Exterior Non-Ductile Beam-Column Joints

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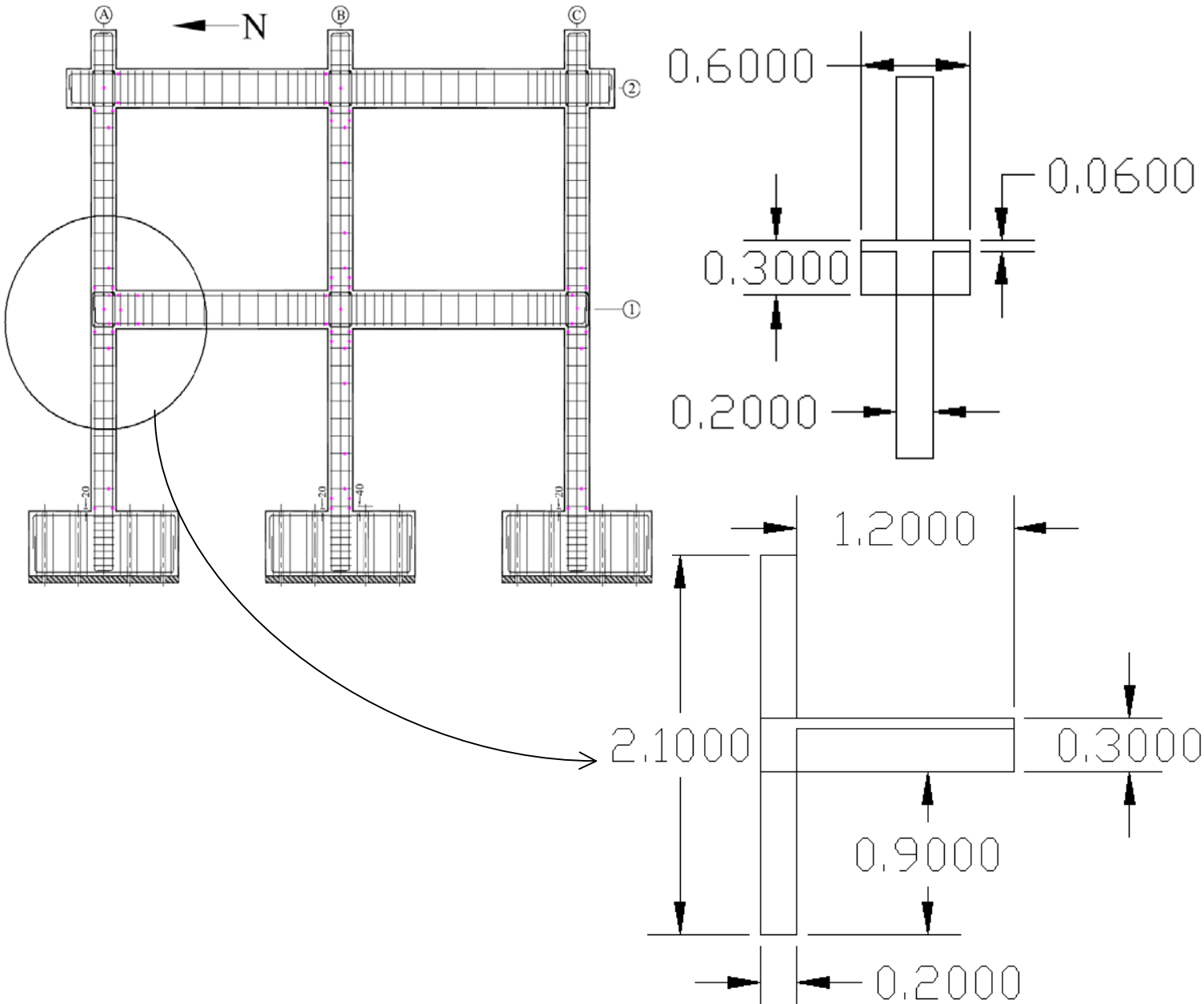
Background

- Many Reinforced Concrete buildings in Los Angeles built prior to the adaptation of modern seismic codes were designed with insufficient lateral capacity
  - Most classified as being insufficient
    - Susceptible to collapse
  - Current guidelines are too conservative
    - Retrofit costs high
- **Objective:** To research exterior non-ductile beam-column joints experiencing early column failure

Specimen Specifications



Specimen Specifications

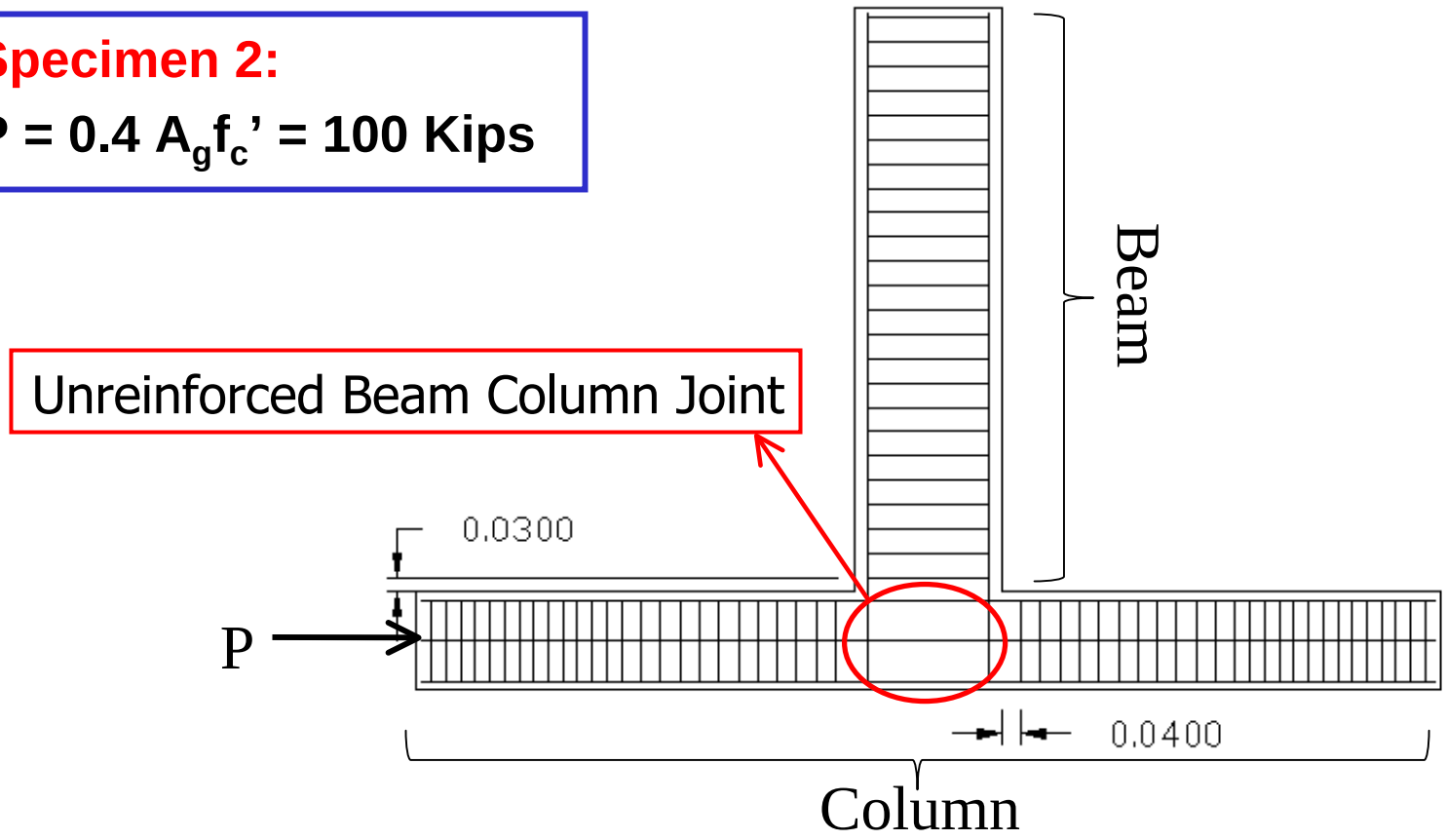
Specimen 1:

P = 0.2 Agfc' = 50 Kips

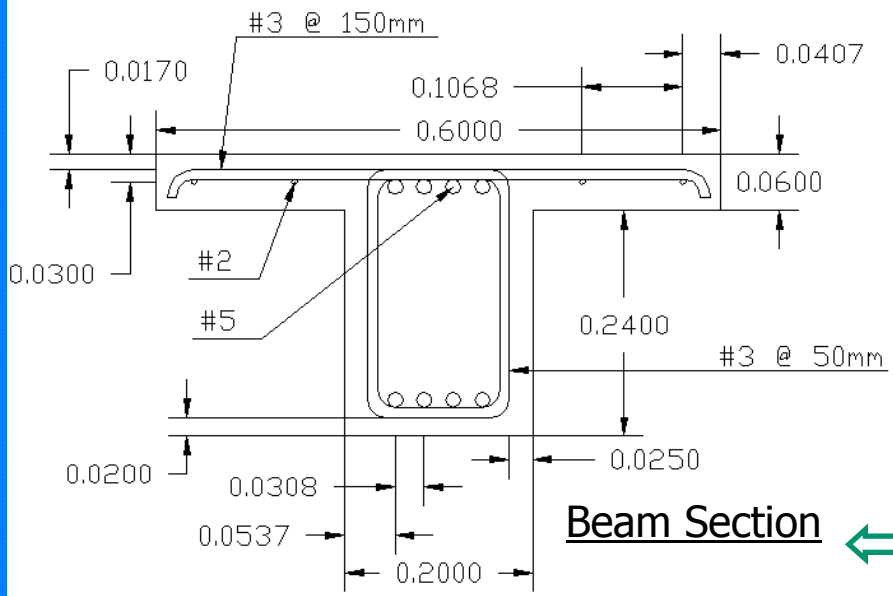
Specimen 2:

P = 0.4 $A_g f_c'$ = 100 Kips

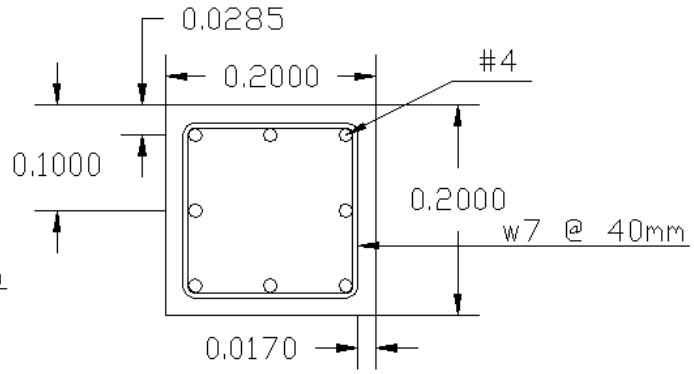
Hoops and Stirrups



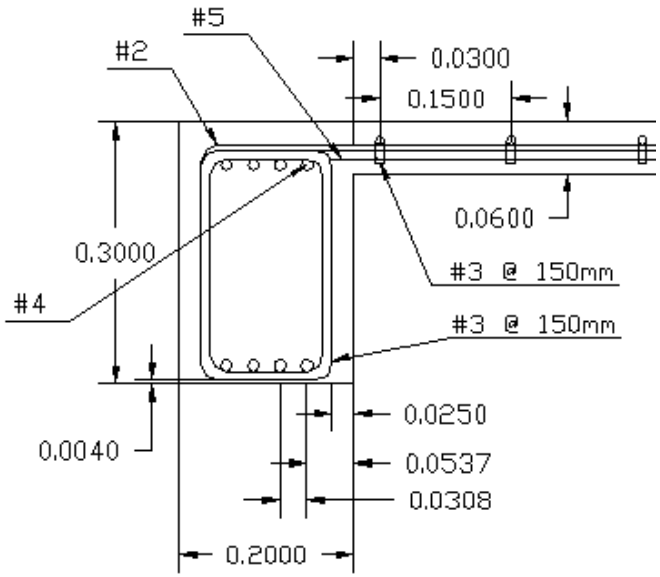
Specimen Specifications



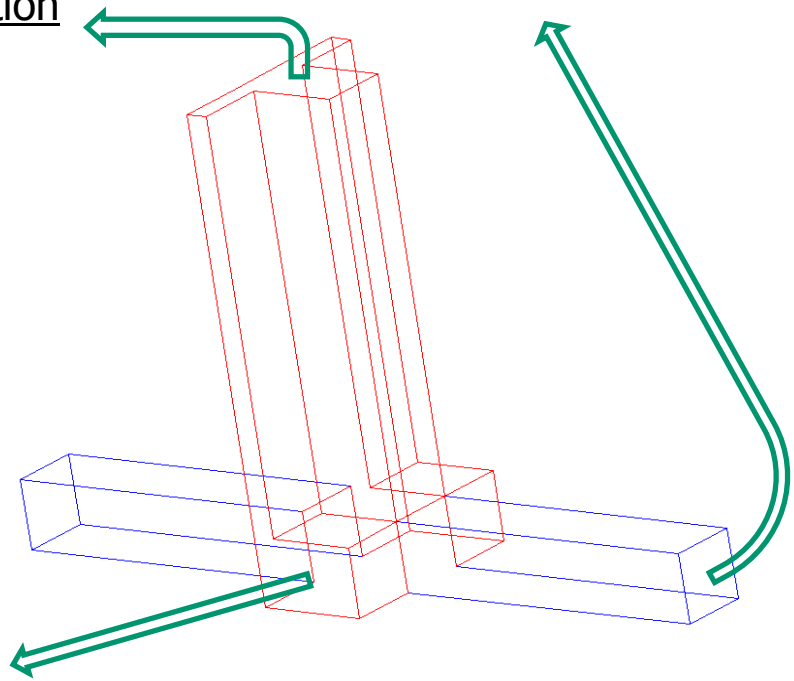
Beam Section



Column Section



Transverse Beam Section



Specimen Specifications

Material properties used in analyses

$f'_c = 4$ Ksi

Steel Bar	F_y (Ksi)	ε_y	F_u (Ksi)	ε_u
5mm (smooth)	95.29	0.005	99.50	0.02
#2 (deformed)	33.61	0.002	51.20	0.12
#3 (deformed)	60.00	0.008	90.00	0.09
#4 (deformed)	70.00	0.005	100.0	0.12
#5 (deformed)	70.00	0.005	100.0	0.12
#6 (deformed)	70.00	0.005	100.0	0.12

Real material properties

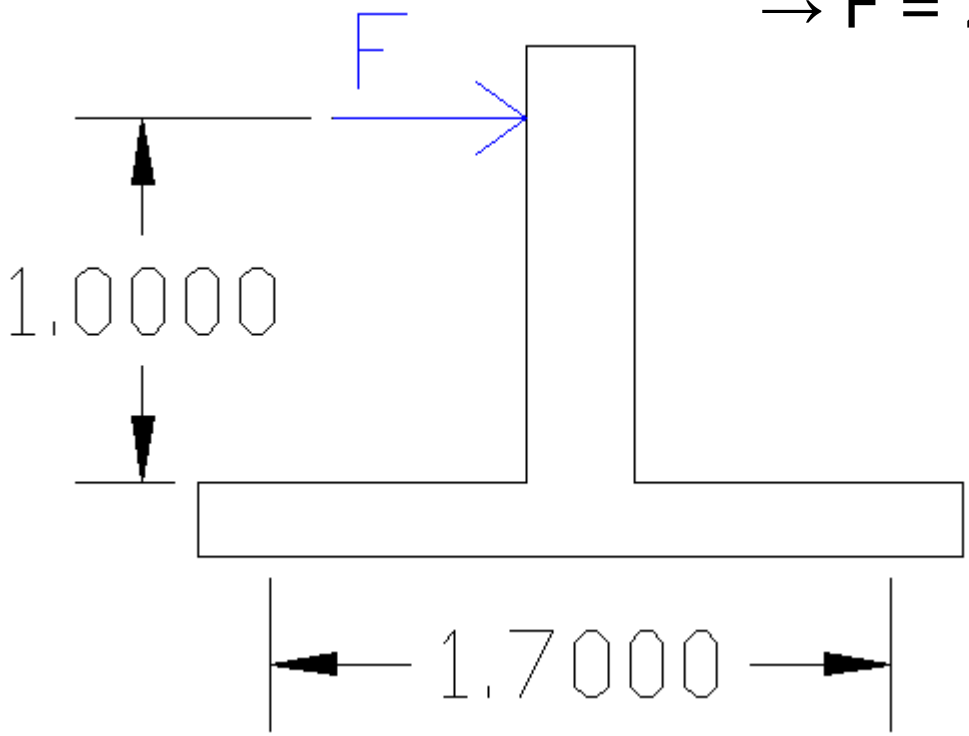
Steel Bar	F_y (Ksi)			ε_y (%)	F_u (Ksi)			ε_u (%)
	max	average	min		max	average	min	
w 7		88.80		0.7		107.1		2.237
#2 (w 5)	64.35	63.45	62.96	0.474	75.26	74.08	72.67	17.88
#3	65.33	65.27	65.23	0.436	105.1	104.8	104.6	11.86
#4	65.92	67.76	71.37	0.460	104.5	96.25	91.36	12.21
#5	67.00	66.60	66.33	0.521	90.43	90.1	90.12	12.5

Shear Capacity Calculations

→ Column failure

Balanced moment failure of the column : 438.6 k-in

→ F = 22.3 kips



Shear Capacity Calculations

γ = Joint Shear Strength Factor

Specimen 1 (50 Kips) :

- Column
  - * Yielding : M=412 k-in -> F=20.9 Kips
  - * Failure : M=412 k-in -> F=20.9 Kips

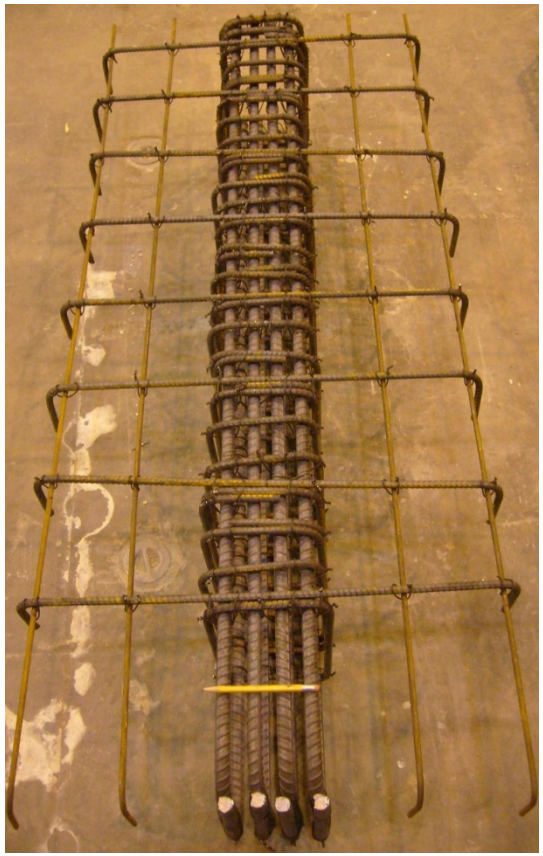
γ = 12.92 (psi)

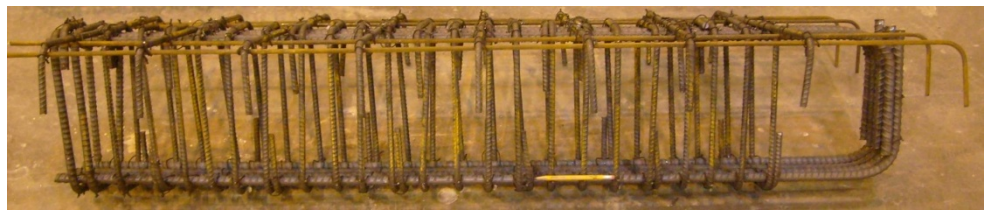
Specimen 2 (100 Kips):

- Column
  - *Yielding : 438.6 k-in ->F=22.3 Kips -> γ = 13.79 (psi)
  - *Failure : 427.1 k-in ->F=22.2 Kips -> γ = 13.74 (psi)

Cage

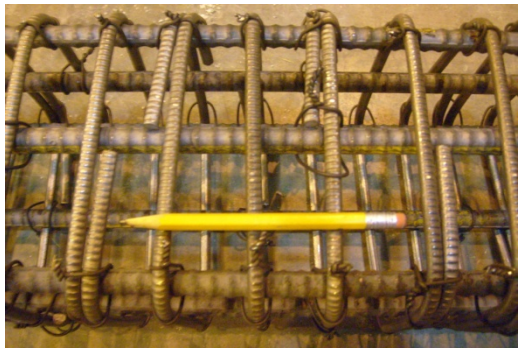
Beam

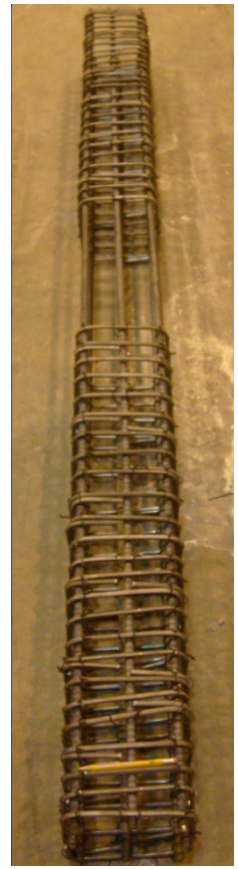


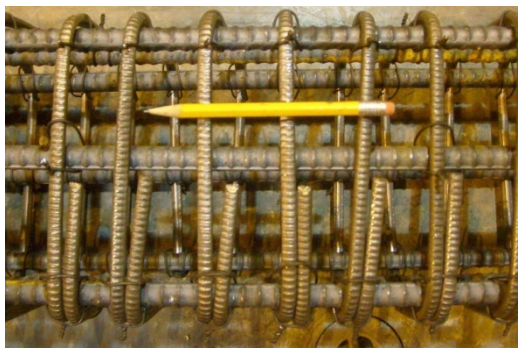


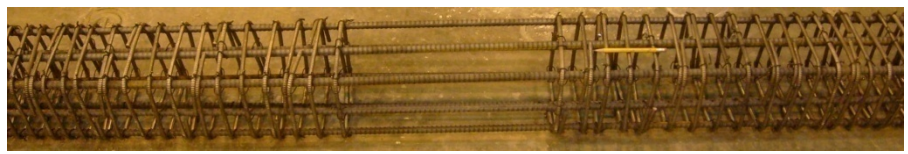
Cage

Column







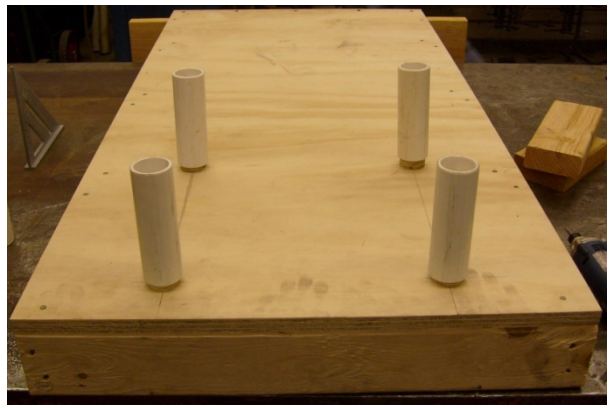


Form

Beam

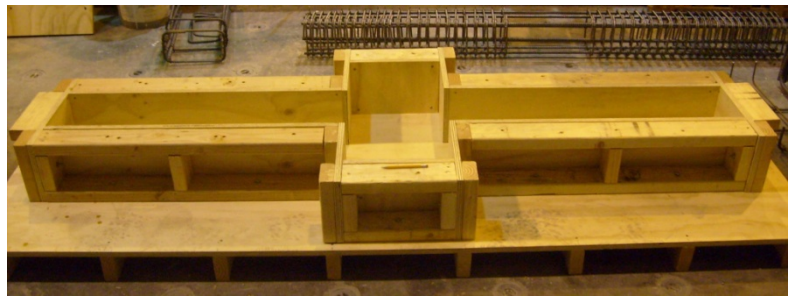
Form

Beam

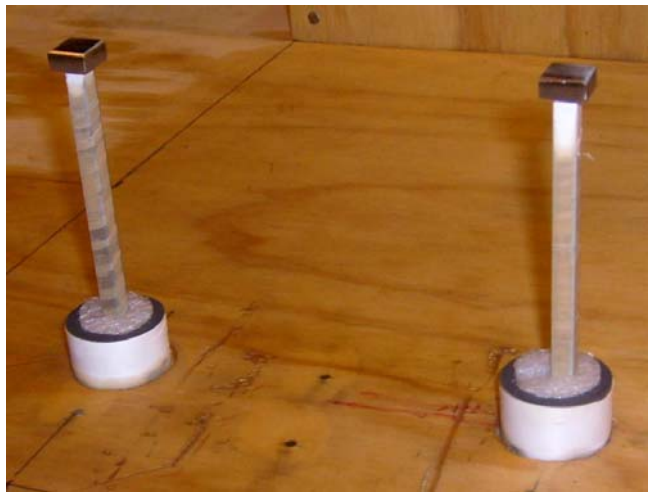


Form

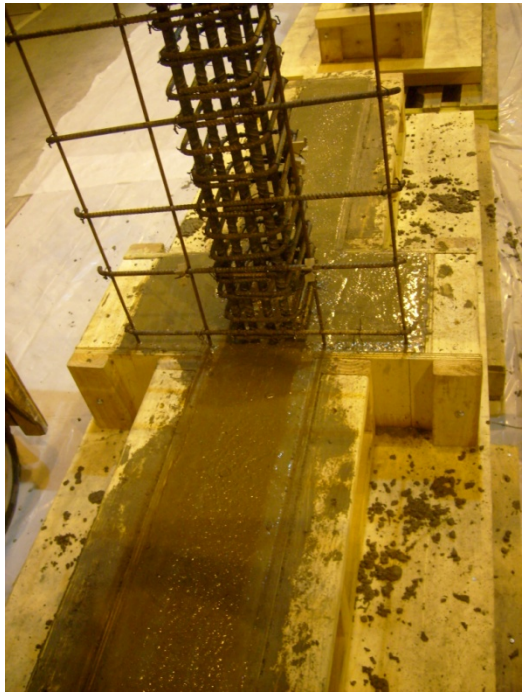
Column



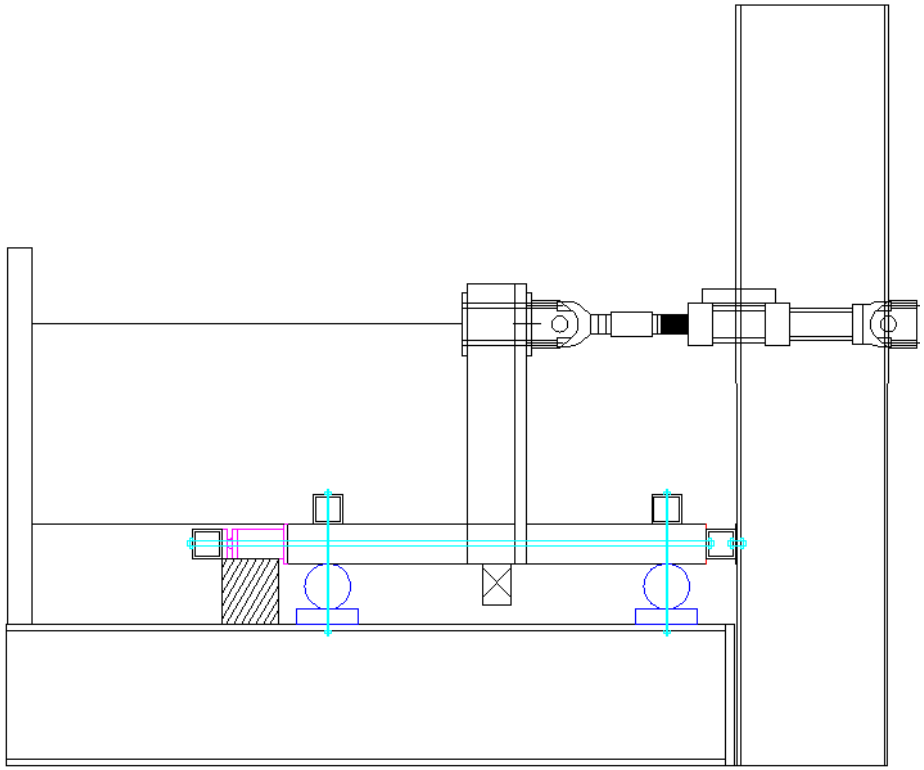
Shear Devices



Casting



Testing



- Location: Richmond Field Station (Structural Research Laboratory)
- Date: The week of August 18
- Axial Load: 0.2 $A_g f_c'$(50 kips) 0.4 $A_g f_c'$(100 kips)
- Beam Loading: Cyclic till failure
- Boundary conditions: Roller and Pin
- Instrumentations:
  - LVDT's (for capturing shear strain)
  - Potentiometers (for capturing beam lateral displacement)