American Concrete Institute®
Advancing concrete knowledge

Post-Earthquake Repairs, Part 1

ACI Spring 2012 Convention
March 18 – 21, Dallas, TX

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Kenneth Bondy is a structural engineer with extensive experience in the retrofit and strengthening of existing concrete and steel structures. He is a member of ACI 318, 332, 423, and the Board Committee on Responsibility in Concrete Construction.

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Seismic Retrofit Using Externally Applied Post-Tensioning Tendons

Ken Bondy, SE, FACI

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External Post-Tensioning

- External post-tensioning (EPT) is an effective method for strengthening and repair of existing structures.
- Used in concrete, steel and wood structures
- Increases strength and reduces deflection

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Seismic Repairs

- Has been used to repair many structures which have been damaged in earthquakes
- Our firm completed repairs on more than 20 buildings damaged in 1994 Northridge earthquake in So. California.
- Techniques for seismic repairs similar to other types of repairs

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Punching Shear Damage in 2-Way Slab (Northridge Earthquake)

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Advantages

- Applies large beneficial loads with minimal headroom.
- Substantially weightless - no impact on existing columns, footings and seismic system.
- Can be adjusted to avoid existing HVAC and mechanical systems. Rarely requires any changes to existing systems
- Can be installed without disrupting building function

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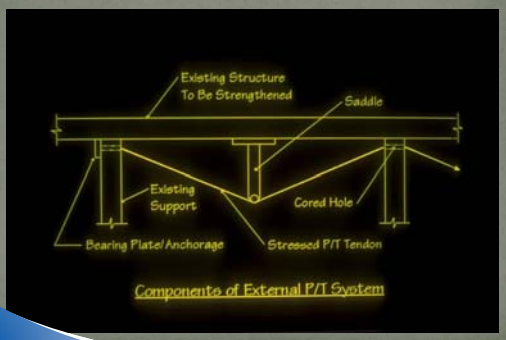
External Post-Tensioning



Components of External P/T System

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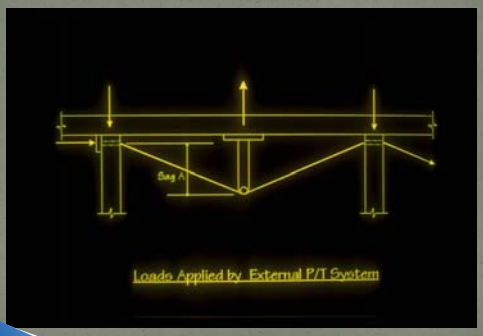
Loads



Loads Applied by External P/T System

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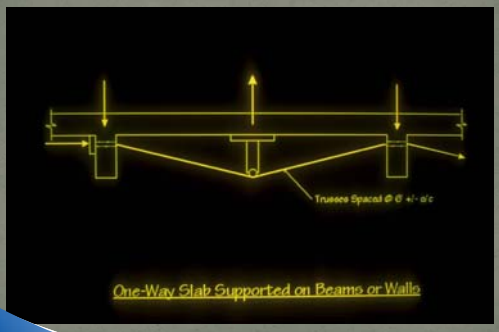
One-Way Slabs



One-Way Slab Supported on Beams or Walls

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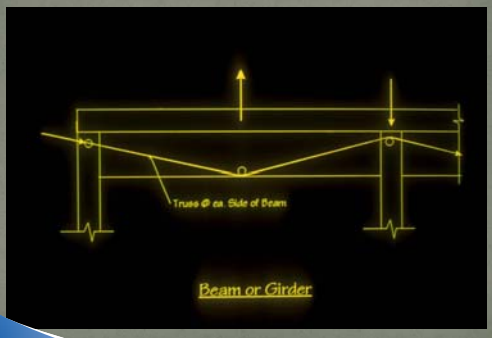
Beams and Girders



Beam or Girder

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Two-Way Slabs

Plan View - 2-Way Slab Supported on Columns

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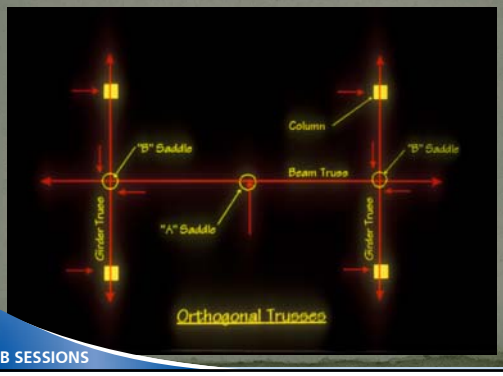
Orthogonal Trusses



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Two-Way Slab Load at Mid-Panel

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Orange County Hall of Administration

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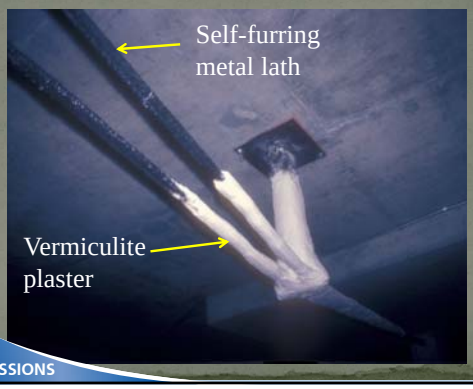
Fireproofing



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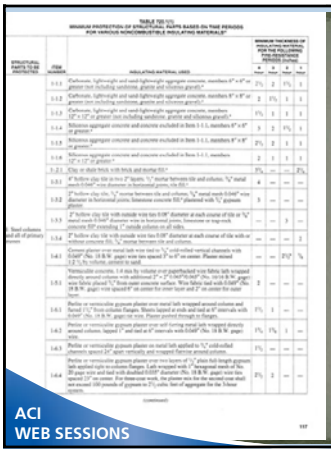

Fireproofing

IBC Table 720.1(1)

"MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON TIME PERIODS FOR VARIOUS NONCUMBUSTIBLE INSULATING MATERIALS"

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"1. Steel columns and all [members] of primary trusses"

- **1.6.2** – Perlite or vermiculite gypsum plaster over self-furring metal lath wrapped directly around column, lapped 1" and tied at 6" intervals with 0.049" (No. 18 B.W. gage) wire.

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Minimum Protection

- 2-hour
  - 1" cover
- 3-hour
  - 1-3/8" cover
- 4-hour
  - 1-3/4" cover

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EPT with "Aesthetic" Fire Proofing

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Coring – Roto-Hammer

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Coring - Larger Holes

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Stressing Tendons

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No Exterior Stressing Access

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Center Stressing

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King Posts ("A" Saddle)

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King-Post – "B" Saddle

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One-Way Slab

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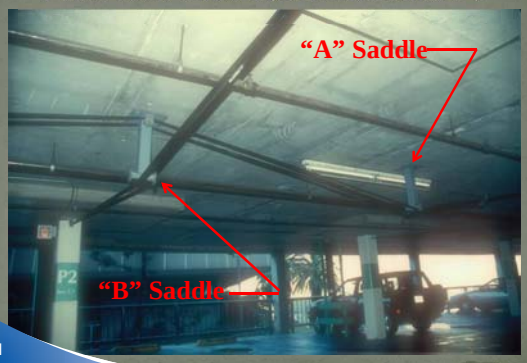
Two-Way Slab (Orthogonal)



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Girders and One-Way Slabs (Truss Below Girder)

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Summary

- EPT is a powerful method for strengthening existing buildings
- Applications:
  - Design errors (increases flexure and shear strength)
  - Occupancy change (increased live load)
  - Damage
    - Corrosion
    - Seismic
- Weightless
- No disruption to existing utilities
- Can generally be executed while building remains in service

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Thank you!!!

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