PCI Design Handbook 8th Edition
Content and Updates

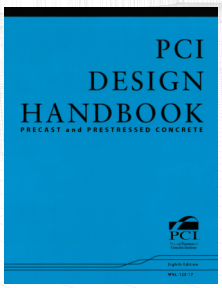
Jared E. Brewe, Ph.D., P.E., S.E.
Simpson Gumpertz & Heger
Chicago, Illinois

Learning Objectives

- Identify the content and reference standards in the PCI Design Handbook
- Follow the updates from the 7th to the 8th Edition
- Explain new component and connection design concepts
- Describe the new information included in appendixes

What is the PCI Design Handbook?

- Industry knowledge on the design, fabrication, and construction of architectural and structural precast and prestressed concrete products.



- 7th Edition published in 2010.
- 8th Edition published in 2017.
- 9th Edition underway (2023/24)

Handbook Process

- Form 8th Edition Committee
- Determine basic content and organization updates
- Develop chapter subcommittees
- Hire a Technical Editor
- Develop the basic chapter content and updates
- Ballot through IHB Committee (~100 ballots since 2011)
- Ballot through TAC
- Blue Ribbon Review Committee (peer/public review)
- Layout and Print

Updating a Design Handbook

- 7th Edition standards:
  - IBC 2006
  - ASCE 7-05
  - ACI 318-05 (ACI 318-08 in Appendix A)
- 8th Edition standards:
  - IBC 2015
  - ASCE 7-10
  - ACI 318-14 (initially ACI 318-11)
- Plus new research and industry practices

Chapters

- Chapter 1 – Applications
- Chapter 2 – Notation
- Chapter 3 – Preliminary Design of P/P Concrete Structures
- Chapter 4 – Analysis and Design of P/P Concrete Structures
- Chapter 5 – Design of P/P Components
- Chapter 6 – Design of Connections
- Chapter 7 – Structural Considerations for Architectural Precast
- Chapter 8 – Component Handling and Erection Bracing
- Chapter 9 – Materials

Chapters

- Chapter 10 – Design for Fire Resistance
- Chapter 11 – Thermal and Acoustical Properties.
- Chapter 12 – Vibration Design of P/P Concrete Floor Systems
- Chapter 13 – Tolerances
- Chapter 14 – Specifications and Standard Practices
- Chapter 15 – General Design Information
- Appendix A – Blast-Resistant Design
- Appendix B – Design for Structural Integrity and Disproportionate Collapse
- Appendix C – DSDM Provisions of ASCE 7-16

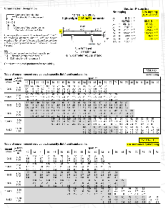
Chapter 1 – Applications

- Overview of precast and prestressed concrete
- Precast applications in the built environment
- Updated Section 1.1.3 – Sustainability
- New Section 1.2.1.8 – Storm Shelters

Chapter 3 – Preliminary Design

- Overview of preliminary structural design
  - Gravity and lateral force resisting systems
- Design tables for preliminary component size
- Updated tables, figures, and photos
- Removed some products no longer commonly used

Chapter 3 – Preliminary Design



Typical Double Tee Load Table

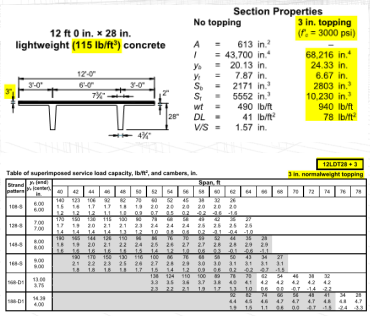


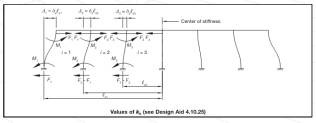
Table of superimposed service load capacity, lb/ft², and cambers, in.

12LDT28 + 3
3 in. normalweight topping

Strand pattern	yt (end) yc (camber) in.	Span, ft																			
		40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78
10-8	6.00 6.00	180 1.5 -1.2	123 1.6 -1.2	106 1.7 -1.2	92 1.7 -1.1	82 1.8 -1.0	70 1.9 -0.9	60 2.0 -0.7	52 2.0 -0.5	45 2.0 -0.2	39 2.0 -0.2	32 2.0 -0.6	26 2.0 -1.0								
12-8	7.00 7.00	170 1.7 -1.6	150 1.8 -1.6	130 2.0 -1.6	115 2.1 -1.6	100 2.1 -1.5	90 2.3 -1.4	78 2.4 -1.2	68 2.4 -1.0	58 2.5 -0.6	49 2.5 -0.3	42 2.5 -0.1	35 2.5 -0.6	27 2.5 -1.1							
14-8	8.00 8.00	190 1.6 -1.6	165 1.9 -1.6	144 2.0 -1.6	126 2.1 -1.6	110 2.2 -1.5	96 2.4 -1.4	84 2.5 -1.2	70 2.6 -1.0	60 2.7 -0.6	52 2.7 -0.3	45 2.8 -0.1	38 2.8 -0.6	28 2.9 -1.1							
16-8	9.00 9.00		180 2.1 -1.8	170 2.2 -1.8	150 2.3 -1.8	130 2.5 -1.8	115 2.6 -1.7	100 2.7 -1.5	86 2.8 -1.4	76 2.9 -1.2	66 3.0 -0.9	58 3.0 -0.6	50 3.1 -0.2	43 3.1 -0.7	34 3.1 -1.5	27					
16-D1	13.00 3.75							138 3.3 2.3	124 3.5 2.2	110 3.6 2.1	100 3.7 1.9	89 3.8 1.7	78 4.0 1.3	70 4.1 1.0	62 4.2 0.6	54 4.2 0.2	46 4.2 -0.7	38 4.2 -1.4	32 4.2 -2.2		
18-D1	14.38 4.00												64 4.4 1.9	58 4.5 1.5	48 4.6 1.1	40 4.7 0.6	34 4.7 0.0	29 4.7 -0.7	24 4.8 -1.8	20 4.8 -2.4	16 4.8 -3.3

Chapter 4 – Analysis of Structures

- Definition of Loads, Load Effects, and Combinations
- Consideration of Volume Changes
- Structural Modeling
- Gravity Systems
- Lateral Load Resisting Systems
- Diaphragms



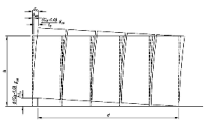
Chapter 4 – Analysis of Structures

Load Standard Changes: Then and Now

PROVISION	ASCE 7-05	ASCE 7-10
Vehicle Impact Load Application	18" Above Driving Surface	18" – 27" above Driving Surface
Wind Speed Maps	Service Level Forces	Strength Level Forces
Determination of Wind Loads	Chapter 6	Chapters 27 through 31 (MWFRS: Ch. 27, 28, 29, & 31) (C&C: Ch. 30 & 31)

Chapter 4 – Analysis of Structures

- Seismic
  - Intermediate P/C Shear Walls covered extensively
  - Moment Resisting Frames
  - Shear Wall – Frame Interaction
  - Diaphragms



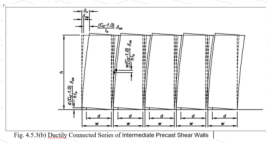


Fig. 4.5.3(b) Ductily Connected Series of Intermediate Precast Shear Walls

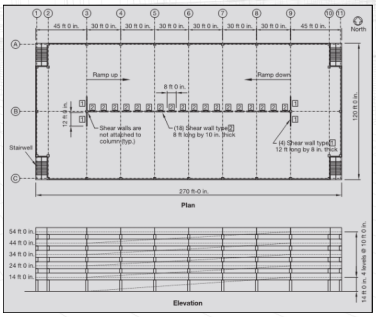
Chapter 4 – Analysis of Structures

- Yielding Element of Seismic Connections
  - ACI 318-14 Requirements:
    - Yielding restricted to steel elements or reinforcement
    - Other elements must develop $1.5S_y$ of yielding element
  - IBC 2015 Requirement:
    - Maintain 80% of strength at the design displacement
  - Discusses deformation demand defined by Code
  - Guidance for strain levels to satisfy requirements

Chapter 4 – Analysis of Structures

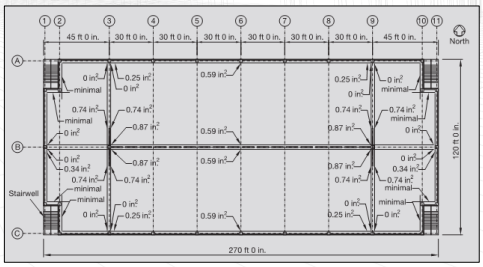
- Detailed Example: Five-Level, Two Bay ~~(Three Level, Three Bay)~~ Parking Structure in SDC "C"
  - Approximate Period Calculation
  - Rayleigh Period Calculation (Conjugate Beam)
  - Stability & P-delta Check
  - Controlling Load Effect: Wind & Seismic
  - Diaphragm Analysis

Chapter 4 – Analysis of Structures



Chapter 4 – Analysis of Structures

- Diaphragm Analysis



Chapter 5 – Design of Components

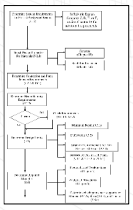
- Covers both Reinforced (Precast) and Prestressed
- Refers to PCI Standard Design Practice
- Contains 40 worked examples

- Includes information not in ACI 318
  - ACI 318-14 §9.5.4.7 – Torsion of solid precast sections with $h/b_t \geq 4.5$
  - Reinforced Concrete Bearing

- 8th Ed. includes Updates, Revisions and New Research

Chapter 5 – Design of Components

- Updated to ACI 318-14
  - Code provisions and references updated
  - Chapter Organization unchanged
  - Section 5.14 flow chart added to assist with the transition

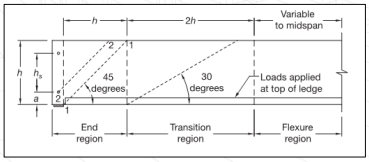


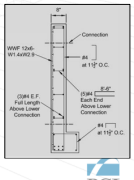
Chapter 5 – Design of Components

- Removed several tables and design aids
  - Rarely used or obsolete
- Design examples updated to current practices
- Corrected decompression force calculation for determining the moment of inertia of a cracked prestressed section
- Clarified the m-factor terms used for calculating the hanger steel in ledger beams and inverted tees

Chapter 5 – Design of Components

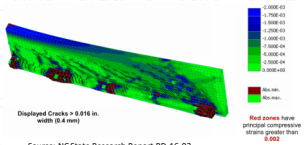
- Slender spandrel torsion design
  - Simply supported spandrel
  - Evenly spaced loads applied along the bottom edge
  - Spandrel is laterally restrained at two points at each end
  - Aspect ratio (h/b_t) is not less than 4.5





Chapter 5 – Design of Components

- New Research
  - Ledge design of L-shaped beams
    - Current equations for punching shear unconservative
    - Strength is a function of the global stress in the beam
    - Requires evaluation at multiple locations



Source: NC State Research Report RD-16-03

Chapter 5 – Design of Components

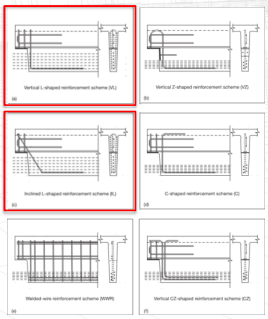
- New Research
  - Ledge design of L-shaped beams

7th Edition	8th Edition
$\phi V_n = 3\phi\lambda\sqrt{f'_c}\,h_\ell\left[2\left(b_\ell - b\right) + b_t + h_\ell\right]$ $\phi V_n = \phi\lambda\sqrt{f'_c}\,h_\ell\left[2\left(b_\ell - b\right) + b_t + h_\ell + 2d_e\right]$	$\phi V_n = \phi\lambda\gamma\beta\sqrt{f'_c}\,h_\ell\left(b_t + 2h_\ell + 2\ell_p\right)$ $\phi V_n = \phi 0.5\lambda\gamma\beta\sqrt{f'_c}\,h_\ell\left(b_t + 2h_\ell + s + 2\ell_p\right)$ $\gamma = \sqrt{1 + 10\frac{f'_{pc}}{f'_c}}$
60.3kip	54.3kip

Chapter 5 – Design of Components

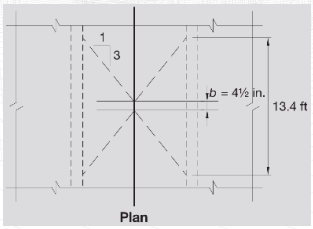
- New Research
  - Dapped ends of thin stem members (8 in. or less)
    - Study included full-scale tests and analytical models
    - Several reinforcement configurations were tested
    - Design for dapped ends of beams has not changed
    - New shear checks for the extended nib
    - New cover and bend requirements
  - Complete design example for new configurations

Chapter 5 – Design of Components



Chapter 5 – Design of Components

- Effective Width of DT Flange for Concentrated Loads
  - 7th Edition: 60°
  - 8th Edition: 3:1 (71°)
- Alternative Methods:
  - Yield-line
  - Influence Charts



Chapter 6 – Design of Connections

- Connections between components
  - Details necessary for precast construction
- Includes necessary information from standards to design the complete connection
- Headed studs covered extensively
  - Common in precast products
- Examples for many typical connections

Chapter 6 – Design of Connections

- Deformed Bar Anchors

$\phi N_n = \phi(n)(A_{se})(f_y)$ (Eq. 6-1)

$\phi C_n = \phi(n)(A_{se})(f_y)$ (Eq. 6-2)

Direct equations for tension / compression

where

ϕ = steel strength-reduction factor

= 0.9 (yielding elements in tension; see ACI 318-14 Table 21.2.1[h])

= 0.75 (strut and tie; see ACI 318-14 Table 21.2.1[g])

Shear friction for shear design

For the shear design strength and combinations of tension and shear, see Section 5.3.4 Shear-friction.

It should be noted that deformed-bar-anchors are not required to conform to ACI 318-14, Chapter 17.

Chapter 6 – Design of Connections

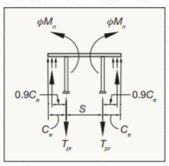
- Post-Installed Anchors (ACI 318-14 Ch 17)
  - Completely revised and rewritten
  - Updated material includes:
    - Expansion Anchors
    - Adhesive Anchors
    - Grouted Anchors
    - Concrete Screw Anchors (new)
  - Complete design examples for:
    - Shear capacity of Expansion Anchor
    - Tension capacity of Adhesive Anchor

Chapter 6 – Design of Connections

- Embedded Plate with Headed Studs
  - Traditionally considered pinned-pinned at studs.
  - Added fixed-fixed plate condition with applicable equations considering prying action.
  - Design example for pinned and fixed plate condition.

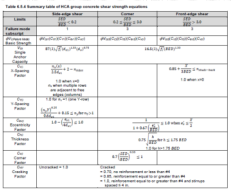
$\phi N_s = \phi[(n)(A_{se})(f_{ut}) - T_{pr}]$ (Eq. 6-5)

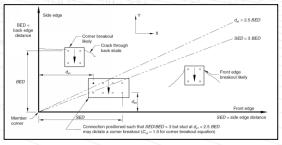
T_{pr} = total tension force due to the prying action



Chapter 6 – Design of Connections

- Embedded Plates with Headed Studs
  - Concrete breakout based on PCI research

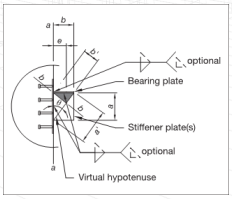




Chapter 6 – Design of Connections

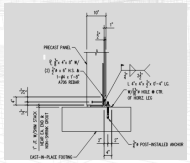
- Steel Design
  - Sections in torsion (plates, bars, tubing)
  - Unstiffened connection angles
  - Stiffener design

    Updated to new methodology in AISC



Chapter 6 – Design of Connections

- Comprehensive Design Examples
  - Consider all modes to determine controlling element

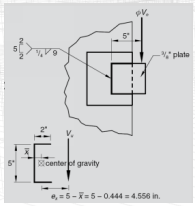


Summary:

Connection Element	Uplift Capacity (kip)	
	Without consideration of prying action versus angle thickness	With consideration of prying action versus angle thickness
Angle	6.32	9.53
Post-Installed Anchor	6.37	9.53
Fillet Weld Group	10.7	10.7
Anchor Bar	10.8	10.8
Headed Studs	9.54	9.54
Controlling Element	6.32	9.53

Chapter 6 – Design of Connections

- Weld Design
  - Types: Fillet, CJP, PJP
  - Welding Reinforcement
  - Weld Groups
    - Elastic Vector Method
    - Instantaneous Center

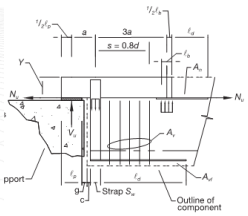


Method of analysis	Design strength, kip
Elastic vector	13.5
Instantaneous center numerical solution	17.9
AISC tabulated solution	21.6

Chapter 6 – Design of Connections

- Structural Steel Corbels
- Loov Hanger
- Cazaly Hanger
- Bearing Pads
- Column Bases

- Examples for Typical Connections



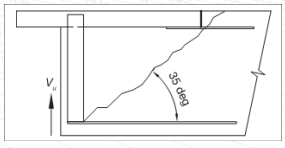
Chapter 6 – Design of Connections

- Cazaly Hanger
  - Updates based on research that found design unconservative for **shallow members without hanger reinforcement**

$$V_{cs3} = 16.5\lambda\sqrt{f'_c}\,(BED)^{1.33}$$

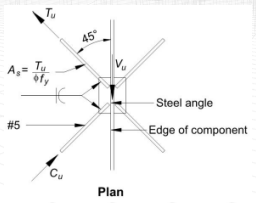
$$C_{s3} = 0.7\sqrt{\frac{SED}{BED}}$$

$$\phi V_{c3} = \phi V_{cs3} C_{s3}$$



Chapter 6 – Design of Connections

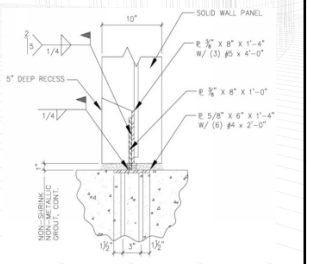
- Diaphragm Shear Connector
  - ϕ = **0.9** prior to 7th Edition
  - ϕ = **0.9 and 0.65** in 7th Edition
    - Design strength equilibrium?
  - ϕ = **0.75** in 8th Edition
    - Strut-and-tie basis



Plan

Chapter 6 – Design of Connections

- Shear Wall Base Connection
  - Connection plate yields
  - Other components provide min. strength of $1.5S_y$

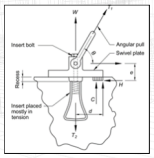


Chapter 7 – Architectural Precast

- Types and Functions of Arch. Precast Components
  - Non-loadbearing: wall panels, spandrels, and covers
  - Loadbearing: wall panels and spandrels
- Structural and Connection Considerations
  - Component and Cladding Wind Loads
  - Seismic Design Considerations
- New Section 7.3.1 oriented toward the SEoR
  - Building codes, loads, and design criteria
  - Story drifts at each floor level
  - Acceptable locations for gravity and tieback connections
  - Any special loading conditions

Chapter 8 – Handling and Erection

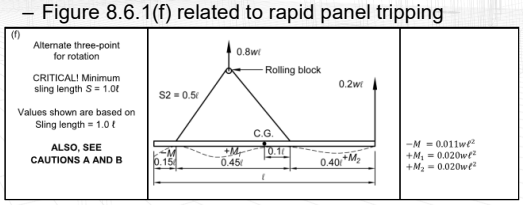
- Handling
  - Stripping (from the casting bed)
  - Yarding and Storage (at the plant)
  - Transportation
- Erection
  - Handling (erecting to final location)
  - Stability (overall structure and component)



- These are sometimes the maximum demands the component will experience.

Chapter 8 – Handling and Erection

- Updates
  - Figure 8.6.1(f) related to rapid panel tripping



- Caution A: May lead to uncontrolled rolling
- Caution B: Stress reversals may occur

Chapter 9 – Materials

- Descriptions of types and uses of concrete
  - HPC, SCC, LWC, FRC
- Discussion of aggregate durability
- Discussion of admixtures
- Discussion of fresh concrete properties
  - Slump, air content, workability, curing
- Discussion of hardened concrete properties
  - Elastic modulus, shrinkage, creep, deterioration mechanisms (durability and reactivity)
- Strand bond and the Peterman test

Chapter 9 – Materials

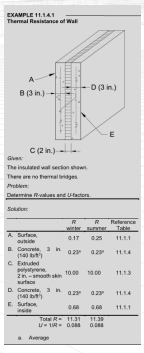
- Discussion and caution on welding of structural bolts, anchor bolts, nuts and washers due to chemical composition and heat treatments
  - Acceptable for A307 but requires SR S1 and appropriate preheat and procedure
  - Not recommended for A325 and A193 B7
  - Not permitted for A490
  - F1554 anchor bolts
    - Acceptable for Grade 36 where composition is known
    - Acceptable for Grade 55 but requires SR S1
    - Not recommended for Grade 105

Chapter 10 – Fire Resistance

- PCI MNL-124: *Design for Fire Resistance* Manual
- Background of Fire Testing
- Designing for Heat Transmission
- Fire Endurance by Rational Design
- Fire Resistance by Concrete Cover
- Miscellaneous Considerations
- Postfire Examination
- Design Aids for Rational Design and Concrete Cover

Chapter 11 – Thermal and Acoustical

- Thermal Properties
  - Thermal Transmittance
  - Thermal Storage Effects
  - Thermal Bridges
  - Condensation Control
- Acoustical Properties
  - Sound Transmission
  - Impact Noise Reduction
  - Noise Isolation



EXAMPLE 11.1.4.1
Thermal Resistance of Wall

Given:

The insulated wall section shown.

There are no thermal bridges.

Problem:

Determine *R*-values and *U*-factors.

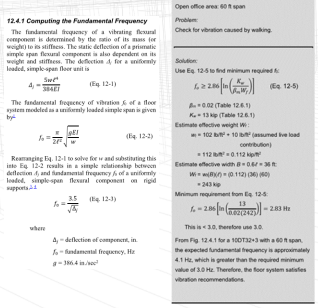
Solution:

		R winter	*R* summer	Reference Table
A.	Surface, outside	0.17	0.25	11.1.1
B.	Concrete, 3 in. (140 lb/ft³)	0.23[a]	0.23[a]	11.1.4
C.	Extruded polystyrene, 2 in. – smooth skin surface	10.00	10.00	11.1.3
D.	Concrete, 3 in. (140 lb/ft³)	0.23[a]	0.23[a]	11.1.4
E.	Surface, inside	0.68	0.68	11.1.1
	Total *R* =	11.31	11.39	
	U = 1/*R* =	0.088	0.088	

a. Average

Chapter 12 – Vibration Design

- Based on:
  - ATC Design Guide 1: Minimizing Floor Vibration
  - AISC Steel Design Guide 11: Floor Vibrations
  - Published Articles



12.4.1 Computing the Fundamental Frequency

The fundamental frequency of a vibrating flexural component is determined by the ratio of its mass (or weight) to its stiffness. The static deflection of a prismatic simple span flexural component is also dependent on its weight and stiffness. The deflection Δ_i for a uniformly loaded, simple-span floor unit is

$$\Delta_i = \frac{5wL^4}{384EI} \quad \text{(Eq. 12-1)}$$

The fundamental frequency of vibration f_n of a floor system modeled as a uniformly loaded simple span is given by[2]

$$f_n = \frac{\pi}{2L^2}\sqrt{\frac{gEI}{w}} \quad \text{(Eq. 12-2)}$$

Rearranging Eq. 12-1 to solve for w and substituting this into Eq. 12-2 results in a simple relationship between deflection Δ_i and fundamental frequency f_n of a uniformly loaded, simple-span flexural component on rigid supports.[1,2]

$$f_n \approx \frac{3.5}{\sqrt{\Delta_i}} \quad \text{(Eq. 12-3)}$$

where

Δ_i = deflection of component, in.
f_n = fundamental frequency, Hz
g = 386.4 in./sec²

EXAMPLE 12.6.1

Vibrations Caused by Walking

Given:

10DT32 + 3 (normalweight, see chapter 3)

Open office area: 60 ft span

Problem:

Check for vibration caused by walking.

Solution:

Use Eq. 12-5 to find minimum required f_n:

$$f_n \geq 2.86\left[\ln\left(\frac{K_m}{\beta_m W_f}\right)\right] \quad \text{(Eq. 12-5)}$$

β_m = 0.02 (Table 12.6.1)

K_m = 13 kip (Table 12.6.1)

Estimate effective weight W_f:

w_f = 102 lb/ft² + 10 lb/ft² (assumed live load contribution)

= 112 lb/ft² = 0.112 kip/ft²

Estimate effective width: B = 0.6ℓ = 36 ft:

$W_f = w_f(B)(\ell)$ = (0.112) (36) (60)

= 243 kip

Minimum requirement from Eq. 12-5:

$$f_n = 2.86\left[\ln\left(\frac{13}{0.02(242)}\right)\right] = 2.83 \text{ Hz}$$

This is < 3.0, therefore use 3.0.

From Fig. 12.4.1 for a 10DT32+3 with a 60 ft span, the expected fundamental frequency is approximately 4.1 Hz, which is greater than the required minimum value of 3.0 Hz. Therefore, the floor system satisfies vibration recommendations.

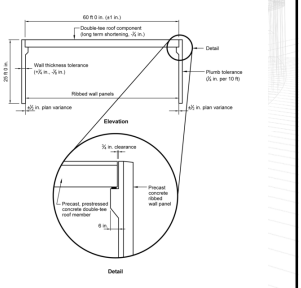
Chapter 13 - Tolerances

- PCI MNL 135: Tolerance Manual for Precast and Prestressed Concrete Construction
- ACI 117: Specification for Tolerances for Concrete Construction and Materials
- ACI ITG-7-09: Specification for Tolerances for Precast Concrete
- PCI Quality Control Manuals

- Discusses purpose and responsibility for tolerances

Chapter 13 - Tolerances

- Product Tolerances
- Erection Tolerances
- Clearances
- Interfacing Tolerances



Chapter 14 – Specs and Standard Practice

- Definition and Terminology of Project Participants
- Discussion of typical contract requirements
  - Shop drawings, tests and inspections, delivery
  - Erection responsibilities
  - Warranty
- Responsibility for Design and Construction
  - Owner, PDP, SER, GC, Precaster, SSE

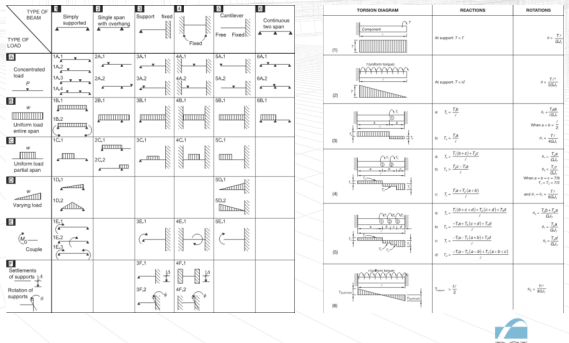
- PCI Standard Design Practice yet to be published.

Chapter 15 – Design Aids

- Design Information (loads, equations, and diagrams)
- Material Properties – Prestressing Steel
- Material Properties – Reinforcing Bars
- Material Properties – Welded-Wire Reinforcement
- Standard, Bolts, Nuts, and Washers
- Welding Information
- Section Properties
- Metric Conversion

- [Quick and easy reference for licensing exams]

Chapter 15 – Design Aids

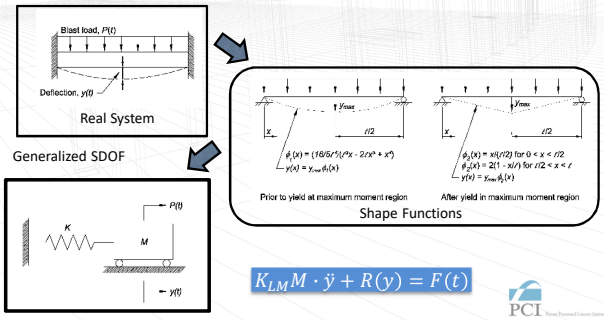


Appendix A – Blast-Resistant Design

- Preliminary Version Published
  - PCI Journal – Winter 2014, Vol.59, No.1, pp. 137-159
- Condensed version of PCI Blast Design Manual
- References GSA, DOD, DOS, ASCE, and others

Appendix A – Blast-Resistant Design

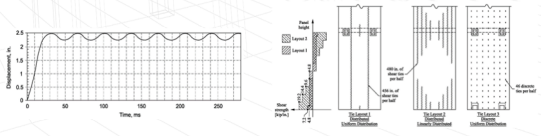
- Single degree of freedom approximations



$$K_{LM}M \cdot \ddot{y} + R(y) = F(t)$$

Appendix A – Blast-Resistant Design

- Design Examples
  - Solid Wall Panel: Determine stiffness, resistance, displacement history of SDOF for blast demand
  - Solid Wall Panel: Determine reaction forces
  - Insulated Wall Panel: Determine wythe connectors



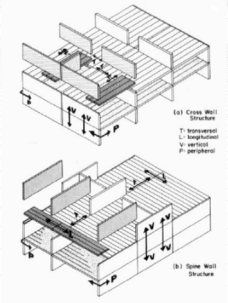
Appendix B – Collapse Resistance

- Structural Integrity and Disproportionate Collapse

- Historical Developments
- Design Approaches
- Building Code Criteria
- Criteria for Government Facilities (UFC, GSA)
- Design Strategies

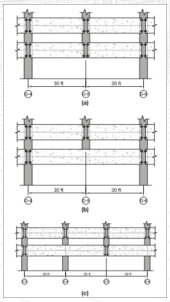
Appendix B – Collapse Resistance

- Large Panel Failure



Appendix B – Collapse Resistance

- Design Approaches
  - Direct Design
    - Alternative Load Path Method
    - Specific Local Resistance Method
  - Indirect Design
    - Structural Integrity
- Design Strategies
  - Component Robustness
  - Connection Robustness



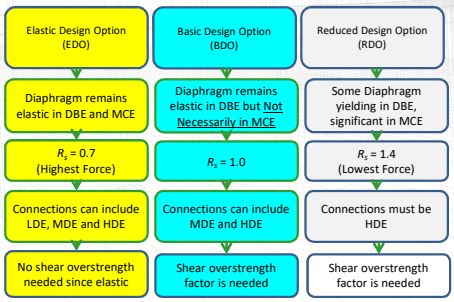
Appendix C – DSDM per ASCE 7-16

- Pankow Project: “Seismic Design Methodology Document for Precast Concrete Diaphragms”
  - 10 years of research
  - Initially design appears more difficult
  - Improved analysis, connection details, and system layout will improve system performance
- Code Force Level Changes
- Diaphragm Connection Qualifications

Appendix C – DSDM per ASCE 7-16

- Design Steps:
  - Determine diaphragm seismic demand level
    - Low, Moderate, or High
  - Select diaphragm design option
    - Elastic, Basic, Reduced
  - Determine diaphragm reinforcement classification
    - LDE (<0.3in), MDE, or HDE (>0.6in)
  - Calculate diaphragm design forces
  - Determine required strength at precast joints
  - Design diaphragm connections

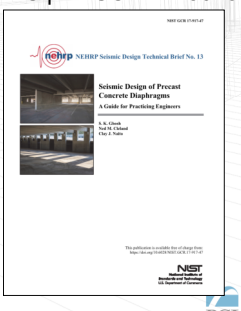
Appendix C – DSDM per ASCE 7-16



R_s = Diaphragm Design Force Reduction Factor

Appendix C – DSDM per ASCE 7-16

- Use with 2012 and 2015 IBC per ICC ESR-3010



PCI Industry Handbook Committee Members		
Timothy R. Salmons, PE, SE, FPCI, Chairman		
Dusty Andrews, PE	**Rob Grosz, PE**	**Michael I. Owings, PE, SE**
Suzanne Aultman, PE	**Gary A. Householder, PE**	Steven H. Peterson, PE
Jared E. Brewe, PhD, PE, SE	Yoo-Jae Kim, PhD, PE, LEED AP	Courtney B. Phillips III, PE, FPCI
Krista M. Brown, PhD, PE	David J. Larsen, PE, SE	Bradley L. Schipper, PE, SE
Ned M. Cleland, PhD, PE, PCI, FACI	Barry N. McKinley, PE	Perry D. Schram, PE
Martin A. Cuadra, PE, SE, FPCI	Alexander Mihaylov, PE, SE	Larbi Sennour, PhD, PE, SE, FPCI, FACI
Jason P. Davis, PE	**Christopher Mosley, PE**	Irwin J. Speyer, PE, FPCI, FACI
Harry A. Gleich, PE, FPCI, FACI	**Clay Naito, PhD, PE**	

Consulting Members		
Greg Force, PE, FPCI, FASCE	Mohammad S. Habib, PE	Karen Laptas, PE, FPCI
SK Ghosh, PhD, FPCI, Hon. MACI, FASCE, FSEI	Walter Korkosz, PE, SE	Peter G. Troiani, PE, SE
Kim Seeber, PE, FPCI		

Thank You!

Jared E. Brewe, Ph.D., P.E., S.E.
Simpson Gumpertz & Heger
JEBrewe@sgh.com