1/4" x 3-5/8" thin brick/ EZ Wall Panelized system imposes a load of 4,565.60 kips per linear foot to a concrete strip footing.

Elevation		Effected Length
South	→	167.59 ft
West	→	303.65 ft
North	→	220.78 ft
East	→	253.55 ft

Note: The following assumptions where made when completing structural calculations for this student breadth:

1. Allowable soil bearing pressure 4 ksf
2. Concrete Strength f'(c) = 4,000 psi
3. Typical column sized used for analysis was an 18" x 18" pre-cast column
4. Strip footing analysis was completed based on pre-determined envelope weights with calculated additions
5. Frame loading on individual beams where held as constants in this scenario due to time constraint for area of focus (Please note that any proposed changes will need to reference analysis of individual beams and column members before any changes can occur in envelope system)
6. Column footings sized for typical condition at 165 columns per building to have equal axial load distribution
7. Costs savings/ overruns for typical columns can only be analyzed for (34) pre-cast columns on project
8. Column Footing sized checked against 12' x 12' existing square footing

Note: Inherent conditions on the project have oversized footings considerably; an additional purpose of this analysis is to re-size the footing, if possible for cost reduction, will providing the required loading.

General Calculations used for analysis:

Strip footing & Column Footing Analysis:

1. $P_{(total\ load)} = P_{(dead\ load)} + P_{(live\ load)}$
2. $q_{(allowable)} = P_{(total\ load)} / A_{(ftg)}$
3. $P_u = 1.2P_{(dead\ load)} + 1.6P_{(live\ load)}$
4. $q_{(factored)} = P_u / A_{(ftg)}$
5. $ØV_c = Ø2\sqrt{f'(c)} * bd$
6. $V_u = [(B_{(ftg\ width)} - \text{largest width of wall}) / 2]*(\text{unit strip})$
7. $d_{(ftg\ depth)} = V_u / P_u$
8. $h = d + 3"(\text{cover}) + 0.25"$ *strip footing only*
9. $h = d + 3"(\text{cover}) + 0.625"$ *column footing only*
   (a) $= [(A_s)(F_y)]/[(\beta)(\sqrt{f'(c)})(\text{unit strip})]$
   (a) $= [(A_s)(Fy)]/[(\beta)(\sqrt{f'(c)})(\text{square column dimension})]$
10. $Mu = ØMn = ØA_sf_y*[d-(a/2)]$
11. $\rho = A_s/[(b)(d)] \geq 0.0018\ in^2/in^2$
12. $c = a/\beta_1$
13. $\varepsilon = [(0.003)/c][(d - c)] > 0.005$ in/in
14. $A_{smin} = 0.0018bh$ *strip footing only*
15. $ØB_n > P_u$ *column footing only*

Calculation Results:

Strip Footing Scenario	*Dimensions*	*C.Y / linear foot (unit length)*
Current Footing	*1'- 4" x 12"x length*	*0.0493 CY/ LF*
Proposed # 1	*1'- 4" x 6"x length*	*0.0246 CY/ LF*
Proposed # 2	*1'- 4" x 8" x length*	*0.0330 CY/ LF*

Square Footing Scenario	*Dimensions*	*C.Y*
Current Footing	*12'-0" x 12' -0"x 2'-8"*	*14.24 CY*
Proposed # 1	*11'-4" x 11' x 4"x 2'-4"*	*11.08 CY*
Proposed # 2	*8'-0" x 8'-0" x 2'-0"*	*4.74 CY*

Cost/ Benefit Analysis:

Strip Footings:

Elevation		CY Strip Footing Reduction
South	@ 8" Depth	2.73 CY
West	@ 8" Depth	4.95 CY
North	@ 8" Depth	3.60 CY
East	@ 8" Depth	4.13 CY
Total	**@ 8" Depth**	**15.41 CY**

Elevation		CY Strip Footing Reduction
South	@ 6" Depth	4.14 CY
West	@ 6" Depth	7.50 CY
North	@ 6" Depth	5.45 CY
East	@ 6" Depth	6.26 CY
Total	**@ 6" Depth**	**23.35 CY**

Square Footings : (Sized for reduction of current condition, then analyzed for added loading)

Columns		CY
12'-0" x 12' -0"x 2'-8"	@ 34 columns	484.16 CY
11'-4" x 11' x 4"x 2'-4"	@ 34 columns	376.64 CY
8'-0" x 8'-0" x 2'-0"	@ 34 columns	161.19 CY

Proposed Reduction	
11'-4" x 11' x 4"x 2'-4"	484.16 CY (less) 376.64 = 107.52 CY
8'-0" x 8'-0" x 2'-0"	484.16 CY (less) 161.19 = 322.97 CY

Determine cost of selected alternative:

Envelope Remediation
$ 559,750 (less) $ 540,708 = $ 19,042 Saved

Cubic Yard Reduction (STR. FTG @ 8" Depth w/ 11'-4" x 11"-4" SQ. FTG)
(15.41 CY + 107.52 CY = 122.93 CY)($ 80.14) = $ 9,851 Saved

Cubic Yard Reduction (STR. FTG @ 6" Depth w/ 8'-0" x 8"-0" SQ. FTG)
(23.35 CY + 322.97 CY = 346.32 CY)($ 80.14) = $ 27,754 Saved

Time Savings (Assuming Panel Placement is the same) = 2 days; 5 days
Total Savings Respectively = $ 28,893 (2 days); $ 46,796 (5 days)!

Thesis Conclusion Summary

Integrated Delivery Research

- The proposed Build-Operate-Transfer approach will generate a project cost recovery within the first (5) years of facilities operations
- 10 yr. Annual Revenue (less) 10 yr. Annual Expense will generate a **$ 176,986,000** for participating consortium
- Integrated Delivery System is an advance procurement network that presents the private industry similar benefits as Public-Private-Partnerships
- ***Operations Budget w/o VEA = $ 448,000/ YR***
- ***Operations Budget w/ VEA = $ 422,200/ YR***

Cast In Place "Cost-Recapture" Costs/ Benefit validation

- Valid solution for non-time sensitive project (CIP/Pre-cast Cost perceived savings **$ 393,000**)
- Invalid Benefit for Sears Centre because of conservative 35 day duration extension

Ice Rink (VEA) – Value Engineering Assessment for facilities operations

(VEA) Assessments

- **Ice-System Overview**
  - *System Design Conditions*
  - *Typical Slab placement Construction*
- **Ice-System Operations**
  - *Brief review of Refrigeration principals for Cold and Warm Brine Refrigerant Solution*
  - *Ice-Surface Formation Procedure*
- **Ice-System Value Engineering Assessments**
  - *Cost Reduction Measures proposed for facilities operations*

(Recognized Annual Savings to Operations Budget = $ 25,800)

Envelope Load Redistribution via Footing Size Reduction

- Thin Brick System Provides a heavier Alternative at a slightly inexpensive costs
- Construction Budget Savings = $ 28,893

Construction Management Appendix

- *Proposed Arena Construction Costs*
- *Commercial Construction Loan Calculator*
- *Facilities Maintenance Strategy*
- *Calculated Operations Costs*
- *CIP Member Identification*
- *R.S. Means Costs Association*

Tabulated Arena Construction Costs

(NBA Arena) Sports Facilities Hard Construction

Site Location (Market)		Cleveland, OH (Quick & Loans Arena)		Miami, FL (American Airlines Arena)		San Antonio, TX (AT&T Center)	
		$ / SF	Hard Cost	$ / SF	Hard Cost	$ / SF	Hard Cost
Demolition & Site Clearing		$0.00	$0	$0.29	$230,000	$0.00	$0
Utility Relocation and New Services		$0.00	$0	$0.00	$0	$0.00	$0
Excavation and Foundations		$18.38	$13,730,000	$12.18	$9,635,000	$17.78	$13,335,000
Structural Frame		$41.21	$30,784,000	$67.23	$53,179,000	$50.05	$37,538,000
Roofing and Waterproofing		$2.98	$2,227,000	$3.31	$2,619,000	$1.54	$1,155,000
Exterior Wall		$19.85	$14,828,000	$21.37	$16,904,000	$12.18	$9,135,000
Interior Finishes		$50.78	$37,933,000	$40.49	$32,028,000	$34.41	$25,808,000
FF&E		$3.43	$2,563,000	$4.74	$3,750,000	$5.95	$4,463,000
Scoreboard		$7.44	$5,558,000	$6.85	$5,419,000	$7.93	$5,948,000
Ice Floor Package		$3.29	$2,458,000	$2.16	$1,709,000	$1.59	$1,193,000
Equipment		$4.12	$3,078,000	$4.67	$3,694,000	$2.08	$1,560,000
Food Service Equipment		$13.05	$9,749,000	$12.62	$9,983,000	$11.89	$8,918,000
Seating		$8.32	$6,216,000	$9.84	$7,784,000	$8.32	$6,240,000
Vertical Transportation		$4.86	$3,631,000	$5.72	$4,525,000	$4.24	$3,180,000
Plumbing		$7.53	$5,625,000	$6.71	$5,308,000	$8.43	$6,323,000
Fire Protection		$3.41	$2,548,000	$2.05	$1,622,000	$2.87	$2,153,000
HVAC		$28.15	$21,029,000	$19.75	$15,623,000	$23.00	$17,250,000
Electrical		$30.85	$23,045,000	$29.66	$23,462,000	$22.46	$16,845,000
Audio/ Visual		$7.59	$5,670,000	$2.11	$1,670,000	$4.16	$3,120,000
Plaza and Site		$11.67	$8,718,000	$12.43	$9,833,000	$20.29	$15,218,000
Direct Work SubTotal			**$199,390,000**		**$208,977,000**		**$179,382,000**
($) Indirect Costs			$15,609,000		$24,145,000		$19,455,000
($) Hard Costs			**$214,999,000**		**$233,122,000**		**$198,837,000**
Gross Square Feet			747,000		791,000		750,000
($) Cost Per Square Feet			$287.82		$294.72		$265.12
Fixed Seats			20,562		21,000		18,399
Cost per Seat			$10,456		$11,101		$10,807

Costs courtesy of Turner Construction

Site Location (Market)		Indianapolis, IN (Conceco Fieldhouse)		Memphis, TN (FedEX Forum)		Average		Scaled Down Average Sears Centre Project	
		$ / SF	Hard Cost	$ / SF	Hard Cost	$ / SF	Hard Cost	$ / SF	Hard Cost
Demolition & Site Clearing		$0.00	$0	$1.53	$1,235,000	$0.36	$280,000	$0.00	$0
Utility Relocation and New Services		$0.27	$203,000	$0.00	$0	$0.05	$42,000	$0.03	$8,000
Excavation and Foundations		$11.63	$8,723,000	$30.54	$24,644,000	$18.10	$13,921,000	$10.43	$2,545,000
Structural Frame		$60.96	$45,720,000	$59.98	$48,400,000	$55.89	$42,976,000	$32.19	$7,855,000
Roofing and Waterproofing		$2.74	$2,055,000	$4.72	$3,809,000	$3.06	$2,352,000	$1.76	$430,000
Exterior Wall		$17.67	$13,253,000	$8.80	$7,101,000	$15.97	$12,284,000	$9.20	$2,246,000
Interior Finishes		$40.20	$30,150,000	$46.48	$37,506,000	$42.47	$32,661,000	$24.46	$5,970,000
FF&E		$3.36	$2,520,000	$3.02	$2,437,000	$4.10	$3,153,000	$2.36	$577,000
Scoreboard		$6.42	$4,815,000	$16.11	$13,000,000	$8.95	$6,883,000	$5.16	$1,258,000
Ice Floor Package		$2.38	$1,785,000	$2.78	$2,244,000	$2.44	$1,877,000	$3.29	**$803,000**
Equipment		$4.92	$3,690,000	$9.84	$7,941,000	$5.13	$3,942,000	$2.95	$721,000
Food Service Equipment		$9.82	$7,365,000	$9.70	$7,828,000	$11.42	$8,779,000	$6.58	$1,605,000
Seating		$6.45	$4,838,000	$6.31	$5,092,000	$7.85	$6,035,000	$4.52	**$1,103,000**
Vertical Transportation		$3.51	$2,633,000	$2.94	$2,373,000	$4.25	$3,272,000	$2.45	$598,000
Plumbing		$7.01	$5,258,000	$11.15	$8,998,000	$8.17	$6,280,000	$4.70	$1,148,000
Fire Protection		$1.82	$1,365,000	$2.94	$2,373,000	$2.62	$2,014,000	$1.51	$368,000
HVAC		$21.29	$15,968,000	$26.08	$21,045,000	$23.65	$18,190,000	$13.62	**$3,325,000**
Electrical		$22.21	$16,658,000	$29.19	$23,554,000	$26.87	$20,666,000	$15.48	$3,777,000
Audio/ Visual		$5.76	$4,320,000	$8.06	$6,504,000	$5.54	$4,258,000	$3.19	$779,000
Plaza and Site		$2.01	$1,502,000	$5.04	$4,067,000	$10.29	$7,912,000	$2.25	$549,000
Direct Work SubTotal			**$172,821,000**		**$230,151,000**		**$197,777,000**		**$35,665,000**
($) Indirect Costs			$14,765,000		$28,064,000		$20,407,600		$11,754,778
($) Hard Costs			**$187,586,000**		**$258,215,000**		**$218,184,600**		**$47,420,000**
								Size Factor	
Gross Square Feet			750,000		806,920		768,984	0.5760	244,000
($) Cost Per Square Feet			$250.11		$320.00		$283.73		$194.34
Fixed Seats			18,345		18,194		19,300		9,000
Cost per Seat			$10,225		$14,192		$11,305		**$5,269**

Commercial Construction Loan Structure

30 Year Treasury Note Interest
Vs.
30 Year Mortgage Interest

A. Bazemore/ Sears Centre
2006 CM Thesis Final Report

Rate Repayment (t) =

$$\frac{(PLA')*[1+(IR + BPP)]^{(NPC)}*(IR + BPP)}{[1+(IR + BPP)]^{(NPC)} - 1}$$

(t) = Time Cycle

(1) BPP or bps is equal to .01% of 1 Percentage Point "1 BPP → .0001 added to indexed interest rate

Equation Terms		Abbreviation	Actual Amounts			Indicator(s)	
Principal Loan Amount		*PLA'*	$50,000,000.00				
Interest Rate (Yr.) *("Bloomberg Benchmark Rates")*		*IR(yr)*	0.0588			$(BPP)_{Base\ Percentage\ Points}$	Base Point Converter
Interest Rate (Yr.) *("Bloomberg Benchmark Rates")*		*IR(mo)*	0.0049				
Base Percentage Point *("Value/10,000)*		*BPP*	0			0	10,000
Number of Loans in Payment Cycle	$NPC =$	$\frac{Cycle\ Duration\ (Yrs)/(Months)}{Number\ of\ \$\ Payments}$			0.0000		Payments
*(For yearly payments * 12)*							
Yearly Interest Rate *("Bloomberg Benchmark Rates")*		$Y_{IR} = IR$	5.88	%	0.0588	Yearly Payments	50
Monthly Interest Rate *("Bloomberg Benchmark Rates)*		$M_{IR} = (Y_{IR} / 12)$	0.49	%	0.0049	Monthly Payments	600

PLA'	=	$50,000,000.00
Monthly Payback Computation		
(IR + BPP)	=	0.0049
1 + (IR + BPP)	=	1.0049
NPC	=	600
$[1 + (IR + BPP)]^{(NPC)}$	=	18.7805
Yearly Payback Computation		
(IR + BPP)	=	0.0588
1 + (IR + BPP)	=	1.0588
NPC	=	50
$[1 + (IR + BPP)]^{(NPC)}$	=	17.4059

Rate Repayment (t) = ***$258,779.12*** **$155,267,472.29** $\$\ \Delta_{12} =$ *($105,267,472.29)*

(12) = Monthly Cycle | *Annuity Payment (Monthly)* | Sum Totals of Annuity Payments | Total Loan Diffierence

Rate Repayment (t) = ***$3,119,203.76*** **$155,960,187.92** $\$\ \Delta_{1} =$ *($105,960,187.92)*

(1) = Yearly Cycle | *Annuity Payment (Yearly)* | Sum Totals of Annuity Payments | Total Loan Diffierence

$\$\ \Delta_{12} - \$\ \Delta_{1} =$ $692,715.64

Rate Repayment (t) =

$$\frac{(PLA')*[1+(IR + BPP)]^{(NPC)}*(IR + BPP)}{[1+(IR + BPP)]^{(NPC)} - 1}$$

(t) = Time Cycle

(1) BPP or bps is equal to .01% of 1 Percentage Point "1 BPP → .0001 added to indexed interest rate

Equation Terms		Abbreviation	Actual Amounts			Indicator(s)	
Principal Loan Amount		*PLA'*	$50,000,000.00				
Interest Rate (Yr.) *("Treasury Note Rates")*		*IR(yr)*	0.0466			$(BPP)_{Base\ Percentage\ Points}$	Base Point Converter
Interest Rate (Yr.) *("Treasury Note Rates")*		*IR(mo)*	0.0039				
Base Percentage Point *("Value/100")*		*BPP*	237			0.0237	10,000
Number of Loans in Payment Cycle	*NPC =*	*Cycle Duration (Yrs)/(Months)*			0.0000		Payments
*(For yearly payments * 12)*		*Number of $ Payments*					
Yearly Interest Rate *("Treasury NotesRates")*		$Y_{IR} = IR$	4.66	%	0.0466	Yearly Payments	50
Monthly Interest Rate *("Treasury Note Rates)*		$M_{IR} = (Y_{IR} / 12)$	0.39	%	0.0039	Monthly Payments	600

PLA'	=	$50,000,000.00
Monthly Payback Computation		
(IR + BPP)	=	0.0059
1 + (IR + BPP)	=	1.0059
NPC	=	600
$[1 + (IR + BPP)]^{(NPC)}$	=	33.2729
Yearly Payback Computation		
(IR + BPP)	=	0.0703
1 + (IR + BPP)	=	1.0703
NPC	=	50
$[1 + (IR + BPP)]^{(NPC)}$	=	29.8728

Rate Repayment (t) = ***$301,992.90*** **$181,195,741.22** Δ_{12} = *($131,195,741.22)*

(12) = Monthly Cycle | *Annuity Payment (Monthly)* | Sum Totals of Annuity Payments | Total Loan Diffierence

Rate Repayment (t) = ***$3,636,740.78*** **$181,837,038.93** Δ_1 = *($131,837,038.93)*

(1) = Yearly Cycle | *Annuity Payment (Yearly)* | Sum Totals of Annuity Payments | Total Loan Diffierence

$\Delta_{12} - \Delta_1$ = $641,297.71

Calculated Facilities Maintenance Costs Strategies

A. Bazemore/ Sears Centre
2006 CM Thesis Final Report

Sears Centre HVAC Maintenance Strategies

Equipment Items	Task Discription	# of Units	Lab Hours/ Unit	Times/ (Yr)	Cost/ Hour	Annual Cost/ (Yearly Cost)
Note: Inflation Conversion Rate $ 1.00 (1993) ≈ $1.31 (2005)						
30,000 CFM Walk-in Air Handling Units Roof Top Units	Replace AHU Filters	8	0.75	4	$39.00	$936.00
	Clean Unit Components	8	1.5	0.5	$39.00	$234.00
	Lub and Lubricate Fan Bearings	8	0.15	1	$39.00	$46.80
	Grease Fan Bearings	8	1	1	$12.34	$98.72
	Adjust/ Replace Belts	8	0.5	2	$39.00	$312.00
	Two month Bearing inspection	8	1	6	$9.74	$467.52
	Three month Damper inspection	8	1	4	$12.99	$415.68
	Three month AHU Inspection	8	1	4	$9.74	$311.68
	Quartly Inspection	8	1	1	$37.61	$300.88
	Six month inspection	8	1	2	$32.14	$514.24
	Yearly Inspectoin	8	1	1	$9.74	$77.92
Fan Coil Units	Replace Filters	16	0.75	4	$39.00	$1,872.00
	Clean Unit Components	16	1.5	0.5	$39.00	$468.00
	Lub and Lubricate	16	0.1	1	$39.00	$62.40
Chiller(s)	Weekly Checks	2	0.5	54	$44.54	$2,405.16
	Spring Commissioning	2	15	1	$44.54	$1,336.20
	Fall Decommissioning	2	7.5	1	$44.54	$668.10
Base BD Radiators	Clean and Adjust	13	0.75	0.5	$44.54	$217.13
Heat Exchangers	Clean	2	2	0.5	$44.54	$89.08
Pumps	Clean	4	0.25	2	$22.27	$44.54
	Align	4	0.25	2	$22.27	$44.54
	Check Brngs/ Package	4	0.25	2	$22.27	$44.54
	Lube	4	0.1	1	$22.27	$8.91
Exhaust Fans	Lube	12	0.25	1	$22.27	$66.81
	Clean	12	0.25	1	$22.27	$66.81
Relief Vents	Lube	4	0.15	1	$39.00	$23.40
	Clean	4	1.5	0.5	$39.00	$117.00
Steam Traps	Adjust & Clean	35	0.5	1	$22.27	$389.73
ATC Controls	Adjust & Clean	240	0.25	2	$27.51	$3,301.20
Fire Alarm	Operational Check	44	0.1	4	$52.40	$922.24
Fire Exiting	Check/ Recharge	50	0.5	2	$23.58	$1,179.00
	Sprinkler Inspection	2	4	1	$157.20	$1,257.60
Kitchen Equipment	Check Hoods	24	0.25	2	$41.92	$503.04
	Oven, P.M.	10	1.5	4	$19.65	$1,179.00
	Fryers	24	0.5	4	$19.65	$943.20
	Refer Equipment Check	28	0.25	52	$22.27	$8,106.28
Elevator Inspections	Hydraulic Elevators Inspections	4	1	0.25	$30.00	$30.00

Total Preventative Maintenance	Preventative Annual	Maint.	--	--	--	$29,061.35

Bryce Jordan Energy Accounting System/ Sears Centre Arena Maintenance Costs Baseline

Month	Facility Electricity Usage	Steam Usage	H_2O Usage	Sanitary	Size Factor	Monthly Costs
July	$32,381.60	$8,917.06	$1,548.80	$2,087.25	0.60	$35,000.00
August	$29,932.22	$9,181.33	$1,560.60	$1,981.80	0.60	$33,000.00
September	$32,160.16	$8,870.99	$1,748.45	$2,220.35	0.60	$35,000.00
October	$30,274.22	$11,294.54	$1,575.05	$2,000.15	0.60	$34,000.00
November	$26,664.22	$17,731.46	$1,156.00	$1,468.00	0.60	$34,000.00
December	$21,074.22	$21,519.98	$881.45	$1,119.35	0.60	$32,000.00
January	$19,797.62	$31,208.90	$751.40	$954.20	0.60	$37,000.00
February	$21,391.72	$40,421.79	$881.45	$1,119.35	0.60	$44,000.00
March	$21,469.00	$40,217.96	$823.65	$1,045.95	0.60	$44,000.00
April	$25,638.56	$19,618.49	$1,040.40	$1,321.20	0.60	$35,000.00
May	$25,704.91	$10,347.74	$1,083.75	$1,376.25	0.60	$30,000.00
June	$21,863.76	$7,528.38	$693.60	$880.80	0.60	$25,000.00
Year to Date Costs	***$308,352.21***	***$226,858.62***	***$13,744.60***	***$17,574.65***		***$418,000.00***

Total Yearly Maintenance Cost(s)	$448,000

Adjusted Facilities Operations Budget

Proposed Operations Budget for Sears Centre (240,000 SF "Convention Centre") Hoffman Estates [Chicago], IL
Baseline provided by the San Diego Convention Center (255,000 SF) San Diego, CA

	Correction Factors	
Size Factor (SC/SDC) = (244,000/ 255,000) =		*0.9569*
	$CPI_{(San\ Diego)}$ = 220.6	*220.6*
	$CPI_{(Chicago)}$ = 194.3	*194.3*
CPI Correction Factor =		*0.8808*

Proposed Revenue and Expense Statement

	FY 2005 Budget	FY 2006 Budget
BEGINNING BALANCE AND RESERVE		
Balance from Previous Year	$ -	
Continuing Appropriations	$ 688,602	$ 426,020
TOTAL BALANCE	$ 688,602	$ 426,020
REVENUE		
Additional Allocations	$ 252,836	$ 294,975
Transfer from Transient Occupancy Tax Fund	$ 3,537,911	$ 3,537,911
TOTAL REVENUE	$ 3,790,747	$ 3,832,886
TOTAL BALANCE AND RESERVE	***$ 4,479,349***	***$ 4,258,906***
OPERATING EXPENSE		
Administration/ Staff and Overhead	$ 600,000	$ 600,000
City Expense in Support of Facility	$ 42,139	$ 42,139
Convention Center Corporation Allocation	$ 3,495,772	$ 3,495,772
TOTAL OPERATING EXPENSE	$ 3,495,772	$ 3,495,772
TOTAL EXPENSE	***$ 4,137,911***	***$ 4,137,911***
RESERVE		
Reserve for Continuing Apportions	$ 688,602	$ 688,602
TOTAL RESERVE	$ 688,602	$ 688,602
TOTAL RESERVE	***$ 688,602***	***$ 688,602***
BALANCE	$ -	$ -
TOTAL EXPENSE, RESERVE AND BALANCE	***$ 4,479,349***	***$ 4,258,906***

Complete (Yr) Opps + Maintenace Costs = ***$*** ***4,927,800***

CIP Member Evaluation Identification

(1) Continuous Raker

(1) Continuous Raker

(1) Continuous Raker

(1) Continuous Raker

(1) Continuous Raker

(1) Single Raker Beam

(1) Single Raker Beam

Arena Bowl Interior

Pre-cast Columns

Pre-cast Rakers Type (D)

Pre-cast Beams

RYAN

BUILDING LASTING RELATIONSHIPS

SEARS CENTRE

VILLAGE OF HOFFMAN ESTATES, IL.

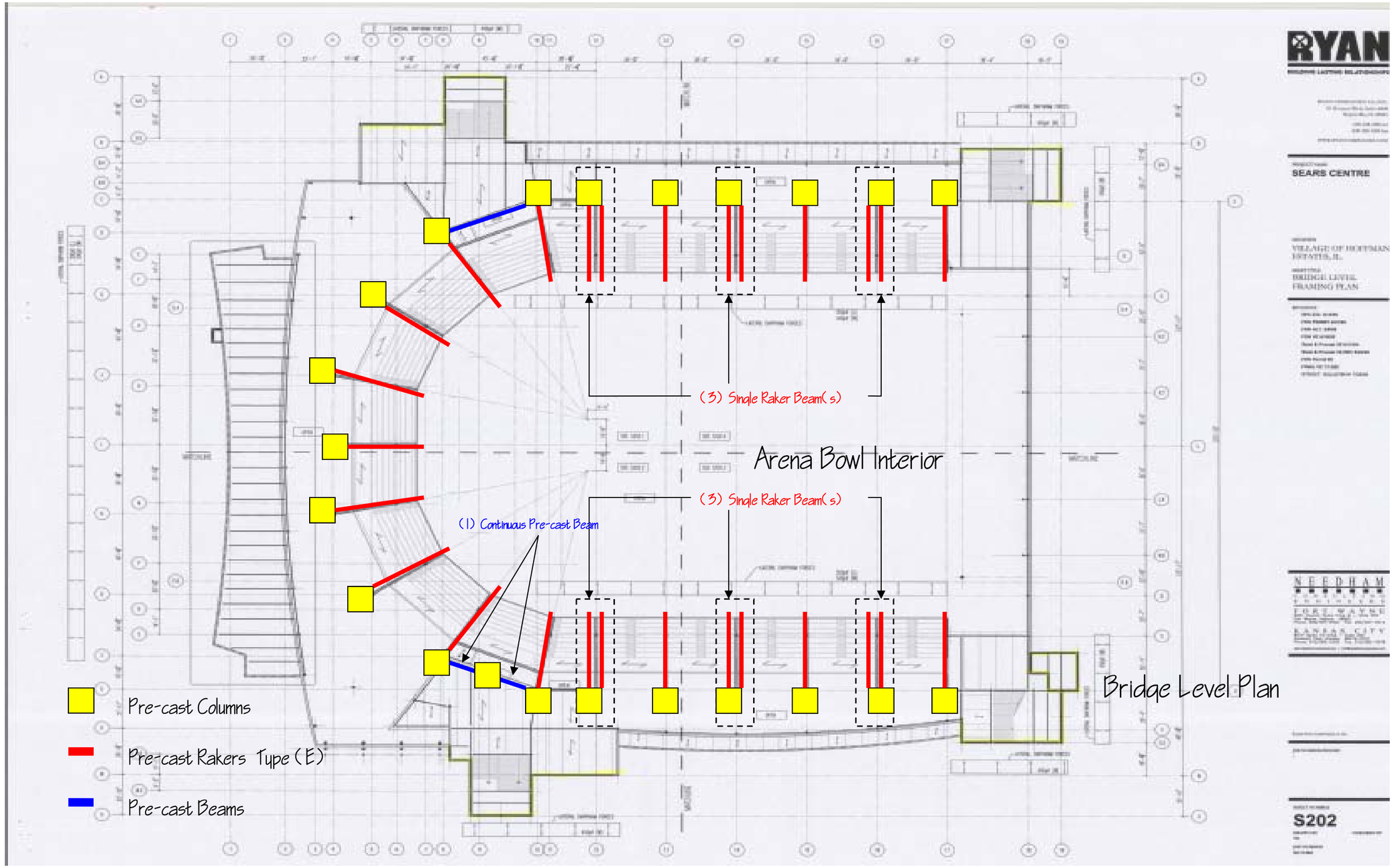
MAIN CONCOURSE FRAMING PLAN

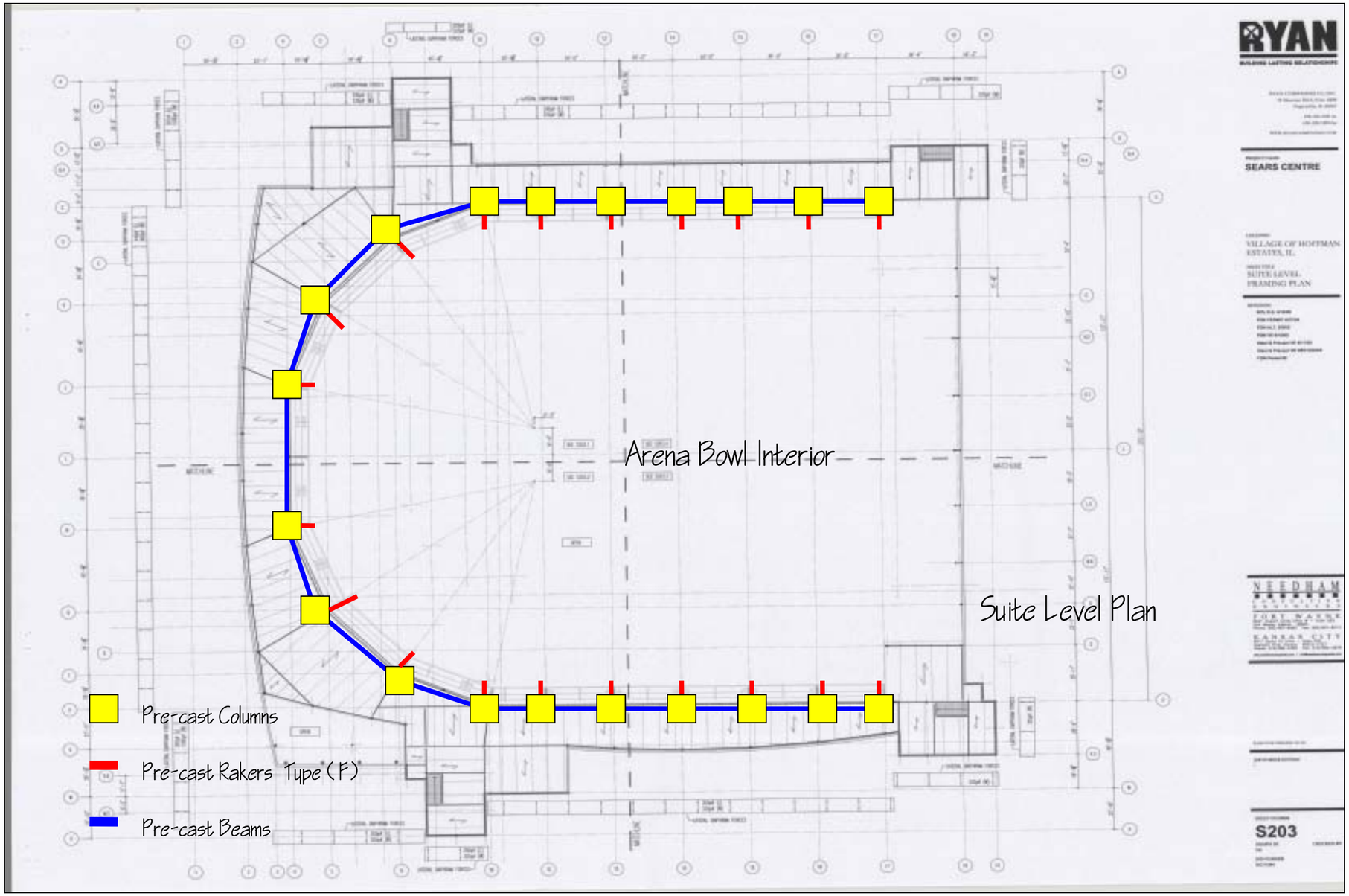
NEEDHAM

FORT WAYNE

KANSAS CITY

Main Concourse Plan


(3) Single Raker Beam(s)
Arena Bowl Interior
(3) Single Raker Beam(s)
(1) Continuous Pre-cast Beam
Pre-cast Columns
Pre-cast Rakers Type (E)
Pre-cast Beams
Bridge Level Plan
RYAN
SEARS CENTRE
VILLAGE OF HOFFMAN ESTATES, IL.
BRIDGE LEVEL FRAMING PLAN
NEEDHAM
FORT WAYNE
KANSAS CITY
S202


RYAN
BUILDING LASTING RELATIONSHIPS
SEARS CENTRE
VILLAGE OF HOFFMAN ESTATES, IL.
SUITE LEVEL FRAMING PLAN
Arena Bowl Interior
Suite Level Plan
Pre-cast Columns
Pre-cast Rakers Type (F)
Pre-cast Beams
NEEDHAM
FORT WAYNE
KANSAS CITY
S203

R.S. Means Costs Associations

R.S. Means Basic Equations/ Construction Labor Adjustments

Base Labor Computation	Crew Discription				
Labor-Hour Crew Costs	x	Labor-Hour Units		=	Labor Costs
Example		Example			Example
$ 33.85	x	32	HR	=	**$ 1,083.20**

Equation Used for Computing Labor Hours per Task (Task Duration)

$$\frac{\textit{Labor Output per Unit by Means (LH)}}{\textit{Daily Output}} \; X \; \textit{Desired Quantity} = \textit{Task Duration}$$

Base Equipment Costs	Crew Discription				
Equipment Costs Depedent on	x	Labor-Hour Units		=	Equipment Costs
Example		Example			Example
$ 33.85	x	32	HR	=	**$ 1,083.20**

Equation Used for Computing Billing Rate for Teams

Task Duration ÷ 8 hour/ Day = Crew Billing Rate

Note: RS. Means reflect Chicago Labor Relation Adjustments

CIP Formwork Scope (Beams)

QTY	Crew Designation **C-14**	**H/WD**		Base Costs Daily Costs		Hourly Costs		Cost plus Overheand & Protection Daily Costs		Hourly Costs		Pre-Labor Costs Base Costs		with O & P Factored
1	Carp. Foreman	8	/HR	$ 400.16		$ 50.02	/HR	$ 567.36		$ 70.92		$ 35.61		$ 55.83
16	Carpenters	8	/HR	$ 6,082.56		$ 47.52	/HR	$ 8,757.76		$ 68.42				
4	Rod Men	8	/HR	$ 1,264.00		$ 39.50	/HR	$ 1,932.80		$ 60.40				
2	Laborers	8	/HR	$ 661.92		$ 41.37	/HR	$ 996.32		$ 62.27				
1	Cement Finishers	8	/HR	$ 382.88		$ 47.86	/HR	$ 550.08		$ 68.76				
1	Equip. Operators	8	/HR	$ 430.24		$ 53.78	/HR	$ 597.44		$ 74.68				
1	Gas Engine Vibrators	1	/HR	$ 21.70		$ 21.70	/HR	$ 42.60		$ 42.60				
1	Concrete Pump Truck	1	/HR	$ 1,800.00		$ 700.60	/HR	$ 721.50		$ 721.50		$ 3.61		$ 3.97
202		Daily	/HR	$ 11,043.46			/HR	$ 14,165.86				$ 39.22		$ 59.80

Note: RS. Means reflect Chicago Labor Relation Adjustments

Masonry/ Brickette Panel Assembly Scope

QTY	Crew Designation **C-8**	**H/WD**		Base Costs Daily Costs		Hourly Costs		Cost plus Overheand & Protection Daily Costs		Hourly Costs		Pre-Labor Costs Base Costs		with O & P Factored
3	Brick Layers	8	/HR	$ 1,171.44		$ 48.81	/HR	$ 1,673.04		$ 69.71		$ 32.15		$ 48.45
2	Brick Helpers	8	/HR	$ 700.96		$ 43.81	/HR	$ 1,035.36		$ 64.71		$ -		$ -
40		Daily	/HR	$ 1,872.40			/HR	$ 2,708.40				$ 32.15		$ 48.45

Note: RS. Means reflect Chicago Labor Relation Adjustments

CIP Formwork Scope (Columns)

QTY	Crew Designation			Base Costs			Cost plus Overheand & Protection			Pre-Labor Costs	
	C-14 A	**H/WD**		Daily Costs	Hourly Costs		Daily Costs	Hourly Costs		Base Costs	with O & P Factored
1	Carp. Foreman	8	/HR	$ 400.16	$ 50.02	/HR	$ 567.36	$ 70.92		$ 35.61	$ 55.83
4	Carpenters	8	/HR	$ 1,520.64	$ 47.52	/HR	$ 2,189.44	$ 68.42			
1	Laborers	8	/HR	$ 330.96	$ 41.37	/HR	$ 498.16	$ 62.27			
	48	Daily	/HR	$ 2,251.76		/HR	$ 3,254.96			$ 35.61	$ 55.83

Note: RS. Means reflect Chicago Labor Relation Adjustments

Pre-cast/ Masonry Panel Errection Crew

QTY	Crew Designation			Base Costs			Cost plus Overheand & Protection			Pre-Labor Costs	
	C-11	**H/WD**		Daily Costs	Hourly Costs		Daily Costs	Hourly Costs		Base Costs	with O & P Factored
1	Struc. Steel Form	8	/HR	$ 415.60	$ 51.95	/HR	$ 582.80	$ 72.85		$ 35.61	$ 55.83
6	Stl. Workers	8	/HR	$ 2,373.60	$ 49.45	/HR	$ 3,376.80	$ 70.35			
2	Laborers	8	/HR	$ 661.92	$ 41.37	/HR	$ 996.32	$ 62.27			
1	Cement Finishers	8	/HR	$ 382.88	$ 47.86	/HR	$ 550.08	$ 68.76			
1	Equip. Operators	8	/HR	$ 430.24	$ 53.78	/HR	$ 597.44	$ 74.68			
1	Equip. Oiler	8	/HR	$ 297.60	$ 37.20	/HR	$ 464.80	$ 58.10			
1	1 Truck Crane 300 T	1	/HR	$ 2,200.00	$ 2,200.00	/HR	$ 2,220.90	$ 2,220.90		$ 3.61	$ 3.97
	97	Daily	/HR	$ 6,761.84		/HR	$ 8,789.14			$ 39.22	$ 59.80

Sears Centre Superstructure System Quantity Takeoff

Ref Sheet SHT: S400

Column Height Determination

	Elev.		Floor Height	
Below Grade Slab:	75.33	LF	--	LF
Finish Floor Grade	100.00	LF	24.67	LF
Top of Low Lobby Roof	114.67	LF	14.67	LF
Bridge Level	123.67	LF	9.00	LF
Suite Level	133.17	LF	9.50	LF
Top of Wall	145.50	LF	12.33	LF

Column Notes:
Assume Column Fabrication in 24'-0" Sections
Assume Typical Column Length 24 LF

Precast Columns SHT S 200.1

Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		Quantities for CIP Conversion SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Column Type	Column Pieces (ea)		Column Ty	Reference SHT
2.00	LF	2.00	LF	70.17	LF	--	LF	4.00	SF	1684.08	SF	600.00	PLF	6.00	ea.	1684.08	CF	62.3733	CY	C17-C20	3	ea	Pre-cast	SHT S507
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*2.00*	*ea.*	*561.36*	*CF*	*20.7911*	*CY*	*C17*	*3*	*ea*	*Pre-cast*	*SHT S 507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*2.00*	*ea.*	*561.36*	*CF*	*20.7911*	*CY*	*C18*	*3*	*ea*	*Pre-cast*	*SHT S 508*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C19*	*3*	*ea*	*Pre-cast*	*SHT S 509*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C20*	*3*	*ea*	*Pre-cast*	*SHT S 510*
																SUM CHECK		*62.3733*	*CY*					
1.33	LF	1.33	LF	70.17	LF	--	LF	1.77	SF	279.98	SF	265.34	PLF	1.00	ea.	124.12	CF	4.5972	CY	C22	3	ea	Pre-cast	SHT S507
2.00	LF	2.00	LF	34.63	LF	--	LF	2.25	SF	1246.68	SF	337.50	PLF	6.00	ea.	467.51	CF	17.3150	CY	C1-C6	2	ea	Pre-cast	SHT S507
2.00	*LF*	*2.00*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*207.78*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C1*	*2*	*ea*	*Pre-cast*	*SHT S 507*
2.00	*LF*	*2.00*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*207.78*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C2*	*2*	*ea*	*Pre-cast*	*SHT S 507*
2.00	*LF*	*2.00*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*207.78*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C3*	*2*	*ea*	*Pre-cast*	*SHT S 507*
2.00	*LF*	*2.00*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*207.78*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C4*	*2*	*ea*	*Pre-cast*	*SHT S 507*
2.00	*LF*	*2.00*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*207.78*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C5*	*2*	*ea*	*Pre-cast*	*SHT S 507*
2.00	*LF*	*2.00*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*207.78*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C6*	*2*	*ea*	*Pre-cast*	*SHT S 507*
																SUM CHECK		*17.3150*	*CY*					
1.50	LF	1.50	LF	11.96	LF	--	LF	2.25	SF	322.92	SF	337.50	PLF	6.00	ea.	161.46	CF	5.9800	CY	C9-C14	1	ea	Pre-cast	SHT S507
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C9*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C10*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C11*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C12*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C13*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C14*	*1*	*ea*	*Pre-cast*	*SHT S 507*
																SUM CHECK		*5.9800*	*CY*					
1.50	LF	1.50	LF	5.57	LF	--	LF	2.25	SF	25.07	SF	337.50	PLF	6.00	ea.	75.20	CF	2.7850	CY	PC Stub	1	ea	Pre-cast	SHT S507
Sub Total				635.96	LF					**3558.72**	**Total SF**			25.00	ea.	2512.36	CF	93.05	CY		34.00	ea		

Precast Columns SHT S 200.2

Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Column Type	Column Pieces (ea)		Column Ty	Reference SHT
2.00	LF	2.00	LF	70.17	LF	--	LF	4.00	SF	1684.08	SF	600.00	PLF	8.00	ea.	2245.44	CF	83.1644	CY	C17-C20	3	ea	Pre-cast	SHT S507
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*2.00*	*ea.*	*561.36*	*CF*	*20.7911*	*CY*	*C17*	*3*	*ea*	*Pre-cast*	*SHT S 507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*2.00*	*ea.*	*561.36*	*CF*	*20.7911*	*CY*	*C18*	*3*	*ea*	*Pre-cast*	*SHT S 508*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*2.00*	*ea.*	*561.36*	*CF*	*20.7911*	*CY*	*C19*	*3*	*ea*	*Pre-cast*	*SHT S 509*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*2.00*	*ea.*	*561.36*	*CF*	*20.7911*	*CY*	*C20*	*3*	*ea*	*Pre-cast*	*SHT S 510*
																SUM CHECK		*83.1644*	*CY*					
1.33	LF	1.33	LF	70.17	LF	--	LF	1.77	SF		SF	265.34	PLF	1.00	ea.	124.12	CF	4.5972	CY	C22	3	ea	Pre-cast	SHT S507
1.50	LF	1.50	LF	34.63	LF	--	LF	2.25	SF	623.34	SF	337.50	PLF	7.00	ea.	545.42	CF	20.2008	CY	C1-C7	2	ea	Pre-cast	SHT S507
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C1*	*2*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C2*	*2*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C3*	*2*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C4*	*2*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C5*	*2*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C6*	*2*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*77.92*	*CF*	*2.8858*	*CY*	*C7*	*2*	*ea*	*Pre-cast*	*SHT S 507*
																SUM CHECK		*20.2008*	*CY*					
1.50	LF	1.50	LF	11.96	LF	--	LF	2.25	SF	215.28	SF	337.50	PLF	7.00	ea.	188.37	CF	6.9767	CY	C9-C15	1	ea	Pre-cast	SHT S507
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C9*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C10*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C11*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C12*	*1*	*ea*	*Pre-cast*	*SHT S 507*

1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C13*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C14*	*1*	*ea*	*Pre-cast*	*SHT S 507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*1.00*	*ea.*	*26.91*	*CF*	*0.9967*	*CY*	*C15*	*1*	*ea*	*Pre-cast*	*SHT S 507*
																SUM CHECK		*6.9767*	*CY*					
1.50	LF	1.50	LF	5.57	LF	--	LF	2.25	SF	25.07	SF	337.50	PLF	6.00	ea.	75.20	CF	2.7850	CY	PC Stub	1	ea	Pre-cast	SHT S507
Sub Total				682.55	LF					**2547.77**	**SF**			29.00	ea.	3178.55	CF	117.72	CY		37.00	ea		
Precast Columns SHT S 200.3																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Column Type	Column Pieces (ea)		Column Ty	Reference SHT
2.00	LF	2.00	LF	70.17	LF	--	LF	4.00	SF	1684.08	SF	600.00	PLF	4.00	ea.	1122.72	CF	41.5822	CY	C17,C20	3	ea	Pre-cast	SHT S507
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C17*	*3*	*ea*	*Pre-cast*	*SHT S507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C18*	*3*	*ea*	*Pre-cast*	*SHT S507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C19*	*3*	*ea*	*Pre-cast*	*SHT S507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C20*	*3*	*ea*	*Pre-cast*	*SHT S507*
																SUM CHECK		*41.5822*	*CY*					
1.50	LF	1.50	LF	34.63	LF	--	LF	2.25	SF	473.13	SF	337.50	PLF	5.00	ea.	389.59	CF	14.4292	CY	C1,C8	2	ea	Pre-cast	SHT S507
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*3.00*	*ea.*	*233.75*	*CF*	*8.6575*	*CY*	*C1*	*2*	*ea*	*Pre-cast*	*SHT S507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*155.84*	*CF*	*5.7717*	*CY*	*C8*	*2*	*ea*	*Pre-cast*	*SHT S507*
																SUM CHECK		*14.4292*	*CY*					
1.50	LF	1.50	LF	11.96	LF	--	LF	2.25	SF	161.46	SF	337.50	PLF	6.00	ea.	161.46	CF	5.9800	CY	C9,C16,C26	1	ea	Pre-cast	SHT S507
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*53.82*	*CF*	*1.9933*	*CY*	*C9*	*1*	*ea*	*Pre-cast*	*SHT S507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*53.82*	*CF*	*1.9933*	*CY*	*C16*	*1*	*ea*	*Pre-cast*	*SHT S507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*53.82*	*CF*	*1.9933*	*CY*	*C26*	*1*	*ea*	*Pre-cast*	*SHT S507*
																SUM CHECK		*5.9800*	*CY*					
1.50	LF	1.50	LF	5.57	LF	--	LF	2.25	SF	25.07	SF	337.50	PLF	5.00	ea.	62.66	CF	2.3208	CY	PC Stub	1	ea	Pre-cast	SHT S507
Sub Total				391.39	LF					**2343.74**	**SF**			20.00	ea.	1736.43	CF	64.31	CY		20.00	ea		
Precast Columns SHT S 200.4																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Column Type	Column Pieces (ea)		Column Ty	Reference SHT
2.00	LF	2.00	LF	70.17	LF	--	LF	4.00	SF	1684.08	SF	600.00	PLF	4.00	ea.	1122.72	CF	41.5822	CY	C17,C20	3	ea	Pre-cast	
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C17*	*3*	*ea*	*Pre-cast*	*SHT S507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C18*	*3*	*ea*	*Pre-cast*	*SHT S507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C19*	*3*	*ea*	*Pre-cast*	*SHT S507*
2.00	*LF*	*2.00*	*LF*	*70.17*	*LF*	*--*	*LF*	*4.00*	*SF*	*421.02*	*SF*	*600.00*	*PLF*	*1.00*	*ea.*	*280.68*	*CF*	*10.3956*	*CY*	*C20*	*3*	*ea*	*Pre-cast*	*SHT S507*
																SUM CHECK		*41.5822*	*CY*					
1.50	LF	1.50	LF	34.63	LF	--	LF	2.25	SF	473.13	SF	337.50	PLF	5.00	ea.	389.59	CF	14.4292	CY	C1,C8	2	ea	Pre-cast	
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*3.00*	*ea.*	*233.75*	*CF*	*8.6575*	*CY*	*C1*	*2*	*ea*	*Pre-cast*	*SHT S507*
1.50	*LF*	*1.50*	*LF*	*34.63*	*LF*	*--*	*LF*	*2.25*	*SF*	*155.84*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*155.84*	*CF*	*5.7717*	*CY*	*C8*	*2*	*ea*	*Pre-cast*	*SHT S507*
																SUM CHECK		*14.4292*	*CY*					
1.50	LF	1.50	LF	11.96	LF	--	LF	2.25	SF	161.46	SF	337.50	PLF	6.00	ea.	161.46	CF	5.9800	CY	C9,C16,C26	1	ea	Pre-cast	
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*53.82*	*CF*	*1.9933*	*CY*	*C9*	*1*	*ea*	*Pre-cast*	*SHT S507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*53.82*	*CF*	*1.9933*	*CY*	*C16*	*1*	*ea*	*Pre-cast*	*SHT S507*
1.50	*LF*	*1.50*	*LF*	*11.96*	*LF*	*--*	*LF*	*2.25*	*SF*	*53.82*	*SF*	*337.50*	*PLF*	*2.00*	*ea.*	*53.82*	*CF*	*1.9933*	*CY*	*C26*	*1*	*ea*	*Pre-cast*	*SHT S507*
																SUM CHECK		*5.9800*	*CY*					
1.50	LF	1.50	LF	5.57	LF	--	LF	2.25	SF	25.07	SF	337.50	PLF	5.00	ea.	62.66	CF	2.3208	CY	PC Stub	1	ea	Pre-cast	
Sub Total				391.39	LF					**2343.74**	**SF**			20.00	ea.	1736.43	CF	64.31	CY		20.00	ea		
Precast Beams SHT S 201.1 - S 201.4 Main Concourse																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Beam Type			Beam Type	Reference SHT
1.33	LF	2.33	LF	34.32	LF	--	LF	3.10	SF	205.58	SF	464.84	PLF	2.00	ea.	212.71	CF	7.8781	CY	1B1	--	ea	A	SHT S505
1.00	LF	2.00	LF	22.57	LF	--	LF	2.00	SF	112.85	SF	300.00	PLF	2.00	ea.	90.28	CF	3.3437	CY	1B3	--	ea	A	SHT S505
1.50	LF	2.50	LF	36.80	LF	--	LF	3.75	SF	956.80	SF	562.50	PLF	12.00	ea.	1656.00	CF	61.3333	CY	1B4-1B7	--	ea	A	SHT S505
1.50	*LF*	*2.50*	*LF*	*36.80*	*LF*	*--*	*LF*	*3.75*	*SF*	*239.20*	*SF*	*562.50*	*PLF*	*3.00*	*ea.*	*414.00*	*CF*	*15.3333*	*CY*	*1B4*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*2.50*	*LF*	*36.80*	*LF*	*--*	*LF*	*3.75*	*SF*	*239.20*	*SF*	*562.50*	*PLF*	*3.00*	*ea.*	*414.00*	*CF*	*15.3333*	*CY*	*1B5*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*2.50*	*LF*	*36.80*	*LF*	*--*	*LF*	*3.75*	*SF*	*239.20*	*SF*	*562.50*	*PLF*	*3.00*	*ea.*	*414.00*	*CF*	*15.3333*	*CY*	*1B6*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*2.50*	*LF*	*36.80*	*LF*	*--*	*LF*	*3.75*	*SF*	*239.20*	*SF*	*562.50*	*PLF*	*3.00*	*ea.*	*414.00*	*CF*	*15.3333*	*CY*	*1B7*	*--*	*ea*	*A*	*SHT S505*
																SUM CHECK		*61.3333*	*CY*					
1.33	LF	3.00	LF	44.84	LF	--	LF	3.99	SF		SF	598.50	PLF	2.00	ea.	357.82	CF	13.2527	CY	1B8	--	ea	A	SHT S505
1.50	LF	3.00	LF	42.36	LF	--	LF	4.50	SF	790.00	SF	675.00	PLF	2.00	ea.	381.24	CF	14.1200	CY	1B9/1B10	--	ea	A	SHT S505
1.50	*LF*	*3.00*	*LF*	*42.36*	*LF*	*--*	*LF*	*4.50*	*SF*	*317.70*	*SF*	*675.00*	*PLF*	*1.00*	*ea.*	*190.62*	*CF*	*7.0600*	*CY*	*1B9*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*3.00*	*LF*	*42.36*	*LF*	*--*	*LF*	*4.50*	*SF*	*317.70*	*SF*	*675.00*	*PLF*	*1.00*	*ea.*	*190.62*	*CF*	*7.0600*	*CY*	*1B10*	*--*	*ea*	*A*	*SHT S505*
																SUM CHECK		*14.1200*	*CY*					
1.00	LF	2.00	LF	30.92	LF	--	LF	2.00	SF	154.60	SF	300.00	PLF	4.00	ea.	247.36	CF	9.1615	CY	1B19	--	ea	A	SHT S505
1.50	LF	2.00	LF	30.92	LF	--	LF	3.00	SF	170.06	SF	450.00	PLF	2.00	ea.	185.52	CF	6.8711	CY	1B21	--	ea	A	SHT S505

Sub Total				395.49	LF					**2389.89**	**SF**			26.00	ea.	3130.93	CF	115.96	CY					
Precast Raker Beams SHT S 201.1 - S 201.4 Main Concourse																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Beam Type			Raker Bea	Reference SHT
1.50	LF	3.00	LF	30.15	LF	--	LF	4.50	SF	904.50	SF	675.00	PLF	14.00	ea.	1899.45	CF	70.3500	CY	1RB1-1RB6	--	ea	D	SHT S506
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*4.50*	*SF*	*226.13*	*SF*	*675.00*	*PLF*	*2.00*	*ea.*	*271.35*	*CF*	*10.0500*	*CY*	*1RB1*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*4.50*	*SF*	*226.13*	*SF*	*675.00*	*PLF*	*2.00*	*ea.*	*271.35*	*CF*	*10.0500*	*CY*	*1RB2*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*4.50*	*SF*	*226.13*	*SF*	*675.00*	*PLF*	*2.00*	*ea.*	*271.35*	*CF*	*10.0500*	*CY*	*1RB3*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*4.50*	*SF*	*226.13*	*SF*	*675.00*	*PLF*	*4.00*	*ea.*	*542.70*	*CF*	*20.1000*	*CY*	*1RB4*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*4.50*	*SF*	*226.13*	*SF*	*675.00*	*PLF*	*2.00*	*ea.*	*271.35*	*CF*	*10.0500*	*CY*	*1RB5*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*4.50*	*SF*	*226.13*	*SF*	*675.00*	*PLF*	*2.00*	*ea.*	*271.35*	*CF*	*10.0500*	*CY*	*1RB6*	*--*	*ea*	*D*	*SHT S506*
																SUM CHECK		*70.3500*	*CY*					
1.50	LF	2.00	LF	17.83	LF	--	LF	3.00	SF	392.26	SF	450.00	PLF	28.00	ea.	1497.72	CF	55.4711	CY	1RB8-1RB13	--	ea	D	SHT S506
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*--*	*LF*	*3.00*	*SF*	*98.07*	*SF*	*450.00*	*PLF*	*4.00*	*ea.*	*213.96*	*CF*	*7.9244*	*CY*	*1RB8*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*--*	*LF*	*3.00*	*SF*	*98.07*	*SF*	*450.00*	*PLF*	*4.00*	*ea.*	*213.96*	*CF*	*7.9244*	*CY*	*1RB9*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*--*	*LF*	*3.00*	*SF*	*98.07*	*SF*	*450.00*	*PLF*	*4.00*	*ea.*	*213.96*	*CF*	*7.9244*	*CY*	*1RB10*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*--*	*LF*	*3.00*	*SF*	*98.07*	*SF*	*450.00*	*PLF*	*8.00*	*ea.*	*427.92*	*CF*	*15.8489*	*CY*	*1RB11*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*--*	*LF*	*3.00*	*SF*	*98.07*	*SF*	*450.00*	*PLF*	*4.00*	*ea.*	*213.96*	*CF*	*7.9244*	*CY*	*1RB12*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*--*	*LF*	*3.00*	*SF*	*98.07*	*SF*	*450.00*	*PLF*	*4.00*	*ea.*	*213.96*	*CF*	*7.9244*	*CY*	*1RB13*	*--*	*ea*	*D*	*SHT S506*
																SUM CHECK		*55.4711*	*CY*					
1.50	LF	2.00	LF	30.15	LF	--	LF	3.00	SF	663.30	SF	450.00	PLF	14.00	ea.	1266.30	CF	46.9000	CY	1RB1-1RB8	--	ea	D	SHT S506
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*1.00*	*ea.*	*90.45*	*CF*	*3.3500*	*CY*	*1RB1*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*2.00*	*ea.*	*180.90*	*CF*	*6.7000*	*CY*	*1RB2*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*2.00*	*ea.*	*180.90*	*CF*	*6.7000*	*CY*	*1RB3*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*2.00*	*ea.*	*180.90*	*CF*	*6.7000*	*CY*	*1RB4*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*2.00*	*ea.*	*180.90*	*CF*	*6.7000*	*CY*	*1RB5*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*2.00*	*ea.*	*180.90*	*CF*	*6.7000*	*CY*	*1RB6*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*2.00*	*ea.*	*180.90*	*CF*	*6.7000*	*CY*	*1RB7*	*--*	*ea*	*D*	*SHT S506*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*--*	*LF*	*3.00*	*SF*	*165.83*	*SF*	*450.00*	*PLF*	*1.00*	*ea.*	*90.45*	*CF*	*3.3500*	*CY*	*1RB8*	*--*	*ea*	*D*	*SHT S506*
																SUM CHECK		*46.9000*	*CY*					
Sub Total				529.08	LF					**1960.06**	**SF**			56.00	ea.	4663.47	CF	172.72	CY					
Precast Beams SHT S 202.1 - S 202.4 Bridge Level																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Beam Type			Beam Type	Reference SHT
1.50	LF	3.00	LF	29.07	LF	--	LF	4.50	SF	218.03	SF	675.00	PLF	4.00	ea.	523.26	CF	19.3800	CY	2B1	--	ea	A	SHT S505
1.50	LF	3.00	LF	49.16	LF	--	LF	4.50	SF	368.70	SF	675.00	PLF	2.00	ea.	442.44	CF	16.3867	CY	2B2	--	ea	A	SHT S506
1.50	LF	3.00	LF	45.14	LF	--	LF	4.50	SF	338.55	SF	675.00	PLF	4.00	ea.	812.52	CF	30.0933	CY	2B3	--	ea	A	SHT S507
1.50	LF	2.00	LF	49.16	LF	--	LF	3.00	SF	270.38	SF	450.00	PLF	2.00	ea.	294.96	CF	10.9244	CY	2B9	--	ea	A	SHT S508
Sub Total				172.53	LF					**1195.66**	**SF**			12.00	ea.	2073.18	CF	76.78	CY					
Precast Raker Beams SHT S 202.1 - S 202.4 Bridge Level																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Beam Type			Raker Bea	Reference SHT
1.50	LF	3.00	LF	40.92	LF	--	LF	4.50	SF	838.86	SF	675.00	PLF	22.00	ea.	4051.08	CF	150.0400	CY	2RB1,2RB2				
1.50	*LF*	*2.50*	*LF*	*40.92*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.98*	*SF*	*675.00*	*PLF*	*11.00*	*ea.*	*2025.54*	*CF*	*75.0200*	*CY*	*2RB1*	*--*	*ea*	*E*	*SHT S506*
1.50	*LF*	*2.50*	*LF*	*40.92*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.98*	*SF*	*675.00*	*PLF*	*11.00*	*ea.*	*2025.54*	*CF*	*75.0200*	*CY*	*2RB2*	*--*	*ea*	*E*	*SHT S506*
																SUM CHECK		*150.0400*	*CY*					
1.50	LF	3.00	LF	40.92	LF	--	LF	4.50	SF	306.90	SF	675.00	PLF	2.00	ea.	368.28	CF	13.6400	CY	2RB3		ea	E	SHT S506
Sub Total				122.76	LF					**1145.76**	**SF**			24.00	ea.	4419.36	CF	163.68	CY					
Precast Beams SHT S 203.1 - S 203.4 Suite Level																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Beam Type			Beam Type	Reference SHT
1.50	LF	3.00	LF	35.40	LF	--	LF	4.50	SF	1062.00	SF	675.00	PLF	9.00	ea.	1433.70	CF	53.1000	CY	3B1-3B7				
1.50	*LF*	*3.00*	*LF*	*35.40*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.50*	*SF*	*675.00*	*PLF*	*2.00*	*ea.*	*318.60*	*CF*	*11.8000*	*CY*	*3B1*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*3.00*	*LF*	*35.40*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.50*	*SF*	*675.00*	*PLF*	*1.00*	*ea.*	*159.30*	*CF*	*5.9000*	*CY*	*3B2*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*3.00*	*LF*	*35.40*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.50*	*SF*	*675.00*	*PLF*	*1.00*	*ea.*	*159.30*	*CF*	*5.9000*	*CY*	*3B3*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*3.00*	*LF*	*35.40*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.50*	*SF*	*675.00*	*PLF*	*1.00*	*ea.*	*159.30*	*CF*	*5.9000*	*CY*	*3B4*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*3.00*	*LF*	*35.40*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.50*	*SF*	*675.00*	*PLF*	*1.00*	*ea.*	*159.30*	*CF*	*5.9000*	*CY*	*3B5*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*3.00*	*LF*	*35.40*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.50*	*SF*	*675.00*	*PLF*	*1.00*	*ea.*	*159.30*	*CF*	*5.9000*	*CY*	*3B6*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*3.00*	*LF*	*35.40*	*LF*	*--*	*LF*	*4.50*	*SF*	*265.50*	*SF*	*675.00*	*PLF*	*2.00*	*ea.*	*318.60*	*CF*	*11.8000*	*CY*	*3B7*	*--*	*ea*	*A*	*SHT S505*
																SUM CHECK		*53.1000*	*CY*					

1.50	LF	2.00	LF	33.24	LF	--	LF	3.00	SF	731.28	SF	450.00	PLF	5.00	ea.	498.60	CF	18.4667	CY	3B13-3B17				
1.50	*LF*	*2.00*	*LF*	*33.24*	*LF*	*--*	*LF*	*3.00*	*SF*	*182.82*	*SF*	*450.00*	*PLF*	*1.00*	*ea.*	*99.72*	*CF*	*3.6933*	*CY*	*3B13*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*2.00*	*LF*	*33.24*	*LF*	*--*	*LF*	*3.00*	*SF*	*182.82*	*SF*	*450.00*	*PLF*	*1.00*	*ea.*	*99.72*	*CF*	*3.6933*	*CY*	*3B14*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*2.00*	*LF*	*33.24*	*LF*	*--*	*LF*	*3.00*	*SF*	*182.82*	*SF*	*450.00*	*PLF*	*1.00*	*ea.*	*99.72*	*CF*	*3.6933*	*CY*	*3B15*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*2.00*	*LF*	*33.24*	*LF*	*--*	*LF*	*3.00*	*SF*	*182.82*	*SF*	*450.00*	*PLF*	*1.00*	*ea.*	*99.72*	*CF*	*3.6933*	*CY*	*3B16*	*--*	*ea*	*A*	*SHT S505*
1.50	*LF*	*2.00*	*LF*	*33.24*	*LF*	*--*	*LF*	*3.00*	*SF*	*182.82*	*SF*	*450.00*	*PLF*	*1.00*	*ea.*	*99.72*	*CF*	*3.6933*	*CY*	*3B17*	*--*	*ea*	*A*	*SHT S505*
																SUM CHECK		*18.4667*	*CY*					
1.50	LF	2.00	LF	34.00	LF	--	LF	3.00	SF	187.00	SF	450.00	PLF	10.00	ea.	1020.00	CF	37.7778	CY	3B17	--	ea	A	SHT S505
Sub Total				448.00	LF					**1980.28**	**SF**			24.00	ea.	2952.30	CF	109.34	CY					
Precast Raker Beams SHT S 203.1 - S 203.4 Suite Level																								
Width (ft)		Height (ft)		Length (ft)		Thickness (ft)		Area (SF)		SFCA	(SF)	Member Wt		Quantity		Cubic Feet		Cubic Yards		Beam Type			Raker Bea	Reference SHT
3.00	LF	3.00	LF	30.48	LF	--	LF	4.50	SF	685.80	SF	675.00	PLF	22.00	ea.	3017.52	CF	111.7600	CY	3RB1,3RB2				
1.50	*LF*	*3.00*	*LF*	*30.48*	*LF*	*--*	*LF*	*4.50*	*SF*	*228.60*	*SF*	*675.00*	*PLF*	*11.00*	*ea.*	*1508.76*	*CF*	*55.8800*	*CY*	*3RB1*	*--*	*ea*	*F*	*SHT S506*
1.50	*LF*	*3.00*	*LF*	*30.48*	*LF*	*--*	*LF*	*4.50*	*SF*	*228.60*	*SF*	*675.00*	*PLF*	*11.00*	*ea.*	*1508.76*	*CF*	*55.8800*	*CY*	*3RB2*	*--*	*ea*	*F*	*SHT S506*
																SUM CHECK		*111.7600*	*CY*					
1.50	LF	3.00	LF	30.48	LF	--	LF	4.50	SF	228.60	SF	675.00	PLF	2.00	ea.	274.32	CF	10.1600	CY	3RB3				
Sub Total				91.44	LF					**914.40**	**SF**			24.00	ea.	6309.36	CF	121.92	CY					
Page Totals																								
Cubic Yards of Concrete =				***1099.81***	***CY***																			

Total Quantity

CIP Column Forms	**Total SFCA**	
12" x 12"	*0*	*SFCA*
16" x 16"	*279.98*	*SFCA*
18" x 18"	*2530.98*	*SFCA*
24" x 24"	*7983.00*	*SFCA*
36" x 36"	*0*	*SFCA*
CIP Beams	**Total SFCA**	
18" x 18" (Assumed)	*5565.82*	*SCFA*

CIP Raker Beams	**18 Riser Bent Form**	
16" x 32" Riser Dimention	**Total Cubic Yards**	
Total Cubic Yards of Concrete Placed for Raker(s)	**448.16**	**CY**
	Quantity	
Type D Raker	**6.82 CY**	**56.00 ea.**
Type E Raker	**6.82 CY**	**24.00 ea.**
Type F Raker	**5.08 CY**	**24.00 ea.**

Uniformat Number	Item Name	Crew Designation	Daily Work/ Unit Output
03110.410.6000	16" Wide Structural CIP Column Forms	C-14	185
03110.410.6300	18" Wide Structural CIP Column Forms	C-14	187
03110.410.6500	24" Wide Structural CIP Column Forms	C-14	190
03110.405.1000	18" Wide Structural CIP Beam Forms	C-14	250
03310.220.0300	Material Costs for 4,000 PSI Concrete	C-14	1
03310.800.0781	16" x 32" Bent Raker Form Rental @ 10 Risers (21 QTY)	C11	3
03310.800.0781	16" x 32" Bent Raker Form Rental @ 8 Risers (21 QTY)	C11	3
03310.800.0781	16" x 32" Bent Raker Form Rental @ 2 Risers (21 QTY)	C11	3
03310.700.0800	Concrete for Beams and Column placed by Pump Truck (assumed use for Beam thickness of 24")	C-14	70
03310.700.0800	Concrete for Beams and Column placed by Pump Truck (assumed use for Beam thickness of 24") Raker Placement	C-14	70

Means Cost Data

Unit	Labor Output per Unit	HR	Requeste Project Quantity	Unit	Total Crew Hours (HR)		Total Crew Days (D)	
SFCA	0.173	HR	279.98	SFCA	0.2618	HR	0.03	D
SFCA	0.17	HR	2530.98	SFCA	2.3009	HR	0.29	D
SFCA	0.168	HR	7983.00	SFCA	7.0587	HR	0.88	D
SFCA	0.192	HR	5565.82	SFCA	4.2746	HR	0.53	D
CY	1	HR	1089.63	CY	1089.6300	HR	136.20	D
ea.	0.25	HR	381.92	CY	31.8267	HR	3.98	D
ea.	0.25	HR	163.68	CY	13.6400	HR	1.71	D
ea.	0.25	HR	121.92	CY	10.1600	HR	1.27	D
CY	1.029	HR	641.53	CY	9.4305	HR	1.18	D
CY	1.029	HR	448.16	CY	6.5880	HR	0.82	D
			Sum Total Duration		521.3930	HR	65.17	D

RS Means Source Data				Quantity Weighted Cost			
Mat'l Costs	Labor Costs	Equipment Costs	Total Costs	Mat'l	Labor	Equipment Costs	Total
$ 2.23	$ 5.80	$ -	$ 8.03	$ 624.35	$ 1.52	$ -	$ 625.87
$ 2.39	$ 5.88	$ -	$ 8.27	$ 6,049.04	$ 13.53	$ -	$ 6,062.57
$ 2.54	$ 5.65	$ -	$ 8.19	$ 20,276.82	$ 39.88	$ -	$ 20,316.70
$ 3.32	$ 6.65	$ -	$ 9.97	$ 18,478.53	$ 28.43	$ -	$ 18,506.95
$ 91.00	$ -	$ -	$ 91.00	$ 99,156.33	$ -	$ -	$ 99,156.33
$ -	$ -	$63,757.17	$ 73,320.74	$ -	$ -	$ 83,738.40	$ 83,738.40
$ -	$ -	$51,005.73	$ 58,656.59	$ -	$ -	$ 62,228.36	$ 62,228.36
$ -	$ -	$31,500.00	$ 36,225.00	$ -	$ -	$ 37,868.06	$ 37,868.06
$ -	$ -	$ 1,800.00	$ 1,800.00	$ -	$ -	$ 2,121.86	$ 2,121.86
$ -	$ -	$ 1,800.00	$ 1,800.00	$ -	$ -	$ 1,482.29	$ 1,482.29
				Sum Total Cost:		$	**332,107.40**

Raker Bent Form Rental Costs *(Raker form for beam servicing 18 Risers)*

Base Line Rate $_{(Baltimore, MD)}$ = *$ 3,500/ 28 Days*

Baltimore-Wash CPI Index	126.3
Chicago $_{CPI\ Index}$	197.2
Chicago $_{(CPI)}$ / Baltimore $_{(CPI)}$ =	1.5614

Adjusted Raker Rental Rate/ 28 Days **$ 5,464.90**

Raker Type D (10 Risers)	**$3,036.06**	/ 28 Days
Raker Type D (8 Risers)	**$2,428.84**	/ 28 Days
Raker Type D (2 Risers)	**$1,500.00**	/ 28 Days

Analysis of Crane Errection Duration (For Placing Bent Forms)

Project Tasks	Crew Discriptions	Proposed Duration	Total Costs
Main course Raker	C11/ (6) Workers, (2) Laborers, (1) Foreman, (1) Operator, (1) Oiler (1) 300 TON Tower Crane	8 Days	$ 70,791.52
Bridge Level Raker	C11/ (6) Workers, (2) Laborers, (1) Foreman, (1) Operator, (1) Oiler (1) 300 TON Tower Crane	4 Days	$ 35,395.76
Suite Raker	C11/ (6) Workers, (2) Laborers, (1) Foreman, (1) Operator, (1) Oiler (1) 300 TON Tower Crane	4 Days	$ 35,395.76
CIP Beam Form Install and Concr. Finish	C14/ (16) Carpenters, (4) Rodmen, (1) Pump Truck Operator, (1) Forman, (2) Laborers, etc.	6 Day	$ 85,353.96
CIP Column Form Install and Concr. Finish	C14/ (16) Carpenters, (4) Rodmen, (1) Pump Truck Operator, (1) Forman, (2) Laborers, etc.	2 Day	$ 28,451.32
CIP Raker Form Install and Concr. Finish	C14/ (16) Carpenters, (4) Rodmen, (1) Pump Truck Operator, (1) Forman, (2) Laborers, etc.	2 Day	$ 28,451.32
Sub Total	***Total Labor/ Work***	***34 Days***	***$ 283,839.64***

Sum Total of CIP Superstructure $ 615,947.04

Alternative Pre-caster Assessment

Precast Columns SHT S 200.1									
Width (ft)		Height (ft)		Length (ft)		Unit Price	Line Total	Quantity	
2.00	LF	2.00	LF	70.17	LF	$ 900.00	$ 5,400.00	6.00	ea.
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 1,800.00	*2.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 1,800.00	*2.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 900.00	*1.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 900.00	*1.00*	*ea.*
1.33	LF	1.33	LF	70.17	LF	$ 900.00	$ 900.00	1.00	ea.
2.00	LF	2.00	LF	34.63	LF	$ 600.00	$ 3,600.00	6.00	ea.
2.00	*LF*	*2.00*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	LF	1.50	LF	11.96	LF	$ 300.00	$ 1,800.00	6.00	ea.
1.50	*LF*	*1.50*	*LF*	*11.96*	LF	$ 300.00	$ 300.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*11.96*	LF	$ 300.00	$ 300.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*11.96*	LF	$ 300.00	$ 300.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*11.96*	LF	$ 300.00	$ 300.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*11.96*	LF	$ 300.00	$ 300.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*11.96*	LF	$ 300.00	$ 300.00	*1.00*	*ea.*
1.50	LF	1.50	LF	5.57	LF	$ 300.00	$ 1,800.00	6.00	ea.
Sub Total				635.96	LF		**$ 10,800.00**	25.00	ea.
Precast Columns SHT S 200.2									
Width (ft)		Height (ft)		Length (ft)				Quantity	
2.00	LF	2.00	LF	70.17	LF	$ 900.00	$ 7,200.00	8.00	ea.
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 1,800.00	*2.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 1,800.00	*2.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 1,800.00	*2.00*	*ea.*
2.00	*LF*	*2.00*	*LF*	*70.17*	LF	$ 900.00	$ 1,800.00	*2.00*	*ea.*
1.33	LF	1.33	LF	70.17		$ 900.00	$ 900.00	1.00	ea.
1.50	LF	1.50	LF	34.63	LF	$ 600.00	$ 4,200.00	7.00	ea.
1.50	*LF*	*1.50*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	*LF*	*1.50*	*LF*	*34.63*	LF	$ 600.00	$ 600.00	*1.00*	*ea.*
1.50	LF	1.50	LF	11.96	LF	$ 300.00	$ 2,100.00	7.00	ea.

1.50	LF	1.50	LF	11.96	LF	$	300.00	$	300.00	1.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	300.00	1.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	300.00	1.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	300.00	1.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	300.00	1.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	300.00	1.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	300.00	1.00	ea.
1.50	LF	1.50	LF	5.57	LF	$	300.00	$	1,800.00	6.00	ea.
Sub Total				682.55				**$**	**29,700.00**	29.00	ea.
Precast Columns SHT S 200.3											
Width (ft)		Height (ft)		Length (ft)						Quantity	
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	3,600.00	4.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
1.50	LF	1.50	LF	34.63	LF	$	600.00	$	3,000.00	5.00	ea.
1.50	LF	1.50	LF	34.63	LF	$	600.00	$	1,800.00	3.00	ea.
1.50	LF	1.50	LF	34.63	LF	$	600.00	$	1,200.00	2.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	1,800.00	6.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	600.00	2.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	600.00	2.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	600.00	2.00	ea.
1.50	LF	1.50	LF	5.57	LF	$	300.00	$	1,500.00	5.00	ea.
Sub Total				391.39				**$**	**9,900.00**	20.00	ea.
Precast Columns SHT S 200.4											
Width (ft)		Height (ft)		Length (ft)						Quantity	
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	3,600.00	4.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
2.00	LF	2.00	LF	70.17	LF	$	900.00	$	900.00	1.00	ea.
1.50	LF	1.50	LF	34.63	LF	$	600.00	$	3,000.00	5.00	ea.
1.50	LF	1.50	LF	34.63	LF	$	600.00	$	1,800.00	3.00	ea.
1.50	LF	1.50	LF	34.63	LF	$	600.00	$	1,200.00	2.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	1,800.00	6.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	600.00	2.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	600.00	2.00	ea.
1.50	LF	1.50	LF	11.96	LF	$	300.00	$	600.00	2.00	ea.
1.50	LF	1.50	LF	5.57	LF	$	300.00	$	1,500.00	5.00	ea.

Sub Total				391.39			**$ 9,900.00**	20.00	ea.
Precast Beams SHT S 201.1 - S 201.4 Main Concourse									
Width (ft)		Height (ft)		Length (ft)				Quantity	
1.33	LF	2.33	LF	34.32	LF	$ 260.00	$ 520.00	2.00	ea.
1.00	LF	2.00	LF	22.57	LF	$ 260.00	$ 520.00	2.00	ea.
1.50	LF	2.50	LF	36.80	LF	$ 260.00	$ 3,120.00	12.00	ea.
1.50	*LF*	*2.50*	*LF*	*36.80*	LF	$ 260.00	$ 780.00	*3.00*	*ea.*
1.50	*LF*	*2.50*	*LF*	*36.80*	LF	$ 260.00	$ 780.00	*3.00*	*ea.*
1.50	*LF*	*2.50*	*LF*	*36.80*	LF	$ 260.00	$ 780.00	*3.00*	*ea.*
1.50	*LF*	*2.50*	*LF*	*36.80*	LF	$ 260.00	$ 780.00	*3.00*	*ea.*
1.33	LF	3.00	LF	44.84	LF	$ 260.00	$ 520.00	2.00	ea.
1.50	LF	3.00	LF	42.36	LF	$ 260.00	$ 520.00	2.00	ea.
1.50	*LF*	*3.00*	*LF*	*42.36*	LF	$ 260.00	$ 260.00	*1.00*	*ea.*
1.50	*LF*	*3.00*	*LF*	*42.36*	LF	$ 260.00	$ 260.00	*1.00*	*ea.*
1.00	LF	2.00	LF	30.92	LF	$ 260.00	$ 1,040.00	4.00	ea.
1.50	LF	2.00	LF	30.92	LF	$ 260.00	$ 520.00	2.00	ea.
Sub Total				395.49			**$ 6,760.00**	26.00	ea.
Precast Raker Beams SHT S 201.1 - S 201.4 Main Concourse									
Width (ft)		Height (ft)		Length (ft)				Quantity	
1.50	LF	3.00	LF	30.15	LF	$ 320.00	$ 4,480.00	14.00	ea.
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 1,280.00	*4.00*	*ea.*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*3.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	LF	2.00	LF	17.83	LF	$ 320.00	$ 8,960.00	28.00	ea.
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*$ 320.00*	$ 1,280.00	*4.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*$ 320.00*	$ 1,280.00	*4.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*$ 320.00*	$ 1,280.00	*4.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*$ 320.00*	$ 2,560.00	*8.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*$ 320.00*	$ 1,280.00	*4.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*17.83*	*LF*	*$ 320.00*	$ 1,280.00	*4.00*	*ea.*
1.50	LF	2.00	LF	30.15	LF	$ 320.00	$ 4,480.00	14.00	ea.
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 320.00	*1.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 640.00	*2.00*	*ea.*
1.50	*LF*	*2.00*	*LF*	*30.15*	*LF*	*$ 320.00*	$ 320.00	*1.00*	*ea.*
Sub Total				529.08	LF		**$ 17,920.00**	56.00	ea.

Precast Beams SHT S 202.1 - S 202.4 Bridge Level									
Width (ft)		Height (ft)		Length (ft)				Quantity	
1.50	LF	3.00	LF	29.07	LF	$ 260.00	$ 1,040.00	4.00	ea.
1.50	LF	3.00	LF	49.16	LF	$ 260.00	$ 520.00	2.00	ea.
1.50	LF	3.00	LF	45.14	LF	$ 260.00	$ 1,040.00	4.00	ea.
1.50	LF	2.00	LF	49.16	LF	$ 260.00	$ 520.00	2.00	ea.
Sub Total				172.53	LF		**$ 3,120.00**	12.00	ea.
Precast Raker Beams SHT S 202.1 - S 202.4 Bridge Level									
Width (ft)		Height (ft)		Length (ft)				Quantity	
1.50	LF	3.00	LF	40.92	LF	$ 341.00	$ 7,502.00	22.00	ea.
1.50	LF	2.50	LF	40.92	LF	$ 341.00	$ 3,751.00	11.00	ea.
1.50	LF	2.50	LF	40.92	LF	$ 341.00	$ 3,751.00	11.00	ea.
1.50	LF	3.00	LF	40.92	LF	$ 341.00	$ 682.00	2.00	ea.
Sub Total				122.76	LF		**$ 8,184.00**	24.00	ea.
Precast Beams SHT S 203.1 - S 203.4 Suite Level									
Width (ft)		Height (ft)		Length (ft)				Quantity	
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 2,340.00	9.00	ea.
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 520.00	2.00	ea.
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	3.00	LF	35.40	LF	$ 260.00	$ 520.00	2.00	ea.
1.50	LF	2.00	LF	33.24	LF	$ 260.00	$ 1,300.00	5.00	ea.
1.50	LF	2.00	LF	33.24	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	2.00	LF	33.24	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	2.00	LF	33.24	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	2.00	LF	33.24	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	2.00	LF	33.24	LF	$ 260.00	$ 260.00	1.00	ea.
1.50	LF	2.00	LF	34.00	LF	$ 260.00	$ 2,600.00	10.00	ea.
Sub Total				448.00	LF		***$ 3,640.00***	24.00	ea.
Precast Raker Beams SHT S 203.1 - S 203.4 Suite Level									
Width (ft)		Height (ft)		Length (ft)				Quantity	
1.50	LF	3.00	LF	30.48	LF	$ 590.00	$ 12,980.00	22.00	ea.
1.50	LF	3.00	LF	30.48	LF	$ 590.00	$ 6,490.00	11.00	ea.
1.50	LF	3.00	LF	30.48	LF	$ 590.00	$ 6,490.00	11.00	ea.
1.50	LF	3.00	LF	30.48	LF	$ 590.00	$ 1,180.00	2.00	ea.
Sub Total				91.44	LF		***$ 14,160.00***	24.00	ea.

Page Totals								
							Total Num. Pieces	
Cubic Yards of Concrete =		***1099.81***	***CY***	Total Base Costs	***$***	***115,884.00***	260.00	ea.

Total Errection Costs =		$	260,000.00
Number of Truck Loads =	214		
Procurement Costs & Travel to Site =		$	214,000.00

Sum Total for High Concrete Precast		***$***	***921,022.37***
	Total Duration	***17.33***	***Crew Day(s)***

Pre-cast/ CIP Cost / Benefit Analysis

Crew Duration		System Costs	Time Costs/ Benefit		$ Cost / Savings
			(Day) = days saved		*$ (Cost Overrun)*
			Day = days added		*$ Cost Savings*
Spancrete *Current Method*	***96***	***DAYS***	***$ 989,866***	***--***	***DAY***	***--***
High Concrete *Alternate Precaster*	***107***	***DAYS***	***$ 921,022***	***11***	***DAY***	***$ 68,844***
CIP/ Method *Evaluated Method*	***131***	***DAYS***	***$ 615,947***	***35***	***DAY***	***$ 373,919***

Structural Appendix

- *Envelope Analysis*
- *Thin Brick System*
- *Structural Calculations*

Thin Brick System

04812/END
BuyLine 6621

THIN BRICK

Sparrow Hospital
Lansing, MI

Arboretum Lakes Building 1
Carol Stream, IL

Target Store
Brighton, MI

Applications for Endicott thin brick are limited only by the imagination.

Endicott thin brick is ideally suited to year-round commercial, residential and remodeling applications.

Genuine, kiln-fired thin brick possesses all the durability and unparalleled elegance of Endicott face brick, yet when installed maximizes space and weighs considerably less.

Installation Techniques

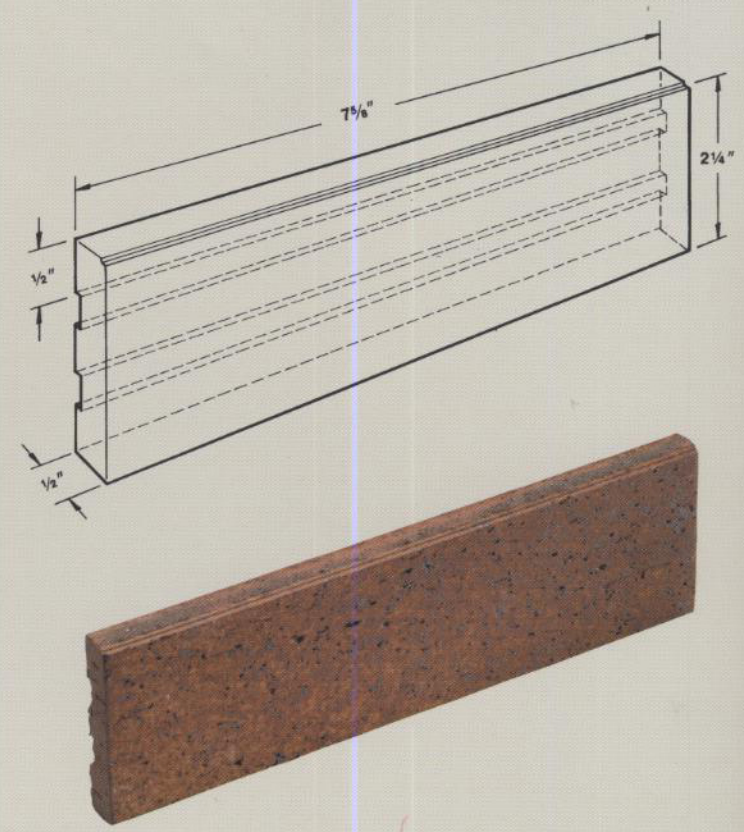
Whether it is a new construction or remodeling project, Endicott thin brick may be applied over any structurally sound substrate. And, because no footings or supports are required, the thin brick may extend all the way to grade.

*There are a number of substrate panels and prefabricated wall panel systems available to the industry that can receive the thin brick as factory or job site applied.**

Reputable installation system suppliers have literature which you my obtain for review regarding project applicability.

The standard Endicott thin brick unit size is 2 1/4" x 7 5/8". Additional unit sizes—3 5/8" x 7 5/8"; 7 5/8" x 7 5/8"; 3 5/8" x 11 5/8"—can, however, be specified for special applications. Endicott thin brick has been tested according to ASTM C1088 specifications and meets Type TBX requirements.

To fully complement the installation process, Endicott also offers all necessary trim units.



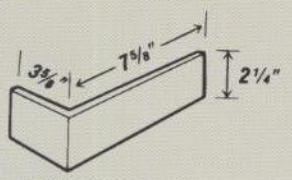
Arboretum Lakes Building 2
Carol Stream, IL

Private Residence
Central City, NE

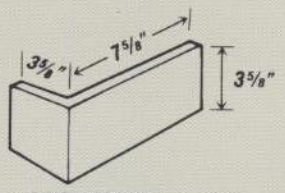
** Code requirements vary from one municipality to the next. Check with your local Code Authority and Engineer for certification of system prior to the start of application.*

THIN BRICK SIZES AND TRIM UNITS

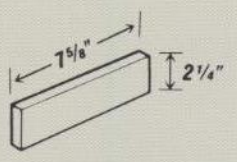
To enhance in-place installation, Endicott thin brick feature a distinct keyback design which provides a mechanical lock into the concrete for maximum durability and permanence. All materials are tested according to ASTM C1088, and meet requirements for Type TBX, Exterior Grade. Testing data is available upon request.

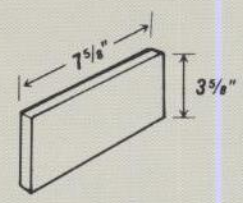


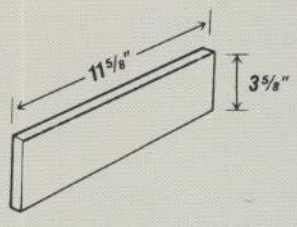
BRICK CORNER BC2¼ 48

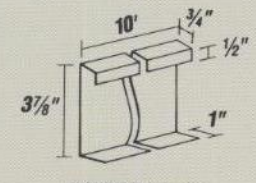


BRICK CORNER BC 448

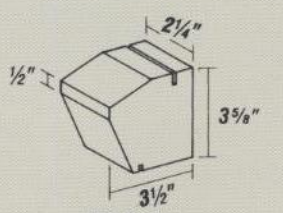




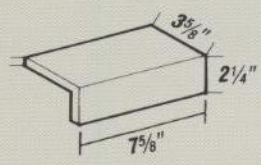




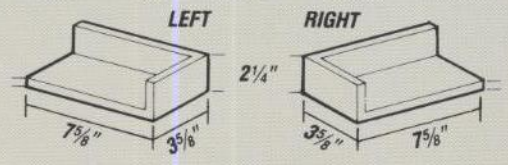
ROLOK SILL BRACKET



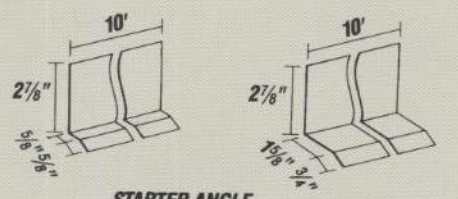
ROLOK SILL



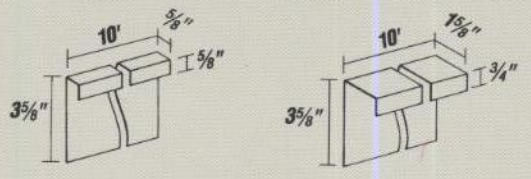
EDGE CAP



EDGE CAP CORNERS (Mitered)



STARTER ANGLE



TOP/SIDE ANGLE

ESTIMATING DATA

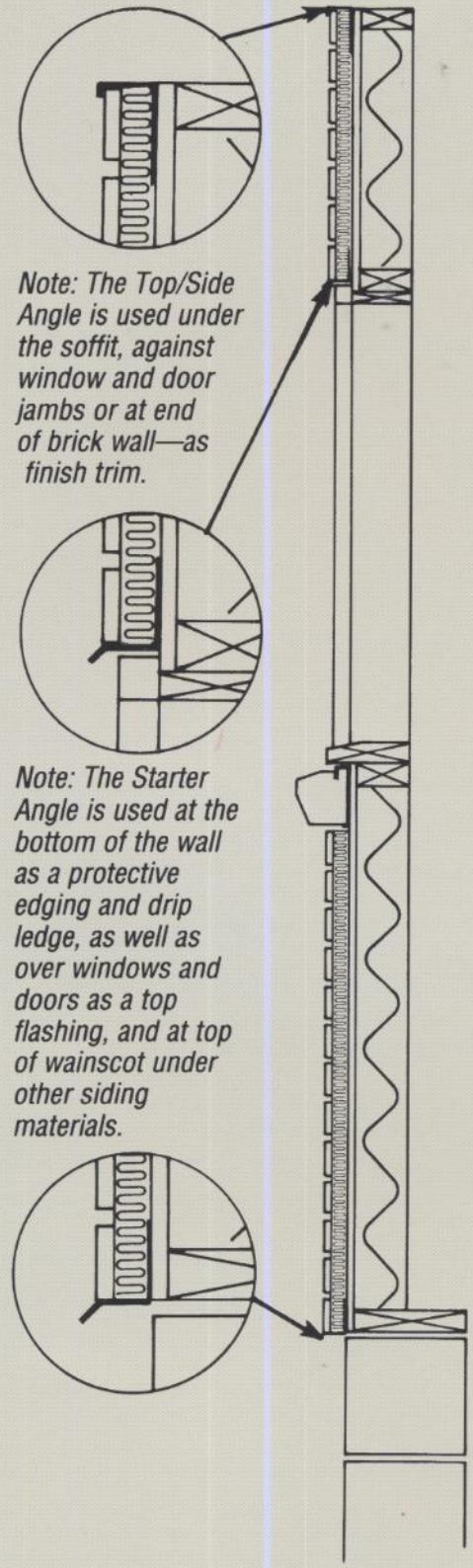
½ x 2¼ x 7⅝	- 6.86 pcs./sq. ft.	Edge Cap	- 1.50 pcs./lin. ft.
½ x 3⅝ x 7⅝	- 4.50 pcs./sq. ft.	Edge Cap - 3 Sided Left/Right	- 1.00 pc./corner
½ x 3⅝ x 11⅝	- 3.00 pcs./sq. ft.	Rolok Sill	- 4.50 pcs./lin. ft.
Corners (2¼")	- 4.50 pcs./lin. ft.		
Corners (3⅝")	- 3.00 pcs./lin. ft.		

METRIC CONVERSION

	Imperial	**Soft (mm)**	**Hard (mm)**
½ x 2¼ x 8	½ x 2¼ x 7⅝	12.5 x 57 x 194	12.5 x 57 x 190
½ x 4 x 8	½ x 3⅝ x 7⅝	12.5 x 92 x 194	12.5 x 90 x 190
½ x 4 x 12	½ x 3⅝ x 11⅝	12.5 x 92 x 295	12.5 x 90 x 290

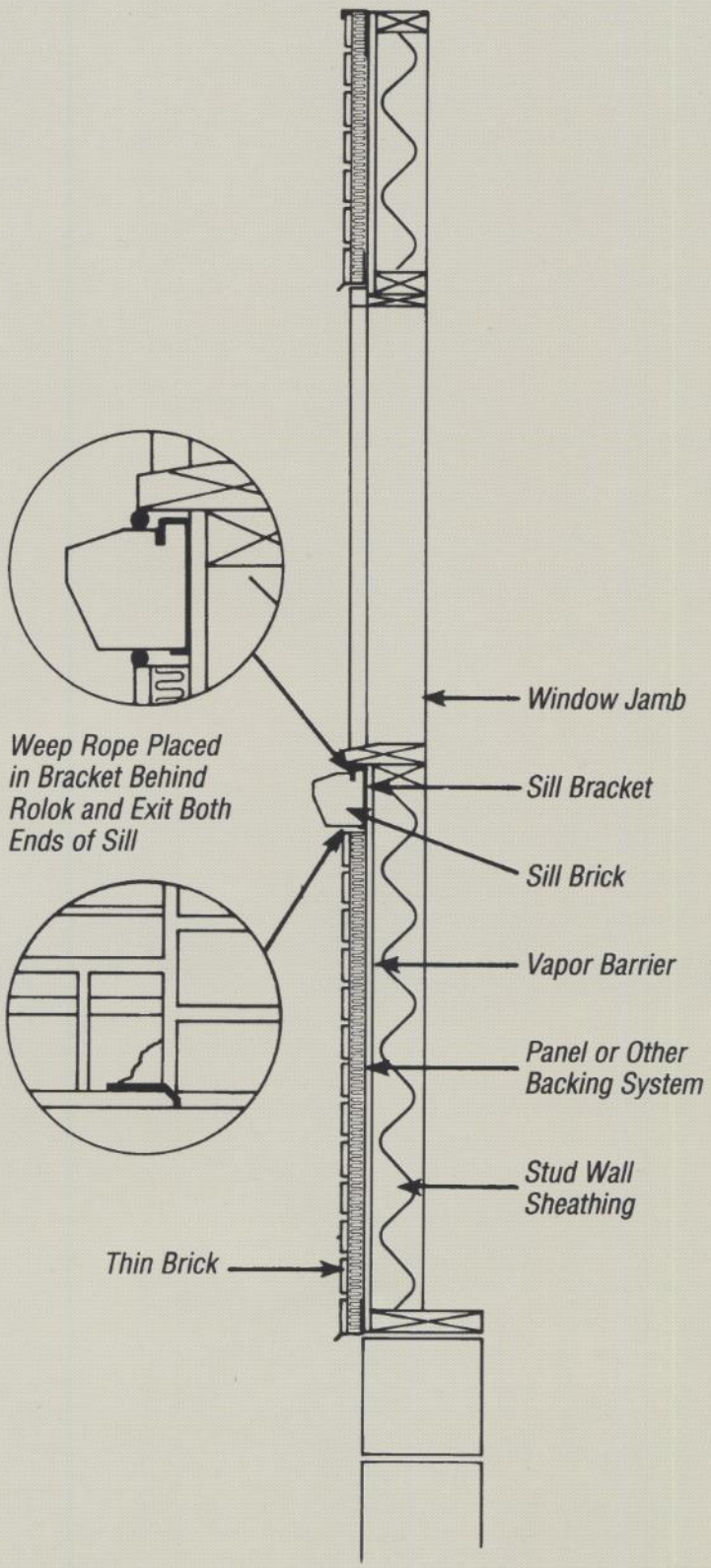
Soft Conversion: *A simple mathematical calculation (inches x 25.4 = mm) that changes Imperial dimension (inches) to metric (millimeters).*
Hard Conversion: *Actual physical changes in dies and equipment to produce metric dimensions (millimeters).*

THIN BRICK CONSTRUCTION DETAILS



Note: The Top/Side Angle is used under the soffit, against window and door jambs or at end of brick wall—as finish trim.

Note: The Starter Angle is used at the bottom of the wall as a protective edging and drip ledge, as well as over windows and doors as a top flashing, and at top of wainscot under other siding materials.

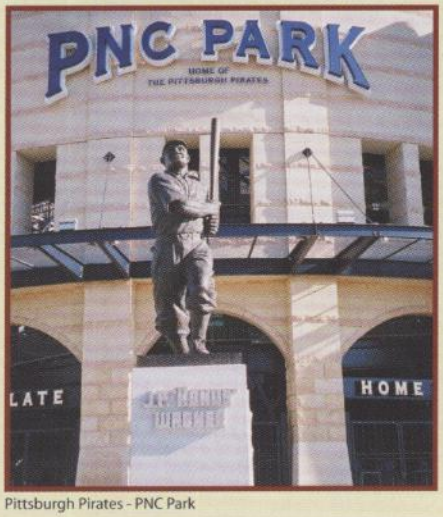


THIN BRICK by Owensboro

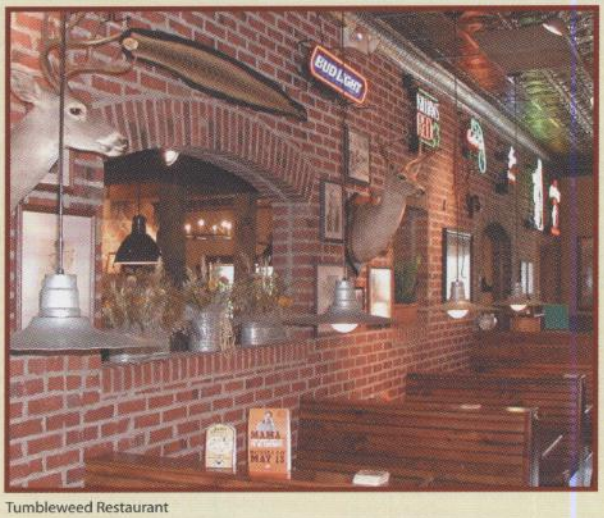
04840/PAN
BuyLine 1749

www.thinbrickbyowensboro.com

THIN BRICK BRICKETTES®



Pittsburgh Pirates - PNC Park

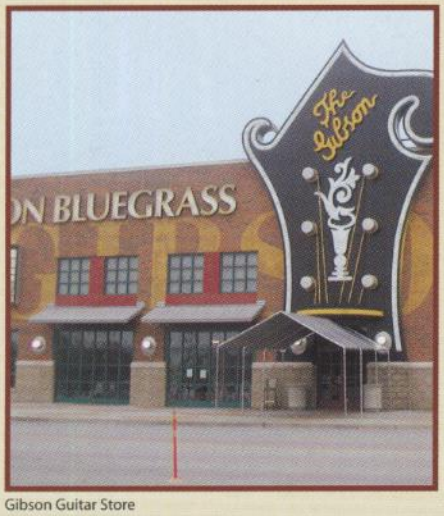


Tumbleweed Restaurant

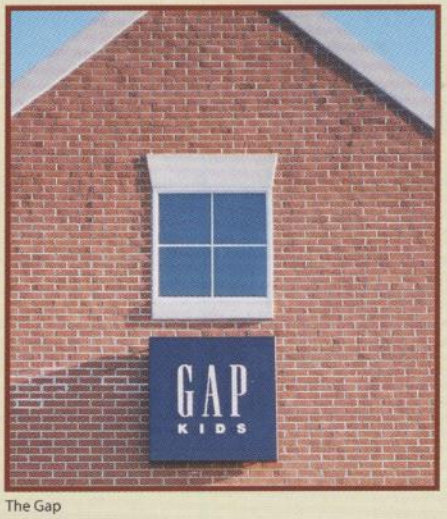
Harley Davidson

Crafting quality thin brick, panel brick and full-size brick, and delivering it with unsurpassed customer service, have been the hallmarks of our 50+ year history in the brick manufacturing business.

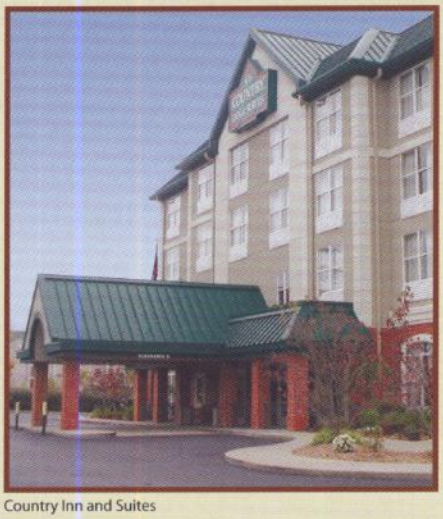
PANEL BRICK



Gibson Guitar Store



The Gap


Country Inn and Suites

Thin Brick by Owensboro | P.O. Box 907 | Owensboro, Kentucky 42302 | 270-684-7268 | 270-685-5128

PANEL BRICK

Shop Rite

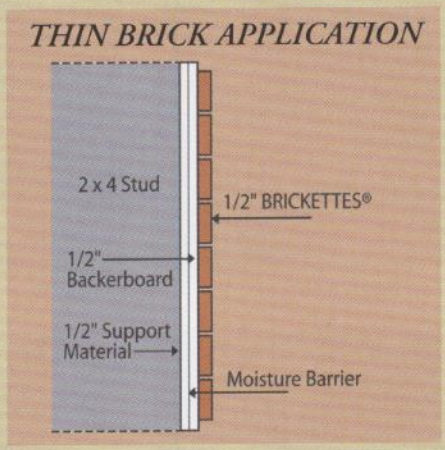
Factory Assembled
Thin Brick Brickette® panels are a factory-assembled system featuring genuine clay kiln ½-inch thin brick facing adhered to a rigid insulation fiberboard backer. Panel Brick weighs less than six pounds per square foot, which is 1/5th the weight of full-size brick.

Materials And Finishes
Panel Brick is a thin brick veneer system comprised of Brickettes® adhered in running bond to a 16" x 48" backer board.

Insulation Board
The rigid backer board used to create Panel Brick is a high density, nail base, asphalt impregnated fiberboard manufactured by Temple-Inland Corporation meeting Federal specification LLL-1-535B, Class E, Style 2 conforms to Industry Standards ANSI/AHA A194, 1-1985 Type IV, Class 2 and ASTM C-208-94.

Adhesives
An exterior, waterproof, synthetic rubber base adhesive that complies with APA specification AFG-01 is used to bond Brickettes® to the backer board.

Assembly And Installation
Installation of Panel Brick is a straight forward construction procedure for prefabricated thin brick systems. Panels are fastened to the supporting construction by driving fasteners into backing material using not less than two fasteners per square foot. A water resistive barrier shall be applied to the substrate behind the Panel Brick. Subsequent panel is interlocked with the first and so on. After all panels are installed, the masonry joints between the Brickettes® are mortared and finished. Panel Brick fabricated with cementations backer board must be used where panels are installed below grade to six inches above grade. Detailed installation procedures are available. Please contact us for more information.



Fasteners
Fasteners must be suitable for the underlying material and of sufficient length to penetrate through the sheathing to insure adequate support for the panels meeting ASTM D-1037-93 testing. Panels shall be mechanically fastened with adequate fasteners to support horizontal and vertical dead loads as listed in BOCA Research Report NO.97-18. Fastener schedule is provided by the manufacturer.

Channels
The design of this thin brick veneer system requires the application of a 1" x 3" J or L channel installed below the bottom edge of the lower panel not to extend more than 3/8" below the bottom course of Brickettes® or the Brick Panel bottom. Channels, through wall flashings and approved vapor barriers will provide adequate system relief in accordance with ASTM E-514.

Mortaring
Over fill masonry joints with mortar after all panels have been set and all individual units have had adequate time for adhesive to set, using a tuck pointing tool, metal-tipped mortar bag kit or mortaring machine. Mortar should be a rich mixture of cement and masonry sand mixed to a consistency that flows smoothly through a grout bag. Finish masonry joints with a mortar into the masonry joints. Brickette® grout mix is available from the manufacturer. Grout mixture shall conform to ASTM C270. Application is applied according to manufacturer's recommendations.

Caulking
Thoroughly caulk all areas where Panel Brick meets non-Panel Brick surfaces and abutting material. Caulk must be a high performance sealant compatible for conditions and installed per caulk/sealant manufacturer's instructions.

SIZE	
Panels	16" x 48" x 1" thick
COVERAGE	
Panels	5.33 square feet per panel Approximately 19 panels per square. One square covers 100 square ft.
WEIGHT	
Panels	28 lbs. per blackboard panel 40 lbs. per cement board panel
PACKAGING	
Panels	91 panels per pallet (Blackboard) 70 panels per pallet (Cementboard)
MORTAR	
Mortar	One 80 lb. bag covers approximately 50 square feet of wall space.

Summitville

When custom shapes and angles are required, Summitville has the experience and capabilities to satisfy your most demanding specifications.

From pre-cast concrete panels to traditional tile setting methods, Summitville Thin Brick has performance qualities that can solve installations or engineering and provide results with confidence.

The Motivating Force

Summitville Tiles has evolved over the past 92 years as a producer of premium grade clay products and installation materials that are as diverse as they are useful and long lasting.

In the earliest days of the company's existence highway *paving brick* was produced for streets and roads, such as the Lincoln Highway…America's first transcontinental highway.

From highway paving brick Summitville evolved into a producer of high grade *face brick* used in thousands of residential and commercial properties including the reconstruction of the White House in 1951.

The manufacture of face brick led to the introduction of acid resistant industrial *floor brick* and to ground-edge *quarry tile* which continue to be used in homes, restaurants, commercial and industrial facilities all over the world.

In addition to these products, Summitville is a leading producer of precision-sized *thin brick* used largely in the emerging pre-cast construction market for large commercial properties like hotels, shopping centers and sports arenas.

Most recently *ceramic roof shingles* have been added to our product offering. A whole new line of frost-resistant, highly durable roofing tiles for up-scale residential and commercial properties.

To ensure a quality installation, a complete line of installation materials including latex modified *mortars* and *grouts, chemical resistant epoxies, surface preparation materials, seamless epoxy floor systems* and an array of *tile care products* are manufactured and offered by Summitville for your one source satisfaction.

From the mining of the raw materials to the manufacture of literally thousands of sizes, shapes and surfaces of clay product, to the materials used to install these clay products, Summitville has withstood the test of time. And it is our commitment to product quality, extraordinary customer service and competitive pricing that has been and will continue to be our motivating force.

Summitville Thin Brick is a product of nature, a mixture of fired shale and clays which results in shade variations from brick to brick and from shipment to shipment. Final selection should be made from actual brick production. Thin Brick should be ordered in quantity sufficient to complete installation.

Thin Brick may vary in size and shade from run to run and within each run. Thin Brick should be blended from numerous cartons on the job site. Do not install any Thin Brick that has not been thoroughly inspected. Do not install without adequate lighting. We will not consider any claims after installation. All Thin Brick shall be installed according to ANSI Standards and the TCA Handbook for Installation. Thin Brick supplied for a particular installation may vary in color tone from samples.

Summitville Thin Brick

CUSTOM CAPABILITIES

Summitville is a single source manufacturer that custom produces colors, shapes, sizes and textures to solve installation or engineering problems or to add that "special dimension"to a unique project.

FLASHED BRICK

Summitville Thin Brick is available in a variety of custom blends: iron spots, light blends, dark blends, vintage blends and mixed blends as shown.

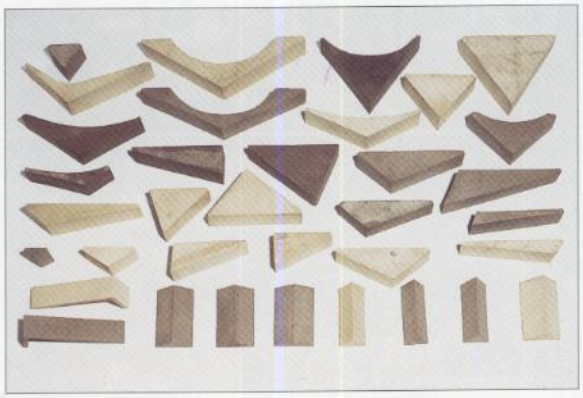
Other flashes and custom blends are also available by special order, minimum quantities may be required for all custom flashes or blends. Always check with factory first, inventory may be available.

Multiple angles and curved walls were designed for this U.S. Naval Air Systems Command Facility to resemble a Stealth aircraft when viewed from overhead.

Large panels were constructed off site in a controlled environment. Using cranes to hang the panels allows for quick and efficient installation

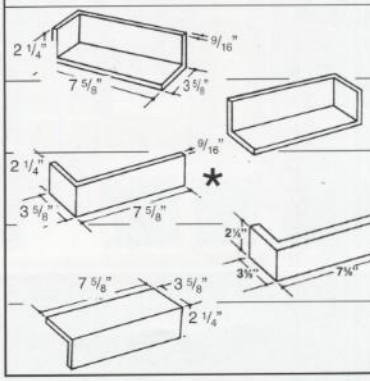
Three custom colors were installed as shown on this curved wall.

Two of the three colors are shown in this panel area with custom size brick (2 13/16" x 11 5/8" x ½") produced for this building.



Summitville produced over 135 custom shapes and angles in order to accomplish the necessary profile required to achieve the desired shape of the building.

SIZES/TRIM/PACKAGING/WEIGHTS

TRIM SHAPES	Item	Color	Pieces Per Tray	Wt. Each
	BTL-248 Left Edge Cap Closed Corner	All Colors	6	2.20
	BTR-248 Right Edge Cap Closed Corner	All Colors	6	2.20
	BC-248-9/16" Corner	All Colors	12	1.13
	BC-248-1" Corner	All Colors	7	2.05
	BT-248 Edge Cap	All Colors	6	1.82

Item	Size	Pieces Per Sq. Ft.	Wt. Per Sq. Ft.	Sq. Ft. Per Tray	Pieces Per Tray	Wt. Per Tray
All Colors	7⅝" x 2¼" x ⅜"	6.87	5.56	3.5	24	19.75

★ Thin Brick Corners are produced to meet 90 degrees (+ or – 2°). A thicker, 1 3/8" corner is available for precast installations which may improve final clean up of the precast panels.

INSTALLATION METHODS

Summitville Thin Brick is installed in numerous ways. It is relatively thin and can be installed by the traditional tile setting and grouting methods or various types of panel systems. Each method of installation has advantages and Summitville does not endorse one method over another. It is always important to use reputable installers, panelized systems with a proven record of performance and installation products formulated for the environmental conditions of the installation.

TRADITIONAL TILE SETTING & GROUTING PROCEDURES

All thin brick and ceramic tile should be installed according to ANSI Standards and the Tile Council of America Handbook. Since the wire cut or rustic surface of thin brick is difficult to grout we recommend the following procedure.

Summitville Thin Brick should be set using one of Summitville's latex modified thin-sets such as S-777 / S-810 or epoxy mortars using a ¼" x ¼" notched trowel and allowed to cure for 48 hours. Brick should be protected from rain during the cure period. S-750 Summitville Thin Brick Grout, a specially formulated sanded brick grout, is recommended for grouting. S-750 should be mixed using clean potable water and a slow speed mixer (under 300 RPM).

The S-750 should be installed in the brick joints to a depth of about ½ to ¾ of the brick thickness, using a standard grout bag, mortar gun, pneumatic applicator or motorized grout applicator with the proper nozzle. Check with factory for additional information regarding sources of supply for grout applicators.

Summitville is the only tile manufacturer that also produces cementitious grouts and mortars, latex formulations, epoxies, furans, membranes and tile care products – for a single source of supply and technical support. Our labs are available to supply a variety of tests, both standard and custom.

Mortar is applied with a 1/4" notched trowel.

Mortar is installed into the brick joints with a grout bag or with mortar dispensing gun.

When mortar is thumb-print hard joints may be tooled.

Brush joints to remove excess mortar before mortar cures.

PANELIZATION METHODS

PRECAST CONCRETE PANELS

Precast concrete panels can be produced off site when on site installation can be difficult or expensive. Off site panels can be assembled in a controlled environment and shipped to the job site for installation.

Brick are placed over retarder paper in gasket liner

After steel reinforcing is in place, concrete is poured over the assembly.

Brick precast panel ready to be cleaned.

Panel is cleaned to remove concrete leakage.

Erected panel shows thickness of concrete bonded to thin brick.

Precast thin brick panels eliminate the need for lintels, sills, weep holes and tie rods.

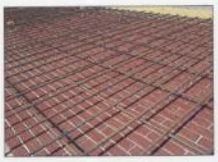
Panelization system shown and photos supplied by The Scott System.

BRICK SNAPS SYSTEM

The Brick Snaps were developed by The Scott System specifically for Cast-in-Place and Tilt-Up contractors on projects requiring a brick facade. This is a simple and cost-effective system for brick work with the end result looking just like field-laid masonry.

Thin Brick are pressed into Brick Snaps (plastic carriers), at the factory.

Assembly of Brick Snaps for Tilt-Up is fast at the rate of 2 to 3 square feet per minute, per man.



Rebar is placed and panel is ready for concrete.

Concrete is poured and vibrated to insure mortar joints are filled properly.

After the panels are tilted and erected, the snap carriers are removed.

Brick panels are cleaned with hot, high-pressure water.

Panelization system shown and photos supplied by The Scott System. Brick Snaps is a registered trademark of The Scott System, Inc.

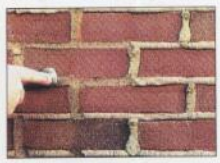
INSULATED BRICK PANELS

Insulated brick panels offer the advantage of insulation with the beauty of brick. Panels can be assembled off site and shipped or assembled on site year-round under any weather conditions, eliminating costly construction delays.

Panels are installed with interlocking clips that mechanically lock the panels and bricks to the structure.

Latex modified mortar bonds to the bricks and clips, creating a permanent mechanical connection to the struc-

After adequate time has been allowed for mortar to set, mortar is applied with a grout bag.



Mortar joints are struck to compress grout and fill joints completely, then tooled to a radius finish.

Installation is cleaned with a brush to remove excess mortar.

Panelization system shown and photos supplied by American Brick Company.

BRICK INLAY TEMPLATES

Brick Inlay Templates (BIT's) are used by precast panelizers for Cast-In-Place or Tilt-Up construction. Design flexibility, speed of installation and cost savings are realized with this system.

Panelization system shown and photos supplied by Innovative Brick Systems, LLC.

Thin Brick are factory set into the BIT's.

Assembly of brick templates are done on site for Tilt-Up or in a controlled environment.

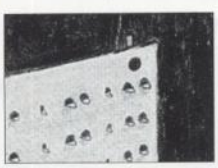
Re-bar and clips or anchors are assembled before concrete is placed.

Concrete is placed and vibrated on panels.

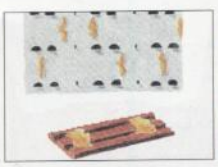
After installation, templates are removed and walls are cleaned with high pressure water.

METAL PANEL SYSTEM

The EZ-Wall System is a true mechanical support and spacing system using an architectural grade galvanized steel panel for thin brick. Each thin brick is supported and spaced with a custom relief ledge integrated into the steel.



Installation begins with a water infiltration barrier stapled over the substrate. Metal panel is then fastened to the wall.



Thin brick is bonded to the panels by applying adhesive in vertical beads to the panel or dabs on the thin brick.

Metal tabs support the thin brick and assure straight, uniform bed joints.

Mortar or grout is applied into joints with a grout bag, gun or pump system and then struck.

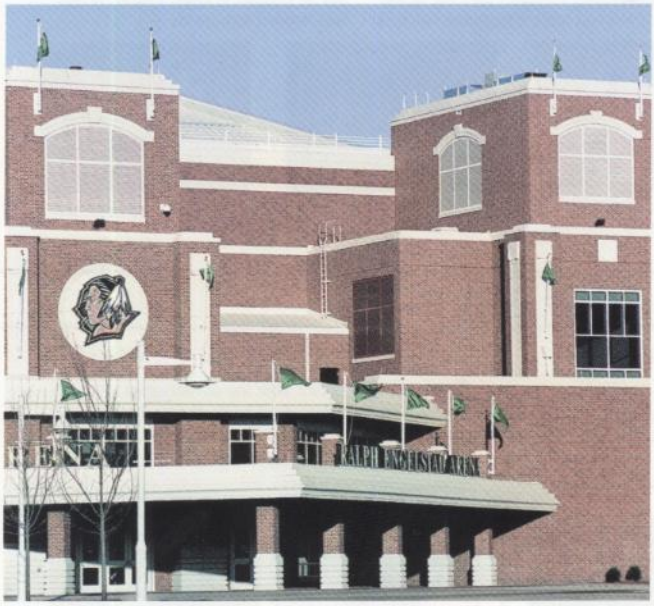
Panelization system shown and photos supplied by EZ-Wall Systems.

Summitville Thin Brick

Summitville, America's leading floor brick producer, offers Thin Brick in 14 colors. Each color offers a wide range of shades. Thin Brick is made from select clays and shale chosen for their relative purity, fired strength and proven characteristics.

Custom flashed blends such as light flash, dark flash, vintage flash and mixed blends are available by special order: minimum quantity may be required. Always check with the factory before ordering, some inventory may be available.

Thin Brick standard size is 2 1/4" x 7 5/8" x 9/16". Special order sizes are available minimum quantity required.



STOCK SIZES

$2\ ^{1}/_{4}$" x $7\ ^{5}/_{8}$" x $^{9}/_{16}$"

SPECIAL ORDER SIZES

Summitville Thin Brick	Summitville Face Brick
$2\ ^{1}/_{4}$" x $3\ ^{5}/_{8}$" x $^{9}/_{16}$"	$2\ ^{1}/_{4}$" x $7\ ^{5}/_{8}$" x $3\ ^{5}/_{8}$"
$2\ ^{1}/_{4}$" x $11\ ^{5}/_{8}$" x $^{9}/_{16}$"	$3\ ^{5}/_{8}$" x $7\ ^{5}/_{8}$" x $3\ ^{5}/_{8}$"
$3\ ^{5}/_{8}$" x $7\ ^{5}/_{8}$" x $^{9}/_{16}$"	$3\ ^{5}/_{8}$" x $11\ ^{5}/_{8}$" x $3\ ^{5}/_{8}$"
$3\ ^{5}/_{8}$" x $11\ ^{5}/_{8}$" x $^{9}/_{16}$"	

Other sizes and shapes may be available, depending on color choice and quality. Minimum quantities required - always check factory - inventory may be available.

INSTALLATION METHODS

Summitville Thin Brick is installed in numerous ways. It is relatively thin and can be installed by the traditional tile setting and grouting methods or various types of panel systems. Each method of installation has advantages and Summitville does not endorse one method over another.

It is always important to use reputable installers, panelized systems with proven record of performance and installation products formulated for the environmental conditions of the installation. All thin brick and ceramic tile should be installed according to ANSI Standards and the Tile Council of America Handbook.

10 Summitville Red
Range of deep red shades

14 Alexandria
Range of medium red shades

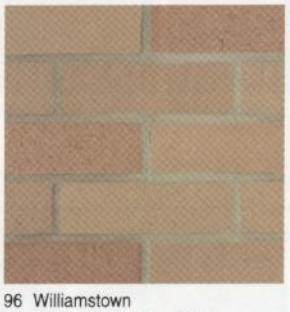
95 New Bedford
Range of warm red shades

16 Plymouth
Range of medium rust brown shades

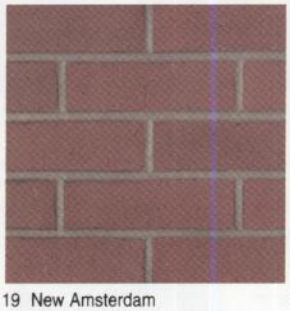
17 Yorktown
Range of red tan shades

15 Providence
Range of red brown shades

94 Colony
Range of light tan shades

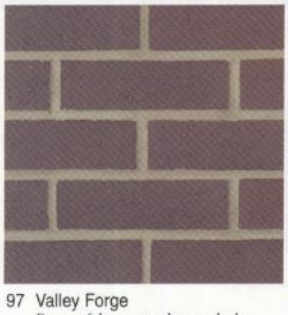


96 Williamstown
Range of medium tan shades



19 New Amsterdam
Range of light brown shades

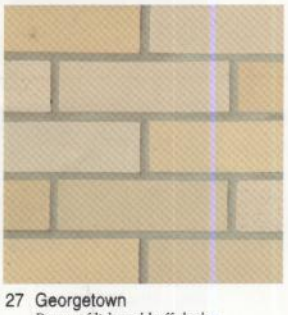
26 Savannah
Range of light buff shades



97 Valley Forge
Range of deep warm brown shades

24 Boston
Range of dark gray shades

21 Raleigh
Range of light tan gray shades



27 Georgetown
Range of light red buff shades

Envelope Analysis

Envelope Elements

Metal Wall Panel Designation

Type	Product Description	Unit	Unit Cost	Base Cost Quote	Calculated Cost	Calculated Panels	Area		SF Cost	Width				Length				Thickness				(ρ = density) Unit Subweight	
1	Versawall; 2" Thick [26-guage embosed stiad finished]	ea	$225.00	$199,800	--	888	0	SF		36.00	in	3.00	lf		in	0.00	lf	2.00	in	0.17	lf	4.7147	lb/ft^3
2	Versawall; 4-1/2" Thick [26-guage embosed plank finished]	ea	$185.00	$198,875	--	1075	0	SF		36.00	in	3.00	lf		in	0.00	lf	4.50	in	0.38	lf	5.2814	lb/ft^3
3	Foamwall; 2" Thick [26-guage smooth metallic finished]	ea	$230.00	$359,950	--	1565	0	SF		36.00	in	3.00	lf		in	0.00	lf	2.00	in	0.17	lf	4.7147	lb/ft^3
	Versawall; 2" Thick & Foamwall; 2" Thick Base Costs Evaluation			$559,750																			

CMU Designation

Type	Product Description	Unit	Unit Cost	Base Cost Quote	Calculated Cost	CMU Totals	Area		SF Cost	Width				Length				Thickness				(ρ = density) Unit Subweight	
1	Burnished Finish w/ integral color	ea	$13.50	$0	--		1	SF	$13.50	8.00	in	0.67	lf	18.00	in	1.50	lf	12.00	in	1.00	lf	135.0000	lb/ft^3
2	Burnished Finish w/ integral color	ea	$13.50	$0	--		1	SF	$13.50	8.00	in	0.67	lf	18.00	in	1.50	lf	12.00	in	1.00	lf	135.0000	lb/ft^3
3	Rock-Split Faced CMU Unit	ea	$12.00	$0	--		1	SF	$12.00	8.00	in	0.67	lf	18.00	in	1.50	lf	12.00	in	1.00	lf	125.0000	lb/ft^3

Pre-cast Panel Designation

Type	Product Description	Unit	Unit Cost	Base Cost Quote	Calculated Cost	Pre-cast Panels	Area		SF Cost	Width				Length				Thickness				(ρ = density) Unit Subweight	
8' x 8'	Pre-cast Architectural Panel	ea	$768.00	$0	--		64	SF	$12.00	96.00	in	8.00	lf	96.00	in	8.00	lf	18.00	in	1.50	lf	150.0000	lb/ft^3
8' x 8'	Pre-cast Architectural Panel w/ Form Liner	ea	$2,240.00	$0	--		64	SF	$35.00	96.00	in	8.00	lf	96.00	in	8.00	lf	18.00	in	1.50	lf	150.0000	lb/ft^3

EZ-Wall Stud System with / Thin Brick

Note: Each option accounts for the total area evaluated for the envelope remediation. Cost Comparisons for each option compared to total Base Costs of Type (1) & Type (3) CIM Panels

Option	Product Description	Unit	Unit Cost	Base Cost Quote	Mat'l Unit Cost	Calculated Panels	Area		SF Cost	Width				Length				Thickness				(ρ = density) Unit Subweight	
1	Edicott Thin Brick System w/ Stud Framing	ea	$16.95	$511,188	$166,788.00	9840	5.333333	SF	$3.18	16.00	in	1.33	lf	48.00	in	4.00	lf	12.00	in	1.00	lf	7.5188	lb/ft^3
2	Owensboro Thin Brick System/ Stud Framing	ea	$18.95	$530,868	$186,468.00	9840	5.333333	SF	$3.55	16.00	in	1.33	lf	48.00	in	4.00	lf	12.00	in	1.00	lf	7.5188	lb/ft^3
3	Summittville Thin Brick System/ Stud Framing	ea	$19.95	$540,708	$196,308.00	9840	5.333333	SF	$3.74	16.00	in	1.33	lf	48.00	in	4.00	lf	12.00	in	1.00	lf	7.5188	lb/ft^3

Envelope Remediation Elements Scenario

1. Option #1

- Use pre-manufactured masonry panels or pre-cast panels with veneer in lieu of
  - Pre-cast Form Liner
  - Type (1) – Type (3) Metal Panels
  - Type (1) – Type (3) Architectural CMU(s)
    - Alternative System Option # 1 – 100 % Pre-manufactured masonry

2. Option #2

- Use pre-manufactured masonry panels or pre-cast panels with veneer in lieu of
  - Type (1) – Type (3) Metal Panels
  - Type (1) – Type (3) Architectural CMU(s)
    - Alternative System Option # 2 – Pre-manufactured masonry w/ Pre-cast Form Liner

3. Option #3

- Use pre-manufactured masonry panels or pre-cast panels with veneer in lieu of
  - Type (1) – Type (3) Metal Panels
    - Alternative System Option # 3 – Pre-manufactured masonry w/ Pre-cast Form Liner & Arch CMU units

4. Option #4

- Use an "EZ-Wall" Thin Brick System in lieu of
  - Type (1) – Type (3) Metal Panels
    - Alternative System Option # 3 – Pre-manufactured masonry w/ Pre-cast Form Liner & Arch CMU units

Note: (66%) of all Architectural CMU(s) used on project are (8") Rock/ Split Face Units — 66% Split Face
(33%) of all Architectural CMU(s) used on project are (8") Burnished Finished integral units — 33% Burnished Finis

South Elevation Envelope Analysis

Elevation	Enclosure Mat'l	Width			Length			Total Length		Thickness			Unit Area
South Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	4321.50 lf		12.00	in	1.00 lf	1.00 SF
South Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	336.00 lf		12.00	in	1.00 lf	1.00 SF
South Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	358.50 lf		12.00	in	1.00 lf	1.00 SF
	Column Totals							***5016.00 lf***					
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	101.38 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	12.25 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	133.88 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	12.25 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	59.75 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	65.00 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	116.00 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	307.63 lf		18.00	in	1.50 lf	64.00 SF
South Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	116.63 lf		18.00	in	1.50 lf	64.00 SF
	Column Totals							***384.50 lf***					
South Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	201.00	in	16.75 lf	186.00 lf		2.00	in	0.17 lf	50.25 SF
South Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	209.00	in	17.42 lf	15.00 lf		2.00	in	0.17 lf	52.25 SF
	Column Totals							***201.00 lf***					
South Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	156.00	in	13.00 lf	216.00 lf		4.50	in	0.38 lf	39.00 SF
South Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	145.00	in	12.08 lf	120.00 lf		4.50	in	0.38 lf	23.93 SF
	Column Totals							***336.00 lf***					
South Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	123.00	in	10.25 lf	183.00 lf		2.00	in	0.17 lf	30.75 SF
South Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	438.00	in	36.50 lf	48.00 lf		2.00	in	0.17 lf	109.50 SF
South Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	438.00	in	36.50 lf	18.00 lf		2.00	in	0.17 lf	109.50 SF
South Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	209.00	in	17.42 lf	15.00 lf		2.00	in	0.17 lf	52.25 SF
South Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	245.00	in	20.42 lf	54.00 lf		2.00	in	0.17 lf	61.25 SF
	Column Totals							***318.00 lf***					

shed

Unit Volume		Unit Weight	Void Area		Section Area		(#) of Units	Cum Weight	Unit Cost	SF Cost	Section Cost
1.00 CF	0.0370 CY	127.05 lbs	0.00	SF	2,881.00	SF	2881 ea.	366,031.05 lbs	$12.38	$12.38	$35,652.38
1.00 CF	0.0370 CY	127.05 lbs	64.00	SF	224.00	SF	224 ea.	28,459.20 lbs	$12.38	$12.38	$1,980.00
1.00 CF	0.0370 CY	127.05 lbs	64.00	SF	239.00	SF	239 ea.	30,364.95 lbs	$12.38	$12.38	$2,165.63
					3,344.00	**SF**	**3344 ea.**	**424,855.20 lbs**			**$39,798.00**
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	811.00	SF	13 ea.	182,475.00 lbs	$768.00	$12.00	$9,732.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	98.00	SF	2 ea.	22,050.00 lbs	$768.00	$12.00	$1,176.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	1,071.00	SF	17 ea.	240,975.00 lbs	$768.00	$12.00	$12,852.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	98.00	SF	2 ea.	22,050.00 lbs	$768.00	$12.00	$1,176.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	478.00	SF	7 ea.	107,550.00 lbs	$768.00	$12.00	$5,736.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	520.00	SF	8 ea.	117,000.00 lbs	$768.00	$12.00	$6,240.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	928.00	SF	15 ea.	208,800.00 lbs	$768.00	$12.00	$11,136.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	2,461.00	SF	38 ea.	553,725.00 lbs	$768.00	$12.00	$29,532.00
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	933.00	SF	15 ea.	209,925.00 lbs	$768.00	$12.00	$11,196.00
					7,398.00	**SF**	**116 ea.**	**1,664,550.00 lbs**			**$88,776.00**
8.38 CF	0.0197 ton	39.49 lbs	0.00	SF	3,075.00	SF	62 ea.	2,448.11 lbs	$225.00	$0.07	$13,950.00
8.71 CF	0.0205 ton	41.06 lbs	0.00	SF	215.00	SF	5 ea.	205.29 lbs	$225.00	$1.05	$1,125.00
					3,290.00	**SF**	**67 ea.**	**2,653.40 lbs**			**$15,075.00**
14.63 CF	0.0386 ton	77.24 lbs	466.00	SF	3,263.00	SF	72 ea.	5,561.29 lbs	$185.00	$0.06	$13,320.00
13.59 CF	0.0359 ton	71.79 lbs	0.00	SF	939.00	SF	40 ea.	2,871.75 lbs	$185.00	$0.20	$7,400.00
					4,202.00	**SF**	**112 ea.**	**8,433.04 lbs**			**$20,720.00**
5.13 CF	0.0121 ton	24.16 lbs	0.00	SF	1,852.00	SF	61 ea.	1,473.94 lbs	$230.00	$0.12	$14,030.00
18.25 CF	0.0430 ton	86.04 lbs	0.00	SF	1,693.00	SF	16 ea.	1,376.70 lbs	$230.00	$0.14	$3,680.00
18.25 CF	0.0430 ton	86.04 lbs	0.00	SF	607.00	SF	6 ea.	516.26 lbs	$230.00	$0.38	$1,380.00
8.71 CF	0.0205 ton	41.06 lbs	0.00	SF	215.00	SF	5 ea.	205.29 lbs	$230.00	$1.07	$1,150.00
10.21 CF	0.0241 ton	48.13 lbs	0.00	SF	1,086.00	SF	18 ea.	866.33 lbs	$230.00	$0.21	$4,140.00
					5,453.00	**SF**	**106 ea.**	**4,438.51 lbs**			**$24,380.00**

Page Totals

Enclosure Mat'l	Total Area	Enclosure Mat'l Ratio
8"x18"x12" Architectural CMU(s)		
Type (1) Burnished Finished	552 SF	2%
Type (2) Burnished Finished	552 SF	2%
Type (3) Rock/ Split Faced	2,240 SF	9%
Total Arch. CMU(s)	**3,344 SF**	**14%**
Cored Insulated Mtl Panels		
Type (1) 26 gauge stl 3'0" (2") Versawall Panel	3,290 SF	14%
Type (2) 26 gauge stl 3'0" (4-1/2") Versawall Panel	4,202 SF	18%
Type (3) 26 gauge stl 3'0" (2") Foamwall Panel	5,453 SF	23%
Total Metal Panels	**12,945 SF**	**55%**
8'x8' Architectural Precast Panels		
Architectural Panels w/ Form Liner	7,398 SF	31%
Total Arch. Pre-cast Panels	**7,398 SF**	**31%**
Interchange Envelope Section	**23,687 SF**	**100%**

Enclosure Mat'l	System Cost(s)
8"x18"x12" Architectural CMU(s)	**$39,798**
Cored Insulated Mtl Panels	**$60,175**
8'x8' Architectural Precast Panels	**$88,776**
Total	**$188,749**

Total System Wt. ***2,104,930.15 lbs.***
2104.93 kips

Proposed Wall Remedy (Thin Brick Wall System Set as pre-manufactured panel

Panel Area (SF)	Proposed Area			No. of Panels		System Wt.		System Wt.	
5	8,743	SF							
Proposed Envelope Area / *Individual Panel Area*		=		*1640*		65,764	lb	65.76444	k

Weight Adjustments to Current System

Current System Weight	=	2,104,930	lb	2104.93	k
(less)	(subtract)				
Type (1) Metal Panels	=	2,653	lb	2.653401	k
Type (3) Metal Panels	=	4,439	lb	4.43851	k
(plus)	(add)				
Thin Brick System	=	65,764	lb	65.76444	k
Adjusted Weight	=	2,163,603	lb	2,163.60	k

Note: (66%) of all Architectural CMU(s) used on project are (8") Rock/ Split Face Units 66%
(33%) of all Architectural CMU(s) used on project are (8") Burnished Finished integral units 33%

West Elevation Envelope Analysis

Elevation	Enclosure Mat'l	Width			Length			Total Length		Thickness		
West Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	5325.00	lf	12.00	in	1.00 lf
	Column Totals							***5325.00***	***lf***			
West Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	31.25	lf	18.00	in	1.50 lf
West Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	100.00	lf	18.00	in	1.50 lf
West Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	51.75	lf	18.00	in	1.50 lf
	Column Totals							***183.00***	***lf***			
West Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	201.00	in	16.75 lf	240.00	lf	2.00	in	0.17 lf
West Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	430.00	in	35.83 lf	36.00	lf	2.00	in	0.17 lf
	Column Totals							***183.00***	***lf***			
West Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	134.00	in	11.17 lf	177.00	lf	4.50	in	0.38 lf
	Column Totals							***177.00***	***lf***			
West Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	123.00	in	10.25 lf	345.00	lf	2.00	in	0.17 lf
West Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	356.00	in	29.67 lf	30.00	lf	2.00	in	0.17 lf
West Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	453.00	in	37.75 lf	30.00	lf	2.00	in	0.17 lf
West Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	371.00	in	30.92 lf	30.00	lf	2.00	in	0.17 lf
West Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	438.00	in	36.50 lf	24.00	lf	2.00	in	0.17 lf
West Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	155.90	in	12.99 lf	9.00	lf	2.00	in	0.17 lf
	Column Totals							***468.00***	***lf***			

Split Face
Burnished Finished

Unit Area	Unit Volume		Unit Weight	Void Area	Section Area	(#) of Units	Cum Weight	Unit Cost	SF Cost	Section Cost
1.00 SF	1.00 CF	0.0370 CY	127.05 lbs	0.00 SF	3,550.00 SF	3550 ea.	451,027.50 lbs	$12.38	$12.38	$43,931.25
					3,550.00 SF	**3550 ea.**	**451,027.50 lbs**			**$43,931.25**
64.00 SF	96.00 CF	3.5556 CY	14,400.00 lbs	64.00 SF	250.00 SF	4 ea.	56,250.00 lbs	$768.00	$12.00	$2,232.00
64.00 SF	96.00 CF	3.5556 CY	14,400.00 lbs	0.00 SF	800.00 SF	13 ea.	180,000.00 lbs	$768.00	$12.00	$9,600.00
64.00 SF	96.00 CF	3.5556 CY	14,400.00 lbs	0.00 SF	414.00 SF	6 ea.	93,150.00 lbs	$768.00	$12.00	$4,968.00
					1,464.00 SF	**23 ea.**	**329,400.00 lbs**			**$16,800.00**
50.25 SF	8.38 CF	0.0197 ton	39.49 lbs	50.25 SF	4,048.00 SF	80 ea.	3,158.86 lbs	$225.00	$0.06	$18,000.00
107.50 SF	17.92 CF	0.0422 ton	84.47 lbs	107.61 SF	1,331.00 SF	12 ea.	1,013.66 lbs	$225.00	$0.17	$2,700.00
					5,379.00 SF	**92 ea.**	**4,172.52 lbs**			**$20,700.00**
33.50 SF	12.56 CF	0.0332 ton	66.35 lbs	33.50 SF	1,996.00 SF	59 ea.	3,914.49 lbs	$185.00	$0.09	$10,915.00
					1,996.00 SF	**59 ea.**	**3,914.49 lbs**			**$10,915.00**
30.75 SF	5.13 CF	0.0121 ton	24.16 lbs	33.39 SF	3,552.00 SF	115 ea.	2,778.73 lbs	$230.00	$0.06	$26,450.00
89.00 SF	14.83 CF	0.0350 ton	69.93 lbs	89.04 SF	973.00 SF	10 ea.	699.35 lbs	$230.00	$0.24	$2,300.00
113.25 SF	18.88 CF	0.0445 ton	88.99 lbs	113.16 SF	1,135.00 SF	10 ea.	889.90 lbs	$230.00	$0.20	$2,300.00
92.75 SF	15.46 CF	0.0364 ton	72.88 lbs	92.75 SF	994.00 SF	10 ea.	728.82 lbs	$230.00	$0.23	$2,300.00
109.50 SF	18.25 CF	0.0430 ton	86.04 lbs	109.55 SF	948.00 SF	8 ea.	688.35 lbs	$230.00	$0.24	$1,840.00
38.98 SF	6.50 CF	0.0153 ton	30.63 lbs	38.98 SF	136.50 SF	3 ea.	91.88 lbs	$230.00	$1.68	$690.00
					7,738.50 SF	**156 ea.**	**5,877.03 lbs**			**$35,880.00**

Page Totals

Enclosure Mat'l	Total Area	Enclosure Mat'l Ratio
8"x18"x12" Architectural CMU(s)		
Type (1) Burnished Finished	586 SF	3%
Type (2) Burnished Finished	586 SF	3%
Type (3) Rock/ Split Faced	2,379 SF	12%
Total Arch. CMU(s)	**3,550 SF**	**18%**
Cored Insulated Mtl Panels		
Type (1) 26 gauge stl 3'0" (2") Versawall Panel	5,379 SF	27%
Type (2) 26 gauge stl 3'0" (4-1/2") Versawall Panel	1,996 SF	10%
Type (3) 26 gauge stl 3'0" (2") Foamwall Panel	7,739 SF	38%
Total Metal Panels	**15,114 SF**	**75%**
8'x8' Architectural Precast Panels		
Architectural Panels w/ Form Liner	1,464 SF	7%
Total Arch. Pre-cast Panels	**1,464 SF**	**7%**
Interchange Envelope Section	**20,128 SF**	**100%**

Enclosure Mat'l	System Cost(s)
8"x18"x12" Architectural CMU(s)	**$43,931**
Cored Insulated Mtl Panels	**$67,495**
8'x8' Architectural Precast Panels	**$16,800**
Total	**$128,226**

Total System Wt. ***794,391.54 lbs***
794.39 kips

Proposed Wall Remedy (Thin Brick Wall System Set as pre-manufactured panel

Panel Area (SF)	Proposed Area		No. of Panels	System Wt.		System Wt.	
5	13,118	SF					
Proposed Envelope Area / *Individual Panel Area*		=	*2460*	98,647	lb	98.64666	k

Weight Adjustments to Current System

Current System Weight	=	794,392	lb	794.39	k
(less)	(subtract)				
Type (1) Metal Panels	=	4,173	lb	4.172521	k
Type (3) Metal Panels	=	5,877	lb	5.877028	k
(plus)	(add)				
Thin Brick System	=	98,647	lb	98.64666	k
Adjusted Weight	=	882,989	lb	882.99	k

Note: (66%) of all Architectural CMU(s) used on project are (8") Rock/ Split Face Units 66% Split Face
(33%) of all Architectural CMU(s) used on project are (8") Burnished Finished integral units 33% Burnished Finis

South Elevation Envelope Analysis

Elevation	Enclosure Mat'l	Width			Length			Total Length		Thickness			Unit Area
North Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	1098.00	lf	12.00	in	1.00 lf	1.00 SF
North Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	145.50	lf	12.00	in	1.00 lf	1.00 SF
North Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	5121.00	lf	12.00	in	1.00 lf	1.00 SF
	Column Totals							**6364.50**	**lf**				
North Elevation	8'x8' Precast Panels												No
North Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	208.00	in	17.33 lf	9.00	lf	2.00	in	0.17 lf	52.00 SF
North Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	468.00	in	39.00 lf	33.00	lf	2.00	in	0.17 lf	117.00 SF
North Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	267.00	in	22.25 lf	213.00	lf	2.00	in	0.17 lf	66.75 SF
	Column Totals							**255.00**	**lf**				
North Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	156.00	in	13.00 lf	216.00	lf	4.50	in	0.38 lf	39.00 SF
North Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	145.00	in	12.08 lf	120.00	lf	4.50	in	0.38 lf	23.93 SF
	Column Totals							**336.00**	**lf**				
North Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	119.00	in	9.92 lf	375.00	lf	2.00	in	0.17 lf	29.75 SF
North Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	349.00	in	29.08 lf	45.00	lf	2.00	in	0.17 lf	87.25 SF
North Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	468.00	in	39.00 lf	33.00	lf	2.00	in	0.17 lf	117.00 SF
North Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	519.00	in	43.25 lf	12.00	lf	2.00	in	0.17 lf	129.75 SF
North Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	119.00	in	9.92 lf	186.00	lf	2.00	in	0.17 lf	29.75 SF
North Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	468.00	in	39.00 lf	51.00	lf	2.00	in	0.17 lf	117.00 SF
	Column Totals							**702.00**	**lf**				

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Unit Volume		Unit Weight	Void Area		Section Area		(#) of Units	Cum Weight	Unit Cost	SF Cost	Section Cost
1.00 CF	0.0370 CY	127.05 lbs	0.00	SF	732.00	SF	732 ea.	93,000.60 lbs	$12.38	$12.38	$9,058.50
1.00 CF	0.0370 CY	127.05 lbs	64.00	SF	97.00	SF	97 ea.	12,323.85 lbs	$12.38	$12.38	$408.38
1.00 CF	0.0370 CY	127.05 lbs	64.00	SF	3,414.00	SF	3414 ea.	433,748.70 lbs	$12.38	$12.38	$41,456.25
					4,243.00	**SF**	**4243 ea.**	**539,073.15 lbs**			**$50,923.13**
8' x 8' Architectural Pre-cast Panels on Elevation											
8.67 CF	0.0204 ton	40.86 lbs	0.00	SF	118.00	SF	3 ea.	122.58 lbs	$225.00	$1.91	$675.00
19.50 CF	0.0460 ton	91.94 lbs	0.00	SF	1,253.00	SF	11 ea.	1,011.31 lbs	$225.00	$0.18	$2,475.00
11.13 CF	0.0262 ton	52.45 lbs	0.00	SF	4,681.00	SF	71 ea.	3,724.03 lbs	$225.00	$0.05	$15,975.00
					6,052.00	**SF**	**85 ea.**	**4,857.92 lbs**			**$19,125.00**
14.63 CF	0.0386 ton	77.24 lbs	466.00	SF	3,263.00	SF	72 ea.	5,561.29 lbs	$185.00	$0.06	$13,320.00
13.59 CF	0.0359 ton	71.79 lbs	0.00	SF	939.00	SF	40 ea.	2,871.75 lbs	$185.00	$0.20	$7,400.00
					4,202.00	**SF**	**112 ea.**	**8,433.04 lbs**			**$20,720.00**
4.96 CF	0.0117 ton	23.38 lbs	38.00	SF	3,733.00	SF	125 ea.	2,922.14 lbs	$230.00	$0.06	$28,750.00
14.54 CF	0.0343 ton	68.56 lbs	0.00	SF	1,222.00	SF	15 ea.	1,028.40 lbs	$230.00	$0.19	$3,450.00
19.50 CF	0.0460 ton	91.94 lbs	0.00	SF	1,181.00	SF	11 ea.	1,011.31 lbs	$230.00	$0.19	$2,530.00
21.63 CF	0.0510 ton	101.96 lbs	0.00	SF	510.00	SF	4 ea.	407.82 lbs	$230.00	$0.45	$920.00
4.96 CF	0.0117 ton	23.38 lbs	228.00	SF	2,068.00	SF	62 ea.	1,449.38 lbs	$230.00	$0.11	$14,260.00
19.50 CF	0.0460 ton	91.94 lbs	0.00	SF	1,904.00	SF	17 ea.	1,562.93 lbs	$230.00	$0.12	$3,910.00
					10,618.00	**SF**	**234 ea.**	**8,381.97 lbs**			**$53,820.00**

Page Totals

Enclosure Mat'l	Total Area	Enclosure Mat'l Ratio
8"x18"x12" Architectural CMU(s)		
Type (1) Burnished Finished	700 SF	3%
Type (2) Burnished Finished	700 SF	3%
Type (3) Rock/ Split Faced	2,843 SF	11%
Total Arch. CMU(s)	**4,243 SF**	**17%**
Cored Insulated Mtl Panels		
Type (1) 26 gauge stl 3'0" (2") Versawall Panel	6,052 SF	24%
Type (2) 26 gauge stl 3'0" (4-1/2") Versawall Panel	4,202 SF	17%
Type (3) 26 gauge stl 3'0" (2") Foamwall Panel	10,618 SF	42%
Total Metal Panels	**20,872 SF**	**83%**
8'x8' Architectural Precast Panels		
Architectural Panels w/ Form Liner	0 SF	0%
Total Arch. Precast Panels	**0 SF**	**0%**
Interchange Envelope Section	**25,115 SF**	**100%**

Enclosure Mat'l	System Cost(s)
8"x18"x12" Architectural CMU(s)	**$50,923**
Cored Insulated Mtl Panels	**$93,665**
8'x8' Architectural Precast Panels	**$0**
Total	**$144,588**

Total System Wt. ***560,746.09 lbs.***
560.75 kips

Proposed Wall Remedy (Thin Brick Wall System Set as pre-manufactured panel

Panel Area (SF)	Proposed Area			No. of Panels		System Wt.		System Wt.	
5	16,670	SF							
Proposed Envelope Area / Individual Panel Area		=		*3126*		125,353	lb	125.3534	k

Weight Adjustments to Current System

Current System Weight	=	560,746	lb	560.75	k
(less)	(subtract)				
Type (1) Metal Panels	=	4,858	lb	4.857923	k
Type (3) Metal Panels	=	8,382	lb	8.381975	k
(plus)	(add)				
Thin Brick System	=	125,353	lb	125.3534	k
Adjusted Weight	=	672,860	lb	672.86	k

Note: (66%) of all Architectural CMU(s) used on project are (8") Rock/ Split Face Units — 66% — Split Face
(33%) of all Architectural CMU(s) used on project are (8") Burnished Finished integral units — 33% — Burnished Finished

West Elevation Envelope Analysis

Elevation	Enclosure Mat'l	Width			Length			Total Length		Thickness			Unit Area	
East Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	780.00 lf	12.00	in	1.00 lf		1.00	SF
East Elevation	Architectural CMU	8.00	in	0.67 lf	18.00	in	1.50 lf	189.00 lf	12.00	in	1.00 lf		1.00	SF
		Column Totals						**969.00 lf**						
East Elevation	8'x8' Precast Panels	96.00	in	8.00 lf	96.00	in	8.00 lf	293.63 lf	18.00	in	1.50 lf		64.00	SF
		Column Totals						**293.63 lf**						
East Elevation	Type (1) Metal Panels	36.00	in	3.00 lf	438.00	in	36.50 lf	267.00 lf	2.00	in	0.17 lf		109.50	SF
		Column Totals						**293.63 lf**						
East Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	119.00	in	9.92 lf	144.00 lf	4.50	in	0.38 lf		29.75	SF
East Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	156.00	in	13.00 lf	135.00 lf	4.50	in	0.38 lf		39.00	SF
East Elevation	Type (2) Metal Panels	36.00	in	3.00 lf	356.16	in	29.68 lf	213.00 lf	4.50	in	0.38 lf		89.04	SF
		Column Totals						**492.00 lf**						
East Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	437.90	in	36.49 lf	39.00 lf	2.00	in	0.17 lf		109.48	SF
East Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	460.00	in	38.33 lf	3.00 lf	2.00	in	0.17 lf		115.00	SF
East Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	223.00	in	18.58 lf	6.00 lf	2.00	in	0.17 lf		55.75	SF
East Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	445.00	in	37.08 lf	33.00 lf	2.00	in	0.17 lf		111.25	SF
East Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	430.00	in	35.83 lf	12.00 lf	2.00	in	0.17 lf		107.50	SF
East Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	445.00	in	37.08 lf	18.00 lf	2.00	in	0.17 lf		111.25	SF
East Elevation	Type (3) Metal Panels	36.00	in	3.00 lf	243.00	in	20.25 lf	24.00 lf	2.00	in	0.17 lf		60.75	SF
		Column Totals						**135.00 lf**						

Unit Volume		Unit Weight	Void Area		Section Area		(#) of Units	Cum Weight	Unit Cost	SF Cost	Section Cost
1.00 CF	0.0370 CY	127.05 lbs	0.00	SF	520.00	SF	520 ea.	66,066.00 lbs	$12.38	$12.38	$6,435.00
1.00 CF	0.0370 CY	127.05 lbs	0.00	SF	126.00	SF	126 ea.	16,008.30 lbs	$12.38	$12.38	$1,559.25
					646.00	**SF**	**646 ea.**	**82,074.30 lbs**			**$7,994.25**
96.00 CF	3.5556 CY	14,400.00 lbs	0.00	SF	2,349.00	SF	37 ea.	528,525.00 lbs	$768.00	$12.00	$28,188.00
					2,349.00	**SF**	**37 ea.**	**528,525.00 lbs**			**$28,188.00**
18.25 CF	0.0430 ton	86.04 lbs	0.00	SF	9,659.00	SF	89 ea.	7,657.87 lbs	$225.00	$0.02	$20,025.00
					9,659.00	**SF**	**89 ea.**	**7,657.87 lbs**			**$20,025.00**
11.16 CF	0.0295 ton	58.92 lbs	0.00	SF	1,407.00	SF	48 ea.	2,828.18 lbs	$185.00	$0.13	$8,880.00
14.63 CF	0.0386 ton	77.24 lbs	0.00	SF	1,727.00	SF	45 ea.	3,475.81 lbs	$185.00	$0.11	$8,325.00
33.39 CF	0.0882 ton	176.35 lbs	0.00	SF	6,291.28	SF	71 ea.	12,520.51 lbs	$185.00	$0.03	$13,135.00
					9,425.28	**SF**	**164 ea.**	**18,824.50 lbs**			**$30,340.00**
18.25 CF	0.0430 ton	86.02 lbs	0.00	SF	1,376.00	SF	13 ea.	1,118.31 lbs	$230.00	$0.17	$2,990.00
19.17 CF	0.0452 ton	90.37 lbs	0.00	SF	115.00	SF	1 ea.	90.37 lbs	$230.00	$2.00	$230.00
9.29 CF	0.0219 ton	43.81 lbs	0.00	SF	111.00	SF	2 ea.	87.62 lbs	$230.00	$2.07	$460.00
18.54 CF	0.0437 ton	87.42 lbs	0.00	SF	1,216.00	SF	11 ea.	961.61 lbs	$230.00	$0.19	$2,530.00
17.92 CF	0.0422 ton	84.47 lbs	0.00	SF	399.30	SF	4 ea.	337.89 lbs	$230.00	$0.58	$920.00
18.54 CF	0.0437 ton	87.42 lbs	0.00	SF	619.60	SF	6 ea.	524.51 lbs	$230.00	$0.37	$1,380.00
10.13 CF	0.0239 ton	47.74 lbs	0.00	SF	441.73	SF	8 ea.	381.89 lbs	$230.00	$0.52	$1,840.00
					4,278.63	**SF**	**45 ea.**	**3,502.19 lbs**			**$10,350.00**

Page Totals

Enclosure Mat'l	Total Area		Enclosure Mat'l Ratio
8"x18"x12" Architectural CMU(s)			
Type (1) Burnished Finished	107	SF	0%
Type (2) Burnished Finished	107	SF	0%
Type (3) Rock/ Split Faced	433	SF	2%
Total Arch. CMU(s)	**646**	**SF**	**2%**
Cored Insulated Mtl Panels			
Type (1) 26 gauge stl 3'0" (2") Versawall Panel	9,659	SF	37%
Type (2) 26 gauge stl 3'0" (4-1/2") Versawall Panel	9,425	SF	36%
Type (3) 26 gauge stl 3'0" (2") Foamwall Panel	4,279	SF	16%
Total Metal Panels	**23,363**	**SF**	**89%**
8'x8' Architectural Precast Panels			
Architectural Panels w/ Form Liner	2,349	SF	9%
Total Arch. Precast Panels	**2,349**	**SF**	**9%**
Interchange Envelope Section	**26,358**	**SF**	**100%**

Enclosure Mat'l	System Cost(s)
8"x18"x12" Architectural CMU(s)	**$7,994**
Cored Insulated Mtl Panels	**$60,715**
8'x8' Architectural Precast Panels	**$28,188**
Total	**$96,897**

Total System Wt. ***640,583.86 lbs.***
640.58 kips

Proposed Wall Remedy (Thin Brick Wall System Set as pre-manufactured panel

Panel Area (SF)	Proposed Area			No. of Panels		System Wt.		System Wt.	
5	13,938	SF							
Proposed Envelope Area / *Individual Panel Area*		=		*2614*		104,822	lb	104.8221	k

Weight Adjustments to Current System

Current System Weight	=	640,584	lb	640.58	k
(less)	(subtract)				
Type (1) Metal Panels	=	7,658	lb	7.657873	k
Type (3) Metal Panels	=	3,502	lb	3.502187	k
(plus)	(add)				
Thin Brick System	=	104,822	lb	104.8221	k
Adjusted Weight	=	734,246	lb	734.25	k

Enclosure Mat'l	Total Area	Enclosure Mat'l Ratio
8"x18"x12" Architectural CMU(s)		
Type (1) Burnished Finished	1,944 SF	2%
Type (2) Burnished Finished	1,944 SF	2%
Type (3) Rock/ Split Faced	7,895 SF	9%
	11,783 SF	**13%**
Cored Insulated Mtl Panels		
Type (1) 26 gauge stl 3'0" (2") Versawall Panel	14,721 SF	16%
Type (2) 26 gauge stl 3'0" (4-1/2") Versawall Panel	20,059 SF	22%
Type (3) 26 gauge stl 3'0" (2") Foamwall Panel	33,235 SF	37%
Total Arch. CMU(s)	**68,015 SF**	**75%**
8'x8' Architectural Precast Panels		
Architectural Panels w/ Form Liner	11,211 SF	12%
Total Arch. CMU(s)	**11,211 SF**	**12%**
Interchange Envelope Section	**91,009 SF**	**100%**

Enclosure Mat'l	System Cost(s)	*Percentage of Cost*
8"x18"x12" Architectural CMU(s)	**$142,647**	*26%*
Cored Insulated Mtl Panels (Type 1)	**$74,925**	*13%*
Cored Insulated Mtl Panels (Type 2)	**$82,695**	*15%*
Cored Insulated Mtl Panels (Type 3)	**$124,430**	*22%*
8'x8' Architectural Precast Panels	**$133,764**	*24%*
Total	**$558,461**	*100%*
Total Check	*$558,461*	

Complete Weight ***4100.65 kips***

Weight of Affected Envelope
Type (1) = ***19.42 kips***
Type (3) = ***22.21 kips***

Total Number of Panels
9840 ***EA.***

Additional System Weight
353.05 ***kips***

Structural Calculations

① Strip Ftg Redesign

② Column Verification

Current Bldg Wt. = 79,246.3^{K}
w/ Envelope Remediation = 83,700^{K}

Total Number of Col(s) Σ_{col} = 165

* Assume Typical Column throughout for analysis condition

$\vec{P}_{Total_D}$ = 57,300^{K} $\quad \vec{P}_{col_D} = \frac{57,300^{K}}{165} = 347.27^{K}$

$\vec{P}_{Total_L}$ = 26,400^{K} $\quad \vec{P}_{col_L} = \frac{26,400^{K}}{165} = 160^{K}$

Length of Affected Area(s)

Elevation	Ftg. Dimension (Perimeter)
South	167.59',
West	303.65',
North	220.78',
East	253.55'

Existing Exterior Wall Weight

CMU	0.0847 Klf
Pre-cast Panel	4.3291 Klf
CIM Type(1)	0.0132 Klf
CIM Type(2)	0.0251 Klf
CIM Type(3)	0.0140 Klf
Total	4.4661 Klf

Adjusted Exterior Wall Weight (using 16"x48" Thin Brick Panel System)

CMU	0.0847 Klf
Pre-cast Panel	4.3291 Klf
CIM Type(2)	0.0251 Klf
Thin Brick Sys.	0.1267 Klf
Total	4.5656 Klf

$\Delta_{Net\ Increase}$ = 0.0995 Klf

Given: a composite wall composed of 8"x16"x12" Split Face / Burnished finish masonry units, 8'x8' Architectural Pre-cast Panels; 4½" thick Cored Insulated Mtl. Panels and 4¾" Thin Brick imposes a 4,565 PLF load to a concrete strip ftg.

Ftg Strength: ≈ 4,000 psi
Soil Bearing Capacity ≈ 4,000 psf
Frost Depth ≈ 48"

Step (1): Assumed Load Includes Live load

$$P_T = P_D + P_L = 4.5656 \text{ Klf}$$

$$q_a \geq P_T / A \rightarrow \text{(Use unit strip Method)}$$

$$\frac{4.5656 \text{ Klf}(1\text{lf})}{(1\text{lf})B} \leq 4 \text{ Ksf}$$

$$B = \frac{4.5656 \text{ Ksf}}{4 \text{ Ksf}(1\text{lf})} \approx 1.14'$$

$$B \geq 1.14' \rightarrow \text{Use } 1.33'$$

Step (2): Factor Loading

$$P_u = 1.4 P_T = 6.3918 \text{ Klf}$$

$$q_u = \frac{P_u}{A} = \frac{6.3918 \text{ Klf}}{(1')(1.33')} \approx 4.8059 \text{ Ksf}$$

Step (3): Footing Reinforcement Option [Wide Beam Shear]

$$\phi V_c = \phi 2 \sqrt{f'_c}\,(b)(d) \qquad \phi = 0.75$$

$$= (0.75)(2)\sqrt{4{,}000 \text{ psi}}\,(12'')(d)$$

(12" ↑ Unit Strip)

$$= 1138d$$

$$V_u = (4.81)\left[\frac{B - \frac{\text{largest width of wall}}{12}}{2}\right](\text{Unit Strip})$$

$$V_u = (4.81)\left[\frac{1.33' - (12/12)}{2}\right](1) = 0.7937^k$$

$$= 794 \text{ lbs}$$

$$\phi V_c = V_u$$

$$d = \frac{794 \text{ lbs}}{1138 \text{ lbs}} = 0.6974''$$

$$h = d + 3''(\text{cover}) + 0.25''$$

$$= 0.6974'' + 3'' + 0.25'' = 3.95'' \rightarrow 4''$$

Use (6")

$$d = 6'' - (3'' + 0.25'') = 2.75''$$

Step (4): Effective Length - Moment Arm

$$l = \frac{B - W}{2} = \frac{1.33' - \left(\frac{12}{12}\right)}{2}$$

$$l = 0.165'$$

$$M_u = \frac{q l^2}{2} = \frac{(4.81)(0.165)^2}{2}$$

$$M_u = 0.0655'^{-k}$$

$$a = \frac{A_s f_y}{0.85 f'_c b} \leftarrow \text{Unit Strip}$$

$$a = \frac{60 \text{ksi}\,(A_s)}{0.85\,(4 \text{ksi})(12'')} \approx 1.47\,A_s$$

$$M_u = \phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

$$\phi = 0.9$$

$$4.81^{'K}(12in/ft) = (0.9)(A_s)(60ksi)\left(2.75" - \frac{1.47A_s}{2}\right)$$

$$\frac{4.81^{'K}(12in/ft)}{(0.9)(60ksi)} = 2.75A_s - 0.735A_s^2$$

$$-0.75A_s^2 + 2.75A_s = 1.07$$

$$-0.75A_s^2 + 2.75A_s - 1.07$$

$$A_s = 0.455\,in^2$$

Use #5 @ 6" o.c. $A_s = (2)(0.31in^2) = 0.62in^2$

Step(5): Check Spacing

$$\rho = \frac{A_s}{bh} = 0.0018$$

$$\rho = \frac{(0.62in^2)}{(12")(6")} = 0.0086$$

$$\rho = 0.0086 \geq \rho = 0.0018$$

$$a = 1.47A_s = 1.47(0.62in^2) = 0.9114$$

$$c = \frac{a}{\beta_1} = \frac{0.9114}{(0.85)} = 1.072 \qquad "\varepsilon_s \geq 0.005\ in/in$$

$$\varepsilon_s = \frac{0.003}{c}(d-c) = \frac{0.003}{1.072}(2.75 - 1.072) = 0.0047$$

To be on safe side / try Using # 4's)

$$A_s = (2)(0.20in^2) = 0.400in^2$$

$$\rho = \frac{(0.40in^2)}{(12")(6")} = 0.0055$$

$$a = 1.47(0.400in^2) \approx 0.588$$

$$c = \frac{a}{\beta_1} = \frac{0.588}{0.85} = 0.6918$$

$$\varepsilon = \frac{0.003}{c}(d-c) = \frac{0.003}{0.588}(2.75 - 0.588)$$

$$= 0.0110 > 0.005 \text{ Spacing} \therefore \text{ok}$$

w/ #4's(s) via inspection

Step (6): Longitudinal shrinkage & Temp. Reinforcement

$$A_{s_{min}} = 0.0018bh$$

$$= 0.0018(1.33 \text{ ft})(12''/1')(6'')$$

$$= 0.1723 \text{ in}^2$$

$$\#\text{ of Required Bars} = \frac{A_{s_{min}}}{A_{bar\ \#4}} = \frac{0.1723 \text{ in}^2}{0.20 \text{ in}^2} = 0.8618 \text{4}$$

# of Required Bars Longitudinal is (1) #4 bar.

FTG_T = Width = 1'-4"

FTG_D = Depth = 6"

Unit Strip 1'-4" x 12" x 6"

$\vec{P}_{col} = \vec{P}_{col_{DL}} + \vec{P}_{col_{LL}} = 347.27^k\ (DL) + 160.00^k\ (LL)$

Assume $q_a = 4\ ksf$ 18" x 18" Pre-cast Column

Step (1)

$\vec{P}_{Total} = 347.27^k + 160.00^k = 507.27^k$

$q_a \geq \frac{P}{A} \rightarrow \frac{P}{B^2}$

$B^2 \geq \frac{507.27^k}{4\ ksf}$

$B^2 \geq 126.82\ sf$

$B \geq 11.26' \rightarrow$ Use $11.33'$

Step (2) Factor Load

$P_u = 1.2(347.27^k) + 1.6(160.00^k) = 672.72^k$

$q = \frac{P_u}{A} \rightarrow \frac{P}{B^2}$

$q = \frac{672.72^k}{(11.33')^2} = 5.24\ ksf$

$= 36.39\ psi$

Step (3)

$V_c = \phi 4\sqrt{f'_c}$

$= (0.75)(4)\sqrt{4,000} = 189.74\ psi$

Step (4) Two way Shear

$d^2(V_c + q/4) + d(V_c + q/2)w = q/4\ (\underbrace{BL}_{(B^2)} - w^2)$

$d^2(189.74 + (36.39)/4) + d(189.74 + (36.39)/2)(18) = (36.39)/4\ ((11.33*12)^2 - 18^2)$

$198.84d^2 + 3742.83d = 165,220$

$.19884d^2 + 3.74283d - 165.221$

$d = 20.65''$

$h = d + 3'' + d_b$

$= 20.65 + 3'' + 0.625$

$= 24.275''$

Use → $28'' \approx 2'-4''$

Step (5)

$d = h - (3''_{\text{cover}} + 0.625)$

$= 28'' - 3.625'' = 24.375''$

$l = \dfrac{B_{FTG} - W_{FTG/PIER}}{2} = \dfrac{11.33' - (18/12)}{2} = 4.92' \Rightarrow$ Use $5'$

Step (6) Factor Moment

$M_u = \dfrac{q l^2}{2} = \dfrac{5.24(5)^2}{2} = 65.5^{1-K}$

$a = \dfrac{A_s f_y}{(0.85) f'_c b} = \dfrac{A_s (60ksi)}{(0.85)(4ksi)(24.375)} = 0.724 A_s$

$M_u = \phi M_n = \phi A_s f_y (d - \frac{a}{2})$

$65.5^{1-K}(12) = (0.9) A_s (60)(24.375 - \dfrac{0.724 A_s}{2})$

$\dfrac{786}{(0.9)(60)} = 24.375 A_s - 0.362 A_s^2$

$-0.362 A_s^2 + 24.375 A_s - 14.56$

$A_s = 0.615 in^2$

Use #7 @ 12" o.c $\quad A_s = 0.60 in^2$

$\therefore$ OK if Slightly Under Sized.

Step (7)

$$\rho = \frac{A_s}{bh} = \frac{0.60 in^2}{(12")(28")} = 0.00178 \leq 0.0018$$

Try Different Rebar Size or Multiple Levels

Try (2) Levels of #5

$$\rho_{(2)\#5} = \frac{A_s}{bh} = \frac{(2)(0.31 in^2)}{(12")(28")} = 0.00185 \geq 0.0018 \therefore OK$$

$$a = 0.724 A_s$$

$$= 0.724(2(0.31 in^2)) = 0.449$$

$$c = \frac{a}{\beta_1} = \frac{a}{0.85} = \frac{0.449}{0.85} = 0.528$$

$$\varepsilon_s = \frac{0.003}{c}(d - c) > 0.005$$

$$\varepsilon_s = \frac{0.003}{0.528}(24.375 - 0.528) = 0.135 > 0.005 \therefore OK$$

Step (8)

$$\phi B_N = \phi(0.85) f'_c A_1$$

$$= (0.65)(0.85)(4 ksi)(11.33(12))^2$$

$$= 40,852^K > 672.72"$$

$$\phi B_N > P_u$$

FTG 11'-3" x 11'-3" x 2-8"

What about an 8' x 8' FTG

Step (1)

$$q = \frac{P_u}{A} \rightarrow \frac{P_u}{B^2}$$

$$q = \frac{672.72^K}{(8)^2} = 10.51^{KSF}$$

$$= 72.99 \text{ psi}$$

Step (2)

$$V_c = 189.74 \text{ psi}$$

$$d^2\left(189.74 + \frac{72.99}{4}\right) + d\left(189.74 + \frac{72.99}{2}\right)(18) = \frac{72.99}{4}\left((96)^2 - 18^2\right)$$

$$207.99d^2 + 4072.23d = 162256.77$$

$$0.208d^2 + 4.072d - 162.257$$

$$d = 19.85''$$

$$h = d + 3'' + d_b$$

$$= 19.85'' + 3'' + 0.625''$$

$$= 23.475'' \rightarrow 24$$

Step (3)

$$l = \frac{8' - (18/12)}{2} = 3.25' \quad / \quad d = 24'' - (3 + 0.625)$$

$$= 20.375$$

Step (4)

$$M_u = \frac{ql^2}{2} = \frac{(10.51)(3.25)^2}{2} = 55.51^{1-K}$$

$$a = \frac{A_s f_y}{(0.85) f'_c b} = \frac{A_s (60ksi)}{(0.85)(4)(20.375)} = 0.866 A_s$$

$$M_u = \phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

$$55.51^{1-K}(12) = 0.9 A_s (60)\left(20.375 - \frac{0.886 A_s}{2}\right)$$

$$\frac{666.12}{(0.9)(60)} = 20.375 A_s - 0.443 A_s^2$$

$-0.443 A_s^2 + 20.375 A_s - 12.34$

$A_s = 0.615 in^2$

Use #7 @ 12" $A_s = 0.60 in^2$

Step (5)

$$\rho = \frac{A_s}{bh} = \frac{0.60 in^2}{(12")(24")} = 0.0021 > 0.0018$$

$$a = 0.724 A_s$$

$$= 0.724(0.60)$$

$$a = .4344$$

$$c = \frac{a}{0.85} = \frac{.4344}{0.85} = 0.511$$

$\beta_1 = 0.85$

$$\varepsilon_s = \frac{0.003}{c}(d - c) > 0.005$$

$$\varepsilon_s = \frac{0.003}{0.511}(19.85 - 0.511) = 0.1135 > 0.005$$

Step (6)

$$\phi B_n = \phi(0.85) f'_c A_1$$

$$= (0.65)(0.85)(4 ksi)((8)(12))^2$$

$$= 20,367.36^k$$

$\phi B_n = 20,367.36^k > 507.27^k$ o.k.

PTG = 8'-0" x 8'-0" x 2'-0"