REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF CONSTRUCTION
DEPARTMENT OF BRIDGE

DETAILED DESIGN STUDY ON THE BAGO RIVER BRIDGE CONSTRUCTION PROJECT

FINAL REPORT ATTACHMENTS

VOLUME II DESIGN REPORT
Part VI Toll Collection Facility

DECEMBER 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.
ORIENTAL CONSULTANTS GLOBAL CO., LTD.
METROPOLITAN EXPRESSWAY COMPANY LIMITED.
CHODAI CO., LTD.
NIPPON ENGINEERING CONSULTANTS CO., LTD.

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TOLL COLLECTION FACILITY

LARGE ROOF

1. Outline of the Building
   - Structure: Steel Structure
   - Structure Type: Rigid-frame Structure
   - Number of Floors: One floor on grand level (without basement level)
   - Maximum Height: Level of Road Surface + 6.52m
   - Maximum Eaves Height: Level of Road Surface + 6.240m
   - Roof Dimensions:644.4㎡（12m×53.7m）
   - Finish: Folded-Plate Roof/ Outer Wall of Folded Punching Panel

2. Design Conditions

◆Compliance standards

- Building Standards Act of Japan
- Guideline of Building Structure Design on the Metropolitan Expressway (July, 2014) Metropolitan Expressway Company Limited
- Design Standard of Building Structure (2013) Ministry of Land, Infrastructure and Transport of Japan

◆Used Program for the Structure Calculation

Super Build / SS3-S
Structure Suite R2.0.2

◆Design Route

X-direction, Y-direction: Route 1-2

◆Standard Shear Coefficient

C0=1.0

◆Importance Factor

I＝1.5

◆Design Policies

（1） Superstructure

- Simulate 3 cases (a/ b/ c) each in 3 models (1/ 2/ 3).
- The ground should be the 2nd type of the soil classification.
- The wind load should be in accordance with “Guideline of Building Structure Design” of Metropolitan Expressway Company Limited.
-

（2） Foundation Structure

- Column bases should be fixed on RC slabs with anchor bolts.
- The concrete strength of individual footing should be Fc24.
- Analysis model should fix fulcrums and assess rotating stiffness of column bases properly, considering their base plates and anchor bolts.

3. Allowable Stress of Material

◆Allowable Stress and Allowable Bond Stress of Concrete (Unit: N/mm^2)

Fc	Long Term				Short Term			
	Compression	Shearing	Bond		Compression	Shearing	Bond	
			Beam Upper End	Others			Beam Upper End	Others
Fc24	8.0	0.73	0.80	1.00	16.0	1.095	1.20	1.500

◆Allowable Stress of Steel Rod (Unit: N/mm^2)

Type	Long Term			Short Term		
	Compression	Tensile		Compression	Tensile	
		Others	Shearing		Others	Shearing
SD295A	195	195	195	295	295	295

◆Allowable Stress of Structural Steel Used (Unit: N/mm^2)

Type of Steel Wire	Board Thickness	Long Term		Short Term	
		Compression/ Tensile/ Flexure	Shearing	Compression/ Tensile/ Flexure	Shearing
SN400(SS400) SM400,SMA400 STK400,STKR400 BCP235	t ≦40	156	90	235	135
BCR295	t ≦40	196	113	295	170
SM490,SMA490 SN490(B,C) STK490,STKR490 BCP325	t ≦40	216	125	325	187

◆Allowable Stress of Weld-throat Section (Unit: N/mm^2)

①Butting Surface

Type of Steel Wire	Board Thickness	Long Term		Short Term	
		Compression/ Tensile/ Flexure	Shearing	Compression/ Tensile/ Flexure	Shearing
SN400(SS400) SM400,SMA400 STK400,STKR400	t ≦40	156	90	235	135

BCP235					
BCR295	t ≦40	196	113	295	170
SM490,SMA490 SN490(B,C) STK490,STKR490 BCP325	t ≦40	216	125	325	187

②Other Parts

Type of Steel Wire	Board Thickness	Long Term	Short Term
		Compression/ Tensile/ Flexure/ Shearing	Compression/ Tensile/ Flexure/ Shearing
SN400(SS400) SM400,SMA400 STK400,STKR400 BCP235	t ≦40	90	135
BCR295	t ≦40	113	170
SM490,SMA490 SN490(B,C) STK490,STKR490 BCP325	t ≦40	125	187

◆Allowable Stress of High-strength Bolt（Unit : N/mm^2）

High-strength bolt		Nominal Diameter of Bolt	Long Term			Short Term		
			Allowable Shearing Stress		Allowable Tensile Force	Allowable Shearing Stress		Allowable Tensile Force
Type	T0		Friction on Single Surface	Friction on Double-Surface		Friction on Single Surface	Friction on Double-Surface	
Zincing F８T	400	M16	24.1	48.2	50.2	36.1	72.3	75.3
		M20	37.6	75.3	78.5	56.5	113.0	117.8

◆Allowable Stress of Anchor Bolt（Unit : N/mm^2）

Anchor Bolt	Long Term		Short Term	
	Allowable Shearing Stress	Allowable Tensile Force	Allowable Shearing Stress	Allowable Tensile Force
SNR490 (ABR490)	125	217	188	325

4． Assumed Load

4-1. Floor Load (Unit: N/m²)

◆Floor Load

Specification	Load
Folded plate (H=173,t=1.0)	150
Horizontal Brace L65x65x6	60
Support of Tight Frame	40
Lighting Equipment	80
Others	160
Total	490

◆Live Load

Purpose	Floor/ Beam	Frame	Earthquake
Roof	980	600	400

◆Building Design Load

Load	Floor/ Beam	Frame	Earthquake
D･L	490	490	490
L･L	980	600	400
T･L	1470	1090	890

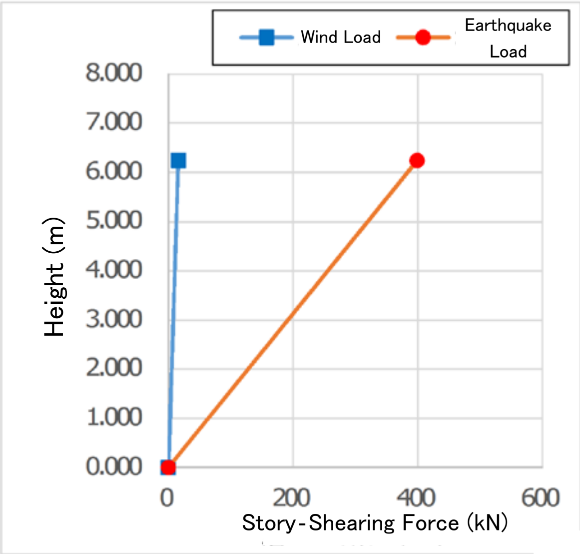
4-2. Seismic Load

- Seismic zoning coefficient is assumed as 1.0.
- Soil classification is assumed as the 2nd type.
- External force distribution of seismic load is assumed as Ai distribution.
- Building height is assumed as the average height between design GL and eaves.

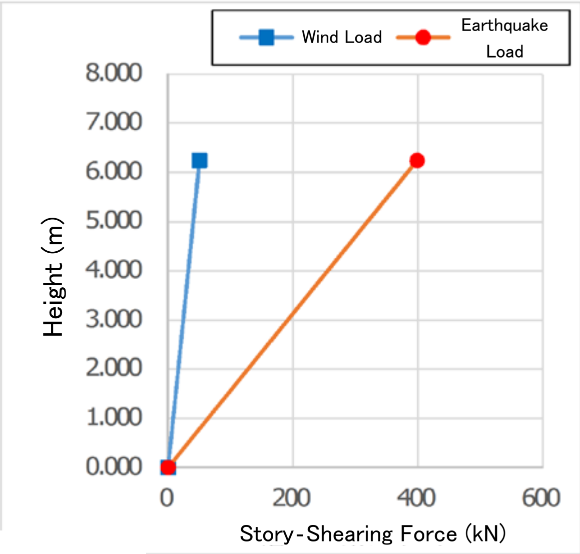
4-3. Wind Load

- Wind pressure should be calculated in accordance with Building Standards Act of Japan. Considering safety, the installation base is set at 10m from ground.
- Wind load, being smaller than seismic load in comparison between them, will

be omitted in the load examination.



X−direction



Y−direction

5．Summary

◆Safety Verification of Structural Members

① Girder

- Determined stress is derived from long-term stress and seismic force (including some long-term force).
- Critical ratio for certified strength of girder resulted in 0.66 at most (at case A of Model 1 and 2 for RF), and long-term deformation in δ／L = 1/4222 (at case A of Model 1 and 2 for RF).

② Pillar

- While the maximum slenderness under the criteria is assumed below 200, the effective slenderness of pillars resulted in 88.7 at most (at case A of Model 1 in Y-direction).
- Determined stress is derived from long term stress and seismic force.
- Critical ratio for certified strength of pillar resulted in 0.46 (At B case of Model1 in X-direction when earthquake), and story drift angle when earthquake in R = 1/235 at most (Y-direction).

③ Column base

- Examination with the extra stress by seismic force: γ=2.00 verified that the ultimate strength of pillar is larger than its ultimate stress.

④ Horizontal brace

- It was verified that there is no problem in load transfer of roof top, because the allowable tensile stress of horizontal brace in short term is larger than the maximum tensile force generated at earthquake.

⑤ Beam

- Beams, in comparison with the critical ratio for certified yield strength: 0.42 at most and the critical ratio for certified strength of bolts at ends: 0.15 at most, were verified that it has sufficient strength, also as transverse stiffeners. Additionally, there is no problem with cantilevers CB1 and CG1 in comparison with the critical ratio for certified strength: 0.77.

⑥ Finishing materials

- Examination of members of roofing and exterior walls against wind load verified that each wind pressure of each span of cladding materials is smaller than the allowable value.

◆Conditions verified in the Steel Structure-Route 2

- Satisfied the required level of story drift angle: within 1/200, since its maximum angle resulted in 1/235（Y-direction）
- Satisfied the required level of rigidity: greater than 0.60, since its maximum rate resulted in 1.00
- Satisfied the required level of eccentricity: within 0.15, since its maximum rate resulted in 0.066 (Y-direction)
- Verified that yield strength of column-beam connection is larger than the required level
- Verified that yield strength of beam joints is larger than the required level
- All the beam-columns are FA type and satisfy the required width-thickness ratio.
- Verified that dynamic bearing capacity of transverse stiffeners in girder has rigidity and yield strength required at the junction of joist B1 and for the function as the transverse stiffener of main girder
- Verified that the ultimate yield strength of column-beams is larger than their ultimate stress with the extra stress by seismic force: $\gamma=2.00$

TOLL COLLECTION FACILITY

ADMINISTRATIVE OFFICE

1. Outline of the Building

- Structure: Steel Structure
- Structure Type: Frame Structure
- Number of Floors: One floor on grand level (without basement level)
- Maximum Height: +3.575m
- Maximum Eaves Height: +3.135m
- Depth of Bottom of Foundation: GL-1.750m
- Roof Dimensions: 200.0m^2 (10.0m x 20.0m)
- Finish: Galvalume Folded-Plate Roof, Outer Wall of ALC

2. Design Conditions

◆Compliance standards

- Building Standards Act of Japan
- Guideline of Building Structure Design on the Metropolitan Expressway (July, 2014) Metropolitan Expressway Company Limited
- Design Standards of Building Structure (2013) Ministry of Land, Infrastructure and Transport of Japan
- Building Foundation Structure Design Guidelines (2001) Architectural Inst. of Japan

◆Used Program for the Structure Calculation

Super Build / SS3-S

◆Design Route

X-direction, Y-direction: Route 1-1

◆Standard Shear Coefficient

C0=0.3

◆Importance Factor

I=1.25

◆Design Policies

(1) Superstructure

- Check the story drift angle (below 1/200) and shape factors (eccentricity and modulus of rigidity).
- The ground should be the 2nd type of the soil classification.
- For calculation, the pillar span should be measured between centerlines of pillars, and the ceiling height measured between centerlines of girders/ footing beams of each floor.
- Member models: pillars and beams are considered as wire rods for the calculation.
- Exterior walls should be composed of 125mm-thick ALC and have story drift angle under 1/100.
- Suspended ceilings should be aseismic type.

(2) Substructure

- The foundation should be spread and mat type.

3. Allowable Stress of Material

◆Allowable Stress and Allowable Bond Stress of Concrete (Unit: N/mm^2)

Fc	Long Term				Short Term			
	Compression	Shearing	Bond		Compression	Shearing	Bond	
			Beam Upper End	Others			Beam Upper End	Others
Fc24	8.0	0.74	—	—	16.0	1.11	—	—

◆Allowable Stress of Steel Rod (Unit: N/mm^2)

Type	Long Term			Short Term		
	Compression	Tensile	Shearing	Compression	Tensile	Shearing
SD295A	195	195	195	295	295	295
SD345A	215	215	215	345	345	345

◆Allowable Stress of Structural Steel Used (Unit: N/mm^2)

Type of Steel Wire	Board Thickness	Long Term		Short Term	
		Compression/ Tensile/ Flexure	Shearing	Compression/ Tensile/ Flexure	Shearing
SS400 STKR400	t ≦40	156	90	235	135

◆Allowable Stress of Weld-throat Section (Unit: N/mm^2)

①Butting Surface

Type of Steel Wire	Board Thickness	Long Term		Short Term	
		Compression/ Tensile/ Flexure	Shearing	Compression/ Tensile/ Flexure	Shearing
SS400 STKR400	t ≦40	156	90	235	135

②Other Parts

Type of Steel Wire	Board Thickness	Long Term	Short Term
		Compression/ Tensile/ Flexure/ Shearing	Compression/ Tensile/ Flexure/ Shearing
SS400 STKR400	t ≦40	90	135

◆Allowable Stress of High-strength Bolt（Unit : N/mm^2）

High-strength bolt		Nominal Diameter of Bolt	Long Term			Short Term		
Type			Allowable Shearing Stress		Allowable Tensile Force	Allowable Shearing Stress		Allowable Tensile Force
			Friction on Single Surface	Friction on Double-Surface		Friction on Single Surface	Friction on Double-Surface	
F 10 T		M16	30.2	60.3	48.6	45.3	90.4	72.9
		M20	47.1	94.2	75.9	70.6	141.3	113.8
		M22	57	114	93.9	85.5	171	140.8
		M24	67.8	135	109	101.7	202.5	163.5

4. Assumed Load

4-1. Floor Load (Unit: N/m^2)

◆Roof

Load			Floor/ Beam	Frame	Earthquake
L・L	—		980	600	400
D・L	Galvalume Folded-Plate	200	750	750	750
	Heat Insulator	150			
	Ceiling/ Equipment	400			
T・T			1730	1350	1150

◆Administrative Office

Load			Floor/ Beam	Frame	Earthquake
L・L	—		2900	1800	800
D・L	Finishing Materials	800	4750	4750	4750
	Slab	3600			
	Heat Insulator	150			
	Equipment	200			
T・T			7650	6550	5550

4-2. Seismic Load

Seismic load is subject to the following conditions:

- Seismic zoning coefficient is assumed as 1.0.
- Soil classification is assumed as the 2^{nd} type.
- External force distribution of seismic load is assumed as Ai distribution.
- Primary natural period for design is assumed as 0.094.

4-3. Wind Load

- Wind pressure should be calculated in accordance with Building Standards Act of Japan.

5．Summary

- This building, for being normal rectangle shaped, has regular properties in stress.
- Critical ratio for certified strength of structural members should be under 1.00. There is no questionable data: girders have 0.585 in stationary load and 0.511/0.459 in short-time loading, and pillars have 0.300 and 0.553/0.569 respectively.