

Government of People's Republic of Bangladesh
Ministry of Road Transport and Bridges
Roads and Highways Department

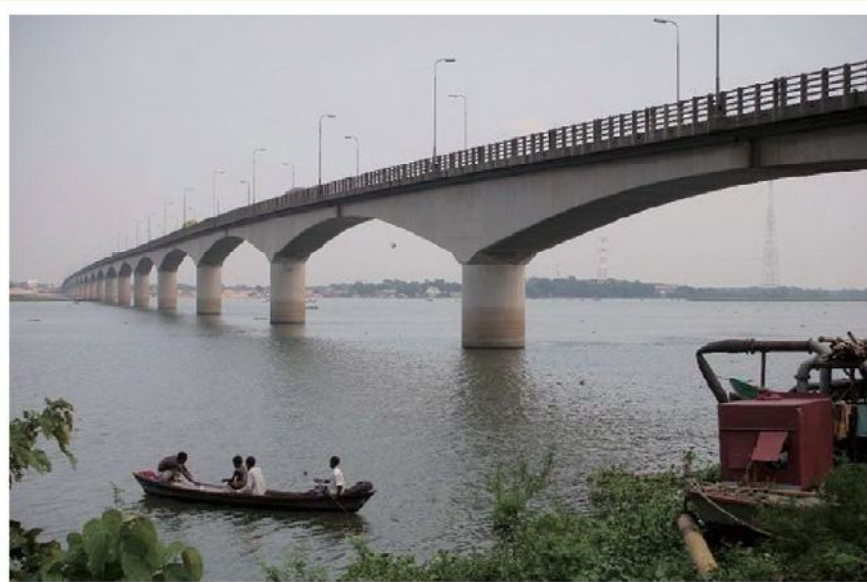


Bridge Rehabilitation and Strengthening Manual

PART 2

Cost Estimate Final Draft

August 2018



PREFACE

It is a matter of great pleasure that the **Bridge Rehabilitation and Strengthening Manual** has been developed by the consultants under the Bridge Management Capacity Development Project (BMCDP) of RHD with the cooperation of JICA.

The Bridge Rehabilitation and Strengthening Manual 2018 is the updated version of the one titled "Major Repair Manual" produced by RHD in 2014. This manual is composed of "Part 1 Method" and "Part 2 Cost Estimate". In Part 1, in order to carry out the appropriate rehabilitation and strengthening of bridges, this manual covers how to select the rehabilitation and strengthening item regarding each defect of bridges and the rehabilitation and strengthening method. In Part 2, this manual covers to calculate the cost of rehabilitation and strengthening items.

This manual would serve as guidance on the fundamentals of bridge rehabilitation and strengthening and help the Bridge Management Wing of RHD to select the rehabilitation and strengthening item in bridge maintenance program. An intranet Bridge Management System (BMS) based on the new concept and functions for effective bridge maintenance management, is also developed under BMCDP as an integrated and accessible information system for the database of bridge inventory, inspection and maintenance work history.

Together with the systematic use of this BMS, this manual will be useful to the RHD field staff responsible for direct maintenance, the policy makers of RHD in this area and also the staff who will be involved in maintenance by contract.

We hope that this manual will assist in improving the understanding of the function of bridge structures and their long term durability and serviceability.

Finally, we would like to take this opportunity to thank the experts of JICA Consultant Team for their efforts in preparing the **Bridge Rehabilitation and Strengthening Manual 2018**.



(Rowshan Ara Khanam)

Project Director of BMCDP
Additional Chief Engineer, Bridge Management Wing
Roads and Highways Department
Sarak Bhaban, Tejgaon, Dhaka

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Standard of Cost Estimate

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List of Abbreviations

SoR	Schedule of Rates (For Road and Bridge Works)
Cost Estimation Standards for Civil Works	Ministry of Land, Infrastructure, Transport and Tourism, Cost Estimation Standards for Civil Works, Construction Research Institute, 2015
Cost Estimation Standards for Bridge Construction Works	Cost Estimate Standards for Bridge Construction Works, Japan Construction Machinery and Construction Associate, 2015
Design and Cost Estimation Manual	Feasibility Study, Design and Cost Estimation Manual (Civil Engineering) (Enforcement Edition), Japan International Cooperation Agency, March 2009
Cost Estimation Standards for Machinery Expense	Cost Estimation Standards for Machinery Expense, Japan Construction Machinery and Construction Associate, 2015
Quantity per Unit for Bridge Rehabilitation/Strengthening Works	Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013

1. INTRODUCTION

1.1 Introduction

There is a cost estimation standard which is “Schedule of Rates (For Road and Bridge Works)” (hereinafter called SoR) in Bangladesh. This standard is for new road and new bridge construction. The rehabilitation/strengthening works for existing bridges is assumed to increase in near future in Bangladesh. However there are no cost estimation standards for bridge rehabilitation/strengthening works in Bangladesh. Therefore, the cost estimation manual for bridge rehabilitation/strengthening works is needed in Bangladesh.

The cost estimation manual for bridge rehabilitation/strengthening works has been made based on the SoR. However, the SoR mainly focuses for new road and bridge construction. To complete the cost estimation manual for bridge rehabilitation/strengthening, following Japanese standards are used. “Ministry of Land, Infrastructure, Transport and Tourism, Cost Estimation Standards for Civil Works, Construction Research Institute, 2015” (hereinafter called “Cost Estimation Standards for Civil Works”) and “Cost Estimate Standards for Bridge Construction Works, Japan Construction Machinery and Construction Associate, 2015” (hereinafter called “Cost Estimation Standards for Bridge Construction Works”) are adopted to make the cost estimation manual for bridge rehabilitation/strengthening works if the items of rehabilitation/strengthening works are not covered in the SoR. Also, in making the cost estimation manual for bridge rehabilitation/strengthening works, reference is made to “Quantity per Unit for Bridge Rehabilitation and Strengthening Works, Kagawa Prefecture in Japan, April 2013” (hereinafter called “Quantity per Unit for Bridge Rehabilitation and Strengthening Works”) and standards for machinery expenses are made with reference to “Cost Estimation Standards for Machinery Expense, Japan Construction Machinery and Construction Associate, 2015” (hereinafter called “Cost Estimation Standards for Machinery Expenses”).

The above cost estimation standards are for civil works in Japan. Therefore quantities per unit and quantities need to be corrected to adopt the cost estimation manual for bridge rehabilitation/strengthening for Bangladesh. Hence, the correction factors for quantities per unit and quantities are adopted according to the “Feasibility Study, Design and Cost Estimation Manual (Civil Engineering) (Enforcement Edition), Japan International Cooperation Agency, March 2009” (hereinafter called “Design and Cost Estimation Manual”).

It should be noted that, collectively, the above standards are referred to as “Cost Estimation Standards for Civil Works in Japan.”

1.2 Objectives of Cost Estimation Manual for Bridge Rehabilitation/Strengthening Works

First, the objective of making cost estimation manual for rehabilitation/strengthening of the existing bridges is to calculate appropriate costs.

Second, the budget from government of Bangladesh for rehabilitation/strengthening of existing bridges is made by the BMS, which is using calculated the costs according to cost estimation manual for bridge rehabilitation/strengthening works.

Third, bridge rehabilitation/strengthening costs received from the bidders can be judged to compare calculated costs based on cost estimation manual for bridge rehabilitation/strengthening works.

2.CONTENTENTS OF COST ESTIMATION STANDARDS

2.1 Contents of Cost Estimation Standard in Bangladesh

Cost estimation standards in Bangladesh for civil works are found only in the SoR. The SoR is mentioned in construction costs that include the direct cost, the temporary facility cost, company profit, TAX and VAT for each item. The official price is calculated by adding the quantities, the site expense and the company overhead. 10% of company profit, 11.7% of TAX and VAT, 5% of company overhead are applied from Bangladesh Standard.

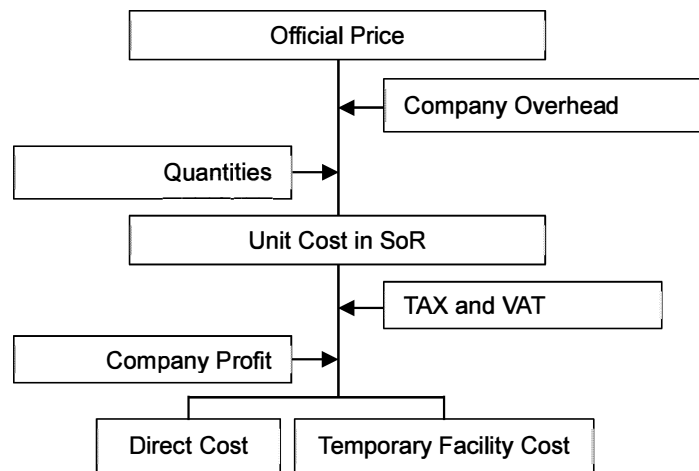
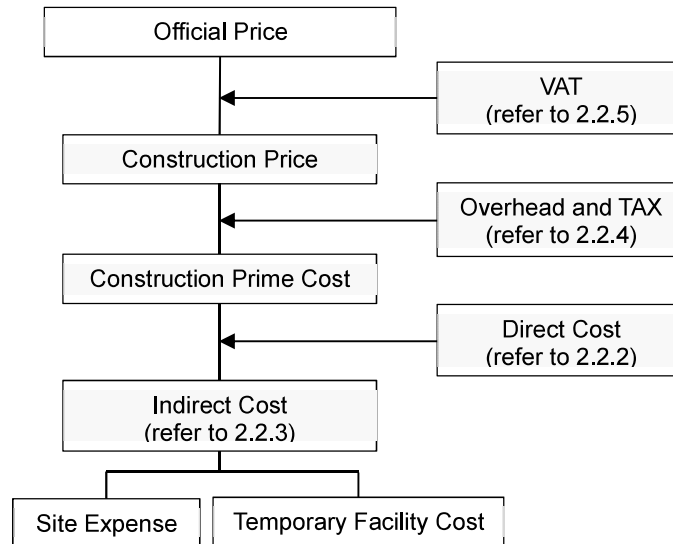


Figure 2.1.1 System of Cost Estimation in Bangladesh

2.2 Contents of Cost Estimation Standards in Japan

2.2.1 System of Cost Estimation in Japan

The system of Cost Estimation Standards for Civil Works in Japan is shown in Figure 2.2.1.



Source: Cost Estimation Standards for Civil Works in Japan

Figure 2.2.1 System of Cost Estimation in Japan

2.2.2 Direct Construction Costs

Direct costs for construction are calculated as the sum of the cost of materials and labour and direct expenses.

The breakdown of direct costs is provided below.

(1) Cost of Materials

1) Quantities

The quantities of materials are calculated by engineers. The sum of materials used in construction and losses during transportation and storage have to be considered in calculating material quantities.

2) Unit Costs

In principle, unit costs of materials are based on market prices. Purchase prices and the cost of transportation to the construction site have to be considered when calculating unit costs.

(2) Labour Costs

1) Required Manpower

In principle, manpower requirements are estimated based on such considerations as conditions at the construction site and the scale of the construction project. Generally, however, required manpower is determined on the basis of past records of construction work.

2) Wages

Wages are in stated in reference to the SoR.

(3) Direct Expenses

Direct expenses needed for construction works are calculated as indicated below.

1) Patents and Royalties

Expenses related to patents and royalties are the sum of patent utilization fees and costs related to engineering consultants sent to the technical assistance required in dealing with patents.

2) Utilities Expenses

Utilities expenses include the costs of heat, light, water and power needed to carry out the construction work.

3) Machinery Expenses

Use the cost estimation standards for machinery expenses to calculate machinery expenses for the construction work.

2.2.3 Indirect Construction Costs

Indirect costs do not remain after completion of the road or bridge. However indirect costs commonly are incurred to carry out the construction work. These costs, which include “Site Expenses” and “Temporary Facilities Costs,” are shown in Figure 2.2.1.

(1) Temporary Facility Costs

The temporary facility cost is common expense for the construction work. The temporary facility cost is including costs of “transportation”, “preliminary work”, “indirect damage prevention facilities”, “safety”, “services”, “engineering management” and “maintenance”.

1) Transportation Costs

- Transportation machinery costs
- Transportation costs for materials needed for temporary facilities at the construction site

2) Cost of Preliminary Works

- Cost of mobilization and demobilization for the construction work
- Cost of investigations, topographic survey and finishing stake work
- Cost of levelling the ground, reclamation and grubbing work

3) Prevention Facilities Expenses for Indirect Damage

- Cost of the installation, removal and maintenance of temporary facilities to prevent indirect damage during the construction such as the noise, land subsidence, disruption of groundwater, etc.

4) Safety Costs

- Cost of traffic management
- Cost of safety facilities
- Cost of safety management
- Other costs for safety measures

5) Service Costs

- Cost of leasing of land
- Basic costs for power and water, etc.

6) Engineering Management Costs

- Cost of quality control tests
- Cost of topographic survey for geometry control
- Cost of making construction control reports
- Cost of making other technical control reports

7) Maintenance Costs

- Cost of site office and testing room maintenance, etc.
- Costs of labour dormitory maintenance
- Maintenance Costs for warehouses and stock yards
- Labour transportation costs
- Building and repair costs for leasing of land

(2) Site Expense

The site expense is the expense of construction management such as the quality management, schedule management, cost management. The site expense is including “Management Cost of Labours”, “Cost of Safety Trainings”, “Taxes and Public Dues”, “Premium”, “Staff Salaries and Allowances”, “Allowance for Retirement”, “Legal Welfare Expense”, “Welfare Expenses”, “Office Supplies Expenses”, “Communication and Traveling Expenses”, “Social Expenses”, “Compensation Cost”, “Subcontract Expenses”, “Construction Registration Fee” and “Miscellaneous Expenses”.

1) Management Cost of Labours

- Cost of recruitment and dissolution
- Cost of comfort, recreation and welfare
- Cost of the work wears and work tools except the direct cost and the temporary facility cost
- Cost of the meal and commuting except salaries
- Cost of the accident except the premium

2) Cost of Safety Trainings

- Cost of labour safety, health and training

3) Taxes and Public Dues

- Taxes and public dues as the fixes assets tax, the automobile tax etc. However, it is excluded for the depreciable value of the construction machinery which is included for machinery expense in the direct cost.

4) Premium

- The automobile insurance (except depreciable value of the automobile insurance which is included for machinery expense in the direct cost), the contractors’ all risks insurance, the

erection all risks insurance, the workers' compensation insurance in illegal, the casualty insurance and the damage insurance

5) **Staff Salaries and Allowances**

- The salaries, allowances and bonus for the staff at the construction site except the overhead and the direct cost for the personnel in construction site

6) **Allowance for Retirement**

- The retirement allowances for construction site personnel

7) **Legal Welfare Expense**

- The insurance premium for workers' compensation, the health insurance etc. for the staffs and labours at the construction site

8) **Welfare Expenses**

- The welfare expense etc. for the personnel at the construction site

9) **Office Supplies Expenses**

- Cost of the office supplies expenses and the newspapers etc.

10) **Communication and Traveling Expenses**

- The communication and traveling expenses

11) **Social Expenses**

- The social expenses at the construction site

12) **Compensation Cost**

- The compensation cost such as the vibration and noise etc. for loss during the construction works

13) **Subcontract Expenses**

- The subcontract expenses to entrust to the subcontractors

14) **Construction Registration Fee**

- Cost of the construction registration

15) **Miscellaneous Expenses**

- Miscellaneous expenses

2.2.4 Overhead and TAX

Overhead includes "Compensation for Executive Officers" "Staff Salaries and Allowances" "Retirement Allowances" "Legal Welfare Expenses" "Welfare Expenses" "Maintenance Costs" "Office Supplies Expenses" "Communication and Travel Expenses" "Utilities Costs" "Cost of Survey

and Research” “Advertisement Costs” “Social (Entertainment) Expenses” “Donations” “Rent for Houses and Land” “Depreciation Costs” “Amortization of Experiment and Research Costs” “Amortization of Development Costs” “Taxes and Public Dues” “Premium” “Contract Warranty Costs” “Miscellaneous Costs”.

(1) Overhead and TAX Items and Contents

1) Compensation of Executive Officers

- Executive officer compensation

2) Staff Salaries and Allowances

- The salaries, allowance and bonus for the head office and branch office personnel

3) Retirement Allowances

- Retirement allowances for executive officers and personnel

4) Legal Welfare Expenses

- Insurance premiums for workers’ compensation, health insurance etc. for head office and branch office personnel

5) Welfare Expenses

- The welfare expense etc. for personnel at the head office and branch office

6) Maintenance Costs

- Maintenance costs for buildings, machinery etc.

7) Office Supplies Expenses

- Cost of office supplies and newspapers, etc.

8) Communications and Travel Expenses

- Communication and travel expenses

9) Utilities Costs

- Expenses for utilities such as power, water and gas, etc.

10) Cost of Surveys and Research

- Cost of technical research and development, etc.

11) Advertising Costs

- The cost of advertising, publicity

12) Entertainment Expenses

- Entertainment expenses at head office and branch office

13) Donations

14) Rent for Houses and Land

- Rent for offices and the dormitories

15) Depreciation Costs

- Depreciation expenses for buildings, automobiles, machinery and office supplies

16) Amortization of Experiment and Research Costs

- Amortization cost of experiments and research of new technologies

17) Amortization of Development Costs

- Amortization of development costs for company expansion

18) Taxes and Public Dues

- The taxes and public dues payable for head office and branch office

19) Insurance Premiums

- The premium for the fire damages and other damages

20) Contract Warranty Costs

- Cost of contract warranty

21) Miscellaneous Costs

- Cost of the computers, meetings etc.

(2) Additional Benefits

- Corporate tax, prefectural tax etc.
- Dividends to stockholders
- Bonuses for executive officers
- Retained internal surplus
- Non-operating expenses

2.2.5 VAT (Value Added TAX)

The value added tax should be considered.

3. SYSTEM OF COST ESTIMATION

3.1 Introduction

To make the system of cost estimation for bridge rehabilitation/strengthening works, both the SoR and the Cost Estimation Standards for Civil Works in Japan are needed. The Cost Estimation Standards for Civil Works in Japan should cover the item where is not mentioned in the SoR. Because the SoR does not focus the bridge rehabilitation/strengthening works. The both standards (the SoR and the Cost Estimation Standards for Civil Works in Japan) should be revised to make the system of cost estimation manual for bridge rehabilitation/strengthening works (this manual).

3.2 Revised System of Cost Estimation from Bangladesh Standard

The left figure in Figure 3.2.1 is from the SoR. To make the system of cost estimation for bridge rehabilitation/strengthening works the SoR is revised. The composition of cost estimation is changed. The quantities are included both of the Direct Cost and Indirect Cost (Temporary Facility Cost). The revised system of cost estimation is shown in right figure in Figure 3.2.1.

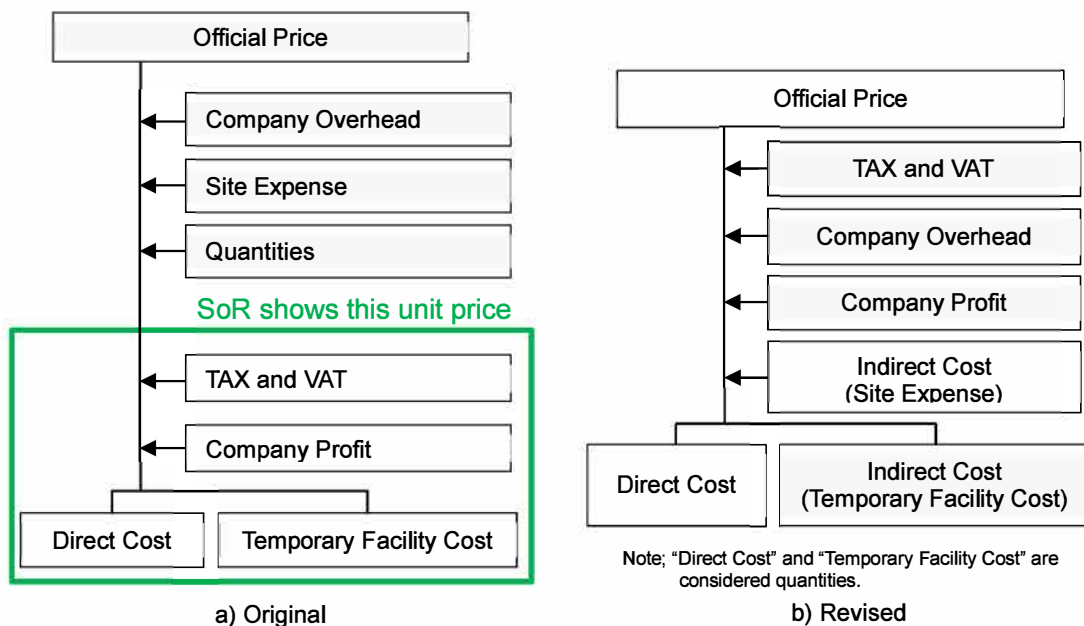


Figure 3.2.1 Revised System of Cost Estimation from Bangladesh Standard

3.3 Revised System of Cost Estimation from Japanese Standards

The left figure in Figure 3.3.1 is from the Cost Estimation Standards for Civil Works in Japan. To make the system of cost estimation for bridge rehabilitation/strengthening works, the Cost Estimation

Standards for Civil Works in Japan are revised. The composition of cost estimation was changed from “Overhead and TAX”, “VAT” to “Company Overhead”, “TAX and VAT”, and the company profit is added. The revised system of cost estimation is shown in right figure in Figure 3.3.1.

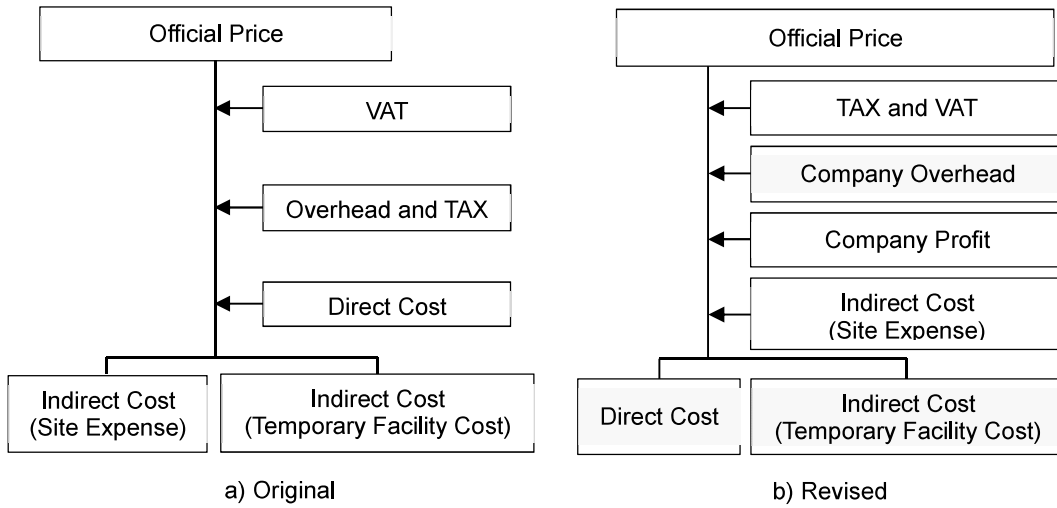


Figure 3.3.1 Revised System of Cost Estimation from Japanese Standards

3.4 Adopted System of Cost Estimation

The adopted system of cost estimation is shown in Figure 3.4.1.

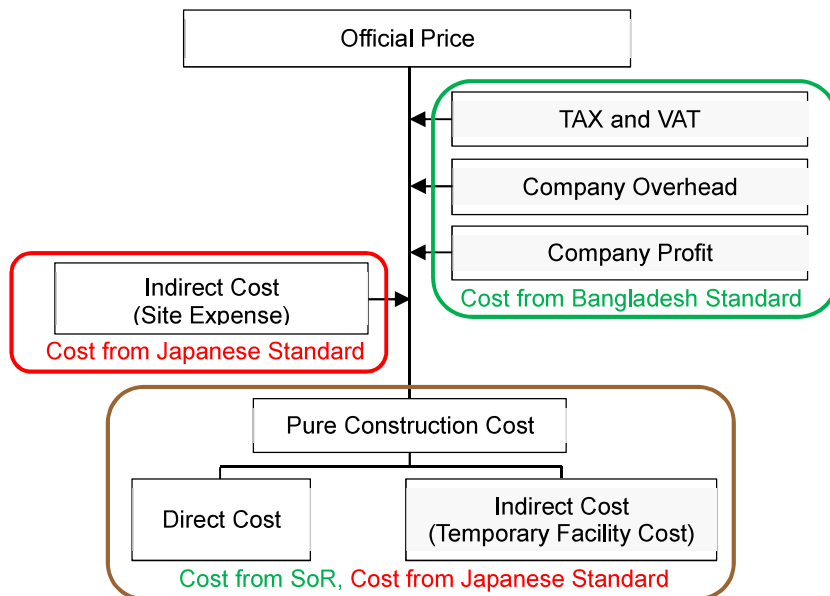


Figure 3.4.1 Adopted System of Cost Estimation

3.4.1 Pure Construction Cost

1) Direct Cost

To calculate the Direct Cost, the system of cost estimation from SoR is generally used. If the item in the SoR is not mentioned, the Cost Estimation Standards for Civil Works in Japan are used.

However if to calculate the Direct Cost the Cost Estimation Standards for Civil Works in Japan are used, the unit cost of Labour, Machinery and Materials to calculate the Direct Cost are adopted in SoR.

2) Indirect Cost (Temporary Facility Cost)

For the Indirect Cost (Temporary Facility Cost), if the system of cost estimation from SoR is used, the Temporary Facility Cost is including the Direct Cost. Therefore the cost is not needed calculated. On the other hand, to calculate the Temporary Facility Cost if the Cost Estimation Standards for Civil Works in Japan are adopted, rate of the Temporary Facility Cost is adopted in following rate.

- Temporary Facility Cost: 15.66% of Direct Cost

The above rate is average of Temporary Facility Cost in the Cost Estimation Standards for Civil Works in Japan.

For reference;

In the Cost Estimation Standards for Civil Works in Japan, the rate of Temporary Facility Cost is calculated in Table 3.4.1.

Table 3.4.1 Rate of Temporary Facility Cost

Work Item	Less than 4 million BDT	Over 4 million BDT and less than 667 million BDT	Over 667 million BDT
River, road and bridge construction works	26.94	$(6907.7 \times P^{0.3554})/1.155$	4.37

Note: P = direct cost + supplied product cost

Source: Cost Estimation Standards for Civil Works

3.4.2 Indirect Cost (Site Expense)

The Indirect Cost (Site Expense) is adopted in the Cost Estimation Standards for Civil Works in Japan. The calculation of rate of Site Expense can be used shown in Table 3.4.2.

Table 3.4.2 Rate of Site Expense

Work Item	Less than 5 million BDT	Over 5 million BDT and less than 714 million BDT	Over 714 million BDT
River, road and bridge construction works	28.22	$(52.6 \times N_p^{-0.0395})/1.0135$ (N_p : Pure construction cost (BDT))	23.20

Note: Pure construction cost, N_p = Direct cost + Temporary facility cost

Source: Cost Estimation Standards for Civil Works

3.4.3 Company Profit

The company profit is adopted in Bangladesh Standard. The rate of company profit is 10% of the pure construction cost and site expense.

3.4.4 Company Overhead

The company overhead is adopted in Bangladesh Standard. The rate of company overhead is 5% of the pure construction cost, site expense and company profit.

3.4.5 TAX and VAT

The TAX and VAT are adopted in Bangladesh Standard. The rate of TAX and VAT is 11.7% of the pure construction cost, site expense, company profit and company overhead.

4. CALCULATION OF PURE CONSTRUCTION COST

4.1 Routine Maintenance Work

The routine maintenance work of bridge is carried out by the foreman, skilled labour and un-skilled labour. The unit price of this work is shown in Table 4.1.1.

Table 4.1.1 Routine Maintenance Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.00			
Un-skilled		person	2.00			
Car Operation	Saloon Car 1200cc Capacity	day	1.00	See Table 4.1.2		
Total						
per 1 day						

Table 4.1.2 Unit Price of Car Operation in Routine Maintenance Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Truck	person	1.00			
Car	Saloon Car 1200cc Capacity	month	0.05			
Petrol		L	32.00			
Total						

4.2 Minor Repair Works

The minor repair work of bridge is carried out by the foreman, skilled labour and un-skilled labour. The unit price of this work is shown in Table 4.2.1.

Table 4.2.1 Minor Repair Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.00			
Un-skilled		person	2.00			
Car Operation	Saloon Car 1200cc Capacity	day	1.00	See Table 4.2.2		
Total						
per 1 day						

Table 4.2.2 Unit Price of Car Operation in Minor Repair Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Truck	person	1.00			
Car	Saloon Car 1200cc Capacity	month	0.05			
Petrol		L	32.00			
Total						

4.3 Common Work

4.3.1 Scaffoldings for Bridge Rehabilitation/Strengthening

There are two types of scaffoldings used for rehabilitation/strengthening of the existing bridges. One is suspended scaffolding, which is used for the rehabilitation/strengthening work for the superstructure. The other is the prefabricated scaffolding, which is used for work on the substructure.

(1) Suspended Scaffolding

1) Suspended Scaffolding Type A

This type of scaffolding is hung by chains under the superstructure. Preparing and setting up safety equipment and facilities such as fences, handrails and safety nets are crucial. Note internal scaffolds shall be installed if the clearance between bottom of deck slab and floor is over 2m. This type is applied for deck slab and girder work. The structure of this type is shown in Figure 4.3.1.

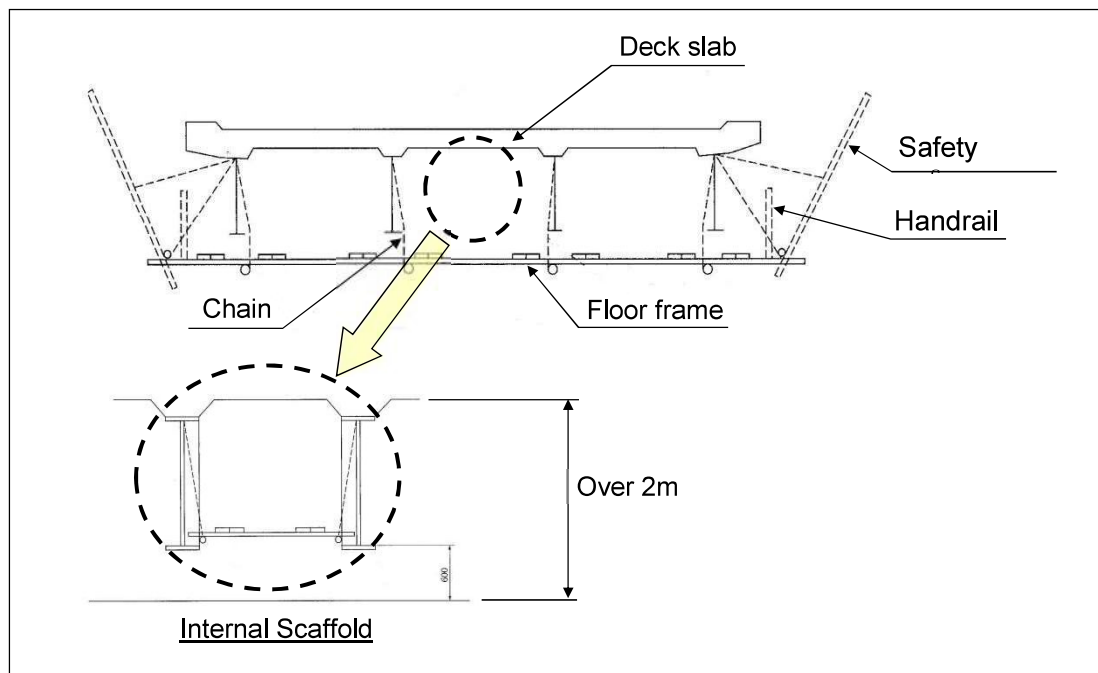


Figure 4.3.1 Suspended Scaffolding Type A

2) Suspended Scaffolding Type B

This type is installed on the sides of the superstructure with chains and steel frames. This type is applied for work on railings and curbs. The structure of this type is shown in Figure 4.3.2.

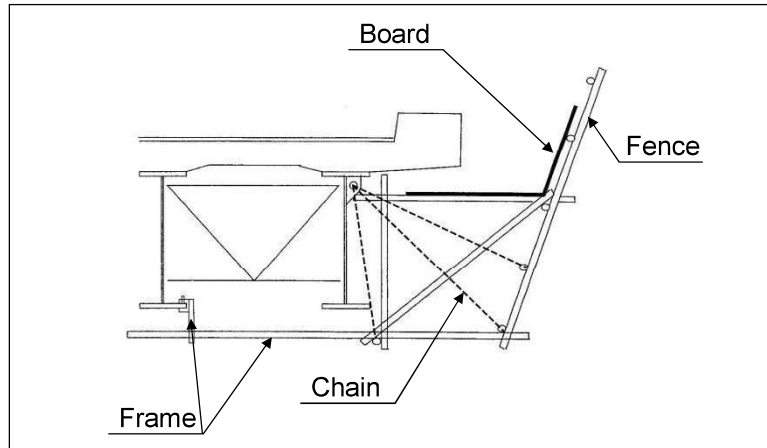


Figure 4.3.2 Suspended Scaffolding Type B

3) Suspended Scaffolding Type C

This type is installed on the circumference of piers by chains. It is applied for work on bearings, unseating prevention systems and expansion joints. The structure of this type is shown in Figure 4.3.3.

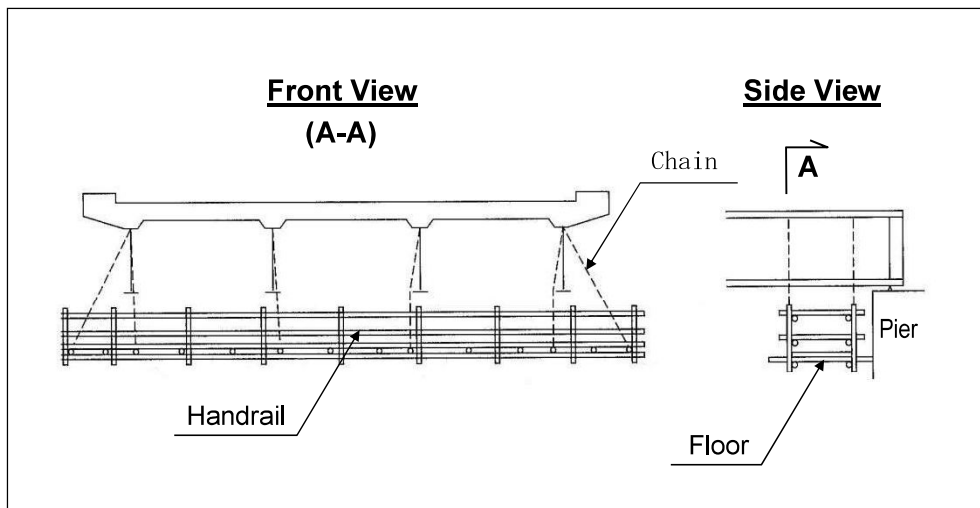


Figure 4.3.3 Suspended Scaffolding Type C

(2) Prefabricated Scaffolding

This type is built to assemble a prefabricated frame. It is applied for building the body of a substructure. The structure of this type is shown in Figure 4.3.4.

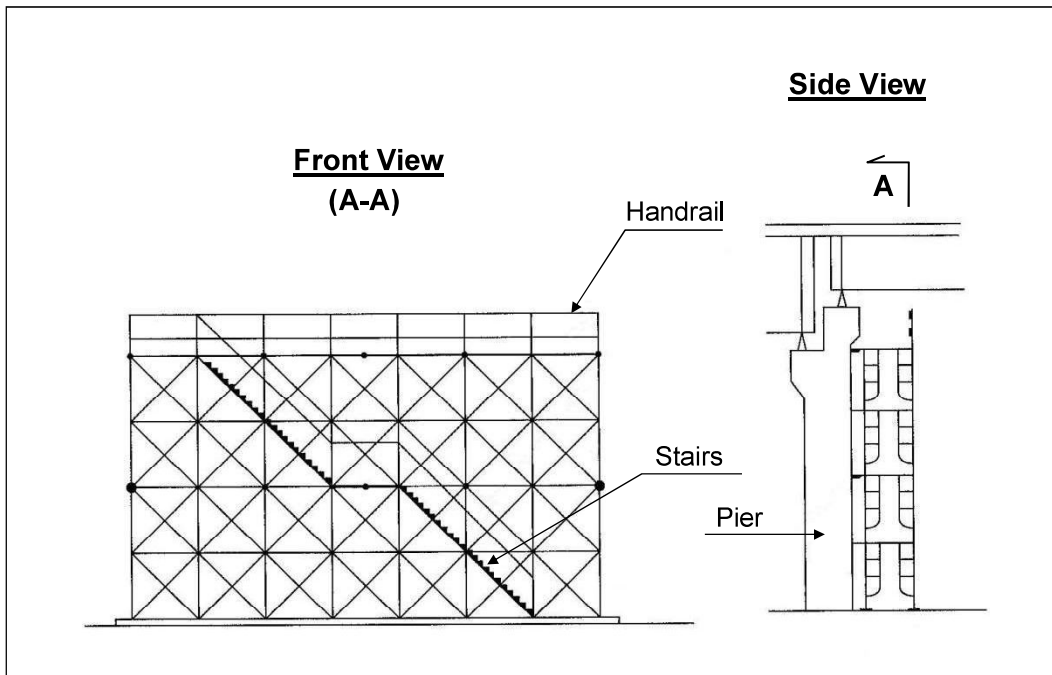


Figure 4.3.4 Prefabricated Scaffolding

4.3.2 Excavation and Backfill for Structures

Excavation and backfill for structures is performed according to the soil state and environmental conditions.

(1) On-land Structural Portion

The construction cost of excavation and backfill work of the on-land structural portion is calculated according to SoR published by RHD.

Table 4.3.1 Excavation and Backfill Work on Land

(per 100 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Semi-skilled		person	5.00			
Un-skilled		person	55.00			
Plate Compactor		day	3.00			
Small Hand Tools		day	60.00			
Water Tanker		day	0.25			
Total						
Per 1 m ³						

Source: SoR, 2015 [02/05/01, Excavation and Backfill for Structures]

(2) Structural Portion inside River

The construction cost of excavation and backfill work for structural portion inside river is calculated according to other project in Bangladesh.

1) Water Depth of 1 m or Less: Sandy Soil

Table 4.3.2 Excavation and Backfill Work in River (Water Depth of 1 m or Less: Sandy Soil)

(per 100 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Semi-skilled		person	11.00			
Un-skilled		person	65.00			
Plate Compactor		day	3.00			
Small Hand Tools		day	76.00			
Water Tanker		day	0.25			
Total						
Per 1 m ³						

Source: othe project in Bangladesh

2) Water Depth of Over 1 m: Sandy Soil

Table 4.3.3 Excavation and Backfill Work in River (Water Depth of Over 1 m: Sandy Soil)(per 100 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Semi-skilled		person	11.00			
Un-skilled		person	65.00			
Plate Compactor		day	3.00			
Small Hand Tools		day	76.00			
Water Tanker		day	0.25			
Water Pump		day	1.00			
Total						
Per 1 m ³						

Source: othe project in Bangladesh

3) Water Depth of 1 m or Less: Soft Rock

Table 4.3.4 Excavation and Backfill Work in River (Water Depth of 1 m or Less: Soft Rock)(per 100 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Semi-skilled		person	15.00			
Un-skilled		person	70.00			
Plate Compactor		day	3.00			
Small Hand Tools		day	76.00			
Water Tanker		day	0.25			
Total						
Per 1 m ³						

Source: othe project in Bangladesh

4) Water Depth of Over 1 m: Soft Rock

Table 4.3.5 Excavation and Backfill Work in River (Water Depth of Over 1 m: Soft Rock)(per 100 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Semi-skilled		person	15.00			
Un-skilled		person	70.00			
Plate Compactor		day	3.00			
Small Hand Tools		day	76.00			
Water Tanker		day	0.25			
Water Pump		day	1.00			
Total						
Per 1 m ³						

Source: othe project in Bangladesh

4.4 Concrete Element (Pure Construction Cost)

4.4.1 Surface Protection Coating

(1) General

The construction cost of this work is not specified in SoR and is calculated according to the Cost Estimation standards for Bridge Construction Works in Japan. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.1.

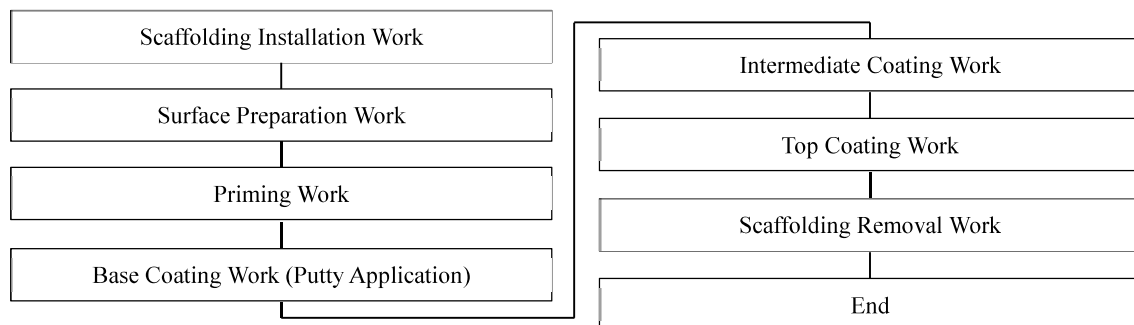


Figure 4.4.1 Flow of Surface Protection Coating

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Surface Preparation Work

Surface preparation work consists of removal of differences in level of the concrete surface to finish it smooth. The unit price of this work is shown in Table 4.4.1.

Table 4.4.1 Surface Preparation Work [Surface Protection Coating](per 50 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	See Table 4.4.2			
Skilled		person	See Table 4.4.2			
Un-skilled		person	See Table 4.4.2			
Petty Charge	22% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.1 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works

The quantity for the surface preparation is shown in Table 4.4.2.

Table 4.4.2 Quantity for Surface Preparation Work

Item	No. of Persons	Construction Period	Correction Factor
Foreman	1	$D = 0.0047 \times A + 0.37$	1.5
Skilled	2		
Un-skilled	1		

Note) A: represents the quantity of construction (m²).

For the correction factor of labour quantity, 1.5 is used.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

3) Priming and Coatings Work (Base, Intermediate and Top Coatings)

Priming work is to apply primer to the concrete surface while coatings work (base, intermediate and top coatings) is to apply coatings to the concrete surface. The unit price of this work is shown in Table 4.4.3 to Table 4.4.6.

Table 4.4.3 Priming Work [Surface Protection Coating](per 50 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1 x D (D: See Table 4.4.7)			
Skilled		person	2 x D (D: See Table 4.4.7)			
Un-skilled		person	1 x D (D: See Table 4.4.7)			
Primer		kg	As required			Including loss rate of 10%
Petty Charge		L.S	See Table 4.4.7			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Source: Cost Estimation Standards for Bridge Construction Works

Table 4.4.4 Base Coating Work (Putty Application) [Surface Protection Coating](per 50 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1 x D (D: See Table 4.4.7)			
Skilled		person	2 x D (D: See Table 4.4.7)			
Un-skilled		person	1 x D (D: See Table 4.4.7)			
Putty		kg	As required			Including loss rate of 10%
Petty Charge		L.S	See Table 4.4.7			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Source: Cost Estimation Standards for Bridge Construction Works

Table 4.4.5 Intermediate Coating Work [Surface Protection Coating](per 50 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1 x D (D: See Table 4.4.7)			
Skilled		person	2 x D (D: See Table 4.4.7)			
Un-skilled		person	1 x D (D: See Table 4.4.7)			
Intermediate Coating Material		kg	As required			Including loss rate of 10%
Petty Charge		L.S	See Table 4.4.7			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Source: Cost Estimation Standards for Bridge Construction Works

Table 4.4.6 Top Coating Work [Surface Protection Coating](per 50 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1 x D (D: See Table 4.4.7)			
Skilled		person	2 x D (D: See Table 4.4.7)			
Un-skilled		person	1 x D (D: See Table 4.4.7)			
Top Coating Material		kg	As required			Including loss rate of 10%
Petty Charge		L.S	See Table 4.4.7			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Source: Cost Estimation Standards for Bridge Construction Works

The quantity for priming and coatings is shown in Table 4.4.7.

Table 4.4.7 Quantity for Priming, and Base, Intermediate and Top Coatings Work

Item	Construction Period	Correction Factor	Petty Charge Ratio
Primer	$D = 0.0024 \times A + 0.25$	1.5	6% of total labour costs
Base Coating	$D = 0.0052 \times A + 0.53$	1.5	6% of total labour costs
Intermediate Coating	$D = 0.0096 \times A + 0.52$	1.5	6% of total labour costs
Top Coating			

Note) A: represents the quantity of construction (m²).

For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.7 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

4.4.2 Repairing of Crack (Filling)

(1) General

The construction cost of this work is calculated according to SoR.

The flow of this work is shown in Figure 4.4.2.

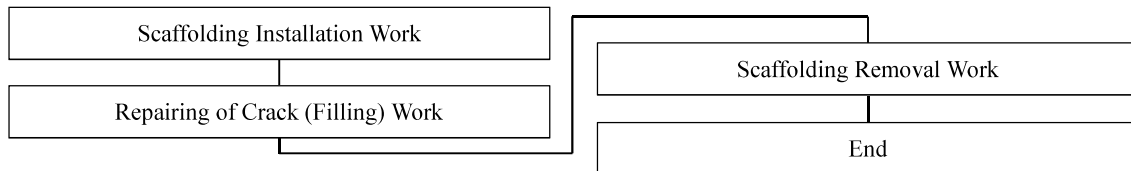


Figure 4.4.2 Flow of Repairing of Crack (Filling)

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Repairing of Crack (Filling) Work

The construction cost of repairing of crack (filling) work is calculated according to SoR published by RHD.

Table 4.4.8 Repairing of Crack (Filling) Work

(per 24 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.00			
Semi-skilled		person	1.00			
Ordinary Portland Cement (OPC)	Grade 60	t	0.0025			
Sand	FM=1.0	m ³	0.0073			
Small Hand Tools		day	2.00			
Total						
Per 1 m						

Source: SoR, 2015 [05/04/05, Cement Mortar in Cracks]

4.4.3 Repairing of Crack (Injection)

(1) General

The construction cost of this work is not specified in SoR, and is calculated according to the Cost Estimation Standards of Bridge Construction Works in Japan. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.3.

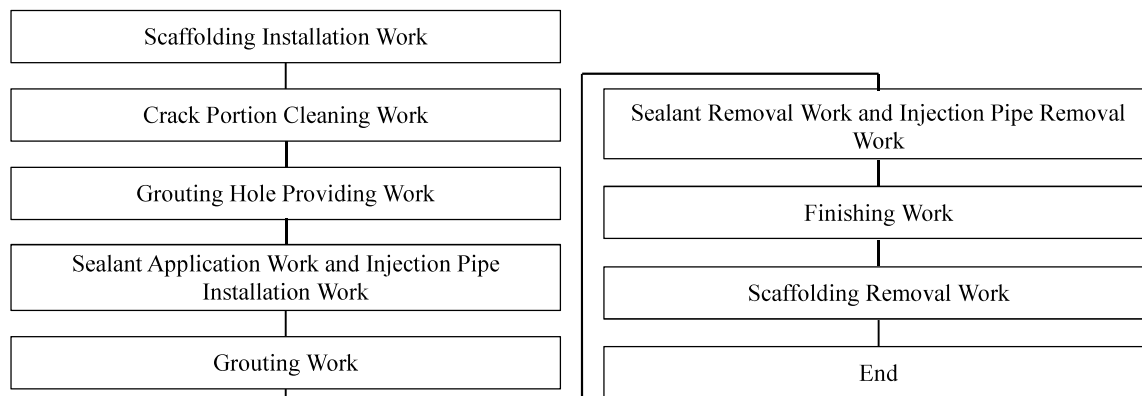


Figure 4.4.3 Flow of Repairing of Crack (Injection)

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Repairing of Crack (Injection) Work

The repairing of crack (injection) work includes “crack portion cleaning work” “grouting hole providing work” “sealant application work and injection pipe installation work” “grouting work” “sealant removal work and injection pipe removal work” and “finishing work”, and the unit price of these works is shown in Table 4.4.9.

Table 4.4.9 Repairing of Crack (Injection) Work

(per 100 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1 x D			
Skilled		person	2 x D			
Un-skilled		person	1 x D			
Grout Material		kg	As required			Including loss rate of 15%
Sealant Material		kg	As required			Including loss rate of 15%
Low-pressure Injection Pipes		number	As required			
Petty Charge	11% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m						

Note) Petty charge is for “cleaning” “installation and removal of injection pipes” “application and removal of sealant” “grouting” and “finishing”. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.9 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works

The quantity for the repairing of crack (injection) work is calculated as follows:

$$D = (0.060 \times L + 0.71) \times 1.5$$

Where;

D : Number of days for work (days)

L : Crack length (m)

1.5 : Correction factor (Design and Cost Estimation Manual)

4.4.4 Concrete Restruction (Hand Applied Mortar)

(1) General

The construction cost of this work is not specified in SoR, and is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.4.

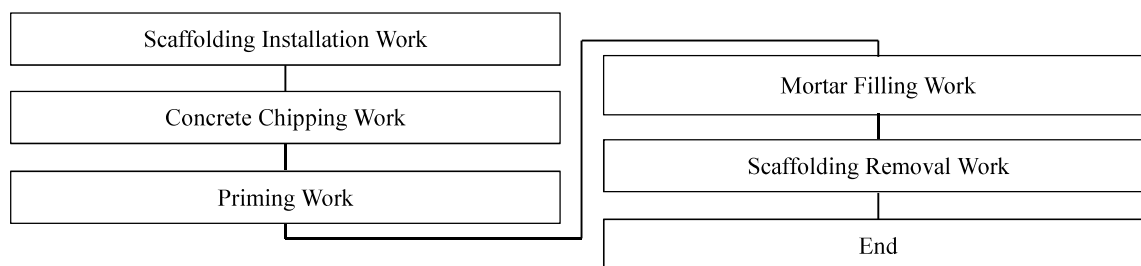


Figure 4.4.4 Flow of Concrete Restruction (Hand Applied Mortar)

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Concrete Chipping Work

Concrete chipping work is to chip any damaged concrete. The unit price of this work is shown in Table 4.4.10.

Table 4.4.10 Concrete Chipping Work [Concrete Restruction (Hand Applied Mortar)]

(per 10 m ³)						
Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	3.00			2.0 x 1.5
Skilled		person	6.00			4.0 x 1.5
Un-skilled		person	7.50			5.0 x 1.5
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.10 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

3) Priming Work

Priming work is to apply primer to the concrete surface. The unit price of this work is shown in Table 4.4.11.

Table 4.4.11 Priming Work [Concrete Restruction (Hand Applied Mortar)]

(per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			0.1 x 1.5
Skilled		person	0.60			0.4 x 1.5
Un-skilled		person	0.30			0.2 x 1.5
Primer		kg	2.00			0.2kg/m ²
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.11 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

4) Mortar Filling Work

The unit price of this work is shown in Table 4.4.12.

Table 4.4.12 Mortar Filling Work [Concrete Restruction (Hand Applied Mortar)]

(per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	7.95			5.3 x 1.5
Skilled		person	22.50			15.0 x 1.5
Un-skilled		person	17.40			11.6 x 1.5
Polymer Cement Mortar		m ³	1.06	See Table 4.4.13		Including loss rate of 6%
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.12 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

The unit price for polymer cement mortar in mortar filling work is shown in Table 4.4.13.

Table 4.4.13 Unit Price for Polymer Cement Mortar in Mortar Filling Work(per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Un-skilled		person	2.25			1.5 x 1.5
Ordinary Portland Cement (OPC)	Grade 60	t	0.50			*1
Sand	FM=1.0	m ³	0.60			*2
Admixture for Polymer Cement		kg	102.00			*3
Water		m ³	0.10			*4
Total						

Note) *1: OPC: $500\text{kg} / 3,000(\text{kg}/\text{m}^3) = 0.17\text{m}^3$

*2: Sand: $1,500\text{kg} / 2,500(\text{kg}/\text{m}^3) = 0.60\text{m}^3$

*3: Admixture: $100\text{L} * 1,020(\text{kg}/\text{m}^3) / 1,000(\text{L}/\text{m}^3) = 102\text{kg}$ [$100\text{L} / 1,020(\text{kg}/\text{m}^3) = 0.10\text{m}^3$]

*4: Water: $100\text{L} / 1,000(\text{L}/\text{m}^3) = 0.10\text{m}^3$

4.4.5 Concrete Restruction (Fluid Recasting Mortar)

(1) General

The construction cost of this work is not specified in SoR, and is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.5.

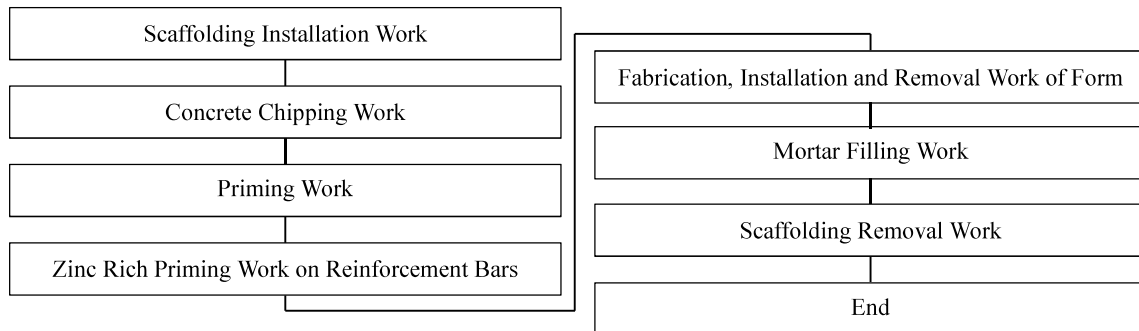


Figure 4.4.5 Flow of Concrete Restruction (Fluid Recasting Mortar)

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Concrete Chipping Work

Concrete chipping work is to chip any damaged concrete. The unit price of this work is shown in Table 4.4.14.

Table 4.4.14 Concrete Chipping Work [Concrete Restruction (Fluid Recasting Mortar)]

(per 10 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	3.00			2.0 x 1.5
Skilled		person	6.00			4.0 x 1.5
Un-skilled		person	7.50			5.0 x 1.5
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.14 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

3) Priming Work

Priming work is to apply primer to the concrete surface. The unit price of this work is shown in Table 4.4.15.

Table 4.4.15 Priming Work [Concrete Restruction (Fluid Recasting Mortar)]

(per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			0.1 x 1.5
Skilled		person	0.60			0.4 x 1.5
Un-skilled		person	0.30			0.2 x 1.5
Primer		kg	2.00			0.2kg/m ²
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.15 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

4) Fabrication, Installation and Removal Work of Form

The unit price of this work is shown in Table 4.4.16.

Table 4.4.16 Fabrication, Installation and Removal Work of Form [Concrete Restruction (Fluid Recasting Mortar)]

(per 100 m2)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	4.65			3.1 x 1.5
Form Worker		person	23.55			15.7 x 1.5
Un-skilled		person	15.00			10.0 x 1.5
Petty Charge	23% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m2						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.16 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

5) Mortar Filling Work

The mortar filling work includes “zinc rich priming work on reinforcement bars” and “mortar filling work”, and the unit price of these works is shown in Table 4.4.17.

Table 4.4.17 Mortar Filling Work [Concrete Restruction (Fluid Recasting Mortar)]

(per 1 m3)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	3.75			2.5 x 1.5
Skilled		person	18.00			12.0 x 1.5
Un-skilled		person	11.25			7.5 x 1.5
Fluid Mortar		m3	1.06	See Table 4.4.18		Including loss rate of 6%
Petty Charge	5% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m3						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.17 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

The unit price for fluid mortar in mortar filling work is shown in Table 4.4.18.

Table 4.4.18 Unit Price for Fluid Mortar in Mortar Filling Work(per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Un-skilled		person	2.25			1.5 x 1.5
Ordinary Portland Cement (OPC)	Grade 60	t	0.23			*1
Sand	FM=1.0	m ³	0.74			*2
Silica Fume		kg	58.00			*3
Water		m ³	0.15			*4
Total						

Note) *1: OPC: $230\text{kg} [230\text{kg}/3,000(\text{kg}/\text{m}^3)=0.08\text{m}^3]$

*2: Sand: $1,839\text{kg}/2,500(\text{kg}/\text{m}^3)=0.74\text{m}^3$

*3: Silica Fume: $58\text{kg} [58\text{kg}/2,270(\text{kg}/\text{m}^3)=0.03\text{m}^3]$

*4: Water: $145\text{kg}/1,000(\text{kg}/\text{m}^3)=0.15\text{m}^3$

4.4.6 Concrete Restruction (Fluid Recasting Concrete)

(1) General

The construction cost of this work is not specified in SoR, and is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.6.

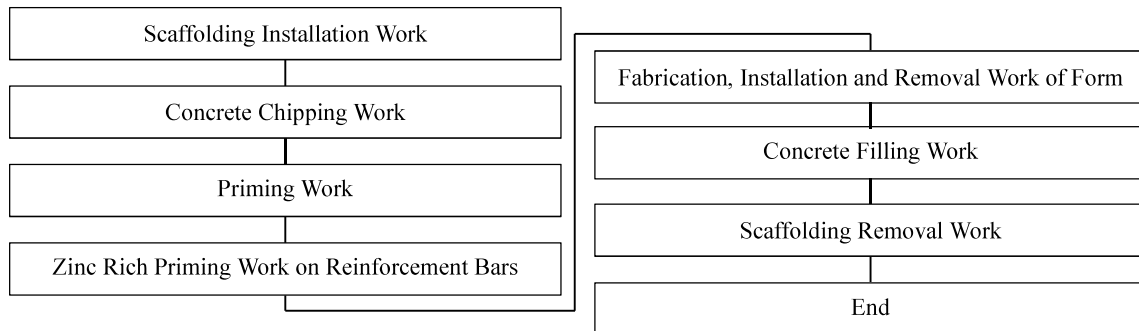


Figure 4.4.6 Flow of Concrete Restruction (Fluid Recasting Concrete)

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Concrete Chipping Work

Concrete chipping work is to chip any damaged concrete. The unit price of this work is shown in Table 4.4.19.

Table 4.4.19 Concrete Chipping Work [Concrete Restruction (Fluid Recasting Concrete)]

(per 10 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	3.00			2.0 x 1.5
Skilled		person	6.00			4.0 x 1.5
Un-skilled		person	7.50			5.0 x 1.5
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.19 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

3) Priming Work

Priming work is to apply primer to the concrete surface. The unit price of this work is shown in Table 4.4.20.

Table 4.4.20 Priming Work [Concrete Restruction (Fluid Recasting Concrete)]

(per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			0.1 x 1.5
Skilled		person	0.60			0.4 x 1.5
Un-skilled		person	0.30			0.2 x 1.5
Primer		kg	2.00			0.2kg/m ²
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.20 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

4) Fabrication, Installation and Removal Work of Form

The unit price of this work is shown in Table 4.4.21.

Table 4.4.21 Fabrication, Installation and Removal Work of Form [Concrete Restruction (Fluid Recasting Concrete)]

(per 100 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	4.65			3.1 x 1.5
Form Worker		person	23.55			15.7 x 1.5
Un-skilled		person	15.00			10.0 x 1.5
Petty Charge	23% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.21 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

5) Concrete Filling Work

The concrete filling work includes “zinc rich priming work on reinforcement bars” and “concrete filling work”, and the unit price of these works is shown in Table 4.4.22.

Table 4.4.22 Concrete Filling Work [Concrete Restruction (Fluid Recasting Concrete)]

(per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	3.75			2.5 x 1.5
Skilled		person	18.00			12.0 x 1.5
Un-skilled		person	11.25			7.5 x 1.5
Fluid Concrete		m ³	1.06	See Table 4.4.23		Including loss rate of 6%
Petty Charge	5% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.22 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

The unit price for fluid concrete in concrete filling work is shown in Table 4.4.23.

Table 4.4.23 Unit Price for Fluid Concrete in Concrete Filling Work(per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Skilled		person	1.43			0.95 x 1.5
Un-skilled		person	0.38			0.25 x 1.5
Ordinary Portland Cement (OPC)	Grade 60	t	0.23			*1
Sand	FM=1.0	m ³	0.35			*2
Aggregate	20mm	m ³	0.39			*3
Silica Fume		kg	58.00			*4
Water		m ³	0.15			*5
Total						

Note) *1: OPC: $230\text{kg} [230\text{kg}/3,000(\text{kg}/\text{m}^3)=0.08\text{m}^3]$

*2: Sand: $875\text{kg}/2,500(\text{kg}/\text{m}^3)=0.35\text{m}^3$

*3: Aggregate: $964\text{kg}/2,500(\text{kg}/\text{m}^3)=0.39\text{m}^3$

*4: Silica Fume: $58\text{kg} [58\text{kg}/2,270(\text{kg}/\text{m}^3)=0.03\text{m}^3]$

*5: Water: $145\text{kg}/1,000(\text{kg}/\text{m}^3)=0.15\text{m}^3$

4.4.7 Concrete Restruction (Spray Applied Mortar)

(1) General

The construction cost of this work is not specified in SoR. The construction cost of “concrete chipping work” and “priming work” are calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013, and the construction cost of “mortar spraying work” is calculated according to the other project in Japan and the Cost Estimation Standards for Machinery Expense in Japan. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.7.

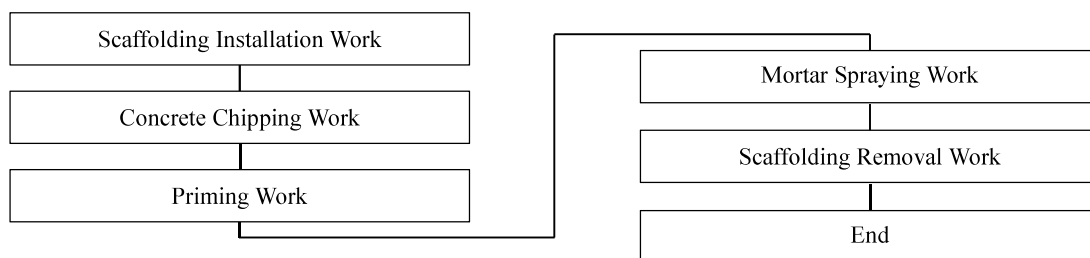


Figure 4.4.7 Flow of Concrete Restruction (Spray Applied Mortar)

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Concrete Chipping Work

Concrete chipping work is to chip any damaged concrete. The unit price of this work is shown in Table 4.4.24.

Table 4.4.24 Concrete Chipping Work [Concrete Restruction (Spray Applied Mortar)](per 10m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	3.00			2.0 x 1.5
Skilled		person	6.00			4.0 x 1.5
Un-skilled		person	7.50			5.0 x 1.5
Petty Charge	3% of total labor costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.24 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

3) Priming Work

Priming work is to apply primer to the concrete surface. The unit price of this work is shown in Table 4.4.25.

Table 4.4.25 Priming Work [Concrete Restruction (Spray Applied Mortar)](per 10m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			0.1 x 1.5
Skilled		person	0.60			0.4 x 1.5
Un-skilled		person	0.30			0.2 x 1.5
Primer		kg	2.00			0.2kg/m ²
Petty Charge	2% of total labor costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.25 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

4) Mortar Spraying Work

The unit price of this work is calculated according to other project in Japan.

Table 4.4.26 Mortar Spraying Work [Concrete Restruction (Spray Applied Mortar)]

(per 11.75 m3)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	22.04			14.69 x 1.5
Carpenter		person	66.09			44.06 x 1.5
Skilled		person	44.07			29.38 x 1.5
Un-skilled		person	44.07			29.38 x 1.5
Spray Applied Mortar		m3	12.46			Including loss rate of 6%
Generator Operation	15kVA	day	14.69	See Table 4.4.27		
Air Compressor Operation	1.4m3/min	day	14.69	See Table 4.4.28		
Mortar Mixer	100L	day	14.69	See Table 4.4.29		
Concrete Pump	3.0 to 4.0 kw	day	14.69	See Table 4.4.30		
Petty Charge	3% of total labor costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m3						

Source: other project in Japan, Design and Cost Estimation Manual

The unit price for generator operation in mortar spraying work is shown in Table 4.4.27.

Table 4.4.27 Unit Price for Generator Operation in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Generator	15kVA	day	1.20			*1
Diesel		L	14.79			*2
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[120 (using day/year) / 100(actual working day/year)]

*2: Quantity is from the other project in Japan. [2.9(L/hour) x 5.1(hour/day)]

The unit price for air compressor operation in mortar spraying work is shown in Table 4.4.28.

Table 4.4.28 Unit Price for Air Compressor Operation in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Air Compressor	1.4m3/min	day	1.75			*1
Diesel		L	12.75			*2
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[140 (using day/year) / 80(actual working day/year)]

*2: Quantity is from the other project in Japan. [2.5(L/hour) x 5.1(hour/day)]

The unit price for mortar mixer in mortar spraying work is shown in Table 4.4.29.

Table 4.4.29 Unit Price for Mortar Mixer in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Mortar Mixer	100L	day	1.63			*1
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[130 (using day/year) / 80(actual working day/year)]

The unit price for concrete pump in mortar spraying work is shown in Table 4.4.30.

Table 4.4.30 Unit Price for Concrete Pump in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Concrete Pump	3.0 to 4.0kw	day	1.63			*1
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[130 (using day/year) / 80(actual working day/year)]

4.4.8 Replacement of Curb

(1) General

The construction cost of “curb construction work” is calculated according to SoR, the construction cost of “demolition and loading work of concrete” is calculated according to the Cost Estimation Standards for Civil Works in Japan and the Cost Estimation Standards for Machinery Expense in Japan, and the construction cost of “priming work” is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.8.

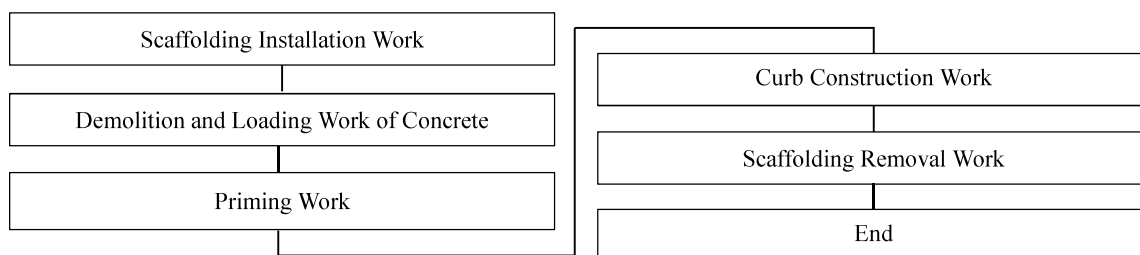


Figure 4.4.8 Flow of Replacement of Curb

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, estimation is made separately according to 4.3.1.

2) Demolition and Loading Work of Concrete

The unit price of this work is shown in Table 4.4.31.

Table 4.4.31 Demolition and Loading Work of Concrete [Replacement of Curb](per 10 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	6.60			4.4 x 1.5
Skilled		person	21.75			14.5 x 1.5
Un-skilled		person	20.40			13.6 x 1.5
Concrete Breaker	20kg class	day	13.20	See Table 4.4.32		
Air Compressor Operation	3.5 to 3.7m ³ /min	day	6.60	See Table 4.4.33		
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.31 is registered as the upper limit.

Source: Cost Estimation Standards for Civil Works, Design and Cost Estimation Manual

The unit price for concrete breaker in demolition and loading work of concrete is shown in Table 4.4.32.

Table 4.4.32 Unit Price for Concrete Breaker in Demolition and Loading Work of Concrete

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Concrete Breaker	20kg class	day	1.71			*1
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[120 (using day/year) / 70(actual working day/year)]

The unit price for air compressor operation in demolition and loading work of concrete is shown in Table 4.4.33.

Table 4.4.33 Unit Price for Air Compressor Operation in Demolition and Loading Work of Concrete

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Air Compressor	3.5 to 3.7m ³ /min	day	1.70			
Diesel		L	31.00			
Total						

Source: Cost Estimation Standards for Civil Works

3) Priming Work

Priming work is to apply primer to the concrete surface. The unit price of this work is shown in Table 4.4.34.

Table 4.4.34 Priming Work [Replacement of Curb]

(per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			0.1 x 1.5
Skilled		person	0.60			0.4 x 1.5
Un-skilled		person	0.30			0.2 x 1.5
Primer		kg	2.00			0.2kg/m ²
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.34 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

4) Curb Construction Work

(a) Bending and Assembling Work of Reinforcement Bars

The unit price of this work is calculated according to SoR published by RHD and loss rate of 2% for reinforcement bars is considered.

For information, the unit price without the profit, TAX and VAT is BDT 77,490/ton in the August version, 2015. [05/02/02, High Yield Reinforcement Bars]

(b) Concrete Work

The unit price of this work is calculated according to SoR published by RHD and loss rate of 5% for concrete is considered.

For information, the unit price without the profit, TAX and VAT in the August version, 2015 is shown below.

- BDT 11,530/m³ [05/01/02 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,630/m³ [05/01/02 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,850/m³ [05/01/03 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]
- BDT 13,950/m³ [05/01/03 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]

4.4.9 CFRP Bonding on Concrete Member

(1) General

The construction cost of this work is not specified in SoR, and is calculated according to the Cost Estimation Standards of Bridge Construction Works in Japan. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.4.9.

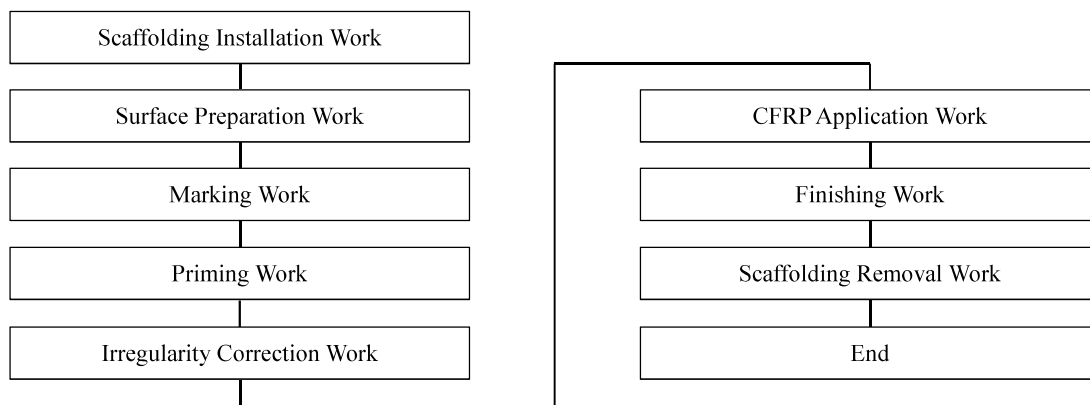


Figure 4.4.9 Flow of CFRP Bonding on Concrete Member

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Surface Preparation Work

Surface preparation work consists of removal of differences in level of the concrete surface to finish it smooth. The unit price of this work is shown in Table 4.4.35. Note that the construction quantity per day is 48m².

Table 4.4.35 Surface Preparation Work [CFRP Bonding on Concrete Member](per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.32			1person/48m ² x 10 x 1.5
Skilled		person	1.25			4person/48m ² x 10 x 1.5
Un-skilled		person	0.63			2person/48m ² x 10 x 1.5
Petty Charge	5% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.35 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

3) Marking Work

Marking work is to mark the position where the CFRP is to be applied. The unit price of this work is shown in Table 4.4.36. Note that the construction quantity per day is 200m².

Table 4.4.36 Marking Work [CFRP Bonding on Concrete Member](per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.08			1person/200m ² x 10 x 1.5
Skilled		person	0.30			4person/200m ² x 10 x 1.5
Un-skilled		person	0.15			2person/200m ² x 10 x 1.5
Petty Charge	1% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.36 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

4) Priming Work

The priming work is to apply the primer to facilitate fitting between concrete and CFRP on the concrete surface. The unit price of this work is shown in Table 4.4.37. Note that the construction quantity per day is 100m².

Table 4.4.37 Priming Work [CFRP Bonding on Concrete Member](per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			1person/100m ² x 10 x 1.5
Skilled		person	0.60			4person/100m ² x 10 x 1.5
Un-skilled		person	0.30			2person/100m ² x 10 x 1.5
Primer		kg	2.00			0.2kg/m ²
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.37 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

5) Irregularity Correction Work

The irregularity correction work is to rehabilitate/strengthen form portions with differences in level and loss to finish it smooth. The unit price of this work is shown in Table 4.4.38. Note that the quantity of construction per day is 48m².

Table 4.4.38 Irregularity Correction Work [CFRP Bonding on Concrete Member](per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.32			1person/48m ² x 10 x 1.5
Skilled		person	1.25			4person/48m ² x 10 x 1.5
Un-skilled		person	0.63			2person/48m ² x 10 x 1.5
Putty		kg	15.0			1.5kg/m ²
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.38 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

6) CFRP (Carbon-fibre Reinforced Plastic) Application Work

The CFRP application work is to apply the CFRP coated with the impregnation material to the concrete surface. The unit price of this work is shown in Table 4.4.39. This unit price covers cutting of the sheet, weighing of the impregnation material and the time required for mixing. Note that the construction quantity per day is 40m².

Table 4.4.39 CFRP Application Work (per Layer) [CFRP Bonding on Concrete Member]

(per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.38			1person/40m ² x 10 x 1.5
Skilled		person	1.50			4person/40m ² x 10 x 1.5
Un-skilled		person	0.75			2person/40m ² x 10 x 1.5
CFRP		m ²	11.50			Including loss rate of 15%
Impregnation Material		kg	See Table 4.4.40			
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.39 is registered as upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

The standard quantity of impregnation material is shown in Table 4.4.40.

Table 4.4.40 Standard Quantity of Impregnation Material in CFRP Application Work

Coating Weight (g/m ²)	Standard Quantity (kg/m ²)
200	0.6
300	0.8
400	1.0
600	1.2

Source: Cost Estimation Standards for Bridge Construction Works

7) Finishing Work

The finishing work consists of protective coating over the CFRP surface to be provided when the sheet is exposed to direct sunshine or when the aesthetic appearance is required. The unit price of this work is shown in Table 4.4.41. Note that the construction quantity per day is 96m².

Table 4.4.41 Finishing Work [CFRP Bonding on Concrete Member](per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			1person/96m ² x 10 x 1.5
Skilled		person	0.63			4person/96m ² x 10 x 1.5
Un-skilled		person	0.32			2person/96m ² x 10 x 1.5
Surface Treatment Material		kg	3.00			0.3kg/m ²
Petty Charge	10% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.4.41 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

4.5 Steel Elements (Pure Construction Cost)

4.5.1 Re-painting of Steel Member

(1) General

The construction cost of “re-painting work” is calculated according to SoR, and the construction cost of “pretreatment work of existing painting” is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.5.1.

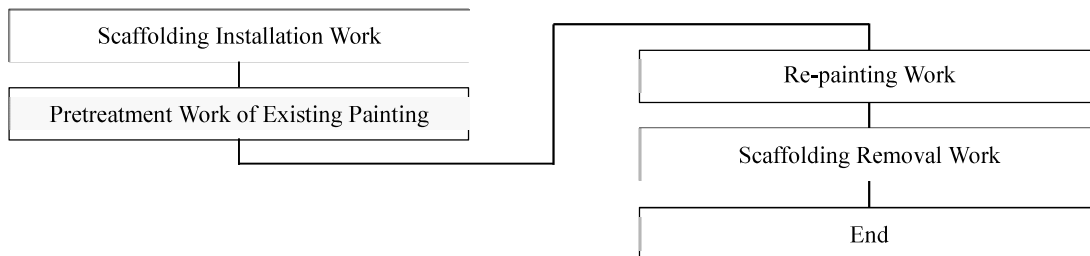


Figure 4.5.1 Flow of Re-painting of Steel Member

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Pretreatment Work of Existing Painting

The unit price of this work is shown in Table 4.5.1.

Table 4.5.1 Pretreatment Work of Existing Painting [Re-painting of Steel Member]

(per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.50			1.0 x 1.5
Skilled		person	6.00			4.0 x 1.5
Un-skilled		person	9.00			6.0 x 1.5
Petty Charge	7% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.5.1 is registered as upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

3) Re-painting Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the construction cost without the profit, TAX and VAT is BDT 430/m² in the August version, 2015. [05/06/01, Preparation and Painting of Existing Structures]

4.5.2 Supplementing Steel Plate

(1) General

The construction cost of “re-painting work” is calculated according to SoR, and the construction cost of “pretreatment work of existing painting” “drilling work on steel plate” and “high-strength bolt fully tightening work” is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.5.2.

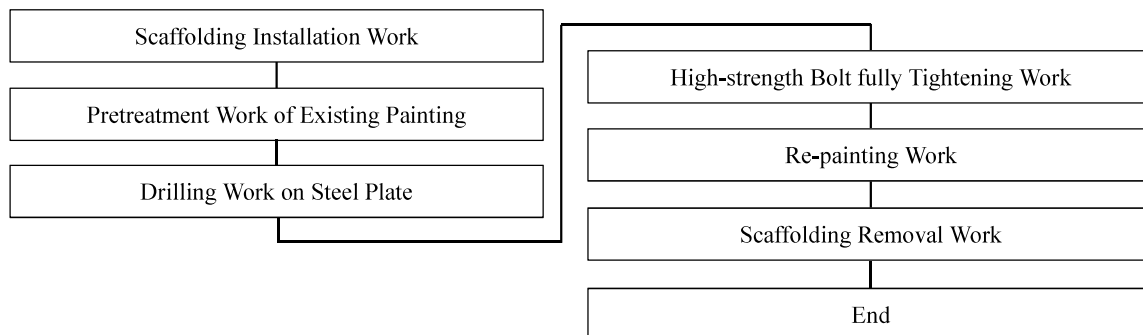


Figure 4.5.2 Flow of Supplementing Steel Plate

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Pretreatment Work of Existing Painting

The unit price of this work is shown in Table 4.5.2.

Table 4.5.2 Pretreatment Work of Existing Painting [Supplementing Steel Plate](per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.50			1.0 x 1.5
Skilled		person	6.00			4.0 x 1.5
Un-skilled		person	9.00			6.0 x 1.5
Petty Charge	7% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.5.2 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

3) Drilling Work on Steel Plate

The unit price of this work is shown in Table 4.5.3.

Table 4.5.3 Drilling Work on Steel Plate [Supplementing Steel Plate]

(per 225 number)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.50			1.00 x 1.5
Skilled		person	4.50			3.00 x 1.5
Un-skilled		person	1.50			1.00 x 1.5
Drill Blade	13mm	number	9.60			
Petty Charge	23% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 number						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.5.3 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

4) High-strength Bolt fully Tightening Work

The unit price of this work is shown in Table 4.5.4.

Table 4.5.4 High-strength Bolt fully Tightening Work [Supplementing Steel Plate]

(per 225 number)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.50			1.00 x 1.5
Skilled		person	4.50			3.00 x 1.5
Un-skilled		person	1.50			1.00 x 1.5
High-strength Bolts		number	225.00			
Petty Charge	20% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 number						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.5.4 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

5) Re-painting Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 430/m² in the August version, 2015. [05/06/01, Preparation and Painting of Existing Structures]

4.5.3 CFRP Bonding on Steel Member

(1) General

The construction cost of “re-painting work” is calculated according to SoR, the construction cost of “surface preparation work” “marking work” “priming work” “irregularity correction work” “CFRP application work” and “finishing work” is calculated according to the Cost Estimation Standards for Bridge Construction Works in Japan, and the construction cost of “pretreatment work of existing painting” is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.5.3.

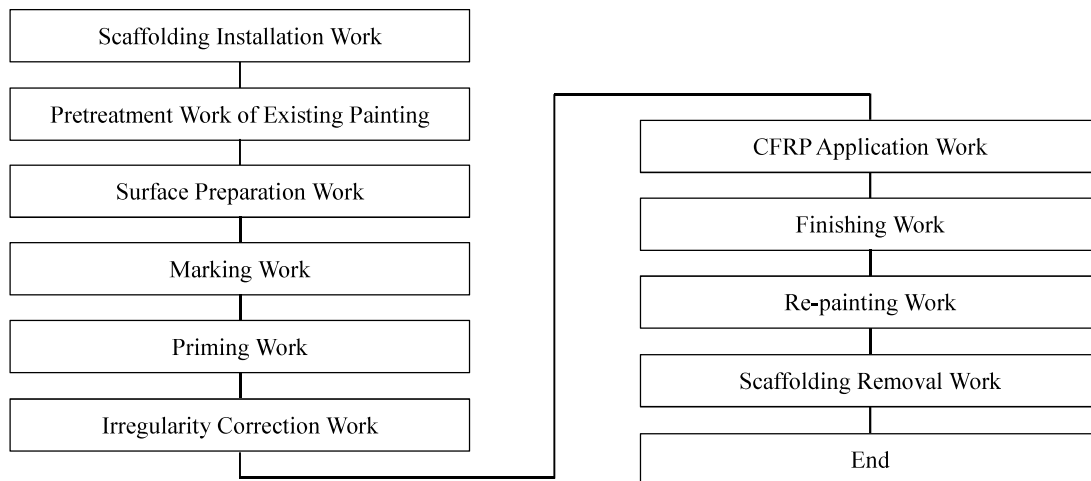


Figure 4.5.3 Flow of CFRP Bonding on Steel Member

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Pretreatment Work of Existing Painting

The unit price of this work is calculated according to 4.5.2(2)2).

3) Surface Preparation Work

The unit price of this work is calculated according to 4.4.9(2)2).

4) Marking Work

The unit price of this work is calculated according to 4.4.9(2)3).

5) Priming Work

The unit price of this work is calculated according to 4.4.9(2)4).

6) Irregularity Correction Work

The unit price of this work is calculated according to 4.4.9(2)5).

7) CFRP Application Work

The unit price of this work is calculated according to 4.4.9(2)6).

8) Finishing Work

The unit price of this work is calculated according to 4.4.9(2)7).

9) Re-painting Work

The unit price of this work is calculated according to 4.5.1(2)3).

4.6 Concrete Deck (Pure Construction Cost)

4.6.1 Replacement of Concrete Deck

(1) General

The construction cost of “asphalt pavement removal work” “deck construction work” “levelling concrete construction work” “prime coat installation work” “curb construction work” “railing installation work” “asphalt pavement placement work” and “road surface marking work” is calculated according to SoR, the construction cost of “railing removal work” “curb and deck removal work (partially broken)” “block removal work” “deck breaking work (above girders)” “secondary breaking work” “main girder flange handling work” and “expansion joint (steel type) removal work” is calculated according the Cost Estimation Standards for Bridge Construction Works in Japan and the Cost Estimation Standards for Machinery Expense in Japan, and the construction cost of “waterproofing installation work” and “expansion joint installation work” is calculated according to the other project. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.6.1.

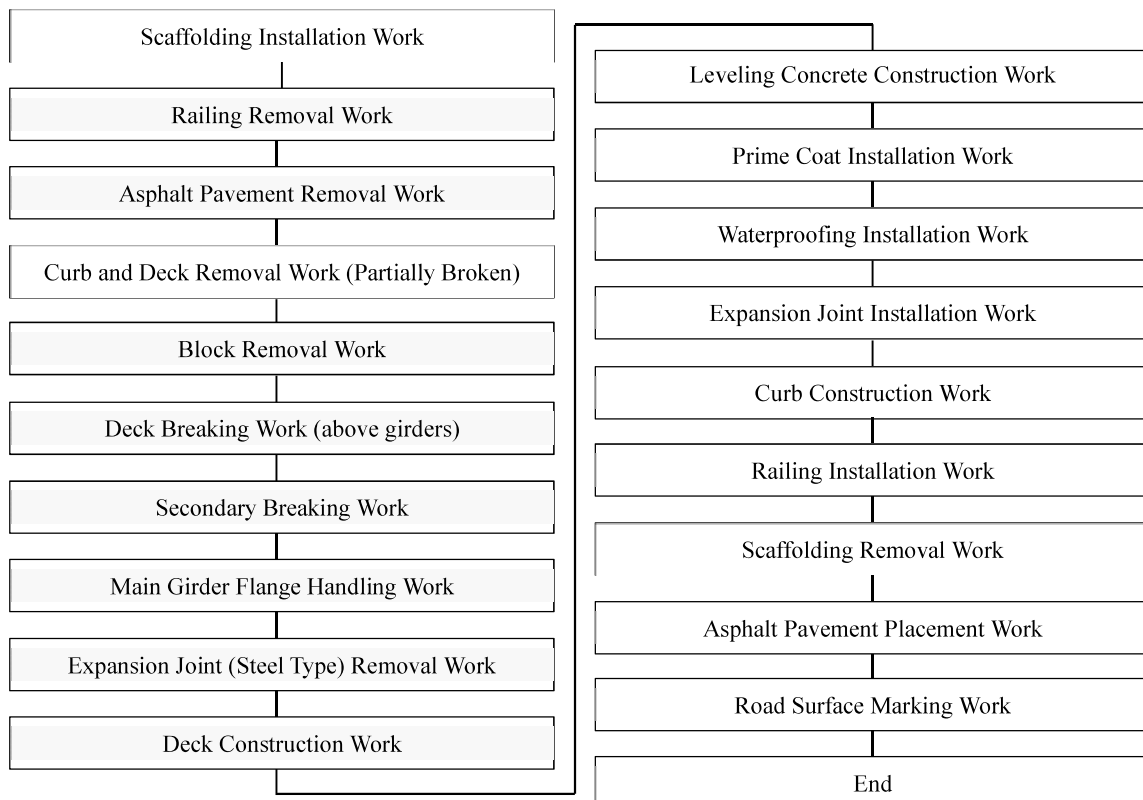


Figure 4.6.1 Flow of Replacement of Concrete Deck

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Railing Removal Work

The unit cost of this work is calculated according to 4.11.2(2)2).

3) Asphalt Pavement Removal Work

The unit cost of this work is calculated according to 4.10.1(2)1).

4) Curb and Deck Removal Work (Partially Broken)

The curb and deck removal work (partially broken) consists of lift hole drilling work and cutting/removal work with the cutter.

(a) Lift Hole Drilling Work

The unit price of this work is shown in Table 4.6.1.

Table 4.6.1 Lift Hole Drilling Work [Replacement of Concrete Deck]

(per 10 number)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.45			0.30 x 1.5
Skilled		person	1.80			1.20 x 1.5
Un-skilled		person	0.90			0.60 x 1.5
Truck Crane Operation	truck crane 4.9t	day	0.80	See Table 4.6.2		
Diamond Bit	50φ	number	0.60			
Petty Charge	21% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 number						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.1 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

The unit price for truck crane operation in lift hole drilling work is shown in Table 4.6.2.

Table 4.6.2 Unit Price for Truck Crane Operation in Lift Hole Drilling Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Machinery	person	1.00			
Truck Crane	4.9t	day	1.40			*1
Diesel		L	29.14			*2
Total						

Note) Quantity is from the Cost Estimation Standards for Machinery Expense.

*1: $[140 \text{ (using day/year)} / 100 \text{ (actual working day/year)}]$

*2: $[4.7 \text{ (L/hour)} \times 620 \text{ (actual working hour/year)} / 100 \text{ (actual working day/year)}]$

(b) Cutting and Removal Work with Cutter

The curb and deck cutting and removal work with cutter consists of cutting with a concrete cutter, along the split work lines in a bridge axial direction and in a direction normal to the bridge axis. The unit price of this work is shown in Table 4.6.3 to Table 4.6.7.

Table 4.6.3 Vertical Deck Cutting Work with Cutter [Replacement of Concrete Deck]

(per 10 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	See Table 4.6.4			
Skilled		person	See Table 4.6.4			
Un-skilled		person	See Table 4.6.4			
Truck Crane Operation	truck crane 4.9t	day	See Table 4.6.4	See Table 4.6.8		
Cutter Blade		number	See Table 4.6.4			
Petty Charge		L.S	See Table 4.6.4			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m						

Source: Cost Estimation Standards for Bridge Construction Works

Table 4.6.4 Quantity for Vertical Deck Cutting Work with Cutter

(per 10 m)

Item	Unit	Up to 200mm	Up to 250mm	Up to 300mm	Correction Factor
Foreman	person	0.39	0.49	0.59	1.5
Skilled	person	0.78	0.98	1.18	1.5
Un-skilled	person	0.78	0.98	1.18	1.5
Truck Crane Operation	day	1.09	1.36	1.63	
Cutter Blade	number	0.47	0.59	0.71	
Petty Charge	%	18	18	18	

Note) The vertical cutting depth is the concrete deck thickness.

For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.4 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

Table 4.6.5 Curb Vertical Cutting Work with Cutter [Replacement of Concrete Deck]

(per 10 time)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.88			1.25 x 1.5
Skilled		person	3.75			2.50 x 1.5
Un-skilled		person	3.75			2.50 x 1.5
Truck Crane Operation	truck crane 4.9t	day	3.50	See Table 4.6.8		
Cutter Blade		number	1.00			
Petty Charge	16% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 point						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.5 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

Table 4.6.6 Horizontal Deck and Curb Cutting Work with Cutter [Replacement of Concrete Deck]

(per 10 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	See Table 4.6.7			
Skilled		person	See Table 4.6.7			
Un-skilled		person	See Table 4.6.7			
Truck Crane Operation	truck crane 4.9t	day	See Table 4.6.7	See Table 4.6.8		
Cutter Blade		number	See Table 4.6.7			
Petty Charge		L.S	See Table 4.6.7			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m						

Source: Cost Estimation Standards for Bridge Construction Works

Table 4.6.7 Quantity for Horizontal Deck and Curb Cutting Work with Cutter

(per 10 m)

Item	Unit	Up to 200mm	Up to 300mm	Up to 400mm	Correction Factor
Foreman	person	0.33	0.36	0.39	1.5
Skilled	person	0.67	0.72	0.79	1.5
Un-skilled	person	0.67	0.72	0.79	1.5
Truck Crane Operation	day	0.67	0.72	0.79	
Cutter Blade	number	0.34	0.46	0.64	
Petty Charge	%	16	16	16	

Note) The horizontal cutting depth is the concrete thickness.

For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.7 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

The unit price for truck crane operation is shown in Table 4.6.8.

Table 4.6.8 Unit Price for Truck Crane Operation in Vertical Deck Cutting Work, Curb Vertical Cutting Work, and Horizontal Deck and Curb Cutting Work with Cutter

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Machinery	person	1.00			
Truck Crane	4.9t	day	1.40			*1
Diesel		L	29.14			*2
Total						

Note) Quantity is from the Cost Estimation Standards for Machinery Expense.

*1: $[140 \text{ (using day/year)} / 100 \text{ (actual working day/year)}]$

*2: $[4.7 \text{ (L/hour)} \times 620 \text{ (actual working hour/year)} / 100 \text{ (actual working day/year)}]$

5) Block Removal Work

The block removal work includes removal, loading onto the dump truck, and transportation of curbs and decks that have been reduced to blocks by means of a concrete cutter or large breaker. The unit price of this work is shown in Table 4.6.9.

Table 4.6.9 Block Removal Work [Replacement of Concrete Deck]

(per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.45			0.30 x 1.5
Skilled		person	1.50			1.00 x 1.5
Un-skilled		person	0.75			0.50 x 1.5
Truck Crane Operation	truck crane 4.9t	day	0.30	See Table 4.6.10		
Dump Truck Operation	10t vehicle	day	0.30			
Petty Charge	10% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.9 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

The unit price for truck crane operation in block removal work is shown in Table 4.6.10.

Table 4.6.10 Unit Price for Truck Crane Operation in Block Removal Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Machinery	person	1.00			
Truck Crane	4.9t	day	1.40			*1
Diesel		L	29.14			*2
Total						

Note) Quantity is from the Cost Estimation Standards for Machinery Expense.

*1: $[140 \text{ (using day/year)} / 100 \text{ (actual working day/year)}]$

*2: $[4.7 \text{ (L/hour)} \times 620 \text{ (actual working hour/year)} / 100 \text{ (actual working day/year)}]$

The unit price for dump truck operation in block removal work is shown in Table 4.6.11.

Table 4.6.11 Unit Price for Dump Truck Operation in Block Removal Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Truck	person	1.00			
Dump Truck	10t vehicle	day	1.29			*1
Diesel		L	71.14			*2
Total						

Note) Quantity is from the Cost Estimation Standards for Machinery Expense.

*1: $[180 \text{ (using day/year)} / 140 \text{ (actual working day/year)}]$

*2: $[12 \text{ (L/hour)} \times 830 \text{ (actual working hour/year)} / 140 \text{ (actual working day/year)}]$

6) Deck Breaking Work (above Girders)

Breaking work of decks above girders consists of manual breaking of the decks on the girder with a concrete breaker, storage, loading, and transport broken concrete wastes and reinforcement bars. The unit price of these works is shown in Table 4.6.12.

Table 4.6.12 Deck Breaking Work (above Girders) [Replacement of Concrete Deck](per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.20			0.80 x 1.5
Welder		person	0.30			0.20 x 1.5
Skilled		person	4.35			2.90 x 1.5
Un-skilled		person	3.15			2.10 x 1.5
Truck Operation	4.5t vehicle	day	0.70	See Table 4.6.13		
Petty Charge	14% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.12 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

The unit price for truck operation in deck breaking work (above girders) is shown in Table 4.6.13.

Table 4.6.13 Unit Price for Truck Operation in Deck Breaking Work (above Girders)

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Truck	person	1.00			
Truck	4.5t vehicle	day	1.13			*1
Diesel		L	32.66			*2
Total						

Note) Quantity is from the Cost Estimation Standards for Machinery Expense.

*1: [170 (using day/year) / 150(actual working day/year)]

*2: [6.9(L/hour) x 710(actual working hour/year) / 150(actual working day/year)]

7) Secondary Breaking Work

The secondary breaking work consists of separation of decks removed as blocks into concrete and reinforcement bars by breaking with a large breaker, and storage, loading, and transportation of wastes. The unit price of this work is shown in Table 4.6.14.

Table 4.6.14 Secondary Breaking Work [Replacement of Concrete Deck]

(per 10 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.45			0.30 x 1.5
Welder		person	0.45			0.30 x 1.5
Un-skilled		person	1.65			1.10 x 1.5
Large Breaker	600kg to 800kg	day	0.70			
Backhoe Operation	0.6m ³	day	0.10	See Table 4.6.15		
Dump Truck Operation	10t vehicle	day	0.60	See Table 4.6.16		
Petty Charge	15% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) The welder is to perform cutting of reinforcement bars.

For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.14 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Estimation Manual

The unit price for the backhoe operation in secondary breaking work is shown in Table 4.6.15.

Table 4.6.15 Unit Price for Backhoe Operation in Secondary Breaking Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Machine	person	1.00			
Backhoe	0.6m ³	day	1.64			*1
Diesel		L	81.55			*2
Total						

Note) Quantity is from the Cost Estimation Standards for Machinery Expense.

*1: [180 (using day/year) / 110(actual working day/year)]

*2: [13(L/hour) x 690(actual working hour/year) / 110(actual working day/year)]

The unit price for the dump truck operation in secondary breaking work is shown in Table 4.6.16.

Table 4.6.16 Unit Price for Dump Truck Operation in Secondary Breaking Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Driver	Truck	person	1.00			
Dump Truck	10t vehicle	day	1.29			*1
Diesel		L	71.14			*2
Total						

Note) Quantity is from the Cost Estimation Standards for Machinery Expense.

*1: [180 (using day/year) / 140(actual working day/year)]

*2: [12(L/hour) x 830(actual working hour/year) / 140(actual working day/year)]

8) Main Girder Flange Handling Work

The main girder flange handling work consists of removal and finishing of slab anchors and dowels on the flange. The unit price of this work is shown in Table 4.6.17.

Table 4.6.17 Main Girder Flange Handling Work [Replacement of Concrete Deck]

(Per 100 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	3.90			2.60 x 1.5
Skilled		person	7.95			5.30 x 1.5
Un-skilled		person	11.85			7.90 x 1.5
Petty Charge	22% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.17 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

9) Expansion Joint (Steel Type) Removal Work

The expansion joint (steel type) removal work consists of concrete chipping, cutting, dismantling, loading, and transportation of details of expansion joint cut away by primary breaking (with a cutter or large breaker). The unit price of this work is shown in Table 4.6.18.

Table 4.6.18 Expansion Joint (Steel Type) Removal Work [Replacement of Concrete Deck]

(per 10 m)						
Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.50			1.00 x 1.5
Skilled		person	6.00			4.00 x 1.5
Un-skilled		person	1.50			1.00 x 1.5
Rough Terrain Crane	capable of lifting 20t	day	1.70			
Petty Charge	17% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.6.18 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

10) Deck Construction Work

(a) Bending and Assembling Work of Reinforcement Bars

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015 is BDT 77,490/ton. [05/02/02, High Yield Reinforcement Bars]

(b) Deck Concrete Construction Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015 is listed below:

- BDT 11,530/m³ [05/01/02 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,630/m³ [05/01/02 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,850/m³ [05/01/03 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]
- BDT 13,950/m³ [05/01/03 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]

11) Levelling Concrete Construction Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015 is listed below:

- BDT 11,530/m³ [05/01/02 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,850/m³ [05/01/03 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]

12) Prime Coat Installation Work

The unit price of this work is calculated according to 4.10.1(2)2).

13) Waterproofing Installation Work

The unit price of this work is calculated according to 4.10.2(2)3).

14) Expansion Joint Installation Work

The unit price of this work is calculated according to 4.9.2(2)3).

15) Curb Construction Work

The unit price of this work is calculated according to 4.4.8(2)4)(a) and 4.4.8(2)4)(b).

16) Railing Installation Work

The unit price of this work is calculated according to 4.11.2(2)3).

17) Asphalt Pavement Placement Work

The unit price of this work is calculated according to 4.10.1(2)3) through 4.10.1(2)5).

18) Road Surface Marking Work

The unit price of this work is calculated according to 4.10.1(2)6).

4.7 Concrete Pier

4.7.1 Strengthening of Concrete Pier with Spray Applied Mortar

(1) General

The construction cost of “bending and assembling work of reinforcement bars” is calculated according to SoR, the construction cost of “surface preparation work” and “concrete drilling work” is calculated according to the Cost Estimation Standards for Bridge Construction Works in Japan, and the construction cost of “mortar spraying work” is calculated according to the other project in Japan and the Cost Estimation Standards for Machinery Expense. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of the work is shown in Figure 4.7.1.

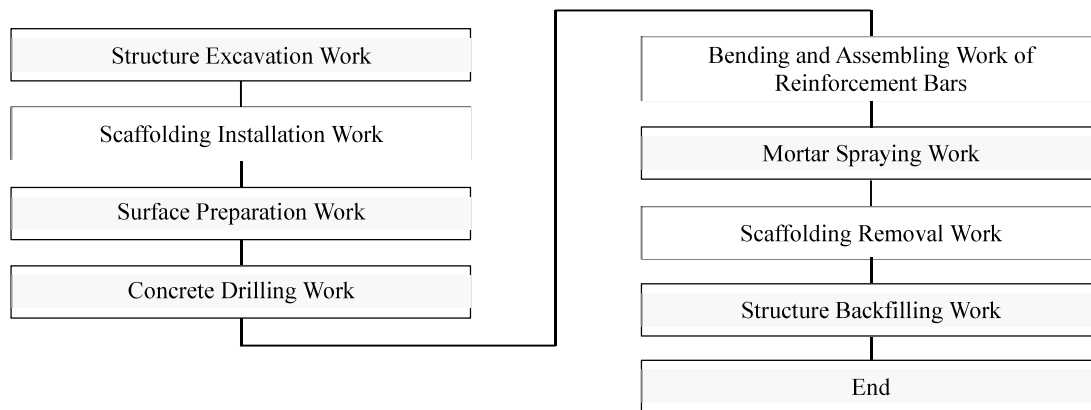


Figure 4.7.1 Flow of Strengthening of Concrete Pier with Spray Applied Mortar

(2) Estimation Procedure

1) Excavation and Backfilling Work for Structure

For excavation and backfilling for structures, the estimation is made separately according to 4.3.2.

2) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

3) Surface Preparation Work

The unit price of this work is shown in Table 4.7.1.

Table 4.7.1 Surface Preparation Work [Strengthening of Concrete Pier with Spray Applied Mortar]

(per 100 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.91			1.27 x 1.5
Skilled		person	6.15			4.10 x 1.5
Un-skilled		person	3.17			2.11 x 1.5
Petty Charge	12% of total labor costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.7.1 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

4) Concrete Drilling Work

The concrete drilling work consists of concrete drilling of pile-cap and supports and up to anchorage through grouting. The unit price of this work is shown in Table 4.7.2.

Table 4.7.2 Concrete Drilling Work [Strengthening of Concrete Pier with Spray Applied Mortar]

(per 100 number)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1 x 100 / D x 1.5 (D: See Table 4.7.3)			
Skilled		person	3 x 100 / D x 1.5 (D: See Table 4.7.3)			
Un-skilled		person	1 x 100 / D x 1.5 (D: See Table 4.7.3)			
Grout Material		kg	As required			
Reinforcement Bar Work		t	As required			
Petty Charge		L.S	See Table 4.7.5			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 number						

Note) D: labour quantity

For the correction factor of labour quantity, 1.5 is used.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

(a) Labour Quantity

The labour quantity in concrete drilling work on the basis of standard manpower is shown in Table 4.7.3.

Table 4.7.3 Labour Quantity in Concrete Drilling Work

Hole Diameter (mm)	(number/day)		
	20 or more, less than 30	30 or more, 50 or less	
Drilling Depth (m)	0.2 or more, 0.4 or less	0.3 or more, less than 0.6	0.6 or more, 0.9 or less
Labour Quantity	127	77	56

Source: Cost Estimation Standards for Bridge Construction Works

(b) Grout Consumption

The grout consumption per 100 numbers is expressed as follows:

$$\text{Consumption (kg)} = [(D^2 - d^2) \times \pi \times 1/4 \times L \times 100 \text{ numbers}] \times M \times (1 + K)$$

Wherein;

D: Hole diameter (m)

d : Anchor material diameter (m)

L : Drilling depth (m)

M: Unit mass of 1,200kg/m³

K: Loss ratio of +0.09

Table 4.7.4 Anchor Material Diameter and Standard Drill Hole Diameter in Concrete Drilling Work

Anchor Material Diameter (d)	Hole Diameter (D)
D16 to D35	D + 10 (mm)

Source: Cost Estimation Standards for Bridge Construction Works

(c) Petty Charge

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.7.5 is registered as the upper limit.

Table 4.7.5 Petty Charge Ratio in Concrete Drilling Work

Hole diameter (mm)	Petty Charge Ratio (%)		
	20 or more, less than 30	30 or more, 50 or less	
Drilling depth (m)	0.2 or more, 0.4 or less	0.3 or more, less than 0.6	0.6 or more, 0.9 or less
Petty Charge Ratio	16	17	25

Source: Cost Estimation Standards for Bridge Construction Works

5) Bending and Assembling Work of Reinforcement Bars

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015 is BDT 77,490/ton. [05/02/02, High Yield Reinforcement Bars]

6) Mortar Spraying Work

The unit price of this work is calculated according to other project in Japan.

Table 4.7.6 Mortar Spraying Work [Strengthening of Concrete Pier with Spray Applied Mortar]

(per 11.75 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	22.04			14.69 x 1.5
Carpenter		person	66.09			44.06 x 1.5
Skilled		person	44.07			29.38 x 1.5
Un-skilled		person	44.07			29.38 x 1.5
Spray Applied Mortar		m ³	12.46			Including loss rate of 6%
Generator Operation	15kVA	day	14.69	See Table 4.7.7		
Air Compressor Operation	1.4m ³ /min	day	14.69	See Table 4.7.8		
Mortar Mixer	100L	day	14.69	See Table 4.7.9		
Concrete Pump	3.0 to 4.0 kw	day	14.69	See Table 4.7.10		
Petty Charge	3% of total labor costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Source: other project in Japan, Design and Cost Estimation Manual

The unit price for generator operation in mortar spraying work is shown in Table 4.7.7.

Table 4.7.7 Unit Price for Generator Operation in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Generator	15kVA	day	1.20			*1
Diesel		L	14.79			*2
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[120 (using day/year) / 100(actual working day/year)]

*2: Quantity is from the other project in Japan. [2.9(L/hour) x 5.1(hour/day)]

The unit price for air compressor operation in mortar spraying work is shown in Table 4.7.8.

Table 4.7.8 Unit Price for Air Compressor Operation in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Air Compressor	1.4m ³ /min	day	1.75			*1
Diesel		L	12.75			*2
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[140 (using day/year) / 80(actual working day/year)]

*2: Quantity is from the other project in Japan. [2.5(L/hour) x 5.1(hour/day)]

The unit price for mortar mixer in mortar spraying work is shown in Table 4.7.9.

Table 4.7.9 Unit Price for Mortar Mixer in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Mortar Mixer	100L	day	1.63			*1
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[130 (using day/year) / 80(actual working day/year)]

The unit price for concrete pump in mortar spraying work is shown in Table 4.7.10.

Table 4.7.10 Unit Price for Concrete Pump in Mortar Spraying Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Concrete Pump	3.0 to 4.0kw	day	1.63			*1
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[130 (using day/year) / 80(actual working day/year)]

4.8 Bearing (Pure Construction Cost)

4.8.1 Repairing of Bearing

(1) General

The construction cost of “re-painting work” is calculated according to SoR, and the construction cost of “existing coating pretreatment work” is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of the work is shown in Figure 4.8.1.

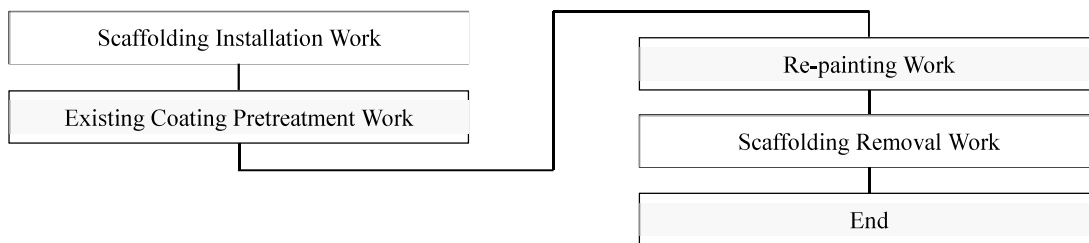


Figure 4.8.1 Flow of Repairing of Bearing

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For Installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Pretreatment Work of Existing Painting

The unit price of this work is calculated according to 4.5.1(2)2).

3) Re-painting Work

The unit price of this work is calculated according to 4.5.1(2)3).

4.8.2 Replacement of Bearing

(1) General

The construction cost of this work is not specified in SoR, and is calculated according to the Cost Estimation Standards for Bridge Construction Works in Japan. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.8.2.

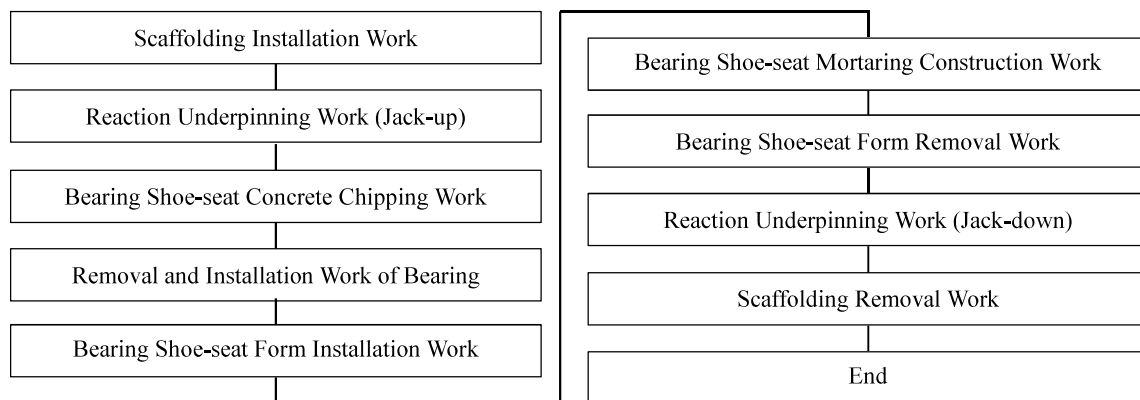


Figure 4.8.2 Flow of Replacement of Bearing

(2) Estimation Procedure

1) Installation and Removal Work of scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Bearing Replacement Work

The bearing replacement work consists of “reaction underpinning work (jack-up)” “bearing shoe-seat concrete chipping work” “removal and installation work of bearing” “bearing shoe-seat form installation work” “bearing shoe-seat mortaring construction work” “bearing shoe-seat form removal work” and “reaction underpinning work (jack-down)”. The unit price of these works is shown in Table 4.8.1 to Table 4.8.7.

Table 4.8.1 Bearing Replacement Work

(per 1 number)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	See Table 4.8.2 to Table 4.8.4			
Skilled		person	See Table 4.8.2 to Table 4.8.4			
Skilled		person	See Table 4.8.2 to Table 4.8.4			
Un-skilled		person	See Table 4.8.2 to Table 4.8.4			
Elastic Bearing		number	1.00			
Bearing Assembly	1% of cost of elastic bearing					*1
Petty Charge		L.S	See Table 4.8.2 to Table 4.8.4			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 number						

Note) *1: Quantity (1% of cost of elastic bearing) is from the other project in Bangladesh.

Source: Cost Estimation Standards for Bridge Construction Works

Table 4.8.2 Quantity for Bearing Replacement Work [Steel Bridge and Steel Bearing]

(per 1 number)

Item	Unit	Steel Bridge [Steel Bearing]				Correction Factor
		150t or less	150t to 250t	250t to 320t	Over 320t	
Foreman	person	$3.0 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$3.6 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$4.3 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Skilled	person	$8.8 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$10.5 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$12.6 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Skilled	person	$4.1 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$4.9 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$5.9 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Un-skilled	person	$2.8 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$3.4 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$4.0 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Petty Charge	%	19	27	27	To be estimated separately	

Note) For the correction factor of labour quantity, 1.5 is used.

α_1 : Correction factor by site conditions (Table 4.8.5)

α_2 : Correction factor by environmental conditions (Table 4.8.6)

α_3 : Correction factor by construction quantity (Table 4.8.7)

The petty charge is for appliances necessary for the work and for materials such as reinforcement bars and mortars. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.8.2 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

Table 4.8.3 Quantity for Bearing Replacement Work [Steel Bridge and Rubber Bearing]

(per 1 number)

Item	Unit	Steel Bridge [Rubber Bearing]				Correction Factor
		150t or less	150t to 250t	250t to 320t	Over 320t	
Foreman	person	$2.4 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$2.9 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$3.4 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Skilled	person	$7.0 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$8.4 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$10.1 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Skilled	person	$3.2 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$3.9 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$4.7 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Un-skilled	person	$2.2 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$2.7 \times \alpha_1 \times \alpha_2 \times \alpha_3$	$3.2 \times \alpha_1 \times \alpha_2 \times \alpha_3$	To be estimated separately	1.5
Petty Charge	%	19	27	27	To be estimated separately	

Note) For the correction factor of labour quantity, 1.5 is used.

α_1 : Correction factor by site conditions (Table 4.8.5)

α_2 : Correction factor by environmental conditions (Table 4.8.6)

α_3 : Correction factor by construction quantity (Table 4.8.7)

The petty charge is for appliances necessary for the work and for materials such as reinforcement bars and mortars. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.8.3 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

Table 4.8.4 Quantity for Bearing Replacement Work [Concrete Bridge and Rubber Bearing]

(per 1 number)

Item	Unit	Concrete Bridge [Rubber Bearing]	Correction Factor
		200t or less	
Foreman	person	$2.2 \times \alpha_1 \times \alpha_2 \times \alpha_3$	1.5
Skilled	person	$6.5 \times \alpha_1 \times \alpha_2 \times \alpha_3$	1.5
Skilled	person	$3.0 \times \alpha_1 \times \alpha_2 \times \alpha_3$	1.5
Un-skilled	person	$2.1 \times \alpha_1 \times \alpha_2 \times \alpha_3$	1.5
Petty Charge	%	19	

Note) For the correction factor of labour quantity, 1.5 is used.

α_1 : Correction factor by site conditions (Table 4.8.5)

α_2 : Correction factor by environmental conditions (Table 4.8.6)

α_3 : Correction factor by construction quantity (Table 4.8.7)

The petty charge is for appliances necessary for the work and for materials such as reinforcement bars and mortars. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.8.4 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

(a) Correction Factor by Site Conditions

The labour for replacing of bearing is corrected according to arrangement and other site conditions of bearing.

Table 4.8.5 Correction Factor by Site Conditions (α_1) in Quantity for Bearing Replacement Work

Site Conditions	(per 1 number)		
	Deck	One Box Girder, Two Bearings	One Box Girder, One Bearing
Correction Factor	1.0	1.2	1.6

Note) The correction shown above applies only to the reaction of 150t to 320t of the steel bridge and steel bearing.

For special type bridges, such as truss bridges, etc., calculation is made separately because of substantial difference between types.

Source: Cost Estimation Standards for Bridge Construction Works

(b) Correction Factor by Environmental Conditions

The labour for replacing of bearing is corrected according to site environmental conditions.

Table 4.8.6 Correction Factor by Environmental Conditions (α_2) in Quantity for Bearing Replacement Work

Environment	Factor
Within the general land, river high-level area, etc.	1.0
Unloading of materials and equipment done from the existing road	1.1
On principal roads, railway	1.2

Note) For special type bridges, such as truss bridges, etc., calculation is made separately because of substantial difference between types.

Source: Cost Estimation Standards for Bridge Construction Works

Table 4.8.7 Correction Factor by the Construction Quantity (α_3) in Quantity for Bearing Replacement Work

Site Conditions	Per bridge (when UP and DOWN ramps are separate per line)			
	1-2 units	3-5 units	6-8 units	9 units or more
Correction Factor	1.20	1.00	0.95	0.90

Note) For special type bridges, such as truss bridges, etc., calculation is made separately because of substantial difference between types.

Source: Cost Estimation Standards for Bridge Construction Works

4.9 Expansion Joint (Pure Construction Cost)

4.9.1 Repairing of Expansion Joint

(1) General

The construction cost of “bending and assembling work of reinforcement bars” “concrete construction work” and “asphalt pavement placement work” is calculated according to SoR, and the construction cost of “cutting work of asphalt pavement and deck” “chipping and removal work of asphalt pavement and deck” “cutting and removal work of existing expansion joint” “backup material installation work” and “adhesives application work” is calculated according to the Cost Estimation Standards for Bridge Construction Works in Japan. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.9.1.

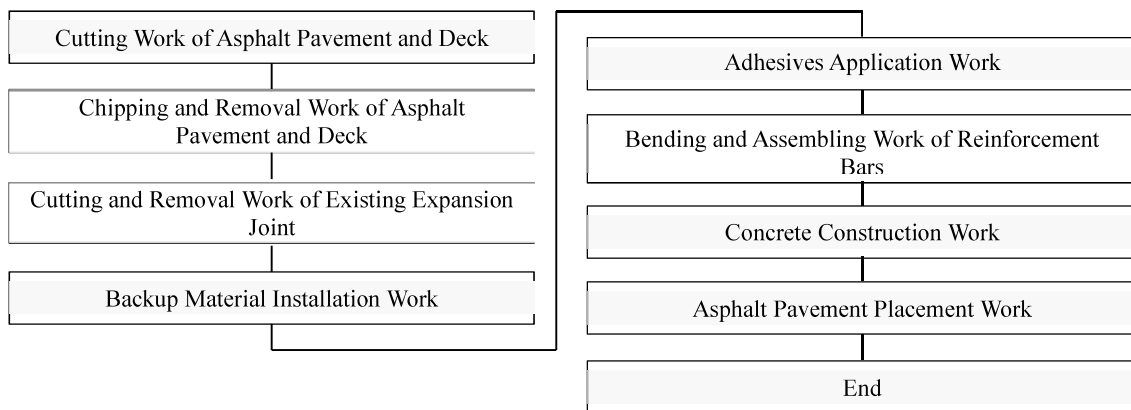


Figure 4.9.1 Flow of Repairing of Expansion Joint

(2) Estimation Procedure

1) Expansion Joint Repairing Work

The expansion joint repair work consists of “cutting work of asphalt pavement and deck” “chipping and removal work of asphalt pavement and deck” “cutting and removal work of exiting expansion joint” “backup material installation work” and “adhesive application work”. The unit price of these works is shown in Table 4.9.1.

Table 4.9.1 Expansion Joint Repairing Work [Repairing of Expansion Joint]

(per 7.5 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.80			1.2 x 1.5
Skilled		person	0.90			0.6 x 1.5
Skilled		person	4.05			2.7 x 1.5
Un-skilled		person	6.30			4.2 x 1.5
Backup Material	thickness of 20mm	m ²	As required			
Steel Material	H-300, section steel	t	As required			
Anchorage	5% of cost of backup material and steel material					*1
Petty Charge	24% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.9.1 is registered as the upper limit.

*1: Quantity (5% of cost of backup material and steel material) is from the other project in Bangladesh.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

2) Bending and Assembling Work of Reinforcement Bars

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 77,490/ton in the August version, 2015. [05/02/02, High Yield Reinforcement Bars]

3) Concrete Construction Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 11,530/m³ [05/01/02 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,630/m³ [05/01/02 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,850/m³ [05/01/03 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]
- BDT 13,950/m³ [05/01/03 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]

4) Surface Course Asphalt Pavement Placement Work

The unit price of this work is calculated according to 4.10.1(2)5).

4.9.2 Replacement of Expansion Joint

(1) General

The construction cost of “bending and assembling work of reinforcement bars” and “concrete construction work” is calculated according to SoR, the construction cost of “expansion joint removal work” is calculated according to the Cost Estimation Standards for Civil Works in Japan and the Cost Estimation Standards for Machinery Expense, the construction cost of “priming work” is calculated according to the Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Kagawa Prefecture in Japan, April 2013, and the construction cost of “expansion joint installation work” is calculated according to other project in Bangladesh. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.9.2.

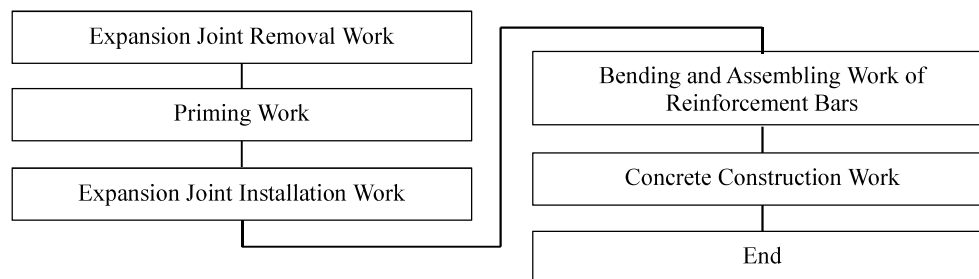


Figure 4.9.2 Flow of Replacement of Expansion Joint

(2) Estimation Procedure

1) Expansion Joint Removal Work

The expansion joint and surrounding concrete are to be removed by using a concrete breaker. The unit price of this work is shown in Table 4.9.2.

Table 4.9.2 Expansion Joint Removal Work [Replacement of Expansion Joint](per 10 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	6.60			4.4 x 1.5
Skilled		person	21.75			14.5 x 1.5
Un-skilled		person	20.40			13.6 x 1.5
Concrete Breaker	20kg class	day	13.20	See Table 4.9.3		
Air Compressor Operation	3.5 to 3.7m ³ /min	day	6.60	See Table 4.9.4		
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.9.2 is registered as the upper limit.

Source: Cost Estimation Standards for Civil Works, Design and Cost Estimation Manual

The unit price for concrete breaker in expansion joint removal work is shown in Table 4.9.3.

Table 4.9.3 Unit Price for Concrete Breaker in Expansion Joint Removal Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Concrete Breaker	20kg class	day	1.71			*1
Total						

Note) *1: Quantity is from the Cost Estimation Standards for Machinery Expense.

[120 (using day/year) / 70(actual working day/year)]

The unit price for the air compressor operation in expansion joint removal work is shown in Table 4.9.4.

Table 4.9.4 Unit Price for Air Compressor Operation in Expansion Joint Removal Work

(per 1 day)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Air Compressor	3.5 to 3.7m ³ /min	day	1.70			
Diesel		L	31.00			
Total						

Source: Cost Estimation Standards for Civil Works

2) Priming Work

Priming work is to apply primer to the concrete surface. The unit price of this work is shown in Table 4.9.5.

Table 4.9.5 Priming Work [Replacement of Expansion Joint](per 10 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			0.1 x 1.5
Skilled		person	0.60			0.4 x 1.5
Un-skilled		person	0.30			0.2 x 1.5
Primer		kg	2.00			0.2kg/m ²
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.9.5 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

3) Expansion Joint Installation Work

The unit price of this work is calculated according to other project in Bangladesh.

Table 4.9.6 Expansion Joint Installation Work [Replacement of Expansion Joint]

(per 12 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.05			
Skilled		person	0.25			
Un-skilled		person	1.00			
Expansion Joint		m	12.00			
Anchorage	5% of cost of expansion joint					
Total						
per 1 m						

4) Bending and Assembling Work of Reinforcement Bars

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is BDT 77,490/ton. [05/02/02, High Yield Reinforcement Bars]

5) Concrete Construction Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 11,530/m³ [05/01/02 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb

etc. (Concrete Mixer))]

- BDT 12,630/m³ [05/01/02 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Concrete Mixer))]
- BDT 12,850/m³ [05/01/03 (e), Concrete Class-20 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]
- BDT 13,950/m³ [05/01/03 (k), Concrete Class-30 (Deck Slab, Side Walk, Wheel Guard, Curb etc. (Batching Plant))]

4.10 Road Surface (Pure Construction Cost)

4.10.1 Replacement of Asphalt Pavement (without Waterproofing)

(1) General

The construction cost of this work is calculated according to SoR.

The flow of this work is shown in Figure 4.10.1.

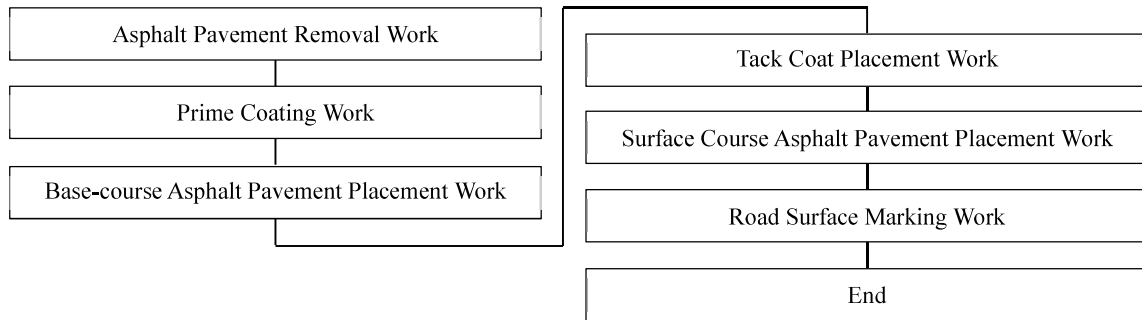


Figure 4.10.1 Flow of Replacement of Asphalt Pavement (without Waterproofing)

(2) Estimation Procedure

1) Asphalt Pavement Removal Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 220/m³ in the August version, 2015. [02/02/03, Roadway Excavation in Existing Pavement]

2) Prime Coating Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 100/m² [03/06/01 (a), Bituminous Prime Coat (Plant Placed)]
- BDT 100/m² [03/06/01 (b), Bituminous Prime Coat (Hand Placed)]

3) Base Course Asphalt Pavement Placement Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 14,150/m³ [03/10/01 (a), Dense Bituminous Surface-Base Course (Plant Method) (Bitumen Grade 80/100)]

- BDT 16,200/m³ [03/10/01 (b), Dense Bituminous Surface-Base Course (Plant Method) (Bitumen Grade 60/70)]

4) Tack Coat Placement Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 40/m² [03/07/01 (a), Bituminous Tack Coat (Plant Work)]
- BDT 40/m² [03/07/01 (b), Bituminous Tack Coat (Labour Intensive Work)]

5) Surface Course Asphalt Pavement Placement Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 15,820/m³ [03/10/02 (a), Dense Bituminous Surfacing-Wearing Course (Plant Method) (Bitumen Grade 80/100)]
- BDT 16,370/m³ [03/10/02 (b), Dense Bituminous Surfacing-Wearing Course (Plant Method) (Bitumen Grade 60/70)]

6) Road Surface Marking Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 860/m² in the August version, 2015. [06/11/02, Road Marking - Thermoplastic Material]

4.10.2 Replacement of Asphalt Pavement (with Waterproofing)

(1) General

This work is performed for simultaneous execution of repairing of asphalt pavement and installation of waterproofing layer. The construction cost of this work is calculated according to SoR and through acquisition of estimation.

The flow of this work is shown in Figure 4.10.2.

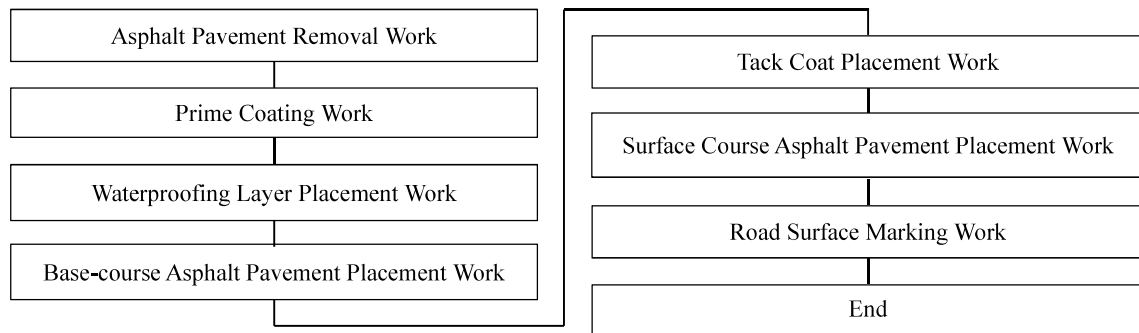


Figure 4.10.2 Flow of Replacement of Asphalt Pavement (with Waterproofing)

(2) Estimation Procedure

1) Asphalt Pavement Removal Work

The unit price of this work is calculated according to 4.10.1(2)1).

2) Prime Coating Work

The unit price of this work is calculated according to 4.10.1(2)2).

3) Waterproofing Layer Placement Work

(a) Waterproofing of Liquid-type

The unit price of this work is shown in Table 4.10.1. Note that the quantity of construction per day is 170m².

Table 4.10.1 Waterproofing Layer Placement Work (Liquid-type) [Replacement of Asphalt Pavement (with Waterproofing)]

(per 100 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.88			1person/170m ² x 100 x 1.5
Skilled		person	2.65			3person/170m ² x 100 x 1.5
Un-skilled		person	2.65			3person/170m ² x 100 x 1.5
Waterproofing (Liquid-type)		kg	As required			Including loss rate of 20%
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

(a) Waterproofing of Sheet-type

The unit price of this work is shown in Table 4.10.2. Note that the quantity of construction per day is 150m².

Table 4.10.2 Waterproofing Layer Placement Work (Sheet-type) [Replacement of Asphalt Pavement (with Waterproofing)]

(per 100 m²)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.00			1person/150m ² x 100 x 1.5
Skilled		person	3.00			3person/150m ² x 100 x 1.5
Un-skilled		person	3.00			3person/150m ² x 100 x 1.5
Waterproofing (Sheet-type)		m ²	As required			Including loss rate of 20%
Petty Charge	2% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ²						

4) Base Course Asphalt Pavement Placement Work

The unit price of this work is calculated according to 4.10.1(2)3).

5) Tack Coat Placement Work

The unit price of this work is calculated according to 4.10.1(2)4).

6) Surface Course Asphalt Pavement Placement Work

The unit price of this work is calculated according to 4.10.1(2)5).

7) Road Surface Marking Work

The unit price of this work is calculated according to 4.10.1(2)6).

4.11 Other (Pure Construction Cost)

4.11.1 Replacement of Catch Basin and Drainage

(1) General

The construction cost of this work is not specified in SoR, and is calculated according to other project in Bangladesh and through acquisition of estimation.

The flow of this work is shown in Figure 4.11.1.

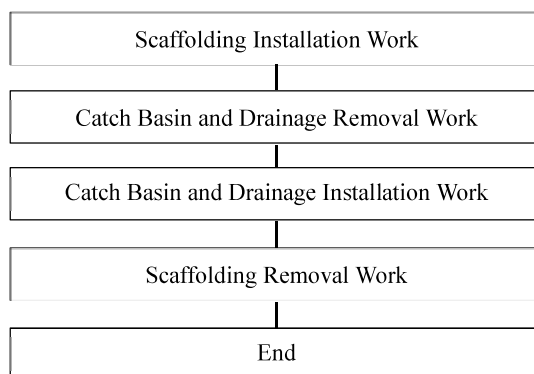


Figure 4.11.1 Flow of Replacement of Catch Basin and Drainage

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Catch Basin and Drainage Removal Work

The unit price of this work is shown in Table 4.11.1.

Table 4.11.1 Catch Basin and Drainage Removal Work [Replacement of Catch Basin and Drainage]

(Per 1 number)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.15			
Skilled		person	0.30			
Un-skilled		person	0.35			
Total						
Per 1 number						

3) Catch Basin and Drainage Installation Work

The unit price of this work is shown in Table 4.11.2.

Table 4.11.2 Catch Basin and Drainage Installation Work [Replacement of Catch Basin and Drainage]

(Per 1 number)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	0.02			For fabrication
Welder		person	0.02			For fabrication
Skilled		person	0.02			For fabrication
Foreman		person	0.01			For fixing in position
Mason		person	0.01			For fixing in position
Un-skilled		person	0.20			For fixing in position
Structural Steel		kg	4.00			
GI pipe	100mm dia.	m	1.60			
GI bolt	10mm dia.	number	6.00			
MS flat clamp		number	2.00			
Anchorage	5% of cost of drainage materials					
Total						
Per 1 number						

4.11.2 Replacement of Railing

(1) General

The construction cost of “railing installation work” is calculated according to SoR and the construction cost of “railing removal work” is calculated according to the Cost Estimation Standards for Bridge Construction Works in Japan. Since the Japanese standard is applied to this work, the coefficient of the Design and Cost Estimation Manual in Japan is applied to the quantity of labour.

The flow of this work is shown in Figure 4.11.2.

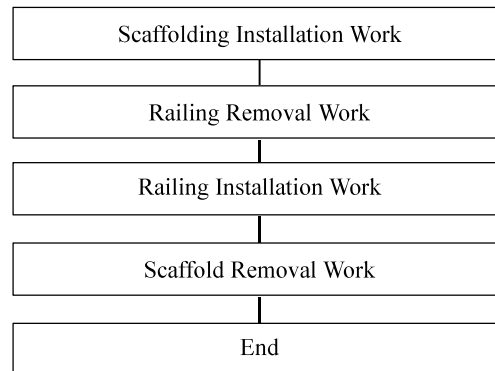


Figure 4.11.2 Flow of Replacement of Railing

(2) Estimation Procedure

1) Installation and Removal Work of Scaffolding

For Installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

2) Railing Removal Work

The unit price of this work is shown in Table 4.11.3.

Table 4.11.3 Railing Removal Work [Replacement of Railing]

(per 30 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	1.50			1person x 1.5
Skilled		person	3.00			2person x 1.5
Un-skilled		person	3.00			2person x 1.5
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
per 1 m						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.11.3 is registered as the upper limit.

Source: Cost Estimation Standards for Bridge Construction Works, Design and Cost Estimation Manual

3) Railing Installation Work

The unit price of this work is shown in Table 4.11.4.

Table 4.11.4 Railing Installation Work [Replacement of Railing]

(per 1 m)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Mobilization for Railing Work		m	1.00			*1 SoR, 2015 [05/15/01]
Steel Beam Installation Work	Steel Beam (W530x167)	m	1.00			*2 SoR, 2015 [05/16/02]
RCC Railing Post	3m post, 150mm x 150mm	m	1.00			*3 SoR, 2015 [06/17/01 (b)]
Total						
per 1 m						

Note) *1 For information, the unit price without the profit, TAX and VAT is BDT 1,520/m in the August version, 2015. [05/15/01, Mobilization for Railing Type Work, etc.]

*2 For information, the unit price without the profit, TAX and VAT is BDT 8,980/m in the August version, 2015. [05/16/02, Steel Beam (W 530 x 167)]

*3 For information, the unit price without the profit, TAX and VAT is BDT 5,370/m in the August version, 2015. [06/17/01 (b), RCC Palisiding (3m post, 150mm x 150mm)]

4.11.3 Additional Support for Superstructure

(1) General

The construction cost of this work is calculated according to SoR.

The flow of this work is shown in Figure 4.11.3.

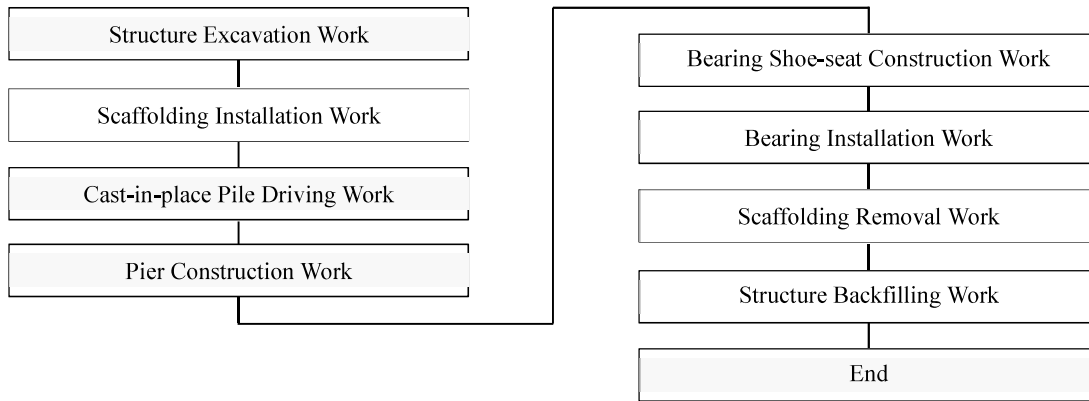


Figure 4.11.3 Flow of Additional Support for Superstructure

(2) Estimation Procedure

1) Excavation and Backfilling Work for Structures

For excavation and backfilling work for structures, the estimation is made separately according to 4.3.2.

2) Installation and Removal Work of Scaffolding

For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

3) Cast-in-place Pile Driving Work

(a) Steel Casing Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price in August version, 2015, is shown below:

- BDT 22,130/m [04/01/05 (g), Permanent Steel Casing (10mm thick, 1000mm dia.)]
- BDT 26,510/m [04/01/05 (h), Permanent Steel Casing (10mm thick, 1200mm dia.)]
- BDT 32,950/m [04/01/05 (i), Permanent Steel Casing (10mm thick, 1500mm dia.)]

(b) Bending and Assembling Work of Reinforcement Bars

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 77,490/ton in the August version, 2015. [04/07/06, High Yield Reinforcement Bars]

(c) Concrete Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 10,210/m [04/01/01 (e), Bored Cast in Place Piles (dia. 1000mm)]
- BDT 15,120/m [04/01/01 (f), Bored Cast in Place Piles (dia. 1200mm)]
- BDT 26,960/m [04/01/01 (g), Bored Cast in Place Piles (dia. 1500mm)]

4) Pier Construction Work

(a) Bending and Assembling Work of Reinforcement Bars

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 77,490/ton in the August version, 2015. [05/02/02, High Yield Reinforcement Bars]

(b) Concrete Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT in August version, 2015, is shown below:

- BDT 12,250/m³ [05/01/02 (c), Concrete Class-20 (Vertical Member col. Pier, Abutment/Wing Wall, Culvert etc.) (Concrete Mixer)]
- BDT 11,570/m³ [05/01/02 (h), Concrete Class-25 (Vertical Member col. Pier, Abutment/Wing Wall, Culvert etc.) (Concrete Mixer)]
- BDT 12,520/m³ [05/01/03 (c), Concrete Class-20 (Vertical Member col. Pier, Abutment/Wing Wall, Culvert etc.) (Batching Plant)]
- BDT 12,890/m³ [05/01/03 (h), Concrete Class-25 (Vertical Member col. Pier, Abutment/Wing Wall, Culvert etc.) (Batching Plant)]

5) Bearing Installation Work

(a) Bearing Shoe-seat Construction Work

The unit price of this work is shown in Table 4.11.5.

Table 4.11.5 Bearing Shoe-seat Construction Work [Additional Support for Superstructure]

(per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Foreman		person	7.95			5.3 x 1.5
Skilled		person	22.50			15.0 x 1.5
Un-skilled		person	17.40			11.6 x 1.5
Polymer Cement Mortar		m ³	1.06	See Table 4.11.6		Including loss rate of 6%
Petty Charge	3% of total labour costs	L.S	1.00			
Temporary Facility Cost	15.66% of above total costs	L.S	1.00			
Total						
Per 1 m ³						

Note) For the correction factor of labour quantity, 1.5 is used.

The petty charge is for appliances necessary for the work. The sum calculated by multiplying the total sum of labour costs by the factor shown in Table 4.11.5 is registered as the upper limit.

Source: Quantity per Unit for Bridge Rehabilitation/Strengthening Works, Design and Cost Estimation Manual

The unit price for polymer cement mortar in bearing shoe-seat construction work is shown in Table 4.11.6.

Table 4.11.6 Unit Price for Polymer Cement Mortar in Bearing Shoe-seat Construction Work

(per 1 m³)

Item	Description	Unit	Quantity	Unit Price	Amount	Remarks
Un-skilled		person	2.25			1.5 x 1.5
Ordinary Portland Cement (OPC)	Grade 60	t	0.50			*1
Sand	FM=1.0	m ³	0.60			*2
Admixture for Polymer Cement		kg	102.00			*3
Water		m ³	0.10			*4
Total						

Note) *1: OPC: $500\text{kg} / 3,000(\text{kg}/\text{m}^3) = 0.17\text{m}^3$

*2: Sand: $1,500\text{kg} / 2,500(\text{kg}/\text{m}^3) = 0.60\text{m}^3$

*3: Admixture: $100\text{L} * 1,020(\text{kg}/\text{m}^3) / 1,000(\text{L}/\text{m}^3) = 102\text{kg}$ [$100\text{L} / 1,020(\text{kg}/\text{m}^3) = 0.10\text{m}^3$]

*4: Water: $100\text{L} / 1,000(\text{L}/\text{m}^3) = 0.10\text{m}^3$

(b) Bearing Installation Work

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 15,730/number in the August version, 2015. [05/13/01 (b), Neoprene Rubber Bearing or Elastomeric Bearing Supplying & Fitting Fixing etc.]

4.11.4 Repairing of Scouring

(1) General

The construction cost of this work is calculated according to SoR. For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

(2) Estimate Procedure

Repair of scouring is made by backfilling with riprap. The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 4,320/m³ in the August version, 2015. [06/01/03, Loose Stone Riprap Protection]

4.11.5 Repairing of Slope Protection (Grass Sodding)

(1) General

The construction cost of this work is calculated according to SoR. For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

(2) Estimation Procedure

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 30/m² in the August version, 2015. [06/07/01, Grass Sodding]

4.11.6 Repairing of Slope Protection (Concrete)

(1) General

The construction cost of this work is calculated according to SoR. For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

(2) Estimation Procedure

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 1,220/m² in the August version, 2015. [06/01/02, Concrete Slope Protection]

4.11.7 Repairing of Foundation Consolidation

(1) General

The construction cost of this work is calculated according to SoR. For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

(2) Estimation Procedure

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 8,300/m³ in the August version, 2015. [02/05/02, Concrete Backfill for Structures]

4.11.8 Repairing of Block Stacking Structure

(1) General

The construction cost of this work is calculated according to SoR. For installation and removal of the scaffolding for rehabilitation/strengthening work, the estimation is made separately according to 4.3.1.

(2) Estimation Procedure

The unit price of this work is calculated according to SoR published by RHD.

For information, the unit price without the profit, TAX and VAT is BDT 12,520/m³ in the August version, 2015. [05/01/03 (c), Concrete Class-20 (Vertical Member col. Pier, Abutment/ Wing Wall, Culvert etc.) (Batching Plant))]