Annex A

ASEAN Highway Network

The overall route configuration of the ASEAN Highway Network is shown in Figure 1. The highway network comprises 23 routes involving some 38,400 kilometers is also in Figure 2a and 2b. Details of each highway route are presented in Table 1.

The route numbering system in this Annex is tentative and presented for reference purposes only Finalization of the route numbering system will be undertaken in due course, following the guidelines adopted in the Fourth ASEAN Highway Expert Meeting (4th AHEM) held in Hanoi, Vietnam on 20-21 August 1999.

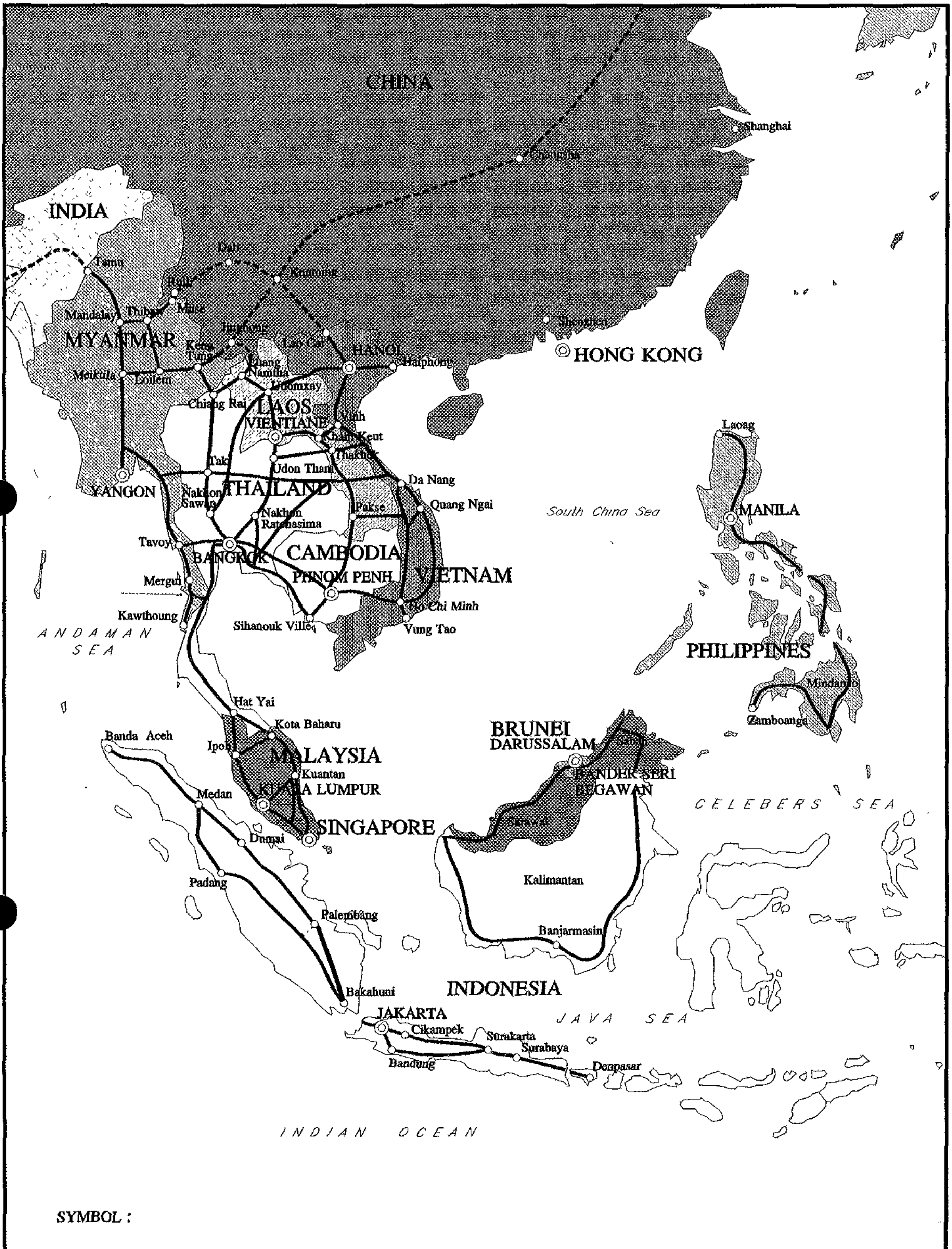

Fig. 1 ASEAN HIGHWAY NETWORK

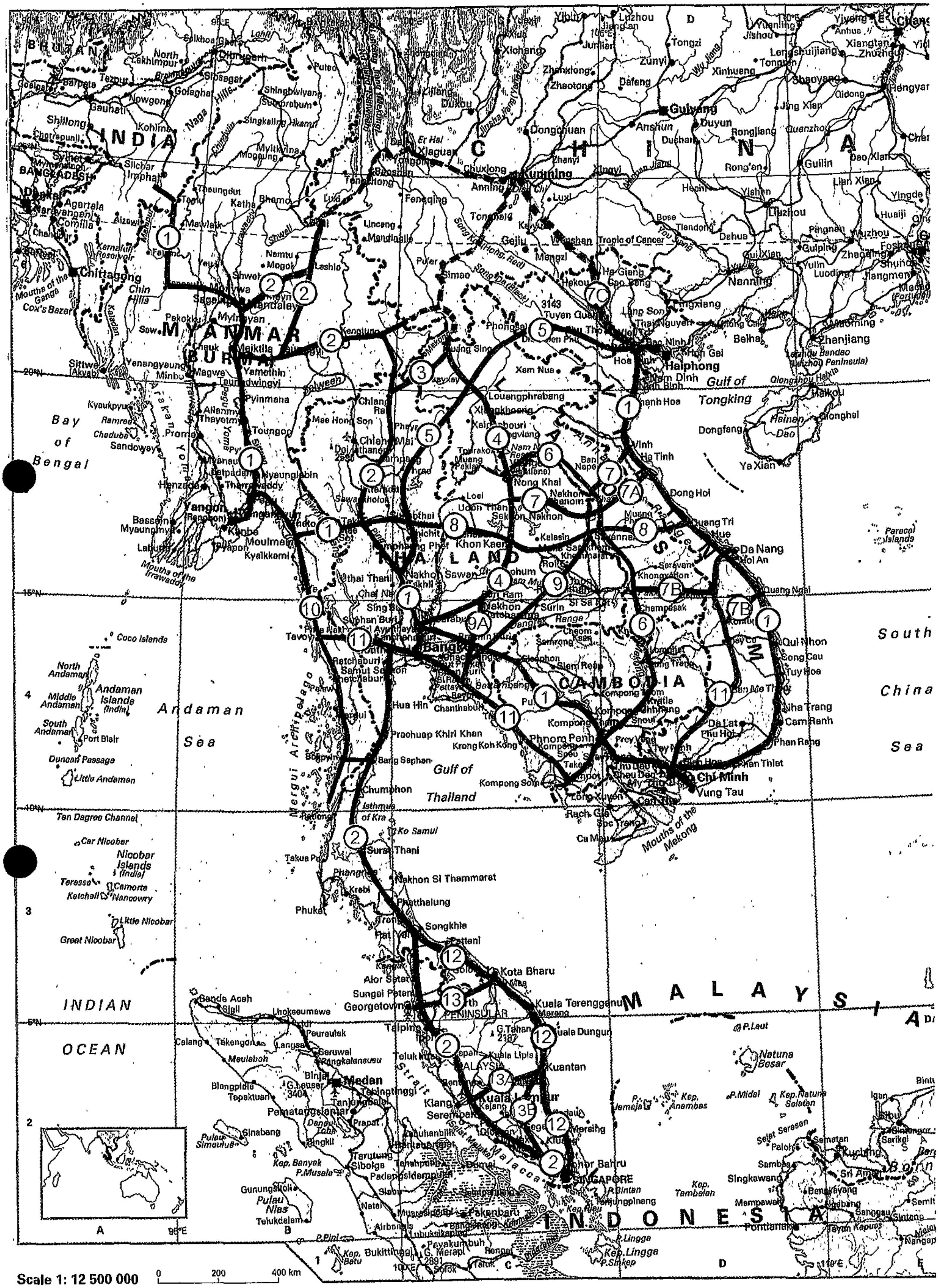

Fig. 2A ASEAN HIGHWAY NETWORK (Mainland)

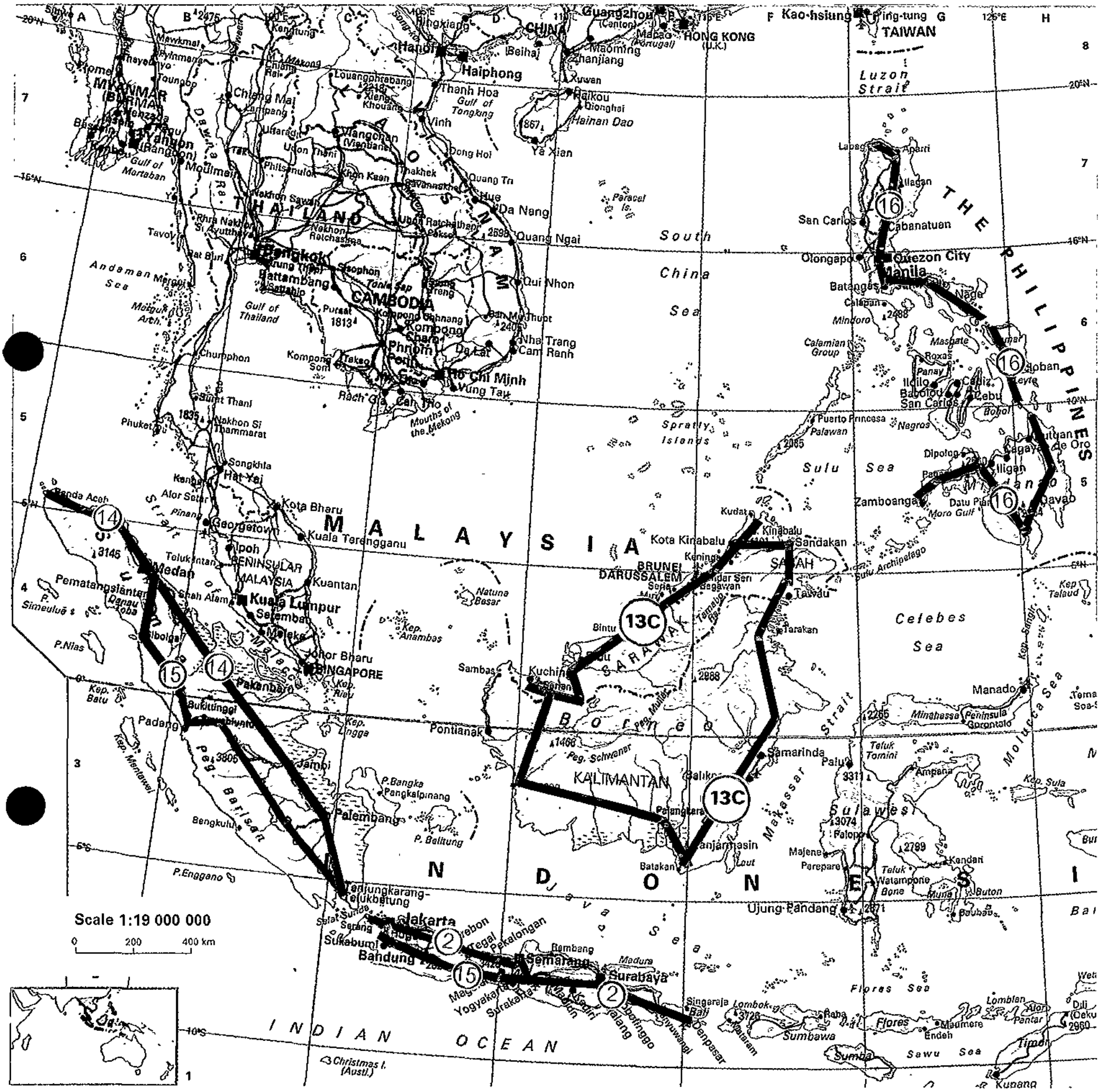

Fig. 2B ASEAN HIGHWAY NETWORK (Islands)

<u>Table 1</u>

ASEAN Highway Network

No.	Origin - Destination	Criteria
1	Tamu (Myanmar / India Border) - Mandalay - Payagyi (Including Payagyi - Yangon) - Myawadi / Mae Sot (Myanmar / Thailand Border) - Tak - Bangkok - Aranyaprahet / Poi Pet (Thailand / Cambodia Border) - Sisophon - Phnom Penh - Bavet / Moc bai (Cambodia / Vietnam Border) - Ho Chi Minh City (Including Dong Nal - Vung Tau) - Danang - Hanoi - Haiphong	Capital - Capital
2	Muse (Myanmar / China Border) - Thibaw - Mandalay - Meiktila - Loilem (Including Loilem - Thibaw) - Keng Tung (Including Keng Tung - Monglar) - Thackileik / Mae Sai (Myanmar / Thailand Border) - Tak - Bangkok - Chumphon - Hat Yai - Sadao / Bukit Kayu Hitam (Thailand / Malaysia Border) - Ipoh - Kuala Lumpur - Seremban - Tanjung Kupang/ Tuas (Malaysia / Singapore Border 2nd link) (Including Johor Bahru - Malaysia / Singapore Border 1st link) - Singapore - (Ferry Service) - Jakarta (Indonesia) - Semarang - Surakarta - Surabaya - Denpasar	Capital - Capital
3	Boten (Lao PDR / China Border) - Luang Namtha - Huai Sai / Chiang Khong (Lao PDR / Thailand Border) - Chiang Rai	Linkage to China
4	Natrey (Lao PDR) - Oudomsay - Luang Phrabang - Vientiane - Thanalaeng / Nong Khai (Lao PDR/Thailand Border) - Khon Kaen - Saraburi - Bangkok	Capital - Capital
5	Hanoi (Vietnam) - Tay Trang / Deo Tay Chang (Vietnam / Lao PDR Border) - Oudomsay - Pak Beng - Muang Ngeon / Huaikon (Lao PDR / Thailand Border) - Nan - Phitsanulok - Nakhon Sawan	Seaport - Capital

No.	Origin - Destination	Criteria
6	Vientiene (Lao PDR) - Savannakhet - Muang Khong/Veun Kham (Lao PDR / Cambodia Border) - Streng Treng - Phnom Penh - Sihanoukville Port	Capital - Capital
7	Vinh (Vietnam) - Keo Nua/Nape (Vietnam/Lao PDR Border) - Laksao - Ban Lao - Thakhek / Nakhon Phanom (Lao PDR / Thailand Border) - Udon Thani	Seaport - Major City
7A	Vung Ang Port (Vietnam) - Mu Ghia (Vietnam / Lao PDR Border) - Thakhek	Seaport - Major City
7B	Quang Ngai Port - Kontum - Ban Het (Vietnam / Lao PDR Border) -Attapeu - Pakse	Seaport - Major City
7C	Hanoi (Vietnam) - Lao Cai (Vietnam/China Border)	Capital - China
8	Tak (Thailand) - Khon Kaen - Mukdahan / Savannakhet (Thailand / Lao PDR Border) - Lao Bao (Lao PDR / Vietnam Border) - Dong Ha	Major City - Seaport
9	Savannakhet / Mukdahan (Lao PDR / Thailand Border) - Yasothon - Buriram - Sakaeo - Phanom Sarakham - Sattahip	Seaport - Seaport
9A	Phnom Sarakham - Kabinburi - Pakthongchai - Nakhon Ratchasima	Seaport - Lao PDR
10	Thaton (Myanmar)-Mawlamyine - Tavoy - Mugui - Lenya - Kawthong (including Lenya-Khlong Loy (Myanmar/Thailand Border) - Bang Saphan)	Country's back bone - port
11	Tavoy (Myanmar) - Sinptyutang/Bong Ti (Myanmar/Thailand Border) - Kanchanaburi - Bangkok - Laem Chabung - Maptaput - Hat Lek/Koh Kong (Thailand/ Cambodia Border) - Sre Ambel - Ho Chi Minh City - Kontum - Danang	Seaport - Seaport

No.	Origin - Destination	Criteria
12	Hat Yai (Thailand) - Pattani - Narathiwat - Sungai Kolok / Rantau (Thailand/Malaysia Border) - Kota Bharu - Kuala Terengganu - Kuantan - Mersing - Johore Bahru (Malaysia/Singapore Border) - Singapore	International linkages Major City - Major City
13	Kota Bharu (Malaysia) - Sungai Patani (Malaysia)	Country's back bone
13A	Port Klang (Malaysia) - Kuala Lumpur - Kuantan (Malaysia)	Seaport - Seaport
13B	Kuantan (Malaysia) - Segamat - Yong Peng (Malaysia)	Major City - Major City
13C	Kuching (Malaysia, Sarawak) - Serian - Bintulu - Miri - Sg. Tujoh (Malaysia/Brunei Darussalam Check Point) - Brunei Darussalam - Kuala Lurah (Brunei Darussalam/MalaysiaCheck Point) - Limbang / Puni (Malaysia / Brunei Darussalam Check Point) - Brunei - Labu (Brunei / Malaysia Check Point) - Lawas - Sindumin - Kota Kinabalu - Sandakan - Lahad Datu - Tawau - Serudong/Nunukan (Malaysia, Sabah / Indonesia Border) - Samarinda - Banjarmasin - Palangka Raya - Pontianak - Entikong/Tebedu (Indonesia/Malaysia,Sarawak Border) - Serian	Major City - Capital City in Pan Borneo Island
14	Banda Aceh (Indonesia) - Medan - Dumai - Palembang - Bakahuni	Country's back bone
15	Tebingtinggi (Indonesia) - Padang - Bakahuni - (Ferry Service) - Merak - Jakarta - Bandung - Jogyakarta - Surakarta (Indonesia)	Major Cities-Major Cities
16	Laoag City (Philippines) - Manila - Matnog - (Ferry Service) - San Isidro - Taeloban City - Liloan - (Ferry Service) - Lipata - Surigao City - Davao City - General Santos City - Zamboanga City (Philippines)	Country's back bone

ANNEX B

ASEAN HIGHWAY STANDARDS

Table I ASEAN Highway Standards

Highway classification		Primary (4 or more lanes) (control access)			Class I (4 or more lanes)		
Terrain classification		**L**	**R**	**M**	**L**	**R**	**M**
Design speed (km/h)		100-120	80-100	60-80	80-110	60-80	50-70
Width (m)	Right of way	(50-70) ((40-60))			(50-70) ((40-60))		
	Lane	3.75			3.50		
	Shoulder	3.00		2.50	3.00		2.50
Min. horizontal curve radius (m)		390	230	120	220	120	80
Type of pavement		Asphalt/cement concrete			Asphalt/cement concrete		
Max. superelevation (%)		(7) ((6))			(8) ((6))		
Max. vertical grade(%)		4	5	6	5	6	7
Min. vertical clearance (m)		4.50 [5.00]			4.50 [5.00]		
Structure loading (minimum)		HS20-44			HS20-44		

Highway classification		Class II (2 lanes)			Class III (2 lanes)		
Terrain classification		**L**	**R**	**M**	**L**	**R**	**M**
Design speed (km/h)		80-100	60-80	40-60	60-80	50-70	40-60
Width (m)	Right of way	(40-60) ((30-40))			30-40		
	Lane	3.50			3.00[3.25]		
	Shoulder	2.50		2.00	1.50[2]		1.0[1.5]
Min. horizontal curve radius (m)		200	110	50	110	75	50
Type of pavement		Asphalt/cement concrete			Double bituminous treatment		
Max. superelevation (%)		(10) ((6))			(10) ((6))		
Max. vertical grade(%)		6	7	8	6	7	8
Min. vertical clearance (m)		4.50			4.50		
Structure loading (minimum)		HS20-44			HS20-44		

Note: 1. Abbreviation : L = Level Terrain M = Mountainous Terrain R = Rolling Terrain

2. ( ) = Rural (( )) = Urban 3. [ ] = Desirable Values

4. *The right of way width, lane width, shoulder width and max. superelevation rate in* urban or metropolitan area can be varied if necessary to conform with the member countries design standards.

ASEAN HIGHWAY DESIGN CRITERIA

1) Classification

ASEAN Highways shall be classified as shown in table 2

Table 2
Classification
(Based on Asian Highway Standards by ESCAP 1995)

Classification	Description	Pavement Type
Primary	Access controlled motorway	Asphalt or cement concrete
Class I	4 or more lanes highway	Asphalt or cement concrete
Class II	2 lanes	Asphalt or cement concrete
Class III	2 lanes (narrow)	Double bituminous treatment

"Primary" class in the new classification is the access controlled motorway Access controlled motorway shall be used exclusively by automobiles. Access to motorway shall be done at grade-separated interchanges only. Motorcycles, bicycles and pedestrians shall not be allowed to enter motorway in order to ensure traffic safety and the high running speed of automobiles except when domestic legislation and regulation allow At-grade intersections shall not be designed on motorway, and carriageway shall be divided by median strip. This class was newly included in the classification in view of the recent development of motorways in the member countries.

Class III can be used only when the funding for the construction and/or land for road is limited. The type of pavement should be upgraded to asphalt concrete or cement concrete as soon as possible in the future. Since Class III is also regarded as the minimum desirable standard, upgrading of any road sections below Class III to comply with the Class III standard should be encouraged.

Future traffic volume projected for 20 years after completion of road construction/ improvement (called Projected daily traffic volume hereinafter) should be used to determine the class of road as described below.

It is recognized internationally that the presence of heavy vehicles and slow-moving vehicles greatly influence the design of a highway. Therefore, in this classification, It is proposed to use the approach of "Passenger Car Unit (pcu)" which is widely used for design purposes in Asian countries. The flow coefficients shown in table 3 are used to convert vehicles into "Passenger Car Unit":

Table 3
Flow coefficients

Vehicle type	Flow coefficient
Bicycles	0.5
Motorcycles	0.5
Light, commercial motor vehicles (gross weight 10 tons)	1
Passenger cars	1
Trucks and buses	2
Semi-trailers and trailers	3

The traffic volume of light vehicles does not need to be taken into account if exclusive lanes for light vehicles are provided. Flow coefficients for heavy vehicles can be increased if the road is located in a mountainous area.

Class of road is_determined as follows using "pcu" as an index representing traffic volume:

i) Determine "PDT" or "projected daily traffic volume (pcu/day)" using projected traffic volume by vehicle type (vehicle/day) and flow coefficients.

ii) Determine "K value" which is the ratio of the 30th highest hourly traffic volume over one year (pcu/hour) to annual average daily traffic (pcu/day). Traffic count data on a road section which has similar characteristics to planned road can be used. K value is usually around 0.10.

iii) Determine "D value" which is the ratio of heavy directional- peak hour (30th highest) traffic volume (pcu/hour) to both directional peak hour (30th highest) traffic volume (pcu/hour). D value usually ranges from 0.55 to 0.60.

iv) Calculate "PPHT" or "planning peak hour traffic volume (pcu/hour)" using a formula PPHT = PDT x K x D. PPHT represents projected heavy directional 30th highest hourly traffic volume (pcu/hour).

v) Divide PPHT (pcu/hour) by 1,800 (pcu/hour) which is widely recognized as standard capacity per one lane and round up the calculated value to determine number of lanes in one direction. Multiplying by 2 gives the required number of lanes (both directions).

vi) Determine the class according to the required number of lanes determined in step v). "Primary" class can be used if the development of access controlled motorway is needed.

2) Terrain classification

Terrain classifications shown in table 4 shall be used.

Table 4
Terrain classification

Terrain classification	**Cross Slope**
Level (L)	0 to 9.9%.
Rolling (R)	10 to 24.9%
Mountainous (M)	25 or more than

3) Design speed

The relation between design speed, highway classification and terrain classification is shown in table I Design speed of 120 km/h shall be used only for Primary class (access controlled motorways) which have median strips and grade separated interchanges. Recommended design speed in **urban** shall be used :

Class Primary	*80 - 100*	*k.p.h.*
Class I	*60 - 80*	*k.p.h.*
Class II	*50 - 60*	*k.p.h.*
Class III	*40 - 50*	*k.p.h.*

4) Cross section

The dimension, such as right of way width, lane width, shoulder width, for each highway classification are shown in table I.

It is highly recommended that pedestrians, bicycles and animal-drawn carts be separated from through traffic by provision, where practical, of frontage roads and/or sidewalks for the sections where smooth traffic is impeded by the existence of this local traffic.

5) Horizontal alignment

Horizontal alignment shall be consistent with the topography of the terrain and should provide for safe and continuous operation at a uniform design speed. Horizontal alignment must afford at least the minimum stopping sight distance for this design speed.

In the design of highway curves it is necessary to establish the proper relation between design speed and curvature and also their joint relations with superelevation and side friction

Radius of curvature is calculated from

$$R = \frac{v^2}{127.5\,(e + f)}$$

Where

- v = Design speed (Kph.)
- e = Rate of roadway superelevation m / m
- f = Side friction factor
- R = Radius of curve (m.)

Table 5

Recommended side friction factor

Design speed (Kph.)	40	50	60	70	80	90	100	110	120
Side friction factor	0.16	0.16	0.15	0.15	0.14	0.13	0.13	0.12	0.11

The minimum curve radius is a limiting value of curvature for a given design speed and is determined from the formula above using the maximum superelevation rate suggested and the related side friction factor. Minimum curve radius shall be applied only when necessary and shall be used in conjunction with transition curve which is also recommended for longer curve, the values larger by so to 100 percent should be considered as the design normal curve radius.

The widening along the horizontal curves should be provided which is based on the design speed, the pavement width the radius of curve and the dimension of the standard truck.

Minimum horizontal curve radius in Urban recommended:

Class Primary	*230*	*m.*
Class I	*120*	*m.*
Class II	*75*	*m.*
Class III	*50*	*m.*

6) Vertical Alignment

The vertical alignment of any highway shall be as smooth as it is economically possible, that is, there shall be a balance of cutting and filling to eliminate the rolling nature of land. In the use of the maximum vertical gradient, it shall be kept clear in the mind of the designer that, once constructed to a given vertical grade, the highway cannot be upgraded to a lesser gradient without the loss of the entire initial investment. The maximum vertical grade shown in table I shall be used. The minimum vertical curve length shall be based on the algebraic difference in grades , the design speed and the minimum stopping sight distance.

The critical length of gradient section for the provision of a climbing lane is recommended to highway classifications Primary and Class 1, as shown in table 6

Table 6
Critical length of gradient section for the provision of a climbing lane

Terrain Classification	Primary	Class I
Level (L)	3% - 800 m	3% - 900 m
	4% - 500 m	4% - 700 m
Rolling (R)	4% - 700 m	4% - 800 m
	5% - 500 m	5% - 600 m
Mountainous (M)	5% - 600 m	5% - 700 m
	6% - 400 m	7% - 400 m

It is desirable to provide a climbing lane to the up-gradient highways with heavy truck traffic where the length of gradient exceeds the above values.

7) Pavement

Carriageways should be paved with cement or asphalt concrete. Only in cases where the anticipated traffic volume is quite low will bituminous treatment be adopted as surfacing. It is also recommended that the shoulders be paved with cement or asphalt concrete or be surfaced with bituminous materials.

However, as road pavement is designed taking into account i) maximum wheel load which should be based on the standard trucks ii) traffic volume iii) Design life iv) qualities of materials to be used.

8) Bridge

Bridges and culverts should be built as permanent structures. For minor bridge shorter than 50 meters , the full roadway width should be carried through including the width of shoulders. The minimum width between curbs for a major bridge longer than 50 meters should be one half meter greater than the width of the pavement approaching it. Walk way should be provided at one meter wide but for long spans can be limited to one side of the bridge only.

9) Structure loading

Increasing heavy traffic, particularly container traffic, requires properly designed load capacity (maximum axle load). In order to prevent serious damage to road structures, and also to reduce maintenance costs, the ASEAN and the Asian Highway network, as an international road network, should have high design load capacity.

The minimum design loading of HS20-44, which is the international standard corresponding to full-size trailer loading, shall therefore be used for design of structures.

10) Vertical clearance

Minimum vertical clearance shall be 4.5 m, which is the requirement for safe passage of standard ISO containers. However, in cases where sufficient clearance cannot be secured because of the high cost of rebuilding existing structures such as bridges, goose - neck trailers with low vehicle bed clearance could be used. Generally the desirable vertical clearance should be 5.00 m.