BAB IV

ANALISIS

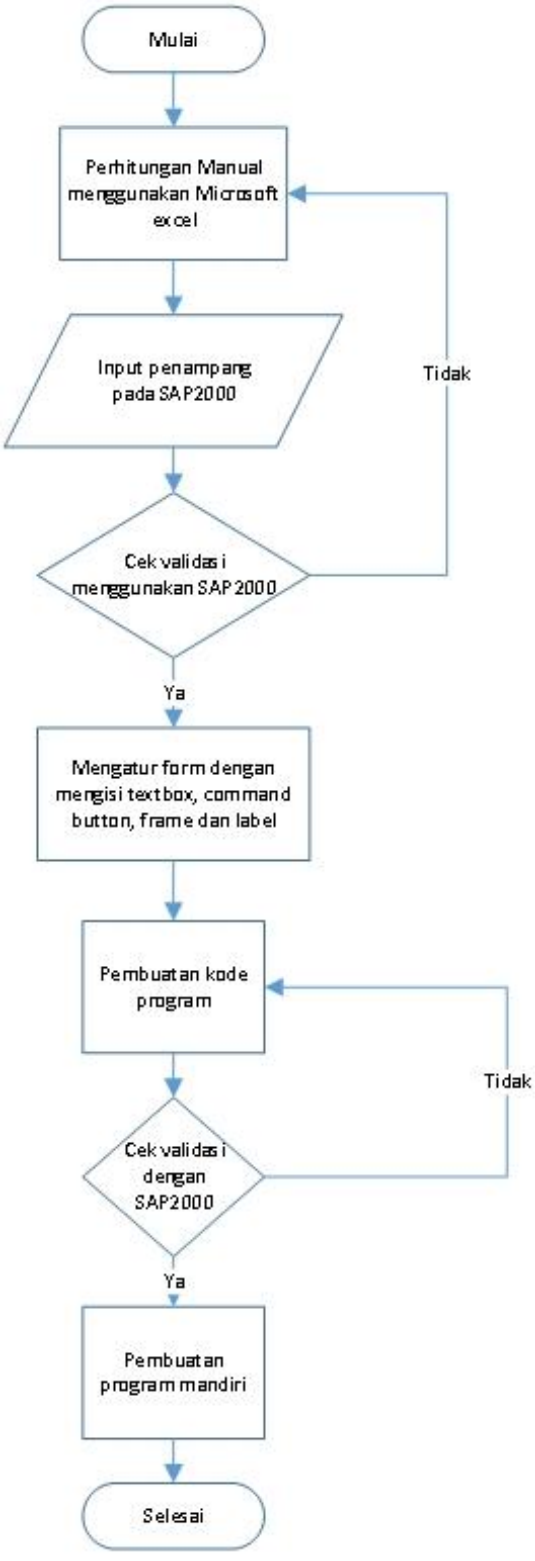
4.1 Studi Kasus

Untuk membuktikan bahwa program ini berjalan dengan semestinya maka dilakukan perhitungan secara manual dan dengan menggunakan program.

Dalam menganalisis perhitungan momen inersia (Ix), penulis melakukan perhitungan manual dengan menggunakan Microsoft excel lalu menginput data dimensi penampang pada program SAP2000 untuk dilakukan proses validasi Hal ini dilakukan agar perhitungan yang dilakukan dengan menggunakan program memiliki hasil yang akurat dan sesuai dengan hitungan manual.

4.2 Diagram Alir Pembuatan Program

Diagram alir ini berfungsi untuk menunjukan bagai mana program dianalisis manual terlebih dahulu sebelum nantinya divalidasi oleh SAP2000 lalu pemasukan kode pemrograman pada visual basic dan pembuatan program mandiri. Berikut merupakan diagram alir pembuatan program:



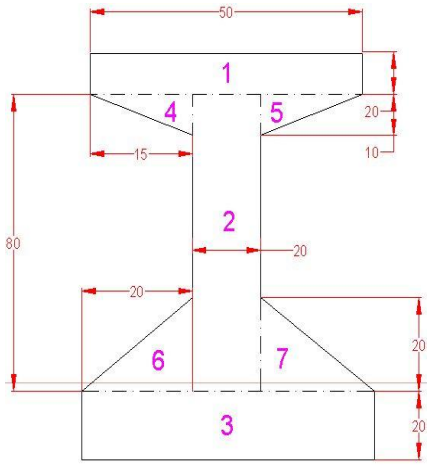
Gambar 4-1 Diagram Alir Pembuatan Program
(Sumber: Dokumentasi Pribadi)

4.3 Perhitungan Manual

Perhitungan manual dilakukan dengan Microsoft excel dengan metode tabel agar memudahkan dalam proses analisis

4.3.1 Momen Inersia PCI Girder

Diketahui besaran dimensi penampang PCI Girder adalah sebagai berikut:



Gambar 4-2 Dimensi PCI Girder
(Sumber: Dokumentasi Pribadi)

Dari gambar di atas dapat digunakan sebagai data masukan manual antara lain sebagai berikut:

1. Tinggi penampang : 120 cm
2. Tinggi segmen 1 : 20 cm
3. Lebar segmen 1 : 50 cm
4. Tinggi segmen 2 : 80 cm
5. Lebar segmen 2 : 20 cm
6. Tinggi segmen 3 : 20 cm
7. Lebar segmen 3 : 60 cm
8. Tinggi segmen 4 : 10 cm
9. Lebar segmen 4 : 15 cm
10. Tinggi segmen 5 : 10 cm
11. Lebar segmen 5 : 15 cm
12. Tinggi segmen 6 : 20 cm
13. Lebar segmen 6 : 20 cm
14. Tinggi segmen 7 : 20 cm

15. Lebar segmen 7 : 20 cm

A. Perhitungan Ix PCI Girder

Tabel 4-1 Perhitungan Momen Inersia (Ix) PCI Girder

		IX						
input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000	110	110000	54.09961686	2926769	33333.33333
20	80	2	1600	60	96000	4.099616858	26890.97	853333.3333
60	20	3	1200	10	12000	-45.90038314	2528214	40000
15	10	4	75	96.66667	7250	40.76628352	124641.7	416.6666667
15	10	5	75	96.66667	7250	40.76628352	124641.7	416.6666667
20	20	6	200	26.66667	5333.333	-29.23371648	170922	4444.444444
20	20	7	200	26.66667	5333.333	-29.23371648	170922	4444.444444
		Σ	4350		243166.7		6073001	936388.9
		Y	55.90038314					
		Ixx	7009390.2					

(Sumber: Data Pribadi)

- Y $= \Sigma A_i Y_i : \Sigma A_i$

  =55.9003831

- Segmen 1

  A_i = b x h

  A_i = 50 x 20 = 1000

  Y_i = h_{tot} – 0.5 x h

  Y_i = 120 – 0.5 x 20

  = 110

  A_iY_i = A_i x Y_i

  A_iY_i = 1000 x 110

  A_iY_i = 110000

  dy_i = Y_i – Y

  dyi = 110 – 55.90038314

$dyi = 54.09961686$

$A_i dy_i^2 = A_i \times dy_i^2$

$A_i dy_i^2 = 1000 \times 54.099^2$

$A_i dy_i^2 = 2926769$

$I_x = (b \times h^3) / 12$

$I_x = (50 \times 20^3) / 12$

$I_x = 33333.333$

- Segmen 2

$A_i = b \times h$

$A_i = 20 \times 80 = 1600$

$Y_i = h_{tot} + 0.5 \times h$

$Y_i = 120 + 0.5 \times 80$

$= 60$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 1600 \times 60$

$A_i Y_i = 96000$

$dy_i = Y_i - Y$

$dyi = 60 - 55.90038314$

$dyi = 4.099$

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 1600 \times 4.099^2$

$A_i dy_i^2 = 26890.97$

$I_x = (b \times h^3) / 12$

$I_x = (20 \times 80^3) / 12$

I_x = 853333.33

- Segmen 3

A_i = b x h

A_i = 50 x 20

A_i = 1200

Y_i = 0.5 x h

Y_i = 0.5 x 20

Y_i = 10

A_iY_i = Ai x Y_i

A_iY_i = 1200 x 10

A_iY_i = 12000

dy_i = Y_i – Y

dyi = 10 – 55.90038314

dyi = - 45.900

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 1200 x $(- 45.900)^2$

$A_idy_i^2$ = 2528214.207

I_x = $(b \times h^3) / 12$

I_x = $(60 \times 20^3) / 12$

I_x = 40000

- Segmen 4

A_i = b x h

A_i = ½ x 15 x 10

A_i = 75

$Y_i = h_{tot} – h_{segmen1} – 1/3\ h$

$Y_i = 120 – 20 – 1/3 \times 10$

$Y_i = 96.6667$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 75 \times 96.6667$

$A_iY_i = 7250$

$dy_i = Y_i – Y$

$dyi = 96.6667 – 55.90038314$

$dyi = 40.76628352$

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 75 \times 40.76628352^2$

$A_i dy_i^2 = 124641.7404$

$I_x = (b \times h^3) / 36$

$I_x = (15x\ 10^3) / 36$

$I_x = 416.6666667$

- Segmen 5

$A_i = b \times h$

$A_i = ½ \times 15 \times 10$

$A_i = 75$

$Y_i = h_{tot} – h_{segmen1} – 1/3\ h$

$Y_i = 120 – 20 – 1/3 \times 10$

$Y_i = 96.6667$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 75 \times 96.6667$

A_iY_i = 7250

dy_i = Y_i – Y

dyi = 96.6667 – 55.90038314

dyi = 40.76628352

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 75 x 40.76628352^2

$A_idy_i^2$ = 124641.7404

I_x = (b x h^3) / 36

I_x = (15x 10^3) / 36

I_x = 416.6666667

- Segmen 6

A_i = b x h

A_i = ½ x 20 x 20

A_i = 200

Y_i = $h_{segmen3}$ + (1/3 x h)

Y_i = 20 + (1/3 x 20)

Y_i = 26.6667

A_iY_i = Ai x Y_i

A_iY_i = 200 x 26.6667

A_iY_i = 5333.33

dy_i = Y_i – Y

dyi = 26.6667 – 55.90038314

dyi = - 29.233

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 200 \times (-29.233^2)$

$A_i dy_i^2 = 170922$

$I_x = (b \times h^3) / 36$

$I_x = (20 \times 20^3) / 36$

$I_x = 4444.444$

- Segmen 7

$A_i = b \times h$

$A_i = ½ \times 20 \times 20$

$A_i = 200$

$Y_i = h_{segmen3} + (1/3 \times h)$

$Y_i = 20 + (1/3 \times 20)$

$Y_i = 26.6667$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 200 \times 26.6667$

$A_i Y_i = 5333.33$

$dy_i = Y_i - Y$

dyi = 26.6667 – 55.90038314

dyi = - 29.233

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 200 \times (-29.233^2)$

$A_i dy_i^2 = 170922$

$I_x = (b \times h^3) / 36$

$I_x = (20 \times 20^3) / 36$

$I_x = 4444.444$

- Momen Inersia (Ixx)

$I_{xx} = \Sigma I_x + \Sigma A_i dy_i^2$

= 7009390

B. Perhitungan Iy PCI Girder

Tabel 4-2 Perhitungan Momen Inersia (Iy) PCI Girder

input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000	30	30000	0	0	208333.3333
20	80	2	1600	30	48000	0	0	53333.33333
60	20	3	1200	30	36000	0	0	360000
15	10	4	75	15	1125	-15	16875	937.5
15	10	5	75	45	3375	15	16875	937.5
20	20	6	200	13.33333	2666.667	-16.66666667	55555.56	4444.444444
20	20	7	200	46.66667	9333.333	16.66666667	55555.56	4444.444444
		Σ	4350		130500		144861.1	632430.6
		Y	30					
		Ixy	777291.7					

(Sumber: Data Pribadi)

- $Y = \Sigma A_i Y_i : \Sigma A_i$

  $= 30$

- Segmen 1

  $A_i = b \times h$

  $A_i = 50 \times 20 = 1000$

  $Y_i = b_{segmen6} + 0.5 \times b_{segmen2}$

  $Y_i = 20 - 0.5 \times 20$

  $= 30$

  $A_i Y_i = A_i \times Y_i$

  $A_i Y_i = 1000 \times 30$

  $A_i Y_i = 30000$

$dy_i = Y_i - Y$

dyi = 30 – 30

dyi = 30

$A_i dy_i^2 = A_i \times dy_i^2$

$A_i dy_i^2 = 1000 \times 0^2$

$A_i dy_i^2 = 0$

$I_x = (b^3 \times h) / 12$

$I_x = (50 \times 20^3) / 12$

$I_x = 208333.3333$

- Segmen 2

$A_i = b \times h$

$A_i = 20 \times 80 = 1600$

$Y_i = b_{tot} + 0.5$

$Y_i = 60 + 0.5$

$= 30$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 1600 \times 30$

$A_i Y_i = 48000$

$dy_i = Y_i - Y$

dyi = 30 – 30

dyi = 0

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 1600 \times 0^2$

$A_i dy_i^2 = 0$

$I_x = (b^3 \times h) / 12$

$I_x = (20^3 \times 80) / 12$

$I_x = 53333.33333$

- Segmen 3

$A_i = b \times h$

$A_i = 50 \times 20$

$A_i = 1200$

$Y_i = 0.5 \times b_{total}$

$Y_i = 0.5 \times 60$

$Y_i = 30$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 1200 \times 30$

$A_iY_i = 36000$

$dy_i = Y_i - Y$

$dyi = 30 - 30$

$dyi = 0$

$A_idy_i^2 = Ai \times dy_i^2$

$A_idy_i^2 = 1200 \times 0^2$

$A_idy_i^2 = 0$

$I_x = (b^3 \times h) / 12$

$I_x = (60^3 \times 20) / 12$

$I_x = 360000$

- Segmen 4

A_i = b x h

A_i = ½ x 15 x 10

A_i = 75

Y_i = ½ x $b_{segmen3}$ – ½ x $b_{segmen2}$ – (1/3 x b)

Y_i = ½ x 60 – ½ x 20 – (1/3 x 15)

Y_i = 15

A_iY_i = Ai x Y_i

A_iY_i = 75 x15

A_iY_i = 1125

dy_i = Y_i – Y

dyi = 15 – 30

dyi = - 15

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 75 x $(-15)^2$

$A_idy_i^2$ = 16875

I_x = $(b^3$ x h) / 36

I_x = $(15^3$x 10) / 36

I_x = 937.5

- Segmen 5

A_i = b x h

A_i = ½ x 15 x 10

A_i = 75

Y_i = ½ x b_{total} + ½ x $b_{segmen2}$ + 1/3 x b

Y_i = ½ x 60 + ½ x 20 + 1/3 x 15

Y_i = 45

A_iY_i = Ai x Y_i

A_iY_i = 75 x 45

A_iY_i = 3375

dy_i = Y_i – Y

dyi = 45 – 30

dyi = 15

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 75 x 15^2

$A_idy_i^2$ = 16875

I_x = (b^3 x h) / 36

I_x = (15^3x 10) / 36

I_x = 937.5

- Segmen 6

A_i = b x h

A_i = ½ x 20 x 20

A_i = 200

Y_i = b - (1/3 x b)

Y_i = 20 - (1/3 x 20)

Y_i = 13.3333

A_iY_i = Ai x Y_i

A_iY_i = 200 x 13.3333

A_iY_i = 2666.67

$dy_i = Y_i - Y$

dyi = 13.3333 – 30

dyi = - 16.67

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 200 \times (-16.67^2)$

$A_i dy_i^2 = 55555.6$

$I_x = (b^3 \times h) / 36$

$I_x = (20^3 \times 20) / 36$

$I_x = 4444.444$

- Segmen 7

$A_i = b \times h$

$A_i = ½ \times 20 \times 20$

$A_i = 200$

$Y_i = ½ \times b_{total} + ½ \times b_{segmen2} + 1/3 \times b$

$Y_i = ½ \times 60 + ½ \times 20 + 1/3 \times 20$

$Y_i = 46.6667$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 200 \times 46.6667.$

$A_i Y_i = 9333.33$

$dy_i = Y_i - Y$

dyi = 46.6667 – 30

dyi = 16.67

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 200 \times 16.67^2$

$A_i dy_i^2 = 55555.6$

I_x = (b^3 x h) / 36

I_x = (20 x 20) / 36

I_x = 4444.444

- Momen Inersia (Ixx)

$I_{xx} = \Sigma I_x + \Sigma A_i dy_i^2$

= 777291.7 cm^4

4.3.2 Perhitungan Modulus Penampang PCI Girder

Sebagai ilustrasi, tinjau penampang sayap berentuk PCI girder dengan lebar b dan tinggi h. dengan modulus penampang untuk sumbu x (Sx) adalah

Sx = 0.21 x Ah

Sx = 0.21 x 4350 x 120

Sx = 109620 cm^3

Sementara untuk modulus penampang sumbu (Sy) adalah

Sy = 0.001654516 x Ab

Sy = 0.001654516 x 4350 x 60

Sy = 25909.721 cm^3

4.3.3 Perhitungan Modulus Elastisitas PCI Girder

Kuantitas E, yaitu rasio unit tegangan terhadap unit regangan, adalah modulus elastisitas bahan. Dimisalkan fc atau mutu beton adalah 20 adapun perhitungan untuk modulus elastisitas adalah

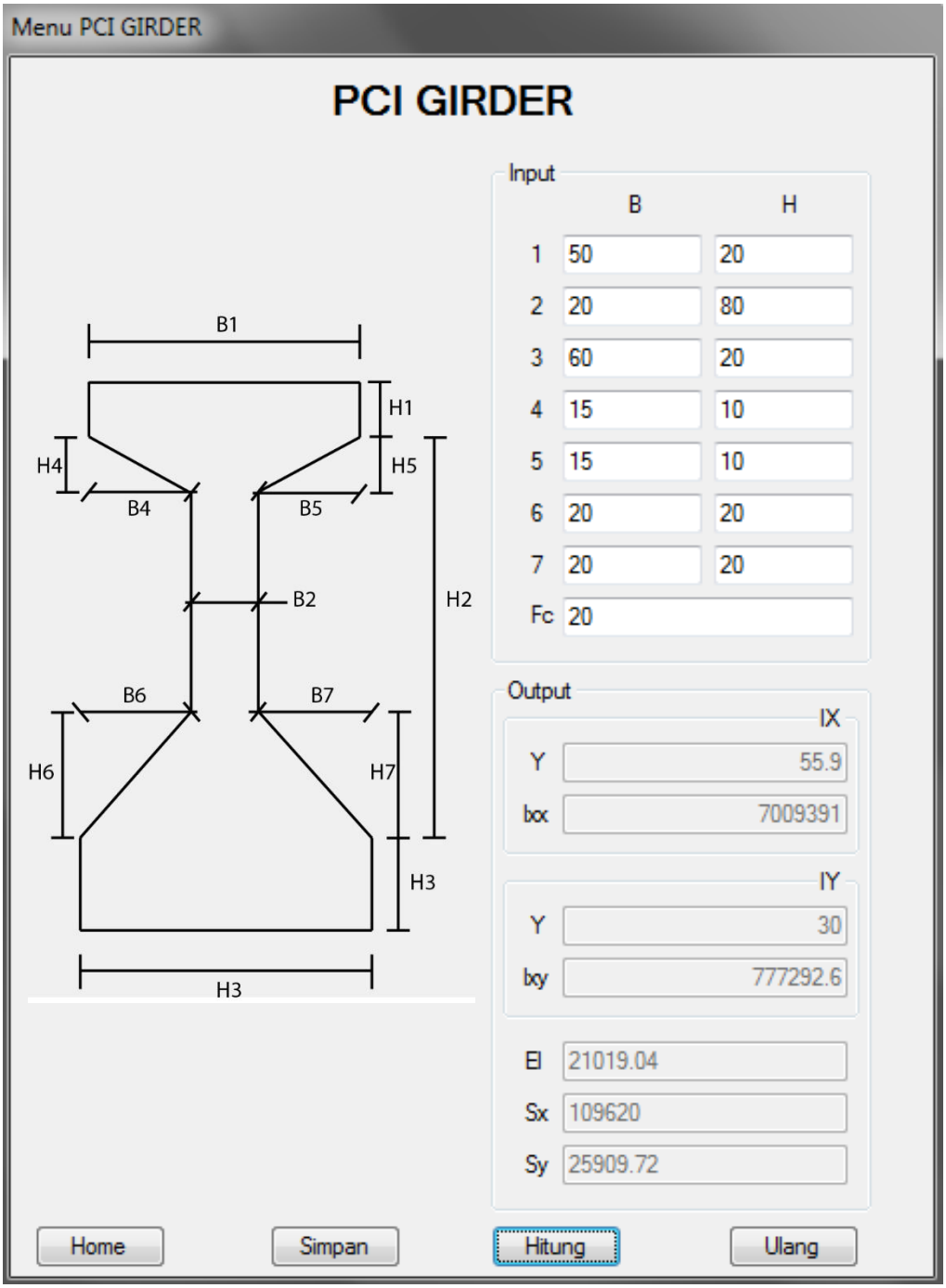
E = 4700 $\sqrt{fc}$

E = 4700 $\sqrt{20}$

E = 21019.03899

4.3.4 Hasil Perhitungan Program Visual Basic PCI Girder

Setelah dilakukan perhitungan manual untuk penampang PCI girder, maka dicocokan dengan perhitungan dengan menggunakan program dari visual basic yang sudah jadi. Adapun hasilnya adalah sebagai berikut

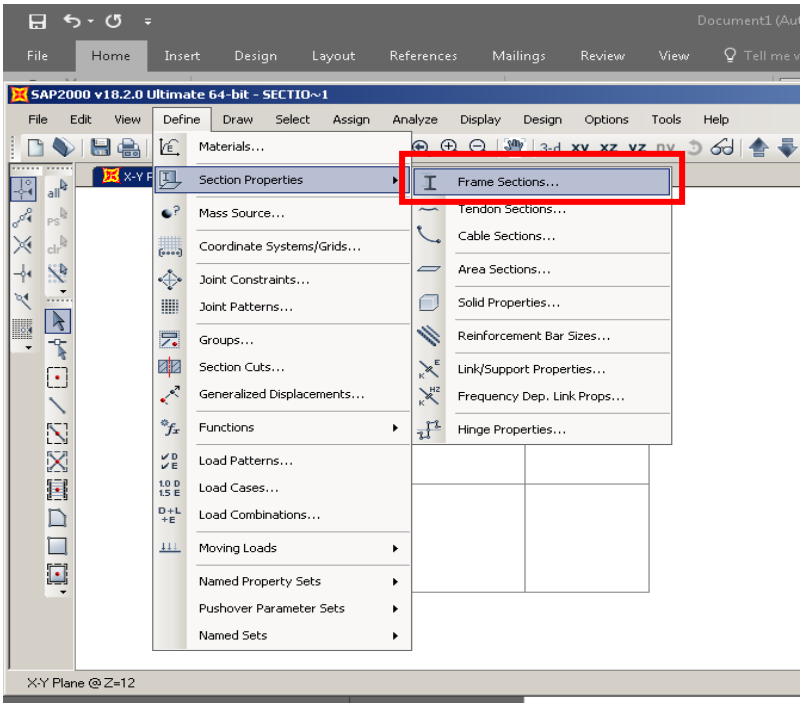


Gambar 4-3 Hasil Perhitungan PCI Girder Visual Basic
(Sumber: Dokumentasi Pribadi)

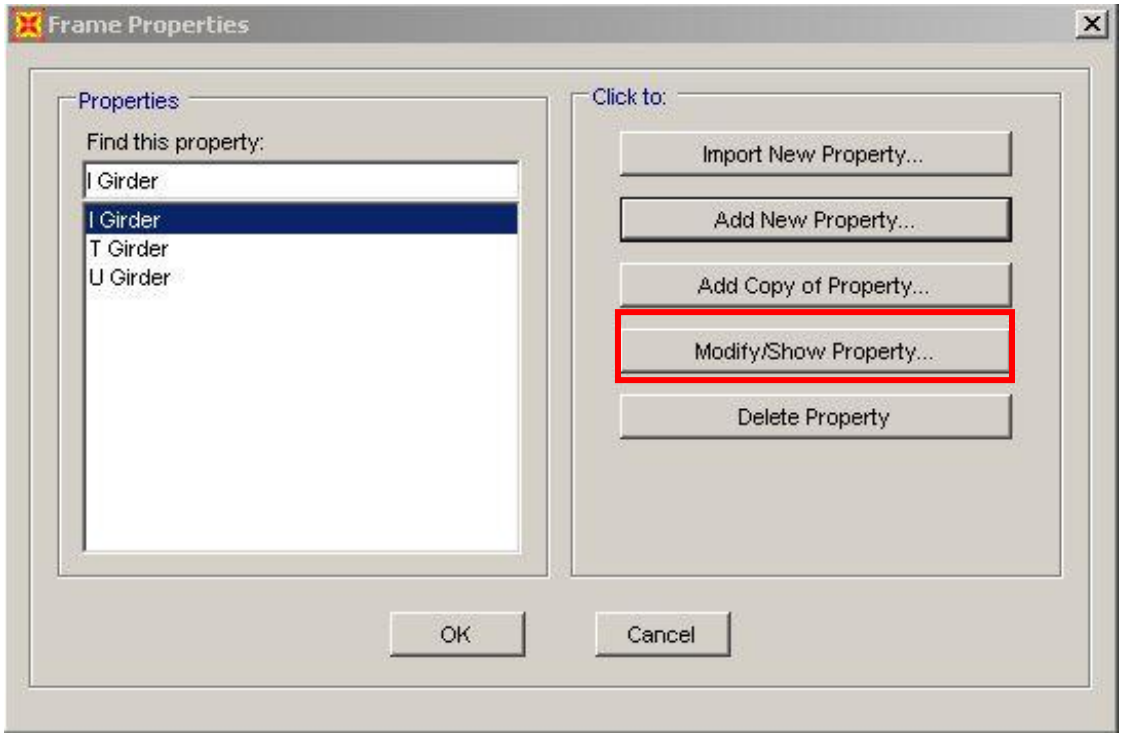
4.3.5 Validasi Penampang PCI Girder Menggunakan SAP2000

Setelah dilakukan analisis hitungan untuk penampang PCI girder secara manual maka dilanjutkan dengan melakuka proses validasi menggunakan SAP2000 dengan mengklik define - section properties - frame section, setelah itu lalu tambahkan penampang atau modify jika sudah tersedia. Isi dimensi penampang pada SAP2000

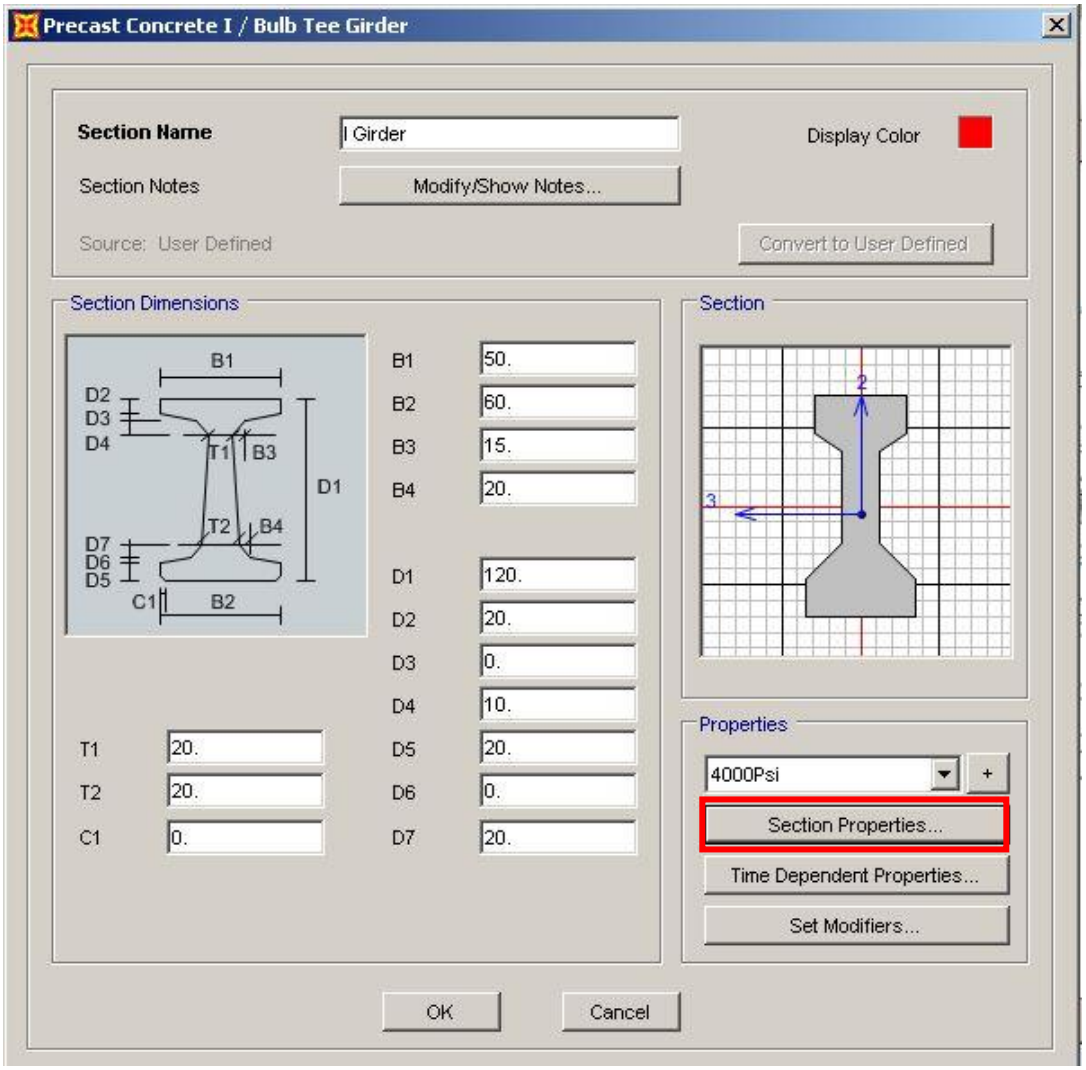
sesuai dengan penampang kita lalu klik tombol section properties untuk pengecekan apakah hitungan manual sudah sesuai atau belum, dengan tampilan sebagai berikut:



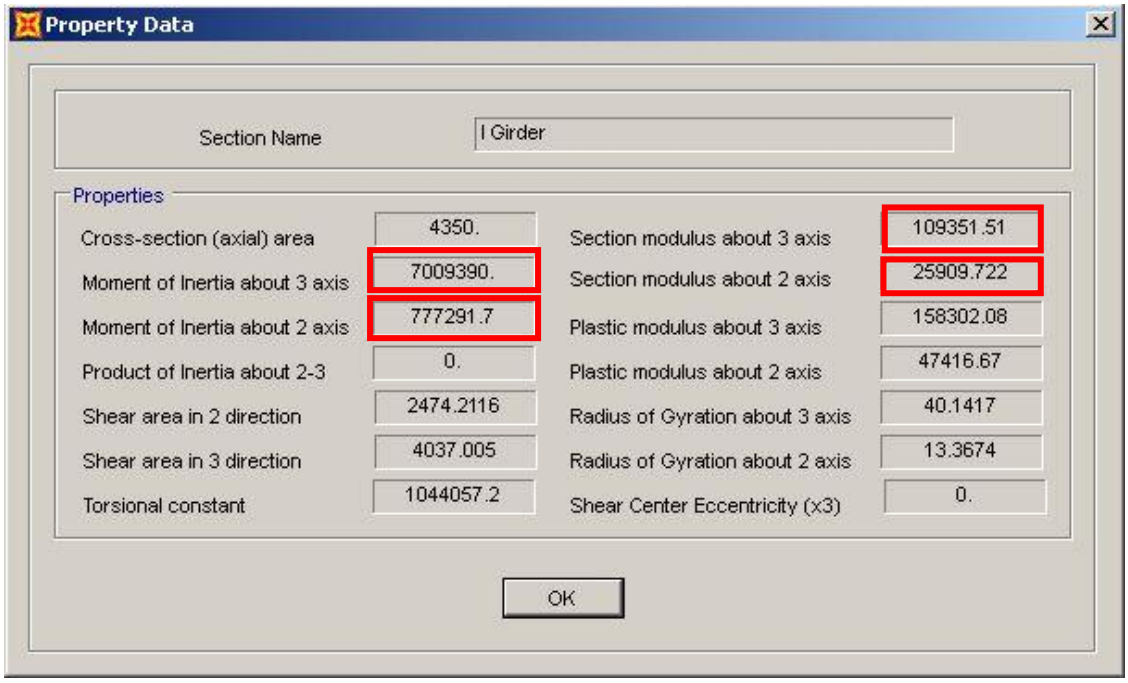
Gambar 4-4 Proses Validasi SAP2000
(Sumber: Dokumentasi Pribadi)



Gambar 4-5 Frame Properties PCI Girder SAP2000
(Sumber: Dokumentasi Pribadi)



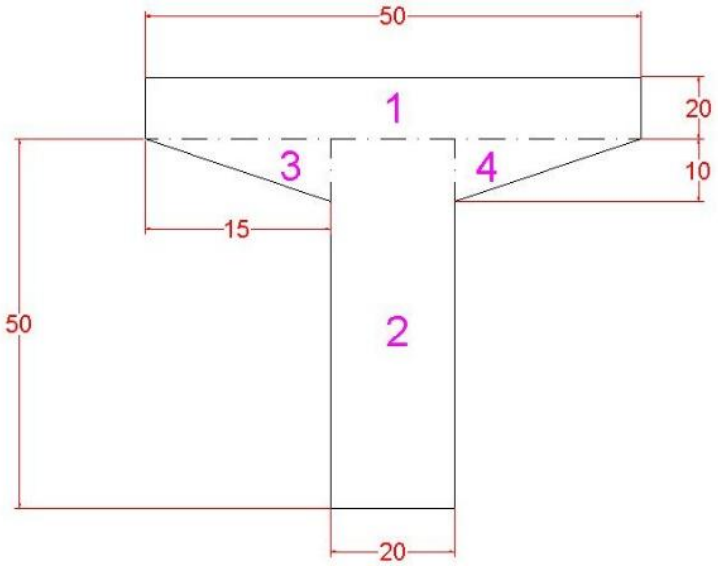
Gambar 4-6 Pengisian Dimensi Penampang PCI Girder
(Sumber: Dokumentasi Pribadi)



Gambar 4-7 Property Data PCI Girder
(Sumber: Dokumentasi Pribadi)

4.3.6 Momen Inersia T Girder

Diketahui besaran dimensi penampang T Girder adalah sebagai berikut:



Gambar 4-8 Dimensi PCI Girder
(Sumber: Dokumentasi Pribadi)

Dari gambar di atas dapat digunakan sebagai data masukan manual antara lain sebagai berikut:

1. Tinggi penampang : 70 cm

2. Tinggi segmen 1 : 20 cm
3. Lebar segmen 1 : 40 cm
4. Tinggi segmen 2 : 50 cm
5. Lebar segmen 2 : 20 cm
6. Tinggi segmen 3 : 10 cm
7. Lebar segmen 3 : 15 cm
8. Tinggi segmen 4 : 10 cm
9. Lebar segmen 4 : 15 cm

A. Perhitungan Ix T Girder

Tabel 4-3 Tabel Perhitungan Momen Inersia (Ix) T Girder

Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000.00	60.00	60000.00	17.21	296160.09	33333.33
20	50	2	1000.00	25.00	25000.00	-17.79	316508.92	208333.33
15	10	3	75	46.66667	3500	3.875968992	1126.735172	416.6666667
15	10	4	75	46.66667	3500	3.875968992	1126.735172	416.6666667
		Σ	2150		92000.00		614922.48	242500.00
		Y	42.7907					
		Ixx	857422.5					

Sumber: (Data Penulis)

- Y $= \Sigma A_i Y_i : \Sigma A_i$

  $= 41.02564103$

- Segmen 1

  $A_i = b \times h$

  $A_i = 50 \times 20$

  $A_i = = 1000$

  $Y_i = h_{tot} - 0.5 \times h$

  $Y_i = 70 - 0.5 \times 20$

  $= 60$

$A_iY_i = A_i \times Y_i$

$A_iY_i = 800 \times 60$

$A_iY_i = 48000$

$dy_i = Y_i - Y$

$dyi = 60 - 41.02564103$

$dyi = 18.97$

$A_i dy_i^2 = A_i \times dy_i^2$

$A_i dy_i^2 = 800 \times 18.97^2$

$A_i dy_i^2 = 288021.04$

$I_x = (b \times h^3) / 12$

$I_x = (40 \times 20^3) / 12$

$I_x = 26666.67$

- Segmen 2

$A_i = b \times h$

$A_i = 20 \times 50$

$A_i = 1000$

$Y_i = 0.5 \times h$

$Y_i = 0.5 \times 50$

$= 25$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 1000 \times 25$

$A_iY_i = 25000$

$dy_i = Y_i - Y$

$dyi = 25 - 41.02564103$

$dyi = -16.03$

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 1000 \times (-16.03)^2$

$A_i dy_i^2 = 256821.17$

$I_x = (b \times h^3) / 12$

$I_x = (20 \times 50^3) / 12$

$I_x = 208333.33$

- Segmen 3

$A_i = b \times h$

$A_i = 15 \times 10$

$A_i = 75$

$Y_i = h_{segmen2} - 1/3 \times h$

$Y_i = 50 - 1/3 \times 10$

$Y_i = 46.66666667$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 75 \times 46.66666667$

$A_i Y_i = 3500$

$dy_i = Y_i - Y$

dyi = 46.66666667 – 41.02564103

dyi = 5.641025641

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 75 \times 5.641025641^2$

$A_i dy_i^2 = 2386.587771$

$I_x = (b \times h^3) / 36$

$I_x = (15 \times 10^3) / 36$

I_x = 416.6666667

- Segmen 4

A_i = b x h

A_i = 15 x 10

A_i = 75

Y_i = $h_{segmen2}$ – 1/3 x h

Y_i = 50 – 1/3 x 10

Y_i = 46.66666667

A_iY_i = Ai x Y_i

A_iY_i = 75 x 46.66666667

A_iY_i = 3500

dy_i = Y_i – Y

dyi = 46.66666667 – 41.02564103

dyi = 5.641025641

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 75 x 5.641025641^2

$A_idy_i^2$ = 2386.587771

I_x = (b x h^3) / 36

I_x = (15 x 10^3) / 36

I_x = 416.6666667

- Momen Inersia (Ixx)

Ixx = ΣIx + Σ $A_idy_i^2$

Ixx = 857422.5 cm^4

B. Perhitungan Iy T Girder

Tabel 4-4 Tabel Perhitungan Momen Inersia (Iy) T Girder

Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000.00	25.00	25000.00	0.00	0.00	208333.33
20	50	2	1000.00	25.00	25000.00	0.00	0.00	33333.33
15	10	3	75	10	750	-15.00	16875	937.5
15	10	4	75	40	3000	15.00	16875	937.5
		Σ	2150		53750.00		33750.00	243541.67
		Y	25					
		Ixx	277291.7					

Sumber: (Data Penulis)

- $Y = \Sigma A_i Y_i : \Sigma A_i$

  $= 25$

- Segmen 1

  $A_i = b \times h$

  $A_i = 50 \times 20$

  $A_i = 1000$

  $Y_i = 0.5 \times b$

  $Y_i = 0.5 \times 50$

  $= 25$

  $A_i Y_i = A_i \times Y_i$

  $A_i Y_i = 1000 \times 25$

  $A_i Y_i = 25000$

  $dy_i = Y_i - Y$

  $dyi = 25 - 25$

  $dyi = 0$

  $A_i dy_i^2 = A_i \times dy_i^2$

  $A_i dy_i^2 = 1000 \times 0^2$

  $A_i dy_i^2 = 0$

$I_x = (b^3 \times h) / 12$

$I_x = (40^3 \times 20) / 12$

$I_x = 208333.33$

- Segmen 2

$A_i = b \times h$

$A_i = 20 \times 50$

$A_i = 1000$

$Y_i = b_{segmen3} + 0.5 \times b$

$Y_i = 15 + 0.5 \times 20$

$= 25$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 1000 \times 25$

$A_iY_i = 25000$

$dy_i = Y_i - Y$

$dyi = 25 - 25$

$dyi = 0$

$A_idy_i^2 = Ai \times dy_i^2$

$A_idy_i^2 = 1000 \times 0^2$

$A_idy_i^2 = 0$

$I_x = (b^3 \times h) / 12$

$I_x = (20^3 \times 50) / 12$

$I_x = 33333.33$

- Segmen 3

$A_i = b \times h$

A_i = 15 x 10

A_i = 75

Y_i = b – 1/3 x b

Y_i = 15 – 1/3 x 15

Y_i = 10

A_iY_i = Ai x Y_i

A_iY_i = 75 x 10

A_iY_i = 750

dy_i = Y_i – Y

dyi = 10 – 25

dyi = -15

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 75 x $(- 15)^2$

$A_idy_i^2$ = 16875

I_x = $(b^3$ x h) / 36

I_x = $(15^3$ x 10) / 36

I_x = 937.5

- Segmen 4

A_i = b x h

A_i = 15 x 10

A_i = 75

Y_i = $b_{segmen3}$ + $b_{segmen2}$ + 1/3 x b

Y_i = 15 + 20 + 1/3 x 15

Y_i = 40

A_iY_i = Ai x Y_i

A_iY_i = 75 x 40

A_iY_i = 3000

dy_i = Y_i – Y

dyi = 40 – 25

dyi = 15

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 75 x 15^2

$A_idy_i^2$ = 16875

I_x = (b^3 x h) / 36

I_x = (15^3 x 10) / 36

I_x = 937.5

- Momen Inersia (Ixx)

Ixx = ΣIx + Σ $A_idy_i^2$

Ixx = 277291.7 cm^4

4.3.7 Perhitungan Modulus Penampang T Girder

Sebagai ilustrasi, ditinjau penampang sayap berentuk T girder dengan lebar b dan tinggi h. dengan modulus penampang untuk sumbu x (Sx) adalah

Sx = 0.21 x Ah

Sx = 0.21 x 2150 x 70

Sx = 20037.6 cm^3

Sementara untuk modulus penampan sumbu y (sy) adalah

Sy = 0.1031783 x Ab

Sy = 0.1031783 x 2150 x 50

Sy = 11091.7 cm^3

4.3.8 Perhitungan Modulus Elastisitas Penampang T Girder

Dimisalkan fc atau mutu beton adalah 30 adapun perhitungan untuk modulus elastisitas adalah

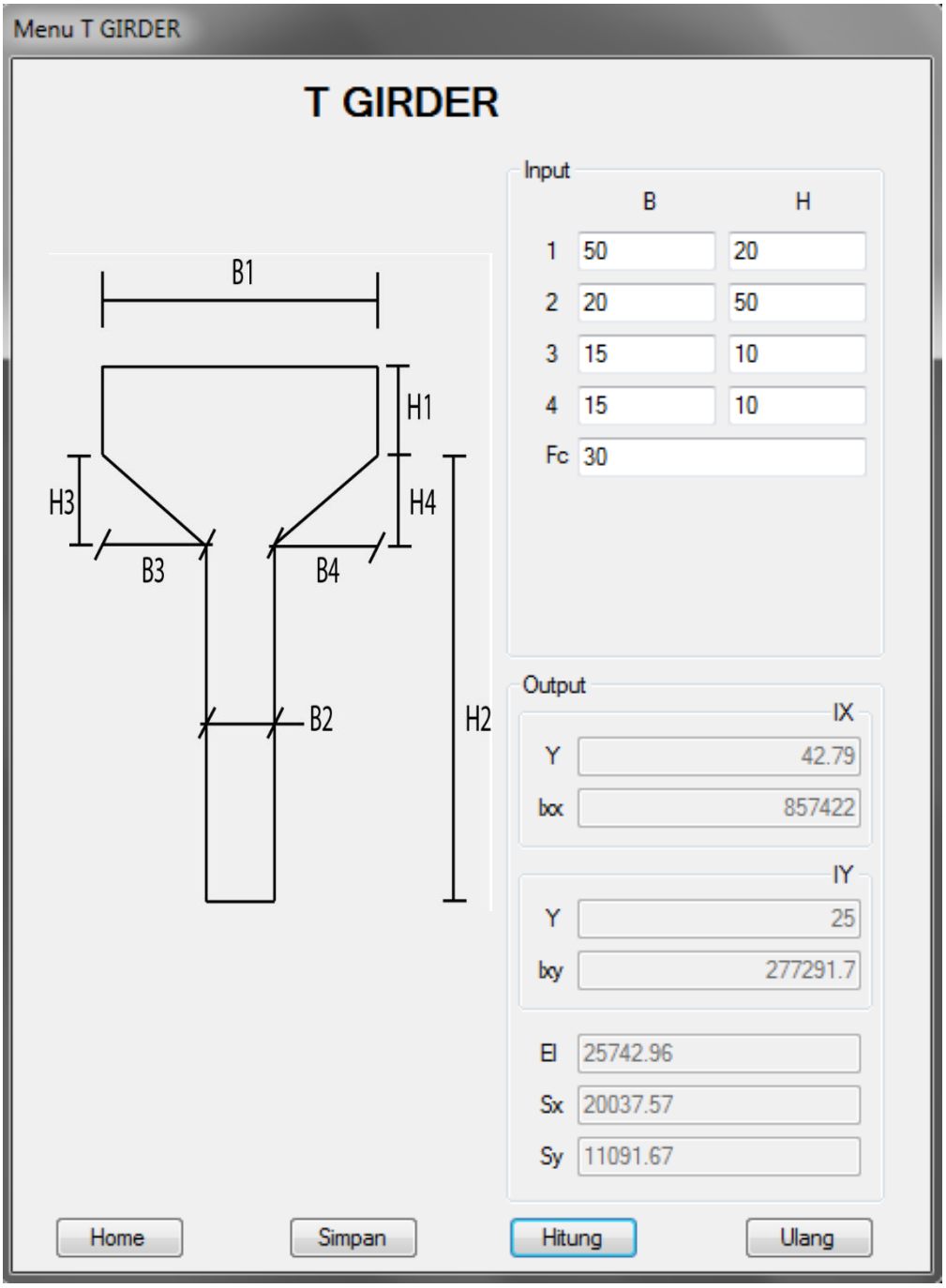
E = 4700 $\sqrt{fc}$

E = 4700 $\sqrt{30}$

E = 25742.9602

4.3.9 Hasil Perhitungan Program Visual Basic Penampang T Girder

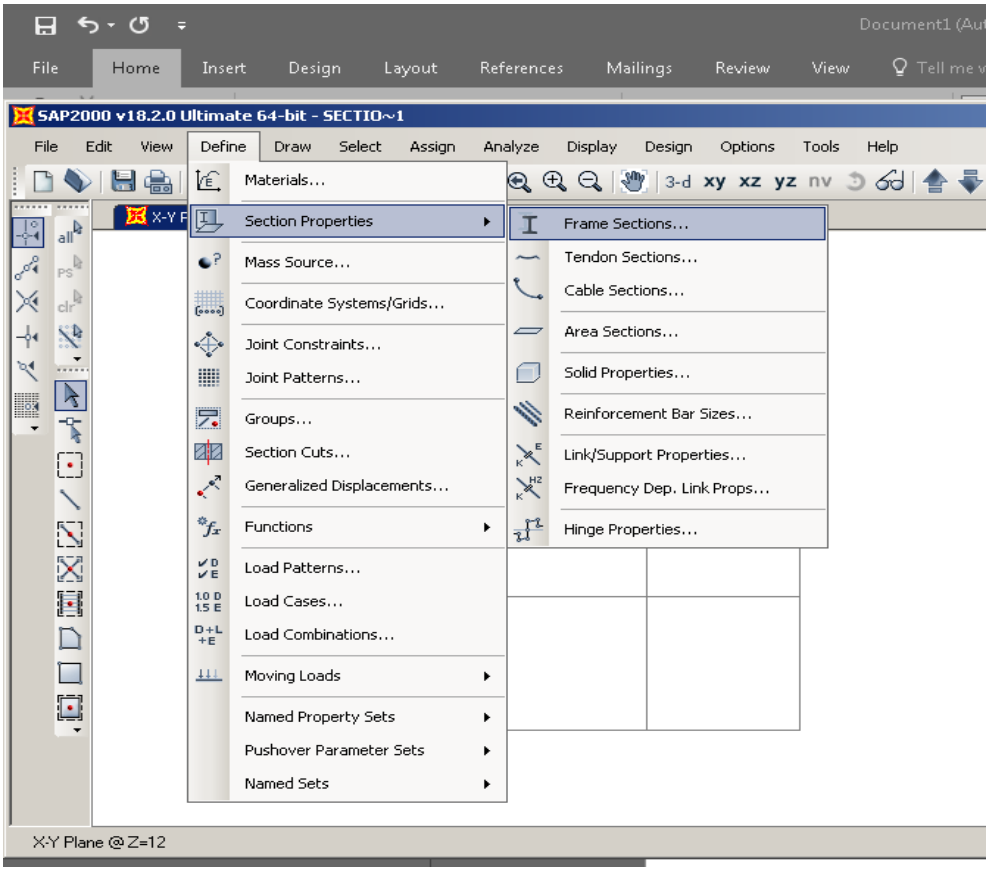
Setelah dilakukan perhitungan manual untuk penampang T girder, maka dicocokan dengan perhitungan dengan menggunakan program dari visual basic yang sudah jadi. Adapun hasilnya adalah sebagai berikut



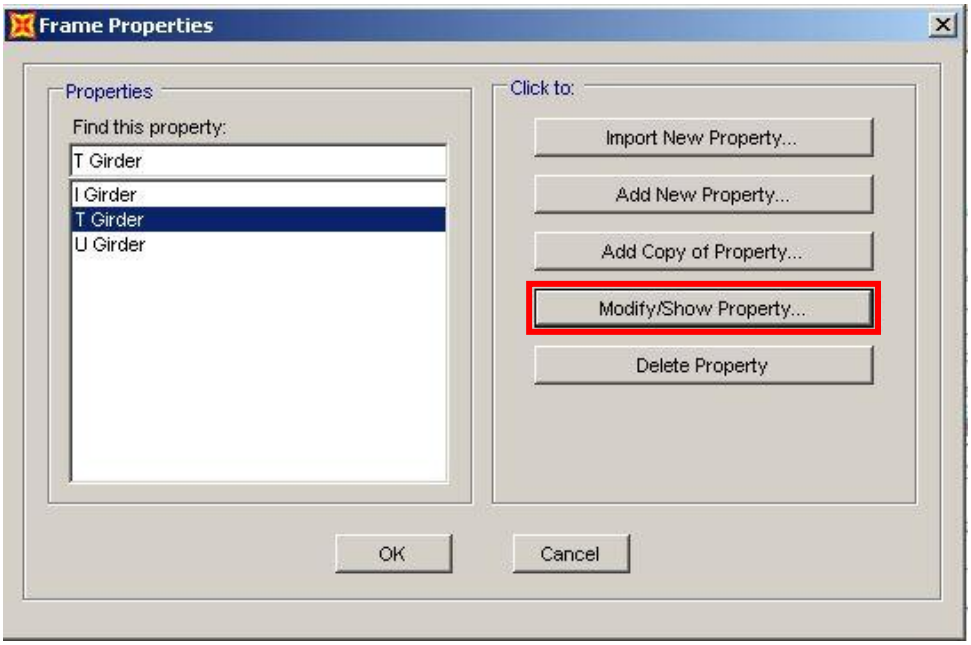
Gambar 4-9 Hasil Perhitungan T Girder Visual Basic
(Sumber: Dokumentasi Pribadi)

4.3.10 Validasi Penampang T Girder Menggunakan SAP2000

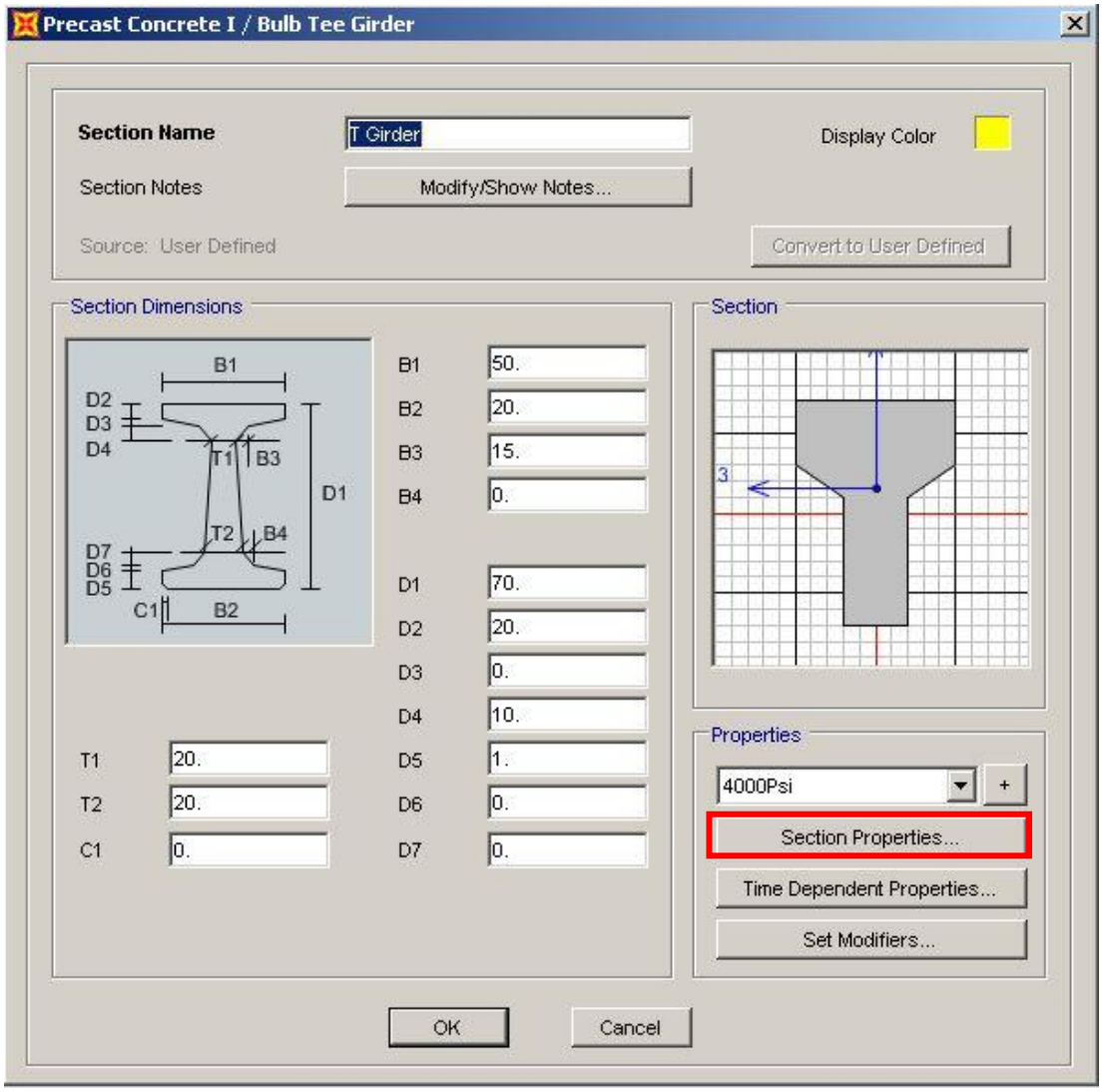
Setelah dilakukan analisis hitungan manual untuk penampang T girder maka dilakukan proses validasi menggunakan SAP2000, dengan tampilan sebagai berikut:



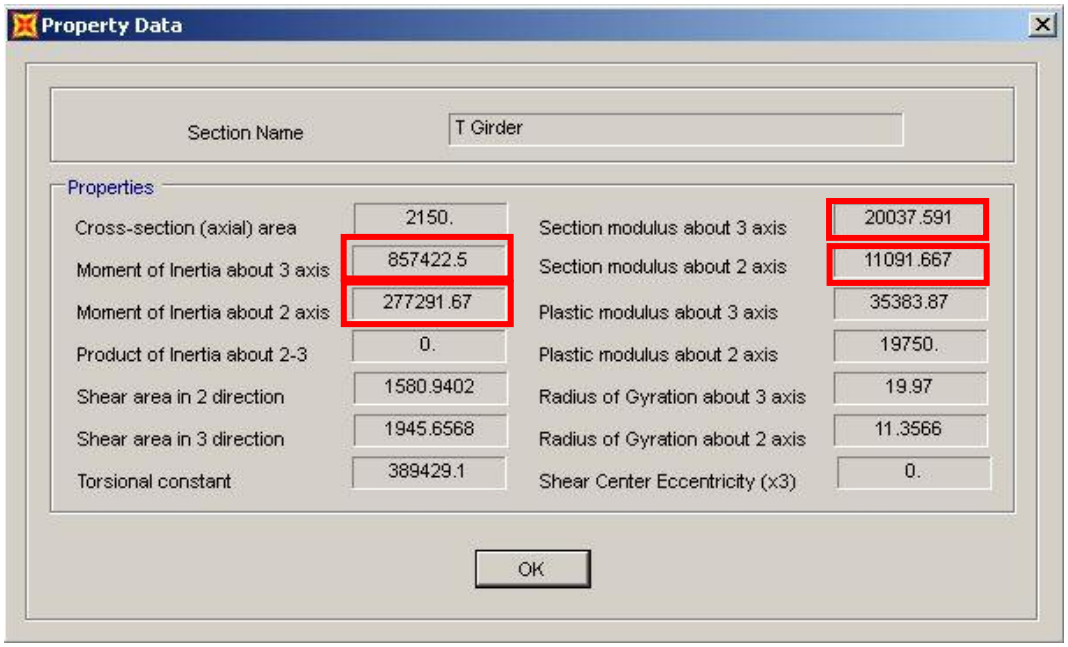
Gambar 4-10 Proses Validasi SAP2000
(Sumber: Dokumentasi Pribadi)



Gambar 4-11 Frame Properties T Girder SAP2000
(Sumber: Dokumentasi Pribadi)



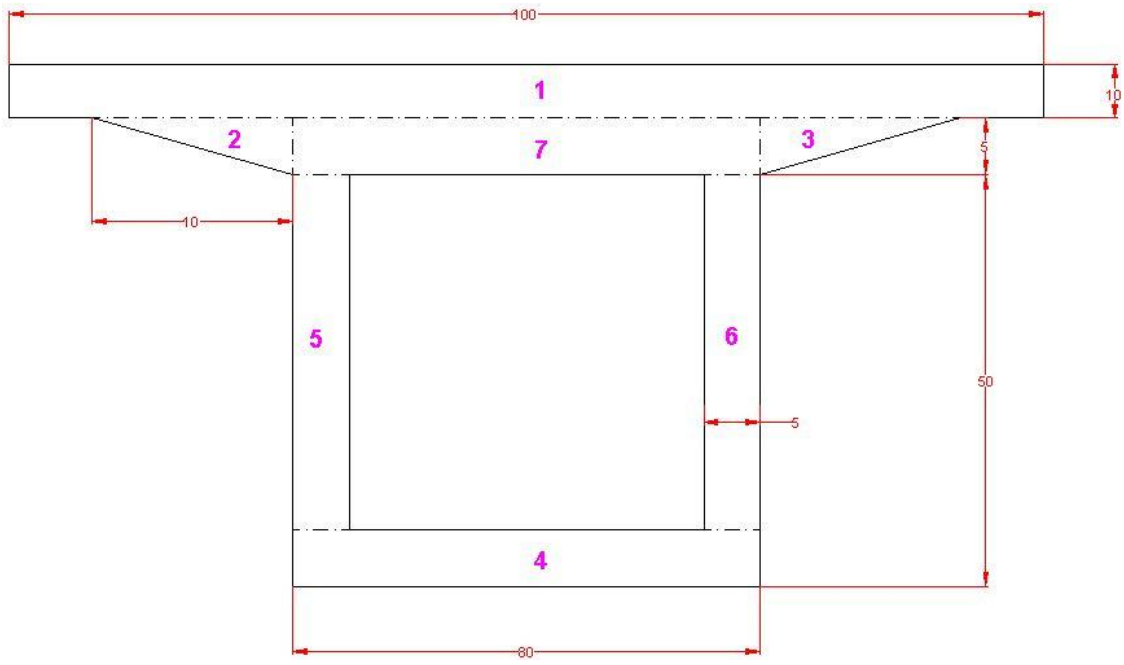
Gambar 4-12 Pengisian Dimensi Penampang T Girder
(Sumber: Dokumentasi Pribadi)



Gambar 4-13 Property Data T Girder
(Sumber: Dokumentasi Pribadi)

4.3.11 Momen Inersia Box Girder

Diketahui besaran dimensi penampang T Girder adalah sebagai berikut:



Gambar 4-14 Dimensi Penampang Box Girder
(Sumber: Dokumentasi Pribadi)

Dari gambar diatas dapat diketahui dimensi masing-masing segmen antara lain:

1. Tinggi penampang : 60 cm

2. Tinggi segmen 1 : 10 cm
3. Lebar segmen 1 : 100 cm
4. Tinggi segmen 2 : 5 cm
5. Lebar segmen 2 : 10 cm
6. Tinggi segmen 3 : 5 cm
7. Lebar segmen 3 : 10 cm
8. Tinggi segmen 4 : 5 cm
9. Lebar segmen 4 : 80 cm
10. Tinggi segmen 5 : 40 cm
11. Lebar segmen 5 : 5 cm
12. Tinggi segmen 6 : 40 cm
13. Lebar segmen 6 : 5 cm
14. Tinggi segmen 7 : 5 cm
15. Lebar segmen 7 : 80 cm

A. Perhitungan Ix Box Girder

Tabel 4-5 Tabel Perhitungan Momen Inersia (Ix) Box Girder

Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
100	10	1	1000	55	55000	16.18518519	261960.2	8333.333333
10	5	2	25	46.666667	1166.667	7.851851852	1541.289	34.72222222
10	5	3	25	46.666667	1166.667	7.851851852	1541.289	34.72222222
80	5	4	400	2.5	1000	-36.31481481	527506.3	833.3333333
5	40	5	200	25	5000	-13.81481481	38169.82	26666.66667
5	40	6	200	25	5000	-13.81481481	38169.82	26666.66667
80	5	7	400	47.5	19000	8.685185185	30172.98	833.3333333
		Σ	2250		87333.33		899061.7	63402.8
		Y	38.814815					
		Ixx	962464.5					

(Sumber: Data Pribadi)

- Y $= \Sigma A_i Y_i : \Sigma A_i$

  $= 38.81481481$

- Segmen 1

A_i = b x h

A_i = 100 x 10 = 1000

Y_i = h_{tot} – 0.5 x h

Y_i = 60 – 0.5 x 10

= 55

A_iY_i = A_i x Y_i

A_iY_i = 1000 x 55

A_iY_i = 55000

dy_i = Y_i – Y

dyi = 55 – 38.81481481

dyi = 16.18

$A_idy_i^2$ = A_i x dy_i^2

$A_idy_i^2$ = 1000 x 16.18^2

$A_idy_i^2$ = 261960.21

I_x = (b x h^3) / 12

I_x = (100 x 10^3) / 12

I_x = 8333.333333

- Segmen 2

A_i = ½ x b x h

A_i = 10 x 5

A_i = 25

Y_i = $h_{segmen4}$ + $h_{segmen4}$ x (1/3 x h)

Y_i = 5 + 40 x (1/3 x 5)

= 46.66666667

A_iY_i = Ai x Y_i

A_iY_i = 25 x 46.66666667

A_iY_i = 1166.666667

dy_i = Y_i – Y

dyi = 46.66666667 – 38.81481481

dyi = 7.851851852

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 25 x 7.851851852^2

$A_idy_i^2$ = 1541.289438

I_x = (b x h^3) / 36

I_x = (10 x 5^3) / 36

I_x = 962464.5

- Segmen 3

A_i = ½ x b x h

A_i = 10 x 5

A_i = 25

Y_i = $h_{segmen4}$ + $h_{segmen4}$ x (1/3 x h)

Y_i = 5 + 40 x (1/3 x 5)

= 46.66666667

A_iY_i = Ai x Y_i

A_iY_i = 25 x 46.66666667

A_iY_i = 1166.666667

dy_i = Y_i – Y

dyi = 46.66666667 – 38.81481481

$dyi = 7.851851852$

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 25 \times 7.851851852^2$

$A_i dy_i^2 = 1541.289438$

$I_x = (b \times h^3) / 36$

$I_x = (10 \times 5^3) / 36$

$I_x = 962464.5$

- Segmen 4

$A_i = b \times h$

$A_i = 80 \times 5$

$A_i = 400$

$Y_i = 0.5 \times h$

$Y_i = 0.5 \times 5$

$Y_i = 2.5$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 400 \times 2.5$

$A_i Y_i = 1000$

$dy_i = Y_i - Y$

$dyi = 2.5 - 38.81$

$dyi = - 36.31$

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 400 \times (- 36.31)^2$

$A_i dy_i^2 = 527506.31$

$I_x = (b \times h^3) / 12$

$I_x = (80 \times 5^3) / 12$

$I_x = 833.33$

- Segmen 5

$A_i = b \times h$

$A_i = 5 \times 40$

$A_i = 200$

$Y_i = h_{segmen4} + (0.5 \times h)$

$Y_i = 5 + (0.5 \times 40)$

$Y_i = 25$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 200 \times 25$

$A_iY_i = 5000$

$dy_i = Y_i - Y$

$dyi = 25 - 38.81481481$

$dyi = - 13.81481481$

$A_idy_i^2 = Ai \times dy_i^2$

$A_idy_i^2 = 200 \times (- 13.81481481)^2$

$A_idy_i^2 = 38169.82167$

$I_x = (b \times h^3) / 12$

$I_x = (5 \times 40^3) / 12$

$I_x = 26666.66667$

- Segmen 6

A_i = b x h

A_i = 5 x 40

A_i = 200

Y_i = $h_{segmen4}$ + (0.5 x h)

Y_i = 5 + (0.5 x 40)

Y_i = 25

A_iY_i = Ai x Y_i

A_iY_i = 200 x 25

A_iY_i = 5000

dy_i = Y_i – Y

dyi = 25 – 38.81481481

dyi = - 13.81481481

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 200 x $(- 13.81481481)^2$

$A_idy_i^2$ = 38169.82167

I_x = $(b \times h^3) / 12$

I_x = $(5 \times 40^3) / 12$

I_x = 26666.66667

- Segmen 7

A_i = b x h

A_i = 80 x 5

A_i = 400

Y_i = h_{tot} – $h_{segmen1}$ - (0.5 x h)

Y_i = 60 – 10 - (0.5 x 5)

Y_i = 47.5

A_iY_i = Ai x Y_i

A_iY_i = 400 x 47.5

A_iY_i = 19000

dy_i = Y_i – Y

dyi = 47.5 – 38.81481481

dyi = 8.68

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 400 x 8.68^2

$A_idy_i^2$ = 30172.98

I_x = (b x h^3) / 12

I_x = (80 x 5^3) / 12

I_x = 833.333

- Momen Inersia (Ixx)

I_{xx} = Σ I_x : Σ $A_idy_i^2$

I_{xx} = 962464.5 cm^4

- Box Girder
- Y = Σ A_iY_i : ΣA_i

= 50

B. Perhitungan Iy Box Girder

Tabel 4-6 Tabel Perhitungan Momen Inersia (Iy) Box Girder

Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
100	10	1	1000	50	50000	0	0	833333.3333
10	5	2	25	6.6666667	166.6667	-43.33333333	46944.44	138.8888889
10	5	3	25	93.333333	2333.333	43.33333333	46944.44	138.8888889
80	5	4	400	50	20000	0	0	213333.3333
5	40	5	200	12.5	2500	-37.5	281250	416.6666667
5	40	6	200	87.5	17500	37.5	281250	416.6666667
80	5	7	400	50	20000	0	0	213333.3333
	60	Σ	2250		112500		656388.9	1261111.1
		Y	50					
		Ixx	1917500.0					

(Sumber: Data Pribadi)

- Segmen 1

A_i = b x h

A_i = 100 x 10 = 1000

Y_i = 0.5 x b

Y_i = 0.5 x 100

= 50

A_iY_i = A_i x Y_i

A_iY_i = 1000 x 50

A_iY_i = 50000

dy_i = Y_i – Y

dyi = 50 – 50

dyi = 0

$A_idy_i^2$ = A_i x dy_i^2

$A_idy_i^2$ = 1000 x 0^2

$A_idy_i^2$ = 0

$I_x = (b^3 \times h) / 12$

$I_x = (100^3 \times 10) / 12$

$I_x = 833333.3333$

- Segmen 2

$A_i = ½ \times b \times h$

$A_i = 10 \times 5$

$A_i = 25$

$Y_i = ½ \times bsegmen1 – ½ \times bsegmen4 – 1/3 \times b$

$Y_i = ½ \times 100 – ½ \times 80 – 1/3 \times 10$

$= 6.666667$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 25 \times 6.666667$

$A_iY_i = 166.6667$

$dy_i = Y_i – Y$

$dyi = 6.666667 – 50$

$dyi = - 43.333$

$A_idy_i^2 = Ai \times dy_i^2$

$A_idy_i^2 = 25 \times (-43.333)^2$

$A_idy_i^2 = 46944.44$

$I_x = (b^3 \times h) / 36$

$I_x = (10^3 \times 5) / 36$

$I_x = 138.89$

- Segmen 3

A_i = ½ x b x h

A_i = 10 x 5

A_i = 25

Y_i = ½ x $b_{segmen1}$ + ½ x $b_{segmen4}$ x (1/3 x b)

Y_i = ½ x 100 + ½ x 80 x (1/3 x 10)

= 93.33

A_iY_i = Ai x Y_i

A_iY_i = 25 x 93.33

A_iY_i = 2333.333

dy_i = Y_i – Y

dyi = 93.33 – 50

dyi = 43.33

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 25 x 43.33^2

$A_idy_i^2$ = 46944.44

I_x = (b^3 x h) / 36

I_x = (10^3 x 5) / 36

I_x = 138.89

- Segmen 4

A_i = b x h

A_i = 80 x 5

A_i = 400

Y_i = 0.5 x $b_{segmen1}$

Y_i = 0.5 x 100

Y_i = 50

A_iY_i = Ai x Y_i

A_iY_i = 400 x 50

A_iY_i = 2000

dy_i = Y_i – Y

dyi = 50 – 50

dyi = 0

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 400 x 0^2

$A_idy_i^2$ = 0

I_x = (b^3 x h) / 12

I_x = (80^3 x 5) / 12

I_x = 213333.33

- Segmen 5

A_i = b x h

A_i = 5 x 40

A_i = 200

Y_i = ½ x $b_{segmen1}$ – ½ x $b_{segmen4}$ + (0.5 x b)

Y_i = ½ x 100 – ½ x 80 + (0.5 x 5)

Y_i = 12.5

A_iY_i = Ai x Y_i

A_iY_i = 200 x 12.5

A_iY_i = 2500

$dy_i = Y_i - Y$

dyi = 12.5 – 50

dyi = - 37.5

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 200 \times (-37.5)^2$

$A_i dy_i^2 = 281250$

$I_x = (b^3 \times h) / 12$

$I_x = (5^3 \times 40) / 12$

$I_x = 416.67$

- Segmen 6

$A_i = b \times h$

$A_i = 5 \times 40$

$A_i = 200$

$Y_i = ½ \times b_{segmen1} + ½ \times b_{segmen4} - (0.5 \times b)$

$Y_i = ½ \times 100 + ½ \times 80 - (0.5 \times 5)$

$Y_i = 87.5$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 200 \times 87.5$

$A_i Y_i = 17500$

$dy_i = Y_i - Y$

dyi = 87.5 – 50

dyi = 37.5

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 200 \times 37.5^2$

$A_i dy_i^2$ = 281250

I_x = $(b^3 \times h) / 12$

I_x = $(5^3 \times 40) / 12$

I_x = 416.67

- Segmen 7

A_i = b x h

A_i = 80 x 5

A_i = 400

Y_i = 0.5 x b_{total}

Y_i = 0.5 x 100

Y_i = 50

$A_i Y_i$ = Ai x Y_i

$A_i Y_i$ = 400 x 50

$A_i Y_i$ = 2000

dy_i = $Y_i - Y$

dyi = 50 – 50

dyi = 0

$A_i dy_i^2$ = Ai x dy_i^2

$A_i dy_i^2$ = 400 x 0^2

$A_i dy_i^2$ = 0

I_x = $(b^3 \times h) / 12$

I_x = $(80^3 \times 5) / 12$

I_x = 213333.33

- Momen Inersia (Ixy)

I_{xy} = Σ I_x : Σ $A_i dy_i^2$

I_{xy} = 1917500.0 cm^4

4.3.12 Perhitungan Modulus Penampang Box Girder

Sebagai ilustrasi, ditinjau penampang sayap berentuk box girder dengan lebar b dan tinggi h. dengan modulus penampang untuk sumbu x (Sx) adalah

Sx = 0.22 x Ah

Sx = 0.22 x 2250 x 60

Sx = 29700 cm^3

Sementara untuk modulus penampan sumbu y (sy) adalah

Sy = 0.22 x Ab

Sy = 0.22 x 2150 x 100

Sy = 49500 cm^3

4.3.13 Perhitungan Modulus Elastisitas Penampang Box Girder

Dimisalkan fc atau mutu beton adalah 400 adapun perhitungan untuk modulus elastisitas box girder adalah

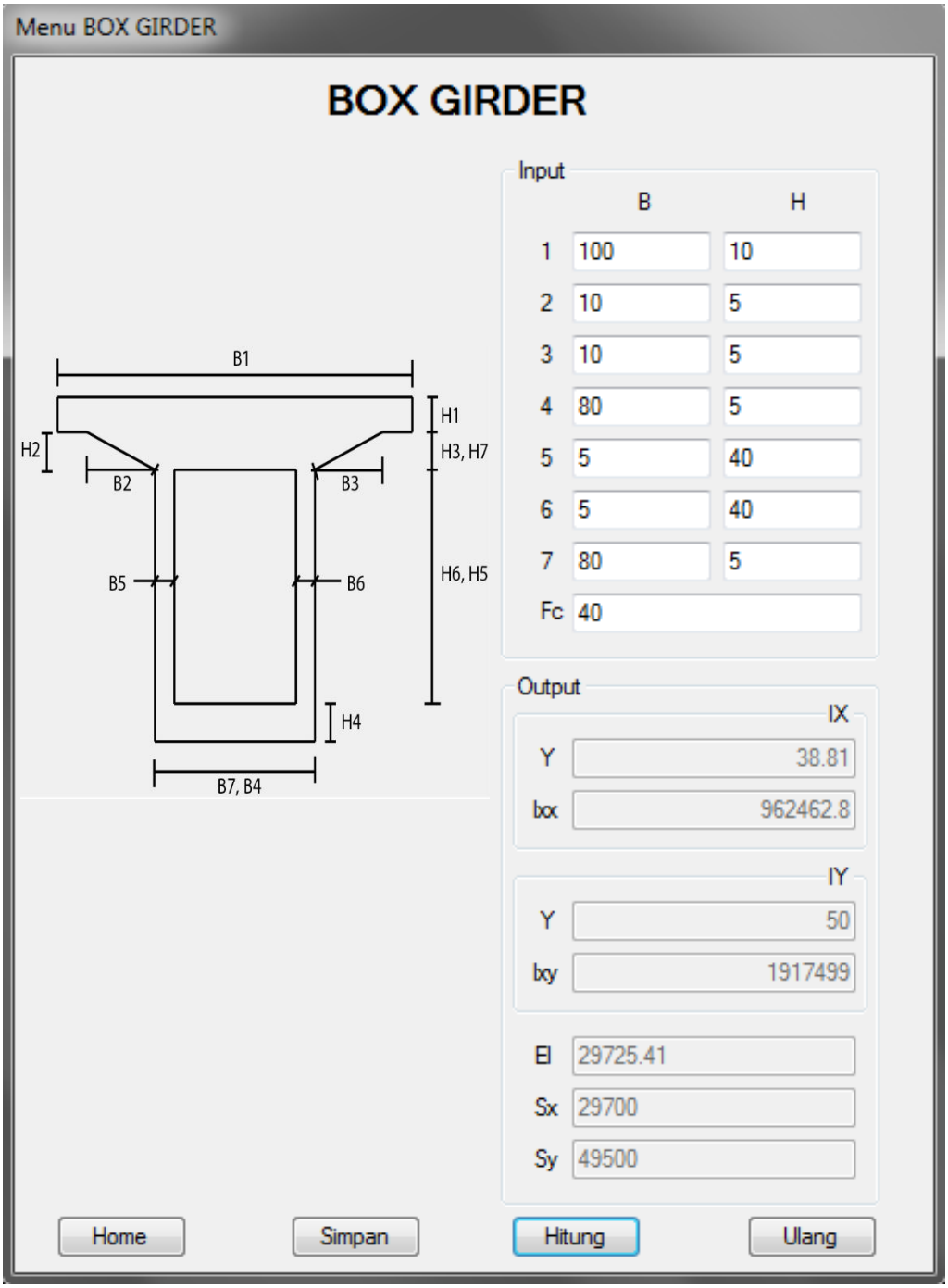
E = 4700 $\sqrt{fc}$

E = 4700 $\sqrt{40}$

E = 29725.41

4.3.14 Hasil Perhitungan Visual Basic Box Girder

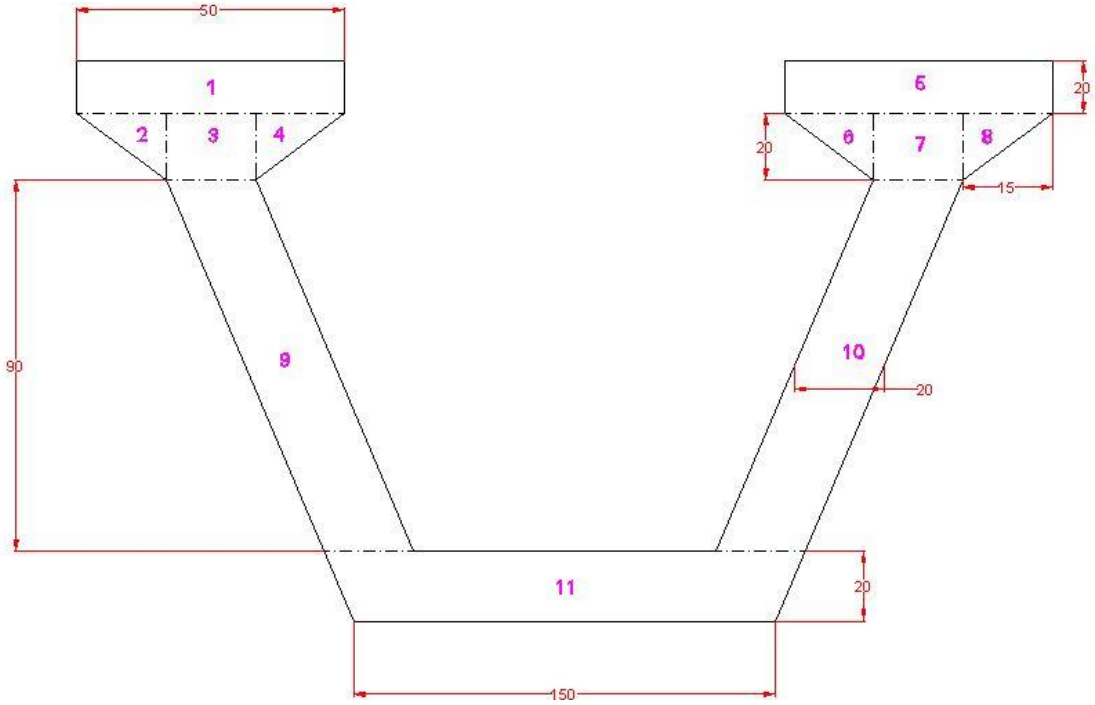
Setelah dilakukan perhitungan manual untuk penampang box girder, maka dicocokan dengan perhitungan dengan menggunakan program dari visual basic yang sudah jadi. Adapun hasilnya adalah sebagai berikut



Gambar 4-15 Hasil Perhitungan Visual Basic Box Girder
(Sumber: Dokumentasi Pribadi)

4.3.15 Momen Inersia U Girder

Diketahui besaran dimensi penampang T Girder adalah sebagai berikut:



Gambar 4-16 Dimensi Penampang U Girder
(Sumber: Dokumentasi Pribadi)

Dari gambar diatas dapat diketahui dimensi masing-masing segmen antara lain:

1. Tinggi penampang : 150 cm
2. Tinggi segmen 1 : 20 cm
3. Lebar segmen 1 : 50 cm
4. Tinggi segmen 2 : 20 cm
5. Lebar segmen 2 : 15 cm
6. Tinggi segmen 3 : 20 cm
7. Lebar segmen 3 : 20 cm
8. Tinggi segmen 4 : 20 cm
9. Lebar segmen 4 : 15 cm
10. Tinggi segmen 5 : 90 cm
11. Lebar segmen 5 : 20 cm
12. Tinggi segmen 6 : 20 cm
13. Lebar segmen 6 : 150 cm

A. Perhitungan Ix U Girder

Tabel 4-7 Tabel Perhitungan Momen Inersia (Ix) U Girder

Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	2000	140	280000	137.2	9411920	66666.66667
15	20	2	300	123.3333	37000	103.8666667	809121.3	6666.666667
20	20	3	800	120	96000	97.2	1889568	26666.66667
15	20	4	300	123.3333	37000	103.8666667	809121.3	6666.666667
20	90	9	3600	65	234000	-12.8	147456	2430000
150	20	11	3000	10	30000	-61.4	11309880	100000
		Σ	10000		714000		24377067	2636666.7
		Y	71.4					
		Ixx	27170986					

(Sumber: Data Pribadi)

- Y $= \Sigma A_i Y_i : \Sigma A_i$

  $= 71.4$

- Segmen 1

  $A_i = b \times h$

  $A_i = 50 \times 20 = 1000$

  $Y_i = h_{tot} - 0.5 \times h$

  $Y_i = 150 - 0.5 \times 20$

  $= 140$

  $A_iY_i = A_i \times Y_i$

  $A_iY_i = 2000 \times 140$

  $A_iY_i = 280000$

  $dy_i = Y_i - Y$

  $dyi = 140 - 71.4$

  $dyi = 137.2$

  $A_i dy_i^2 = ((0.5 \times A_i) \times (0.5 \times dy_i^2)) \times 2$

$A_i dy_i^2$ = ((0.5 x 2000) x (0.5 x 137.2)^2)

$A_i dy_i^2$ = 9411920

I_x = ((b x h^3) / 12) x 2

I_x = ((50 x 20^3) / 12) x 2

I_x = 66666.66667

- Segmen 2

A_i = ((b x h)/2) x 2

A_i = ((15 x 20)/2) x 2

A_i = 300

Y_i = h_{tot} - $h_{segmen1}$ - (1/3 x h)

Y_i = 150 + 20 x (1/3 x 20)

= 123.3333333

$A_i Y_i$ = Ai x Y_i

$A_i Y_i$ = 300 x 123.3333333

$A_i Y_i$ = 37000

dy_i = Y_i – Y

dyi = 123.3333333 – 71.4

dyi = 103.8666667

$A_i dy_i^2$ = ((0.5 x Ai) x (0.5 x dy_i^2)) x 2

$A_i dy_i^2$ = ((0.5 x 300) x (0.5 x 103.8666667^2)) x 2

$A_i dy_i^2$ = 809121.3333

I_x = ((b x h^3) / 36) x 2

I_x = ((15 x 20^3) / 36) x 2

I_x = 6666.666667

- Segmen 3

A_i = (b x h) x 2

A_i = (20 x 20) x 2

A_i = 800

Y_i = h_{tot} - $h_{segmen1}$ - (1/3 x h)

Y_i = 150 - 20 - (1/3 x 5)

= 120

A_iY_i = Ai x Y_i

A_iY_i = 800 x 120

A_iY_i = 96000

dy_i = Y_i – Y

dyi = 120 – 71.4

dyi = 97.2

$A_idy_i^2$ = ((0.5 x Ai) x (0.5 x dy_i^2)) x 2

$A_idy_i^2$ = ((0.5 x 800) x ((0.5 x 97.2)^2) x 2

$A_idy_i^2$ = 1889568

I_x = ((b x h^3) / 12) x 2

I_x = ((20 x 20^3) / 12) x 2

I_x = 26666.66667

- Segmen 4

A_i = ((b x h)/2) x 2

A_i = ((15 x 20)/2) x 2

A_i = 300

Y_i = h_{tot} - $h_{segmen1}$ - (1/3 x h)

Y_i = 150 + 20 x (1/3 x 20)

= 123.3333333

A_iY_i = Ai x Y_i

A_iY_i = 300 x 123.3333333

A_iY_i = 37000

dy_i = Y_i – Y

dyi = 123.3333333 – 71.4

dyi = 103.8666667

$A_idy_i^2$ = ((0.5 x Ai) x (0.5 x dy_i^2)) x 2

$A_idy_i^2$ = ((0.5 x 300) x (0.5 x 103.8666667^2)) x 2

$A_idy_i^2$ = 809121.3333

I_x = ((b x h^3) / 36) x 2

I_x = ((15 x 20^3) / 36) x 2

I_x = 6666.666667

- Segmen 5

A_i = b x h

A_i = 20 x 90

A_i = 3600

Y_i = $h_{segmen11}$ + (0.5 x h)

Y_i = 20 + (0.5 x 90)

Y_i = 65

A_iY_i = Ai x Y_i

A_iY_i = 3600 x 65

A_iY_i = 234000

$dy_i = Y_i - Y$

dyi = 65 – 71.4

dyi = - 12

$A_i dy_i^2 = ((0.5 \times Ai) \times ((0.5 \times dy_i^2)) \times 2$

$A_i dy_i^2 = ((0.5 \times 3600) \times ((0.5 \times (-12.8))^2) \times 2$

$A_i dy_i^2 = 147456$

$I_x = ((b \times h^3) / 12) \times 2$

$I_x = ((20 \times 90^3) / 12) \times 2$

$I_x = 2430000$

- Segmen 6

$A_i = b \times h$

$A_i = 150 \times 20$

$A_i = 3000$

$Y_i = 0.5 \times h$

$Y_i = 0.5 \times 20$

$Y_i = 10$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 3000 \times 10$

$A_i Y_i = 30000$

$dy_i = Y_i - Y$

dyi = 10 – 71.4

dyi = - 61.4

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2$ = 3000 x (- 61.4)^2

$A_i dy_i^2$ = 11309880

I_x = (b x h^3) / 12

I_x = (150 x 20^3) / 12

I_x = 100000

- Momen Inersia (Ixx)

Ixx = ΣIx + Σ $A_i dy_i^2$

Ixx = 27170986 cm^4

B. Perhitungan Iy U Girder

Tabel 4-8 Tabel Perhitungan Momen Inersia (Iy) U Girder

Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	2000	25	50000	-65.78947368	8656510	208333.3333
15	20	2	150	10	1500	-80.78947368	979040.9	1875
20	20	3	800	25	20000	-65.78947368	3462604	13333.33333
15	20	4	150	40	6000	-50.78947368	386935.6	1875
50	20	5	1000	175	175000	84.21052632	7091413	208333.3333
15	20	6	150	160	24000	69.21052632	718514.5	1875
20	20	7	400	175	70000	84.21052632	2836565	13333.33333
15	20	8	150	190	28500	99.21052632	1476409	1875
20	90	9	1800	45	81000	-45.78947368	3774017	60000
20	90	10	1800	155	279000	64.21052632	7421385	60000
150	20	11	3000	100	300000	9.210526316	254501.4	5625000
		Σ	11400		1035000		37057895	6195833.3
		Y	90.78947					
		Ixy	43859280					

(Sumber: Data Pribadi)

- Y = Σ $A_i Y_i$: ΣA_i

= 92.72368

- Segmen 1

A_i = b x h

A_i = 50 x 20 = 1000

Y_i = 0.5 x b

Y_i = 0.5 x 50

= 25

A_iY_i = A_i x Y_i

A_iY_i = 2000 x 25

A_iY_i = 50000

dy_i = Y_i – Y

dyi = 25 – 92.72368

dyi = - 65.789

$A_idy_i^2$ = A_i x dy_i^2

$A_idy_i^2$ = 2000 x (- 65.723)^2

$A_idy_i^2$ = 8656510

I_x = (b^3 x h) / 12)

I_x = 50^3 x 20 / 12

I_x = 208333.33

- Segmen 2

A_i = ((b x h)/2)

A_i = ((15 x 20)/2)

A_i = 150

Y_i = b - (1/3 x b)

Y_i = 15 - (1/3 x 15)

= 10

A_iY_i = Ai x Y_i

A_iY_i = 150 x 10

A_iY_i = 1500

dy_i = Y_i – Y

dyi = 10 – 90.723

dyi = - 80.789

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 150 x 80.723^2

$A_idy_i^2$ = 979040.9

I_x = $((b^3 \text{ x } h) / 36)$

I_x = $((15^3 \text{ x } 20) / 36)$

I_x = 1875

- Segmen 3

A_i = (b x h) x 2

A_i = (20 x 20) x 2

A_i = 800

Y_i = $b_{segmen2}$ + (1/2 x b)

Y_i = 15 + (1/2 x 20)

= 25

A_iY_i = Ai x Y_i

A_iY_i = 800 x 25

A_iY_i = 20000

dy_i = Y_i – Y

dyi = 25 – 90.723

dyi = - 65.789

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 800 \times (-65.723)^2$

$A_i dy_i^2 = 3462604$

$I_x = ((b^3 \times h) / 12)$

$I_x = ((20^3 \times 20) / 12)$

$I_x = 13333.33$

- Segmen 4

$A_i = ((b \times h)/2)$

$A_i = ((15 \times 20)/2)$

$A_i = 150$

$Y_i = b_{segmen2} + b_{segmen3} + (1/3 \times b)$

$Y_i = 15 + 20 \times (1/3 \times 15)$

$= 40$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 150 \times 40$

$A_i Y_i = 6000$

$dy_i = Y_i - Y$

$dyi = 40 - 90.723$

$dyi = -50.789$

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 40 \times 90.723^2$

$A_i dy_i^2 = 386935.6$

$I_x = (b^3 \times h) / 36)$

$I_x = (15^3 \times 20) / 36)$

I_x = 1875

- Segmen 5

A_i = b x h

A_i = 50 x 20

A_i = 1000

Y_i = b_{tot} - 0.5 x $b_{segmen1}$

Y_i = 200 + (0.5 x 50)

Y_i = 175

A_iY_i = Ai x Y_i

A_iY_i = 1000 x 175

A_iY_i = 175000

dy_i = Y_i – Y

dyi = 175 – 90.723

dyi = 84.210

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 1000 x 84.276^2

$A_idy_i^2$ = 7091413

I_x = $((b^3 \text{ x } h) / 12)$

I_x = $((20^3 \text{ x } 90) / 12)$

I_x = 208333.33

- Segmen 6

A_i = $b_{segmen2}$ x $h_{segmen2}$

A_i = 15 x 20

A_i = 150

Y_i = b_{tot} – bsegmen4 – bsegmen3 – 1/3 x bsegmen2

Y_i = 200 – 15 – 20 – 1/3 x 15

Y_i = 160

A_iY_i = Ai x Y_i

A_iY_i = 150 x 160

A_iY_i = 24000

dy_i = Y_i – Y

dyi = 160 – 90.72

dyi = 69.210

$A_i dy_i^2$ = Ai x dy_i^2

$A_i dy_i^2$ = 150 x $(69.27)^2$

$A_i dy_i^2$ = 718514.5

I_x = (b^3 x h) / 12

I_x = ($15^3$0 x 20) / 12

I_x = 1875

- Segmen 7

A_i = (bsegmen3 x hsegmen3)

A_i = (20 x 20)

A_i = 400

Y_i = b_{total} – $b_{segmen4}$ - 1/2 x $b_{segmen3}$

Y_i = 200 – 15 – ½ x 20

= 175

A_iY_i = Ai x Y_i

A_iY_i = 400 x 175

A_iY_i = 70000

$dy_i = Y_i - Y$

dyi = 175 – 90.723

dyi = 84.210

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 400 \times 84.276^2$

$A_i dy_i^2 = 2836565$

$I_x = ((b^3 \times h) / 36)$

$I_x = ((20^3 \times 20) / 36)$

$I_x = 13333.33$

- Segmen 8

$A_i = ½ \times b_{segmen4} \times h_{segmen4}$

$A_i = ½ \times 15 \times 20$

$A_i = 150$

$Y_i = b_{total} - b_{segmen4} + (1/2 \times segmen4)$

$Y_i = 200 - 15 + (1/2 \times 15)$

$= 190$

$A_i Y_i = Ai \times Y_i$

$A_i Y_i = 150 \times 190$

$A_i Y_i = 28500$

$dy_i = Y_i - Y$

dyi = 190 – 90.723

dyi = 99.210

$A_i dy_i^2 = Ai \times dy_i^2$

$A_i dy_i^2 = 150 \times 99.21^2$

$A_i dy_i^2$ = 1476409

I_x = b^3 x h / 36

I_x = 20^3 x 20/ 36

I_x = 1875

- Segmen 9

A_i = b x h

A_i = 20 x 90

A_i = 1800

Y_i = $b_{segmen2}$ + $b_{segmen3}$ + (1/2 x b)

Y_i = 15 + 20 x (1/3 x 20)

= 45

$A_i Y_i$ = Ai x Y_i

$A_i Y_i$ = 1800 x 45

$A_i Y_i$ = 81000

dy_i = Y_i – Y

dyi = 45 – 90.78

dyi = - 45.78

$A_i dy_i^2$ = Ai x dy_i^2

$A_i dy_i^2$ = 1800 x $(-45.78)^2$

$A_i dy_i^2$ = 3774017

I_x = (b^3 x h) / 12)

I_x = (20^3 x 90) / 12)

I_x = 60000

- Segmen 10

$A_i = b_{total} – b_{segmen4} – b_{segmen3}$ ½ x $b_{segmen9}$

$A_i = 200 – 15 – 20 – ½ \times 20$

$A_i = 1800$

$Y_i = b_{tot} - 0.5 \times b_{segmen1}$

$Y_i = 200 + (0.5 \times 50)$

$Y_i = 155$

$A_iY_i = Ai \times Y_i$

$A_iY_i = 1800 \times 155$

$A_iY_i = 279000$

$dy_i = Y_i – Y$

$dyi = 155 – 90.78$

$dyi = 64.21$

$A_idy_i^2 = Ai \times dy_i^2$

$A_idy_i^2 = 1800 \times 64.21^2$

$A_idy_i^2 = 7421385$

$I_x = ((b_{segmen9}^3 \times h_{segmen9}) / 12)$

$I_x = ((20^3 \times 90) / 12)$

$I_x = 60000$

- Segmen 11

$A_i = b_{segmen2} \times h_{segmen2}$

$A_i = 150 \times 20$

$A_i = 3000$

Y_i = b_{total} x 0.5

Y_i = 200 x 0.5

Y_i = 100

A_iY_i = Ai x Y_i

A_iY_i = 3000 x 100

A_iY_i = 300000

dy_i = Y_i – Y

dyi = 100 – 90.78

dyi = 9.21

$A_idy_i^2$ = Ai x dy_i^2

$A_idy_i^2$ = 3000 x 9.21^2

$A_idy_i^2$ = 254501.4

I_x = (b^3 x h) / 12

I_x = (150^3 x 20) / 12

I_x = 5625000

- Momen Inersia (Ixy)

I_{xx} = Σ I_x : Σ $A_idy_i^2$

I_{xx} = 43859280 cm^4

4.3.16 Perhitungan Modulus Penampang U Girder

Ditinjau penampang sayap berentuk U girder dengan lebar b dan tinggi h. dengan modulus penampang untuk sumbu x (Sx) adalah

Sx = 0.229 x Ah

Sx = 0.22 x 11400 x 150

Sx = 344893.5 cm^3

Sementara untuk modulus penampan sumbu y (sy) adalah

Sy = 0.219 x Ab

Sy = 0.219 x 11400 x 200

Sy = 438592 cm^3

4.3.17 Perhitungan Modulus Elastis Penampang U *Girder*

Rasio unit tegangan terhadap unit regangan, adalah modulus elastisitas bahan. Dimisalkan fc atau mutu beton adalah 50 adapun perhitungan untuk modulus elastisitas adalah

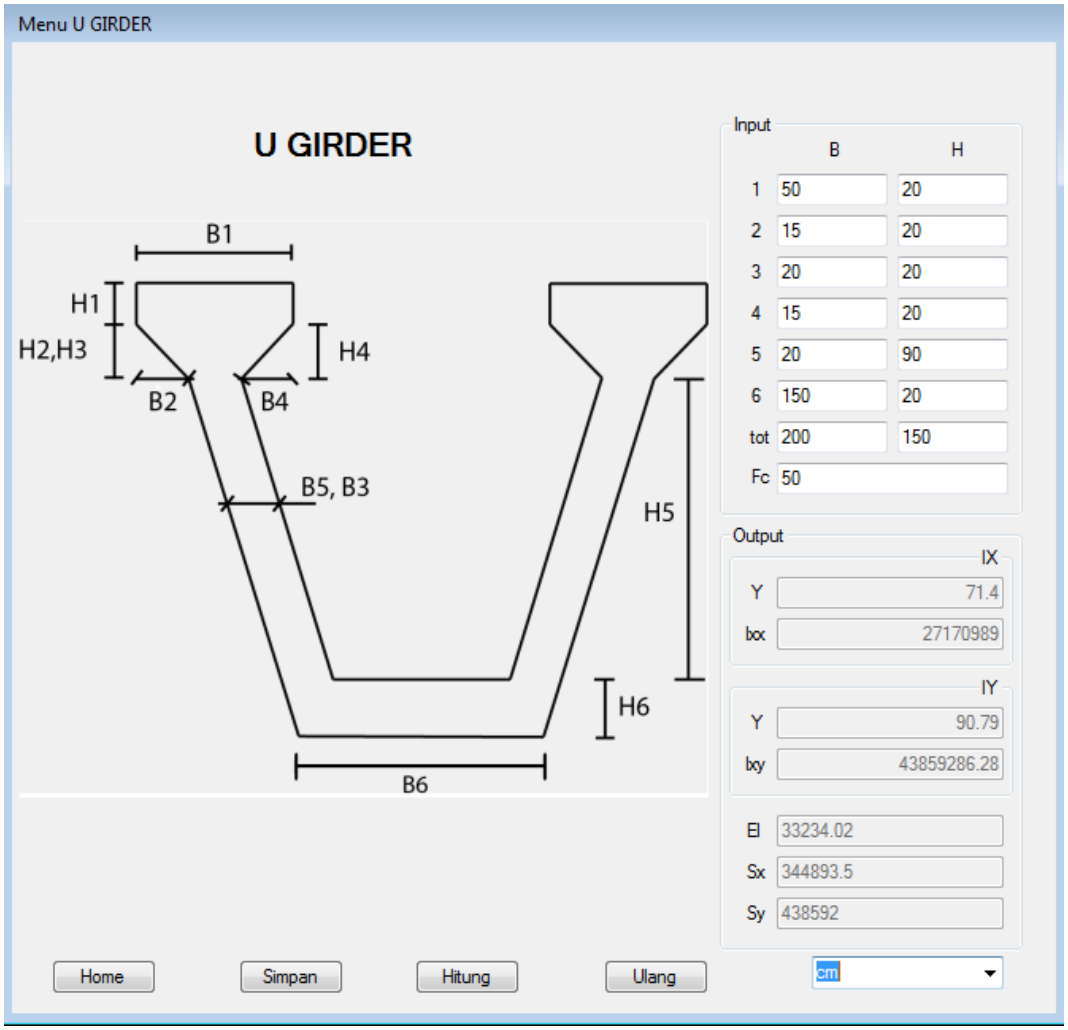
$E = 4700 \sqrt{fc}$

$E = 4700 \sqrt{50}$

E = 33234.01872

4.3.18 Hasil Perhitungan Visual Basic U Girder

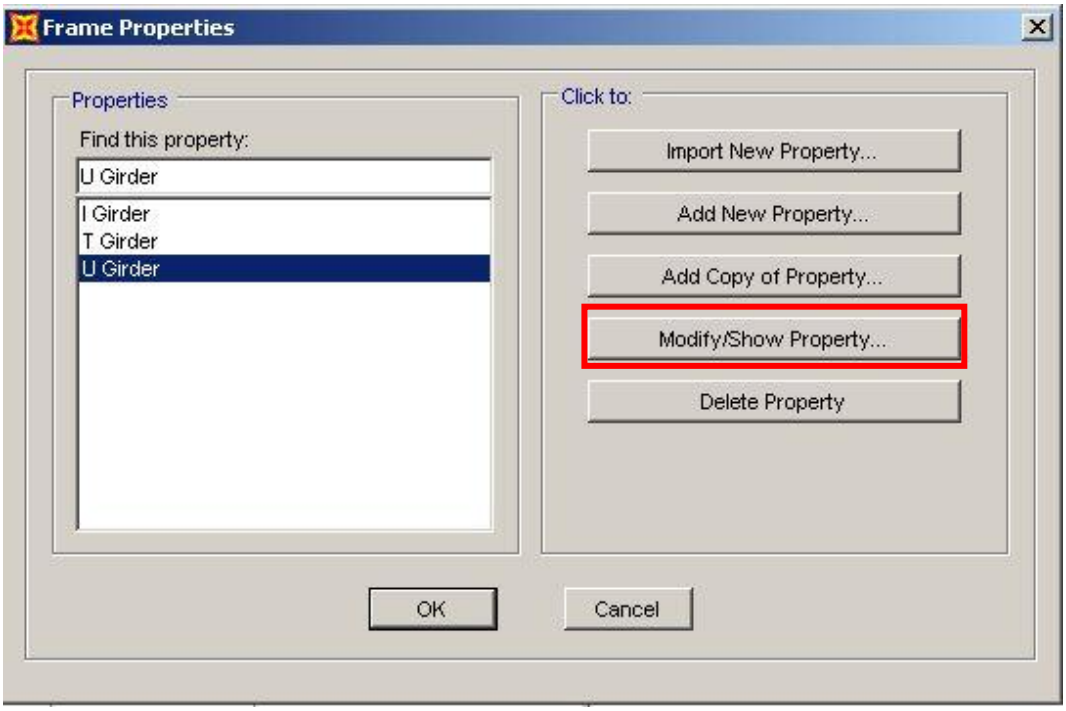
Hasil dari perhitungan manual yang sudah tervalidasi oleh SAP2000 diaplikasikan kedalam program visual basic yang telah jadi. Adapun hasilnya adalah sebagai berikut



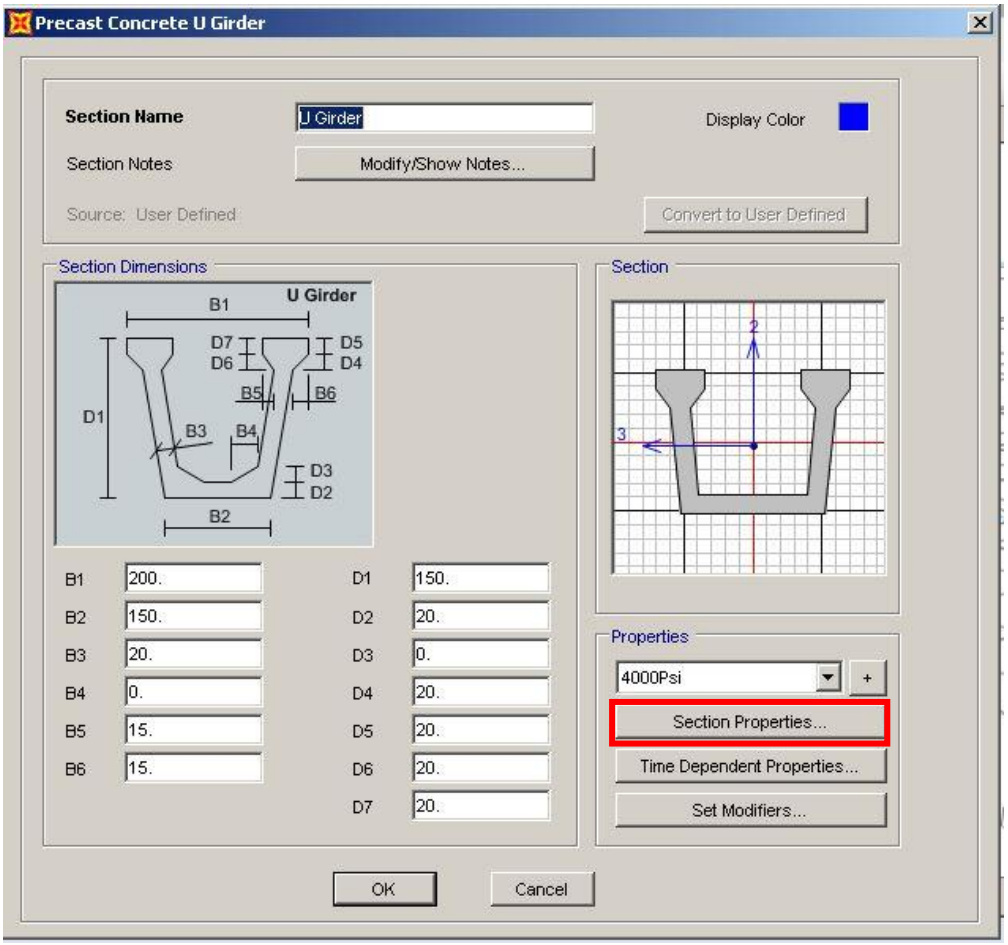
Gambar 4-17 Hasil Perhitungan Visual Basic U Girder
(Sumber: Dokumentasi Pribadi)

4.3.19 Validasi Penampang U Girder Menggunakan SAP2000

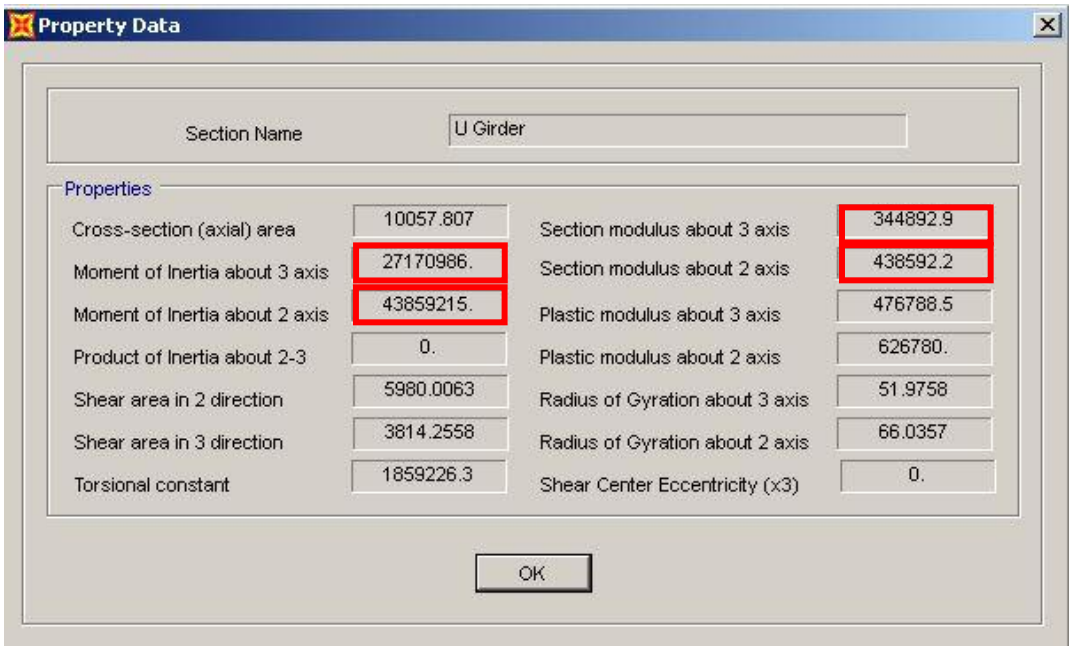
Setelah dilakukan analisis hitungan manual untuk penampang U girder maka dilakukan proses validasi menggunakan SAP2000, dengan tampilan sebagai berikut:



Gambar 4-18 Frame Properties U Girder SAP2000
(Sumber: Dokumentasi Pribadi)



Gambar 4-19 Pengisian Dimensi U Girder SAP2000
(Sumber: Dokumentasi Pribadi)



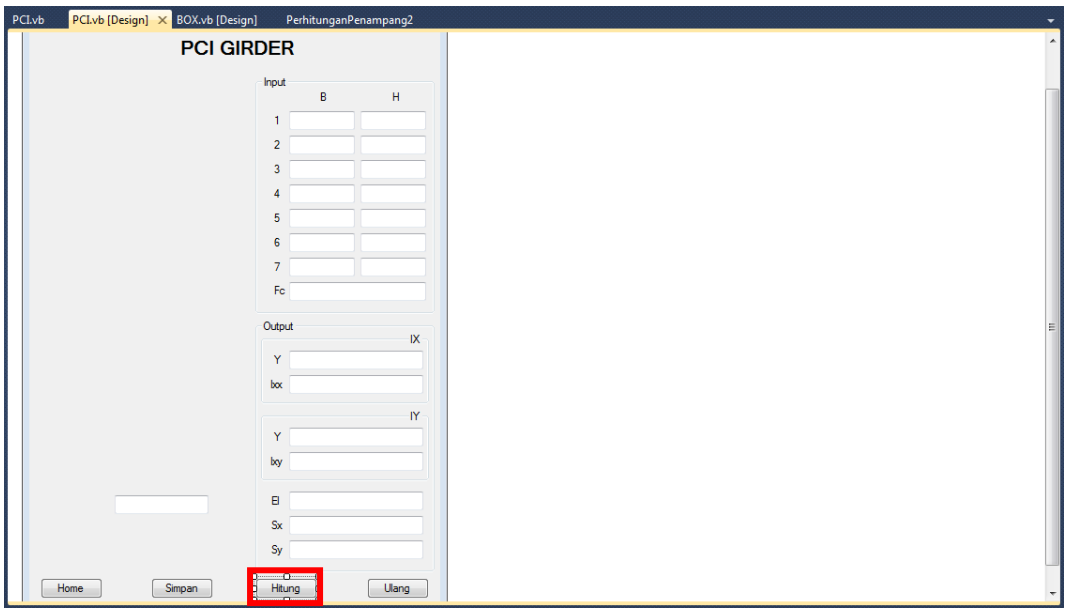
Gambar 4-20 Property Data U Girder SAP2000
(Sumber: Dokumentasi Pribadi)

4.4 Input Kode Pada Visual Basic

Setelah menganalisis secara manual dengan Microsoft excel dan tervalidasi oleh SAP2000 maka dilanjutkan dengan penerjemahan hasil analisis kedalam *visual basic* dengan memasukan Bahasa pemrograman yang nantinya dapat dihitung kembali oleh *visual basic*.

4.4.1 Input Kode Pada Penampang PCI Girder

Langkah selanjutnya setelah membuat interface untuk PCI girder adalah input kode perhitungan dengan cara *double* klik pada *command button* Hitung lalu mulai isi dengan Bahasa pemrograman agar perhitungan pada Microsoft excel dapat diterjemahkan oleh visual basic.



Gambar 4-21 Form Visual Basic Untuk PCI Girder
(Sumber: Dokumentasi Pribadi)

Tabel 4-9 Tabel Perhitungan Manual Ix PCI Girder

		IX						
input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000	110	110000	54.09961686	2926769	33333.33333
20	80	2	1600	60	96000	4.099616858	26890.97	853333.3333
60	20	3	1200	10	12000	-45.90038314	2528214	40000
15	10	4	75	96.66667	7250	40.76628352	124641.7	416.6666667
15	10	5	75	96.66667	7250	40.76628352	124641.7	416.6666667
20	20	6	200	26.66667	5333.333	-29.23371648	170922	4444.444444
20	20	7	200	26.66667	5333.333	-29.23371648	170922	4444.444444
120		Σ	4350		243166.7		6073001	936388.9
		Y	55.90038314					
		Ixx	7009390.2					

(Sumber: Data Pribadi)

Tabel 4-10 Tabel Perhitungan Manual Iy PCI Girder

		IY						
input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000	30	30000	0	0	208333.3333
20	80	2	1600	30	48000	0	0	53333.33333
60	20	3	1200	30	36000	0	0	360000
15	10	4	75	15	1125	-15	16875	937.5
15	10	5	75	45	3375	15	16875	937.5
20	20	6	200	13.33333	2666.667	-16.66666667	55555.56	4444.444444
20	20	7	200	46.66667	9333.333	16.66666667	55555.56	4444.444444
		Σ	4350		130500		144861.1	632430.6
		Y	30					
		Ixy	777291.7					

(Sumber: Data Pribadi)

Terdapat text box yang di peruntukan untuk menginput penampang serta sebagai pengganti tabel perhitungan di Microsoft excel agar memudahkan penulis dalam proses perhitungan.

Setelah mengklik command button di atas maka akan muncul jendela pengkodean seperti yang tertera pada gambar di bawah ini

But_Hitung | Click

```
Imports System.Math
Public Class PCI

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button1.Click
        Me.Close()
        Home.Show()
    End Sub

    'variabel IX
    Dim Yi1, Yi2, Yi3, Yi4, Yi5, Yi6, Yi7 As Single
    Dim b1, b2, b3, b4, b5, b6, b7, h1, h2, h3, h4, h5, h6, h7 As Single
    Dim ai1, ai2, ai3, ai4, ai5, ai6, ai7 As Single
    Dim sumAI As Decimal
    Dim E11 As Integer
    Dim ay1, ay2, ay3, ay4, ay5, ay6, ay7 As Single
    Dim sumAY As Decimal
    Dim Y As Single
    Dim dy1, dy2, dy3, dy4, dy5, dy6, dy7 As Single
    Dim ady1, ady2, ady3, ady4, ady5, ady6, ady7 As Single
    Dim sumady As Decimal
    Dim ix1, ix2, ix3, ix4, ix5, ix6, ix7 As Single
    Dim sumix As Decimal
    Dim Ixx As Single
    Dim fc As Single

    Dim El As Single
    Dim Sx As Single
    Dim Sy As Single

    'variabel IY
    Dim Yiz1, Yiz2, Yiz3, Yiz4, Yiz5, Yiz6, Yiz7 As Single
    Dim ayz1, ayz2, ayz3, ayz4, ayz5, ayz6, ayz7 As Single
    Dim sumAYz As Decimal
    Dim Yz As Single
    Dim dyz1, dyz2, dyz3, dyz4, dyz5, dyz6, dyz7 As Single
```

100 %

But_Hitung | Click

```
    Dim dyz1, dyz2, dyz3, dyz4, dyz5, dyz6, dyz7 As Single
    Dim adyz1, adyz2, adyz3, adyz4, adyz5, adyz6, adyz7 As Single
    Dim sumadyz As Decimal
    Dim ixz1, ixz2, ixz3, ixz4, ixz5, ixz6, ixz7 As Single
    Dim sumixz As Decimal
    Dim Ixxz As Single

    Private Sub But_Hitung_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles But_Hitung.Click
        If TB1.Text = "" Or TB2.Text = "" Or TB3.Text = "" Or TB4.Text = "" Or TB5.Text = "" Or TB6.Text = "" Or TB7.Text = "" Or TH1.Text = "" Or TH2.Te
            MsgBox("Input tidak boleh kosong!")
        Else

            'PERHITUNGAN IX
            'parsing
            b1 = TB1.Text
            b2 = TB2.Text
            b3 = TB3.Text
            b4 = TB4.Text
            b5 = TB5.Text
            b6 = TB6.Text
            b7 = TB7.Text
            h1 = TH1.Text
            h2 = TH2.Text
            h3 = TH3.Text
            h4 = TH4.Text
            h5 = TH5.Text
            h6 = TH6.Text
            h7 = TH7.Text
            fc = TFc.Text

            'SUM Ai
            ai1 = b1 * h1
            ai2 = b2 * h2
            ai3 = b3 * h3
            ai4 = (0.5 * b4 * h4)
```

100 %

But_Hitung | Click

```
            ai6 = (0.5 * b6 * h6)
            ai7 = (0.5 * b7 * h7)
            sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6 + ai7)
            'TextBox1.Text = sumAI

            'E11
            E11 = (h1 + h3 + h5 + h7) + (h2 - h5 - h7)
            'TextBox1.Text = E11

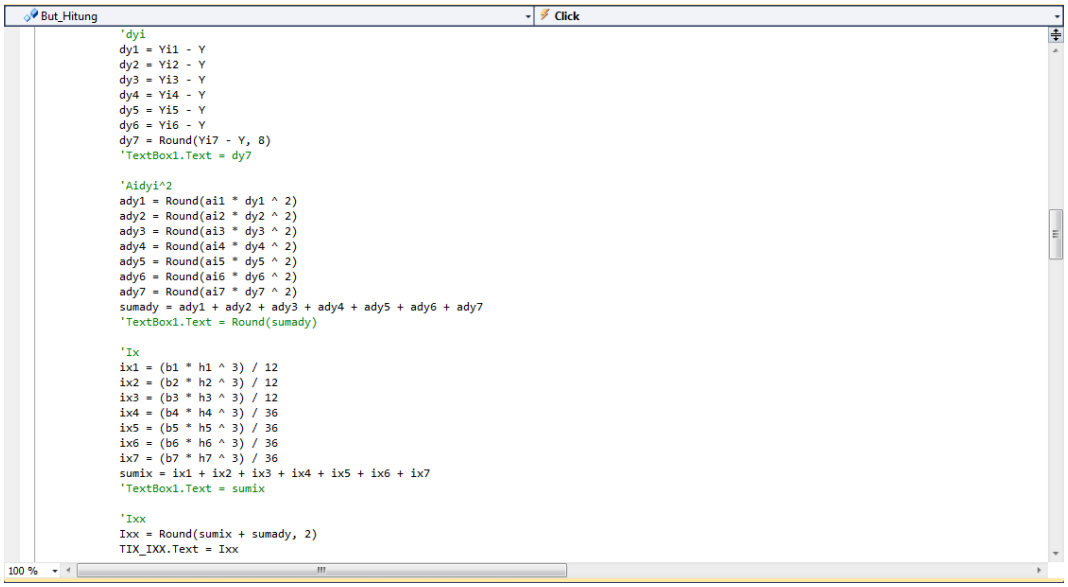
            'Yi
            Yi1 = E11 - 0.5 * h1
            Yi2 = h3 + 0.5 * h2
            Yi3 = 0.5 * h3
            Yi4 = E11 - h1 - (1 / 3) * h4
            Yi5 = E11 - h1 - (1 / 3) * h5
            Yi6 = h3 + ((1 / 3) * h6)
            Yi7 = h3 + ((1 / 3) * h7)
            'TextBox1.Text = Yi4

            'AiYi
            ay1 = ai1 * Yi1
            ay2 = ai2 * Yi2
            ay3 = ai3 * Yi3
            ay4 = ai4 * Yi4
            ay5 = ai5 * Yi5
            ay6 = ai6 * Yi6
            ay7 = ai7 * Yi7
            sumAY = Round(ay1 + ay2 + ay3 + ay4 + ay5 + ay6 + ay7)
            'TextBox1.Text = sumAY

            'Y
            Y = Round(sumAY / sumAI, 2)
            TIX_Y.Text = Y

            'dyi
```

100 %



But_Hitung | Click

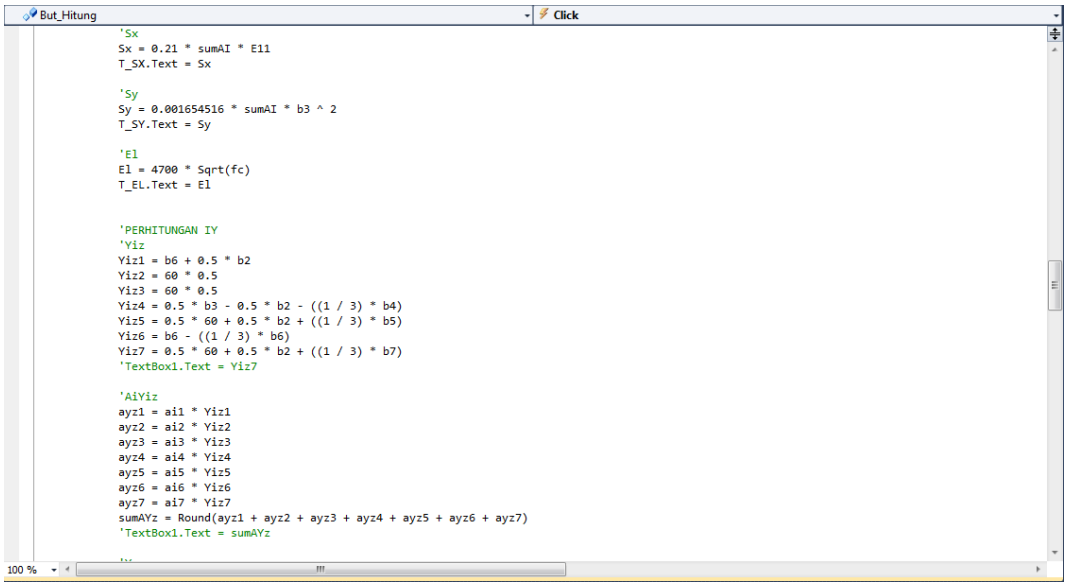
```
'dyi
dy1 = Yi1 - Y
dy2 = Yi2 - Y
dy3 = Yi3 - Y
dy4 = Yi4 - Y
dy5 = Yi5 - Y
dy6 = Yi6 - Y
dy7 = Round(Yi7 - Y, 8)
'TextBox1.Text = dy7

'Aidyi^2
ady1 = Round(ai1 * dy1 ^ 2)
ady2 = Round(ai2 * dy2 ^ 2)
ady3 = Round(ai3 * dy3 ^ 2)
ady4 = Round(ai4 * dy4 ^ 2)
ady5 = Round(ai5 * dy5 ^ 2)
ady6 = Round(ai6 * dy6 ^ 2)
ady7 = Round(ai7 * dy7 ^ 2)
sumady = ady1 + ady2 + ady3 + ady4 + ady5 + ady6 + ady7
'TextBox1.Text = Round(sumady)

'Ix
ix1 = (b1 * h1 ^ 3) / 12
ix2 = (b2 * h2 ^ 3) / 12
ix3 = (b3 * h3 ^ 3) / 12
ix4 = (b4 * h4 ^ 3) / 36
ix5 = (b5 * h5 ^ 3) / 36
ix6 = (b6 * h6 ^ 3) / 36
ix7 = (b7 * h7 ^ 3) / 36
sumix = ix1 + ix2 + ix3 + ix4 + ix5 + ix6 + ix7
'TextBox1.Text = sumix

'Ixx
Ixx = Round(sumix + sumady, 2)
TIX_IXX.Text = Ixx
```

100 %



But_Hitung | Click

```
'Sx
Sx = 0.21 * sumAI * E11
T_SX.Text = Sx

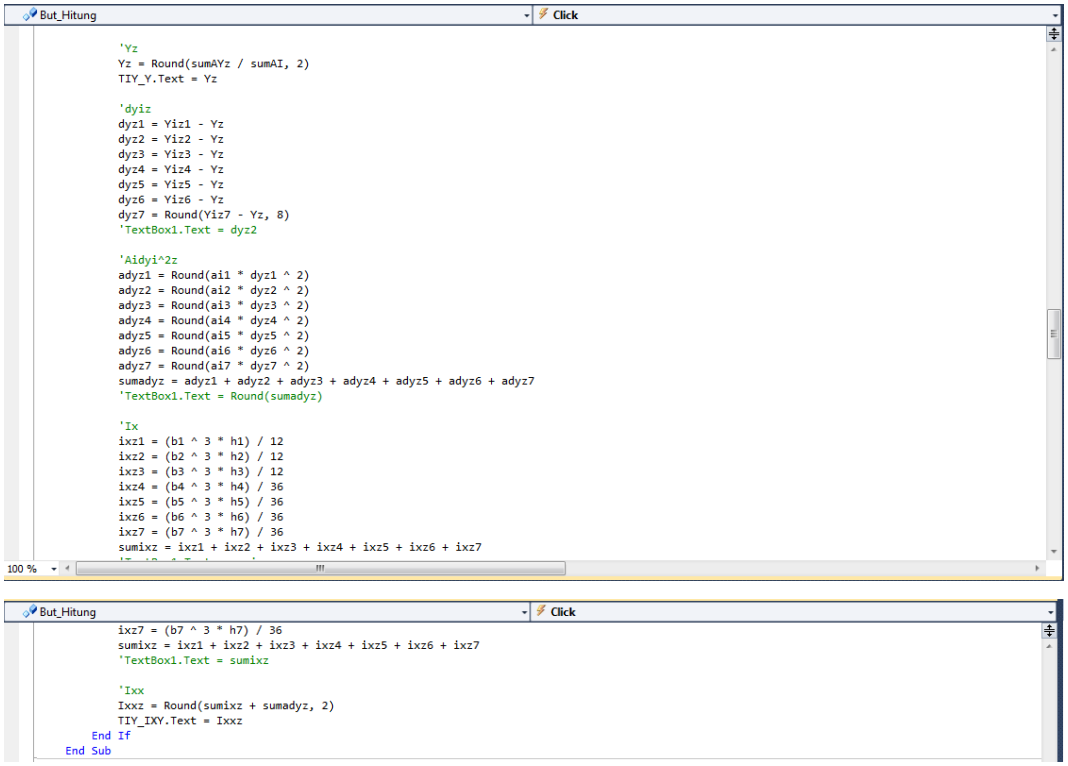
'Sy
Sy = 0.001654516 * sumAI * b3 ^ 2
T_SY.Text = Sy

'El
El = 4700 * Sqrt(fc)
T_EL.Text = El


'PERHITUNGAN IY
'Yiz
Yiz1 = b6 + 0.5 * b2
Yiz2 = 60 * 0.5
Yiz3 = 60 * 0.5
Yiz4 = 0.5 * b3 - 0.5 * b2 - ((1 / 3) * b4)
Yiz5 = 0.5 * 60 + 0.5 * b2 + ((1 / 3) * b5)
Yiz6 = b6 - ((1 / 3) * b6)
Yiz7 = 0.5 * 60 + 0.5 * b2 + ((1 / 3) * b7)
'TextBox1.Text = Yiz7

'AiYiz
ayz1 = ai1 * Yiz1
ayz2 = ai2 * Yiz2
ayz3 = ai3 * Yiz3
ayz4 = ai4 * Yiz4
ayz5 = ai5 * Yiz5
ayz6 = ai6 * Yiz6
ayz7 = ai7 * Yiz7
sumAYz = Round(ayz1 + ayz2 + ayz3 + ayz4 + ayz5 + ayz6 + ayz7)
'TextBox1.Text = sumAYz
```

100 %



Gambar 4-22 Jendela Pengkodean PCI Girder
(Sumber: Dokumentasi Pribadi)

Dimana:

B dan h : Pengganti variable untuk panjang dan lebar

Val(Text) : Penerjemahan textbox agar terbaca sebagai nilai (*value*)

Text_.text : Tempat menginput dan memunculkan hasil perhitungan.

Dalam jedela kode yang tertera terdapat 63 textbox dimana pada textbox 1 sampai dengan textbox 14 digunakan untuk menginput luasan area penampang (b dan h) seperti pada Microsoft excel.

A. Pengkodean Momen Inersia (Ix) PCI Girder

1. B (Lebar segmen penampang)

b1 = TB1.Text

b2 = TB2.Text

b3 = TB3.Text

b4 = TB4.Text

```
b5 = TB5.Text

b6 = TB6.Text

b7 = TB7.Text
```

2. H (Tinggi segmen penampang)

```
h1 = TH1.Text

h2 = TH2.Text

h3 = TH3.Text

h4 = TH4.Text

h5 = TH5.Text

h6 = TH6.Text

h7 = TH7.Text
```

3. A_i (Luasan area persegmen)

```
'SUM Ai

ai1 = b1 * h1

ai2 = b2 * h2

ai3 = b3 * h3

ai4 = (0.5 * b4 * h4)

ai5 = (0.5 * b5 * h5)

ai6 = (0.5 * b6 * h6)

ai7 = (0.5 * b7 * h7)

sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6 + ai7)

'TextBox1.Text = sumAI
```

4. **Y_i (Jarak titik berat segmen terhadap sumbu)**

```
'Yi

Yi1 = E11 - 0.5 * h1

Yi2 = h3 + 0.5 * h2

Yi3 = 0.5 * h3

Yi4 = E11 - h1 - (1 / 3) * h4

Yi5 = E11 - h1 - (1 / 3) * h5

Yi6 = h3 + ((1 / 3) * h6)

Yi7 = h3 + ((1 / 3) * h7)

'TextBox1.Text = Yi4
```

5. **A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)**

```
 'AiYi

ay1 = ai1 * Yi1

ay2 = ai2 * Yi2

ay3 = ai3 * Yi3

ay4 = ai4 * Yi4

ay5 = ai5 * Yi5

ay6 = ai6 * Yi6

ay7 = ai7 * Yi7

sumAY = Round(ay1 + ay2 + ay3 + ay4 + ay5 + ay6 + ay7)

'TextBox1.Text = sumAY
```

6. **dy_i (besaran titik berat segmen terhadap titik berat penampang)**

```
'dyi
dy1 = Yi1 - Y
dy2 = Yi2 - Y
dy3 = Yi3 - Y
dy4 = Yi4 - Y
dy5 = Yi5 - Y
dy6 = Yi6 - Y
dy7 = Round(Yi7 - Y, 8)
'TextBox1.Text = dy7
```

7. **$A_i dy_i$ (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)**

```
'Aidyi^2
ady1 = Round(ai1 * dy1 ^ 2)
ady2 = Round(ai2 * dy2 ^ 2)
ady3 = Round(ai3 * dy3 ^ 2)
ady4 = Round(ai4 * dy4 ^ 2)
ady5 = Round(ai5 * dy5 ^ 2)
ady6 = Round(ai6 * dy6 ^ 2)
ady7 = Round(ai7 * dy7 ^ 2)
sumady = ady1 + ady2 + ady3 + ady4 + ady5 + ady6 + ady7
'TextBox1.Text = Round(sumady)
```

8. **Ix (Momen Inersia Persegmen Penampang)**

```
Text50 = (a * b ^ 3) / 12
```

```
Text51 = (c * d ^ 3) / 12
Text52 = (e * f ^ 3) / 12
Text53 = (g * h ^ 3) / 36
Text54 = (i * j ^ 3) / 36
Text55 = (k * l ^ 3) / 36
Text56 = (m * n ^ 3) / 36
```

9. ȳ (Garis netral / titik berat)

```
Text61 = Val(Text58) / Val(Text57)
```

10. I_{xx} (Momen Inersia)

```
ix1 = (b1 * h1 ^ 3) / 12

ix2 = (b2 * h2 ^ 3) / 12

ix3 = (b3 * h3 ^ 3) / 12

ix4 = (b4 * h4 ^ 3) / 36

ix5 = (b5 * h5 ^ 3) / 36

ix6 = (b6 * h6 ^ 3) / 36

ix7 = (b7 * h7 ^ 3) / 36

sumix = ix1 + ix2 + ix3 + ix4 + ix5 + ix6 + ix7

'TextBox1.Text = sumix

'Ixx

Ixx = Round(sumix + sumady, 2)

TIX_IXX.Text = Ixx
```

B. Pengkodean Momen Inersia (Iy) PCI Girder

1. A_i (Luasan area persegmen)

```
'SUM Ai
ai1 = b1 * h1
ai2 = b2 * h2
ai3 = b3 * h3
ai4 = (0.5 * b4 * h4)
ai5 = (0.5 * b5 * h5)
ai6 = (0.5 * b6 * h6)
ai7 = (0.5 * b7 * h7)
sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6 + ai7)
'TextBox1.Text = sumAI
```

2. **Y_i (Jarak titik berat segmen terhadap sumbu)**

```
'Yiz
Yiz1 = b6 + 0.5 * b2
Yiz2 = 60 * 0.5
Yiz3 = 60 * 0.5
Yiz4 = 0.5 * b3 - 0.5 * b2 - ((1 / 3) * b4)
Yiz5 = 0.5 * 60 + 0.5 * b2 + ((1 / 3) * b5)
Yiz6 = b6 - ((1 / 3) * b6)
Yiz7 = 0.5 * 60 + 0.5 * b2 + ((1 / 3) * b7)
'TextBox1.Text = Yiz7
```

3. **A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)**

```
'AiYiz
```

```
ayz1 = ai1 * Yiz1

ayz2 = ai2 * Yiz2

ayz3 = ai3 * Yiz3

ayz4 = ai4 * Yiz4

ayz5 = ai5 * Yiz5

ayz6 = ai6 * Yiz6

ayz7 = ai7 * Yiz7

sumAYz = Round(ayz1 + ayz2 + ayz3 + ayz4 + ayz5 + ayz6 + ayz7)

'TextBox1.Text = sumAYz
```

4. **dy_i (besaran titik berat segmen terhadap titik berat penampang)**

```
'dyiz

dyz1 = Yiz1 - Yz

dyz2 = Yiz2 - Yz

dyz3 = Yiz3 - Yz

dyz4 = Yiz4 - Yz

dyz5 = Yiz5 - Yz

dyz6 = Yiz6 - Yz

dyz7 = Round(Yiz7 - Yz, 8)

'TextBox1.Text = dyz2
```

5. **$A_i dy_i$ (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)**

```
'Aidyi^2z

adyz1 = Round(ai1 * dyz1 ^ 2)
```

```
adyz2 = Round(ai2 * dyz2 ^ 2)

adyz3 = Round(ai3 * dyz3 ^ 2)

adyz4 = Round(ai4 * dyz4 ^ 2)

adyz5 = Round(ai5 * dyz5 ^ 2)

adyz6 = Round(ai6 * dyz6 ^ 2)

adyz7 = Round(ai7 * dyz7 ^ 2)

sumadyz = adyz1 + adyz2 + adyz3 + adyz4 + adyz5 + adyz6 + adyz7

'TextBox1.Text = Round(sumadyz)
```

6. Ix (Momen Inersia Persegmen Penampang)

```
'Ix

ixz1 = (b1 ^ 3 * h1) / 12

ixz2 = (b2 ^ 3 * h2) / 12

ixz3 = (b3 ^ 3 * h3) / 12

ixz4 = (b4 ^ 3 * h4) / 36

ixz5 = (b5 ^ 3 * h5) / 36

ixz6 = (b6 ^ 3 * h6) / 36

ixz7 = (b7 ^ 3 * h7) / 36

sumixz = ixz1 + ixz2 + ixz3 + ixz4 + ixz5 + ixz6 + ixz7

'TextBox1.Text = sumixz
```

7. ȳ (Garis netral / titik berat)

```
Text61 = Val(Text58) / Val(Text57)
```

8. I_{xy} (Momen Inersia)

```
'Ixx
```

```
Ixxz = Round(sumixz + sumadyz, 2)

TIY_IXY.Text = Ixxz
```

4.4.2 Input Kode Pada Penampang T Girder

untuk T girder input kode perhitungan dengan cara *double* klik pada *command button* Hitung lalu mulai isi dengan bahasa pemrograman agar perhitungan pada *Microsoft excel* dapat diterjemahkan oleh *visual basic*.

Tabel 4-11 Tabel Perhitungan Manual (Ix) T Girder

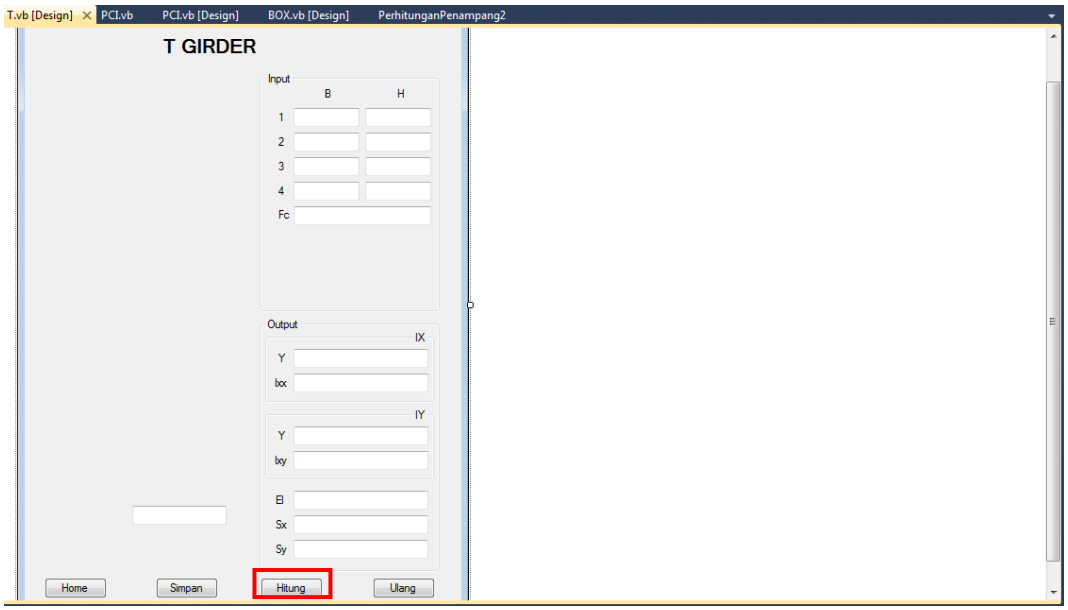
		IX						
Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000.00	60.00	60000.00	17.21	296160.09	33333.33
20	50	2	1000.00	25.00	25000.00	-17.79	316508.92	208333.33
15	10	3	75	46.66667	3500	3.875968992	1126.735172	416.6666667
15	10	4	75	46.66667	3500	3.875968992	1126.735172	416.6666667
		Σ	2150		92000.00		614922.48	242500.00
		Y	42.7907					
		Ixx	857422.5					

(Sumber: Data Pribadi)

Tabel 4-12 Tabel Perhitungan Manual (Iy) T Girder

		IY						
Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	1000.00	25.00	25000.00	0.00	0.00	208333.33
20	50	2	1000.00	25.00	25000.00	0.00	0.00	33333.33
15	10	3	75	10	750	-15.00	16875	937.5
15	10	4	75	40	3000	15.00	16875	937.5
		Σ	2150		53750.00		33750.00	243541.67
		Y	25					
		Ixy	277291.7					

(Sumber: Data Pribadi)



Gambar 4-23 Form Visual Basic Untuk T Girder
(Sumber: Dokumentasi Pribadi)

Text box di peruntukan untuk menginput penampang serta sebagai pengganti tabel perhitungan di Microsoft excel agar memudahkan penulis dalam proses perhitungan.

Setelah mengklik command button di atas maka akan muncul jendela pengkodean seperti yang tertera pada gambar di bawah ini dan dimulai untuk mengisikan pengkodean perhitungan program.

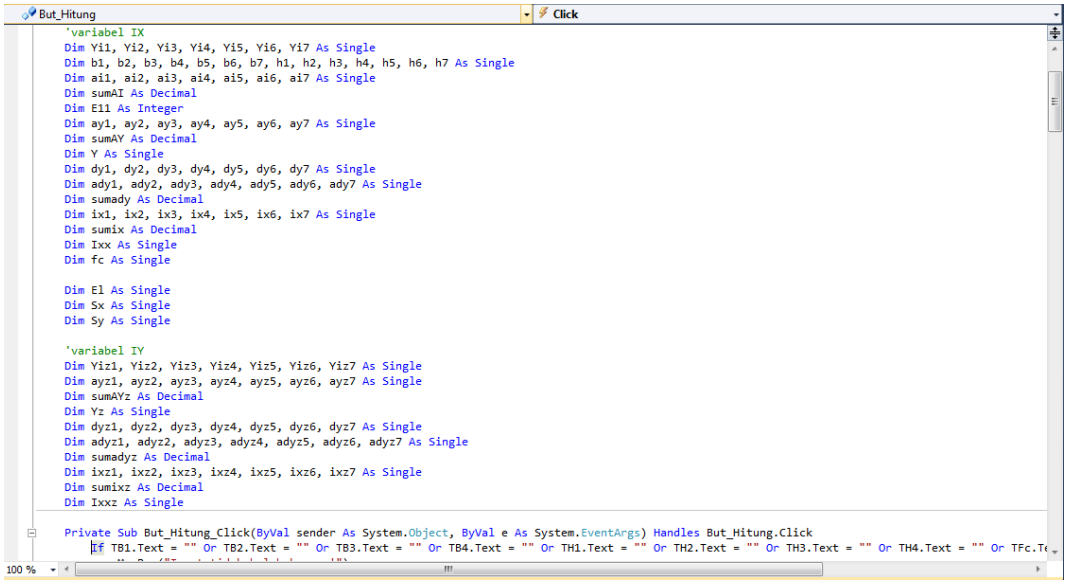
Dimana:

B dan h : Pengganti variable untuk textbox panjang dan lebar.

Val(Text) : Penerjemahan textbox agar terbaca sebagai nilai (*value*)

Text_.text : Tempat menginput dan memunculkan hasil perhitungan.

Dalam jedela kode yang tertera terdapat 38 textbox dimana pada textbox 1 sampai dengan textbox 8 digunakan untuk menginput luasan area penampang (b dan h) seperti pada Microsoft excel.



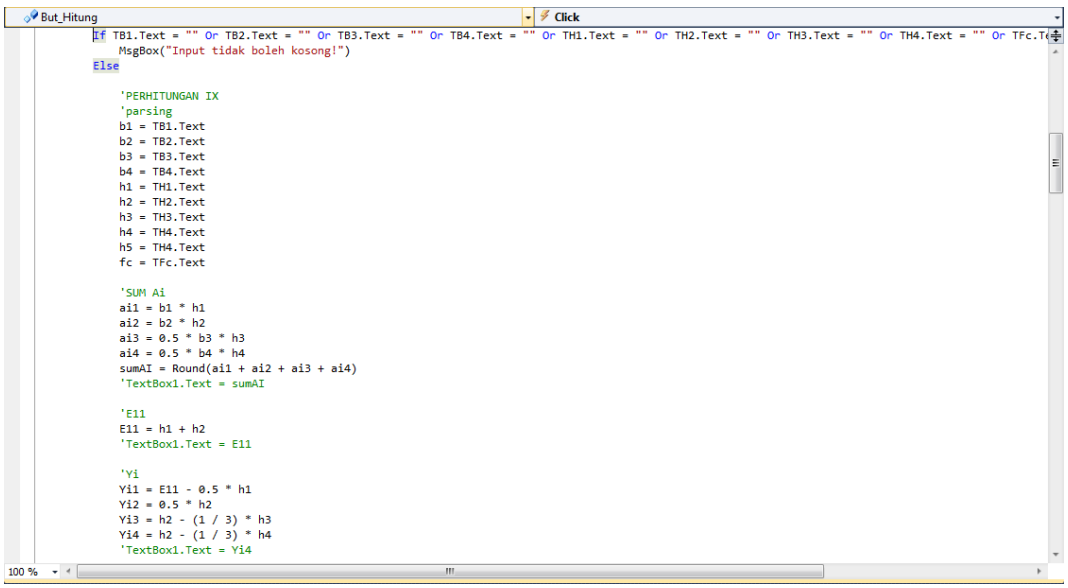
```
But_Hitung                                                    Click

    'variabel IX
    Dim Yi1, Yi2, Yi3, Yi4, Yi5, Yi6, Yi7 As Single
    Dim b1, b2, b3, b4, b5, b6, b7, h1, h2, h3, h4, h5, h6, h7 As Single
    Dim ai1, ai2, ai3, ai4, ai5, ai6, ai7 As Single
    Dim sumAI As Decimal
    Dim E11 As Integer
    Dim ay1, ay2, ay3, ay4, ay5, ay6, ay7 As Single
    Dim sumAY As Decimal
    Dim Y As Single
    Dim dy1, dy2, dy3, dy4, dy5, dy6, dy7 As Single
    Dim ady1, ady2, ady3, ady4, ady5, ady6, ady7 As Single
    Dim sumady As Decimal
    Dim ix1, ix2, ix3, ix4, ix5, ix6, ix7 As Single
    Dim sumix As Decimal
    Dim Ixx As Single
    Dim fc As Single

    Dim El As Single
    Dim Sx As Single
    Dim Sy As Single

    'variabel IY
    Dim Yiz1, Yiz2, Yiz3, Yiz4, Yiz5, Yiz6, Yiz7 As Single
    Dim ayz1, ayz2, ayz3, ayz4, ayz5, ayz6, ayz7 As Single
    Dim sumAYz As Decimal
    Dim Yz As Single
    Dim dyz1, dyz2, dyz3, dyz4, dyz5, dyz6, dyz7 As Single
    Dim adyz1, adyz2, adyz3, adyz4, adyz5, adyz6, adyz7 As Single
    Dim sumadyz As Decimal
    Dim ixz1, ixz2, ixz3, ixz4, ixz5, ixz6, ixz7 As Single
    Dim sumixz As Decimal
    Dim Ixxz As Single

    Private Sub But_Hitung_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles But_Hitung.Click
        If TB1.Text = "" Or TB2.Text = "" Or TB3.Text = "" Or TB4.Text = "" Or TH1.Text = "" Or TH2.Text = "" Or TH3.Text = "" Or TH4.Text = "" Or TFc.Te
```



```
But_Hitung                                                    Click

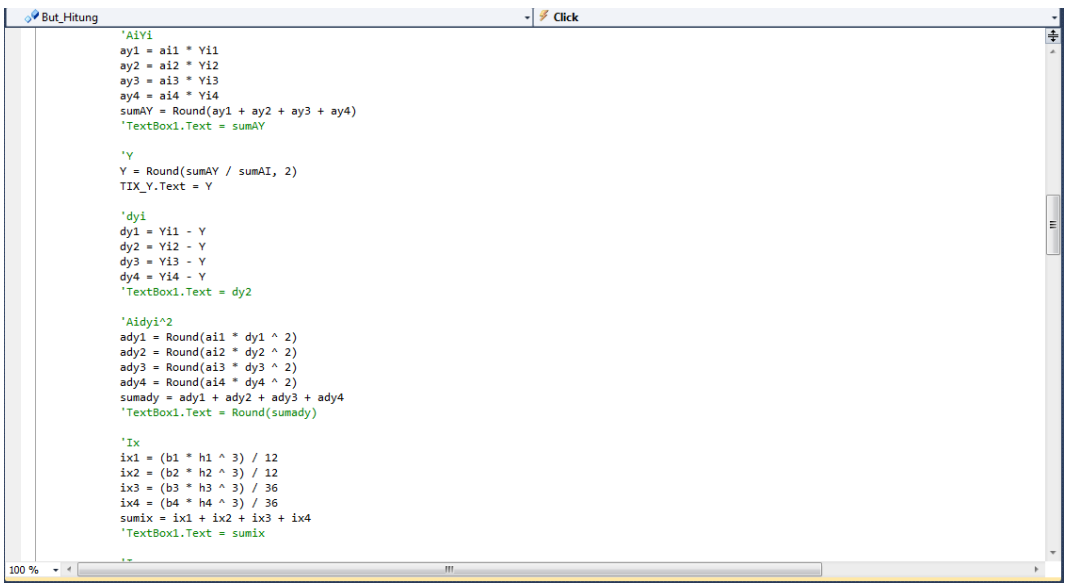
        If TB1.Text = "" Or TB2.Text = "" Or TB3.Text = "" Or TB4.Text = "" Or TH1.Text = "" Or TH2.Text = "" Or TH3.Text = "" Or TH4.Text = "" Or TFc.Te
            MsgBox("Input tidak boleh kosong!")
        Else

            'PERHITUNGAN IX
            'parsing
            b1 = TB1.Text
            b2 = TB2.Text
            b3 = TB3.Text
            b4 = TB4.Text
            h1 = TH1.Text
            h2 = TH2.Text
            h3 = TH3.Text
            h4 = TH4.Text
            h5 = TH4.Text
            fc = TFc.Text

            'SUM Ai
            ai1 = b1 * h1
            ai2 = b2 * h2
            ai3 = 0.5 * b3 * h3
            ai4 = 0.5 * b4 * h4
            sumAI = Round(ai1 + ai2 + ai3 + ai4)
            'TextBox1.Text = sumAI

            'E11
            E11 = h1 + h2
            'TextBox1.Text = E11

            'Yi
            Yi1 = E11 - 0.5 * h1
            Yi2 = 0.5 * h2
            Yi3 = h2 - (1 / 3) * h3
            Yi4 = h2 - (1 / 3) * h4
            'TextBox1.Text = Yi4
```



```
But_Hitung                                                    Click

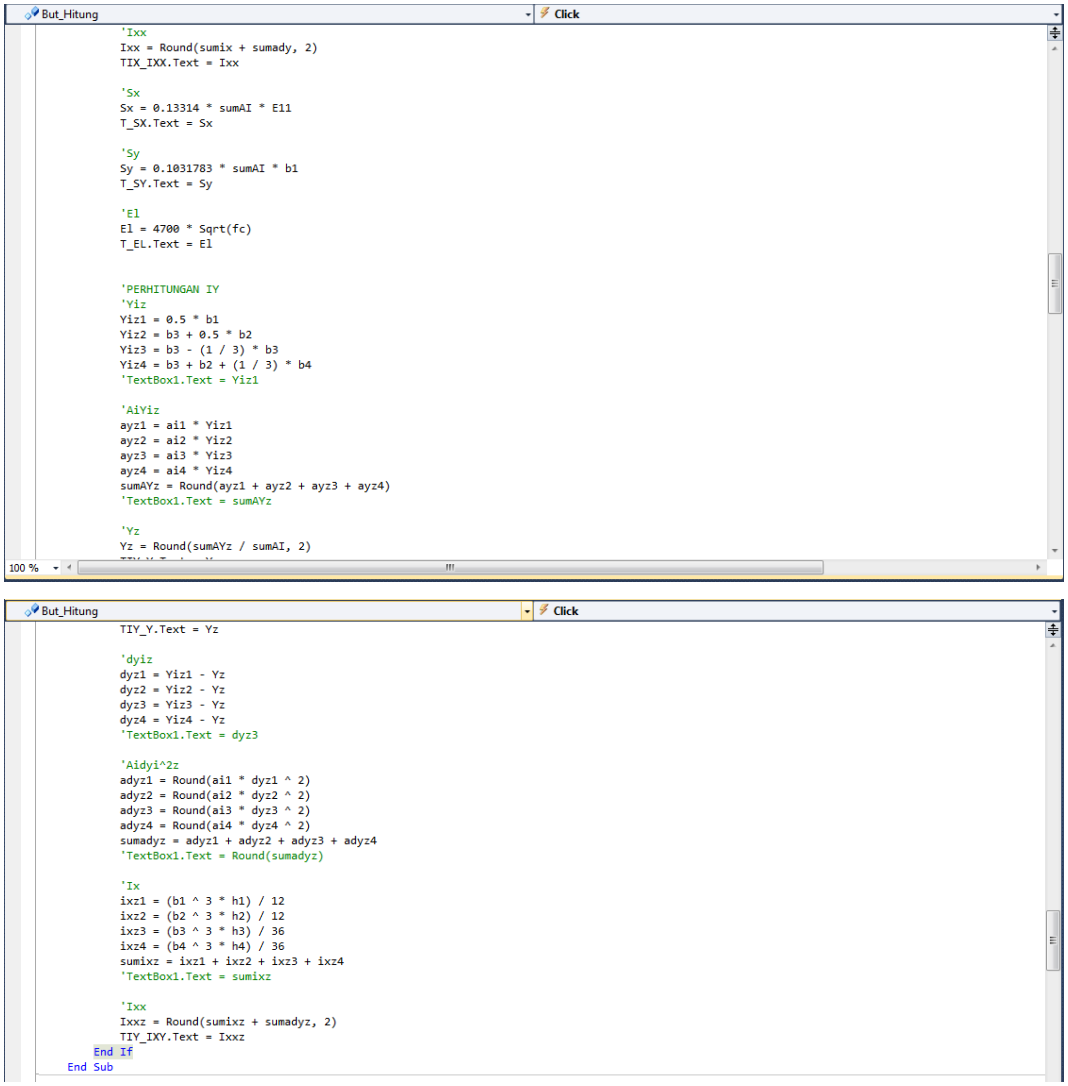
            'AiYi
            ay1 = ai1 * Yi1
            ay2 = ai2 * Yi2
            ay3 = ai3 * Yi3
            ay4 = ai4 * Yi4
            sumAY = Round(ay1 + ay2 + ay3 + ay4)
            'TextBox1.Text = sumAY

            'Y
            Y = Round(sumAY / sumAI, 2)
            TIX_Y.Text = Y

            'dyi
            dy1 = Yi1 - Y
            dy2 = Yi2 - Y
            dy3 = Yi3 - Y
            dy4 = Yi4 - Y
            'TextBox1.Text = dy2

            'Aidyi^2
            ady1 = Round(ai1 * dy1 ^ 2)
            ady2 = Round(ai2 * dy2 ^ 2)
            ady3 = Round(ai3 * dy3 ^ 2)
            ady4 = Round(ai4 * dy4 ^ 2)
            sumady = ady1 + ady2 + ady3 + ady4
            'TextBox1.Text = Round(sumady)

            'Ix
            ix1 = (b1 * h1 ^ 3) / 12
            ix2 = (b2 * h2 ^ 3) / 12
            ix3 = (b3 * h3 ^ 3) / 36
            ix4 = (b4 * h4 ^ 3) / 36
            sumix = ix1 + ix2 + ix3 + ix4
            'TextBox1.Text = sumix
```



```
But_Hitung                                   Click

            'Ixx
            Ixx = Round(sumix + sumady, 2)
            TIX_IXX.Text = Ixx

            'Sx
            Sx = 0.13314 * sumAI * E11
            T_SX.Text = Sx

            'Sy
            Sy = 0.1031783 * sumAI * b1
            T_SY.Text = Sy

            'El
            El = 4700 * Sqrt(fc)
            T_EL.Text = El


            'PERHITUNGAN IY
            'Yiz
            Yiz1 = 0.5 * b1
            Yiz2 = b3 + 0.5 * b2
            Yiz3 = b3 - (1 / 3) * b3
            Yiz4 = b3 + b2 + (1 / 3) * b4
            'TextBox1.Text = Yiz1

            'AiYiz
            ayz1 = ai1 * Yiz1
            ayz2 = ai2 * Yiz2
            ayz3 = ai3 * Yiz3
            ayz4 = ai4 * Yiz4
            sumAYz = Round(ayz1 + ayz2 + ayz3 + ayz4)
            'TextBox1.Text = sumAYz

            'Yz
            Yz = Round(sumAYz / sumAI, 2)
100 %
```



```
But_Hitung                                   Click

            TIY_Y.Text = Yz

            'dyiz
            dyz1 = Yiz1 - Yz
            dyz2 = Yiz2 - Yz
            dyz3 = Yiz3 - Yz
            dyz4 = Yiz4 - Yz
            'TextBox1.Text = dyz3

            'Aidyi^2z
            adyz1 = Round(ai1 * dyz1 ^ 2)
            adyz2 = Round(ai2 * dyz2 ^ 2)
            adyz3 = Round(ai3 * dyz3 ^ 2)
            adyz4 = Round(ai4 * dyz4 ^ 2)
            sumadyz = adyz1 + adyz2 + adyz3 + adyz4
            'TextBox1.Text = Round(sumadyz)

            'Ix
            ixz1 = (b1 ^ 3 * h1) / 12
            ixz2 = (b2 ^ 3 * h2) / 12
            ixz3 = (b3 ^ 3 * h3) / 36
            ixz4 = (b4 ^ 3 * h4) / 36
            sumixz = ixz1 + ixz2 + ixz3 + ixz4
            'TextBox1.Text = sumixz

            'Ixx
            Ixxz = Round(sumixz + sumadyz, 2)
            TIY_IXY.Text = Ixxz
        End If
    End Sub
```

Gambar 4-24 Jendela Pengkodean T Girder
(Sumber: Dokumentasi Pribadi)

A. Pengkodean Momen Inersia (Ix) T Girder

1. B (Lebar segmen penampang)

b1 = TB1.Text

b2 = TB2.Text

b3 = TB3.Text

b4 = TB4.Text

2. H (Tinggi segmen penampang)

h1 = TH1.Text

```
h2 = TH2.Text

h3 = TH3.Text

h4 = TH4.Text

h5 = TH4.Text
```

3. A_i (Luasan area persegmen)

```
'SUM Ai

ai1 = b1 * h1

ai2 = b2 * h2

ai3 = 0.5 * b3 * h3

ai4 = 0.5 * b4 * h4

sumAI = Round(ai1 + ai2 + ai3 + ai4)

'TextBox1.Text = sumAI
```

4. Y_i (Jarak titik berat segmen terhadap sumbu)

```
'Yi

Yi1 = E11 - 0.5 * h1

Yi2 = 0.5 * h2

Yi3 = h2 - (1 / 3) * h3

Yi4 = h2 - (1 / 3) * h4

'TextBox1.Text = Yi4
```

5. A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)

```
'AiYi
```

```
ay1 = ai1 * Yi1

ay2 = ai2 * Yi2

ay3 = ai3 * Yi3

ay4 = ai4 * Yi4

sumAY = Round(ay1 + ay2 + ay3 + ay4)

'TextBox1.Text = sumAY
```

6. dy_i (besaran titik berat segmen terhadap titik berat penampang)

```
'dyi

dy1 = Yi1 - Y

dy2 = Yi2 - Y

dy3 = Yi3 - Y

dy4 = Yi4 - Y

'TextBox1.Text = dy2
```

7. $A_i dy_i$ (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)

```
'Aidyi^2

ady1 = Round(ai1 * dy1 ^ 2)

ady2 = Round(ai2 * dy2 ^ 2)

ady3 = Round(ai3 * dy3 ^ 2)

ady4 = Round(ai4 * dy4 ^ 2)

sumady = ady1 + ady2 + ady3 + ady4

'TextBox1.Text = Round(sumady)
```

8. Ix (Momen Inersia Persegmen Penampang)

```
'Ix
ix1 = (b1 * h1 ^ 3) / 12
ix2 = (b2 * h2 ^ 3) / 12
ix3 = (b3 * h3 ^ 3) / 36
ix4 = (b4 * h4 ^ 3) / 36
sumix = ix1 + ix2 + ix3 + ix4
'TextBox1.Text = sumix
```

9. ȳ (Garis netral / titik berat)

```
'Y
Y = Round(sumAY / sumAI, 2)
TIX_Y.Text = Y
```

10. Modulus Penampang (Sx)

```
'Sx
Sx = 0.13314 * sumAI * E11
T_SX.Text = Sx
```

11. **I_{xx} (Momen Inersia)**

```
'Ixx
Ixxz = Round(sumixz + sumadyz, 2)
TIY_IXY.Text = Ixxz
```

B. Pengkodean Momen Inersia (Iy) T Girder

1. A_i (Luasan area persegmen)

```
'SUM Ai
ai1 = b1 * h1
ai2 = b2 * h2
ai3 = 0.5 * b3 * h3
ai4 = 0.5 * b4 * h4
sumAI = Round(ai1 + ai2 + ai3 + ai4)
'TextBox1.Text = sumAI
```

2. **Y_i (Jarak titik berat segmen terhadap sumbu)**

```
'Yiz
Yiz1 = 0.5 * b1
Yiz2 = b3 + 0.5 * b2
Yiz3 = b3 - (1 / 3) * b3
Yiz4 = b3 + b2 + (1 / 3) * b4
```

3. **A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)**

```
'AiYiz
ayz1 = ai1 * Yiz1
ayz2 = ai2 * Yiz2
ayz3 = ai3 * Yiz3
ayz4 = ai4 * Yiz4
sumAYz = Round(ayz1 + ayz2 + ayz3 + ayz4)
'TextBox1.Text = sumAYz
```

4. **dy_i (besaran titik berat segmen terhadap titik berat penampang)**

```
'dyiz
dyz1 = Yiz1 - Yz
dyz2 = Yiz2 - Yz
dyz3 = Yiz3 - Yz
dyz4 = Yiz4 - Yz
'TextBox1.Text = dyz3
```

5. **A_idy_i (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)**

```
 'Aidyi^2z
adyz1 = Round(ai1 * dyz1 ^ 2)
adyz2 = Round(ai2 * dyz2 ^ 2)
adyz3 = Round(ai3 * dyz3 ^ 2)
adyz4 = Round(ai4 * dyz4 ^ 2)
sumadyz = adyz1 + adyz2 + adyz3 + adyz4
'TextBox1.Text = Round(sumadyz)
```

6. **Ix (Momen Inersia Persegmen Penampang)**

```
'Ix
ixz1 = (b1 ^ 3 * h1) / 12
ixz2 = (b2 ^ 3 * h2) / 12
ixz3 = (b3 ^ 3 * h3) / 36
ixz4 = (b4 ^ 3 * h4) / 36
sumixz = ixz1 + ixz2 + ixz3 + ixz4
```

'TextBox1.Text = sumixz

7. E (Modulus Elastisitas)

'El

El = 4700 * Sqrt(fc)

T_EL.Text = El

8. Modulus Penampang (Sy)

'Sy

Sy = 0.1031783 * sumAI * b1

T_SY.Text = Sy

9. I_{xx} (Momen Inersia)

'Ixx

Ixxz = Round(sumixz + sumadyz, 2)

TIY_IXY.Text = Ixxz

4.4.3 Input Kode Pada Penampang Box Girder

Input kode perhitungan *box girder* dapat dilakukan dengan cara *double* klik pada *command button* Hitung lalu mulai isi dengan bahasa pemrograman agar perhitungan pada *Microsoft excel* dapat diterjemahkan oleh *visual basic*.

Tabel 4-13 Tabel Perhitungan Manual (Ix) Box Girder

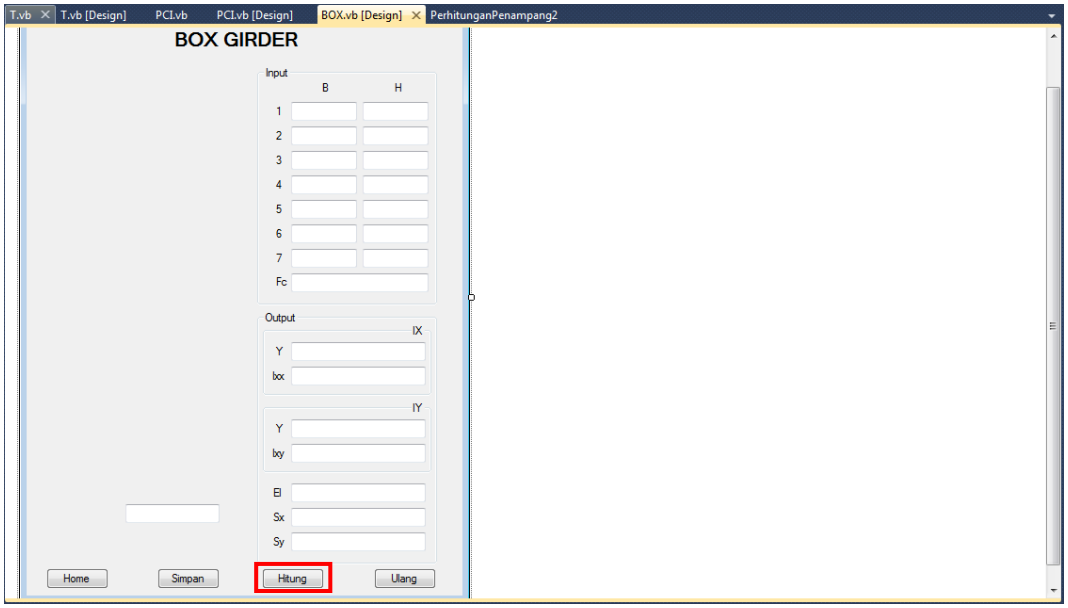
		IX						
Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
100	10	1	1000	55	55000	16.18518519	261960.2	8333.333333
10	5	2	25	46.666667	1166.667	7.851851852	1541.289	34.72222222
10	5	3	25	46.666667	1166.667	7.851851852	1541.289	34.72222222
80	5	4	400	2.5	1000	-36.31481481	527506.3	833.3333333
5	40	5	200	25	5000	-13.81481481	38169.82	26666.66667
5	40	6	200	25	5000	-13.81481481	38169.82	26666.66667
80	5	7	400	47.5	19000	8.685185185	30172.98	833.3333333
		Σ	2250		87333.33		899061.7	63402.8
		Y	38.814815					
		Ixx	962464.5					

(Sumber: Data Pribadi)

Tabel 4-14 Tabel Perhitungan Manual (Iy) Box Girder

		IY						
Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
100	10	1	1000	50	50000	0	0	833333.3333
10	5	2	25	6.6666667	166.6667	-43.33333333	46944.44	138.8888889
10	5	3	25	93.333333	2333.333	43.33333333	46944.44	138.8888889
80	5	4	400	50	20000	0	0	213333.3333
5	40	5	200	12.5	2500	-37.5	281250	416.6666667
5	40	6	200	87.5	17500	37.5	281250	416.6666667
80	5	7	400	50	20000	0	0	213333.3333
	60	Σ	2250		112500		656388.9	1261111.1
		Y	50					
		Ixx	1917500.0					

(Sumber: Data Pribadi)



Gambar 4-25 Form Visual Basic Untuk Box Girder
(Sumber: Dokumentasi Pribadi)

Pada penampang *box girder* textbox di peruntukan untuk menginput penampang serta sebagai pengganti tabel perhitungan di Microsoft excel agar memudahkan penulis dalam proses perhitungan.

Setelah mengklik command button di atas maka akan muncul jendela pengkodean seperti yang tertera pada gambar di bawah ini.

But_Hitung | Click

```
Private Sub But_Hitung_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles But_Hitung.Click
    If TB1.Text = "" Or TB2.Text = "" Or TB3.Text = "" Or TB4.Text = "" Or TB5.Text = "" Or TB6.Text = "" Or TB7.Text = "" Or TH1.Text = "" Or TH2.Te
        MsgBox("Input tidak boleh kosong!")
    Else

        'PERHITUNGAN IX
        'parsing
        b1 = TB1.Text
        b2 = TB2.Text
        b3 = TB3.Text
        b4 = TB4.Text
        b5 = TB5.Text
        b6 = TB6.Text
        b7 = TB7.Text
        h1 = TH1.Text
        h2 = TH2.Text
        h3 = TH3.Text
        h4 = TH4.Text
        h5 = TH5.Text
        h6 = TH6.Text
        h7 = TH7.Text
        fc = TFc.Text

        'SUM Ai
        ai1 = b1 * h1
        ai2 = 0.5 * b2 * h2
        ai3 = 0.5 * b3 * h3
        ai4 = b4 * h4
        ai5 = b5 * h5
        ai6 = b6 * h6
        ai7 = b7 * h7
        sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6 + ai7)
        'TextBox1.Text = sumAI

        'E11
```

100 %

But_Hitung | Click

```
        E11 = (h1 + h2 + h4 + h5)
        'TextBox1.Text = E11

        'Yi
        Yi1 = E11 - 0.5 * h1
        Yi2 = h4 + h5 + (1 / 3) * h2
        Yi3 = h4 + h5 + (1 / 3) * h3
        Yi4 = 0.5 * h4
        Yi5 = h4 + (0.5 * h5)
        Yi6 = h4 + (0.5 * h5)
        Yi7 = E11 - h1 - (0.5 * h7)
        'TextBox1.Text = Yi7

        'AiYi
        ay1 = ai1 * Yi1
        ay2 = ai2 * Yi2
        ay3 = ai3 * Yi3
        ay4 = ai4 * Yi4
        ay5 = ai5 * Yi5
        ay6 = ai6 * Yi6
        ay7 = ai7 * Yi7
        sumAY = Round(ay1 + ay2 + ay3 + ay4 + ay5 + ay6 + ay7)
        'TextBox1.Text = sumAY

        'Y
        Y = Round(sumAY / sumAI, 2)
        TIX_Y.Text = Y

        'dyi
        dy1 = Yi1 - Y
        dy2 = Yi2 - Y
        dy3 = Yi3 - Y
        dy4 = Yi4 - Y
        dy5 = Yi5 - Y
        dy6 = Yi6 - Y
```

100 %

But_Hitung | Click

```
        dy7 = Round(Yi7 - Y, 8)
        'TextBox1.Text = dy6

        'Aidyi^2
        ady1 = Round(ai1 * dy1 ^ 2)
        ady2 = Round(ai2 * dy2 ^ 2)
        ady3 = Round(ai3 * dy3 ^ 2)
        ady4 = Round(ai4 * dy4 ^ 2)
        ady5 = Round(ai5 * dy5 ^ 2)
        ady6 = Round(ai6 * dy6 ^ 2)
        ady7 = Round(ai7 * dy7 ^ 2)
        sumady = ady1 + ady2 + ady3 + ady4 + ady5 + ady6 + ady7
        'TextBox1.Text = Round(sumady)

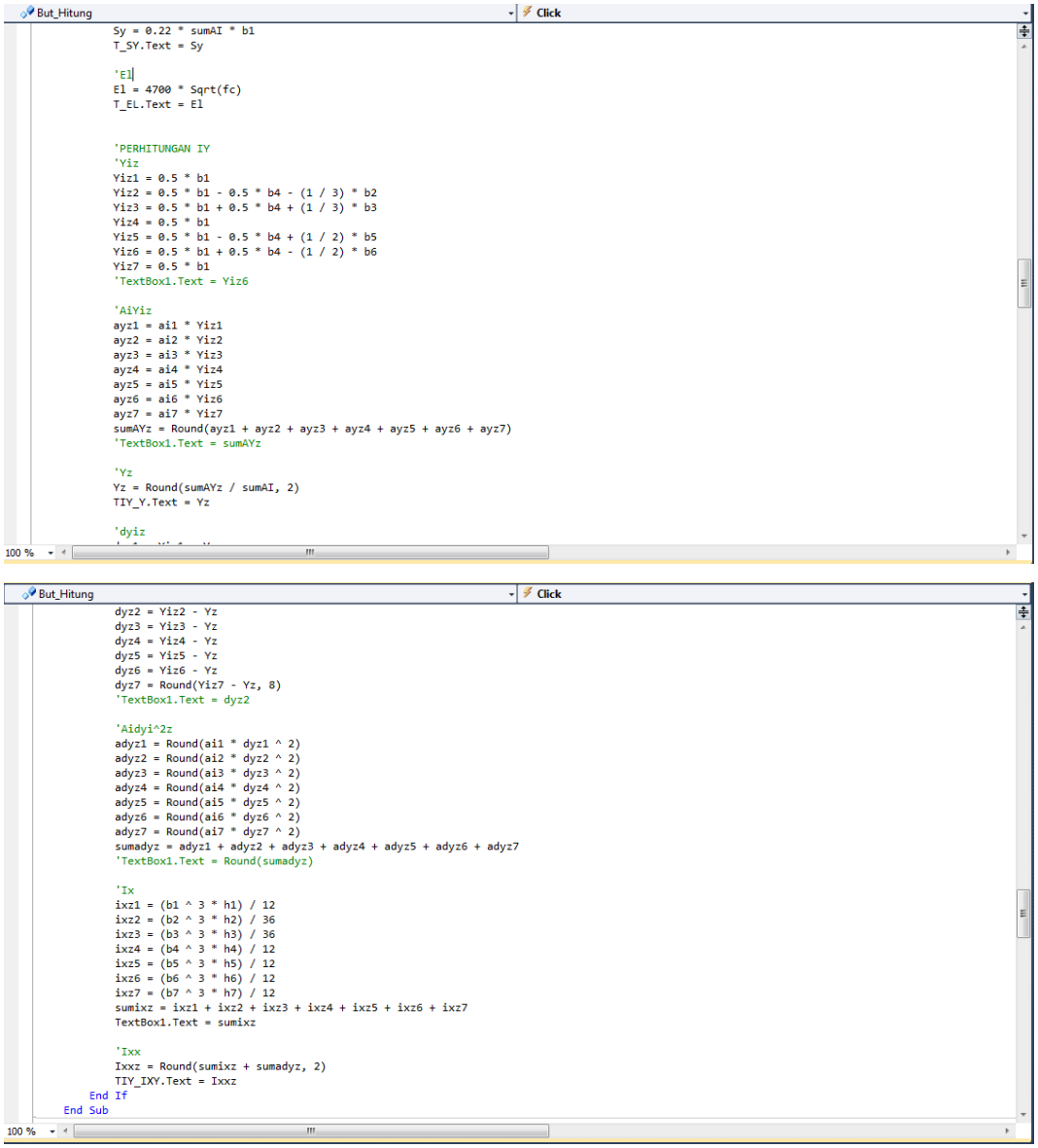
        'Ix
        ix1 = (b1 * h1 ^ 3) / 12
        ix2 = (b2 * h2 ^ 3) / 36
        ix3 = (b3 * h3 ^ 3) / 36
        ix4 = (b4 * h4 ^ 3) / 12
        ix5 = (b5 * h5 ^ 3) / 12
        ix6 = (b6 * h6 ^ 3) / 12
        ix7 = (b7 * h7 ^ 3) / 12
        sumix = ix1 + ix2 + ix3 + ix4 + ix5 + ix6 + ix7
        'TextBox1.Text = sumix

        'Ixx
        Ixx = Round(sumix + sumady, 2)
        TIX_IXX.Text = Ixx

        'Sx
        Sx = 0.22 * sumAI * E11
        T_SX.Text = Sx

        'Sy
        Sy = 0.22 * sumAI * b1
```

100 %



```
But_Hitung                                                    Click
            Sy = 0.22 * sumAI * b1
            T_SY.Text = Sy

            'El
            El = 4700 * Sqrt(fc)
            T_EL.Text = El


            'PERHITUNGAN IY
            'Yiz
            Yiz1 = 0.5 * b1
            Yiz2 = 0.5 * b1 - 0.5 * b4 - (1 / 3) * b2
            Yiz3 = 0.5 * b1 + 0.5 * b4 + (1 / 3) * b3
            Yiz4 = 0.5 * b1
            Yiz5 = 0.5 * b1 - 0.5 * b4 + (1 / 2) * b5
            Yiz6 = 0.5 * b1 + 0.5 * b4 - (1 / 2) * b6
            Yiz7 = 0.5 * b1
            'TextBox1.Text = Yiz6

            'AiYiz
            ayz1 = ai1 * Yiz1
            ayz2 = ai2 * Yiz2
            ayz3 = ai3 * Yiz3
            ayz4 = ai4 * Yiz4
            ayz5 = ai5 * Yiz5
            ayz6 = ai6 * Yiz6
            ayz7 = ai7 * Yiz7
            sumAYz = Round(ayz1 + ayz2 + ayz3 + ayz4 + ayz5 + ayz6 + ayz7)
            'TextBox1.Text = sumAYz

            'Yz
            Yz = Round(sumAYz / sumAI, 2)
            TIY_Y.Text = Yz

            'dyiz
100 %
```



```
But_Hitung                                                    Click
            dyz2 = Yiz2 - Yz
            dyz3 = Yiz3 - Yz
            dyz4 = Yiz4 - Yz
            dyz5 = Yiz5 - Yz
            dyz6 = Yiz6 - Yz
            dyz7 = Round(Yiz7 - Yz, 8)
            'TextBox1.Text = dyz2

            'Aidyi^2z
            adyz1 = Round(ai1 * dyz1 ^ 2)
            adyz2 = Round(ai2 * dyz2 ^ 2)
            adyz3 = Round(ai3 * dyz3 ^ 2)
            adyz4 = Round(ai4 * dyz4 ^ 2)
            adyz5 = Round(ai5 * dyz5 ^ 2)
            adyz6 = Round(ai6 * dyz6 ^ 2)
            adyz7 = Round(ai7 * dyz7 ^ 2)
            sumadyz = adyz1 + adyz2 + adyz3 + adyz4 + adyz5 + adyz6 + adyz7
            'TextBox1.Text = Round(sumadyz)

            'Ix
            ixz1 = (b1 ^ 3 * h1) / 12
            ixz2 = (b2 ^ 3 * h2) / 36
            ixz3 = (b3 ^ 3 * h3) / 36
            ixz4 = (b4 ^ 3 * h4) / 12
            ixz5 = (b5 ^ 3 * h5) / 12
            ixz6 = (b6 ^ 3 * h6) / 12
            ixz7 = (b7 ^ 3 * h7) / 12
            sumixz = ixz1 + ixz2 + ixz3 + ixz4 + ixz5 + ixz6 + ixz7
            TextBox1.Text = sumixz

            'Ixx
            Ixxz = Round(sumixz + sumadyz, 2)
            TIY_IXY.Text = Ixxz
        End If
    End Sub
100 %
```

Gambar 4-26 Jendela Pengkodean Box Girder
(Sumber: Dokumentasi Pribadi)

Dimana:

b s/d h : Pengganti variable untuk textbox panjang dan lebar.

Val(Text) : Penerjemahan textbox agar terbaca sebagai nilai (*value*)

Text_.text : Tempat menginput dan memunculkan hasil perhitungan.

Textbox digunakan untuk menginput luasan area penampang (b dan h) seperti pada Microsoft excel.

A. **Pengkodean Momen Inersia (Ix) Box Girder**

1. **B (Lebar segmen penampang)**

   b1 = TB1.Text

   b2 = TB2.Text

   b3 = TB3.Text

   b4 = TB4.Text

   b5 = TB5.Text

   b6 = TB6.Text

   b7 = TB7.Text

2. **H (Tinggi segmen penampang)**

   h1 = TH1.Text

   h2 = TH2.Text

   h3 = TH3.Text

   h4 = TH4.Text

   h5 = TH5.Text

   h6 = TH6.Text

   h7 = TH7.Text

3. **A_i (Luasan area persegmen)**

   'SUM Ai

   ai1 = b1 * h1

   ai2 = 0.5 * b2 * h2

   ai3 = 0.5 * b3 * h3

   ai4 = b4 * h4

```
ai5 = b5 * h5

ai6 = b6 * h6

ai7 = b7 * h7

sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6 + ai7)

'TextBox1.Text = sumAI
```

4. **Y_i (Jarak titik berat segmen terhadap sumbu)**

```
'Yi

Yi1 = E11 - 0.5 * h1

Yi2 = h4 + h5 + (1 / 3) * h2

Yi3 = h4 + h5 + (1 / 3) * h3

Yi4 = 0.5 * h4

Yi5 = h4 + (0.5 * h5)

Yi6 = h4 + (0.5 * h5)

Yi7 = E11 - h1 - (0.5 * h7)

'TextBox1.Text = Yi7
```

5. **A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)**

```
 'AiYi

ay1 = ai1 * Yi1

ay2 = ai2 * Yi2

ay3 = ai3 * Yi3

ay4 = ai4 * Yi4
```

```
ay5 = ai5 * Yi5

ay6 = ai6 * Yi6

ay7 = ai7 * Yi7

sumAY = Round(ay1 + ay2 + ay3 + ay4 + ay5 + ay6 + ay7)

'TextBox1.Text = sumAY
```

6. **Y (Titik berat)**

```
'Y

Y = Round(sumAY / sumAI, 2)

TIX_Y.Text = Y
```

7. **dy_i (besaran titik berat segmen terhadap titik berat penampang)**

```
'dyi

dy1 = Yi1 - Y

dy2 = Yi2 - Y

dy3 = Yi3 - Y

dy4 = Yi4 - Y

dy5 = Yi5 - Y

dy6 = Yi6 - Y

dy7 = Round(Yi7 - Y, 8)

'TextBox1.Text = dy6
```

8. **$A_i dy_i$ (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)**

```
'Aidyi^2

ady1 = Round(ai1 * dy1 ^ 2)
```

```
ady2 = Round(ai2 * dy2 ^ 2)

ady3 = Round(ai3 * dy3 ^ 2)

ady4 = Round(ai4 * dy4 ^ 2)

ady5 = Round(ai5 * dy5 ^ 2)

ady6 = Round(ai6 * dy6 ^ 2)

ady7 = Round(ai7 * dy7 ^ 2)

sumady = ady1 + ady2 + ady3 + ady4 + ady5 + ady6 + ady7

'TextBox1.Text = Round(sumady)
```

9. Ix (Momen Inersia Persegmen Penampang)

```
'Ix

ix1 = (b1 * h1 ^ 3) / 12

ix2 = (b2 * h2 ^ 3) / 36

ix3 = (b3 * h3 ^ 3) / 36

ix4 = (b4 * h4 ^ 3) / 12

ix5 = (b5 * h5 ^ 3) / 12

ix6 = (b6 * h6 ^ 3) / 12

ix7 = (b7 * h7 ^ 3) / 12

sumix = ix1 + ix2 + ix3 + ix4 + ix5 + ix6 + ix7

'TextBox1.Text = sumix
```

10. Modulus Penampang (Sx)

```
'Sx

Sx = 0.22 * sumAI * E11

T_SX.Text = Sx
```

11. Modulus Elastisitas (E)

```
'El

El = 4700 * Sqrt(fc)

T_EL.Text = El
```

12. I_{xx} (Momen Inersia)

```
'Ixx

Ixx = Round(sumix + sumady, 2)

TIX_IXX.Text = Ixx
```

B. **Pengkodean Momen Inersia (Iy) Box Girder**

1. A_i (Luasan area persegmen)

```
'SUM Ai

ai1 = b1 * h1

ai2 = 0.5 * b2 * h2

ai3 = 0.5 * b3 * h3

ai4 = b4 * h4

ai5 = b5 * h5

ai6 = b6 * h6

ai7 = b7 * h7

sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6 + ai7)

'TextBox1.Text = sumAI
```

2. Y_i (Jarak titik berat segmen terhadap sumbu)

```
'Yiz
```

```
Yiz1 = 0.5 * b1

Yiz2 = 0.5 * b1 - 0.5 * b4 - (1 / 3) * b2

Yiz3 = 0.5 * b1 + 0.5 * b4 + (1 / 3) * b3

Yiz4 = 0.5 * b1

Yiz5 = 0.5 * b1 - 0.5 * b4 + (1 / 2) * b5

Yiz6 = 0.5 * b1 + 0.5 * b4 - (1 / 2) * b6

Yiz7 = 0.5 * b1

'TextBox1.Text = Yiz6
```

3. **A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)**

```
'AiYiz

ayz1 = ai1 * Yiz1

ayz2 = ai2 * Yiz2

ayz3 = ai3 * Yiz3

ayz4 = ai4 * Yiz4

ayz5 = ai5 * Yiz5

ayz6 = ai6 * Yiz6

ayz7 = ai7 * Yiz7

sumAYz = Round(ayz1 + ayz2 + ayz3 + ayz4 + ayz5 + ayz6 + ayz7)

'TextBox1.Text = sumAYz
```

4. **Y (Titik berat)**

```
'Yz

Yz = Round(sumAYz / sumAI, 2)
```

```
TIY_Y.Text = Yz
```

5. dy_i (besaran titik berat segmen terhadap titik berat penampang)

```
'dyiz
dyz1 = Yiz1 - Yz
dyz2 = Yiz2 - Yz
dyz3 = Yiz3 - Yz
dyz4 = Yiz4 - Yz
dyz5 = Yiz5 - Yz
dyz6 = Yiz6 - Yz
dyz7 = Round(Yiz7 - Yz, 8)
'TextBox1.Text = dyz2
```

6. $A_i dy_i$ (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)

```
'Aidyi^2z
adyz1 = Round(ai1 * dyz1 ^ 2)
adyz2 = Round(ai2 * dyz2 ^ 2)
adyz3 = Round(ai3 * dyz3 ^ 2)
adyz4 = Round(ai4 * dyz4 ^ 2)
adyz5 = Round(ai5 * dyz5 ^ 2)
adyz6 = Round(ai6 * dyz6 ^ 2)
adyz7 = Round(ai7 * dyz7 ^ 2)
sumadyz = adyz1 + adyz2 + adyz3 + adyz4 + adyz5 + adyz6 + adyz7
'TextBox1.Text = Round(sumadyz)
```

7. Ix (Momen Inersia Persegmen Penampang)

```
'Ix

ixz1 = (b1 ^ 3 * h1) / 12

ixz2 = (b2 ^ 3 * h2) / 36

ixz3 = (b3 ^ 3 * h3) / 36

ixz4 = (b4 ^ 3 * h4) / 12

ixz5 = (b5 ^ 3 * h5) / 12

ixz6 = (b6 ^ 3 * h6) / 12

ixz7 = (b7 ^ 3 * h7) / 12

sumixz = ixz1 + ixz2 + ixz3 + ixz4 + ixz5 + ixz6 + ixz7

TextBox1.Text = sumixz
```

8. Modulus Penampang (Sy)

```
'Sy

Sy = 0.22 * sumAI * b1

T_SY.Text = Sy
```

9. I_{xy} (Momen Inersia)

```
'Ixx

Ixxz = Round(sumixz + sumadyz, 2)

TIY_IXY.Text = Ixxz
```

4.4.4 Input Kode Pada Penampang U Girder

Adapun perhitungan manual menggunakan Microsoft excel untuk penampang U girder adalah sebagai berikut:

Tabel 4-15 Tabel Perhitungan Manual (Ix) U Girder

Ix								
Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	2000	140	280000	137.2	9411920	66666.66667
15	20	2	300	123.3333	37000	103.8666667	809121.3	6666.666667
20	20	3	800	120	96000	97.2	1889568	26666.66667
15	20	4	300	123.3333	37000	103.8666667	809121.3	6666.666667
20	90	9	3600	65	234000	-12.8	147456	2430000
150	20	11	3000	10	30000	-61.4	11309880	100000
		Σ	10000		714000		24377067	2636666.7
		Y	71.4					
		Ixx	27170986					

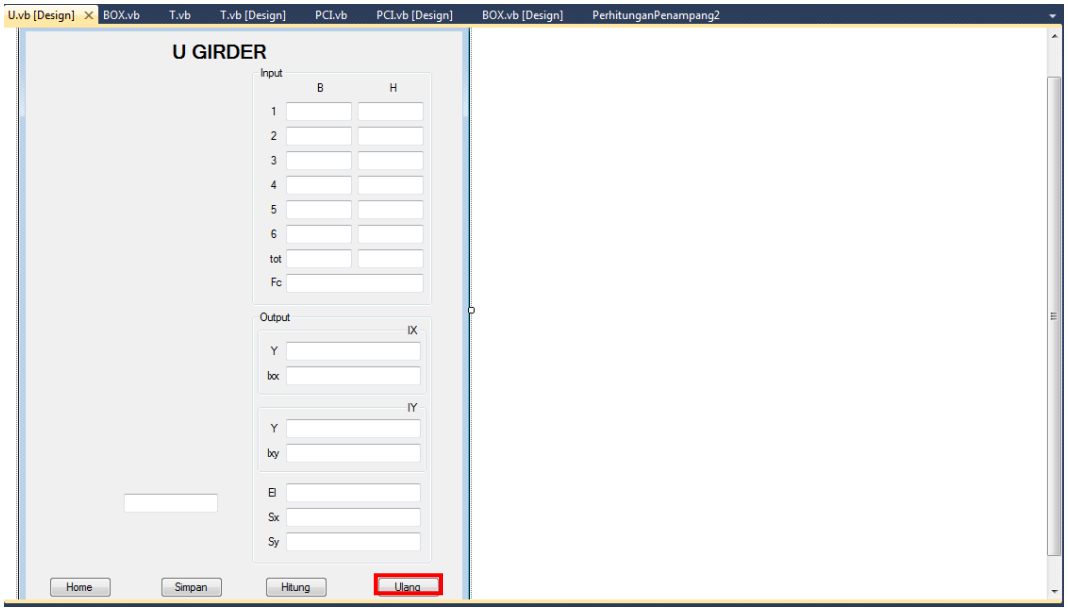
(Sumber: Data Pribadi)

Tabel 4-16 Tabel Perhitungan Manual (Iy) U Girder

Iy								
Input		Garis netral				Momen Inersia		
b	h	No	Ai	Yi	AiYi	dyi	Aidyi^2	Ix
50	20	1	2000	25	50000	-65.78947368	8656510	208333.3333
15	20	2	150	10	1500	-80.78947368	979040.9	1875
20	20	3	800	25	20000	-65.78947368	3462604	13333.33333
15	20	4	150	40	6000	-50.78947368	386935.6	1875
50	20	5	1000	175	175000	84.21052632	7091413	208333.3333
15	20	6	150	160	24000	69.21052632	718514.5	1875
20	20	7	400	175	70000	84.21052632	2836565	13333.33333
15	20	8	150	190	28500	99.21052632	1476409	1875
20	90	9	1800	45	81000	-45.78947368	3774017	60000
20	90	10	1800	155	279000	64.21052632	7421385	60000
150	20	11	3000	100	300000	9.210526316	254501.4	5625000
		Σ	11400		1035000		37057895	6195833.3
		Y	90.78947					
		Iyy	43859280					

(Sumber: Data Pribadi)

Untuk penampang U girder terdapat text box yang di peruntukan untuk menginput penampang serta sebagai pengganti tabel perhitungan di Microsoft excel agar memudahkan penulis dalam proses perhitungan.



Gambar 4-27 Form Visual Basic Untuk U Girder
(Sumber: Dokumentasi Pribadi)

Setelah mengklik command button (hitung) di atas maka akan muncul jendela pengkodean seperti yang tertera pada gambar di bawah ini dan dimulai untuk mengisikan pengkodean perhitungan program.

But_Hitung | Click

```
'PERHITUNGAN IX
'parsing
b1 = TB1.Text
b2 = TB2.Text
b3 = TB3.Text
b4 = TB4.Text
b5 = TB5.Text
b6 = TB6.Text
h1 = TH1.Text
h2 = TH2.Text
h3 = TH3.Text
h4 = TH4.Text
h5 = TH5.Text
h6 = TH6.Text
fc = TFc.Text
btot = tbtot.Text
htot = thtot.Text

'SUM Ai
ai1 = (b1 * h1) * 2
ai2 = ((b2 * h2) / 2) * 2
ai3 = (b3 * h3) * 2
ai4 = (0.5 * b4 * h4) * 2
ai5 = (b5 * h5) * 2
ai6 = (b6 * h6)
sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6)
'TextBox1.Text = sumAI

'E11
E11 = (h1 + h2 + h5 + h6)
'TextBox1.Text = E11

'Yi
Yi1 = E11 - 0.5 * h1
Yi2 = E11 - h1 - ((1 / 3) * h2)
Yi3 = E11 - h1 - 0.5 * h3
Yi4 = E11 - h1 - ((1 / 3) * h4)
Yi5 = h6 + (0.5 * h5)
Yi6 = 0.5 * h6
'TextBox1.Text = Yi6

'AiYi
ay1 = ai1 * Yi1
ay2 = ai2 * Yi2
ay3 = ai3 * Yi3
ay4 = ai4 * Yi4
ay5 = ai5 * Yi5
ay6 = ai6 * Yi6
sumAY = Round(ay1 + ay2 + ay3 + ay4 + ay5 + ay6)
'TextBox1.Text = sumAY

'Y
Y = Round(sumAY / sumAI, 2)
TIX_Y.Text = Y

'dyi
dy1 = (Yi1 - Y) * 2
dy2 = (Yi2 - Y) * 2
dy3 = (Yi3 - Y) * 2
dy4 = (Yi4 - Y) * 2
dy5 = (Yi5 - Y) * 2
dy6 = Yi6 - Y
'TextBox1.Text = dy6

'Aidyi^2
ady1 = Round((0.5 * ai1) * (0.5 * dy1) ^ 2) * 2
ady2 = Round((0.5 * ai2) * (0.5 * dy2) ^ 2) * 2
ady3 = Round((0.5 * ai3) * (0.5 * dy3) ^ 2) * 2
ady4 = Round((0.5 * ai4) * (0.5 * dy4) ^ 2) * 2
ady5 = Round((0.5 * ai5) * (0.5 * dy5) ^ 2) * 2
ady6 = Round(ai6 * dy6 ^ 2)
sumady = ady1 + ady2 + ady3 + ady4 + ady5 + ady6
'TextBox1.Text = Round(sumady)

'Ix
ix1 = ((b1 * h1 ^ 3) / 12) * 2
ix2 = ((b2 * h2 ^ 3) / 36) * 2
ix3 = ((b3 * h3 ^ 3) / 12) * 2
ix4 = ((b4 * h4 ^ 3) / 36) * 2
ix5 = ((b5 * h5 ^ 3) / 12) * 2
ix6 = (b6 * h6 ^ 3) / 12
sumix = ix1 + ix2 + ix3 + ix4 + ix5 + ix6
'TextBox1.Text = sumix

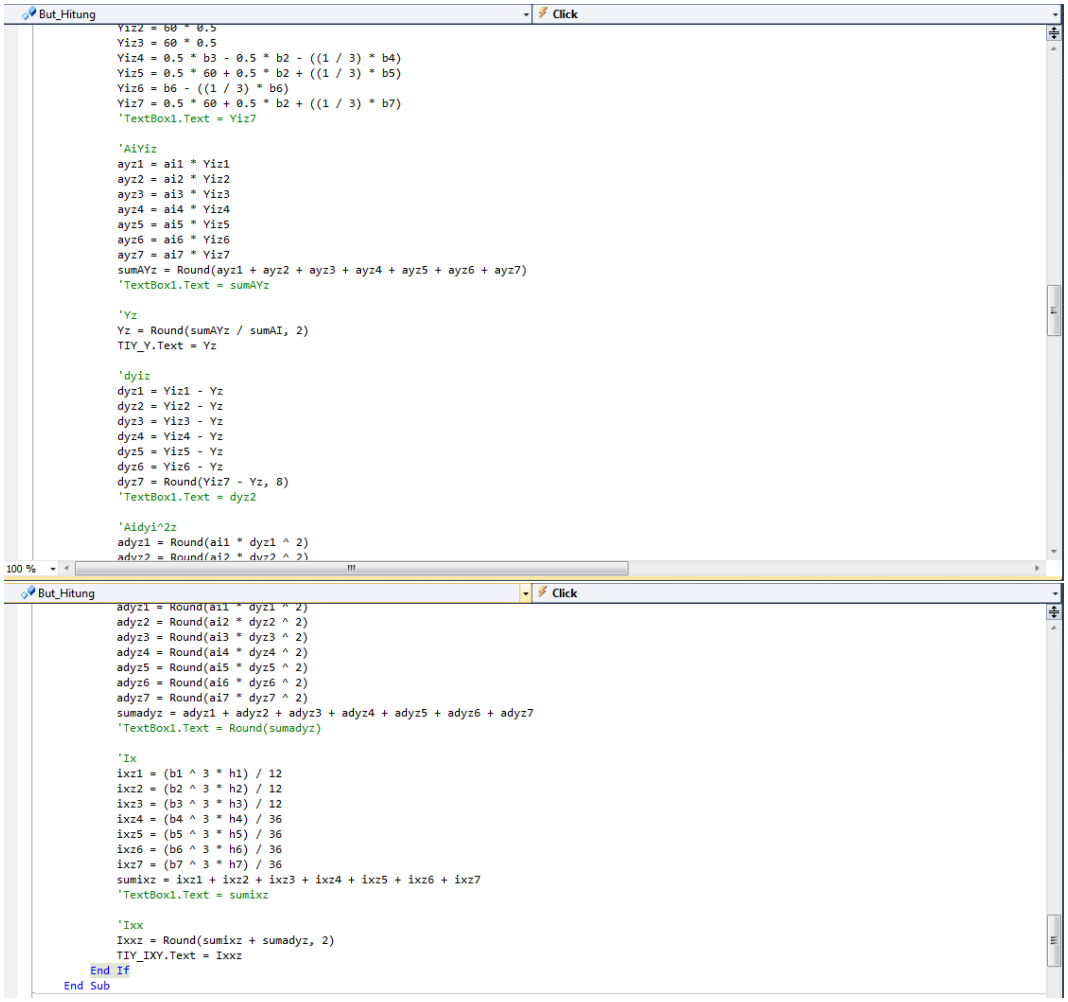
'Ixx
Ixx = Round((sumix + sumady) * 1.0058212)
TIX_IXX.Text = Ixx

'Sx
Sx = 0.229929 * sumAI * htot
T_SX.Text = Sx

'Sy
Sy = 0.219296 * sumAI * btot
T_SY.Text = Sy

'El
El = 4700 * Sqrt(fc)
T_EL.Text = El


'PERHITUNGAN IY
'Yiz
Yiz1 = b6 + 0.5 * b2
Yiz2 = 60 * 0.5
```



Gambar 4-28 Jendela Pengkodean U Girder
(Sumber: Dokumentasi Pribadi)

Dimana:

b s/d h : Pengganti variable untuk textbox panjang dan lebar

Val(Text) : Penerjemahan textbox agar terbaca sebagai nilai (*value*)

Text_.text : Tempat menginput dan memunculkan hasil perhitungan.

Textbox 1 sampai dengan textbox 11 dan textbox 49 digunakan untuk menginput luasan area penampang (b dan h) seperti pada Microsoft excel.

A. **Pengkodean Momen Inersia (Ix) U Girder**

1. **B (Lebar segmen penampang)**

   b1 = TB1.Text

   b2 = TB2.Text

```
b3 = TB3.Text

b4 = TB4.Text

b5 = TB5.Text

b6 = TB6.Text
```

2. H (Tinggi segmen penampang)

```
h1 = TH1.Text

h2 = TH2.Text

h3 = TH3.Text

h4 = TH4.Text

h5 = TH5.Text

h6 = TH6.Text
```

3. A_i (Luasan area persegmen)

```
'SUM Ai

ai1 = (b1 * h1) * 2

ai2 = ((b2 * h2) / 2) * 2

ai3 = (b3 * h3) * 2

ai4 = (0.5 * b4 * h4) * 2

ai5 = (b5 * h5) * 2

ai6 = (b6 * h6)

sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6)

'TextBox1.Text = sumAI
```

4. **Y_i (Jarak titik berat segmen terhadap sumbu)**

```
'Yi
Yi1 = E11 - 0.5 * h1
Yi2 = E11 - h1 - ((1 / 3) * h2)
Yi3 = E11 - h1 - 0.5 * h3
Yi4 = E11 - h1 - ((1 / 3) * h4)
Yi5 = h6 + (0.5 * h5)
Yi6 = 0.5 * h6
'TextBox1.Text = Yi6
```

5. **A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)**

```
'AiYi
ay1 = ai1 * Yi1
ay2 = ai2 * Yi2
ay3 = ai3 * Yi3
ay4 = ai4 * Yi4
ay5 = ai5 * Yi5
ay6 = ai6 * Yi6
sumAY = Round(ay1 + ay2 + ay3 + ay4 + ay5 + ay6)
'TextBox1.Text = sumAY
```

6. **Y (Titik berat)**

```
'Y
Y = Round(sumAY / sumAI, 2)
```

```
TIX_Y.Text = Y
```

7. dy_i (besaran titik berat segmen terhadap titik berat penampang)

```
'dyi
dy1 = (Yi1 - Y) * 2
dy2 = (Yi2 - Y) * 2
dy3 = (Yi3 - Y) * 2
dy4 = (Yi4 - Y) * 2
dy5 = (Yi5 - Y) * 2
dy6 = Yi6 - Y
'TextBox1.Text = dy6
```

8. $A_i dy_i$ (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)

```
'Aidyi^2
ady1 = Round((0.5 * ai1) * (0.5 * dy1) ^ 2) * 2
ady2 = Round((0.5 * ai2) * (0.5 * dy2) ^ 2) * 2
ady3 = Round((0.5 * ai3) * (0.5 * dy3) ^ 2) * 2
ady4 = Round((0.5 * ai4) * (0.5 * dy4) ^ 2) * 2
ady5 = Round((0.5 * ai5) * (0.5 * dy5) ^ 2) * 2
ady6 = Round(ai6 * dy6 ^ 2)
sumady = ady1 + ady2 + ady3 + ady4 + ady5 + ady6
'TextBox1.Text = Round(sumady)
```

9. Ix (Momen Inersia Persegmen Penampang)

```
'Ix
ix1 = ((b1 * h1 ^ 3) / 12) * 2
ix2 = ((b2 * h2 ^ 3) / 36) * 2
ix3 = ((b3 * h3 ^ 3) / 12) * 2
ix4 = ((b4 * h4 ^ 3) / 36) * 2
ix5 = ((b5 * h5 ^ 3) / 12) * 2
ix6 = (b6 * h6 ^ 3) / 12
sumix = ix1 + ix2 + ix3 + ix4 + ix5 + ix6
'TextBox1.Text = sumix
```

10. Modulus Penampang (Sx)

```
'Sx
Sx = 0.229929 * sumAI * htot
T_SX.Text = Sx
```

11. Modulus Elastisitas (E)

```
'El
El = 4700 * Sqrt(fc)
T_EL.Text = El
```

12. I_{xx} (Momen Inersia)

```
'Ixx
Ixx = Round((sumix + sumady) * 1.0058212)
TIX_IXX.Text = Ixx
```

B. **Pengkodean Momen Inersia (Iy) Box Girder**

10. A_i (Luasan area persegmen)

```
'SUM Ai

ai1 = b1 * h1

ai2 = 0.5 * b2 * h2

ai3 = 0.5 * b3 * h3

ai4 = b4 * h4

ai5 = b5 * h5

ai6 = b6 * h6

ai7 = b7 * h7

sumAI = Round(ai1 + ai2 + ai3 + ai4 + ai5 + ai6 + ai7)

'TextBox1.Text = sumAI
```

11. Y_i (Jarak titik berat segmen terhadap sumbu)

```
'Yiz

Yiz1 = b6 + 0.5 * b2

Yiz2 = 60 * 0.5

Yiz3 = 60 * 0.5

Yiz4 = 0.5 * b3 - 0.5 * b2 - ((1 / 3) * b4)

Yiz5 = 0.5 * 60 + 0.5 * b2 + ((1 / 3) * b5)

Yiz6 = b6 - ((1 / 3) * b6)

Yiz7 = 0.5 * 60 + 0.5 * b2 + ((1 / 3) * b7)

'TextBox1.Text = Yiz7
```

12. A_iY_i (Luasan area persegmen dikali dengan jarak titikberat segmen terhadap sumbu)

```
'AiYiz

ayz1 = ai1 * Yiz1

ayz2 = ai2 * Yiz2

ayz3 = ai3 * Yiz3

ayz4 = ai4 * Yiz4

ayz5 = ai5 * Yiz5

ayz6 = ai6 * Yiz6

ayz7 = ai7 * Yiz7

sumAYz = Round(ayz1 + ayz2 + ayz3 + ayz4 + ayz5 + ayz6 + ayz7)

'TextBox1.Text = sumAYz
```

13. Y (Titik berat)

```
'Yz

Yz = Round(sumAYz / sumAI, 2)

TIY_Y.Text = Yz
```

14. dy_i (besaran titik berat segmen terhadap titik berat penampang)

```
'dyiz

dyz1 = Yiz1 - Yz

dyz2 = Yiz2 - Yz

dyz3 = Yiz3 - Yz

dyz4 = Yiz4 - Yz

dyz5 = Yiz5 - Yz
```

```
dyz6 = Yiz6 - Yz

dyz7 = Round(Yiz7 - Yz, 8)

'TextBox1.Text = dyz2
```

15. $A_i dy_i$ (luasan area persegmen dikali Besaran titik berat segmen terhadap titik berat penampang)

```
'Aidyi^2z

adyz1 = Round(ai1 * dyz1 ^ 2)

adyz2 = Round(ai2 * dyz2 ^ 2)

adyz3 = Round(ai3 * dyz3 ^ 2)

adyz4 = Round(ai4 * dyz4 ^ 2)

adyz5 = Round(ai5 * dyz5 ^ 2)

adyz6 = Round(ai6 * dyz6 ^ 2)

adyz7 = Round(ai7 * dyz7 ^ 2)

sumadyz = adyz1 + adyz2 + adyz3 + adyz4 + adyz5 + adyz6 + adyz7

'TextBox1.Text = Round(sumadyz)
```

16. Ix (Momen Inersia Persegmen Penampang)

```
'Ix

ixz1 = (b1 ^ 3 * h1) / 12

ixz2 = (b2 ^ 3 * h2) / 12

ixz3 = (b3 ^ 3 * h3) / 12

ixz4 = (b4 ^ 3 * h4) / 36

ixz5 = (b5 ^ 3 * h5) / 36

ixz6 = (b6 ^ 3 * h6) / 36

ixz7 = (b7 ^ 3 * h7) / 36
```

```
sumixz = ixz1 + ixz2 + ixz3 + ixz4 + ixz5 + ixz6 + ixz7

'TextBox1.Text = sumixz
```

17. Modulus Penampang (Sy)

```
'Sy

Sy = 0.219296 * sumAI * btot

T_SY.Text = Sy
```

18. I_{xy} (Momen Inersia)

```
'Ixx

Ixxz = Round(sumixz + sumadyz, 2)

TIY_IXY.Text = Ixxz
```