## II.2.7.Calculul arborilor

### II.2.7.1.Determinarea reactiunilor din reazeme

**Forte ce actioneaza pe arborele II** (fig.2.45)

- ce cunosc fortele ce actioneaza pe arbore II,in punctul 1 si 4,din II.2.6

$H_{II_4} := 250N \quad H_{II_1} := 0N$

$V_{II_4} := 687N \quad V_{II_1} := 878N$

- aleg distantele intre punctele de aplicare ale fortelor pe arbore

$a_{II} := 60mm$

$c_{II} := 30mm$

$b_{II} := 45mm$

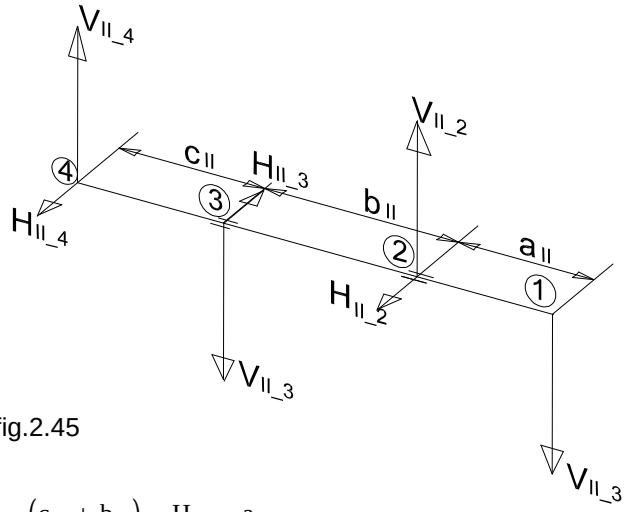


fig.2.45

- reactiuni din plan orizontal in punctul 2 si 3

$$H_{II_3} := \frac{H_{II_4}\cdot(c_{II} + b_{II}) - H_{II_1}\cdot a_{II}}{b_{II}} \qquad H_{II_3} = 416.667\,N$$

$$H_{II_2} := H_{II_1} - H_{II_4} + H_{II_3} \qquad H_{II_2} = 166.667\,N$$

- reactiuni din plan vertical in punctul 2 si 3

$$V_{II_3} := \frac{V_{II_4}\cdot(c_{II} + b_{II}) + V_{II_1}\cdot a_{II}}{b_{II}} \qquad V_{II_3} = 2.316\times 10^3\,N$$

$$V_{II_2} := V_{II_1} + V_{II_3} - V_{II_4} \qquad V_{II_2} = 2.507\times 10^3\,N$$

- rezultantele reactiunilor in punctul 2 si 3

$$R_{II_2} := \sqrt{H_{II_2}^{\,2} + V_{II_2}^{\,2}} \qquad R_{II_2} = 2.512\times 10^3\,N$$

$$R_{II_3} := \sqrt{H_{II_3}^{\,2} + V_{II_3}^{\,2}} \qquad R_{II_3} = 2.353\times 10^3\,N$$

**Forte ce actioneaza pe arborele III** (fig.2.46)

- se cunosc fortele ce actioneaza pe arbore III in punctul 3,din II.2.6

$H_{III_3} := 250N \quad H'_{III_3} := 67.4N$

$V_{III_3} := 687.3N \quad V'_{III_3} := 997.7N$

- aleg distantele intre punctele de aplicare ale fortelor pe arbore

$a_{III} := 30mm$

$b_{III} := 30mm$

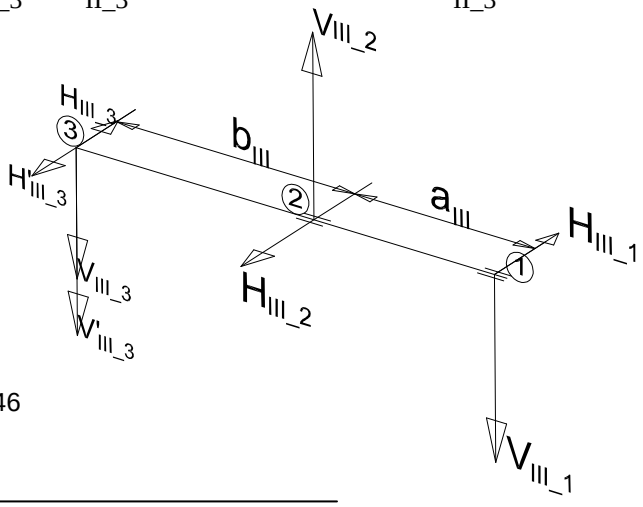


fig.2.46

- forta rezultanta ce apasa pe arbore in punctul 3

$$R_{III_3} := \sqrt{\left(H_{III_3} - H'_{III_3}\right)^2 + \left(V_{III_3} + V'_{III_3}\right)^2} \qquad R_{III_3} = 1.695\times 10^3\,N$$

- reactiuni din plan orizontal in punctul 1 si 2

$$H_{III_1} := \left(H_{III_3} - H'_{III_3}\right)\cdot\frac{b_{III}}{a_{III}} \qquad H_{III_1} = 182.6\,N$$

$$H_{III_2} := H_{III_1} + H_{III_3} - H'_{III_3} \qquad H_{III_2} = 365.2\,N$$

- reactiuni din plan vertical in punctul 1 si 2

$$V_{III_1} := \left(V_{III_3} + V'_{III_3}\right)\cdot\frac{b_{III}}{a_{III}} \qquad V_{III_1} = 1.685\times 10^3\,N$$

$$V_{III_2} := V_{III_1} + H_{III_3} + V'_{III_3} \qquad V_{III_2} = 2.933\times 10^3\,N$$

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**Forte ce actioneaza pe arborele IV** (fig.2.47)

- se cunosc fortele ce actioneaza pe arbore IV,in punctul 2,din II.2.6

$V_{IV_2} := 997N \quad V'_{IV_2} := 2048N$

$H_{IV_2} := 67N \quad H'_{IV_2} := 473N$

- aleg distantele intre punctele de aplicare ale fortelor pe arbore

$a_{IV} := 85mm$

$b_{IV} := 50mm$

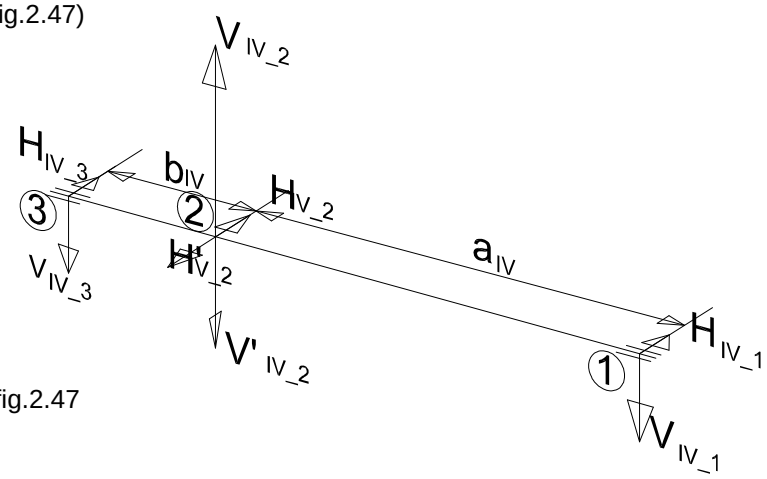


fig.2.47

- forta rezultanta ce apasa pe arbore in punctul 2

$$R_{IV_2} := \sqrt{\left(H_{IV_2} - H'_{IV_2}\right)^2 + \left(V_{IV_2} - V'_{IV_2}\right)^2} \qquad R_{IV_2} = 1.127 \times 10^3\,N$$

- reactiuni din plan orizontal in punctul 1 si 3

$$H_{IV_1} := \left(H'_{IV_2} - H_{IV_2}\right)\cdot\frac{b_{IV}}{a_{IV} + b_{IV}} \qquad H_{IV_1} = 150.37\,N$$

$$H_{IV_3} := H'_{IV_2} - H_{IV_2} - H_{IV_1} \qquad H_{IV_3} = 255.63\,N$$

- reactiuni din plan vertical in punctul 1 si 3

$$V_{IV_1} := \left(V_{IV_2} - V'_{IV_2}\right)\cdot\frac{b_{IV}}{a_{IV} + b_{IV}} \qquad V_{IV_1} = -389.259\,N$$

$$V_{IV_3} := \left(V_{IV_2} - V_{IV_1} - V'_{IV_2}\right) \qquad V_{IV_3} = -661.741\,N$$

**Forte ce actioneaza pe arborele V** (fig.2.48)

- se cunosc fortele ce actioneaza pe arbore V,in punctul 1 si 4,din II.2.6

$H_{V_4} := 567N \quad A_{V_4} := 2N$

$V_{V_4} := 206N \quad V_{V_1} := 697N$

$H_{V_1} := 161N$

- aleg distantele intre punctele de aplicare ale fortelor pe arbore

$a_V := 30mm \quad b_V := 45mm$

$c_V := 40mm$

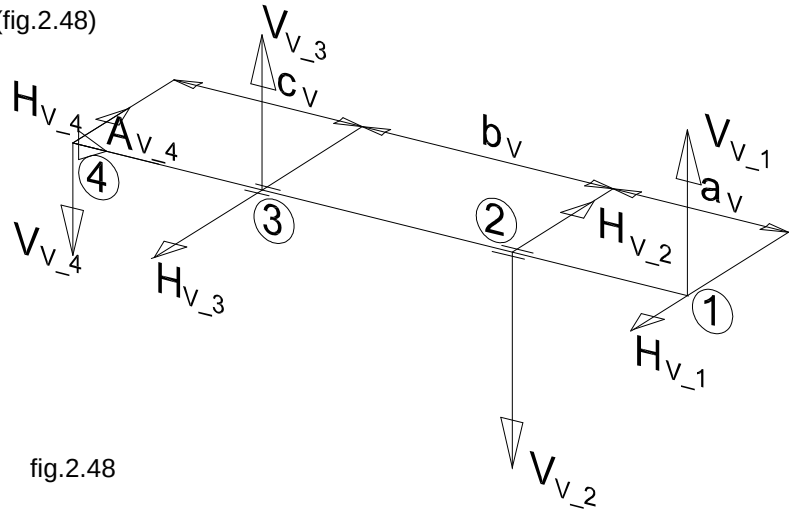


fig.2.48

- reactiuni din plan orizontal in punctul 2 si 3

$$H_{V_3} := \frac{H_{V_4}\cdot\left(c_V + b_V\right) + H_{V_1}\cdot a_V}{b_V} \qquad H_{V_3} = 1.178 \times 10^3\,N$$

$$H_{V_2} := H_{V_1} + H_{V_3} - H_{V_4} \qquad H_{V_2} = 772.333\,N$$

- reactiuni din plan vertical in punctul 2 si 3

$$V_{V_3} := \frac{V_{V_4}\cdot\left(b_V + c_V\right) + V_{V_1}\cdot a_V}{b_V} \qquad V_{V_3} = 853.778\,N$$

$$V_{V_2} := V_{V_1} + V_{V_3} - V_{V_4} \qquad V_{V_2} = 1.345 \times 10^3\,N$$

- rezultantele in punctul 2 si 3

$$R_{V_3} := \sqrt{H_{V_3}^2 + V_{V_3}^2} \qquad R_{V_3} = 1.455 \times 10^3\,N$$

$$R_{V_2} := \sqrt{H_{V_2}^2 + V_{V_2}^2} \qquad R_{V_2} = 1.551 \times 10^3\,N$$

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## II.2.7.2.Dimensionarea arborilor

**Arbore II-**diagrame pentru momente de torsiune si de incovoiere (fig.2.49)

- in fig.2.49 se arata:diagramle de momente de incovoiere (in plan vertical si in plan orizontal), diagramele de momente de torsiune si fortele ce actioneaza asupra arborelui.
- se cunosc fortele ce actioneaza asupra arborelui din 2.6

$H_{II_4} := 250N \quad H_{II_1} := 0N$

$V_{II_4} := 687N \quad V_{II_1} := 878N$

- se cunosc dimensiunile arborelui din II.2.7.1

$a_{II} := 60mm \; b_{II} := 45mm \; c_{II} := 30mm$

- se cunoaste momentul de torsiune din II.2.5

$M_{tII} := 20620N \cdot mm$

unde $\alpha := \frac{60}{100}$

$\alpha = 0.6$

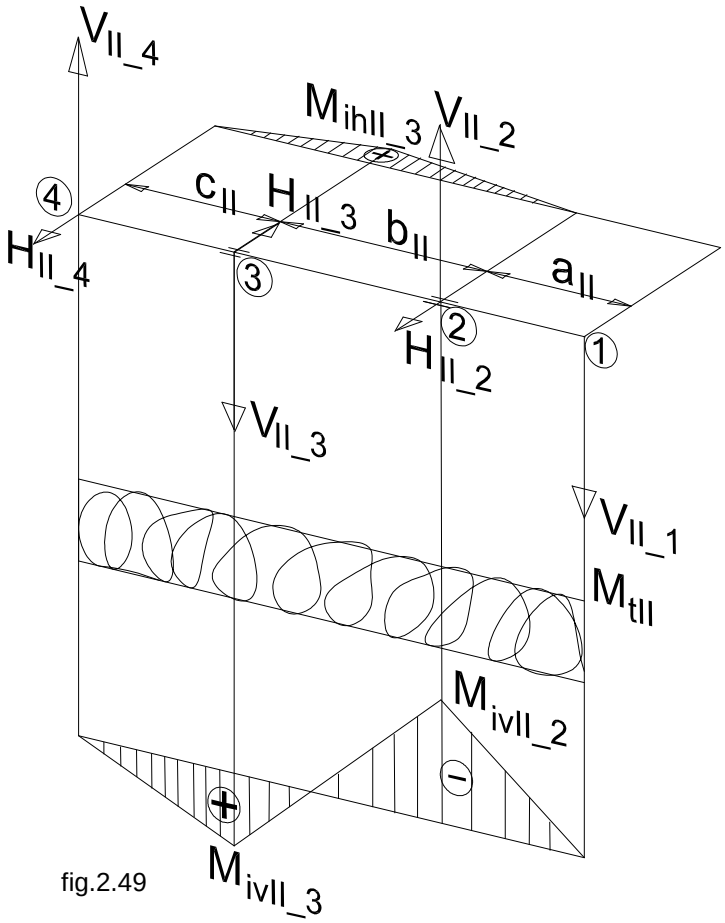

fig.2.49

- moment de incovoiere in punct 2 — $M_{ivII_2} := -V_{II_1} \cdot a_{II}$ — $M_{ivII_2} = -5.268 \times 10^4 N \cdot mm$
- moment de incovoiere echivalent in punct 2 — $M_{eII_2} := \sqrt{M_{ivII_2}^2 + (\alpha \cdot M_{tII})^2}$ — $M_{eII_2} = 5.411 \times 10^4 N \cdot mm$
- moment de incovoiere in punct 3,in plan orizontal — $M_{ihII_3} := H_{II_4} \cdot c_{II}$ — $M_{ihII_3} = 7.5 \times 10^3 N \cdot mm$
- moment de incovoiere in punct 3,in plan vertical — $M_{ivII_3} := V_{II_4} \cdot c_{II}$ — $M_{ivII_3} = 2.061 \times 10^4 N \cdot mm$
- moment de incovoiere rezultant in punct 3 — $M_{iII_3} := \sqrt{M_{ivII_3}^2 + M_{ihII_3}^2}$ — $M_{iII_3} = 2.193 \times 10^4 N \cdot mm$

**Arbore II-**predimensionare si dimensionare

-arborele se dimensioneaza in punctul 2 unde momentul de incovoiere este maxim

- alegerea materialului — OLC35 cu τat=15..25N/mm2 aleg — $\tau_{at} := 20 \frac{N}{mm^2}$
- diametrul preliminar al arborelui — $d := \sqrt[3]{\frac{16}{\pi} \cdot \frac{M_{tII}}{\tau_{at}}}$ — $d = 17.381 mm$
- tensiunea admisibila pentru ciclul alternativ — pentru OLC 35 aleg — $\sigma_a := 70 \frac{N}{mm^2}$
- coeficient de siguranta — aleg — $c := 2$
- diametrul arborelui — $d := \sqrt[3]{\frac{M_{eII_2} \cdot c}{0.1 \cdot \sigma_a}}$ — $d = 24.912 mm$
- diametrul adoptat — adopt — $d := 25mm$

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**Arbore III-**diagrame pentru momente de incovoiere (fig.2.50)

- in fig.2.50 se arata diagramele de momente de incovoiere (in plan vertical si in plan orizontal) si fortele ce actioneaza asupra arborelui
- se cunosc fortele ce actioneaza asupra arborelui,din II.2.6

  $H_{III_3} := 250N \quad H'_{III_3} := 64N$

  $V_{III_3} := 687.3N \quad V'_{III_3} := 997N$
- se cunosc dimensiunile arborelui, din II.2.7.1

  $a_{III} := 30mm \quad b_{III} := 30mm$

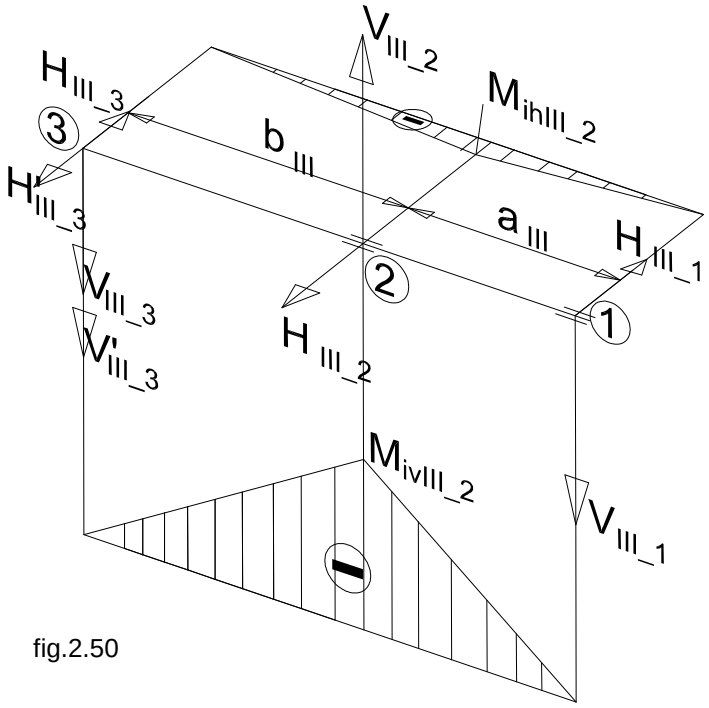


fig.2.50

- moment din incovoiere in punct 2,in plan orizontal

  $M_{ihIII_2} := -\left(H_{III_3} - H'_{III_3}\right)\cdot b_{III}$ $\quad M_{ihIII_2} = -5.58\times 10^{3}\,N\cdot mm$
- moment din incovoiere in punct 2 din plan vertical

  $M_{ivIII_2} := -\left(V_{III_3} + V'_{III_3}\right)\cdot b_{III}$ $\quad M_{ivIII_2} = -5.053\times 10^{4}\,N\cdot mm$
- moment de incovoiere rezultant,in punct 2

  $M_{iIII_2} := \sqrt{M_{ivIII_2}^{\,2} + M_{ihIII_2}^{\,2}}$ $\quad M_{iIII_2} = 5.084\times 10^{4}\,N\cdot mm$

**Arbore III-**dimensionare

- tensiunea admisibila la incovoiere — pentru OLC 35 si pentru pentru ciclul alternativ

  $\sigma_a := 60\,\frac{N}{mm^2}$
- coeficient de siguranta — aleg

  $c := 2$
- diametrul de calcul al arborelui

  $d := \sqrt[3]{\frac{M_{iIII_2}\cdot c}{0.1\cdot\sigma_a}}$ $\quad d = 25.685\,mm$
- diametrul minim stabilit — adopt

  $d := 26mm$

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**Arbore IV-**diagrame pentru momente de incovoiere (fig.2.51)

- in fig.2.51 se arata diagramele de momente de incovoiere (in plan vertical si in plan orizontal) si fortele ce actioneaza asupra arborelui.
- se cunosc fortele ce actioneaza asupra arborelui din II.2.6

  $V'_{IV_2} := 2048N$ $V_{IV_2} := 997N$

  $H'_{IV_2} := 473N$ $H_{IV_2} := 67N$
- se cunosc dimensiunile arborelui din II.2.7.1

  $a_{IV} := 85mm$ $b_{IV} := 50mm$

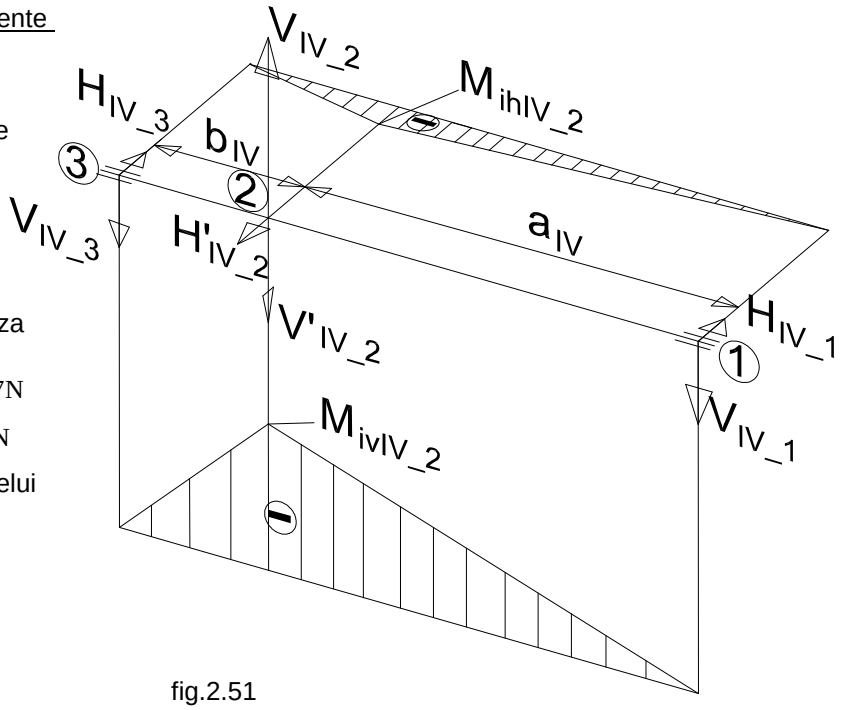


fig.2.51

- moment de incovoiere in punct 2,in plan orizontal

$$M_{ihIV_2} := -\left(H'_{IV_2} - H_{IV_2}\right)\cdot\frac{a_{IV}\cdot b_{IV}}{a_{IV} + b_{IV}} \quad M_{ihIV_2} = -1.278\times 10^{4}\,N\cdot mm$$

- moment de incovoiere in punct 2,in plan vertical

$$M_{ivIV_2} := -\left(-V_{IV_2} + V'_{IV_2}\right)\cdot\frac{a_{IV}\cdot b_{IV}}{a_{IV} + b_{IV}} \quad M_{ivIV_2} = -3.309\times 10^{4}\,N\cdot mm$$

- moment de incovoiere in punct 2

$$M_{iIV_2} := \sqrt{M_{ivIV_2}^{2} + M_{ihIV_2}^{2}} \quad M_{iIV_2} = 3.547\times 10^{4}\,N\cdot mm$$

**Arbore IV-**dimensionare

- tensiunea admisibila la incovoiere — pentru OLC 35 si pentru ciclul alternativ

$$\sigma_a := 70\,\frac{N}{mm^2}$$

- coeficient de siguranta — aleg

$$c := 2$$

- diametrul arborelui

$$d := \sqrt[3]{\frac{M_{iIV_2}\cdot c}{0.1\cdot\sigma_a}} \quad d = 21.64\,mm$$

- diametrul minim stabilit — adopt

$$d := 22mm$$

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**Arbore V-**diagrame pentru momente de torsiune si de incovoiere (fig.2.52)

- in fig.2.52 se arata diagramele de momente de incovoiere (in plan vertical si in plan orizontal),diagramele de momente de torsiune si fortele ce actioneaza asupra arborelui.
- se cunosc fortele ce actioneaza asupra arborelui din II.2.6

$H_{V_4} := 500N \quad V_{V_1} := 2048N$

$V_{V_4} := 151.5N \quad H_{V_1} := 473N$

$A_{V_4} := 100N$

- se cunosc dimensiunile arborelui din II.2.7.1

$a_V := 30mm \quad b_V := 50mm \quad c_V := 35mm$

- se cunoaste momentul de torsiune din II.2.5

$M_{tV} := 20620N \cdot mm$

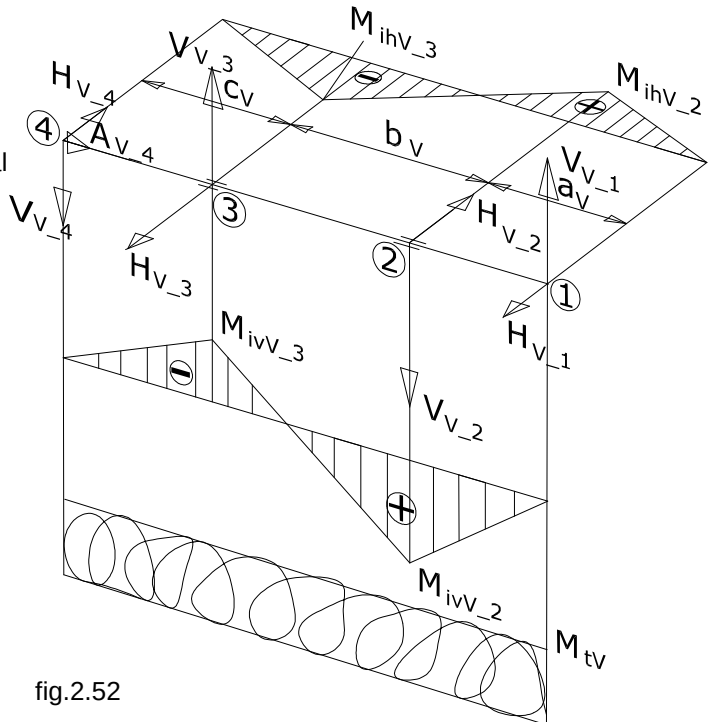


fig.2.52

- moment din incovoiere din plan orizontal,pct.2 $M_{ihV_2} := H_{V_1} \cdot a_V$ $M_{ihV_2} = 1.419 \times 10^4 N \cdot mm$
- moment din incovoiere din plan vertical,pct.2 $M_{ivV_2} := V_{V_1} \cdot a_V$ $M_{ivV_2} = 6.144 \times 10^4 N \cdot mm$
- moment din incovoiere rezultant,pct.2 $M_{iV_2} := \sqrt{M_{ivV_2}^2 + M_{ihV_2}^2}$ $M_{iV_2} = 6.306 \times 10^4 N \cdot mm$
- moment din incovoiere din plan orizontal,pct.3 $M_{ihV_3} := -H_{V_4} \cdot c_V$ $M_{ihV_3} = -1.75 \times 10^4 N \cdot mm$
- moment din incovoiere din plan vertical,pct.3 $M_{ivV_3} := -V_{V_4} \cdot c_V$ $M_{ivV_3} = -5.303 \times 10^3 N \cdot mm$

$M_{iV_3} := \sqrt{M_{ivV_3}^2 + M_{ihV_3}^2}$ $M_{iV_3} = 1.829 \times 10^4 N \cdot mm$

- moment din incovoiere rezultant $M_{eV3} := \sqrt{M_{iV_3}^2 + M_{tV}^2}$ $M_{eV3} = 2.756 \times 10^4 N \cdot mm$

**Arbore V-** Predimensionare si dimensionare

-arborele se dimensioneaza in punctul 2 deoarece momentul de incovoiere este maxim

- alegerea materialului — aleg OLC 35 cu τat=15..25N/mm2 — $\tau_{at} := 20 \frac{N}{mm^2}$
- diametrul preliminar al arborelui — $d := \sqrt[3]{\frac{16}{\pi} \cdot \frac{M_{tV}}{\tau_{at}}}$ — $d = 17.381 mm$
- tensiunea admisibila la incovoiere — pentru OLC 35 si pentru ciclul alternativ — $\sigma_a := 85 \frac{N}{mm^2}$
- coeficient de siguranta — aleg — $c := 2$
- diametrul arborelui — $d := \sqrt[3]{\frac{M_{iV_2} \cdot c}{0.1 \cdot \sigma_a}}$ — $d = 24.572 mm$
- diametrul minim stabilit — adopt — $d := 25mm$

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