Name	Asim Ali
ID	7763
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Teacher	Engr. Amjid Islam
Department	BS Civil

IMU peshawar

Q: 1

Ans: General Statement of design philosophies:-

A general statement assuming Safety in engineering design

Resistance (of materials and x-section) ≥ Effect of applied loads.....(1)

In eq (1) it is essential that both sides are evaluated for same conditions eg

~~eg: if~~

~~if effect of evaluated for~~

e.g:

If effect of load is to produce Compressive stress on soil, then it Should be compared with bearing capacity of Soil.

* When particular loading reaches its limit, failure is the assumed result,

i.e.

The loading condition become failure modes, Such a condition is referred to as limit state and it can be defined as

"

A limit state is a condition beyond which a structural system or a structural component ceases to fulfill the function for which it is designed."

ASD :-

Safety in the design is obtained by Specifying, that the effect of the loads should produce stresses that is a fraction of the yield stress f_y, say one half.

* This is equivalent to:

$$FOS = \text{Resistance, } R / \text{Effect of load, } Q$$

$$= \frac{fy}{0.5fy}$$

$$= 2$$

→ Mathematically:

$$\frac{\phi R_n}{\gamma} \geq \Sigma Q_i$$

R_n = Resistance or Strength of the Component being designed.

ϕ = Resistance Factor or Strength Reduction Factor

γ = Overload or load Factors

$\frac{\gamma}{\phi}$ = Factor of Safety FS

Q_i = Effect of applied loads

→ Drawbacks:-

Implied in the ASD method is the assumption that the stress in the member is zero before any loads are applied, i.e; no residual stresses exist from forming the members.

ASD does not give reasonable measure of strength, which is more fundamental measure of resistance than is allowable stress.

Another drawback in ASD is that safety is applied only to stress level. Loads are considered to be deterministic (without variation)

LRFD:-

* To overcome the deficiencies of ASD, the LRFD method is based on: Strength of Materials
* It Consider the variability not only in resistance but also in the effects of load.
* It provides measure of safety related to probability of failure.
* Safety in the design is obtained by Specifying that the reduced Nominal strength of a designed Structure is less than the effect of factored loads acting on the Structure

$$\phi R_n \geq \eta \sum \gamma \varphi_i$$

R_n = Resistance or Strength of the Component being designed.

Q_i = Effect of Applied loads.

n = Takes into account ductility, redundancy and Operational imp.

γ = Over load or Load factors

$\frac{\gamma}{\phi}$ = Factor of Safety

* Advantages:

→ LRFD accounts for both Variability in resistance and Load

→ It achieves fairly uniform levels of Safety for different limit states.

* Disadvantages:

It's disadvantages is change in design philosphy from previous method.

Q:1 complete

Q: NO: 2

Ans: Bolted Connection:-

Structural bolts are specifically designed for use with heavy hex nuts in the connection of structural members (as opposed to tapped holes). The nuts for structural connections shall conform to ASTM A563 or ASTM A194.

Bolted connections are used when it is necessary to fasten two elements tightly together, especially to resist shear and bending, as in column and beam connections.

→ Types of bolt's :-

The two commonly used types of bolts for steel structures are the unfinished bolt (A307) and the high-strength bolt (A325, A449 & A490)

The A307 bolt is known by a variety of names —— unfinished, rough common, ordinary, and machine. It is furnished in two grades, A and B, the former for general purposes and the latter for joints in pipe systems. They are made of low-carbon steel with a minimum tensile strength of 60 ksi. They are tightened by using long-handled manual wrenches, so the induced tension is relatively small and unpredictable. They are satisfactory for use in building frames not subject to shock or vibration and are used in both

hot-rolled and cold-formed steel connection. Castellated nuts with cotter pins, jam nuts and various types of locknuts can be used to prevent loosening where shock and vibration are a consideration.

The A 325 is made of medium-carbon steel. It is also used in both hot-rolled and cold-formed steel construction. The tensile strength of this bolt decreases with increases in diameter of the bolt, so two ranges of diameter are specified. The A449 bolt, also medium-carbon steel, is furnished in three ranges of diameter. The A490 bolt is made of alloy steel in one tensile-strength grade. It should be noted that the tensile properties are based on the "stress Area".

High-strength bolts can be tightened

large tensions, which produce high clamping forces between the connected parts. The Research council on structural Connections (RCSC) Specification for Structural Joints using ASTM A325 or A490 bolts[7] prescribes four tightening Procedure for control of the pre tension.

1) Turn-of-the-nut Method
2) Calibrated-wrench tightening
3) Installation of alternate design bolts.
4) Direct-tension-indicator tightening.

① Slip-critical Connections:

Connection transmits the force by friction produced b/w the faying surfaces by the clamping action of the bolts.

→ Slip-critical Connections are recomended for joints subjected to stress reversal,

Severe stress fluctuation, Impact, Vibration or where slip objectionable

② Bearing type connection:

Load is transfered by Shearing and bearing on the bolt

→ Capacity in shear depends on whether shear plane intersects the body of bolt or threaded portion.

→ Types of Failures:-

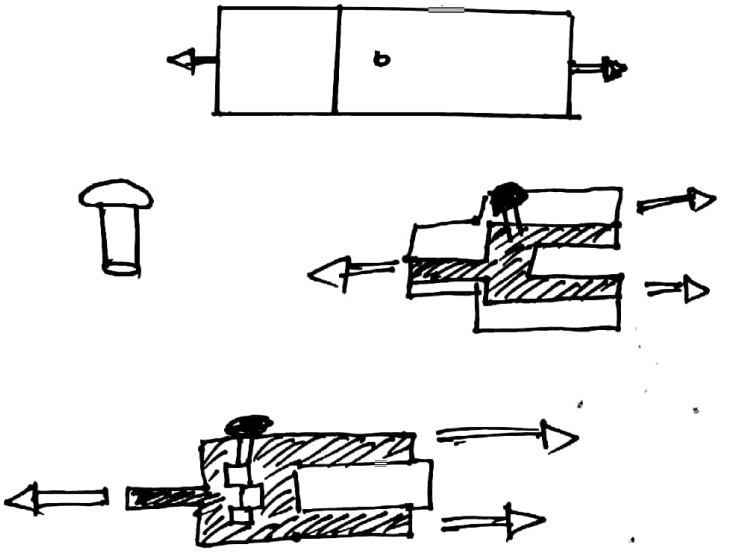
i) Shearing Failure of bolt

ii) Bearing Failure of ~~bolt~~ plate

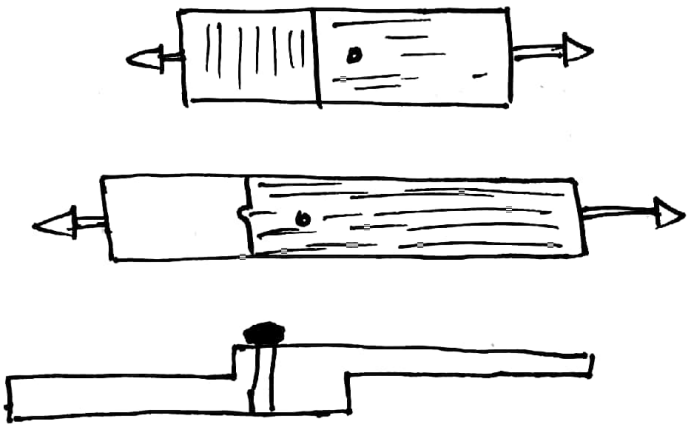
iii) Tearing Failure ~~of~~ ~~bolt~~ edge of plate

ii) Shearing Failure of bolt:

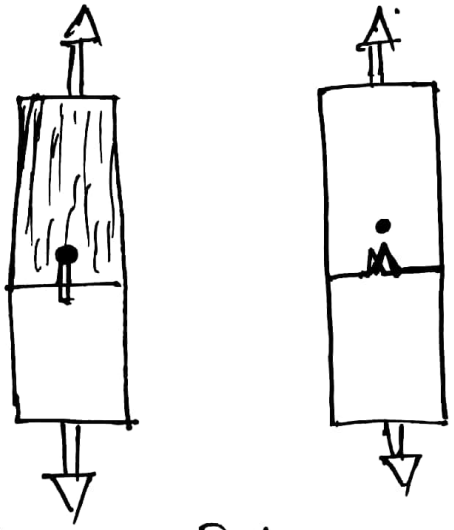
Acting stress in the bolt is assumed be distributed uniformly over the cross-section and is determined dividing force over section area of bolt. Bolt Shear Failure Takes place when acting stress exeeds Shear strength of material (approx half of tension strength).



(2) Bearing Failure of Plate

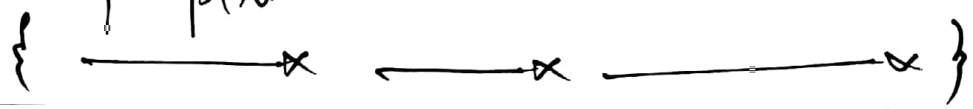


(3) Tearing Failure at the edge:



Shearing Failure of plate

Transverse Tension Failure



If the **plate** material is weaker than the bolt material, then **failure** will occur by **bearing** of the bolt on the **plate** and the hole will elongate. ... **Bearing failure**. If the connected **plates** are made of high strength steel then **failure** of bolt can take place by **bearing** of the **plates** on the bolts. Jul 10, 2016

www.brainkart.com › article › Bearing-failure-of-Bolts... ▾

Q: 3 (16)

Given data:-

Dead load = 130 K

Live Load = 265 K

Channel C10 x 30

Gussed plate thickness 1"

Steel – A36

Bolts are A325

Diameter = 3/4"

Bearing type connections with thread excluded.

Use three line of bolts

Required data:-

Determine the no. of bolts?

check the capacities for channal only ?

Solution:

ASD Method

Q1: (17)

Design Load = D.L + L.L

= 130K + 265 = 395 Kips

Design for bolts:

$$A = \frac{\pi}{4} d^2$$

$$A = \frac{\pi}{4}(3/4)^2 = 0.4418 \text{ in}^2$$

FV = 30 (Table 2-11)

RV = A × fV

= 0.4418 × 30

= 13.254 kips / shear surface

Design bolt: $= \frac{\text{Total load}}{2 \times RV}$

$$= \frac{395}{2 \times 13.254} = 14.90 \text{ Say}$$

15 bolt

Bearing strength = 1.2 Fu → From table

Fp = 1.2 × 58

Fp = 69.6 ksi

Channel :

$(t = 0.673)$

$$R_p = dt\,F_p$$

$$= \frac{3}{4} \times 0.673 \times 69.6$$

$$\boxed{R_p = 35.13 \text{ kips}}$$

For bolt, there are 30 bearing surface

So

$$\text{Capacity} = 30 \times 35.13 = 1053.9 > 395 \text{ kips}$$

Gusset plate

$(t = 1)$

$$R_p = dt\,F_p$$

$$= \frac{3}{4} \times 1 \times 69.6 = 52.5 \text{ kips}$$

For Gusset plate there are 15 bearing Surface, so

$$\text{Capacity} = 15 \times 52.5 = 783 \text{ kips} > 395 \text{ kips}$$

Spacing:

End distance, sheared edge : $1\frac{1}{4}$ in minimum

End spacing $1\frac{1}{2}d = 1.13 < 1\frac{1}{4}$ in

Center to center spacing for $Fp = 1.2Fu$ is

$$Fp = 1.2Fu$$

$$Le = \frac{2P}{Fut} = 1.25 \frac{2P}{58 \times 0.673} = 24.41 \text{ Kips}$$

$$L = \frac{2P}{Fut} + \frac{d}{2} \Rightarrow 2 = \frac{2P}{58 \times 0.673} + \frac{3/4}{2} = 31.7 \text{ Kips}$$

Gusset plate:

$$Le = \frac{2P}{Fut} = 1.25 = \frac{2P}{58 \times 1} \Rightarrow P = 36.25 \text{ Kips}$$

$$L = \frac{2P}{Fut} + \frac{d}{2} \Rightarrow 2 = \frac{2P}{68 \times 1} + \frac{3/4}{2} = 47.13 \text{ Kips}$$

Capacity $= 3 \times 36.25 + 12 \times 47.13 = 674.31$

$674.31^{\text{kips}} > 395$ Kips

Therefore 15 bolts in three rows of five are adiquate with end distance of $1\frac{1}{4}$ in and center to center Spacing of 2 in.

Complete Q:3