

Leo Panian, SE



2016 Convention | PT Buildings II

INSTITUTE[™]

Seismic Environment and Resilience



63% probability of M6.7+ earthquakes in the SF Bay Area in the next 30 years

Resilient design is sustainable, seismically durable design Buildings and communities "bouncing back" - not just





Seismic Performance of Concrete Structures Design codes are no guarantee

Serious vulnerabilities in existing and new construction

Individual building response vs. community resilience

From Life-Safety to Life Resumption



Inspiration and Adaptation

Shinbashira - traditional timber mast

Tough and damage resistant

Self-centering behavior

Maintains structural integrity

Protects building systems:

- Cladding
- Elevators
- Interiors



Concrete Mast

Cast-in-place cantilever
wall with unbonded posttensioning (SRCSW)

PT provides elastic restoring force

Mild steel yields to absorb *PT Wall Advantages* energy

Self-centering

Reduced rebar congestion

Stronger and more compact

Reduced damage

PT Wall Components



High strength, green Multi-strand posttensioning tendons in critical zones concrete and anchors

Heads & couplers

PT Wall Design





Recentering Response



Recentering Parameter





Inelastic Mechanism Study

Proportioned for flexural yielding

Well defined plastic hinge zone, confined boundaries

Capacity design, avoid shear failure, web crushing

Protect PT tendons slenderness

Design Rules



PT - SRCSW

...don't just call is special make it special

PT Wall Systems

2850 Telegraph, Berkeley					
	2005	Retrofit	6-story M0B	60,000 gsf	
\$4.DM					
David Brower Center, Berkeley					
	2009	New	4-story office	44,000 gsf	
\$22.0M					
SFPUC Headquarters, San Francisco					
	5075	New	14-story office	278,000 gsf	
\$145.5M					
Rene Cazanave Apartments, San Francisco					
	5073	New	8-story residenti	al 75,000 gsf	
\$31.OM					
UCB Campbell Hall, UC Berkeley					
	2014	New	L-story lab/offic	e 89,000 gsf	
\$42.OM					
270 Brannan, San Francisco					
	2012	New	7-story office	202,000 gsf	
\$52.OM					
Haas North Academic Building, UC Berkeley					
	2016	New	L-story academic	78,000 gsf	
\$46M					



PT Wall Systems - BOD and Approvals

2850 Telegraph, Berkeley					
	Code (LS)	ELF/RSA	Ext PC/PR	Telesis	
Engineers					
David Brower Center, Berkeley					
	Code (LS)	RSA/NLA	Ext PC/PR	Telesis	
Engineers					
SFPUC Headquarters, San Francisco					
	PBD (IO)	NLA	SFDBI/PR F	R&C₁ Prof∙	
Mahin (UCB)					
Rene Cazanave Apartments, San Francisco					
	PBD (IO)	NLA	SFDBI/PR	Prof. Chopra	
(UCB)					
UCB Campbell Hall, UC Berkeley					
	PBD (LS)	NLA	Ext PC/PR	R&C UCB SRC	
270 Brannan, San Francisco					
	Code (LS)	RSA	SFDBI/PR*	Maffei	
Structural					
Haas North Academic Building, UC Berkeley					
	Code (LS)	RSA/NLA	Ext PC/PR	Α.Τ.	
Merovich, UCB SRC					



PT Wall Systems - Design Parameters

2850 Telegraph	γ _{ΡΤ}	ρ	P/A	V _n
2"- 	47% 6,40	1.67% 10 k	0.14	f' _c
UCB Campbell Hall	72%	0.72%	0.11	f'c
קיי 14י–0יי	3 - 50	ID k		C
Rene Cazanave Apartments I'- J'-L'' 21'-L''	43% 4,80	1.30% k	0.07	f' _c
270 Brannan				
-יב יים יים	37% 4,40	1.86% 10 k	0.08	f' _c
Haas North Academic				
Building ELII ((((((()))))) ()) 2 - o"	49%	1.10%	0.07 f'	:

6,400 k



PT Wall Systems - Design Parameters



SFPUC Headquarters



38%	1.00%	0.05	f' _c
20,600	k		

V_n



Prescriptive Approach

Meets Special Concrete Shear Wall criteria in ACI 318 Chapter 21

PT in combination with mild steel for shear walls explicitly addressed in ACI 318 Section 18.11.2.3 "...the design and detailing for the post-tensioned concrete walls meet the requirements of the building code"

"...the structural concrete walls are detailed to meet the requirements for Special Concrete Walls contained in ACI 318-05 Chapter 21"

Peer Reviewer

Resources





PT Wall Systems

Planar walls

Basement lock off

Anchorage blockouts





PT Wall System

Core walls

Composite link beams

Micropiles for overturning



UCB Haas School - North Academic Building





Structural System



Haas NAB - PT Wall Analysis



Non-Linear Model

Haas NAB - NLA Results







PT Wall Construction



Loop Anchors

Loop Anchors



Loop Anchor Detail





Stressing Anchors

Anchor Zone Reinforcement



Fabrication & Assembly





Fabrication & Assembly

Anchorage & Stressing Blockout



Anchorage & Stressing Blockout





Tendon Assembly



Tendon Installation



Base Anchorage Blockout



Stressing Procedure



Tendon Installation & Stressing





Retrofit Application

Individually sheathed and greased strand bundles



Retrofit Application

Placed with rebar



Stressing Anchors for Retrofit

Additional Resources



ARCHITECTURAL R E C O R D

Green at Its Core

06 2011

An innovative and robust seismic frame is a key part of a San Francisco office building's sustainable strategy and its bid for LEED Platinum. By Joann Gonchar, AIA

BLOWLETFA set of at the object vertical as lat turbus will be incorporated into a stat town on the PUC building's most heverlass. A sown in the faced a will help a sown incorporate will be incorporated will help a sown incore here turbus. BLOW BIGH: The monitory of the Galaxies has faced a bading op decises portoding into mits main-performance deas sals. A shown in the state will be a south faced has help a south faced has help a shown faced. The monitor help-performance deas sals. a sign the upper-mast levels. a sign a south faced has help the upper-mast levels.

POSTPONED AND NEARLY dewas to build a new tower, designed railed several times, the justby a joint venture of the San topped out concrete structure Francisco-based firms Kaplan of the 13-story office building at McLaughlin Diaz (KMD) and 525 Golden Gate Avenue, a balf Stevens + Associates, for several block away from San Francisco city departments. But in 2002. City Hall, now seems on a smooth with design development for the path toward completion next sum-277,500-square-foot building well mer, more than a decade after the advanced, work stalled in the wake project was first conceived. Twelve of the dot-com bust. years ago, the city acquired the Then in 2006, the San Francisco site, which contained a vacant Public Utilities Commission (PUC) state office building damaged beresuscitated the project with plans yond repair by the 1989 Loma to consolidate 1,000 employees

Prieta earthquake. The intention

or animations of 525 Golden Gate's structure, see our website or IPad edition

Contraction Contra

McLanghin Diaz (AVD) and Stewers 4 Association, 5 reserval chy departments. But in 2002, with design development for the 277,500-square-foot building with advanced, work table in the wake of the dot com busit. Thenin 2006, the San Francisco Public Utilities Commission (PUC) Public Viet Public Public Public Public Public Public Viet Public Public

Resilience & A Sustainability

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23 Redefining High-Performance Concrete Structures





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POST-TENSIONING

Thank You