

TECHNICAL SPECIFICATION

CONTENT

1 INTRODUCTION

General

2 GENERAL REQUIREMENTS

Scope Of Works
Permanent Works
Temporary Works
Standard
Key Personnel,
Plant and Machinery

3 GENERAL DESIGN INFORMATION

Corrosion
Power
Codes
Environmental Condition
Climate

4 TEMPORARY WORKS

Water supply
Storage facilities
Co-ordination
First-aid and Safety

5 PERMANENT WORKS

Road construction
Sub-grade preparation
Geo-Cell
Base Course
Concrete pavers
Asphalt Sealing
Asphalt and mix design
Kerbs
Galvanized components
Traffic signs and pavement markings
Concrete and reinforcing
Testing

6 QUALITY CONTROL

7 TABLES

8 ELECTRICAL CABLES AND TELEPHONE JUNCTION BOX FOR ROADS

1) INTRODUCTION

a) GENERAL

The project of which these works (also known as the Thilafushi Pilot Road Project) form a part will be constructed on the island of K. Thilafushi in the Republic of Maldives.

Site Conditions

The part of Thilafushi where Site is located is reclaimed by waste and hence the composition of underground and its properties may vary. Several industrial operational works and construction works are carried out on the island. The island is a heavy industrial zone. The contractor shall assess and take in to consideration the difficulties and challenges in respect to all these site conditions. The contract sum shall be inclusive of such considerations. The detailed EIA report and relevant test reports attached shall be referred.

The Site is an existing main access route being used by the tenants/owners of properties in surrounding areas. Hence the Works shall be planned and executed in such a way to avoid inconvenience to the public or tenants. In addition, the Site has some existing street lights, distribution boxes, junction boxes which will be removed and relocated as required.

At some locations the Site area is overlapping with some portion of surrounding properties. In particular to this, for some properties with minor structures the rectification works shall be carried out (by the contractor) as per details provided in the drawings. For 3 Nos. properties having structures such as warehouse, Shed, Storage etc. which are partly overlapping with part of the Site, the Employer is in the process of acquiring these parts of properties for the project and the works shall be planned and executed considering such scenario as per instruction of the Engineer.

2) GENERAL REQUIREMENTS

a) SCOPE OF WORKS

The works, included in this contract will comprise but not limited to the following major elements.

i) Permanent Work

- Rectification works (demolition, reconstruction or relocation)
- Construction of a new road
- Planting strip
- Road drainage on planting strip
- Sealing of the road
- Road lighting
- Road Sign Boards
- Road Markings
- Road crossing pipes and junction Boxes

ii) Temporary Work

Establishing all the temporary works, facilities, infrastructure and utilities required for the completion of the project as per contract. All such temporary works shall be performed as per relevant standards and approval of relevant authorities as applicable. The Contract Sum is deemed to be inclusive of all such requirements.

b) STANDARDS

All work shall be carried out to the standards quoted in this specification. If no particular standard is quoted then the appropriate British Standard shall apply.

c) KEY PERSONNEL

The contractor shall provide the following key personal throughout the project

Position	Qualification
Project Manager	Degree in Project management / Civil Engineering with 10 years of Project Management experience out of which 5 years in road projects management or equivalent.
Civil Engineer / Road Engineer	Degree in Civil engineering with 5 years of Road Project experience or equivalent.
Site engineer	Degree in Civil engineering with 3 years of Site management experience or equivalent.
Site supervisor	Diploma in Civil engineering or construction related field with 3 years of experience, or 7 years of experience in Construction field or equivalent.
Quantity surveyor	Degree in Quantity Surveying or relevant field with 5 years of Quantity Surveying experience or equivalent.
Land/Engineering Surveyor	Degree in Land Surveying or equivalent with 5 years of surveying experience, out of which 3 years in Road Projects.
Laboratory Technician	Degree in Material Engineering, Civil Engineering or equivalent with 3 years of experience in material testing lab work or equivalent.
Laboratory Assistant	Diploma in Civil engineering or construction related field with 3 years of road projects laboratory experience, or 7 years of experience in road projects laboratory work or equivalent.
Project Administrator	Degree in Business Administration with 3 years of experience or equivalent.

d) PLANT AND MACHINERY (NOT LIMITED TO)

1. Motor Grader
2. Excavators
3. Dump Trucks / Tipper Trucks
4. Wheel Loaders
5. Soil Compactors
6. Plate Compactors
7. Asphalt Paver
8. Road Rollers (Pneumatic & Tandem)
9. Asphalt Mixing plant
10. Bitumen Sprayer
11. Mobile crane / Hydraulic mobile crane
12. Telescopic Handler
13. Road marking machine
14. Concrete Mixer machines
15. Power Generators

and any other necessary equipment to carry out the works.

e) Laboratory Facilities

Contractor is expected to provide laboratory facilities consisting of all equipment and apparatus needed to carry out the tests required for the project as per specifications. The contractor shall ensure and make necessary arrangements to ensure the testes being witnessed by the Employer's representative.

3) GENERAL DESIGN INFORMATION

a) Corrosion

It shall be the contractor's responsibility to ensure that all materials and equipment supplied are suitable for all possible conditions of operation peculiar to the environment in Thilafushi. All instrumentation and control, and electrical equipment shall be protected from the effects of the marine environments. The Bidder shall give full details of how this requirement shall be met.

Any Steelwork used in construction shall be protected by and appropriate paint finish as outlined in this specification or by hot dip galvanization.

b) Electrical Power Supplies for Plant Items

The Electrical Poser supplied for items will have the following nominal values:

- 401 VAC 3 phase 50Hz for larger motors and drivers.
- 2 31 VAC 1 phase 50Hz for lighting and fractional horsepower drivers.
- 2 5 VDC for controls wiring.

Where not otherwise specified elsewhere in this specification or in the appropriate IEC Standard, the equipment provided under this Contract is to capable of operating reliably at all voltage within the range of+ 1·1 0% of the stated voltage.

c) Design Codes

Unless otherwise specified or specially approved by the Engineer the project shall be designed to comply with appropriate British Standards.

- BS CP3 Chapter 5 loadings
- BS60 31 1 981 Earthworks
- BS5930 1 999 Site Investigation
- BS8002 1994 Earth Retaining Structures
- BS8004 1986 Foundations
- AASHTO Green Book Geometric Design of Highways & Streets 2004
- AASHTO Design of Pavement Structures 1993
- Asphalt Institute Ms-2 Asphalt Mix Design Method 7th edition
- BS811 0 1985 Structural Use of Concrete.

d) Environmental Considerations

GENERALENVIRONMENTALSTATEMENT

The Contractor shall undertake the project in accordance with the National Environmental Action Plan for the Republic of Maldives.

The plan adopted by the government in 1989, resulted from the recognition of the need for environmental management and planning in the Maldives.

The principal aim of the Action Plan is to help the government of the Republic of Maldives and improve the environment of the country. Including the marine and ocean area contained within the Exclusive Economic Zone, and to manage the resources contained therein for the collective benefit and enjoyment of present and future generations.

The directives principals of the Action Plan are:

- The continuous assessment of the state of the environment within the country, including the impacts of man's activities on land, in freshwater, in lagoons, reefs and ocean and of the effects of these activities on the quality of the human environment.
- The development and implementation of management methods situated to the natural and social environment of the country, which will maintain or enhance environmental quality, while at the same time utilizing resources on a sustainable basis.
- The preparation and implementation of comprehensive national environmental legislation and participation in international agreements to provide for responsible and effective management of the environment.
- The strengthening of national capabilities, institutional arrangements and financial support which will enable the Action Plan to be implemented in an efficient and economic manner.

General

The proposed project involves the construction of a civil engineering project in a very sensitive coral island chain.

There are measures that can be taken to prevent environmental damage caused by the inappropriate construction activities and management, in particular excessive damage to or interference with native vegetation and wildlife. These are set out below as requirements to be met by the Contractor.

SPECIFIC

-Introduction of Exotic Flora and Fauna

- i) All cargoes are checked for exotic animals (spiders, insects, mice and rats, etc.,) and appropriate measures undertaken to prevent the introduction of exotic animals to the island (including a prohibition on exotic pets).
- ii) All exotic vegetable and plant material/refuse is appropriately destroyed or disposed of, to prevent seeding.

-Direct Impact on Native Flora and Fauna

Disturbance to or destruction of native flora and fauna shall be kept to the minimum necessary to construct the work. The Contractor shall ensure that:

- i. There shall be no destruction or removal of existing plants except those required for construction of the project. Site clearance shall be minimized, including for roads and track.
- ii. There shall be no foraging for native animals (quills, turtles, turtle eggs). Turtle egg-laying locations shall be specifically protected.

iii. All rare endangered plant and animal species shall be protected and relocated if possible.

Coral Reef

Coral reef shall be left intact.

Solid Waste Management

- i) All waste should be contained in bins or in waste storage sited providing protection from scavenging, wind, animals or rain.
- ii) All combustible solid wastes, waste oil and other burnable material shall be burned in approved industrial incinerator, with ash to be buried in designated pits, and located near the outer edge of the constructed area.
- iii) All non-combustible wastes shall be removed from the island by the Contractor, including all residual or waste construction materials, debris, etc.,
- iv) There shall not be land filling of waste or materials on the island, nor creation of rubbish piles/heaps except as approved by the Regional Development Management Office (RDMO).
- v) No waste material shall be disposed of into or adjacent to the lagoon.
- vi) There shall be no dumping of solid wastes or hydrocarbons at sea.

Liquid Waste Management

Oil and similar liquids should be stored on a concrete pad with walls to contain any spillage. Vehicle servicing areas should be designed, constructed and operated so that spilt or waste liquids are contained and do not escape into the environment.

Sewage and wastewater shall be passed through a septic tank constructed in accordance with Design Standard ASI NZS 1 546.1. Onsite domestic wastewater treatment units Part 1: Septic Tanks. The effluent from the septic tank shall be disposed of in accordance with AS/NZS 1 54 7 On-Site domestic wastewater management, any trench or disposal point required shall not be located to prevent contamination of groundwater by the effluent and be located immediately behind a coastal vegetation buffer strip.

Accidents

In most circumstances such as this, it is the incidence of accidental spillage and leakage that can cause the greatest environmental damage.

The contractor shall ensure that:

- i) Appropriate monitoring and early-warning detection systems shall be set in place in order to prevent or minimize environmental damage caused by accidents, spills and leakage.
- ii) Fuels and other hydrocarbons shall be stored in secure containment facilities that can be retaining 120% of the entire contents in the event of a spillage or accident.
- iii) Appropriate spill containment and clean-up equipment, and staff trained in its use, are provided at the earliest possible stage during construction, in particular related to oil and / or hydrocarbon contamination of groundwater or the lagoon. This provision shall also apply to marine vessels.

Visual Impact

An essential part of this project is the eventual successful blending of facilities and accommodation into general island landscape and visual setting. The contractor shall ensure that all steps shall be taken to minimize the long-term visual impact of the project, including retention of coastal vegetation buffer strips, replanting cleared areas, and minimizing waste incinerator smoke wherever practicable.

Cultural/Ethnic Impact

The Contractor shall ensure that there shall be no disturbance, destruction or removal of any historic buildings, graveyards, and other sites on any of the islands.

e) CLIMATE CONDITIONS

The project climate has a tropical climate in an oceanic setting. The climate is dominated by the two monsoon seasons. A north east monsoon occurs from December through March and is with more gentle winds and generally lower rainfall. The southwest monsoon extends from April through November during with gale force winds and heavy rainfall can be experienced.

The daytime temperature in the shade normally ranges from 25°C to 32°C falling slightly at night.

The average relative humidity ranges from 75 to 85 per cent with a maximum close to 100 percent with high salinity in the atmosphere. The average temperature of the sea inside the atoll is approximately 27°C.

The average yearly rainfall is approximately 2500mm.

4) TEMPORARY WORKS

a) CONSTRUCTION WATER SUPPLY

The Contractor may elect to utilize ground water with suitable treatment, depending Upon the final use, or may elect to provide a desalination plant of the temporary facilities. The Contractor is bound by the recommended extraction philosophy for groundwater and that groundwater shall be mentioned to ensure its continuing suitability for the use for which is intended.

b) STORAGE FACILITIES

- i) Storage Facilities shall be provided to Achiever the Following:
 - Protection of components and equipment for the Contract work to ensure they are in as new condition at the time of substantial completion of the works.
 - Protection of materials to ensure they are in suitable condition for use in the construction of the works.
 - Protection of the environment from contamination, pollution and degradation resulting from spills leakage. This applies especially to hydrocarbons and waste.
- ii) The storage of hydrocarbons shall include an impervious bund system capable of holding the 120% of the contents of the container of hydrocarbons. Adequate arrangements for drainage of rainwater shall be made such that no over tapping of the bund occurs. No hydrocarbons shall be permitted to enter groundwater.
- iii) Waste that cannot be burnt shall be collected In such a manner that no containments enter the groundwater. The waste so accumulated shall be removed from the atoll and shall be disposal of without detrimental effects to the environment of the Republic of Maldives.

c) CO-OPERATION WITH BUILDING CONTRACTOR

The employment will let a separate Contract for the construction of buildings.

The building Contract will run concurrently with this Road-Contract and attention is drawn to the provisions of the Conditions of Contract regarding co-operation between Contractors.

In particular, it will be necessary for the following take place.

i) Co-ordination

Co-ordination meetings will be held at weekly intervals on site chaired by the project manager or his representative. The Site Manager for both Contractors will be required to attend.

ii) Use of Roads

By the nature of the project the building Contractor, the Engineer, the Employer and the general public can be expected to use the roads and other parts of the permanent work before they have been taken over by the Employer. The Contractor is to allow for reasonable use of these facilities and shall not restrict the activities of the building Contractor or the general Public unnecessarily

d) FIRST AID AND SAFETY

i) General

The attention of the Contractor is drawn to the Conditions of Particular Application and the requirement to have in place contingency arrangements should a medical emergency take place and it becomes necessary to evacuate injured personnel.

ii) Personnel

The Contractor shall ensure that all times there is available on site trained medical personnel with experience in dealing with construction related injuries. The person may have other duties but must be available at any time to attend any patients suffering from injury or illness.

iii) Health and Safety

Contract intentions with Regard to HSE

- That so far as is reasonably practicable, no person working under this contract will suffer harm as a result of the works performed.
- That so far as it is reasonably practicable public or private assets will not suffer loss, or deterioration in condition because of works performed.
- That so far as it is reasonably practicable, no detriment to the environment will be caused as a result of the performance of works.
- To meet this HSE intent the Contractor shall:
- Provide a safe, risk free working environment.
- Provide amenities and facilities for employee health and safety.
- Ensure plant is safe to use.
- Introduce systems to identify and monitor, eliminate, or isolate workers and public from hazards.
- Where elimination or isolation is not feasible, reduce the chance of employees or public being harmed.
- Provide sufficient training and / or supervision for employees to undertake their work, in manner to satisfy the above HSE intentions.

The tenderer shall provide documentation to show their management, compliance, and performance with HSE issues.

Standards:

HSE issues shall be based on the appropriate British Standards, including, but not limited to:

BSEN 471:1994 - Specification for high- visibility warning clothing.

BSEN 536:1999 - Road construction machines. Asphalt mixing plants. Safety Requirements.

BSEN12353:2000 - Traffic control equipment. Warning and safety light devices.

99/ 1 00045 DC - Vertical road signs. Portable road traffic signs. Cones and
prEN 134 22 - Cylinders Draft

R S 6912:21:9996 - Safety of earth-moving machinery. Specification for lighting,

ISO 12509:1995 - Signaling and marking lights, and reflex – reflector devices.

BSEN 1 2368:2000 - Traffic control equipment. Signal heads.

Specific information required from the tenderers:

A copy of the contractor's health and safety policy and rules·

- A copy of the contractor's Health and Safety Executive arrangements (safe working procedures including training, personnel experience, and hazard identification of particular interest will be the contractor's traffic management capabilities).
- A copy of the contractor's means of measuring health and safety performance of the contractor's activities.
- A copy of the contractor's means of compliance with the above HSE intent.

The following potential hazards shall be addressed by the Contractor during the undertaking of the works.

- Construction machinery operating within the work area.
- Heavy equipment and construction activities.
- Open trenches.
- Vehicle and public passing through the work area.
- Material stockpiled on site.
- Contractor's and other personnel engaged on site.

In the course of the contract the Contractor shall provide reasonable documentation within 2 days of the Engineer's request to show the HSE requirements are being managed, continually maintained, and continually controlled.

No claims for additional costs or extensions of time will be allowable should the Contractor be directed by the Engineer to cease any work that compromise the contract HSE intent.

e) FOUNDATION PROTECTION FOR ADJACENT BUILDINGS

Where adjacent building is less than 3 stories high or where the foundation of the adjacent building is below the excavation of the road, foundations protection methods should be provided. Any protection should be provided prior to excavation.

It can be done by: -

- Driving the upright G.I pipes (with the upvc sleeves) into the ground.
- Driving the steel plates 400-500 mm into the ground below the excavated depth.

OR Contractor to check the site conditions and proposed an adequate foundation protection method.

All the materials used for foundation protections should be removed before backfilling

5) PERMANENT WORKS

a) DEMOLITION AND RELOCATIONS

i) Select Suitable Methods

Employ methods that cause no shocks or vibration likely to damage surrounding property or equipment housed therein or buried services. The use of explosives is forbidden.

ii) Precautions

Take protective measures as referred

- Ensure there are no risks of uncontrolled collapse.
- Leave partly demolished structures secure.
- Prevent overloading of the existing structures by debris.
- Demolition Contractor to provide all appropriate signage notices and barriers to protect site operatives, the general public or any person affected by the work.

iii) Temporary Supports

The Demolition Contractor shall design and provide all necessary shores and other temporary supports required to facilitate a safe and appropriate demolition scheme

iv) Prevent Nuisance

Prevent nuisance with particular reference to dust, smoke and noise. The Demolition Contractor to carry out a noise assessment as there are residential / office properties in very close proximity to the demolition area. The Demolition Contractor is to ensure adequate precautions are in place with regard to noise and dust suppression as not to cause nuisance to local residents. All public footpaths are to remain free of dust, mud or general demolition debris throughout the contract.

v) Rot infected Timber

Ensure that infected timber does not contaminate any materials for re-use.

vi) Disconnecting

Disconnect by means causing least damage. Leave no unnecessary projections or obstructions.

vii) Stockpiling the removed existing structure.

All removed structures such as existing light poles to be stockpile in to temporary site provided or a site shown by the project engineer.

viii) Relocation of Distribution box and Junction box

Any distribution box/junction box which needs to be adjusted should be moved after the approval of relevant authorities.

b) TRANSPLANTING

i) Tools and equipment

All tools and equipment should be appropriate to the operations and prepared in advance. Digging and root pruning tools shall be sharp and clean in order to cut without breaking, crushing or tearing roots. Mechanical digging and root pruning equipment shall be operated according to manufacturers' recommendations to minimize root damage.

Lifting cables, chains, straps, and/or slings shall be inspected and used according to manufacturers' instructions and specifications.

ii) Timing of transplanting

In temperate areas, fall and spring are considered as optimal time for transplanting whereas it is not so clear in subtropical areas like Hong Kong. In general, summer is not a common transplanting season as evapo-transpiration rate is high and the transplanted trees will be under stress when transplanting work is taken place during that time. The risks of inclement weather and typhoons will also affect the work progress and the transplanting outcome.

iii) Preparation of root ball

Root pruning is sometimes required before transplanting a tree. Sufficient time should be allowed between preparation and final lifting for development of new roots capable of sustaining and continuing the growth of the transplanted tree.

The root system of a woodland or open-grown tree will normally be widespread. Lifting such trees without initial preparation of a root ball will result in much of the root system being left in the soil. After transplanting, the tree crown may then die back, or the tree may not be able to recover and will die eventually.

The root ball size varies depending on species, habit, location and specific attributes which shall be as large as practicable to maximize the potential of survival during and after transplanting while balancing other logistical and cost concerns. In general, the root ball diameter to tree

diameter ranges from 8:1 to 10:1 according to international standards (except for a palm which may require a smaller root ball). The root ball sizes should be of a diameter and depth to encompass enough of the root system as necessary for establishment. Normally the diameter of a root ball is larger than its depth which seldom exceeds 1 meter. There may be practical difficulties in forming a root ball of regular shape or recommended size due to intrinsic conditions of the site or tree, e.g., conflict with adjacent structures or utilities. In such cases the advice of a tree specialist has to be sought on the optimal dimensions of the root ball to be achieved specific to the situation.

iv) Stage digging

Root pruning to form a reasonable size of root ball is required and may be adjusted to suit specific tree species and/or imposed project constraints. For mature trees, root pruning is usually required to be carried out at different stages with a minimum of 1 month allowed for root regeneration between cuts. Stage digging can be carried out in the following stages in situations if the locations and work programme are considered suitable. The four stages are:

- (a) 1st stage – Dig a trench on the outside of the marked circumference in only two opposing segments;
- (b) 2nd stage – After a period of no less than 1 month since the 1st root pruning, dig a trench on the outside of the marked circumference in the adjacent two opposing segments;
- (c) 3rd stage – After another period of no less than 1 month since the 2nd root pruning, dig a trench on the outside of the marked circumference, in the remaining two opposing segments; and
- (d) 4th stage – After a further period of not less than 1 month since the 3rd root pruning, prepare the root ball and cut the underside.

c) ROAD CONSTRUCTION

i) Scope of work

The work covered by this section basically includes the construction of road network, asphalt paving, Green area, Pedestrian paving and vehicle parking area as per the contract agreement.

The contractor shall comply with the condition of contract together with methodology for each activity of construction phases.

It involves:

- Setting out works and Construction of a new asphalt road
- Planting strip
- Road drainage on planting strip
- Sealing of the road
- Streetlamp posts and lighting
- Road Sign Boards
- Road Markings
- Disabled road access
- Road crossing pipes and Junction Boxes
- Cross-over utilities, excavation and backfilling trenches for (Laying of Electrical cables, Sewer Pipes, Water Supply pipes and provision for any future crossings)

As this works progressing simultaneously with road construction works, the contractor shall cooperate and co-ordinate with Maldives State Electric Company (STELCO), Maldives Water and Sewerage Company (MWSC) and any other Utility Organizations, the client will give necessary assistant in this regard.

ii) Standards

The work in this section for sub base and Base course layers shall comply with British standards (Specification for Highway Works) unless or otherwise specified and "Specification for highway works: 1986 Department of Transport".

iii) Sub-Grade Preparation

Earth subgrade: When the foundation is an earth subgrade it shall be prepared by removing all vegetation, excavating and removing, filling depressions, scarifying, shaping, smoothing and compaction to meet the required grade as mentioned in Table 1, section and density. Stones or rock particles over 150mm in size and greater dimensions shall be removed.

Sub-grade material is to be either existing road material or existing reclaimed land with dredged fill materials. The sub-grade to be cut or filled and shaped to the cross falls, lines and levels shown in the drawings.

CBR tests shall be carried out to cover every 1500M.Sq of road asphalt area at a depth of 550mm from the designed asphalt top elevation and the strength shall be read $\geq 60\%$ of CBR and conform to 4 day soaked CBR of the soil at the optimum moisture content to a field density of $\geq 98\%$ under standard conditions of compaction.

The contractor shall bring the soil bearing capacity of sub-grade where the area reads less than 60% CBR value, the coverage of such area will be 1500M.Sq / test and at the depth of 550mm from the designed asphalt top elevation for each test location.

• Preliminaries

The construction of the sub-grade/sub-base shall not commence in any section of the works until the drainage works in that section have been completed and without approval from the Engineer.

Temporary cross drains shall be provided to suitably drain the sub grade as approved by the Engineer.

Immediately prior to spreading of sub base material surface shall be suitably moistened.

• Placing of sub-grade (or) Sub base Material and Compaction

The materials shall be deposited or spread on sub-grade soil foundation in manner to minimize segregation and to facilitate spreading to a uniform layer of the required section. In the event of blending of the materials is necessary to provide requires gradation and properties of the sub base material, and is done in the road way the same shall be accomplished by mixing the crushed aggregate and blending material by means of blade grader, discs, harrows or other equipment to effect the uniform distribution and gradation throughout the finished mixture.

The sub base material shall spread with blade grader not exceeding 150mm thick layers at the fill and compaction using 8·1 0 tonne smooth wheeled rolled or any other roller of comparable compaction effort.

The compaction shall be carried out at or near the optimum moisture content and the field dry density value to reach above 98% of CBR of sub base material.

The moisture content of the material shall be checked at the time of compaction at the frequency specified in Table-1 as directed by the Engineer. If the material is too wet it shall be dried by aeration and if it is too dry, the material shall be sufficiently wetted to reach optimum moisture content prior to compaction.

Rolling and compaction shall commence longitudinally starting at the edge and proceed towards the center line of the road, except at super elevated section where the rolling shall commence at the lower edge and proceed towards the higher edge.

Should soft areas be encountered, the Engineer shall determine with the contractor the extent of soft material to be removed and re-filled or any other improvements to the soil. A Variation Order will be issued for the volume of compacted fill paid at contract rates.

- **Degree of Compaction of sub-base**

The sub base shall be compacted to degree of field density not less than 98% of the maximum dry density at optimum moisture content as determined by the standard CBR compaction test as specified.

- **Quality control of the Work**

Contractor shall propose and obtain approval for the establishment of a materials. Laboratory at site and testing arrangements for construction materials.

The control of quality of the material and the work shall be carried out as per guidance given in Table 1.

- **Finishing Operations**

The compacted sub base shall be finished to levels, grades and cross sections shown in the drawings and as directed by the Engineer, subject to the requirements given in quality control sections.

- **Protection of Sub-base**

Prior to the construction of the base-course the contractor shall protect the sub-base from damage caused either by the water, by traffic or by any other means. Any damage caused shall be made good prior to the construction of the base. Where the damage may be attributed to the negligence of the contractor the repairs shall be at the own expense.

iv) Geo-cell and gravel layer

- **Preliminaries**

The construction of the Geo-cells/gravel layer shall not commence in any section of the works until the sub-grade works in that section have been completed and the target soil bearing capacity is achieved.

- **Placing of gravel layer**

The gravel layer of 150mm should consist of particle size not more than 20mm. This layer to be spread without segregation.

The compacted thickness of this layer should not exceed 150mm.

A geotextile approved by the engineer shall be placed over the compacted gravel layer for geo-webs to be fixed.

• **Geo-web**

Contractor shall propose and obtain approval from engineer on the type of geo-webs to be used.

The Geo-web cells shall have a nominal cell depth of 200mm.

The minimum short-term cell seam peel-strength shall not be less than 2840N.

The seam peel strength shall survive a loading of at least 95kg for a minimum of 10,000 hours.

v) Base-course

• **Base course materials shall be selected and graded crushed aggregate and fines recommended for highway construction works.**

The contractor shall provide a method statement as to how they will be managing and maintaining quality control of the base-course material.

The statement shall include but not be limited to:

- Source of materials and approval from engineer
- Sampling
- Testing
- Stockpile Management
- Cartage

• **Dense Graded Aggregate Base-course Materials**

AGGREGATE SAMPLING

The contractor shall be made to obtain approval from the Engineer, on full details of the source of aggregate, Samples of aggregate, and they shall be tested before being transported to the work site and before used in the Works, also, from time to time during the process of the works, and obtain approval from the Engineer, and the Engineer may order the Contractor to obtain suitable and approved aggregates from some other source of aggregate if the test results are do not confirms and comply with the specification during the construction process.

The aggregate shall be graded crushed rock with nominal maximum size of 50mm, 37.5mm (1.5") OR 25mm (1 ") OR 19 mm (0.75") conforming to general specifications and grading requirements are given below

- General Requirements

The contractor is to submit a Method Statement describing the method of execution of the works.

The use of all types of machinery equipment and other requirement that will utilize for laying and compaction of Base and Sub-base.

The coarse aggregate (aggregate substantially retained on 4.75mm sieve) used for roads bases and surfacing shall be crushed rock from an approved quarry and shall consist of clean hard sound durable particles of angular shape and rough surface texture.

They shall be free from weathered, soft, laminated or elongated pieces, deleterious matter and shall be free from clay and excess dust. The coarse aggregate shall also conform to the following requirements.

The contractor shall conduct the following preliminary tests and submit test results together with source of aggregate quarry for the approval of Engineer.

(i) Sieve analysis and gradations.

(ii) The aggregate Impact Value (AIV) determined as specified and shall not be greater than 30%.

(iii) The flakiness index determined as specified and shall not be greater than 35%

(iv) The aggregate crushing value determined as specified and shall not be greater than 20%.

(v) For coarse aggregate used for asphalt concrete surfacing treatment shall have a Los Angeles abrasion Value not greater than 40% when determined.

(vi) Fine aggregate (aggregate substantially passing the 4.75mm sieve) used for road bases and surfacing shall either be crusher fines or river sand. Where crusher fines are used they shall be derived from rock meeting the requirements of coarse aggregate for road bases and surfacing.

The grading and the grading limits of graded aggregates used for base course constructions are given below

Sieve Size mm/ μ m	Percentage Passing			
	Nominal Size			
	50mm	37.5mm	25mm	19mm
63	100	-	-	-
50	-	100	-	-
37.5	87-100	95-100	100	-
25	-	-	85-100	100
19	53-85	58-92	70-95	85-100
9.5	33-65	38-70	50-80	55-90
4.75	18-50	23-55	30-63	35-70
2.36	15-40	18-45	22-50	26-55
600	8-25	8-25	8-25	8-25
75	0-10	0-10	0-10	0-10

• The contractor is to allow for impact hammer testing of the "Clegg" type or similar British Standard recognized and calibrated impact hammers. Readings will generally be taken on the outer edge of the traffic lanes at 20m intervals.

• CONSTRUCTION REQUIREMENTS

- (a) Preparation of existing surface.
The surface shall be brushed free of dust and extract matter and if required, wetted before laying the base course.
- (b) Spreading and rolling
The aggregate shall be spread using blade grader without segregation over the prepared surface of an accepted sub grade, sub base or existing pavement uniformly and in sufficient quantities to give the required dense thickness when compacted.

It shall be ensured that the thickness of each layer compaction shall not exceed 200mm. Where 8-10 tonne smooth wheeled rollers are used the compacted thickness shall normally not exceed 150mm or 100mm. However, with heavy vibration roller greater thickness may be compacted with the prior approval of the Engineer.

The compaction shall be carried out at or near optimum moisture content to reach 98% of Maximum Dry Density obtained in Standard Proctor Compaction test, and degree of compaction shall be decided as per BS-1 377-75

In order to reduce tendency for segregation, the material shall be kept wet during transport and spreading. The material deposited on the prepared existing surface may be spread and shaped by any method which will not cause the segregation of the coarse and fine particles. When directed by the Engineer all areas of segregated coarse or fine material shall be corrected by removing and replacing with well graded material. The base material shall be compacted using an 8-10 tonne smooth wheeled roller or any other approved roller. Sufficient water shall be added to facilitate compaction and the required moisture content shall be determined by carrying out a field trial. The method of rolling shall be as follows.

The 19mm (3/4") or 12.5mm (1/2") choker stone shall then be spread evenly and rolled to ensure that the stones are well embedded in the surface interstices of the base course. While the rolling is bedding done, the surface shall be wetted and lightly brushed so as to ensure that finer aggregate include fines are worked into the crevices.

The compacted thickness of base course layer shall not 05% less than the designed thickness shown in drawings.

The control on the quality of materials and works shall be exercised in accordance with table 1.

vi) CONCRETE PAVERS & CURB STONES

- The pre-cast concrete slab prepared using concrete grade not less than 25Mpa & shall be laid on existing compacted sand with crushed stone dust filling the gap. In-situ grade 25 concrete shall be used for odd shape gaps at the bends & junctions.
- The paving blocks shall be prepared, tested & laid in accordance with BS6717-Part1 1997.Precast Concrete Paving Blocks, Specification for Paving Blocks & BS6717.1989.PrecastConcrete Paving Blocks, and Code of Practice for Laying.
- Edge concrete shall comply with curb concrete specifications using a minimum strength at 28 days of 25 MPa, bedding & backing concrete grade for curb stone shall be not less than 20Mpa, and 16mm@900mm c/c dowel bar shall be placed on the bedding of A-curb if the backing concrete is casted separately with the construction joint between bedding & backing.
- The bond pattern shall be as shown.
- The contractor shall submit production details of pre-cast concrete slabs and the supply company's quality control procedures. A copy of delivery documentation from the supply company is required certifying the source and quality check of the batch delivered to site.

vii) ASPHALT SEALING

- 50mm thick asphalt seal generally 4m - 7.4 m wide intersections with connecting Street lines are to be sealed also to the extent shown.
- Materials used for the hot rolled asphalt are to comply with BS 594 part -1992 "Hot Rolled Asphalt for roads and other Paved Areas". Part 1 specification for Constituent Materials and Asphalt Mixtures and other related referred to in these standards.
- Laying of the Asphalt is to comply with: BS 594 Part 2-1992 "Hot Rolled Asphalt Road and other Paved Areas" Part 2 of Specifications for the Transport, Laying and compaction of Rolled Asphalt.
- Apply prime coat of bitumen emulsion complying BS 594 Part 2 Clause S.5.

PRIME COAT

Description

This work shall consist of an application of a prime coat on the base course. Prior to laying asphalts so as to provide a proper bond between the layers and also to serve as a protective measure for the base course.

Materials

Materials used shall meet the requirements of following unless otherwise directed.

Binder shall be medium curing cutback bitumen (20- 45 percent (%)) or MC 30 at MC 70 or MC 250 or MC 800 given below bituminous emulsion of grade CSS – I of CSS - I h to sub section given below

Medium Curing cutback Bitumen

Medium curing cutback bitumen used for road construction and maintenance shall be prepared at site by fluxing 80 -1 00 penetration bitumen with Kerosene oil. The percentage of kerosene added shall be as specified or as directed by the Engineer depending on the purpose for which the binder is to be used. The cutback bitumen prepared shall be designated by the percentage quantity by volume of kerosene present in the binder (e.g. 1 0 percent (%) cutback bitumen shall contain 10 percent (%) by volume of Kerosene and 90 percent (%) by volume of bitumen).

In the alternative medium curing cutback bitumen shall conform to the requirement of ASTM D 2027, 76th Edition

Where, they are designated as MC 30, MC 70, MC 250, MC 800, and MC 3000. The residue from distillation of these grades when heated to 360°C shall not be less than 50%, 55%, 67%, 75% & 80% respectively.

Cationic Bitumen Emulsion

Cationic bitumen emulsion used for road construction and maintenance shall be the rapid setting, medium setting and slow setting types which shall conform to ASTM D 239 -79.

These emulsions shall conform to the requirements given therein, respect of the following:

- Viscosity
- Settlement
- Storage Stability
- Particle charge test
- Sieve test
- Distillation characteristics
- Characteristics of the residue of distillation

In addition the rapid setting emulsion shall conform to the requirements of demulsibility, the medium setting emulsion shall conform to the requirements of coating ability and water resistance and slow setting emulsion shall conform to the requirement of the cement mixing test.

All acceptance tests shall be carried out as specified in Table III, Test quality control of materials at work.

Construction Requirements

(a) Weather limitations

The prime coat shall generally spray in dry weather and when the ambient temperature is not below 1 5°C. It shall not be applied when rain is imminent.

(b) Preparations of Surface

Prior to the application of prime coats the surfaces shall be dust free, the surface shall well brushed to remove all dust, loose particles and other objectionable

material, with a power broom or any other means approved by the Engineer. In the case of aggregate bases, such cleaning shall continue until the entire surface shows a pattern of exposed, large particles free from dust as far as application of the binder, unless otherwise directed by the Engineer.

(c) Application of Binder

Binder Type	Temperatures Degrees C
MC 30 or 45 percent (%) Cutback Bitumen	40- 50
MC 70 or 35 percent (%) Cutback Bitumen	55- 70
MC 250 percent (%) Cutback Bitumen	80-90
MC 800 or percent (%) Cutback Bitumen	105- 115
Emulsions	Ambient Temperature

The prime coat shall be applied by means of a mechanical sprayer or a hand sprayers or any other means approves by the Engineer, at a temperature within the range given here.

Spraying Temperature for Binder

Note

Where the ambient temperatures are low, the emulsions shall be suitably heated to facilitate spraying.

The rate of application of binder shall be as specified or as directed and shall generally range between 0.5 and 1.5 liters per square meter (1 .0 and 3.0 gallon/square). However, this rate shall be such that the surface becomes dry with a matt finish within 4 hours when emulsions are used or within 24 hours when cutbacks are used. Emulsions shall be diluted with water where so directed by the Engineer.

Any prescribed rate of application may be achieved by two or more repeated applications, when necessary to prevent asphalt flowing off the surface. Also where surface conditions necessitate, additional binder shall be applied with the approval of the Engineer.

No base course or surfacing shall be constructed until the prime coat has cured or set in the opinion of the Engineer.

In areas being treated precautions shall be taken to prevent the surfaces of structures and trees being spattered or marred and binder getting into channels, catch pits and drains.

(d) Aftercare

Traffic shall not be permitted on the primed surface for a minimum period of 3 hours or longer until the binder has penetrated and dried up and in the opinion of the Engineer. Which the prime coat will not be picked up by the traffic wheels.

However, where the Engineer deems it impracticable to detour traffic, the contractor shall spread a sufficient quantity of blotting material in order to prevent the prime coat from being picked up prior to allowing the traffic to pass. Any areas which are in

excess of deficient in priming material shall be corrected by the addition of blotting material or binder, as appropriate. Such corrections shall be considered as incidental work.

viii) ASPHALT AND MIX DESIGN

The contractor shall submit the asphalt mix design and with the specification using an approved standard asphalt mix design method and shall obtain the approval from the Engineer. A Method Statement shall submit for, setting out the equipment sequence and methods he proposes to use to achieve a high standard of asphalt seal applicable to the tropical conditions in relation to the 50years forecast of traffic volume expected in the Thilafushi' region.

Asphalt Concrete Surfacing

The work shall consist of the construction of asphaltic concrete surfacing on newly constructed bases course.

The asphaltic concrete surfacing shall consist of binder course and a wearing course.

Materials:

Materials used shall conform to the requirements of the following unless otherwise specified.

(a) The binder shall be 80- 100 or 60-70 penetration grade bitumen to the section under binder. Which shall confirm to the requirements of ASTM 0946 or AASHTO M20

(b) The coarse aggregate of nominal maximum sizes 19mm and 12.5mm and the fine aggregate shall conform to the general requirements of sub section 0.9.4.2 (a) When the coarse and fine aggregate are combined, along with filler where required, the combined grading requirements shall be as given below.

Samples of aggregate shall be tested before being used in the Works, and from time to time during the process of the Works under arrangements to be approved by the Engineer and may order the Contractor to obtain suitable aggregates from some other source if testing confirms that the aggregates do not comply with the specification.

The grading requirements for the combined aggregate and the binder content shall be as given below for the wearing courses.

Aggregate grading, binder and thickness requirements.
Mix classification

Course Laying Thickness of compacted (mm)	-	Wearing course Max 50
	-	Min 25

Sieve Size		Total % by weight passing including filler if used
mm	μ	
25		
19		100
12.5		80-100
9.5		73-93
4.75		52-69
2.36		32-50
1.18		25-43
	600	19-35
	300	14-27
	150	9-18
	75	5-10

Note: The sieve sizes used herein are of ASTM designation. However, equivalent BS sizes as may be used with the prior approval of the Engineer.

The Contractor is to advise in writing for approval by the Engineer the type, source, and composition of the aggregate and binders.

Asphalt mixtures are to be sampled and tested in accordance with BS 598: part 100, Part 101: 1987 and Part 102: 1989.

Mix Characteristics

The mix characteristics as determined by the Marshall Mix Designs procedure shall be as given in Table below for wearing courses for medium traffic.

Wearing Courses

Percentage of binder content by total weight of mix between 5.0%- 7.0%, however the optimum bitumen content shall be decided based on the Trial-Mix performed as satisfy the below requirements.

Job Mix Formula

The contractor shall intimate to the Engineer's approval, in writing at least two weeks

Test	Description	Limits
1	Marshall stability in KN	Not less than 13
2	Marshall flow (0.25 mm)	8 - 18
3	Air voids in mix percent (%)	4-7
4	Voids in mineral aggregate percent (%)	13 - 14

before the start of asphalt production for the work, the job mix formula proposed to be used by him for the work which shall give the following details :-

- (i) A single percentage of aggregate passing each specified test sieve.
- (ii) A single percentage of binder content by total weight of total mix.
- (iii) A single temperature at which the mix is emptied from the mixer.
- (vii) A single temperature at which the mix is to be delivered on the road.

In addition the contractor shall give the sources, locations of all material and the details of the mix design based on requirements given in above table.

All mixes furnished shall conform to the job mix formula approved by the Engineer within the ranges of tolerance given be low.

Job Mix Tolerance

Aggregate passing 9.5 mm and large sieve	± 6%
Aggregate passing sieve between 9.5 mm and 75 urn	±4%
Aggregate passing 75 urn sieve	± 2%
Binder content per cent (%)	± 0.3%
Temperature of mixture when emptied from mixer	± 10% °C
Temperature of mixer when delivered at the point of place	± 10% °C

If a change in the materials or source of materials is proposed, a new job mix formula shall be submitted and approved before the mix containing the new material is delivered to site.

The mix if not within the specified limits given above shall be rejected.

When unsatisfactory results or changed conditions make it necessary, the contractor, if required, shall submit a new job mix formula to the Engineer for approval.

Construction Requirements

(a) Preparation of Existing Surface

When asphaltic concrete surfacing is laid over newly constructed aggregate bases, prior to construction, the surface shall be cleaned of extraneous matter and applied with a prime coat.

(b) Weather Limitations

The bituminous mix shall not be laid during rainy, wet weather or when the surface on which it is laid is damp or wet.

(c) Limitations Due to Equipment Etc.

No work shall be carried out when there is insufficient equipment for hauling, spreading or finishing or insufficient labour to ensure progress at a rate compatible with the output of the mixing plant.

(d) Mixing Plant and the Preparation of Mix

An approved mixing plant of the batch type or of the continuous type shall be used for the preparation of the mix, which shall have the capacity sufficient to supply the paver continuously.

The mixer shall be capable of accurately batching the aggregates, filler and binder and mixing same thoroughly so that the mixed material on discharge from the mixer is uniform in composition and that all aggregate particles are completely coated.

Batch type plants, shall be equipped with suitable means for accurately weighing of each bin size aggregate and the filler. The scales of such the weighing mechanisms shall be calibrated at the frequencies as determined by the Engineer using standard weights. The contractor shall always have at hand sufficient 25kg weights for such calibration.

In continuous type plants the gate openings of the aggregate shall be calibrated by an approved process of weighing test samples. The bitumen feed line shall have a by-pass arrangement in order that the meter could be calibrated. These calibrations shall be carried out at frequencies determined by the Engineer.

The mixing plant shall be capable of heating the aggregate and the binder to the appropriate temperatures. When wet aggregate is used, the plant shall have an added capacity to dry the aggregate before heating.

The binder and mineral aggregate shall be heated separately to temperatures between 130°C & 160 °C, and 150 °C & 175 °C respectively. The materials shall be mixed at temperatures within absolute limits of 145°C and 170°C, even allowing for tolerances.

The plants shall, be equipped with a dust collector so constructed as to waste or return uniformly to the elevator all or any part of the material collected.

The mixing plant shall be capable of loading the mix into transport vehicles in such a manner that there is no heat losses and segregation does not occur.

In addition the plant shall be provided with the following:

- i. Covered or protected ladders or stairways with secure hand rails in adequate number which shall be placed at all points required for accessibility to all plant operations.
 - ii. Covering devices for pulleys, belts and drive mechanisms and other moving parts.
- II. Ample and unobstructed space on the mixing platform.
 - III. A clear and unobstructed passage at all the times in and around that tipper loading space which shall be kept free from drippings from the mixing platform.
 - IV. Insulated flexible pipe connections to carry bitumen.

(e) Transport of Mix

The mix shall be immediately transported from the mixing plant to the point of placing in covered tipping trucks to avoid heat losses.

The mix shall be delivered to the point of placing at a temperature within the absolute minimum limit of 115°C.

The trucks shall be good mechanical condition at all times. They shall have clean and smooth metal beds that have been sprayed with soapy water or lime solution or any other detergent solution approved by the Engineer, to prevent the mix from adhering to the beds. The amount of sprayed fluid shall however be kept to a practical minimum. All precautions shall be taken to avoid segregation of mixed materials and to ensure that they do not become contaminated with dust or foreign matter.

Any truck causing excessive segregation of bituminous material by its spring suspension or other contributing factors, or that shows oil leaks in detrimental amounts of that causes undue delays, shall upon direction of the Engineer be removed from the works until such conditions are corrected.

When directed by the engineer, each load shall be covered with a properly fastened canvas or other suitable material of such size as to protect the mix from the weather. In order that the mix shall be delivered to the site within the specified temperature range, during cold weather or during long hauls, a properly fastened insulating cover shall be used when necessary.

Load and transporting shall be coordinated such that spreading, compacting and finishing shall be completed during daylight hours unless adequate illumination, as approved by the Engineer, is provided by the Contractor.

(f) Asphalt Paver and laying of the mix

The hot mix asphalt shall be laid immediately after transporting by means of approved mechanical self-powered asphalt pavers. They shall be capable of spreading, finishing and providing initial compaction to the mix so that, the surfacing can be finished to the required lines, grades, levels, dimensions and cross sections intended, either over the entire width or over such other partial widths as may be practicable.

The asphalt pavers shall be equipped with receiving hoppers and spreading screws of the reversing type of place the mix evenly in front of adjustable steering devices and shall have reverse as well as forward travelling speeds. They shall also be furnished with vibrating screed (levelling) unit equipped with suitable burners or heaters and tamping bars or vibration attachments.

The asphalt pavers shall be able to confine the edges to confine the edges of the pavement to true lines without the use of stationery side forms. The equipment shall include bending or joint levelling devices for smoothening and adjusting longitudinal joints between lanes. The assembly shall be adjustable to give the cross sectional

shape prescribed and shall be as designed and operated as to place the required thickness and weight per square meters of material.

A fully trained and experienced operator shall be in direct charge of the paver at all times. The pavers shall be operated so as to avoid dragging of the material.

The bituminous mix, after spreading, finishing and initial compaction by the paver, shall have a smooth surface free of irregularities caused by dragging, tearing or gauging.

During construction, if it is seen that the paver in operation leaves on the surfacing tracks or intended areas or other objectionable irregularities or segregation of mix, that cannot be satisfactorily corrected by normal operations, the use of such a paver shall be discontinued forthwith and another satisfactory paver shall be provided by the contractor.

In narrow widths and in restricted area where the plant cannot operate, the mix may be manually laid, in which case, care shall be taken to avoid segregation. Manually laid strips shall be rolled at the same time as the paver laid work and allowance shall be made for extra compaction of these strips. Any defects in laid surface immediately be rectified before rolling commences and there shall be no unnecessary scattering back by hand of material on paver laid work.

(g) Compaction Procedure

Immediately after the mix has been spread and struck off, the surface shall be checked and any irregularities adjusted. Rolling shall commence as soon as the material will support the roller without undue displacement or cracking. The mix shall then be thoroughly and uniformly compacted by rolling, according to the sequence of rolling as given below:-

- i) Transverse joints
- ii) Longitudinal joints, where applicable
- iii) Outside edge
- iv) Initial or breakdown rolling
- v) Second or intermediate rolling
- vi) Finish or final rolling

Normally the first rolling joints and edges and the initial or breakdown rolling, shall all be done with static weight (Tandem or three wheels) or vibratory steel wheeled tandem rollers and the second or intermediate rolling with pneumatic tyred rollers. Use of any other rollers for the above purposes shall be with the prior approval of the Engineer. During initial or breakdown rolling, the direction of travel of the roller shall be such that the powered or driving wheel passes over the un-compacted mix first, before the driven wheel. The second intermediate rolling shall follow the initial or breakdown rolling as close as possible while the bituminous mix is still plastic and at a temperature that will result in maximum density. The final rolling shall be accomplished with static weight tandems or vibratory tandems (without vibration) while material is still warm enough for removal of roller marks.

In general the type of roller or roller combination to be used shall be nominated by the contractor for the approval of the Engineer prior to the commencement of work and the rollers shall satisfy the requirements given in compacting equipment section.

The moving speed of the rollers shall not exceed the limits given in Table below and shall be at all times be slow enough to avoid displacement of the hot mix.

Type of Roller	Spread in Km/hr.		
	Breakdown	Intermediate	Finish
Steel Wheeled Rollers	3	5	5
Pneumatic Tyred Rollers	5	5	8
Vibratory Rollers	5	5	-

During stages of initial, intermediate and final rolling, rolling shall commence at the low side of the spread and progress towards the higher side parallel to the center line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by either removing or by adding fresh material. The rolling shall be continued till the entire surface had been compacted adequately and the roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one half of the proceeding pass. The roller wheels shall be kept damp if required to avoid the material sticking to the wheels and being picked up. However, the quantity of water used for this purpose shall be the minimum required.

When using a vibratory roller for the compaction of a surfacing the vibration shall be turned off before the roller stops when reversing direction, and turned on after it starts in the new direction.

Vibratory rollers shall not be used for surfacing of thickness less than 50mm, unless otherwise approved by the engineer. The breakdown and the intermediate rolling shall be carried out at temperatures or less than 105°C degree 135°C degree respectively.

The final rolling shall be completed before asphalt mix temperature falls below 85°C. When the bituminous mix is spread in areas that are inaccessible to rollers such as places as curbs and manhole etc., compaction shall be obtained by hand tampers, mechanical tampers, walk behind rollers or small vibrating plate compactors.

The core samples shall be taken to cover for every 400m² of asphalt area

(h)Requirements of Compacting Equipment **General**

Generally, with each paver, a minimum of 3 rollers shall be provided by the contractor.

All rollers shall be self-propelled, capable of being reversed without backlash and equipped with power steering, dual controls allowing operation from either the right or left side. They shall have water tanks with sprinkler systems to ensure even wetting of rolls or tyres. The rolling surface of the wheels of a steel wheel roller shall be checked for wear. If grooves or pits have worn into the rolling surface, the roller shall not be used on the job.

Each roller has a calibration chart showing the relationship between depth of ballast and weight and giving the tare weight of the roller. Each roller shall be in a good condition and shall be operated by a competent and experienced driver.

Steel wheeled Rollers

Pneumatic tyred rollers shall have not less than seven wheels (3 wheels on the front axle and four on the rear) fitted with smooth tread compactor tyres, of equal size and construction, capable of operating at inflated pressures up to 850/ LN/ Square meter. The wheels shall be able to move up and down independently of one another.

Wheels shall be equally spaced along both axle lines and arranged so that the tyres on one axle line track falls midway between those on the other with overlap. The tyres shall be kept inflated to specified operating pressures with variation not exceeding 36KN/square meter.

Means shall be provided for checking and adjusting the tyre pressures on the job at all times for each size and type of tyre used, each roller shall have charts or tabulations showing the relationship between wheel load, inflation pressure and tyre contact pressure, width and area. Each roller shall be equipped with means of adjusting its total weight by ballasting so that the load per wheel can be varied from 1,500 to 2,500 kilograms. In operation the tyre inflation pressure and the wheel load shall be adjusted, as required by the Engineer, to meet the requirements of each particular application. In general the compaction of any course with a pneumatic tyred roller shall be accomplished with contact pressures as high as the material will support.

Vibratory Rollers

Generally vibratory rollers shall be equipped with automatic vibration control which cuts out the vibratory system before the machine comes to a halt.

The minimum operating weight of the roller shall be 6 tones and minimum drum width 0.9m, the minimum linear drum applied force 44 KN/ m and the minimum frequency of vibration 33 Hz (2000 cycles/ min).

(i) Joints

Both longitudinal and transverse joints in successive course shall be staggered so as not to be one above the other. As far as practicable, longitudinal joints shall be arranged so that the joints in the top course shall be at the location of the line dividing the traffic lanes, and the transverse joints shall be staggered at a minimum of 250mm and be straight. Longitudinal and transverse joints shall be made in a careful manner so that well bonded and sealed joints are provided for the full depth of the course no mixture shall be placed against previously rolled material unless the edge is trimmed

to line and applied with a very thin coating of binder just before additional mix is placed against the previously rolled material. Spreading shall be as nearly continuous as possible and rollers shall pass over the unprotected end of freshly laid mix only when authorized by the Engineer. In all such cases provision shall be made for a properly bonded and sealed joint with the new surface for the full depth of the courses as specified above. Before placing mix against them, all contact surfaces of curbs, gutters, manholes etc. shall be given a thin uniform coating of hot bitumen and the joints between these structures and the surface mix shall be effectively sealed by the subsequent spreading, finishing and compaction operations.

(j) Aftercare

Sections of the newly finished work shall be protected from traffic of any kind until the mix had sufficiently hardened. Also traffic shall normally, not be permitted over newly laid surfaces at least for six hours after laying.

In the event any binder course is constructed initially the surface so formed shall be maintained in its finished condition until the surface course is placed thereon, and any damage caused shall be made good by the contractor if it shall be corrected at his own expense.

(l) Surface Finish and Quality Control

The Asphaltic Concrete surfacing shall be finished to the requirements given in quality control section.

The control on the quality of materials and works shall be exercised in accordance with Table 1.

ix) Kerbs

The work included in this section is the:

Kerb for the road and the foot path along the roads and the housing area.

Kerb can be either machine extruded to the dimensions given on the drawings or cast using steel moulds.

The foot path kerb can either be cast in-situ or pre-cast with satisfactory cast in-situ jointing and lap weld of the reinforcing of the sections.

Concrete for road kerb shall comply with BS 5328 and clause 3D/17 concrete and reinforcing. This concrete is to have minimum 28 days strength of 20 MPa.

The contractor is to have string lines for kerbing inspected by the Engineer prior to construction.

CONSTRUCTION REQUIREMENTS

•Precast Concrete Units

Excavation for placement of pre-cast kerb units shall be made to the required depths and the base upon which they are placed shall be compacted using Vibrating tampers or by other approved means to an even surface. All soft and unsuitable material encountered during such excavation shall be removed and replaced with suitable material, which too shall thoroughly compacted.

Where pre-cast kerbs are used they shall be fitted in place on a bed of grade 20 concrete is indicated in drawing or as required by the Engineer.

The kerbs should be laid so that the face and top lines confirm to the line and grade required. The units are to be placed side by side without mortar jointing the faces shall be made to fit as closely as practicable and where approved the surfaces shall be chipped and/ or applied with a thin film of cement grout achieve the desired fit and also a bond between the units.

In resetting previously salvaged kerb units the procedure given above shall be followed.

•Cast in - situ Kerbs

Excavation and bedding for in-situ kerb or kerb shall conform to the requirements of above shall be followed.

Forms used for concrete shall be of wood, metal or other suitable material and shall extend the full depth of the concrete. All forms shall be free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. All forms shall be cleaned and coated with approved form oil before concrete is placed. Expansion joints shall be made at the required intervals using spacer plates made of metal, as directed by the Engineer. Concrete shall be proportioned, mixed and placed in accordance with the requirements of grade of concrete specified. Compaction of concrete placed in the forms shall be by vibration or by other acceptable means. Forms shall be left in place 24 hours or until the concrete has set sufficiently, so that they could be removed without injury to the concrete placed.

The concrete shall be struck off to the cross section specified, after which it shall be finished smooth by means of a wood float.

Plastering of concrete deficiencies shall; be done only with the approval of the Engineer.

The finished concrete shall be kept continuously moist for a minimum period of 3 days and the method of curing shall be subject to the approval of the Engineer. For a further period of 4 days the concrete shall not be exposed to the hot sun.

After the concrete has set sufficiently, the spaces in front and back of the kerb shall be refilled to the required elevation using approved material which shall be thoroughly compacted.

x) GALVANIZED COMPONENTS

Equipment shall be prepared for galvanizing by degreasing and picking. Galvanizing shall be applied by the hot dip process in accordance with BS 729.

All galvanizing shall be done by the hot dip process with spelter, not less than 98% of which must be pure zinc. No alternative process is to be used without the approval of the Engineer. Blots shall be completely galvanized including the threads, but the threads shall be left uncoated in the case of nuts.

The zinc coating shall be uniform, clean, smooth and free from spangle as possible. In the case of component parts the zinc coating shall weigh not less than 600g/m² of area covered and be not less than 80 microns in thickness.

All galvanized parts shall be protected from damage to the zinc coating due to differential aeration and abrasion during the periods of transit, storage and erection, damaged areas of the coating shall be touched up with approved zinc dust paint or other approved flake metallic compounded.

Where the galvanizing coat has been broken during fabrication or damaged in handling, the exposed surface shall be painted as soon as possible in accordance

with the following. Clean back bright metal feathering the edges of the surrounding galvanized coating degrease and apply two coats of zinc rich primer each 75 microns dry film thickness. If large areas of the galvanizing coat are damaged (> 200mm² per item), re-galvanizing will be required.

xi) Traffic signs and pavement marking

GENERAL

The contractor is to supply and place all the road markings post in accordance with the contractor plans and prevailing standards.

STANDARDS

Road marking shall be carried to the appropriate British Standards including but not limited to:

BS 873 1 to 8: 1984 Road traffic signs and internally illuminated bollards. Various specifications.

- BS Er412802:2000 Road marking materials. Laboratory methods for identification.
- BS ENV 13459- 1 to 3 Road marking. Material. Quality control. Various specifications
- BS EN 1424: 1998 Road marking materials. Premix glass beads.
- BS EN 1436: 1998 Road marking materials. Road marking performance for road users
- BS 3262 - 1 to 3 Hot applied thermoplastic road marking materials. Various specifications.
- BS EN 1790: 1998 Road marking materials. Preformed road/ marking
- BS EN 1824: 1998 Road marking materials. Road trials.
- BSEN1871 2000 Road marking materials. Physical properties.

TRAFFIC SIGNS

Signage to be purchased from a member of the road safety manufacturer association. All traffic signs are to be manufactured in accordance with the Maldivian Traffic Regulations and British Standards.

All traffic signage shall be erected by the Contractor in accordance with the Maldivian Traffic Regulations and British standards in accordance with the construction drawings.

Signage footings shall be nominally 40 mm diameter concrete piles 1000 mm deep, with frangible fittings if necessary as defined in the standards. Footings to be approved by the Engineer.

Sign layouts and lateral and vertical clearances shall conform to all above standards, Regulations, the contract plans and sight lines to be approved by the Engineer prior to erection.

PAVEMENT MARKING

Scope of Work

The Contractor is to supply materials and apply road marking as shown on the plans. Road marking applies to paved sections of roads only, marking includes center lines and limit lines.

Marking Dimension

The Contractor is to apply road marking in accordance with layout details shown on the contract plans.

All lines shall appear by eye to be straight or where designated as a true curve.

Tolerances for location with respect to the drawings are:

1. Transverse location 20mm
2. Longitudinal location 50mm

Any paint on the pavement surface as a result of the Contractor's operations outside the area of the specified markings and tolerance whether caused by mechanical or operator fault, spillage or transfer of the paint from markings by traffic, shall be removed by wet sandblasting before any pavement is made. Under these circumstances, on no account will cover of such paint by paint, bitumen or other material be accepted.

Materials

The contractor shall supply a certificate from Paint Manufacturer's for the compliance issued from an authority implementing British Standards approach to paint manufacture.

Certificate shall include:

- Date of Manufacture
- Product Description
- Batch Number
- Appropriate Standards and Specification
- Classification Daytime - Dry time - Resistance to traffic
- Certificate Date
- Colour
- Batch Quantity
- Test results showing requirements and results for:
 - Viscosity
 - Density
 - Fineness of Grind
 - Volume Solid Content

- %Non-volatile of Mass

APPLICATION AND EQUIPMENT

The Contractor shall provide personnel and equipment appropriate to provide a high performing finished product including templates for road marking arrows and tests etc.

Paint of Thermoplastics material shall be supplied in containers which are sound and airtight and be labelled appropriately indicating direct reference to the manufacturer's certification details.

xii) CONCRETE AND REINFORCING

STANDARD

All reinforced and concrete wall shall comply with the provisions of BS 5328 parts 1, 2, 3 and 4 as appropriate, unless further modified by this specification.

CONCRETE MATERIALS

CEMENT

Cement shall comply with the requirements of BS.12.Cement Supply

CEMENT SUPPLY

Cement shall be from a source approved by the Engineer. The manufacturer's test certificate shall be provided to the Engineer for all consignments and no cement shall be used on the Works until the Engineer has been satisfied that the consignment had been tested and complies with the specification.

CEMENT DELIVERY

Cement shall be transported to the site in bulk pressurized vehicles or in bags. Cement delivered in bulk shall be transported in vehicles having effective means to transfer without damage from vehicles to the storage silos. If the cement is delivered in bags, each shall contain 50Kgs and the bags shall bear the manufacturer's name or registered mark.

CEMENT SAMPLING

The Engineer shall have the right to require the contractor at any time to draw samples according to the relevant BS and from locations to be specified by the Engineer.

CEMENT STORAGE

Storage shall be in watertight silos or in dry, well ventilated, weather and watertight sheds. The capacity of silos and sheds shall be adequate to avoid de lays in construction owing to shortage tested and proved cement. Different types of cement shall be stored in separate sections of the shed and/or in separate silos.

CEMENT USAGE

Cement shall be used as soon as possible after delivery 1 each consignment being used in correct rotation to prevent overlong in storage. Cement which has been more than 28 days in store at the site shall be re -tested before use.

xiii) AGGREGATES

FINE AGGREGATES

Fine aggregate for concrete shall comply with the requirements for Fine Aggregate for BS 882. It shall be graded to fall within grading zones 1, 2 or 3 of Table 2 of BS 882 but the percentage by weight passing the No. 100 sieve shall not exceed 5 percent, unless with the special permission of the Engineer. Fine sand of uniform shall not be used. Fine aggregate shall not contain more than a total of 3 percent (%) of loam, clay, fine dust and other impurities, nor shall it contain more than 3 percent (%) of mica. The total amount of mica, loam, clay silt, fine dust and other impurities shall not exceed 5 percent (%). Sand containing salt or coal dust shall not be permitted.

COARSE AGGREGATE

Coarse aggregate for concrete shall be uncrushed gravel, crushed gravel or crushed stone from an approved source and complying with the requirements of BS 882 and graded to fall within the grading zones of Table 1.

Coarse aggregate shall be "single sized" screened to the requirements of BS 882. The nominal sizes required on site shall be 19 mm and 85 mm. All fine material less than 5mm shall be removed.

When tested in accordance with BS 812 the Flakiness index for any size of aggregate shall not exceed 35.

No surface or decomposed rock or sandstone shall be used.

STORAGE OF AGGREGATES

The coarse and fine aggregate shall be stored separately at site, and the coarse aggregate shall be stored separately in its various grading.

Approved containers or bins constructed with concrete columns, and concrete panels or timber walls shall be used for the storage of aggregates and these shall be sufficiently large to avoid delays in construction work. Storage arrangement shall be such that intermingling of materials in separate stockpiles is not possible, and so as to prevent contamination of aggregates soil, vegetation, rubbish or windblown dust. Fine material which accumulates at the bottom of the storage shall be removed at frequent intervals so that specified grading is maintained throughout.

AGGREGATE SAMPLING

Samples of aggregate shall be tested before being used in the Works, and from time to time during the process of the Works under arrangements to be approved by the Engineer. Notwithstanding previous approval of aggregates, the Engineer may order the Contractor to obtain suitable aggregates from some other source if testing confirms that the aggregates do not comply with the specification.

The Engineer shall have the right to require the Contractor at any time to draw samples of aggregate from locations to be indicated by the Engineers. The samples shall be drawn and tested in accordance with clause 5 of BS 882.

AGGREGATES- DRYING SHRINKAGE

Should the aggregates proposed for use in the concrete work produce concrete with and above average drying shrinkage: then the recommendations of BRE digest 35 shall be applied. Aggregates with excessive drying shrinkage characteristics shall not be used in the concrete Works.

AGGREGATES- ALKALI- SILICA REACTION

The contractor shall provide evidence to the effect that the aggregates proposed for use in the work do not have a history of damage due to alkali-silica reaction.

xiv) WATER

Water to be used for mixing concrete shall comply with BS 3148 unless otherwise approved by the Engineer.

xv) CONCRETE ADDITIVES

Concrete additives shall not be used in the concrete works without the prior approval of the Engineer.

Any mixture used in the Work shall comply with relevant part of BSS075.

xvi) CONCRETE MANUFACTURE

MIX DESIGN

The Contractor shall design the concrete mixes to comply with BS 5328 part 2 section 2 and with the specification using an approved standard concrete mix design method. The Contractor shall provide the Engineer with the details of the mix design and shall obtain his approval as to the mix design details and to the mix design method before concrete work commences.

- The Contractor's proposals for the mix and mixing plant shall include the following:
 - The source of supply of aggregates and cements
 - The anticipated drying shrinkage value of concrete prisms when prepared and tested in accordance with Appendix 11 of the Building Research Digest (2ndSeries) 35.
 - The grading, in tabular form, of the coarse and fine aggregates.
 - The grading, in graphical form, of the coarse and fine aggregates plotted on the relevant grading envelopes specified in BS 882.
 - The combined grading in tabular form and graphical form of the coarse and fine aggregates.
 - The water/ cement ratio by weight
 - The aggregate/cement ratio by weight
 - The workability of the mix
 - For air entrained concrete; details of the air entraining agent.
 - Details of the quality control which the Contractor propose to use including the type of mixing plant.
 - The design standard deviation
 - The design average 28days compressive strength.

STABILITY OF MIX DESIGN

Following provisional acceptance of the Contractor's mix design proposals by the Engineer, the contractor shall provide the Engineer with the evidence in accordance with BS 5328 Part 3 that the proposed mix design is adequate to meet the specified strength and other specified requirements .

CHARACTERISTIC STRENGTH GRADES

The characteristic strength grades for the various parts of the Contract shall be C20 as described in BS 5328 part 2.

The mix designations used are those described in BS 5328 part 2.

MAXIMUM AGGREGATE SIZE

The maximum aggregate size used in mixes shall be 20mm.

MINIMUM AGGREGATE SIZE

The minimum cement contents and maximum free water/cement ratios of the various mixes shall comply with Table 14 of BS 5328 part 1.

SLUMP

Concrete mixes shall generally be designed for an 80mm slump unless otherwise approved by the Engineer.

MAXIMUM CHLORIDE CONTENT

The maximum chloride content of the concrete shall not exceed the limits specified in clause 422 and Table BS 5328: Part 1

BATCHING AND TRANSPORT OF CONCRETE

All concrete shall be weigh batched and delivered to the placement site in accordance with section 4 of BS 5328 part 3.

Concrete shall be mixed in a power driven concrete mixer, of the type stated on the Contractor's mix design proposals, until such time as there is a uniform distribution of materials throughout the mix and the mix is uniform in colour and consistence.

Notwithstanding the foregoing the mixing time shall not be less than recommended by the manufacturer of the concrete mixer. The concrete mixer shall revolve at the speed recommended by the manufacturer.

A concrete mixer of any type which has been out of use for more than 30 minutes shall be cleaned out before any fresh concrete is mixed.

xvii) PLACEMENT

CONCRETE PLACEMENT

Concrete shall be handed in such a manner as will ensure that at the time and place of deposition it is of the correct quality and workability.

The placing and compaction of concrete shall be completed within 20 minutes of its leaving the mixer unless the concrete is transported in a revolving agitator drum kept continuously in motion when the concrete shall be placed and compacted within 20 minutes of its leaving the agitator. Concrete shall be placed within 2 hours of the cement being introduced into the mix.

Concrete shall be handled so that segregation of the constituent materials does not occur.

Concrete in deep sections shall be placed in layers not over 0.5m deep and each layer shall be compacted in place by methods which will not cause the ingredients to segregate. Vibration shall not be used to move concrete along the forms. Surfaced shall be free from voids caused by stone pockets. Where necessary, vibration shall be supplemented by hand spading to secure these results. Fresh concrete shall not

be placed upon the preceding layer after interval as the engineer supervisor may determine in the circumstances. A succeeding layer may not be placed unless vibration and reworking causes the concrete of the preceding to become plastic.

Where delays have been too great for the foregoing to be complied with, the surface of the concrete shall be treated as for a construction joint.

Concreting of any unit or section of the works between construction joints shall be carried out in one continuous and uniform operation, and no interruption of the concrete placing and compaction shall occur unless agreed by the Engineer. The temperature of concrete when placed in the works shall not be less than 50 degree Celsius nor greater than 30 degree Celsius.

PLACING IN WATER

Concrete shall not be placed in water unless in the opinion of the Engineer's representative the removal of water prior to the placing of concrete is not practicable. In such cases the cement content of the concrete shall be increased by 25%.

COMPACTION

As concrete is placed in position it shall be compacted by using mechanical vibrators in such a manner as to produce a dense. Uniform and homogeneous mass free from voids and other imperfections.

Unless approved otherwise, compaction of all concrete, including vehicle crossing slabs, shall be carried out principally by the use of immersion vibrators.

If external type vibrators are used they shall be augmented by the use of immersion type vibrators.

The top surfaces of slabs shall be compacted by beam vibrators. Ample numbers of serviceable vibrators shall be available consistent with the type of work and the rate of placing of the concrete so as to ensure that the specification is complied with even if vibrator failures occur.

VIBRATORS

Vibrators shall be capable of transmitting to the concrete not less than 8000 cycles of vibration per minutes. The vibration of immersion and form vibrators shall be sufficiently intense to cause the concrete to settle readily into place and to positively affect the concrete over a radius of at least 500 mm and to a depth of 150mm for slabs. A sufficient number of vibrators shall be employed so that at the required rate of placement, vibration throughout the entire volume of each layer of concrete and complete compaction is achieved. At least one extra vibrator shall be on hand for emergency use.

INTERNAL VIBRATION

Internal vibration shall be applied at points uniformly spaced not farther apart than the radius over which the vibration is visibly effective. Vibrators concrete at the formed surface.

FORM VIBRATORS

Form vibrators shall be attached to or held on the forms in such a manner as to effectively transmit the vibration to the concrete and shall be raised in lifts as filling of the forms proceeds, each lift being not more than the height of concrete visibly affected by the vibration. They shall be placed horizontally at distances not greater than those through which the concrete is visibly affected.

GENERAL

Irrespective of the method of application, vibration of the concrete shall be such that expulsion of entrapped air and settlement of the concrete is visibly evident over all areas of the surface and shall be maintained until this action ceases and until coarse aggregate at the surface is embedded. Vibration shall not be prolonged beyond the time at which this condition is reached.

FINISHING

Immediately after compaction, the surface of the concrete shall be screeded by straight, edge or vibrating screed to the specified grade within the tolerances specified. Screeding shall be carried out with a minimum of working to avoid concentration of excess sand/ cement paste at the concrete surface.

Final finishing, including floating and troweling, shall be delayed until any water sheen has disappeared from the surface and the concrete is sufficiently stiff to prevent concentration of fine material at the surface. No work shall be carried out on any area where there is free surface water. Application of dry cement or sand to absorb free water is not permitted.

CURING AND PROTECTION

- **General**
From immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures and mechanical injury, and shall be maintained with minimal moisture loss for the period necessary for hydration of the cement and hardening of the concrete.

- **Unformed Surfaces**
For concrete surfaces not in contact with the forms, one of the following procedures shall be applied on completion of concrete finishing operations as soon as it is possible to do so without damaging the surface:
 - Ponding or continuous sprinkling
 - Continuous application of a mist spray
 - Application of a curing compound conforming as to ASTM C309 Specification for Liquid Membrane-Forming Compounds for curing Concrete. Curing compounds shall not be used on any surface against which additional concrete or other material is to be bonded, or unless positive measures are subsequently to be taken such as sandblasting, scrubbing or other effective means, to remove it completely from areas which are to receive bonded applications.
 - Covering with an impermeable sheet such as polyethylene in a manner to prevent undue loss of water from the concrete.

- **Formed Surfaces**
For concrete surfaces in contact with forms, immediately after loosening or removal of the forms, the concrete shall be cured until the end of the prescribed time by the one of the methods specified in for the curing of unformed surfaces.

LENGTH OF CURING PERIOD

Concrete shall be cured for a minimum of continuous seven days after placement.

DESIGN OF FORMWORK

Forms shall be so designed and constructed that the concrete can be properly placed thoroughly compacted and that the hardened concrete while still supported by the forms shall conform accurately to the required shape, position and level and to the standards of finishes specified. Care shall be taken to maintain the stability of the formwork and the tightness of the joints during vibrating operations.

TIES

The material and position of any ties passing through the concrete shall be approved by the Engineer. The whole or part of the ties shall be capable of being removed so that no part remaining embedded in the concrete shall be nearer the surface of the concrete than the specified thickness of cover to the reinforcement. Holes left after the removal of ties shall be filled with concrete or mortar of approved composition.

EDGES

Edges shall have 20mm x 20mm chamfers unless otherwise indicated on the drawings.

REMOVAL OF DEBRIS

Rubbish, debris and water shall be removed from the interior forms before the concrete is placed and temporary openings shall be provided in the formwork to facilitate their removal.

RELEASE OIL

The face of formwork to be in contact with concrete shall be through cleaned and shall be coated with non-staining formwork oil or other approved material to prevent adhesion. Care shall be taken that the coating material is kept out of contact with reinforcement for embedded steelwork.

INSPECTION OF FORMWORK

Formwork shall be approved by the Engineer's representative before concrete is placed.

REMOVAL OF FORMWORK

Forms shall be removed without shock, vibration or other to the concrete. Before soffits forms and props are removed the concrete shall be exposed by removal of the side forms or otherwise as required by the Engineer in order to ensure that it has sufficiently hardened. Forms shall not be struck until the concrete has reached cube strength of at least twice the stress to which the concrete may be subjected at the time of striking.

Unless otherwise approved by the Engineer formwork shall not be removed unless the minimum period set out below has elapsed.

Item	Minimum Stripping Time
Sides of beams, slabs, kerb, walls and columns	12 Hours
Soffits of beams and slabs (prop left in place)	7 Days
Props to beams and slabs	14 Days

xix) REUSE OF FORMWORK

Formwork shall be thoroughly scraped, cleaned and repaired before being reused

TOLERANCES

Where no specific tolerance is stated on the drawings or in the specification, permissible deviations from the required alignments and levels shall comply with the values contained in BS 5606:1 990. "A Guide to Accuracy in Building" and where appropriate with section 6.11 of BS 811 0 part 1 1985 'Structural Use of Concrete.

xx) CLASS OF SURFACE FINISH

FORMED SURFACES

Class F-1 Surface Finish

Class F-1 finish is for surface against which backfill or further concrete will be placed. Formwork shall consist of sawn boards, sheet metal or any other material which will prevent the loss of grout when the concrete is vibrated.

Item	Acceptability
Colour Variation	Shall be acceptable
Physical irregularities	Shall be acceptable
Surface dressing	Shall comply with the tolerances set out in BS 5606 all tie holes shall be fitted with 2:1 sand cement mortar Repair of defected shall not be required to match the shade or texture of surrounding concrete.

Class F-2 Finish

Class F-2 finish is for surfaces prominently exposed to view where good appearance and alignment are of special importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood or equivalent material in large sheets. The sheets shall be arranged in an approved, uniform pattern. Wherever

possible, joints between sheets shall be arranged to conclude with architectural features, or change in direction of the surface. All joints between panels shall be

Item	Acceptability
Colour variations	Shall be minimized as far as practical. Acceptance shall be based on standard of sample panels approved by the Engineer.
Physical Irregularities	Abrupt changes shall not exceed 2 mm at construction joints nor 1 mm at joints in formwork sheeting. Gradual changes shall not exceed that of sample panels. Grout loss leading to honeycombing shall be prevented.
Surface dressing	All ties shall be filled with a 2:1 sand cement mortar. Where permitted by the Engineer all repairs of all minor defects shall match as near as practical the shade and texture of surrounding concrete.

vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets. Unfazed wrought boarding or standard steel panels will not be permitted for Class F2 finish.

UNFORMED FINISHES

Class U-1 Finish

Class Type U-1 is a screed finish for surfaces of foundations, beds, slabs and structural members to be covered by backfill, subsequent stages of construction, or bonded concrete toppings and on exposed surfaces of paving where a superior finish is not required. It is also the first stage for finishes U2 and U3. The finishing operations shall consist of levelling and screed the concrete to produce a uniform, plain or ridged surface, surplus concrete being struck off by edge immediately after compaction.

Item	Acceptability
Abrupt deviations	Shall not exceed 3 mm
Gradual deviations	Shall not exceed 10 mm
Colour deviations	No special precautions are required other than to prevent contamination or oil discoloration.

Class U-2 Finish

Type U2 finish is a hard smooth hand or mechanical steel-towelled finish for surfaces of concrete floors, tops of walls, copings and other members exposed to weathering. Towelling or floating shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. The surfaces shall be towelled wider firm pressure and left from trowel marks.

Item	Acceptability
Abrupt deviations	Shall not exceed 3 mm
Gradual deviations	Shall not exceed 5mm
Colour deviations	Shall be kept to a minimum. The contractor shall ensure that contamination dusting of the surface and oil discolouration shall be prevented.

Class U-3 Finish

Type U3 finish is a type which has been given in a shallow textured surface with a hard or a soft bristled broom. It is intended for use in areas of roads and pavements which are not permanently wet and are outside the process area.

SURFACE FINISH

The surface finishes to be achieved in the various parts of the building shall be as follows:

External ground slabs	U-3
Foundations	F-1
Pre cast kerbs	F-2

xxi) CONSTRUCTION JOINTS-LOCATION

The position and arrangement of construction joints shall be as indicated on the drawings, unless otherwise agreed with the Engineer. All construction joints shall be at right angles to the members concerned and shall be made horizontal or vertical unless otherwise approved.

Where during a continuous concreting operation it becomes necessary in An emergency to stop placing concrete before a section is completed , bulkheads shall be placed at right to the long axis of the section, the concrete squared up to this bulkhead and the resulting joint treated as a construction joint.

CONSTRUCTION JOINTS METHOD OF CONSTRUCTION

For horizontal joints, the surface of the concrete may be prepared by green cutting (using high velocity air water jets or vigorous wire brushing) to remove all laitance and inferior surface concrete has hardened sufficiently to prevent raveling of the aggregate. The time during which green cutting is feasible can be extended by the surface application of an approved retarder.

For other than horizontal joints an approved retarder shall be used to prepare the joint. Immediately on removal of the formwork the surface shall be prepared in a similar manner to horizontal joints.

Alternatively, the treatments mentioned above may be omitted and the surface prepared immediately prior to placing the new concrete by scrubbing and sandblasting and washing to produce a clean new surface free from all laitance and

weak or damaged concrete, The treatment used shall produce a sound dense surface free from loose material with surface amplitude of approximately +3 mm. The surface shall be washed clean and dampened before concreting is resumed.

xxii) TESTING

SITE LABORATORY

The contractor shall set up on site a site laboratory complete with all apparatus necessary for carrying out the 'in situ ' and laboratory tests in accordance with the relevant specifications. The apparatus shall be maintained in serviceable condition and any measuring or control equipment shall be immediately repaired or replaced if it becomes inaccurate.

The apparatus shall comply with the relevant British Standard where one is applicable and shall be subject to the agreement of the Engineer. The staff shall include one qualified fully experienced in all aspects of materials control. Alternatively the Contractor may arrange to use another contractor's site laboratory or share equipment.

SAMPLING AND TESTING

GENERAL

The Contractor shall carry out such laboratory and field tests (including tests to check the accuracy of testing equipment and methods) as may be necessary to ensure, and satisfy the Engineer that the requirements of the specifications are met. The type and frequency of testing shall be in accordance with the relevant British Standard, BS 5328 or other, except as otherwise specified herein or directed by the Engineer.

Unless otherwise - agreed or directed test procedures shall be on accordance with relevant British Standards, codes of Practice the Contractor shall keep clear, accurate and up-to date records of all tests and shall supply copies and summaries thereof in such form as the Engineer may require. All testing equipment, operations and records shall be available for inspection by the Engineer at all times.

AGGREGATES

Work tests shall be carried out on the aggregate to ensure that the aggregate incorporated in the work comply with the specifications. The tests shall be carried out in accordance with BS 5328, BS 812 or BRS digest No 35 as appropriate.

The frequency of testing of the aggregate shall be as follows

Material	Test	Frequency
Coarse aggregate	Sieve analysis determination of clay fine site and fine dust Flakiness Aggregate crushing value organic impurities We 10% fine value moisture content	Weekly Weekly On delivery On delivery On delivery Daily
Sands	Sieve analysis Clay fine silt and fine dust Organic impurities Drying Shrinkage Moisture content	Weekly Weekly On delivery to site Monthly Daily

WATER

Water for concrete shall be tested in accordance with BS 3148 as and when directed by the Engineer.

The minimum frequency testing of the suitability of the water shall be once per month.

COMPREHENSIVE STRENGTH

Concrete for the works shall be Sampled and tested in accordance with BS 53 28 part 4 1990.

The samples shall be taken at such times and places as directed by the Engineer.

The minimum frequency of sampling for each class of concrete used in the Works shall be one sample per 30 cubic meters. The test cubes shall be marked in an indelible and unique manner in accordance with the system approved by the Engineer. The test cubes shall be tested at the site laboratory.

If the results of the tests do not comply with the criteria set out in BS 5328 part 4, then such remedial works as the Engineer may accept or direct shall be carried out and if appropriate the concrete mix shall be redesigned to ensure future compliance with the specification.

DENSITY OF HARDENED CONCRETE

The density of each individual test cube shall be measured and recorded.

WORKABILITY TESTING

The contractor shall provide the necessary materials and equipment shall carry out one slump test on each batch of concrete used in the Works.

The information obtained from these tests shall be recorded, and the information forwarded to the Engineer within three days of the test. Unless otherwise agreed between the Contractor and the Engineer, the slump shall be 80mm.

TEMPERATURE

The temperature of fresh concrete shall be measured as and when directed by the Engineer.

Measurements shall be carried out in accordance with BS 5328. If the temperature recorded exceeds 30°Celsius then the concrete work shall cease until measures approved by the Engineers have been taken to produce concrete at a lower temperature.

FIELD CONTROL TESTS

Field control test specimens may be taken by the Contractor to determine formwork, stripping times, or influence of the weather. These test specimens shall be moulded, cured and tested in accordance with BS 1881.

REPORTING

The Contractor shall provide the Engineer with one copy of a test report within 48 hours of any test being carried out. This report shall include all relevant dates where appropriate:

1. Reference number test
2. Date of test
3. Location of Sample
4. Type of test
5. Results of test and additional in the case of compression test results shall include:
6. Slump of concrete
7. Date of cast
8. Age of cube
9. Crushing strength value of cube

xxiii) REPAIRS TO DEFECTIVE CONCRETE

The contractor shall not apply any cement mortar or slurry to the concrete surfaces as struck from the formwork, or carry out any operation which will hinder the proper examination of the concrete surface by the Engineer.

Concrete which in the opinion of the Engineer does not comply with the specification or drawings shall be repaired, using one of the appropriate methods specified below: The repair work will be inspected by the Engineer and if in his opinion it does not comply with the specification, the Contractor shall repeat the operation until the repairs are acceptable.

xxiv) PRE-CAST CONCRETE

GENERAL

Pre-cast concrete units shall be manufactured in a designated pre-casting area using materials, construction methods and testing procedures complying with this specification.

CASTING

The units shall be formed by casting face downwards in approved moulds to the dimensions shown on the drawings. Care shall be taken when stripping the moulds to ensure that the facings of the units remain undamaged.

HANDLING AND STORAGE

The units at all times be handed right way up using the cast in lifting attachments. The units shall be stored clear of the ground on timber located close to the ends of the units.

The units may be stacked up provided that the supporting timbers are properly aligned to prevent shear loads being transmitted to the lower units.

CONSTRUCTION DETAILS

The Contractor shall provide the Engineer with specific details of the methods of manufacture, handling, storage and emplacement of pre-cast units.

These details shall include information on the following:

1. Curing methods
2. Minimum ages handling and transporting
3. Position and design of lifting points
4. Method of lifting
5. Type of lifting equipment
6. Methods of supporting and stacking
7. Methods of assembly and erection
8. Finer structural connections
9. Marking identification system

The manufacture of the units shall not proceed until the Engineer has approved all the details of the pre-cast construction proposed.

DAMAGE REPAIR

Repair of damage units shall only be carried out at the discretion of the Engineer using one of the methods listed in Methods of Repair of this specification.

Should the Engineer consider that the repaired unit will not be acceptable then the Contractor shall provide a new at his own expense.

xxv) REINFORCING STEEL

STANDARDS

Reinforcement and the placement of reinforcement shall generally comply with the requirements of BS 11985 section 7 unless otherwise modified by this specification.

MATERIALS

(1) Steel Type

Generally steel bars 8mm diameter and less used as stirrups shall be mild steel round bars. All other steel bars shall be deformed high yield bars.

(2) Mild Steel Bars

Mild steel bar reinforcement shall have a characteristic strength of 250 MPa and shall comply with BS 4445. The contractor shall provide the engineer with certificates from the manufacturers confirming that all the steel supplied is in accordance with these tests conditions.

(3) High Yield Steel

Reinforcement shall have a characteristic strength of 460 MPa and shall comply with BS 4445. The Contractor shall provide the Engineer with certificates from the manufacturers that all the steel supplied is in accordance with these tests and conditions.

(4) Steel Fabric

Steel fabric reinforcement shall comply with the requirements of BS 4483. The wires shall be welded at the intersections. The fabric shall be supplied in flat sheets and must be laid flat and made to overlap at joints by an amount equal to 40 diameters of the wire, unless otherwise ordered.

HANDLING AND PLACING

(i) **Steel Cleanliness**

All reinforcement shall be free from loose mill scale, loose rust, oil and grease or other deleterious matter immediately before the concrete is placed.

(ii) **Steel Bending**

Bar reinforcement shall be bent cold in accordance with BS 4466 and unless specifically directed, Bars shall be bent accurately to the form required and shall be placed and maintained in the positions shown on the drawings, particular care being taken that the specified amount of cover to bars is everywhere maintained.

(iii) **Steel Placing**

Reinforcing bars shall be firmly bound together with No.16 gauge soft annealed wire at all intersections to ensure that the network of bars will retain its design form and be so supported as to retain its correct position and cover in the moulds during concreting.

The ends of bars in the assembly of the reinforcement shall be turned inwards towards the body of the concrete.

(iv) **Spacer Blocks**

Where the Engineer approves the use of spacer blocks to support reinforcement they shall be formed of concrete of the same quality as the member.

Alternatively, in specific location the Engineer can approve the use of proprietary plastic spacers.

xxvi) METHODS OF REPAIR

DRY PACK MORTAR

Dry pack mortar shall be used for holes with square or re-entrant edges of depth greater than their least surface dimension.

The concrete to be repaired shall be saturated but surface dry. Dry pack mortar comprising three parts of fine sand to one part of cement with sufficient water to achieve cohesion without plasticity shall be rammed into place. Dry pack mortar shall be cured for seven days.

REPAIR BY PLASTER

Repair using plaster may be permitted when the depth of repair is in the range 10 to 40mm. The area shall be prepared with square edges. The work shall be carried out by the experienced craftsmen in accordance with the best trade practice. Plaster repairs shall be cured for seven days.

REPAIR USING CONCRETE

Repair using concrete may be permitted when the depth of repair exceeds 100 mm. The bottom and sides of the area shall be cut square and the top shall slope upwards towards the surface. Formwork for concrete replacement shall be arranged to put a surcharge of pressure on all joints with existing concrete by overfilling with concrete. The consequent projections should be removed after 24 hours and after curing the surface treated as for surface defects.

EPOXY BONDED MORTAR OR CONCRETE

Mortar or concrete replacement may be bonded to the existing concrete by epoxy resins recommended for this purpose by their manufacturer. Such work shall be carried out in accordance with the instructions of the resin manufacturer.

EPOXY MORTAR

Shallow repairs may be carried out using epoxy resin mortar comprising clean sand bonded with suitable epoxy resin. Such work shall be carried out in accordance with the instructions of the resin manufacturer.

EPOXY RESIN INJECTION

Cracked concrete may be repaired by epoxy resin injection. Cracks of some age may include foreign material, which should be removed as far as possible.

xxvii) LIGHTING

Scope of Work

Supply, install and commission light columns and the fluorescent lanterns as set out on the drawings.

Specifications

Lighting shall be carried out to the appropriate British Standards including, but not limited to:

BS EN 40- 11 3, 5 & 6	Lighting columns - various specifications
BS 5489 - 10	Road lighting- various specifications
BS 5649 - 2 to 9	Lighting columns - various specifications
BS 5,649- 5: 1982 {EN 40 - 5:1982)	Lighting columns. Specification
BS5649- 7: 1985	Lighting columns. Method of verification of structural design by calculation.

General Requirements

MATERIALS

Column and outreach arms shall be manufactured from:

- Galvanized Steel

Street light poles polygonal with cross arm, type "J" anchor bolts (as per drawings), washers and hexagonal nuts, square base plate. Wall thickness 4.6mm

Description - Finish antiseptic disposing of the light pole shall be hot dip galvanize and the surface is smooth and beautiful,

Hot Dip Galvanizing according GB2694-88

Single arm or double arm as per drawings,

Yield strength minimum 235mpa, Ultimate tensile strength minimum 375mpa and maximum 500mpa.

Standard ISO-9001,

Welding AWS (American Welding Society) ·D 1 .1,

Galvanize standard ASTM·A 123,

Chemical Properties. C≤0.2, Mn≤1.4, Si≤.35, P≤0.045, S≤0.045.

Designed for wind pressure 160Kms/Hr.

Zinc coating thickness ≥ 86µm.

- Fiberglass reinforced plastic
- Pre-cast concrete
- Or combination of the above

The Contractor shall provide an endorsement from pole and light manufacturer that the supplied items satisfies British Standards and meets with the Maldivian Government Ministry of Transport requirements for street lighting.

Information to be supplied with the tender for:

(a) Lanterns

Lanterns shall be fluorescent lamps conforming to British Standards and shall be power rated to meet STELCO power authority requirements.

Lux requirements of the of the lantern shall meet the British Standard and suit the light spacing set out on the plans. The tenderer shall supply details of the lighting proposal. The lux levels shall satisfy the British Standards.

6) QUALITY CONTROL OF WORK

Control of Alignment, Surface Regularity and Pavement Layer Thickness

- General

All work carried out shall conform to the lines, grade, cross sections and dimensions shown in the drawings or as directed by the Engineer, subjected to the permitted tolerances given hereafter or as otherwise specified.

- Horizontal Alignment

The horizontal Alignment shall be reckoned with respect to the center line of the carriageway as given in the drawing the edges of the carriageway shall be within a tolerance of+ 25 mm there form.

- Longitudinal profile and Payment Layer Thickness

The Longitudinal formation level and the levels of different pavement courses as constructed shall not vary beyond the tolerances given below when measured from levels from shown in the drawing or as directed by the Engineer.

	+20mm
Formation level	-30mm
	+10mm
Sub base	-20mm
Base course	+15mm
Surfacing	+10mm

However, the combination of permitted tolerance in different pavements shall not result in a reduction of the various pavement layers beyond the limits give below:-

The thickness of surfacing	-5 mm or 10% of its thickness whichever is the less.
The thickness of base	-5 mm or 10% of its thickness whichever is the less.
The thickness of sub base	-20 mm or 10% of its thickness whichever is the less.

- **Surface Regularity of Sub grade and Pavement layers**

Surface regularity of the sub grade and the pavement shall be within the

Type of Construction	Maximum permissible Undulation (mm)	
	Longitudinally	Transversely
Soil Sub grade	25mm	15mm
Asphalt Concrete Surfacing	6mm	4mm

tolerance indicated in the Table.

The longitudinal undulations shall be checked with a 3m long straight edge at the middle of each traffic lane parallel to the center line of the road. The transverse undulations shall be within the tolerance indicated in the Table.

The longitudinal undulations shall be checked with a 3m long straight edge at the middle of each traffic lane parallel to the center line of the road. The transverse undulations shall be check with camber boards at intervals of 10m.

TOLERANCES OF SURFACE REGULARITY

QUALITY CONTROL TESTS DURING CONSTRUCTION

The material supplied and work carried out shall conform to the relevant sections of these specifications covering each type of work for ensuring quality of construction, the materials and work shall be subjected to quality control tests prescribed in Table-1

These tests shall be carried out as specified. The testing frequencies given on table 1 are desirable minimum values and the Engineer may direct the contractor to carry out tests as frequently as he may deem necessary to satisfy himself, that the materials and the work comply with the appropriate specifications.

However, where testing facilities are limited, the Engineer may relax the requirements, and carry out tests at frequencies compatible with the available facilities.

7) TABLES

Table-I QUALITY CONTROL TESTS AND THEIR FREQUENCIES

Type of Construction	Quality Control Test		
	Materials	Works	Frequency
Sub-Grade	1.Sub-grade CBR field Test	1. Measure sub-grade strength at a depth of 500mm from the designed asphalt elevation.	One (01) CBR field test to cover every 1500m ² of the road asphalt area.
Sub-Base	1. CBR Test	1. Measure sub-grade strength	Each soil type to be tested at least once. There after strength one test for every 1000m ² of the road asphalt area.
	2. Standard compaction test	1. Field density test	One (01) Standard compaction test for every 800m ² of the road asphalt area.
	3. Sieve Analysis		As required
		1. Layer thickness while spreading	Regularly
		2. Field moisture content prior to compaction.	One test per 250m ²
		3. Degree of compaction of compacted layer	One test per 500 m ²
Graded Aggregate Base Course	1. CBR Test 2. Aggregate Impact Value 3. Sieve Analysis of combined aggregate		ABC materials to be tested prior to start the work. Thereafter one test for every 600m ² of the road asphalt area.

	1. Standard Compaction tests	1. Thickness of layer	Regularly
		2 Degree of Compaction	One test per 600m ²
Prime Coat	2. Acceptance testing of binder		As required
		1. Rate of application	Two tests every 250m ²
		2. Temperature of application	Regularly
Asphaltic Concrete	1 Acceptance testing of binder		As required
	2. Aggregate impact Value of aggregate		One test per 200 m ³ . However at least one test per each source of aggregate shall be done.
	3 Log Angeles Abrasion Value of		
	4. Flakiness Index of aggregate		
	5. Soundness of aggregate		As required
	6 Acceptance testing of filler		
	7 Marshall mix design		One for each job
		1 Temperature of binder	At regular close intervals
		2. Temperature of aggregate	
		3. Temperature of mixing	
		4. Temperature of laying	
		5. Hot bin grading	One test per 300 tonnes. However at least one test per day shall be done.
		6 Compliance to job mix	
		7. Marshall stability and flow	
		8. Laboratory compacted Density of mix (Marshall) voids in material aggregate	One test per 300 tonnes. However at least one test per day shall be done.

		9. Thickness of layer core samples	One test to cover for every 400m ² of asphalt area
		10. Degree of compaction of compacted layer	

Table-II TEST QUALITY CONTROL OF MATERIALS AT WORK

Sieve Analysis Test for Soils	The sieve analysis test for soils shall be carried out in accordance with test 7A of BS 1377 75 or ASTM D 44- 62 (reapproved 1972)
Standard Compaction	The standard compact ion test shall be carried out in accordance with test 12 of BS 1377-75 or ASTM D 698- 98.
California Bearing Ratio (CBR)	The California bearing ratio test shall be carried out in accordance with test 16 of BS 1377-75 or ASTM D 1883- 73 (re-approved 1978).
Field Moisture	The field moisture content shall be determined as directed by the Engineer.
Field Density	The field density test shall be carried out in accordance with test 15A of BS 1377- 75 or ASTM D 1556- 64 (re-approved 1974).

**Table- III
TEST FOR QUALITY CONTROL OF MATERIAL AND WORKS – AGGREGATES**

Sieve Analysis	The sieve analysis test for aggregates shall be out in accordance with clause 7.1 of BS 81 2: Part 1:1 975 or ASTM test designation C 136- 76.
Clay Silt and Dust Fraction	The clay silt and dust fraction (fraction passing the 75 mm sieve) in aggregates shall be determined in accordance with clause 7.2 of BS 812 : Part 1975 or ASTM test designation C 11 7. 76.
Aggregate Impact Value (AIV)	The test to determine aggregate impact value (A IV) shall be carried out in accordance with clause 6 of BS 812 Part 3: 1975.
Aggregate Crushing Value (ACV)	The test to determine aggregate impact value (AIV) shall be carried out in accordance with BS Part 11 0: 1990

10% Fine Value	The 10% fine value test shall be carried out in accordance with clause 8 of BS 812 : Part 3: 1975.
Los Angeles Abrasion Value (LAAV)	The test to determine Los Angeles Abrasion (LAAV) shall be carried out in accordance with ASTM C 131 - 76 or 535- 69 (re - approved 1975) for small size and large size aggregates respectively.
Flakiness Index	The flakiness Index test shall be carried out in accordance with I clause 7.3 of BS 8 12: Part 1: 1975.
Specific Gravity of Coarse Aggregate	The Specific Gravity of Coarse Aggregate shall be determined in accordance with clause 5.3 of BS 812: Part 2: 1975 or ASTM C 127- 77.
Specific Gravity of Fine Aggregate	The Specific Gravity of Fine Aggregate shall be determined in accordance with clause 5.5 of BS 812: Part 2: 1975 or ASTM C 128- 73.
Soundness of Aggregate	The soundness of aggregate shall be determined by ASTM 88 - 76
Field Density	The field density of graded aggregate layers shall be determined by test 15 B of BS 1377: 1975 or ASTM D 1556 - 64 (re-approved 1974).

Table- IV
ASPHALT- PENETRATION GRADE BITUMEN

Penetration	Penetration test shall be carried out in accordance with BS 2000: Part 49:7983 or ASTM test designation D5 -73 (re-approved 1978).
Softening Point	The Softening Point test shall be carried out in accordance with BS 2000 Part 58:1983 or ASTM test designation D 36 - 76.
Ductility	The ductility test shall be carried out in accordance with ASTM test designation.
Loss Heating	The Lost on Heat shall be carried out in accordance with BS 2000 Part 45:1982 or ASTM test designation D6- 67 (re-approved 1973).
Flash Point	The Flash Point test penetration grade bitumen shall be carried out in accordance with ASTM test designation D 92 - 78.

Solubility	The Solubility test shall be carried out in accordance with BS 2000 Part 47: 1982 or ASTM test designation D 2024-76.
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Table- V
CUTBACK BITUMEN

Viscosity	The viscosity test for cutback bitumen shall be carried out in accordance with ASTM test designation D 2170- 76.
Distillation	The distillation test for cutback bitumen shall be carried out in accordance with ASTM test designation D 2170 - 76.
Ductility for Residue	The ductility test shall be carried out in accordance with ASTM test designation D 113- 79.
Water Percentage	The Water Percentage of cutbacks shall be determined in accordance with ASTM test designation D 95 - 70 (re-approved 1975).
Flash Point	The flash point test for cutback bitumen using the tag cup shall be carried out in accordance with ASTM test designation D 341 3- 78.

Table - VI
BITUMINOUS EMULSIONS

Viscosity Test	The Viscosity test for bitumen emulsion shall be carried out in accordance with section 22-24 of ASTM test designation D 244- 77.
Settlement	The settlement test for bitumen emulsion shall be carried out on accordance with section 29- 32 of ASTM test designation D 244- 77.
Storage Stability	The storage stability test for bitumen emulsions shall be carried out in accordance with section 56 - 62 of ASTM test designation D 244 - 77.

Particle Charge	The Particle Charge test for bitumen emulsions shall be carried out in accordance with section 19- 21 of ASTM test designation D 244- 77.
Sieve Test	The Sieve Test for bitumen emulsions shall be carried out in accordance with section 38-41 of ASTM test designation D 244- 77.
Distillation	The distillation test for bitumen emulsions shall be carried out in accordance with section 8- 1 0 of ASTM test designation D 244- 77.
Characteristics of Residue	The characteristic of Residue by distillation shall be examined by carrying out Residue tests in accordance with section 63 - 68 of ASTM designation D 244 - 77.
Coating Ability and Resistance	The Coating Ability and Water Resistance for bitumen emulsion shall be carried out in accordance with section 50-55 of ASTM designation D 244-77.
Cement Mixing	Cement Mixing test for bitumen emulsions shall be carried out in accordance with sections 25-28 of ASTM test designation D 244-77.
Demulsibility	The demulsibility test for bitumen emulsions shall be carried out in accordance with sections 25-28 of ASTM test designation D 244-77.

Rate of Spared of Binders

Rate of Binder shall be determined by the Tray test as described below.

Three square metal trays, each of area between 0.06-012 m² and of know weight are placed on the surface on which the binder is to be applied. After the binder is applied, the trays are weighed and the rate of application of binder calculated in 1 / m²

The specific gravity of the binder to be used in the calculation shall be as determined in the laboratory, which for most purposes may be taken as 1.0. Care shall be taken to ensure that the binder does not drip off the tray prior to weighing.

Table-VIII
RATES OF SPREAD OF AGGREGATE

Nominal thickness of base layer	Aggregate Size	Rates of Spread	
		Cubic meters per 100 sq.m	Cubic feet per 100 sq.ft

75mm	50mm (2") aggregate	8.5 - 10.0	28 - 33
	19mm (3/4") Choker Stone	1.0 - 1.3	3.3 - 4.2
55mm (2 1/4")	37.5mm (1 1/2") aggregate	6.6 - 7.5	21 - 25
	12.5mm (1/2") Choker Stone	0.8 - 1.0	5 - 3.2

8) SPECIFICATION FOR ELECTRICITY AND TELEPHONE DUCTS FOR ROADS

a) DUCT WORK FOR ELECTRICITY AND TELEPHONE SERVICE CABLES

Description

This section covers the furnishing and laying of 200 mm internal bore PVC pipes as given in the drawings and specification of the general specifications and these task specific specifications. Piping requirements for the electrical and telephone ducts are as given in Drawing.

Materials

All ducts are to be buried circular PVC pipes of the dimensions as given in the drawings. PVC pipe piles shall be transported, handled and stored so as to prevent any damage to them.

Construction Requirements

Equipment, materials and construction work shall conform to the appropriate paragraph in this section.

Pipe Bedding

When excavated to the required depth (as given in the drawings) the pipe bedding is to be prepared as follows:

Excavated trench is to be compacted by a vibrating tamper to an optimum density not less than its original state before excavation.

A 200mm thick layer of dredged or excavated clean coral sand is to be placed on the trench and vibro-compacted (water content 15%).

The pipes are then to be placed on this bedding.

A 200mm thick layer of dredged or excavated clean coral sand is to be placed on the pipes and warning tapes are laid

Pipe joints

All pipes should be heat welded to make complete and non-broken joints all-round the pipe.

Typical joints should be made and the engineer allowed opening the joints and inspecting the quality of the welds prior to the actual works beginning on site. The engineer does have the right to order the opening or pressure testing (3 atm) of any weld that he may deem inappropriate, and should it proved to be inappropriate, the contractor shall rectify it at his own expense.

Inspection Chambers

The inspection chambers should be to the required dimensions and details as given in the drawing and should be pre-cast and subject to the general concrete specifications of the general conditions of contract.

Inspection Chamber Opening and Frames

General Description

This specification describes a range of Frames and Covers consisting of single and multiple cover units of being installed over a jointing chamber entrance in an area designated for pedestrian use, with occasional use for service and emergency vehicles. Specifically the covers meet the requirement of Class B125 of BS EN 124:1994.

All multiple cover units shall incorporate a removable crosspiece(s) to allow the associated covers to be slid out in either direction.

Each cover shall be supplied unfilled but capable of receiving a depth of concrete, paving bricks, cobble or natural stones of varying depth and are suitable for internal or external use.

Construction, materials and performances shall comply with EN 124, Class B125.

Construction

The frame and covers shall be manufactured from steel of a minimum thickness of 6mm. All welded butt joints shall be flush, being free from steps and raised welded runs on seating surfaces.

The interface between each cover and the frame will provide a seating width 30mm minimum. Each frame shall be provided with a flange or steel lugs to allow bonding of the frame in to bedding material.

Each cover shall be provided with a drain hole of not less than 20mm diameter positioned in the base under each keyhole.

Each cover shall be constructed so as to provide an internal angle of 95 degree minimum between the seating and upright face.

Frames containing multiple covers will be fitted with removable

Crosspieces(s) so as to provide a minimum overlapping flange width level with frame seating flange of 30mm minimum beneath each unsupported cover seat.

The up stand each crosspiece shall be the same height as the frame.

Each cover within a frame shall be interchangeable with any other within that frame.

Dimensions

Each frame shall be dimensioned to provide the required clear opening.

The overall depth of any cover shall be dependent on the depth of brick or filling material.

Weight

The maximum weight of any cover when filled with proprietary paviour blocks or concrete to density of 2210kg/m³ shall not exceed 19kg.

The maximum weight of any crosspiece shall not exceed 19Kg.

Materials

Materials shall be as specified in EN 124 paragraph 6.

Each cover shall be resistant to frost, petrol, oil, salt and de-icing solutions.

The cover shall be resistant to impact damage and will warp at temperatures up to 40 degrees Celsius.

Lifting

Each cover shall be provided with keyholes to accept lifting keys/lifting.
The keyhole shall be designed so that the key tang can be turned through 360 degree.
The keyhole shall be capable of withstanding a 250 kgf pull without duress.
The keyhole engagement depth to be a maximum of 150mm.
The keyhole shall be self-draining of water and stones.
The keyhole shall be sufficiently durable to withstand damage and long term wear.

Each crosspiece shall contain keyhole to facilitate removal.

Surface Finish

All steel will be hot dip galvanized to BSS 729.

Load Test

Testing and test loads shall be specified in EN 124 paragraph 8 for Class 8125, all load tests shall be carried out using the cover(s) in their condition in service and without its filling.

Cover Rock

When the cover is placed firmly on a flat surface and held such that it is resting on any points of contact, it will not be possible to insert a gauge in excess of 3mm thickness fully between the cover and the seating at any point.

Installation

Frames are supplied with slots in the flanges and expansion bolts should be used for securing the frame to the top of the chamber. Frames need to be bedded on resin mortar type 1866 or equivalent.

Paving Brick infill

Precinct cover trays are supplied empty ready to receive brick infill. Paving bricks need to be bedded on resin mortar type 1866 or equivalent and laid in accordance with BS677 Part III.

Grout paving bricks by brushing bedding sand into joints. After materials have set remove trays and thoroughly clean in side of frame and all seating surface.