BAB VI
PERHITUNGAN KONSTRUKSI

Analisa Struktur :

Perhitungan Beban

- **Beban Mati (qD)**
  - Berat Penutup Atap

    Berat Penutup Atap = Jarak Miring Antar Gording x Berat Asbes Berat Penutup Atap
    = 1.7 x 18
    = 30.6 kg.m
  - Berat Alat Pengikat

    Berat Alat Pengikat = 10% x (Berat Atap + Berat Profil Gording) Berat Alat Pengikat
    = 10% x (30.6 + 25.3)
    = 10% x (55.9)
    = 5.59 kg/m
  - Beban Mati (qD)

    Berat Total (qD) = Berat Atap + Berat Gording + Berat Alat Pengikat Berat Total (qD)
    = 30.6 + 25.3 + 5.59
    = 61.05 kg/m
  - PD

    PD = qD x Jarak Kuda-Kuda
    PD = 61.05 x 5,5
    PD = 335.75 kg

- **Beban Hidup (qL)**
  - Beban Hidup Terbagi Rata Akibat Air Hujan q = (40 – (0,8α))

    q = (40 – (0,8 x 21))
    q = 23,2 kg/m²
    23,2 kg/m² > 20 kg/m²

    Karena nilai q lebih besar dari 20 kg/m^2 maka digunakan q = 20 kg/m²
  - Beban Hidup (qL)

    qL = q x Jarak Datar Antar Gording
    qL = 20 x 1,59 qL = 31.8 kg/m
  - PL

    PL = qL x Jarak kuda-kuda
    PL = 31.8 x 5,5
    PL = 174.9 kg
- **Beban Angin**

  Tekanan angin (W) = 25 kg/m² → Jauh Dari Pantai (Menurut PPI UG 1983 Pasal 2.1.3.2)
  - Koefisien Angin

    Koefisien angin (C) = [(0,02 x α) – 0,4]
    = [(0,02 x 21) – 0,4]

= 0,02

- Angin Tekan

  Angin Tekan = C x W x Jarak Kuda-Kuda
  = 0.02 x 25 x 5.5
  = 2.75 kg/m

- Angin Hisap

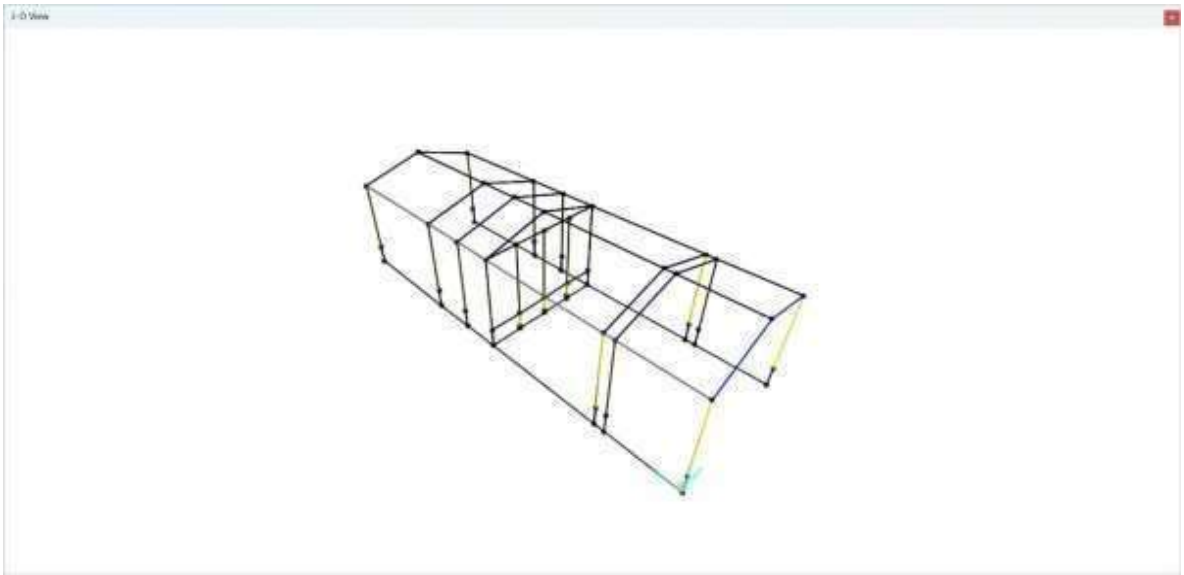
  Angin Hisap = C x W x Jarak Kuda-Kuda
  = 0.4 x 25 x 5.5
  = 55 kg/m

Karena beban angin hisap dan tekan lebih kecil dibandingkan dengan beban mati dan beban hidup, maka beban angin tidak diperhitungkan.

- **Beban Terfaktor**

  Pu = 1,2 P_D + 1,6 P_L
  Pu = (1,2 x 335.75) + (1,6 x 174.9)
  Pu = 682.74 kg

PERENCANAAN BALOK DAN KOLOM



- **Perencanaan kolom**

  Direncanakan kolom menggunakan profil WF 300.150.6,5.9 mutu baja BJ 37 dan data sebagai berikut :

Ag	= 300cm^2	Zy	= 67,7 cm^3
tw = t1	= 6,5mm	Zx	= 481 cm^3
tf = t2	= 9 mm	ix	= 12,4 cm
W	= 36,7 kg/m	iy	= 3,29 cm
r	= 13 mm	Iy	= 508 cm^4
B	= 150 mm	Ix	= 7,210cm^4
h	= 300 mm	fy	= 240 Mpa
fu	= 370 Mpa	E	= 200000 Mpa

Panjang Kolom = 3,15m
P max = 1804,97 kgf
V max = 93,82 kgf
M max = 178,46 kgf.m

KONTROL PENAMPANG PROFIL

- Untuk Sayap

$$\frac{b}{2\,x\,tf} < \frac{250}{\sqrt{fy}}$$

$$\frac{150}{2\,x\,9} < \frac{250}{\sqrt{240}}$$

8,3 < 16,13

- Untuk Badan

H Bersih = h – 2(t2+r)
H Bersih = 300 – 2(9+13)

H Bersih = 256 mm

$$\frac{H\ bersih}{tw} < \frac{665}{\sqrt{fy}}$$

$$\frac{256}{6,5} < \frac{665}{\sqrt{240}}$$

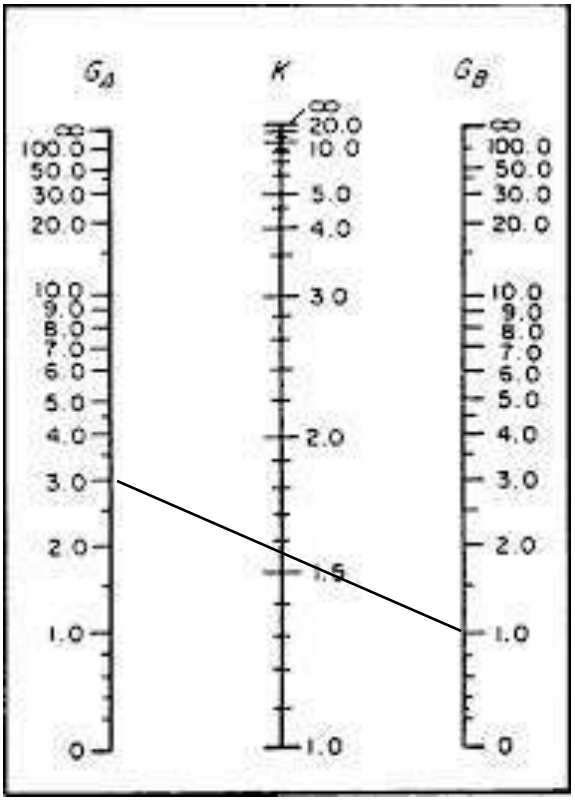
$$39,3 < 42,9$$

TEKUK TERHADAP SUMBU X

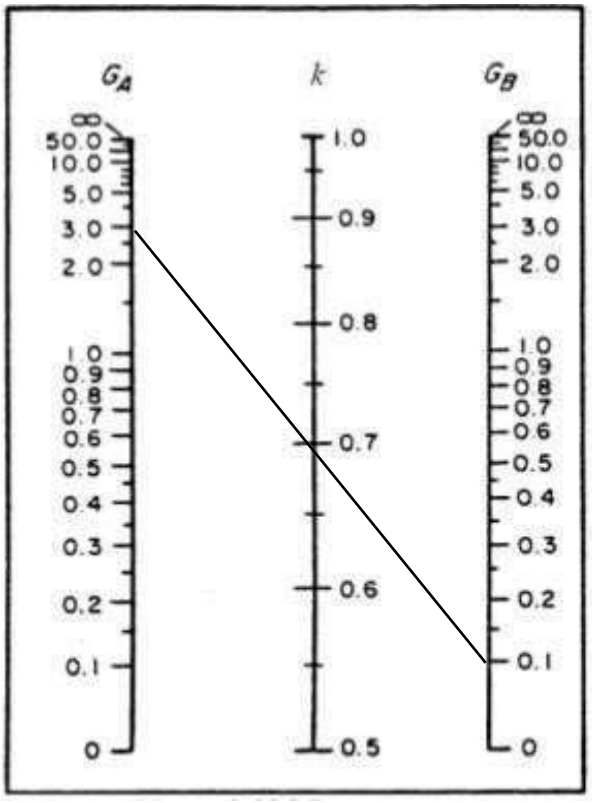
- GA $= \frac{\frac{7210}{315}}{\frac{7210}{540}}$

GA = 3,05

GB = 1 (JEPIT)



(a) Komponen Struktur Bergoyang



(b) Komponen Struktur Tak Bergoyang

TAK BERGOYANG

- $\lambda x = \frac{k\ x\ l}{ix}$

$$\lambda x = \frac{0,7\ x\ 315}{12,4}$$

$$\lambda x = 17,78$$

BERGOYANG

- $\lambda x = \frac{k\ x\ l}{ix}$

$$\lambda x = \frac{1{,}6\ x\ 315}{12{,}4}$$

$\lambda x = 40{,}64$

$\lambda x = 40{,}64$

Di Pakai λmax = 40,64

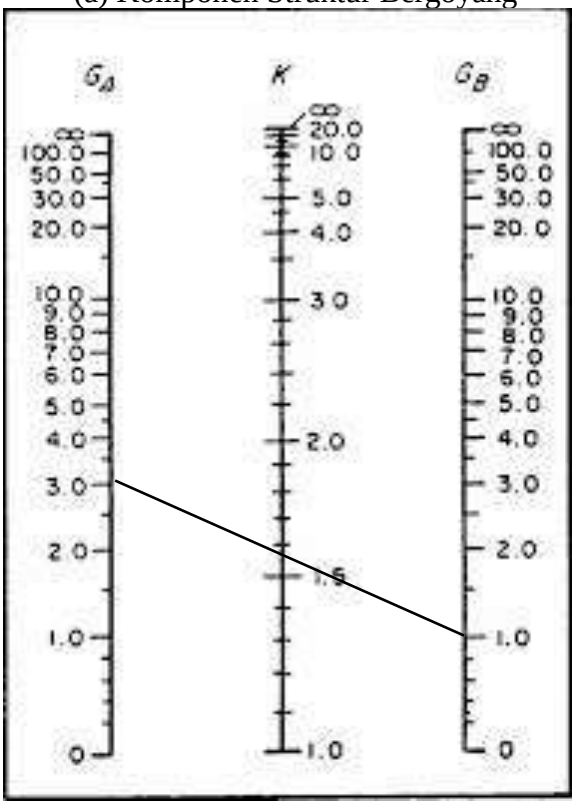
TEKUK TERHADAP SUMBU Y

- GA $= \frac{\frac{508}{315}}{\frac{508}{540}}$

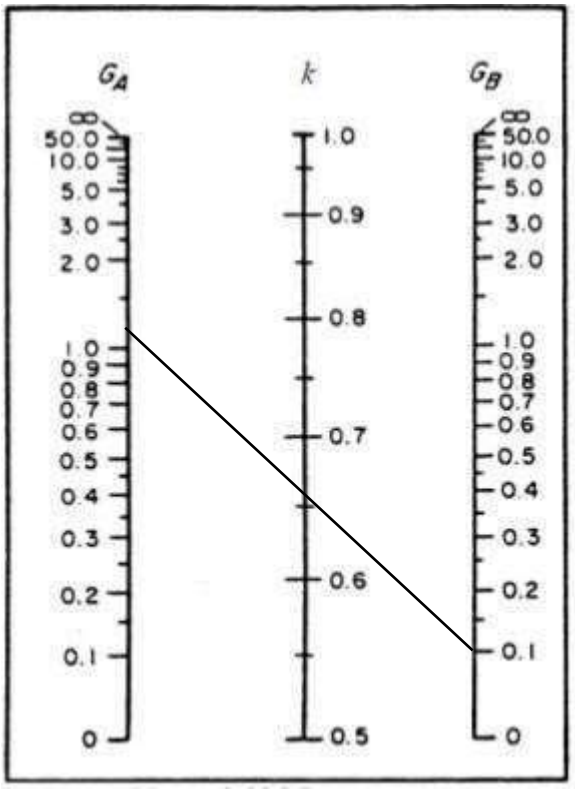
GA = 1,51

GB = 1 (JEPIT)

(a) Komponen Struktur Bergoyang



(b) Komponen Struktur Tak Bergoyang



TAK BERGOYANG

- $\lambda x = \frac{k\ x\ l}{ix}$

$$\lambda x = \frac{0{,}7\ \ x\ 315}{3{,}29}$$

$\lambda x = 67{,}02$

BERGOYANG

- $\lambda x = \frac{k\ x\ l}{ix}$

$$\lambda x = \frac{1{,}6x\ 315}{3{,}29}$$

$\lambda x = 153{,}19$

Dipakai λmax = 153,19

$\lambda c = \frac{\lambda}{\pi} x \sqrt{\frac{fy}{e}}$

$\lambda c = \frac{153,19}{3,14} x \sqrt{\frac{240}{200000}}$

$\lambda c = 1,69$

Karena 0.24 < λc < 1,2, maka menggunakan rumus $\omega = \frac{153}{1,6-0,67\lambda c}$

➢ $\omega = \frac{153}{1,6-0,67\lambda c}$

$\omega = \frac{153}{1,6-0,67\ 1,69}$

$\omega = 3,27$

Pn = Ag x $\frac{fy}{\varpi}$

Pn = 300 x $\frac{240}{3,27}$

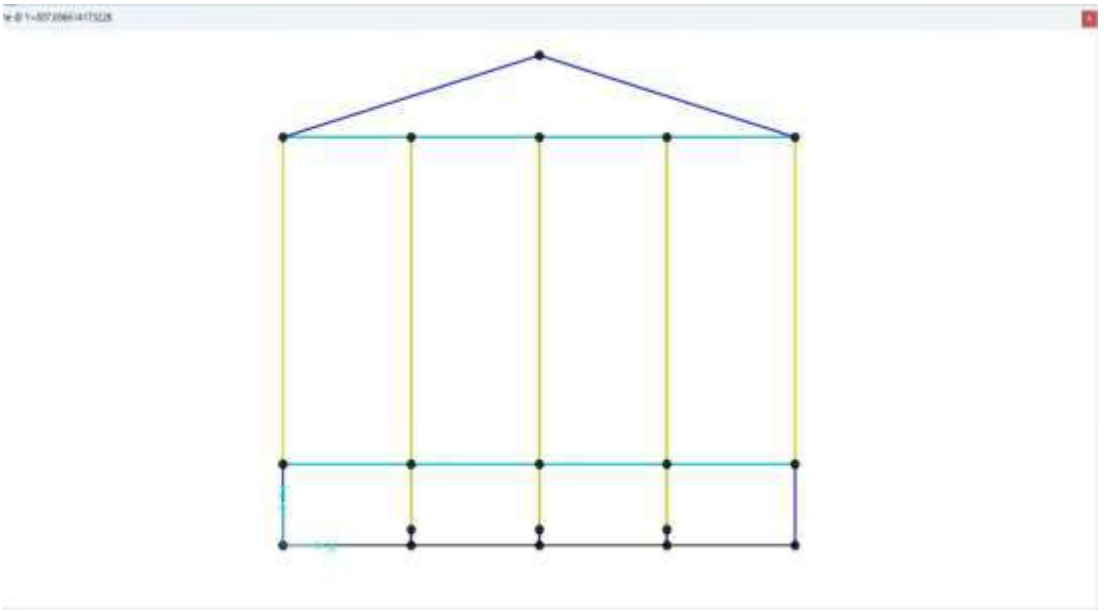
Pn = 22018,34 kg

$\frac{Pu}{\phi Pn} = \frac{1804,97}{22018,34}$

$\frac{Pu}{\phi Pn}$ = 0,08

0.08 < 1 (OK)

PERENCANAAN PERLETAKAN KOLOM



DATA PERENCANAAN

Direncanakan kolom menggunakan profil WF 300.150.6,5.9 mutu baja BJ 37 dan data sebagai berikut :

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B	= 150 mm	Ix	= 7,210cm^4
h	= 300 mm	fy	= 240 Mpa
fu	= 370 Mpa	E	= 200000 Mpa
D	300-2(9+13)= 256		

Panjang Kolom = 3,15m
P max = 1804,97 kgf
V max = 93,82 kgf
M max = 178,46 kgf.m = 178460 kgf.mm

PLAT TUMPUAN (BASE PLATE)

- Direncanakan

  Nilai B = 250 mm

  Nilai L = 400 mm

  Tebal Plat = 10 mm

  A1 = B X L

  = 250 X 400

  = 100000 mm^2

KOLOM PEDESTAL

- Di rencanakan

  Nilai I = 400

  Nilai J = 400

  A2 = I x J

  A2 = 400 X 400

  A2 = 160000 mm^2

ANGKUR BAUT

- Mutu Baut A325

  f_u^b = 825 mpa

  f_u^b = 400 mpa

- Diameter Baut (d_b) = 20 mm

  f = 150 mm

  nt = 2 buah

  nc = 2 buah

  La = 400 mm

- Tegangan Baut Mutu Tinggi

  f1 = 807 Mpa

  f2 = 621 Mpa

  r1 = 0,4

  r2 = 0,9

PERHITUNGAN

- Direncanakan Las Mutu E60XX
- f_y^w = 414 mpa
- f_y^w = 620 mpa
- Tebal las = 5 mm

KAPASITAS GESER LAS (Vn)

- Vn = A Las x f_y^w
- A las = t (2 In1 + 2 In2 + 4 In3)

  In1 = B – 2t

  In1 = 250 – (2 x 5)

  In1 = 240 mm

  In1 = 240 mm

In2 = 256 – (2 x 5)

In2 = 256 – (2 x 5)

In2 = 256 – (2 x 5)

In3 = $\frac{1}{2}$ 250 – (2 x 5)

In3 = 115 mm

- A las = t (2 In1 + 2 In2 + 4 In3)

A las = 5 (2 x 240+ 2 x 246 + 4 x 115)

A las = 7160 mm^2

Vn = A Las x f^w

Vn = 7160 x 414

Vn = 2964240 N = 296424 kg

ϕVn = 0,75 x Vn

ϕVn = 0,75 x 296424

ϕVn = 222318 kg

ϕ Vn > V Max

222318 > 20.44 (OK)

Eksentrisitas Beban

- $e > \frac{1}{6}$
- $\frac{mu}{Pu} > \frac{L}{6}$
- $\frac{mu}{Pu} > \frac{L}{6}$

$\frac{178460}{1804,97} > \frac{400}{6}$

98,87mm > 67,55mm

- h = B – tf

h = 250 – 9

h = 241

et = f + $\frac{h}{2}$

et = 150 + $\frac{241}{2}$

et = 270 mm

ec = f - $\frac{h}{2}$

ec = 150 – $\frac{241}{2}$

ec = 29 mm

TAHAPAN MUTU BETON

- Pt = Pu x $\frac{ec}{et}$

Pt = 1804,97 x $\frac{29}{270}$

- Pt = 193,8 kg = 1938 N
- Puc = Pu + Pt

Puc = 1804,97 + 193,8

Puc = 1998,78 kg = 19987,8 N

- y = 3 x $\left(\frac{L-h}{2}\right)$

  y = 3 x $\left(\frac{400-300}{2}\right)$

  y = 150 mm
- fcu = 2 x $\left(\frac{Puc}{y\ x\ B}\right)$

  fcu = 2 x $\left(\frac{1998,78}{150\ x\ 250}\right)$

  fcu = 0,106 kg mm^2 = 1,06 MPa
- fcn = 0,85 x fc x $\sqrt{\frac{A2}{A1}}$

  fcn = 0,85 x 30 x $\sqrt{\frac{160000}{100000}}$

  fcn = 32,25 MPa

- Φ fcn = 0,65 x 32,25

  Φ fcn = 21,02 MPa

  Syarat : fcu < Φ fcn

  1,06 < 32,25 (OK)

PERIKSA DIMENSI DAN PLAT TUMPUAN

- BP Min = $\frac{Puc}{0,5x\ \Phi x\ \Phi\ fcn\ x\ y}$

  BP Min = $\frac{19987,8}{0,5x\ 0,65\ x\ 21,02\ x\ 150}$

  BP Min = 19,50

  BP Min < B

  19,50 < 250 (OK)
- a = $\frac{L-0,45\ x\ h}{2}$

  a = $\frac{400-0,45\ x\ 300}{2}$

  a = 132,5 mm
- fcu1 = $1 - \frac{a}{y}$

  fcu1 = $1 - \frac{132,5}{150}$

  fcu1 = 0,88 MPa
- Z = $\frac{1}{4}$ x B x (tebal plat x tebal plat)

  Z = $\frac{1}{4}$ x 250 x (10x10)

  Z = 6250 mm^2
- Mup = $\frac{1}{2}$ x B x fcu1 x (a x a) + $\frac{1}{3}$ x B x (fcu – fcu1)

  Mup = $\frac{1}{2}\ x\ 250\ x\ 0,88\ x\ (132,5\ x\ 132,5) + \frac{1}{2} x\ 250\ x\ (1,06 -\ 0,88)$

  Mup = 193121
- ΦMn = Φ fy x Z

  ΦMn = 0,9 x 240 x 6250

ΦMn = 13500000 Nmm

- Mup < ΦMn

  193121 < 13500000 (OK)

Gaya Tarik pada Angkur Baut

- Tu1 $= \frac{Pt}{nt}$

  Tu1 $= \frac{1804,97}{2}$

  Tu1 = 902,48 N
- ϕTn = ϕ x 0,75 x $\frac{1}{4}$ x × π × d × d × f_b^u

  ϕTn = 0,9 x 0,75 x $\frac{1}{4}$ x × π × 20 × 20 × 825

  ϕTn = 175017,9 N

  Tu1 < ϕTn

  902,48 N < 175017,9 N (OK)

Gaya Geser pada Angkur Baut

- Vu1 $= \frac{Vu}{n}$

  Vu1 $= \frac{9382}{4}$

  Vu1 = 2345 N
- ΦVn = Φ x r1 x m x $\frac{1}{2}$ x π x d x d x f_b^u

  ΦVn = 0,9 x 0,4 x 1 x $\frac{1}{2}$ x π x 20 x 20 x 825

  ΦVn = 59400 N
- Vu1 < ΦVn

  2345 N < 59400 N (OK)

Gaya Tumpu pada Angkur Baut

- Ru1 = Vu1 = 2345 N
- ϕRn = ϕ × 2.4 × db × Tebal Plat × fu

  ϕRn = 0,75 × 2.4 × 20 × 10 × 370

  ϕRn = 133200
- Ru1 < ϕRn

  2345 N < 133200 N (OK)

Kombinasi Geser dan Tarik

- Pada bidang geser
- Fuv $= \frac{Vu}{n\left(\frac{1}{4}\pi(20x20)\right)}$

  Fuv $= \frac{9382}{4\left(\frac{1}{4}\pi(20x20)\right)}$

  Fuv = 7,46 MPa
- Φfn = ϕ × r1 × m × f_b^u

  Φfn = 0,75 x 0,4 x 1 x 825

Φfn = 247,50 MPa

- fuv < Φfn

  7,46 MPa < 247,50 MPa

Pada Bidang Tarik

- Tu1 = 902,48 N
- ΦTn = Φ x f1 x $\frac{1}{4}$ x π x $(d_b x\ d_b)$

  ΦTn = 0,75 x 807 x $\frac{1}{4}$ x π x (20 x 20)

  ΦTn = 190221,4 N
- Tu1 < ϕTn

  902,48 N < 190221,4 N (OK)

Kombinasi

- ft = Φ x f_b^u

  ft = 0,75 x 825

  ft = 618,75 MPa
- Batas Tulangan = f1 – r2 × fuv

  Batas Tulangan = 807 – 1,9 × 7,46

  Batas Tulangan = 792,826 MPa
- ft < Batas Tulangan

  618,75 MPa < 792,826 MPa
- ft < f2

  618,75 MPa < 621 Mpa

Periksa Panjang Angkur Baut

- La = 400 mm

  L min = $\frac{fy}{4\sqrt{fc}} x\ d_b$

  L min = $\frac{240}{4\sqrt{25}} x\ 20$

  L min = 240 mm

  L min < La

  240 mm < 400 mm (OK)