

社会開発調査部報告書

No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

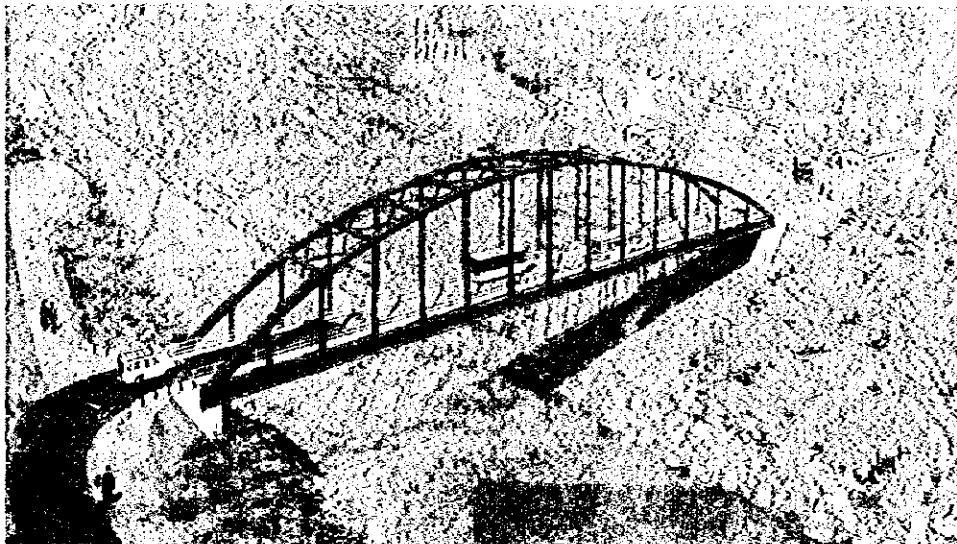
MINISTRY OF COMMUNICATIONS,  
THE ROYAL GOVERNMENT OF BHUTAN

**THE STUDY  
ON  
NATIONAL HIGHWAY BRIDGE CONSTRUCTION  
IN  
THE KINGDOM OF BHUTAN**

**FINAL REPORT**

**VOLUME 3**

**APPENDIX**



JULY 1998

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HOKKAIDO ENGINEERING CONSULTANTS Co., Ltd.**

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1145123 (4)

**NOTE**

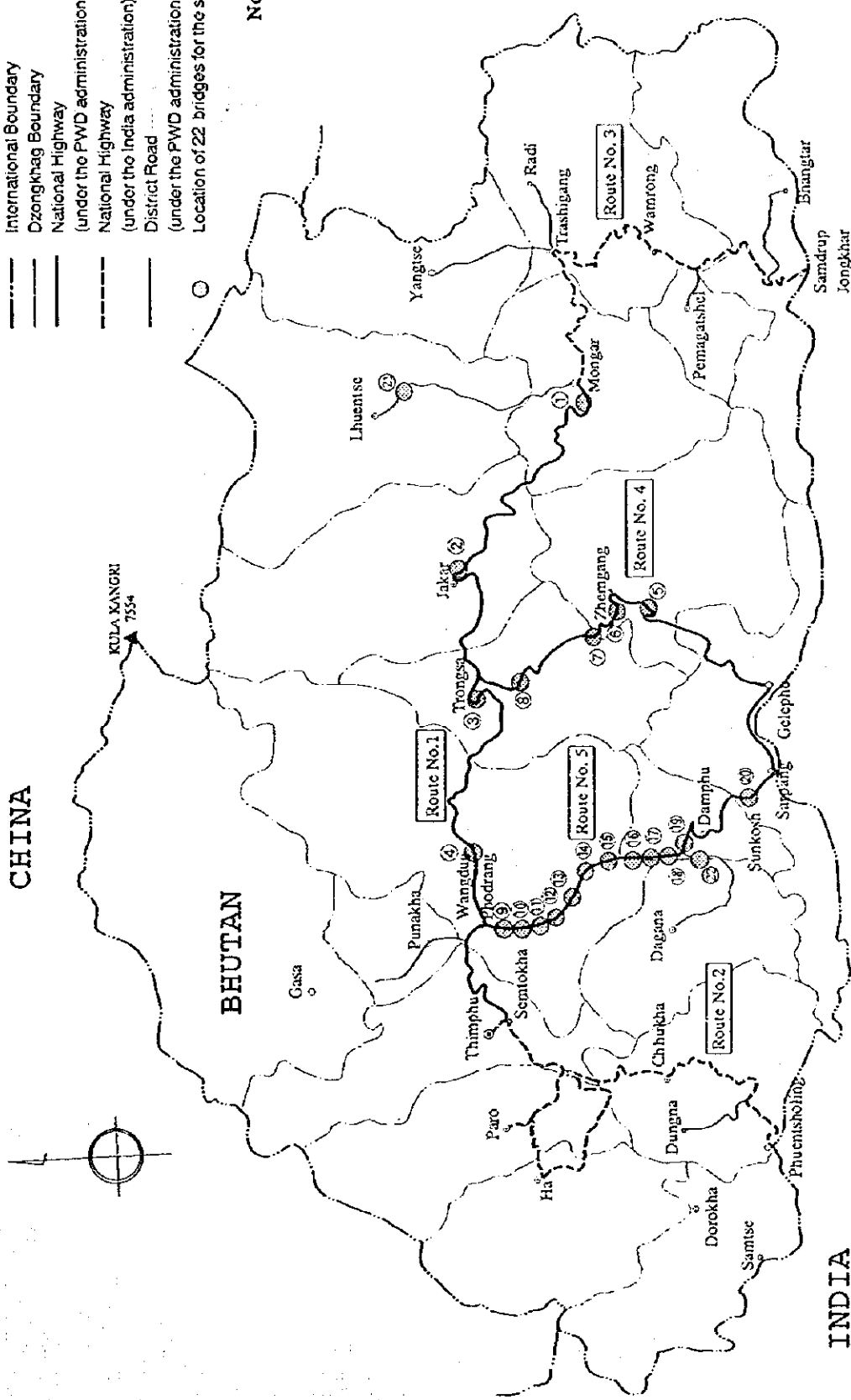
The following exchange rate was adopted through this report.

**US\$ 1.00 = Nu. 38.6 (March 1998)**

- Legend :**
- Capital
  - Dzongkhag (District) Headquarters
  - Major Town
  - International Boundary
  - Dzongkhag Boundary
  - National Highway
  - National Highway (under the PWD administration)
  - National Highway (under the India administration)
  - District Road
  - District Road (under the PWD administration)
  - Location of 22 bridges for the study

**No. : Bridge Name**

- ①: Kunzampa
- ②: Chamkar Zam
- ③: Bjee
- ④: Wachy Zam
- ⑤: Mangdichu
- ⑥: Wangdigang
- ⑦: Pan, armani
- ⑧: Ishigangchu
- ⑨: Hesothangkha
- ⑩: Lawakha
- ⑪: Basochu
- ⑫: Kunichu
- ⑬: Baychu
- ⑭: Kamichu
- ⑮: Narachu
- ⑯: Wakleytar
- ⑰: Mechikhola
- ⑱: Durichu
- ⑲: Chanchey
- ⑳: Loringkhola
- ㉑: Tangmachu
- ㉒: Sunkosh



**Location Map of Bridges for the Study**





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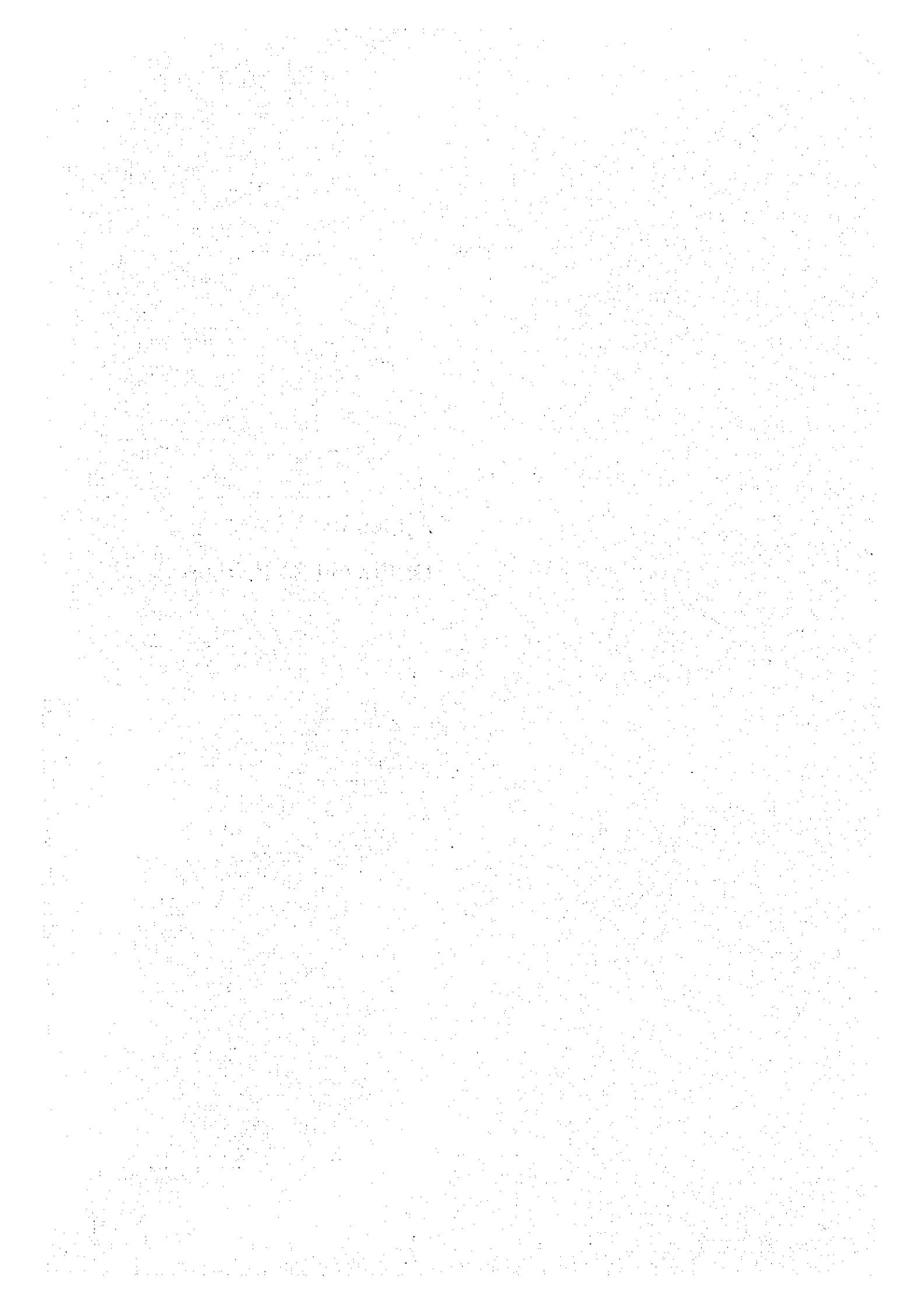
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### **APPENDIX**

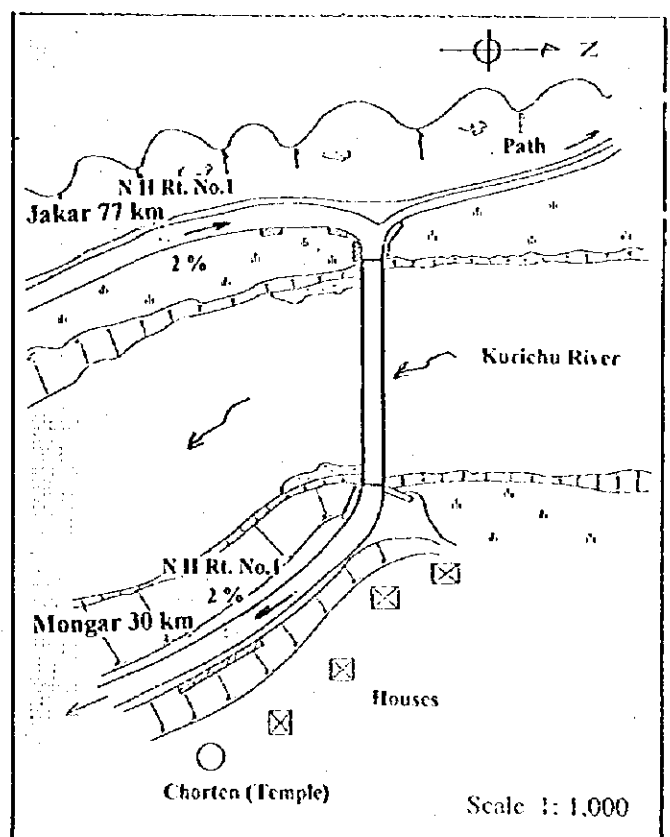
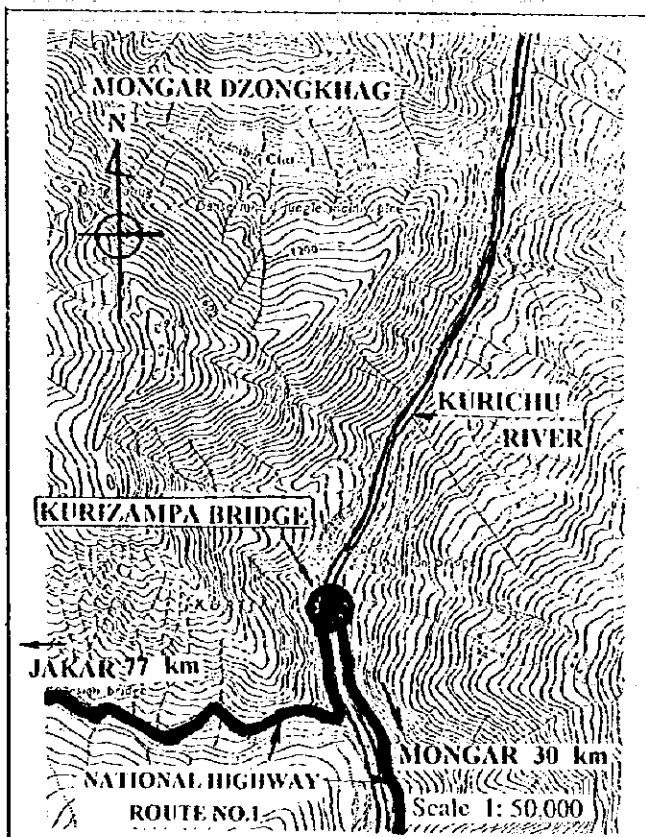
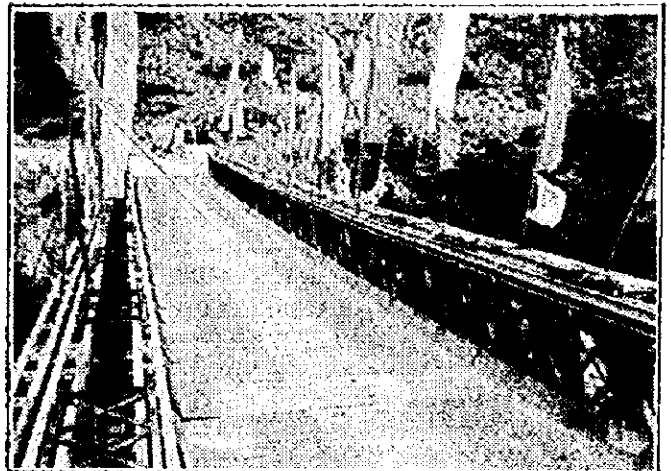
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## **APPENDIX**

**Appendix-A**  
**Outline of 22 Bridges**



## BRIDGE NO. 1 KURIZAMPA BRIDGE



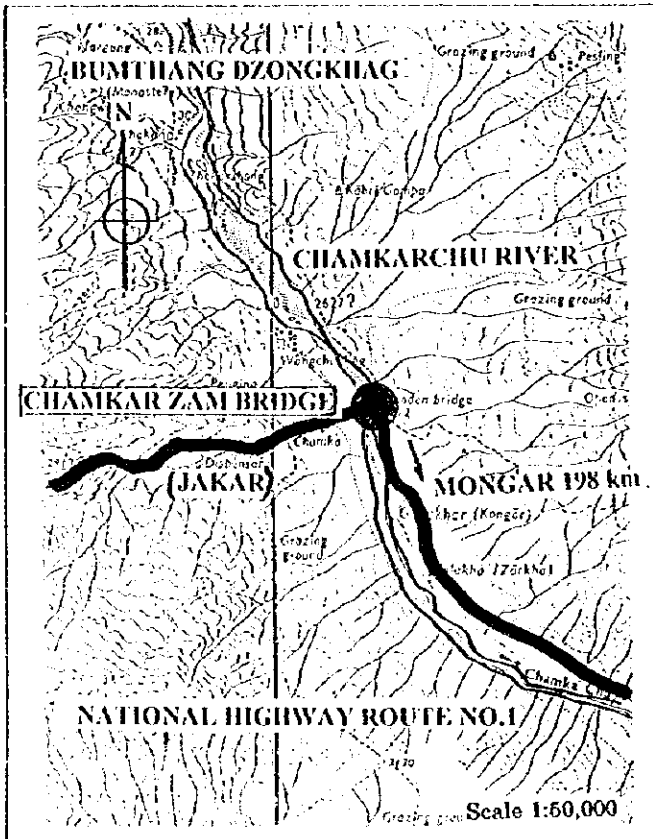
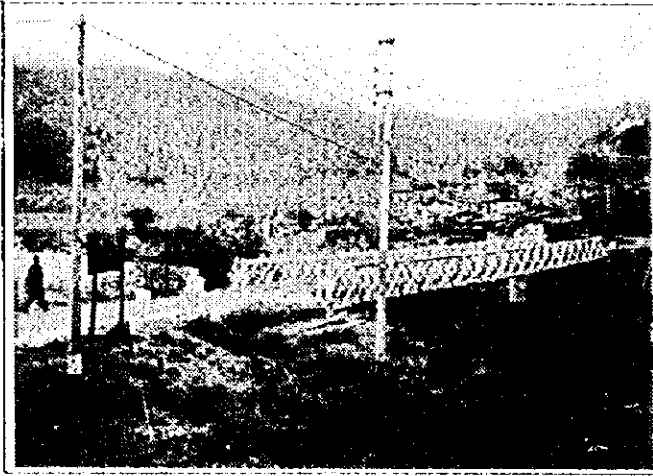
### Existing Conditions

- |  |                                   |
|--|-----------------------------------|
| 1. Location:   | Kurichu River, Mongar Dzongkhag   |
| 2. Class of road:  | National Highway Route No. 1      |
| 3. Superstructure:   | Bailey TSR                        |
| 4. Substructure:   | Masonry abutments on natural rock |
| 5. Approach roads:   | Sealed macadam paved 4 m wide     |
| 6. Bridge length:  | 42.7 m                            |
| 7. Bridge width:   | 3.36 m (carriageway)              |
| 8. Maintenance, especially repainting manner, is not satisfactory. |                                   |

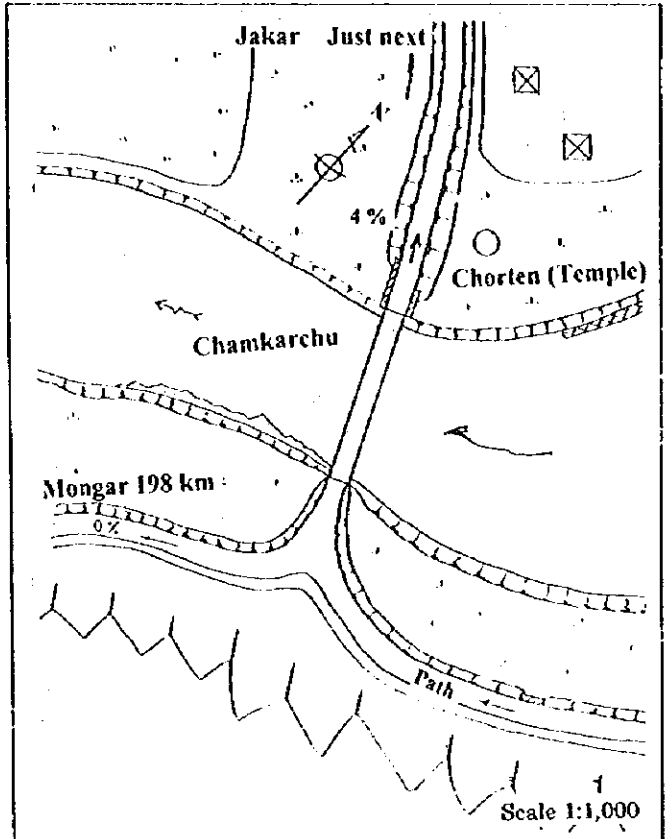
### Other Information

1. Completed in 1971
2. Original load capacity: 18 ton  
Present limited load capacity: 5 ton
3. In down stream, Kurichu Hydro Power Plant is under construction. However there is no influence to water level at the bridge site.
4. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 2 CHAMKAR ZAM BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

### Existing Conditions

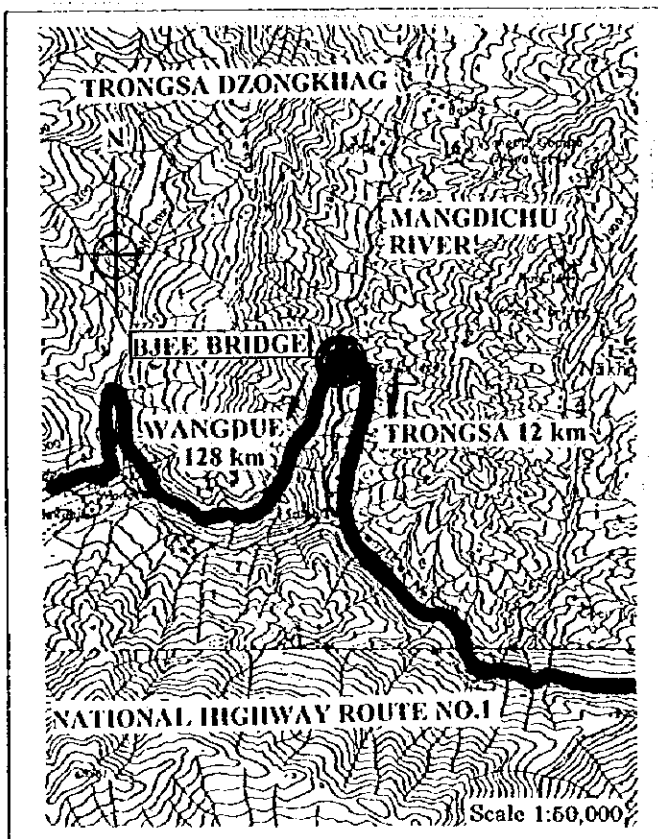
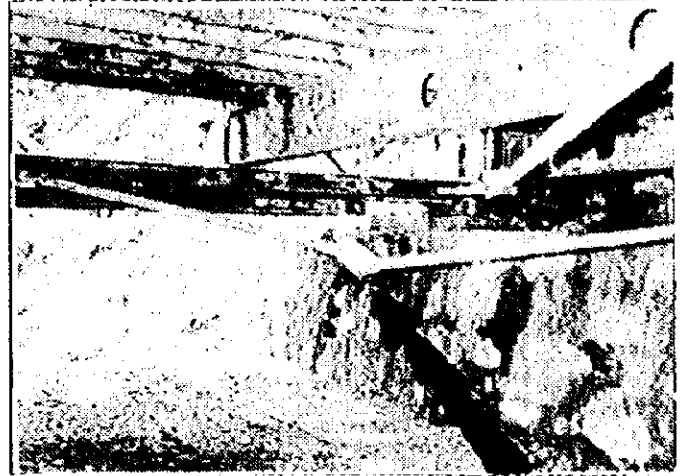
- |  |  |
|--|--|
| 1. Location:   | Chamkarchu River, Bumthang Dzongkhag                       |
| 2. Class of road:  | National Highway Route No.1                                |
| 3. Superstructure:   | Bailey DS  |
| 4. Substructure:   | Masonry abutments on natural rock                          |
| 5. Approach roads:   | Sealed macadam paved 4 m wide                              |
| 6. Bridge length:  | 33.7 m   |
| 7. Bridge width:   | 3.22 m (carriageway)                                       |
| 8. Maintenance, especially on the underside of superstructure, | is not satisfactory. The rust has gone into steel members. |

superstructure is not satisfactory. The rust has gone into steel members.

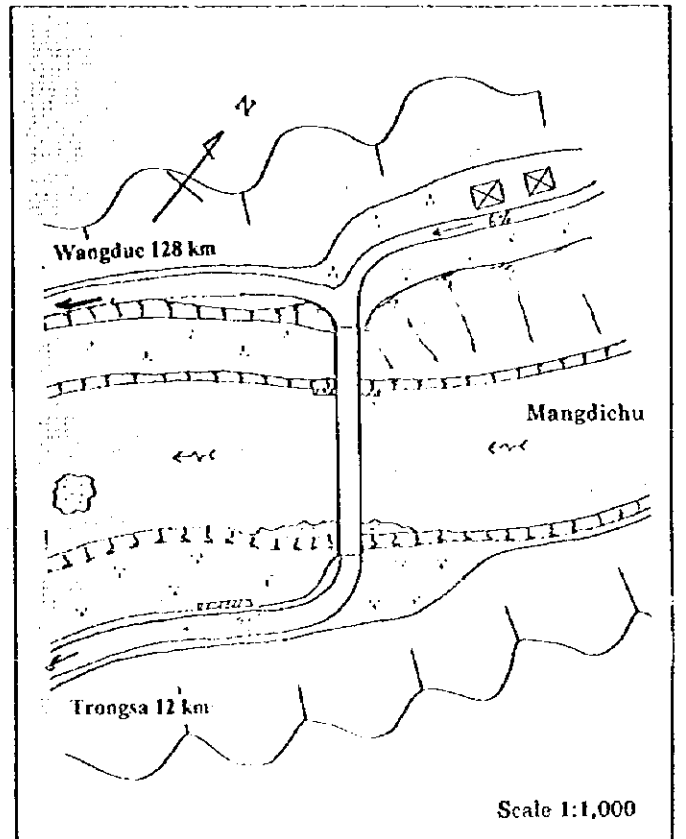
### Other Information

1. Completed in 1973
2. Original load capacity: 18 ton  
Present limited load capacity: 5 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 3 BJEE BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

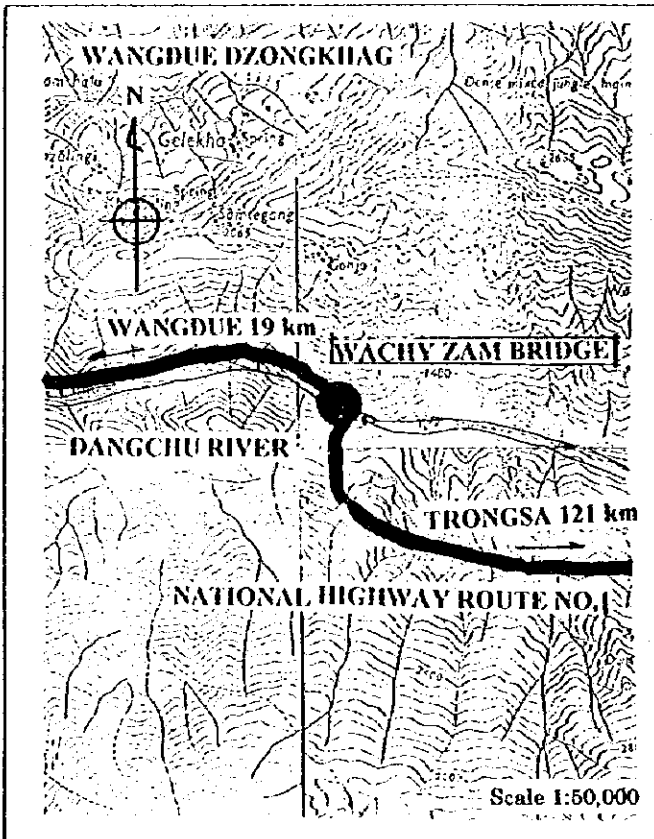
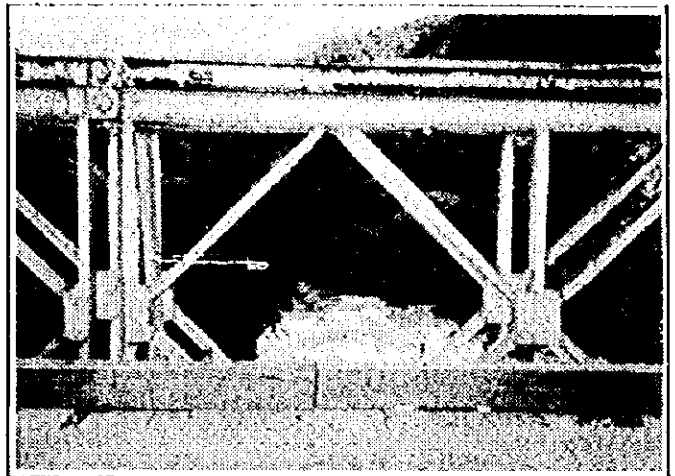
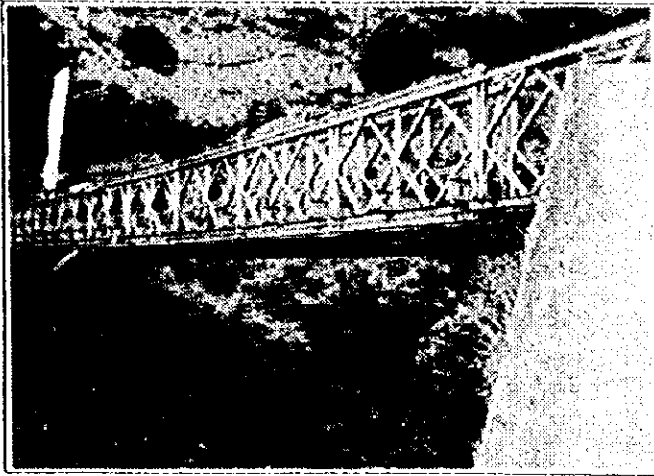
### Existing Conditions

1. Location: Mangdichu River, Trongsa Dzongkhag
2. Class of road: National Highway Route No.1
3. Superstructure: Bailey TSR
4. Substructure: Masonry abutments on natural rock
5. Approach roads: Scaled macadam paved 4 m wide
6. Bridge length: 42.7 m
7. Bridge width: 3.36 m (carriageway)
8. The underside of the superstructure is very rusty and there is no sign of past maintenance. A turn-buckle doesn't work as shown in the photo, pins are missing, and main beams are crushed by vehicles and left bent severely at 24 locations.

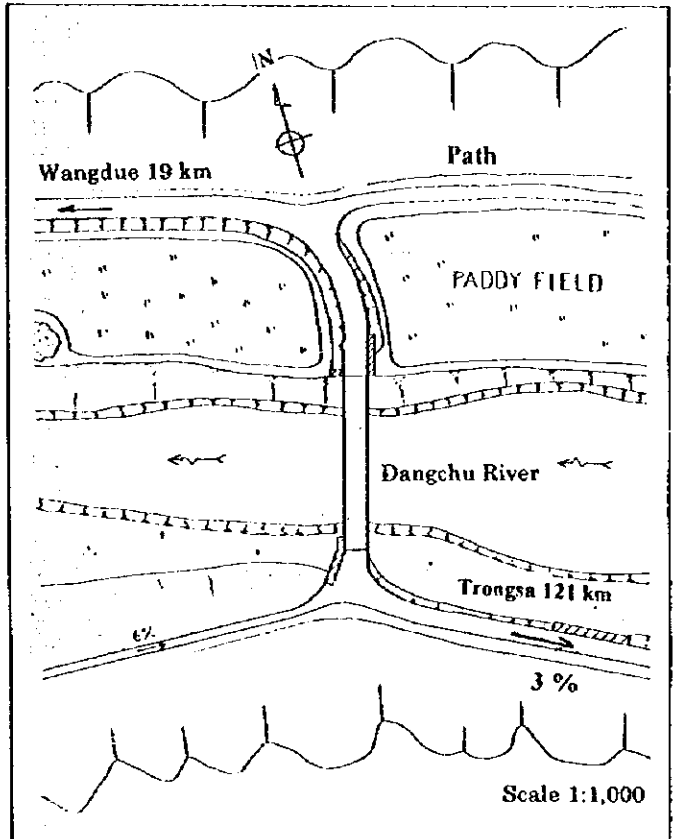
### Other Information

1. Completed in 1971
2. Original load capacity: 18 ton  
Present limited load capacity: 9 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 4 WACHY ZAM BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

### Existing Conditions

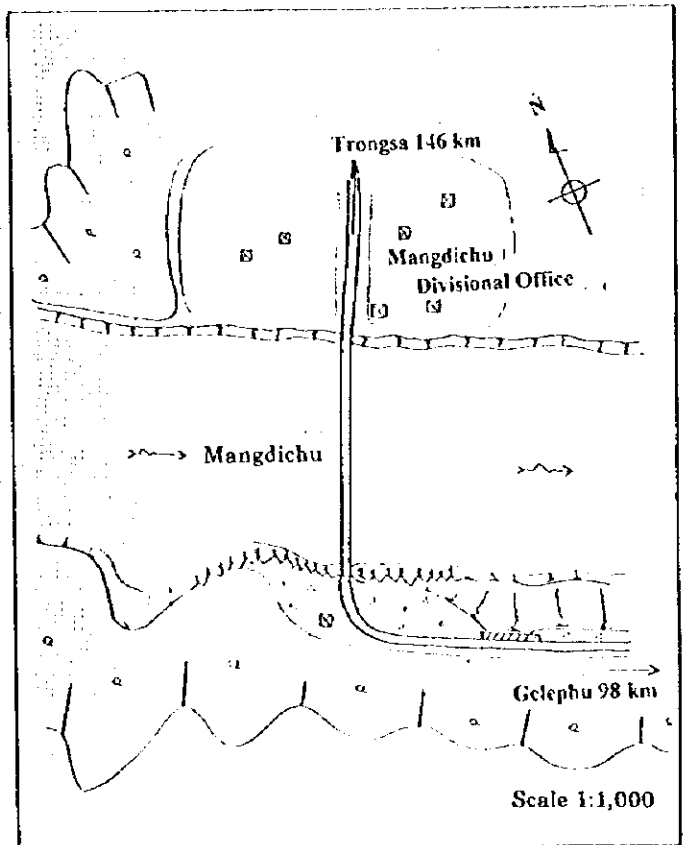
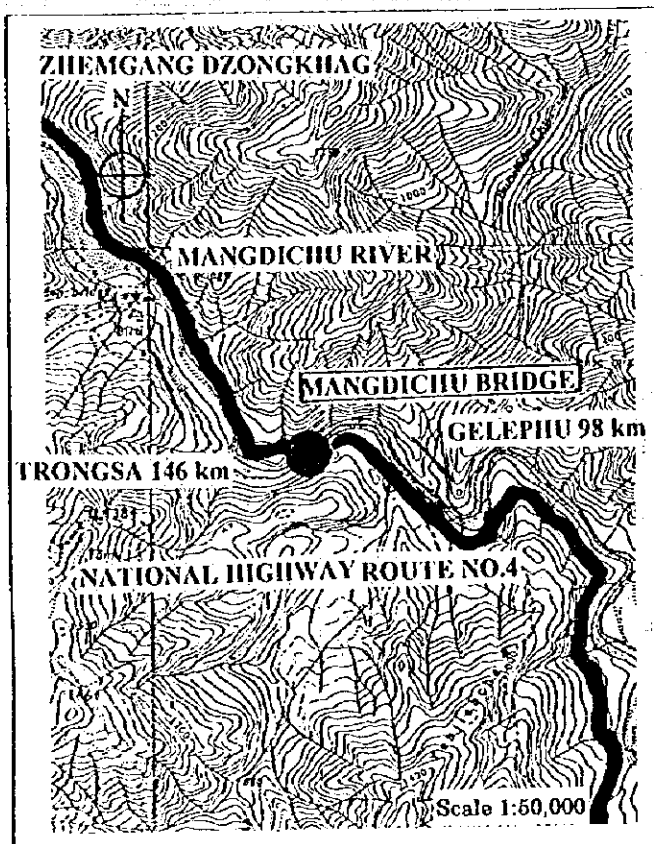
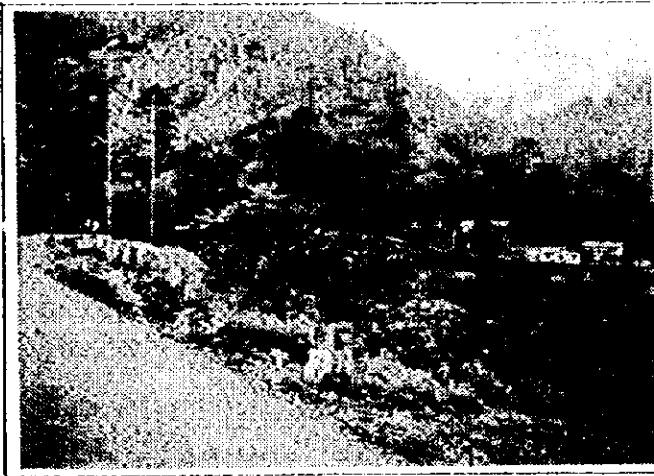
1. Location: Dangchu River, Wongdue Dzongkhag
2. Class of road: National Highway Route No.1
3. Superstructure: Bailey DSR
4. Substructure: Masonry abutments on natural rock
5. Approach roads: Sealed macadam paved 4 m wide
6. Bridge length: 33.7 m
7. Bridge width: 3.15 m (carriageway)
8. Main steel members are seriously got rusted into the mother materials.

### Other Information

1. Completed in 1969
2. Original load capacity: 18 ton  
Present load capacity: 18 ton
3. Near bridge site a space for construction materials and equipment is available.



## BRIDGE NO. 5 MANGDICHU BRIDGE



**Existing Conditions**

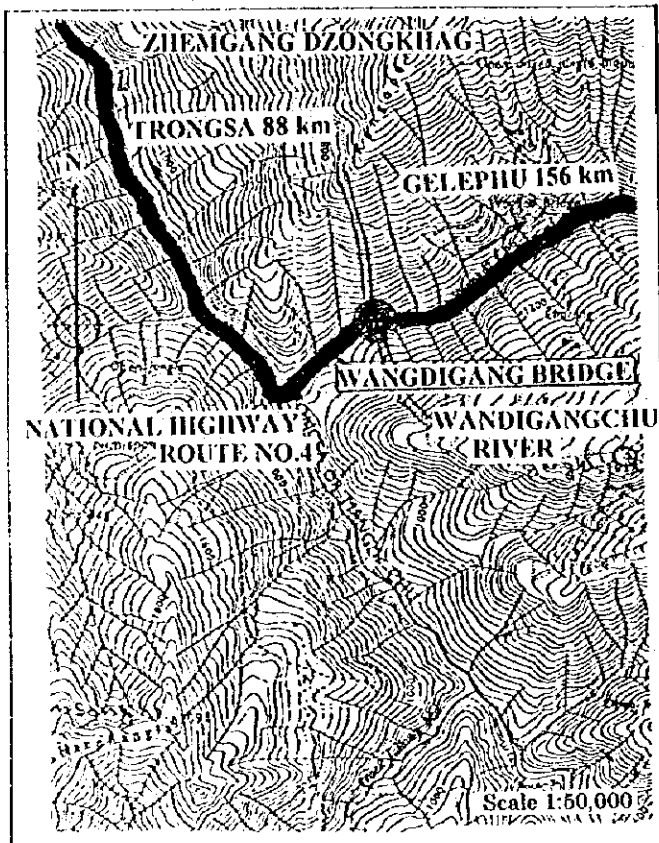
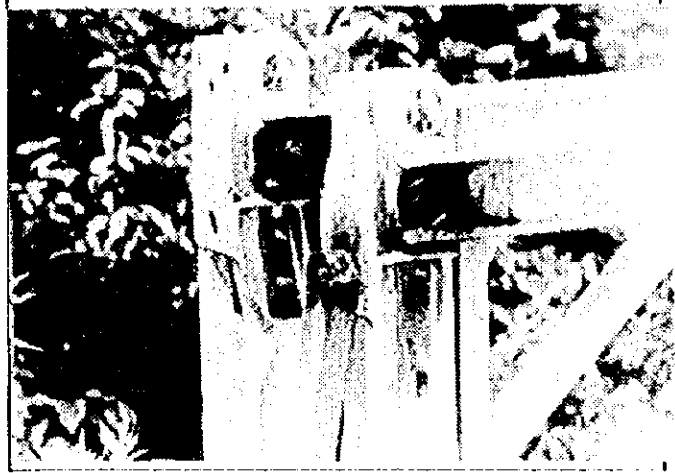
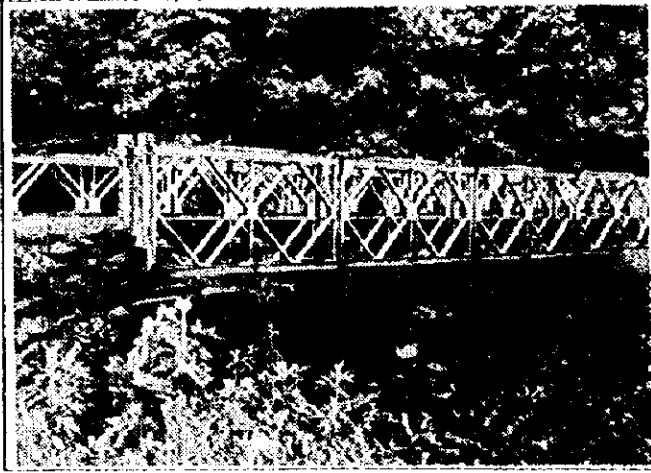
- 1. Location: Mangdichu River, Zhemgang Dzongkhag
- 2. Class of road: National Highway Route No. 4
- 3. Superstructure: Bailey Suspension
- 4. Substructure: Masonry abutments on
- 5. Approach roads: Sealed macadam paved 4 m wide
- 6. Bridge length: 97.4 m
- 7. Bridge width: 3.20 m (carriageway)

8. Some wires of main cables were damaged. It is very dangerous.

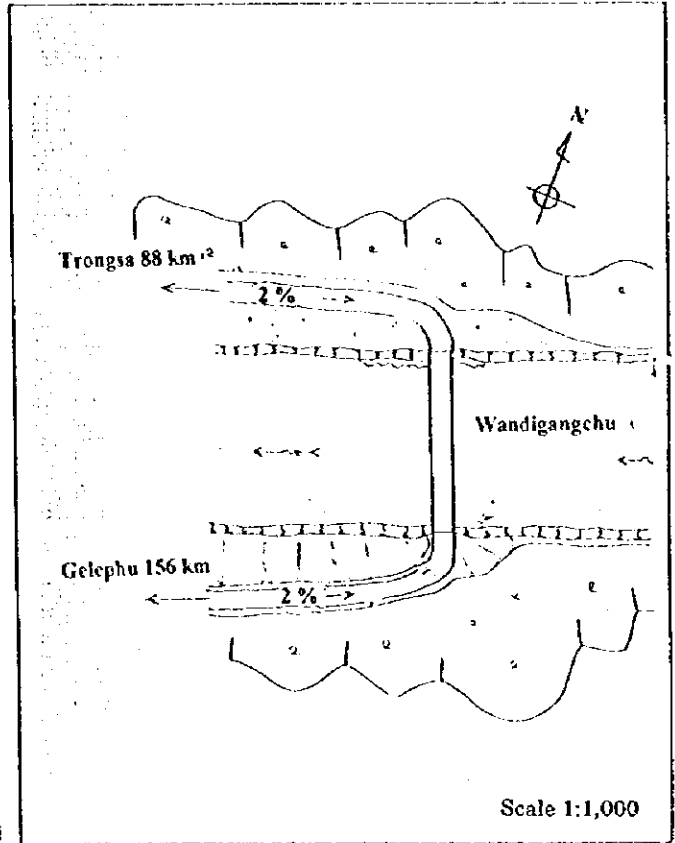
**Other Information**

- 1. Completed in 1965
- 2. Original load capacity: 18 ton
- Present limited load capacity: 4 ton
- 3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 6 WANGDIGANG BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

### Existing Conditions

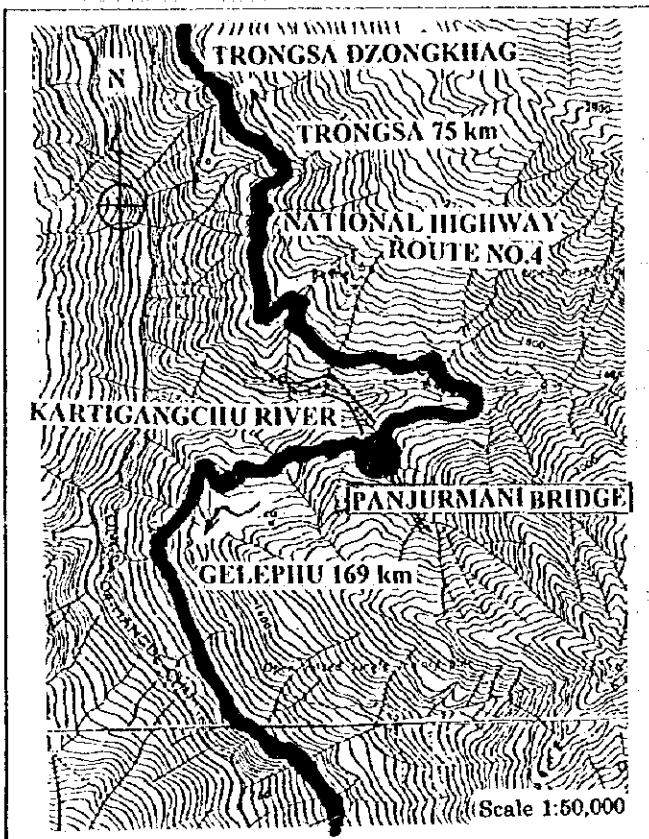
- |                    |   |
|--------------------|---|
| 1. Location:       | Wangdigangchu River, Zhemgang Dzongkhag |
| 2. Class of road:  | National Highway Route No. 4            |
| 3. Superstructure: | Bailey DS                               |
| 4. Substructure:   | Masonry abutments on natural rocks      |
| 5. Approach roads: | Sealed macadam paved 4 m wide           |
| 6. Bridge length:  | 30.5 m                                  |
| 7. Bridge width:   | 3.35 m (carriageway)                    |

8. One pin on the end post is missing, and main frames were crushed and bent at 3 locations.

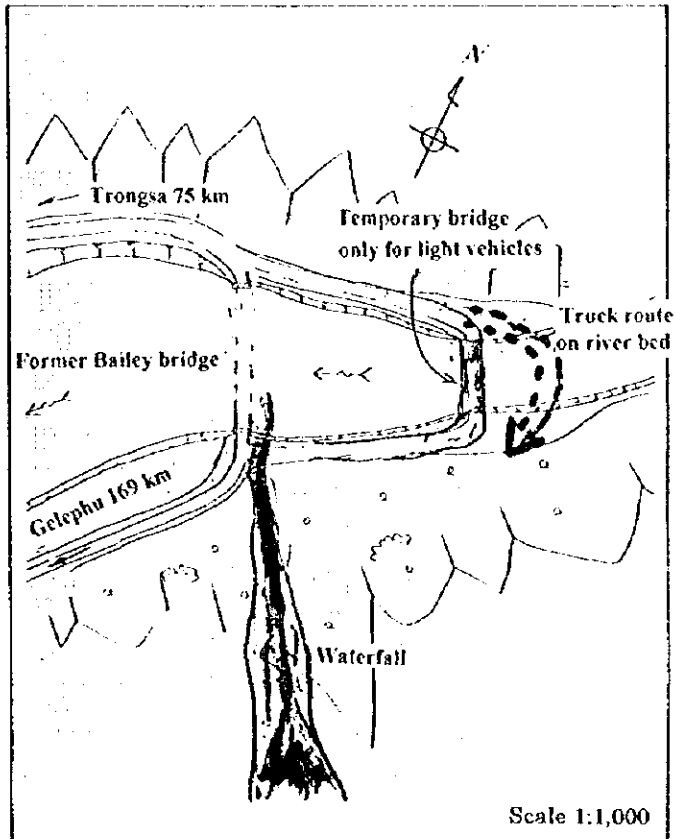
### Other Information

1. Completed in 1969
2. Original load capacity: 15 ton  
Present load capacity: 15 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 7 PANJURMANI BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

**Existing Conditions**

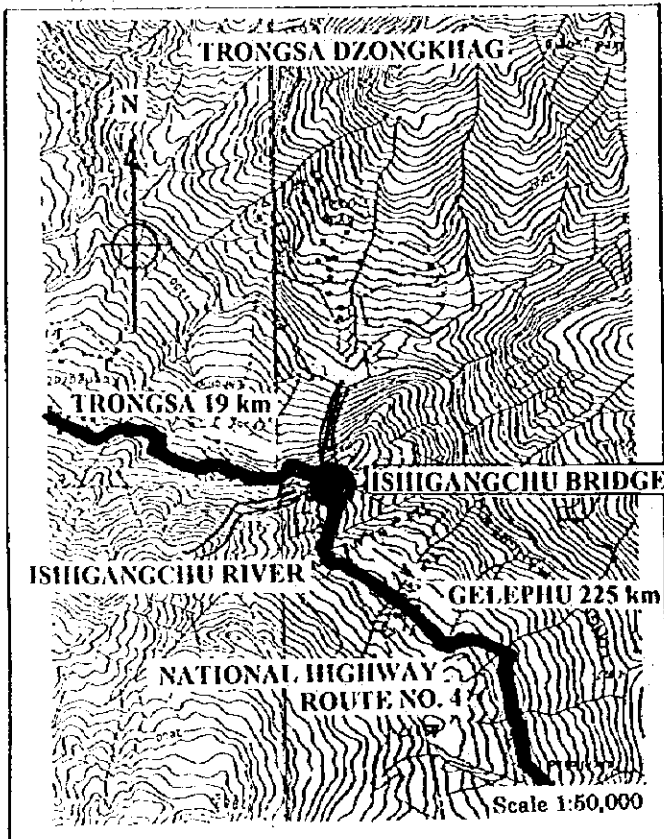
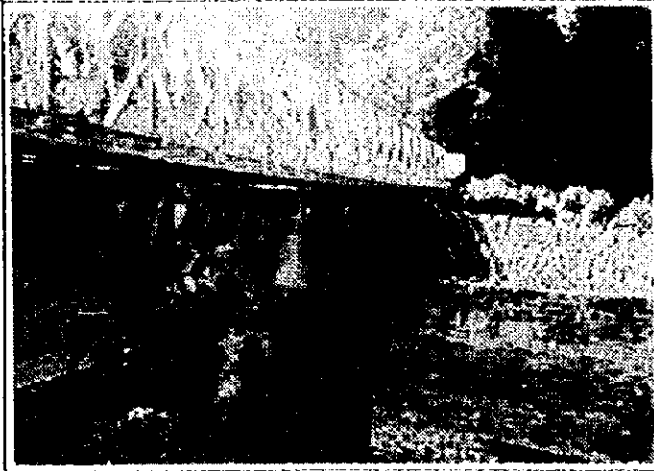
- |   |                                       |
|---|---------------------------------------|
| 1. Location:  | Kartigangchu River, Trongsa Dzongkhag |
| 2. Class of road:   | National Highway Route No.4           |
| 3. Superstructure:  | Steel I girder with timber deck       |
| 4. Substructure:  | Masonry abutments                     |
| 5. Approach roads:  | Scaled macadam paved 4 m wide         |
| 6. Bridge length:   | 9.0 m                                 |
| 7. Bridge width:  | 4.0 m (carriageway)                   |
| 8. Former Bailey bridge was damaged by flood and falling trees. |                                       |

Existing steel girder with log deck is a temporary one.  
Heavy trucks are crossing the river bed at upper stream.

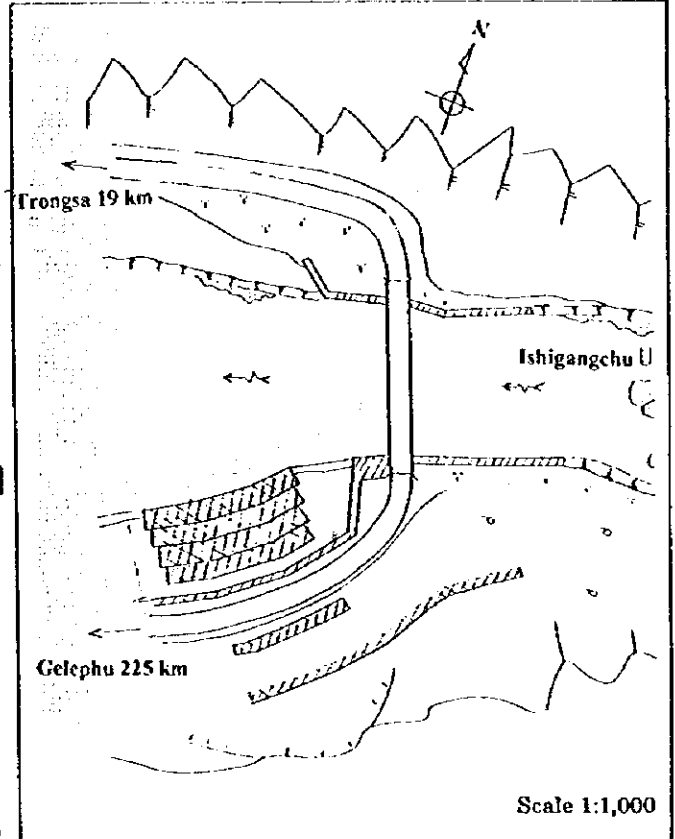
**Other Information**

- |  |         |
|--|---------|
| 1. Completed in  | 1995    |
| 2. Original load capacity:   | unknown |
| Present limited load capacity:   | 7 ton   |
| 3. Near bridge site a space for construction materials and equipment is available. |         |

## BRIDGE NO. 8 ISHIGANGCHU BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

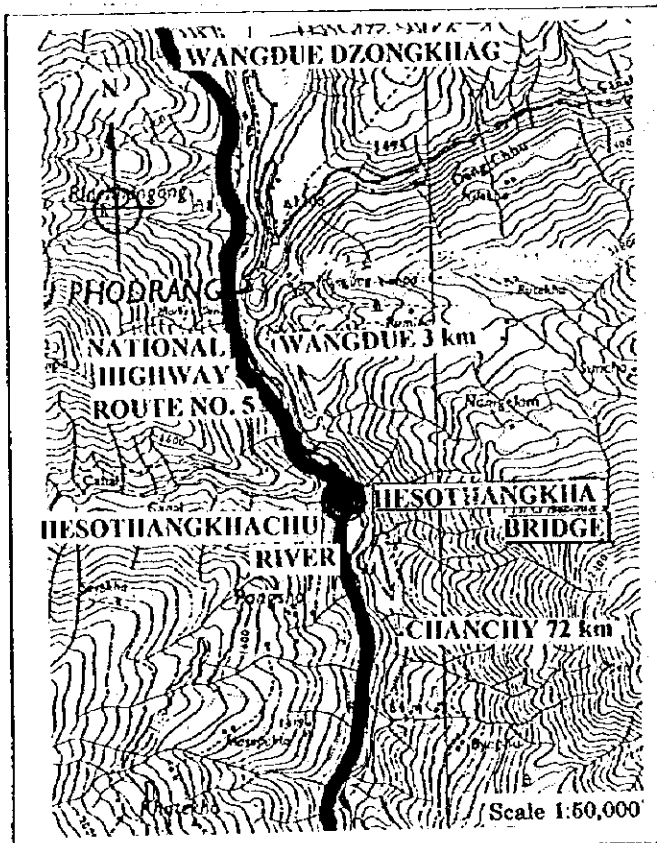
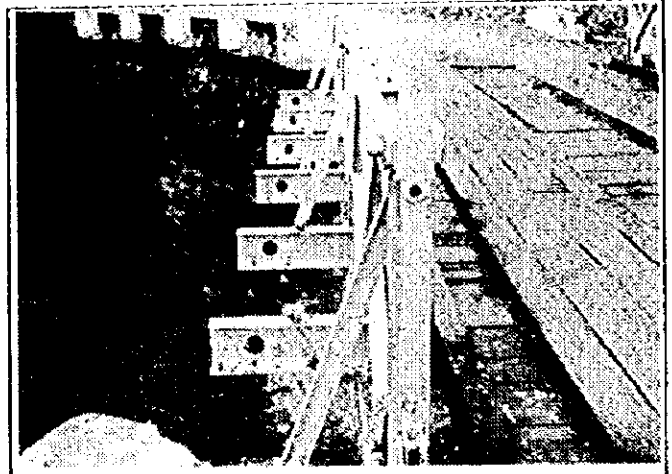
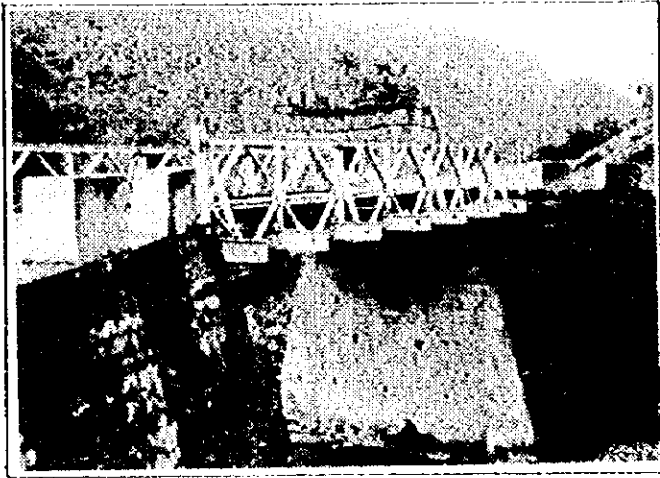
### Existing Conditions

1. Location: Ishigangchu River, Trongsa Dzongkhag
2. Class of road: National Highway Route No.4
3. Superstructure: Bailey DS
4. Substructure: Masonry abutments on natural rock
5. Approach roads: Scaled macadam paved 4 m wide
6. Bridge length: 36.6 m
7. Bridge width: 3.34 m (carriageway)
8. This is a temporary bridge.

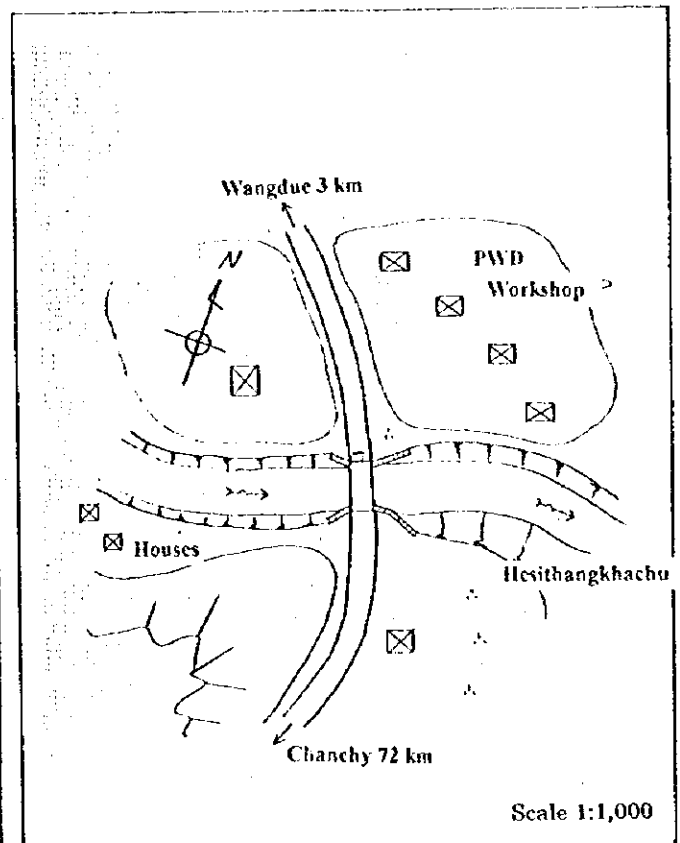
### Other Information

1. Completed in 1992
2. Original load capacity: 18 ton  
Present limited load capacity: 15 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 9 HESOTHANGKHA BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

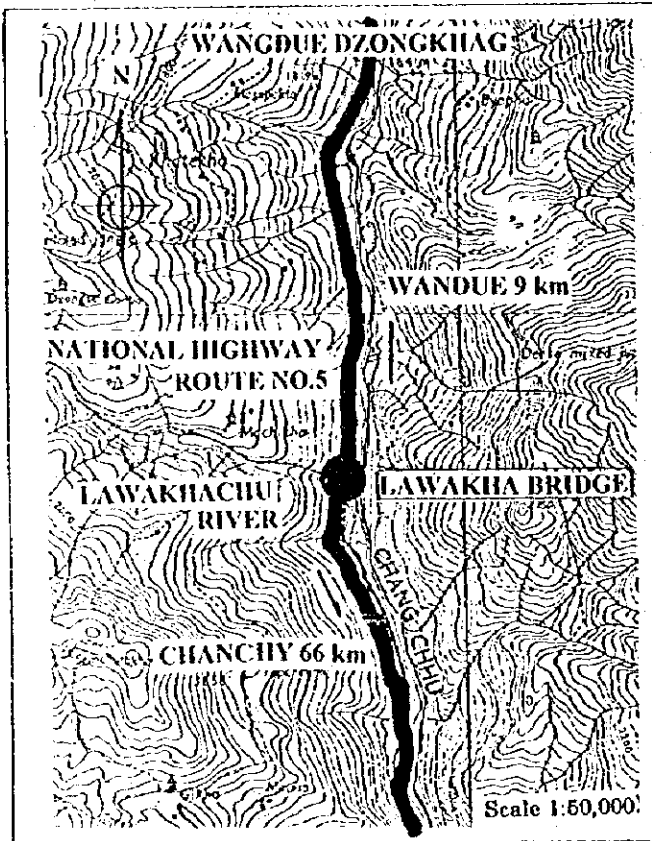
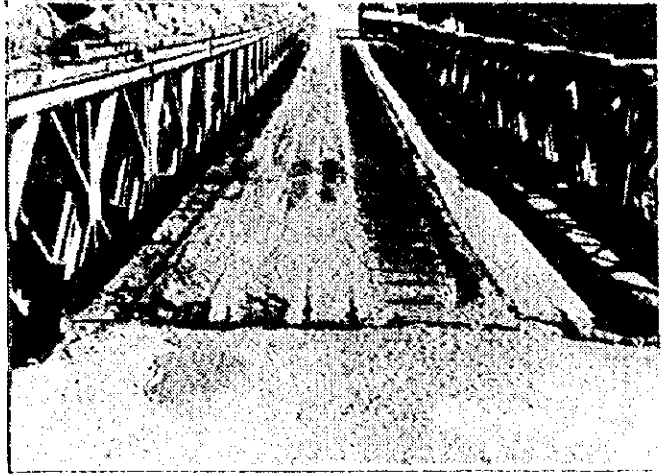
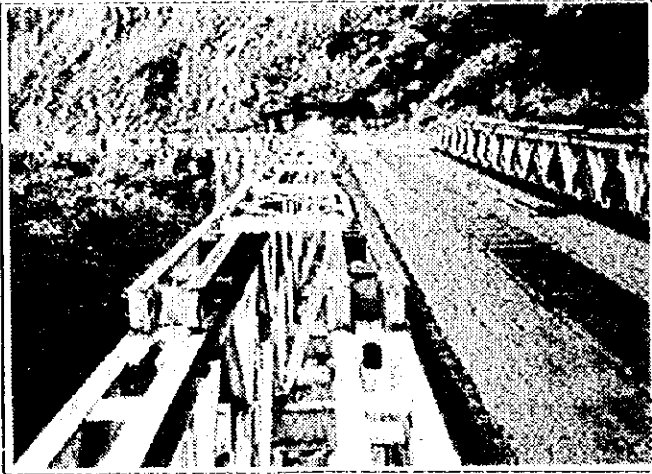
### Existing Conditions

1. Location: Hesothangkhachu River, Wangdue Dzongkhag
2. Class of road: National Highway Route No. 5
3. Superstructure: Bailey SS
4. Substructure: Masonry abutments on natural rock
5. Approach roads: Sealed macadam paved 4 m wide
6. Bridge length: 9.2 m
7. Bridge width: 3.34 m (carriageway)
8. totally very good condition

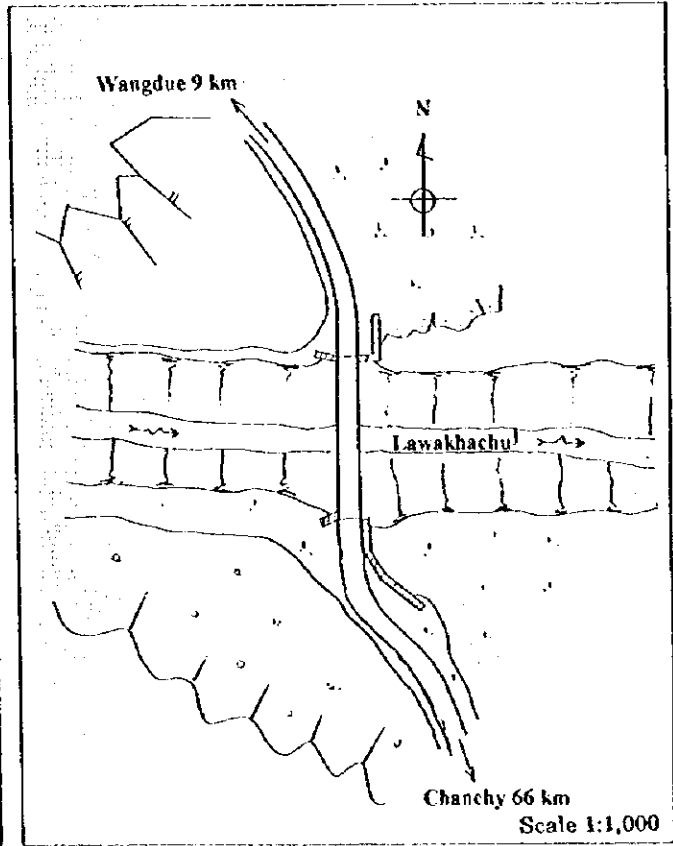
### Other Information

1. Completed in 1985
2. Original load capacity: 24 ton  
Present limited load capacity: 18ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 10 LAWAKHA BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

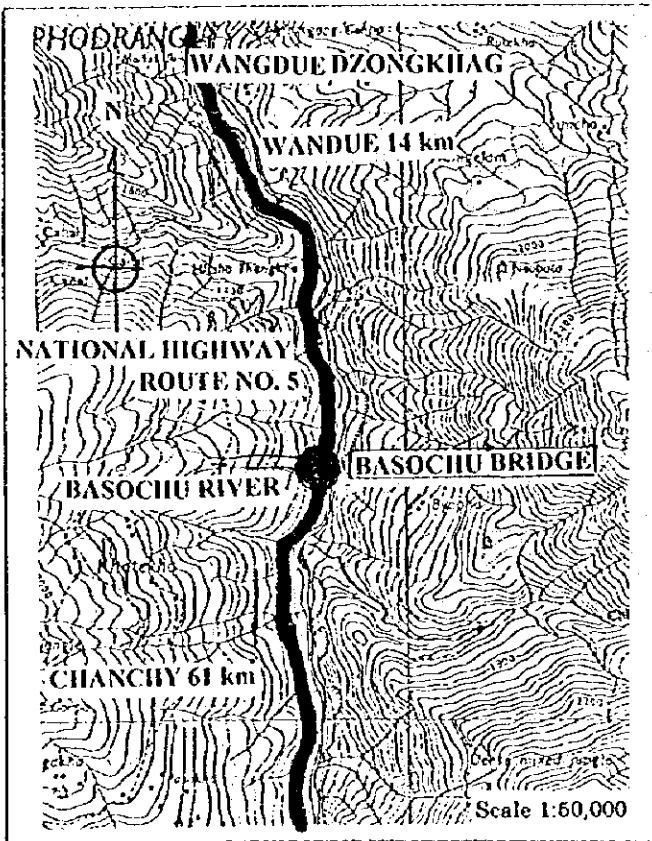
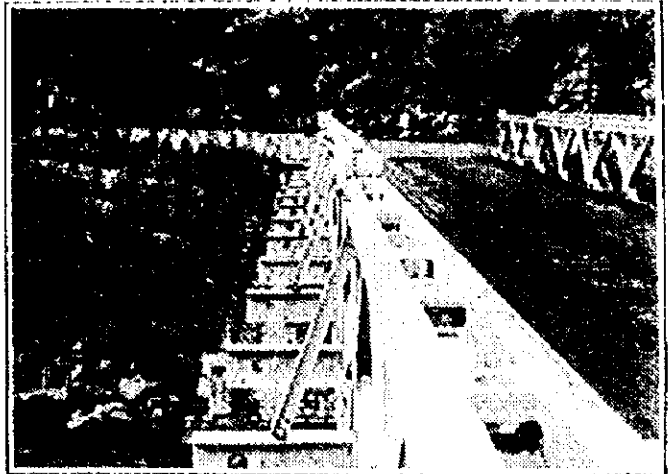
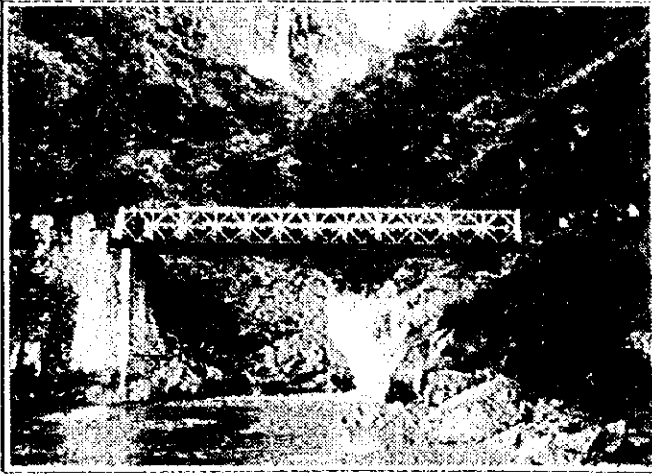
### Existing Conditions

- |                                 |                                     |
|---------------------------------|-------------------------------------|
| 1. Location:                    | Lawakhachu River, Wangdue Dzongkhag |
| 2. Class of road:               | National Highway Route No.5         |
| 3. Superstructure:              | Bailey DSR                          |
| 4. Substructure:                | Masonry abutments on natural rocks  |
| 5. Approach roads:              | Scaled macadam paved 4 m wide       |
| 6. Bridge length:               | 30.5 m                              |
| 7. Bridge width:                | 3.37 m (carriageway)                |
| 8. Deck timber is deteriorated. |                                     |

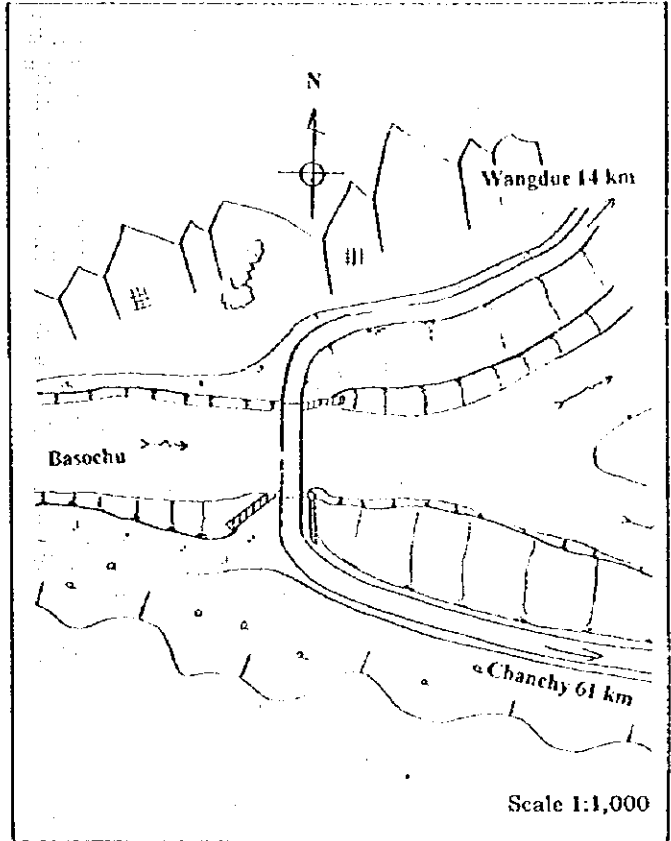
### Other Information

- |  |        |
|--|--------|
| 1. Completed in  | 1988   |
| 2. Original load capacity:   | 24 ton |
| Present limited load capacity:   | 18 ton |
| 3. Near bridge site a space for construction materials and equipment is available. |        |

## BRIDGE NO. 11 BASOCHU BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

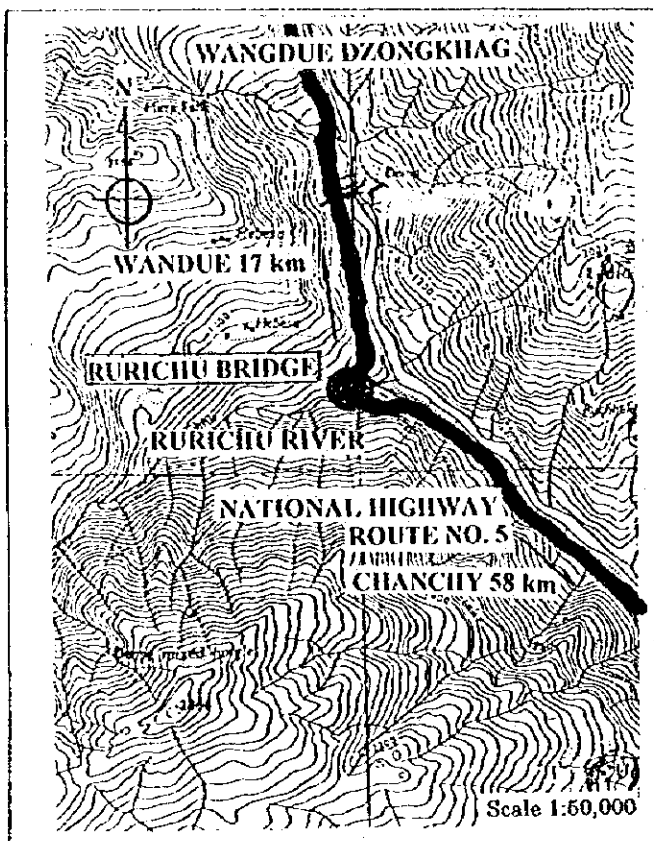
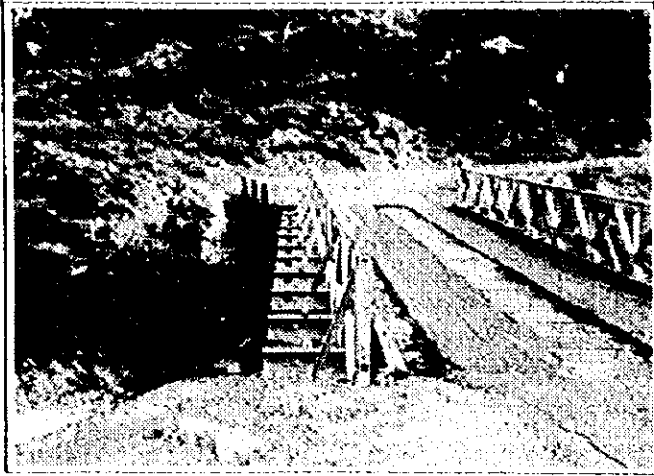
### Existing Conditions

- |                    |                                   |
|--------------------|-----------------------------------|
| 1. Location:       | Basochu River, Wangdue Dzongkhag  |
| 2. Class of road:  | National Highway Route No.5       |
| 3. Superstructure: | Bailey SSR                        |
| 4. Substructure:   | Masonry abutments on natural rock |
| 5. Approach roads: | Sealed macadam paved 4 m wide     |
| 6. Bridge length:  | 18.3 m                            |
| 7. Bridge width:   | 3.34 m (carriageway)              |

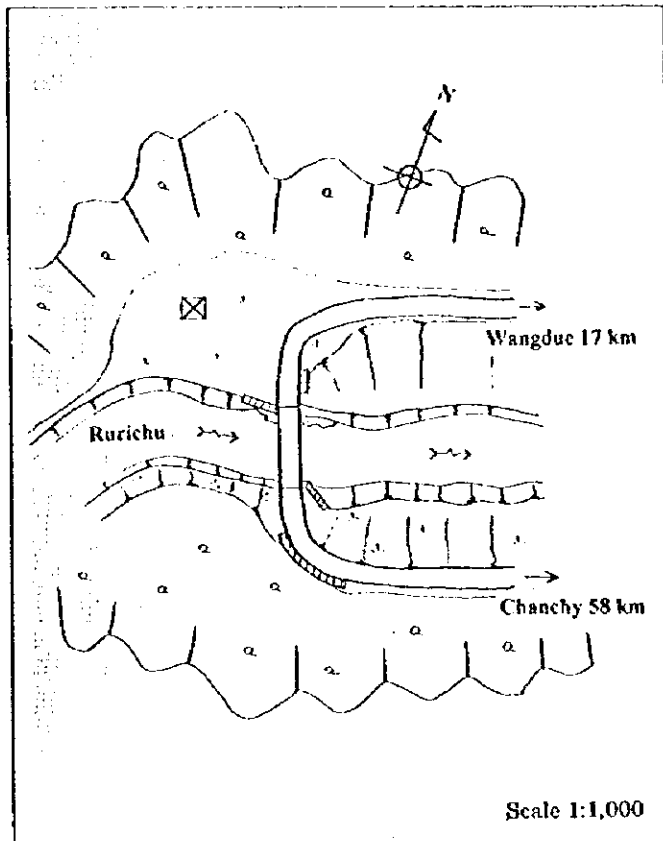
### Other Information

- |  |        |
|--|--------|
| 1. Completed in  | 1985   |
| 2. Original load capacity:   | 18 ton |
| Present limited load capacity:   | 15 ton |
| 3. Near bridge site a space for construction materials and equipment is available. |        |

## BRIDGE NO. 12 RURICHU BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

### Existing Conditions

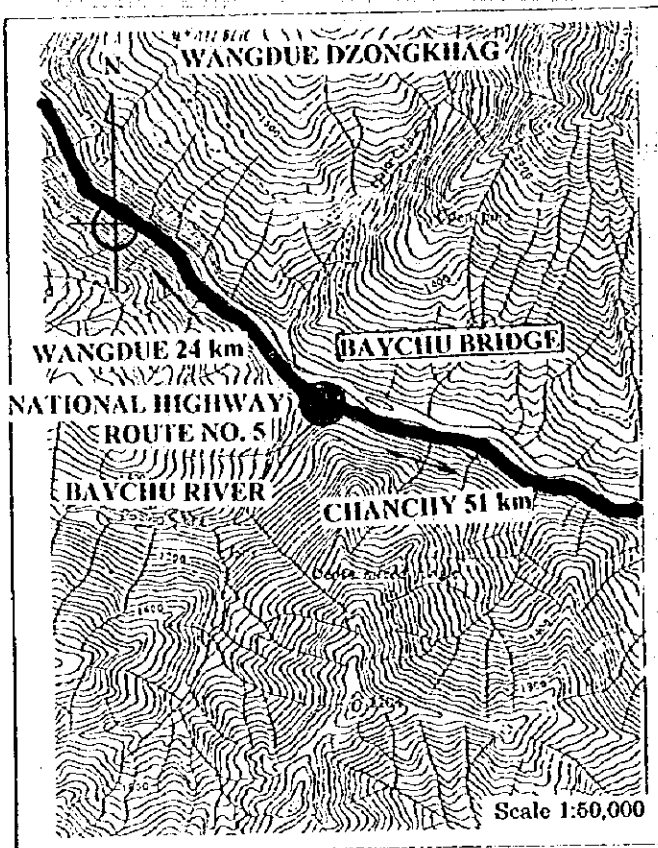
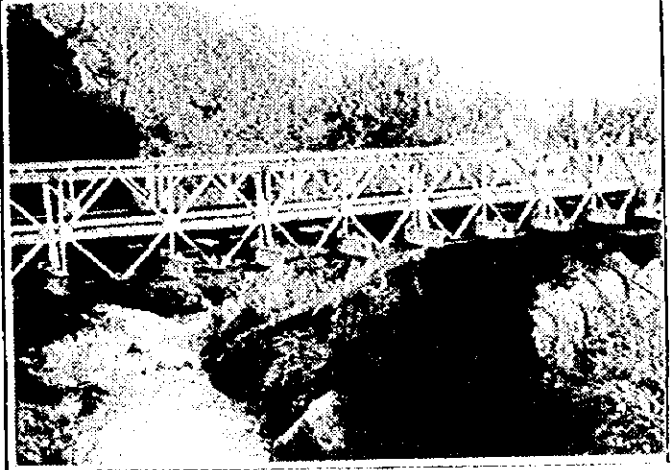
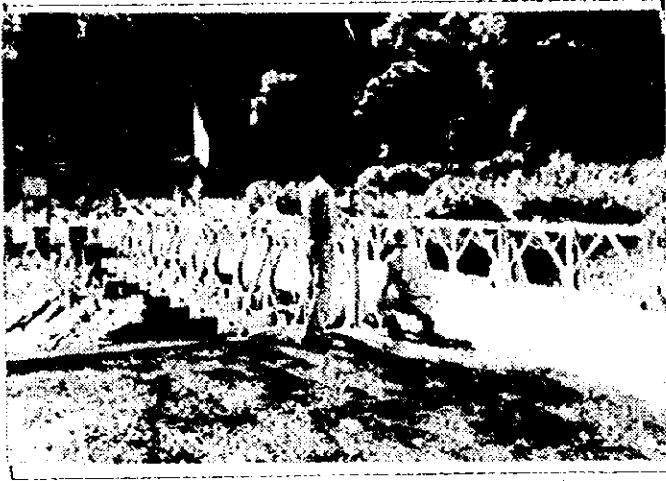
- |  |                                   |
|--|-----------------------------------|
| 1. Location:                             | Rurichu River, Wangdue Dzongkhag  |
| 2. Class of road:                        | National Highway Route No.5       |
| 3. Superstructure:                       | Bailey SS                         |
| 4. Substructure:                         | Masonry abutments on natural rock |
| 5. Approach roads:                       | Sealed macadam paved 4 m wide     |
| 6. Bridge length:                        | 15.3 m                            |
| 7. Bridge width:                         | 3.34 m (carriageway)              |
| 8. Very good condition, except bearings. |                                   |

### Other Information

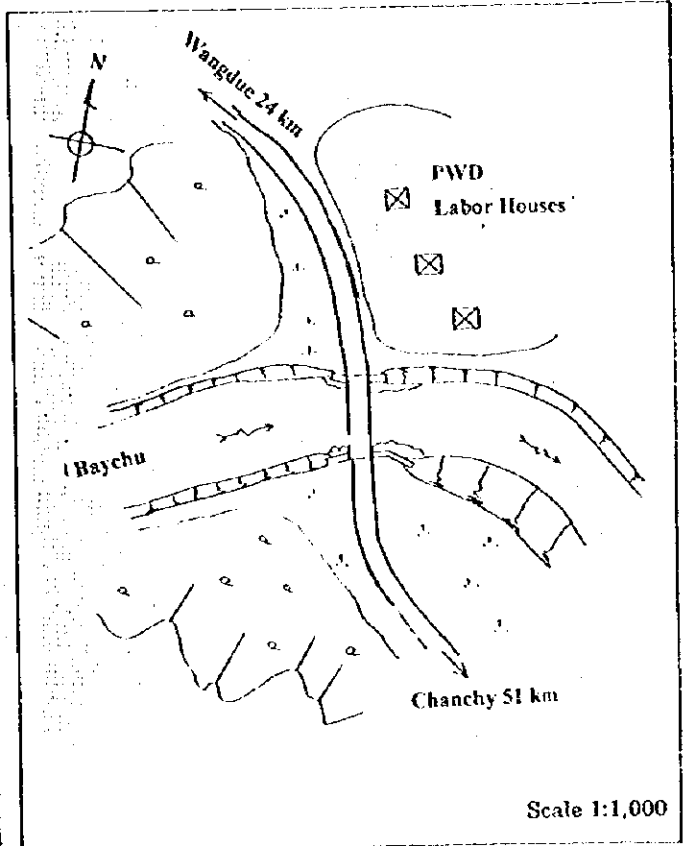
1. Completed in 1987
2. Original load capacity: 18 ton  
Present load capacity: 18 ton
3. Near bridge site a space for construction materials and equipment is available.



## BRIDGE NO. 13 BAYCHU BRIDGE



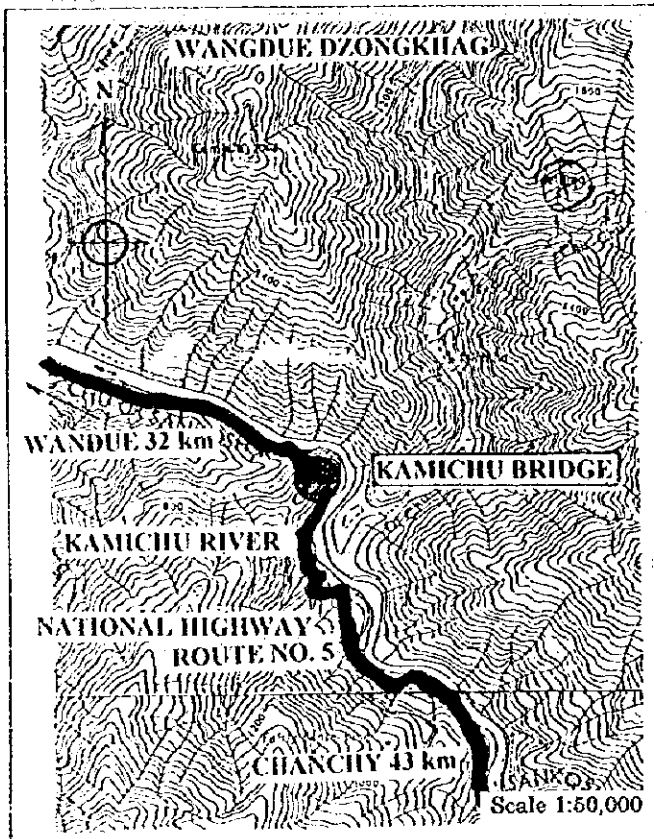
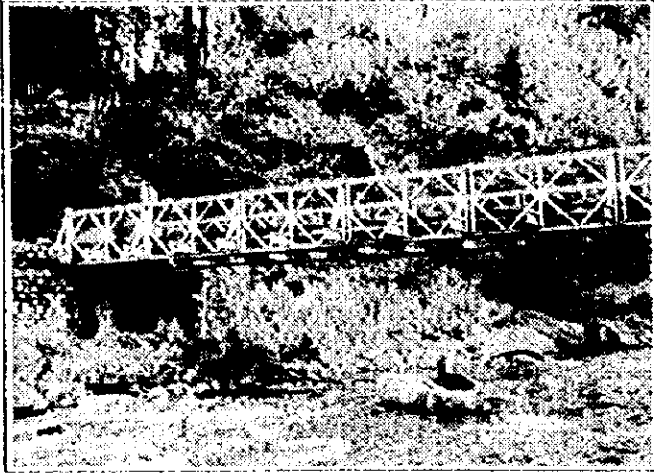
**LOCATION MAP**



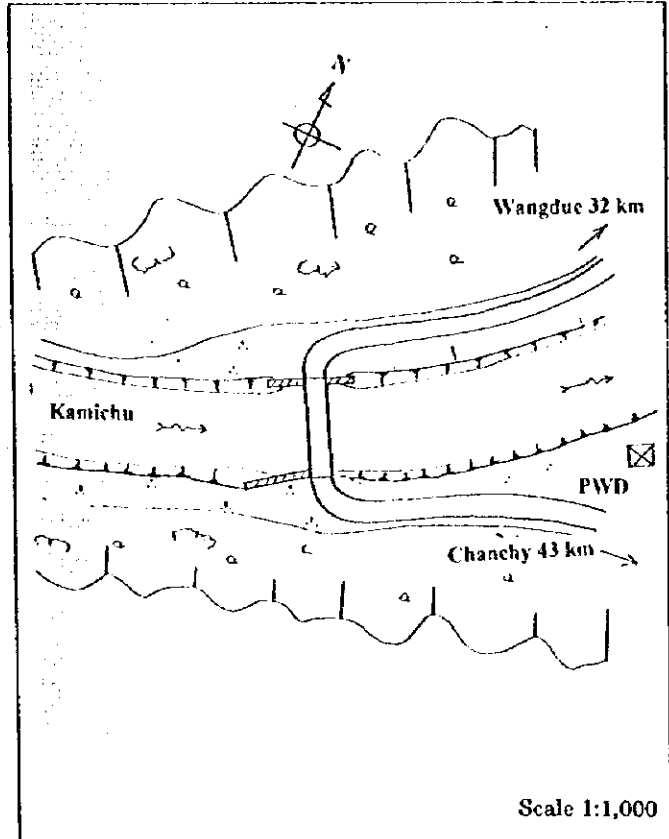
**BRIDGE SITE MAP**

Existing Conditions	Other Information
1. Location: Baychu River, Wangdue Dzongkhag	1. Completed in 1985
2. Class of road: National Highway Route No.5	2. Original load capacity: 18 ton
3. Superstructure: Bailey SS	Present limited load capacity: 17 ton
4. Substructure: Masonry abutments on natural rock	3. Near bridge site a space for construction materials and equipment is available.
5. Approach roads: Scaled macadam paved 4 m wide	
6. Bridge length: 15.3 m	
7. Bridge width: 3.34 m (carriageway)	
8. Very good condition	

## BRIDGE NO.14 KAMICHU BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

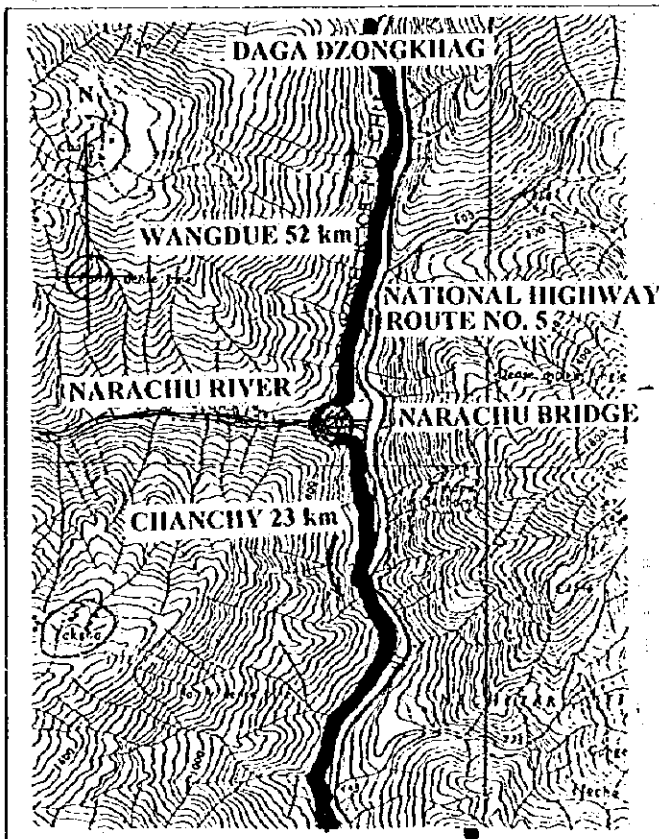
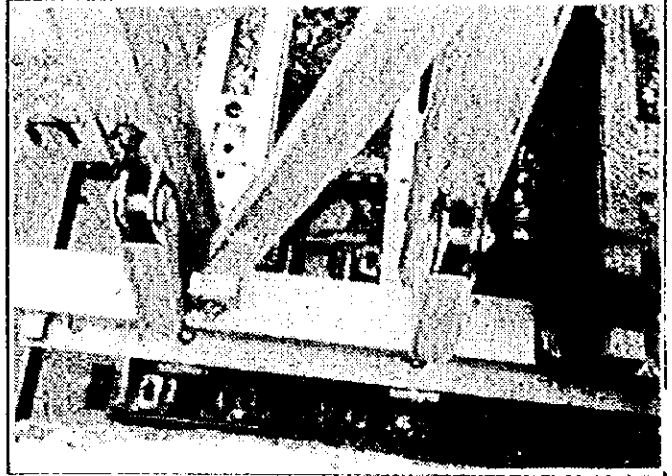
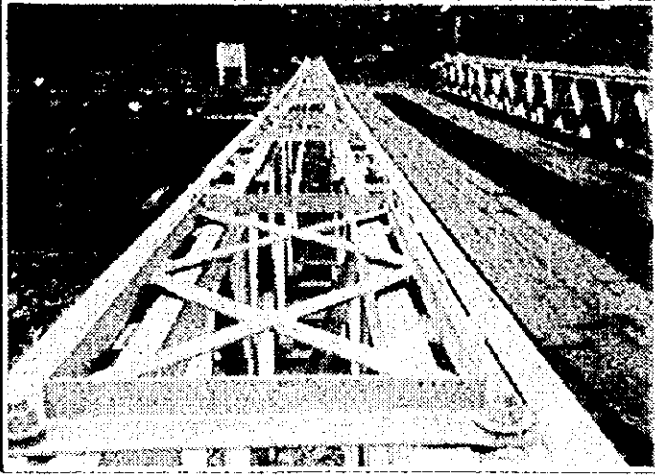
### Existing Conditions

- |                    |                                    |
|--------------------|------------------------------------|
| 1. Location:       | Kamichu River, Wangdue Dzongkhag   |
| 2. Class of road:  | National Highway Route No.5        |
| 3. Superstructure: | Bailey SS                          |
| 4. Substructure:   | Masonry abutments on natural rocks |
| 5. Approach roads: | Sealed macadam paved 4 m wide      |
| 6. Bridge length:  | 18.3 m                             |
| 7. Bridge width:   | 3.34 m (carriageway)               |

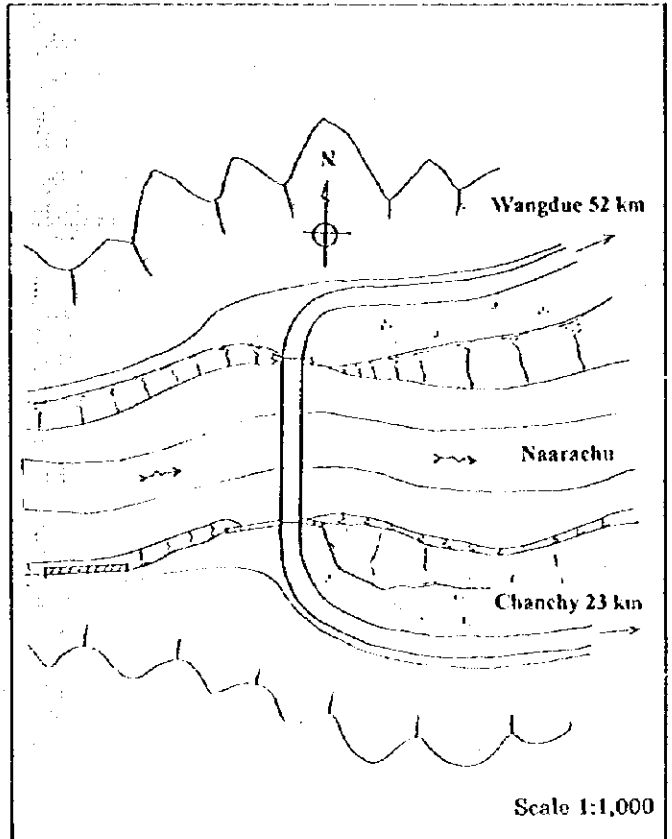
### Other Information

1. Completed in 1986
2. Original load capacity: 24ton  
Present limited load capacity: 15 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 15 NARACHU BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

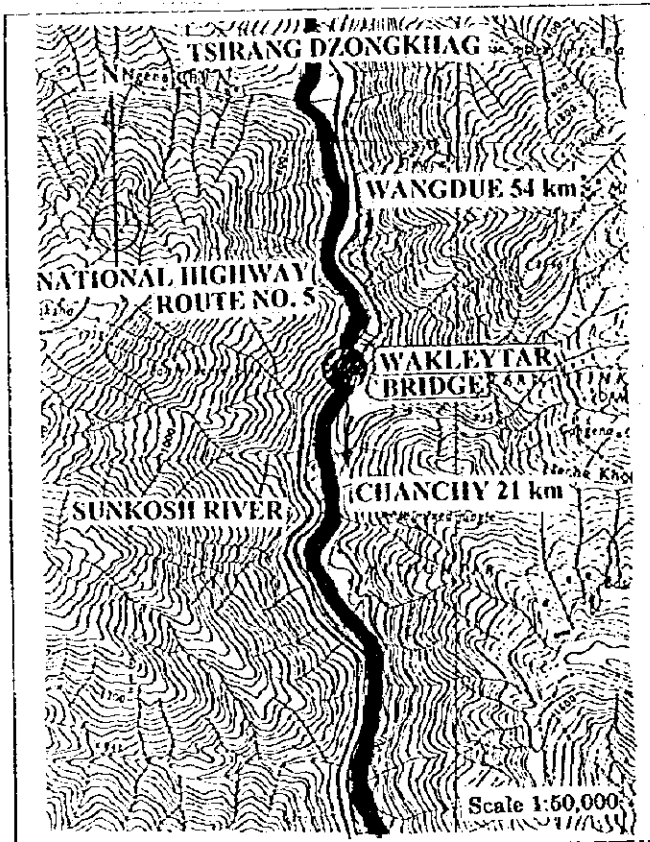
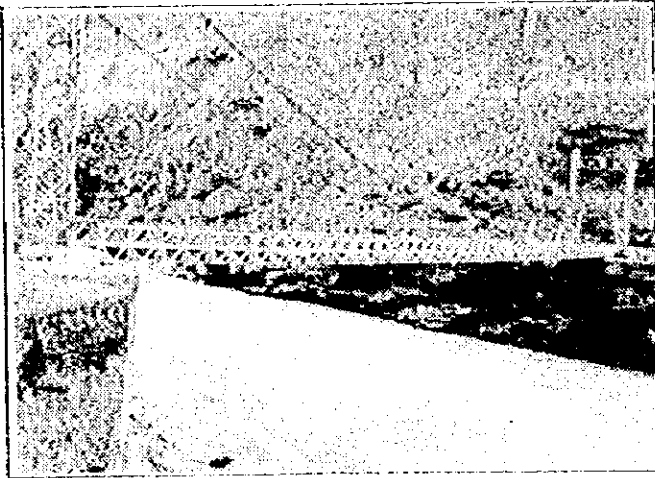
### Existing Conditions

1. Location: Narachu River, Daga Dzongkhag
2. Class of road: National Highway Route No. 5
3. Superstructure: Bailey DS
4. Substructure: Masonry abutments on natural rock
5. Approach roads: Sealed macadam paved 4 m wide
6. Bridge length: 30.5 m
7. Bridge width: 3.31 m (carriageway)
8. Very good condition

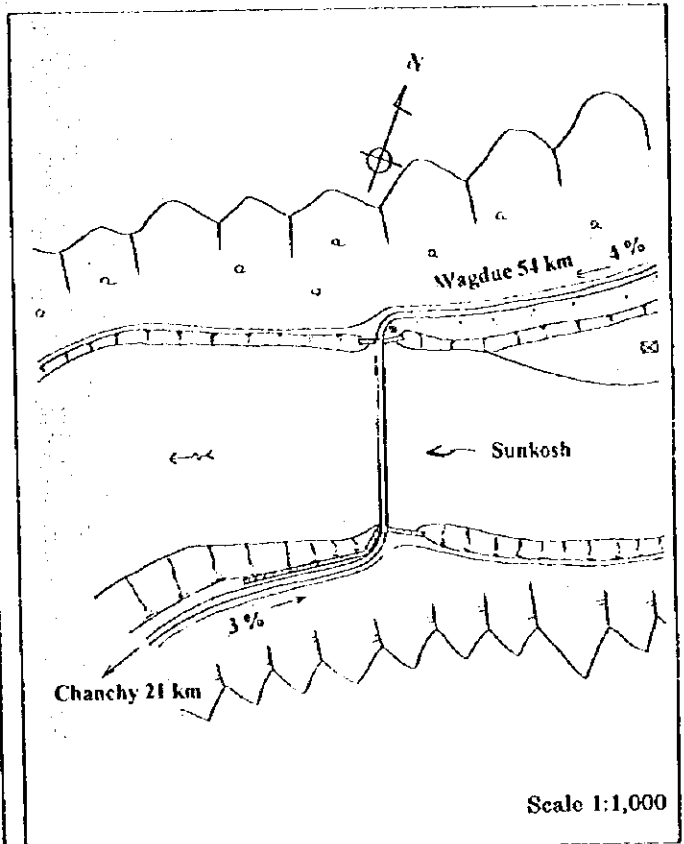
### Other Information

1. Completed in 1991
2. Original load capacity: 24 ton  
Present load capacity: 24 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 16 WAKLEYTAR BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

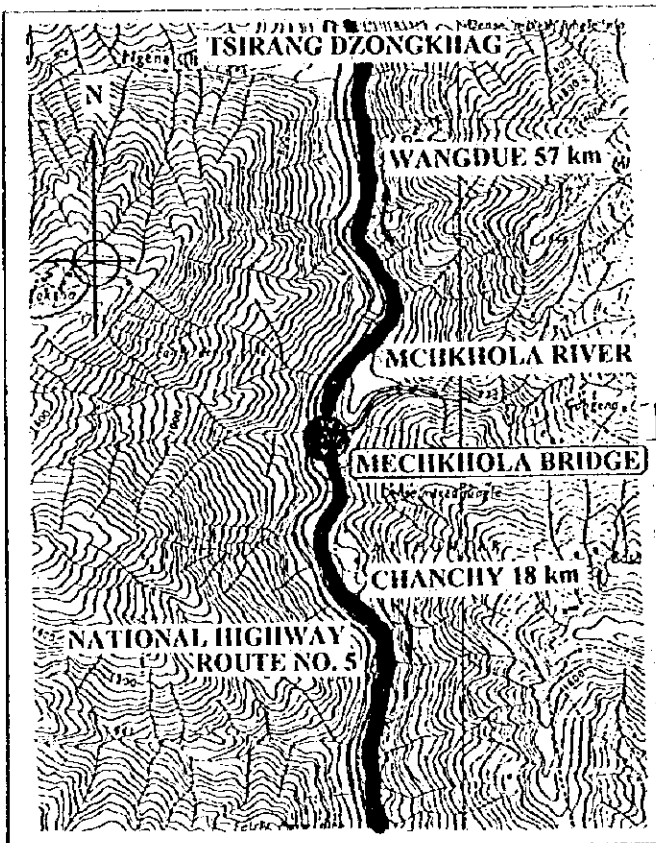
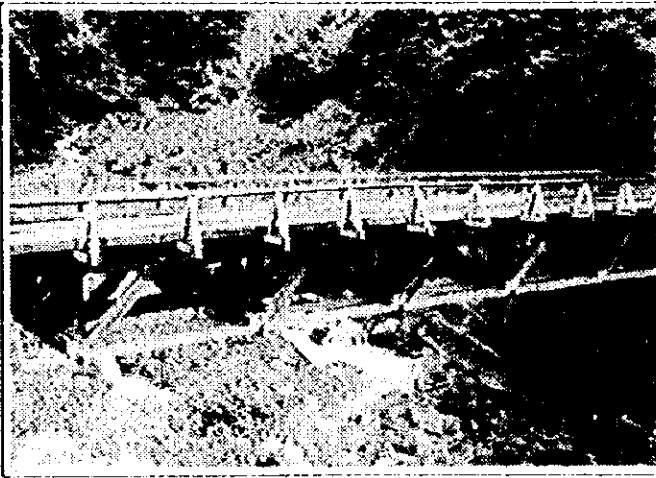
**Existing Conditions**

1. Location: Sunkosh River, Tsirang Dzongkhag
2. Class of road: National Highway Route No.5
3. Superstructure: Bailey Suspension
4. Substructure: Masonry abutments on natural rock
5. Approach roads: Sealed macadam paved 4 m wide
6. Bridge length: 73.2 m
7. Bridge width: 3.37 m (carriageway)
8. Members underside of superstructure is very rusty. The above photo shows one example of very rusty turn-buckles.

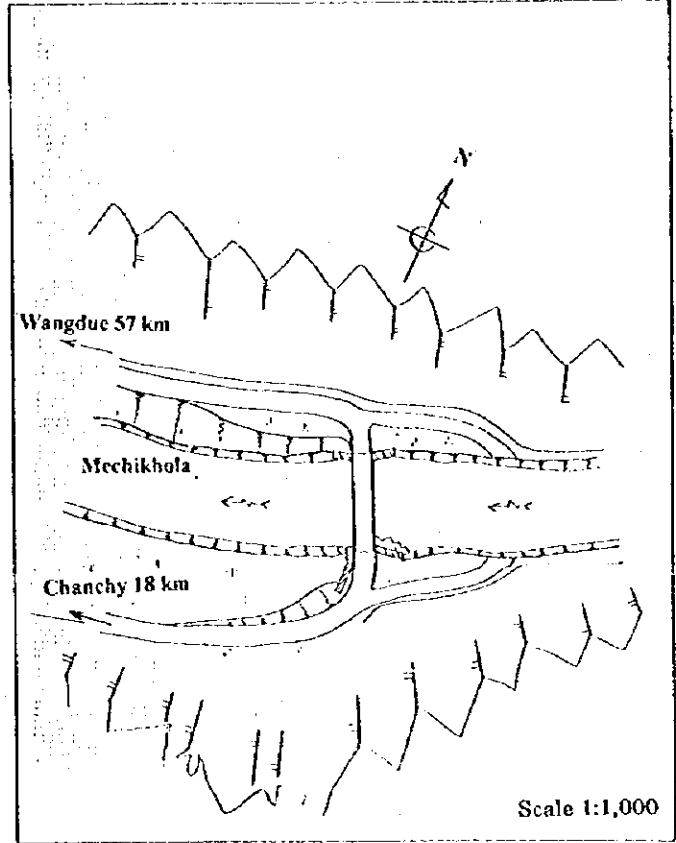
**Other Information**

1. Completed in 1987
2. Original load capacity: 24 ton  
Present limited load capacity: 12 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 17 MECHIKHOLA BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

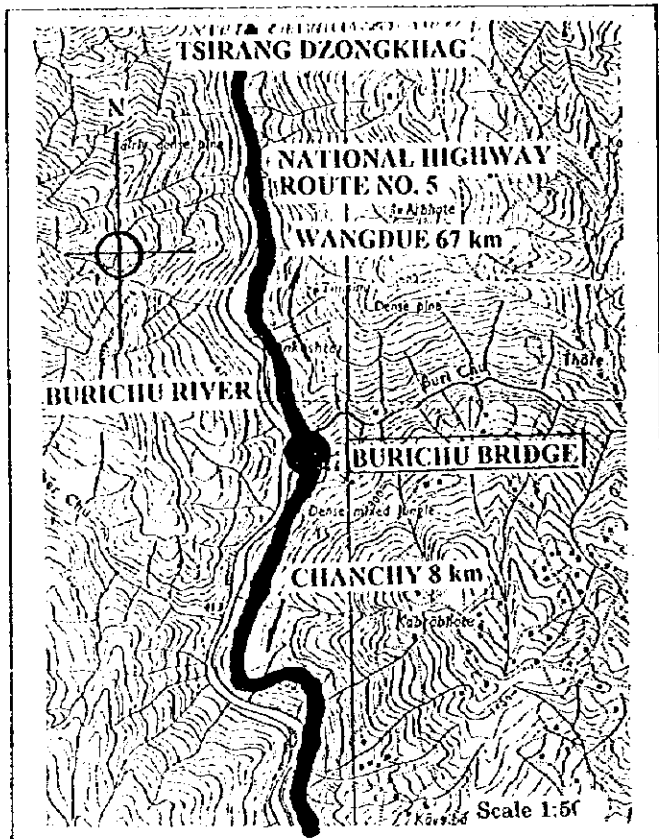
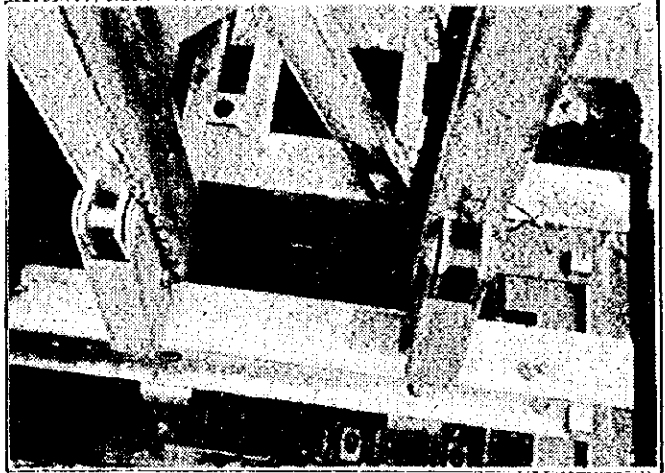
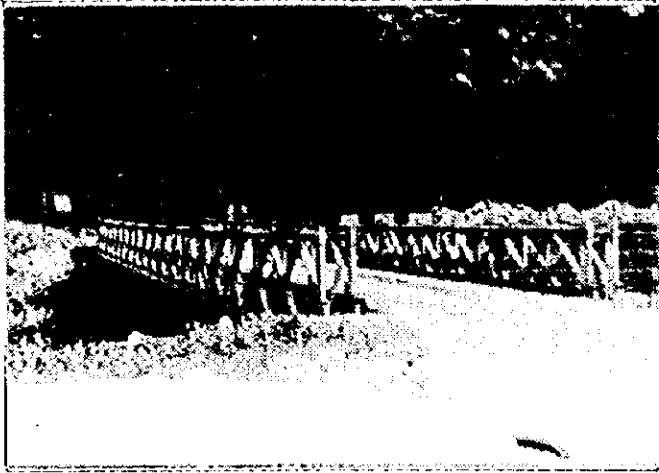
### Existing Conditions

1. Location: Mechikhola River, Tsirang Dzongkhag
2. Class of road: National Highway Route No.5
3. Superstructure: Timber Truss
4. Substructure: Masonry abutments on natural rock
5. Approach roads: Scaled macadam paved 4 m wide
6. Bridge length: 18.0 m
7. Bridge width: 3.69 m (carriageway)
8. Very good condition. However in PWD's classification, this is a temporary bridge

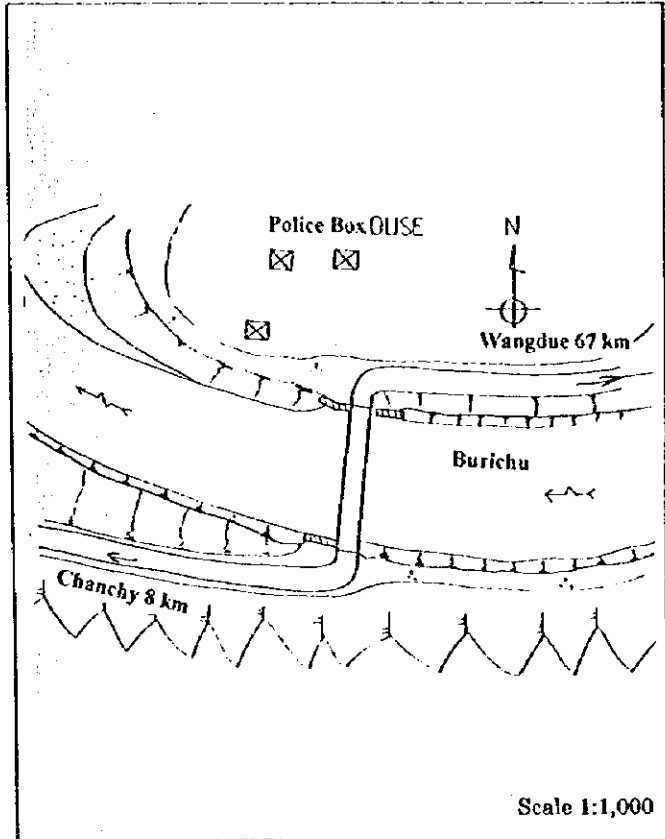
### Other Information

1. Completed in 1990
2. Original load capacity: 18 ton  
Present limited load capacity: 8 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 18 BURICHU BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

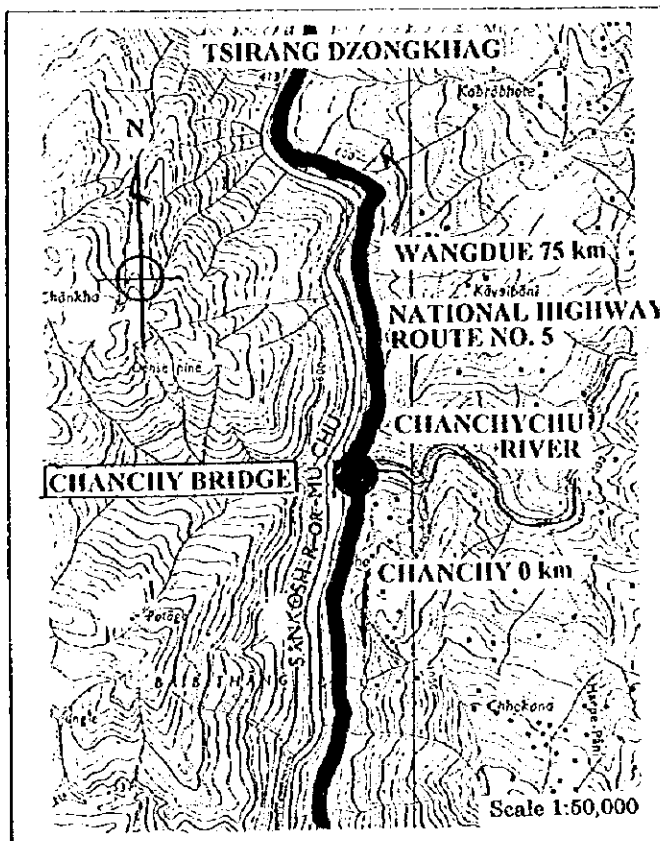
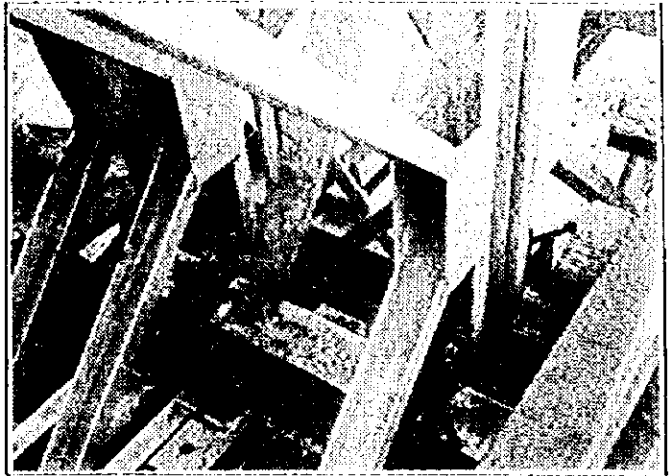
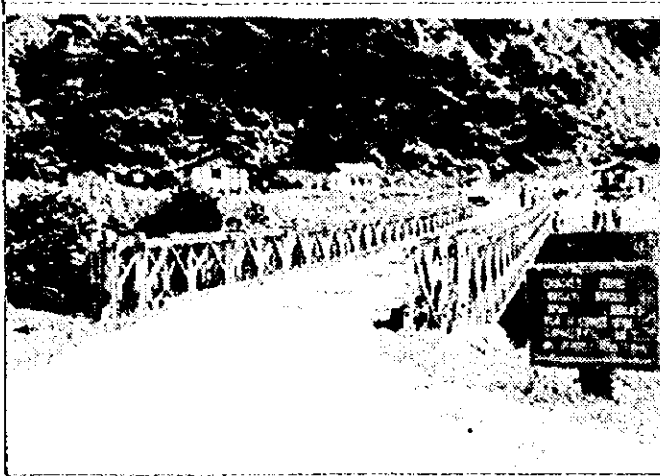
### Existing Conditions

1. Location: Burichu River, Tsirang Dzongkhag
2. Class of road: National Highway Route No.5
3. Superstructure: Bailey DS
4. Substructure: Masonry abutments on natural rocks
5. Approach roads: Sealed macadam paved 4 m wide
6. Bridge length: 27.5 m
7. Bridge width: 3.37 m (carriageway)
8. Very good condition

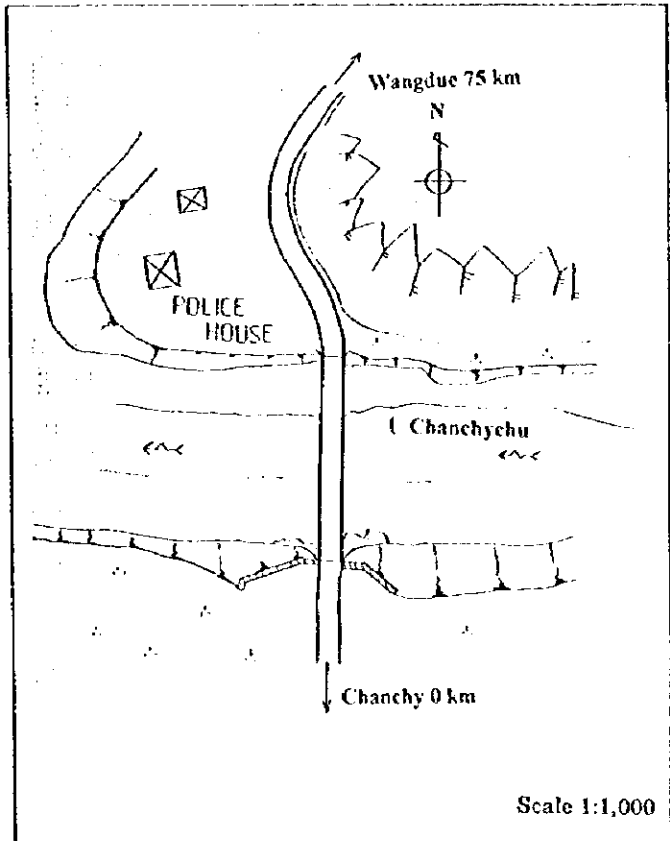
### Other Information

1. Completed in 1985
2. Original load capacity: 24 ton  
Present limited load capacity: 18 ton
3. Near bridge site a space for construction materials and equipment is available.

## BRIDGE NO. 19 CHANCHY BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

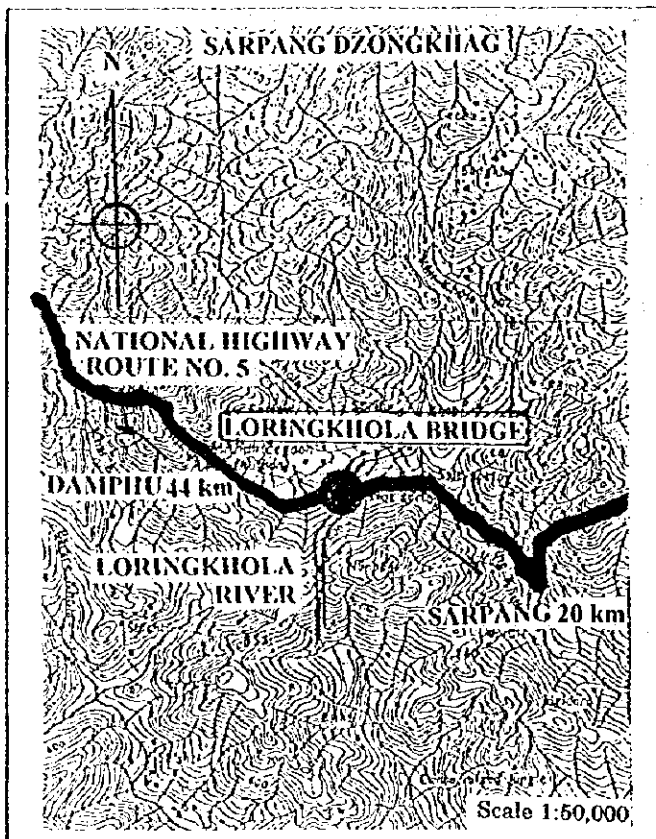
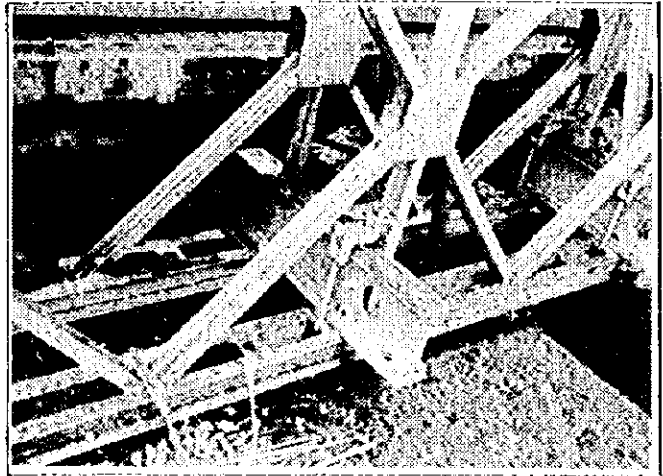
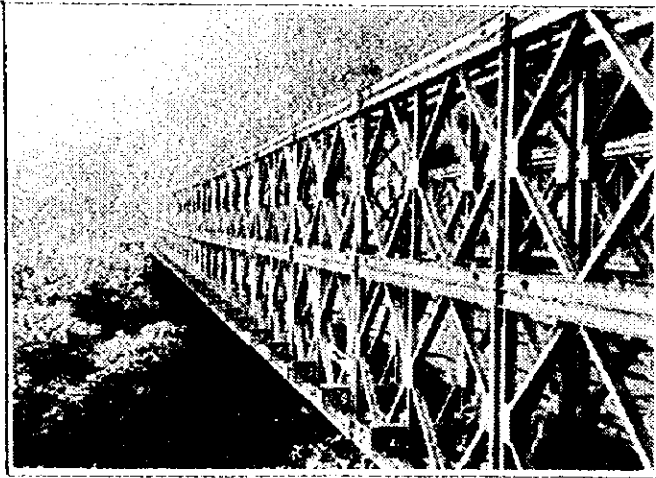
### Existing Conditions

- |                        |                                     |
|------------------------|-------------------------------------|
| 1. Location:           | Chanchyehu River, Tsirang Dzongkhag |
| 2. Class of road:      | National Highway Route No. 5        |
| 3. Superstructure:     | Bailey TS                           |
| 4. Substructure:       | Masonry abutments on natural rock   |
| 5. Approach roads:     | Scaled macadam paved 4 m wide       |
| 6. Bridge length:      | 39.7 m                              |
| 7. Bridge width:       | 3.31 m (carriageway)                |
| 8. Very good condition |                                     |

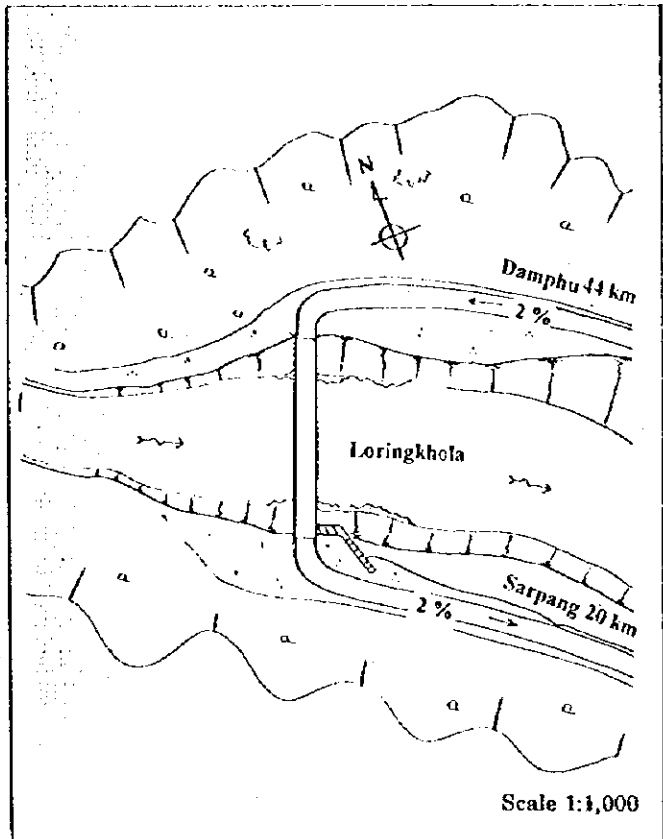
### Other Information

- |  |        |
|--|--------|
| 1. Completed in  | 1986   |
| 2. Original load capacity:   | 24 ton |
| Present limited load capacity:   | 18 ton |
| 3. Near bridge site a space for construction materials and equipment is available. |        |

## BRIDGE NO. 20 LORINGKHOLA BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

### **Existing Conditions**

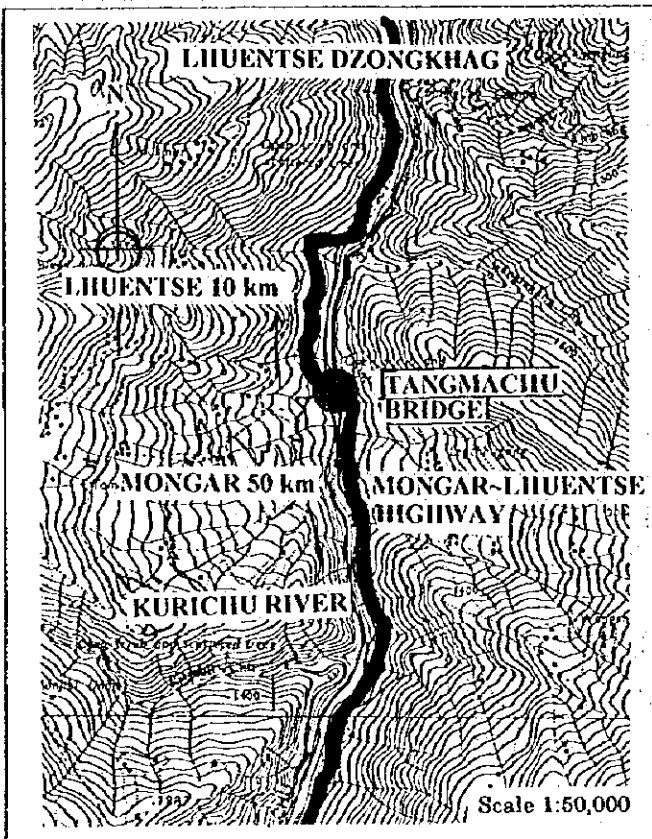
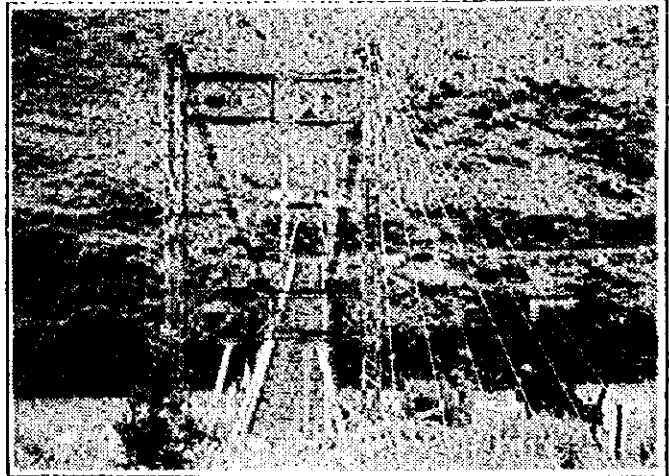
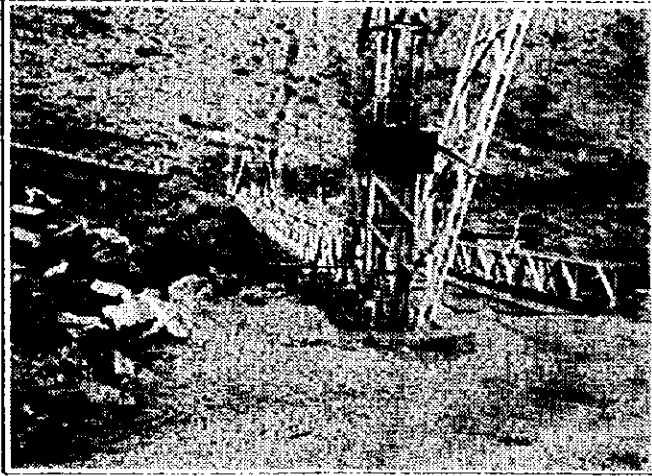
- |  |                                      |
|--|--------------------------------------|
| 1. Location:   | Loringkhola River, Sarpang Dzongkhag |
| 2. Class of road:  | National Highway Route No. 5         |
| 3. Superstructure:   | Bailey DDR                           |
| 4. Substructure:   | Masonry abutments on natural rock    |
| 5. Approach roads:   | Sealed macadam paved 4 m wide        |
| 6. Bridge length:  | 48.8 m                               |
| 7. Bridge width:   | 3.30 m (carriageway)                 |
| 8. Environment the bridge site is very wet by the high waterfall at the upper stream side. |                                      |

### **Other Information**

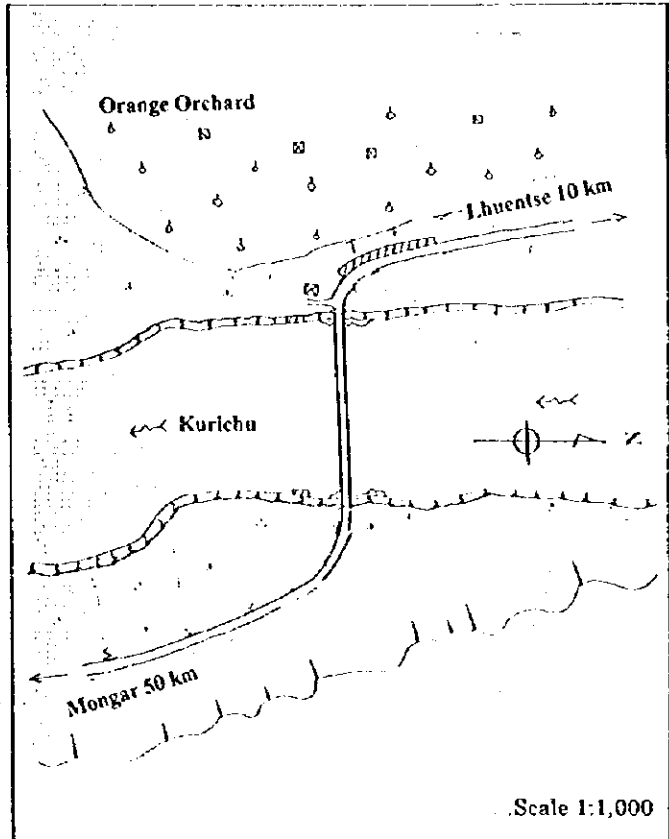
- |  |        |
|--|--------|
| 1. Completed in  | 1992   |
| 2. Original load capacity:   | 24 ton |
| Present limited load capacity:   | 18 ton |
| 3. Near bridge site a space for construction materials and equipment is available. |        |



## BRIDGE NO. 21 TANGMACHU BRIDGE



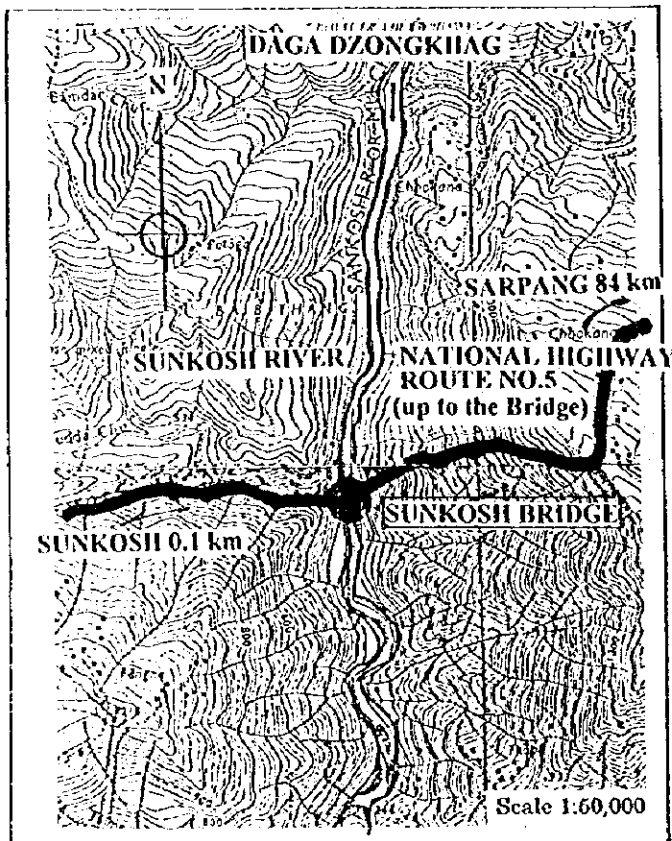
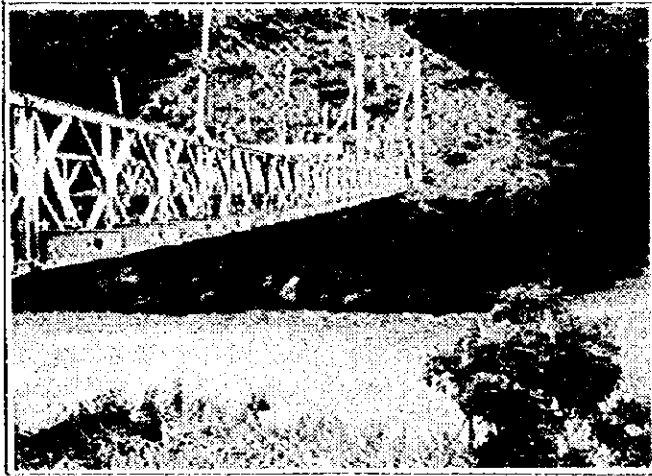
**LOCATION MAP**



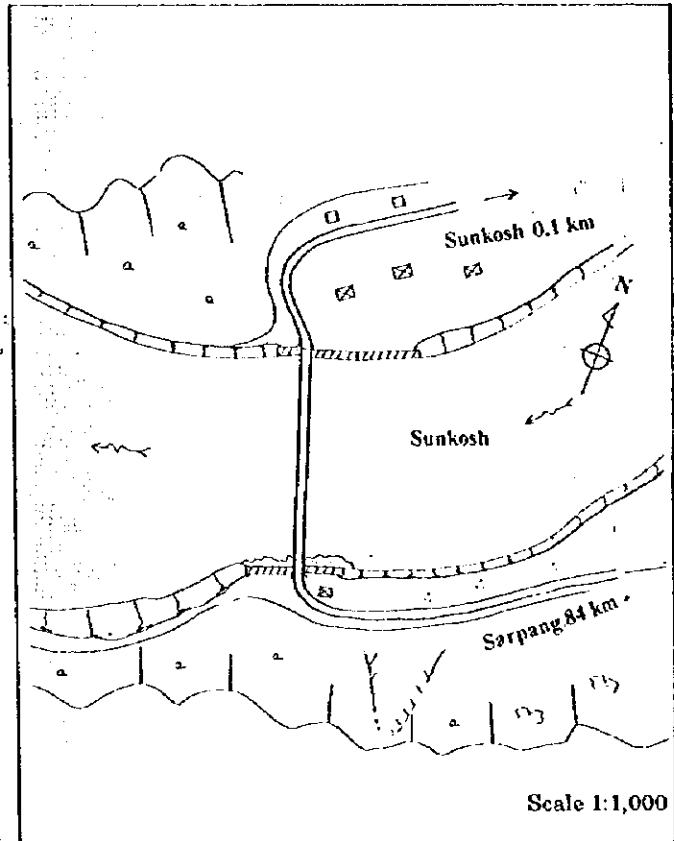
**BRIDGE SITE MAP**

Existing Conditions	Other Information
1. Location: Kurichu River, Lhuentse Dzongkhag	1. Completed in 1982
2. Class of road: District Road Monga-Lhuentse	2. Original load capacity: 24 ton
3. Superstructure: Bailey Suspension	Present limited load capacity: 12 ton
4. Substructure: Masonry abutments on natural rock	3. Near bridge site a space for construction materials and equipment is available.
5. Approach roads: Sealed macadam paved 4 m wide	
6. Bridge length: 85.4 m	
7. Bridge width: 3.30 m (carriageway)	

## BRIDGE NO.22 SUNKOSH BRIDGE



**LOCATION MAP**



**BRIDGE SITE MAP**

### Existing Conditions

- |                    |                                    |
|--------------------|------------------------------------|
| 1. Location:       | Sunkosh River, Daga Dzongkhag      |
| 2. Class of road:  | National Highway Route No.5        |
| 3. Superstructure: | Bailey Suspension                  |
| 4. Substructure:   | Masonry abutments on natural rocks |
| 5. Approach roads: | Sealed macadam paved 4 m wide      |
| 6. Bridge length:  | 85.4m                              |
| 7. Bridge width:   | 3.30 m (carriageway)               |

### Other Information

- |  |        |
|--|--------|
| 1. Completed in  | 1982   |
| 2. Original load capacity:   | 24 ton |
| Present limited load capacity:   | 12 ton |
| 3. Near bridge site a space for construction materials and equipment is available. |        |