Prevention through Design

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More resources on Prevention through Design
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Prevention through Design

Course Description:
This session will focus on an important emerging topic within the construction industry: Prevention through Design (PtD), also known as Design for Construction Safety. Learn what PtD is and how it is directly connected to topics that are important to your customers: social sustainability, corporate social responsibility, and innovation. You will learn how PtD is both the right thing to do and the smart thing to do in terms of cost, time and quality. You will see common examples of PtD and hear about tools (including a resource focused on concrete available free from NIOSH) and contracts that enable it. PtD has been required in Europe for many years and is becoming common in other nations, too. In the U.S., PtD is often practiced by owners and large design-build firms in the process industry and is slowly moving into other segments of the design and construction industry. The session will conclude with tips associated with organizational culture, processes, and project partners that will help you implement PtD within your organization and gain a reputation as an innovative, sustainable, and ethical leader.

Learning Objectives:
- Define Prevention through Design (PtD).
- Describe common examples of PtD and examples specifically for concrete.
- Identify tools and processes that enable PtD.
- Summarize three sets of organizational actions necessary to implement PtD.

Dr. T. Michael Toole, P.E.
Mike Toole is Professor of Civil and Environmental Engineering and Director of the Grand Challenge Scholars Program at Bucknell University. He received his B.S. in Civil Engineering cum laude from Bucknell University and his M.S. in Civil Engineering and his Ph.D. in Technology Strategy from the Massachusetts Institute of Technology. His research includes construction safety (especially designing for safety), construction innovation, and project management. Dr. Toole is a professional civil engineer, a member of the Order of the Engineer, and a Fellow within the American Society of Civil Engineers. He initiated and maintains www.designforconstructionsafety.org. His professional employment includes serving as a Company Commander in a Seabee Battalion and Assistant Resident Officer in Charge of Construction with the U.S. Navy Civil Engineer Corps, serving as the Purchasing and Construction Services Manager with a publicly traded homebuilder, and as a Vice President with a multidisciplinary engineering firm that specialized in forensics engineering.

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The American Institute of Architects has approved this course for 1 AIA/CES LU Learning Unit.
PREVENTION THROUGH DESIGN: MAKING CONCRETE MORE SOCIALLY SUSTAINABLE

ACI UNIVERSITY WEBINAR JANUARY 10, 2017

T. Michael Toole, PhD, PE
Professor, Civil and Env. Engineering, Bucknell University

Based on past presentations with
John Gambatese, PhD, PE
Professor, Civil and Construction Engineering, Oregon State University

PRESENTATION DESCRIPTION

- The presentation will summarize the PtD concept and the ethical and sustainability-related reasons for PtD, provide examples for concrete construction, and summarize tools and processes that enable PtD. The presentation will conclude with suggestions for how to move forward with implementing PtD in your organization.

WEBINAR 13

LEARNING OBJECTIVES

- Participants will be able to:
  - Define Prevention through Design (PtD)
  - Describe common examples of PtD and examples specifically for concrete
  - Identify tools and processes that enable PtD
  - Summarize three sets of organizational actions necessary to implement PtD

WEBINAR 14

OVERVIEW

- PtD Concept
- Motivation
- Concrete Examples
- Leaders
- Tools and Processes
- Moving forward in your organization

WEBINAR 15

PREVENTION THROUGH DESIGN (PTD)

“Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipment.”

(http://www.cdc.gov/niosh/topics/ptd/)

WEBINAR 16

PTD IN CONSTRUCTION IS...

- Explicitly considering construction safety in the design of a project.
- Being conscious of and valuing the safety of construction workers when performing design tasks.
- Making design decisions based in part on a design element's inherent safety risk to construction workers.

“Safety Constructability”

WEBINAR 17
WHY PTD? ANNUAL CONSTRUCTION ACCIDENTS IN U.S.
- Nearly 200,000 serious injuries
- 1,000+ deaths

WEBINAR 19

WHY PTD? DESIGN- SAFETY LINKS
- 22% of 226 injuries that occurred from 2000-2002 in Oregon, WA, and CA
- 42% of 224 fatalities in US between 1990-2003
- 60% of fatal accidents resulted in part from decisions made before site work began
- 63% of all fatalities and injuries could be attributed to design decisions or lack of planning

2 European Foundation for the Improvement of Living and Working Conditions
3 NSW WorkCover, CHAIR Safety in Design Tool, 2001

WEBINAR 20

WHY PTD? PROFESSIONAL ETHICS
- National Society of Professional Engineers (NSPE) Code of Ethics:
  - Engineers shall hold paramount the safety, health, and welfare of the public.

- American Society of Civil Engineers (ASCE) Code of Ethics:
  - Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering decisions ....

WEBINAR 21

WHY PTD? SUSTAINABILITY

PTD’S TIE TO SUSTAINABILITY
- Focus on people as much as on the environment
  - Meet the needs of people who can’t speak for themselves

WEBINAR 22

CORPORATE SOCIAL RESPONSIBILITIES
- “Commitment by business to behave ethically and contribute to economic development;
  “Improve quality of life of the local community and society at large.”

- “Improve quality of life of the workforce and their families;

Source: World Business Council for Sustainable Development

WEBINAR 23

WEBINAR 24
SUSTAINABILITY IS NOT JUST BEING GREEN

- PEOPLE
- SUSTAINABLE
- PROFIT
- PLANET

PTD AND SOCIAL SUSTAINABILITY/EQUITY

- Do not our duties include minimizing all risks that we have control over?
- Do not we have the same duties for construction, maintenance, line workers as for the “public”?
- Is it ethical to create designs that are not as safe as they could (practically) be?

DESIGN HAS MAJOR LEVERAGE

- PTD is the Right thing to do and...
- The Smart thing to do

WHY PTD? BANG FOR THE BUCK

- Ability to influence safety is greatest early in the project schedule during planning and design (Szymberski, 1997)

HIERARCHY OF CONTROLS

- Elimination: Eliminates the hazard during design
- Substitution: Substitutes a non-hazardous material or form during design
- Engineering Controls: In design, incorporate warning systems
- Administrative Controls: Well-designed work methods & organization
- PPE (Personal Protective Equipment): Available, effective, easy to use

WHY PTD? TANGIBLE BENEFITS

- Reduced site hazards
  - Fewer worker injuries and fatalities
- Reduced workers’ compensation premiums
- Increased productivity and quality
- Fewer delays due to accidents
- Encourages designer-constructor collaboration
- Improved operations/maint. safety
OVERVIEW

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EXAMPLE OF THE NEED FOR PTD

- Design spec:
  - Dig groundwater monitoring wells at various locations.
  - Wells located directly under overhead power lines.

- Accident:
  - Worker electrocuted when his drill rig got too close to overhead power lines.

- Engineer could have:
  - Specified wells be dug away from power lines; and/or
  - Better informed the contractor of hazard posed by wells' proximity to power lines through the plans, specifications, and bid documents.

PTD EXAMPLE: ANCHORAGE POINTS

PTD EXAMPLE: ROOFS AND PERIMETERS

- Skylights
- Upper story windows
- Parapet walls

PTD EXAMPLE: PREFABRICATION

- Structural Tees
- Wall Panels
- Segmented Bridge

Reinforced Concrete Design

EDUCATION MODULE

Photo courtesy of Thinkstock

Developed by Jon Gambatese, Ph.D., P.E.
Ryan Lujan
School of Civil and Construction Engineering
Oregon State University
Concrete Construction Hazards

- Tripping
- Muscle strain caused by repeated lifting
- Structural collapse
- Falling materials
- Manipulation and erection of reinforcing steel and formwork
- Silicosis
- Falls
- Obstructions
- Cave-in during foundation construction
- Lung or skin irritation from exposure to cement or admixtures
- Jack, cable, or fitting failure during tensioning

Rebar

- Use one grade of rebar throughout the whole job
- Prefabricate column and wall cages when feasible
- Utilize welded wire fabric (WWF) (flat sheets) for area paving reinforcement
- Show splice location and splice lengths on the drawings
- Standardize use of a few sizes of rebar such as #5, #7, and #10

Foundations

- Use 4" × 4" mat mesh or welded wire fabric (WWF) on top of more widely spaced top rebar
  - Provides walking surface
- Review clearances between forms, anchor bolts, sleeves, and rebar at congested pier locations
  - Ensure sufficient room for equipment
- Standardize foundation sizes for pumps, pipe racks, structures, and miscellaneous supports
  - Standard, regular work environment helps workers
- Dimension concrete foundations and structures to maximize use of commercial form sizes
  - Custom forms may be under-designed or difficult to install

Floor Surfaces
Floor Surfaces
- Keep steps, curbs, blockouts, slab depressions, and other similar floor features away from window openings, exterior edges, and floor openings.
- Design the covers over sumps, outlet boxes, drains, etc., to be flush with the finished floor.
- Provide a non-slip walking surface on walkways and platforms that are adjacent to open water or exposed to the weather.
- Locate floor openings away from passageways, work areas, and the structure perimeter.
- Eliminate tripping hazards (changes in elevation, curbs, etc.) around floor openings.

Elevated Slabs
- Note on the contract drawings the existing and new floor design loads.
  - Help the constructor in determining material stockpile locations and heavy equipment maneuverability.
- Provide permanent guardrails around floor openings.
- Design concrete members to be of similar size and regularly spaced to facilitate the use, and re-use, of pre-fabricated forms.
- Minimize the number of details to reduce costs and construction errors.
- Specify composite steel-form deck.
  - Eliminate formwork and minimize rebar in elevated slabs.

Concrete Beams and Girders
- Design members of consistent size and shape.
  - Standardize the work environment.
  - Facilitates the use, and reuse, of prefabricated forms.
- Specify a minimum beam width of 6 inches.
  - Provides a wide walking surface.
- Minimize the use of cantilevers, which can be hard to form and finish.
- Design pre-fabricated members to be of one size and shape, or make them easily distinguishable to avoid incorrect placement.
- Design member depths to allow adequate head room clearance around stairs, platforms, valves, and all areas of egress.

OVERVIEW
- PtD Concept
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PTD IN PRACTICE: OWNERS

- USACE
- Southern Co.
- BHP Billiton
- Intel
- ExxonMobil
  - MWCS

USACE SYSTEMS SAFETY

To incorporate systems safety engineering and management practices into a facility life cycle process used in the conceptual phase, planning stages, construction of facilities, and facility reduction (demolition).

FACILITY SYSTEMS SAFETY PATH FORWARD

<table>
<thead>
<tr>
<th>Year</th>
<th>Initiative</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2004</td>
<td>Web Design Established</td>
</tr>
<tr>
<td>FY 2007</td>
<td>FASS Training for Designers</td>
</tr>
<tr>
<td>FY 2011</td>
<td>FASS 2012 for USACE</td>
</tr>
<tr>
<td>FY 2012</td>
<td>Create FASS Program Manual</td>
</tr>
<tr>
<td>FY 2013</td>
<td>Create FASS Plan Program at Division</td>
</tr>
<tr>
<td>FY 2013</td>
<td>Owner Design Division FASS</td>
</tr>
<tr>
<td>FY 2013</td>
<td>Develop FASS Procedures EDMS</td>
</tr>
<tr>
<td>FY 2014</td>
<td>Review Progress with FASS Pilot Programs</td>
</tr>
<tr>
<td>FY 2014</td>
<td>Implement FASS in Construction with USACE</td>
</tr>
<tr>
<td>FY 2015</td>
<td>FASS Mandatory Training for All Employees</td>
</tr>
</tbody>
</table>

BHP BILLITON’S PTD INITIATIVES

- PtD staff embedded in procurement and design
- PtD in technical specifications
- Required designer PtD training
- Design reviews includes 3D models

SOUTHERN CO.’S DESIGN CHECKLISTS

DESIGN SAFETY CHECKLIST

- This hazard or concern needs to be addressed on the project
- Yes/No
- This hazard or concern will be addressed in our design
- Yes/No

- Project Engineer has communicated "Hazard" project information required for design engineering personnel to examine a site visit. Client personnel that visit the project site may refer to any information provided to them it is permitted by all other personnel or authorities.

- Site visit must provide the necessary field data and reference items to evaluate the importance of the site hazards.

- Design engineer must prepare 3D models to provide a clear understanding of the potential hazards.

- Design review must be conducted to ensure that the project meets the safety requirements.

- Design review must be conducted to ensure that the project meets the safety requirements.

- Site visit must be conducted to ensure that the project meets the safety requirements.

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NATIONAL INITIATIVES AND ACTIVITIES

- NIOSH
  - PtD National Initiative
  - PtD Workshops: July 2007 and August 2011
  - NORA Construction Sector Council CHPtD Workgroup
- OSHA Construction Alliance Roundtable
- ANSI/ASSE PtD Standard (Z590.3-2011)

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PTD DESIGN REVIEW

- Hazard identification
  - What construction safety hazards does the design create?
- Risk assessment
  - What is the level of safety and health risk associated with each hazard?
- Design option identification and selection
  - What can be done to eliminate or reduce the risk?
  - Remember the hierarchy of controls.......

PTD TOOL – DESIGN RISK ASSESSMENT

Safety in Design...

PTD TOOL

PTD PROCESS

Get the right people talking about the right things at the right time!
DESIGN FOR CONSTRUCTION SAFETY TOOLBOX

- Created by Construction Industry Institute (CII)
- Interactive computer program
- Used in the design phase to decrease the risk of incidents
- Over 400 design suggestions

CHAIR SAFETY IN DESIGN TOOL

Begin Concept Design

-> Review of Concept Design

-> CHAIR-1

-> Review of Detailed Design

扣 CHAIR-2

Commence Construction

扣 CHAIR-3

Construction Hazard Assessment and Implication Review (CHAIR)

(Source: NSW WorkCover, CHAIR Safety in Design Tool, 2001)

PTD TOOLS – BIM AND VISUALIZATION

PTD INFORMATION SOURCES

www.designforconstructionsafety.org

1700+ ITEM PTD CHECKLIST

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Structural Framing</td>
</tr>
<tr>
<td>1.1</td>
<td>Space slab and mat foundation top reinforcing steel at no more than 6 inches on center each way to provide a safe walking surface.</td>
</tr>
<tr>
<td>1.2</td>
<td>Design floor perimeter beams and beams above floor openings to support lanyards.</td>
</tr>
<tr>
<td>1.3</td>
<td>Design steel columns with holes at 21 and 42 inches above the floor level to support guardrail cables.</td>
</tr>
<tr>
<td>2.0</td>
<td>Accessibility</td>
</tr>
<tr>
<td>2.1</td>
<td>Provide adequate access to all valves and controls.</td>
</tr>
<tr>
<td>2.2</td>
<td>Orient equipment and controls so that they do not obstruct walkways and work areas.</td>
</tr>
<tr>
<td>2.3</td>
<td>Locate shutoff valves and switches in sight of the equipment which they control.</td>
</tr>
<tr>
<td>2.4</td>
<td>Provide adequate head room for access to equipment, electrical panels, and storage areas.</td>
</tr>
</tbody>
</table>
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THREE STEPS TOWARDS PTD

1. Establish a lifecycle safety culture
2. Establish enabling processes
3. Team with organizations who value lifecycle safety

ESTABLISH A LIFECYCLE SAFETY CULTURE

- Instill the right safety values
- Secure management commitment
- Training
- Confirm Life Cycle Costing criteria
- Ensure recognition that designing for safety is the smart thing to do and the right thing to do
  1. Professional Codes of Ethics
  2. Payoff data

ESTABLISH ENABLING PROCESSES

- Designer training and tools
- Qualifications-based contracting
- Negotiated or Cost-Plus contracting
- IPD or enabled safety constructability input
- Collaborative decision processes

CHOOSE YOUR PARTNERS WISELY

- Owners and GCs that value safety
- Collaborative culture and experiences
- Open to change
  - PtD capability in designer RFP
  - Designer interaction experience in GC RFP
  - Consider Design-Builders with industrial and international project experience

PTD: AN OPPORTUNITY FOR YOU

- All organizational change starts with individual initiative
- Will you and your firm be leaders or laggards?
- Will ACI be a leader in identifying PtD opportunities in concrete?
INITIATING PTD IN YOUR ORGANIZATION

- Leadership
- Sustainability and Social Responsibility
- Ethics
- Innovation

SUMMARY

- PTD is tied with sustainability, CSR, ethics
- Successful organizations have implemented PTD
- More resources for concrete PTD are needed
- Three first steps to implementing PTD
  - Culture, Processes, Partners
- You can be a leader in implementing PTD in your organization

THANK YOU FOR YOUR TIME!

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Questions?

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Thank you to our presenter: Dr. T. Michael Toole.
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Cold Weather Series

February
Presidents Series: "ACI 318: What's in Your Spec?"

March
Shotcrete ACI 506R/506.2

April
Chemical Admixtures

April
Repair Code (presented in Spanish)

Recorded Webinars

ACI 562-16 Repair Code
Learning from the Nepal 2015 Earthquake
Concrete Mix Design: Basics
Concrete Mix Design: Advanced
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