[**CONTOH PERENCANAAN BALOK BETON BERTULANG**](http://handoko10.wordpress.com/2010/03/03/contoh-perencanaan-balok-beton-bertulang/)

Posted by [handoko10](http://handoko.web.id) pada 3 Maret 2010

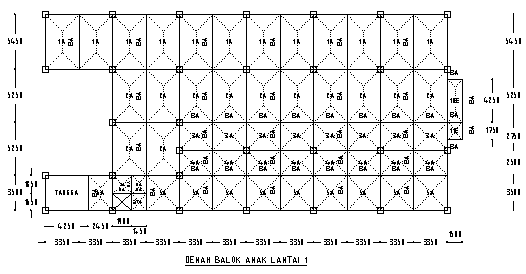
**4.5.1 Perencanaan Balok Anak**

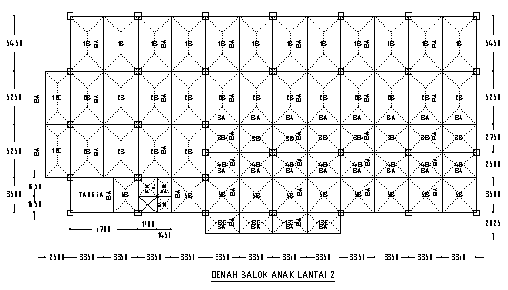
Pada struktur bangunan gedung ini direncanakan menggunakan balok anak dengan dimensi [clip_image002](http://handoko10.files.wordpress.com/2010/03/clip_image002.gif)cm. Untuk mengetahui besaran beban yang ditumpu tiap balok dan balok anak dalam struktur gedung ini melalui pembagian beban ekuivalen dari plat yang gayanya ditransfer ke balok dan balok anak.

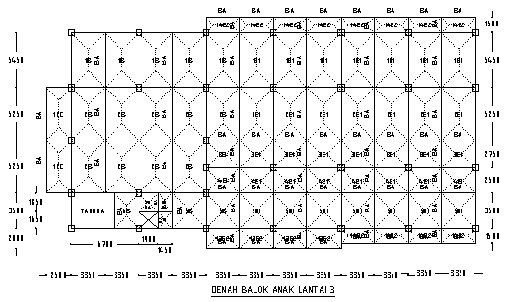
Mutu bahan: – f’c = 25 MPa

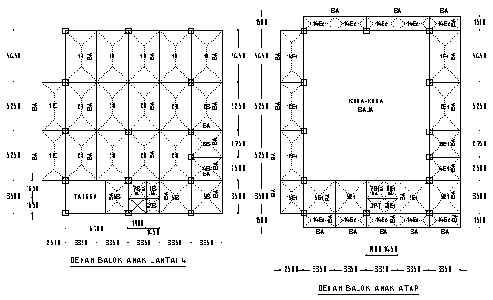
- fy = 400 MPa

Denah balok anak dari struktur gedung ini adalah sebagai berikut:

[](http://handoko10.files.wordpress.com/2010/03/clip_image004.gif)

[](http://handoko10.files.wordpress.com/2010/03/clip_image006.gif)

[](http://handoko10.files.wordpress.com/2010/03/clip_image008.gif)

[](http://handoko10.files.wordpress.com/2010/03/clip_image010.gif)

**Gambar 4.25 *Denah Struktur Balok Anak Lantai 1 s/d 4 dan Pelat Atap***

**4.5.2 Metode Pembebanan**

Pelimpahan beban merata pada balok-balok struktur dilakukan dengan metode amplop. Dengan cara ini, balok-balok struktur tersebut ada yang memikul beban trapesium dan beban segitiga. Untuk memudahkan perhitungan, beban trapesium dan beban segitiga diubah menjadi beban merata ekuivalen (qc).

Rumus:

Ø Beban trapesium diubah menjadi beban merata ekuivalen

qek **= [clip_image012](http://handoko10.files.wordpress.com/2010/03/clip_image012.gif)**

Ø Beban segitiga diubah menjadi beban merata ekuivalen

qe = [clip_image014](http://handoko10.files.wordpress.com/2010/03/clip_image014.gif)

Dimana: Lx dan Ly adalah panjang bentang untuk segmen pelat.

**4.5.3 Pembebanan Balok Anak**

□ **Beban Tipe A (Kantor)**

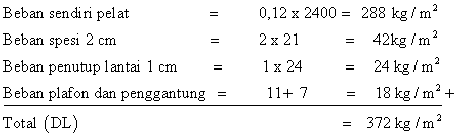
1. Beban mati (DL)

[](http://handoko10.files.wordpress.com/2010/03/clip_image016.gif)

2. Beban hidup (LL) = 250 kg/m2

□ **Beban Tipe B (Rumah Tinggal)**

1. Beban mati (DL)

[](http://handoko10.files.wordpress.com/2010/03/clip_image0161.gif)

2. Beban hidup (LL) = 200 kg/m2

□ **Beban Tipe C (Balkon)**

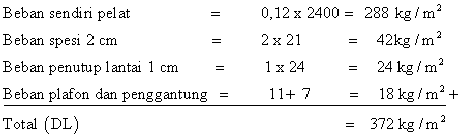
1. Beban mati (DL)

[](http://handoko10.files.wordpress.com/2010/03/clip_image0162.gif)

2. Beban hidup (LL) = 300 kg/m2

□ **Beban Tipe D (Aula)**

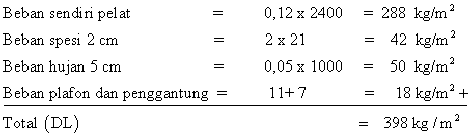
1. Beban mati (DL)

[](http://handoko10.files.wordpress.com/2010/03/clip_image0163.gif)

2. Beban hidup (LL) = 400 kg/m2

□ **Beban Tipe E1 (Atap)**

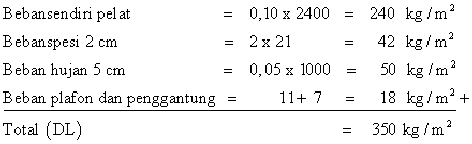
1. Beban mati (DL)

[](http://handoko10.files.wordpress.com/2010/03/clip_image018.gif)

2. Beban hidup (LL) = 100 kg/m2

□ **Beban Tipe E2 (Atap)**

1. Beban mati (DL)

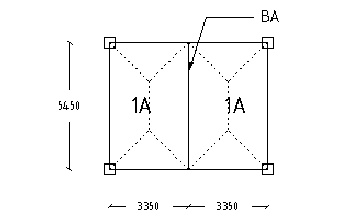
[](http://handoko10.files.wordpress.com/2010/03/clip_image020.gif)

2. Beban hidup (LL) = 100 kg/m2

Contoh perhitungan beban dan gaya dalam balok

Balok anak untuk beban A pada Lantai 1 Þ Ba (1A-1A)

Dimensi balok adalah [clip_image002[1]](http://handoko10.files.wordpress.com/2010/03/clip_image0021.gif)cm

[](http://handoko10.files.wordpress.com/2010/03/clip_image022.gif)

**Gambar 4.26 *Pola* *Pembebanan Ba(1A-1A)***

- Beban mati (DL)

qek **= [clip_image024](http://handoko10.files.wordpress.com/2010/03/clip_image024.gif)**

**= [clip_image026](http://handoko10.files.wordpress.com/2010/03/clip_image026.gif)**

= 1089,25 kg/m

- Beban hidup (LL)

qek **= [clip_image024[1]](http://handoko10.files.wordpress.com/2010/03/clip_image0241.gif)**

**= [clip_image029](http://handoko10.files.wordpress.com/2010/03/clip_image029.gif)**

= 732,02 kg/m

Dengan cara yang sama, dilakukan perhitungan terhadap balok anak yang lain dan ditabelkan sebagai berikut:

**Tabel 4.15 *Pembebanan* *Balok Anak Lantai 1***

|  |  |  |
| --- | --- | --- |
| Balok | Panjang (m) | Pembebanan |
| B. Mati | B. Hidup |  |
| (kg/m) | (kg/m) |  |
| BA(1A-1A) | 5.45 | 1089.25 | 732.02 |
| BA(2A-2A) | 5.25 | 1077.06 | 723.83 |
| BA(3A-3A) | 2.75 | 682.00 | 458.33 |
| BA(4A-4A) | 2.5 | 620.00 | 416.67 |
| BA(5A-5A) | 3.5 | 865.64 | 581.75 |
| BA(5A-9A-8A) | 3.5 | 847.57 | 569.60 |
| BA(6A) | 3.5 | 381.27 | 256.23 |
| BA(2A-3A) | 3.35 | 812.01 | 545.70 |
| BA(4A-5A) | 3.35 | 794.08 | 533.65 |
| BA(10E) | 1.5 | 175.00 | 50.00 |
| BA(10E-11E) | 1.5 | 350.00 | 100.00 |
| BA(11E) | 1.5 | 175.00 | 50.00 |
| BA(10E) | 4.25 | 251.60 | 71.89 |
| BA(11E) | 1.75 | 198.21 | 56.63 |
| BA(7A) | 1.9 | 235.36 | 158.17 |
| BA(8A-9A) | 1.45 | 359.60 | 241.67 |
| BA(9A) | 1.65 | 200.27 | 134.59 |
| BA(7A-8A) | 1.85 | 443.87 | 298.30 |

**Tabel 4.16 *Pembebanan Balok Anak Lantai 2***

|  |  |  |
| --- | --- | --- |
| Balok | Panjang (m) | Pembebanan |
| B. Mati | B. Hidup |  |
| (kg/m) | (kg/m) |  |
| BA(1B-1B) | 5.45 | 1089.25 | 585.62 |
| BA(2B-2B) | 5.25 | 1077.06 | 579.07 |
| BA(12C) | 5.25 | 429.85 | 346.66 |
| BA(3B-3B) | 2.75 | 682.00 | 366.67 |
| BA(4B-4B) | 2.5 | 620.00 | 333.33 |
| BA(5B-5B) | 3.5 | 865.64 | 465.40 |
| BA(5B-9B-8B) | 3.5 | 847.57 | 455.68 |
| BA(6B) | 3.5 | 381.27 | 204.98 |
| Balok | Panjang (m) | Pembebanan |  |
| B. Mati | B. Hidup |  |  |
| (kg/m) | (kg/m) |  |  |
| BA(13C-13C) | 2 | 496.00 | 400.00 |
| BA(2B-3B) | 3.35 | 812.01 | 436.56 |
| BA(4B-5B) | 3.35 | 794.08 | 426.92 |
| BA(13C) | 3.35 | 327.80 | 264.36 |
| BA(7B) | 1.9 | 235.36 | 126.54 |
| BA(8B-9B) | 1.45 | 359.60 | 193.33 |
| BA(9B) | 1.65 | 200.27 | 107.67 |
| BA(7B-8B) | 1.85 | 443.87 | 238.64 |

**Tabel 4.17 *Pembebanan Balok Anak Lantai 3***

|  |  |  |
| --- | --- | --- |
| Balok | Panjang (m) | Pembebanan |
| B. Mati | B. Hidup |  |
| (kg/m) | (kg/m) |  |
| BA(1B-1B) | 5.45 | 1089.25 | 585.62 |
| BA(1B-1E1) | 5.45 | 1127.31 | 439.21 |
| BA(1E1-1E1) | 5.45 | 1165.38 | 292.81 |
| BA(12C) | 5.25 | 429.85 | 346.66 |
| BA(2B-2B) | 5.25 | 1077.06 | 579.07 |
| BA(2B-2E1) | 5.25 | 1127.31 | 439.21 |
| BA(2E1-2E1) | 5.25 | 1165.38 | 292.81 |
| BA(3B-3E1) | 2.75 | 705.83 | 275.00 |
| BA(3E1-3E1) | 2.75 | 729.67 | 183.33 |
| BA(4B-4E1) | 2.5 | 641.67 | 250.00 |
| BA(4E1-4E1) | 2.5 | 663.33 | 166.67 |
| BA(5B-5E1) | 3.5 | 895.89 | 349.05 |
| BA(5E1-5E1) | 3.5 | 926.14 | 232.70 |
| BA(5B-9B-8B) | 3.5 | 847.57 | 455.68 |
| BA(6B) | 3.5 | 381.27 | 204.98 |
| BA(13E2-13E2) | 2 | 466.67 | 133.33 |
| BA(14E2-14E2) | 1.5 | 350.00 | 100.00 |
| BA(2B-3B) | 3.35 | 812.01 | 436.56 |
| BA(2E1-3E1) | 3.35 | 868.76 | 218.28 |
| BA(4B-5B) | 3.35 | 794.08 | 426.92 |
| Balok | Panjang (m) | Pembebanan |  |
| B. Mati | B. Hidup |  |  |
| (kg/m) | (kg/m) |  |  |
| BA(4E1-5E1) | 3.35 | 849.58 | 213.46 |
| BA(13E2) | 3.35 | 308.42 | 88.12 |
| BA(14E2) | 3.35 | 244.96 | 69.99 |
| BA(7B) | 1.9 | 235.36 | 126.54 |
| BA(8B-9B) | 1.45 | 359.60 | 193.33 |
| BA(9B) | 1.65 | 200.27 | 107.67 |
| BA(7B-8B) | 1.85 | 443.87 | 238.64 |

**Tabel 4.18 *Pembebanan Balok Anak Lantai 4***

|  |  |  |
| --- | --- | --- |
| Balok | Panjang (m) | Pembebanan |
| B. Mati | B. Hidup |  |
| (kg/m) | (kg/m) |  |
| BA(1D-1D) | 5.45 | 1089.25 | 1171.24 |
| BA(1D) | 5.45 | 544.62 | 585.62 |
| BA(12C) | 5.25 | 429.85 | 346.66 |
| BA(2D-2D) | 5.25 | 1077.06 | 1158.13 |
| BA(2B) | 5.25 | 538.53 | 289.53 |
| BA(3B) | 2.75 | 341.00 | 183.33 |
| BA(4B) | 2.5 | 310.00 | 166.67 |
| BA(5B) | 3.5 | 432.82 | 232.70 |
| BA(5B-9B-8B) | 3.5 | 847.57 | 455.68 |
| BA(6B) | 3.5 | 381.27 | 204.98 |
| BA(7B) | 1.9 | 235.36 | 126.54 |
| BA(8B-9B) | 1.45 | 359.60 | 193.33 |
| BA(9B) | 1.65 | 200.27 | 107.67 |
| BA(7B-8B) | 1.85 | 443.87 | 238.64 |

**Tabel 4.19 *Pembebanan Balok Anak Plat Atap***

|  |  |  |
| --- | --- | --- |
| Balok | Panjang (m) | Pembebanan |
| B. Mati | B. Hidup |  |
| (kg/m) | (kg/m) |  |
| BA(1E1) | 5.45 | 582.69 | 146.40 |
| BA(16E1) | 5.45 | 462.61 | 116.23 |
| BA(2E1) | 5.25 | 576.17 | 144.77 |
| BA(12E1) | 5.25 | 459.90 | 115.55 |
| BA(3E1) | 2.75 | 364.83 | 91.67 |
| BA(4E1) | 2.5 | 331.67 | 83.33 |
| BA(5E1) | 3.5 | 463.07 | 116.35 |
| BA(5E1-9E1-8E1) | 3.5 | 906.81 | 227.84 |
| BA(5E1-5E1) | 3.5 | 926.14 | 232.70 |
| BA(15E1) | 3.5 | 412.89 | 103.74 |
| BA(14E2-14E2) | 1.5 | 350.00 | 100.00 |
| BA(14E2) | 1.5 | 175.00 | 50.00 |
| BA(14E2) | 3.35 | 244.96 | 69.99 |
| BA(7E1) | 1.9 | 497.61 | 125.03 |
| BA(8E1-9E1) | 1.45 | 384.73 | 96.67 |
| BA(9E1) | 1.65 | 433.17 | 108.84 |
| BA(7E1-8E1) | 1.85 | 474.90 | 119.32 |

**4.5.1 Perhitungan Tulangan Balok Anak**

**4.5.5.1 Tulangan Lentur**

Contoh perhitungan tulangan lentur balok anak Ba1 lantai 1

M tump = 6134,4 kgm = 61,344 kNm

M lap = 3067,2 kgm = 30,672 kNm

Tinggi balok (h) = 350 mm

Lebar balok (b) = 250 mm

Penutup beton (p) = 40 mm

Diameter tulangan (D) = 16 mm

Diameter sengkang (ø) = 8 mm

Tinggi efektif (d) = h – p – ø – ½ D

= 350 – 40 – 8 – ½ . 16

= 294 mm

f’c = 25 Mpa

fy = 400 Mpa

Tulangan Tumpuan

Mu = 61,344 kNm

[clip_image002[6]](http://handoko10.files.wordpress.com/2010/03/clip_image0026.gif)kN/m2

[clip_image004[5]](http://handoko10.files.wordpress.com/2010/03/clip_image0045.gif)

[clip_image006[5]](http://handoko10.files.wordpress.com/2010/03/clip_image0065.gif)

[clip_image008[5]](http://handoko10.files.wordpress.com/2010/03/clip_image0085.gif)

Dengan rumus abc didapatkan nilai ρ = 0,0098

Pemeriksaan syarat rasio penulangan (ρmin < ρ < ρmax)

[clip_image010[5]](http://handoko10.files.wordpress.com/2010/03/clip_image0105.gif)

[clip_image012[4]](http://handoko10.files.wordpress.com/2010/03/clip_image0124.gif)

As1 = ρ.b.d.106

= 0,0098 . 0,250 . 0,294 . 106

= 718,086 mm2

Dipakai tulangan tekan 2D16 (As terpasang = As2 = 402 mm2)

As = As1 + As2

= 718,086 + 402

= 718,086 mm2

Digunakan tulangan tarik 6D16 (As = 1206 mm2)

Tulangan Lapangan

Mu = 30,672 kNm

[clip_image014[4]](http://handoko10.files.wordpress.com/2010/03/clip_image0144.gif)kN/m2

[clip_image004[6]](http://handoko10.files.wordpress.com/2010/03/clip_image0046.gif)

[clip_image016[11]](http://handoko10.files.wordpress.com/2010/03/clip_image01611.gif)

[clip_image018[5]](http://handoko10.files.wordpress.com/2010/03/clip_image0185.gif)

Dengan rumus abc didapatkan nilai ρ = 0,0046

Pemeriksaan syarat rasio penulangan (ρmin < ρ < ρmax)

[clip_image010[6]](http://handoko10.files.wordpress.com/2010/03/clip_image0106.gif)

[clip_image012[5]](http://handoko10.files.wordpress.com/2010/03/clip_image0125.gif)

As1 = ρ.b.d.106

= 0,0046 . 0,250 . 0,294 . 106

= 340,792 mm2

Dipakai tulangan tekan 2D16 (As terpasang = As2 = 402 mm2)

As = As1 + As2

= 340,792 + 402

= 742,792 mm2

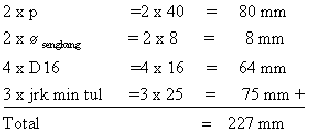
Digunakan tulangan tarik 4D16 (As = 804 mm2)

Periksa lebar balok

Maksimal tulangan yang hadir sepenampang adalah 6D16 (dipasang posisi 2 lapis, lapis atas 4D16 dan lapis bawah 2D16).

Jarak minimum tulangan yang disyaratkan adalah 25 mm.

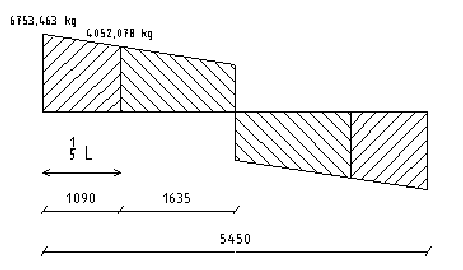
Lebar balok minimum:

[](http://handoko10.files.wordpress.com/2010/03/clip_image0206.gif)

Jadi lebar balok sebesar 250 mm cukup memadai.

**4.5.5.2 Perhitungan Tulangan Geser Balok Anak**

Bidang lintang yang terjadi pada balok digunakan untuk mendesain tulangan geser pada daerah tumpuan dan lapangan. Daerah lapangan berjarak 1/5L dari ujung balok.

[](http://handoko10.files.wordpress.com/2010/03/clip_image0225.gif)

**Gambar 4.27 *Posisi Gaya Lintang***

Contoh perhitungan tulangan geser balok anak Ba1 lantai 1

Tulangan Geser Tumpuan

Vu = 6753,463 kg = 67534,63 N

*V*n = [clip_image024[6]](http://handoko10.files.wordpress.com/2010/03/clip_image0246.gif)N

*V*c = [clip_image026[4]](http://handoko10.files.wordpress.com/2010/03/clip_image0264.gif)N

Vs = Vn – Vc = 112557,72 – 61250 = 51307,72 N

Periksa *v*u > f*v*c:

*v*u = [clip_image028](http://handoko10.files.wordpress.com/2010/03/clip_image028.gif)MPa

*v*c = [clip_image030](http://handoko10.files.wordpress.com/2010/03/clip_image030.gif)MPa

f*v*c = 0,6 x 0,8333 = 0,50

*v*u > f*v*c Þ perlu tulangan geser

Periksa f*v*s ≤ f*v*s maks:

f*v*s = *v*u – f*v*c

= 0,919 – 0,50

= 0,419 Mpa

f’c = 25 MPa → f*v*s maks = 2,00 (Tabel nilai f*v*s maks, CUR 1 hal 129)

f*v*s< f*v*s maks → OK

Syarat : s < d/2 = 294/2 = 147 mm, diambil s = 125 mm

Av = [clip_image032](http://handoko10.files.wordpress.com/2010/03/clip_image032.gif)mm2

Dipakai tulangan sengkang ø 8 – 125 (Av = 101 mm2)

Tulangan Geser Lapangan

Vu = 4052,078 kg = 40520,78 N

*V*n = [clip_image034](http://handoko10.files.wordpress.com/2010/03/clip_image034.gif)N

*V*c = [clip_image026[5]](http://handoko10.files.wordpress.com/2010/03/clip_image0265.gif)N

Vs = Vn – Vc = 67534,633 – 61250 = 6284,633 N

Periksa *v*u > f*v*c:

*v*u = [clip_image037](http://handoko10.files.wordpress.com/2010/03/clip_image037.gif)MPa

*v*c = [clip_image030[1]](http://handoko10.files.wordpress.com/2010/03/clip_image0301.gif)MPa

f*v*c = 0,6 x 0,8333 = 0,50

*v*u > f*v*c Þ perlu tulangan geser

Periksa f*v*s ≤ f*v*s maks:

f*v*s = *v*u – f*v*c

= 0,551 – 0,50

= 0,051 Mpa

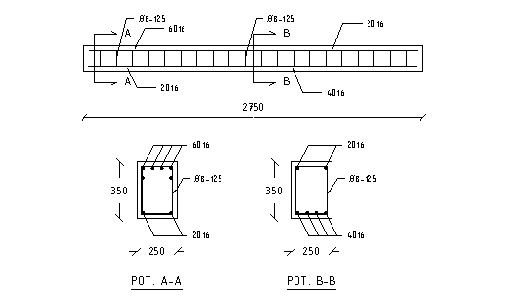
f’c = 25 MPa → f*v*s maks = 2,00 (Tabel nilai f*v*s maks, CUR 1 hal 129)

f*v*s< f*v*s maks → OK

Syarat : s < d/2 = 294/2 = 147 mm, diambil s = 125 mm

Av = [clip_image039](http://handoko10.files.wordpress.com/2010/03/clip_image039.gif)mm2

Dipakai tulangan sengkang ø 8 – 125 (Av = 101 mm2)

[](http://handoko10.files.wordpress.com/2010/03/clip_image041.gif)

**Gambar 4.28 *Penulangan Ba1 Lantai 1***

**Tabel 4.23 *Rekapitulasi Tipe Balok Anak***

|  |  |  |  |
| --- | --- | --- | --- |
| Tipe Balok | Dimensi (mm) | Tumpuan | Lapangan |
| B | H | Tekan | Tarik | Geser | Tekan | Tarik | Geser |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BA1 | 250 | 350 | 2 | D | 16 | 6 | D | 16 | ø | 8 | - | 125 | 2 | D | 16 | 4 | D | 16 | ø | 8 | - | 125 |
| BA2 | 250 | 350 | 2 | D | 16 | 4 | D | 16 | ø | 8 | - | 250 | 2 | D | 16 | 4 | D | 16 | ø | 8 | - | 250 |
| BA3 | 250 | 350 | 2 | D | 16 | 6 | D | 16 | ø | 8 | - | 125 | 2 | D | 16 | 4 | D | 16 | ø | 8 | - | 250 |
| BA4 | 250 | 350 | 2 | D | 16 | 5 | D | 16 | ø | 8 | - | 125 | 2 | D | 16 | 4 | D | 16 | ø | 8 | - | 250 |
| BA5 | 250 | 350 | 2 | D | 16 | 7 | D | 16 | ø | 8 | - | 125 | 2 | D | 16 | 5 | D | 16 | ø | 8 | - | 125 |