11.2 Master Plan of Jomsom Airport

11.2.1 Development Works

Development works to be carried out are as follows:

- Runway extension
- Grading the runway strip
- Protection works for river erosion
- Paving the runway

The development plan of Jomsom airport is shown in Fig. 11.2.1.

11.2.2 Physical Characteristics

(1) Runway Extension Length

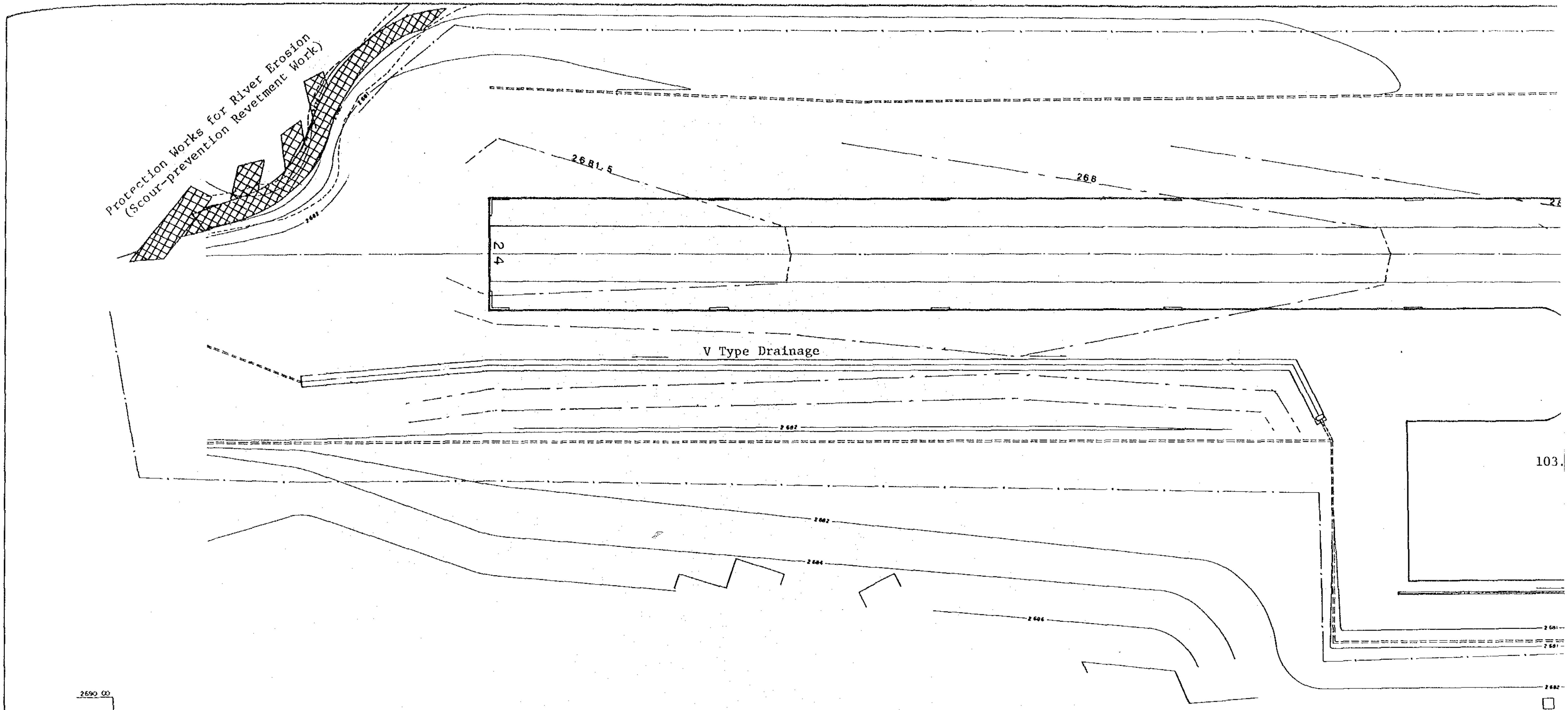
Since insufficient runway length is a major issue concerning safe aircraft operations, the extension should be a high priority. Under the following conditions, the runway will be extended by 110 m. However, it should be understood that the 110 m is only the "minimum necessary length" because it does not suffice for ASD (Accelerate Stop Distance).

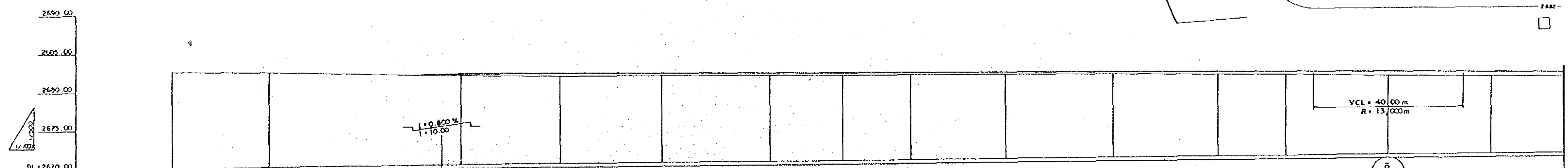
Assumptions:

Aircraft : DHC-6
Runway slope : 0%
Runway surface : Paved condition
Maximum performance STOL take-off to 50 ft.
Temperature : ISA + 20°C
Maximum all up weight : 12,500 lbs.
Altitude : 8,800 ft. (2,682 m)
Existing length : 610 m

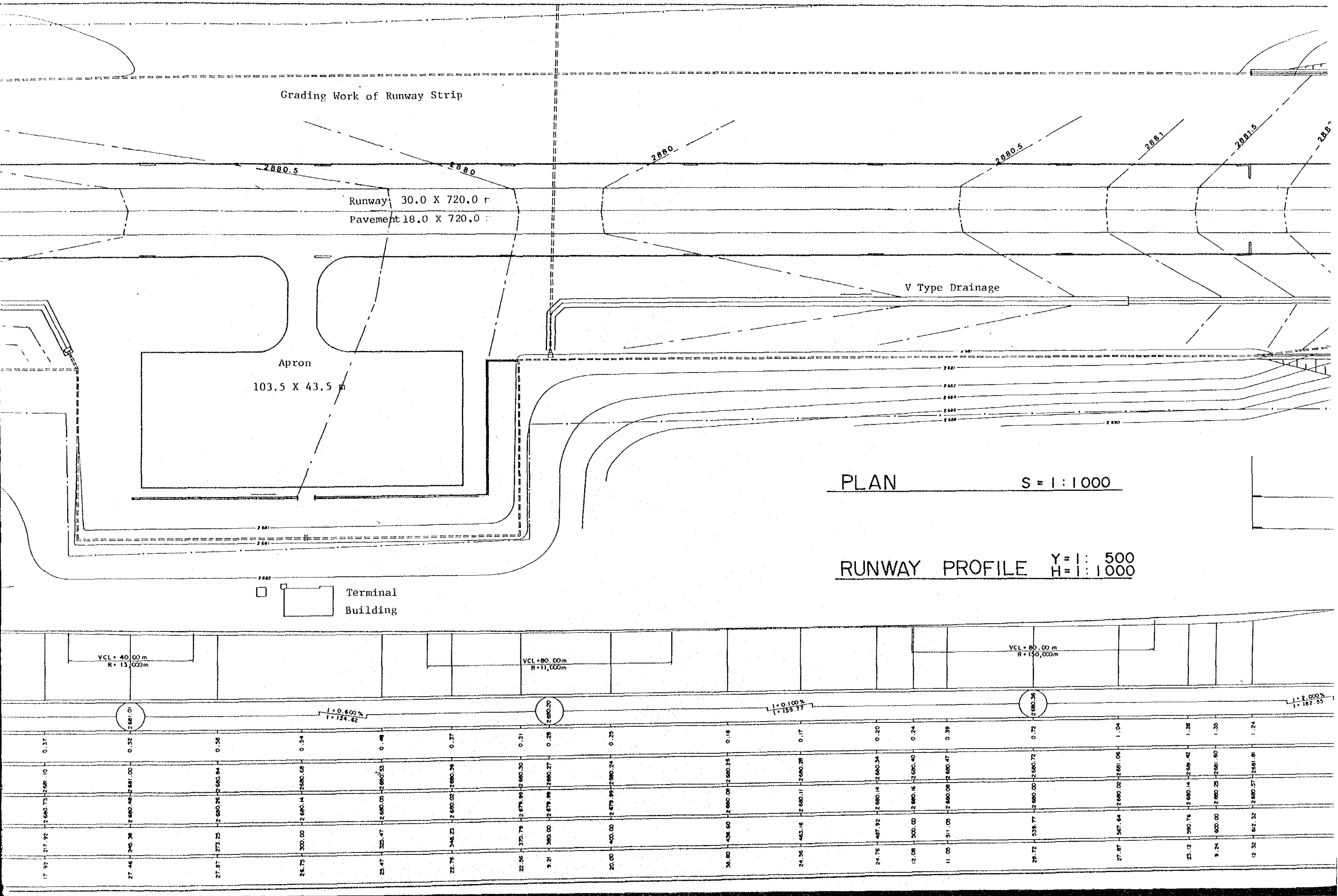
(2) Physical Characteristics

This runway is topographically favored, but the operational condition of approaching aircraft is severe, and existing runway is set under regulation of Stolport Manual. Therefore, this regulation is followed.





GRADIENT			2681.67	2681.75										2681.01	
CUT & BANK				0.24	0.31	0.32	0.32	0.38	0.33	0.24	0.31	0.31	0.37	0.52	0.56
PROPOSED HEIGHT			2681.67	2681.75	2681.67	2681.59	2681.51	2681.45	2681.40	2681.32	2681.23	2681.15	2681.10	2681.00	2680.84
GROUND HEIGHT	2682.52	2682.32	2681.67	2681.54	2681.36	2681.27	2681.19	2681.07	2681.07	2681.08	2680.92	2680.84	2680.73	2680.48	2680.26
ACCUMULATED DISTANCE	-75.00	-50.00	-10.00	0.00	25.60	52.49	81.08	100.00	117.87	143.22	171.92	200.00	217.92	245.38	273.25
DISTANCE	-25.00	-40.00	-10.00	0.00	25.60	26.89	28.59	18.92	17.87	25.35	28.70	28.08	17.92	27.46	27.87


Grading Work of Runway Strip
Runway 30.0 X 720.0 m
Pavement 18.0 X 720.0
Apron
103.5 X 43.5 m
V Type Drainage
Terminal Building
PLAN S = 1 : 1000
RUNWAY PROFILE Y = 1 : 500 H = 1 : 1000
VCL = 40.00 m R = 13,000 m
VCL = 80.00 m R = 11,000 m
VCL = 80.00 m R = 150,000 m

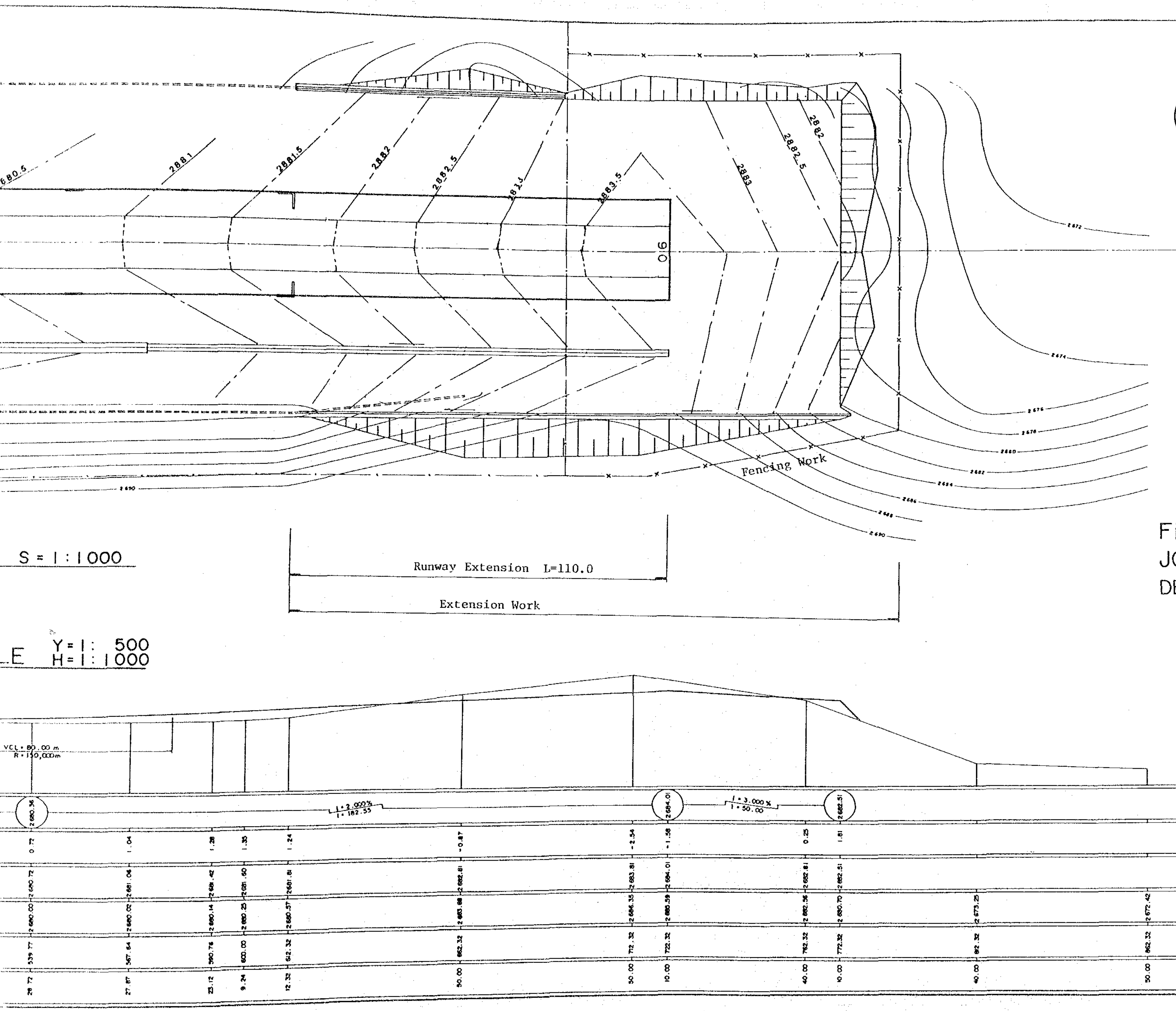


Fig.11.2.1
JOMSOM AIRPORT
DEVELOPMENT PLAN

The physical characteristics of basic facilities are as shown in Table 11.2.1.

Table 11.2.1 Physical Characteristics of Basic Facilities

Runway			Runway Strip		Taxiway		Apron	
L	W	S	L	W	L	W	L	W
720 (610+110)	30	2	820 (720+100)	90	31	10.5	43.5	103.5 (3 spot)

Note:
L=Lengh (m)
W=Width (m)
S=Longitudinal slope (%)

11.2.3 Runway Extension Work

The runway is to be extended 110 m to the south west. At the same time, the high ground at south west part of the existing runway will be removed because it is an obstruction to aircraft approaching from the south west. The longitudinal slope will be improved from 5.78% to 2.0%, which is stipulated in Stolport Manual.

The excavation volume is estimated to be 20,000 cubic meters including approximately 15,000 cubic meters of blasted rock.

11.2.4 Grading Work of The Runway Strip

As the existing runway strip is transversely flat, it is easily eroded by running water or softened by standing water. In this plan, the cross section of the runway strip will be improved as in Fig. 11.2.2.

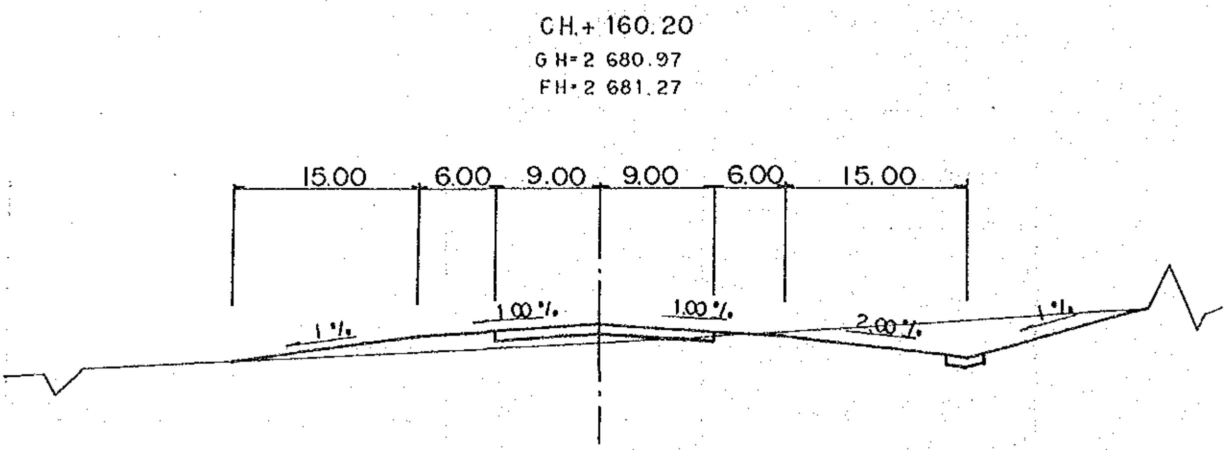


Fig. 11.2.2 Cross Section of Runway Strip

11.2.5 Paving Work for the Runway

(1) Kind of Pavement

Pavement can be generally classified as "Cement Concrete Pavement", "Asphalt Concrete Pavement", "Asphalt Penetration Pavement" and "Cement Stabilized Pavement." Cement concrete pavement is costly. The asphalt penetration pavement and the cement stabilized pavement are finished by means of a seal coat which is easily weakened by rainwater. For that reason, they need frequent maintenance to prevent damage.

Therefore, the introduction of asphalt concrete pavement is recommened for airports in remote areas where maintenance is difficult.

(2) Thickness of Pavement

The thickness and structure of pavement is as shown in Fig. 11.2.3, assuming the following.

Design aircraft: DHC-6
CBR value of subgrade: More than 6%

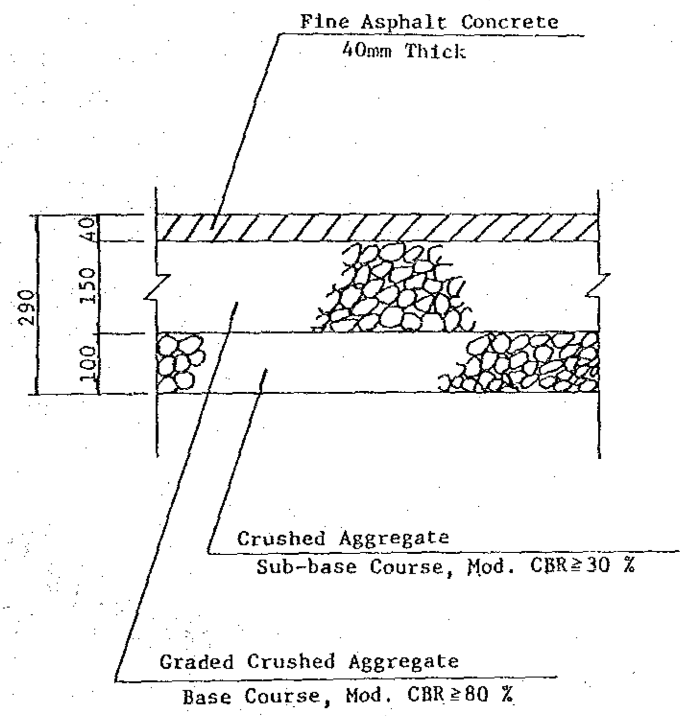


Fig. 11.2.3 Asphalt Pavement Structure

(3) Width of Pavement

The width of pavement is recommended to be 18 m taking into consideration the deviation of where aircraft generally land on the pavement of the runway and erosion from both side by storm water.

(4) The Future Theme for Enforcement

According to available information, it is assumed that the frost heaving on pavement would not be found, however, the conditions should be confirmed by means of excavation of pits on cold days to make sure.

11.2.6 Protection Works for River Erosion

As the north east part of runway strip is being eroded away by the river. Protection works for river erosion are urgently required. Wire cylinders shall be diagonally placed in order to alter the flow of the river and two parallel rows of wire cylinders will be placed so as to prevent the bank from caving as Fig.11.2.4. The revetment work shall be sufficiently back-filled.

Moreover, the monitoring and maintenance work for revetment shall be frequently carried out during the monsoon season. If the method is not effective, cement concrete revetment would be considered at the time.

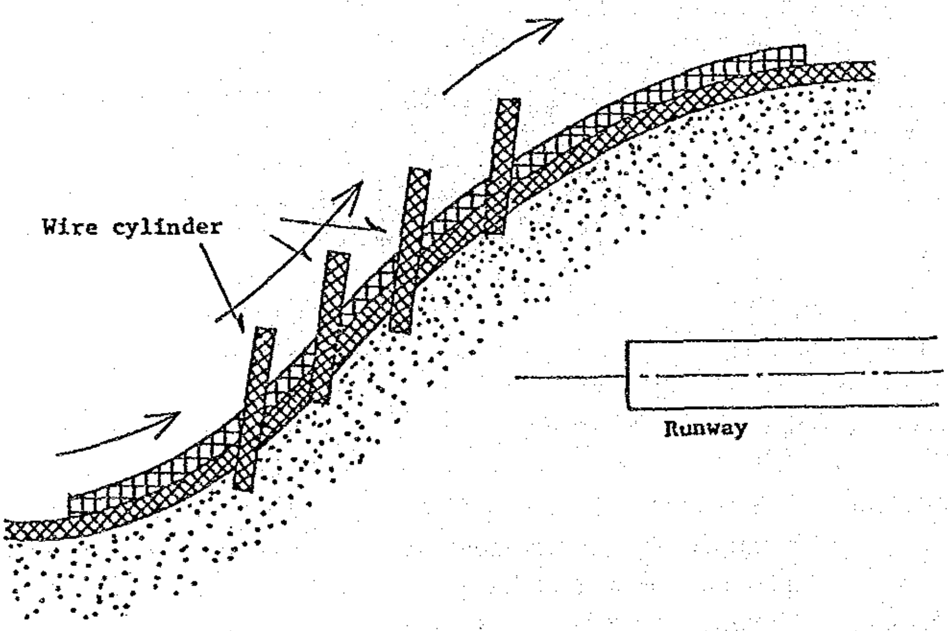


Fig. 11.2.4 Concept of Protection Works for River Erosion

11.3 Master Plan of Simikot Airport

11.3.1 Development Works

Development works to be carried out are as follows:

- Runway extension
- Grading the runway strip
- Paving the runway

The development plan of Simikot airport is shown in Fig. 11.3.1.

11.3.2 Physical Characteristics

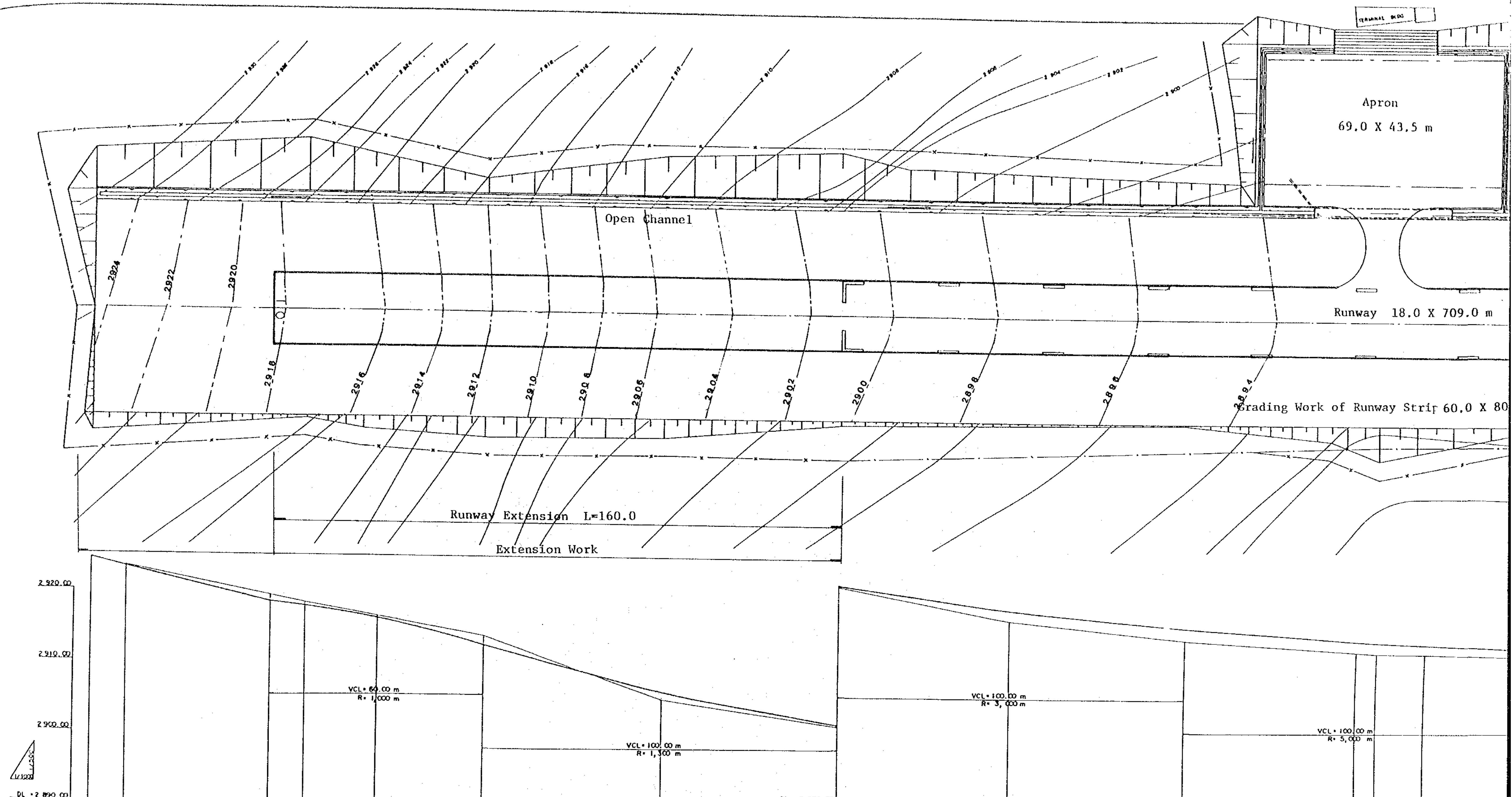
(1) Runway Extension Length

Runway extension length is calculated 160 m based on the following assumptions:

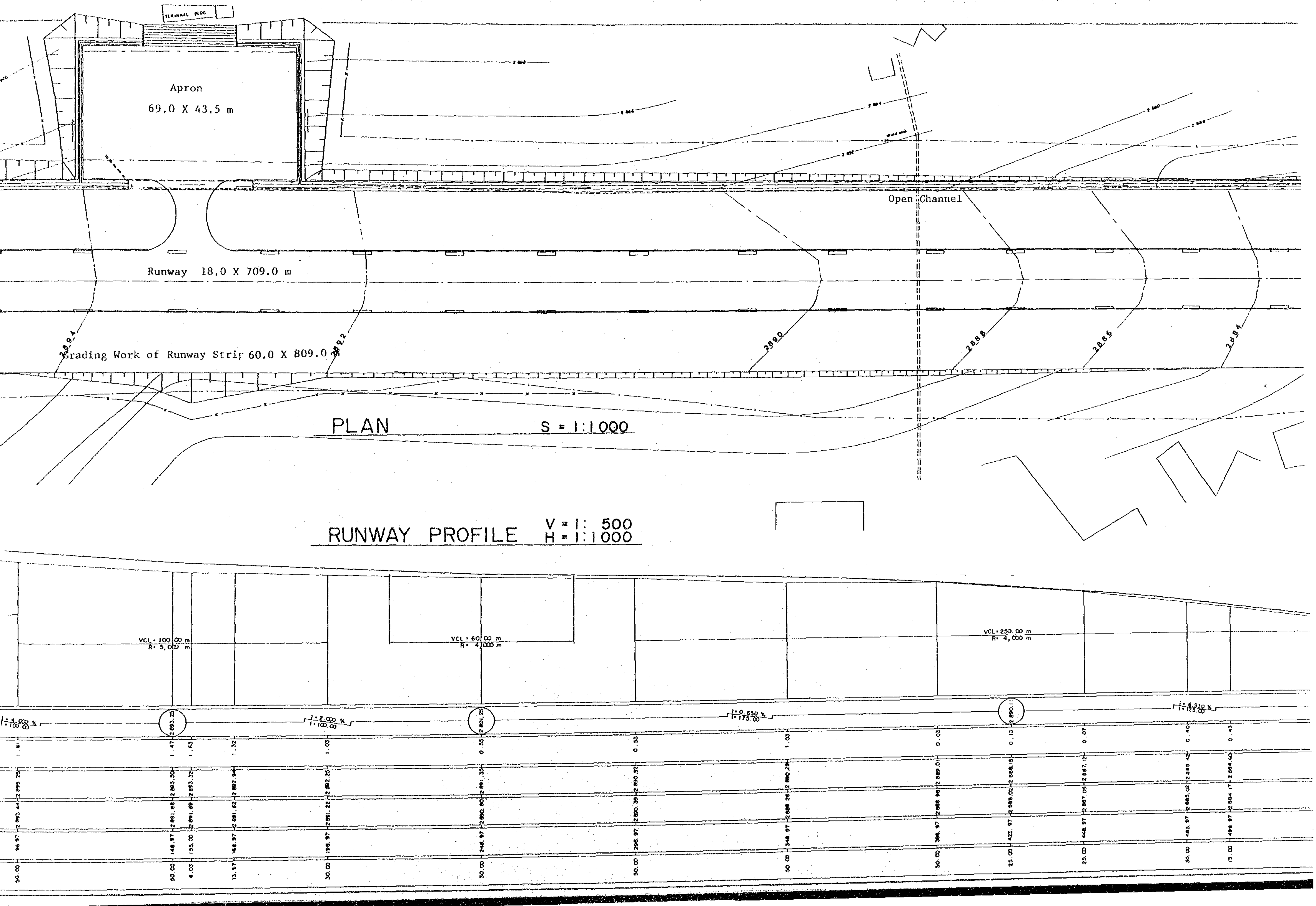
Aircraft:	DHC-6
Runway slope:	2%
Runway surface:	Grass
Maximum performance STOL take-off to 50 ft.	
Temperature:	ISA + 20°C
Maximum all up weight:	12,500 lbs.
Altitude:	9,246 ft. (2,818 m)
Existing length:	549 m

(2) Physical Characteristics

Altiport Recommendations are basically adopted as a minimum design criteria of physical characteristics. Therefore, the runway longitudinal slope should be less than 15% and the runway width remains at 18 m as present. But the runway strip is kept 60 m referring to Annex 14, code 1B-CTOL. (According to Altiport Recommendations, it is 50 m.) Physical characteristics of basic facilities are as shown in Table 11.3.1.



GRADIENT	2 924.26	12.000 % / 30.00	2 918.25	5.000 % / 30.00	2 916.75	15.000 % / 80.00	2 904.75	7.500 % / 100.00	2 897.25	4.000 % / 100.00	2 893.25		
CUT & BANK	0	0.33	1.00	0.54	0.34	1.29	1.18	0.20	1.53	1.81	1.47	1.63	1.32
PROPOSED HEIGHT	2 924.26	2 923.06	2 918.25	2 917.67	2 916.00	2 912.25	2 905.69	2 901.00	2 897.69	2 895.25	2 893.30	2 893.32	2 892.94
GROUND HEIGHT	2 924.26	2 923.39	2 919.25	2 918.21	2 916.34	2 913.54	2 904.51	2 900.80	2 896.16	2 893.44	2 891.88	2 891.69	2 891.62
ACCUMULATED DISTANCE	210.00	200.00	160.00	150.00	130.00	100.00	50.00	0.00	48.97	98.97	148.97	155.00	168.97
DISTANCE	10.00	40.00	10.00	20.00	30.00	50.00	50.00	0.00	48.97	50.00	50.00	6.03	13.97



Apron
69.0 X 43.5 m
Runway 18.0 X 709.0 m
Grading Work of Runway Strip 60.0 X 809.0 m
Open Channel
2894
2892
2890
2888
2886
2884
PLAN S = 1:1000
RUNWAY PROFILE V = 1: 500 H = 1:1000
VCL = 100.00 m R = 5,000 m
VCL = 60.00 m R = 4,000 m
VCL = 250.00 m R = 4,000 m

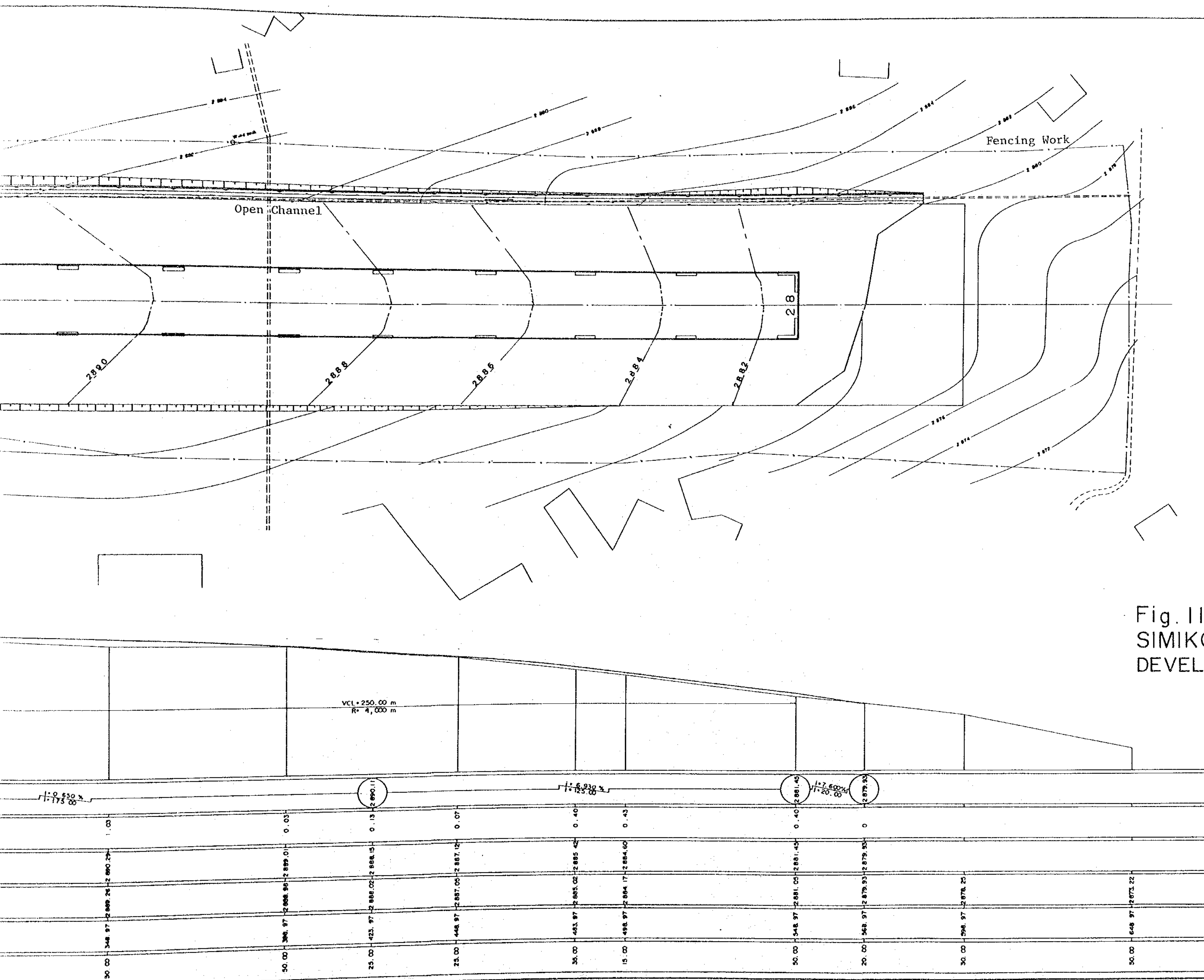


Fig. 11.3.1
SIMIKOT AIRPORT
DEVELOPMENT PLAN

Table 11.3.1 Physical Characteristics of Basic Facilities

Runway			Runway Strip		Taxiway		Apron	
L	W	S	L	W	L	W	L	W
709 (549+160)	18	15	809	60	23	10.5	43.5	69 (2 spot)

Note:
L=Lengh (m)
W=Width (m)
S=Longitudinal slope (%)

11.3.3 Runway Extension Work

The runway is to be extended 160 m to the north east. The longitudinal slope is established at 15% in consideration of existing topographical features. The excavation volume is estimated to be approximately 30,000 cubic meters.

11.3.4 Grading Work of Runway Strip

Similar to the Jomsom Airport, existing transverse slope of the runway strip is almost level and a suitable slope for effective drainage should be set. Improvement of cross section of the runway strip is planned as in Fig. 11.3.2.

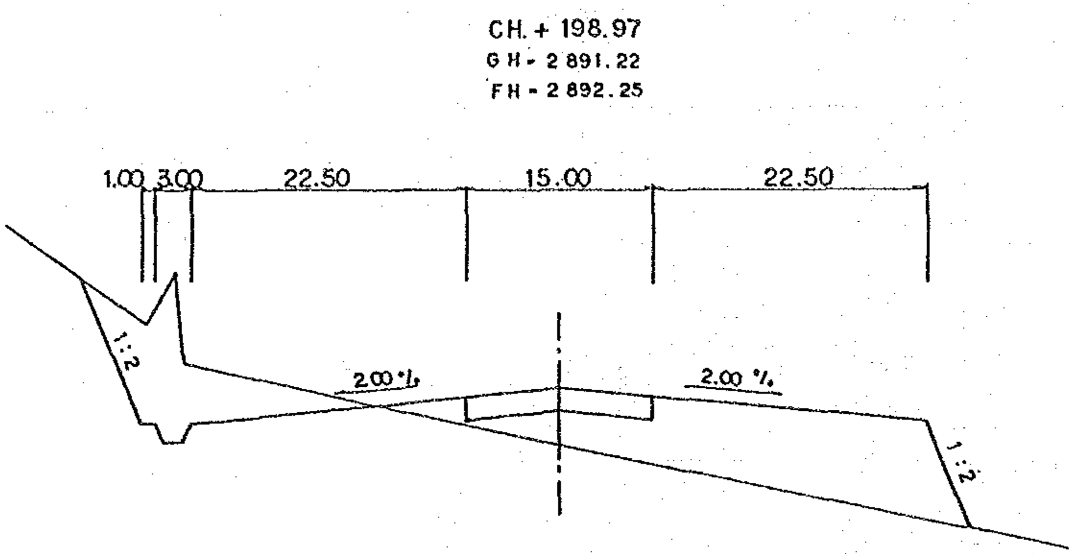


Fig. 11.3.2 Cross Section of Runway Strip

11.3.5 Paving Work of the Runway

It is assumed that frost heaving occurs at the airport, considering meteorological conditions such as low temperatures and snowfall during the winter. Asphalt pavement would not be appropriate for this airport in view of the work scale.

Aggregate-turf pavement, recommended by FAA AC 150/5370 item P-217, is considered to be suitable for Simikot Airport. An aggregate turf pavement is explained as follows by FAA:

Aggregate-turf runways differ from the usual turf runway in that the stability of the soil has been increased by the addition of granular materials prior to establishment of the turf. The objective of this type of construction is to provide a landing area that will not soften appreciably during wet weather and yet will retain sufficient soil to promote the growing of turf. Such a runway is designed to serve aircraft having a gross weight not exceeding 12,500 pounds (5,700 kg), although under certain conditions aircraft considerably in excess of this loading might be accommodated.

The pavement structure is as Fig. 11.3.3.

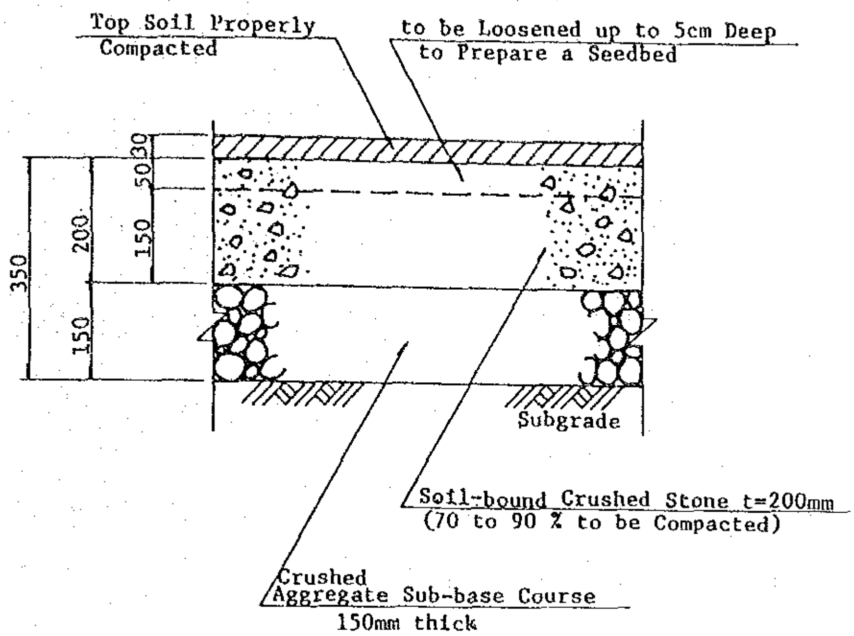


Fig. 11.3.3 Pavement Structure of Aggregate-Turf

11.3.6 Future Theme for Enforcement

Because paving method of aggregate-turf has not been so much experienced, following investigation should be carried out:

(1) Soil investigation (including underground water test)
(2) Selection of turf
(3) Research of underground frost condition
(4) Construction test
(5) Fertilization and management test

11.4 Master Plan of Lukla Airport

11.4.1 Development Works

Development works to be carried out in Lukla Airport are as follows;

- Grading of the runway strip
- Paving of the runway
- Construction of apron
- Installation of storm water drainage facilities

The development plan of Lukla Airport is shown in Fig. 11.4.1.

11.4.2 Physical Characteristics

This airport has the steepest slope runway (average slope: 11.7%, maximum slope in part: 25.1%) of the airports in Nepal and this runway cannot be extended to both end due to topographical conditions.

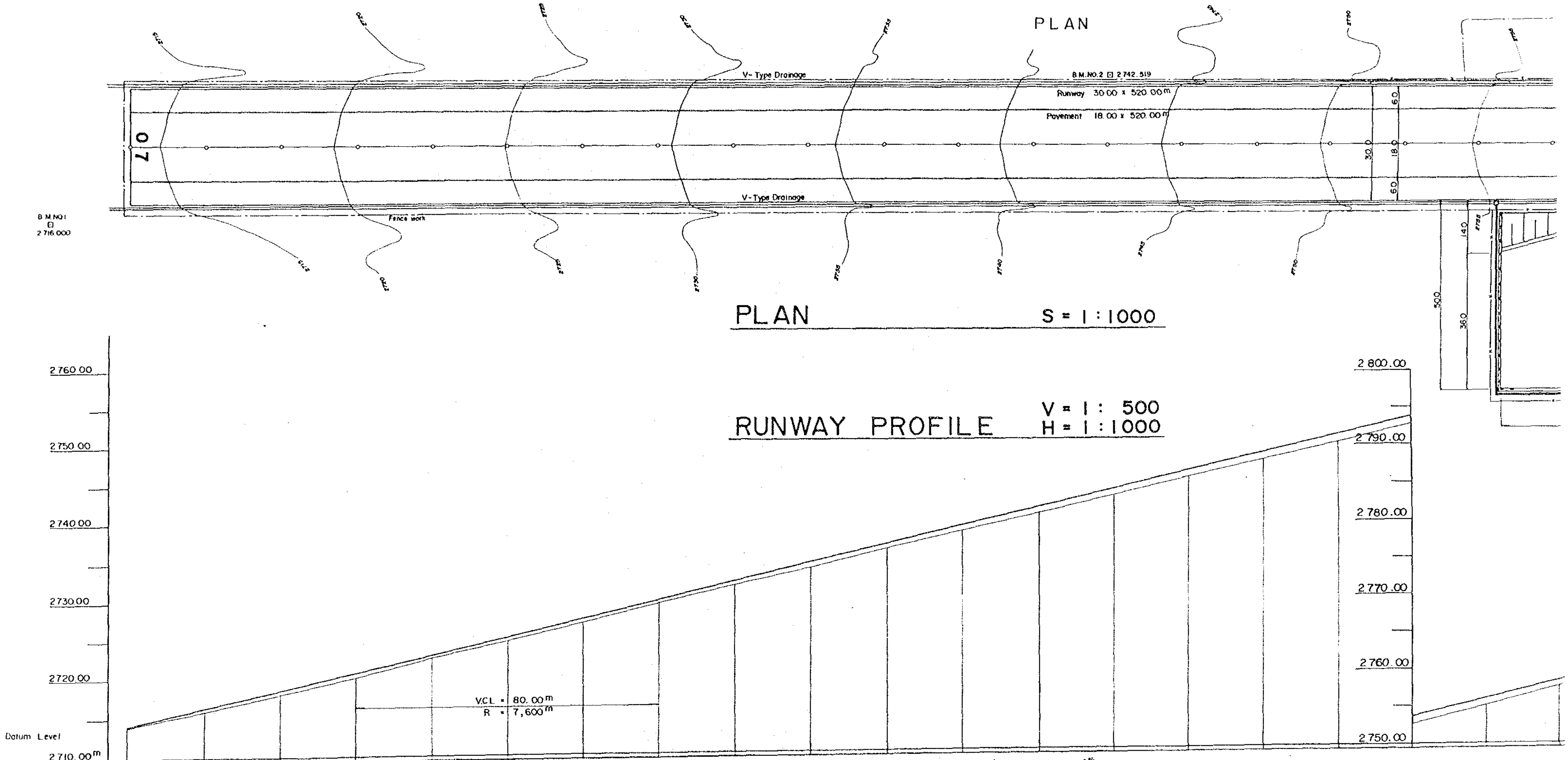
The physical characteristics of existing basic facilities are as shown in Table 11.4.1.

Table 11.4.1 Physical Characteristics of Basic Facilities

Runway			Runway Strip		Taxiway		Apron	
L	W	S	L	W	L	W	L	W
488	30 (18)	11.7 (15)	540	30 (50)	-	-	65	50

Note:
L=Lengh (m)
W=Width (m)
S=Longitudinal slope (%)
( )=According to Altiport Recommendations

As seen in this table, width of the runway and the runway strip are irregulary both 30 m.



	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180
GRADIENT	2714.150		$i = 10.850\%$ $L = 100.000^m$			2725.000				
CUT & BANK	+0.209	+0.575	+0.460	+0.399	+0.332	+0.284	+0.314	+0.356	+0.408	+0.561
PROPOSED HEIGHT	2714.150	2716.320	2718.490	2720.660	2722.856	2725.105	2727.406	2729.760	2732.140	2734.520
GROUND HEIGHT	2713.941	2715.745	2718.030	2720.261	2722.524	2724.821	2727.092	2729.404	2731.732	2733.959
ACCUMULATED DISTANCE	0	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00
STATION	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180

	0+200	0+220	0+240	0+260	0+280	0+300	0+320	0+340	0+360	0+380
GRADIENT			$i = 11.900\%$ $L = 300.00^m$							
CUT & BANK	+0.570	+0.682	+0.846	+0.840	+1.024	+1.110	+1.179	+1.174	+1.141	+0.941
PROPOSED HEIGHT	2736.900	2739.280	2741.660	2744.040	2746.420	2748.800	2751.180	2753.560	2755.940	2758.320
GROUND HEIGHT	2736.330	2738.598	2740.814	2743.200	2745.396	2747.690	2750.001	2752.386	2754.799	2757.379
ACCUMULATED DISTANCE	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	380.00
STATION	0+200	0+220	0+240	0+260	0+280	0+300	0+320	0+340	0+360	0+380

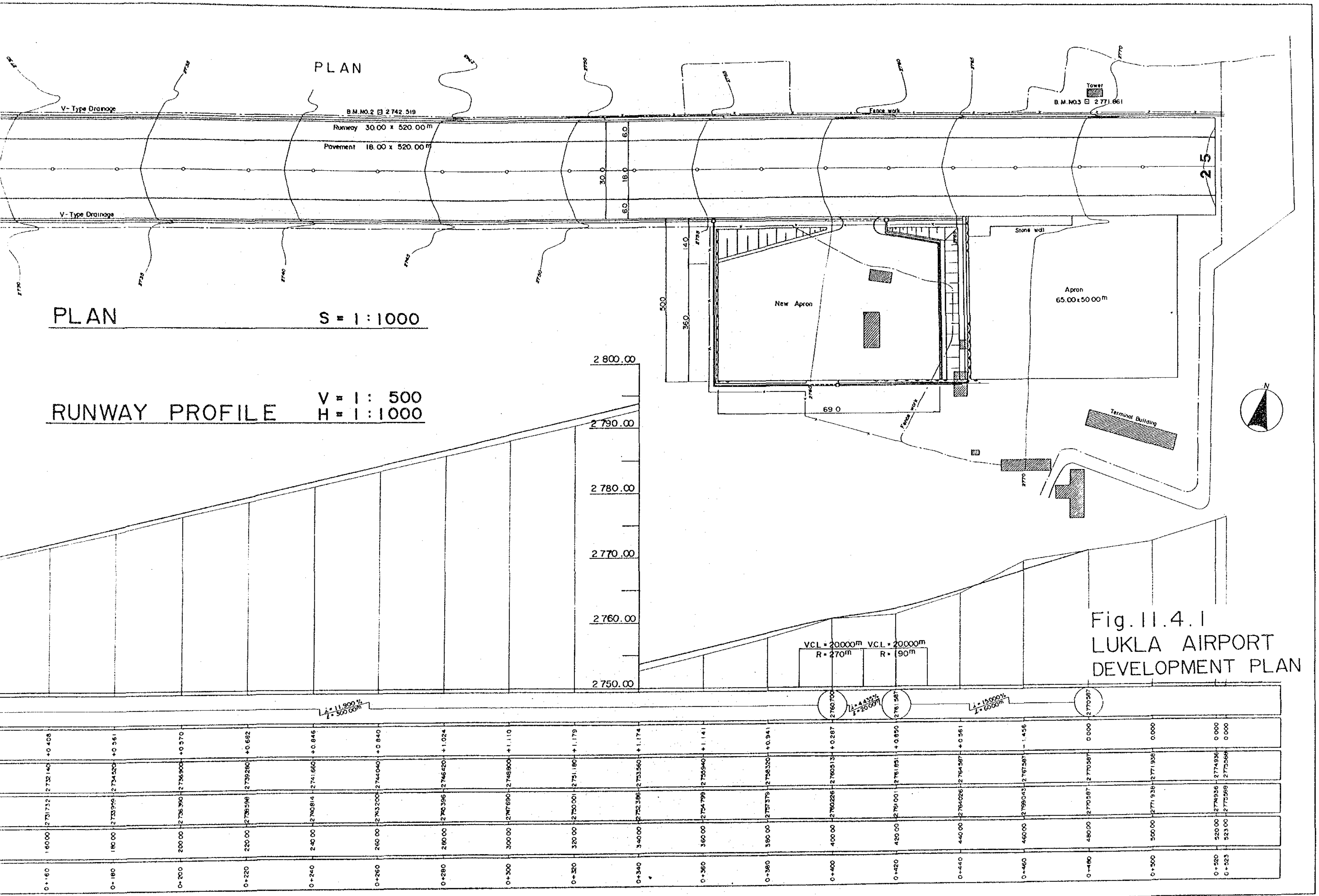


Fig. 11.4.1
LUKLA AIRPORT
DEVELOPMENT PLAN

This means that the Altiport Recommendations, which is minimum criteria, cannot be satisfied. In this study application of Altiport Recommendations is recommended as much as possible.

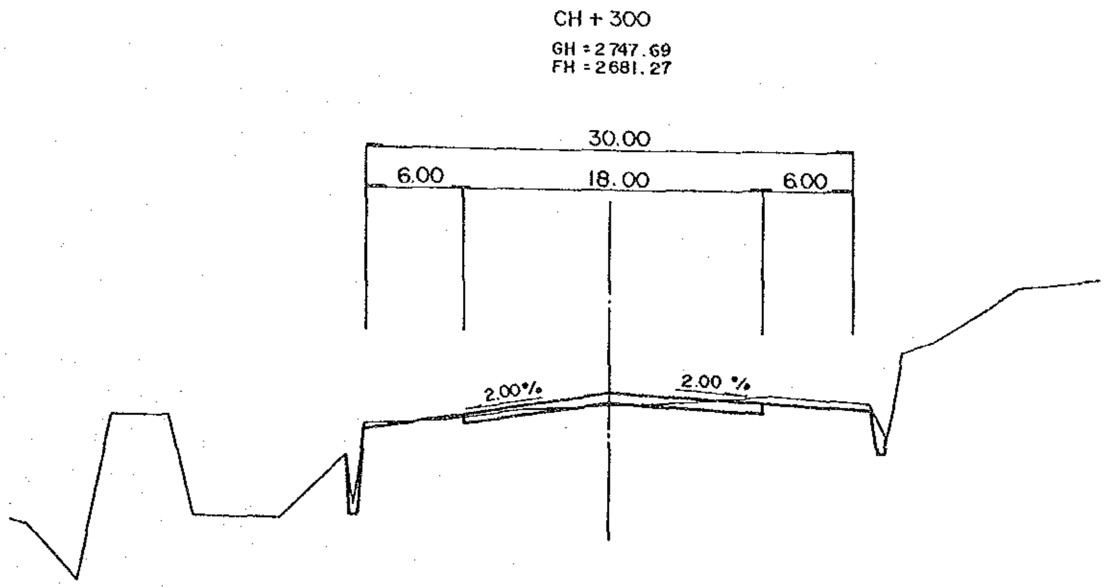


Fig. 11.4.2 Cross Section of Runway Strip

11.4.3 Grading of the Runway Strip

As maximum slope (25.1%) of the existing runway strip is over that of the Altiport Recommendations (15%) and is easy to be eroded, maximum longitudinal slope are planned to improve to 15.0% within a economical range. Besides transverse slope of the runway strip is very flat at present, grading for effective drainage is required. Improvement of the cross section of the runway strip is planned as in Fig. 11.4.2.

The excavation and embankment volume is estimated to be 6,000 cubic meters of gravel, and may include hard rock.

11.4.4 Paving Work for the Runway

(1) Kind of Pavement

Asphalt concrete pavement is recommended for Lukla Airport as described in Chapter 11.2.5.

(2) Thickness of Pavement

The thickness and structure of the pavement are as shown in Fig. 11.4.3, assuming the following:

Design aircraft : DHC-6
CBR value of subgrade: 5%
Judging from the soil investigation CBR value of subgrade is 5% as shown in Appendix Table 11.4.4.

In designing the thickness of the subbase, freezing of pavement was taken into consideration because the heaving action of the existing runway during winter had been monitored at the site. In this study, a design thickness of 50 cm of crushed aggregate was used as the subbase thickness, however, due to the lack of sufficient information at this time, further studies should confirm the exact thickness prior to detailed design.

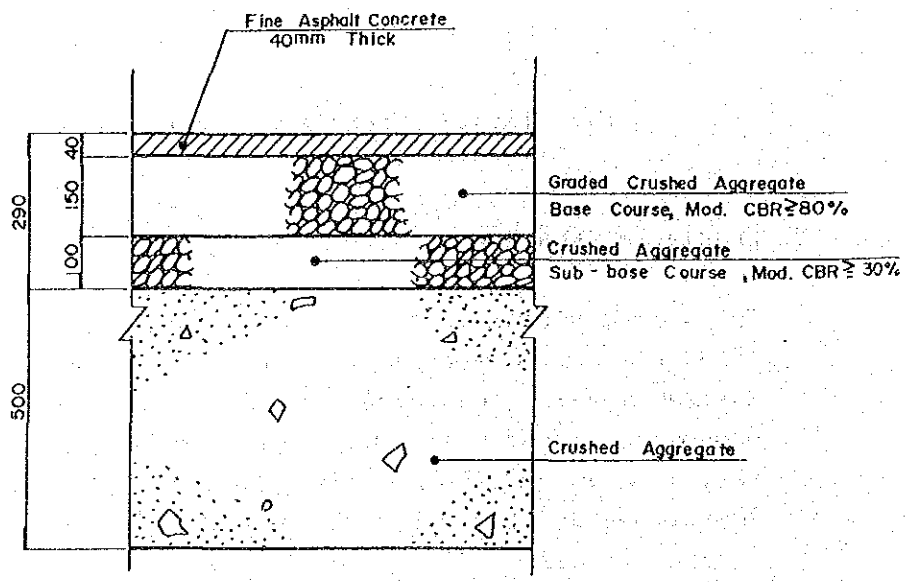


Fig. 11.4.3 Asphalt Pavement Structure

(3) Width of Pavement

The width of pavement is recommended to be 18 m taking into consideration the deviation of landing aircraft and erosion from both edge by storm water. This 18 m is equal to the width in the Altiport Recommendations.

(4) The Future Theme for Enforcement

Although the frost heaving has been reported at the site, there is no data on it so far. Depth of frost penetration should be observed prior to enforcement of the project.

11.4.5 Construction of Apron

(1) Dimension and Site

Dimension of the apron was planned to be 69 m long and 36 m deep for two spots of DHC-6 parking simultaneously at the western part of existing apron.

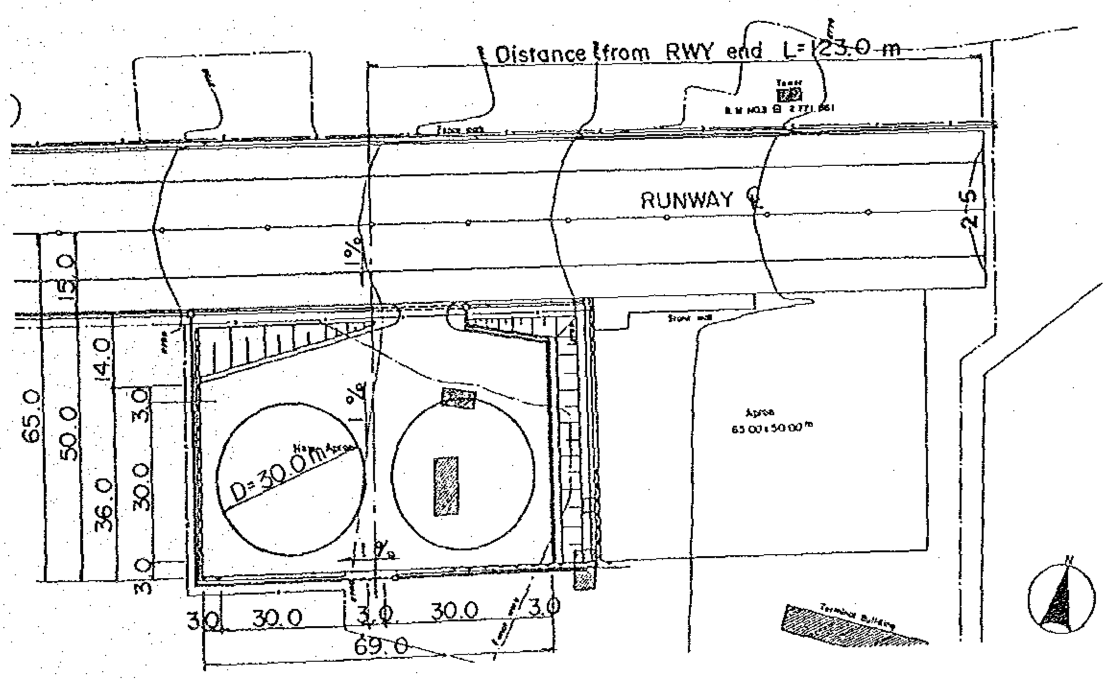


Fig. 11.4.4 Plan of New Apron

(2) Earth Work

Gradient of apron surface is planned 1% in both direction as shown in Fig. 11.4.4. North edge of apron is embanked with slope (2:1) so as to meet with transitional surface. Other sides are heaped up with stone wall to reduce land acquisition.

(3) Drainage

Drainage should be provided to take away the surface water of apron and sorrounding area. Drains are planned as lined canal with stone lining ditch along with apron edge.

11.4.6 Installation of Storm Water Drainage System

Existing runway has so steep gradient that it is easy to be eroded by storm water. Following facilities should be installed:

a) "Deep drain" with enough capacity to protect the erosion by jumping water

b) "Water energy dissipator" to reduce high energy of rapid water

c) "Water drop" as same as above

11.5 Review of Feasibility Study of Syangboche Airort

"Technical and Economical Feasibility Study of Syangboche Airport(final report, December 1986)" was reviewed as follows:

11.5.1 Design Criteria

As compared with three criteria of

(1) Annex 14-Aerodrome Ref. Code "1B"-CTOL,
(2) Utility/Stolport (FAA & ICAO-STOL) and
(3) Altiport Recommendations (Design Acft. - Twin Otter),

the criteria from Altiport Recommendations were adopted in the study. Taking into account the kinds of aircraft served in this airport, the topographical circumstances around the airport, etc., the adoption of Altiport Recommendations can be judged reasonable.

11.5.2 Runway and Runway Strip

(1) Length

The altitude of the runway is about 3,750 m. Due to this extremely high altitude the graph for determination of runway length shown in the operation manual is not usable.

Therefore, a 550 m runway, which is longer than that recommended in the final report, is proposed for the purpose of review. The strip length is recommended to be 650 m (50+550+50) to increase safety during taking-off, though 610 m (30+550+30) would meet the requirement.

(2) Orientation

Two alternatives were reviewed.

Alternative-I is inclined 13 degrees east from the orientation of the existing runway. Alternative-II is inclined 5 degrees east.

Alternative-II is considered the best based on the following reasons:

a) The center line of Alternative-II is proposed to ease or lessen the angle of turn from the flight path along the valley in comparison to the existing runway/strip center line.

b) This Alternative-II can minimize the necessary amount of earth work (excavation/embankment) for the construction of the 550 m long runway.

c) Alternative-II can lessen the amount of earth work necessary for the construction of the runway strip having 50 m in width as compared to Alternative-I.

d) The runway longitudinal slope of ALT-II is gentler and the condition of the slope change is ideal for taking-off/landing operations.

(3) Width of Runway Strip

With regard to the width of runway strip, three alternatives of 30 m, 40 m and 50 m were studied in the report. According to the said three criteria, the requirement of runway strip width is as indicated in Table 11.5.1.

Table 11.5.1 Criterion of Width of Runway Strip

ICAO Annex 14	Utility/ Stolport	Altiport Recommendations
60 m	90 m	50 m

Irrespective of earth work quantities or criteria, the minimum width of 50 m is required for safer aircraft operation. Particularly at this airport, where the direction of the runway and wind is planned to be different by about 37 degrees (runway alignment - 37 degrees west to north, wind direction - south to north), and the influence of lateral wind is expected to be strong.

(4) Runway Longitudinal Slope

Although the allowable slope of ALT-II according to requirements is 15%, a maximum 10.5% of slope is proposed at the north end of the runway. This point lies on a slope-changing spot of 25.5% and the slope is locally considered around 18% exceeding the above requirement. This point, however, is situated near the beginning zone of take-off and therefore, it will not come into question.

(5) Vertical Curve

Vertical curves are planned to be set at all slope-changing points in the longitudinal slope of ALT-II so that aircraft may run smoothly with less impact.

(6) Slope-Change

The maximum amount of slope change is 16.5% (17.5-1.0) which exceeds the 15.0% requirement. The above 16.5%, however, is not regarded as the amount of slope-change, because the central point of the vertical curve is located just at the runway end (0+600) and consequently is not important.

(7) Distance between Slope-changing Points

The minimum distance between slope-changing points is planned as 150 m for the amount of slope-change of 5.5%. Though no requirement for this item is indicated in Altiport Recommendations, the distance of 475 m [D=50x((10.5-5.0)+(5.0-1.0))] is required according to ICAO Annex 14.

The proposed 150 m does not meet the requirement. But it is excusable because this area in question lies at the beginning point of take-off where the speed of an aircraft is low.

(8) Transverse Slope

In the final report, a 1.0% transverse slope of the runway and strip is proposed. To ensure immediate and smooth drainage of rainwater, the transverse slope of 1.5% to 2.0% is recommended in lieu of the 1.0%.

11.5.3 Drainage

According to the final report, the intensity of rainfall is 130 mm per hour which is fairly heavy. It is recommended that drainage facilities be installed on the cut and embankment slopes in order to prevent slopes from being eroded.

The following measures are also recommended to maintain effective of drainage :

(1) Increase in drain depth

To prevent scour on steep slopes much deeper drains than calculated by formula should be constructed to deal with the extremely high velocity of the water current.

(2) Energy dissipator

In order to slow down current velocity, a staircase-shaped drainage ditch bottom is planned.

(3) Water drop

Water drop is proposed to decrease water velocity running in drainage.

11.6 Review of Feasibility Study of Mugu Airport

"Feasibility Study of Talcha (Mugu) Airport (draft report, July, 1988)" has been reviewed as stated below:

11.6.1 Design Criteria

Annex 14 is chiefly used as the design criteria for this airport, and the Stolport Manual (ICAO) as well as the Altiport Recommendations (Design Acft. - Twin Otter) are partly used with regard to airport terrain and economics. This is reasonable consideration of the characteristics of this STOL airport.

11.6.2 Runway and Runway Strip

(1) Length

The length of the runway and runway strip are planned as 550 m and 610 (30+550+30) m respectively. These lengths meet the requirements of Altiport Recommendations.

(2) Width

The width of the runway and runway strip are proposed to be 30 m and 60 m, which meet the requirements of Annex 14. According to Annex 14, although the minimum width of runway is 18 m, 30 m wide which is stipulated in the Stolport Manual is desirable as far as circumstances permit.

(3) Orientation

Two alternatives were reviewed.

a) Alternative A is inclined 1.7 degrees north from the direction of the existing runway center line to avoid the toe of a ridge which obstructs the approach or take-off surfaces.

b) Alternative B is inclined 0.07 degrees west from the existing runway center line in order to utilize the earthwork that had already been carried out and also to avoid the said hillside obstruction.

Alternative B is recommended as the most suitable orientation.

(4) Runway Longitudinal Slope

Alternative B/L6 is recommended as the requirement for slope specified in Altiport Recommendations is met, that is, 12% at maximum to specified 15%.

(5) Vertical Curve

Vertical curves are planned to be set at all slope-changing points in the longitudinal slope of ALT B/L6 so that aircraft may run smoothly with less impact.

(6) Slope-Change

The maximum amount of slope-change is 12% (0-12). This figure is below the specified maximum 15%.

(7) Distance between Slope-changing Points

The minimum distance between slope-changing points is planned as 160 m for the amount of slope-change of 12%. Though no requirement for this item is indicated in Altiport Recommendations, the distance of 931.5 m [D=50((0-12.0)+(12-5.37))] is required according to ICAO Annex 14.

The proposed 160 m do not meet the requirement, but it is inevitable. It is considered to be in allowable range, because this area in question lies in the beginning zone of take-off, where the speed of an aircraft is low.

(8) Transverse Slope

Transverse slope of the runway and runway strip is planned as 2.0% in the report and this slope is reasonable.

11.6.3 Drainage

According to the final report, the intensity of rainfall is 124 ㎜ per hour which is fairly heavy. It is recommended that drainage facilities be installed on cut and embankment slopes in order to prevent slopes from being eroded.

The following measures are also recommended to maintain effective drainage facilities:

a) Increase in drain depth

To prevent scour on steep slopes much deeper drains than calculated by formula should be constructed to deal with the extremely high velocity of the water current.

b) Water energy dissipator

In order to slow down current velocity, a staircase-shaped drainage ditch bottom is planned.

c) Water drop

Water drop is proposed to decrease water velocity of drainage.

11.6.4 The Airspace of Mugu Airport

Mugu Airport is surrounded by mountain peaks more than 9,000 ft high. The obstacle limitation surfaces are protruded by many obstructions, especially in the western section where the inner horizontal and conical surfaces are almost completely occupied by obstacles as shown in Fig. 11.6.1. Consequently, aircraft utilizing this airport must strictly observe operational limitations.

A number of mountains also protrude the south side approach surface so in the previous study the airport was planned for landings from the north and take-offs to the north. Of course, such limitations are unavoidable in establishing airports in mountainous regions. Accordingly, before operations begin at the airport, geographical conditions as well as special weather conditions should be carefully studied.

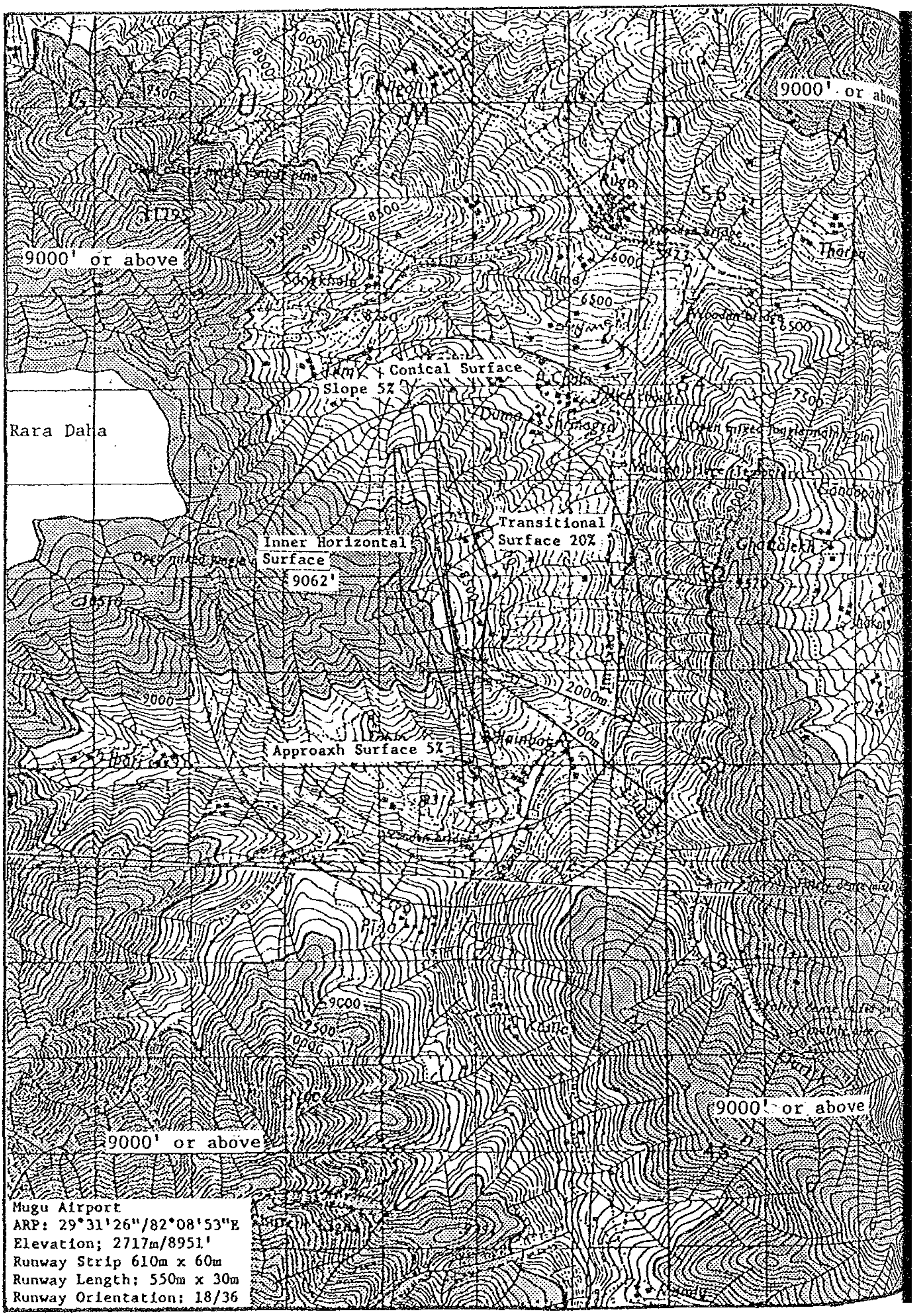


Fig. 11.6.1 The Obstacle Limitation Surfaces of Mugu Airport

11.7 Master Plan of Other STOL Airports

In this chapter, the master plans of four STOL airports, Dolpa, Jumla, Sanfebagar and Phaplu are summarized.

11.7.1 Surfacing Work of the Runway for the Four Airports

Using the result of the study for runway surfacing work at Jomsom Airport as a model, the cost of the runway surfacing work for four airports are properly estimated to be around US$9,300,000 as shown in Table 11.7.1.

Table 11.7.1 Preliminary Cost of the Development Work for Each Airport

Unit : US$ 1,000

Name of Airport	Surfacing Work for Runway		Building Work	Other Work	Total	Remarks (*)
	Length	Cost				
Dolpa	457 m	1,900		* 100	2,000	High speed turn-off, L=150m
Jumla	670	2,800			2,800	
Sanfebagar	427	1,800		* 100	1,900	Protection works for river erosion
Phaplu	670	2,800	* 300	450	3,550	Refer to Mugu Airport
Total	-	9,300	300	650	10,250	

11.7.2 High Speed Turn Off

Although, the Dolpa Airport's runway needs to be extended by 75 m, it is difficult to do because of topographical conditions. To compensate for this deficiency, a "high speed turn off" as shown in Fig. 11.7.1 should be constructed. This neccessary length should be calculated based on the topographical features. Since that is not clear at present, the length is assumed to be 150 m for the estimate of construction cost in this study.

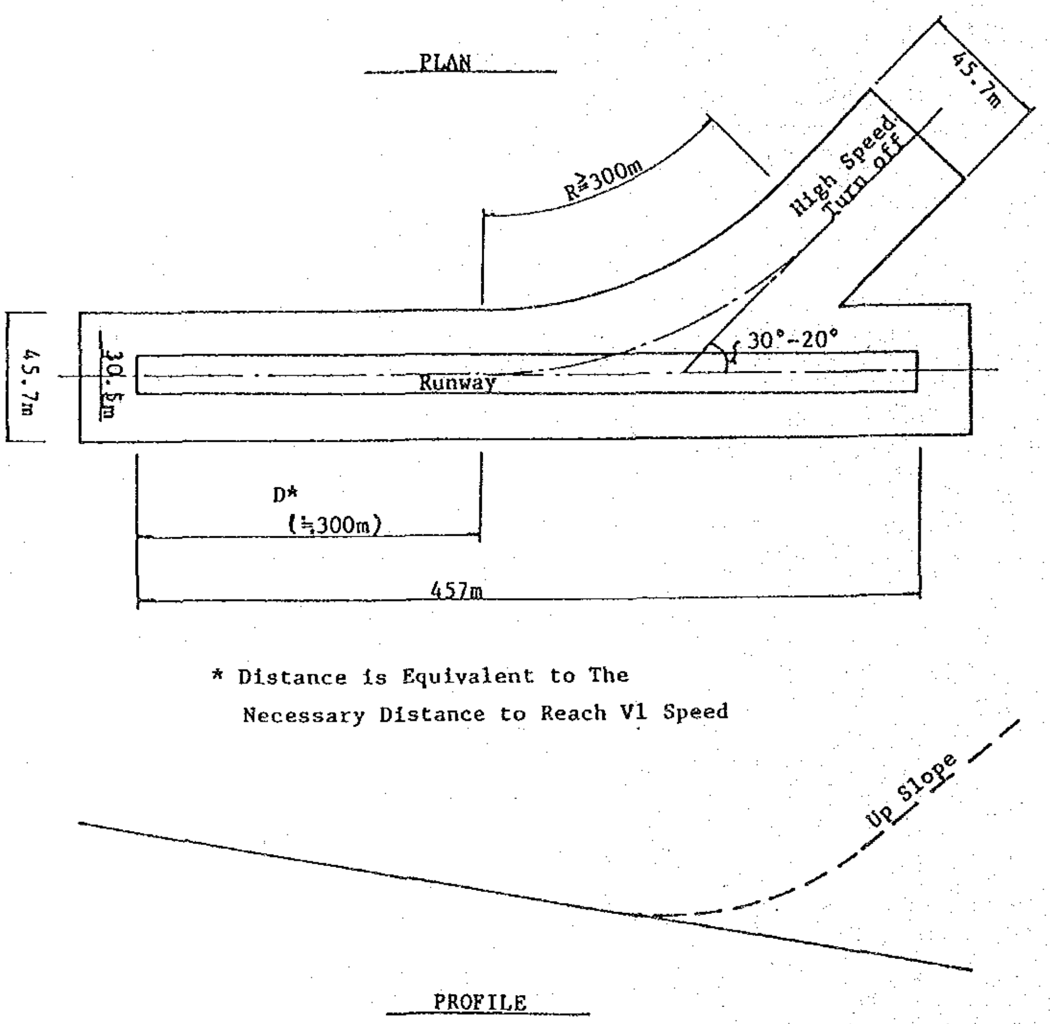


Fig. 11.7.1 Concept of High Speed Turn Off

11.7.3 Drainage Facilities

It is recommended that the following facilities be installed at Dolpa Airport and Phaplu Airport which have a high intensity of rainfall and a steep slope runway.

(1) Deep drain
(2) Water energy dissipator
(3) Water drop

At Sanfebagar Airport in addition to these, drainage facilities sufficient in cpacity and strength should be installed so as to prevent the runway strip from being eroded by flood water.

11.8 Master Plan of Navigation Aids

As indicated in Table 3.3.11, the installation of navigation aids and air traffic control facilities, etc. has been carried out by French grant aid program at Dolpa, Jomsom, Jumla, Lukla, Sanfebagar and Simikot Airports.

The French grant aid program for airports included the following facilities:

(1) Single position console including the following components:

- a) VHF transceiver
- b) HF transceiver
- c) Wind direction and speed observation and indicator
- d) Barometer
- e) Tape recorder
- f) Public address system
- g) Intercom and clock
- h) Siren

(2) Solar power supply facilities

(3) Precision approach path indicator

(4) Non-directional beacon

The same navigation facilities as those included in the French grant aid package have been planned for Mugu, Phaplu and Syangboche Airports.

CHAPTER 12 IDENTIFICATION OF PRIORITY PROJECTS

CHAPTER 12 IDENTIFICATION OF PRIORITY PROJECTS

Priority projects should be selected for the subsequent feasibility study by the following considerations:

(1) Projects with high priority for the purpose of the enhancement of air safety and punctuality of aircraft operations

(2) Projects with high efficiency of investment which will contribute to the development of the national economy and tourism

(3) Projects requiring urgent improvement

The following projects have been selected as priority projects:

- Tribhuvan International Airport Development Project

  Development of the basic facilities, which are insufficient in capacity and function even at present, will greately contribute to the national economy and others.

  * Domestic terminal building
  * Passenger loading apron
  * Air navigation systems
  * Cargo terminal building
  * Maintenance hangar

- New Pokhara Airport Development Project

  The existing airport is under severe circumstances in terms of air safety. A new airport is expected to enhance air safety and to develop tourism.

- Jomsom and Simikot Airports Development Projects

  As discussed in Chapter 8 "Selection of key airports" (Table 8.1.1), runways in these airports are too short. For safety, extension of the runways is urgently required.

- Lukla, Syangboche and Mugu Airports Development Project

  As described in Chapter 2, air traffic analysis and demand forecast, these airports have high demand of tourist. Development of these will contribute to regional economy and tourism.

- Nationwide Navaids Network and Aeronautical Telecommunications Network Project

  En-route navigation aids should be developed in order to compose IFR airways and ensure safety and efficiency of civil air transport. A nationwide aeronautical telecommunications network for domestic AFTN and ATS direct speech circuits should be developed in order to improve the difficulties in communications and to expedite air traffic services.

  The estimated project costs of priority projects are tabulated in Table 12.1.1.

Table 12.1.1 Estimated Project Costs of Priority Projects

Unit : US$1,000

Project Name	Costs
1) Tribhuvan International Airport Development Project	
- Phase I	174,200
- Phase II	313,300
2) New Pokhara Airport Development Project	
- Phase I	39,700
- Phase II	45,200
3) Jomsom Airport Development Project	3,200
4) Simikot Airport Development Project	2,600
5) Lukla Airport Development Project	1,900
6) Syangboche Airport Development Project	2,900
7) Mugu Airport Development Project	5,400
8) En-route Navaids Network Project and Nationwide Aeronautical Telecom. Network Project	16,600
Grand Total	605,000

PART II PRELIMINARY STUDY OF TIA

CHAPTER 13 SCOPE OF THE PHASE I DEVELOPMENT PROJECT OF TIA

PART II PRELIMINARY STUDY OF TIA

CHAPTER 13 SCOPE OF THE PHASE I DEVELOPMENT PROJECT OF TIA

13.1 General

Future demand of TIA has been predicted to be rapidly increased and annual passenger and cargo volume will reach as many as 1.6 million passengers and 71 thousands tons in the year 2000 and similarly 2.4 million passenger and 140 thousand tons in the year 2010 respectively, as described in Chapter 2. While the some of existing facilities are insufficient for requirements even at present.

In Chapter 9, airport master plan has been made taking into consideration of the air traffic demand and present condition of existing facilities.

In this chapter, the construction items for phased development, i.e., the scope of the Phase I development project is clarified.

13.2 Project Phases

The airport master plan will be implemented utilizing the basic concept of phased development as described below, for the purpose of economical and cost-effective investment.

(1) Phase I Development

Phase I development is focused on the major facilities whose capacity is short.

Domestic passenger terminal building, cargo terminal building and aircraft maintenance hangar, which are already insufficient in capacity or function, shall be developed as soon as possible as indicated in Chapter 9.

Widening of runway strip from 150 m to 300 m, which is required for instrument approach system according to the international standard, is very costly because of high embankment and it needs difficult land acquisition. Therefore it is considered to be impractical in Phase I.

Diversion of the Ring road, which is accompanied by land acquisition, is necessary prior to the above development projects.

Planning will be made in order to meet the demand anticipated for the year 2000 based on the premise that major work will not be required for at least five to six years after the completion of the construction.

(2) Phase II Development

Tribhuvan International Airport will be upgraded to meet international standards in terms of airport facilities, operations, and maintenance.

Facilities in which larger capacity will be required with increasing of air traffic demand will be developed in Phase II.

Widening of runway strip will be carried out together with upgrading of navigation system.

Efficiency and air safety will be increased by the introduction of such facilities as a microwave landing system, an air traffic control radar system, etc.

Planning will be made to meet the demand anticipated in the year 2010 so that the demand for ten years after the service period of Phase I development can be accommodated.

Accordingly, the phases of airport development are summarized below and are shown in Fig. 13.2.1.

Phase	Design Year	Service Period
Phase I development	2000	1995-2000
Phase II development	2010	2001-2010

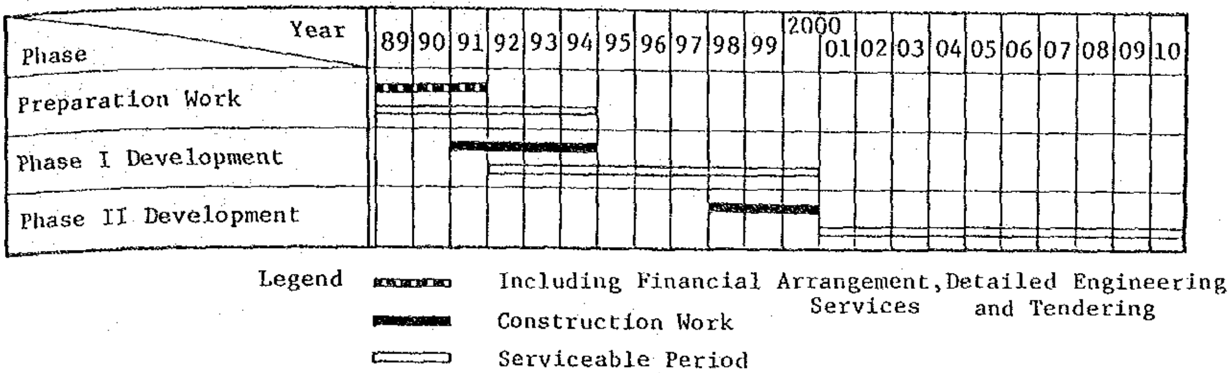


Fig. 13.2.1 Phases of Airport Development

13.3 Facility Requirements for Phases I and II

The facility requirements for Phases I and II are summarized in Table 13.3.1 based on the study discussed in Chapters 2 and 9.1 - 9.3.

Table 13.3.1 Airport Facility Requirements for Phase I and II at TIA

No	Facility		Phase / Design Year / Unit	Present Conditions (as of 1988)	Phase I 2000	Phase II 2010
1	Runway		meter	3,050 x 46	3,050 x 45	3,050 x 45
2	Runway Strip		meter	3,140 x 150	3,140 x 150	3,110 X 300
3	Taxiway		meter	Partial Parallel Taxiway	Partial Parallel Taxiway	Parallel Taxiway
4	Passenger Terminal Apron		gate position	Dom : 3 Int'l : 6 Total : 9	Dom HS748 class: 2 DHC6 class : 2 Int'l J,L class : 2 M class : 1 N.S class : 5 Total :12	Dom HS748 class: 2 DHC6 class : 2 Int'l J,L class : 4 M class : 1 N.S class : 5 Total :14
5	Cargo Terminal Apron		gate position	Nil	Nil	J class : 1
6	Passenger Terminal Building	Dom	sq.meter	700	3,200	4,200
		Int'l	sq.meter	10,750	10,800	19,700
		Total	sq.meter	11,450	14,000	23,900
7	Cargo Terminal Building		sq.meter	3,500	Dom 400 Int'l 13,500	500 27,000
8	Administration Building		sq.meter	2,100	4,000	4,000
9	Air Navigation Systems			Non Precision, Instrument	Non Precision, Instrument	Precision Approach Cat-I (MLS)
10	Car Park		cars sq.meter	17,000	550 19,300	970 34,000
11	Access Road			1 lane for each direction	1 lane for each direction	1 lane for each direction
12	Fuel Supply (Jet. A-1)		kl/week sq.meter	500 15,000	1,100 25,000	2,000 30,000
13	Rescue and Fire-Fighting		Category cars sq.meter	5 6 800	7 5 450	8 5or6 550
14	Utilities					
	Power Supply System		KVA	N.A	2,300	3,600
	Water Supply System		ton/month	N.A	10,900	16,100
	Sewerage System		ton/month	N.A	7,800	11,600
	Solid Waste Disposal System		ton/month	N.A	80	140
15	Ground Support Equipment		cars	Nil	Towing tractor 2	Towing tractor 3

13.4 Construction Requirements for the Phased Development

The construction items to be included in the two phases described in Chapter 13.2 are tabulated in Table 13.4.1 in order to clarify the scope of the Phase I development project. In Table 13.4.1, the mark "x" indicates the phase in which each construction item should be implemented.

Table 13.4.1 Construction Items in Phases

Construction Item	Phase I	Phase II
A. Civil Works		
1) Construction of runway shoulders		x
2) Runway pavement overlay		x
3) Widening of runway strip		x
4) Construction of parallel taxiway		x
5) Construction of a passenger terminal apron	x	x
6) Construction of a cargo terminal apron		x
7) Construction of a maintenance apron and taxiway	x	x
8) Construction of an isolated apron with cross runway		x
9) Construction of Ring road	x	
10) Construction of internal roads and car parks	x	x

Table 13.4.1 Continued

Construction Item	Phase I	Phase II
11) Construction of a storm water drainage system	x	x
12) Constructin of utilities	x	x
13) Construction of new security fence	x	x
14) Construction of perimeter roads	x	x
15) Construction of water reservoirs along the runway		x
B. Architectural Works		
1) Construction of domestic passenger terminal building	x	
2) Expansion of international terminal building	x	
3) Construction of second international terminal building		x
4) Construction of new cargo terminal building	x	x (expansion)

Table 13.4.1 Continued

Construction Item	Phase I	Phase II
5) Construction of maintenance hangar	x	x (expansion)
6) Construction of airport work shop and storage		x
7) Construction of new fire station		x
C. Air Navigation System Works		
1) Installation of localizer/DME	x	
2) Replacement of KTM DVOR/DME	x	
3) Installation of a new DVOR/DME for Kathmandu terminal control area	x	
4) Relocation and replacement of NDB	x	
5) Installation of MLS		x
6) Installation of ATC radar		x
7) Relocation of HF transmitter station	x	

Table 13.4.1 Continued

Construction Item	Phase I	Phase II
8) Replacement/upgrading of aeronautical ground lights (AGL)	x	x (upgrading)
9) Construction of Substation for AGL	x	
10) Installation of meteorological observation system	x	
D. Airport Utilities		
1) Expansion of the water supply system and increase of the capacity	x	x
2) Construction of a new sewerage system	x	x
3) Installation of an incinerator	x	x
4) Expansion of public telecommunications	x	x
E. General Services		
1) Provision of an ambulance		x

Table 13.4.1 Continued

Construction Item	Phase I	Phase II
2) Replacement and provision of major vehicles	x	x
3) Provision of towing tractor	x	x

CHAPTER 14 PRELIMINARY STUDY FOR AIRPORT FACILITIES OF TIA

CHAPTER 14 PRELIMINARY STUDY FOR AIRPORT FACILITIES OF TIA

14.1 GENERAL

The preliminary study for the major airport facilities is described in this chapter. A layout plan of the Tribhuvan International Airport Phase I development, which will meet the demand anticipated in the year 2000 is shown in Fig. 9.4.9.

14.2 Runway, Taxiway and Apron

14.2.1 Runway

The existing runway pavement will be able to serve with the traffic of Phase I. The overlay is required for Phase II.

14.2.2 Taxiway

A taxiway from the maintenance apron is connected to the existing No. 5 taxiway. The taxiway is basically 23 m wide and is provided with a 10.5 m shoulder on each side.

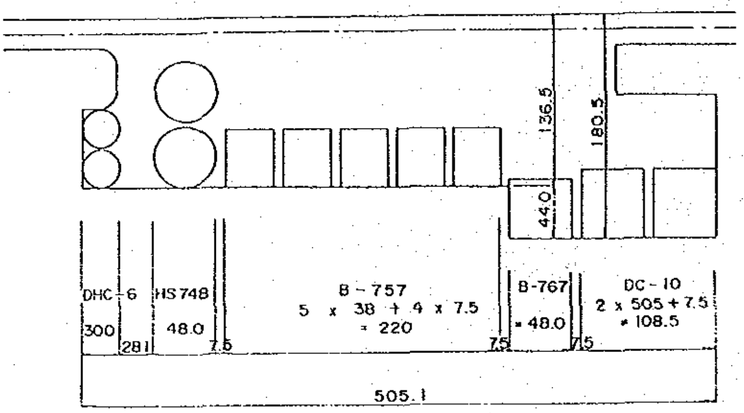
14.2.3 Apron

A 505.1 m wide and 180.5 - 136.5m deep passenger terminal apron is planned in order to accommodate two DC-10 class aircraft, one B-767 class aircraft, and five B-757 class aircraft for international service by nose-in parking configurations and two HS-748 class aircraft and two DHC-6 class aircraft for domestic service by self-maneuvering configuration. Two B-727 class spots for domestic service are commonly used with B-757 class spot for international service. While the adoption of nose-in parking configurations make it possible to reduce the apron area, two towing tractors are required. The apron will be expanded by 227.9 m on both sides for Phase II. It will be possible to accommodate B-747-400 class aircraft. These are illustrated in Fig. 14.2.1.

Service road and parking area for Ground Service Equipment (GSE) are planned in the space between aircraft stands and terminal buildings. Vacant space around the buildings are also available for GSE parking.

A maintenance apron for B-757 class aircraft which will be separated from passenger terminal apron is also planned as shown in Fig. 9.4.9.

Phase I



Phase II

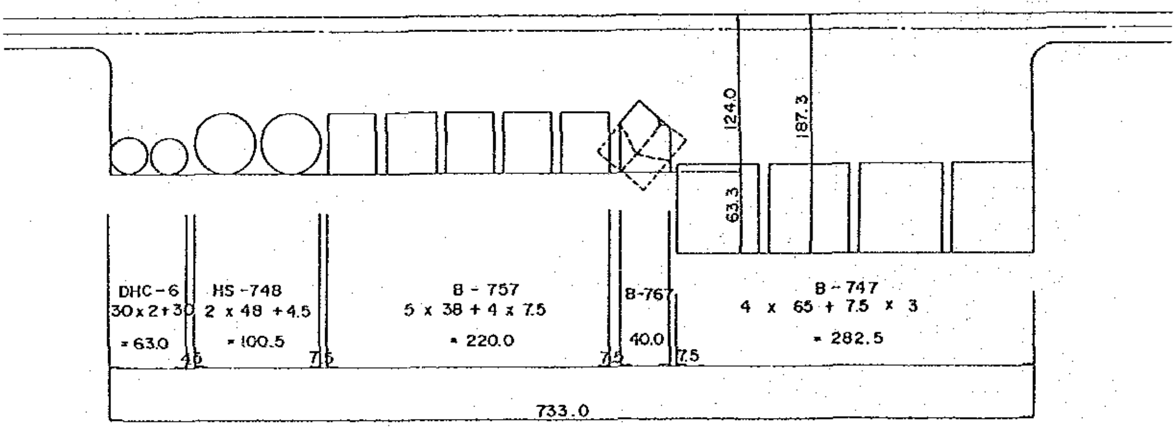


Fig. 14.2.1 Dimension of Apron

14.2.4 Grading Plan

Large scale grading is required for the passenger terminal area, cargo terminal area and maintenance terminal area. The earthwork volume amounts are approximately 1.2 million cubic meters in Phase I.(6.2 million cubic meters in Phase II) The earth material for the purpose of embankment should be hauled from outside of the airport. Therefore, procurement and transportation may be in critical. Typical cross section is shown in Fig. 14.2.2.

14.2.5 Pavement Plan

Asphalt concrete pavement will be adopted for the maintenance taxiway. Cement concrete pavement will be adopted for the passenger terminal apron and maintenance terminal apron in order to avoid rutting from the heavy landing (wheel loads) gear of the jet aircraft and also taking the oil proof character into account. The pavement structures are shown in Fig. 14.2.3.

14.2.6 Storm Water Drainage Plan

Surface water collected by catchment area from the new terminal area will run through the oil separater and will be discharged to the Bagmati river by box culvert.

14.2.7 Ring Road

The Ring road is planned to be relocated prior to the construction of terminal facilities. Length of the relocation is about 2 km. A part of the section to be relocated goes through the soft ground area where a special construction method will be required.

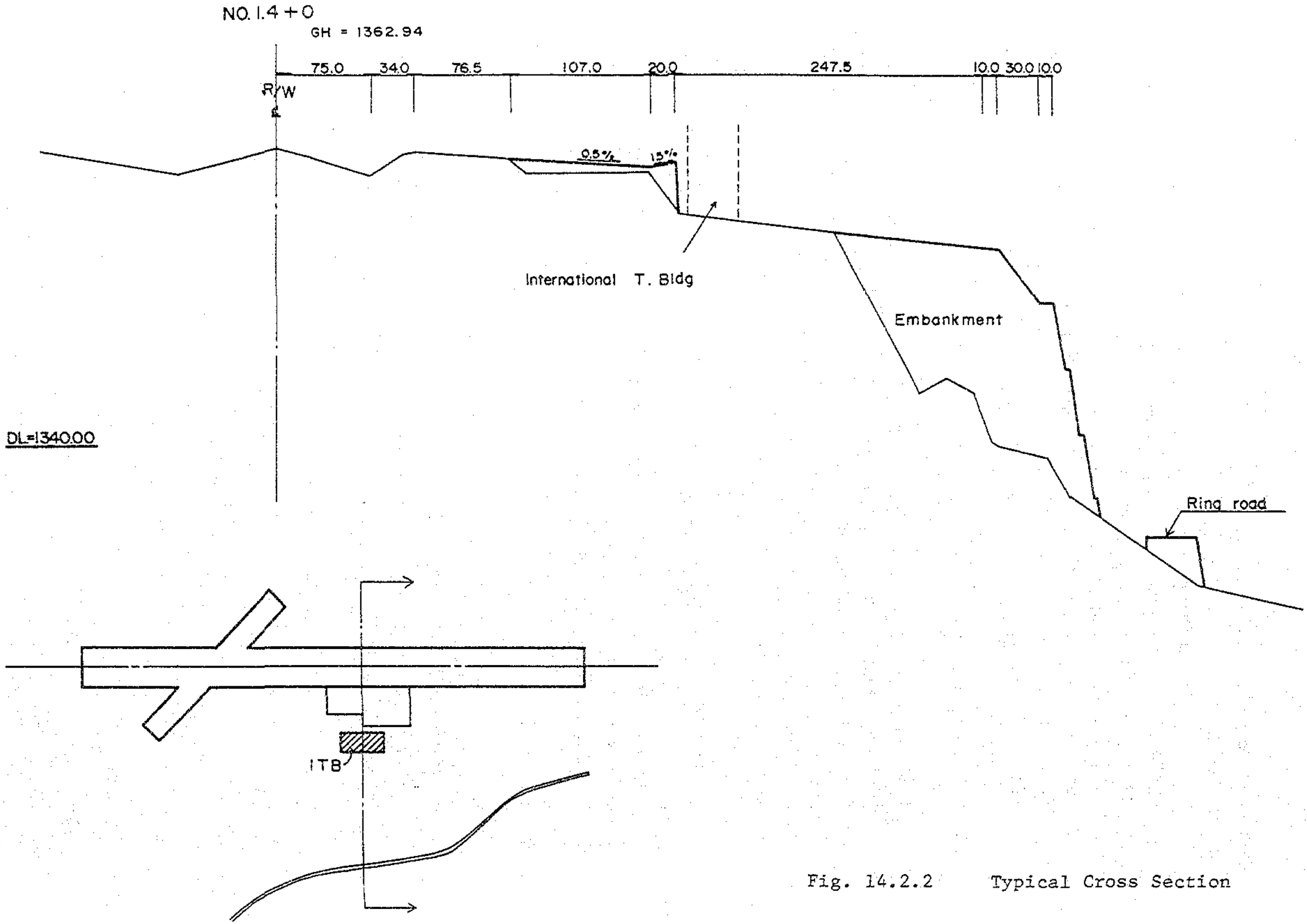


Fig. 14.2.2 Typical Cross Section

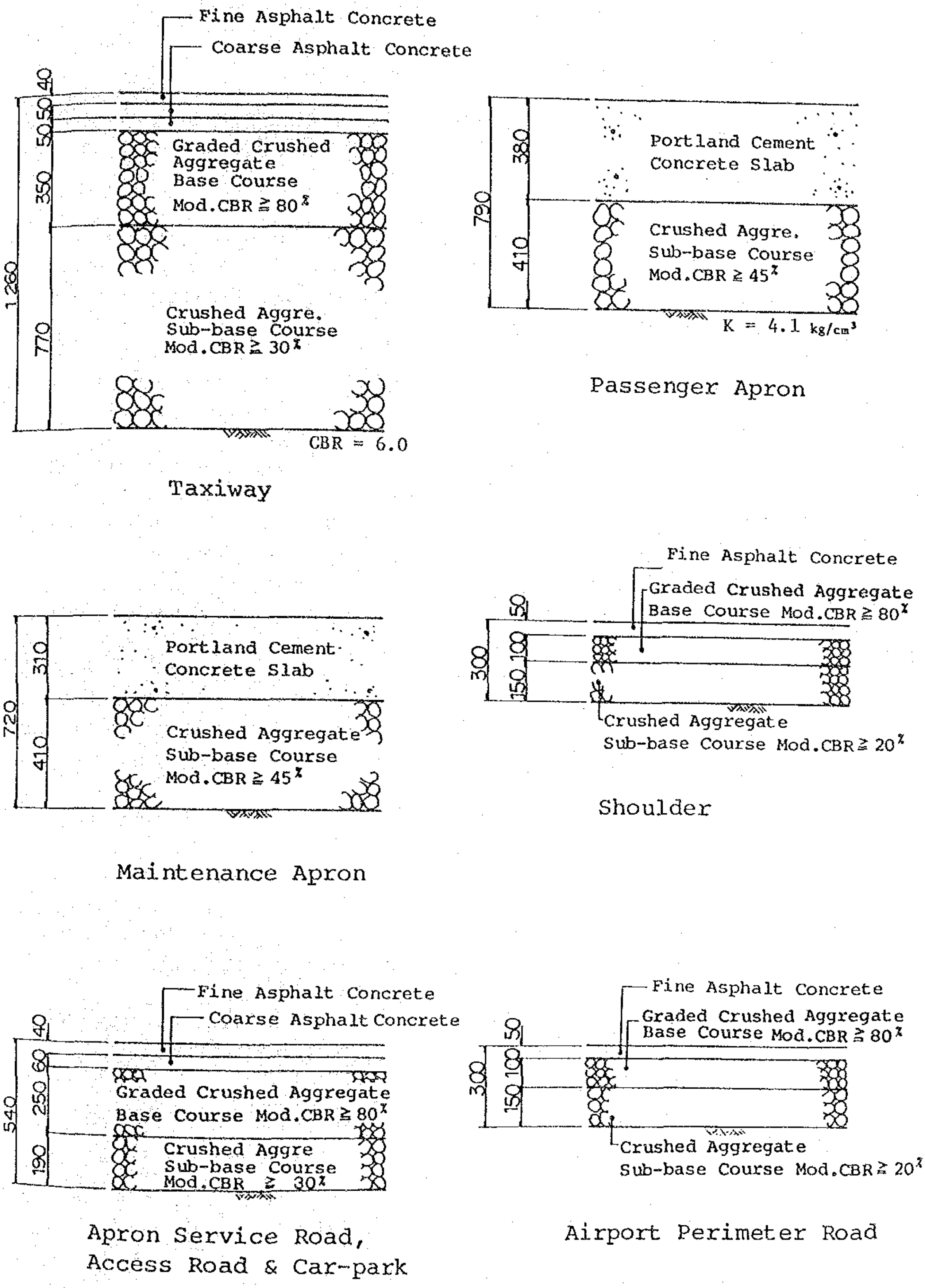


Fig. 14.2.3 Typical Pavement Structures