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7386

STEEL STRUCTURE

Summer Mid term.

Q # 1

GENERAL STATEMENT OF DESIGN PHILOSOPHIES:-

A General Statement assuming Safety in engineering Design.

Resistance of Materials and Cross-Section

$\geq$

Effect of Applied Loads.

1. It is essential that both Sides are evaluated for Some Conditions e.g. If effect of ~~Soil~~ load is to produce Compressive Stress on Soil, then it should be Compared with bearing Capacity of Soil.
2. when particular loading reaches it's 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 Structural Component Ceases to fulfill the function for which it's designed.

Limit State examples be:-

1. Deflection
2. Torsion
3. Cracking.

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ALLOWABLE STRESS DESIGN (ASD):-

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

$$FOS = \frac{\text{Resistance}, R}{\text{Effect of load}, Q} = \frac{f_y}{0.5 f_y} = 2$$

Mathematical Description:-

$$\frac{☒ R_n}{☒} ☒ ☒ Q_i$$

R_n: Resistance or Strength of the Component being Designed

ϕ = Resistance factor or Strength Reduction Factor.

☒ = Overload or Load factors.

$\frac{☒}{☒}$ = Factory of Safety F_s

Q_i: Effect of Applied loads.

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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 doesnt give reasonable Measures of Strength which is more fundemental measure of resistance than is allowable stress.

- Another drawback in ASD is that safety is applied only to stress level. Loads are Considered to deterministic.

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 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.

$$\boxtimes R_n \boxtimes \eta \boxtimes \boxtimes Q_i$$

R_n = Resistance or Strength of the Component being Designed

Q_i = Effect of Applied loads.

η = Takes into Account ductility, Redundancy and operational ~~Imp~~ Imp.

ϕ = Resistance factor or Strength Reduction factor.

$\boxtimes$ = Over load or Load Factors.

$\frac{\boxtimes}{\boxtimes}$: Factor of Safety.

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LRFD ADVANTAGES:-

1. LRFD accounts for both variability in resistance and load.

2. It achieves fairly uniform factor of Safety for different limit States.

3. It provides a rational a Consistent Method of design.

ASD ADVANTAGES:-

1. Elastic analysis for loads become Compatible for Design

2. Old famous books are according to this Method.

3. Experienced Engineers are used to this method.

DISADVANTAGE OF LRFD:-

1. It requires a change in design philosphy (from previous AASHTO methods).

2. It requires an understanding of the basic concepts of Probability and Statistics.

3. It requires availability of sufficient statistical data and Probabilistic design algorithms to make adjustments in the Resistance factors to meet individual situation.

DISADVANTAGES OF ASD:-

1. Latest research and literature is very limited.
2. Same factor of Safety is used for different loads.
3. Failure Mode is not directly Predicted.

Q#2

Types Of Bolted Connections

There are three basic joint types that we will consider.
1. Snug tight
2. Pretensioned
3. Slip Critical

The differences among these joint types are essentially the amount of Clamping force that is achieved when tightening the bolts and the degree to which the Connected Parts move while in service.

- The Contact area between the Connected Parts is Called the faying surface.
- In Any Project the engineer must indicate the joint Type and the faying surface that are to be used for any given Connection.

1. Snug Tight Connection

- A Snug tight Condition occurs when the bolts are in direct bearing and the Plies of Connection are in firm Contact.
- This Can be Accomplished by the full effort of a worker using a Spud wrench. which is an open-ended wrench approximately 16 in long.

A Snug tight Joint Can be Specified for most simple Shear Connection as well as tension only Connections.

- Snug tight Joints are not Permitted for Connecting supporting non static loads. nor are they Permited with A490 bolts loaded in tension.
- There is generally no need to limit the Situation.

2. PRETENSIONED CONNECTION:-

- A Pretensioned Joint has a greater amount for Clamping force than the Snugtight Condition and therefore Provides a greater degree of Slip-resistance in the joint.
- Pretensioned joints are used for joints that are subject to Cylical loads for fatigue loads.
- They are also required for joints with A490 bolts in tension.
- Some Specific examples of Connection where Pretensioned joints should be Specified are
  - ~~Eto~~ Column splices in buildings with high height to width ratios.
  - Connection with in the load Path of the lateral force resisting System.

3- SLIP- CRITICAL CONNECTION:-

This type of Joint is Similar to a Pretensioned joint Except that failure is assumed to occur when the applied load is greater than the friction force and thus slip doesn't occur between the faying Surfaces.

As with Pretensioned joints, Slip- Critical joints are used for joints Subjected to Cylical loads on fatigue loads.

- They should also be used in Connections that have Slotted holes parallel to the direction of the load or in Connection that use a Combination of welds and bolts along the Same faying Surface.

- The Amount of Pretension or Clamping force for a Slip Critical ~~bolt~~ bolt is the Same that was used for Pretensioned joints.

1:- BEARING FAILURE

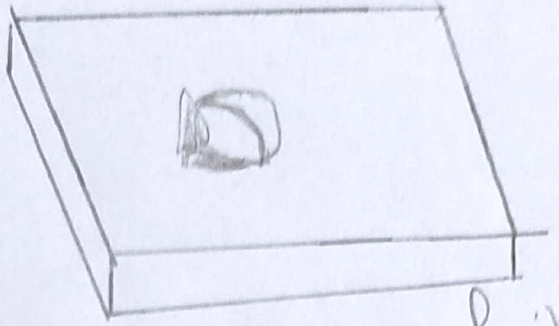
Bearing failure Reduces a Plants operating efficiency; ~~increase~~ increase downtime, driving Cost of operations up and in the worst Cases may injure workers.

2. NET TENSION FAILURE:-

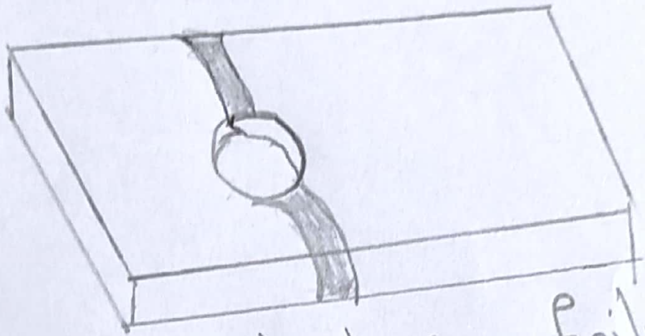
Net Tension failures Can be net Section failures of the Part or degradation of the Composite at a microscopic Scale where one or more layers in the Composite fail in tension of Matrix or failure of the bond between the Matrix and fibres.

Shear Failure:-

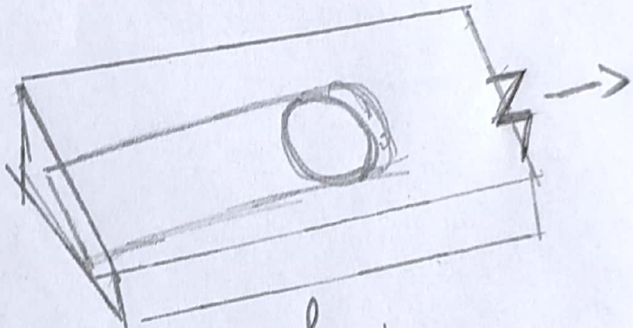
It Consist of hairline Vertical Cracks in the Masonary substrate Close to the Supports which developed at a slope of approximately 45°



Bearing failure



Net tension failure



Shear failure

Q# 3

Given Data:-

Dead Load = 130k

Live Load = 265k

Section = C10 × 30

Gusset Plate = 1 in

Bolts diameter = 3/4 in

A325, A36

threee bolts lines

Required:-

No of boltts = ?

Capacity using ASD = ?

Solution:-

① Finding total Service load

130 + 265 = 395 Kips

② Bolts Design:-

For 3/4 Dia

Area = $0.4418 in^2$ (Nominal Area)

Fv = 30 ksi (Taken from table 2.11)

Rv = 0.4418 × 30

Rv = 13.25 kips / shear Surface.

It is the Resistance offered by a single in Shear.

As there are two Shear surface per bolt

No of Bolts $= \frac{395}{2 \times 13.25} = 14.90 = \boxed{15 \text{ bolts.}}$

③ BEARING:-

$F_P = 1.2 F_V$

$F_P = 1.2 \times 58$

$\boxed{F_P = 69.6 \text{ ksi}}$

$\Rightarrow L_e = 1\frac{1}{2} d$

$L = 3d$ (Table 2-9)

Channel

$R_P = d t F_P = 3/4 \times 0.673 \times 69.6$

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

It is the single bearing surface of Channel.

For Bolts there are 30 Bearing surface So,

Capacity $= 30 \times 35.13$

$\boxed{= 1053.9 > 395 \text{ kips.}}$

GUSSET PLATE:-

$R_P = d t F_P$

$R_P = 3/4 \times 1 \times 69.6$

$\boxed{R_P = 52.2 \text{ kips}}$

It is the single bearing surface of Gusset Plate.

For gusset Plate there are 15 bearing surface So;

Capacity $= 15 \times 52.2$

$\approx 783 > 395$ kips.

④ SPACING:-

End Distance sheared Edge $= 1\frac{1}{4}$

End Distance $= 1\frac{1}{2} d = 1.13 \text{ in} \leq 1\frac{1}{4}$ in ⇒ Taken from Table 2-8

Center to Center $= 3d = 2\frac{1}{4}$ in ⇒ Taken from Table 2-9

As we can see that R_P for both channel and gusset Plate is considerably greater than required.

Consider minimum end distance of $1\frac{1}{4}$ in and the minimum between connection spacing of 2 in.

$$L_e = \frac{2P}{F_u t} = 1.25$$

t = will be 0.673 taken from Table 1-5 AISC manual.

$$\frac{2P}{58 \times 0.673} = 1.25$$

P = 24.4 kips.

$$L = \frac{2P}{F_u t} + \frac{d}{2}$$

$$2 = \frac{2P}{58 \times 0.673} + \frac{3/4}{2}$$

P = 31.7 kips.

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$$\text{Capacity} = 2(3(24.4) + 12(13.7))$$

$$\boxed{\text{Capacity} = 907.2 > 395 \text{ kips}}$$

Gusset

$$L_e = \frac{2P}{F_u t} \Rightarrow 1.25 = \frac{2P}{58 \times 1}$$

$$\boxed{P = 36.25 \text{ kips}}$$

$$L = \frac{2P}{F_u t} + \frac{d}{2} \Rightarrow 2 = \frac{2P}{58 \times 1} + \frac{3/4}{2}$$

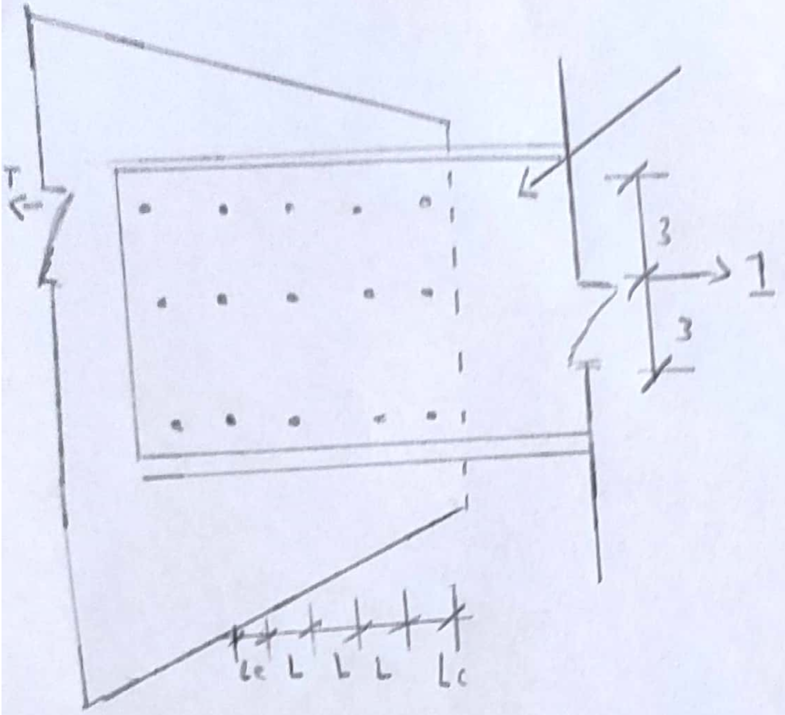
$$\boxed{P = 47.13 \text{ kips}}$$

$$\text{Capacity} = (3 \times (36.25) + 12(47.13))$$

$$\boxed{\text{Capacity} = 674.31 > 395 \text{ kips}}$$

So use 15 bolts in 3 rows of five with end distance $1\frac{1}{4}$ in and center to center spacing of 2 in.

DIAGRAM:-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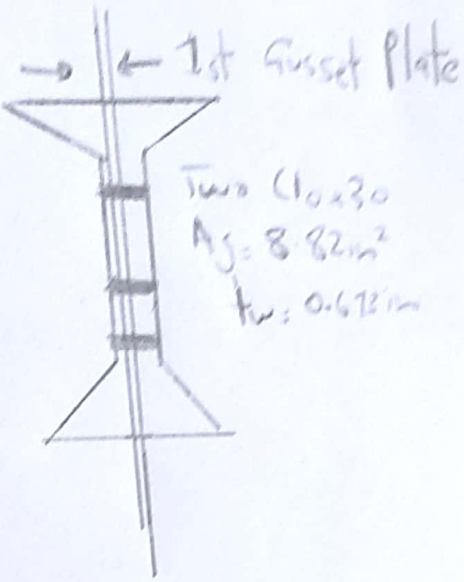
1st Gusset Plate
Two C10x30
Ag= 8.82in²
tw= 0.673in