

STRUKTUR BAJA I



Perhitungan
Sambungan Paku Keling

Sama seperti pada sambungan baut, pada sambungan paku keling juga harus diperhitungkan terhadap geser dan tumpu. Besarnya tegangan geser dan tegangan tumpu yang diijinkan adalah sbb :

$$\bar{\tau} = 0,8\bar{\sigma}$$

$$\bar{\sigma}_{tp} = 2\bar{\sigma}; \text{bila} \Rightarrow a_1 \geq 2d$$

$$\bar{\sigma}_{tp} = 1,6\bar{\sigma}; \text{bila} \Rightarrow 1,5 \leq a_1 < 2d$$

Daya pikul 1 (satu) paku keling adalah:

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$N_{gs} = \frac{1}{4} \pi d^2 \cdot \bar{\tau} \quad \Rightarrow \quad \text{Sambungan tunggal}$$

$$N_{gs} = 2 \cdot \frac{1}{4} \pi d^2 \cdot \bar{\tau} \quad \Rightarrow \quad \text{Sambungan dobel}$$

Note: setelah dikeling \emptyset pk = \emptyset lubang
 $d = \emptyset$ lubang = \emptyset pk + 1 mm



Contoh 1

Dua plat akan disambungkan secara sambungan tunggal, spt gbr di bawah dengan data sbb:

$$P = + 1500 \text{ kg}$$

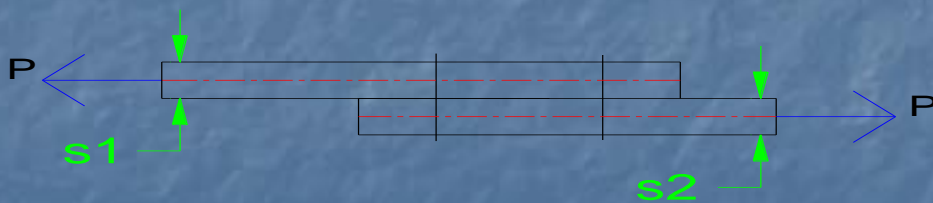
$$s_1 = 10 \text{ mm} = 1 \text{ cm}$$

$$s_2 = 8 \text{ mm} = 0,8 \text{ cm}$$

$$\varnothing \text{ pk} = 17 \text{ mm} = 1,7 \text{ cm (lubang)}$$

$$\bar{\sigma} = 1400 \text{ kg} / \text{cm}^2$$

Hitunglah jumlah baut yang diperlukan



$$s_2 < s_1$$

$$s_2 = s_{\min} = 0,8 \text{ cm}$$

$$N_{gs} = \frac{1}{4} \pi d^2 \cdot \bar{\tau}$$

$$\begin{aligned} N_{gs} &= \frac{1}{4} \times 3,14 \times (1,7 \text{ cm})^2 \times 0,8 \times 1400 \text{ kg/cm}^2 \\ &= 2541 \text{ kg} \end{aligned}$$

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$\begin{aligned} N_{tp} &= 1,7 \text{ cm} \times 0,8 \text{ cm} \times 2 \times 1400 \text{ kg/cm}^2 \\ &= 3808 \text{ kg} \end{aligned}$$

$N_{\min} = N_{gs} = 2541 \text{ kg} \rightarrow$ menentukan
Jumlah baut (n) yg dibutuhkan adalah:

$$n = \frac{P}{N_{\min}} = \frac{1500 \text{ kg}}{2541 \text{ kg}} = 0,59 \approx 1 \text{ buah}$$

Jumlah pk minimal 2 buah, ambil 2 Ø 17 mm

Contoh 2

Dua plat akan disambungkan secara sambungan dobel, spt gbr di bawah dengan data sbb:

$$P = 5000 \text{ kg}$$

$$s_1 = 10 \text{ mm} = 1 \text{ cm}$$

$$s_2 = s_3 = 8 \text{ mm} = 0,8 \text{ cm}$$

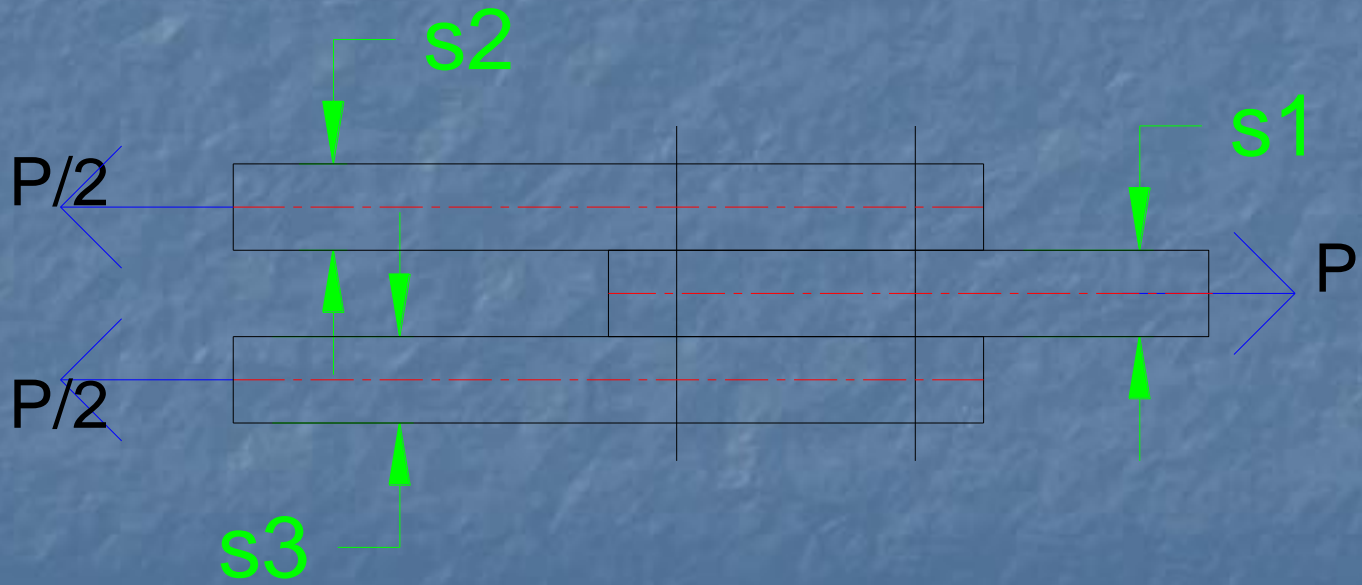
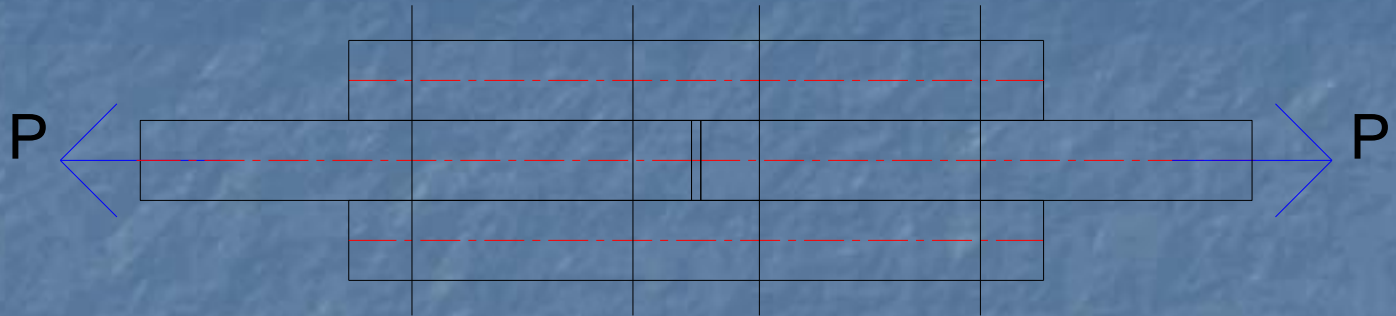
$$\emptyset \text{ pk} = 17 \text{ mm} = 1,7 \text{ cm (lubang)}$$

$$\bar{\sigma} = 1400 \text{ kg} / \text{cm}^2$$

$$s_1 = 1 \text{ cm} < (s_2 + s_3) = 1,6 \text{ cm}$$

$$s_1 = s_{\min}$$

Hitunglah jumlah pk yang diperlukan



$$N_{gs} = 2 \frac{1}{4} \pi d^2 \cdot \bar{\tau}$$

$$\begin{aligned} N_{gs} &= 2 \times \frac{1}{4} \times 3,14 \times (1,7 \text{ cm})^2 \times 1120 \text{ kg/cm}^2 \\ &= 5082 \text{ kg} \end{aligned}$$

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$\begin{aligned} N_{tp} &= 1,7 \text{ cm} \times 1 \text{ cm} \times 2800 \text{ kg/cm}^2 \\ &= 4760 \text{ kg} \end{aligned}$$

$N_{\min} = N_{tp} = 4760 \text{ kg} \rightarrow$ menentukan
Jumlah pk (n) yg dibutuhkan adalah:

$$n = \frac{P}{N_{\min}} = \frac{5000 \text{ kg}}{4760 \text{ kg}} = 1,05 \approx 2 \text{ buah}$$

Jadi jumlah pk 2 \emptyset 17 mm

Soal 3

Dua batang baja L 50.50.5 akan disambung secara sambungan tunggal, dengan data sbb:

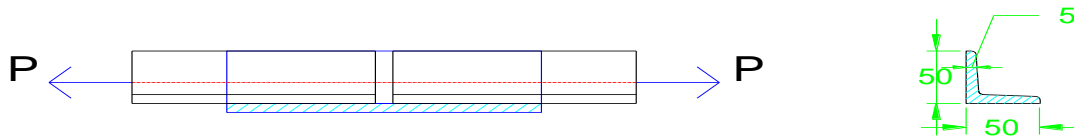
$$P = 3000 \text{ kg}$$

Tebal plat penyambung $s = 6 \text{ mm} = 0,6 \text{ cm}$

$\varnothing \text{ pk} = 13,5 \text{ mm} = 1,35 \text{ cm}$ (lubang)

Sambungan pada kedua kakinya

$$\bar{\sigma} = 1400 \text{ kg} / \text{cm}^2$$



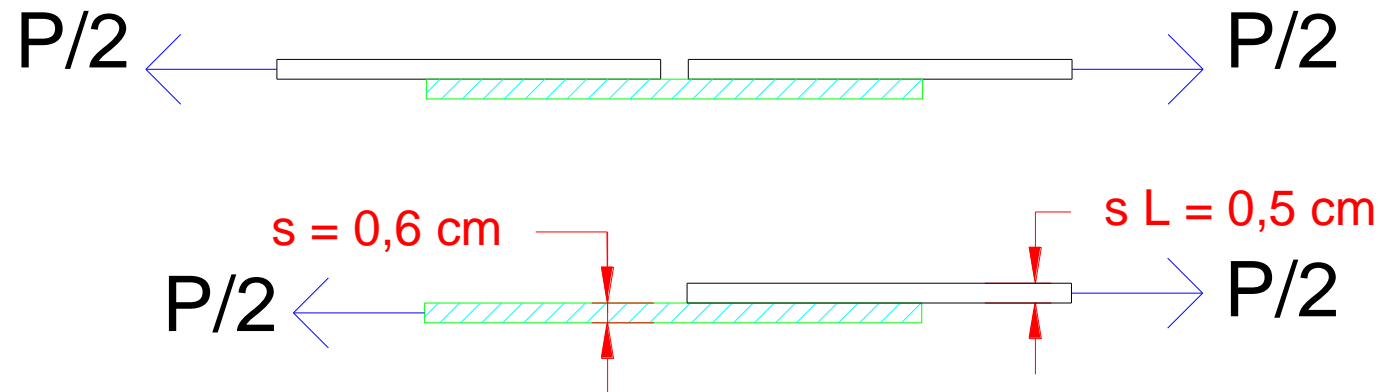
Hitunglah jumlah pk yang diperlukan

Penyelesaian:

$P = 3000 \text{ kg}$ ditahan oleh penampang profil L 50.50.5.

Untuk 1 kaki $P/2 = 3000\text{kg}/2 = 1500\text{kg}$.

Plat datar:



$$s_{\min} = 0,5 \text{ cm}$$

$$N_{gs} = \frac{1}{4} \pi d^2 \cdot \bar{\tau}$$

$$\begin{aligned} N_{gs} &= \frac{1}{4} \times 3,14 \times (1,35 \text{ cm})^2 \times 1120 \text{ kg/cm}^2 \\ &= 1602 \text{ kg} \end{aligned}$$

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$\begin{aligned} N_{tp} &= 1,35 \text{ cm} \times 0,5 \text{ cm} \times 2800 \text{ kg/cm}^2 \\ &= 1890 \text{ kg} \end{aligned}$$

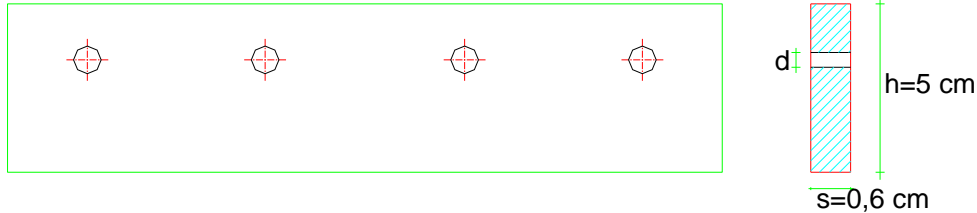
$N_{\min} = N_{gs} = 1602 \text{ kg} \rightarrow$ menentukan
Jumlah pk (n) yg dibutuhkan adalah:

$$n = \frac{P}{N_{\min}} = \frac{1500 \text{ kg}}{1602 \text{ kg}} = 0,936 \approx 1 \text{ buah}$$

Jadi jumlah pk 2 \emptyset 13,5 mm

Untuk plat tegak analog dengan plat datar

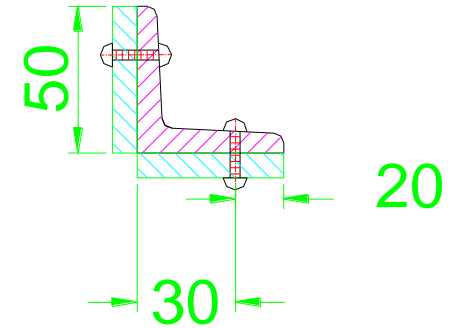
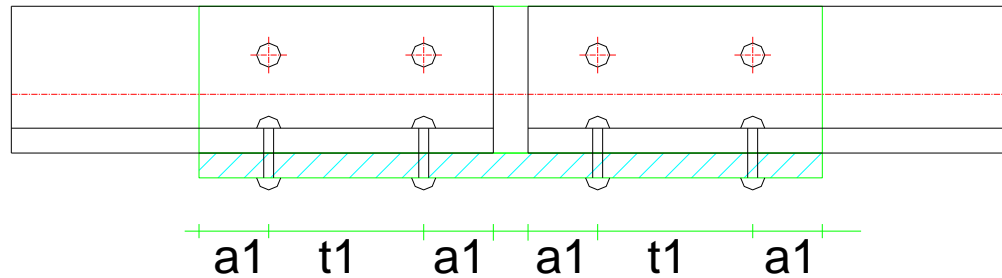
Kontrol plat penyambung:



$$\begin{aligned}F_n &= (hxs) - (dxs) \\ &= (5 \times 0,6) - (1,35 \times 0,6) \\ &= 2,19 \text{ cm}^2\end{aligned}$$

$$\sigma = \frac{P/2}{F_n} = \frac{1500 \text{ kg}}{2,19 \text{ cm}^2} = 684,932 \text{ kg/cm}^2 < \bar{\sigma} = 1400 \text{ kg/cm}^2$$

Gambar skets sambungan:



$$a_1 = 35 \text{ mm}$$

$$t_1 = 60 \text{ mm}$$

Soal 4

Dua batang baja kanal [14 akan disambung secara sambungan tunggal, dengan data sbb:

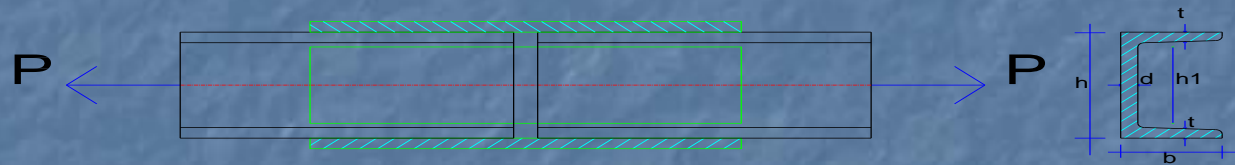
$P = 6120 \text{ kg}$ (bekerja pada titik berat profil)

Tebal plat penyambung $s = 10 \text{ mm} = 1 \text{ cm}$

$\varnothing \text{ pk} = 17 \text{ mm} = 1,7 \text{ cm}$ (lubang)

Sambungan pada badan dan kedua kakinya

$$\bar{\sigma} = 1400 \text{ kg} / \text{cm}^2$$



Hitunglah jumlah pk yang diperlukan

Penyelesaian:

Dari tabel profil [14 diperoleh:

$$h = 140 \text{ mm} = 14 \text{ cm} \quad h_1 = 98 \text{ mm} = 9,8 \text{ cm}$$

$$b = 60 \text{ mm} = 6 \text{ cm} \quad d = 7 \text{ mm} = 0,7 \text{ cm}$$

$$t = 10 \text{ mm} = 1 \text{ cm} \quad F_{1 \text{ flens}} = 6,0 \text{ cm}^2$$

$$F_{\text{rib}} = 8,4 \text{ cm}^2 \quad F_{\text{profil}} = 20,4 \text{ cm}^2$$

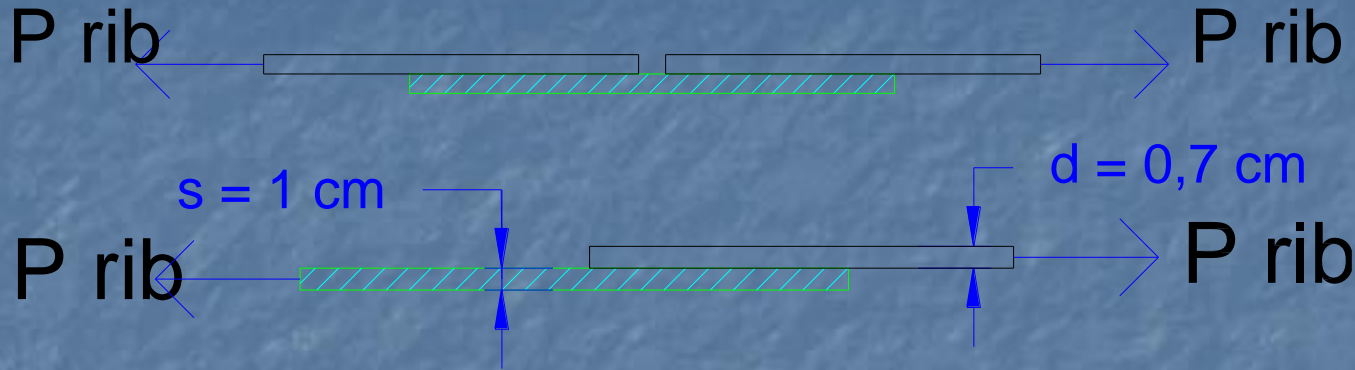
Gaya $P = 6120 \text{ kg}$ ditahan oleh seluruh penampang profil.

Distribusi gaya:

$$P_{\text{rib}} = \frac{F_{\text{rib}}}{F_{\text{prof}}} \times P = \frac{8,4 \text{ cm}^2}{20,4 \text{ cm}^2} \times 6120 \text{ kg} = 2520 \text{ kg}$$

$$P_{\text{flens}} = \frac{F_{\text{flens}}}{F_{\text{prof}}} \times P = \frac{6,0 \text{ cm}^2}{20,4 \text{ cm}^2} \times 6120 \text{ kg} = 1800 \text{ kg}$$

Sambungan rib (badan).



$$N_{gs} = \frac{1}{4} \pi d^2 \cdot \bar{\tau}$$

$$N_{gs} = \frac{1}{4} \times 3,14 \times (1,7 \text{ cm})^2 \times 1120 \text{ kg/cm}^2 = 2541 \text{ kg}$$

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$N_{tp} = 1,7 \text{ cm} \times 0,7 \text{ cm} \times 2800 \text{ kg/cm}^2 = 3332 \text{ kg}$$

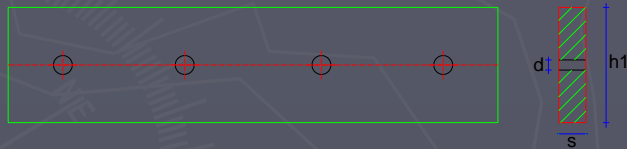
$$N_{\min} = N_{gs} = 2541 \text{ kg} \rightarrow \text{menentukan}$$

Jumlah pk (n) yg dibutuhkan pada rib adalah:

$$n = \frac{P_{rib}}{N_{min}} = \frac{2520kg}{2541kg} = 0,992 \approx 1 buah$$

Ambil pk 2 Ø 17 mm

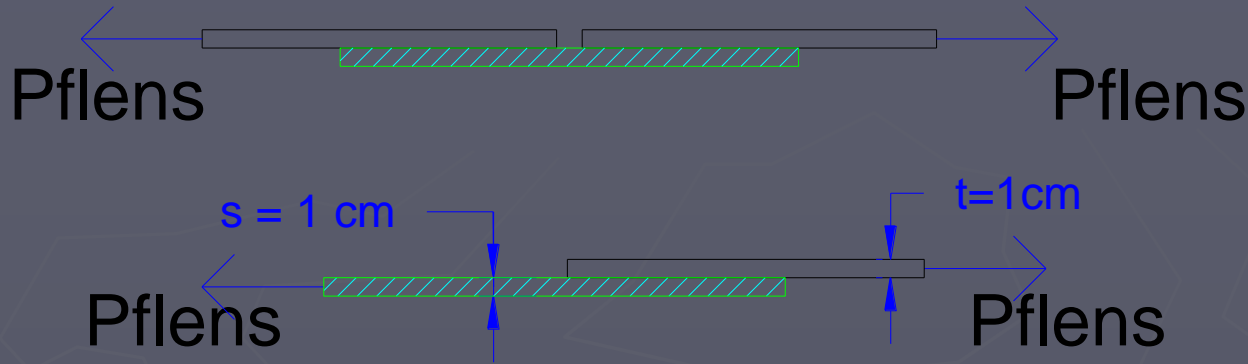
Kontrol plat penyambung:



$$\begin{aligned} F_n &= (h_1 \times s) - (d \times s) \\ &= (9,8 \times 1) - (1,7 \times 1) \\ &= 8,1 \text{ cm}^2 \end{aligned}$$

$$\sigma = \frac{P_{rib}}{F_n} = \frac{2520 \text{ kg}}{8,1 \text{ cm}^2} = 311,11 \text{ kg/cm}^2 < \bar{\sigma} = 1400 \text{ kg/cm}^2$$

Sambungan flens:



$$N_{gs} = \frac{1}{4} \pi d^2 \cdot \bar{\tau}$$

$$N_{gs} = \frac{1}{4} \times 3,14 \times (1,7 \text{ cm})^2 \times 1120 \text{ kg/cm}^2 = 2541 \text{ kg}$$

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$N_{tp} = 1,7 \text{ cm} \times 1 \text{ cm} \times 2800 \text{ kg/cm}^2 = 4760 \text{ kg}$$

$$N_{\min} = N_{gs} = 2541 \text{ kg} \rightarrow \text{menentukan}$$

Jumlah pk (n) yg dibutuhkan pada flens adalah:

$$n = \frac{P_{rib}}{N_{min}} = \frac{1800kg}{2541kg} = 0,708 \approx 1 buah$$

Ambil pk 2 Ø 17 mm

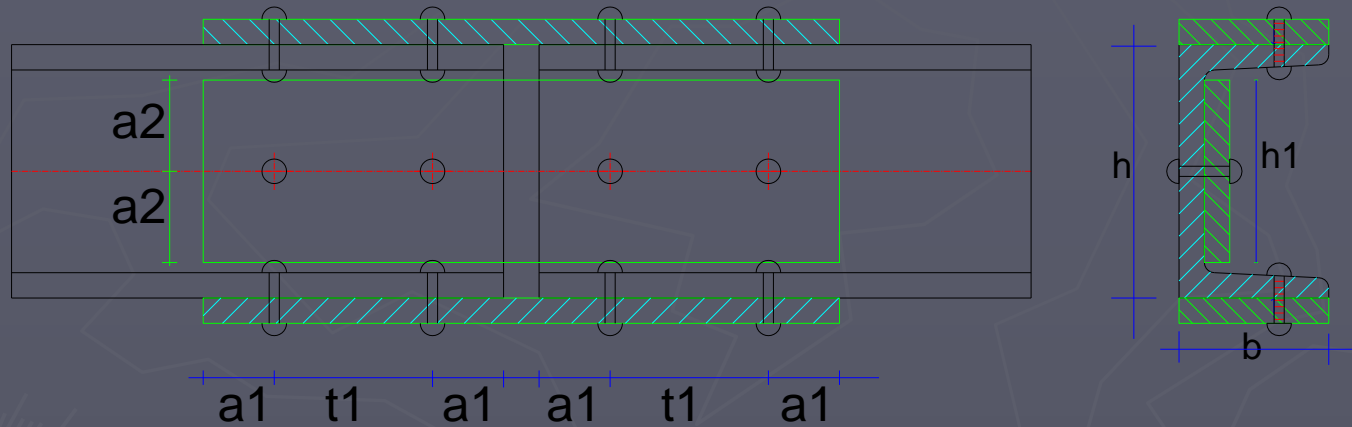
Kontrol plat penyambung:



$$\begin{aligned} F_n &= (h_1 \times s) - (d \times s) \\ &= (6 \times 1) - (1,7 \times 1) \\ &= 4,3 \text{ cm}^2 \end{aligned}$$

$$\sigma = \frac{P_{flens}}{F_n} = \frac{1800 \text{ kg}}{4,3 \text{ cm}^2} = 418,605 \text{ kg/cm}^2 < \bar{\sigma} = 1400 \text{ kg/cm}^2$$

Gambar skets sambungan:



$$a_1 = 35 \text{ mm}$$

$$t_1 = 60 \text{ mm}$$

$$a_2 = 48 \text{ mm}$$

Soal 5

Dua batang baja dari profil DIE akan disambungkan, dengan data sbb:

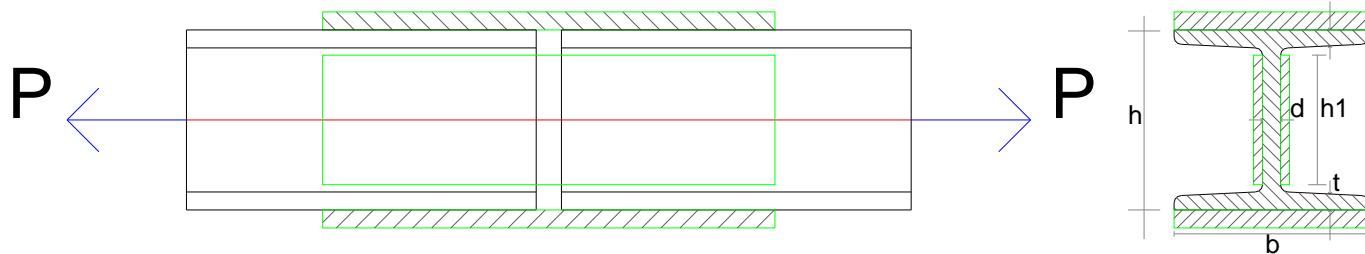
$P = 11.400 \text{ kg}$ (bekerja pada titik berat profil)

Tebal plat penyambung s-rib = 0,5 cm dan s-flens=1 cm

$\varnothing \text{ pk} = 17 \text{ mm} = 1,7 \text{ cm}$ (lubang)

Sambungan pada badan dan kedua flensnya (spt gbr)

$$\bar{\sigma} = 1400 \text{ kg} / \text{cm}^2$$



Hitunglah jumlah pk yang diperlukan

Penyelesaian:

Dari tabel profil diperoleh:

$$h = 190 \text{ mm} = 19 \text{ cm} \quad h_1 = 138 \text{ mm} = 13,8 \text{ cm}$$

$$b = 197 \text{ mm} = 19,7 \text{ cm} \quad d = 7 \text{ mm} = 0,7 \text{ cm}$$

$$t = 11 \text{ mm} = 1,1 \text{ cm} \quad F_{rib} = 13,6 \text{ cm}^2$$

$$F_{profil} = 57 \text{ cm}^2$$

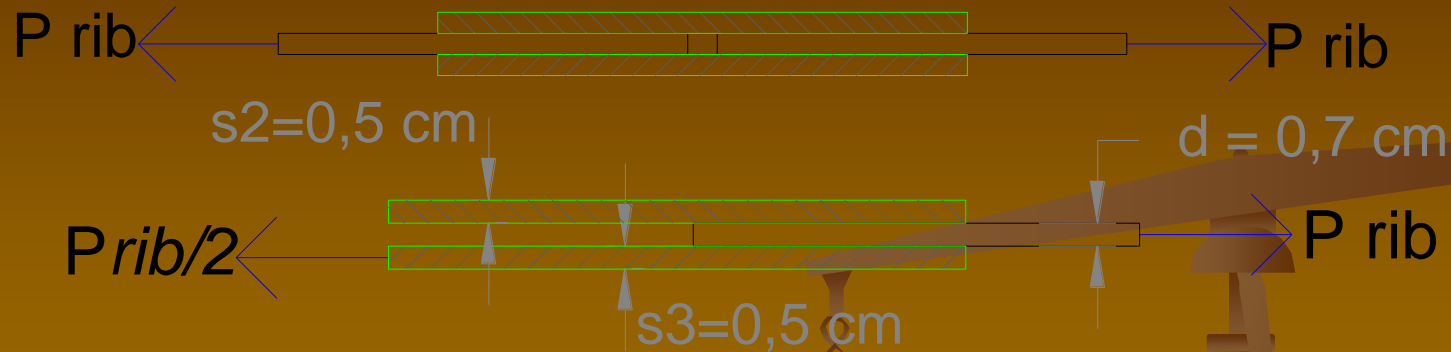
$P = 11.400 \text{ kg}$ ditahan oleh seluruh penampang profil.

Distribusi gaya:

$$P_{rib} = \frac{F_{rib}}{F_{prof}} \times P = \frac{13,6 \text{ cm}^2}{57 \text{ cm}^2} \times 11.400 \text{ kg} = 2.720 \text{ kg}$$

$$P_{1flens} = \frac{P - P_{rib}}{2} = \frac{(11.400 - 2720) \text{ kg}}{2} = 4.340 \text{ kg}$$

Sambungan rib (samb. dobel).



$$N_{gs} = 2 \frac{1}{4} \pi d^2 \cdot \bar{\tau}$$

$$N_{gs} = 2 \times \frac{1}{4} \times 3,14 \times (1,7 \text{ cm})^2 \times 1.120 \text{ kg/cm}^2 = 5.082 \text{ kg}$$

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$N_{tp} = 1,7 \text{ cm} \times 0,7 \text{ cm} \times 2.800 \text{ kg/cm}^2 = 3.332 \text{ kg}$$

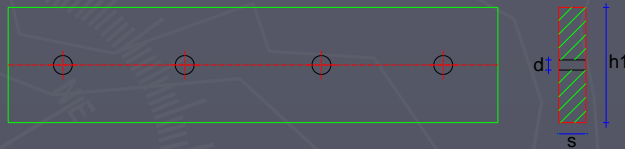
$$N_{\min} = N_{tp} = 3.332 \text{ kg} \rightarrow \text{menentukan}$$

Jumlah pk (n) yg dibutuhkan pada rib adalah:

$$n = \frac{P_{rib}}{N_{min}} = \frac{2.720kg}{3.332kg} = 0,816 \approx 1 \text{ buah}$$

Ambil pk 2 Ø 17 mm

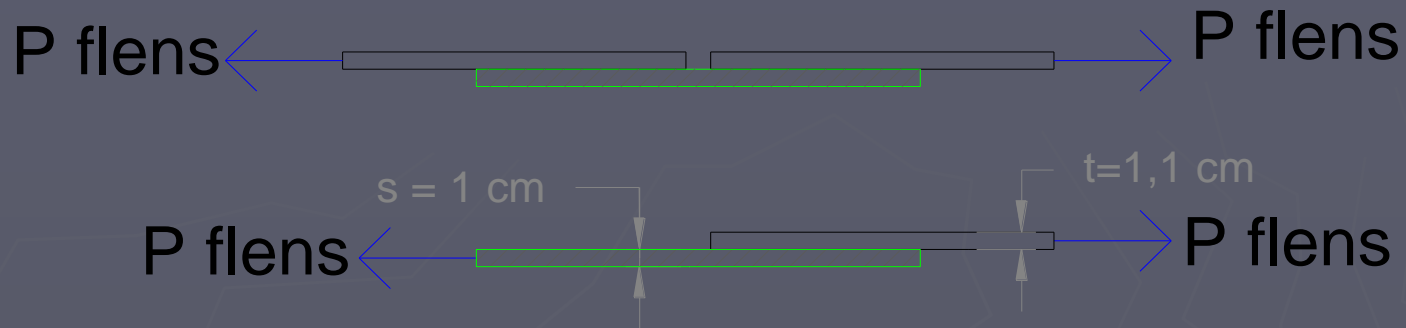
Kontrol plat penyambung rib:



$$\begin{aligned} F_n &= (h_1 \times s) - (d \times s) \\ &= (13,8 \times 0,5) - (1,7 \times 0,5) \\ &= 6,05 \text{ cm}^2 \end{aligned}$$

$$\sigma = \frac{P_{rib} / 2}{F_n} = \frac{2.720 \text{ kg} / 2}{6,05 \text{ cm}^2} = 224,793 \text{ kg/cm}^2 < \bar{\sigma} = 1400 \text{ kg/cm}^2$$

Sambungan flens (samb. tunggal).



$$N_{gs} = \frac{1}{4} \pi d^2 \cdot \bar{\tau}$$

$$N_{gs} = \frac{1}{4} \times 3,14 \times (1,7 \text{ cm})^2 \times 1.120 \text{ kg/cm}^2 = 2.541 \text{ kg}$$

$$N_{tp} = d \cdot s_{\min} \cdot \bar{\sigma}_{tp}$$

$$N_{tp} = 1,7 \text{ cm} \times 1 \text{ cm} \times 2.800 \text{ kg/cm}^2 = 4.760 \text{ kg}$$

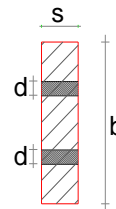
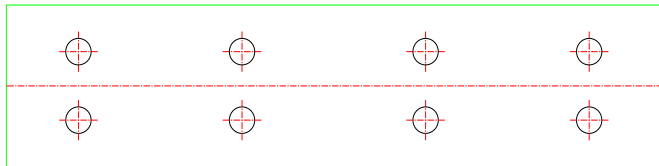
$$N_{\min} = N_{gs} = 2.541 \text{ kg} \rightarrow \text{menentukan}$$

Jumlah pk (n) yg dibutuhkan pada rib adalah:

$$n = \frac{P_{flens}}{N_{min}} = \frac{4.340kg}{2.541kg} = 1,708 \approx 2 \text{ buah}$$

Ambil pk 4 Ø 17 mm (kiri dan kanan flens masing-masing 2 buah)

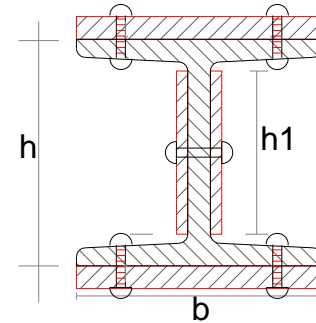
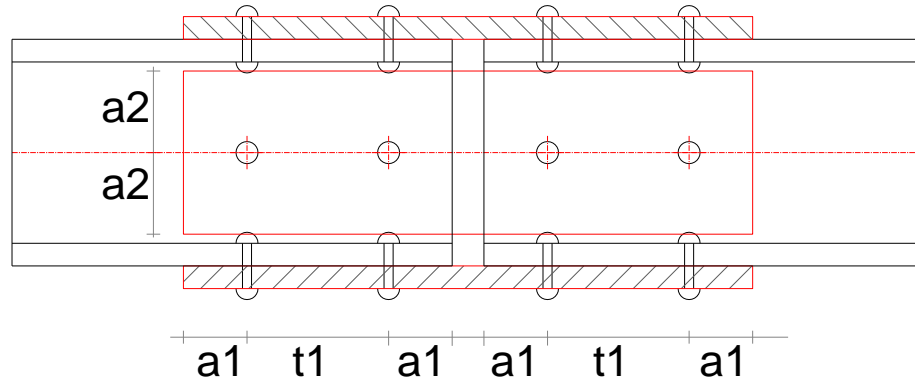
Kontrol plat penyambung flens:



$$\begin{aligned} F_n &= (bxs) - 2(dxs) \\ &= (19,7 \times 1) - 2(1,7 \times 1) \\ &= 16,3 \text{ cm}^2 \end{aligned}$$

$$\sigma = \frac{P_{flens}}{F_n} = \frac{4.340 \text{ kg}}{16,3 \text{ cm}^2} = 266,257 \text{ kg/cm}^2 < \bar{\sigma} = 1400 \text{ kg/cm}^2$$

Gambar skets sambungan:



$$a_1 = 35 \text{ mm}$$

$$t_1 = 60 \text{ mm}$$

$$w = 55 \text{ mm}$$