

CHAPTER IV



APPLICATION OF THE HDM MODEL TO THE THA MADUK - SRI THEP PROVINCIAL ROAD

4.1 General Description of the Road:

The Ban Tha Maduk - Sri Thep has already been constructed, by the Productivity Road Office, Department of Highways, since 1977 in the construction project name of "Bua Chum - Ko Rang - Dong Chaniang - Na Sanun". The total length of this road is 30.5 kilometers and its highway registered number is Route No. 2275. The existing surface of this road is lateritic gravel surface and its carriage way width is 6 and 8 meters. The main proposal of this road in formerly decision making to construct were to served, expedited and facilitated the delivery of farm product to market place in all weather transportation.

For the responds of the objectives of National Economic and Social Development Plan, as described in chapter I, the Department of Highways (DOH) is contemplating to expand about 8,000 kilometers of additional provincial road networks by the target year of its Plan for Provincial Road Construction and improvement (1977-1981).

The proposed Phetchabun - Chai Badan Highway Project is a part of the above-mentioned government program. The feasibility study of this project was done by the Japan International Cooperation Agency (hereinafter referred to as JICA), as the request of the DOH, and completed in March, 1979. The JICA was recommended that the Royal Thai Government will

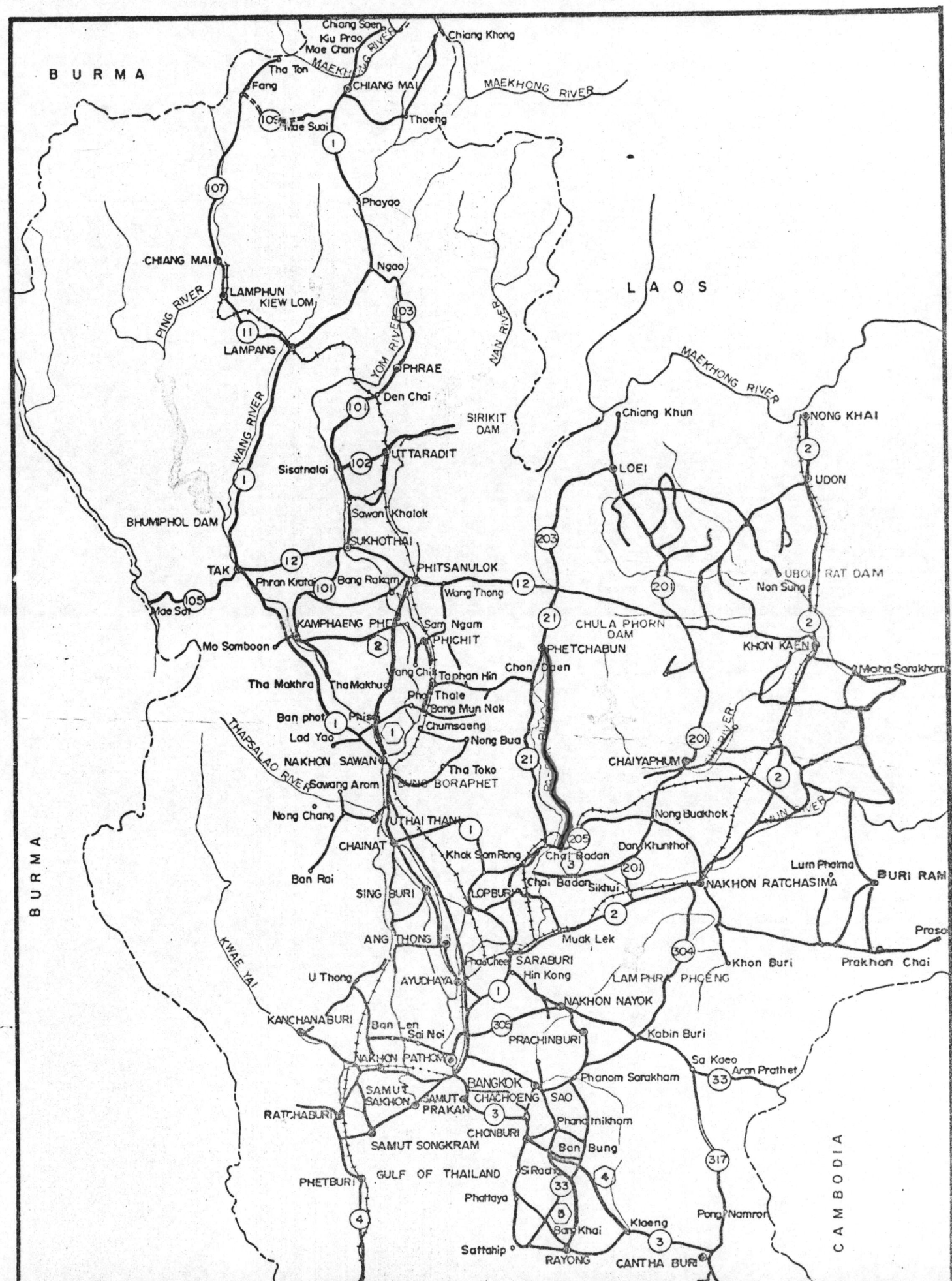
proceed to the further steps for the implementation of the project so as to open the proposed road to traffic in 1983 as planned.

In the JICA feasibility study, there are many route alternatives were formulated for connecting Phetchabun Province and Chai Badan District, and after, the optimum route (most economic route) was selected based on economic comparison of route alternatives. The selected route runs in north-south direction in flat terrain about five kilometers east of the Pasak River. After diverging from the National Highway Route 205 at Tha Maduk, it runs north and reaches Phetchabun via Rang Yoi, Sri Theps, Wichian Buri, Nong Daeng, Na Khao Do, Rawing, Tham Nam Bang and Nam Ron. Out of the total length of 157.4 kilometers, the route includes only 10 kilometers new construction for the section between Na Khao Do and Rawing. Location of this route is shown in Figure 4.1.

The recommended surface types of this road, based on the DOH's minimum design standards for provincial roads, especially, based on the average daily traffic (ADT), are bituminous surface treatment and soil aggregate surface, in the percentage of length are 62% and 38% respectively.

4.2 Objectives of the HDM Model application

The detailed design works are being made for the above-mentioned highway project and will be already completed in August 1980. The Standards of for designing were specified by DOH, referred to JICA recommendations. The stage construction is scheduled, by DOH, to begin in January 1981. The road construction would be already completed in quite short period to accomplished the objectives of National Development plan, thus



to respond this propose, the construction is separately done in five sections as Tha Maduk - Sri Thep, Sri Thep - Wichian Buri, Wichian Buri - Noen Sadao, Noen Sadao - Yang Lat, and Yang Lat - Phetchabun. The detailed engineering is also separated.

Because of the economic studys of this project were based on route alternative comparisons for search out the most economic route and had only one road improvement type, new construction, for computing of initial investment cost, therefore the initial construction cost may be unrealized cost due to unsuitable type of road improvement. Thus, to search out the most appropriate type of road improvement specified to each road section, the economic analysis must be done based on comparison of road improvement alternatives. The HDM model can then be use to find out this propose.

Based on the above - mentioned reasons, the objectives of this present research study, by application of the HDM model, are formulated into two cases as follows:

- i) To determine the most theoretical suitable type of road surface improvement for the Tha Maduk - Sri Thep provincial road, to which was selected as a representative road that the HDM model is applied.
- ii) To determine the most theoretical suitable maintenance policy and maintenance standards those would be applied after the completion of road construction.

4.3 Geography

The study area extends over two provinces; the Phetchabun Province in the southeastern end of the Northern Region and the Lop Buri Province in the northeastern end of the Central Region of the Kingdom.

Out of total 14 districts in the provinces, only the following six districts are related to the study area: Muang Phetchabun District, Nong Phai District, Bung Sam Phan Subdistrict, Wichian Buri District, Sri Thep Subdistrict and Chai Badan District. The area covered by these six related districts (hereinafter called as the "Study Area") occupies 9,475 square kilometers extending around 70 kilometers in the east-west direction and stretching about 50 kilometers from the north to the south.

In the middle of the Study Area, the Pasak River meanders down from the north to the south. The National Highway Route 21 runs in parallel with the west bank of the Pasak River. The topography of the Study Area is flat in the western part of the Pasak River while the east side consists of flat and undulating terrain. In the southern part, the average elevation of low land is about 60 meters above sea level and it gradually ascends to 100 meters in the northern part.

4.4 Climate

The climate of the Study Area is tropical and monsoonal. It is characterized by a distinct wet season (May-October) and dry season (November - April). Temperature is warm and hot throughout the year, ranging from 30 °C in April to 23 °C in December, and suitable for growing crops. Almost 90 percent of annual rainfall, 1,100 millimeters in average,

concentrates in wet season. For example, the mean monthly rainfall varies from 1.0 millimeter in December and more than 232 millimeters in September averaged in the year of 1973-1975. Hence, little dry season cropping is possible without irrigation system.

4.5 Land Use

Present land use in the Study Area is summarized as follows:

	(Km ²)	
Paddy field	340	(16%)
Maize land	440	(21%)
Forest	510	(25%)
Idle (Vacant) land	20	(1%)
Paddy and Maize land	50	(2%)
Forest and Maize land	720	(35%)
Total	2,080	(100%)

Major characteristics of the land use in the Study Area are briefly mentioned below.

- Paddy field occupies the alluvial plains.
- Around 8 percent of paddy field is cultivated for mung and soy beans and sesame as second crops.
- Maize land cover the terrace between the Pasak River and Mountains; more intensive for mountainous side in the northern part, and more intensive in lowland area in the central and southern part of the Study Area.

- The percentage of forest mixed with maize land is larger in southern part of the Study Area. Consequently, new cultivable land for upland crops, especially for maize, extend widely in the southern part.
- About 30 percent of maize land is cultivated for mung and soy beans and sesame as second crops.
- The forest land on undulating and rolling topography in the southern part of the Study Area is not yet used but has high potential for new cultivation.
- The forest land in mountainous area is not used for agricultural crops due to steep slope and shallow thickness of soil. It should be maintained as a forest reserve to protect from erosion, ecological distortion, etc.
- The forest land on isolated hill is also not used for agricultural crops, because those hill, is mostly of weathered limestone.

4.6 Population

The past records of population are available at District level. Those of the related districts, in which the Study Area is included, are shown below.

Population of the Related Districts

District	(Persons)		
	1972	1974	1977
Phetchabun	107,449	120,385	123,724
Nong Phai*	133,026	141,508	154,346
Wichian Buri	68,923	75,760	82,551
Sri Thep	47,119	49,666	48,541
Sub-total	<u>356,517</u>	<u>387,319</u>	<u>409,162</u>
Chai Badan	86,224	94,641	n.a.
Total	442,741	481,960	-

* including Bung Sam Phan

The population density in the related Districts was, in average, 56 person per square kilometer in 1977. Within the whole related Districts, the density of the east bank area of the Pasak River (the Study Area) is lower than that of the west bank area, because of the delay of development. The average population growth of the related Districts was 4.34 percent per annum in 1972-1974 period. In 1974-1977 period, it decreased to 1.85 percent, which was lower than the national average of 2.6 percent.

To find the population of the Study Area, further divided population data is required. Though the population data at Tambon (sub-district) level was collected from District Offices, some discrepancies of the boundaries of Tambons were found in the information obtained from these

offices. The population of the Study Area was estimated, therefore, based on the collected population data at Tambon level adjusting with the population of Districts as control total. The estimated population of the Study Area (Project Area) is 50,800 in 1977 as shown in Table 4.1.

4.7 Economic Activities

As more than 95 percent of the Study Area belongs to Phetchabun Province, the economic characteristics of the Area be represented by those of the Province.

Agriculture is the most predominant sector in the economy of the Study Area. Gross Regional Product (GRP) of the Province in 1977 was estimated at 4,019.6 million Bahts of which 2,486.5 million Bahts or 62 percent came from agricultural sector. Agricultural sector absorbs about 84 percent of the total labor force. Although manufacturing sector shares 10 percent of the Province's GRP, almost none of manufacturing activities are seen in the Study Area. Per capita GRP of the Province was 5,500 Bahts in 1977.

As the Province produce big volume of cash crops such as maize and beans to be shipped to Bangkok, trading business is quite active in the Province. In the Study Area, major commercial centers are concentrated in the specific spots along the Route 21. Hence, the present economic activities between the inside of the Study Area and the outside of it are mainly in east-west movement crossing the Pasak River. However, in rainy season, due to the flooding of the Pasak River and its tributaries and lack of complete route in north-south direction linking to Route 205,

TABLE 4.1
POPULATION IN PROJECT AREA (1977)

CHANGWAT PHETCHABUN		<u>146,200</u>
AMPHOE PHETCHABUN		28,200
Tambon Chon Prai	5,000	
" Na Yon	3,800	
" Na Pa	6,200	
" Tha Bo	5,100	
" Nam Ron	5,900	
" Huai Sakae	2,200	
AMPHOE NONG PHAI		47,600
Tambon Bo Thai	9,400	
" Tha Dang	16,600	
" Phet Lakhon	11,200	
" Sap Bon	10,400	
AMPHOE WICHIAN BURI		42,500
Tambon Tha Rong	17,500	
" Bo Rang	8,600	
" Kok Prong	9,300	
" Nam Ron	7,100	
AMPHOE SI THEP		27,900
Tambon Si Thep	17,200	
" Na Sanim	6,500	
" Nong Yai Toai	4,200	
CHANGWAT LOP BURI		<u>4,600</u>
AMPHOE CHAI BADAN		4,600
Tabon Koa Rang	4,600	
WHOLE PROJECT AREA		<u>150,800</u>

SOURCE : JAPAN INTERNATIONAL COOPERATION AGENCY., VOL.1., Final Report., 1979.

economic interchange between the Study Area and the outer area can hardly be performed. Under these circumstances, improvement of all-weather road network to connect the Study Area with outer area especially in north-south direction is quite necessitated to activate the economic movement in the Area.

4.8 Agriculture

4.8.1 Agricultural Production

i) Cropping Patterns and Cultivated Area

Major crops in the Study Area are maize, rice, mung beans and soy beans. According to the statistical data in 1976, these crops covered more than 90 percent of the total cultivated area in the Study Area, 3.2 million rai. The other minor crops are sorghum, groundnuts, cotton, sesame, vegetable and fruits. As same as beans, these crops except cotton are planted mainly as second crops of maize and paddy fields.

ii) Crop Production and Average Yield

A great majority of crop production volume in the Phetchabun Province is shared by maize, rice and beans. Their production volume in 1976 were 624,000 tons, 340,000 tons and 90,000 tons, respectively, and their share in the total production in whole Kingdom were 23 percent, 2.3 percent and 36 percent, respectively.

Average annual yield per rai of the main crops in the Study Area are shown below.

Average Yield of Major Crops in Study Area*

	(kg/rai)
Paddy	344
Maize	321
Mung Bean/Soy Bean	133

* 1975 - 1977 average

4.8.2 Farm economy

i) Crop Production Cost

Referring to the information obtained in the field survey in 1978, the current production costs of major crops in the Study area were estimated as follows:

Maize

Guatemala or Local variety	β 440/rai
Suwan I	β 470/rai
Paddy	β 485/rai
Beans	β 540/rai

ii) Farm Income

Average holding of cultivation land by one household with six person in the Study Area is about 25 rai. Under the above conditions, the current farm incomes of typical maize farm and rice farm in the Study Area were estimated as follows:

Farm Incomes of Typical Farms

	Cultivation Area (rai)	Net Value of Production (Baht)
<u>Maize Farm</u>		
Maize		
Guatemala & Local	20	1,440
Suwan I	5	850
Beans	7	1,323
Other second crops	3	<u>546</u>
Total		4,159
Rice Farm		
Paddy	25	5,375
Beans	2	378
Other second crops	1	<u>182</u>
Total		5,935

As shown in the above, income of farms, even rice farm, is quite low. Reduction of transportation costs brought by a construction of new road and introduction of new varieties, fertilizer and agro-chemicals will contribute to the increment of farm incomes.

4.9 Transportation

Main transportation system in the Study Area is land transportation. In flooding season, however, tentative boat services supplement the unpassable roads crossing over the Pasak River and its tributaries.

Based on the field survey in the Study Area, the characteristics of present transportation are summarized as follows:

4.9.1 Freight Traffic

- Agricultural products are collected primarily to villages by carts or tractors. Average distance of primary transportation ranges from 1-3 kilometers.
- Agricultural products are transported secondarily to the assembly centers located along the route 21 mainly by small trucks due to rather worse trafficability. The secondary transportation in rainy season has to take sometimes along trips using only certain better roads still depending on the weather conditions.
- Lacking any all-weather road in the Study Area, the traffic in rainy season, especially in heavy flooding

period, is tremendously interfered. Sometimes cargoes have to be reloaded to small boat to cross over the flood rivers. Further, they have to spend long time to pass there including waiting time and consequently they suffer losses by deterioration of products' quality and by missing sales opportunity in high prices.

- Averaged and maximum distance of secondary transportation is about 10 and 30 kilometers, respectively. The freight charge of secondary transportation of agricultural products per average 10 kilometers ranges from 3.5 Bahts per 100 kilograms on better conditioned roads to 14 Bahts on bad roads.
- Agricultural products are transported thirdly to the terminal markets in the outside of the Study Area, to Bangkok (10-30%) or Tha Rua (70-90%) in case of maize and beans, by large trucks on paved national highways including the Route 21.
- The freight charge of third transportation of agricultural products is about 4 Bahts per 100 kilograms per 100 kilometers. The freight charge of third transportation per kilometer is about 1/10 of that of secondary transportation.
- Necessary goods for living of inhabitants in the Study Area are being transported by the returning trucks from Bangkok to the Study Area. The tonnage of necessary

goods is about 1/10 of the agricultural products transported to Bangkok only.

- Other products in the Study Area than crops, such as pigs, chicken, charcoal, firewood are being transported mainly together with the inhabitants in the same buses or trucks.

4.9.2 Passenger Traffic

- About 95 percent of passenger traffic going out and coming from the outside of the Study Area has its destination and origin in the towns along the Route 21 between Phetchabun and Lam Narai and Wichian Buri.
- The Transportation mode of passenger is mainly light bus (or modified truck) of capacity from 8 to 20 persons. It allows to load some goods including charcoal, chicken and so on.
- In rainy season, many passengers are crossing the Pasak River and its tributaries partially on foot and partially on small wooden boats.

4.10 Road Links and Road Standards

4.10.1 Road Links

Road Link is used as the basic unit for traffic forecast, calculation of road users' cost savings and estimation of construction and road maintenance costs. Each road link is assumed

to have uniform conditions in traffic volume and road surface condition over its length, and can be divided into sections. A section is assumed to have constant terrain, climate, road geometrics, subgrade, surface type and condition. The computational procedure for these data are described below.

- a) Terrain: The average altitude of the section is a main data in the terrain, it is calculated by averaging the height of points of vertical intersection (P.V.I) over all the section.
- b) Subgrade: The finished subgrade CBR is the main data needed.
- c) Weather: There are two data required, viz, annual rainfall intensity, period of dry and wet season.
- d) Road geometric: The geometry of the section is described by road rise and road fall, the average degree of horizontal curvature, width of carriageway, and width of each shoulder.
 - Road rise and road fall is calculated by accumulating the rise and fall among elevations of point of vertical intersection (P.V.I) within the section and divided by the length of the section.
 - Average degree of horizontal curvature is calculated by summing the deflection angle within the section and divided by the section length.

- e) Surface Type: The data required are carriage way, surface thickness, shoulder surface thickness, and structural number.
- f) Condition: The condition of road can be described by roughness, rut depth, present serviceability index (PSI), surface cracking.

4.10.2 Road Standards

Department of Highways has separate design standards for Primary Highways, Secondary Highways and Provincial Roads. For the studied road, as this is classified into the Provincial Road, the Standard for Provincial Roads is to be applied. The Standards of Provincial Roads are subdivided into seven road classes from F_D to F_6 , according to the projected ADT, as shown in Table 4.2.

TABLE 4.2

MINIMUM DESIGN STANDARDS
FOR PROVINCIAL ROADS

1. Access control : When designated under the Highway Law.
2. Highway Crossing : Grade Separation only after proven viable by economic feasibility calculations.
3. Railroad crossing : Grade Separation only after proven viable by economic feasibility calculations.
4. Bridge width (1) : 8 m. for F₁ & F₂ , 7 m. for F₃ to F₆
5. Vertical clearance = 4.50
6. Design bridge loading = HS 20
7. Pavement design shall be based on the accumulated number of equivalent axle load predicted during the first 7-year after construction.
8. Follow AASHO recommendation for any design details not separately specified.

Class (5)	F _D	F ₁	F ₂	F ₃	F ₄	F ₅	F ₆
Average Daily Traffic (5)	Above 8,000	4,000-8,000	2,000-4,000	1,000-2,000	300-1,000	← Below 300 →	
Design Speed k.p.h. (2)							
Flat and moderately rolling		70	90		60-80	60	
Rolling and hilly		55	70		45-60	45	
Mountainous		40	55		30-45	30	
Maximum Gradient % (3)							
Flat and moderately rolling			6		8	12	
Rolling and hilly			8		10	12	
Mountainous			10		10	12	
Suggested Surface Type							
Width of Carriageway m.	High		Intermediate		Low	Soil Aggregate	
Width of Shoulder m.	Divided 2@ 7.00 2.50	7.00 2.50	6.50 2.25	6.00 2.00	5.50 1.75	9.00	6.00
Right of Way m. (4)		40	60			Travelled way 20 - 40	Travelled way

Explanatory Notes

1. Any F_D, F₁ or F₂ road that planned to be raised to national highway system in the future, bridges less than 15 m. long shall be to the full roadbed width.
2. Design speed may be relaxed in exceptional circumstances on account of right of way difficulties or mountainous terrain.
3. Refer to the AASHO Policy on Geometric Design of Rural Highways to relate desirable grade lengths, climbing lanes, etc.
4. May be reduced in urban or semi-urban conditions at the discretion of the Department provided that a suitable cross section including service roads, where necessary, is obtainable.
5. Class F_D roads are required on the basis of a 7-year ADT projection or be justified by economic feasibility calculations. Class F₁ to F₃ roads are required on the basis of a 15-year ADT projection. Class F₄ roads have a projected

ADT more than 300 in 7 years and less than 1,000 in 15 years. Class F₅ roads have a projected ADT less than 300 in 7 years and more than 300 in 15 years. Class F₆ roads have a projected ADT less than 300 in 15 years.

Remark

In special cases, the Department may reduce the carriageway width to 3.5, 4, 4.5 or 5 m. on various roadbed widths, i. e. 5 m. on 7 m. roadbed width. Such the case the class of the road will be defined as class F₄ (5/7). If the geometric standard of the road section in the said case below than F₄ then the road class will be defined as F (4) (5/7).

For laterite road the travelled way width may be reduced from 9 m. to 7 m. and the standard will be defined as class F₅ (0/7).