CHAPTER VII ACCESS (MAINTENANCE) ROAD

7.1 Design Conditions and Standard

7.2 Route Alignments

7.3 Basic Design of the Road

CHAPTER Ⅶ ACCESS (MAINTENANCE) ROAD

7.1 Design Conditions and Standard

7.1.1 Design Standard

The Access (Maintenance) roads are designed in the following design standards.

- Japanese government ordinance for road structures.
- Design standard for agricultural road in land improvement projects, established by Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries of Japan.

7.1.2 Design Conditions

(1) Design Speed

The design speed is decided at 100 km in the discussion with NSDO. However, in consideration that the total length 1.0 km of No.1 Access Road is short and No.2 Access Road has many curves with curve radiuses of 200 m-1,000 m to avoid the sand dunes. The curve radius of 200 m is desirable for the design speed 60 km/hr. Judging from the above fact, the design speed is decide as following table.

Table 7.1-1 Design Speed of Access Road

	Length of Road (km)	Radius of Curve (m)		Length of Curve (m)		Design Speed (km/hr)
		Actual	Desirable	Actual	Desirable	
No.1 Access Road	1.05	700 ~ 1,000	400	288 ~ 409	140	80
No.2 Access Road	2.84	200 ~ 1,000	200	137 ~ 376	100	60
No.3 Access Road	5.10	600 ~ 1,000	700	275 ~ 470	170	100

Remarks; Actual length of curve is the curve length with intersection angle more than 20 degree

(2) Minimum and Desirable Minimum Radius of Curve

In order to secure the stable and comfortable driving of the vehicle through curves, the criteria for the minimum curve radius is given. And furthermore the desirable minimum curve radius, if the topography permit, to ensure more stable and comfortable is also given as follows;

Table 7.1-2 Minimum and Desirable Minimum Radius of Curve

Design Speed (km/hr)	Minimum Radius (m)	Desirable Minimum Radius (m)
60	150	200
80	280	400
100	460	700

(3) Length, Superelevation and Widening of Curve

(a) Minimum Length of Curve

The minimum length of curve is given in Table 7.1-3 in consideration of the following conditions;

i) The minimum length of curve shall be decided to ensure that driving time on the curve with intersection angle more than 20 degree is more than 6 seconds and a driver would not feel difficulties in steering a vehicle.

ii) The change rate of centrifugal acceleration on the curve shall be less than 0.5 m/s^2 and the human body would not feel discomfort.

(b) Super-elevation of Curve

Super-elevation of curve is given in the table to ensure stable and comfortable driving.

(c) Widening of Curve Section

The traces of front-wheels and rear-wheels are different when driving on curves. Therefor, in order to give additional space for the different trace of front and rear wheels, the widening of the curve section is given as follows;

Table 7.1-3 Minimum Length, Superelevation and Widening of Curve

Design Speed (km/hr)	Radius (m)	Min. Length (m)	Superelevation (%)	Widening (m)	Remarks
60	200	100	8.0	0.25	No.2 Access Road
	300	100	6.0	0	
	400	100	5.0	0	
	800	100	2.0	0	
	1,000	100	2.0	0	
80	700	140	4.0	0	No.1 Access Road
	1,000	140	3.0	0	
100	600	170	7.0	0	No.3 Access Road
	700	170	6.0	0	
	1,000	170	4.0	0	

Notes :1) Minimum length is the curve length with intersection angle more than 20 degree

2) Widening of 0.25 m is required for curve with radius 200 m.
However the sufficient road width of 3.5 m is given for the design vehicle width of 2.5 m. therefor no widening will be applied.

(4) Longitudinal Slope

The longitudinal slope and exceptional slope with limited length is given in the table below in consideration of the following items;

i) The longitudinal slope is decided so that passenger car can drive at an average speed and trucks can drive at about half of the design speed.

ii) The exceptional longitudinal slope with the limited length is decided so that passenger cars can secure an average speed at the end of the slope and trucks can

secure about half of the design speed.

Table 7.1-4 Longitudinal Slope and Limited Length of Exceptional Slope

Design Speed (km/hr)	Longitudinal Slope (%)	Exception	
		Longitudinal Slope (%)	Limited Length (m)
60	5.0	6.0	500
		7.0	400
		8.0	300
80	4.0	5.0	600
		6.0	500
		7.0	400
100	3.0	4.0	700
		5.0	600
		6.0	500

(5) Longitudinal Curve

Longitudinal curve is necessary for the section of change of longitudinal slope in order to avoid the shock caused by the change of motion and to secure the sight. The radius and length of the longitudinal curve is given in the following table.

Table 7.1-5 Radius and Length of Longitudinal Curve

Design Speed (km/hr)	Shape of Curve	Minimum Radius (m)	Minimum Length of Curve (m)
60	Convex Shape	1,400	50
	Dent Shape	1,000	
80	Convex Shape	3,000	70
	Dent Shape	2,000	
100	Convex Shape	6,500	85
	Dent Shape	3,000	

(6) Others

The other design conditions for access road are as follows;

i) The width of the access road will be 14 meters. The road section is composed of two roadways of 4.0 meters wide each, two shoulders of 2.5 meters wide each and two protective shoulders of 0.5 meters wide each.
ii) The access roads are planned to be paved with asphalt and the cross grade will be 2.0 %.
iii) Drainage ditches along the road are not required.
iv) Lighting facilities will be not installed along the access road.

7.2 Route Alignments

7.2.1 Purposes of the Access Road

Those facilities of the open canal, box culvert pipelines, pumping station, surge tank and the discharge tank will be maintained by the use of the maintenance road to be constructed along the conveyance canal. The maintenance road from the BP (KM 86.50) to No.7 Pumping station (KM 108.87) runs through the area of drifting sand nearby the coastal area and would be suffered from the sand intrusion to the facilities. Therefor, frequency of access to this section for the maintenance will be high.

Easy access from the existing road to the section requiring frequent maintenance would be necessary for the easy maintenance. Fortunately, as the conveyance canal is planned almost in parallel with the existing national highway (from East Kantara to El Arish), three access roads are planned connecting from the beginning point of the box culvert (KM 94.77), end point of the box culvert (KM 102.38) and No.7 Pumping station to the national highway.

7.2.2 Route Alignment of No.1 Access Road (KM 94.77)

The No.1 Access Road is planned to improve the existing gravel paved village road of 4 m width. The total length of the access road is 1 km with two curves. As the internal angles are as large as 23 degrees, the curve radius of 700 m and 1,000 m which are larger than the desirable curve radius of 400m. And the curve length of 287.7 m and 409.0 m which are larger than minimum curve length of 140 m can be secured, based on the design speed 80 km/hr. Although the design slope is less than 4.0 % for the design speed of 80 km/hr, the steepest slope of the existing road is 8.5 % at the connecting section to the national highway with 5.0 m elevation difference. And gentle slope of 2.3 % is found in most of the section with 3.7 m elevation difference.

The route alignment of the No.1 Access Road follows the existing village road. However, because the existing road adjacent to the national highway is close the village houses and the planned elevation of the access road is 3.7 m higher than the existing one, the center line shall be set at 7.0 m west from the existing one.

Table 7.2-1 Dimensions of Curve along No.1 Access Road

Intersection Point	Internal Angle	Radius of Curve(m)		Length of Curve (m)		Remarks
		Actual	Desirable	Actual	Minimum	
IP.1	23° 32' 53"	700	> 400	287.70	> 140	OK
IP.2	23° 25' 53"	1,000	> 400	408.96	> 140	OK

Note: Design speed should be 80 km/hr.

7.2.3 Route Alignment of No.2 Access Road (KM 102.30)

The No.2 Access Road is planned to connect the end point of the box culvert (KM 102.38) to the national highway. The beginning point of the access road is selected so that the alignment of the road crosses the lowest part of the sand dune lying at about 80 m south of the national highway. The length between BP and IP.1 is measured at 134.59 m as the result of the route selection to the south avoiding the sand dune and lowland. Setting 50 m straight alignment at the intersection part to the national highway, the tangent length (TL) must be less than 84.59 m and the corresponding curve radius, 238 m. Therefor, the curve radius is set at 200 m. As the distance between IP.1 and IP.2 is 259.1 m and TL must be less than 188.83 m (=259.91-71.08) and the corresponding curve radius, 410 m, the curve radius of the IP.2 is set at 400 m.

The alignment between IP.3 and IP 4 is selected to the south avoiding about 100 m from the sand dune and lowland. However, as the sand dune lies across the road alignment at 1.5 km point from the beginning point, the alignment is selected to cross the lowest part of the sand dune, which gives the length 309.81 m between IP.4 and IP.5. The TL of IP.5 must be less than 150.23 m (=309.81-159.58) and the corresponding curve radius, 810 m. Therefor, the curve radius of IP.5 is decided at 800 m.

There is also a high sand dune in the west of the alignment at the point of 2.1 km from the beginning point, and the alignment of the road is selected to avoid about 100 m from the sand dune. As the length between IP.6 and IP.7 is measured at 196.96 m, the same curve radius of 300 m is set for both IP.6 and IP.7, which is less than the maximum possible curve radius of 303 m.

Table 7.2-2 Dimensions of Curve along No.2 Access Road

Intersection Point	Internal Angle	Radius of Curve(m)		Length of Curve (m)		Remarks
		Actual	Desirable	Actual	Minimum	
IP.1	39° 07' 46"	200	= 200	136.58	> 100	OK
IP.2	49° 24' 58"	400	> 200	344.98	> 100	OK
IP.3	21° 32' 06"	1,000	> 200	375.86	> 100	OK
IP.4	18° 08' 00"	1,000	> 200	316.48	—	OK
IP.5	21° 00' 30"	800	> 200	293.34	> 100	OK
IP.6	51° 56' 24"	300	> 200	271.96	> 100	OK
IP.7	18° 24' 43"	300	> 200	96.40	—	OK

Note: Design speed should be 60 km/hr.

7.2.4 Route Alignment of No.3 Access Road (No.7 Pumping Station KM 102.93)

The No.3 Access Road is planned to connect the point of around the No.7 Pumping station (KM 108.79) and the national highway. There is a existing road at the due north of the No.7 Pumping station extending to the south from the national highway. This road has 4 m width and the 500 m length from the national highway is asphalt paved and the rest is gravel paved. Therefor, this existing road will be used as the access road by improving.

The existing road has almost straight alignment in the first 1.4 km section from the national highway. IP.1 and IP.2 are set to coincide the center line of the existing road. As there are many small curves in the south of IP.2 on the existing road, the improved straight alignment is adopted in the section between IP.2 and IP.3 (Distance : 1.3 km). The IP.3 and IP.4 are selected so that the access road crosses between two sand dunes.

If the alignment of access road is selected to connect IP.4 and No.7 Pumping station with straight line, the access road will run through the lowland of elevation 10 m at the point 3.6 km, the lowland of elevation 10 m at the point of 3.9 km, the sand dune of elevation 30 m at the point 4.1 km, the lowland of elevation 10 m at the point 4.4 km, the sand dune of elevation 35 m at the point 4.5 km. Therefor, the south west alignment of the access road is selected to avoid the difficult topography.

IP.5 is set to avoid the sand dune at the point 4.2 km. If the straight alignment is selected from IP.4 to the conveyance canal through IP.5, the access road will run through the sand dune of elevation 25 m at the point 4.5 km, the lowland of elevation 6 m at the point 4.6 km, the sand dune of elevation 25 m at the point 4.9 km. The alignment of the access road is selected in west-south-west direction from the IP.5 to the point KM 107.93 of the conveyance canal to avoid the difficult topography. The maintenance road can be used as access road from the point KM 107.93 to the No.7 Pumping station.

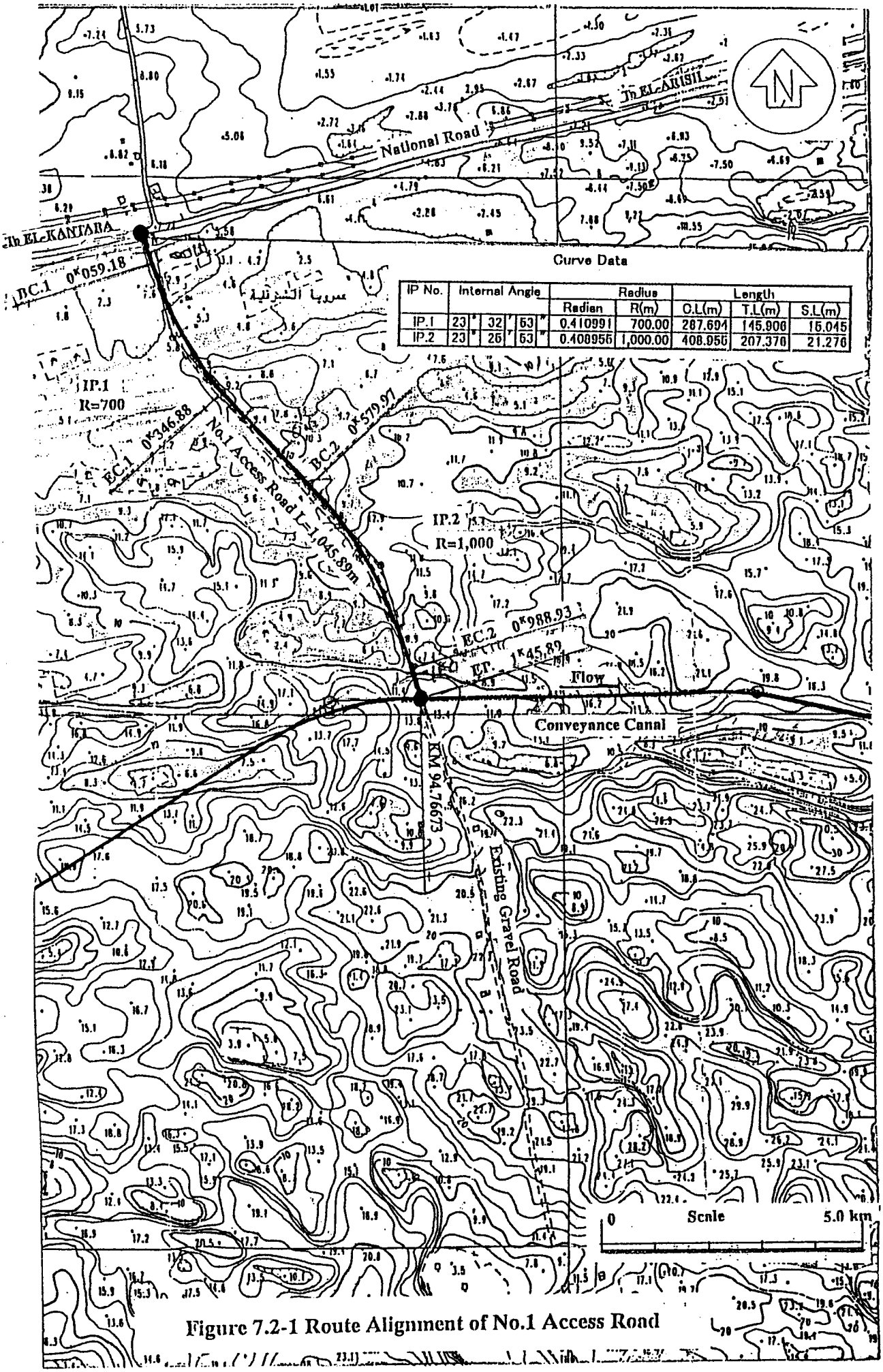
The distances between IP.1 to IP.4 range from 786 m to 1,304 m, which are long enough to set curves for the design speed 100 km/hr (desirable minimum radius : 700 m), and the curve radius of 1,000 m is adopted for IP.1 to IP.4. Because the distance between IP.5 and IP.6 is 448 m and rather short, the curve radius of 700 m is set for IP.5. The tangent length of the IP.6 must be less than 204 m (= 448-244) and corresponding curve radius of 610 m, and accordingly the curve radius of 600 m is adopted.

Table 7.2-3 Dimensions of Curve along No.3 Access Road

Intersection Point	Internal Angle	Radius of Curve(m)		Length of Curve (m)		Remarks
		Actual	Desirable	Actual	Minimum	
IP.1	8° 26' 00"	1,000	> 700	147.18	—	OK
IP.2	3° 05' 03"	1,000	> 700	53.82	—	OK
IP.3	15° 46' 48"	1,000	> 700	275.42	—	OK
IP.4	43° 11' 32"	1,000	> 700	753.84	> 170	OK
IP.5	38° 29' 10"	700	> 700	470.20	> 170	OK
IP.6	36° 56' 06"	600	< 700	386.78	> 170	Min. Radius : 460 m

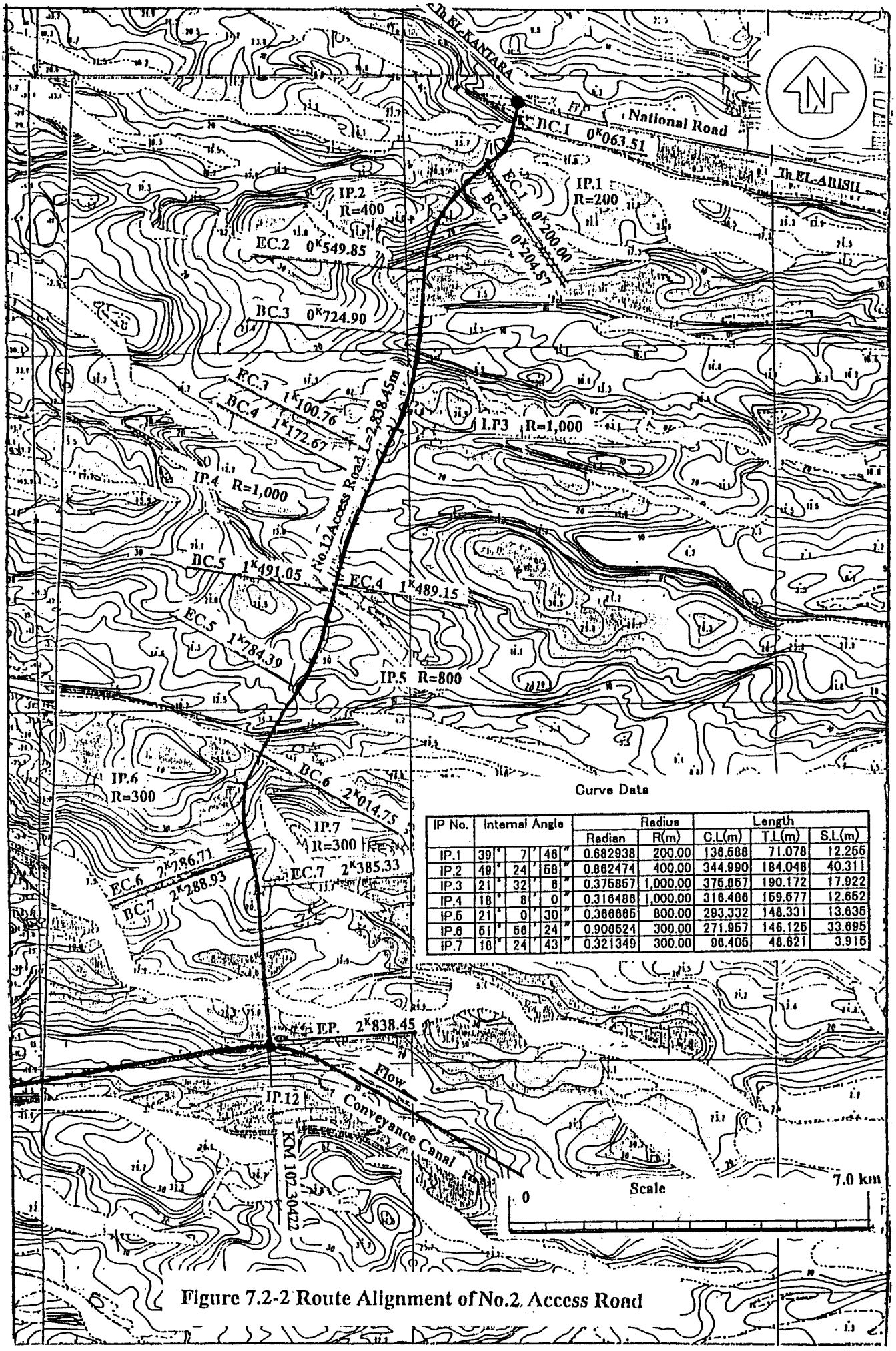
Note: Design speed should be 60 km/hr.

Route Alignments of No.1 ,No.2 and No.3 access road are shown in Figure 7.3-1,2,3, respectively.



IP No.	Internal Angle	Radius		Length		
		Radian	R(m)	C.L(m)	T.L(m)	S.L(m)
IP.1	23° 32′ 53″	0.410991	700.00	287.694	145.906	15.045
IP.2	23° 26′ 53″	0.408955	1,000.00	408.956	207.376	21.276

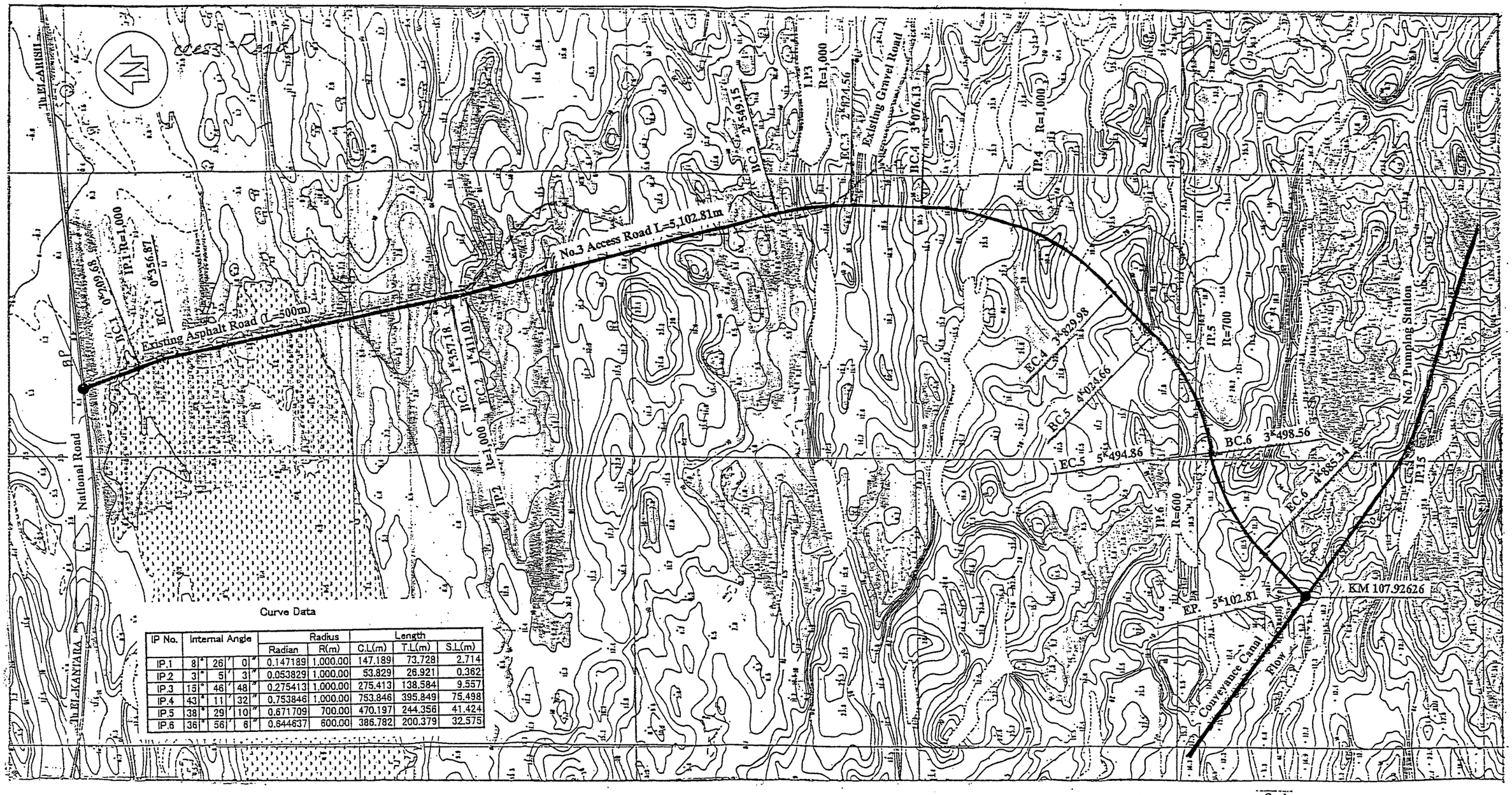
Figure 7.2-1 Route Alignment of No.1 Access Road



Curve Data

IP No.	Internal Angle	Radius	Length		
		Radian	R(m)	C.L(m)	T.L(m)	S.L(m)
IP.1	39° 7' 46"	0.682938	200.00	136.588	71.078	12.266
IP.2	49° 24' 56"	0.862474	400.00	344.990	184.048	40.311
IP.3	21° 32' 8"	0.375857	1,000.00	375.857	190.172	17.922
IP.4	18° 8' 0"	0.316486	1,000.00	316.486	159.677	12.652
IP.5	21° 0' 30"	0.366666	800.00	293.332	148.331	13.636
IP.6	51° 56' 24"	0.906524	300.00	271.957	146.126	33.695
IP.7	18° 24' 43"	0.321349	300.00	96.406	48.621	3.915

Figure 7.2-2 Route Alignment of No.2 Access Road



Curve Data

IP No.	Internal Angle				Radius		Length		
					Radian	R(m)	C.L(m)	T.L(m)	S.L(m)
IP.1	8°	26′	0″		0.147189	1,000.00	147.189	73.728	2.714
IP.2	3°	5′	3″		0.053829	1,000.00	53.829	26.921	0.362
IP.3	15°	46′	48″		0.275413	1,000.00	275.413	138.584	9.557
IP.4	43°	11′	32″		0.753846	1,000.00	753.846	395.849	75.498
IP.5	38°	29′	10″		0.671709	700.00	470.197	244.356	41.424
IP.6	36°	56′	6″		0.644637	600.00	386.782	200.379	32.575

Figure 7.2-3 Route Alignment of No.3 Access Road

7.3 Basic Design of the Road

7.3.1 Basic Design of Standard Section

(1) Road Width

The width of access road is as follows;

For vehicles	2 lanes	x 4.0 m	=	8.0 m
For shoulder	2	x 2.5 m	=	5.0 m
For protective shoulder	2	x 0.5 m	=	1.0 m
Total width				14.0 m

(2) Cross Slope

According to the design criteria of the Japanese government ordinance for road structures, the cross slope of the proposed road should be 2.0 percent.

(3) Cutting and Embankment Slope

The slope of the road cutting and embankment will be 1 to 3.0 in accordance with the practice in Egypt.

(4) Pavement Works

(a) Design Conditions

- Daily traffic capacity (large size vehicles)
  : A - traffic (100 - 250/day)
- Design CBR : 5 %
- Minimum thickness of each paved layer
- Surface course : 5.0 cm
  Base course : 10.0 cm
  Sub-base course : 10.0 cm

(b) Pavement thickness required (T_A)

$$T_A = \frac{3.84 \cdot N^{0.16}}{C.B.R.^{0.3}}$$

where, T_A : Thickness required (cm)
N : Number of wheels of vehicles passing for 10 years. (150,000 wheels/dir.)
C.B.R. : C.B.R. for road grade (5 %)

T_A is obtained as about 16 cm.

(c) Design Pavement Thickness

$T'_A = a_1 \cdot T_1 + a_2 \cdot T_2 + a_3 \cdot T_3$

where, T'_A : Design pavement thickness (cm)

T_1, T_2 & T_3 : Thickness of surface course, base course and sub-base course, respectively (cm)

a_1, a_2 & a_3 : Equivalent conversion coefficient of each course by 1.00, 0.35 and 0.20, respectively.

The pavement thickness of T_1, T_2 and T_3 will be 5 cm, 30 cm and 25 cm, respectively in accordance with the practice in Egypt.

$T'_A = 1.00 \times 5.0 + 30 \times 0.35 + 25 \times 0.20 = 20.5 \text{ cm} > 16.0 \text{ cm}$ OK.

(5) Tree Planting

(a) Open Canal

Tree planting on both side of the maintenance road as a countermeasure of the wind blown sand. Irrigation water is essential, and can be supplied from the conveyance canal when it is completed.

(b) Box Culvert and Pipeline

There is no fear of wind blown sand falling into the conveyance canal in the section of box culvert and pipeline. However, maintenance road is planned through the drifting sand dunes, and it is feared that those maintenance roads might be buried by the wind blown drifting sand. Countermeasure would be (1) protection roadside tree against wind blown sand, (2) extrusion of sand by bulldozers by the use of the maintenance road. The roadside tree requires irrigation water, which is essential and can be supplied from the box culvert and delivery pressured pipeline.

(c) Access Road

The access roads passing through the area of sand dunes have possibility to be buried with sand. Countermeasure would be (1) protection roadside tree against wind blown sand, (2)extrusion of sand by bulldozers by the use of the access road. The roadside tree requires irrigation water, which is not easy to get from the conveyance canal, and the efficiency is not sure against the drifting sand dune. Therefor, tree planting is not adopted for the access roads.

(d) Spillway Dike

The maintenance road of the spillway dike is planned in the area of low elevation. There is little possibility of being buried with sand because of no sand dune along the dike. Therefor, no countermeasure will be planned.

7.3.2 Typical Cross Section of the Road

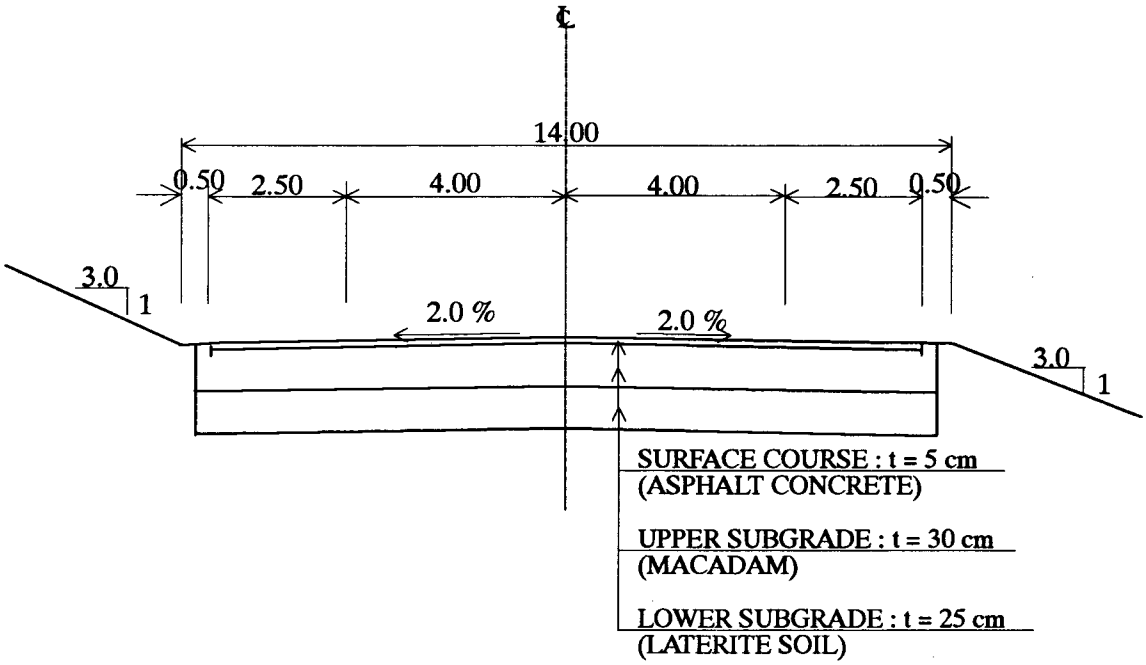


Figure 7.3-1 Standard Cross Section of Access Road

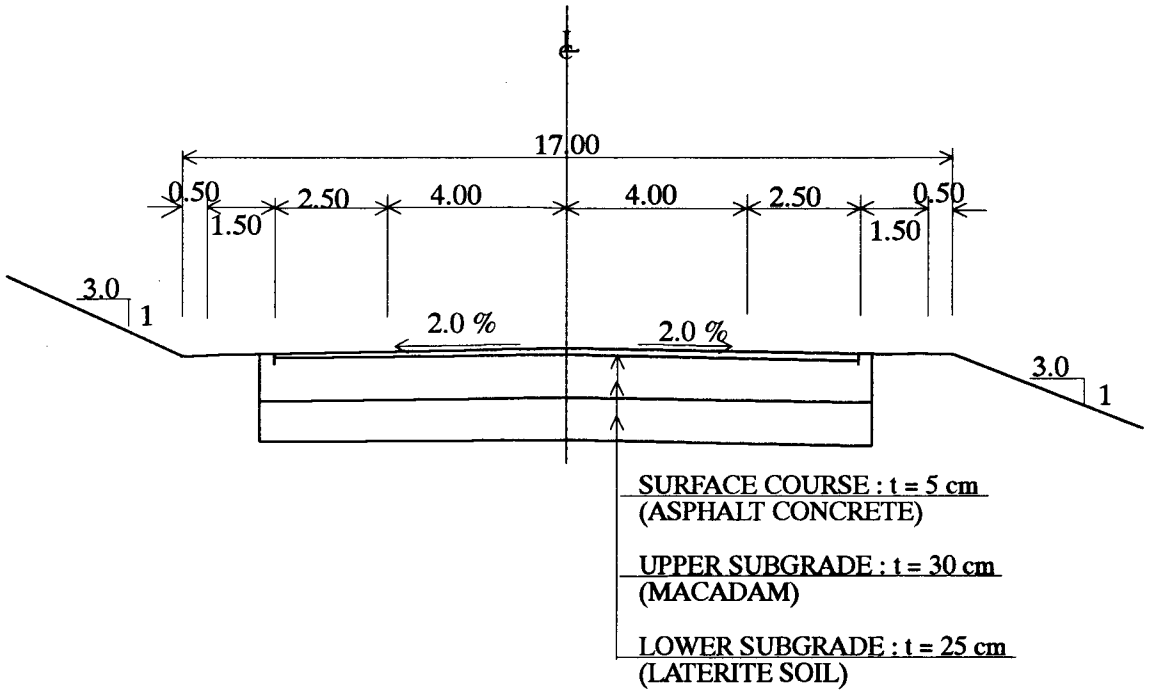


Figure 7.3-2 Standard Cross Section of Maintenance Road