

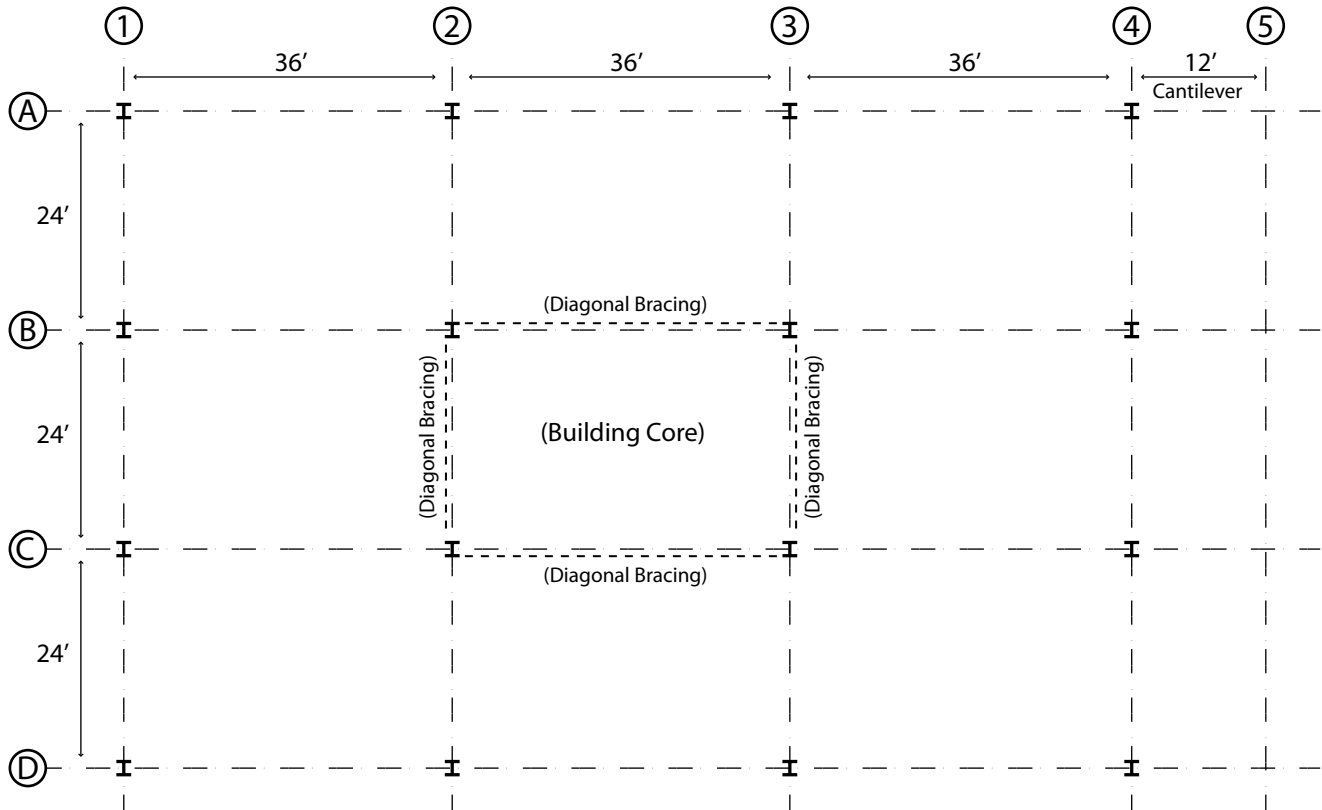
Structural Steel Design

LRFD Beam Sizing

NAME _____

REFERENCE

See the LRFD Beam Sizing notes for formulas and physical constants.



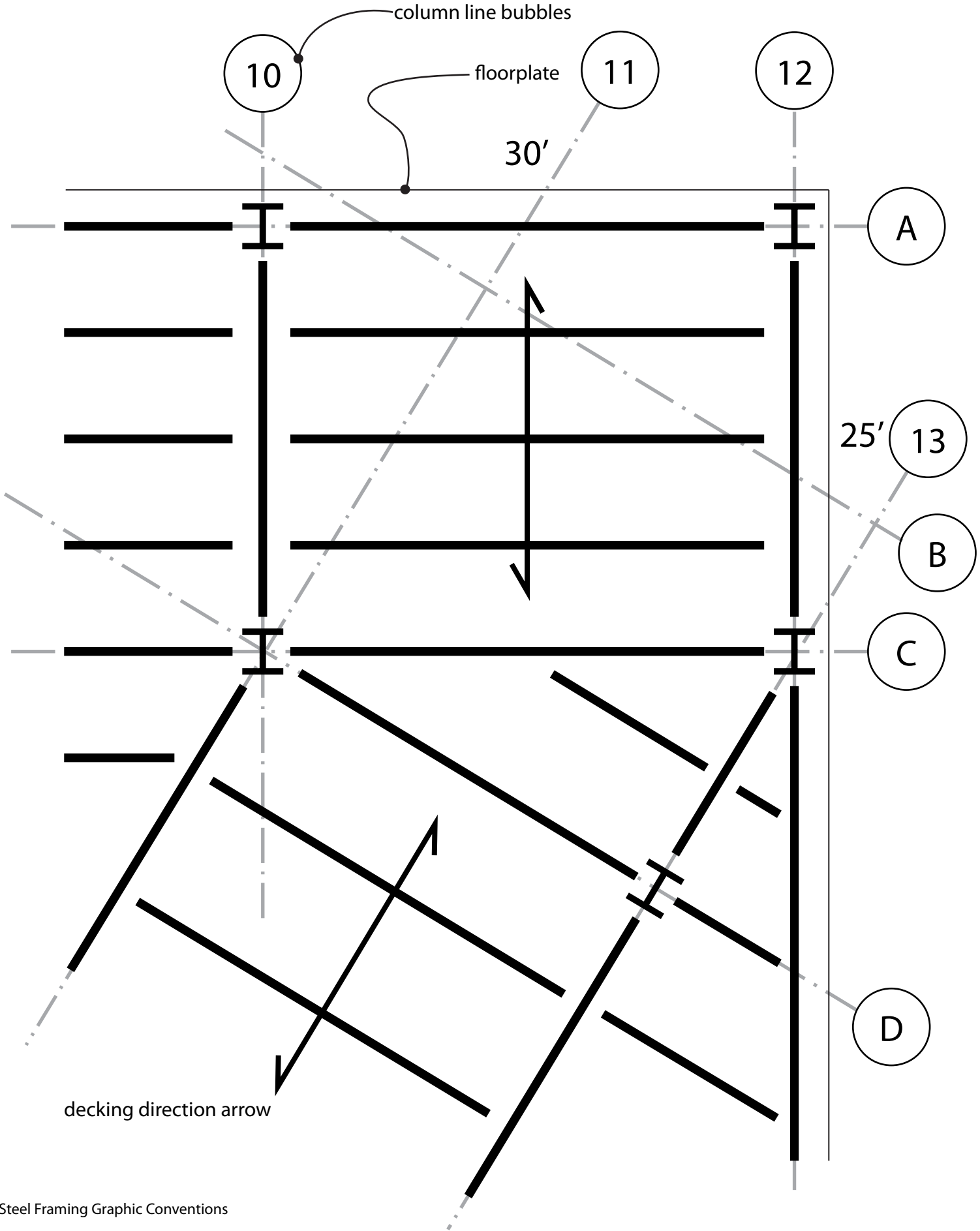
Even as an architect, it is very important to understand structural framing plans and approximate sizing of structural members to better coordinate your design project with structural engineers. For this exercise, perform the following:

1. Reasonably place steel girders, beams and metal decking on the unfinished framing plan shown above. Clearly indicate the deck span.
2. Design at least one typical interior girder, interior beam, and cantilevered beam to meet both strength and stiffness requirements. Assume floor live load for an Office occupancy. Determine floor dead load from Vulcraft deck tables and add 10 psf for the ceiling and 20 psf for partitions. Present this analysis in a clear graphic manner.

Note: The Vulcraft Deck Catalog is on the class site and excerpts from the IBC code are on the following 2 pages. Assume the floor beams are not part of the lateral resistance.

Grading will depend on the accuracy and clarity of the analysis and the clarity of the graphic presentation. Present the assignment with a cover sheet, shear and moment diagrams, brief text explanations, a clearly drawn floor framing plan, and diagrammatic sections where needed.

Graphic References - Steel Frames



STRUCTURAL DESIGN

**TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_e AND
MINIMUM CONCENTRATED LIVE LOADS⁹**

OCCUPANCY OR USE	UNIFORM (pst)	CONCENTRATED (lbs.)
1. Apartments (see residential)	-	-
2. Access floor systems Office use Computer use	50 100	2,000 2,000
3. Armories and drill rooms	150	-
4. Assembly areas and theaters Fixed seats (fastened to floor) Follow spot, projections and control rooms Lobbies Movable seats Stages and platforms Other assembly areas	60 50 100 100 125 100	- - - - - -
5. Balconies (exterior) and decks ^h	Same as occupancy served	-
6. Bowling alleys	75	-
7. Catwalks	40	300
8. Cornices	60	-
9. Corridors, except as otherwise indicated	100	-
10. Dance halls and ballrooms	100	-
11. Dining rooms and restaurants	100	-
12. Dwellings (see residential)	-	-
13. Elevator machine room grating (on area of 4 in ²)	-	300
14. Finish light floor plate construction (on area of 1 in ²)	-	200
15. Fire escapes On single-family dwellings only	100 40	- -
16. Garages (passenger vehicles only) Trucks and buses	40 See Section 1607.6	Note a -
17. Grandstands (see stadium and arena bleachers)	-	-
18. Gymnasiums, main floors and balconies	100	-
19. Handrails, guards and grab bars	See Section 1607.7	
20. Hospitals Corridors above first floor Operating rooms, laboratories Patient rooms	80 60 40	1,000 1,000 1,000
21. Hotels (see residential)	-	-
22. Libraries Corridors above first floor Reading rooms Stack rooms	80 60 150 ^b	1,000 1,000 1,000

continued

**TABLE 1607.1-continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_e AND
MINIMUM CONCENTRATED LIVE LOADS⁹**

OCCUPANCY OR USE	UNIFORM (pst)	CONCENTRATED (lbs.)
23. Manufacturing Heavy Light	250 125	3,000 2,000
24. Marquees	75	-
25. Office buildings Corridors above first floor File and computer rooms shall be designed for heavier loads based on anticipated occupancy Lobbies and first-floor corridors Offices	80 - 100 50	2,000 - 2,000 2,000
26. Penal institutions Cell blocks Corridors	40 100	- -
27. Residential One- and two-family dwellings Uninhabitable attics without storage ⁱ Uninhabitable attics with limited storage ^{i, j, k} Habitable attics and sleeping areas All other areas Hotels and multifamily dwellings Private rooms and corridors serving them Public rooms and corridors serving them	10 20 30 40 40 100	- - - - -
28. Reviewing stands, grandstands and bleachers	Note c	
29. Roofs All roof surfaces subject to maintenance workers Awnings and canopies Fabric construction supported by a lightweight rigid skeleton structure All other construction Ordinary flat, pitched, and curved roofs Primary roof members, exposed to a work floor Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs: Over manufacturing, storage warehouses, and repair garages All other occupancies Roofs used for other special purposes Roofs used for promenade purposes Roofs used for roof gardens or assembly purposes	nonreducible 5 20 20 Note 1 60 100	300 - - - - - 2,000 300 Note 1 -
30. Schools Classrooms Corridors above first floor First-floor corridors	40 80 100	1,000 1,000 1,000
31. Scuttles, skylight ribs and accessible ceilings	-	200
32. Sidewalks, vehicular driveways and yards, subject to trucking	250 ^d	8,000 ^e
33. Skating rinks	100	-

continued

**SECTION 1604
GENERAL DESIGN REQUIREMENTS**

1604.1 General. Building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional construction methods, as permitted by the applicable material chapters.

1604.2 Strength. Buildings and other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this code without exceeding the appropriate strength limit states for the materials of construction. Alternatively, buildings and other structures, and parts thereof, shall be designed and constructed to support safely the nominal loads in load combinations defined in this code without exceeding the appropriate specified allowable stresses for the materials of construction.

Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the building official.

1604.3 Serviceability. Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections and lateral drift. See Section 12.12.1 of ASCE 7 for drift limits applicable to earthquake loading.

1604.3.1 Deflections. The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 1604.3.2 through 1604.3.5 or that permitted by Table 1604.3.

1604.3.2 Reinforced concrete. The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

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**TABLE 1604.3
DEFLECTION LIMITS^{a, b, c, h, i}**

CONSTRUCTION	<i>L</i>	<i>S</i> or <i>W</i> ^f	<i>D</i> + <i>L</i> ^{d,g}
Roof members: ^e			
Supporting plaster ceiling	<i>l</i> /360	<i>l</i> /360	<i>l</i> /240
Supporting nonplaster ceiling	<i>l</i> /240	<i>l</i> /240	<i>l</i> /180
Not supporting ceiling	<i>l</i> /180	<i>l</i> /180	<i>l</i> /120
Floor members	<i>l</i> /360	—	<i>l</i> /240
Exterior walls and interior partitions:			
With brittle finishes	—	<i>l</i> /240	—
With flexible finishes	—	<i>l</i> /120	—
Farm buildings	—	—	<i>l</i> /180
Greenhouses	—	—	<i>l</i> /120

For SI: 1 foot = 304.8 mm.

- a. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed *l*/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed *l*/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed *l*/90. For roofs, this exception only applies when the metal sheets have no roof covering.
- b. Interior partitions not exceeding 6 feet in height and flexible, folding and portable partitions are not governed by the provisions of this section. The deflection criterion for interior partitions is based on the horizontal load defined in Section 1607.13.
- c. See Section 2403 for glass supports.
- d. For wood structural members having a moisture content of less than 16 percent at time of installation and used under dry conditions, the deflection resulting from *L* + 0.5*D* is permitted to be substituted for the deflection resulting from *L* + *D*.
- e. The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to assure adequate drainage shall be investigated for ponding. See Section 1611 for rain and ponding requirements and Section 1503.4 for roof drainage requirements.
- f. The wind load is permitted to be taken as 0.7 times the “component and cladding” loads for the purpose of determining deflection limits herein.
- g. For steel structural members, the dead load shall be taken as zero.
- h. For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers, not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed *l*/₆₀. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed *l*/₁₂₀.
- i. For cantilever members, *l* shall be taken as twice the length of the cantilever.

1604.3.3 Steel. The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI-NAS, AISI-General, AISI-Truss, ASCE 3, ASCE 8, SJI JG-1.1, SJI K-1.1 or SJI LH/DLH-1.1, as applicable.

1604.3.4 Masonry. The deflection of masonry structural members shall not exceed that permitted by ACI 530/ASCE 5/TMS 402.

1604.3.5 Aluminum. The deflection of aluminum structural members shall not exceed that permitted by AA ADM1.

1604.3.6 Limits. Deflection of structural members over span, *l*, shall not exceed that permitted by Table 1604.3.