AECT 460 – Structural Steel Design (Worth $\frac{1}{3}$ of Final Course Grade!!)

Fall 2011 **DUE: Friday December 9th 2:00 pm NO LATE PROJECTS ACCEPTED!**

Steel Design Project

You are to analyze and design ALL structural steel members of the 2-story office building as shown in conformance with loads, member types, materials and other criteria as outlined below. Design must be in strict conformance with the 14th Edition of the AISC Steel Construction Manual. You are free to use either ASD or LRFD for design of the members but NOT BOTH. Use only one of those methods throughout. Unless otherwise specified, the design of ALL members shall be on the basis of lightest weight.

This project is to be done INDIVIDUALLY and any evidence of cheating, copying, "sharing" or exact same designs in calculations and/or drawings will be met with a grade of ZERO for the project for ALL parties involved. Failure to turn in Project by the due date & time will result in ZERO grade for the project.

1. REQUIRED SUBMITTALS:

a. Bound Booklet of Calculations:

i. Table of Contents
ii. Key Plan for Floor & Roof Framing Plans
iii. Word-processed (or CAD) for ALL sketches, FBDs, shear & moment diagrams, etc.
iv. Every member calculation shall include **at least one fully-labeled sketch**.
v. Circle & highlight ALL answers
vi. Clearly state sources of ALL data, i.e., references from AISC Manual
vii. Clearly indicate ALL units used for every number in all calculations
viii. New page for every member
ix. Separate Key Plan for Roof Truss design
x. Hand-calcs for design of all Floor Truss members as referenced from axial loads obtained from printout of RAM computer analysis
xi. Appendix shall include the following:
    1. Computer output of your Truss analysis using RAM software (circle + highlight answers) as referenced in your calculations.
    2. Photocopied pages from Vulcraft catalog (circle + highlight answers) as referenced in your calculations.
    3. Photocopied page from AISC manual of "All-Bolted Double Angle Connection", clearly circling and highlighting all numbers as referenced in your calculations.

b. Floor Framing Plan "S-1":

Clearly show ALL floor beams, columns, column grid centerlines and dimensions and designations in CAD format plotted on 11" x 17" bordered sheet with Title Block at a scale of 1/8" = 1'-0". Label the support reaction (in units of kips) at the ends of all beams and girders. Follow drafting conventions learned in ARCH 220 – Commercial Detailing course.

c. Roof Framing Plan "S-2":

Clearly show ALL roof steel joists (including horizontal bridging locations), end beams, roof truss, columns, column grid centerlines and dimensions and designations in CAD format plotted on 11" x 17" bordered sheet with Title Block at a scale of 1/8" = 1'-0". Label the support reaction (in units of kips) at the ends of all beams, steel joists and truss members. Follow drafting conventions learned in ARCH 220 – Commercial Detailing course.

d. Roof Truss Elevation "S-3":

Clearly show all truss members, member centerlines, floor beams, dimensions and designations in CAD format plotted on 11" x 17" bordered sheet with Title Block at a scale of 1/8" = 1'-0". In addition, clearly indicate the axial load (in units of kips) and indicate Tension or Compression for ALL members. Be sure to note whether these axial loads are ASD Service loads OR LRFD Factored loads. Label material specs. Follow drafting conventions learned in ARCH 220 – Commercial Detailing course.

e. Interior Floor Beam-to-Girder Connection/Wall Section "S-4":

Using AutoCAD, draw a fully-labeled, fully-dimensioned architectural "Wall Section" at a plotted scale of 1" = 1'-0" thru the exterior wall of the building extending about 5'-0" above and below the girder. Be sure to include all dimensions and connection information of the all-bolted beam-to-girder steel connection (similar to sketch shown in Lecture 16 notes). In addition, design and draw the architectural finishes, including exterior wall, floor, ceiling, insulation, finishes, etc.

2. DESIGN "SERVICE" LOADS:

a. Roof Loads:

i. Flat Roof Snow Load "P_f" = 44 PSF
ii. Roof Live Load, "L_r" = 20 PSF
iii. Superimposed Dead Load (NOT incl. member wt.) = 28 PSF
iv. All perimeter roof beams and roof trusses carry an additional wall service dead load = 500 PLF.

b. Floor Loads:

i. Floor Live Load = 75 PSF
ii. Superimposed Dead Load (NOT incl. beam wt.) = 72 PSF
iii. All perimeter floor framing members of the building carry an additional wall service dead load = 700 PLF

3. MEMBER DESIGN:

a. **Interior Floor Beam:** Shall be W-section of A992 steel. Beams are simply-supported, non-composite spanning between floor girders. Assume beams are continuously laterally-supported. Beams must be spaced evenly and no less than 5'-0" o.c., nor greater than 8'-0" o.c. Design MUST satisfy **flexure** and **deflection limit** = L/360 under full service DL + LL. **Largest beam is nominal W24x___.** No need to check shear.

b. **End Floor Beam:** Shall be W-section of A992 steel, simply-supported, non-composite between corner columns and continuously laterally-supported. Beam carries additional exterior wall weight. Design MUST satisfy **flexure** and **deflection limit** = L/360 under full service DL + LL. **Largest beam is nominal W24x___.** No need to check shear.

c. **Floor Girder:** Shall be W-section of A992 steel, simply-supported, non-composite between corner column and interior column. Lateral unbraced length, (i.e., "L_b") shall be determined as the spacing of the floor beams framing into it. Girder carries additional exterior wall weight. Design MUST satisfy **flexure** and **deflection limit** = L/360 under full service DL + LL (check deflection using load equivalents found on AISC p. 3-210). **Largest girder is nominal W30x___.** No need to check shear.

d. **Roof Steel BarJoist:** The roof shall be supported by steel "K" or "LH" series joists. Spacing of these joists shall be evenly between corner columns, with a minimum spacing = 3'-0" and a maximum spacing = 9'-0". Design of joists shall be limited to a live load deflection not to exceed L/360. Bridging shall be "horizontal."

e. **Roof Truss:** Analysis and design is based on assumption that all members are pinned and carry compression or tension load ONLY. Assume the depth of truss $\cong$ span/10 (to nearest 6 inches) where the span is the distance between corner columns. Assume the truss overhangs the exterior column by one steel joist spacing (as determined in your joist design). **Perform analysis of truss using RAM software** and compare the results of the computer analysis with hand-calcs of at least 3 different truss members. Truss is loaded by end reactions of roof steel joists and end roof beam applied at panel points, as well as additional perimeter wall load spread out and acting at same panel points (see Structural Theory truss lecture notes). All truss members shall consist of rectangular HSS shapes using A500 F_y = 46 ksi steel using the lightest weight member possible. Group all top chord members as the same size and design for "worst case" loading. Group all bottom chord members as the same size and also design for "worst case" loading. Top chord size does NOT necessarily need to be the same size as bottom chord. Use rectangular HSS shapes using A500 F_y = 46 ksi steel for all vertical and diagonal interior members. Design for "worst case" for each. Assume all truss members will be welded together, and therefore the design of the tension members shall be for yielding on gross area ONLY.

f. **Corner Column:** Use W10 of A992 steel. Design of lightest weight column is based on total axial load obtained from support reactions of truss, floor girder and end floor beam. In addition, assume the column experiences **bi-axial bending moment** from the support reaction of the floor girder and end floor beam. Assume "K" = 1.0 and unbraced length "L" is noted as the larger of the two vertical dimensions as shown on sketch. Also, assume L3x3x¼ connection angles are used.

g. **Interior Column:** Use W10 of A992 steel. Design of lightest weight column is based on total axial load obtained from support reactions of exterior floor beams, ridge girder and exterior sloped roof girders. Assume the column experiences **NO bending moment**. Assume "K" = 1.0 and unbraced length "L" is distance from ground up to 2nd floor as noted on sketch. Size of interior column is not necessarily same as corner column.

h. **Base Plate for Corner Column:** Use A36 steel and f'_c = 3000 PSI concrete. Also, use 4 – ¾" dia. F1554 anchor rods and 1" non-shrink grout & leveling nuts. Round base plate dimensions to the nearest whole inch for length & width and to the nearest 1/8" for thickness. **Provide neat sketches of a section and plan at 3" = 1'-0" scale** showing all components, materials, dimensions, etc., necessary for fabrication. Refer to AISC p. 14-4 and 14-7 for details. Follow drafting conventions learned in ARCH 220 – Commercial Detailing course.

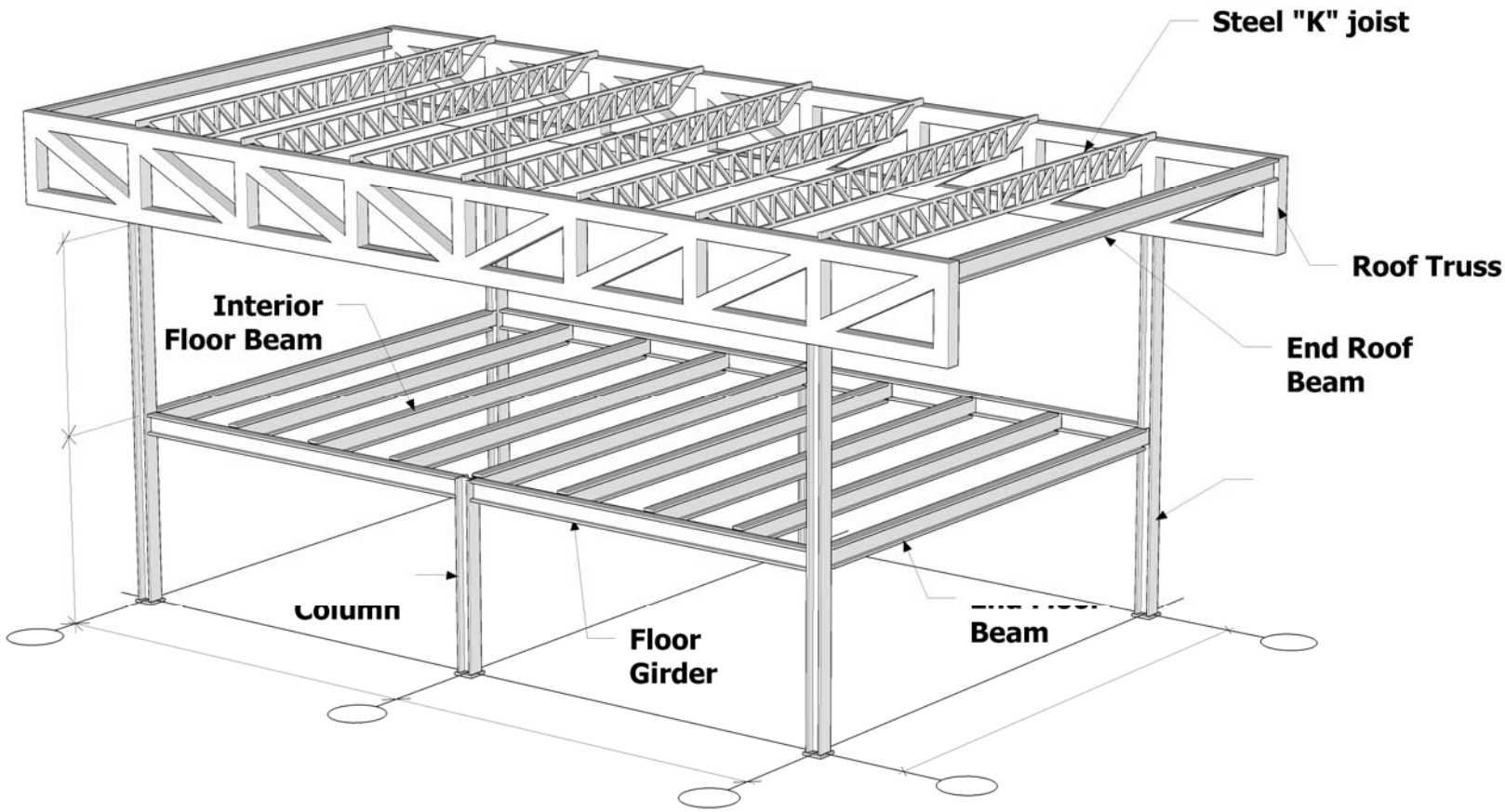
i. **Interior Floor Beam-to-Girder Connection:** Use all-bolted double angle connection. Use L3x3x¼ A36 steel angles and 1" diameter A325-N bolts.

AECT 460 - Structural Steel Design
Steel Design Project - Grading

Name:	**GRADE: /100 =**
Criteria:	**Comments:**
Interior & End Floor Beams: (10 pts.)	
Correct loads applied using ASD or LRFD:	
Deflection check (using service loads):	
Analysis (Max. moment):	
Design (Lightest wt. beam):	
Floor Girders: (5 pts.)	
Correct loads applied using ASD or LRFD:	
Deflection check (using service loads):	
Analysis using correct L_b (Max. moment):	
Design (Lightest wt. beam):	
Roof Joists: (5 pts.)	
Correct loads applied using ASD or LRFD:	
Design (Lightest wt. joist):	
Bridging analysis satisfactory	
Roof End Beams: (5 pts.)	
Correct loads applied using ASD or LRFD:	
Deflection check (using service loads):	
Analysis (Max. moment):	
Design (Lightest wt. beam):	
Roof Truss: (20 pts.)	
Correct loads applied, incl. wall load:	
Analysis using RAM software:	
Hand-calc analysis of 3 members (match RAM results)	
Design of top & bottom chords:	
Design of interior verticals & diagonals:	
Corner and Interior Columns: (10 pts.)	
Correct axial loads applied:	
Correct moments applied:	
Design (Lightest wt. Column):	
Base Plate Detail: (5 pts.)	
Calculations complete:	
Plan view correctly detailed:	
Section view correctly detailed:	

Bound Calculations: (10 pts.)	
Table of contents refd. w/ page numbers on calcs.	
Key Plans refd. w/ calc. page numbers	
Circle & highlight answers	
Sources of data stated	
Appendix items cross-refd. w/ hand calcs.	
Floor Framing Plan S-1: (5 pts.)	
All beams & girders properly designated:	
All columns properly designated:	
All dimensions shown & accurate:	
All floor beam & truss end reactions noted:	
Drawing to scale & correct arch. conventions	
Roof Framing Plan S-2: (5 pts.)	
All beams & girders properly designated:	
All columns properly designated:	
All dimensions shown & accurate:	
All floor beam & truss end reactions noted:	
Drawing to scale & correct arch. conventions	
Truss Elevation S-3: (5 pts.)	
All top & bottom chord members designated	
All vert. & diag. members designated	
All dimensions shown & accurate:	
All axial ten. & comp. loads shown	
Drawing to scale & correct arch. conventions	
Wall Section (5 pts.)	
All-bolted connection fully documented	
Architectural details & finishes fully documented	
Drawing to scale & correct arch. conventions	
Quality of Work: (10 pts.)	
Calculations:	
Drawings:	

Total Possible = 100 points


Steel "K" joist
Roof Truss
Interior
Floor Beam
End Roof
Beam
Column
Floor
Girder
Beam