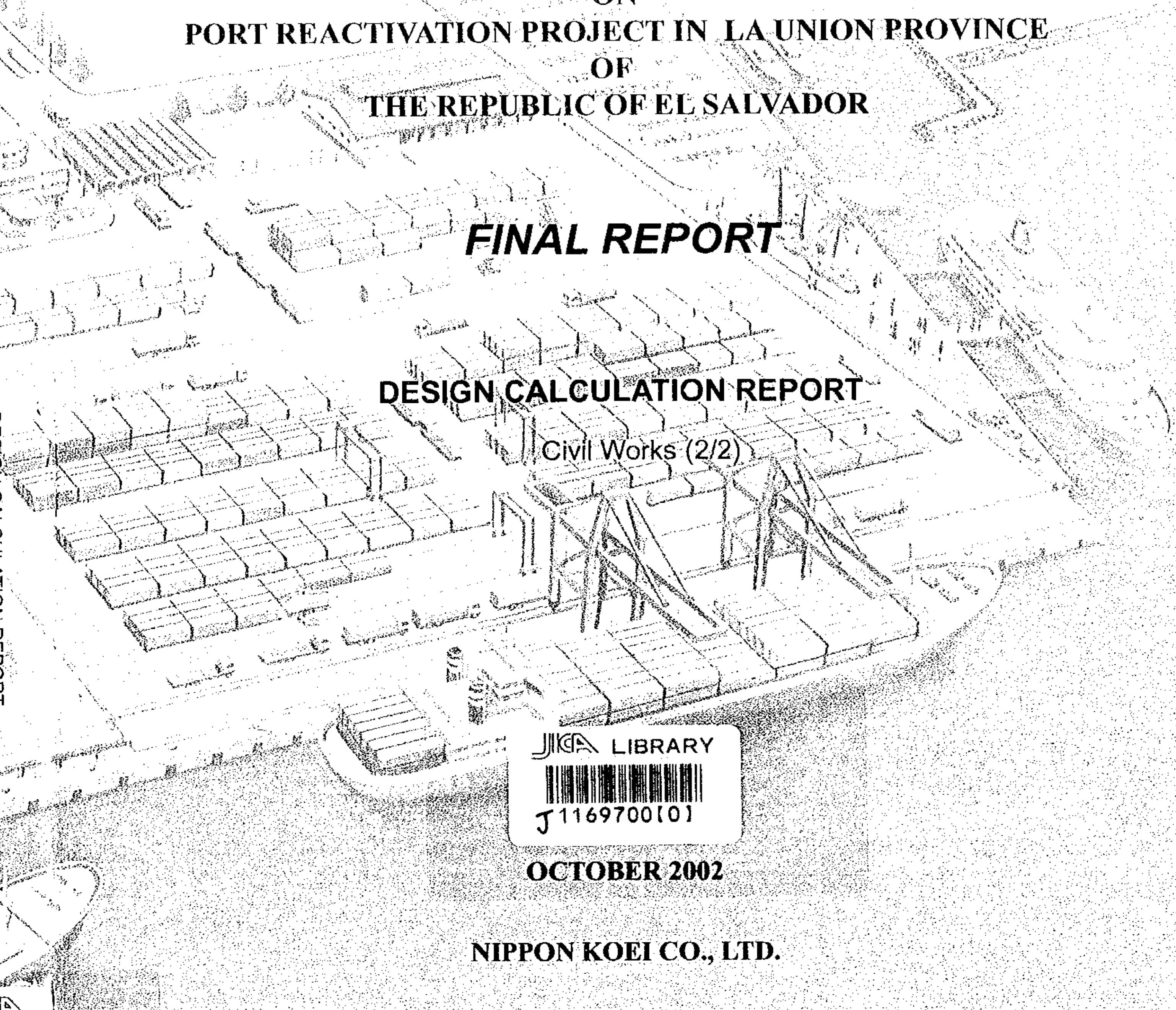
社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
COMISION EJECUTIVA PORTUARIA AUTONOMA (CEPA)

THE DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE OF THE REPUBLIC OF EL SALVADOR



FINAL REPORT

DESIGN CALCULATION REPORT

Civil Works (2/2)

OCTOBER 2002

NIPPON KOEI CO., LTD.

THE DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE OF THE REPUBLIC OF EL SALVADOR FINAL REPORT DESIGN CALCULATION REPORT Civil Works (2/2) OCTOBER 2002 NIPPON KOEI

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
COMISION EJECUTIVA PORTUARIA AUTONOMA (CEPA)

THE DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE OF THE REPUBLIC OF EL SALVADOR

FINAL REPORT

DESIGN CALCULATION REPORT

Civil Works (2/2)

OCTOBER 2002

NIPPON KOEI CO., LTD.

NIPPON KOEI CO.,LTD.

DESIGN CALCULATION COVER SHEET

Project	Detailed Design on Port Reactivation Project in La Union Province	**Project Code**	JC1N004
Section	**Civil**	Calc. File No.	
Sub-Section	**Quaywall**	Calc. Index No.	

Subject: **Passenger Berth**

Calculation Objective:

Stability of Breasting Dolphin .

References, Calculation Notes and Comments

Refer toDrawings **QW-02-001,QW-02-004**

Calculation based on

TECHNICAL STANDERDS AND COMMENTARIES

FOR

PORT AND HARBOUR FACILITIES IN JAPAN

Design Load **Refer to Design Conditions of this Report**

Considered **Berthing Condition**

Seismic Condition

Mooring Condition

Rev	Prepared by	Prepared Date	No. of Pages	Checked by	Checked Date	Reviewed by	Reviewed Date	Superseded by Calc No.
O	[signature]	26/07/2002	54	[signature]	26 July 02	[signature]	26/08/02	
A								
B								
C								

File in Calc. File

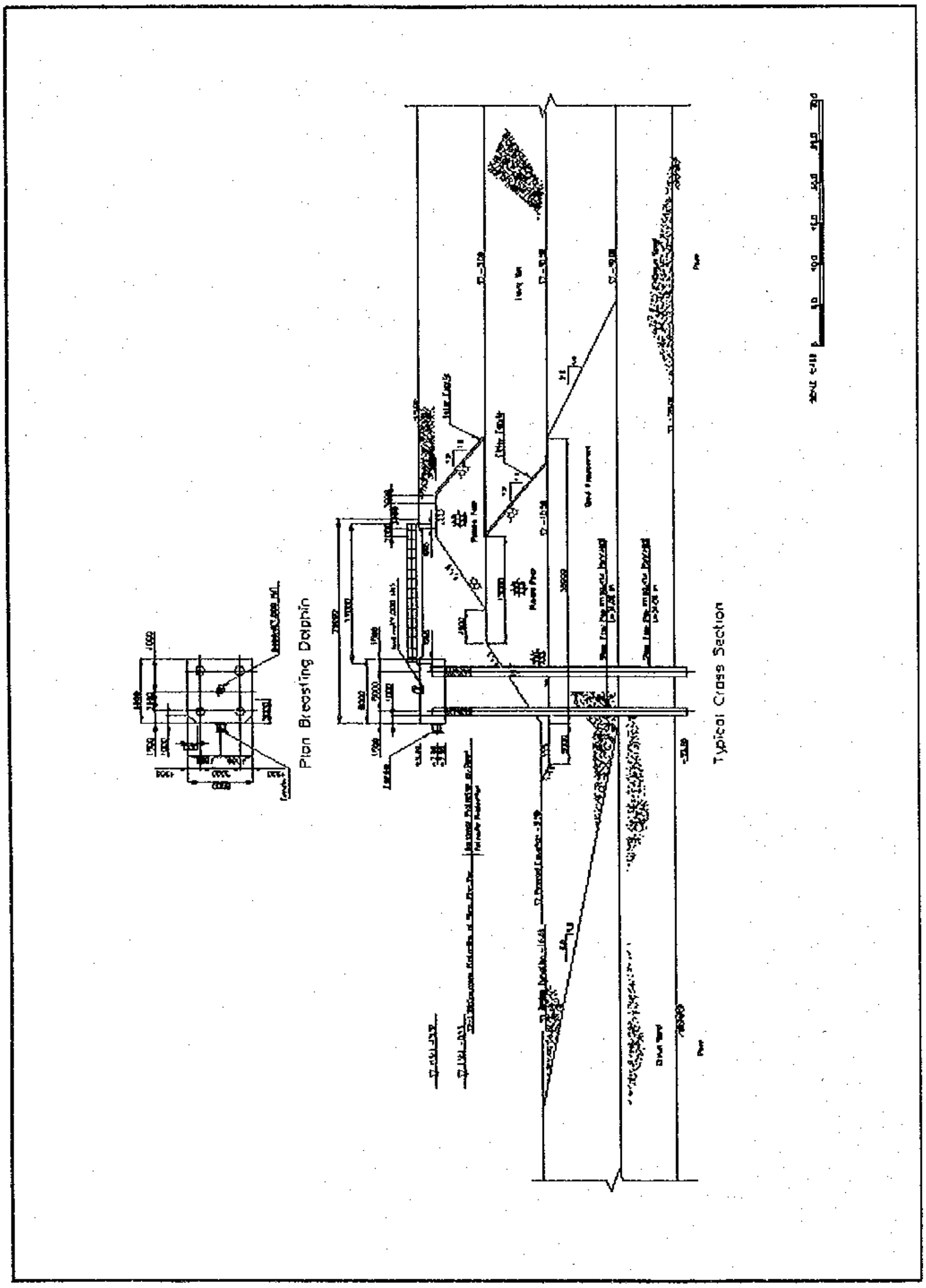
FN : Calculation_Cover_Sheet

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. /	Rev.

References/ Notes

5 . Basic Design of Breasting Dolphin (Passenger Berth)

1) Outline structure of Breasting Dolphin

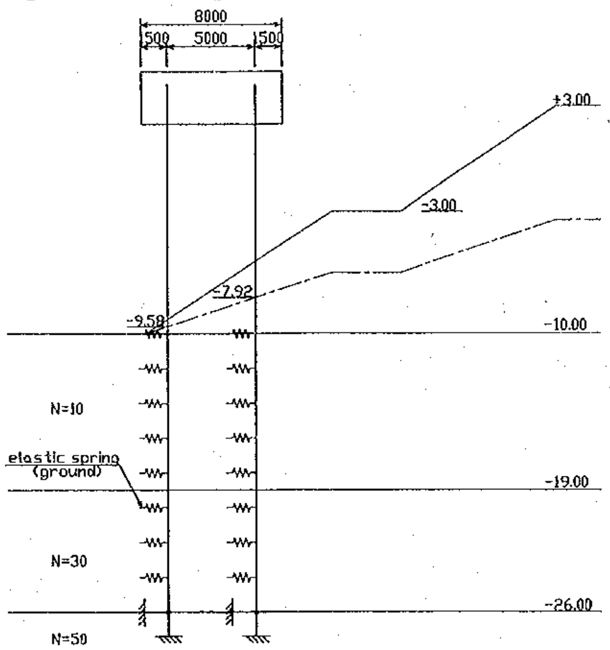


		Prepared by Y. Ando		Checked by R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

References/ Notes

2) Analysis model

Member forces acting on individual piles are calculated in 3-dimensional analysis.



Analysis model outline figure (Frame model)

An analysis model is taken as frame structure. (in which the ground is evaluated as an elastic spring.)

A transverse direction spring constant of ground (Kh) is computed using the following formulas.

$Kh = kh \times D$ (N/cm^2) kh : coefficient of horizontal subgrade reaction(N/cm^3)

D : pile width (cm)

Ground level	Average N-value	$kh(N/cm^3)$	pile width(m)	$Kh(kN/m^2)$
Virtual ground surface				
		3.5	1.10	3,850
-10.00				
	10	15	1.10	16,500
-19.00				
	30	45	1.10	49,500
-26.00				

○Dimensions of Steel Pipe Pile

ϕ 1,100×t14 Section area $A = 477.6\ cm^2$ (Corrosion consideration $A' = 443.1\ cm^2$)

Geometrical moment of inertia $I = 704,287\ cm^4$

(Corrosion consideration $I' = 652,161\ cm^4$

Section modulus $Z = 12,805\ cm^3$

Type of Steel : SKK490 (Design Yield Strength $315\ N/mm^2$)

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

NIPPON KOEI CO.,LTD.

DESIGN CALCULATION COVER SHEET

Project	Detailed Design on Port Reactivation Project in La Union Province	**Project Code**	JC1N004
Section	**Civil**	Calc. File No.	
Sub-Section	**Quaywall**	Calc. Index No.	

Subject: **Passenger Berth**

Calculation Objective:

Fender system

References, Calculation Notes and Comments

Refer to Drawings **QW-02-005,QW-02-031**

Calculation based on

TECHNICAL STANDERDS AND COMMENTARIES

FOR

PORT AND HARBOUR FACILITIES IN JAPAN

Design Load **Refer to Design Condition**

Rev	Prepared		No. of	Checked		Reviewed		Superseded
	by	Date	Pages	by	Date	by	Date	by Calc No.
O	[signature]	26/07/02						
A								
B								
C								

File in Calc. File

FN : Calculation_Cover_Sheet

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 3	Rev.

References/ Notes

3) Calculation of Load

(1) Calculation of reaction force of the fender

a) Dimensions of the target vessel

Deadweight tonnage : 25,000DWT、

length overall : 200.0m、Molded breadth : 32.2m、Full load draft : 8.5m

Gross tonnage (GT) of car carriers is computed using the following formulas.

GT=1.477×DWT

Gross tonnage (GT) of car carriers 1.477×25,000 = 36,925 GT

Length between perpendiculars : 187.0 m

Full load displacement : log(DT)=1.915+0.588 log(36,925) = 4.6006

DT = 39,864 t → DT = 40,000t

b) Calculation of Ship's berthing energy

berthing velocity of vessel	: v=0.10m/s
Length between perpendiculars	: Lpp = 187.0 m
softness factor	: Cs=1.0
berth configuration factor	: Cc=1.0

distance from the point where the vessel touches the mooring facilities to the center of gravity of the vessel as measured along the face line of the mooring facilities : l = 35.0m

(The central line between dolphins, and the vessel center of gravity shall be in agreement. l = 70.0 /2 = 35.0m)

block coefficient	: Cb=40,000 / (187.0×32.2×8.5×1.03) = 0.759
radius of gyration	: r = (0.19×0.759 + 0.11)×187.0 = 47.537
eccentricity factor	: Ce = 1 / (1 + (35 / 47.537)^2) = 0.648
vessel mass factor	: Cm=1+(π /(2×0.759))×(8.5/32.2)=1.546
berthing energy	: Ef=((40,000×0.10^2)/2)×0.648×1.546×1.0×1.0 =200.36 kN・m

c) Reaction Force of the Fender

An advantageous thing is economically used for fender among following two.

・HC 800H(J2)	Catalog value	Energy Absorption	E = 224.0 kN・m
(HYPER SELL)		Reaction Force	R = 502.0 kN
・HO 800H(X100)	Catalog value	Energy Absorption	E = 224.0 kN・m
(HYPER OMEGA)		Reaction Force	R = 502.0 kN

Energy absorption of fender checks that it is less than berthing energy. Energy absorption of the fender used for examination is the value that multiplies above-mentioned value (written to catalog) by 0.9.

HC 800H 224.0×0.9 = 201.6 kN・m ≧ Ef = 200.36 kN・m O.K

HO 800H 224.0×0.9 = 201.6 kN・m ≧ Ef = 200.36 kN・m O.K

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

In consideration of product deviation, 110% of value of catalog value is used for reaction force of fender.

HC 800H R = 502.0×1.1 = 442.2 kN → 552.2 kN

HO 800H R = 502.0×1.1 = 441.1 kN → 552.2 kN

Therefore, even if it uses which fender, reaction force of the fender is taken as R=560.0 kN.

(2) Calculation of Deadweight of the Superstructure

W1 = 8.0m×8.0m×3.0m×24.0 kN/m^3 = 4,608 kN

(3) Calculation of Buoyancy

Buoyancy, which acts on superstructure in the examination at the time of HWL, is taken into consideration.

U = 8.0m×8.0m×1.37m×10.1 kN/m^3 = 885.57 kN

(4) Calculation of Earthquake Force

P = 4,608×0.20 = 921.60 kN

(5) Tractive Force of Vessel

Bollard (1,000kN) is prepared in breasting dolphin. The action direction to examine is carried out as follows.

- the vertical direction to the face line (0°)
- the parallel direction to the face line (90°)
- the direction of 45 degree to the face line

Moreover, tractive force of vessel shall act in the place which separated only 50 cm from the surface (+5.00) of superstructure. The moment by tractive force of vessel in pile head (+3.50) is as follows.

M = 1,000.00×2.0 = 2,000.00 kN・m

4) Examination case

The load generalization table of each examination case (kN · m)

Case		Vertical Forces (kN)		Horizontal Forces (kN)				Condition	Action direction	Premium coefficient
		Dead weight	Buoyancy	Reaction force of the fender	Tractive force of vessel	Momrnt of tractive force	Earthquake force of superstructure			
case1	berthing	4,608.00	885.57	560.00	—	—	—	Ordinary	Sea→Land	1.00
case2	berthing	4,608.00	—	560.00	—	—	—	Ordinary	Sea→Land	1.00
case3	earthquake	4,608.00	885.57	—	—	—	921.60	Extraordinary	Sea→Land	1.50
case4	earthquake	4,608.00	—	—	—	—	921.60	Extraordinary	Sea→Land	1.50
case5	earthquake	4,608.00	885.57	—	—	—	921.60	Extraordinary	Land→Sea	1.50
case6	earthquake	4,608.00	—	—	—	—	921.60	Extraordinary	Land→Sea	1.50
case7	earthquake	4,608.00	885.57	—	—	—	921.60	Extraordinary	Parallel to face line	1.50
case8	earthquake	4,608.00	—	—	—	—	921.60	Extraordinary	Parallel to face line	1.50
case9	mooring	4,608.00	885.57	—	1,000.00	2,000.00	—	Extraordinary	Land→Sea	1.50
case10	mooring	4,608.00	—	—	1,000.00	2,000.00	—	Extraordinary	Land→Sea	1.50
case11	mooring	4,608.00	885.57	—	1,000.00	2,000.00	—	Extraordinary	direction of 45°	1.50
case12	mooring	4,608.00	—	—	1,000.00	2,000.00	—	Extraordinary	direction of 45°	1.50
case13	mooring	4,608.00	885.57	—	1,000.00	2,000.00	—	Extraordinary	Parallel to face line	1.50
case14	mooring	4,608.00	—	—	1,000.00	2,000.00	—	Extraordinary	Parallel to face line	1.50

Since horizontal force of mooring condition is larger than horizontal force of earthquake condition, only mooring condition performs examination of extraordinary condition.

An examination case is shown below. (kN · m)

Case		Vertical Forces (kN)		Horizontal Forces (kN)			Condition	Action direction	Premium coefficient
		Deadweight	Buoyancy	Reaction force of the fender	Tractive force of vessel	Momrnt of tractive force			
case1	berthing	4,608.00	885.57	560.00	—	—	Ordinary	Sea→Land	1.00
case2	berthing	4,608.00	—	560.00	—	—	Ordinary	Sea→Land	1.00
case3	mooring	4,608.00	885.57	—	1,000.00	2,000.00	Extraordinary	Land→Sea	1.50
case4	mooring	4,608.00	—	—	1,000.00	2,000.00	Extraordinary	Land→Sea	1.50
case5	mooring	4,608.00	885.57	—	1,000.00	2,000.00	Extraordinary	direction of 45°	1.50
case6	mooring	4,608.00	—	—	1,000.00	2,000.00	Extraordinary	direction of 45°	1.50
case7	mooring	4,608.00	885.57	—	1,000.00	2,000.00	Extraordinary	Parallel to face line	1.50
case8	mooring	4,608.00	—	—	1,000.00	2,000.00	Extraordinary	Parallel to face line	1.50

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 6	Rev.

References/ Notes

5) Section force of pile

Computed section force acting on pile is shown below as a result of analysis.

Case	Pile	Maximum Moment kN・m	Composition Moment kN・m	Axial force kN	Maximum Axial force kN	Displacement cm
case1	Pile 1	1,078.0	1,078.0	481.7	1,479.0	4.9
	(Sea side)	0.0				
HWL	Pile 2	1,170.0	1,170.0	1,381.0		
	(Land side)	0.0				
case2	Pile 1	1,078.0	1,078.0	703.1	1,701.0	4.9
	(Sea side)	0.0				
LWL	Pile 2	1,170.0	1,170.0	1,603.0		
	(Land side)	0.0				
case3	Pile 1	1,906.0	1,906.0	1,927.0	2,025.0	8.9
	(Sea side)	0.0				
HWL	Pile 2	2,070.0	2,070.0	-63.7		
	(Land side)	0.0				
case4	Pile 1	1,906.0	1,906.0	2,246.0	2,246.0	9.0
	(Sea side)	0.0				
LWL	Pile 2	2,070.0	2,070.0	2,255.8		
	(Land side)	0.0				
case5	Pile 1	1,303.0	1,909.6	2,339.0	2,437.0	9.3
	(Sea side)	1,396.0				
HWL	Pile 2	1,512.0	2,073.6	-476.5		
	(Land side)	1,419.0			-378.4	
	Pile 1	1,415.0	2,003.2	932.0		
	(Sea side)	1,418.0				
case6	Pile 2	1,303.0	1,909.6	2,560.0	2,658.0	9.3
	(Land side)	1,396.0				
LWL	Pile 1	1,512.0	2,073.6	-255.0		
	(Sea side)	1,419.0			-156.9	
	Pile 2	1,415.0	2,003.2	1,153.0		
	(Land side)	1,418.0				
case7	Pile 1	62.4	1,974.0	1,927.0	2,025.0	9.4
	(Sea side)	1,973.0				
HWL	Pile 2	69.5	2,007.2	1,927.0		
	(Land side)	2,006.0				
case8	Pile 1	62.3	1,974.0	2,148.0	2,247.0	9.4
	(Sea side)	1,973.0				
LWL	Pile 2	68.5	2,007.2	2,149.0		
	(Land side)	2,006.0				

Examination of stress performs only the pile and case in the table where stress becomes large by which hatching is carried out.

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 7	Rev.

References/ Notes

6) Stress Examination of Piles

Passenger Berth Breasting Dolphin ϕ1100*t14

Stress Calculation (Case2) Pile 1

Pile	Dimension	ϕ1100*t14		SKK 490		
	Cross-sectional Area	A=	477.6 cm^2			
	Section modulus	Z=	12,805 cm^3			
	Radius of gyration of area	r=	38.4 cm^2			
	Buckling length	l=	1308 cm			
		l/r=	34.1			
Section force	Bending Moment	M=	1,078.0 kN·m			
	Axial Force	N=	703.1 kN			
Stress	Allowable Bending Stress	σba=	185 N/mm^2			
	Allowable Axial Compressive Stress	σca=	163 N/mm^2			
	Premium coefficient		1.0			
	Bending Stress	σb=	84 N/mm^2	<	185 N/mm^2	O.K.
	Axial Compressive Stress	σc=	15 N/mm^2	<	163 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment		0.55			O.K.

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

References/ Notes

Passenger Berth Breasting Dolphin φ1100*t14

Stress Calculation (Case2) Pile 2

Pile	Dimension	φ1100*t14	SKK 490		
	Cross-sectional Area	A=	477.6 cm^2		
	Section modulus	Z=	12,805 cm^3		
	Radius of gyration of area	r=	38.4 cm^2		
	Buckling length	l=	1142 cm		
		l/r=	29.7		
Section force	Bending Moment	M=	1,170.0 kN·m		
	Axial Force	N=	1,603.0 kN		
Stress	Allowable Bending Stress	σba=	185 N/mm^2		
	Allowable Axial Compressive Stress	σca=	169 N/mm^2		
	Premium coefficient		1.0		
	Bending Stress	σb=	91 N/mm^2	< 185 N/mm^2	O.K.
	Axial Compressive Stress	σc=	34 N/mm^2	< 169 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment		0.69		O.K.

		Prepared by	Y. Ando	Checked by	R. NUKIMURA
			26 / 07/2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 9	Rev.

References/ Notes

6) Stress Examination of Piles

Passenger Berth Breasting Dolphin ϕ1100*t14

Stress Calculation (Case2) Pile 1

Pile	Dimension	ϕ1100*t14		SKK 490		
	Cross-sectional Area	A=	477.6 cm^2			
	Section modulus	Z=	12,805 cm^3			
	Radius of gyration of area	r=	38.4 cm^2			
	Buckling length	l=	1308 cm			
		l/r=	34.1			
Section force	Bending Moment	M=	1,078.0 kN·m			
	Axial Force	N=	703.1 kN			
Stress	Allowable Bending Stress	σba=	185 N/mm^2			
	Allowable Axial Compressive Stress	σca=	163 N/mm^2			
	Premium coefficient		1.0			
	Bending Stress	σb=	84 N/mm^2	<	185 N/mm^2	O.K.
	Axial Compressive Stress	σc=	15 N/mm^2	<	163 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment		0.55			O.K.

		Prepared by Y. Ando		Checked by R. NISHIMURA
			26/07/2002	08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 10	Rev.

References/ Notes

Passenger Berth Breasting Dolphin φ1100*t14

Stress Calculation (Case2) Pile 2

Pile	Dimension	φ1100*t14		SKK 490	
	Cross-sectional Area	A= 477.6 cm^2			
	Section modulus	Z= 12,805 cm^3			
	Radius of gyration of area	r= 38.4 cm^2			
	Buckling length	l= 1142 cm			
		l/r= 29.7			
Section force	Bending Moment	M= 1,170.0 kN·m			
	Axial Force	N= 1,603.0 kN			
Stress	Allowable Bending Stress	σba= 185 N/mm^2			
	Allowable Axial Compressive Stress	σca= 169 N/mm^2			
	Premium coefficient	1.0			
	Bending Stress	σb= 91 N/mm^2	<	185 N/mm^2	O.K.
	Axial Compressive Stress	σc= 34 N/mm^2	<	169 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment	0.69			O.K.

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

References/ Notes

Passenger Berth Breasting Dolphin φ1100*t14

Stress Calculation (Case4) Pile 2

Pile	Dimension	φ1100*t14	SKK 490		
	Cross-sectional Area	A= 477.6 cm^2			
	Section modulus	Z= 12,805 cm^3			
	Radius of gyration of area	r= 38.4 cm^2			
	Buckling length	l= 1142 cm			
		l/r= 29.7			
Section force	Bending Moment	M= 2,070.0 kN·m			
	Axial Force	N= 255.8 kN			
Stress	Allowable Bending Stress	σba= 185 N/mm^2			
	Allowable Axial Compressive Stress	σca= 169 N/mm^2			
	Premium coefficient	1.5			
	Bending Stress	σb= 162 N/mm^2	<	278 N/mm^2	O.K.
	Axial Compressive Stress	σc= 5 N/mm^2	<	253 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment	0.60			O.K.

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

References/ Notes

Passenger Berth Breasting Dolphin φ1100*t14

Stress Calculation (Case5) Pile 2

Pile	Dimension	φ1100*t14 SKK 490
	Cross-sectional Area	A= 477.6 cm^2
	Section modulus	Z= 12,805 cm^3
	Radius of gyration of area	r= 38.4 cm^2
	Buckling length	l= 0 cm
		l/r= 0.0
Section force	Bending Moment	M= 2,073.6 kN·m
	Axial Force	N= -476.5 kN
Stress	Allowable Bending Stress	σba= 185 N/mm^2
	Allowable Axial Compressive Stress	σta= 185 N/mm^2
	Premium coefficient	1.5
	Bending Stress	σbt= 162 N/mm^2 < 278 N/mm^2 O.K.
	Axial Compressive Stress	σt= 10 N/mm^2 < 278 N/mm^2 O.K.
	Examination of members simultaneously subject to axial force and bending moment	σt+σbt= 171.91 N/mm^2 < 278 N/mm^2 O.K.

	Prepared by	Y. Ando	Checked by	R. NISHIMURA
		26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 13	Rev.

References/ Notes

Passenger Berth Breasting Dolphin φ1100*t14

Stress Calculation (Case6) Pile 1

Pile	Dimension	φ1100*t14 SKK 490			
	Cross-sectional Area	A= 477.6 cm^2			
	Section modulus	Z= 12,805 cm^3			
	Radius of gyration of area	r= 38.4 cm^2			
	Buckling length	l= 1308 cm			
		l/r= 34.1			
Section force	Bending Moment	M= 1,909.0 kN·m			
	Axial Force	N= 2,560.0 kN			
Stress	Allowable Bending Stress	σba= 185 N/mm^2			
	Allowable Axial Compressive Stress	σca= 163 N/mm^2			
	Premium coefficient	1.5			
	Bending Stress	σb= 149 N/mm^2	<	278 N/mm^2	O.K.
	Axial Compressive Stress	σc= 54 N/mm^2	<	245 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment	0.76			O.K.

	Prepared by	Y. Ando	Checked by	R. NISHIMURA
		26/07/2002		08/08/2002

References/ Notes

Passenger Berth Breasting Dolphin ϕ1100*t14

Stress Calculation (Case8) Pile 1

Pile	Dimension	ϕ1100*t14	SKK 490		
	Cross-sectional Area	A= 477.6 cm^2			
	Section modulus	Z= 12,805 cm^3			
	Radius of gyration of area	r= 38.4 cm^2			
	Buckling length	l= 1308 cm			
		l/r= 34.1			
Section force	Bending Moment	M= 1,974.0 kN·m			
	Axial Force	N= 2,148.0 kN			
Stress	Allowable Bending Stress	σba= 185 N/mm^2			
	Allowable Axial Compressive Stress	σca= 163 N/mm^2			
	Premium coefficient	1.5			
	Bending Stress	σb= 154 N/mm^2	<	278 N/mm^2	O.K.
	Axial Compressive Stress	σc= 45 N/mm^2	<	245 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment	0.74			O.K.

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

References/ Notes

Passenger Berth Breasting Dolphin φ1100*t14

Stress Calculation (Case8) Pile 2

Pile	Dimension	φ1100*t14	SKK 490			
	Cross-sectional Area	A=	477.6 cm^2			
	Section modulus	Z=	12,805 cm^3			
	Radius of gyration of area	r=	38.4 cm^2			
	Buckling length	l=	1142 cm			
		l/r=	29.7			
Section force	Bending Moment	M=	2,007.2 kN·m			
	Axial Force	N=	2,149.0 kN			
Stress	Allowable Bending Stress	σba=	185 N/mm^2			
	Allowable Axial Compressive Stress	σca=	169 N/mm^2			
	Premium coefficient		1.5			
	Bending Stress	σb=	157 N/mm^2	<	278 N/mm^2	O.K.
	Axial Compressive Stress	σc=	45 N/mm^2	<	253 N/mm^2	O.K.
	Examination of members simultaneously subject to axial force and bending moment		0.74			O.K.

Prepared by	Y. Ando	26 / 07 /2002	Checked by	R. NISHIMURA 08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 16	Rev.

References/ Notes

7) Examination of Bearing Capacity of Pile

Ultimate bearing capacity(Ru) is computed using the following formulas.

$Ru = 300 \times q \times N \times Ap + N' \times As$ (kN)

Where q : Closed area ratio of pile

N : N-value of the ground around pile toe

$N = (N1+N2)/2$

N1 : N-value at the toe of pile

N2 : mean N-value in the range from the toe of pile to the level 4B above

B : diameter or width of pile (m)

N' : mean N-value for total penetration length of pile

Ap : toe area of pile (m^2)

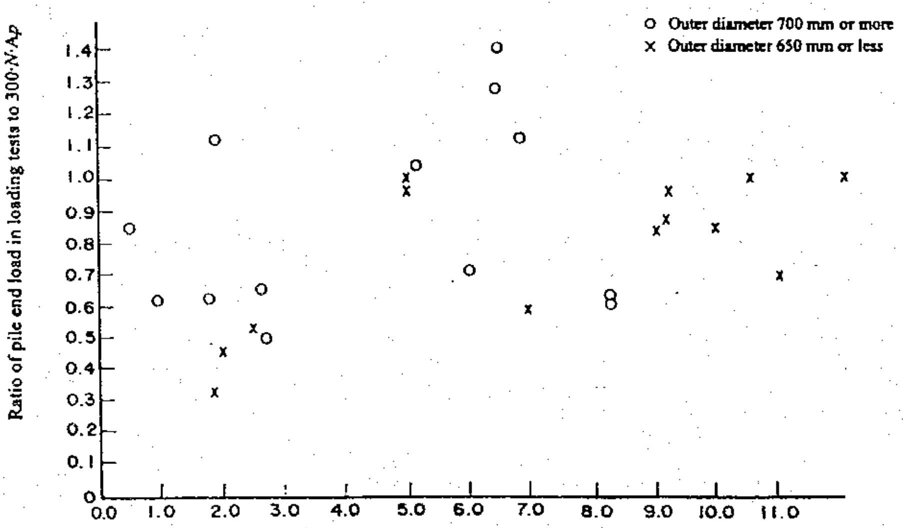
As : total circumferential area of pile (m^2)

※The pile installation method assumes from Soil Condition that it is the pile installation by inner excavation. Therefore, the 2nd term of the upper formula is made into "N×As." (see "Highway Bridge Specifications and the Commentary(in Japan)") (According to the standard, it is "2×N×As".)

(1) Closed Area Ratio

The piles shall drive only the length of pile diameter into the bearing stratum (below -26m).

The Closed area ratio is set to "q= 0.6" from the following figures.



		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 17	Rev.

References/ Notes

(2) Calculation of Ultimate Bearing Capacity

$N2 = (1.1\times50 + 3\times1.1\times30) / (4\times1.1) = 35$

$N = (50+35) / 2 = 42.5 \rightarrow 42$

$Ap = 1.1^2\times \pi/4 = 0.950\ m^2$

Circumferential area of pile per 1m $As' = 1.1\times \pi = 3.45\ m^2/m$

$Ru = 300\times0.6\times42\times0.950 + (9.5\times10 + 6.0\times30)\times3.45$

$= 8{,}130\ kN$

(3) Calculation of Maximum Pulling Resistance

$Rut = (9.5\times10 + 6.0\times30)\times3.45 = 948\ kN$

(4) Examination of Bearing Capacity

The allowable bearing capacity is calculated using the following formulas.

$Ra = Ru / F$

where

Ra : allowable bearing capacity

Ru : ultimate bearing capacity

F : safety factor (= 2.50 : berthing condition)

(= 1.50 : mooring condition)

a) Examination of Bearing Capacity (Berthing Condition)

Allowable bearing capacity $Ra = 8{,}130 / 2.5 = 3{,}252\ kN \geqq 1{,}701\ kN$ O.K

b) Examination of Bearing Capacity (Mooring Condition)

Allowable bearing capacity $Ra = 8{,}130 / 1.5 = 5{,}420\ kN \geqq 2{,}658\ kN$ O.K

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 18	Rev.

References/ Notes

(5) Examination of Pulling Resistance

The allowable pulling resistance is calculated using the following formulas.

Rat = Rut / F

where

Rat : allowable pulling resistance

Rut : maximum pulling resistance

F : safety factor (= 3.00 : berthing condition)

(= 2.50 : mooring condition)

a) Examination of Pulling Resistance (Berthing Condition)

Allowable pulling resistance Rat = 948 / 3.0 = 316 kN ≧ 0 kN O.K

b) Examination of Pulling Resistance (Mooring Condition)

Allowable pulling resistance Rat = 948 / 2.5 = 379 kN ≧ 378.4 kN O.K

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 19	Rev.

References/ Notes

8) Examination of Earthquake-Resistant Performance

The examination of earthquake-resistant is performed by the "simplified method" from the following things.

- An object institution does not have complicated structure.
- A raking pile is not included.

The simplified method evaluates the load carrying capacity of pier by summing up the strength of the steel pipe piles, while assuming that the pier superstructure is a rigid body.

(1) Determination of seismic coefficient for examination

The seismic coefficient for examinations is obtained for the different regional classification in a structure installation position and the natural periods of the ground and the pile-supported section. Regional classification is set as region category A.

a) Natural Period of the Ground

The natural period of the ground is computed using the following formulas.

$$T_g=4\Sigma H_i/V_{si}$$

T_g ; natural period of the ground (s)

H_i ; thickness of the i-th layer (m)

V_{si} ; shear wave velocity in the i-th layer $V_{si}=\sqrt{(G_0 g/\gamma_t)}$ (m/s)

G_0 ; shear modulus (kN/m^2)

- sandy ground $G_0=14,400N^{0.68}$ (kN/m^2)

g ; gravitational acceleration (=9.8m/s^2)

γ_t ; wet unit weight (kN/m^3)

N ; standard penetration test value

The natural period of the ground is computed for the engineering foundation.

The crown height of rubble is set as -6.5m(virtual ground surface). Therefore, it is aimed at the -6.5m ～ -26m foundation.

Level	Hi (m)	soil	N	γ_t(kN/m^3)	G_0(kN/m^2)	V_{si}(m/s)
-8.75～-10.0	1.25	sandy	2.33	20.0	25,596	112.05
-10.0～-20.0	10.0	sandy	10	20.0	68,923	183.87
-20.0～-26.0	6.0	sandy	30	20.0	145,481	267.13

- Natural Period of the Ground

$$T_g=4\times(1.25/112.05+10.0/183.87+6.0/267.13)=0.352s$$

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 20	Rev.

References/ Notes

b) Natural Period of Breasting Dolphin

The coefficient of horizontal subgrade reaction and the characteristic value of a pile are computed using the following formulas.

- coefficient of horizontal subgrade reaction $k_h = 2 \times 1.5N$ (N/cm^3)
- characteristic value of a pile $\beta = \sqrt[4]{(k_h D/(4EI))}$ (cm^{-1})
- horizontal spring constant $K_H = 12 \times EI/(Li^3)$ (kN/m)
- natural period pf a Breasting Dolphin $Ts = 2 \times \pi \times \sqrt{(W / (g \times K_H))}$ (s)

where N : average N-value of the ground down to a depth of about $1/\beta$

D : deameter or width of the pile (=1.10m)

Li : free length of a pile 、 $= hi + 1/\beta$

hi : vertical distance between the pile head and the virtual ground surface

W : sum of deadweight and surcharge during an earthquake (=4,608 kN)

The calculation result of the spring constant of individual pile

	D (cm)	thickness of pile(cm)	I (cm^4)	hi (m)	N	kh	β (cm^{-1})	1/β (m)	Li (m)	K_H (kN/m)
Pile 1	109.8	1.3	652,161	13.08	9.11	27.33	0.00275	3.63	16.71	3,354
Pile 2	109.8	1.3	652,161	11.42	6.04	18.12	0.00249	4.02	15.44	4,249

The number of piles of individual pile rows is twe

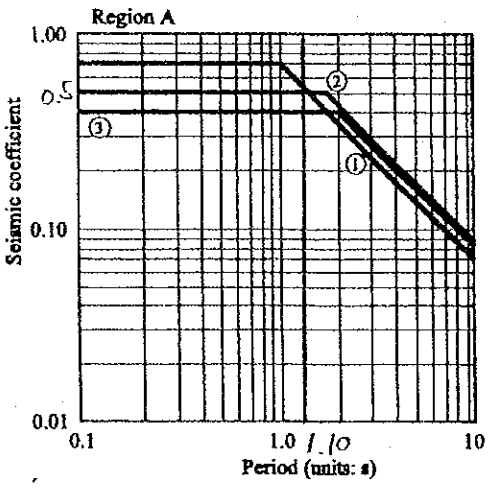
sum of horizontal spring constant $\Sigma K_H = (2 \times 3{,}354 + 2 \times 4{,}249) = 15{,}205$ kN/m

natural period of Breasting Dolphin

$$Ts = 2 \times \pi \times \sqrt{(4{,}608 / (9.81 \times 15{,}205))} = 1.10 \text{ s}$$

c) Determination of seismic coefficient for examination

From the following figures, seismic coefficient for examination by reference is set to "kh=0.5".



Legend
① $T_g < 0.1s$
② $0.1s \leq T_g < 0.5s$
③ $0.5s \leq T_g$
T_g ; natural period of the ground calculated with equation(s)

		Prepared by	Y. Ando	Checked by	E. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 21	Rev.

(2) Examination of Load Carrying Capacity Using Simplified Method

References/ Notes

In the examination of the load carrying capacity of pier using the simplified method, the pile-supported section shall be represented with a frame structure model and the horizontal displacement ductility factor of the pile-supported section shall be used. Examination is performed using the following formulas.

$R_a \geqq k_h W$

$R_a = \sqrt{(2\mu_a - 1 + \theta(\mu_a - 1)^2)} \times P_y$

R_a ; load carrying capacity during an earthquake (kN)

k_h ; seismic coefficient derived

W ; deadweight of pier and surcharge acting during an earthquake (kN)

μ_a ; allowable displacement ductility factor (=1.3 ; Class A)

θ ; =0 (see "TECHNICAL STANDARDS AND COMMENTARIES FOR PORT AND HARBOUR FACILITIES IN JAPAN")

P_y ; the horizontal force corresponding to the elastic limit $=0.82P_{uall}$ (kN)

P_{uall} ; the horizontal load level at which the bending moment of all piles of the wharf reach the fully plastic state moments both at the pile heads and underground virtual fix points $=\Sigma 2M_{pi}/L_i$ (kN)

M_p ; fully plastic state moment $=M_{p0}\cdot\cos(\alpha\pi/2)$ (kN·m)

L_i ; The length of individual pile $=h_i+1/\beta$ (m)

M_{p0} ; fully plastic state moment of steel pipe pile when no axial force is acting $=Z_p f_y$ (kN·m)

Z_p ; plastic sectional modulus of steel pipe pile $=4/3\times(r^3-(r-t)^3)$ (mm³)

f_y ; design yield strength of steel pipe pile (N/mm²)

SKK490 ; 315 N/mm²

r ; radius of steel pipe pile (mm)

t ; thickness of steel pipe pile (mm)

α ; ratio of the acting axial force N to the yield axial force $N_0(=A\times fy)$ when no bending moment is acting $=N/N_0$

A ; cross-sectional area of steel pipe pile (mm²)

The case where the examination of load carrying capacity is performed is the case where load acts on land from the sea.

		Prepared by	Y. Ando	Checked by R. NISHIMURA
			26/07/2002	08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 22	Rev.

References/ Notes

a) Calculation of Member Forces Acting on Individual Piles

Earthquake force of using for examination of load carrying capacity

$P = 4{,}608 \times 0.50 = 2{,}304$ kN

The horizontal force acting on the heads of individual piles may be calculated using following formula.

$H_i = (K_{Hi} / \Sigma K_{Hi}) \times P$ (kN)

K_{Hi} : horizontal spring constant of individual piles

	free length of a pile Li (m)	K_{Hi}	$K_{Hi} / \Sigma K_{Hi}$	Hi(kN)
Pile 1	16.71	3,354	0.441136	508.189
Pile 2	15.44	4,249	0.558864	643.811
	ΣK_{Hi} =	7,603		

※The number of piles of individual pile rows is two.

"Hi" is the horizontal force per a pile.

The pile head moments (Mi) of individual piles may be calculated using following formula.

$M_i = (1/2) \times L_i \times H_i$ (kN・m)

	free length of a pile Li (m)	Hi	M_0
Pile 1	16.71	508.189	4,246.22
Pile 2	15.44	643.811	4,971.55

The axial force of individual piles may be calculated using following formula.

$N_i' = (M_1 + M_2) / LL$ (kN)

M_1、M_2 : the pile head moment of pile1 and pile2

LL : pile interval (=5.00m)

$N_1' = (-1) \times (4{,}246.22 + 4{,}971.55) / 5.00 = -1{,}843.55$ kN・m

$N_2' = (4{,}246.22 + 4{,}971.55) / 5.00 = 1{,}843.55$ kN・m

The axial force (Ni), which acts on pile head of each pile, is shown below.

	Pile 1	Pile 2
Deadweight + Surcharge ※1	1,152.00	1,152.00
Ni	-1,843.55	1,843.55
Total (Ni)	-691.55	2,995.55

※1 : It computes in static analysis.

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 23	Rev.

References/ Notes

b) Calculation of the element characteristics of a pile

The element characteristics of a pile consider corrosion.

(i) Sectional modulus of steel pipe pile in elastic domain

$Z_p = 4/3 \times (r^3 - (r-t)^3) = 4/3 \times (549^3 - (549-13)^3) = 15{,}304{,}657\ mm^3$

(ii) Fully plastic state moment of steel pipe pile when no axial force acting (M_{po}) and The yield axial force (N_0)

Cross-section area of steel pipe pile A' = 44,312 mm^2

$M_{p0} = Z_p f_y = 15{,}304{,}657 \times 315 / 1{,}000{,}000 = 4{,}820.97\ kN \cdot m$

$N_0 = A f_y = 44{,}312 \times 315 / 1{,}000 = 13{,}958.33\ kN$

c) Calculation of Fully Plastic State Moment (M_p)

(i) Calculation of "α (=N/N₀)"

No.	N (kN)	N_0 (kN)	α (=N/N_0)
Pile 1－1	-691.55	13,958.33	-0.04954421
Pile 1－2	-691.55	13,958.33	-0.04954421
Pile 2－1	2,995.55	13,958.33	0.21460691
Pile 2－2	2,995.55	13,958.33	0.21460691

(ii) Calculation of fully plastic state moment (M_p)

Fully plastic state moments are computed using the following formulas.

$Mp = Mp_0 \times \cos(\alpha \times \pi/2)$ (kN・m)

No.	M_{p0} (kN·m)	M_p (kN·m)	Mi (kN·m)
Pile 1－1	4,820.97	4,806.38	＞ 4,246.22
Pile 1－2	4,820.97	4,806.38	＞ 4,246.22
Pile 2－1	4,820.97	4,549.63	＜ 4,971.55
Pile 2－2	4,820.97	4,549.63	＜ 4,971.55

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 28	Rev.

d) Calculation of the Horizontal Force (Py) Corresponding to the Elastic Limi

References/ Notes

The horizontal force (Py) corresponding to the elastic limit is computed using the following formulas.

$$Py = 0.82 \times P_{uall}$$

where P_{uall} : the horizontal load level at which the bending moments of all the piles of the pier reach the fully plastic state moments

($= \Sigma Hj$ (kN))

Hj : the horizontal load level at which the bending moments of individual piles reach the fully plastic state moments

($=2 \times Mpi / Li$) (kN)

Mpi : fully plastic state moment of individual pile

No.	L_i (m)	M_{pi} (kN·m)	H_i (kN)
Pile 1 − 1	16.71	4,806.38	575.23
Pile 1 − 2	16.71	4,806.38	575.23
Pile 2 − 1	15.44	4,549.63	589.17
Pile 2 − 2	15.44	4,549.63	589.17
	P_{uall} =		2,328.80

The pile head moment of "Pile2" exceeds the fully plastic state moment. Therefore, other piles shall share a part of horizontal load of acting on "Pile2".

a − 1) Calculation of Member Forces Acting on Individual Piles

The redistributed horizontal load is shown below.

	free length of a pile Li (m)	K_{Hi}	K_{Hi} / ΣK_{Hi}	Hi(kN)
Pile 1	16.71	3,354	0.441136	567.000
Pile 2	15.44	4,249	0.558864	585.000
	ΣK_{Hi} =	7,603		

※The number of piles of individual pile rows is two.

"Hi" is the horizontal force per a pile.

The pile head moments (Mi) of individual piles are shown below.

	free length of a pile Li (m)	Hi	M_i
Pile 1	16.71	567.000	4,737.29
Pile 2	15.44	585.000	4,516.20

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 25	Rev.

References/ Notes

The axial force by pile head moment of each pile (Ni) is calculated as follows.

$N_1' = (-1) \times (4{,}737.29 + 4{,}516.20) / 5.00 = -1{,}850.70$ kN・m

$N_2' = (4{,}737.29 + 4{,}516.20) / 5.00 = 1{,}850.70$ kN・m

The axial force (Ni), which acts on pile head of each pile, is shown below.

	Pile 1	Pile 2
Deadweight + Surcharge※1	1,152.00	1,152.00
Ni	-1,850.70	1,850.70
Total (Ni)	-698.70	3,002.70

※1 : It computes in static analysis.

c − 1) Calculation of Fully Plastic State Moment (M_p)

(i) Calculation of " α (=N/N_0)"

No.	N (kN)	N_0 (kN)	α (=N/N_0)
Pile 1 − 1	-698.70	13,958.33	-0.0500561
Pile 1 − 2	-698.70	13,958.33	-0.0500561
Pile 2 − 1	3,002.70	13,958.33	0.2151189
Pile 2 − 2	3,002.70	13,958.33	0.2151189

(ii) Calculation of fully plastic state moment (M_p)

No.	M_{p0} (kN·m)	M_p (kN·m)	Mi (kN·m)
Pile 1 − 1	4,820.97	4,806.08	> 4,737.29
Pile 1 − 2	4,820.97	4,806.08	> 4,737.29
Pile 2 − 1	4,820.97	4,548.35	> 4,516.20
Pile 2 − 2	4,820.97	4,548.35	> 4,516.20

d − 1) Calculation of the Horizontal Force (Py) Corresponding to the Elastic Limit

No.	L_i (m)	M_{pi} (kN·m)	H_i (kN)
Pile 1 − 1	16.71	4,806.08	575.23
Pile 1 − 2	16.71	4,806.08	575.23
Pile 2 − 1	15.44	4,548.35	589.16
Pile 2 − 2	15.44	4,548.35	589.16
P_{uall} =			2,328.78

・Calculation of the horizontal force (Py) corresponding to the elastic limit

$$P_y = 0.82\ P_{uall} = 0.82 \times 2{,}328.78 = 1{,}909.60 \text{ kN}$$

	Prepared by	Y. Ando	Checked by	R. NISHIHURA
		26/ 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 26	Rev.

References/ Notes

e) Examination of Earthquake-Resistant Performance

As for the allowable displacement ductility factor (μa), importance level adopts the value 1.30 of the class-A.

・Calculation of the Load Carrying Capacity of the Pile-Supported Section during an Earthquake(Ra) of Breasting Dolphin

$R_a = \sqrt{(2\mu_a - 1)} \times P_y = \sqrt{(2 \times 1.3 - 1)} \times 1{,}909.60 = 2{,}415.47$ kN

・Earthquake force of using for examination of load carrying capacity

$k_h W = 0.50 \times 4{,}608.00 = 2{,}304.00$ kN $\leqq$ Ra O.K

		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

NIPPON KOEI CO.,LTD.

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 27	Rev.

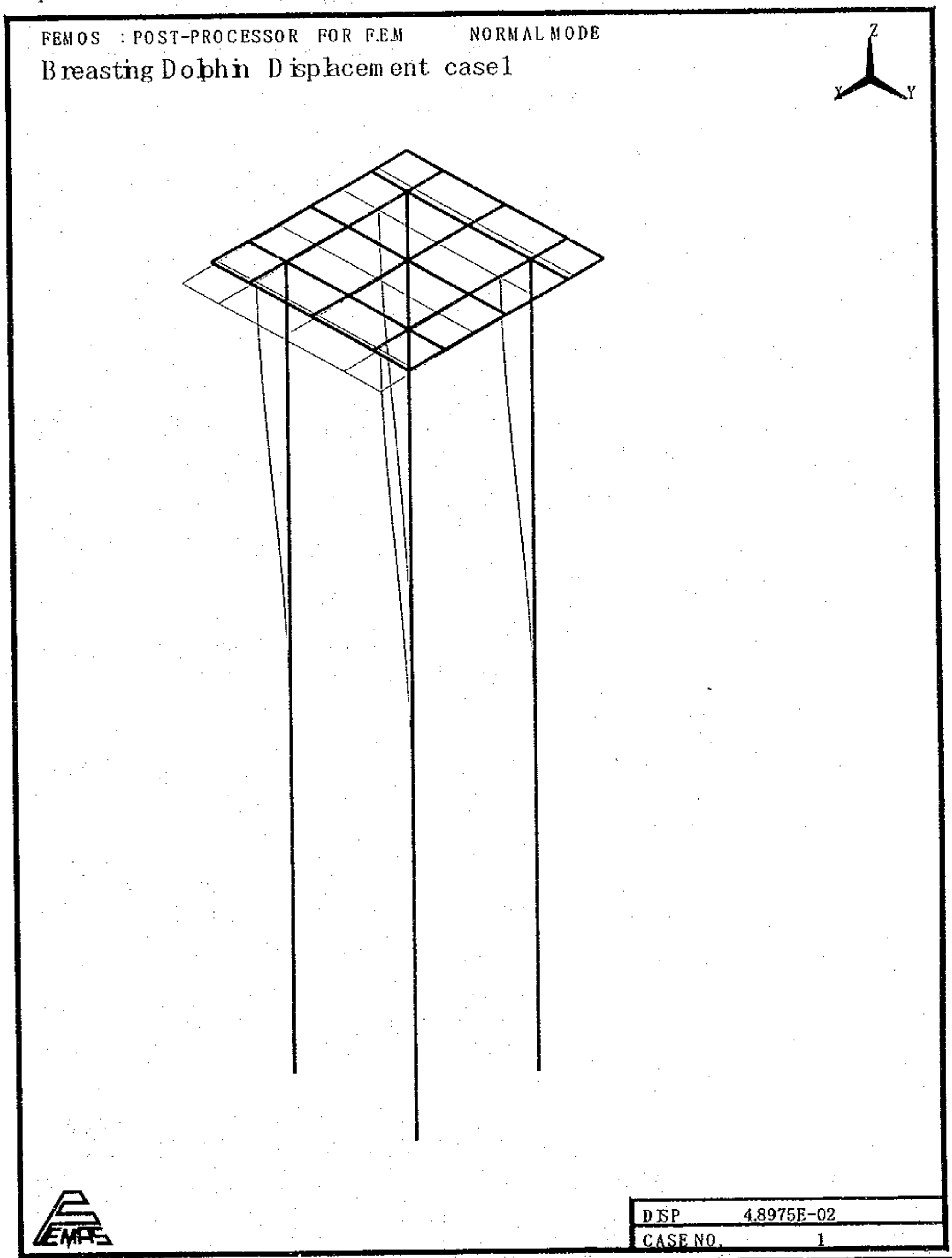
References/ Notes

<Appending Data>

1) Cross-Sectional Force Figure

(1) case1 (Berthing Water Level : HWL)

a) Displacement

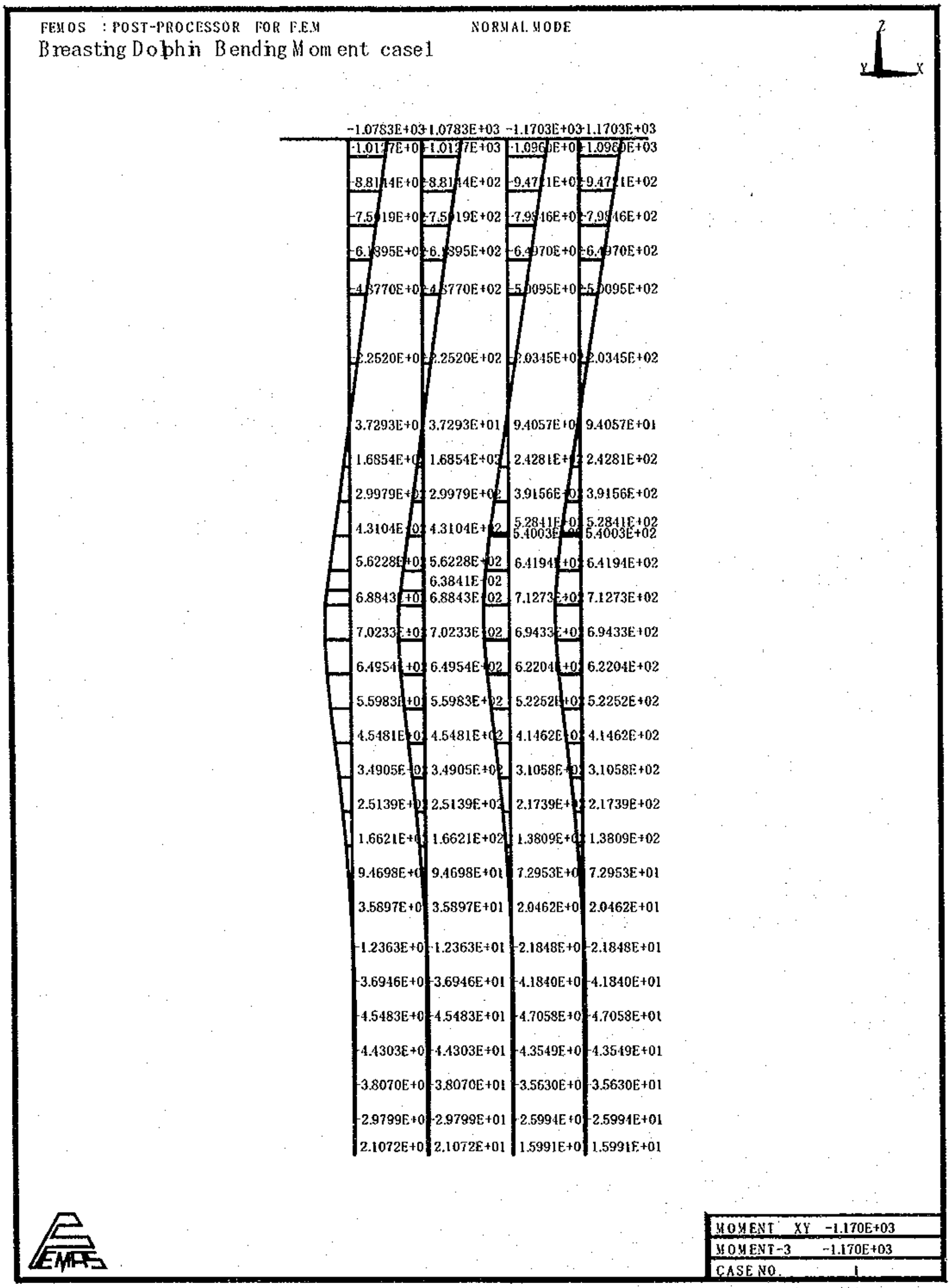


	Prepared by	Y. Ando	Checked by	R. NISHIMURA
		26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 28	Rev.

References/
Notes

b) Bending Moment

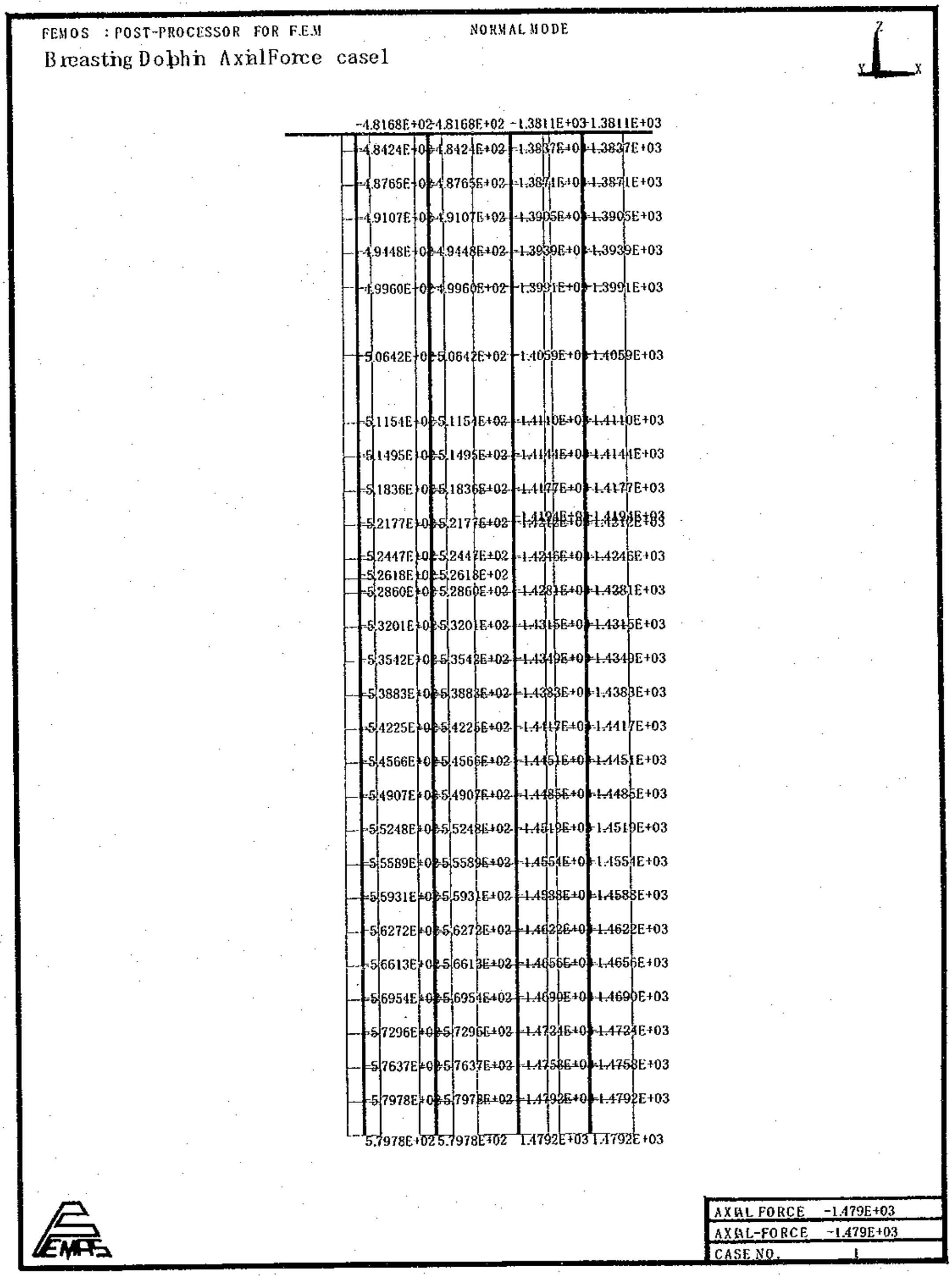


	Prepared by Y. Ando		Checked by R. NISHIMURA
		26/07/2002	08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 29	Rev.

References/ Notes

c) Axial Force



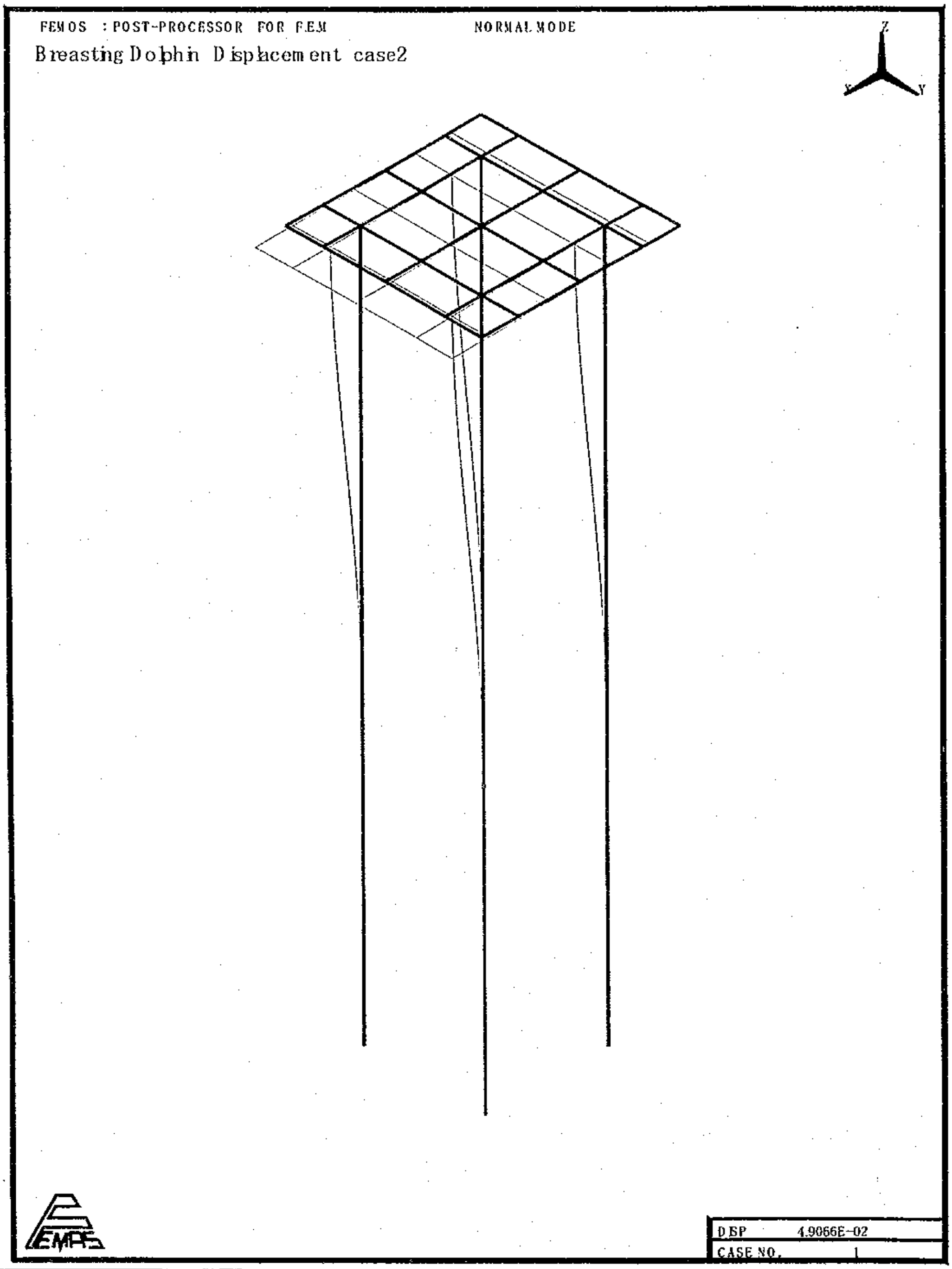
		Prepared by	Y. Ando	Checked by R. NISHIHURA
			26/07/2002	08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 30	Rev.

References/ Notes

(2) case2 (Berthing Water Level : LWL)

a) Displacement

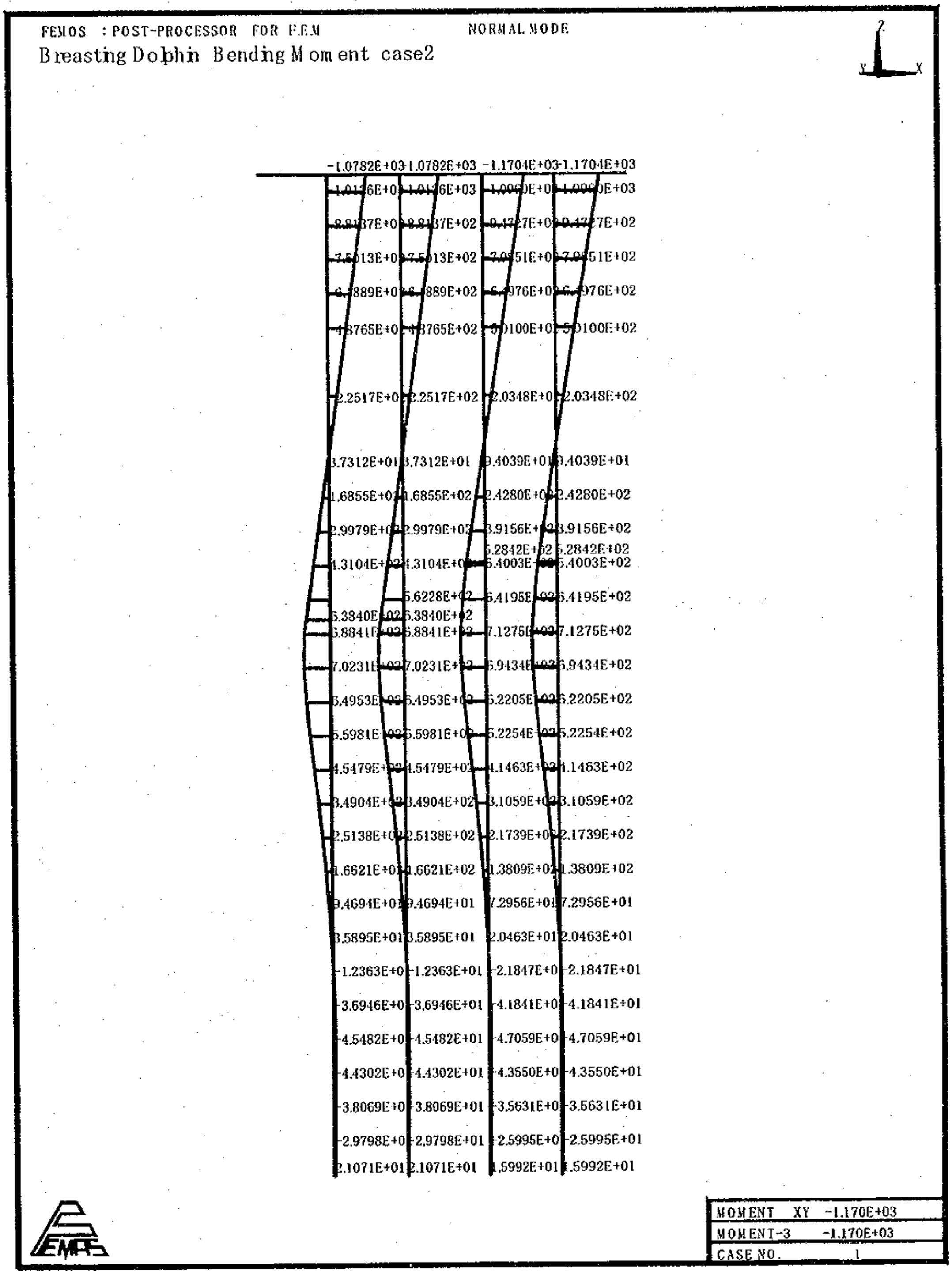


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 31	Rev.

References/
Notes

b) Bending Moment

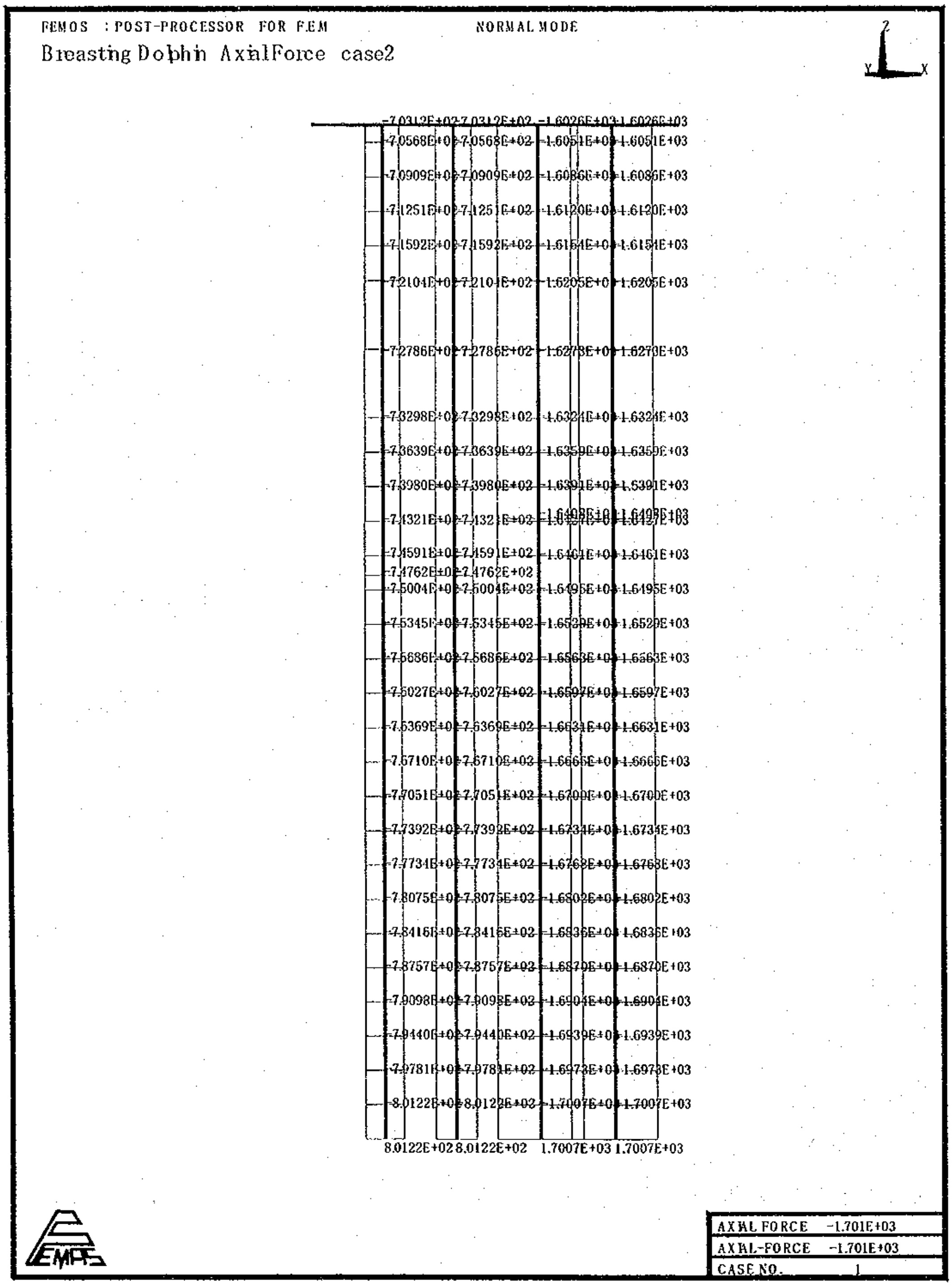


	Prepared by	Y. Ando	Checked by R. NISHIMURA
		26 / 07 /2002	08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 32	Rev.

References/ Notes

c) Axial Force



		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/ 07 /2002		08 / 08 /2002

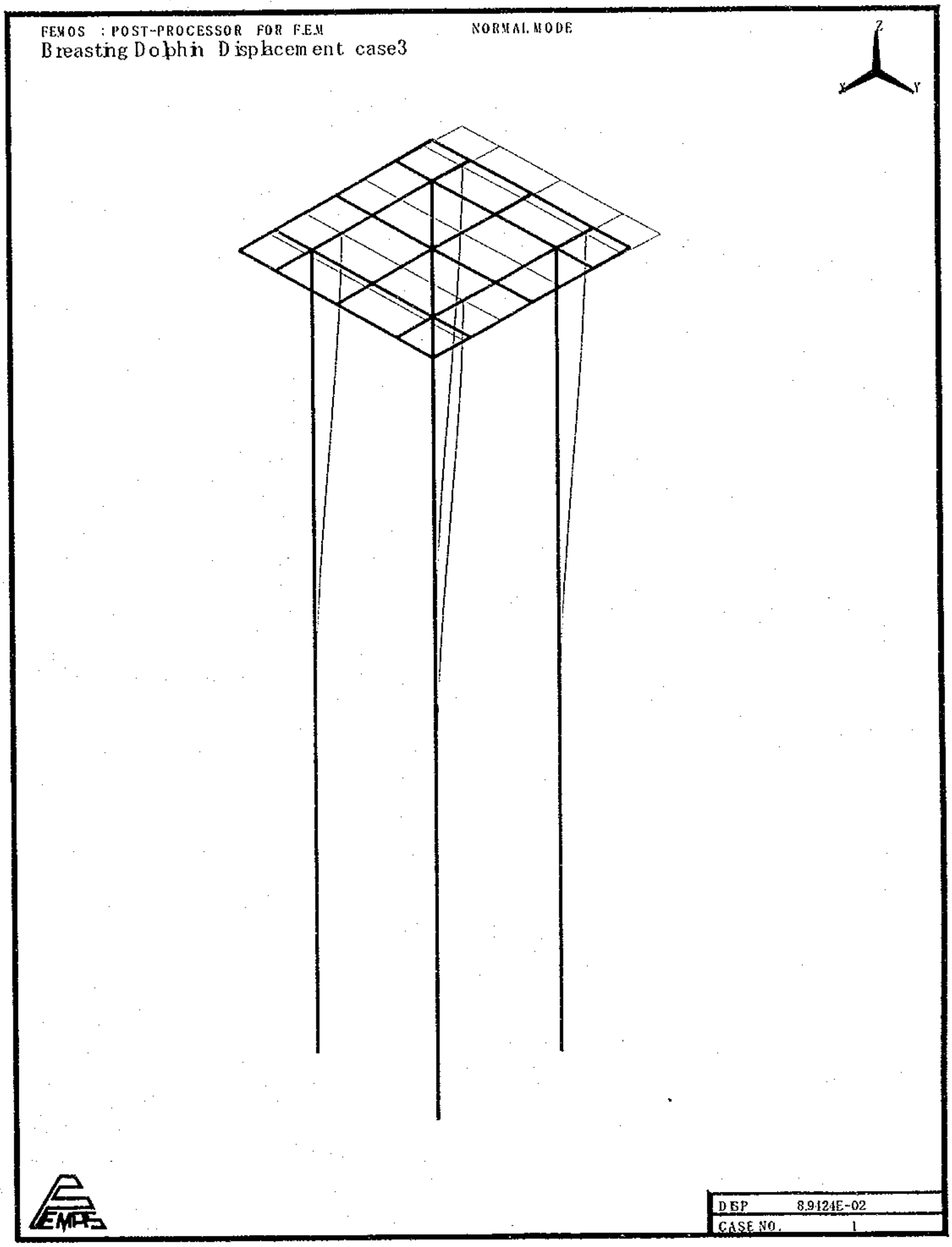
Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 33	Rev.

References/ Notes

(3) case3 (Mooring Water Level : HWL

Action Direction : The Vertical to the Face Line (Land→Sea))

a) Displacement

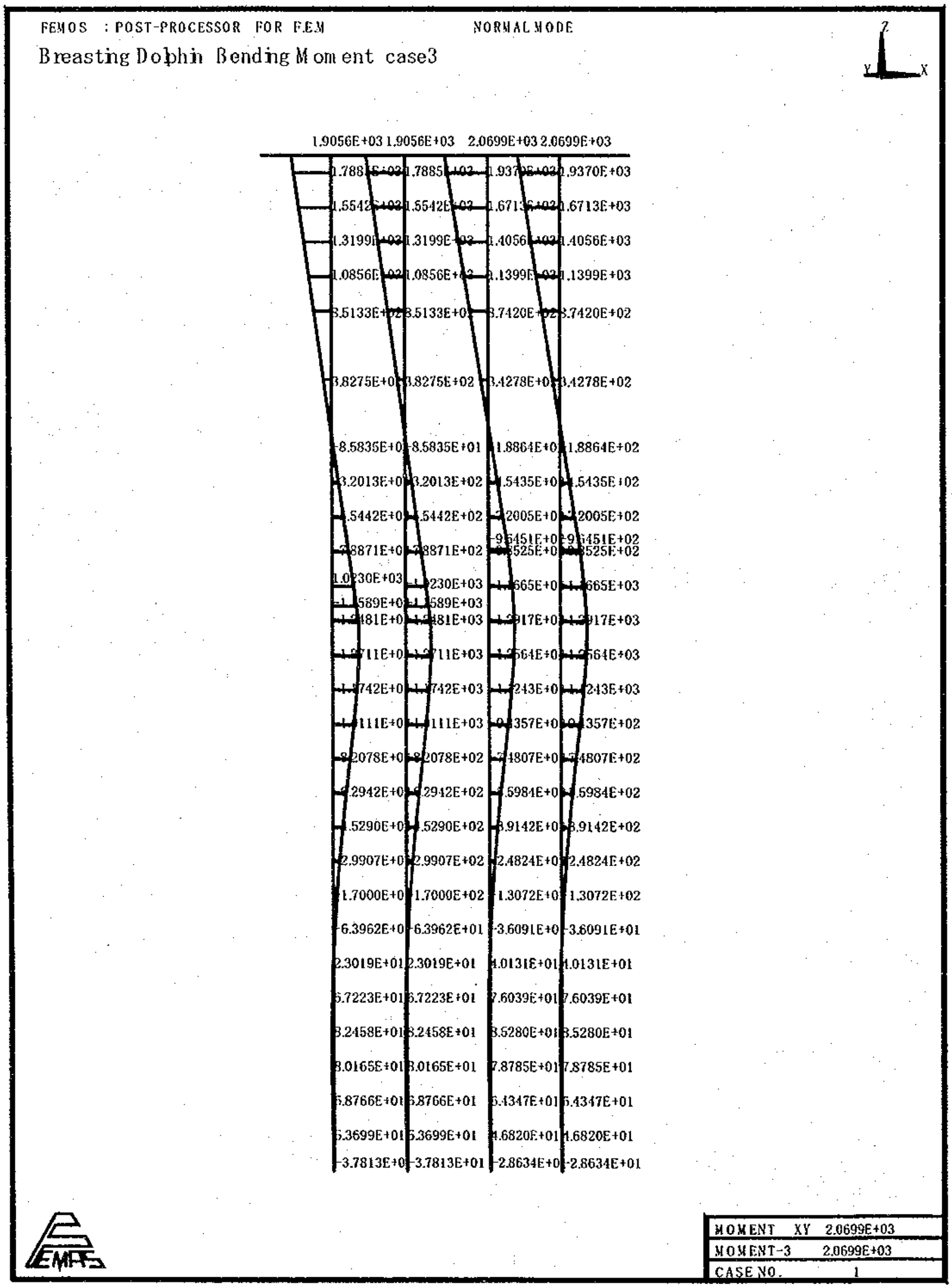


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 34	Rev.

References/ Notes

b) Bending Moment

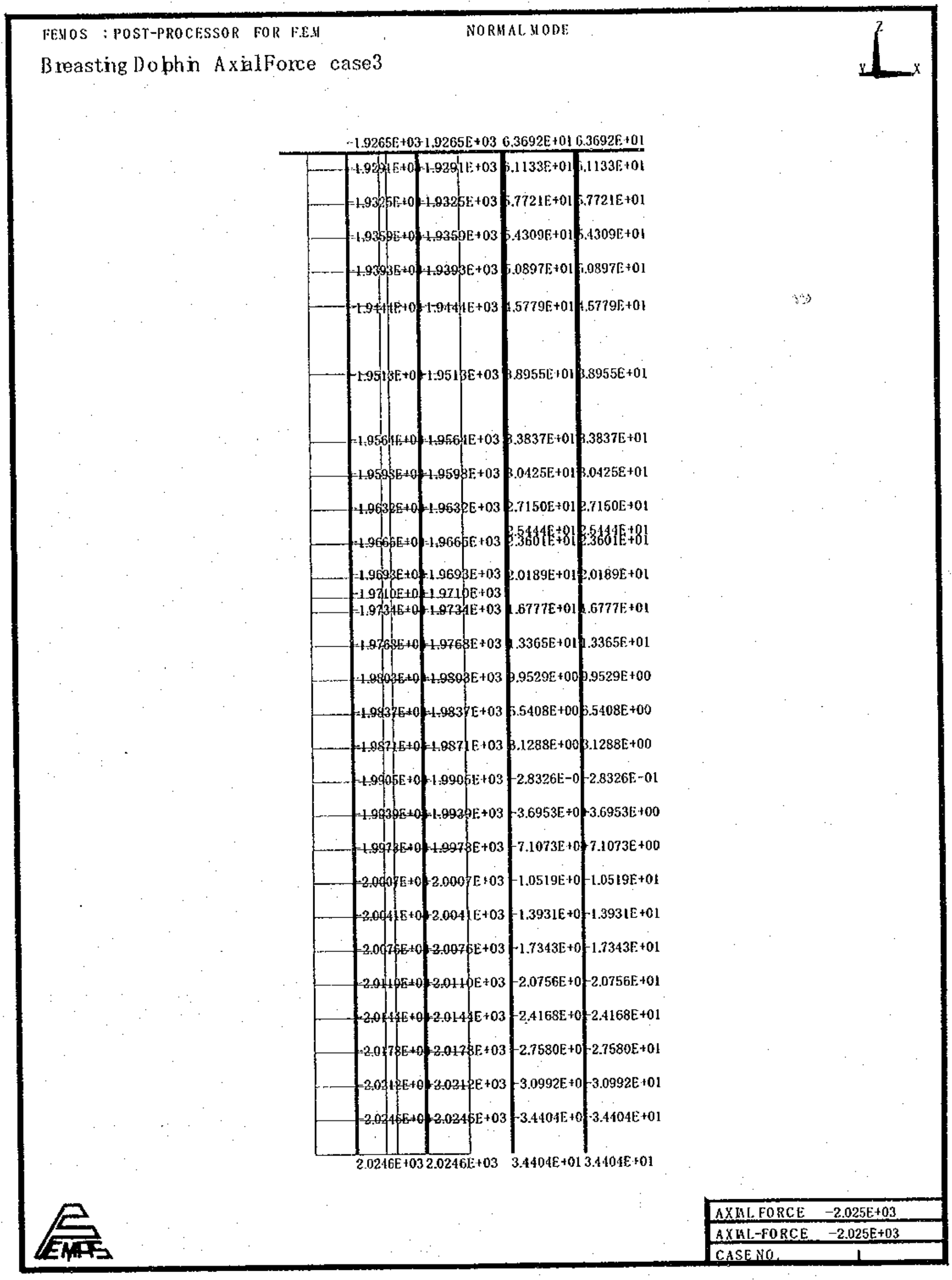


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 35	Rev.

References/ Notes

c) Axial Force



	Prepared by Y. Ando		Checked by R. NISHIMURA
	26 / 07 /2002		08 / 08 /2002

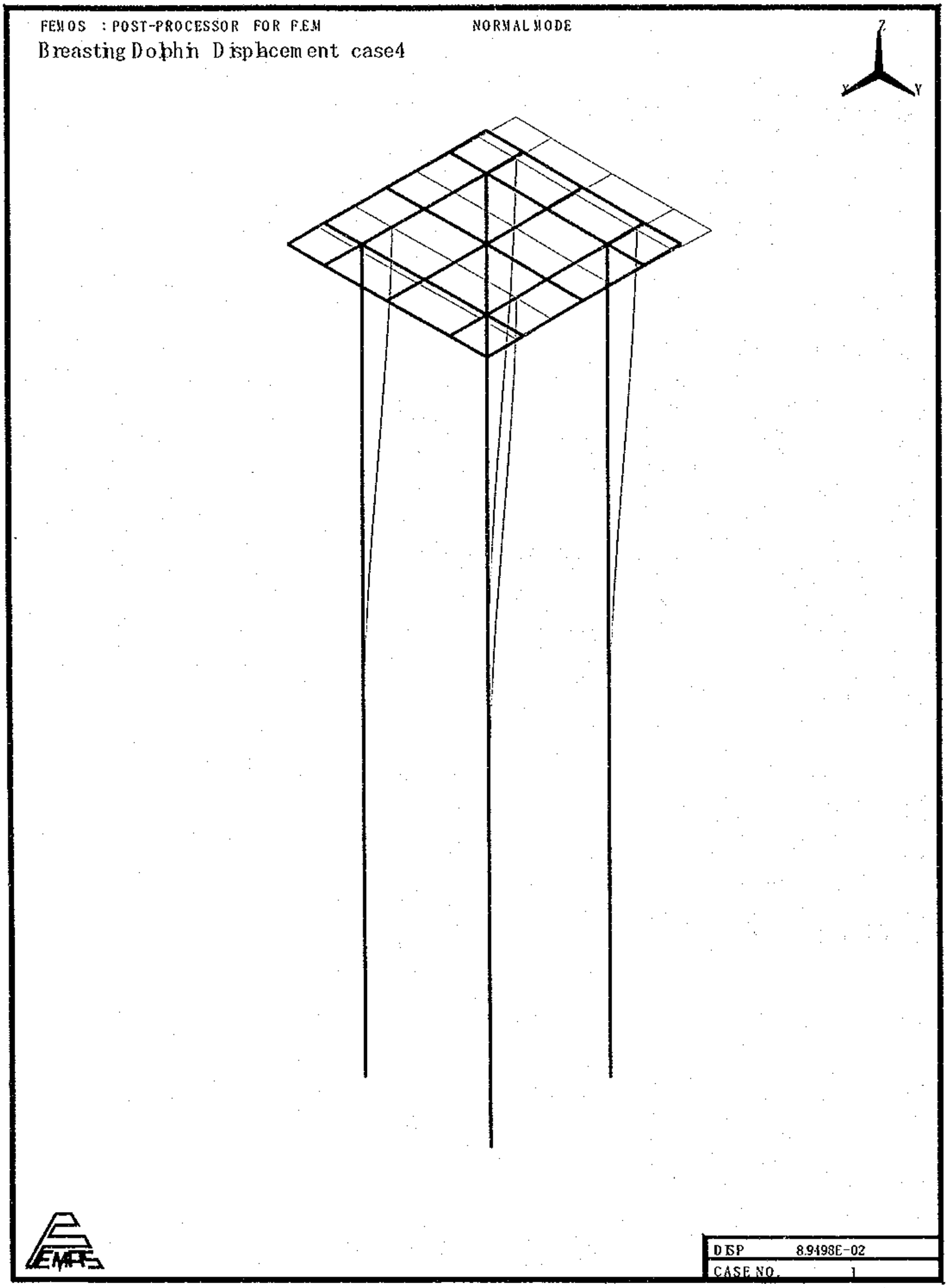
Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 36	Rev.

References/ Notes

(4) case4 (Mooring Water Level : LWL

Action Direction : The Vertical to the Face Line (Land→Sea))

a) Displacement

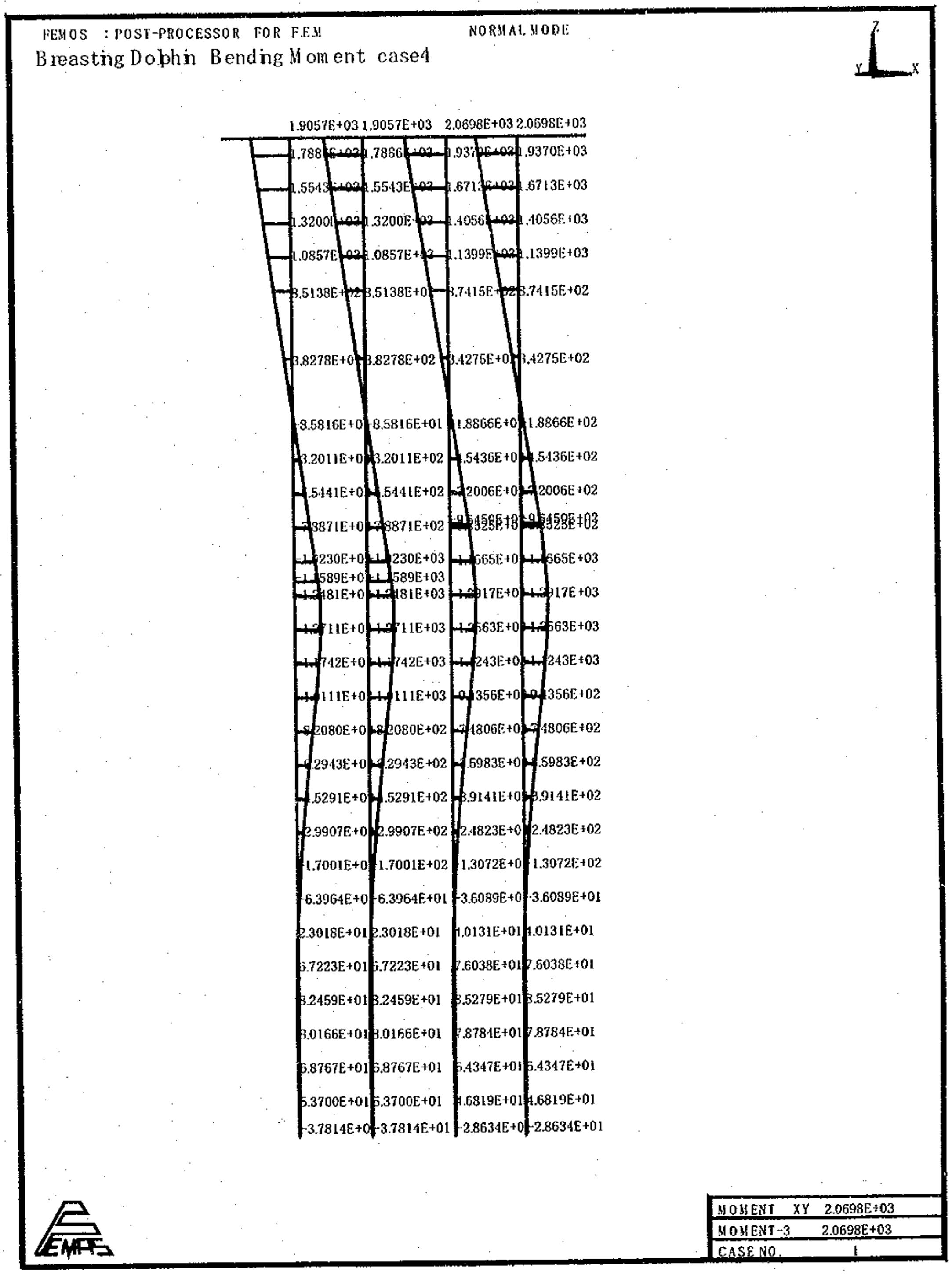


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 37	Rev.

References/ Notes

b) Bending Moment

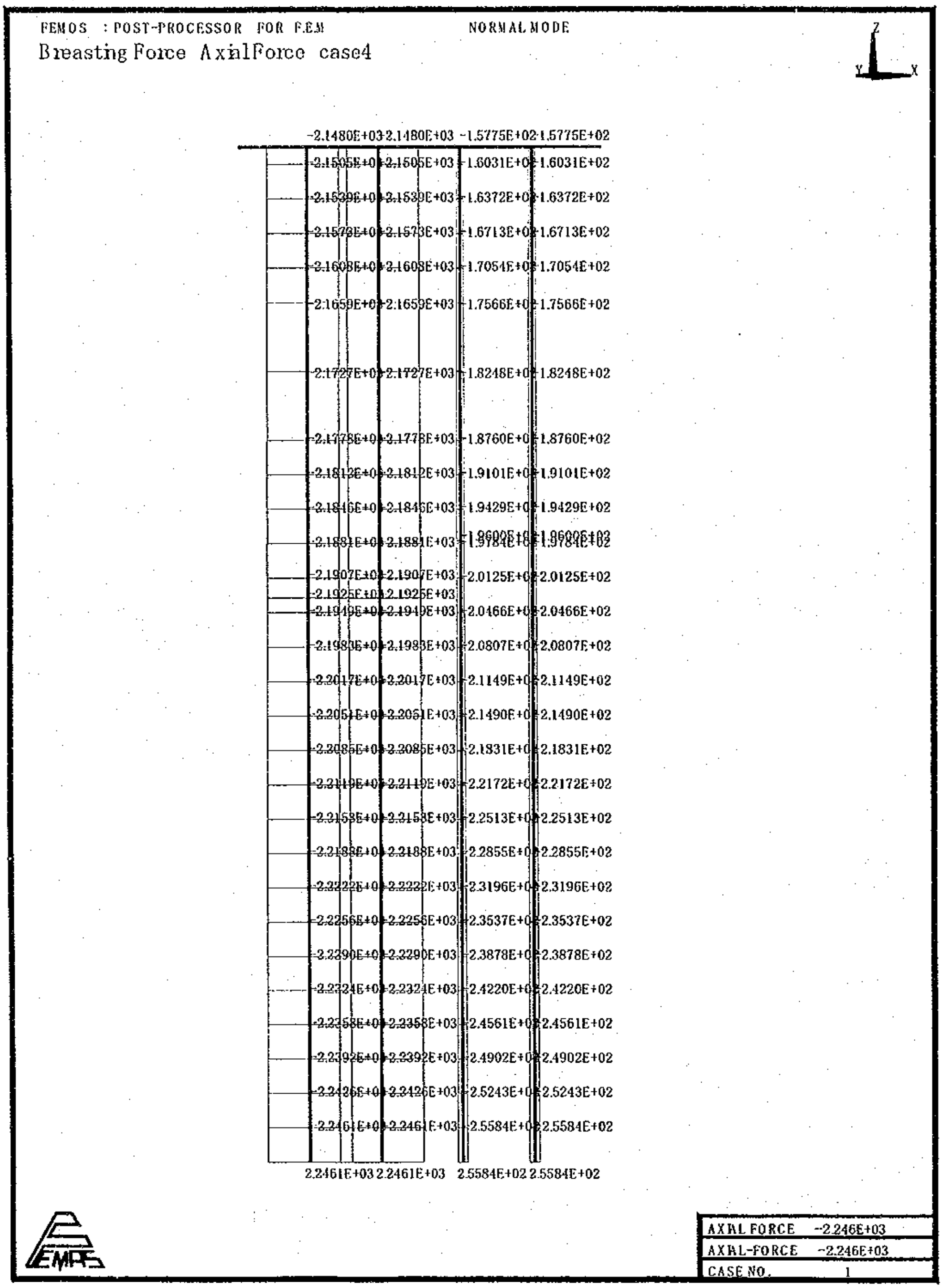


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 38	Rev.

References/ Notes

c) Axial Force



		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

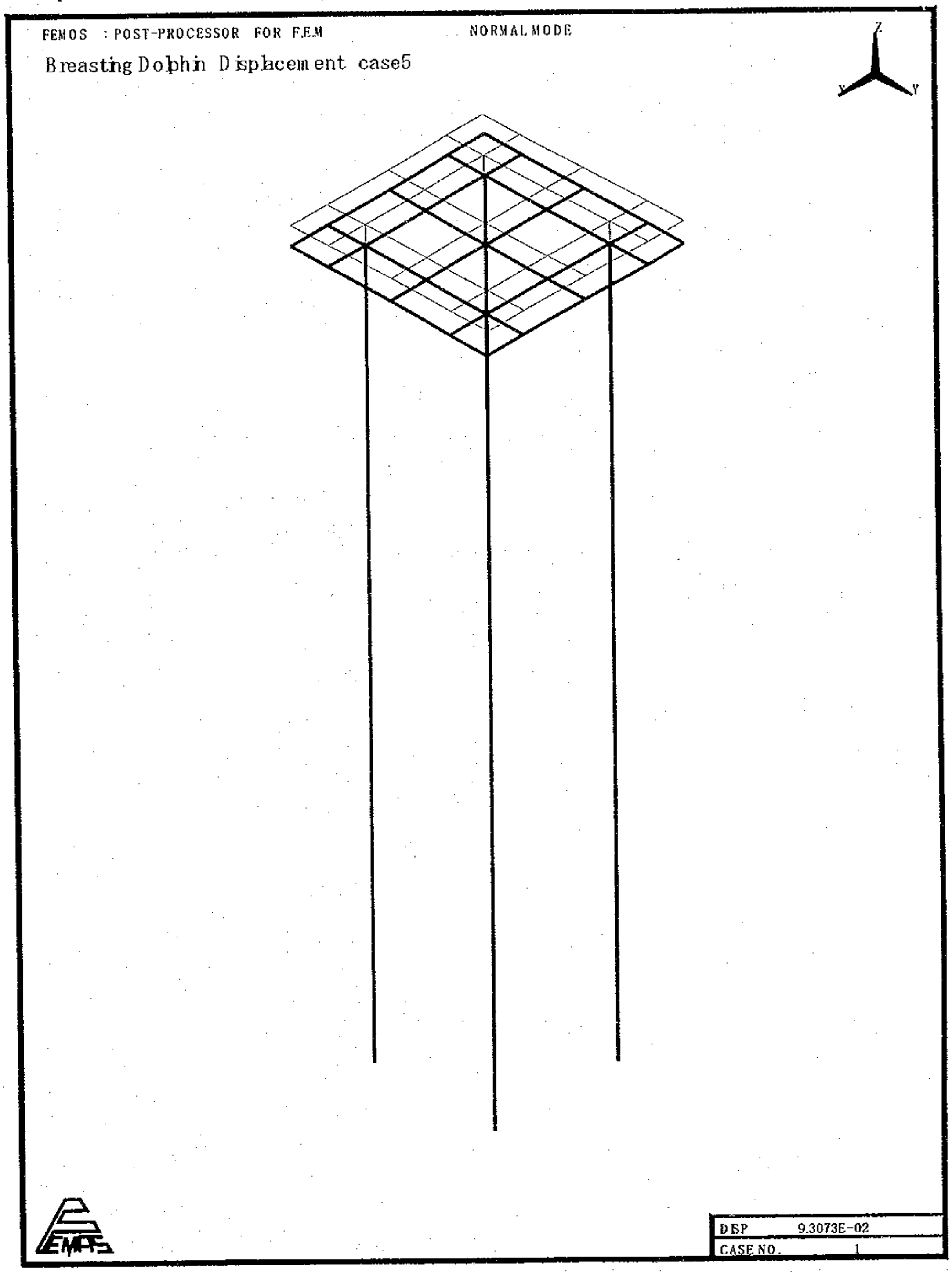
Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 39	Rev.

References/
Notes

(5) case5 (Mooring Water Level : HWL

Action Direction : 45 degree to the face line)

a) Displacement

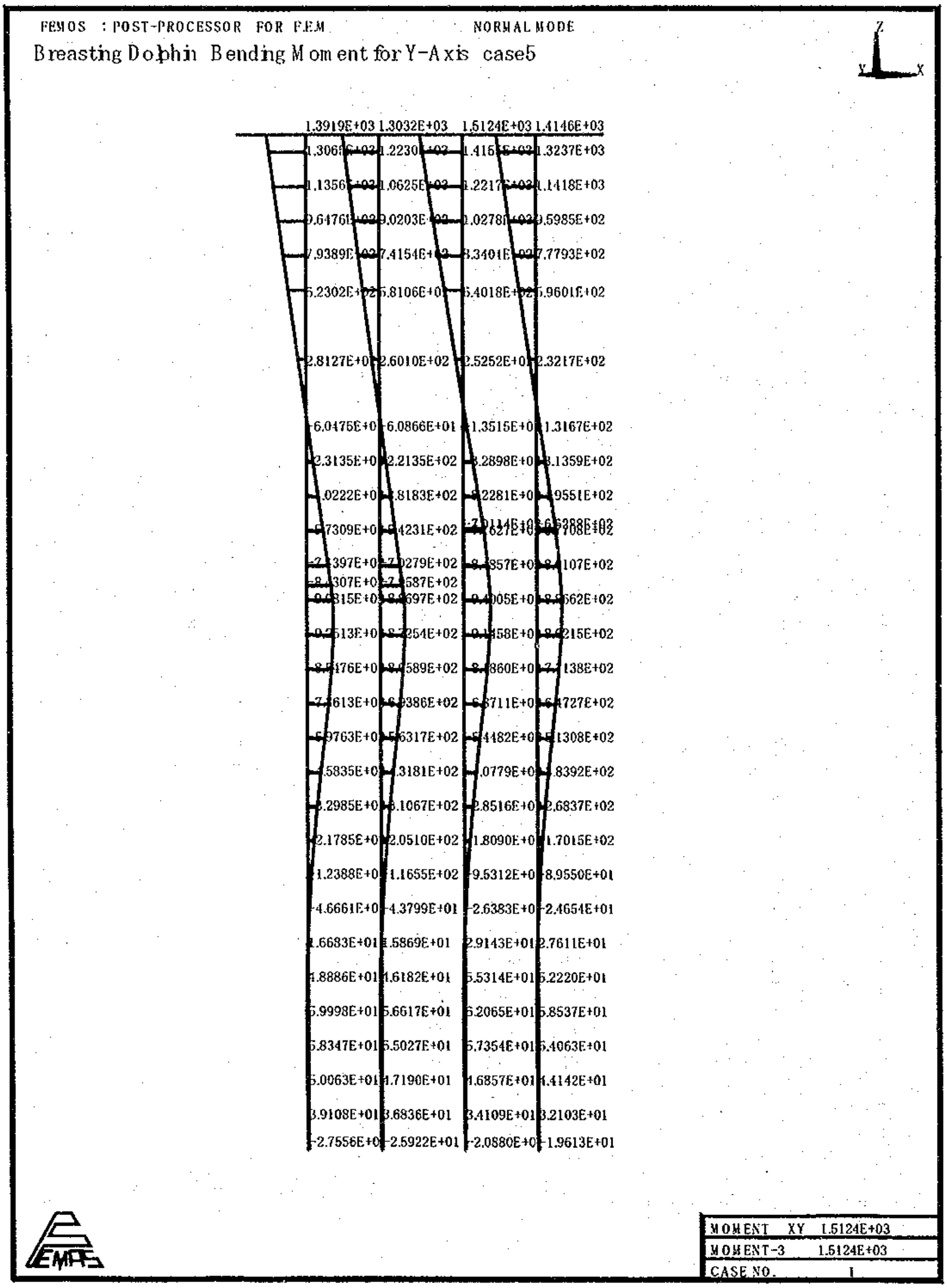


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 40	Rev.

b) Bending Moment for Y-Axis

References/
Notes

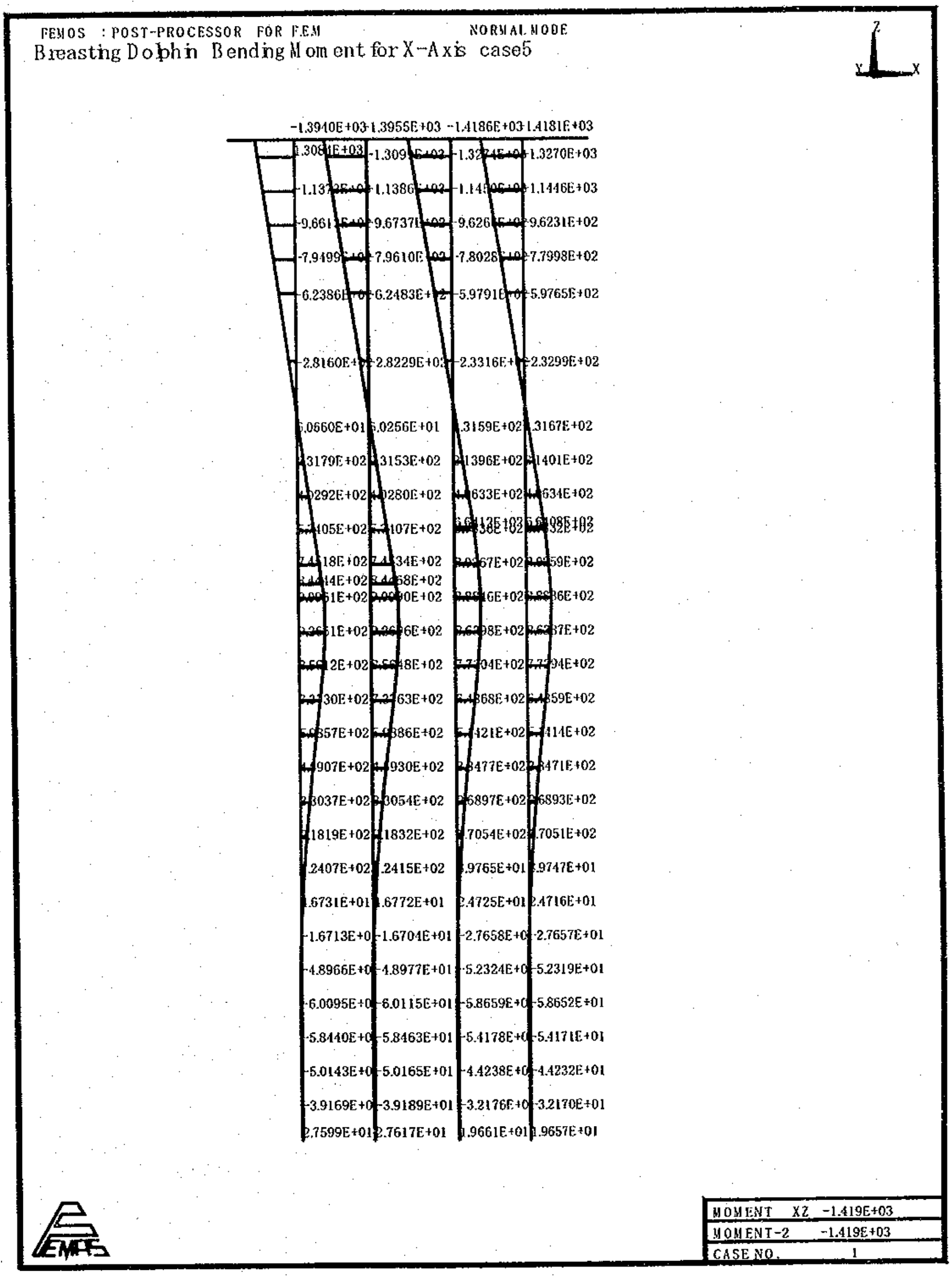


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 41	Rev.

References/ Notes

c) Bending Moment for X-Axis

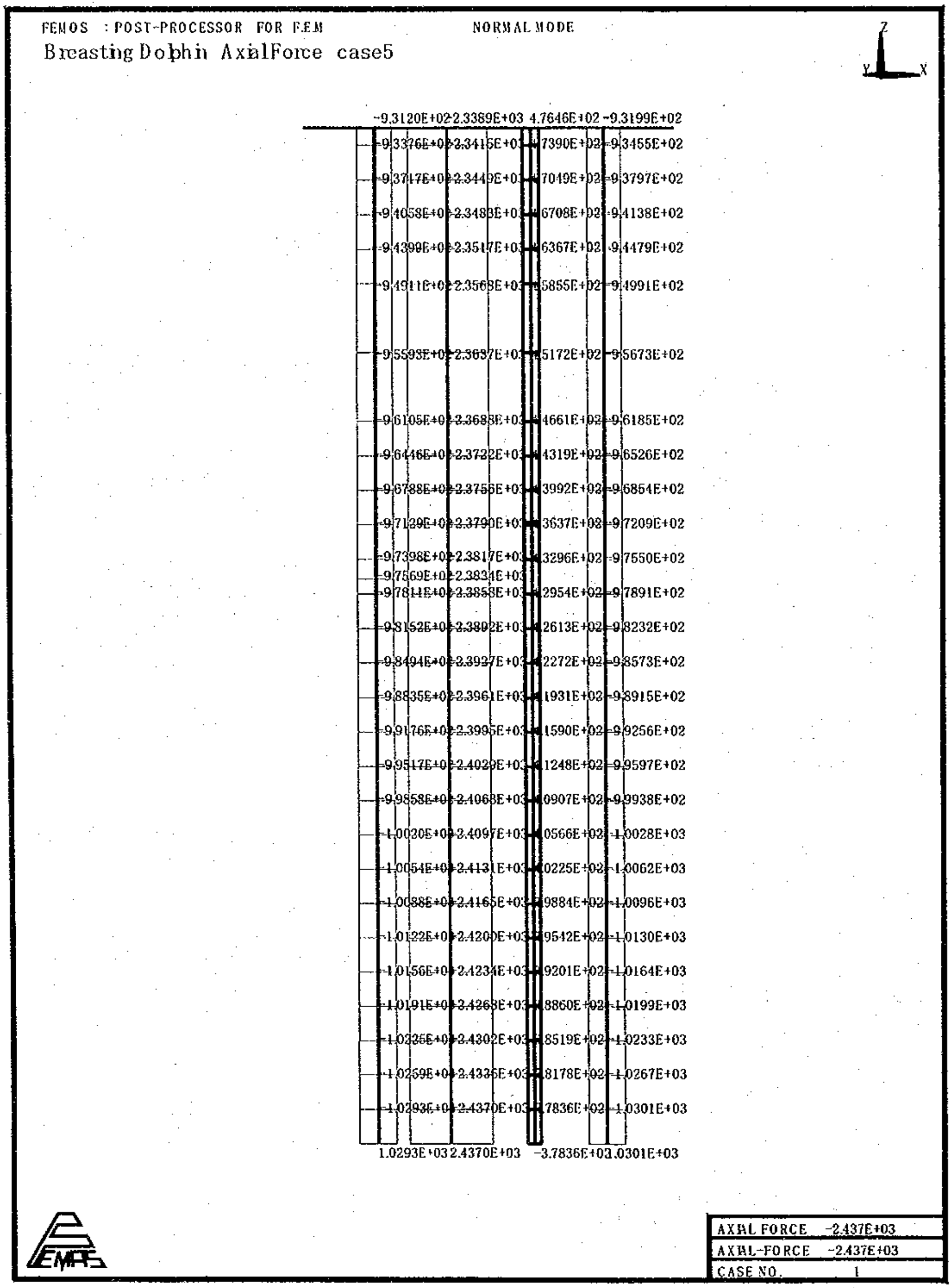


		Prepared by	Y. Ando	Checked by K. NISHIMURA
			26 / 07 /2002	08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 42	Rev.

c) Axial Force

References/ Notes



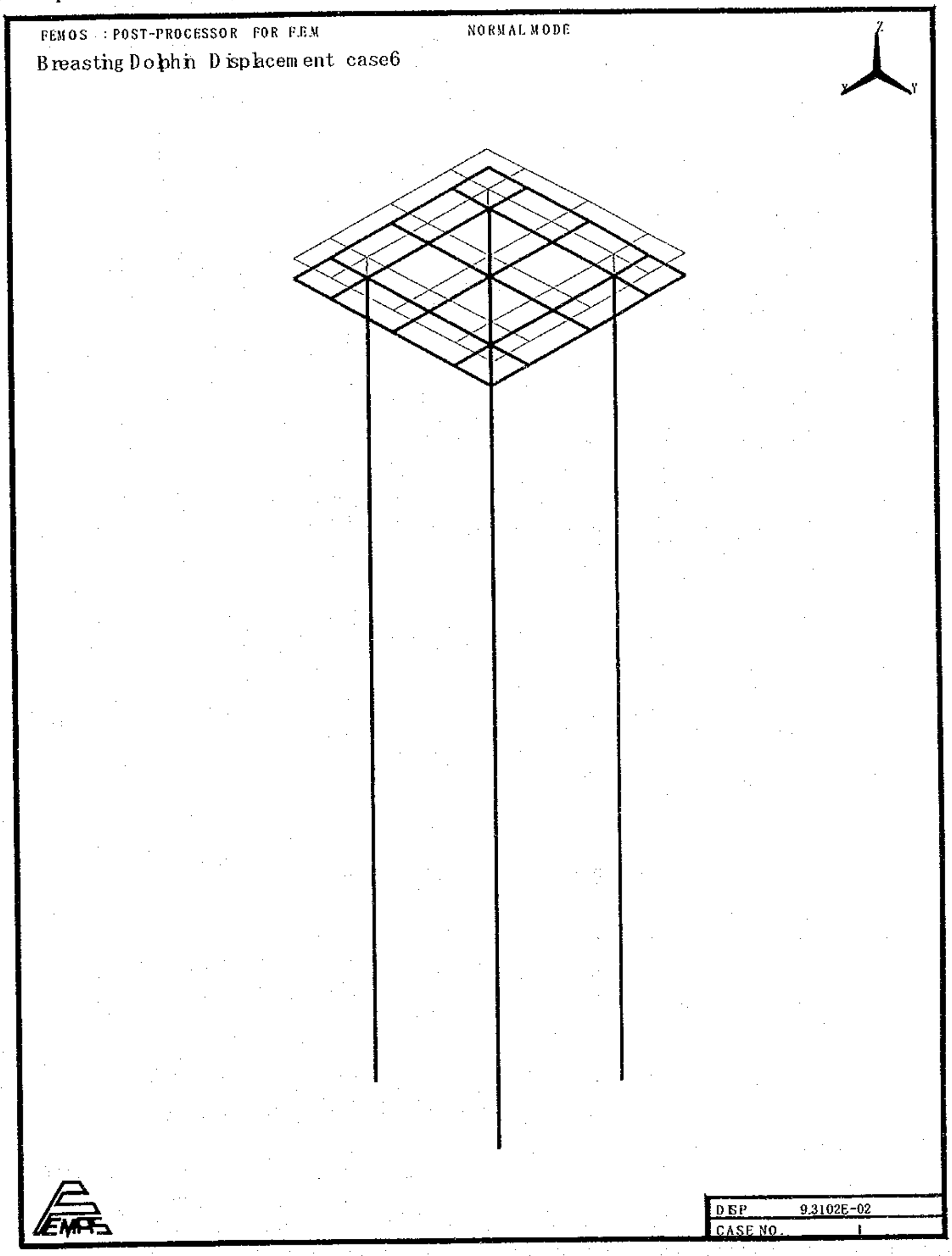
		Prepared by	Y. Ando	Checked by	K. NISHIMURA
			26/ 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 43	Rev.

References/ Notes

(6) case6 (Mooring Water Level : LWL
Action Direction : 45 degree to the face line)

a) Displacement

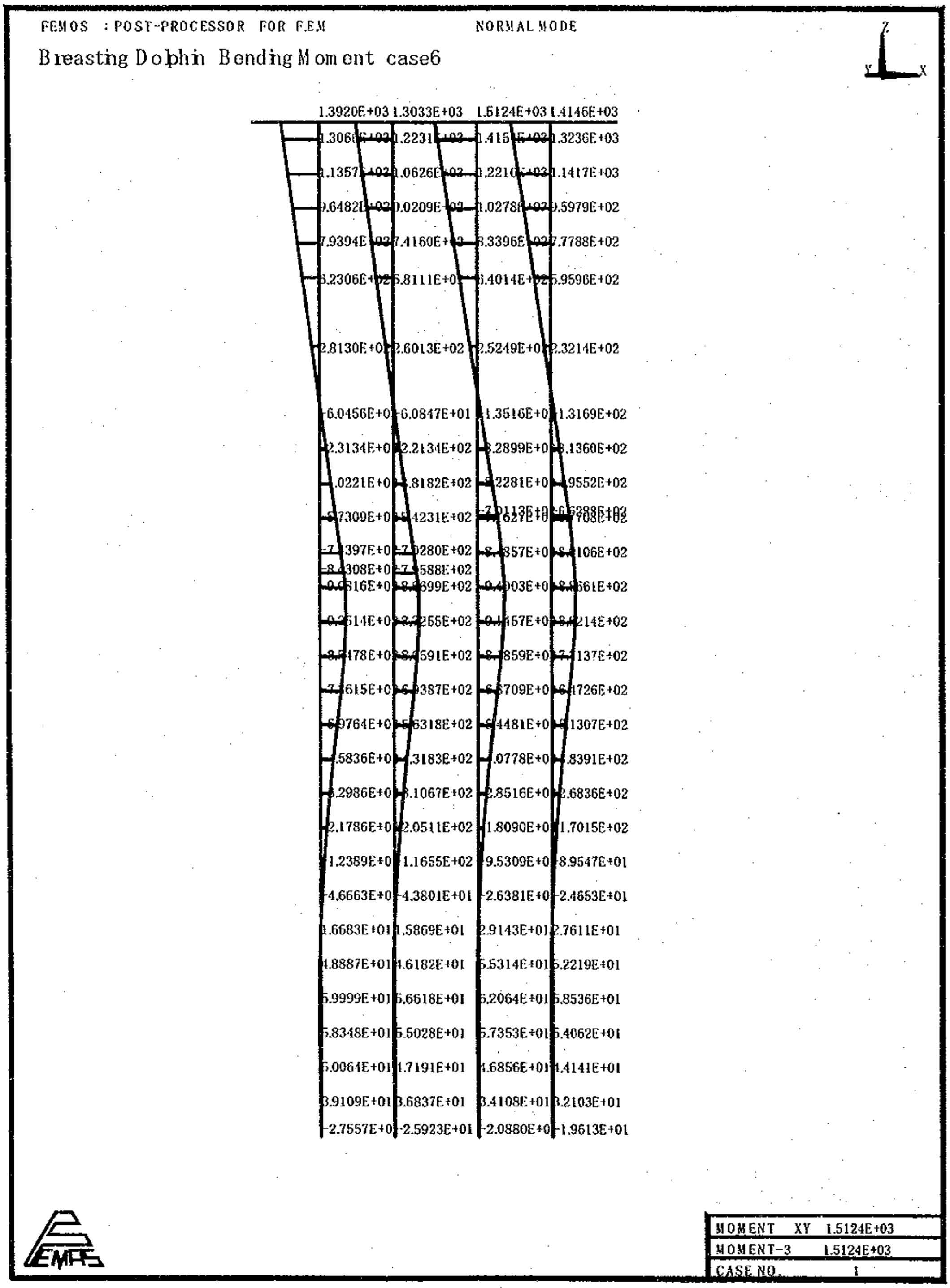


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 44	Rev.

b) Bending Moment for Y-Axis

References/ Notes

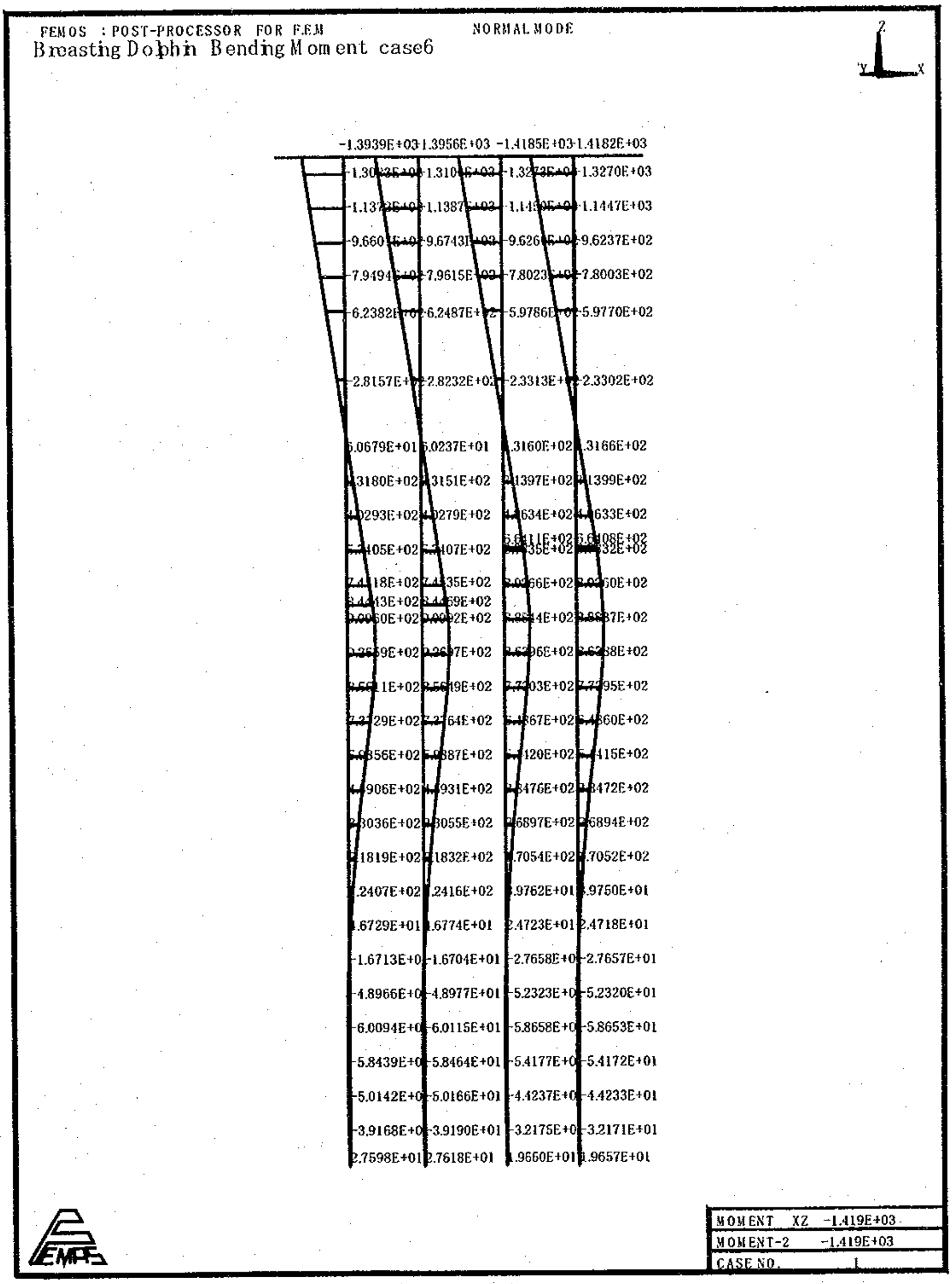


	Prepared by	Y. Ando	Checked by	R. NISHIMURA
		26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 45	Rev.

c) Bending Moment for X-Axis

References/ Notes

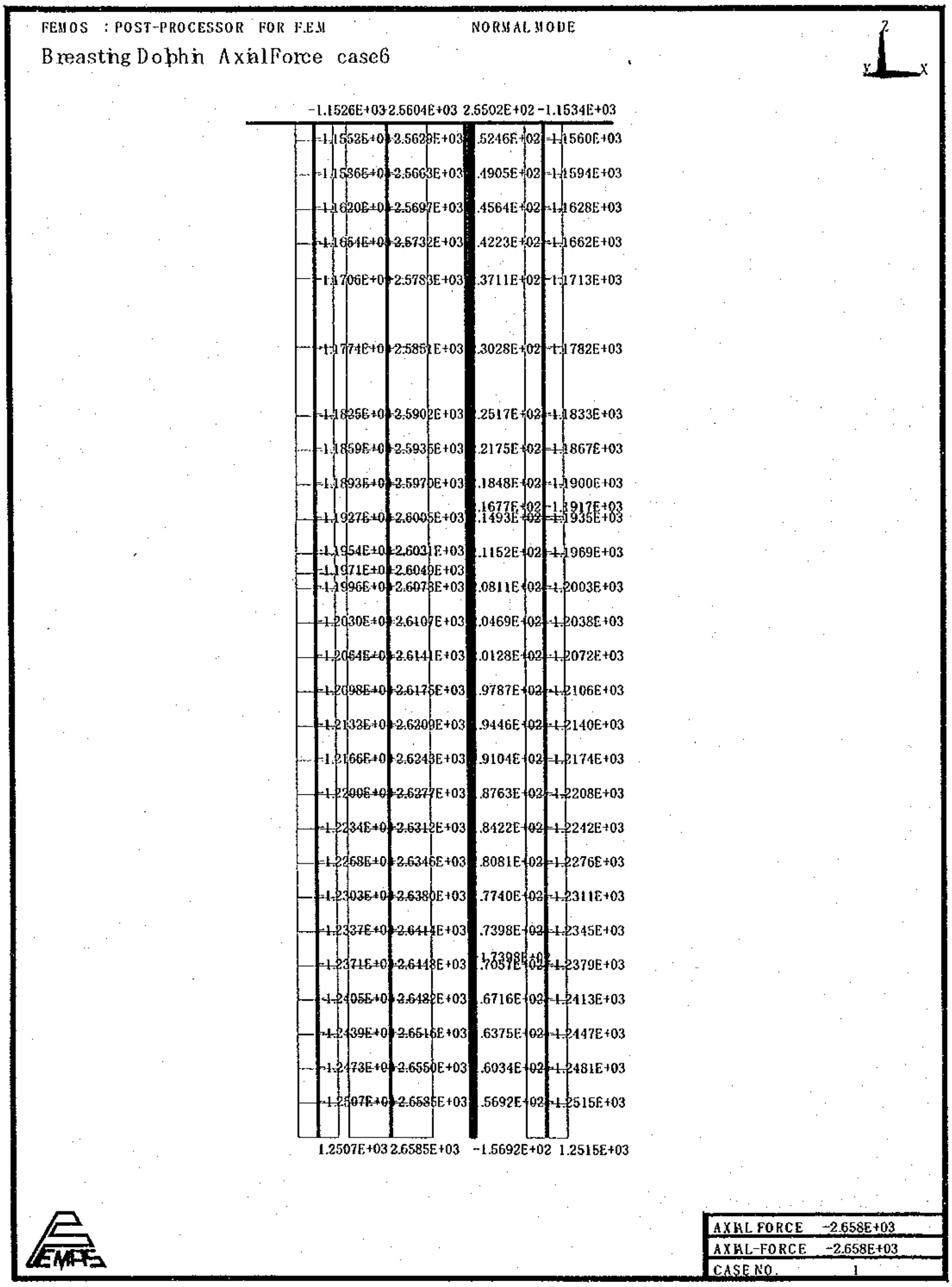


	Prepared by	Y. Ando	Checked by	R. NISHIMURA
		26/ 07 /2008		08 / 08 /2008

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. X6	Rev.

c) Axial Force

References/ Notes



	Prepared by	Y. Ando	Checked by	R. NISHIMURA
		26 / 07 /2002		08 / 08 /2002

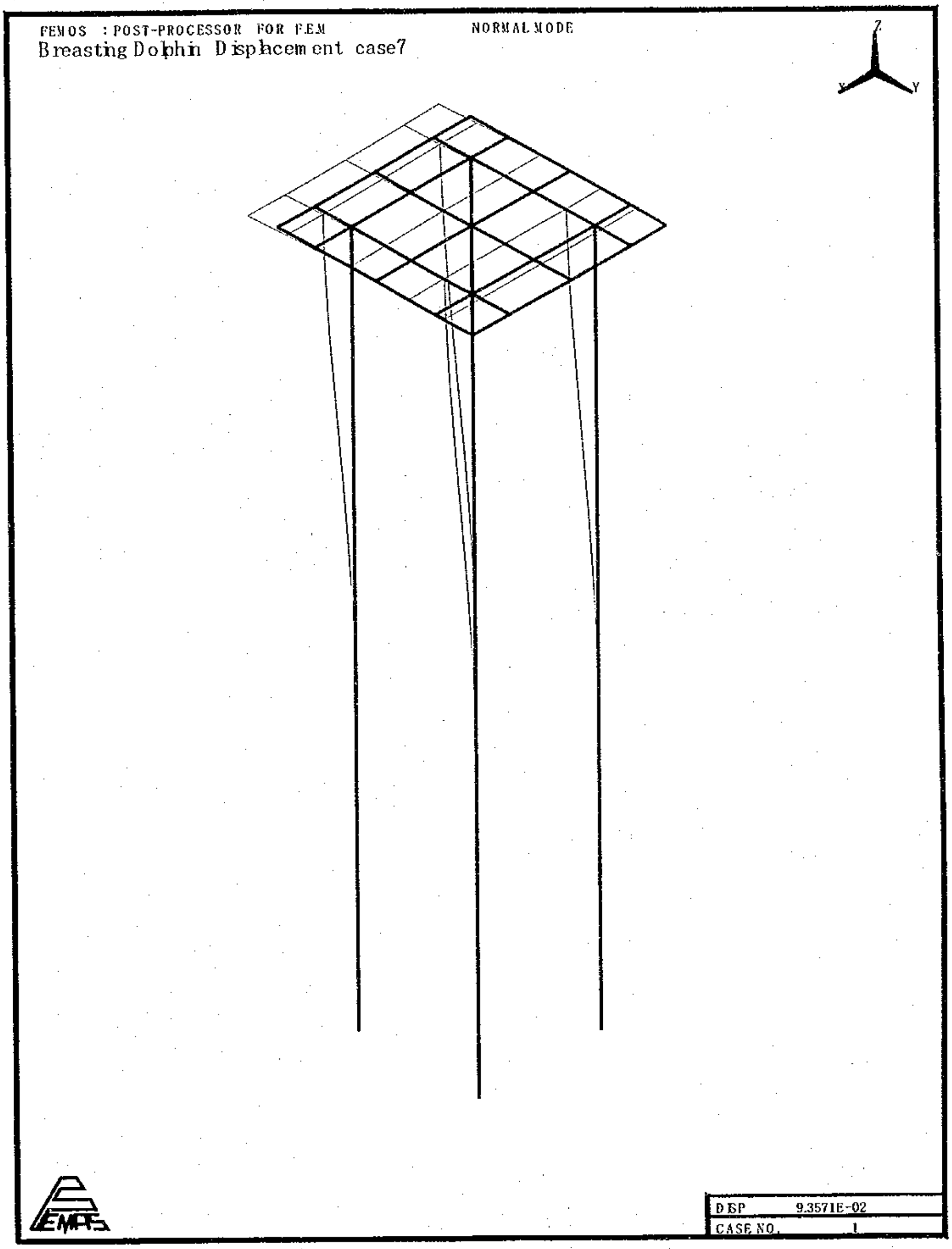
Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 47	Rev.

References/ Notes

（7）case7（Mooring　Water Level：HWL　法線平行方向けん引）

Action Direction：The Parallel to the Face Line）

a ）Displacement

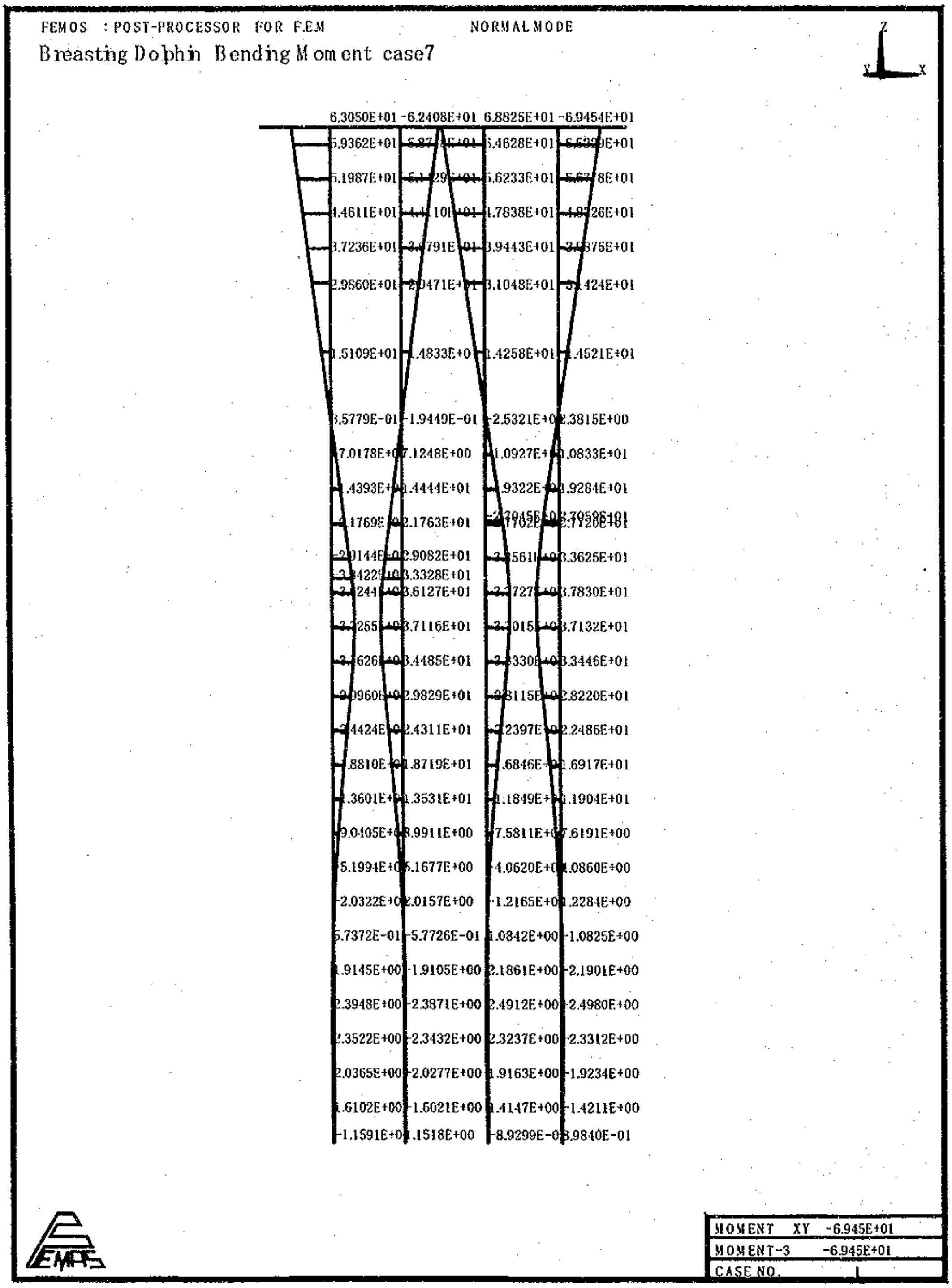


	Prepared by Y. Ando		Checked by R. NISHIMURA
		26/07/2002	08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 48	Rev.

References/ Notes

b) Bending Moment for Y-Axis

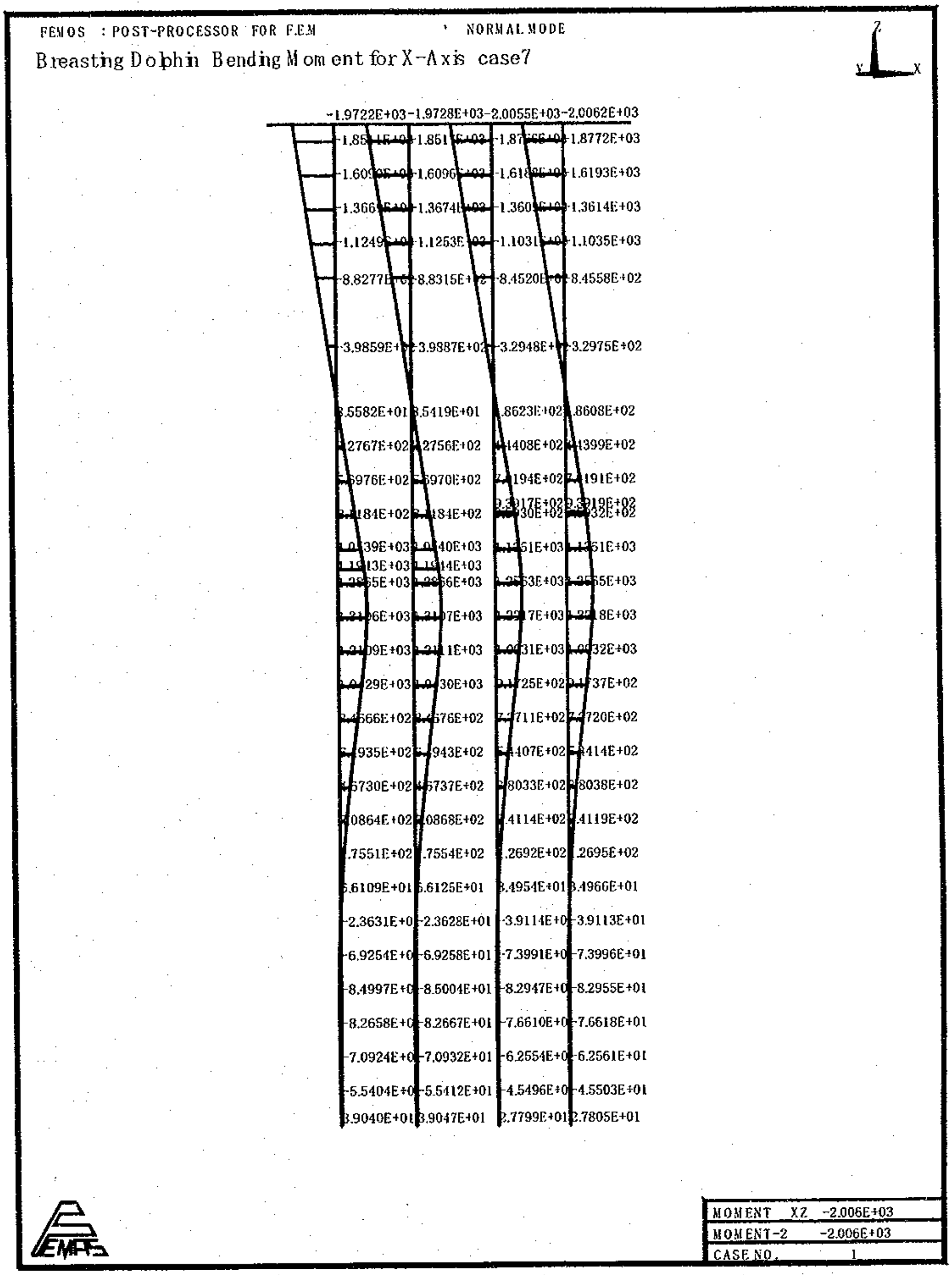


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. X9	Rev.

References/ Notes

c) Bending Moment for X-Axis



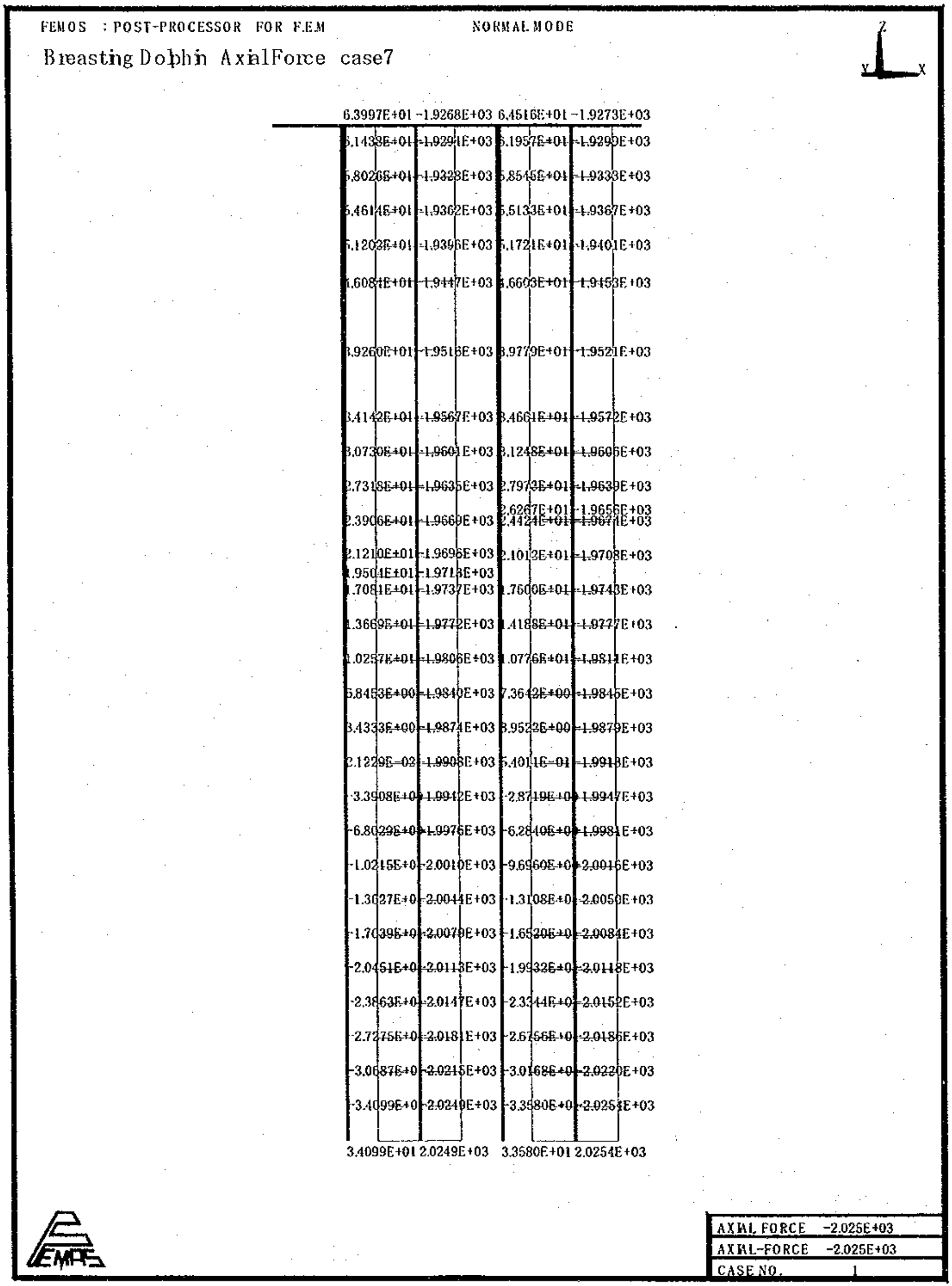
		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

NIPPON KOEI CO.,LTD.

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 50	Rev.

References/ Notes

c) Axial Force



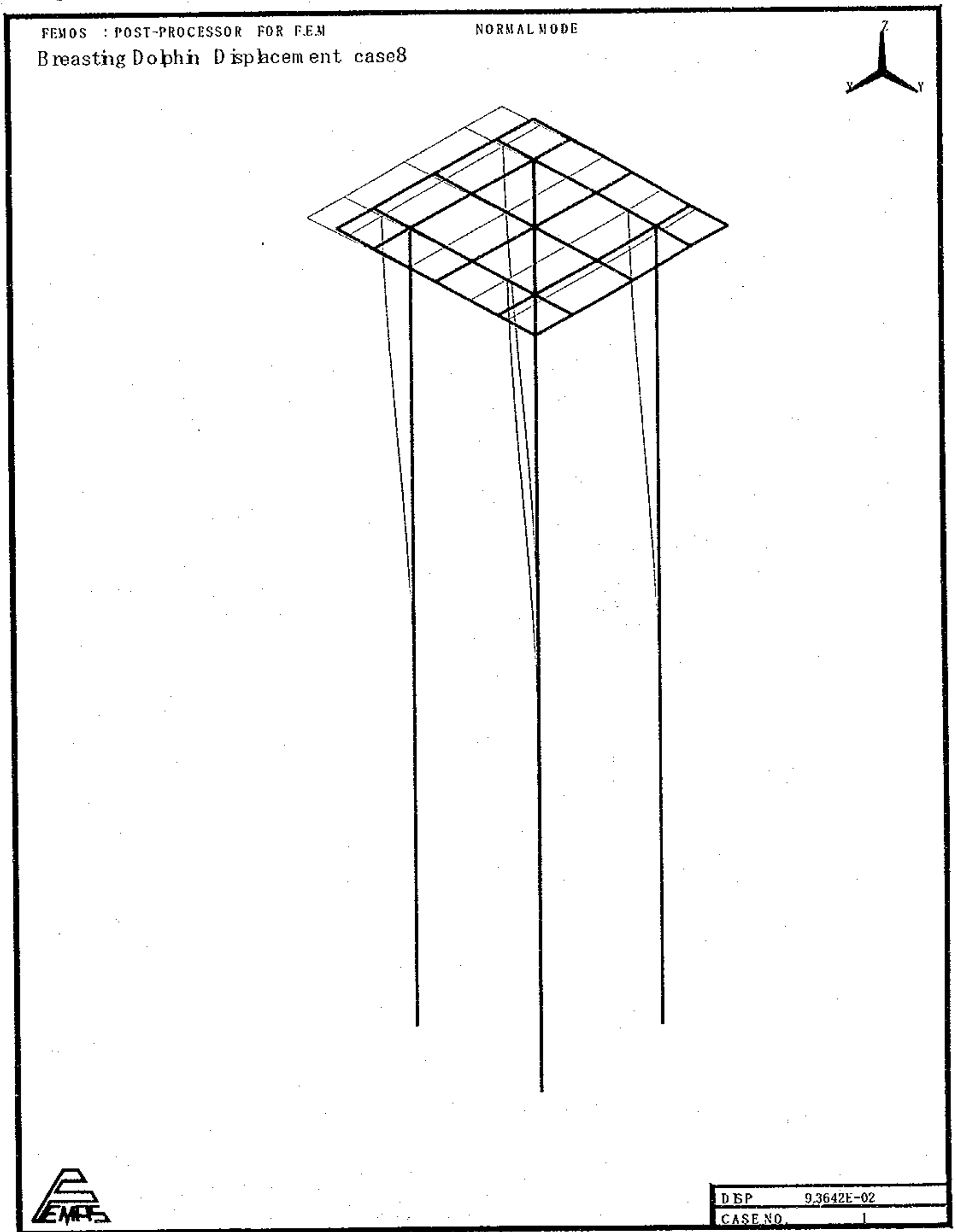
	Prepared by Y. Ando	Checked by R. NISHIMURA	
	26 / 07 /2002	08 / 08 /2002	

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 51	Rev.

References/ Notes

(8) case8 (Mooring Water Level : LWL
Action Direction : The Parallel to the Face Line)

a) Displacement

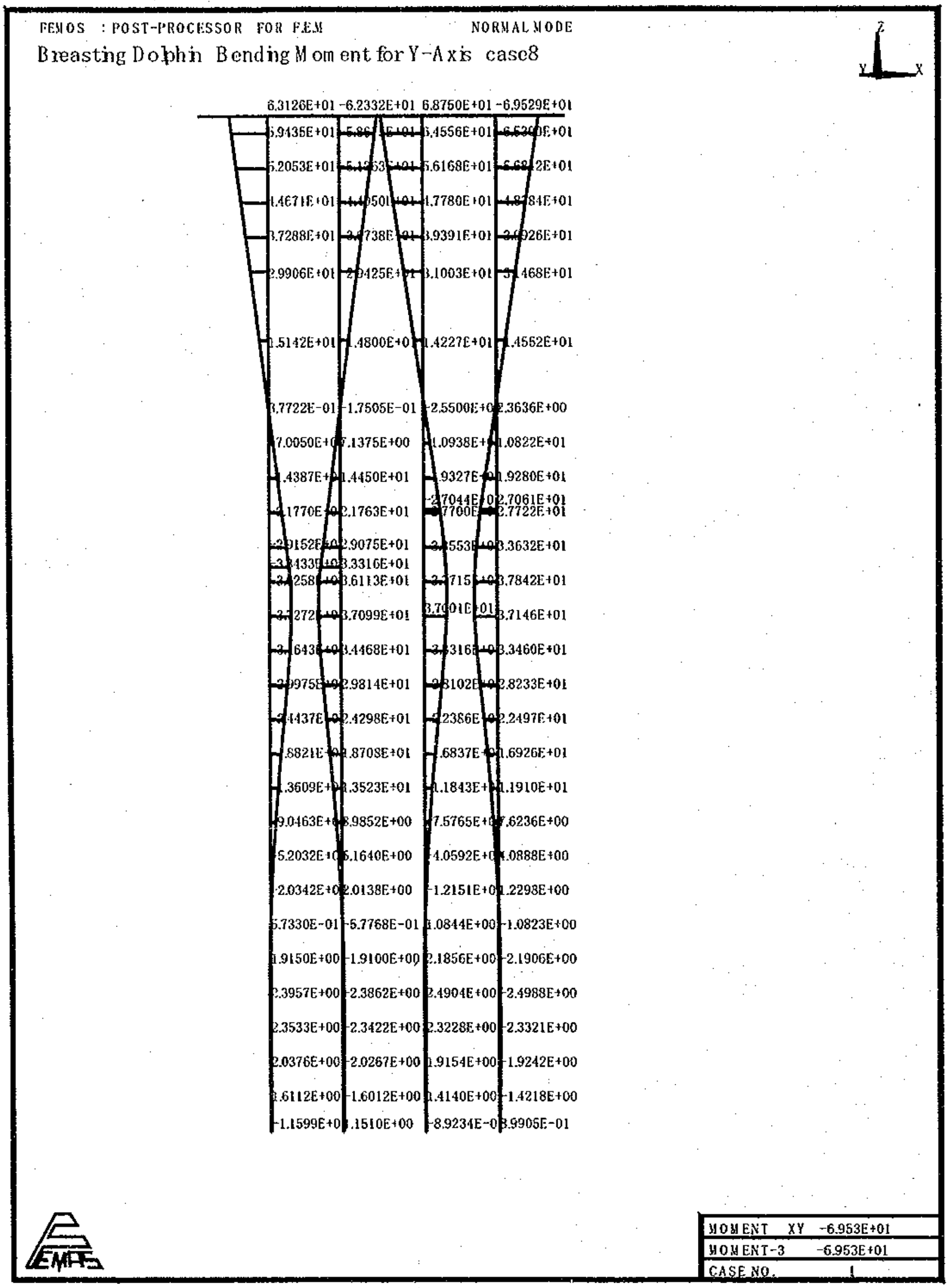


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26/07/2002		08/08/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 52	Rev.

References/ Notes

b) Bending Moment for Y-Axis

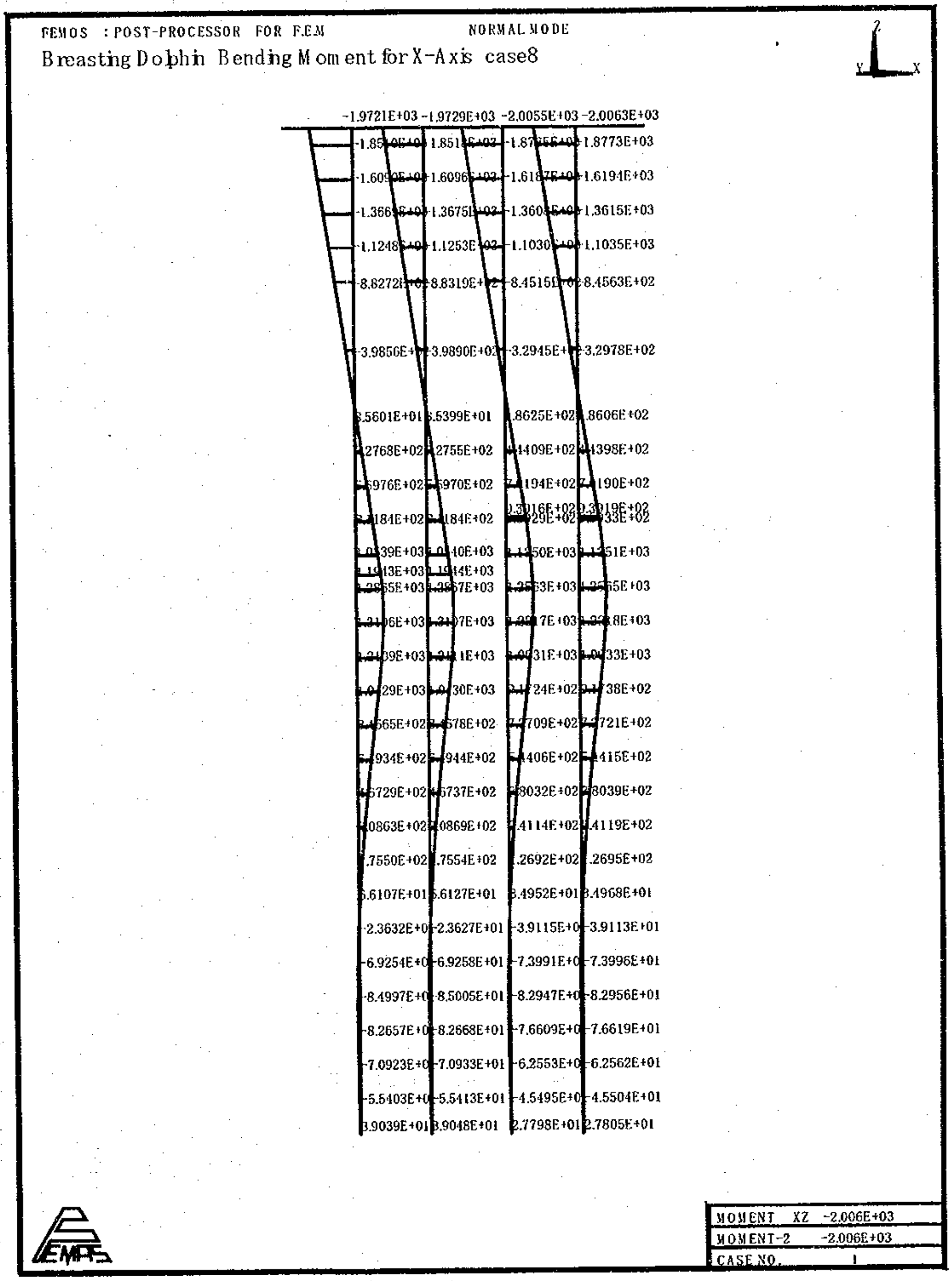


		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 53	Rev.

References/ Notes

c) Bending Moment for X-Axis

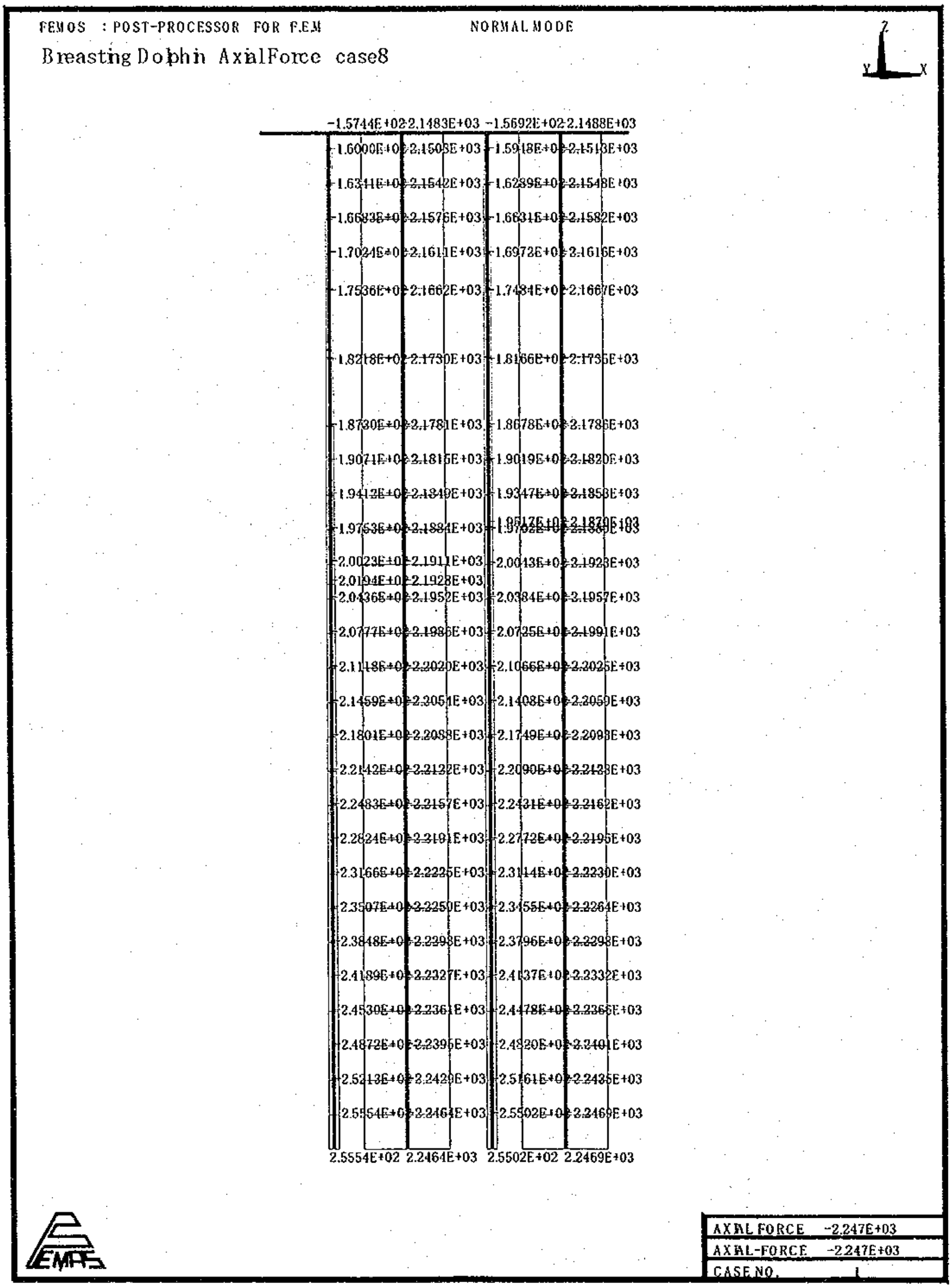


Prepared by	Y. Ando	Checked by	R. NISHIMURA
	26/ 07 /2002		08 / 08 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Quaywall	Page No. 54	Rev.

References/ Notes

c) Axial Force



		Prepared by	Y. Ando	Checked by	R. NISHIMURA
			26 / 07 /2002		08 / 08 /2002