

**HOW TO TAKE THE
LOAD OFF YOUR MIND**

**ADULT READING FOR
ARCHITECTS AND ENGINEERS**

**Western States Clay Products Association
55 New Montgomery Street, Suite 501
San Francisco, California 94105**

OH, YES YOU CAN!

Since the beginning of time, man has been plagued with misconceptions. The enclosed study is a real “eye-opener”, and lays to rest the popular misconception that a **heavier** skin on a building results in increased square foot costs. It will take you less than five minutes to discover that adhered brick veneer, anchored brick veneer and pre-fabricated brick panels with their structural support systems are **totally** competitive with even the lowest unit weight cladding systems.

Extensive studies by two Southern California Structural Engineers prove that varying the weight of the exterior facade from 10#/sf to 50#/sf has less than a 1% effect in total cost of construction. Standard construction techniques were used for a prototype five story, and ten story building in Seismic Zone #4. Obviously, these examples represent the “worst-case” scenario. Costs were based on “Current Construction Costs, 1985” by Lee Saylor, Inc. and factored for various West Coast locales.

Share the study with your Engineer **before** he starts calculations on the next project. You are both invited to verify the numbers. The bottom line is, the exterior system unit weight is not a viable criteria for the selection of cladding systems.

You **can** take the load off your mind, put in on your building, and be totally cost effective. You now can enjoy the freedom of design creativity that is self-evident with brick buildings.

Brick on a budget? of course you can.

WALL WEIGHTS & THEIR EFFECTS
ON BUILDING COSTS

WESTERN STATES CLAY PRODUCTS ASSOCIATION

Lawrence G. Selna, Ph.D., S.E.
Professor, Department of Civil Engineering
University of California at Los Angeles

and

Jefferson W. Asher, P.E.
Project Engineer
K P F F Consulting Engineers

TABLE OF CONTENTS

5 STORY STEEL FRAME STRUCTURE:

General Description & Scope	p. 2
Cost Summary	p. 3
General Design/Construct Data Summary	p. 4
Building Elevation, Plans, & Details	p. 5
Summary of Structural Quantities	p. 10

10 STORY STEEL FRAME STRUCTURE:

General Description & Scope	p. 12
Cost Summary	p. 13
General Design/Construct Data Summary	p. 14
Building Elevation, Plans, & Details	p. 15
Summary of Structural Quantities	p. 21

DESCRIPTION OF CONSTRUCTION

- 5 story building
- Steel frame with metal deck and light weight concrete fill
- Steel moment frames (single bay) located at center of each side of structure for lateral force resisting system
- Spread footings/grade beams for foundation system

(see sheets 5-11 for building elevation, plans, and details)

ALTERNATE EXTERIOR SYSTEMS FOR CONSIDERATION

- Insulated gypsum board panels with textured coating
- Aluminum spandrel panels
- Adhered brick veneer
- Anchored brick veneer
- Brick panels

SCOPE/OBJECTIVE

For each alternate exterior system, perform a structural analysis and design of sufficient detail such that all major vertical and lateral load carrying components are sized. Having defined the structure, carry out a cost analysis based on an accepted and consistent set of construction cost data. Compare the results of the structural designs and the cost analyses' for the various alternate exterior systems. Draw conclusions regarding the effect of weight of the exterior systems on structure cost and total building cost.

COST SUMMARY

EXTERIOR SYSTEM

	GYP. BOARD PANELS	ALUMINUM PANELS	ADHERED BRICK VENEER	ANCHORED BRICK VENEER	BRICK PANELS
UNIT WEIGHT (PSF)	10.0	15.0	20.0	35.0	50.0
COST ITEM	(\$K)	(\$K)	(\$K)	(\$K)	(\$K)
FOUNDATIONS	307.8	307.8	307.8	322.3	322.3
FLOOR & ROOF DECKS	423.7	423.7	423.7	423.7	423.7
STRUCTURAL STEEL	942.0	942.0	942.0	948.5	950.1
SUB-TOTAL, STRCTR. ONLY (UNIT COST, \$/sf)	1,673.5 (14.50)	1,673.5 (14.50)	1,673.5 (14.50)	1,694.5 (14.67)	1,696.1 (14.68)

 NOTE THAT THE INCREASE IN THE COST OF THE STRUCTURE IS 1.2% FOR
 UTILIZING THE HEAVIEST EXTERIOR SYSTEM AS COMPARED WITH UTILIZING
 THE LIGHTEST EXTERIOR SYSTEM.

SPANDREL * SYSTEM (UNIT COST, \$/sf)	393.6 (16.00)	738.0 (30.00)	369.0 (15.00)	393.6 (16.00)	442.8 (18.00)
HVAC, ELEC., GLAZING, FIN., ETC.	4,382.9	4,382.9	4,382.9	4,382.9	4,382.9
TOTAL (UNIT COST, \$/sf)	6,450.0 (55.84)	6,794.4 (58.82)	6,425.4 (55.62)	6,471.0 (56.02)	6,521.8 (56.46)

 NOTE THAT THERE IS NO DIRECT CORRELATION BETWEEN THE WEIGHTS OF THE
 ALTERNATE EXTERIOR SYSTEMS AND THE TOTAL CONSTRUCTION COSTS. THE
 RELATIVE TOTAL CONSTRUCTION COSTS ARE MOST SENSITIVE TO THE RELATIVE
 UNIT COSTS OF THE ALTERNATE EXTERIOR SYSTEMS.

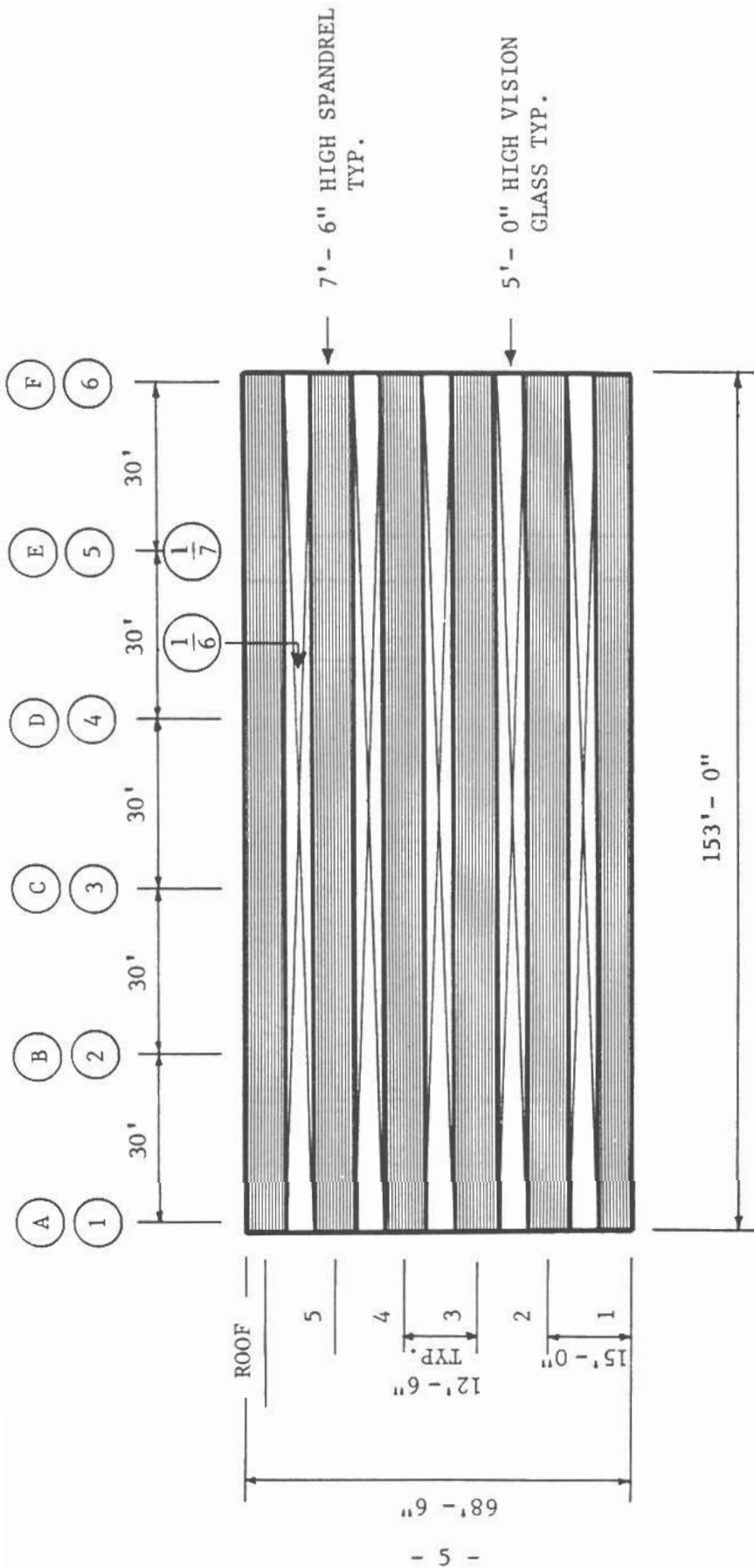
* NOTE:

Spandrel system costs refer to the installed cost of the composite exterior system, including facing material, back-up structural system &/or attachments, insulation, and interior finish.

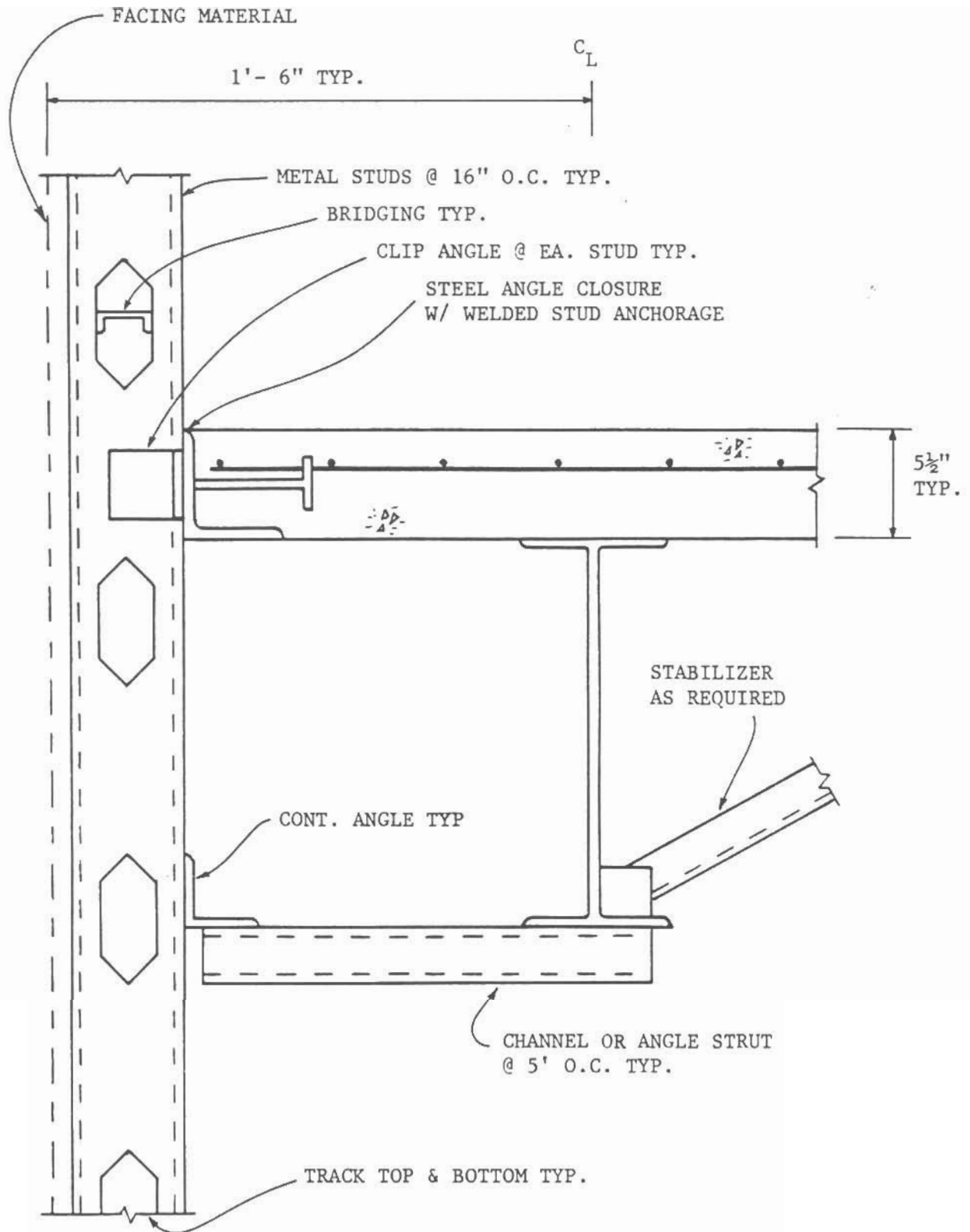
All costs are based on "Current Construction Costs, 1985", Lee Saylor, Inc., 1985, or direct quotes from manufacturers', contractors, and industry representatives, and are normalized for wage rates and material costs in San Francisco, CA. Geographical adjustments are made as follows: Los Angeles, CA: .93; Salt Lake City, Utah: .79; Seattle, WA: .83; Denver, CO: .82; Pheonix, AZ: .82)

GENERAL DESIGN/CONSTRUCT DATA SUMMARY

ITEM	<u>EXTERIOR SYSTEM</u>				
	GYP. BOARD PANELS	ALUMINUM PANELS	ADHERED BRICK VENEER	ANCHORED BRICK VENEER	BRICK PANELS
TOTAL STRUCTURE WEIGHT (kips)	9,184	9,306	9,419	9,783	10,137
STEEL FRAMING WEIGHT/SF (psf)	10.1	10.1	10.1	10.1	10.2
EXTERIOR WEIGHT /SF (psf)	10.0	15.0	20.0	35.0	50.0
DESIGN BASE SHEAR (kips)	564	571	575	596	614
BUILDING PERIOD (sec.)	1.53	1.55	1.56	1.57	1.60



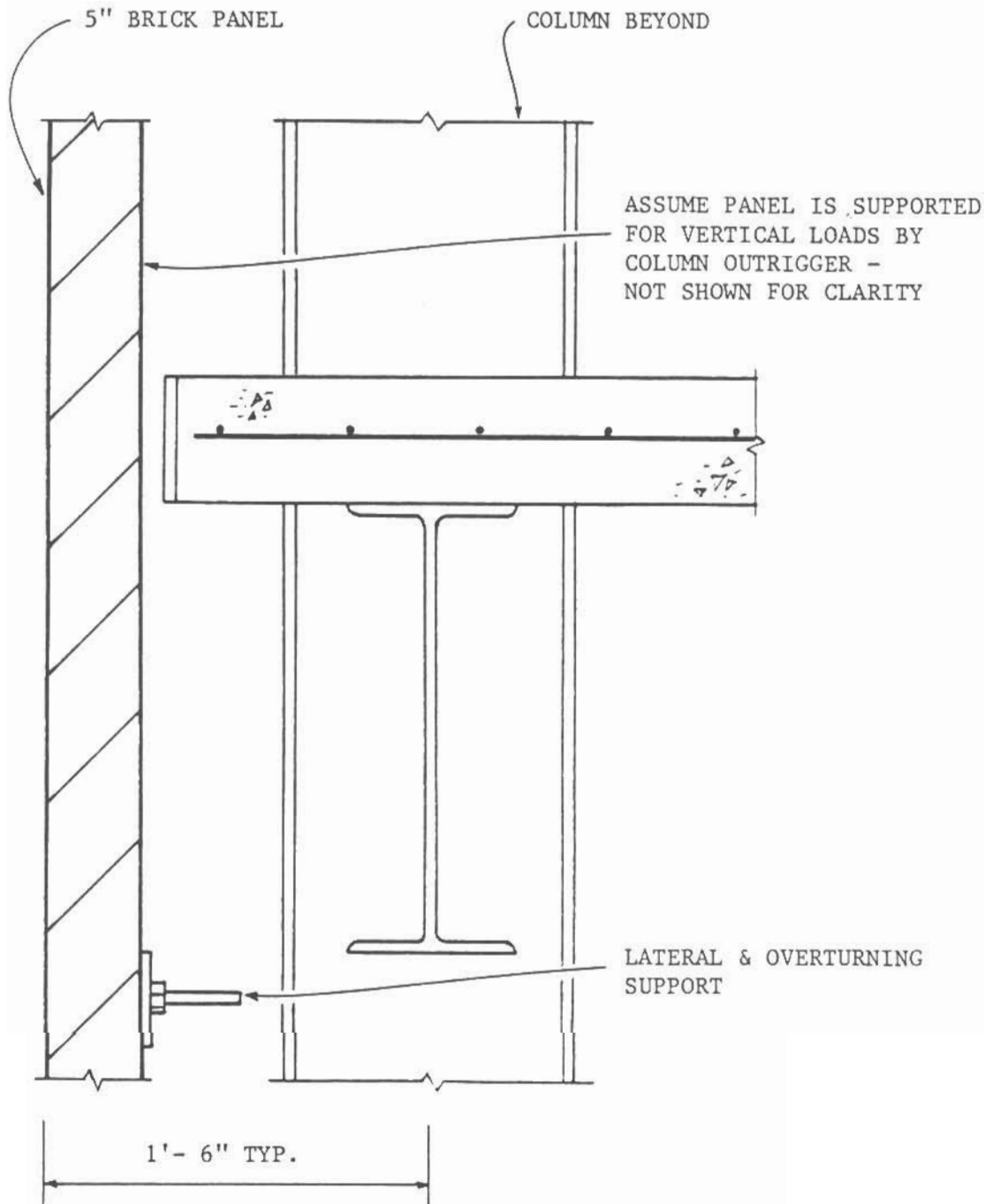
TYPICAL ELEVATION



TYPICAL SECTION AT METAL STUD-SUPPORTED VENEERS

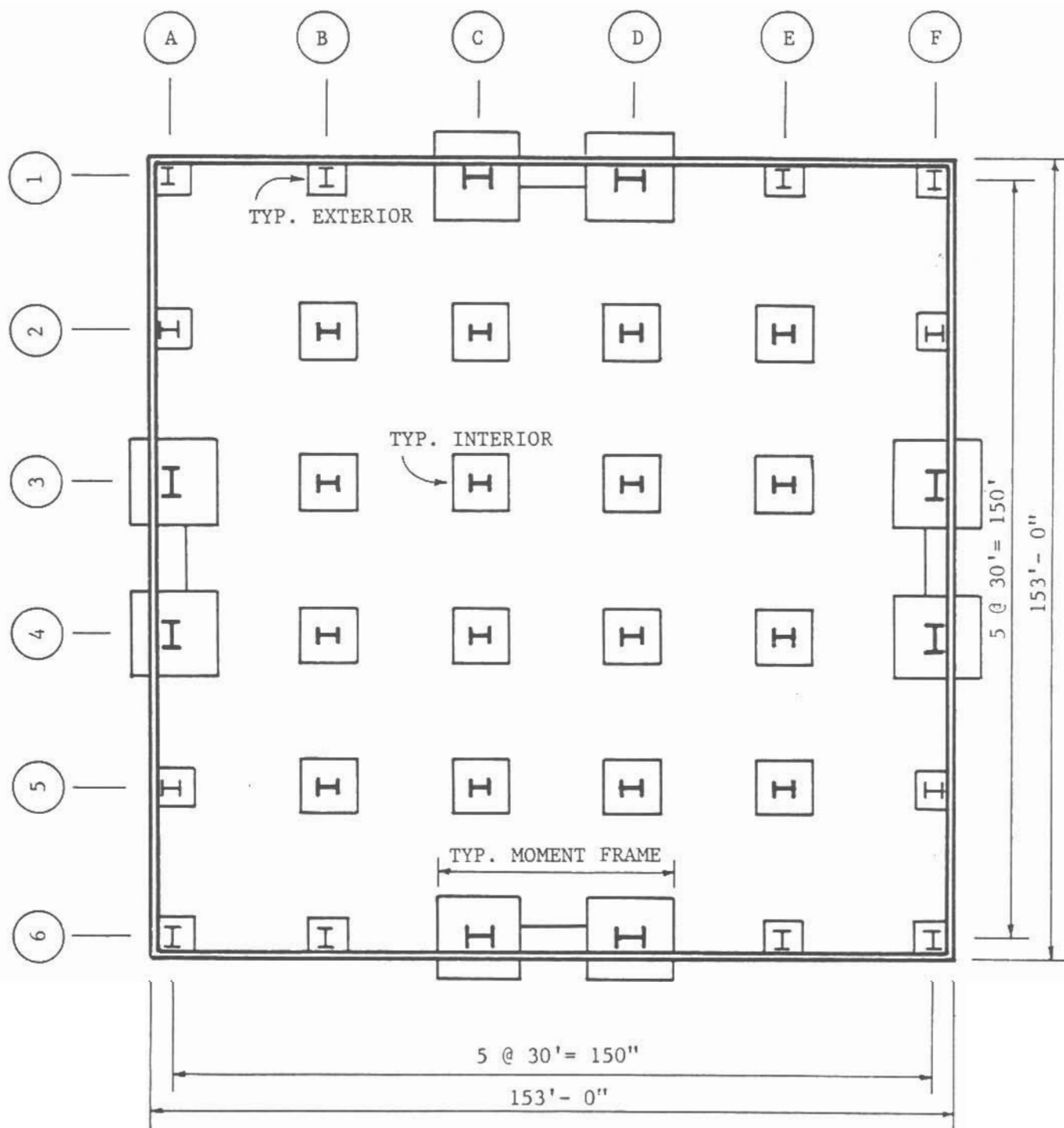
1

(PARALLEL TO JOISTS)



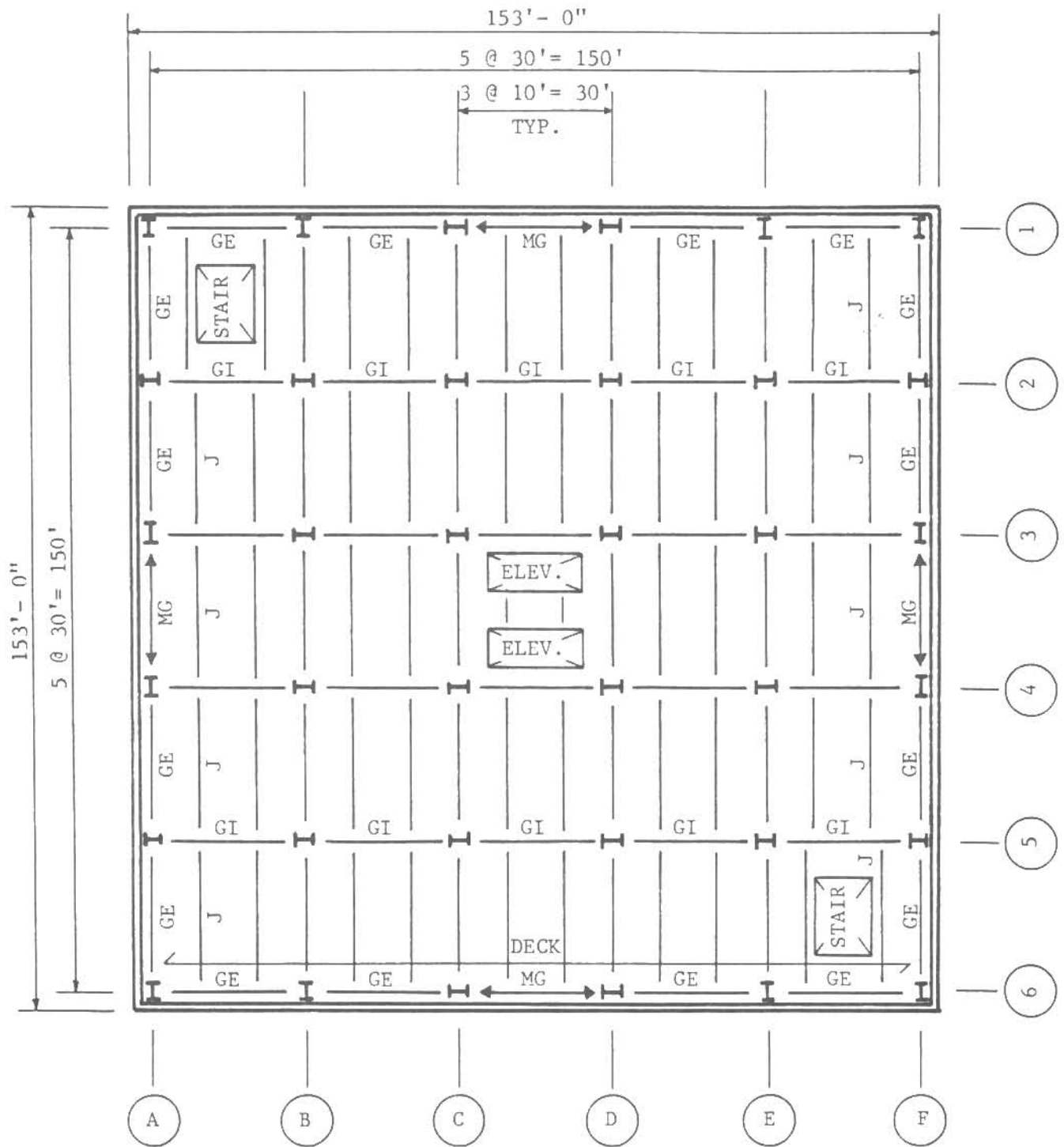
TYPICAL SECTION AT BRICK SPANDREL PANEL (1)

(PARALLEL TO JOISTS)



FOUNDATION PLAN

(SEE SUMMARY SHEET, P. 10, FOR CONCRETE QUANTITIES)



TYPICAL FLOOR & ROOF FRAMING PLAN

(SEE SUMMARY SHEET, P.10, FOR MEMBER SIZES)

SUMMARY OF STRUCTURAL QUANTITIES

(see p. 8 for foundation plan)

(see p. 9 for floor and roof framing plan and definition of symbols)

	GYP.BD. PANELS	ALUMINUM PANELS	ADHERED BRICK	ANCHORED BRICK	BRICK PANELS
<u>FOUNDATIONS</u> (cy of concrete)					
Interior	107				
Exterior	50			57	
Moment Fr.	715			790	
Total	872	872	872	954	954
<u>STEEL FRAMING</u>					
COLUMNS:					
Interior:					
fndtn.	W12x87				
2-4	W12x65				
4-R	W12x40				
Exterior:					
fndtn.	W12x53			W12x58	W12x65
2-4	W12x45			W12x50	
4-R	W12x40				
Moment:					
fndtn.	W14x426				
2-4	W14x426				
4-R	W14x211				
ROOF FRAMING:					
GE	W16x26		W16x31		W16x26
GI	W18x35				
J	W14x22				
MG	W27x94				
Deck	1-1/2"/ 16 GA.				

SUMMARY OF STRUCTURAL QUANTITIES - CONTINUED

(see p. 9 for framing plan and definition of symbols)

	GYP.BD. PANELS	ALUMINUM PANELS	ADHERED BRICK	ANCHORED BRICK	BRICK PANELS
FLOOR FRAMING:					
GE	W24x55	—	—	—	—
GI	W24x76	—	—	—	—
J	W21x44	—	—	—	—
MG-5	W36x182	—	—	—	—
MG-4	W36x260	—	—	—	—
MG-3	W36x300 (1)	—	—	—	—
MG-2	W36x300 (1)	—	—	W36x300 (2)	—
Deck	1-1/2"/ 16 GA.w/ 4" Lt.Wt.	—	—	—	—

(1) add 1/2" x 16" cover plate top and bottom

(2) add 1" x 16" cover plate top and bottom

DESCRIPTION OF CONSTRUCTION

- 10 story building
- Steel frame with metal deck and light weight concrete fill
- Steel eccentric braced frames (single bay) located at center of each side of structure for lateral force resisting system
- Spread footings/grade beams/friction piles for foundation system

(see sheets 15-22 for building elevation, plans, and details)

ALTERNATE EXTERIOR SYSTEMS FOR CONSIDERATION

- Insulated gypsum board panels with textured coating
- Aluminum spandrel panels
- Adhered brick veneer
- Anchored brick veneer
- Brick panels

SCOPE/OBJECTIVE

For each alternate exterior system, perform a structural analysis and design of sufficient detail such that all major vertical and lateral load carrying components are sized. Having defined the structure, carry out a cost analysis based on an accepted and consistent set of construction cost data. Compare the results of the structural designs and the cost analyses' for the various alternate exterior systems. Draw conclusions regarding the effect of weight of the exterior systems on structure cost and total building cost.

COST SUMMARY

EXTERIOR SYSTEM

	GYP. BOARD PANELS	ALUMINUM PANELS	ADHERED BRICK VENEER	ANCHORED BRICK VENEER	BRICK PANELS
UNIT WEIGHT (PSF)	10.0	15.0	20.0	35.0	50.0
COST ITEM	(\$K)	(\$K)	(\$K)	(\$K)	(\$K)
FOUNDATIONS	603.6	603.6	603.6	603.6	603.6
FLOOR & ROOF DECKS	901.7	901.7	901.7	901.7	901.7
STRUCTURAL STEEL	2,246.1	2,246.1	2,246.1	2,308.5	2,311.7
SUB-TOTAL, STRCTR. ONLY (UNIT COST, \$/sf)	3,751.4 (16.24)	3,751.4 (16.24)	3,751.4 (16.24)	3,813.8 (16.51)	3,817.0 (16.52)

 NOTE THAT THE INCREASE IN THE COST OF THE STRUCTURE IS 1.7% FOR
 UTILIZING THE HEAVIEST EXTERIOR SYSTEM AS COMPARED WITH UTILIZING
 THE LIGHTEST EXTERIOR SYSTEM.

SPANDREL * SYSTEM (UNIT COST, \$/sf)	744.0 (16.00)	1,395.0 (30.00)	697.5 (15.00)	744.0 (16.00)	837.0 (18.00)
HVAC, ELEC., GLAZING, FIN., ETC.	9,309.4	9,309.4	9,309.4	9,309.4	9,309.4
TOTAL (UNIT COST, \$/sf)	13,804.8 (59.75)	14,455.8 (62.57)	13,758.3 (59.55)	13,867.2 (60.02)	13,963.4 (60.44)

 NOTE THAT THERE IS NO DIRECT CORRELATION BETWEEN THE WEIGHTS OF THE
 ALTERNATE EXTERIOR SYSTEMS AND THE TOTAL CONSTRUCTION COSTS. THE
 TOTAL CONSTRUCTION COSTS ARE MOST SENSITIVE TO THE RELATIVE UNIT
 COSTS OF THE ALTERNATE EXTERIOR SYSTEMS.

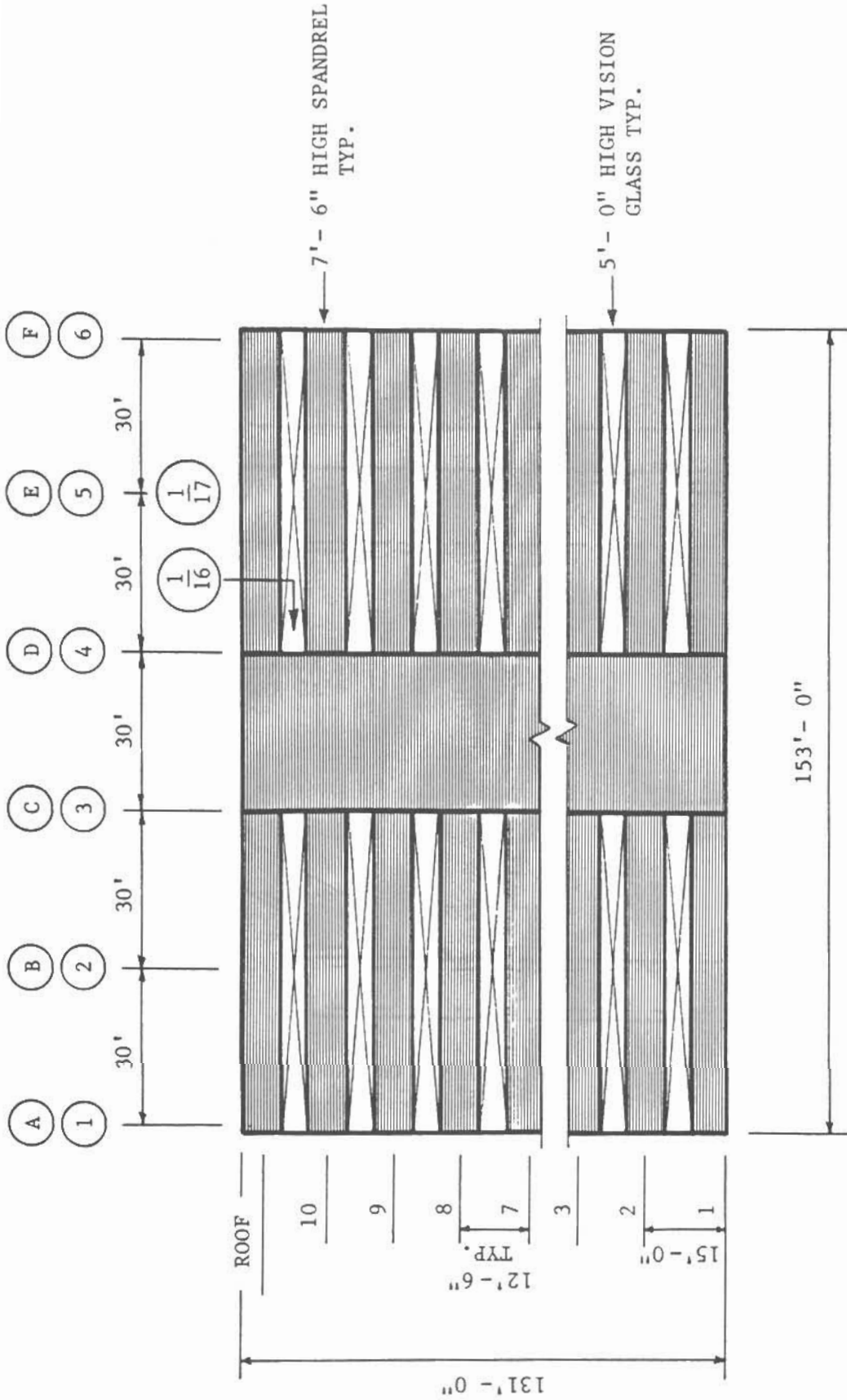
* NOTE:

Spandrel system costs refer to the installed cost of the composite exterior system including facing material, structural back-up system &/or attachments, insulation, and interior finish.

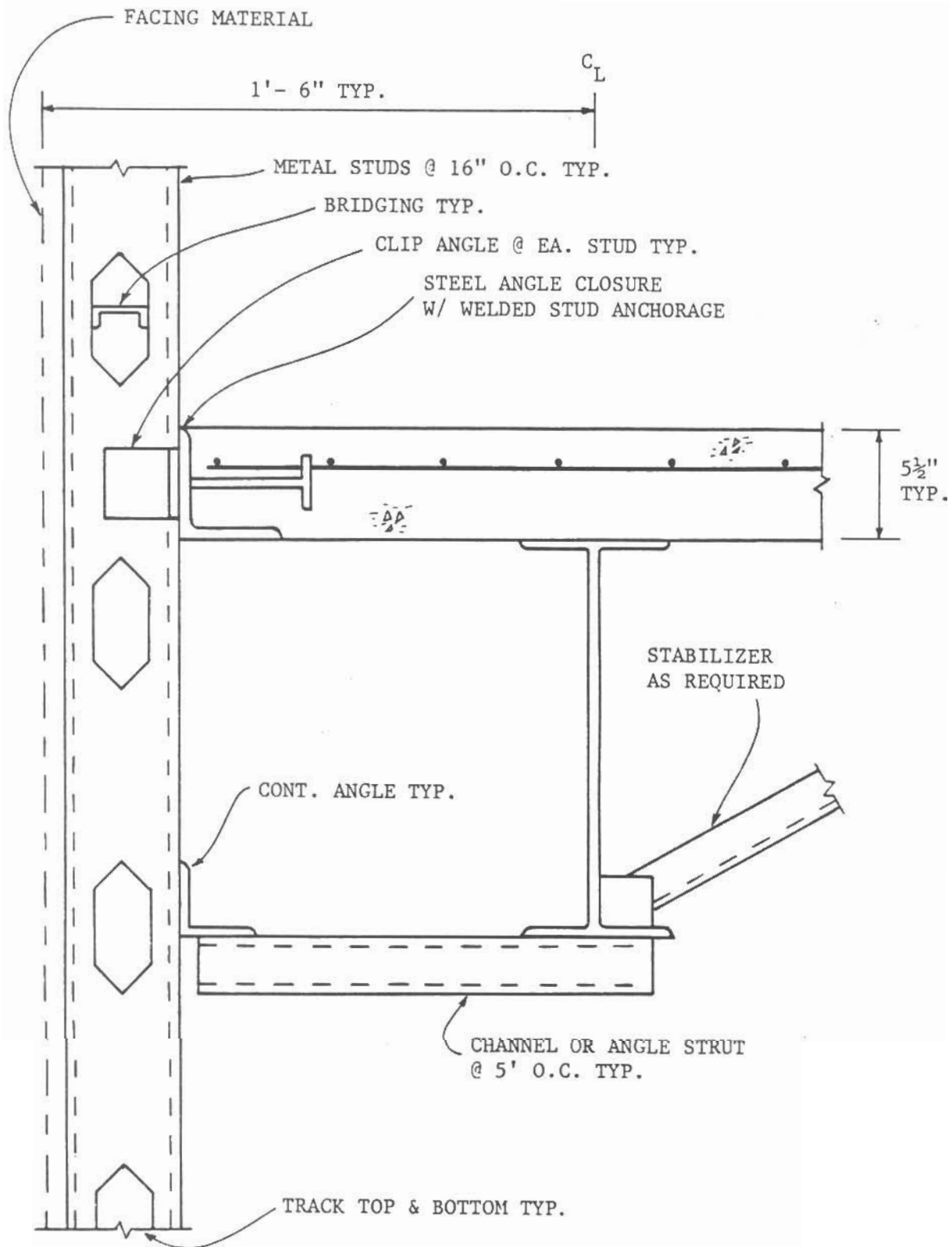
All costs are based on "Current Construction Costs, 1985", Lee Saylor, Inc., 1985, or direct quotes from manufacturers', contractors, and industry representatives, and are normalized for wage rates and material costs in San Francisco, CA. Geographical adjustments are made as follows: Los Angeles, CA: .93; Salt Lake City, Utah: .79; Seattle, WA: .83; Denver, CO: .82; Pheonix, AZ: .82)

GENERAL DESIGN/CONSTRUCT DATA SUMMARY

ITEM	<u>EXTERIOR SYSTEM</u>				
	GYP. BOARD PANELS	ALUMINUM PANELS	ADHERED BRICK VENEER	ANCHORED BRICK VENEER	BRICK PANELS
TOTAL STRUCTURE WEIGHT (kips)	18,815	19,059	19,285	20,074	20,782
STEEL FRAMING WEIGHT/SF (psf)	12.0	12.0	12.0	12.4	12.4
EXTERIOR WEIGHT /SF (psf)	10.0	15.0	20.0	35.0	50.0
DESIGN BASE SHEAR (kips)	1,774	1,794	1,814	1,882	1,936
BUILDING PERIOD (sec.)	1.63	1.65	1.66	1.64	1.65



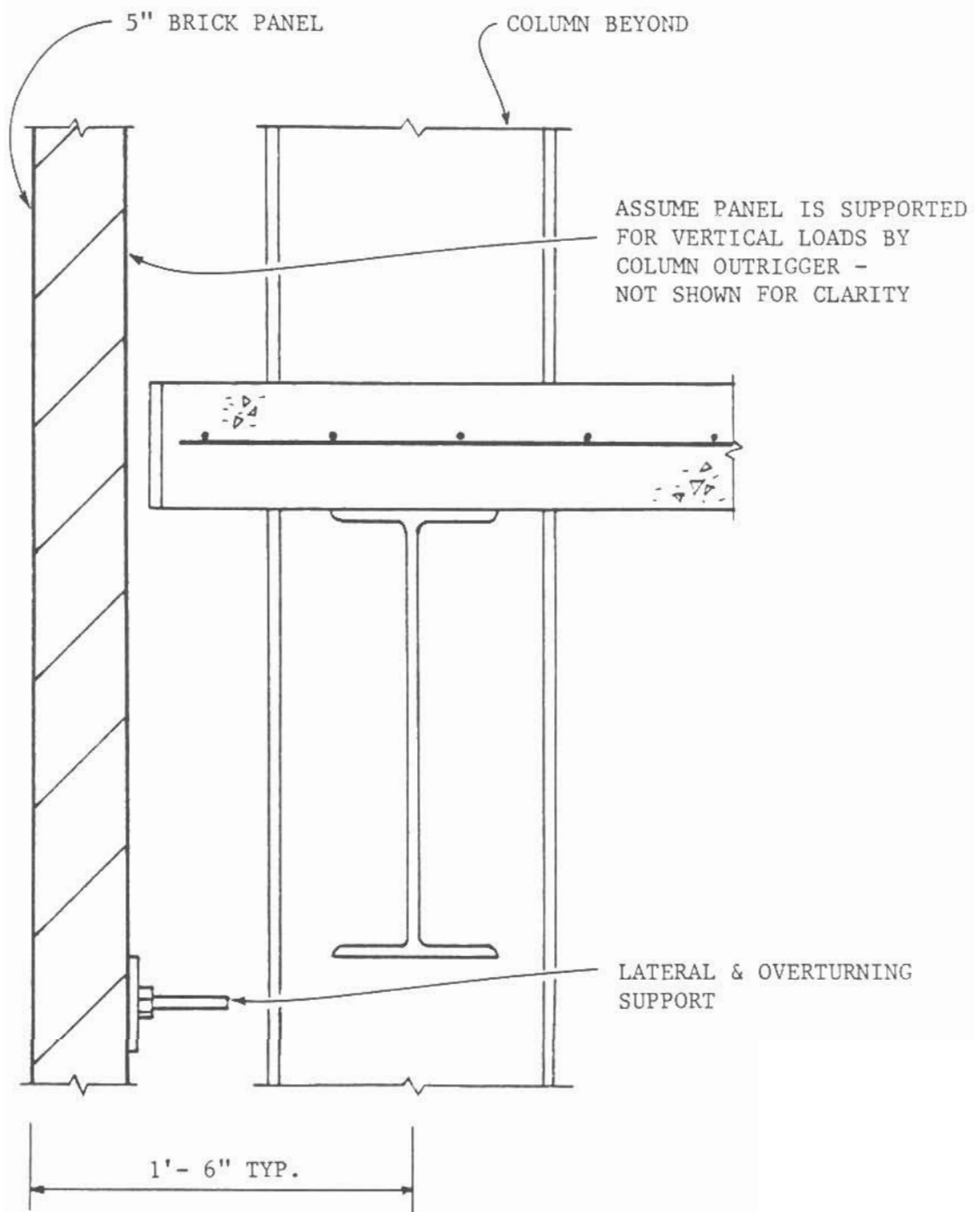
TYPICAL ELEVATION



TYPICAL SECTION AT METAL STUD-SUPPORTED VENEERS

1

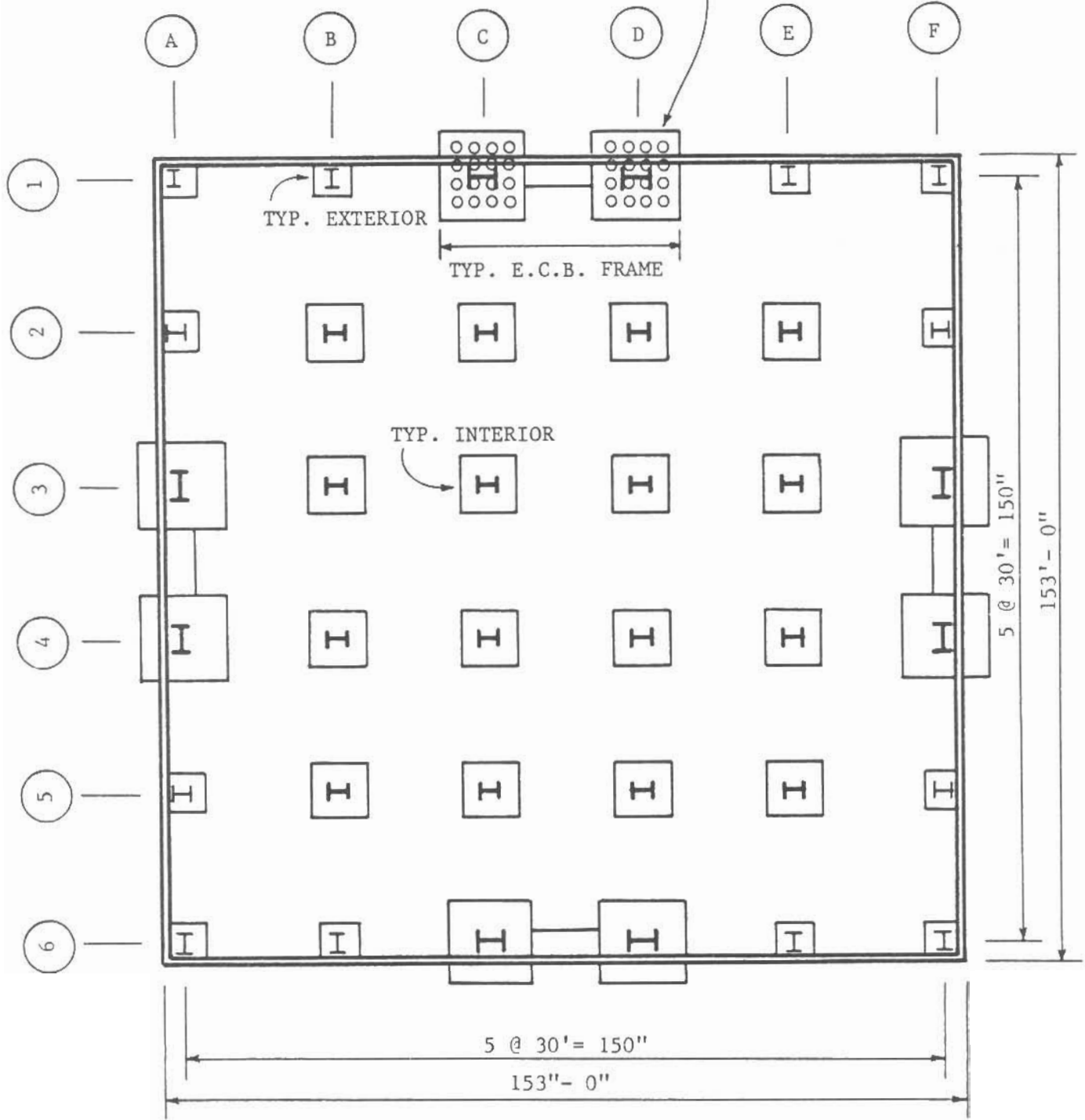
(PARALLEL TO JOISTS)



TYPICAL SECTION AT BRICK SPANDREL PANEL (1)

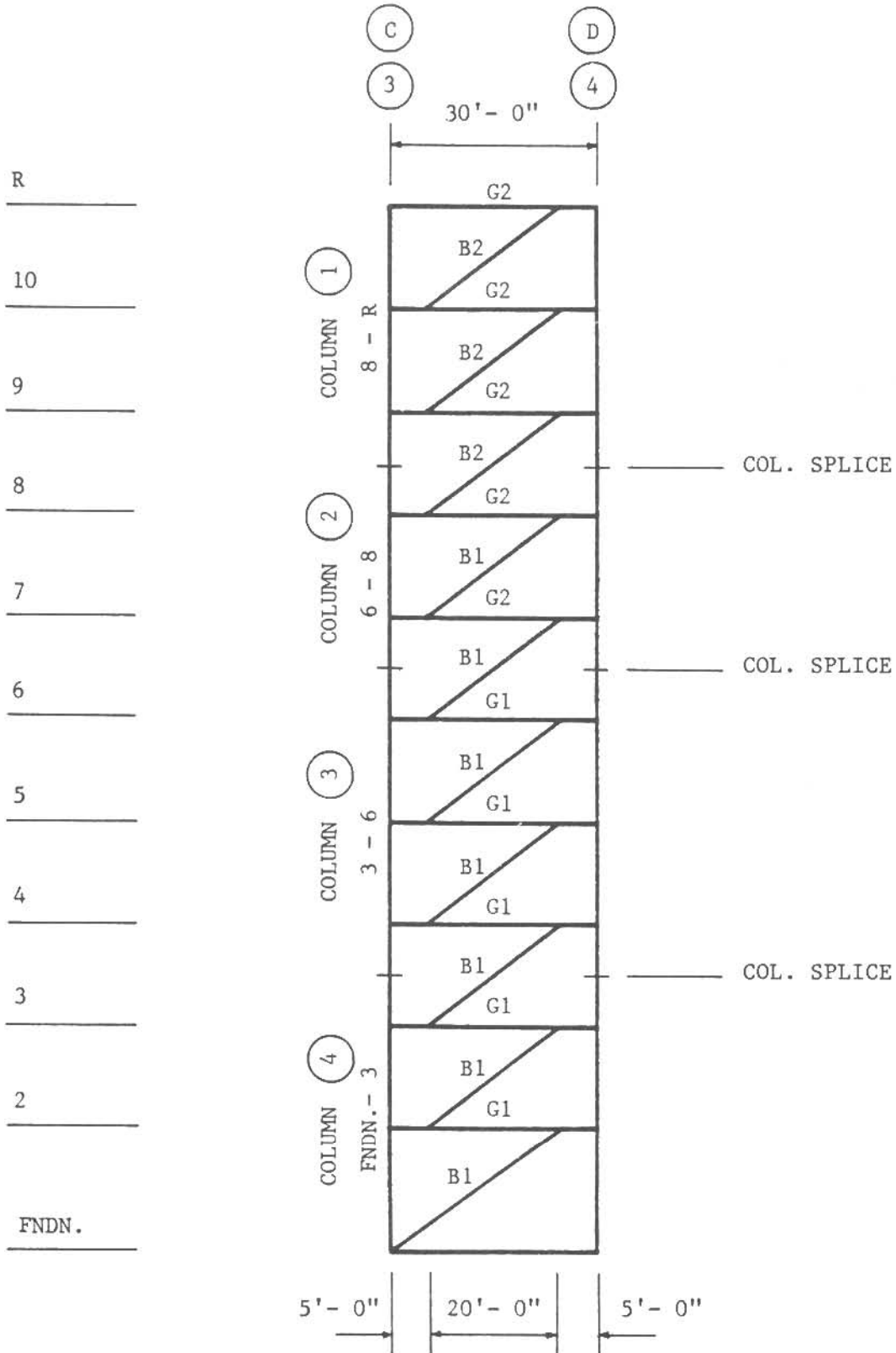
(PARALLEL TO JOISTS)

SEE SUMMARY SHT. FOR INFO.
ON PILES @ E.C.B. FRAMES



FOUNDATION PLAN

(SEE SUMMARY SHEET, P. 21, FOR CONCRETE QUANTITIES)



ELEVATION - ECCENTRIC BRACED FRAME

(SEE SUMMARY SHEET, P. 22, FOR MEMBER SIZES)

SUMMARY OF STRUCTURAL QUANTITIES

(see p. 18 for foundation plan)

(see p. 19 for floor and roof framing plan and definition of symbols)

	GYP.BD. PANELS	ALUMINUM PANELS	ADHERED BRICK	ANCHORED BRICK	BRICK PANELS
FOUNDATIONS (cy/lf of concrete)					
Interior	139				
Exterior	62				
Moment Fr.	549				
24" piles	7,680 *				
Total (cy)	750	750	750	750	750
Total (lf)	7,680	7,680	7,680	7,680	7,680
* (lineal feet of 24" dia. concrete friction piles)					
STEEL FRAMING					
COLUMNS:					
Interior:					
fndtn.	W12x170				
3-6	W12x136				
6-8	W12x79				
8-R	W12x50				
Exterior:					
fndtn.	W12x106			W12x120	
3-6	W12x79			W12x87	W12x96
6-8	W12x53			W12x58	
8-R	W12x40				
E.C.B. Frame:					
fndtn.	W14x665			W14x730	
3-6	W14x550			W14x605	
6-8	W14x342			W14x370	
8-R	W14x211			W14x233	
ROOF FRAMING:					
GE	W16x26		W16x31		W16x26
GI	W18x35				
J	W14x22				
Deck	1-1/2"/ 16 GA.				

SUMMARY OF STRUCTURAL QUANTITIES - CONTINUED

(see p. 19 for framing plan and definition of symbols)

	GYP.BD. PANELS	ALUMINUM PANELS	ADHERED BRICK	ANCHORED BRICK	BRICK PANELS
FLOOR FRAMING:					
GE	W24x55	—————	—————	—————	—————
GI	W24x76	—————	—————	—————	—————
J	W21x44	—————	—————	—————	—————
Deck	1-1/2"/ 16 GA.w/ 4" Lt.Wt.	—————	—————	—————	—————
E.C.B. FRAMING:					
G1	W36x245	—————	—————	—————	—————
G2	W36x150	—————	—————	—————	—————
B1	W12x230	—————	—————	W12x252	—————
B2	W12x120	—————	—————	W12x136	—————