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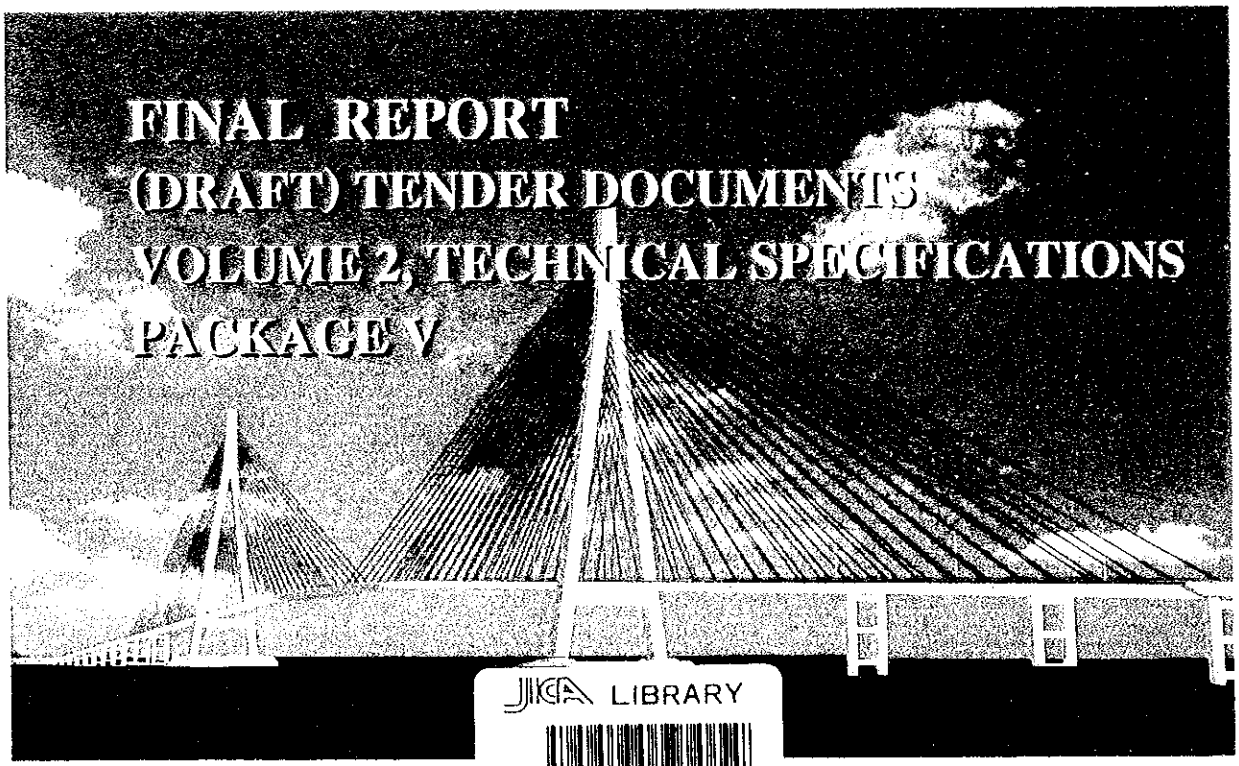
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF TRANSPORT
SOCIALIST REPUBLIC OF VIET NAM

THE DETAILED DESIGN ON THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM



FINAL REPORT
(DRAFT) TENDER DOCUMENTS
VOLUME 2, TECHNICAL SPECIFICATIONS
PACKAGE V

OCTOBER 2000

NIPPON KOEI CO., LTD.

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TECHNICAL SPECIFICATION

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SECTION 1 GENERAL

S1.01 Outline Drawings and Specifications.

S1.01 (1) General.

The Contractor shall keep at the Work site a copy of the Outline Drawings and Specifications, to which the Inspector shall have access at all times.

The Outline Drawings, Specifications and other Contract Documents will govern the Work. The Contract Documents are intended to be complementary and cooperative and to describe and provide for a complete project. Anything in the Specifications and not on the Outline Drawings, or on the Outline Drawings and not in the Specifications, shall be as though shown or mentioned in both.

The Contractor shall, upon discovering any error or omission in the Outline Drawings or Specifications, immediately call it to the attention of the Inspector.

S1.01 (2) Shop Drawings.

When shop drawings or other drawings are required by the Outline Drawings or Specifications or requested by the Inspector, they shall be prepared in accordance with current modern engineering practice at the Contractor's expense. Drawings shall be of a size and scale to show clearly all necessary details and shall be transmitted by letter to the Engineer for approval or correction at least 30 days before approved drawings will be required for commencing the work.

Materials shall not be furnished or fabricated nor any work done for which drawings are required, before approval of the drawings by the Employer.

When first submitted by the Contractor, each drawing shall be a good quality transparency, accompanied by two prints. If approved without change or correction, three approved copies on paper will be furnished to the Contractor. If extensive additions or corrections are required, the Inspector will return one marked-up copy to the Contractor, together with the transparency, for correction and resubmission. Approved transparencies will be retained by the Employer.

Approval of drawings by the Employer shall not relieve the Contractor from the responsibility for errors or omissions in the drawings or from deviations from the Contract Documents unless such deviations were specifically called to the attention of the Employer in the letter of transmittal submitted with the drawings. The Contractor shall be

responsible for the correctness of the drawings, for shop fits and field connections, and for the results obtained by use of such drawings.

S1.01 (3) Subsurface Data.

All soil and test hole data, water table elevations, and soil analyses shown on the drawings or included in the Specifications apply only at the location of the test holes and to the depths indicated. Soil test reports for test holes which have been drilled are available for inspection at the office of the Inspector. Any additional subsurface exploration shall be done by Bidders or the Contractor at their own expense.

The indicated elevation of the water table is that existing at the date the test hole data was determined. It is the Contractor's responsibility to determine and allow for the elevation of groundwater at the date of project construction. A difference in elevation between groundwater shown in soil boring logs and groundwater actually encountered during construction will not be considered as a basis for extra work.

S1.02 Right-of-Way.

Rights-of-way, easements or rights-of-entry for the Work will be provided by the Employer. Unless otherwise provided, the Contractor shall make arrangements, pay for, and assume all responsibility for acquiring, using, and disposing of additional work areas and facilities temporarily required. The Contractor shall indemnify and hold the Employer harmless from all claims for damages caused by such actions.

S1.03 Surveying.

S1.03 (1) Permanent Survey Markers.

The Contractor shall not disturb permanent survey monuments or benchmarks without the consent of the Inspector, and shall bear the expense of replacing any that may be disturbed without permission. Replacement shall be done only by the Employer.

S1.03 (2) Lot Stakes.

The Contractor shall preserve property line and corner survey markers, except where their destruction is unavoidable, and the Contractor is proceeding in accordance with accepted practice. Markers that otherwise are lost or disturbed by its operations shall be replaced at the Contractor's expense by a Land Surveyor.

S1.03 (3) Line and Grade.

All work shall conform to the lines, elevations, and grades shown on the Outline Drawings.

Three consecutive points set on the same slope shall be used together so that any variation from a straight grade can be detected. Any such variation shall be reported to the Inspector. In the absence of such report, the Contractor shall be responsible for any error in the grade of the finished work.

Grades for underground conduits will be set at the surface of the ground. The Contractor shall transfer them to the bottom of the trench.

S1. 04 Authority of Board and Employer.

The Board has the final authority in all matters affecting the Work. Within the scope of the Contract, the Employer has the authority to enforce compliance with the Outline Drawings and Specifications. The Contractor shall promptly comply with instructions from the Inspector or an authorized representative.

On all questions relating to quantities, the acceptability of material, equipment, or work, the execution, progress or sequence of work, and the interpretation of Specifications or drawings, the decision of the Employer is final and binding, and shall be precedent to any payment under the Contract, unless otherwise ordered by the Board.

S1.05 Inspection.

The Work is subject to inspection and approval by the Inspector and the Employer. The Contractor shall notify the Employer before noon of the working day before inspection is required. Unless otherwise authorized, work shall be done only in the presence of the Inspector or an authorized representative. Any work done without proper inspection will be subject to rejection. The Inspector and any authorized representatives shall at all times have access to the Work during its construction at shops and yards as well as the project site. The Contractor shall provide every reasonable facility for ascertaining that the materials and workmanship are in accordance with these specifications. Inspection of the Work shall not relieve the Contractor of the obligation to fulfill all conditions of the Contract.

S1.06 Daily Reports by Contractor.

The Contractor shall submit a daily report to the Employer on forms approved by the Agency, together with applicable delivery tickets, listing all labor, materials, and equipment involved for that day and for other services and expenditures when authorized.

The report shall:

1) Show names of workers, classifications, and hours worked.

2) Describe and list quantities of materials used.

3) Show type of equipment, size, identification number, and hours of operation, including loading and transportation, if applicable.

4) Describe other services and expenditures in such detail as the Agency may require

S1.07 Materials and Workmanship.

S1.07 (1) General.

All materials, parts, and equipment furnished by the Contractor in the Work shall be new, high grade, and free from defects. Quality of work shall be in accord with the generally accepted standards. Material and work quality shall be subject to the Employer's approval.

Materials and work quality not conforming to the requirements of the Specifications shall be considered defective and will be subject to rejection. Defective work or material, whether in place or not, shall be removed immediately from the site by the Contractor, at its expense, when so directed by the Employer.

If the Contractor fails to replace any defective or damaged work or material after reasonable notice, the Inspector may cause such work or materials to be replaced. The replacement expense shall be deducted from the amount to be paid to the Contractor.

Used or secondhand materials, parts, and equipment may be used only if permitted by the Specifications.

S1.07 (2) Protection of Work and Materials.

The Contractor shall provide and maintain storage facilities and employ such measures as will preserve the specified quality and fitness of materials to be used in the Work. Stored materials shall be reasonably accessible for inspection. The Contractor shall also adequately protect new and existing work and all items of equipment for the duration of the Contract.

The Contractor shall not, without the Employer consent, assign, sell, mortgage, hypothecate, or remove equipment or materials which have been installed or delivered and which may be necessary for the completion of the Contract.

S1.08 Inspection Requirements.

S1.08 (1) General.

Unless otherwise specified, inspection is required at the source for such typical materials and fabricated items as structural concrete, metal fabrication, metal casting, welding, concrete pipe manufacture, protective coating application, and similar shop or plant operations. Standard items of equipment such as electric motors, conveyors, plumbing fixtures, etc., are subject to inspection at the job site only. Special items of equipment such as designed electrical panel boards, large pumps, water supply plant equipment, etc., are subject to inspection and performance testing in a factory or manufacture's shop. The Specifications may require inspection at the source for other items

S1.08 (2) Test of Materials.

Before incorporation in the Work, the Contractor shall submit samples of materials, as the Inspector may require, at no cost to the Employer. The Contractor, at its expense, shall deliver the materials for testing to the place and at the time designated by the Inspector. All initial testing and a reasonable amount of retesting shall be performed under the direction of the Inspector and at its expense to the Contractor.

The Contractor shall notify the Employer in writing, at least 15 days in advance, of its intention to use materials for which tests are specified, to allow sufficient time to perform the tests. The notice shall name the proposed supplier and source of material.

If the notice of intent to use is sent before the materials are available for testing or inspection, or is sent so far in advance that the materials on hand at the time will not last but will be replaced by a new lot prior to use on the work, it will be the Contractor's responsibility to renotify the Employer when samples which are representative may be obtained.

S1.08 (3) Certification.

The Employer may waive materials testing requirements of the Specifications and accept the manufacturer's written certification that the materials to be supplied meet those requirements. Materials test data may be required as part of the certification.

S1.08 (4) Trade Names or Equals.

The Contractor may supply any of the materials specified or offer an equivalent. The Inspector shall determine whether the material offered is equivalent to that specified. Adequate time shall be allowed for the Employer to make this determination. Unless otherwise authorized by

the Employer, the substantiation of offers must be submitted within 14 days after award of Contract.

Whenever any particular material, process, or equipment is indicated by patent, proprietary or brand name, or by name of manufacturer, such wording is used for the purpose of facilitating its description and shall be deemed to be followed by the words or equal. A listing of materials is not intended to be comprehensive, or in order of preference. The Contractor may offer any material, process, or equipment considered to be equivalent to that indicated.

The Contractor shall, at its expense, furnish data concerning items offered by it as equivalent to those specified. The Contractor shall have the material tested as required by the Inspector to determine that the quality, strength, physical, chemical, or other characteristics, including durability finish, efficiency, dimensions, service, and suitability are such that the item will fulfill its intended function.

Test methods shall be subject to the approval of the Employer. Test results shall be reported promptly to the Employer, who will evaluate the results and determine if the substitute item is equivalent. The Engineer's findings shall be final. Installation and use of a substitute item shall not be made until approved by the Employer.

If a substitute offered by the Contractor is not found to be equal to the specified material, the Contractor shall furnish and install the specified material.

The specified Contract completion time shall not be affected by any circumstance developing from the provisions of this subsection.

S1.08 (5) Weighing Equipment.

All scales used for proportioning materials shall be inspected for accuracy and certified within the past 12 months by the State of Control Bureau of Weights and Measures, by the People Committee or Sealer of Weights and Measures, or by a scale mechanic registered with or licensed by the Province.

All scales shall be so arranged that they may be read easily from the operator's platform or area. They shall indicate the true net weight without the application of any factor. The figures of the scales shall be clearly legible. Scales shall be accurate to within 1 percent when tested with the plant shut down. Weighing equipment shall be so insulated against vibration or moving of other operating equipment in the plant

area that the error in weighing with the entire plant running will not exceed 2 percent for any setting nor 1.5 percent for any batch.

S1.08 (6) Calibration of Testing Equipment.

Testing equipment, such as, but not limited to pressure gages, metering devices, hydraulic systems, force (load) -measuring instruments, and strain measuring devices shall be calibrated by a testing agency acceptable to the Employer at intervals not to exceed 12 months and following repairs, modification, or relocation of the equipment. Calibration certificates shall be provided when requested by the Employer.

S1.09 Project Site Maintenance.

S1.09 (1) Cleanup and Dust Control.

Throughout all phases of construction, including suspension of work, and until final acceptance of the project, the Contractor shall keep the Work site clean and free from rubbish and debris. The Contractor shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water resulting in mud on public road will not be permitted as substitute for sweeping or other methods.

When required by the Inspector, the Contractor shall furnish and operate a self-loading motor sweeper with spray nozzles at least once each working day to keep paved areas acceptably clean wherever construction, including restoration, is incomplete.

Materials and equipment shall be removed from the site as soon as they are no longer necessary; and upon completion of the Work and before final inspection the entire Work site shall be cleared of equipment, unused materials, and rubbish so as to present a satisfactory clean and neat appearance.

Care shall be taken to prevent spillage on haul routes. Any such spillage shall be removed immediately and the area cleaned.

Excess excavated material from catch basins or similar structures shall be removed from the site immediately. Sufficient material may remain for use as backfill if permitted by the Specifications. Forms and form lumber shall be removed from the site as soon as practicable after stripping.

Failure of the Contractor to comply with the Employer's cleanup orders may result in an order to suspend work until the condition is corrected.

No additional compensation will be allowed as a result of such suspension

S1.09 (2) Air Pollution Control.

The Contractor shall not discharge smoke, dust, or any other air contaminants into the atmosphere in such quantity as will violate the regulations of any legally constituted authority

S1.09 (3) Vermin Control.

At the time of acceptance, structures entirely constructed under the Contract shall be free of rodents, insects, vermin and pests. Necessary extermination work shall be arranged and paid for by the Contractor as part of the Work within the Contract time and shall be performed by a licensed agency in accordance with requirements of governing authorities. The Contractor shall be liable for injury to persons or property and responsible for the elimination of offensive odors resulting from extermination operations.

S1.09 (4) Sanitation.

The Contractor shall provide and maintain enclosed toilets for the use of employees engaged in the Work. These accommodations shall be maintained in a neat and sanitary condition. They shall also comply with all applicable laws, ordinances and regulations pertaining to the public health and sanitation of dwellings and camps.

Wastewater shall not be interrupted. The Contractor shall be conveyed in closed conduits and disposed of in a sanitary sewer system. Sewage shall not be permitted to flow in trenches or be covered by backfill before any treatment. The Contractor provides potable septic tank.

S1.09 (5) Temporary Light, Power, and Water.

The Contractor shall at its own expense, furnish, install, maintain, and remove all temporary light, power, and water, including piping, wiring, lamps, and other equipment, necessary for the Work. The Contractor shall not draw water from any fire hydrant, except to extinguish a fire, without first obtaining permission from the water agency concerned.

S1.09 (6) Water Pollution Control.

The Contractor shall exercise every reasonable precaution to protect channels, storm drains, and bodies of water from pollution and shall conduct and schedule its operations so as to minimize or avoid muddying and silting of said channels, drains, and waters. Water pollution control

work shall consist of constructing those facilities which may be required to provide prevention, control, and abatement of water pollution.

S1.09 (7) Drainage Control.

The Contractor shall maintain drainage within and through the work areas. Earth dams will not be permitted in paved areas. Temporary dams of sandbags, asphaltic concrete or other acceptable material will be permitted when necessary to protect the Work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as their use is no longer necessary.

S1. 10 Protection and Restoration of Existing Improvements.

The Contractor shall be responsible for the protection of public and private property adjacent to the Work and shall exercise due caution to avoid damage to such property.

The Contractor shall repair or replace all existing improvements within the right-of-way which are not designated for removal (e.g., curbs, sidewalks, driveways, fences, walls, signs, utility installations, pavements, structures, etc.) which are damaged or removed as a result of its operations; the remaining lines shall be capped. Repairs and replacements shall be at least equal to existing improvements, and shall match them in finish and dimension.

Trees, lawns, and shrubbery that are not to be removed shall be protected from damage or injury. If damaged or removed because of the Contractor's operations, they shall be restored or replaced in, as nearly the original condition and location as is reasonably possible. Lawns shall be reseeded and covered with suitable mulch.

The Contractor shall give reasonable notice to occupants or owners of adjacent property to permit them to salvage or relocate plants, trees, fences, sprinklers and other improvements within the right-of-way which are designated for removal and would be destroyed because of the Work.

All costs to the Contractor for protecting, removing, and restoring existing improvements shall be included in the unit price in its Bid.

S1.11 Public Convenience and Safety.

S1.11(1) Traffic and Access.

The Contractor's operations shall cause no unnecessary inconvenience. The access rights of the public shall be considered at all times. Unless otherwise authorized, traffic shall be permitted to pass through the Work, or an approved detour shall be provided.

Vehicular access to residential driveways shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time. If backfill has, been completed to such extent that safe access may be provided, and the street is opened to local traffic, the Contractor shall immediately clear the street and driveways and provide and maintain access.

Grading operations, roadway excavation and fill construction shall be conducted by the Contractor in a manner to provide a reasonably satisfactory surface for traffic. When rough grading is completed, the roadbed surface shall be brought to a smooth, even condition satisfactory for traffic.

The Contractor shall include, in the unit price in its Bid all costs for the above requirements.

S1.11(2) Storage of Equipment and Materials in Public Streets.

Construction materials shall not be stored in streets, roads, or highways for more than 5 days after unloading. All materials or equipment not installed or used in the construction within 5 days after unloading shall be stored elsewhere by the Contractor at its expense unless authorized addition storage time.

Excavated material, except that which is to be used as backfill in the adjacent trench, shall not be stored in public streets, roads, or highways unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

S1.11(3) Street Closures, Detours, Barricades.

The Contractor shall comply with all applicable, State, County and City requirements for closure of streets. The Contractor shall provide barriers, guards, lights, signs, and watch persons, advising the public of detours and construction hazards. The Contractor shall also be responsible for compliance with additional public safety requirements which may arise during construction. The Contractor shall furnish and install, and upon completion of the Work, promptly remove all signs and warning devices.

The Contractor shall notify the Police, Fire, Traffic and Engineering Departments of jurisdictional agencies involved, and comply with their requirements. Deviations must first be approved in writing by the Employer.

S1.11(4) Special Hazardous Substances and Processes.

Materials that contain hazardous substances or mixtures one required on the Work. A Material Safety Data Sheet as described in Section "

Material and Workmanship" shall be provide by the Contractor to the Inspector from the manufacturer of any hazardous product used.

S1.12 Advertising.

The names of Contractors, Subcontractors, or Inspector, with their addresses and the designation of their particular specialties, may be displayed on removable signs. The size and location of such signs shall be subject to the Engineer's approval.

Commercial advertising matter shall not be attached to or painted on the surfaces of buildings, fences, canopies or barricades.

S1.13 Laws To Be Observed and Pubic Safety

The Contractor shall keep fully informed of Viet Nam laws and Province and Municipal ordinances and regulations which in any manner affect those employed in the Work or the materials used in the Work or in any way affect the conduct of the Work. The Contractor shall at all times observe and comply with all such laws, ordinances and regulations.

S1.14 Facilities For The Employer and Inspector.

S1.14 (1) General

All facilities provided for Inspector or Employer personnel shall be at suitable locations approved by the Employer.

A field office shall be provided at site subject to Employer inspection during manufacture. A Field Laboratory shall be provided at project site.

All facilities shall conform to the applicable codes, ordinances and regulations of the local jurisdiction and of the Government of Viet Nam and shall conform to current practice.

All costs to furnish, maintain, service, and remove the specified facilities at the project site shall be included in the unit price in its bid.

S1.14 (2) Field Office

The office shall be of suitable proportions with $25m^2$ of floor area. It shall be equipped with one table, four chairs and one plan rack. It shall be adequately lighted and two duplex convenience outlets shall be provided.

The Contractor shall provide drinking water within the office and integral sanitary facilities directly adjoining, for the sole use of the Inspector. Sanitary facilities shall include a toilet and wash basin with hot and cold running water.

Air conditioning and telephone services are also required.

S1.14 (3) At Project Site

Field laboratories equipment of sieves, scales, weights, burner plates, sampling devices, pans, and thermometer shall be furnished by the Contractor.

These facilities shall be for the exclusive use of the Inspector. However, a separate building need not be provided for this purpose if such facilities are located in a separate room in a building which includes other facilities.

S1.14 (4) Removal of Facilities.

Field offices, laboratories, and bathhouse facilities at the project site shall be removed upon completion of the Work. Buildings and equipment furnished by the Contractor at the project site under the provisions of this section are the property of the Contractor.

S1.15 Measurement and Payment

S1.15 (1) General

Unless otherwise specified, quantities of work shall be determined from measurements or dimensions in horizontal planes. However, linear quantities of pipe, ditch, fencing, and wire or cable shall be considered as being the true length measured along the longitudinal axis.

Unless otherwise provided in the Specifications, volumetric quantities shall be the product of the mean area of vertical or horizontal sections and the intervening horizontal or vertical dimension.

S1.15 (2) Methods of Measurement

Materials and items of work which are to be paid for on the basis of measurement shall be measured in accordance with the methods stipulated in the particular sections involved.

S1.15 (3) Units of Measurement

Measurement shall be in accordance with Standard metric Measures. A ton basis the unit shall be the tonne of 1000kilograme.

S1.15 (4) Lump Sum Work

Items for which quantities are indicated as "Lump Sum", "L.S" or "Job" shall be paid for at the price indicated in the Bid. Such payment shall be full compensation for the items of work and all work appurtenant thereto.

When required by the Specifications or requested by the Employer, the Contractor shall submit to the Employer within 15 days after award of Contract, a detailed schedule in triplicate, to be used only as a basis for determining progress payments on a lump sum contract or any designated lump sum bid item. This schedule shall equal in total the lump sum bid and shall be in such form and sufficiently detailed as to satisfy the Employer that it correctly represents a reasonable apportionment of the lump sum.

S1.15 (5) Payment

General. The quantities listed in the Bid schedule will not govern final payment. Payment to the Contractor will be made only for the actual quantities of Contract items constructed in accordance with the shop Drawings and Specifications. Upon completion of the construction, if the actual quantity either an increase or decrease from the quantities given in the Bid schedule, the Contract Unit Prices.

The unit and lump sum prices to be paid shall be full compensation for the items of work and all appurtenant work, including furnishing all materials, labor, equipment, tools, and incidentals.

Payment will not be made for materials wasted or disposed of in manner not called for under the Contract. This includes rejected material not unloaded from vehicles, material rejected after it has been placed and material placed outside of the Plan lines. No compensation will be allowed for disposing of rejected or excess material.

Payment shall not relieve the Contractor from its obligations under the Contract; nor shall such payment be construed to be acceptance of any of the Work. Payment shall not be construed as the transfer of ownership of any equipment or materials to the Agency. Responsibility of ownership shall remain with the Contractor who shall be obligated to store, protect, repair, replace, rebuild or otherwise restore any fully or partially completed work or structure for which payment has been made; or replace any materials or equipment required to be provided under the Contract which may be damaged, lost, stolen or otherwise degraded in any way prior to acceptance of the Work.

SECTION 2 EARTH WORK

S2.01 Clearing and Grubbing

Clearing and grubbing shall consist of removing all natural and artificial objectionable materials from the right-of-way in construction areas, road approaches, material sites within the light-of-way, areas through which ditches and channels are to be excavated, and such other areas as may be shown in the specifications. This work shall be performed in advance of grading operations and in accordance with the requirements herein specified, subject to erosion control requirements.

The natural ground surface shall be cleared of all vegetable growth, such as trees, logs, upturned stumps, roots of downed trees, brush, grass, weeds, and all other objectionable materials, within the limits of construction.

Grubbing shall extend to the outside excavation and fill slope lines, except that where slopes are to be rounded, the areas shall extend to the outside limits of slope rounding. Within the limits of clearing, all stumps, roots 5 centimeters in diameter or larger, buried logs, and all other objectionable material shall be removed 30 cm below the existing ground surface or subgrade, whichever is deeper

No payment will be made to the Contractor for clearing and grubbing outside the stated limits is including removal of organic material in sub section S2.02

S2.02 Removal of Organic Materials

S2.02(1) General

The removal and disposal of such unsuitable material will be paid for as unclassified excavation for the quantities involved if the removal of such material is shown on the Outline Drawings or in the Specifications.

If the removal of unsuitable material is not shown on the Outline Drawings or in the Specifications, the removal and disposal of such unsuitable materials will be paid for the contract unit price, in the Bid.

S2.02(2) Wet Material

If required excavated material is unsatisfactory for the specified use on the project solely because of high moisture content, the Contractor may be directed by the Employer to either process the material to reduce the moisture content to an optimum condition, or to remove the material and replace it with suitable material. If such high moisture content is not the result of any action on the part of the Contractor, or inaction in protecting the work during the course of the Contract, the work involved

will be paid for in accordance with Sub section S2.03. Otherwise, the Contractor shall submit to the Employer for approval, a plan for drying or removing and replacing the wet material, and such work and material shall be at the expense of the Contractor.

Care shall be exercised to prevent excavating below grade. Areas excavated below grade shall be filled with suitable material and compacted by the Contractor at its expense.

S2.02(3) Measurement Payment

Payment for all removal of organic materials will be made at the Contract Unit Price per cubic meter. Payment for unclassified excavation shall include compensation for removal of organic materials, sloping, rounding tops and ends of excavations, loading, disposing of surplus material, stockpiling and hauling it to its final location.

S2.03 Filling

S2.03(1) General

Construction of fill included preparing the area on which fill is to be placed, and the depositing, conditioning, and compacting of fill material.

Rocks, broken concrete, or other solid materials, which are larger than 10cm in greatest dimension shall not be placed in fill areas.

Clods or hard lumps of earth of 15cm in greatest dimension shall be broken up before compacting the material in fill, with the following exception:

When the fill material originating from the project contains large rocks, boulders, or hard lumps (such as hardpan or cemented gravel which cannot be broken readily) over 30cm in greatest dimension, such materials may be incorporated in the fill. The location and depth of its placement in the fill and the method to be used shall be subject to the approval of the Engineer.

S2.03 (2) Preparation of Fill Areas

Areas over which fills are to be placed shall first be cleared an grubbed in accordance with the provisions of subsection S2.01. The areas shall then be scarified to provide a bond between the existing ground and the material to be deposited thereon.

When fills are designated to be placed over existing surface improvements which are to remain in place, 10 centimeter drainage holes shall be made through the structure on 1.5meter centers each way or the pavement shall be broken in a grid pattern of 1.5 meter each way.

S2.03 (3) Placing Materials for Fills

Fill material shall be placed in horizontal layers of depths compatible to the material being placed and the type of equipment being used. Each layer shall be evenly spread and moistened or aerated, as necessary. Unless otherwise approved by the Employer, each layer spread for compaction shall not exceed 20 centimeter of compacted thickness.

Unless otherwise permitted by the Employer, each layer of fill material shall cover the length and width of the area to be filled before the next higher layer of material is placed. The top surface of each layer shall be approximately level but with a crown or crossfall of at least 2%, but no more than 5%, to provide adequate drainage at all times during the construction period.

When fill material contains by volume over 25 percent of rock larger than 15 centimeter in greatest dimension, the fill below a plane one meter from finished grade may be constructed in layers of a loose thickness before compaction up the maximum size of rock in the material but not exceeding one meter in thickness. The interstices around the rock in each layer shall be filled with earth or other fine material and compacted.

S2.03(4) Application of Water

At the time of compaction, the moisture content of fill material shall be such that the specified relative compaction will be obtained and the fill will be firm, hard and unyielding. Fill material which contains excessive moisture shall not be compacted until the material is dry enough to obtain the required relative compaction.

S2.03 (5) Compacting

Each layer of earth fill shall be compacted by approved tamping or sheepfoot rollers, pneumatic - tired rollers, or other mechanical means acceptable to the Employer, to such extent as will produce the specified relative compaction. At locations where it would be impractical because of inaccessibility to use such compacting equipment, fill layers shall be compacted to the specified requirements by hand directed compaction equipment.

Unless otherwise specified, each layer of earth fill shall be compacted to a minimum 90 percent of a maximum dry density.

When soil types, or a combination of soil types, are encountered which tend to develop densely packed surfaces as a result of spreading or compacting operations, the surface of each layer of fill shall be

sufficiently roughened after compaction to ensure bond to the succeeding layer.

S2.03 (6) Slopes and Sodding

Fill slopes shall be finished in conformance with the lines and grades shown on the Outline Drawings. When completed, the average plane of the slopes shall conform to the slopes indicated on the Outline Drawings and no point on the completed slopes shall vary from the designated drawings by more than 15cm measured at right angles to the slope.

After completed finished on slope to furnishing grass sods as required stable covering of grass which will maintain its growth in any weather and prevent erosion of slope. Grass sod shall be placed at the interval of 30cm of sob blocks as to cover 50% of the surface by forming sod strips as directed by the Employer.

S2.04 Measurement and Payment

The Contract Unit Price per cubic meter for fill shall include full compensation for the all grading, shaping, compacting or consolidating including grass sodding. The quantities used in determining payment for fill shall be those of the completed fills within the limits shown on the Outline Drawing or as directed by the Employer.

SECTION 3 ROAD WORK

S3.01 Bituminous Surface Treatment

S3.01 (1) Description

This section specifies requirements for single bituminous surface treatment, prime coat and stabilized course, concrete curb and gutter, and concrete plate sidewalk of construction of an access and inner road.

The work includes supply and placing of aggregate and bituminous binder, concrete curb, gutter and sidewalk.

S3.01 (2) Submittals

The Contractor shall prepare and submit in duplicate copies of the design for binder and aggregate application rates using the design methodology describe in specification or directed by the Employer.

The Contractor shall submit duplicate of a spray chart for the bitumen distributor.

S3.02 Materials

S3.02 (1) Bituminous Binder

Bituminous Materials: The bituminous material shall conform to Vietnam Construction Specification 22 TCN 294-98 Grade 60/70.

Shade Temperature C^0: 18 to 36

% Kerosene to 60/70 Grade Bitumen: 13 to 0

Spraying Temperature C^0: 150 to 185

S3.02 (2) Mineral Aggregate

Aggregate Gradation Single Bituminous Surface Treatment (Present by Weight Passing)

Sieve Designation	No. 1	No. 2	No. 3
25.0mm	100	- -	- -
19.0mm	90 – 100	100	- -
12.5mm	20 – 55	90 – 100	100

9.5mm	0 – 15	40 - 70	85 - 100
4.75mm	0 – 5	0 – 15	10 - 30
2.36mm	- -	0 – 5	0 - 10
1.18mm	- -	- -	0 – 5

S3.03 Equipment, Tools, and Machines

S3.03 (1) Bituminous Distributors

The distributors shall have pneumatic tires of such width and number that the load produced on the base surface does not exceed 12 kg per mm of tire width. Distributors shall be designed and equipped to distribute bituminous material uniformly at even heat on various widths of surface at readily determined and controlled rates ranging from 0.20 to 9.0 liters per square meter with a pressure range of 170 to 520 kPa. The allowable variation from any specified rate shall not exceed 5 percent. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, a thermometer for reading the temperature of tank contents, and a hose attachment suitable for applying bituminous material to areas not accessible with distributor spray bar. The distributor shall be equipped for circulation and agitation of bituminous material during the heating process.

S3.03 (2) Single-Pass, Surface-Treatment Machines

The machines shall be capable of spraying bituminous material and spreading aggregate in one pass. Bituminous spraying equipment shall conform to the requirements given above for a bituminous distributor. The machine shall be capable of spreading aggregates-at controlled amounts per square yard as specified. In addition, the single-pass, surface-treatment machine shall be capable of placing a surface treatment adjacent to an existing surface treatment, forming a joint of the same thickness and uniformity as other portions of the surface treatment. Ridges or blank spaces will not be permitted. Joints in the application shall be formed at least 300mm, those formed in the first application.

S3.03 (3) Heating Equipment for Storage Tanks

The equipment shall consist of coils and equipment for producing steam or hot oil and be designed to prevent the introduction of steam or hot oil into the material. An armored thermometer with a range of 35 to 200 degrees C shall be affixed to the tank so the temperature of the bituminous material may be determined at all times.

S3.03(2) Power Rollers

Power rollers shall be steel-wheeled or pneumatic-tired type, conforming to the following requirements:

a. Steel-wheeled rollers shall have at least one steel drum and weigh a minimum of 4 metric tons 4 steel wheels of the rollers shall be equipped with adjustable scrapers.

b. Pneumatic-tired rollers shall be self-propelled and have wheels mounted on two axles in such manner that the rear tires will not follow in the tracks of the forward group. Tires shall be uniformly inflated to not less than 415 kPa more than 550 kPa pressure. The pneumatic-tired rollers shall be equipped with boxes or platforms for ballast loading and shall be loaded so that the tire print width of each wheel is not less than the clear distance between tire prints.

S3.04 Production

S3.04 (1) Materials

Mineral aggregate and bituminous material of the following types, gradations, grades, and consistencies that meet the requirements of stripping, wear, and soundness tests as specified in accordance with Construction Specification.

S3.04 (2) Mineral Aggregate

The aggregate shall consist of crushed stone, crushed gravel, or crushed slag and shall be of such nature that thorough coating of bituminous material used in the work will not strip off upon contact with water.

S3.04 (3) Crushed Stone

Crushed stone shall consist of clean, sound, durable particles, free of soft or disintegrated pieces, dust, or foreign matter.

S3.04 (4) Crushed Gravel

Crushed gravel shall consist of clean, sound, durable particles, free of soft or disintegrated pieces or foreign matter. At least 90 percent by weight of the particles shall have at least two fractured faces.

S3.04 (5) Crushed Slag

Crushed slag shall be an air-cooled blast-furnace product having a dry weight of not less than 1120 kg per cubic meter, and shall consist of angular particles uniform in density and quality and free of dust and foreign matter.

The bituminous material and aggregate shall be spread within the quantity limits shown below. The individual quantities of bituminous material and aggregate may be varied to meet specific field conditions at all during progress of the work, as directed, times unit prices. Aggregate weights shown are without adjustments to contract gravity of 2.65.for aggregates having a specific If the specific gravity of the aggregate used is other than 2.65, appropriate adjustments shall be made in number of kilograms Pounds required to ensure a constant volume of aggregate per square meter yard of treatment.

S3.04 (6) Quantities Per Square Meter

Gradation No.	Bituminous Material (Liter)	Aggregate (Kilograms)
1	1.10-1.70	15-22
2	0.50-1.10	9-15
3	0.30-0.70	6-11

S3.04(7) Preparation of Surface

Immediately before applying the first application of bituminous material, the surface shall be cleaned of loose material with power brooms or power blowers. Care shall be taken to remove all dirt, clay, and other loose or foreign matter.

S3.04(8) Mechanical Spreaders

The spreaders shall be adjustable and capable of spreading aggregate at controlled amounts per square yard, as specified.

S3.04 (9) Brooms and Blowers

The machines shall be of the power type, capable of cleaning surfaces to be treated.

S3.05 Scales

The scales shall be standard truck scales of the beam type equipped with a weight-recording device. The scales shall be sufficient in size and capacity to accommodate the trucks used in hauling aggregates. The scales shall be tested and approved by an inspector of the State Inspection Bureau charged with scale inspection within the state in which the project is located. If an official of the inspection bureau is not

available, the scales shall be tested in accordance with state specifications by the Contractor in the presence of the Contracting officer. The Contractor shall have the necessary number of standard weights on hand at all times for testing the scales.

S3.06 Weighhouse

The house shall be weatherproof and shall be constructed in a manner to afford adequate protection for the indicating and recording devices of the scales.

S3.07 Sampling and Testing

The sampling and testing shall be the responsibility of the Contractor. Sampling and testing s all be performed by an approved commercial testing laboratory, or by the Contractor, subject to approval. Sampling shall be in accordance with material unless otherwise directed. Tests shall be performed in sufficient number to insure that materials meet specified requirements.

S3.08 Application of Bituminous Material

S3.08(1) General

Bituminous material shall be applied by means of a bituminous distributor at a temperature within the range of 150 to degrees 185 C, as directed. The bituminous material shall be applied within the limits

Specified in paragraph QUANTITIES OF MATERIAL PER SQUARE METER. Subsection S3.04 (6)

Bituminous material shall be applied in such a manner that uniform distribution is obtained over all surfaces treated. Unless the distributor is equipped to obtain a satisfactory result at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application so that flow through the sprays may be started and stopped on the paper in order that all sprays will operate at full force on the surface treated. Immediately after application, the building paper shall be removed and destroyed.

Areas inaccessible to the distributor shall be properly treated with bituminous material using the hose attachment.

S3.08 (2) Spreading of Aggregate

Immediately following application of bituminous material, aggregate shall be spread uniformly over the surface within the limits of the quantities specified in paragraph QUANTITIES OF MATERIAL PER

SQUARE METER. Spreading shall be done with mechanical spreaders. Aggregate shall be spread evenly by hand on all areas missed by the mechanical spreader. Equipment spreading aggregate shall be operated so that bituminous material will be covered before any vehicle travels thereon. When hand spreading is employed on inaccessible areas, aggregate shall be spread directly from trucks. Additional aggregate shall be spread by hand over areas having insufficient cover, and spreading shall continue during these operations when necessary.

S3. 08(3) Brooming and Rolling

The surface shall be rolled with a pneumatic-tired and a steel-wheeled roller after sufficient aggregate is spread. Rolling shall continue until no more aggregate can be worked into the treated surface. The use of the steel-wheeled roller will be discontinued, or a lighter weight steel wheel roller substituted, as directed, if the roller being used causes excessive crushing and shattering of the aggregate. If the aggregate is not distributed properly, the surface shall be broomed as soon as possible after the first coverage by the roller, but not until the surface has set sufficiently to prevent excessive marking. Brooming, rolling, and supplemental spreading of aggregate shall continue until the Surface is cured and rolled sufficiently to key and set the aggregate. In places not accessible to rollers, the aggregate shall be compacted with pneumatic tampers aggregate that becomes contaminated with foreign matter shall be removed, replaced with clean aggregate, and rerolled, as directed. The Contractor shall maintain and protect the treated areas by use of barricades for a period not to exceed 30 days.

S3.09 Prime coat

S3.09 (1) Plant, equipment, machine and tools

General Requirement of plant, equipment, machine and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at al times.

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. The distributor shall be designed and equipped to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate or not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full- circulation spray include a tachometer, pressure gauges, volume –measuring devices, adequate heaters for heating of materials to the proper application temperature, a the remoter for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material

manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate to agitate the bituminous material during the heating process.

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the bituminous coat is to be applied.

S3.09 (2) Weather Limitations

Bituminous coat shall be applied only when the surface to receive the bituminous coat is dry. Bituminous coat shall be applied only when the atmosphere temperature in the shade had not been below 2 degrees C 35 degrees C for the 12 hours prior to application.

S3.09 (3) Production

S3.09(3)i Prime coat

Cutback asphalt shall conform to Construction Specification 22 TCN 249-98 are Grade RC 70 or MC 250

S3.09 (4) Execution

S3.09(4)i Preparation of surface

Immediately before applying the bituminous coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. The surface shall be dry and clean at the time of treatment.

S3.09(4)ii Application Prime coat

Bituminous material for the prime coat shall be applied in quantities of not less than 0.70 liter nor more than 1.80 liter per square meter pavement surface.

The viscosity requirements shall determine the application temperature to be used. The following is a normal range of application temperature:

Liquid Asphalts

MC – 250	75 – 131 Degrees C
RC – 70	50 –90 degrees C

Following preparation and subsequent inspection of the surface, the bituminous coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by distributor shall be properly treated with the hand spray. Until the protecting the surface against damage and by repairing deficient areas at

no additional cost to the Employer. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. No Smoking, fires, or flames other than those from the heaters that are s part of the equipment shall be permitted within 8 meters of heating, distributing, and transferring operations of bituminous emulsions. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent application, building paper shall be spread on the surface for a sufficient distance back from the ends of each application to start and stop the prime shall be removed and destroyed.

S3.09(4)iii Curing period

Following application of the bituminous material and prior to application of the succeeding layer of pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles of moisture. Prime coat shall be allowed to cure without being distributed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course.

S3.10 Sampling and testing

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

S3.11 Prime Coat Trial Application Rate

Unless otherwise authorized, the trial application rate of bituminous material shall be in the amount of 1.10 liters per square meter. Other trial application shall be made using various amount of material as may be deemed necessary.

S3.12 Stabilized Base Course

S3.12(1) General.

Base course for pavement, curb, gutter similar types of improvements, shall be constructed of material as specified in the following

Materials for use as base shall be classified in the order of preference as Crushed Aggregate Base.

When base material without further qualification is specified, the Contractor shall supply crushed aggregate base or crushed slag base. When a particular classification of base material is specified, the Contractor may, following the order of preference listed above, substitute any higher classification of base material for that specified. All

processing or blending of materials to meet the grading requirement will be performed at the plant or source. The materials shall compact to a hard, firm, unyielding surface and shall remain stable when saturated with water.

S3.12(2) Crushed Aggregate Base.

Crushed aggregate base shall consist entirely of crushed rock and rock dust conforming to the requirements of the following gradation:

CRUSHED AGGREGATE BASE

Sieve size (mm)	Percentage Passing Sieve
40	100
20	90-100
10	50-80
9.5	35-55
4.75	10-30
2.36	2-9

S3.12 (3) Quality Requirements.

The material shall conform to the requirement in accordance with Vietnam Construction Specification.

S3.12 (4) Preparation of Subgrade.

After rough grading has been completed, when pavement is to be placed directly on subgrade material, the top 15cm of subgrade material shall be compacted to a relative compaction of 95 percent. When base material, curb, gutter, sidewalks are to be placed on the subgrade material, the top 15 centimeters of such subgrade material shall be compacted to a relative compaction degree of 90 percent.

After compaction and trimming, the subgrade shall be firm, hard, and unyielding.

S3.12 (5) Subgrade Tolerances.

Subgrade for pavement, curb and gutter, or other roadway structures shall not vary more than 5cm from the specified grade and cross section. Subgrade for base material shall not vary more than 10cm from the specified grade and cross section. Variations within the above specified tolerances shall be compensating so that the average grade and cross section specified are met.

S3.12(7) Spreading.

Imported aggregate bases shall be delivered to the roadbed as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free from pockets of coarse or fine material.

Aggregate bases shall be deposited on the roadbed at a uniform quantity per linear foot, which quantity will provide the required compacted thickness within the tolerances specified herein without resorting to spotting, picking up or otherwise shifting the aggregate base material. At the time aggregate base is spread, it shall have a moisture content sufficient to obtain the required compaction. Such moisture shall be uniformly distributed throughout the material.

Where the required thickness is 15cm or less, the base material may be spread and compacted in one layer. Where the required thickness is more than 15cm the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 15cm. Each layer shall be spread and compacted in a similar manner.

The use of motor graders will be permitted during depositing, spreading and compacting operations, except, when self-propelled spreaders are specified.

When the subgrade for aggregate base consists of cohesionless sand and written permission is granted by the Employer, a portion of the aggregate base may be dumped in piles upon the subgrade and spread ahead from the dumped material in sufficient quantity to stabilize the subgrade. Segregation of aggregates shall be avoided and the material as spread shall be free from pockets of coarse or fine material.

S3.12 (8) Compacting.

Rolling shall always be commenced along the edge of the area to be compacted and the roller shall gradually advance toward the center of the area d to be compacted.

Rollers shall be operated along lines parallel or concentric with the centerline of the road being constructed, and no material variation therefrom will be permitted. All rollers must be maintained in good mechanical condition.

The relative compaction of each layer of compacted base material shall not be less than 95 percent, except in the areas back of curb (under sidewalks and driveways). Compaction in the excepted areas shall be as specified in each layer of compacted base material having a minimum relative compaction degree of 90 percent.

The surface of the finished aggregate base at any point shall not vary more than 5 cm above or below the grade established by the Inspector.

Base which does not conform to the above requirements shall be reshaped or reworked, watered and thoroughly recompacted to conform to the specified requirements.

S3.12 (9) Measurement and Payment.

Bituminous surface treatment including prime cost and stabilized base course will be paid for by the square meter as stipulated in the Bid. The Contract Unit Price shall include full compensation for mixing, spreading, shaping, compacting, trimming, and curing.

S3.13 Concrete Curb and Gutter, and Side Walks

Materials

Curbs may be cast-in-place or precast. The concrete for reinforced or precast curbs shall be for non-reinforced cast-in-place curbs, and concrete plate side walk as shown on the Outline Drawing. All concrete shall meet the requirements of Section S4.01 to 13 of these Specifications.

The contractor proposes to the Employer when it be used in precast concrete curb and gutter, concrete plate in factory are made.

S3.13(1) Requirements.

Concrete curb and gutters, walks shall be constructed of Concrete structures of the class II as specified and other requirements in Section S4.01 (2), (3) and (4)

Subgrade preparation shall conform to the requirements of Subsection S3.02 (5)

Unless otherwise specified on the Drawings, thickness of walks, thickness of gutters, shall be as shown on the Drawings.

S3.13 (2) Drainage Outlets Through Curb.

Where from housing drains occur along the line of work, the new curb shall be suitably sleeved to provide for such drains. Similar sleeves shall be installed to serve low areas on adjacent property where drainage has been affected by the work.

The location and size of the sleeves and construction of connecting sidewalk drain. The Contractor submitted a shop drawing for Employer's approval.

S3.13 (3) Forms.

Form material shall be free from warp, with smooth and straight upper edges, and if used for the face of curb, shall be surfaced on the side against which the concrete is to be placed. Metal forms for such a work shall be of a gage that will provide equivalent rigidity and strength. Curb face forms used on monolithic curb and gutter construction shall be of a single plank width when curb face is 20cm, except for those used on curb returns. All forms used on curb return shall be not less than 20mm in thickness, cut in the length and radius as shown on the Drawings, and held rigidly in place by the use of metal stakes and clamps. The curb face form shall be cut to conform exactly with the curb face batter as well as being cut to the required length and radius. Forms shall be of sufficient rigidity and strength, and shall be so supported, as to adequately resist springing or deflection from placing and tamping the concrete.

Form material shall be clean at the time it is used; and shall be given a coating of fight oil, or other equally suitable material, immediately prior to the placing of the concrete.

All forms except back planks of curb shall be set with the upper edges flush with the specified grade of the finished surface of the improvement to be constructed, and all forms shall be not less than a depth equivalent to the full specified thickness of the concrete to be placed.

Back forms shall be held securely in place by means of stakes driven in pairs at intervals not to exceed 1.5m, one at the front form and one at the back. Clamps, spreaders, and braces shall be used to such extent as may be necessary to ensure proper form rigidity. Forms for walk, gutter, and similar work shall be firmly secured by means of stakes driven flush with the upper edge of the form at intervals not to exceed 1.5m. Form stakes shall be of sufficient size and be driven so as to adequately resist lateral displacement.

Commercial form clamps for the curb and gutter may be used provided they fulfill the requirements specified herein.

S3.13(4) Placing Concrete.

Concrete shall be placed on a subgrade sufficiently dampened to ensure that no moisture will be absorbed from the fresh concrete.

Concrete shall be placed in curb, gutter, and curb and gutter forms in horizontal layers not exceeding 15cm in thickness, each layer being spaded along the forms and thoroughly tamped and the spading and tamping is sufficient to consolidate the concrete for its entire depth.

After the concrete for walk has been placed, a strike off shall be used to bring the surface to the proper elevation when compacted. It shall be spaded along the form faces and tamped to assure a dense and compact mass, and to force the larger aggregate down while bringing to the surface not less than 10mm of the free mortar for finishing purposes.

Concrete shall be placed in cross gutters in horizontal layers of not more than 5cm in thickness, each layer being spaded along the form faces and thoroughly tamped into a dense and compact mass. If internal vibrators are used, the full specified thickness may be placed in one operation.

After the concrete has been placed and tamped, the upper surface shall be struck off to the specified grade.

S3.13 (5) Joints.

Joints in concrete curb, gutter, and walk shall be designated as expansion joints and weakened plane joints. It may be construct a Precast curb and concrete plate are not required.

S3.13(6) Finishing

Finishing shall be completed as specified herein for type work being performed.

S3.13 (7) Curb and Gutter

The front forms may be stripped as soon as the concrete has set sufficiently and thinned to the consistency of grout, shall be immediately applied to the top and face of the curb. If monolithic curb and gutter is being constructed, this mortar shall be applied to the full exposed curb face; otherwise, it shall extend 5cm below the gutter surface.

The face and top of the curb shall then be carefully trowelled to a smooth an even finish; the top being finished to a transverse slope of 5mm toward the gutter, with both edges rounded to a radius of 10mm. The trowelled surface shall be finished with a fine-hair broom applied parallel with the line of the work.

After the concrete has been thoroughly tamped in such manner as to force the larger aggregate into the concrete and bring to the top sufficient free mortar for finishing, the surface shall be worked to a true and even grade by means of a float, trowelled with a long handled trowel or wood float-finished. The flow line of the gutter shall be trowelled smooth for a width of approximately 10mm for integral curb and gutter.

S3.13 (8) Backfilling and Cleanup

Backfilling to the finished surface of the newly constructed improvement must be completed before acceptance of the Work.

Upon completion of the work the surface of the concrete shall be thoroughly cleaned and the site left in a neat and orderly condition.

S3.13 (9) Measurement and Payment

Concrete curb and gutter, concrete block will be measure by liner meter. Concrete plate sidewalk will be measured by square meter.

Payment for concrete curbs and gutters, concrete block and concrete plate sidewalks were made as stipulated in the Bid.

Such payment shall be considered to be full compensation for the cost of all labor, tools, materials, and other items incidental to the satisfactory completion of the work.

SECTION 4 DRAINAGE SYSTEM

S4.01 General

This work shall consist of the construction of drainage pipes, U Ditch, and other concrete structure of drainage system for class of concrete with or without reinforcement, constructed in accordance with these Specifications and the lines, levels, grades and dimensions shown on the Outline Drawings, and as required by the Employer.

Portland cement concrete shall consist of a mixture of cement, water and coarse and fine aggregates.

Concrete will be specified by class or by compressive strength. When specified by class the concrete will be designated by a symbol consisting of a number, a letter and a number. The first number is the weight of cement in kilogram per meter, the letter is the combined aggregate gradation, and the last number is the minimum compressive strength of 28 days. Concrete specified by compressive strength shall be designed by the Contractor in accordance with Subsection S4.05

Approved admixtures shall be in accordance with Subsection S4.04

S4.02 Concrete Specified by Class

The concrete class and maximum slump for the various types of construction shall be as designated in the following table. The exact proportions of aggregate and water to be used in the concrete will be determined by the Inspector from tests of the material to be used.

The use of each class of concrete shall be as follows unless otherwise shown on the Outline Drawings or directed by the Employer:

Strength Class Use of Class of Concrete in the following;

Class I - Pipe Culverts

Class II - Cast-in-place Reinforced Concrete U Ditch

- Concrete, curbs and cover for U Ditch.

- Concrete Plate for sidewalk.

S4.03 Test for Portland Cement Concrete

Portland cement concrete shall be sampled and tested in accordance with the Construction Specification.

A compressive strength test shall consist of the average strength of two cylinders fabricated from a single load of concrete except that, if any cylinder should show evidence of improper handling, molding, or testing, said cylinder shall be discarded and the strength test shall consist of the strength of the remaining cylinder.

The frequency of sampling will be determined by the Employer. The Contractor shall afford the Inspector all reasonable access, without charge, for the procurement of sample of fresh concrete at time of placement.

Concrete specified by class under Subsection shall attain the minimum 28-day strength designated.

Concrete specified by compressive strength under Subsection shall attain the following 28-day strength: the average of any three consecutive strength tests shall be equal to or greater than the specified 28-day strength. Not more than 10 percent of the tests shall be less than specified 28-day strength. No test shall be less than 85 percent of the specified 28-day strength.

S4.04 Materials

S4.04 (1) Portland Cement

All cement to be used or furnished shall be low alkali portland or portland – pozzolan cement conforming to Vietnam Standard TCVN 2682-92 PC 30 or PC 40 unless otherwise specified.

The Contractor shall furnish a Certificate of Compliance signed by the manufacturer identifying the cement and stating that the cement complies with these requirements. Supporting test data shall be furnished when requested by the Employer.

Whenever suitable facilities approved by the Employer available for handling and weighing bulk cement, such facilities shall be used. Otherwise, the cement shall be delivered in original unopened sacks that have been filled by the manufacturer. They shall be plainly marked with the manufacturer's name or brand, cement type and weight.

Cement shall be stored in such a manner as to permit ready access for the purpose of inspection and sampling, and suitably protected against contamination or moisture. Should any cement delivered show evidence of contamination or be otherwise unsuitable, the Employer may reject it and require that it be removed from the site.

All portland cement used in concrete for any individual structure shall be of the same brand and type unless otherwise approved by the Employer.

S4.04 (2) Aggregates

Aggregate shall conform to the requirements in Subsection S4.06 (2) and shall be approved by the Engineer prior to use. Aggregate shall be of such character that it will be possible to produce workable concrete within the limits of slump and water content in Subsections.

Methods of handling materials resulting in segregation, degradation or the combining of materials which results in failure to meet specifications shall not be permitted. The free moisture content of sand shall not exceed 8 percent at the time of batching.

S4.04 (3) Water

Water used for concrete shall not contain deleterious substances. Water shall not contain an amount of impurities that will cause a change in the time of setting of portland cement of more than 25 percent nor a reduction in relative mortar strength at 7 and 28 days of more than 10 percent compared to results obtained with distilled water.

S4.04 (4) Admixtures

Water Reducing, Set Retarding, and Accelerating Admixtures

Water reducing, set retarding, and accelerating admixtures other than calcium chloride shall not be used in greater dosages than those recommended by the manufacturer, or permitted by the Inspector. The permitted dosage of the admixture shall not exceed that which will result in an increase in the drying shrinkage of the concrete in excess of 10 percent when used in any other structural concrete. The strength of concrete containing the admixture in the amount proposed shall, at the age of 48 hours and longer, be not less than that of similar concrete without the admixture. The admixture shall not adversely affect the specified air content, unless permitted by the Inspector.

S4.05 Concrete Specified by Compressive Strength

When so specified, the Contractor shall determine the mix proportions of concrete specified on the Outline Drawings by its 28-day compressive strength within the minimum cement, maximum, size coarse aggregate, and admixture limitations designed herein or in the Specifications.

The proposed mix design shall be evaluated from field tests of a trial batch conforming to the size of load, materials, proportions, slump, mixing and placing equipment and procedures to be used in the actual work. The trial batch procedure herein may be waived when test data of prior performance of the proposed mix design is presented by the Contractor and approved by the Inspector. The Contractor may utilize any strength data on file with the Agency for this purpose.

When approved by the Inspector, trial batches may be placed in the Work at designated locations where concrete of a lower quality is specified. Concrete so placed will be considered for purpose of payment to be of the type of concrete specified at that location.

Ten test cylinders shall be molded from the trial batch containing the maximum water content indicated by the mix design. Five of the cylinders shall be tested at 7 days in order to establish 7-day average compressive strength information. The remaining five cylinders shall be tested at no more than 28 days. The minimum strength of any one cylinder shall not be less than the specified strength.

The placing of concrete specified by compressive strength shall not begin until the mix design has qualified in accordance with the aforesaid test

criteria. Should the source of materials or established procedures change, new trial batches may be required.

Sample of Standard Mix Proportions of Concrete Structures

Class	I	II
Maximum size of coarse aggregate (mm)	20	20
Slump (cm) / maximum	7.5 ±2.5	7.5 ±2.5
Water/ cement ratio W/C (%)	49	60
Water content W (kg/m^3)	180	180
Cement content C (kg/m^3)	370	300
Fine aggregate S (kg/m^3)	820	890
Coarse aggregate G (kg/m^3)	1050	1040
Minimum 28 days compressive Strength by cylinder test (30 x 15 (Φ) cm) ((kg/m^2))	290	210

S4.06 Proportioning.

S4.06 (1) General

Aggregates and cement shall be proportioned by weight except that when the amount of concrete required for any one contract is 10 cubic meters or less, the materials may be measured by volume. Materials that are proportioned by volume shall be measured in containers of known capacity.

Weigh hoppers shall be charged from bins located directly over them or from conveyor belts. When conveyor belts are used, there shall be a separate belt for each size aggregate. There shall be a moisture meter installed, accurate within 1 percent of the actual moisture content, to indicate the moisture in the sand.

Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the ingredients are released for discharge. The cement hopper shall be attached to a separate scale for individual weighing.

The amount of water to be added to the mixture shall be measured into the mixing drum through a valve with a positive cutoff. When water is measured by weight, it shall be weighed on a separate scale.

Whenever a portable batch plant is set up at a new location, the scale assemblies shall be inspected and certified regardless of the date the scales were last tested.

Weighing equipment shall be insulated against vibration and movement of other operating equipment in the plant. When the entire plant is running, the scale reading at cutoff shall not vary from the weight designated by more than 1 percent for cement, I percent for water, 11/2percent for any size of aggregate, nor 1 percent for the total aggregate in any batch.

S4.06(2) Combined Aggregate Gradings

The combined aggregates shall conform to the gradings specified in the following table or in accordance with Construction Specification.

Sample of combined gradings for portland cement concrete
percentage passing sieves

	Passing by weight									
Sieve size (mm)	25	20	10	9.5	4.75	23.6	1.18	0.6	0.3	0.15
Coarse Aggregate	100	90-100	20-55	0-10	0-5					
Fine Aggregate				100	95-100	80-100	50-85	25-60	10-30	2-10

S4.06 (3) Concrete Consistency

The amount of water added at the mixer shall be regulated to take into account the free water in the aggregates. Free water is defined as the total water minus the water absorbed by the aggregate in a saturated surface-dry condition.

The amount of water used in the mixture shall not exceed the amount necessary to permit practical placement and consolidation of the concrete. Total free water in the mixture shall not exceed an amount producing the maximum slump specified in Subsection.

When adverse or difficult conditions affect the placement of concrete, the Engineer may authorize a greater slump to be provided the cement is increased. Water shall be added at a ratio not to exceed 30 percent of added cement per cubic meter concrete, and such additional water and cement shall be at the Contractor's expense.

S4.07 Mixing

S4.07 (1) General

Machine mixing will be required in all cases other than those in which it would obviously prove to be impractical, in which event hand mixing will be permitted. Mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregates, but in no event shall the intervening period exceed 30 minutes.

All concrete mixers shall be of such design and construction and so operated as to provide thoroughly and properly mixed concrete in which the ingredients are uniformly distributed. Mixers shall be maintained in proper and serviceable working condition and any part or portion thereof that is out of order, or becomes worn to such extent as to detrimentally affect the quality of mixing, shall be promptly repaired or replaced. Mixers shall not have any aluminum parts which will have direct contact with concrete.

S4.07 (2) Stationary Mixers

Stationary mixers shall be equipped with an accurate automatic timing device so designed and constructed as to lock the discharge lever before aggregate and cement enter the drum and release such lever only after the specified mixing time has elapsed. The regulation of the setting of said device shall be under the supervision of the Inspector. Water control equipment shall be provided with each concrete mixer.

The proper proportions of aggregate, cement d water for each batch of concrete shall be placed in the mixer and shall be mixed for a period of not less than 01 minute after all s materials are in the drum. The minimum mixing time per batch for reinforced concrete, however, shall not be less than 11 minutes.

When the mix proportions are not designated by number, or when required by the Inspector, the certificate shall contain the following additional information:

1) Actual weights of cement and of each size of aggregate

2) Brand and type of cement

3) Brand, type, and amount of admixture

Space shall be provided on the certificate so that amount of water added on the job may be indicated

S4.07 (3) Hand Mixing

Hand mixing will be permitted when the amount of concrete required for any one job is one cubic yard or less. Hand mixed concrete shall be mixed on a watertight platform or in a mortar box in batches not to exceed 1/3 cubic meters each. The aggregates shall first be spread in a uniform layer

over which the required quantity of cement shall be evenly distributed. The entire batch shall be turned with shovels until the ingredients are thoroughly blended before adding the water. After adding the proper amount of water, the batch shall again be turned with shovels until a uniform consistency is obtained. Methods of hand mixing which allow the loss of mixing water will not be permitted

S4.07 (4) Transporting Batched Materials and Mixed Concrete

The compartments of trucks or other equipment used for the purpose of transporting proportioned dry aggregate and cement, or mixed concrete, shall be suitably constructed to adequately protect and prevent loss or leakage of the contents during charging, transit or discharging.

S4.08 Steel reinforcement for concrete

S4.08 (1) General

This section specified for cast – in – place reinforcement concrete U Type ditch as shown on the Outline Drawings. Bar, wire and wire mesh reinforcement shall conform accurately to the dimensions and details indicated on the Outline Drawings or otherwise prescribed. Before being placed in any concrete work, it shall be cleaned thoroughly of all rust, mill scale, mortar, oil, dirt, or coating of any character which would be likely to destroy, reduce, or impair its proper bonding with the concrete.

S4.08 (2) Reinforcing Steel

Unless otherwise specified, reinforcing steel shall be conforming to Vietnam Standard TCVN 1765-75, CT4, or CT6 and BCT 51.

Steel bending processes shall conform to the requirements of the Manual of Standard Practice of the Vietnam Construction Code.

Bending or straightening shall be accomplished so that the will not be damaged. Kinked bars shall not be used.

S4.08 (3) Frame, Grating and inlet Mesh

Frames and inlet mesh gratings except as otherwise specified in this section shall conform to class T- 14 and as shown on the Outline Drawings. Frame: gratings and inlet mesh shall be fabricated of standard commercial grade steel and shall be welded by qualified welders in accordance with standard commercial practice. After fabricated shall be galvanized in factory Material shall conform to Construction Specification galvanized.

S4.09 Construction Method

S4.09 (1) Forms

Forms shall be of suitable material and of a type, size, shape, quality, and strength to ensure construction as designed. The forms shall be true to line and grade, mortar-tight, and sufficiently rigid to resist deflection

during placing of the concrete. The responsibility for their adequacy shall rest with the Contractor. All dirt, chips, sawdust, nails, and other foreign matter shall be completely removed from forms before any concrete is deposited therein. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent which will leave no objectionable film on the surface of the forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete.

Forms for all surfaces that will not be completely enclosed or hidden below the permanent surface of the ground shall be made of surfaced lumber, or material which will provide 2 surface at least equal to surfaced lumber or plywood. Any lumber or material which becomes badly checked or warped, prior to placing concrete, shall not be used.

S4.09 (2) Removal of Forms

The periods of time for form removal set forth herein are permissive only and subject to the Contractor assuming all risks that may be involved. At times of low temperature, or other-adverse conditions, the Engineer may require the forms to be kept in place for longer periods of time.

The minimum time periods for stripping forms will be established by the Engineer in accordance with the materials, methods to be used, and the stresses to which the structure may be subjected.

S4.09 (3) Falsework

The Contractor shall, in accordance with Subsection submit detailed Outline Drawings of the falsework proposed to be' used. Such Outline Drawings shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads.

Construction of falsework which is to be supported on a concrete invert may be started 48 hours after the concrete is placed, provided no heavy equipment or concentrated loads are placed on the concrete invert. When heavy equipment must be placed on the concrete invert to erect falsework, the concrete shall be 7 days old.

Falsework and forms shall be so constructed as to produce in the finished structure the lines and grades indicated

S4.10 Placing Reinforcement

S4.10(1) General

Before placing reinforcement steel, the Contractor shall submit a reinforcing steel placing plan in accordance with Subsection S1.01 (2)

Reinforcing bars shall be placed in accordance with the size and spacing shown on the Outline Drawings. Reinforcing bars shall be firmly and securely held in position in accordance with the placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted. Before placing in the form, all reinforcing steel shall be cleaned thoroughly of mortar, oil, dirt, loose mill scale, loose or thick rust, and coatings of any character that would destroy or reduce the bond. No concrete shall be deposited until the placing of the reinforcing steel has been inspected and approved.

Bar spacing is center to center of bars. Bar cover is clear distance between surface of bar and face of concrete and shall be 5cm unless otherwise noted on the Outline Drawings. Reinforcement shall terminate 5cm from concrete surfaces and expansion joints, unless otherwise noted on the Outline Drawings.

S4.10(2) Splicing

Splices of bars shall be made only where shown on the Outline Drawings or as approved by the Engineer. Where bars are spliced, they shall be lapped at least. 30 diameters, unless otherwise shown on the Outline Drawings.

Splicing shall be accomplished by placing the bars in contact with each other and wiring them together.

Welding of reinforcing steel will not be permitted unless specifically authorized by the Employer.

S4.10(3) Bending Reinforcement

Bends and hooks in bars shall be made in the manner prescribed in the Construction specification.

Bars shall not be bent or straightened in a manner which will injure the material. Bars with kinks or unspecified bends shall not be used.

S4.11 Curb Inlet Construction

Construction base of stone masonry base sections. Make inverts in bases with a smooth – surface bottom conforming to the inside contour of the adjacent is type ditch sections. For changes in direction of the drain and entering branches into the manhole. For either pour bottom slabs and walls integrally or key and bond walls to bottom slab. Construct masonry walls of stone masonry units. Provide plaster of 12mm minimum thickness mortar, on interior of masonry manhole walls. Give a smooth

finish to inside joints of stone masonry work shall be in accordance with the requirements specified under this section.

S4.12 Metal Work

Workmanship and Finish

Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form steel to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surface are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary. Apply zinc coating to steel gratings after fabrication in accordance with Plan. Clean surfaces of steel frames and covers to bare metal by a suitable blasting process. Where surfaces cannot be cleaned satisfactorily by blasting, clean to bare metal by wire brushing or other mechanical means. For surfaces contaminated with rust, dirt, oil, grease, or other contaminants, wash with solvents until thoroughly clean. Immediately after cleaning, coat surfaces with a coat of pretreatment coating. As soon as practicable after the pretreatment coating has dried, primer treated surfaces with a coat of zinc chromate primer.

S4.13 Placing Concrete

S4.13 (1) General

Concrete shall be conveyed, deposited, and consolidated by any method which will preclude the segregation or loss of ingredients. Equipment used in conveying and depositing concrete shall not have any aluminum component in direct contact with the concrete. All concrete work in accordance with in these specifications.

All surfaces against which concrete is to be placed shall be thoroughly moistened with water immediately before placing concrete. All ponded and excess water shall be removed to leave surfaces moist but not flooded.

Chutes used in conveying concrete shall be sloped to permit concrete of the consistency required to flow without segregation. Where necessary to prevent segregation, chutes shall be provided with baffle boards or a reversed section at the outlet.

S4.13(2) Depositing

To avoid segregation, concrete shall be deposited as near to its final position as is practicable. The use of vibrators for extensive shifting of the

mass of concrete will not be permitted. Concrete that has partially hardened, has been retempered, or is contaminated by foreign materials shall not be deposited in the structure.

Concrete shall be placed in horizontal layers insofar as practical. Placing shall start at the low point and proceed upgrade unless otherwise permitted by the Employer. Concrete shall be placed in a continuous operation between construction joints and shall be terminated with square ends and level tops unless otherwise shown on the Outline Drawings.

Concrete shall not be permitted to fall more than 1.5m without the use of pipes or tremies. Pipes and tremies shall be at least 15cm in diameter, or the equivalent cross-sectional area for rectangular sections. Concrete shall not be placed in horizontal members or sections until the concrete in the supporting vertical members or sections has been consolidated and a 2-hour Period has elapsed to permit shrinkage to occur.

S4.13(3) Consolidating

Concrete shall be thoroughly consolidated in a manner that will encase the reinforcement and inserts, fill the forms, and produce a surface of uniform texture free of rock pockets and excessive voids.

The number of vibrators employed shall be sufficient to consolidate the concrete within 15 minutes after it has been deposited in the forms. At least two vibrators in good operating condition shall be available at the site of the structure in which more than 25 cubic meters of concrete is to be placed.

S4.13 4) Curing

As soon after the completion of the specified finishing operations as the condition of the concrete will permit without danger of consequent damage thereto, all exposed surface shall either be sprinkled with water, covered with plastic sheet, or covered with earth, sands. Roadway areas, curbs, walks, and the like, that are water cured may be covered with sand to a depth of at least 5cm in lieu of the burlap as prescribed above, as soon as the condition of the concrete will permit, and such covering shall remain wet and in place for at least 10 days, unless otherwise directed by the Engineer or prescribed by the Specifications.

If there is any likelihood of the fresh concrete checking or cracking prior to the commencement of the curing operations (due to weather conditions, materials used, or for any other reason), it shall be kept damp, but not wet, by means of an indirect fine spray of water until it is not likely that checking or cracking will occur, or until the curing operations are started in the area affected.

S4.14 General Manufacturing Requirements of Reinforced Concrete Pipe (RCP)

S4.14(1) General

These specifications apply to reinforced concrete pipe intended to be used for the construction of storm drains, and related structures.

The size and type of the concrete pipe to be furnished shall be as shown on the Outline Drawings or in the Specifications.

Prior to the manufacture of the RCP, three sets of prints of pipeline layout diagrams shall be furnished to the Inspector per Subsection except transparencies will not be required. Catch basin connector pipe need not be included in the pipeline layout; but, in lieu thereof, a list of catch basin connector pipes shall accompany the layout. The connector pipe list shall include size of pipe, station at which pipe joins mainline, number of sections of pipe, length of sections, and type of sections (straight, horizontal bevel, vertical bevel, etc.). The diagrams and lists submitted will be used by the Agency for reference only, and their use shall in no way relieve the Contractor of its responsibility for correctness. The Employer may waive the pipeline layout and connector pipe list requirement. Unless otherwise specified, RCP shall be either wet cast, spun, or machine-made.

Plants and processes not previously qualified by the Agency may required initial qualification by the Agency using any or all of the following tests described in accordance with Construction Code. Upon qualification, no additional qualification tests will be required unless changes have been made in the equipment and procedures, or an increase in the largest aggregate size is made from the previous approved mix designs. The manufacturer shall provide qualifying data upon request by the Employer.

S4.14(2) Three Edge Bearing Test

Two tests minimum on each of three different pipe sizes as per Outline Drawings. Testing in accordance with Construction Specifications.

S4.14 (3) Visual Inspection

Pipe inspection shall include the following:

Reinforcing steel placement and twist, as per Outline Drawings. Concrete from a portion of one piece of green pipe shall be stripped or raked to determine cage twist, location, clearance, and voids. Voids around reinforcing steel cage caused by cage twist will not be acceptable. Plant

inspection shall include cage manufacturing, curing process, batching equipment and process, aggregate and cement storage, concrete mix designs, and product handling.

The interior surface of the pipe shall be smooth and well finished. Joints shall be of such type and design and so constructed as to be adequate for the purpose intended so that, when laid, the pipe will form a continuous conduit with a smooth and uniform interior surface.

Sockets and spigots shall be free from any deleterious substance or condition which might prevent a satisfactory mortar bond at the joints.

If the Employer determines that the forms, end rings or form gaskets used in the manufacture of the pipe are inadequate for the purpose intended, the Contractor shall replace or repair said equipment to the satisfaction of the Employer.

The Contractor shall furnish, install, and maintain stulls or other devices in the pipe as may be necessary to meet the limitations on cracks as specified herein, throughout pipe handling, transportation, and field installation.

S4.15 Materials

Except when otherwise permitted by the Employer, no materials shall be used in manufacturing of the pipe other than water, water reducing admixture, portland cement, mineral aggregates, and steel conforming to the following requirements:

1) The portland cement shall be as specified in Subsection S4.04 (1).

2) All aggregate shall conform to the reactivity requirements in Subsection S4.06 (2)

The aggregate shall be so graded, proportioned, and thoroughly mixed in a batch mixer to produce a homogeneous concrete mixture of such quality that the pipe will conform to the test and design requirements of these specifications. The proportion of portland cement shall be not less than 370 kilogram per cubic meter of concrete.

S4.15 (1) Reinforcement

The reinforcement shall be as specified in Subsection S4.08 (2) and a cage fabricated of bars or wire. circumferential reinforcement shall be in the amount and type shown on the Outline Drawings, or that required to sustain the specified test loads. Longitudinal reinforcement shall be sufficient to make the cage rigid and to support the circumferential

reinforcement firmly in place in the forms during placing and consolidation of the concrete.

Pipe which is to be jacked shall have a circular cage reinforcement.

Fastenings (supports), and/or retractable mechanical devices, approved by the Employer, shall be used for holding the cage rigidly in place in the form in its elliptical or circular shape. In wet cast and machine-made pipe these fastenings shall be spaced not closer than 50cm center-to-center along the length of the longitudinal reinforcement, except for pipe having a nominal length of 1.2 meter or less.

All reinforcing steel shall be clean and free from loose rust, scale, paint, grease, form oil, or other foreign matter.

Splices shall be butt-welded, or lap-welded a minimum of 6 diameters. Nonwelded splices shall be lapped a minimum of 20 diameters for deformed bars and 40 diameters for plain bars or cold-drawn wire. Nonwelded lapped splices shall be wired tightly. Welds shall develop not less than 75 percent of the minimum specified ultimate strength of the bars or wires being welded.

Elliptical cages may be specifically fabricated or deformed from a circular cage to the required elliptical dimensions. Cages for machine-made pipe shall be circular.

Upon request, the Contractor shall furnish data to the Employer indicating the lot number, wall thickness, and the size, spacing, and positioning of reinforcement for any pipe manufactured.

For storm drainpipe, the longitudinal reinforcement may extend to the base plate or ring to act as a cage support. For sanitary sewer pipe, the longitudinal reinforcement shall have a minimum cover of 20mm from the end faces of the pipe.

Circumferential reinforcement may be included in the joint projection at the option of the manufacturer, and shall be included when required by the Drawings or Specifications.

Where the wall reinforcement does not extend into the joint projection, the longitudinal distance to the last circumferential reinforcement from the inside shoulder of the bell or shoulder of the spigot shall be a maximum of 50mm, but not less than 20mm from any face.

S4.15(2) Joints

Joints shall be designed so as to be self-centering. Unless otherwise specified, joints in concrete pipe shall be of the tongue and groove mortar type of joint.

When pipe joints of the reinforced concrete collar type or of rubber-gasketed type are specified or indicated on the Outline Drawings, joint details shall be submitted to the Employer for approval before commencing pipe manufacture.

Pipe with beveled ends for use around curves, the radii of which are shown on the Outline Drawings, shall be provided where necessary. Either one or both ends shall be beveled a maximum of 5 degrees as may be required to provide well-fitting joints.

If required by the Employer, the pipe shall be "match-marked" to meet specified laying tolerances at the place of manufacture and laying diagrams shall be furnished to the Contractor.

S4.15(3) Machine-made Pipe

Machine-made RCP shall be manufactured by placing the concrete between vertical cylindrical forms or by placing concrete into a vertical cylindrical form and the interior surface formed with one or more roller packing heads and a long bottom-trowel rotating in opposite directions. The concrete shall be mixed to a uniform consistency and the reinforcing cage shall be held by fastening (supports) and/or retractable mechanical devices to ensure correct cage position.

Concrete placed between inner and outer forms shall be continuously vibrated throughout the manufacturing cycle and after all concrete has been placed in the forms, axial pressure shall be applied simultaneously with vibration to further density the concrete, or the concrete shall be placed against the outer jacket and then densified by continuous vibration during the manufacturing cycle. On completion of densification, the pipe may be removed immediately from the forms.

S4.15(4) Curing

a) Steam Curing Facilities

The manufacturer shall provide adequate enclosures, steam plant, piping, and other facilities for curing pipe. The enclosures shall be such that the temperature and humidity can be controlled to keep the pipe surfaces moist at all times and the temperature maintained continuously between

30^0 and 50^0. Bulkhead curing is permissible, but will only be given credit for a maximum of 12 hours of the steam cycle.

b) Water Curing

Pipe may be water cured by any method that will keep the outside surface continuously moist for 4 consecutive days. Pipe to be given a total water cure may not be stripped from the forms until 20 hours after concrete placement or until the concrete has reached a compressive strength of $210kg/cm^2$, whichever occurs first.

S4.15(5) Causes for Rejection

Inspection of pipe as may be deemed necessary by the Agency will be made at the place of manufacture, pipe may be rejected for any of the following reasons:

1) A piece of any size broken out of the pipe.

2) Defects that indicate imperfect mixing or molding.

3) Any crack extending entirely through the wall of the pipe and having a longitudinal or transverse length greater than the wall thickness of the pipe.

4) Any shattering or flaking of concrete at a crack.

5) A deficiency greater than 5mm from the specified wall thickness of pipe 700mm or smaller in diameter, or a deficiency greater than 6 percent from the specified wall thickness of pipe larger than 700mm in internal diameter, except that the deficiency may be 8 percent adjacent to the longitudinal form joint, provided that the additional deficiency does not lie closer than 20 percent of the internal diameter to the vertical axis of the pipe and does not extend along the circumference for a distance greater than 20 percent of the internal diameter of the pipe.

   The deficiencies in wall thickness permitted herein do not apply to gasket contact surfaces in gasketed joint pipe. Dimensions and tolerances of such contact surfaces shall be submitted for approval.

6) A variation from a true circle of the specified diameter by more than 1 percent.

7) Rock pockets and water pockets in any pipe.

8) Exposure of any reinforcement arising from misplacement thereof.

9) Evidence of. cage twist or misplacement of reinforcement.

S4.16 Field Jointing of Reinforced Concrete Pipe

S4.16(1) General

All joints shall be cleaned with a wire brush and wetted before mortaring. All mortar shall conform to the applicable provisions of Subsection S4.18 (2)

S4.16(2) Gasket-type Joints for Reinforced Concrete Pipe

The ends of the pipe shall be so formed that, when the pipes are laid together and joined, they shall make a continuous and uniform line of pipe with a smooth and regular surface.

Joints shall be watertight and flexible. Each joint shall contain a solid gasket of neoprene or other material approved by the Employer, which shall be the sole element responsible for water tightness of the joint. This gasket shall be of circular cross section unless otherwise approved by the Employer. The length at and cross sectional diameter of the gasket, the annular space provided for the gasket, and all other joint details shall be such as to produce a watertight joint The slope of the longitudinal gasket contact surfaces of the joint with respect to the longitudinal axis of the pipe shall not exceed 2 degrees.

Under ordinary laying conditions, the work shall be, scheduled so that the socket end of the pipe faces mill, the direction of laying. Prior to placing the spigot into the socket of the pipe previously laid, the spigot groove, the gasket and the inside of the socket shall be thoroughly cleaned. Then the spigot groove, the gasket and the first 5cm of the inside surface of the socket shall be lubricated with a soft vegetable soap compound.

The gasket after lubrication shall be uniformly stretched when placing it in the spigot groove so that the gasket is distributed evenly around the circumference.

For pipe in which the inside joints are to be pointed, suitable spacers shall be placed against the inside, shoulder of the socket to provide the proper space between abutting ends of the pipe.

After the joint is assembled, a thin metal feeler gage shall be inserted between the socket and the spigot and the position of the gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked.

Where steel joint rings are used, a suitable cloth, plastic or paper band shall be placed around the outside of the pipe and centered over the joint to prevent dirt from entering the joint recess.

The joint band shall be bound to the pipe by the use of steel box strapping or by an equivalent method, and shall completely and snugly encase the outside joint except for an opening near the top where grout is to be poured into the joint recess. Grout shall be poured and allowed to set before densification of be ding and backfill materials by jetting or flooding methods. In any case, joints shall be grouted before backfill is placed over the top of the pipe. With the jointing band properly secured, the joint recess shall be moistened with water and then filled with mortar. The mortar grout shall completely fill the outside annular space between the ends of the pipe and around the complete circumference. After the recess has been filled, the jointing band shall be replaced over the opening left for pouring and the mortar allowed to set. After the bedding and backfill have been densified, the inside joint recess shall first be moistened, then filled with stiff mortar. The finished joint shall be smooth and flush with the adjacent pipe surfaces.

S4.17 Stone Masonry

S4.17(1) General

This work shall consist of the stone masonry of U Ditch with concrete cover or without, Curb Inlet and Side Ditch in accordance with these specifications and in conformity with the lines and grades shown on the Outline Drawings. Concrete cover in accordance with Subsection.

S4.17(2) Rubble Masonry

Rubble masonry, as here specified, shall include various classes of roughly squared and dressed stone laid in cement mortar.

S4.18 Materials

Stone for masonry shall be tough, dense, sound and durable and free of seams, cracks, inclusions or other structural defects. Stone shall be of the type and quality shown on the Outline Drawings or otherwise specified. Prior to shipment of stone to the job site, the Contractor shall obtain approval of the proposed source and shall submit a representative sample of stone to the Inspector for inspection and, if necessary, testing. The sample shall be dressed and finished as specified for use in the work and shall not be less than 15 centimeter in any dimension. All stone used in the work shall of a quality comparable to that of the sample submitted.

S4.18(1) Rubble Stone

Stone for mortar rubble masonry shall be free from rounded, worn, or weathered surfaces. All weathered stone shall be rejected.

S4.18(2) Mortar

The ingredients used in making mortar shall conform to the following requirements:

Portland Cement, Admixtures and Water; Subsection S4.04

Sand Aggregate; Subsection S4.06

The proportions of materials shall be such that the volume of sand in a damp, loose condition is between 2-1/4 and 3 times the volume of the cementitious materials.

S4.18(3) Rubble Masonry

Individual tones shall have a thickness of not less than 20cm and a width of not less than 1-1/2 times the thickness. No stones, except headers, shall have a length less than 1-1/2 times their width.

S4.18(4) Shape

The stones shall be roughly squared on joints, beds, and faces. Selected stone, roughly squared and pitched to line, shall be used at all angles and ends of walls.

All shaping or dressing of stone shall be done before the stone is laid in the wall, and no dressing or hammering which will loosen the stone will be permitted after it is placed.

S4.19 Dressing

Stone shall be dressed to remove any thin or weak portions. Face stones shall be dressed to provide bed and joint lines with a maximum variation from true line of 3 centimeters.

S4.20 Construction

S4.20(1) Trench Excavation and Backfilling

Stone masonry U ditch excavation, backfilling and compaction shall be applied in Section S5.08.

S4.20(2) Mixing Mortar

The mortar shall be hand or machine mixed, as may be required by the Engineer. In the preparation of hand- mixed mortar, the sand and cement shall be thoroughly mixed together in a clean, tight mortar box until the mixture is of uniform color, after which clean water shall be added in such quantity as to form a stiff plastic mass. Machine-mixed mortar shall be prepared in an approved mixer and shall be mixed not less than 3 minutes nor more than 10 minutes. Mortar shall be used within 1-1/2 hours after mixing and before final set begins. Retempering of mortar shall be done as necessary to maintain proper consistency during placement.

S4.20(3) Selection and Placing of Stone

All masonry shall be constructed by experienced Workmen. Face stones shall be set in random bond to produce the effect shown on the Outline Drawings.

Care shall be taken to prevent the bunching of small stones or stones of the same size, When weathered or colored stones, or stones of varying texture, are being used, care shall be exercised to distribute the various kinds of stones uniformly throughout the exposed faces of the work. Large stones shall be used for the bottom courses and large, selected stones shall be used in the corners. In general, the stones shall decrease in Size from the bottom to the top of work.

Stone shall not be dropped upon, or slid over the wall, nor will hammering, rolling, or turning of stones on the wall be allowed. They shall be carefully set without jarring the stone already laid and they shall be handled with a lewis or other appliance that will not cause disfigurement.

In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.

S4.20(4) Rubble Masonry

Rubble masonry shall be laid to line and in courses roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones and all courses shall be laid with bearing beds parallel to the natural bed of the material. The vertical joints in each course of rubble masonry shall break with those in adjoining courses at least 15cm. In no case shall a vertical joint be so located as to occur directly above or below a header.

S4.21 Measurement And Payment

Pipe culvert, cast-in-place U ditch with grating cover and stone masonry U ditch with concrete cover or without will be measured by linear meter as listed in the schedule of bid items. The volume or area will be that actually placed to the limiting dimensions shown on the Drawings, pipe culvert, cast-in-place U ditch and stone masonry U ditch, as measured above, will be paid for by the contract price per linear meter. Such payment shall be considered to be full compensation for the cost of all labor, tools, materials, and other items incidental to the satisfactory completion of the work.