VII-3 Specifications of Main Machinery and Equipment

The following are the specifications of main machinery and equipment of the plant in cases of 750 t·cℓ/d , 1,000 t·cℓ/d and 1,500 t·cℓ/d of production.

The symbols I, II and III in descriptions stand for the cases of 750 t·cℓ/d, 1,000 t·cℓ/d and 1,500 t·cℓ/d basis respectively.

VII-3-1 Main Machinery and Equipment of Plant

(1) Limestone storage

No. of sets	:	1
Type of storage	:	Layered stockpile, open type
Type of discharger	:	Reclaiming scraper
Dimensions of stockpile	: I	24 mW x 160 mL x 10 mH
	II	26 mW x 170 mL x 11 mH
	III	30 mW x 190 mL x 13 mH
Capacity (Wet basis)	: I	22,000 t
	II	27,500 t
	III	41,500 t

(2) Clay storage

No. of sets	:	1
Type of storage	:	Layered stockpile, sheltered type
Type of discharger	:	Reclaiming scraper
Dimensions of stockpile	: I	20 mW x 160 mL x 9 mH
	II	22 mW x 170 mL x 9 mH
	III	26 mW x 190 mL x 11 mH
Capacity (Wet basis)	: I	14,500 t
	II	19,000 t
	III	29,000 t

(3) Limestone reclaimer

No. of sets	:	1
Type	:	Reclaiming scraper
Capacity (Wet base)	: I	80 t/h
	II	110 t/h
	III	160 t/h
Operating time	:	20 hours per day

(4) Clay reclaimer

No. of sets	:	1

Type : Reclaiming scraper

Capacity (Wet basis) : I 20 t/h
II 30 t/h
III 40 t/h

Operating time : 20 hours per day

(5) Limestone dryer

No. of sets : 1

Type : Rotary dryer

Dimensions : I 2.5 mφ x 25 mL
II 2.8 mφ x 28 mL
III 3.2 mφ x 32 mL

Moisture content

Material : Max. 5 %

Product : Max. 1 %

Capacity (Dry basis) : I 70 t/h
II 100 t/h
III 140 t/h

Operating time : 20 hours per day

(6) Clay dryer

No. of sets : 1

Type : Rotary dryer

Dimensions : I 3.0 mφ x 30 mL
II 3.3 mφ x 33 mL
III 3.8 mφ x 38 mL

Moisture content

Material : Max. 30 %

Product : Max. 1 %

Capacity (Dry basis) : I 12.5 t/h
II 17 t/h
III 25 t/h

Operating time : 20 hours per day

(7) Silica sand storage

No. of set : 1

Type of storage : Open stockpile

Type of discharger : Shovel loader

Dimensions of stockpile : I 12 mW x 50 mL x 3 mH
II 13 mW x 55 mL x 3 mH

		III	15 mW x 70 mL x 3 mH
	Capacity (Wet basis)	: I	1,500 t
		II	2,000 t
		III	3,000 t

(8) Raw mix grinding mill

	No. of sets	:	1
	Type	:	Two compartment tube mill, closed circuit with separator
	Dimensions	: I	3.1 mφ x 9.9 mL
		II	3.6 mφ x 11.0 mL
		III	4.0 mφ x 10.8 mL
	Material size	:	Max. 25 mm
	Product fineness	:	10 % residue on 88 μ sieve
	Capacity	: I	65 t/h
		II	90 t/h
		III	130 t/h
	Motor	: I	1,200 kW
		II	1,900 kW
		III	2,500 kW
	Operating time	:	22 hours per day

(9) Raw meal homogenizing silo

	No. of sets	:	2
	Type	:	Concrete structure
	Dimensions	: I	14 mφ x 18 mH
		II	15 mφ x 20 mH
		III	18 mφ x 22 mH
	Capacity	: I	1,500 t x 2
		II	2,000 t x 2
		III	3,000 t x 2

(10) Raw meal storage silo

	No. of sets	:	2
	Type	:	Concrete structure
	Dimensions	: I	14 mφ x 18 mH
		II	15 mφ x 20 mH
		III	18 mφ x 22 mH
	Capacity	: I	2,000 t x 2
		II	2,500 t x 2

III 4,000 t x 2

(11) Kiln

No. of sets	:	1
Type	:	Suspension preheater kiln
Dimensions	:	I 3.5 mφ x 62 mL
		II 3.9 mφ x 69 mL
		III 4.4 mφ x 82 mL
Capacity	:	I 750 t/d
		II 1,000 t/d
		III 1,500 t/d
Operating time	:	24 hours per day
		330 days per year

(12) Clinker cooler

No. of sets	:	1
Type	:	Horizontal grate cooler
Capacity	:	I 750 t/d
		II 1,000 t/d
		III 1,500 t/d
Operating time	:	24 hours per day
		330 days per year

(13) Clinker silo

No. of sets	:	2
Type	:	Concrete structure
Dimensions	:	I 14 mφ x 26 mH
		II 15 mφ x 28 mH
		III 18 mφ x 31 mH
Capacity	:	I 4,000 t x 2
		II 5,000 t x 2
		III 8,000 t x 2

(14) Gypsum storage

No. of sets	:	1
Type of storage	:	Open stockpile
Type of discharge	:	Shovel loader
Dimensions of stockpile	:	I 13 mW x 75 mL x 3 mH
		II 14 mW x 85 mL x 3 mH
		III 16 mW x 100 mL x 3 mH
Capacity	:	I 2,500 t

II 3,000 t
III 4,500 t

(15) Cement grinding mill

No. of sets : 1

Type : Two compartment tube mill, closed circuit with separator

Dimensions : I 3.4 mφ x 11.4 mL
II 4.0 mφ x 10.8 mL
III 4.3 mφ x 12.7 mL

Material size : Max. 30 mm

Product fineness : 3,100 cm^2/g or more

Capacity : I 45 t/h
II 60 t/h
III 90 t/h

Motor : I 1,800 kW
II 2,500 kW
III 3,400 kW

Operating time : 22 hours per day

(16) Cement silo

No. of sets : 2

Type : Concrete structure

Dimensions : I 14 mφ x 25 mH
II 15 mφ x 27 mH
III 18 mφ x 29 mH

Capacity : I 4,000 t x 2
II 5,000 t x 2
III 8,000 t x 2

(17) Packer

No. of sets : I 3
II 4
III 5

Type : Rotary packer

Capacity : 100 t/h per each set

Operating time : 6 hours per day
6 days per week

(18) Coal storage

No. of sets : 1

Type of storage : Stockpile layered and trodden sheltered type

Type of discharge : Shovel loader

Dimensions of stockpile :
- I 20 mW x 130 mL x 4 mH
- II 22 mW x 150 mL x 4 mH
- III 26 mW x 180 mL x 4 mH

Capacity :
- I 6,000 t
- II 8,000 t
- III 12,000 t

(19) Coal mill

No. of sets : 1

Type : Vertical roller mill

Dimensions :
- I 4.8 mφ x 6.2 mH
- II 5.2 mφ x 6.8 mH
- III 5.6 mφ x 7.6 mH

Material size : Max. 25 mm

Product fineness : 12 % residue on 88 μ sieve

Moisture content of material : Max. 3 %

Capacity :
- I 7 t/h
- II 10 t/h
- III 14 t/h

Motor :
- I 230 kW
- II 310 kW
- III 420 kW

Operating time : 20 hours per day

VII-3-2 Electrical Equipment

Refer to Dwg. No. E-01 Single-line diagram which is applicable to Case III (1,500 t.cℓ/d).

(1) Power supply equipment

(i) Extra-high voltage switchgear

Quantity : 1 set

Type : Outdoor type

Consisting of :-

1 (4) - Disconnecting switch (isolator), remotely air-operated

1 (2) - Gas circuit breaker

1 (2) - Set of current transformer

1 - Metering outfit for supply meter

3 (6) - Lightning arrester

Note. Figures in ( ) are applicable to the case of "double-circuits" power distribution.

(ii) Extra-high voltage transformer

Quantity : 1

Type : Outdoor, oil-immersed with on-load tap-changer

Ratings : Primary voltage 129 ± 15 kV

Secondary voltage 6.9 kV

Capacity Case I 10,000 kVA

Case II 12,000 kVA

Case III 15,000 kVA

(iii) High-voltage power distributing equipment

(To be installed in Main Distribution Substation)

Quantity : 1 set

Type : Indoor, enclosed cubicle type switchboard

Main specification :

- Bus duct ; Outdoor type (between main transformer and main switchboard)
- Circuit breaker ; Small-oil-volume or magnetic-blast type

Main services :

1 - Main transformer cubicle

1 - Interconnection cubicle

1 - Emergency diesel generator cubicle

1 - Station service

1 lot - Feeder cubicle

8 sets for Case I and II,

10 sets for Case III

1 - Capacitor cubicle, inclusive of H.V. static capacitors for power-factor correction.

Note. The total capacity of installed capacitors must be big enough to ensure that power factor of power supply line is not lower than 0.85. The total capacity is to be specified after determining the specification of mill-drive motors.

(iv) Control board

Quantity : 1 set

Type : Indoor, benchboard type, Inclusive of one set of

relay panels.

(v) Electrical equipment for station service

Quantity : 1 set

Consisting of ;

1 set - DC power supply apparatus

1 set - L.V. control board

(iv) Emergency power generating equipment

Quantity : 1 set

Type : Diesel engine generating set

Main specification :

- Diesel engine ; Stational four-cycle engine with super charger
- AC generator ; 6.6 kV, 50 Hz, 3-phase, 1,500 rpm
- Rated generator output ,

Case I 200 kW

Case II 300 kW

Case III 400 kW

(2) H.V. and L.V. switchgear

(To be installed in local substations)

Quantity and main specification of main equipment are as follows :

1 set - H.V. circuit breaker cubicle

1 set - Power transformer, 6.6 kV/400 V, 50 Hz, 3-phase

1 set - Lighting transformer, 6.6 kV/400/230 V, 50 Hz, 3-phase

1 set - L.V. power distribution board

1 set - Motor control center

Locations of the local electric rooms :

- Limestone quarry
- Limestone and clay storage
- Raw grinding dept.
- Kiln burning section
- Cement grinding dept.
- Workshop

(3) Power transmission line to limestone quarry

Quantity : 1 set

Type : H.V. (or extra H.V.) overhead transmission line

Electric system : A.C. 6.6 kV (or 11 kV) 50 Hz, 3-phase, 3-wire, single-circuit

Main specification :

Support structure ; Concrete pole or tubular steel pole, joint use for power transmission and communication

Span length ; Standard 50 m,

Conductor ; Steel-cored aluminum cable (ACSR), and PVC insulated wire

Note. In case power transmission line is specified to be at 11 kV, necessary power transforming equipment must be included in this item.

Drawing E-01 Single-line diagram shows only the case at 6.6 kV.

(4) Motors

Quantity : 1 lot

Main specification :

- Degrees of protection ; In principle, totally enclosed fan-cooled (Dust-proof or explosion-proof must be considered for hazardous locations.)
- Voltage ; 6.6 kV, for motors exceeding 150 kW
  400 V, for motors 150 kW or smaller
  250 V, for single-phase small motors for controlling or else
- Insulation class ; In principle, class-B for H.V. motors and class-E for L.V. motors
- Limit of temperature rise ; The reference ambient temperature is 40°C.
- Dimensions, Noise limits ; IEC standards shall apply.
- Motors for special purposes ;
  1) Kiln drive - DC motor
  2) Mill drive - Synchronous (induction) motor or wound-rotor induction motor
  3) Variable speed drive-DC motor or induction motor with eddy-current coupling
  4) Low speed drive-Geared-motor

(5) Process control equipment

(Including instruments)

(i) Central control switchboard

Quantity : 1 set

Type : Indoor, dust-proof, benchboard

Inclusive of instrument and auxiliary relay panels.

(ii) Local control switchboard

Quantity : 1 set

Type : Indoor, dust-proof, metal-enclosed self-standing type

Services : Refer to VI-1-2 (12)

Inclusive of 1 set of local control switches

(iii) Instruments

Quantity : 1 set

Type : Indoor or outdoor, dust-proof type

Common specification : Power source - AC 100 V, 50 Hz

Note. This power must be supplied from control power line (AC 230 V, single-phase) through a private transformer.

Output signal - In principle DC 4 - 20 mA

(6) Lighting

Quantity and main specifications are as follows :

1 set : Lighting distribution board

1 lot : Mercury-vapour lamps
for outdoor illumination and for indoor illumination in case of high-ceiled rooms.
AC 230 V, 50 Hz, 200 ~ 1,000 W,
improved-power-factor type

1 lot - Fluorescent lamps for indoor, general and emergency illumination (including offices),
AC 230 V, 50 Hz, 20 ~ 65 W,
Inclusive of lamps with a built-in-battery

1 lot - Incandescent lamps for spot illumination,
AC 230 V, 50 Hz, 100 ~ 1,000 W

1 lot - L.V. power distribution board for repairing works, inclusive of ;

1 lot - Power supply boxes for welders, AC 400/230 V, 50 Hz, single-phase, 3 wire

1 lot - Sockets and outlets for maintenance works, AC 230 V, 50 Hz, single-phase

Note. As a guide for illumination design, illumination levels and specification of sockets and outlets are shown below.

Illumination levels :

Indoor Control rooms 250 ~ 500 lx

	Working places	More than 100 lx
Outdoor	Working places	More than 50 lx
	Roads, storage	More than 10 lx
Sockets and outlets		
	Rated current	2P 15 A
		3P 63 A or more

(7) Communication equipment

Quantity : 1 set

Type : Automatic exchange, dial type telephone

Main specification :

- Capacity ; Trunk line - Max. 10 lines
  Extension - Max. 200 lines
  Mounted 100 lines
- Power supply ; Storage battery

Note. It is recommendable to provide one set of broadcasting apparatus for paging and for emergency announcement including indoor and outdoor loud-speakers.

(8) Wiring and piping works

(i) Cables

Quantity and main specifications are as follows :

1 lot - H.V. cables, 6.6 kV cross-linked polyethylene insulated and PVC sheathed cable, 3-core or single-core. The min. cable size : 22 mm^2.

1 lot - L.V. power cables, 600 V cross-linked polyethylene insulated and PVC sheathed cable, 3-core or single-core. The min. cable size : 3.5 mm^2.

1 lot - Control cables, 600 V PVC insulated and PVC sheathed cable

1 lot - Communication cable, 600 V PVC insulated and PVC sheathed cable

1 lot - Earthing wires, 600 V PVC insulated wire

(ii) Power distribution outdoor construction

Quantity and main specifications are as follows :

1 lot - Cable racks for trunk lines on steel lattice structure (5 m or more above ground level)

1 lot - Concrete troughes buried underground and conduits directly buried for branch lines

(iii) Power distribution indoor construction

Quantity and main specifications are as follows :

1 lot - Cable racks and cable pits on the floor with covers for main lines

1 lot - Conduits for branch lines

(iv) Grounding circuits

Quantity : 1 set

Main specification :

- Grounding network ; Loops consisting of copper ground rods and wires

The grounding system must be installed in conformity with the Standards as mentioned in VI-5-2 (4).

VII-3-3 Specifications for the Design and Construction of the Building and Civil Engineering Work

The specifications for the design and construction of the building and civil engineering work of the Project shall be, in general, in accordance with the usually recognized international standards, and, in addition, the following shall be observed.

(1) Type of construction

(i) From the standpoint of durability and fireproofing, underground substructure shall, as a rule, be constructed of reinforced concrete, and the superstructure shall, as a rule, be constructed of reinforced concrete or structural steel.

Provided that light and minor structures may be constructed of masonry (brick, concrete blocks, etc.) or timber.

(ii) The design shall be of such a nature that as much domestic building materials as practicable are incorporated in the design, in order to promote regional development and the improvement of the international trade balance of Nepal.

(2) Design standards

Because of India's geographical proximity to Nepal, The National Building Code of India (NBCI) should be adopted as the design standards so far as is applicable.

(3) Design load

(i) Wind load

Among the various design wind loads provided in NBCI depending on the

locality, the following shall apply to the design of the Project :

Height from the ground (m)	Less than 30	35	40	45	50	60	70
Wind pressure (kg/m^2)	100*	104	105	108	111	115	118

* Corresponding to the wind velocity of about 40 m/s (144 km/h)

(iii) Seismic load

The design seismic load shall be in accordance with NBCI, and the following values shall be adopted :

- Basic horizontal seismic coefficient --- 0.8
- Importance factor coefficient ---------- 1.5
- Coefficient depending on types of both soils and foundations (β)

β ---------- 1.0 to 1.5

Thus, the design seismic coefficient shall be,

$$0.08 \times 1.5 \times \beta$$

Furthermore, it is desirable, in the case of tall buildings or structures, (that part of a building higher than 20 m, for example), that a greater design seismic load be adopted than the aforesaid. (Although this method is not provided in NBCI, the building codes of Japan and that of USA have a similar provision to this. NBCI, instead, provides a guide to a dynamic design. --- See Section 5-3-1-1 of NBCI.)

(4) Soil investigation and design of foundations

(i) Foundations sensitive to differential settlement (those for kiln, mill, dryer, etc.)

Where a hard and strong strutum (equivalent to, or more than a dense gravel layer) exists within a short depth, the foundations should be placed directly on it, or on lean-mix cobble concrete which replaces the soil overlying the said strutum.

Where the soil condition is otherwise, point-bearing piles shall be used to support the foundations.

(ii) Foundations other than mentioned in 4-1 above.

Where the soil has enough bearing capacity, the foundations may be placed directly on it. Where the soil condition is otherwise, the foundations shall be supported by piles or gravel beds to replace the upper weak soil.

(iii) Soils investigation

At least the following soils investigation are necessary to make judgements with regard to the cases mentioned in the foregoing sections, 4-(i) and 4-(ii).

- Seismic refraction test
- Boring test (at least one for each main structure)
- Standard penetration test
- Measurement of lateral elastic modulus of soils by using a boring hole
- Such other tests as are suitable for the encountered soils, and necessary for estimating the strength and the settlement thereof.

(5) Requirements for design of main structures

(Note : Wherever the indication "drawing", appears at the last of any heading line of the following sub-sections, it means that a drawing of the structure represented by the heading is attached (bound) to the last part of this report.)

(i) Limestone storage (drawing)

The limestone to be used for the Project has rather small water absorption ratio. Hence, it may be stored in the open air. The storage floor shall be of earth so compacted as to form slopes to facilitate drainage.

Thus, the structures composing the storage will be :

(a) Foundations for belt conveyors (charging and discharging)
(b) Foundations for limestone stacker rails
(c) Foundations for limestone reclaiming scraper rails.

(ii) Clay storage (drawing)

The requirements for the limestone storage shall apply to the clay storage, except that the latter needs roofing.

(iii) Raw material weighing tank

Four tanks are to be provided, one each for limestone, clay, silica sand and iron ore.

The shells and roofs shall be of reinforced concrete or steel.

For the shells of the tanks for limestone and silica sand, more abrasion allowance should be considered than for the others.

(iv) Raw material mill house (drawing)

The separator floor and the parts up to this level of the mill house

should be constructed of reinforced concrete (or steel-framed concrete) to increase the rigidity against vibration.
The structure above the separator floor will be constructed of structural steel.
The mill motor room shall be dust-proof, and designed to be maintained at a temperature not exceeding the outdoor temperature plus 10°C. For this purpose, a mechanical ventilation system will be needed.

(v) Homogenizing silo and raw meal silo
The shells and the roofs shall be constructed of reinforced concrete or steel.

(vi) Coal storage (drawing)
The coal transported by trucks to the storage will be placed in uniform thickness and compacted by means of bulldozer, sheep's foot roller, and the like to prevent the spontaneous combustion of the stored coal.
The coal must not be piled up higher than 4 m.
The height of the roof shall be decided keeping in mind the above-mentioned procedure.

(vii) Burning operation room (including clinker cooler room)(drawing)
It is recommended that most part of this building be constructed of reinforced concrete, and the roof be constructed of steel.
The floor in front of the kiln mantle, where fire bricks will be piled temporarily, shall be designed to resist a uniformly distributed load of 2,000 kg/m^2 or so.

(viii) Clinker silo
In addition to the description in Section 5-(v), thermal stress shall be taken into account in designing the shell, because this silo often receives clinker as hot as 100°C or so.

(ix) Gypsum storage
The gypsum will be stored in the open air. As much gypsum as needed will be transferred from the open storage to a bin installed beside the cement mill house, and then sent to the mill.
The open storage floor shall be constructed of concrete to prevent any foreign material from getting mixed with the gypsum.

(x) Cement mill house (drawing)
See Section 5-(iv) (Raw material mill house).

(xi) Cement packing house (drawing)

This building will be of "piloti" type, with a ground floor designed so that trucks can be loaded there with bag cement packed in the upper room, and after being loaded go out through the building. The ground floor shall be spacious enough to accommodate twelve trucks at a time (in case of 1,500 t/day plant). Ten trucks out of the twelve are for bag cement and two for bulk cement which will be needed in the future.

The vacant space in the packing house will be used as the bag storage.

(xii) Workshop (drawing)

The following shops will be included in this building.

(a) Mechanical shop (including a black-smith shop)
(b) Electrical shop (including motor drying room)
(c) Carpenters' shop
(d) Tin-smith shop
(e) Car repair shop
(f) Tool room
(g) Shop office and rest room.

An overhead crane shall be provided for carrying heavy items.

(viii) Laboratory

The laboratory shall be divided into the following sections :

(a) Physical testing room (including a constant temperature and humidity room)
(b) Chemical testing room (including chemical balance room)
(c) Laboratory office.

(xiv) Warehouse

Warehouses shall be provided for storing spare parts of the mechanical and the electrical equipment, consumables (such as lubricant oil, fire bricks, mill balls, mill liners, etc.) and repair material (steel, for example).

The number of the warehouses is not necessarily limited to one but may be several, and all of the warehouses shall be designed to different specifications in accordance with the respective kinds of materials to be stored.

There may be some materials which can be stored temporarily in the open air. For this purpose, an open storage should be provided in the vicinity of the warehouses.

(xv) Ancillary building

The following buildings will be needed in addition to the aforementioned.

(a) Administration office (including a garage and a car park)
(b) Canteen (The requirement for the capacity depends on the policy of cement plant administration)
(c) Clinic (mainly for first aid purposes)
(d) Locker room for workers (including shower rooms)
(e) Guard houses (one at each gate)
(f) Toilet blocks (a few blocks in the plant where and as necessary)

(xvi) Pavement

The pavement in the plant shall be of cement concrete of 20 cm thick or more, to stand up to the heavy traffic and to be durable.

From an economical point of view, the roads in the plant may be paved only with crushed stone at the time of the plant operation commencement, and afterwards be gradually paved with concrete using the produced cement.

(xvii) Drainage system

Where it is anticipated that heavy traffic will cross over a drainage channel or pass along it, such channel shall be constructed of reinforced concrete to stand up to the heavy traffic load.

Channels other than the aforesaid will be constructed economically of brick or stone masonry.

VII-4 Plant Flow Sheet

Refer to DWG. No. P-01 Plant Flow Sheet in case of 1,500 t/d of clinker production in VOLUME TWO.

VII-4-1 Flow Sheets for the Cases of 750 t·cℓ/d and 1,000 t·cℓ/d

The flow sheet in case of 1,500 t/d clinker production can be applied for the cases of 750 t/d and 1,000 t/d clinker production, except the number of packing equipment sets.

The number of packing equipment to be provided is three sets in case of 750 t·cℓ/d and four sets in case of 1,000 t·cℓ/d.

VII-4-2 Miscellaneous Equipment

In order to simply show the flow of raw materials and product and to avoide complexity on the flow sheet, we have omitted mentioning of such

miscellaneous equipment and apparatus as are evident to be provided upon the planning of the plant and as are easily understood to be provided judging from the flow sheet.

Such miscellaneous equipment and apparatus are listed as follows : -

(1) Dedusting lines from each equipment to dust collectors
(2) Dust transport systems from dust collectors
(3) Water supply system
(4) Compressors and air supply system
(5) Oil supply system
(6) Miscellaneous equipment such as shut-off dampers, two-way dampers, flap dampers and rotary valves, etc.

VII-5 Plant Layout

Refer to DWG. No. P-02 Plant Layout in case of 1,500 t/d of clinker production in VOLUME TWO.

The plant layout for the case of 1,500 t·cℓ/d can be applied for the cases of 750 t·cℓ/d and 1,000 t·cℓ/d, except the dimensions of the plant which are mentioned later.

VII-5-1 Arrangement of Machinery and Equipment

(1) Upon planning the arrangement of machinery and equipment, the following matters should be mainly taken into consideration.

(i) Easy handling of raw material, raw mix, fuel, clinker and cement.
(ii) Convenience of simple operation and easy maintenance and repair.
(iii) Wind direction

Prevailing wind direction at proposed plant site is assumed to be east throughout the year.

Upon designing plant layout, adequate dust collecting facilities should be provided in the plant, however, it is desirable that important machinery and equipment are arranged to be kept free from dust.

(iv) Position of limestone unloading

Limestone is transported by ropeway from northwest of the plant.

(v) Power transmission lines

Electric power transmission line will be installed along the proposed public road between East-west highway and Gaighat.

(vi) Space for future expansion

(2) The following are some of important items upon planning of the plant arrangement.

(i) Limestone and clay storage yards

Limestone and clay storage yards are to be located at the northern corner of the plant, taking into consideration ; the direction of limestone ropeway, dust scattering from limestone and clay by natural seasoning in the dry season and wind direction.

(ii) Sand, gypsum and coal storage yards

These storage yards are to be located at the western side of the plant, taking into consideration dust scattering by natural seasoning in the dry season and wind direction.

(iii) Main power distribution substation

Main power distribution substation is to be located at the southern corner of the plant considering the location of coming power transmission lines and in order to keep it away from dust scattering sources.

(iv) Workshop and warehouse

Workshop and warehouse are to be located nearly in the center of the plant, in order to make repair work convenient and easy.

(v) Offices and welfare facilities, etc.

Above offices and welfare facilities are to be located at the eastern side of the plant, considering proposed public road (between East-west highway and Gaighat) to be build to the east of the plant and dust scattering.

(vi) Space for future expansion

Regarding the method of future plant expansion, it is alternative method to construct separately the new plant paralleling the existing plant.

In this case, it is possible to carry out land preparation after decision of expansion plan and to execute construction works for the new plant without disturbing the existing plant in operation.

However, in general, the same kind of machinery and equipment are to be installed close to each other, from the viewpoint of easiness and convenience for operation, maintenance and repair work.

In addition, the Project has a great possibility of expansion in the near future.

Therefore, the spaces for future expansion are to be arranged, in advance, to enable to install the same kind of machinery and equipment

for expansion close to the existing ones.

VII-5-2 Plant Site

Necessary size and area for the plant site are approximately estimated as follows : -

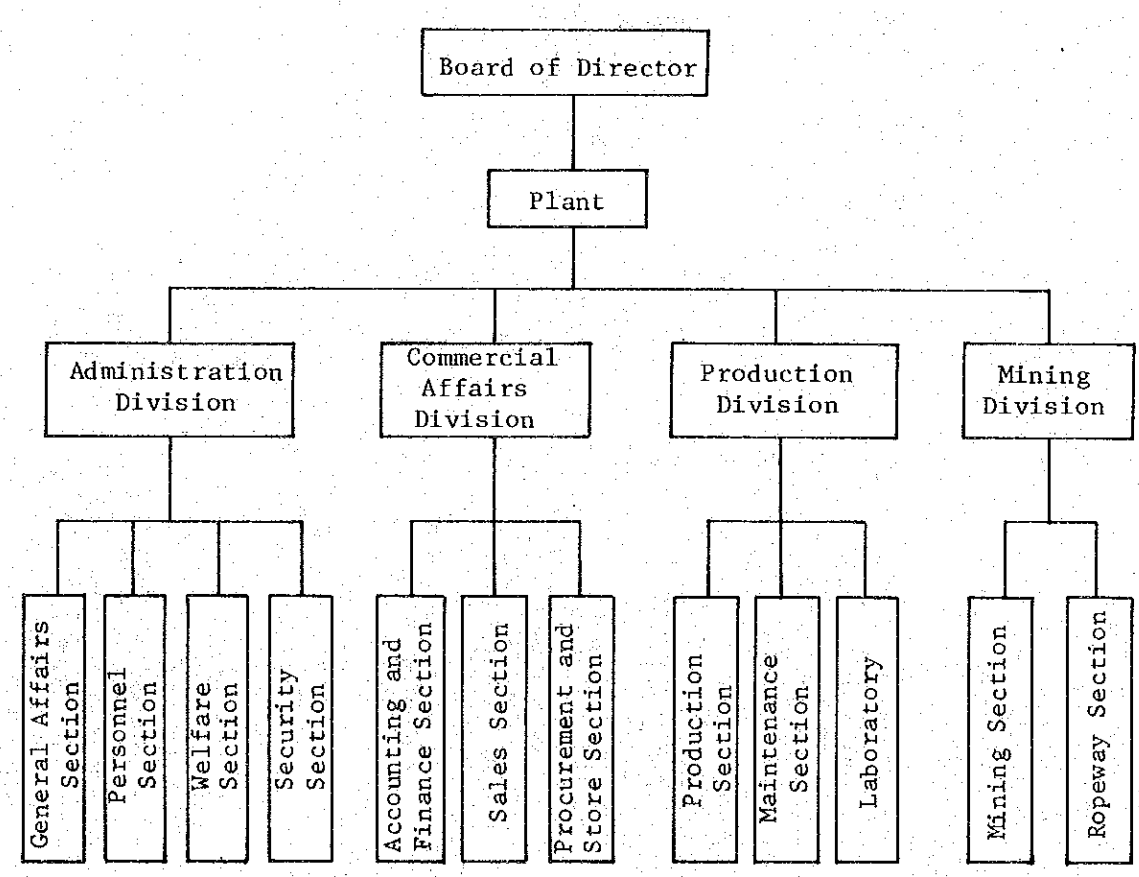
Case I	750 t·cℓ/d	:	300 mW x 600 mL	180,000 m^2
Case II	1,000 t·cℓ/d	:	300 mW x 650 mL	195,000 m^2
Case III	1,500 t·cℓ/d	:	300 mW x 700 mL	210,000 m^2

SECTION VIII ORGANIZATION AND PERSONNEL REQUIREMENTS

VIII-1 Organization

The outline of organization is shown in Table 8-1-1.

Fig. 8-1-1 The Organization Chart



VIII-2 Personnel Requirements

VIII-2-1 Personnel Requirements

The following table shows personnel requirements for plant and quarry of the Project.

Capacity		Plant	Quarry	Total
Case I	750 t·cℓ/d	342	95	437
Case II	1,000 t·cℓ/d	346	106	452
Case III	1,500 t·cℓ/d	350	125	475

VIII-2-2 Breakdown of Personnel Requirements

The following are the breakdown of personnel requirements for the organization mentioned in clause VIII-1 Organization.

The figures show personnel requirements in case of 1,500 t·cℓ/t basis and the figures in parentheses, in cases of 1,000 t·cℓ/t and 750 t·cℓ/t basis respectively.

(1) Plant manager : 1

(2) Administration division

Administration manager	: 1
General affairs section	: 10
Personnel section	: 12
Welfare section	: 7
Security section	: 24
Sub-total	: 54

(3) Commercial affairs division

Commercial manager	: 1
Accounting and finance section	: 10
Sales section	: 10
Procurement and store section	: 14
Sub-total	: 35

(4) Production division

Production manager	: 1
Production management office	: 10
Production section	:131(127, 123)
Maintenance section	: 96
Laboratory	: 22
Sub-total	:260(256, 252)

(For details, refer to VIII-2-3 Appendix.)

(5) Mining division

Mining manager	: 1
Mining section	: 94(75, 64)
Ropeway section	: 30
Sub-total	:125(106, 95)

(6) Total personnel requirements :475(452, 437)

VIII-2-3 Appendix

Detail breakdown of personnel requirements for production division.

(1) Production management office

Production manager	: 1
Assistant manager	: 1
Engineer	: 4
Shift engineer, 1 x 4 shift	: 4
Helper	: 1
Total	: 11

(2) Production section

(i) Raw material handling and grinding

Foreman	: 1
Limestone and clay unloading (incl. helper)	: 4
Limestone and clay storage, 1 x 4 shift	: 4
Limestone and clay dryers 2 x 4	: 8
Sand unloading and transport	: 2
Raw grinding mill (incl. raw meal silos), 4 x 4	: 16
Compressors, 4 x 4	: 4
Sub-total	: 39

(ii) Kiln and cooler

Foreman	: 1
Kiln and cooler (incl. clinker silos) 5 x 4 shift	: 20
Coal storage (incl. unloading and transport)	: 4
Coal mill, 3 x 4	: 12
Sub-total	: 37

(iii) Cement grinding

Foreman	: 1
Gypsum unloading and transport	: 2
Cement grinding mill (incl. cement silos), 4 x 4 shift	: 16
Sub-total	: 19

(iv) Cement shipping

Foreman and assistant foreman	: 2
Operator	: 2
Packer, 5 x 2 parties	: 10(8, 6)
Loading	: 10(8, 6)
Sub-total	: 24(20, 16)

(v) Main power distribution substation

Foreman and assistant foreman	: 2
Operator, 2 x 4 shift	: 8
Assistant	: 2
Sub-total	: 12
Total	131(127, 123)

(3) Maintenance section

(i) Workshop(mechanical)

Foreman and assistant foreman	: 3
Mechanician and assistant mechanician, 2 + 2	: 4
Welder and assistant, 6 + 4	: 10
Turner and frazer (incl. assistant), 4 + 1	: 5
Fitter and assistant, 6 + 4	: 10
Blacksmith and assistant, 3 + 2	: 5
Caster and assistant, 2 + 1	: 3
Shift mechanician, 3 x 4 shift	: 12
Helper	: 2
Sub-total	54

(ii) Workshop(electrical)

Foreman and assistant foreman	: 2
Electrician and assistant electrician, 2 + 2	: 4
Rewinder	: 2
Shift electrician, 3 x 4 shift	: 12

	Helper	: 1
	Sub-total	: 21
(iii)	Workshop(miscellaneous)	
	Foreman and assistant foreman	: 2
	Carpenter and assistant, 2 + 1	: 3
	Mason and assistant, 4 + 2	: 6
	Helper	: 1
	Sub-total	: 12
(iv)	Garage	
	Foreman and assistant foreman	: 2
	Repairer and assistant, 4 + 2	: 6
	Helper	: 1
	Sub-total	: 9
	Total	: 96
(4)	Laboratory	
	Chief chemist and assistant chemist	: 2
	Chemist	: 3
	Tester	: 3
	Shift tester, 2 x 4 shift	: 8
	Gauger	: 5
	Helper	: 1
	Total	: 22
(5)	Grand total	:260(256, 252)

SECTION IX IMPLEMENTATION PROGRAM FOR PLANT CONSTRUCTION

IX-1 Procurement of Machinery and Equipment and Construction Materials

The following is the three comprehensive categories of the items needed for a cement plant construction.

(1) Mechanical and electrical equipment incorporated in a cement plant, and spare parts thereof (hereinafter referred to as Plant Equipment)

(2) Building materials forming permanent parts of the facilities to support or house the Plant Equipment, and to store the raw materials and fuel, and of the buildings and structures necessary for operating or maintaining the plant (hereinafter referred to as Plant Building Material)

(3) Equipment and temporary work materials needed in the construction of the faciilties mentioned in (2) above using the Plant Building Material, and those needed in the erection of the Plant Equipment (hereinafter referred to as Plant Construction Equipment)

The following is the comment on the procurement of the respective items as classified above.

(i) Plant equipment

The Plant Equipment consists of many components, most of which must be imported. There are some common components among the Plant Equipment, and, therefore, the interchangeability should be taken into account when being procured. (to procure, for example, machines of same sort-bucket elevators, belt conveyors, motors, etc. from the same manufacturer so far as is possible.)

The standards to be based on should be uniform or, should be the ones well-known in Nepal.

In addition, in the light of the present level of Nepal, the Plant Equipment should be such as is durable and seldom gets out of order, though this is not particular to the Project but also applicable to all the project.

(ii) Plant building material

Materials other than stone and wood seem to have to be imported. Judging from the capacity of steel fabrication in Nepal, the steel should be imported in so fabricated form as to be ready for the erection, except for steel rods for concrete.

The cement to be imported for the Project should be in paper bags, because the "jute" bag cement is not favourable for maintaining its original quality. Most cement is now sold in jute bags in Nepal,

though.

Steel rods for concrete is being manufactured in Nepal, using imported ingots, but only round bars are available. Accordingly, some deformed steel bars should be imported. (It is preferable to use deformed steel bars to prevent water-tight concrete structures such as silos from developing cracks due to the contraction of the concrete.)

(iii) Plant construction equipment

The features of cement plant construction, like other chemical plant, are that much work must be carried out at a time with many departments forming the plant, and that handling and installing of heavy machines are needed.

To cope with this need, concrete batching plant, big cranes, and so on are needed. Those needed but not available in Nepal should be brought in from India, as much as possible, for the economical reason, because of India's proximity to Nepal.

IX-2 Transport of Machinery and Equipment and Construction Materials

It is one of the prerequisites for constructing a cement plant that the transportation of heavy and bulky cargos can be transported upto the plant site.

The heaviest and the bulkiest of the cargos for the Project are expected to weigh 60 ton, and the bulkiest to measure O.D. 4 m x 12 m long. Such cargos will be transported from, or via Calcutta through India to Nepal. In any way, it will have to cross the Nepal/India border. Hence, the routes from the border to the plant site have great importance. In this case, there are 4 such routes to be considered.
(Refer to X-1-1 (2) (i) hereof)

The main check points for bulky cargo transportation are as follows :

(1) Structures traversing over roads (including lateral bracings of a through-type bridge, arches of tunnel lining)

(2) Alignment of roads and street (e.g. hair pin curves, street corners, etc.)

(3) Width of roads and spaces aside roads (including bridge width)

In the route survey made by the Japanese team, it is found that only one bridge is obstructive against the transportation. That bridge is 3.9 m wide. Other three routes than the one including the said bridge have no obstruction in the light of the abovementioned check points. Accordingly, there is no problem with regard to the aforementioned check points.

Further, the main check points for heavy cargo transportation are as follows :

(1) Strength of bridges

(2) Gradient of roads.

As for the point (2) above, the said four routes except the part to be newly constructed have no problem because all these routes are located within the northern part of the Indian Plain.

As for the bridge strength, also, no serious problem is seen owing to the present circumstances as mentioned hereafter.

Most parts of the said routes are East-West Highway constructed by India as an aid to Nepal, and, the bridges on the Highway are turned out to have been designed to withstand the travelling of 70-ton tank, except four bridges, the strength of which is not confirmed yet.

It seems very possible for the four bridges with unknown strength to withstand the travelling of as heavy cargo as 60 ton, though this must be investigated further upon the implementation of the Project. (It may be necessary to ristrict the other traffic or to reinforce the bridges temporarily upon the travelling on the bridges of the heavy cargo.)

Should any of these four bridges be turned out to have problem with its strength, then, another route via Siraha can be considered alternatively. (This route is defined as route 4 in X-1-1 (2) d. hereof.)

Provided that the road from Siraha to East-West Highway now under construction of this route should be completed by the time of the Project implementation.

IX-3 Time Schedule for Plant Construction

Speaking in general the most important things to implement such a project smoothly amd complete the plant as planned are to appoint an appropriate consultant, to select a suitable construction contractor and to conclude a resonable contract.

These matters are described hereinafter.

IX-3-1 Appointment of a Consultant

It is necessary to appoint the consultant who is well experienced on cement plant projects as an assistant for the implementation of the Project.

The consultant will

(a) prepare the basic design of the Project ;

(b) prepare a tender document for tenderers ;

(c) evaluate tenders submitted by tenderers ; and

(d) assist the executing agency in negotiating with the tenderers and conclude a contract with the successful tenderer

And further during the construction period, the consultant, on behalf of the executing agency, will carry out the check and the approval of the detailed design submitted by the contractor and supervise the construction works.

IX-3-2 Forms of Contract

Generally speaking, the forms of contract should be examined on both faces, i.e. a face of the scope of contract works and a face of the contract account. As for the Project the form of contract should be determined taking into account of such various conditions as the characteristics of the Project, the actual conditions of industries in Nepal, the import policy of Nepal and the source and method of the construction fund etc.

(1) The classification of contract by scope of works

The construction works of a plant is generally composed of design, supply of machinery and equipment, civil works, erection and commissioning etc., and the contract form is divided into two types, i.e. one type in which the construction works are performed by two or more contractors and the other type, so-called Full Turn Key type, in which the works is executed by only one contractor.

In the former, unless the scope of works, guarantee and responsibility of each contractor are strictly specified, the ambiguous parts, which will take place in the responsibility of each contractor, will cause the congestion of the construction works and hinderance in guarantee of plant performance.

Accordingly a careful consideration should be taken for the preparation of the agreement and the conclusion of the contract.

In the Full Turn Key type contract, the works are generally carried out by sub-contractors based on the contracts concluded between the contractor and several sub-contractors and therefore the same kinds of problems as those in the former may be existent. Neverthless, this type of contract is simple and clear for the client because all the works are executed, all the guarantees are made and all the responsibilities are assumed by the contractor.

The contract amount of this type of contract, however, generally tends

more expensive than that of the former due to the costs to be added to the estimate for covering the risk caused by those problems.

(2) The classification of contract by determining method of the contract amount

The form of contract is divided into two types by the captioned method, i.e. Lump Sum type and Cost plus Fee type.

The Lump Sum type is mostly adopted in case the scope of works is definite and the following types are included in it.

- Lump Sum Fixed Price Contract :
  Original Type of the Lump Sum contract
- Lump Sum Contract with Escalation :
  This type is applied for eliminating the risk due to inflation.
- Lump Sum plus Unit Price Contract :
  This type is applied in case a part of quantity of work is undecided.

The Cost plus Fee type is adopted for following cases in which,

- the definite estimate can not be made because the scope of works, the specification and the risk of inflation etc. are not determined at the conclusion of contract ;
- the changes of specifications and construction works are foreseen ; and
- the client wants to leave the door open to further negotiation on the determination of suppliers of machinery and equipment as well as method of construction works etc.

In this contract the following types are included.

- Cost plus Fixed Fee Contract
- Cost plus Sliding Fee Contract
- Cost plus Fee Contract with Ceiling Amount Guaranteed

The common problem of each type lies in whether which part of the scope of work is included in Cost and which is in Fee.
Accordingly it is important to specify clearly the division of Cost and Fee in the contract taking account of the characteristics of the Project and the conditions of the client and the contractor.
The forms of contract are described as above and the form to be adopted for the Project should be determined after careful examination taking account of the various conditions given at the beginning.

IX-3-3 Schedule of Project Implementation

The approximate schedule of the Project implementation is described as follows.

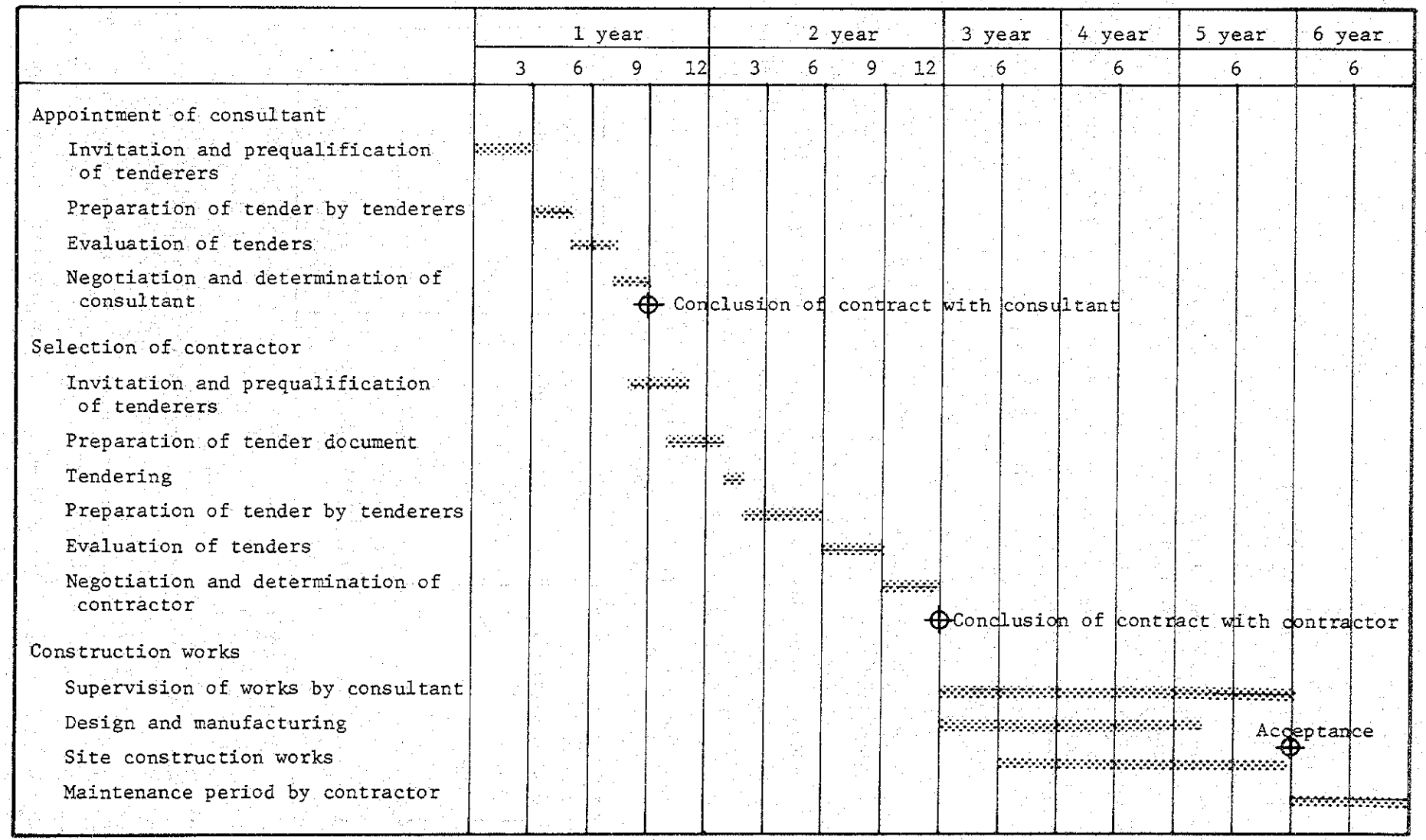
(In case of Full Turn Key Contract)

Appointment of a consultant	:	about 9 months
Selection of a contract	:	about 1 year 3 months
Construction works	:	about 3 years
Total	:	about 5 years

The schedule mentioned above is estimated in case the Project is implemented smoothly.

The schedule list is attached to the following page.

Fig. 9-3-1 List of Project Implementation



SECTION X INFRASTRUCTURE

X-1 Infrastructure to be Developed

X-1-1 Road

(1) Required functions of the roads necessary for the Project

In general, the followings are the main functions of the roads involved in a cement project :

- to allow during the construction stage the transporation of heavy cargo and bulky cargo
- to have after the completion of the plant the capacity and structure suitable for smooth transportation of the fuel and raw materials to the plant, and of the cement from the plant.

Among all the cargoes to be brought to the plant site during the construction stage of the Project, the heaviest and bulkiest will weigh about 60 tons and measure 12 m long (in case of 1,500 t/day plant). Meanwhile, after the completion of the proposed plant, the fuel and the raw materials to be brought in, and the cement to be shipped out will amount to the figures per day as shown in the Table 10-1-1.

Table 10-1-1 Transportation Amount of Fuel, Raw Material & Cement in case of 1,500 t/day plant

Cargo	Transportation route	Maximum amount a day
Clay & Silica Sand	Beltar/Gaighat	900 t
Coal	India/Gaighat	300 t
Gypsum	India/Gaighat	100 t
Iron Ore	India/Gaighat	30 t
Cement	not to be specified but mainly Gaighat/ East-West Highway	2,000 t
Total		3,330 t *

* (Equivalent to about 440 times a day of transportation by a 7.5 ton truck)

Note: (1) In case of 1,000 t/day plant, the respective figures in the Table should be multiplied by 2/3.

(2) The transportation amount of the cargoes is variable from day to day due to holidays, seasonal change in the demand, etc. The above-mentioned are the expected maximum

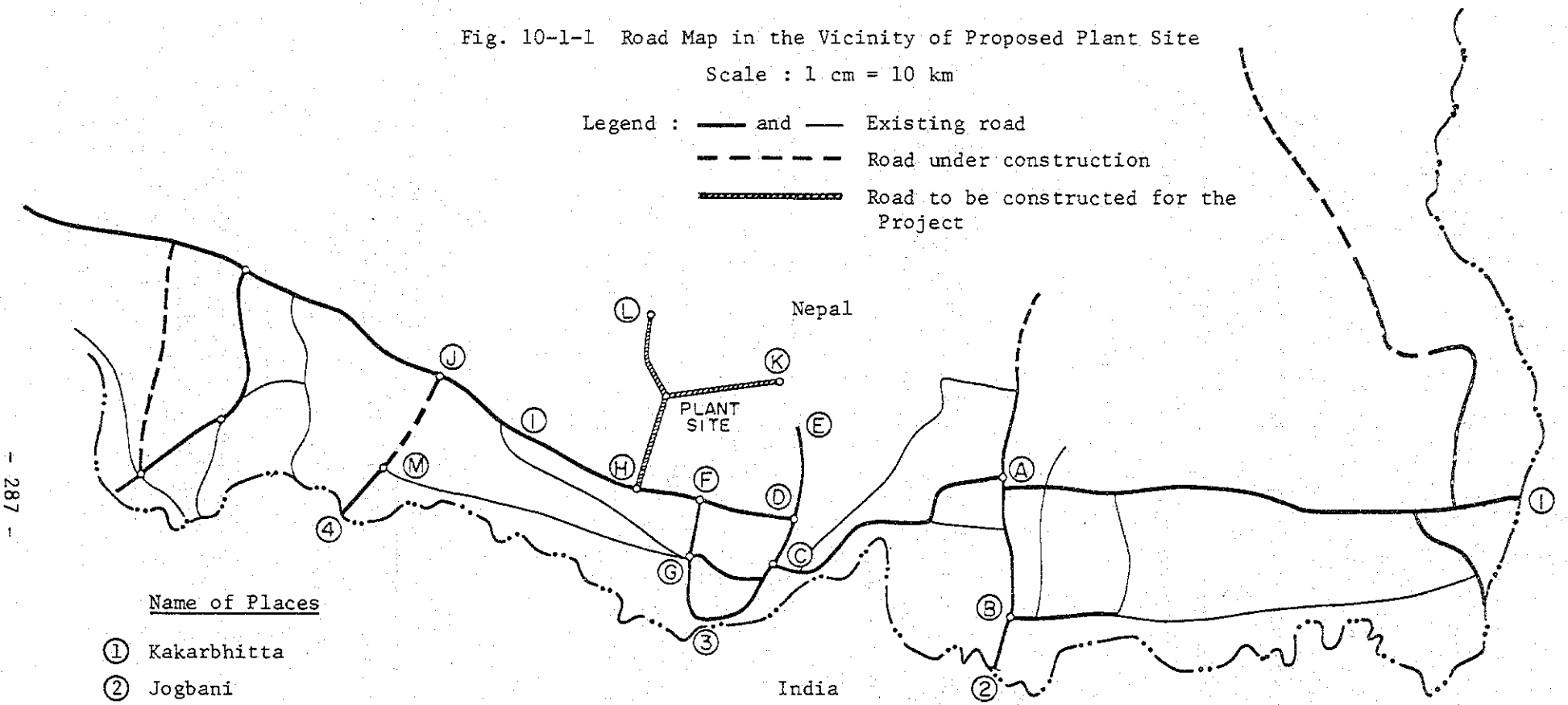
Fig. 10-1-1 Road Map in the Vicinity of Proposed Plant Site

Scale : 1 cm = 10 km

Legend : —— and —— Existing road

- - - - - Road under construction

▬▬▬ Road to be constructed for the Project



Name of Places

①	Kakarbhitta		
②	Jogbani		
③	Kunauli		
④	Jayanagar	G	Rajbiraj
A	Ithahari	H	Kathauna
B	Biratnagar	I	Lahan
C	Bharda	J	Galbazar
D	Kanchanpur	K	Beltar
E	Fatehpur	L	Sindali and Murkuchi
F	Rupani	M	Siraha

transportation amount a day.

(3) The transportation of the limestone is to be made by a ropeway, and, therefore, is not shown in the Table.

(2) Conditions of existing roads

(i) Roads from Nepal/India border to the proposed plant site

It has been stipulated in an agreement between Nepal and India that the transportation of goods between the both countries be made through any of the 13 stipulated points on the border.

From a geographical point of view, the following four points among the aforesaid 13 points are expected to have connection with this project :

1) Kakarbitta
2) Jogbani
3) Bhimnagar
4) Jayanagar.

Following is the description on the roads leading to the proposed plant site from the above-mentioned respective 4 points.

(a) Route 1-A-C-D-F-H-Plant Site on Fig. 10-1-1 (hereinafter referred to as Route 1)

The zone 1-H, about 180 km long out of this Route 1, is a part of so-called East-West Highway, and runs east-westward through the nothernmost part of the Indian Plain. Hence, the road of this zone is nearly flat and the line is good. Shown below in Fig. 10-1-2 is the standard cross section of the zone 1-H. (See the photograph attached to the last of this report.)

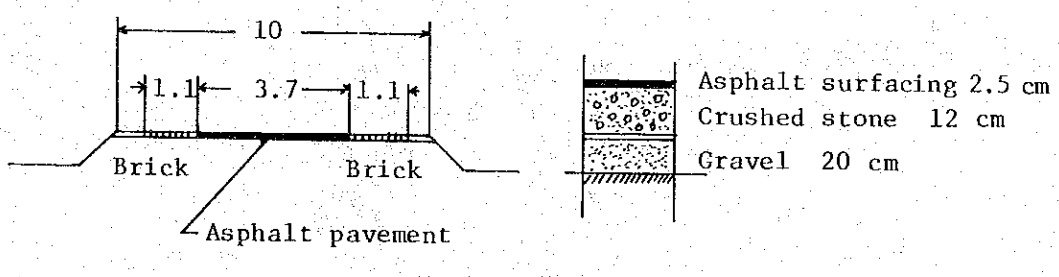


Fig. 10-1-2 Standard Cross Section of the East-West Highway (in m.)

When automobiles pass by each other, brick paved part of the road shoulders must be utilized because the asphalt surfacing measures only 3.7 m wide. However, the traffic at present is as little as the traffic observation data shown below, and, therefore, the matter of the pavement width is not a problem for the time being. In addition, expansion of the pavement width is being done in some parts of this zone.

"East-West Highway Traffic Observation Data"

- Date of Observation — February 15, 1978
- Observer — Japanese survey team for this Project
- Method of Observation — Recorded was the number of automobiles by type, driving toward East and passed by the survey team's jeep which drove one hour toward West from Itahari (Point A on Fig. 10-1-1) to the Kosi river (Point D on Fig. 10-1-1 for a distance of about 50 km.)

Result of Observation

Truck	Bus	Sedan	Wagon	Jeep	Motor Bicycle	Total
8	5	1	1	1	1	17

Because the observer also was driving towards the direction opposit to that of the observed automobiles, the above-mentioned figures must be multiplied by 1/2 in order to estimate the traffic at a fixed point within the aforesaid 50 km observation zone. Namely, the traffic per hour in one direction in this case is,
$17 \times \frac{1}{2} = 8.5$ (No./h)

There can be seen in 1-H zone some paved surfaces which have lost their smoothness, but a jeep with a trailer attached to could drive with a speed of 50 km/h to 60 km/h on average.
This part of the East-West Highway was constructed by India as an aid to Nepal. (See Drawing C - 01.) The superstructures of the bridges are made of pre-stressed concrete. As a whole the rivers in Nepal flow from north to south, and on the other hand this highway runs east-westward. Accordingly the number of bridges is considerably large as shown in the bridge list. (See page 307)

These bridges have been designed in accordance with the Indian design standard.
The design live load is of Class AA which is provided in the said Indian road standard. (Considering travelling of 70-ton tank.) Refer (page 321) to the excerpt of the said Indian standard.)
The culverts (Spans are less than 6 m according to the said Indian standard.) are 10 m wide, and the design live load for them is of the aforesaid Class AA.
The longest of all the bridges in this zone is the one spanning the Kosi river. Its overall length is approximately 1,200 m (in 56 spans) and the effective width is 7 m. This bridge is not included in the bridge list (given by Indian Cooperation Mission, Lahan. See page 307)
Our survey team tried to confirm the design load for this bridge, but no reliable information on this matter could be obtained. Judging from the fact that this prestressed concrete bridge is just aside and along the Kosi river Dam, it seems to have been constructed as a part of the Dam project, separately from and prior to the East-West Highway project. Seeing the design policy for the other bridges as aforesaid, it can be easily supposed that this bridge have been designed to withstand Class AA live load or Class A live load which is one grade under Class AA. (See page 321) However, this is a question to be confirmed.

In the zone from the Kosi river to Fatepur (zone C-D-E in Fig. 10-1-1), there are six bridges which are not listed in the aforesaid bridge list, different from the other bridges in the type of construction and the shape of handrails.
The superstructure of these six bridges are all 7 m wide and, composed of multiple 7-meter span concrete slabs each with the both ends simply supported. (Photograph attached to the last hereof) The design live load for these bridges are supposed to be of Class A.
It is Point H (Kathauna-Fig. 10-1-1) which gives the shortest of all the straight lines beginning from the proposed plant site and running upto East-West Highway.
At present there is no road (other than foot path) between Point H including its vicility to the proposed palnt site. (There is a road leading to the proposed plant site from Point I - Lahan - 15km

west of Point H. Description of this road will appear hereinafter.)
The elevation is about 120 m at Point H and about 160 m at the proposed plant site. There lies a range of hills, so-called Siwarik, east-westerly in between the above-mentioned two points. The elevation of the hill ridge is, as a whole, 300 m.

(b) 2-B-A-C-D-F-H-Plant Site (hereinafter referred to as Route 2)
The zone from Point A to the proposed plant site is common to Route 1. Hence, the description about it is omitted here.
The ramaining zone 2-B-A, about 30 km long, is a part of the road constructed by England. Its standard cross section is as shown in Fig. 10-1-3,

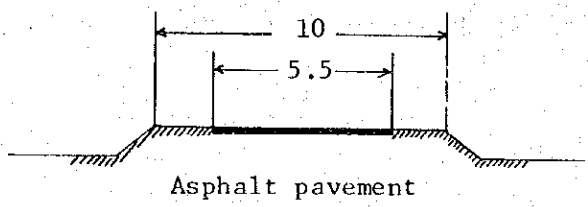


Fig. 10-1-3 Standard Cross Section of Zone 2-A

The road in this zone is flat and the line is good.
This road passes through Biratnagar, the biggest city in the eastern Nepal.
However, it does not run through the heart of the city, but like a By-path.
Accordingly, the congestion of the city traffic is seen little on this road.

There is a bridge spanning the Buri River 14 km away from Biratnagar toward Itahari (Point B and Point A in Fig. 10-1-1)
This bridge spans the Buri river, with the effective width of 3.9 m and overall length of 95 m (7 spans), and is of steel girders. (Photograph attached to the last hereof)

The bridge piers are of timber in the form of trestles, and, therefore, appears like one constructed urgently. According to Biratnagar District office of the Road Department of the government, the travelling load over this bridge is limited to 15 ton in the dry season, and 8 ton in the rainy season. (When the river flow swells, the load bearing capacities of the piers desrease, according to the said office's explanation.)

(c) 3-G-F-H-Plant Site (hereinafter referred to as Route 3)

The zone F-H-Plant Site in this route is common to Route 1 and 3, and therefore the description about it is omitted here.

Point G (Rajbiraj) is the place where exists the district office of the government, the government office for Sagarmatha Zone which includes Udaipur. The zone 3-G forms a part of the bus route which connect this city to East-West Highway or some places beyond the Highway.

The standard cross section of the road in this zone, 3-G, is shown in Fig. 10-1-4.

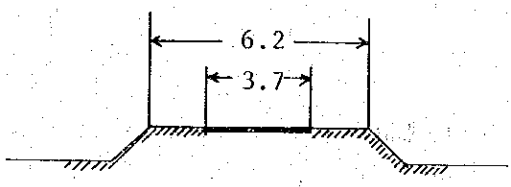


Fig. 10-1-4 Standard Cross Section of the Road in 3-G zone

The zone G-H is surfaced with gravel. The surface is maintained as well as a jeep can drive easily with a speed of 40 km/h on the average. The gravel surfacing width is 5.5 m and the total width of the road is 10m.

(d) 4-J-I-H-Plant Site

The zone J-I-H is a part of the East-West Highway which has already been described hereinbefore.

The zone 4-J was not surveyed by the Japanese survey team, but, according to the information from the Department of Roads of the

government (See Drawing C-01.), this zone is now under construction. The Zonal Commissioner of Sagarmatha Zone pointed out that the route including this zone together with a zone which continues to it extending northward beyond East-West Highway is very important. Judging from the above-mentioned information, the completion of the construction of 4-J zone seems to be a matter of time.

(ii) Roads between the proposed plant site and raw materials deposit, etc.

(a) Plant Site --- Limestone Deposit (Sindali)

There is nothing to have been constructed as road, but only some naturally formed path ways exist between the plant site and the limestone deposit. (The said path ways are mainly footpaths, and partially allow bull carts to travel.) In the dry season, jeeps can drive a distance of about 10 km from the plant site by using the river beds and a mud road along the river, but, after that people can not help going on foot a distance of about 8 km even in the dry season to reach the limestone deposit. This zone of the foot path is located on the left or the right side of the Trijuga river, and therefore people have to cross on foot the river en route. Besides the aforesaid route, there is another route along a branch river (the Baruwa river) of the Trijuga. In this case there is 5 km to go by jeep and 13 km to go on foot.

(b) Plant Site --- Clay Deposit (Beltar) --- Fatepur

Between the plant site and the clay deposit, about 20 km, there is no road having been constructed for use of automobiles.

In the dry season, bull carts, jeeps, tractors (wheel type), etc. can cross the streams of the Trijuga river and its branchs and travel on the river beds. (Partially, mud roads exist within the flood plain along the Trijuga river.)

The average driving speed of a jeep traveling this zone is 10 to 15 km/h.

Further, from the clay deposit to Fatepur, 13 km, the condition is the same as aforesaid, but, the number of bull carts and travelers on foot is more than that of the aforesaid zone, because Fatepur is a town connected to the East-West Highway by an asphalt surfaced road (bus route).

(c) Plant Site --- Lahan (point J in Fig. 10-1-1)

A road exists between the plant site and Lahan, but it can be used by jeeps or tractors only in the dry season. It is, as a whole,

a mud road with a width of 2.5 to 3 m.
The following is the outline of the route of this road.

For a distance of about 6 km from the plant site, the road runs towards upstream of the Trijuga river (partially in the river bed), and then turn to the left heading towards the Siwarik hill range which separates this area from the East-West Highway. For a distance of about 4 km from there, it runs along a branch of the Trijuga river and in a sparse forest. The ground here slopes gently.

En route, it crosses twice the said branch river bed.
After this zone the road approachs the most upstream part of the branch river, where the bed is utilized as a path for a distance of about 0.5 km. The topography around here becomes steeper and steeper. Then, an artificially opened road (with a cut slope on one side) follows for a distance of about 1 km. Thus, the road reachs the hill pass. (Photograph attached to the last hereof)
The elevation of this hill pass is about 380m. (estimated from a map of 1 inch : 1 mile).

For a distance of 1km or a little less the road descend with a large inclination. (partially more than 10 %)
This part has cut slope on one side, and many sharp bends and curves. In this zone, there are four bridges of wood in logs each spanning a small crevice. After passing this zone, the topography becomes gentle, the road runs for a distance of about 3 km, crossing more than 10 times the bed of a sharply meandering branch river (of the Patle river) which has its source around the said hill pass.

Then the road comes to the plain area. After passing the plain for a distance of about 6 km, it crosses the Balan river, runs the plain area again and reaches Lahan.
According to the odometer of the Japanese survey team's jeep,the total distance between the plant site and Lahan is 32 km, and the time taken to drive for the said distance is 2.5 hours. (average speed = 13 km/h)

(3) Roads to be developed

(i) Construction of roads

In the light of the present circumstances as described above it is

Considered necessary to complete the roads shown in Table 10-1-2 prior to the implementation of the Project.

Table 10-1-2 Roads needed for the Project

	(I)	(II)	(III)
Route	From Gaighat To Limestone ** deposit (Sindali)	From Gaighat To Clay deposit (Beltar)	From Gaighat To East-West Highway
Approximate length	18 km	20 km	25 km
Use for the Project	Transportation of labour and materials for the construction Transportation of labour for quarry operation	Transporation of clay and silica sand	Transportation of labour and materials for construction Imported fuel/ raw materials transportation Cement shipping
Structure & specification	Effective width 3.5 m Pavement: Gravel Minimum radius of horizontal circular curve: 15 m Other specifications: Those applicable to 2nd class district road provided in the Nepal Road Standard*	Effective width 7 m Pavement: Crushed stone Minimum radius of horizontal circular curve: 15 m Other specifications: Those applicable to 1st class district road provided in the Nepal Road Standard	Effective width 7 m Pavement: Asphalt concrete Minimum radius of horizontal circular curve: 15 m Other specifications: Those applicable to 1A class feeder road provided in the Nepal Road Standard

* The Nepal Road Standard is shown on page 310 hereof.

** This road means from Gaighat to Murkuchi and the rest (from Murkuchi to the limestone deposit) will be constructed as a part of quarry development works.

(ii) Improvement of existing road

- Expansion of pavement width

  It is recommended that, by the time of completion of the Project, the pavement of the roads expected to be used for the cement shipping be expanded upto 7 m wide.

- Improvement of bridge

  The Buri river bridge mentioned in (2) (a) hereof is recommended to be improved by the time of completion of the Project.

X-1-2 Houses for Employees

Murkuchi is the village closest to the limestone deposit, but it is no more than a small group of sparsely located farmers' houses.

The villages near the plant site comprise, except the heart of Gaighat, farmers' houses. At the heart of Gaighat exist some shops including barber's and tailer's, a bank, two hospitals, a district court, and a district office of the government, all of which make Gaighat the center of living of this zone.

However, the population of Gaighat including farmers in the nearby villages is the order of 8,000. Hence, Gaighat is considered too small to be the main source of the plant operation labour. (Refer to V-2-2.)

For the above-mentioned reasons, the following supposition has been introduced for the estimation of the number of employees' houses.

- 10 % the limestone quarry employees (13 out of 125) will be employed locally, and the rest (112) will be from the other district with houses furnished by the employer.
- 15 % the plant employees (50 out of 350) will be employed locally, and the rest (300) will be from the other district with houses furnished by the employer.
- All the employees for clay quarry will be employed locally.

(They will work mainly for clay excavation and truck loading both by hand.)

According to the above, the construction of houses for the employers will be needed as shown below.

Location	Employees	Number of houses	Land needed(Incld. common space)
Gentle mountain slope near Shriwani	of limestone quarry	112	about 3 ha
Matigarha (sparse forest 0.5km east of the plant site)	of cement plant	300	about 10 ha
Total		412	about 13 ha

As for the area per one house, it will be helpful to refer to the standard of the area of the government officials' houses. According to the Department of Housing of the government, this standard by classes is as shown below.

Class	House area (m^2)	(sq. ft)
1	186	2,000
2	139	1,500
3	93	1,000
4	70	750
5	48	515

The above-mentioned classes will correspond to the positions of the cement plant employees as shown below.

Officials' class	Plant employees' position
1	Plant manager
2	Deputy plant manager
3	Section chief
4	Sub-section chief
5	Workers

X-1-3 Communication

By the time the Project comes into effect, communication facilities between the main cities and the plant site and between the site and raw material quarries - limestone and clay quarry - must be provided. At present, Gaighat is connected with Kathmandu and Rajbiraj, the headquarter of the Sagarmatha zone. According to the Development Plans up to the Fifth Plan (1976-80) including the First Modernization Plan of Communication Facilities started in 1968, the following works are scheduled to be effected : (1) extension of the international communication facilities - the telex services in Kathmandu, from 60 to 200 lines -, (2) installation of long-distance communication facilities which connect Kathmandu with 75 major towns in various regions - a micro-wave system including several relay stations and a direct telephone system between Kathmandu and Birganj and Biratnagar -,(3) extension of the automatic and manual telephone exchange system - total available telephone lines from 9,000 to 13,900 in three years -.

It is desirable that, by the time the Project is completed, the plant will be multiply interconnected with Rajbiraj, Biratnagar, Kathmandu and other important cities.
Refer to VII-3-2 as to communication facilities between the plant and the limestone quarry.

X-1-4 Power Transmission

(1) Power transmission lines between the East-West power transmission line and the plant site.

As mentioned in VI-5-2, it is highly recommendable to supply electric power from the East-West power transmission line (132 kV) which is now scheduled by His Majesty's Government. Assuming that this branch line is installed along the access road from Kathauna, the town facing the East-West Highway, to Gaighat, crossing the Siwalik, there is no big electric load to be expected between the East-West power transmission line and the plant.
(Refer to X-1.)

The specifications of the branch line are, therefore, recommended to be as follows :
a 132 kV line on steel lattice towers with ACSR (Steel-cored Alminum cable), the same specifications as of the line between Gandak hydro-plant and Hetauda through Bharatpur, the length of which is 150 km. There will be no serious problems in construction although the line passes across the Siwalik which is some hundred meters high.

It will also be necessary to provide a power supply with a capacity of some hundred kW for plant construction, the capacity of which depends on the scale of the plant to be constructed.
Diesel engine generators provided by the contractors will be available. Consequently, the 132 kV power transmission line to the plant may be constructed by the time the plant itself is constructed.

(2) Power transmission line between the plant and raw material quarries
In the limestone, quarry, limestone mining and crushing equipment is to be installed. Crushed limestone is transported from there to the plant using a ropeway. Electric power necessary for the quarry is calculated as approx. 2,100 kW (in case of 1,500 t·cℓ/d plant), and is to be supplied by a 6.6 kV or 11 kV power transmission line from the plant. Refer to VII-3-2 as to the detail.

In the clay quarry, which is located 20 km from the plant, no electrical equipment will be necessary for mining because clay is planned to be extracted by hand. Clay will then be transported to the plant by trucks. Therefore, no power transmission line to the clay quarries is needed.

(3) Power supply to the villages around the plant

Gaighat is the headquarter of Udaipur district and is expected to expand after the plant is constructed. In this district no hydro or other type of power plants are proposed so far. Thus, it would be quite useful if electric power were supplied to houses, agriculture facilities and for road lighting from the plant.

As stated in II-2-1, Udaipur is in a sub-equotorial zone. The climate here is fairly mild and so the residents will not need air-conditioning apparatus for the time being. Electric load outside the plant is expected to be, at most, several hundred kW. For this purpose, one feeder will be provided in the Main Distribution Substation in the plant. (Refer to Dwg. E-01 Single-line Diagram.)

Because power distribution equipment for the Project is to be designed taking into consideration the future extensions, it can supply electric power necessary for developing the towns and surrounding areas with plenty in reserve for the time being.

It is also possible to supply electric power to the villages near the limestone quarry from the power distribution system to the quarry.

X-1-5 Recommendation of Economic Routes

After examining the present conditions of the roads in the neighboring area of the proposed plant site, the following roads are recommended. However more advantageous route being expected in future, it is necessary to reexamine the road condition in advance.

(1) Imports of plant machinery and equipment

For heavy machinery and equipment

Route 1

For medium and light machinery and equipment

Route 1 or Route 2

(2) Imports of coal and gypsum

Route 2

(3) Exports of cement

To India

Route 2 or Route 4

In case the road linking Lahan with Thari is improved, this road could also be used.

To Bangladesh

Route 1

X-2 Approximate Cost Estimate

X-2-1 Road

(1) Construction of Roads

The roads needed to be constructed are as shown in the Table 10-1-2 which has been provided hereinbefore.

Here, the said Table is shown again in the next page.

Table 10-1-2 Roads needed for the Project

	(I)	(II)	(III)
Route	From Gaighat To Limestone ** deposit (Sindali)	From Gaighat To Clay deposit (Beltar)	From Gaighat To East-West Highway
Approximate length	18 km	20 km	25 km
Use for the Project	Transportation of labour and materials for the construction Transportation of labour for quarry operation	Transporation of clay and silica sand	Transportation of labour and materials for construction Imported fuel/ raw materials transportation Cement shipping
Structure & specification	Effective width 3.5 m Pavement: Gravel Minimum radius of horizontal circular curve: 15 m Other specifications: Those applicable to 2nd class district road provided in the Nepal Road Standard*	Effective width 7 m Pavement: Crushed stone Minimum radius of horizontal circular curve: 15 m Other specifications: Those applicable to 1st class district road provided in the Nepal Road Standard	Effective width 7 m Pavement: Asphalt concrete Minimum radius of horizontal circular curve: 15 m Other specifications: Those applicable to 1A class feeder road provided in the Nepal Road Standard

* The Nepal Road Standard is shown on page 310 hereof.

** This road means from Gaighat to Murkuchi and the rest (from Murkuchi to the limestone deposit) will be constructed as a part of quarry development works.

The construction cost per linear km of the above-mentioned road I, II, and III is estimated respectively as shown below. (inclusive of culverts, but exclusive of bridges)

Road	Estimated construction cost per km (million Rs)	(Thousand US$)
I	1.5	120
II	2.0	160
III	2.5	200

In addition, 50 million Rs is taken into account as the bridge construction cost.

(With this cost 1,400 m of the total length of bridges can be constructed, supposing the effective width is 7 m, and the unit cost is 5,000 Rs/m^2.)

Thus, the rough estimate of the construction cost for the new roads is,

(including bridges)

$1.5 \times 18 + 2.0 \times 20 + 2.5 \times 25 + 50 = 179.5$, say 180 million Rs

or 14.4 million US$

(2) Improvement of existing roads

The rough cost estimation is made as follows for the expansion of the pavement width and the improvement of the bridge both mentioned hereinbefore in X-1-(3)-(ii).

- Expansion of pavement width

  It is difficult to predict to what extent and how often the existing roads will be used for the cement shipping. Therefore, to give rough idea, it is supposed that the expansion of the pavement be carried out over a length of 200 km in all. (For reference, the distance between the plant and Rajbiraj, the capital city of Sagarmatha Zone where the plant will be located, is about 40 km, and the distance between the plant and Biratnagar, the largest city in the eastern part of Nepal, is about 140 km.)

  Taking 100 Rs/m^2 for the pavement unit cost (Asphalt top layer, 5 cm + subbase, 30 cm), and 3.5 m for the expansion width, the rough cost estimate for the pavement expansion is,

  $100 \times 3.5 \times 200 \times 1{,}000 = 70$ million Rs. or 5.6 million US$

- Improvement of bridge

  Supposing that the aforementioned Buri river bridge (95 m long) be removed, and replaced by e new bridge of 95 m long and 7 m wide,

and that the unit cost for this be 5,000 Rs/m^2, then, the rough cost estimate is,

$5{,}000 \times 95 \times 7 = 3.3 \times 10^6$ Rs = 3.3 million Rs
or 0.26 million US$

Thus, the total of the existing roads improvement cost is, roughly,

70 + 3.3 = 73.3 million Rs., say 73 million Rs
or 5.9 million US$

(3) Finances of the aforementioned roads development

As shown in the foregoing clause (1) and (2), the rough cost estimate of the development of the roads having connection with the Project is as follows :

1)	New roads construction	180 million Rs
2)	Existing roads improvement	73 million Rs
	Total	253 million Rs
		or 20.3 million US$

Above all, the new roads construction is indispensable for the Project, while the existing roads improvement will give far less merit than the new roads construction does, because the said improvement will be effective just for decreasing the cement transportation cost to some extent.

For this reason, it is considered to be natural that the existing roads improvement cost be borne by the government.

As for the new roads construction, too, the cost is desirably to be borne by the government for the following reasons, though it is an undouted fact that the cement plant will receive the most merit from the new roads.

From this viewpoint the aforementioned new road construction cost (180 million Rs) is not included in the project cost estimate. (See Chapter XI.)

"The reasons for the Government to bear the said New Road construction"

(a) The new road can be used publicly, and have great effects on the public convenience. Though Gaighat is the place of the Udaipur district office of the government, it is not yet connected by any all-weather road to East-West Highway.

On the other hand, it may be natural to consider that it will be one of the Nepal government's policies to construct the roads which connect the respective district headquarters to East-West Highway which runs through Nepal longitudinally. (Such roads are called "Feeder Roads" according to the Nepal Roads Standard.) Accordingly, the government should construct a road, separately from the Project, between East-West Highway and Gaighat which will gain more importance after the completion of the cement plant.

In fact, the Roads Department of the government is constructing an 80 km long road in between East-West Highway and Illam in the eastern part of Nepal.
If the road from Gaighat to the limestone deposit is constructed, it will be greatly helpful for the public, because, due to the topography there, the inhabitants both along, and not along this road route, have been forced to transport their goods on shoulders. Further this road will be able to be used as a part of the route between Gaighat and Udaipurgali where, formerly, the Udaipur district office of the government was located.

The road from Gaighat to the clay deposit will be located along the Trijuga river and will form a part of the route from Gaighat to Fatepur (as mentioned before, being connected to East-West Highway by a bus route). Accordingly, this road, if constructed, will give great benefit to the public.
One thing to add is that it is desirable to construct a road beyond the clay deposit to Fatepur as soon as possible.

(b) The revenue of the government from cement is 190 Rs/ton (same as adopted in the profitability calculation hereinafter) even by ways of the Excise duty and the sales tax only.
If the cement shipping by the Project amounts either 450,000 tons a year or alternatively 300,000 tons a year, the revenue in these two cases will reach the following amounts.

Cement Shipping a year	Revenue from the left-mentioned cement
450,000 ton	85.5 million Rs
	or 6.9 million US$
300,000 ton	57 million Rs
	or 4.6 million US$

Simply, comparing the abovementioned estimated revenue with the estimated cost of the new road construction (180 million Rs), it is considered possible for the government to return to the cement industry a part of the revenue from it (in the form of road development in advance).

X-2-2 Houses for Employees

(1) Cost for houses construction

As mentioned in X-1-2, 412 houses will be needed for the employees. Assume that the area of a workers-class house be 48 m^2, and the unit construction cost be 1,000 Rs/m^2.

Then, a workers-class house will cost 48,000 Rs/house.

Houses for the upper class employees have larger area and are of better quality. Accordingly, for convenience purpose, the said 412 houses of various types are assumed to be equivalent to 1.25 x 412 houses for workers class. (1.25 is a coefficient.) Thus, the estimated total cost for the houses construction is,

$$1.25 \times 412 \times 48{,}000 = 24.7 \times 10^6 = 24.7 \text{ million Rs},$$

say, 25 million Rs

(2) Common facilities in housing site

Approximately as much cost as 30 % the houses construction cost will be needed for the construction of streets, play grounds and other welfare facilities. Then, the cost for this is,

$$0.3 \times 25 \text{ million Rs} = 7.5 \text{ million Rs}$$

(3) Land price and site preparation

Assume that the land price be 2.5 Rs/m^2, and cost for site preparation be 10 Rs/m^2.

Then, the necessary land area being 13 ha, the total of the land price and site preparation cost is,

$$(2.5 + 10) \times 13 \times 10{,}000 = 1.63 \times 10^6 \text{ Rs}$$

say, 1.6 million Rs

(4) Summary

As seen from the abovementioned calculations, the total cost for the employees' houses is estimated as follows :

Houses	25 million Rs
Common facilities	7.5 million Rs
Land	1.6 million Rs

Total 34.1 million Rs,

say, 34 million Rs

Judging from its purpose, this cost should, naturally, be borne by the Project owner. Hence, this cost is included in the estimated cost for the whole project.

X-2-3 Communication

If, by the time the plant has been constructed, an adequate public communication system between the plant and main cities is not available, it will be necessary to install, at the minimum, a wireless telecommunication system for this purpose. The cost of the system is to be included in the budget of the Project.

X-2-4 Power Transmission

(1) With respect to the branch power line between the East-West power transmission line and the plant site.

Assuming that the construction cost of the 132 kV overhead power transmission line per km is Rs 400 thousand ($33 thousand), the total construction cost of this line is calculated as Rs 10 million ($800 thousand) : The above mentioned cost is to be borne by the power supply corporation. This is based on the consideration that (1) a cement plant will, as one of the major customers of electric energy, contribute to the utilization of hydro-power sources in Nepal (the annual electric energy charges payable is calculated as Rs 20 million ($ 1.6 million) in case of 1,500 t·cl/d plant), and (2) in principle, the public power transmission lines belong to the public sector.

(2) The line between the plant and the limestone quarry

The construction cost of the line is included in the budget of the project because the line is needed for cement production.

(3) The lines to the villages

The construction cost of the lines is excluded here, although only the feeder for the power supply is provided in the power receiving station.

LIST OF BRIDGES

IN BETWEEN MECHI AND BASAI

(Source:Indian Cooperation Mission, Lahan)

Bridge	Location (in km from Mechi)	Capacity (t)	Width (m)	Number x Span (m)	Overall length (m)
1. Mechi	0	70	7	20 x 28.35	56.7
2. Kali	1.30	70	7	3 x 8.37	26.11
3. Ninda	5.513	70	7	12 x 25.0	309.6
4. Pali	2.466	70	7	3 x 15.6	46.8
5. Timai	6.556	70	7	4 x 15.6	62.40
6. Nagarduba	7.85	70	7	4 x 8.35	33.48
7. Hadiya	8.94	70	7	3 x 15.6	46.8
8. Phulyosa	10.54	70	7	3 x 15.6	46.8
9. Deowa	13.345	70	7	3 x 8.37	26.11
10. Rekha	14.6	70	7	4 x 8.37	34.48
11. Adwa	17.58	70	7	4 x 8.39	33.48
12. Krishnabari	21.35	70	7	4 x 8.37	33.48
13. Biring	23.11	70	7	15 x 25.8	387.00
14. Suranga	26.28	70	7	2 x 15.6	31.20
15. Kankai	30.146	70	7	40 x 28.35	680.40
16. Gaida	30.95	70	7	Pipes	6.00
17. Bhalu	32.205	70	7	Pipes	10.00
18. Sobana	32.463	70	7	Pipes	-
19. Jharna	34.374	70	7	2 x 15.6	31.70
20. Jharna	34.20	70	7	Pipes	32.00
21. Dndha	35.96	70	7	Pipes	8.00
22. Dudhi	35.179	70	7	2 x 15.6	31.70
23. Satase	35.956	70	7	4 x 8.37	33.48
24. Komal	39.50	70	7	6 x 20.7	124.2
25. Kerha	42.28	70	7	3 x 15.6	46.8
26. Dhingri	41.05	70	7	Pipes	28.00
27. Gauya	45.00	70	7	Pipes	10.00
28. Ratuwa	47.5	70	7	20 x 28.35	567.00
29. Dhardhariya	52.40	70	7	1 x 15.18	15.18
30. Betni	52.70	70	7	2 x 15.86	31.72
31. Mawa (Main)	54.68	70	7	6 x 21.40	128.40
32. Mawa (Branch)	54.90	70	7	1 x 14.95	14.95
33. Bokra	57.40	70	7	12 x 25.80	309.60
34. Solti	58.40	70	7	4 x 20.70	82.80
35. Saniori	60.30	70	7	3 x 20.70	62.10
36. Pathri	63.20	70	7	1 x 15.18	15.18
37. Dane	64.70	70	7	5 x 18.20	91.00
38. Marang	65.30	70	7	2 x 18.20	36.40
39. Chisang I	69.70	70	7	3 x 11.80	35.40
40. Chisang II	70.00	70	7	3 x 28.35	85.05

Bridge	Location (in km from Mechi)	Capacity (t)	Width (m)	Number x Span (m)	Overall length (m)
41. Chisang, Bhanghari	74.00	70	7	2 x 14.71	29.42
42. Bethna	75.00	70	7	1 x 11.83	11.83
43. Lohendra	78.00	70	7	18 x 20.70	372.60
44. Lalbhiti	80.50	70	7	2 x 15.80	31.60
45. Sukha Pani	81.00	70	7	1 x 20.70	20.70
46. Sukha	81.00	70	7	3 x 20.70	62.10
47. Jharna	82.00	70	7	2 x 9.00	18.00
48. Madhyali	84.50	70	7	1 x 8.00	8.00
49. Modh	86.00	70	7	1 x 8.00	8.00
50. Gachia	87.50	70	7	8 x 20.70	165.60
51. Burhi	91.00	70	7	6 x 20.70	124.20
52. Tengra	91.50	70	7	2 x 15.80	31.60
53. Kheti	92.65	70	7	1 x 9.0	9.00
54. Pakli	97.39	70	7	2 x 7.0	14.00
55. Chatra Canal	99.35	70	7	3 x 6.3	18.90
56. Shankarpur Distributory	106.25	70	7	1 x 5.00	5.00
57. Sunsari	111.50	70	7	3 x 28.35	85.05
58. Sukhsiha Distributory	113.00	70	7	1 x 55.00	55.00
59. Khunia	116.35	70	7	3 x 6.00	18.00
60. Maria	117.65	70	7	2 x 6.00	12.00
61. Jharma	117.78	70	7	2 x 5.00	10.00
62. Jamna	119.50	70	7	1 x 7.00	7.00
63. Chandra canal	150.80	70	7	1 x 10.0	10.00
64. Sundri	153.90	70	7	72 x 5.0	141.00
65. Bavana	155.80	70	7	1 x 10.0	10.00
66. Bhagwa	156.60	70	7	3 x 20.7	62.10
67. Bundh	157.80	70	7	1 x 10.0	10.00
68. Rai	158.00	70	7	3 x 20.7	62.10
69. Murkutwa	158.50	70	7	1 x 10.0	10.00
70. Dumerjore I	158.70	70	7	1 x 10.0	10.00
71. Dumerjore II	158.70	70	7	1 x 10.0	10.00
72. Mahuli (Cause way cum bridge)	160.70	70	7	132 x 5.0 + 474 (cause way)	1,134.0
73. Asota khola	164.00	70	7	2 x 20.7	41.4
74. Gohri khola	165.00	70	7	1 x 20.7	20.7
75. Dumerjore khola III	165.50	70	7	2 x 15.6	31.2
76. Behai khola	116.20	70	7	2 x 15.6	31.2
77. Budhela khola	169.00	70	7	3 x 20.7	62.1
78. Khandio khola	169.90	70	7	9 x 20.7	186.3
79. Tarkhana khola	174.80	70	7	2 x 11.18	22.36
80. Deodhar	177.50	70	7	3 x 20.7	62.1

Bridge	Location (in km from Mechi)	Capacity (t)	Width (m)	Number x Span (m)	Overall length (m)
81. Lokeshar	179.30	70	7	2 x 25.8	51.6
82. Tharak	180.90	70	7	6 x 20.7	124.2
83. Old Chapin	181.80	70	7	1 x 8.0	8.0
84. Chapin	183.20	70	7	4 x 20.7	82.8
85. Singrshra	184.87	70	7	1 x 10.0	10.0
86. Amah	186.36	70	7	2 x 25.9	51.8
87. Patharaw I	187.27	70	7	1 x 10.0	10.0
88. Patharaw II	187.80	70	7	1 x 10.0	10.0
89. Surauga	189.92	70	7	3 x 15.6	46.8
90. Bridhan	190.36	70	7	2 x 21.4	42.8
91. Balan	193.66	70	7	18 x 26.6	478.8
92. Saraswoti	202.96	70	7	1 x 14.83	14.83
93. Baburam	206.30	70	7	2 x 14.82	29.64
94. Patharia	209.87	70	7	2 x 10.0	20.0
95. Kasaha	210.85	70	7	1 x 15.0	15.0
96. Gagau I	211.79	70	7	1 x 11.2	11.2
97. Jagan II	212.07	70	7	6 x 21.4	128.4
98. Mainawati	216.19	70	7	4 x 21.4	85.6
99. Ghurwi	220.64	70	7	5 x 21.41	107.05
100. Bataha	221.88	70	7	2 x 21.41	42.82
101. Jiwa	224.76	70	7	2 x 26.62	53.24
102. Mainwati II	225.42	70	7	1 x 16.18	16.18
103. Titaria	225.75	70	7	1 x 16.18	16.18
104. Dima	227.95	70	7	2 x 16.18	32.36
105. Bhalu	228.76	70	7	1 x 16.18	16.18
106. Suklaha	229.32	70	7	2 x 11.18	22.36
107. Bagaha	229.54	70	7	1 x 16.18	16.18
108. Bhairwa	231.77	70	7	3 x 21.48	64.44
109. Bulkia	233.01	70	7	2 x 11.18	22.36
110. Ghatia	233.69	70	7	1 x 11.18	11.18
111. Baraha	233.96	70	7	1 x 11.18	11.18
112. Balwa	244.84	70	7	7 x 15.9	111.3
113. Charnath	241.20	70	7	15 x 21.4	321.0
114. Jagdar(Branch)	250.42	70	7	1 x 26.65	26.65
115. Jagdar(Main)	250.69	70	7	(2 x 26.6, 2 x 21.5)	96.2
116. Jalad	251.96	70	7	(8 x 26.60, 2 x 26.81)	266.42

NEPAL ROAD STANDARDS (2027)

HIS MAJESY'S GOVERNMENT

MINISTRY OF WORKS AND TRANSPORT

DEPARTMENT OF ROADS

1. Nepal Road Standards (2027), (in short called 'NRS) will apply to all road being constructed within the Kingdom of Nepal. In case of urban roads, individual requirements will also be considered. In case of such standards which are not covered by NRS, the standards of ECAFE will be followed.

1-1. These standards may be relaxed by His Majesty's Government to meet special circumstances.

1-2. The initial traffic on some roads will normally be comparatively light but their development function will result in a steep rise in traffic volume over the first 10-15 years. The roads provided initially must, therefore, be capable of progressive improvement to the higher standards which the higher traffic volumes will demand.

1-3. These considerations lead to the conclusion that the roads should be designed for stage construction and that the standards should be framed on the same principle, i.e. flexible standards, suitable for modification to higher standards but incorporating the lower standards.

1-4. At any stage in the life of the road it must be capable of providing passage to the traffic wishing to use it at the lowest overall cost per kilometre. The overall annual cost will comprise of:-

(a) The amortised cost of the original investment in the road and its improvement to the stage under consideration per vehicle Kilometre;

(b) The annual cost of maintaining the road per vehicle Kilometre;

(c) The cost of providing the operating vehicles on the road per vehicle kilometre. (The effect of raising standards is to raise (a) but lower (c) if standards are not raised (a) will decrease but there will be a heavy resultant increase in (c)).

2. Traffic

2-1. It is not feasible to improve the standards of a road by very small increments and it is normal practise to design and construct new roads and improvement works to withstand the estimated traffic at some future date. In Nepal this forward period will be 10 years, i.e. roads works will be designed with a capacity sufficient to cater for the estimated traffic volume 10 years after the date of completion of the works (This agrees with ECAFE Recommendations for the Asian Highway).

2-2. Different types of traffic take up differing amounts of road space and impose differing load on the road structure. It is necessary, therefore, to adopt a standard traffic unit to which other types of traffic may be related. This standard is the "Transport Unit (T.U.)" which is that of a normal car, (passenger car), light van or pick-up. This unit is also sometimes called "Passenger Car Unit". Other types of traffic are related to this unit on the basis of the amount of road space they occupy, and the loads they impose on the road structure relative to these of a normal car travelling at the running speed of the road.

2-3. The traffic co-efficients to be adopted are as follows:-

	Trans port Units 'T.U.'
Cars, light vans and pick-up	1.0
Cars, light vans and pick-up	1.0
Light trucks upto 2-1/2 tons gross	1.5
Trucks 10 "	3.0
Trucks 15 "	4.0
Trucks 25 "	5.0
Trucks 40 "	6.0
Buses 40 passenger	3.0
Buses over 40 "	4.0
By-cycles	0.5
Rickshaws and goods tri-cycles	1.0
Hand-carts	2.0
Bullock-carts	8.0
Mule-carts or horse-drawn-carts	6.0
Pack animals	2.0
Pedestrians where no separate footpath is provided	0.25
Porters where no separate footpath is provided	0.50

3. Classification by Traffic Flow

This classification will be based on the volume of existing and anticipated traffic and with their function. This classification accords broadly with that proposed by the ECAFE HIGHWAY SUB-COMMITTEE at its fourth session in Bangkok (4th - 11th November 1958). The figures indicate total traffic in both direction or the summation of all traffic.

Classification	Type of carriageway	Type of topography	Transport Units (T.U.) per day
Class I AA	4 lanes divided 2 x 2 x 3.5 metres	Level	7,000
	with central median	Rolling	5,000
	Asphaltic concrete or Cement concrete.	Mountainous	3,000
Class I A	Two lanes	Level	3,000
	2 x 3.5 metres	Rolling	2,500
	Bituminous	Mountainous	1,500
	wearing course		

Cassification

Class I	Two lanes	Level	1,500
	2 x 3.5 metres	Rolling	1,000
	Surface Treatment	Mountainous	300
Class II	Single Lane	Level	300
	3.5 metres	Rolling	150
	Surface Treatment	Mountainous	75
Class III	Single Lane	All topography	less than 75
	3.5 metres gravel.		

Roads having transport units greater than 3,000 per hour (30 th highest hour over year's time) will be termed primary highways. These are destined to be mostly near metropolitan areas only in the foreseeable future.

Median strip of adequate width should be provided wherever necessary. The A.D.T.(Average Daily Traffic in T.U.) figures are quoted only as a general guide. The actual capacity of each road must be estimated. Class I AA or divided Roads should have a median width of minimum 2 metres. Wherever feasible, medians should be 5 to 10 m. wide or wider to obtain full advantages of Traffic Separation. New roads of Class I and above shall have full control of access, Class II roads shall have partial access control. Access control may be achieved by the use of frontage roads or without.

3-1. Classification by Service

In addition the Roads shall also be identified on the basis of the character of service provided by them. The classification shall be drawn up according to the mobility interest e.g. inter community mobility (regional interest), community wide interest service (community interest), and land access (local interest). In Nepal there shall be broadly four systems of Roads:-

(1) Trunk Road: (Rajmarg or National Highway) These serve directly the greater portion of the longer distance travel, provide consistently higher level or service in terms of travel speeds, and bear the inter community mobility (regional interest). These roads shall be the main arterial routes passing through the length and breadth of the country as a whole.

(2) Feeder Roads: These roads are important to travel of a localised nature than that which Trunk Roads are intended to serve. These serve the community's wide interest and connect important towns, districts and zonal head quarters to the Trunk Roads.

(3) District Roads: This class of road consisting of all roads not defined as Trunk or Feeder and city roads, serves primarily by providing access to abutting land carrying little or no through movement. These roads serve as collector to the feeder roads. These roads should give access to one or more villages to the nearest market or to high types of roads. Moderate travel speeds are typical on so roads.

4. Design Standards

4-1. Speed: The following design speeds will K.P.H.

Trunk Roads	Level	120
	Rolling	80
	Mountainous	50
Feeder Roads	Level	100
	Rolling	60
	Mountainous	40
District Roads	Level	60
	Rolling	40
	Mountainous	30

4-2. Gradients:

Acceptable Gradients are related to truck operating characteristics and the design speed on the roads themselves. The gradients proposed are calculated as acceptable for trucks of a gross weight of 18 tons with a weight-power ratio of 400 lb/hp and a speed reduction of 25 kph below average truck running speed.

These criteria have been adopted after the following consideration:-

i. The gross weight of the average trucks operating now is of the order of 8 tons. This may be expected to increase as road design improves and enables heavier vehicles to operate. A figure of 18 tons has been selected as the largest vehicle for which it is practical to design roads in rough terrain of Nepal.

ii. The weight-power ratio of existing trucks is generally below 400 lbs/hp but this may be expected to increase as the design criteria of the present truck manufacture improve and approach international levels.

4-3. The gradient standards will be as follows:- The gradients shall be ceased by 5% for every 500 metres, above mean sea level.

Trunk Roads	Mountainous	Rolling	Level
Maximum Average Gradient	5%	4%	3%
Maximum Gradient	8%	6%	5%
Maximum length of grade in excess of average grade	150 metres	210 metres	250 metres
Minimum length of Recovery at grade Specified	210 metres 3%	300 metres 2%	600 metres 2%
Feeder Roads			
Maximum Average Gradient	7%	6%	5%
Maximum	10%	8%	7%
Maximum length of grade in excess of average grade	120 meters	180 metres	210 metres
Maximum length of Recovery at grade Specified	150 metres 3%	150 metres 3%	300 metres 2%
District Roads			
Maximum Average Gradient	7%	6%	5%
Maximum Gradient	12%	10%	7%
Maximum length of grade in excess of average	100 metres	120 metres	180 metres
Maximum length of Recovery at grade Specified	150 metres 4%	150 metres 3%	150 metres 3%

Note: Minimum Grandient on hill roads shall be 1% to facilitate better drainage

5. Horizontal Curvature

5-1. The following criteria for curve design will be adopted: side friction factor (f) from 0.17 at 30 kph to 0.12 at 120 kph (uniformly distributing for other speeds).

Maximum super-elevation rate (e)

a. Where snow and ice conditions exist for a significant portion of the year. 0.80
b. Where snow and ice conditions are occasional 0.10
c. Where snow and ice conditions are extremely rare or not existent 0.10

For calculation of e, following formula will be adopted-

$$e + f \frac{V^2}{126.5\ R}$$

Where, V = Designs Speed, kph.
R = Radius of curvature in metres

Full super-elevation will be achieved in the length of the transition curve revolving the pavement around the centre line of the pavement. Following formula will be used to relate the design speed and the minimum radius of curvature:

$$R = \frac{0.0079\ V2}{(e + f)} \quad \text{or} \quad V = \sqrt{126.5\ R\ (e + f)}$$

Where, R = Radius of curve, metres
V = Design speed, kph.
e = Super-elevation in metres/metre
f = Co-efficient of friction

Minimum straight between two successive curves should be 100 with exception in Mountainous terrain.

Rate of gain of radial accelaration in transition curves 1 metre/sec/ sec/ maximum.

Spiral transition curves will be provided an all curves shorter than 200 metres radius.

5-2. Widening on Curves:- The criteria on which the additional width have been calculated are for two way traffic, normal 2 axle trucks passing with standard clearance and semi-trailer-trucks, passing with reduced clearance.

Radius of inner edge of carriageway in metres		Number of Lanes	Widening on Curve in Metres	
			Hard verges less than 1.5 metres	Hard verges more than
From	To			
15	30	2	3.00	2.50
30	60	2	2.00	1.50
60	120	2	1.5	1.00
120	220	2	1.0	1.70
220	660	2	0.50	-
15	30	1	3.50	3.00
30	60	1	3.00	2.50
60	120	1	2.50	2.00
120	220	1	1.50	1.20
220	360	1	1.00	-

6. Sight Distance:

Minimum stopping sight distances shall be as follows:-

Design Speed kph	Minimum Stopping sight distances metres
120	200
100	145
80	110
60	85
50	65
40	45
30	30
20	20

Based on total perception and Brake Reaction time of 2.5 second and co-efficient of friction from 0.42 at 20 kph to 0.28 at 120 kph. Increase in stopping sight distance on down grades.

Speed	Increase per 1% grade
120 kph	6.0 M
100 kph	4.5 M
80 kph	3.0 M
60 kph	1.5 M

No decreases in stopping sight distances will be permitted on up grade except on divided carriageway.

7. Vertical Curves:

All vertical curves shall be simple parabolas.

7-1. Summit Curve:

The criterion to be adopted is that the minimum sight distance shall be equal to the stopping sight distance laid down in para 6. The length of the curves necessary will be calculated as follows:-

L = Length of vertical curve in metres
S = Sight distance in metre
A = Algebraic difference in approach grades percent,
Height of eye = 1.0 metre
Height of lowest subject visible = 0.10 metre

Then,

When S is less than L, $L = \frac{AS^2}{200}$

When S is greater than L, $L = 25 - \frac{200}{A}$

It is emphasized that these are minimum lengths and that greater sight distance upto the passing sight distance should be provided where this is economically and technically feasible (refer to annexure I).

7-2. Valley Curves

The criteria to be adopted are that the headlight sight distance shall be equal to the stopping sight distance given on para 6 and that the centripetal acceleration shall be limited to 0.3 metres/sec/sec. The ruling fact is normally the sight distances except for small values of algebraic grade difference, the length of the curves will be calculated as follows:-

Where the sight distance rules,
Where S is less than L, $L = \frac{AS^2}{500 + 3.5S}$

When S is greater than L, $L = 2S - \frac{500 + 3.5S}{A}$

Where the centripetal acceleration rules. $L = \frac{AV^2}{395}$
V = Speed in kilometre per hour,

(refer to annexure II)

7-3. Combination of vertical and horizontal alignment:- When vertical and horizontal curves occur in combination or in close proximity to each other, it is recommended that the vertical curves will be either wholly within or wholly out side the horizontal curve. Care should be taken particularly to avoid sharp horizontal curves near the top of pronounced vertical curves.

8. Following minimum shoulder width will be provided:-

Class of Road	Total shoulder width in metres (Both sides included)
I to I AA	4.00 to 6.00
II	4.00 to 5.00
III	3.00 to 5.00

1. Shoulder width does not include widths made up of side cut spoil.

2. Lateral slopes on shoulders will be 5% for gravel and 8% for turf.

9. Right of Way

The minimum right of way will be as follows:-

	Between Building Lines
Trunk Roads - 50 metres (25m. on either side of the road centre line)	62 metres
Feeder Roads - 30 metres (15" " " ")	42 metres
District Roads 20 metres (10" " " ")	32 metres

NOTE:- In case of special circumstances, greater right of way will be required on technical reasons. In case of urban and sub-urban roads, the right of way will be as per the Annexure III (50 m. for 4 lane roads and 30 metres for 2 lane roads). This may not be strictly applicable in down-town areas where roads have already been constructed.

10. Structures:

10-1. Classification of structures will be as following:-

i.	Culverts	upto 6 metres length
ii.	Minor Bridges	more than 6 metres and upto 20 metres length
iii.	Medium Bridges	above 20 metres length, span lengths less than 20 metres
iv.	Major Bridges	bridges with span-lengths greater than 20 metres

10-2. Vertical Clearance:

Minimum vertical clearance for through structures will be 4.75 metres. Overhead wires, poles, etc. will be at least 7.0 metre above the road surface.

10-3. Lateral Clearence:

For culverts, the full roadway width will be carried through including the width of the shoulders. For minor and medium bridges, minimum width between curbs will be one half metre greater than the approaching pavement width. The between railings or trussess will be increased beyond the curves by at least one half metre on each side. On all trunk roads and other roads requiring a two lane carriageway, the bridge shall be designed for a two lane carriageway with necessary widenings as above.

10-4. Sidewalks:

Sidewalks should be provided, wherever found necessary, for at least one metre width on both sides on minor and medium bridges, but for major bridge can be limited to one side of the structure only. Sidewalks must be provided on all major bridges, if no other way is available for pedestrians to cross the river in the vicinity.

In urban areas the sidewalk should be provided as per the number of pedestrians estimated for future. Usually a clear 60 cm. width should be provided for a pedestrian density of 30 pedestrians/ minute, subject to a minimum sidewalk width of 2.5 metre on each side of the carriageway.

10-5. The following standards of loading will be adopted provisionally for design of structures:-

Major Bridges	-	HS 20-44 or IRS - Class AA or any other equivalent loading.
Medium & Minor Bridges & Culverts	-	HS 15-44 or IRC Class A or any other equivalent loading.
Temporary Structures		15-44 or IRC - Class B or any other equivalent loading.

11. Signs

11-1. Distance Signs:

The standard designs for kilometre and 5 kilometre posts issued separately by the Roads Department will be followed on all roads.

11-2. Traffic Signs:

The standard designs for traffic signs issued separately by the Roads Department will be followed on all roads.

12. General

12-1. Drainage:

Provisions for road side drains and cross-drains should be made as necessary.

12-2. Parapets and guard rails:

In hilly and mountainous roads parapets and guard rails should be provided as per standards to be issued by the Roads Department.

12-3. Tree-Plantation:

In rural areas trees will be planted on either side of the roads. In case of urban roads trees or hedges will be planted as and where possible.

CHIEF ENGINEER
ROADS DEPARTMENT
HMG

EXTRACTION FROM

STANDARD SPECIFICATIONS

AND

CODE OF PRACTICE

FOR

ROAD BRIDGES

SECTION II

LOADS AND STRESSES

The INDIAN ROADS CONGRESS

(IRC : 6-1966)

207. LIVE LOADS

207.1. Details of I.R.C. Loadings

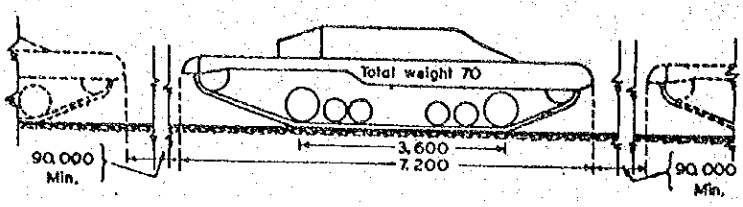
207.1.1. For bridges classified under Clause 201.1, the designed live load shall consist of standard wheeled or tracked vehicles or trains of vehicles as illustrated in Figs. 1 to 3 and Appendix 1. The trailers attached to the driving unit are not to be considered as detachable.

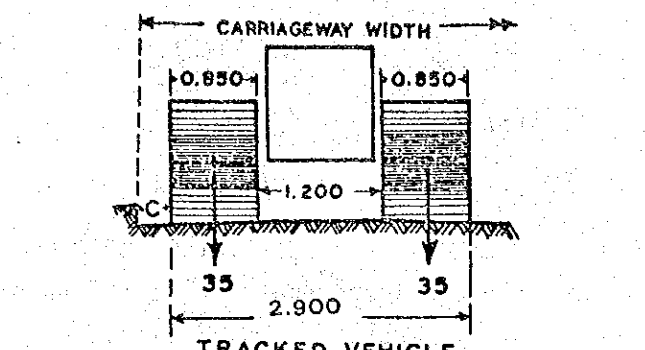
207.1.2. Within the kerb to kerb width of the roadway, the standard vehicle or train shall be assumed to travel parallel to the length of the bridge, and to occupy any position which will produce maximum stresses provided that the minimum clearances between a vehicle and the roadway face of kerb and between two passing or crossing vehicles, shown in Figs. 1 to 3, are not encroached upon.

207.1.3. For each standard vehicle or train, all the axles of a unit of vehicles shall be considered as acting simultaneously in a position causing maximum stresses.

207.1.4. Vehicles in adjacent lanes shall be taken as headed in the direction producing maximum stresses.

207.1.5. The spaces on the carriageway left uncovered by the standard train of vehicles shall not be assumed as subject to any additional live load.





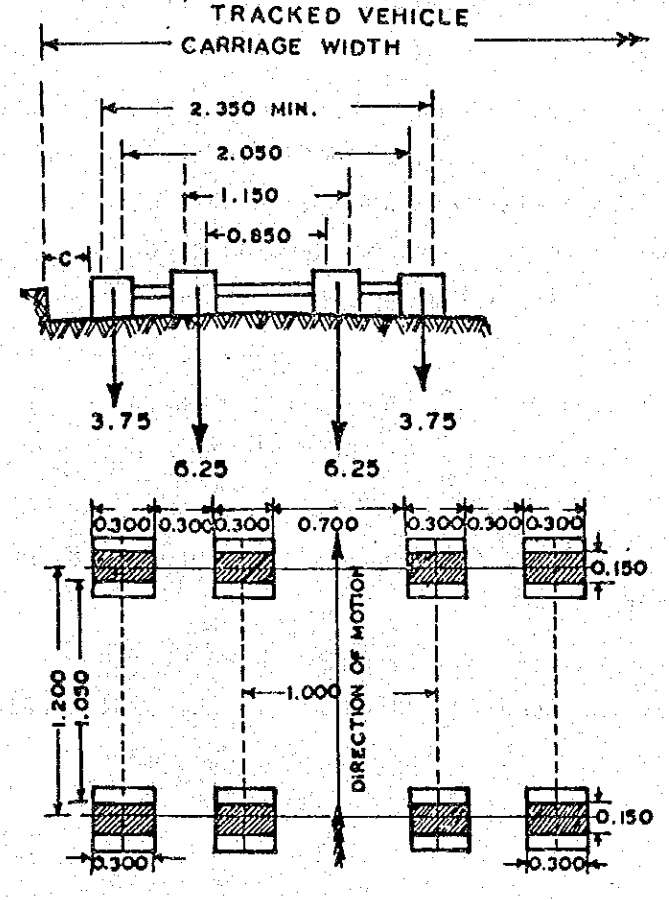


Fig. 1. Class AA tracked and wheeled vehicles (Clause 207.1)

Notes :

1. The nose to tail spacing between two successive vehicles shall not be less than 90 m.

2. For multi-lane bridges and culverts, one train of Class AA tracked or wheeled vehicles whichever creates severer conditions shall be considered for every two traffic lane width.

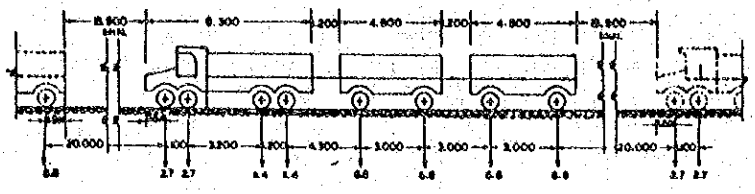
No other live load shall be considered on any part of the said 2-lane wide carriageway of the bridge when above mentioned train of vehicles is crossing the bridge.

3. The maximum loads for the wheeled vehicle shall be 20 tonnes for a single axle or 40 tonnes for a bogie of two axles spaced not more than 1.2 m centres.

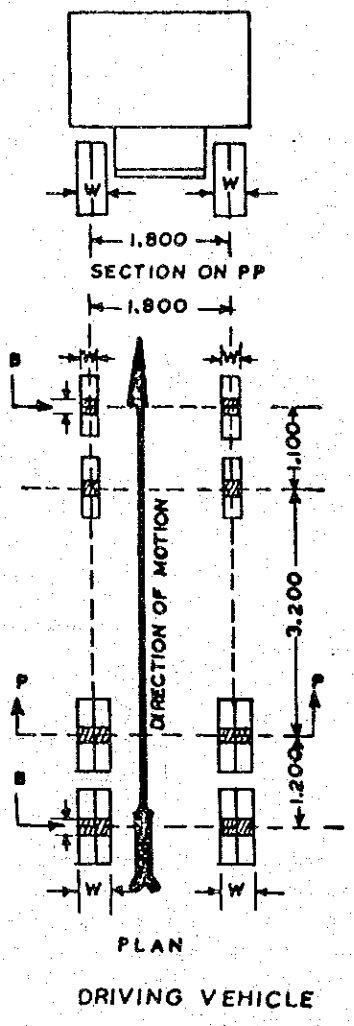
4. The minimum clearance between the road face of the kerb and the outer edge of the wheel or track. C, shall be as under :

Carriageway width	Minimum value of C
Single-Lane Bridges	
3.8 m and above	0.3 m
Multi-Lane Bridges	
Less than 5.5 m	0.6 m
5.5 m or above	1.2 m

5. Axle loads in tonne linear dimensions in metre.



Class A train of vehicles



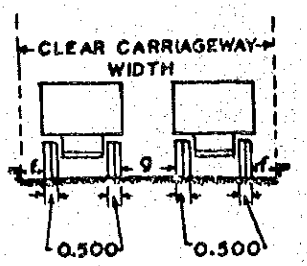


Fig. 2
Class 'A' train of vehicles
(Clause 207.1)

Notes :

1. The nose to tail distance between successive trains shall not be less than 18.4 m.

2. No other live load shall cover any part of the carriageway when a train of vehicles (or trains of vehicles in multi-lane bridge) is crossing the bridge.

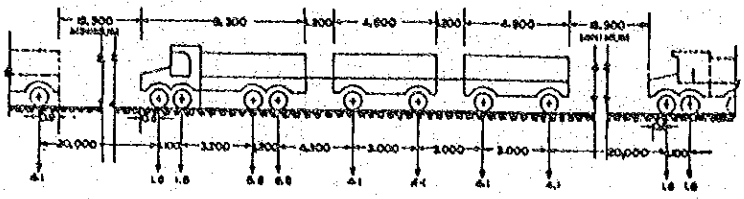
3. The ground contact area of the wheels shall be as under :

Axle load tonne	Ground contact area	
	B mm	W mm
11.4	250	500
6.8	200	380
2.7	150	200

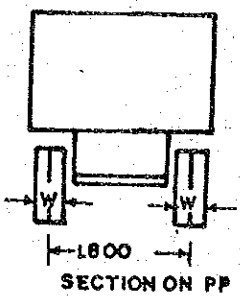
4. The minimum clearance, f, between outer edge of the wheel and the roadway face of the kerb, and the minimum clearance, g, between the outer edges of passing or crossing vehicles on multi-lane bridges shall be given below :

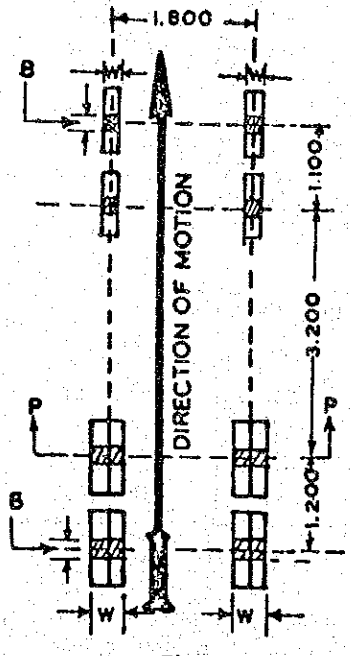
Clear carriageway width	g	f
5.5 m to 7.5 m	Uniformly increasing from 0.4 m to 1.2 m	150 mm for all carriageway widths
Above 7.5 m	1.2 m	

5. Axle loads in tonne linear dimensions in metre.

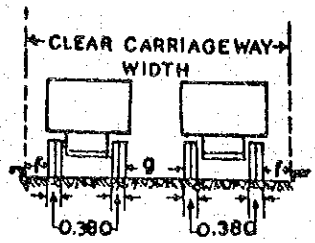


Class B train of vehicles





Plan
Driving vehicle
Fig. 3
Class B train of vehicles
(Clause 207.1)



Notes :

1. The nose to tail distance between successive trains shall not be less than 18.4 m.

2. No other live load shall cover any part of the carriageway when a train of vehicles (or trains of vehicles in multi-lane bridge) is crossing the bridge.

3. The ground contact area of the wheels shall be as under :

Axle load tonne	Ground contact area	
	B mm	W mm
6.8	200	380
4.1	150	300
1.6	125	175

4. The minimum clearance, f, between outer edge of the wheel and the roadway face of the kerb, and the minimum clearance, g, between the outer edges of passing or crossing vehicles on multi-lane bridges shall be as given below :

Clear carriageway width	g	f
5.5 m to 7.5 m	Uniformly increasing from 0.4 m to 1.2 m	150 mm for all carriageway widths
Above 7.5 m	1.2 m	

5. Axle loads in tonne linear dimensions in metre.

SECTION XI CALCULATION OF COST AND PROFITABILITY

XI-1 Construction Cost

The construction cost of the plant including the quarry was estimated by examining on the mechanical, electrical equipment and facilities as well as building and structure. The results are shown in Table 11-1-1 ~ 11-1-3 by capacity of the plant.

(1) Plant capacity (clinker base 750 t/d)

Table 11-1-1 Construction Cost (1) (Rs)

		Foreign currency	Local currency	Total
Quarry development		153,344,220	21,442,580	174,786,800
Building and structure		184,904,900	64,966,600	249,871,500
Machinery and equipment		222,357,000	11,703,000	234,060,000
Erection		25,678,130	8,559,370	34,237,500
Construction expenses		74,202,000	0	74,202,000
Total		660,486,250	106,671,550	767,157,800
Construction interest (C.I.)	rate 9.5%/y	0	123,229,480	123,229,480
	7 %/y	0	90,799,400	90,799,400
	3 %/y	0	38,914,500	38,914,500
Working capital		9,977,000	7,839,000	17,816,000
Grand Total	C.I rate 9.5%/y	670,463,250	237,740,030	908,203,280
	7 %/y	670,463,250	205,309,950	875,773,200
	3 %/y	670,463,250	153,425,050	823,888,300

Note. The construction interest was assumed to be the local currency portion. (Table 11-1-1 ~ 11-1-3).

(2) Plant capacity (clinker base 1,000 t/d)

Table 11-1-2 Construction Cost (2) (Rs)

		Foreign currency	Local currency	Total
Quarry development		179,997,030	23,763,470	203,760,500
Building and structure		201,488,310	70,793,190	272,281,500
Machinery and equipment		265,882,200	13,993,800	279,876,000
Erection		31,374,000	10,458,000	41,832,000
Construction expenses		90,885,000	0	90,885,000
Total		769,626,540	119,008,460	888,635,000
Construction interest (C.I.)	rate 9.5%/y	0	142,740,700	142,740,700
	7 %/y	0	105,177,200	105,177,200
	3 %/y	0	45,076,000	45,076,000
Working capital		13,024,000	10,234,000	23,258,000
Grand Total	C.I rate 9.5%/y	782,650,540	271,983,160	1,054,633,700
	7 %/y	782,650,540	234,419,660	1,017,070,200
	3 %/y	782,650,540	174,318,460	956,969,000

(3) Plant capacity (clinker base 1,500 t/d)

Table 11-1-3 Construction Cost (3) (Rs)

		Foreign currency	Local currency	Total
Quarry development		216,840,420	27,094,580	243,935,000
Building and structure		227,561,100	79,953,900	307,515,000
Machinery and equipment		340,986,820	17,946,680	358,933,500
Erection		41,645,300	13,881,700	55,527,000
Construction expenses		120,765,000	0	120,765,000
Total		947,798,640	138,876,860	1,086,675,500
Construction interest (C.I.)	rate 9.5%/y	0	174,551,770	174,551,770
	7 %/y	0	128,617,000	128,617,000
	3 %/y	0	55,121,610	55,121,610
Working capital		19,215,000	15,098,000	34,313,000
Grand Total	C.I. rate 9.5%/y	967,013,640	328,526,630	1,295,540,200
	7 %/y	967,013,640	282,591,860	1,249,605,500
	3 %/y	967,013,640	209,096,470	1,176,110,100

Note. 1. The construction interest was calculated based on the normal payment schedule.
As for the detail, refer to Annexure 11-1.

2. As for the detail of the cost for quarry development, refer to V-2.

3. As for the breakdown of the working capital, refer to Annexure 11-2.

4. The unit prices used for the calculation of cost of construction works are shown in Annexure 11-3.

(4) Construction cost per ton of annual cement production

Construction cost per ton of annual cement production, which is one of the reference values to judge the whole construction cost, is shown in Table 11-1-4.

Table 11-1-4 Construction Cost per Ton of Annual Production

(Rs/t-cement)

Plant capacity(clinker base)	750 t/d	1,000 t/d	1,500 t/d
Construction cost	2,952	2,565	2,091
Construction interest*	349	303	247
Working capital	69	67	66
Total	3,370	2,935	2,404

Note : * Interest rate : 7 %/y

XI-2 Production Cost

The production cost was estimated under the following conditions, where the marks I, II and III show the capacity of 750 t·cℓ/d, 1,000 t·cℓ/d and 1,500 t·cℓ/d respectively.

Table 11-2-1 Production

Material		I	II	III
Clinker	t/d	750	1,000	1,500
	t/y	247,500	330,000	495,000
Cement	t/d	787.5	1,050	1,575
	t/y	259,875	346,500	519,750

Note. The annual working days are assumed to be 330 days.

XI-2-1 The Calculation Basis for Production Cost

(1) Direct cost

(i) Raw material

Unit consumption of raw materials (dry base, including 2.5 % of loss in process)

Limestone	1.252 t/t·cℓ
Clay	0.222 t/t·cℓ
Silica sand	0.078 t/t·cℓ
Iron ore	0.013 t/t·cℓ
Total	1.565 t/t·cℓ
Gypsum	0.050 t/t·cℓ

Unit price (dry base) : As for the detail, refer to Annexure 11-4.

Limestone	5.83 Rs/t
Clay	32.62 Rs/t
Silica sand	13.80 Rs/t
Iron ore	180.00 Rs/t
Gypsum	366.00 Rs/t

(ii) Fuel

Unit consumption (coal) 0.127 t/t·cℓ

Unit price 510 Rs/t : As for the detail, refer to Annexure 11-4.

(iii) Fire brick

Unit consumption	1.5 kg/t·cℓ
Unit price	7,310 Rs/t

(iv) Grinding media

Unit consumption	
Raw mill	0.210 kg/t·cℓ
Cement mill	0.250 kg/t.cℓ
Total	0.460 kg/t·cℓ
Unit price	15,000 Rs/t

(v) Lubricant oil

Unit consumption	
Oil	0.02 ℓ/t·cℓ
Grease	0.005 kg/t·cℓ

Unit price

Oil	12 Rs/ℓ
Grease	10 Rs/kg

(vi) Electric power

Unit consumption	I	130 kWh/t·cℓ
	II	128 kWh/t·cℓ
	III	125 kWh/t·cℓ
Unit price		0.32 Rs/kWh

(vii) Repair expenses

Unit price per ton clinker	28 Rs/t·cℓ

(2) Fixed cost

(i) Salary and wage

Number of employee	I	342 men
	II	346 men
	III	350 men
Average salary		500 Rs/man-month

(ii) Depreciation

Residual value	0 %
Durable year	
building and structure	30 year, 3.3 %/y
machinery and electrical equipment	18 year, 5.6 %/y
vehicle and quarry equipment	5 year, 20 %/y

(iii) Interest

Construction cost Refer to Table 11-1-1 ~ 11-1-3.

Financing

Construction cost, Construction interest

Loan (long term) : 70 %

Interest rate 3.7 or 9.5 %/y

Investment : 30 % (by HMG, Nepal)

Working capital

Loan (short term) 100 %

Interest rate 9 %/y

(iv) Administrative and selling expenses

Unit cost per ton of cement 7.65 Rs/t·cement

(v) Fixed cost of quarry Refer to V-2.

(vi) Jute bag

Unit consumption 20 bag/t·cement

Unit price 3 Rs/bag

(3) Year of calculation base

4th year of the plant operation

XI-2-2 Production Cost

The production cost calculated based on the basis mentioned above are shown in Table 11-2-2. (In case of interest rate for long term loan 7 %/y and for short term loan 9 %/y)

Table 11-2-2 Production Cost

Plant capacity (clinker base)	750 t/d		1,000 t/d		1,500 t/d	
	Rs/y	Rs/t-cement	Rs/y	Rs/t-cement	Rs/y	Rs/t-cement
Direct cost						
Raw material	9,023,675	34.72	11,964,876	34.53	17,855,006	34.35
Fuel	16,030,575	61,69	21,374,100	61,69	32,061,150	61,69
Fire brick	2,713,838	10.44	3,618,450	10.44	5,427,675	10.44
Grinding media	1,707,750	6.57	2,277,000	6.57	3,415,500	6.57
Lubricant oil	71,775	0.28	95,700	0.28	143,550	0.28
Electric power	10,788,000	41.50	13,981,000	40.30	20,678,000	39.80
Repair expenses	6,930,000	26.67	9,240,000	26.67	13,860,000	26.67
Total of direct cost	47,265,595	181.88	62,551,126	180.52	93,440,881	179.78
Fixed cost						
Salary and wage	2,052,000	7.90	2,076,000	5.99	2,100,000	4.04
Depreciation	37,090,830	142.73	43,699,436	126.12	54,525,664	104.91
Interest						
Construction cost	37,590,732	144.65	43,543,115	125.67	53,247,099	102.45
Construction interest	4,449,171	17.12	5,153,683	14.87	6,302,233	12.13
Working capital	1,603,440	6.17	2,093,220	6.04	3,088,170	5.94
Expenses	1,988,044	7.65	2,650,725	7.65	3,976,088	7.65
Quarry expenses	5,830,397	22.44	6,847,700	19.76	9,269,499	17.83
Total of fixed cost	90,604,614	348.65	106,063,870	306.10	132,508,750	254.95
Others						
Jute bag	15,592,500	60.00	20,790,000	60.00	31,185,000	60.00
Grand total	153,462,709	590.53	189,404,996	546.62	257,134,631	494.73

As for the production costs in case of different interest rate, main items of the cost are shown in Table 11-2-3 and 11-2-4.

- Interest rate for long term loan 9.5 %/y
  for short term loan 9 %/y

Table 11-2-3 Production Cost (Rs/t-cement)

Plant capacity (clinker base)	750 t/d	1,000 t/d	1,500 t/d
Direct cost	181.88	180.52	179.78
Fixed cost	414.72	363.50	301.74
Others	60.00	60.00	60.00
Total	656.60	604.02	541.52

- Interest rate for long term loan 3 %/y
  for short term loan 9 %/y

Table 11-2-4 Production Cost (Interest 3 %/Y)

(Rs/t-cement)

Plant capacity (clinker base)	750 t/d	1,000 t/d	1,500 t/d
Direct cost	181.88	180.52	179.78
Fixed cost	252.01	221.15	186.51
Others	60.00	60.00	60.00
Total	493.89	461.67	426.29

XI-3 Profitability

XI-3-1 Break-even Point

In the Project it is assumed that the production of the rated capacity is obtained in the fourth year after completion and the economical life is 18 years, and therefore the break-even point was calculated both in fourth year and in 18th year.

(1) Equation used

At the break-even point, the sum of sales revenue equals to the sum of production cost.

Accordingly,

$$x\ (\%) = \frac{\text{Fixed cost}}{\text{Sales revenue} - (\text{Direct cost} + \text{Excise duty} + \text{Sales tax})}$$

where

x : The capacity utilization of plant at the break-even point(%)

Using Rs/t-cement as the unit of each item,

Sales revenue : 880.0 Rs/t.cement

Excise duty : 100.0 Rs/t·cement

Sales tax : 94.4 Rs/t·cement

Since the depreciation is reserved the inside of the company, the cash break-even point, which takes only cash production expenses into account and thereby disregards depreciation as a non-cash expense, was separately calculated.

The results of calculation for each case are shown in Table 11-3-1.

Table 11-3-1 Break-even Point (%)

Plant capacity (clinker base)	Interest rate (%/y)		Year	Break-even point	Cash break-even point
	Long term loan	Short term			
750	9.5	9	4	93.3	61.2
			18	62.5	30.4
	7	9	4	78.4	46.3
			18	56.6	24.5
	3	9	4	56.7	24.6
			18	47.9	15.8
1,000	9.5	9	4	81.5	53.2
			18	55.6	27.3
	7	9	4	68.7	40.4
			18	49.7	21.5
	3	9	4	49.6	21.3
			18	42.2	13.9
1,500	9.5	9	4	67.6	44.1
			18	45.9	22.4
	7	9	4	57.1	33.6
			18	41.7	18.2
	3	9	4	41.8	18.3
			18	35.6	12.1

XI-3-2 DCF Analysis

Discount cash flow (DCF) analysis was performed under the following conditions.

(1) Conditions

(i) Construction cost

Refer to Table 11-1-1 ~ 11-1-3.

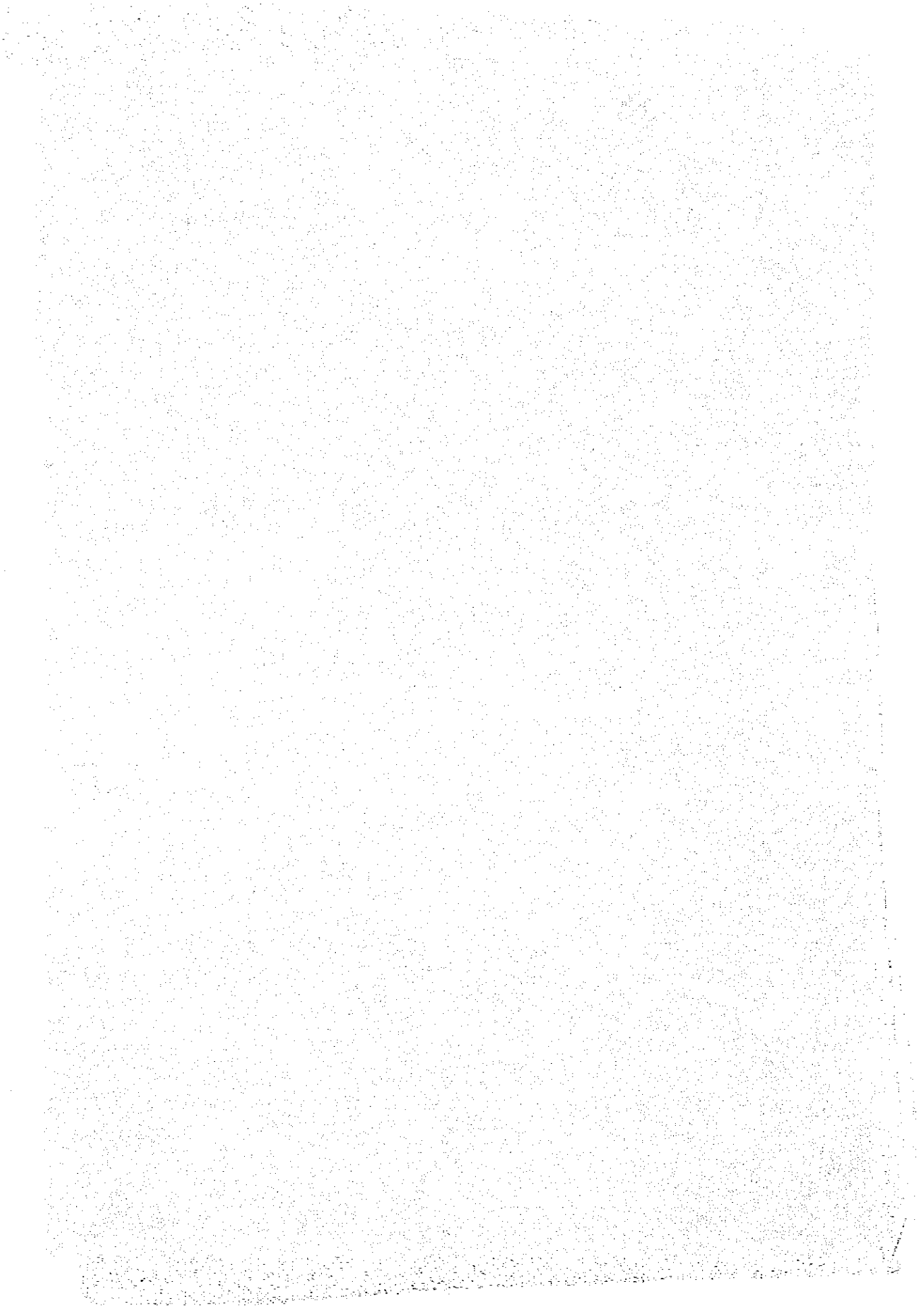


Table 11-3-2 Profit and Loss Statement

Case 2-2, Capacity 1,000 t/day(clinker base)
Interest rate : for construction cost 7 %/y,
for working capital 9 %/y

x 1,000 Rs

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Investment(Construction cost)	888,635																	
Sales volume (t)	242,550	277,200	311,850	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500	346,500
Unit sales price of cement (Rs/t)	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8
Sales revenue	213,638	244,158	274,677	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197	305,197
Excise duty	0	6,930	15,593	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650
Sales tax	22,897	26,168	29,439	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710	32,710
Net sales revenue	190,741	211,060	229,645	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837	237,837
Expenses																		
Direct cost	58,339	66,673	75,007	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341	83,341
Fixed cost	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574	11,574
Depreciation	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699
Interest for construction cost	43,543	43,543	43,543	43,543	43,543	43,543	41,366	39,189	37,012	34,835	32,657	30,480	28,303	26,126	23,949	21,772	19,595	17,417
Interest for working capital	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Total	159,248	167,582	175,916	184,250	184,250	184,250	182,073	179,896	177,719	175,542	173,364	171,187	169,010	166,833	164,656	162,479	160,302	158,124
Net earning (before tax)	31,493	43,478	53,729	53,587	53,587	53,587	55,764	57,941	60,118	62,295	64,473	66,650	68,827	71,004	73,181	75,358	77,535	79,713
Income tax	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Net earning (after tax)	31,493	43,478	53,729	53,587	53,587	53,587	55,764	57,941	60,118	62,295	64,473	66,650	68,827	71,004	73,181	75,358	77,535	79,713
Net earning (after tax)	31,493	43,478	53,729	53,587	53,587	53,587	55,764	57,941	60,118	62,295	64,473	66,650	68,827	71,004	73,181	75,358	77,535	79,713
Depreciation	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699	43,699
Total	75,192	87,177	97,428	97,286	97,286	97,286	99,463	101,640	103,817	105,994	108,172	110,349	112,526	114,703	116,880	119,057	121,234	123,412
Cumulative cash	75,192	162,369	259,797	357,083	454,369	551,655	651,118	752,758	856,575	962,569	1,070,741	1,181,090	1,293,616	1,408,319	1,525,199	1,644,256	1,765,490	1,888,902
Loan payment	–	–	–	–	–	31,102	31,102	31,102	31,102	31,102	31,102	31,102	31,102	31,102	31,102	31,102	31,102	31,102
Earnings (before distribution)	75,192	87,177	97,428	97,286	97,286	66,184	68,361	70,538	72,715	74,892	77,070	79,247	81,424	83,601	85,778	87,955	90,132	92,310
Total	75,192	87,177	97,428	97,286	97,286	97,286	99,463	101,640	103,817	105,994	108,172	110,349	112,526	114,703	116,880	119,057	121,234	123,412
Cash flow	75,192	87,177	97,428	97,286	97,286	66,184	68,361	70,538	72,715	74,892	77,070	79,247	81,424	83,601	85,778	87,955	90,132	92,310

Table 11-3-3 Profit and Loss Statement

Case 3-4, Capacity 1,500 t/d(clinker base)
Interest rate : for construction cost 7 %/y,
for working capital 9 %/y

x 1,000 Rs

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Investment (Construction cost)	1,086,675																	
Sales volume (t)	363,825	415,800	467,775	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750	519,750
Unit sales price of cement (Rs/t)	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8	880.8
Sales revenue	320,457	366,237	412,016	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796	457,796
Excise duty	0	10,395	23,389	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957	51,957
Sales tax	34,345	39,252	44,158	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064	49,064
Net sales revenue	286,112	316,590	344,469	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757	356,757
Expenses																		
Direct cost	87,238	99,701	112,163	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626	124,626
Fixed cost	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346	15,346
Depreciation	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526
Interest for construction cost	53,247	53,247	53,247	53,247	53,247	53,247	50,584	47,922	45,260	42,598	39,935	37,273	34,610	31,948	29,286	26,623	23,961	21,299
Interest for working capital	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088	3,088
Total	213,445	225,900	238,370	250,833	250,833	250,833	248,170	245,508	242,846	240,184	237,521	234,859	232,196	229,534	226,872	224,209	221,547	218,885
Net earning (before tax)	72,667	90,690	106,099	105,924	105,924	105,924	108,587	111,249	113,911	116,573	119,236	121,898	124,561	127,223	129,885	132,548	135,210	137,872
Income tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net earning (after tax)	72,667	90,690	106,099	105,924	105,924	105,924	108,587	111,249	113,911	116,573	119,236	121,898	124,561	127,223	129,885	132,548	135,210	137,872
Net earning (after tax)	72,667	90,690	106,099	105,924	105,924	105,924	108,587	111,249	113,911	116,573	119,236	121,898	124,561	127,223	129,885	132,548	135,210	137,872
Depreciation	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526	54,526
Total	127,193	145,216	160,625	160,450	160,450	160,450	163,113	165,775	168,437	171,099	173,762	176,424	179,087	181,749	184,411	187,074	189,736	192,398
Cumulative cash	127,193	272,409	433,034	593,484	753,934	914,384	1,077,497	1,243,272	1,411,709	1,582,808	1,756,570	1,932,994	2,112,081	2,293,830	2,478,241	2,665,315	2,855,051	3,047,449
Loan payment	-	-	-	-	-	38,034	38,034	38,034	38,034	38,034	38,034	38,034	38,034	38,034	38,034	38,034	38,034	38,034
Earnings (before distribution)	127,193	145,216	160,625	160,450	160,450	122,416	125,079	127,741	130,403	133,065	135,728	138,390	141,053	143,715	146,377	149,040	151,702	154,364
Total	127,193	145,216	160,625	160,450	160,450	160,450	163,113	165,775	168,437	171,099	173,762	176,424	179,087	181,749	184,411	187,074	189,736	192,398
Cash flow	127,193	145,216	160,625	160,450	160,450	122,416	125,079	127,741	130,403	133,065	135,728	138,390	141,053	143,715	146,377	149,040	151,702	154,364

(ii) Production of cement

The capacity utilization for the first year, second year, third year and fourth year and thereafter is assumed to be 70 %, 80 %, 90 % and 100 % of the rated capacity respectively.

As to the rated capacity refer to Table 11-2-1.

(iii) Unit sales price of cement

880.0 Rs/t·cement

The calculation was made in case of the varied sales price for reference.

(iv) Taxes

Refer to I-1.

(v) Production cost

Refer to XI-2.

(vi) Depreciation

Refer to I-1 and XI-2.

(vii) Financing

Refer to I-1 and XI-2.

(viii) Interest

Long term loan : 3, 7, 9, 9.5 or 11 %/y

Short term loan : 9 or 11 %

(ix) Repayment schedule

Refer to I-1 and Annexure 11-5.

(x) The construction interest was eliminated from the DCF analysis, except 2 cases of 2-11 and 3-13.

(2) Profit and loss statements

(i) Profit and loss calculation

Profit and loss statements were prepared to show income, costs, resulting earnings and cash flow.

These profit and loss statements extend over the project life of 18 years and the following economical indices can be obtained out of them.

The example of the profit and loss statement for case 2-2 and 3-4 is shown in Table 11-3-2 and 11-3-3 respectively.

(ii) Economic indices

(a) Rate of minimum annual net earnings (RME) :

(in case capacity utilization : 100 %)

$$RME = \frac{\text{Min. annual net earnings}}{\text{Net sales revenue}} \ (\%)$$

(b) Rate of minimum annual return of investment (RMR) :

(in case of capacity utilization : 100 %)

$$RMR = \frac{\text{Min. annual net earnings}}{\text{Investment (Construction cost)}} \ (\%)$$

(c) Payout :

The time (year) in which the investment (construction cost) is recovered by cumulative cash.

(d) Internal rate of return :

The coefficient of present value which makes the present value of the investment equal to that of cash flow.

(iii) Cases examined

The cases to be examined were set by production capacity as shown in Table 11-3-4, especially in cases of 1,000 and 1,500 t·cℓ/d the profitability were examined by various cases.

Table 11-3-4 Cases Examined

Plant Capacity (clinker base)	Case No.	Interest rate (%/y)		Sales price	Construc-tion cost	Coal price	Capacity build-up	Construc-tion interest	Equity ratio
		Construc-tion cost	Working capital	%	%	Rs/t			%
750 t/d	1-1	7	9	100	100	510	Normal	N.I.	30
	1-2	3	9	100	100	510	Normal	N.I.	30
1,000 t/d	2-1	9.5	9	100	100	510	Normal	N.I.	30
	2-2	7	9	100	100	510	Normal	N.I.	30
	2-3	3	9	100	100	510	Normal	N.I.	30
	2-4	3	11	100	100	510	Normal	N.I.	30
	2-5	3	9	90	100	510	Normal	N.I.	30
	2-6	3	9	110	100	510	Normal	N.I.	30
	2-7	3	9	100	90	510	Normal	N.I.	30
	2-8	3	9	100	110	510	Normal	N.I.	30
	2-9	3	9	100	100	390	Normal	N.I.	30
	2-10	3	9	100	100	510	Slow	N.I.	30
	2-11	3	9	100	100	510	Normal	Included	30
	2-12	3	9	100	100	510	Normal	N.I.	20
1,500 t/d	3-1	11	9	100	100	510	Normal	N.I.	30
	3-2	9.5	9	100	100	510	Normal	N.I.	30
	3-3	9	9	100	100	510	Normal	N.I.	30
	3-4	7	9	100	100	510	Normal	N.I.	30
	3-5	3	9	100	100	510	Normal	N.I.	30
	3-6	3	11	100	100	510	Normal	N.I.	30
	3-7	3	9	90	100	510	Normal	N.I.	30
	3-8	3	9	110	100	510	Normal	N.I.	30
	3-9	3	9	100	90	510	Normal	N.I.	30
	3-10	3	9	100	110	510	Normal	N.I.	30
	3-11	3	9	100	100	390	Normal	N.I.	30
	3-12	3	9	100	100	510	Slow	N.I.	30
	3-13	3	9	100	100	510	Normal	Included	30
	3-14	3	9	100	100	510	Normal	N.I.	20

Note: 1. Sales price

100 % : 880.8 Rs/t·cement

2. Construction cost

100 % : Refer to Table 11-1-1 ~ 11-1-3.

3. Capacity build up

Normal: Capacity utilization of 70 - 80 - 90 - 100 per cent in the initial years

Slow : Capacity utilization of 50 - 60 - 70 - 80 - 90 - 100 per cent in the initial years

4. Construction interest

N.I. : Construction interest is eliminated in the investment cost.

Included : Construction interest is included in the investment cost.

(iv) Economic indices

The results of calculation are shown in Table 11-3-5.

Table 11-3-5 Economic Indices

Plant Capacity (clinker base)	Case No.	RME (%)	RMR (%)	Payment (year)	IRR (%)	Remark: Interest rate(%/y) Construction cost	Remark: Interest rate(%/y) Working capital	Remark: Other conditions
750 t/d	1-1	16.5	3.8	11.3	2.6	7	9	B.C.
	1-2	28.2	6.6	9.0	6.2	3	9	B.C.
1,000 t/d	2-1	16.0	4.3	10.8	3.9	9.5	9	B.C.
	2-2	23.4	6.0	9.3	6.1	7	9	B.C.
	2-3	33.0	8.8	7.5	9.4	3	9	B.C.
	2-4	32.8	8.8	7.6	9.3	3	11	Refer to Table 11-3-4.
	2-5	24.3	5.8	9.5	5.2	3	9	
	2-6	39.9	11.9	6.3	13.1	3	9	
	2-7	35.6	10.6	6.7	11.6	3	9	
	2-8	30.4	7.4	8.3	7.5	3	9	
	2-9	35.1	9.4	7.3	10.1	3	9	
	2-10	33.0	8.8	10.0	4.5	3	9	
	2-11	32.6	8.3	7.9	8.4	3	9	
	2-12	31.9	8.5	7.7	8.7	3	9	
1,500 t/d	3-1	21.2	7.0	8.6	7.9	11	9	B.C.
	3-2	24.4	8.0	8.0	9.1	9.5	9	B.C.
	3-3	25.4	8.4	7.8	9.5	9	9	B.C.
	3-4	29.7	9.8	7.1	11.1	7	9	B.C.
	3-5	38.2	12.6	5.9	14.1	3	9	Refer to Table 11-3-4.
	3-6	38.0	12.5	6.0	14.0	3	11	
	3-7	30.2	8.8	7.4	9.7	3	9	
	3-8	44.6	16.3	5.0	18.1	3	9	
	3-9	40.4	14.7	5.1	16.6	3	9	
	3-10	36.1	10.8	6.6	12.0	3	9	
	3-11	40.3	13.2	5.7	14.9	3	9	
	3-12	29.7	9.8	7.4	8.6	3	9	
	3-13	37.5	11.0	6.7	11.7	3	9	
	3-14	37.3	12.3	6.0	13.5	3	9	

Note. B.C. : Basic condition