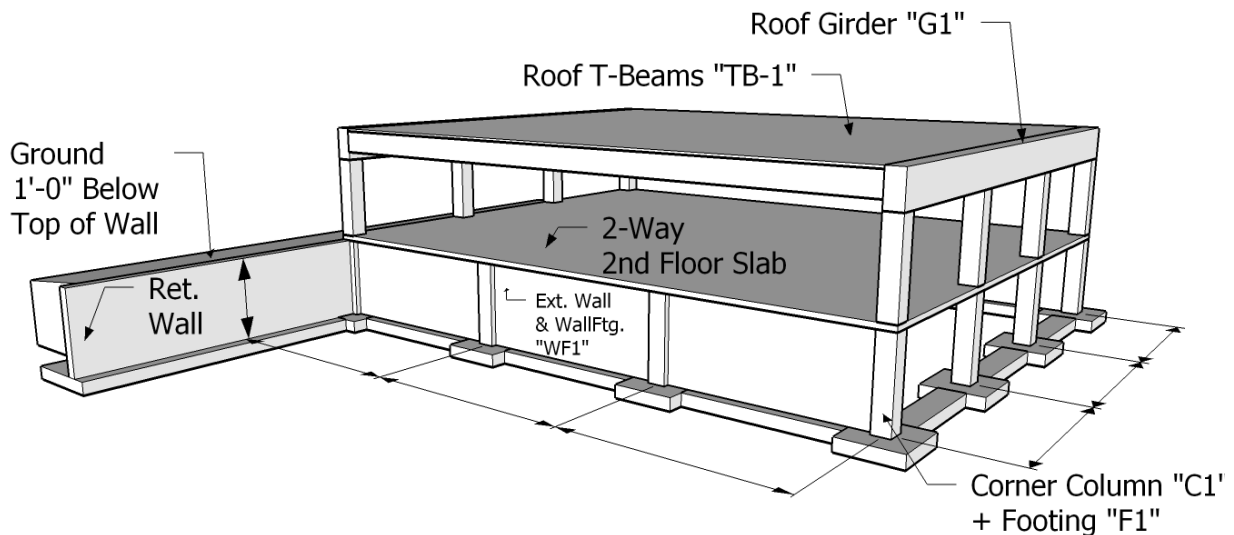


# Concrete Design Project

The proposed building is a two-story commercial office building. You are to prepare the following:



1. Prepare a complete **ROOF FRAMING PLAN** and a **SECOND FLOOR FRAMING PLAN**. The attached drawings show the layout and dimensions. The plans must be prepared in CAD format and PLOTTED to scale at  $1/8" = 1'-0"$  on  $11" \times 17"$  bordered sheet. Each T-beam and girder shall be given a mark (i.e., TB-1, G-1, etc.), and each column must be given a mark (i.e., C-1, C-2, etc.) which corresponds to the beam and column schedule to be included on the plan (see attached example). The framing plans must be inserted inside bordered sheets complete with Title Block containing all necessary info.
2. Prepare a **WALL SECTION "A"** view thru the exterior wall from footing up through roof, showing ALL materials, finishes, dimensions, etc., necessary to build it. Be sure to use CORRECT architectural drafting conventions as used in your ARCH 220 – Commercial Detailing course. Plot on a bordered  $11" \times 17"$  sheet complete with a Title Block plotted at a scale of  $3/4" = 1'-0"$ .
3. Prepare a **RETAINING WALL SECTION "B"** view thru the cantilevered retaining wall, showing ALL materials, finishes, dimensions, etc., necessary to build it. Be sure to use CORRECT architectural drafting conventions as used in your ARCH 220 – Commercial Detailing course. Plot on a bordered  $11" \times 17"$  sheet complete with a Title Block plotted at a scale of  $3/4" = 1'-0"$ .

4. Prepare an organized and **BOUND BOOKLET OF WORD-PROCESSED CALCULATIONS** for the design of roof girder, roof T-beam, one-way slab between stems of T-beam, corner column + footing, 2-way 2<sup>nd</sup> floor slab, exterior load-bearing concrete wall + wall footing, and, retaining wall. All numbers must have units attached. A “Table of Contents” and a “key plan” (showing locations of beams, columns, etc.) must accompany the calculations. You **MUST** use RAM computer software in the flexural design of one of the roof girder members, however, you MUST do a hand-calculation for the design of that member and compare the results with that of the computer output. Remember - YOU are personally responsible for the design. ALL calculations **MUST INCLUDE LABELED F.B.Ds AND SKETCHES** and be NEAT and easy to follow, or no credit will be awarded.

This is a take-home assignment to be done INDIVIDUALLY. Any blatant copying, evidence of electronic files shared, or exact same designs will result in a grade of ZERO for all parties involved. Everyone is strongly encouraged to consult with me if there are any questions or problems.

**DUE DATE:** This project is DUE at 12:00 noon on Friday, May 14, 2010. **NO LATE PROJECT WILL BE ACCEPTED, and a grade of ZERO will result.**

## Design Criteria:

1. Roof Loads: (The loads listed below are SERVICE loads. Be sure to use appropriate factors). **DOES NOT INCLUDE WEIGHT OF CONCRETE MEMBERS!!**
  - a) Flat roof snow load.....40 psf
  - b) Wind uplift.....-12 psf
  - c) Roof live load, “ $L_r$ ”.....20 psf
  - d) Roof Dead Loads (not including concrete weight):
    - i. Mechanical, electrical & lighting.....14 psf
    - ii.  $\frac{3}{4}$ ” acoustical hung ceiling (below roof framing).....2 psf
    - iii. Roof insulation, membrane.....5 psf
    - iv. Roof girders carry an additional curtain wall weighing 500 PLF
  
2. Floor Loads: (The loads listed below are SERVICE loads. Be sure to use appropriate factors). **DOES NOT INCLUDE WEIGHT OF CONCRETE MEMBERS!!**
  - a) Floor Live Load = **100 psf** based on anticipated occupancy, incl. partitions.
  - b) Floor Dead Loads (not including concrete weight):
    - i. Mechanical, electrical & lighting.....14 psf
    - ii.  $\frac{3}{4}$ ” acoustical hung ceiling (below floor framing).....2 psf
    - iii. Finished flooring.....12 psf
  
3. The **2<sup>nd</sup> Floor-to-roof height** = 14’-0”.
  
4. Horizontal SERVICE wind pressure acting on exterior concrete walls = 35 psf.
  
5. All **columns** are to be 20” x 20” square. The moments applied to your columns may be calculated by the *approximate* method as shown in Lecture.
  
6. Main column reinforcing is “tied” and use #3 ties. Main reinforcing bars shall be no smaller than #7 and no larger than #10.
  
7. All **roof girders** are rectangular in cross section, 20” wide and a depth of approximately L/16 of the span up to a maximum of 54” deep. The girder **MUST** be as deep as or deeper than the “T-Beams” framing into them. The roof girders are assumed to be “simply supported” and symmetrically loaded by the support reactions of the T-beams. Main tension bars are to be no smaller than #5 bars, and no larger than #8 bars. You may use two layers of main tension bars if necessary (remember to adjust your “d” dimension). Use  $\frac{3}{4}$ ” cover and #3 stirrup bars. Use only one spacing for stirrups (assume worst case) where stirrups are actually required from analysis. Use 2 - #5 “hanger” bars. You must analyze and design the flexural reinforcing using RAM computer software, and check results using hand-calculations.

8. **Interior roof beams** are to be designed as "**T-Beams**", having an overall depth of at least  $L/16$  of the span. T-Beams shall be spaced no closer than 4'-0" o.c., and no greater than 8'-0" o.c. The web width ( $b_w$ ) shall be no less than 6" and no greater than 10". Main reinforcing bars shall be no less than #5 bars and no larger than #8. Use  $\frac{3}{4}$ " for cover and #3 stirrups. Use only one spacing for stirrups (assume worst case) where stirrups are actually required from analysis. Use 2 - #5 "hanger" bars.
9. The continuous **one-way slab** (between stems of roof T-beams) shall be  $3\frac{1}{2}$ " thick, spanning between T-Beams. Be sure to determine positive and negative moments, taking into consideration interior and end spans. Main tension reinforcing bars (positive & negative bending) shall be #4 bars. Use #4 temperature bars spanning perpendicular to the main tension bars. Use  $\frac{3}{4}$ " concrete cover.
10. The **2<sup>nd</sup> floor two-way slab** must be analyzed and designed using the ACI 318 "Direct Design Method." Analyze and design one "design strip" along the long axis, being sure to determine positive and negative column + middle strip moments, taking into consideration all 5 interior and end spans. Use #4 bars throughout.
11. The **exterior wall** supports a vertical service dead load = 4000 PLF and a service vertical live load = 6000 PLF, as well as a service horizontal wind pressure as noted above. Assume the wall is reinforced with #4 bars for all horizontal and vertical bars.
12. The **corner column footing** shall be square, with  $f'_c = 4000$  psi and grade 60 bars. The footing reinforcing bars shall have 3" cover and be equal number of bars each way. Assume the allowable soil bearing pressure is 3500 PSF and the bottom of the footing is 4'-0" below grade. There are no moments acting on the footing. Use #6 main reinforcing bars.
13. The **exterior wall footing** shall be rectangular, with  $f'_c = 4000$  psi and grade 60 bars. The footing reinforcing bars shall have 3" cover. Assume the allowable soil bearing pressure is 3500 PSF and the bottom of the footing is 4'-0" below grade. Use #6 longitudinal reinforcing bars, and #4 transverse bars.
14. The **cantilevered Retaining Wall** shall be designed and analyzed such that the minimum factor of safety against overturning is at least 1.5, and the factor of safety against sliding is between 1.5  $\rightarrow$  1.6 (see Structural Theory notes). Assume the backfill has an active horizontal soil pressure, " $K_h$ " = 40 psf/ft, a coefficient of friction " $\mu$ " = 0.45, soil unit weight " $\gamma_{soil}$ " = 110 pcf and concrete unit weight " $\gamma_{concrete}$ " = 150 pcf. Use #7 bars for all reinforcing in the wall and footing.
15. All concrete shall have  $f'_c = 4000$  psi and use ASTM A615 grade 60 reinforcing bars.

16. Provide the following general notes on "**2<sup>nd</sup> FLOOR FRAMING PLAN**":

**GENERAL NOTES:**

1. DATUM TOP OF SLAB ELEVATION = 1424.67' N.G.V.D.
2. ALL CONCRETE CONSTRUCTION SHALL BE NORMAL WEIGHT STONE AGGREGATE HAVING A MINIMUM COMPRESSIVE STRENGTH,  $f'_c = 4000$  PSI AT 28 DAYS. CONSTRUCTION SHALL CONFORM WITH THE SPECIFICATIONS OF THE AMERICAN CONCRETE INSTITUTE ACI 318-08 (OR LATEST EDITION).
3. ALL REINFORCING SHALL BE NEW, DEFORMED BILLET STEEL CONFORMING TO ASTM A615 GRADE 60 WITH A MINIMUM YIELD OF 60,000 PSI. ALL BAR DEVELOPMENT LENGTHS, LAPS, SPLICES, HOOKS AND BENDS SHALL CONFORM TO ACI 318-08 (OR LATEST EDITION). PROVIDE ADDITIONAL 4 - #8 TOP REINFORCING BARS CENTERED OVER COLUMNS INSIDE BEAMS AND GIRDERS AT LEAST 1/3 OF THE SPAN TOWARDS EACH ADJACENT COLUMN.
4. UNLESS OTHERWISE NOTED, PROVIDE 3/4" CONCRETE COVER.
5. PROVIDE #4 CONTINUOUS TEMPERATURE BARS AT 18" O.C. PLACED IN CENTER OF SLAB PERPENDICULAR TO MAIN SLAB BARS.

**Schedules – Include on “ROOF FRAMING PLAN”:**

<b><u>BEAM SCHEDULE</u></b>							
MARK	SIZE		MAIN REINF.		STIRRUPS (@ EA. END OF BM.)		
	WIDTH	HEIGHT	TOP BARS*	BOTTOM BARS	QUANTITY	BAR SIZE	SPACING
G1	20"		2 - #5			#3	
TB-1			2 - #5			#3	

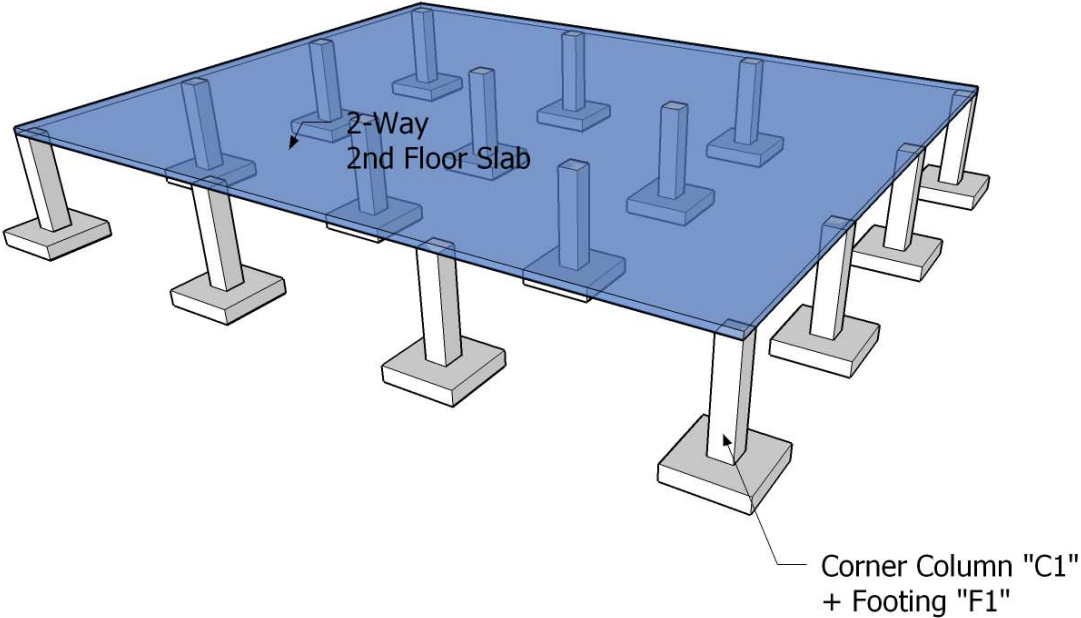
\* = PROVIDE ADDITIONAL TOP BARS IN BEAMS SPANNING OVER COLUMNS AS NOTED IN GENERAL NOTES

<b><u>COLUMN SCHEDULE</u></b>						
MARK	SIZE		VERT. REINF.		TIES	
	WIDTH	LENGTH	QUANTITY	BAR SIZE	BAR SIZE	SPACING
C1	20"	20"			#3	

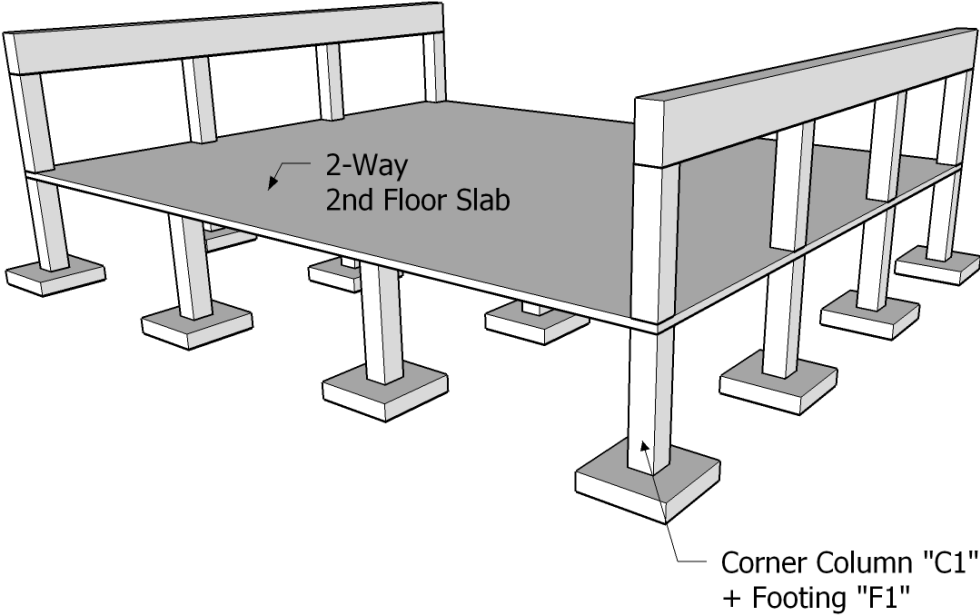
<b><u>COLUMN FOOTING SCHEDULE</u></b>				
MARK	SIZE		REINF.	
	WIDTH x LENGTH	THICKNESS	QUANTITY	BAR SIZE
F1				

<b><u>WALL FOOTING SCHEDULE</u></b>				
MARK	SIZE		REINF.	
	WIDTH	THICKNESS	Longitudinal Bars (Quantity & Size)	Transverse Bars (Size & Spacing)
WF1				

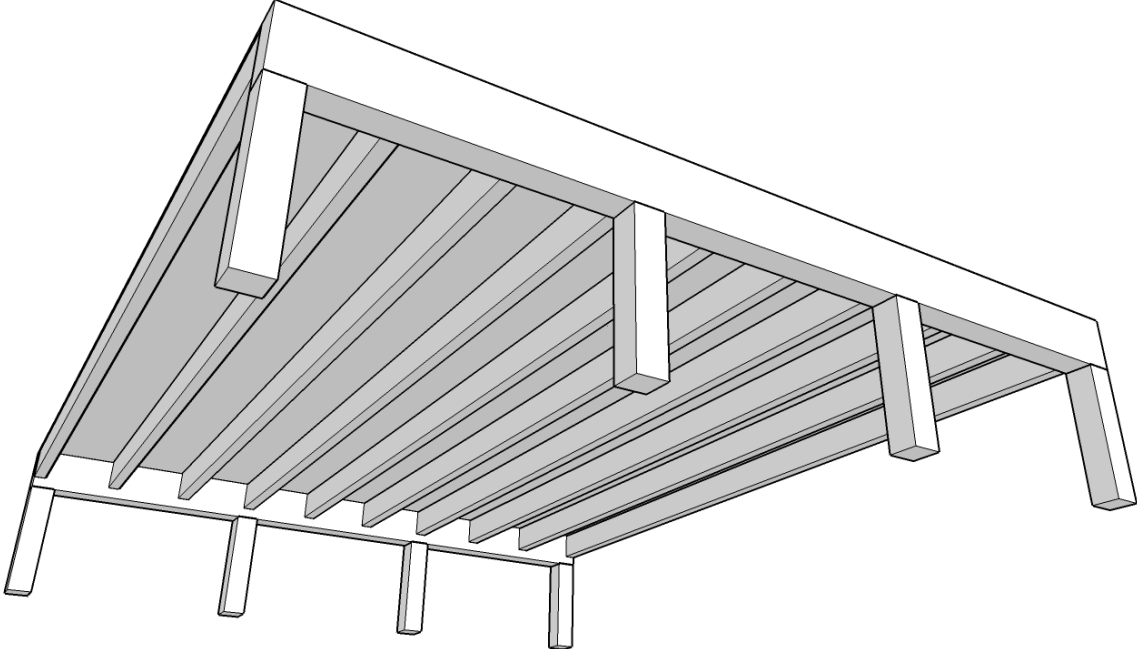
**Columns, Footings and 2<sup>nd</sup> Floor Two-Way Slab:**



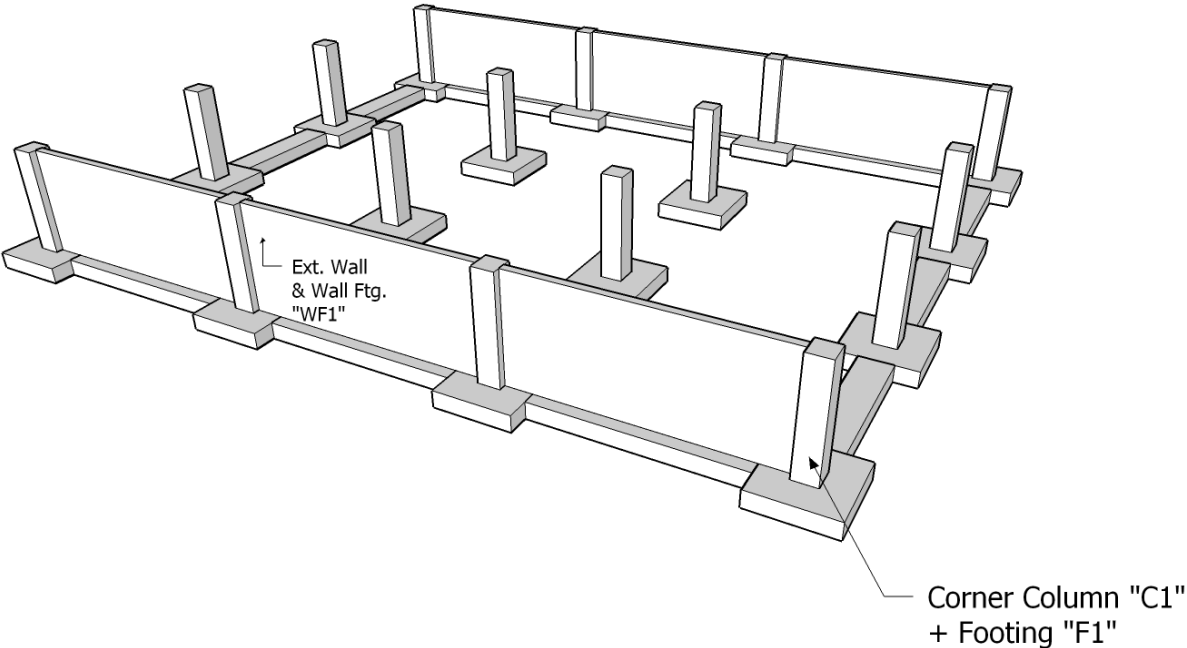
**Roof Girders (supporting T-Beams):**



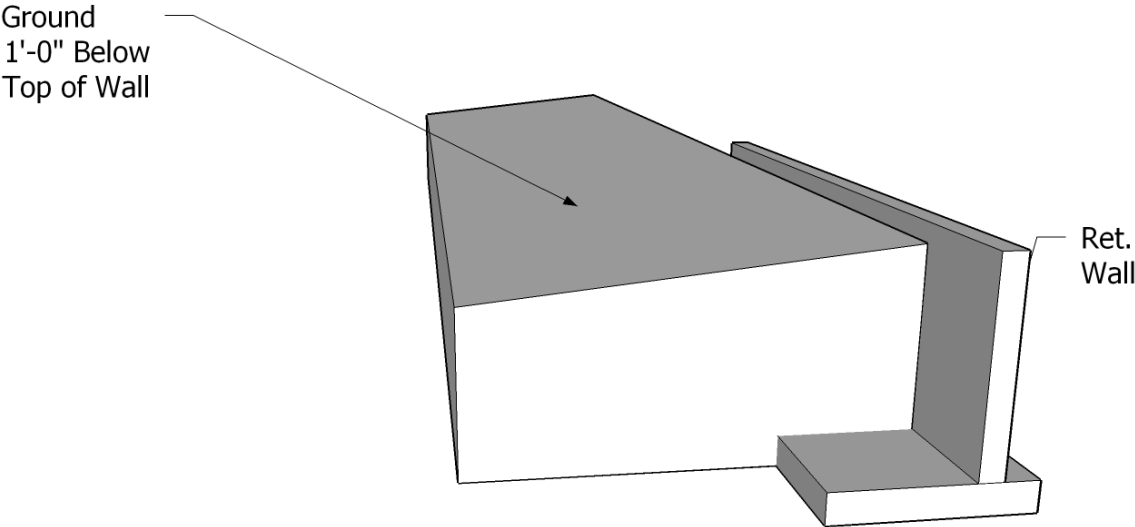
**Roof T-Beams:**



**Exterior Wall + Footings:**



**Cantilevered Retaining Wall:**



Name: \_\_\_\_\_

Total available points = 160

Member Type:	Criteria:	Comments:
Roof T-Beam (15 points)	Loads applied correctly Flexure analysis & design Shear analysis & design One-way slab analysis & design	
Roof Girder (15 points)	Loads applied correctly - Shear/Moment Flexure analysis & design using hand-calculations Flexure analysis & design using RAM software Shear analysis & design	
Corner Column (10 points)	Loads & moment applied correctly Vert. bars designed correctly Tie bars designed correctly	
Floor two-way slab (10 points)	Loads & positive + negative moments applied correctly Flexure analysis & design Reinf. Bars designed correctly	
Exterior wall (10 points)	Loads & moments applied correctly Flexure analysis & design Reinf. Bars designed correctly	
Column Footing (10 points)	Loads applied correctly Footing sized correctly using soil properties Reinf. Bars designed correctly	
Wall Footing (10 points)	Loads applied correctly Footing sized correctly using soil properties Reinf. Bars designed correctly	
Retaining Wall (15 points)	Loads applied correctly Sliding + overturning criteria satisfied Flexural analysis & design Reinf. Bars designed correctly	
Roof Framing Plan (10 points)	Drawn correctly using ARCH 220 conventions All dimensions provided All members properly designated Beam, Column, Footing schedules complete One-way Slab reinforcing properly indicated	
2nd Floor Framing Plan (10 points)	Drawn correctly using ARCH 220 conventions All dimensions provided All members properly designated Two-way Slab reinforcing properly indicated	
Wall Section "A" (15 points)	Drawn correctly using ARCH 220 conventions All dims., materials, notes shown per calcs.	
Ret. Wall Section "B" (10 points)	Drawn correctly using ARCH 220 conventions All dims., materials, notes shown per calcs.	
Quality of Calcs. (10 points)	Table of contents "Key" plan Referencing of given information Sketches Units attached to ALL numbers in ALL calculations Accuracy RAM computer analysis results clear & accurate Answers circled + highlighted	
Quality of CAD (10 points)	Completed Title Block info. Provided Plotted to scale requested Correct use of arch. conventions (dims., linewt., etc.)	

