Reducing the Human Cost in Construction Through Design

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The Human Cost of Construction

Highest risk industry for Work-related Musculoskeletal Disorders (WMSDs)

- 5 of top 12 high-risk industries are in construction
- Average 6,500 State Fund claims/year
- More than $60 million per year in direct workers compensation costs for State Fund employers
- Improvements can reduce construction time and increase quality, and keep skilled workers on the job
- Attention in the design phase could reduce the risk of injuries and the cost of buildings

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Design for Workers and End-Users

- Design improvements can affect both workers and end-users
- Examples:
  - High parapet walls can protect workers on the roof and end-users during the life of the building
  - Permanent catwalks and fall protection tie-offs can facilitate both construction and future maintenance- Seahawk Stadium/Qwest Field

Where Design Can Make a Difference

- Access for material and equipment
- Size and weight of materials
- Modular buildings
- Roofing and guarding

Design for Material and Equipment Access

- Equipment & material need to be delivered / removed during and after construction
- Design of vertical wall hatches on all floors can provide access for machine stocking
- Mechanized lifting greatly reduces the chance of injury and cost of the job

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Design for Material and Equipment Access (cont.)

- Hatch access provided (common for commercial stocking)

- Hatch access provided - improved (ramp built up to window sill level)

Anthropometry and Access

- Anthropometry – “Fit the Job to the Person”
- The building is a construction worker’s workstation
- Design impacts access during and after construction

Anthropometry and Access (cont.)

- Allow access for cable pullers in electrical rooms and worker-lifts in other areas (41”-46”)
- Design for placement by crane or other lifting equipment (ie. lifting eyes, access)

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Size and Weight of Materials

- Size and weight of materials directly impact construction workers
- ½” drywall longer than 10 feet and 5/8” drywall longer than 9 feet weigh more than 90 lbs
- Material choice and dimension can be used to protect workers and reduce cost

Size and Weight of Materials (cont.)

- Using large diameter rebar instead of smaller diameter rods can increase lifting risks, but reduce hand repetition from tying
- Rebar tying may be tied using a powered tier in the future

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Modular Building

- Use of standard dimensions throughout a building can make pre-assembly or re-use of gang forms possible
- Use of pre-fabricated components reduces human and material costs of construction on-site

Modular Building (cont.)

- Pre-fabricated components can reduce time and physical stress of installation in awkward positions on-site
- Design should include storage/staging areas, crane and building access
- Embedding anchors in concrete for fall protection, HVAC, piping, and equipment can greatly reduce overhead work and exposure to vibration

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Modular Building (cont.)

- Using pre-cast concrete and masonry can reduce safety and ergonomics risks on-site
- Building construction can be faster and less prone to delay or clutter
- Build-in cut-outs, anchor points, uni-strut channel in ceiling to minimize awkward postures and vibration exposure

Modular Building (cont.)

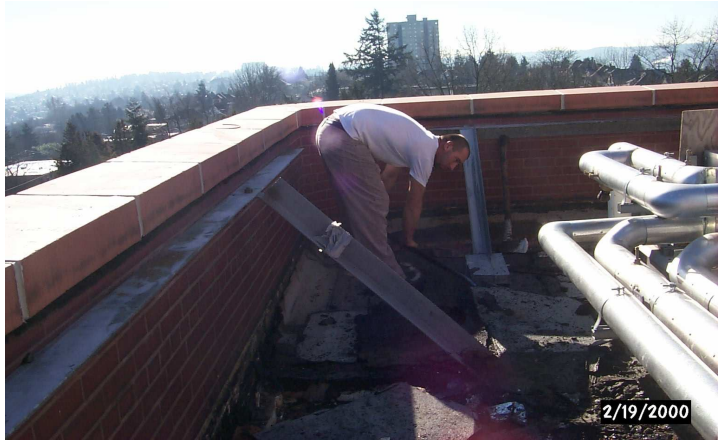
- Centralizing plumbing fixtures and bathrooms can allow pre-assembly of sub-systems
- Straight runs of pipe and ductwork also allow pre-assembly

Roofing and Guarding

- Unbroken roof areas allow use of mechanized equipment
- Placing HVAC and other equip. on the ground, side, or in a penthouse can ease construction and maintenance
- Roof structures that support equipment can speed up work and help protect workers

Roofing and Guarding (cont.)

- High parapet walls (42”) are wanted by all trades to eliminate the need for fall protection



- High window sills would reduce the installation of extra guarding

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Human Cost: General Design Ideas

- Minimize overhead or floor-level work
  - Installation of electrical, plumbing and HVAC in walls can be more easily accessible
- Consider permanent catwalks for installation and maintenance of tall, long span structures
- Consider the Order of Installation
  - Can electrical be installed before HVAC?
- Minimize the number of confined spaces
- Design permanent lighting and handrails to be constructed early in the project

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Human Cost: General Design Ideas (cont.)

- Larger, unbroken slabs, roofing and walls allow use of equipment such as riding trowel machines and felt-laying machines
- Design for Future Renovation and Repair
  - Access for equipment and materials
  - Easily replaceable sections and material

Design

- Design - Concerned with our ability to adapt our environment to suit our needs
- Design – A problem-solving process
- Process begins with identification of problems
  - Analysis of site
  - Owner’s intended use
  - Daily use of facility
  - Form Generation (sculptural quality)

Design (cont.) For Daily Use

- End-users and the Public
  - International Building Code (IBC) Requirements
    - » Mostly fire related NOT ergonomics related
  - Non-slip Flooring: required
  - Contrast Edging on Stairs: required
  - Windows in fire doors: 100 sq in allowed.
  - Design for Aging
    - » Accessibility
    - » Low Force Requirements
    - » Ideas for the Aging are Good for Everyone

Design (cont.) Means and Methods

- Means and Methods
  - Architect and Contactors
  - Architect plans, Contractor does
  - Specifier can define type of roofing, order of materials, basic type of application, but not specific technique
- Gray Areas
  - Type or Quality of construction may force the means. Safety/Ergonomics is another criteria that should be considered.
    - » Example: torch-down roofs
  - Means and Methods are interrelated with design decisions

Facility Specifications

- What are Specifications? - “The Spec”
  - The drawings describe quantity, the specs describe quality
  - Organization of specifications
    - » 16 divisions divided into two main parts
    - » Divisions 0-1: Contract/General Req. (Safety/Ergo Addressed)
    - » Divisions 2-16 - The Technical Spec
  - Each section has 3 parts
    - » Part 1- General admin, procedural requirements
    - » Part 2- Materials, products, equipment defined
    - » Part 3- Execution and method of incorporation into project

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Safety in Drawings

- Safety in Drawings
  - An architect can draw an assembly or arrange space to promote a safer environment during work and after completion
    - » Example- Minimizing the number of confined spaces

Safety in Specifications

- Safety in Specifications
  - Division 0
    - » Place important items in the Contract
    - » Required safety programs
    - » Reinforce existing Federal/State code
  - Include a Safety section in Division 1 (01415±)
    - » As a topic in pre-construction and installation meetings. 01300 Administrative Requirements
    - » Transportation and handling. 01600 Product Requirements.
      - Example: storage 18 off the ground

Safety in Specifications (cont.)

- Technical Sections
  - Use particular products or types of products.
    - » Example: Manufactured metal stairs
    - » Example: Fall protection
- Within a section
  - Part 1: Administration:
    - » Submit safety plans
    - » Delivery Storage and Handling
    - » Project Conditions

Safety in Specifications (cont.)

- Within a section (cont)
  - Part 2: Products:
    - » Select safer products
    - » Use less hazardous material
      - Examples: Linoleum and PVC
    - » Shop Assembly and Finishing

Safety in Specifications (cont.)

- Part 3 Execution:
  - » Examination: look for safety issues
  - » Preparation: Protect adjacent work and workers
  - » Erection, Installation, Application, Construction
    - This is the portion of the written material most subject to the means and methods problem.
    - The location for specific assembly instructions. We can't trust "common practice" or "workman like manner" any more .
    - Provide higher quality at lower risk of injury:
      - Mechanical troweling and/or the use of a laser screed on large concrete slabs (Will not penetrate vapor barrier)
      - Use of Powered Carpet Stretcher
      - Use of Felt-Laying Machine
  - » Demonstration: include safety and ergonomics issues and tape the instruction for future use.
  - » Protection of installed work: must be safe as well.

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Looking to the Future

- There is an opportunity to both protect workers and reduce construction costs through attention to human costs during design.
- Form partnerships between architects, engineers builders and owners, particularly at early stages.
- Safety and ergonomics training for architects that includes the contractors point of view.
- Projects to investigate the problems, solutions and costs.