

ภาคผนวก

ตารางที่ 1

Parameter ที่ใช้คำนวณออกแบบ

ชั้น คุณภาพ ของเหล็ก เสริม	เหล็กเสริม			คอนกรีต				n	k	j	R ksc
	f_y ksc	f_s ksc	E_s ksc	f'_c ksc	ตัว คูณ	$\beta f'_c$ ksc	E_c ksc				
SR-24	2,400	1,200	2,040,000	145	0.45	65.25	183,153	11	0.734	0.875	10.687
SR-24	2,400	1,200	2,040,000	150	0.45	67.50	186,284	11	0.382	0.873	11.257
SR-24	2,400	1,200	2,040,000	175	0.45	78.75	201,209	10	0.396	0.868	13.541
SR-24	2,400	1,200	2,040,000	180	0.45	81.00	204,064	10	0.403	0.866	14.129
SR-24	2,400	1,200	2,040,000	210	0.45	94.50	220,414	9	0.415	0.862	16.889
SR-24	2,400	1,200	2,040,000	240	0.45	108.00	235,632	9	0.448	0.851	20.561
SR-24	2,400	1,200	2,040,000	280	0.45	126.00	254,512	8	0.457	0.848	24.384
SR-24	2,400	1,200	2,040,000	300	0.45	135.00	263,445	8	0.474	0.842	26.925
SD-30	3,000	1,500	2,040,000	145	0.45	65.25	183,153	11	0.324	0.892	9.420
SD-30	3,000	1,500	2,040,000	150	0.45	67.50	186,284	11	0.331	0.890	9.941
SD-30	3,000	1,500	2,040,000	175	0.45	78.75	201,209	10	0.344	0.885	12.000
SD-30	3,000	1,500	2,040,000	180	0.45	81.00	204,064	10	0.351	0.883	12.541
SD-30	3,000	1,500	2,040,000	210	0.45	94.50	220,414	9	0.362	0.879	15.035
SD-30	3,000	1,500	2,040,000	240	0.45	108.00	235,632	9	0.393	0.869	18.450
SD-30	3,000	1,500	2,040,000	280	0.45	126.00	254,512	8	0.402	0.866	21.928
SD-30	3,000	1,500	2,040,000	300	0.45	135.00	263,445	8	0.419	0.860	24.313
SD-40	4,000	1,700	2,040,000	145	0.45	65.25	183,153	11	0.297	0.901	8.727
SD-40	4,000	1,700	2,040,000	150	0.45	67.50	186,284	11	0.304	0.899	9.220
SD-40	4,000	1,700	2,040,000	175	0.45	78.75	201,209	10	0.317	0.894	11.150
SD-40	4,000	1,700	2,040,000	180	0.45	81.00	204,064	10	0.323	0.892	11.664
SD-40	4,000	1,700	2,040,000	210	0.45	94.50	220,414	9	0.333	0.889	14.005
SD-40	4,000	1,700	2,040,000	240	0.45	108.00	235,632	9	0.364	0.879	17.262
SD-40	4,000	1,700	2,040,000	280	0.45	126.00	254,512	8	0.372	0.876	20.541
SD-40	4,000	1,700	2,040,000	300	0.45	135.00	263,445	8	0.388	0.871	22.827

SD-50	5,000	1,700	2,040,000	145	0.45	65.25	183,153	11	0.297	0.901	8.727
SD-50	5,000	1,700	2,040,000	150	0.45	67.50	186,284	11	0.304	0.899	9.220
SD-50	5,000	1,700	2,040,000	175	0.45	78.75	201,209	10	0.317	0.894	11.150
SD-50	5,000	1,700	2,040,000	180	0.45	81.00	204,064	10	0.323	0.892	11.664
SD-50	5,000	1,700	2,040,000	210	0.45	94.50	220,414	9	0.333	0.889	14.005
SD-50	5,000	1,700	2,040,000	240	0.45	108.00	235,632	9	0.364	0.879	17.262
SD-50	5,000	1,700	2,040,000	280	0.45	126.00	254,512	8	0.372	0.876	20.541
SD-50	5,000	1,700	2,040,000	300	0.45	135.00	263,445	8	0.388	0.871	22.827



ตารางที่ 2

2-1 จำนวนเส้น และพื้นที่หน้าตัดขวางของเหล็กเสริม

จำนวน เส้น	เส้นผ่านศูนย์กลาง (มิลลิเมตร) และพื้นที่ภาคตัดขวาง (ตารางเซนติเมตร)										
	6	9	10	12	15	16	19	20	25	28	32
1	0.28	0.64	0.79	1.13	1.77	2.01	2.84	3.14	4.91	6.16	8.04
2	0.57	1.27	1.57	2.26	3.53	4.02	5.67	6.28	9.82	12.32	16.08
3	0.85	1.91	2.36	3.39	5.30	6.03	8.51	9.42	14.73	18.47	24.13
4	1.13	2.54	3.14	4.52	7.07	8.04	11.34	12.57	19.63	24.63	32.17
5	1.41	3.18	3.93	5.65	8.84	10.05	14.18	15.71	24.54	30.79	40.21
6	1.70	3.82	4.71	6.79	10.60	12.06	17.01	18.85	29.45	36.95	48.25
7	1.98	4.45	5.50	7.92	12.37	14.07	19.85	21.99	34.36	43.10	56.30
8	2.26	5.09	6.28	9.05	14.14	16.08	22.68	25.13	39.27	49.26	64.34
9	2.54	5.73	7.07	10.18	15.90	18.10	25.52	28.27	44.18	55.42	72.38
10	2.83	6.36	7.85	11.31	17.67	20.10	28.35	31.42	49.09	61.58	80.42
11	3.11	7.00	8.64	12.44	19.44	22.12	31.19	34.56	54.00	67.73	88.47
12	3.39	7.63	9.42	13.57	21.21	24.13	34.02	37.70	58.90	73.89	96.51
13	3.68	8.27	10.21	14.70	22.97	26.14	36.86	40.84	63.81	80.05	104.55
14	3.96	8.91	11.00	15.83	24.74	28.15	36.69	43.98	68.72	86.21	112.59
15	4.24	9.54	11.78	16.96	26.51	30.16	42.53	47.12	73.63	92.36	120.64
16	4.52	10.18	12.57	18.10	28.27	32.17	45.36	50.27	78.54	98.52	128.68
17	4.81	10.81	13.35	19.23	30.04	34.18	48.20	53.41	83.45	104.68	136.72
18	5.09	11.45	14.14	20.36	31.81	36.19	51.04	56.55	88.36	110.84	144.76
19	5.37	12.09	14.92	21.49	33.58	38.20	53.87	56.69	93.27	116.99	152.81
20	5.65	12.72	15.71	22.62	35.34	40.21	56.71	62.83	98.17	123.15	160.85

2-2 เส้นรอบรูปของเหล็กเสริม

จำนวน เส้น	เส้นผ่าศูนย์กลาง (มิลลิเมตร) และ เส้นรอบรูป (เซนติเมตร)										
	6	9	10	12	15	16	19	20	25	28	32
1	1.88	2.83	3.14	3.77	4.71	5.03	5.97	6.28	7.85	8.80	10.05
2	3.77	5.65	6.28	7.54	9.42	10.05	11.94	12.57	15.71	17.59	20.11
3	5.65	8.48	9.42	11.31	14.14	15.08	17.91	18.85	23.56	26.39	30.16
4	7.54	11.31	12.57	15.08	18.85	20.11	23.88	25.13	31.42	35.19	40.21
5	9.42	14.14	15.71	18.85	23.56	25.13	29.85	31.42	39.27	43.98	50.27
6	11.31	16.69	18.85	22.62	28.27	30.16	35.81	37.70	47.12	52.78	60.32
7	13.19	19.79	21.99	26.39	32.99	35.19	41.78	43.98	54.98	61.58	70.37
8	15.08	22.62	25.13	30.16	37.70	40.21	47.75	50.27	62.83	70.37	80.42
9	16.96	25.45	28.27	33.93	42.41	45.24	53.72	56.55	70.69	79.17	90.48
10	18.85	28.27	31.42	37.70	47.12	50.27	59.96	62.83	78.54	87.96	100.53
11	20.73	31.10	34.56	41.47	51.84	55.29	65.66	69.12	86.39	97.76	110.58
12	22.62	33.93	37.70	45.24	56.55	60.32	71.63	75.40	94.25	105.56	120.64
13	24.50	36.76	40.84	49.01	61.62	65.35	77.60	81.68	102.10	114.35	130.69
14	26.39	39.58	43.98	52.78	65.97	70.37	83.57	87.96	109.96	123.15	140.74
15	28.27	42.41	47.12	56.55	70.69	75.40	89.54	94.25	117.81	131.95	150.80
16	30.16	45.24	50.27	60.32	75.40	80.42	95.50	100.53	125.66	140.74	160.85
17	32.04	48.07	53.41	64.09	80.11	85.45	101.47	106.81	133.52	149.54	170.90
18	33.93	50.89	56.55	67.86	84.82	90.48	107.44	113.10	141.37	158.34	180.96
19	35.81	53.72	59.69	71.63	89.54	95.50	113.41	119.38	149.23	167.13	190.01
20	37.70	56.55	62.83	75.40	94.25	100.53	119.38	125.66	157.08	179.93	201.06

2-3 เส้นผ่าศูนย์กลาง ระยะเรียง และพื้นที่ภาคตัดขวางของเหล็กเสริม
ค่าแถบความกว้าง 1 เมตร

ระยะ เรียง (เมตร)	เส้นผ่าศูนย์กลาง (มิลลิเมตร) และพื้นที่ภาคตัดขวาง (ตารางเซนติเมตร)										
	6	9	10	12	15	16	19	20	25	28	32
0.050	5.65	12.72	15.71	22.62	35.34	40.21	56.71	62.83	98.17	123.15	160.85
0.075	3.77	8.48	10.47	15.08	23.56	26.81	37.80	41.89	65.45	82.10	107.23
0.100	2.83	6.36	7.85	11.31	17.67	20.11	28.35	31.42	49.09	61.58	80.42
0.125	2.26	5.09	6.28	9.05	14.14	16.8	22.68	25.13	39.27	49.26	64.34
0.150	1.88	4.24	5.24	7.54	11.78	13.40	18.90	20.94	32.72	41.05	53.62
0.175	1.62	3.64	4.49	6.46	10.10	11.49	16.20	17.95	28.05	35.19	45.96
0.200	1.41	3.18	3.93	5.65	8.84	10.05	14.18	15.71	24.54	30.79	40.21
0.225	1.26	2.83	3.49	5.03	7.85	8.94	12.60	13.96	21.82	27.37	35.74
0.250	1.13	2.54	3.14	4.52	7.07	8.04	11.34	12.57	19.63	24.63	32.17
0.275	1.03	2.31	2.86	4.11	6.43	7.31	10.31	11.42	17.85	22.39	29.25
0.300	0.94	2.12	2.62	3.77	5.89	6.70	9.45	10.47	16.36	20.53	26.81
0.325	0.87	1.96	2.42	3.48	5.44	6.19	8.27	9.67	15.10	18.95	24.75
0.350	0.81	1.82	2.24	3.23	5.05	5.74	8.10	8.98	14.02	17.59	22.98
0.375	0.75	1.70	2.09	3.02	4.71	5.36	7.56	8.38	13.09	16.42	21.45
0.400	0.71	1.59	1.96	2.83	4.42	5.03	7.09	7.85	12.27	15.39	20.11
0.425	0.67	1.50	1.85	2.66	4.16	4.73	6.67	7.39	11.55	14.49	18.92
0.450	0.63	1.41	1.75	2.51	3.93	4.47	6.30	6.98	10.91	13.68	17.87
0.475	0.60	1.34	1.65	2.38	3.72	4.23	5.97	6.61	10.33	12.96	16.93
0.500	0.57	1.27	1.57	2.26	3.53	4.02	5.67	6.28	9.82	12.32	16.08

2-4 เส้นผ่านศูนย์กลาง ระยะเรียง และเส้นรอบรูปของเหล็กเสริมต่อแถบความกว้าง 1 เมตร

ระยะ เรียง (เมตร)	เส้นผ่านศูนย์กลาง (มิลลิเมตร) และพื้นที่ภาคตัดขวาง (ตารางเซนติเมตร)										
	6	9	10	12	15	16	19	20	25	28	32
0.050	37.70	56.55	62.83	75.40	94.25	100.53	119.38	125.66	157.08	175.93	201.06
0.075	25.13	37.70	41.98	50.27	62.83	67.02	79.59	83.78	104.72	117.29	134.04
0.100	18.85	28.27	31.42	37.70	47.12	50.27	59.69	62.83	78.54	87.96	100.53
0.125	15.08	22.62	25.31	30.16	37.70	40.21	47.75	50.27	62.83	70.37	80.42
0.150	12.57	18.85	20.94	25.13	31.42	33.51	39.79	41.89	52.36	58.64	67.02
0.175	10.77	16.16	17.95	21.54	26.93	28.72	34.11	35.90	44.88	50.27	57.45
0.200	9.42	14.14	15.71	18.85	23.56	25.13	29.85	31.42	39.27	43.98	50.27
0.225	8.38	12.57	13.96	16.76	20.94	22.34	26.53	27.93	34.91	39.10	44.68
0.250	7.54	11.31	12.57	15.08	18.85	20.11	23.88	25.13	31.42	35.19	40.21
0.275	6.85	10.28	11.42	13.71	17.14	18.28	21.71	22.85	28.56	31.99	36.56
0.300	6.28	9.42	10.47	12.57	15.71	16.76	19.90	20.94	26.18	29.32	33.51
0.325	5.80	8.70	9.67	11.60	14.50	15.47	18.37	19.33	24.17	27.07	30.93
0.350	5.39	8.08	8.98	10.77	13.46	14.36	17.05	17.95	22.44	25.13	28.72
0.375	5.03	7.45	8.38	10.05	12.57	13.40	15.92	16.67	20.94	23.46	26.81
0.400	4.71	7.07	7.85	9.42	11.78	12.57	14.92	15.71	19.63	21.99	25.13
0.425	4.44	6.65	7.39	8.87	11.09	11.83	14.04	14.78	18.48	20.70	23.65
0.450	4.19	6.28	6.98	8.38	10.47	11.17	13.26	13.96	17.45	19.55	22.34
0.475	3.97	5.95	6.61	7.49	9.92	10.58	12.57	13.23	16.53	18.52	21.16
0.500	3.77	5.65	6.28	7.54	9.42	10.05	11.94	12.57	15.71	17.59	20.11

Modules for Beam Design (Ultimate Theory)

■ การออกแบบคานคอนกรีตเสริมเหล็ก "วิธีกำลัง"

■ Utility

```

TsP[front_, val_] := Prefix[f[val], front];
TsP[front_, val_, unit_] := Flatten[Prefix[f[Prefix[f[unit], val]], front]];
LText[list_] := Apply[StringJoin, Map[ToString, list]];
BlueText[ex_] :=
  DisplayForm[StyleBox[ex, FontColor -> RGBColor[0, 0, 1], FontWeight -> "Bold"]];
RedText[ex_] := DisplayForm[
  StyleBox[ex, FontColor -> RGBColor[1, 0, 0], FontWeight -> "Bold"]];
TsT[front_, val_] := BlueText[TsP[front, val]];
TsT[front_, val_, unit_] := BlueText[TsP[front, val, unit]];
TsB[front_, val_] := DisplayForm[FrameBox[TsT[front, val]]];
TsB[front_, val_, unit_] := DisplayForm[FrameBox[TsT[front, val, unit]]];
RPrint[expr_] := StylePrint[expr, FontWeight -> "Bold", FontColor -> RGBColor[1, 0, 0]];
NRound[x_, digit_: 3] := If[NumericQ[x], N[Round[x*10^digit]/10^digit], x, x];
  
```

■ Input & Parameter

```

InputParameter[dat_] :=
Block[{},
Clear[b, h, cov, L, upper, tie, lower, M, V, T, kg, m, ksc,
cm, type, ค่าแรง, สภาพของ, หล็ก, เหล็ก, SD30, SD40, SD50, SR24, DB, RB];
"-----";
fcp = dat[[1, 1, 2]];
b = dat[[1, 2, 2]];
h = dat[[1, 3, 2]];
cov = dat[[1, 4, 2]];
L = dat[[1, 5, 2]];
"-----";
fyU = fSteel[dat[[2, 2, 2]]][[2]];
fvy = fSteel[dat[[2, 3, 2]]][[2]];
fv = fSteel[dat[[2, 3, 2]]][[3]];
fy = fSteel[dat[[2, 4, 2]]][[2]];
"-----";
upper1 = dSteel[dat[[2, 2, 3]]];
tie = dSteel[dat[[2, 3, 3]]];
lower1 = dSteel[dat[[2, 4, 3]]];
upper2 = dSteel[dat[[2, 2, 4]]];
nleg = dSteel[dat[[2, 3, 4]]];
lower2 = dSteel[dat[[2, 4, 4]]];
"-----";
ConcreteSectionParameter[];
Clear[BCode, BType];
BCode = supportC[dat[[3, 2, 2]], dat[[3, 2, 4]]][[1]];
BType = supportC[dat[[3, 2, 2]], dat[[3, 2, 4]]][[2]];
checkN = CheckNarrowBeam[];
checkD = CheckDeepBeam[];
checkW = CheckDeflection[];
"-----";
M1 = dat[[3, 3, 2]];
V1 = dat[[3, 4, 2]];
resA1 = computeMVT[M1, V1];
"-----";
M2 = dat[[3, 3, 3]];
V2 = dat[[3, 4, 3]];
resA2 = computeMVT[M2, V2];
"-----";
M3 = dat[[3, 3, 4]];
V3 = dat[[3, 4, 4]];
resA3 = computeMVT[M3, V3];
"-----";
];

```

```

fSteel[SRSD_] :=
Block[{},
  SRSD = .;
  If[SRSD == SR24, fyS = 2400; fsS = 1200];
  If[SRSD == SD30, fyS = 3000; fsS = 1500];
  If[SRSD == SD40, fyS = 4000; fsS = 1700];
  If[SRSD == SD50, fyS = 5000; fsS = 1700];
  {SRSD, fyS, fsS}]

dSteel[RBDB_] :=
FromDigits[Select[ToExpression[Characters[ToString[RBDB]]], IntegerQ]]

supportC[end1_, end2_] :=
Block[{},
  If[And[end1 == "S", end2 == "S"],
    BeamType = {1, "คานปลายไม่ต่อเนื่อง"}];
  If[Or[And[end1 == "S", end2 == "C"], And[end1 == "C", end2 == "S"]],
    BeamType = {2, "คานต่อเนื่องหนึ่งปลาย"}];
  If[And[end1 == "C", end2 == "C"],
    BeamType = {3, "คานต่อเนื่องสองปลาย"}];
  If[Or[And[end1 == "C", end2 == "F"], And[end1 == "F", end2 == "C"]],
    BeamType = {4, "คานยื่น"}]; BeamType]

ConcreteSectionParameter[] :=
Block[{},
  ϕ = 0.9;
  ϕs = 0.85;
  β1 = 0.85;
  If[280 < fcp ≤ 560, β1 = 0.85 - 0.05 (fcp - 280) / 70];
  If[fcp > 560, β1 = 0.65];
  d = h - cov - (tie*0.1) -  $\left(\frac{\text{lower}*0.1}{2}\right)$ ;
  dp = cov + (tie*0.1) +  $\left(\frac{\text{upper}*0.1}{2}\right)$ ;
  pb = 0.85 β1  $\frac{fcp}{fy}$   $\frac{6117}{6117 + fy}$ ;
  ρmax = 0.75 pb;
  qmax = ρmax  $\frac{fy}{fcp}$ ;
  Rmax = fcp qmax (1 - 0.59 qmax);
  Mr = 0.01 ϕ Rmax b d^2]

```

■ Check

```

CheckNarrowBeam[] :=
Block[{},
  nRatio = 100. L / b;
  If[nRatio < 30, checkN = {"<30", "(ผ่าน) ไม่เป็นคานแคบ"},
    checkN = {"≥30", "(ไม่ผ่าน) เป็นคานแคบ"}];
  checkN];

```

```

CheckDeepBeam[] :=
Block[{ },
dRatio = h / (100. L);
If[Or[BCode = 1, BCode = 4],
If[dRatio ≥ 0.8,
checkD = { "≥0.8", " (ไม่ผ่าน) เป็นคานาลึก"},
checkD = { "<0.8", " (ผ่าน) ไม่เป็นคานาลึก"} ]];
If[Or[BCode = 2, BCode = 3],
If[dRatio ≥ 0.4,
checkD = { "≥0.4", " (ไม่ผ่าน) เป็นคานาลึก"},
checkD = { "<0.4", " (ผ่าน) ไม่เป็นคานาลึก"} ]];
checkD];

CheckDeflection[] :=
Block[{ },
If[BCode = 1, dw = N[100 L / 16]; checkWT = "L/16"];
If[BCode = 2, dw = N[100 L / 18.5]; checkWT = "L/18.5"];
If[BCode = 3, dw = N[100 L / 21]; checkWT = "L/21"];
If[BCode = 4, dw = N[100 L / 8]; checkWT = "L/8"];
If[d > dw,
{">" <> checkWT, " (ผ่าน) ไม่ต้องการสอบการโก่ง"},
{"≤" <> checkWT, " (ไม่ผ่าน) ต้องการสอบการโก่ง"}];

```

■ Compute

```

ComputeAsBending[] :=
Block[{ },
If[M ≤ Mr,
tq = Solve[q (1 - 0.59 q) ==  $\frac{100 (M / \phi)}{f_{cp} b d^2}$ , q];
ρ = Select[ $\frac{f_{cp}}{f_y} q /. tq$ , 0 < # < ρmax &];
As = Max[b d ρ];
As1 = 0; As2 = 0; As3 = 0];
If[M > Mr,
As1 = b d ρmax;
As2 =  $\frac{100 (M - Mr)}{\phi f_y (d - d_p)}$ ;
As = As1 + As2;
As3 = As2]];

```

```

ComputeAvBending[] :=
Block[{},
"-----เหล็กเสริมด้านทานแรงเฉือน-----";
Av = Pi / 4 * (0.1 tie) ^ 2;
v =  $\frac{V}{b * d}$ ;
vc = 0.53  $\phi$ s  $\sqrt{f_{cp}}$ ;
"-----";
vp = Max[0, v - vc];
Vp = vp * b * d;
nV =  $\frac{100 Vp}{nLeg Av \phi s f_y d}$ ]

ComputeStirrup[] :=
Block[{},
"-----";
If[nV  $\neq$  0, SPACING = 1 / nV, SPACING = 100];
SPACINGMAX =  $\frac{2 Av}{0.0015 (100 b)}$ ;
"-----";
If[v  $\leq$  vc, Sp = Min[SPACING, 0.01 d / 2, 0.60]];
If[0.53  $\phi$ s  $\sqrt{f_{cp}}$  < v  $\leq$  1.59  $\phi$ s  $\sqrt{f_{cp}}$ , Sp = Min[SPACING, 0.01 d / 2, 0.60, SPACINGMAX]];
If[1.59  $\phi$ s  $\sqrt{f_{cp}}$  < v  $\leq$  2.65  $\phi$ s  $\sqrt{f_{cp}}$ , Sp = Min[SPACING, 0.01 d / 4, 0.30, SPACINGMAX]];
"-----";
vCheck = {"<" <> ToString[NRound[2.65  $\phi$ s  $\sqrt{f_{cp}}$ , 2]], RedText["(ผ่าน)"]};
vCheck2 = "<2.65 $\phi$ s $\sqrt{f'_c}$  (ผ่าน)";
If[v > 2.65  $\phi$ s  $\sqrt{f_{cp}}$ ,
vCheck = {">" <> ToString[NRound[2.65  $\phi$ s  $\sqrt{f_{cp}}$ , 2]], RedText["(ไม่ผ่าน)"]};
; vCheck2 = ">2.65 $\phi$ s $\sqrt{f'_c}$  (ไม่ผ่าน)"; Sp = 0]]

ComputeMainSteel[] :=
Block[{},
"-----";
Asmin = 14 b d / fy;
If[As < Asmin,
AsCheck1 = " < "; AsUse1 = Asmin,
AsCheck1 = "  $\geq$  "; AsUse1 = As];
"-----";
AsUse2 = As3]

SteelCheck[dia_: "mm", AsUse1_: "cm2"] :=
Module[{}, As1bar = (Pi / 4) (0.1 dia) ^ 2;
steel = Ceiling[AsUse1 / As1bar];
If[steel  $\leq$  1, steel = 2];
If[steel > 8, steel = "ขนาดเหล็กเสริมไม่เหมาะสม กรุณาเพิ่มขนาดเหล็กเสริม"];
{dia, AsUse1, steel, steel As1bar}]

```

```

computeMVT[Mz_, Vy_] :=
Block[{},
M = Abs[Mz];
signM = Sign[Mz];
V = Vy;
If[signM = 1, upper = upper1; lower = lower1, upper = -lower1; lower = upper1];
ComputeAsBending[];
ComputeAvBending[];
ComputeStirrup[];
ComputeMainSteel[];
steel1 = SteelCheck[lower, AsUse1];
steel2 = SteelCheck[upper, AsUse2];
"-----";
If[signM = 1,
resultA = Map[NRound, {As, As3, v, vc, vp, nV, Ac, z, Ast, vt, nt, vCheck,
vtCheck, Sp, Asmin, AsUse1, AsUse2, steel1, steel2,  $\mu$ CHE1,  $\mu$ CHE2}],
resultA = Map[NRound, {As, As3, v, vc, vp, nV, Ac, z, Ast, vt, nt, vCheck,
vtCheck, Sp, Asmin, AsUse2, AsUse1, steel2, steel1,  $\mu$ CHE2,  $\mu$ CHE1}]];
resultA];

```

■ Print Output

```

printOutput[data_] :=
Module[{}],
Print[{{
  RedText[LText[{"ถู ", data[[2, 1, 1]], " un grid ",
    data[[3, 1, 2]], "-", data[[3, 1, 4]]}],
  LText[{BType, "ม ", L, " m"}],
  LText[{"ขนาด bxh= ", b, "x", h, " cm2"}],
  LText[{"ระยะห่าง= ", cov, " cm"}]],
{BlueText["คอนกรีต  $f'_c$ " <> ToString[fc] <> "ksc"],
  TsP[" $\rho_b$  =",  $\rho_b$ ],
  TsP[" $\rho_{max}$  =",  $\rho_{max}$ ]},
{"", ""},
  TsP[" $R_{u,max}$ =", NRound[Rumax, 3], "ksc"],
  TsP[" $M_{u,max}$ =", Round[Mr], "kg.m"}],
{BlueText[LText[{"เหล็กเสริม ", data[[2, 2, 2]]}],
  LText[{data[[2, 2, 3]], "/", data[[2, 2, 4]]}],
  TsP[" $f_y$ =", fyU, "ksc"]},
{BlueText[LText[{"เหล็กเสา ", data[[2, 3, 2]]}],
  LText[{data[[2, 3, 3]], "(", nLeg, "ม)"}],
  TsP[" $f_y$ =", fvy, "ksc"]},
{BlueText[LText[{"เหล็กเสริม ", data[[2, 4, 2]]}],
  LText[{data[[2, 4, 3]], "/", data[[2, 4, 4]]}],
  TsP[" $f_y$ =", fy, "ksc"]},
{BlueText["ตรวจสอบความเค้น "],
  TsP["L/b=", nRatio, checkN[[1]], RedText[checkN[[2]]]},
{BlueText["ตรวจสอบความเครียด "],
  TsP["h/L=", dRatio, checkD[[1]], RedText[checkD[[2]]]},
{BlueText["การคำนวณการโก่ง "],
  TsP["d=", d, checkW[[1]], RedText[checkW[[2]]]},
{"",
  {RedText["ค่าหน่วย "],
    RedText[data[[3, 1, 2]], RedText["-"], RedText[data[[3, 1, 4]]]},
  {RedText["โมเมนต์ (kg.m)"], M1, M2, M3},
  {RedText["แรงเฉือน(kg)"], V1, V2, V3},
  {BlueText["As (cm2)"],
    LText[{resA1[[1]]}],
    LText[{resA2[[1]]}],
    LText[{resA3[[1]]}]},
  {RedText["vc (ksc)"],
    "0.53 $\phi_s \sqrt{f'_c}$ " <> ToString[NRound[0.53  $\phi_s \sqrt{fc}$ ] ],
    "1.59 $\phi_s \sqrt{f'_c}$ " <> ToString[NRound[1.59  $\phi_s \sqrt{fc}$ ] ],
    "2.65 $\phi_s \sqrt{f'_c}$ " <> ToString[NRound[2.65  $\phi_s \sqrt{fc}$ ] ]},
  {RedText["v (ksc)"],
    ToString[resA1[[3]]] <> resA1[[12, 1]] resA1[[12, 2]],
    ToString[resA2[[3]]] <> resA2[[12, 1]] resA2[[12, 2]],

```

```

ToString[resA3[[3]]] <> resA3[[12, 1]] resA3[[12, 2]]],
{RedText["v-vc(ksc)"],
LText[{resA1[[3]] - resA1[[4]]}],
LText[{resA2[[3]] - resA2[[4]]}],
LText[{resA3[[3]] - resA3[[4]]}]},
{RedText["nV(พุ่มพวง)"],
LText[{resA1[[6]]}],
LText[{resA2[[6]]}],
LText[{resA3[[6]]}]},
{BlueText["Asmin(cm2)"],
LText[{resA1[[15]]}],
LText[{resA2[[15]]}],
LText[{resA3[[15]]}]},
{BlueText["Aupper(cm2)"],
BlueText[LText[{resA1[[17]]}]]],
BlueText[LText[{resA2[[17]]}]]],
BlueText[LText[{resA3[[17]]}]]],
{BlueText["Alower(cm2)"],
BlueText[LText[{resA1[[16]]}]]],
BlueText[LText[{resA2[[16]]}]]],
BlueText[LText[{resA3[[16]]}]]],
{RedText["Upper(cm2)"],
RedText[
LText[{resA1[[19, 3]], data[[2, 2, 3]], "(", NRound[resA1[[19, 4]], 2], ")"}]],
RedText[LText[{resA2[[19, 3]], data[[2, 2, 3]], "(",
NRound[resA2[[19, 4]], 2], ")"}]],
RedText[LText[{resA3[[19, 3]], data[[2, 2, 3]], "(",
NRound[resA3[[19, 4]], 2], ")"}]]],
{RedText["Tie"],
RedText[LText[{data[[2, 3, 3]], "@", resA1[[14]]}]]],
RedText[LText[{data[[2, 3, 3]], "@", resA2[[14]]}]]],
RedText[LText[{data[[2, 3, 3]], "@", resA3[[14]]}]]],
{RedText["Lower(cm2)"],
RedText[
LText[{resA1[[18, 3]], data[[2, 4, 3]], "(", NRound[resA1[[18, 4]], 2], ")"}]],
RedText[LText[{resA2[[18, 3]], data[[2, 4, 3]], "(",
NRound[resA2[[18, 4]], 2], ")"}]],
RedText[LText[{resA3[[18, 3]], data[[2, 4, 3]], "(",
NRound[resA3[[18, 4]], 2], ")"}]]], {""} // TableForm];
"-----";
sect1 = graphicBeam[{0.01 b, 0.01 h, 0.01 cov},
{{lower, resA1[[18, 3]]}, {upper, resA1[[19, 3]]}, {tie, resA1[[14]]}},
{ToString[data[[2, 4, 3]]], ToString[data[[2, 2, 3]]], ToString[data[[2, 3, 3]]]};
sect2 = graphicBeam[{0.01 b, 0.01 h, 0.01 cov},
{{lower, resA2[[18, 3]]}, {upper, resA2[[19, 3]]}, {tie, resA2[[14]]}},
{ToString[data[[2, 4, 3]]], ToString[data[[2, 2, 3]]], ToString[data[[2, 3, 3]]]};
sect3 = graphicBeam[{0.01 b, 0.01 h, 0.01 cov},
{{lower, resA3[[18, 3]]}, {upper, resA3[[19, 3]]}, {tie, resA3[[14]]}},
{ToString[data[[2, 4, 3]]], ToString[data[[2, 2, 3]]], ToString[data[[2, 3, 3]]]};
"-----";
Show[GraphicsArray[{sect1, sect2, sect3}], ImageSize -> 520];

```

■ graphics

```
graphicBeam[{B_, H_, cov_}, {{dLower_, nLower_}, {dUpper_, nUpper_}, {dhoop_, shoop_}},
  RDB_ : {"DB20", "DB20", "RB6"}] :=
Module[{},
  cow = cov + dhoop / 1000;
  envelop = {{0, 0}, {0, H}, {B, H}, {B, 0}, {0, 0}};
  hoop1 = {{cov, cov}, {cov, H - cov}, {B - cov, H - cov}, {B - cov, cov}, {cov, cov}};
  hoop2 = {{cow, cow}, {cow, H - cow}, {B - cow, H - cow}, {B - cow, cow}, {cow, cow}};
  "-----";
  sLower = (B - 2 cov - 0.002 dhoop - 0.001 dLower) / (nLower - 1);
  sUpper = (B - 2 cov - 0.002 dhoop - 0.001 dUpper) / (nUpper - 1);
  coorLow = {1.1 B, cow}; txtLow = ToString[nLower] <> RDB[[1]];
  coorUp = {1.1 B, H - cow}; txtUp = ToString[nUpper] <> RDB[[2]];
  coorHoop = {1.1 B, 0.5 H}; txtHoop = RDB[[3]] <> " @ " <> ToString[shoop];
  "-----";
  Graphics[
    {Line[envelop], Line[hoop1], Line[hoop2],
     Table[Circle[{cow + 0.0005 dLower + i sLower, cow + 0.0005 dLower}, 0.0005 dLower],
           {i, 0, nLower - 1}],
     Table[Circle[{cow + 0.0005 dUpper + i sUpper, H - cow - 0.0005 dUpper}, 0.0005 dUpper],
           {i, 0, nUpper - 1}],
     Text[txtUp, coorUp, {-1, 0}],
     Text[txtLow, coorLow, {-1, 0}],
     Text[txtHoop, coorHoop, {-1, 0}]],
    AspectRatio -> Automatic, PlotRange -> {{-0.1 B, 3.5 B}, {-0.1 H, 1.0 H}}]
```