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LAMPIRAN

LAMPIRAN 1

PERHITUNGAN EXCEL

ANALISIS JEMBATAN PELENGKUNG BAJA

REKAPITULASI GAYA DALAM STRUKTUR

-REKAP GAYA DALAM GELAGAR MEMANJANG

CASE	FX	FY	FZ	MX	MY	MZ
	kN	kN	kN	kNm	kNm	kNm
KUAT I	265.43	0.00	248.71	0.32	1315.27	0.00
KUAT II	240.72	0.00	193.94	0.27	1055.92	0.00
KUAT III	215.73	0.00	65.02	0.14	121.74	0.00
KUAT IV	154.22	0.00	66.55	0.10	149.58	0.00
KUAT V	171.23	0.00	66.10	0.11	144.05	0.00
LAYAN I	194.76	0.00	139.39	0.20	758.52	0.00
LAYAN II	200.58	0.00	180.37	0.24	956.44	0.00
LAYAN III	169.68	0.00	112.69	0.17	632.26	0.00
LAYAN IV	150.32	0.00	51.47	0.09	103.69	0.00
EKSTREM I	981.99	0.00	428.12	0.67	1194.32	0.00
EKSTREM II	136.37	0.00	72.60	0.12	420.64	0.00

-REKAP GAYA DALAM GELAGAR MELINTANG

CASE	FX	FY	FZ	MX	MY	MZ
	kN	kN	kN	kNm	kNm	kNm
KUAT I	0.04	73.82	922.92	210.25	3550.41	94.83
KUAT II	0.04	66.64	836.40	163.52	3084.77	85.66
KUAT III	6.66	66.35	487.36	0.22	1538.46	83.33
KUAT IV	0.03	41.53	533.58	0.14	1577.02	53.76
KUAT V	0.70	48.52	519.14	0.14	1521.24	61.95
LAYAN I	0.24	55.56	603.10	116.81	2243.25	70.94
LAYAN II	0.03	55.70	678.91	151.85	2630.62	71.56
LAYAN III	0.03	46.73	570.76	93.44	2048.57	60.11
LAYAN IV	2.65	44.67	373.10	0.10	1135.85	56.48
EKSTREM I	2.10	265.37	3019.31	58.30	9707.69	342.17
EKSTREM II	0.03	37.36	428.22	58.40	1534.84	48.09

-REKAP GAYA DALAM LATERAL BEAM

CASE	FX	FY	FZ	MX	MY	MZ
	kN	kN	kN	kNm	kNm	kNm
KUAT I	-1711.63	0.12	79.97	5.13	1139.59	0.69
KUAT II	-1549.60	0.11	76.83	4.65	948.89	0.61
KUAT III	-431.14	0.17	249.62	15.32	693.50	74.89
KUAT IV	-982.53	0.08	65.65	2.97	377.40	0.31
KUAT V	-821.61	0.01	42.42	6.49	373.95	21.26
LAYAN I	-1049.87	0.04	43.50	6.12	703.80	16.17
LAYAN II	-1292.33	0.10	59.18	3.84	846.96	0.53
LAYAN III	-1089.81	0.09	55.17	3.24	608.57	0.42
LAYAN IV	-485.94	0.06	47.72	8.45	279.94	37.35
EKSTREM I	-6205.49	5.68	357.21	18.83	2348.60	61.92
EKSTREM II	-873.54	0.07	42.77	2.54	449.76	0.34

-REKAP GAYA DALAM IKATAN ANGIN AKIBAT TARIK

MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
1507	KUAT I	12.78	0.88	-2.03	-1.96	0.70	-3.31
1552	KUAT II	12.37	0.84	-2.08	-1.81	0.62	-3.24
1507	KUAT III	-1483.29	34.22	-27.21	-4.42	-78.90	-98.31
1581	KUAT IV	10.46	-0.28	-2.02	-0.31	1.87	0.74
1507	KUAT V	-416.00	10.29	-9.38	-2.19	-22.27	-30.24
1507	LAYAN I	-310.19	7.90	-7.32	-2.10	-16.59	-23.27
1507	LAYAN II	10.34	0.74	-1.94	-1.53	0.44	-2.90
1552	LAYAN III	9.83	0.70	-2.00	-1.34	0.35	-2.81
1507	LAYAN IV	-738.14	17.38	-14.58	-2.62	-39.41	-50.34
1582	EKSTREM I	71.57	1.40	-40.24	1.28	-18.42	-3.04
1507	EKSTREM II	9.17	0.70	-2.33	-1.16	0.14	-2.96

-REKAP GAYA DALAM IKATAN ANGIN AKIBAT TEKAN

MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
1587	KUAT I	931.12	4.43	4.45	-1.33	-2.29	17.75
1587	KUAT II	836.17	3.99	4.73	-1.31	-4.45	15.96
1508	KUAT III	1505.80	33.19	30.15	-2.34	-171.91	221.92
1584	KUAT IV	503.85	2.42	5.70	-1.25	-11.99	9.69
1584	KUAT V	494.10	2.39	5.38	-0.94	-9.69	9.67
1584	LAYAN I	622.55	2.97	4.19	-0.78	-3.64	11.97
1587	LAYAN II	701.21	3.33	4.23	-0.99	-3.83	13.34
1587	LAYAN III	582.53	2.78	4.58	-0.97	-6.52	11.10
1508	LAYAN IV	757.42	16.33	17.13	-0.76	-91.07	109.59
1587	EKSTREM I	3209.22	15.30	48.54	-6.92	-101.11	61.12
1587	EKSTREM II	462.63	2.20	5.24	-0.79	-9.12	8.78

-REKAP GAYA DALAM RANGKA LENGKUNGAN ATAS

MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
84	KUAT I	18308.5	-44.77	26.23	13.64	106.16	56.68
84	KUAT II	16461.97	-39.12	21.85	10.52	89.77	48.9
84	KUAT III	9541.24	-19.73	8.49	-3.96	30.52	26.74
371	KUAT IV	9999.86	19.32	6.49	0.39	32.42	-21.67
81	KUAT V	9866.96	19.43	-7.06	1.41	31.86	23.11
84	LAYAN I	12299.95	-29.77	16.19	6.6	65.83	38.11
84	LAYAN II	13784.03	-33.92	19.05	9.7	78.53	42.86
84	LAYAN III	11475.88	-26.85	13.56	5.8	58.04	33.14
84	LAYAN IV	7552.24	-15.74	5.79	-2.22	24.31	20.11
84	EKSTREM I	63522.87	-135.08	44.96	-0.9	211.15	156.96
84	EKSTREM II	9111.68	-21.45	9.25	3.31	42.63	26.21

-REKAP GAYA DALAM RANGKA LENGKUNGAN BAWAH

MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
434	KUAT I	19675.85	-0.63	-78.75	-1.92	320.1	-2.72
434	KUAT II	17958.5	-0.56	-71.04	-1.96	290.35	-2.21
434	KUAT III	12473.25	-180.23	-26.73	-253.19	109.36	-1249.92
434	KUAT IV	11947.92	-0.35	-44.05	-2.09	186.19	-0.42
434	KUAT V	12056.26	-51.74	-42.72	-73.83	180.48	-357.42
434	LAYAN I	13651.23	-39.01	-51.81	-55.66	214.09	-269.32
434	LAYAN II	14861.01	-0.51	-58.33	-1.82	239.5	-1.96
434	LAYAN III	12714.38	-0.43	-48.69	-1.87	202.3	-1.32
434	LAYAN IV	9491.32	-90.25	-29.04	-127.49	124.24	-625.05
434	EKSTREM I	74885.05	8.49	-258.07	-3.4	1130.77	92.2
434	EKSTREM II	10227.63	-0.4	-37.1	-2.15	158.59	-0.85

-REKAP GAYA DALAM RANGKA UTAMA VERTIKAL AKIBAT TARIK

MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
192	KUAT I	-405.8	-19.89	18.64	-0.21	-68.1	-103.39
192	KUAT II	-361.36	-17.21	17.02	-0.15	-62.49	-87.93
192	KUAT III	-193.24	-21.67	11.55	0.26	-43.94	-65.73
479	KUAT IV	-205.92	7.82	11.35	-0.07	-42.86	33.84
192	KUAT V	-202.2	-11.77	11.41	0.12	-43.16	-42.95
192	LAYAN I	-263.12	-16.72	12.99	-0.06	-47.88	-76.05
192	LAYAN II	-299.1	-15.76	14.16	-0.15	-51.86	-80.8
192	LAYAN III	-243.54	-12.41	12.14	-0.07	-44.85	-61.49
192	LAYAN IV	-148.35	-13.97	8.99	0.15	-34.17	-46.52
192	EKSTREM I	-1202.56	-69.73	72.74	0.33	-274.85	-308.62
192	EKSTREM II	-182.06	-11.01	9.9	-0.03	-36.85	-52.7

-REKAP GAYA DALAM RANGKA UTAMA VERTIKAL AKIBAT TEKAN

MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
171	KUAT I	6241.33	-3.35	-56.20	-0.02	-242.38	4.47
171	KUAT II	5690.54	-3.34	-51.37	-0.02	-221.31	4.35
458	KUAT III	3830.53	-117.36	-39.59	-0.46	-168.69	773.72
211	KUAT IV	3762.61	-3.33	34.48	0.01	147.54	3.92
458	KUAT V	3845.84	-31.15	-35.71	-0.13	-152.64	218.27
498	LAYAN I	4366.07	-22.79	39.72	0.08	170.94	162.73
171	LAYAN II	4711.91	-3.07	-42.44	-0.02	-183.00	4.01
171	LAYAN III	4023.33	-3.07	-36.41	-0.01	-156.66	3.86
458	LAYAN IV	3033.75	-57.28	-29.02	-0.23	-123.92	385.21
171	EKSTREM I	23595.99	-23.62	-214.69	0.60	-923.66	71.57
171	EKSTREM II	3223.09	-3.41	-29.16	-0.01	-125.42	4.09

-REKAP GAYA DALAM RANGKA UTAMA DIAGONAL AKIBAT TARIK

MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
527	KUAT I	-3228.5	3.15	-35.7	0.21	130.26	18.44
527	KUAT II	-2969.34	3.17	-32.47	0.21	119.32	18.61
527	KUAT III	-2040.09	-73.1	-16.2	29.04	71.46	-215.63
527	KUAT IV	-2062.12	3.24	-21.17	0.21	81	19.19
527	KUAT V	-2109.01	-18.57	-21.26	8.45	82.16	-47.91
527	LAYAN I	-2279.32	-13.47	-24.02	6.37	90.29	-33.2
527	LAYAN II	-2434.67	2.88	-26.27	0.19	97.34	16.99
527	LAYAN III	-2110.65	2.9	-22.23	0.19	83.65	17.2
527	LAYAN IV	-1646.32	-35.23	-15.13	14.61	61.75	-99.89
269	EKSTREM I	-12649.44	34.47	-119.05	3.03	481.96	201.28
269	EKSTREM II	-1695.6	3.21	-16.71	0.21	65.64	19.19

-REKAP GAYA DALAM RANGKA UTAMA DIAGONAL AKIBAT TEKAN

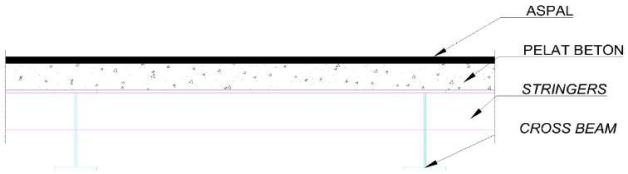
MEMBER	CASE	FX kN	FY kN	FZ kN	MX kNm	MY kNm	MZ kNm
555	KUAT I	383.41	-0.49	36.08	-0.1	153.24	1.88
555	KUAT II	303.95	-0.47	31.94	-0.1	137.56	1.72
287	KUAT III	-26.07	4.18	-2.26	0.09	5.56	-35.91
555	KUAT IV	25.65	-0.4	17.44	-0.09	82.66	1.16
242	KUAT V	60.61	-15.48	16.36	1.49	78.16	67.05
242	LAYAN I	253.94	-11.72	22.38	1.09	99.35	50.84
555	LAYAN II	283.2	-0.43	26.24	-0.09	114.25	1.55
555	LAYAN III	183.79	-0.4	21.06	-0.08	94.64	1.35
242	LAYAN IV	57.46	-26.76	10.51	2.67	53.76	116.33
555	EKSTREM I	360.61	-0.3	95.99	-0.16	503.18	24.59
555	EKSTREM II	128.37	-0.43	15.1	-0.09	73.23	1.3

-REKAP GAYA AXIAL HANGERS

MEMBER	Beban mati	BTR	BGT	Total
	FX (kN)	FX (kN)	FX (kN)	FX (kN)
1627	227.95	351.81	229.73	809.49
1628	245.79	384.79	245.97	876.55
1629	246.57	389.7	246.66	882.93
1630	245.87	390.44	246.32	882.63
1631	245.04	389.91	245.71	880.66
1632	244.5	389.24	245.17	878.91
1633	244.27	388.82	244.68	877.77
1634	244.4	388.9	244.28	877.58
1635	244.78	389.43	243.87	878.08
1636	245.46	390.43	243.6	879.49
1637	246.28	391.6	243.71	881.59
1638	246.45	391.59	244.14	882.18
1639	244.89	388.65	245.08	878.62
1640	240.46	380.9	246.92	868.28
1641	231.52	365.97	249.06	846.55
1642	217.62	343.63	250.44	811.69
1643	199.27	315.34	247.63	762.24
1644	191.3	303.23	246.58	741.11
1645	184.4	293.21	242.3	719.91

PERENCANAAAN GELAGAR MEMANJANG JEMBATAN

-PERENCANAAN GELAGAR MEMANJANG



-DESAIN RENCANA GELAGAR MEMANJANG DENGAN L = 5 M

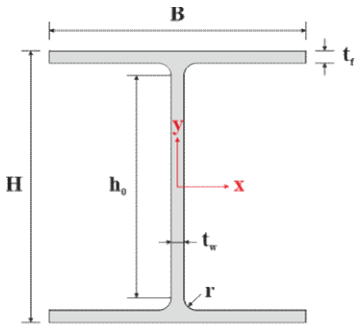
Panjang gelagar memanjang	L =	5	m
Jarak antar gelagar memanjang	s =	1.5	m

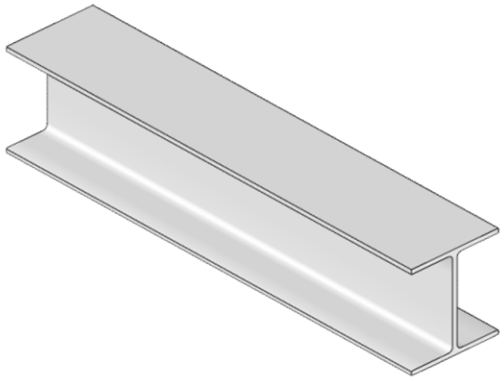
-KARAKTERISTIK MATERIAL

Tegangan leleh	f_y =	250	MPa
Tegangan putus	f_u =	410	MPa
Modulus elastisitas	E =	200000	MPa
Modulus geser	G =	76923	MPa

-SIFAT-SIFAT PENAMPANG

Digunakan **WF. 769.8 X 268 . 15.6 . 25.4**





Tinggi	H =	769.8	mm
Lebar sayap	B =	268	mm
Tebal web	t_w =	15.6	mm
Tebal flange	t_f =	25.4	mm
Radius	r =	16.5	mm
Tinggi web	h_o =	686	mm
Luas penampang	A_x =	25064	mm^2
Berat penampang	W_x =	1.930	kN/m
Inersia X	I_x =	2400000000	mm^4
Inersia Y	I_y =	81750000	mm^4
Modulus penampang plastis sumbu-x	Z_x =	7167000	mm^3
Modulus penampang elastis sumbu x	S_x =	6234000	mm^3
Radius girasi sumbu y	r_y =	57.1	mm
Konstanta torsi	$J = 1/3 \times (H - 2 \times t_f) \times t_w^3 + 2 \times 1/3 \times B \times t_f^3$ =	3837696	mm^4
Konstanta pilin	$C_w = (I_y \times (H - 2 \times t_f)^2) / 4$ =	10565390437500	mm^6
Radius girasi efektif	$r_{ts}^2 = \sqrt{(I_y \times C_w)} / S_x$ =	4714	mm^2

-PEMBEBANAN GELAGAR MEMANJANG JEMBATAN

-Material, Faktor Beban, dan Geometri Pembebanan

Berat jenis beton	ρ_{beton} =	24	kN/m^3
Berat jenis aspal	ρ_{aspal} =	22	kN/m^3
Tebal pelat beton	$t_{pelat\ beton}$ =	0.2	m
Tebal aspal	t_{aspal} =	0.07	m
Faktor beban sendiri	γ^u_{MS} =	1.1	
Faktor beban mati tambahan	γ^u_{MA} =	2	
Faktor beban lajur "D"	γ^u_{TD} =	2	
Faktor beban lajur "D"	γ^u_{TT} =	2	

-Beban Mati

Pelat beton	$q_{beton} = \rho_{beton} \times t_{pelat\ beton} \times S \times \gamma^u_{MA}$ =	14.4	kN/m
Aspal	$q_{aspal} = \rho_{aspal} \times t_{aspal} \times S \times \gamma^u_{MA}$ =	4.62	kN/m
Berat sendiri stringers	$q_w = W \times \gamma^u_{MS}$ =	2.12	kN/m
Berat total sendiri	$q_{D(U)} = q_{beton} + q_{aspal} + q_w$ =	21.14	kN/m

-Beban Lajur "D"

Beban terbagi rata	$q_{L\ (BTR)} = 9.0\ (0.5 + 15/L) \times S \times \gamma^u_{TD}$ =	15.1	kN/m
Faktor beban dinamis	FBD =	0.3	
Beban garis terpusat	$p_{L\ (BGT)} = (1+FBD) \times 49\ kN/m \times S \times \gamma^u_{TD}$ =	191.1	kN

-Beban truk "T"

Faktor beban dinamis	FBD =	0.3	
Beban roda rencana	m_s =	112.5	kN
Beban truk	$T_{(U)} = (1+FBD) \times m_s \times \gamma^u_{TT}$ =	292.5	kN

-PERHITUNGAN MOMEN GELAGAR MEMANJANG

Momen akibat beban mati

$M_{D(U)} = 1/8 \times q_{D(U)} \times L^2$ = 66.072 kNm

Momen akibat beban lajur "D"

$M_{L(U)} = (1/8 \times q_{L(BTR)} \times L^2) + (1/4 \times p_{L(BGT)} \times L)$ = 285.930 kNm

Momen akibat beban truk

$M_{T(U)} = 1/4 \times T_{(U)} \times L$ = 365.625 kNm

Momen total

$M_{total(U)} = M_{D(U)} + M_{T(U)}$ = 431.697 kNm

-PERHITUNGAN GAYA GESER GELAGAR MEMANJANG

Gaya geser akibat beban mati

$V_{D(U)\ max} = q_{D(U)} \times 1/2\ L$ = 52.857 kN

Gaya geser akibat beban lajur 'D"

$V_{L(U)\ max} = (q_{L(BTR)} \times 1/2\ L) + (p_{L(BGT)} / 2)$ = 133.194 kN

Gaya geser akibat beban truk 'T"

$V_{T(U)\ max} = T_{(U)} / 2$ = 146.250 kN

Gaya geser total

$V_{Total(U)} = V_{D(U)} + V_{T(U)}$ = 199.107 kN

-Rekapitulasi Gaya Rencana Program RSAP 2020

Momen negatif rencana	$M_{(u)}^{-}$ =	986.23	kNm
Momen positif rencana	$M_{(u)}^{+}$ =	1315.27	kNm
Gaya geser rencana	$V_{(u)}^{+}$ =	248.71	kN

-KONTROL PROFIL GELAGAR MEMANJANG

-Kontrol Momen Lentur

Kontrol penampang;

Sayap

Kelangsingan penampang	$\lambda = b/2t_f$ =	5.28	
Kelangsingan maksimum penampang kompak	$\lambda_{pf} = 170/\sqrt{f_y}$ =	10.75	
Kelangsingan maksimum penampang non kompak	$\lambda_{rf} = 370/\sqrt{f_y} - 70$ =	27.58	
	$\lambda pf \geq \lambda$	**(Kompak)**	

Badan

Kelangsingan penampang	$\lambda = h/t_w$ =	43.97	
Kelangsingan maksimum penampang kompak	$\lambda_{pf} = 1680/\sqrt{fy}$ =	106.25	
Kelangsingan maksimum penampang non kompak	$\lambda_{rf} = 2550/\sqrt{f_y}$ =	161.28	
	$\lambda pf \geq \lambda$	**(Kompak)**	

Penampang kompak, sehingga $M_n = M_p$

Faktor reduksi	ϕ =	0.9	
Momen rencana	$M_{(U)}$ =	1315.270	kNm
Momen lentur nominal rencana	$M_n = Z_x \times f_y$ =	1791750000	Nmm
	ϕM_n =	1612.575	kNm
	$\phi M_n > M_{(U)}$ =	**(OK)**	

-Kontrol Lateral Buckling

Gaya total pada gelagar memanjang	$V_a = (q_{D(U)} \times L)/2 + T_{(U)}/2$ =	199.107	kN

Momen pada 1/4 bentang

$M_A = M_C = V_a \times 1/4\ L - (1/2 \times q_{D(U)} \times (L/4)^2)$ = 232.366 kNm

Momen maksimum (momen di tengah bentang)

$M_{max} = M_B = V_a \times 1/2L - (1/2 \times q_{D(U)} \times (L/2)^2)$ = 431.697 kNm

Faktor modifikasi momen nominal

$C_b = 12.5 \times M_{max} / (2.5M_{max} + 3M_A + 4M_B + 3M_C)$ = 1.285

Batas panjang antara lateral support	L_b =	5000	mm
Batas panjang lateral untuk keadaan leleh	$L_p = 1.76 \times r_y \times \sqrt{E/f_y}$ =	2842	mm

Batas panjang untuk keadaan batas tekuk torsi lateral

$X_1 = \pi/S \times \sqrt{E \times G \times J \times A / 2}$ =	13708.04	
$X_2 = 4\ (S/G \times J)^2 \times C_w/I_y$ =	0.00023	
$L_r = r_y \times (X_1/fy - 70)\sqrt{1+\sqrt{1 + X_2 \times (f_y - 70)^2}}$ =	8598.82	mm
Lp ≤ Lb ≤ Lr =	**Tekuk Inelastik**	

Faktor reduksi	ϕ =	0.9	

Momen rencana	$M_{(U)}$ =	1315.2700	kNm
Momen lentur plastis	$M_p = Z_x \times f_y$ =	1791750000	Nmm
Momen residual	$M_r = S_x \times (f_y - 70)$ =	1122120000	Nmm
Momen nominal rencana			
	$M_n = C_b \times [M_R - (M_p - M_R) \times ((L_r - L)/(L_r - L_p))]$ =	1979487473	Nmm
	Mn > Mp =	**Pakai nilai Mp**	
	ϕM_n =	1612.575	kNm
	$\phi M_n > M_{total(U)}$ =	**(OK)**	
-Kontrol Rencana Geser			
Kontrol penampang;			
Badan			
Kelangsingan penampang	h/t_w =	43.97	
Kelangsingan maksimum penampang	$1.1\sqrt{5.54 \times E/f_y}$ =	73.23	
	$h/t_w \leq 1.1\sqrt{5.54 \times E/f_y}$ =	**(OK)**	
Faktor reduksi geser	ϕ =	0.9	
Gaya geser rencana	$V_{(U)}$ =	248.710	kN
Luas badan	$A_w = h_o \times t_w$ =	10701.6	mm^2
Kuat nominal geser	$V_n = 0.6 \times A_w \times f_y$ =	1605240	N
	ϕV_n =	1444.716	kN
	$\phi V_n > V_{(U)}$ =	**(OK)**	
-Kontrol Lendutan			
-Beban Lajur "D"			
Beban terbagi rata	$q_{L\,(BTR)} = 9.0\ (0.5 + 15/L) \times S$ =	7.53	kN/m
Faktor beban dinamis	FBD =	0.3	
Beban garis terpusat	$p_{L\,(BGT)} = (1+FBD) \times 49\ kN/m \times S$ =	95.55	kN
-Beban truk "T"			
Faktor beban dinamis	FBD =	0.3	
Beban gandar rencana	m_s =	112.5	kN
Beban truk	$T_{(U)} = (1+FBD) \times m_s$ =	146.25	kN
Lendutan akibat beban lajur "D"			
	$\Delta^{\circ}_{(BTR)} = 5 \times q_{L(BTR)} \times L^4 / 384 \times E \times I_x$ =	0.13	mm
	$\Delta^{\circ}_{(BGT)} = (p_{L(BGT)} \times L^3 / 48 \times E \times I_x)$ =	0.52	mm
	$\Delta^{\circ}_{(BTR+BGT)}$ =	0.65	mm
Lendutan akibat beban truk "T"			
	$\Delta^{\circ}_{T(U)} = (T_{(U)} \times L^3 / 48 \times E \times I_x)$ =	0.79	mm
Lendutan izin	$\Delta^{\circ}_{Izin} = L/500$ =	10.00	mm
	$\Delta^{\circ}_{Izin} > \Delta^{\circ}_{(BTR+BGT)}$ =	**(OK)**	
	$\Delta^{\circ}_{Izin} > \Delta^{\circ}_{T(U)}$ =	**(OK)**	

PERENCANAAAN LATERAL BEAM JEMBATAN

-PERENCANAAN LATERAL BEAM

-DESAIN RENCANA LATERAL BEAM DENGAN L = 5 M

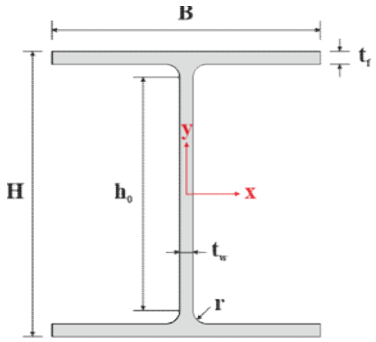
Panjang lateral beam	L =	5	m

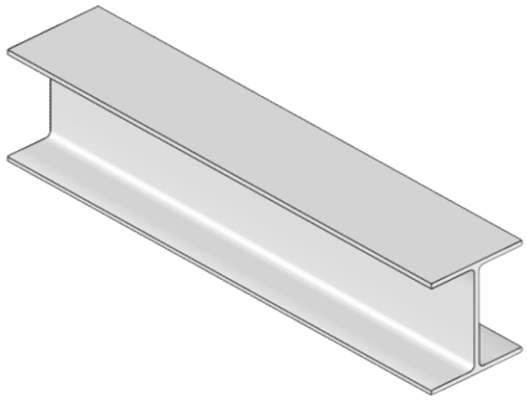
-KARAKTERISTIK MATERIAL

Tegangan leleh	f_y =	250	MPa
Tegangan putus	f_u =	410	MPa
Modulus elastisitas	E =	200000	MPa
Modulus geser	G =	76923	MPa

-SIFAT-SIFAT PENAMPANG

Digunakan **WF. 921 X 420.5 . 21.4 . 36.6**





Tinggi	H =	921.0	mm
Lebar sayap	B =	420.5	mm
Tebal web	t_w =	21.4	mm
Tebal flange	t_f =	36.6	mm
Radius	r =	16.5	mm
Tinggi web	h_o =	814.8	mm
Luas penampang	A_x =	49422	mm^2
Berat penampang	W_x =	3.805	kN/m
Inersia X	I_x =	7196000000	mm^4
Inersia Y	I_y =	454400000	mm^4
Modulus penampang plastis sumbu-x	Z_x =	17670000	mm^3
Modulus penampang elastis sumbu x	S_x =	15639000	mm^3
Radius girasi sumbu y	r_y =	95.9	mm
Konstanta torsi	$J = 1/3 \times (H - 2 \times t_f) \times t_w^3 + 2 \times 1/3 \times B \times t_f^3$ =	16513731	mm^4
Konstanta pilin	$C_w = (I_y \times (H - 2 \times t_f)^2) / 4$ =	81651685824000	mm^6
Radius girasi efektif	$r_{ts}^2 = \sqrt{(I_y \times C_w)} / S_x$ =	12317	mm^2

-PEMBEBANAN LATERAL BEAM JEMBATAN

-Material, Faktor Beban, dan Geometri Pembebanan

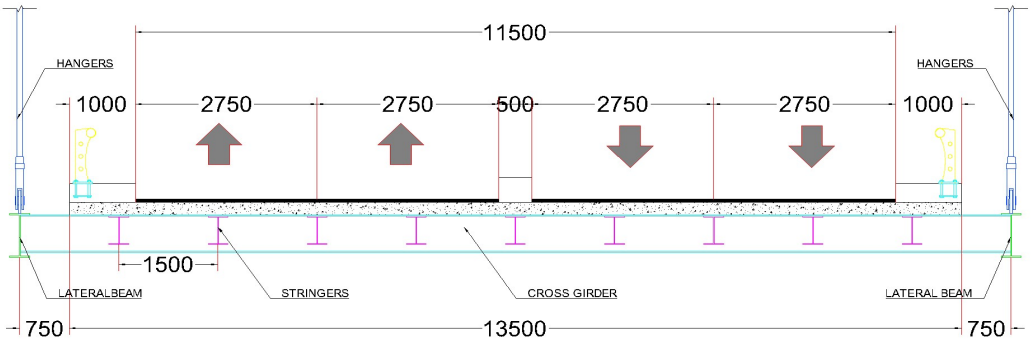
Faktor beban sendiri	γ^u_{MS} =	1.1
Faktor beban mati tambahan	γ^u_{MA} =	2

-Beban Mati		
Berat sendiri lateral beam	$q_w = W \times \gamma^u_{MS} =$	4.19 kN/m
Berat total sendiri	$q_{D(U)} = q_w =$	4.19 kN/m
-PERHITUNGAN MOMEN LATERAL BEAM		
Momen akibat beban mati		
	$M_{D(U)} = 1/8 \times q_{D(U)} \times L^2 =$	13.079 kNm
Momen total		
	$M_{total(U)} = M_{D(U)} + M_{T(U)} =$	13.079 kNm
-PERHITUNGAN GAYA GESER LATERAL BEAM		
Gaya geser akibat beban mati		
	$V_{D(U)\,max} = q_{D(U)} \times 1/2\ L =$	10.464 kN
Gaya geser total		
	$V_{Total(U)} = V_{D(U)} =$	10.464 kN
-Rekapitulasi Gaya Rencana Program RSAP 2020		
Momen negatif rencana	$M_{(u)}^- =$	963.90 kNm
Momen positif rencana	$M_{(u)}^+ =$	1139.59 kNm
Gaya geser rencana	$V_{(u)}^+ =$	249.62 kN
-KONTROL PROFIL LATERAL BEAM		
-Kontrol Momen Lentur		
Kontrol penampang;		
Sayap		
Kelangsingan penampang	$\lambda = b/2t_f =$	5.74
Kelangsingan maksimum penampang kompak	$\lambda_{pf} = 170/\sqrt{f_y} =$	10.75
Kelangsingan maksimum penampang non kompak	$\lambda_{rf} = 370/\sqrt{f_y} - 70 =$	27.58
	$\lambda pf \geq \lambda$	**(Kompak)**
Badan		
Kelangsingan penampang	$\lambda = h/t_w =$	38.07
Kelangsingan maksimum penampang kompak	$\lambda_{pf} = 1680/\sqrt{fy} =$	106.25
Kelangsingan maksimum penampang non kompak	$\lambda_{rf} = 2550/\sqrt{f_y} =$	161.28
	$\lambda pf \geq \lambda$	**(Kompak)**
Penampang kompak, sehingga $M_n = M_p$		
Faktor reduksi	$\phi =$	0.9
Momen rencana	$M_{(U)} =$	1139.590 kNm
Momen lentur nominal rencana	$M_n = Z_x \times f_y =$	4417500000 Nmm
	$\phi M_n =$	3975.75 kNm
	$\phi M_n > M_{(U)} =$	**(OK)**
-Kontrol Lateral Buckling		
Gaya total pada gelagar memanjang	$V_a = (q_{D(U)} \times L)/2 =$	10.464 kN
Momen pada 1/4 bentang		
	$M_A = M_C = V_a \times 1/4\ L - (1/2 \times q_{D(U)} \times (L/4)^2) =$	9.810 kNm
Momen maksimum (momen di tengah bentang)		

	$M_{max} = M_B = V_a \times 1/2L - (1/2 \times q_{D(U)} \times (L/2)^2) =$	13.079	kNm
Faktor modifikasi momen nominal			
	$C_b = 12.5 \times M_{max} / (2.5M_{max} + 3M_A + 4M_B + 3M_C) =$	1.136	
Batas panjang antara lateral support	$L_b =$	5000	mm
Batas panjang lateral untuk keadaan leleh	$L_p = 1.76 \times r_y \times \sqrt{E/f_y} =$	4774	mm
Batas panjang untuk keadaan batas tekuk torsi lateral			
	$X_1 = \pi/S \times \sqrt{E \times G \times J \times A / 2} =$	15916.64	
	$X_2 = 4 (S/G \times J)^2 \times C_w/I_y =$	0.00011	
	$L_r = r_y \times (X_1/fy - 70)\sqrt{1+\sqrt{1 + X_2 \times (f_y - 70)^2}} =$	14998.69	mm
	$Lp \le Lb \le Lr =$	**Tekuk Inelastik**	
Faktor reduksi	$\phi =$	0.9	
Momen rencana	$M_{(U)} =$	1139.5900	kNm
Momen lentur plastis	$M_p = Z_x \times f_y =$	4417500000	Nmm
Momen residual	$M_r = S_x \times (f_y - 70) =$	2815020000	Nmm
Momen nominal rencana			
	$M_n = C_b \times [M_R - (M_p - M_R) \times ((L_r - L)/(L_r - L_p))] =$	4979624385	Nmm
	$Mn > Mp =$	**Pakai nilai Mp**	
	$\phi M_n =$	3975.750	kNm
	$\phi M_n > M_{total(U)} =$	**(OK)**	
-Kontrol Rencana Geser			
Kontrol penampang;			
Badan			
Kelangsingan penampang	$h/t_w =$	38.07	
Kelangsingan maksimum penampang	$1.1\sqrt{5.54 \times E/f_y} =$	73.23	
	$h/t_w \le 1.1\sqrt{5.54 \times E/f_y} =$	**(OK)**	
Faktor reduksi geser	$\phi =$	0.9	
Gaya geser rencana	$V_{(U)} =$	249.6200	kN
Luas badan	$A_w = h_o \times t_w =$	17436.72	mm^2
Kuat nominal geser	$V_n = 0.6 \times A_w \times f_y =$	2615508	N
	$\phi V_n =$	2353.9572	kN
	$\phi V_n > V_{(U)} =$	**(OK)**	

PERENCANAAAN GELAGAR MELINTANG JEMBATAN

-PERENCANAAN GELAGAR MELINTANG



-DESAIN RENCANA GELAGAR MELINTANG DENGAN L = 5 M

Panjang cross girder	L =	15	m
Jarak antar cross girder	s =	5	m

-KARAKTERISTIK MATERIAL

Tegangan leleh	f_y =	250	MPa
Tegangan putus	f_u =	410	MPa
Modulus elastisitas	E =	200000	MPa

-SIFAT-SIFAT PENAMPANG

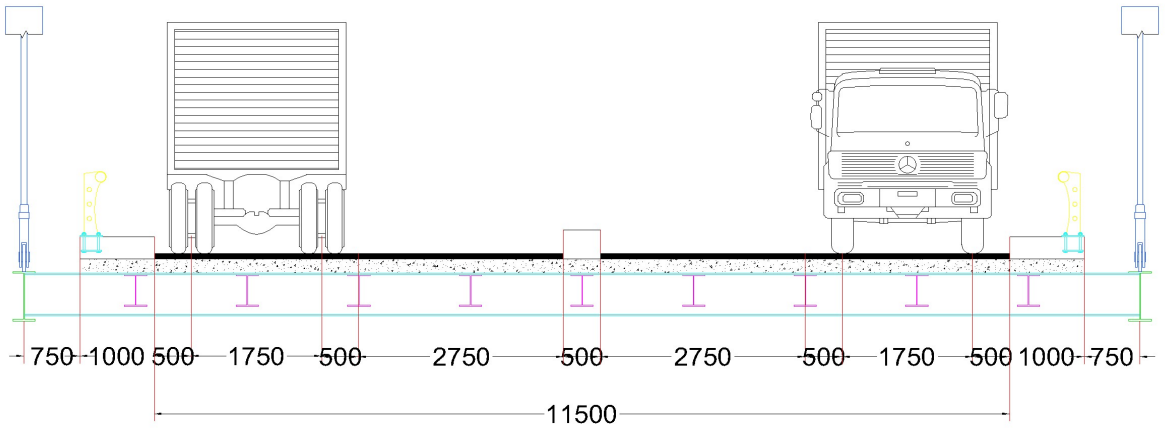
Digunakan	**WF. 850.9 X 293.8 . 16.1 . 26.8**		
Tinggi	H =	850.9	mm
Lebar sayap	B =	293.8	mm
Tebal web	t_w =	16.1	mm
Tebal flange	t_f =	26.8	mm
Radius	r =	17.8	mm
Tinggi web	h_o =	761.7	mm
Luas penampang	A_x =	28856	mm^2
Berat penampang	W_x =	2.221	kN/m
Inersia X	I_x =	3397000000	mm^4
Inersia Y	I_y =	113600000	mm^4
Modulus penampang plastis sumbu-x	Z_x =	9155000	mm^3
Modulus penampang elastis sumbu x	S_x =	7985000	mm^3
Konstanta torsi	$J = 1/3 \times (H - 2 \times t_f) \times t_w^3 + 2 \times 1/3 \times B \times t_f^3$ =	4879323.54	mm^4
Konstanta pilin	$C_w = (I_y \times (H - 2 \times t_f)^2) / 4$ =	18053519036000	mm^6
Radius girasi efektif	$r_{ts}^2 = \sqrt{(I_y \times C_w)} / S_x$ =	5671	mm^2
Radius girasi sumbu y	r_y =	62.7	mm

-PEMBEBANAN GELAGAR MELINTANG JEMBATAN

-Material, Faktor Beban, dan Geometri Pembebanan

Berat sendiri gelagar memanjang	$W_{gmemanjang}$ =	1.930	kN/m
Jarak antara gelagar memanjang	$S_{gmemanjang}$ =	1.5	m
Jumlah gelagar memanjang	$n_{gmemanjang}$	9	
Berat jenis beton	ρ_{beton} =	24	kN/m^3
Berat jenis aspal	ρ_{aspal} =	22	kN/m^3
Tebal pelat beton	$t_{pelat\ beton}$ =	0.2	m
Tebal aspal	t_{aspal} =	0.07	m
Tebal trotoar	$t_{trotoar}$ =	0.3	m
Tebal median	t_{median} =	0.4	m
Faktor beban sendiri	γ^u_{MS} =	1.1	
Faktor beban mati tambahan	γ^u_{MA} =	1.3	
Faktor beban lajur "D"	γ^u_{TD} =	1.8	
Faktor beban pejalan kaki	γ^u_{TP} =	1.8	
Faktor beban truk "T"	γ^u_{TT} =	1.8	

Panjang trotoar	$L_{trotoar}$ =	1	m
Panjang aspal	L_{aspal} =	5.5	m
Panjang median	L_{median} =	0.5	m
Panjang lantai kendaraan	$L_{lantai\ kendaraan}$ =	11.5	m
Panjang lantai beton kendaraan	$L_{pelat\ beton}$ =	13.5	m
Jarak lantai kendaraan dengan lateral beam	$S_{lateral\ beam}$ =	0.75	m
-Beban Mati Sebelum Komposit			
Beban sendiri gelagar melintang	$q_w = W \times \gamma^u_{MS}$ =	2.443	kN/m
Berat sendiri gelagar memanjang	$q_{w(gmemanjang)} = (W_{gmemanjang} \times S / S_{gmemanjang}) \times \gamma^u_{MS}$ =	7.076	kN/m
Berat total sendiri	$q_{D1(U)} = q_w + q_{w(stringers)}$ =	9.520	kN/m
-Beban Mati Setelah Komposit			
Beban pelat beton	$q_{beton} = \rho_{beton} \times t_{pelat\ beton} \times S \times \gamma^u_{MA}$ =	31.2	kN/m
Beban aspal	$q_{aspal} = \rho_{aspal} \times t_{aspal} \times S \times \gamma^u_{MA}$ =	10.01	kN/m
Beban trotoar	$q_{trotoar} = \rho_{beton} \times t_{trotoar} \times S \times \gamma^u_{MA}$ =	46.8	kN/m
Beban median	$q_{median} = \rho_{beton} \times t_{median} \times S \times \gamma^u_{MA}$ =	62.4	kN/m
-Beban Lajur "D"			
Beban terbagi rata	$q_{L\ (BTR)} = 9.0\ (0.5 + 15/L) \times S \times \gamma^u_{TD}$ =	45.17	kN/m
Faktor beban dinamis	FBD =	0.3	
Beban garis terpusat	$q_{L\ (BGT)} = (1+FBD) \times 49\ kN/m \times \gamma^u_{TD}$ =	114.66	kN/m
Beban lajur "D"	$q_{L\ (BTR+BGT)} = q_{L\ (BTR)} + q_{L\ (BGT)}$ =	159.83	kN/m
-Beban Pejalan Kaki			
Beban pejalan kaki	$q_{(TP)} = 5\ kN/m^2 \times S \times \gamma^u_{TP}$ =	45	kN/m
-Beban truk "T"			
Faktor beban dinamis	FBD =	0.3	
Beban gandar rencana	m_s	112.5	kN
Beban truk	$T_{(U)} = (1+FBD) \times m_s \times \gamma^u_{TT}$ =	263.25	kN



-PERHITUNGAN MOMEN GELAGAR MELINTANG

Momen akibat beban mati sebelum komposit

$M_{D1(U)} = 1/8 \times q_{D1(U)} \times L^2$ =	267.74	kNm

Momen akibat pelat beton

$\sum M_B = 0$		
$M_{pelat\ beton} = q_{beton} \times L_{pelat\ beton} \times (L_{pelat\ beton} / 2 + S_{lateral\ beam})$ =	3159.00	kNm
$R_A = M_{beton} / L$ =	210.60	kN
$M_{D2(U)} = R_A \times L/2 - (q_{beton} \times (L_{lantai} / 2) \times (L_{lantai} / 4))$ =	868.73	kNm

Momen akibat beban mati setelah komposit

$\sum M_B = 0$		
$M_{aspal1} = q_{aspal} \times L_{aspal} \times ((L_{aspal} / 2) + L_{trotoar} + S_{lateral\ beam})$ =	247.748	kNm
$M_{aspal2} = q_{aspal} \times L_{aspal} \times ((L_{aspal} / 2) + L_{median} + L_{aspal} + L_{trotoar} + S_{lateral\ beam})$ =	578.078	kNm
$M_{trotoar1} = q_{trotoar} \times L_{trotoar} \times ((L_{trotoar} / 2) + S_{lateral\ beam})$ =	58.500	kNm
$M_{trotoar2} = q_{trotoar} \times L_{trotoar} \times ((L_{trotoar} / 2) + L_{aspal} + L_{median} + L_{aspal} + L_{trotoar} + S_{lateral\ beam})$ =	643.500	kNm
$M_{median} = q_{median\ x} L_{median} \times ((L_{median} / 2) + L_{aspal} + L_{trotoar} + S_{lateral\ beam})$ =	234.000	kNm

$R_A = (M_{trotoar1} + M_{aspal1} + M_{median} + M_{aspal2} + M_{trotoar2}) / L =$	117.455	kN
$M_{D3(U)} = (R_A \times L/2) - (q_{tr} \times L_{tr} \times (L_{tr}/2 + L_{as} + L_{md}/2) - (q_{as} \times L_{as} \times (L_{as}/2 + L_{md}/2) - (q_{md} \times L_{md}/2 \times L_{md}/4) =$	421.30	kNm
Momen akibat beban lajur "D" dan pejalan kaki		
$\sum M_B = 0$		
$M_{(TP)1} = q_{(TP)} \times L_{trotoar} \times ((L_{trotoar} / 2) + S_{lateral\ beam}) =$	56.25	kNm
$M_{(BTR+BGT)} = q_{L(BTR+BGT)} \times L_{lajur} \times ((L_{lajur} / 2) + L_{trotoar} + S_{lateral\ beam}) =$	13785.60	kNm
$M_{(TP)2} = q_{(TP)} \times L_{trotoar} \times ((L_{trotoar} / 2) + L_{lantai} + L_{trotoar} + S_{lateral\ beam}) =$	618.75	kNm
$R_A = (M_{(TP)1} + M_{(BTR+BGT)} + M_{(TP)2}) / L =$	964.04	kN
$M_{L1} = (R_A \times L/2) - (q_{(TP)} \times L_{trotoar} \times (L_{trotoar} / 2 + L_{lk} / 2) - (q_{L(BGT+BTR)} \times (L_{lk} / 2) \times (L_{lk} / 4)) =$	4306.81	kNm
Momen akibat beban truk "T" dan pejalan kaki		
$\sum M_B = 0$		
$M_{(TP)1} = q_{(TP)} \times L_{trotoar} \times (L_{trotoar} / 2 + S_{lateral\ beam}) =$	56.2500	kNm
$M_{T(U)} = T_{(U)} \times ((S_{lb} + L_{tr} + 0.5) + (S_{lb} + L_{tr} + 2.25) + (S_{lb} + L_{tr} + L_{lk} - 2.25) + (S_{lb} + L_{tr} + L_{lk} - 0.5)) =$	7897.5000	kNm
$M_{(TP)2} = q_{(TP)} \times L_{trotoar} \times ((L_{trotoar} / 2) + L_{lantai} + L_{trotoar} + S_{lateral\ beam}) =$	618.7500	kNm
$R_A = (M_{L(TP)1} + M_{T(U)} + M_{L(TP)2}) / L =$	571.5000	kN
$M_{L2} = (R_A \times L/2) - (q_{(TP)} \times L_{trotoar} \times (L_{tr}/2 + L_{lk}/2)) - (T(U) \times (L_{lk}/2 - 0.5)) - (T_{(U)} \times (L_{lk}/2 - 2.25) =$	1701.563	kNm
Momen total		
$M_{total(U)} = M_{D1(U)} + M_{D2(U)} + M_{D3(U)} + M_{L1} =$	5864.575	kNm
-PERHITUNGAN GAYA GESER GELAGAR MELINTANG		
Gaya geser akibat beban mati sebelum komposit		
$V_{D1(U)\ max} = q_{D1(U)} \times 1/2\ L =$	71.398	kN
Gaya geser akibat pelat beton		
$V_{D2(U)\ max} = M_{beton} / L =$	210.600	kN
Gaya geser akibat beban mati setelah komposit		
$V_{D3(U)\ max} = (M_{trotoar1} + M_{aspal1} + M_{median} + M_{aspal2} + M_{trotoar2}) / L =$	117.455	kN
Gaya geser akibat beban lajur 'D" dan pejalan kaki		
$V_{L(U)\ max} = (M_{(TP)1} + M_{(BTR+BGT)} + M_{(TP)2}) / L =$	964.040	kN
Gaya geser akibat beban truk 'T" dan pejalan kaki		
$V_{T(U)\ max} = (M_{(TP)1} + M_{T(U)} + M_{(TP)2}) / L =$	571.500	kN
Gaya geser total		
$V_{Total(U)} = V_{D(U)1} + V_{D(U)2} + V_{D(U)3} + V_{T(U)} =$	1363.49	kN
-GAYA RENCANAN HASIL PROGRAM RSAP 2020		
-Gaya Rencana akibat kombinasi pembebanan KUAT I		
Momen rencana $M_{(u)} =$	5864.58	kNm
Gaya geser rencana $V_{(u)} =$	1001.90	kN
-KONTROL PROFIL GELAGAR MELINTANG		
-Kontrol Lendutan		
-Beban Lajur "D"		
Beban terbagi rata $q_{L\ (BTR)} = 9.0\ (0.5 + 15/L) \times S =$	25.10	kN/m
-Beban truk "T"		
Faktor beban dinamis $FBD =$	0.3	
Beban gandar rencana $m_s =$	112.5	kN
Beban truk $T_{(U)} = (1+FBD) \times m_s =$	146.25	kN
Lendutan akibat beban lajur "D"		
$\Delta^{\circ}_{(BTR)} = q_{L(BTR)} \times L_{lantai\ kendaraan} (L^3 - 2 \times L \times L_{lantai\ kendaraan}^{\ 2} + L_{lantai\ kendaraan}^{\ 3}) / 24 \times E \times I_x =$	16.43	mm
Lendutan akibat beban truk "T"		
$\Delta^{\circ}_{T(U)1} = (T_{(U)} \times 2.25 \times (3L^2 - 4 \times 2.25^2)) / (24 \times E \times I_x) =$	13.21	mm
$\Delta^{\circ}_{T(U)2} = (T_{(U)} \times 4 \times (3L^2 - 4 \times 4^2)) / (24 \times E \times I_x) =$	21.92	mm
$\Delta^{\circ}T_{(U)Total} = \Delta^{\circ}T_{(U)1} + \Delta^{\circ}_{T(U)2} =$	35.13	mm
Lendutan izin $\Delta^{\circ}_{Izin} = L/360 =$	41.67	mm
$\Delta^{\circ}_{Izin} > \Delta^{\circ}_{(BTR)} =$	**(OK)**	
$\Delta^{\circ}_{Izin} > \Delta^{\circ}_{T(U)} =$	**(OK)**	
-Kontrol Rencana Geser		
Kontrol penampang;		
Badan		
Kelangsingan penampang $h/t_w =$	47.31	
Kelangsingan maksimum penampang $1.1\sqrt{5.54 \times E/f_y} =$	73.23	
$\mathbf{h/t_w \leq 1.1\sqrt{5.54 \times E/f_y} =}$	**(OK)**	

Faktor reduksi geser	ϕ =	0.9	
Luas badan	$A_w = h_o \times t_w$ =	12263.37	mm^2
Kuat nominal geser	$V_n = A_w \times f_y$ =	3065842.50	N
	ϕV_n =	2759.26	kN
	$\phi V_n > V_{total(U)}$ =	**(OK)**	
-Kontrol Momen Lentur Sebelum Komposit			
Kontrol penampang;			
Sayap			
Kelangsingan penampang	$\lambda = b/2t_f$ =	5.48	
Kelangsingan maksimum penampang kompak	$\lambda_{pf} = 170/\sqrt{f_y}$ =	10.75	
Kelangsingan maksimum penampang non kompak	$\lambda_{rf} = 370/\sqrt{f_y} - 70$ =	27.58	
	$\lambda pf \geq \lambda$	**(Kompak)**	
Badan			
Kelangsingan penampang	$\lambda = h/t_w$ =	47.31	
Kelangsingan maksimum penampang kompak	$\lambda_{pf} = 1680/\sqrt{fy}$ =	106.25	
Kelangsingan maksimum penampang non kompak	$\lambda_{rf} = 2550/\sqrt{f_y}$ =	161.28	
	$\lambda pf \geq \lambda$	**(Kompak)**	
Penampang kompak, sehingga $M_n = M_p$			
Faktor reduksi	ϕ =	0.9	
Momen lentur nominal rencana	$M_n = Z_x \times f_y$ =	2288750000	Nmm
	ϕM_n =	2059.875	kNm
	$\phi M_n > M_{total(U)}$ =	**(OK)**	

PERHITUNGAN IKATAN ANGIN

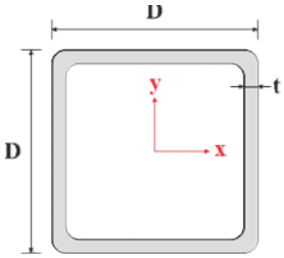
-PERENCANAAN IKATAN ANGIN

-MATERIAL PROPERTI

Tegangan leleh	f_y =	250	MPa
Tegangan putus	f_u =	410	MPa
Modulus elastisitas	E =	200000	MPa

-SECTION PROPERTI

Digunakan **SHS. 250 X 250. 10**



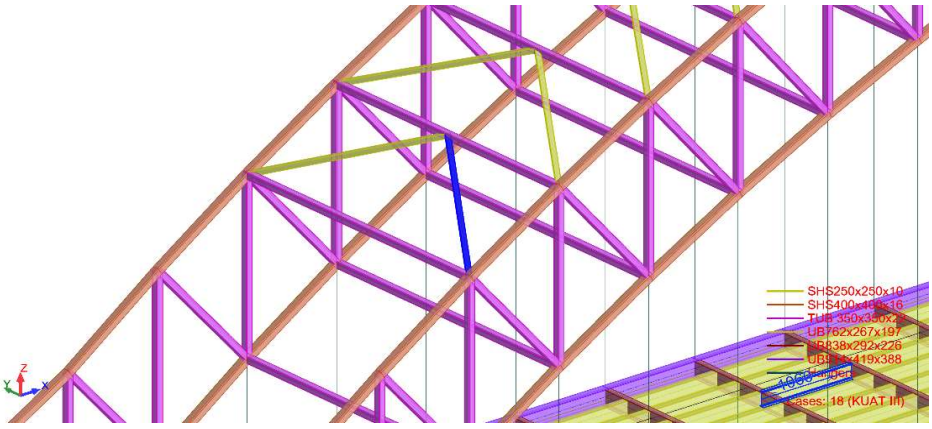
Badan profil	B =	250	mm
Tebal badan	t =	10	mm
Luas penampang	A_g =	9493	mm^2
Berat penampang	W_x =	1.147	kN/m
Momen inersia	$I_x = I_y$ =	90550000	mm^4
Modulus penampang plastis sumbu-x	$Z_x = Z_y$ =	7240000	mm^4
Modulus penampang elastis sumbu x	$S_x = S_y$ =	851000	mm^3
Radius girasi sumbu y	$r_x = r_y$ =	97.7	mm

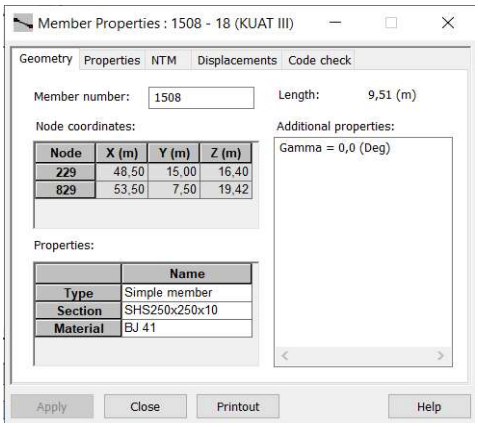
-KONTROL PROFIL IKATAN ANGIN RANGKA ATAS

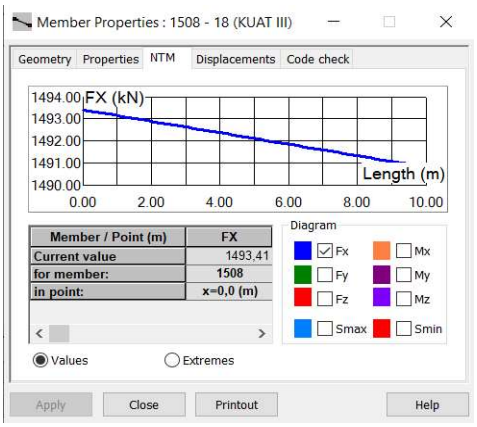
-Kontrol Kapasitas Tekan

Gaya aksial tekan	$P_{(U)\ Tekan}$ =	1505.80	kN
Gaya aksial tarik	$P_{(U)\ Tarik}$ =	1483.29	kN

-Kontrol Kapasitas Tekan



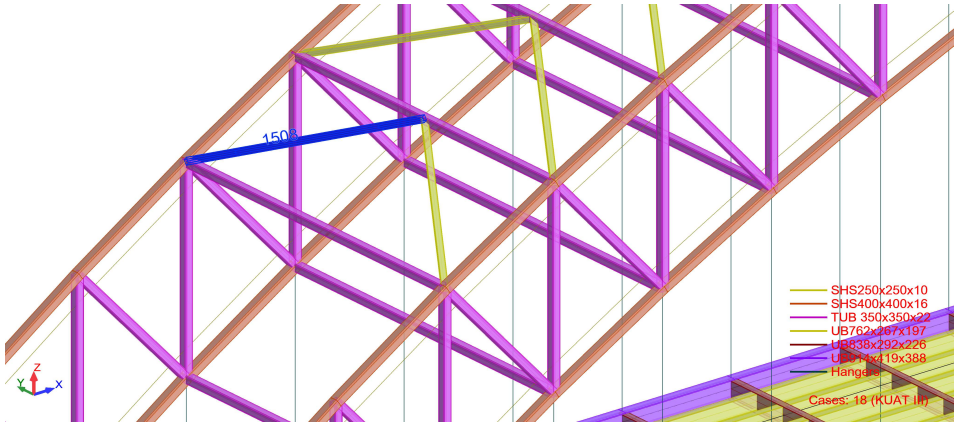


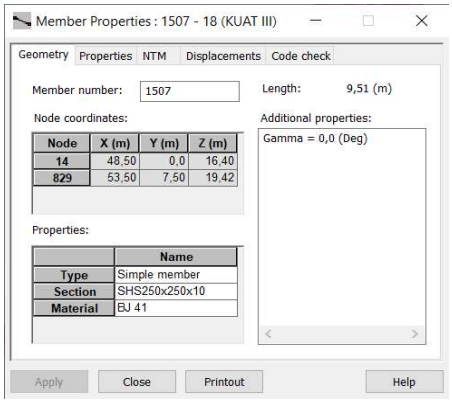


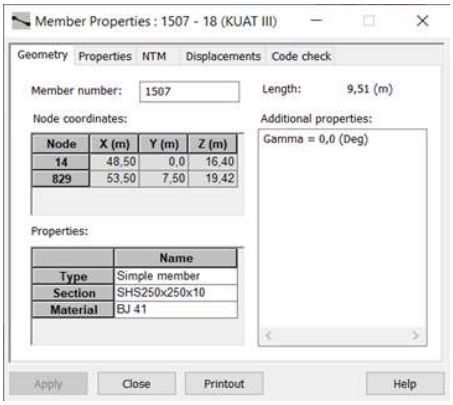
Kontrol penampang;

Kelangsingan kaki siku	$b/t =$	23	
Kelangsingan maksimum kaki siku	$625/\sqrt{f_y} =$	39.53	
	$b/t \leq 625/\sqrt{f_y} =$	**(OK)**	
Faktor tekuk	$K =$	1	
Panjang penampang ikatan angin	$L =$	9510	mm
Panjang efektif	$L_c = K \times L =$	9510	mm
Kelangsingan komponen struktur	$\lambda = L_c / r =$	97.34	
Batas kelangsingan komponen	$\lambda_c = (L_c / \pi) \times \sqrt{(f_y / E)} =$	1.10	
	$\lambda c \leq 1.5 =$	**(OK)**	
Faktor reduksi	$\phi =$	0.9	
Kapasitas tekan rencana	$P_u =$	1505.8	kN
Kapasitas tekan nominal rencana	$P_n = (0.88 / \lambda_c^2) \times A_g \times f_y =$	1740324	N
	$\phi P_n =$	1566.29	kN
	$\phi P_n > P_U =$	**(OK)**	

-Kontrol Kapasitas Tarik







-Kondisi leleh

Faktor reduksi	ϕ =	0.9	
Luas bruto dari komponen struktur	A_g =	9493	mm^2
Kapasitas tarik rencana	P_u =	1483.29	kN
Kapasitas leleh tarik komponen struktur	$P_n = f_y \times A_g$ =	2373175	N
	ϕP_n =	2135.86	kN
	$\phi P_n > P_U$ =	**(OK)**	

-Kondisi Putus

Faktor reduksi	ϕ =	0.75	
Luas neto efektif	$A_e = 0.85 \times A_g$ =	8068.8	mm
Kapasitas tarik rencana	P_u =	1483.29	kN
Kapasitas putus tarik komponen struktur	$P_n = f_u \times A_e$ =	3308206	N
	ϕP_n =	2481.15	kN
	$\phi P_n > P_U$ =	**(OK)**	

PERHITUNGAN RANGKA UTAMA

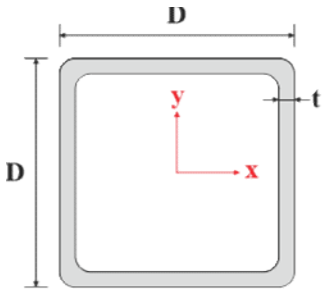
-PERENCANAAN RANGKA UTAMA PELENGKUNG ATAS DAN BAWAH

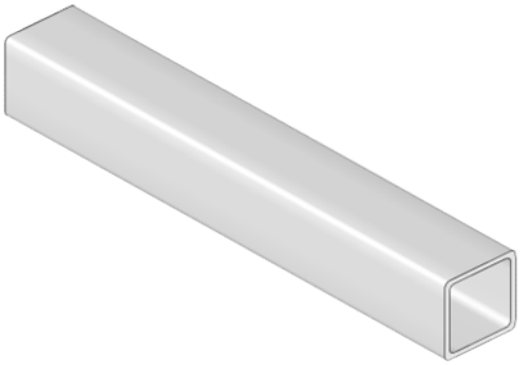
-MATERIAL PROPERTI

Tegangan leleh	f_y =	250	MPa
Tegangan putus	f_u =	410	MPa
Modulus elastisitas	E =	200000	MPa

-SECTION PROPERTI

Digunakan **SHS. 400 X 400 . 16**





Badan profil	B =	400	mm
Tebal badan	t =	16	mm
Luas penampang	A_g =	24301	mm^2
Berat penampang	W_x =	1.883	kN/m
Momen inersia	$I_x = I_y$ =	593400000	mm^4
Modulus penampang plastis sumbu-x	$Z_x = Z_y$ =	29670000	mm^4
Modulus penampang elastis sumbu x	$S_x = S_y$ =	3484000	mm^3
Radius girasi sumbu y	$r_x = r_y$ =	156	mm

-KONTROL PROFIL RANGKA ATAS (LENGKUNGAN ATAS)

-Gaya Dalam Rencana

Gaya aksial tekan	$P_{(U)\ Tekan}$ =	18308.5	kN
Gaya aksial tarik	$P_{(U)\ Tarik}$ =	0	kN

-Kontrol Kapasitas Tekan Akibat Tekuk Lentur

Kontrol penampang;			
Kelangsingan badan profil	b/t =	23	
Kelangsingan maksimum badan profil	$625/\sqrt{f_y}$ =	39.53	
	$b/t \le 625/\sqrt{f_y}$ =	**(OK)**	
Faktor tekuk	K =	1	
Panjang penampang ikatan angin	L =	3250	mm
Panjang efektif	$L_c = K \times L$ =	3250	mm
Kelangsingan komponen struktur	$\lambda = L_c / r$ =	20.833	
Batas kelangsingan komponen	$\lambda_c = (L_c / \pi) \times \sqrt{(f_y / E)}$ =	0.234	
	$\lambda c \le 1.5$ =	**(OK)**	

Faktor reduksi	ϕ =	0.9	
Kapasitas tekan rencana	P_u =	18308.5	kN
Kapasitas tekan nominal rencana	$P_n = (0.88 / \lambda_c^2) \times A_g \times f_y$ =	97257828	N
	ϕP_n =	87532.0	kN
	$\phi P_n > P_U$ =	**(OK)**	

-Kontrol Kapasitas Tekan Akibat Tekuk Lentur - Torsi

Modulus geser	G =	76923	MPa
Konstanta torsi	J =	292500000	mm^4
Jarak pusat geser terhadap titik berat sumbu - x	x_0 =	0	mm
Jarak pusat geser terhadap titik berat sumbu - y	y_0 =	0	mm
Jari-jari girasi polar terhadap pusat geser			
$\bar{r}_0^2 = ((I_x + I_y)/A_g) + x_0^2 + y_0^2$ =		48836.87411	mm^2
Konstanta lentur	$H = 1 - ((x_0^2 + y_0^2) / \bar{r}_0^2)$ =	1	
Tegangan kritis akibat tekuk lentur	$f_{cry} = (0.88 / \lambda_c^2) \times f_y$ =	4002.2	MPa
Tegangan kritis akibat tekuk torsi	$f_{crz} = G \times J / A_g \times \bar{r}_0^2$ =	18958.5	MPa
Tegangan kritis akibat tekuk lentur-torsi			
$f_{clt} = ((f_{cry} + f_{crz})/2 \times H) \times [1-\sqrt{(1-((4 \times f_{cry} \times f_{crz} \times H)/((f_{cry}+f_{crz})^2)))}$ =		4002.2	MPa

Faktor reduksi	ϕ =	0.9	
Kapasitas tekan rencana	P_u =	18308.5	kN
Kapasitas tekan nominal rencana	$P_n = f_{clt} \times A_g$ =	97257828.16	N
	ϕP_n =	87532.0	kN
	$\phi P_n > P_U$ =	**(OK)**	

-KONTROL PROFIL RANGKA ATAS (LENGKUNGAN BAWAH)

-Gaya Dalam Rencana

Gaya aksial tekan	$V_{(U)\ Tekan}$ =	19675.85	kN
Gaya aksial tarik	$V_{(U)\ Tarik}$ =	0	kN

-Kontrol Kapasitas Tekan Akibat Tekuk Lentur

Kontrol penampang;

Kelangsingan badan profil	b/t =	23	
Kelangsingan maksimum badan profil	$625/\sqrt{f_y}$ =	39.528	
	$b/t \leq 200/\sqrt{f_y}$ =	**(OK)**	

Faktor tekuk	K =	1	
Panjang penampang ikatan angin	L =	6320	mm
Panjang efektif	$L_c = K \times L$ =	6320	mm
Kelangsingan komponen struktur	$\lambda = L_c / r$ =	40.513	
Batas kelangsingan komponen	$\lambda_c = (L_c / \pi) \times \sqrt{(f_y / E)}$ =	0.456	
	$\lambda c \leq 1.5$ =	**(OK)**	

Faktor reduksi	ϕ =	0.9	
Kapasitas tekan rencana	P_u =	19675.9	kN

Kapasitas tekan nominal rencana	$P_n = (0.88 / \lambda_c^2) \times A_g \times f_y =$	25719181	N
	$\phi P_n =$	23147.3	kN
	$\phi P_n > P_U =$	**(OK)**	

-Kontrol Kapasitas Tekan Akibat Tekuk Lentur - Torsi

Modulus geser	$G =$	76923	MPa
Konstanta torsi	$J =$	292500000	mm^4
Jarak pusat geser terhadap titik berat sumbu - x	$x_0 =$	0	mm
Jarak pusat geser terhadap titik berat sumbu - y	$y_0 =$	0	mm
Jari-jari girasi polar terhadap pusat geser			
	$\bar{r}_0^2 = ((I_x + I_y)/A_g) + x_0^2 + y_0^2 =$	48836.87411	mm^2
Konstanta lentur	$H = 1 - ((x_0^2 + y_0^2) / \bar{r}_0^2) =$	1	
Tegangan kritis akibat tekuk lentur	$f_{cry} = (0.88 / \lambda_c^2) \times f_y =$	1058.3	MPa
Tegangan kritis akibat tekuk torsi	$f_{crz} = G \times J / A_g \times \bar{r}_0^2 =$	18958.5	MPa
Tegangan kritis akibat tekuk lentur-torsi			
$f_{clt} = ((f_{cry} + f_{crz})/2 \times H) \times [1-\sqrt{(1-((4 \times f_{cry} \times f_{crz} \times H)/((f_{cry}+f_{crz})^2)))} =$		1058.3	MPa
Faktor reduksi	$\phi =$	0.9	
Kapasitas tekan rencana	$P_u =$	19675.85	kN
Kapasitas tekan nominal rencana	$P_n = f_{clt} \times A_g =$	25719180.87	N
	$\phi P_n =$	23147.3	kN
	$\phi P_n > P_U =$	**(OK)**	

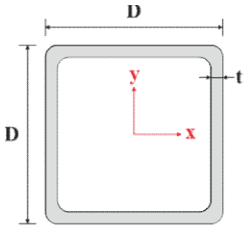
-PERENCANAAN RANGKA UTAMA VERTIKAL DAN DIAGONAL

-MATERIAL PROPERTI

Tegangan leleh	$f_y =$	250	MPa
Tegangan putus	$f_u =$	410	MPa
Modulus elastisitas	$E =$	200000	MPa

-SECTION PROPERTI

Digunakan **SHS. 350 X 350 . 22**



Badan profil	$B =$	350	mm
Tebal badan	$t =$	22	mm
Luas penampang	$A_g =$	28345	mm^2
Berat penampang	$W_x =$	1.863	kN/m
Momen inersia	$I_x = I_y =$	389400000	mm^4
Modulus penampang plastis sumbu-x	$Z_x = Z_y =$	22250000	mm^4

Modulus penampang elastis sumbu x	$S_x = S_y =$	2630000	mm^3
Radius girasi sumbu y	$r_x = r_y =$	136	mm

-KONTROL PROFIL RANGKA ATAS (VERTIKAL MEMBER)

-Gaya Dalam Rencana

Gaya aksial tekan	$V_{(U)\ Tekan} =$	6241.33	kN
Gaya aksial tarik	$V_{(U)\ Tarik} =$	405.8	kN

-Kontrol Kapasitas Tekan

Kontrol penampang;			
Kelangsingan badan profil	$b/t =$	13.909	
Kelangsingan maksimum badan profil	$625/\sqrt{f_y} =$	39.528	
	$b/t \leq 200/\sqrt{f_y}$ =	**(OK)**	
Faktor tekuk	$K =$	1	
Panjang penampang ikatan angin	$L =$	7500	mm
Panjang efektif	$L_c = K \times L =$	7500	mm
Kelangsingan komponen struktur	$\lambda = L_c / r =$	55.147	
Batas kelangsingan komponen	$\lambda_c = (\lambda / \pi) \times \sqrt{(f_y / E)} =$	0.621	
	$\lambda c \leq 1.5$ =	**(OK)**	
Faktor reduksi	$\phi =$	0.9	
Kapasitas tekan rencana	$P_u =$	6241.33	kN
Kapasitas tekan nominal rencana	$P_n = (0.88 / \lambda_c^2) \times A_g \times f_y =$	16189707.77	N
	$\phi P_n =$	14570.7	kN
	$\phi P_n > P_U$ =	**(OK)**	

-Kontrol Kapasitas Tarik

-Kondisi leleh			
Faktor reduksi	$\phi =$	0.9	
Luas bruto dari komponen struktur	$A_g =$	28345	mm^2
Kapasitas tarik rencana	$P_u =$	405.8	kN
Kapasitas leleh tarik komponen struktur	$P_n = f_y \times A_g =$	7086166	N
	$\phi P_n =$	6377.55	kN
	$\phi P_n > P_U$ =	**(OK)**	
-Kondisi Putus			
Faktor reduksi	$\phi =$	0.75	
Luas neto efektif	$A_e = 0.85 \times A_g =$	24093.0	mm
Kapasitas tarik rencana	$P_u =$	405.8	kN
Kapasitas putus tarik komponen struktur	$P_n = f_u \times A_e =$	9878115	N
	$\phi P_n =$	7408.59	kN
	$\phi P_n > P_U$ =	**(OK)**	

-KONTROL PROFIL RANGKA ATAS (DIAGONAL MEMBER)

-Gaya Dalam Rencana

Gaya aksial tekan	$V_{(U)\ Tekan} =$	383.41	kN
Gaya aksial tarik	$V_{(U)\ Tarik} =$	3228.5	kN

-Kontrol Kapasitas Tekan			
Kontrol penampang;			
Kelangsingan badan profil	$b/t =$	13.90909091	
Kelangsingan maksimum badan profil	$625/\sqrt{f_y} =$	39.528	
	$b/t \leq 200/\sqrt{f_y}$ =	**(OK)**	
Faktor tekuk	$K =$	1	
Panjang penampang ikatan angin	$L =$	7530	mm
Panjang efektif	$L_c = K \times L =$	7530	mm
Kelangsingan komponen struktur	$\lambda = L_c / r =$	55.368	
Batas kelangsingan komponen	$\lambda_c = (\lambda / \pi) \times \sqrt{(f_y / E)} =$	0.623	
	$\lambda c \leq 1.5$ =	**(OK)**	
Faktor reduksi	$\phi =$	0.9	
Kapasitas tekan rencana	$P_u =$	383.41	kN
Kapasitas tekan nominal rencana	$P_n = (0.88 / \lambda_c^2) \times A_g \times f_y =$	16060963.09	N
	$\phi P_n =$	14454.87	kN
	$\phi P_n > P_U$ =	**(OK)**	
-Kontrol Kapasitas Tarik			
-Kondisi leleh			
Faktor reduksi	$\phi =$	0.9	
Luas bruto dari komponen struktur	$A_g =$	28345	mm^2
Kapasitas tarik rencana	$P_u =$	3228.5	kN
Kapasitas leleh tarik komponen struktur	$P_n = f_y \times A_g =$	7086166	N
	$\phi P_n =$	6377.55	kN
	$\phi P_n > P_U$ =	**(OK)**	
-Kondisi Putus			
Faktor reduksi	$\phi =$	0.75	
Luas neto efektif	$A_e = 0.85 \times A_g =$	24093.0	mm^2
Kapasitas tarik rencana	$P_u =$	3228.5	kN
Kapasitas putus tarik komponen struktur	$P_n = f_u \times A_e =$	9878115	N
	$\phi P_n =$	7408.59	kN
	$\phi P_n > P_U$ =	**(OK)**	

PERHITUNGAN HANGERS

-PERENCANAAN KABEL

-KARAKTERISTIK MATERIAL

Tegangan leleh	f_y =	410	MPa
Tegangan putus	f_u =	1860	MPa
Modulus elastisitas	E =	200000	MPa

-SIFAT-SIFAT PENAMPANG

Diameter kabel	d =	40	mm
Radius girasi sumbu y	A_x =	1060	mm^2
Gaya tarik putus minimum	P_n =	1520	kN
Gaya leleh minimum	P_y =	1292	kN

-KONTROL KABEL PENGGANTUNG

-Gaya Dalam Rencana

Gaya aksial akibat beban sendiri	$P_{(U)1}$ =	246.57	kN
Gaya aksial akibat beban terbagi rata	$P_{(U)2}$ =	391.6	kN
Gaya aksial akibat beban garis terpusat	$P_{(U)3}$ =	250.44	kN
Gaya aksial total	$P_{(U)\ maks}$ =	888.61	kN

-Kontrol Kapasitas Kabel

	$P_n > P_{(U)}$ =	**(OK)**

PERHITUNGAN SAMBUNGAN

-PERENCANAAN SAMBUNGAN *GELAGAR MEMANJANG - GELAGAR MELINTANG*

-MATERIAL DAN DIMENSI BAUT RENCANA

Digunakan mutu baut	Grade =	A325	
Tegangan putus	f_u =	830	MPa
Tegangan leleh	f_y =	660	MPa
Diameter baut	d_f =	20	mm
Gaya tarik minimum baut	N_t =	145	kN
Luas efektif baut	A_e =	225	mm^2
Luas tegangan tarik	A_s =	245	mm^2
Luas nominal baut	A_0 =	314	mm^2

-MATERIAL DAN DIMENSI PELAT RENCANA

Tebal pelat	t_p =	10	mm
Tegangan tarik pelat	f_{up} =	370	MPa

-DESAIN SAMBUNGAN

Gaya geser rencana	V_u =	247.02	kN

-Kekuatan Geser Nominal Baut

Koefisien geser permukaan	μ =	0.3	
Jumlah bidang geser	n_i =	1	
Faktor ukuran pengisi baut	K_h =	1	
Faktor reduksi	ϕ =	0.75	
Kekuatan geser nominal baut (*Slip Critical*)	$V_{sf} = \mu \times n_i \times K_h \times N_t$ =	43.5	kN
	ϕV_{sf} =	32.625	kN
Jumlah baut yang diperlukan	**$n = V_u / \phi V_{sf}$ =**	**8**	Baut

-Jarak Pemasangan Baut

-Kontrol jarak antar baut (S_b)

Jarak minimum	$S_{b\,min} = 2.5 \times d_f$ =	50	mm
Jarak maksimum	$S_{b\,max} = 4 \times t_p + 100$ =	140	mm
Jarak yang digunakan	S_b =	100	mm
	$S_{b\,min} \le S_b \le S_{b\,max}$ =	**(OK)**	

-Kontrol jarak tepi baut (S_{tb})

Jarak minimum	$S_{tb\,min} = 1.5 \times d_f$ =	30	mm
Jarak maksimum	$S_{tb\,max} = 12 \times t_p$ =	120	mm
Jarak yang digunakan	S_{tb} =	50	mm
	$S_{tb\,min} \le S_{tb} \le S_{tb\,max}$ =	**(OK)**	

-Kekuatan Tumpu dan Sobek Pelat Penyambung

Jarak antar baut	S_b =	100	mm
Jarak tepi baut	S_{tb} =	50	mm
Jarak ujung lubang dengan ujung pelat	a_e =	39	mm
Kuat tumpu pelat	$V_{b\,tumpu} = 3.2 \times d_f \times t_p \times f_{up}$ =	236.8	kN

Kuat sobek pelat	$V_{b\ sobek} = a_e \times t_p \times f_{up} =$	144.3 kN
	$a_e \times t_p \times f_{up} < 3.2 \times d_f \times t_p \times f_{up} =$	**(OK)**

PERENCANAAAN *SHEAR CONNECTOR*

-MATERIAL DAN DIMENSI LANTAI JEMBATAN

Mutu beton lantai jembatan	f'_c =	30	MPa
Modulus elastisitas beton	E_c =	25742.9602	MPa
Tinggi pelat lantai	$t_{pelat\ jembatan}$ =	200	mm
Lebar efektif pelat lantai	b_{eff} =	2400	mm

-MATERIAL DAN DIMENSI SHEAR CONNECTOR RENCANA

Kekuatan tarik shear connector	F_u =	830	MPa
Diameter shear connector	d_{sc} =	25	mm
Luas penampang shear connector	A_{sc} =	490.87	mm^2

-MATERIAL DAN DIMENSI GELAGAR MELINTANG

Tegangan leleh	f_y =	250	MPa
Tegangan tarik	f_u =	410	MPa
Digunakan profil	WF. 850.9 X 293.8 . 16.1 . 26.8		
Tinggi	H =	850.9	mm
Lebar sayap	B =	293.8	mm
Tebal web	t_w =	16.1	mm
Tebal flange	t_f =	26.8	mm
Radius	r =	17.8	mm
Tinggi web	h_o =	761.7	mm
Luas penampang	A_x =	28856	mm^2
Berat penampang	W_x =	2.221	kN/m

-PERENCANAAN SHEAR CONNECTOR

Lebar efektif pelat	b_{eff}= Jarak antar balok melintang =	5000	mm
Lebar efektif pelat	b_{eff}= 12 x t_{pelat} =	2400	mm
Lebar efektif pelat	b_{eff}= $L_{melintang}$ /4 =	3750	mm
	diambil b_{eff} =	2400	mm
Modulus ratio	n = E_s / E_c =	7.77	
Lebar equivalen baja	b_{eff} / n =	309	mm

Letak garis netral komposit

Luas penampang baja equivalen	A_c = (b_{eff} / n) x t_{pelat} =	61783	mm^2
Luas total	A_{total} = A_c + A_x =	90639	mm^2
Statis momen sisi atas	Y_a = (A_c x (t_{pelat}/2) + A_x x (H/2 + t_{pelat})) / A_{total} =	267	mm
Statis momen sisi bawah	Y_b = (A_c x (H + t_{pelat}/2) + (A_x x (H/2)) / A_{total} =	784	mm

Penampang baja equivalen

Luas penampang baja equivalen	A_c =	61783.10	mm^2
Momen inersia terhadap diri sendiri	I_{oc} = 1/12 x (b_{eff} / n) x t_{pelat}^3 =	205943682	mm^4

Jarak pusat penampang baja equivalen terhadap garis netral komposit

	d_1 = Y_a - (t_{pelat} / 2) =	167.28	mm

Momen inersia penampang baja equivalen terhadap garis netral komposit

	I_c = I_{oc} + A_c x d_1^2 =	1934863176	mm^4

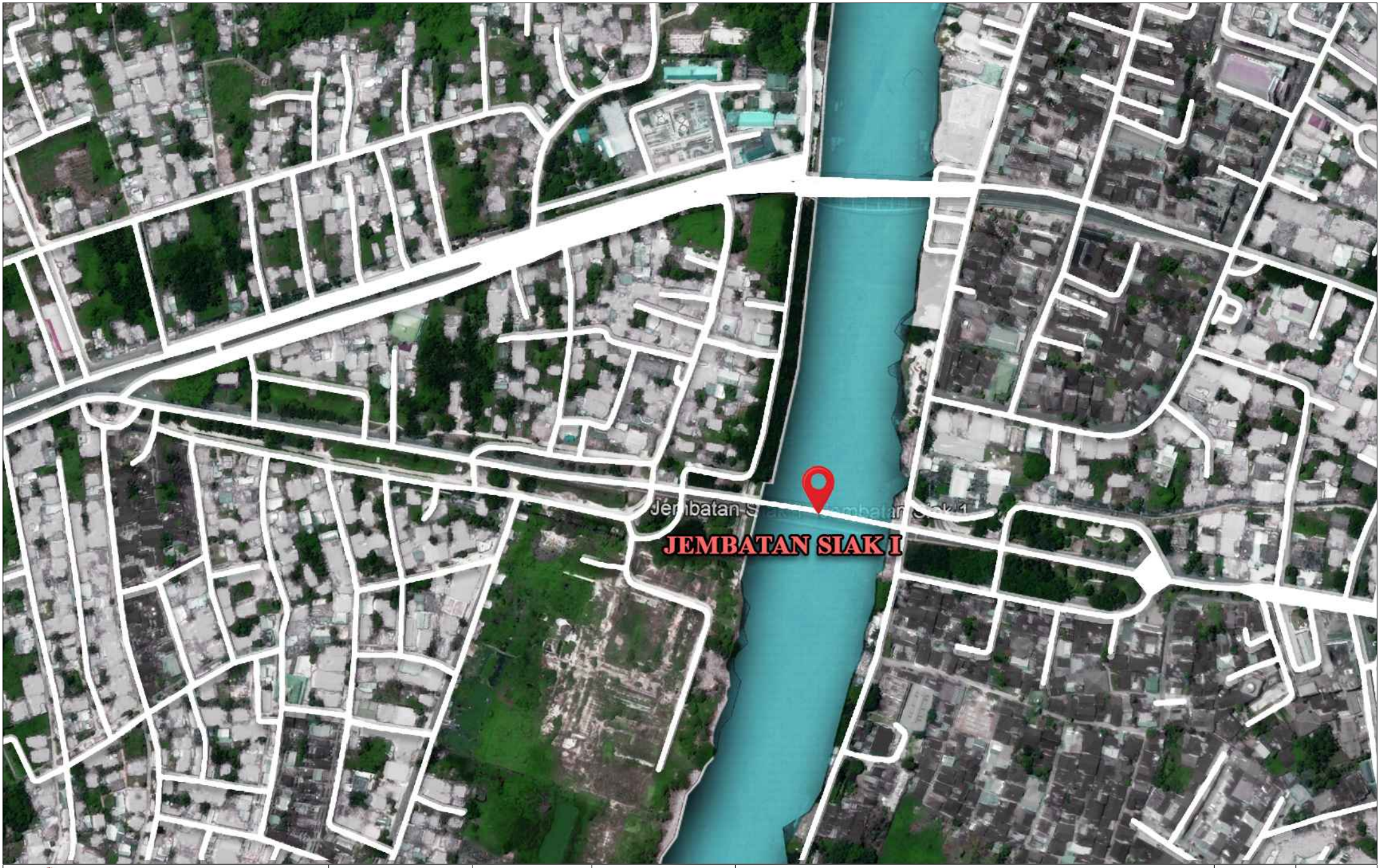
Profil baja

PERENCANAAAN *SHEAR CONNECTOR*

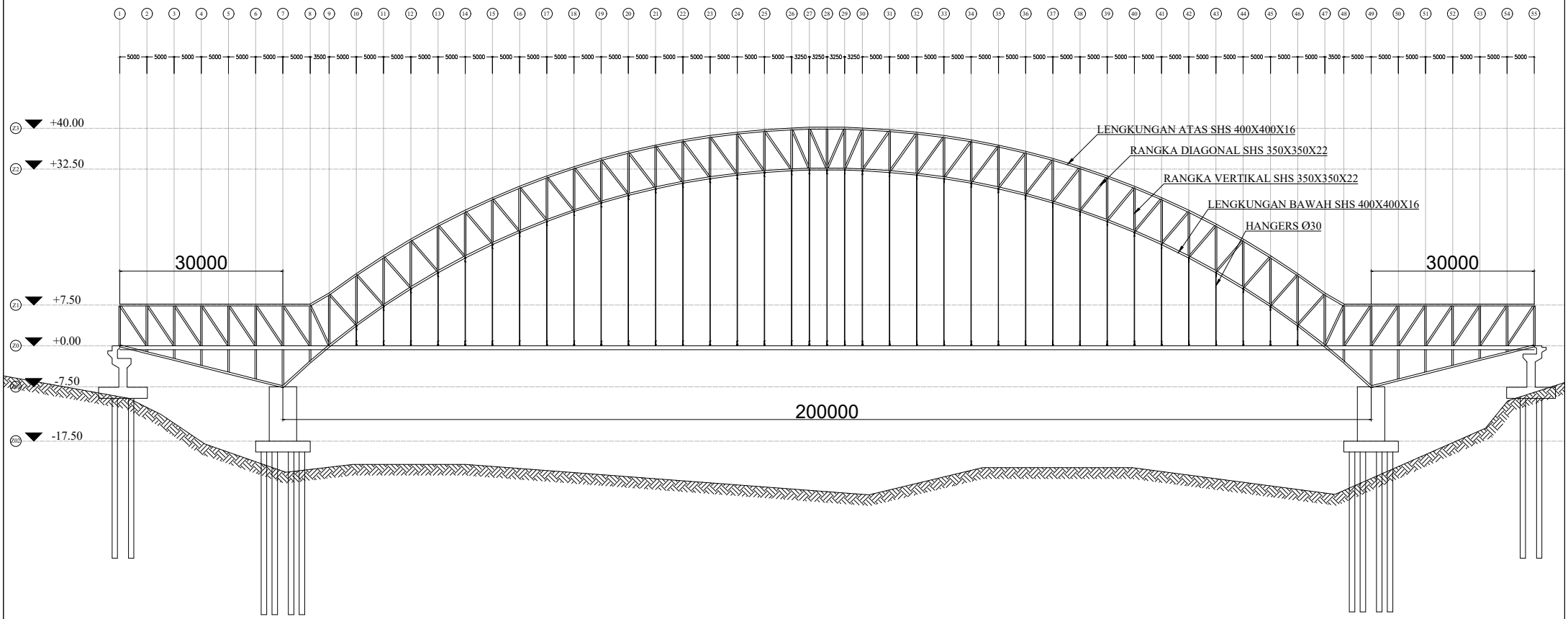
Luas penampang	A_x =	28856	mm^2
Momen inersia terhadap diri sendiri	I_{os} =	3397000000	mm^4
Jarak pusat profil baja terhadap garis netral komposit			
	$d_2 = Y_b - (H/2)$ =	358.17	mm
Momen inersia profil baja terhadap garis netral komposit			
	$I_s = I_{os} + A_x \times d_2^2$ =	7098753409	mm^4
Momen Inersia penampang komposit	$I_{comp} = I_c + I_s$ =	9033616585	mm^4
-Kebutuhan Shear Connector			
Luas shear connector	A_{sc} =	490.87	mm^2
Kapasitas geser nominal shear connector	$Q_n = 0.5 \times A_{sc} \times (f'_c \times E_c)^{0.5}$ =	215690	N
	$Q_n' = A_{sc} \times F_u$ =	407425	N
	Qn ≤ Qn' =	**Pakai nilai Qn**	
Kegagalan akibat profil baja	$T = A_s \times f_y$ =	7214015	N
Kegagalan akibat lantai beton	$C = 0.85 \times f'_c \times b_{eff} \times t_{pelat\ jembatan}$ =	12240000	N
	T ≤ C =	**Pakai nilai T**	
Gaya geser memanjang	V_L^* =	7214015	N
Faktor reduksi	ϕ =	0.75	
Gaya geser rencana	$V_{LS} = V_L^* / \phi$ =	9618686	N
Jumlah shear connector	$n = V_{LS} / 0.55 \times Q_n$ =	90.00	Buah
KONTROL SHEAR CONNECTOR			
-Kontrol Gaya Geser Memanjang			
Gaya geser memanjang	$V_L^* = T$ =	7214015	N
Gaya tarik aksial rencana	N^* =	6660	N
Gaya geser total rencana	$\phi n \times (Q_n - (N^*/\phi \times 3^{0.5}))$ =	14559067	N
	$\phi n \times (Q_n - (N^*/\phi \times 3^{0.5})) > V_L$ =	**(OK)**	
-Kontrol Terhadap Fatik			
Gaya geser ultimit	$V^* = V_{(U)}$ =	1363493	N
Gaya geser fatik	$V_{fat} = \sqrt{((V^*)^2 + (N^*/3)^2)}$ =	1363495	N
	$\phi n \times (Q_n - (N^*/\phi \times 3^{0.5})) > V_{fat}$ =	**(OK)**	

LAMPIRAN 2

GAMBAR DETAIL JEMBATAN PELENGKUNG



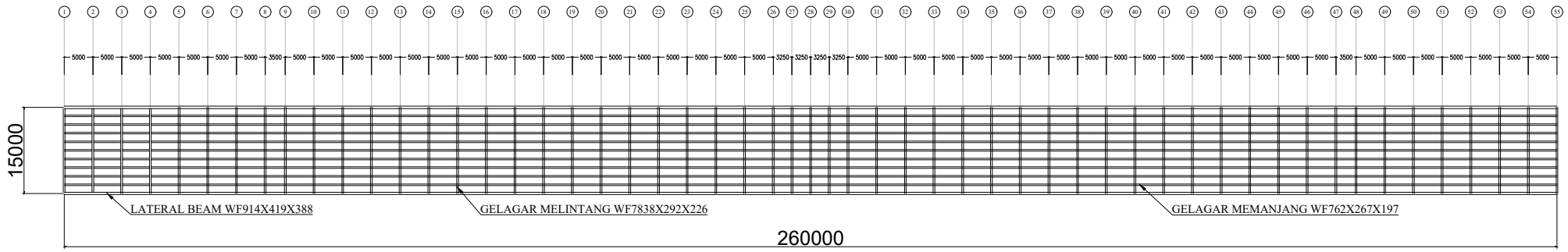
DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001	**SITE PLAN**	1	15
		NIM	DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005			
		D011191075				



TAMPAK SAMPING

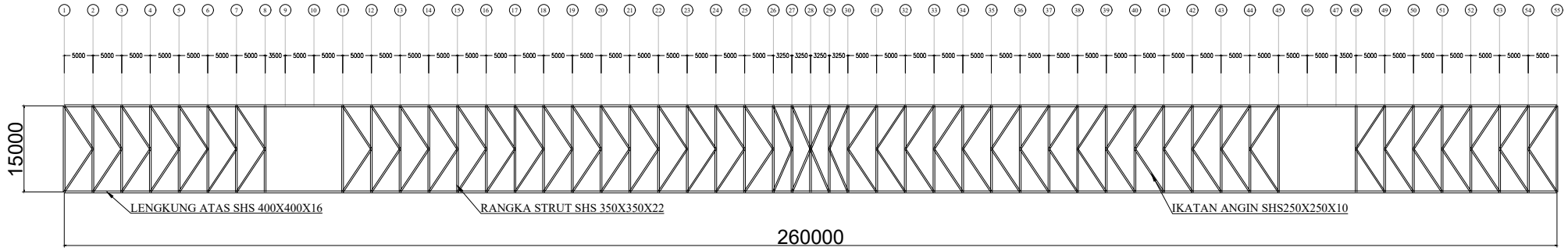
SKALA 1 : 1000

DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM **NIM** D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**TAMPAK MEMANJANG**	2	15



TAMPAK BAWAH

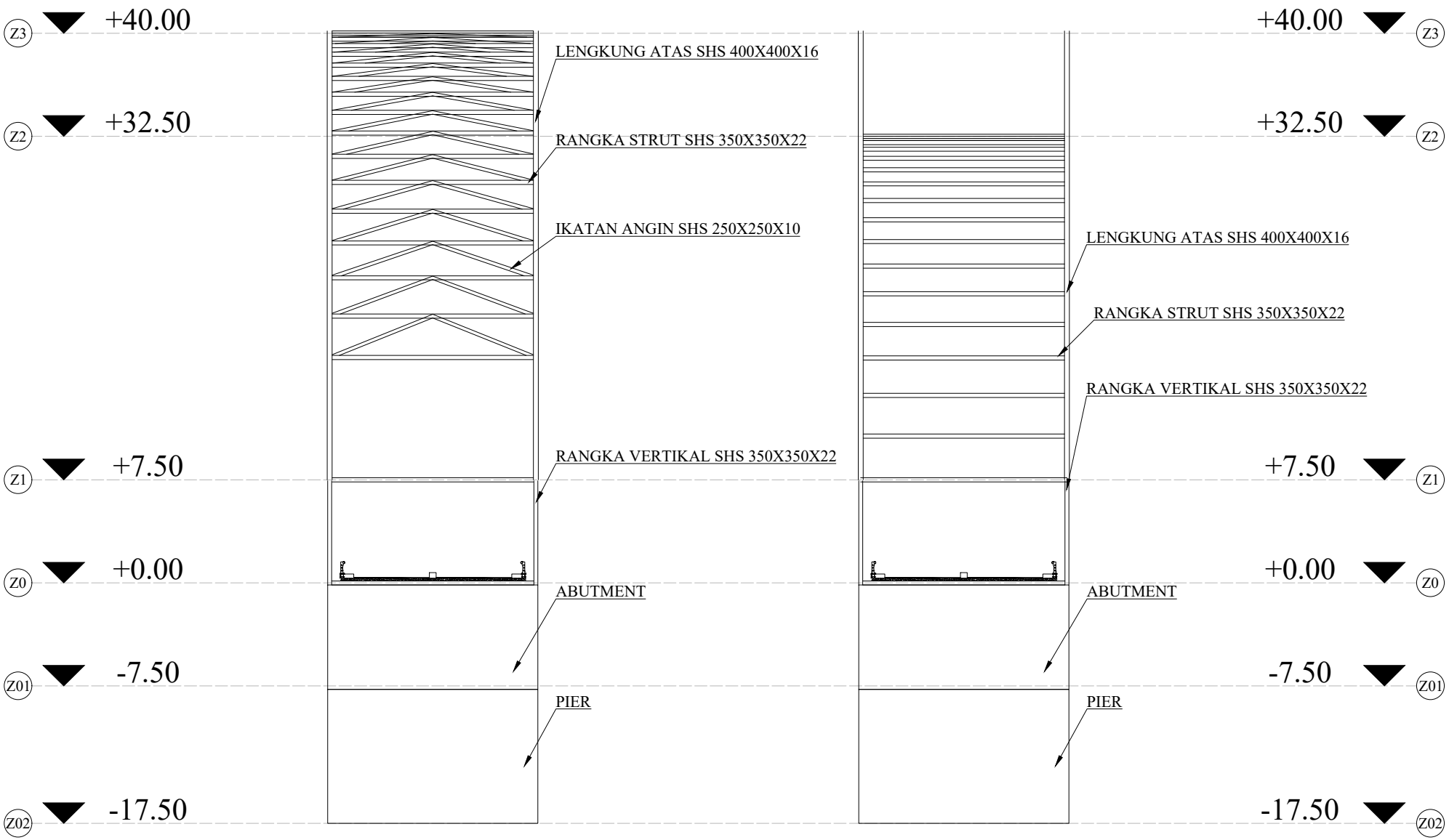
SKALA 1 : 1000



TAMPAK ATAS

SKALA 1 : 1000

DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**TAMPAK**	3	15



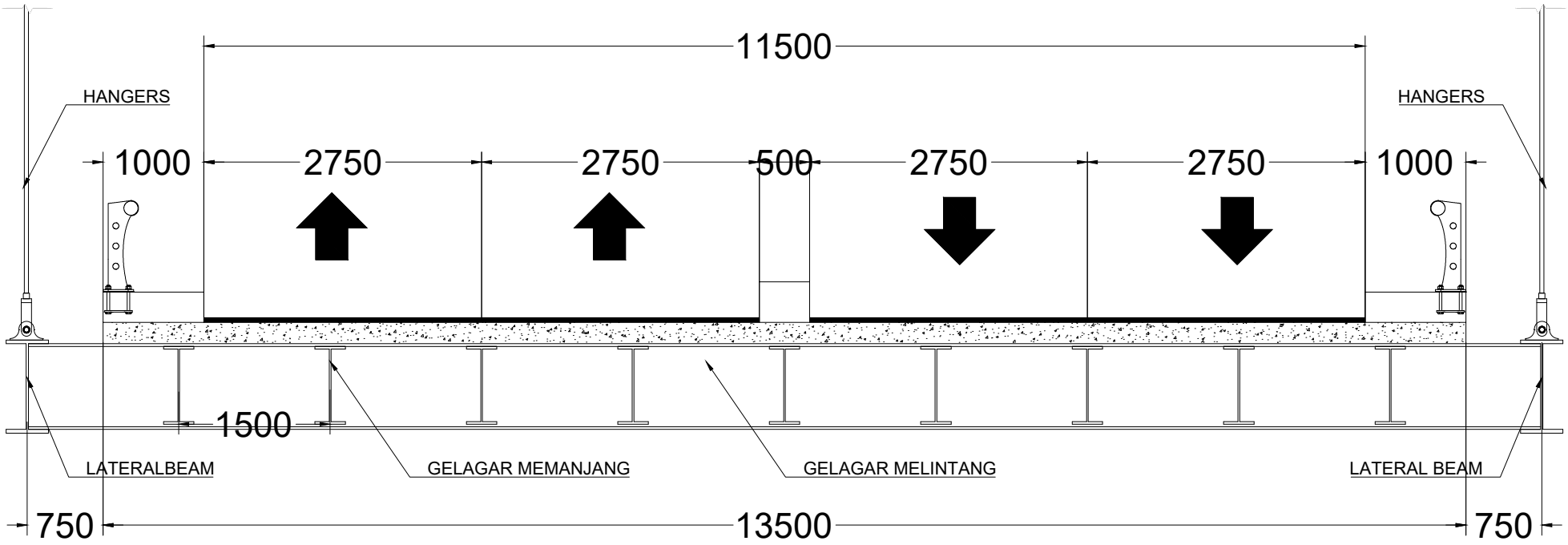
TAMPAK MELINTANG (RANGKA ATAS)

SKALA 1 : 400

TAMPAK MELINTANG (RANGKA BAWAH)

SKALA 1 : 400

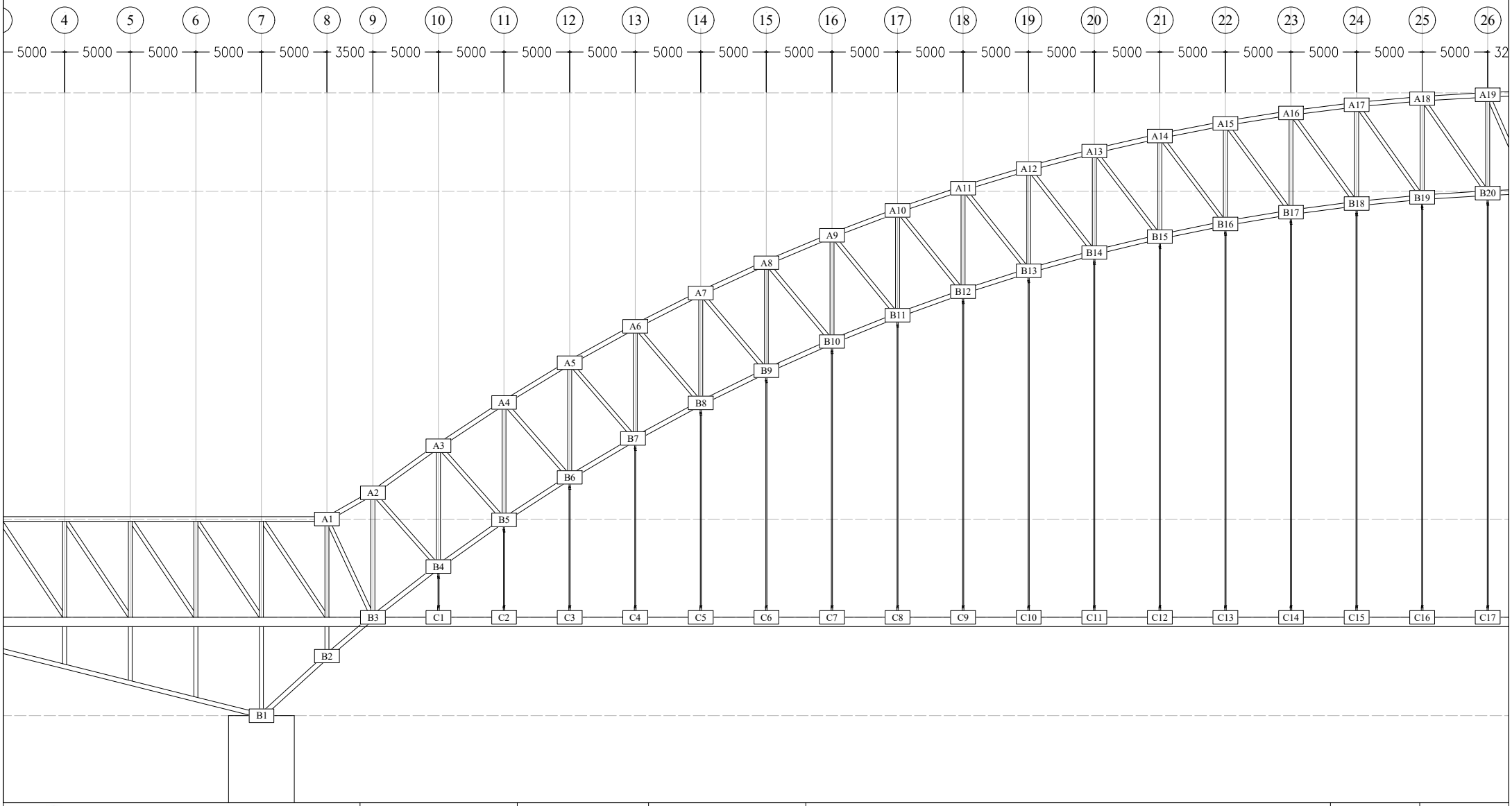
DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**TAMPAK MELINTANG**	4	15



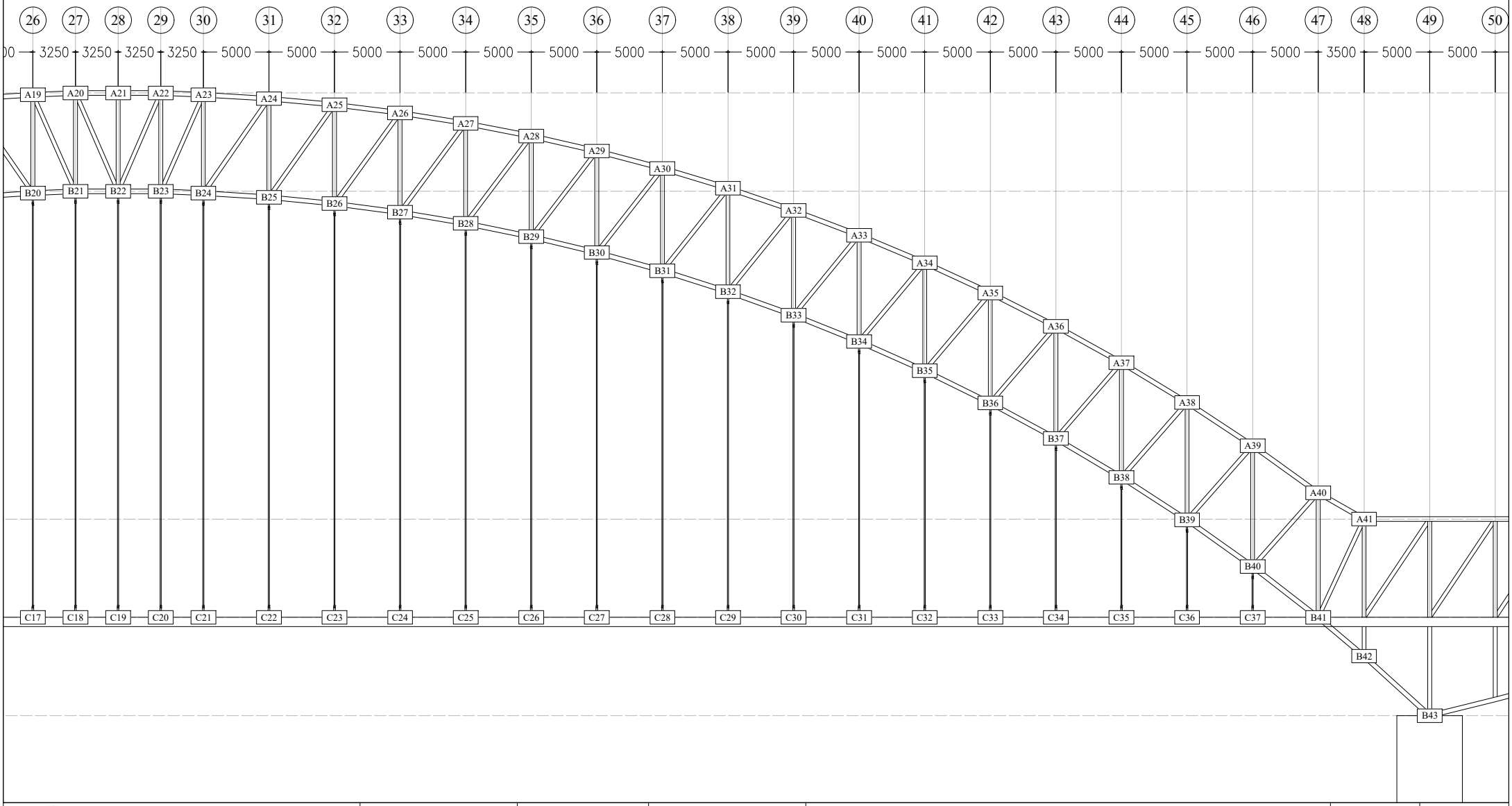
POTONGAN MELINTANG

SKALA 1 : 60

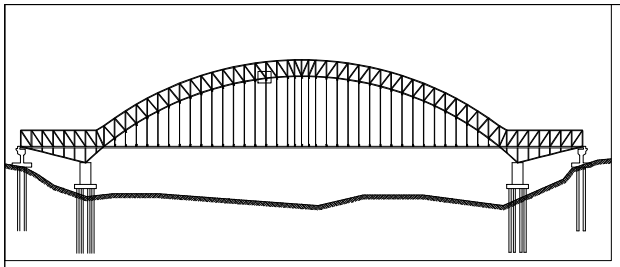
DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**POTONNGAN MELINTANG**	5	15

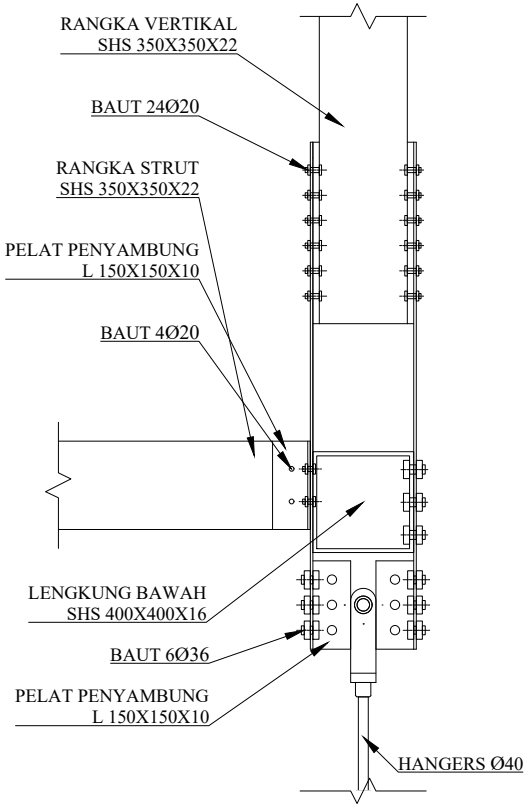


DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**PENOMORAN TITIK BENTANG UTAMA**	6	15



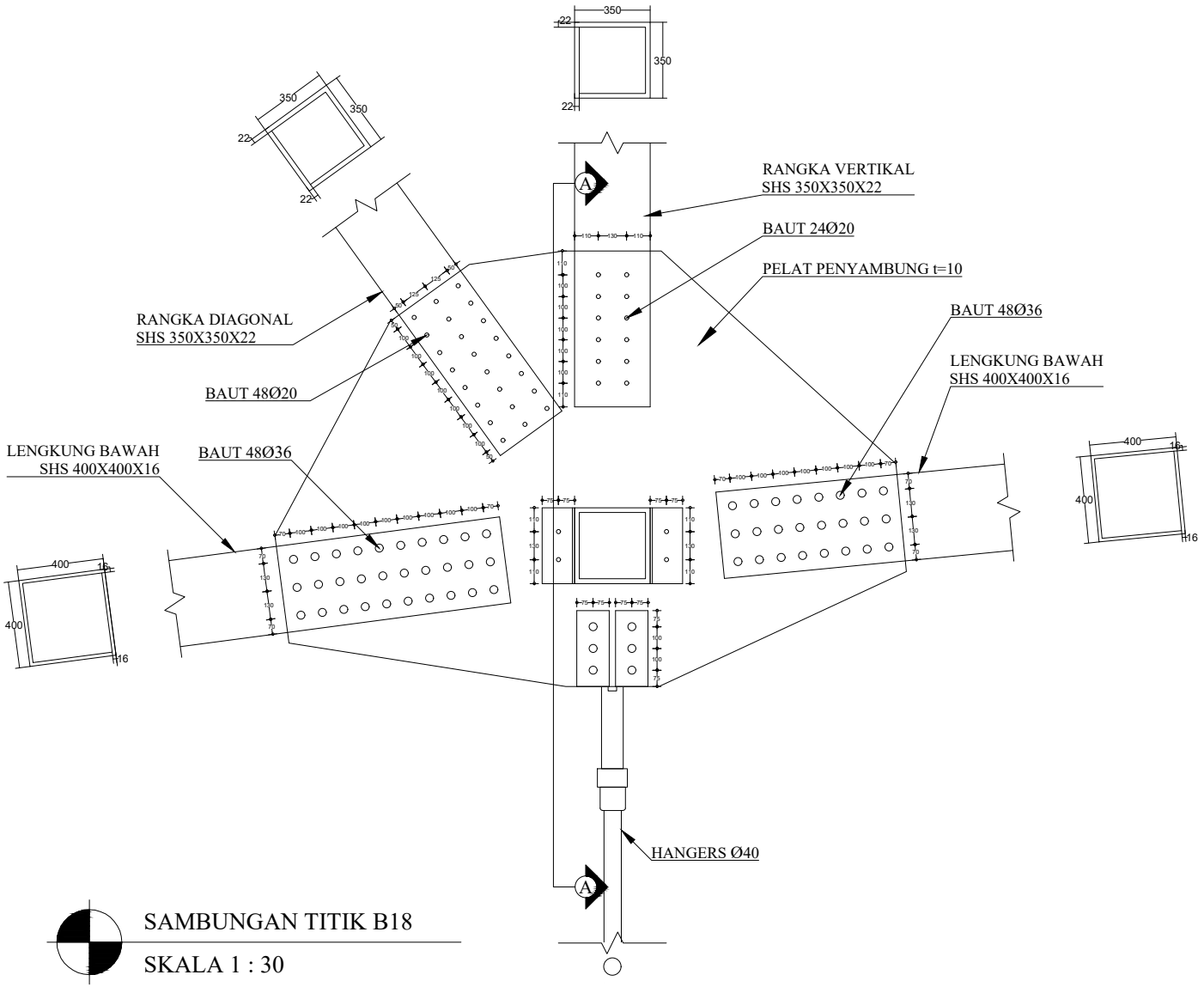
DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**PENOMORAN TITIK BENTANG UTAMA**	7	15





POTONGAN A-A

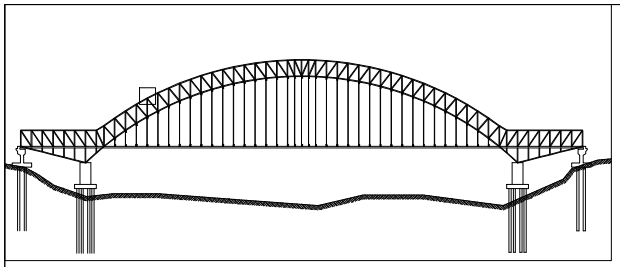
SKALA 1 : 30

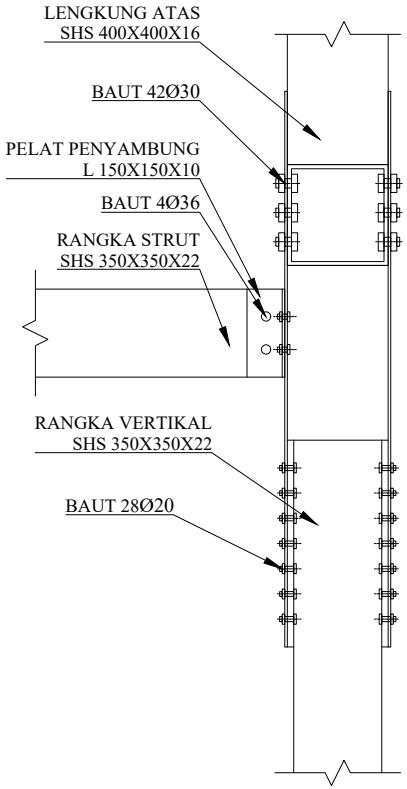


SAMBUNGAN TITIK B18

SKALA 1 : 30

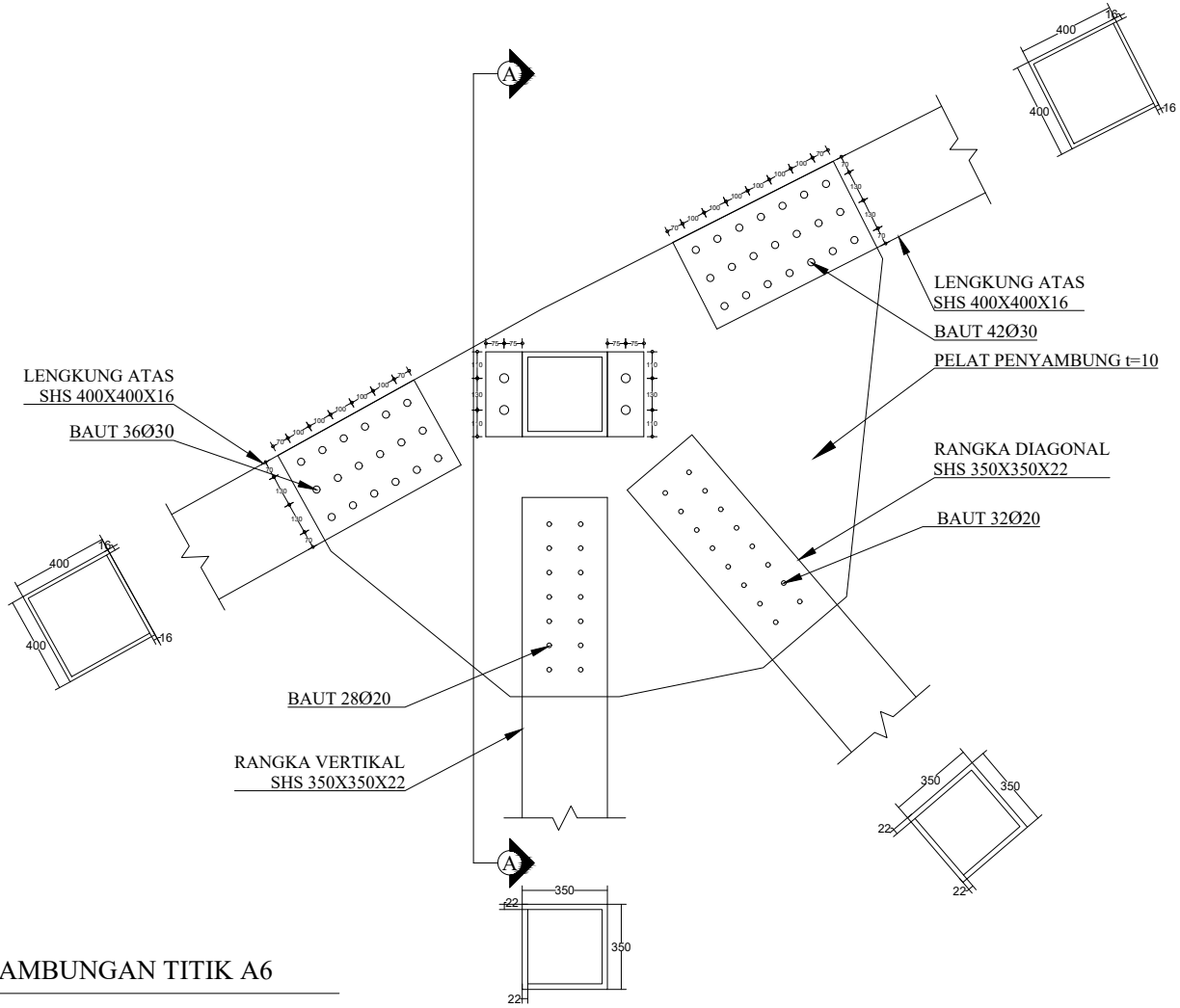
DEPARTEMEN TEKNIK SIPIL **FAKULTAS TEKNIK** **UNIVERSITAS HASANUDDIN** **GOWA 2023**	**TUGAS AKHIR**	**MAHASISWA**	**DOSEN PEMBIMBING**	**NAMA GAMBAR**	**NO. GAMBAR**	**JML. GAMBAR**
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM **NIM** D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**SAMBUNGAN TITIK B18**	8	15





POTONGAN A-A

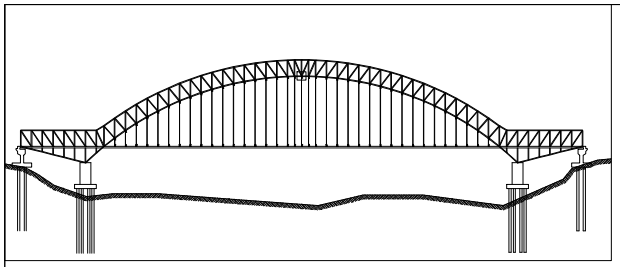
SKALA 1 : 30

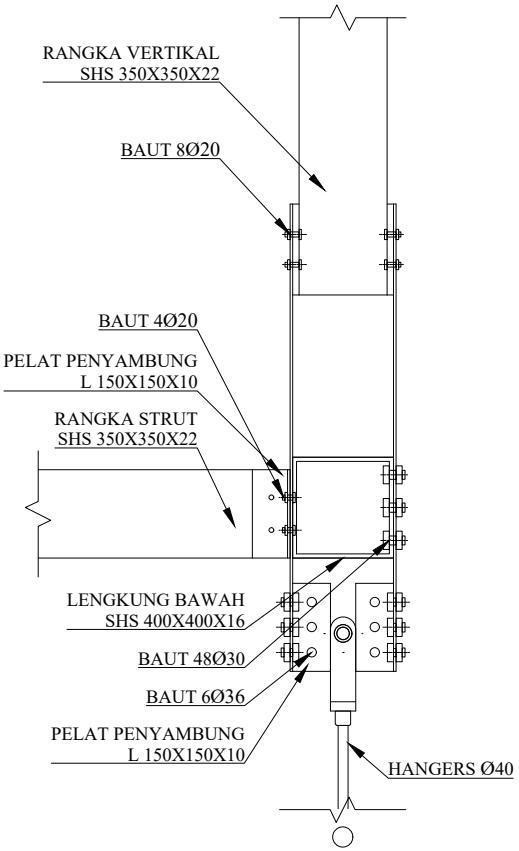


SAMBUNGAN TITIK A6

SKALA 1 : 30

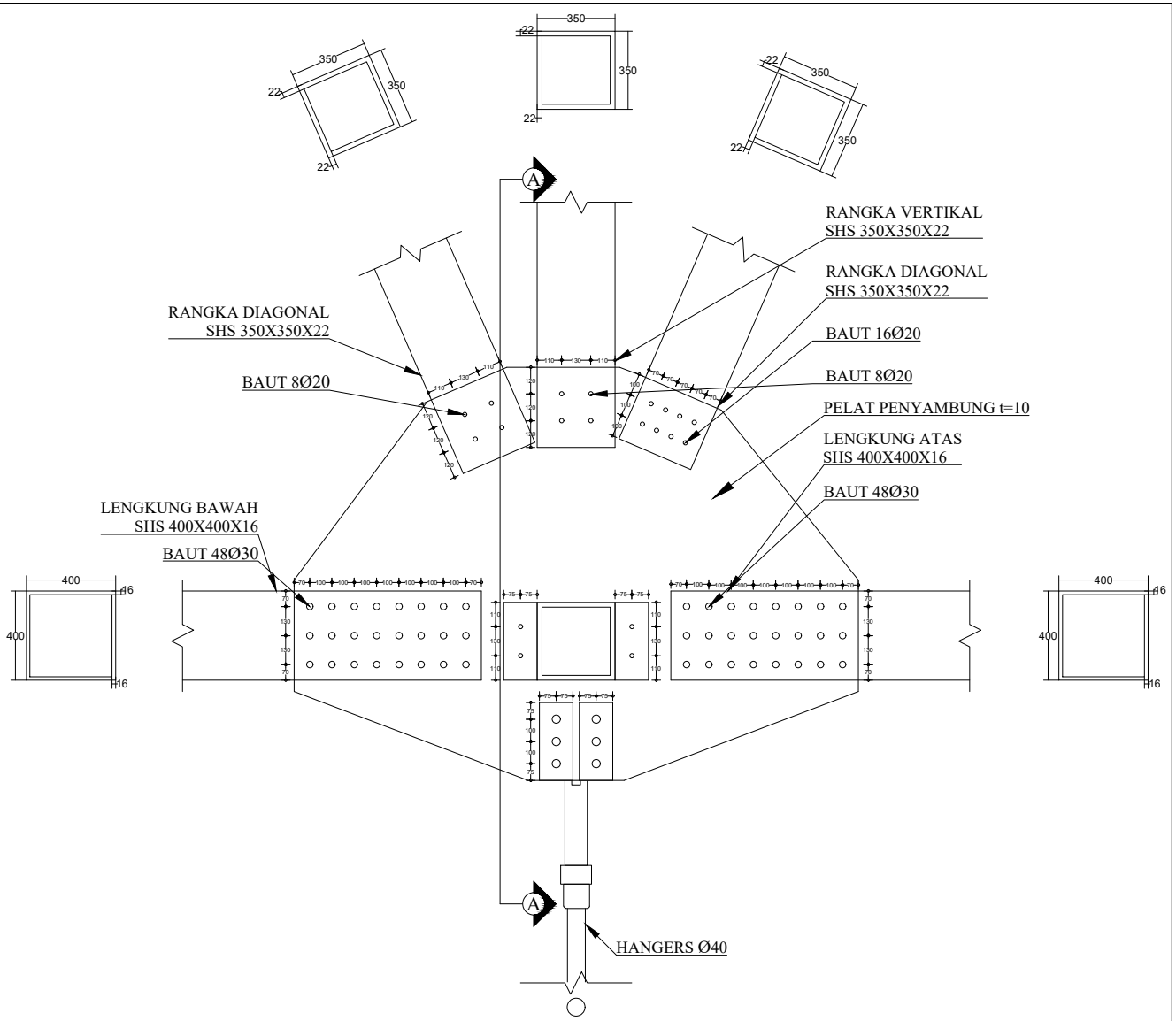
	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**SAMBUNGAN TITIK A6**	9	15





POTONGAN A-A

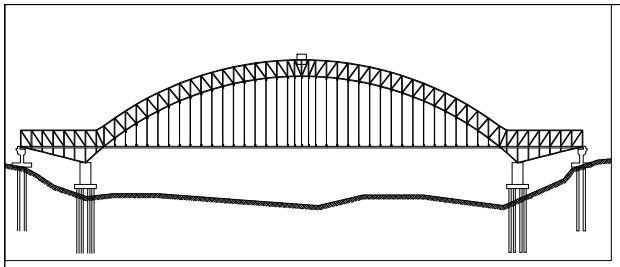
SKALA 1 : 30

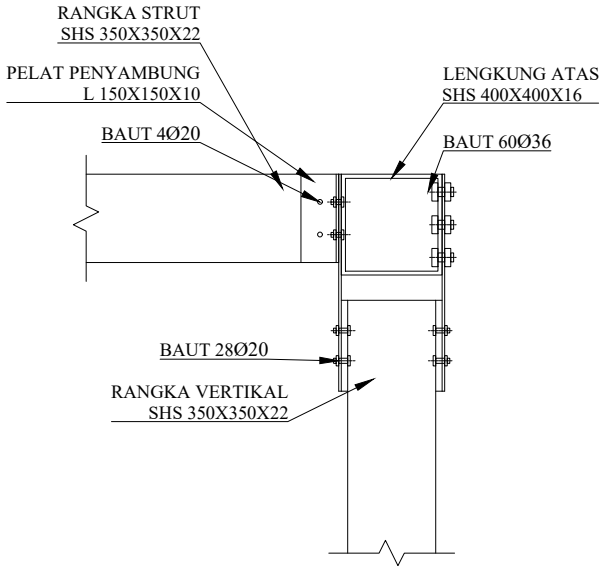


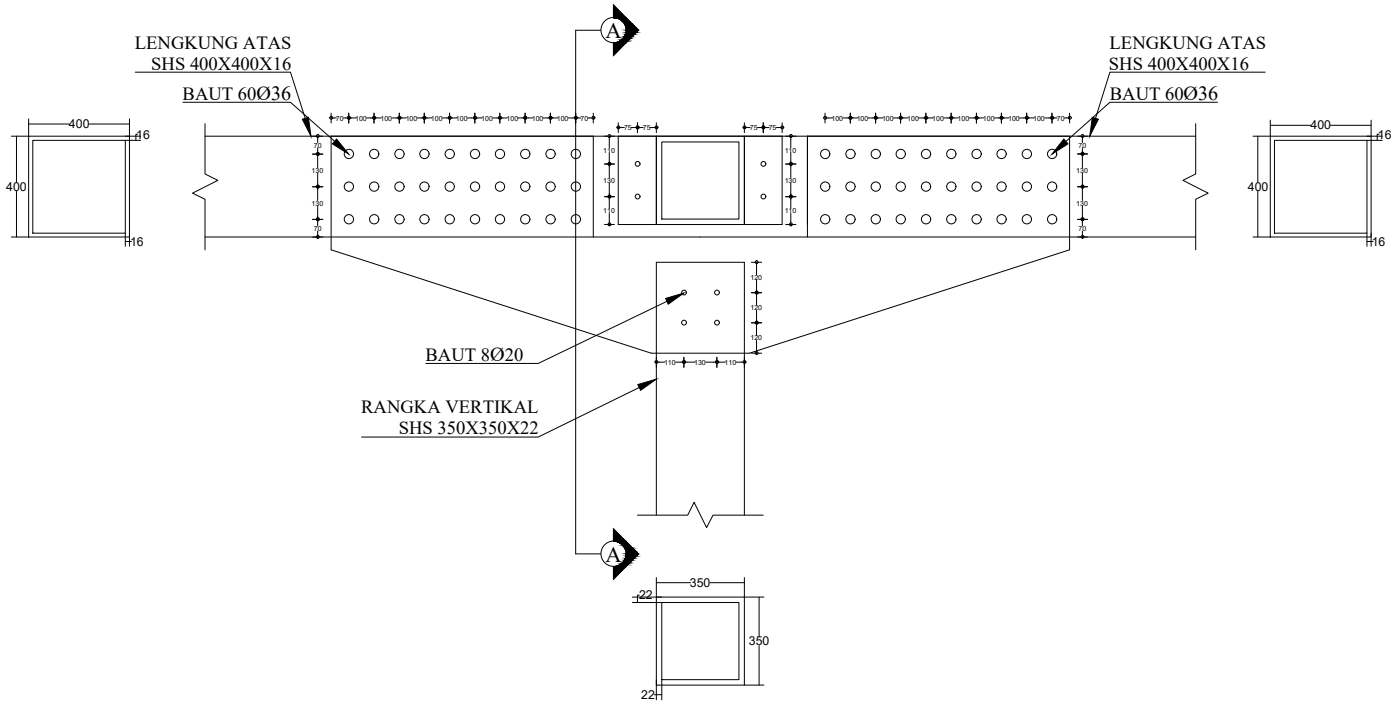
SAMBUNGAN TITIK B22

SKALA 1 : 30

DEPARTEMEN TEKNIK SIPIL **FAKULTAS TEKNIK** **UNIVERSITAS HASANUDDIN** **GOWA 2023**	**TUGAS AKHIR**	**MAHASISWA**	**DOSEN PEMBIMBING**	**NAMA GAMBAR**	**NO. GAMBAR**	**JML. GAMBAR**
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM **NIM** D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**SAMBUNGAN TITIK B22**	10	15







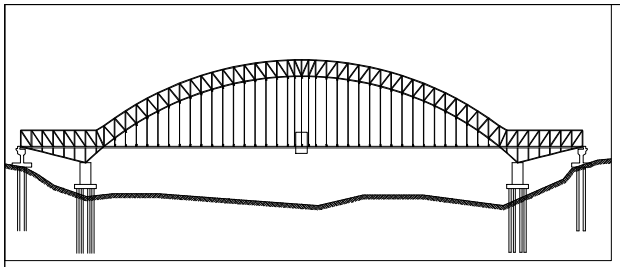
POTONGAN A-A

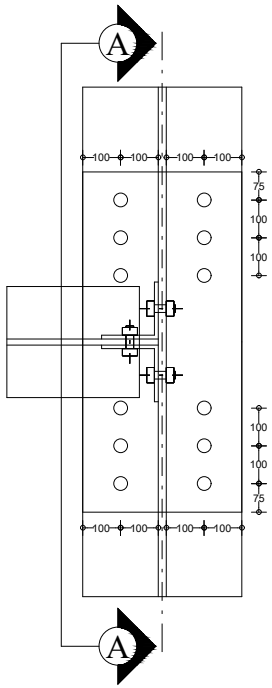
SKALA 1 : 30

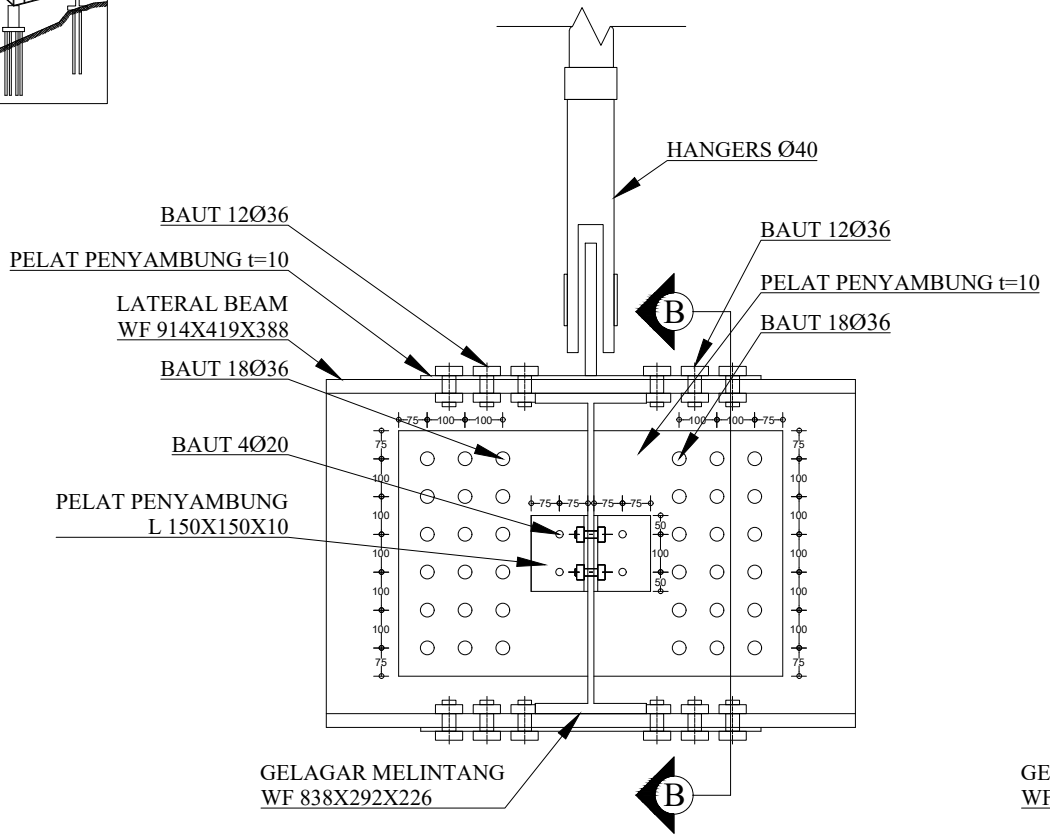
SAMBUNGAN TITIK A21

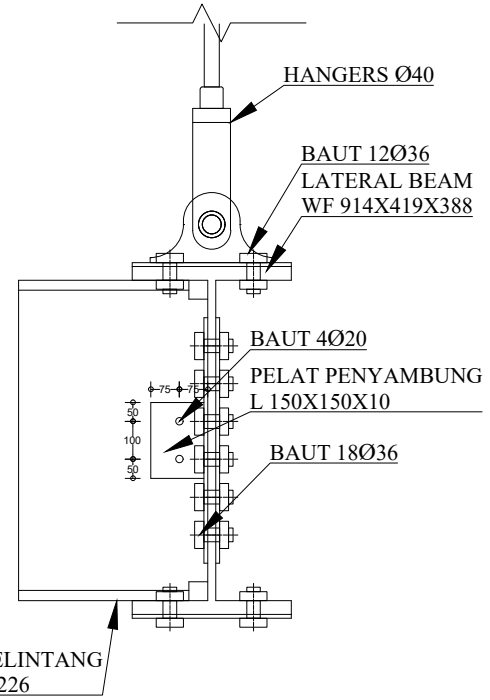
SKALA 1 : 30

DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**SAMBUNGAN TITIK A21**	11	15









SAMBUNGAN TITIK C19

SKALA 1 : 20

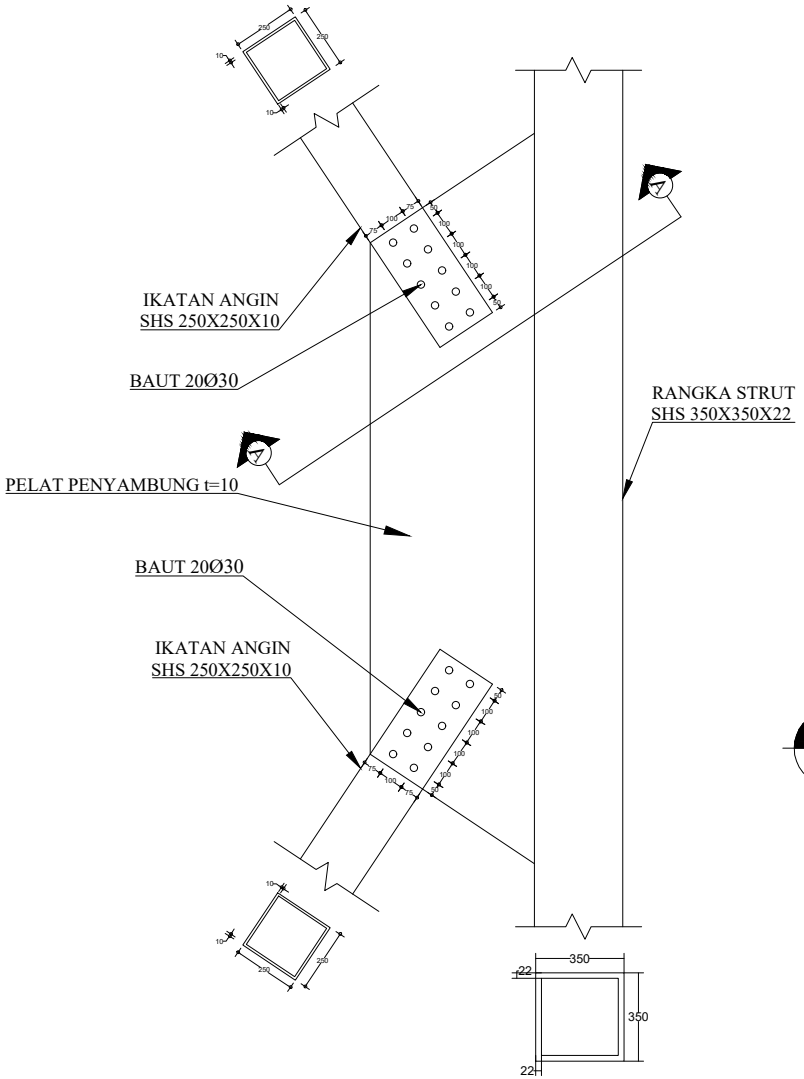
POTONGAN A-A

SKALA 1 : 20

POTONGAN B-B

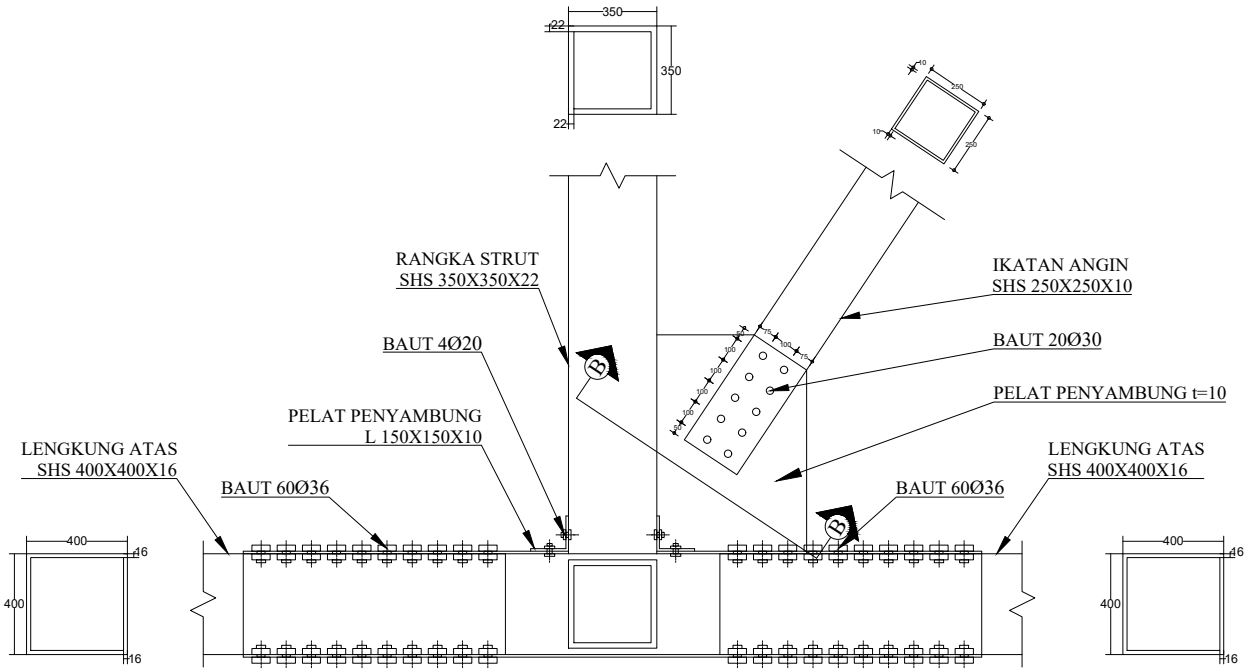
SKALA 1 : 20

DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**SAMBUNGAN TITIK C19**	12	15



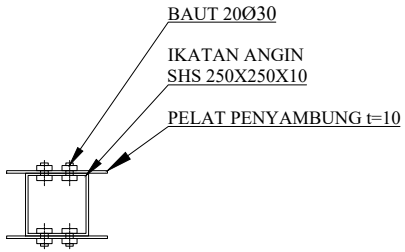
SAMBUNGAN IKATAN ANGIN TIPE 1

SKALA 1 : 30



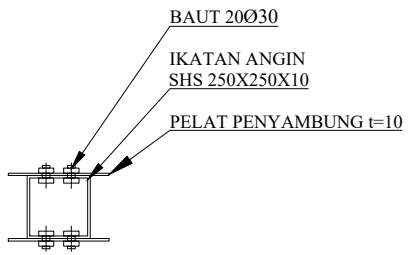
SAMBUNGAN IKATAN ANGIN TIPE 2

SKALA 1 : 30



POTONGAN A-A

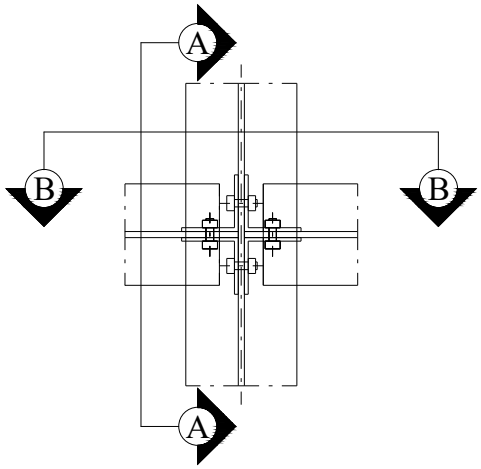
SKALA 1 : 30



POTONGAN B-B

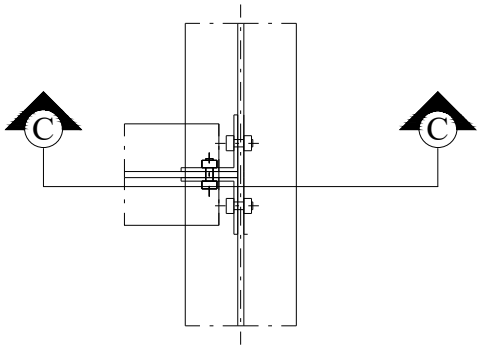
SKALA 1 : 30

DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**SAMBUNGAN IKATAN ANGIN**	13	15



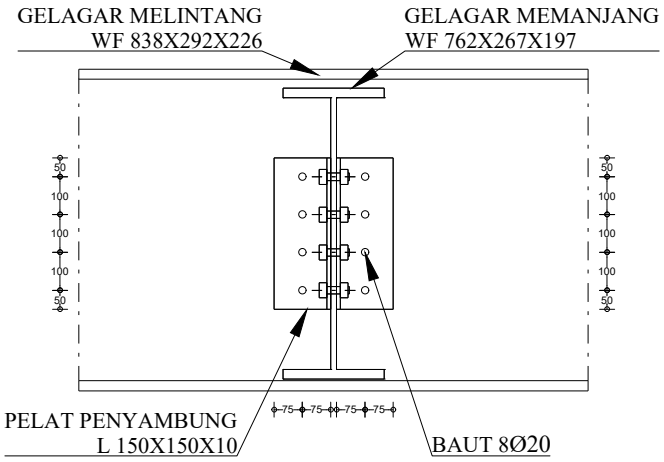
SAMBUNGAN MEMANJANG DAN MELINTANG TIPE 1

SKALA 1 : 20



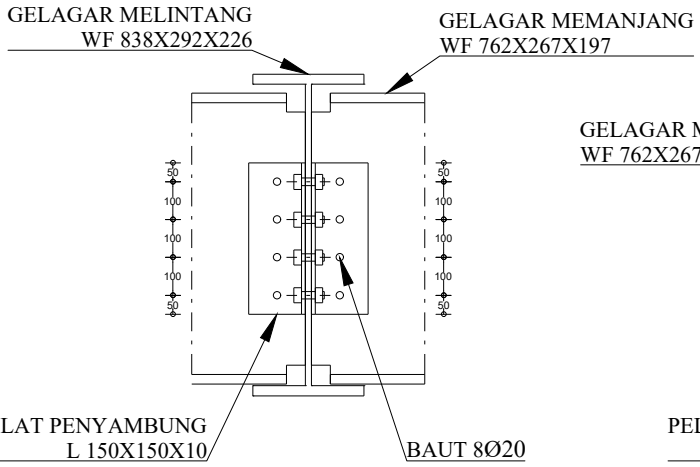
SAMBUNGAN MEMANJANG DAN MELINTANG TIPE 2

SKALA 1 : 20



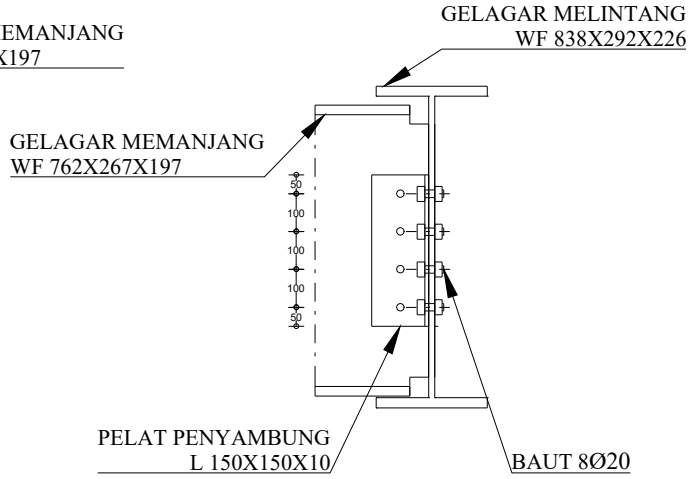
POTONGAN A-A

SKALA 1 : 20



POTONGAN B-B

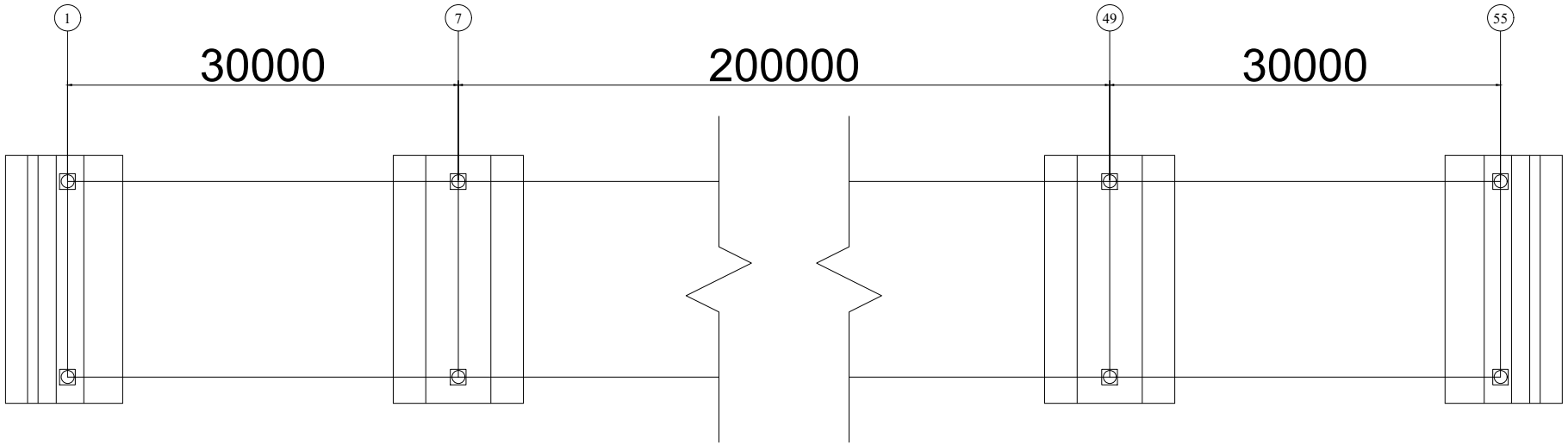
SKALA 1 : 20



POTONGAN C-C

SKALA 1 : 20

DEPARTEMEN TEKNIK SIPIL **FAKULTAS TEKNIK** **UNIVERSITAS HASANUDDIN** **GOWA 2023**	**TUGAS AKHIR**	**MAHASISWA**	**DOSEN PEMBIMBING**	**NAMA GAMBAR**	**NO. GAMBAR** / **JML. GAMBAR**
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM **NIM** D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**SAMBUNGAN GELAGAR MEMANJANG DAN MELINTANG**	14 / 15



DENAH PERLETAKAN POT BEARING

SKALA 1 : 500

DEPARTEMEN TEKNIK SIPIL FAKULTAS TEKNIK UNIVERSITAS HASANUDDIN GOWA 2023	TUGAS AKHIR	MAHASISWA	DOSEN PEMBIMBING	NAMA GAMBAR	NO. GAMBAR	JML. GAMBAR
	PEMODELAN JEMBATAN PELENGKUNG BAJA	ANDI AFDALIHILLAH RUSTAM NIM D011191075	DR. ENG. HJ. RITA IRMAWATY, S.T., M.T. NIP. 197206192000122001 DR. ENG. FAKHRUDDIN, ST., M.ENG. NIP. 198702282019031005	**DENAH PERLETAKAN POT BEARING**	15	15

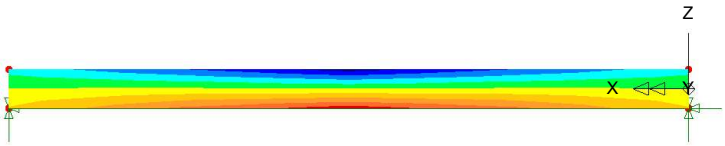
LAMPIRAN 3

ANALISIS FEA MENGGUNAKAN SOFTWARE LUSAS

Loadcase: 1
Title: Beban Lajur "D"
Results File: 0
Entity: Top Stress
Component: SX

-304,837
-261,289
-217,741
-174,192
-130,644
-87,0962
-43,5481
0,0
43,5481

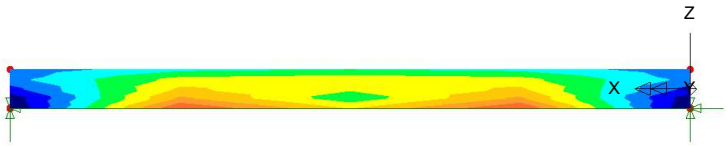
Max 68,8575 at Node 40
Min -323,075 at Node 33



Loadcase: 1
Title: Beban Lajur "D"
Results File: 0
Entity: Top Stress
Component: SZ

-40,4255
-32,3404
-24,2553
-16,1702
-8,0851
0,0
8,0851
16,1702
24,2553

Max 24,4766 at Node 41
Min -48,2894 at Node 35



Loadcase: 1
Title: Beban Lajur "D"
Results File: 0
Entity: Top Stress
Component: SZX

-73,5242
-55,1432
-36,7621
-18,3811
-7,10543E-15
18,3811
36,7621
55,1432
73,5242

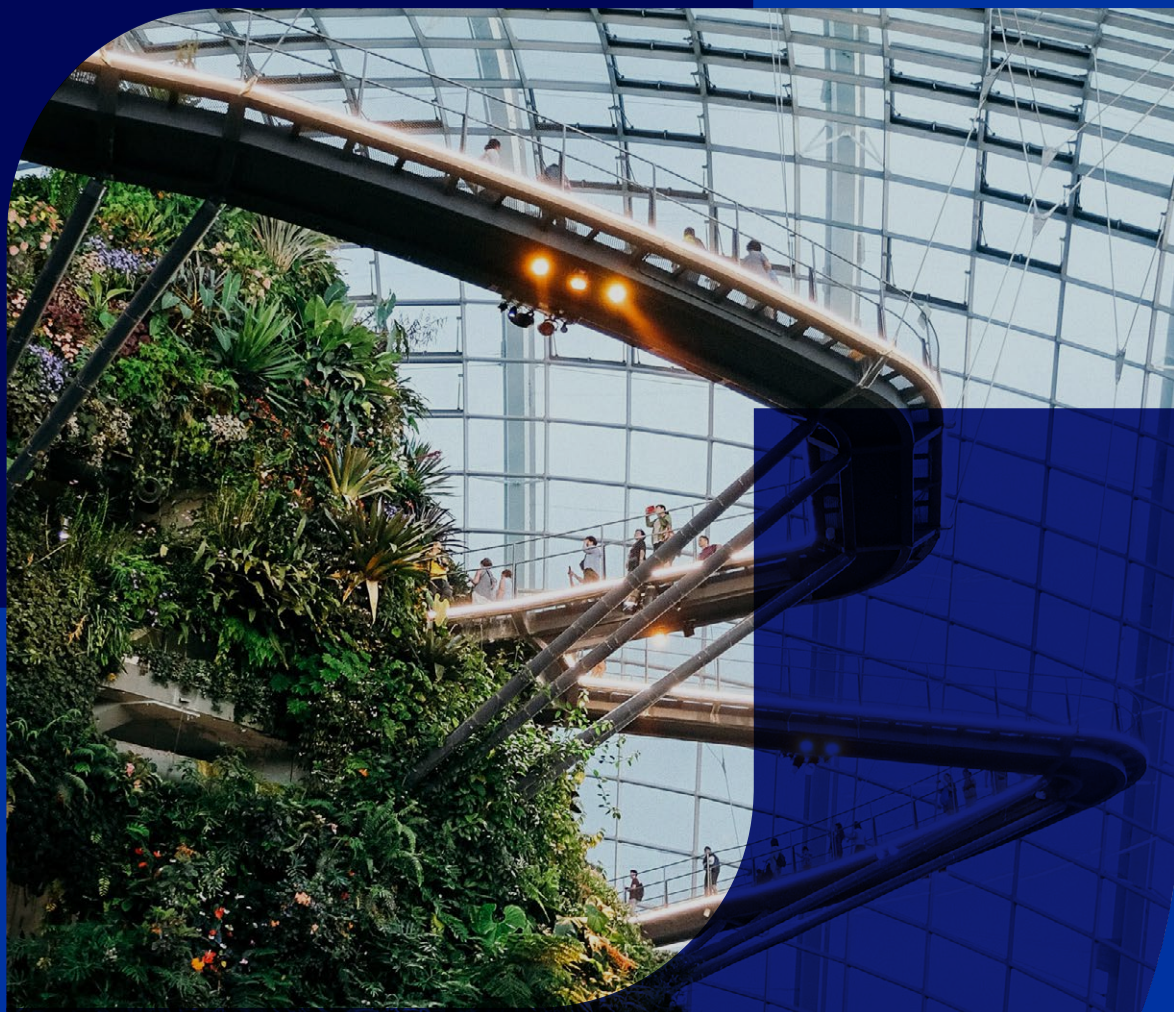
Max 82,7148 at Node 39
Min -82,7148 at Node 41

LAMPIRAN 4

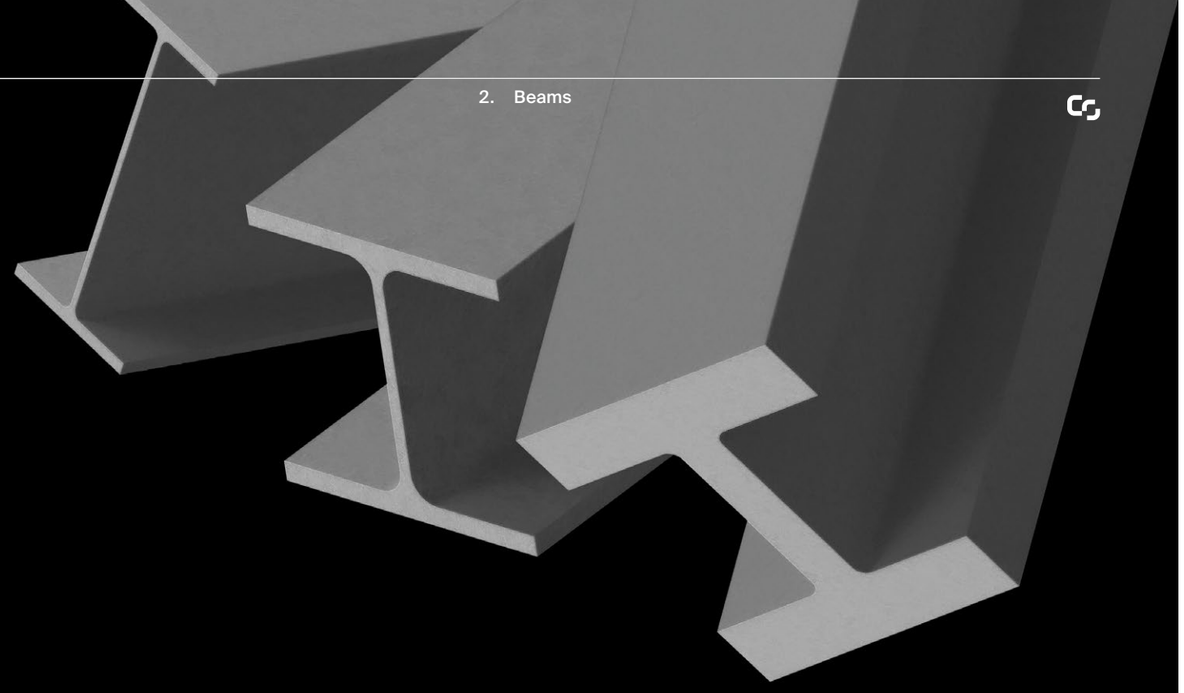
KATALOG PRODUK PROFIL PENAMPANG

Structural Steel Product Catalogue

2022 EDITION



Continental Steel



2. Beams

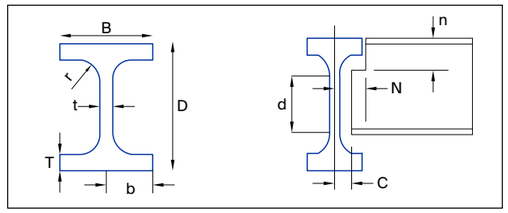
Structural steel product having a profile of a specific cross section, like a H or I, usually used in construction and is designed to support heavy loads.

Universal Beams and Columns
Standard specifications

The standard specifications used for production of universal beams and columns in this region are listed in this table.

Material	Yield strength N/mm²			Tensile strength N/mm²	Min. Elongation $L_0=5.65\sqrt{S_0}$	Min. Charpy V-notch.	Dimensions & Tolerances
AS 3679.1	**≤11mm**	**>11 - <40mm**	**≥40mm**				***AS 3679.1***
Grade 300	320	300	280	min. 440	22%	27J @ 0°C	
Grade 350	360	340	330	min. 480	20%	27J @ 0°C	
ASTM A36 (1996)	min. 250			400-550	20-21 %	-	***ASTM A6***
ASTM A572							
Grade 42	min. 290			min. 415	20-24 %	-	
Grade 50	min. 345			min. 450	18-21 %	-	
Grade 60	min. 415			min. 520	16-18 %	-	
Grade 65	min. 450			min. 550	15-17 %	-	
ASTM A992	345 - 450			min. 450	18-21 %	-	
EN 10025	**≤16mm**	**>16 - ≤40mm**	**>40 - ≤150mm**	**3-100mm**			***EN 10034***
S275JR	275	265	255 - 225	410-560	18-23 %	27J @ 20°C	
S355JR	355	345	335 - 295	470-630	17-22 %	27J @ 20°C	
S355J0	355	345	335 - 295	470-630	17-22 %	27J @ 0°C	
S355J2	355	345	335 - 295	470-630	17-22 %	27J @ -20°C	
S460M	460	440	430 - 385	500-720	17%	40J @ -20°C	
ETA - 10/0156	**≤100mm**	**>100 - ≤140mm**					***EN 10034***
HISTAR460	460	450		540-720	17%	40J @ -20°C	
JIS 3101	**≤16mm**	**>16 - ≤40mm**	**>40 - ≤100mm**	**t<100mm**			***JIS 3192***
SS400	245	235	215	400-510	17-23 %	-	
SS490	285	275	255	490-610	15-21 %	-	
SS540	400	390	-	min. 540	13-17 %	-	
JIS 3106	**≤16mm**	**>16 - ≤40mm**	**>40mm**	**t<100mm**			
SM400A	245	235	215	400-510	18-24 %	-	
SM400B	245	235	215	400-510	18-24 %	27J @ 0°C	
SM400C	245	235	215	400-510	18-24 %	47J @ 0°C	
SM490A	325	315	295	490-610	17-23 %	-	
SM490B	325	315	295	490-610	17-23 %	27J @ 0°C	
SM490C	325	315	295	490-610	17-23 %	47J @ 0°C	
SM490YA	365	355	335	490-610	15-21 %	-	
SM490YB	365	355	335	490-610	15-21 %	27J @ 0°C	
SM520B	365	355	335	520-640	15-21%	27J @ 0°C	
SM520C	365	355	335	520-640	15-21 %	47J @ 0°C	

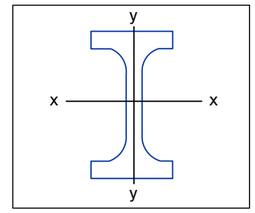
2.3
Universal Beams & Columns (UB & UC)



Imperial Units

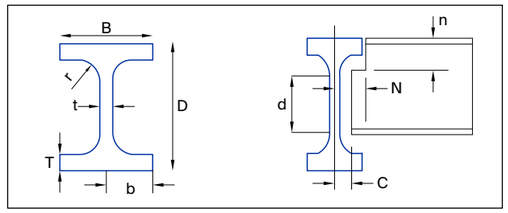
Designation			Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Area of Section	Ratios for Local Buckling		Dimensions for Detailing		
Size	Mass per Metre				Flange	Web				Flange	Web	End clearance	Notch	
			D	B	T	t	r	d	A	b/T	d/t	C	N	n
in (mm)	lb/ft	kg/m	mm	mm	mm	mm	mm	mm	cm²			mm	mm	mm
W27-27x10 (686x254)	84	125.2	677.9	253.0	16.2	11.7	15.2	615.1	159	7.81	52.6	8	131	31
	94	140.1	683.5	253.7	19.0	12.4	15.2	615.1	178	6.68	49.6	8	131	34
	102	152.4	687.5	254.5	21.0	13.2	15.2	615.1	194	6.06	46.6	9	131	36
	114	170.2	692.9	255.8	23.7	14.5	15.2	615.1	217	5.40	42.4	9	131	39
	129	192	701.8	254.3	27.9	15.5	15.2	615.6	244	4.56	39.7	10	129	43
	143	213	707.9	255.8	31.0	17.0	15.2	615.5	270	4.13	36.2	11	129	46
	159	237	714.0	257.8	34.0	19.1	15.2	615.6	301	3.79	32.2	12	129	49
	182	271	723.9	260.2	39.1	21.6	15.2	615.3	345	3.33	28.5	13	129	54
	201	299	732.0	262.8	42.9	23.9	15.2	615.8	382	3.06	25.8	14	129	58
	221	329	739.9	264.8	47.0	25.9	15.2	615.5	418	2.82	23.8	15	129	62
	247	368	749.8	267.7	52.1	28.9	15.2	615.2	468	2.57	21.3	16	129	67
	271	404	760.0	270.3	56.9	31.5	15.2	615.8	513	2.38	19.5	18	129	72
	302	449	771.9	273.8	63.0	35.1	15.2	615.5	574	2.17	17.5	20	129	78
W27-27x14 (686x356)	146	217.3	695.5	354.7	24.8	15.4	15.2	615.6	277	7.16	40.1	10	180	40
	161	239.6	700.8	356.1	27.4	16.8	15.2	615.5	306	6.49	36.7	10	180	43
	178	264.9	706.4	357.8	30.2	18.4	15.2	615.5	337	5.92	33.4	11	180	45
	194	288.7	714.0	356.4	34.0	19.1	15.2	615.5	368	5.24	32.3	12	179	49
	217	322.9	722.1	358.5	38.1	21.1	15.2	615.5	411	4.70	29.2	13	179	53
	235	349.7	728.0	360.4	40.9	23.1	15.2	615.8	446	4.41	26.6	14	179	56
	258	383.9	736.1	362.5	45.0	24.9	15.2	615.8	489	4.03	24.7	14	179	60
	281	418.2	744.0	364.5	49.0	26.9	15.2	615.6	533	3.72	22.9	15	179	64
	307	456.9	752.1	366.9	53.1	29.5	15.2	615.5	582	3.46	20.9	17	179	68
	336	500	762.0	369.0	57.9	32.0	15.2	615.8	636	3.19	19.2	18	179	73
W30-30x10 1/2 (762x267)	90	133.9	750.0	264.4	15.5	12.0	16.5	686.0	171	8.53	57.2	8	136	32
	99	146.9	754.0	265.2	17.5	12.8	16.5	686.0	187	7.58	53.6	8	136	34
	108	160.7	757.7	266.1	19.3	13.8	16.5	686.1	205	6.89	49.6	9	136	36
	116	173	762.2	266.7	21.6	14.3	16.5	686.0	220	6.17	48.0	9	136	38
	124	184.5	766.3	267.1	23.6	14.9	16.5	686.1	235	5.65	46.2	9	136	40
	132	196.8	769.8	268.0	25.4	15.6	16.5	686.0	251	5.28	44.0	10	136	42
	148	220	779.0	266.2	30.0	16.5	16.5	686.0	281	4.44	41.6	10	135	47
	165	246	785.1	268.1	33.0	18.5	16.5	686.1	312	4.06	37.1	11	135	50
	185	275	793.0	270.1	37.1	20.6	16.5	685.8	351	3.64	33.3	12	135	54
	207	308	801.1	272.7	40.9	23.1	16.5	686.3	392	3.33	29.7	14	135	57
	226	337	809.0	274.6	44.9	24.9	16.5	686.2	428	3.06	27.6	14	135	61
	246	366	817.1	276.6	48.0	26.9	16.5	688.1	462	2.88	25.6	15	135	65

Dimensions	EN10365 / ASTM A6
Specification	EN10025 / ASTM A36 / ASTM A572
Size Range	UB: 5”x3” (127mm x 76mm) to 44”x16” (1118mm x 406mm) UC: 4”x4” (102mm x 102mm) to 14”x16” (356mm x 406mm)



Surface Area	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant
Per metre	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y				
									u	x	H	J
m²	cm⁴	cm⁴	cm	cm	cm³	cm³	cm³	cm³			dm⁶	cm⁴
2.32	118000	4383	27.2	5.24	3481	347	3994	542	0.862	43.9	4.80	116
2.33	136300	5184	27.6	5.39	3987	409	4558	638	0.868	38.7	5.72	169
2.34	150400	5784	27.8	5.46	4374	455	5000	710	0.871	35.5	6.42	220
2.35	170300	6631	28.0	5.53	4916	518	5631	811	0.872	31.8	7.42	308
2.36	198000	7670	28.5	5.61	5644	603	6462	943	0.878	27.7	8.71	462
2.38	222000	8678	28.7	5.67	6272	678	7204	1063	0.878	25.2	9.94	627
2.39	247800	9750	28.7	5.69	6940	756	8016	1191	0.877	23.0	11.3	840
2.42	289300	11540	29.0	5.78	7993	887	9282	1402	0.878	20.3	13.5	1260
2.44	323800	13060	29.1	5.85	8847	994	10330	1577	0.877	18.6	15.5	1675
2.46	359400	14640	29.3	5.92	9715	1106	11390	1759	0.877	17.2	17.6	2186
2.49	406900	16800	29.5	5.99	10850	1255	12810	2005	0.877	15.6	20.4	2993
2.51	453800	18910	29.7	6.07	11940	1399	14170	2243	0.877	14.4	23.4	3897
2.54	515400	21790	30.0	6.16	13350	1592	15950	2565	0.876	13.2	27.4	5322
2.75	234200	18440	29.1	8.16	6735	1040	7558	1598	0.884	29.7	20.7	454
2.77	261200	20670	29.2	8.22	7455	1161	8389	1787	0.885	27.0	23.4	610
2.78	290800	23120	29.4	8.28	8233	1292	9297	1992	0.885	24.6	26.4	813
2.79	325500	25720	29.8	8.36	9118	1444	10300	2223	0.889	22.3	29.7	1100
2.81	369200	29310	30.0	8.44	10230	1635	11610	2523	0.890	20.1	34.3	1532
2.83	402300	31970	30.0	8.47	11050	1774	12600	2745	0.888	18.8	37.7	1914
2.85	447800	35780	30.3	8.56	12170	1974	13930	3057	0.889	17.2	42.7	2518
2.87	494700	39680	30.5	8.63	13300	2177	15290	3377	0.890	15.9	47.9	3250
2.89	545000	43850	30.6	8.68	14990	2390	16750	3717	0.889	14.8	53.6	4152
2.91	604800	48670	30.8	8.75	15870	2638	18450	4111	0.889	13.7	60.3	5373
2.51	150700	4788	29.7	5.30	4018	362	4644	570	0.854	49.8	6.46	119
2.51	168500	5456	30.0	5.40	4470	411	5156	647	0.858	45.2	7.40	159
2.52	185900	6080	30.1	5.45	4907	457	5665	720	0.859	41.5	8.29	208
2.53	205300	6850	30.5	5.58	5387	514	6198	807	0.864	38.1	9.39	267
2.54	223100	7525	30.8	5.65	5821	563	6689	885	0.867	35.4	10.4	333
2.55	240000	8175	30.9	5.71	6234	610	7167	959	0.869	33.2	11.3	404
2.56	278200	9463	31.5	5.81	7142	711	8197	1115	0.875	28.9	13.3	605
2.58	310700	10640	31.5	5.84	7914	794	9129	1251	0.874	26.4	15.0	815
2.60	353200	12240	31.7	5.91	8909	906	10320	1433	0.874	23.7	17.5	1147
2.62	397200	13900	31.8	5.96	9916	1020	11550	1620	0.873	21.6	20.1	1555
2.64	440500	15600	32.1	6.04	10890	1136	12720	1808	0.874	19.9	22.8	2029
2.66	480200	17050	32.2	6.08	11750	1233	13790	1971	0.873	18.7	25.2	2500

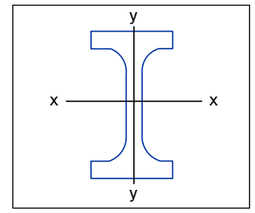
2.3
Universal Beams & Columns (UB & UC)



Imperial Units

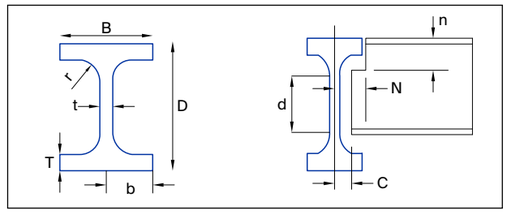
Designation			Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Area of Section	Ratios for Local Buckling		Dimensions for Detailing		
Size	Mass per Metre				Flange	Web				Flange	Web	End clearance	Notch	
			D	B	T	t	r	d	A	b/T	d/t	C	N	n
in (mm)	lb/ft	kg/m	mm	mm	mm	mm	mm	mm	cm²			mm	mm	mm
W30-30x10 1/2 (762x267)	269	401	825.0	279.1	53.1	29.5	16.5	685.8	511	2.63	23.2	17	135	70
	295	439	835.2	281.7	57.9	32.0	16.5	686.4	559	2.43	21.5	18	135	74
W30-30x15 (762x381)	173	257.5	773.2	380.6	27.1	16.6	16.5	686.1	328	7.04	41.2	10	192	44
	191	284.2	779.3	382.0	30.1	18.0	16.5	686.1	362	6.35	38.1	11	192	47
	211	314	785.9	383.7	33.4	19.7	16.5	686.1	400	5.74	34.9	12	192	50
	235	349.7	795.0	382.4	38.1	21.1	16.5	685.8	445	5.02	32.5	13	191	55
	261	388.4	802.9	384.9	41.9	23.6	16.5	686.1	495	4.59	29.0	14	191	58
	292	434.5	813.1	387.5	47.0	25.9	16.5	686.1	553	4.12	26.5	15	191	63
	326	485.1	823.0	390.4	52.1	29.0	16.5	685.9	617	3.75	23.7	16	191	69
	357	531	833.0	393.0	56.9	31.5	20.0	679.2	677	3.45	21.6	18	191	77
W33-33x11 1/2 (838x292)	118	175.9	834.9	291.7	18.8	14.0	17.8	761.7	224	7.76	54.4	9	149	37
	130	193.8	840.7	292.4	21.7	14.7	17.8	761.7	247	6.74	51.8	9	149	40
	141	209.8	845.8	293.0	24.4	15.4	17.8	761.4	268	6.01	49.5	10	149	42
	152	226.5	850.9	293.8	26.8	16.1	17.8	761.7	289	5.48	47.3	10	149	45
	169	252	859.0	292.1	31.0	17.0	17.8	761.4	319	4.71	44.8	11	148	49
	187	278	865.1	294.1	34.0	19.1	17.8	761.5	355	4.33	39.9	12	148	52
	204	304	871.2	295.7	37.1	20.6	17.8	761.4	386	3.99	37.0	12	148	55
	219	326	877.1	297.2	39.9	22.1	17.8	761.7	416	3.72	34.5	13	148	58
	243	362	885.2	299.7	43.9	24.4	17.8	761.8	460	3.41	31.2	14	148	62
	271	404	895.1	302.1	49.0	26.9	17.8	761.5	513	3.08	28.3	15	148	67
	301	449	905.0	305.2	54.1	30.0	17.8	761.2	572	2.82	25.4	17	148	72
	332	494	915.2	308.1	58.9	33.0	17.8	761.8	629	2.62	23.1	19	148	77
	361	537	925.1	310.6	64.0	35.6	17.8	761.5	684	2.43	21.4	20	148	82
W33-33x15 3/4 (838x400)	201	299.1	855.5	399.9	29.2	18.2	17.8	761.5	381	6.85	41.9	11	201	47
	221	328.9	861.8	401.4	32.4	19.7	17.8	761.4	420	6.20	38.7	12	201	50
	241	358.6	868.2	402.8	35.6	21.1	17.8	761.5	457	5.66	36.1	13	201	53
	263	391.4	877.1	401.4	39.9	22.1	17.8	761.7	499	5.03	34.5	13	200	58
	291	433.1	884.9	404.0	43.9	24.4	17.8	761.4	552	4.60	31.2	14	200	62
	318	473.2	893.1	406.0	48.0	26.4	17.8	761.5	603	4.23	28.8	15	200	66
	354	526.8	903.0	408.9	53.1	29.5	17.8	761.2	672	3.85	25.8	17	200	71
	387	575.9	913.1	411.5	57.9	32.0	17.8	761.7	734	3.55	23.8	18	200	76
	424	631	923.0	414.0	63.0	35.1	20.0	757.0	805	3.29	21.6	20	199	83
	468	697	935.0	418.0	69.1	38.6	20.0	756.8	889	3.02	19.6	21	200	89

Dimensions	EN10365 / ASTM A6
Specification	EN10025 / ASTM A36 / ASTM A572
Size Range	UB: 5”x3” (127mm x 76mm) to 44”x16” (1118mm x 406mm) UC: 4”x4” (102mm x 102mm) to 14”x16” (356mm x 406mm)

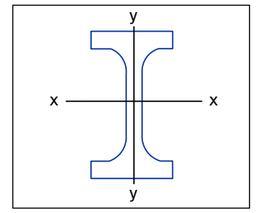


Surface Area	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant
Per metre	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y				
									u	x	H	J
m²	cm⁴	cm⁴	cm	cm	cm³	cm³	cm³	cm³			dm⁶	cm⁴
2.68	536500	19400	32.4	6.16	13010	1390	15330	2229	0.874	17.0	28.9	3361
2.70	595900	21780	32.7	6.24	14270	1546	16900	2486	0.874	15.8	32.9	4345
3.01	341200	24890	32.3	8.71	8827	1308	9916	2012	0.883	30.3	34.6	635
3.02	381700	28000	32.5	8.80	9796	1466	11030	2258	0.885	27.5	39.3	859
3.04	427000	31500	32.7	8.87	10870	1642	12270	2531	0.886	25.0	44.6	1161
3.05	485900	35570	33.0	8.94	12220	1860	13830	2869	0.889	22.2	50.9	1651
3.07	543700	39920	33.1	8.98	13540	2074	15410	3208	0.888	20.3	57.8	2218
3.10	618300	45680	33.4	9.09	15210	2358	17380	3653	0.889	18.3	67.0	3090
3.12	697600	51790	33.6	9.16	16950	2653	19500	4123	0.888	16.7	77.0	4224
3.14	776600	57770	33.9	9.24	18650	2940	21550	4579	0.888	15.3	87.0	5563
2.78	246000	7800	33.1	5.90	5893	535	6808	842	0.856	46.5	13.0	221
2.79	279200	9067	33.6	6.06	6642	620	7640	974	0.862	41.6	15.2	306
2.80	310200	10250	34.0	6.18	7334	700	8416	1097	0.867	37.9	17.3	404
2.81	339700	11360	34.3	6.27	7985	773	9155	1212	0.870	35.0	19.3	514
2.82	386500	12920	34.8	6.36	8999	884	10310	1383	0.875	30.9	22.1	735
2.84	430400	14470	34.8	6.38	9950	984	11450	1547	0.874	28.3	25.0	983
2.85	473000	16050	35.0	6.45	10860	1086	12530	1710	0.874	26.1	27.9	1265
2.87	513500	17540	35.1	6.49	11710	1180	13550	1864	0.874	24.4	30.7	1569
2.89	573400	19800	35.3	6.56	12960	1321	15060	2095	0.874	22.3	35.0	2095
2.91	648200	22660	35.5	6.64	14480	1500	16910	2385	0.875	20.2	40.5	2884
2.94	729200	25820	35.7	6.72	16120	1692	18920	2704	0.874	18.4	46.7	3910
2.97	810000	28960	35.9	6.79	17700	1880	20890	3018	0.873	17.0	53.1	5088
2.99	892800	32280	36.1	6.87	19300	2078	22880	3346	0.873	15.8	59.8	6494
3.24	479800	31180	35.5	9.05	11220	1559	12640	2405	0.881	31.2	53.2	855
3.26	534700	34970	35.7	9.13	12410	1742	14020	2690	0.882	28.4	60.1	1146
3.27	590000	38800	35.9	9.21	13590	1927	15380	2977	0.884	26.1	67.3	1491
3.29	659000	43070	36.3	9.29	15030	2146	17020	3314	0.888	23.6	75.5	2008
3.31	735400	48390	36.5	9.36	16620	2396	18910	3709	0.887	21.6	85.6	2687
3.33	812500	53680	36.7	9.43	18200	2644	20780	4101	0.888	19.9	95.8	3488
3.35	913500	60680	36.9	9.50	20330	2968	23230	4616	0.887	18.1	110	4737
3.38	1012000	67480	37.1	9.59	22170	3280	25570	5113	0.887	16.7	123	6135
3.40	1120000	74810	37.3	9.64	24260	3614	28140	5652	0.886	15.5	138	7983
3.43	1253000	84520	37.6	9.75	26810	4044	31270	6342	0.886	14.2	158	10569

2.3
Universal Beams & Columns (UB & UC)



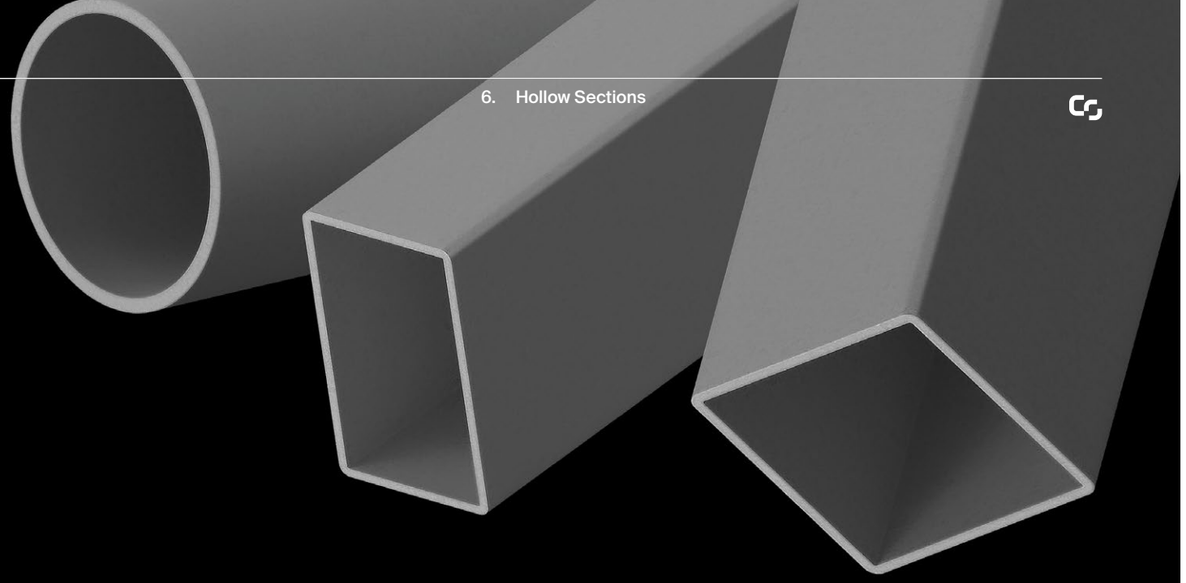
Dimensions	EN10365 / ASTM A6
Specification	EN10025 / ASTM A36 / ASTM A572
Size Range	UB: 5”x3” (127mm x 76mm) to 44”x16” (1118mm x 406mm) UC: 4”x4” (102mm x 102mm) to 14”x16” (356mm x 406mm)



Imperial Units

Designation			Depth of section	Width of section	Thickness		Root radius	Depth between fillets	Area of section	Ratios for local buckling		Dimensions for detailing		
Size	Mass per metre				Flange	Web				Flange	Web	End clearance	Notch	
			D	B	T	t	r	d	A	b/T	d/t	C	N	n
in (mm)	lb/ft	kg/m	mm	mm	mm	mm	mm	mm	cm²			mm	mm	mm
W36-36x12 (914x305)	135	200.9	903.0	303.3	20.2	15.1	19.1	824.4	256	7.51	54.6	10	154	39
	150	224.2	910.4	304.1	23.9	15.9	19.1	824.4	286	6.36	51.8	10	154	43
	160	238.1	914.7	304.8	25.9	16.5	19.0	824.9	304	5.88	50.0	10	154	45
	170	253.4	918.4	305.5	27.9	17.3	19.1	824.4	323	5.47	47.7	11	154	47
	182	270.8	922.8	306.7	30.0	18.4	19.0	824.9	346	5.12	44.8	11	154	49
	194	289.1	926.6	307.7	32.0	19.5	19.1	824.4	368	4.81	42.3	12	154	51
	210	312.5	931.9	309.4	34.5	21.1	19.0	824.8	399	4.48	39.1	13	154	54
	232	345	942.9	307.8	39.9	22.1	19.1	824.9	440	3.86	37.3	13	153	59
	256	381	950.7	310.3	43.9	24.4	19.1	824.7	486	3.53	33.8	14	153	63
	286	426	960.9	312.8	48.0	26.9	19.1	826.7	536	3.26	30.7	15	153	67
	318	474	970.8	315.7	54.1	29.9	19.1	824.4	603	2.92	27.6	17	153	73
	350	521	980.7	318.8	58.9	33.0	19.1	824.7	663	2.71	25.0	19	153	78
	387	576	992.9	321.8	65.0	36.1	19.1	824.7	733	2.48	22.8	20	153	84
W36-36x16 1/2 (914x419)	230	343.3	911.8	418.5	32.0	19.4	24.1	799.6	437	6.54	41.2	12	210	56
	245	364.6	916.4	419.4	34.3	20.3	24.1	799.6	465	6.12	39.4	12	210	58
	260	388	921.0	420.5	36.6	21.4	24.1	799.6	494	5.74	37.4	13	210	61
	280	416.7	927.6	421.5	39.9	22.5	24.1	799.6	532	5.28	35.6	13	210	64
	300	446.4	933.2	423.0	42.7	24.0	24.1	799.7	569	4.96	33.3	14	210	67
	328	488.1	942.1	422.4	47.0	25.9	24.1	799.9	622	4.49	30.9	15	208	71
	359	534.2	950.0	424.9	51.1	28.5	24.1	799.7	680	4.16	28.1	16	208	75
	393	584.8	960.1	427.5	55.9	31.0	24.1	800.1	746	3.83	25.8	17	208	80
W40-40x12 (1016x305)	149	222	970.3	300.0	21.1	16.0	30.0	868.1	283	7.11	54.3	10	152	51
	167	249	980.2	300.0	26.0	16.5	30.0	868.2	317	5.77	52.6	10	152	56
	183	272	990.1	300.0	31.0	16.5	30.0	868.1	347	4.84	52.6	10	152	61
	211	314	1000.0	300.0	35.9	19.1	30.0	868.2	400	4.18	45.5	12	150	66
	235	349	1008.1	302.0	40.0	21.1	30.0	868.1	445	3.78	41.1	13	150	70
	264	393	1016.0	303.0	43.9	24.4	30.0	868.2	500	3.45	35.6	14	149	74
	294	438	1025.9	305.4	49.0	26.9	30.0	867.9	557	3.12	32.3	15	149	79
	327	487	1036.1	308.5	54.1	30.0	30.0	867.9	620	2.85	28.9	17	149	84
	359	535	1046.0	311.4	58.9	33.0	30.0	868.2	681	2.64	26.3	19	149	89

Surface area	Second moment of area		Radius of gyration		Elastic modulus		Plastic modulus		Buckling parameter	Torsional index	Warping constant	Torsional constant
Per metre	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y				
m²	cm⁴	cm⁴	cm	cm	cm³	cm³	cm³	cm³	u	x	H	J
2.96	325300	9424	35.7	6.07	7204	621	8351	982	0.854	46.8	18.4	291
2.97	376400	11240	36.3	6.27	8269	739	9535	1163	0.861	41.3	22.1	422
2.98	406100	12270	36.6	6.36	8879	805	10230	1266	0.864	38.6	24.2	515
2.99	436300	13300	36.8	6.42	9501	871	10940	1371	0.866	36.2	26.4	626
3.00	470700	14460	36.9	6.47	10200	943	11770	1487	0.866	33.9	28.8	767
3.01	504200	15600	37.0	6.51	10880	1014	12570	1601	0.867	31.9	31.2	926
3.03	549000	17130	37.1	6.55	11780	1107	13650	1754	0.866	29.7	34.5	1164
3.04	625200	19480	37.7	6.66	13260	1266	15340	2000	0.872	26.4	39.7	1648
3.06	696900	21980	37.9	6.72	14660	1416	17030	2247	0.872	24.1	45.2	2199
3.09	777000	24640	38.1	6.78	16170	1575	18870	2510	0.871	22.2	51.3	2891
3.11	884100	28580	38.3	6.89	18210	1810	21350	2895	0.872	19.9	60.0	4091
3.14	981300	32080	38.5	6.95	20010	2013	23590	3235	0.871	18.4	68.1	5337
3.17	110100	36460	38.8	7.05	22180	2266	26260	3654	0.871	16.8	78.5	7127
3.42	625800	39160	37.8	9.46	13730	1871	15480	2890	0.883	30.1	75.8	1193
3.43	671700	42240	38.0	9.53	14660	2014	16550	3111	0.884	28.3	82.2	1442
3.44	719600	45440	38.2	9.59	15630	2161	17670	3341	0.885	26.7	88.9	1734
3.45	785700	49870	38.4	9.68	16940	2366	19170	3658	0.887	24.8	98.3	2188
3.47	846900	53940	38.6	9.73	18150	2550	20600	3948	0.887	23.3	107	2671
3.48	936400	59170	38.8	9.76	19880	2801	22640	4344	0.887	21.4	119	3500
3.50	1031000	65450	38.9	9.81	21700	3081	24820	4790	0.886	19.8	132	4508
3.53	1144000	73000	39.2	9.89	23840	3415	27390	5320	0.887	18.2	149	5890
3.06	408000	9553	38.0	5.81	8409	637	9807	1020	0.850	45.7	21.5	390
3.08	481300	11760	39.0	6.09	9821	784	11350	1245	0.861	39.9	26.8	582
3.10	554000	14010	40.0	6.36	11190	934	12830	1470	0.873	35.0	32.2	835
3.11	644200	16240	40.1	6.37	12880	1083	14850	1713	0.872	30.7	37.7	1264
3.13	723100	18470	40.3	6.44	14350	1223	16590	1941	0.872	27.9	43.3	1718
3.14	807700	20500	40.2	6.40	15900	1353	18540	2168	0.868	25.5	48.4	2330
3.17	909900	23450	40.4	6.49	17740	1536	20760	2469	0.868	23.1	56.0	3185
3.19	1021000	26730	40.6	6.57	19720	1733	23200	2800	0.867	21.1	64.4	4299
3.22	1131000	29970	40.8	6.63	21620	1925	25570	3126	0.866	19.5	73.0	5576



6. Hollow Sections

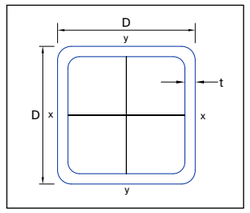
Structural steel tubes that can be circular, hollow or rectangular, each with its own attributes, used for a wide range of construction and industrial applications.

6.1 Hot Finished Hollow Sections
Standard specifications

Material	Yield strength N/mm²						Tensile strength N/mm²	Min. Elongation $L_0=5.65\sqrt{S_0}$	Min. Charpy V-notch.	Dimensions & Tolerances
EN 10210	≤16mm	>16 - ≤40mm	>40 - ≤63mm	>63 - ≤80mm	>80 - ≤100mm	>100 - ≤120mm	3-100mm			*EN10210*
S275J0H	275	265	255	245	235	225	410-560	19-23 %	27J @ 0°C	
S275J2H	275	265	255	245	235	225	410-560	19-23 %	27J @ -20°C	
S355J0H	355	345	335	325	315	295	470-630	18-22 %	27J @ 0°C	
S355J2H	355	345	335	325	315	295	470-630	18-22 %	27J @ -20°C	
S355NH	355	345	335	-	-	-	470-630	22%	40J @ -20°C	
S420NH	420	400	390	-	-	-	520-680	19%	40J @ -20°C	
S460NH	460	440	430	-	-	-	540-720	17%	40J @ -20°C	

* S460NH only available up to 16mm thickness

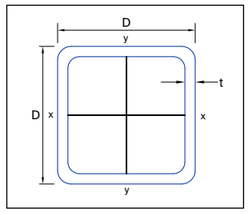
6.1.3 Hot Finished Square Hollow Section (SHS)



Designation		Mass per Metre	Area of Section	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area per Metre
Size	Thickness									
DxD	t		A	I	r	Z	S	J	C	
mm	mm	kg/m	cm²	cm⁴	cm	cm³	cm³	cm⁴	cm³	m²/m
200x200	5	30.50	38.7	2445	7.95	245	283	3756	362	0.787
	6	36.40	46.2	2883	7.90	288	335	4449	426	0.785
	6.3	38.20	48.4	3011	7.89	301	350	4653	444	0.784
	8	48.00	60.8	3709	7.81	371	436	5778	545	0.779
	10	59.30	74.9	4471	7.72	447	531	7031	655	0.774
	12.5	73.00	92.1	5336	7.61	534	643	8491	778	0.768
	16	91.50	115	6394	7.46	639	785	10340	927	0.759
220x220	5 *	33.50	42.7	3281	8.76	298	344	5028	442	0.867
	6	40.00	51.0	3875	8.72	352	408	5963	521	0.865
	8	52.70	67.2	5002	8.63	455	532	7765	669	0.859
	10	65.10	82.9	6050	8.54	550	650	9473	807	0.854
	12	77.20	98.3	7023	8.45	638	762	11090	933	0.849
	14 *	88.90	113	7922	8.36	720	868	12620	1049	0.844
250x250	6	45.80	58.2	5752	9.94	460	531	8825	681	0.985
	6.3	48.10	61.0	6014	9.93	481	556	9238	712	0.984
	8	60.50	76.8	7455	9.86	596	694	11530	880	0.979
	10	75.00	94.9	9055	9.77	724	851	14110	1065	0.974
	12.5	92.60	117	10920	9.66	873	1037	17160	1279	0.968
	16	117.00	147	13270	9.50	1061	1280	21140	1546	0.959
260x260	6	47.60	60.6	6491	10.4	499	576	9951	740	1.02
	6.3	49.90	63.5	6788	10.3	522	603	10420	773	1.02
	8	62.80	80.0	8423	10.3	648	753	13010	956	1.02
	10	77.70	98.9	10240	10.2	788	924	15930	1159	1.01
	12	92.20	117	11950	10.1	920	1087	18730	1348	1.01
	12.5	95.80	122	12370	10.1	951	1127	19410	1394	1.01
	14 *	106.00	136	13560	10.0	1043	1244	21400	1525	1.00
	14.2 *	108.00	137	13710	9.99	1055	1259	21660	1542	1.00
	16	120.00	153	15060	9.91	1159	1394	23940	1689	1.00
300x300	6.3	57.95	73.6	10550	12.0	703	809	16140	1043	1.18
	8	73.10	92.8	13130	11.9	875	1013	20190	1294	1.18
	9 *	81.93	104	14600	11.9	973	1130	22520	1437	1.18
	10	90.70	115	16030	11.8	1068	1246	24810	1575	1.17
	12	107.97	137	18780	11.7	1252	1470	29250	1840	1.17
	12.5	112.00	142	19440	11.7	1296	1525	30330	1904	1.17
	16	142.00	179	23850	11.5	1590	1895	37620	2325	1.16
350x350	6 *	64.50	82.2	16170	14.0	924	1058	24650	1373	1.38
	8	85.70	109	21130	13.9	1207	1392	32380	1789	1.38
	10	106.00	135	25880	13.9	1479	1715	39890	2185	1.37
	12	127.00	161	30440	13.8	1739	2030	47150	2563	1.37
	12.5	132.00	167	31540	13.7	1802	2107	48930	2654	1.37
	14 *	146.00	186	34790	13.7	1988	2334	54190	2922	1.36
	14.2 *	148.00	189	35210	13.7	2012	2364	54880	2957	1.36
	16	167.00	211	38940	13.6	2225	2630	60990	3264	1.36
	19 *	190.00	248	44820	13.5	2561	3055	70760	3744	1.35
	22 *	217.00	283	50270	13.3	2873	3460	80010	4187	1.34
	25 *	242.00	318	55320	13.2	3161	3845	88750	4595	1.34

* Sizes not included in EN 10210 Part 2 (1997) + Seamless process Δ S.A.W process

Dimensions	EN10210-2
Specification	EN10210-1
Size Range	40mm x 40mm to 400mm x 400mm



Designation		Mass per Metre	Area of Section	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area per Metre
Size	Thickness									
DxD	t		A	I	r	Z	S	J	C	
mm	mm	kg/m	cm²	cm⁴	cm	cm³	cm³	cm⁴	cm³	m²/m
350x350	6 *	64.50	82.2	16170	14.0	924	1058	24650	1373	1.38
	8	85.70	109	21130	13.9	1207	1392	32380	1789	1.38
	10	106.00	135	25880	13.9	1479	1715	39890	2185	1.37
	12	127.00	161	30440	13.8	1739	2030	47150	2563	1.37
	12.5	132.00	167	31540	13.7	1802	2107	48930	2654	1.37
	14 *	146.00	186	34790	13.7	1988	2334	54190	2922	1.36
	14.2 *	148.00	189	35210	13.7	2012	2364	54880	2957	1.36
	16	167.00	211	38940	13.6	2225	2630	60990	3264	1.36
	19 *	190.00	248	44820	13.5	2561	3055	70760	3744	1.35
	22 *	217.00	283	50270	13.3	2873	3460	80010	4187	1.34
	25 *	242.00	318	55320	13.2	3161	3845	88750	4595	1.34
400x400	8 *	97.90	125	31860	16.0	1593	1830	48700	2363	1.58
	10	122.00	155	39130	15.9	1956	2260	60090	2895	1.57
	12	145.00	185	46130	15.8	2306	2679	71180	3405	1.57
	12.5	152.00	192	47840	15.8	2392	2782	73910	3530	1.57
	14 *	168.00	214	52870	15.7	2643	3087	81960	3894	1.56
	14.2 *	170.00	217	53530	15.7	2676	3127	83030	3942	1.56
	16	192.00	243	59340	15.6	2967	3484	92440	4362	1.56
	20 #	237.00	300	71540	15.4	3577	4247	112500	5237	1.55
	22 *	251.00	327	77260	15.4	3863	4612	122100	5646	1.54
	25 *	282.00	368	85380	15.2	4269	5141	135900	6223	1.54
450x450	12 *	162.00	209	66460	17.8	2954	3419	102200	4368	1.77
	16 *	213.00	275	85860	17.7	3816	4459	133200	5620	1.76
	19 *	250.00	324	99540	17.5	4424	5208	155400	6497	1.75
	22 *	286.00	371	112500	17.4	5000	5929	176700	7324	1.74
	25 *	321.00	418	124700	17.3	5544	6624	197200	8101	1.74
	28 Δ*	355.00	464	136300	17.1	6058	7292	216800	8832	1.73
	32 Δ*	399.00	524	150700	17.0	6696	8143	241700	9735	1.72
500x500	12 *	181.00	233	92030	19.89	3681	4248	141200	5451	1.97
	16 *	238.00	307	119300	19.71	4771	5554	184400	7038	1.96
	19 *	280.00	362	138600	19.58	5545	6498	215500	8159	1.95
	22 *	320.00	415	157100	19.44	6283	7411	245600	9222	1.94
	25 *	360.00	468	174600	19.31	6986	8295	274600	10230	1.94
	28 Δ*	399.00	520	191300	19.18	7653	9149	302600	11180	1.93
	32 Δ*	450.00	588	212300	19.00	8491	10242	338200	12370	1.92
	36 Δ*	498.00	654	231700	18.82	9269	11283	372000	13470	1.91
550x550	16 *	263.00	339	160400	21.75	5833	6769	247300	8616	2.16
	19 *	309.00	400	186800	21.62	6793	7930	289500	10010	2.15
	22 *	355.00	459	212100	21.49	7714	9058	330400	11340	2.14
	25 *	399.00	518	236300	21.35	8594	10150	370100	12610	2.14
	28 Δ*	443.00	576	259500	21.22	9436	11220	408400	13810	2.13
	32 Δ*	500.00	652	288700	21.04	10500	12580	457500	15330	2.12
	36 Δ*	555.00	726	316100	20.86	11500	13890	504400	16740	2.11
	40 Δ*	608.00	799	341800	20.68	12430	15140	549000	18060	2.10

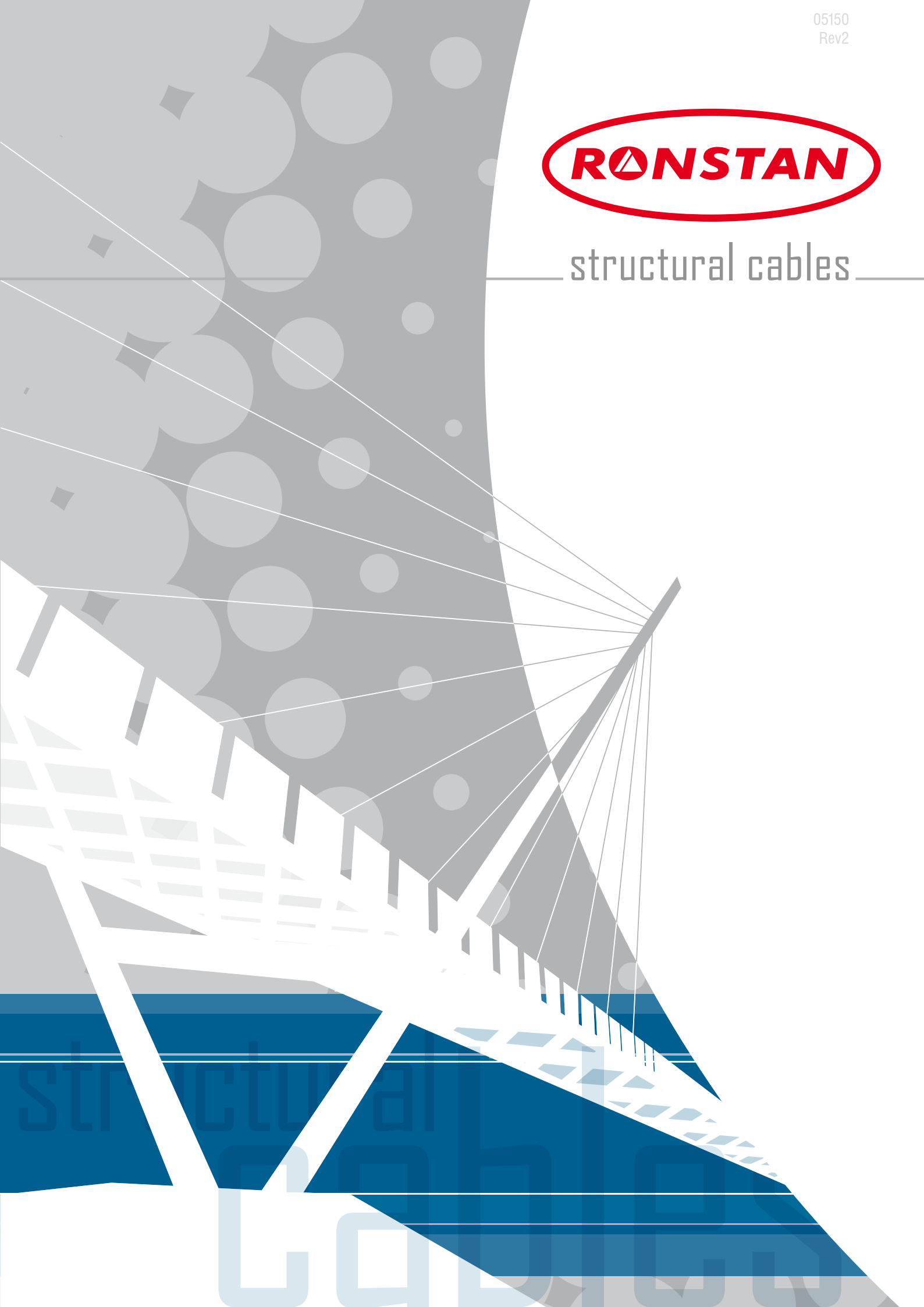
LAMPIRAN 5

KATALOG PRODUK *CABLE*

05150
Rev2

RONSTAN

structural cables



GS GALFAN Coated Steel - Open Spiral Strands

PFEIFER


1x19


1x37


1x61

Modulus of Elasticity: 160 ± 10 kN/mm²
Tolerance Cable Diameter: +3%
Corrosion Protection: GALFAN coated without inner filling

NOMINAL CABLE DIAMETER	CABLE CONSTRUCTION	METALLIC CROSS SECTION AREA		MINIMUM BREAKING LOAD			WEIGHT APPROX	
mm		mm²	in.²	kN	kg	lb	kg/m	lb/ft
8.1	1 x 19	39.0	0.060	59	6020	13250	0.3	0.202
10.1	1 x 19	60.0	0.093	93	9480	20890	0.5	0.336
12.2	1 x 19	87.0	0.135	134	13670	30100	0.7	0.470
14.1	1 x 37	117.0	0.181	181	18460	40660	0.9	0.605
17.0	1 x 37	168.0	0.260	260	26530	58420	1.3	0.874
20.1	1 x 37	237.0	0.367	367	37440	82460	1.9	1.277
24.4	1 x 37	347.0	0.538	537	54790	120660	2.7	1.814
28.3	1 x 37	467.0	0.724	722	73670	162220	3.7	2.486
31.3	1 x 61	572.0	0.887	884	90204	198620	4.5	3.024
36.3	1 x 61	769.0	1.192	1189	121320	267160	6.1	4.099

GF GALFAN Coated Steel - Full Locked Strands

PFEIFER


VVS-1


VVS-2


VVS-3

Material: Unalloyed quality steel
Modulus of Elasticity: 160 ± 10 kN/mm²
Tolerance Wire Diameter: +3%
Corrosion Protection: Inner layers: Hot dip galvanized with inner filling
Outer layers: GALFAN coated without inner filling

NOMINAL CABLE DIAMETER	CABLE CONSTRUCTION	METALLIC CROSS SECTION AREA		MINIMUM BREAKING LOAD			WEIGHT APPROX	
mm		mm²	in.²	kN	kg	lb	kg/m	lb/ft
21.0	VVS-1	281.0	0.436	405	25000	91040	2.4	1.613
26.0	VVS-1	430.0	0.667	621	38360	139600	3.6	2.419
31.0	VVS-2	634.0	0.983	916	56630	205920	5.3	3.561
35.0	VVS-2	808.0	1.252	1170	72340	263020	6.8	4.569
40.0	VVS-2	1060.0	1.643	1520	93970	341710	8.9	5.981
45.0	VVS-2	1340.0	2.077	1930	119380	433880	11.2	7.526
50.0	VVS-2	1650.0	2.558	2380	147140	535040	13.8	9.273
55.0	VVS-3	2090.0	3.240	3020	186730	678920	17.2	11.558
60.0	VVS-3	2490.0	3.860	3590	222040	807060	20.5	13.775
65.0	VVS-3	2920.0	4.526	4220	261020	948690	24.1	16.194
70.0	VVS-3	3390.0	5.255	4890	302440	1099310	27.9	18.748
75.0	VVS-3	3890.0	6.030	5620	347550	1263420	32.1	21.570
80.0	VVS-3	4420.0	6.851	6390	395200	1436520	36.4	24.460
85.0	VVS-3	4990.0	7.735	7210	445910	1620870	41.1	27.618
90.0	VVS-3	5600.0	8.680	8090	500300	1818700	46.2	31.045
95.0	VVS-3	6310.0	9.781	9110	563360	2048000	52.0	34.942
100.0	VVS-3	6990.0	10.835	10100	624590	2270570	57.6	38.705
105.0	VVS-3	7710.0	11.951	11100	686420	2495370	63.5	42.670
110.0	VVS-3	8460.0	13.113	12200	754480	2742660	69.7	46.836
115.0	VVS-3	9240.0	14.322	13400	828670	3012440	76.2	51.204
120.0	VVS-3	10100.0	15.655	14500	896730	3259730	83.2	55.908
125.0	VVS-3	10900.0	16.895	15800	977140	3551980	89.8	60.343
130.0	VVS-3	11900.0	18.445	17300	1069890	3889190	96.7	64.979
135.0	VVS-3	12900.0	19.995	18600	1150300	4181440	104.8	70.422
140.0	VVS-3	13900.0	21.545	20000	1236830	4496170	112.9	75.865

Due to pre-stressing and / or differing weather conditions inner filling may escape to the surface.
Subject to technical modification.
Other sizes available upon request.

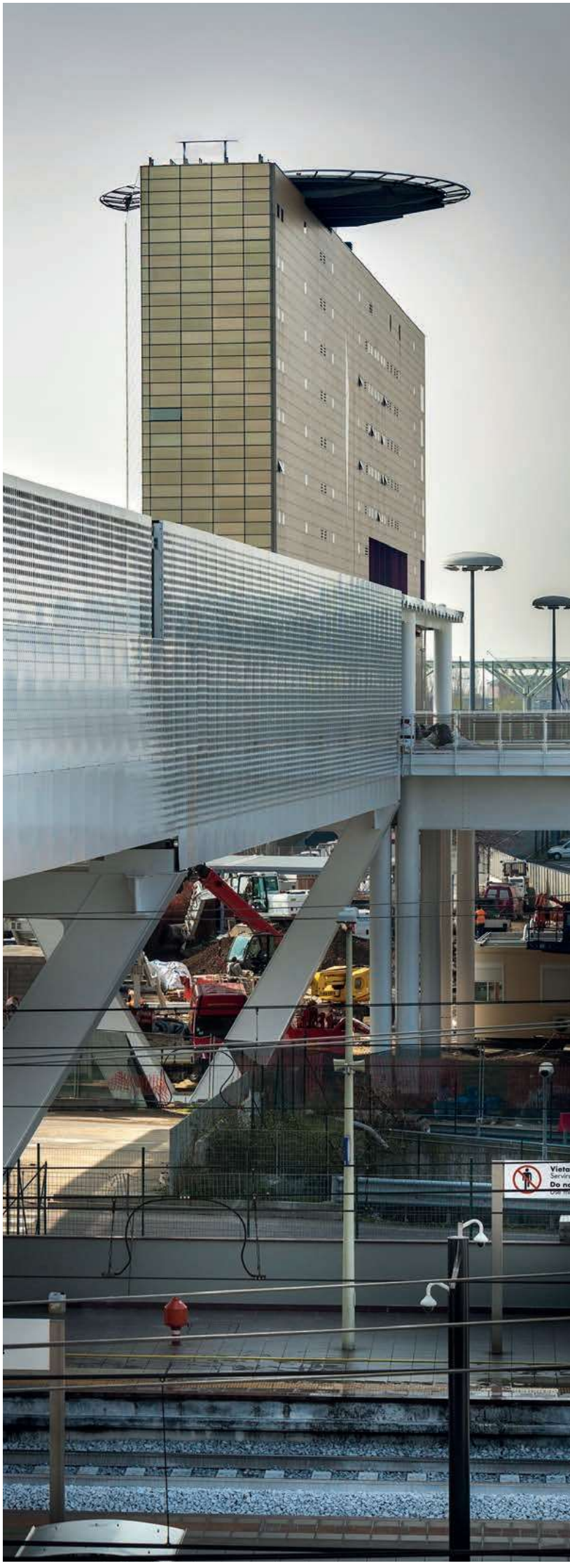
LAMPIRAN 6

KATALOG PRODUK *BEARING*

TENSA

VOLUME	PRODUCTS CATALOGUE
05	**BEARINGS**

YOUR CHALLENGES,
OUR SOLUTIONS



TPL NORMAL

GUIDED SLIDING TENS POT BEARINGS $V_{Sd\text{-}SEISM}/N_{Sd\text{-}SLU}$=10%

BEARING	Seismic Combination ULS		Static Combination ULS		Static Combination SLS		Overall Size	Sliding Plate Plan Dimensions	Net Weight (anchorages excluded)	Pot Diameter	Piston Diameter	Pin Diameter	Pin Protrusion	Bottom Anchor Dowels	
	$N_{Sd\text{-}Seism}$ (kN)	$V_{Sd\text{-}Seism}$ (kN)	$N_{Sd\text{-}SLU}$ (kN)	$V_{Sd\text{-}SLU}$ (kN)	$N_{Sd\text{-}SLE}$ (kN)	$V_{Sd\text{-}SLE}$ (kN)	Do x Do x Htot (mm)	B x L (mm)	W_{net} (kg)	Do (mm)	D' (mm)	D_{pin} (mm)	t_{pin} (mm)	N°	$d_{Dow,inf}$ (mm)
TPL 500/50/±50	340	50	500	25	360	20	150 x 150 x 90	300 x 175	23	150	175	50	15	2	30
TPL 1000/100/±50	670	100	1000	50	720	40	215 x 215 x 89	355 x 230	37	215	230	5 0	15	2	30
TPL 1500/150/±50	1000	150	1500	75	1080	50	245 x 245 x 98	375 x 250	48	245	250	50	15	4	30
TPL 2000/200/±50	1340	200	2000	100	1430	70	300 x 300 x 103	425 x 300	67	300	300	30	15	4	30
TPL 2500/250/±50	1670	250	2500	125	1790	90	315 x 315 x 107	435 x 310	74	315	310	40	15	4	30
TPL 3000/300/±50	2000	300	3000	150	2150	100	340 x 340 x 106	455 x 330	87	340	330	60	15	4	30
TPL 3500/350/±50	2340	350	3500	175	2500	120	375 x 375 x 111	485 x 360	105	375	360	60	15	4	30
TPL 4000/400/±50	2670	400	4000	200	2860	140	395 x 395 x 115	500 x 375	118	395	375	40	16	4	40
TPL 4500/450/±50	3000	450	4500	225	3220	150	420 x 420 x 119	525 x 400	137	420	400	60	15	4	40
TPL 5000/500/±50	3340	500	5000	250	3580	170	445 x 445 x 124	545 x 420	154	445	420	50	16	4	40
TPL 6000/600/±50	4000	600	6000	300	4290	200	485 x 485 x 137	575 x 450	198	485	450	60	16	4	50
TPL 7000/700/±50	4670	700	7000	350	5000	240	515 x 515 x 141	605 x 480	228	515	480	60	18	4	50
TPL 8000/800/±50	5340	800	8000	400	5720	270	555 x 555 x 140	635 x 510	259	555	510	70	18	4	50
TPL 9000/900/±50	6000	900	9000	450	6430	300	595 x 595 x 154	670 x 545	328	595	545	70	19	4	60
TPL 10000/1000/±50	6670	1000	10000	500	7150	340	625 x 625 x 159	695 x 570	370	625	570	70	21	4	60
TPL 11000/1100/±50	7340	1100	11000	550	7860	370	655 x 655 x 158	720 x 595	398	655	595	70	22	4	60
TPL 12000/1200/±50	8000	1200	12000	600	8580	400	685 x 685 x 172	745 x 620	473	685	620	70	24	4	60
TPL 13000/1300/±50	8670	1300	13000	650	9290	440	710 x 710 x 166	765 x 640	487	710	640	80	23	4	70
TPL 14000/1400/±50	9340	1400	14000	700	10000	470	755 x 755 x 170	805 x 680	555	755	680	80	24	4	70
TPL 15000/1500/±50	10000	1500	15000	750	10720	500	770 x 770 x 184	815 x 690	627	770	690	80	26	4	70
TPL 16000/1600/±50	10670	1600	16000	800	11430	540	790 x 790 x 184	830 x 705	654	790	705	90	25	4	70
TPL 17000/1700/±50	11340	1700	17000	850	12150	570	815 x 815 x 188	855 x 730	714	815	730	90	26	4	70
TPL 18000/1800/±50	12000	1800	18000	900	12860	600	845 x 845 x 192	880 x 755	795	845	755	90	27	4	90
TPL 19000/1900/±50	12670	1900	19000	950	13580	640	870 x 870 x 211	895 x 770	928	870	770	90	28	4	90
TPL 20000/2000/±50	13340	2000	20000	1000	14290	670	890 x 890 x 200	915 x 790	898	890	790	90	29	4	90
TPL 22500/2100/±50	15000	2100	22500	1050	16080	700	985 x 985 x 220	1005 x 880	1204	985	880	100	28	4	90
TPL 25000/2200/±50	16670	2200	25000	1100	17860	740	990 x 990 x 229	1005 x 880	1254	990	880	100	29	4	90
TPL 27500/2300/±50	18340	2300	27500	1150	19650	770	1035 x 1035 x 219	1045 x 920	1276	1035	920	100	30	4	90
TPL 30000/2400/±50	20000	2400	30000	1200	21430	800	1070 x 1070 x 238	1075 x 950	1490	1070	950	100	31	4	90
TPL 32500/2500/±50	21670	2500	32500	1250	23220	840	1115 x 1115 x 237	1115 x 990	1596	1115	990	110	30	4	90
TPL 35000/2600/±50	23340	2600	35000	1300	25000	870	1210 x 1210 x 247	1215 x 1090	1937	1210	1090	110	31	4	90
TPL 37500/2700/±50	25000	2700	37500	1350	26790	900	1220 x 1220 x 257	1215 x 1090	2062	1220	1090	110	32	4	90
TPL 40000/2800/±50	26670	2800	40000	1400	28580	940	1270 x 1270 x 267	1265 x 1140	2331	1270	1140	120	31	4	100
TPL 45000/3200/±50	30000	3200	45000	1600	32150	1070	1335 x 1335 x 275	1315 x 1190	2639	1335	1190	120	34	4	100
TPL 50000/3500/±50	33340	3500	50000	1750	35720	1170	1390 x 1390 x 297	1365 x 1240	3093	1390	1240	130	35	4	100
TPL 55000/3900/±50	36670	3900	55000	1950	39290	1300	1445 x 1445 x 320	1415 x 1290	3617	1445	1290	130	38	4	100
TPL 60000/4200/±50	40000	4200	60000	2100	42860	1400	1510 x 1510 x 313	1465 x 1340	3776	1510	1340	110	29	4	100
TPL 65000/4600/±50	43340	4600	65000	2300	46430	1540	1570 x 1570 x 322	1515 x 1390	4202	1570	1390	110	31	8	90
TPL 70000/4900/±50	46670	4900	70000	2450	50000	1640	1630 x 1630 x 322	1565 x 1440	4472	1630	1440	110	33	8	90
TPL 75000/5300/±50	50000	5300	75000	2650	53580	1770	1685 x 1685 x 347	1615 x 1490	5176	1685	1490	120	32	8	90
TPL 80000/5600/±50	53340	5600	80000	2800	57150	1870	1750 x 1750 x 349	1665 x 1540	5591	1750	1540	120	34	8	100
TPL 90000/6300/±50	60000	6300	90000	3150	64290	2100	1865 x 1865 x 365	1765 x 1640	6579	1865	1640	130	35	8	100