



**UNOPS**

**UNITED NATIONS OFFICE FOR PROJECT SERVICES**

**PROJECT SPECIFICATION**

**CONSTRUCTION OF SALANG PASS BOOM GATES**

**AT PARWAN, AFGHANISTAN**

**Issued for Tender only**

**PROJECT No: 1112.01**

**Parwan - Afghanistan**

May 23, 2011

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**1.1 PRELIMINARIES**

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**1.1.1 GENERAL**

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**1.1.1.1 Pre-Construction Work**

Notice to Proceed will be issued within 3 days after signing the contract. The contract period begins on the day the Notice to Proceed is issued.

The Engineer and Contractor will carry out a joint condition-in survey using video or digital photographs to record the condition of the site upon handover to the Contractor. This will determine the state of the site that the Contractor must hand back upon completion of the works.

The Contractor will carry out a detailed site set out survey for the works.

The contractor may not proceed with on-site mobilization or construction works before the Engineer approves the following documentation that shall be covered in Program:

- Condition-in Survey
- Site Survey
- Work Method Statement
- Program
- Quality Assurance / Quality Control Plan (QA/QC) as per minimum requirement 1.3 Contractor's Quality Control Plan specification.
- Health and Safety Plan (H&S) as per minimum requirement Health and Safety Specification no. 1.4.
- Environmental Protection Plan as per minimum requirement ...
- Dust and Noise Protection Plan
- Schedule of Materials and Installed Equipment

A Pre-Construction Meeting will be held between the Engineer and the Contractor to review the above documentation. If the documentation is incomplete, the Contractor will have 3 calendar days to revise and resubmit the documentation for approval.

Site restrictions

Site security limitations: Comply with any restrictions on site area, access or working times advised by the Engineer.

Access: Access on to and within the site, use of the site for temporary works and constructional plant, including working and storage areas, location of offices, workshops, sheds, roads and parking, is restricted to the areas shown on the drawings or as agreed with the Engineer.

Occupied Areas of Site or Buildings

For the parts of the site designated as occupied areas in the **Occupied Areas** schedule:

Allow occupants to continue using the area for the required period.

Make available safe access for occupants.

Arrange work to minimise nuisance to occupants and ensure their safety.

Protect occupants against weather, dust, dirt, water or other nuisance, by such means as temporary screens.

Protection of persons and property

Temporary works: Provide and maintain required barricades, guards, fencing, shoring, temporary roadways, footpaths, signs, lighting and traffic flagging.

Accessways, services: Do not obstruct or damage roadways and footpaths, drains and watercourses and other existing services in use on or adjacent to the site. Determine the location of such services. If damage occurs, immediately repair it at the Contractors cost.

Property: Do not damage property which is to remain on or adjacent to the site, including adjoining property encroaching onto the site. If damage occurs, immediately repair it at the Contractors cost.

#### Existing services

Attend to existing services as follows:

If the service is to be continued, repair, divert or relocate as required.

If the service is to be abandoned, cut and seal or disconnect, and make safe.

Submit proposals to the Engineer for action for existing services before starting this work. Minimise the number and duration of interruptions.

#### Adjoining Property

Records: For properties described in the **Adjoining Properties to be Recorded** schedule:

The Contractor is to inspect the properties with the Engineer and owners and occupants of the properties, before start of work.

Make detailed records of conditions existing within the properties, especially structural defects and other damage or defacement.

Arrange for at least 2 copies of each record, including drawings, written descriptions, and photographs, to be endorsed by the owners and occupants, or their representatives, as evidence of conditions existing before commencement of work.

Submit one endorsed copy of each record to the Engineer. The Contractor is to keep the other endorsed copy.

#### **1.1.1.2 Construction Plant**

##### Access

Access route and site access point are as shown on the drawings or as agreed with the Engineer.

##### Use of Existing Services

Existing services may be used as temporary services for the performance of the contract subject to conditions stated in the **Existing Services** schedule.

##### Contractors Facilities and Work Practices

The Contractor is required to provide adequate toilet and washroom facilities for his staff. These facilities shall be kept clean and serviceable at all times.

The Contractor is required to provide adequate first aid equipment on-site, failure of the Contractor to ensure the availability of first aid equipment on-site will result in an immediate 'stop work' order being issued. All costs and time delays resulting from any such 'stop work' order are entirely the Contractors responsibility.

A site office will be established by the Contractor at the work site. The location of the site office will be identified by the Engineer to the Contractor. The office will have a complete set of the contract documents.

The Contractor is to maintain a safe, healthy and tidy worksite at all times and all work activities are to be performed with protective and safety equipment appropriate for the task. The Contractor is entirely

responsible for workplace safety and unsafe work practices will be identified and recommendations made for revised work methods as appropriate.

**The Contractor will be required to comply to the approved Health and Safety Plan.**

#### Project Signboards

Provide project-specific signboards and the following:

- Location, size and wording as directed by Engineer.
- Maintain in good condition for duration of the work.
- Remove on completion.

Obtain approval before display of advertisements or provision of other signboards.

#### **1.1.1.3 Building the Works**

##### Surveys

Setting out: Set out the works from the dimensioned drawings

Check surveys: Check the setout regularly on site

Final survey: Confirm final setout of roads, services and buildings on the as constructed drawings after Practical Completion

##### Survey marks

Definition: The term “survey mark” means a survey peg, bench mark, reference mark, signal, alignment, level mark or any other mark used or intended to be used for the purpose of setting out, checking or measuring the work.

Care of survey marks: Preserve and maintain the survey marks in their true positions. The Contractor shall check survey marks for consistency and if there are inconsistencies, the Contractor shall give written information to the Engineer with his proposed corrections. If the survey marks are damaged, the Contractor shall immediately advise the Engineer and rectify the damage.

##### Contractor's Representative

The contractor must employ a suitably experienced engineer as the Site Manager. This person must be on site during working hours, and fluent in English and technical terminology. The Contractor's Site Manager will have the authority to make all decisions concerning the project on behalf of the Contractor.

##### Program of Work

The Contractor is to provide a construction baseline program with MS Project which has the following information:

Sequence of Work. (Work Breakdown Structure)

Activity inter-relationships. (Should be closed loop)

Activity durations with start and finish dates

Periods within which various stages or parts of the work are to be executed.

Time scale: Calendar Days

Line items in program are to be based on UNOPS Bill of Quantities numbering system (see index). Update the program weekly. Submit hardcopy and softcopy. Identify changes since the previous version, and show the actual starts and finishes, actual percentage of completion for each item of work.

### Site Meetings

Hold and attend weekly site meetings throughout the contract and ensure attendance of appropriate subcontractors, the Site Manager and Engineer. The meeting schedule may be modified by the Engineer.

The meeting will consider the following items:

- Technical issues.
- Commercial issues.
- Program.
- Quality of work.

### Items Supplied by Owner

Materials and other items identified in the **Items to be Supplied** schedule will be supplied free of charge to the Contractor for installation in the execution of the works. Unload and take delivery of them, inspect them for defects and then take care of them. If defects are found, advise. Return unused items to the owner.

#### **1.1.1.4 Completion of the Works**

### Final Cleaning

Before Practical Completion, clean throughout, including interior and exterior surfaces exposed to view. Clean carpeted and soft surfaces. Clean debris from the site, roofs, gutters, downpipes and drainage systems. Remove waste and surplus materials.

### Reinstatement

Before practical completion, clean and repair damage caused by installation or use of temporary work and restore existing facilities used during construction to original condition.

### Adjoining Property

At practical completion, for properties described in the **Adjoining Properties to be Recorded** schedule inspect the properties with the Engineer and owners and occupants of the properties, recording any damage that has occurred since the pre-commencement inspection.

### Post Construction Works

The Contractor will provide the following documentation after all site construction has been completed:

- Warranty Statement
- Material Test Certificates
- As-Built Drawings
- List of the suppliers with their contact information
- Spare materials, where applicable

A condition-out survey will be conducted with the Contractor and Engineer at which damages caused by the Contractor will be identified. The Engineer will determine if the Contractor is to make repairs or if the damage will be deducted from the Contractor's final invoice.

### Removal of plant

Within 10 working days after practical completion, remove temporary works and construction plant no longer required. Remove the balance before the end of the defects liability period.

**1.1.1.5 Payment for the works**Anticipated Progress Claims Schedule

The method of measurement and payment will be SMM7 – Standard Method of Measurement for Building Works (latest version).

The Contractor is to submit a schedule of anticipated progress claims which will be made throughout the contract. Submit a revised schedule with each progress claim.

**1.1.1.6 Miscellaneous**Compliance with the Law

The Contractor is responsible for compliance with all requirements of authorities. The owner, before entering into the contract, has given the notices, paid the fees, and obtained the permits, approvals and other authorisations stated in the **Prior Applications and Approvals** schedule.

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## 1.2 GENERAL REQUIREMENTS

### 1.2.1 GENERAL

#### 1.2.1.1 CONTRACT DOCUMENTS

##### Drawings

Large scale drawings take precedence over small scale drawings. Written or calculatable dimensions take precedence over scaled dimensions.

If there are any errors in dimensions, set out or size, immediately notify the Engineer.

##### Schedule

The schedule forms part of the specification. Information in the schedule will take precedence over information in the specification.

##### Bill Of Quantities

If there are any errors in description of items or omissions in the BOQ, immediately notify the Engineer.

If there are any items which are unclear or are not available within the project program, immediately notify the Engineer.

##### Services diagrammatic layouts

Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable.

Before commencing work:

- Obtain measurements and other necessary information.

- Coordinate the design and installation in conjunction with all trades.

##### Site Levels

Spot levels and identified levels on drawings take precedence over contour lines and ground profile lines.

#### 1.2.1.2 INSPECTION

##### Inspection Notification Schedule

The Contractor is to notify the Engineer when the items identified in the **Inspection notification schedule** are ready for inspection.

##### Written Notice

Minimum notice for inspections to be made on site is 24 hours for off site personnel, 4 hours for onsite personnel.

If notice of inspection is required in respect of parts of the works that are to be concealed, advise when the inspection can be made before concealment.

#### 1.2.1.3 SUBMISSIONS

##### Samples

The Engineer must approve the laboratory used for testing.

Submit nominated samples for approval of the Engineer.



If it is intended to incorporate samples into the works, submit proposals for approval. Only incorporate samples in the works which have been approved. Do not incorporate other samples.

Keep endorsed samples in good condition on site, until practical completion.

#### Shop Drawings

General: If required, submit dimensioned drawings showing details of the fabrication and installation of services and equipment, including relationship to building structure and other services, cable type and size, and marking details.

Diagrammatic layouts: Coordinate work shown diagrammatically in the contract documents, and submit dimensioned set-out drawings.

### **1.2.2 PRODUCTS**

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#### **1.2.2.1 TESTS**

##### Notice

Give notice of time and place of nominated tests.

##### Attendance

The Contractor is to carry out and attend all tests where nominated in this specification.

The independent approved testing laboratory shall perform the required tests and report results of all tests noting if the tested material passed or failed such tests and shall furnish copies to the Engineer.

#### **1.2.2.2 MATERIALS AND COMPONENTS**

##### Consistency

For the whole quantity of each material or product use the same approved manufacturer or source and provide consistent type, size, quality and appearance.

##### Manufacturers' or Suppliers' Recommendations

Proprietary items: Select, if no selection is given, and transport, deliver, store, handle, protect, finish, adjust, prepare for use, and provide manufactured items in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Proprietary systems/assemblies: Assemble, install or fix in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Project modifications: Advise of activities that supplement, or are contrary to, manufacturer's or suppliers' written recommendations and instructions.

##### Proprietary Items

Identification of a proprietary item does not necessarily imply exclusive preference for the item so identified, but indicates the necessary properties of the item.

Alternatives: If alternatives are proposed, submit proposed alternatives and include samples, available technical information, reasons for proposed substitutions and cost. If necessary, provide an English translation. State if provision of proposed alternatives will necessitate alteration to other parts of the works and advise consequent costs.

### **1.2.3 EXECUTION**

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Use of explosives will not be permitted.

### 1.2.3.1 COMPLETION

#### Warranties

Name the owner as warrantee in conformance with the **Warranty** schedule. Register with manufacturers as necessary. Retain copies delivered with components and equipment.

Commencement: Commence warranty periods at practical completion or at acceptance of installation, if acceptance is not concurrent with practical completion.

### 1.2.3.2 OPERATION AND MAINTENANCE MANUALS

#### General

General: Submit operation and maintenance manuals for installations.

#### Format – hard copy

These will be A4 size loose leaf, in commercial quality files with hard covers, each indexed, divided and titled. Include the following features:

- Cover: Identify each binder with typed or printed title “*OPERATION AND MAINTENANCE MANUAL*”, to spine. Identify title of project and date of issue.
- Drawings: Fold drawings to A4 size and accommodate them in the files so that they may be unfolded without being detached from the rings.
- Text: Manufacturers’ printed data, including associated diagrams, or typewritten, single-sided on paper, in clear concise English.

Number of copies: 3.

#### Format – soft copy

- In PDF, AutoCad or Microsoft Word, Excel format.

- On compact disk properly identified as above

Number of copies: 3.

### 1.3 CONTRACTOR QUALITY CONTROL PROGRAM

#### 1.3.1 GENERAL

When the specification requires a Contractor Quality Control Program, the Contractor shall establish, provide, and maintain an effective Quality Control Program that details the methods and procedures that will be taken to assure that all materials and completed construction required by this contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the contract technical specifications, the Contractor shall assume full responsibility for accomplishing the stated purpose.

The intent of this section is to enable the Contractor to establish a necessary level of control that will:

- a. Adequately provide for the production of acceptable quality materials.
- b. Provide sufficient information to assure both the Contractor and the Engineer that the specification requirements can be met.
- c. Allow the Contractor as much latitude as possible to develop his or her own standard of control.

The Contractor shall be prepared to discuss and present, at the preconstruction conference, his/her understanding of the quality control requirements. **The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the Quality Control Program has been reviewed by the Engineer.** No partial payment will be made for materials subject to specific quality control requirements until the Quality Control Program has been reviewed.

The quality control requirements contained in this section and elsewhere in the contract technical specifications are in addition to and separate from the acceptance testing requirements. Acceptance testing requirements are the responsibility of the Engineer.

#### 1.3.2 DESCRIPTION OF PROGRAM.

##### General Description

The Contractor shall establish a Quality Control Program to perform inspection and testing of all items of work required by the technical specifications, including those performed by subcontractors. This Quality Control Program shall ensure conformance to applicable specifications and plans with respect to materials, workmanship, construction, finish, and functional performance. The Quality Control Program shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the technical specifications, in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of quality control.

##### Quality Control Program

The Contractor shall describe the Quality Control Program in a written document that shall be reviewed by the Engineer prior to the start of any production, construction, or off-site fabrication.

The Engineer will choose an adequate period for review. A minimum of 5 days before the preconstruction conference or the start of work is recommended.

Submittal of the written Quality Control Program prior to the preconstruction conference will allow the Engineer to review the contents and make suggestions at the preconstruction meeting.

Submittal of the written Quality Control Program prior to the start of work will allow for detailed discussion of the requirements at the preconstruction meeting. This will give the Contractor a better understanding of the requirements before developing the Quality Control Program.

When selecting the required days for the contractor to submit the Quality Control program, adequate time should be allowed for the Quality Control Program to be a supplement to the Owner's Construction Management Plan.

The Quality Control Program shall be organized to address, as a minimum, the following items:

- a. Quality control organization;
- b. Project progress schedule;
- c. Submittals schedule;
- d. Inspection requirements;
- e. Quality control testing plan;
- f. Documentation of quality control activities; and
- g. Requirements for corrective action when quality control and/or acceptance criteria are not met.

The Contractor is encouraged to add any additional elements to the Quality Control Program that he/she deems necessary to adequately control all production and/or construction processes required by this contract.

### 1.3.3 QUALITY CONTROL ORGANIZATION

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The Contractor Quality Control Program shall be implemented by the establishment of a separate quality control organization. An organizational chart shall be developed to show all quality control personnel and how these personnel integrate with other management/production and construction functions and personnel.

The organizational chart shall identify all quality control staff by name and function, and shall indicate the total staff required to implement all elements of the Quality Control Program, including inspection and testing for each item of work. If necessary, different technicians can be utilized for specific inspection and testing functions for different items of work. If an outside organization or independent testing laboratory is used for implementation of all or part of the Quality Control Program, the personnel assigned shall be subject to the qualification requirements of paragraph 100-03a and 100-03b. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

The quality control organization shall consist of the following minimum personnel:

**a. Program Administrator:** The Program Administrator shall be a full-time employee of the Contractor, or a consultant engaged by the Contractor. The Program Administrator shall have a minimum of 5 years of experience in building construction and shall have had prior quality control experience on a project of comparable size and scope as the contract.

Additional qualifications for the Program Administrator shall include at least 1 of the following requirements:

- (1) Professional engineer with 1 year of building construction acceptable to the Engineer.
- (2) Engineer-in-training with 2 years of building construction experience acceptable to the Engineer.
- (3) An individual with 3 years of building construction experience acceptable to the Engineer, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.
- (4) Certified Construction materials technician

The Program Administrator shall have full authority to institute any and all actions necessary for the successful implementation of the Quality Control Program to ensure compliance with the contract plans

and technical specifications. The Program Administrator shall report directly to a responsible officer of the construction firm.

The Engineer may require a full time, on-site Program Administrator, should the project be of sufficient scope and size.

**b. Quality Control Technicians.** A sufficient number of quality control technicians necessary to adequately implement the Quality Control Program shall be provided. These personnel shall be either engineers, engineering technicians, or experienced craftsman with qualifications in the appropriate field higher construction materials technician and shall have a minimum of 2 years of experience in their area of expertise.

The quality control technicians shall report directly to the Program Administrator and shall perform the following functions:

- (1) Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by Section 1.3.6
- (2) Performance of all quality control tests as required by the technical specifications and Section 100-07.

**c. Staffing Levels.** The Contractor shall provide sufficient qualified quality control personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the work, separate plant and field technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The Quality Control Program shall state where different technicians will be required for different work elements.

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#### 1.3.4 PROJECT PROGRESS SCHEDULE

The Contractor shall submit a coordinated construction schedule for all work activities. The schedule shall be prepared as a network diagram in Critical Path Method (CPM), PERT, or other format, or as otherwise specified in the contract. As a minimum, it shall provide information on the sequence of work activities, milestone dates, and activity duration. Ms Project and soft copy has to be submitted.

The Contractor shall maintain the work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule shall not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

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#### 1.3.5 SUBMITTALS SCHEDULE

The Contractor shall submit a detailed listing of all submittals (e.g., mix designs, material certifications) and shop drawings required by the technical specifications. The listing can be developed in a spreadsheet format and shall include:

- a. Specification item number;
- b. Item description;
- c. Description of submittal;
- d. Specification paragraph requiring submittal; and
- e. Scheduled date of submittal.

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**1.3.6 INSPECTION REQUIREMENTS**

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Quality control inspection functions shall be organized to provide inspections for all definable features of work, as detailed below. All inspections shall be documented by the Contractor as specified by Section 1.3.7.

Inspections shall be performed daily to ensure continuing compliance with contract requirements until completion of the particular feature of work. These shall include the following minimum requirements:

- a.** During plant operation for material production, quality control test results and periodic inspections shall be utilized to ensure the quality of aggregates and other mix components, and to adjust and control mix proportioning to meet the approved mix design and other requirements of the technical specifications. All equipment utilized in proportioning and mixing shall be inspected to ensure its proper operating condition. The Quality Control Program shall detail how these and other quality control functions will be accomplished and utilized.
- b.** During field operations, quality control test results and periodic inspections shall be utilized to ensure the quality of all materials and workmanship. All equipment utilized in placing, finishing, and compacting shall be inspected to ensure its proper operating condition and to ensure that all such operations are in conformance to the technical specifications and are within the plan dimensions, lines, grades, and tolerances specified. The Program shall document how these and other quality control functions will be accomplished and utilized.

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**1.3.7 QUALITY CONTROL TESTING PLAN**

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As a part of the overall Quality Control Program, the Contractor shall implement a quality control testing plan, as required by the technical specifications. The testing plan shall include the minimum tests and test frequencies required by each technical specification Item, as well as any additional quality control tests that the Contractor deems necessary to adequately control production and/or construction processes.

The testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:

- a.** Specification item number (e.g., P-401);
- b.** Item description (e.g., Plant Mix Bituminous Pavements);
- c.** Test type (e.g., gradation, grade, asphalt content);
- d.** Test standard (e.g., ASTM or AASHTO test number, as applicable);
- e.** Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated);
- f.** Responsibility (e.g., plant technician); and
- g.** Control requirements (e.g., target, permissible deviations).

The testing plan shall contain a statistically-based procedure of random sampling for acquiring test samples in accordance with ASTM D 3665. The Engineer shall be provided the opportunity to witness quality control sampling and testing.

All quality control test results shall be documented by the Contractor as required by Section 1.3.8.

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**1.3.8 DOCUMENTATION**

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The Contractor shall maintain current quality control records of all inspections and tests performed. These records shall include factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of defects, deviations, causes for rejection, etc.; proposed remedial action; and corrective actions taken.

These records must cover both conforming and defective or deficient features, and must include a statement that all supplies and materials incorporated in the work are in full compliance with the terms of the contract. Legible copies of these records shall be furnished to the Engineer daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the Contractor's Program Administrator.

Specific Contractor quality control records required for the contract shall include, but are not necessarily limited to, the following records:

**a. Daily Inspection Reports.** Each Contractor quality control technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations on a form acceptable to the Engineer. These technician's daily reports shall provide factual evidence that continuous quality control inspections have been performed and shall, as a minimum, include the following:

- (1) Technical specification item number and description;
- (2) Compliance with approved submittals;
- (3) Proper storage of materials and equipment;
- (4) Proper operation of all equipment;
- (5) Adherence to plans and technical specifications;
- (6) Review of quality control tests; and
- (7) Safety inspection.

The daily inspection reports shall identify inspections conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective actions taken or proposed.

The daily inspection reports shall be signed by the responsible quality control technician and the Program Administrator. The Engineer shall be provided at least one copy of each daily inspection report on the work day following the day of record.

**b. Daily Test Reports.** The Contractor shall be responsible for establishing a system that will record all quality control test results. Daily test reports shall document the following information:

- (1) Technical specification item number and description;
- (2) Test designation;
- (3) Location;
- (4) Date of test;
- (5) Control requirements;
- (6) Test results;
- (7) Causes for rejection;
- (8) Recommended remedial actions; and
- (9) Retests.

Test results from each day's work period shall be submitted to the Engineer prior to the start of the next day's work period. When required by the technical specifications, the Contractor shall maintain statistical quality control charts. The daily test reports shall be signed by the responsible quality control technician and the Program Administrator.

#### 1.3.9 CORRECTIVE ACTION REQUIREMENTS

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The Quality Control Program shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process

into control. The requirements for corrective action shall include both general requirements for operation of the Quality Control Program as a whole, and for individual items of work contained in the technical specifications.

The Quality Control Program shall detail how the results of quality control inspections and tests will be used for determining the need for corrective action and shall contain clear sets of rules to gauge when a process is out of control and the type of correction to be taken to regain process control.

When applicable or required by the technical specifications, the Contractor shall establish and utilize statistical quality control charts for individual quality control tests. The requirements for corrective action shall be linked to the control charts.

#### **1.3.10 SURVEILLANCE BY THE ENGINEER**

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All items of material and equipment shall be subject to surveillance by the Engineer at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate quality control system in conformance with the requirements detailed herein and the applicable technical specifications and plans. In addition, all items of materials, equipment and work in place shall be subject to surveillance by the Engineer at the site for the same purpose.

Surveillance by the Engineer does not relieve the Contractor of performing quality control inspections of either on-site or off-site Contractor's or subcontractor's work.

#### **1.3.11 NONCOMPLIANCE.**

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The Engineer will notify the Contractor of any noncompliance with any of the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. Any notice, when delivered by the Engineer or his/her authorized representative to the Contractor or his/her authorized representative at the site of the work, shall be considered sufficient notice.

In cases where quality control activities do not comply with either the Contractor Quality Control Program or the contract provisions, or where the Contractor fails to properly operate and maintain an effective Quality Control Program, as determined by the Engineer, the Engineer may:

- (1) Order the Contractor to replace ineffective or unqualified quality control personnel or subcontractors.
- (2) Order the Contractor to stop operations until appropriate corrective actions are taken.



**1.4 HEALTH AND SAFETY****1.4.1 GENERAL****1.4.1.1 1.1 Responsibility For Safety**

The contractor shall be responsible for the safety of all operations in connection with the Contract and shall take all necessary actions and precautions to ensure the safety of all persons who may be in, on or adjacent to the Site.

**1.4.1.2 Compliance With UNOPS Workplace Safety and Health Policy & Procedures**

The Contractor shall comply with the compliance with the UNOPS Workplace Safety and Health Policy & Procedures for the purposes of this clause including all sub clauses under it) and any amendment or re-enactment thereto and including but not limited to:

Any other rules and regulations, Standards and Codes of Practices related and relevant to the promotion of safe practices and conduct at the worksite.

It shall be the duty of the Contractor to comply with all such requirements of the Workplace Safety and Health Policy & Procedures, as affect him or any person or persons employed by him, and as related to any work, act or operation performed or about to be performed by him. The Contractor shall not permit any person to do anything not in accordance with the generally accepted principles of safe and sound practices.

The Contractor shall ensure a safe environment on the site at all times. All safety provisions shall be properly maintained and shall not be removed. The Contractor shall ensure that necessary and sufficient precautions are taken by his workmen when safety provisions are used. The Contractor shall not allow any of the safety provisions to be used unless he has satisfied himself that the provisions are safe.

Where UNOPS Project Manager appoints an engineer to carry out any work for any temporary works specified below, the engineer shall comply with any duties imposed on him under those regulations:

- 1) Cantilevered platforms erected more than 3m above ground;
- 2) Formwork structure;
- 3) Runway and ramp for use of motor trucks or heavy vehicles;
- 4) Stability of structure adjacent to excavation;
- 5) Shoring and bracing for trench excavation > 4m; and

Duties on engineers undertaking temporary works regulated by UNOPS Health & Safety Policy & Procedures:

- a) Design it to acceptable codes and standards and in accordance with good engineering practices;
- b) Ensure that it is constructed accordance with his design;
- c) When it is constructed, satisfy himself that it is safe for its intended use and if so, issue a certificate stating that it is safe for its intended use;
- d) The engineer shall exercise due diligence when carrying out his duties; and

The Contractor shall ensure that the requirements of Health & Safety Policy & Procedures and the requirements specified hereunder are strictly complied with at all times.

**1.4.1.3 Undertaking by Contractor**

The Contractor shall undertake to ensure that the provisions of the Health & Safety Policy and Procedures are complied with. The attached safety provisions undertaking form for the Occupier/Contractor in “**Appendix I**” shall be complied by a Managing Director or other duly authorized representative of the company/firm awarded the Contract.

**1.4.1.4 Site Safety Programme**

The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the Contractor's Health and Safety Plan has been reviewed by UNOPS. The relevant safety equipment and safe method of work employed at each stage of construction shall be described in detail. Special risks involving specialized equipment shall also be highlighted. The programme shall also include company safety policy, risk assessment, safety rules and regulations, small group activities, safety promotion programme (safety slogans, safety campaign, slide shows etc), safety training, emergency procedures and other such activities. The safety programme must be displayed outside the site office. The Contractor shall display safety posters at the site office, site canteen, exit/entry points of buildings and passenger cum material hoist area.

**1.4.1.5 Monthly Safety Review**

The Contractor shall carry out monthly safety review of the measures contained within the Safety Programme to demonstrate that the required level of safety are being achieved and maintained and make a full report to UNOPS on each such review. UNOPS will review the Safety Programme from time to time and will advise the Contractor of any matter with which he is not satisfied and the Contractor shall take such steps as are necessary to satisfy UNOPS. UNOPS will carry out such safety studies or audits, as considered necessary. The Contractor shall make available, specialist personnel as the UNOPS may consider necessary for the performance of such safety studies or audits.

**1.4.1.6 Risk Management**

The contractor shall conduct a risk assessment in relation to the safety and health risks posed to any person who may be affected by his undertaking prior to the commencement of work in accordance to UNOPS Health and Safety Policy & Procedures

The contractor shall take all reasonably practicable steps to eliminate any foreseeable risk to any person who may be affected by his undertaking.

The contractor shall maintain a record of risk assessments conducted, including any control measures taken or to be taken and any safe work procedures.

The contractor shall ensure that his employees are informed of the nature of the risk involved, the measures implemented to control the risk and applicable safe work procedures. Whenever the assessment of a risk is revised, or where control measures or safe work procedures are changed, employer shall inform employees of such changes.

**1.4.2 SITE SAFETY MEASURES****1.4.2.1 Physical Measures**

The contractor must develop procedures in a fall protection plan for the construction site if his worker at the work site may fall 3 metres or more and the worker is not protected by guardrails.

The contractor must have a fall protection system in place and available at the construction site before work with a risk of falling begins.

The contractor must have the following devices and system in place prior to start of the work:

- (i) fall arresting devices such as rope grabs, guard rails etc
- (ii) safety belts, body harness, lanyards consisting of carabiners, D-rings, O-Rings, ovals rings, self locking connectors and snap hooks

**1.4.2.2 Metal Access Scaffold And Working Platforms**

The Contractor shall provide, erect and maintain metal access scaffold for all building blocks of 2 storey and above or 3.0 m in height and above.

The scaffold shall be erected ahead of the structural work from the second storey and supported by cantilevered platforms erected according to the reasonable safety standards. The cantilevered platforms

shall project about 1.1m from the edge of the building or any other distance. The scaffold shall be erected within 300mm from the building edge. Where the structure does not allow the scaffold to be erected from the second storey or where the building is less than 12.0m in height, the Contractor may erect the scaffold from the first storey subject to review by UNOPS.

The Contractor and his Engineer shall ensure that the building structure can resist the load imposed by the scaffold. The scaffold shall be designed to carry metal working platforms and two working levels in use concurrently. The maximum average loading per working level per bay is 220 kg per m<sup>2</sup>. Signboards showing the maximum loading allowed on the scaffold may be displayed on the scaffold.

The Contractor shall provide, erect and maintain continuous metal work platforms or other types of work platforms at every alternate lift starting from the 2<sup>nd</sup> lift of the scaffold, the immediate level below the top most level and the roof level of the building block under construction.

Where the height between the work platform at the roof level and the platform directly below is two lifts or less, the latter work platform may not be necessary. No omission from the Contract Sum shall be made in the event that such a work platform is not necessary.

The material used for the metal work platform shall be steel. Work platforms shall be adequately secured to scaffolding frames at the required levels. The connections between work platform and scaffolding frame, and between the work platforms shall be subject to review by UNOPS.

For any portion of the work platform where the use of metal is not suitable, the Contractor may use timber platform subject to the review by the SO. The platform shall be complete with at least 90 mm high coloured toeboards and metal guardrails at least 1.0 m above the work platform.

The work platform shall be at least 500mm in width. The platform shall be used for:

- (i) Erecting and dismantling of formwork of structural elements;
- (ii) Transferring of formwork or other materials from one working level to another; and
- (iii) External finishing works.

The Contractor shall provide, erect and maintain an overlying screening net to cover the entire external face of the scaffold. The installation of the net shall follow the erection of the scaffold closely. A 90mm high coloured toeboard shall be provided at the base of the net. After installation, there shall be no opening between separate sets of the net and any torn net shall be replaced or repaired immediately. The scaffold shall be effectively tied to the building structure by means of tie-backs. All tie-backs shall be painted with bright colour for easy identification.

For buildings next to areas less than 30m away from the Site boundary, the Contractor shall provide special mid-height platform supporting metal access scaffold at the building elevation directly facing public areas, walkways, children playgrounds, schools and other locations with public traffic.

The special mid-height work platform shall be installed from the floor level at the mid height of the building and shall project 6m from the edge of the floor. They shall be supported at the floor level below by diagonal members. Tension tie backs to upper floors shall not be used.

Around the edges of the 6m platform, guardrails and toe boards shall be provided. Guardrail shall have sufficient strength and rigidity to withstand, without permanent deformation or failure, a 50 kg loads applied in any direction at right angles to the guardrail.

The work platform and its supports shall be designed by an Engineer to a uniformly distributed live load of 1.5 kg per m<sup>2</sup> and the loading from the scaffold. Supports for platform shall be spaced at not more than 1.8m centre to centre.

#### **1.4.2.3 Personal Protective Equipment**

The Contractor shall provide and maintain suitable personal protective equipment for all workmen employed on the Site.

- The Personal Protective Equipment consists of the following:

- Hearing protection equipment such as ear defenders, ear plugs etc. (where required)
- Eye protection such as safety eye wear, welding goggles and shields etc.
- Foot protection such as safety shoes/boots etc.
- Head protection such as hard hats
- Limb and body protection such as gloves, reflective vests etc.
- Respirators, as necessary and adequate

The Contractor shall ensure that such personal protective equipment comply with the requirements of UNOPS.

The Contractor shall also ensure that all equipment is properly used by his workmen during the course of their work. The Contractor shall record the issuance of all equipment to his workmen in the prescribed forms and such forms shall be kept in the site office and made available for inspection at all times.

#### **1.4.2.4 Overhead Shelters**

The Contractor shall provide, erect and maintain overhead shelters at every point of entry/exit of buildings two or more storey in height. The overhead shelters shall be constructed immediately below the second storey. The overhead shelters shall project at least 3.0m from the building edge and shall be at least 1.5m wide. The overhead shelters shall be made of curved metal roofing with a diameter of at least 1.5m or pitched metal roofing with a slope greater than one in two, with timber boarding below supported by steel pipes resting on rigid bases.

The access to, along and egress from the entry/exit points shall be kept free from obstructions and accumulation of oil, grease, water and other substances that may cause slipping and tripping.

Overhead shelters shall also be provided for person(s) exposed to falling objects.

#### **1.4.2.5 Peripheral Overhead Shelters**

The Contractor shall provide peripheral overhead shelters for buildings of 15.0m or more in height. It shall be erected in place when the construction reaches the third storey slab. The overhead shelter shall be at least 2.0m wide, and inclined so that the outer edge is at least 150mm higher than the inner edge. The overhead shelter shall be sufficiently strong to support a weight of at least 75 kg point load.

#### **1.4.2.6 Barricades To Lift Openings, Voids, Open Sides Of Buildings And Excavations**

The Contractor shall barricade all lift openings, internal voids, open sides of buildings and excavations where a person is liable to fall. The barricade shall be at least 1.1m high and shall have sufficient strength and rigidity to withstand a lateral point load of 50 kg.

#### **1.4.2.7 Suspended Scaffolds**

A suspended scaffold system shall only be used for touching up, repair and redecoration and minor work. Where suspended scaffold system is to be used, the Contractor shall notify UNOPS prior to its installation and usage. The safe working load will be prominently displayed. The Contractor shall ensure that there are weekly checks and additional check after inclement weather by his supervisor and monthly check by an Engineer (Civil). Where the use of access scaffolding is not stipulated, suspended scaffold may be used for finishing works. Independent lifelines shall be provided for suspended scaffold riggers and users to anchor their safety harness attached with shock absorbing device.

#### **1.4.2.8 Ladders**

The Contractor must ensure that ladders are in an acceptable sound condition and submit a written inspection report to UNOPS.

If the ladder is made of a material other than steel, the contractor must ensure that the ladder is in sound condition.

If the ladder is constructed of lumber/timber, the contractor must ensure that the timber is free of loose knots or knot holes, must not have a split and must be strong and sturdy.

The contractor's worker must ensure that:

- the ladder is secured against movement and placed on a base that is stable
- the base of an inclined ladder is no further from the base of the wall or structure than 1.4 of the height to where the ladder contacts the wall or structure.

#### **1.4.2.9 Mobile Cranes**

No person shall install, repair, alter or dismantle a mobile crane unless he is an approved mechanic. The contractor/mechanic shall ensure, so far as is reasonably practicable, that the mobile crane is erected, installed or modified in such a manner that it is safe, and without risk to health, when properly used.

The Contractor shall ensure that the crane access is properly constructed and weekly check by supervisor is carried out. The boom of the mobile crane with hoisted load shall not be allowed to swing outside the contract boundary without the review by UNOPS. All hoisting areas must be effectively barricaded.

The Contractor shall ensure there is installation of barriers to warn the crane operator of depressions, excavated areas and other obstructions.

The Contractor shall station a lifting supervisor on the Site to oversee and guide the crane operator during positioning, hoisting and slewing. The Contractor shall ensure daily checks are carried out by the crane operator. The cranes must have overhaul checks before being used on the Site.

#### **1.4.2.10 Temporary Chute For The Removal Of Construction Debris**

The Contractor shall provide adequate number of temporary chutes to dispose construction debris from the upper storey of all building blocks 2 storey and above. It shall be erected to follow the structural work. A large bin at the lower end of each chute shall be provided and emptied regularly. "**DANGER - KEEP OUT**" in the official languages shall be posted at the bin area.

#### **1.4.2.11 Warning Signs And Lights**

The Contractor shall display warning signs of sizes 900 mm x 600 mm at strategic points around the periphery of the Site where trespassing is likely to occur. Such signs shall have the words "**DANGER - KEEP OUT**" in the two languages (Dari & English) painted in red on a white background in gloss finishing paint. Warning lights shall be placed at similar positions at night to serve as warnings.

#### **1.4.2.12 Housekeeping**

The Contractor shall maintain and ensure a safe working environment by keeping the Site neat and tidy, and free from hazards and debris. Materials shall be stacked up safely. All work areas and access thereto shall be kept free from hazards and debris.

Housekeeping shall be carried out in such a manner and at such times so as not to cause any inconvenience to either the adjoining occupiers or the public. Debris shall be wetted to minimize the risk of dust. Containers for debris and rubbish are to be provided at the designated places.

#### **1.4.2.13 Temporary Staircases**

The Contractor shall provide and maintain a minimum 0.8m wide temporary metal staircase from one working floor to another. The staircase shall be placed against the adjacent staircase wall or formwork of the staircase walls that are under construction. The outer sides of the staircases shall be provided with metal handrails 1.1m above the outer staircase strings. The bottom of the staircase shall be covered fully with metal plate.

#### **1.4.2.14 Safety Information Signboard And Assembly Stage**

The Contractor shall erect and maintain a Safety Information Signboard and Assembly Stage. The signboard shall be 6.0m x 3.0m, made of timber plywood and fixed at a steel frame. The signboard shall

consist of safety posters, safety theme and pictures, safety news, photos of good safety measures, one 600mm x 1500mm mirror. The safety posters, news and photos shall be protected from weather.

The arrangement and size of display of all items referred herein shall be submitted to the UNOPS. The stage shall be constructed in front of the signboard and made of concrete. The stage shall consist of a raised platform of 4.5m x 1.0m with at least one step.

The location of the signboard and stage shall be review by UNOPS. As and when instructed by UNOPS, the Contractor shall remove or relocate and reconstruct the signboard and stage, and reinstate all the affected ground to the satisfaction of UNOPS, all at the cost and expense of the Contractor. On Substantial Completion of the Works, the signboard and stage shall be cleared away upon the review of UNOPS.

#### **1.4.2.15 Gas Cylinders And Related Equipment**

The Contractor shall use gas cylinders, each fitted with a low pressure gauge, a high pressure gauge, a reducing valve with pressure regulator, and a safety relief device. The gas cylinders shall not be kept in the same room where welding, cutting or heating is being carried out or placed within five metres of any source of heat. The gas cylinders must always be kept upright in a wheeled-trolley. When lifted by crane, hoist or derrick, cylinders must be placed in cradles or skip box design. Protective valve caps shall also be in place.

The hose connecting a gas cylinder to an apparatus for cutting, welding, heating or other related works shall be of good construction and sound material, free from defect, properly maintained, and not entangled or kinked. Valves and fittings shall be tested for leak with "soap water" everyday before use.

#### **1.4.2.16 Safety Reflective Apparel (Traffic Control)**

A worker designated to control traffic shall wear approved type of reflective apparel during all hours of the day when so engaged.

#### **1.4.2.17 Health Measures**

##### Noise Management

The contractor shall as far as practicable, ensure that all processes, machines and equipment used, do not cause workers to be exposed to excessive noise, i.e. above an equivalent sound level of 85 dBA for 8 hour workday. This can be done by implementing one or more of the following measures:

- Engineering noise control, e.g., modifying noisy processes, machines and equipment, relocating noisy processes or isolating them within enclosures, erecting sound barriers, reducing kinetic or potential energy and regularly maintaining machines and equipment;
- Administrative noise control, e.g., rotating noisy jobs among workers so that they are not exposed to noise above the permissible exposure limit;
- Using quiet machines and equipment when such machines and equipment are available in the market. Examples are generators, compressors and concrete breakers. The contractor shall provide hearing protectors for workers who are exposed to excessive noise and ensure that they are worn at all times. Warning signs to remind workers that hearing protectors must be worn shall be put up at areas with excessive noise.
- Contract workers should be trained and educated on the hazards of noise, noise control and the prevention.

##### First-Aid

All workplaces as specified within the class or description shall establish and implement a first-aid programme to provide emergency treatment to victims of accidents, chemical poisoning or excessive exposure to toxic substances.

The programme shall include: -

- First-aid facilities;
- First-aid boxes;
- First-aid room, where there are 500 or more workers at site;
- First-aid treatment procedures;
- First aid for exposure to toxic or corrosive substances
- Standard procedures;
- Maintenance of first-aid facilities.

All first-aid provisions shall comply with the UNOPS Health & Safety (First-Aid) Regulations.

#### **1.4.2.18 Electrical Works**

Where work to be carried out involves electricity/power, installing temporary wiring, usage of power tools and equipment, no worker shall connect, maintain or modify electrical tools, equipment or installation unless the worker is a qualified electrician.

The contractor shall take every reasonable precaution to prevent hazards to workers from energized electrical equipment, installations and conductors

No person, other than a person authorized to do so by the contractor of the project, shall enter or be permitted to enter a room or other enclosure containing exposed energized electrical parts.

The entrance to a room or other enclosure containing exposed energized electrical parts shall be marked by conspicuous warning signs stating that entry by unauthorized persons is prohibited.

All electrical equipment, installations, conductors and insulating materials shall be suitable for their intended use and shall be installed, maintained, modified and operated so as not to pose a hazard to a worker.

Contractor shall use mats, shields or other protective devices or equipment, including personal protective equipment, adequate to protect the worker from electrical shock and burns.

#### **1.4.2.19 Work in Confined Space**

Where work is to be carried out in any confined space as defined in UNOPS, code of practice for entry into and safe working in confined spaces shall be followed.

#### **1.4.2.20 Excavations and Tunnels**

No person shall enter or be permitted to enter an excavation that does not comply with this Part.

Work shall not be performed in a trench unless another worker is working above ground in close proximity to the trench or to the means of access to it.

The type of soil in which an excavation is made shall be determined by visual and physical examination of the soil,

- (a) at the walls of the excavation; and
- (b) within a horizontal distance from each wall equal to the depth of the excavation measured away from the excavation.

Before an excavation is begun,

- (a) gas, electrical and other services in and near the area to be excavated shall be accurately located and marked; and
- (b) if a service may pose a hazard, the service shall be shut off and disconnected.

An excavation in which a worker may work shall have a clear work space of at least 450 mm between the wall of the excavation and any formwork or masonry or similar wall.

The walls of an excavation shall be stripped of loose rock or other material that may slide, roll or fall upon a worker.

A level area extending at least one metre from the upper edge of each wall of an excavation shall be kept clear of equipment, excavated soil, rock and construction material.

The stability of a wall of an excavation shall be maintained where it may be affected by stockpiling excavated soil or rock or construction materials.

No person shall operate a vehicle or other machine and no vehicle or other machine shall be located in such a way as to affect the stability of a wall of an excavation.

If a person could fall into an excavation that is more than 2.4 metres deep, a barrier at least 1.1 metres high shall be provided at the top of every wall of the excavation that is not sloped.

Where the excavation is a trench and the depth exceeds six metres or the width exceeds 3.6 metres, a support system shall consisting of either timber or of an engineered support system designed for the specific location and project shall be installed.

#### **1.4.2.21 Control of Traffic**

If vehicle traffic at the construction site is dangerous to workers, pedestrians, school children on foot, the contractor and his workers must ensure that the traffic movement is controlled to protect against accident related injuries and fatalities.

The contractor must designate a worker to control traffic on the construction site, the contractor must ensure that the designated traffic controller wears a reflective vest, safety footwear and hard hat.

The passage of vehicles across a footpath shall be supervised to remove danger to the school children and the public.

The contractor and his workers must be vigilant at all times and must ensure that pedestrians and school children **DO NOT** cross the safety barriers and enter the construction site.

#### **1.4.2.22 Others**

The Contractor shall provide and maintain guards, fences or barriers around the construction site, excavations, lift pits or other similar potential places of danger to prevent accidents. The guards, fences and barriers shall be of sound material, good construction and possess adequate strength.

### **1.4.3 NON-COMPLIANCE WITH CONTRACT SAFETY SPECIFICATIONS**

In the event of contravention or non-compliance with the safety specifications, UNOPS shall suspend the progress of works or any part of them if necessary for the safety of the works or if he is of the opinion that the working environment or procedure is unsafe for the works to continue. In such event, the Contractor shall not be entitled to any claims for compensation or extension of time for completion.



## Appendix I

### Form For Undertaking Safety Provision By Contractor

**Project Manager**

**United Nations Office for Project Services**

**Kabul Schools Project**

**Copy: UNOPS Health & Safety Officer**

**RE : SAFETY PROVISIONS AT**

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I, \_\_\_\_\_ of \_\_\_\_\_  
(Name of Managing Director) (Name of Company)

I/C No: \_\_\_\_\_ understand that as the Contractor of /for the above worksite / work area or order, it is my duty and responsibility to ensure that the provisions of UNOPS Health & Safety Policy & Procedures, and any amendments or re-enactments thereto are complied with.

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(Managing Director) (Signature)

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(Name of Company / Company Stamp)

(Date)

**2.3 EARTHWORK****2.3.1 GENERAL****2.3.1.1 Interpretation**Description

Perform earthwork necessary to complete site clearing, excavating, filling, and grading, including preparation of sub-grade for building and structures, and in accordance with Contract Documents.

Definitions

For the purposes of this work section the definitions given below apply.

A. Unauthorized Excavation: Removal of materials beyond indicated sub-grade elevations or dimensions without Engineer's authorization. No payment will be made for unauthorized excavation or remedial work.

B. Authorized Additional Excavation: Removal of material authorized by Engineer based on determination by Testing Agency that the material is soil not capable of supporting design load, or otherwise unsuitable material.

C. Bad ground: Ground unsuitable for the purposes of the works, including fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances and ground which is or becomes soft, wet or unstable.

D. Line of influence: A line extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement.

Project Conditions

Examine site, drawings, records of existing utilities and construction, record of test borings, and subsurface exploration report available. Records of test borings are for information only and are not guaranteed to represent all conditions that will be encountered.

**2.3.1.2 Records of Measurement**Excavation and Backfilling

Do not commence backfilling or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.

Method of measurement: The volume excavated material will be calculated from the measurements given on the drawing. No allowance will be made for bulking.

Excavate the ground as found. No additional payment will be made for rock excavation, or over excavation. Over-excavation at footings shall be filled with concrete during footing placement.

#### **2.3.1.3 Inspection**

##### Notice

Give sufficient written notice so that inspection may be made of the following:

- Excavation completed to contract levels or founding material.
- Filling completed to contract levels.

#### **2.3.1.4 Tolerances**

##### Tolerances

Finish the surface to the required level, grade and shape within the following tolerances:

- Under building slabs and load bearing elements: + 0, -40 mm.
- Pavement sub grades; + 0, - 60 mm.
- Other ground surfaces:  $\pm 50$  mm, provided the area will drain and matches adjacent construction where required.

### **2.3.2 PRODUCTS**

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#### **2.3.2.1 Fill materials**

##### General

Fill material is to be inorganic, non-perishable material.

Excluded materials:

- Organic soils.
- Materials contaminated through past site usage.
- Silts or silt-like materials.
- Fill containing wood, metal, plastic, boulders or other deleterious material.

Classifications for structural fill are based on the intended use of the fill, and defined as follows:( all subject to approval)

Class I structural fill - used as support for shallow foundations, paved areas, and slabs each with loadings of 3660 kgf/m<sup>2</sup> or more, for storage tanks, truck turnarounds, and base course and sub-base course. The fill must not contain more than 15% clay ( non plastic ).

Class II structural fill - used as support for shallow foundations, paved areas, and slabs each with a minimum loading of 2000 kgf/m<sup>2</sup> and for parking areas, backfill around foundations, the construction of embankments, and for roadways pavement sub grades.

Class III non-structural fill - used in areas where installation of structures or equipment is not planned and in open areas where grading is only required to reach levels noted on the drawings.

#### Re-use of Material Recovered from Excavation

Re-use excavated material elsewhere on site if approved by the Engineer.

#### Additional filling layers: (Geotextile)

Quality – Geotextiles shall conform to the requirements mentioned at the given project schedules. Besides, Geotextiles shall only be used after the Engineer approves its quality.

### **2.3.3 EXECUTION**

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#### **2.3.3.1 Preparation**

A. Reference Points: Provide and maintain throughout construction, benchmarks and other reference points on and off site.

B. Site Preparation: Clean areas within Contract Limit Lines as required. Remove trees (except trees indicated to remain or to be relocated), shrubs and vegetation. Prior to removal of trees or other existing items, verify removal with Engineer in writing.

1. Remove existing concrete, masonry, rubble, and paving to a depth of at least 60 centimeters below sub-grade in paved and graded areas. In areas to be paved, spread leveling courses of crushed material acceptable to Engineer over surface of remaining rubble and compact with vibrating compactors. Provide additional crushed material and compact as required to produce a dense uniform surface. Lift thickness, measured before compaction, shall not exceed 20 centimeters. Refer to paragraphs FILLING for material and compaction requirements of the sub grade.

2. Remove rubble beneath areas where building slabs are to be supported on grade. Remove abandoned slabs, footings, foundation walls, pits, manholes, conduit, pipes and other existing below-grade construction that may obstruct new work. Demolish and remove such obstructions as required to provide at least 60 centimeters horizontal and vertical clearance from new construction, including

excavation and placement of engineered fill beneath footing and slabs-on-grade.

3. Beneath areas where building slabs, walks and paving are supported on grade, excavate existing fill soils and loose, soft, or disturbed natural soils and replace with properly compacted fill per the recommendations of the Geotechnical Report.

C. Fill above described areas to sub-grade with acceptable material as specified in the Geotechnical Report.

#### **2.3.3.2 Removal of topsoil**

##### General

Topsoil is the upper portion of a soil, usually dark colored and rich in organic material.

Where applicable, remove topsoil to all areas to be cut, areas to be filled, areas to be occupied by structures, pavements, embankments and the like.

The depth specified should be varied to suit the recommendations of the geotechnical report.

##### Re-use of removed topsoil

Re-use removed topsoil elsewhere on site as directed by the Engineer.

#### **2.3.3.3 Excavation**

##### Extent

Excavate over the site to give correct levels for construction, pavements, filling and landscaping.

Excavate for footings, pits and shafts, to the required sizes and depths. Confirm that bearing capacity is adequate.

##### Proof Rolling

Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the extent of any bad ground.

##### Disposal of Excess Excavated Material

Remove the following material from site and dispose of legally:

1. Unsuitable excavated materials.
2. Excess excavated material.
3. Stripped topsoil which is not being stockpiled for future work, unless disposition on site is directed by Engineer.

B. Do not burn material resulting from clearing and grubbing operations on site.

#### **2.3.3.4 Bearing surfaces**

##### General

Provide flat bearing surfaces for load bearing elements including footings. Step to suit changes in levels. Make the steps to the appropriate courses if supporting masonry.

#### **2.3.3.5 Reinstatement of excavation**

##### General

Where excavation is deeper than the required depth, fill and consolidate to the correct depth.

#### **2.3.3.6 Supporting Excavations**

##### Provision of Supports

Provide temporary supports to all excavations greater than 1.8m deep. Confirm type of supports and level of protection required with the Engineer.

##### Removal of Supports

Remove temporary supports progressively as backfilling proceeds.

#### **2.3.3.7 Adjacent Structures**

##### Temporary Supports

Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works. This applies to all structures where the line of influence is interfered with by the proposed excavation works.

Lateral supports: Provide lateral support using shoring.

Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

##### Permanent supports

If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

#### **2.3.3.8 Preparation for filling**

##### General

Materials for fills shall be approved by Engineer.

Prepare the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements. Shape to assist drainage. Compact the ground exposed after stripping or excavation.

#### **2.3.3.9 Placing Fill**

##### General

**Layers:** Place fill in maximum 15cm horizontal layers across the fill area.

**Mix:** Place fill in a uniform mixture.

**Protection:** Protect the works from damage due to compaction operations. Where necessary, limit the size of compaction equipment or compact by hand. Commence compacting each layer at the structure and proceed away from it.

##### Execution of Geotextile layer:

If geotextile is one of the layers shown among the filling layers, following specification shall be considered in specific to the geotextile material execution:

**Quality:** Geotextiles shall conform to the requirements mentioned at the given project schedules. Besides, Geotextiles shall only be used after the Engineer approves its quality.

**Storage:** Before use, the geotextile shall be stored in a clean, dry location out of direct sunlight, not subject to extremes of either hot or cold temperatures, and with the manufacturer's protective cover undisturbed. Receiving, storage, and handling at the job site shall be in accordance with the requirements listed in ASTM D 4873.

**Surface preparation:** The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the drawings. It shall be reasonably smooth and free of loose rock and clods, holes, depressions, projections, muddy conditions, and standing or flowing water (unless otherwise specified anywhere in given documents).

**Placement:** Before the geotextile is placed, the soil surface will be reviewed for quality assurance of the design and construction. The geotextile shall be placed on the approved prepared surface at the locations and in accordance with the details shown on the drawings and specified in the given project schedules. It shall be unrolled along the placement area and loosely laid, without stretching, in such a manner that it conforms to the surface irregularities when material are placed on or against it. The geotextile may be folded and overlapped to permit proper placement in designated area(s).

The geotextile shall be joined by overlapping a minimum of 18 inches (unless otherwise specified) and secured against the underlying foundation material. Securing pins, approved and provided by the geotextile manufacturer, shall be placed along the edge of the panel or roll material to adequately hold it in place during installation. Pins shall be steel or fiberglass formed as a U, L, or T shape or contain "ears" to prevent total penetration through the geotextile. Steel washers shall be provided on all but

the U-shaped pins. The upstream or upslope geotextile shall overlap the abutting downslope geotextile. At vertical laps, securing pins shall be inserted through the bottom layers along a line through approximately the mid-point of the overlap. At horizontal laps and across slope labs, securing shall be inserted through the bottom layer only. Securing pins shall be placed along a line about 2 inches in from the edge of the placed geotextile at intervals not to exceed 12 feet unless otherwise specified. Additional pins shall be installed as necessary and where appropriate to prevent any undue slippage or movement of the geotextile. The use of securing pins will be held to the minimum necessary. Pins are to remain in place unless otherwise specified. The geotextile shall be furnished in rolls not less than 12 ft. in width.

Should the geotextile be torn or punctured, or the overlaps or sewn joint disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or grade distortion, the backfill around the damaged or displaced area shall be removed and restored to the original approved condition. The repair shall consist of a patch of the same type of geotextile being used and overlaying the existing geotextile. When the geotextile seams are required to be sewn, the overlay patch shall extend a minimum of 1 foot beyond the edge of any damaged area and joined by sewing as required for the original geotextile except that the sewing shall be a minimum of 6 inches from the edge of the damaged geotextile. Geotextile panels joined by overlap shall have the patch extend a minimum of 2 feet from the edge of any damaged area.

The geotextile shall not be placed until it can be anchored and protected with the specified covering within 48 hours or protected from exposure to ultraviolet light. In no case shall material be dropped on uncovered geotextile from a height of more than 3 feet.

#### **2.3.3.10 Compaction Requirements for Fill and Subgrade**

##### Compaction

Compact each layer of fill with acceptable equipment to achieve the following minimum percentages of maximum dry density at the moisture content specified in these Specifications. Class II and III fill shall be compacted to a minimum of 90% relative compaction (ASTM D1557); Class I fill must contain less than 15% clay (finer than 0.005 mm) and shall be compacted to 95% relative compaction (ASTM D1557). Compaction or consolidations by soaking or jetting with water are not acceptable alternative methods to **utilization of mechanical equipment**.

##### Moisture Control for Fill and Sub-grade

1. Maintain moisture content by wetting or drying manipulation. Suspend compacting operations when satisfactory results cannot be obtained because of rain or other unsatisfactory conditions.
2. Fill and sub-grade material to be compacted in accordance with requirements of Specifications, which does not contain sufficient moisture shall be sprinkled with water.



3. Reduce moisture content of fill and sub-grade material containing excess moisture prior to or during compaction to moisture content not greater than three percentage points (3%) above optimum.
4. Reduce moisture content of material which displays pronounced elasticity or deformation under action of loaded rubber tired conveyances to optimum if necessary to secure stability.
5. For sub-grade material, these requirements for maximum moisture apply at time of compaction of sub-grade. Subgrade and fill soils shall not be allowed to dry/or crack and shall be kept moist (between optimum and three percent above optimum moisture content) until covered with subsequent construction.

#### Density

Compact the subgrade exposed by excavation to a minimum depth of 15cm. Compact each layer of fill to the required depth and density, as a systematic construction operation. Shape surfaces to provide drainage and prevent ponding.

Density of all layers of filling are to be approved by the Engineer before subsequent layers are placed.

Maximum rock and lump size in layer after compaction: 2/3 compacted layer thickness.

#### Tests

Soils Testing Laboratory will perform tests herein specified and additional tests required, and submit test reports to Engineer including the following:

1. Optimum Moisture-Maximum Density curve shall be supplied by the Soils Testing Laboratory. Determine maximum densities by ASTM D1557.
2. Import material shall be tested and approved prior to importing to the job site. Up to three days of testing are required before approval of soils.

**3.1 CONCRETE – GENERAL****3.1.1 GENERAL****3.1.1.1 Inspection**Notice

Give sufficient notice so that inspection may be made of the following:

- Base or subgrade before covering.
- Membrane or film underlay installed on the base.
- Completed formwork, and reinforcement, cores, fixings and embedded items fixed in place.
- Surfaces or elements to be concealed in the final work before covering.
- Commencement of concrete placing.

**REFERENCES**

- ASTM – C33 Concrete
- ASTM – C150 Portland Cement
- ACI 318 - Building Code Requirements for Structural Concrete
- ASTM C494 - Chemical Admixtures for Concrete
- ASTM C94 - Ready-Mixed Concrete
- ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- ACI 305 - Recommended Practice for Hot Weather Concreting.
- ACI 306 - Recommended Practice for Cold Weather Concreting.
- ACI 301 - Specifications for Structural Concrete for Buildings.

**3.1.1.2 Submissions**

Submit mix designs for each concrete strength identifying all admixtures, mix ingredients and properties.

Products – Proposals

Curing compounds: If it is proposed to use a liquid membrane-forming curing compound submit certified test results for water retention.

Curing by the covering sheet method: Submit details of the proposed covering material.

Repair materials: Submit proposals for epoxy resin/grout and elastomeric sealant.

**3.1.1.3 Tests**General

Perform tests of the type and frequency necessary to adequately control the materials and processes used in the construction of the works and in conformance with the **Concrete Tests Table**.

Compliance Assessment Tests

Timing: Obtain materials samples at the time of delivery to the site.

Location: Sample from selected sample sites within designated uniform test lots, consisting of an area placed, or compacted or both in one day. Test lots must be uniform in terms of material properties and density.

#### *Flatness and Levelness of Floors*

Floors shall be measured for levelness and flatness as indicated below. Measurements shall be made within 24 hrs after placement of the slab and shall be reported to the Engineer as soon as possible and not later than 72 hrs after installation. All tests are to be performed prior to removing shoring. Proposed sectional boundaries for taking measurements shall be submitted to the Engineer for review and approval prior to pouring the slabs. In general, use one-half bay spacings, control and cold joint locations for sectional boundaries.

Where these tolerances are not met it shall be immediately be brought to the Engineer's attention.

Remedial measures can be conducted with approval of the Engineer but should remedial measures not be possible, the contractor shall remove and replace the portions of the slab that are not in conformance at the contractor's expense.

#### *Testing of Concrete*

Contractor's Independent Testing/Inspection Laboratory shall perform following tests. Samples for testing shall be obtained in accordance with ASTM C172, and shall be taken from as close to point of placement as possible.

The specimens within each set shall be tested at the following ages in conformance with the **Concrete Tests** table.

**1. Compressive Strength Tests:** Specimen type: A set of compression test specimens shall consist of six 200 x 200 x 200 mm cubes or six 150mm diameter x 300 mm high cylinders. Cast at least 1 set from each day's placing. Cast an additional set for each 38 m<sup>3</sup>, or fraction thereof, or not less than one set for each 185 m<sup>2</sup> of surface area for slabs and walls, of each strength of structural concrete. Date cylinders, assign record number, and tag showing the location from which sample was taken. Also record slump test result of sample. Do not make more than 2 series of tests from any 1 location or batch of concrete.

**2. Test Cylinders:** Samples will be made in accordance with ASTM C172. Cast cylinders according to ASTM C31; 24 hours later, store cylinders under moist curing conditions at about 21°C. Test according to ASTM C39 at 7 and 28 day ages. The remaining cylinder shall be kept in reserve in case tests are unsatisfactory.

**3. Control Test Cylinders:** Cast a set of two or more cylinders for each day's placing of concrete for slabs supported on shoring. Place test cylinders on slabs represented by cylinders and cure the same as slabs. Test cylinders to determine proper times for removal of shores and re-shoring. A strength test shall be the average of the compressive strengths of 2 cylinders made from the same sample of concrete and tested at 28 days.

**4. Core Tests:** If tests show the compressive strength of any concrete falls below the required minimum, additional testing of concrete which unsatisfactory tests represent may be required. Make core tests at approved locations according to ASTM C42. Fill core holes with drypack concrete of strength required for concrete. Contractor shall bear cost of tests for below-strength concrete even if such tests indicate concrete has attained required minimum compressive strength, and all costs for required corrections.

**5. Discharge Slump Tests:** Carry out slump tests at approximately one quarter and three quarter points of the load during discharge.

See section 3.1.2.7 for slump and water/cement ratios.

#### **Concrete Tests Table:**

<b>Samples</b>	<b>ASTM C172</b>
Curing of Samples	ASTM C31

Cylinder or Cube Testing (see below)	ASTM C39,
Slump Determination	ASTM C143
Air Content (for mix design – test by concrete supplier)	ASTM C231 or C173

#### Conversion between Cube and Cylinder Strengths

The following matching values of cylinder and cube strengths convert between cylinder and cube strengths, employing linear interpolation for intermediate values and linear extrapolation for values outside the range.

Cylinder Strength		Cube Strength	
MPa	Psi	MPa	Psi
12	1740	15	2175
16	2320	20	2900
20	2900	25	3625
25	3625	30	4350
30	4350	37	5365
35	5075	45	6525
50	7250	60	8700

### **3.1.2 PRODUCTS**

#### **3.1.2.1 Reinforcement**

a. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A185, in flat sheets, not rolls. Welded wire fabric used in concrete paving shall have lapped splices made so that the overlap between the outermost cross wires of each fabric sheet is at least 50 mm.

b. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.

c. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Provide each dowel in one piece, straight, cut accurately to length with ends square and free from burrs. Fix in locations as shown on the design drawings

All reinforcing shall be supported and wired together to prevent displacement by construction loads, or the placing of concrete, beyond the tolerances specified in ACI 301. Any tack or spot welding of reinforcement shall not be performed without approval from the Engineer.

Reinforcement shall be free of loose rust and of any other coating which may adversely affect the bond.

Splices in bar reinforcement shall be located and lapped as shown on the design drawings. Bars in lapped splices shall be in contact unless otherwise shown on the design drawings. Additional splices, if required, shall be made only at locations, and in a manner approved by the Engineer. Welded splices shall not be used. All lap splices in bar reinforcement shall be fully in compliance with ACI 318-05.

Unless specifically indicated on the design drawings, splicing by means of proprietary mechanical splices shall not be used.

Concrete spacers, metal or plastic bar spacers i.e. chairs, shall be used for obtaining proper spacing of reinforcement from the bottom and sides of formwork.

### 3.1.2.2 Formwork

Construct forms according to ACI 347 "Recommended Practice for Concrete Formwork", and conforming to tolerances specified in ACI 301, "Specifications for Structural Concrete for Buildings"

Construct formwork to support concrete for full duration of critical curing period. Construct in a durable manner with sufficient props and fixings to ensure that the formwork remains in position at all times.

Metal formwork shall not be used in cold weather use (see below).

Formwork plans and details to be submitted to Engineer for approval.

Materials: Use a formwork system and material so that there will not be any additional plastering required on concrete surfaces. Wooden planks shall not be used as formwork.

Workmanship: Rigidly construct forms to prevent mortar leakage, sagging, displacement or bulging between studs. Use clean, sound, approved form material, coated with specified materials only, not oil. Provide backing on all plywood joints.

Formwork Erection and Removal: Conform to ACI 301 and ACI 347.

Cleanouts and Cleaning: Provide temporary openings in all wall forms and other vertical forms for cleaning and inspection. Clean forms and surfaces to receive concrete prior to placing.

Re-Use: Clean and recondition form material before re-use.

Form Removal: Do not remove concrete forms until concrete attains sufficient strength to support its own weight and all superimposed loads as determine by testing field cured concrete cylinders, but not sooner than specified in ACI 347, paragraph 3.6.2.3. Load supporting forms may be removed when concrete has attained 75% of required 28 day compressive strength, but no sooner than 10 days provided construction is re-shored.

1. Re-shore structural members as specified below because of design requirements or construction conditions to permit successive construction.
2. Remove formwork progressively so unbalanced loads are not imposed on the structure.
3. Avoid damage concrete surfaces during form removal.
4. Store reusable forms for exposed architectural concrete to prevent damage to contact surfaces.
5. Remove formwork in same sequence as concrete placement to achieve similar concrete surface coloration.
6. Re-shoring loads to the lower floors shall be consistent with the design loads specified on the construction documents and with the acquired strength of the lower floors based on the time they have been allowed to cure before being loaded.

#### Re-shoring

1. Minimum re-shoring shall consist of not less than half the full required shoring added under last placed floor over which full shoring is to be placed for the next floor above. Leave re-shoring in place for at least 10 days after the floor above is placed, but in no case remove re-shoring until next concrete placing has attained a compressive strength equal to 75% of that required for the 28 day age as determined by control test cylinders specified hereinafter.

2. Record: Maintain a form and shoring removal record.

#### Survey and Adjustment

Check forms before and during placement of concrete, using an instrument, and make corrections as work proceeds.

### 3.1.2.3 Cores, fixings and embedded items

A. Where work of other sections require openings for passage of pipes, conduits, ducts, and other inserts in the concrete, obtain all dimensions and other information. All necessary pipe sleeves,

anchors, or other required inserts shall be accurately installed as part of the work of other sections, according to following requirements

B. Conduits or Pipes: Locate so as not to reduce strength of concrete. In no case place pipes, other than conduits, in a slab 108 mm thick or less. Conduit buried in a concrete slab shall not have an outside diameter greater than 1/3 the slab thickness nor be placed below the bottom reinforcing steel or over top reinforcing steel.

C. Sleeves: Pipe sleeves may pass through slabs or walls if not exposed to rusting or other deterioration and are of uncoated or galvanized iron or steel. Provide sleeves of diameter large enough to pass any hub or coupling on pipe, including any insulation.

D. Conduits: Conduits may be embedded in walls only if the outside diameter does not exceed 1/3 the wall thickness, are spaced no closer than 3 diameters on centers, and do not impair the strength of the structure.

Inspection: Obtain inspection and approval of forms before placing structural concrete.

#### Adjoining elements

For adjoining elements to be fixed to or supported on the concrete, provide for the required fixings. If required, provide for temporary support of adjoining elements during construction of the concrete.

#### Protection

Grease threads. Protect embedded items against damage.

Compatibility: Ensure inserts, fixings and embedded items are compatible with each other, with the reinforcement and with the concrete mix to be used.

Corrosion: If in external or exposed locations, galvanize anchor bolts and embedded fixings.

#### Structural Integrity

Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, reposition but do not cut reinforcement, and maintain cover to reinforcement.

#### Tolerances

Maximum deviation from correct positions:

Cores and embedded items generally: 10 mm.

Other fixing bolts: 3 mm.

### **3.1.2.4 Polymeric Film Underlay**

#### Location

Provide a vapour barrier under slabs on ground including integral ground beams and footings.

#### Installation

Lay over the base, lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape. Face the laps away from the direction of concrete pour. Patch or seal punctures or tears before pouring concrete. Cut back as required after concrete has gained strength and forms have been removed.

#### Base preparation

According to base type, as follows:

- Concrete working base: Remove projections above the plane surface, and loose material.

- Graded prepared subgrade: Blind with sufficient sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay.

### 3.1.2.5 Curing Products

Curing compounds: Liquid-Membrane Forming and Sealing Curing Compound: Comply with ASTM C 309, Type I, Class A unless other type acceptable to Engineer. Moisture loss no more than

0.055 gr./sq. cm. when applied at 5 m<sup>2</sup>/liters. Obtain approval from the Engineer for all curing compounds prior to use.

Covering sheet materials: To be opaque polyethylene film, or burlap-polyethylene sheet, or equivalent material.

### 3.1.2.6 Concrete

Furnish ready-mixed concrete from an approved concrete batch plant. Conform to ASTM C94, except materials, testing, and mix designs as specified herein. Use transit mixer trucks equipped with automatic devices for recording number of revolutions of drum. Design mix to produce normal-weight concrete consisting of Portland cement, aggregate, water-reducing or high-range water-reducing admixture (super-plasticizer), air-entraining admixture, and water to produce the following properties:

1. Compressive Strength: All concrete shall be C30 with a minimum cylindrical compressive strength of 25 N/mm<sup>2</sup> (3625 psi) at 28 days.

2. Slump: Adjust quantity of water so concrete at point and time of placing does not exceed the following slumps when tested according to ASTM C143. Use the minimum water necessary for workability required by part of structure being cast.

Slump Limit

Slump and Water/Cement Ratios		
Part of Structure	Maximum Slump	Maximum Water Cement Ratio
Footings, foundation walls, and mass concrete, not reinforced	100 mm	0.5
Slabs on grade, reinforced and non-reinforced	100 mm	0.45
Reinforced concrete over 200 mm thick	100 mm	0.5
Reinforced concrete 200 mm or less thick	100 mm	0.5
All other concrete	100 mm	0.5

If super-plasticizers are used, slumps may be 180 mm for all concrete, with water-cement ratio unchanged or lower than slumps without admixture.

3. Air Content: 5 to 8 percent.

### Source Quality Control

Refer to the following paragraphs for specific procedures. Concrete materials which, by previous tests or actual service, have shown conformance may be used without testing when so approved by the Engineer. Approved testing Laboratory performs following conformance tests:

1. Portland Cement: Furnish Mill Certificates, acceptable to the Engineer, showing conformance with requirements specified; otherwise, the Contractor's approved independent testing/inspection laboratory shall test cement in accordance with ASTM C150.

2. Aggregate For Normal Weight Concrete: Test the aggregate before and after concrete mix is designed and whenever character of aggregate varies or source of material is changed. Include a sieve analysis. Obtain samples of aggregates at the dry batching or ready-mix concrete plant in

accordance with ASTM D75 and perform tests for the following properties:

3. Lightweight Aggregates: Test the lightweight aggregates before mix is designed and whenever the character of aggregate varies or source is changed in accordance with ASTM C330. Include a sieve analysis and report on unit weights, deleterious substances, unburned or under-burned lumps, loss on ignition, soundness, and staining materials.

#### Materials

**A. Portland cement:** Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement as approved by Engineer.

Cement shall be free from any hardened lumps and foreign matter. It shall have a minimum of 90% of particles by weight passing the 75-micron sieve, an initial setting time in excess of 30 minutes and a final setting time of less than 7 hours.

Cement shall be stored in a waterproof shaded area. The cement stacks shall be placed at a minimum distance of 300mm from the walls. The damp proof floor shall be constructed by raising it minimum 300mm above the ground.

#### **B. Aggregates:**

1. Normal weight aggregates: ASTM C33.

2. Lightweight aggregates: ASTM C330, expanded shale type coarse aggregate, dry loose weight maximum 38 lbs. per cubic foot, maximum 9/16" size; all aggregate vacuum or thermally fully saturated for pumped concrete.

#### **C. Admixtures**

1. Chemical (Water Reducing) Admixture: ASTM C494, Type A, D, or E. Only one brand. When used, are subject to approval of the ENGINEER, and must reduce the mixing water at least 10% without entraining air in excess of 2% by volume. If the water reducing agent entrains more than 2% air, the water reduction shall be at least 12 %, but in no case shall the water reducing agent entrain air in excess of 4 %.

2. Air-entraining admix: ASTM C260.

3. Super-Plasticizers (High Range Water Reducers): ASTM C494, Type F or G. Master Builders "Rheobuild", Euclid "Eucon 37" or equal, capable of producing concrete which can be placed at 8-11" slump without segregation, capable of maintaining slump within 50 mm of that initially mixed for 2 hours, and of maintaining concrete temperature within 2°F. from time of batching for 2 hours minimum.

4. Concrete Waterproofing Admixture: Xypex Concentrate Admix C-1000 (standard set time) or C-2000 (extended set time), or approved equal that shall be of the cementitious crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the concrete. Use of waterproofing admixture shall be at locations specified per the Architectural drawings or schedules and shall follow all manufacturer recommendations for quantity and preparation.

**D. Water:** From potable domestic source. Water must be tested in an approved laboratory and deemed suitable for concrete, plaster, etc.

#### **E. Curing Materials:**

1. Liquid Curing compound: ASTM C309, Type I, Class B, W.R. Meadows 1100 Series, Master Builders "Mastercure W", or equal,

2. Curing sheet: ASTM C171, non-staining white types.

3. Evaporation retardant and finishing aid: Master Builders "Confilm", Euclid "Eucobar", or equal.

F. Vapor barrier: At typical locations use under slab vapor/methane membrane barrier as specified in Section 03106.

#### **G. Non-shrink grout:**



1. Pre-package, non-metallic, non-gaseous when tested in accordance with ASTM C117, Grade C at fluid (flow cone) consistency of 20- to 30- seconds. Grout shall attain 530 kg/m<sup>2</sup> compressive strength in 28-days at specified flow and shall not bleed. [Master Builders "Masterflow 928", Euclid Chemical Co. "Euco Hi-Flow Grout", L&M Construction Chemicals "Crystex"]

2. Epoxy grout where indicated: Multi-component, premeasured, fastcuring combination of thermosetting resins and inert fillers, [Master Builders "Ceilcote 648", Sikadur 42 Industrial Group-Pak by Sika Chemical Corporation, or Euclid "Euco High Strength Grout"].

H. Drypack: Field mixture of 1 part Portland cement to 2 parts fine aggregate mixed to a damp consistency such that a ball molded in the hands will stick together and hold its shape. At Contractor's option, the specified admixture may be added for increased workability at lower water/cement ratio. In lieu of field mixing, Contractor may use factory mixed drypack material, such as [Master Builders "SetGrout" or Euclid "Euco Dry Pack Grout"].

I. Expansion Joint Filler: Asphalt impregnated fiber or non-extruding foam type, conforming to ASTM D994 and D1751, or D1752.

J. Construction Joint Materials: "[Key-Kold]" or "[Kwik-Joint]", of profiles indicated.

K. Bonding Agent: "[Weld-Crete]", manufactured by , Master Builders "Concresive]", or equal.

L. Integral Color Concrete: As specified in Section [03331]

#### Concrete Mix Designs

Contractor's approved independent testing/inspection laboratory shall design concrete mixes for concrete requiring 28-day cylindrical compressive strength exceeding 25N/mm<sup>2</sup> (3625 psi). Mix designs shall be stamped and signed by the approved laboratory. Contractor shall bear all costs for concrete mix designs.

**1. Strength Requirements:** Design mixes for structural concrete for minimum 28-day compressive strengths required by Drawings and Specifications. All mix designs for structural concrete shall be proportioned in accordance with Section 3.9 of ACI 301. If trial batches are used, the mix design shall be prepared by an independent testing laboratory and shall achieve an average compressive strength 85 kg/cm<sup>2</sup> higher than the specified strength. This over-design shall be increased to 100 kg/cm<sup>2</sup> when concrete strengths over 350 kg/cm<sup>2</sup> are used.

Physical Properties, Units	Test Method	Minimum Values
Sieve Analysis	ASTM C136	
Organic Impurities	ASTM C40	Fine Aggregate not darker than reference standard colour
Soundness	ASTM C88	Loss after 5 cycles not more than 8% of coarse aggregate, nor more than 10% of fine aggregate
Abrasion	ASTM C131	Weight loss not more than 10.5% after 100 revolutions, 42% after 500 revolutions
Deleterious materials	ASTM C33	
Materials finer than No. 200 sieve	ASTM C117	Not over 1% for gravel, 1.5% for crushed aggregate
Reactivity potential	ASTM C227, C289, C342	Ratio of silica released to reduction in alkalinity not to exceed 1.0
Sand equivalent	ASTM D2419	California sand equivalent values operating range not below 71%

**2. Basis of Mix Designs:** Design all mixes for workability and durability of concrete. Control mixes in accordance with ACI 301. Make adjustments in water/cement ratios as necessary for required concrete strengths at the Contractor's expense. Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are not permitted.

**3. Maximum Aggregate Sizes:** Not exceeding 3/4 of minimum clear space between bars and between bars and forms, nor larger than 1/5 of least dimensions between the forms. Design the mixes with 1" maximum size, except maximum 38 mm size for foundations and maximum 10 mm size at congested reinforcing or thin sections, when approved by the Owner's Representative.

**4. Lightweight Structural Concrete:** Design for air-dry density of 1794 kg/m<sup>3</sup> maximum. With each mix design, include test reports showing that concrete covered by the mix design meets shrinkage test requirements specified under Article "Field Quality Control" herein, or include certified test reports showing conformance as furnished by ready-mix concrete manufacturer.

### **Delivery, Storage, and Handling**

A. Deliver all materials in timely manner to ensure uninterrupted progress of the Work.

B. Store materials by methods that prevent damage and permit ready access for inspection and identification.

#### **Project Site Conditions**

Do not place concrete during rain or adverse weather conditions without means to prevent all damage. Conform to requirements specified hereinafter whenever concrete placement is required during cold or hot weather.

#### **On-Site Batch Mixed Concrete**

On site batch mixed concrete shall be used only where designated and shall have characteristics and proportions of concrete ingredients conforming to those specified above.

Mixing time: Measure the mixing time after solid materials are in the mixer, provided that mixing water is introduced before a quarter of the mixing time has elapsed. Increase mixing time if necessary to obtain the required uniformity and consistence of concrete. Do not overmix such that additions of water are needed.

#### **3.1.2.7 Transport**

Transport and discharge the concrete without segregation.

Elapsed delivery time: Discharge truck mixed concrete within a time (t hours) determined as follows, where T is the temperature of the concrete in degrees Celsius:

$$t = 2 - 0.05T.$$

### **3.1.3 EXECUTION**

#### **3.1.3.1 Preparation For Concrete Placing**

A. Remove all free water from forms before concrete is deposited. Remove hardened concrete, debris, and foreign materials from interior surfaces of forms, exposed reinforcing, and from surfaces of mixing and conveying equipment.

B. Wet materials sufficiently to reduce adsorption and to help maintain concrete workability.

C. Earth Subgrade: Dampen 24 hours before placing concrete, but do not muddy. Re-roll where necessary for smoothness and remove loose material.

D. Gravel Fill: Recompact disturbed gravel and bring to correct elevation.

E. Sand Beds or Subslab Drainage Fill: Re-compact disturbed material and bring to correct elevation

F. Vapor Barrier: Install under interior floor slabs on grade. Lap joints 200 mm in the direction of concrete spreading and tape seal. Seal the joints at walls and around penetrations with tape.

G. Screeds: Set screeds at walls and maximum 2.4 m centers between. Set to provide level floor. Check with an instrument level, transit, or laser during placing operation to maintain level floor.

H. Screeds Over Vapor Barrier: Use weighted pad or cradle type screeds and do not drive stakes through the vapor barrier. Check with an instrument level, transit, or laser.

I. Metal Floor Decking: Verify that decking joints are sealed and there are no openings or voids that will permit concrete leakage.

J. Expansion Joint Filler: Install where slabs abut buildings and elsewhere as indicated. Install full depth of concrete with top level with finished surface of concrete.

### **3.1.3.2 Conveying and Placing**

Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Use placing methods which avoid segregation and loss of concrete, and which minimise plastic settlement. Maintain a generally vertical and plastic concrete edge at faces of a pour. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

Place concrete by methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading. Do not use rakes. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.

Do not place concrete until the reinforcing steel, forms, or metal decking have been approved. Do not use aluminum tubes or any aluminum equipment for pumping concrete, nor allow concrete to free fall from its point of release at mixer, hoppers, tremies, or conveying equipment more than 1.5 m for concealed concrete and 1 m for exposed concrete. Deposit concrete so that the surface is kept level throughout, a minimum being permitted to flow from one portion to another. Place concrete in horizontal layers not more than 450 mm thick within 45 minutes after water is first added to the batch. Place concrete by methods that prevent segregation of materials.

Exception: When using super-plasticizers, the free fall, horizontal layer thickness and time limitations may be doubled.

Where new concrete is placed against or on old or existing concrete, apply bonding agent to properly prepared surface of old concrete prior to placement of new concrete.

### **3.1.3.3 Joints In Concrete**

Locate joints only where approved, and obtain prior approval for points of stoppage of any pour. Clean and roughen the surface of construction joints by removing the entire surface and exposing 6.5 mm amplitude of clean aggregate solidly embedded in mortar matrix by chipping, use of an approved surface retarder, or equal. Water and keep hardened concrete wet for not less than 24 hours and slush with portland cement slurry just before placing joining concrete. Cover horizontal surfaces of existing or previously placed and hardened concrete with a 50 mm thick layer of fresh concrete less 50% of coarse aggregate just before balance of concrete is placed.

#### Construction Joints

Location: Do not relocate or eliminate construction joints, or make construction joints not shown on the drawings. If emergency construction joints are made necessary by unforeseen interruptions to the concrete pour, consult Engineer and submit a report on the action taken.

Joint preparation: Roughen and clean the hardened concrete joint surface. Remove loose or soft material, free water, and foreign matter. Dampen the surface just before placing the fresh concrete and coat with a neat cement slurry.

#### Expansion joints

Conform to details and approved submittal.

Preparation: Before filling, dry and clean the joint surfaces, and prime.

Joint filling: Fill with jointing materials. Finish visible jointing material neatly flush with adjoining surfaces except for those joints shown to be sealed with sealant.

Watertightness: Apply the jointing material so that joints subject to ingress of water are made watertight.

#### Control Joints

Provide for concrete slabs as indicated. At Contractor's option, "Soff-Cut" saw may be used to depth of 32 mm (1-1/4") immediately providing spalling or undercutting of the concrete does not occur, and in no case shall slab reinforcement be cut or damaged. Conventional saws shall be used as soon as possible without dislodging aggregate to ¼ slab thickness. Complete sawing of joints within 12 hours after finishing is completed. If early sawing causes undercutting or washing of the concrete, delay the sawing operation and repair the damaged areas. The saw cut shall not vary more than 13mm (1/2") from the true joint alignment. Discontinue sawing if a crack develops ahead of a saw cut. Immediately after each joint is sawed, thoroughly clean the saw cut and adjacent concrete surface. Respray surfaces treated with curing compound which are damaged during the sawing operations as soon as the water disappears. Protect joints in a manner to prevent the curing compound from entering the joints. Conform to approved submittal.

#### **3.1.3.4 Compaction**

Compact each layer of the concrete as placed with mechanical vibrators or equivalent equipment. Transmit vibration directly to concrete and in no case through the forms unless approved. Accomplish thorough compaction. Supplement by rodding or spading by hand adjacent to forms. Compact concrete into corners and angles of forms and around reinforcement and embedded fixtures. Re-compact deep sections with congestion due to reinforcing steel as required.

Layers: Place concrete in layers  $\leq 300$  mm thick, such that each succeeding layer is compacted before previous layer has taken initial set.

Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

Deposit and spread concrete in a continuous operation between transverse joints as far as possible.

Compact concrete using internal mechanical vibration of sufficient amplitude to produce noticeable vibrations at 300 mm radius. Insert vibrators into the concrete to the depth which will provide the best compaction, but not deeper than 50 mm above the surface of the subbase, and for a duration sufficient to produce satisfactory compaction, but not longer than 30 seconds in any one location.

#### Operation of Vibrators

Do not horizontally transport concrete in forms with vibrators nor allow vibrators to contact forms or reinforcing. Push vibrators vertically into the preceding layers that are still plastic and slowly withdraw, producing maximum obtainable density in concrete without creating voids or segregation. In no case disturb concrete that has partially set. Vibrate at intervals not exceeding two-thirds the effective visible vibration diameter of the submerged vibrator. Avoid excessive vibration that causes segregation. Use and type of vibrators shall conform to ACI 309 "Recommended Practice for Consolidation of Concrete".

Do not allow vibrators to come into contact with partially hardened concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the forms. Avoid over-vibration that may cause segregation.

Vertical elements: In vertical elements, limit the free fall of concrete to 1500 mm per 100 mm element thickness, up to a maximum free fall of 3000 mm, using enclosed vertical chutes or access hatches in forms.

Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

Deposit and spread concrete in a continuous operation between transverse joints as far as possible. If interrupted for more than 1/2 hour, place a construction joint.

#### Correction of Segregation

Before placing next layer of concrete, and at the top of last placement for vertical elements, remove concrete containing excess water or fine aggregate or showing deficiency of coarse aggregate and fill the space with compacted concrete of correct proportions.

#### **3.1.3.5 Waterproof Membranes**

Perform work adjacent to waterproof membranes to prevent damage to membranes. Arrange work so that membrane is left unprotected for minimum period of time, as approved. Prior to placing concrete, inspect the membrane and arrange for repair to all damage which may have occurred.

#### **3.1.3.6 Rain**

Do not expose concrete to rain before it has been placed and set.

#### **3.1.3.7 Slabs**

1. Float Finish: Place, consolidate, strike off and level concrete slab to proper elevation. Use highway straightedge, bull float or darby. Remove all bleed water. After the concrete has stiffened sufficiently to permit the operation, and water sheen has disappeared, the surface shall be floated, at least twice, to a uniform sandy texture.

2. On-Grade Slabs: Generally locate joints on column lines, exact locations as directed or approved. Submit joint locations and pour sequence for review and approval.

3. On-Grade Slab Construction and Contraction Joints: Use types as indicated at column lines intermediate locations.

#### **3.1.3.8 Cold Weather Provisions**

A. The guidelines of ACI 306R shall be followed when the Forecasted Mean Daily Temperature drops below 4°C for three consecutive days. The minimum concrete temperature when delivered at the site shall be in accordance with ACI 306R.

B. Normal Concrete: When the temperature is below 4°C, the temperature of the concrete placed in the forms shall be at least 10°C. When the temperature is below -1°C, the temperature of the concrete as mixed shall be 18°C. In all cases, when the daily average temperature is below 4°C, the concrete shall be kept at 10°C for the 72 hours and then allowed to drop uniformly to the air temperature over the next 24 hours.

Concrete temperature shall be measured by placing a thermometer 50 mm below the top of the concrete being placed.

C. Air-entrained concrete shall be kept at the above temperature for 27 hours and above freezing for an additional 72 hours.

D. No calcium chloride shall be used to accelerate hardening of concrete. Contractor to certify that any additive used does not contain calcium chloride.

E. If low temperature accelerating admixture is proposed, adjust concrete mix as required and obtain approval of Engineer.

F. All concrete materials, reinforcement, forming materials and ground with which concrete is to come in contact shall be free of frost.

G. The covering or other protection used in connection with the curing shall remain in place and intact for at least 24 hours.

H. The work shall be protected from the elements, flowing water, and defacements of any nature during the construction operations.

I. Conform to the provisions of ACI 306, Recommended Practice for Cold Weather Concreting, except as modified herein.

J. Subbase: Ensure that the subbase surface is free of frost.

K. If water or aggregate is heated above 38°C, the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 38°C.

L. Hot water may be added to the concrete on-site. A minimum of 70% mix-design water must be added at the batching plant. The water temperature may not exceed 60°C. Mixing must conform to ASTM C94 Section 11.

M. Concrete shall only be poured when the ambient temperature is rising.

N. All concrete shall be insulated from freezing for the greater of following:

1. 3 days

2. Until the concrete reaches an in-place compressive strength of 35 kg/cm<sup>2</sup>,

O. Metal formwork shall not be used in cold weather concrete.

P. All materials shall be free from frost.

#### **3.1.3.9 Hot Weather Provisions**

Conform to ACI 305R and the following requirements:

Take extra care to reduce the temperature of the concrete being placed, and to prevent rapid drying of newly placed concrete. When the outdoor ambient temperature is more than 32°C, shade the fresh concrete as soon as possible after placing, and start curing as soon as the surface of the fresh concrete is sufficiently hard to permit it without damage. Concrete placement temperatures shall be controlled by the Contractor and shall not be limited to:

1. Shading and cooling the aggregate;
2. Avoiding use of hot cement;
3. Cooling mixing water by additions of ice;
4. Insulating water supply lines and tanks; and
5. Insulating mixer drums or cooling them with sprays or wet burlap.
6. For mass concrete, i.e., concrete sections having a minimum dimension of 750mm or greater, the maximum acceptable concrete temperature is 21°C at time of discharge.
7. For other concrete structures, the maximum acceptable concrete temperature is 32°C at time of discharge.
8. Avoid premature stiffening of the mix and reduce water absorption and evaporation losses. If the temperature of the surrounding air is higher than 32°C:
  - Mix, transport, place and compact the concrete as rapidly as possible, and cover with an impervious membrane or hessian kept wet until moist curing begins.
  - Hold the concrete to a temperature < 32°C when placed.
9. If ice is used as part of the mixing water, mixing should be continued until the ice is completely melted.
10. Retempering shall not increase the water content above that in the mix design.

#### **3.1.3.10 Curing Formed Concrete**

Protect fresh concrete from premature drying and from excessively hot or cold temperatures. Maintain the concrete at a reasonably constant temperature with minimum moisture loss for the curing period.

Temperature: Maintain the concrete at a temperature above 5°C and below 32°C for at least 7 days.

Curing compound method: Spray the entire surface including edges using a mechanical sprayer, at a uniform application rate as per manufacturer's specifications. Respray defective areas within 30 minutes. Respray within 3 hours after heavy rain. Apply as a continuous coating without visible breaks or pinholes.

Covering sheet method: Immediately after finishing operations cover concrete using damp hessian or cotton mats overlapped at least 150 mm and anchored against displacement by wind or other interference. Keep the mats continuously damp until covered by the covering sheet material. Repair tears and the like immediately.

Joint sawing: Sheet materials may be removed for the minimum distance and period to permit joint sawing, provided the concrete is kept moist by other means.

Moist curing method: Immediately after finishing operations keep the concrete surface continuously damp by spraying constantly with water, fog, or mist, using suitable spraying equipment. In cold weather, only steam is allowed for curing.

Do not use any type of finishing or curing materials or methods that interfere with the correct application or bonding of subsequent materials; verify exact requirements as they apply to all applicable materials.

### 3.1.3.11 Patching Formed Concrete

A. Remove fins, projections, and offsets. Cut out rock pockets, honeycomb, and all other defects to sound concrete, with edges of cuts straight and back-beveled. Dampen cut-outs and edges, and scrub with neat Portland cement slurry just before patching, or apply an approved epoxy concrete adhesive.

B. Saturate form tie holes with water and fill voids and patches with flush smooth finished mortar of same mix as concrete (less coarse aggregate), cure, and dry.

### 3.1.3.12 Grouting and Drypacking

A. Install as indicated or required. Where grouting and drypacking is part of the work of other sections, it shall conform to the following requirements, as applicable.

B. Drypacking: Mix materials thoroughly with minimum amount of water. Install drypack by forcing and rodding to fill voids and provide complete bearing under plates. Finish exposed surfaces smooth and cure with damp burlap or liquid curing compound.

C. Non-Shrink Grouting:

Mixing: Mix the approved non-shrink grout material with sufficient water per manufacturers recommendations.

Application: Surfaces to receive the non-shrink grout shall be clean, and shall be moistened thoroughly immediately before placing the mortar. Before grouting, surfaces to be in contact shall be roughened and cleaned thoroughly, all loose particles shall be removed and the surface flushed thoroughly with neat cement grout immediately before the grouting mortar is placed. Place fluid grout from one side only and puddle, chain, or pump for complete filling of voids; do not remove the dams or forms until grout attains initial set. Finish exposed surfaces smooth, and cure as recommended by grout manufacturer.

### 3.1.3.13 Elapsed delivery time

General: Ensure that the elapsed time between the wetting of the mix and the discharge of the mix at the site is in conformance with the Elapsed delivery time table. Do not discharge below 10°C or above 32°C.

Elapsed Delivery Time Table (without admixtures)

Concrete temperature at time of discharge (°C)	Maximum elapsed time (hours)
10 – 24	2.00

Concrete temperature at time of discharge (°C)	Maximum elapsed time (hours)
24 – 27	1.50
27 – 30	1.00
30 – 32	0.75

#### 3.1.3.14 Finishing

Immediately after placement and spreading and compaction of the plastic concrete, start finishing operations to achieve finish shown on the drawings.

#### 3.1.3.15 Finishing Exposed Formed Concrete

Sack and patch as required to remove fins and correct errors.

#### 3.1.3.16 Tolerances

Allowable Tolerances: Construct concrete conforming to the tolerances specified in ACI 117 "Recommended Tolerances for Concrete Construction and Materials", as applicable, unless exceeded by requirements of regulatory agencies or otherwise indicated or specified. In exceptional cases, where corrections can be met by a subsequent sequence of work, the method must be approved by the Engineer prior to commencing work.

### 3.1.4 COMPLETION

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#### 3.1.4.1 Protection

Keep traffic, including construction plant, off the pavement entirely during curing, and thereafter permit access only to necessary constructional plant vehicles until the pavement is at least 14 days old.

#### 3.1.4.2 Traffic on pavement

General: Give notice before opening the pavement to traffic before the work is completed. Provide adequate means of protection.



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**3.8 STEELWORK PAINTING**

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**3.8.1 GENERAL**

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**3.8.1.1 Inspection**Notice

Give sufficient notice so that inspection may be made of the following:

- Surfaces after preparation prior to application of first coating.
- Coating after application of final coat.

**3.8.1.2 Samples**Painting and Coating Colour

Submit a sample of the finished product for each different coating system.

Size of each sample: 200 x 200 mm.

**3.8.2 PRODUCTS**

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**3.8.2.1 General**General

All protective coatings must be handled, stored, mixed and applied strictly in accordance with the manufacturer's instructions and Product Data Sheets.

**3.8.3 EXECUTION**

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**3.8.3.1 Protection**Surroundings

Provide protection of the surroundings to the coating works and ensure that no abrasive, overspray or paint waste debris is released either to air, ground or to any watercourse. Repair or clean damage as appropriate.

Contamination

Ensure protection of sensitive items during surface preparation and coating works. Do not permit surface preparation debris to contaminate coated surfaces which are not yet dry, nor cause damage to any other services or equipment.

Stacking and Handling

Do not stack, handle or transport coated items until the coating has sufficiently cured so as to resist handling actions.

Stack and handle all steelwork using fabric slings or padded chains, used in a manner that ensures that no damage is caused to the coating system. Adopt soft packaging, carpet strips or other deformable materials between all steel items. Do not permit steel to steel contact in any situation.

Water ponding: Stack coated items so that water ponding does not or cannot occur whilst the items are in storage, transport or “laydown”.

#### Repair of Coating Damage

If damage occurs repair so as to ensure that the full corrosion protection ability of the system is reinstated.

### **3.8.3.2 Surface Preparation**

#### General

Coatings shall be applied only to properly prepared and cleaned surfaces.

#### Surface Preparation

Ensure all surfaces are free from oil, grease, dirt, bird droppings or any other contaminants, particularly soluble contaminants.

Surface defects: Remove or correct other surface defects, including cracks, laminations, deep pitting, undercutting, weld spatter, slag, burrs, fins and sharp edges.

Remove all weld spatter by grinding or chipping.

#### Priming

Prime coat all surfaces with zinc rich primer on the same day as the completion of surface preparation works. In every case, the specified surface preparation standard, in both cleanliness and profile, shall be evident at the time that the primer coating is applied.

### **3.8.3.3 Coating application**

#### General

Apply the coatings in accordance with the **Interior and Exterior Painting** schedules.

#### Final Surface Preparation or Coating Application

Limits: If the following climatic/substrate conditions are present do not apply coating:

- The ambient air temperature is below 5°C or above 40°C.
- The substrate temperature is below 10°C or above 35°C.
- The surface to be coated is wet or damp.

Defects: Apply materials so as to produce an even coating free from film defects.

Detail: Stripe coat all welds, bolt holes, sharp edges and difficult to spray areas by brushing in with the prime coat and intermediate coat material prior to the full coating application.

#### Subsequent Coats

Ensure that before any subsequent coating layer is applied, the surface condition of the preceding coat is complete and correct in all respects, including its cleanliness and freedom from defects. Correct any defects before the next coating layer is applied.

**3.11 STRUCTURAL STEEL****3.11.1 GENERAL**

This section includes fabrication and erection of structural steel work, as shown on drawings including schedules, notes, and details showing size and location of members, typical connections, and types of steel required. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges" and as otherwise shown on drawings.

Related Sections: Refer to the following sections for related work:

3.1 Concrete Concrete General

3.8 Steelwork painting

3.10 Concrete Blockwork

**REFERENCES**

American Society of Testing and Materials (ASTM)

ASTM - A6: Specification for General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use

ASTM - A36: Specification for Structural Steel

ASTM - A53: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM - A307: Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile Strength

ASTM - A325: Specification for High-Strength Bolts for Structural Steel Joints

ASTM - A500: Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM - A501: Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

ASTM - E94: Guide for Radiographic Testing

ASTM - E142: Method for Controlling Quality of Radiographic Testing

ASTM - F959: Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

American Welding Society (AWS)

AWS - D1.1: Structural Welding Code - Steel

**3.11.1.1 Inspection**Notice

Give notice so that inspection may be made of steel framing before erection, lining or cladding.

**3.11.1.2 Submissions**Product Data:

Submit product data or manufacturer's specifications and installation instructions for the following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

- Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.

- Anchor bolts.
- Unfinished threaded fasteners.
- High-strength bolts (each type), including nuts and washers; include direct tension indicators if used.

Material Safety Data Sheets (MSDS):

Submit MSDS for structural steel (each type), anchor bolts, unfinished threaded fasteners, high-strength bolts (each type) including nuts and washers, structural steel primer paint and nonmetallic shrinkage-resistant grout.

Shop drawings:

Submit shop drawings, including complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.

- Include details of cuts, connections, cambers, holes and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld.
- Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.

Welder Certifications:

Provide certification that welders to be employed in work have satisfactorily passed qualification tests in accordance with AWS D1.1. If recertification of welders is required, retesting will be Contractor's responsibility.

Test reports:

Submit test reports conducted on shop- and field-bolted and welded connections. Include data on type(s) of tests conducted and test results.

Welding Procedures:

Provide written welding procedure specification (WPS) document per AWS Code requirements.

QUALITY ASSURANCE

*Codes and Standards:* Comply with provisions of the following, except as otherwise indicated:

- AISC "Code of Standard Practice for Steel Buildings and Bridges" with paragraph 4.2.1 modified by deletion of the following sentence: "This approval constitutes the owner's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as a part of his preparation of these shop drawings."
- AISC "Specifications for Structural Steel Buildings" including the "Commentary", later referred to as "AISC Specifications".
- ASTM A325 or A490 Bolts "Specifications for Structural Joints using".
- AWS D1.1
- ASTM A6

*Qualifications for Welding Work:* Qualify welding procedures and welding operators in accordance with the requirements of AWS D1.1.

All materials used shall not contain asbestos fibers.

DELIVERY, STORAGE, AND HANDLING

- Deliver materials to site at such intervals to ensure uninterrupted progress of work.
- Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time so that work will not be delayed.
- Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. If bolts and nuts become dry or rusty, clean and lubricate before use.

Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

### PROJECT CONDITIONS

*Field Measurements:* Check actual locations of walls and other construction to which steel framing must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings.

## **3.11.2 PRODUCTS**

### **3.11.2.1 Materials**

**Metal Surfaces, General:** For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and applying surface finishes.

**Structural Steel Shapes, Plates, and Bars:** ASTM A36

**Cold-Formed Steel Tubing:** ASTM A500, Grade B.

**Hot-Formed Steel Tubing:** ASTM A501.

**Steel Pipe:** ASTM A53, Type E or S, Grade B: or ASTM A501.

**Finish:** Black, except where indicated to be galvanized.

**Steel Castings:** ASTM A27, Grade 65-35, medium-strength carbon steel.

**Headed Stud-Type Shear Connectors:** ASTM A108, Grade 1015 or 1020, cold-finished carbon steel with dimensions complying with AISC Specifications.

**Anchor Bolts:** ASTM A307, nonheaded type unless otherwise indicated.

**Unfinished Threaded Fasteners:** ASTM A307, Grade A, regular low-carbon steel bolts and nuts; provide hexagonal heads and nuts for all connections.

**High-Strength Threaded Fasteners:** Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:

- Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325.
- Where indicated as galvanized, provide units that are zinc-coated, either mechanically deposited complying with ASTM B695, Class 50, or hot-dip galvanized complying with ASTM A153.

**Direct Tension Indicators:** ASTM F959, type as required; use at Contractor's option.

**Electrodes for Welding:** Comply with AWS Code.

**Structural Steel Primer Paint:** Red oxide, lead- and cadmium-free, corrosion-inhibiting primer complying with performance requirements of FS TT-P-664.

**Non-metallic Shrinkage-Resistant Grout:** Premixed, nonmetallic, noncorrosive, nonstaining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107 (formerly referenced as CE CRD C621).

Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

100 Non-Shrink Grout (Non-Metallic) - Conspec, Inc.

Crystex - L & M Construction Chemicals, Inc.

Euco N-S Grout - Euclid Chemical Co.

Kemset - Chem-Masters Corp.

SonogROUT - Sonneborn Building Products Div., Rexnord Chemical Products, Inc.

Supreme Grout - Cormix, Inc.

Sure-Grip High Performance Grout - Dayton Superior

Vibropruf #11 - Lambert Corp.

### **3.11.2.2 Fabrication**

#### Shop Fabrication and Assembly:

Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.

- Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.

- Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

#### Connections:

Weld or bolt shop connections, as indicated.

- Bolt field connections, except where welded connections or other connections are indicated.
- Provide high-strength threaded fasteners, unless otherwise indicated.

#### High-Strength Bolted Connections:

Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A325 or A490 Bolts".

#### Welded Construction:

Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.

#### Shear Connectors:

Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld shear connectors in field, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed stud shear connectors in accordance with manufacturer's printed instructions.

#### Steel Wall Framing:

Select members that are true and straight for fabrication of steel wall framing. Straighten as required to provide uniform, square, and true members in complete wall framing.

Build up welded door frames attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug-weld steel bar stops to frames, except where shown removable. Secure

removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches (25 cm) o.c., unless otherwise indicated.

#### Holes for Other Work:

Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on final shop drawings.

- Provide threaded nuts welded to framing and other specialty items as indicated to receive other work.
- Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

### **3.11.2.3 Shop Drawing**

#### General:

Shop-paint structural steel, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel that is partially exposed on exposed portions and initial 2 inches (51 mm) of embedded areas only.

- Do not paint surfaces to be welded or high-strength bolted with friction-type connections.
- Do not paint surfaces scheduled to receive sprayed-on fireproofing.
- Apply 2 coats of paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

#### Surface Preparation:

After inspection and before shipping, clean steelwork to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Clean steel in accordance with SSPC as follows:

SP-1 "Solvent Cleaning"

SP-2 "Hand-Tool Cleaning"

SP-3 "Power-Tool Cleaning"

#### Painting:

Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 3.0 mils. Use painting methods that result in full coverage of joints, corners, edges, and exposed surfaces. Refer to 3.8 Steelwork Painting and 6.6 Painting Sections for more details.

### **3.11.2.4 Source Quality Control**

Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements. Promptly remove and replace materials or fabricated components that do not comply.

## **3.11.3 EXECUTION**

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### **3.11.3.1 Erection**

#### Temporary Shoring and Bracing:

Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.

#### Anchor Bolts:

Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place work. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.

#### Setting Bases and Bearing Plates:

Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.

- Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.
- Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
- Pack grout solidly between bearing surfaces and bases or plates to insure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
- For proprietary grout materials, comply with manufacturer's instructions.

#### Field Assembly:

Set structural frames accurately to lines and elevations indicated and in accordance with AISC Specifications. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

- Level and plumb individual members of structures within specified AISC tolerances.
- Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- Splice members only where indicated and accepted on shop drawings.
- Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
- Do not enlarge unfair holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

#### Gas Cutting:

Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to the SDR. Finish gas-cut sections equal to a sheared appearance when permitted. Comply with NFPA 51B for cutting processes.

#### Touch-Up Painting:

Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

Apply by brush or spray to provide minimum dry film thickness of 3.0 mils.



### 3.11.3.2 Quality Control

Sandia National Laboratories (SNL) may engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.

- Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.
- Provide access for testing agency to places where structural steel work is being fabricated or produced so required inspection and testing can be accomplished.
- Testing agency may inspect structural steel at plant before shipment. SNL reserves the right, at any time before construction complete, to reject materials not complying with specified requirements.

Correct Deficiencies in structural steel work that inspections and laboratory test reports have indicated are not in compliance with requirements. Perform additional tests, at Contractor's expense, as necessary to reconfirm any noncompliance of original work and to show compliance of corrected work.

Shop-Bolted and Field-Bolted Connections: Inspect or test in accordance with AISC Specifications.

Verify that gaps of installed direct tension indicators are less than gaps specified in ASTM F959, Table 2.

Shop Welding and Field Welding: Inspect and test during fabrication for shop welding and during erection for field welding, of structural steel assemblies, as follows:

- Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

- Perform visual inspection of all welds.

- Perform tests up to and including 100% of welds at SNL's option. Inspection procedures may include the following:

a. Liquid Penetrant Inspection: ASTM E165.

b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not acceptable.

c. Radiographic Inspection: ASTM E94 and ASTM E142; minimum quality level "2-2T".

d. Ultrasonic Inspection: ASTM E164.

Acceptance criteria shall be as specified in AWS D1.1.

### 3.11.3.3 Completion

#### Cleaning

On completion of framing remove debris from any gaps between members.