APPENDIX - B APPENDIX TO THE CHAPTERS

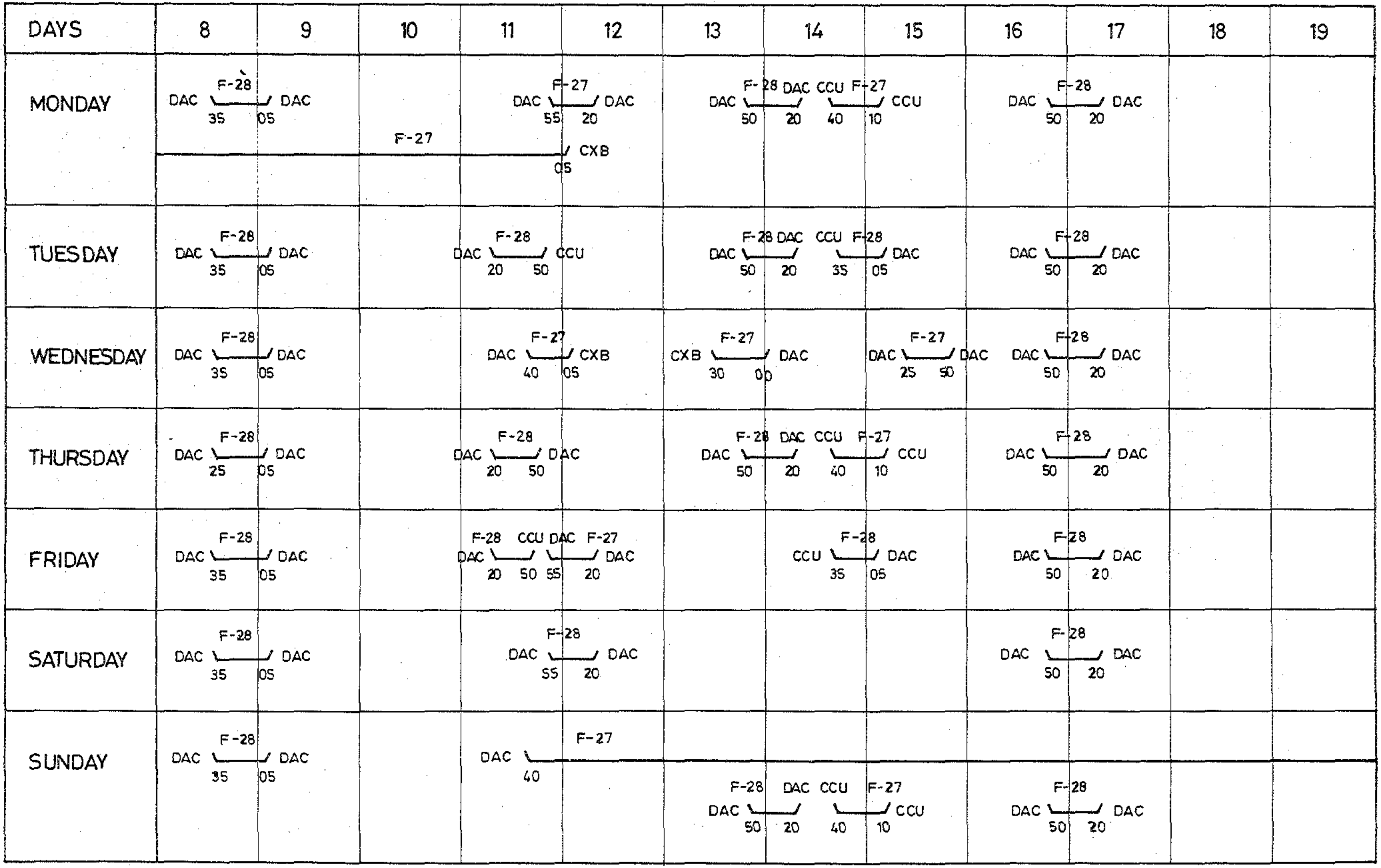
Appendix 3.1 Flight Shedule at Chittagong Airport

- 1989 Winter Schedule
- 1989 Summer Schedule

Flight Schedule at Chittagong Airport (1989 Winter Schedule)

DAYS	8	9	10	11	12	13	14	15	16	17	18	19
MONDAY	F-27 DAC 55 – 20 DAC			F-28 DAC 20 – 50 DAC		F-28 DAC 35 – 05 DAC	F-27 CCU 40 – 10 CCU				F-27 DAC 25 – 50 DAC	
TUESDAY	F-27 DAC 55 – 20 DAC			F-28 DAC 20 – 50 CCU			F-28 CCU 25 – 55 DAC				F-27 DAC 25 – 50 DAC	
WEDNESDAY	F-28 DAC 35 – 05 DAC			F-27 DAC 40 – 05 DAC		F-28 DAC 35 – 05 DAC					F-27 DAC 25 – 50 DAC	
THURSDAY	F-28 DAC 35 – 05 DAC			F-28 DAC 20 – 50 DAC	F-28 CXB 45 – 10 DAC	F-28 DAC 35 – 05 DAC	F-27 CCU 40 – 10 CCU				F-27 DAC 25 – 50 DAC	
FRIDAY	F-28 DAC 35 – 05 DAC			F-28 DAC 20 – 50 DAC			F-28 CCU 25 – 55 DAC				F-27 DAC 25 – 50 DAC	
SATURDAY	F-28 DAC 35 – 05 DAC			F-27 DAC 40 – 05 CXB		F-28 DAC 35 – 05 DAC					F-27 DAC 25 – 50 DAC	
SUNDAY	F-28 DAC 35 – 05 DAC			F-27 DAC 40 – 25 CXB		F-27 CXB 30 – 50 DAC F-28 DAC 35 – 05 DAC	F-27 DAC 40 – 10 CCU				F-27 DAC 25 – 50 DAC	

Flight Schedule at Chittagong Airport (1989 Summer Schedule)



Appendix 3.2 List of Diverted Aircraft at ZIA

(1) Year 1981 - 1982
(2) Year 1983 - 1984
(3) Year 1985 - 1986
(4) Year 1987 - 1988

List of Diverted Aircraft at ZIA (1)

Year 1981 — 1982

Year	Month	Day	Flight No	Aircraft Type	Aerodrome of Departure	Diverted to	Reason of Diversion
1981	1		NIL				
	2	15	BG-004	B-707	Dubai	Calcutta	Bad weather
		16	BG-026	B-707	Dubai	Calcutta	Bad weather
		16	BG-006	B-707	Dubai	Calcutta	Bad weather
	3	12	BG-075	B-707	Kuala Lumpur	Calcutta	Poor visibility
	4	7	BG-002	B-707	Dubai	Calcutta	Poor visibility
		19	BG-010	B-707	Bombay	Bangkok	Poor visibility
	5	13	BG-494	F-27	Calcutta	Calcutta	Enroute weather
		17	TG-321	DC-8	Kathmandu	Calcutta	Poor visibility
		29	TG-304	DC-8	Delhi	Calcutta	Bad weather
	6		NIL				
	7		NIL				
	8		NIL				
	9		NIL				
	10		NIL				
	11		NIL				
	12		NIL				
1982	1		NIL				
	2		NIL				
	3		NIL				
	4	6	PK-264	B-707	Karachi	Rangoon	Bad weather
		8	BG-406	F-27	Sylhet	Chittagong	Bad weather
		10	BG-426	F-27	Chittagong	Chittagong	Bad weather
		19	BG-073	F-28	Bangkok	Chittagong	Bad weather
	5	11	TG-304	EA-30	Delhi	Calcutta	Bad weather
		11	TG-304	EA-30	Calcutta	Bangkok	Bad weather
		12	BG-032	B-707	Karachi	Calcutta	Bad weather
		30	BG-004	B-707	Dubai	Calcutta	Bad weather
	6		NIL				
	7	2	BG-624	F-28	Chittagong	Chittagong	Bad weather
	8		NIL				
	9		NIL				
	10	21	BG-406	F-27	Sylhet	Chittagong	Bad weather
		21	BG-624	F-28	Chittagong	Chittagong	Bad weather
	11		NIL				
	12		NIL				

List of Diverted Aircraft at ZIA (2)

Year 1983 – 1984

Year	Month	Day	Flight No	Aircraft Type	Aerodrome of Departure	Diverted to	Reason of Diversion
1983	1		NIL				
	2		NIL				
	3		NIL				
	4	10	IC-223	B-737	Calcutta	Calcutta	Bad weather
		10	BG-406	F-27	Sylhet	Chittagong	Bad weather
		13	BG-406	F-27	Sylhet	Chittagong	Bad weather
		25	IC-223	B-737	Calcutta	Calcutta	Bad weather
		25	SU-549	TU-54	Bombay	Calcutta	Bad weather
		27	BG-071	B-707	Rangoon	Calcutta	Bad weather
		27	BG-081	B-707	Singapure	Calcutta	Bad weather
		28	BG-073	B-707	Bangkok	Calcutta	Bad weather
	5	1	IC-223	B-737	Calcutta	Calcutta	Enroute weather
		6	RA-403	B-727	Kathmandu	Kathmandu	Major snag
		7	BG-424	F-27	Chittagong	Chittagong	Enroute weather
		14	IC-224	B-737	Calcutta	Calcutta	Bad weather
		17	IC-223	B-737	Calcutta	Calcutta	Enroute weather
	6		NIL				
	8		NIL				
	9		NIL				
	10		NIL				
	11		NIL				
	12	24	RA-404	B-727	Hongkong	Chittagong	Due fog
1984	1	15	BG-004	DC-10	Bombay	Bangkok	Bad weather
		15	RA-404	B-727	Hongkong	Chittagong	Bad weather
	2	16	BG-024	DC-10	Muscat	Bangkok	Bad weather
	3		NIL				
	4	30	BG-612	F-28	Chittagong	Chittagong	Bad weather
	5		NIL				
	6	6	BG-612	F-28	Chittagong	Sylhet	Bad weather
		15	BG-426	F-27	Chittagong	Chittagong	Enroute weather
	7	8	BG-624	F-28	Chittagong	Chittagong	Bad weather
		30	BG-071	B-707	Rangoon	Chittagong	Bad weather
	8	5	BG-424	F-27	Chittagong	Chittagong	Bad weather
		17	BG-602	F-28	Chittagong	Chittagong	Bad weather
	9		DATA N.A.				
	10		DATA N.A.				
	11		DATA N.A.				
	12		DATA N.A.				

List of Diverted Aircraft at ZIA (3)

Year 1985 - 1986

Year	Month	Day	Flight No	Aircraft Type	Aerodrome of Departure	Diverted to	Reason of Diversion
1985	1		DATA N.A.				
	2		DATA N.A.				
	3		DATA N.A.				
	4		DATA N.A.				
	5		DATA N.A.				
	6		DATA N.A.				
	7		DATA N.A.				
	8		NIL				
	9		NIL				
	10		NIL				
	11		NIL				
	12		NIL				
1986	1	5	BG-044	B-707	Baghdad	Rangoon	Poor visibility
		5	GF-156	B-747	Muscat	Bangkok	Poor visibility
		17	BG-028	DC-10	Abu Dhabi	Bangkok	Poor visibility
		17	GF-150	L-1011	Abu Dhabi	Bangkok	Poor visibility
		17	KU-283	A-310	Kwait	Bangkok	Poor visibility
	2		NIL				
	3	31	BG-071	B-707	Rangoon	Calcutta	Bad weather
	4		NIL				
	5		NIL				
	6		NIL				
	7		NIL				
	8		NIL				
	9	27	GF-150	L-1011	Muscat	Bangkok	Bad weather
		27	BG-468	F-28	Jessore	Chittagong	Bad weather
	10	8	SU-332	B-747	Dhahran	Bangkok	Bad weather
	11	9	GF-156	B-747	Muscat	Bangkok	Bad weather
		9	BG-004	DC-10	London	Calcutta	Bad weather
		9	BG-044	B-707	Baghdad	Calcutta	Bad weather
		9	BG-010	DC-10	Bombay	Calcutta	Bad weather
		9	RA-404	B-727	HongKong	Calcutta	Bad weather
	12	23	PK-707	B-707	Karachi	Calcutta	Runway blokage by F-27 tire burst
		23	RA-404	B-727	HongKong	Calcutta	Runway blokage by F-27 tire burst

List of Diverted Aircraft at ZIA (4)

Year 1987 — 1988

Year	Month	Day	Flight No	Aircraft Type	Aerodrome of Departure	Diverted to	Reason of Diversion
1987	1	22	BG-024	DC-10	Muscat	Calcutta	Bad weather
		22	GQ-103	DO-228	Paro	Paro	Bad weather
	2		NIL				
	3		NIL				
	4	10	BG-618	F-28	Jessore	Jessore	Bad weather
		13	BG-404	F-27	Sylhet	Chittagong	Bad weather
	5	20	RA-221	B-727	Kathmandu	Calcutta	Bad weather
		27	BG-702	F-28	Kathmandu	Calcutta	Bad weather
	6	18	BG-618	F-28	Chittagong	Chittagong	Bad weather
	7	24	BG-256	B-707	Jeddha	Calcutta	Bad weather
	8	1	BG-612	F-28	Chittagong	Jessore	Bad weather
		1	BG-616	F-28	Chittagong	Jessore	Bad weather
	9		NIL				
	10		NIL				
	11		NIL				
	12		NIL				
1988	1		NIL				
	2		NIL				
	3		NIL				
	4		NIL				
	5		NIL				
	6		NIL				

Appendix 4.1 Calculation of Take-off Runway Length.

Design Aircraft : DC-10-30

Study Route : Jeddah
Route Distance : 5,400 km

Airport Altitude : Sea Level
Surface Wind : 0 kt
Runway Slope : 0 %
Surface Condition : Wet
Temparature : 35°C

Take-off Weight

Operational Weight Empty : 268,000 lbs
Reserve Fuel (2 hours) : 33,000 lbs
Fuel for 5,400 km Haul : 101,000 lbs
Maximum Structural Payload : 101,000 lbs

Total : 503,000 lbs

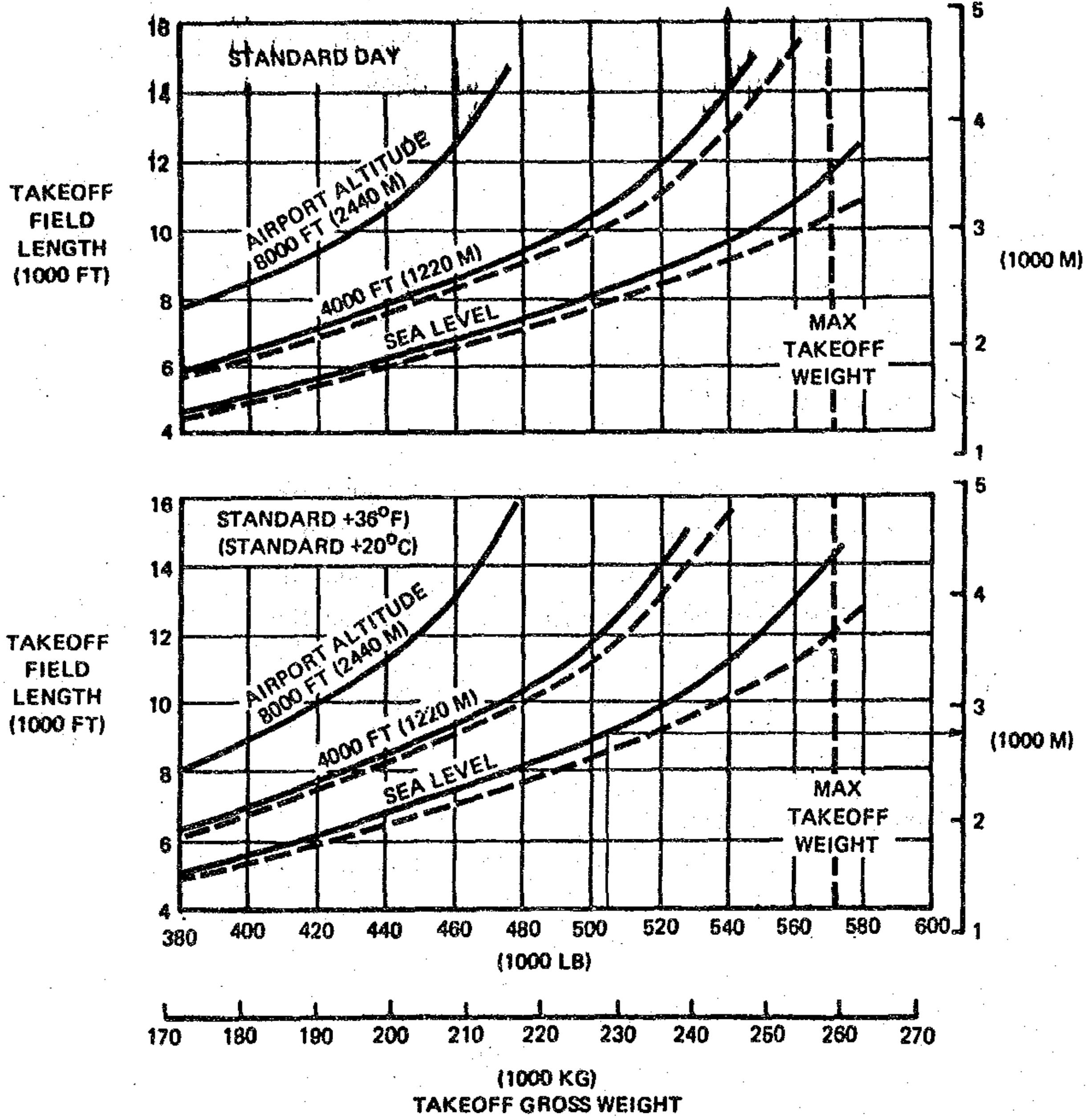
Take-off Runway Length : 2,750 m
(See attached chart)

NOTES:

- TAKEOFF THRUST
- ZERO RUNWAY SLOPE
- ZERO WIND
- A/C PACKS OFF
- G.E. ENGINES

——— CF6-50C

— — — CF6-50C1



FAR TAKEOFF RUNWAY LENGTH REQUIREMENTS
MODEL DC-10 SERIES 30 AND 30CF

Design Aircraft : B-747-200B

Study Route : Jeddah
Route Distance : 5,400 km

Airport Altitude : Sea Level
Surface Wind : 0 kt
Runway Slope : 0 %
Surface Condition : Wet
Temparature : 32°C(90° F)

Take-off Weight

Opertional Weight Empty with 2 Hour Reserve Fuel : 414,000 lbs

Fuel for 5,400 km Haul : 158,600 lbs
Maximum Structural Paybad : 160,700 lbs
Injection Water : 5,900 lbs

Total : 739,200 lbs

Refarence Factor "R" : 67.8
(See attached chart)

Take-off Runway Length : 9,600 ft
≒ 2,950 m
(See attached chart)

TABLE 53. AIRCRAFT PERFORMANCE, TAKEOFF (BOEING 747 SERIES) JT9D-7A ENGINE, 20° FLAPS

MAXIMUM ALLOWABLE TAKEOFF WEIGHT (1000 LBS)

TEMP °F	AIRPORT ELEVATION (FEET) 0	1000	2000	3000	4000	5000	6000	7000	8000
50	785.0	771.0	751.0	730.0	710.0	689.5	669.0	647.0	626.5
55	785.0	771.0	751.0	730.0	710.0	689.5	669.0	647.0	626.5
60	785.0	771.0	751.0	730.0	710.0	689.5	669.0	647.0	622.0
65	785.0	771.0	751.0	730.0	710.0	689.5	666.9	640.2	614.7
70	785.0	771.0	751.0	730.0	710.0	684.9	657.6	631.6	606.4
75	785.0	771.0	751.0	730.0	701.8	674.2	647.7	622.2	597.5
80	785.0	771.0	747.0	717.9	690.0	663.1	637.2	612.2	588.0
85	785.0	763.0	733.7	705.5	678.2	651.9	626.5	601.9	578.2
90	779.1	749.6	721.0	693.3	666.6	640.7	615.6	591.5	568.1
95	765.9	736.8	708.7	681.4	655.0	629.5	604.8	581.0	558.1
100	753.1	724.4	696.7	669.8	643.7	618.6	594.3	570.8	548.3
105	740.3	712.0	684.7	658.3	632.8	608.0	584.2	561.1	538.8
110	727.0	699.4	672.8	647.0	622.1	598.0	574.6	551.9	529.8

REFERENCE FACTOR "R"

TEMP °F	AIRPORT ELEVATION (FEET) 0	1000	2000	3000	4000	5000	6000	7000	8000
50	60.5	64.5	68.6	73.0	77.8	83.1	89.0	95.5	102.8
55	61.2	65.1	69.3	73.8	78.7	84.0	89.9	96.5	103.8
60	61.8	65.8	70.0	74.6	79.5	84.9	90.9	97.6	104.2
65	62.4	66.5	70.7	75.3	80.3	85.8	90.9	98.7	107.8
70	63.1	67.2	71.5	76.1	81.1	86.4	93.6	101.7	111.1
75	63.7	67.9	72.2	76.8	82.2	88.8	96.2	104.6	114.3
80	64.4	68.6	72.6	78.2	84.3	91.1	98.8	107.5	117.4
85	65.0	69.2	74.5	80.2	86.5	93.6	101.5	110.4	120.5
90	66.0	71.0	76.4	82.3	88.8	96.1	104.3	113.5	123.8
95	67.8	72.8	78.4	84.5	91.3	98.8	107.3	116.7	127.2
100	69.6	74.8	80.5	86.8	93.9	101.7	110.5	120.2	131.0
105	71.5	76.8	82.7	89.3	96.7	104.9	114.0	124.1	
110	73.5	79.0	85.2	92.1	99.8	108.4	117.9		

RUNWAY LENGTH (1000 FEET)

WEIGHT 1000 LBS	REFERENCE FACTOR "R" 60	70	80	90	100	110	120	130	140
530	4.34	4.93	5.53	6.15	6.77	7.40	8.01	8.61	9.18
550	4.58	5.27	5.96	6.65	7.34	8.02	8.69	9.36	10.01
570	4.86	5.65	6.43	7.19	7.94	8.69	9.43	10.17	10.91
590	5.18	6.06	6.92	7.76	8.59	9.41	10.23	11.05	11.88
610	5.55	6.51	7.44	8.36	9.27	10.17	11.08	11.98	12.90
630	5.95	6.98	8.00	9.01	10.00	10.99	11.98	12.98	13.98
650	6.39	7.49	8.59	9.69	10.78	11.87	12.95	14.03	15.10
670	6.86	8.03	9.22	10.41	11.61	12.80	13.97	15.13	
690	7.35	8.60	9.89	11.19	12.49	13.79	15.06		
710	7.88	9.21	10.59	12.01	13.43	14.84			
730	8.42	9.84	11.34	12.88	14.43	15.95			
750	8.99	10.51	12.13	13.81	15.49				
770	9.57	11.20	12.96	14.79					
790	10.17	11.93	13.85	15.84					

Appendix 4.2 Calculation of Landing Runway Length

Design Aircraft : B-747-200B

Airport Altitude : Sea Level
Surface Wind : 0 kt
Runway Slope : 0 %
Surface Condition : Wet

Landing Weight

Maximum Landing Weight : 564,000 lbs

Landing Runway Length (Dry) : 2,150 m
(Wet) : 2,450 m
(See attached chart)

Design Aircraft : DC-10-30

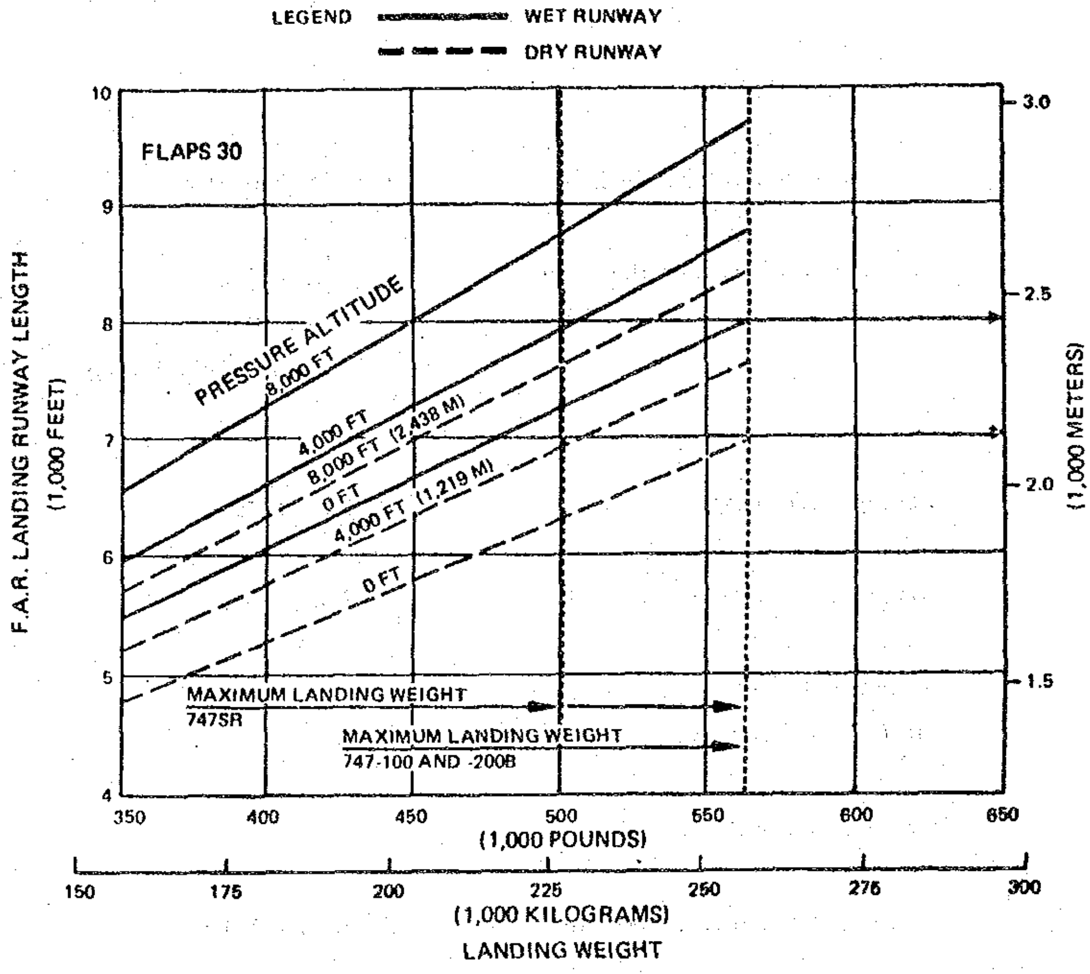
Airport Altitude : Sea Level
Surface Wind : 0 kt
Runway Slope : 0 %
Surface Condition : Wet

Landing Weight

Maximum Landing Weight : 421,000 lbs

Landing Runway Length (Dry) : 1,900 m
(Wet) : 2,200 m
(See attached chart)

NOTES:
- CONSULT USING AIRLINE FOR SPECIFIC OPERATING PROCEDURE PRIOR TO FACILITY DESIGN.
- FOR IMPROVED PERFORMANCE, SEE PAGE 107.



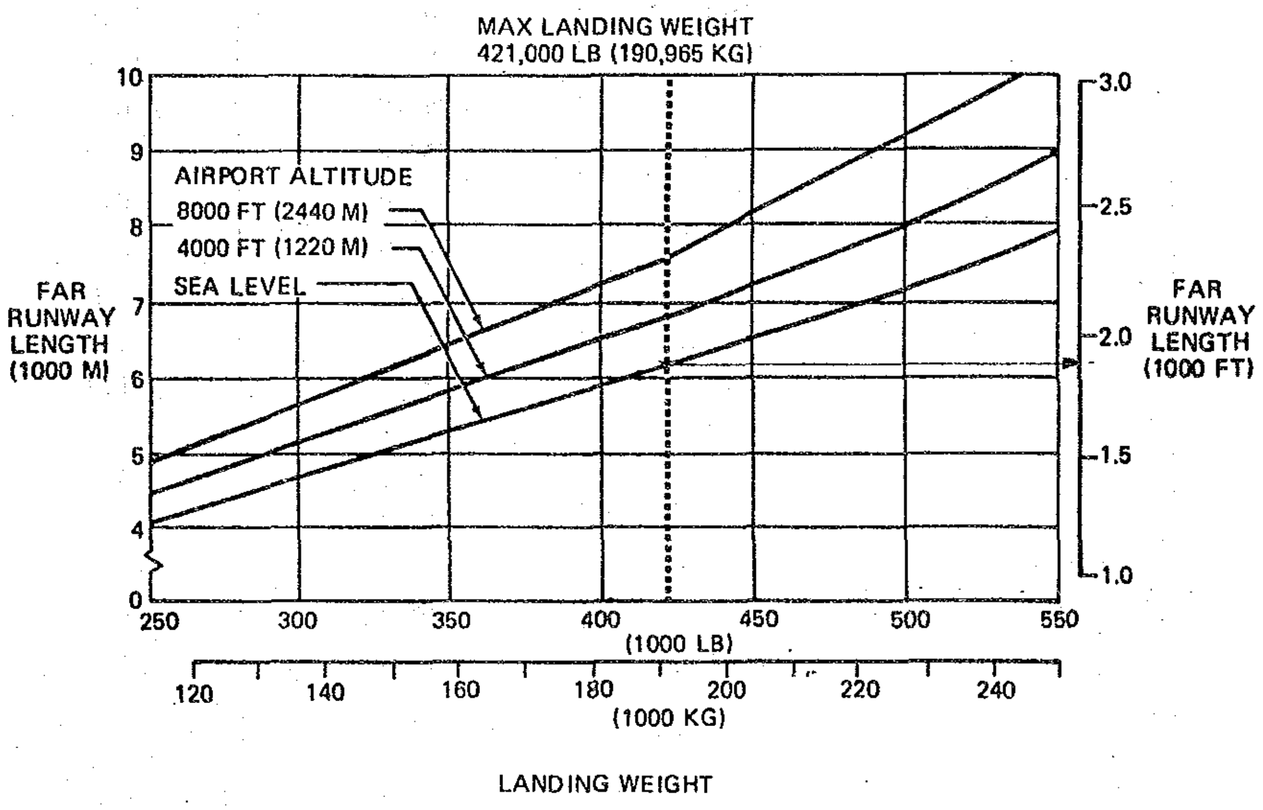
F.A.R. LANDING RUNWAY–LENGTH REQUIREMENTS–INITIAL CERTIFICATION,
***(NO IMPROVEMENTS)* – FLAPS 30**
MODELS 747-100, SR, AND -200B

NOTES:

- FLAPS 50°
- $V_{APP} = 1.3\ V_S$ AT 50 FT
- ANTISKID OPERATIVE
- DRY HARD-SURFACE RUNWAY
- WET RUNWAY LENGTH REQUIREMENTS = 1.15 x DRY RUNWAY LENGTH REQUIREMENTS
- ENGINE CF6-50C, -50C1
- REVERSE THRUST NOT INCLUDED

LEGEND:

- V_{APP} IS APPROACH VELOCITY
- V_S IS STALL VELOCITY



FAR LANDING RUNWAY LENGTH REQUIREMENTS
MODEL DC-10 SERIES 30 AND 30CF

Appendix 4.3 : Dimension of Typical Aircraft

Aircraft Model	Wing Span	Overall Length	Height
B-747-400	64.7	70.7	19.3
B-747-300	59.6	70.5	19.3
B-747-200	59.6	70.5	19.3
DC-10	50.4	55.5	17.4
MD-11	50.4	62.1	17.7
L-1011	47.4	54.2	16.9
B-767-200	47.2	48.5	15.9
A-300	44.8	53.6	16.5
B-707-320	44.4	46.6	12.9
B-757	38.0	47.3	13.6
A-320	34.5	37.4	11.8
B-727-200	32.9	46.7	10.5
MD-80	32.9	45.1	9.2
B-727-100	32.9	40.6	10.4
B-737-300	28.9	33.4	11.1
DC-9-40	28.4	38.3	8.5
B-737-200	28.4	30.5	11.3
ATP	30.6	26.0	7.1
F-50	29.0	25.2	8.6
F-27	29.0	25.1	8.7
F-28-4000	25.1	29.6	8.5
DASH-8	25.6	22.2	7.6
ATR-42-100	24.6	22.5	7.6
SF-340	21.4	19.7	6.7

Appendix 4.4 The Unit Space for a Parking Lot

The following formula is used to calculate the unit space for a Parking Lot.

$$U = S_c \times A_c + S_a \times R_a \times A_c + S_a \times (1-R)_a \times A_a$$

where U : Estimated unit parking space

S_c : Present share of car parking (24%)

S_a : Present share of autorickshow parking (76%)

A_c : Unit space for car
(A_c = 35 sq.m from Japanese practice for car parking space)

A_a : Unit space for autorickshow
(A_a = 9 sq.m estimated space based on the size of autorickshow)

R_a : Assumed share of car replaced from autorickshow
(75%)

Therfore,

$$U = 0.24 \times 35 + 0.76 \times 0.75 \times 35 + 0.76 \times (1-0.75) \times 9 = 30 \text{ sq.m}$$

Appendix 5.1 Runway Capacity Calculation

The capacity of the existing runway is calculated based on the following conditions.

a) Runway and Taxiway Configuration

Existing runway with one exit taxiway located at the centre of the runway

b) Ratio of Take-offs and Landings during Peak Hour

1 : 1

c) Sparation Minima

Approach : 120 sec
Take-off : 60 sec

d) Aircraft Mix

Maximum take-off weight of all aircraft is assumed to be more than 15,500 lbs and 300,000 lbs

e) Aircraft Speed

Approach : 120 kt = 222 km/hr
Taxiing : 40 km/hr

f) Necessary Time for Take-off and Landing

Landing : 60 sec (From runway threshold to starting point of taxiing)
Take-off : 60 sec (From runway treshold to runway end)

g) Runway Occupancy Time

- Take-off
  - From taxiway to runway : 10 sec
  - Taxiing runway for 1,500m : 135 sec
  - Turn at runway threshold : 10 sce
  - Take-off and reach runway end : 60 sec
  - Total : 215 sec

- Landing
  - Landing : 60 sec
  - Turn : 10 sec
  - Taxing runway for 300m : 30 sec
  - From runway to taxiway : 10 sec
  - Total : 110 sec

- Landing followed by Landing
  - Separation minima : 120 sec
  - Landing : 110 sec
  - Total : 230 sec

- Landing followed by Take-off
  - Separation minima : 120 sec
  - Landing : 110 sec
  - Taxiway to apron : 20 sec
  - Apron to taxiway : 20 sec
  - Total : 270 sec

- Take-off followed by Take-off : 215 sec

- Take-off followed by Landing : 215 sec

- Averge Occupancy Time (230+270+215+215)/4 : 233 sec

Hourly capacity of the runway is 15 operations

Assuming the operational hours of 12 hours per day, annual capacity of the runway is calculated as 66,000 annual operations.

Appendix 5.2 Result of Visual Investigation of Pavement Surface Condition

The result of visual investigation of pavement surface condition is shown in Figure A5-2-1.

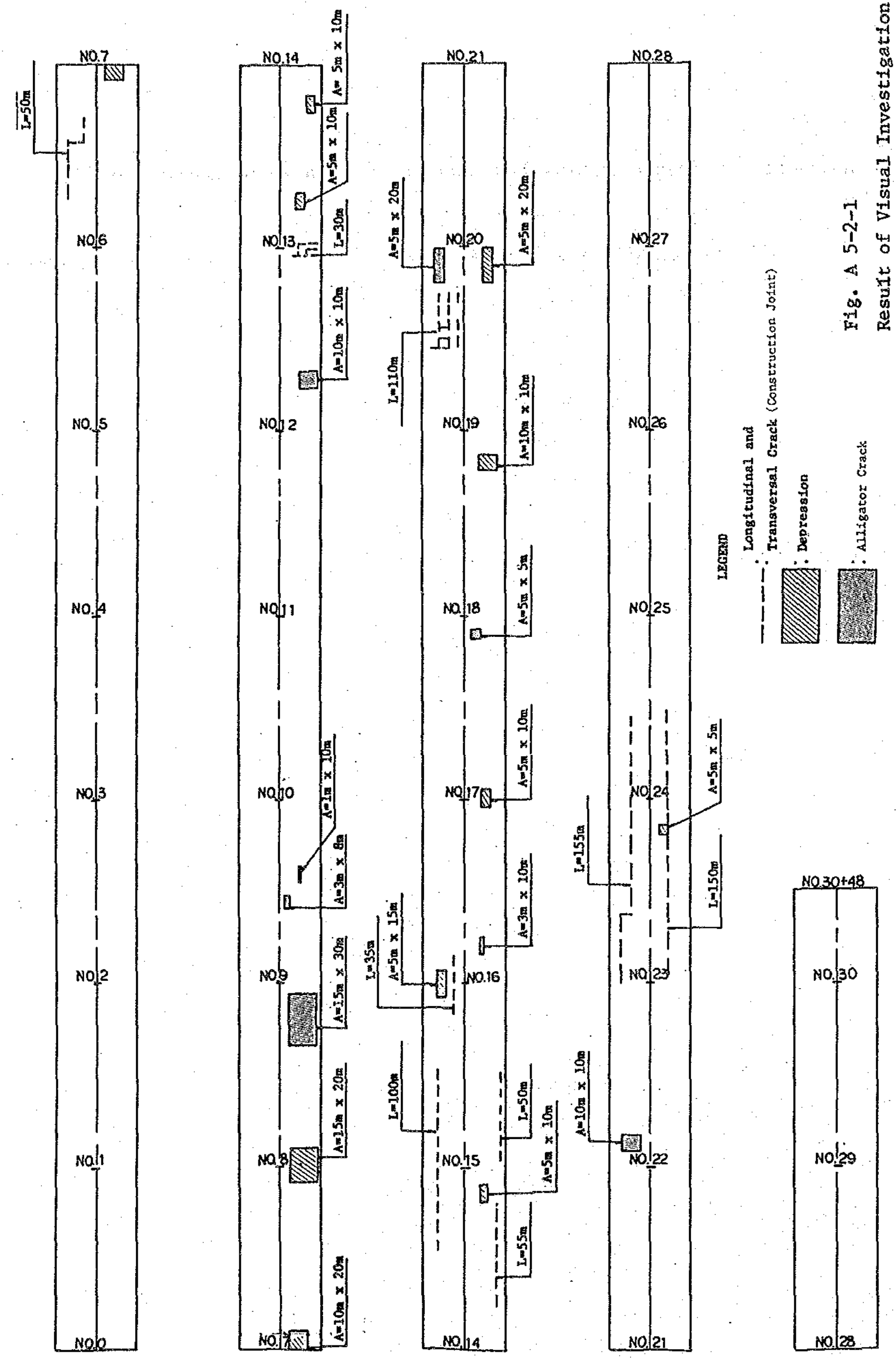


Fig. A 5-2-1
Result of Visual Investigation of Runway Pavement

Appendix 5.3 Result of Soil Investigation for Pavement

Soil Investigation was carried out at the points shown in Fig A5-3-1 and result are summarized as follows :

(1) Soil condition investigated at 7 test pits in runway strip are shown in Table A5-3-1 and A5-3-2, and summarized as follows :

- Classificaiton of soil : Silty sand, silty clay or silt
- Field CBR : Approximately 3.5%
- Field density : Approximately 1.44g/Cm^3

(2) Situation of runway pavement is shown in Table A5-3-3 and A5-3-4 and summzrized as follows :

- Classification of subgrade : Silty sand and silty clay
- Field CBR : 7.0%
  (Based on the Dynamic Cone Penetration Test Result at Subgrade of Runway)
- Design CBR : 5.5%

$$7.0\% \times \frac{4.3}{5.5} = 5.5\%$$

Taking account of the decrease of the value of CBR due to ground water, the above field CBR 7.0% is adjusted based on the value of soaked and unsoaked CBR shown on the Table A5-3-2 .

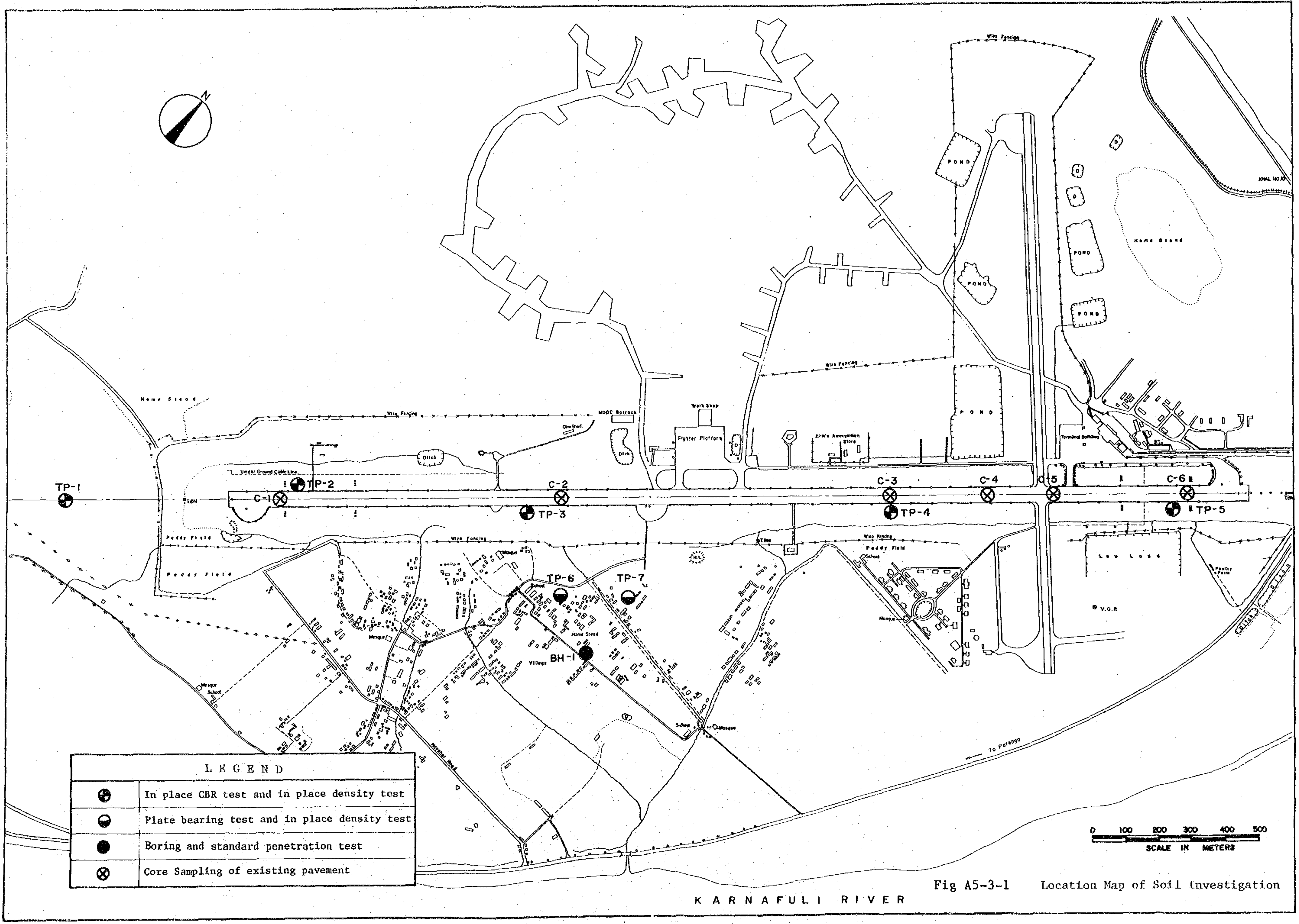


Fig A5-3-1 Location Map of Soil Investigation

Table A5-3-1 Test Pit (Physical Property Test)

Sample Number	Depth (Meter)	Gradation (%)				Uc	Ucl	W_L	Ip	Specific Gravity	Classification
		Graval	Sand	Silt	Clay						
TP-1	0-2	-	39	52	9	25	0.63	39.0	12.2	2.64	ML
TP-2	0-2	-	32	55	13	7	0.02	52.8	21.3	2.65	MH
TP-3	0-2	-	34	52	14	-	-	45.6	15.3	2.65	ML
TP-4	0-2	-	37	49	14	-	-	51.4	19.5	2.64	MH
TP-5	0-2	-	37	53	10	30	1.01	40.0	13.6	2.65	CL
TP-6	0-2	-	42	45	13	70	1.03	48.0	19.7	2.65	CL
TP-7	0-2	-	32	56	12	55	1.02	42.0	13.6	2.65	ML

Uc : Coefficient of Uniformity D60/D10
Ucl : Coefficient of Curvature $(D30)^2/D10xD60$
W_L : Liquid Limit
Ip : Plasticity Index

Table A5-3-2 Test Pit (CBR Test)

Sample Number	Depth (Meter)	Field Density			Field CBR	Modified Compaction		Laboratory CBR Test	
		Wet g/cm^3	Dry g/cm^3	NMC %		MDD g/cm^3	OMC %	Unsoaked CBR	Soaked CBR
TP-1	1	1.78	1.38	29.0	0.9	1.75	17.5	7.2	4.0
	2	1.89	1.46	28.7	-				
TP-2	1	1.86	1.45	27.6	3.4	1.73	17.8	4.3	5.0
	2	1.86	1.38	34.3	-				
TP-3	1	1.86	1.43	29.2	3.4	1.76	18.2	6.0	7.0
	2	1.76	1.23	41.9	-	1.80	16.0	9.1	11.0
TP-4	1	1.90	1.46	29.6	3.7	1.75	17.7	5.7	4.4
	2	1.88	1.42	32.2	-				
TP-5	1	1.90	1.48	27.5	4.0	1.79	16.2	8.1	6.0
	2	1.88	1.44	30.0	-				
TP-6	1	1.75	1.30	34.2		Average		5.5	4.3
	2	1.90	1.47	29.0		Plate Bearing Test K30 = 1.5 kg/cm^3			
TP-7	1	1.86	1.43	29.8		Plate Bearing Test K30 = 0.33 kg/cm^3			
	2	1.86	1.38	34.6					

Abbreviations

NMC : Natural Moisture Content	OMC : Optimum Moisture Contnent
CBR : California Bearing Ratio	MC : Moisture Content
MDD : Maximum Dry Density	

Table A5-3-3 Core Sampling

Sample Number	Depth Meter	Gradation				Uc	Ucl	W_L	Ip	Specific Gravity	Classification
		Graval	Sand	Silt	Clay						
C-1	0.7-0.8	-	22	66	12	55.0	4.8	37	12	2.66	ML
C-2	0.75-0.90	-	28	54	18	-	-	45	17	2.67	ML
C-3	0.73-0.90	-	22	61	17	-	-	43	17	2.66	CL
C-4	0.66-0.75	-	34	49	17	38.0	1.68	36	12	2.66	CL

Uc : Coefficient of Uniformity D60/D10
Ucl : Coefficient of Curvature $(D30)^2/D10xD60$
W_L : Liquid Limit
Ip : Plasticity Index

Table A-3-2 CBR of RWY Subgrade Obtained from Dynamic Cone Penetration Test

Number	C-1	C-2	C-3	C-4	Average
mm/5, blows	154	135	100	121	
CBR %	5.3	6.3	9.3	7.3	7.05

$$\text{DCP CBR} = \frac{3700}{(\text{mm/5 Blow})^{1.3}}$$

Appendix 5.4 Analysis for the Consolidation of Runway Foundation

(1) Consolidation Settlement

Consolidation settlement is estimated by the following formula:

$$S = \frac{Cc}{f_o} * H * \log \frac{Pv + \Delta P}{Pv}$$

S : Consolidation Settlement (cm)
Cc : Compression Index
(0.34 obtained from consolidation test)
f_o : Initial Volume Ratio ($f_o = 1.0 + e_o$)
e_o : Initial Void Ratio (1.2 obtained from consolidation test)
H : Thickness of Consolidation Layer (585 cm measurered from Boring Log)
Pv : Initial Effective Overburden Layer
($585/2$ cm*1.76 g/cm^3 = 515 g/cm^2)
ΔP : Consolidation Pressure (70 cm * 2.1g/cm^3 =147 g/cm^2)

Therfore

$$S = \frac{o.34}{2.2} * 585 * \log \frac{515 + 147}{515} = 9.8 \text{ cm}$$

(2) Maximum Duration Time of Consolidation

Maximum duration time of consolidation is estimated by the following formula :

$$t = T \cdot \frac{H^2}{Cv}$$

t : Duration Time of Consolidation
T : Time Factor
(When 100% of consolidation is achieved, T = 3.0)
Cv : Coefficient of Consolidation
(0.067 cm^2/minutes obtained from the consolidation test)
H : Drainage Distance
(When well-drain layers exist in both end of consolidation layer,
Thickness of consolidation is deemed to be half of total depth i.e.
Thickness of layer : 5.85m
Thickness of consolidation : 5.85m x 1/2 = 2.93m)

Therefore

$$t = 3.0 \times \frac{293^2}{0.067} = 3,800,000 \text{ minutes} = 7.3 \text{ years}$$

(3) Strength of Consolidated Soil

The foundation below the runway pavement has been strengthened by the consolidation. The strength of consolidated soil is estimated by the following formula:

$$Cu = Cuo + m*(Pv - P'c + P)*V$$

Cu : Strength of Consolidated Soil (t/m^2)

Cuo : Strength of Original Soil
($qu/2 = 0.306/2 = 0.153\ kg/cm^2 = 1.53\ t/m^2$)

m : Increase Rate of Strength
(m = 0.35, when clay or silt)

Pv : ($= 515\ g/cm^2 = 5.15\ t/m^2$)

P'c : ($= Cuo/m = 1.53/0.35 = 4.37\ t/m^2$)

P : ($= 147\ g/cm^2 = 1.47\ t/m^2$)

V : Rate of Consolidation (=1.0)

Therefore

$$Cu = 1.53 + 0.35\ (5.15 - 4.37 + 1.47) \times 1.0$$
$$= 2.32\ t/m^2$$

Strength of original soil, i.e., 1.53 t/m^2 has been intensified to 2.32 t/m^2 (=0.232 kg/cm^2) by the consolidation.

Table A5-4-1 Phisical Property Test of Mechanical Boring

Sample Number	Depth (Meter)	Gradation				Uc	Ucl	W_L	Ip	Specific Gravity	Classification
		Graval	Sand	Silt	Clay						
D-2	1.9-2.3	-	32	53	15	48.33	0.60	40.75	18.83	2.66	CL
UD-1	2.5-2.9	-	30	50	20	-	-	47.25	19.55	2.66	CL
D-6	5.9-6.8	-	82	18	0	5.70	0.80	-	NP	2.64	CL
D-9	8.9-9.3	-	52	41	7	15.56	2.15	28.70	20.72	2.65	SC
UD-3	9.5-9.9	-	38	54	8	28.57	0.34	36.33	23.54	2.65	CL
D-12	11.9-12.3	-	34	56	10	27.78	1.6	36.05	13.04	2.64	CL
D-14	13.9-14.3	-	50	43	7	18.9	0.88	34.25	12.10	2.66	SC
D-18	17.9-18.3	-	92	8	0	5.14	2.1	-	NP	2.64	SM
D-21	20.9-21.3	-	90	10	0	4.83	1.86	-	NP	2.63	SM
D-40	39.9-40	-	78	22	0	-	-	-	NP	2.64	SM

Table A5-4-2 Result of Mechanical Property Test

Sample Item		UD-1	UD-3
Unconfined Compression	Compressive Strength qu(kg/cm^2)	0.306	0.214
	Modulas of Elasticity E (kg/cm^2)	8.15	3.35
Consolidation	Compression Index Cc	0.34	0.1588
	Coefficient of Consolidation Cv (cm^2/minite)	0.041-0.092 (Average:0.067)	0.727-2.723 (Average:1.725)

BORE HOLE LOG
(BH-1)

CLIENT :
PROJECT : CHITTAGONG AIR PORT
LOCATION : POTENGA
BORE HOLE NO. 1

GROUND LEVEL : 2.850 m
GROUND WATER LEVEL : 1·90m(Below G.L)
DATE : 21-1-89
TIME :

DATE	NUMBER OF SAMPLE	TYPE OF SA	DEPTH IN METER	THICKNESS IN METER	DESCRIPTION OF MATERIALS	LOG	BLOWS ON SPOON PER 10 cm PENETRATION 10 cm	10 cm	10 cm	10 cm	N-MEASURED
	D1	▨	1·0	5.85	Light brown/grey very soft to soft CLAY, low to medium plastic	CL	·5	·5	1	1·5	3
	D2	▨	2·0				1	1	1	1	3
	UD1	▩									
	D3	▨	3·0				0	·5	·5	1	2
	D4	▨	4·0				0	·5	·5	·5	1·5
	UD2	▩									
	D5	▨	5·0				0	·5	·5	·75	1·75
	D6	▨	6·0	0.90	Grey, very loose silty FINE SAND, nonplastic	SM	1	2	2	1	5
	D7	▨	7·0	3.85	Grey very soft to soft CLAY, low plastic	CL	·5	·5	·5	·5	1·5
	D8	▨	8·0				·5	1	·5	·5	2
	D9	▨	9·0				3	1	·5	·5	2
	UD3	▩									
	D10	▨	10·0				1	1	1	1	3
	D11	▨	11·0	1.60	Grey soft CLAY, low plastic	CL	1	2	2	1·5	5·5
	D12	▨	12·0				1	1	1	1	3
	D13	▨	13·0	3.0	Grey soft to medium stiff CLAY, low plastic (CL)	CL	1	1	2	2	5
	D14	▨	14·0				2	1	2	3	6
	D15	▨	15·0				2	1	3	3	7
	D16	▨	16·0	1.0	Grey loose silty FINE SAND	SM	3	2	1	4	7
	D17	▨	17·0		Grey medium dense to very dense silty FINE SAND non-plastic	SM	5	6	12	24	42
	D18	▨	18·0				22	cm			
	D19	▨	19·0				16	cm			
	D20	▨	20·0				18	cm			

STANDARD PENETRATION RESISTANCE
BLOWSPER 30cm OF PENETRATION

INDEX
▨ DISTURBED
▩ UN DISTURBED
REMARKS

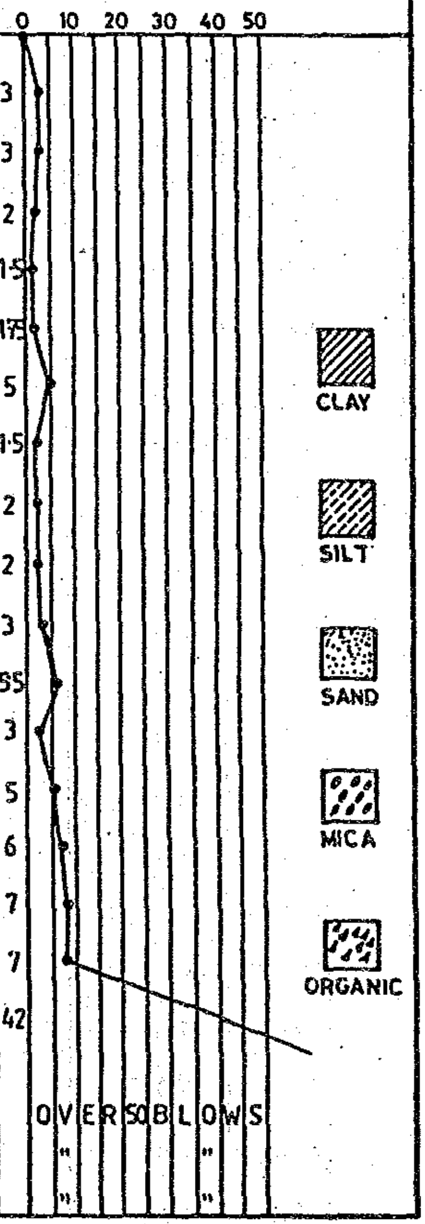


Figure A-4-1 Mechanical Boring (1)

BORE HOLE LOG
(BH-1)

CLIENT PROJECT CHITTAGONG AIRPORT LOCATION POTENGA BORE HOLE NO. I	GROUND LEVEL: 2.850 m GROUND WATER LEVEL: 1·90m(Below G·L) DATE 21—1—89 TIME:

DATE	NUMBER OF SAMPLE	TYPE OF SAMPLE	DEPTH IN METER	THICKNESS IN METER	DESCRIPTION OF MATERIALS	LOG	BLOWS ON SPOON PER 10 cm PENETRATION 10 cm	10 cm	10 cm	10 cm	N-MEASURED	STANDARD PENETRATION RESISTANCE BLOWSPER 30cm OF PENETRATION 0 10 20 30 40 50	INDEX ▨ DISTURBED ▨ UN DISTURBED REMARKS
	D21	▨	21·0		Gray medium dense to very dense silty FINE SAND non-plastic		17	cm				OVER 50 BLOWS	
	D22	▨	22·0				18	cm				" "	
	D23	▨	23·0				20	cm				" "	
	D24	▨	24·0				19	cm				" "	
	D25	▨	25·0				20	cm				" "	
	D26	▨	26·0				19	cm				" "	▨ CLAY
	D27	▨	27·0			SM	23	cm				" "	
	D28	▨	28·0	24.1			18	cm				" "	
	D29	▨	29·0				19	cm				" "	▨ SILT
	D30	▨	30·0				18	cm				" "	
	D31	▨	31·0				17	cm				" "	▨ SAND
	D32	▨	32·0				17	cm				" "	
	D33	▨	33·0				15	cm				" "	
	D34	▨	34·0				16	cm				" "	▨ MICA
	D35	▨	35·0				13	cm				" "	
	D36	▨	36·0				14	cm				" "	▨ ORGANIC
	D37	▨	37·0				14	cm				" "	
	D38	▨	38·0				15	cm				" "	
	D39	▨	39·0				14	cm				" "	
	D40	▨	40·0				16	cm				" "	

Figure A-4-1 Mechanical Boring (2)

Appendix 5.5 Evaluation of Existing Runway Pavement

Judging from the observation of the core samples, strength of the existing runway pavement are evaluated as follows :

(1) Equivalency Factor

Equivalency factor of existing sub-base and base course are determined in accordance with FAA standard

i) Base Course Material	Equivalency Factor
a) Asphalf Concrete (Good)	1.4
b) Asphalt Concrete (Fair)	1.2
c) Cement Concrete	1.2
d) Rainforced Cement Concrete	1.4
e) Brick	0.8 (For Evaluation of Existing Pavement Only)

ii) Sub-base Course Material	
a) Asphalt Concrete (Good)	1.5
b) Asphalt Concrete (Fair)	1.3
c) Cement Concrete	1.4
d) Rainforced Cement Concrete	1.6
e) Cement Gravel	1.0
f) Gravel	1.0
g) Brick	1.0

(2) Evaluated Thickness of Runway Pavement

Based on the above equivalency factor, thickness of the existing runway pavement are evaluated as follows:

Conditions: Required thicknesss of surface & binder course and base course are estimated as 10cm and 25cm respectively based on the FAA design standard.

Table A5-4-1 Evaluated Thickness of Runway Pavement (1)

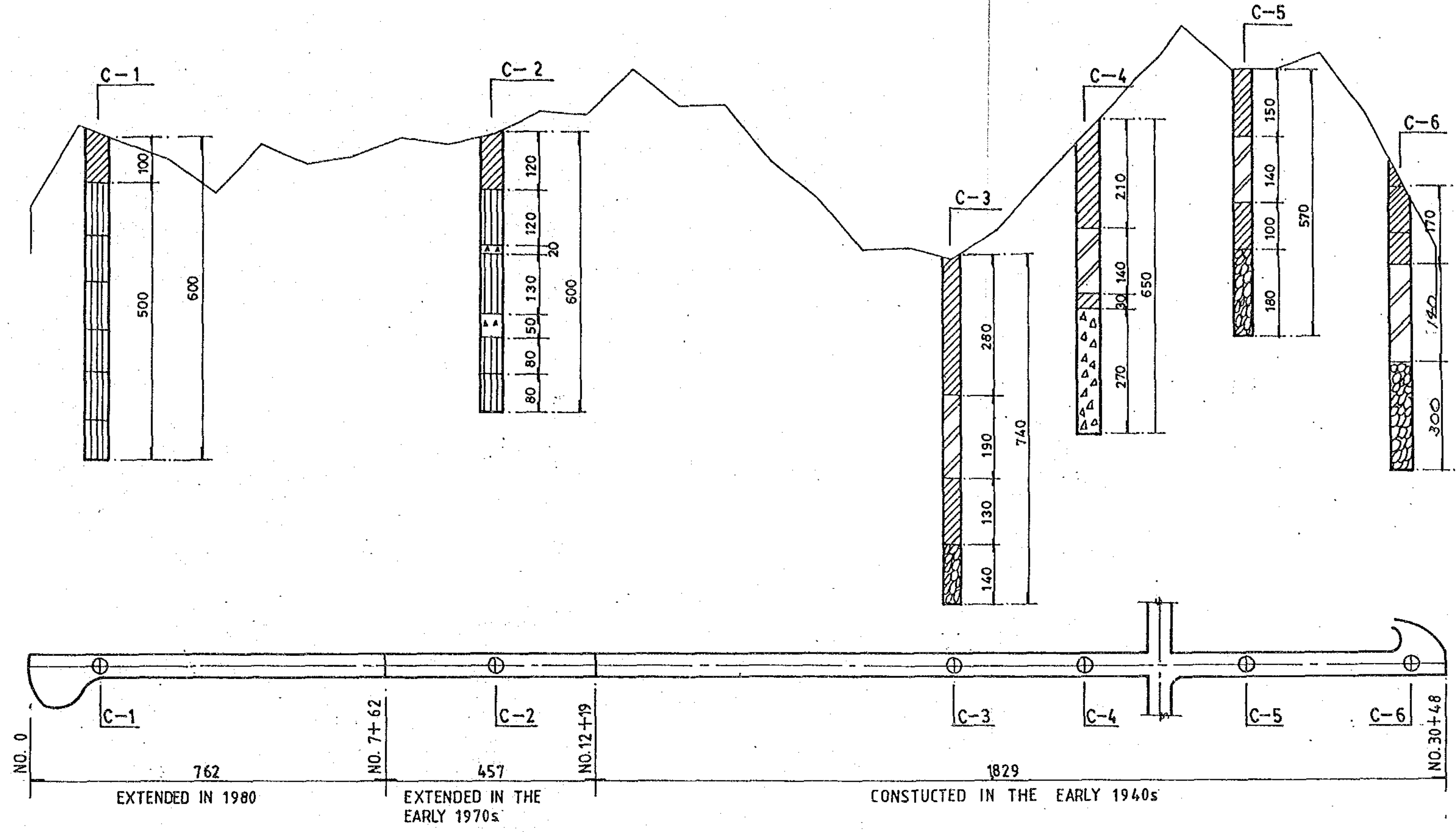
(Unit: m/m)

Number of Core Sample	C − 1		C − 2		C − 3	
	Actual Thickness	Evaluated Thickness	Actual Thickness	Evaluated Thickness	Actual Thickness	Evaluated Thickness
Calculation of Pavement Thickness	Asphalt 100	Surface & Binder 100	Asphalt 120	Surface & Binder 100	Asphalt 280	Surface & Binder 100
	Brick 500	Base 310x0.8= 250 Sub-base 190x1.0= 190		Base 20x1.2=24		Base 180x1.2= 216
			Brick 120	120x0.8= 96	Reinforced Concrete 190	24x1.4=34 Sub-base 166x1.6= 266
			Cement 20	20x1.2=24		
			Brick 130	130x0.8= 104	Asphalt 130	130x1.2= 156
			Cement 50	Sub-base 50x1.4=70	Gravel 140	140x1.0= 140
			Cement 80	80x1.0=80		
			Brick 80	80x1.0=80		
Total Thickness	600	540	600	578	740	912

Table A5-5-1 Evaluated Thickness of Runway Pavement (2)

(Unit: m/m)

Number of Core Sample	C − 4		C − 5		C − 6	
	Actual Thickness	Evaluated Thickness	Actual Thickness	Evaluated Thickness	Actual Thickness	Evaluated Thickness
Calculation of Pavement Thickness	Asphalt 210	Surface & Binder 100	Asphalt 150	Surface & Binder 100	Asphalt 170	Surface & Binder 100
		Base 110x1.2= 132		Base 50x1.2=60		Base 70x1.4=98
	Reinforced Concrete 140	84x1.4= 118	Reinforced Concrete 140	136x1.4= 190 Sub-base 4x1.6=6	Reinforced Concrete 140	109x1.4= 153
		Sub-base 56x1.6=90	Asphalt 100	100x1.2= 120		Sub-base 31x1.6= 50
	Asphalt 30	30x1.2=36	Gravel 180	180x1.0= 180	Gravel 300	300x1.0= 300
	Cement Gravel 270	270x1.0= 270				
Total Thickness	650	746	570	656	610	701

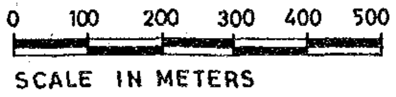


PCNs	20	23	57	33

LEGEND

MARK	DESCRIPTION	MARK	DESCRIPTION
▨	ASPHALT CONCRETE	▲▲▲	CEMENT CONCRETE
▧	REINFORCED CEMENT CONCRETE	△△△	CEMENT GRAVEL
░	GRAVEL	C −	NEMBRE OF CORSE SAMPLING
▥	BRICK		

FIG. A5-5-1 STRUCTURE AND PCNs OF EXISTING RUNWAY PAVEMENT

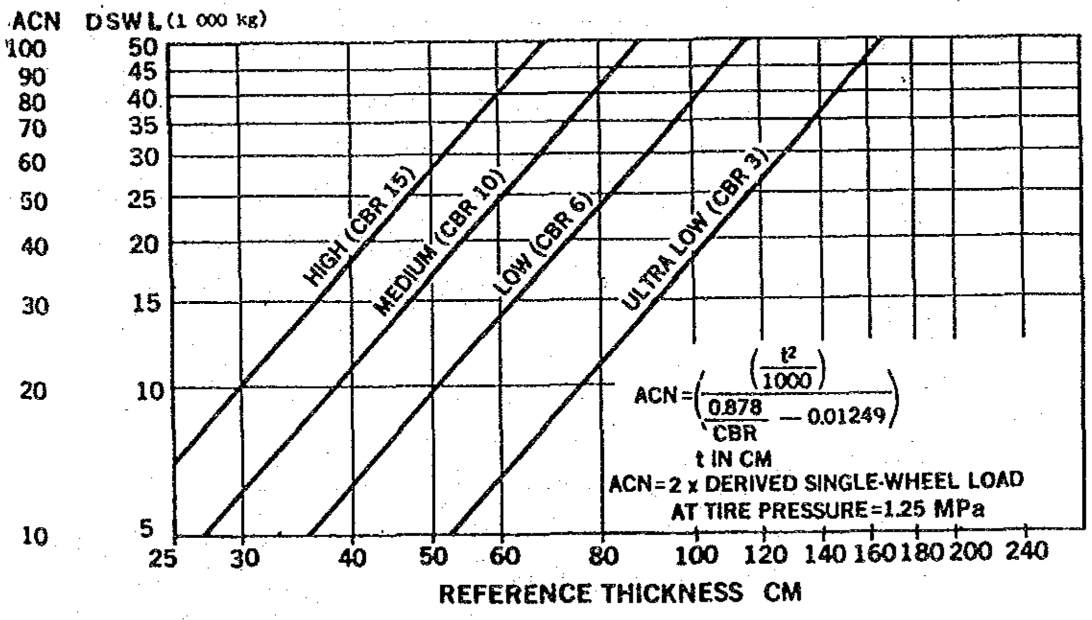


(3) PCNs of Existing Runway

Existing runway pavement is evaluated based on the design CBR and thickness which are described in Appendix 5-3 and 5-5 respectively , and indicated by the value of PCN.

Table A5-5-2 PCNs of Existing Runway

Sample Item	C-1	C-2	C-3	C-4	C-5	C-6
Evaluated Strength of Subgrade(%)	5.5	5.5	5.5	5.5	5.5	5.5
Evaluated Reference Thickness(cm)	540	578	912	746	656	701
PCNs of RWY	20	23	57	38	29	33



Source : FAA

Fig. A5-5-1 ACN Flexible Pavement Conversion Chart

Appendix 5,6 Bearing Strength of Foundation of Runway

1. Design Conditions

i) Design Aircraft : DC-10-30 <B-747-400>

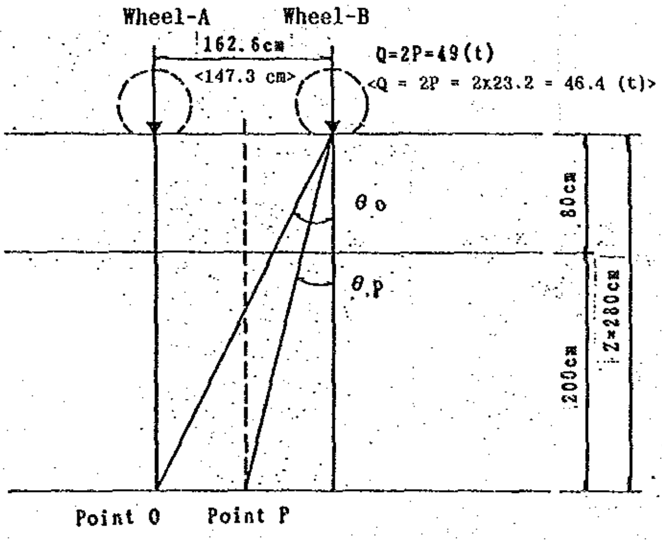
ii) Thickness of Pavement : 80 cm

iii) Wheel Load : 24.5 ton (98.05 ÷ 4 = 24.51)<23.2 ton (92.75/4=23.19)>

iv) Thickness of Subgrade : 200 cm

v) Allowable Strength of Foundation : 0.232 kg/cm^2

(Strength of Consolidated Soil is calculated in Appendix 5-3 (3).)



$$\theta o = \tan^{-1} \frac{162.6}{280}$$

$$\theta p = \tan^{-1} \frac{162.6 \times 1/2}{280}$$

Note : Figures put in angle bracket < > show the design condition and calculation for B-747-400

2. Calculation of Stress

i) Point O

(wheel-B)

$$\tau \, PZB = \frac{3\theta}{2\pi Z^2} \cos^4\theta o \, \sin\theta o = 0.0838$$

$$\sigma \, ZB = \frac{3\theta}{2\pi Z^2} \cos^5\theta o = 0.1443$$

$$\sigma \, PB = \frac{3\theta}{2\pi Z^2} \cos^3\theta o \, \sin^2\theta o = 0.0487$$

(Wheel-A)

$\theta o = 0$

$\tau PZA = 0$

$$\sigma ZA = \frac{3\theta}{2\pi Z^2} \times 1.0000 = 0.2984$$

$\sigma PA = 0$

Stress at Point 0 is :

$\tau PZ = 0.0838 \ (kg/cm^2)$

$\sigma Z = 0.4427 \ (kg/cm^2)$

$\sigma P = 0.0487 \ (kg/cm^2)$

$$\sigma 1,2 = \frac{(\sigma Z + \sigma P) \pm \sqrt{(\sigma Z - \sigma P)^2 + (2\tau PZ)^2}}{2}$$

$\therefore \ \sigma_1 = 0.4598 \ (kg/cm^2)$

$\therefore \ \sigma_2 = 0.0316 \ (kg/cm^2)$

$$\tau \max = \frac{0.4598 - 0.0316}{2} = 0.2141 \ (kg/cm^2)$$

ii) Point P

The result of calculation is:

$\tau \max = 0.265 \ (Kg/cm^2)$

<0.27>

3. Adjustment of Stress in the Two Flexible Layers

The above stress is estimated under the assumption of the stress in the single flexible layer. In the case of different flexible layer under the same intensity of surcharge load, the above stress can be reduced because of wider distribution of surcharge load than that of single flexible layer. The stress is calculated as follows:

i) Coefficient of elasticity (E)

a. Flexible Pavement : $Ep = 3,000 \ Kg/cm^3$

b. Subgrade and Foundation : $Es = 35CBR = 140 \ Kg/cm^3$

c. Ratio of E : $\frac{Ep}{Es} = \frac{3,000}{140} = 21$

ii) Reduction of Stress

According to the diagram prepared by Dr. Burmister, the coefficient of elasticity is about 20, and the stress in the two different flexible layers is about 64% of the stress in the single layer.

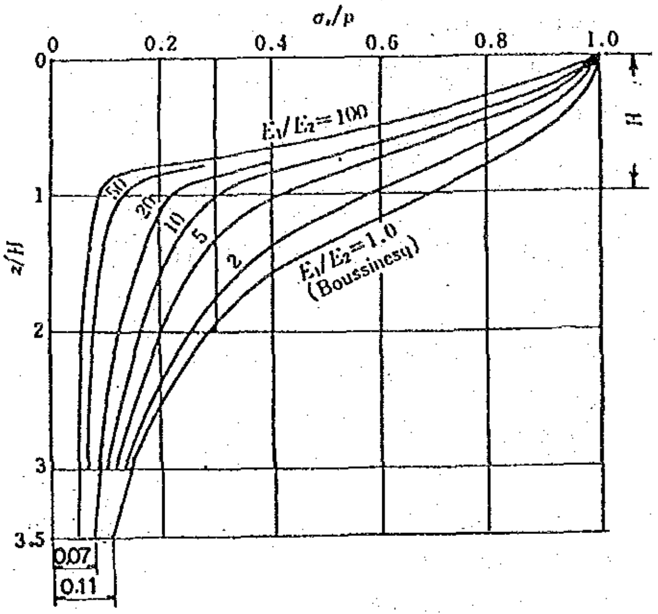


Figure A5-6-1 Diagram for Distribution of Stress in Two Flexible Layers

where,

$$\frac{Z}{H} = \frac{280\ \text{cm}}{80\ \text{cm}} = 3.5$$

$$\frac{Ep}{Es} \fallingdotseq 20 \qquad \therefore \frac{\sigma z}{P} = 0.07$$

$$\frac{Ep}{Es} = 1 \qquad \therefore \frac{\sigma z}{P} = 0.11$$

Therefore

$$\frac{0.7}{0.11} \fallingdotseq 0.64$$

Adjusted stress is:

$\tau'\text{max} = 0.265 \times 0.64 = 0.17\ (\text{Kg/cm}^2) < 0.232\ (\text{Kg/cm}^2)$

<0.27> <0.17>

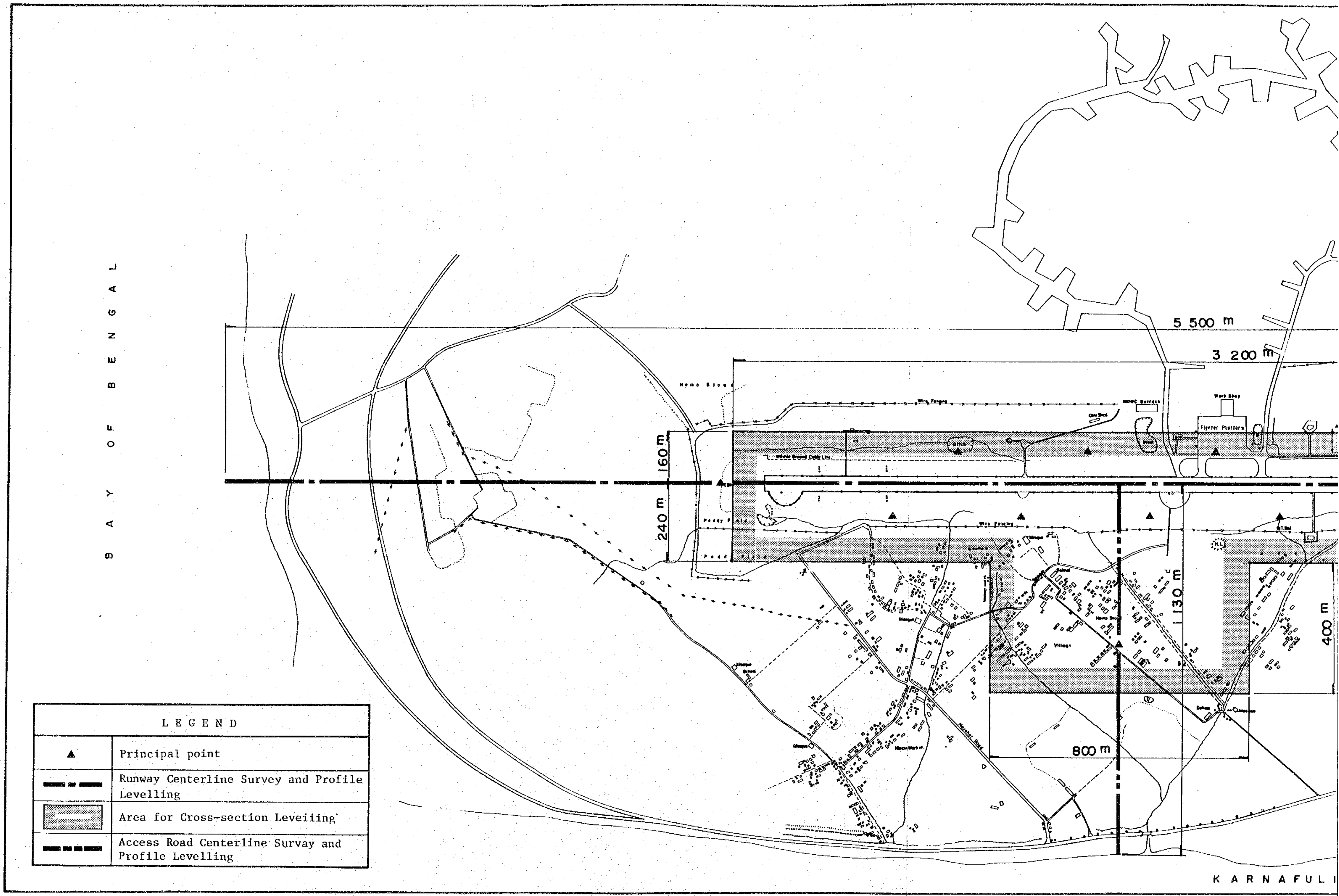
Therefore, the foundation has sufficient strength to bear the load of DC-10 and B-747-400 aircraft.

Appendix 5.7 Result of Topographic Survey

The survey work consisted of the following items:

a) Establishment of Principal Points
b) Centerline Survey
c) Profile Survey
d) Cross-section Survey
e) Topographic Survey
f) Obstruction Survey

Survey area and location are shown in Fig. A5-7-1


BAY OF BENGAL
5 500 m
3 200 m
160 m
240 m
1130 m
400 m
800 m
Wire Fencing
Wire Fencing
MODC Barrack
Work Shop
Fighter Platform
Cow Shed
Ditch
Under Ground Cable Line
Paddy Field
Paddy Field
Mosque
Village
School
Market Road
Karnafuli Market
KARNAFULI
LEGEND
Principal point
Runway Centerline Survey and Profile Levelling
Area for Cross-section Leveiing
Access Road Centerline Survay and Profile Levelling

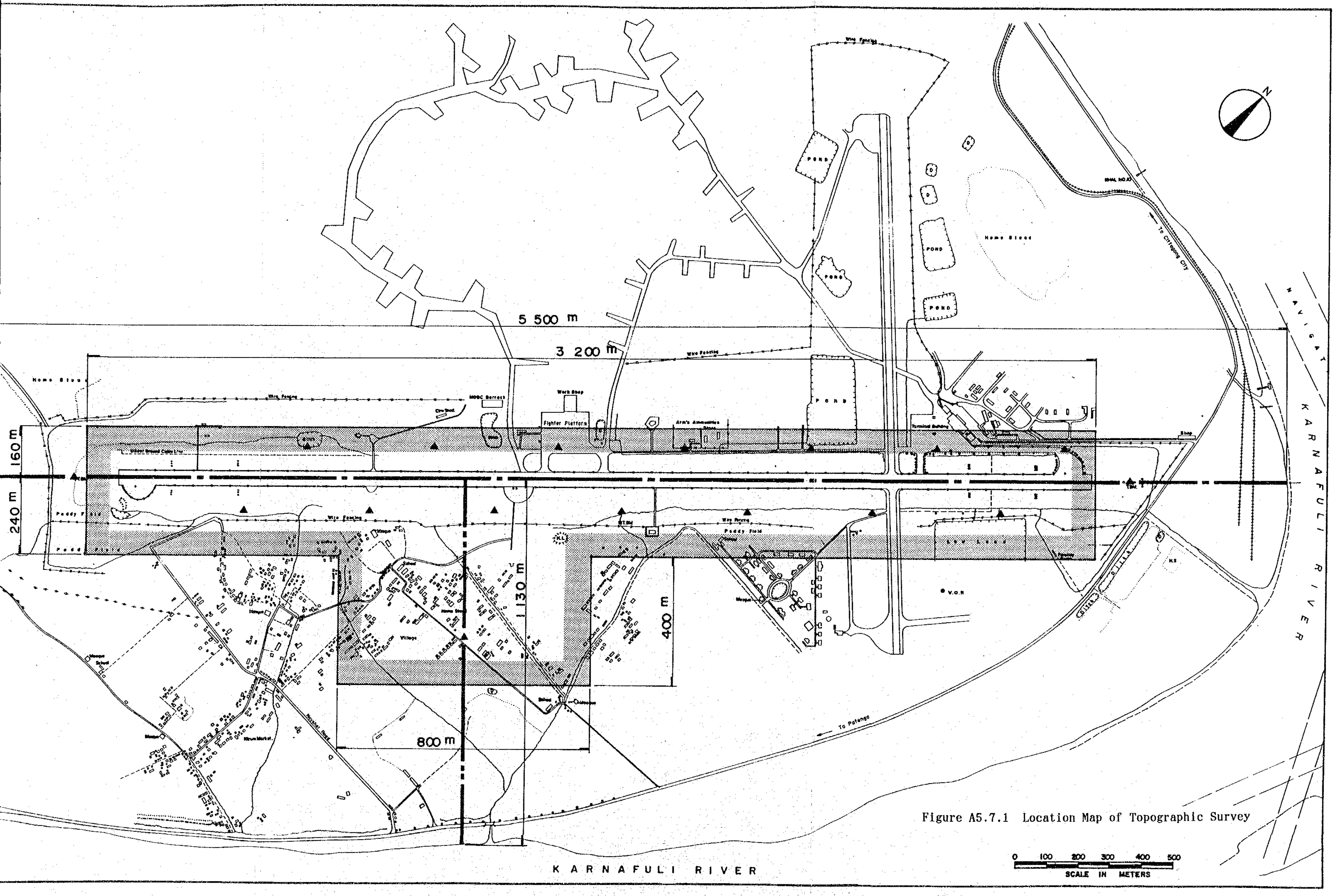


Figure A5.7.1 Location Map of Topographic Survey

Appendix 8.1 Calculation of the Required Overlay Thickness of Runway

(1) Design CBR

Design CBR is estimated considering the DCP and Field CBR value described in Appeidix 5.3 and the increase in soil strength by the consolidation shown in Appendix 5.4. The process and result of the calculation are shown in Table A8.1.1.

Table A8.1.1 Calculation of Design CBR

		C-1	C-2	C-3	C-4	C-5	C-6	Remarks
DCP CBR (%) {A}		5.3	6.3	9.3	7.3	7.3	7.3	Shown in App.5.3
Field CBR (%) {B}		3.4	3.4	3.7	3.7	4.0	4.0	
Field CBR (%) (Strengthened by Consolidation) {C}		5.1	5.1	5.6	5.6	6.1	6.1	$\{B\}x1.51=\{B\}x\frac{2.32*}{1.53}$ *Ratio of Strength (Shown in App.5.4)
Synthetic CBR (%) {D}		5.2	5.7	7.3	6.4	6.7	6.7	$\left\{\frac{1.0x\{A\}^{1/3}+1.0x\{C\}^{1/3}}{2.0}\right\}^{3}$
Adjustment	Sample Number	TP-2	TP-3	TP-4	TP-4	TP-5	TP-5	Shown in App.5.3
	Soak (%) {E}	5.0	7.0	4.4	4.4	6.0	6.0	
	Unsoak (%) {F}	4.3	6.0	5.7	5.7	8.1	8.1	
	K {G}	1.0	1.0	0.78	0.78	0.74	0.74	If {E}≥ {F} K=1 If {E}<{F} K={E}/{F}
Design CBR (%) {H}		5.2	5.7	5.6	4.9	5.0	5.0	{D}x{G}

(2) Total Required Thickness

The required thickness of each portion is determined by using the authorized diagram shown in Figure A8.1.1 relating the required pavement thickness, weight of aircraft, frequency of annual departures and dersign CBR.

The result is summarized in Table A8.1.2.

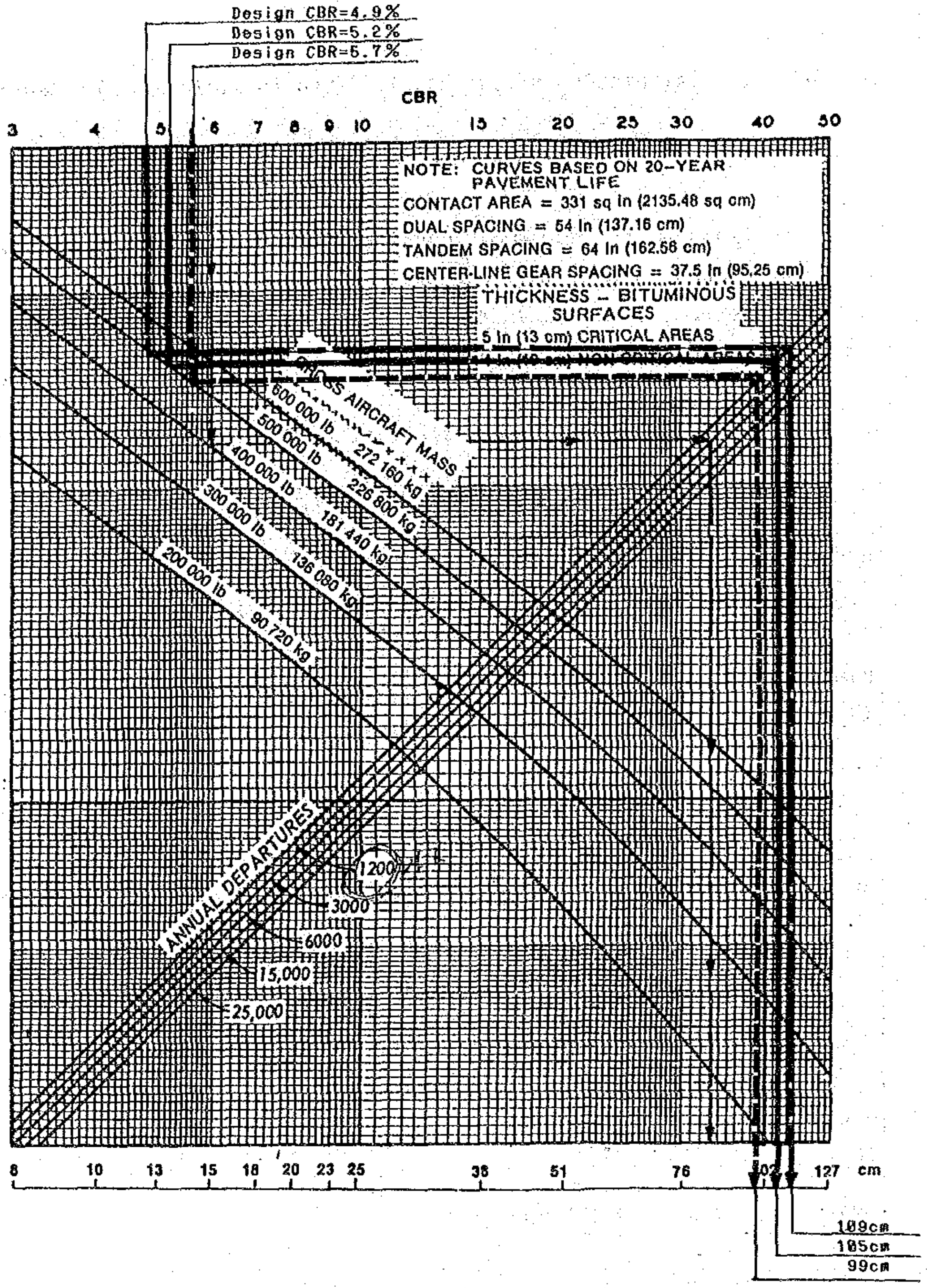


Figure A8.1.1 Flexible Pavement Design Curves for Critical Areas, DC-10-30, 30CF, 40, and 40CF

(ICAO "Aerodrome Desigtn Manual")

Table A8.1.2 Total Required Thickness of Each Portion

Location	C-1	C-2	C-3	C-4	C-5	C-6
Design CBR	5.7	5.7	5.6	4.9	5.0	5.0
Required Thickness	105	99	100	109	108	108

(3) Required Overlay Thickness

Based on the above total required thickness, the required overlay thickness of each portion is determined and shown in Table A8.1.3.

Table A8.1.3 Calculation of Required Overlay Thickness

ITEM / SAMPLE		C-1	C-2	C-3	C-4	C-5	C-6
TOTAL REQUIRED THICKNESS		105	99	100	109	108	108
SURFACE BINDER COURSE		13	13	13	13	13	13
THICKNESS OF BASE COURSE		33	33	33	33	33	33
THICKNESS OF REQUIRED OVERLAY		13+15 =28	13+11 =24	8	13+ 9 =22	13+12 =25	13+11 =24
CALCULATION	Surface	13×1.0 =13	13×1.0 =13	8×1.0 = 8 5×1.0 = 5	13×1.0 =13	13×1.0 =13	13×1.0 =13
		13	13	13	13	13	13
	Base	15×2.0 =30 (10- 7)×1.2= 4	11×2.0 =22 (12- 2)×1.2=12	23×1.2 =28 (19-15)×1.4= 6	9×2.0 =18 (21- 8)×1.2=16	12×2.0 =24 (15- 7)×1.2=10	11×2.0 =22 (17- 8)×1.2=11
		34	34	34	34	34	33
	Sub-Base	7×1.3 = 9 50×1.0 =50	2×1.3 = 3 12×1.0 =12 2×1.4 = 3 13×1.0 =13 5×1.4 = 7 8×1.0 = 8 8×1.0 = 8	15×1.6 =24 13×1.3 =17 14×1.0 =14	8×1.3 =10 14×1.6 =22 3×1.3 = 4 27×1.0 =27	7×1.3 = 9 14×1.6 =22 10×1.3 =13 18×1.0 =18	8×1.3 =10 14×1.6 =22 30×1.0 =30
		59	54	55	63	62	62
	Total	13+34+59 =106 >105	13+34+54 =101 > 99	13+34+55 =102 >100	13+34+63 =110 >109	13+34+62 =109 >108	13+33+62 =108 =108

Appendix 8.2 Calculation of Pavements for Apron and Taxiway

(1) Design K-Value

Based on the results of the plate bearing test tabulated in Table A5-2-2, the K-value is estimated as follows:

$$K_{30} = \frac{1.5 + 0.33}{2} = 0.92\ (\mathrm{Kg/cm^3})$$

K_{75} is applied to the design of the airport concrete pavement, and the above K_{30} is converted into K_{75} by the following formula:

$$K_{75} = \frac{K_{30}}{2.5}$$

K_{30} : K-value of plate with 30 cm in diameter

K_{75} : K-value of plate with 75 cm in diameter

Therefore,

$$K_{75} = \frac{0.92}{2.5} = 0.38\ (\mathrm{Kg/cm^3})$$

The above K_{75} can be converted into CBR by using a diagram shown in Figure A8.2.1.

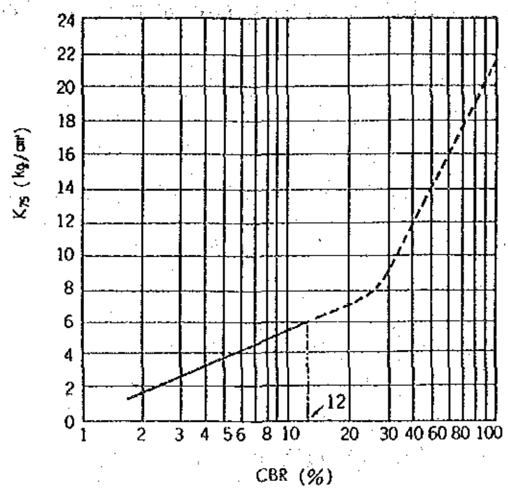


Figure A8.2.1 Relationship between CBR and K_{75}

When K_{75} value is 0.38 Kg/cm^3, the value of CBR 1.1% is obtained from the above diagram. Therefore, the bearing capacity of the subgrade soil is judged to be insufficient, and the measures to replace or stabilize the subgrade should be taken.

(2) Improvement of Subgrade

i) Improvement Method

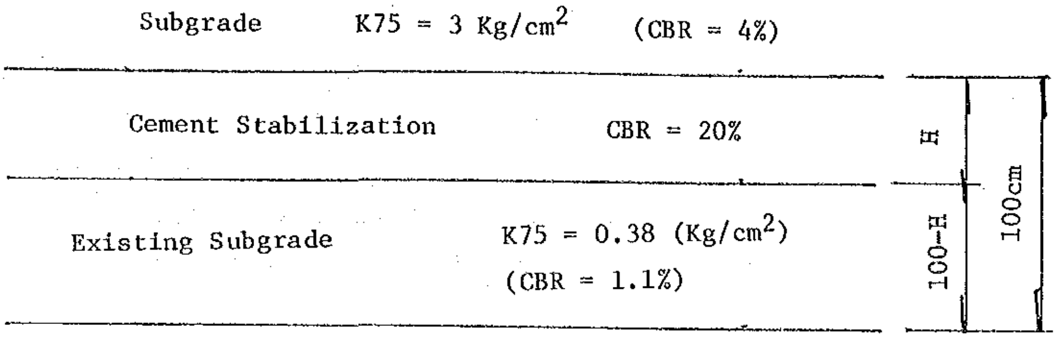
In this study, two methods, i.e., the replacement of poor subgrade with qualified sand and stabilizing poor subgrade with cement mixture were compared and cement stabilization was adopted for the following reasons:

ii) Cement Stabilization

Required thickness of improvement layer by cement stabilization is calculated under the following conditions:

a) Required design CBR on subgrade is 4%.

b) Modified CBR of cement stabilization layer is not less than 20%.



$$\left[\frac{(1.0 - H) \times 1.1^{1/3} + H \times 20^{1/3}}{1.0}\right]^3 = 4$$

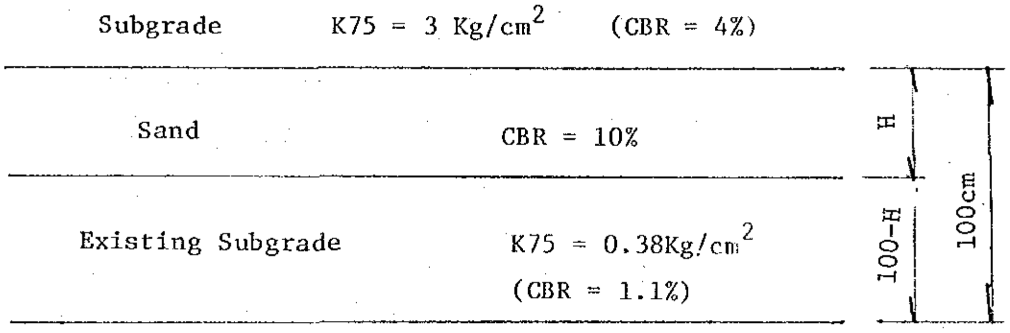
Required thickness of cement stabilization: $H = 0.33$ (m)

iii) Replacement with Qualified Sand

Required thickness of qualified sand is calculated under the following conditions:

a) Required CBR on subgrade is 4%.

b) CBR of qualified sand is 10%.



$$\left[\frac{(1.0 - H) \times 1.1^{1/3} + H \times 10^{1/3}}{1.0}\right]^3 = 4$$

Required thickness of replacement: $H = 0.50$ (m)

Required thickness of replacement: H = 0.50 (m)

iv) Cost Comparison

Cement stabilization was adopted because of the lower cost of cement stabilization, as compared with the replacement with qualified sand. The costs are shown in Table A8.2.1.

Table A8.2.1 Unit Price of Work

Cement Stabilization	Replacement of Subgrade
Thickness : 0.33 m Unit Price $3,817 \text{ (Yen/cu.m)} \times \frac{33}{100}$ $= 1,260 \text{ (Yen/sq.m)}$	Thickness : 0.50 m Unit Price $6,065 \text{ (Yen/cu.m)} \times \frac{50}{100}$ $= 3,030 \text{ (Yen/sq.m)}$

(3) Structure of Pavement

Design criteria which are applied for calculation of pavement thickness are as follows:

- Design aircraft : DC-10 (gross weight : 50,000 lb)
- Repetition of design load : 1,200 times
- Subgrade modules : K_{75} = 3 Kg/cu.cm (= 108 lb/cu.in.)
- Sub-base modules : K_{75} = 7 kg/cu.cm (= 253 lb/cu.in.)
- Concrete flexural strength : 50 kg/sq.cm (= 710 lb/sq.in.)

On the basis of the above criteria, the thickness of sub-base is estimated by using the diagram shown in Figure A8.2.2.

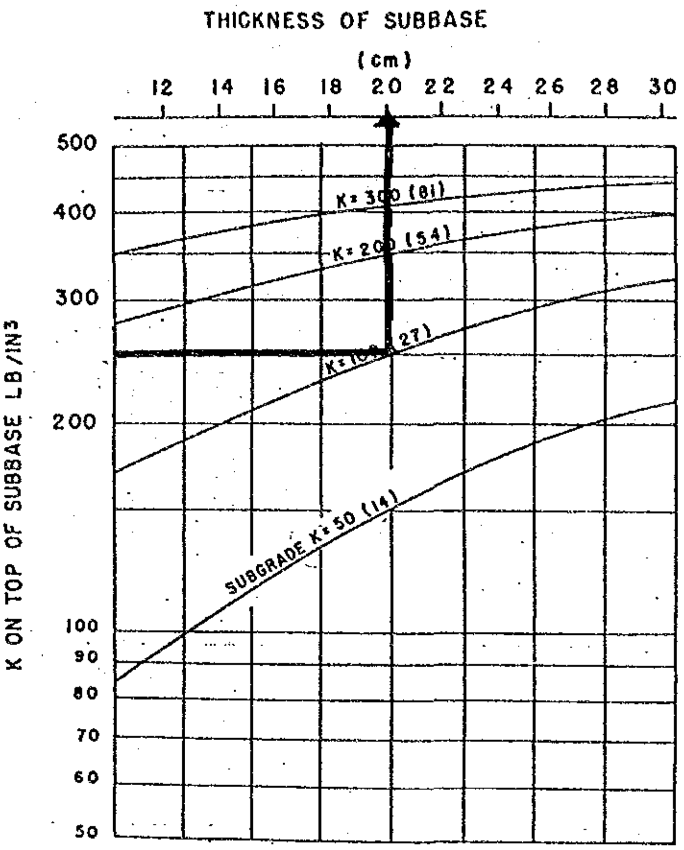


Figure A8.2.2 Effect of Stabilized Sub-base on Subgrade Modules

The slab thickness is estimated at 31 cm by using the design curve shown in Figure A8.2.3.

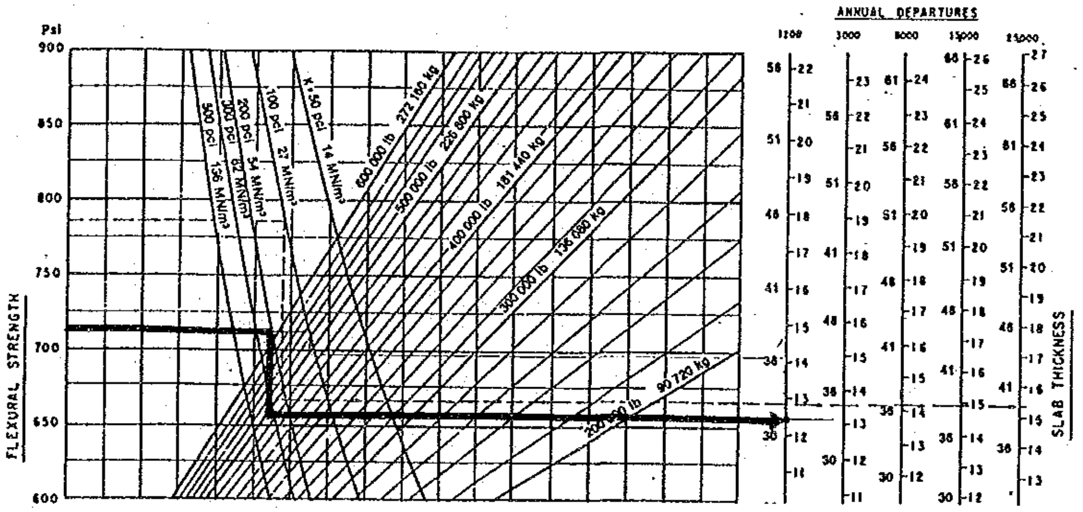


Figure A8.2.3 Rigid Pavement Design Curves - DC-10-30, 30CF, 40, and 40CF

The structure of the concrete pavement is as shown in Figure A8.2.4.

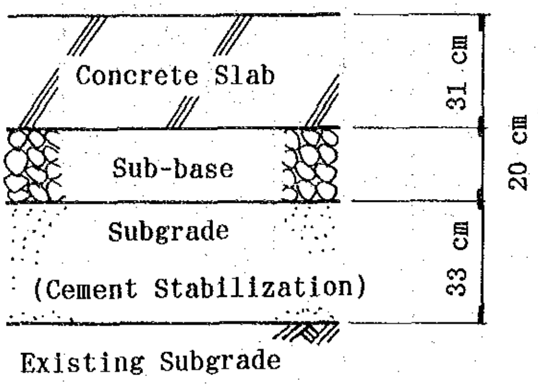


Figure A8.2.4 Structure of Pavement

Appendix 8.3 Calculation of Rainfall Intensity

(1) Probable Rainfall Precipitation

Based on the rainfall precipitation data from 1960 to 1968, the probable rainfall intensity for 5 and 60 minutes is estimated as shown in Table A8.3.1.

Table A8.3.1 Probable Rainfall Intensity

Method Duration	Gumbel Method	Iwai Method	Moment Method	Thomas Method	Hazen Method
5 minutes	11.7	11.5	11.5	11.7	11.7
60 minutes	107.9	104.5	105.4	108.0	105.7

Rainfall intensity by Thomas method is chosen among the above results, because of its safety value.

(2) Rainfall Intensity

Rainfall intensity is determined by using specific modulus. According to the FAA standard, 5 years return period is adopted for the design of storm water drainage. The detailed process of calculation is as follows:

$$I_5 = R_5 \cdot \beta_5 = R_5 \cdot \frac{a'}{t+b}$$

where I_5 : Rainfall intensity

R_5 : Rainfall precipitation for 60 minutes

β_5 : Specific modulus

$$\beta_5 = \frac{I^5}{I^{60}} = \frac{R^5 \times \frac{60}{5}}{I^5} = \frac{11.7 \times \frac{60}{5}}{108}$$

$$= \frac{140}{108} \text{ (shown in Table A8.3.1)}$$

a', b: constant

t : optional time

when t = 60 min., N = 1

therefore,

$$a' = b + 60$$

$$b = (60 - \beta_5 . t)/(\beta_5 - 1)$$

$$b = \frac{60 - \frac{140}{108} \times 5}{\frac{140}{108} - 1} = 180$$

$$a' = b + 60 = 240$$

$$R_5 = 108$$

$$\therefore \beta_5 = \frac{a'}{t + b} = \frac{240}{t + 180}$$

$$\therefore I_5 = R_5 \cdot \beta_5 = \frac{25920}{t + 180} = \frac{25900}{t + 180}$$

Appendix 8.4

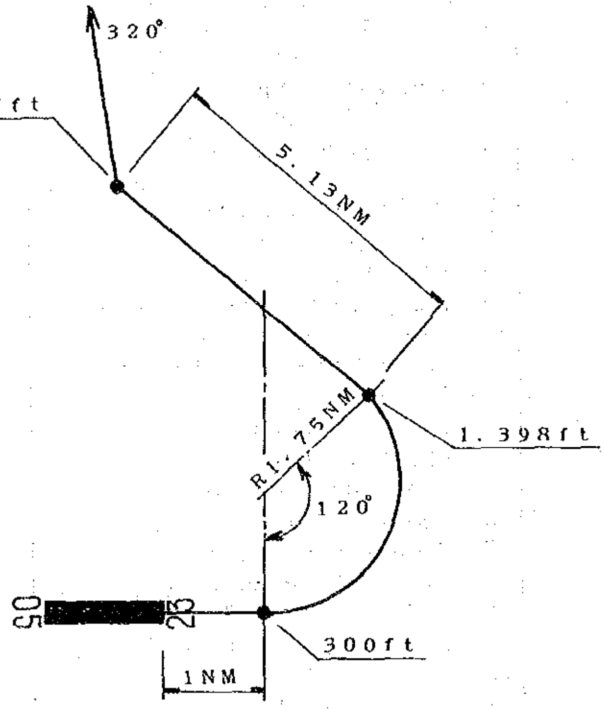
Table A8.4.1 Comparison for the Size of Operational Facilities of Passenger Terminal Building

Design Year Facilities	2000	2010	Remarks
1. Domestic Total Area	1,300 m^2	2,100 m^2	+ 800 m^2
2. Check-in Counter	5.6 m	7.4 m	
3. Check-in Lobby	196 m^2	252 m^2	
4. Departure Lounge	170 m^2	270 m^2	
5. Public Hall	1,850 m^2	2,020 m^2	
6. Security Counter	2 nos.	2 nos.	
7. Arrival Curb	6 m	10 m	
8. Departure Curb	6 m	10 m	
9. Baggage Conveyor	100 m^2	216 m^2	
1. International Total Area	4,100 m^2	4,500 m^2	+ 400 m^2
2. Check-in Counter	14.8 m	16.6 m	
3. Check-in Lobby	(196 m^2)	(252 m^2)	
4. Departure Lounge	510 m^2	580 m^2	
5. Public Hall	(1,850 m^2)	(2,020 m^2)	
6. Security Counter	(2 nos.)	(2 nos.)	
7. Immigration Booth (Dep.)	6 booths	7 booths	
8. " " (Arrv.)	6 booths	6 booths	
9. Customs Booth (Dep.)	4 positions	5 positions	
10. " " (Arrv.)	6 positions	7 positions	
11. Arrival Curb	19 m	22 m	
12. Departure Curb	19 m	22 m	
13. Baggage Conveyor	390 m^2	480 m^2	

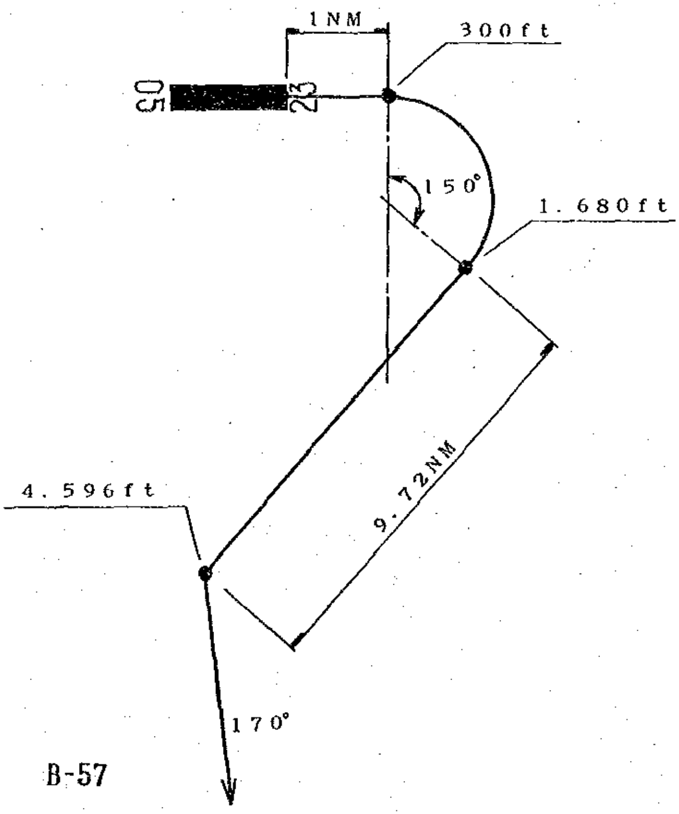
Appendix 10.1 Traffic Pattern for the Calculation of Noise Contours

RWY 05 TAKE OFF

(1) Dhaka

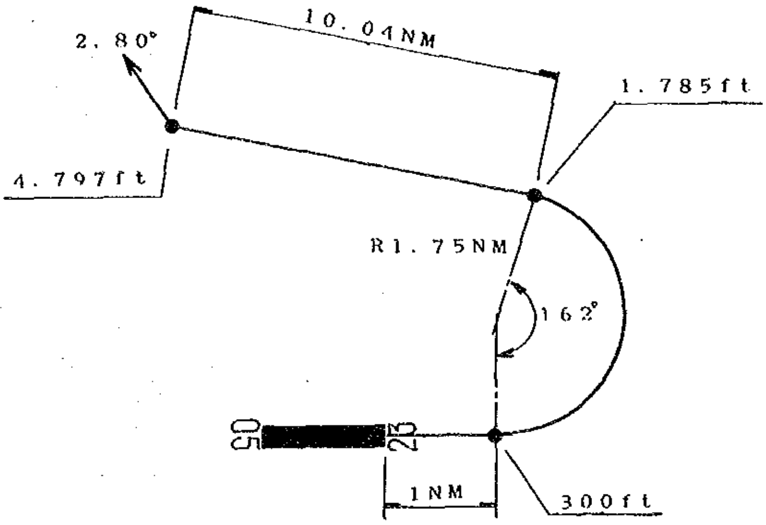


(2) Cox's Bazar

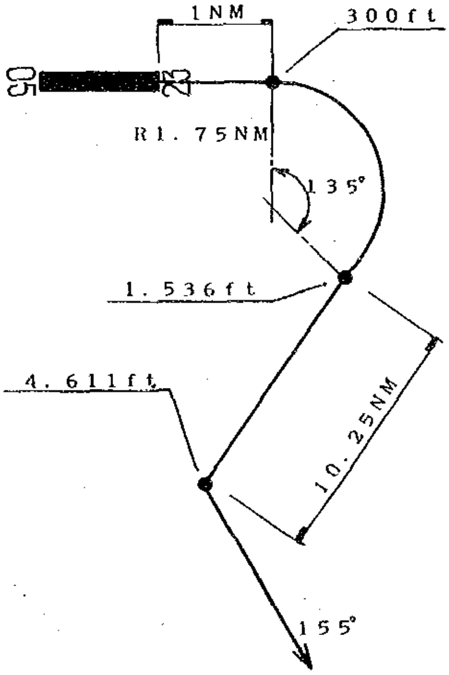


RWY 05 TAKE OFF

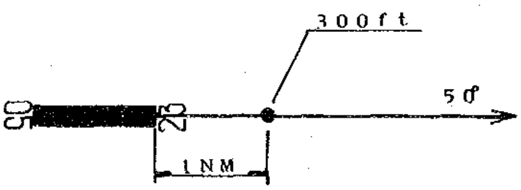
(3) Calcutta, Jeddah



(4) Bangkok

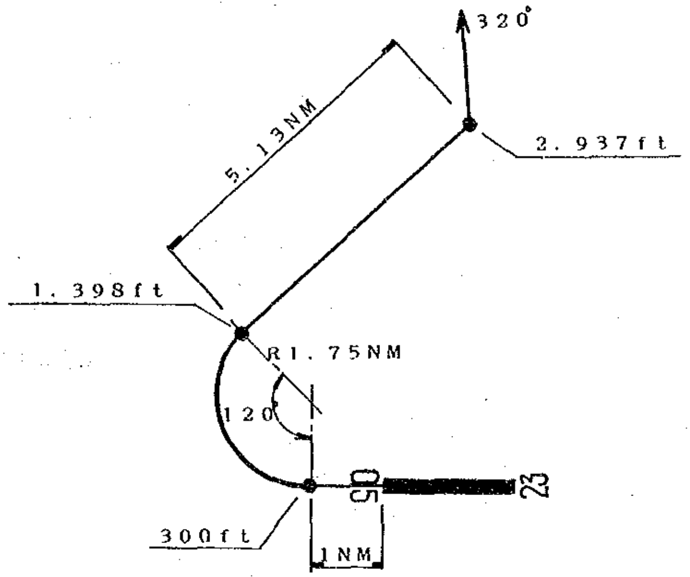


(5) Others

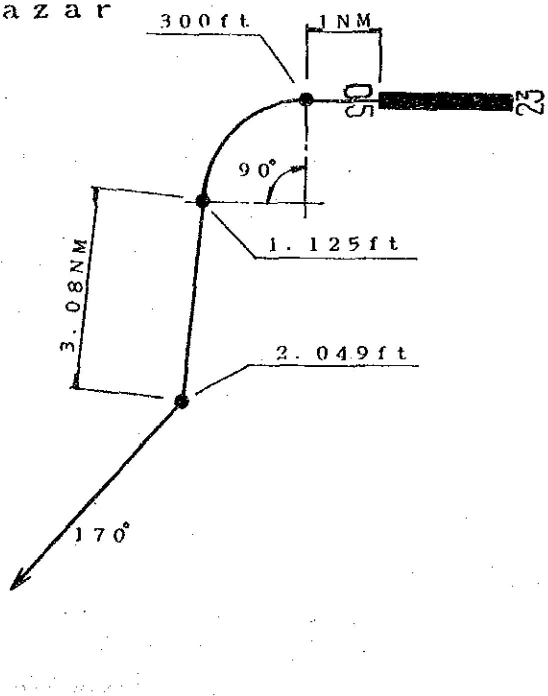


RWY 23 TAKE OFF

(1) Dhaka

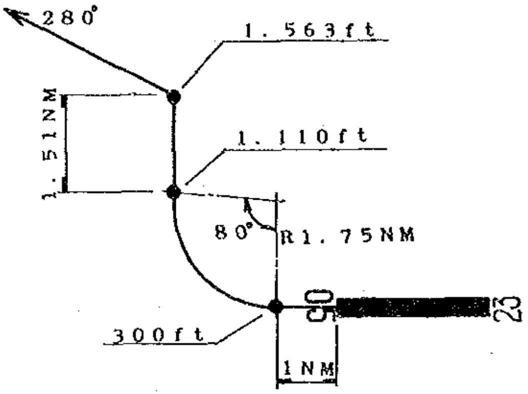


(2) Cox's Bazar

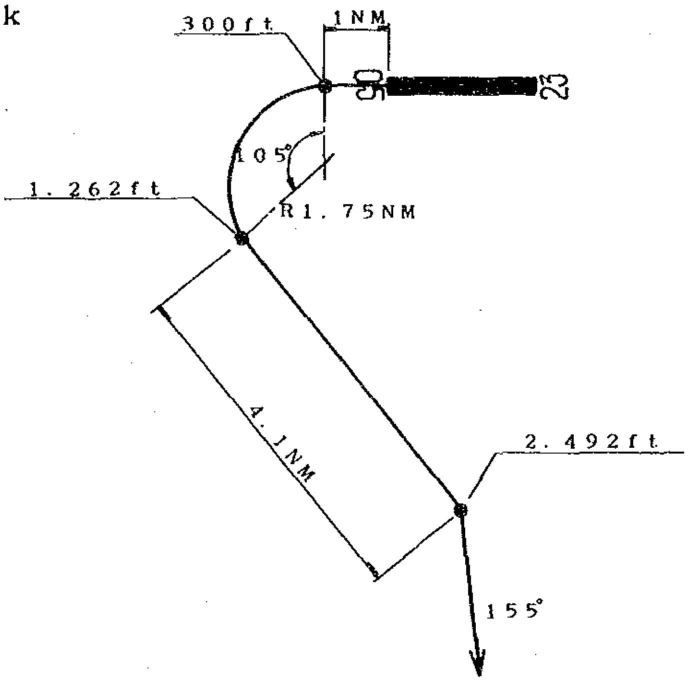


RWY 23 TAKE OFF

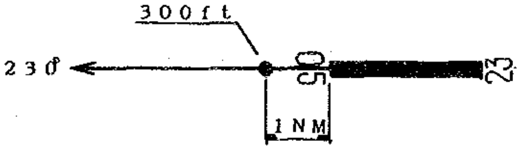
(3) Calcutta, Jeddah



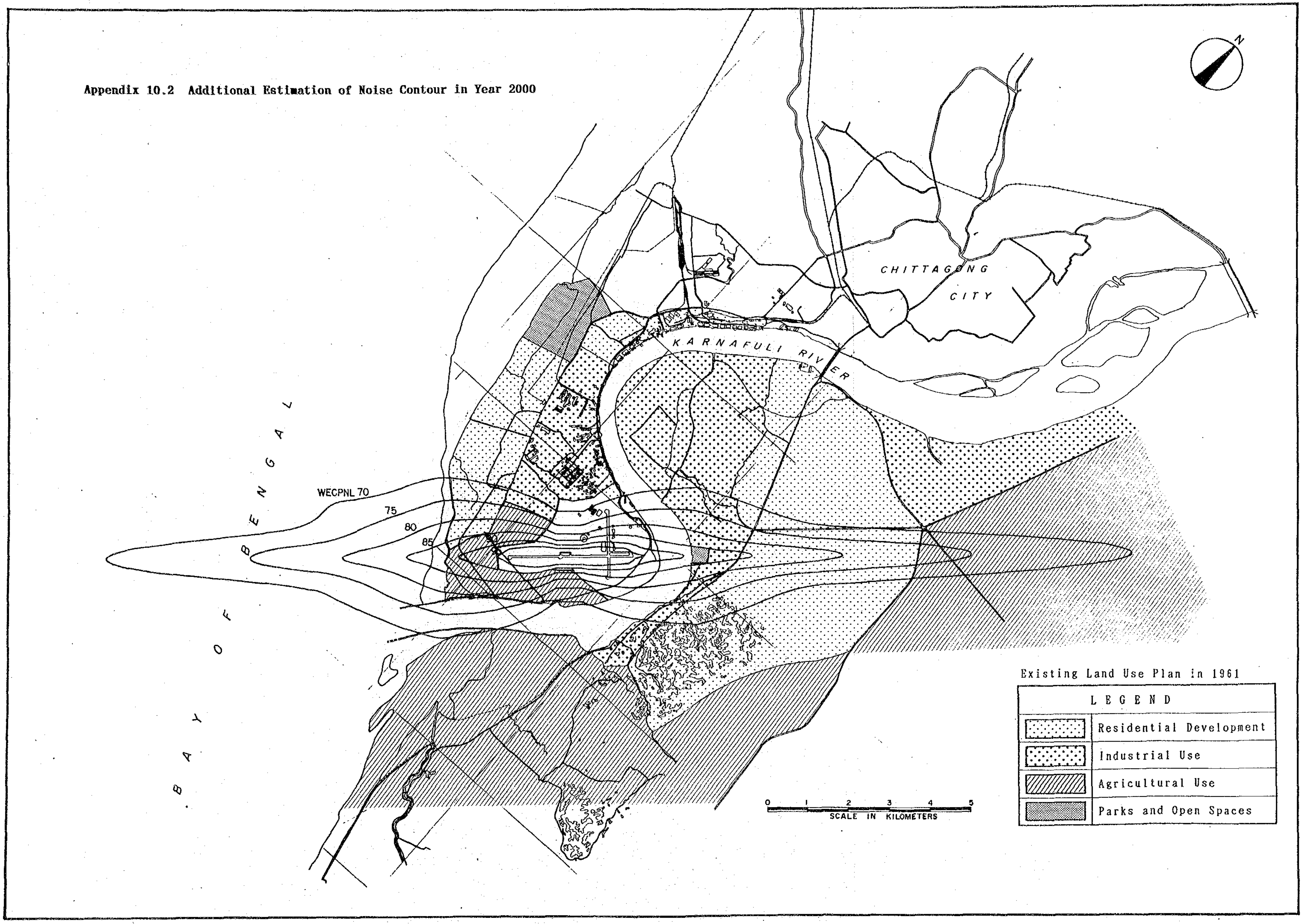
(4) Bangkok



(5) Others



Appendix 10.2 Additional Estimation of Noise Contour in Year 2000



Appendix 11.1 Principal Unit Prices of Construction Works

As of March 1989
Exchange Rate : US$1.00 = TK.32.2 = ¥140

1. Unit Price for Civil works

(1) Unit Price of Materials

	Unit	Producing Country	Unit Price in Bangladesh
- Straight asphalt	t	Singapore	TK.13,570
- Portland cement	t	Indonesia	TK.3,220
- Aggregate for asphalt concrete mix or cement concrete mix	m^3	Bangladesh	TK.1,500*1
- Aggregate for base course	m^3	Bangladesh	TK.1,290*1
- Aggregate for sub-base course	m^3	Bangladesh	TK.1,290*1
- Reinforcing steel	t	Indonesia or Korea	TK.23,000
- Diesel			TK.10
- Gasoline	liter	Bangladesh	TK.20
- Asphalt concrete mix	t		TK.2,300
- Cement concrete mix (flexural strength 45 kg per sq.cm)	m^3		TK.3,170

Note *1 : Unit price at the project site

Item	Unit	Unit Price in Bangladesh
(2) Labor		
Skilled labor	day	TK.60
Common Labor	day	TK.50
Operator of heavy machine		TK.190
Driver of truck	day	TK.140
Foreman	day	TK.320

(3) Unit Price of Works

Item	Unit	Unit Price in Bangladesh
Excavation (Back Hoe)	m^3	TK.60
Hauling of 5 km	m^3	TK.370
Spreading and grading for earchwork	m^2	TK.10
Compaction of earthwork	m^2	TK.15
Grading and compaction of subgrade	m^2	TK.15
Sub-base course (30 cm thick)	m^2	TK.620
Base course (20 cm thick)	m^2	TK.410
Asphalt concrete (5 cm thick)	m^2	TK.550
Prime coat (1.5 liter per sq.m)	m^2	TK.60
Tack coat (0.5 liter per sq.m)	m^2	TK.20
Cememt concrete slab (31 cm thick including wire mesh and dowel bar)	m^2	TK.1,700

2. Unit Price for Architectural works

(1) Unit Prices of Structure including Electrical and Mechanical Facilities

Item	Unit	Unit Price in Bangladesh
Passenger terminal building	m^2	TK.35,100
Cargo terminal building	m^2	TK.25,300
Administration building	m^2	TK.26,200
Control tower	m^2	TK.64,400
Airport maintenance	m^2	TK.14,950
Fire station	m^2	TK.14,950

Appendix 12.1 Number of CAAB Staff at Chittagong Airport

Case / Section	"Without Project Case"	"With Project Case"		Remarks
		Phase I	Phase II	
Airport Manager	1	1	1	
Aerodrome Operation	8	8	8	This function does not require additional staff regardless of traffic increase.
Administration and Accounting	15	20	22	Estimated as 8% of total number of staff based on the existing condition.
Air Traffic Services	13	13	13	Remain unchanged as the basic requirements of ATS will be the same as the present.
Radio and Communications	24	34	34	Introduction of ILS will require an additional 10 staff for operations and maintenance.
Sanitation and Horticulture	21	60	73	Assumed to increase in accordance with total floor area of passenger terminal building and administration building.
Vehicle Operation and Maintenance	10	10	10	Remain unchanged based on an assumption that the number of CAAB vehicles will not increase.
Rescue and Fire Fighting	28	28	28	Remain unchanged taking into account the number of fire staff at ZIA with higher category.
Security	76	76	76	Existing organization with 3 shits of each 25 staff is assumed to be maintained basically.
Total	196	250	265	

Appendix 12.2 Calculation of Benefit for Domestic Passengers

1	2	3		4	5 (=3x4)
Year	Route	Overflowing Traffic		Willingness to Pay or Fare (TK)	Amount (1,000 TK)
1995	Chittagong - Dhaka	Bangladeshi (90%)	49,500	921.4*	45,609
		Foreigners (10%)	5,500	(615 - 250)**	2,008
	Chittagong - Cox's Bazar	Bangladeshi (90%)	900	345.7*	311
		Foreigners (10%)	100	(235 - 13)**	22
	Total at Economic Price (45,609 + 311) x 0.82 + (2,008 + 22) = 39,684				
2000	Chittagong - Dhaka	Bangladeshi (90%)	80,100	998.2*	79,956
		Foreigners (10%)	8,900	(615 - 250)**	3,249
	Chittagong - Cox's Bazar	Bangladeshi (90%)	1,800	384.1*	691
		Foreigners (10%)	200	(235 - 13)	44
	Total at Economic Price (79,956 + 691) x 0.82 + (3,249 + 44) = 69,424				
2005	Chittagong - Dhaka	Bangladeshi (90%)	115,200	1,086.4*	125,153
		Foreigners (10%)	12,800	(615 - 250)**	4,672
	Chittagong - Cox's Bazar	Bangladeshi (90%)	2,700	428.2*	1,156
		Foreigners (10%)	300	(235 - 13)**	67
	Total at Economic Price (125,153 + 1,156) x 0.82 + (4,672 + 67) = 108,312				
2010	Chittagong - Dhaka	Bangladeshi (90%)	159,300	1,185.4*	188,834
		Foreigners (10%)	17,700	(615 - 250)**	6,461
	Chittagong - Cox's Bazar	Bangladeshi (90%)	3,600	477.7*	1,720
		Foreigners (10%)	400	(235 - 13)**	89
	Total at Economic Price (188,834 + 1,720) x 0.82 + (6,461 + 89) = 162,804				

Note, *: Fare of Alternative Mode + Time Value x Travel Time by Alternative Mode - Time Value x Travel Time by Air

**: Airfare + Airport Tax - Fare of Alternative Mode

Appendix 12.3 Benefit Due to Accommodation of Overflowing International Passengers

1	2	3		4	5 (=3x4)
Year	Route	Overflowing Traffic		Willingness to Pay or Fare (TK)	Amount (1,000 TK)
1995	Chittagong - Via ZIA	Bangladeshi (75%)	22,500	*647.8	14,576
		Induced Foreigners**	7,500x0.2/2	***1.69 x 4,000	5,070
	Chittagong - Middle East	Bangladeshi (75%)	21,750	794.7	17,285
		Induced Foreigners	7,250x0.2/2	11,600	8,410
	Chittagong - Calcutta	Bangladeshi (75%)	17,250	794.7	13,709
		Induced Foreigners	5,750x0.2/2	1,400	805
	Chittagong - Bangkok	Bangladeshi (75%)	8,250	794.7	6,556
		Induced Foreigners	2,750x0.2/2	6,300	1,733
	Total at Economic Price	52,126 x 0.82 + 16,018 = 58,761			
2000	Chittagong - Via ZIA	Bangladeshi (75%)	42,000	692.8	29,098
		Induced Foreigners	14,000x0.2/2	1.69 x 4,000	9,464
	Chittagong - Middle East	Bangladeshi (75%)	39,750	856.6	34,050
		Induced Foreigners	13,250x0.2/2	11,600	15,370
	Chittagong - Calcutta	Bangladeshi (75%)	33,000	856.6	28,268
		Induced Foreigners	11,000x0.2/2	1,400	1,540
	Chittagong - Bangkok	Bangladeshi (75%)	15,000	856.6	12,849
		Induced Foreigners	5,000x0.2/2	6,300	3,150
	Total at Economic Price	104,265 x 0.82 + 29,524 = 115,021			
2005	Chittagong - Via ZIA	Bangladeshi (75%)	63,750	745.0	47,494
		Induced Foreigners	21,250x0.2/2	1.69 x 4,000	14,365
	Chittagong - Middle East	Bangladeshi (75%)	60,000	928.4	55,704
		Induced Foreigners	20,000x0.2/2	11,600	23,200
	Chittagong - Calcutta	Bangladeshi (75%)	50,250	928.4	46.652
		Induced Foreigners	16,750x0.2/2	1,400	2,345
	Chittagong - Bangkok	Bangladeshi (75%	23,250	928.4	21,585
		Induced Foreigners	7,750x0.2/2	6,300	4,883
	Total at Economic Price	171,435 x 0.82 + 44,793 = 185,370			

(Cont'd)

1	2	3		4	5 (=3x4)
Year	Route	Overflowing Traffic		Willingness to Pay or Fare (TK)	Amount (1,000 TK)
2010	Chittagong - Via ZIA	Bangladeshi (75%)	89,250	803.2	71,686
		Induced Foreigners	29,750x0.2/2	1.69 x 4,000	20,111
	Chittagong - Middle East	Bangladeshi (75%)	84,750	1,008.4	85,462
		Induced Foreigners	28,250x0.2/2	11,600	32,770
	Chittagong - Calcutta	Bangladeshi (75%)	72,000	1,008.4	72,605
		Induced Foreigners	24,000x0.2/2	1,400	3,360
	Chittagong - Bangkok	Bangladeshi (75%)	33,750	1,008.4	34,034
		Induced Foreigners	11,250x0.2/2	6,300	7,088
	Total at Economic Price 263,787 x 0.82 + 63,329 = 279,634				

Note, * : The willingness to pay of Bangladeshi international passengers
(Fare by Railway) + Time value x (Time by Railway - Time by Air)
256 TK 65.3 TK/hr 8.25 hrs 2.25 hrs

** : Number of induced foreiners who will use Biman Airlines.
Total overflowing foreigners 7,500 x Percentage of induced foreigners 20% x Share of Biman Airlines 50%

*** : Average operating revenue per passenger kilometer 1.69 TK/km x Average flight length for international service by Biman 4,000km
(Source: Biman Bangladesh Airlines "Annual Report" and Statistical Yearbook of Bangladesh, 1987)

Appendix 12.4 Benefit due to Introducing Large Aircrafts

(1) No. of Passengers to be Transported

Route		No. of Passengers
Domestic	Chittagong - Dhaka (DAC)	106,000
	- Cox's Bazar	3,000
Total		109,000
(*) International	Chittagong - via ZIA	21,300
	- Middle East (ME)	20,800
	- Calcutta (CCU)	17,000
	- Bangkok (BKK)	7,900
Total		67,000
Grand Total		176,000

Note; (*) Total No. of passengers 67,000 were distributed to each route with the shares of future demend presented in Table 12.2.4.

(2) Benefit Calculation

1	2	3	4	5	6	7	8 (4x6x7)	9
Year	Route	Without project (WOP) or with project	Distance (km)	Type of aircraft	Unit cost TK/passenger.km	No. of passengers	Total operation cost (1,000 TK)	Remarks
1995	CGP-ME	WOP	220	SJ/TP	2.45	20,800	11,211	To ZIA
			3,600	WB	1.80	20,800/2*	67,392	To DXB
		Sub Total					78,603	
		with	3,700	WB	1.80	20,800/2	69,264	Direct
		WOP - with = 78,603 - 69,264 = 9,339 (Operation cost saving)						
	CGP-BKK	WOP	220	SJ/TP	2.45	7,900	4,258	To ZIA
			1,500	WB	1.80	7,900/2	10,665	To BKK
		Sub Total					14,923	
		with	1,300	WB	1.80	7,900/2	9,243	Direct
		WOP - with = 14,923 - 9,243 = 5,680 (Operation cost saving)						
	Total benefit at economic price (9,339 + 5,680) x 0.82 = 12,316							

(Cont'd)

1	2	3	4	5	6	7	8 (4x6x7)	9
Year	Route	Without project (WOP) or with project	Distance (km)	Type of aircraft	Unit cost TK/passenger.km	No. of passengers	Total Operation cost (1,000 TK)	Remarks
2000	CGP-ME	Same benefit as the year 1995; 9,339 (1,000 TK)						
	CGP-CCU	WOP	350	SJ/TP	2.45	17,000/2	7,289	Direct
		with	350 350	SJ/TP NB	2.45 2.00	6,200/2 10,800/2	2.659 3,780	Direct Direct
		Sub Total					6,439	
		WOP - with = 7,289 - 6,439 = 850 (Operation cost saving)						
	CGP-BKK	Same benefit as the year 1995; 5,680 (1,000 TK)						
	Total benefit at economic price (9,339+850+5,680) x 0.82 = 13,013							
2005	CGP-DAC	WOP	220	SJ/TP	2.45	106,000	57,134	Domestic
		with	220 220	SJ/TP NB	2.45 2.00	62,000 44,000	33,418 19,360	Domestic
		Sub Total					52,778	
		WOP - with = 57,134 - 52,778 = 4,356						
	CGP-via ZIA	WOP	220	SJ/TP	2.45	21,300	11,481	
		with	220 220	SJ/TP NB	2.45 2.00	12,400 8,900	6,684 3,916	
		Sub Total					10,600	
		WOP - with = 11,481 - 10,600 = 881						
	CGP-ME	Same benefit as the year 1995; 9,339 (1,000 TK)						
	CGP-CCU	WOP	350	SJ/TP	2.45	17,000/2	7,289	Direct
		with	350	NB	2.00	17,000/2	5,950	Direct
		WOP - with = 7,289 - 5,950 = 1,339						
	CGP-BKK	Same benefit as the year 1995; 5,680 (1,000 TK)						
	Total benefit at economic price (4,356+881+9,339+1,339+5,680) x 0.82 = 17,708							

(Cont'd)

1	2	3	4	5	6	7	8 (4x6x7)	9
Year	Route	Without project (WOP) or with project	Distance (km)	Type of aircraft	Unit cost TK/passenger.km	No. of passengers	Total Operation cost (1,000 TK)	Remarks
2010	CGP-DAC	WOP	220	SJ/TP	2.45	106,000	57,134	Domestic
		with	220	SJ/TP	2.45	34,000	18,326	Domestic
			220	NB	2.00	72,000	31,680	
		Sub Total					50,006	
		WOP - with = 57,134 - 50,006 = 7,128						
	CGP-via ZIA	WOP	220	SJ/TP	2.45	21,300	11,481	
		with	220	SJ/TP	2.45	6,800	3,665	
			220	NB	2.00	14,500	6,380	
		Sub Total					10,045	
		WOP - with = 11,481 - 10,045 = 1,436						
	CGP-ME	Same benefit as the year 1995; 9,339						
	CGP-CCU	Same benefit as the year 2005; 1,339						
	CGP-BKK	Same benefit as the year 1995; 5,680						
	Total benefit at economic price (7,128 + 1,436 + 9,339 + 1,339 + 5,680) x 0.82 = 20,437							

Note, *: Half of international passengers are assumed to be transported by Bangladesh Biman Airlines.

Total No. of passengers are distributed to each type of aircraft according to the shares of seat capacity multiplied by number of corresponding aircrafts.

Appendix 12.5 Difinition of Economic Internal Rate of Return (EIRR), Cost Benefit Ratio (B/C Ratio) and Net Present Value (NPV)

1. Efficiency or acceptability of a project is measured or evaluated through the comparison of an outflow (costs) with an inflow (benefits). The outflow consists of costs for the construction of the facilities and management of the project, while the inflow consists of benefits which are acquired from the operation of the facilities.

   Economic Internal Rate of Return (EIRR), Benefit Cost Ratio (B/C Ratio) and Net Present Value (NPV) are used as indicators for the economic evaluation.

2. Timing of the outflow and inflow are different. The construction cost of the facilities are generated in the early stage of the project evaluation period, while the benefits are generated after the completion of the facilities.

   All costs and benefits should be discounted and compared at a fixed time, i.e., the present value of costs and the present value of benefits.

Present value of benefits $$B = \sum_{t=0}^{T} \frac{Yt}{(1 + ro)^{t}}$$

Present value of costs $$C = \sum_{t=0}^{T} \frac{It + Ot}{(1 + ro)^{t}}$$

Where;

Yt: Benefits in year t
It: Capital expenditure in year t
Ot: Operation and maintenance costs in year t
ro: Discount rate or opportunity cost of capital of the country concerned (Maximum profit rate which would be anticipated when the fund is used for other projects)
T: Project life

3. Definition of the evaluation indicators (EIRR, B/C Ratio and NPV) is as follows:

EIRR : A discount rate to make a present value of the benefits equal to a present value of the cost, i.e., ro in above formulas on condition of B = C.

B/C Ratio : Ratio of the present value of benefits to that of costs, i.e. B/C.

NPV : Difference between the present value of benefits and that of costs, i.e., B - C. This represents the net contribution of the project to the national economy.

4. Economic Evaluation

(1) When EIRR exceeds the opportunity cost of capital for the country concerned, the project is judged to be economically feasible.

(2) When B/C ≧ 1 or NPV ≥ 0, the project is judged to be economically feasible.

APPENDIX - C RESULT OF TRAFFIC SURVAY

Appendix - C Result of Traffic Survey

1. General

a) Objective of Survey

The survey was executed to obtain the actual data on the characteristics of passengers, generated car traffic and parked cars, and passenger processing time at each part of passenger terminal building.

b) Date of Survey

The survey were carried out on the following date :

December 22, 1988	10:30 a.m.	-	5:00 p.m.
January 04, 1989	8:30 a.m.	-	6:00 p.m.
January 27, 1989	8:30 a.m.	-	6:00 p.m.

c) Surveyed Flight

The surveyed flights and actual departure time are shown in Table 1.

Table 1 Flight Number and Actual Departure Time

	Flight No.	Actual Dep. Time	Delay
Dec. 22	BG 412	9:20	0 min.
	BG 616	13:20	80 min.
	BG 622	15:45	55 min.
	India 226	18:05	70 min.
	BG 424	19.00	10 Min.
Jan. 04	BG 612	10:00	55 min.
	BG 414	12:55	50 min.
	BG 622	15:00	55 min.
	BG 424	18:50	0 min.
Jan. 27	BG 612	10:10	65 min.
	BG 414	10:50	0 min.
	BG 697	12:40	50 min.
	BG 618	15:20	25 min.
	BG 424	18:55	5 min.

Note : Approx. delay time informed by Biman Airlines
- Monsoon Season : Ave. 90 min.
- Winter Season : Ave. 20 min.

2. Number and Destination of Passengers

The following list were given by Biman Bangladesh Airlines

Table 2. Number and Destination of Departure Passenger

Date	Flight No.		Total Pax	Destination	Number of Pax
i) Dec. 22 1988	BG	412	53	DAC	53
	BG	616	77	DAC	55
				ME	22
	BG	622	74	DAC	28
				ME	16
	IC	226	31	CCU	31
	BG	424	56	DAC	56
ii) Jan. 04 1989	BG	612	77	DAC	43
				ME	34
	BG	414	44	DAC	2
				ME	42
	BG	622	85	DAC	24
				ME	61
	BG	424	77	DAC	77
iii) Jan. 27 1989	BG	612	79	DAC	79
	BG	414	23	DAC	23
	BG	697	60	CCU	60
	BG	618	69	DAC	67
				New York	2
	BG	424	31	DAC	25
				New York	6

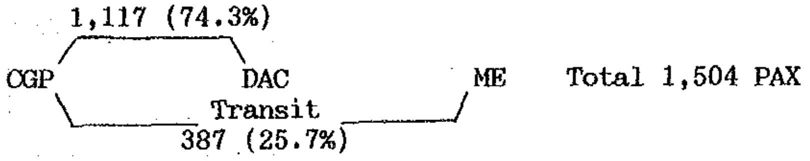
Note, DAC : Dhaka
CCU : Calcutta
ME : Middle East

BG : Biman Bangladesh
IC : Indian Airlines
CGP : Chittagong
CXB : Cox's Bazar

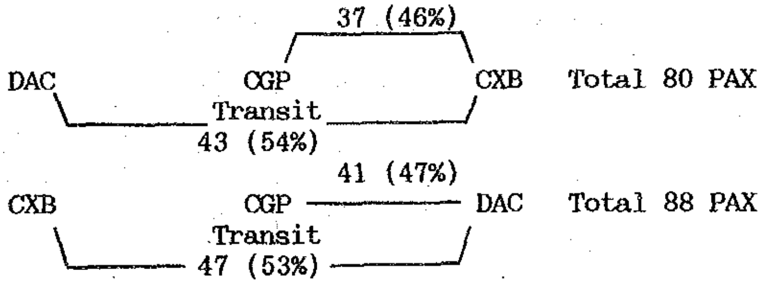
For Reference :

Proportion of passenger destination for a week (Dec. 17 to Dec. 23) based on the passenger list given by Biman Airlines is as follows :

a) Dhaka and Middle East



b) Cox's Bazar and Dhaka



3. Result of the Survey on the Characteristics of Passenger

The interview to departure passengers (336 samples) was carried out in the departure lounge in order to grasp the characteristics of passenger. The results are shown in Tables 3 through 10.

a) Occupation of Passengers

Table 3. Occupation of Passenger

Occupation	International		Domestic	
	No.	%	No.	%
1. Professional	0	0	1	1
2. Manufacturing	31	15	6	5
3. Services/Sales	86	41	34	27
4. Government	1	1	17	13
5. Agriculture	19	8	6	5
6. Education	1	1	4	3
7. Other	71	34	59	46
Total	209	100	127	100

b) Purpose of Travel

Table 4. Purpose of Travel

Purpose	International		Domestic	
	No.	%	No.	%
1. Business	5	2	37	29
2. Tourism	12	6	19	15
3. Private and Job Outside	191	92	70	56
Total	208	100	126	100

c) Accomodation of Passenger in Chittagong

Table 5. Accomodation of Passenger

Accomodation	International		Domestic	
	No.	%	No.	%
1. Private Residence	190	91	90	73
2. Hotel	11	5	16	13
3. Places of Business	0	0	4	3
4. Others	7	4	13	11
Total	208	100	123	100

D) Range of Yearly Income

Table 6. Range of Yearly Income

Range (Taka)	International		Domestic	
	No.	%	No.	%
1. Under - 10,000	1	1	8	9
2. 10,000 - 50,000	61	33	22	25
3. 50,000 - 100,000	67	37	24	27
4.100,000 - 150,000	30	16	13	14
5.150,000 - 200,000	5	2	5	6
6.200,000 - 300,000	11	6	5	6
7.300,000 - 500,000	4	3	3	3
8.500,000 -1,000,000	1	1	5	6
9.Over 1,000,000	1	1	4	4
Total	181	100	89	100

e) Destination of Passengers

Table 7. Destination of Passengers

Destination	International		Domestic	
	No.	%	No.	%
1. Dhaka	–	–	80	63
2. Middle East *1	187	90	36	28
3. Other City *2	21	10	11	9
Total	208	100	127	100

Note *1 : Abudhabi, Kuwait, Saudi Arabia, Dubai, Muscat etc.
*2 : Calcutta, Bangkok, Tokyo, Sylhet etc.

f) Transportation Mode to Airport

Table 8. Transportation Mode

Transportation	International		Domestic	
	No.	%	No.	%
1. Private Car	16	7	43	34
2. Rental Car	1	1	3	2
3. Company Car	0	0	12	9
4. Taxi	30	14	29	23
5. Bus	46	22	1	1
6. Hotel Car	0	0	0	0
7. Motor-Rickshaw	97	47	35	28
8. Rickshaw	2	1	1	1
9. Other	15	8	3	2
Total	207	100	127	100

g) Time Arrival Before Departure Time

Table 9. Time Arrival Before Departure Time

Range(Minutes)	International		Domestic	
	No.	%	No.	%
1. Less than 20	70	3	19	14
2. 20 - 40	22	11	35	28
3. 40 - 60	71	34	55	43
4. 60 - 80	24	12	5	4
5. 80 - 100	39	19	7	6
6.100 - 120	36	17	5	4
7.More than 120	9	4	1	1
Total	271	100	127	100

h) Number of Well-wishers

The following average number of well-wishers are derived from the survey:

- (International Passenger) : 6.1 well-wisher/pax
- (Domestic Passenger) : 1.7 well-wisher/pax

i) Number of Check-in Baggage

The following average number of check-in baggage are derived from the survey:

- (International Passenger) : 1.3 baggage/pax
- (Domestic Passenger) : 1.4 baggage/pax

j) Expenditure at Terminal Shop

Table 10. Expenditure at Terminal Shop

Range(Taka)	International		Domestic	
	No.	%	No.	%
1. Less than 20	29	26	22	43
2. 20 - 40	22	19	16	31
3. 40 - 60	21	18	4	8
4. 60 - 80	0	0	4	8
5. 80 - 100	8	7	4	8
6. More than 100	34	30	1	2
Total	114	100	51	100

4. Result of Vehicle Survey

a) Traffic Volume

The traffic volume during peak hour is shown in Table 11.

Table 11. Traffic Volume during Peak Hour

Survey Date	Direction and Time	Number of Passengers	Vehicler Traffic Volume				
			Bus	Mini-Bus	Car	Auto Rickshaw	Total
Dec. 22, 1988	Incomming (12:30 ~ 13:30)	162	4	10	6	62	82
	Outgoing (12:30 ~ 13:30)	162	5	6	27	50	88
Jan. 04, 1988	Incomming (12:00 ~ 13:00)	85	4	8	3	73	88
	Outgoing (12:30 ~ 13:30)	85	4	4	9	64	81

Number of vehicles generated per peak hour passenger for each direction is estimated by taking an average as follows:

(Traffic volume)/(Peak Hour Passenger) = 88/85 = 1.0

b) Number of Parked Car

Number of parked car at peak time is shown in Table 12

Table 12. Number of Parked Car

Date	Time	Number of Passengers	Number of Parked Cars					
			Bus	Mini-bus	Car	Auto rickshaw	Taxi	Total
Dec. 22, '88	14:30	162	2	5	12	51	4	74
Jan. 04, '89	12:30	85	1	2	1	42	4	49

Parked cars per peak hour passenger is estimated by taking an average as follows:

(Parked Car)/(Peak Hour Passenger) = 123/247 = <u>0.5</u>

5. <u>Result of the Survey on the Passenger Processing Time.</u>

a) Check-in Counter

i) Domestic Flight (one position available)

Flight Number	Number of Passenger	Processing Time (Second)	Maximum Porocessing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second)
BG 414	14	531	120	15	38
BG 618	11	420	107	18	38
BG 424	21	720	116	14	34

ii) International Flight (one position available)

Table 14. Processing Time at International Check-in

Flight Number	Number of Passenger	Processing Time (Second)	Maximum Porocessing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second)
BG 697	14	485	150	22	35
BG (Jan.28)	24	1,020	181	28	43

b) Immigration Counter

i) Departure (two counters available)

Table 15. Processing Time at Departure Immigration

Flight Number	Number of Passenger	Processing Time (Second)	Maximum Porocessing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second)
BG 697	12	620	155	44	103

ii) Arrival (two counters available)

Table 16. Processing Time at Arrival Immigration

Flight Number	Number of Passenger	Processing Time (Second)	Maximum Porocessing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second)
BG 611 BG 413	18	480	105	21	53
BG 615	16	360	122	14	45

c) Customs Counter

i) Departure (three positions available)

Table 17. Processing Time at Departure Custom

Flight Number	Number of Passenger	Processing Time (Second)	Maximum Porocessing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second)
BG 69	21	1,1400	240	70	163

ii) Arrival (Six positions available)

Table 18. Processing Time at Arrival Custom

Flight Number	Number of Passenger	Processing Time (Second)	Maximum Porocessing Time per Passenger (second)	Minimum Processing Time per Passenger (second)	Average Processing Time per Passenger (second)
BG 413 BG 615	36	8,100	2,500	870	1350

d) Embarkation Fee Counter

Prior to the formalities of immigration, passengers are requested to pay embarkation fee at the Counter.

Processing time of the payment for the embarkation fee is 240 seconds per passenger in average.

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