TENSION MEMBER DESIGN

INTRODUCTORY CONCEPTS

• Stress: The stress in an axially loaded tension member is given by Equation AP=*f*

where, P is the magnitude of load, and

A is the cross-sectional area normal to the load

• The stress in a tension member is uniform throughout the cross-section except:
- near the point of application of load, and
- at the cross-section with holes for bolts or other discontinuities, etc.

DESIGN STRENGTH

• A tension member can fail by reaching one of two limit states:

(1) excessive deformation; or (2) fracture

Important notes

• Note 1. Why is fracture (& not yielding) the relevant limit state at the net section?

Yielding will occur first in the net section. However, the deformations induced by yielding will be localized around the net section. These localized deformations will *not* cause excessive deformations in the complete tension member. Hence, yielding at the net section will *not* be a failure limit state.

• Note 2. Why is the resistance factor (φ_t) smaller for fracture than for yielding?

The smaller resistance factor for fracture ($\varphi_t = 0.75$ as compared to $\varphi_t = 0.90$ for yielding) reflects the more serious nature and consequences of reaching the fracture limit state.

4.4 EFFECTIVE NET AREA

• The *connection* has a significant influence on the performance of a tension member. A connection almost always weakens the member, and a measure of its influence is called joint efficiency.

• Joint efficiency is a function of: (a) material ductility; (b) fastener spacing; (c) stress concentration at holes; (d) fabrication procedure; and (e) shear lag.

• All factors contribute to reducing the effectiveness but shear lag is the most important.

• Shear lag occurs when the tension force is not transferred *simultaneously* to all elements of the cross-section.

This will occur when some elements of the cross-section are not connected.

STAGGERED BOLTS

For a bolted tension member, the connecting bolts can be staggered for several reasons:

(1) To get more capacity by increasing the effective net area
(2) To achieve a smaller connection length
(3) To fit the geometry of the tension connection itself.

• For a tension member with staggered bolt holes (see example figure above), the relationship $f = P/A$ does not apply and the stresses are a combination of tensile and shearing stresses on the inclined portion.

Source : http://www.nprcet.org/e%20content/Misc/e-Learning/CIVIL/VI%20SEMESTER/10111CE603%20-%20DESIGN%20OF%20STEEL%20STRUCTURES.pdf