HPR Integrated Design

Penn State Ice Hockey Arena

Ice Arena Research Presentation

Mission Statement:

HPR Integrated Design combines innovative, cutting edge concepts with a collaborative multi-disciplinary approach through the utilization of state-of-the-art BIM technologies to exceed owner expectations both in system efficiencies and the enrichment of the human experience within its aesthetic.

Jeremy Heilman ○ Josh Progar ○ Nico Pugliese ○ Jim Rodgers

Penn State Ice Hockey Arena

Site | Codes | Arena Based Concerns | Precedents

http://www.centredaily.com/2011/07/20/2845377

- University Drive, University Park PA between Holuba hall and Shields Building.
- *Holds 6,000 for Hockey Games and an additional 1,800 on the floor for concerts*
- 2 Sheets of ice (Main Arena, Community Rink)
- The site in located partially in College Township and a partially in State College Borough . Both are part of the University Planned district 9.
- Construction slated for Jan 2012 – Sept 2013
- *Design-Build delivery method*

- Zoning Requirements for UPD 9
  - Maximum permitted density based on a FAR of 0.17
  - Maximum impervious surface coverage of 50%
  - Minimum open space of not less than 50%
  - Minimum Setbacks
    - No setback required along neighboring UPD 5
    - Minimum setback along University Dr of not less than 50 ft
  - Maximum building of no more than 90 ft
  - No requirement of buffer yard
  - Utilities must be installed underground

- General Site Conditions
  - Paved parking to the North & NE
  - Fenced in artificial-turf lacrosse field and tennis courts to the South & SE
  - Utilities located above and below throughout site
  - Site down from the NE to SE
  - Soil is made of fine to coarse crystalline dolomite, also consisting of sand and cherty dolomite. Bedrock pinnacles are also common in this location which could make for difficult rock excavation.
  - Topsoil is present
  - Groundwater was not encountered in boring sample, however it can not be certain where the water table may be as the samples do indicate season and daily ground water level fluctuations

General Information

HOCKEY VALLEY

Penn State Ice Hockey Arena

Site | Codes | Arena Based Concerns | Precedents

- Mechanical Codes
  - IBC 2009
  - ASHRAE 90.1 2007
  - ASHRAE 62.1 2007
  - US Climate Zone 5A (ASHRAE)
  - Design Conditions: 92ºF (Cooling) and 9ºF (Heating)

ASHRAE Advancing HVAC&R to serve humanity and promote a sustainable world

www.ashrae.org

- Structure Codes (based on DD drawings):
  - Building Code: 2009 IBC
  - Structural Concrete: ACI318-08
  - Concrete Masonry: ACI530-05
  - Structural Steel: AISC Steel Manual, 19th edition

http://www.aisc.org/

American Concrete Institute® Advancing concrete knowledge

http://cmpbs.org/blog/category/aci-student-competition/

- Electrical Codes & Design Criteria
  - NEC 2011
  - IES Lighting Handbook 10th ed.
  - ASHRAE 90.1 2007
  - NCAA Best Lighting Practices

IES Illuminating Engineering Society

http://www.iesna.org/

- Structural Loads Assumptions (based on DD drawings):

Fixed Arena Seating:	60 psf
Arena Aisles & Stairs:	100 psf
Mechanical Rooms:	150 psf
Light Storage:	125 psf
Event Floor:	350 psf
Truck Access:	350 psf
All Other Areas:	100 psf
Snow Loads:	40 psf + drift considerations

Codes and Loads

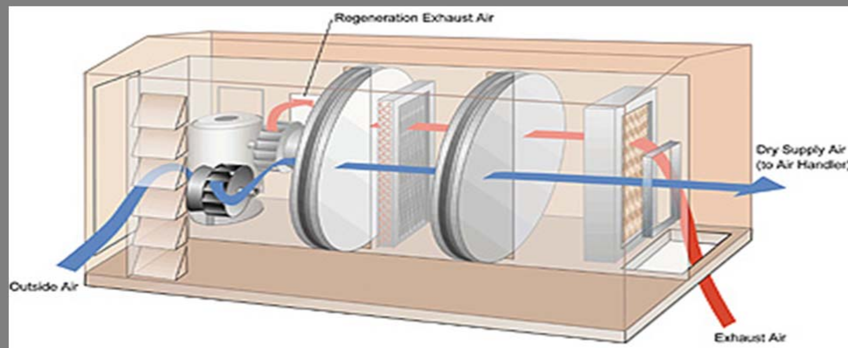
- Other Structural Loads:

Rigging Loads	20 kip point loads (max)
Wind Loads	90 mph, Exposure C
Seismic Loads	Site Class C (Geotech. Report)

Penn State Ice Hockey Arena

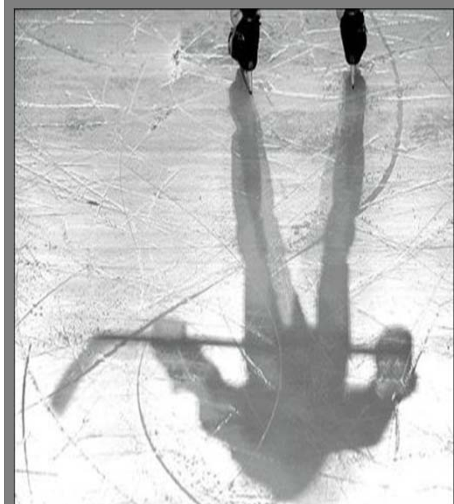
Site | Codes | Arena Based Concerns | Precedents

http://soleradaylighting.files.wordpress.com/2010/
0



http://cipco.apogee.net/ces/library/graphic/energy.jpg

http://cache.gawkerassets.com/assets/images



http://cincinnatiadulticehockey.com/

Mechanical Loads and Design Factors

- When determining the ice making load chose the greater of:
  - Refrigeration required to freeze the rink in a particular period of time
  - Refrigeration required to maintain the ice under maximum cooling load.
- Mechanical make up air dehumidification system can be downsized by up to 50% with the use of an enthalpy wheel.
- *An effective heat recovery system can meet 75-100% of your heating load.*
- Main refrigerants for ice making include R-404A, R-507, and R-717. Many others are being phased out.

- *40°F - 60°F typical temperatures for ice arenas*
- Fog can be a big issue.
- Acoustics- Reverberation Time for Auditoriums and Arenas should be around 1.2 seconds.
- *Exhaust form gas operated ice resurfacers can cause IAQ concerns*

Penn State Ice Hockey Arena

Site | Codes | Arena Based Concerns | Precedents

Overview - Long Span Framing:

http://srt251ddha.blogspot.com/2007_04_01_archive.html

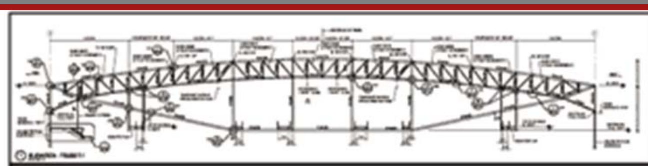
- Long spans demand close attention to unbalance load conditions (including wind pressures, snow drifts, etc.)
- Construction is complex and can become a significant driver of a schedule.
- Technical problem: balance weight, deflections (sway), and foundation forces.
- *Considered most efficient structure type.*

Tied Arch Framing:

http://acec-wa.org/blog

- Curved arches that have the curved upper chord in compression and the bottom chord in tension to resist the outward thrust.
- *Catwalks and rigging systems often act as bridging or stability members on bottom compression chord.*
- Bridging trusses may also be required for stability of the long span trusses.
- Structural members are usually deep.

http://www.structuremag.org/article.aspx?articleID=463

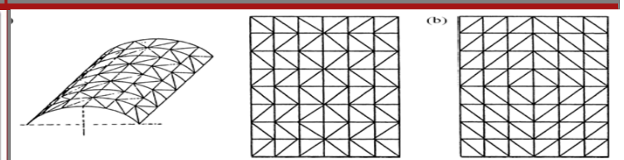


Space Frames:

http://laylool.blogspot.com/

- Three dimensional assemblies of linear members that form a flat grid system
- Highly statically indeterminate which leads to tedious analysis
- Construction is tough due to problems connecting a large number of members through different angles
- *Grid construction allows for omnidirectional spread of load*
- Forms a lattice structure

http://img20.imageshack.us/img20/5880/ch24spaceframestructure.pdf



Structural Framing Systems

Jeremy Heilman ○ Josh Progar ○ Nico Pugliese ○ Jim Rodgers

Penn State Ice Hockey Arena

Site | Codes | Arena Based Concerns | Precedents

Structural Case Studies:

http://articles.wsbt.com/2011-06-14/brian-boitano_29659291

- **Compton Family Ice Arena**
  University of Notre Dame, *Under Construction*
  Completion Date: December 1, 2011
  - 2 ice rinks, 5,000 seat facility
  - Curved long span trusses spanning 156'
  - Precast Stadia – flexible precast concrete seating
  - *Lateral System: Braced frames, difficult diaphragm due to donut shaped roof.*

http://www.gwinnettcenter.com/thearena.0.html

- **Gwinnett Civic and Cultural Center**
  Duluth, Georgia
  - Used super trusses spanning 247 feet supported by 14 parallel chord trusses
  - *Moved HVAC service equipment to perimeter of the arena so it was not in the long span roof area.*
  - Rigging grid consists of structural steel that provides bottom chord bracing and can hold 5 kip point loads.
  - *2" acoustical deck was used to for acoustical and sound considerations.*

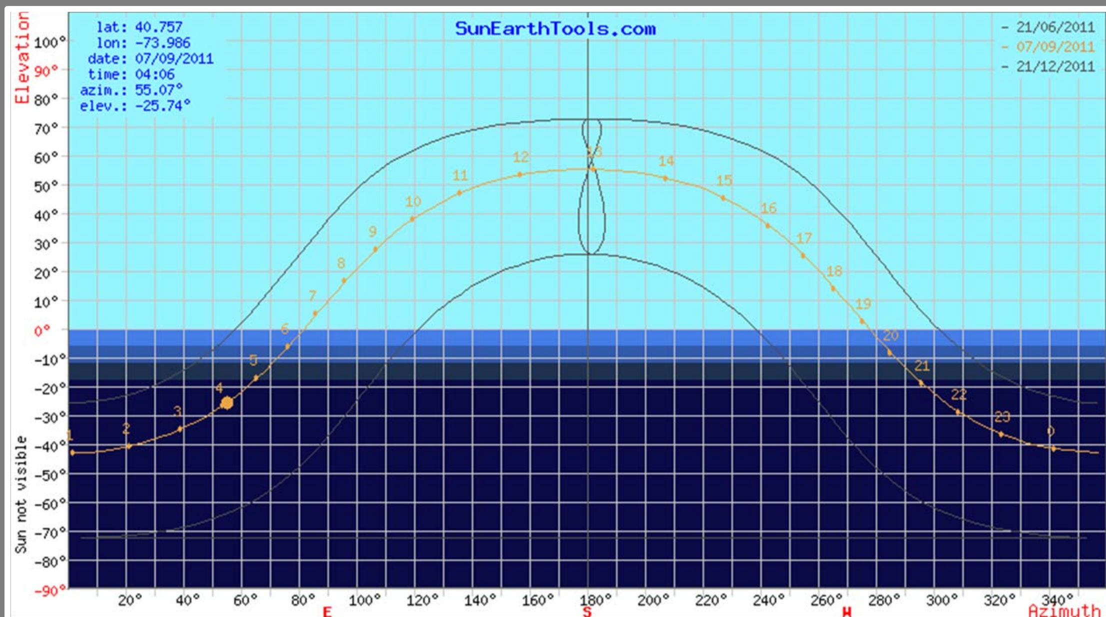
http://www.channels.com/

- **Newark Arena**
  Newark, New Jersey
  - *Used shallow foundations bearing on dynamically compacted soils as compared to micropiles which are typical*
  - Primary structural scheme consists of 40 bent frames; also acts as lateral system
  - *Lateral systems uses braced frames in each direction, transfers loads to upper deck level; uses a continuous ring at this level.*
  - Tied-arch structural system provided open rigging and catwalk level
  - Truss members were simply supported and light due to 3 span condition.

Penn State Ice Hockey Arena

Site | Codes | Arena Based Concerns | Precedents

Daylighting:



http://www.sunearthtools.com/dp/tools/pos_sun.php

Arena Luminaire Comparison:

http://www.northerntool.com/images/product/zoom_images/385463.jpg

http://cfnewsads.thomasnet.com/images/large/018/18110.jpg

Daylighting in State College, Pa

- The feasibility of daylighting will need to be investigated
  - Is it physically possible, given location, building facade?
  - Will it help reduce the amount of total energy needed in the building?

Ceramic Metal Halide vs. Linear Fluorescent

- Investigate different sources to provide the best solution

Lighting/Electrical Design Factors

Jeremy Heilman ○ Josh Progar ○ Nico Pugliese ○ Jim Rodgers

Penn State Ice Hockey Arena

Site | Codes | Arena Based Concerns | Precedents

Alternative Venues/Functions

Concerts/Theatre:

http://www.discoverbuenosaires.com/

- **Structural**: Rigging system needed to account for point loads
- **Structural**: Account for additional loads on rink foundation system for temporary seating
- **Mechanical**: Account for added load and reduced cooling affect from the ice
- **Lighting**: System must have flexibility to account for high illuminance sports lighting and versatile concert/show lighting

Graduation/Assemblies:

http://www.lehighvalleylive.com/

- **Structural**: Account for additional loads on rink foundation for temporary seating
- **Mechanical**: Acoustical requirements will differ from sporting events and concerts
- **Electrical**: Audio and video (A/V) equipment will need to be integrated into the structure, event specific A/V will need reachable power

Others:

http://corncommentary.com/

- **Structural**: Rigging system needed to account for equipment.
- **Structural**: Account for dynamic loads (trapeze artists, etc.)
- **Electrical:** Emergency circuits must provide lighting and power where needed for all of building functions

Penn State Ice Hockey Arena

Site | Codes | Arena Based Concerns | Precedents

Lighting/Electrical:

- Arena Lighting Systems
  - Efficient sources
  - High performance luminaires
- Public Area Lighting
  - Tailored for event
- Electrical systems
  - 12,470 Volt normal service
  - 4,160 Volt emergency service
  - Demand factors
- Daylighting Potentials
  - Step-Dim vs. Fully dimmable
  - Sky lights for Community Rink

Mechanical:

- Ice Generation
  - Campus Utilities
  - On site Chillers
  - Floor systems (with structural)
- Ventilation
  - Arena seating
  - Playing surfaces
  - Flexibility
- Acoustics
  - Acoustic response

Structural:

- Lateral Systems
  - Diaphragm
  - Load paths
- Long-Span Framing System
  - Rigging Systems
  - Stabilization of Members
- Ice Rink Foundations
  - Flexibility

Construction:

- Schedule Concerns
  - Long Span
  - Ice Flooring systems
- Value Engineering
  - Roof Ideas
  - Structural System Selection

Design Focus Areas for Schematic Design:

Jeremy Heilman ○ Josh Progar ○ Nico Pugliese ○ Jim Rodgers