7.2.2. Description of master plan

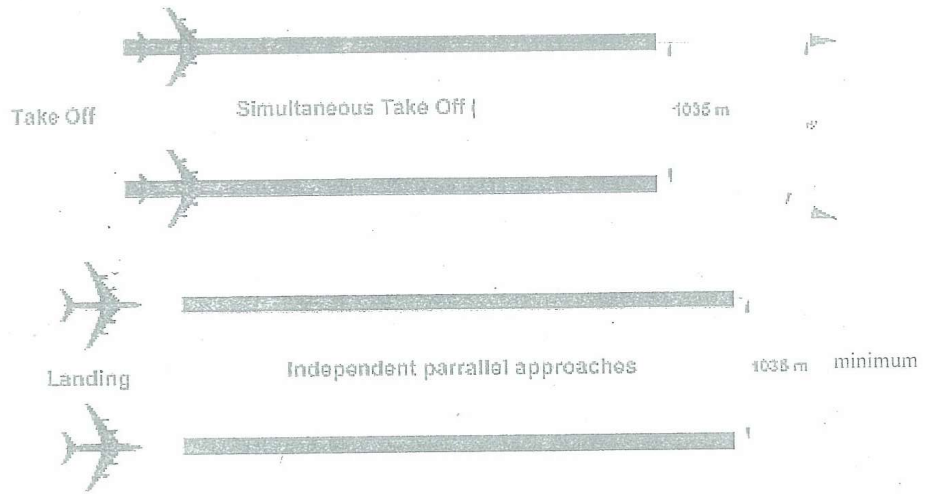
In the solution recommended by the Consultant, the installations (infrastructures, buildings and facilities) will be located on the northern plateau for the first phase. The runway is oriented on a 09/27 axis and deserved by a single parallel taxiway partially built. Turning pads shall thus be implemented.

The southern plateau is reserved for ultimate development of airside infrastructures of the plat-form, after 2034 milestone. A second parallel runway could be built and linked directly to terminal installations. The distance between the two runways will be at least of 1 900 m and thus is compliant with ICAO Annex 14 for independent parallel operations.
The passenger terminal is located toward the east end of the site, between the runways. With a runway separation of 1 900 meters, about 800 hectares are available in the midfield area, with the passenger terminal occupying 100 hectares. The passengers installations, including aircraft stands, passenger terminal, curb side and car parks are positioned on the connection between South & North plateaus.

With the Passenger Terminal Building located in the midfield area, other key aviation-related and support facilities are also located in the same area, east providing adjacency to the passenger terminal and aircraft access and landside road access as required.

The commercial development facilities (Airport City) could also be located between the runways, and can have superior accessibility when they are located at the east of the site, near arrival of access road.

The access road for the first phase will stay within the contours of Land Acquisition. A new access road will be necessary when the second runway will be built. This new road will go round the runway by the west and reach the main round about.



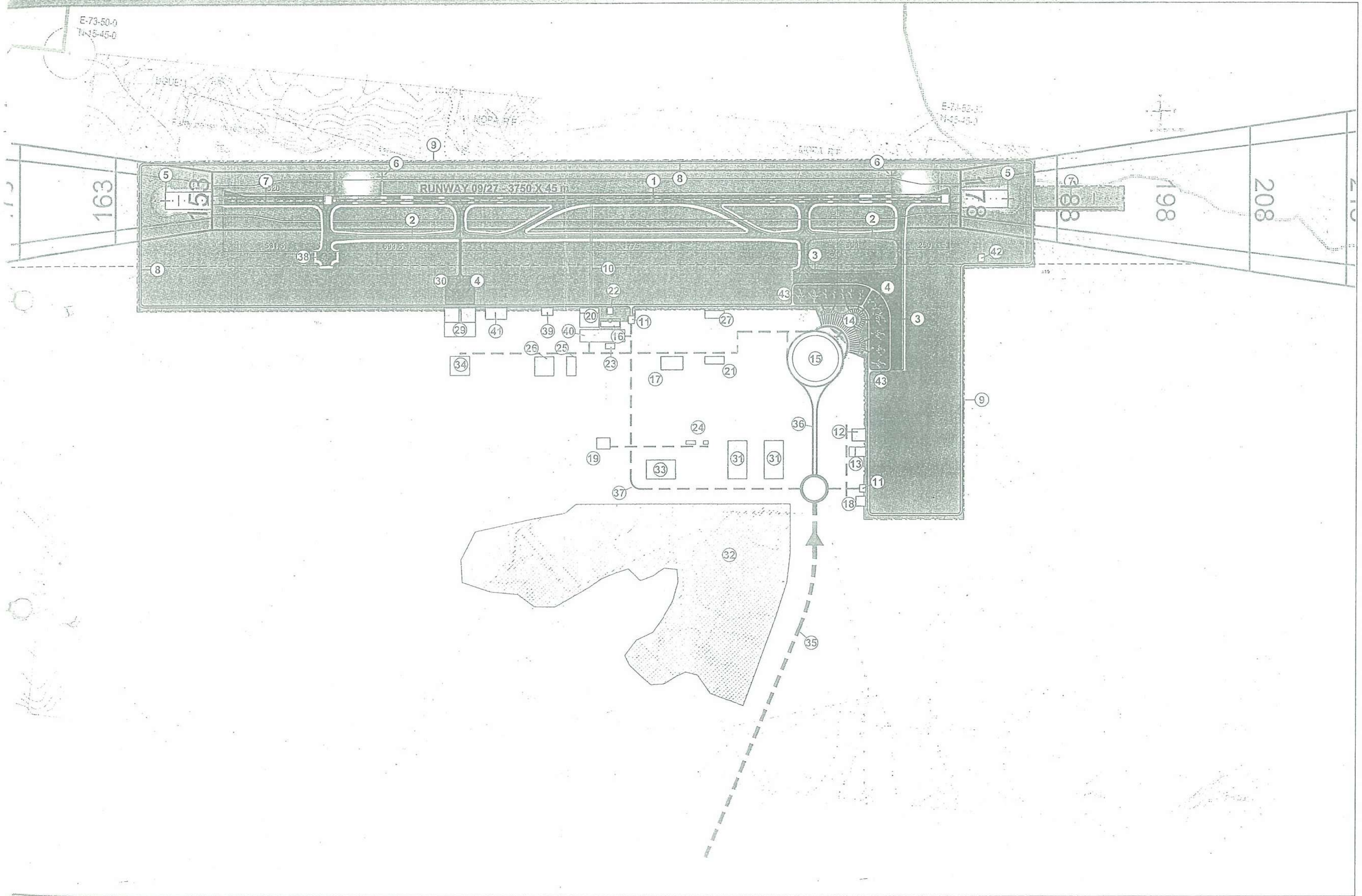
7.2.3. Ultimate stage

Along years, the system of taxiways that links terminal installations with the runway shall be upgraded.
Additional exits from taxiways and a second parallel taxiway are concerned as far as traffic will grow.
The second taxiway will bring flexibility for airport controllers on taxi operations, a dedicated taxiway sense could be define in order to limit conflicts between arriving and departing aircraft.
As a strategic provision for possible future development, land is reserved for the construction of a second runway. The length of the runway that could be implemented on the south plateau (around 2800m) will allow take off for narrow bodies only. This second runway will form with the existing one either a doublet used in segregated mode (Landing on southern runway, take offs on northern one) or a system with two independent parallel runways (with only narrow bodies take off on southern runway)..

With an efficient system of taxiway and necessary navaids (PRM, redundancy of radar coverage…) the capacity in terms of movement will be :

Around 70-80 mvts/h depending on fleet mix.

NEW G[illegible] INTERNATIONAL AIRPORT



LEGEND

1. RUNWAY 09-27 3750 x 45 m
2. TAXIWAY CODE E
3. TAXILANE CODE E
4. APRON
5. LOCALIZER
6. GLIDE PATH
7. APPROACH RAMP
8. AIRSIDE SERVICE ROAD
9. PERIMETER FENCE
10. RFF DEDICADED ROAD
11. CONTROL POINT
12. GSE STORAGE AREA
13. GSE MAINTENANCE
14. TERMINAL
15. CAR PARK
16. CONTROL TOWER AND TECHNICAL BLOCK
17. POWER SUPPLY
18. CATERING
19. FUEL FARM
20. RESCUE AND FIRE FIGHTING SERVICES
21. AIRPORT MAINTENANCE
22. METEO STATION
23. CUSTOM AND POLICE
24. WATER SUPPLY - FILTRATION STATION
25. SEWAGE AND WASTE WATER
26. INCINERATOR AND GARBAGE STORAGE
27. CARGO AREA
28. AIRCRAFT MAINTENANCE
29. GENERAL AVIATION AND BUSINESS AVIATION
30. HELICOPTERS AREA
31. HOTEL AND CONFERENCE CENTER
32. GOLF
33. EMPLOYEES ACCOMMODATIONS
34. FIRE TRAINING
35. MAIN ACCESS ROAD
36. PASSENGER ACCESS ROAD
37. LANDSIDE SERVICE ROAD
38. ISOLATION PAD
39. FUELLING STATION
40. STAFF CAR PARK
41. TRANSMITTING AND RECEIVING CENTER
42. RADAR STATION
43. RESERVE STANDS

0 200 400 600m

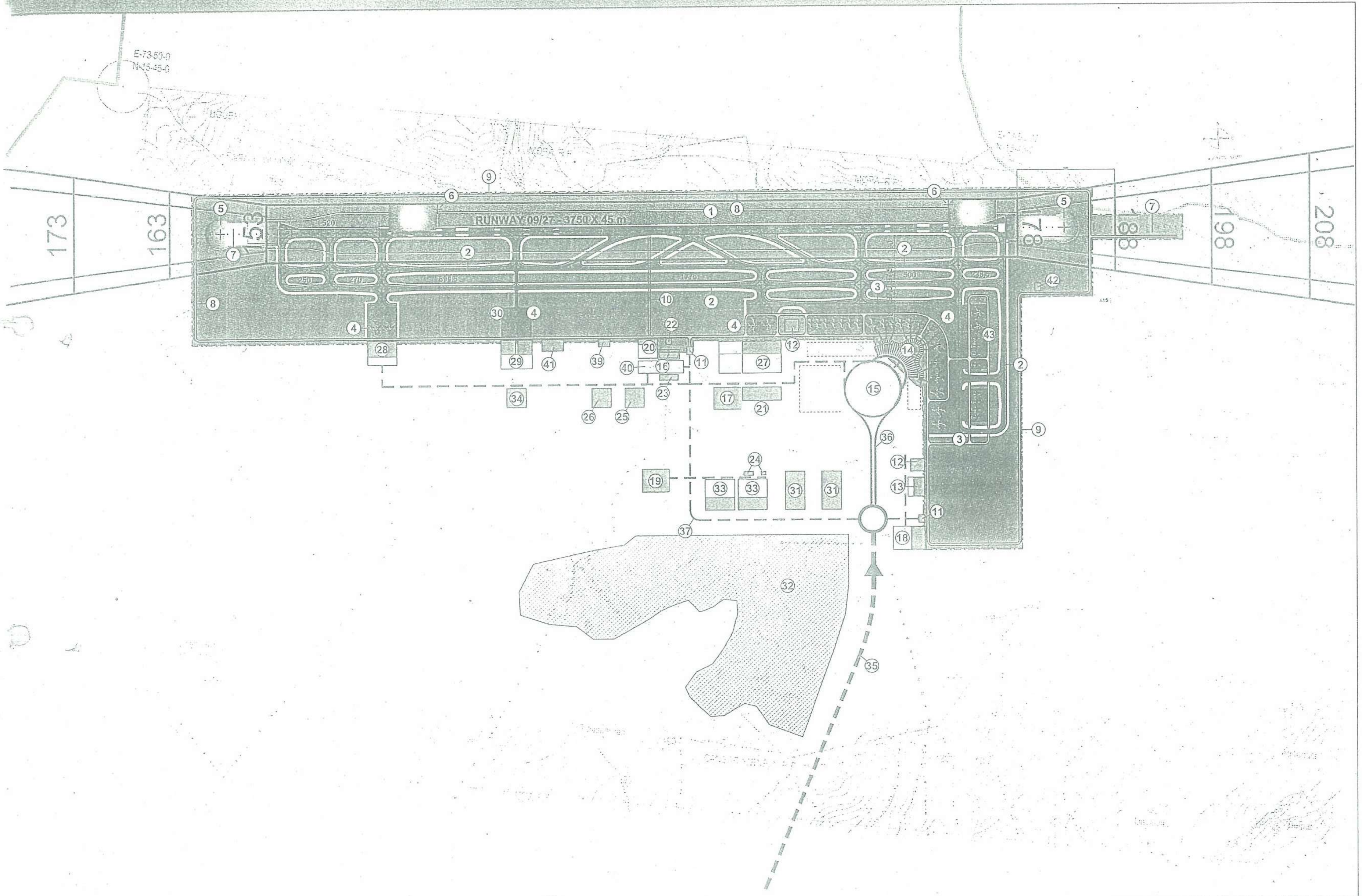
Scale : 1/10000

Date: August 2005

FEASIBILITY STUDY - MASTER PLAN - STAGE 1

ADPi

NEW C INTERNATIONAL AIRPORT



LEGEND

1. RUNWAY 09-27 3750 x 45 m
2. TAXIWAY CODE E
3. TAXILANE CODE E
4. APRON
5. LOCALIZER
6. GLIDE PATH
7. APPROACH RAMP
8. AIRSIDE SERVICE ROAD
9. PERIMETER FENCE
10. RFF DEDICATED ROAD
11. CONTROL POINT
12. GSE STORAGE AREA
13. GSE MAINTENANCE
14. TERMINAL
15. CAR PARK
16. CONTROL TOWER AND TECHNICAL BLOCK
17. POWER SUPPLY
18. CATERING
19. FUEL FARM
20. RESCUE AND FIRE FIGHTING SERVICES
21. AIRPORT MAINTENANCE
22. METEO STATION
23. CUSTOM AND POLICE
24. WATER SUPPLY - FILTRATION STATION
25. SEWAGE AND WASTE WATER
26. INCINERATOR AND GARBAGE STORAGE
27. CARGO AREA
28. AIRCRAFT MAINTENANCE
29. GENERAL AVIATION AND BUSINESS AVIATION
30. HELICOPTERS AREA
31. HOTEL AND CONFERENCE CENTER
32. GOLF
33. EMPLOYEES ACCOMMODATIONS
34. FIRE TRAINING
35. MAIN ACCESS ROAD
36. PASSENGER ACCESS ROAD
37. LANDSIDE SERVICE ROAD
38. ISOLATION PAD
39. FUELLING STATION
40. STAFF CAR PARK
41. TRANSMITTING AND RECEIVING CENTER
42. RADAR STATION
43. RESERVE STANDS

0 200 400 600m

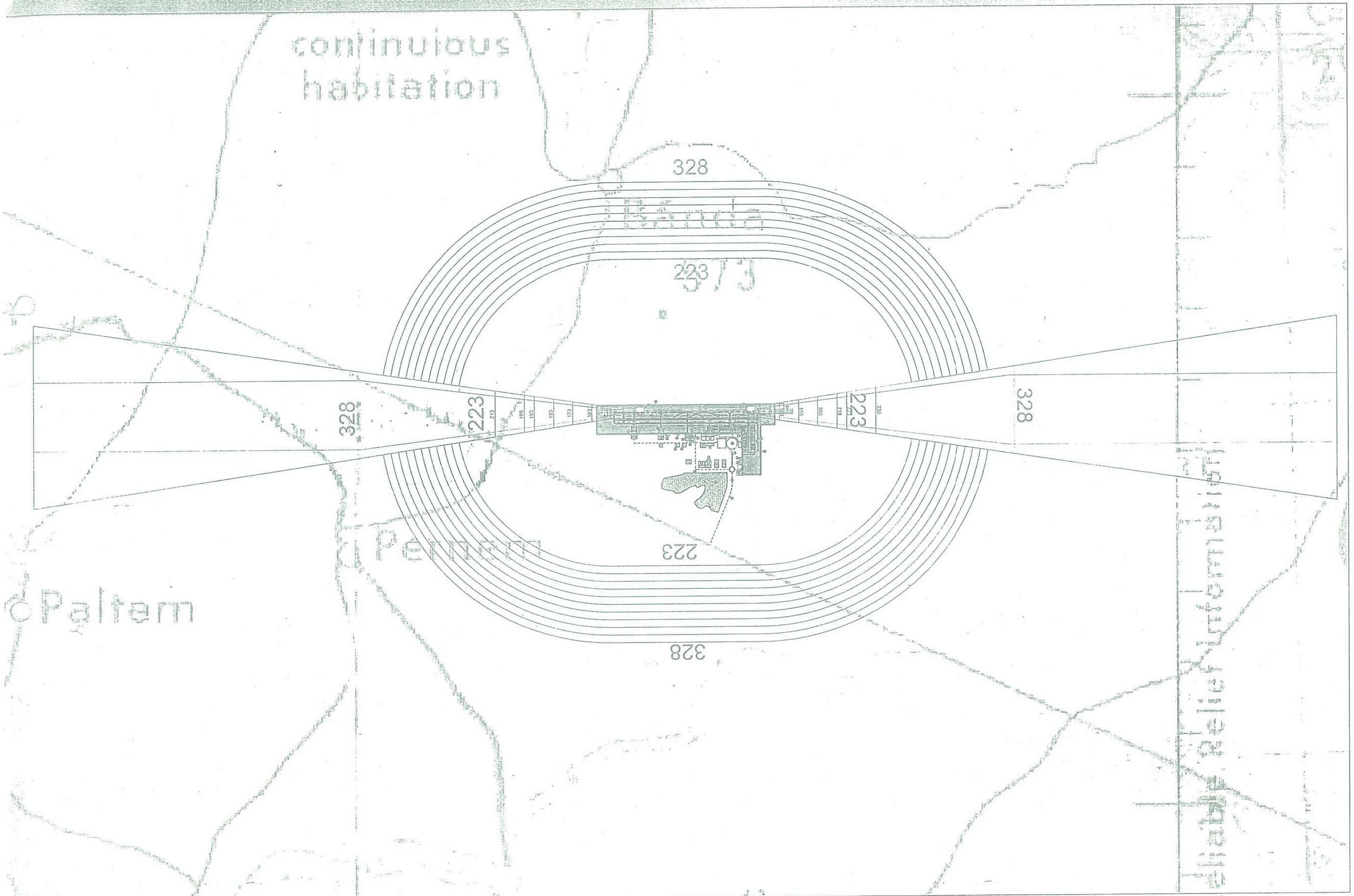
Scale : 1/10000

Date: August 2005

FEASIBILITY STUDY - MASTER PLAN - STAGE 2

ADP.i

NEW G... INTERNATIONAL AIRPORT



LEGEND

1. RUNWAY 09-27 3750 x 45 m
2. TAXIWAY CODE E
3. TAXILANE CODE E
4. APRON
5. LOCALIZER
6. GLIDE PATH
7. APPROACH RAMP
8. AIRSIDE SERVICE ROAD
9. PERIMETER FENCE
10. RFF DEDICADED ROAD
11. CONTROL POINT
12. GSE STORAGE AREA
13. GSE MAINTENANCE
14. TERMINAL
15. CAR PARK
16. CONTROL TOWER AND TECHNICAL BLOCK
17. POWER SUPPLY
18. CATERING
19. FUEL FARM
20. RESCUE AND FIRE FIGHTING SERVICES
21. AIRPORT MAINTENANCE
22. METEO STATION
23. CUSTOM AND POLICE
24. WATER SUPPLY - FILTRATION STATION
25. SEWAGE AND WASTE WATER
26. INCINERATOR AND GARBAGE STORAGE
27. CARGO AREA
28. AIRCRAFT MAINTENANCE
29. GENERAL AVIATION AND BUSINESS AVIATION
30. HELICOPTERS AREA
31. HOTEL AND CONFERENCE CENTER
32. GOLF
33. EMPLOYEES ACCOMMODATIONS
34. FIRE TRAINING
35. MAIN ACCESS ROAD
36. PASSENGER ACCESS ROAD
37. LANDSIDE SERVICE ROAD
38. ISOLATION PAD
39. FUELLING STATION
40. STAFF CAR PARK
41. TRANSMITTING AND RECEIVING CENTER
42. RADAR STATION
43. RESERVE STANDS

0 1000 2000 3000m

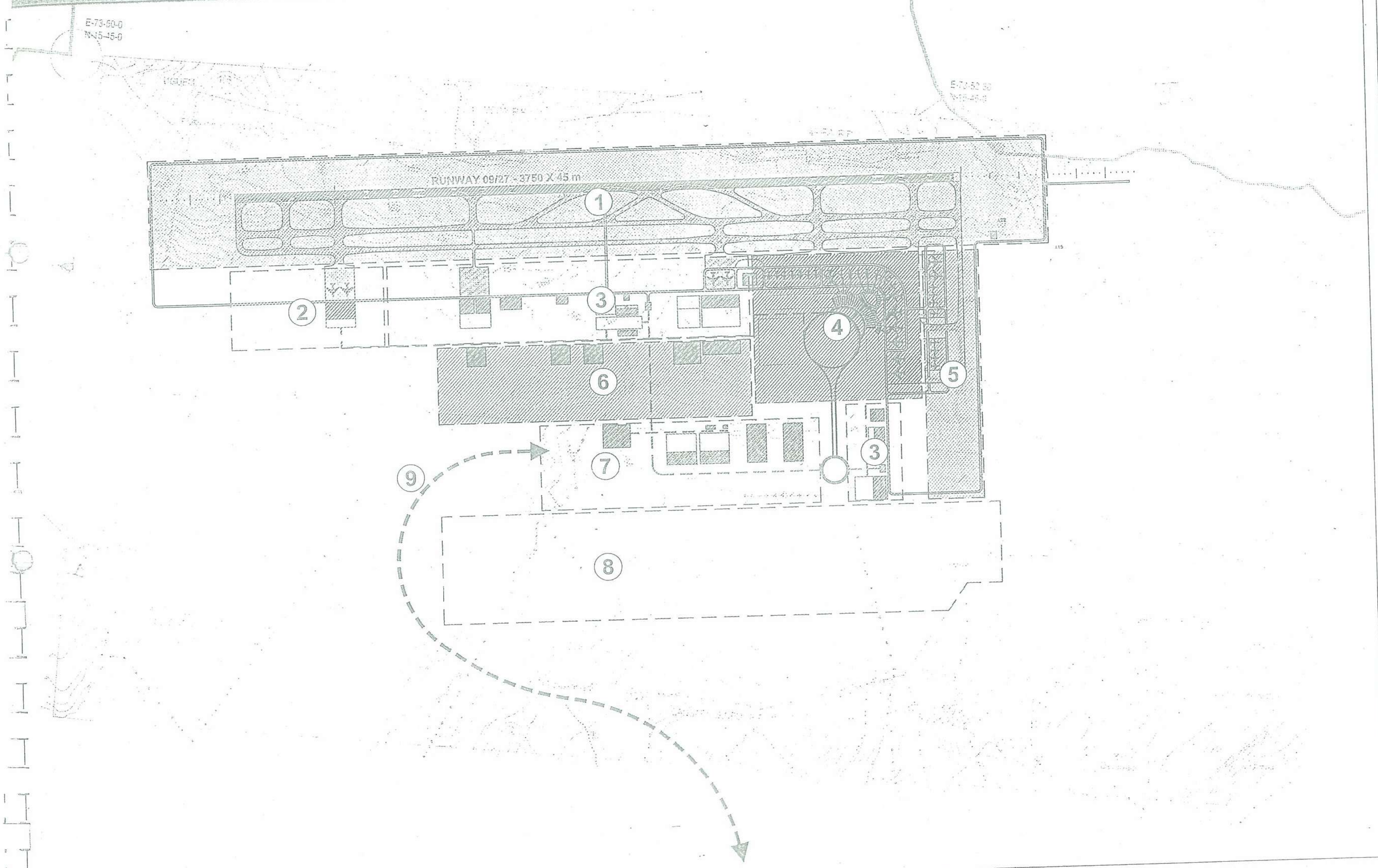
Scale : 1/50000

Date: August 2005

FEASIBILITY STUDY - AERONAUTICAL CLEARANCES - STAGE 2

ADPi

NEW C[illegible] INTERNATIONAL AIRPORT



LEGEND

1. RUNWAY 09-27 3750 x 45 m
2. AIRCRAFT MAINTENANCE
3. AIRSIDE TECHNICAL FACILITIES
4. PASSENGER TERMINAL AREA
5. REMOTE STANDS AND CONNECTING TAXIWAYS
6. LANDSIDE AIRPORT FACILITIES
7. AIRPORT CITY - BUSINESS FACILITIES
8. 2nd RUNWAY AREA
9. NEW ACCESS ROAD

0 200 400 600

Scale : 1/10000

ADP.i

FEASIBILITY STUDY - MASTER PLAN - ULTIMATE STAGE

Date: August 2005

8. Project Identification for First phase of construction

8.1. Reminder of 1st Phase Program (2014)

Mpax	2 803 683
Mpax int	753 205
Mpax dom	2 050 478
Cargo	21 095
Mvts pax	26 147
Mvts cargo	67
Mvts int pax	4128
Mvts dom pax	22019

Infrastrutures	Runway	1	
Area or facility			
	1 Security area vehicles control point	5000 m²	2
	2 Apron stands		
	NB stands	7	
	WB stands	4	
	Reserve stands	2	
	3 GSE storage		
	Covered	1500 m²	
	Uncovered	2650 m²	
	4 Park		
	Cars and car rental	23917 m²	797
	Motorcycles	4486 m²	897
	Taxis	1748 m²	70
	Bus	5826 m²	58
	5 Control tower and technical blok land requirement	3000 m²	
	6 Maintenance workshop		
	Building floor area	4369 m²	
	Land requirement	5461 m²	
	7 Power supply land requirement	8000 m²	
	8 Catering & aircraft cleaning		
	Building floor area	2839 m²	
	Land requirement	8620 m²	
	9 Fuel farm (2 weeks storage)		
	Storage volume	4200 m3	
	Land area	5880 m²	
	10 Fire protection land requirement	16000 m²	1
	11 Meteo station land requirement	1000 m²	
	12 Water supply	500 m²	
	13 Dilaceration area+Tank	500 m²	1
	14 Sewage	5000 m²	
	15 Maintenance (35% of traffic)		
	Bays		0
	Land area (including bays, apron, workshops, car parks...)	0 m²	
	16 General aviation	10000 m²	20
	17 Business aviation	15000 m²	4
	18 Helicopters	12000 m²	4
	19 Airport city		
	Hotel, offices and business center(land)	40000 m²	
	Golf course (if area is available...)	63000 m²	18
	Employees accomodations	16320 m²	168
	20 Main access road	2x1 lanes	
	21 Custom and police auxilliary facilities	1500 m²	
	22 Cargo		
	Terminal floor area	4500	
	Land requirement	22500	
	Apron stands	0	
	23 Passenger terminal floor area	31732 m²	
	24 Transmitting and Receiving Remote station		
	Floor area	220 m²	
	Land requirement	6 600 m²	
	25 Radar station	500 m²	

8.2. Infrastructures conceptual design

8.2.1. Airfield pavement network

8.2.1.1. Runway

8.2.1.1.1. Runway pavement geometry

According to ICAO standards, the runway will be designed for category 4E in order to receive wide body aircrafts such as B747-400 and new generations aircrafts, corresponding to A340-600; B777-300ER .

According to the approved Inception Report, the runway will be of 3750 m long and 45 m wide. Shoulders will be of 7.5 m width according to ICAO standards for airport code 4E to obtain a total treated width of 60 m for runway and shoulders.

According to ICAO standards for airport code 4, the runway will verify the following geometrical dispositions:

a) longitudinal slope will be lower than 1 %, and even limited to 0.8 % on the first and last quarter of the runway. Changing in slope will respect a maximum of 0.1 % per 30 m (minimum radius of curve 30 000 m).

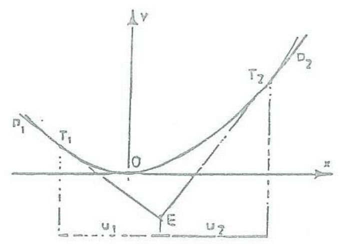
b) transversal slope will be limited to 1.5 % on the runway. On runway shoulder the maximum transversal slope will be taken at 2.5 %.

New runway geometrical standards proposed according to ICAO and Inception Report are presented in table below :

	Projected runway geometry
Runway	
– runway length	3 750 m
– runway width	45
– maximal longitudinal slope	1 %
– maximal transversal slope	1.5 %
Shoulders	
– shoulder width on both side	7.5 m
– maximal transversal slope	2.5 %
– blast pad on runway end	60 m

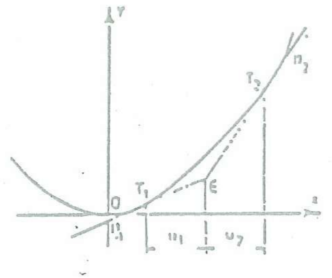
In addition, transitional curve surface should verify following principles:

- The radius involved being very large and the slopes of low values; the circle is taken as corresponding to parabolic curve.



$$u_1 = u_2 = \frac{R}{2}(p_1 + p_2)$$

Fig. 8.1 - Transitional curve cases 1 : P1 and P2 are contrary in sign



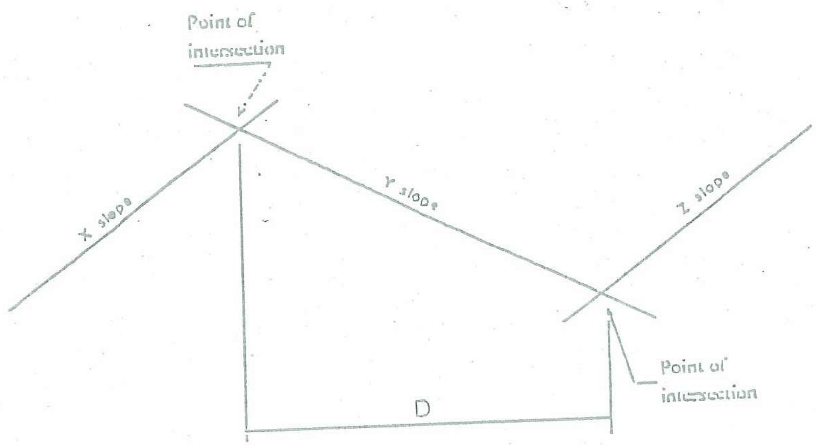
$$u_1 = u_2 = \frac{R}{2}(p_2 - p_1)$$

Fig. 8.2 - Transitional curve cases 2 : P1 and P2 have same sign

Starting from polyline of length profile and slopes P1, P2 first are determined the coordinates of E point. Then are determined T1 and T2 by using the values found for U1 and U2, then O point from T1 or T2 previously determined by using X1 = P1 R, X2 = P2 R. The coordinates of any point M of the parabola will be determined by fixing X with O as reference and determining the corresponding value of :

$$Y = \frac{X^2}{2R}$$

- The minimum distance Between Slope Changes according to ICAO is calculated as here under :



D (for runway) $\geq$ 30 000 (| X – Y | + | Y – Z |) m

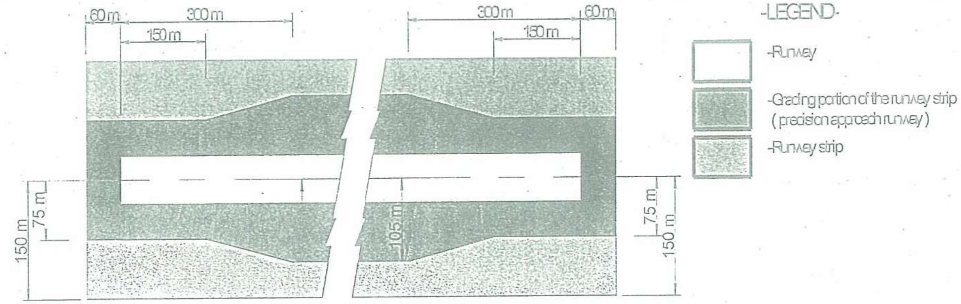
Fig. 8.3 - Distance between slope changes for runway

The above dispositions are taken into account in the attached drawings showing projected runway and taxiways longitudinal profiles (see Appendix 3).

8.2.1.1.2. Runway strip geometry

According to ICAO standards for airport code 4, runway strip of 300 m wide is required and along with expansions of 60 m at each extremity of the runway. Taking into consideration the runway of 3 750 m, total runway strip will be of 300 m by 3 870 m.

As recommended by ICAO, the graded strip will be extended from 105 m up to 210 m as illustrated in the figure 4.4 attached to this report.



The maximal longitudinal slope will be limited to 1.5 %. Changing in slope will be as gradual as possible, brutal changing or reverse in slope will be avoided.

The maximal transversal slope will be 2.5 %.

According to specific requirements for glide and localizer areas the following specifications will be satisfied:

- Glide area: longitudinal slope will be limited to 0.5 % and transversal slope will be lower than 1%.
- Localizer area: longitudinal slope will be limited to 1 % and transversal slope lower than 0.5 %.

These dispositions are presented in the typical cross sections drawings.

8.2.1.1.3. Runway end safety area

According to ICAO standards the runway end safety area will extend on 240 m from each extremity of the runway and by a width of 90 m (twice the runway width).

8.2.1.2. Taxiways network

8.2.1.2.1. Taxiway pavement and strip geometry

According to ICAO standards, taxiways are required to have a width of 25 m (Code F requirements), and shoulders will be of 10.5 m width, corresponding to a total treated width of 44 m for taxiway and shoulders . The taxiway strip for Code F is 60 m according to ICAO Annex 14. The remaining 7 meters ate each side of the shoulders wont be treated but only graded.

ICAO suggested on its comments on Inception Report to achieve at first step a taxiway of 25 m in order to consider the fact that widening the taxiways in the future to 25 m (code 4F) will be very difficult if not impossible as construction equipment may not permit work in such narrow lane.

According to ICAO standards for airport code 4, the runway will verify the following geometrical dispositions :

a) longitudinal slope will be lower than 1.5 %. Changing in slope will respect a maximum of 1 % per 30 m (minimum radius of curve 3000 m).

b) transversal slope will be lower than 1.5 % on the taxiway, and maximum transversal slope of 2.5 % on taxiway shoulder.

Geometrical standards proposed according to ICAO and Terms Of References are presented below :

	Projected taxiways geometry
Taxiway	
– taxiway width	25 m
– maximal longitudinal slope	1.5 %
– maximal transversal slope	1.5 %
Shoulders	
– shoulder width on both sides	10.5 m
– levelled strip on both sides	7 m
– maximal transversal slope	2.5 %

Fillets

Fillets will be design according to ICAO Aerodrome Manual Part 2 "Taxiway, Aprons and Holding Bays" third edition 1991 and Path-Planner sofwares, taking into account new large aircraft A340-600, and B777-300ER whose wheelbases are up to 8 meters longer that for other code 4E aircraft such as B747-400.

The design of taxiway fillets will be such that when the cockpit of the aircraft for which the taxiway is intended to remains over the taxiway centre line marking, the clearance distance between the outer main wheel of the aircraft and the edge of the taxiway will be not less than 4.5 m.

8.2.1.3. Earthworks

According to the above recommendations et the longitudinal and cross section profiles of airside infrastructures attached to this report; the total amount of earthworks can be estimated as the following:

- 3 700 000 cubic meter of cuts.
- 5 000 000 cubic of meter of fill material

8.2.1.4. Airfield pavement design

8.2.1.4.1. Subgrade Quality

According to the preliminary geotechnical data and local experience, the subgrade bearing capacity can be characterised by a minimum CBR of 10 % (corresponding to modulus value of 90 MN/m3) corresponding and to an ICAO code B of subgrade condition. This performance will be obtain by adding the following thickness of selected material on top of cutting line or embankment.

- 25 cm of Granular Subbase (GSB)
- 50 cm of Selected Subgrade (SB)

8.2.1.4.2. Runway and taxiways pavement design

The pavement structure design of runway and taxiway will be based on :

- FAA Advisory Circular No.150/5320-6D "Airport Pavement Design and Evaluation" dated 2004
- FAA Advisory Circular No.150/5335-5 "Standardized Method of Reporting Pavement Strength – PCN".

- *Proposed type of pavement structure*

According to local experience, the pavement structure of the projected runway is proposed to be flexible.

This technique is well adapted to the Goa climate and the local firms experience and is cheaper than rigid one.

- ***Traffic data***

FAA pavement design method takes into account aircraft departures for a period of 20 years.

Assuming an initial total traffic on Goa Airport of 18 000 movements, a figure of 9 000 departures can be taken as a basic data for the design.

The expected final traffic for 20 years (2029) is evaluated at 50 000 movements for the airport, which corresponds to 25 000 departures on the runway to be design with a geometrical progression of 5.20 %.

Therefore, the total traffic cumulated for the period of 20 years will be of 304 000 departures . The average number of departures per year will be 15 200.

Traffic distribution considering typical aircraft on the runway to be design is derived from:

Aircraft		Traffic (departures) on the new runway			
Class	Reference aircraft	Percentage	2009	2029	Cumulated
E	B 747-400	1 %	90	250	3 040
E	B 777-300	2 %	180	500	9 120
E	A 330-200	5 %	450	1 250	15 200
D	B 767-300ER	12 %	1 080	3 000	33 440
C	A 321-200	1 %	90	250	6 080
C	A 320-200	17 %	1 530	4 250	54 720
C	A 319-100	7 %	630	1 750	18 240
C	B 737-800	17 %	1 530	4 250	54 720
C	ERJ 195	16 %	1 440	4 000	48 640
C	ERJ 170	17 %	1 530	4 250	48 640
B	ATR 42	4 %	360	1 000	12 160
Total :		100 %	9 000	25 000	304 000

Reference aircrafts will be taken at Maximum Take Off Weight that is to say ;

Reference aircraft	MTOW (tons)
B 747-400	395.9
B 777-300	300.2
A 330-200	230.9
B 767-300ER	185.6
A 321-200	83.4
A 320-200	75.9
A 319-100	70.4
B 737-800	78.5
ERJ 195	49.0
ERJ 170	48.5
ATR 42	16.2

Because of their loads , ERJ and ATR aircrafts are no more considered in the design as negligible compared to other aircrafts

- ***Proposed structures :***

According to FAA :

- aggregate base course is not permissible since the weight of the design aircraft exceeds 60 000 lbs (27 000 kg). Therefore, plant mix bituminous for base (P401) is proposed for base course.
- a stabilized subbase courses should be chosen for new pavements designed to aircraft weighting 100 000 pounds or more. However, according to local experience pavement non-stabilized course is preferred.
- Material for subbase can be uncrushed aggregate material (P 154) but for quality improvement crushed aggregate base course (P209) is proposed.

- ***Determination of pavement structure***

FAA pavement design method is consider with use of LEDFAA v1.3 sofware for a typical flexible pavement structure.

Wearing course :

The hot mix asphalt surface course on critical area should be of 4 inches (10,1 cm).

Base course :

Thickness pavement for base course is set at 6 inches (15,2 cm)

Subbase course :

Thickness pavement for subbase course is calculated at 16,7 inches (42,5 cm)

The aircraft pavement structure for taxiways and runway recommended by the consultant to a lesser use of bituminous materials is finally the following:

Hot mix asphalt surface course	–	P 401 :	10 cm
Plant mix bituminous for base course	–	P 401 :	15 cm
Crushed aggregate subbase course	–	P 209 :	44 cm (2 layers of 22 cm)

8.2.1.4.3. Aprons pavement design

The pavement structure design of runway and taxiway will be based on :

- FAA Advisory Circular No.150/5320-6D "Airport Pavement Design and Evaluation" dated 2004
- FAA Advisory Circular No.150/5335-5 "Standardized Method of Reporting Pavement Strength – PCN".

- ***Proposed type of pavement structure***

According to experience of apron pavement design, the pavement structure of aprons is proposed to be rigid.

This technique is well adapted to take account high shearing stress constraints linked to wide body aircraft and airbridges rotation as well as the contamination by oil and kerosene.

- ***Traffic data***

FAA pavement design method takes into account aircraft departures for a period of 20 years.

Assuming an initial total traffic on Goa Airport of 18 000 movements, a figure of 9 000 departures can be taken as a basic data for the design.

The expected final traffic for 20 years (2029) is evaluated at 50 000 movements for the airport, which corresponds to 25 000 departures on the runway to be design with a geometrical progression of 5.20 %.

Therefore, the total traffic cumulated for the period of 20 years will be of 304 000 departures . The average number of departures per year will be 15 200.

Traffic distribution considering typical aircraft on the runway to be design is derived from:

Aircraft		Traffic (departures) on the new runway			
Class	Reference aircraft	Percentage	2009	2029	Cumulated
E	B 747-400	1 %	90	250	3 040
E	B 777-300	2 %	180	500	9 120
E	A 330-200	5 %	450	1 250	15 200
D	B 767-300ER	12 %	1 080	3 000	33 440
C	A 321-200	1 %	90	250	6 080
C	A 320-200	17 %	1 530	4 250	54 720
C	A 319-100	7 %	630	1 750	18 240
C	B 737-800	17 %	1 530	4 250	54 720
C	ERJ 195	16 %	1 440	4 000	48 640
C	ERJ 170	17 %	1 530	4 250	48 640
B	ATR 42	4 %	360	1 000	12 160
Total :		100 %	9 000	25 000	304 000

Reference aircrafts will be taken at Maximum Take Off Weight that is to say ;

Reference aircraft	MTOW (tons)
B 747-400	395.9
B 777-300	300.2
A 330-200	230.9
B 767-300ER	185.6
A 321-200	83.4
A 320-200	75.9
A 319-100	70.4
B 737-800	78.5
ERJ 195	49.0
ERJ 170	48.5
ATR 42	16.2

Because of their loads , ERJ and ATR aircrafts are no more considered in the design as negligible compared to other aircrafts

- *Concrete flexural strength value*

  It is fixed at 5 MPa (28 days)

- *Proposed structures* :

  According to FAA :

  - Surface course will be of typical PCC Slabs .
  - Stabilized Base Course is shoosen as Cement Treated Base (P 304)
  - Material for subbase can be uncrushed aggregate material (P 154) but for quality improvement crushed aggregate base course (P 209) is proposed.

- *Determination of pavement structure*

FAA pavement design method is considered with use of LEDFAA v1.3 software for a typical rigid pavement structure.

Wearing course:

Concrete slab on critical area should be of 14,96 inches (38,0 cm).

Base course:

Thickness pavement for base course is set at 6 inches (15,2 cm)

Subbase course:

Thickness pavement for subbase course is calculated at 6 inches (15,2 cm)

The aircraft pavement structure for aprons recommended by the consultant is finally the following:

Concrete slab	–	PCC :	38 cm
Cement Treated Base	–	P 204 :	15 cm
Uncrushed Aggregate	–	P154 :	15 cm

8.2.1.5. PCN evaluation

For pavement of variable strength, the PCN numerical value should report the weakest segment of the pavement.

The PCN for any pavement is reputed by a code consisting of five elements : PCN Numerical values, Pavement type, subgrade strength, tire pressure and evaluation method.

In the case of airfield pavements for new Goa airport :

- Pavement types are F (flexible) for the runway and taxiway and R (rigid) for aprons,
- Subgrade strength is B (CBR = 10 % on existing or backfill soil),
- No tire limitation (code W),
- Evaluation method (T) as the design is based on a technical assessment.

According to the reference aircrafts, pavements have been designed to obtain Pavement Classification Number (PCN) higher than the Aircraft Classification Number (ACN) of the expected aircrafts and according to classification of soil (CBR of 10 %).

The most significant existing aircrafts ACN are presented in the table below , ...ement types :

Flexible pavement :

Aircraft	Aircraft Classification Number ACN on flexible pavement			
	Soil classified A 13 ≤ CBR	Soil classified B 8 ≤ CBR ≤ 13	Soil classified C 4 ≤ CBR ≤ 8	Soil classified D CBR ≤ 4
B777-300@300 tons	53	59	73	100
B747-400@396 tons	58	64	81	103
B767-300ER@186 tons	52	58	71	92
A330-200@231 tons	62	67	79	107
A340-600@365 tons*	68	74	87	118
B777-300ER@340 tons*	62	69	89	119
A380-800@560 tons*	62	67	80	108

* Non scheduled aircrafts

According to the projected cumulated traffic of 304 000 departures expected for 20 years on the new airfield network and soil classification B (CBR = 10 %) assumption, the calculated PCN is 67.

Rigid pavement :

Aircraft	Aircraft Classification Number ACN on rigid pavement			
	Soil classified A 120 MN/m^3 ≤ K	Soil classified B 60 MN/m^3 ≤ K ≤ 120 MN/m^3	Soil classified C 25 MN/m^3 ≤ K ≤ 60 MN/m^3	Soil classified D K ≤ 25 MN/m^3
B777-300@300 tons	55	68	88	108
B747-400@396 tons	53	63	74	85
B767-300ER@186 tons	48	57	67	77
A330-200@231 tons	53	62	73	86
A340-600@ 365 tons*	58	67	80	94
B777-300ER@340 tons*	65	83	106	129
A380-800@560 tons*	54	67	87	110

* Non scheduled aircrafts

According to the projected cumulated traffic of 304 000 departures expected for 20 years on the new airfield network and soil classification B (K = 90 MN/m^3) assumption, the calculated PCN is 72.

Therefore proposed PCN publication are :

- **For flexible pavement : 67/F/B/W/T**
- **For rigid pavement : 72/R/B/W/T**

This value indicates that the pavement thickness design is optimised according to the traffic.

8.2.1.6. Shoulders pavement structures

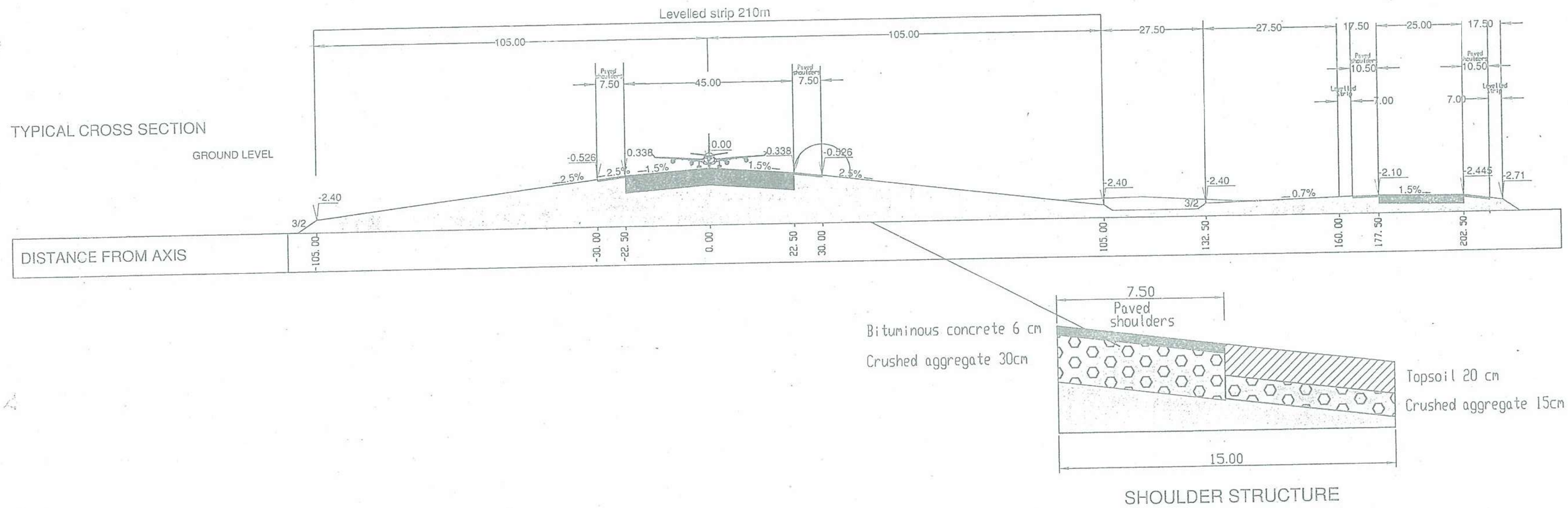
According to the terms of reference :

- runway shoulders are required to be 7.5 m wide m to obtain a total treated width of 60 m for runway and shoulders.
- the taxiway is required to have a width of 25 m, and shoulders should have a width of 10.5 m on each side.

Therefore shoulder structures proposed on a CBR = 10 soil for the 7.5 m runway shoulders and the 10,5 taxiway shoulders are :

Course	Material	Thickness
Surface	Hot mix asphalt surface – P 401	6 cm
Base	Crushed aggregate base course – P 209	30 cm

NEW GOA INTERNATIONAL AIRPORT



Date: August 2005

FEASIBILITY STUDY - TYPICAL CROSS SECTION RUNWAY/TAXIWAY

ADPi

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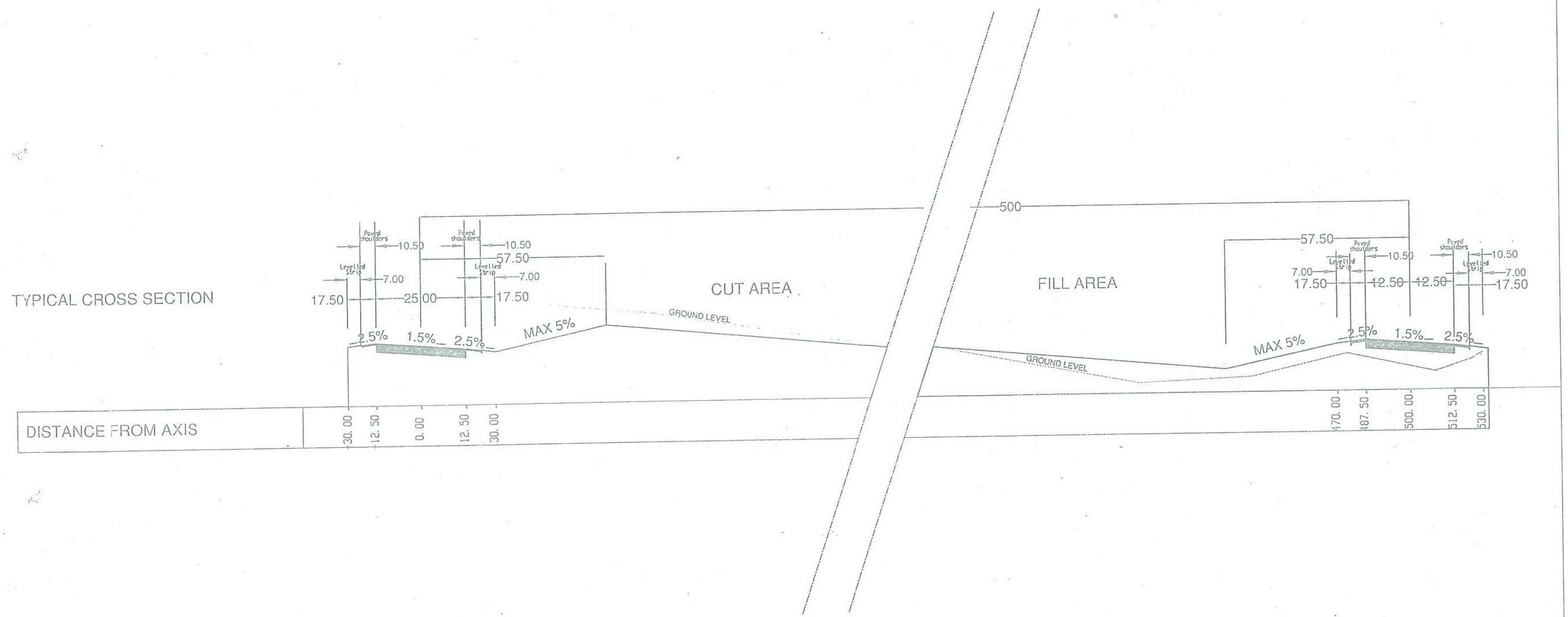
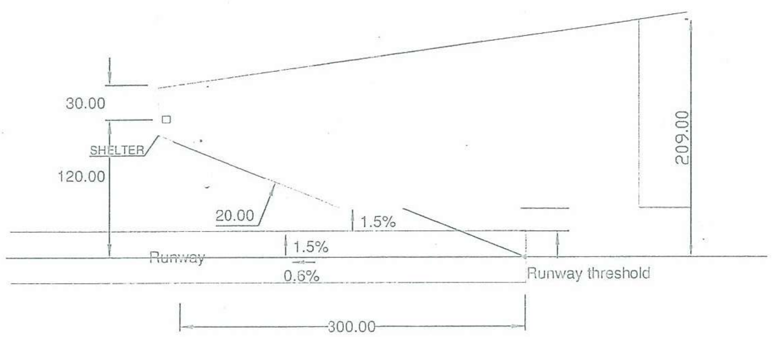
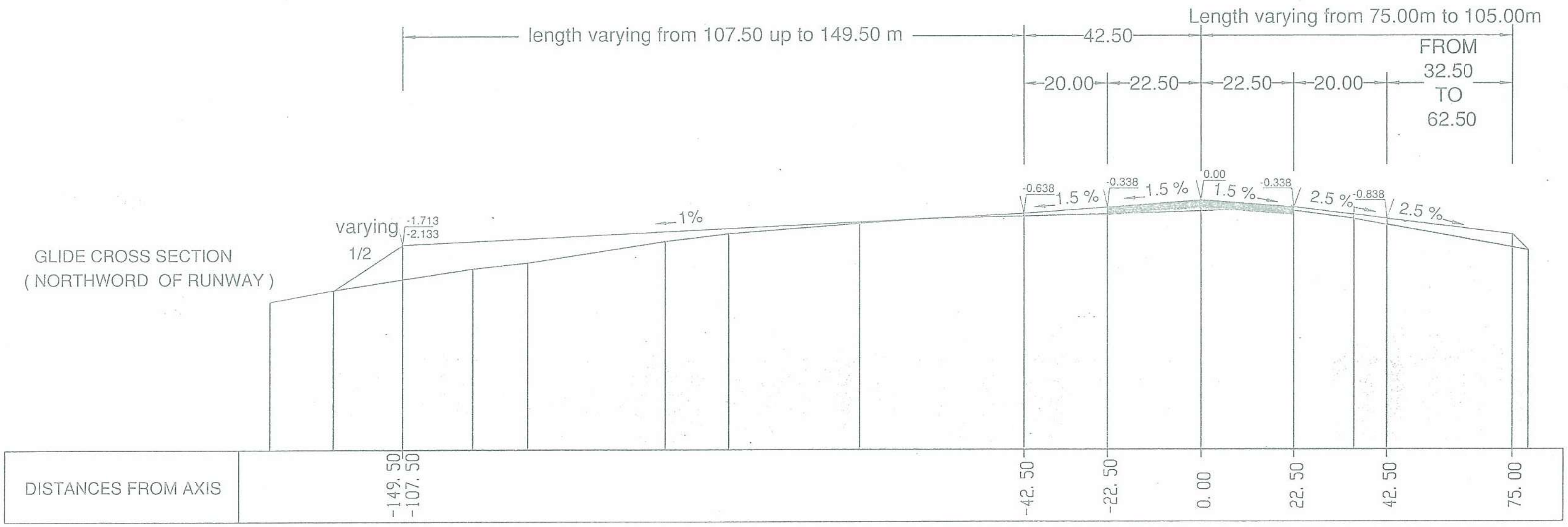


Date: August 2005

FEASIBILITY STUDY - TYPICAL CROSS SECTION TAXIWAYS 1 & 2

NEW GOA INTERNATIONAL AIRPORT



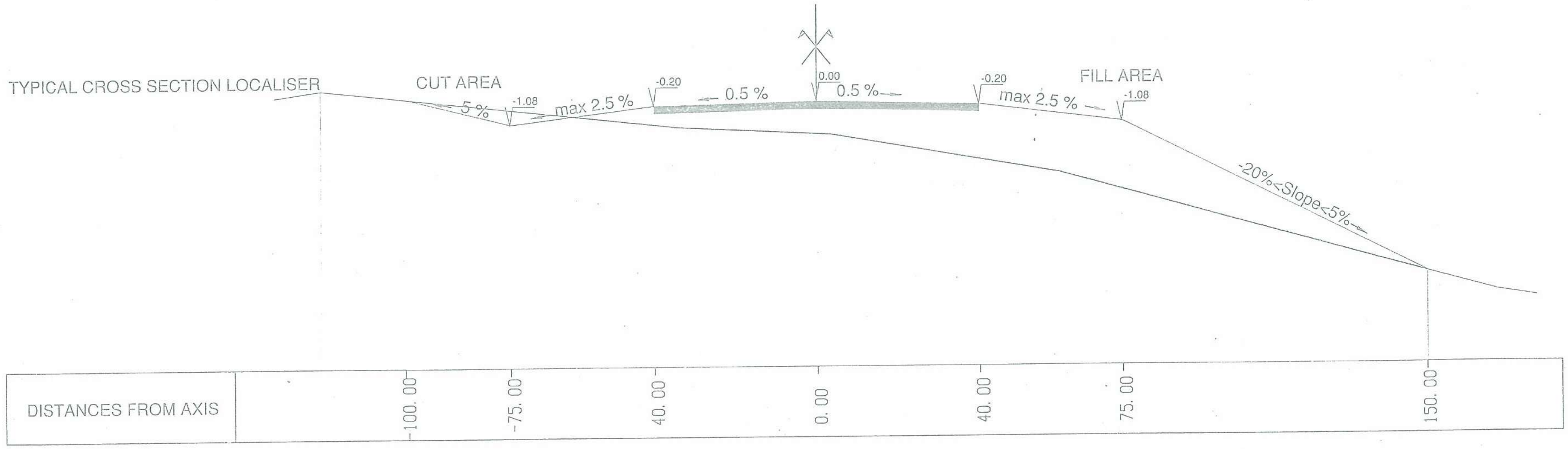


Date: August 2005

FEASIBILITY STUDY - TYPICAL CROSS SECTION GLIDE PATH

ADPi

NEW GOA INTERNATIONAL AIRPORT



Date: August 2005

FEASIBILITY STUDY - TYPICAL CROSS SECTION LOCALISER

ADPi

8.2.2. Airside service and fire fighting roads network

8.2.2.1. Future situation

Airside Service roads network can be distinguished at the limit of the aeronautical infrastructures, connecting :

- aprons stands of terminal , cargo hanger and catering area,
- maintenance equipments (approach ramps, LLZ, GP, etc.)
- runways thresholds.

8.2.2.2. Service and fire fighting roads

Projected service and fire fighting roads network have been designed in order to connect installations; equipments and the projected runway.

In particular will be considered:

- access along aprons of terminal,
- access from fire station to the runway and to runway safety areas,
- access road to navaids and met equipments (approach ramps, LLZ, GP, etc.).

A security road along the boundary fence is projected and will be connected to existing service roads.

8.2.2.3. Adapted Specifications

The following specifications and design procedures were adapted for the geometric and structural design for the Fire Fighting and the Service Roads :

- American Association of State Highway and Transportation Officials (AASHTO), " A Policy on Geometric Design of Highways and Streets," Release 1994, Washington D.C. 2001, U.S.A
- American Association of State Highway and Transportation Officials, " AASHTO Guide for Design of Pavement Structures," Release 1993, Washington D.C. 2001, U.S.A.

8.2.2.4. Conceptual Design Purpose

The preliminary design of the Fire Fighting Road and Service Roads include the study and submittal of the following :

- Geometric design features of the selected route/alignment, which include the layout plan and the profile,
- Typical proposed carriageway section,
- Typical pavement design section(s).

8.2.2.5. Geometric Design Standards

Based on the adapted specs and standards of the project, the following geometric design standards were selected :

- Design Speed = 40 km/h
- Design Vehicle = Single Unit Truck (SU)
- Minimum Turning Radius = 15.0 m
- Stopping Sight Distance (SSD) = 60.0 m (Wet Condition)
- Passing Sight Distance (DSD) = 300.0 m

- Horizontal Alignment
  - ☒ Minimum Radius = 15.0 m
  - ☒ Maximum Superelevation = 6.0 % Minimum Length between Broken-back Curves = 150.0 m
  - ☒ Compound Curve Radii Ratios ≤ 1.5
  - ☒ Maximum Relative Slope = 0.50 %

- Vertical Alignment :
  - ☒ Type = Circular
  - ☒ Maximum Grade : 5.0 % (3.0 % for apron service road)
  - ☒ Critical Length of Grade :
    - 650.0 m for Gradient 3.0 %
    - 425.0 m for Gradient 4.0 %
    - 300.0 m for Gradient 5.0 %
  - ☒ Minimum Radius :
    - For Crest Curves = 500.0 m
    - For Sag Curves = 800.0 m
  - ☒ Vertical Curve is Omitted when difference in Grades is Less Than 0.50 %
  - ☒ Minimum Length of vertical Curve = 50.0 m
  - ☒ Minimum Tangent Between Curves = 50.0 – 100.0 m

- Cross Sectional Elements :
  - ☒ Apron Service Roads (from Catering to Cargo : 2 lanes road) :

- Lane width = 5.0 m
- Shoulder :
  - Paved = 0.0 m
  - Unpaved = 0.5 m
- Cross Slope = 1.5 %
- Cross Fall for Shoulder = 1.5 %
- Side Slopes[12]
  - Cohesive Soft Material = 2 : 3
  - Maximum Cut Height or Fill = 4.0 m (without berm)
- Horizontal Clearance
  - Clear Obstruction Area = 1.5 m from the Edge of Traveled Way
  - Sign Supports and Poles = 0.5 m from the Shoulder Break Point
- Speed Change Lanes
  - Deceleration Lanes : Not Applicable
  - Acceleration Lanes : Not Applicable
- Turning Roadways : Not Applicable

☒ Fire Fighting Road (2 lanes road) :

- Lane width = 3.0 m
- Shoulder :
  - Paved = 0.5 m
  - Unpaved = 1.5 m
- Cross Slope = 1.5 %
- Cross Fall for Shoulder = 2.5 %
- Side Slopes[13]
  - Cohesive Soft Material = 2 : 3
  - Maximum Cut Height or Fill = 4.0 m (without berm)
- Horizontal Clearance
  - Clear Obstruction Area = 4 m from the Edge of Traveled Way
  - Sign Supports and Poles = 0.5 m from the Shoulder Break Point
- Speed Change Lanes
  - Deceleration Lanes : Not Applicable
  - Acceleration Lanes : Not Applicable
- Turning Roadways : Not Applicable

☒ Airside Service Roads (except for navaids access) :

- Lane width = 3.0 m
- Shoulder :
  - Paved = 0.0 m
  - Unpaved = 0.5 m
- Cross Slope = 1.5 %
- Cross Fall for Shoulder = 1.5 %
- Side Slopes[14]
  - Cohesive Soft Material = 2 : 3
  - Maximum Cut Height or Fill = 4.0 m (without berm)
- Horizontal Clearance
  - Clear Obstruction Area = 1.5 m from the Edge of Traveled Way
  - Sign Supports and Poles = 0.5 m from the Shoulder Break Point
- Speed Change Lanes
  - Deceleration Lanes : Not Applicable
  - Acceleration Lanes : Not Applicable
- Turning Roadways : Not Applicable

☒ Navaids Service Roads :

- Lane width = 3.0 m
- Shoulder :
  - Paved = 0.5 m
  - Unpaved = 1.5 m
- Cross Slope = 1.5 %
- Cross Fall for Shoulder = 1.5 %
- Side Slopes[2]
  - Cohesive Soft Material = 2 : 3
  - Maximum Cut Height or Fill = 4.0 m (without berm)
- Speed Change Lanes

[12] Actual values will be determined based on geotechnical analysis of embankment or cut stability.

[13] Actual values will be determined based on geotechnical analysis of embankment or cut stability.

- Deceleration Lanes : Not Applicable
- Acceleration Lanes : Not Applicable
- Turning Roadways : Not Applicable

8.2.2.6. Carriageway Cross Section

- <u>*Apron Service Roads Cross Section*</u>

Based on the recommendations of the adapted geometric design criteria, the following cross section elements were selected :

- Type = Two Lanes Two Ways Road
- Number of lanes = 2 (total directions),
- Lane width = 5.0 m
- Shoulder width for each direction = 0.5 m unpaved
- Median Width = 0.0 m
- Pavement cross slopes = 1.5 %

- <u>*Fire Fighting Road Cross Section*</u>

Based on the recommendations of the adapted geometric design criteria, the following cross section elements were selected :

- Type = Two Lanes Two Ways Road
- Number of lanes = 2 (total directions)
- Lane width = 3.0 m
- Shoulder width for each direction = 2.0 m (0.5 m paved and 1.5 m unpaved)
- Median Width = 0.0 m
- Pavement cross slopes = 1.5 %

- <u>*Airside Service Roads Cross Section*</u>

Based on the recommendations of the adapted geometric design criteria, the following cross section elements were selected :

- Type = Two Lanes Two Ways Road
- Number of lanes = 2 (total directions),
- Lane width = 3.0 m
- Shoulder width for each direction = 0.5 m unpaved
- Median Width = 0.0 m
- Pavement cross slopes = 1.5 %

- <u>*Navaids Service Roads Cross Section*</u>

Based on the recommendations of the adapted geometric design criteria, the following cross section elements were selected:

- Type = One Lane One Way Road
- Number of lanes = 1
- Lane width = 3.0 m
- Shoulder width for each direction = 2.0 m (0.5 m paved and 1.5 m unpaved)
- Median Width = 0 m
- Pavement cross slopes = 1.5 %

8.2.2.7. Roads pavement design

8.2.2.7.1. *Subgrade Quality*

According to the preliminary geotechnical data and local experience, the subgrade bearing capacity can be characterised by a minimum CBR of 10 %. This performance will be obtain by adding the following thickness of selected material on top of cutting line or embankment.

- **25 cm of Granular Subbase (GSB)**
- **50 cm of Selected Subgrade (SB)**

8.2.2.7.2. *Apron Service Road*

The front service road will have to bear handling vehicles, fuel servicers and towing tractors weighting approximately 25 tons per axle.

The structure of the road (10m wide) as been design as a aeronautical pavement bearing an equivalent traffic of n annual departures of a single wheel gear corresponding to that of an aircraft with gross weight of 25 tons (55 000 lbs).

Number of annual departures	Design CBR
15 000	10

The structure of front service road will be as follows;

Total Equivalent thickness	Pavement structures
22 inches = 51 cm	5 cm Hot Mix asphalt surface Course (P 401) 10 cm Plant Mix bituminous for Base (P 401) * 30 cm Uncrushed aggregate subbase (P 154).

* The Plant Mix Bituminous for base as an equivalency factor of 1.6.

[14] Actual values will be determined based on geotechnical analysis of embankment or cut stability.

8.2.2.7.3. Fire Fighting Road

A multilayer elastic analysis were used to estimate the pavement cross section. The limiting subgrade strain and the tensile strain at the bottom of the asphalt layer were used in this analysis to establish the pavement section. In absence of the soil investigation data and according to the available collected data, the following factors were selected/estimated for design of the new pavement section(s) :

a. Climatic Conditions = Dry-Nonfreeze

b. Subgrade Class = Medium Strength (CBR = 10 %)

c. Design Traffic Class = 70,000 ESAL during the design life

Traffic were estimated using the following assumptions :

- Weight of Design Vehicle = 26 t
- Weight Distribution (6t on single axle and 2 x 10t on single axles)
- Assumed Repetitions = 2 trips/day/direction
- Calculation of ESAL

The fourth power model were used to estimate the number of repetitions of the standard load (18 kip). The results were as follows :

ESAL for 6t axle load	$= (6 \times 2.2/18)^4$	= 0.30
ESAL for 2 x 10t axle load	$= 2 \times (10 \times 2.2/18)^4$	= 4.4
Total ESAL per direction	= 2 x (4.4 + 0.30)	= 9.4
ESAL in Opening Year	= 9.4 x 365	= 3 431
ESAL in 20 Years (Design)	= 3431 x 20	= 68 620 (taken 70,000)

d. Design Life = 20 years

e. Growth Rate = 0.0 %

f. Preliminary Design Section :

The results of the multilayer elastic analysis yielded the following pavement section :

- 10 cm of Hot Mix Asphalt Layer
- 15 cm of Granular Base Layer (CBR ≥ 60 %)
- 20 cm of Subbase Granular Layer (CBR > 40 %)

8.2.2.7.4. Common Service Roads

AASHTO 1993 for Design of pavements were used to estimate the pavement cross section. The limiting layer analysis was applied to establish the pavement section. The following factors were assumed for design of the new pavement section(s) :

a. Terminal Serviceability = 2.0

b. Reliability = 80 %

c. Subgrade Class = Medium Strength (CBR =10 %)

d. Design Traffic Class = 45,000 ESAL during the design life

Traffic were estimated using the following assumptions :

- Weight of Design Vehicle = 26 t
- Weight Distribution (6t on single axle and 2 x 10t on single axles)
- Assumed Repetitions = 1 trips/day/direction
- Calculation of ESAL

The fourth power model were used to estimate the number of repetitions of the standard load (18 kip). The results were as follows :

ESAL for 6t axle load	$= (6 \times 2.2/18)^4$	= 0.30
ESAL for 2 x 10t axle load	$= 2 \times (10 \times 2.2/18)^4$	= 4.4
Total ESAL per direction	= (4.4 + 0.30)	= 5.7
ESAL in Opening Year	= 5.7 x 365	= 2 080
ESAL in 20 Years (Design)	= 2080 x 20	= 41 600 (taken 45,000)

e. Design Life = 20 years

f. Growth Rate = 0.0 %

g. Preliminary Design Section :

The results of the limiting layer analysis from AASHTO design suggested the following pavement section:

- 7 cm of Hot Mix Asphalt Layer
- 15 cm of Granular Base Layer (CBR ≥ 60 %)

8.2.2.7.5. Navaids Service Roads

Only light vehicles would operate on these roads, therefore, the proposed design for pavement structure is the following :

- 5 cm of Hot Mix Asphalt Layer
- 15 cm of Granular Base Layer (CBR ≥ 60 %)

8.2.3. Landside network pavement

8.2.3.1. **Main Access Road**

The main access road starts from the NH-17 at the intersection of Shemeche Advane village and passes through Nagjhar village to Airport Terminal curbside. It provides the access to the traffic coming from National Highway to Airport. It is approximately 8.0 km long and configured as a two-lane single carriageway road oriented in South - North direction. (Future widening is possible according to availability of land). From the airport entrance round about, the access road will 2 x 2 lanes with central landscaping.
The road system includes 3 major intersections up to the Airport.

Geometry design Standard:

The horizontal alignment and vertical profile of the main access road has been designed in accordance with the guidelines of Indian Road Congress (IRC).
The following IRC guidelines shall be followed while designing the geometry of the main access road.

IRC:86 – 1983	:	"Geometric Design Standards for Urban Roads in Plains"
IRC:73 – 1980	:	"Geometric Design Standards for Rural (non-urban) Highways"
IRC:38 – 1988	:	"Guidelines for Design of Horizontal Curves and Design Tables"
IRC:SP-23 – 1994	:	"Vertical Curves for Highways"
IRC:SP-41 - 1994	:	"Guidelines for design of at grade intersection for rural and urban areas"
IRC:65 – 1976	:	"Recommended Practice for traffic rotaries".
IRC:92 – 1985	:	"Guidelines for the design of interchanges in urban areas.

Based on the adapted specs and standards of the project, the following geometric design standards were selected:

- Design Speed = 60Km/h
- Terrain Type = Plain/Rolling Terrain
- Design Service Volumes in Nos. = 1400 per day (CV) in year 2014

8.2.3.1.1. *Carriageway Configuration*

The carriageway for the main access road has been configured as a two lane single carriageway with paved and unpaved shoulder on either side. The different elements for the carriageway are as under:

1. No. of lanes = 2 (or 2 x 2)
2. Carriageway Width = 7.5m (or 2 x 7,5 m)
3. Paved Shoulder = 1.5m (Each)
4. Earthen Shoulder = 1.0m(Each)
5. Cross Slope for Main carriageway = 2.5%
6. Cross Slope for paved Shoulder = 2.5%
7. Cross Slope For Earthen shoulder = 3.0%

- Horizontal Alignment
  - Minimum Radius = 150m
  - Maximum Super elevation = 7%
  - Minimum Length Between Broken – back – Curves = 150m
  - Minimum Transition Length = 65m
- Vertical Alignment
  - Type = Parabolic
  - Ruling Gradient = 3.3%
  - Limiting Gradient = 5%
  - Stopping Sight Distance = 80m
  - Overtaking Sight Distance = 300m
  - Intermediate sight Distance = 160m
  - Minimum Vertical Curve Length = 40m
  - Minimum Gradient For Drainage = 0.5% to 1%
  - Vertical Curve is omitted when difference in Grades is Less than 0.8%

Cross-sections indicating the details of carriageway configurations are enclosed with the report.

8.2.3.1.2. *Pavement*

Flexible pavement has been proposed for the main access road.
Pavement has been designed in accordance with IRC: 37 – 2001 "Guidelines for the design of flexible pavements" with 10% CBR over subgrade.
The pavements have been designed for the full design life of 20 years for traffic of 15 Million Standard Axles (MSA).
Pavement composition for the main carriageway and paved shoulder has been proposed as under:

- Bituminous Concrete (BC) : 40 mm
- Dense Bituminous Macadam (DBM) : 60 mm
- Wet Mix Macadam (WMM) : 250 mm
- Granular Sub-base (GSB) : 200 mm
- Subgrade : 500 mm

However, for cut section, sub grade layer may be omitted. The detailed pavement composition has been shown separately in pavement cross-section drawing.

8.2.3.2. Land side Service Road / Public Car parks

The service road network which will allow easy access to the cargo area, technical area, maintenance area, general aviation & helicopters & business aviation area should use a specific part of the road network to lighten terminal access occupancy at peak time.
In this section, the carriageway configuration and pavement details of the connecting roads to main access road with various facilities will be discussed as per IRC.

8.2.3.2.1. *Carriageway Configuration*

The carriageway for the landside service road has been configured as a two lane single carriageway with paved and unpaved shoulder on either side.
The different elements for the carriageway are as under:

1. No. of lanes = 2
2. Carriageway Width = 7.5m
3. Paved Shoulder = 1.5m (Each)
4. Earthen Shoulder = 1.0m(Each)
5. Cross Slope for Main carriageway = 2.5%
6. Cross Slope for paved Shoulder = 2.5%
7. Cross Slope For Earthen shoulder = 3.0%

Cross-section indicating the details of carriageway configuration is enclosed in the drawing list.

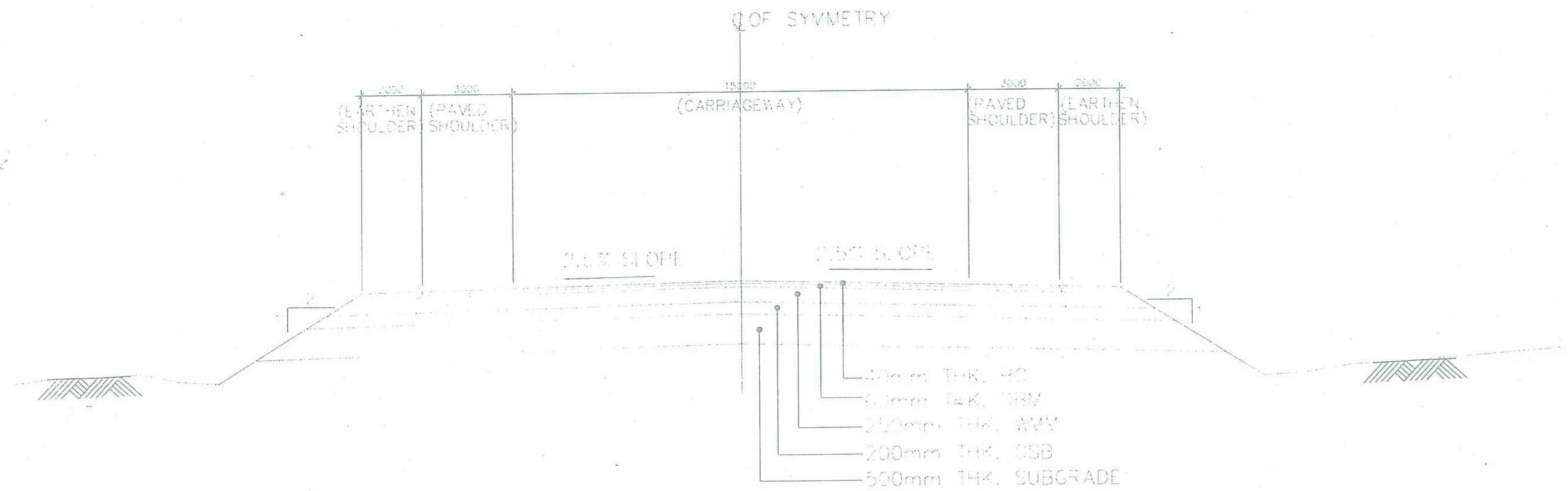
8.2.3.2.2. *Pavement*

Flexible pavement has been proposed for the land side service road.
Pavement has been designed in accordance with IRC: 37 – 2001 "Guidelines for the design of flexible pavements".
The pavements have been designed for the full design life of 20 years for traffic of 5 Million Standard Axles (MSA) with 10% CBR over subgrade.

Pavement composition for the main carriageway and paved shoulder has been proposed as under:

- Bituminous Concrete (BC) : 25 mm
- Dense Bituminous Macadam (DBM) : 50 mm
- Wet Mix Macadam (WMM) : 250 mm
- Granular Sub-base (GSB) : 150 mm
- Subgrade : 500 mm

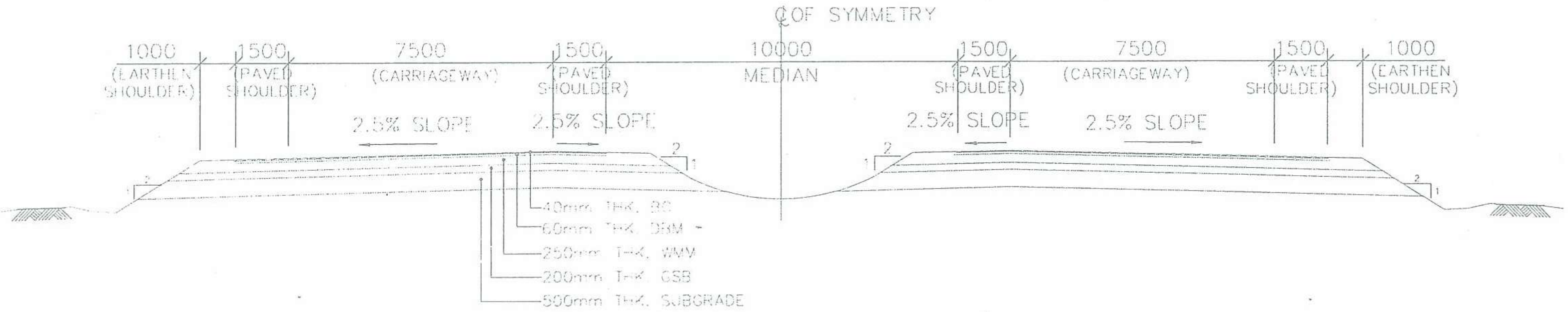
However, for cut section, sub grade layer may be omitted. The detailed pavement composition has been shown separately in pavement cross-section drawing.



TYPICAL CROSS SECTION OF MAIN ACCESS ROAD

FOR PHASE-I (TWO LANES)

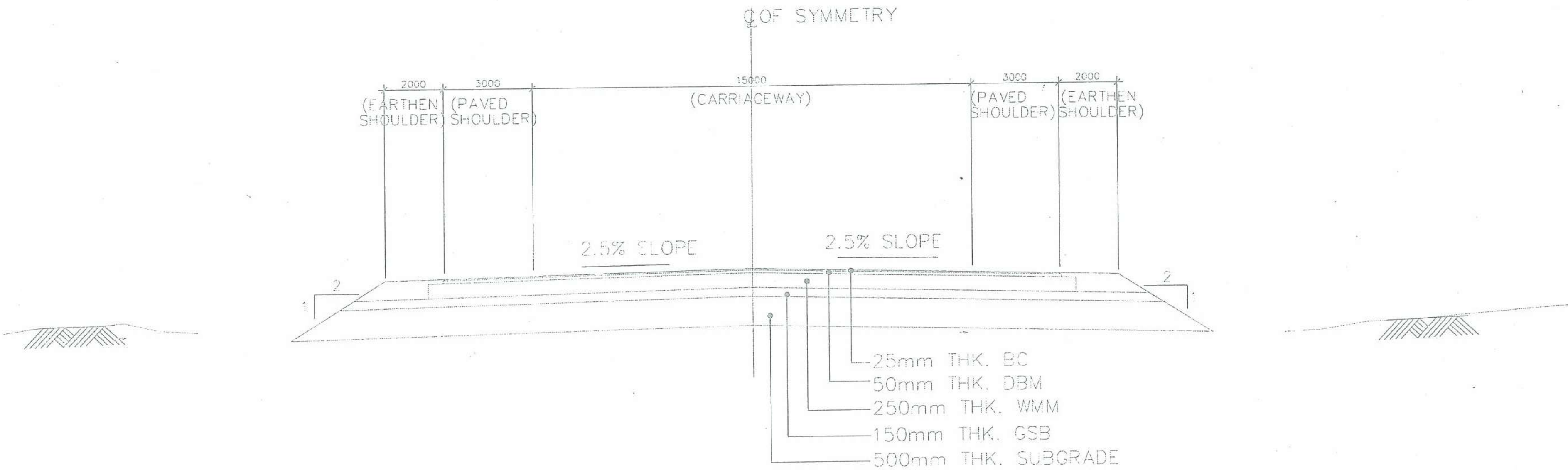
(SCALE 1:1500)



TYPICAL CROSS SECTION OF MAIN ACCESS ROAD

FOR PHASE–II (FOUR LANES)

(SCALE 1:1500)



TYPICAL CROSS SECTION OF TWO LANES ROAD

FOR LANDSIDE SERVICE ROAD

(SCALE 1:1500)

8.2.4. Airfield Lighting Conceptual Design

The 09-27 runway of the new Goa airport is intended for CAT I precision approaches (RVR >550 meters and <800 meters ; a minimum of 60 m for decision height) and takeoffs on both its QFUs. The lighting equipment for QFUs 09 and 27 is composed of the items described in the following paragraphs.

8.2.4.1. Regulations and standards

AGL system will be based on compliance with International Standards and Recommended Practices for Aerodromes, as described in Annex 14 to the Convention of International Civil Aviation, Fourth Edition 2004 published by the International Civil Aviation Organisation (ICAO).

Design and installation of the AGL system will refer, where applicable, to the ICAO Aerodrome Design Manual Part 4, Visual Aids and Part 5 Electrical Systems.

ICAO will be considered for operational rules and photometrical performance to be archived where as FAA standards will be taken in consideration for mechanical and structural strength.

General electrical installation, for High and Low Voltage distribution part will comply with the IEEE Wiring Regulations published by IEEE, London.

8.2.4.2. Environmental conditions

All equipment exposed to weather will be designed to withstand continuous, full capacity duty, in the specific conditions which prevail in the site of GOA.

Moreover, the elevated runway-edge lights, the approach lights to be installed less than 300 m from the threshold, the threshold lights and the runway-end lights shall withstand the blast of the most powerful jet aircraft existing to date.

All other inset lights shall withstand the rolling, parking and manoeuvring loads generated by aircraft and vehicles used at the airport.

Outdoor equipment will be designed with adequate protection against water and dust.

Elevated devices will be provided with holes for evacuation of condensation ; the size of these holes will not allow ingress of insects.

All equipment normally intended for indoor installation will be designed for continuous, full-capacity operation at 50°C ambient temperature.

8.2.4.3. Power supply

Normal supply has to be provided by a substation that will be located close to the Airport Power Station.

The affected power of 315 kVA in the power balance is suitable for the load represented by all of the airfield lighting equipment (not including Navaids , Radar and communication equipments).
A secondary power supply has to be foreseen.

In order to be able to comply with take-off in runway visual range conditions less than 800 m and according to the hazardous and precipitous terrain approaches, a maximum switch-over time of 1 s should be provided when switching to the secondary power supply. Proper no-break generator-sets and uninterruptible power suppliers are to be provided for this purpose and their rate should cover the entire 315 kVA load.
As most of the equipment is current driven (different brightness levels possible), continuous Current Regulators must be provided.
Their installation enables the connection of power and control electric supply in optimal conditions.

8.2.4.4. Airfield Lighting Control/Monitoring

The lighting installations are controlled and monitored by lighting control / monitoring, including:

- control and monitoring of the lighting functions in the control tower,
- switching of the stop bars,
- the supervision of the lighting equipment:
- circuit breakers for the Low Voltage lighting outgoing supplies,

A control & monitoring panel has to be installed for this purpose. Relevant information for lighting control is visualized on a touch screen in the Control Tower. A PLC system + optical fiber wiring system ensure the lighting system control and status check.

8.2.4.5. Landings 09

CAT I approach ramp

A CALVERT approach of 900 meters in length formed by Cross Bars, at intervals of 30 meters (122 white lights).. The lights positioned immediately from the extremity of the runway up to the 520 m displaced threshold will be of the inset type.

PAPI 09

A 3° PAPI or visual approach slope indicator is to be installed. This improves perception of the approach slope. Location of PAPI is related to location of Glide Path and altitude of aircraft upon threshold.

RTIL threshold identification flashing lights 09

The threshold is identified visually by 2 flashing lights (RTIL).

Threshold 09

The threshold is composed of green inset lights at maximum intervals of 3 meters.

Runway edge

The runway edge is indicated by white lights at intervals of 60 meters. These lights are elevated along normal sections of runway and inset level with the runway exits. The elevated lights are omni / bidirectional and the inset lights are bidirectional in order to create a passageway in line with the exits. Because of the 520 m displaced threshold the lights between the beginning of the runway and the displaced threshold shall be shown red in the approach.
A section of 600 meters at the remote end of the runway may show yellow.

Runway end 09

The runway end is indicated by 6 red inset lights

Wind direction indicator

A wind direction indicator cone made of cloth or very resistant synthetic material, has to be installed close to 09 threshold, and a lighting has to be provided for nightly use.

8.2.4.6. Take Offs 09

Takeoffs are possible on 09. Airfield Lighting Equipment for the QFU 09 on takeoff are as follows,

Runway edge
Runway end 09
Wind direction indicator

as described above.

8.2.4.7. Landings 27

CAT I approach ramp

A CALVERT approach of 900 meters in length formed by around elevated Cross Bars at intervals of 30 meters (122 white lights).

PAPI 27

A PAPI or visual approach slope indicator is to be installed. This improves perception of the approach slope nad is used for flights operated under VFR conditions.

RTIL threshold identification flashing lights 27

The threshold is identified visually by 2 flashing lights (RTIL).

Threshold 27

The threshold is composed of green inset lights at maximum intervals of 3 meters.

Runway edge

The runway edge is indicated by lights at intervals of 60 meters. These lights are elevated along norm sections of runway and inset level with the runway exits. The elevated lights are omni / bidirectional ar the inset lights are bidirectional in order to create a passageway in line with the exits.

Runway end 27

The runway end is indicated by about 6 red inset lights

Wind direction indicator

A wind direction indicator cone made of cloth or very resistant synthetic material, has to be installe close to 27 threshold, and a lighting has to be provided for nightly use.

8.2.4.8. Take Offs 27

Takeoffs are possible on 27. Airfield ighting equipment for the QFU 27 on takeoff are as follows,

Runway edge
Runway end 27
Wind direction indicator

as described above.

8.2.4.9. Taxiways

Edge lighting

The taxiways are equipped with blue elevated edge lighting in the following places:

- edges of straight sections of taxiway or with a curve radius of more than 50 meters, at intervals of no more than 60 meters.
- curves pans or pointes.
- inner edges of curved taxiways

Stop bars (runway protection)

Stop Bars should be installed at a distance of 90m from the runway centerline, consisting of a line of inset red lights at maximum intervals of 3 meters confirmed by pairs of elevated red lights set up on either side of the taxiway.

8.2.4.10. Installation features

Elevated lights (for approach lights and edge lights) will generally be installed on concrete blocks, with isolating transformers located inside nearby pits.

Inset lights will be installed on the runway and taxiways on FAA 16/12" or 8" shallow bases. This will allow a future resurfacing of the pavement without changing the cabling of the lights.

The installation of bases will include if necessary for low thickness areas, the stabilization on concrete piles needed to ensure stability of light fittings embedded in the asphalt concrete.

Transformers will be installed inside pits located on the side of the runway or of taxiways.

Cables along the runway and taxiways will be laid inducts buried in trenches. Crossings of the runway and taxiways will use ducts concrete bank of.

Secondary cables to the lights will be laid in ducts below the surface of the pavement. These ducts will be embedded in the pavement construction.

8.3. *Utilities and drainage conceptual design*

8.3.1. Water Supply

Water Sources

The water supply system of the greenfield airport is based on assumption that water of adequate quantity will be made available near to the project site at the treatment plant and storage location. It is also assumed that water resources by tapping of ground water will not be required as the case of ground water extraction is to be approved by ground water authority of government of India. So the proposed airport complex will be a supplied water scheme which will be submitted to MOEF & Goa Pollution Control Authority for environmental clearance.

Water Quantity

In order to assess the quantity of water likely to be required during the first phase of the airport which is expected to have handling capacity of 2,624,868 passengers an assessment has been made for demand from various facilities.

Sr. No	Description	Approx occupancy per day	Water Requirements per day(L)
1	Passengers	9000 (peak)	135,000
2	Visitors(same as above)	9000 (peak)	45,000
3	Staff	3000	135,000
4	Catering	3000 meals	150,000
5	Hotel with restaurant	200 beds	100,000
6	Housing	150 families	22,500
7	Other business areas		200,000
8	Irrigation & landscaping		200,000
		Total	987,500

Say 1000 cum per day

This requirement doesn't include the water requirement or storage for firefighting and/or fire training facility.

The nearest available source of perennial surface water is river Colvale. The nearest village on the bank of this river is Tandel village where an arrangement of Jackwells is in place. However, it is not proposed to tap the river at this source since it may interfere with existing supplies.

It would be more desirable to have a committed intake solely for the purpose of servicing the airport.

A possible spot at a distance of 3 kms. on the south east of airport site is available which will give an assured yield of 1000 cu.m. of raw water per day.

8.3.1.1. Water Quality

It is assumed that the water supply to the proposed airport location will not be of required quality so as to make it useful adequate level of treatment is envisaged. The nominal treatment required may be chemical dosing and coagulation with settlement, pressure sand filtration followed by chlorination; but specific requirements such as treatment for potable water, soft water has to be outlined for treatment plant design. Therefore a water treatment plant is proposed with a capacity of 1000cum in at least 10 hours duration i.e. 100cum per hour with the level of treatment to be adopted in line with the raw water quality & seasonal variations.

8.3.1.2. Storage & Treatment

A minimum of five days storage capacity is planned at the raw water receiving station which will include the subsequent fire storage capacity of the airport fire fighting facilities. Additionally two days storage capacity is envisaged for treated water storage requirements for potable water quality. A pump house with suitable capacity of pumping arrangements will be provided to lift the water to the elevated water reservoir. The elevated water reservoir will have a capacity of one day supply i.e. 1000 cum to be further distributed to various facilities.

8.3.1.3. Distribution

The treated water will be pumped mainly into the main header to lift upto approx 15m height at the elevated water reservoir. Also there will be raw water connection to other satellite storage & distribution areas such as terminals, fire fighting & fire training facilities, hotels, accommodation etc. Suitable hydro pneumatic system is proposed at those satellite locations to supply water to terminal points as per pressure requirements. All water supply systems will have adequate monitoring facilities & control measures to control any pressure variations & water hammer effects.

8.3.1.4. Irrigation

The entire airport complex will have landscaping & green areas with varieties as per local horticultural planning & practice. Because of the scale of the airport complex proper irrigation system must be provided to ensure adequate quantities of water for all green area during dry period of the year. It is envisaged that adequate quantity of water will be available from the waste water or sewage treatment plant with a quality standard to be easily used for irrigation purpose. Only proper storage facilities for treated water at suitable locations with pumping stations have to be provided for individual areas along with a complete piping network. The irrigation system proposed will be a combination of sprinkler system for lawns & small shrubs to a flexible pipe drip irrigation network to water the trees.

8.3.2. Fire fighting storage

The total airport land spans over 4 500m length and in such facilities the main objective is to achieve a response time of maximum two minutes for any aircraft related rescue & fire fighting services. Also it is proposed that the entire airport complex should be fully self sufficient for any emergency handling situation because of lack of any existing infrastructure facilities around. The prime task of the rescue & fire fighting facilities will be handling aircraft related emergencies. Other types of fires within airport complex may occur in human centric area such as terminals, air traffic control & offices, catering, hotels, housings etc where human safety is prime consideration. Also there will be areas such as workshops, cargo & storage areas where material protection is of prime objective along with human safety.

It is proposed to create a central rescue and fire fighting station to command the entire area within the complex. The centre will be manned continuously with automated monitoring system. In case of an emergency it will allow simultaneous notification to control tower, rescue & fire fighting team, airport management, and any other authorities as required by the airports emergency plan.

Considering the diverse requirements of air & landside safety multiple underground fire water reserves along with pumping stations are proposed. The static fire water reserves for the air side shall include adequate water storage and foam storage facilities to replenish the fire fighting vehicles in case of emergency. It is also proposed to provide hydrant network for supplemental safety of the airside fire fighting arrangements. For land side areas adequate static water reserves are envisaged for both hydrant & sprinkler system for main facilities along with other fire fighting systems. Pumping stations provided with each static fire water reservoir shall comprise irrespective of location required electrically driven hydrant pumps and diesel engine driven pumps. A residual pressure head of 3.5kg/sqcm has to be maintained on all air & landside locations.

8.3.3. Storm Drainage

8.3.3.1. The site

The site is located on flat plateaus of an altitude of 150 to 170m above mean sea level. The natural ground has a fall on south & north direction which will help to remove storm water independently from both parallel sides of the runway.

8.3.3.2. Storm water drainage

It is envisaged that storm water will be collected parallelly i.e. along north & along south side of the main runway separately by natural slopes so as to avoid any below runway cross drainage. On northern part half of the runway & general surface storm water collection will be taken to northwest end for main outfall and storm disposal facility. On southern part other half of the runway & taxiways along with other area drainage will be taken to southwest direction of the airport layout to form the outfall drainage to appropriate rainwater harvesting system

8.3.3.3. Runoff estimation

The storm drainage will be calculated as per rational formula of : Q=CiA; where Q=runoff in cum/sec, C=runoff coefficient, i= intensity of rainfall in mm/hr, A=catchment area in Ha.

Runoff coefficient 'C' is dependent on catchment condition and are taken as below

Runway, Taxiway, Apron=0.90, Buildings=0.85, General macadam etc=0.60, General ground=0.30

The coefficients given above are generally for initial spell of rainfall but looking at the overall rainfall pattern of the area it is envisaged that during peak period an overall runoff coefficient of 0.80 can be accepted to estimate peak discharge.