

BAB IV

RENCANA KONSTRUKSI
(PROFILE CONSTRUCTION)

Perhitungan profile construction (rencana konstruksi) berdasarkan ketentuan BKI (Biro Klasifikasi Indonesia) Th. 2006 Volume II.

A. PERKIRAAN BEBAN

A.1 Beban geladak cuaca (Load and Weather Deck)

Yang dianggap sebagai geladak cuaca adalah semua geladak yang bebas kecuali bangunan atas yang tidak efektif yang terletak di belakang 0,5L dari garis tengah.

$$P_D = P_o \frac{20T}{(10+Z-T) \times H} \times c_D \quad [\text{KN/m}^2]$$

(Ref : BKI Th. 2006 Vol. II Sec. 4 B.1.1)

Dimana :

P_o = Basis Eksternal dinamic Load

$P_o = 2,1 \times (C_b + 0,7) \times C_o \times C_L \times f \times C_{RW} \quad \text{KN/m}^2$

$c_D = 1$ untuk $L > 50$

$C_b =$ koefisien block 0,69

$C_o = 10,75 - \left(\frac{300 - L}{100} \right)^{1,5}$ for $90 \leq L \leq 300 \text{ M}$

$$= 10,75 - \left(\frac{300 - 113}{100} \right)^{1,5}$$

$$= 8,192$$

$C_L = 1,0$ for $L \geq 90 \text{ M}$

$f_1 = 1,0$ Untuk tebal plat Geladak Cuaca

$f_2 = 0,75$ Untuk Main Frame, Stiffener, dan Deck Beam

$f_3 = 0,6$ Untuk SG, CG, CDG, Web Frame, Stringers, Grillage

$C_{rw} = 0,9$ untuk pelayaran nasional

(Ref : BKI Th. 2006 Vol. II Sec. 4.A.2.2)

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Jadi :

untuk plat Geladak Cuaca (Po_1)

$$\begin{aligned}Po_1 &= 2,1 \times (Cb + 0,7) \times Co \times C_L \times f_1 \times C_{rw} \\ &= 2,1 \times (0,69 + 0,7) \times 8,192 \times 1,0 \times 1,0 \times 0,9 \\ &= 21,521 \text{ KN/m}^2\end{aligned}$$

untuk Main Frame, Deck Beam (Po_2)

$$\begin{aligned}Po_2 &= 2,1 \times (Cb + 0,7) \times Co \times C_L \times f_2 \times C_{rw} \\ &= 2,1 \times (0,69 + 0,7) \times 8,192 \times 1,0 \times 0,75 \times 0,9 \\ &= 16,141 \text{ KN/m}^2\end{aligned}$$

untuk Web Frame, Strong Beam, Girder, Stringer, dan Grillage (Po_3)

$$\begin{aligned}Po_3 &= 2,1 \times (Cb + 0,7) \times Co \times C_L \times f_3 \times C_{rw} \\ &= 2,1 \times (0,69 + 0,7) \times 8,192 \times 1,0 \times 0,6 \times 0,9 \\ &= 12,913 \text{ KN/m}^2\end{aligned}$$

Z = jarak vertikal dari pusat beban ke base line

$$\begin{aligned}Z &= H \\ &= 9,40 \text{ m}\end{aligned}$$

C_D = faktor penambahan / pengurangan untuk daerah

$$\begin{aligned}C_{D1} &= 1,2 - X/L \quad \left(\text{untuk } 0 \leq \frac{X}{L} \leq 0,2 ; \text{buritan kapal}\right) \\ &= 1,2 - 0,1 \\ &= 1,1\end{aligned}$$

$$C_{D2} = 1,0 \quad \left(\text{untuk } 0,2 \leq \frac{X}{L} \leq 0,7 ; \text{tengah kapal}\right)$$

$$\begin{aligned}C_{D3} &= 1,0 + \frac{C}{3} \left\{ \frac{X}{L} - 0,7 \right\} \quad \left(\text{untuk } 0,7 \leq \frac{X}{L} \leq 1,0 ; \text{haluan kapal}\right) \\ &= 1,0 + \frac{5}{3} (0,93 - 0,7) \\ &= 1,383\end{aligned}$$

Dimana :

Nilai C : $0,15 L - 10$

Apabila L min = 100 M

Lmax = 200 M

Diambil 100 M

$$C = (0,15 \times 100) - 10$$

$$= 5$$

(Ref : BKI Th. 2006 Vol. II Sec. 4 Tabel. 4.1)

a. Beban Geladak Cuaca untuk menghitung plat Geladak

1) Pada daerah buritan

$$P_{D1} = P_{o1} \frac{20T}{(10+Z-T) \times H} \times C_{D1}$$

$$= 21,521 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,1$$

$$= 29,923 \text{ KN/m}^2$$

2) Pada daerah midship

$$P_{D2} = P_{o1} \frac{20T}{(10+Z-T) \times H} \times C_{D2}$$

$$= 21,521 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,0$$

$$= 27,202 \text{ KN/m}^2$$

3) Pada daerah Haluan

$$P_{D3} = P_{o1} \frac{20T}{(10+Z-T) \times H} \times C_{D3}$$

$$= 21,521 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,383$$

$$= 37,621 \text{ KN/m}^2$$

b. Beban Geladak untuk menghitung Deck Beam, Main frame, Stiffener

1) Pada daerah buritan

$$P_{D1} = P_{o2} \frac{20T}{(10+Z-T) \times H} \times C_{D1}$$

$$= 16,141 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,1$$

$$= 22,442 \text{ KN/m}^2$$

2) Pada daerah Midship kapal

$$P_{D2} = P_{o2} \frac{20T}{(10+Z-T) \times H} \times C_{D2}$$

$$= 16,141 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,0$$

$$= 20,402 \text{ KN/m}^2$$

3) Pada daerah Haluan kapal

$$P_{D3} = P_{o2} \frac{20T}{(10+Z-T) \times H} \times C_{D3}$$

$$= 16,141 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,383$$

$$= 28,216 \text{ KN/m}^2$$

c. Beban Geladak untuk menghitung CDG, SDG dan SG

1) Pada daerah buritan

$$P_{D1} = P_{o3} \frac{20T}{(10+Z-T) \times H} \times C_{D1}$$

$$= 12,913 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,1$$

$$= 17,954 \text{ KN/m}^2$$

2) Pada daerah Midship kapal

$$P_{D2} = P_{o3} \frac{20T}{(10+Z-T) \times H} \times C_{D2}$$

$$= 12,913 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,0$$

$$= 16,322 \text{ KN/m}^2$$

3) Pada daerah Haluan kapal

$$P_{D3} = P_{o3} \frac{20T}{(10+Z-T) \times H} \times C_{D3}$$

$$= 12,913 \times \frac{20 \times 7,23}{[10 + 9,40 - 7,23] \times 9,40} \times 1,383$$

$$= 22,573 \text{ KN/m}^2$$

A.2 Beban Geladak pada bangunan atas (Superstructures Decks) dan rumah geladak (Deck Houses)

Beban Geladak pada bangunan atas dan rumah geladak dihitung berdasarkan formula sebagai berikut :

$$P_{DA} = P_D \times n \quad [\text{KN/m}^2]$$

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(Ref : BKI Th. 2006 Vol. II Sec.4. B.5.1)

Dimana :

P_{DA} = Beban geladak pada buritan

$$n = \left[1 - \frac{Z - H}{10} \right] \quad Z = H + h$$

$n = 1$ untuk Forecastle Deck

$n_{min} = 0,5$

$h_1, h_2, h_3 = 2,2 \text{ m}$

$H = 9,40 \text{ m}$

Nilai "Z" bangunan atas & rumah geladak untuk beban geladak :

1. $Z_1 = H + 2,2 = 11,60 \text{ m}$ (Poop Deck)
2. $Z_2 = Z_1 + 2,2 = 13,80 \text{ m}$ (Boat Deck)
3. $Z_3 = Z_2 + 2,2 = 16,00 \text{ m}$ (Navigation Deck)
4. $Z_4 = Z_3 + 2,2 = 18,20 \text{ m}$ (Compas Deck)
5. $Z_5 = H + 2,2 = 11,60 \text{ m}$ (Forcastle Deck)

a. Beban geladak bangunan atas pada Geladak Kimbul [poop deck]

$Z_1 = 11,40 \text{ m}$

$$n = \left[1 - \frac{11,60 - 9,40}{10} \right] \\ = 0,78$$

$P_{D1} = 29,923 \text{ KN/m}^2$

$P_{D1} = 22,442 \text{ KN/m}^2$

$P_{D1} = 17,954 \text{ KN/m}^2$

1) Untuk menghitung plat geladak.

$$P_{DA} = 29,923 \times 0,78 \\ = 23,340 \text{ KN/m}^2$$

2) Untuk menghitung deck beam.

$$P_{DA} = 22,442 \times 0,78 \\ = 17,505 \text{ KN/m}^2$$

3) Untuk menghitung CDG, SDG dan strong beam.

$$\begin{aligned}P_{DA} &= 17,954 \times 0,78 \\ &= 14,004 \text{ KN/m}^2\end{aligned}$$

b. Beban geladak rumah geladak pada Geladak Sekoci [boat deck]

$$Z_2 = 13,80 \text{ m}$$

$$\begin{aligned}n &= \left[1 - \frac{13,80 - 9,40}{10} \right] \\ &= 0,56\end{aligned}$$

$$P_{D1} = 29,923 \text{ KN/m}^2$$

$$P_{D1} = 22,442 \text{ KN/m}^2$$

$$P_{D1} = 17,954 \text{ KN/m}^2$$

1) Untuk menghitung plat geladak.

$$\begin{aligned}P_{DA} &= 29,923 \times 0,56 \\ &= 16,757 \text{ KN/m}^2\end{aligned}$$

2) Untuk menghitung deck beam.

$$\begin{aligned}P_{DA} &= 22,442 \times 0,56 \\ &= 12,567 \text{ KN/m}^2\end{aligned}$$

3) Untuk menghitung CDG, SDG dan strong beam.

$$\begin{aligned}P_{DA} &= 17,954 \times 0,56 \\ &= 10,054 \text{ KN/m}^2\end{aligned}$$

**c. Beban geladak rumah geladak pada Geladak Kemudi
[Navigation deck]**

$$Z_3 = 16,00 \text{ m}$$

$$\begin{aligned}n &= \left[1 - \frac{16,00 - 9,40}{10} \right] \\ &= 0,34 \approx n_{\min} = 0,5\end{aligned}$$

$$P_{D1} = 29,923 \text{ KN/m}^2$$

$$P_{D1} = 22,442 \text{ KN/m}^2$$

$$P_{D1} = 17,954 \text{ KN/m}^2$$

1) Untuk menghitung plat geladak.

$$\begin{aligned}P_{DA} &= 29,923 \times 0,5 \\ &= 14,962 \text{ KN/m}^2\end{aligned}$$

2) Untuk menghitung deck beam.

$$\begin{aligned}P_{DA} &= 22,442 \times 0,5 \\ &= 11,221 \text{KN/m}^2\end{aligned}$$

3) Untuk menghitung CDG, SDG dan strong beam.

$$\begin{aligned}P_{DA} &= 17,954 \times 0,5 \\ &= 8,977 \text{KN/m}^2\end{aligned}$$

d. Beban geladak rumah geladak pada geladak kompas [Compass deck]

$$Z_4 = 18,20 \text{ m}$$

$$\begin{aligned}n &= \left[1 - \frac{18,20 - 9,40}{10} \right] \\ &= 0,12 \approx n_{\min} = 0,5\end{aligned}$$

$$P_{D1} = 29,923 \text{ KN/m}^2$$

$$P_{D1} = 22,442 \text{ KN/m}^2$$

$$P_{D1} = 17,954 \text{ KN/m}^2$$

1) Untuk menghitung plat geladak.

$$\begin{aligned}P_{DA} &= 29,923 \times 0,5 \\ &= 14,962 \text{ KN/m}^2\end{aligned}$$

2) Untuk menghitung deck beam.

$$\begin{aligned}P_{DA} &= 22,442 \times 0,5 \\ &= 11,221 \text{KN/m}^2\end{aligned}$$

3) Untuk menghitung CDG, SDG dan strong beam.

$$\begin{aligned}P_{DA} &= 17,954 \times 0,5 \\ &= 8,977 \text{ KN/m}^2\end{aligned}$$

e. Beban geladak bangunan atas pada Geladak Akil [Fore Castle deck]

$$n = 1$$

$$P_{D3} = 37,622 \text{ KN/m}^2$$

$$P_{D3} = 28,216 \text{ KN/m}^2$$

$$P_{D3} = 22,573 \text{KN/m}^2$$

1) Untuk menghitung plat geladak.

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$$\begin{aligned}P_{DA} &= 37,622 \times 1,0 \\ &= 37,622 \text{ KN/m}^2\end{aligned}$$

2) Untuk menghitung deck beam.

$$\begin{aligned}P_{DA} &= 28,216 \times 1,0 \\ &= 28,216 \text{ KN/m}^2\end{aligned}$$

3) Untuk menghitung CDG, SDG dan strong beam.

$$\begin{aligned}P_{DA} &= 22,5733 \times 1,0 \\ &= 22,573 \text{ KN/m}^2\end{aligned}$$

f. Beban geladak rumah geladak pada Geladak Derek [Winch deck]

$$Z_5 = Z_1 = 11,40 \text{ m}$$

$$\begin{aligned}n &= \left[1 - \frac{11,40 - 9,20}{10} \right] \\ &= 0,78\end{aligned}$$

$$P_{D2} = 27,203 \text{ KN/m}^2$$

$$P_{D2} = 20,402 \text{ KN/m}^2$$

$$P_{D2} = 16,322 \text{ KN/m}^2$$

1) Untuk menghitung plat geladak.

$$\begin{aligned}P_{DA} &= 27,203 \times 0,78 \\ &= 21,218 \text{ KN/m}^2\end{aligned}$$

2) Untuk menghitung deck beam.

$$\begin{aligned}P_{DA} &= 20,402 \times 0,78 \\ &= 15,914 \text{ KN/m}^2\end{aligned}$$

3) Untuk menghitung CDG, SDG dan strong beam.

$$\begin{aligned}P_{DA} &= 16,322 \times 0,78 \\ &= 12,731 \text{ KN/m}^2\end{aligned}$$

A.3 Beban sisi kapal

a. Beban sisi kapal dibawah garis air muat tidak boleh kurang dari rumus sebagai berikut :

$$P_s = 10 \times (T - Z) + P_o \times C_F \left(1 + \frac{Z}{T} \right) \text{ KN/m}^2$$

(Ref : BKI Th. 2006 Vol. II Sec.4. B.2.1.1)

Dimana :

$$Po_1 = 21,521 \text{ KN/m}^2 \text{ (untuk plat geladak dan geladak cuaca)}$$

$$Po_2 = 16,140 \text{ KN/m}^2 \text{ (untuk stiffener, main frame, deck beam)}$$

$$Po_3 = 12,912 \text{ KN/m}^2 \text{ (untuk web, stringer, girder)}$$

z = Jarak tengah antara pusat beban ke base line

$$= \frac{1}{3} \times T = \frac{1}{3} \times 7,23$$

$$= 2,41 \text{ m}$$

$$CF_1 = 1,0 + \frac{5}{Cb} \left[0,2 - \frac{X}{L} \right] \text{ (buritan kapal)}$$

$$= 1,0 + \frac{5}{0,69} [0,2 - 0,1]$$

$$= 1,725$$

$$CF_2 = 1,0 \text{ untuk } 0,2 \leq \frac{X}{L} \leq 0,7 \text{ (tengah kapal)}$$

$$CF_3 = 1,0 + \frac{20}{Cb} \left[\frac{X}{L} - 0,7 \right]^2 \text{ (haluan kapal)}$$

$$= 1,0 + \frac{20}{0,69} [0,93 - 0,7]^2$$

$$= 2,533$$

1) Beban sisi kapal di bawah garis air muat untuk pelat sisi

a) Untuk buritan kapal

$$Ps_1 = 10 \times (T - Z) + Po_1 \times CF_1 \left(1 + \frac{Z}{T} \right)$$

$$= 10 (7,23 - 2,41) + 21,521 \times 1,725 \left[1 + \frac{2,41}{7,23} \right]$$

$$= 97,698 \text{ KN/m}^2$$

b) Untuk midship kapal

$$Ps_2 = 10 \times (T - Z) + Po_1 \times CF_2 \left(1 + \frac{Z}{T} \right)$$

$$= 10 (7,23 - 2,41) + 21,521 \times 1,0 \left[1 + \frac{2,41}{7,23} \right]$$

$$= 76,894 \text{ KN/m}^2$$

c) Untuk haluan kapal

$$\begin{aligned}
 P_{S_3} &= 10 \times (T - Z) + P_{O_1} \times C_{F_3} \left(1 + \frac{Z}{T}\right) \\
 &= 10 (7,23 - 2,41) + 21,521 \times 2,533 \left[1 + \frac{2,41}{7,23}\right] \\
 &= 120,883 \text{KN/m}^2
 \end{aligned}$$

2) **Beban sisi kapal di bawah garis air muat untuk main frame.**

a) Untuk buritan kapal

$$\begin{aligned}
 P_{S_1} &= 10 \times (T - Z) + P_{O_2} \times C_{F_1} \left(1 + \frac{Z}{T}\right) \\
 &= 10 (7,23 - 2,41) + 16,141 \times 1,725 \left[1 + \frac{2,41}{7,23}\right] \\
 &= 85,315 \text{ KN/m}^2
 \end{aligned}$$

b) Untuk midship kapal

$$\begin{aligned}
 P_{S_2} &= 10 \times (T - Z) + P_{O_2} \times C_{F_2} \left(1 + \frac{Z}{T}\right) \\
 &= 10 (7,23 - 2,41) + 16,141 \times 1,0 \left[1 + \frac{2,41}{7,23}\right] \\
 &= 69,726 \text{ KN/m}^2
 \end{aligned}$$

c) Untuk haluan kapal

$$\begin{aligned}
 P_{S_3} &= 10 \times (T - Z) + P_{O_2} \times C_{F_3} \left(1 + \frac{Z}{T}\right) \\
 &= 10 (7,23 - 2,41) + 16,141 \times 2,533 \left[1 + \frac{2,41}{7,23}\right] \\
 &= 102,699 \text{ KN/m}^2
 \end{aligned}$$

3) **Beban sisi kapal di bawah garis air muat untuk web frame dan stringers.**

a) Untuk buritan kapal

$$\begin{aligned}
 P_{S_1} &= 10 \times (T - Z) + P_{O_3} \times C_{F_1} \left(1 + \frac{Z}{T}\right) \\
 &= 10 (7,23 - 2,41) + 12,913 \times 1,735 \left[1 + \frac{2,41}{7,23}\right] \\
 &= 77,892 \text{ KN/m}^2
 \end{aligned}$$

b) Untuk midship kapal

$$\begin{aligned}
 P_{S_2} &= 10 \times (T - Z) + P_{O_3} \times C_{F_2} \left(1 + \frac{Z}{T}\right) \\
 &= 10 (7,23 - 2,41) + 12,913 \times 1,0 \left[1 + \frac{2,41}{7,23}\right] \\
 &= 65,413 \text{ KN/m}^2
 \end{aligned}$$

c) Untuk haluan kapal

$$\begin{aligned}
 P_{S_3} &= 10 \times (T - Z) + P_{O_3} \times C_{F_3} \left(1 + \frac{Z}{T}\right) \\
 &= 10 (7,23 - 2,41) + 12,913 \times 2,533 \left[1 + \frac{2,41}{7,23}\right] \\
 &= 91,801 \text{ KN/m}^2
 \end{aligned}$$

b. Beban sisi kapal di atas garis air muat tidak boleh kurang dari rumus sebagai berikut :

$$P_s = P_o \times C_F \times \left(\frac{20}{10+Z-T}\right) \text{ KN/m}^2$$

(Ref : BKI Th.2006 Vol. II Sec. 4.B.2.1.2)

Dimana :

$$P_{O_1} = 21,521 \text{ KN/m}^2 \quad \text{untuk plat kulit dan geladak cuaca}$$

$$T = 7,23 \text{ m}$$

$$Z = T + \frac{1}{2} (H - T)$$

$$Z = 7,23 + \frac{1}{2} (9,40 - 7,23)$$

$$= 8,315 \text{ m}$$

$$C_{f_1} = 1,725 \quad \text{Untuk Buritan Kapal}$$

$$C_{f_2} = 1,0 \quad \text{Untuk Midship}$$

$$C_{f_3} = 2,533 \quad \text{Untuk Haluan Kapal}$$

1) Beban sisi kapal di atas garis air muat untuk menghitung ketebalan plat sisi :

a) Untuk Buritan kapal

$$\begin{aligned}
 P_{s1} &= P_{o1} \times CF_1 \times \left(\frac{20}{10+Z-T} \right) \\
 &= 21,521 \times 1,725 \left[\frac{20}{10+8,315-7,23} \right] \\
 &= 66,980 \text{ KN/m}^2
 \end{aligned}$$

b) Untuk Midship kapal

$$\begin{aligned}
 P_{s2} &= P_{o1} \times CF_2 \times \left(\frac{20}{10+Z-T} \right) \\
 &= 21,521 \times 1,0 \times \left[\frac{20}{10+8,315-7,23} \right] \\
 &= 38,829 \text{ KN/m}^2
 \end{aligned}$$

c) Untuk haluan kapal

$$\begin{aligned}
 P_{s3} &= P_{o1} \times CF_3 \times \left(\frac{20}{10+Z-T} \right) \\
 &= 21,521 \times 2,533 \times \left[\frac{20}{10+8,315-7,23} \right] \\
 &= 98,354 \text{ KN/m}^2
 \end{aligned}$$

c. Beban sisi kapal di atas Garis air muat pada bangunan atas (Superstructure Decks) dan rumah geladak (Deck Houses).

Beban geladak pada bangunan atas dan rumah geladak dihitung berdasarkan formula sbb :

$$P_s = P_o \times C_f \times \left[\frac{20}{10+Z-T} \right] \quad [\text{KN/m}^2]$$

(Ref : BKI Th. 2006 Vol. II Sec. 2.1.2)

Dimana :

$P_{o1} = 21,521 \text{ KN/m}^2$ untuk plat kulit dan geladak cuaca

$P_{o2} = 16,141 \text{ KN/m}^2$ untuk untuk main frame dan deck beam

$P_{o3} = 12,913 \text{ KN/m}^2$ untuk web frame

$h_1, h_2, h_3 = 2,2 \text{ m}$

$H = 9,40 \text{ m}$

1) Beban sisi di atas garis air muat pada Geladak Kimbul (Poop Deck) :

a) Untuk menghitung Plat kulit :

Dimana :

$$Z_1 = 10,50 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O1} = 21,521 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned} P_{S1} &= P_{O1} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right) \\ &= 21,521 \times 1,725 \times \left[\frac{20}{10+10,50-7,23} \right] \\ &= 56,807 \text{ KN/m}^2 \end{aligned}$$

b) Untuk menghitung Frame :

Dimana :

$$Z_1 = 10,30 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O2} = 16,141 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned} P_{S1} &= P_{O2} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right) \\ &= 16,141 \times 1,725 \times \left[\frac{20}{10+10,50-7,23} \right] \\ &= 42,606 \text{ KN/m}^2 \end{aligned}$$

c) Untuk menghitung web frame :

Dimana :

$$Z_1 = 10,30 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O3} = 12,913 \text{ KN/m}^2$$

Sehingga :

$$P_{S1} = P_{O3} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right)$$

$$= 12,913 \times 1,725 \times \left[\frac{20}{10 + 10,50 - 7,23} \right]$$
$$= 34,086 \text{ KN/m}^2$$

2) Beban sisi di atas garis air muat pada Geladak Sekoci (Boat Deck)

a) Untuk menghitung Plat sisi :

Dimana :

$$Z_2 = 12,7 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O1} = 21,521 \text{ KN/m}^2$$

Sehingga :

$$P_{S1} = P_{O1} \times C_{F1} \times \left(\frac{20}{10 + Z - T} \right)$$
$$= 21,521 \times 1,735 \times \left[\frac{20}{10 + 12,7 - 7,23} \right]$$
$$= 48,905 \text{ KN/m}^2$$

b) Untuk menghitung Main Frame :

Dimana :

$$Z_2 = 12,5 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O2} = 16,141 \text{ KN/m}^2$$

Sehingga :

$$P_{S1} = P_{O2} \times C_{F1} \times \left(\frac{20}{10 + Z - T} \right)$$
$$= 16,141 \times 1,725 \times \left[\frac{20}{10 + 12,7 - 7,23} \right]$$
$$= 36,679 \text{ KN/m}^2$$

c) Untuk menghitung web frame :

Dimana :

$$Z_2 = 12,5 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O3} = 12,913 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned}
 P_{S1} &= P_{O3} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right) \\
 &= 12,913 \times 1,725 \times \left[\frac{20}{10+12,7-7,23} \right] \\
 &= 29,344 \text{ KN/m}^2
 \end{aligned}$$

3) Beban sisi di atas garis air muat pada Deck Kemudi (navigasi deck)

a) Untuk menghitung Plat sisi :

Dimana :

$$Z_3 = 14,9 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O1} = 21,521 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned}
 P_{S1} &= P_{O1} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right) \\
 &= 21,521 \times 1,725 \times \left[\frac{20}{10+14,9-7,23} \right] \\
 &= 42,746 \text{ KN/m}^2
 \end{aligned}$$

b) Untuk menghitung Main Frame :

Dimana :

$$Z_3 = 14,9 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O2} = 16,141 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned}
 P_{S1} &= P_{O2} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right) \\
 &= 16,141 \times 1,725 \times \left[\frac{20}{10+14,9-7,23} \right] \\
 &= 32,060 \text{ KN/m}^2
 \end{aligned}$$

c) Untuk menghitung web frame :

Dimana :

$$Z_3 = 14,9 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O3} = 12,913 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned} P_{S1} &= P_{O3} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right) \\ &= 12,913 \times 1,725 \times \left[\frac{20}{10+14,9-7,23} \right] \\ &= 25,648 \text{ KN/m}^2 \end{aligned}$$

4) Beban sisi di atas garis air muat pada Deck Kompas (compass deck)

a) Untuk menghitung Plat sisi :

Dimana :

$$Z_4 = 17,1 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O1} = 21,521 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned} P_{S1} &= P_{O1} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right) \\ &= 21,521 \times 1,725 \times \left[\frac{20}{10+17,1-7,23} \right] \\ &= 37,965 \text{ KN/m}^2 \end{aligned}$$

b) Untuk menghitung Frame :

Dimana :

$$Z_4 = 17,1 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O2} = 16,141 \text{ KN/m}^2$$

Sehingga :

$$P_{S1} = P_{O2} \times C_{F1} \times \left(\frac{20}{10+Z-T} \right)$$

$$= 16,141 \times 1,725 \times \left[\frac{20}{10 + 17,1 - 7,23} \right]$$

$$= 28,474 \text{ KN/m}^2$$

c) Untuk menghitung web frame :

Dimana :

$$Z_4 = 17,1 \text{ m}$$

$$C_{F1} = 1,725$$

$$P_{O3} = 12,913 \text{ KN/m}^2$$

Sehingga :

$$P_{S1} = P_{O3} \times C_{F1} \times \left(\frac{20}{10 + Z - T} \right)$$

$$= 12,913 \times 1,735 \times \left[\frac{20}{10 + 17,1 - 7,23} \right]$$

$$= 22,779 \text{ KN/m}^2$$

5) Beban sisi di atas garis air muat untuk menghitung Geladak Akil (Fore Castle deck)

a) Untuk menghitung Plat kulit :

Dimana :

$$Z_5 = Z_1 = 10,5 \text{ m}$$

$$C_{F3} = 2,533$$

$$P_{O1} = 21,521 \text{ KN/m}^2$$

Sehingga :

$$P_{S1} = P_{O1} \times C_{F3} \times \left(\frac{20}{10 + Z - T} \right)$$

$$= 21,521 \times 2,533 \times \left[\frac{20}{10 + 10,5 - 7,23} \right]$$

$$= 83,416 \text{ KN/m}^2$$

b) Untuk menghitung Main Frame:

Dimana :

$$Z_5 = Z_1 = 10,5 \text{ m}$$

$$C_{F3} = 2,533$$

$$P_{O2} = 16,141 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned}
 P_{S1} &= P_{O2} \times C_{F3} \times \left(\frac{20}{10+Z-T} \right) \\
 &= 16,141 \times 2,533 \times \left[\frac{20}{10+10,5-7,23} \right] \\
 &= 62,563 \text{ KN/m}^2
 \end{aligned}$$

c) Untuk menghitung web frame :

Dimana :

$$Z_5 = Z_1 = 10,5 \text{ m}$$

$$C_{F3} = 2,533$$

$$P_{O3} = 12,913 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned}
 P_{S1} &= P_{O3} \times C_{F3} \times \left(\frac{20}{10+Z-T} \right) \\
 &= 12,913 \times 2,533 \times \left[\frac{20}{10+10,5-7,23} \right] \\
 &= 50,051 \text{ KN/m}^2
 \end{aligned}$$

6) Beban sisi di atas garis air muat untuk menghitung Winch

Deck

a) Untuk menghitung Plat sisi :

Dimana :

$$Z_6 = Z_1 = 10,5 \text{ m}$$

$$C_{F2} = 1,0$$

$$P_{O1} = 21,521 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned}
 P_{S1} &= P_{O1} \times C_{F3} \times \left(\frac{20}{10+Z-T} \right) \\
 &= 21,521 \times 1,0 \times \left[\frac{20}{10+10,5-7,23} \right] \\
 &= 32,932 \text{ KN/m}^2
 \end{aligned}$$

b) Untuk menghitung Main Frame :

Dimana :

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$$Z_6 = Z_1 = 10,5 \text{ m}$$

$$C_{F2} = 1,0$$

$$P_{O2} = 16,141 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned} P_{S1} &= P_{O2} \times C_{F3} \times \left(\frac{20}{10+Z-T} \right) \\ &= 16,141 \times 1,0 \times \left[\frac{20}{10+10,5-7,23} \right] \\ &= 24,699 \text{ KN/m}^2 \end{aligned}$$

c) Untuk menghitung web frame :

Dimana :

$$Z_6 = Z_1 = 10,5 \text{ m}$$

$$C_{F2} = 2,556$$

$$P_{O3} = 12,913 \text{ KN/m}^2$$

Sehingga :

$$\begin{aligned} P_{S1} &= P_{O3} \times C_{F3} \times \left(\frac{20}{10+Z-T} \right) \\ &= 12,913 \times 1,0 \times \left[\frac{20}{10+10,5-7,23} \right] \\ &= 19,759 \text{ KN/m}^2 \end{aligned}$$

A.4 Beban Alas Kapal

Beban luar pada alas / dasar kapal adalah dihitung menurut formula sebagai berikut :

$$P_B = 10 \times T + P_o \times C_f \quad \text{KN/m}^2$$

(Ref : BKI Th. 2006 Vol. II Sec.4. B.3)

Dimana :

$$T = 7,23 \text{ m}$$

$$P_{O1} = 21,521 \text{ KN/m}^2$$

untuk plat kulit dan geladag cuaca

$$P_{O2} = 16,141 \text{ KN/m}^2$$

untuk untuk frame, deck beam dan bottom

$$C_{f1} = 1,725$$

untuk buritan kapal

$$C_{f2} = 1,0$$

untuk Midship kapal

$$Cf_3 = 2,533 \quad \text{untuk Haluan kapal}$$

a. Beban alas kapal untuk menghitung plat Alas

1). Untuk Buritan kapal

$$\begin{aligned} P_{B1} &= 10 \times T + P_{O1} \times Cf_1 \\ &= 10 \times 7,23 + 21,521 \times 1,725 \\ &= 109,424 \text{ KN/m}^2 \end{aligned}$$

2). Untuk Midship kapal

$$\begin{aligned} P_{B2} &= 10 \times T + P_{O1} \times Cf_2 \\ &= 10 \times 7,23 + 21,521 \times 1,0 \\ &= 93,821 \text{ KN/m}^2 \end{aligned}$$

3). Untuk haluan kapal

$$\begin{aligned} P_{B3} &= 10 \times T + P_{O1} \times Cf_3 \\ &= 10 \times 7,23 + 21,521 \times 2,556 \\ &= 126,813 \text{ KN/m}^2 \end{aligned}$$

b. Beban alas untuk menghitung bottom frame

1). Untuk Midship kapal

$$\begin{aligned} P_{B2} &= 10 \times T + P_{O2} \times Cf_2 \\ &= 10 \times 7,23 + 16,141 \times 1,0 \\ &= 88,441 \text{ KN/m}^2 \end{aligned}$$

A.5. Beban Alas Dalam (Load on inner bottom)

Beban alas dalam dihitung dengan formula sebagai berikut :

$$P_B = 9,81 \times \frac{G}{V} \times h (1 + av) \quad \text{KN/m}^2$$

(Ref : BKI Th. 2006 Vol. II Sec. 4.C.2.1)

Dimana :

$$G = \text{Berat muatan bersih} = 5797,477 \text{ Ton}$$

$$V = \text{Volume muatan kapal} = 8870,139 \text{ m}^3$$

$$\begin{aligned} H &= H - h_{DB \text{ KM}} \quad \text{untuk buritan, kamar mesin} \\ &= 9,40 - 1,320 \\ &= 8,08 \text{ m} \end{aligned}$$

$$\begin{aligned} H &= H - h_{db} \quad \text{untuk midship dan haluan} \\ &= 9,40 - 1,1 \end{aligned}$$

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$$= 8,3 \text{ m}$$

$$av = F \times m$$

$$F = 0,11 \times \frac{V_o}{\sqrt{L}} \text{ dimana } V_o = 14 \text{ Knots}$$

Sehingga :

$$F = 0,11 \times \frac{14}{\sqrt{113}}$$

$$= 0,144$$

$$m_o = 1,5 + F$$

$$= 1,5 + 0,144 = 1,644$$

$$m_1 = m_o - 5 [m_o - 1] X/L$$

untuk Buritan kapal

$$= 1,644 - 5 [1,644 - 1] 0,1$$

$$= 1,322$$

$$m_2 = 1,0$$

untuk Midship

$$m_3 = 1 + \frac{m_o + 1}{0,3} (X/L - 0,7)$$

untuk Haluan kapal

$$= 1 + \frac{1,644 + 1}{0,3} \times (0,8 - 0,7)$$

$$= 1,881$$

sehingga ;

$$av_1 = F \times m_1$$

untuk buritan kapal

$$= 0,144 \times 1,322 = 0,190$$

$$av_2 = F \times m_2$$

untuk Midship

$$= 0,144 \times 1,0 = 0,144$$

$$av_3 = F \times m_3$$

untuk Haluan kapal

$$= 0,144 \times 1,881 = 0,271$$

Jadi beban alas dalam (P_B) :

a). Untuk Buritan kapal

$$P_B = 9,81 \times \frac{G}{V} \times h (1 + av_1)$$

$$= 9,81 \times \frac{5797,477}{8870,139} \times 9,40 (1 + 0,190)$$

$$= 71,722 \quad \text{KN/m}^2$$

b). Untuk Midship kapal

$$\begin{aligned}
 P_B &= 9,81 \times \frac{G}{V} \times h (1 + av_2) \\
 &= 9,81 \times \frac{5797,477}{8870,139} \times 9,40 (1 + 0,144) \\
 &= 68,949 \quad \text{KN/m}^2
 \end{aligned}$$

c). Untuk haluan kapal

$$\begin{aligned}
 P_B &= 9,81 \times \frac{G}{V} \times h (1 + av_3) \\
 &= 9,81 \times \frac{5797,477}{8870,139} \times 9,40 (1 + 0,271) \\
 &= 76,604 \quad \text{KN/m}^2
 \end{aligned}$$

B. PERHITUNGAN PLAT KULIT DAN PLAT GELADAK KEKUATAN

B.1. Menentukan Tebal Plat Geladak

a. Menentukan Tebal plat geladak Cuaca

Tebal plat geladak cuaca pada kapal tidak boleh kurang dari :

$$t_{G1} = 1,21 \times a \sqrt{P_D \times k} + tk \quad (\text{mm})$$

(Ref : BKI Th. 2006 Vol. II Sec. 7.C.7.1)

Dimana :

- P_{D1} = 29,923 KN/m² untuk buritan kapal
- P_{D2} = 27,202 KN/m² untuk midship kapal
- P_{D3} = 37,621 KN/m² untuk haluan kapal
- a = jarak antar gading
 = 0,6 m (pada AP – fr 10 & fr 149 – fr 161)
 = 0,7 m (pada fr. 10 – fr. 149)
- k = 1,0 faktor bahan
- tk = 1,5 untuk $t_B \leq 10$ mm
- tk = 0,5 untuk $t_B \geq 10$ mm

1) Tebal plat geladak pada 0,1 L pada buritan kapal tidak boleh kurang dari :

Tebal plat geladak pada 0,1L buritan untuk a = 0,6 m (AP – fr. 10) :

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$$\begin{aligned}tG_1 &= 1,21 \times 0,6 \times \sqrt{29,923x1} + 1,5 \\ &= \mathbf{5,472 \text{ mm}}\end{aligned}$$

$$\begin{aligned}tG_{\min} &= (4,5 + 0,05L)\sqrt{k} \\ &= (4,5 + 0,05 \times 113)\sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}}\end{aligned}$$

Tebal plat geladak pada 0,1L buritan untuk a = 0,7 (fr 10 – fr. 45) m:

$$\begin{aligned}tG_1 &= 1,21 \times 0,7 \times \sqrt{29,923x1} + 1,5 \\ &= \mathbf{6,133 \text{ mm}}\end{aligned}$$

$$\begin{aligned}tG_{\min} &= (4,5 + 0,05L)\sqrt{k} \\ &= (4,5 + 0,05 \times 113)\sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}}\end{aligned}$$

2) Tebal plat geladak pada daerah midship

$$\begin{aligned}tG_2 &= 1,21 \times 0,7 \times \sqrt{27,202x1} + 1,5 \\ &= \mathbf{5,286 \text{ mm}}\end{aligned}$$

$$\begin{aligned}tG_{\min} &= (5,5 + 0,02L)\sqrt{k} \\ &= (5,5 + 0,02 \times 113)\sqrt{1} \\ &= \mathbf{7,76 \text{ mm} \approx 10 \text{ mm}}\end{aligned}$$

3) Tebal plat geladak pada daerah haluan kapal

Tebal plat geladak pada haluan untuk a = 0,6 m (fr. 149 – fr. 161) :

$$\begin{aligned}tG_3 &= 1,21 \times 0,6 \times \sqrt{37,621x1} + 1,5 \\ &= \mathbf{5,953 \text{ mm}}\end{aligned}$$

$$\begin{aligned}tG_{\min} &= (4,5 + 0,05L)\sqrt{k} \\ &= (4,5 + 0,05 \times 113)\sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}} \\ &= \mathbf{7,76 \text{ mm} \approx 10 \text{ mm}}\end{aligned}$$

b. Tebal plat geladak bangunan atas

$$t G = 1,21 \times a \sqrt{P_D \times k} + tk \quad (\text{mm})$$

(Ref : BKI Th. 2006 Vol. II Sec. 7.C.7.1)

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- 1) Tebal plat geladak kimbul (poop deck)

Tebal plat geladak kimbul untuk a = 0,6 m (AP – fr. 10) :

$$\begin{aligned}t G_1 &= 1,21 \times 0,6 \times \sqrt{23,340x1} + 1,5 \\ &= \mathbf{5,008 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

Tebal plat geladak kimbul untuk a = 0,7 m (fr. 10 – fr. 45) :

$$\begin{aligned}t G_1 &= 1,21 \times 0,7 \times \sqrt{23,340x1} + 1,5 \\ &= \mathbf{5,593 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

- 2) Tebal plat geladak sekoci (Boat Deck)

Tebal plat geladak sekoci untuk a = 0,6 m (fr. 5 – fr. 10) :

$$\begin{aligned}t G_2 &= 1,21 \times 0,6 \times \sqrt{16,757x1} + 1,5 \\ &= \mathbf{4,471 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

Tebal plat geladak sekoci untuk a = 0,7 m (fr. 10 – fr. 45)

$$\begin{aligned}t G_2 &= 1,21 \times 0,7 \times \sqrt{16,757x1} + 1,5 \\ &= \mathbf{4,967 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

- 3) Tebal plat geladak navigasi

$$\begin{aligned}t G_3 &= 1,21 \times 0,7 \times \sqrt{14,962x1} + 1,5 \\ &= \mathbf{4,776 \text{ mm} \approx 6 \text{ mm}}\end{aligned}$$

- 4) Tebal plat geladak kompas (compass deck)

$$\begin{aligned}t G_4 &= 1,21 \times 0,7 \times \sqrt{14,962x1} + 1,5 \\ &= \mathbf{4,776 \text{ mm} \approx 6 \text{ mm}}\end{aligned}$$

- 5) Tebal plat geladak akil (fore castle deck)

Tebal plat geladak akil untuk a = 0,6 m (fr. 149 – fr. 161) :

$$\begin{aligned}t G_5 &= 1,21 \times 0,6 \times \sqrt{37,622x1} + 1,5 \\ &= \mathbf{5,953 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

- 6) Tebal plat geladak Derek (winch deck)

$$\begin{aligned}t G_6 &= 1,21 \times 0,7 \times \sqrt{21,218x1} + 1,5 \\ &= \mathbf{5,402 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

B.2. Menentukan Tebal Plat sisi Kapal

a. Tebal plat sisi kapal di bawah garis air muat adalah sbb :

$$t_s = 1,21 \times a \times \sqrt{P_s \times k} + t_k \quad (\text{mm}), \text{ Untuk } L \geq 90 \text{ m}$$

(Ref : BKI Th. 2006 Vol. II Sec. 6.C.1.2)

Dimana :

$$P_{S1} = 97,685 \quad \text{KN/m}^2 \quad \text{untuk buritan kapal}$$

$$P_{S2} = 76,887 \quad \text{KN/m}^2 \quad \text{untuk midship kapal}$$

$$P_{S3} = 120,865 \quad \text{KN/m}^2 \quad \text{untuk haluan kapal}$$

a = jarak antar gading

$$= 0,6 \text{ m (pada AP - fr 10 \& fr 149 - fr 161)}$$

$$= 0,7 \text{ m (pada fr. 10 - fr. 149)}$$

k = 1,0 faktor bahan

t_k = 1,5 untuk t_B ≤ 10 mm

1) Tebal plat sisi kapal pada 0,05 L pada buritan kapal tidak boleh kurang dari :

$$\begin{aligned} t_{s1} &= 1,21 \times 0,6 \times \sqrt{97,685 \times 1} + 1,5 \\ &= \mathbf{8,682 \text{ mm}} \end{aligned}$$

$$\begin{aligned} t_{G_{\min}} &= (4,5 + 0,05L) \sqrt{k} \\ &= (4,5 + 0,05 \times 113) \sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}} \end{aligned}$$

2) Tebal plat sisi pada daerah midship

$$\begin{aligned} t_{s2} &= 1,21 \times 0,7 \times \sqrt{76,887 \times 1} + 1,5 \\ &= \mathbf{8,926 \text{ mm}} \end{aligned}$$

$$\begin{aligned} t_{G_{\min}} &= (5,5 + 0,02L) \sqrt{k} \\ &= (5,5 + 0,02 \times 113) \sqrt{1} \\ &= \mathbf{7,76 \text{ mm} \approx 10 \text{ mm}} \end{aligned}$$

3) Tebal plat sisi pada daerah haluan kapal

Tebal plat sisi haluan untuk a = 0,6 m (fr. 149 - fr. 161) :

$$\begin{aligned} t_{s3} &= 1,21 \times 0,6 \times \sqrt{120,865 \times 1} + 1,5 \\ &= \mathbf{9,481 \text{ mm}} \end{aligned}$$

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$$\begin{aligned}t_{G_{\min}} &= (4,5 + 0,05L)\sqrt{k} \\ &= (4,5 + 0,05 \times 113)\sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}}\end{aligned}$$

b. Ketebalan plat sisi kapal di atas garis air muat adalah sbb :

$$t_s = 1,21 \times a \times \sqrt{P_s \times k} + t_k \quad \text{Untuk } L \geq 90 \text{ m}$$

(Ref : BKI Th. 2006 Vol. II Sec. 6.C.1.2)

Dimana :

$$P_{S1} = 66,980 \text{ KN/m}^2 \quad \text{untuk buritan kapal}$$

$$P_{S2} = 38,829 \text{ KN/m}^2 \quad \text{untuk midship kapal}$$

$$P_{S3} = 98,354 \text{ KN/m}^2 \quad \text{untuk haluan kapal}$$

a = jarak antar gading

$$= 0,6 \text{ m (pada AP - fr 10 \& fr 149 - fr 161)}$$

$$= 0,7 \text{ m (pada fr. 10 - fr. 149)}$$

$$k = 1,0 \quad \text{faktor bahan}$$

$$t_k = 1,5 \quad \text{untuk } t_B \leq 10 \text{ mm}$$

jadi :

1) Tebal plat sisi pada 0,1 L pada buritan kapal tidak boleh kurang dari :

Tebal plat sisi pada 0,1L buritan untuk a = 0,6 m (AP - fr. 10) :

$$\begin{aligned}t_{s1} &= 1,21 \times 0,6 \times \sqrt{66,980 \times 1} + 1,5 \\ &= \mathbf{7,441 \text{ mm}}\end{aligned}$$

$$\begin{aligned}t_{G_{\min}} &= (4,5 + 0,05L)\sqrt{k} \\ &= (4,5 + 0,05 \times 113)\sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}}\end{aligned}$$

Tebal plat geladak pada 0,1L buritan untuk a = 0,7 m :

$$\begin{aligned}t_{s1} &= 1,21 \times 0,7 \times \sqrt{66,980 \times 1} + 1,5 \\ &= \mathbf{8,432 \text{ mm}}\end{aligned}$$

$$\begin{aligned}t_{G_{\min}} &= (4,5 + 0,05L)\sqrt{k} \\ &= (4,5 + 0,05 \times 113)\sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}}\end{aligned}$$

2) Tebal plat sisi pada daerah midship

$$\begin{aligned}ts_2 &= 1,21 \times 0,7 \times \sqrt{38,829 \times 1} + 1,5 \\ &= \mathbf{6,777 \text{ mm}}\end{aligned}$$

$$\begin{aligned}tG_{\min} &= (5,5 + 0,02L)\sqrt{k} \\ &= (5,5 + 0,02 \times 113)\sqrt{1} \\ &= \mathbf{7,76 \text{ mm} \approx 10 \text{ mm}}\end{aligned}$$

3) Tebal plat sisi pada daerah haluan kapal

Tebal plat sisi haluan untuk a = 0,6 m (fr. 149 – fr. 161) :

$$\begin{aligned}ts_3 &= 1,21 \times 0,6 \times \sqrt{98,354 \times 1} + 1,5 \\ &= \mathbf{8,700 \text{ mm}}\end{aligned}$$

$$\begin{aligned}tG_{\min} &= (4,5 + 0,05L)\sqrt{k} \\ &= (4,5 + 0,05 \times 113)\sqrt{1} \\ &= \mathbf{10,15 \text{ mm} \approx 11 \text{ mm}}\end{aligned}$$

c. Tebal Plat Sisi Geladak Bangunan Atas

$$T_s = 1,21 \times a \times \sqrt{P_s \times k} + t_k \quad (\text{mm})$$

(Ref : BKI Th. 2006 Vol. II Sec. 6.C.1.2)

1) Tebal plat sisi geladak kimbul (poop deck)

Tebal plat sisi pada geladak kimbul untuk a = 0,6 m (AP – fr. 10) :

$$\begin{aligned}t S_1 &= 1,21 \times 0,6 \times \sqrt{57,137 \times 1} + 1,5 \\ &= \mathbf{6,987 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

Tebal plat sisi pada geladak kimbul untuk a = 0,7 m (fr. 10 – fr. 45) :

$$\begin{aligned}t S_1 &= 1,21 \times 0,7 \times \sqrt{57,137 \times 1} + 1,5 \\ &= \mathbf{7,902 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

2) Tebal plat sisi geladak sekoci (Boat Deck)

Tebal plat sisi pada geladak sekoci untuk a = 0,6 m (fr. 5 – fr. 10) :

$$\begin{aligned}t S_2 &= 1,21 \times 0,6 \times \sqrt{48,905 \times 1} + 1,5 \\ &= \mathbf{6,577 \text{ mm} \approx 8 \text{ mm}}\end{aligned}$$

Tebal plat sisi pada geladak sekoci untuk a = 0,7 m (fr. 10 – fr. 45) :

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$$t S_2 = 1,21 \times 0,7 \times \sqrt{48,905 \times 1} + 1,5$$
$$= 7,423 \text{ mm} \approx 8 \text{ mm}$$

3) Tebal plat sisi geladak navigasi

$$t S_3 = 1,21 \times 0,7 \times \sqrt{42,746 \times 1} + 1,5$$
$$= 7,020 \text{ mm} \approx 8 \text{ mm}$$

4) Tebal plat sisi geladak kompas (compass deck)

$$t S_4 = 1,21 \times 0,7 \times \sqrt{37,965 \times 1} + 1,5$$
$$= 6,718 \text{ mm} \approx 8 \text{ mm}$$

5) Tebal plat sisi geladak akil (fore castle deck)

Tebal plat geladak akil untuk a = 0,6 m (fr. 149 – fr. 161) :

$$t S_5 = 1,21 \times 0,6 \times \sqrt{84,174 \times 1} + 1,5$$
$$= 8,160 \text{ mm} \approx 10 \text{ mm}$$

6) Tebal plat sisi winch deck

$$t S_6 = 1,21 \times 0,7 \times \sqrt{32,932 \times 1} + 1,5$$
$$= 6,360 \text{ mm} \approx 8 \text{ mm}$$

B.3. Menentukan Tebal Plat Alas Kapal (Bottom Plate)

$$T_B = 1,21 \times n_f \times a \times \sqrt{P_B \times k} + t_k \text{ (mm) , Untuk } L \geq 90 \text{ m}$$

(Ref : BKI Th. 2006 Vol. II Sec. 6.B.1.1)

Dimana :

$P_{B1} = 109,639$	KN/m^2	untuk buritan kapal
$P_{B2} = 93,821$	KN/m^2	untuk midship kapal
$P_{B3} = 127,308$	KN/m^2	untuk haluan kapal
$n_f = 1,0$		

a = jarak antar gading

= 0,5 m (pada fr. 161 – FP)

= 0,6 m (pada AP – fr 10 & fr 149 – fr 161)

= 0,7 m (pada fr. 10 – fr. 149)

k = 1

t_k = 1,5

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1) Tebal plat alas pada daerah buritan kapal

Tebal plat alas pada buritan untuk $a = 0,6$ m (AP – fr. 10) :

$$\begin{aligned}t B_1 &= 1,21 \times 1,0 \times 0,6 \times \sqrt{109,639 \times 1} + 1,5 \\ &= \mathbf{9,102 \text{ mm}}\end{aligned}$$

$$\begin{aligned}t_{\min} + 1,5 &= 10,630 + 1,5 \\ &= \mathbf{12,130 \text{ mm} \approx 13 \text{ mm}}\end{aligned}$$

Tebal plat alas pada buritan untuk $a = 0,7$ m :

$$\begin{aligned}t B_1 &= 1,21 \times 1,0 \times 0,7 \times \sqrt{109,639 \times 1} + 1,5 \\ &= \mathbf{10,368 \text{ mm}}\end{aligned}$$

$$\begin{aligned}t_{\min} + 1,5 &= 10,630 + 1,5 \\ &= \mathbf{12,130 \text{ mm} \approx 13 \text{ mm}}\end{aligned}$$

2) Tebal plat alas pada daerah midship

$$\begin{aligned}t B_1 &= 1,21 \times 1,0 \times 0,7 \times \sqrt{93,821 \times 1} + 1,5 \\ &= \mathbf{9,70 \text{ mm}}\end{aligned}$$

$$\begin{aligned}t_{\min} + 1,5 &= 10,630 + 1,5 \\ &= \mathbf{12 \text{ mm}}\end{aligned}$$

3) Tebal plat alas pada daerah haluan kapal

Tebal plat alas pada haluan untuk $a = 0,6$ m (fr. 149 – fr. 161) :

$$\begin{aligned}t B_1 &= 1,21 \times 1,0 \times 0,6 \times \sqrt{127,308 \times 1} + 1,5 \\ &= \mathbf{9,691 \text{ mm}}\end{aligned}$$

$$\begin{aligned}t_{\min} + 1,5 &= 10,630 + 1,5 \\ &= \mathbf{12,130 \text{ mm} \approx 13 \text{ mm}}\end{aligned}$$

B.4. Menentukan Tebal Plat Lajur Bilga

a. Tebal plat lajur bilga diambil harga terbesar dari harga tebal plat alas atau plat sisi (*BKI Th. 2006 Vol. II Sec 6.B.4.2*).

1) Tebal plat-plat lajur bilga pada daerah 0,05 L dari AP = 13 mm

2) Tebal plat-plat lajur bilga pada daerah 0,4 L midship = 12 mm

3) Tebal plat-plat lajur bilga pada daerah 0,1 L dari FP = 13 mm

b. Lebar lajur bilga tidak boleh kurang dari :

$$\begin{aligned}b &= 800 + 5 L \\ &= 800 + 5 (113)\end{aligned}$$

$$= 1360 \text{ mm} \approx 1400 \text{ mm}$$

(Ref : BKI Th. 2006 Vol. II Sec. 6.B.4.2)

B.5 Menentukan Plat Lajur Atas (Sheer Strake)

- a. Lebar plat sisi lajur atas tidak boleh kurang dari :

$$\begin{aligned} b &= 800 + 5 L \\ &= 800 + 5 (112) \\ &= 1365 \text{ mm} \approx 1400 \text{ mm} \end{aligned}$$

(Ref : BKI Th. 2006 Vol. II Sec. 6.C.3.1)

Tebal plat lajur atas di luar midship umumnya tebalnya sama dengan

$$t = 0,5 (t_D + t_S)$$

(Ref : BKI Th. 2006 Vol. II Sec. 6.C.3.2)

Dimana :

t_D : Tebal plat geladak

t_S : Tebal plat sisi

- | | |
|----------------------|-------------------------------------|
| 1) Pada 0,5L dari AP | $t = 0,5 (11 + 11) = 11 \text{ mm}$ |
| 2) Pada 0,4L Midship | $t = 0,5 (10 + 10) = 10 \text{ mm}$ |
| 3) Pada 0,5L dari FP | $t = 0,5 (11 + 11) = 11 \text{ mm}$ |

B.6. Plat penguat pada linggi buritan dan lunas, baling-baling dan lebar bilga

(Ref : BKI Th. 2006 Vol. II Sec. 6.F.1.1)

- a. Tebal plat kulit linggi buritan sekurang-kurangnya sama dengan plat sisi tengah kapal = 10 mm
- b. Tebal penyangga baling-baling harus dipertebal menjadi :

$$t = 1,5 + t_1$$

Dimana :

$$\begin{aligned} t_1 &= \text{tebal plat sisi pada } 0,4 \text{ L tengah kapal} \\ &= 10 \text{ mm} \end{aligned}$$

Maka :

$$\begin{aligned} t &= 1,5 + 10 \\ &= 11,5 \text{ mm maka diambil } 12 \text{ mm} \end{aligned}$$

- c. Tebal Plat lunas, $t_k = t_a + 2 = 13 + 2 = 15 \text{ mm}$

Lebar plat lunas tidak boleh kurang dari) :

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(Ref : BKI Th. 2006 Vol. II Sec. 6.B.5.1)

$$\begin{aligned} b &= 800 + 5 L \\ &= 800 + 5 (113) \\ &= 1365 \text{ mm} \approx 1400 \text{ mm} \end{aligned}$$

d. Lunas bilga dipasang pada plat kulit bagian bawah yang sekelilingnya dilas kedap air. Sehingga jika ada sentuhan dengan dasar laut plat kulit tidak akan rusak.

e. Tebal pelat linggi haluan

Tebal plat linggi haluan tidak boleh kurang dari :

$$t = (0,6 + 0,4 aB) \times (0,08 L + 6) \sqrt{k} \quad (\text{mm})$$

(BKI Th. 2006 Vol II Sec 13.B.2.1)

Dimana :

$$\begin{aligned} aB &= \text{spacing of fore hooks} \\ &= 0,9 \text{ m} \end{aligned}$$

$$\begin{aligned} t &= (0,6 + 0,4 \cdot 0,9) \times (0,08 \cdot 113 + 6) \sqrt{1} \\ &= 13,54 \text{ mm} \approx 20 \text{ mm} \end{aligned}$$

$$\begin{aligned} t_{\text{max}} &= 25 \sqrt{1} \text{ mm} \\ &= 25 \text{ mm} \end{aligned}$$

B.7. Bukaan pada plat kulit

- Bukaan untuk jendela, lubang udara dan lubang pembuangan katub laut sudut-sudutnya harus dibulatkan dengan konstruksi kedap air.
- Pada lubang jangkar di haluan plat kulit harus dipertebal dengan doubling.
- Dibawah konstruksi pipa duga, pipa limbah, pipa udara dan alas diberi plat doubling.

B.8. Kotak laut (Sea Chest)

Tebal plat sea chest tidak boleh kurang dari :

$$T = 12 \times a \sqrt{P \times k} + t_k \quad (\text{mm})$$

(Ref : BKI Th. 2006 Vol. II Sec. 8.B.5.4.1)

Dimana :

$$P = 2 Mws$$

$$a = 0,7 \text{ m}$$

$$t = 12 \times 0,7 \times \sqrt{2 \times 1} + 1,5$$

$$= 13,379 \text{ mm} \approx \text{diambil } 14 \text{ mm}$$

B.9. Kubu-kubu (Bulwark)

- a. Tebal kubu-kubu untuk kapal > 100 m tidak boleh kurang dari :

(Ref : BKI Th. 2006 Vol. II Sec. 6.K.1)

$$t = 0,65\sqrt{L}$$

$$= 0,65\sqrt{113}$$

$$t = 6,909 \text{ mm} \approx 8 \text{ mm}$$

- b. Tinggi kubu-kubu minimal = 1000 mm

- c. Stay Bulwark

$$W = 4 \times P_s \times e \times (l^2) \text{ cm}^3$$

(BKI Th 2006 Vol II Sec 6.K.4)

Dimana :

$$P_s = 38,829 \text{ KN/m}^2$$

e = jarak antar stay (m)

$$= 2 \times 0,7 = 1,4 \text{ m}$$

l = panjang stay (m)

$$= 1 \text{ m}$$

Sehingga :

$$W = 4 \times 38,829 \times 1,4 \times (1^2)$$

$$= 217,442 \text{ cm}^3$$

Profil T = 150 × 12 FP 90 × 12

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 9 \times 1,2 = 9 \text{ cm}^2$$

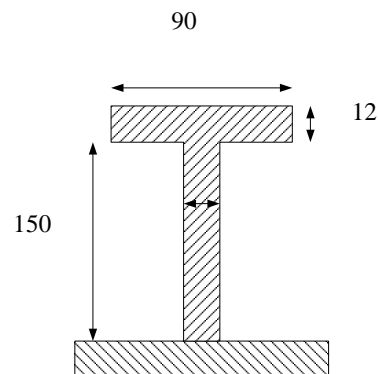
$$f_s = 15 \times 1,2 = 15 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,27$$

$$f_s/F = 0,45$$

$$w = 0,37$$



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$$\begin{aligned}W &= w \times F \times h \\ &= 0,37 \times 40 \times 15 \\ &= 219 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$219 > 217,442 \quad (\text{memenuhi})$$

d. Freeing Ports

A = 0,07 L Untuk L > 20 m

(BKI Th 2006 Vol II Sec 21.D.2.2)

Dimana :

A = panjang freeing ports (m)

L = panjang bulwark (m)

$$= 70 \text{ m}$$

Sehingga :

$$A = 0,07 \times 70$$

$$= 4,9 \text{ m}$$

B.10. Tebal Plat Antara Lubang Palka

Tebal plat geladak pada 0,1 L dari ujung dan antara lubang palka tidak boleh kurang dari :

(Ref : BKI Th. 2006 Vol. II Sec. 7.A.7.1)

$$T_{i1} = 1,21 \times a \sqrt{P_D \times K} + tk \quad (\text{mm})$$

P_D = Beban geladak cuaca

$$= 27,203 \text{ KN/m}^2$$

$$T_{i1} = 1,21 \times 0,7 \sqrt{27,203 \times 1} + 1,5 \quad (\text{mm})$$

$$= 5,917 \text{ mm}$$

$$t_{\text{min}} = 5,5 + 0,02 L$$

$$= 5,5 + (0,02 \times 113)$$

$$= 7,76 \text{ mm} \approx 8 \text{ mm}$$

C. KONSTRUKSI DASAR GANDA

C.1. Secara umum

- a. Pada kapal cargo, dasar ganda terletak antara sekat tubrukan dengan sekat buritan

- b. Dalam tangki ceruk haluan dan ceruk buritan tidak perlu dipasang alas ganda.

C.2. Penumpu Tengah (Centre Girder)

- a. Penumpu tengah harus kedap air, sekurang-kurangnya 0,5 L tengah kapal jika dasar gandan tidak dibagi kedap air oleh penumpu samping.
b. Penumpu tengah pada 0,75 L di tengah kapal tidak boleh kurang dari :

(Ref : BKI Th. 2006 Sec. 8.B.2.2)

- c. Tinggi Penumpu tengah

$$h = 350 + 45 \times B \qquad h_{min} = 600 \text{ mm}$$
$$= 350 + 45 \times 18,20$$

$$\mathbf{h = 1169 \text{ mm} \approx 1180 \text{ mm}}$$

- d. Tebal penumpu tengah

$$t = (h/100 + 1,0) \sqrt{tk}$$
$$= (1180/100 + 1,0) \sqrt{1}$$
$$= \mathbf{12,8 \text{ mm} \approx 13 \text{ mm}}$$

untuk 0,15 L pada ujung kapal, tebal penumpu tengah ditambah 10%.

$$t = 13 + 10\% \times 12$$
$$= \mathbf{14,2 \text{ mm} \approx 14 \text{ mm}}$$

C.3. Penumpu samping (Side Girder)

- a. Penumpu samping (S.G) sekurang-kurangnya dipasang dalam kamar mesin dan 0,25 L, bagian haluan. Satu penumpu samping dipasang apabila lebar horizontal dari sisi bawah plat tepi ke penumpu tengah > dari 4,5 m.
b. Tebal penumpu samping tidak boleh kurang dari :

(Ref : BKI Th. 2006 Sec. 8.B.3.2)

$$t = \left[\frac{h^2}{120 \times h} \right] \cdot \sqrt{k} \qquad (\text{mm})$$
$$= \left[\frac{1180^2}{120 \times 1180} \right] \cdot \sqrt{1}$$
$$= \mathbf{9,833 \text{ mm} \approx 10 \text{ mm}}$$

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untuk 0,15 L pada ujung kapal, tebal penumpu samping ditambah 10%.

$$t = 10 + 10\% \times 10 \\ = 10,0 \text{ mm} \approx 10 \text{ mm}$$

c. Alas dalam

Tebal plat alas dalam (inner Bottom) tidak boleh kurang dari :

$$t = 1,1 \times a \sqrt{P \times k} + t_k \\ (\text{Ref : BKI Th. 2006 Sec. 8.B.4.1})$$

Dimana :

P = Beban alas dalam (inner bottom, midship)

$$= 68,949 \quad \text{KN/m}^2$$

jadi,

$$t_B = 1,1 \times 0,7 \times \sqrt{68,949 \times 1} + 1,5 \\ = 7,89 \text{ mm} \approx 8 \text{ mm}$$

C.4. Alas Ganda Sebagai Tangki

Tangki bahan bakar dan minyak lumas :

- Tangki alas ganda boleh digunakan untuk mengangkut minyak guna keperluan kapal yang titik nyalanya dibawah 60° C, tangki ini dipisahkan oleh cofferdam.
- Tangki minyak lumas, tangki buang, dan tangki sirkulasi harus dipisahkan oleh cofferdam.
- Minyak buang dan tangki sirkulasi minyak harus dibuat sedapat mungkin dipisahkan dari kulit kapal.
- Penumpu tengah harus dibuat kedap dan sempit diujung kapal jika alas ganda pada tempat tersebut tidak melebihi 4 m.
- Papan diatas alas ganda harus ditekan langsung diatas gelar-gelar guna mendapatkan celah untuk aliran air.

C.5. Dasar Ganda Dalam, Sistem Gading Melintang

- Wrang alas penuh (Solid Floor)

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- 1) Dianjurkan untuk memasang wrang pada setiap gading dimana sistem gadingnya adalah :
 - a) Dibagian penguat alas haluan
 - b) Didalam kamar mesin
 - c) Dibawah ruang muat
 - d) Pondasi Ketel
- 2) Wrang alas penuh harus dipasang sekat melintang di bawah topang ruang muat.
 - 1) Dibagian lain D.G. jarak terbesar wrang alas penuh tidak boleh kurang dari 2,4 m untuk kapal $L \leq 100$ m
 - 2) Tebal wrang alas penuh

Tidak boleh kurang dari :

(Ref : *BKI Th. 2006 Sec. 8.B.6.2*)

$$T_{pf} = (t_m - 2) \sqrt{k}$$

t_m = tebal centre girder

$$= (13 - 2) \sqrt{1}$$

$$= 11 \text{ mm}$$

- 3) Lubang peringan
 - a) Panjang max = $0,75 \times h$
= $0,75 \times 1180$
= 885 mm
Direncanakan = 800 mm
 - b) Tinggi max = $0,5 \times h$
= $0,5 \times 1180$
= 590 mm
Direncanakan = 500 mm
 - c) Diameter = $1/3 \times 1180$
= 389,4 mm
Direncanakan = 350 mm
 - d) Jarak max. Lubang peringan dari penumpu tengah dan plat tepi tidak boleh melebihi dari 0,4 tinggi penumpu tengah.

b. Wrang Alas Kedap Air

- 1) Tebal dari wrang alas kedap air tidak boleh kurang dari wrang alas penuh = 10 mm
- 2) Ukuran Stiffener pada wrang kedap air :

$$W = 0,55 \times k \times a \times l^2 \times P$$

(Ref : BKI Th. 2006 Sec. 8.B.6.4.3)

Dimana :

$$l = h_{DB} - 50$$

$$= 1180 - 50$$

$$= 1130 \text{ mm}$$

$$a = \text{jarak antar stiffener}$$

$$= 0,6 \text{ m}$$

$$n = 0,55 \text{ jika } P = P_i$$

$$k = 1,0$$

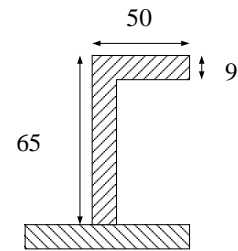
$$PB = 88,441 \text{ KN/m}^2$$

Jadi,

$$W = 0,55 \times 1,0 \times 0,6 \times (1,130)^2 \times 88,441$$

$$= 37,267 \text{ cm}^2$$

$$L = 65 \times 50 \times 9$$



c. Wrang alas terbuka

Wrang alas terbuka terdiri dari gading-gading pada plat dasar dan gading balik pada plat alas dalam yang dihubungkan pada penumpu tengah dan plat tepi melalui plat penunjang.

Modulus penampang gading-gading alas tidak boleh kurang dari :

$$W = n \times c \times a \times l^2 \times P \times k \quad (\text{cm}^3)$$

(Ref : BKI Th. 2006 Sec. 8.B.6.4.3)

- 1) Untuk gading balik

$$P = 68,949 \text{ KN/m}^2$$

$$l = \text{Panjang tak ditumpu}$$

$$= 3 - (0,75 \times h_{DB})$$

$$= 3 - (0,75 \times 1,18)$$

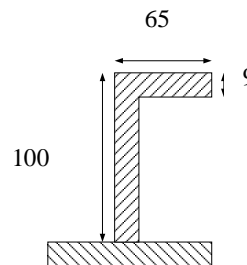
$$= 2,115 \text{ m}$$

$$n = 0,55$$

$$c = 0,65$$

$$k = 1$$

$$a = 0,7 \text{ m}$$



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$$W = 0,55 \times 0,65 \times 0,7 \times 68,949 \times (2,115)^2 \times 1,0 \\ = 77,179 \text{ cm}^3$$

$$\text{Profil perencanaan (L)} = 100 \times 65 \times 9$$

2) Gading alas

$$P = 88,441 \text{ KN/m}^2$$

$$l = \text{Panjang tak ditumpu} \\ = 3 - (0,75 \times h_{DB}) \\ = 3 - (0,75 \times 1,18) \\ = 2,115 \text{ m}$$

$$n = 0,55$$

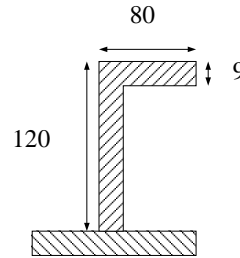
$$c = 0,65$$

$$k = 1$$

$$a = 0,7$$

$$W = 0,55 \times 0,7 \times 0,65 \times (2,115)^2 \times 88,441 \times 1,0 \\ = 98,998 \text{ KN/m}^3$$

$$\text{Profil perencanaan (L)} = 120 \times 80 \times 9$$



C.6. Konstruksi alas ganda pada kamar mesin

Tinggi Alas Ganda pada Kamar Mesin

Dasar ganda Ruang Mesin ditambah 20 % h_{DB} (ht) :

$$ht = (20\% \times 1180) + 1180$$

$$= 1416 \text{ mm} \approx 1420 \text{ mm}$$

a. Tebal plat penumpu memanjang (pondasi mesin)

(Ref : BKI Th. 2006 Sec. 8.C.3.2.1)

Tebal plat pondasi mesin tidak boleh kurang dari :

$$t = \frac{P}{750} + 14 \quad (\text{mm})$$

$$P = \text{daya mesin} \times 0,7355$$

$$= 5500 \times 0,7355$$

$$P = 4045,25 \text{ kW}$$

$$t = \frac{4045,25}{750} + 14$$

$$= 19,39 \approx \text{diambil } 20 \text{ mm}$$

b. Tebal Top Plate

(Ref : BKI Th. 2006 Sec. 8.C.3.2.3)

$$A_r = \frac{P}{75} + 70 = \frac{4045,25}{75} + 70$$

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$$= 123,936 \text{ cm}^2$$

Lebar Top Plate antara 200 s/d 400, diambil 400 mm

$$\begin{aligned} \text{Jadi tebal top plate} &= \frac{A_r}{400} \\ &= \frac{123,936}{400} \end{aligned}$$

$$= 0,309 \text{ cm} = 30,9 \text{ mm} \approx \text{diambil } 31 \text{ mm}$$

- c. **Tebal wrang alas penuh pada daerah kamar mesin diperkuat sebesar**

(Ref : BKI Th. 2006 Sec. 8.C.2.2)

$$\begin{aligned} t &= 3,6 + \frac{P}{500} (\%) \\ &= 3,6 + \frac{4045,25}{500} (\%) \end{aligned}$$

$$t = 10,955 \%$$

$$t = 10 \text{ mm} + (10,955 \% \times 10) \text{ mm}$$

$$= 11,955 \text{ mm} \approx 12 \text{ mm}$$

D. PERHITUNGAN GADING-GADING

Jarak Gading Normal

- Menurut BKI Th. 2006 jarak gading normal antara 0,2 L dari FP sampai sekat ceruk buritan adalah tidak boleh kurang dari 600 mm
- Di depan sekat tubrukan dan di belakang sekat ceruk buritan jarak gading normal maksimal 600 mm

$$a = \frac{L}{500} + 0,48$$

$$= \frac{113}{500} + 0,48$$

$$= 0,706 \text{ m} \approx \text{diambil } 0,7 \text{ m}$$

D.1. Gading-gading utama pada kapal

Modulus gading utama tidak boleh kurang dari :

$$W = n \times c \times a \times l^2 \times Ps \times Cr \times k \text{ (cm}^3\text{)}$$

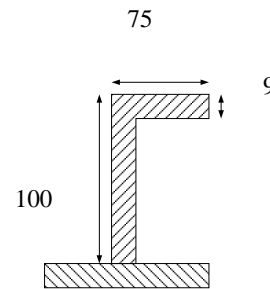
(Ref : BKI Th. 2006 Sec. 9.A.2.1.1)

Dimana :

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$$\begin{aligned}k &= 1 \\n &= 0,55 \quad \text{Untuk } L \geq 100 \text{ m} \\a &= \text{jarak antar gading} \\&= 0,6 \text{ m (AP - Fr 10)} \quad \text{Buritan} \\&= 0,7 \text{ m (Fr 10 - Fr 45)} \quad \text{Buritan} \\&= 0,7 \text{ m (Fr 45 - Fr 149)} \quad \text{midship} \\&= 0,6 \text{ m (Fr 149 - FP)} \quad \text{Haluan} \\l &= \text{panjang tak ditumpu} \\&= 1/3 (H - h) \\&= 1/3 (9,40 - 0,118)\text{s} \\&= 2,74 \text{ m} \\P_{s1} &= 85,315 \text{ KN/ m}^2 \\P_{s2} &= 69,726 \text{ KN/ m}^2 \\P_{s3} &= 102,699 \text{ KN/ m}^2 \\C_{r_{\min}} &= 0,75 \\k &= 1,0 \\c_{\min} &= 0,6\end{aligned}$$



Jadi :

- a. Modulus gading utama pada daerah buritan $a = 0,6 \text{ m}$ (AP - Fr 10)

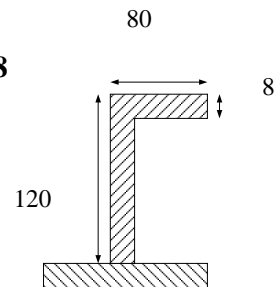
$$\begin{aligned}W &= 0,55 \times 0,6 \times 0,6 \times (2,74)^2 \times 85,315 \times 0,75 \times 1,0 \\&= \mathbf{95,019 \text{ cm}^3}\end{aligned}$$

Profil yang direncanakan = **L 100 × 75 × 9**

- b. Modulus gading utama pada daerah buritan $a = 0,7 \text{ m}$ (Fr 10 - Fr 45)

$$\begin{aligned}W &= 0,55 \times 0,6 \times 0,7 \times (2,74)^2 \times 85,315 \times 0,75 \times 1,0 \\&= \mathbf{110,856 \text{ cm}^3}\end{aligned}$$

Profil yang direncanakan = **L 120 × 80 × 8**



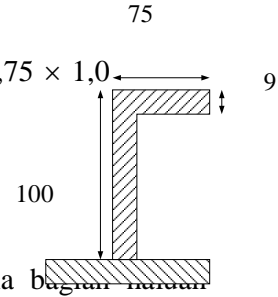
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- c. Modulus gading utama pada daerah midship a = 0,7 m (Fr 45 – Fr 149)

$$W = 0,55 \times 0,6 \times 0,7 \times (2,74)^2 \times 69,726 \times 0,75 \times 1,0$$
$$= 90,600 \text{ cm}^3$$

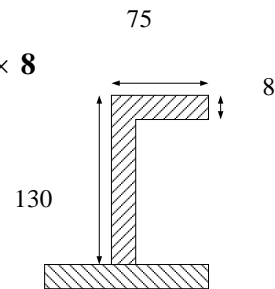
Profil yang direncanakan = L 100 × 75 × 9



- d. Modulus penampang gading pada gading utama bangunan kapal a = 0,6 m (Fr 149 – FP)

$$W = 0,55 \times 0,6 \times 0,6 \times (2,74)^2 \times 102,699 \times 0,75 \times 1,0$$
$$= 114,381 \text{ cm}^3$$

Profil yang direncanakan = L 130 × 75 × 8



D.2. Gading-gading bangunan atas & rumah geladak

Modulus gading bangunan atas tidak boleh kurang dari:

(Ref : BKI Th. 2006 Sec. 9.A.3.2)

a. Poop Deck

$$W = 0,55 \times a \times l^2 \times Ps \times Cr \times k \text{ (cm}^3\text{)}$$

Dimana :

- a = 0,6 m (AP – Fr 10)
= 0,7 m (Fr 10 – Fr 45)
- l = panjang tak ditumpu
= 2,2 m
- Ps = 42,853 KN/m²
- Cr = 0,75
- k = 1,0

Jadi,

- 1) Modulus & perencanaan profil gading utama pada poop deck untuk jarak gading (a) = 0,6 m (AP – Fr 10) :

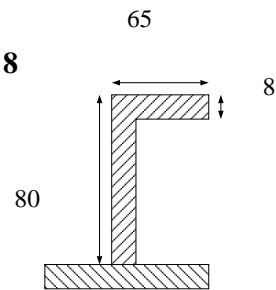
$$W = 0,55 \times 0,6 \times (2,2)^2 \times 42,853 \times 0,75 \times 1,0$$

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$$= 51,334 \text{ cm}^3$$

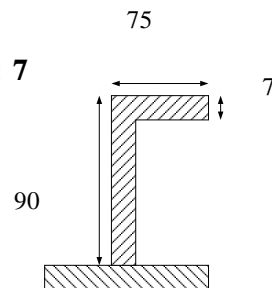
Profil yang direncanakan = L 80 × 65 × 8



- 2) Modulus & perencanaan profil gading utama pada poop deck untuk jarak gading (a) = 0,7 m (Fr 10 – Fr 45) :

$$W = 0,55 \times 0,7 \times (2,2)^2 \times 42,853 \times 0,75 \times 1,0 \\ = 59,889 \text{ cm}^3$$

Profil yang direncanakan = L 90 × 75 × 7



b. Boat Deck

$$W = 0,55 \times a \times l^2 \times ps \times Cr \times k \quad (\text{cm}^3)$$

Dimana :

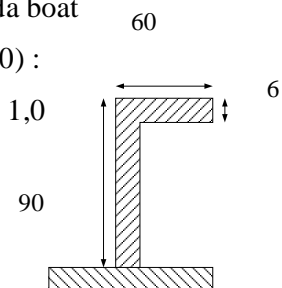
$$a = 0,6 \text{ m (Fr 5 – Fr 10)} \\ = 0,7 \text{ m (Fr 10 – Fr 45)} \\ l = \text{panjang tak ditumpu} \\ = 2,2 \text{ m} \\ Ps = 36,679 \text{ KN/m}^2 \\ Cr = 0,75 \\ k = 1,0$$

Jadi,

- 1) Modulus & perencanaan profil gading utama pada boat deck untuk jarak gading (a) = 0,6 m (Fr 5 – Fr 10) :

$$W = 0,55 \times 0,6 \times (2,2)^2 \times 36,679 \times 0,75 \times 1,0 \\ = 43,937 \text{ cm}^3$$

Profil yang direncanakan = L 90 × 60 × 6



- 2) Modulus & perencanaan profil gading utama pada boat deck untuk jarak gading (a) = 0,7 m (Fr 10 – Fr 45) :

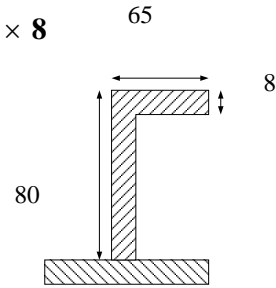
$$W = 0,55 \times 0,7 \times (2,2)^2 \times 36,679 \times 0,75 \times 1,0$$

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$$= 51,260 \text{ cm}^3$$

Profil yang direncanakan = L 80 × 65 × 8



c. Navigation Deck

$$W = 0,55 \times a \times l^2 \times Ps \times Cr \times k \quad (\text{cm}^3)$$

Dimana :

$$a = 0,7 \text{ m}$$

l = panjang tak ditumpu

$$= 2,2 \text{ m}$$

$$Ps = 32,060 \text{ KN/m}^2$$

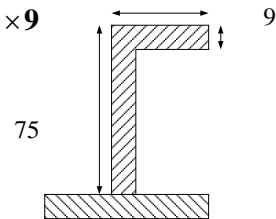
$$Cr = 0,75$$

$$k = 1,0$$

$$W = 0,55 \times 0,7 \times (2,2)^2 \times 32,060 \times 0,75 \times 1,0$$

$$= 44,805 \text{ cm}^3$$

Profil yang direncanakan = L 75 × 50 × 9



d. Compass Deck

$$W = 0,55 \times a \times l^2 \times Ps \times Cr \times k \quad (\text{cm}^3)$$

Dimana :

$$a = 0,7 \text{ m}$$

l = panjang tak ditumpu

$$= 2,2 \text{ m}$$

$$P = 28,474 \text{ KN/m}^2$$

$$Cr = 0,75$$

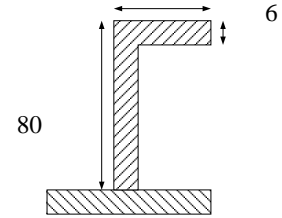
$$k = 1,0$$

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$$W = 0,55 \times 0,7 \times (2,2)^2 \times 28,474 \times 0,75 \times 1,0 \quad 65$$
$$= 39,793 \text{ cm}^3$$

Profil yang direncanakan = L 80 × 65 × 6



e. Fore Castle Deck

$$W = 0,55 \times a \times l^2 \times Ps \times Cr \times k \quad (\text{cm}^3)$$

Dimana :

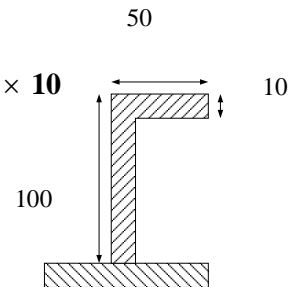
$$a = 0,6 \text{ m (Fr 149 – FP)}$$
$$= 0,7 \text{ m (Fr 145 – 149)}$$
$$l = \text{panjang tak ditumpu}$$
$$= 2,2 \text{ m}$$
$$P = 63,131 \text{ KN/m}^2$$
$$Cr = 0,75$$
$$k = 1,0$$

Jadi,

- 1) Modulus & perencanaan profil gading utama pada fore castle deck untuk jarak gading (a) = 0,6 m (Fr 149 – FP) :

$$W = 0,55 \times 0,6 \times (2,2)^2 \times 63,131 \times 0,75 \times 1,0 \quad 50$$
$$= 75,624 \text{ cm}^3$$

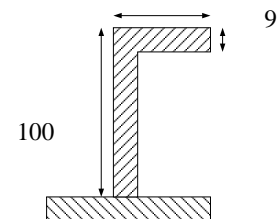
Profil yang direncanakan = L 100 × 50 × 10



- 2) Modulus & perencanaan profil gading utama pada fore castle deck untuk jarak gading (a) = 0,7 m (Fr 145 – Fr 149) :

$$W = 0,55 \times 0,7 \times (2,2)^2 \times 63,131 \times 0,75 \times 1,0 \quad 75$$
$$= 88,228 \text{ cm}^3$$

Profil yang direncanakan = L 100 × 75 × 9



f. Winch Deck

$$W = 0,55 \times a \times l^2 \times Ps \times Cr \times k \quad (\text{cm}^3)$$

Dimana :

$$l = \text{panjang tak ditumpu} \\ = 2,2 \text{ m}$$

$$P = 24,699 \text{ KN/m}^2$$

$$Cr = 0,75$$

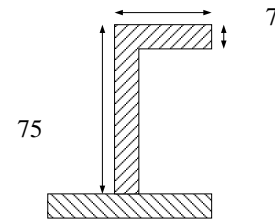
$$k = 1,0$$

Jadi,

1) Modulus & perencanaan profil gading utama pada Winch deck :

$$W = 0,55 \times 0,7 \times (2,2)^2 \times 24,699 \times 0,75 \times 1,0 \quad 50 \\ = 34,518 \text{ cm}^3$$

Profil yang direncanakan = **L 75 × 50 × 7**



D.3. Gading-gading besar (web frame)

Modulus gading Besar tidak boleh kurang dari :

(Ref : BKI Th. 2006 Sec. 9.A.5.3)

$$W = 0,55 \times e \times l^2 \times Ps \times n \times k$$

Dimana :

a = 0,6 m (AP – Fr 10)	buritan
= 0,7 m (Fr 10 – Fr 45)	buritan
= 0,7 m (Fr 45 – Fr 149)	midship
= 0,6 m (Fr 149 – FP)	haluan

$$e = 4 \times a \\ = 4 \times 0,6 = 2,4 \text{ m} \quad \text{untuk } a = 0,6$$

$$e = 4 \times a \\ = 4 \times 0,7 = 2,8 \text{ m} \quad \text{untuk } a = 0,7$$

$$l = 1/3 (H - h_{db}) \\ = 1/3 (9,40 - 1,18) \\ = 2,74 \text{ m}$$

$$Ps_1 = 77,892 \text{ kN / m}^2$$

$$Ps_2 = 65,413 \text{ kN / m}^2$$

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$$Ps_3 = 91,801 \text{ kN / m}^2$$

$$n = 1,0$$

$$k = 1,0$$

Jadi,

- 1) Modulus & perencanaan profil penampang gading besar pada daerah buritan a = 0,6 m (AP- Fr 10)

$$\begin{aligned} W &= 0,55 \times 2,4 \times (2,74)^2 \times 77,892 \times 1,0 \times 1,0 \\ &= 771,131 \text{ kN / m}^2 \end{aligned}$$

Profil yang direncanakan **T 300 × 14 FP 120 × 14**

Koreksi modulus :

Lebar berguna (40 – 50) = 50 cm

$$f = 12 \times 1,4 = 16,8 \text{ cm}^2$$

$$fs = 30 \times 1,4 = 42 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,30$$

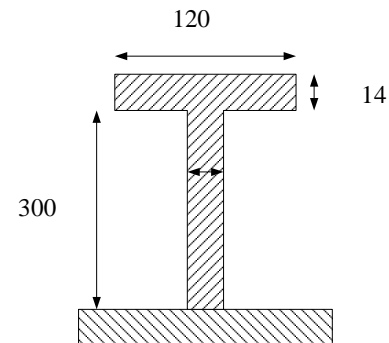
$$fs/F = 0,76$$

$$w = 0,47$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,47 \times 55 \times 30 \\ &= 775 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$775 > 771,131 \quad (\text{memenuhi})$$



- 2) Modulus & perencanaan profil penampang gading besar pada daerah midship a = 0,7 m (Fr 45 – Fr 149)

$$Ps_2 = 65,413 \text{ kN / m}^2$$

$$\begin{aligned} W &= 0,55 \times 2,8 \times (2,74)^2 \times 65,413 \times 1,0 \times 1,0 \\ &= 755,520 \text{ kN / m}^2 \end{aligned}$$

Profil yang direncanakan

T 280 × 14 FP 120 × 14

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 12 \times 1,4 = 19,8 \text{ cm}^2$$

$$f_s = 28 \times 1,4 = 39,2 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^2$$

$$f/F = 0,39$$

$$f_s/F = 0,78$$

$$w = 0,54$$

$$W = w \times F \times h$$

$$= 0,54 \times 50 \times 28$$

$$= 756 \text{ cm}^3$$

W rencana > W perhitungan

$$756 > 755,520 \quad (\text{memenuhi})$$

- 3) Modulus & perencanaan profil penampang gading besar pada daerah haluan a = 0,6 m (Fr 149 – FP)

$$P_{s3} = 91,801 \text{ kN / m}^2$$

$$W = 0,55 \times 2,4 \times (2,74)^2 \times 91,801 \times 1,0 \times 1,0$$

$$= 908,829 \text{ kN / m}^2$$

Profil yang direncanakan

T 300 × 14 FP 140 × 14

Koreksi modulus :

Lebar berguna (40 – 50) = 50

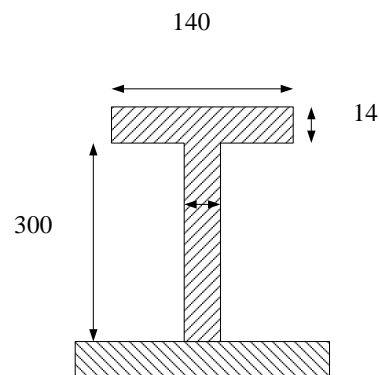
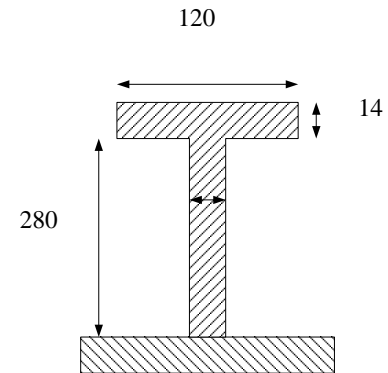
$$f = 14 \times 1,4 = 19,6 \text{ cm}^2$$

$$f_s = 30 \times 1,4 = 42 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,35$$

$$f_s/F = 0,76$$



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$$\begin{aligned}w &= 0,552 \\W &= w \times F \times h \\&= 0,552 \times 55 \times 30 \\&= 910,8 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$910,8 > 908,829 \text{ (memenuhi)}$$

- 4) Modulus penampang gading besar pada Kamar mesin a = 0,7 m (Fr 10 – Fr 45)

(Ref : BKI Th. 2006 Sec. 9.A.6.2.1)

$$W = 0,8 \times e \times l^2 \times P_s \times k$$

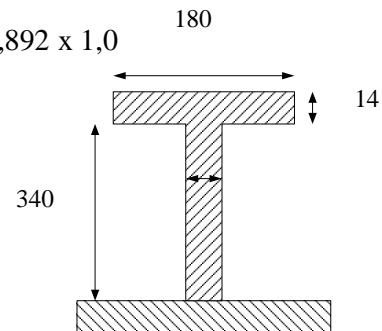
Dimana ;

$$\begin{aligned}a &= 0,7 \text{ m} \\e &= 4 \times a \\&= 4 \times 0,7 = 2,8 \text{ m} \\l &= 1/3 (H - h_{db \text{ kamar mesin}}) \\&= 1/3 (9,40 - 1,32) \\&= 2,626 \text{ m}\end{aligned}$$

$$\begin{aligned}P_s &= 77,892 \text{ kN / m}^2 \\W &= 0,8 \times 2,8 \times (2,626)^2 \times 77,892 \times 1,0 \\&= 1191,254 \text{ kN / m}^2\end{aligned}$$

Profil yang direncanakan

$$T = 340 \times 14 \text{ FP } 180 \times 14$$



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$\begin{aligned}f &= 18 \times 1,4 = 25,2 \text{ cm}^2 \\f_s &= 34 \times 1,4 = 47,6 \text{ cm}^2 \\F &= 50 \times 1,1 = 55 \text{ cm}^2 \\f/F &= 0,45 \\f_s/F &= 0,86\end{aligned}$$

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$$w = 0,64$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,64 \times 55 \times 34 \\ &= 1196,8 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$1196,8 > 1191,254 \quad (\text{memenuhi})$$

D.4. Modulus Gading besar pada bangunan atas & Rumah geladak :

$$W = 0,55 \times e \times l^2 \times P_s \times n \times k$$

(Ref : BKI Th. 2006 Sec. 9.A.5.3.1)

a) Pada poop deck

$$P_s = 34,283 \quad \text{KN/m}^2$$

$$a = 0,6 \text{ m} \quad (\text{AP} - \text{Fr } 10)$$

$$= 0,7 \text{ m} \quad (\text{Fr } 10 - \text{Fr } 45)$$

$$= 0,7 \text{ m} \quad (\text{Fr } 45 - \text{Fr } 149)$$

$$= 0,6 \text{ m} \quad (\text{Fr } 149 - \text{FP})$$

$$e = 4 \times a$$

$$= 4 \times 0,6 = 2,4 \text{ m} \quad \text{untuk } a = 0,6$$

$$e = 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m} \quad \text{untuk } a = 0,7$$

$$l = \text{panjang tak ditumpu}$$

$$= 2,2 \text{ m}$$

Jadi,

- 1) Modulus & perencanaan profil penampang gading besar pada poop deck untuk jarak gading $a = 0,6 \text{ m}$ (AP – Fr 10) :

$$\begin{aligned} W &= 0,55 \times 2,4 \times (2,2)^2 \times 34,283 \times 1,0 \times 1,0 \quad (\text{cm}^3) \\ &= 219,027 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

$$\mathbf{T \ 150 \times 12 \ FP \ 90 \times 12}$$

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Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 15 \times 1,2 = 18 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,27$$

$$f_s/F = 0,45$$

$$w = 0,37$$

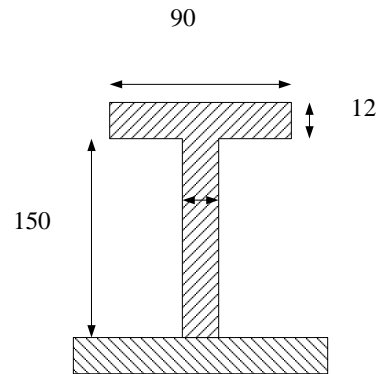
$$W = w \times F \times h$$

$$= 0,37 \times 40 \times 15$$

$$= 222 \text{ cm}^3$$

W rencana > W perhitungan

$$222 > 219,027 \text{ (memenuhi)}$$



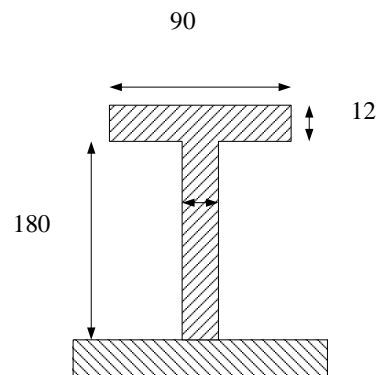
- 2) Modulus & perencanaan profil penampang gading besar pada poop deck untuk jarak gading $a = 0,7 \text{ m}$ (Fr 10 – Fr 45) :

$$W = 0,55 \times 2,8 \times (2,2)^2 \times 34,283 \times 1,0 \times 1,0 \quad (\text{cm}^3)$$

$$= 255,531 \text{ cm}^3$$

Profil yang direncanakan

T 180 × 12 FP 90 × 12



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 18 \times 1,2 = 21,6 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,27$$

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$$\begin{aligned}f_s/F &= 0,54 \\w &= 0,36 \\W &= w \times F \times h \\&= 0,36 \times 40 \times 18 \\&= 258 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$259 > 255,531 \quad (\text{memenuhi})$$

b) Pada Boat deck

$$\begin{aligned}P_s &= 29,344 \text{ KN/m}^2 \\e &= 4 \times a \\&= 4 \times 0,6 = 2,4 \text{ m} \quad \text{untuk } a = 0,6 \text{ (Fr 5 – Fr 10)} \\e &= 4 \times a \\&= 4 \times 0,7 = 2,8 \text{ m} \quad \text{untuk } a = 0,7 \text{ (Fr 10 – Fr 45)}\end{aligned}$$

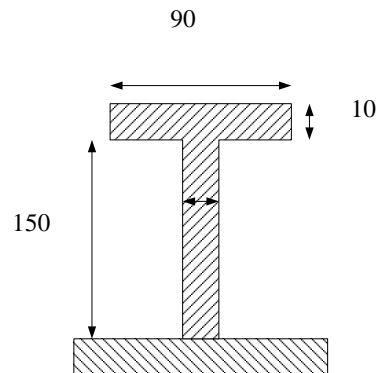
Jadi,

- 1) Modulus & perencanaan profil penampang gading besar pada boat deck untuk jarak gading (a) = 0,6 m (Fr 5 – Fr 10) :

$$\begin{aligned}W &= 0,55 \times 2,4 \times (2,2)^2 \times 29,344 \times 1,0 \times 1,0 \quad (\text{cm}^3) \\&= 187,472 \text{ cm}^3\end{aligned}$$

Profil yang direncanakan

T 150 × 10 FP 90 × 10



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$\begin{aligned}f &= 9 \times 1,0 = 9 \text{ cm}^2 \\f_s &= 15 \times 1,0 = 15 \text{ cm}^2 \\F &= 50 \times 0,8 = 40 \text{ cm}^2 \\f/F &= 0,22 \\f_s/F &= 0,37 \\w &= 0,32 \\W &= w \times F \times h\end{aligned}$$

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$$= 0,32 \times 40 \times 15$$
$$= 192 \text{ cm}^3$$

W rencana > W perhitungan

$$192 > 187,472 \quad (\text{memenuhi})$$

- 2) Modulus & perencanaan profil penampang gading besar pada boat deck untuk jarak gading (a) = 0,7 m (Fr 10 – Fr 45) :

$$W = 0,55 \times 2,8 \times (2,2)^2 \times 29,344 \times 1,0 \times 1,0 \quad (\text{cm}^3)$$
$$= 218,718 \text{ cm}^3$$

Profil yang direncanakan

T 150 × 12 FP 90 × 12

Koreksi modulus :

$$\text{Lebar berguna } (40 - 50) = 50$$

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 15 \times 1,2 = 18 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,27$$

$$f_s/F = 0,45$$

$$w = 0,37$$

$$W = w \times F \times h$$
$$= 0,37 \times 40 \times 15$$
$$= 222 \text{ cm}^3$$

W rencana > W perhitungan

$$222 > 218,718 \quad (\text{memenuhi})$$

c) Navigation Deck

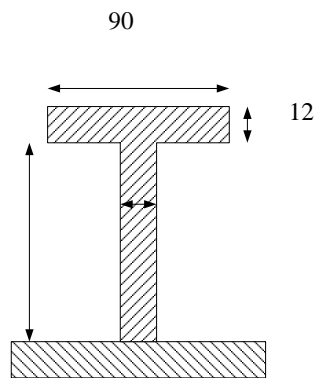
$$P_s = 25,648 \text{ KN/m}^2$$

$$e = 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m}$$

- 1) Modulus & perencanaan profil penampang gading besar pada navigation deck a = 0,7 m :

$$W = 0,55 \times 2,8 \times (2,2)^2 \times 25,648 \times 1,0 \times 1,0 \quad (\text{cm}^3)$$



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$$= 191,169 \text{ cm}^3$$

Profil yang direncanakan

T 150 × 10 FP 90 × 10

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 9 \times 1,0 = 9 \text{ cm}^2$$

$$f_s = 15 \times 1,0 = 15 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,22$$

$$f_s/F = 0,37$$

$$w = 0,32$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,32 \times 40 \times 15 \\ &= 192 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

192 > 191,469 (memenuhi)

d) Compass Deck

$$P_s = 22,779 \text{ KN/m}^2$$

$$\begin{aligned} e &= 4 \times a \\ &= 4 \times 0,7 = 2,8 \text{ m} \end{aligned}$$

1) Modulus & perencanaan profil penampang gading besar pada compass deck a = 0,7 m:

$$\begin{aligned} W &= 0,55 \times 2,8 \times (2,2)^2 \times 22,779 \times 1,0 \times 1,0 \quad (\text{cm}^3) \\ &= 169,785 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan **T 150 × 10 FP 75 × 10**

PROFILE CONSTRUCTION

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Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 8 \times 1,0 = 8 \text{ cm}^2$$

$$f_s = 15 \times 1,0 = 15 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,2$$

$$f_s/F = 0,37$$

$$w = 0,29$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,29 \times 40 \times 15 \\ &= 174 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$174 > 169,785 \text{ (memenuhi)}$$

e) Fore Castle Deck

$$P_s = 50,505 \text{ KN/m}^2$$

$$e = 4 \times a$$

$$= 4 \times 0,6 = 2,4 \text{ m} \quad \text{untuk } a = 0,6 \text{ (Fr 149 - FP)}$$

$$e = 4 \times a$$

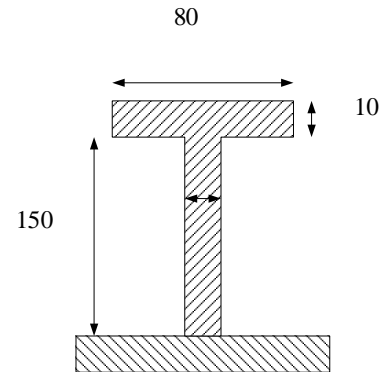
$$= 4 \times 0,7 = 2,8 \text{ m} \quad \text{untuk } a = 0,7 \text{ (Fr 145 - Fr 149)}$$

Jadi,

- 1) Modulus & perencanaan profil penampang gading besar pada fore castle deck untuk jarak gading $a = 0,6 \text{ m}$ (Fr 149 - FP) :

$$\begin{aligned} W &= 0,55 \times 2,4 \times (2,2)^2 \times 50,505 \times 1,0 \times 1,0 \quad (\text{cm}^3) \\ &= 322,666 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan **T 180 × 14 FP 90 × 14**



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 9 \times 1,4 = 12,6 \text{ cm}^2$$

$$f_s = 18 \times 1,4 = 25,2 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^2$$

$$f/F = 0,25$$

$$f_s/F = 0,50$$

$$w = 0,36$$

$$W = w \times F \times h$$

$$= 0,36 \times 50 \times 18$$

$$= 324 \text{ cm}^3$$

W rencana > W perhitungan

$$324 > 322,666 \text{ (memenuhi)}$$

- 2) Modulus & perencanaan profil penampang gading besar pada fore castle deck untuk jarak gading $a = 0,7 \text{ m}$ (Fr 145 – Fr 149) :

$$W = 0,55 \times 2,8 \times (2,2)^2 \times 50,505 \times 1,0 \times 1,0 \quad (\text{cm}^3)$$

$$= 376,444 \text{ cm}^3$$

Profil yang direncanakan

T 200 × 14 FP 90 × 14

Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 10 \times 1,4 = 14 \text{ cm}^2$$

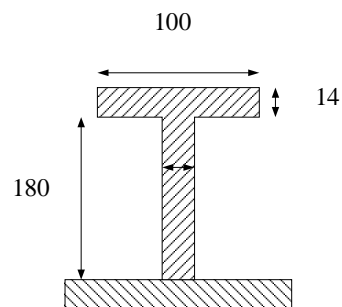
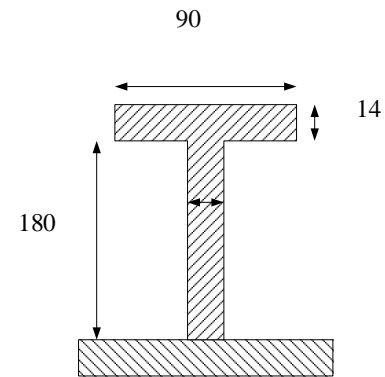
$$f_s = 20 \times 1,4 = 28 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^2$$

$$f/F = 0,25$$

$$f_s/F = 0,56$$

$$w = 0,38$$



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$$\begin{aligned}W &= w \times F \times h \\ &= 0,38 \times 50 \times 20 \\ &= 380 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$380 > 376,444 \text{ (memenuhi)}$$

f) Winch Deck

$$\begin{aligned}P_s &= 19,759 \text{ KN/m}^2 \\ e &= 4 \times a \\ &= 4 \times 0,7 = 2,8 \text{ m}\end{aligned}$$

Jadi,

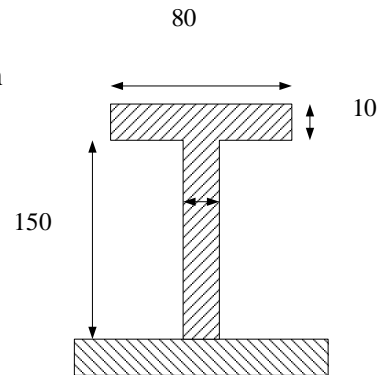
1) Modulus & perencanaan profil penampang gading besar pada

Winch deck a = 0,7 m :

$$\begin{aligned}W &= 0,55 \times 2,8 \times (2,2)^2 \times 19,759 \times 1,0 \times 1,0 \quad (\text{cm}^3) \\ &= 147,275 \text{ cm}^3\end{aligned}$$

Profil yang direncanakan

T 130 × 10 FP 75 × 10



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 80 \times 1,0 = 8 \text{ cm}^2$$

$$f_s = 13 \times 1,0 = 13 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,2$$

$$f_s/F = 0,32$$

$$w = 0,29$$

$$\begin{aligned}W &= w \times F \times h \\ &= 0,29 \times 40 \times 13 \\ &= 150,8 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$150,8 > 147,275 \text{ (memenuhi)}$$

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E. PERHITUNGAN SENTA SISI

Modulus senta sisi tidak boleh kurang dari :

$$W = 0,55 \times e \times l^2 \times P_s \times n \times k$$

(Ref : BKI Th. 2006 Sec. 9.A.5.3)

Dimana :

$$k = 1,0$$

$$n = 1,0$$

e = lebar pembebanan

$$= 1/3 (H - h)$$

$$= 1/3 (9,40 - 1,32)$$

$$= 2,626 \text{ m}$$

(pada daerah kamar mesin)

e = lebar pembebanan

$$= 1/3 (H - h)$$

$$= 1/3 (9,40 - 1,18)$$

$$= 2,74 \text{ m}$$

(pada daerah midship & haluan)

$$P_{s1} = 77,892 \text{ KN/ m}^2 \text{ (Untuk daerah buritan kapal)}$$

$$P_{s2} = 65,413 \text{ KN/ m}^2 \text{ (Untuk daerah tengah kapal)}$$

$$P_{s3} = 91,801 \text{ KN/ m}^2 \text{ (Untuk daerah haluan kapal)}$$

l = panjang tak di tumpu

$$= 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m}$$

Jadi :

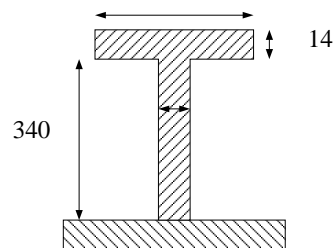
a. Modulus senta sisi pada daerah buritan (pada kamar mesin)

$$W = 0,55 \times 2,626 \times (2,8)^2 \times 77,892 \times 1,0 \times 1,0 \text{ (cm}^3\text{)}$$

$$= 881,995 \text{ cm}^3$$

Profil yang direncanakan = **T 340 × 14 FP 110 × 14**

110



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Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 11 \times 1,4 = 15,4 \text{ cm}^2$$

$$f_s = 34 \times 1,4 = 47,6 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,25$$

$$f_s/F = 0,86$$

$$w = 0,475$$

$$W = w \times F \times h$$

$$= 0,475 \times 55 \times 34$$

$$= 888,25 \text{ cm}^3$$

W rencana > W perhitungan

$$888,25 > 881,995 \quad (\text{memenuhi})$$

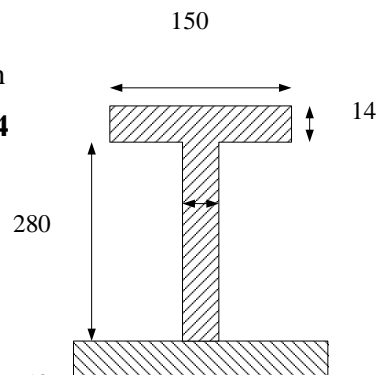
b. Modulus senta sisi pada daerah midship

$$W = 0,55 \times 2,74 \times (2,8)^2 \times 65,413 \times 1,0 \times 1,0 \text{ (cm}^3\text{)}$$

$$= 772,846 \text{ cm}^3$$

Profil yang direncanakan

T 280 × 14 FP 150 × 14



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 15 \times 1,4 = 21 \text{ cm}^2$$

$$f_s = 28 \times 1,4 = 39,2 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^2$$

$$f/F = 0,42$$

$$f_s/F = 0,78$$

$$w = 0,55$$

$$W = w \times F \times h$$

$$= 0,505 \times 50 \times 28$$

$$= 777,7 \text{ cm}^3$$

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W rencana > W perhitungan

$$777,7 > 772,846 \quad (\text{memenuhi})$$

c. Modulus penampang senta sisi pada haluan kapal :

$$\begin{aligned} W &= 0,55 \times 2,74 \times (2,8)^2 \times 91,801 \times 1,0 \times 1,0 \quad (\text{cm}^3) \\ &= 1084,618 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 300 × 14 FP 180 × 14

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 18 \times 1,4 = 25,2 \text{ cm}^2$$

$$f_s = 30 \times 1,4 = 42 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^2$$

$$f/F = 0,50$$

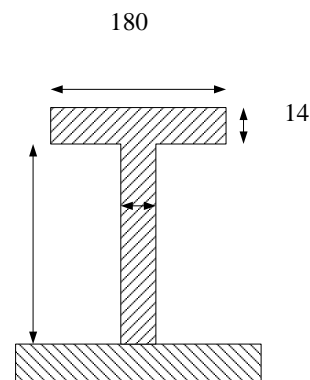
$$f_s/F = 0,84$$

$$w = 0,725$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,725 \times 50 \times 30 \\ &= 1087,5 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$1087,5 > 1084,618 \quad (\text{memenuhi})$$



F. PERHITUNGAN BALOK GELADAK

F.1. Balok geladak (Deck beam)

a. Modulus penampang balok geladak melintang tidak boleh kurang dari:

$$W = c \times a \times P_d \times l^2 \times k \quad (\text{cm}^3)$$

(Ref : BKI Th. 2006 Sec. 10.B.1)

dimana :

$$c = 0,75$$

untuk Beam

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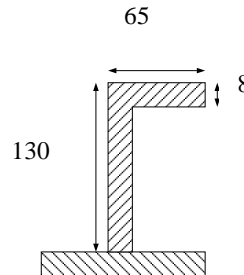
a	= jarak gading		
	= 0,6 m (AP – Fr 10)	buritan	
	= 0,7 m (Fr 10 – Fr 45)	buritan	
	= 0,7 m (Fr 45 – Fr 149)	midship	
	= 0,6 m (Fr 149 – FP)	haluan	
P_{D1}	= 22,442	KN/m ²	untuk Buritan kapal
P_{D2}	= 20,402	KN/m ²	untuk Midship kapal
P_{D3}	= 28,216	KN/m ²	untuk Haluan kapal
l	= Panjang tak ditumpu		
	= 3 m		
k	= 1,0		

- a) Modulus penampang deck beam pada buritan kapal a = 0,6 m (AP – Fr 10)

$$W = 0,75 \times 0,6 \times 22,442 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$
$$= 90,890 \text{cm}^3$$

Profil yang direncanakan

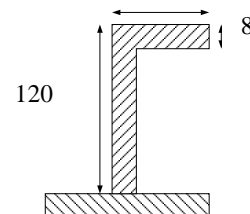
L 130 × 65 × 8



- 2) Modulus penampang deck beam pada buritan kapal a = 0,7 m (Fr 10 – Fr 45)

$$W = 0,75 \times 0,7 \times 22,442 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$
$$= 106,038 \text{cm}^3$$

Profil yang direncanakan L 120 × 80 × 8



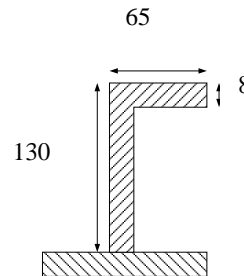
- 3) Modulus penampang deck beam pada Midship kapal a = 0,7 m
(Fr 45 – Fr 149)

$$W = 0,75 \times 0,7 \times 20,402 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$

$$= 96,399 \text{ cm}^3$$

Profil yang direncanakan

$$L \ 130 \times 65 \times 8$$



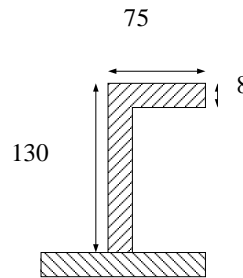
- 4) Modulus penampang deck beam pada haluan kapal a = 0,6 m
(Fr 149 – FP)

$$W = 0,75 \times 0,6 \times 28,216 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$

$$= 114,275 \text{ cm}^3$$

Profil yang direncanakan

$$L \ 130 \times 75 \times 8$$



- b. Balok geladak bangunan atas

Modulus balok geladak bangunan atas :

$$W = c \times a \times P \times l^2 \times k \quad (\text{cm}^3)$$

(Ref : BKI Th. 2006 Sec. 10.B.1)

- 1) Modulus Deck Beam pada geladak kimbul (Poop Deck)

$$c = 0,75$$

a = jarak gading

$$= 0,6 \text{ m (AP – Fr 10)}$$

$$= 0,7 \text{ m (Fr 10 – Fr 45)}$$

l = panjang tak ditumpu

$$= 3 \text{ m}$$

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$$k = 1$$

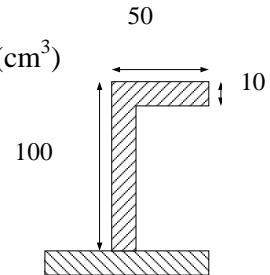
$$P = 17,505 \text{ KN/m}^2$$

- a) Modulus Deck Beam pada geladak kembang (poop deck) untuk a = 0,6 m (AP – Fr 10)

$$W = 0,75 \times 0,6 \times 17,505 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$
$$= 70,895 \text{ cm}^3$$

Profil yang direncanakan

$$L 100 \times 50 \times 10$$

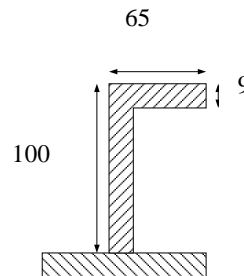


- b) Modulus Deck Beam pada geladak kembang (poop deck) untuk a = 0,7 m (Fr 10 – Fr 45)

$$W = 0,75 \times 0,7 \times 17,505 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$
$$= 82,711 \text{ cm}^3$$

Profil yang direncanakan

$$L 100 \times 65 \times 9$$



- 2) Modulus Deck Beam pada geladak sekoci (Boat Deck)

$$c = 0,75$$

a = jarak gading

$$= 0,6 \text{ m (Fr 5 – Fr 10)}$$

$$= 0,7 \text{ m (Fr 10 – Fr 45)}$$

l = panjang tak ditumpu

$$= 3 \text{ m}$$

$$k = 1$$

$$P = 12,568 \text{ KN/m}^2$$

PROFILE CONSTRUCTION

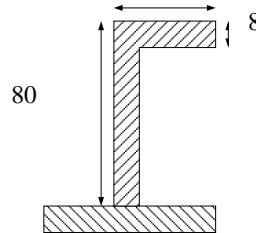
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- a) Modulus Deck Beam pada geladak sekoci (boat deck) untuk a = 0,6 m (Fr 5 – Fr 10)

$$\begin{aligned} W &= 0,75 \times 0,6 \times 12,568 \times (3)^2 \times 1,0 \quad (\text{cm}^3) \\ &= 50,900 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

$$L \ 80 \times 65 \times 8$$

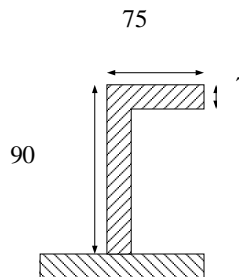


- b) Modulus Deck Beam pada geladak sekoci (boat deck) untuk a = 0,7m (Fr 10 – Fr 45)

$$\begin{aligned} W &= 0,75 \times 0,7 \times 12,568 \times (3)^2 \times 1,0 \quad (\text{cm}^3) \\ &= 59,383 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

$$L \ 90 \times 75 \times 7$$



- 3) Modulus deck beam pada geladak kemudi (navigation deck) a = 0,7 m

$$c = 0,75$$

$$a = 0,7 \text{ m}$$

$$\begin{aligned} l &= \text{panjang tak ditumpu} \\ &= 2,6 \text{ m} \end{aligned}$$

$$k = 1$$

$$P = 11,221 \text{ KN/m}^2$$

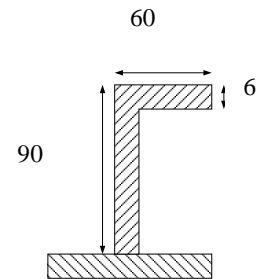
$$\begin{aligned} W &= 0,75 \times 0,7 \times 11,221 \times (2,6)^2 \times 1,0 \quad (\text{cm}^3) \\ &= 39,823 \text{ cm}^3 \end{aligned}$$

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Profil yang direncanakan

$$L 90 \times 60 \times 6$$



4) Modulus Deck Beam pada geladak kompas (compass deck)

$$c = 0,75$$

$$a = 0,7 \text{ m}$$

l = panjang tak ditumpu

$$= 2,2 \text{ m}$$

$$k = 1$$

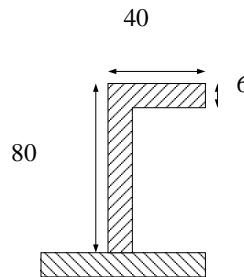
$$P = 11,221 \text{ KN/m}^2$$

$$W = 0,75 \times 0,7 \times 11,221 \times (2,2)^2 \times 1,0 \quad (\text{cm}^3)$$

$$= 28,513 \text{ cm}^3$$

Profil yang direncanakan

$$L 80 \times 40 \times 6$$



5) Modulus Deck Beam pada Fore castle deck

$$c = 0,75$$

$$a = 0,6 \text{ m (Fr 149 – FP)}$$

$$= 0,7 \text{ m (Fr 145 – Fr 149)}$$

l = panjang tak ditumpu

$$= 3 \text{ m (diambil terbesar)}$$

$$k = 1$$

$$P = 28,216 \text{ KN/m}^2$$

PROFILE CONSTRUCTION

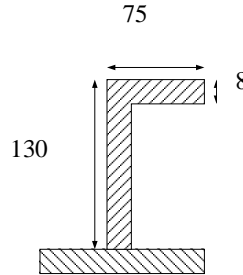
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- a) Modulus Deck Beam pada geladak akil (fore castle deck) untuk a = 0,6m (Fr 149 – FP)

$$W = 0,75 \times 0,6 \times 28,216 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$
$$= 114,274 \text{ cm}^3$$

Profil yang direncanakan

$$L \ 130 \times 75 \times 8$$

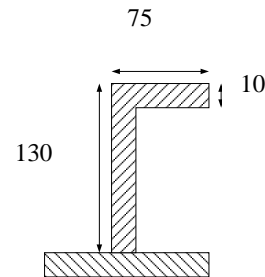


- b) Modulus Deck Beam pada geladak akil (fore castle deck) untuk a = 0,7m (Fr 145 – 149)

$$W = 0,75 \times 0,7 \times 28,216 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$
$$= 133,320 \text{ cm}^3$$

Profil yang direncanakan

$$L \ 130 \times 75 \times 10$$



- 6) Modulus Deck Beam pada Winch deck

$$c = 0,75$$

$$a = 0,7 \text{ m}$$

$$l = \text{panjang tak ditumpu} = 3 \text{ m}$$

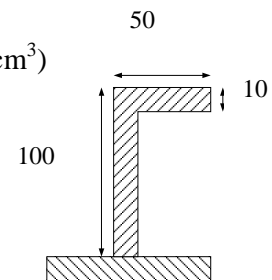
$$k = 1$$

$$P = 15,914 \text{ KN/m}^2$$

$$W = 0,75 \times 0,7 \times 15,914 \times (3)^2 \times 1,0 \quad (\text{cm}^3)$$
$$= 75,194 \text{ cm}^3$$

Profil yang direncanakan

$$L \ 100 \times 50 \times 10$$



F.2. Balok Geladak Besar (Strong Beam)

- a. Modulus penampang strong beam tidak boleh kurang dari :

$$W = c \times e \times l^2 \times P_D \times k \quad (\text{cm}^3)$$

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Dimana,

$c = 0,75$ untuk Beam

$e =$ jarak gading besar

$$= 4 \times a$$

$$= 4 \times 0,6 = 2,4 \text{ m} \quad \text{Untuk } a = 0,6 \text{ m}$$

$$= 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m} \quad \text{Untuk } a = 0,7 \text{ m}$$

$l =$ panjang tak di tumpu

$$= 3 \text{ m}$$

$P_{D1} = 17,954 \text{ KN/m}^2$ untuk Buritan kapal

$P_{D2} = 16,322 \text{ KN/m}^2$ untuk Midship kapal

$P_{D3} = 22,573 \text{ KN/m}^2$ untuk Haluan kapal

$k = 1,0$

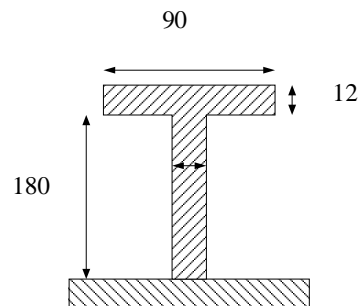
jadi :

1) Modulus Strong beam pada buritan kapal $a = 0,6 \text{ m}$ (AP – Fr 10)

$$\begin{aligned} W &= 0,75 \times 2,4 \times (3)^2 \times 17,954 \times 1,0 \text{ (cm}^3\text{)} \\ &= 290,855 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 180 × 12 FP 90 × 12



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 18 \times 1,2 = 21,6 \text{ cm}^2$$

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$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,19$$

$$f_s/F = 0,39$$

$$w = 0,30$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,30 \times 55 \times 18 \\ &= 297 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$297 > 290,855 \quad (\text{memenuhi})$$

2) Modulus Strong beam pada buritan kapal a = 0,7 m (Fr 10 – Fr 45)

$$\begin{aligned} W &= 0,75 \times 2,8 \times (3)^2 \times 17,954 \times 1,0 \text{ (cm}^3\text{)} \\ &= 339,330 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

$$T \ 180 \times 14 \text{ FP } 90 \times 14$$

Koreksi modulus :

$$\text{Lebar berguna (40 – 50) = 50}$$

$$f = 9 \times 1,4 = 12,6 \text{ cm}^2$$

$$f_s = 18 \times 1,4 = 25,2 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,22$$

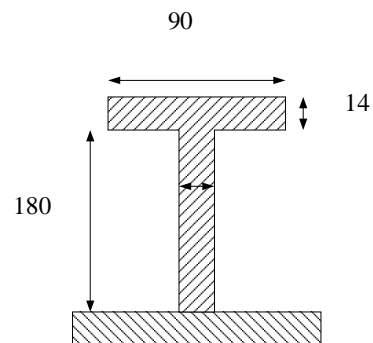
$$f_s/F = 0,45$$

$$w = 0,32$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,34 \times 55 \times 18 \\ &= 341,55 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$341,55 > 339,330 \quad (\text{memenuhi})$$



PROFILE CONSTRUCTION

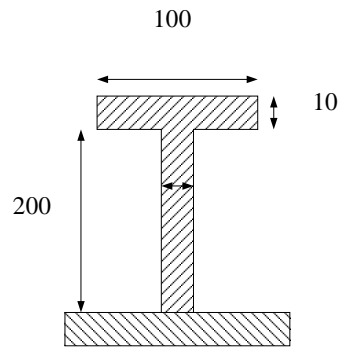
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- 3) Modulus Strong beam pada midship kapal a = 0,7 m (Fr 45 – Fr 149)

$$\begin{aligned}W &= 0,75 \times 2,8 \times (3)^2 \times 16,322 \times 1,0 \text{ (cm}^3\text{)} \\ &= 308,486 \text{ cm}^3\end{aligned}$$

Profil yang direncanakan

$$T \quad 200 \times 10 \text{ FP } 100 \times 10$$



Koreksi modulus :

$$\text{Lebar berguna (40 – 50) = 50}$$

$$f = 10 \times 1,0 = 10 \text{ cm}^2$$

$$f_s = 20 \times 1,0 = 20 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^2$$

$$f/F = 0,20$$

$$f_s/F = 0,40$$

$$w = 0,31$$

$$\begin{aligned}W &= w \times F \times h \\ &= 0,31 \times 50 \times 20 \\ &= 315 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

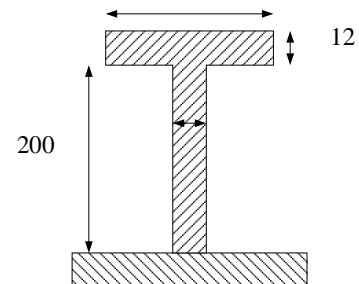
$$315 > 308,486 \quad (\text{memenuhi})$$

- 4) Strong beam pada Haluan kapal a = 0,6 m (Fr 149 – FP)

$$\begin{aligned}W &= 0,75 \times 2,4 \times (3)^2 \times 22,573 \times 1,0 \text{ (cm}^3\text{)} \\ &= 365,683 \text{ cm}^3\end{aligned}$$

Profil yang direncanakan

$$T \quad 200 \times 12 \text{ FP } 100 \times 12$$



Koreksi modulus :

$$\text{Lebar berguna (40 – 50) = 50}$$

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$$f = 10 \times 1,2 = 12 \text{ cm}^2$$

$$f_s = 20 \times 1,2 = 24 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,21$$

$$f_s/F = 0,43$$

$$w = 0,33$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,33 \times 55 \times 20 \\ &= 368,5 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$368,5 > 365,683 \quad (\text{memenuhi})$$

1) Strong beam pada bangunan atas & rumah geladak

1) Pada Poop Deck

e = jarak gading besar

$$= 4 \times a$$

$$= 4 \times 0,6 = 2,4 \text{ m} \quad \text{Untuk } a = 0,6 \text{ m}$$

$$= 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m} \quad \text{Untuk } a = 0,7 \text{ m}$$

l = panjang tak di tumpu

$$= 3 \text{ m}$$

$$P_D = 14,004 \text{ KN/m}^2$$

a) Modulus Strong Beam pada geladak kembang (poop deck) untuk a =

0,6 m (AP – Fr 10)

$$\begin{aligned} W &= 0,75 \times 2,4 \times (3)^2 \times 14,004 \times 1,0 \text{ (cm}^3\text{)} \\ &= 226,864 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

$$T 150 \times 12 \text{ FP } 90 \times 12$$

Koreksi modulus

PROFILE CONSTRUCTION

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Lebar berguna (40 – 50) = 50

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 15 \times 1,2 = 18 \text{ cm}^2$$

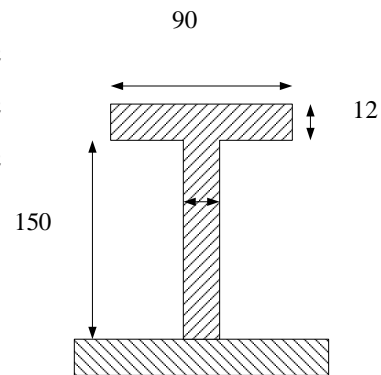
$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,27$$

$$f_s/F = 0,45$$

$$w = 0,38$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,38 \times 40 \times 15 \\ &= 231 \text{ cm}^3 \end{aligned}$$



W rencana > W perhitungan

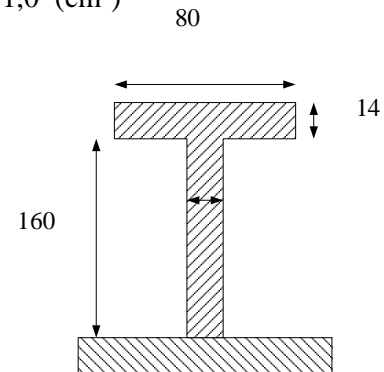
$$231 > 226,864 \quad (\text{memenuhi})$$

b) Modulus Strong Beam pada geladak kembang (poop deck) untuk a = 0,7 m (Fr 10 – Fr 45)

$$\begin{aligned} W &= 0,75 \times 2,8 \times (3)^2 \times 14,004 \times 1,0 \text{ (cm}^3\text{)} \\ &= 264,676 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 160 × 14 FP 80 × 14



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 8 \times 1,4 = 11,2 \text{ cm}^2$$

$$f_s = 16 \times 1,4 = 22,4 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,28$$

$$f_s/F = 0,56$$

$$w = 0,42$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,42 \times 40 \times 16 \\ &= 268,8 \text{ cm}^3 \end{aligned}$$

PROFILE CONSTRUCTION

TUGAS AKHIR KM "FREEDOM" GC 4990 BRT

W rencana > W perhitungan

$$268,8 > 264,676 \quad (\text{memenuhi})$$

2) Pada Boat Deck

e = jarak gading besar

$$= 4 \times a$$

$$= 4 \times 0,6 = 2,4 \text{ m} \quad \text{Untuk } a = 0,6 \text{ m}$$

$$= 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m} \quad \text{Untuk } a = 0,7 \text{ m}$$

l = panjang tak di tumpu

$$= 3 \text{ m}$$

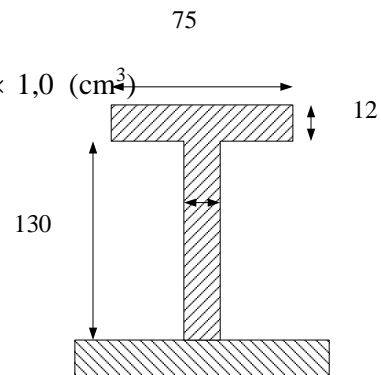
$$P_D = 10,054 \text{ KN/m}^2$$

a) Modulus Strong Beam pada geladak sekoci (boat deck) untuk a = 0,6 m (Fr 5 – Fr 10)

$$W = 0,75 \times 2,4 \times (3)^2 \times 10,054 \times 1,0 \text{ (cm}^3\text{)}$$
$$= 162,875 \text{ cm}^3$$

Profil yang direncanakan

T 130 × 12 FP 75 × 12



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 7,5 \times 1,2 = 9 \text{ cm}^2$$

$$f_s = 13 \times 1,2 = 15,6 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,22$$

$$f_s/F = 0,39$$

$$w = 0,32$$

$$W = w \times F \times h$$

$$= 0,32 \times 40 \times 13$$

$$= 166,4 \text{ cm}^3$$

PROFILE CONSTRUCTION

TUGAS AKHIR KM "FREEDOM" GC 4990 BRT

W rencana > W perhitungan

$$166,4 > 162,875 \quad (\text{memenuhi})$$

b) Modulus Strong Beam pada geladak sekoci (boat deck) untuk a =

0,7 m (Fr 10 – Fr 45)

$$\begin{aligned} W &= 0,75 \times 2,8 \times (3)^2 \times 10,054 \times 1,0 \quad (\text{cm}^3) \quad 90 \\ &= 190,020 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 150 × 10 FP 90 × 10

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 9 \times 1,0 = 9 \quad \text{cm}^2$$

$$f_s = 15 \times 1,0 = 15 \quad \text{cm}^2$$

$$F = 50 \times 0,8 = 40 \quad \text{cm}^2$$

$$f/F = 0,22$$

$$f_s/F = 0,37$$

$$w = 0,32$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,32 \times 40 \times 15 \\ &= 192 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$192 > 190,020 \quad (\text{memenuhi})$$

3) Pada Navigation Deck

$$P_d = 8,977 \text{ KN/m}^2$$

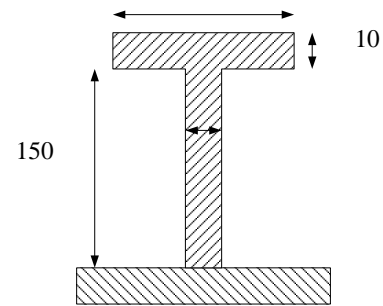
l = panjang tak di tumpu

$$= 2,6 \text{ m}$$

$$\begin{aligned} W &= 0,75 \times 2,8 \times (2,6)^2 \times 8,977 \times 1,0 \quad (\text{cm}^3) \\ &= 127,437 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 130 × 10 FP 65 × 10



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 6,5 \times 1,0 = 6,5 \text{ cm}^2$$

$$f_s = 13 \times 1,0 = 13 \text{ cm}^2$$

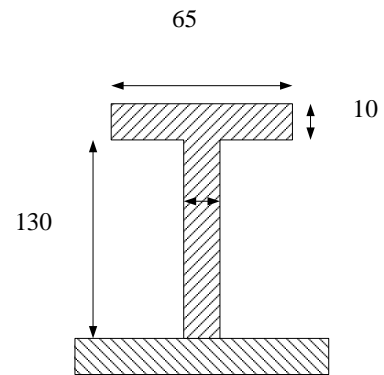
$$F = 50 \times 0,6 = 30 \text{ cm}^2$$

$$f/F = 0,21$$

$$f_s/F = 0,43$$

$$w = 0,33$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,33 \times 30 \times 13 \\ &= 128,7 \text{ cm}^3 \end{aligned}$$



W rencana > W perhitungan

$$128,7 > 127,437 \quad (\text{memenuhi})$$

4) Pada Compass Deck

$$P_d = 8,977 \text{ KN/m}^2$$

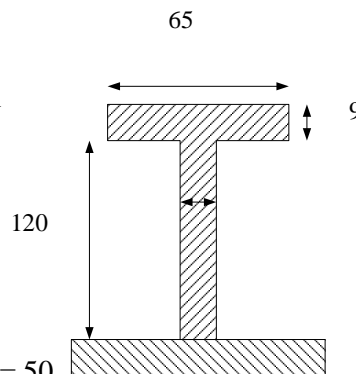
l = panjang tak di tumpu

$$= 2,2 \text{ m}$$

$$\begin{aligned} W &= 0,75 \times 2,8 \times (2,2)^2 \times 8,977 \times 1,0 \text{ (cm}^3\text{)} \\ &= 91,242 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 120 × 9 FP 65 × 9



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 6,5 \times 0,9 = 5,85 \text{ cm}^2$$

$$f_s = 12 \times 0,9 = 10,8 \text{ cm}^2$$

$$F = 50 \times 0,6 = 30 \text{ cm}^2$$

$$f/F = 0,19$$

$$f_s/F = 0,36$$

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$$\begin{aligned}w &= 0,26 \\W &= w \times F \times h \\&= 0,26 \times 30 \times 12 \\&= 93,6 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$93,6 > 91,242 \text{ (memenuhi)}$$

5) Fore castle Deck

e = jarak gading besar

$$= 4 \times a$$

$$= 4 \times 0,6 = 2,4 \text{ m} \quad \text{Untuk } a = 0,6 \text{ m (Fr 149 - FP)}$$

$$= 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m} \quad \text{Untuk } a = 0,7 \text{ m (Fr 145 - Fr 149)}$$

$$P = 22,573 \text{ KN/m}^2$$

a) Modulus Strong Beam pada geladak akil (fore castle deck) untuk a = 0,6 m (Fr 149 - FP)

$$\begin{aligned}W &= 0,75 \times 2,4 \times (3)^2 \times 22,573 \times 1,0 \text{ (cm}^3\text{)} \quad 90 \\&= 365,683 \text{ cm}^3\end{aligned}$$

Profil yang direncanakan

T 200 × 14 FP 90 × 14

Koreksi modulus :

Lebar berguna (40 - 50) = 50

$$f = 90 \times 1,4 = 12,6 \text{ cm}^2$$

$$f_s = 20 \times 1,4 = 28 \text{ cm}^2$$

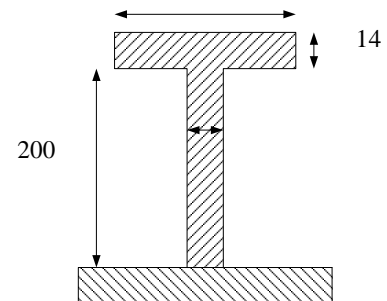
$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,31$$

$$f_s/F = 0,70$$

$$w = 0,46$$

$$W = w \times F \times h$$



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$$\begin{aligned} &= 0,46 \times 40 \times 20 \\ &= 368 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

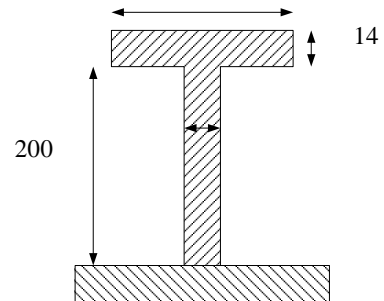
$$368 > 365,683 \quad (\text{memenuhi})$$

b) Modulus Strong Beam pada geladak akil (fore castle deck) untuk a
= 0,7 m (Fr 145 – Fr 149)

$$\begin{aligned} W &= 0,75 \times 2,8 \times (3)^2 \times 22,573 \times 1,0 \text{ (cm}^3\text{)} \quad 100 \\ &= 426,629 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

$$T \ 200 \times 14 \ \text{FP} \ 100 \times 14$$



Koreksi modulus :

$$\text{Lebar berguna } (40 - 50) = 50$$

$$f = 10 \times 1,4 = 14 \text{ cm}^2$$

$$f_s = 20 \times 1,4 = 28 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,35$$

$$f_s/F = 0,70$$

$$w = 0,54$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,54 \times 40 \times 20 \\ &= 432 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$432 > 426,262 \quad (\text{memenuhi})$$

6) Strong beam pada Winch Deck

$$P_s = 12,731 \text{ KN/m}^2$$

l = panjang tak di tumpu

PROFILE CONSTRUCTION

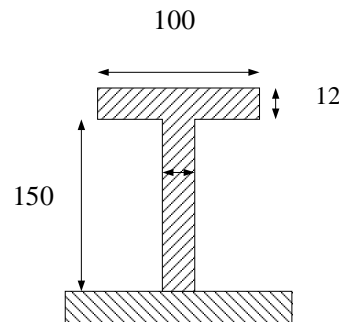
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$$= 2,2 \text{ m}$$

$$W = 0,75 \times 2,8 \times (3)^2 \times 12,731 \times 1,0 \text{ (cm}^3\text{)}$$
$$= 240,616 \text{ cm}^3$$

Profil yang direncanakan

T 150 × 12 FP 100 × 12



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 10 \times 1,2 = 12 \text{ cm}^2$$

$$f_s = 15 \times 1,2 = 18 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,30$$

$$f_s/F = 0,45$$

$$w = 0,41$$

$$W = w \times F \times h$$

$$= 0,41 \times 40 \times 15$$

$$= 246 \text{ cm}^3$$

W rencana > W perhitungan

246 > 240,616 (memenuhi)

G. PENUMPU GELADAK (DECK GIRDER)

Tinggi penumpu tidak boleh kurang dari 1/25 panjang tak ditumpu tinggi plat bilah hadap, penumpu yang dilubangi (lubang las) untuk balok geladak yang menerus minimal 1,5 × tinggi geladak.

G.1. Modulus Penumpu tengah (Center Deck Girder)

$$W = c \times e \times l^2 \times Pd \times k \text{ (cm}^3\text{)}$$

Dimana :

$$c = 0,75$$

e = lebar pembebanan

$$= 3 \text{ m}$$

l = panjang tak di tumpu

$$= 4 \times a$$

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$$= 4 \times 0,6 = 2,4 \text{ m} \quad a = 0,6 \text{ m (AP - Fr 10 \& Fr 149 - FP)}$$

l = panjang tak di tumpu

$$= 4 \times a$$

$$= 4 \times 0,7 = 2,8 \text{ m} \quad a = 0,6 \text{ m (Fr 10 - 45 \& FR 45 - Fr 145)}$$

$$P_{D1} = 17,953 \quad \text{KN/m}^2 \quad (\text{buritan})$$

$$P_{D1} = 16,322 \quad \text{KN/m}^2 \quad (\text{midship})$$

$$P_{D1} = 22,573 \quad \text{KN/m}^2 \quad (\text{haluan})$$

$$k = 1,0$$

- a. Modulus penampang CDG pada daerah 0,1 L dari AP tidak boleh kurang dari :

$$\begin{aligned} W &= 0,75 \times 3 \times (2,4)^2 \times 17,954 \times 1,0 \text{ (cm}^3\text{)} \\ &= 234,109 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 180 × 10 FP 90 × 10

Koreksi modulus :

Lebar berguna (40 - 50) = 50

$$f = 9 \times 1,0 = 9 \text{ cm}^2$$

$$f_s = 18 \times 1,0 = 18 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,16$$

$$f_s/F = 0,32$$

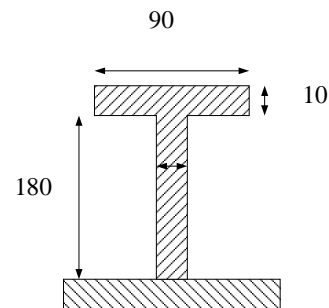
$$w = 0,24$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,24 \times 55 \times 18 \\ &= 237,6 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$237,6 > 234,109 \quad (\text{memenuhi})$$

- b. Modulus penampang penumpu tengah (Centre Deck Girder) pada daerah 0,6 L, tengah kapal tidak boleh kurang dari :



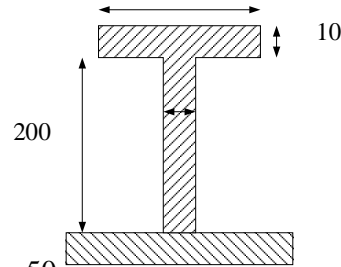
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$$\begin{aligned} W &= 0,75 \times 3 \times (2,8)^2 \times 16,422 \times 1,0 \text{ (cm}^3\text{)} \\ &= 289,684 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 200 × 10 FP 90 × 10



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 9 \times 1,0 = 9 \text{ cm}^2$$

$$f_s = 20 \times 1,0 = 20 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^2$$

$$f/F = 0,18$$

$$f_s/F = 0,40$$

$$w = 0,29$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,29 \times 50 \times 20 \\ &= 290 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

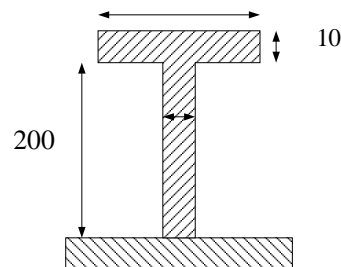
290 > 289,684 (memenuhi)

- c. Modulus penampang penumpu tengah (Center Deck Girder) pada 0,1 L dari FP tidak boleh kurang dari :

$$\begin{aligned} W &= 0,75 \times 3 \times (2,4)^2 \times 22,711 \times 1,0 \text{ (cm}^3\text{)} \\ &= 294,334 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 200 × 10 FP 90 × 10



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 90 \times 1,0 = 9 \text{ cm}^2$$

$$f_s = 20 \times 1,0 = 24 \text{ cm}^2$$

PROFILE CONSTRUCTION

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$$F = 50 \times 1,1 = 55 \text{ cm}^2$$

$$f/F = 0,16$$

$$f_s/F = 0,43$$

$$w = 0,27$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,27 \times 55 \times 20 \\ &= 297 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$297 > 294,334 \quad (\text{memenuhi})$$

➤ Center Deck Girder (CDG) Pada Bangunan Atas

a. Poop Deck

1) Untuk $a = 0,6 \text{ m}$:

$$\begin{aligned} W &= 0,75 \times 3 \times (2,4)^2 \times 14,089 \times 1,0 \text{ (cm}^3\text{)} \\ &= 182,593 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 150 × 10 FP 90 × 10

Koreksi modulus

$$\text{Lebar berguna } (40 - 50) = 50$$

$$f = 9 \times 1,0 = 10 \text{ cm}^2$$

$$f_s = 15 \times 1,0 = 15 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,25$$

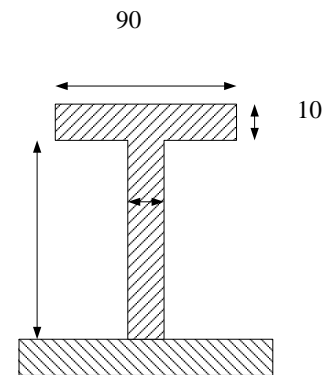
$$f_s/F = 0,37$$

$$w = 0,38$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,32 \times 40 \times 15 \\ &= 192 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$192 > 182,593 \quad (\text{memenuhi})$$



PROFILE CONSTRUCTION

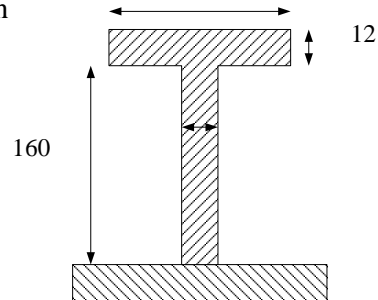
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2) Untuk $a = 0,7$ m

$$\begin{aligned} W &= 0,75 \times 3 \times (2,8)^2 \times 14,089 \times 1,0 \text{ (cm}^3\text{)} \\ &= 248,529 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 160 × 12 FP 80 × 12



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 8 \times 1,2 = 9,6 \text{ cm}^2$$

$$f_s = 16 \times 1,2 = 19,2 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,24$$

$$f_s/F = 0,48$$

$$w = 0,39$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,39 \times 40 \times 16 \\ &= 249,6 \text{ cm}^3 \end{aligned}$$

W rencana $>$ W perhitungan

249,6 > 248,529 (memenuhi)

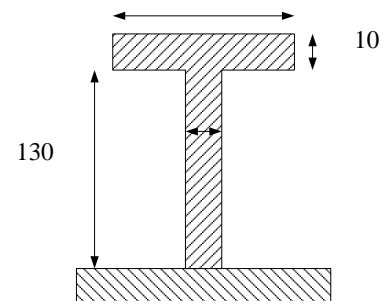
b. Boat Deck

a. Untuk $a = 0,6$ m

$$\begin{aligned} W &= 0,75 \times 3 \times (2,4)^2 \times 10,115 \times 1,0 \text{ (cm}^3\text{)} \quad 75 \\ &= 131,090 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 130 × 10 FP 75 × 10



Koreksi modulus :

Lebar berguna $(40 - 50) = 50$

$$f = 7,5 \times 1,0 = 7,5 \text{ cm}^2$$

PROFILE CONSTRUCTION

TUGAS AKHIR KM "FREEDOM" GC 4990 BRT

$$f_s = 13 \times 1,0 = 13 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,18$$

$$f_s/F = 0,32$$

$$w = 0,26$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,26 \times 40 \times 13 \\ &= 135,2 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$135,2 > 131,090 \quad (\text{memenuhi})$$

b. untuk a = 0,7 m :

$$\begin{aligned} W &= 0,75 \times 3 \times (2,8)^2 \times 10,115 \times 1,0 \text{ (cm}^3\text{)} \\ &= 178,428 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 150 × 10 FP 80 × 10

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 8 \times 1,0 = 8 \text{ cm}^2$$

$$f_s = 15 \times 1,0 = 15 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,20$$

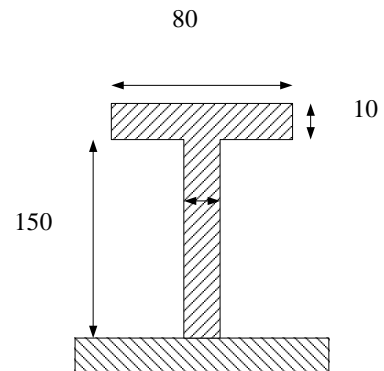
$$f_s/F = 0,37$$

$$w = 0,29$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,29 \times 40 \times 15 \\ &= 180 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$180 > 178,428 \quad (\text{memenuhi})$$



c. Navigation Deck

$$W = 0,75 \times 2,6 \times (2,8)^2 \times 9,032 \times 1,0 \text{ (cm}^3\text{)} \quad 80$$

$$= 138,081 \text{ cm}^3$$

Profil yang direncanakan

T 130 × 9 FP 80 × 9

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 80 \times 0,9 = 7,2 \text{ cm}^2$$

$$f_s = 13 \times 0,9 = 11,7 \text{ cm}^2$$

$$F = 50 \times 0,6 = 30 \text{ cm}^2$$

$$f/F = 0,24$$

$$f_s/F = 0,39$$

$$w = 0,36$$

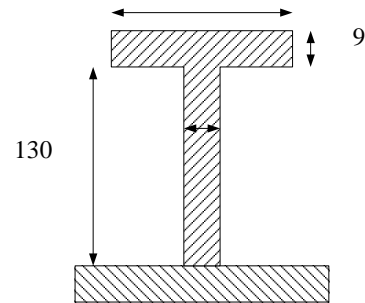
$$W = w \times F \times h$$

$$= 0,36 \times 30 \times 13$$

$$= 140,4 \text{ cm}^3$$

W rencana > W perhitungan

$$140,4 > 138,081 \quad (\text{memenuhi})$$



d. Compas Deck

$$W = 0,75 \times 2,2 \times (2,8)^2 \times 9,032 \times 1,0 \text{ (cm}^3\text{)} \quad 65$$

$$= 116,837 \text{ cm}^3$$

Profil yang direncanakan

T 150 × 8 FP 65 × 8

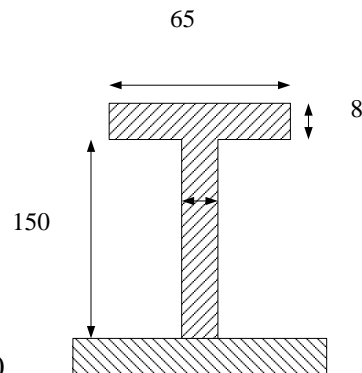
Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 6,5 \times 0,8 = 5,2 \text{ cm}^2$$

$$f_s = 15 \times 0,8 = 12 \text{ cm}^2$$

$$F = 50 \times 0,6 = 30 \text{ cm}^2$$



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$$\begin{aligned}f/F &= 0,17 \\fs/F &= 0,40 \\w &= 0,36 \\W &= w \times F \times h \\&= 0,36 \times 30 \times 15 \\&= 117 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$117 > 116,837 \quad (\text{memenuhi})$$

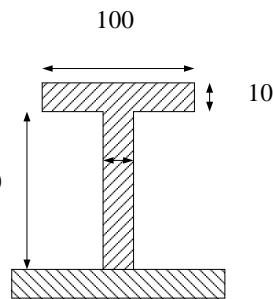
e. Forecastle Deck

1) Untuk a = 0,6

$$\begin{aligned}W &= 0,75 \times 3 \times (2,4)^2 \times 22,711 \times 1,0 \text{ (cm}^3\text{)} \\&= 294,334 \text{ cm}^3\end{aligned}$$

Profil yang direncanakan

T 200 × 10 FP 100 × 10



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$\begin{aligned}f &= 10 \times 1,0 = 10 \text{ cm}^2 \\fs &= 20 \times 1,0 = 20 \text{ cm}^2 \\F &= 50 \times 0,8 = 40 \text{ cm}^2\end{aligned}$$

$$f/F = 0,25$$

$$fs/F = 0,50$$

$$w = 0,37$$

$$\begin{aligned}W &= w \times F \times h \\&= 0,37 \times 40 \times 20 \\&= 296 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$296 > 294,334 \quad (\text{memenuhi})$$

2) Untuk a = 0,7 m

$$W = 0,75 \times 3 \times (2,8)^2 \times 22,711 \times 1,0 \text{ (cm}^3\text{)}$$

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$$= 400,622 \text{ cm}^3$$

Profil yang direncanakan

T 200 × 14 FP 100 × 14

Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 10 \times 1,4 = 14 \text{ cm}^2$$

$$f_s = 20 \times 1,4 = 28 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,35$$

$$f_s/F = 0,70$$

$$w = 0,51$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,51 \times 40 \times 20 \\ &= 408 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

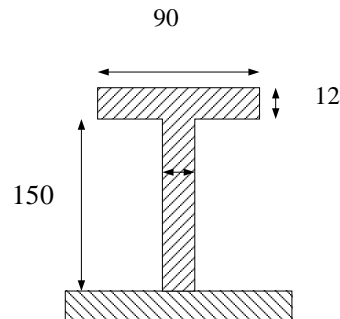
$$408 > 400,622 \quad (\text{memenuhi})$$

f. Winch Deck

$$\begin{aligned} W &= 0,75 \times 3 \times (2,8)^2 \times 12,809 \times 1,0 \text{ (cm}^3\text{)} \\ &= 225,950 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

T 150 × 12 FP 90 × 12



Koreksi modulus :

Lebar berguna (40 – 50) = 50

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 15 \times 1,2 = 18 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,27$$

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$$\begin{aligned}f_s/F &= 0,45 \\w &= 0,38 \\W &= w \times F \times h \\&= 0,38 \times 40 \times 15 \\&= 228 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$228 > 225,950 \quad (\text{memenuhi})$$

G.2. Modulus Penumpu samping (Side Deck Girder)

$$W = c \times e \times l^2 \times P_{Dl} \times k \quad (\text{cm}^3)$$

Dimana :

$$c = 0,75$$

e = lebar pembebanan

$$= 3 \text{ m}$$

l = panjang tak di tumpu

$$= 4 \times 0,6 = 2,4 \text{ m}$$

$$= 4 \times 0,7 = 2,8 \text{ m}$$

$$P_{Dl} = 18,064 \text{ KN/m}^2$$

$$P_{Dl} = 16,422 \text{ KN/m}^2$$

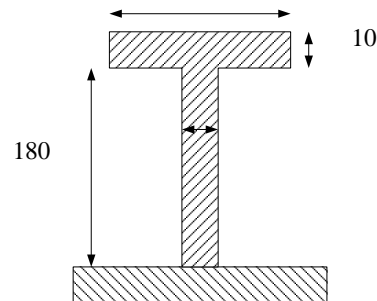
$$P_{Dl} = 22,711 \text{ KN/m}^2$$

$$k = 1,0$$

- a. Modulus penampang SDG pada daerah 0,1 L dari AP tidak boleh kurang dari :

$$\begin{aligned}W &= 0,75 \times 3 \times (2,4)^2 \times 18,064 \times 1,0 \text{ (cm}^3\text{)} \\&= 234,109 \text{ cm}^3\end{aligned}$$

$$\text{Profil T} = 180 \times 10 \text{ FP } 90 \times 10 \quad 90$$



Koreksi modulus

$$\text{Lebar berguna } (40 - 50) = 50$$

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$$f = 9 \times 1,0 = 9 \text{ cm}^2$$

$$f_s = 18 \times 1,0 = 18 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^3$$

$$f/F = 0,16$$

$$f_s/F = 0,32$$

$$w = 0,24$$

$$W = w \times F \times h$$

$$= 0,24 \times 55 \times 18$$

$$= 237,6 \text{ cm}^3$$

W rencana > W perhitungan

$$237,6 > 234,109 \text{ (memenuhi)}$$

- b. Modulus penampang penumpu samping (Side Deck Girder) pada daerah 0,6 L, tengah kapal tidak boleh kurang dari :

$$W = 0,75 \times 3 \times (2,8)^2 \times 16,422 \times 1,0 \text{ (cm}^3\text{)}$$

$$= 289,684 \text{ cm}^3$$

Profil T = 200 × 10 FP 90 × 10

Koreksi modulus

Lebar berguna (40 – 50) = 50

$$f = 9 \times 1,0 = 9 \text{ cm}^2$$

$$f_s = 20 \times 1,0 = 20 \text{ cm}^2$$

$$F = 50 \times 1,0 = 50 \text{ cm}^3$$

$$f/F = 0,18$$

$$f_s/F = 0,40$$

$$w = 0,29$$

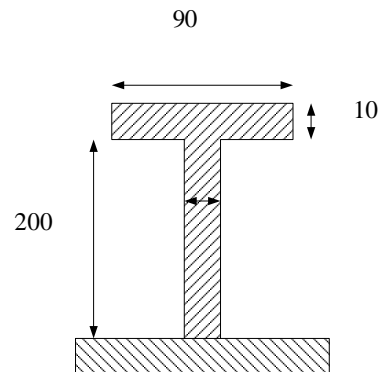
$$W = w \times F \times h$$

$$= 0,29 \times 50 \times 20$$

$$= 290 \text{ cm}^3$$

W rencana > W perhitungan

$$290 > 289,684 \text{ (memenuhi)}$$



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- c. Modulus penampang penumpu samping pada 0,1 L, dari FP tidak boleh kurang dari :

$$\begin{aligned}W &= 0,75 \times 3 \times (2,4)^2 \times 22,711 \times 1,0 \text{ (cm}^3\text{)} \quad 100 \\ &= 294,334 \text{ cm}^3\end{aligned}$$

Profil T = 200 × 10 FP 100 × 10

Koreksi modulus

Lebar berguna (40 – 50) = 50

$$f = 10 \times 1,0 = 10 \text{ cm}^2$$

$$f_s = 20 \times 1,0 = 20 \text{ cm}^2$$

$$F = 50 \times 1,1 = 55 \text{ cm}^3$$

$$f/F = 0,18$$

$$f_s/F = 0,36$$

$$w = 0,27$$

$$\begin{aligned}W &= w \times F \times h \\ &= 0,27 \times 55 \times 20 \\ &= 297 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$297 > 294,334 \quad (\text{memenuhi})$$

- d. Modulus penampang penumpu samping pada Ambang Palka tidak boleh kurang dari :

$$W = c \times e \times l^2 \times Pd \times k \quad (\text{cm}^3)$$

Dimana :

$$c = 0,75$$

e = lebar pembebanan

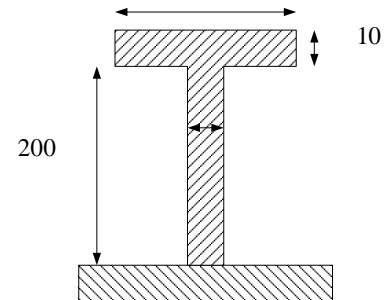
$$= 3 + \left(\frac{3,05}{2} \right) \text{ m}$$

$$= 3 + 1,525$$

$$= 4,525 \text{ m}$$

l = panjang tak di tumpu

$$= 4 \times 0,7 = 2,8 \text{ m}$$



PROFILE CONSTRUCTION

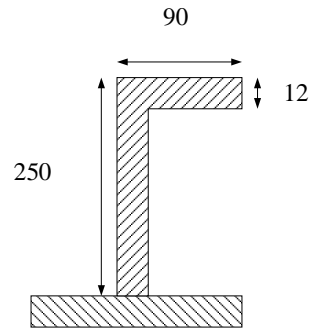
TUGAS AKHIR KM "FREEDOM" GC 4990 BRT

$$P_{D1} = 16,422 \text{ kN/m}^2 \quad (\text{untuk daerah ruang muat tengah})$$

- untuk daerah ruang muat tengah

$$\begin{aligned} W &= 0,75 \times 4,525 \times (2,8)^2 \times 16,422 \times 1,0 \text{ (cm}^3\text{)} \\ &= 436,940 \text{ cm}^3 \end{aligned}$$

$$\text{Profil} = \text{L } 250 \times 90 \times 12$$



H. BULKHEAD (SEKAT KEDAP)

Sebuah kapal harus mempunyai sekat tubrukan pada haluan sekat buritan, sekat ruang mesin dan sekat antar ruang muat.

H.1. Sekat Tubrukan pada haluan

Tebal sekat kedap air :

$$t_s = C_p \times a \times \sqrt{P} + t_k \quad (\text{mm})$$

Dimana:

$$\begin{aligned} C_p &= 1,1 \sqrt{f}, \quad \longrightarrow \quad f = \frac{235}{\text{Re} \cdot H} \cdot \text{Re} \cdot H = 265 \text{ N/mm}^2 \\ &= 1,1 \sqrt{0,917} &= \frac{235}{265} \\ &= 1,035 &= 0,886 \text{ N/mm}^2 \end{aligned}$$

$$a = 0,6 \text{ (stiffeners spacing)}$$

$$P = 9,81 \times h$$

Dimana,

$$\begin{aligned} h &= \left(\frac{H - h_{DB}}{2} \right) + 1 \text{ m} \\ &= 5,05 \text{ m} \end{aligned}$$

$$\begin{aligned} P &= 9,81 \times h \\ &= 9,81 \times 5,05 = 49,540 \text{ kN/m}^2 \end{aligned}$$

$$t_k = 1,5$$

$$t_{\min} = 6,0 \times \sqrt{f}$$

$$\begin{aligned}
 &= 6,0 \times \sqrt{0,886} \\
 &= 6,0 \times 0,941 \\
 &= 5,647 \text{ mm}
 \end{aligned}$$

jadi,

$$\begin{aligned}
 ts_1 &= 1,035 \times 0,6 \times \sqrt{49,540} + 1,5 \\
 &= 5,870 \text{ mm} > t_{\min} \approx \text{diambil } 8 \text{ mm}
 \end{aligned}$$

H.2. Tebal sekat kedap lainnya

$$ts = C_p \times a \times \sqrt{P} + tk \quad (\text{mm})$$

Dimana:

$$\begin{aligned}
 C_p &= 0,9 \sqrt{f}, \longrightarrow f = \frac{235}{Re.H} \cdot Re.H = 265 \text{ N/mm}^2 \\
 &= 0,9 \sqrt{0,886} &= \frac{235}{265} \\
 &= 0,892 &= 0,886 \text{ N/mm}^2
 \end{aligned}$$

a = 0,6 (stiffeners spacing)

$$P = 9,81 \times h$$

Dimana,

$$\begin{aligned}
 h &= \left(\frac{H - h_{DB}}{2} \right) + 1 \text{ m} \\
 &= 5,05 \text{ m}
 \end{aligned}$$

$$\begin{aligned}
 P &= 9,81 \times h \\
 &= 9,81 \times 5,05 = 49,540 \text{ kN/m}^2
 \end{aligned}$$

$$tk = 1,5$$

$$\begin{aligned}
 t_{\min} &= 6,0 \times \sqrt{f} \\
 &= 6,0 \times \sqrt{0,886} \\
 &= 6,0 \times 0,941 \\
 &= 5,647 \text{ mm}
 \end{aligned}$$

jadi,

$$\begin{aligned}
 ts_1 &= 0,892 \times 0,6 \times \sqrt{49,540} + 1,5 \\
 &= 5,266 \text{ mm} > t_{\min} \approx \text{diambil } 8 \text{ mm}
 \end{aligned}$$

H.3. Modulus Penampang Penegar Sekat Kedap Air

$$W = C_s \times a \times I^2 \times P \quad (\text{cm}^3)$$

Dimana :

$$\begin{aligned} C_s &= 0,33 \times f \\ &= 0,33 \times 0,886 \\ &= 0,292 \end{aligned}$$

$$\begin{aligned} I &= \left(\frac{H - h_{DB}}{3} \right) \\ &= 2,7 \text{ m} \end{aligned}$$

$$P = 49,540 \text{ kN/m}^2$$

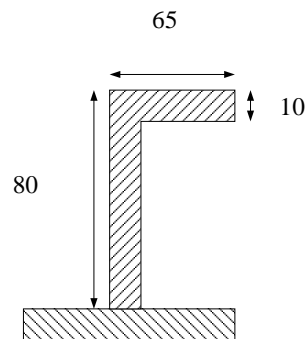
$$a = 0,6 \text{ m}$$

maka :

$$\begin{aligned} W &= 0,292 \times 0,6 \times (2,7)^2 \times 49,540 \\ &= 63,272 \text{ cm}^3 \end{aligned}$$

Profil yang di rencanakan

$$L = 80 \times 65 \times 10$$



H.4. Stiffener pada sekat antara ruang muat

Modulus penampang stiffener antara ruang muat tidak boleh kurang dari :

$$W = C_s \times a \times I^2 \times P \quad (\text{cm}^3)$$

Dimana :

$$\begin{aligned} C_s &= 0,265 \times f \\ &= 0,265 \times 0,886 \\ &= 0,234 \end{aligned}$$

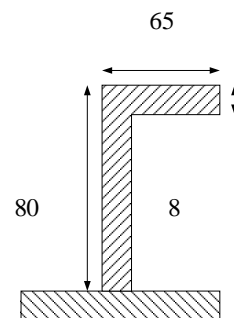
$$\begin{aligned} I &= \left(\frac{H - h_{DB}}{3} \right) \\ &= 2,7 \text{ m} \end{aligned}$$

$$P = 49,540 \text{ kN/m}^2$$

$$a = 0,6 \text{ m}$$

maka :

$$W = 0,234 \times 0,6 \times (2,7)^2 \times 49,540$$



$$= 50,704 \text{ cm}^3$$

Profil yang di rencanakan

$$L = 80 \times 65 \times 8$$

H.5. Stiffener pada sekat antara ruang muat dengan kamar mesin

Modulus penampang stiffener antara ruang muat dengan kamar mesin tidak boleh kurang dari :

$$W = C_s \times a \times I^2 \times P \quad (\text{cm}^3)$$

Dimana :

$$\begin{aligned} C_s &= 0,265 \times f \\ &= 0,265 \times 0,886 \\ &= 0,234 \end{aligned}$$

$$\begin{aligned} I &= \left(\frac{H - h_{DBKM}}{3} \right) \\ &= 2,626 \text{ m} \end{aligned}$$

$$P = 9,81 \times h$$

Dimana,

$$\begin{aligned} h &= \left(\frac{H - h_{DBKM}}{2} \right) + 1 \\ &= 4,94 \text{ m} \end{aligned}$$

$$\begin{aligned} P &= 9,81 \times h \\ &= 9,81 \times 4,94 = 48,461 \text{ kN/m}^2 \end{aligned}$$

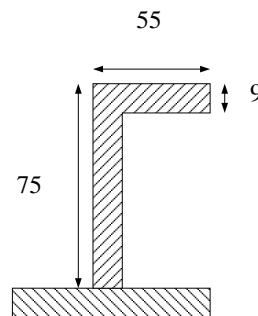
$$a = 0,6 \text{ m}$$

maka :

$$\begin{aligned} W &= 0,234 \times 0,6 \times (2,626)^2 \times 48,461 \\ &= 46,919 \text{ cm}^3 \end{aligned}$$

Profil yang di rencanakan

$$L = 75 \times 55 \times 9$$



a. Penegar (stiffener) untuk Poop Deck

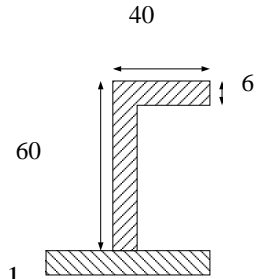
$$\begin{aligned} W &= 0,234 \times 0,6 \times (2,2)^2 \times 17,612 \times 1 \\ &= 11,967 \text{ cm}^3 \end{aligned}$$

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Profil yang di rencanakan

$$L = 60 \times 40 \times 6$$

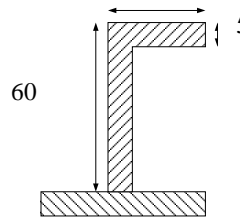


b. Penegar (stiffener) untuk Boat Deck

$$\begin{aligned} W &= 0,234 \times 0,6 \times (2,2)^2 \times 12,644 \times 1 \\ &= 8,592 \text{ cm}^3 \end{aligned}$$

Profil yang di rencanakan

$$L = 60 \times 40 \times 5$$

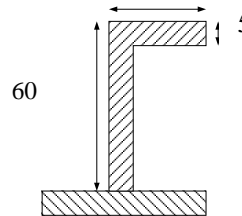


c. Penegar (stiffener) untuk Navigation Deck

$$\begin{aligned} W &= 0,234 \times 0,6 \times (2,2)^2 \times 11,290 \times 1 \\ &= 7,671 \text{ cm}^3 \end{aligned}$$

Profil yang di rencanakan

$$L = 60 \times 40 \times 5$$

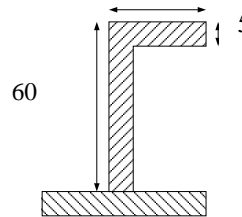


d. Penegar (stiffener) untuk Compass Deck

$$\begin{aligned} W &= 0,234 \times 0,6 \times (2,2)^2 \times 11,290 \times 1 \\ &= 7,671 \text{ cm}^3 \end{aligned}$$

Profil yang di rencanakan

$$L = 60 \times 40 \times 5$$

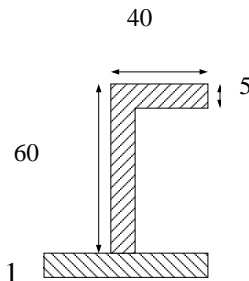


e. Penegar (stiffener) untuk winch Deck

$$\begin{aligned} W &= 0,234 \times 0,6 \times (2,2)^2 \times 16,011 \times 1 \\ &= 10,880 \text{ cm}^3 \end{aligned}$$

Profil yang di rencanakan

$$L = 60 \times 40 \times 5$$



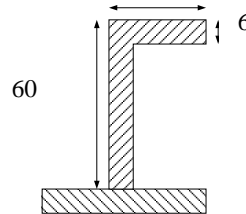
f. Penegar (stiffener) untuk Fore Castle Deck

$$W = 0,234 \times 0,6 \times (2,2)^2 \times 28,389 \times 1$$

$$= 19,291 \text{ cm}^3$$

Profil yang di rencanakan

$$L = 60 \times 40 \times 6$$



H.6. Web Stiffener pada Sekat

a. Modulus web stiffener sekat tubrukan tidak boleh kurang dari :

$$W = C_s \times e \times l^2 \times P \quad (\text{cm}^3)$$

Dimana :

$$C_s = 0,45 \times 0,886 = 0,40$$

$$e = \text{lebar pembebanan} = 3 \text{ m}$$

$$l = 1/3 (H - h)$$

$$= 1/3 (9,20 - 1,1) = 2,7 \text{ m}$$

$$P_s = 49,540 \text{ KN/m}^2$$

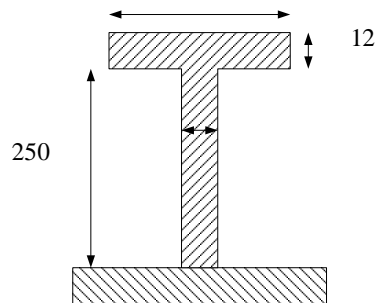
Maka :

$$W = 0,40 \times 3 \times (2,7)^2 \times 49,540$$

$$= 433,375 \text{ cm}^3$$

Profil yang direncanakan

$$T = 250 \times 12 \text{ FP } 90 \times 12$$



Koreksi modulus

Lebar berguna $(40 - 50) = 50$

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 25 \times 1,2 = 30 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

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$$f/F = 0,27$$

$$f_s/F = 0,75$$

$$w = 0,44$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,44 \times 40 \times 25 \\ &= 440 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$440 > 433,375$$

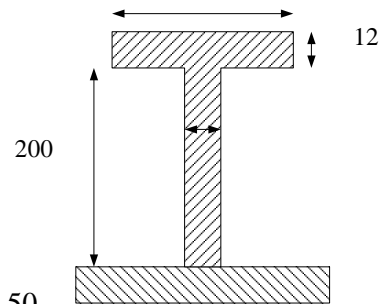
b. Web stiffener daerah buritan kapal :

$$C_s = 0,36 \times 0,886 = 0,318$$

$$\begin{aligned} W &= C_s \times e \times l^2 \times P \times k \quad (\text{cm}^3) \\ &= 0,318 \times 3 \times (2,626^2) \times 49,540 \times 1 \\ &= 325,315 \text{ cm}^3 \end{aligned}$$

Profil yang direncanakan

$$T = 200 \times 12 \text{ FP } 90 \times 12$$



Lebar berguna $(40 - 50) = 50$

$$f = 9 \times 1,2 = 10,8 \text{ cm}^2$$

$$f_s = 20 \times 1,2 = 24 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^2$$

$$f/F = 0,27$$

$$f_s/F = 0,60$$

$$w = 0,41$$

$$\begin{aligned} W &= w \times F \times h \\ &= 0,41 \times 40 \times 20 \\ &= 328 \text{ cm}^3 \end{aligned}$$

W rencana > W perhitungan

$$328 > 325,315 \quad (\text{memenuhi})$$

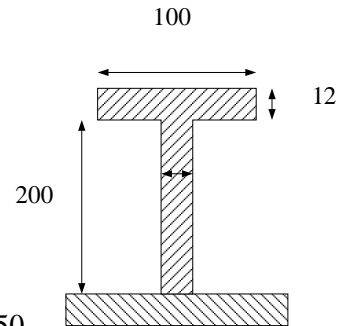
PROFILE CONSTRUCTION

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c. Web stiffener tengah kapal :

$$\begin{aligned}W &= 0,318 \times 3 \times (2,7^2) \times 49,540 \times 1 \\ &= 344,533 \text{ cm}^3\end{aligned}$$

Profil yang direncanakan = T = 200 x 12 FP 100 x 12



Lebar berguna (40 – 50) = 50

$$f = 10 \times 1,2 = 12 \text{ cm}^2$$

$$f_s = 20 \times 1,2 = 24 \text{ cm}^2$$

$$F = 50 \times 0,8 = 40 \text{ cm}^3$$

$$f/F = 0,30$$

$$f_s/F = 0,60$$

$$w = 0,44$$

$$\begin{aligned}W &= w \times F \times h \\ &= 0,44 \times 40 \times 20 \\ &= 352 \text{ cm}^3\end{aligned}$$

W rencana > W perhitungan

$$352 > 344,533 \text{ (memenuhi)}$$

I. BRACKET

Untuk bracket biasanya digunakan untuk menghubungkan dua buah profil, yang mana diatur oleh bagian yang lebih kecil. (BKI 2001 Sec. 3 D.2.2)

1) Tebal dari bracket tidak boleh kurang dari : (tidak pakai flange)

$$\begin{aligned}t &= c \times \sqrt[3]{\frac{W}{k_1}} + tk \\ &= 1,2 \times \sqrt[3]{\frac{W}{k_1}} + tk\end{aligned}$$

2) Tebal dari bracket tidak boleh kurang dari : (pakai flange)

$$t = c \times \sqrt[3]{\frac{W}{k1}} + tk$$
$$= 0,95 \times \sqrt[3]{\frac{W}{k1}} + tk$$

- a) Tebal bracket antara gading utama (main frame) dengan balok geladak (deck beam) :

$$t = 1,2 \times \sqrt[3]{\frac{86,958}{1,0}} + 1,5$$

$$t = 6,8 \text{ mm diambil } 7 \text{ mm}$$

$$t \text{ min} = 6,5 \text{ mm}$$

Panjang lengan (l)

$$= 50,6 \times \sqrt[3]{\frac{W \cdot k2}{t \cdot k1}}$$
$$= 50,6 \times \sqrt[3]{\frac{86,958 \times 0,886}{7 \times 1,0}}$$

$$= 112,555 \text{ mm}$$

$$l \text{ min} = 100 \text{ mm}$$

$$\text{direncanakan} = 200 \times 7$$

- b) Tebal bracket antara gading utama (main frame) dengan inner bottom :

$$t = 1,2 \times \sqrt[3]{\frac{86,958}{1,0}} + 1,5$$

$$t = 6,816 \text{ mm diambil } 7 \text{ mm}$$

$$t \text{ min} = 6,5 \text{ mm}$$

Panjang lengan (l)

$$= 50,6 \times \sqrt[3]{\frac{86,958 \times 0,886}{7 \times 1,0}}$$
$$= 112,555 \text{ mm}$$

$$l \text{ min} = 100 \text{ mm}$$

$$\text{direncanakan} = 150 \times 7$$

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- c) Tebal bracket antara gading utama (main frame) dengan balok geladak (deck beam) pada bangunan atas :

$$t = 1,2 \times \sqrt[3]{\frac{50,450}{1,0}} + 1,5$$

$$t = 5,934 \text{ mm diambil } 7 \text{ mm}$$

$$t \text{ min} = 6,5 \text{ mm}$$

Panjang lengan (l)

$$= 50,6 \times \sqrt[3]{\frac{W \cdot k2}{t \cdot k1}}$$

$$= 50,6 \times \sqrt[3]{\frac{50,450 \times 0,886}{7 \times 1,0}}$$

$$= 93,874 \text{ mm}$$

$$l \text{ min} = 100 \text{ mm}$$

$$\text{direncanakan} = 150 \times 7$$