C-5 FUEL CELL FACILITY
167TH AIRLIFT WING
MARTINSBURG, WV

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BAE in Construction Management
Pennsylvania State University
Senior Thesis Presentation
April 12, 2010

Presentation Outline

- Project Background Information
- Solar Energy Collection
  - Electrical Breadth
- Precast Concrete Walls
  - Structural Breadth
- Hangar Slab Sequence
- Design/Build Productivity
- Conclusions
- Questions and Answers

Special Thanks to:

Kinsley Construction, Inc.

167th Airlift Wing

Penn State AE Faculty

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Project Background

- Client: 167th Airlift Wing – WV Air National Guard
- Site: Martinsburg, WV
  - WV Eastern Regional Airport
- Purpose
  - C-5 Galaxy Conversion Project

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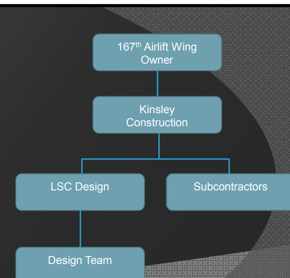
Project Background

- Design/Build Contract
  - Kinsley Construction – Design/Build Manager
    - Holds all subcontracts
  - LSC Design – contracted by Kinsley Construction
    - Holds all design team subcontracts
  - All contracts based on lump sum



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Project Background

- Cost: $26.8 million
- Schedule
  - NTP for design: October 2008
  - Office Mobilization: March 2009
  - Scheduled Completion: March 2010
  - Expected Completion: July 2010 – extensions granted for additions to scope and weather delays

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Breadth Topics

- Electrical Breadth Study
  - Addition of solar collection system
- Structural Breadth Study
  - Design of load-bearing concrete walls in place of masonry

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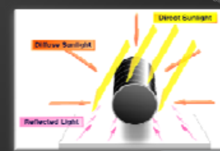
Solar Energy Collection

- Goal of Analysis
  - Determine if the installation of Solyndra panels is a positive addition
    - Potential energy production
    - Building power usage
    - Purchase and installation costs
    - Payback period



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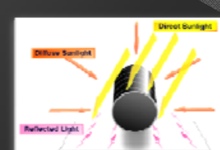
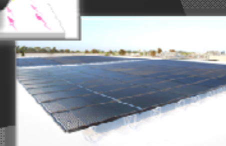
Solar Energy Collection

- Solyndra, Inc. Panels
  - Array of cylinders
  - Collects direct, diffuse, and reflected light
    - Reflected light gain based on roof material
  - Airflow between cylinders
    - Reduced wind uplift
    - Cooler operating temperatures



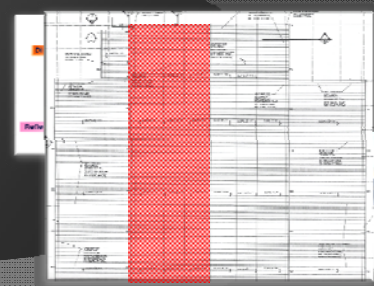


Presentation Outline

Electrical Breadth Study

- How many Solyndra panels can be installed on the roof?
  - Orientation of building
  - Dimensions of panels vs. Dimensions of roof
- 3 sections of usable roof space on SW side
- 13 panels lengthwise along slope of roof
- 78 panels across the roof

1014 panels total



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Electrical Breadth Study

- Energy Production Potential
  - Power Rating of Solyndra panel
  - Monthly insolation values for location
  - Max annual output: 274 kWh/panel
  - Reflectivity reduction: 88%
  - Potential annual output: 241 kWh/panel

241kWh/panel/year x 1014 panels = **244,374 kWh/year**

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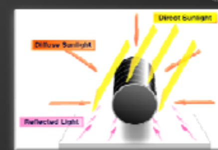
Electrical Breadth Study

- Building Energy Usage
    - Existing hangar energy usage
    - Average office energy usage
    - Total Expected Energy Usage = **213,773 kWh/year**
- Cost of Installing Solyndra System
    - $7 per Watt per panel
    - $7/W/panel x 200W x 1014 panels
    - **$1,419,600** to purchase and install



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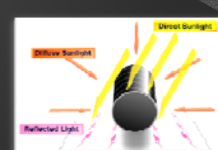
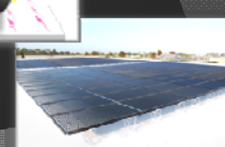
Electrical Breadth Study

- Payback Period of System
    - Cost of electricity: 6.64 cents per kWh in WV
    - Expected savings plus sale of electricity
        - $0.0664/kWh x 244,374 kWh/year = **$16, 226/year**

$1,419,600 / $16,226/year = **87.5 years**





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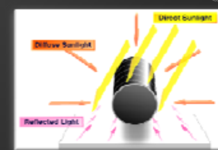
Conclusion and Recommendation

- System produces more than building uses
- Payback period is extremely long
  - Low cost of energy for project location
  - More feasible in higher cost region
- Recommendation: Do not install Solyndra system on this project.



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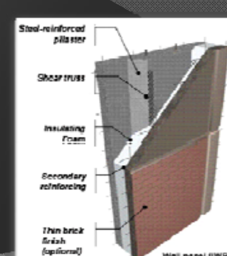
Precast Concrete Walls

- Goal of Analysis
  - Is precast concrete a better option than CMU for wall construction?
    - Exterior façade
    - Interior load-bearing walls



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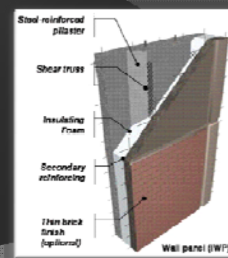
Precast Concrete Walls

- Exterior Façade
  - Currently split-face CMU to match existing buildings
  - Carbon Cast panels
    - Thin-brick technology to match aesthetics
    - Produced in controlled conditions
    - Higher quality product than masonry



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Structural Breadth Study

- Load Determination
  - Dead Load: 21.3 PSF
  - Live Load: 20 PSF
- Strength Design Method
  - Load combination: 1.2D + 1.6L
  - Total Axial Load = 3.22 kips

P_D = 1193 lbs
P_L = 1120 lbs
$P_U = 1.2P_D + 1.6P_L$ = 3223 lbs = 3.22 kips

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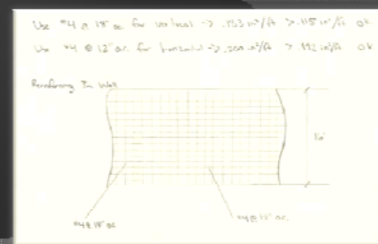
Structural Breadth Study

- Using 8" wall thickness
  - Bearing Capacity
  - Axial Load Capacity
- Minimum Reinforcement
  - #4's @ 18"oc in vertical direction
  - #4's @ 12"oc in horizontal direction



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Structural Breadth Study

- Cost Comparison
  - Masonry package: $230,011
  - Precast package: $506,084
    - $38/SF estimate from High Concrete
- Increased Floor Space
  - Change from 12" masonry to 8" concrete walls
  - 117 SF added at $340/SF
  - $39,720 worth additional usable space

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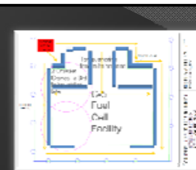
Structural Breadth Study

- Schedule Comparison
  - Masonry package: 25 days on-site
  - Precast concrete package: 15 days on-site
  - Not on critical path: does not change project schedule
- Productivity Impact
  - Fewer workers for precast
  - More moving equipment for precast



MASONRY LOGISTICS PLAN

PRECAST LOGISTICS PLAN

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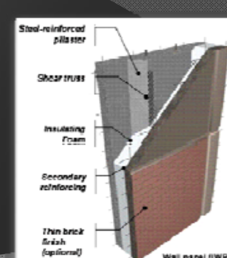
Conclusion and Recommendation

- Cost of change is more than double
- Overall schedule not reduced
- Increased floor space
- Higher quality facade

- Recommendation: Use the masonry system as designed instead of precast concrete option.



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- **Hangar Slab Sequence**
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Hangar Slab Sequence

- Goal of Analysis
  - Determine most efficient sequence for concrete placement in hangar area
    - Cost
    - Duration
    - Productivity

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- **Hangar Slab Sequence**
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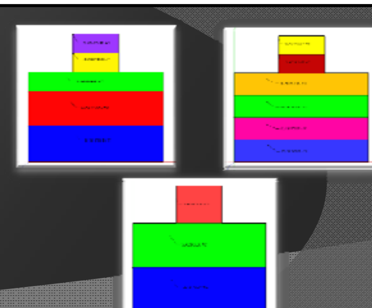
Hangar Slab Sequence

- Industry Survey
  - Larger pour size = higher productivity
- 3 Sequences
  - As-built
  - More pours/smaller width
  - Less pours/greater width



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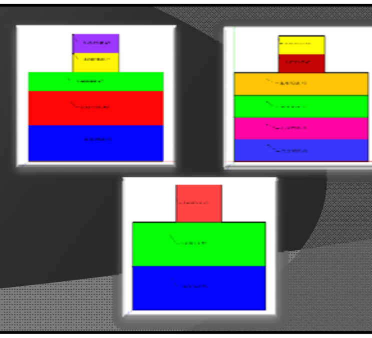
Hangar Slab Sequence

- Cost and Duration Comparison
  - Larger pour width costs less and completed faster
  - Smaller pour width costs more and completed slower
- Quality Comparison
  - Larger width makes finishing more difficult
  - Higher quality with smaller width pours



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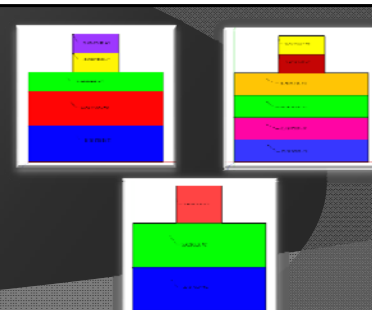
Conclusion and Recommendation

- Quality vs. Cost
- Hangar dimensions
- Recommendation: Employ the slab pour sequence that was chosen by project team.
  - Slightly larger pours if dimensions allow



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Design/Build Productivity

- Goal of Analysis
  - Does design/build construction increase productivity for the management and design team as well as in the field?

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Design/Build Productivity

- Measurements
  - Preconstruction activity time
  - Paperwork during construction
  - Ability to work ahead

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Design/Build Productivity

- Research Steps
  - Project Manager Survey
  - Owner Perspective
  - Causes of Delays
  - Potential Benefits

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Design/Build Productivity

- Findings of Research
  - Preconstruction time reduced
    - Design is better the first time
    - Estimating is completed simultaneously
    - Subcontractors acquired earlier for design-assist
  - Less paperwork during construction
    - RFI's handled in open meetings
    - Change Orders almost completely eliminated
    - Submittal process much shorter: subcontractors know the specifications

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Design/Build Productivity

- Findings of Research continued
  - Able to start activities sooner
    - Procurement of long-lead items
    - Subcontractors determine means and methods of construction during design phase
    - Subcontractors can schedule labor and equipment to reduce chance of delays
  - Success of delivery method depends on the team
    - Good contractor with good design can make any method work
    - D/B requires background knowledge of project
    - Owner must know what they want

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Conclusion

- If the design/build team and owner coordinate well, there is potential for higher productivity

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Conclusions

- Project Team made good decisions in selection of systems and design methods
- For other projects, proposed changes may be more beneficial
- Use of Design/Build delivery should continue to be implemented at greater levels

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QUESTIONS?