Tender documents for new railway line for Cengkareng Airport construction project : structural

REPUBLIC OF INDONESIA

MINISTRY OF COMMUNICATIONS
DIRECTORATE GENERAL OF LAND TRANSPORT
AND INLAND WATERWAYS

TENDER DOCUMENTS
FOR
NEW RAILWAY LINE FOR CENGKARENG AIRPORT
CONSTRUCTION PROJECT

STRUCTURAL CALCULATION SHEETS

PACKAGE-1 CIVIL AND ARCHITECTURAL WORK

11 of 11

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JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

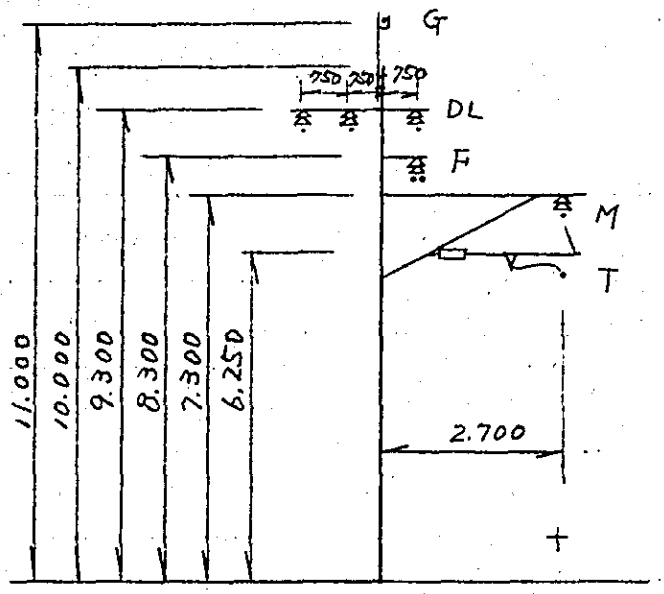
STRUCTURAL CALCULATION SHEETS

CONTENTS

§§17. SUPPORTING STRUCTURE FOR OVERHEAD CONTACT SYSTEM

Moment Calculation of General Supporting Structure Between Stations

Standard Supporting Structure



G : Ground Wire St 55 mm²

DL : Distribution Line OE-Cu 38 mm²

F : Feeder Wire Cu 300 mm²

M : Messenger Wire St 90 mm²

T : Trolley Wire Cu 110 mm²

1. Vertical Load

Item	Wire Classification	Unit Weight (kgf/m)	SPAN 60 M	SPAN 50 M	SPAN 40 M
Feeder Wire	Cu 300 mm² × 2	2.715	325.8	271.5	217.2
Messenger Wire	St 90 mm²	0.697	41.8	34.9	27.9
Trolley Wire	Cu 110 mm²	0.9877	59.3	49.4	39.5
Distribution Line	OE-Cu 38 mm² × 3	0.405	72.9	60.8	48.6
Ground Wire	St 55 mm²	0.446	26.8	22.3	17.8
Rigid Contilever			70		
Total Weight (kgf)			596.6	508.9	421.0

2. Horizontal Load

2-1 Wind Load

Item	Wire Classification	Unit Wind Load (kgf/m)	SPAN 60 M	SPAN 50 M	SPAN 40 M
Feeder Wire	Cu300 mm² × 2	0.5625 × 1.2	40.5	33.8	27.0
Messenger Wire	St 90 mm²	0.3	18.0	15.0	12.0
Trolley Wire	Cu 110 mm²	0.3085	18.5	15.4	12.3
Distribution Line	OE-Cu 38 mm² × 3	0.295 × 3	53.1	44.3	35.4
Ground Wire	St 55 mm²	0.24	14.4	12.0	9.6
Concrete Pole	0.35 M × 20 kgf = 7 kgf	7 × 10 M = 70	70.0	70.0	70.0
Total Wind Load (kgf)			212.4	188.4	164.2

2-2 Tension (Temperature 20°C, Velocity of the Wind 20 m/sec)

Item	Wire Classification	Standard Tension (kgf)	SPAN 60 M	SPAN 50 M	SPAN 40 M
Feeder Wire	Cu 300 mm²	1,200	1.320	1.360	1.430
Messenger Wire	St 90 mm²	1,000	1.120	1.140	1.160
Trolley Wire	Cu 110 mm²	900	900	900	900
Distribution Line	OE-Cu 38 mm²	200	220	230	250
Ground Wire	St 55 mm²	300	370	380	400

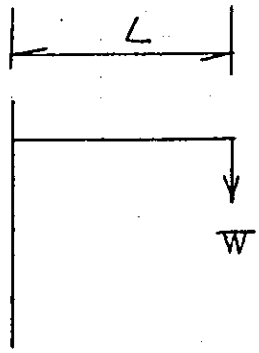
2-3 Cross Tension Load

$$C = \frac{ST}{R}$$

C: Cross Tension (kgf)
S: Span (M)
T: Tension (kgf)
R: Truck Curve Radius (M)

Item	Wire Classification	R=1.000		R=500
		60 M	50 M	40 M
Feeder Wire	Cu 300 mm^2 x 2	158.4	136.0	228.8
Messenger Wire	St 90 mm^2	67.2	57.0	92.8
Trolley Wire	Cu 110 mm^2	54.0	45.0	72.0
Distribution Line	OE-Cu 38 mm^2 x 3	39.6	34.5	60.0
Ground Wire	St 55 mm^2	22.2	19.0	32.0
Total Cross Tension (Kgf)		341.4	291.5	485.6
Total Wind Load (Kgf)		212.4	188.4	164.2
Total Horizontal Load (Kgf)		553.8	479.9	649.8

3. Moment



3-1. By Weight

$M_1 = WL$

W : Weight (Kgf)

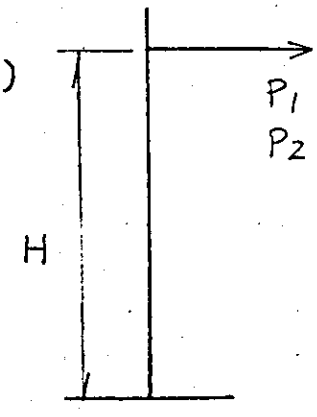
L : Length (M)

3-2 By Wind pressure Load

$M_2 = P_1 H$

P_1 : Wind pressure Load (Kgf)

H : Height (M)



3-3 By Cross Tension

$M_3 = P_2 H$

P_2 : Cross Tension (Kgf)

3-4 Total Moment

$$M = M_1 + M_2 + M_3 \quad (Kgf - M)$$

3-1 By Weight

Item	Wire Classification	Lenght (M)	SPAN		
			60m	50m	40m
Feeder Wire	Cu 300 mm^2 × 2	0.75	244.4	203.6	162.9
Messenger Wire	St 90 mm^2	2.7	112.9	94.2	75.3
Trolley Wire	Cu 110 mm^2	2.7	160.1	133.4	106.7
Distribution Line	OE-Cu 38 mm^2	1.5	-36.5	-30.4	-24.3
Ground Wire	St 55 mm^2	0	0	0	0
Rigid Cantilever		2.7/2	94.5	94.5	94.5
Total M_1 (Kgf-M)			575.4	495.3	415.1

3-2 By Wind pressure Load

Item	Wire Classification	Height (M)	SPAN		
			60M	50M	40M
Feeder Wire	Cu 300 mm^2 × 2	8.3	336.2	280.5	224.1
Messenger Wire	St 90 mm^2	7.3	131.4	109.5	87.6
Trolley Wire	Cu 110 mm^2	6.25	115.6	96.3	76.9
Distribution Line	OE-Cu 38 mm^2 × 3	9.3	493.8	412.0	229.2
Ground Wire	St 55 mm^2	11.0	158.4	132.0	105.6
Concrete Pole		5.0	350.0	350.0	350.0
Total M_2 (Kgf-M)			1585.4	1380.3	1073.4

3-3 By Cross Tension

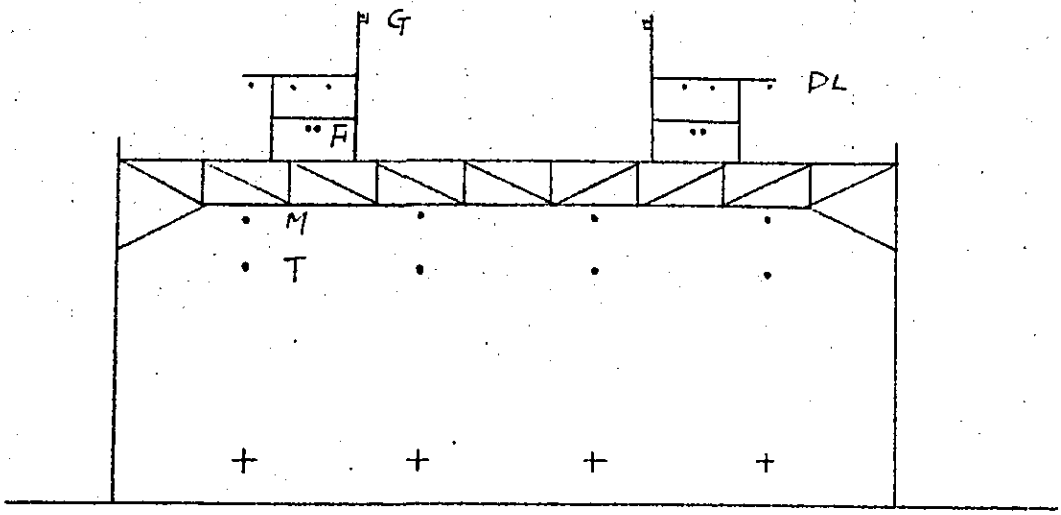
Item	Wire Classification	Height (M)	R = 1.000		R=500
			60 M	50 M	40 M
Feeder Wire	Cu 300 mm^2 × 2	8.3	1314.7	1.128.8	1.899.0
Messenger Wire	St 90 mm^2	7.3	490.6	416.1	677.4
Trolley Wire	Cu 110 mm^2	6.25	337.5	281.3	450.0
Distribution Line	CE-Cu 38 mm^2 × 3	9.3	368.3	320?	558.0
Ground Wire	St 55 mm^2	11.0	242.0	209.0	352.0
Total M3 (Kgf-M)			2.753!	2.356!	3.936.4

3-4 Total Moment (Kgf-M)

Item	Straight Section			Curve Section	
	60 M	50 M	40 M	R=1000 60 M	R=500 40 M
Total Moment by Weight (M_1)	575.4	495.3	415.1	575.4	415.1
Total Moment by Wind Load (M_2)	1.585.4	1.380.3	1.073.4	1.585.4	1.073.4
Total Moment by Cross Tension (M_3)				2.753.1	3.936.4
Total Moment (Outside of Curve)	2.160.8	1.875.6	1.488.5	4.913.9	※ 5424.9
Total Moment (Inside Curve)	1.010.0	885.0	658.3	3.763!	4.594.7
Concrete Pole	N5.000	N5.000	N5.000	N5.000	※ N6.500 N5.000

※ This case is not concerned with this project design.

Inside of Station (V-Truss Beam)



G : Ground Wire St 55 mm² × 2

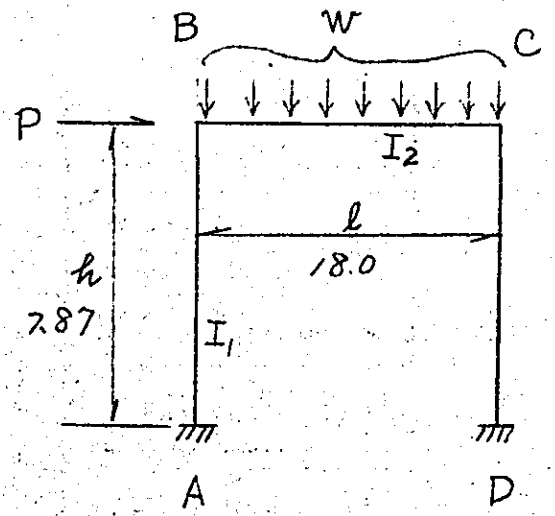
DL : Distribution Line OE-Cu 38 mm² × 3 × 2

F : Feeder Wire Cu 300 mm² × 2 × 2

M : Messenger Wire St 90 mm² × 4

T : Trolley Wire Cu 110 mm² × 4

Span 60 M R = 1.000



(1) Moment at Weight

$$M_{A_1} = M_{D_1} = \frac{w l^2}{12(K+2)}$$

$$M_{B_1} = M_{C_1} = -2 M_{A_1}$$

(2) Moment at Horizontal Load

$$M_{A2} = -M_{D_2} = -\frac{Ph}{2} \cdot \frac{3K+1}{6K+1}$$

$$M_{B2} = -M_{C_2} = \frac{Ph}{2} \cdot \frac{3K}{6K+1}$$

(3) Total Moment

$M_A = M_{A_1} + M_{A2}$ $M_C = M_{C_1} + M_{C_2}$

$M_B = M_{B_1} + M_{B_2}$ $M_D = M_{D_1} + M_{D_2}$

$K = \frac{I_2}{I_1} \cdot \frac{h}{\ell}$

I_1 : Inertia Moment of Pole (cm^4)

I_2 : Inertia Moment of Beam (cm^4)

W : Vertical Load Unit Weight (Kgf)

ℓ : Beam Lenght (M)

h : Horizontal Load Height (M)

P : Horizontal Load

Inertia Moment

Concrete Pole N5.000 = 9,880 cm^4

N6.500 = 10,196 cm^4

N7.500 = 10,526 cm^4

V-Truss Beam ∠75×75×6 = 62.149 cm^4

∠75×75×9 = 91.100 cm^4

1. Vertical Road (Span 60 M)

Item	Quantity	Weight (Kgf)
Feeder Wire Cu300 mm^2	4	651.6
Messenger Wire St90 mm^2	4	167.2
Trolley Wire Cu110 mm^2	4	237.2
Distribution Line OE-Cu38 mm^2	6	145.8
Ground Wire St55 mm^2	2	53.6
V-Truss Beam ∠75×75×9	1	(18M) 1001.0
Total Weight (Kgf)		2,256.4

Unit Weight $W = 2.256^{4}/_{18} = 125.^{3}$ kgf

2. Horizontal Load (Span 60M. R=1.000)

Item	Load Classification	Quantity	Load (kgf)
Feeder Wire Cu 300 mm²	Wind	4	85.0
	Cross Temsion		332.6
Messenger Wire St 90 mm²	Wind	4	22.3
	Cross Tenision		250.0
Trolley Wire Cu 110 mm²	Wind	4	19.5
	Cross Temsion		170.6
Distribution Line OE-Cu 38 mm²	Wind	6	125.4
	Cross Temsion		93.4
Ground Wire St 55 mm²	Wind	2	40.2
	Cross Temsion		62.2
Concrete Pole		2	72.0
Total Horizontal Load (Kgf)			1.273.2

$$K = \frac{I_2}{I_1} \cdot \frac{h}{\ell} = \frac{91.100}{9.880} \cdot \frac{7.87}{18} = 4.03$$

(1) Moment by Weight

$$MA_1 = MD_1 = \frac{w\ell^2}{12(K+2)} = \frac{125.^{3} \times 18^{2}}{12(4.03+2)} = 561$$

$$MB_1 = MC_1 = -2MA = -2 \times 561 = -1122$$

(2) Moment by Horizontal Load

$$MA_2 = -MD_2 = -\frac{Ph}{2} \cdot \frac{3K+1}{6K+1} = -\frac{1273.^{2} \times 7.87}{2} \cdot \frac{3 \times 4.03 + 1}{6 \times 4.03 + 1}$$

$$= -2.639$$

$$MB_2 = -MC_2 = \frac{Ph}{2} \cdot \frac{3K}{6K+1} = \frac{1.273.2 \times 7.87}{2} \cdot \frac{3 \times 4.03}{6 \times 4.03 + 1}$$

$$= 2.394$$

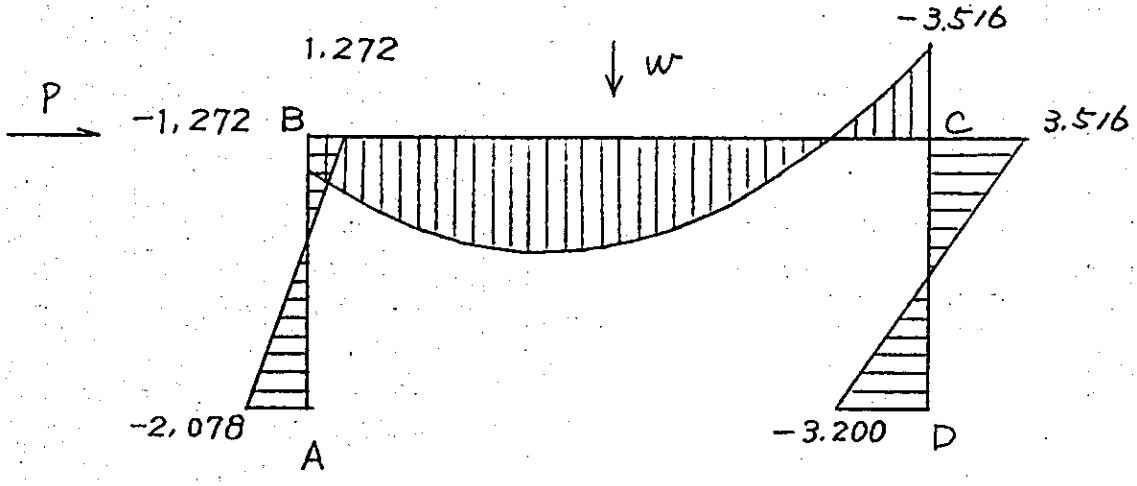
(3) Total Moment

$MA = MA_1 + MA_2 = 561 - 2.639 = -2.078$ Kgf-M

$MB = MB_1 + MB_2 = -1.122 + 2.394 = 1.272$ Kgf-M

$MC = MC_1 + MC_2 = -1.122 - 2.394 = -3.516$ Kgf-M

$MD = MD_1 + MD_2 = 561 + 2639 = 3.200$ Kgf-M



The designed bending moment of 5000 N concrete poles is 5000 kgf·m. Therefore the strength of 5000 N concrete poles is enough to the above loads.