Steel Design - LRFD AISC Steel Manual 13th edition Beam Limit States

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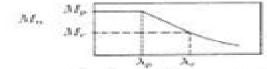
1 Moment Limit State

In steel design it is often necessary to design a beam to resist bending moments. In order to design the beam according to LRFD, ϕM_n must be determined for the trial beam selected. Once ϕM_n is determined it can then be compared to the factored moment M_n to evaluate the adequacy of the selected beam. This is often an iterative process. Hence, in order to determine ϕM_n three bending limit states must be considered:

- A. Lateral Torsional Buckling (LTB).
- B. Flange Local Buckling (FLB).
- C. Web Local Buckling (WLB).

For each of the above limit states beams will, if loaded to failure, fail in one of three failure modes:

- Failure by yielding (material failure). λ ≤ λ_p.
- Failure by inelastic buckling, λ_p < λ ≤ λ_r.
- 3. Failure by elastic buckling. $\lambda_r < \lambda$



Slenderness Parameter, λ

Figure I —
$$M_n$$
 vs λ

For example, if loaded to failure, a beam failing according to limit state "A" will fail by failure mode 1, 2, or 3. The failure mode for the limit state "A" can be determined by calculating a sleaderness parameter, λ . This slenderness parameter will indicate if the mode of failure occurs in the material, inelastic, or elastic range (see Figure I). Based on the mode of failure the value of ϕM_{π} for limit state "A" can be calculated.

This same procedure must be followed for limit state "B" and for limit state "C". By this process three values of ϕM_n , one for each limit state, are obtained. The smallest value of ϕM_n governs and indicates the factored nominal moment capacity of the beam which is compared to M_n .

In what follows a procedure to calculate ϕM_n for each limit state is given. For each limit state the procedure provides all of the information needed to calculate ϕM_n . In each case

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