

MUKAVEMET

KESME KUVVETİ

Perçin hesabı nda üç tahkik vardır.

- 1- perçinde kesme tahkiki
- 2- en ince levhada ezilme tahkiki
- 3- levhada gerilme tahkiki

N = perçin sayısı

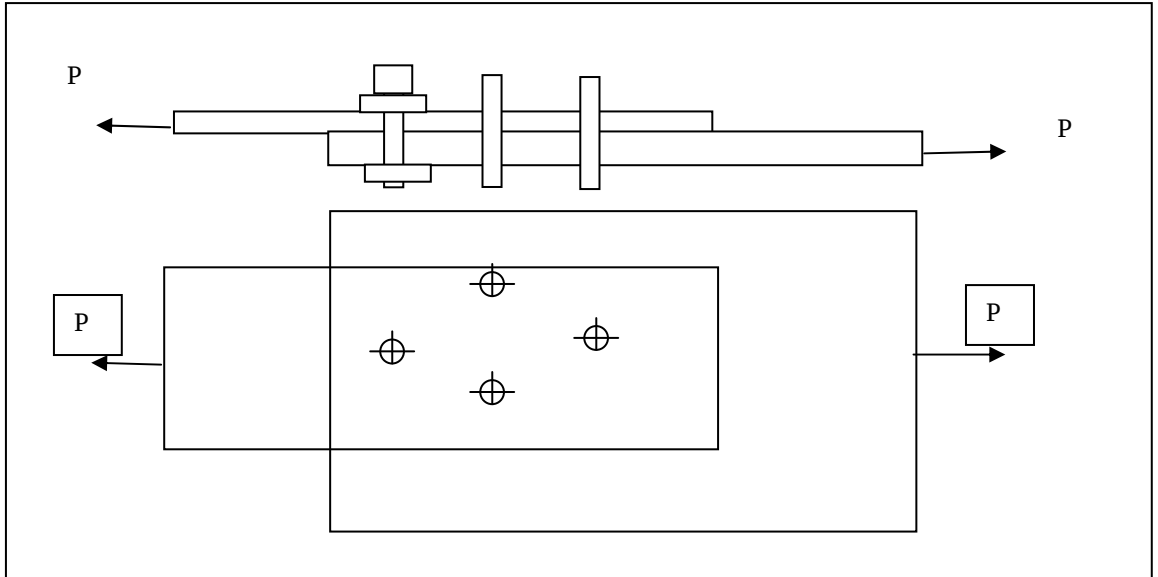
d = perçin çapı

A = perçin kesit alanı

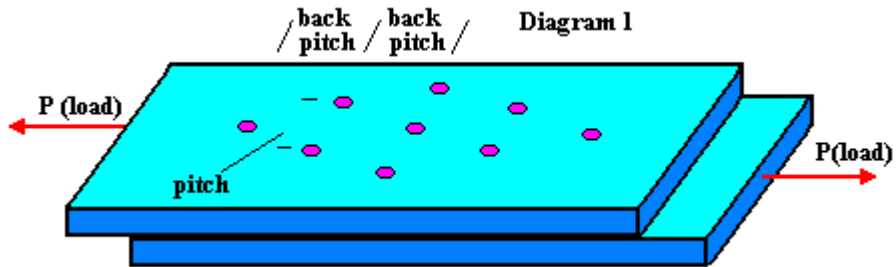
t = plak kalı nı ğ ı

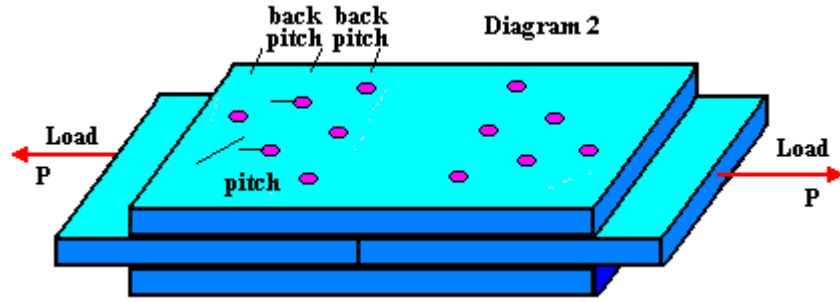
w = plak geniş liğ i

n = bir sı rada ki perçin sayısı (örneğ in 1. sı rada 1 perçin)

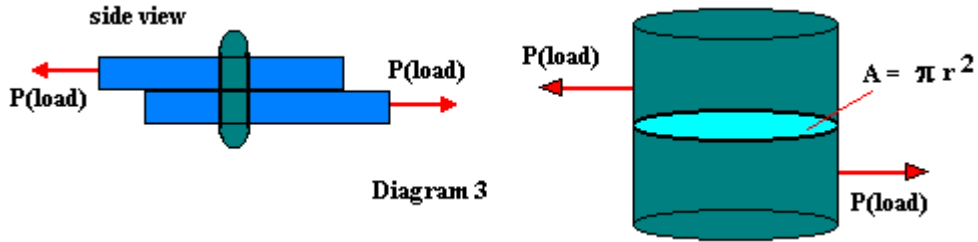


2.





1. Perçin Kesme kuvveti:



$$P_{\text{rivet shear}} = N (\pi \cdot d^2/4) \tau_{\text{all}}$$

N = perçin sayısı

$$A = \pi \cdot d^2/4 \text{ (or } \pi \cdot r^2)$$

2. Perçin /levha kontrolü

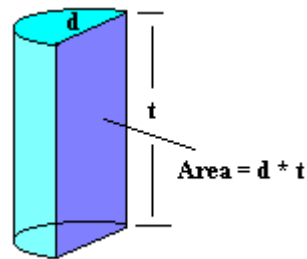
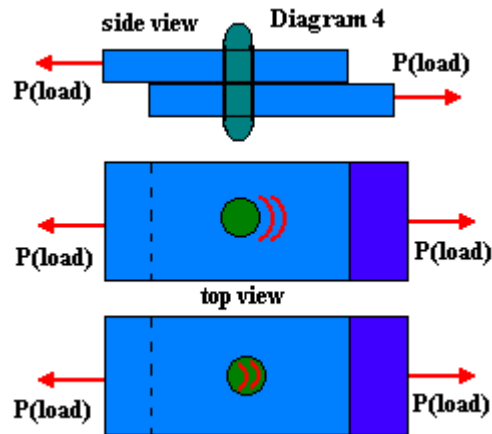


Diagram 5

$$P_{\text{bearing}} = N (d \cdot t) \sigma_{\text{all}}$$

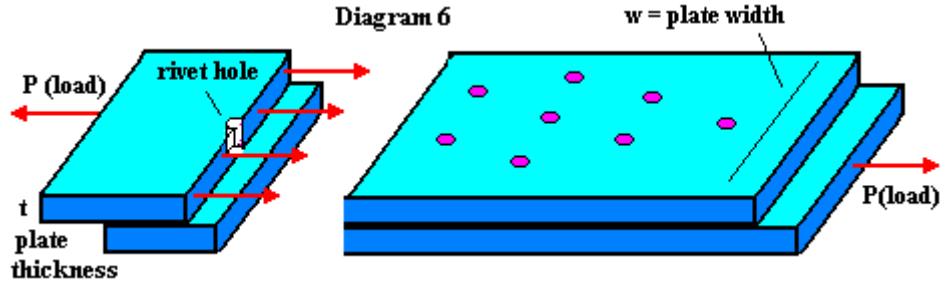
N = Perçin sayısı

d = perçin çapı

t = plak kalınlığı

3. Plak:

$$A = w \cdot t$$



$$P_{row1} = (w - n d)t \sigma_{all.},$$

w = plak genişliği

n = bir sıradaki perçin sayısı (örneğin 1. sırada 1 perçin)

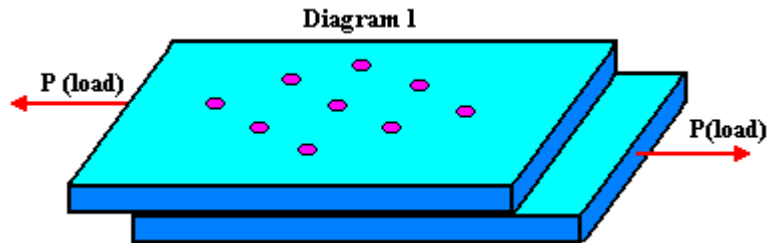
Örnek 1

$d = 5/8$ inch.

genişlik 6 inch ve kalınlık $1/2$ inch. Emniyet gerilmeler:

perçinde: $\tau = 16,000$ lb/in², $\sigma_t = 22,000$ lb/in², $\sigma_c = 24,000$ lb/in²

Plakta: $\tau = 14,000$ lb/in², $\sigma_t = 20,000$ lb/in², $\sigma_c = 23,000$ lb/in²



$$P = N (\pi \cdot d^2/4) \tau = (9 \text{ rivet areas}) \cdot [3.1416 \cdot (5/8)^2/4] \cdot 16,000 \text{ lb/in}^2 = 44,200 \text{ lb.}$$

$$P_{bearing} = N (d \cdot t) \sigma_{all} = (9 \text{ rivets}) \cdot (5/8" \cdot 1/2") \cdot (23,000 \text{ lb/in}^2) = 64,700 \text{ lb.}$$

Plak 1. sırası:

$$P_{row1} = (w - n d)t \sigma_{all} = (6" - 1 \cdot 5/8") \cdot (1/2") \cdot (20,000 \text{ lb/in}^2) = 53,750 \text{ lb.}$$

Plak 2.sırası

$$(8/9)P_{row2} = (w - n d)t \sigma_{all} = (6" - 2 \cdot 5/8") \cdot (1/2") \cdot (20,000 \text{ lb/in}^2) = 47,500 \text{ lb.},$$

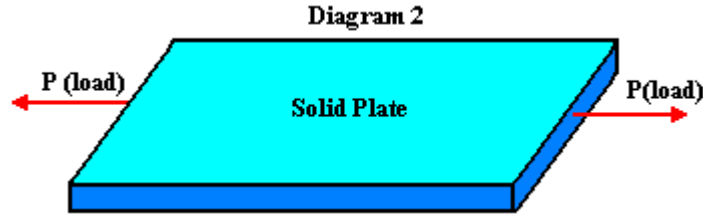
$$P_{row2} = (9/8) \cdot 47,500 \text{ lb.} = 53,400 \text{ lb.}$$

Plak 3 sırası:

$$(6/9)P_{\text{row3}} = (w - n d)t \sigma_{\text{all}} = (6'' - 3 * 5/8'') * (1/2'') * (20,000 \text{ lb/in}^2) = 41,250 \text{ lb.},$$

$$P_{\text{row3}} = (9/6) * 41,250 \text{ lb.} = 61,900 \text{ lb.}$$

$$P_{\text{plate}} = (w * t) * \sigma_{\text{all}} = (6'' * 1/2'') * 20,000 \text{ lb/in}^2 = 60,000 \text{ lb.}$$



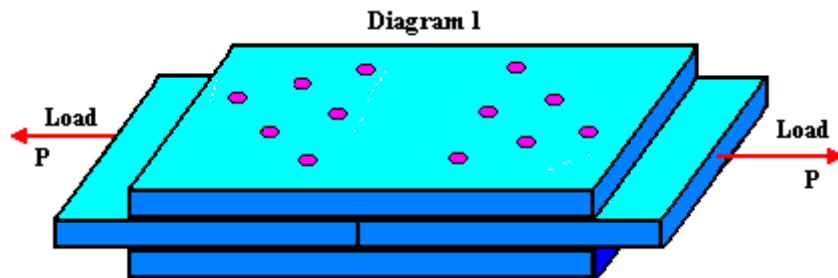
$$\text{Efficiency} = \text{Joint Strength} / \text{Plate Strength} = 44,200 \text{ lb.} / 60,000 \text{ lb.} = .737 = 73.7 \%$$

Örnek 2

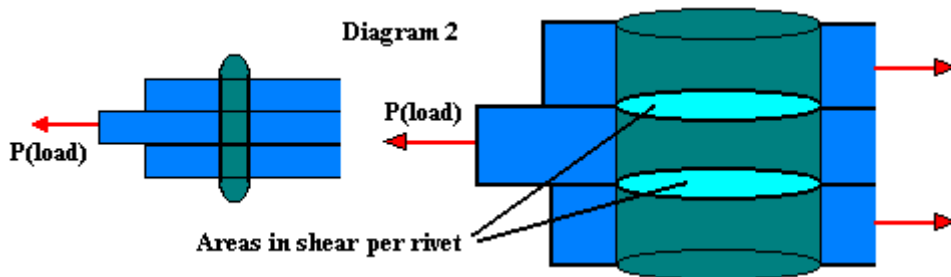
D= 3/4 inch. geniş lik 6 inch ve kalı nlı k 1/2 inch. Emniyet gerilmeleri:

Perçinde: $\tau = 18,000 \text{ lb/in}^2$, $\sigma_t = 22,000 \text{ lb/in}^2$, $\sigma_c = 24,000 \text{ lb/in}^2$

Plakta: $\tau = 16,000 \text{ lb/in}^2$, $\sigma_t = 21,000 \text{ lb/in}^2$, $\sigma_c = 22,000 \text{ lb/in}^2$



$$P = N (\pi * d^2/4) \tau = (12 \text{ rivet areas}) * [3.1416 * (3/4)^2/4] * 18,000 \text{ lb/in}^2 = 95,400 \text{ lb.}$$



$$P_{\text{bearing}} = N (d * t) \sigma_{\text{all}} = (6 \text{ rivets}) * (3/4'' * 1/2'') * (22,000 \text{ lb/in}^2) = 49,500 \text{ lb.}$$

1. Sı ra:

$$P_{\text{row1}} = (w - n d)t \sigma_{\text{all}} = (6'' - 1 * 3/4'') * (1/2'') * (21,000 \text{ lb/in}^2) = 55,100 \text{ lb.}$$

2 sı ra:

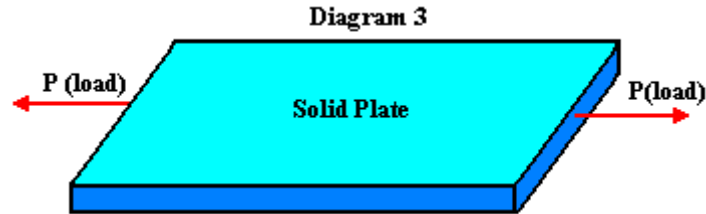
$$(5/6)P_{row2} = (w - n d)t \sigma_{all} = (6" - 2 * 3/4") * (1/2") * (21,000 \text{ lb/in}^2) = 47,250 \text{ lb.},$$

$$P_{row2} = (6/5) * 47,500 \text{ lb.} = 56,700 \text{ lb.}$$

3. SIRA:

$$(3/6)P_{row2} = (w - n d)t \sigma_{all} = (6" - 3 * 3/4") * (1/2") * (21,000 \text{ lb/in}^2) = 39,400 \text{ lb.},$$

$$P_{row2} = (6/3) * 39,400 \text{ lb.} = 78,800 \text{ lb.}$$



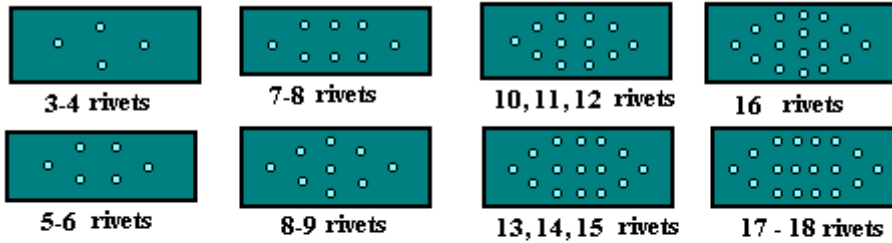
$$P_{plate} = (w * t) * \sigma_{all} = (6" * 1/2") * 21,000 \text{ lb/in}^2 = 63,000 \text{ lb.}$$

This is the plate

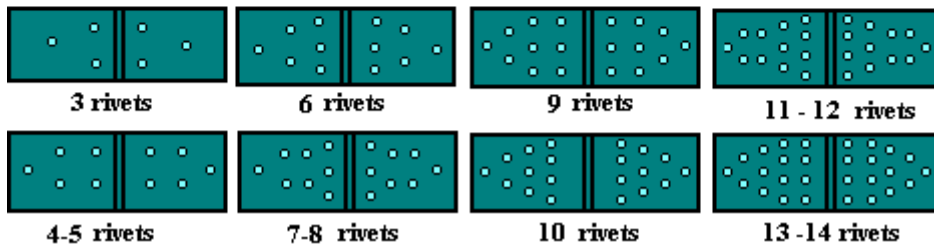
$$\text{Efficiency} = \text{Joint Strength} / \text{Plate Strength} = 49,500 \text{ lb.} / 63,000 \text{ lb.} = .786 = 78.6 \%$$

Perçin düzenekleri

Diagram 1 Lap Joint Patterns

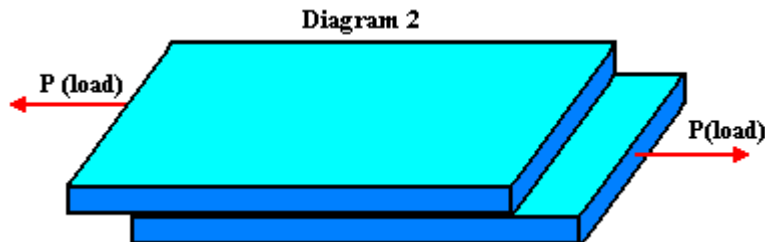


Butt Joint Patterns



Örnek

Geniş lik 6 inch, kalı nlı k 1/2 inch. çap 3/4 inch.



Perçinde: $\tau = 16,000 \text{ lb./in}^2$, $\sigma_t = 22,000 \text{ lb./in}^2$, $\sigma_c = 25,000 \text{ lb./in}^2$

Plakta: $\tau = 17,000 \text{ lb./in}^2$, $\sigma_t = 20,000 \text{ lb./in}^2$, $\sigma_c = 24,000 \text{ lb./in}^2$

$$P_{\text{row1}} = (w - n d)t \sigma_{\text{all}} ,$$

$$w = 6$$

n = perçin sayısı (bir sırada , 1 perçin)

$$d = 3/4 \text{ inch}$$

$$t = 1/2 \text{ inch}$$

$$\sigma_{\text{all}} = 20,000 \text{ lb./in}^2,$$

$$P_{\text{row1}} = (6" - 1 * 3/4") * (1/2") * 20,000 \text{ lb./in}^2 = 52,500 \text{ lb.}$$

$$P_{\text{rivet shear}} = N (\pi * d^2/4) \tau_{\text{all}}.$$

$$N = 1$$

$$d = 3/4 \text{ inch}$$

$$\tau_{\text{all}} = 16,000 \text{ lb./in}^2$$

$$P_{\text{rivet shear}} = 1 [3.1416 * (3/4")^2/4] * 16,000 \text{ lb./in}^2 = 7070 \text{ lb./rivet}$$

$$P_{\text{bearing}} = N (d*t) \sigma_{\text{all}} ,$$

$$N = 1$$

$$d = 3/4 \text{ inch}$$

$$t = 1/2 \text{ inch}$$

$$\sigma_{\text{all}} = 24,000 \text{ lb./in}^2$$

$$P_{\text{bearing}} = 1 * [(3/4") * (1/2")] * 24,000 \text{ lb./in}^2 = 9000 \text{ lb./rivet}$$

$$\# \text{ Perçinler} = 52,500 \text{ lb.} / 7070 \text{ lb./perçin} = 7.43 ; \# 8 \text{ perçin seçilir}$$

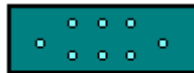


Diagram 3

$$P_{\text{shear}} = 8 * 7070 \text{ lb./rivet} = 56,560 \text{ lb.}$$

$$P_{\text{bearing}} = 8 * 9000 \text{ lb./rivet} = 72,000 \text{ lb.}$$

$$P_{\text{row1}} = (6" - 1 * 3/4") * (1/2") * 20,000 \text{ lb./in}^2 = 52,500 \text{ lb.}$$

$$(7/8)P_{\text{row2}} = (6" - 2 * 3/4") * (1/2") * 20,000 \text{ lb./in}^2 = 45,000 \text{ lb.}, \text{ and then}$$

$$P_{\text{row2}} = (8/7) 45,000 \text{ lb.} = 51,400 \text{ lb.}$$

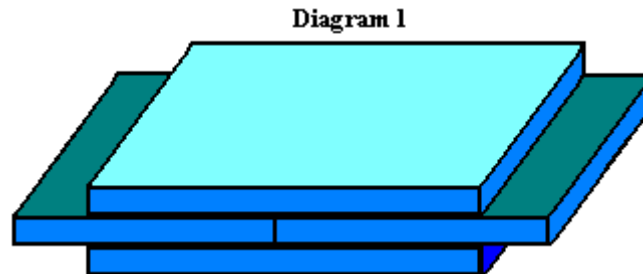
$$(5/8)P_{\text{row3}} = (6" - 2 * 3/4") * (1/2") * 20,000 \text{ lb./in}^2 = 45,000 \text{ lb.}, \text{ and then}$$

$$P_{\text{row3}} = (8/5) 45,000 \text{ lb.} = 72,000 \text{ lb.}$$

Strength of the Joint is 51,400 lb. (plate tearing row 2)

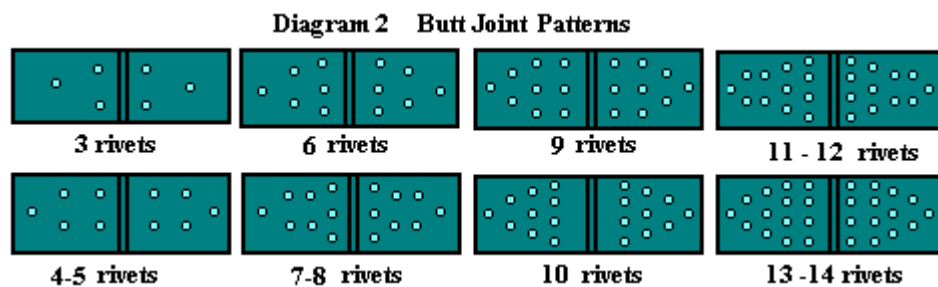
Efficiency = Joint Strength / Plate Strength = $51,400 \text{ lb.} / (6" * 1/2") * 20,000 \text{ lb./in}^2$
 = .86 = 86%

Örnek perçin seçimi



perçin: $\tau = 15,000 \text{ lb/in}^2$, $\sigma_t = 24,000 \text{ lb/in}^2$, $\sigma_c = 26,000 \text{ lb/in}^2$

Plak: $\tau = 16,000 \text{ lb/in}^2$, $\sigma_t = 22,000 \text{ lb/in}^2$, $\sigma_c = 24,000 \text{ lb/in}^2$



$$P_{\text{row1}} = (w - n d)t \sigma_{\text{all.}},$$

$w = 7 \text{ inches}$

$n = \text{bir sıradaki perçin sayısı}$

$d = 5/8 \text{ inch}$

$t = 3/4$

$\sigma_{\text{all}} = 22,000 \text{ lb/in}^2$,

$$P_{\text{row1}} = (7" - 1 * 5/8") * (3/4") * 22,000 \text{ lb/in}^2 = 105,200 \text{ lb.}$$

$$P_{\text{rivet shear}} = N (\pi * d^2/4) \tau_{\text{all.}}$$

$N = 2$

$d = 5/8 \text{ inch}$

$\tau_{\text{all}} = 15,000 \text{ lb/in}^2$

$$P_{\text{rivet shear}} = 2 [3.1416 * (5/8")^2/4] * 15,000 \text{ lb/in}^2 = 9200 \text{ lb./rivet}$$

$$P_{\text{bearing}} = N (d * t) \sigma_{\text{all.}}, \text{ where}$$

$N = 1$

$$d = 5/8 \text{ inch}$$

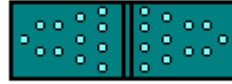
$$t = 3/4 \text{ inch}$$

$$\sigma_{\text{all}} = 24,000 \text{ lb/in}^2$$

$$P_{\text{bearing}} = 1 * [(5/8") * (3/4")] * 24,000 \text{ lb/in}^2 = 11,250 \text{ lb./rivet}$$

$$\# \text{ Perçin} = 105,200 \text{ lb.} / 9200 \text{ lb./perçin} = 11.43 ; \# \text{ seçilen} = 12$$

Diagram 3



11 - 12 rivets

$$P_{\text{shear}} = 12 * 9200 \text{ lb/rivet} = 110,400 \text{ lb.}$$

$$P_{\text{bearing}} = 12 * 11,250 \text{ lb./rivet} = 135,000 \text{ lb.}$$

$$P_{\text{row1}} = (7" - 1 * 5/8") * (3/4") * 22,000 \text{ lb/in}^2 = 105,200 \text{ lb.}$$

$$(11/12)P_{\text{row2}} = (7" - 2 * 5/8") * (3/4") * 22,000 \text{ lb/in}^2 = 94,875 \text{ lb., and then}$$

$$P_{\text{row2}} = (12/11) 94,875 \text{ lb.} = 103,500 \text{ lb.}$$

$$(9/12)P_{\text{row3}} = (7" - 2 * 5/8") * (3/4") * 22,000 \text{ lb/in}^2 = 94,875 \text{ lb., and then}$$

$$P_{\text{row3}} = (12/9) 94,875 \text{ lb.} = 126,500 \text{ lb.}$$

Kaynaklı birleşimler

Diagram 1a

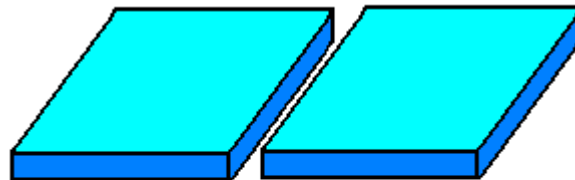
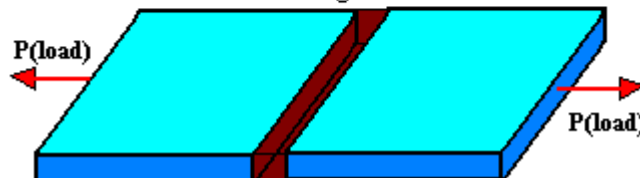


Diagram 1b



$$P_{\text{weld}} = (w * t) * \sigma_{\text{tension}}$$

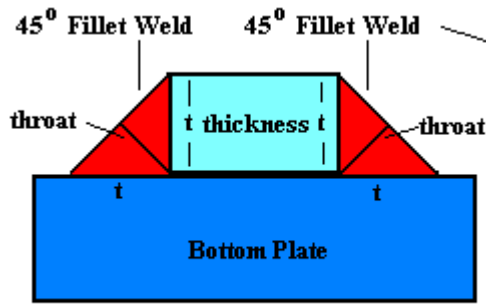


Diagram 2a

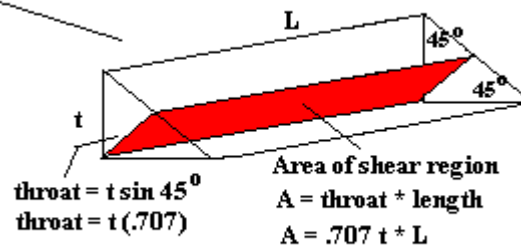


Diagram 2b

$$P_{\text{weld}} = \text{Area} * \tau_{\text{all}} = (\text{throat} * \text{length}) * \tau_{\text{all}} = (t \sin 45^\circ * L) * \tau_{\text{all}},$$

$$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}},$$

t = plak kalı nlı ğ ı

L = kaynak uzunluğ u

τ_{all} = kaynak malzemesinin kayma gerilmesi

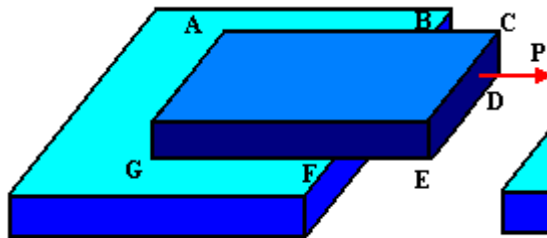


Diagram 3a

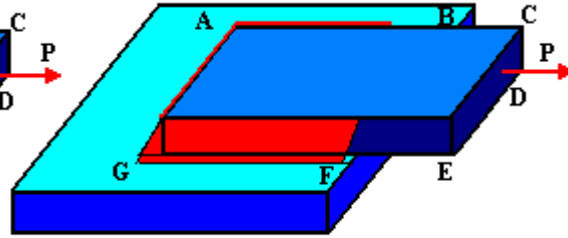


Diagram 3b

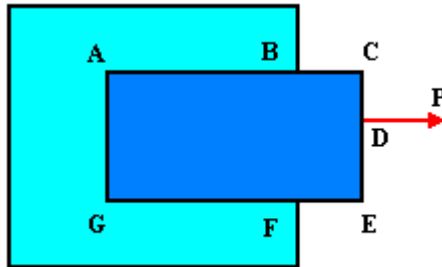


Diagram 4a

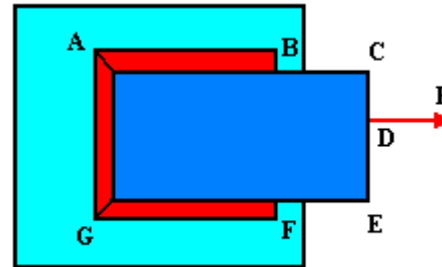


Diagram 4b

Örnek

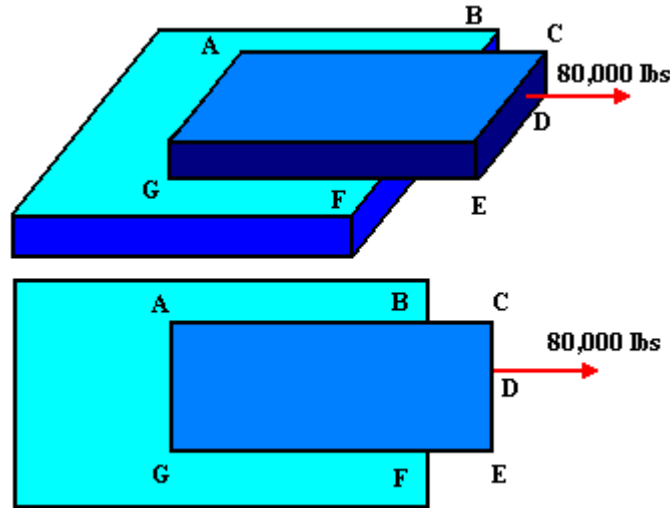


Diagram 5

Kaynak malzemesi: $\tau = 14,000 \text{ lb/in}^2$; $\sigma_t = 24,000 \text{ lb/in}^2$

Plak: $\tau = 15,000 \text{ lb/in}^2$; $\sigma_t = 30,000 \text{ lb/in}^2$

Boyutlar: AB = GF = 20 inches; CD = 3 inc; DE = 5 inc

Çözüm:

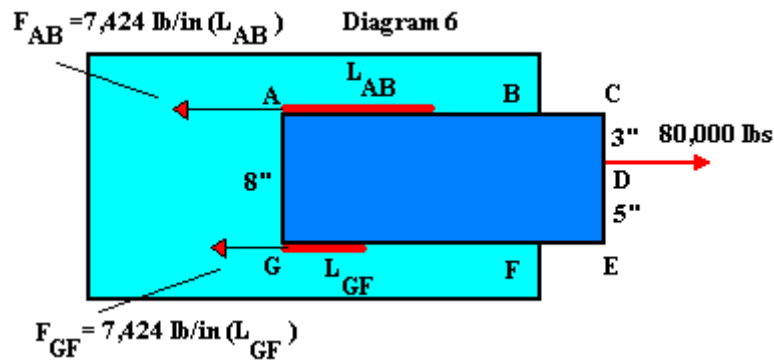
$$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}} ,$$

$$80,000 \text{ lb} = (.707 * 3/4" * L) * 14,000 \text{ lb/in}^2 = (7,424 \text{ lb./in.})L;$$

$$L = 80,000 \text{ lb.}/(7,424 \text{ lb./in.}) = 10.78 \text{ inches.}$$

$$F_{AB} = (7,424 \text{ lb./in.}) * L_{AB} ,$$

$$F_{GF} = (7,424 \text{ lb./in.}) * L_{GF} ,$$



$$\text{Toplam kuvvet } 80,000 \text{ lb.} - (7,424 \text{ lb./in.}) * L_{AB} - (7,424 \text{ lb./in.}) * L_{GF} = 0$$

$$\text{Toplam moment about G: } -80,000 \text{ lb.} * (5") + (7,424 \text{ lb./in.}) * L_{AB} * (8") = 0$$

$$L_{AB} = 6.73 \text{ inches,}$$

$$L_{GF} = 10.78" - 6.73" = 4.05"$$

$$P_{\text{plate}} = (w * t) * \sigma_t .$$

$$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}} = P_{\text{plate}} = (w * t) * \sigma_t , \text{ or}$$

$$(.707 t * L) * \tau_{\text{all}} = (w * t) * \sigma_t , \text{ and then}$$

$$(.707 * 3/4" * L) * 14,000 \text{ lb/in}^2 = (8" * 3/4") 30,000 \text{ lb/in}^2 ,$$

$$L = 24.25 \text{ inches}$$

Örnek 2

T= .5 inch, w= 10 inches

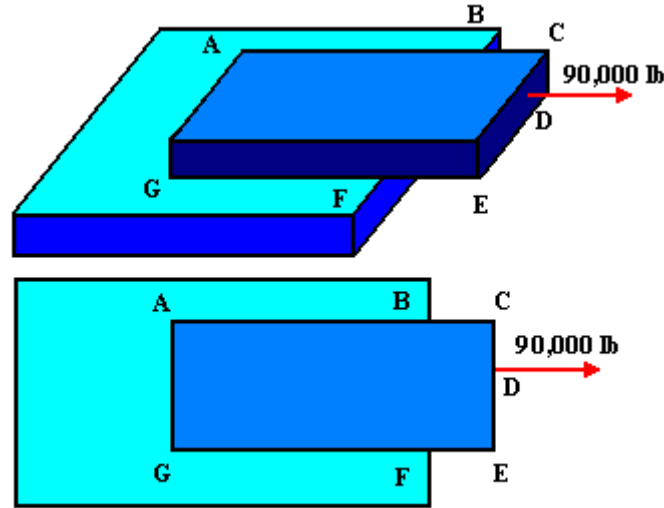


Diagram 1

Kaynakta: $\tau = 15,000 \text{ lb/in}^2$; $\sigma_t = 24,000 \text{ lb/in}^2$

Plakta: $\tau = 14,000 \text{ lb/in}^2$; $\sigma_t = 28,000 \text{ lb/in}^2$

AB = GF = 20 inches; CD = 4 inches; DE = 6 inches

Çözüm:

$$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}} , \text{ or}$$

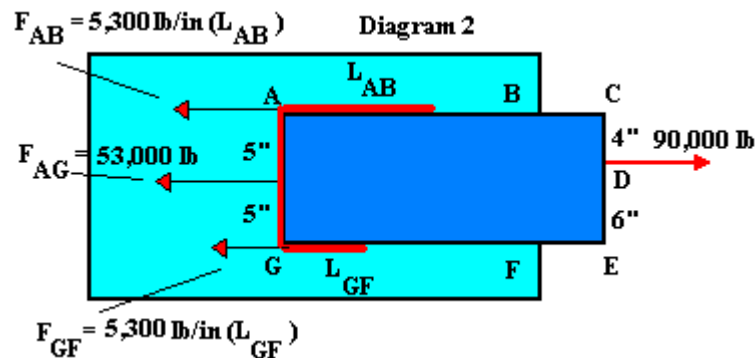
$$90,000 \text{ lb} = (.707 * .5" * L) * 15,000 \text{ lb/in}^2 = (5,300 \text{ lb./in.}) * L;$$

$$L = 90,000 \text{ lb.} / (5,300 \text{ lb./in.}) = 16.98 \text{ inches.}$$

$$F_{AB} = (5,300 \text{ lb./in.}) * L_{AB} ,$$

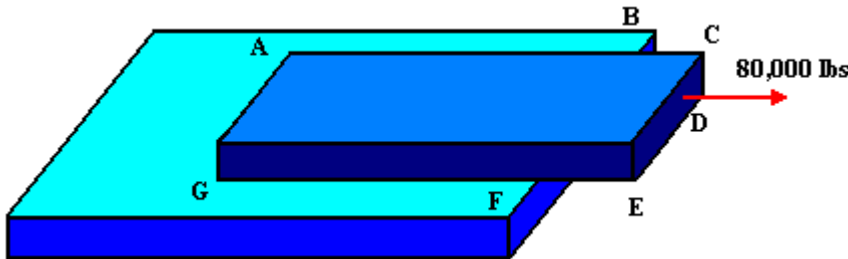
$$F_{GF} = (5,300 \text{ lb./in.}) * L_{GF} ,$$

$$F_{AG} = 5,300 \text{ lb/in} * 10" = 53,000 \text{ lb.}$$



Toplam kuvvet: $90,000 \text{ lb.} - (5,300 \text{ lb./in.}) * L_{AB} - (5,300 \text{ lb./in.}) * L_{GF} - 53,000 \text{ lb.}$
 $= 0$

Toplam moment _{about G}: $-90,000 \text{ lb.} * (6'') + (5,300 \text{ lb./in.}) * L_{AB} * (10'') + 53,000 \text{ lb.} * 5'' = 0$



$L_{AB} = 5.19 \text{ inches,}$

$L_{AB} + L_{GF} + 10'' = 16.98$
inches.

$L_{GF} = 16.98'' - 5.19'' - 10'' =$
 $1.79''$

$P_{\text{plate}} = (w * t) * \sigma_t.$

$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}} = P_{\text{plate}} = (w * t) * \sigma_t, \text{ or}$

$(.707 t * L) * \tau_{\text{all}} = (w * t) * \sigma_t, \text{ and then}$

$(.707 * .5'' * L) * 15,000 \text{ lb/in}^2 = (10'' * .5'') * 28,000 \text{ lb/in}^2,$

$L = 26.4 \text{ inches}$

Örnek

Üst plaka $t = .5 \text{ inch}, w = 8 \text{ inc}$

Kaynak: $\tau = 12,000 \text{ psi}, \sigma_t = 24,000 \text{ psi}$

Plaka: $\tau = 15,000 \text{ psi}, \sigma_t = 30,000 \text{ psi}$

$AB = GF = 20 \text{ inches:}$

$CD = 3 \text{ inches: } DE = 5 \text{ inches}$

Çözüm:

$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}}, \text{ or}$

$80,000 \text{ lb} = (.707 * .5'' * L) * 12,000 \text{ lb/in}^2 = (4,242 \text{ lb./in.}) * L; \text{ then solving for } L$

$L = 80,000 \text{ lb.} / (4,242 \text{ lb./in.}) = 18.86 \text{ inches.}$

$F_{AB} = (4,242 \text{ lb./in.}) * L_{AB}, F_{GF} = (4,242 \text{ lb./in.}) * L_{GF}, \text{ and } F_{AG} = 4,242 \text{ lb/in} * 8''$

$= 33,936 \text{ lb.}$ as shown in Diagram 2. We now apply static equilibrium conditions to the top plate:

Sum of Forces: $80,000 \text{ lb.} - (4,242 \text{ lb./in.}) * L_{AB} - (4,242 \text{ lb./in.}) * L_{GF} - 33,936 \text{ lb.}$

$= 0$

Sum of Torque _{about G}: $-80,000 \text{ lb.} * (5'') + (4,242 \text{ lb./in.}) * L_{AB} * (8'') + 33,936 \text{ lb.}$

$$\sum M_A = 0$$

$$L_{AB} = 7.79 \text{ inches,}$$

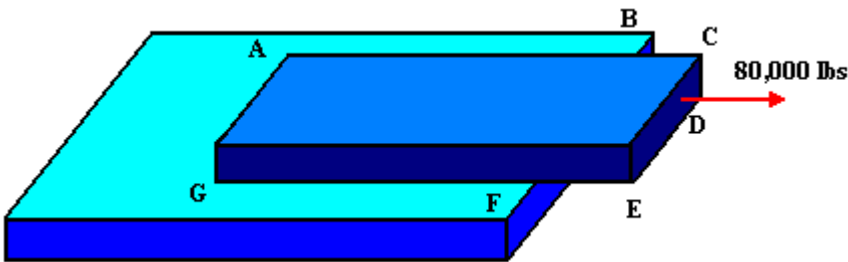
$$L_{GF} = 18.86" - 7.79" - 8" = 3.07"$$

$$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}} = P_{\text{plate}} = (w * t) * \sigma_t, \text{ or}$$

$$(.707 t * L) * \tau_{\text{all}} = (w * t) * \sigma_t, \text{ and then}$$

$$(.707 * .5" * L) * 12,000 \text{ lb/in}^2 = (8" * .5") * 30,000 \text{ lb/in}^2,$$

$$L = 28.29 \text{ inches}$$



Örnek

Üstteki plaka kalınlığı 1/2 in.

0.7 inch genişliğinde 6 inch, 45° açılı ile kaynaklanıyor.

Kaynak uzunluğunu bulunuz:

kaynak malzemesi: $\tau = 16,000 \text{ psi}$, $\sigma_t = 30,000 \text{ psi}$

Plak Malzemesi: $\tau = 14,000 \text{ psi}$, $\sigma_t = 28,000 \text{ psi}$

Boyutlar:

AB = GF = 30 inches:

CD = 2 inches: DE = 4 inches

Çözüm:

$$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}},$$

$$80,000 \text{ lb} = (.707 * .7" * L) * 16,000 \text{ lb/in}^2 = (7,918 \text{ lb./in.}) * L;$$

$$L = 80,000 \text{ lb.} / (7,918 \text{ lb./in.}) = 10.1 \text{ inches.}$$

$$F_{AB} = (7,918 \text{ lb./in.}) * L_{AB},$$

$$F_{GF} = (7,918 \text{ lb./in.}) * L_{GF},$$

$$F_{AG} = 7,918 \text{ lb/in} * 6" = 47,510 \text{ lb.}$$

$$\text{Kuvvet dengesi: } 80,000 \text{ lb.} - (7,918 \text{ lb./in.}) * L_{AB} - (7,918 \text{ lb./in.}) * L_{GF} - 47,510$$

$$\text{lb.} = 0$$

$$\text{Moment dengesi about G: } -80,000 \text{ lb.} * (4") + (7,918 \text{ lb./in.}) * L_{AB} * (6") + 47,510$$

$$\text{lb.} * 3" = 0$$

$$L_{AB} = 3.74 \text{ inches,}$$

$$L_{GF} = 10.1" - 3.74" - 6" = .36"$$

$$P_{\text{weld}} = (.707 t * L) * \tau_{\text{all}} = P_{\text{plate}} = (w * t) * \sigma_t, \text{ or}$$

$$(.707 t * L) * \tau_{\text{all}} = (w * t) * \sigma_t,$$

$$(.707 * .7" * L) * 16,000 \text{ lb/in}^2 = (6" * .7") * 28,000 \text{ lb/in}^2,$$

$$L = 14.85 \text{ inches}$$

