

INTERNATIONAL SEMINOR  
ON  
THE APPROPRIATE USE OF  
NATURAL MATERIALS IN ROADS

**WORLD ROAD ASSOCIATION**

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Ministry of Infrastructure of Mongolia

Department of Roads

Government Implementing Agency of Mongolia

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# Natural condition in Mongolia (1)

=> Extremely cold in long winter and very hot in short summer

Table: Temperature in Ulaanbaatar

	January	February	March	April	May	June	July	August	September	October	November	December
Ave. Max.T	-7.4	-1.2	9.7	20.6	29.3	30.6	32.1	29.1	25.3	16.5	6.01	-5.2
Max.T	-4.4	8.5	15.5	23.6	30.8	34.5	36.7	34.6	28.8	21.7	10.6	-2.4
Min.T	-38.8	-31.4	-26.6	-15.6	-8.4	-2.7	4	2.2	-6.5	-17.5	-32.2	-34.5
Ave. Min.T	-33.3	-27.7	-23	-12.3	-4.7	1.9	6.5	4.9	-3.6	-15.4	-25.9	-31

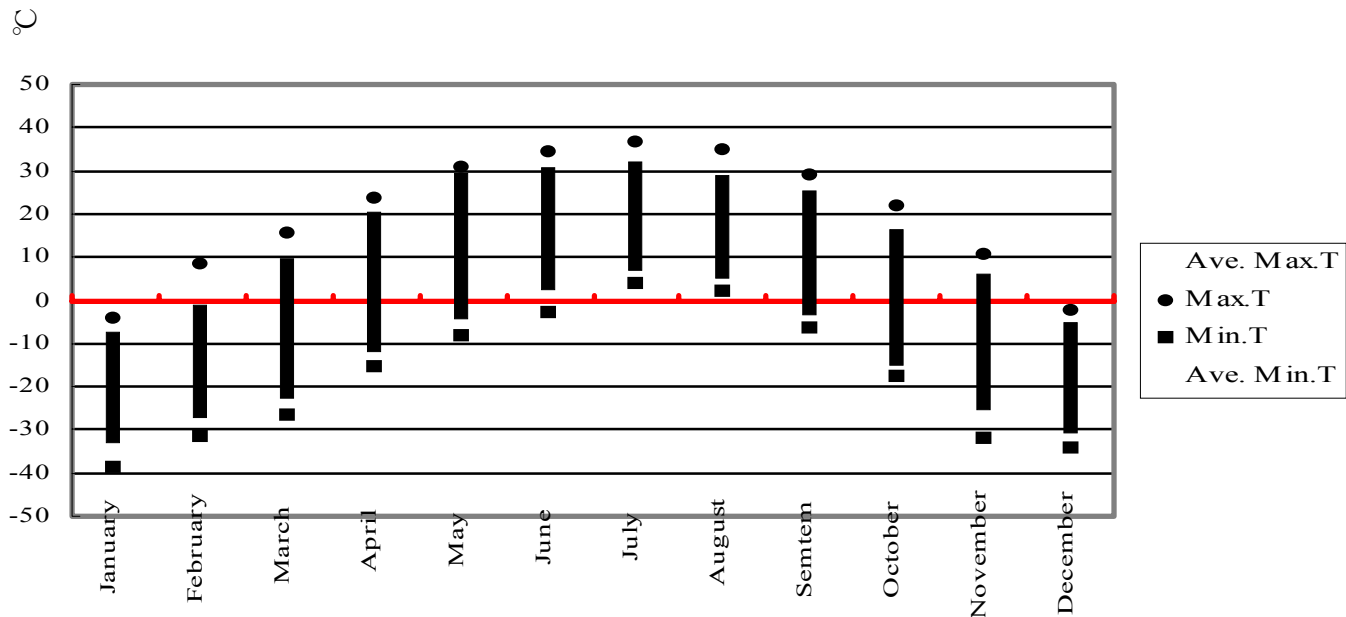
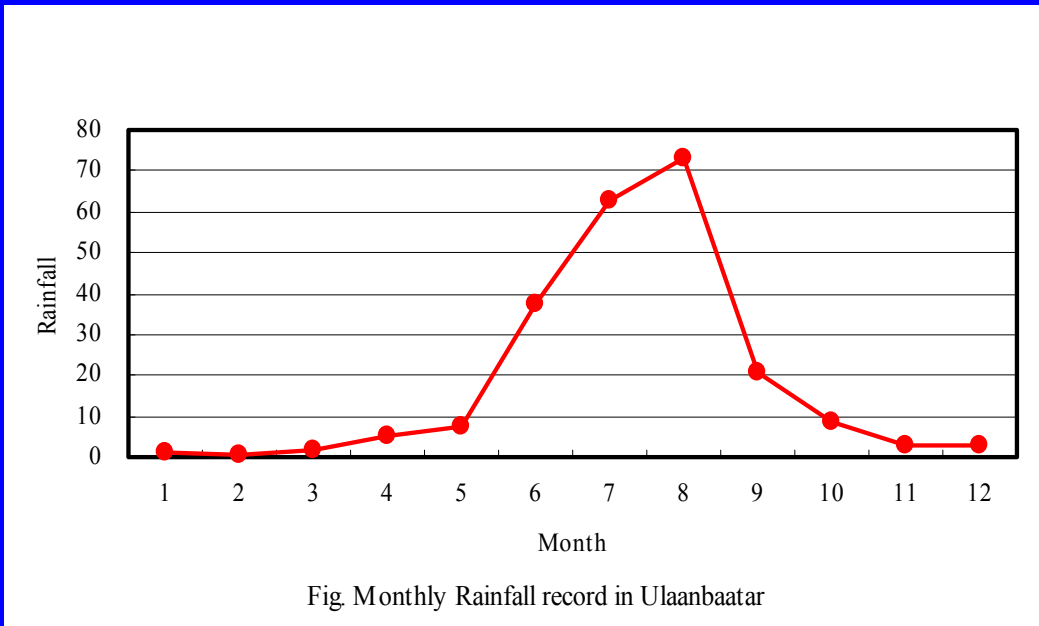


Fig. Temperature in Ulaanbaatar

Natural condition in Mongolia (2) => Very little precipitation  
 Almost zero in winter season and high intensity in summer season

Monthly Rainfall record for 7 years at Ulaanbaatar station (mm)													
Year	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
1994	2.8	1.7	1.5	2.4	2.8	47.6	70.0	168.0	54.7	17.9	1.3	5.0	375.7
1995	-	0.5	1.2	7.4	21.6	22.6	57.2	140.8	35.8	11.7	0.5	0.8	300.1
1996	0.7	0.5	1.1	-	6.5	30.0	84.5	61.0	10.4	8.0	4.6	0.6	207.9
1997	0.3	-	1.6	0.3	5.2	36.6	114.6	33.8	9.1	0.4	1.1	9.6	212.6
1998	2.4	-	-	18.6	3.1	45.9	55.4	66.6	1.0	15.4	10.4	2.3	221.1
1999	2.0	3.0	8.0	9.0	15.0	79.0	59.0	40.3	32.9	8.3	2.3	3.8	262.6
2000	2.6	3.2	1.9	9.7	16.0	59.0	60.0	135.9					288.3
Ave.	1.2	0.8	1.9	5.4	7.7	37.4	<b>63.0</b>	<b>72.9</b>	20.6	8.8	2.9	3.2	225.7



## Road condition in dry season



very little accumulation of  
snow in winter

very dusty in spring and autumn



## **Influence of Freeze-thaw**

Basically there are few Freeze-thaw influence because of very little precipitation through the year and good subgrade condition.

However, some area has evidence of Freeze-thaw influence.

=>Thick green in summer season by rich soil

=>Earth hammock

=>Most of cut area in hill

**Influences of Freeze-thaw  
shown in photos**



Thick green in summer season

Cut area in hill



# Consideration of frost penetration depth

It is written and considered in Mongolian Highway Standard

## Active subgrade layer

\*Active subgrade layer is the upper part of the roadbed from the lowest elevation of the pavement structure to 2/3 of the frost penetration depth but not less than 1.5 m from the pavement surface.

## Minimum pavement elevation above ground water level

Soil of the active subgrade layer	Minimum rise of the pavement surface, by climatic zones			
	II	III	IV	V
Fine sand, lightweight coarse sandy loam, lightweight sandy loam	1.1/0.9	0.9/0.7	0.75/0.55	0.5/0.3
Silty sand, silty sandy loam	1.5/1.2	1.2/1.0	1.1/0.8	0.8/0.5
Lightweight loam, healoam, clays	2.2/1.6	1.8/1.4	1.5/1.1	1.1/0.8
Heavy silty sandy loam, lightweight silty loam, heavy silty loam	2.4/1.8	2.1/1.5	1.8/1.3	1.2/0.8

1. Left of slash : rise of pavement surface above ground water table, perched water table or standing surface level ( for more than 30 days )

2. Right of slash : rise of pavement surface above the earth surface at locations where surface run-off is inhibited or above standing surfacewater level ( for less than 30 days ).

Generally, it is not necessary to consider this because of less precipitation and soil condition.



# Pavement structures in recent project

**Table: Comparison of Pavement structures in each project**

	JICA Road Construction Project	JICA Feasibility study for Eastern Arterial Road	ADB First Road Development Project	ADB Second Road Development Project	Kuwait Fund Road Project
Design Method	Japanese Manual for Asphalt Pavement	AASHTO Pavement Design	TRRL Road Note 31	Asphalt Institute	Empirical design methodology
ESALs	365,000 / 10 years	-	400,000 / 10 years	-	500,000 / 10 years
	-	1,730,000-2,261,000 / 20 years	1,100,000 / 20 years	660,000-805,000 / 20 years	-
Subgrade CBR	12	8 -12	7	10	2 - 30
Surface course	6 cm AC	5 cm AC	2.5 cm AC	5 cm AC	5 cm AC
Binder course	-	-	5 cm AC	-	-
Base Course	18 cm	10 - 15 cm	25 cm	15 cm	15 cm
Subbase	20 - 25 cm	20 - 26 cm	25 cm	25 -40 cm	10 - 52 cm
Total thickness	44 - 49 cm	35 - 46 cm	57.5 cm	45 - 60 cm	30 - 72 cm

Mostly rigid bearing capacity of existing ground: CBR= 8-12

Pavement thickness is around 40 cm in all project

# Material availability (1)

## Bituminous Material: Mostly imported from Russia

Using ordinal straight asphalt is preferable by following reasons.

- a) There is not much traffic volume in typical Mongolian highways.
- b) Initial paving cost is not very high.
- c) Construction speed is faster than other pavement.

However, asphaltic concrete has a disadvantage of thermal shrinkage cracks. This is unavoidable in these severe weather.

It is recommended to repair crack opening by sealing after winter season.

**Rock Asphalt** is naturally produced in Mongolia.

- a) Use of Rock Asphalt in AC mixture saves 2% of straight asphalt in mixture.
- b) However, mixing time is increasing 40%. (Production rate decreases 40%)
- c) Rock Asphalt mixture is more sensitive for temperature.(more cracks)
- D) Lay down crushed Rock Asphalt itself is beneficial for low traffic volume road.

## **Material availability (2)**

### **Base Course Material**

- \*Well graded crushed aggregate is desirable.
- \*Mostly, reddish brown to dark brown silty very fine sand to sandy silt covers the ground.
  - => Therefore side borrow is not preferable for base course.
- \*Granitic rocks are widely distributed in the country.
- \*Fresh to moderately weathered portions of these rocks can be used as sources of aggregate.

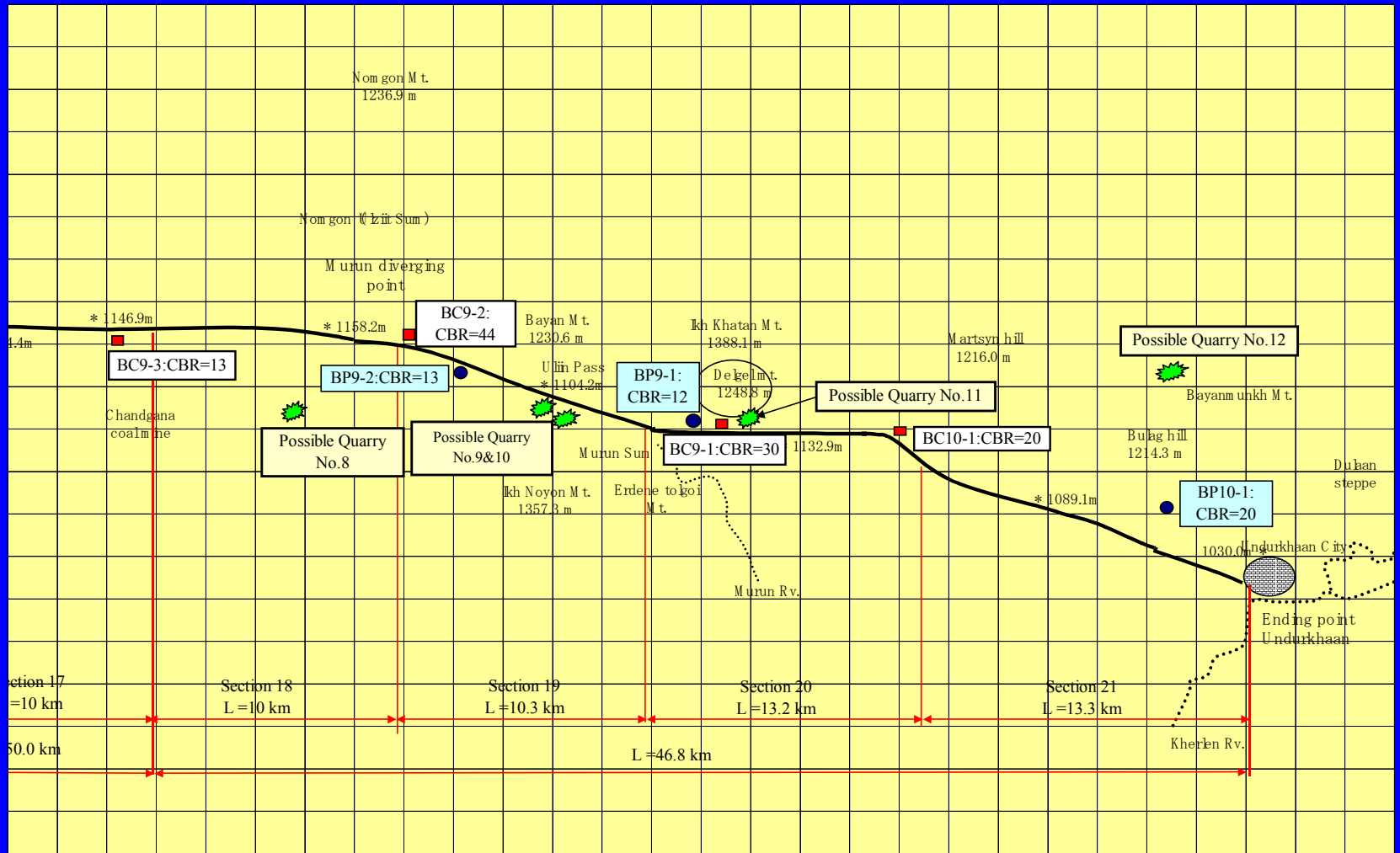


Fig. Quarry and Borrow pit locations in Eastern Arterial Road

# Earth Road

Low Initial construction cost comparing with other paved road.  
However, it is necessary to maintain more frequently than any paved road.

