

To:Infrastructure Development Institute

Report on
“Introduction of road paving machinery and technical support
for maintenance” in Bhutan, IDI donor country

Training report on how to learn skills for road
maintenance in 1 week1

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On March 3, 2004

Edited by NPO, **SECONEQ**



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[Photo:River sand pit in Hesothingkha, Bhutan]

1 Schedule

Installation of road pavement machinery and technical support for maintenance
Schedule

<p align="center"><u>Training schedule for SECONEQ road paving expert dispatching project</u> supported by Ministry of Land and Infrastructure and Transport of Japan and Infrastructure Development Institute (IDI)</p>					
No.	Date		Place and transportation: In ()		Content of work
1	13-Jan-04	Tue	Lv.	Narita:19:00 (TG773/Y)	Movement (From Japan to BKK)
			Ar.	Bangkok:23:59	
2	14-Jan-04	Wed	Lv.	Bangkok:06:50 (KB 127/Y)	Movement from BKK to Paro
			Ar.	Paro 11:10	DoR HQ and Mechanical Devision
3	15-Jan-04	Thu		Thimpu Service Shop	Finisher Check and Repair
4	16-Jan-04	Fri		Thimpu Service Shop	Paving practical training
5	17-Jan-04	Sat		Thimpu Service Shop	Paving material and Asphalt plant check
6	18-Jan-04	Sun			Training preparation
7	19-Jan-04	Mon		Thimpu Service Shop	Practical paving training with finisher
8	20-Jan-04	Tue		Thimpu Service Shop	Practical paving training and repair of finisher
9	21-Jan-04	Wed		Thimpu	Implementation of road paiving by finisher
10	22-Jan-04	Thu		Thimpu (National Holyday)	Paving site inspection and preperationof text and document
11	23-Jan-04	Fri	7:30	Thimpu to Hesothangkha	Meeting and work shop inspection
12	24-Jan-04	Sat	7:30	Hesothangkha to Thimpu	Meeting with AOTS trainees
13	25-Jan-04	Sun		Thimpu	Making report on the project
14	26-Jan-04	Mon		Thimpu	Report to DoR, MoF and JICA
15	27-Jan-04	Tue	Lv.	Paro:09:30 (KB 126/Y)	Movement
			Ar.	Bangkok:15:45	
	27-Jan-04		Lv.	Bangkok:23:40 (TG 642/Y)	Movement
16	28-Jan-04	Wed	Ar.	Narita:07:30	
					
			<p align="center"><u>Peakhouse</u></p>		<p align="center"><u>January 2004 Calendar</u></p>
TG:THAI AIRWAYS INTERNATIONAL KB:DRUK AIR					

2 Introduction

Bhutan, at the foot of Himalaya mountains, is connected by mountain road.

However, it is not expanded to the inlands and its population has not been identified yet. In addition, Bhutan is located in the east of Himalaya mountains in Southwest Asia as [Figure-2] shows and governed by kingship.

Bhutan shares a border with Xizang, China in the north and northwest, upper half of deltaic nation's land. It also shares a border with Indian in lower half of nation's land, in the south, east and southwest.

Official name is Royal Government of Bhutan and the land is 47000k² m², 1,1 time as large as Kyushu. The population is announced to be 660,000 as of 1999. The capital is Thimpu where is the biggest city in Bhutan and has the population of 30,000.

3 Purpose

At present, road conditions in the country are very poor and it doesn't have even 10m long smooth road. The purpose of this project is to dispatch experts and impart road maintenance skills to this small Buddhist country with the mean height of over 2,000 m. Especially, the following is our 2 major skills to transfer.

- Pavement skill with road pavement machinery
- Maintenance skill of road paving machinery

In field exercise, we instructed road maintenance skills and maintenance method for machinery provided through Japan's ODA in 1997, especially asphalt finisher.

Our final objective is effective use of only 1 asphalt finisher, having Bhutanese recognize the importance of compacting roller, upgrading and expanding of road network which is vital for their economic activity.

In view that Bhutan is not known well in Japan, we would like to provide basic information about Bhutan before reporting on the training. At the beginning, we would like to inform you



[Figure-1 : National flag of Bhutan]



[Figure-2: Location of Bhutan in Southwest Asia Source: Encarta[World Atlas]]

that government of Bhutan reorganized ministries and agencies in August, 2003. Accordingly, our technical support target organization, Ministry of Communication has been changed to be called Ministry of Works & Human Settlement. The number of ministries has been increased to 10 from 7.

4 Basic data of Bhutan

4 - 1 Geography and resources

Most of the nation's land is mountainous as you see in

【Figure- 3】 on the right.

Precipitous Himalaya mountains stand in the north, at the border with Tibet. Also, at the border with

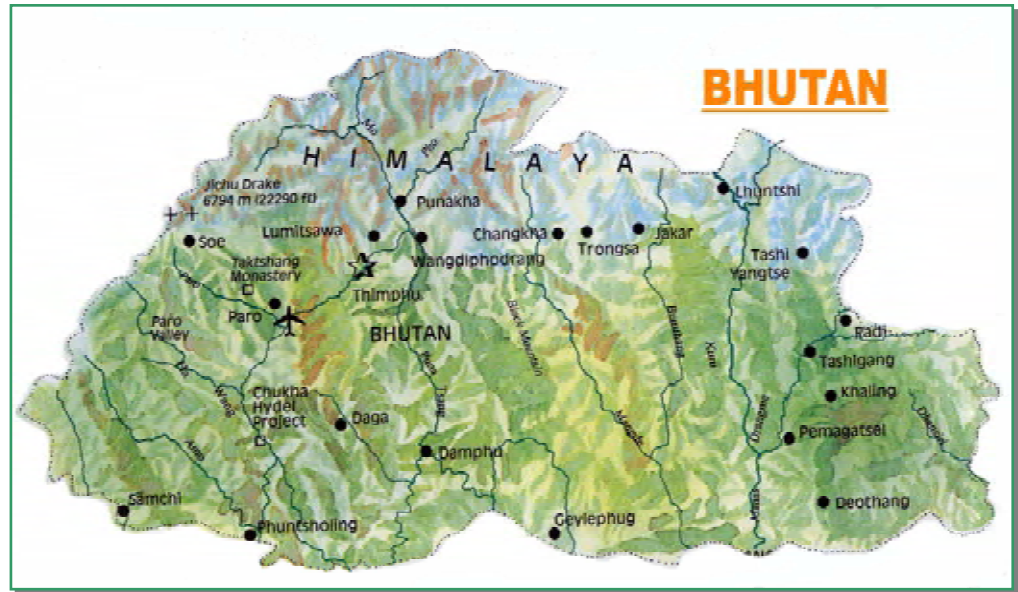
China, 7554m high Kula Kangri is standing.

Duar field at the border with India in the south is the only flat field in Bhutan except small area in the center, Paro.

All the rivers running through northern precipitous mountainous area are not well suited for sailing. However, they are well suited for power generation of electricity, a big industry in Bhutan. The rivers run southward up to India, then flow into River Brahmaputra in Assam, India.

Climate of Duar field can be classified into subtropical. And that of mountain basin in the center is temperate, warm in summer and cool in winter. The roads were narrow, which makes car transportation longer and harder. But if you go southward dozens of km, you can get out of snowy bitter cold region and go into temperate region with rape blossoms. It is one of Bhutan's charm. On the other hand, highland along Himalaya Mountains is severe cold district. Wet southwest monsoon in summer hits into Himalaya Mountains and causes a lot of rain. Annual rainfall reaches up to 5,000 mm at maximum in Duar field. The monsoon also causes cliff failure and blocks mountain roads, which has become a big problem and economic burden for BPR.

70% of national land is covered by forest where is home of wild animals as elephants, leopards, deer herd and bears. In addition, underground mineral resources such as copper, plaster, ironstone, limestone, lead and coal are reserved, but they are not developed enough.



【Figure- 3 : Topographic map】

Item	Numeric value	Remarks
Area	46,500 km ²	East-west about 300km× South-west 150km
GDP	US\$662/person	
Population (1999)	657,550 people	
Growth rate of population (1994)	3.1%	
Population density (1999)	14.1 people /km ²	
Urban population ratio (1999)	21%	
Country population ratio (1999)	79%	
Land use (1999)		
Forest	72.5%	Including 8.1% coppice
Agricultural	7.7%	
Meadowland	3.9%	
Horticultural	0.1%	
Residential	0.1%	
Others	15.7%	Rocks, snow and glacier
Health		
Infant mortality rate (1994)	80 people /10 people	
Average expectation of life at birth (1994)	66 years old	
Ratio of people who can drink clean water (1999)	63%	
Population per doctor (1999)	6,384 people	
Population per bed (1999)	1,023 people	
Education		
Enrollment ration of primary education (1999)	72%	
Number of schools (1999)	343 schools	
Number of students (1999)	107,792 people	Including technical school students
Number of students (1999)	2,856 people	Including technical school students

[Table- 1 : Major social indicators Source: UNDP[Bhutan Joint Donor Database Report]]

Item	Numeric value	Remarks
GDP growth rate (1999)	6.0%	
GDP (1999) (value in 1980)	Nu.3,700million	
GDP (1999) (present value)	Nu.19,273.5million	
Proportion of GDP (1999)		
Agricultural	34.8%	
Industrial	34.7%	Including mining, stone crushing, manufacturing, power generation, construction
Service	29.6%	Including wholesale and retail trade, restaurant, hotel, transportation, banking, insurance, real estate business
Balance of international payments (1998/99)		
Export value	Nu. 4,455.6million	
Import value	Nu. 5,516.4million	
Trade difference	Nu. 1,060.8million	
ODA amount received (1995/96)	US \$ 69.8million	
Remaining value of foreign debt (1996/97)	US\$83million Rs.1,170million	Forecasted amount
Debt-repayment ratio of foreign debt (1996/97)	9%	Forecasted amount
Inflation ratio (1997)	6.6%	
Average exchange rate (2000)		
In calendar year	1US \$=Nu.43.59	
In account year	1US \$=Nu.43.49	From July to the following June
Principal exports (1994/95)	Electricity(24.9%), carbide(19.8%), timber(11.9%), agricultural products (14.3%), cement(12.9%)	
Major market	India (96.4% of exports in 1997), Bangladesh	
Principal import products	Vehicles, spare parts, petrochemical products	
Major importing country	India(69.4% of imports in 1997)	

4 - 2 Population, Education and Politics

Approximately 60% of people in Bhutan is Tibetan Botes mainly living in the east and most of the rest is Nepalese in the south.

The biggest city is the capital, Thimpu with 27,000 people in 1991. Their official language is Tibetan Dzongka and the

national religion is greater vehicle Buddhism, Lamaism. So lamaseries are in various locations and the number of monks is over 6.000. As for education, they have 11 year long primary and secondary education system though, enrollment ration is still at a low level and literacy rate is below 20 %. Chief of state is Crown Jigme Singye Wangchuck who ascended the throne in 1972. Under Crown, there are council of ministers and Crown’s council. Bhutan has one-house parliament called Zondu as legislative body with 150 seats (Term is 3 years.) However, they do not have written constitution or political party.

[Table-2 :Major economic indicators Source: UNDP[Bhutan Joint Donor Database Report]

4 - 3 Economics

Agriculture constitutes the mainstay of Bhutan’s economy. Their major crops are rice, wheat, corns and potatoes, plus ginger, apples, pears and plums for export. Livestock farming is also growing vigorously and cattle, yaks, sheep are bred. They also regard paper and cement industry, textile, match making and brewing industries as important. As for power, production of electricity in 1991 was 1.95 billion kWh, of which 38% was produced by water. In 6th 5 year plan conducted from 1987 to 1992, forest and mineral resources were developed and health care system was improved.

After long-term national isolation, they opened the country in 1974. Since then, the number of visiting tourists and academic investigation staff has been increased. In 1990’s, approximately 3,000 people visit the country annually. However, their transportation system is not developed well yet. They do not have railway network and connecting roads between cities is only 2.336 km long. As to the air, Druk Air has a flight to India, Bangladesh, Nepal and Thailand, whose 2 small aircrafts are over 20 years old.

In the field of communication, Bhutan established satellite-based information exchange system with India and U.K long time ago. Also in this field, Japanese government-sponsored communications facility with antenna is built at the top of mountains and Japanese experts have been dispatched.



[Photo-1: Druk Air s aircraft]

Their local currency is Ngultrum(Nu). Except for the indicators in 【Table - 2】 , Bhutan has their own indicator propounded by Crown called Gross National Happiness, which shows

Bhutan’s policy, not to pursue economic development only.

4 - 4 History

First habitants in Bhutan were Indian people in 8th century. Later in 9th century, Tibetan military broke into Bhutan. Consequently, present major ethnic group, Tibetan Bote became the largest group. At the same time, Tibetan Buddhism was brought in to Bhutan. Then, at various places in Himalaya mountains, dzongs were built and



【図 - 4: ブータン国行政区分地図】

later in 17th century, Tibetan Buddhist high priest unified the nation. In the latter half of the century, administration system with 2 leaders, religious and political leader, started. In 18th century, U.K. started to come into South Asia and East India Company was found in 1772. In 1826, they annexed Assam, which triggered further strained relations between Bhutan and U.K. As the result, in 1826, Bhutan War broke out. In the end, U.K. and Bhutan agreed to Xinchula treaty which stipulates to assign U.K. the southern part as their territory and provide annual financial assistance to Bhutan in return

In 1907, First Crown, Crown Wang Choc established present dynasty, then Bhutan became a British protectorate in 1910. The treaty made at this time stipulated that Bhutanese owns governing body and receive financial assistance while U.K. keeps the rights of military and foreign affairs. In 1943, the treaty partner changed to India.

Relations with India

Relations between India and Bhutan became closer and closer after Tibet Invasion by China in 1959 and Indian military is stationed in Haa. In addition, 50 % of major national roads in 【Figure-3】 below are maintained by Indian army’s Construction Force, DANTAK. Moreover, financial support from India accounts for a big part in foreign aid which covers 40 % of Bhutan’s annual expenditure. However, Bhutanese government has been searching their own diplomatic policy since 1970’s. In 1971, they decided to become a U.N. member state and join Conference of the Non-Aligned Countries (CNAC) in 1973, which shows that they are trying to be independent. In 1990’s, pro-democracy of Nepalese inhabitants in the south who are against Bhutanese nationalism including obligation to wear ethnic costume became active. Still it is not solved.

5 Road conditions

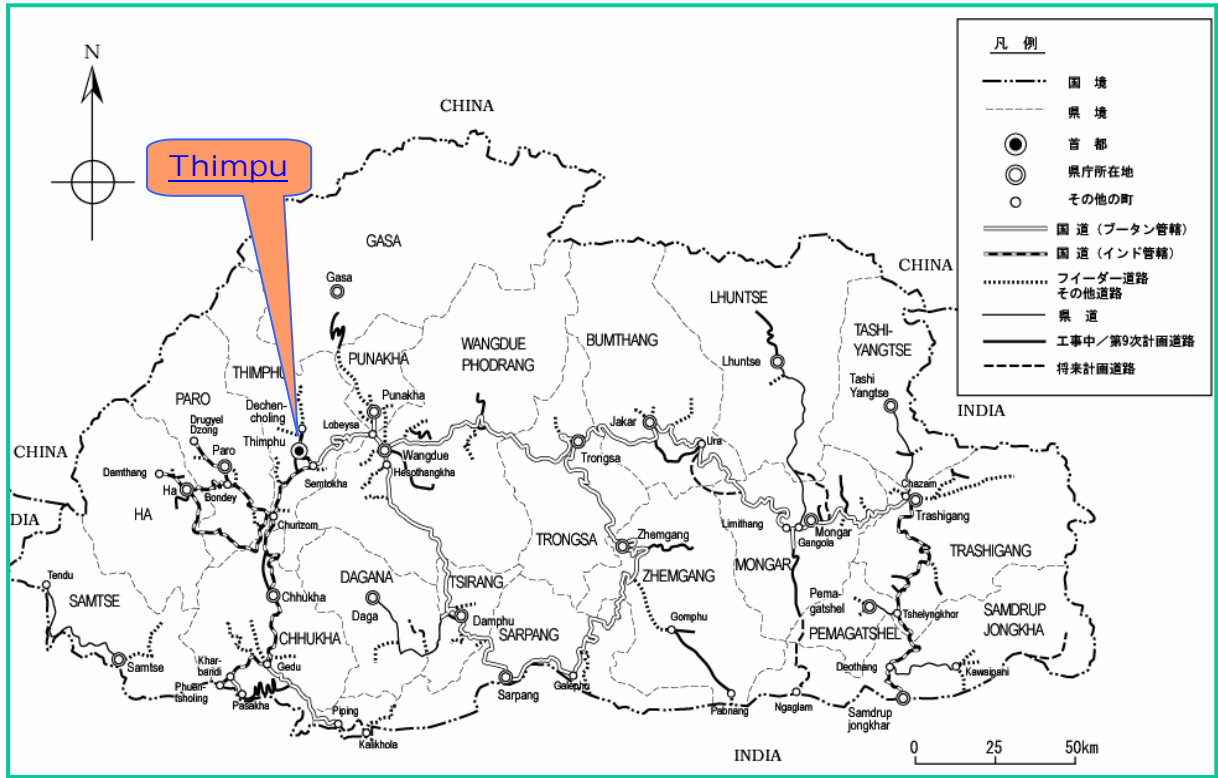
Road construction in Bhutan started with 179 km long road between Phuentsholing at the boarder with India and Thimphu in 1959. Since then, 3,920km road, 638 km of national road, 415km of prefectural road, 1,205km of feeder road, 98km of urban road, 564km of forest road has

been constructed as date of June, 2002. Pavement ration of these roads are 98% of national road, 72% of prefectural road, 29% of feeder road, 91 % of urban road and 10% of forest road as you see in 【Table-3】 below.

	subtotal	1,638	415	1,205	98	564	3,920
Governing body	Type of road pavement ratio	National road 98%	Prefectural road 72%	Feeder road 29%	Urban road 91%	Forest road 10%	Sum (km)
BPR	paved	1,053	297	161	89		1,600
Ministry of Communications	gravel	11	118	521	9		659
	subtotal	1,064	415	682	98		2,259
DANTAK (Indian army's Construction Force)	paved	556					556
	gravel	18					18
	subtotal	574					574
Prefectural government (Dzongkhag)	paved			8			8
	gravel			123			123
	subtotal			131			131
Agriculture and Livestock Bureau, Ministry of Agriculture	paved			4			4
	gravel			122			122
	subtotal			126			126
Department of Health and Education Education Bureau	paved			35			35
	gravel			33			33
	subtotal			68			68
The Telephone Service Ministry of communications	paved			24			24
	gravel			13			13
	subtotal			37			37
Power industry Bureau Ministry of International Trade and Industry	paved			118			118
	gravel			43			43
	subtotal			161			161
Forest Bureau Ministry of Agriculture	paved					0	0
	gravel					564	564
	subtotal					564	564
Total	paved	1,609	297	350	89	0	2,345
	gravel	29	118	855	9	564	1,575

[Table-3: Road constructed by each governing body Source: BPR's data as of June, 2002]

Prefectural road of 4 prefectures, Gasa, Lhunste, Pemagatshel and Trashi-Yangtse as you see in **【Figure- 5】** in the following page, is still short, cannot be constructed adequately. According to BPR's data, their road construction is still at low level below 100 km. Especially in Gasa where is the closest to Himalaya mountains, only 9 km road was newly constructed due to environmental conditions and topographical problems. As described above, Bhutanese are living in such tough conditions and without establishment of road network, their safe, educational and cultural life



[Figure - 5 : Road network in Bhutan (BPR s data as date of June, 2002.6)]

cannot be achieved.

Bhutan's national road, equivalent to Japanese forest road



[Photo- 2 : National road in mountainous area]

National roads in Bhutan are quite short even taking account of their small land. In specific figures, as it is shown by double line in **【Figure□5】**, it is only 1,906 km. Even those national roads have only 1 lane, which



[Photo-3: National road maintenance in winter]

is equivalent to forest roads in Japan. That is a reason why domestic transportation is time-consuming. In addition, they are winding in mountainous area and not flat. Proportion of paved road is considerably good, 98 %, but actually asphalt mixtures are just spread over the surface and not maintained adequately.

【Photo-2】 is national road between Thimpu and Hesothangkha. Two-axle heavy trailer can go up to Hesothangkha indicated by arrow above. As for sightseeing bus, 20-30 seat vehicle as you see on the right is operative for mountain roads. Larger bus is too heavy to run through the road safely. As to dump truck, 2 axle 7-8t truck is ideal.

Maintenance of national road

Road network as life line is maintained by full-time staff under contract who has 14 km road of responsibility. Their work includes taking away cliff failure stones and patching of paved road. In winter, they also need to clear snow to prevent frozen road which stops vehicles. 【Photo-4】 shows that a lot of tough work as clearing of snow is women’s job. And another labor force is immigrants from India or Nepal who engage in heavy work as road construction.

As I mentioned, Nepalese in the south are against Bhutanese government’s nationalism, so they became refugees and went into Nepal. It has been a pending issue between Bhutan and Nepal and they have been struggling with it as people in developed countries do. In developing countries, 3D job, dirty, dangerous and demanding work is taken on immigrants or minorities as well as it is in developed countries. As a Japanese engineer and road constructing machinery expert, I have been working on that and I believe that those work is not such an unpleasant duty.



【Photo-4: Road maintenance work at national road】

Japanese government sponsored bridges

On the way to the eastern extremity of Bhutan, border with India, Trashingang, 5 bridges were built in Wangdue, Trongsa, Bumthang, Mongar and Lhuentse with Japanese government’s free financial aid. At present, some road construction plans have been promoted for the future. 【Photo-5】 shows one of those bridges with over 50 year durability. The bridge is characterized by red rust, which prevents further rusting as it does for Japanese sword. In the expectation that a lot of Japanese tourists will visit Bhutan in the future, we would like to introduce this as a Japanese government’s ODA project.



【Photo-5: Japanese government sponsored bridge】

6 Major working area :

Dispatched expert’s work can be categorized as follows;

Work	Place of work	Work
Maintenance of machinery	In Thimpu	Inspection and check of defects with paving machinery Repair of defects
Operation training of paving machinery	At DoR machinery storage	Training on adequate operation of finisher (Lecture and field exercise) Lecture and field exercise of paving method
Field exercise of paving	In Thimpu	Preparatory work for pavement including procurement of asphalt mixtures and preparing work for pavement Spreading and shaping of mixtures with asphalt finisher Dispersion of asphalt emulsion and compaction
Field survey	On the street in Wangdue and at Hesothangkha factory	Visit road pavement site to see actual operations Inspection of maintenance factory and meeting for next pavement

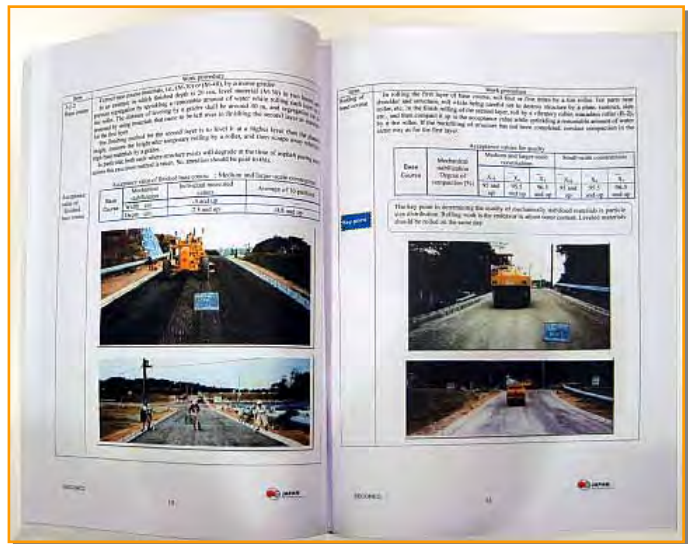
【Table- 4 : Dispatched expert’s work place and scope of work】

7 Scope of activities and result

7 - 1 Preparation in Japan

As it is said, preparation determines success of the work. In this project, we provided training on appropriate operation of machinery and paving with asphalt finisher. For these training, we prepared “Handbook on asphalt pavement” and “Operation and maintenance manual for asphalt finisher.

【Photo - 6】 on the right shows the handbook edited by a supervisor of road construction company for construction workers. In the handbook, the supervisor introduces specific operating instructions and presents actual conditions of the pavement with photos. We also prepared papers on “Maintenance of road



【Photo - 6 : Handbook on road paving】



【Photo-7: text CD-ROM】

construction machinery”, “Stabilizing treatment with stabilizer”, “Handbook on rental and lease of construction machinery” and sent them to BRP with workwear, safety shoes, helmet and cotton work gloves in advance. Data of these handbooks are recorded in CD-ROM so that we can hand out to local engineers. We believe that they will provide very useful information to Bhutanese engineers with English proficiency.

7 - 2 Pre-training in Japan

Training plan for 2 Bhutanese trainees of BPR in Japan

Period	Course	Item	Objective and expected standard
I n t r o	Oct. 1 - Nov. 11, 2003 Lecture	General	General:
		Japanese lesson:6 week	Prepare for field exercise at companies
		Management:	Management:
			acquire knowledge and skills required to managers
T r a i n i n g	Nov. 12 - Dec. 26, 2003 Lecture: 40 hrs Exercise: 208 hrs	Safety education	Safety education
		Maintenance of diesel engine	Understand functions and structure of diesel engine and maintenance
		Basic information of standard construction	Failure diagnosis of construction mach
		Field exercise	Field exercise at actual construction site
		Management of repair factory	Maintenance operation·man-hour cont
T r a i n i n g	Jan. 5- Jan. 20, 2004 Lecture: 18 hrs Exercise: 62 hrs	Functions and structure of hydraulic components and maintenance skills	Acquire maintenance skills for hydraulic components
		Road paving technology	Understand functions and structure of asphalt paving machinery. then acquire skills of machine
		Functions and structure of crusher plant	Understand functions and structure of crusher and acquire operation skills
		Compacting machinery as road rollers	Understand functions and structure, type of road roller and importance of compacting. then
		Outline of rad paving plant and machinery	

【Table-5 : Training for AOTS trainees from BPR in Japan】

AOTS field training

By request from BPR, Association for Overseas Technical Scholarship (AOTS) brought in trainees from maintenance factory in Hesothangkha and Lingmethang. Then, we conducted field exercise following the plan above in 【Table—5】 at member companies with the support of road paving machinery manufacturer, and constructors. This was because IDI does not have a program to bring in foreign trainees at present. We hope IDI to move into this field and effective, consistent technology transfer system will be established.



【Photo-8: Field exercise of finisher operation in Japan】

Developing countries do not have adequate facilities or machinery. Moreover, scale of road construction is pretty limited and engineers do not have a chance to see model construction or paving.

Therefore, we provided comprehensive training

on standard maintenance method, operation of crusher, compacting road roller, asphalt finisher and mixing and shaping of asphalt mixture with asphalt-mixing plant.



[Photo-9: Trainees in paving machinery operation training]

7 - 3 Inspection and maintenance of facility and machinery

Inspection of asphalt finisher

At the beginning, we inspected asphalt finisher and found the following problems.

- (1) Misaligned ironing part
- (2) Malfunction of traveling direction switch
- (3) Defect at steering in translatory movement
- (4) Misfiring of burner
- (5) Damaged side cover
- (6) Inappropriate cleaning



[Photo-10: Inspection of paving machinery]

Operating hour of asphalt finisher increased to 950 hrs from 416 hrs this time, which means that its annual operating hour was around 500 hrs last year. However, we asked the operator and found that it had not been used for asphalt finishing, but for transportation to construction site. That is the reason the machine got abrasion at underbody and defect at steering.

Defect in translatory movement could be a big obstruction, so we disconnected a part of wiring on steering control device as first aid.

Except for that, we spent the first week on cleaning sliding parts, ironing parts of compacting machinery, level adjustment and other preparatory work and fixing.

If we do all the fixings, we would not make time for field exercise of finisher, so we decided to conduct this maintenance work between trainings.



[Photo-11: Repairing side cover]

Storage site of machinery in Thimpu without maintenance facility and equipment

Since the site did not have required facility and tools, we needed to visit auto repair shop and sheet metal plant in neighborhood to ask them to borrow required tools for repairing. An operator just had some tools as screw driver, nipper and hammer, which were enough to check the wiring. There was gas welding and cutting machine to process sheet metal.



[Photo-12: Cleaning of paving machinery]

However, repair equipment to be stored at storage site in Thimpu still lacks. JICA provided machines for free twice, but they did not provide minimum repair facility and tools to maintain these machines because of inadequate understanding and consideration of local situation, which is the biggest issue on ODA projects.

7 - 4 Asphalt finisher operation training

(1) Procurement of required materials for operation training

Original application of asphalt finisher

We visited Bhutan in winter when is not suited for paving this time. Besides, asphalt mixing plant of BPR had some defects in operation and had not been working. Consequently, we could not obtain asphalt mixture and provided finisher operation training with blended subbase course material to do shaping.



[Photo-13: 1 cft inlet for paving material]

Model mix design of subbase course material

Crushed stoneS30 (30 - 20mm)	: 33%
Crushed stoneS13 (13 - 5 mm)	: 33%
Coarse sand	: 17%
Fine sand	: 17%
Water	: 6-8%



[Photo-14: Water content adjustment for shaping material]

In stead of (30×30×30) cm big wooden inlet in 【Photo-13】 which is ordinary used in Bhutan for measurement, we used bucket of wheel loader this time. We could obtain quite good quality river sand as paving material which is sold by 1 cubic foot or ton. As an example, 1 ctf crushed stone is sold at 15 Nu (40 yen) at road side, which is equivalent to 1500 yen for 1 cubic meter.

We blended materials following the design above and add water to achieve adequate viscosity.

After cross cut with heavy wheel loader, we conducted training on shaping with asphalt finisher.



[Photo-15: Crosscut blending of subbase material]

Asphalt finisher operation training

What is important for the training is (1) Even thickness of mixture, (2) Smooth surface and (3)Translatory movement . At this phase, we just repeat spreading and shaping of asphalt mixture. Of all operations, Screed, continuous adjustment of shaping level, is primary work. Acquisition of this skill is essential to conduct homogeneous paving. Red arrow in 【Photo-16】 points at temporal suspender nut as check point.



[Photo-16: Level check mark]

7 - 5 Field exercise with asphalt finisher

Wooden form

In asphalt paving, it is required to spread asphalt mixture evenly at designated thickness in road range . Therefore, we made the same conditions for the training and conducted everything carefully as we do in service. First of all, we set wooden form in 【Photo-17】 . Second, we decided who will be an operator, running the finisher straight, and a screed man, taking charge of adjustments for screed. Then, we started the training with positioning the finisher at the center of the road.



[Photo-17: Setting wooden form for shaping]

Adequate material supply

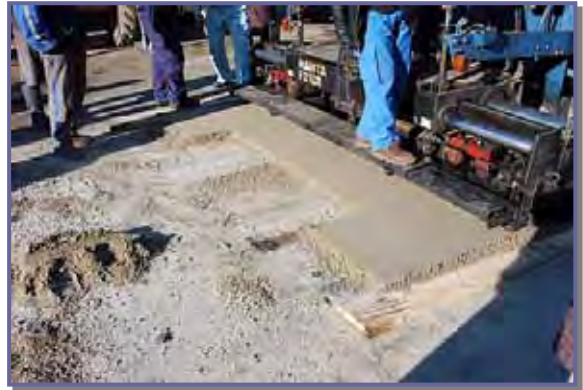
Ironing part of the finisher is angled by the weight of mixture and designated paving thickness is ensured. As the amount of mixture decreases, the lower the angle becomes. To ensure adequate level, we should provide adequate mixture at the beginning.



[Photo-18: Adequately filled subbase course material]

Starting position

Before the operator runs the finisher, starting position as you see in **【Photo- 19】** should be formed to ensure designated paving thickness. Preparation starts with shoveling by the operator gathering by and the screed man. Bhutanese operators and mechanics usually do not do these work, but we asked them to change their fixed idea to conduct technology transfer.



【Photo-19:Forming of starting position】

Keep the level of ironing part

In Bhutan, an operator has been playing 2 roles, an operator and a screed man to run the finisher. Well experienced operator might be able to operate small size finisher alone, but in principle, an operator and a screed man should be engaged in paving. In 4 day training, we had 2 screed men on both sides of the finisher to instruct how to keep the level and operate the machine appropriately.



【Photo-20: Accomplishment of the training on paving】

7 - 6 Paving in the field

Appointment of the site

With the help of Public Works Department of BPR, we searched candidate site for low cost road pavement in Thimpu and selected the site in **【Photo-21】** . On the site, Half width of the slopewise road was paved but another half was covered with gravel. Width of the paved road was 2.6m and its length was approximately 50 m.



【Photo-21 :Candidate site for low cost pavement】

Quantity calculation of required materials for pavement work

The road is consisted of compacted 50 mm crushed stone on subgrade, earth and sann for filling.

First of all, we removed earth and sand, then 30-50mm pitching to ensure 40 mm thick paving.

【Photo-22】 shows road conditions after removal of earth and sand on the surface.

【Photo-23】 shows road conditions after removal of 30-50mm crushed stone. Public Works



【Photo-22 :Road surface after removal of pitching】

Department claimed that if we remove crushed stone more, thickness of bottoming will not be enough. Therefore, we abandoned to ensure 50mm pavement and decided to set it 40 mm thick and procured materials.

【Photo-24】 shows road conditions after spreading 12 mm crushed stone and compaction.

In fact, we used 20 mm and 12mm crushed stone both since we could not get enough amount of 12mm stone.



[Photo-23: Road conditions after removal of 30 50mm crushed stone]

Materials

No	Material	Weight
1	25mm crushed stone	2 ton
2	16mm crushed stone	2 ton
3	9mm crushed stone	2 ton
4	River sand (coarse sand)	2 ton
5	River sand (fine sand)	1 ton
6	River sand(for compaction)	3 ton
7	Asphalt emulsion	260 Little



[Photo-24: Road conditions after compacting 12m crushed stone]



[Photo-25: Asphalt emulsion made in India]

7 - 7 Paving in the field

We conducted model paving to see the trainee’s achievements after operation training of asphalt finisher, compaction and shaping.

We had manpower planning as follows, but actually twice the number of the staff joined.

Required number of staff for pavement work

No	Work	Staff
1	Shoveling	More than 4
2	Operator of finisher	1
3	Operator of roller	1
4	Operator of wheel loader	1
5	Driver of dump truck	1
6	Dispersion of emulsion	2
7	Voluntary worker	5
		15



[Photo-26: Field exercise of compacting and shaping with finisher]

On the morning of pavement work, an accident happened. Mr. Karma K Hundo, who was a second operator and a mechanic, had to be absent from the training since he had to take his baby to the hospital. As his replacement, Mr. Kimura, the instructor worked as a screed man.

Demonstrate, let them try and demonstrate again

At Toyota South Africa, we heard that having more multiskilled workers leads to improve production efficiency and quality. However, in Europe, it is common to promote fostering single skill workers. As Bhutan is British protectorate, European way is adopted, the operator doesn't have a shovel or rake. We demonstrated and said, “In Japanese way, it is required for the operator to work with shovel and rake.”

Pavement work without adequate facility and equipment

Compacting is the most important part in pavement work. Through 2 ODA projects, road rollers were provided, but they were not well suited for the conditions of Bhutan. Consequently new heavy rollers which weighs over 8 tons have been kept in the storage and never been used.

In our training, with too heavy roller without sprinkler, we managed to do model compacting and achieve adequate smoothness on the surface as you see in **【Photo-28】**. But we believe that compacting could be better with smaller machine and we can ensure adequate durability.

8 Feedback from Bhutanese

(1) This project was, originally to instruct BPR engineers how to operate and maintain paving machinery. But actually, we conducted a training of bottoming penetration macadam with finisher. In the end, we could recognize Bhutanese engineers of BPR that the macadam has great accuracy and receive favorable feedback from them. They also said that they would like to keep their eye on this paving site to see conditions and make final evaluation. We believe it is a great achievement that we could change their fixed idea, “Asphalt finisher is a machine to spread and shape asphalt mixture”. We also believe that engineers understood that bottoming penetration macadam with finisher is the most operative method for Bhutan with no operative mixer plant for asphalt mixture to achieve great degree of accuracy.



[Photo-27: Emulsion dispersion after compacting and shaping]



[Photo-28: Compacting after dispersion of emulsion and sand]



[Photo-29: Paved road after compaction]

(2) Bhutanese operators and mechanics had very strong will to learn and acquire new construction and maintenance method during our visit and we were glad to have such a meaningful and fruitful training. It was also meaningful for BPR engineers who could learn maintenance method for road construction machinery and construction method at the same time and had a chance to see actual operations.



[Photo-30: commemorative photo]

- (3) We repaired the only asphalt finisher with defects and conducted 50 m long model road paving. Department of machinery which is in charge of maintenance expressed their gratitude to us.
- (4) Operators and mechanics who have been learning how to operate or maintain asphalt finisher from manuals have never had a chance to understand basic functions and structure of components until our visit. As we mentioned, at the end of the training, we received big gratitude from operators and mechanics and Department of Machinery and Public Works of BPR requested us to conduct the training again. We also would like to express our gratitude to them for helping us to conduct effective and meaningful field exercise.
- (5) From BPR, we received a request to give them advice on selection of road construction machinery and materials. As for this, we prepared a list of minimum required road construction machinery and presented.
- (6) We also received a request from regional manager of Hesothangkha to conduct the same training. We replied them that we need to discuss on the budget but we will consider the possibilities.
- (7) Mr. Sugimoto, general manager of Bhutan JICA, visited our site to see the training as this project is to promote effective use of asphalt finisher provided through Japanese government's ODA project with the assistance of experts of NGO. He expressed his gratitude on positive results of the training and said he would like to make a plan to supply required components and equipments to fix defects with finisher since some problems were identified in this training. JICA is expected to work on those as follow up.

Institutional reform through technology transfer

Japanese engineers instructed how to use shovel and rake in field exercise of this project,

which is not allowed in Bhutanese class system though. For operators and engineers who have never experienced the work with shovel and rake, it must be a big surprise. However, to learn new technology, they need to change their common practice and tradition sometimes. If they reject to do that, their industrial development would not be realized. But as you see in the following photos, they actually worked with shovel and rake to acquire new technology this time.



[Photo-31 (Upper left) : Civil engineer working with a shovel]
[Photo-32 (Upper right) : Japanese expert demonstrating how to use rake]
[Photo-33 (Lower left) : Sifter of pavement materials]
[Photo-34 (Lower down on the right) : Dispersion of sand following Japanese instructor's guidance (Right after demonstration)]
[Photo-35 (Lower down on the left) : Dispersion of sand (Not accomplished yet)]

9 Issues in the future

Big-hearted people

Bhutan is developing but still short of social overhead capital such as human resources, supplies, funds and information. On the other hand they have irreplaceable gift, big-hearted people. As the other developing countries do, people in Bhutan possess a richness of spirit.

Their religious feelings have been a base of social infrastructure. But as we do in Japan, they have social problems as increased number



[Photo-36: Too heavy compacting roller]

of AIDS patients, pregnant girl students according to only English newspaper, KUENSEL. In addition, changing their hair color has become popular, too.

As for road conditions, we have to say that there is no safety and smooth road in Bhutan.

The biggest challenge they face is human resources development for road construction. High level activities are conducted by experts of JICA and senior volunteer with good knowledge and experience in road construction, so we would like to present some problems at local site.



[Photo-37: Compacting with appropriate machinery in Europe]

Appropriate facility, machinery and maintenance tools are required

Procurement of required machinery and materials for road construction :

(Small machinery should be well suited for local specifications and road conditions)

Machinery has been imported from India at 20~30% cost of European or Japanese ones When we think of performance and operating efficiency, it is not a good purchase, but they have no choice under the present circumstances. See 【Photo-36, 37】 .

Procurement of asphalt, crusher plant and other equipments or materials required for on-going 25 km highway construction :

(Medium-sized plant, mobile small-sized plant, wheelbarrow and shovels are required)

See 【Photo-39 : Present crushed stone production】

Motor lorry for road construction machinery :

See 【Photo-38 : Unloading of finisher at bank】 .

Maintenance equipments and tools: Repair tools as we have at gas station in Japan should be stored at storage site at least.



[Photo-38: Unloading of finisher]



[Photo-39: Stone breaker on site]

Mixing of asphalt on site in Japan

Right after Great Kanto Earthquake in 1923, hotmixing of asphalt in 【Photo-40】 was pretty common in Japan to meet increasing demands for road pavement. Japanese mixing plant was twice as deep as Bhutanese one, 50 cm deep and 1m length and breadth. At that time,

length and breadth. At that time, asphalt mixture was heated over a wood fire, filled in a can and carried by pole, later by wheel barrow. According to the record, asphalt is supposed to be imported to Japan in this age. So conditions in Bhutan are same as we had 80 years ago.

In view of asphalt mixture mixer in 【Photo-41】 and existing overlay pavement in 【Photo-42】 , we recommend machinery in the box below.

Instead of repeating overlay, we recommend to remove the pavement and reuse it for repaving.

For that work, mobile small-sized asphalt mixer is well suited. In aforementioned time, concrete mixer was found useful for mixing asphalt mixture.



【Photo-40: Hot mixing on site】

Required equipment for field exercise of pavement work

In our original plan, asphalt finisher operation training was supposed to be held in Thimpu and Hesothangkha. However, owing to fixing defects

with machinery took us long and conducting unplanned model paving, we could not make time for the training in Hesothangkha. Therefore, Mr. Sangay Dorji, Regional Manager of Hesothangkha requested us to give them a training next time. For that training, we listed

required equipments for field exercise as follows,

which cannot be procured in Bhutan.

1. Wood form : (50mm × 100mm × 5m) × 40 forms
2. Iron tie wire : (12 × 200mm × L shaped head 30mm) × 100 pieces (for fixing form)
3. Wheelbarrow : 20 barrows
4. Tandem Roller 4Ton × 1 roller
5. Combined Roller 4Ton × 1 roller
6. Tired Roller 4Ton × 1 roller

【Photo-41 : Asphalt mixture blender at Hesothangkha factory (Hard to be repaired)】



【Photo-42: Overlay pavement site in Hesothangkha 50 maintenance staff are working】



【Photo-43: Mr. Kimura, carrying hot melting asphalt mixture】

10 Closing

Some countries where are supported by European and American governments and highly evaluated by UN agencies are called Model ODA countries. Most of Japanese government’s supporting countries receiving 5 or 6 billion yen a year are included in this group. In those countries, smooth and safety roads have been constructing by provided road construction machinery or with the help of European or Japanese road construction companies, Chinese or Korean agencies. On the other hand, in a country in Southwest Asia near Bhutan, tens of provided machinery are stored and never been used. Bhutanese government investigated to see actual conditions and determined their policy, “No hasty development”

Some countries in East Africa are in the same situation and a lot of machinery are not fully used but just stored. Major reasons for this problem are as follows:

- (1) Since government agencies have been supported by European and American government directly and indirectly, the country’s uniqueness or ability of independent operation was significantly decreased. Consequently, they are not functioning well. The biggest reason of this is dropping support of European government due to financial problems. In addition, developing countries do not have established system to run a country or enough number of skilled engineers to make full use of products imported from developed countries. In other words, they need to establish a system to foster engineers who can take charge of maintenance of provided facility and machinery and create a civil infrastructure. In every way, there is plenty of scope for evolution.
- (2) A problem on donor country’s side is that they have not been providing technical support to help the recipient making the best use of provided facility or machinery. It is difficult for anyone to learn operation of machinery without preparation and training. However, it is true that donor countries have not been provided knowledge, skills and capability of recognizing importance, purpose of use and operation method.

Actual conditions of Bhutan

Bhutanese government and people have been working on social development seriously. Despite small-scaled government, their agencies are functioning effectively. Provided facility or equipments have been actually used for construction and maintained. In accordance with the principles of studying new system before introduction and deciding on their future course, they are running a country.

Plan for the future

What is required to developing country is sprit of self-help.

In Nihon Keizai Shimbun, I found the local news article under the heading of “Road maintenance by citizens in Kawachi-nagano, Osaka” According to the article, local farm family joined road construction as voluntary workers while Osaka Prefectural Government bore the costs of materials in return and prefectural road was



[Photo-44 : Voluntary workers working at road construction site in Osaka (Nikkei afternoon newspaper)]

expanded to 2 m in width and 300 m was newly paved. In Japan of 30-40 years ago, road construction was commonly conducted by voluntary local citizens. But now in Japan, it can be a news. As in the case of Osaka, prefectural government is in financial difficulties and they couldn't repair road by itself, which is true in current Japan, it is said that budget allocations for public works projects is spent like water though. Japan is sometimes called “No.1 ODA spending country” or “Rich Japan” but I hope news on this kind of hard-working efforts should be delivered more.

[Japanese people construct road and African people walk there](#)

When I visited model ODA recipient, a 20 years old man said, “European and Japanese people blessed with financial resources and technical capabilities construct roads for us. We have little funds and low technical capabilities, so we thank them and walk the roads.”

It happened at CETC (Construction Equipment Training Center) constructed as Japanese government's ODA project during our visit for field study of construction machinery maintenance training.



[Photo-45: Road in East Africa constructed with the assistance of Scandinavian government]

When we were running transcontinental express highway constructing with the assistance of Scandinavian government, we answered the man's comment and expressed our opinion.

Refer to **【Photo-45】** .

[Roads should be looked after as we do for children](#)

“Road construction is like raising children. It is tough for some people while it is easy for the others. If there are established procedures, anyone can do, which means that if you learn the skills appropriately, you must be able to acquire them. Without practicing, you cannot learn how to construct and maintain roads though, people in developing countries rarely have a chance to do that after foreign agencies went back to their countries. At present, Scandinavian government-backed road constructor hires



[Photo-46: Maintenance of East Africa transcontinental Express highway]

local citizens, but after they are gone, people with no skills would not have a chance to get a job. In the end, technical learning is the key to keep your job. Unless getting a job, you cannot be independent economically, which means you cannot marry or raise children. Even if roads are well developed by foreign government, they cannot be used for a long time without maintenance.

Moreover, citizens of Bhutan do not have adequate technical capabilities for maintenance would have difficulties in keeping their jobs. As described above, people could fall in a vicious cycle”. We explained the man aforementioned that learning skills to make full use of construction

machinery and construct roads with them is top priority.

The driver listening to our conversation understood what we meant quickly and said, “Construction of road can create more jobs, more people can get a job and our lives become easier. We must do it, so please teach us those skills.” That was a beginning of our support as a leading player in road construction technology transfer to developing countries.

[Fostering the spirit of self-help through road pavement technology transfer](#)

I have been consulting Mr. Kimura, specialist of road pavement, about all the issues on road construction. Mr. Kimura is a president of the company whose base in Yokohama with broad experience in asphalt pavement. They have constructed undersea tunnel connecting Third Keihin, Kawasaki and Kisarazu, paved “Umihotaru”, runway of Haneda Airport, tennis court in Tokai University, Yokohama Nissan’s and Toyota’s test driving course, Honmoku and Oguro Wharf. So I have been getting technological coaching from Mr. Kimura on asphalt pavement.

Following his advice, we conducted training on “Appropriate construction of paved road” and “Maintenance of paving machinery” by local citizens and obtained some good results. Our mission is to transfer the most appropriate method, recognize them the importance of maintenance by themselves and spirit of self-help to the citizens. This is philosophy of Japanese government’s ODA projects.

End

Japanese government’s ODA philosophy

(1) Support for self-help of developing countries

To support self-help of developing countries based on good governance, we help human resources development, institutional reform, infrastructure improvement and building an economic base, which is our ODA philosophy. We also show our respect for their ownership and their own development strategy. Then, we support the countries working actively for peace, democratization, protection of human rights and economic restructuring.

(2) Human security

To counter the threat of conflicts, disasters and infectious diseases, we should see things from various prospective as human security points of view global, regional and country level prospective. To help people in conflicts, we will provide ODA, develop human resources and foster their abilities to ensure their individual security, personal dignity.

(3) Ensure fairness

Considering gender and minorities issue, gap between rich and poor, regional difference and impacts on environment and society, we provide ODA so that people can enjoy its profits fairly.

(4) Share our experience and knowledge

We share our experience and knowledge on development of economic society and providing economic assistance with developing countries and utilize our excellent skills, knowledge, specialists and system to their development.

As for ODA execution, we consider impact on our economy and society, coordinate with our policy and ensure consistency.

(5) Cooperation with international community

International authorities have been promoting to share the goal and strategy of development and provided assistance in corporation with other authorities. Japanese authority will join this and makes every effort to play a key role. We also promote cooperation with UN agencies, International cooperation financial institutions, other supporting countries, NGO and private companies. Above all, we will coordinate our ODA with international authorities which has expertise and political neutrality. Meantime, we also make efforts to help their administration. Moreover, we will work actively on south-south cooperation with relatively advanced developing countries. We also will proceed with regional cooperation and alliances to establish multilateral support system.

Source : Proposed ODA outlines of Ministry of Foreign Affairs