3.5 Engineering Study

1) AD-1-1

(1) Summary

The horizontal alignment of the additional two lanes is designed to follow the existing alignment on the left side. Route 4135 is to be widened to the right side. The vertical alignment also follows the existing alignment. Existing pavement is overlaid by 5.0 cm for Route 401 and 7.5 cm for Route 4153. Pavement for additional two lanes comprises surface course of 7.5 cm, base course of 15 cm and subbase course of 20 cm, 42.5 cm in total.

For additional two lanes, five bridges are proposed in parallel with the existing ones. The longest bridge crossing the Ta Pi river is 204 meters long. Although the existing Ta Pi river bridge is under standard for proposed road class, widening is not proposed because the existing truss bridge prevents widening and railway uses the same bridge as well.

Two three-leg intersections with Route 41 and Route 4008 are proposed to be signalized. To facilitate traffic flow at the intersection with Route 4213, the bypass (Rt.401-0700) is directly connected to Rt.401-0801.

AD-1-1	Description
Changwat	: Surat Thani
Name or Location	: Rt.4153/4008/401, J.Rt.41 - J.Rt.4010
Road Class	: SD (F3 and S1)
Cross Section	: Rt.4153<2.5 + 7.0 + 1.5> x 2 (2.0 + 6.0 + 2.0)
	: Rt.401 <2.5 + 7.0 + 1.5> + (2.5 + 7.0 + 2.5)
Surface Type	: SA / ASC / SA (SA / ASC / SA)
Bridge:New	: 5 sites, 594 m
Without Work	: 5 sites, 594 m
Length: Total	: 40.5 km
Without Work	: 8.6 km
Additional 2 Lanes	: 31.9 km
Widening	: 8.5 km
AADT ('96/'01/'06)	: 9,800 / 15,100 / 21,900
Financial Cost	: 375.6 million baht (in 1990 price)
NPV	: 1,792 million baht (12% discount rate)
B/C	: 8.8 (12% discount rate)
EIRR	: 57.3 %

( ): Existing Conditions

(2) Design Standard and Conditions

(a) Design Criteria

Road Class : SD
Design Speed : 70 - 90 km/h

Geometric Design Criteria

Description	Design Speed (km/h)		
	90	80	70
Minimum Radius of Curvature (m)	280	220	160
Minimum Stopping Sight Distance (m)	150	120	100
Maximum Gradient (%)	6	7	7
Minimum Gradient for Drainage (%)	0.3	0.3	0.3

(b) Navigational Clearance

Navigational clearance for the Tapi river

Vertical : 5.6 m
Horizontal : 30.0 m

(c) Pavement Design Conditions

Design CBR : 10 %
Design Method : AASHTO
Design Period : 7 years

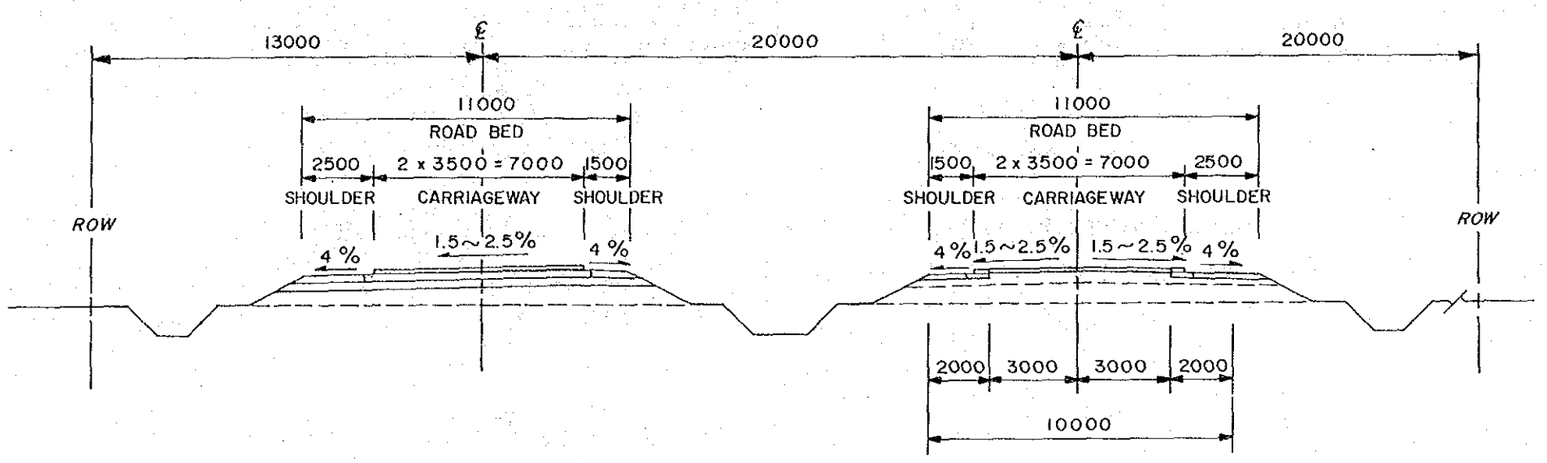
(d) Drainage Design Conditions

Rainfall Intensity : Rainfall Intensity Duration Curve at Songkhla Observatory

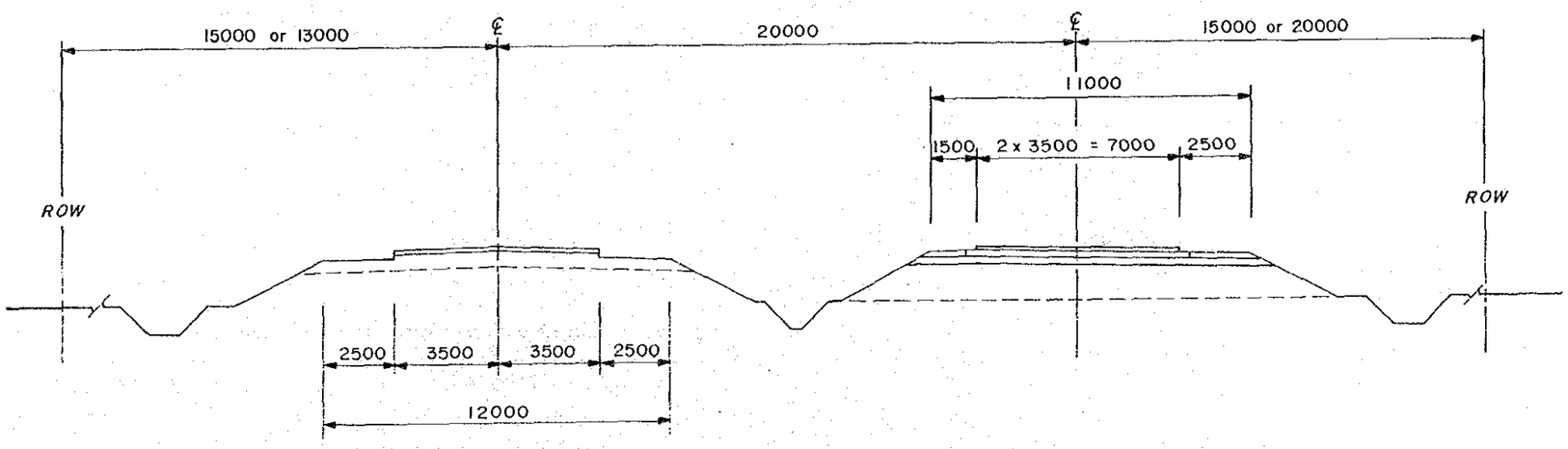
Return Period : Culvert--------10 years
: Minor Bridge---20 years
: Major Bridge---30 years

(3) Typical Cross Section

STA. 0 + 000 ~ STA. 8 + 536



STA. 17 + 117 ~ STA. 40 + 527



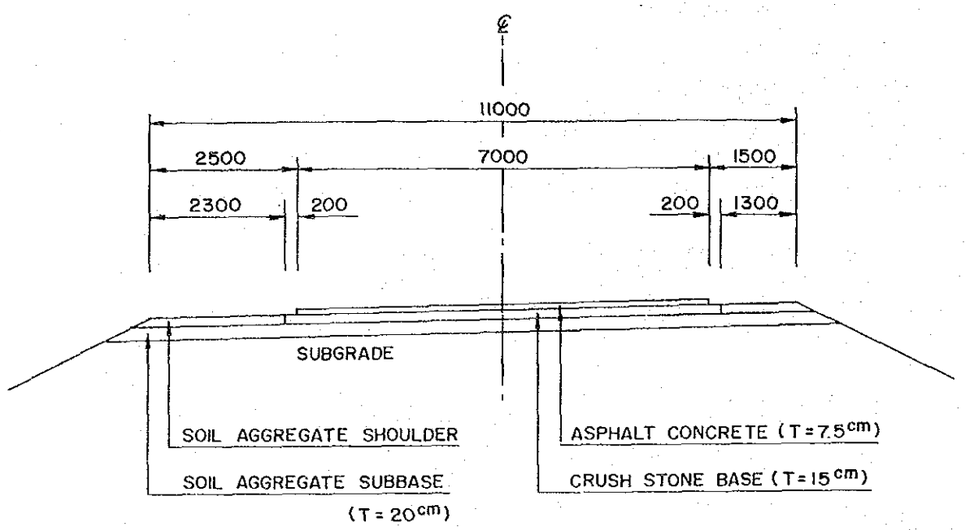
(4) Pavement Design

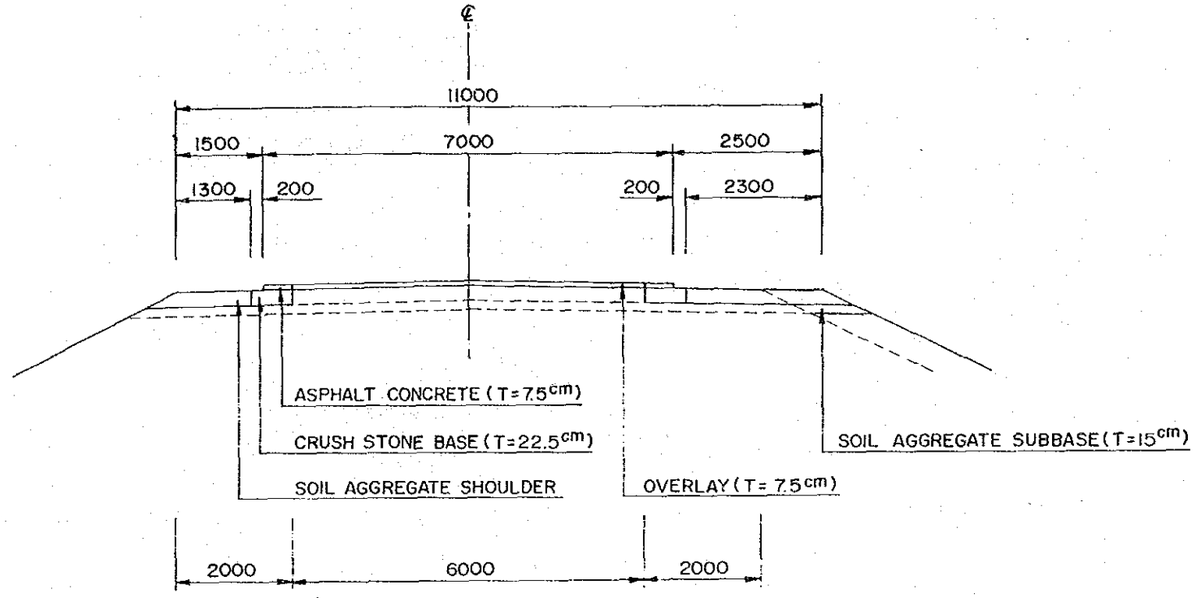
New Road

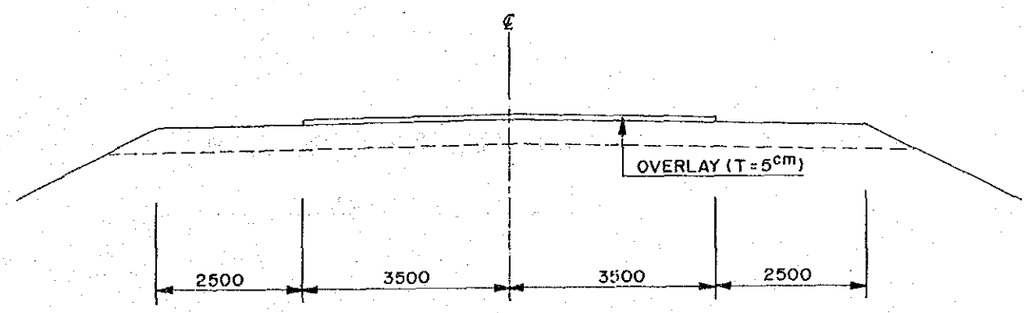
Design CBR of Subgrade	Cumulative No. of ESA W18 x 10^3 (7 years)	Thickness of Pavement Structure (cm)
10.0	6,503	Surface 7.5 Base 15 Subbase 20

Existing Road

Existing Road	Design CBR of Subgrade	Cumulative No. of ESA W18 x 10^3 (7 years)	Thickness of Overlay (cm)
Route No. 4153	10.0	6,503	7.5
Route No. 401	10.0	6,503	5







2) AD-1-2

(1) Summary

The project is an alternative route for a part of AD-1-1 with a view to providing a direct access to Surat Thani Airport from Surat Thani city instead of constructing additional two lanes on Route 4153.

The alternative section originates at the airport and ends at the junction with Route 401 (Surat Thani Bypass) with a length of 16.7 km. The whole section passes on a flat terrain in the Ta Pi river basin.

Height of the embankment is planned to be 2.0 m in minimum height to avoid flooding damages in rainy season. The project area is covered by a soft alluvium layer with the depth of about 20 m. Sand drain method is proposed to cope with the ground settlement caused by embankment load.

The pavement comprises surface course of 7.5 cm, base course of 15 cm and subbase course of 20 cm, 42.5 cm in total.

Four bridges are to be constructed on this section, 431 m in total length. A bridge crossing the Ta Pi river and another crossing the Phumphin river are long bridges of about 200 meter length.

AD-1-2	Description
Changwat	: Surat Thani
Name or Location	: Access Link to the Airport : Surat Thani airport - J.Rt.4010
Road Class	: S1, SD (F3 and S1)
Cross Section(m):	S1: 2.5 + 7.0 + 2.5 SD: <2.5 + 7.0 + 1.5> + (2.5 + 7.0 + 2.5)
Surface Type	: SA / ASC / SA
Bridge:New	: 8 sites, 821 m
Without Work	: 4 sites, 390 m
Length: Total	: 43.3 km
Without Work	: 3.3 km
New	: 16.6 km
Additional 2 Lanes	: 23.4 km
AADT ('96/'01/'06)	: 7,400 / 10,000 / 15,000
Financial Cost	: 468.6 million baht (in 1990 price)
NPV	: 1,804 million baht (12% discount rate)
B/C	: 7.7 (12% discount rate)
EIRR	: 58.1 %

( ): Existing Condition

(2) Design Standard and Conditions

(a) Design Criteria

Road Class : New Link ---------- S1
: Additional Two Lane -- SD
Design Speed : 70 - 90 km/h

Geometric Design Criteria

Description	Design Speed (km/h)		
	90	80	70
Minimum Radius of Curvature (m)	280	220	160
Minimum Stopping Sight Distance (m)	150	120	100
Maximum Gradient (%)	6	7	7
Minimum Gradient (%)	0.3	0.3	0.3

(b) Navigational Clearance

Navigational clearance for the Tapi river and the Phunphin river

Vertical : 5.6 m
Horizontal : 30.0 m

(c) Pavement Design Conditions

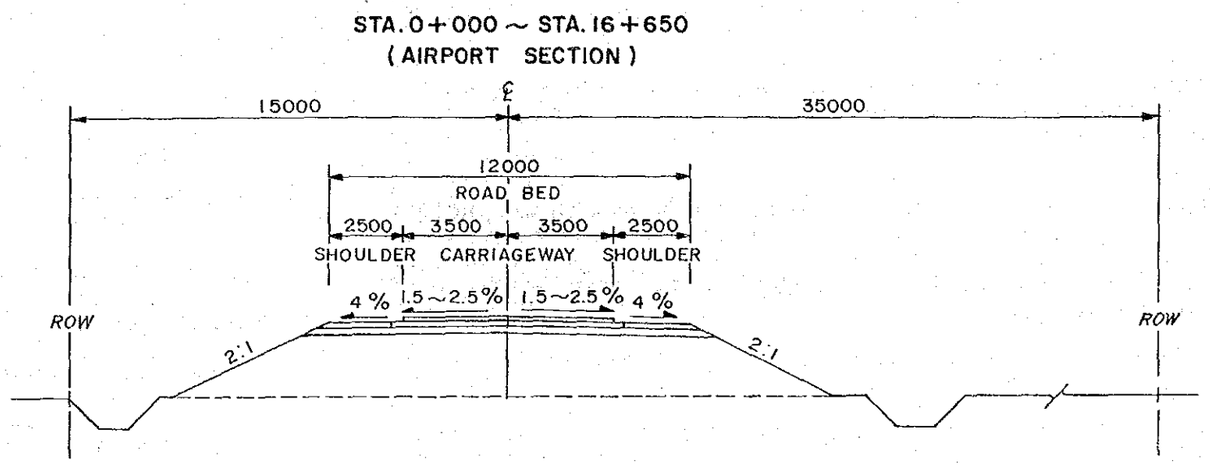
Design CBR : 10 %
Design Method : AASHTO
Design Period : 7 years

(d) Drainage Design Conditions

Rainfall Intensity : Rainfall Intensity Duration Curve at Songkhla Observatory

Return Period : Culvert--------10 years
: Minor Bridge---20 years
: Major Bridge---30 years

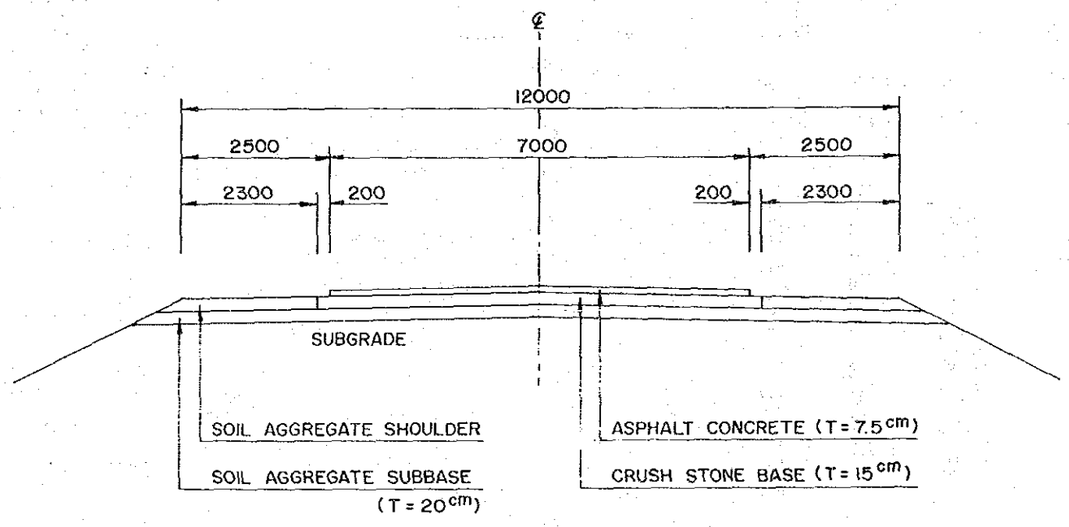
(3) Typical Cross Section



(4) Pavement Design

New Road

Design CBR of Subgrade	Cumulative No. of ESA W18 x 10^3 (7 years)	Thickness of Pavement Structure (cm)
10.0	6,503	Surface 7.5 Base 15 Subbase 20



3.6 Construction Cost

Table 3.5.1 CONSTRUCTION COST

1) AD 1-1

(1) CONSTRUCTION QUANTITIES AND COSTS

(Project AD -1-1 Length = 40.527 Km)
(Improved Length 31.946 Km)

ITEM	Unit	Financial Unit Cost Baht	Quantity	Financial Total cost 1000 Baht	Economic cost %	Economic cost 1000 Baht	Residual Value %	Residual Value 1000 Baht
EARTH WORK					83		90	
Clearing & Grubbing	SQ.M	1	681,412	681				
Roadway Excavation(classified)	CU.M	85	0	0				
Embankment(Borrowed Material)	CU.M	100	450,270	45,027				
Slope Protection(Stripe Sodding)	SQ.M	6	207,673	1,246				
(Sodding)	SQ.M	9	0	0				
(Shot Concrete)	SQ.M	500	0	0				
(Concrete Block)	SQ.M	450	0	0				
Excavate Existing Thickness Over 10cm (2Lay)	SQ.M	14	48,880	684				
Sand Mat (t=0.5m)	SQ.M	100	19,462	1,946				
Sand Drain (O 0.40cm)	M	200	38,928	7,786				
SUB TOTAL				57,371		47,618		42,856
SUBBASE AND BASE					83		50	
Subbase(Soil Aggregate)	CU.M	190	76,495	14,534				
Base Coarses(Crush Stone)	CU.M	295	37,425	11,040				
Shoulder(Soil Aggregate)	CU.M	190	17,360	3,298				
SUB TOTAL				28,873		23,964		11,982
SURFACE					83		50	
Asphaltic Prime coat	SQ.M	13	243,670	3,168				
Asphaltic Tack coat	SQ.M	7	211,132	1,478				
Asphalt concrete Surfacing	CU.M	1,900	17,085	32,462				
Overlay (5cm,7.5cm)	CU.M	1,900	11,806	22,431				
SUB TOTAL				59,539		49,417		24,708
STRUCTURES(Equivalent)					83		50	
RC Pipe Culvert(D= 600 m)	M	1,300	124	161				
(D= 800 m)	M	1,780	160	285				
(D=1000 m)	M	2,445	249	609				
(D=1200 m)	M	3,575	33	118				
(D=600m*2)	M	2,600	31	81				
(D=1.0m*2)	M	4,900	60	294				
(D=1.0m*3)	M	14,700	20	294				
(D=1.2m*2)	M	7,200	14	101				
RC Box Culvert(1-1.80*1.00 m)	M	3,200	17	54				
(2-2.10*2.10 m)	M	10,000	17	170				
(2-2.40*2.70 m)	M	12,800	17	218				
(3-2.50*1.25 m)	M	12,300	45	554				
(3-2.50*1.70 m)	M	14,700	17	250				
(4-2.50*2.50 m)	M	24,800	14	347				
RC Bridge Wideing	SQ.M	9,600	0	0				
RC Bridge (W=13.0 m)	M	83,200	180	14,976				
PC Bridge (W=13.0 m)	M	130,000	210	27,300				
PC Bridge (W=13.0 m,L>50 m)	M	195,000	204	39,780				
Bearing Unit Of Bridge	Ls	500,000	5	2,500				
SUB TOTAL				88,091		73,115		36,558
INTERSECTION					90		90	
T-Intersection (Signal)	Ls	800,000	2	1,600				
T-Intersection (Unsignal)	Ls	80,000	1	80				
Four-Leg Intersection (Unsignal)	Ls	100,000	3	300				
SUB TOTAL				1,980		1,782		1,604
TOTAL (a)				235,853		195,896		117,708
Miscellaneous Works [(a)*7%]	Ls	1		16,510		13,713		8,240
CONTRACT AMOUNT (b)				252,362		209,609		125,948
PHYSICAL CONTINGENCIES [(b)*10%] (c)	Ls	1		25,236		20,961		12,595
ENGINEERING & SUPERVISION [((b)+(c))*10%] (d)	Ls	1		27,760	85	23,596	0	0
LAND ACQUISITION & COMPENSATION								
Land Acquisition (Average)	SQ.M	244	272,701	66,485	100	66,485	100	66,485
Compensation	Ls	3,800,000	1	3,800	100	3,800	100	3,800
TOTAL (e)				70,285		70,285		70,285
PROJECT COST [(b)+(c)+(d)+(e)]				375,643		324,450		208,827
AVERAGE COST PER KM				11,759				

(2) MAINTENANCE COST

Project Road No, AD -1-1 Na= 8,200 Baht/Km/year
(Existing Road) Km= 1.001
Length = 40.527 Km

Asphalt Pavement

	ITEMS		Proposed Road Condition	Factor
1.	Surface /Bace Type	X1	AC	0.00
2.	Subgrade CBR	X2	4 %	0.50
3.	A.D.T	X3	>5,700	2.25
4.	Service Life (year)	X4	4	0.20
5.	Pavement Width (m)	X5	6 m	0.05
6.	R-O-W Width (m)	Y1	40 m	0.00
7.	Shoulder,Access,Median Width (m)	Y2	2.00 m	0.00
8.	Traffic Service Operation Topography	Y3	0 - 3 %	0.00
9.	Drainage Topography	Y4	0 - 3 %	0.00
10.	Bridge Quantity (m/Km)	Y5	9	0.00
11.	NO. Of Lanes		2	

Ka = 1+0.5(X1+X2+X3+X4+X5+Y1+Y2+Y3+Y4+Y5)= 2.500
Maintenance cost + Overhead= Ka * Km * Na * 1.28 = 26,266 Baht/Km/year
Total Cost (Financial) = Length *(Baht/Km/year)= 1,064,492 Baht/year
(Economic) = = 883,528 Baht/year

Project Road No, AD -1-1 Na= 8,200 Baht/Km/year
(Proposed Road) Km= 1.001
Length = 40.527 Km

Asphalt Pavement

	ITEMS		Proposed Road Condition	Factor
1.	Surface /Bace Type	X1	AC	0.00
2.	Subgrade CBR	X2	4 %	0.50
3.	A.D.T	X3	>5,700	4.50
4.	Service Life (year)	X4	NEW	0.00
5.	Pavement Width (m)	X5	7 m * 2	0.38
6.	R-O-W Width (m)	Y1	50 m	0.05
7.	Shoulder,Access,Median Width (m)	Y2	2.50m * 2	0.10
8.	Traffic Service Operation Topography	Y3	0 - 3 %	0.00
9.	Drainage Topography	Y4	0 - 3 %	0.00
10.	Bridge Quantity (m/Km)	Y5	19	0.00
11.	NO. Of Lanes		4	

Ka = 1+0.5(X1+X2+X3+X4+X5+Y1+Y2+Y3+Y4+Y5)= 3.765
Maintenance cost + Overhead= Ka * Km * Na * 1.28 = 39,557 Baht/Km/year
Total Cost (Financial) = Length *(Baht/Km/year)= 1,603,125 Baht/year
(Economic) = = 1,330,594 Baht/year

Overlay Cost (2004) = = 74,076,872 Baht

(3) CONSTRUCTION SCHEDULE

Project AD 1-1

(Two Section)

year and Month	First Year												Second Year												Third Year											
Work Items	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Land Acquisition	======																																			
Preparatory Works		======																																		
Earth Works			==========										==========																							
Pavement Works																									==========											
Bridge Works				==========									==========																							
Miscellaneous Works			=========											=========															=========							
Clearing -Up																																				=========
Percentage Of Disbursement (%)					40 %											34 %													26 %							

4) ECONOMIC EVALUATION

Cost and Benefit Flows of the Project

Project; AD-1-1

(unit ; 1000 Baht)

Year	Construction Cost	Maintenance Cost	Total Cost	VOC Saving	Time Saving	Balance	Benefit= Cost =	Sensi. Analysis 0.8 1.2
1991	0	0	0	0	0	0		0
1992	0	0	0	0	0	0		0
1993	150,106	0	150,106	0	0	(150,106)		(180,127)
1994	97,653	0	97,653	0	0	(97,653)		(117,184)
1995	76,692	0	76,692	0	0	(76,692)		(92,030)
1996	0	447	447	36,724	205,436	241,713		193,191
1997	0	447	447	49,848	252,827	302,227		241,603
1998	0	447	447	62,971	300,218	362,742		290,015
1999	0	447	447	76,095	347,608	423,256		338,426
2000	0	447	447	89,218	394,999	483,771		386,838
2001	0	447	447	102,342	442,390	544,285		435,249
2002	0	447	447	106,797	496,821	603,170		482,357
2003	0	447	447	111,251	551,252	662,056		529,466
2004	0	74,077	74,077	115,706	605,682	647,311		488,218
2005	0	447	447	120,160	660,113	779,827		623,682
2006	0	447	447	124,615	714,544	838,712		670,791
2007	0	447	447	124,615	714,544	838,712		670,791
2008	0	447	447	124,615	714,544	838,712		670,791
2009	0	447	447	124,615	714,544	838,712		670,791
2010	0	447	447	124,615	714,544	838,712		670,791
Total	324,451	80,336	404,787	1,494,187	7,830,066	8,919,466		6,973,658
						EIRR =	57.25%	45.50%
						NPV (i;12%) =	1,791,945	
						B/C (i;12%) =	8.82	

2) AD 1-2

(1) CONSTRUCTION QUANTITIES AND COSTS

(Project AD -1-2 Length = 43.327 Km)
(Improved Length 40.060 Km)

ITEM	Unit	Financial Unit Cost Baht	Quantity	Financial Total cost 1000 Baht	Economic cost %	Economic cost 1000 Baht	Residual Value %	Residual Value 1000 Baht
EARTH WORK					83		90	
Clearing & Grubbing	SQ.M	1	1,035,800	1,036				
Roadway Excavation(classified)	CU.M	85	0	0				
Embankment(Borrowed Material)	CU.M	100	1,046,087	104,609				
Slope Protection(Stripe Sodding)	SQ.M	6	321,332	1,928				
(Sodding)	SQ.M	9	0	0				
(Shot Concrete)	SQ.M	500	0	0				
(Concrete Block)	SQ.M	450	23,616	10,627				
Sand Mat (t=0.5m)	SQ.M	100	21,400	2,140				
Sand Drain (O 0.40cm)	M	200	46,775	9,355				
SUB TOTAL				129,695		107,647		96,882
SUBBASE AND BASE					83		50	
Subbase(Soil Aggregate)	CU.M	190	97,420	18,510				
Base Coarses(Crush Stone)	CU.M	295	43,556	12,849				
Shoulder(Soil Aggregate)	CU.M	190	16,796	3,191				
SUB TOTAL				34,550		28,677		14,338
SURFACE					83		50	
Asphaltic Prime coat	SQ.M	13	290,376	3,775				
Asphaltic Tack coat	SQ.M	7	161,140	1,128				
Asphalt concrete Surfacing	CU.M	1,900	20,602	39,144				
Overlay (5cm)	CU.M	1,900	8,057	15,308				
SUB TOTAL				59,355		49,265		24,632
STRUCTURES(Equivalent)					83		50	
RC Pipe Culvert(D= 600 m)	M	1,300	757	984				
(D= 800 m)	M	1,780	422	751				
(D=1000 m)	M	2,445	737	1,802				
(D=1200 m)	M	3,575	88	315				
(D=600m*2)	M	2,600	31	81				
RC Box Culvert(1-1.80*1.00 m)	M	3,200	17	54				
(1-1.80*1.80 m)	M	4,200	163	685				
(2-2.10*2.10 m)	M	10,000	17	170				
(2-2.40*2.70 m)	M	12,800	17	218				
(2-2.50*1.50 m)	M	9,000	14	126				
RC Bridge Wideing	SQ.M	9,600	0	0				
RC Bridge (W=13.0 m)	M	83,200	180	14,976				
(W=14.0 m)	M	89,600	31	2,778				
PC Bridge (W=13.0 m)	M	130,000	120	15,600				
(W=14.0 m)	M	140,000	160	22,400				
PC Bridge (W=13.0 m,L>50 m)	M	195,000	240	46,800				
Bearing Unit Of Bridge	Ls	500,000	4	2,000				
SUB TOTAL				109,739		91,083		45,542
INTERSECTION					90		90	
T-Intersection (Unsignal)	Ls	80,000	2	160				
Four-Leg Intersection (signal)	Ls	1,000,000	1	1,000				
Four-Leg Intersection (Unsignal)	Ls	100,000	3	300				
SUB TOTAL				1,460		1,314		1,183
TOTAL (a)				334,798		277,985		182,577
Miscellaneous Works [(a)*7%]	Ls	1		23,436		19,459		12,780
CONTRACT AMOUNT (b)				358,234		297,444		195,357
PHYSICAL CONTINGENCIES [(b)*10%] (c)	Ls	1		35,823		29,744		19,536
ENGINEERING & SUPERVISION [((b)+(c))*10%] (d)	Ls	1		39,406	85	33,495	0	0
LAND ACQUISITION & COMPENSATION								
Land Acquisition (Average)	SQ.M	25	975,385	24,385	100	24,385	100	24,385
Compensation	Ls	10,800,000	1	10,800	100	10,800	100	10,800
TOTAL (e)				35,185		35,185		35,185
PROJECT COST [(b)+(c)+(d)+(e)]				468,648		395,868		250,077
AVERAGE COST PER KM				11,699				

(2) MAINTENANCE BUDEGE CALCULATION

Project Road No, AD -1-2 (Existing Road)
Na= 8,200 Baht/Km/year
Km= 1.001
Length = 26.677 Km

Asphalt Pavement

ITEMS			Proposed Road Condition	Factor
1.	Surface /Bace Type	X1	AC	0.00
2.	Subgrade CBR	X2	4 %	0.50
3.	A.D.T	X3	>5,700	2.25
4.	Service Life (year)	X4	4	0.20
5.	Pavement Width (m)	X5	6 m	0.05
6.	R-O-W Width (m)	Y1	40 m	0.00
7.	Shoulder,Access,Median Width (m)	Y2	2.00 m	0.00
8.	Traffic Service Operation Topography	Y3	0 - 3 %	0.00
9.	Drainage Topography	Y4	0 - 3 %	0.00
10.	Bridge Quantity (m/Km)	Y5	9	0.00
11.	NO. Of Lanes		2	

Ka = 1+0.5(X1+X2+X3+X4+X5+Y1+Y2+Y3+Y4+Y5)= 2.500
Maintenance cost + Overhead= Ka * Km * Na * 1.28 = 26,266 Baht/Km/year
Total Cost (Financial) = Length *(Baht/Km/year)= 700,704 Baht/year
(Economic) = = 581,585 Baht/year

Project Road No, AD -1-2 (Proposed Road)
Na= 8,200 Baht/Km/year
Km= 1.001
Length = 26.677 Km (4 Lanes)
= 16.650 Km (2 Lanes)

Asphalt Pavement

ITEMS			Proposed Road (4 Lanes) Condition	Factor	Proposed Road (2 Lanes) Conditio	Factor
1.	Surface /Bace Type	X1	AC	0.00	AC	0.00
2.	Subgrade CBR	X2	4 %	0.50	4 %	0.50
3.	A.D.T	X3	>5,700	4.50	>5,700	2.25
4.	Service Life (year)	X4	NEW	0.00	NEW	0.00
5.	Pavement Width (m)	X5	7 m * 2	0.38	7 m	0.19
6.	R-O-W Width (m)	Y1	50 m	0.05	50 m	0.05
7.	Shoulder,Access,Median Width (m)	Y2	2.50m * 2	0.10	2.50m	0.05
8.	Traffic Service Operation Topography	Y3	0 - 3 %	0.00	0 - 3 %	0.00
9.	Drainage Topography	Y4	0 - 3 %	0.00	0 - 3 %	0.00
10.	Bridge Quantity (m/Km)	Y5	16	0.00	16	0.00
11.	NO. Of Lanes		4		2	

	(4 Lanes)	(2 Lanes)
Ka = 1+0.5(X1+X2+X3+X4+X5+Y1+Y2+Y3+Y4+Y5)=	3.765	2.520
Maintenance cost + Overhead= Ka * Km * Na * 1.28 =	39,557	26,476 Baht/Km/year
Total Cost (Financial) = Length *(Baht/Km/year)		1,496,093 Baht/year
(Economic) =		1,241,757 Baht/year

Overlay Cost (2004) = 63,978,056 Baht

(3) CONSTRUCTION SCHEDULE

Project AD 1-2

(Two Section)

year and Month / Work Items	First Year												Second Year												Third Year											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Land Acquisition	=========																																			
Preparatory Works		=========																																		
Earth Works				==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========												
Pavement Works																									==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
Bridge Works				==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
Miscellaneous Works				==========	==========	==========	==========	==========					=========	=========	=========	=========	=========								=========	=========	=========	=========	=========							
Clearing -Up																																				=========
Percentage Of Disbursement (%)								33 %												40 %												27 %				

4) ECONOMIC EVALUATION

Cost and Benefit Flows of the Project
Project; AD-1-2

(unit ; 1000 Baht)

Year	Construction Cost	Maintenance Cost	Total Cost	VOC Saving	Time Saving	Balance	Benefit= / Cost =	Sensi. Analysis 0.8 / 1.2
1991	0	0	0	0	0	0		0
1992	0	0	0	0	0	0		0
1993	120,044	0	120,044	0	0	(120,044)		(144,053)
1994	167,547	0	167,547	0	0	(167,547)		(201,057)
1995	108,278	0	108,278	0	0	(108,278)		(129,934)
1996	0	660	660	55,757	232,970	288,067		230,189
1997	0	660	660	68,400	285,470	353,210		282,304
1998	0	660	660	81,043	337,971	418,354		334,419
1999	0	660	660	93,687	390,471	483,498		386,534
2000	0	660	660	106,330	442,972	548,641		438,649
2001	0	660	660	118,973	495,472	613,785		490,764
2002	0	660	660	125,230	513,217	637,786		509,965
2003	0	660	660	131,487	530,961	661,788		529,166
2004	0	63,978	63,978	137,744	548,706	622,472		472,386
2005	0	660	660	144,001	566,450	709,791		567,569
2006	0	660	660	150,258	584,195	733,793		586,770
2007	0	660	660	150,258	584,195	733,793		586,770
2008	0	660	660	150,258	584,195	733,793		586,770
2009	0	660	660	150,258	584,195	733,793		586,770
2010	0	660	660	150,258	584,195	733,793		586,770
Total	395,870	73,221	469,090	1,813,942	7,265,635	8,610,487		6,700,753
					EIRR =		58.11%	45.36%
					NPV (i;12%) =		1,804,446	
					B/C (i;12%) =		7.71	

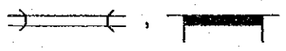
3.7 Drawings

1) AD-1-1

Drawing

SHEET NO.	LIST OF DRAWINGS
1. - 5.	Plan and Profile
6.	Plan of Intersection
7.	(A) Bridge for Maenam Ta Pi
8.	(B) Bridge for Khlong Ma Kham Tia
9.	(C) Briege for Khlong Tha Thong
10.	(D) Reinforced Concrete Slab Bridge
11.	Box Culvert
12.	Pipe Culvert

ABBREVIATION AND SYMBOLS FOR PROFILE AND PLAN

	: Alignment of Proposed Route
	: Proposed Bridge
	: Proposed Box Culvert
	: High Water Level
	: Water Level
No.	: Number
R	: Radius of Curvature
L	: Length of Curve
BR.RC.SP.SL L	: Reinforced Concrete Bridge (Bridge Length)
BR.PC.GRDR L	: Prestressed Concrete Bridge (Bridge Length)
BR.ST.SP.TR L	: Steel Bridge (Bridge Length)
RC-B m - n x a x b x i	: Box Culvert (No. of Locations - No. of Cells x Clear Span x Depth x Length)

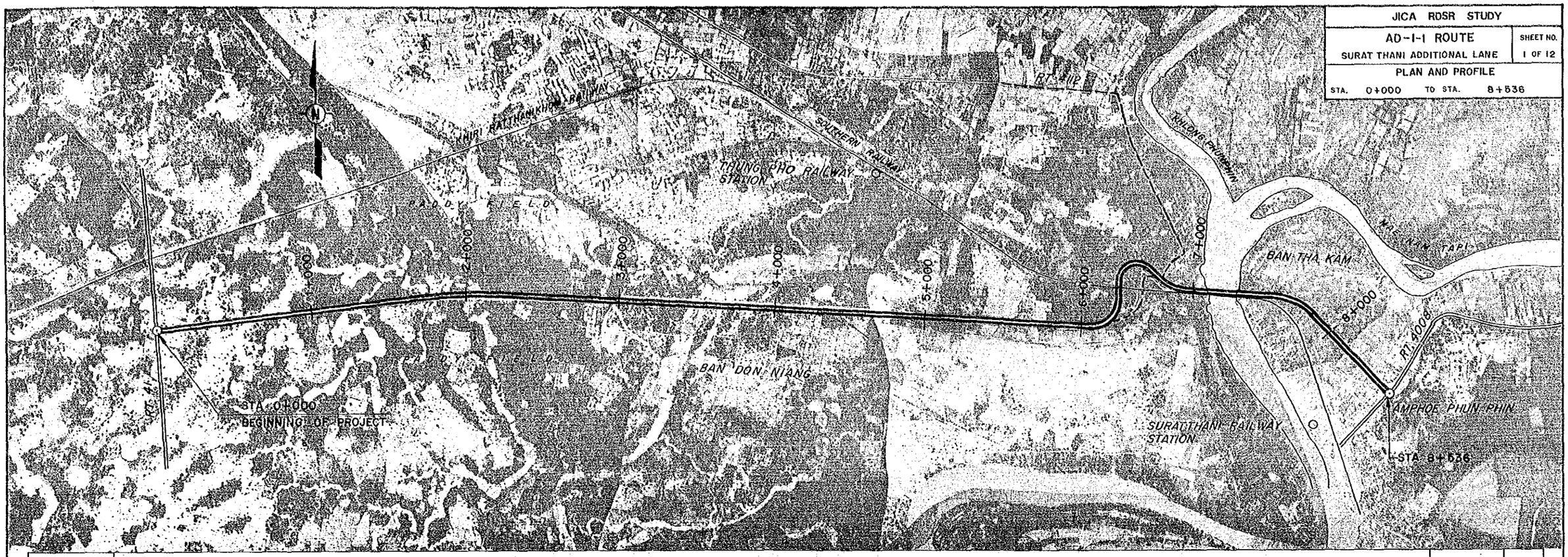
JICA RDSR STUDY

AD-1-1 ROUTE — SHEET NO. 1 OF 12

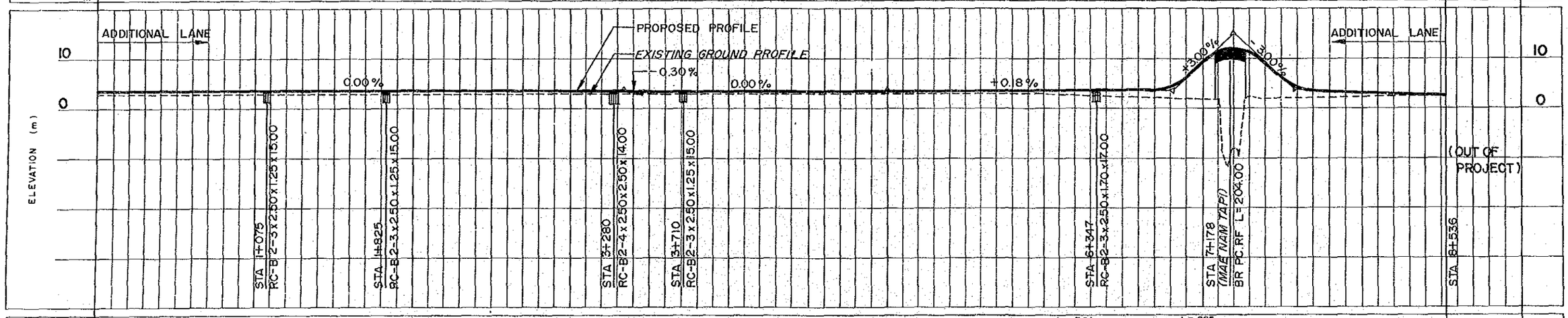
SURAT THANI ADDITIONAL LANE

PLAN AND PROFILE

STA. 0+000 TO STA. 8+636

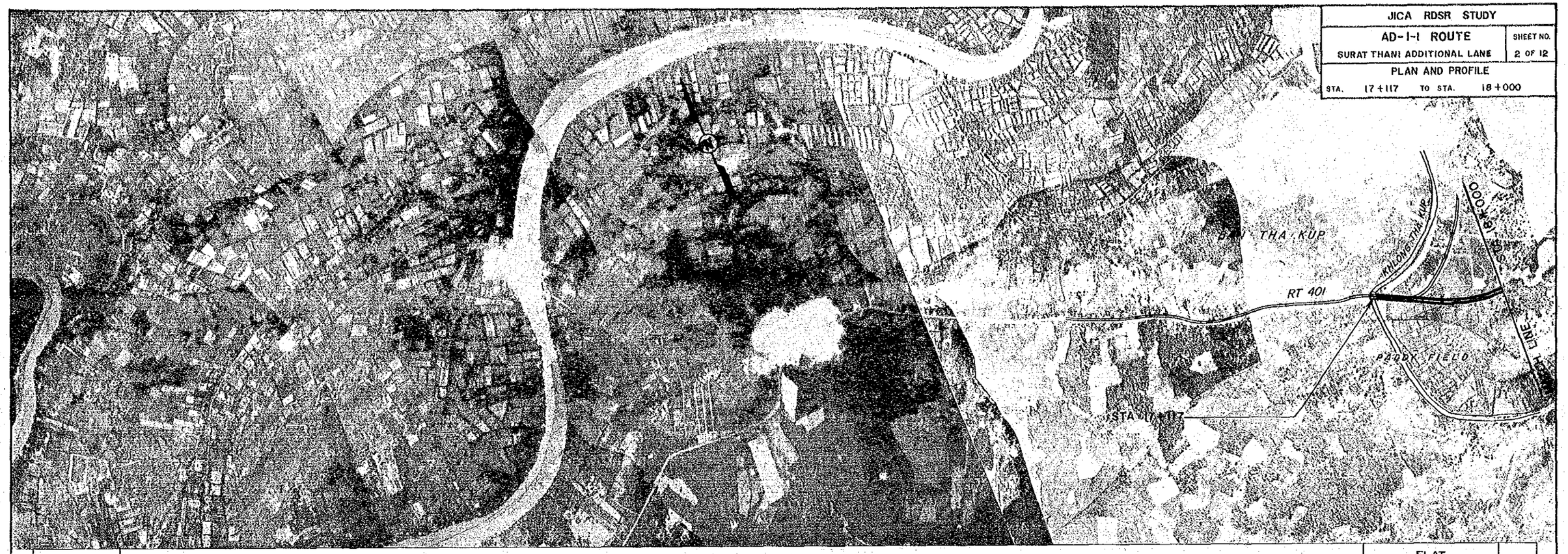


TERRAIN		FLAT
PAVEM'T	Type	AC PAVEMENT
	Existing Condition	FAIR
FLOODING	Length (Km.) / Hight (m.)	–
RIGHT OF WAY (m.)	L.	33.00
	R.	20.00



CURVATURE BAND	Existing Alignment	L = 443, R = 2,885
	Proposed Alignment	R = ∞ ; L = 443, R = 2,885 ; R = ∞ ; L = 301, R = 191 ; L = 157, L = 190, R = 100, R = 241 ; L = 225, R = 286 ; R = ∞ ; L = 266, R = 358 ; R = ∞
STATION (Km.)		0+000 1+000 2+000 3+000 4+000 5+000 6+000 7+000 8+000 9+000

JICA RDSR STUDY	
AD-1-1 ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 2 OF 12
PLAN AND PROFILE STA. 17+117 TO STA. 18+000	



TERRAIN		FLAT
PAVEM'T Type		AC. PAVEMENT
PAVEM'T Existing Condition		GOOD
FLOODING Length (Km.)		—
FLOODING Hight (m.)		—
RIGHT OF WAY (m) L.		15.00
RIGHT OF WAY (m) R.		35.00

ELEVATION (m): 20, 10, 0

(OUT OF PROJECT)

ADDITIONAL LANE

PROPOSED PROFILE

EXISTING GROUND PROFILE

0.00% +0.70%

STA. 17+117

CURVATURE BAND	Existing Alignment	L= 627 R= 895
CURVATURE BAND	Proposed Alignment	R=∞ L= 627 R= 895

STATION (Km.) 9+000 10+000 11+000 12+000 13+000 14+000 15+000 16+000 17+000 18+000

JICA RDSR STUDY

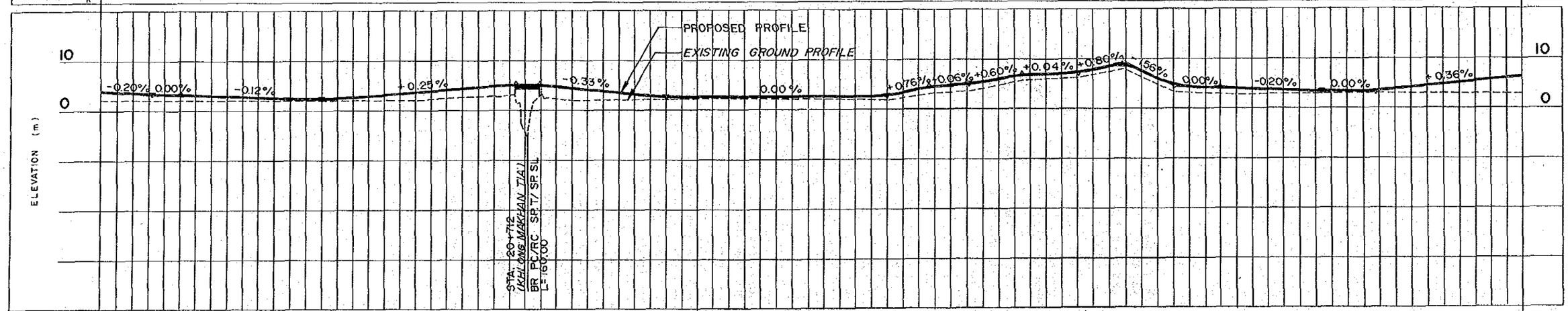
AD-1-1 ROUTE — SHEET NO. 3 OF 12

SURAT THANI ADDITIONAL LANE

PLAN AND PROFILE

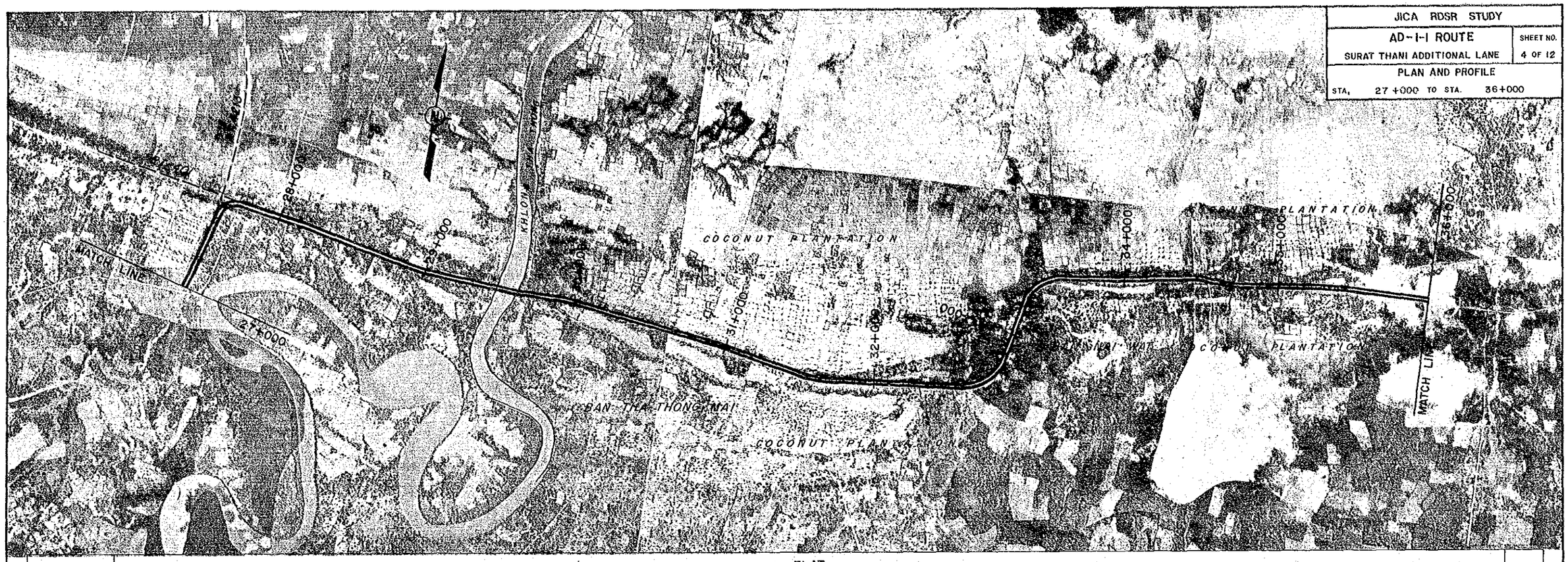
STA. 18+000 TO STA. 27+000

TERRAIN		FLAT
PAVEM'T	Type	AC PAVEMENT
	Existing Condition	GOOD
FLOODING	Length(Km.) Hight (m.)	–
RIGHT OF WAY (m.)	L	15.00
	R	35.00

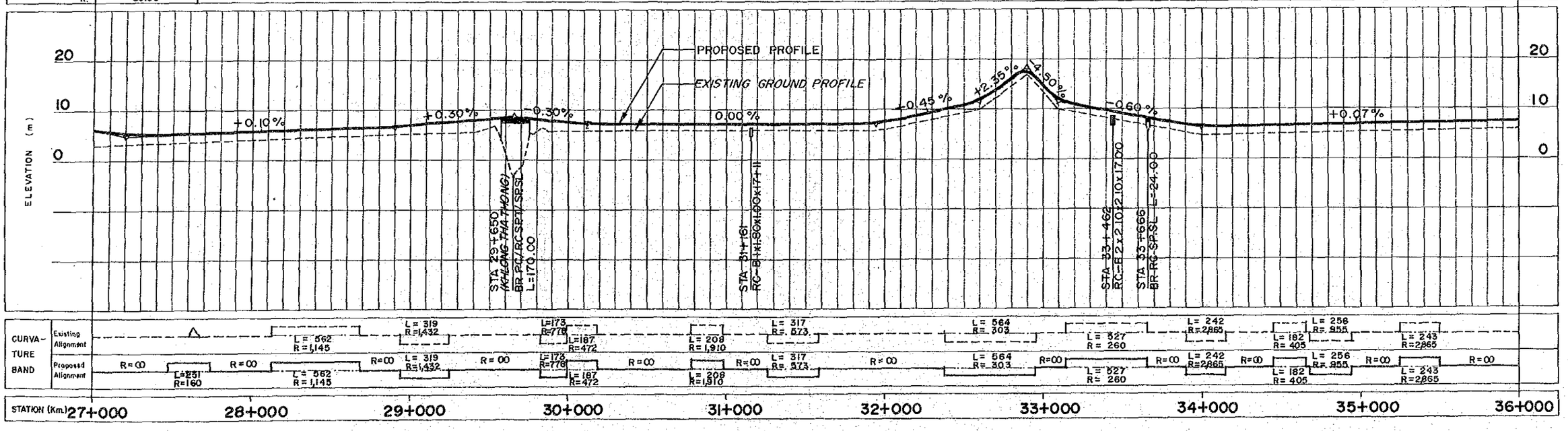


CURVATURE BAND	Existing Alignment	L= 548 R= 572		L= 412 R=1,432			L= 682 R= 550		L= 333 R=4774
	Proposed Alignment	R = ∞	L= 548 R= 672	R= ∞	L= 412 R=1,432	R = ∞		L= 682 R= 550 R = ∞	L= 333 R=4774
STATION (Km.)		18+000	19+000	20+000	21+000	22+000	23+000	24+000 25+000	26+000 27+000

JICA RDSR STUDY	
AD-1-1 ROUTE	SHEET NO. 4 OF 12
SURAT THANI ADDITIONAL LANE	
PLAN AND PROFILE	
STA. 27+000 TO STA. 36+000	



TERRAIN		FLAT	
PAVEM'T	Type	AC PAVEMENT	
	Existing Condition	GOOD	GOOD / FAIR
FLOODING	Length (Km.) / Hight (m.)	-	
RIGHT OF WAY (m)	L	15.00	20.00
	R.	35.00	33.00



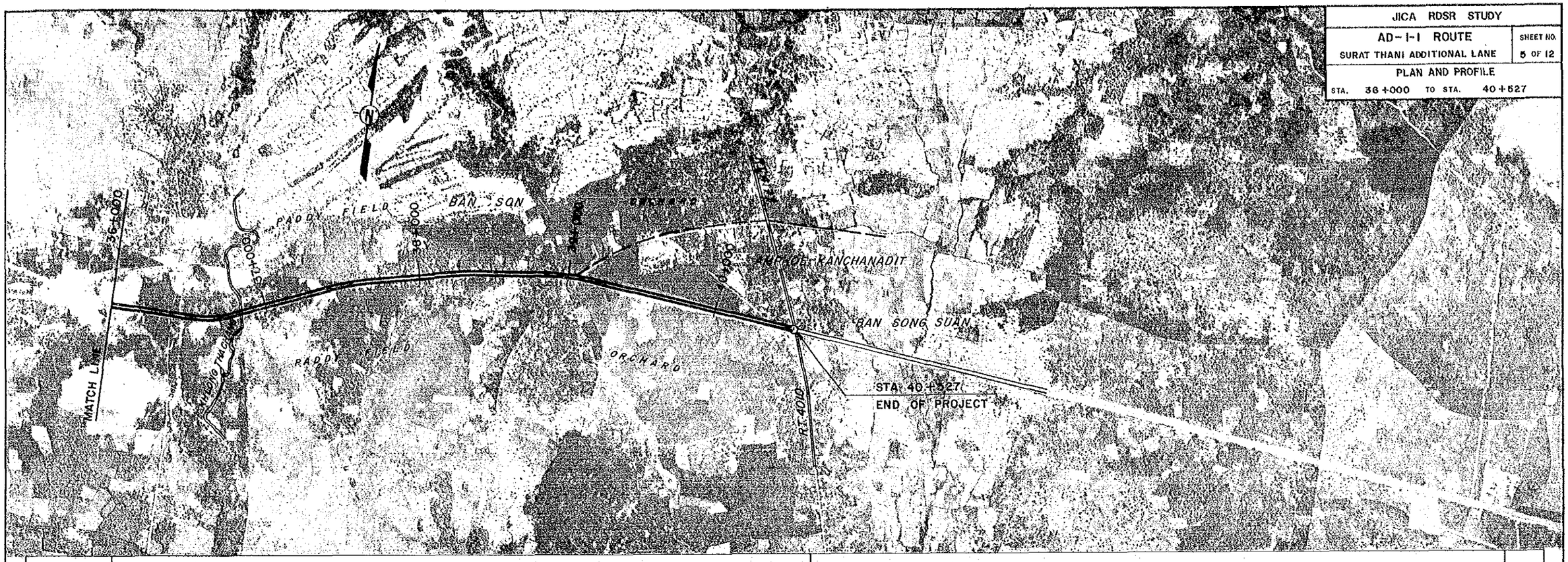
JICA RDSR STUDY

AD-1-1 ROUTE — SHEET NO. 5 OF 12

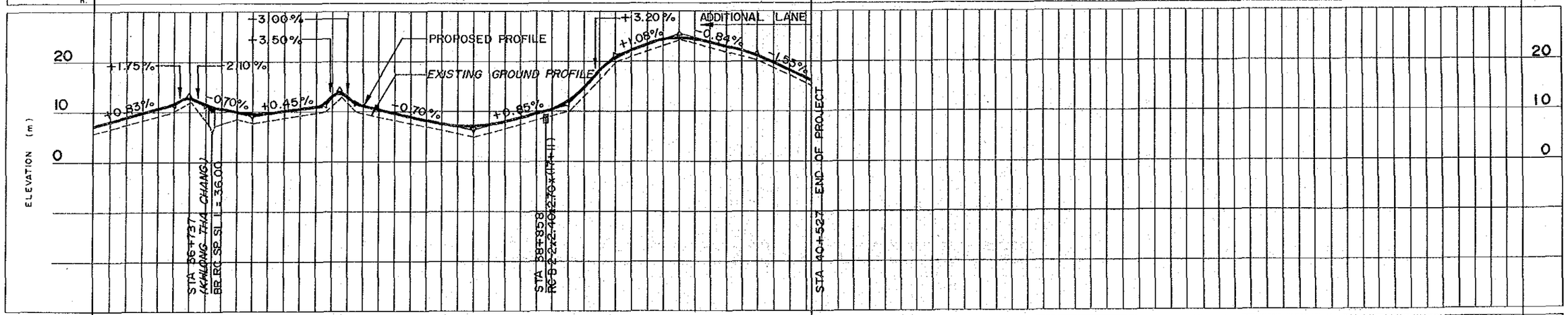
SURAT THANI ADDITIONAL LANE

PLAN AND PROFILE

STA. 36+000 TO STA. 40+527

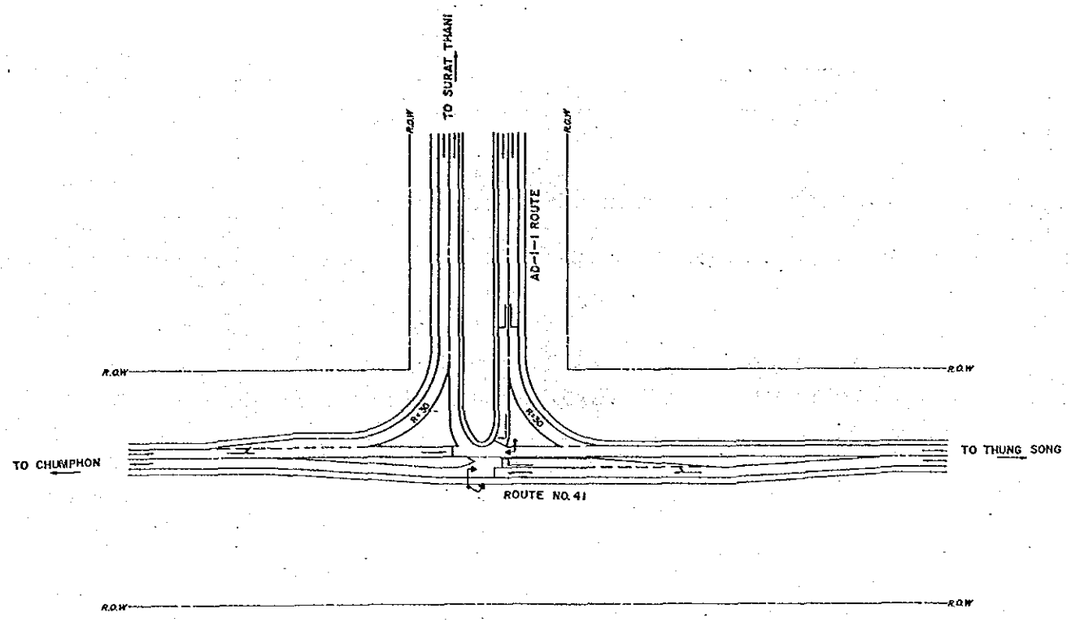


TERRAIN		FLAT
PAVEM'T	Type	AC PAVEMENT
	Existing Condition	GOOD / FAIR
FLOODING	Length(Km.) Hight (m.)	-
RIGHT OF WAY (m)	L.	20.00
	R.	33.00

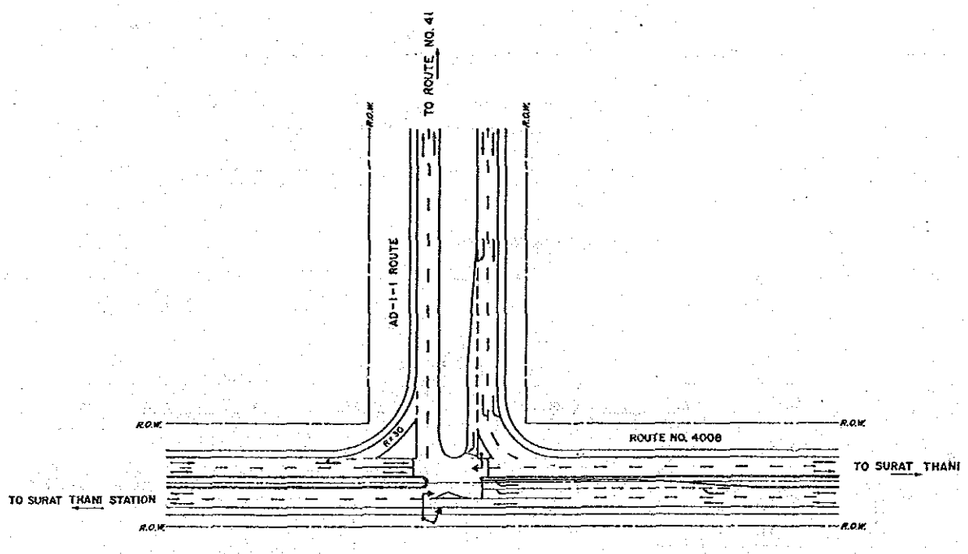


CURVATURE BAND	Existing Alignment			L = 320 R = 573			L = 229 R = 1,432		L = 211 R = 1,910			L = 419 R = 1,637				
	Proposed Alignment	R = ∞	L = 320 R = 573	R = ∞		L = 229 R = 1,432	R = ∞		L = 211 R = 1,910	R = ∞	L = 419 R = 1,637	R = ∞				
STATION (Km.)		36+000		37+000			38+000			39+000			40+000			

JICA RDSR STUDY	
AD-1-1 ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 6 OF 12
PLAN OF INTERSECTION	

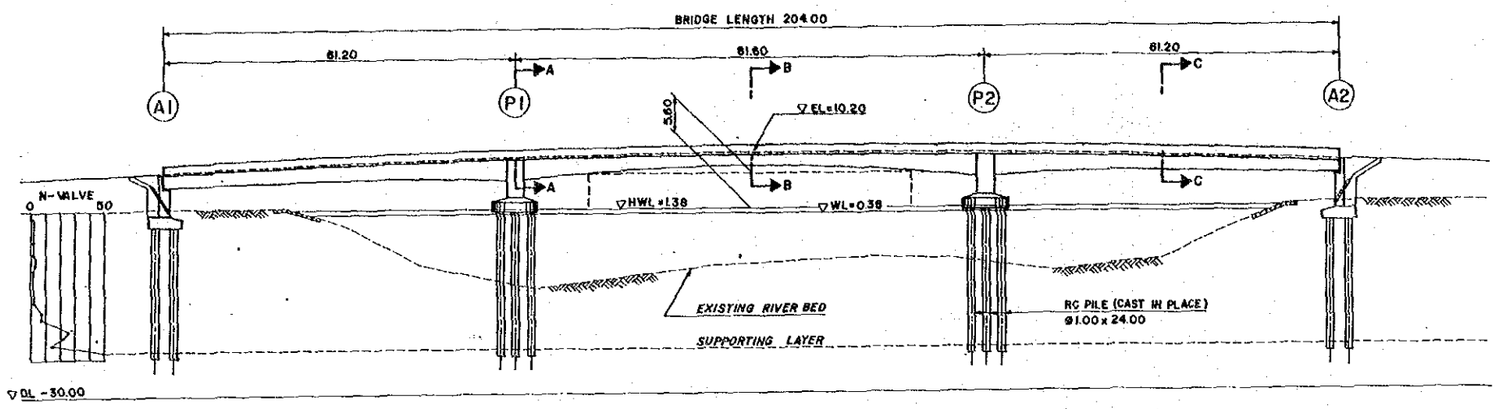


Intersection with Rt.41
Scale 1:2000

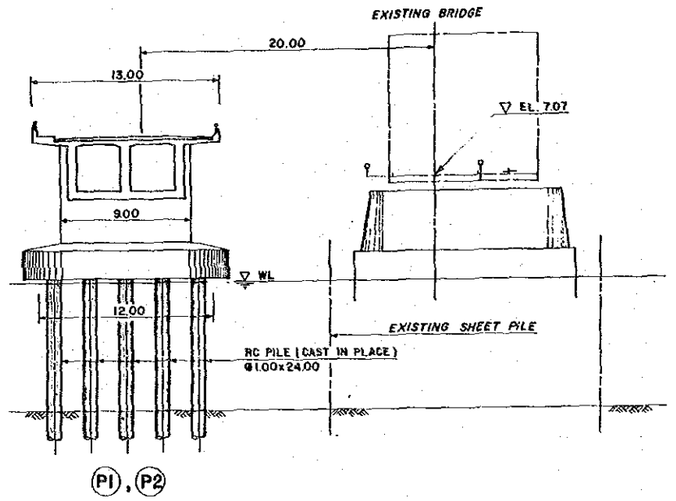


Intersection with Rt.4008
Scale 1:2000

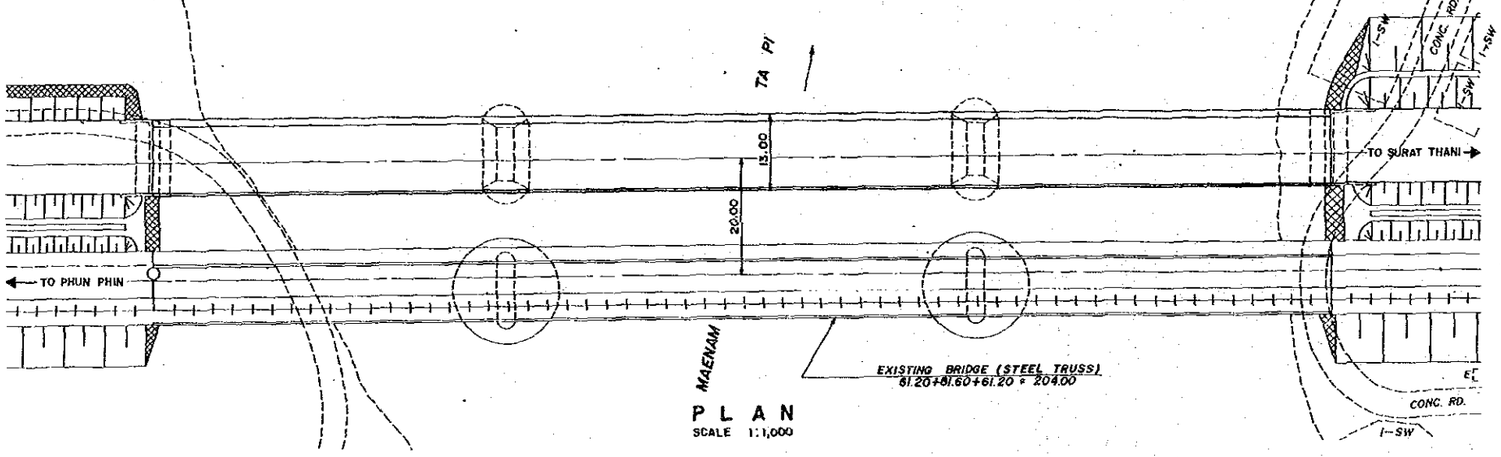
JICA RDSR STUDY	
AD-1-1 ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 7 OF 12
BRIDGE FOR MAENAM TA PI (A)	



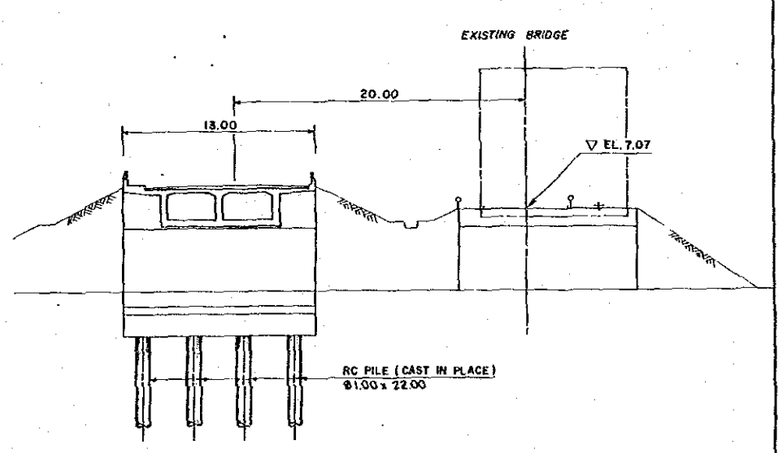
ELEVATION
SCALE 1:1,000



P1, P2

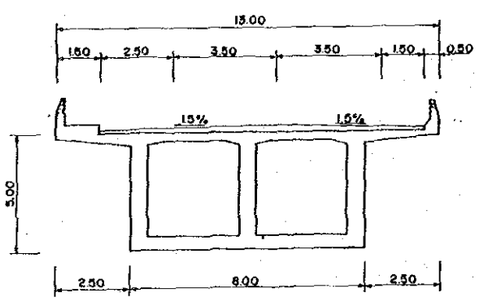


PLAN
SCALE 1:1,000

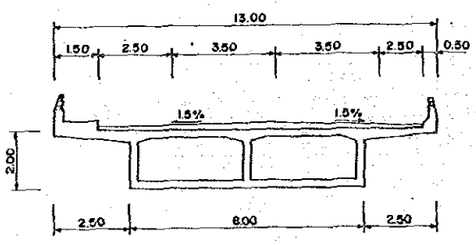


A1, A2

FRONT ELEVATION
SCALE 1:400

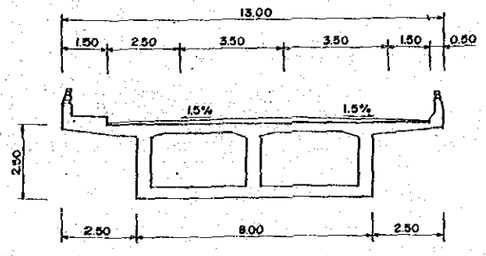


A-A



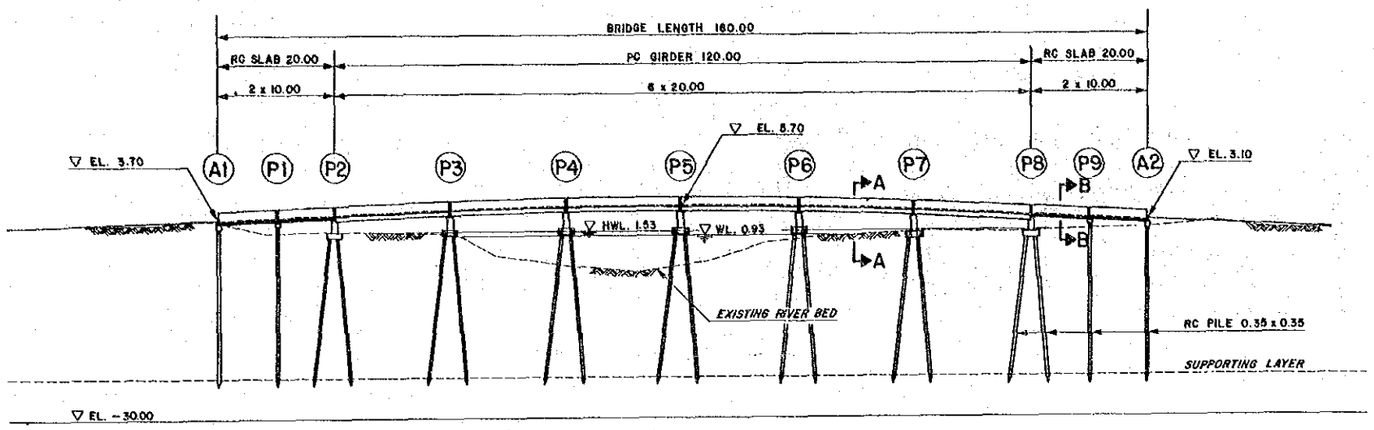
B-B

SECTION
SCALE 1:200

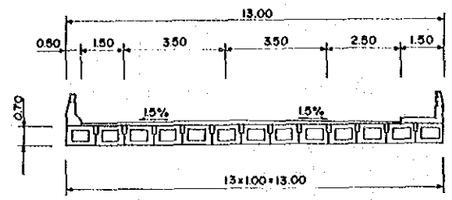


C-C

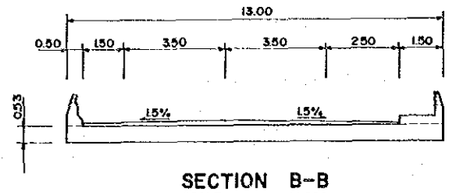
JICA RDSR STUDY	
AD-1-1 ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 8 OF 12
BRIDGE FOR KHLONG MAKHAM TIA (B)	



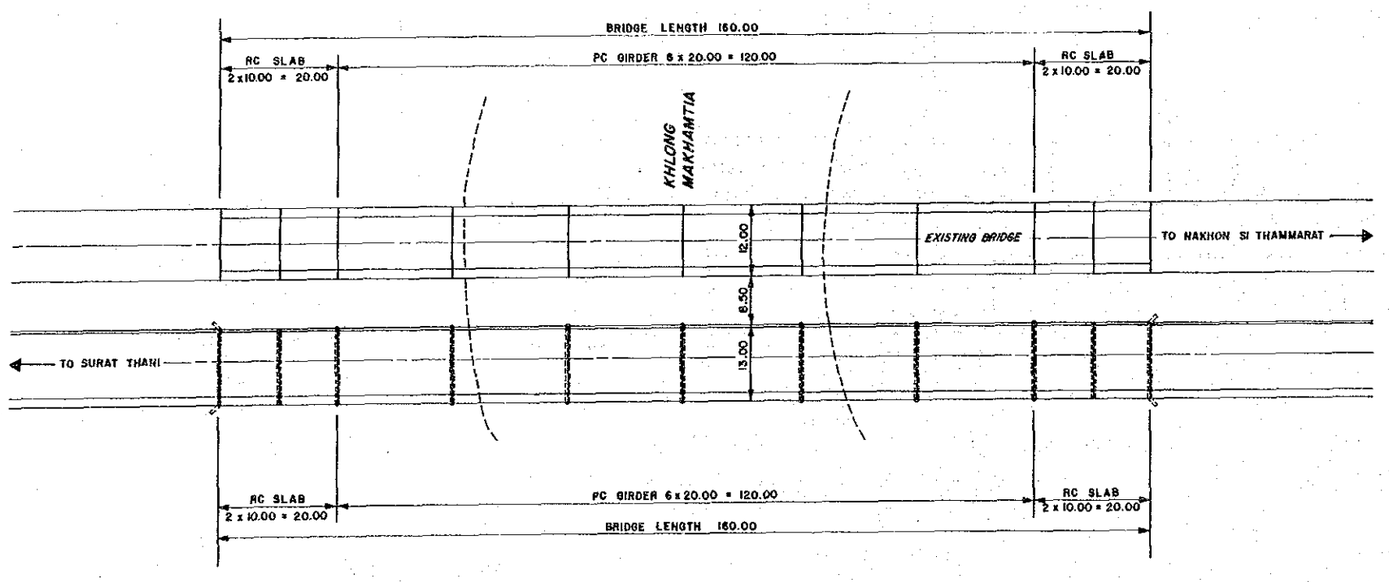
ELEVATION
SCALE 1:1,000



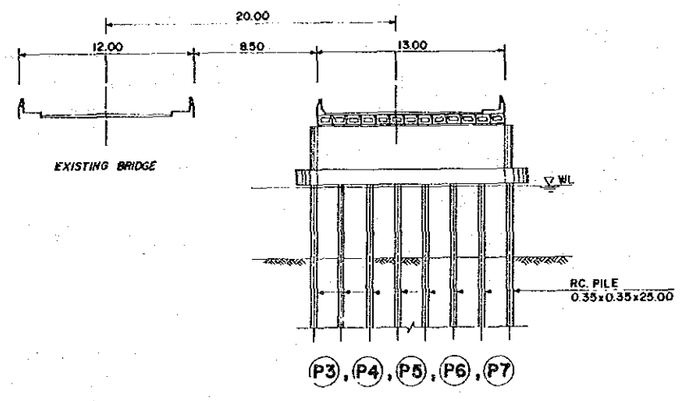
SECTION A-A
SCALE 1:200

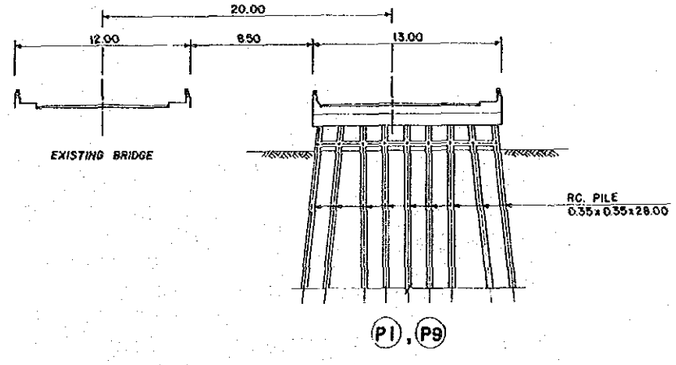


SECTION B-B
SCALE 1:200



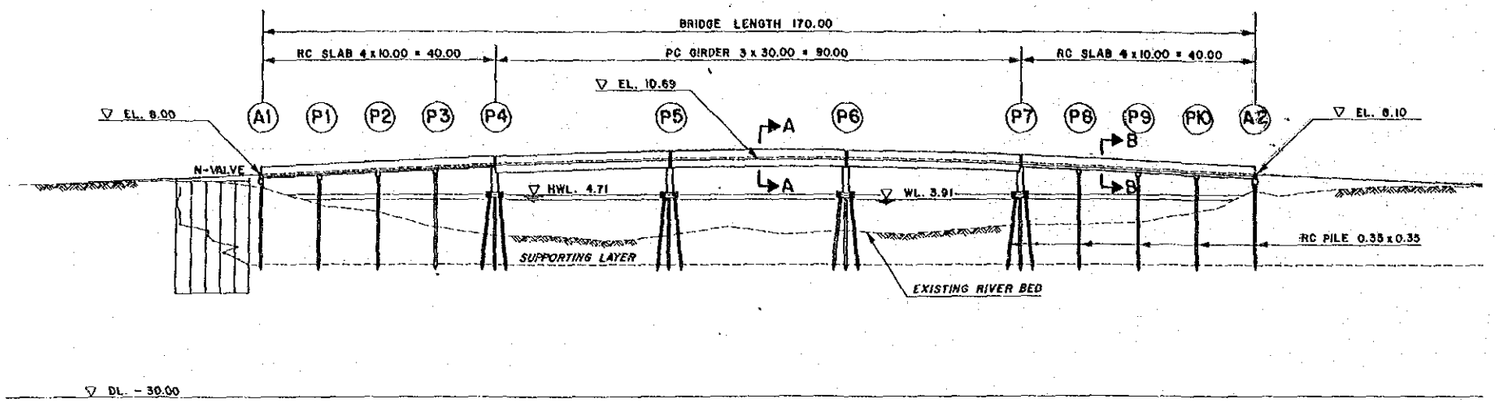
PLAN
SCALE 1:1,000



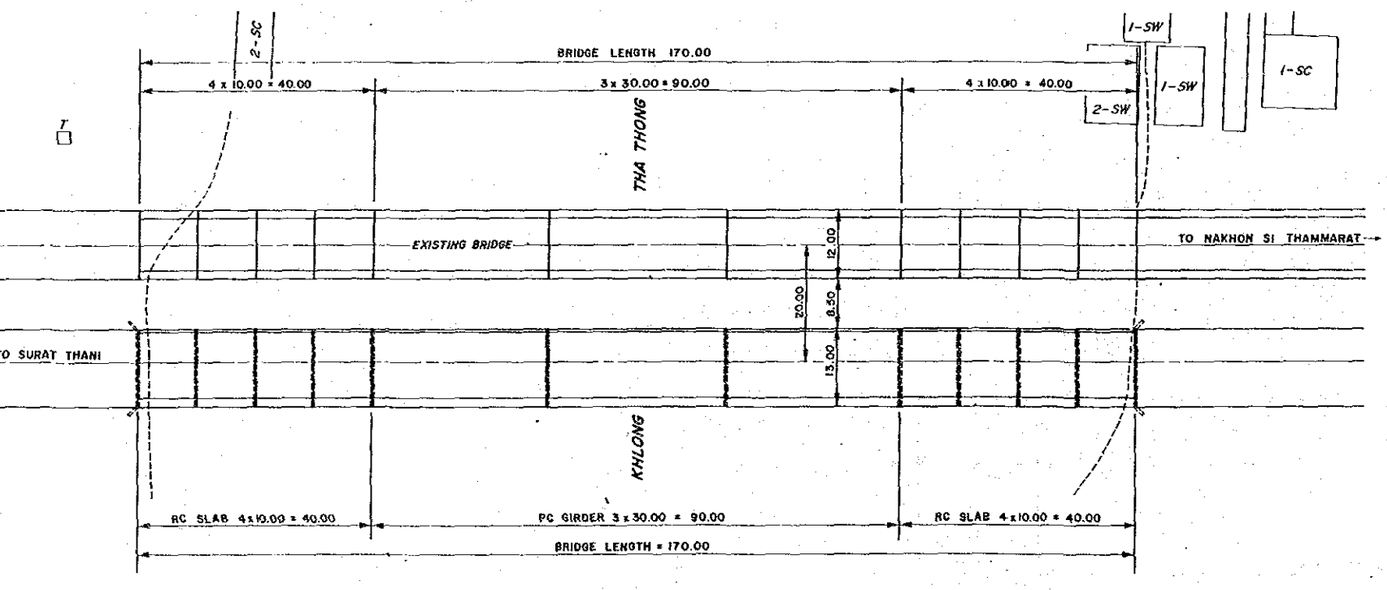


FRONT ELEVATION
SCALE 1:400

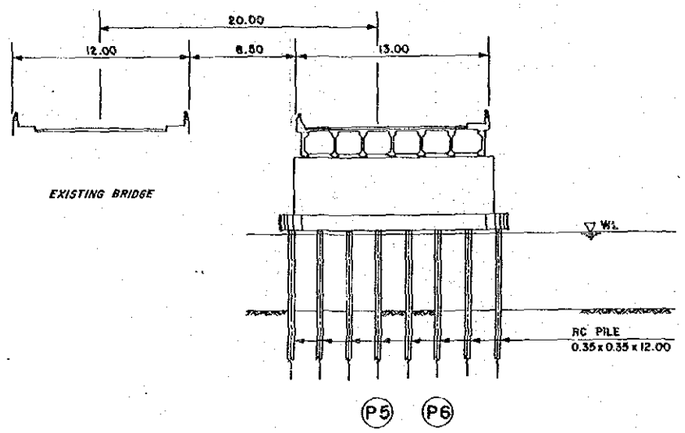
JICA RDSR STUDY	
AD-1-1 ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 9 OF 12
BRIDGE FOR KHLONG THA THONG (C)	

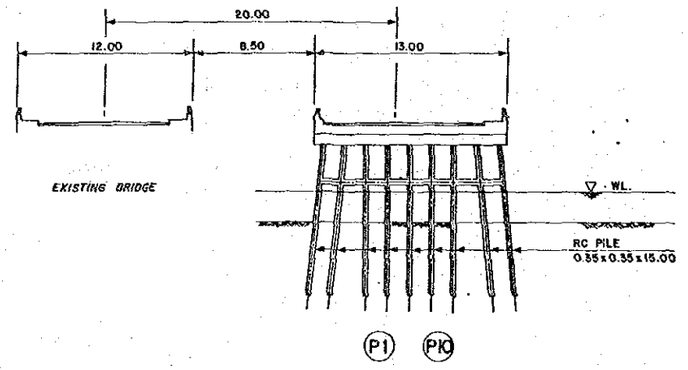


ELEVATION
SCALE 1:1,000

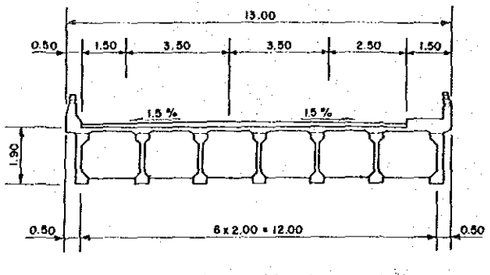


PLAN
SCALE 1:1,000

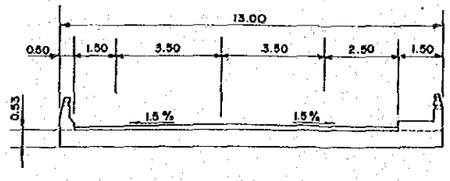




FRONT ELEVATION
SCALE 1:400



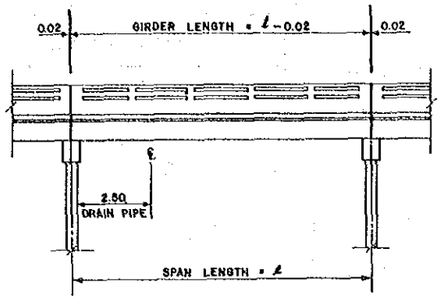
A—A



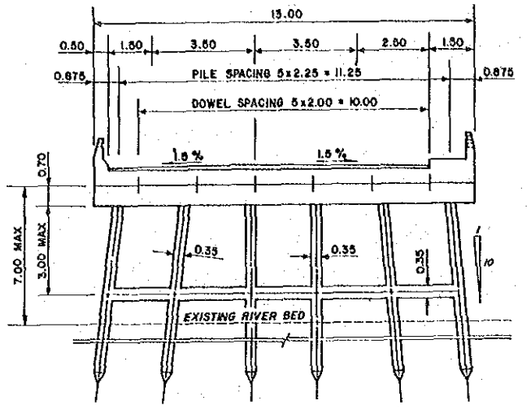
B—B

SECTION
SCALE 1:200

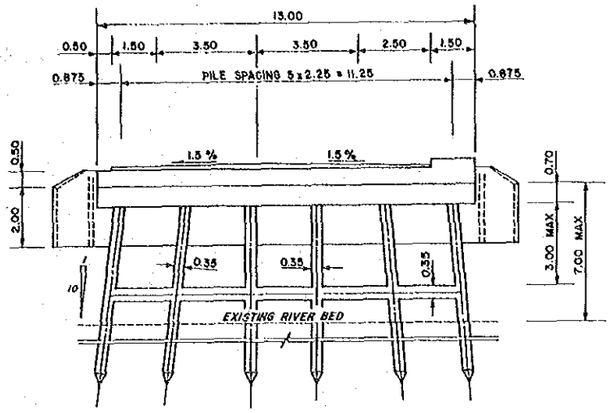
JICA RDSR STUDY	
AD-I-I ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 10 OF 12
REINFORCED CONCRETE SLAB BRIDGE (D)	



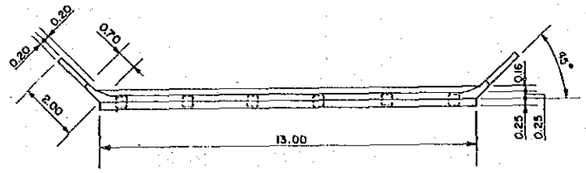
SECTION A-A
SCALE 1:200



FOR 7.00 – 8.00 M. SPAN
SCALE 1:200



ELEVATION
SCALE 1:200



ABUTMENT FOR 7.00 – 8.00 M. SPAN

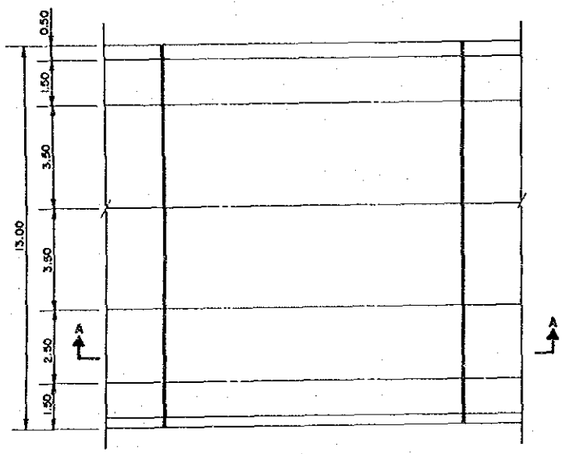
PLAN
SCALE 1:200

NOTES :

1. DESIGN STRESSES :
   a) CONCRETE , f_c = 70 KSC.
   b) STEEL , f_s = 1,400 KSC. (INTERMEDIATE GRADE)
   f_s = 1,200 KSC. (STRUCTURAL GRADE)
2. CONCRETE SHALL HAVE MINIMUM ULTIMATE COMPRESSIVE STRENGTH OF 210 KG/CM^2 FOR .15 X .15 X .15 CUBE AT 28 DAYS. AND APPROXIMATE MIX DESIGN PER CUBIC METER IS SUGGESTED AS FOLLOWS :

PORTLAND CEMENT, MIN.	350 KG.
SAND	0.43 M^3
CRUSHED ROCK OR GRAVEL	0.86 M^3
CONCRETE SLUMP, MAX	10 CM.

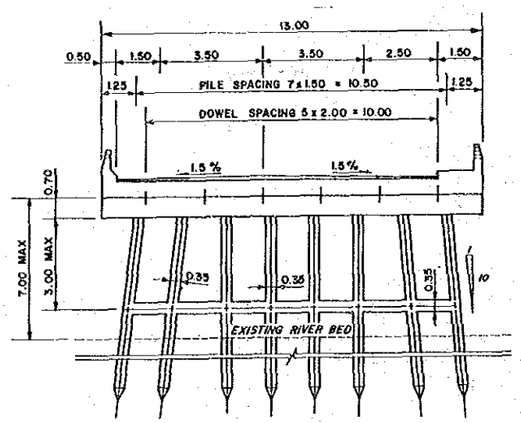
3. CLEAR CONCRETE COVER FOR TOP REINFORCEMENT IN SLAB BRIDGE SHALL BE 3.5 CM. ELSEWHERE OF SLAB BRIDGE AND SIDEWALK SHALL BE 2.5 CM.
4. ALL CONCRETE EXPOSED CORNERS SHALL HAVE 2 CM. CHAMFER UNLESS OTHERWISE INDICATED.
5. REBARS #4 OR LARGER SHALL BE INTERMEDIATE GRADE DEFORMED BARS, OTHERS SHALL BE STRUCTURAL GRADE PLAIN BARS UNLESS OTHERWISE INDICATED.
6. LOCATIONS OF LAP SPLICE OF REBARS SHALL BE APPROVED BY THE ENGINEER.
7. LAP LENGTH SHALL NOT BE LESS THAN 40 DIAMETERS OF BIGGER BAR IN CASE OF PLAIN BARS AND 24 DIAMETERS OF BIGGER BAR FOR DEFORMED BARS.
8. IN CASE OF SALINE PROTECTION, HIGH SULPHATE RESISTANT PORTLAND CEMENT TYPE 5 CONFORMED TO AASHTO SPECIFICATIONS SHALL BE USED AND ADDITIONAL CONCRETE COVER OF 2.5 CM. FROM NORMAL CASE ALL AROUND SHALL BE PROVIDED WITHOUT ALTERING THE LOCATIONS OF REBARS.
9. ALL MATERIALS SHALL BE USED UNDER THE APPROVAL OF THE ENGINEER.
10. PAINTING SHALL BE PROVIDED ON ALL SURFACES AT BRIDGE ENDS WHICH EXPOSED TO TRAFFIC. WHITE AND BLACK COLOUR SHALL BE PAINTED ALTERNATELY. WHITE COLOUR SHALL BE LIGHT REFLECTED TYPE.
11. ALL DIMENSIONS SHOWN ARE IN METERS UNLESS OTHERWISE INDICATED.
12. BAR MARK S101 MAY BE TAKEN OUT ONE BAR ON EACH SIDE OF THE BRIDGE WHEREVER THEY PASS THROUGH DRAIN PIPES. IF THE LOCATIONS OF THESE BARS ARE NEAR V-DRIP SUCH THAT CONCRETE COVER IS NOT ADEQUATE, THEY SHALL BE PLACED ON TOP OF ST 101. OTHER BARS WHICH PASS THROUGH DRAIN PIPES SHALL BE BENT ALONG THE PIPES.
13. ALL PIERS WHICH DO NOT HAVE LOG PROTECTION WALLS SHALL BE HAUNCH UNDER THE TOP CROSS BRACING.
14. IF ANY NOTES ON THE DRAWINGS OF PIERS CONTRADICT THE NOTES ON THIS DRAWING, THEY WILL BE SUPERSEDED BY THESE NOTES.
15. THIS DRAWING IS ADAPTED FROM DOH DWG NO. 3 AD5-106-14/1A IN CASE OF ANY DISCREPANCY BETWEEN SUCH DRAWINGS ARISES, THE DOH. STANDARD DRAWING WILL PREVAIL UNDER THE APPROVAL OF THE ENGINEER.



PLAN
SCALE 1:200

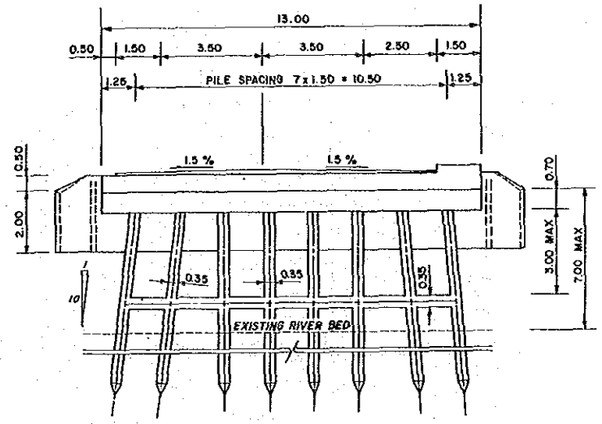
LIST OF BRIDGES

STATION	SPAN OF LENGTH(m)
33+668	3x 8.00 = 24.00
36+737	8.00+2x10.00+8.00 = 36.00

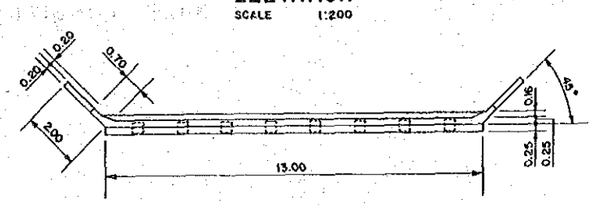


FOR 9.00 – 10.00 M. SPAN

PILE BENT ELEVATION
SCALE 1:200



ELEVATION
SCALE 1:200

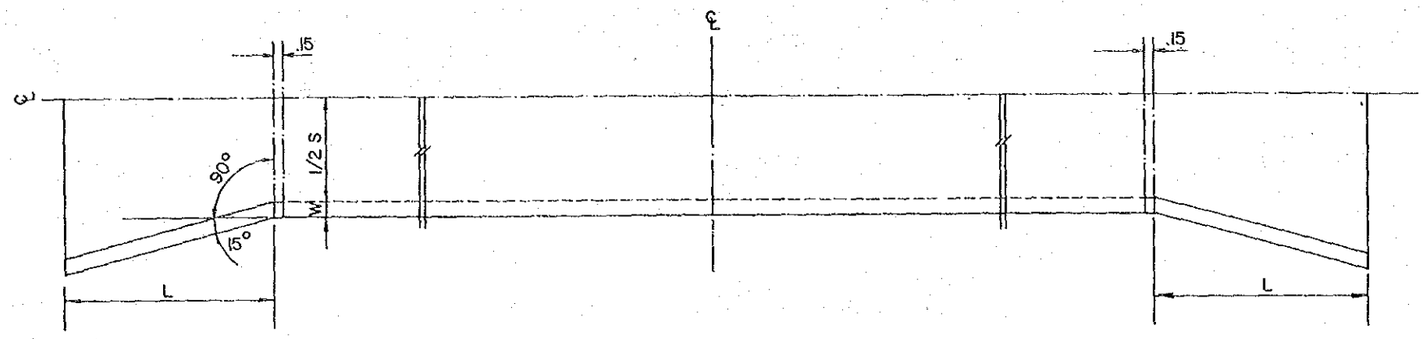


ABUTMENT FOR 9.00 – 10.00 M. SPAN

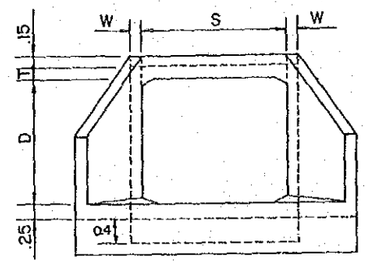
PLAN
SCALE 1:200

JICA RDSR STUDY	
AD-1-1 ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 11 OF 12
BOX CULVERT	

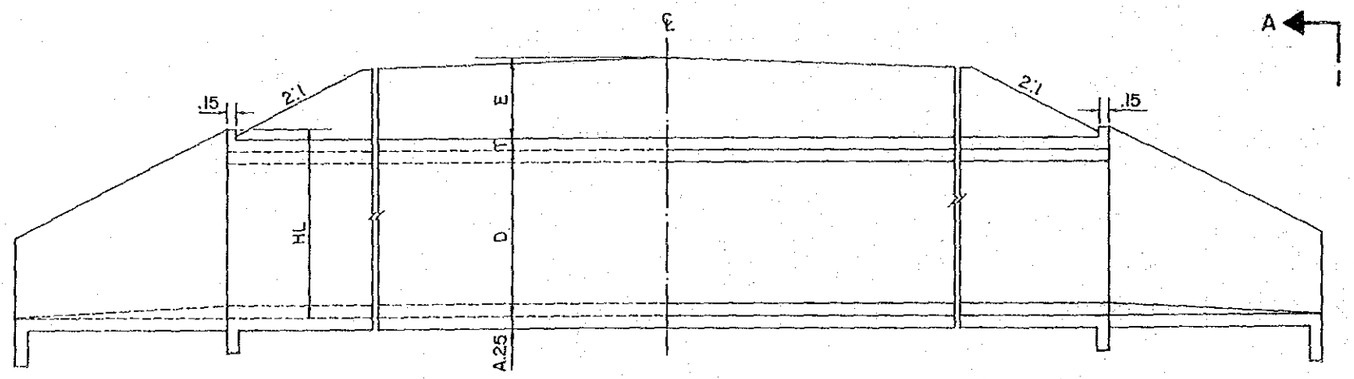
BOX CULVERT



HALF LONGITUDINAL PLAN

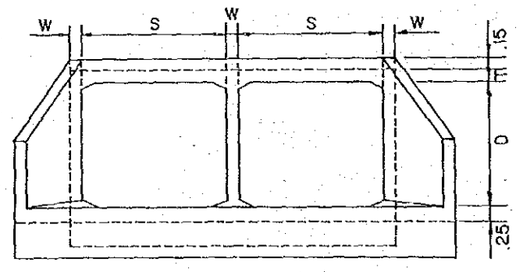


SINGLE TYPE



HALF LONGITUDINAL ELEVATION

HALF LONGITUDINAL SECTION

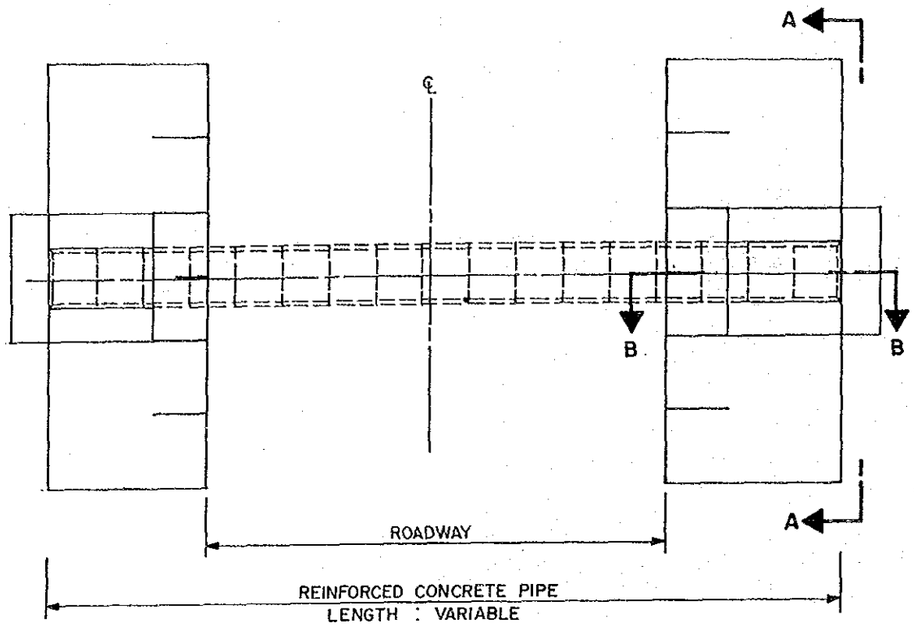


DOUBLE TYPE

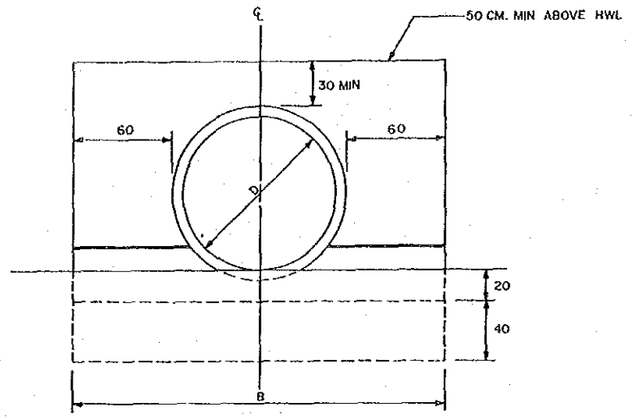
SECTION A-A

JICA RDSR STUDY	
AD-1-1 ROUTE SURAT THANI ADDITIONAL LANE	SHEET NO. 12 OF 12
PIPE CULVERT	

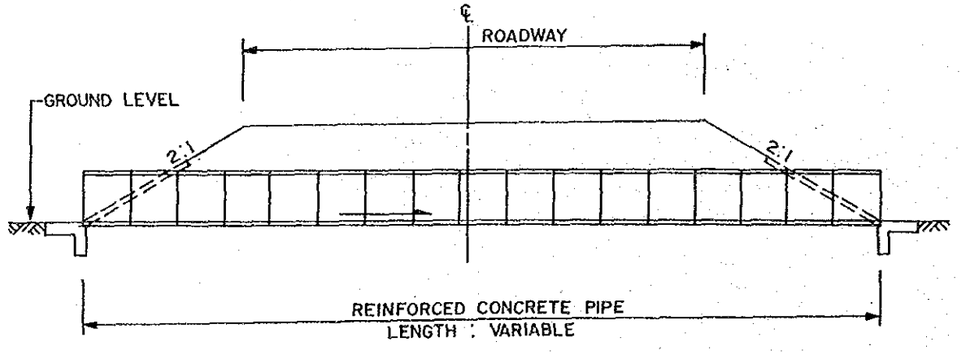
PIPE CULVERT



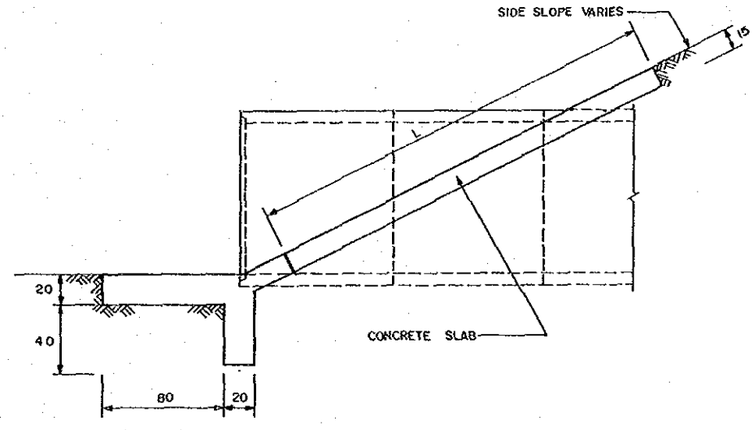
PLAN



SECTION A-A



PROFILE



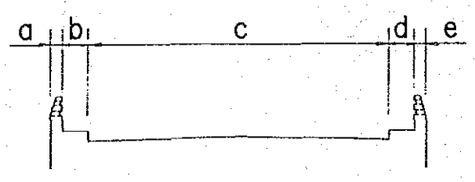
SECTION B-B

List of Bridge

LIST OF BRIDGES (AD-1-1:SD)

Station	Materials	Structural System	Width (a+b+c+d+e:m)	Span and Length (m)	Remarks	(Fig.)
7+178 Ta Pi	ST	SP.TR	RW+0.0+6.0+1.5+0.0=10.0	61.2+81.6+61.2=204.0	Used as existed	
	PC	RF.BX	0.3+1.2+11.0+0.0+0.5=13.0	61.2+81.6+61.2=204.0	New construction	(A)
20+712 Makham Tia	PC/RC	SP.T/SP.SL	0.3+1.2+9.0+1.2+0.3=12.0	2*10.0+6*20.0+2*10.0=160.0	Used as existed	
	PC/RC	SP.T/SP.SL	0.3+1.2+11.0+0.0+0.5=13.0	2*10.0+6*20.0+2*10.0=160.0	New construction	(B)
29+650 Tha Thong	PC/RC	SP.T/SP.SL	0.3+1.2+9.0+1.2+0.3=12.0	4*10.0+3*30.0+4*10.0=170.0	Used as existed	
	PC/RC	SP.T/SP.SL	0.3+1.2+11.0+0.0+0.5=13.0	4*10.0+3*30.0+4*10.0=170.0	New construction	(C)
33+666	RC	SP.SL	0.3+1.2+8.0+1.2+0.3=11.0	3*8.0=24. 0	Used as existed	
	RC	SP.SL	0.3+1.2+11.0+0.0+0.5=13.0	3*8.0=24.0	New construction	(D)
36+737	RC	SP.SL	0.3+1.2+8.0+1.2+0.3=11.0	8.0+2*10.0+8.0=36.0	Used as existed	
	RC	SP.SL	0.3+1.2+11.0+0.0+0.5=13.0	8.0+2*10.0+8.0=36.0	New construction	(D)

Note: (1) Materials
RC: Reinforced Concrete Bridge
PC: Prestressed Concrete Bridge
ST: Steel Bridge
(2) Structural System
SP.SL: Simply Supported Slab
SP.T : Simply Supported T-shape Girder
RF.BX: Continuously Supported Box Girder
SP.TR: Simply Supported Truss



List of Culvert

LIST OF BOX AND PIPE CULVERT

STATION	CULVERT TYPE	CULVERT SIZE (m)		NO. of LOCATIONS	CULVERT LENGTH (m)		
		PIPE	BOX				
		NO. of ROW x DIAMETER	NO. of CELLS (CLEAR SPAN x DEPTH)		EXISTING	EXTENDED CONST-RUCTION	NEW CONST-RUCTION
0+180	Pipe	1x⊙0.80		2	16.0	1.0	17.0
0+400	Pipe	1x⊙0.80		2	11.0	1.0	12.0
0+600	Pipe	1x⊙0.80		2	12.0	1.0	13.0
1+075	Box		3(2.50x1.25)	2	13.0	1.0	15.0
1+525	Pipe	1x⊙0.80		2	14.0	1.0	15.0
1+825	Box		3(2.50x1.25)	2	13.0	1.0	15.0
2+475	Pipe	1x⊙0.80		2	13.0	1.0	14.0
2+725	Pipe	1x⊙1.00		2	14.0	1.0	15.0
3+280	Box		4(2.50x2.50)	2	12.0	1.0	14.0
3+440	Pipe	1x⊙1.00		2	14.0	1.0	15.0
3+710	Box		3(2.50x1.25)	2	13.0	1.0	15.0
5+175	Pipe	2x⊙1.20		2	13.0	1.0	14.0
5+725	Pipe	1x⊙1.20		2	15.0	1.0	16.0
6+347	Box		3(2.50x1.70)	2	15.0	1.0	17.0
7+025	Pipe	1x⊙1.20		2	16.0	1.0	17.0
7+565	Pipe	1x⊙1.00		2	19.0	1.0	20.0
17+192	Pipe	1x⊙0.60		2	20.0	1.0	19.0
17+192	Pipe	1x⊙0.60		2	22.0	1.0	21.0
17+295	Pipe	2x⊙1.00		2	26.0	1.0	25.0
17+573	Pipe	1x⊙1.00		2	24.0	1.0	23.0
17+817	Pipe	1x⊙0.80		2	19.0	1.0	18.0
18+255	Pipe	1x⊙0.60		2	18.0	1.0	17.0
18+469	Pipe	1x⊙0.80		2	19.0	1.0	18.0
18+768	Pipe	1x⊙0.60		2	17.0	1.0	16.0
18+967	Pipe	1x⊙0.60		2	19.0	1.0	18.0
19+095	Pipe	1x⊙0.80		2	19.0	1.0	18.0
19+387	Pipe	1x⊙0.80		2	19.0	1.0	18.0
19+752	Pipe	1x⊙1.00		2	23.0	1.0	22.0
19+896	Pipe	2x⊙1.00		2	23.0	1.0	22.0
20+293	Pipe	1x⊙0.60		2	19.0	1.0	18.0
21+732	Pipe	1x⊙1.00		2	21.0	1.0	20.0
22+214	Pipe	1x⊙1.00		2	22.0	1.0	21.0
22+446	Pipe	1x⊙1.00		2	21.0	1.0	20.0
22+968	Pipe	1x⊙1.00		2	21.0	1.0	20.0
25+125	Pipe	1x⊙1.00		2	17.0	1.0	16.0
25+417	Pipe	1x⊙1.00		2	20.0	1.0	19.0
25+722	Pipe	1x⊙1.00		2	20.0	1.0	19.0
27+430	Pipe	2x⊙1.00		2	14.0	1.0	13.0
27+651	Pipe	2x⊙0.60		2	16.0	1.0	15.0
28+092	Pipe	1x⊙0.60		2	16.0	1.0	15.0
30+042	Pipe	1x⊙0.80		2	18.0	1.0	17.0
31+161	Box		1(1.80x1.00)	2	11.0	1.0	17.0
33+462	Box		2(2.10x2.10)	2	17.0	1.0	17.0
36+342	Pipe	3x⊙1.00		2	21.0	1.0	20.0
38+142	Pipe	2x⊙0.60		2	17.0	1.0	16.0
38+442	Pipe	1x⊙1.00		2	20.0	1.0	19.0
38+858	Box		2(2.40x2.70)	2	11.0	1.0	17.0