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No. 52

# THE STUDY ON THE DEVELOPMENT PLAN
# OF
# THE INTERNATIONAL AIRPORT OF CARRASCO
# IN
# THE ORIENTAL REPUBLIC OF URUGUAY

## FINAL REPORT
## (ATTACHMENT)

MARCH 1990

JAPAN INTERNATIONAL COOPERATION AGENCY



THE STUDY ON THE DEVELOPMENT PLAN OF THE INTERNATIONAL AIRPORT OF CARRASCO IN THE ORIENTAL REPUBLIC OF URUGUAY FINAL REPORT (ATTACHMENT) MARCH 1990

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| | | |
|---|---|---|
| Attachment 1 | Summary of Requirement for Terminal Area Facilities |
| Attachment 2 | Calculation Formulae for Facility Requirement for Terminal Area Facilities<br>(1) Passenger Terminal Building<br>(2) Cargo Terminal Facilities<br>(3) Other Terminal Facilities |
| Attachment 3 | Result of Demand and Capacity Analysis on Terminal Area Facilities<br>(1) Passenger Terminal Building<br>(2) Cargo Terminal Facilities |
| Attachment 4 | Initial Load-Carrying Capacity of Existing Pavement |
| Attachment 5 | Required Thickness of Pavement |
| Attachment 6 | Alternatives for Correction of Longitudinal Slope of RWY06/24 |
| Attachment 7 | Wind Coverage |
| Attachment 8 | Comparison Between Alternatives for Secondary Runway Development |
| Attachment 9 | Obstacle Limitation Height at Western Apron |
| Attachment 10 | Off Peak Construction Practices for Airfield Pavements Utilizing Asphaltic Concrete |
| Attachment 11 | Summary on Improvement of B-Runway of Osaka International Airport |
| Attachment 12 | Supplementary Information of Pavement Work |
| Attachment 13 | Breakdown of Costs and Benefits |
| Attachment 14 | Location of the Airport Fire Station |
| Attachment 15 | Layout Plan of Apron and Passenger Terminal Building for Long-term Development |
| Attachment 16 | Minutes of Meetings |

# ATTACHMENT 1

# SUMMARY OF REQUIREMENT FOR TERMINAL AREA FACILITIES

## 1-1 Calculation of Facility Requirement

### 1) Apron

Table 1-1 shows required number of aircraft parking aprons.

There should be the following four types of parking aprons:
- category 1: B747, DC-10 (MD-11) class
- category 2: B767, B707 class
- category 3: B727, B737, (MD81) class
- category 4: F27 class for domestic flight

Table 1-1 Required number of aircraft parking apron

| category / year | 1 B747 DC-10 (MD-11) | 2 B707 B767 | 3 B727 (MO-81) B737 | 4 F27 class | 5 cargo freighter B707 |
|---|---|---|---|---|---|
| 1989 actual capacity | 4 | 2 | 2 | 2 | 1 |
| 1995 | 3 | 1 | 3 | 3 | 1 |
| 2000 | 4 | 2 | 2 | 3 | 1 |
| 2010 | 5 | 2 | 2 | 3 | 1<br>1 B747 |

### 2) Passenger Terminal and Cargo Terminal Buildings

Table 1-2 and Table 1-3 show estimated facility requirements in total.

Calculation formulae are shown in Attachment 2,(1) and 2, (2).

Table 1-2 Estimated Facility Requirements in Total for Passenger Terminal Building ($M^2$)

| Design year / Name of facility | (Actual Capacity) in 1989 | Short Term Development | | Long Term Development 2010 |
|---|---|---|---|---|
| | | 1995 | 2000 | |
| 1) Public Area | 8,130 | 6,955 | 7,590 | 9,065 |
| 2) Concessions Annual PA x (10,000) x 20 $m^2$ | 2,435 | 1,934 | 2,236 | 3,862 |
| - Non Public Area - | | | | |
| 3) Airline Offices | 2,301 | 1) x 0.8 | 1) x 0.9 | 1) x 1.0 |
| 4) Administrative and Technical Area (Non-Concessions) | 1,620 | = | = | = |
| 5) Others | 1,514 1) x (0.7) | 5,564 | 6,831 | 9,065 |
| Total | 16,000 | 14,453 | 16,657 | 21,992 |

Table 1-3 Estimated Facility Requirements in Total for Cargo Terminal Building

($M^2$)

| Design year / Name of facility | (Actual Capacity) in 1989 | Short Term Development 1995 | Short Term Development 2000 | Long Term Development 2010 |
|---|---|---|---|---|
| 1) Export Cargo Facilities | 1,220 | 515 | 590 | 890 |
| 2) Import Cargo Facilities | 2,740 | 1,330 | 1,450 | 3,060 |
| 3) Airline Offices | 400 | 235 | 500 | 1,385 |
| 4) Customs Offices | 260 | | | |
| Sub-Total | 4,620 | 2,080 | 2,540 | 5,335 |
| 5) Work Station (Export) | | (2) 180 | (2) 180 | (5) 450 |
| 6) Work Station (Import) | 0 | (2) 180 | (2) 180 | (7) 630 |
| Total | 4,620 | 2,440 | 2,900 | 6,415 |

3) Car Parks

According to the result of survey on the actual car incoming and outgoing situation performed June 2 through June 4, 1989, and peak-hour passenger movement, required number of car parks in the each design year have been estimated as Table 1-4.

Table 1-4 Required Number of Car Parks

| Design Year | Peak-hour Departure Passengers | Required number of carparks | | | |
|---|---|---|---|---|---|
| | | Private | Taxi | Bus | Total |
| Actual | 321 | 352 | 42 | 8 | 402 |
| 1995 | 352 | 386 | 46 | 9 | 441 |
| 2000 | 388 | 422 | 50 | 10 | 482 |
| 2010 | 532 | 585 | 70 | 14 | 669 |

4) Other Terminal Area facilities

Table 1-5 shows result of facility requirement calculation on other terminal area facilities.

The calculation formulae are made, as Attachment 2 (3), due consideration with actual data on consumption and treatment volume by flight and passenger.

Table 1-5 Estimated Facility Requirements for Other Terminal Area Facilities

| Design Year / Facility | (Actual Capacity) in 1989 | Short Term Development | | Long Term Developmemt | Remarks |
|---|---|---|---|---|---|
| | | 1995 | 2000 | 2010 | |
| 1. FUEL OIL FACILITY Fuel Oil Tank | 1290 kl | 1484 kl | 1636 kl | 2444 kl | Reservation 4 days |
| 2. WATER SUPPLY FAC. Water Tank | 133 kl | 764 kl | 876 kl | 1320 kl | Reservation 2 days |
| 3. SEWAGE FACILITY Sewage Treatment Plant | 15 $M^3$/Hr | 15.9$M^3$/Hr | 18.3$M^3$/Hr | 27.5$M^3$/Hr | --- |
| 4. FIRE FIGHT. FAC. Water Tank | 0 kl | 30 kl | 30 kl | 30 kl | For 3 vehicles |
| 5.GARBAGE HANDLING FACILITY (ton/day) Incinerator | 0 | 10.7 | 11.3 | 13.7 | --- |

## 1-2 Demand/Capacity and Facility Requirement Analysis

Comparison between actual and required capacities of major terminal area facilities in each target year shown in Fig. 1-1 ~ Fig. 1-3.

These figures, cleary indicates that the most of actual terminal area facilities are capable of adequately meeting the demand in the year 1995 and 2000.

However, the following facilities require reconstruction, expansion or modification, from the functional and physical points of view;

1) Apron
   - Location and aircraft parking concept (parking configuration) should be modified to suit depending the airport development plan.
   - Pavement structures should be improved to achieve the required thickness and profile by ICAO recommendations.

2) Passenger terminal building

1. Public area

| Facility | Development measures |
|---|---|
| - departure concourse | Modify or newly expand existing central terminal |
| - departure lounge<br>- security check<br>- check-in counter for Puente Aereo and domestic | Modify existing central terminal |
| - arrival health check<br>- baggage claim area and device | Modify arrival terminal<br>To be installed at existing building |

2. Other area

| Facility | Development measures |
|---|---|
| non-public area mainly, administrative area | Modify existing central terminal |

Result of demand and capacity analysis by facility is shown in Attachment 3, (1) and (2).

3) Cargo terminal facilities

The result of survey on existing situation clearly indicates that the following facilities have to be developed in the year 1995 and 2000.

| Facility | Development measures |
|---|---|
| Export cargo facilities | |
| - pallet build-up area | Modifying existing warehouse or newly expand "open shed" at the infront of existing warehouse (1995) |
| - work station (removable) | To be installed at existing warehouse or inside of "open shed," (2000) |
| Import cargo facilities | |
| - pallet break-down area | Modifying existing warehouse or newly expand "open shed" at the infront of existing warehouse (1995) |
| - work station (removable) | To be installed at existing warehouse or inside of "open shed," (2000) |
| - rack | Modifying existing warehouse (2000) |

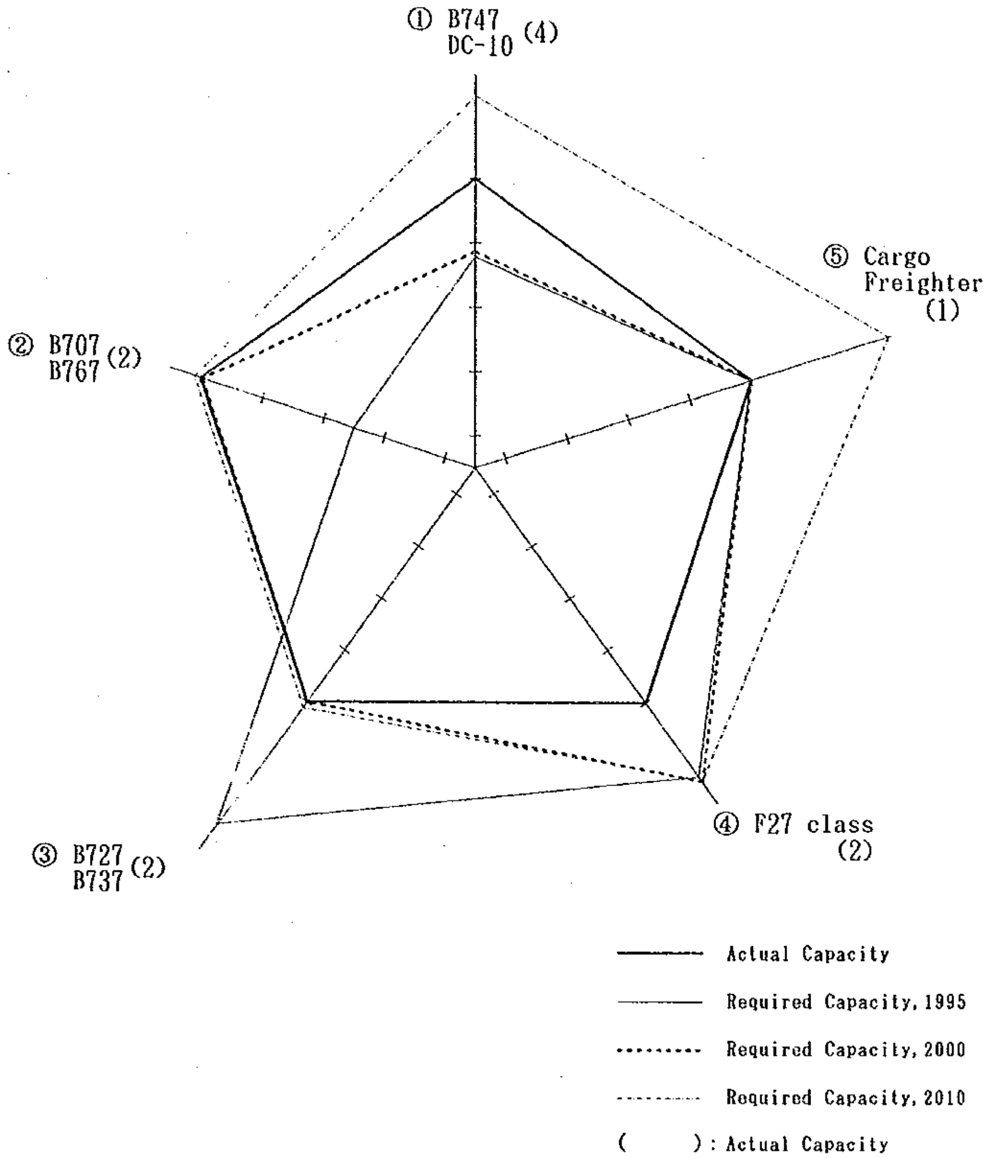



Fig 1-1 Comparison between actual and required capacity (Apron)

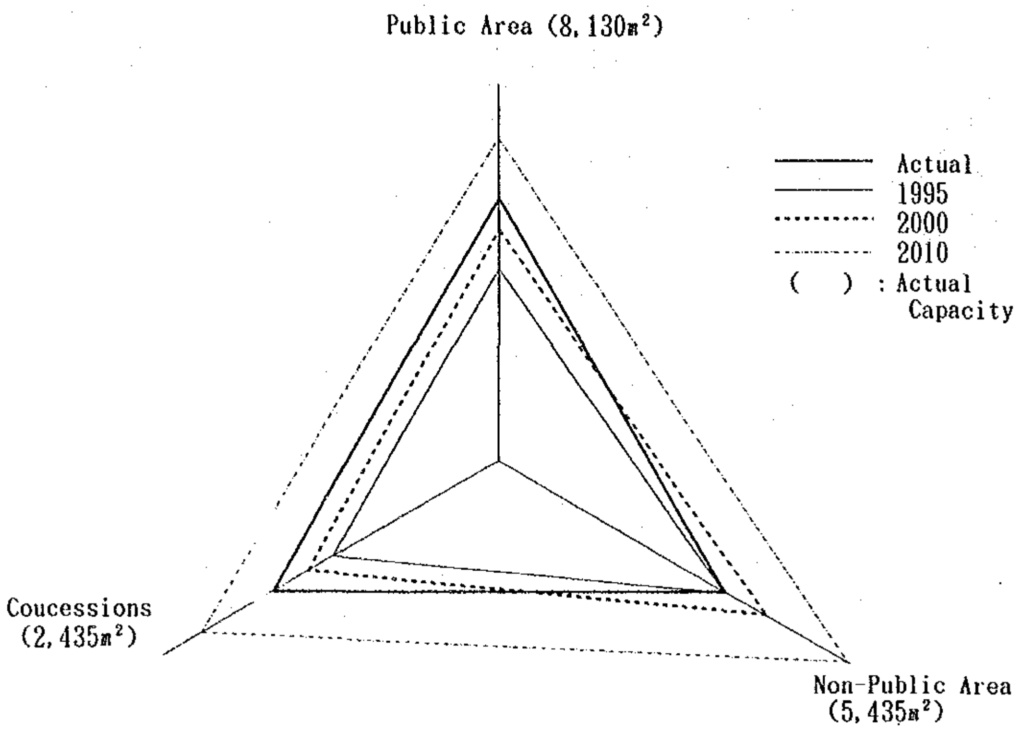
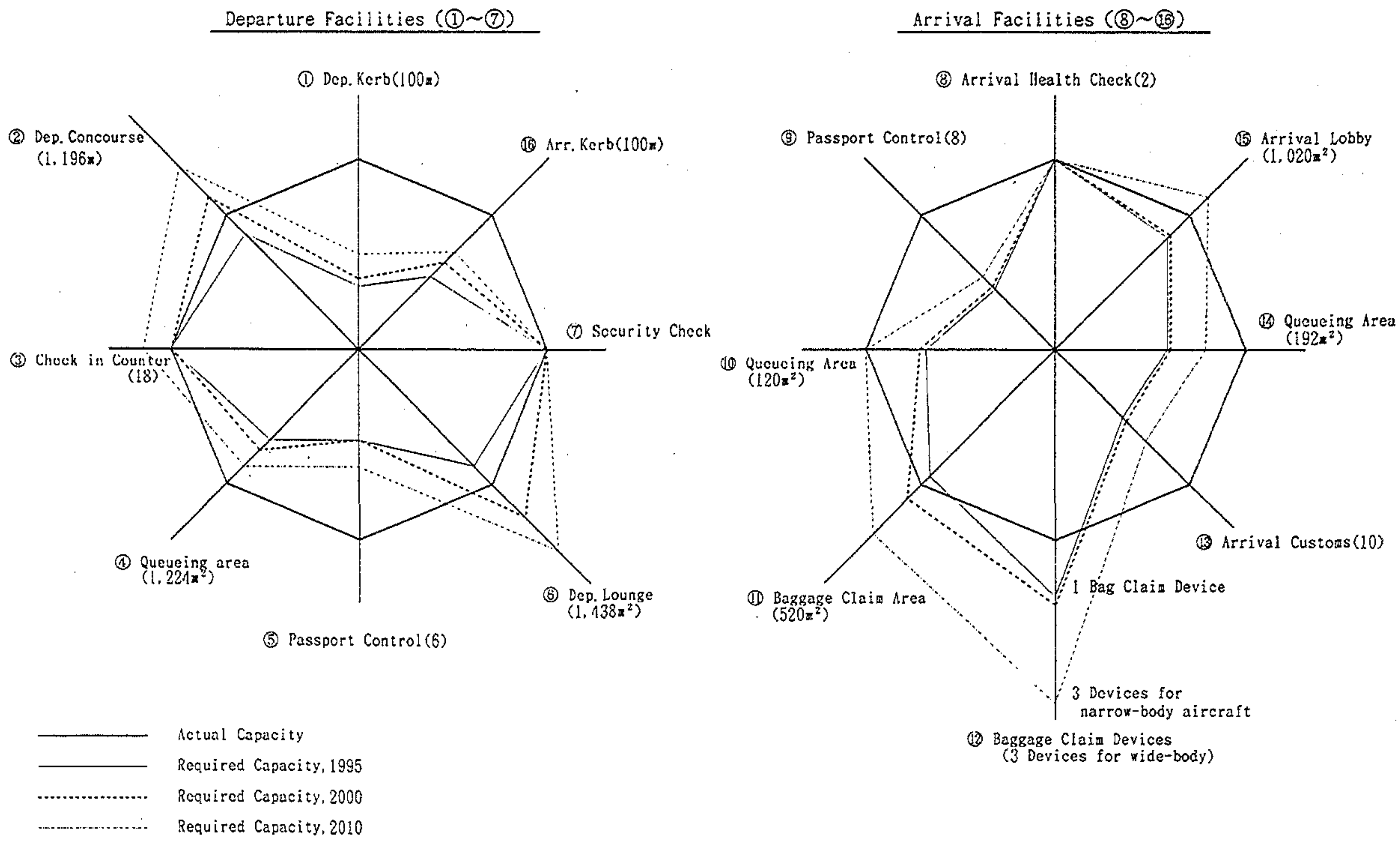



Fig 1-2 Comparison between actual and required capacity

Fig. 1-3 Comparison between actual and required capacities.
(Public area)



4) Rescue and Fire-Fighting Facility

(1) Short term development

To cope with emergency use for fire-fighting vehicles and to avoid interference of water supply to the terminal building, an elevated water tank will be urgently required for exclusive use of the airport fire brigade.

Since the airport still falls in the category 8 airport even in 2010, it will not be required to reinforce the airport fire-fighting vehicles.

(2) Long term development

If the short-term development is materialized, new development will not be required.

5) Fuel Oil Facility

(1) Short term development

In 1995, fuel oil storage capacity of the present facility is slightly less than the required capacity. The existing ESSO and SHELL facility have no oil separaters, so it will be required to install simple oil separaters similar to ANCAP facility.

To satisfy the increasing demand, an additional 346 KL fuel oil reserve will be required by the year of 2000.

(2) Long term development

In 2010, the required oil reserve in the airport will reach 2,444 KL against present capacity of 1,290 KL. It will be necessary to develop a fuel oil facility fundamentally.

6) Water Supply Facility

(1) Short term development

To secure two days consumption, additional 631 $M^3$ water reservation will be required in the year of 1995. Also a new pipe line from the public 800 mm diameter new water line will be required.

In 2000, further 112 $M^3$ water reservation will be required.

(2) Long term development

In 2010, the required water reserve for two days will reach 1,320 $M^3$ against present capacity of 133 $M^3$.

7) Sewage Facility

(1) Short term development

In 1995, the peak-day demand will be slightly higher the capacity of the existing sewage treatment plan. The peak-day demand in 2000 will reach 18.3 $M^3$ an hour.

(2) Long term development

In 2010, the required capacity of the sewage treatment plant will reach 27.5 $M^3$ an hour against present capacity of 15 $M^3$.

8) Garbage Handling Facility

(1) Short term development

At present, there is no facility to handle garbage in the airport, so it is necessary to install incinerators to suit present demand. In 2000 a further development will be necessary.

(2) Long term development

In 2010, the required capacity of the facility will reach 13.7 tons a day.

# ATTACHMENT 2 (1)

# CALCULATION FORMULAE

# FOR

# FACILITY REQUIREMENT

# FOR

# PASSENGER TERMINAL BUILDING

## (1) Passenger Terminal Building

| | | data & assumptions | | |
|---|---|---|---|---|
| | | 1995 | 2000 | 2010 |
| 1. DEPARTURES KERB<br>Data Required: | | | | |
| a = Peak hour number of ORIGINATING passengers | | 352 | 388 | 532 |
| p = Proportion of passengers using car/taxi | | 0.75 | 0.75 | 0.75 |
| n = Average number of passengers per car/taxi | | 1.2 | 1.2 | 1.2 |
| l = Average kerb length required per car/taxi(metres) | | 6.5 | 6.5 | 6.5 |
| t = Average kerb occupancy time per car/taxi(minutes) | | 1.5 | 1.5 | 1.5 |
| Assumptions:<br>p = 0.75<br>n = 1.2 passengers<br>l = 6.5 metres<br>t = 1.5 minutes<br>--- Separate kerb length provided for buses<br>--- Average number of passengers and size of vehicle is same for cars and taxis | | | | |
| Kerb length required:<br>$L = \frac{aplt}{60n} = 0.095\ ap$ metres(+10%) | | | | |
| 2. DEPARTURES CONCOURSE(LOBBY)<br>Data Required: | | | | |
| a = Peak hour number of ORIGINATING passengers | INT | 276 | 328 | 367 |
| | P/A | 138 | 138 | 176 |
| | DOMES | 45 | 60 | 68 |
| | TOTAL | 352 | 388 | 532 |
| s = Space required per person(square metres) | | 1.5 | 1.5 | 1.5 |
| o = Number of visitors per passenger | INT | 2.0 | 2.0 | 2.0 |
| | P/A | 0.3 | 0.3 | 0.3 |
| | DOMES | 0.5 | 0.5 | 0.5 |
| Assumptions:<br>s = 1.5(square metres)<br>o = 2.0(INT), 0.3(P/A), 0.5(DOMES) | | | | |
| Area Required:<br>A = s x a(1 + O)square meteres(+10%) | | | | |

| | | data & assumptions | | |
|---|---|---|---|---|
| | | 1995 | 2000 | 2010 |
| **3. CHECK-IN COUNTERS (CENTRALIZED, COMMON CHECK-IN)** | | | | |
| Data Required: | | | | |
| a = Peak hour number of ORIGINATING passengers | INT | 276 | 328 | 367 |
| | P/A | 138 | 138 | 176 |
| | DOMES | 45 | 60 | 68 |
| $t_1$= Average processing time per passenger (minutes) | INT | 2 | 2 | 2 |
| | P/A | 1 | 1 | 1 |
| | DOMES | 1 | 1 | 1 |
| Counter Required: $N = \frac{at_1}{60}$ counters(+10%) | | | | |
| **4. QUEUEING AREA - (CHECK-IN LOBBY)** | | | | |
| Data Required: | | | | |
| a = Peak hour number of ORIGINATING passengers | INT | 276 | 328 | 367 |
| | P/A | 138 | 138 | 176 |
| | DOMES | 45 | 60 | 68 |
| s = Space required per passenger(square metres) | | 1.5 | 1.5 | 1.5 |
| Assumptions: s = 1.5 square metres | | | | |
| Area Required: A = as square metres(+10%) | | | | |

| | | 1995 | 2000 | 2010 |
|---|---|---|---|---|
| | | data & assumptions | | |
| **5. PASSPORT CONTROL - (DEPARTURE IMMIGRATION)** | | | | |
| Data Required: | | | | |
| a = Peak hour number of ORIGINATING passengers | INT | 276 | 328 | 367 |
| | P/A | 138 | 138 | 176 |
| $t_2$= Average processing time per passenger(minutes) | | 0.3 | 0.3 | 0.3 |
| Assumptions: $t_2$ = 0.3 minutes | | | | |
| Control Positions Required: $N = \frac{at_2}{60}$ positions(+10%) | | | | |
| **6. DEPARTURE LOUNGE (excluding concessions except bar/snack bar facilities)** | | | | |
| Data Required: | | | | |
| c = Peak hour number of DEPARTING passengers | INT | 276 (138) | 328 (164) | 367 (183) |
| | P/A | 138 | 138 | 176 |
| | DOMES | 45 | 60 | 68 |
| s = Space required per passenger(square metres) | | 2.0 | 2.0 | 2.0 |
| Assumption: s = 2.0 square metres | | | | |
| Area Required: A = cs(+10%) | | | | |

(  ): number of transit passengers

| | | 1995 | 2000 | 2010 |
|---|---|---|---|---|
| **7. SECURITY CHECK - CENTRALIZED**<br><br>Data Required: | | | | |
| a = Peak hour number of ORIGINATING passengers | INT P/A | 307 | 328 | 464 |
| | DOMES | 45 | 60 | 68 |
| y = Capacity of X-ray Hand Baggage Unit(pcs/hour) | | | | |
| w = Number of hand baggage items per passenger | | | | |
| Assumptions:<br>y = 600 pcs/hour<br>w = 2.0 | | | | |
| X-Ray Units Required:<br><br>$N = \frac{aw}{y} = \frac{a}{300}$ units | | | | |
| **8. ARRIVALS HEALTH CHECK**<br><br>Data Required: | | | | |
| d = Peak hour number of TERMINATING passengers | INT P/A | 400 | 400 | 526 |
| t = Average service time per passenger(minutes) | | | | |
| Assumption:<br><br>t = 0.1 minutes<br>--- Facilities for clearance of passengers within 30 minutes will be sufficient | | | | |
| Control Positions Required:<br><br>$N = \frac{dt}{30}$ positions | | | | |

| | | data & assumptions | | |
|---|---|---|---|---|
| | | 1995 | 2000 | 2010 |
| 15. ARRIVALS LOBBY (excluding concessions)<br>Data Required: | | | | |
| d = Peak hour number of TERMINATING passengers | INT | 312 | 312 | 432 |
| | P/A | 156 | 156 | 188 |
| | DOMES | 45 | 60 | 68 |
| w = Average occupancy time per passenger(minutes) | | 15 | 15 | 15 |
| z = Average occupancy time per visitor(minutes) | | 30 | 30 | 30 |
| s = space required per person(square metres) | | 1.5 | 1.5 | 1.5 |
| o = Number of visitors per passenger | INT | 2.0 | 2.0 | 2.0 |
| | P/A | 0.3 | 0.3 | 0.3 |
| | DOMES | 0.5 | 0.5 | 0.5 |
| Assumptions:<br>w = 15 minutes<br>z = 30 minutes<br>s = 1.5 square metres | | | | |
| Area Required:<br>$A = s(\frac{wd}{60} + \frac{zdo}{60}) = 0.375(d + 2do)$ square metres(+10%) | | | | |
| 16. ARRIVALS KERB<br>Data Required: | | | | |
| d = Peak hour number of TERMINATING passengers | | 445 | 460 | 594 |
| p = Proportion of passengers using car/taxi | | 0.75 | 0.75 | 0.75 |
| n = Average number of passengers per car/taxi | | 1.2 | 1.2 | 1.2 |
| l = Average kerb length required per car/taxi(metres) | | 6.5 | 6.5 | 6.5 |
| t = Average kerb occupancy time per car/taxi(minutes) | | 1.5 | 1.5 | 1.5 |
| Assumptions:<br>p = 0.75<br>n = 1.2 passengers<br>l = 6.5 metres<br>t = 1.5 minutes<br>--- Separate kerb length provided for buses<br>--- Average number of passengers and size of vehicle is same for cars and taxis | | | | |
| Kerb Length Required:<br>$L = \frac{dplt}{60n} = 0.095dp$ metres(+10%) | | | | |

| | | data & assumptions | | |
|---|---|---|---|---|
| | | 1995 | 2000 | 2010 |
| **13. ARRIVALS CUSTOMS**<br><br>The requirements for Customs check areas (baggage and personal examination) vary widely depending on the level of inspection required by the authorities and the inspection procedures involved. Each case will require individual consideration following discussion with the inspection authorities at the pre-planning stage, especially where the Red/Green channel system is implemented.<br><br>Where Customs checks are implemented on the basis of inspection of the baggage of a proportion of passengers, the following formula can be utilized.<br><br>Data Required: | | | | |
| e = Peak hour number of TERMINATING passengers | INT | 312 | 312 | 432 |
| | P/A | 156 | 156 | 188 |
| f = Proportion of passengers to be customs checked | | | | |
| $t_4$= Average processing time per passenger(minutes) | | | | |
| Assumptions:<br>$f = 0.5$<br>$t_4$= 1.0 minutes | | | | |
| Number of Customs positions required:<br>$N = \frac{eft_4}{60}$ positions(+10%) | | | | |
| **14. QUEUEING AREA - ARRIVALS CUSTOMS**<br><br>Data Required: | | | | |
| e = Peak hour number of TERMINATING passengers | INT | 312 | 312 | 432 |
| | P/A | 156 | 156 | 188 |
| f = Proportion of passengers to be customs checked | | | | |
| s = Space required per passenger(square metres) | | | | |
| Assumptions:<br>s = 1.5 square metres<br>--- 50% of peak hour number of passengers arrive at Customs within the first 20 minutes | | | | |
| Area Required:<br>$A = s \times \frac{20}{60}(\frac{3e}{2} - e) = 0.25e(+10\%)$ | | | | |

| | | data & assumptions | | |
|---|---|---|---|---|
| | | 1995 | 2000 | 2010 |
| **11. BAGGAGE CLAIM AREA(excluding claim devices)**<br><br>Data Required: | | | | |
| e = Peak hour number of TERMINATING passengers | INT | 312 | 312 | 432 |
| | P/A | 156 | 156 | 188 |
| | DOMES | 45 | 60 | 68 |
| w = Average occupancy time per passenger(minutes) | | | | |
| s = Space required per passenger(square metres) | | | | |
| Assumptions:<br><br>w = 30 minutes<br>s = 1.8 square metres | | | | |
| Area Required:<br><br>$A = \frac{ews}{60} = \frac{e \times 30 \times 1.8}{60} = 0.9e$ square metres(+10%) | | | | |
| **12. NUMBER OF BAGGAGE CLAIM DEVICES AND AREA TOB REQUIRED**<br><br>Data Required:<br><br>y = Average claim device occupancy time per wide-body aircraft(minutes): 30(minutes)<br>z = Average claim device occupancy time per narrow-body aircraft(minutes): 20(minutes)<br><br>number of devices should be calculated based on the result of simulated flight schedule and following assumptions | | | | |
| Required Claim Length:<br><br>Wide-body aircraft: 50-65 metres<br>Narrow-body aircraft: 30-40 metres | | | | |

| | | data & assumptions | | |
|---|---|---|---|---|
| | | 1995 | 2000 | 2010 |
| **9. PASSPORT CONTROL - (ARRIVAL IMMIGRATION)**<br><br>Data Required: | | | | |
| $d$ = Peak hour number of TERMINATING passengers | INT | 312 | 312 | 432 |
| $t_3$= Average processing time per passenger(minutes) | | | | |
| Assumptions:<br>$t_3$ = 0.5 minutes | | | | |
| Control Positions Required:<br><br>$N = \frac{dt_3}{60}$ positions(+10%) | | | | |
| **10. QUEUEING AREA - (PASSPORT CONTROL - ARRIVAL IMMIGRATION AREA)**<br><br>Data Required: | | | | |
| $d$ = Peak hour number of TERMINATING passengers | INT | 312 | 312 | 432 |
| $s$ = Space required per passenger(square metres) | | | | |
| Assumptions:<br>$s$ = 1 square metre<br>--- 50% of peak hour number of passengers arrive within the first 15 minutes | | | | |
| Area Required:<br><br>$A = s \times \frac{15}{60} \times (\frac{4d}{2} - d) = 0.25d$ square metres(+10%) | | | | |

## (2) Cargo Terminal Facilities

| | data & assumptions | | |
|---|---|---|---|
| | 1995 | 2000 | 2010 |
| 1. TRACK DOCK (EXPORT CARGO)<br><br>Data Required: | | | |
| a = peak day export cargo volume (ton) | 41 | 53 | 93 |
| f = peak hour factor | 0.4 | 0.35 | 0.3 |
| k1= cargo handling capacity per dock (ton/h) | 6 | 6 | 6 |
| w = required width for one dock (M)<br>W1 (10 ton trailer)<br>W2 (truck) | <br>3.6<br>2.4 | <br>3.6<br>2.4 | <br>3.6<br>2.4 |
| Track dock width required: | | | |
| $L = \frac{af}{k1} \times w\ (+10\%)$ | | | |
| 2. TRACK DOCK (IMPORT CARGO)<br><br>Data Required: | | | |
| b = peak day import cargo volume (ton) | 39 | 60 | 140 |
| f = peak hour factor | 0.4 | 0.35 | 0.3 |
| k2= cargo handling capacity per dock (ton/h) | 2 | 2 | 2 |
| w = required width for one dock (M)<br>W1 (10 ton trailer)<br>W2 (truck) | <br>3.6<br>2.4 | <br>3.6<br>2.4 | <br>3.6<br>2.4 |
| Track dock width required: | | | |
| $L = \frac{bf}{k2} \times w\ (+10\%)$ | | | |

| | data & assumptions | | |
|---|---|---|---|
| | 1995 | 2000 | 2010 |
| **3. WORK STATION AREA (EXPORT CARGO - BUILT UP AREA)** | | | |
| **Data Required:** | | | |
| a = peak day export cargo volume (ton) | 41 | 53 | 93 |
| h = working hour (hour) | 12 | 12 | 12 |
| x1= pallet share | 0.15 | 0.2 | 0.3 |
| x2= container share | 0.25 | 0.3 | 0.4 |
| t = handling time (min) | 30 | 25 | 20 |
| Us= unit space for work station | 90 | 90 | 90 |
| **Work station area required:** | | | |
| $A = a \times \frac{1}{h} \times (x1 \times 1.2 + X2 \times 0.5) \times \frac{t}{60} \times Us$ | | | |
| **4. WORK STATION AREA(IMPORT CARGO - BREAK DOWN AREA)** | | | |
| **Data Required:** | | | |
| b = peak day import cargo volume (ton) | 39 | 60 | 140 |
| h = working hour (hour) | 12 | 12 | 12 |
| x1= pallet share | 0.15 | 0.2 | 0.3 |
| x2= container share | 0.25 | 0.3 | 0.4 |
| t = handling time (min) | 30 | 25 | 20 |
| Us= unit space for work station | 90 | 90 | 90 |
| **Work station area required:** | | | |
| $A = b \times \frac{1}{h} \times (x1 \times 1.2 + X2 \times 0.5) \times \frac{t}{60} \times Us$ | | | |

| | data & assumptions | | |
|---|---|---|---|
| | 1995 | 2000 | 2010 |
| 5. EXPORT BULK CARGO HANDLING AREA<br>Data Required: | | | |
| a = peak day export cargo volume (ton) | 41 | 53 | 93 |
| f = peak hour factor | 0.4 | 0.35 | 0.3 |
| x3= bulk cargh share | 0.5 | 0.4 | 0.3 |
| Us= unit space for handling area (M2/ton) | 40 | 40 | 40 |
| Handling area required: | | | |
| A = a x f x x3 x Us (+10%) | | | |
| 6. IMPORT BULK CARGO HANDLING AREA<br>Data Required: | | | |
| b = peak day import cargo volume (ton) | 39 | 60 | 140 |
| f = peak hour factor | 0.4 | 0.35 | 0.3 |
| x3= bulk cargh share | 0.5 | 0.4 | 0.3 |
| Us= unit space for handling area ($M^2$/ton) | 40 | 40 | 40 |
| Handling area required: | | | |
| A = b x f x x3 x Us (+10%) | | | |

| | data & assumptions | | |
|---|---|---|---|
| | 1995 | 2000 | 2010 |
| **7. CUSTOMS AREA (EXPORT + IMPORT)**<br>Data Required: | | | |
| a = peak day export cargo volume (ton) | 41 | 53 | 93 |
| b = peak day import cargo volume (ton) | 39 | 60 | 140 |
| f = peak hour factor | 0.4 | 0.35 | 0.3 |
| k1= cargo handling capacity per dock (ton/h) | 6 | 6 | 6 |
| k2= cargo handling capacity per dock (ton/h) | 2 | 2 | 2 |
| l = depth of customs area per dock (M) | 9 | 9 | 9 |
| customs area required: | | | |
| $A = (\frac{af}{k1} + \frac{bf}{k2}) \times l$ (+10%) | | | |
| **8. STORAGE AREA FOR IMPORT CARGO**<br>Data Required: | | | |
| b = peak day import cargo volume (ton) | 39 | 60 | 140 |
| d = duration of storage (day) | 7 | 5 | 5 |
| s = story of rack system | 2 | 2 | 2 |
| Us= unit space ($M^2$/ton) | 6.5 | 6.5 | 6.5 |
| Storage area required: | | | |
| $A = b \times d \times \frac{1}{s} \times Us$ (10%) | | | |

| | data & assumptions | | |
|---|---|---|---|
| | 1995 | 2000 | 2010 |
| 9. COLD STORAGE FOR PERISHBLE CARGO | | | |
| Data Required: | | | |
| a = peak day export cargo volume (ton) | 41 | 53 | 93 |
| b = peak day import cargo volume (ton) | 39 | 60 | 140 |
| x4= share of perishble cargo | 0.05 | 0.1 | 0.1 |
| Us= unit space ($M^2$/ton) | 10 | 10 | 10 |
| Cold storage area required: | | | |
| A = (a + b) x x4 x Us (+10%) | | | |
| 10. AIRLINE AND AGENT OFFICE AREA | | | |
| Data Required: | | | |
| ac= annual cargo volume (ton) | 21.365 | 30.437 | 62.812 |
| Us= Unit space ($M^2$/ton) | 0.01 | 0.015 | 0.02 |
| Office area required: | | | |
| A = ac x Us (+10%) | | | |

(3) Other Terminal Facilities

| | data & assumptions | | |
|---|---|---|---|
| | 1995 | 2000 | 2010 |
| 1. FUEL OIL FACILITY.<br>Data Required ; | | | |
| s = Fuel oil demand (kl/day) | 371 | 409 | 611 |
| n = Number of days to stock fuel oil | 4 | 4 | 4 |

Assumptions :

n = 4 days

Table of Fuel Consumption (kl)

| Destination | Flying time (Hr) | Type of Airplane | | | |
|---|---|---|---|---|---|
| | | 727 | 707 & 767 | DC10 | 747 |
| POA | 1.2 | 8 | 9 | 13 | 16 |
| ASU | 2.2 | 14 | 16 | 24 | 29 |
| AEP | 0.4 | 3 | 3 | 5 | 5 |
| SAO | 2.2 | 14 | 16 | 24 | 29 |
| EZE | 0.4 | 3 | 3 | 5 | 5 |
| RIO | 3.4 | 21 | 24 | 38 | 45 |
| SRZ | 4.0 | 24 | 28 | 44 | 52 |
| SCL | 2.6 | 16 | 19 | 29 | 34 |

| | | | |
|---|---|---|---|
| Total Tank Volume Required ;<br>V = n.s | | | |

| | data & assumptions | | |
|---|---|---|---|
| | 1995 | 2000 | 2010 |
| 2. WATER SUPPLY<br>Data Required ; | | | |
| n = Peak-day passenger movement — INT'L | 3318 | 3816 | 5816 |
| DOMES | 158 | 164 | 181 |
| TOTAL | 3476 | 3980 | 5997 |
| p = water consumption per passenger (l/person) | 110 | 110 | 110 |
| Assumptions ;<br>p = 110 l/person<br>………… p is estimated from yearly average consumption per passenger in year of 1988.<br>………… Tank volume shall be capable of having two days holding of the consumption | | | |
| Tank volume ;<br>$V = n.\ p.\ 2.\ 10^{-3} = 0.22\ n\ M^3$ | | | |
| | | | |

| | | data & assumptions | | |
|---|---|---|---|---|
| | | 1995 | 2000 | 2010 |
| 3. SEWAGE TREATMENT<br>Data Required ; | | | | |
| n = Peak-day passenger movement | INT'L | 3318 | 3816 | 5816 |
| | DOMES | 158 | 164 | 181 |
| | TOTAL | 3476 | 3980 | 5997 |
| w = Sewage water per passenger. (l/person) | | 110 | 110 | 110 |
| Assumptions ;<br>w = 110 l/person<br>·········· w is same as water consumption per passenger.<br>·········· Total sewage water quantity is in proportion to passenger movement. | | | | |
| Total sewage water ;<br>$Q = \frac{n.\ w.\ 10^{-3}}{24} = 0.00458\ n \quad M^3/Hr$ | | | | |
| | | | | |

| | | | data & assumptions | | |
|---|---|---|---|---|---|
| | | | 1995 | 2000 | 2010 |
| 4. GARBAGE TREATMENT<br>Data Required ; | | | | | |
| n = Peak-day passenger movement | $n_i$ | INT'L | 3318 | 3816 | 5816 |
| | nd | DOMES | 158 | 164 | 181 |
| | na | TOTAL | 3476 | 3980 | 5997 |
| $w_i$ = Generated quantity per passenger. (kg/person)<br>$w_1$ = International line (kg/person)<br>$w_2$ = Domestic line (kg/person) | | | <br>1.2<br>0.45 | <br>1.2<br>0.45 | <br>1.2<br>0.45 |
| $w_t$ = Generated quantity from place other than airport. (ton/day) | | | 6.6 | 6.6 | 6.6 |
| Assumptions ;<br>$w_1$ = 1.2 kg/day<br>$w_2$ = 0.45 kg/day<br>……… $w_t$ is estimated by reducing quantity generated in airport from current quantity in year 1988 ;<br>$9.0 - (1.2\times \frac{59185}{30}\times 10^{-3}) = 6.6$ ton/day<br>and, $w_t$ is costant even in future. | | | | | |
| Total generated quantity<br>$W_a = \frac{w_1 . n_i + w_2 . nd}{1000} + 6.6$ ton/day | | | | | |
| | | | | | |

# ATTACHMENT 3 (1)

# RESULT OF DEMAND

# AND

# CAPACITY ANALYSIS

# ON

# PASSENGER TERMINAL BUILDING

## (1) Passenger Terminal Building

| name of facility | A. required capacity | | | B. actual capacity | c. facility to be developed(A-B) | | | note |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | | 1995 | 2000 | 2010 | |
| 1. DEPARTIRES KERB (M) | | | | | | | | |
| total | 28 | 31 | 42 | 100 | — | — | — | |
| 2. DEPARTIRES CONCOURSE ($M^2$) | | | | | | | | |
| INT | 1,370 | 1,630 | 1,820 | | | | | |
| P/A | 300 | 300 | 380 | | | | | |
| DOMES | 120 | 150 | 170 | | | | | |
| total | 1,810 | 2,100 | 2,400 | 1,916 | — | 184 | 484 | |

| name of facility | A. required capacity | | | B. actual capacity | c. facility to be developed (A-B) | | | note |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | | 1995 | 2000 | 2010 | |
| 3. CHECK-IN COUNTERS (Number) CASE－1 COMMON USE | | | | | | | | |
| INT | 10 | 12 | 14 | 18 | － | － | － | |
| P/A | 3 | 3 | 4 | 6 (P/A + DOMES) | － | － | － | |
| DOMES | 1 | 2 | 2 | | － | － | － | |
| total | 14 | 17 | 20 | 18＋6 * | － | － | － | |
| CASE－2 EXCLUSIVE USE | | | | | | | | |
| INT | 12 (PUA 3, RG 3, other 6) | 12 | 18 | 18 | － | － | － | |
| P/A | 4 (PUA 2, ARG 2) | 4 | 4 | 6 (P/A + DOMES) | － | － | － | |
| DOMES | 2 | 2 | 2 | | － | － | － | |
| total | 18×30m² (540m²) | 18×30m² (540m²) | 24×30m² (720m²) | 18＋6 * (720m²) | － | － | － | |

* at central terminal for puente aereo and domestic

| name of facility | A. required capacity 1995 | A. required capacity 2000 | A. required capacity 2010 | B. actual capacity | c. facility to be developed (A-B) 1995 | c. facility to be developed (A-B) 2000 | c. facility to be developed (A-B) 2010 | note |
|---|---|---|---|---|---|---|---|---|
| 4. QUEUEING AREA (Check-in Lobby) ($M^2$) | | | | | | | | |
| INT | 420 | 500 | 550 | | | | | |
| P/A | 210 | 210 | 270 | | | | | |
| DOMES | 70 | 90 | 110 | | | | | |
| total | 700 | 800 | 930 | 1,224 + 170 * | – | – | – | |
| 5. PASSPORT CONTROL (Dep. Immigration) (Number) | | | | | | | | |
| INT | 2 | 2 | 3 | | | | | |
| P/A | 1 | 1 | 1 | | | | | |
| total | $3 \times 10m^2$ ($30m^2$) | $3 \times 10m^2$ ($30m^2$) | $4 \times 10m^2$ ($40m^2$) | 6 + 4 ** ($100m^2$) | – | – | – | |
| | | | | | | | | |

* at central terminal
** at central terminal for puente aereo

| name of facility | A. required capacity | | | B. actual capacity | c. facility to be developed(A-B) | | | n o t e |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | | 1995 | 2000 | 2010 | |
| 6. DEPARTURE LOUNGE ($M^2$) | | | | | | | | |
| INT | 910 | 1,090 | 1,220 | | | | | |
| P/A | 310 | 310 | 390 | | | | | |
| DOMES | 100 | 140 | 150 | | | | | |
| total | 1,320 | 1,540 | 1,760 | 1,438 * | – | 102 | 322 | |
| 7. SECURITY CHECK (UNIT) | | | | | | | | |
| INT/P/A | 1 or 2 | 2 | 2 | | 2 | 2 | 2 | |
| DOMES | 1 | 1 | 1 | – | 1 | 1 | 1 | |
| total | ($300m^2$) | ($300m^2$) | ($300m^2$) | ($300m^2$) | ($300m^2$) | ($300m^2$) | ($300m^2$) | |
| 8. ARRIVAL HEALTH CHECK (POSITION) | | | | | | | | |
| INT/P/A | $2\times 60m^2$ ($120m^2$) | $2\times 60m^2$ ($120m^2$) | $2\times 60m^2$ ($120m^2$) | actuary there are no inspection counters, but in the future it is can be installed ($120m^2$) | (2) | (2) | (2) | |

* including transit lounge

| name of facility | A. required capacity | | | B. actual capacity | c. facility to be developed (A-B) | | | note |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | | 1995 | 2000 | 2010 | |
| 9. PASSPORT CONTROL (Arr. Immigration) (Position) | | | | | | | | |
| INT | 3×20$m^2$ (60$m^2$) | 3×20$m^2$ (60$m^2$) | 4×20$m^2$ (60$m^2$) | 8 (160$m^2$) | – | – | – | |
| 10. QUEUEING AREA (Arrival Immigration Area) ($M^2$) | | | | | | | | |
| INT | 90 | 90 | 120 | 24M×5M (120) | (90) | (90) | (120) | |

| name of facility | | | A. required capacity | | | | | | B. actual capacity | c. facility to be developed (A-B) | | | | | | note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1995 | | 2000 | | 2010 | | | 1995 | | 2000 | | 2010 | | |
| 11. BAGGAGE CLAIM AREA ($M^2$) | | | | | | | | | | | | | | | | |
| | | INT | 310 | | 310 | | 430 | | | | | | | | | |
| | | P/A | 160 | | 160 | | 190 | | | | | | | | | |
| | | DOMES | 45 | | 60 | | 70 | | | | | | | | | |
| | | total | 515 | | 530 | | 690 | | 520 | – | | 10 | | 170 | | |
| 12. NOMBER OF BAGGAGE CLAIM DEVICES | | | W | N | W | N | W | N | W | W | N | W | N | W | N | |
| | NUMBER | INT | 2 | 1 | 2 | 1 | 3 | 1 | 49M Length × 3 | – | | – | | – | 1 | |
| | | P/A | | (2) 1 | | (2) 1 | | 2 | | – | 1 | – | 1 | – | 2 | |
| | | DOMES | | 1 | | 1 | | 1 | | – | 1 | – | 1 | – | 1 | |
| | AREA | INT | | | | | | | | | | | | | | |
| | | P/A | | 330m² | | 330m² | | 410m² | 240m² | | 90m² | | 90m² | | 170m² | |
| | | DOMES | | | | | | | | | | | | | | |

W : for wide−body aircraft
N : for Narrow−body aircraft

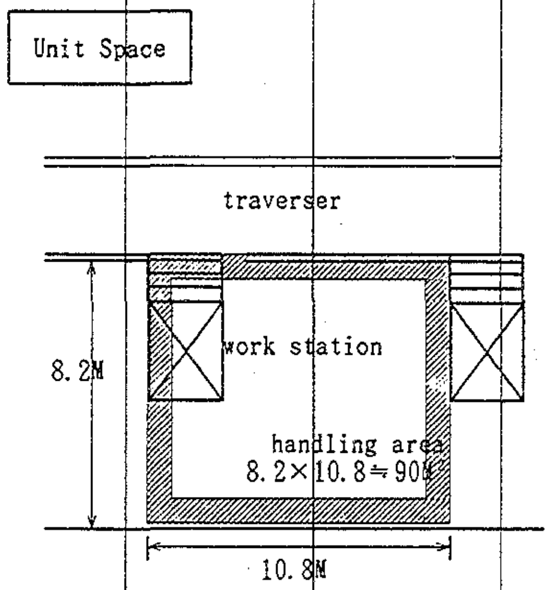
| name of facility | A. required capacity | | | B. actual capacity | c. facility to be developed (A-B) | | | n o t e |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | | 1995 | 2000 | 2010 | |
| 13. ARRIVALS CUSTOMS (position) | | | | | | | | |
| INT | 3 | 3 | 4 | | — | — | — | |
| P/A | 2 | 2 | 2 | | — | — | — | |
| total | 5×40$m^2$ (200$m^2$) | 5×40$m^2$ (200$m^2$) | 6×40$m^2$ (200$m^2$) | 10 (400$m^2$) | — | — | — | |
| 14. QUEUEING AREA (Arrival Customs) ($M^2$) | | | | | | | | |
| INT | 80 | 80 | 110 | | | | | |
| P/A | 40 | 40 | 50 | | | | | |
| total | 120 | 120 | 160 | 192 | — | — | — | |

| name of facility | | A. required capacity | | | B. actual capacity | c. facility to be developed (A-B) | | | note |
|---|---|---|---|---|---|---|---|---|---|
| | | 1995 | 2000 | 2010 | | 1995 | 2000 | 2010 | |
| 15. ARRIVAL LOBBY | ($M^2$) | | | | | | | | |
| | INT | 660 | 660 | 900 | | | | | |
| | P/A | 110 | 110 | 125 | | | | | |
| | DOMES | 40 | 50 | 60 | | | | | |
| | total | 820 | 830 | 1,090 | 1,020 | – | – | 70 | |
| 16. ARRIVAL KERB | | | | | | | | | |
| | total | 45 | 50 | 65 | 100 | – | – | – | |

## (2) Cargo Terminal Facilities

| name of facility | A. required Capacity | | | B. Capacity of existing facilities | | c. facility to be developed (A − C) | | | n o t e |
|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | A c t u a l | After Modification | 1995 | 2000 | 2010 | |
| 1. TRACK DOCK (M) (EXPORT CARGO) | 3×2.4 =7.2<br>7.2 | 3×2.4 =7.2<br>1×3.6 =3.6<br>10.8 | 3×2.4 =7.2<br>2×3.6 =7.2<br>14.8 | | Of Existing terminal | | | | |
| 2. (IMPORT CARGO) | 8×2.4 =19.2<br>19.2 | 9×2.4 =21.6<br>2×3.6 =7.2<br>28.8 | 17×2.4 =40.8<br>4×3.6 =14.4<br>55.2 | | | | | | |
| | | | | | | | | | |

| name of facility | A. required Capacity | | | B. Capacity of existing facilities | | c. facility to be developed (A − C) | | | note |
|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | Actual | After Modification | 1995 | 2000 | 2010 | |
| 3. WORK STATION AREA (EXPORT CARGO -BUILT-UP AREA) ($M^2$) | 2<br>180 | 2<br>180 | 5<br>450 | − | Of Existing terminal<br>450 | − | − | − | |



| name of facility | A. required Capacity | | | B. Capacity of existing facilities | | c. facility to be developed (A − C) | | | note |
|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | Actual | After Modification | 1995 | 2000 | 2010 | |
| 4. WORK STATION AREA (IMPORT CARGO -BREAK DOWN AREA) ($M^2$) | 2<br>180 | 2<br>180 | 7<br>630 | − | 180<br>180<br>630 | − | − | − | |
| 5. EXPORT BULK CARGO HANDLING AREA ($M^2$) | 360 | 330 | 370 | 325 | 185<br>(175)<br>605 | − | − | − | |
| 6. IMPORT BULK CARGO HANDLING AREA ($M^2$) | 350 | 370 | 560 | | | | | | |

| name of facility | A. required Capacity | | | B. Capacity of existing facilities | | c. facility to be developed (A − C) | | | note |
|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2010 | Actual | After Modification | 1995 | 2000 | 2010 | |
| 7. CUSTOMS AREA (EXPORT + IMPORT) ($M^2$) | 110 | 135 | 260 | 240 | − | − | − | 20 | |
| 8. STORAGE AREA FOR IMPORT CARGO ($M^2$) | 980 | 1,080 | 2,500 | 2,175 | *two stories rack system should be provided − | − | − | 325 | |
| 9. COLD STORAGE FOR PERISHBLE CARGO ($M^2$) | 45 | 125 | 260 | − | 260 | − | − | − | |
| Total<br>Export | 2,205 | 2,400 | 4,580 | 1,220<br>1,940<br>800<br>3,960 | | − | − | 620 | |
| 10. AIRLINE AND AGENT OFFICE AREA ($M^2$) | 235 | 500 | 1,385 | 400 | − | − | 100 | 985 | |
| | | | | | | | | | |

# ATTACHMENT 4

# INITIAL LOAD-CARRYING CAPACITY

# OF

# EXISTING PAVEMENT

The comparison between initial allowable load of existing pavement and operation weight of aircraft in the Short-term and Long term is shown in Table 4-1.

If the initial allowable load is less than future operation weight, reinforcement of pavement should be made.

If the initial allowable load is adequate and existing conditions of pavement is not so poor, repair will be required.

The reinforcement of pavement should be made by the following manner.

a. Flexible pavement

| | Short term | Long term |
|---|---|---|
| Design load | Take-off weight to RIO DE JANAIRO | Take-off weight to CARACAS |
| Design life | 10 years | 10 years |

b. Rigid pavement

| | Short term | Long term |
|---|---|---|
| Design load | Take-off weight to CARACAS | Take-off weight to CARACAS |
| Design life | 20 years | 20 years |

Table 4-1 Comparison between initial allowable load and aircraft operation weight

a. RWY06/24, TWY-A, TWY-B, TWY-D, APRON

| Name of Facility | Location | Initial allowable load(ton) | Operation weight of B-747(ton) Short term (RIO DE JANAIRO) | Operation weight of B-747(ton) Long term (CARACAS) | Existing pavement conditions |
|---|---|---|---|---|---|
| RWY06/24 | 2K448-2K698 | 340 | 284 | 340 | Good |
| | Others | 181 - 245 | | | Fair to poor |
| TWY-A | - | 159 - 168 | | | Very poor |
| TWY-B | T7 | 340 | | | Good |
| | Others | 168 - 213 | | | Fair to poor |
| TWY-D | - | 32 | | | Very poor |
| APRON | S - 1 | 340 | | | Fair |
| | S - 2 | 281 | | | Fair |
| | S - 3 | 191 | | | Poor |
| | S-4, S-5 S-6 | 32 - 42 | | | Fair to very poor |

b. RWY01/19, TWY-C, RWY10.28, TWY-E

| Name of Facility | Location | Initial allowable load(ton) | Operation weight of B-747(ton) F27 - MK500 | Operation weight of B-747(ton) S - 340 | Existing pavement conditions |
|---|---|---|---|---|---|
| RWY01/19 | 0K170-0K400 | 68 | 20 | 12 | Poor |
| | Others | 23 - 41 | | | Fair to poor |
| TWY-C | - | 45 - 59 | | | Very poor |
| RWY10/28 | 0K360-0K725 | 68 | | | Poor |
| | Others | 23 | | | Poor |
| TWY-E | - | 27 - 33 | | | Poor |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: RWY06/24 | | LOCATION: 1K722 ~ 2K148 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Ballast | 37 | | | | | 37 | 1.0 | 37 |
| Macadam | 23 | | | | | 23 | 1.0 | 36.8 |
| Asphalt concrete | 35.5 | 13 | 22.5 | 1.2 | 27 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | | 13 | | | 27 | | | 73.8 |

| TOTAL EQUIVALENT THICKNESS | | 113.8 cm (45 in) | |
|---|---|---|---|
| SUB-BASE | MATERIAL: Ballast | ASSUMED CBR: 40 % | |
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 13 cm | 40 cm |
| | MINIMUM BASE REQUIREMENT | 27 cm | 27 cm |
| | SURFACING | 13 cm | 13 cm |
| | ALLOWABLE LOAD | 470,000 lb (213 t) | |

## LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: RWY06/24 | | LOCATION: 2K148 ~ 2K298 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMI-NOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Granular | 55 | | | | | 55 | 1.0 | 55 |
| Bitumi-nous base | 10 | | | | | 10 | 1.6 | 16 |
| Asphalt concrete | 33 | 13 | 20 | 1.2 | 24 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 98 | 13 | | | 24 | | | 71 |
| TOTAL EQUIVALENT THICKNESS | | | 108 cm (43 in) | | | | | |

| SUB-BASE | MATERIAL: Granular | ASSUMED CBR: 40 % | |
|---|---|---|---|
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 13 cm | 37 cm |
| | MINIMUM BASE REQUIREMENT | 24 cm | 24 cm |
| | SURFACING | 13 cm | 13 cm |
| | ALLOWABLE LOAD | 460,000 lb (209 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: RWY06/24 | | LOCATION: 2K298 - 2K448 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE ACTUAL THICKNESS (cm) | BASE EQUIVALENCY FACTOR | BASE EQUIVALENT THICKNESS (cm) | SUB-BASE ACTUAL THICKNESS (cm) | SUB-BASE EQUIVALENCY FACTOR | SUB-BASE EQUIVALENT THICKNESS (cm) |
|---|---|---|---|---|---|---|---|---|
| Granular | 25 | | | | | 25 | 1.0 | 25 |
| Cement concrete | 32 | | 12 | 1.2 | 14.4 | 20 | 1.7 | 34 |
| Asphalt concrete | 20 | 13 | 7 | 1.4 | 9.8 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 77 | 13 | | | 24.2 | | | 59 |

| TOTAL EQUIVALENT THICKNESS | 96.2 cm (38 in) |
|---|---|

| SUB-BASE | MATERIAL: Granular | ASSUMED CBR: 40 % | |
|---|---|---|---|
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 13 cm | 37.2 cm |
| | MINIMUM BASE REQUIREMENT | 23 cm | 24.2 cm |
| | SURFACING | 13 cm | 13 cm |
| | ALLOWABLE LOAD | 400,000 lb (181 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: RWY01/19, RWY10/28 | | LOCATION: 0K170 ~ 0K400, 0K360 ~ 0K725 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sand | 30 | | | | | 30 | 1.0 | 30 |
| Cement concrete | 20 | | | | | 20 | 1.7 | 34 |
| Asphalt concrete | 30 | 10 | 20 | 1.2 | 24 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 80 | 10 | | | 24 | | | 64 |
| TOTAL EQUIVALENT THICKNESS | | | 98 cm (39 in) | | | | | |

| SUB-BASE | MATERIAL: | ASSUMED CBR: | |
|---|---|---|---|
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | cm | cm |
| | MINIMUM BASE REQUIREMENT | cm | cm |
| | SURFACING | cm | cm |
| | ALLOWABLE LOAD | 150,000 lb (68 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: RWY01/19 | | LOCATION: 1K598 - 1K748 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sand | 30 | | | | | 30 | 1.0 | 30 |
| Cement concrete | 20 | | 10 | 1.2 | 12 | 10 | 1.7 | 17 |
| Asphalt concrete | 20 | 10 | 10 | 1.4 | 14 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 70 | 10 | | | 26 | | | 47 |
| TOTAL EQUIVALENT THICKNESS | | | | 83 cm (33 in) | | | | |

| SUB-BASE | MATERIAL: | ASSUMED CBR: | |
|---|---|---|---|
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | cm | cm |
| | MINIMUM BASE REQUIREMENT | cm | cm |
| | SURFACING | cm | cm |
| | ALLOWABLE LOAD | 91,000 lb (41 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - A | | | LOCATION: T - 1 | | | | | |
|---|---|---|---|---|---|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | | 3.5 % | | | | | |
| | AIRCRAFT(GEAR) TYPE | | B-747-200B | | | | | |
| | ANNUAL DEPARTURES | | 3,000 | | | | | |
| CALCULATION OF EQUIVALENT THICKNESS | | | | | | | | |
| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sandy gravel | 38 | | | | | 38 | 1.0 | 38 |
| Cement concrete | 25 | | 15 | 1.2 | 18 | 10 | 1.7 | 17 |
| Asphalt concrete | 15 | 13 | 2 | 1.2 | 2.4 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 78 | 13 | | | 20.4 | | | 55 |
| TOTAL EQUIVALENT THICKNESS | | | | 88.4 cm (35 in) | | | | |
| SUB-BASE | MATERIAL: Sandy gravel | | | | ASSUMED CBR: 40 % | | | |
| CHECK OF THICKNESS | ITEM | | | | REQUIRED | | ASSUMED | |
| | SURFACING AND BASE | | | | 13 cm | | 33.4 cm | |
| | MINIMUM BASE REQUIREMENT | | | | 21 cm | | 20.4 cm | |
| | SURFACING | | | | 13 cm | | 13 cm | |
| ALLOWABLE LOAD | | | | | 350,000 lb (159 t) | | | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - A | | LOCATION: T - 2 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE ACTUAL THICKNESS (cm) | BASE EQUIVALENCY FACTOR | BASE EQUIVALENT THICKNESS (cm) | SUB-BASE ACTUAL THICKNESS (cm) | SUB-BASE EQUIVALENCY FACTOR | SUB-BASE EQUIVALENT THICKNESS (cm) |
|---|---|---|---|---|---|---|---|---|
| Sandy gravel | 38 | | | | | 38 | 1.0 | 38 |
| Cement concrete | 25 | | 15 | 1.2 | 18 | 10 | 1.7 | 17 |
| Asphalt concrete | 20 | 13 | 7 | 1.2 | 8.4 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 83 | 13 | | | 26.4 | | | 55 |
| TOTAL EQUIVALENT THICKNESS | | | | 94.4 cm (37 in) | | | | |

| SUB-BASE | MATERIAL: Sandy gravel | ASSUMED CBR: 40 % | |
|---|---|---|---|
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 13 cm | 39.4 cm |
| | MINIMUM BASE REQUIREMENT | 22 cm | 26.4 cm |
| | SURFACING | 13 cm | 13 cm |
| | ALLOWABLE LOAD | 370,000 lb (169 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - A | | LOCATION: T - 1 (Widened part) |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Tosca | 52 | | | | | 52 | 1.0 | 52 |
| Sandy gravel | 15 | | | | | 15 | 1.0 | 15 |
| Asphalt concrete | 12 | *1 10 | 2 | 1.2 | 2.4 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 98 | 10 | | | 2.4 | | | 67 |
| TOTAL EQUIVALENT THICKNESS | | | 79.4 cm (31 in) | | | | | |

| SUB-BASE | MATERIAL: | | ASSUMED CBR: | |
|---|---|---|---|---|
| CHECK OF THICKNESS | | ITEM | REQUIRED | ASSUMED |
| | | SURFACING AND BASE | 10 cm | 12.4 cm |
| | *2 | MINIMUM BASE REQUIREMENT | 18 cm | 2.4 cm |
| | | SURFACING | 10 cm | 10 cm |
| | | ALLOWABLE LOAD | --- | |

*1 Non-critical area.

*2 Thickness of base is less than required.

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - B | | LOCATION: T5 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sand | 30 | | | | | 30 | 1.0 | 30 |
| Cement concrete | 20 | 3 | 17 | 1.2 | 20.4 | | | |
| Asphalt concrete | 10 | 10 | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 60 | 13 | | | 20.4 | | | 30 |

| TOTAL EQUIVALENT THICKNESS | | 63.4 cm (25 in) | |
|---|---|---|---|
| SUB-BASE | MATERIAL: | ASSUMED CBR: | |
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | cm | cm |
| | MINIMUM BASE REQUIREMENT | cm | cm |
| | SURFACING | cm | cm |
| | ALLOWABLE LOAD | --- | |

This structure is not applicable to design curve of B-747.
(Thickness is too thin.)

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - B | | | LOCATION: T5 (Widened part) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DESIGN CONDITIONS | | CBR OF SUBGRADE | 3.5 % | | | | | | |
| | | AIRCRAFT(GEAR) TYPE | B-747-200B | | | | | | |
| | | ANNUAL DEPARTURES | 3,000 | | | | | | |
| CALCULATION OF EQUIVALENT THICKNESS | | | | | | | | | |
| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | | |
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | |
| Tosca | 50 | | | | | 50 | 1.0 | 50 | |
| Gravel | 20 | | | | | 20 | 1.0 | 20 | |
| Asphalt concrete | 20 | 13 | 7 | 1.2 | 8.4 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| TOTAL | | 13 | | | 8.4 | | | 70 | |
| TOTAL EQUIVALENT THICKNESS | | | | 91.4 cm (36 in) | | | | | |
| SUB-BASE | MATERIAL: Tosca | | | | ASSUMED CBR: 40 % | | | | |
| CHECK OF THICKNESS | ITEM | | | | REQUIRED | | ASSUMED | | |
| | SURFACING AND BASE | | | | 13 cm | | 21.4 cm | | |
| | * MINIMUM BASE REQUIREMENT | | | | 21 cm | | 8.4 cm | | |
| | SURFACING | | | | 13 cm | | 13 cm | | |
| ALLOWABLE LOAD | | | | | --- | | | | |

*Thickness of base is less than required.

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - B | | LOCATION: T6 - 1 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sand | 30 | | | | | 30 | 1.0 | 30 |
| Cement concrete | 25 | | | | | 25 | 1.7 | 42.5 |
| Asphalt concrete | 33 | 13 | 20 | 1.4 | 28 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 88 | 13 | | | 28 | | | 72.5 |
| TOTAL EQUIVALENT THICKNESS | | | | 113.5 cm (45 in) | | | | |
| SUB-BASE | MATERIAL: Sand | | | | ASSUMED CBR: 20 % | | | |

| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
|---|---|---|---|
| | SURFACING AND BASE | 26 cm | 41 cm |
| | MINIMUM BASE REQUIREMENT | 26 cm | 28 cm |
| | SURFACING | 13 cm | 13 cm |
| | ALLOWABLE LOAD | 470,000 lb (213 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - B | | LOCATION: T6 - 2 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Ballast | 50 | | | | | 50 | 1.0 | 50 |
| Macadam | 20 | | 10 | 1.0 | 10 | 10 | 1.6 | 16 |
| Asphalt concrete | 24 | 13 | 11 | 1.4 | 15.4 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 94 | 13 | | | 25.4 | | | 66 |

| TOTAL EQUIVALENT THICKNESS | 104.4 cm (41 in) | |
|---|---|---|
| SUB-BASE | MATERIAL: Ballast | ASSUMED CBR: |

| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
|---|---|---|---|
| | SURFACING AND BASE | 13 cm | 38.4 cm |
| | MINIMUM BASE REQUIREMENT | 24 cm | 25.4 cm |
| | SURFACING | 13 cm | 13 cm |
| | ALLOWABLE LOAD | 420,000 lb (191 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - B | | LOCATION: T8 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE ACTUAL THICKNESS (cm) | BASE EQUIVALENCY FACTOR | BASE EQUIVALENT THICKNESS (cm) | SUB-BASE ACTUAL THICKNESS (cm) | SUB-BASE EQUIVALENCY FACTOR | SUB-BASE EQUIVALENT THICKNESS (cm) |
|---|---|---|---|---|---|---|---|---|
| Sand | 30 | | | | | 30 | 1.0 | 37 |
| Cement concrete | 25 | | 10 | 1.2 | 12 | 15 | 1.7 | 25.5 |
| Aggregate | 8 | | 8 | 1.0 | 8 | | | |
| Macadam | 6 | | 6 | 1.0 | 6 | | | |
| Asphalt concrete | 12 | 12 | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 81 | 12 | | | 26 | | | 55.5 |

| TOTAL EQUIVALENT THICKNESS | | 93.5 cm (37 in) | |
|---|---|---|---|
| SUB-BASE | MATERIAL: Sand | ASSUMED CBR: 20 % | |
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 20 cm | 38 cm |
| | MINIMUM BASE REQUIREMENT | 22 cm | 26 cm |
| | SURFACING | 13 cm | 12 cm |
| | ALLOWABLE LOAD | 370,000 lb (168 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - C | | LOCATION: T4 - 1 |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sandy gravel | 55 | | | | | 55 | 1.0 | 55 |
| Well-graded aggregate | 25 | | 25 | 1.0 | 25 | | | |
| Asphalt concrete | 15 | 10 | 5 | 1.2 | 6 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 95 | 10 | | | 31 | | | 55 |

| TOTAL EQUIVALENT THICKNESS | | 96 cm (38 in) | |
|---|---|---|---|
| SUB-BASE | MATERIAL: Sandy gravel | ASSUMED CBR: 40 % | |
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 10 cm | 41 cm |
| | MINIMUM BASE REQUIREMENT | 23 cm | 31 cm |
| | SURFACING | 10 cm | 10 cm |
| | ALLOWABLE LOAD | 130,000 lb (59 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - C | | | LOCATION: T4 - 2 | | | | | |
|---|---|---|---|---|---|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | | 3.5 % | | | | | |
| | AIRCRAFT(GEAR) TYPE | | Dual wheel | | | | | |
| | ANNUAL DEPARTURES | | 3,000 | | | | | |
| CALCULATION OF EQUIVALENT THICKNESS | | | | | | | | |
| MATERIAL | ACTUAL THICKNESS (cm) | BITUMI-NOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sandy gravel | 55 | | | | | 55 | 1.0 | 55 |
| Well-graded aggregate | 25 | | 25 | 1.0 | 25 | | | |
| Asphalt concrete | 10 | 10 | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 90 | 10 | | | 25 | | | 55 |
| TOTAL EQUIVALENT THICKNESS | | | | 90 cm (35 in) | | | | |
| SUB-BASE | MATERIAL: Sandy gravel | | | | ASSUMED CBR: 40 % | | | |
| CHECK OF THICKNESS | ITEM | | | | REQUIRED | | ASSUMED | |
| | SURFACING AND BASE | | | | 10 cm | | 10 cm | |
| | MINIMUM BASE REQUIREMENT | | | | 21 cm | | 25 cm | |
| | SURFACING | | | | 10 cm | | 10 cm | |
| ALLOWABLE LOAD | | | | | 100,000 lb (45 t) | | | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - C | | LOCATION: |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sand | 30 | | | | | 30 | 1.0 | 30 |
| Cement concrete | 20 | | 15 | 1.2 | 18 | 5 | 1.7 | 8.5 |
| Asphalt concrete | 15 | 10 | 5 | 1.2 | 6 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 65 | 10 | | | 24 | | | 38.5 |

| TOTAL EQUIVALENT THICKNESS | | 72.5 cm (29 in) | |
|---|---|---|---|
| SUB-BASE | MATERIAL: Sand | ASSUMED CBR: 20 % | |
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 16 cm | 34 cm |
| | MINIMUM BASE REQUIREMENT | 17 cm | 24 cm |
| | SURFACING | 10 cm | 10 cm |
| ALLOWABLE LOAD | | 70,000 lb (32 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: TWY - E | | LOCATION: |
|---|---|---|
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Sand | 30 | | | | | 30 | 1.0 | 30 |
| Cement concrete | 22 | | 12 | 1.2 | 14.4 | 10 | 1.7 | 17 |
| Asphalt concrete | 14 | 10 | 4 | 1.2 | 4.8 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 66 | 10 | | | 19.2 | | | 47 |
| TOTAL EQUIVALENT THICKNESS | | | | 76.2 cm (30 in) | | | | |

| SUB-BASE | MATERIAL: Sand | ASSUMED CBR: 20 % | |
|---|---|---|---|
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 17 cm | 39.2 cm |
| | MINIMUM BASE REQUIREMENT | 18 cm | 19.2 cm |
| | SURFACING | 10 cm | 10 cm |
| | ALLOWABLE LOAD | 73,000 lb (33 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

<table>
<tr><td colspan="4">FACILITY: APRON</td><td colspan="5">LOCATION: S - 4</td></tr>
<tr><td colspan="2" rowspan="3">DESIGN CONDITIONS</td><td colspan="2">CBR OF SUBGRADE</td><td colspan="5">3.5 %</td></tr>
<tr><td colspan="2">AIRCRAFT(GEAR) TYPE</td><td colspan="5">Dual wheel</td></tr>
<tr><td colspan="2">ANNUAL DEPARTURES</td><td colspan="5">3,000</td></tr>
<tr><td colspan="9">CALCULATION OF EQUIVALENT THICKNESS</td></tr>
<tr><td rowspan="2">MATERIAL</td><td rowspan="2">ACTUAL THICKNESS (cm)</td><td rowspan="2">BITUMINOUS SURFACE (cm)</td><td colspan="3">BASE</td><td colspan="3">SUB-BASE</td></tr>
<tr><td>ACTUAL THICKNESS (cm)</td><td>EQUIVALENCY FACTOR</td><td>EQUIVALENT THICKNESS (cm)</td><td>ACTUAL THICKNESS (cm)</td><td>EQUIVALENCY FACTOR</td><td>EQUIVALENT THICKNESS (cm)</td></tr>
<tr><td>Sand</td><td>30</td><td></td><td></td><td></td><td></td><td>30</td><td>1.0</td><td>30</td></tr>
<tr><td>Cement concrete</td><td>20</td><td></td><td>10</td><td>1.2</td><td>12</td><td>10</td><td>1.7</td><td>17</td></tr>
<tr><td>Aggregate</td><td>8</td><td></td><td>8</td><td>1.0</td><td>8.0</td><td></td><td></td><td></td></tr>
<tr><td>Macadam</td><td>6</td><td>6 x 0.5<br>3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Asphalt concrete</td><td>6</td><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>TOTAL</td><td>70</td><td>9</td><td></td><td></td><td>20</td><td></td><td></td><td>47</td></tr>
<tr><td colspan="4">TOTAL EQUIVALENT THICKNESS</td><td colspan="5">76 cm (30 in)</td></tr>
<tr><td>SUB-BASE</td><td colspan="4">MATERIAL: Sand</td><td colspan="4">ASSUMED CBR: 20 %</td></tr>
<tr><td rowspan="4">CHECK OF THICKNESS</td><td colspan="4">ITEM</td><td colspan="2">REQUIRED</td><td colspan="2">ASSUMED</td></tr>
<tr><td colspan="4">SURFACING AND BASE</td><td colspan="2">17 cm</td><td colspan="2">29 cm</td></tr>
<tr><td colspan="4">MINIMUM BASE REQUIREMENT</td><td colspan="2">18 cm</td><td colspan="2">20 cm</td></tr>
<tr><td colspan="4">SURFACING</td><td colspan="2">10 cm</td><td colspan="2">9 cm</td></tr>
<tr><td colspan="5">ALLOWABLE LOAD</td><td colspan="4">73,000 lb (33 t)</td></tr>
</table>

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| | | |
|---|---|---|
| FACILITY: APRON | | LOCATION: S - 5 |
| DESIGN CONDITIONS | CBR OF SUBGRADE | 3.5 % |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |

CALCULATION OF EQUIVALENT THICKNESS

| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) |
| Aggregate | 46 | | | | | 46 | 1.0 | 46 |
| Macadam | 23 | 5 x 0.5<br>2.5 | 18 | 1.0 | 18 | | | |
| Asphalt concrete | 7.5 | 7.5 | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTAL | 76.5 | 10 | | | 18 | | | 46 |

| | | | |
|---|---|---|---|
| TOTAL EQUIVALENT THICKNESS | | 74 cm (29 in) | |
| SUB-BASE | MATERIAL: Aggregate | ASSUMED CBR: 40 % | |
| CHECK OF THICKNESS | ITEM | REQUIRED | ASSUMED |
| | SURFACING AND BASE | 10 cm | 28 cm |
| | MINIMUM BASE REQUIREMENT | 17 cm | 18 cm |
| | SURFACING | 10 cm | 10 cm |
| | ALLOWABLE LOAD | 70,000 lb (32 t) | |

LOAD CARRYING CAPACITY OF FLEXIBLE PAVEMENT

| FACILITY: APRON | | | | LOCATION: S - 6 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DESIGN CONDITIONS | | CBR OF SUBGRADE | | 3.5 % | | | | | |
| | | AIRCRAFT(GEAR) TYPE | | Dual wheel | | | | | |
| | | ANNUAL DEPARTURES | | 3,000 | | | | | |
| CALCULATION OF EQUIVALENT THICKNESS | | | | | | | | | |
| MATERIAL | ACTUAL THICKNESS (cm) | BITUMINOUS SURFACE (cm) | BASE | | | SUB-BASE | | | |
| | | | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | ACTUAL THICKNESS (cm) | EQUIVALENCY FACTOR | EQUIVALENT THICKNESS (cm) | |
| Sand | 30 | | | | | 30 | 1.0 | 30 | |
| Cement concrete | 20 | | 5 | 1.2 | 6 | 15 | 1.7 | 25.5 | |
| Asphalt concrete | 20 | 10 | 10 | 1.4 | 14 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| TOTAL | 70 | 10 | | | 20 | | | 55.5 | |
| TOTAL EQUIVALENT THICKNESS | | | | 85.5 cm (34 in) | | | | | |
| SUB-BASE | MATERIAL: Sand | | | | ASSUMED CBR: 20 % | | | | |
| CHECK OF THICKNESS | ITEM | | | | REQUIRED | | ASSUMED | | |
| | SURFACING AND BASE | | | | 22 cm | | 30 cm | | |
| | MINIMUM BASE REQUIREMENT | | | | 20 cm | | 20 cm | | |
| | SURFACING | | | | 10 cm | | 10 cm | | |
| ALLOWABLE LOAD | | | | | 93,000 lb (42 t) | | | | |

## LOAD CARRYING CAPACITY OF RIGID PAVEMENT

| FACILITY AND LOCATION | RWY06/24 | 2K298 ~ 2K448 |
|---|---|---|
| DESIGN CONDITIONS | SUBGRADE K-VALUE | 63 pci |
| | FLEXURAL STRENGTH | 670 psi (Existing) |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |
| SUB-BASE 1 | MATERIAL | Graular |
| | THICKNESS | 25 cm |
| | EFFECTIVE K | 108 pci |
| SUB-BASE 2 | MATERIAL | |
| | THICKNESS | |
| | EFFECTIVE K | |
| EXISTING SLAB THICKNESS | | 32 cm |
| ALLOWABLE LOAD | | 540,000 lb (245 t) |

$t = 2.5\ (Fh - C_b h_e)$

$F = 1.0$
$C_b = 0.75$
$h_e = 12.6$ in
$t = 7.9$ in
$h = 12.6$ in

| |
|---|
| Asphalt concrete 20 cm (7.9 in) |
| Cement concrete 32 cm (12.6 in) |
| Graular 25 cm |

Bituminous overlay on rigid pavement

(Optional design curve is not used.)

LOAD CARRYING CAPACITY OF RIGID PAVEMENT

| FACILITY AND LOCATION | | RWY06/24-2K448~2K698,TWY-B T7,APRON S-1 |
|---|---|---|
| DESIGN CONDITIONS | SUBGRADE K-VALUE | 63 pci |
| | FLEXURAL STRENGTH | 670 psi (Existing) |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |
| SUB-BASE 1 | MATERIAL | Tosca |
| | THICKNESS | 30 cm |
| | EFFECTIVE K | 123 pci |
| SUB-BASE 2 | MATERIAL | Cement treated base |
| | THICKNESS | 30 cm |
| | EFFECTIVE K | 335 pci |
| EXISTING SLAB THICKNESS | | 35 cm |
| ALLOWABLE LOAD | | 750,000 lb (340 ton) |

LOAD CARRYING CAPACITY OF RIGID PAVEMENT

| FACILITY AND LOCATION | | RWY01/19, RWY10/28 |
|---|---|---|
| DESIGN CONDITIONS | SUBGRADE K-VALUE | 63 pci |
| | FLEXURAL STRENGTH | 670 psi (Existing) |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |
| SUB-BASE 1 | MATERIAL | Sand |
| | THICKNESS | 30 cm |
| | EFFECTIVE K | 123 pci |
| SUB-BASE 2 | MATERIAL | |
| | THICKNESS | |
| | EFFECTIVE K | |
| EXISTING SLAB THICKNESS | | 20 cm |
| ALLOWABLE LOAD | | 50,000 lb (23 ton) |

LOAD CARRYING CAPACITY OF RIGID PAVEMENT

| FACILITY AND LOCATION | APRON S - 2 | |
|---|---|---|
| DESIGN CONDITIONS | SUBGRADE K-VALUE | 63 pci |
| | FLEXURAL STRENGTH | 670 psi (Existing) |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |
| SUB-BASE 1 | MATERIAL | Tosca |
| | THICKNESS | 35 cm |
| | EFFECTIVE K | 137 pci |
| SUB-BASE 2 | MATERIAL | |
| | THICKNESS | |
| | EFFECTIVE K | |
| EXISTING SLAB THICKNESS | | 35 cm |
| ALLOWABLE LOAD | | 620,000 lb (281 ton) |

LOAD CARRYING CAPACITY OF RIGID PAVEMENT

| FACILITY AND LOCATION | | APRON S - 3 |
|---|---|---|
| DESIGN CONDITIONS | SUBGRADE K-VALUE | 63 pci |
| | FLEXURAL STRENGTH | 670 psi (Existing) |
| | AIRCRAFT(GEAR) TYPE | B-747-200B |
| | ANNUAL DEPARTURES | 3,000 |
| SUB-BASE 1 | MATERIAL | Sand |
| | THICKNESS | 30 cm |
| | EFFECTIVE K | 123 pci |
| SUB-BASE 2 | MATERIAL | |
| | THICKNESS | |
| | EFFECTIVE K | |
| EXISTING SLAB THICKNESS | | 26 cm |
| ALLOWABLE LOAD | | 420,000 lb (191 ton) |

$$hc = \sqrt[1.4]{h^{1.4} - Cr \cdot he^{1.4}}$$

| | | |
|---|---|---|
| Cr = 0.35<br>he = 20 cm<br>hc = 15.5 | Cr = 0.75<br>he = 20 cm<br>hc = 15.5 | Cr = 1.0<br>he = 20 cm<br>hc = 15.5 |
| $15.5^{1.4} = h^{1.4} - 0.35 \times 20^{1.4}$ | | |
| $h^{1.4} = 70$<br>h = 21 cm | h = 26 cm | h = 29 cm |

LOAD CARRYING CAPACITY OF RIGID PAVEMENT

| | | |
|---|---|---|
| FACILITY AND LOCATION | TWY - E T3 - 2 | |
| DESIGN CONDITIONS | SUBGRADE K-VALUE | 63 pci |
| | FLEXURAL STRENGTH | 670 psi (Existing) |
| | AIRCRAFT(GEAR) TYPE | Dual wheel |
| | ANNUAL DEPARTURES | 3,000 |
| SUB-BASE 1 | MATERIAL | Sand |
| | THICKNESS | 30 cm |
| | EFFECTIVE K | 123 pci |
| SUB-BASE 2 | MATERIAL | |
| | THICKNESS | |
| | EFFECTIVE K | |
| EXISTING SLAB THICKNESS | | 22 cm |
| ALLOWABLE LOAD | | 59,000 lb (27 t) |

# ATTACHMENT 5

# REQUIRED THICKNESS OF PAVEMENT

Table Calculation of Annual Departures (Year 2000)

| Aircraft | Gear type | Forecast annual departures | Conversion factor | Equivalent annual departures | Wheel load of aircraft (kg) | Wheel load of design aircraft (kg) | Equivalent annual departures of design aircraft |
|---|---|---|---|---|---|---|---|
| B747-200B | D.D.T. | 1,049 | 1.0 | 1,049 | 16,160 | 16,160 | 1,049 |
| DC-10-30 | D.T. | 839 | 1.0 | 839 | 16,160 | 16,160 | 839 |
| B707-320 | D.T. | 210 | 1.0 | 210 | 16,480 | 16,160 | 221 |
| B767-200 | D.T. | 629 | 1.0 | 629 | 16,060 | 16,160 | 617 |
| B727-200 | D. | 210 | 0.6 | 126 | 18,127 | 16,160 | 168 |
| B737-200 (Other Int'l) | D. | 1,258 | 0.6 | 755 | 11,970 | 16,160 | 300 |
| Subtotal | | | | | | | 3,194 |
| B737-200 (Puente Aereo) | D. | 2,565 (70%) | 0.6 | 1,796 | 11,970 | 16,160 | 632 |
| Total | | | | | | | 3,826 → 4,000 |
| B737-200 (Puente Aereo) | D. | 1,100 | 1.0 | 1,100 | 11,970 | 11,970 | 1,100 |
| F-27-MK500 (Domestic) | D. | 1,665 | 1.0 | 1,665 | 4,697 | 11,970 | 104 |
| Total | | | | | | | 1,204 → 1,200 |

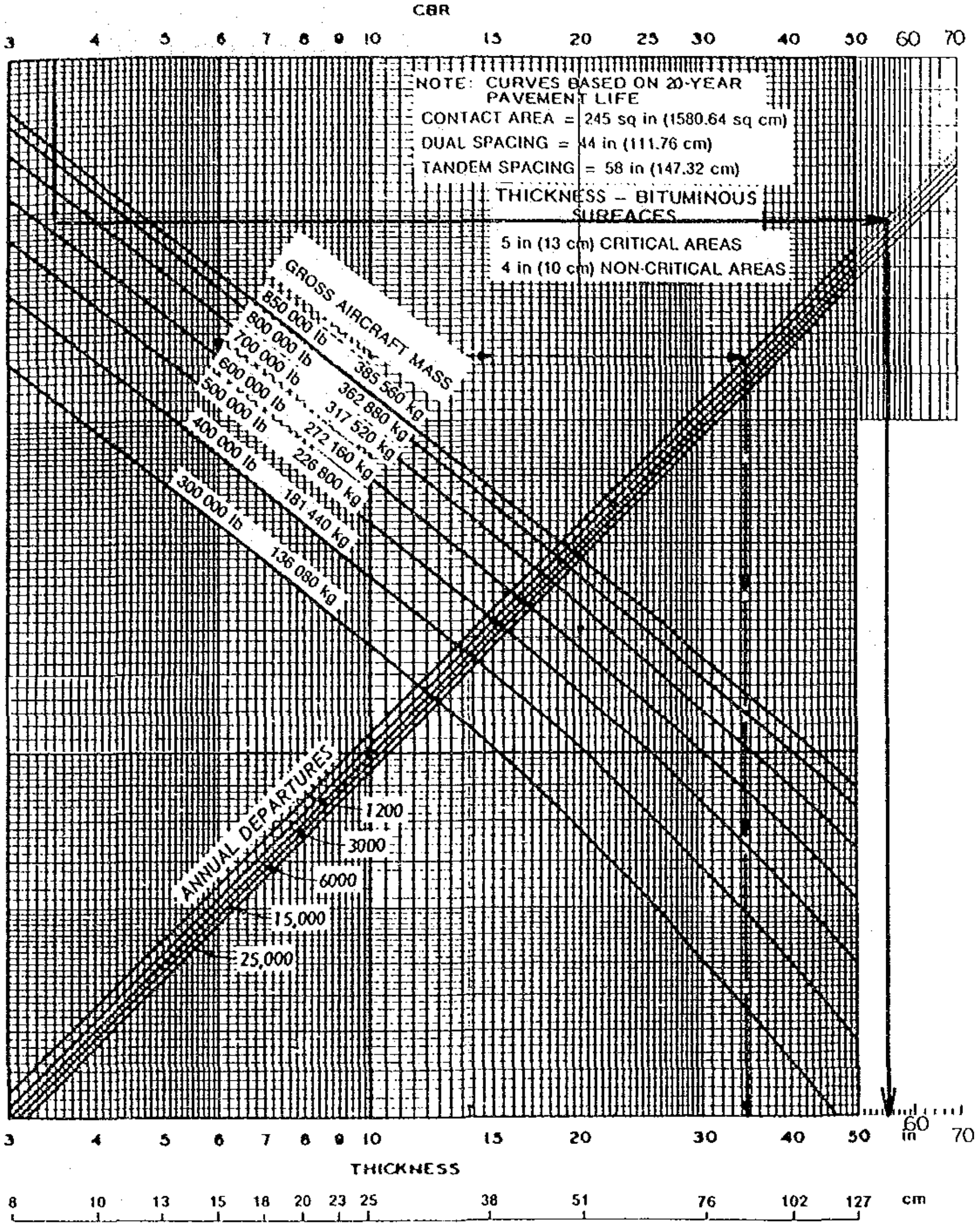



Figure 4-39. Flexible pavement design curves for critical areas, B747-100, SR, 200 B, C, F

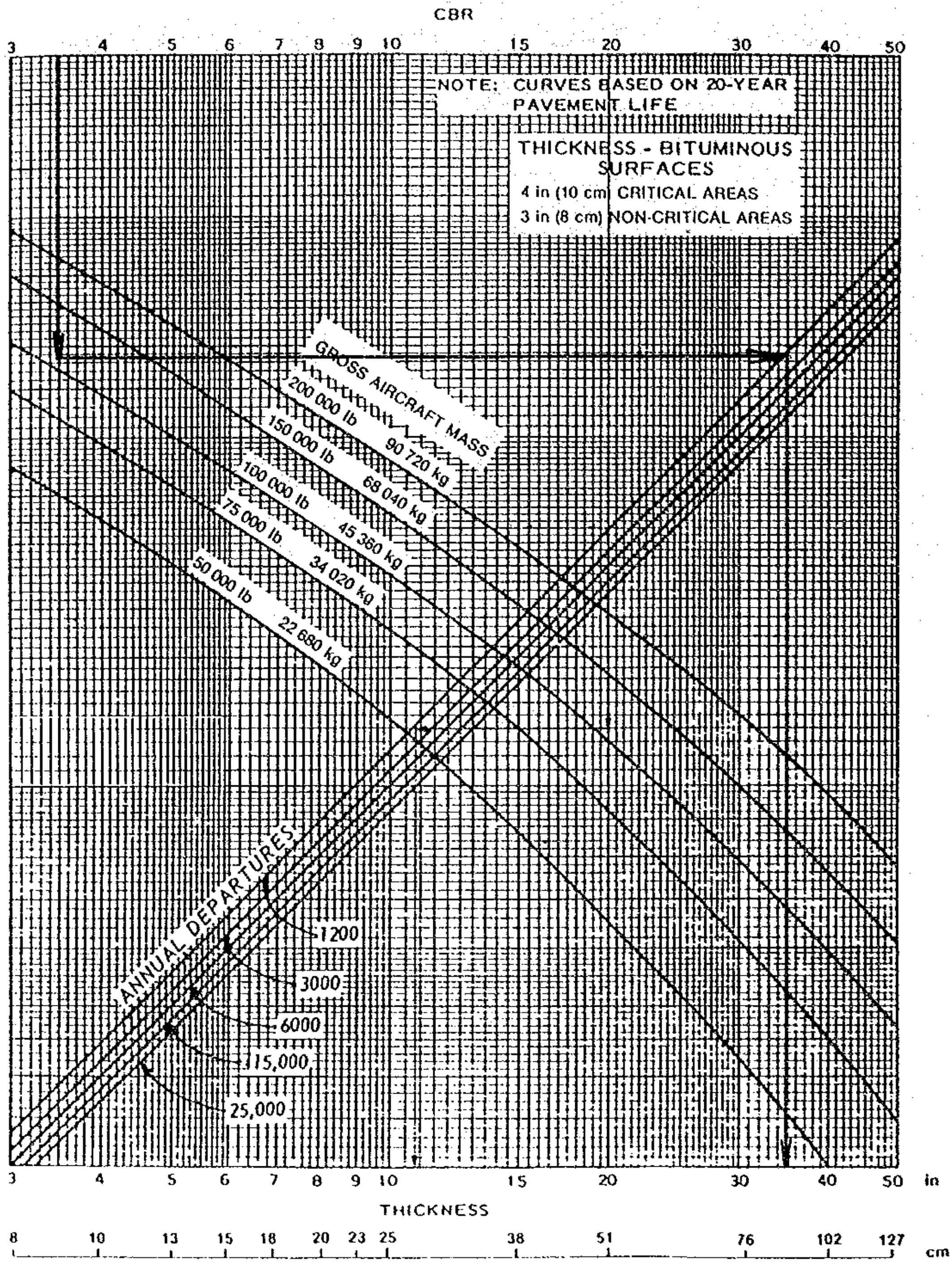



Figure 4-37. Flexible pavement design curves for critical areas, dual wheel gear

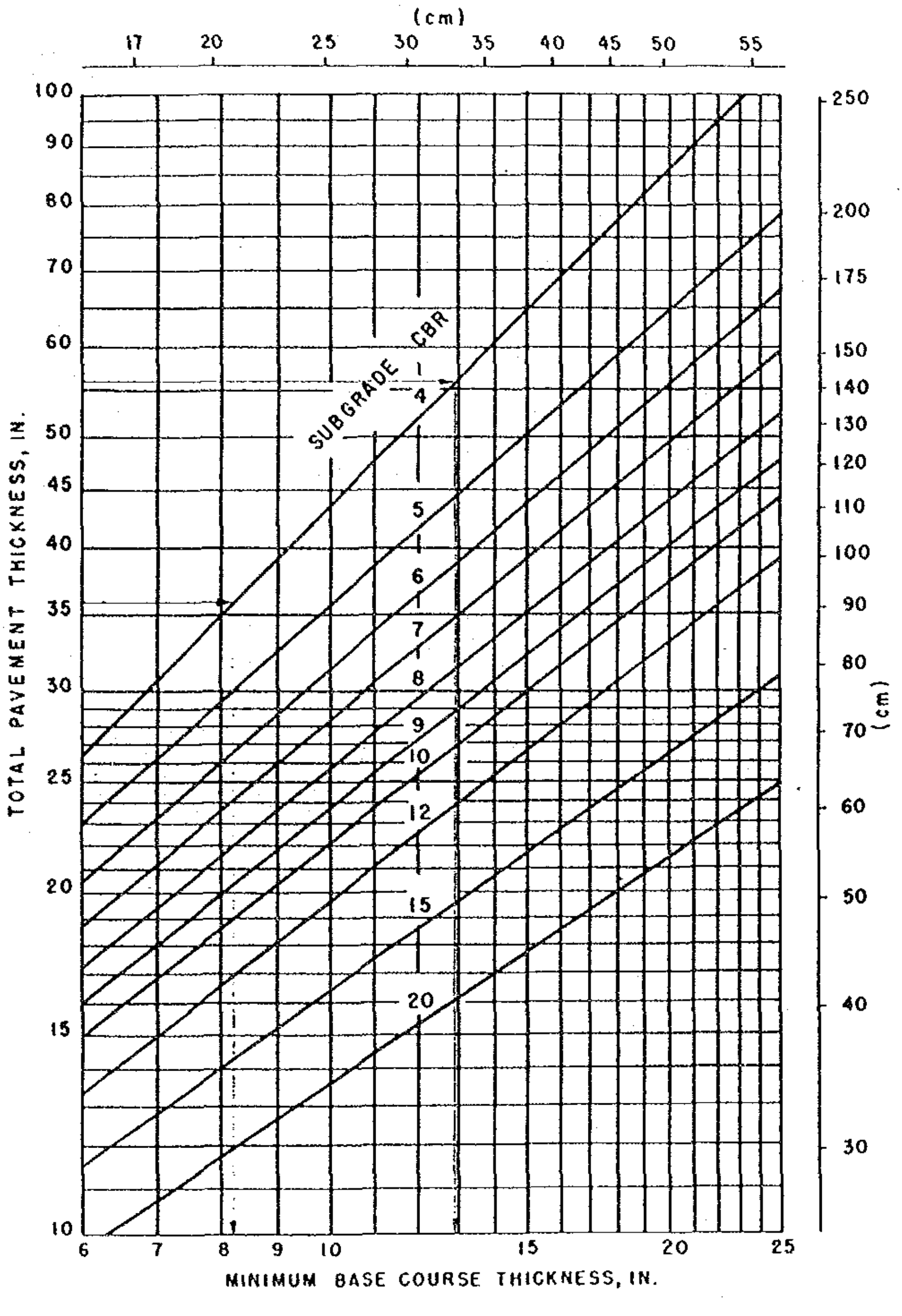



Figure 4-45. Minimum base course thickness requirements

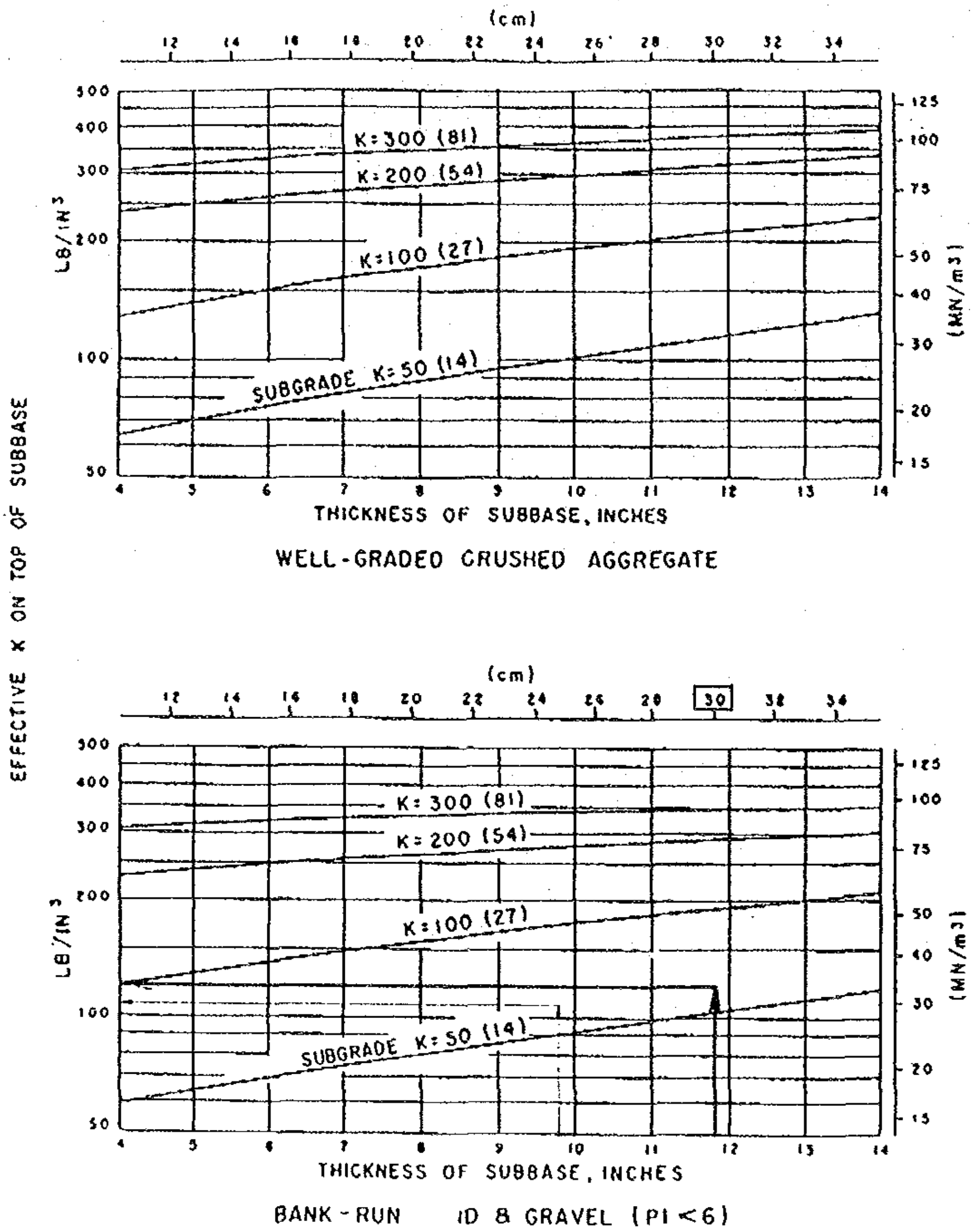



Figure 4-35. Effect of sub-base on modulus of subgrade reaction

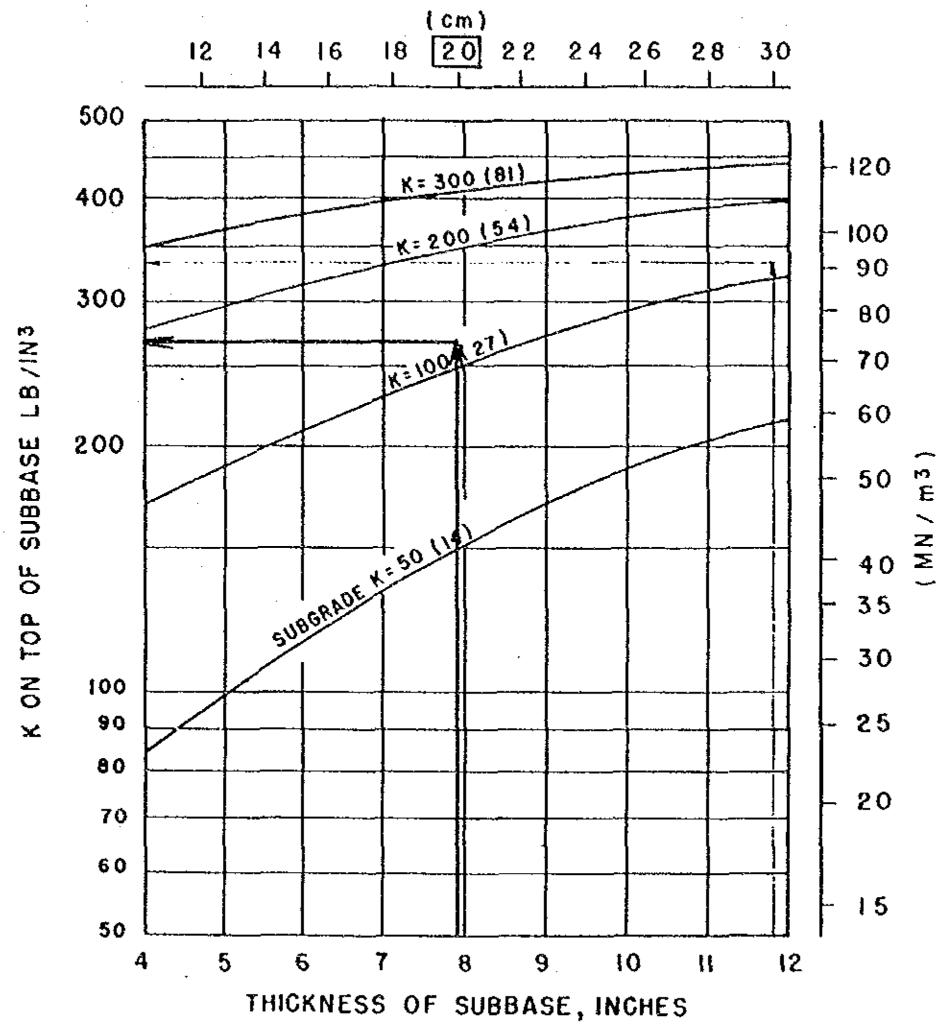



Figure 4-55. Effect of stabilized sub-base on subgrade modulus

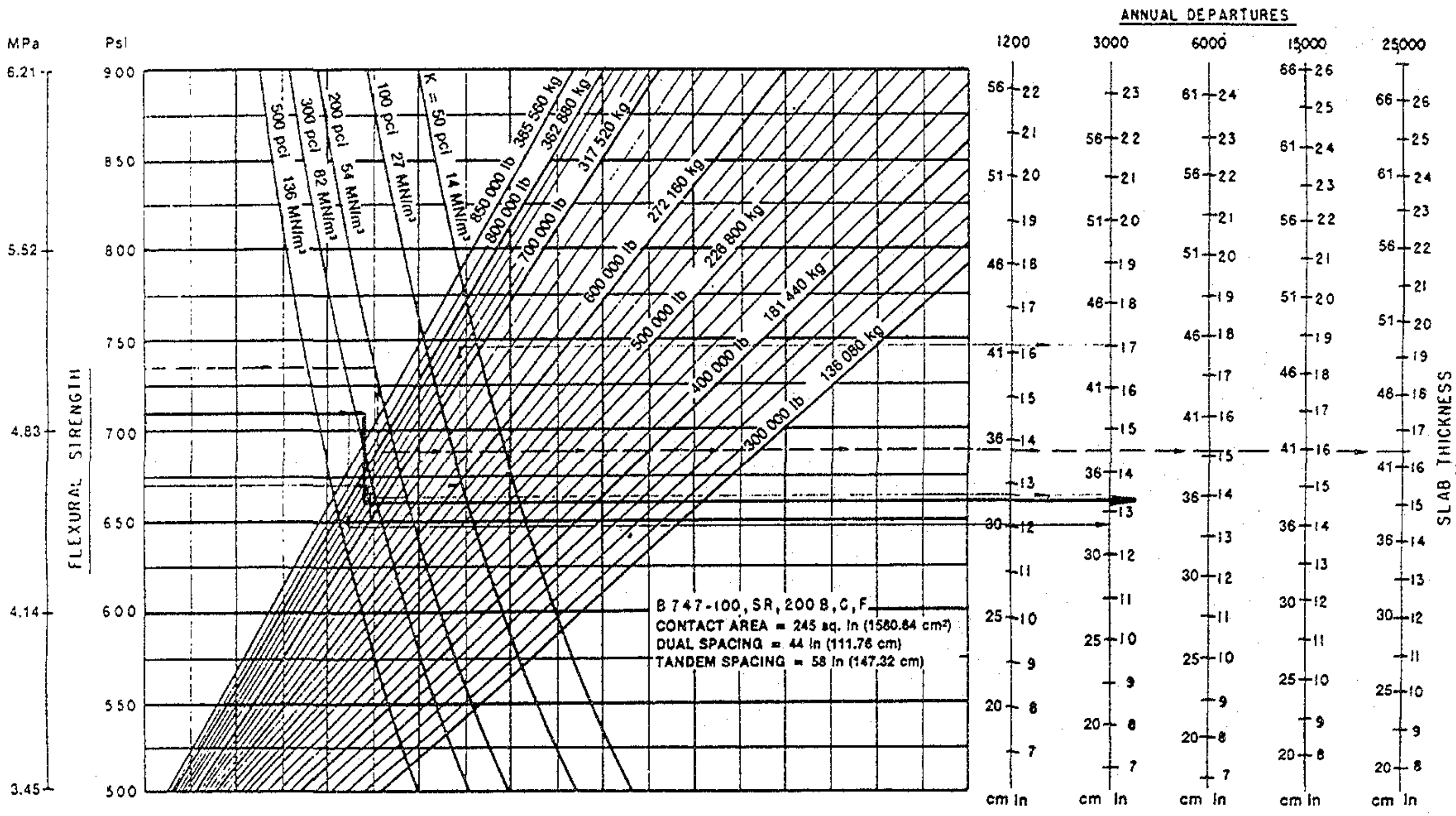



Figure 4-57. Optional rigid pavement design curves - B-747-100, SR, 200 B, C, F

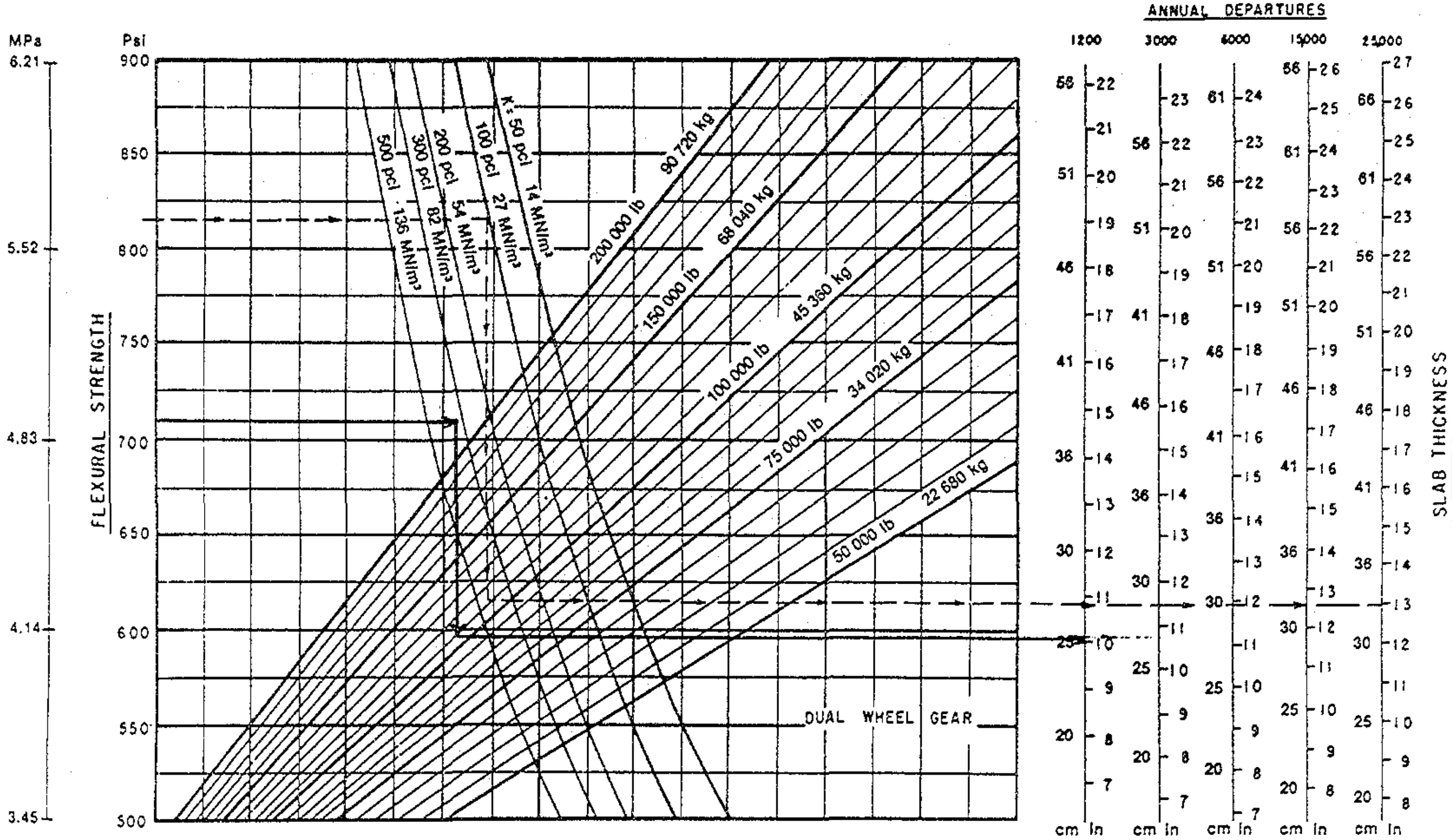
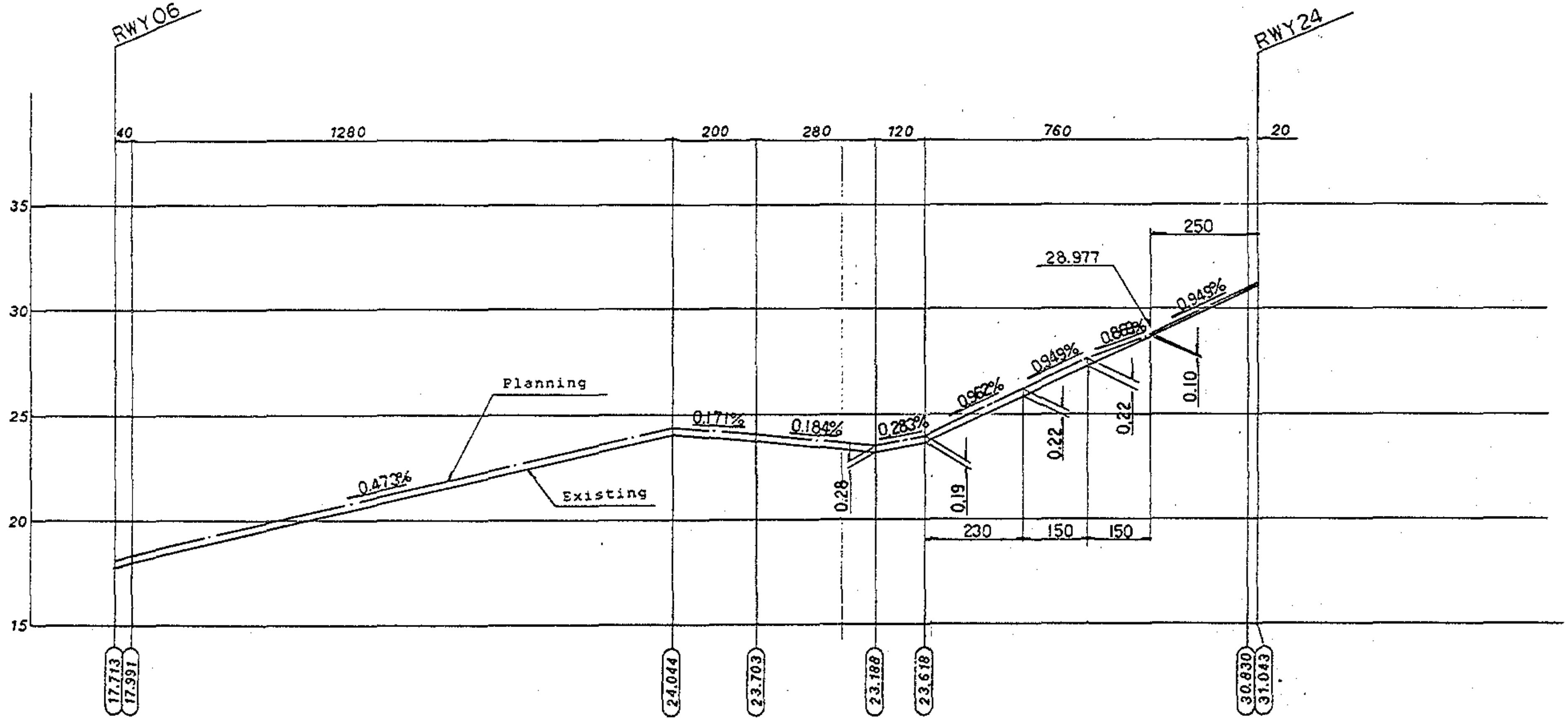



Figure 4-47. Rigid pavement design curves - dual wheel gear

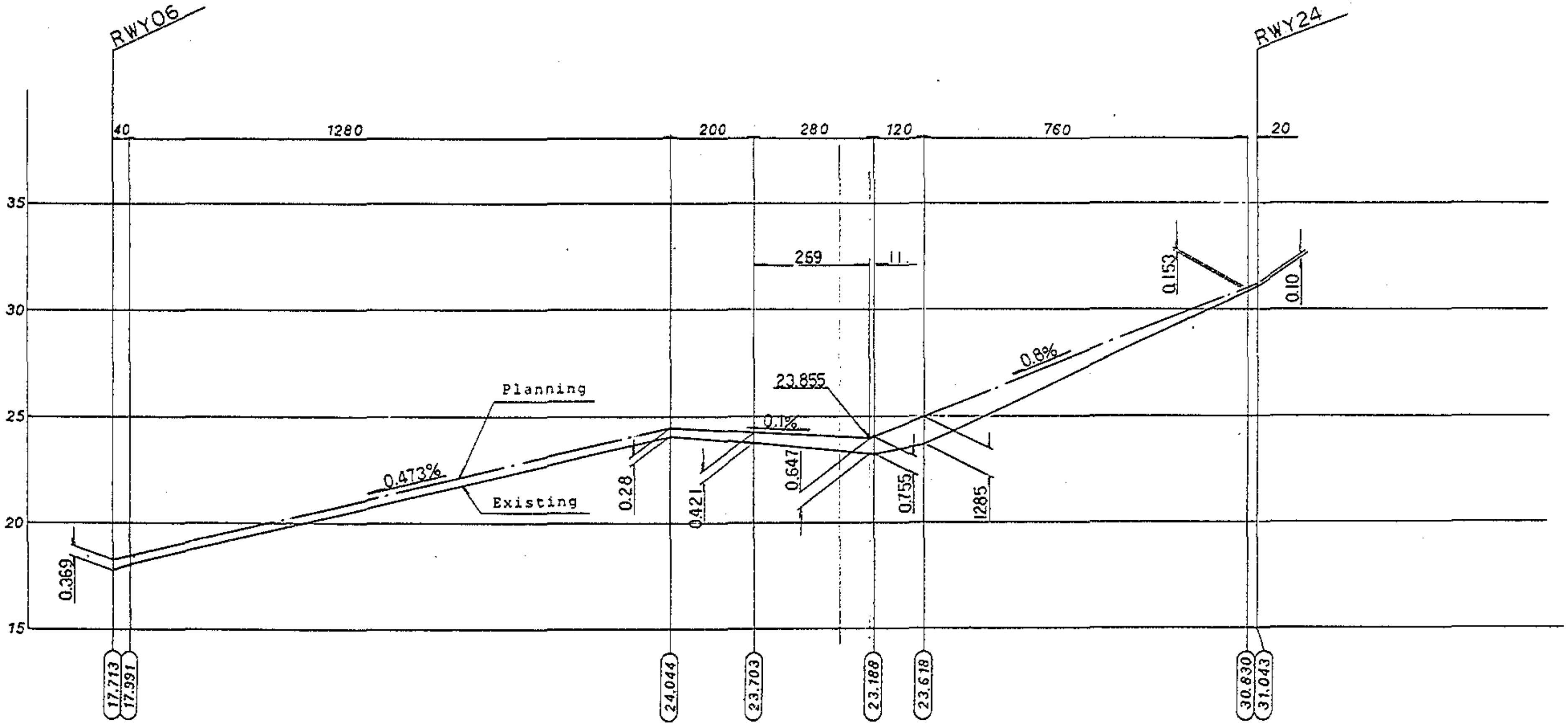
# ATTACHMENT 6

# ALTERNATIVES FOR CORRECTION OF LONGITUDINAL SLOPE OF RWY06/24

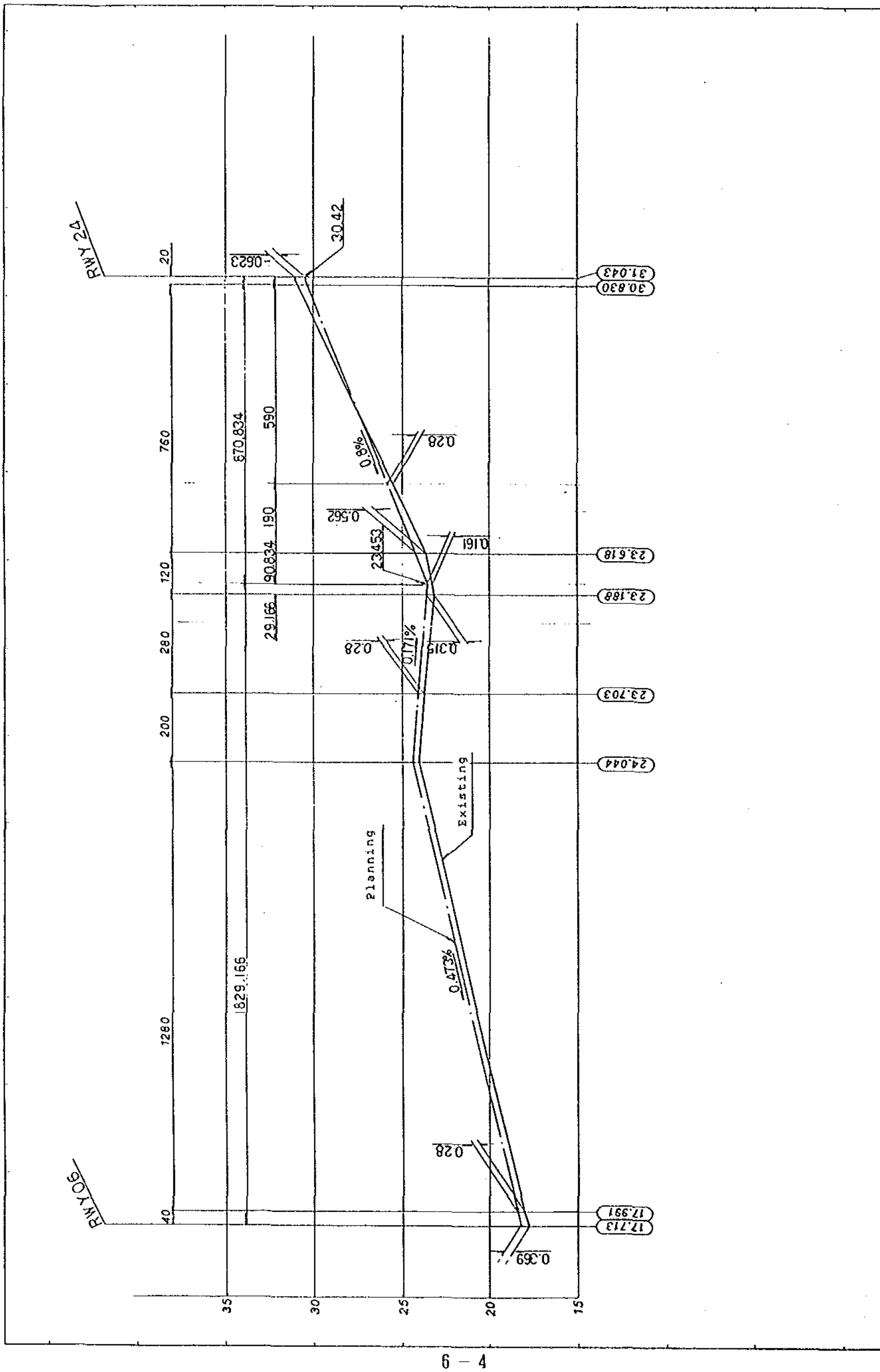
| Item \ Alternative | | Alternative-1 | Alternative-2 | Alternative-3 |
|---|---|---|---|---|
| Amount of Construction Work | Volume of Overlay | 32,150 $m^3$ | 56,890 $m^3$ | 28,370 $m^2$ |
| | Area of Replacement | Nil | Nil | 28,390 $m^2$ |
| Limitation of Runway Operation | | Nil<br>All construction work will be done at night. (out of operation hours) | Nil<br>As same as Alternative-1 | Runway will be operated with the length of 2,050 m, 650 m shorter than existing.<br>Overlay and a part of replacement will be done at night. |
| Maximum thickness of overlay | | 28 cm(6 layers) | 128 cm(26 layers) | 56 cm(11 layers) |
| Planning Longitudinal Profile | | Maximum slope is 0.95% at the end portion of the Runway 24.<br>As same condition as existing one.<br>It does not satisfy the recommendation of ICAO. | Maximum slope is corrected to 0.8%.<br>It satisfies the recommendation of ICAO. | As same as Alternative-2 |
| Construction Cost (Relative Evaluation) | | 1 | 1.8 | 1.6 |
| Remarks | | The distance of points at which the longitudinal slope change also does not satisfy the recommendation of ICAO. | | It is afraid that the drainage of surface water will be difficult because the elevation of the end of Runway 24 is 60 cm lowered. |




Runway 06/24 Longitudinal Profile Plan Alternative-1




Runway 06/24 Longitudinal Profile Plan Alternative-2




Runway 06/24 Longitudinal Profile Plan Alternative-3

# ATTACHMENT 7

# WIND COVERAGE

TABLE WIND COVERAGE AT CARRASCO INT'L AIRPORT

unit %

| RWY DIR. | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N 010°E | 99.19 | 98.73 | 99.44 | 97.28 | 97.01 | 97.12 | 97.81 | 97.95 | 98.01 | 98.52 | 98.19 | 98.67 | 98.16 |
| 020 | 99.19 | 98.77 | 99.44 | 97.42 | 97.37 | 97.58 | 97.96 | 98.16 | 98.36 | 98.62 | 97.89 | 98.68 | 98.29 |
| 030 | 99.15 | 98.73 | 99.34 | 97.63 | 97.78 | 98.04 | 98.07 | 98.37 | 98.46 | 98.69 | 97.54 | 98.56 | 98.37 |
| 040 | 99.07 | 98.71 | 99.19 | 97.88 | 98.17 | 98.32 | 98.15 | 98.61 | 98.50 | 98.67 | 97.27 | 98.28 | 98.40 |
| 050 | 98.94 | 98.74 | 99.05 | 98.19 | 98.54 | 98.32 | 98.24 | 98.82 | 98.51 | 98.51 | 97.16 | 98.09 | 98.43 |
| 060 | 98.81 | 98.77 | 98.98 | 98.44 | 98.75 | 98.11 | 98.28 | 98.92 | 98.51 | 98.19 | 97.22 | 98.10 | 98.42 |
| 070 | 98.67 | 98.68 | 98.94 | 98.47 | 98.63 | 97.82 | 98.14 | 98.89 | 98.25 | 97.73 | 97.37 | 98.09 | 98.31 |
| 080 | 98.49 | 98.50 | 98.92 | 98.38 | 98.35 | 97.51 | 97.93 | 98.75 | 97.59 | 97.23 | 97.57 | 98.09 | 98.11 |
| 090 | 98.34 | 98.34 | 98.88 | 98.31 | 98.12 | 97.24 | 97.65 | 98.50 | 96.64 | 96.72 | 97.65 | 98.06 | 97.87 |
| 100 | 98.27 | 98.28 | 98.89 | 98.29 | 97.91 | 96.95 | 97.28 | 98.23 | 95.68 | 96.22 | 97.62 | 98.01 | 97.64 |
| 110 | 98.32 | 98.31 | 98.92 | 98.25 | 97.73 | 96.56 | 97.07 | 98.00 | 95.05 | 95.92 | 97.58 | 97.99 | 97.47 |
| 120 | 98.47 | 98.29 | 98.95 | 98.04 | 97.42 | 96.13 | 96.95 | 97.83 | 94.74 | 95.89 | 97.58 | 97.98 | 97.36 |
| 130 | 98.73 | 98.23 | 99.04 | 97.75 | 97.00 | 95.83 | 96.88 | 97.71 | 94.70 | 96.10 | 97.64 | 98.05 | 97.31 |
| 140 | 99.05 | 98.25 | 99.18 | 97.57 | 96.66 | 95.63 | 96.89 | 97.61 | 94.85 | 96.49 | 97.77 | 98.37 | 97.36 |
| 150 | 99.29 | 98.38 | 99.32 | 97.56 | 96.56 | 95.65 | 96.98 | 97.55 | 95.22 | 96.97 | 97.94 | 98.75 | 97.52 |
| 160 | 99.38 | 98.52 | 99.41 | 97.55 | 96.60 | 95.88 | 97.12 | 97.56 | 95.77 | 97.48 | 98.12 | 98.90 | 97.70 |
| 170 | 99.32 | 98.62 | 99.43 | 97.44 | 96.65 | 96.21 | 97.36 | 97.65 | 96.47 | 97.94 | 98.29 | 98.85 | 97.85 |
| 180 | 99.22 | 98.67 | 99.42 | 97.30 | 96.75 | 96.64 | 97.60 | 97.77 | 97.29 | 98.30 | 98.32 | 98.73 | 98.00 |

REMARKS 1) Single RWY and Cross Wind Factor 20 KT

2) Wind Data (1979 ~ 1984)

TABLE WIND COVERAGE AT CARRASCO INT'L AIRPORT

unit %

| RWY DIR. | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N 010°E | 90.69 | 90.72 | 93.71 | 90.60 | 90.71 | 86.29 | 91.39 | 90.90 | 88.37 | 89.60 | 87.53 | 89.52 | 90.02 |
| 020 | 89.18 | 90.05 | 92.95 | 90.66 | 90.47 | 86.16 | 91.49 | 90.61 | 88.09 | 89.28 | 86.18 | 87.94 | 89.43 |
| 030 | 87.74 | 89.68 | 92.23 | 90.71 | 90.18 | 85.79 | 90.98 | 90.28 | 87.56 | 88.57 | 85.12 | 86.56 | 88.79 |
| 040 | 86.55 | 89.47 | 91.77 | 90.71 | 89.84 | 85.51 | 89.96 | 89.97 | 86.53 | 87.74 | 84.46 | 85.79 | 88.20 |
| 050 | 85.82 | 89.26 | 91.56 | 90.54 | 89.20 | 85.41 | 88.47 | 89.47 | 85.22 | 87.04 | 84.09 | 85.62 | 87.64 |
| 060 | 85.46 | 89.13 | 91.41 | 90.29 | 88.54 | 85.50 | 86.64 | 88.71 | 83.89 | 86.42 | 83.85 | 85.75 | 87.13 |
| 070 | 85.37 | 89.07 | 91.30 | 90.06 | 88.04 | 85.57 | 84.78 | 87.81 | 82.50 | 85.79 | 83.76 | 86.06 | 86.67 |
| 080 | 85.75 | 89.01 | 91.26 | 89.72 | 87.53 | 85.48 | 83.26 | 87.09 | 81.44 | 85.16 | 83.89 | 86.57 | 86.34 |
| 090 | 86.16 | 88.91 | 90.98 | 89.02 | 86.62 | 85.10 | 82.01 | 86.48 | 80.87 | 84.38 | 84.14 | 86.88 | 85.95 |
| 100 | 86.28 | 88.63 | 90.19 | 88.10 | 85.47 | 84.77 | 81.32 | 85.93 | 80.59 | 83.55 | 84.61 | 86.91 | 85.52 |
| 110 | 86.50 | 88.46 | 89.38 | 87.29 | 84.53 | 84.69 | 81.22 | 85.70 | 80.39 | 83.00 | 85.33 | 87.01 | 85.28 |
| 120 | 87.13 | 88.78 | 89.20 | 86.99 | 84.42 | 84.58 | 82.12 | 86.07 | 80.67 | 83.05 | 86.31 | 87.38 | 85.55 |
| 130 | 88.03 | 89.48 | 89.49 | 87.12 | 84.94 | 84.43 | 83.64 | 86.78 | 81.67 | 83.57 | 87.53 | 87.90 | 86.20 |
| 140 | 89.11 | 90.31 | 90.10 | 87.69 | 85.99 | 84.43 | 85.30 | 87.60 | 83.25 | 84.45 | 88.69 | 88.57 | 87.11 |
| 150 | 90.24 | 90.96 | 91.02 | 88.35 | 87.15 | 84.72 | 86.75 | 88.47 | 84.93 | 85.63 | 89.59 | 89.43 | 88.10 |
| 160 | 91.26 | 91.36 | 92.21 | 88.97 | 88.23 | 85.08 | 88.25 | 89.46 | 86.61 | 86.99 | 90.10 | 90.34 | 89.07 |
| 170 | 91.85 | 91.52 | 93.38 | 89.69 | 89.44 | 85.44 | 89.69 | 90.36 | 88.02 | 88.32 | 89.74 | 90.78 | 89.86 |
| 180 | 91.75 | 91.35 | 94.04 | 90.36 | 90.50 | 86.00 | 90.81 | 90.91 | 88.60 | 89.32 | 88.81 | 90.52 | 90.26 |

REMARKS 1) Single RWY and Cross Wind Factor 13KT

2) Wind Data (1979 ~ 1984)

# ATTACHMENT 8

# COMPARISON BETWEEN ALTERNATIVES FOR SECONDARY RUNWAY DEVELOPMENT

Comparison between alternatives for
secondary runway development

<table>
<tr><th colspan="3">Items</th><th>RWY01/19<br>and<br>TWY - C</th><th>RWY10/28<br>and<br>TWY - E</th></tr>
<tr><td rowspan="6">1. Wind<br><br>coverage<br>%</td><td rowspan="2">Cross wind<br>20 kt</td><td>whole year</td><td>98.2</td><td>97.6</td></tr>
<tr><td>worst month</td><td>97.0<br>(May)</td><td>95.7<br>(Sep)</td></tr>
<tr><td colspan="2">Evaluation</td><td>Good</td><td>Good</td></tr>
<tr><td rowspan="2">Cross wind<br>13 kt</td><td>whole year</td><td>90.0</td><td>85.5</td></tr>
<tr><td>worst month</td><td>86.3<br>(Jun)</td><td>80.6<br>(Sep)</td></tr>
<tr><td colspan="2">Evaluation</td><td>Fair</td><td>Poor</td></tr>
<tr><td colspan="3">2. Obstacles to be removed</td><td>Trees</td><td>Trees</td></tr>
<tr><td></td><td colspan="2">Evaluation</td><td>Good</td><td>Good</td></tr>
<tr><td rowspan="2">3. Construction cost (US$1,000)</td><td colspan="2">Precision approach runway (with ILS equipment)</td><td>12,000</td><td>11,000</td></tr>
<tr><td colspan="2">Non-precision approach runway</td><td>8,000</td><td>8,000</td></tr>
<tr><td colspan="3">4. Connection with terminal area</td><td>Fair</td><td>Good</td></tr>
<tr><td colspan="3">5. Expandability of terminal area beyond 2010</td><td>Good<br>New terminal area can be provided at north of air base</td><td>Good</td></tr>
<tr><td colspan="3">6. Aircraft noise to Montevideo city center</td><td>Moderate</td><td>Significant</td></tr>
</table>

Remarks:

1. Runway length should be extended to 2,050 m and pavement reinforced to accommodate B737 operations.

2. Costs of earth works, pavement works and lighting are included in the construction cost.

   Cost of ILS equipment is also included in case of precision approach runway.

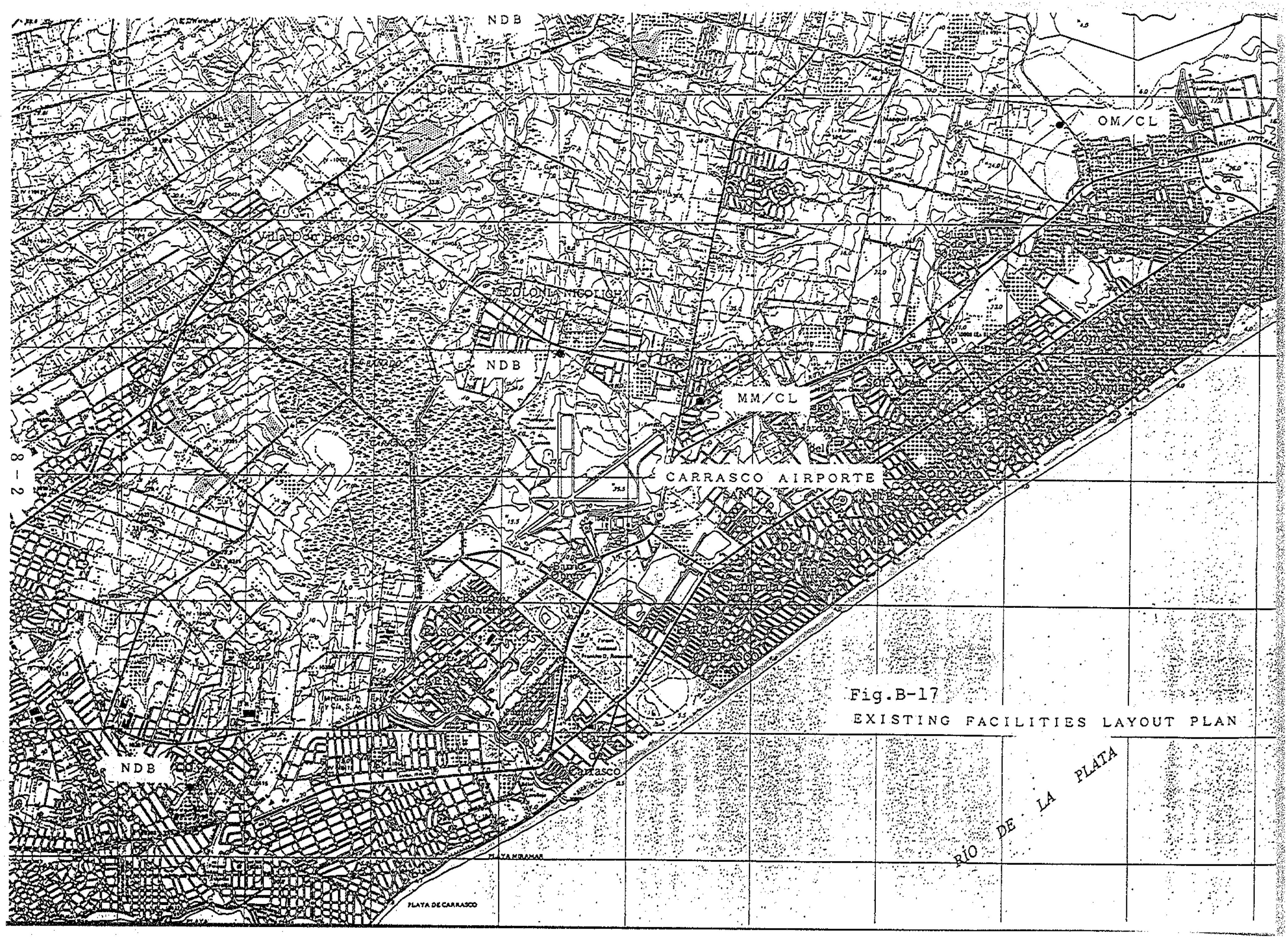
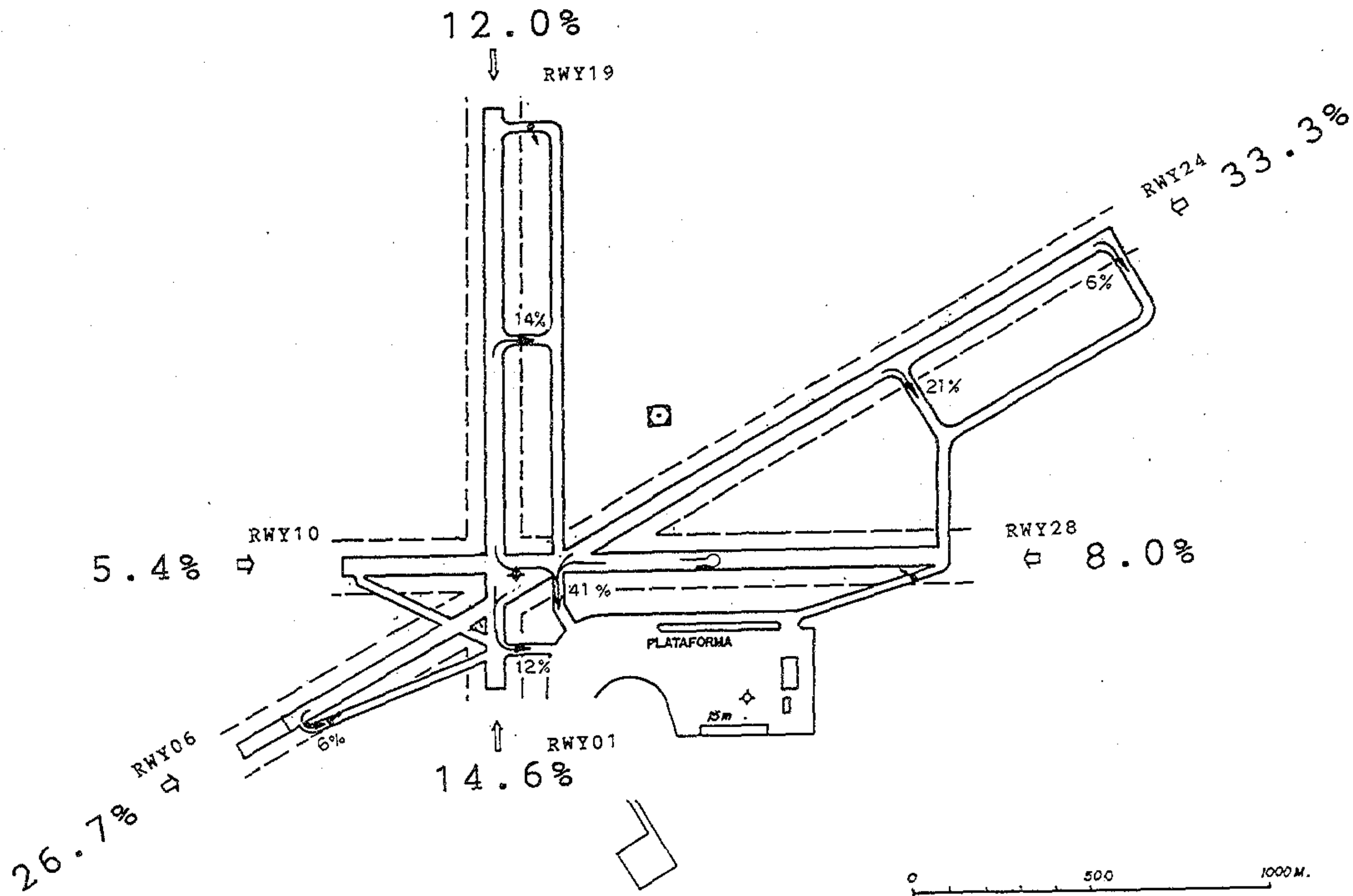



Fig.B-17
EXISTING FACILITIES LAYOUT PLAN




Runway and Taxiway Utilizations
(1988)

Attachment 9

# OBSTACLE LIMITATION HEIGHT AT WESTERN APRON

## Attachment 9 Obstacle Limitation Height at Westen Apron.

In the long-term layout plan, some of the aircraft stands may cause a little problem for obstacle clearance surface. The transitional surface of RWY 01/19 runs close to the tail of some aircraft.

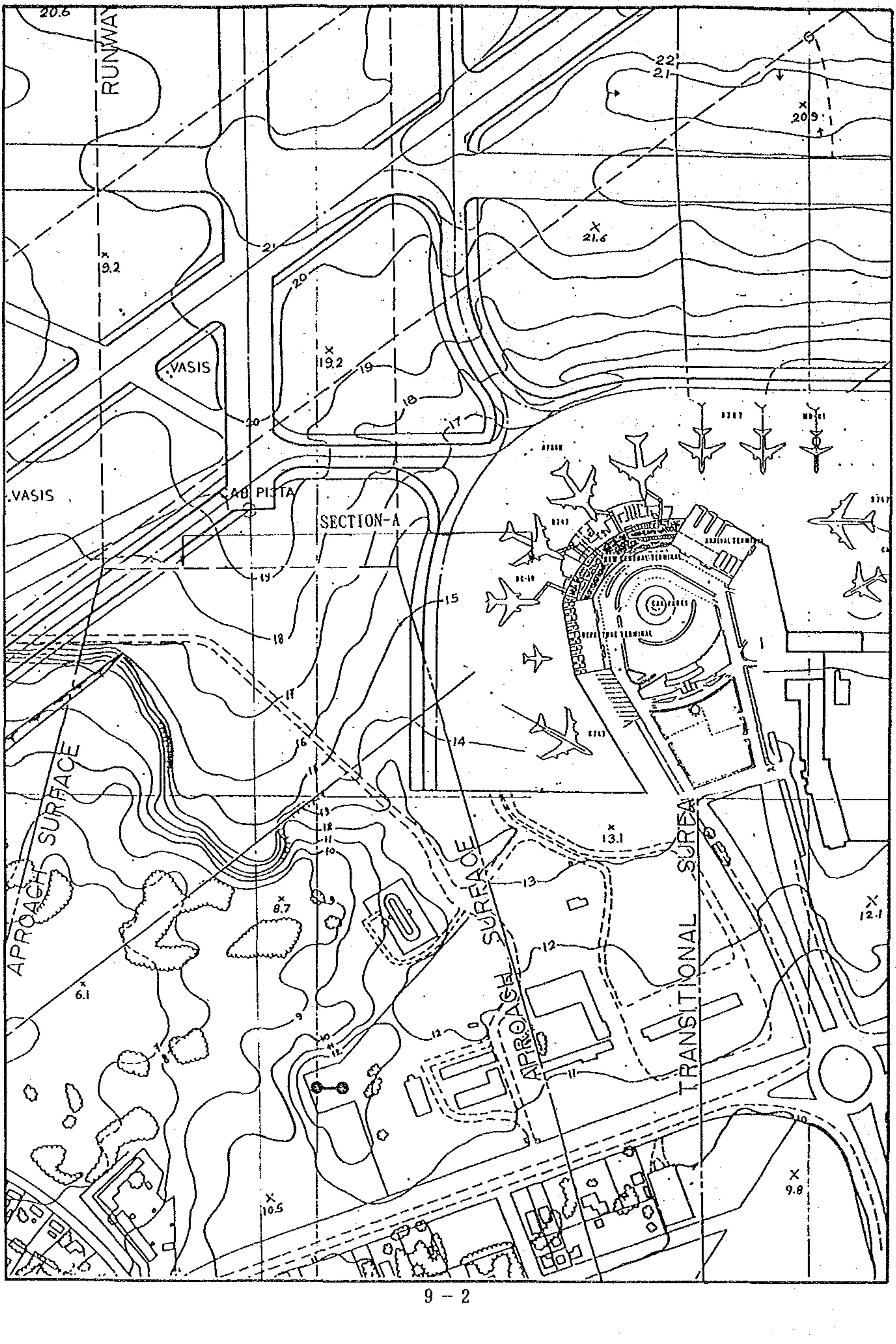
This attachment explains the relationship between the nearest B-747 stand and the transitional surface.

The following figures show this condition.

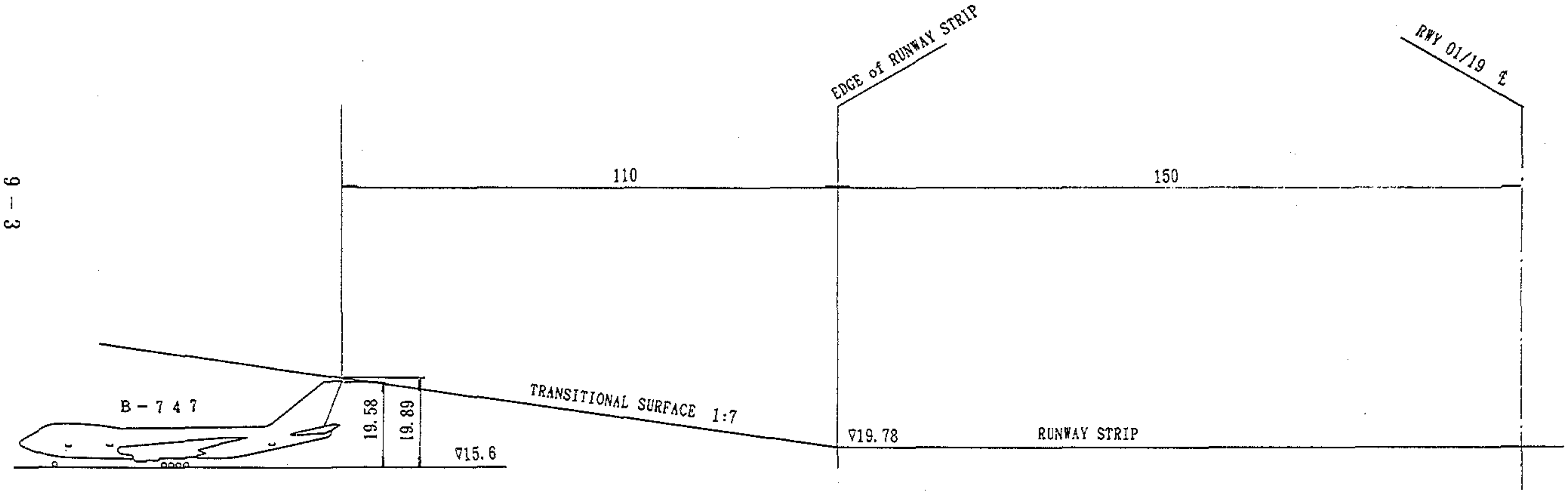
In Section A, the tail of B-747 is below the transitional surface, and this cause no problem.

At this stage, it is considered that this master plan will cause no significant problem with obstacle clearance.

In the preliminaly design, exact dimensions will be fixed according to this master plan.


RUNWAY
20.6
22
21
20.9
21.6
9.2
21
20
VASIS
19.2
19
18
17
20
VASIS
CAB PISTA
SECTION-A
19
15
18
17
16
14
13.1
APPROACH SURFACE
APPROACH SURFACE
TRANSITIONAL SUREA
8.7
13
12
12.1
6.1
9
12
11
10.5
9.8

# SECTION－A



EDGE of RUNWAY STRIP
RWY 01/19 ℄
110
150
B－747
19.58
19.89
∇15.6
TRANSITIONAL SURFACE 1:7
∇19.78
RUNWAY STRIP

Attachment 10

# OFF PEAK CONSTRUCTION PRACTICES
# FOR AIRFIELD PAVEMENTS
# UTILIZING ASPHALTIC CONCRETE

Attachment 10

# OFF PEAK CONSTRUCTION PRACTICES FOR AIRFIELD PAVEMENTS UTILIZING ASPHALTIC CONCRETE

INTERNATIONAL INDUSTRY WORKING GROUP


International Air Transport Association

Airport Associations Coordinating Council

International Coordinating Council of Aerospace Industries Associations


APRIL 1988

## 1.0 INTRODUCTION

Use of hot dense graded bituminous concrete for overlaying and repairing runways and taxiways during off-peak (in most cases nighttime) periods while reopening to operations (the next morning) has for many years been used for airports throughout the United States. As we conclude the first decade of deregulated environment with air traffic increasing and greater emphasis on capacity, more airports are considering the procedures of off-peak construction for runways and taxiways without loss of revenues, inconvenience to passengers or delays to the air traffic system.

In 1984, the Federal Aviation Administration (FAA) stated that the delays, as a result of runway construction, are of the order of $135 million, half of which are in direct operating airplane costs. Late in 1985, the Industry Working Group (IWG) composed of representatives from the airline, airport and aircraft industries, designated a task force to provide a working paper to assist airports that are unfamiliar with procedures and practices in developing an off peak construction project. It is the objective of this paper will be able to provide the Airport Manager, Project Manager, Designer and Contractors with insight regarding methods and procedures to be used while employing a contractor for reconstruction of critical areas of the airport that must be available during the peak operating periods each day.

Each airport is unique and will have its own special set of problems. This paper is not a panacea, but will act as a guide to the procedures that are available and should be followed in order to maximize airfield operations and ensure quality construction during critical airfield projects.

In addition to this document, readers could advantageously acquaint themselves with the following publications:

FAA AC 150/5340-1E Marking of Paved Areas on Airports

FAA AC 150/5370-10 Standards for Specifying Construction of Airports

FAA AC 150/5370-2C Operational Safety on Airports During Construction

FAA AC 150/5300-9A Pre-Design, Pre-Bid and Pre-Construction Conferences for Airport Grant Projects

DOT/FAA/RD-80/121 Current Practice on Nighttime Pavement Construction Asphaltic Concrete

ICAO Annex 14

## 2.0 AIRPORT AUTHORITY'S ROLE

### 2.1 Project Coordination

Off-peak construction is, by its very nature, a highly visible project requiring close coordination with all elements of the airport during planning, design and virtually daily during construction. Once an airfield paving project has been identified by the Airport, it is important that the airport, users and FAA meet to discuss the manner in which construction is to be implemented. The following key personnel should be in attendance at all planning meetings. From the Airport Authority - the Project Manager, the Operations, Planning, Engineering, and Maintenance, Directors; from the Airlines/FBO's - local Station Managers, Airlines Technical Committee representatives, Pilot and Airline Associations; from FAA - representatives from the control tower, the Airport District Office and Airport Certification inspector. The agenda should include:

1. Determination of working hours. Since time is of the essence in off-peak construction, the contractor should be given as much time as possible to overlay the pavement each work period. A minimum period of 8-1/2 hours is recommended. Scheduling of work should be predicated on a time period that will displace the least amount of scheduled flights. The selection of a specific time period should be developed and coordinated with airline and other representatives during the initial planning meetings. Early identification of the hours will allow the airlines to adjust future schedules, as needed, to meet construction demands. It is essential that the runway be opened and closed at the designated time without exception, as airline flight schedules, as well as the contractor's schedules will be predicated on the availability of the runway at the designated time.

2. Identification of operational factors during construction and establishment of acceptable criteria including:

    - Aircraft operations.
    - Affected NAVAIDS and visual aids.
    - Security requirements and truck haul routes.
    - Inspection and requirements to open the area for operational use.
    - Placement and removal of construction barricades.
    - Temporary airfield pavement marking and signing.
    - Anticipated days of the week that construction will take place.
    - Issuance of NOTAMS and advisories.

3. Lines of Communication and Coordination Elements

It is essential that the Project Manager be the only person to conduct coordination of the pavement project. The methods and lines of communication will be discussed for determining the availability of the runway to start each work period and the condition of the runway prior to opening it for operations.

4. Special aspects of construction including pavement transitions and other details as described herein.

5. Contingency plan in case of abnormal failure or an unexpected disaster.

## 2.2 Project Management

### 2.2.1 Project Manager

It is essential that the Airport Authority selects a qualified Project Manager to oversee all phases of the project, from planning through final inspection of the completed work. This individual should be experienced in design and management of airfield pavement construction projects and be familiar with the operation of the Airport. The Project Manager should be the final authority on all technical aspects of the project and be responsible for its coordination with Airport Operations. All contact with any element of the Airport Authority should be made only by the Project Manager so as to ensure continuity and proper coordination with all elements of airfield operations. Responsibilities should include:

I. Planning and Design

a. Establishment of clear and concise lines of communications.

b. Participation as a member of the Design Engineer's selection team.

c. Coordination of project design to meet applicable budget constraints.

d. Coordination of airport and airlines with regards to design review, including designated working hours, aircraft operational requirements, technical review and establishment of procedures for coordinating all work.

e. Chairmanship of all meetings pertaining to the project.

II. Construction

a. Complete management of construction with adequate number of inspectors to observe and document work by the contractor.

b. Checking with the weather bureau, airport operations and air traffic control prior to starting construction and confiring with the contractor's Superintendent to verify if weather and air traffic conditions will allow work to proceed as scheduled.

c. Conferring with the contractor's Project Superintendent daily and agreeing on how much work to attempt, to ensure the opening of the runway promptly at the specified time each morning. This is especially applicable in areas where pavement repair and replacement are to take place.

d. Conducting an inspection with airport operations of the work area before opening it to aircraft traffic to ensure that all pavement surfaces have been swept clean, transitions are properly constructed and marking is available for aircraft to operate safely.

### 2.2.2 Resident Engineer

The designation of a Resident Engineer, preferably a civil engineer, will be of great benefit to the project, and of great assistance to the Project Manager. Duties of the Resident Engineer should include:

a. Preparation of documentation of all quantities constructed during each work period.

b. Ensuring all tests are performed and results obtained from each work period.

c. Scheduling of inspection to occur each work period.

d. Observing contract specification compliance and reporting of any discrepancies to the Project Manager and the Contractor.

e. Maintain a construction diary.

## 2.3 Testing Requirements

There is no requirement for additional tests for off-peak construction versus conventional construction. The only difference with off-peak construction is that it requires acceptance testing to be performed at the completion of each work period and prior to opening to operations and results reviewed before beginning work again. These procedures normally will require additional personnel to ensure that tests are performed correctly and on time.

## 2.4 Inspection Requirements

One of the most important aspects of successful completion of any kind of paving project is the amount and quality of inspection performed. Since the Airport accepts beneficial occupancy each time the runway is open to traffic, acceptance testing must take place each work period.

In addition to the Project Manager and Resident Engineer, the following personnel are recommended as a minimum to observe compliance with specifications:

- o <u>Asphalt Plant Inspector</u>. A Plant Inspector with a helper whose primary duty it will be to perform quality control tests, including aggregate gradation, hot bin samples and Marshall tests.

- o <u>Paving Inspectors</u>. There should be two Paving Inspectors with each paving machine. Their duties should include collection of delivery tickets, checking temperatures of delivered material, inspection of grade control methods, and inspection of asphalt lay down techniques and joint construction smoothness.

- o <u>Compaction Inspector</u>. The Compaction Inspector should be responsible for observing proper sequencing of rollers and to work with a field density meter to provide the contractor with optimum compaction information.

- o <u>Survey Crew</u>. Finished grade information from each work period is essential to ensuring a quality job. An independent registered surveyor and crew should take cross-sections of the completed pavement at least every 25-foot intervals, transversely and longitudinally, and report the results to the Project Manager at the completion of each work period.

- o <u>Pavement Repair Inspector</u>. Shall be responsible for inspection of all pavement repairs and surface preparation prior to paving.

- o <u>Electrical Inspector</u>. Ensures compliance with specifications.

## 3.0 DESIGN CONSIDERATIONS

Plans and specifications for pavement repair and overlay during off-peak periods should be presented in such detail as to allow ready determination of the limits of pavement repair, finish grades and depths of overlay. Plans and specifications are to be used for each work period by the contractor and inspection personnel, and should be clear and precise in every detail.

### 3.1 Pavement Survey

A complete system of bench marks should be set on the side of the runway or taxiway to permit a ready reference during cross-sectioning operations. The bench marks should be set at approximately 400-foot intervals. Pavement cross-sectioning should be performed on 25-foot intervals longitudinally, and 12-1/2-foot intervals transversely. Extreme care should be exercised in level operations, since the elevations are to be used in determining the depth of asphalt overlay. The designer should not consider utilizing grade information from previous as-built drawings nor should he consider using surveys that were run during the winter months, as it has been shown that elevations can vary from one season to the next. This is especially critical for single lift asphalt overlays.

After finish grades and transverse slope of the runway are determined, a tabulation of grades should be included in the plans for the contractor to use in bidding the project and for establishment of erected stringline. The tabulation of grades should include a column showing existing runway elevation, a column showing finish overlay grade, and a column showing depth of overlay. Grades should be shown longitudinally every 25 feet and transversely every 12-1/2 feet. This item is considered essential in the preparation of plans for contracting off-peak construction.

### 3.2 Special Details

Details pertaining to the following items should be included in the plans:

#### 3.2.1 Transitions

At the end of each hot mix asphalt concrete overlay work period, it will be necessary that a ramp be constructed to provide a transition from the completion of a particular course of overlay to tie-in to the existing pavement. In multiple lift overlays, these transitions should be no closer than 500 feet to one another. As far as possible, overlay should proceed from one end of the runway toward the other end in the same direction as predominant aircraft operations so that most aircraft encounter a downward ramp slope. The construction of this transition is one of the most important features in the work period. A ramp that is too steep could cause possible structural damage to the operating aircraft or malfunction of the aircraft's instruments. A ramp that is too long may result in a raveling of the pavement, and foreign object damage to aircraft engines, as well as taking excessive time to construct. The length of all longitudinal ramp slopes should be 10 feet for each inch of depth of compacted overlay.* If required, assuming the full runway width cannot be paved, then five feet of ramp slope in the transverse direction for each inch of overlay is acceptable. The only exception to construction of a ramp is when the depth of overlay is one and one-half inch or less.

A transition ramp may be constructed in two ways, depending upon the type of equipment that is available. The most efficient way is to utilize a cold planing machine to heel-cut the pavement at the beginning and at the end of the work period overlay (Refer to Figures 1 and 2). If cold planing equipment is not available, then a transition ramp should be constrcted as shown in Figure 3. In no case should a bond-breaking layer be placed under the transition ramp for easy removal the next work period. Experience has shown that this bond-breaking layer almost always comes loose causing subsequent breaking-up of the pavement under aircraft operations.

3.2.2 <u>In-Pavement Lighting</u>

Details depicting the removal and re-installation of in-pavement lighting are to be included on the plans where applicable. The details should depict the removal of the light fixture and extension ring, placement of a target plate over the light base, filling the hole with hot mix dense graded asphalt until overlay operations are complete, accurate survey location information, core drilling with a 4-inch core to locate the center of the target plate, and final coring with an appropriate sized core machine. The light and new extension ring can then be installed to the proper elevation.

3.2.3 <u>Runway Markings</u>

During the course of off-peak construction of a runway overlay, it has been found acceptable if properly NOTAM'd to mark only centerline stripes and numbers on the new pavement until the final asphalt lift has been completed and final striping can then be performed. In some cases where cold planing of the surface or multiple lift overlays are used, as many as three consecutive centerline stripes may be omitted to enhance the bond between layers.

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* <u>NOTE</u>: In coordinating the review of this paper with airports outside the United States, it was found that the slope of the transition ramp varies with a number of countries. Included as Exhibit 1 and 2 are recommendations from Boeing Commercial Airplane Company depicting runway roughness criteria as a guide for determining the length (longitudinally) for transition ramps. This is especially critical where overlay asphalt thicknesses are over four inches, a practice not normally used in the United States.

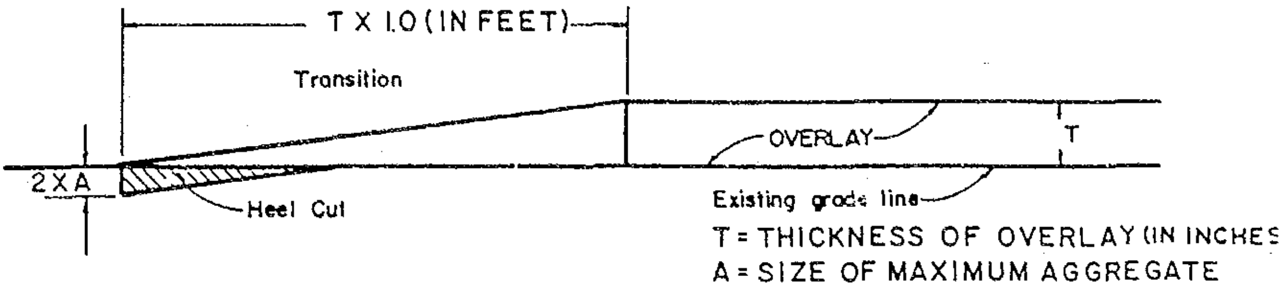


FIGURE 1

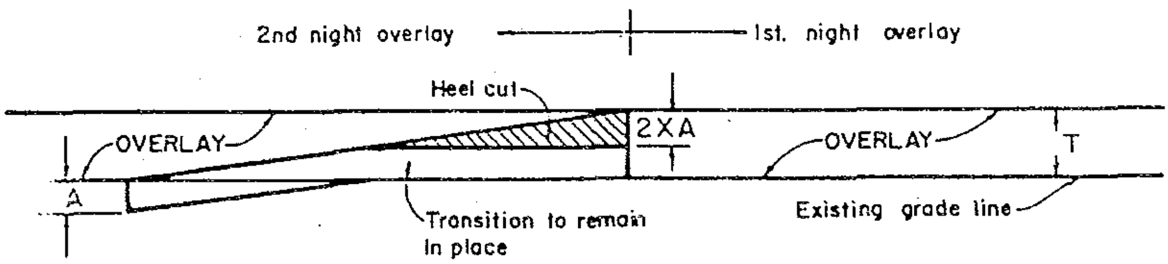


FIGURE 2

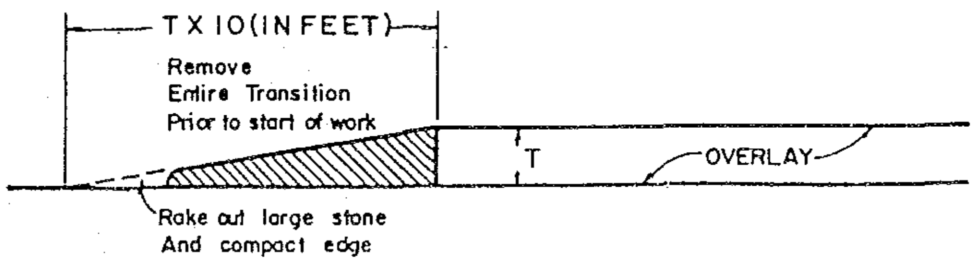


FIGURE 3

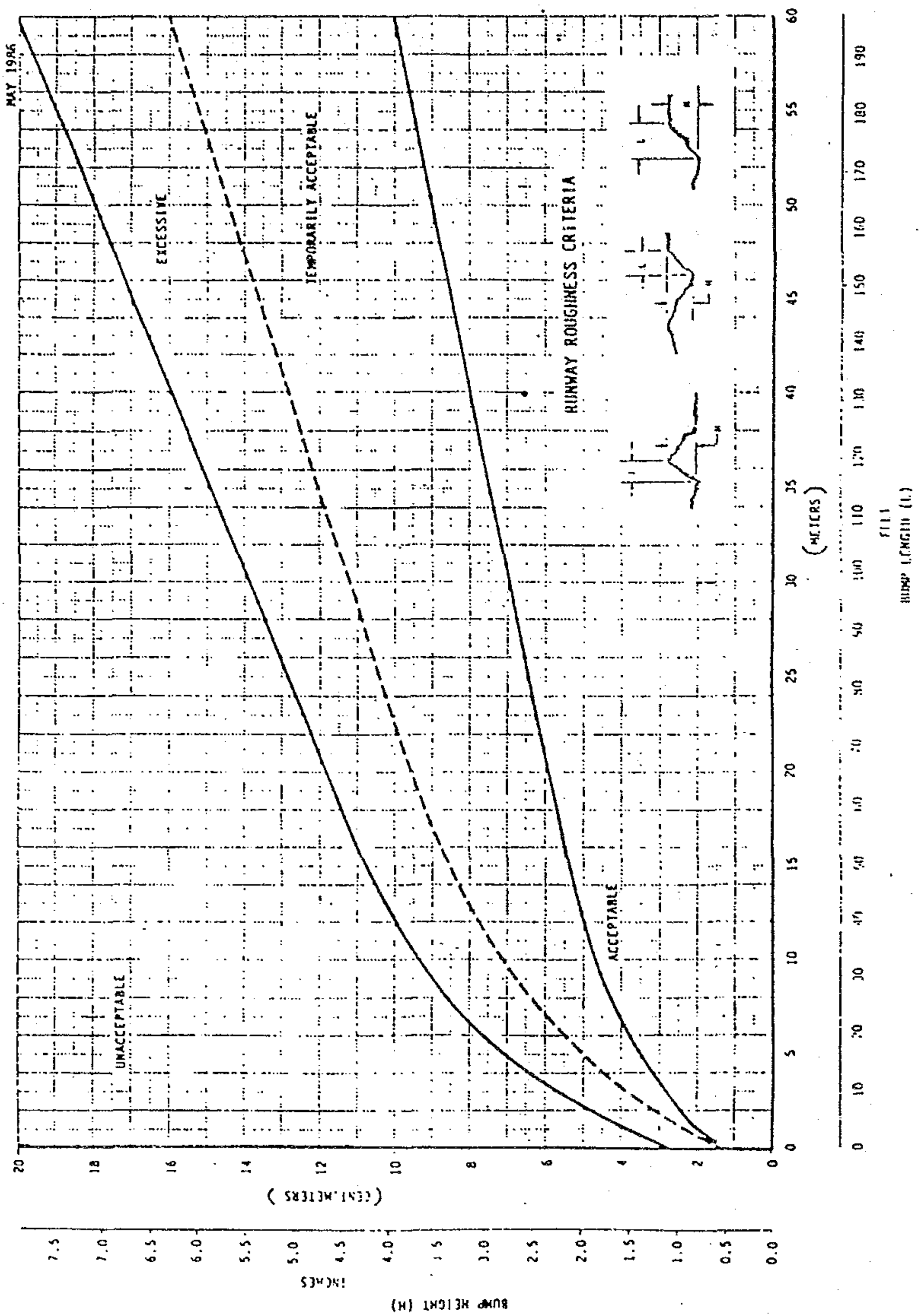
MAY 1986
RUNWAY ROUGHNESS CRITERIA
UNACCEPTABLE
EXCESSIVE
TEMPORARILY ACCEPTABLE
ACCEPTABLE
(CENTIMETERS)
INCHES
BUMP HEIGHT (H)
(METERS)
FEET
BUMP LENGTH (L)



EXHIBIT 1

## ACCEPTABLE RUNWAY ROUGHNESS LIMITS (REFERENCE EXHIBIT 1)

- ACCEPTABLE (CLASSIFICATION I)

  ANY ROUGHNESS IN THIS AREA OF FIGURE I IS ENTIRELY ACCEPTABLE; GENERALLY MOST NEW CONSTRUCTION FALLS INTO THE MIDDLE OF THIS REGIME ON THE CHART.

- TEMPORARILY ACCEPTABLE (CLASSIFICATION II)

  DURING CONSTRUCTION OR REPAIR, THE DASHED LINE CONSTITUTES THE UPPER LIMIT OF ACCEPTABLE GRADIENTS THAT CAN BE USED FOR THOSE DISCRETE SECTIONS OF THE RUNWAY OR TAXIWAY THAT ARE UNDER CONSTRUCTION.

- EXCESSIVE (CLASSIFICATION III)

  ANY BUMP IN THE EXCESSIVE AREA OF THE CHART IS CAUSE FOR THE RUNWAY TO REQUIRE IMMEDIATE REPAIR, SINCE THESE BUMPS INDUCE AIRCRAFT STRUCTURAL FATIGUE.

- UNACCEPTABLE (CLASSIFICATION IV)

  THE UPPER LINE DEFINES OUR <u>ABSOLUTE</u> UPPER LIMIT FOR AIR CARRIER OPERATIONS. ANY BUMP ABOVE THIS LINE IS CAUSE ENOUGH FOR THE RUNWAY TO BE CLOSED TO HIGH SPEED TRAFFIC IN THE SECTION OF THE RUNWAY THAT HAS THE BUMP.



EXHIBIT 2

## 3.3 Specifications

In addition to the typical specifications required on any pavement project, the following items should be included:

### 3.3.1 Stand-By Equipment

The contract should require stand-by equipment at the construction site for all work performed during off-peak construction. The type and amount of stand-by equipment is that which is necessary for completion of the work period should any piece of equipment break down, eg., paving machine; rollers, milling machine, tack truck, etc. Provision should be made for a standby asphalt production plant or sufficient storage bins to provide enough material to reopen the runway should the primary plant break down. Standby equipment may be used for construction to improve productivity, but the contractor should be required to properly repair or replace broken equipment before being allowed to proceed with the next work period. Stand-by equipment should be listed on the daily equipment log as usually required by the contract's specifications.

### 3.3.2 Obstruction Lighting and Barricades

The contractor will be required to have on hand ample obstruction lighting and barricades to block off any intersecting taxiways or runways and to delineate haul routes to the work site.

Details of lighting and barricades to be used must be documented in drawings as well as the specifications applicable to the work.

### 3.3.3 Construction Lighting

Adequate temporary construction lighting is another important factor in obtaining quality asphalt overlay during nighttime construction. It is recommended that a minimum of 10 foot candles of illumination be provided in the work area. Highly maneuverable light plants with 1,000 watt metal halide flood lights mounted as high as aircraft, airspace and practicality will allow, should be positioned in sufficient amounts to provide the most natural color illumination and contrast with a minimum of shadows. In addition, all paving machines, rollers, distributor trucks and other equipment, except haul trucks, should be equipped with artificial lumination to safely light-up the area immediately surrounding their work areas. In addition, the Project Manager should strictly enforce lighting requirements as sufficient light is a major factor in constructing satisfactory overlays. Pay items should be established in the contract to allow the contractor to provide temporary lights on a per unit basis.

### 3.3.4 Special Pay Items

In order to maintain the maximum flexibility in the scheduling of the work, and to avoid unnecessarily inflated prices, special bid items pertaining to lost time may be incorporated in the specifications. These bid items would include suspension time, stand-by time and down time. Suspension time is the suspension of the entire work period with notice of this occurring at least two hours prior to the scheduled start time. Stand-by time occurs when a contractor's forces are mobilized for work and waiting to start. This condition would last for a maximum of two hours after the scheduled start time. At that time a condition called down time would occur, which is the period between the end of the stand-by time and normal quitting time. By having these delay times defined as pay items, the contractor will not have to include compensation in other bid items to cover these delays.

### 3.3.5 Bonus/Penalty Clauses

As has been stressed throughout this document, it is imperative that the runway be opened on time - following completion of each day's work. One way to highlight this to the contractor is with the use of a Bonus/Penalty Clause. It should for the most part be in proportion to how much revenue is lost by the users when the pavement is not usable. Scheduled airlines and the air traffic control system usually have aircraft en route to coincide with the opening. If this opening is delayed, diversions and/or cancellations costing thousands of dollars will be incurred. Limits to Bonus/Penalty or Liquidated Damage Clauses may vary by jurisdiction but some sort of motivating pressure must be put on the contractor to open on time.

## 4.0 RECOMMENDED CONSTRUCTION PRACTICES

### 4.1 Pre-Construction Conference

A pre-construction conference convened and conducted by the Project Manager should be used to discuss various items, including operational safety, testing, quality control, security, safety, labor requirements and environmental factors. At this meeting, all parties affected by construction should assist in a better understanding of potential problems and possible solutions. In addition to the standard checklist of items to discuss at the meeting (Ref: Advisory Circular 150/5300-9A, dated May 1, 1985), the following items are added for emphasis:

#### 4.1.1 Project Submittals

Prior to commencing work on the project, the contractor should be required to file the following with the Project Manager for approval:

a. A detailed progress schedule showing the proposed schedule of work in areas to be constructed each period.

b. A complete list of equipment and personnel to be used, including stand-by equipment required by the specifications.

c. Evidence that the central hot mix asphalt plant(s) meet the requirements of the specifications.

d. Evidence that the amount of hot mix asphaltic concrete that the contractor proposes to place each work period can be supplied to the job in the time required.

e. Experience record of the project's Superintendent that the contractor proposes to place in charge of the job. The experience record should list experience on hot mix asphaltic concrete overlays, including any nighttime or off-peak construction.

#### 4.1.2 Inspection and Testing

It should be emphasized to the contractor that acceptance testing will take place each night, and that work will not proceed unless all tests have been recorded and approved. The daily inspection reports should be made by the inspection team and testing lab. Reports should include location and description of work, results of inspection and comments on the specifications. Items considered to be crucial are Marshall test results, in-place density, pavement smoothness and finished grade elevation.

### 4.1.3 Construction Progress Meetings

A daily progress meeting between the Project Manager and the contractor's project Superintendent should be held to discuss work requirements for the next work period and to review tests results from the previous work period. In addition, there should be a weekly scheduled progress meeting in which elements of the Airport and the local user committee would be invited to attend. Discussions will include scheduling of work for the up-coming week, any new problems, and other operational aspects, as required. Additionally, the Project Manager and the contractor's Superintendent should agree on the amount of quantities placed to date.

### 4.1.4 Weather

In addition to the requirements of the contract specifications, the Contractor, Project Manager and Airport Operations should establish procedures for determining weather conditions under which work will not begin as scheduled.

### 4.1.5 Communication

The contractor should be made aware that all communication with the control tower or any other element of the Airport should be made through the Project Manager or his designated representative. This is important as the number of people having contact with elements of the Airport should be limited in order to prevent possible misunderstandings or conflicting information. The Project Manager should have direct radio contact with Airport operations at all times. All requests for closing and opening the runway should be made only by the Project Manager.

### 4.1.6 Security During Construction

In addition to the security requirements of the Airport, all personnel and suppliers should be given a drawing showing haul routes, restricted areas and any other details pertinent to the overlay operation. The drawing should contain a note which states: "ANYONE FOUND IN RESTRICTED AREAS WILL BE PROMPTLY AND PERMANENTLY REMOVED FROM THE JOB."

### 4.1.7 Assembling of Equipment for Nighttime or Off-Peak Overlay Operations

After checking with the weather bureau and airport operations, and the contractor and the Project Manager have determined that the work period can proceed as scheduled. The contractor should be sure that all equipment, including stand-by equipment, is in operating condition and ready to go. The contractor then assembles all personnel and equipment as close as possible to the work area. Equipment and personnel should be organized so that when notice is given, the contractor's personnel can proceed immediately to the work area. All hot mix plants should be operating and ready to proceed with production of the hot mix asphaltic concrete.

## 4.2 Construction Techniques

### 4.2.1 Test Sections

Prior to beginning any work on the project, it is strongly recommended that a test strip with a minimum length of 150 feet, and a nominal thickness of 2 inches, complete with transition ramps, must be placed to provide a trial run for all aspects of the paving operation, communications and acceptance testing.

### 4.2.2 Limits of Overlay Operations

It is essential that the full width of the overlay be placed each work period. The length of each period's construction should be the maximum possible to limit the number of transverse joints for the entire job. It is recommended that overlay operation begin at the end of the runway and proceed in the primary direction of aircraft operations. In the case of multiple lift overlay operations, it is recommended that the minimum distance between transition ramps be 500 feet.

### 4.2.3 Asphalt Placing

It is recommended that the contractor should operate two or more paving spreaders in echelon. Each paver should start on the centerline working their way outboard independently, so that as much as possible of the center portion of the runway is overlaid first in case of equipment or weather problems force early suspension of the work. The contractor should hold raking to very minimum and casting of raked material on the mat should be prohibited. If the runway is considered sufficiently smooth, the contractor should be permitted to place hot mix asphalt concrete by use of a traveling stringline. In no circumstances should slope control device be used, since the cumulative error in multiple lane paving will violate the grade control criteria. If in the event that erected stringline is required, then it must be utilized on both sides of the paver for the initial pass followed by a joint matcher on the newly overlaid side of the paver and an erected stringline or traveling stringline on the opposite side. Asphalt placing can continue up to an hour before opening of the runway for traffic, depending upon the capabilities of the inspectors and survey crew to get acceptance testing, striping, and cleaning of the area completed prior to the first aircraft operation, and the pavement surface temperature is below 150$^{\circ}$F.

4.2.4 Transitions, In Pavement Lighting, and R/W Marking

See Section 3.2 Special Details.

4.2.5 Work Area Clean-Up

Construction debris must be totally removed from the work area prior to it becoming available for aircraft operations. suction/brush type sweepers should be in operation during the majority of the work period.

The Contractor's Superintendent should accompany the Project Manager and Airport Operations during inspection of the work area and have the necessary manpower and equipment nearby to perform any additional cleanup that may be identified during the inspection.