Inspection of these loading conditions confirms that Case I controls deflection at the end of the cantilever, Case II controls deflection in the interior span, and either Case IIIa or IIIb controls the structural safety checks (i.e., bending, horizontal shear, and bearing).

Since the cantilever span, *X*, is unknown at this point, it is not possible to determine structural actions in the joist (i.e., shear and moment) by using traditional engineering mechanics and free-body diagrams. However, the beam equations could be solved and a solution for *X* iterated for all required structural safety and serviceability checks (by computer). Therefore, a trial value for *X* is determined in the next step. If an off-the-shelf computer program is used, verify its method of evaluating the above load cases.

4. Determine a trial cantilever span based on a deflection limit of $\ell/120$ and load Case I.

Use a 2 ft-10 in cantilever span (calculations not shown - see beam equations in Appendix A).

5. Determine the maximum bending moment and shear for the three load cases governing the structural safety design checks by using the trail cantilever span:

The following is determined by using free-body diagrams and shear and moment diagrams (or beam equations, see Appendix A)

	Case II	Case IIIa	Case IIIb
R_1	1,008 lb	938 lb	**1,088 lb**
R_2	301 lb	40 lb	286 lb
V_{max}*	511 lb	**626 lb**	576 lb
M_{max}	1,170 ft-lb	**1,638 ft-lb**	1,352 lb

**NDS•3.4.3 allows loads within a distance of the member depth, d, from the bearing support to be ignored in the calculation of shear V when checking horizontal shear stress. However, this portion of the load must be included in an analysis of the bending moment. It would reduce the value of V_{max} as calculated above by using beam equations by approximately 100 pounds in Case II and Case IIIb and about 44 pounds in Case IIIa by eliminating the uniform load, w, within a distance, d, from the exterior bearing support.*

6. Determine design bending moment capacity of the given joist and verify adequacy

$$F_b' \geq f_b = \frac{M_{all}}{S}$$

$$M_{all} = F_b'S = (1{,}581\text{ psi})(21.4\text{ in}^3)(1\text{ ft}/12\text{ in})$$

$$= 2{,}819\text{ ft-lb}$$

$$M_{all} > M_{max} = 1{,}638\text{ ft-lb} \quad \text{OK}$$

7. Determine design shear capacity of the given joist and verify adequacy:

$$F_v = \frac{3V_{all}}{2A} \text{ and } F_v \geq F_v'$$

$$V_{all} = \frac{2AF_v'}{3} = \frac{2(1.5\text{ in})(9.25\text{ in})(238\text{ psi})}{3}$$

$$= 2{,}202\text{ lbs}$$

$$V_{all} > V_{max} = 626\text{ lbs} \quad \text{OK}$$

8. Check bearing stress

$$f_{c\perp} = \frac{R_{max}}{A_b} = \frac{1{,}088 \text{ lb}}{(1.5 \text{ in})(3.5 \text{ in})}$$

$$= 207 \text{ psi}$$

$$F_{c\perp}' = 694 \text{ psi} > 207 \text{ psi} \quad \text{OK}$$

Conclusion

A cantilever span of 2 ft-10 in (2.8 feet) is structurally adequate. The span is controlled by the selected deflection limit (i.e., serviceability) which illustrates the significance of using judgment when establishing and evaluating serviceability criteria. Allowance for a 2-foot cantilever is a common field practice in standard simple span joist tables for conventional residential construction. A check regarding interior span deflection of the joist using load Case II may be appropriate if floor vibration is a concern. However, unacceptable vibration is unlikely given that the span is only 12 feet. Also, Douglas-Fir, Larch, No. 1 Grade, is considered premium framing lumber and No. 2 Grade member should be evaluated, particularly if only a 2-foot cantilever is required.