TUGAS MEKANIKA BAHAN

"TITIK BERAT BIDANG DATAR DAN MOMEN INERSIA"

Laporan Ini Dibuat Untuk Memenuhi Tugas Mata Kuliah Mekanika Bahan
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PROGRAM STUDI TEKNIK SIPIL

FAKULTAS TEKNIK DAN INFORMATIKA

UNIVERSITAS PGRI SEMARANG

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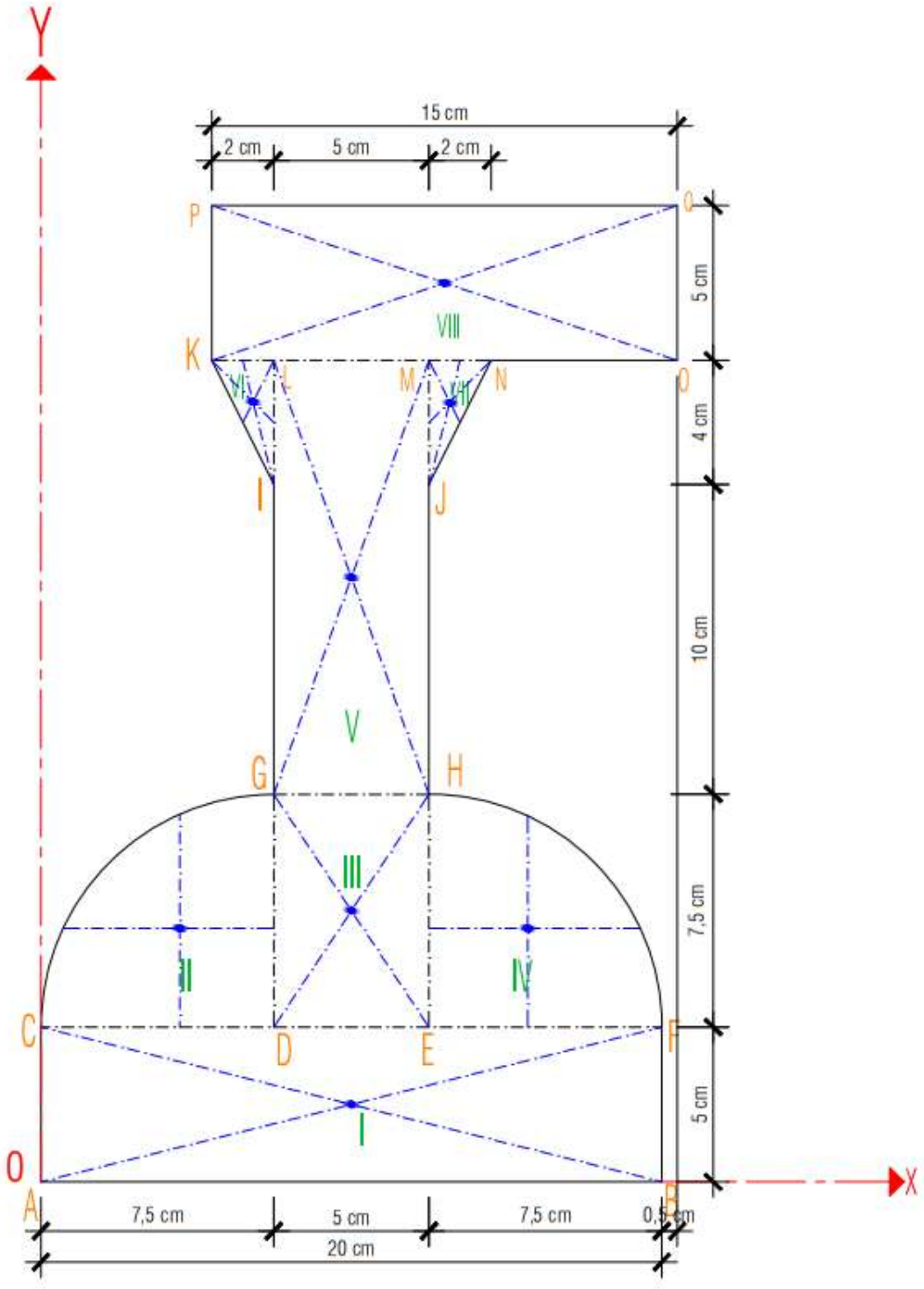

Y
15 cm
2 cm
5 cm
2 cm
P
Q
5 cm
VIII
K
VII
L
M
VII
N
O
4 cm
I
J
10 cm
V
G
H
III
7,5 cm
II
IV
C
D
E
F
5 cm
I
O
X
A
7,5 cm
5 cm
7,5 cm
B
20 cm

MENCARI MOMEN INERSIA

- **BIDANG I (ABCF)**

A_1 = 20 x 5 = 100 cm^2

X_1 = $\frac{1}{2}$ x 20 cm = 10 cm

Y_1 = $\frac{1}{2}$ x 5 cm = 2,5 cm

- **BIDANG II (GCD)**

A_2 = $\frac{1}{4}$ x π x r^2

= $\frac{1}{4}$ x 3,14 x $7,5^2$

= $\frac{3,14}{4}$ x 56,25m

= 44,156 cm^2

X_2 = r – 0,212 x d

= 7,5 – 0,212 x 15

= 7,5 – 3,18 = 4,32 cm

Y_2 = 5 + 0,212 x d

= 5 + 0,212 x 15

= 5 + 3,18 = 8,18 cm

- **BIDANG III (GHDE)**

A_3 = 5 x 7,5 = 37,5 cm^2

X_3 = 7,5 + $\frac{1}{2}$ x 5

= 7,5 + 2,5 = 10 cm

Y_3 = 5 + $\frac{1}{2}$ x 7,5

= 5 + 37,5 = 8,75 cm

- **BIDANG IV (HEF)**

A_4 = $\frac{1}{4}$ x π x r^2

= $\frac{1}{4}$ x 3,14 x $7,5^2$

= $\frac{3,14}{4}$ x 56,25 = 44,156 cm^2

X_4 = 12,5 + 0,212 x d

= 12, 5 + 0,212 x 15

= 15,68 cm

Y_4 = 5 + 0,212 x d

= 5 + 0,212 x 15 = 8,18 cm

- **BIDANG V (GHLM)**

$A_5 = 5 \times 14 = 70\ cm^2$

$X_5 = 7{,}5 + \frac{1}{2} \times 5$

$= 7{,}5 + 2{,}5 = 10\ cm$

$Y_5 = 12{,}5 + \frac{1}{2} \times 14$

$= 12{,}5 + 7 = 19{,}5\ cm$

- **BIDANG VI (KLI)**

$A_6 = \frac{1}{2} \times 2 \times 4 = 4\ cm^2$

$X_6 = 5{,}5 + \frac{2}{3} \times b$

$= 5{,}5 + \frac{2}{3} \times 2$

$= \frac{5{,}5}{1} + \frac{4}{3}$

$= \frac{16{,}5}{3} + \frac{4}{3} = \frac{20{,}5}{3} = 6{,}833\ cm$

$Y_6 = 22{,}5 + \frac{2}{3} \times h$

$= 22{,}5 + \frac{2}{3} \times 4$

$= \frac{22{,}5}{1} + \frac{8}{3}$

$= \frac{67{,}5}{3} + \frac{8}{3} = \frac{75{,}5}{3} = 25{,}167\ cm$

- **BIDANG VII (MNJ)**

$A_7 = \frac{1}{2} \times 2 \times 4 = 4\ cm^2$

$X_7 = 12{,}5 + \frac{1}{3} \times b$

$= 12{,}5 + \frac{1}{3} \times 2$

$= \frac{12{,}5}{1} + \frac{2}{3}$

$= \frac{37{,}5}{3} + \frac{2}{3} = \frac{39{,}5}{3} = 13{,}167\ cm$

$Y_7 = 22{,}5 + \frac{2}{3} \times h$

$= 22{,}5 + \frac{2}{3} \times 4$

$= \frac{22{,}5}{1} + \frac{8}{3}$

$= \frac{67{,}5}{3} + \frac{8}{3} = \frac{75{,}5}{3} = 25{,}167\ cm$

- **BIDANG VIII (KOPQ)**

A_8 = 15 x 5 = 75 cm^2

$X_8 = 5{,}5 + \frac{1}{2}$ x 15

= 5,5 + 7,5 = 13 cm

Y_8 = 26,5 + $\frac{1}{2}$ x 5

= 26,5 + 2,5 = 29 cm

MENGHITUNG TITIK BERAT

$$\bar{X} = \frac{(X_1 \text{ x } A_1)+(X_2 \text{ x } A_2)+(X_3 \text{ x } A_3)+(X_4 \text{ x } A_4)+(X_5 \text{ x } A_5)+(X_6 \text{ x } A_6)+(X_7 \text{x } A_7)+(X_8 \text{ x } A_8)}{A_1+A_2+A_3+A_4+A_5+A_6+A_7+A_8}$$

$$= \frac{(10 \text{ x } 100)+(4{,}32 \text{ x } 44{,}156)+(10 \text{ x } 37{,}5)+(15{,}68 \text{ x } 44{,}156)+(10 \text{ x } 70)+(6{,}833 \text{ x } 4)+(13{,}167\text{x } 4)+(13 \text{ x } 75)}{100+44{,}156+37{,}5+44{,}156+70+4+4+75}$$

$$= \frac{1000 + 190{,}754 + 375 + 692{,}366 + 700 + 27{,}332 + 52{,}668 + 975}{378{,}812}$$

$$= \frac{4013{,}12}{378{,}812} = 10{,}594 \text{ cm}$$

$$\bar{Y} = \frac{(Y_1 \text{ x } A_1)+(Y_2 \text{ x } A_2)+(Y_3 \text{ x } A_3)+(Y_4 \text{ x } A_4)+(Y_5 \text{ x } A_5)+(Y_6 \text{ x } A_6)+(Y_7\text{x } A_7)+(Y_8 \text{ x } A_8)}{A_1+A_2+A_3+A_4+A_5+A_6+A_7+A_8}$$

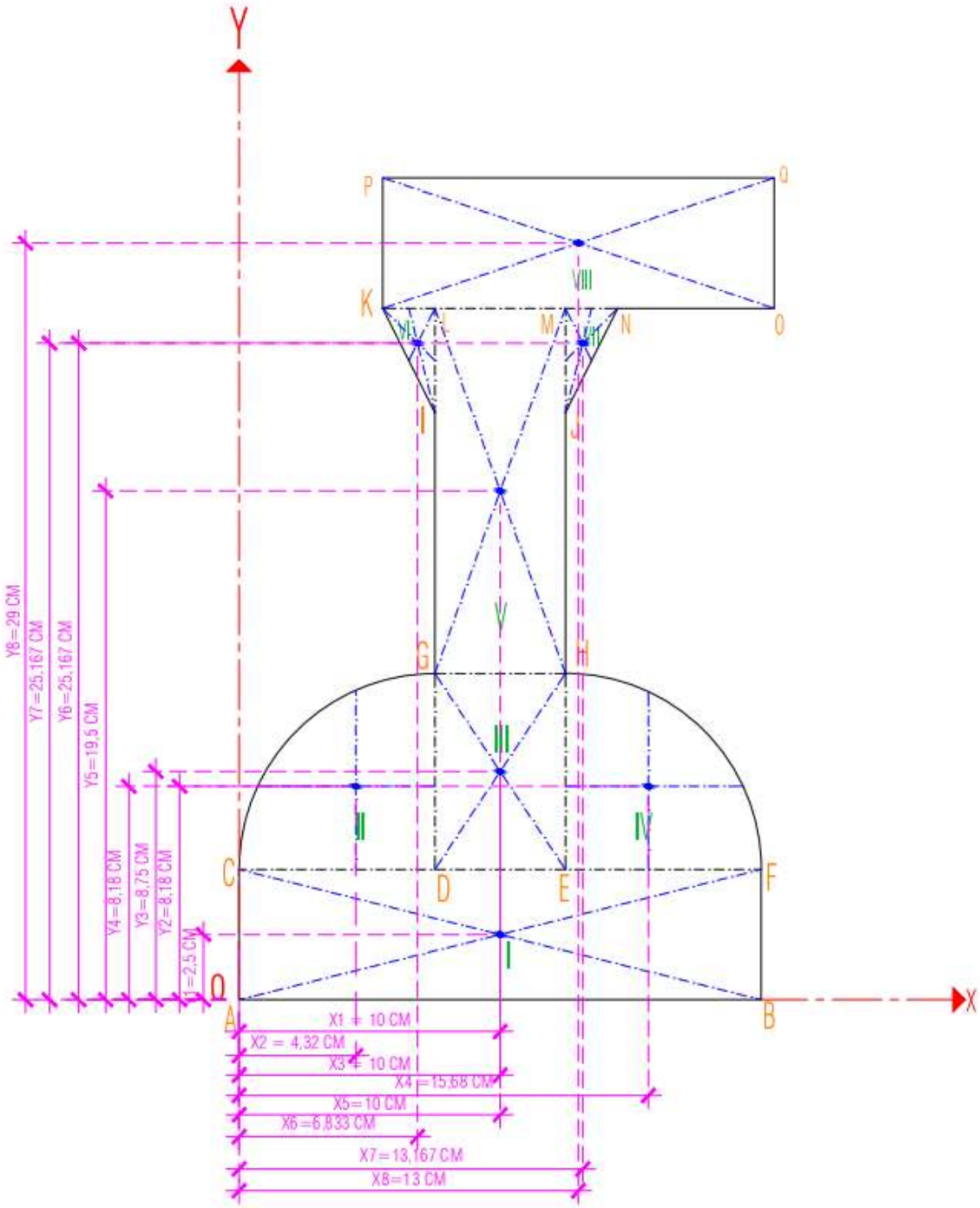
$$= \frac{(2{,}5 \text{ x } 100)+(8{,}18 \text{ x } 44{,}156)+(8{,}75 \text{ x } 37{,}5)+(8{,}18 \text{ x } 44{,}156)+(19{,}5 \text{ x } 70)+(25{,}167 \text{ x } 4)+(25{,}167\text{x } 4)+(29 \text{ x } 75)}{100+44{,}156+37{,}5+44{,}156+70+4+4+75}$$

$$= \frac{250 + 361{,}196 + 328{,}125 + 361{,}196 + 1365 + 10{,}668 + 10{,}668 + 2175}{378{,}812}$$

$$= \frac{5041{,}853}{378{,}812} = 13{,}310 \text{ cm}$$

MENCARI TITIK BERAT

SKALA 1 : 10



MENCARI MOMEN INERSIA

- **BIDANG I (ABCF)**

$Ix_1 = \frac{1}{12}$ x b x h^3

$= \frac{1}{12}$ x 20 x 5^3

$= \frac{1}{12}$ x 20 x 125 = $\frac{2500}{12} = 208{,}333\ cm^4$

$Iy_1 = \frac{1}{12}$ x b^3 x h

$= \frac{1}{12}$ x 20^3 x 5

$= \frac{1}{12}$ x 8000 x 5 = $\frac{40000}{12} = 3333{,}333\ cm^4$

- **BIDANG II (GCD)**

Ix_2 = 0,055 x r^4

= 0,055 x $7{,}5^4$

= 0,055 x 3164,063 = 174,023 cm^4

Ixy_2 = - ((r^4) / 8)

= - (($7{,}5^4$) / 8)

= $-\frac{3164{,}063}{8}$ = -395,508 cm^4

Iy_2 = 0,055 x r^4

= 0,055 x $7{,}5^4$

= 0,055 x 3164,063 = 174,023 cm^4

- **BIDANG III (GHDE)**

$Ix_3 = \frac{1}{12}$ x b x h^3

$= \frac{1}{12}$ x 5 x $7{,}5^3$

$= \frac{1}{12}$ x 5 x 421,875 = $\frac{2109{,}375}{12} = 175{,}781\ cm^4$

$Iy_3 = \frac{1}{12}$ x b^3 x h

$= \frac{1}{12}$ x 5^3 x 7,5

$= \frac{1}{12}$ x 125 x 7,5 = $\frac{937{,}5}{12} = 78{,}125\ cm^4$

- **BIDANG IV (HEF)**

$Ix_4 = 0{,}055 \times r^4$

$= 0{,}055 \times 7{,}5^4$

$= 0{,}055 \times 3164{,}063 = 174{,}023\ cm^4$

$Ixy_4 = -((r^4) / 8)$

$= -((7{,}5^4) / 8)$

$= -\frac{3164{,}063}{8} = -395{,}508\ cm^4$

$Iy_4 = 0{,}055 \times r^4$

$= 0{,}055 \times 7{,}5^4$

$= 0{,}055 \times 3164{,}063 = 174{,}023\ cm^4$

- **BIDANG V (GHLM)**

$Ix_5 = \frac{1}{12} \times b \times h^3$

$= \frac{1}{12} \times 5 \times 14^3$

$= \frac{1}{12} \times 5 \times 2744 = \frac{13720}{12} = 1143{,}333\ cm^4$

$Iy_5 = \frac{1}{12} \times b^3 \times h$

$= \frac{1}{12} \times 5^3 \times 14$

$= \frac{1}{12} \times 125 \times 14 = \frac{1750}{12} = 145{,}833\ cm^4$

- **BIDANG VI (KLI)**

$Ix_6 = \frac{1}{36} \times b \times h^3$

$= \frac{1}{36} \times 2 \times 4^3$

$= \frac{1}{36} \times 2 \times 64 = \frac{128}{36} = 3{,}556\ cm^4$

$Iy_6 = \frac{1}{36} \times b^3 \times h$

$= \frac{1}{36} \times 2^3 \times 4$

$= \frac{1}{36} \times 8 \times 4 = \frac{32}{36} = 0{,}889\ cm^4$

$Ixy_6 = -\frac{1}{72} \times b^2 \times h^2$

$= -\frac{1}{72} \times 2^2 \times 4^2$

$= -\frac{1}{72} \times 4 \times 16$

$= -\frac{64}{72} = -0{,}889\ cm^4$

- **BIDANG VII (MNJ)**

$Ix_7 = \frac{1}{36}$ x b x h^3

$= \frac{1}{36}$ x 2 x 4^3

$= \frac{1}{36}$ x 2 x 64 = $\frac{128}{36}$ = 3,556 cm^4

$Iy_7 = \frac{1}{36}$ x b^3 x h

$= \frac{1}{36}$ x 2^3 x 4

$= \frac{1}{36}$ x 8 x 4 = $\frac{32}{36}$ = 0,889 cm^4

$Ixy_7 = -\frac{1}{72}$ x b^2 x h^2

$= -\frac{1}{72}$ x 2^2 x 4^2

$= -\frac{1}{72}$ x 4 x 16

$= -\frac{64}{72}$ = -0,889 cm^4

- **BIDANG VIII (KOPQ)**

$Ix_8 = \frac{1}{12}$ x b x h^3

$= \frac{1}{12}$ x 15 x 5^3

$= \frac{1}{12}$ x 15 x 125 = $\frac{1875}{12}$ = 156,25 cm^4

$Iy_8 = \frac{1}{12}$ x b^3 x h

$= \frac{1}{12}$ x 15^3 x 5

$= \frac{1}{12}$ x 3375 x 5 = $\frac{16875}{12}$ = 1406,25 cm^4

$dx_1 = X_1 - \overline{X} = 10 - 10{,}594 = -0{,}594$ cm

$dx_2 = X_2 - \overline{X} = 4{,}32 - 10{,}594 = -6{,}274$ cm

$dx_3 = X_3 - \overline{X} = 10 - 10{,}594 = -0{,}594$ cm

$dx_4 = X_4 - \overline{X} = 15{,}68 - 10{,}594 = 5{,}086$ cm

$dx_5 = X_5 - \overline{X} = 10 - 10{,}594 = -0{,}594$ cm

$dx_6 = X_5 - \overline{X} = 6{,}883 - 10{,}594 = -3{,}761$ cm

$dx_7 = X_7 - \overline{X} = 13{,}167 - 10{,}594 = 2{,}573$ cm

$dx_8 = X_8 - \overline{X} = 13 - 10{,}594 = 2{,}406$ cm

$dy_1 = Y_1 - \overline{Y} = 2{,}5 - 13{,}310 = -10{,}81$ cm

$dy_2 = Y_2 - \overline{Y} = 8{,}18 - 13{,}310 = -5{,}13$ cm

$dy_3 = Y_3 - \overline{Y} = 8{,}75 - 13{,}310 = -4{,}56$ cm

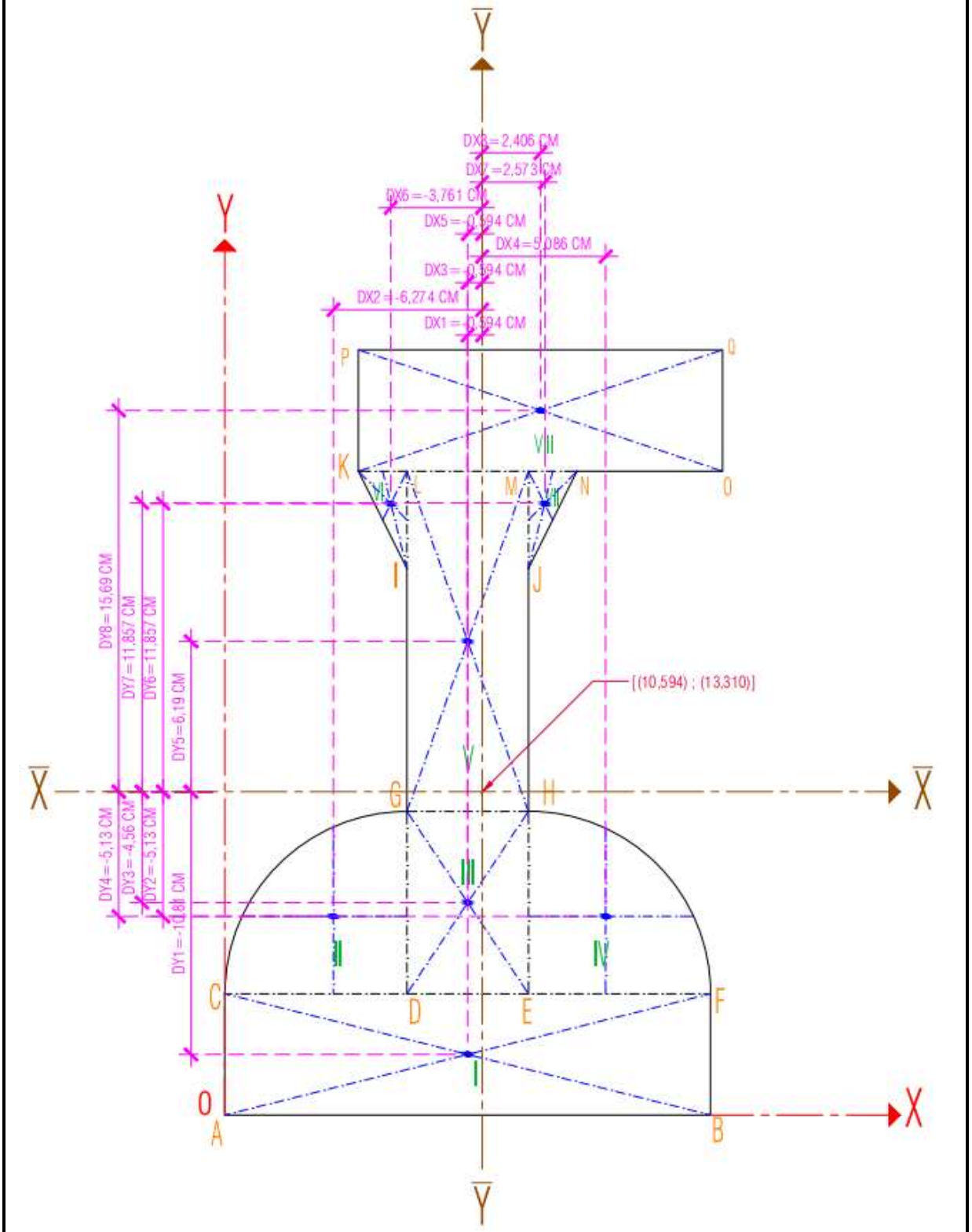
$dy_4 = Y_4 - \overline{Y} = 8{,}18 - 13{,}310 = -5{,}13$ cm

$dy_5 = Y_5 - \overline{Y} = 19{,}5 - 13{,}310 = 6{,}19$ cm

$dy_6 = Y_6 - \overline{Y} = 25{,}167 - 13{,}310 = 11{,}857$ cm

$dy_7 = Y_7 - \overline{Y} = 25{,}167 - 13{,}310 = 11{,}857$cm

$dy_8 = Y_8 - \overline{Y} = 29 - 13{,}310 = 15{,}69$ cm


Y
DX8 = 2,406 CM
DX7 = 2,573 CM
DX6 = -3,761 CM
DX5 = -0,194 CM
DX4 = 5,086 CM
DX3 = -0,194 CM
DX2 = -6,274 CM
DX1 = -0,194 CM
P
Q
K
VIII
VI
I
M
VII
N
O
J
DY8 = 15,69 CM
DY7 = 11,857 CM
DY6 = 11,857 CM
DY5 = 6,19 CM
[(10,594) ; (13,310)]
V
X
G
H
X
DY4 = -5,13 CM
DY3 = -4,56 CM
DY2 = -5,13 CM
DY1 = -10,81 CM
III
II
IV
C
D
E
F
I
0
A
B
X
Y

MENCARI MOMEN INERSIA GABUNGAN

Ix = $Ix_1 + A_1 \times dy_1^2 + Ix_2 + A_2 \times dy_2^2 + Ix_3 + A_3 \times dy_3^2 + Ix_4 + A_4 \times dy_4^2 + Ix_5 + A_5 \times dy_5^2 + Ix_6 + A_6 \times dy_6^2 + Ix_7 + A_7 \times dy_7^2 + Ix_8 + A_8 \times dy_8^2$

= $(208{,}333 + 100 \times (-10{,}81)^2) + (174{,}023 + 44{,}156 \times (-5{,}13)^2) + (175{,}781 + 37{,}5 \times (-4{,}56)^2) + (174{,}023 + 44{,}156 \times (-5{,}13)^2) + (1143{,}333 + 70 \times (6{,}19)^2) + (3{,}556 + 4 \times (11{,}857)^2) + (3{,}556 + 4 \times (11{,}857)^2) + (156{,}25 + 75 \times (15{,}69)^2)$

= 1189,933 + 1336,076 + 955,556 + 1336,076 + 3825,453 + 565,908 +565,908 + 18619,45

= 39098,36 cm^4

Iy = $Iy_1 + A_1 \times dx_1^2 + Iy_2 + A_2 \times dx_2^2 + Iy_3 + A_3 \times dx_3^2 + Iy_4 + A_4 \times dx_4^2 + Iy_5 + A_5 \times dx_5^2 + Iy_6 + A_6 \times dx_6^2 + Iy_7 + A_7 \times dx_7^2 + Iy_8 + A_8 \times dx_8^2$

= $(3333{,}333 + 100 \times (-0{,}594)^2) + (174{,}023 + 44{,}156 \times (-6{,}274)^2) + (78{,}125 + 37{,}5 \times (-0{,}594)^2) + (174{,}023 + 44{,}156 \times (5{,}086)^2) + (145{,}833 + 70 \times (-0{,}594)^2) + (0{,}889 + 4 \times (-3{,}761)^2) + (0{,}889 + 4 \times (2{,}573)^2) + (1406{,}25 + 75 \times (2{,}406)^2)$

= 3368,617 + 1912,139 + 91,356 + 1316,224 + 170,532 + 67,469 + 27,370 + 1840,413

= 8794,12 cm^4

MOMEN POLAR

Ip = Ix + Iy

= 39098,36 + 8794,12

= 47892,48 cm^4

MOMEN INERSIA GABUNGAN Ixy

Ixy = $(Ixy_1 + A_1 \times dx_1 \times dy_1) + (Ixy_2 + A_2 \times dx_2 \times dy_2) + (Ixy_3 + A_3 \times dx_3 \times dy_3) + (Ixy_4 + A_4 \times dx_4 \times dy_4) + (Ixy_5 + A_5 \times dx_5 \times dy_5) + (Ixy_6 + A_6 \times dx_6 \times dy_6) + (Ixy_7 + A_7 \times dx_7 \times dy_7) + (Ixy_8 + A_8 \times dx_8 \times dy_8)$

= (0 + 100 x (-0,594) x (-10,81)) + (-395,508 + 44,156 x (-6,274) x (-5,13)) + (0 + 37,5 x (-0,594) x (-4,56)) + (-395,508 + 44,156 x (5,086) x (-5,13)) + (0 + 70 x (-0,594) x (6,19)) + (-0,889 + 4 x (-3,761) x (11,857)) + (-0,889 + 4 x (2,573) x (11,857)) + (0 + 75 x (2,406) x (15,69))

= 642,114 + 1025,680 + 101,574 + (-1547,590) + (-257,380) + (-179,266) + 121,143 + 2831,261

= 2737,536 cm^4

MOMEN INERSIA UTAMA

$$\textbf{Imax} = \frac{Ix+Iy}{2} + \sqrt{\frac{(Ix - Iy)^2}{2} + Ixy^2}$$

$$= \frac{39098,36 + 8794,12}{2} + \sqrt{\frac{(39098,36 - 8794,12)^2}{2} + 2737,536^2}$$

$$= \frac{47892,48}{2} + \sqrt{15152,12^2 + 2737,536^2}$$

$$= 23946,24 + \sqrt{229586740,5 + 7494103,351}$$

$$= 23946,24 + \sqrt{237083843,9}$$

$$= 23946,24 + 15397,527$$

$$= 39343,767 \text{ cm}^4$$

$$\textbf{Imin} = \frac{Ix+Iy}{2} - \sqrt{\frac{(Ix - Iy)^2}{2} + Ixy^2}$$

$$= \frac{39098,36 + 8794,12}{2} - \sqrt{\frac{(39098,36 - 8794,12)^2}{2} + 2737,536^2}$$

$$= \frac{47892,48}{2} - \sqrt{15152,12^2 + 2737,536^2}$$

$$= 23946,24 - \sqrt{229586740,5 + 7494103,351}$$

$$= 23946,24 - \sqrt{237083843,9}$$

$$= 23946,24 - 15397,527$$

$$= 8548,713 \text{ cm}^4$$

MENCARI SUMBU UTAMA

$$\text{Tg } 2\,\theta = -\frac{2\,(Ixy)}{Ix - Iy}$$

$$= -\frac{2\,(2737{,}536)}{39098{,}36 + 8794{,}12}$$

$$= -\frac{5475{,}072}{30304{,}24}$$

$$\text{Tg } 2\,\theta = -\,0{,}181$$

$$2\,\theta = -\,10{,}260°$$

$$\theta = -\,5{,}13°$$

MENCARI SUMBU UTAMA

SKALA 1 : 10