1.9.2 Maintenance of Transport Facilities

The Contractor shall arrange to service and repair vehicles at regular intervals in accordance with the manufacturers' recommendations and to provide all necessary spare parts to maintain the vehicles in a proper and safe running condition.

All consumables, including fuel, oil, filters, etc., required for the vehicles shall be provided by the Contractor.

If any vehicle requires maintenance for a period exceeding 2 days, the Contractor shall provide an alternative vehicle to the vehicle being repaired for the use of the Engineer.

1.9.3 Measurement and Payment

Measurement, for payment, for the provision of transport shall be made for each month for each type of vehicle provided.

Measurement for less than one month shall be proportioned on the basis of calendar days each vehicle is actually provided, except that normal maintenance of up to one (1) day's duration shall not be deducted.

Payment for Supply, operate and maintain new four-door, four-wheel drive vehicles shall be made at the rate per month entered in the priced Bill of Quantities.

Payment for Supply, operate and maintain new two-wheel drive station wagon shall be made at the rate per month entered in the priced Bill of Quantities.

Payment for the Supply, operate and maintain new motor cycle with capacity greater than 100 cc shall be made at the rate per month entered in the priced Bill of Quantities.

The above rates shall include all costs of repair, maintenance, fuel, oil, insurance and registration and provision of drivers and the provision of temporary vehicles if necessary.

1.10 TEMPORARY FACILITIES

1.10.1 General

For the purposes of this Specification temporary facilities shall include buildings and areas used for the storage of Equipment or preparation and storage of materials for the Works.

All Temporary Facilities shall be provided, installed, operated, maintained and subsequently removed by the Contractor, except as otherwise provided in the Contract.

1.10.2 Approval of Temporary Facilities

a. The Contractor's proposal for the erection of all temporary facilities shall be in accordance with the proposals submitted with the Contractor's Bid or with such modifications as approved by the Engineer from time to time.

b. The Contractor shall submit to the Engineer for approval, within thirty (30) days from the receipt of the Letter of Acceptance, the revised general plan of temporary facilities, based on the proposals in the Bid including scale, capacity, layout, dimension, installation programme and

schedule, and foundations. The Engineer may direct the Contractor to modify or change the proposals, if in the opinion of the Engineer it is deemed necessary. Such direction of the Engineer shall not relieve the Contractor from any of his obligations and responsibilities under the Contract.

c. Before starting any part of temporary facilities the Contractor shall, at least thirty (30) days before starting construction, submit to the Engineer for the approval the detailed proposal for such part of the temporary facilities including plans, drawings, schedules, and other information as specified in clauses 1.4 and 1.5 of the General Specification which will supplement or modify the general plan of the temporary facilities already submitted by him.

1.10.2.1 Removal of Temporary Facilities

Unless otherwise directed or approved by the Engineer, all temporary facilities constructed by the Contractor shall be removed and the area made safe, vegetation and natural drainage reinstated prior to the end of the Defects Liability Period.

1.10.2.2 Payment

Separate payment will not be made for temporary facilities and all the costs thereof shall be deemed to be included in the various rates and lump sum prices entered in the priced Bill of Quantities.

1.10.3 Use of Construction Facilities and Work Areas

1.10.3.1 Location of Temporary Works

The Contractor shall, as far as practicable, lay out the temporary facilities within the site for such provided by the Employer at no cost to the Contractor.

1.10.3.2 Damage to Flora and Fauna

The Contractor shall limit the movement of his crew and equipment so as to minimise damage to flora and fauna, particularly in the Goa Kreo park.

1.10.3.3 Indemnity against damage or injury

The Contractor shall be directly responsible to the Employer for any damage or injury to crops or land whether in the possession of the Employer or any other person, resulting from his operations and shall indemnify and keep indemnified the Employer against all losses and claims for such damage and injuries which may arise in connection with the risk as provided for in clause 12 of the Conditions of Contract

1.11 TEMPORARY TRAFFIC CONTROL

1.11.1 Scope

To facilitate traffic through or around the Works, or wherever ordered by the Engineer, the Contractor shall install and maintain at prescribed points on the Site and at the approaches to the Site, traffic signs, lights, barricades and other facilities as required by the Engineer for the direction and control of traffic. The wordings on all signs shall be in the Indonesian and English languages. The size, colour, lettering and location of all signs shall be

subject to the Engineers approval. Attention shall be paid to the international system of traffic sign or as applicable in Indonesia.

Where required, or on when directed by the Engineer, the Contractor shall furnish and station competent flagmen whose sole duty shall be to direct the movement of the traffic through or around the Site.

In addition to the requirements of the above clauses, the Contractor shall furnish and erect, within or in public areas in the vicinity of the Site, such warning and guide signs as may be ordered by the Engineer.

1.11.2 Payment

Separate payment will not be made for complying with the provisions of this Clause 1.10 and the cost of all works required by this clause shall be deemed to be included in the rates and lump sum prices of the various items in the priced Bill of Quantities.

1.12 GARBAGE DISPOSAL

1.12.1 Scope

a. The Contractor shall undertake the collection of and disposal of all garbage from within the Site, the Contractor's Site office, the Contractor's temporary facilities, the Engineer's Site office and other areas used in connection with the Works. Garbage collections shall be made at least twice each week and shall continue until completion of the Works.

b. Garbage shall be disposed of in a properly constructed incinerator followed by burial of the residue in an approved location. The Contractor shall submit the proposed design and layout of garbage disposal facilities for approval. Where available, garbage collection by local authorities shall be used in preference to disposal as noted above.

1.12.2 Payment

Separate payment will not be made for the provision for garbage disposal and the cost of this work shall be deemed to be included in the rates and lump sum prices of the various items in the priced Bill of Quantities.

1.13 DIVERSION AND CARE OF WATER

1.13.1 General Requirements

The Contractor shall be responsible for the removal of all water encountered during the execution of the whole of the Works.

The Contractor shall design, construct and maintain all temporary diversion and protective works which are necessary for construction and to prevent surface, drainage and groundwater from entering excavations and shall furnish all materials required therefor.

The Contractor shall furnish, install, maintain and operate all necessary pumping and other equipment for dewatering the various parts of the Works on the surface, in open cut excavation and shall maintain the foundations and other parts of the work free from water as required for constructing each part of the Works and as required, and for a period after any part of the Works is completed for inspection, safety or for any reason determined by the Engineer to be necessary.

The Contractor shall remove all water from the Sites of all construction work and shall keep the excavations free of water while excavating, preparing foundations and while placing backfill or concrete or as otherwise required for completing the Works. The Contractor shall be responsible for and shall repair, at his expense, any damage to foundations, excavation slopes or any other parts of the Works caused by water, floods or by his failure to protect the Works in accordance with the requirements of this clause. Temporary diversion and protective works, conduits, and sumps shall be readily accessible at all times and the Contractor shall maintain in operating condition an assembly of standby transportable and portable lighting facilities which is adequate, as determined by the Engineer, to provide illumination, at short notice, to any or all of the temporary works.

1.13.2 Payment

No payment shall be made for complying with this general obligation of the Contractor described in this clause and the cost of this work shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities.

1.14 MAINTENANCE OF EXISTING PUBLIC ROADS

1.14.1 General

The Contractor shall maintain all roads within the vicinity of the Site which he uses for purposes of carrying out the Works required by this Contract.

For the purposes of this clause the road to be maintained by the Contractor shall be limited to the existing road and pedestrian path leading to the Goa Kreo Bridge Site from the existing car parking area.

During the construction of the Goa Kreo Bridge public shall not be permitted to enter the Goa Kreo park for reasons of safety. The Contractor shall erect barrier and explanatory signs to prevent public access to the Site.

1.14.2 Maintenance of Roads

a. The Contractor shall be wholly responsible for maintenance of the public roads used by him in the execution of the Works.

b. In maintaining these roads the Contractor shall:

(i) reinforce to pass his traffic, if necessary, and keep in good working condition at all times all road structures, steps, culverts, drains and other waterways;

(ii) patch potholes with approved materials, keep the road surfaces in good repair, and perform all grading and necessary resurfacing;

(iii) maintain all fenders, posts, guideposts, guard posts, rails, fencing, signs, signposts and other roadside structures;

(iv) keep road surfaces and shoulders free from all earth, mud, stones, timber, rubbish, and other debris and materials removed from the Works;

(v) adequately maintain cut-slopes and fill-slopes of the roads and appurtenant drainage ditches; and

(vi) keep the road surface watered where dust is likely to be a safety or health problem.

1.14.3 Payment

Separate payment will not be made for complying with the requirements of this Clause, and the cost of this work shall be deemed to be included in the various rates and lump sum prices entered in the priced Bill of Quantities.

1.15 PLANT, EQUIPMENT AND MATERIALS TO BE FURNISHED BY THE CONTRACTOR

General

The Contractor shall furnish all items of plant, equipment and materials required for the execution of the Works except as otherwise provided for in the Contract.

Payment

a. When a separate item, which includes the furnishing of any plant, equipment or materials, is provided in the Bill of Quantities, the cost of furnishing, transporting, storing and handling such plant, equipment or materials shall be deemed to be included in the rate or lump sum price entered for that item in the priced Bill of Quantities.

b. Where no separate item is provided in the Bill of Quantities for furnishing any plant, equipment or materials required to be furnished by the Contractor, the cost of furnishing, transporting, storing and handling such plant, equipment or materials shall be deemed to be included in the rates or lump sum prices entered in the priced Bill of Quantities for the items for which plant, equipment or materials are required.

1.16 SAFETY, HEALTH CONTROL AND SECURITY

1.16.1 General

The Contractor shall be responsible for all safety, health controls and security and shall submit to the Engineer details of the organisation and regulations for these purposes.

1.16.2 Safety Precautions

1.16.2.1 General

The Contractor shall comply with any safety instruction given by the Engineer. In the performance of the Works, the Contractor shall exercise every reasonable precaution to protect from injury persons or property. The Contractor shall erect and maintain all necessary temporary fencing, barricades, barriers, signs and lights and provide fire alarm, fire extinguishing and fire fighting services at strategic points on the Site and adequate ventilation, lighting and safe working conditions for his workmen engaged in the performance of the Works. The Contractor shall adopt and enforce such rules and regulations as may be necessary and desirable in the work and in its supervision. Safety measures shall include but shall not be limited to those measures mentioned in this clause.

1.16.2.2 Safety Officer

The Contractor shall constantly employ during the progress of the Works an employee qualified in safety, and familiar with the type of work being performed, whose assignment shall include initiation of measures for the protection of health and the prevention of accidents and who shall see, by

personal inspection, that all safety rules and regulations are enforced. The Contractor shall hold regularly scheduled safety meetings at least once each month with his Engineers, supervisors and foremen and, when directed, with the Engineer. The Contractor shall keep the Engineer advised as to when these meetings are to be held and shall provide the Engineer with a copy of the proposed agenda.

1.16.2.3 Temporary Fencing

The Contractor shall erect, maintain and remove suitable and approved temporary fencing to enclose such areas of the Permanent Works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract in approved manner. Where any temporary fence has to be erected alongside a road, footpath, or other public thoroughfare, it shall be of the type required by and shall be erected to the satisfaction of the Government authority concerned.

1.16.2.4 Lighting

a. In the event of night work being carried out, the Contractor shall provide sufficient lighting to ensure that in all places where work is in progress :

   (i) safe working conditions are provided for the Contractor's personnel and the Engineer;

   (ii) the Works can be constructed in complete compliance with the Contract; and

   (iii) a complete inspection of all Works in progress can be made by the Engineer.

b. Unless otherwise directed by the Engineer, the minimum service illuminance on ground or working surfaces to be provided for the various operations or work areas shall be as tabulated below :

ILLUMINANCE		
OPERATION OR AREA	Design Value (Lux)	Minimum Measured Value (Lux)
Building Construction Site	50	20
Concrete placing	100	50
Maintenance shops and Auxiliary Buildings	300	200

c. All moving equipment or plant used during night operations shall be equipped with sufficient lights and reflectors.

d. Not less than fourteen (14) days before the start of any night operations, the Contractor shall submit to the Engineer his proposals for lighting in the areas in which he proposes to work at night. The Contractor shall modify the proposals if directed and shall not begin operations at night, until the proposals for lighting have been approved.

e. The submission to or approval by the Engineer of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

1.16.2.5 Signs

a. The Contractor shall provide all necessary signs for the Works. These shall include, but not be limited to

- standard road signs;
- warning signs;
- danger signs;
- control signs;
- safety signs; and
- direction signs.

b. Wording on all signs shall be in the Indonesian and English languages. The size, colour, lettering and location of all signs will be subject to approval, and attention shall be paid to international system of signs.

c. The Contractor shall maintain all signs placed by himself as well as those placed by the Employer.

d. If the Engineer considers that the system of signs provided by the Contractor is inadequate to ensure safety, or unsatisfactory in other respects, the Contractor shall add to, amend, or otherwise change the system to the satisfaction of the Engineer.

1.16.2.6 Other Safety Measures

a. When working in the vicinity of electrical equipment and in the interest of safety and security, the Contractor shall complete the erection of any safety fencing around electrical and mechanical equipment by the time that the said apparatus is connected to any electrical supply.

b. Use of Lasers - The use of lasers on the Site shall be done with due regard to eye hazard and all personnel working on the site shall be warned accordingly.

c. Safety instructions - Within sixty (60) days of receiving the Letter of Acceptance, the Contractor shall, at his own cost, supply and issue to his employees, those of his subcontractors and the Engineer, in English, Bahasa Indonesia and in other languages used by his employees at the Site, a booklet containing safety regulations based on good practice. The booklet shall be pocket size and issued to each person employed at the Site. Proof copies of the booklet shall be submitted to the Engineer for approval before printing and amendments shall be made to the booklet to his entire satisfaction. The Contractor shall issue the booklet immediately after printing as required by this clause and ensure that all employees are fully conversant with the instructions. Safety instructions shall deal with all safety including but not limited to the following items where relevant to the Works :

(i) protective clothing, headgear and footwear;

(ii) use of lifting equipment;

(iii) earthmoving;

(iv) formwork and reinforcement erection;

(v) concreting;

(vi) routine for accidents or fires; and

(vii) watchman, warning notices and barriers

(viii) electrical safety

The Contractors shall allow for ten (10) booklets in the English language for the use of the Engineer.

d. Accident Report - The Contractor shall promptly report to the Engineer, in a form to be prescribed, all accidents involving death or serious injury to staff or workmen, and shall furnish monthly reports of all accidents to staff or workmen involving loss of time, giving such information as may be directed.

1.16.2.7 Provision of Safety Equipment

All persons employed on the Works are to be provided with safety equipment appropriate to the tasks upon which the are engaged such as helmets and safety equipment shall be compulsory as deemed necessary by the Engineer.

1.16.2.8 Payment

Separate payment will not be made for complying with the provisions of this Clause and all costs shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities.

1.16.3 Sanitary Arrangements

1.16.3.1 Scope of Work

a. The Contractor shall keep the Site in a clean and hygienic condition, and shall provide and maintain sanitary conveniences for use of the persons employed in the Works to the extent, in the manner and at such places as approved by the Engineer and by any Government health authority concerned. All persons connected with the Works shall be enjoined to use these conveniences.

b. The Contractor shall install, operate and maintain an adequate treatment process for disposal of sewage from all temporary buildings including houses, offices, camps, etc., to be constructed by the Contractor, and from all temporary toilet facilities at the Site. Sewage shall be disposed of in a hygienic manner. The Contractor shall post notices and take such other necessary precautions as may be necessary to keep the Site clean. The sewage treatment plant shall be subsequently remove upon completion of the Contract.

1.16.3.2 Payment

Separate payment will not be made for complying with the requirements of this Clause and all costs shall be deemed to be included in the item in the priced Bill of Quantities for Contractor's Site Office and Facilities.

1.16.4 Fuel Storage

1.16.4.1 General

a. The Contractor shall make arrangement for the transportation, storage and handling of fuels in a safe manner to protect the public in accordance with the laws and security regulations of Republic of Indonesia.

b. Above-ground gasoline and liquefied petroleum gas storage tanks shall not be located within 1,000 meters of any building.

1.16.4.2 Payment

Separate payment will not be made for complying with the requirements of this Clause and all costs shall be deemed to be included in the item in the priced Bill of Quantities for Contractor's Site Office and Facilities.

1.16.5 Fire Prevention

1.16.5.1 General

The Contractor shall take every precaution to prevent fire occurring on or about the Site. The Contractor shall comply with the laws and regulations of the appropriate Government authority relating to fires and shall provide fire fighting equipment, which the Engineer considers to be suitable and adequate, ready to use in all structures, buildings or the works under construction, including his labour camps and ancillary buildings. The Contractor shall maintain such equipment and such additional fire fighting equipment as may be required, in good working condition until the Works are accepted by the Employer.

The Contractor shall extinguish promptly any fire which may occur on the Site wherever the fire may originate. In this regard, he shall employ all requisite equipment and manpower for fire fighting up to the limits of his equipment and manpower employed at the Site including the equipment and manpower of his subcontractors.

1.16.5.2 Payment

Separate payment will not be made for complying with the requirements of this Clause and all costs shall deemed to be included in the various rates and lump sums entered in the priced Bill of Quantities.

1.16.6 Earthing

1.16.6.1 General

All appliance and facilities which are possibly subject to lightning strikes shall be electrically grounded and the effectiveness of such grounding shall be periodically checked by the Contractor.

1.16.6.2 Payment

Separate payment will not be made for complying with the requirements of this Clause and all costs shall deemed to be included in the various lump sums and rates entered in the priced Bill of Quantities.

1.16.7 Medical and Health Services

1.16.7.1 General

a. The Contractor shall provide a person qualified in first aid at all working hours on the Site.

b. The Contractor shall provide a first aid unit on the Site for treatment of casualties in conformity with the requirements of all duly constituted medical and health authorities. The Contractor shall provide such first aid units and shall responsible for and bear all costs in connection with the first aid services including removal by ambulance of injured or sick employees to hospital in Semarang or other places.

c. The Contractor shall provide first aid services for the Employer's and Engineer's staff working on the Site.

1.16.7.2 Payment

Separate payment will not be made for medical and health facilities provided by the Contractor for his employees, for his subcontractors and the Employer's and Engineer's staff, as required by this clause, and all costs shall deemed to be included in the various rates and lump sums entered in the priced Bill of Quantities.

1.16.8 Security

1.16.8.1 Responsibility of the Contractor

a. The Employer will specify overall security requirements for the project and the Contractor shall perform to such requirements and be responsible for such action of his personnel in respect of such requirements.

b. The Contractor shall be responsible for the security of the Works and the at Site and shall provide and maintain continuously and adequate security force to fulfil these obligations. The duties of the Contractor's security force shall include, but not be limited to, maintenance of order on the Site, provision of all lighting, fencing, guards, flagmen, all other measures necessary for the protection of the Works within the Site, all material delivered to the Site, the public, and all persons employed in connection with the Works, continuously throughout working and non-working periods, including nights, Sundays and holiday, for the duration of the Contract.

1.16.8.2 Payment

a. Separate payment will not be made for the provisions of security services and all costs shall be deemed to be included in the various rates and lump sum prices entered in the priced Bill of Quantities.

1.17 SURVEY AND MEASUREMENT OF THE WORKS

1.17.1 Bench Mark and Reference Point

Reference points have been established on the Site by the Employer as shown on the Drawings or as advised by the Engineer. The Contractor shall use the co-ordinates and elevations of such reference points in setting out the Works. Any reference points damaged as the result of action by the Contractor shall be replaced by the Contractor at his own expense.

The Contractor may establish temporary reference points for his own convenience but each point shall be of a design and at a location approved by the Engineer. Each point shall be accurately related to the points established by the Employer.

1.17.2 Responsibility for Setting Out

The Contractor shall be solely responsible for the correct setting out of the Works and shall employ experienced and qualified surveyors approved by the Engineer.

The Contractor shall furnish all materials, labour and equipment including stakes, templates, patterns, platforms and special labour that may be required by the Contractor in setting out any part of the Works. The Contractor shall use survey equipment of the type and accuracy to permit correct setting out and control of the Works.

The Contractor's obligations for surveying shall include the surveying of the original surface levels where works are to be performed. The method used and spacing of cross-sections shall be agreed by the Engineer prior to commencement of the survey.

Before surveying the original surface levels to be plotted in the working drawings as described in Clause 1.4.4, the Contractor shall give the Engineer at least 7 days notice before commencing such survey in order that the Engineer or his representative can witness and verify levels so determined. The original surface level determined shall be subject to the Engineer's approval.

The Contractor shall co-operate with the Engineer in checking the setting-out and in performing the measurement surveys for record and payment purposes. The Contractor shall render all necessary assistance to the Engineer and shall provide, as required for the use of the Engineer, sufficient quantities of pegs, poles, straight edges, stagings, mounds, templates, profiles, survey assistants, labourers and transport for checking the Contractor's setting-out and measurement of the Works.

1.17.3 Survey Data and Calculations

The Contractor shall submit all survey data, information, calculations, results and records to the Engineer as soon as they are available.

1.17.5 Payment

Payment for surveying shall be made at the lump sum entered in the priced Bill of Quantities. Monthly progress payments shall be made in proportion to the progress of the Work.

1.18 OTHER ITEMS

1.18.1 Information Board

The Contractor shall provide a free-standing board for the purpose of providing information about the project to the public. The board shall be not less than 2 m x 1.5 m. The information to be displayed and the location shall be directed by the Engineer. The design of the display and the supporting structure shall be subject to the Engineer's approval.

1.18.2 Securities and Insurance

1.18.2.1 Performance Security and Advance Payment Security

The Contractor shall furnish an Advance Payment Security and a Performance Security and in accordance with Clause 52 of the Conditions of Contract to ensure the refund of the Advance Payment and for the due performance of the Contract respectively. .

1.18.2.2 Insurance

The Contractor shall effect certain insurances relating to the Contract in accordance with Clause 13 of the Conditions of Contract. In handling compensation to workmen under the above Clauses, the Contractor shall arrange that any compensation amount determined shall be paid without delay by the Contractor to the workmen entitled to such compensation irrespective of the time for payment of insured amount from the Insurance company to the Contractor.

1.18.2.3 Payment

Separate payment will not be made for complying with this Clause and the Conditions of Contract and all costs shall be deemed to be included in the rates and lump sums for the various items entered in the priced Bill of Quantities.

1.18.3 Audits by the Employer

1.18.3.1 General

The Employer shall be entitled at his discretion to conduct audits as necessary for his own investigation in connection with :

a. Cost incurred in relation to any compensation event as provided in clause 44 of the Conditions of Contract;

b. Cost incurred in the event of termination of the contract as provided in Clause 59 or 63 of the Conditions of Contract; and

c. Any other costs that the Contractor may claim to the Employer, which are not specifically covered by the terms of the Contract.

1.18.3.2 Records

The Contractor is obligated to keep accurate and up-to-date accounts and records concerning the above items.

1.18.3.3 Payment

Separate payment will not be made for complying with the requirements of this Clause and all costs shall be deemed to be included in the rates and lump sums entered in the priced Bill of Quantities.

1.18.4 Liquidated Damages

1.18.4.1 Amount of Liquidated Damages

If the Contractor should fail to complete the Works by the Intended Completion Date as defined in Clause 1.1 of the Conditions of Contract, the Contractor shall pay to the Employer liquidated damages pursuant to clause 49 of the Conditions of Contract,.

1.18.4.2 Maximum Damages

The maximum amount of liquidated damages payable or allowable to the Employer will be limited to the percentage of the final Contract Price stated in the Contract Data.

1.18.4.3 Other Rights of the Employer

Nothing contained in this Clause shall prejudice or affect any other rights of the Employer under the Contract.

1.18.5 Monthly Statement

1.18.5.1 General

The Contractor shall submit a monthly statement in accordance with the requirements of Clause 42 of the Conditions of Contract. The monthly statement shall be accompanied by copies of all survey notes, records of measurements and calculation which the Engineer has directed to be prepared by the Contractor in support of the amounts claimed for the claimed for the work executed.

1.18.5.2 Payment

All costs associated with the submission of the monthly statement shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities.

1.18.6 Hours and Days of Working

Before commencement of work on the Contract, the Contractor shall notify the Engineer, in writing, of the days, hours and of the number of shifts that he proposes to work and shall give at least 48 hours notice to the Engineer of any changes to such hours of working and/or number of shifts that may be necessary during the currency of the Contract.

1.18.7 Prevention of Water Pollution

1.18.7.1 Scope

The Contractor's construction activities shall be performed by methods that prevent entrance or accidental spillage of solid matter, contaminants, debris and other objectionable pollutants and wastes into streams, flowing or dry water courses and underground water sources. Such pollutants and wastes include but not restricted to refuse, garbage, cement, concrete, sewage effluent, industrial waste, oil and other petroleum products. The Contractor shall submit his plan showing the location and design of the water pollution prevention systems and facilities to the Engineer for approval.

1.18.7.2 Payment

Separate payment will not be made for complying with the provisions of this Clause, and the costs shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities.

1.19 MEASUREMENT AND PAYMENT (GENERAL)

1.19.1 General

The method of measurement shall be in accordance with the methods and procedures stipulated in the particular clauses and as set forth herein.

The various unit rates and lump sums for each work item entered in the priced Bill of Quantities shall be deemed to have included full compensation for supplying all materials, labour, equipment consisting of owning, operation and repair costs, and other expenses necessary to complete the work in accordance with the Drawings, the Specifications, the instructions of the Engineer and compliance with all other obligations, including rectification of defects, as required under the Contract.

1.19.2 Tolerance for Measurement

This clause explains the tolerance for measuring the dimensions of the work and the method of calculation of the quantity of the work completed in the following categories:

(1) Category - 1 (linear metres, m)

The work item shall be measured to the second decimal place of a metre and be approved by the Engineer at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the measured length by the unit rate and then rounding the result to the nearest integer.

The following items are to be included in this category :

- Drain Pipe, PVC Pipe Dia. 100 mm
- Expansion Joint

(2) Category - 2 (square metres, m^2)

The work item shall be measured to the second decimal place of a square metre by multiplying the two dimensions, measured to two decimal places, and rounded off, and approved by the Engineer at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the measured area by the unit rate and then rounding the result to the nearest integer.

The following item is to be included in this category :

- Clearing and Grubbing

(3) Category – 3 (cubic metres, m3)

The work item shall be measured to the second decimal place of a cubic metre by multiplying the three dimensions, measured to two decimal places of a metre, and rounded off and approved by the Engineer at every work stage on an inspection Sheet.

The amount of payment will be determined by multiplying the measured volume by the unit rate and then rounding the result to the nearest integer.

The following items are to be included in this category :

- Concrete Type B including Formwork
- Concrete Type C-1 including Formwork
- Levelling Concrete Type E

- Stripping of Topsoil
- Excavation
- Backfilling
- Embankment
- Wet Stone Masonry
- Wet Stone Masonry Reconstruction
- Stone Block Reconstruction

(4) Category - 4 (Lump Sum Item)

The method of measurement and payment shall be as set out in the respective payment clause for each of the following items for which payment is by lump sum.

- Mobilization and Demobilization
- Establishment
- Drawings
- Administration Building
- Staff House 1
- Staff Houses 2-1 to 2-4
- Mushola
- External Works
- Demolition of Existing Gate

(5) Category - 5 (mass)

a) (Mass in kg)

The work item shall be measured to the second decimal place of a metre and multiplied by the approved mass per metre at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the calculated quantity by the unit rate and then rounding the result to the nearest integer.

The following items are to be included in this category :

- Deformed Reinforcing Bars
- Hand Rail

b) (Mass in tonne, Note: 1 tonne = 1000 kg mass)

The mass shall be determined by reference to delivery notes from the specialised supplier, duly approved by the Engineer or his representative, to the accuracy of the third decimal place of a tonne (1 kg).

The amount of payment will be determined by multiplying the approved quantity by the unit rate and then rounding the result to the nearest integer.

The following item is to be included in this category :

- Asphaltic Concrete

(6) Category - 6 (Number {No.})

The work item shall be measured to the exact number of items installed and approved by the Engineer at every work stage on an Inspection Sheet.

The amount of payment will be determined by multiplying the number by the unit rate and then rounding the result to the nearest integer.

The following items are to be included in this category :

- Elastomeric Bearing Pad
- Weep Hole, Dia 50 mm

Category – 6 (month)

Refer to clause GS 1.9.3

DIVISION B

TECHNICAL SPECIFICATIONS
CIVIL WORKS

TABLE OF CONTENTS

SECTION TS 1. PREPARATORY WORKS

SECTION TS 1. PREPARATORY WORKS

1.1 GENERAL

This section of the Technical Specification covers the preparatory works to be carried out by the Contractor for the Goa Kreo Bridge site works.

The work comprises clearing and grubbing.

1.2 CLEARING AND GRUBBING

1.2.1 Scope

The work shall consist of felling, cutting into manageable lengths, grubbing of stumps and roots, removal of all timber, leaves and debris from the site and the demolition and removal of existing concrete and masonry structures. The material shall be disposed of, off-site, in a manner approved of by the Engineer.

Where directed by the Engineer, the holes resulting from grubbing operations shall be filled with approved materials which shall be placed and compacted to the same density as the adjoining soil.

1.3 MEASUREMENT AND PAYMENT

Measurement shall be made of the area cleared and grubbed to the Engineer's approval.

Payment I will be made at the unit rate entered in the priced Bill of Quantities which includes the entire cost of completing the work including materials, labour, equipment, transportation, disposal of materials, cleaning up and all associated costs.

Categories of work to be paid under this clause are as follows:

Description	Unit of Measurement
Clearing and Grubbing	m^2

TABLE OF CONTENTS

SECTION TS 2. EARTHWORKS

SECTION TS 2. EARTHWORKS

2.1 GENERAL

This section of the Technical Specification covers the general and specific requirements of earthworks.

2.1.1 Character of Strata

The Contractor shall acquaint himself with all available data regarding earthworks and the character of strata and materials to be excavated and used as filling. He shall satisfy himself as to :

- the general circumstances at the Site of the Works
- any obstructions thereon
- the surface of the ground
- possible subsidence of soft ground
- poor materials
- possibility of floods
- his obligations for diversion and care of water under clause 1.13 of the General Specification
- slipping clay
- running sand
- gravel and boulders
- springs, subsoil and river water, loose or solid rock and stones
- trees, brushwood, timber and debris
- obstructions of any kind and material of whatever nature.

Rates entered in the Bill of Quantities shall reflect the Contractor's own assessment of risk and influence that these matters may have on his costs and no subsequent adjustments shall be made to rates for any reason.

2.1.2 Earthworks to Dimensions, Lines and Levels

All earthworks shall be carried out to the dimensions, lines and levels as shown on the Drawings, or to such other dimensions, lines and levels as may ordered by the Engineer. Dimensions and lines, which are based on or related to ground levels, shall be referred to the Engineer before commencing earthworks at any location.

2.1.3 Method of Excavation

The Contractor shall carry out excavation in whatever material may be encountered and by any method or combination of methods he considers most suitable subject to any restrictions herein.

The Contractor shall give due consideration to the matters in clause TS 1.1.1 (Character of Strata), clause GS 1.13 (Diversion and Care of Water) of the General Specification, location and access to soil disposal areas, fill and stock pile areas and all other relevant factors.

2.1.4 Unsuitable Materials

Excavated materials which, in the opinion of the Engineer, do not meet required Specifications for fill, embankment or backfill shall not be used for such purpose and shall be transported to spoil dumps or stockpiles.

2.1.5 Transportation of Excavated Material

The transportation of excavated material to fill embankment, backfilling or stockpile site or disposal of excess or unsuitable materials shall be carried out in accordance with the approved schedule of earthworks operations. The Contractor shall transport material by the most appropriate route between excavation and placement or disposal areas. Protective measures shall be made and maintained throughout for the safety of operations both on-site and off-site.

When hauling is done off-site loads shall be trimmed to prevent spillage. Wet materials to be hauled shall be dried sufficiently prior to loading to prevent spillage by leaking. Any damage or unsightly appearance on the surface of any road caused by the Contractor's hauling operation shall be reinstated by the Contractor at his own expense.

2.1.6 Disposal of Excavated Materials

Excavated material which, in the opinion of the Engineer, is suitable for use in filling backfill may be transported directly to its final position, stock piled, or placed as otherwise approved by the Engineer.

Unsuitable soil or surplus excavated materials shall be disposed of in approved disposal areas as directed by the Engineer. The Contractor shall trim and grade spoil tips to profiles, heights and levels approved by the Engineer.

2.2 STRIPPING TOPSOIL

2.2.1 General

Stripping topsoil shall consist of the removal of all organic materials such as sod, topsoil and roots from areas where earth fill or embankment are to be constructed.

2.2.2 Method of Execution

Stripping of topsoil shall be to the depth and area limits shown on the drawings or as directed by the Engineer. All topsoil stripped, except that as may be used or saved in accordance with the Engineer's order, shall be disposed of in the manner described for soil unfit for reuse in clause 2.1.6. The minimum depth of topsoil stripping shall be 250 mm unless otherwise specified on the Drawings or directed by the Engineer.

2.3 EXCAVATION

2.3.1 General

This clause refers to all excavation (including structural excavation) to be carried out under the Contract and shall be read in conjunction with clause 2.1.

The Contractor shall carry out all excavation in whatever material may be encountered in accordance with these Specifications, Drawings and any directions of the Engineer. The Contractor shall provide and operate all necessary excavating, lifting, hauling, transport and other equipment to deal with any type of material encountered. Excavation for the various works shall be carried out to such widths, lengths, depths and profiles as shown on the Drawings, or to such other dimensions as may be ordered by the Engineer in writing.

Where necessary the sides of all excavations shall be properly shored up and supported with strutting and planking, and the sides shall be close sheeted where necessary to prevent the entry of running sand, mud and the like. Sheet piling shall be used where site constraints preclude the use strutting and planking.

When any excavation has been completed and trimmed, the Engineer shall be informed so that he may make a formal inspection. No excavation shall be backfilled or covered with concrete until it has been inspected and the Contractor has been authorised to proceed.

2.3.2 Excavation Beyond True Line

Where any over-excavation occurs for whatever reason or cause, unless as a result of the Engineer's direction, the Contractor shall, at his own expense, make good those excavations to the required line and level with :

1) approved material and in such manner as the Engineer may direct where the excavation is other than for concrete work; or
2) concrete of the same grade as that to be used in the true excavated shape, unless directed otherwise by the Engineer, where the excavation is for concrete work.

2.3.3 Structural Excavation

Except where otherwise shown on the Drawings or directed by the Engineer, Structural Excavation shall comprise excavation associated with the construction of structures.

Except where otherwise shown on the Drawings or directed by the Engineer the Contractor shall perform structural excavation to one of the two relevant typical profiles described below.

1) Where soil conditions do not require shoring, the side slope shall be at 1.0 unit vertical to 1.0 unit horizontal with a horizontal clearance at the underside of the proposed footing to the start of the excavation slope of 500 mm.
2) Where shoring is necessary owing to constricted working area, the need to prevent the entry of running sand or mud, shoring or sheet piling shall be placed such that there is a horizontal clearance of 1000 mm between the underside of the proposed footing and the inner face of the shoring.

The base and side slopes of excavation against which concrete is to placed shall be finished accurately to the dimensions shown on the Drawings or prescribed by the Engineer and the surface so prepared shall be thoroughly compacted with suitable equipment to obtain a satisfactory foundation. If at any point the natural foundation material is disturbed during the excavation process or otherwise, it shall be compacted in place to obtain a satisfactory foundation, or it shall be removed and replaced with approved compacted materials or concrete , all the Contractor's expense.

2.4 FILL

2.4.1 General

The work described in this clause shall consist of the furnishing of necessary materials and selecting, stockpiling and blending if required, transporting, placing , spreading, adjustment of moisture content, compaction, shaping and doing incidental items of work to construct the finished fill to the lines, grades and profiles as shown on the drawings or as directed by the Engineer.

The Contractor shall make due allowance for consolidation and settlement whether compaction is specified or not, such that the levels, widths and dimensions of the finished surfaces at the end of the Defects Liability Period shall not be less than the levels and dimension shown on the Drawings.

All filling and embankments shall be constructed to the lines and levels shown on the Drawings or established by the Engineer.

2.4.2 Materials

Materials to be used for the various types of fills shall conform to the requirements specified herein or as approved by the Engineer.

The Contractor shall submit to the Engineer for approval, samples and grading analyses (as applicable) of all materials proposed to be used for the various types of fill as specified below.

Earth Fill for Embankment, and Backfill

Material to be used shall be extracted and selected from excavated material and shall not contain roots, turf or clod exceeding 75 mm in size or organic matter of any kind and shall be approved by the Engineer.

Generally material shall not be used, unless permitted by the Engineer, where:

1) its 60% particle size is less than four times its 10% particle size.
2) it contains less than 8% passing 0.075 mm test sieve.

Gravel

Gravel shall consist of hard durable stone which will not break down or deteriorate in service and shall be clean and free from clay or other deleterious materials. Unless otherwise specified or directed, gravel shall be natural gravel or crushed stone with grading, by weight, determined in accordance with AASHTO test methods, conforming to the grading shown in the following table:

Sieve Size	Percentage Passing
2 inch (50 mm)	100
1½ inch (37 mm)	95-100
3/4 inch (19 mm)	50-100
1/2 inch (2 mm)	-
3/8 inch (8mm)	15-55
No 4	0-25
No 8	0-5
No 200	0-3

2.4.3 Placing, Compaction and Moisture Content of Filling

This clause relates to the earth fill used in backfill and embankment as shown on the drawings.

Fill material shall not be placed when, in the opinion of the Engineer, satisfactory results cannot be achieved due to heavy rain or other adverse conditions.

Fill shall be spread and compacted in approximately horizontal layers of uniform moisture content and uniform compacted thickness not exceeding 300 mm (or to lesser thickness as specified elsewhere). Filling, operations shall be such as to ensure that materials will be blended sufficiently to achieve the highest practicable dry density, and stability. Where the surface of any layer of filling is too dry or too smooth to bond properly with the next layer of material, it shall be moistened and/or scarified in an approved manner to provide a satisfactory bonding surface before the next layer is placed.

The moisture content of filling shall be carefully controlled, either by natural drying or wetting with a fine spray, to achieve optimum values. Fill material shall be compacted to a density of not less than 90% maximum standard dry density determined in accordance with AASHTO T 99. For portions of embankment upon which road pavements are to be constructed the upper 300 mm of fill material directly below the road pavement shall be compacted at optimum moisture content to a compaction of 90% maximum standard dry density in accordance with AASHTO T 99 for the full width of the roadway. Where practical, as determined by the Engineer, moistening of the material shall be performed at the site of stockpiles but such moistening shall be supplemented by fine spraying at the time of compaction, if necessary. Where moisture content is beyond the optimum range, the operation shall not proceed except with the specific approval of the Engineer, until the material has been conditioned by wetting or drying to achieve a moisture content in the required range.

All compaction equipment shall be approved by the Engineer in writing before commencement of any filling operations.

2.4.4 Preparation of Surface under Embankment

Filling shall not be placed on any portion of embankment foundation until such foundation has been cleared, stripped of topsoil, suitably prepared and has been approved by the Engineer. Tests pits, trenches and cavities resulting from the removal of unsound foundation materials or for inspection of sub-surface conditions shall be filled with selected materials.

Foundation material which does not have a density in the undisturbed condition as specified for the fill material to be placed upon it shall be moistened and compacted to specified dry density or shall be removed, filled and compacted or shall be treated in a manner as directed by the Engineer.

2.4.5 Filling Adjacent to Structures

Filling adjacent to structures shall be placed and compacted to avoid damage to such structures. Compaction adjacent to structures shall be carried out by hand or with suitable hand-operated equipment in horizontal layers not exceeding 150 mm thickness after compaction.

Unless otherwise specified or permitted by the Engineer, filling shall not be placed and compacted adjacent to concrete until at least fourteen (14) days after the placing of the concrete.

2.4.6 Embankment Construction

Filling for embankment construction shall mean completion of all filling constructed in accordance with the requirements of clause 2.4.3 and to the lines, levels and profiles shown on the Drawings or as directed by the Engineer.

2.4.7 Soil Tests

Tests on materials for use as filling shall be performed by the Contractor and shall enable determination of soil characteristics, suitability, dry density/moisture content relationships and the like. A formal report of all tests shall be prepared by the Contractor and approved by the Engineer. Tests shall be performed by the Contractor prior to commencement of earthworks, and every time soil characteristics change. Tests to be performed shall be directed by the Engineer and may include but not be limited to the following :

a) Compaction (AASHTO T 99) (Dry Density)

b) Particle size distribution

c) Specific gravity

d) Moisture content

e) Plastic limit

f) Direct shear

Test results shall be submitted to the Engineer for approval.

Field moisture content tests of compacted filling shall be made on each layer and at a frequency of one test for every 200 m^2.

The Contractor shall prepare a soil test programme in conjunction with his earthworks operation schedule and submit it to the Engineer for approval.

For gravel, only particle size distribution tests are required.

2.4.8 Backfill

Backfill comprising approved materials complying with the specification for filling provided in clause 2.4.2, shall be placed and compacted adjacent structures as shown on the Drawings or as directed by the Engineer.

Prior to commencement of backfilling adjacent to structures, the area shall be cleared of all formwork and other temporary works. Compaction shall be carried out by hand or with suitable hand operated equipment so as to achieve specified compaction without damage to structures. Backfilling material shall be wetted or allowed to dry in order achieve optimum moisture content for compaction.

Backfilling shall be placed and compacted in continuous horizontal layers of not more than 150 mm compacted thickness. Unless otherwise specified, backfilling shall be compacted to 90% of the maximum dry density as determined in the laboratory compaction test referred to in clause TS 2.4.7.

Unless otherwise specified or permitted by the Engineer, backfilling shall not be placed and compacted adjacent to concrete until at least fourteen (14) days after the placing of concrete.

Compaction of backfilling material placed above buried concrete, however, shall not be permitted to be carried out with vibrating equipment except with the prior approval of the Engineer.

2.5 MEASUREMENT AND PAYMENT

2.5.1 Stripping of Topsoil

Measurement shall be made of the volume of topsoil stripped in accordance with the requirements of clause TS 2.2 of the Technical Specification. No measurement shall be made of stripping in excess of 250 mm unless authorised by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

Categories of work to be paid under this clause are as follows:

Description	Unit of Measurement
Stripping of Top Soil	m^3

2.5.2 Excavation

Measurement of the volume excavation will be made using the average end area method or other method approved by the Engineer.

Measurement for payment shall not be made of over-excavation beyond the lines, levels and profiles shown on the drawings.

Payment shall be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the excavation from the approved original surface levels down to the lines, levels and profiles shown on the drawings including materials, labour, equipment, transportation and any other associated costs.

Payment shall be deemed to include allowance for the cost of:

1. excavation through any material and to any depth
2. trimming to the correct profiles, lines and levels as shown in the Drawings
3. separating and setting aside those excavated materials suitable for re-use for other purposes and transporting to spoil those materials unsuitable for re-use
4. transporting excavated materials to spoil disposal areas or stockpiles
5. preparation, clearing and clearing up spoil disposal areas after completion to the satisfaction of the Engineer.

Categories of work to be paid under this clause are as follows:

Description	Unit of Measurement
Excavation	m^3

2.5.3 Fill

2.5.3.1 Embankment

Measurement of the volume of embankment shall be made of the actual volume in cubic meters as determined by the measurement taken before and after filling operation. No measurement and payment shall be made for unauthorised filling outside the lines shown on the Drawings.

Payment shall include the cost of quarrying (in case of borrow), sorting, grading, handling, hauling, placing, watering, levelling, compacting and testing of the materials of in-place fill. Payment shall also include cost of preparation for surface and trimming of slopes and all labour, materials and equipment necessary to complete the work.

Categories of work to be paid under this clause are as follows:

Description	Unit of Measurement
Embankment	m^3

2.5.3.2 Backfill

Measurement shall be made of the volume of the backfill. Measurement will not be made of the volume of backfilling of structural excavation beyond the limits described in clause 2.3.2.4 of the Technical Specification.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

Categories of work to be paid under this clause are as follows:

Description	Unit of Measurement
Backfill	m^3

TABLE OF CONTENTS

SECTION TS 3. CONCRETE WORK

SECTION TS 3. CONCRETE WORK

3.1 GENERAL

3.1.1 Scope

This section of the Technical Specification covers the general and specific requirements of concrete. It relates to the concrete in the Goa Kreo Bridge, the Dam Management Comples and all other parts of the Works which contain concrete.

This section particularly covers the supply and mixing of materials, the forming, placing, curing and finishing of the concrete, the quality of concrete required, and the supply, handling and placing of steel reinforcement for concrete.

Special requirements for concrete with respect to prestressed, precast or other types of concrete are specified in the relevant sections of the Technical Specification.

3.1.2 Description of Concrete, Mortar and Grout

3.1.2.1 Concrete

Concrete shall be composed of water, cement, fine aggregate and coarse aggregate and of any admixture that may be specified or consented to by the Engineer.

The consistency is to be in accordance with Clause 3.2.5.2

Testing is to be witnessed by the Engineer unless otherwise directed by the Engineer.

3.1.2.2 Cement Mortars

Cement mortar shall be composed of one part of cement to one part of fine aggregate by volume, or such other proportions as shall be directed by the Engineer, or as shown on the Drawings but not exceeding three parts by volume of fine aggregate to one part of cement mixed with water so that the water-cement ratio does not exceed 0.45 by weight.

Stiff cement mortar shall be as above, but with a water-cement ratio not exceeding 0.35, or to a consistency consented to by the Engineer.

Dry pack cement mortar shall be as above, but with water just sufficient to ensure full hydration of cement.

Mix proportions for mortar for wet stone masonry are specified in the technical specification for wet stone masonry in this specification.

3.1.2.3 Grout

Grout for sealing prestressing tendon ducts of other purposes shall be composed of cement, fine aggregate, water and admixtures as consented to or directed by the Engineer. The proportion of fine aggregate in the mix shall be as determined by the Engineer, who may direct that it be omitted altogether. The admixtures may be expanding and/or flow promoting agents. If aluminium powder is used as an expanding agent, the proportion shall be fifty parts per million of the cement by weight and the powder shall be mixed

with ground pumice stone and/or dry cement prior to adding to the cement dry. The proportion and colour of the pumice used shall be as consented to by the Engineer and shall ensure that accurate and uniform mixing with the cement is obtained.

The water-cement ratio shall be between 0.40 and 0.50 by weight. When used for sealing ducts in prestressed concrete, the grout shall be mixed to the stiffest consistency that can be forced through the ducts at as pressure consented to by the Engineer, generally not more than 700 kPa (7 kg/cm^2).

Grout for sealing ducts shall not be fed to the grout pump until the whole batch is thoroughly mixed. The grout shall be free of lumps and shall be strained, using a suitable filter.

Where non-shrink grout is specified for use, the Contractor shall submit technical data of the particular product proposed to be used for the Engineer's review and approval.

3.1.3 Classes of Concrete

The class or strength grade of concrete used in each part of the Works shall be that called for on the Drawings or ordered by the Engineer.

Where not shown on the Drawings or ordered by the Engineer the use of each class of concrete shall be as shown in Table 3.1. Attention is drawn to the alternative notation for concrete class. The upper designation C1, D etc. refers to the notation shown on the drawing and in the Bill of Quantities whilst the lower designation (K250 etc) refers to the notation used throughout this specification and the Indonesian Concrete Code.

Table 3.1: Classes of Concrete

Class of Concrete	28-day Compressive Strength MPa	kgf/cm^2	Max. Size of Aggregate mm	Application
A-1 K500	50	500	-	Prestressed concrete piles from commercial suppliers
A-2 K400	40	400	25	Prestressed concrete for bridge beams and prestressed concrete piles
A-3 K350	35	350	25	Prestressed concrete slabs, precast concrete piles
B K250	25	250	25	Reinforced concrete bridge beams
C1 K225	22.5	225	25	General use for reinforced concrete
C2 K225	22.5	225	15	Secondary concrete for blockouts.
D K175	17.5	175	40	Plain concrete for structures
E K125	12.5	125	25	Plain concrete for levelling

The class of concrete is defined as the Characteristic Strength at 28 days as defined in the Indonesian Concrete Code, (PBI 71), for samples tested in accordance with the requirements of AASHTO T 22 (ASTM C 39) using standard cubes of 150 mm.

Air - entrained is not required unless called for in the Drawings.

3.1.4 Strength Requirements

The mean compressive strength of the concrete shall be determined on the specimens obtained in prepared in accordance with AASHTO T 141 (ASTM C 172) and AASHTO T 23 (ASTM C 31). Test specimens made and cured in the laboratory shall conform to AASHTO T 126 (ASTM C 192). The compression test shall be performed on specimens according to specification AASHTO T 22.

The Characteristic Strength of the various classes of concrete, an accordance with the Indonesian Concrete Code (PBI 71), is obtained as defined as being the strength below which only 5 percent of specimens fall for a minimum of 20 specimens tested.

The mean compressive strength of concrete after 28 days shall be equal to or greater than the sum of the relevant Characteristic Strengths, as shown in Table 3.2, plus the strength margin as defined in Clause 3.2.1.2 below, while the mean compressive strength at 7 (seven) days shall, unless otherwise shown on the Drawings or directed by the Engineer, be 75 % (seventy five percent) of the prescribed values at 28 (twenty eight) days.

Table 3.2- Strength Requirements

Classes of Concrete	Characteristic Strength at 28 days (kg/cm^2)	
	Cube(1)	Cylinder(2)
K500	500	-
K400	400	-
K350	350	290
K225	225	185
K175	175	145
K125	125	100

(1) Cube of 15 cm size (2) Cylinder of 15x30 cm size

3.2 SUPPLY AND DELIVERY OF CONCRETE

3.2.1 Mix Design

3.2.1.1 General

The concrete shall consist of a mixture of cement, fine aggregate, coarse aggregate and water.

The concrete may also contain admixtures where these have been consented to by the Engineer.

3.2.1.2 Target Strength

The concrete mix shall be designed for a target strength in excess of the specified Characteristic Strength. The target strength shall be selected

3.2.1.2 Target Strength

The concrete mix shall be designed for a target strength in excess of the specified Characteristic Strength. The target strength shall be selected having regard to the degree of quality control which the Contractor can expect over the materials and handling of concrete in the field.

For water cured concrete the target strength shall not be less than T, where:

$$F_c = T - 1.64\ s$$

and F_c is the specified Characteristic Strength at 28 days, and is the standard deviation as defined below.

For other methods if curing the Contractor shall submit the method of calculation of T.

3.2.1.3 Standard Deviation

For classes of concrete with the Characteristic Strengths less than or equal to 35 MPa (350 kg/cm^2) the estimated standard deviation of the compressive strengths of the concrete produced shall not be less than 4.5 MPa (45 kg/cm^2) nor greater than 8.5 MPa (85 kg/cm^2).

For classes of concrete with the Characteristic Strengths above 35 MPa (350 kg/cm^2) the estimated standard deviation of the compressive strengths of the concrete produced shall not be less than 25 MPa (250 kg/cm^2) nor greater than 5.0 MPa (50 kg/cm^2).

The Contractor shall nominate the target strength for the Engineer's consent. The standard deviation shall be determined for the concrete batch plant used and shall allow for variability of materials, batching, mixing, sampling and delivery operations. The target strength nominated shall take into account that the characteristic minimum compressive strength of concrete is based on the testing of samples taken at the point of use. Table 3.3 may be used as an initial guide in the determination of the estimated standard deviation.

Table 3.3 – Initial Estimate of Standard Deviation

Job	Standard of Control	Estimated Standards Deviation (MPa) – (kg/cm^2)		Margin by which target should exceed specified strength (MPa) - (kg/cm^2)	
		F'c < 35 (MPa)–(350 kg/cm^2)	F'c < 35 (MPa)–(350 kg/cm^2)	F'c < 35 (MPa)–(350 kg/cm^2)	F'c < 35 (MPa)–(350 kg/cm^2)
Weigh batching of all materials, aggregate moisture and slump checks, uniform materials, very good methods of transport and placement and complete freedom from contamination of the concrete, constant supervision.	Excellent (automated control)	3.5 – 4.5 (35-45)	2.5 – 3.5 (25-35)	6.0 – 7.5 (60-75)	4.0 – 6.0 (40-60)
Weigh batching of all material, slump checked, occasional changes in production and slump, good methods of transport and placing and regular supervision	Very Good	4.5 – 5.5 (45-55)	3.5 – 5.0 (35-50)	7.5 – 9.0 (75-90)	6.0 – 8.0 (60-80)
Weigh batching of all materials or volume batching of aggregates plus allowance for moisture bulking, regular supervision of mixing and placing of concrete	Fair	5.5 – 7.5 (55-75)	Not Applicable	9.0 – 12.0 (90-120)	Not Applicable

In the design of a mix the Contractor shall take into account the slump requirements and the grading and maximum size of aggregates specified.

3.2.1.4 Proportions of Mix

i. Design submitted by the Contractor

The Contractor shall submit to the Engineer for his consent details of the concrete mix design, including the water-cement ratio proposed to be used for each class of concrete. These details shall be supplied six (6) weeks in advance of placing that particular class of concrete in the work so as to permit strength test to be made from trial mixes. The trial mixes will be carried out using samples of the materials submitted, and in the proportions proposed, by the Contractor. Alternatively the Engineer may request the Contractor to prepare, at the Contractor's expense, a trial mix of each class of concrete proposed to be used incorporating only such materials as have been tested and their use consented to by the Engineer. The trial mixes shall be made in the presence of the Engineer or his representative using the plant and the degree of quality control proposed for the work. Each mix shall be tested for slump, workability and strength.

If the coarse aggregate of fine aggregate is composed of more than one material of size of material the mix proportions of each shall be specified separately. Samples of each type of material and/or each size of material shall also be supplied by the Contractor as specified in Clauses 3.2.2.2 and 3.2.2.3

The Proportions of the concrete mixes shall be designed by the Contractor to satisfy the specified requirements of strength, grading and consistency.

Unless otherwise specified or consented to the Engineer, slump, water cement ratio and cement content shall conform to the values in Table 3.3.

Table 3.4- Properties of Concrete Mix

Class	Characteristic Minimum Strength (MPa)		Minimum Cement Content 3) (kg/m^3)	Maximum Water/Cement Ratio by mass	Maximum Slump[4] (mm)
	Cube[1]	Cylinder[2]			
K125	12.5	10.0	200	0.60	100
K175	17.5	14.5	240	0.60	100
K225	22.5	18.5	280	0.60	100
K350	35.0	29.0	360	0.50	100
K400	40				
K500	50				

Note:

1) Compressive strength based on 150 mm cube

2) Compressive strength based on 150 mm diameter x 300 mm high cylinder.

Concrete to be paced under water shall have a minimum cement content of 400 kg/cm3.

Slump will be determined in accordance with Clause 3.2.5.2

The maximum cement content in any concrete mixture shall not exceed 450 kg/m^3.

ii. Trial Mix Results

Prior to consent being given to a mix by the Contractor its compressive strength and shrinkage at 28 days will be checked from trial mixes.

A minimum of 20 Specimens shall be cast for the purpose of ascertaining the compressive strength of the trial mix.

In the case of urgency or for mixes which contain special admixtures, or are stream cured the Engineer may give a provisional consent based on test at an earlier age than 28 days but tests at age 28 days shall be the basis of final consent.

After the Engineer has consented to the use of a certain mix design of a particular class of concrete this mix shall be used for the work. In the event of changes in either properties or sources of materials or in their relative proportions the Engineer may require changes in the proportion of the materials and further testing.

iii. Control of Mix During Contract

In order to determine any need for mix adjustment the progress of the work, a statistical check may be made of the compressive strength of concrete, using consecutive 28 days test result representing concrete placed in the work, and making separate checks of each mix.

For each separate class of concrete, the concrete mix and its method of productions will be considered satisfactory should the following requirements be met:

i. Not more than one specimen from a group of twenty (20) consecutive specimens shall have a compressive strength at 28 days less than the Characteristic Strength for that class of concrete.

ii. The average of compressive strength at 28 day of any four (4) consecutive specimen shall not be less than the Characteristic Strength for that class of concrete plus 0.82 times the standard deviation as defined below.

iii. The difference in the values of compressive strength at 28 days between the highest and lowest value of any four (4) consecutive specimen shall be less than 4.3 times the standard deviation defined below.

The standard deviation shall be taken as the initial estimate (Clause 3.2.1.3 refers) until 20 specimens from concrete in the structure have been tested. At this stage the value of standard deviation shall be calculated from the result of the 20 strength tests this review process shall be repeated after every successive 20 test result and the requirement i, ii, and iii above applied succeeding batches of concrete.

In any case the standard deviation shall not exceed 8.5 MPa (85 kg/cm^2) for classes of concrete with Characteristic Strengths less than or equal to 35 MPa (350 kg/cm^2) or 5.0 MPa (50 kg/cm^2) for classes of concrete with Characteristic Strength above 35 MPa (350 kg/cm^2).

Notwithstanding consent by the Engineer to a proposed mix, the Contractor shall be solely responsible for producing concrete with satisfies the requirements of this Specification.

Should the Contractor propose to place concrete by pumping and the design of a mix suitable for pumping requires cements additional to that specified above, the cost of the additional cement shall be borne by the Contractor.