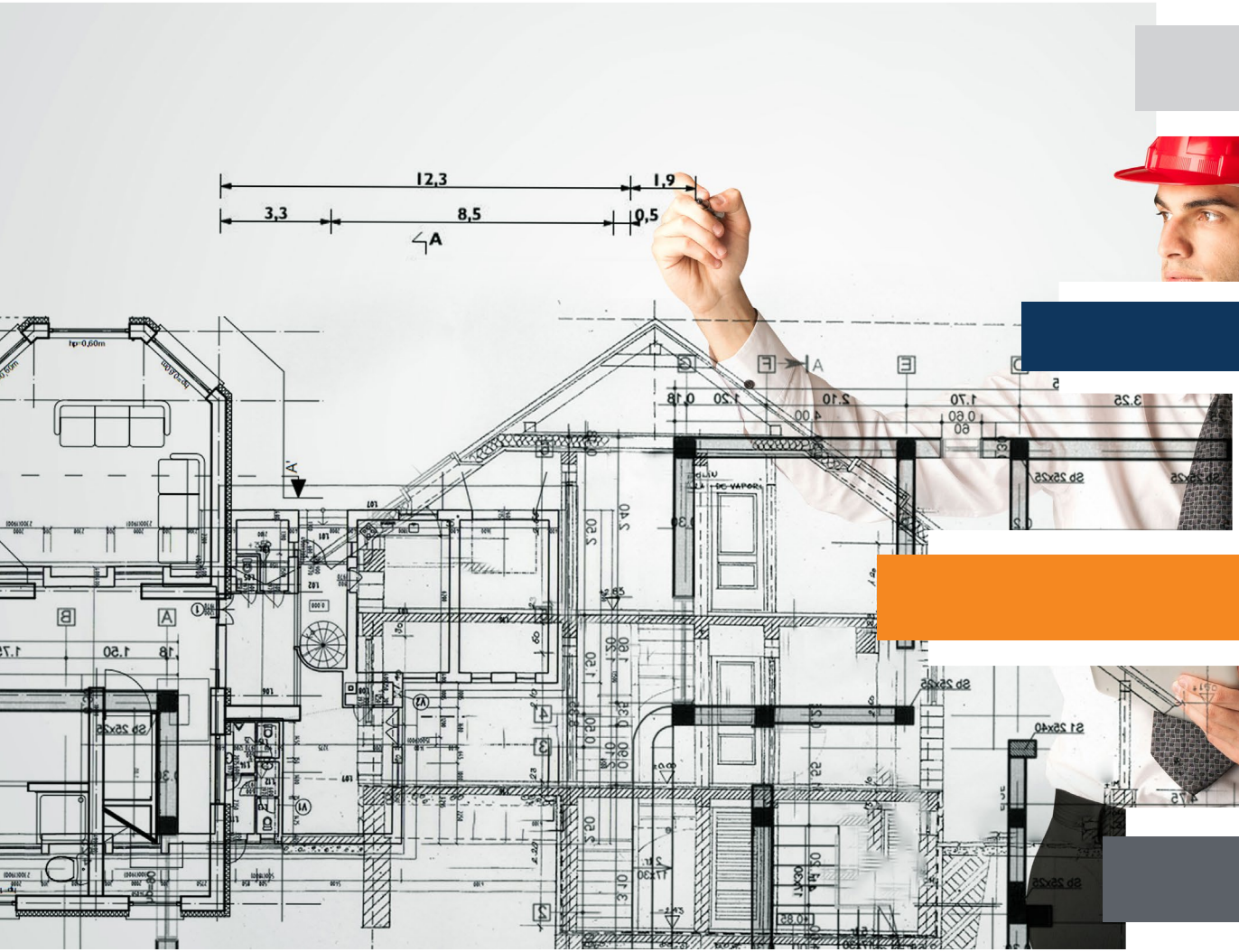
الدقم Duqm
المنطقة الاقتصادية الخاصة
Special Economic Zone
Sultanate of Oman سلطنة عُمان



STRUCTURAL
GUIDLINES / REGULATIONS
2022

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2022

DISCLAIMER

1. SEZAD Structural Guidelines here-in shall be applied to all building structures and are intended to provide minimum structural design requirements for building sub and super structures. Please refer to the applicable codes, standards and specifications for detailed technical guidance and requirements for project. SEZAD Structural Guidelines are not intended to be, nor should they be treated as being, legal advice.

2. The purpose of the SEZAD Structural Guidelines is to set down the basic principles governing the design of all building projects in SEZAD jurisdiction. The guidelines are aimed to give the design engineers a general idea of the basic requirements in designing the structures to comply with the SEZAD regulations and the relevant building codes. It is anticipated that the use of these guidelines will result in a uniform design and construction of buildings throughout projects in SEZAD jurisdiction.

3. SEZAD and its personnel shall bear no liability for providing No Objection/ Permit to any project; Contractor(s) & Consultant(s) will bear the full liability for errors in design, drafting, calculations, execution, stability and safety of the construction in accordance with the applicable codes, standards and

specification. The No Objection/Permit issued by the SEZAD shall not be construed as a recommendation or requirement to use any policy, material, product, process, system or application. The No Objection/Permit and inspections by the SEZAD and its personnel does not relieve the consultant(s) and / or the contractor(s) and / or specialist contractor(s) in any way from their obligations, duties, liabilities and responsibilities of the design and construction in accordance with applicable codes, standards and specifications.

4. Consultant and / or the contractor or any user of this publication will make their own determination as to the suitability and applicability of SEZAD Structural Guidelines for his or her purpose(s) prior to its use.

5. In no event will SEZAD and its personnel be responsible or liable for damages of any kind resulting from the use or reliance upon information or the policies, materials, products, systems or applications to which the information refers. In addition to and notwithstanding the foregoing, in no event shall SEZAD and its personnel be liable for any consequential or special damages or for any loss of profits incurred by the user or any third party in connection with or arising out of use or reliance of SEZAD Structural Guidelines.

CONTENT

Structural Guidelines/ Regulations

1

INTRODUCTION

SEZAD Structural Guidelines present technical advice and guidelines for the structural design of RCC and steel buildings, workshops, industrial buildings etc. within SEZAD jurisdiction. These guidelines shall be used in conjunction with other applicable codes, standards, specifications and related industry norms.

2 NOTATIONS

AASHTO
American Association of State Highway and Transportation Officials

AISC
American Institute of Steel Construction

ANSI
American National Standards Institute

ASCE
American Society of Civil Engineers

ASTM
American Society for Testing and Materials

Basic Wind Speed (V)
3-second gust speed at 10m above the ground – as per ASCE-7

BS
British Standards

CSI
Construction Specifications Institute

DD
Dead Load

$E_{x,y}$
Earthquake / Seismic Load in x / y direction

EN
European Standards

IBC
International Building Code

kN/m²
Kilo Newton of weight per unit square meter

kN/m³
Kilo Newton of weight per unit cubic meter

LL
Live Load

MPa
Mega Pascale (= N/mm^2)

MODES
Ministry of Defense Engineering Services

SDL
Superimposed Dead Load

SEZ Duqm
Special Economic Zone at Duqm

SEZAD
Special Economic Zone at Duqm

SQU
Sultan Qaboos University

SQU-EMC
Sultan Qaboos University - Earthquake Monitoring Center

WL
Wind Load

Ω_o
Seismic Force Amplification Factor, which is required to account for structural overstrength

ACI
American Concrete Institute

3

GENERAL PROVISIONS

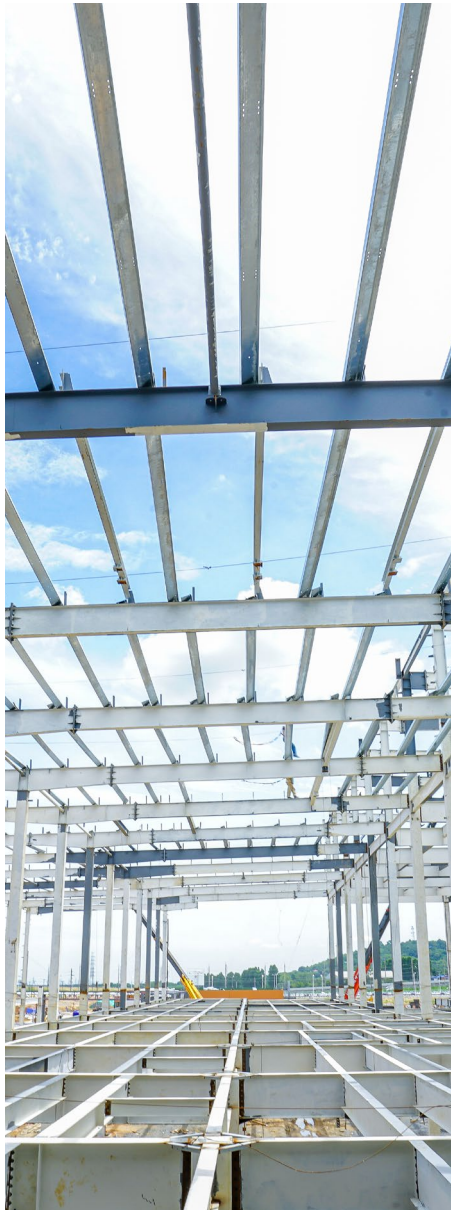
1. Structural Design shall be carried out by registered company in Sultanate of Oman that is permitted / licensed from concerned authority. Structural design by freelancers, un-licensed company, sub-contractors are not permitted.

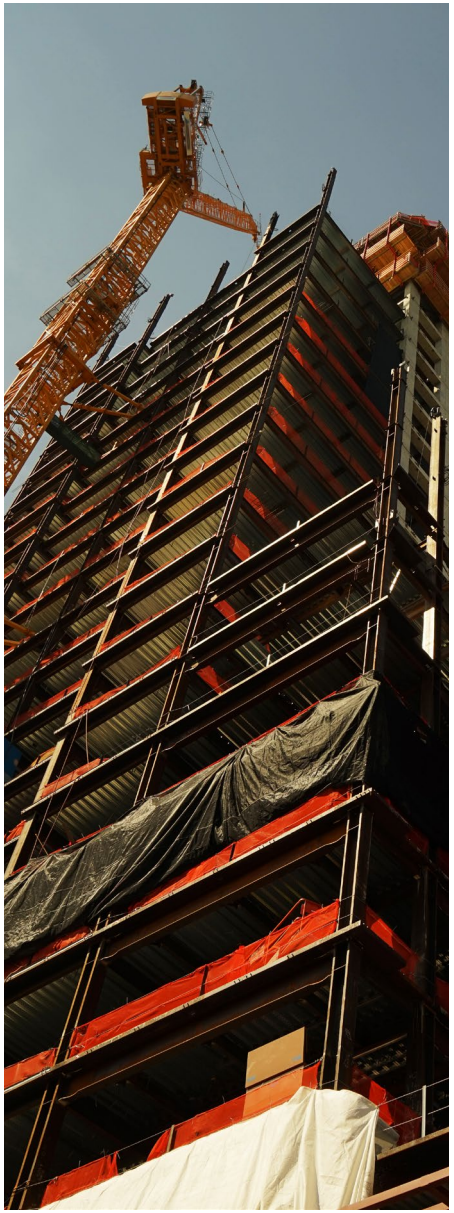
2. Geo-technical investigation study shall be carried out by registered company in Sultanate of Oman that is permitted / licensed from concerned authority and all test shall be carried out by registered laboratory.

3. All foreign consultants shall be registered in Sultanate of Oman and shall be authorized by the local concerned authorities to carry out the design services.

4. For joint-venture between local consultant and foreign consultant, all liabilities and responsibility will be borne by the local consultant.

5. For specialized design such as pre-stressing, pre-cast, steel structure, deep foundation, foundation improvement, shoring system, de-watering system; design shall be carried out by approved specialized consultant / contractor / supplier and design liability and responsibility shall be with the specialized consultant / contractor / supplier. This shall not relieve the main consultant in any way from their obligations, duties, liabilities and responsibilities of the design and construction in accordance with applicable codes, standards and specifications.





6 In-case, the structure is designed for phases and has a provision of additional floors in future; structure shall be designed for all floors (as per Krookie) and drawings for columns and foundation shall be submitted for all floors.

7 For any technical discussion and meetings with SEZAD, only qualified / approved and licensed Structural Engineer shall attend the meetings.

8 Consultant and / or contractor shall report any modification, revision, discrepancy, deficiency, failure in the works at site and any deviation from the approved drawings to SEZAD as soon as the issue arises and shall halt the said works unless SEZAD provide no objection.

9 In event of any failure, deficiency, defect in design and / or construction; site area shall be curtain-off and all personnel shall be evacuated from the site. No personnel shall enter the said site unless the site is inspected, repaired and declared safe to proceed and no objection is attained from SEZAD.

10 Consultant(s) and / or Contractor(s) and / or Sub-Contractor(s) and / or Supplier(s) shall ensure compliance of all comments, including instruction during inspection by SEZAD and / or any other concerned authority. Non-compliance of any comment will lead to suspension of work at site, without any obligation to SEZAD or its personnel.

11 SEZAD, without any prior notice, may cancel or suspend any or all kind of permits already issued if work is not carried out as per approved drawings, conditions or non-compliance of any legislation / requirement or if application / information provided contains any false information (including regarding capabilities, licenses etc.).

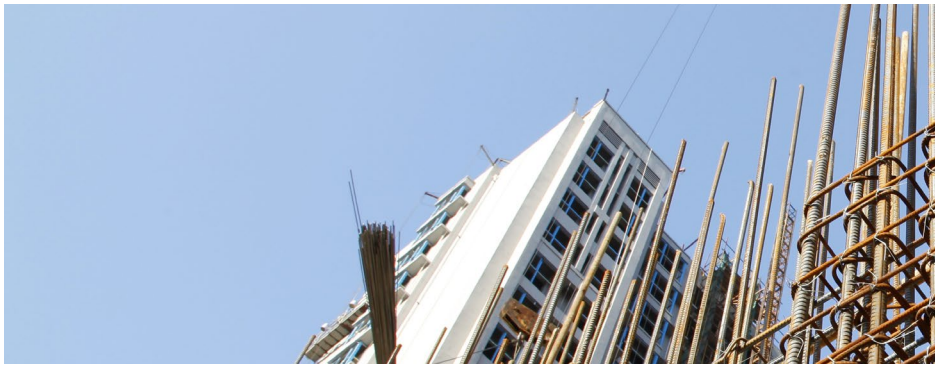
12 Consultant shall coordinate with all relevant authorities and carry out independent survey to identify all existing utilities, heritage site, grave yard etc and shall include the protection scheme or diversion for all utilities in the construction drawings and shall attain NOC from all relevant authorities before applying for permit. Contractor shall carry out protection or diversion of all existing utilities, heritage site, grave yard etc. as per scheme and specification within his own cost and shall attain NOC and approval from all relevant authorities.

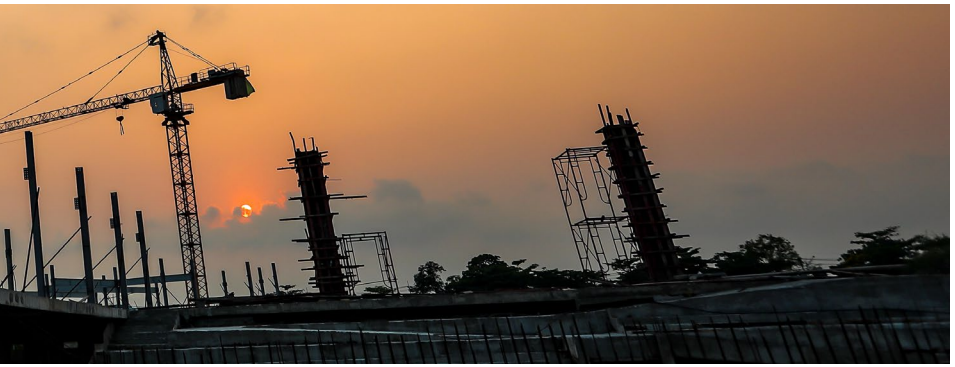
13 In-event of detection of any other existing utilities, heritage site, grave yard etc. during construction at site, contractor shall take all measures to protect it and shall coordinate with relevant authority for further action and NOC.

14 It is sole responsibility of consultant(s) and / or contractor(s) to coordinate with relevant authorities including SEZAD relevant departments and to identify all existing utilities, heritage site, grave yard etc. SEZAD is not liable to provide any drawing / document / information on any of utilities, heritage site, grave yard etc.

15 Consultant shall include the protection scheme of all adjacent / neighboring properties including infrastructure / utilities in the construction drawings before applying for permit. Contractor shall ensure the protection of all adjacent / neighboring / any affected properties including infrastructure / utilities and shall closely monitor for any hazard / damage to private and public properties. Contractor will be responsible for any damages to any private and public property due to his construction activities.

16 Contractor shall carry out all the works in accordance with safety precautions / regulations / practices including SEZAD HSE Regulations (SEZAD HSRS Manual) Contractor shall ensure safety of all private and public properties and personals.





17 Contractor shall secure and fence the construction site to limit the access to site to authorized personnel only.

18 All construction works including deep excavation, work at height shall be marked properly as per safety precautions / regulations / practices in order to inform passer-by regarding any hazard.

19 Construction site including excavation shall not be abandoned without taking precautionary measures and securing the adjacent properties. In event of any stoppage of work for any timeline, contractor shall intimate SEZAD with reasoning of stoppage and timeline. SEZAD will review the request as per lease agreement conditions and timeline for allotted for construction and timeline for operation and SEZAD have a right to reject the request.

4

STRUCTURAL SUBMISSION PROCEDURE

1. All Structural Drawings and Calculations shall be endorsed by licensed and approved Structural Consultant. Geo-technical investigation reports shall be endorsed by licensed and approved Geo-technical Consultant.

2. Structural Submission Package shall only be submitted after the approval of Site Plan, Elevations, Sections and Architectural drawings from SEZAD concern departments.

3. Licensed and approved Structural Engineer can be called for a meeting / discussion / presentation during review period on demand of SEZAD.

4. Structural Submission shall include, but not limited to, followings:
A. Geo-technical Investigation report shall include, but not limited to, followings:
- Geo-technical report shall endorsed by licensed and approved Geo-technical Consultant. A readable and clear endorsed PDF file of report shall be submitted through SEZAD Online Portal. If required, SEZAD will demand hard copy or native PDF file.
- Report shall contain information on the Project, Investor / Client, Plot Details and shall include the approved krookie.

- A soil investigation report shall carry out and shall include all physical and chemical tests on soil (including gypsum content), rock and ground water and any additional test necessary for the design and construction of the proposed project.
- General topography, regional geological set up, local geology and surface condition of the plot shall be mentioned.
- SBC, settlement and sub grade value calculation shall be provided. For mudstone/ clay, swelling test shall be conducted using consolidation cell for establishing swelling pressure /swelling percentage on undisturbed sample of soil.
- Tabulation of location of each borehole shall be recorded in plan, coordinates by Northing and Easting in coordinate system as per SEZAD Krookie.
- Design criteria including recommended Foundation system, allowable bearing capacity, modulus of sub-grade reaction and allowable settlement.
- Soil replacement / improvement (if required) along with the specification and methodology of engineering fill material.
- Provisions to mitigate the effects of expansive soils, Soil liquefaction, soil settlement and the effects of adjacent loads.
- Piles working load (in case of pile foundation) capacity under compression and tension for different sizes at varying depths and effective length. All levels shall be in Vertical Coordinate system as per SEZAD Ground Control Points.
- Values of Young's modulus (Es), horizontal modulus of sub-grade reactions (Kh), Constant of horizontal sub-grade reaction (nh), Vertical spring constants (Kv), Poisson's ratio, Piles stiffness (Ks),
- Soil parameters required for shoring and basement wall design such as average bulk density, angle of shearing resistance, cohesion, average coefficient of earth pressure at rest (Ko) and coefficient of active and passive pressure for different layers of soil profile.
- Soil classification, grain size distribution and overall soil profile.
- Permeability of the soil for varying layers.
- Subsurface profile based on boring showing cross-sectional view for all boreholes.
- Plan showing boreholes and in-situ test location along with coordinates by Northing and Easting in coordinate system as per SEZAD Krookie.
- The minimum number of Bore Holes (BH) & Trial Pits (TP) shall be

as below:

> Plot area upto 1000 sq m – 2 Bore Hole (BH), 2 Trial Pit (TP)

> Plot area more 1000 sq m - Additional to above 1 bore hole and 1 trial pit per 1000sm of area.

All bore holes shall be minimum 15m deep and 25 m deep if encounter soft ground, sabkha soil /mud stone /clay.

- If SILT or CLAY soils are encountered, Atterberg Limit & Hydrometer Tests shall be conducted and results shall be presented in report.
- Geotechnical report shall describe the likelihood and potential consequences of liquefaction and soil strength loss including estimate of differential settlement, lateral movement, lateral load, reduction in bearing capacity or any other geotechnical hazards.
- Ground Water table level and temperature.
- Laboratory test result on soil & ground water samples for the presence and concentration of P.H, Sulphate and Chloride or any other chemicals/ component that may affect the structure.
- Type of Cement based on the chemical test results of soil types.
- Complete borehole logs showing detailed record of soil strata, soil description, soil classification & RQD, TCR, SCR values to be provided.

B. Structural Drawings shall include, but not limited to, followings:

- Structural drawings shall be endorsed by licensed and approved Structural Consultant. A readable and clear endorsed PDF file (plotted in A1 size) of structural drawings shall be submitted through SEZAD Online Portal. If required, SEZAD will demand AutoCAD File or native PDF file or hard copy of drawings.
- Copy of approved drawings will be returned and shall be available at site during the course of construction and shall be presented to the SEZAD Personnel during any inspection.
- All dimensions in structural drawings shall be in metric system.
- All drawings shall be in Black and White colors.
- Logos and names of companies can be in color.
- All drawings shall have a revision numbers and first submission to SEZAD

GENERAL NOTES:

KEY PLAN:

SEZAD:

CLIENT/DEVELOPER:
[LOGO WITH NAME]

MAIN CONSULTANT:
[LOGO WITH NAME]

SPECIALIZED CONSULTANT:
(IN CASE NO SPECIALIZED CONSULTANT, THE BLOCK SHALL BE DELETED AND WHOLE TITLE BLOCK SHALL BE ADJUSTED)
[LOGO WITH NAME]

CONTRACTOR:
[LOGO WITH NAME]

PROJECT:
LINE 1
LINE 2
LINE 3

REV.	DATE	DESCRIPTION	DESIGNED	APPROVED
00	ABC	ISSUED FOR PERMIT	ABC	ABC

DRAWING NAME:
LINE 1
LINE 2

DRAWING NO.: ABC
SIZE: ABC
SCALE: ABC

KROOKIE No.: ABC
IRMS No.: ABC

PLOT No.: ABC
BLOCK No.: ABC
ZONE No.: ABC

Title Block

shall be marked as Rev. 00.

- Any modification / revision / addition / deletion in the approved drawings shall be marked with RED color cloud and shall have a revision mark next to cloud with brief description of revision. In-case of any subsequent revisions, previous revision marks and clouds shall persist in black and white color and a new revision numbers shall be given to latest revisions.
- Drawings shall mention the name of client / developer, project name, consultant(s) name, IRMS number, Krookie number and plot address. Refer Title Block templet herein.
- All drawings shall be marked as ISSUED FOR APPROVAL.
- Grid Layout drawing tied with coordinates as per SEZAD Control points shall be included.
- General Notes drawings shall include (but not limited to) concrete strength, cement type, reinforcing type, clear covers, loading criteria, design codes, foundation bearing capacity, removal of form works period, lap lengths, development lengths, water proofing, concrete protection etc.
- General Notes drawings shall also include (but not limited to) construction joint details, expansion joint details, water proofing details, block wall types and restraint details, water tank general details etc.
- Foundation drawings with (but not limited to) foundation locations, sizes, reinforcement, depth / level of foundation, and engineering fill (if required by geo-technical report) with reference to Geo-Technical Report.
- Column / Wall drawing with (but not limited to) column / wall locations, sizes, reinforcement, stirrups / ties / horizontal bars, lap locations and lap size.
- Floor plans with (but not limited to) slab outlines, openings, slab thickness, reinforcements, lap location and sizes, cambers (if required), beam calls, punching share details (if required), pick-up columns (if any), additional bars at openings.
- Beam details with (but not limited to) sizes, reinforcement, stirrups / ties, lap locations and size, face bars.
- Dewatering and earthworks detail including shoring system (if required).
- Stair details, ramp details, landscaping features details, fencing/boundary wall detail, roof protection details etc.

- Any drawing / detail deemed necessary for the purpose of review and approval and required by SEZAD.
- All structural drawings shall be on the title block shown herein and adjusted for different sheet size as per requirement.

C. Structural Calculation shall include, but not limited to, following:

- Structural calculation shall be endorsed by licensed and approved Structural Consultant. A readable and clear endorsed PDF file of structural calculation shall be submitted through SEZAD Online Portal.
- All calculation shall be in SI system of measurement.
- Design criteria including design philosophy, applicable codes, design loads including lateral loads, load combinations, description of structure, foundation type, lateral load resisting system, flooring system, material properties, durability requirement etc.
- 3D analysis model using finite element modeling software, concise inputs and outputs with loadings information, material properties / strengths, lateral loads parameters, sectional properties, load combinations, analysis results, forces, deflections / drifts, design-capacity ratio, stresses, reinforcement required, base share, consideration of discontinuity and vertical irregularities, torsional calculation, load combination, thermal loading and its effect, etc.
- 3D Model shall reflect the actual geometry of structure / building.
- Slab and foundation analysis and design shall be provided using Finite element modeling software and shall include loading information, material properties / strengths, deflection results, punching shear results, moments, reinforcement required, bearing pressure (in case of foundation) for foundations.
- Isolated footings calculation can be submitted using spreadsheets and shall include loading information, material properties / strengths, punching share results, moments, reinforcement required, bearing pressure, footing size.
- Any other calculation including model file shall be provided on demand of SEZAD without any delay.
- Any calculation deemed necessary for the purpose of review and approval.
- If required by SEZAD, qualified / approved and licensed Structural Engineer shall in person present the 3D model analyses and its design result in software to SEZAD.

5

APPLICABLE CODES & STANDARDS AND DESIGN & ANALYSIS SOFTWARE

1

Codes & Standards

Following internationally approved and recognized codes and standards shall be used:

- ACI
- Eurocode / European Standards (EN)
- British Standards (BS)
- ASCE
- IBC
- AISC
- Seismic Design Code for Buildings, Sultanate of Oman – SQU-EMC

The purpose of listing down sets of codes and standards is to ensure the consistent design practice. Consultant shall adopt the set of consistent codes throughout the design and construction phase. In-case of contradictory clause, consultant shall apply more onerous clause in design and construction.

Latest versions of the codes and standards shall be referred and applied in all occasions.

2

Design & Analysis Software

Following internationally approved and recognized software shall be used:

- ETABS
- SAFE
- SAP2000
- CSi Software (CSiCOL)
- STAAD
- MIDAS
- PROKON
- TEKLA

Latest licensed versions of software shall be used at all times. SEZAD can demand the proof of valid license of a software at any time. Consultant can request concerned department of SEZAD for the permission for the use of any other software. Request will be reviewed on case to case basis.

No in-house software / spread sheet will be acceptable.

6

STRUCTURAL DESIGN CRITERIA

1

Minimal Loading Criteria

Following loading criteria is minimal requirement and consultant shall ensure the use of all applicable / relevant actual loading as per requirement and codes / specifications.

A. Minimal Dead Loads

Dead loads consist of the weight of all materials of construction incorporated into the building including (but not limited to) self-weight of structure, walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and fixed service equipment including the weight of cranes.

Self-weight shall be calculated on the basis of actual weights of materials used in construction. Reinforced Concrete self-weight shall be used as minimum 25 kN/m^3.

Superimposed Dead Load shall be calculated on the basis of actual weight of material and actual thickness of finishes / cladding. In any case, SDL shall not be less then following:

- Partition Wall

200mm th. Normal Weight Hollow Block Works = 3.50 kN/m2
200mm th. Normal Weight Solid Block Works = 4.80 kN/m2
Light Weight Block Works=2.50 kN/m^2
False Ceiling and MEP Services = 0.60 kN/m^2
Minimum or as per Drawing
Dry Wall Partition=1.25 kN/m^2
In case of no partition, minimum load of 0.75 kN/m^2 for partition shall be considered.

- Floor Finishing

Upto 5cm Thick Finishing = 1.00 kN/m^2
Upto 10cm Thick Finishing = 2.00 kN/m^2
More than 10cm Thick Finishing = As per Specification
In case of no finishing, minimum load of 0.5 kN/m^2 for finishing shall be considered.

B. Minimal Live Loads

Live loads consist of loads produced by the use and occupancy of the building or other structure. Live loads on a roof shall also include the load of workers, equipment, and materials during operation and maintenance.

The live load shall be as per applicable codes (ASCE 7 or British / European Standard) / standards / specification and live loads used in the design of buildings and other structures shall be the maximum loads expected by the intended use or occupancy of structure but shall in no case be less than the minimum uniformly distributed unit loads mentioned here-in.

Occupancy / Use	Loads (kN/m²)
Residential Units	2.00
Residential Corridors and Public Areas	4.80
Staircases	4.80
Balconies	4.80
Accessible Roofs	1.50
Inaccessible Roofs	0.70
Gyms / Health Clubs	5.00
Ramps and Access Areas	5.00
Hotels (Private Rooms and Corridors Serving Them)	2.00
Hotels (Public Rooms and Corridors Serving Them)	4.80
Shopping / Commercial Area	5.00
Wholesale Area	6.00
Office Area	2.50
Office Corridors and Public Access	4.80
Dining Room / Restaurants	4.80

Occupancy / Use	Loads (kN/m²)
Recreational Areas (Equipment and Landscaping Load shall be as per actual calculation)	4.80
Hospitals – Operations Theaters and Laboratories (Equipment Load shall be as per actual calculation)	4.00
Hospitals – Private Rooms and Wards (Equipment Load shall be as per actual calculation)	2.50
School – Classrooms	3.00
School – Corridors	4.80
School – Library (Shall be verified as per actual calculation)	8.00
School – Assembly Area	5.00
School – Staged Area	7.20
Storage Area – Light	6.00
Storage Area – Heavy	12.00
Elevator Machine / Electrical / HVAC Room	As per Actual Calculation with min. of 7.50
Parking and Driveways	As per OHDS / AASHTO LRFD

Note Above mentioned Live Loads are minimal loads and shall be verified by actual calculation / codes / standards / specifications.

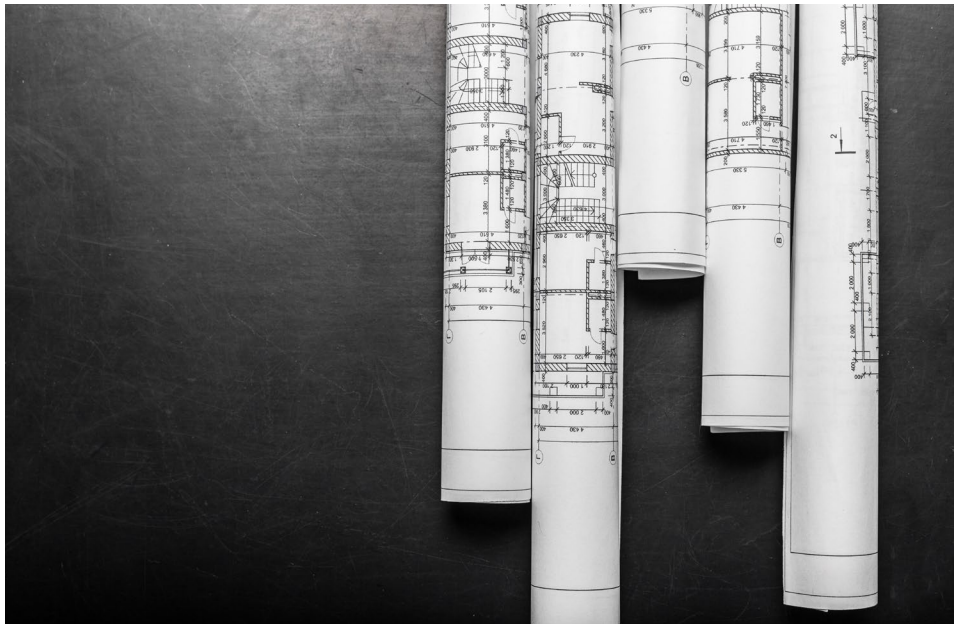
C. Wind Load

Basic Wind speed – a minimum of 55m/sec, 3 second gust measured at 10m height above the ground level shall be considered in all design. All structures shall be analyzed and designed on the basis of above-mentioned Basic Wind Speed in accordance with ASCE-7.

D. Seismic Load

Structures shall be analyzed and designed on the basis of study carried out by SQU-EMC. The probability of exceedance of the design level earthquake in 50 years in 10% which correspondence to return period of 475 years.

Values of the peak ground acceleration (PGA), and the short and long period horizontal response spectral accelerations (Ss at a Period of 0.2 sec and S_1 at a Period of 1 sec, respectively) shall be determined from Maps provided within Oman Highway Design Standards 2017 (OHDS-2017 or latest edition) and presented in publication "El-Hussain, I. et.al., Probabilistic and Deterministic Seismic Hazard Assessment for Sultanate of Oman (Phase 1), Sultan Qaboos University, Earthquake Monitoring Center, 2010".



- Importance factor (I), Ductility Factor (R) shall be as per applicable codes.
- Mass source shall be Self Weight of Structure + SDL + LL more than 4.8kN/m^2 + weight of permanent equipment.
- Soil Profile shall be as per Geo-technical Investigation Report.
- Dynamic Analysis shall be carried out as per applicable codes and standards.
- Minimum scale factor for response spectrum analysis to be 9.81/ R.
- Effects of vertical component of earthquake ground motion shall be considered according to applicable codes and standards adopted for analysis and design.
- Time period to be as per the provisions of the applicable codes and standards.
- Elements supporting discontinuous members of lateral load resisting systems shall be designed using the provisions of applicable codes and standards, with special seismic load combinations considering overstrength factor (Ωo).
- The damping ratio for seismic design to be considered is 5%.
- Structural irregularities shall be considered as per applicable codes and standards.

E. Thermal Loads

Structures shall be analyzed and designed to resist the thermal loading as per below:

- Seasonal variation of temperature for exposed area shall not be less than ± 25 °C.
- Seasonal variation of temperature for non-exposed area shall not be less than ±15 °C.
- Gradient temperature shall be considered for exposed area.
- Early thermal and shrinkage effect shall be considered.
- Long term shrinkage and creep effect shall be considered.

F. Lateral Soil Pressure

Structures shall be analyzed and designed to resist the lateral soil pressures plus surcharge loads and any other loads as per site conditions and calculation.

Lateral soil pressures shall be considered in seismic analysis and design.

G. Dynamic Load

Structures shall be analyzed and designed considering the weight and dynamic effect of equipment as per supplier / manufacturer specification and as per calculation.

2 Load Combinations

All structures, components, foundation etc. shall be designed in way that their design strength shall equals or exceed the effect of factored loads as per Load Combinations.

Load combination shall be as per applicable codes and shall be consistent throughout the project as per adopted design code. Use of load combinations from different code than design code is unacceptable.

3 Design Requirement

- All structures and components shall be designed on the basis of guidelines mentioned here-in and requirement of applicable codes, standards and specifications.
- All components of lateral force resisting system shall comply with the requirement of Lateral Force Resisting system as per applicable codes.
- Stirrups/ties shall meet the minimum requirement of applicable codes.
- Minimum diameter of reinforcing bars in structural slab shall not be less than 10mm and maximum spacing shall not be greater than 300mm.
- Minimum diameter of stirrups shall not be less than 10mm and maximum spacing shall not be greater than 300mm.
- Minimum diameter of main reinforcing bar in columns, beams and structural walls shall not be less than 12mm.
- The minimum percentage of reinforcement in column shall be 1% and the maximum shall not exceed 4%. (with exception of maximum of 8% at splice location).
- Ties in columns shall be arranged in such a way that every corner and alternate longitudinal bar shall have lateral support provided by the corner of a tie with an included angle of not more than 135° and no bar shall be farther than 200 mm on each side along the tie.
- Least dimension of column shall not be less than 200mm.
- Beam width shall not be less than 150mm.
- Slab thickness shall not be less than 150mm.
- Reinforcement for shrinkage and temperature shall be provided as per applicable codes.
- In-case, the structure is designed for phases and has a provision of additional floors in future, structure shall be designed for all floors (as per Krookie) and drawings for columns and foundation shall be for all floors.

4 Material Specification

Material used in construction including finishing shall be selected considering extreme weather and climatic condition of SEZ Duqm.

General specifications of work quality are available in numerous fields and are issued in publications of organizations such as the ASTM, ACI, ASCE, ANSI, CSI or equivalent British / European Standards. These general specifications must be suitably modified to reflect local weather, climatic conditions, site conditions, policies, available materials, local guidelines and other special circumstances.

All structural reinforcement shall be protected against corrosion that may impair the strength or serviceability of the structure. Proper concrete cover shall be provided to mitigate the corrosion and proper admixtures and / or water proofing system shall be adopted.

Steel members may deteriorate in particular adverse/aggressive environments. This deterioration may appear either in external corrosion, which would be visible upon inspection, or in undetected changes that would reduce its strength. The designer shall provide adequate protection systems such as epoxy coatings, cathodic protection and / or planned maintenance programs so that such problems do not occur.

In case of suspended projects or delaying of concrete casting of members, exposed steel must be protected.

7

DURABILITY AND PERFORMANCE CRITERIA

1

Durability

Following minimum criteria shall be met for durability of structures.

A. Concrete

• Concrete shall conform to ACI / ASTM or equivalent British / European Standard.

• Minimum 28 days cylindrical strength shall be as follows:

- Structural Slab / beam = 30 MPa
- Columns / Walls = 35 MPa
- Foundation = 30 MPa
- PCC = 15 MPa

• Minimum cement content and water / cement ratio shall be as per recommendation of soil investigation report / standard and design.

• Minimum concrete cover shall be as follows:

- Slab = 20 mm
- Beam = 40 mm
- Columns / Walls = 40mm
- Columns / Walls (in contact with earth / water) = 75 mm
- Foundation = 75 mm

• Aggregate shall be of normal weight with particle density greater than 2000 kg/m^3 but shall not exceed 3000 kg/m^3.

• Aggregate shall conform to the ASTM / BS codes in regards to material content.

• Maximum size of coarse aggregate shall be less than 20mm.

• Quality of water shall comply with ASTM / BS codes.

B. Reinforcement

• Reinforcing steel bar shall conform to ASTM A615 / BS 4449 latest version.

• Reinforcing steel bar shall be deformed high grade steel with minimum yield strength of 420 MPa.

• All reinforcing steel shall be free from rust, organic material, dust, oil, acids, paint or any other foreign material.

2

Performance Criteria

Following minimum performance criteria shall be met for all structures.

A. Fire Protection

• All structures shall be protected against fire as per Civil Defense requirement.

• Minimum Fire rating of structures shall be as follows:

- Columns / Walls = 4 h
- Beams / Slabs = 2 h

B. Design Life

Unless otherwise specified, minimum design life for structures shall be 50 years.

8

GEOTECHNICAL INVESTIGATION CRITERIA AND REQUIREMENT

1

Geo-Technical Investigation

• All soil / geotechnical investigation study shall be carried out by licensed registered company in Sultanate of Oman and all test shall be carried out by licensed registered laboratory and all reports shall be endorsed by licensed Geo-Technical Consultant.
• Geotechnical investigation shall include all physical and chemical tests on soil, rock and ground water and any additional test necessary for the design and construction of the proposed project.
• General topography of the site shall be mentioned and all levels shall be in Vertical Coordinate System as per SEZAD Ground Control Points.
• Tabulation of location of each borehole shall be recorded in plan. Northing and Easting coordinates shall be in coordinate system as per SEZAD Krookie.
• Appointed Laboratory shall conduct soil investigation strictly adhering to the procedures and recommendations illustrated in Local and International codes / guidelines / specification during the soil investigation operation with proper sampling and extraction of material.
• Standard Penetration Test (SPT) values to be obtained at 0.5m interval for initial 3.0m depth.
• Undisturbed core samples shall be taken where applicable and unconfined compressive strength test (UCS) to be carried out on all such samples.
• Geotechnical investigation report shall include, but not limited to, following:
- Sub soil condition and description.
- Recommended Foundation system, allowable bearing capacity / pile capacity, modulus of sub-grade reaction and allowable settlement.
- Piles working load capacity under compression and tension and effective length and minimum spacing between piles. All levels shall be in Vertical Coordinate System as per SEZAD Ground Control Points.
- Provisions to mitigate the effects of expansive soils, Soil liquefaction, soil settlement and the effects of adjacent loads.
- Likelihood and potential consequences of liquefaction and soil strength loss including estimate of differential settlement, lateral movement, lateral load, reduction in bearing capacity or any other geotechnical hazards.
- Seismic parameters, Young›s modulus (Es), horizontal modulus of sub-grade reactions (Kh), Constant of horizontal sub-grade reaction (nh), Vertical spring constants (Kv), Poisson's ratio, Piles stiffness (Ks), Soil parameters required for shoring and basement wall design including, but not limited to, average bulk density, angle of shearing resistance, cohesion, average coefficient of at rest (Ko) pressure and coefficient of active and passive pressure for different layers of soil profile.
- Soil classification, grain size distribution and overall soil profile.
- Permeability of the soil for varying layers.
- Plan showing boreholes and in-situ test location along with coordinates. Borehole logs showing Subsurface profile, water table, soil strata, soil

description, soil classification, RQD, TCR, SCR value.

- In case of presence of Silt or Clay is encountered, Atterberg Limit & Hydrometer Tests shall be conducted.
- Ground Water table.
- Type of cement, cement content, concrete cover, concrete protection including water proofing system based on the chemical test results of soil types and ground water.
- Laboratory test result of soil and ground water samples for the presence and concentration of P.H, Sulphate and Chloride or any other chemicals / component that may affect the durability and life of structure.

• Final data of geo-technical study shall be submitted to SEZAD in CAD files and GIS files. Northing and Easting coordinates shall be in Coordinate System as per SEZAD Krookie and all levels shall be in Vertical Coordinate System as per SEZAD Ground Control Points.

2 Open Excavation

• All excavation shall be carried out within the plot boundary. For any Excavation outside plot boundary NOC shall be attained from SEZAD, all concerned authorities and plot owner.
• Angle of inclinations for all open excavation shall be as per Soil Investigation report.
• All excavations and slopes shall be continuously monitored.
• All adjacent / neighboring infrastructure, utilities, properties, structures shall be protected and continuously monitored for any damages / settlement.
• In-event of any damage / settlement to adjacent / neighboring infrastructure, utilities, properties, structures; contractor shall rectify all damages at his expense upto the satisfaction of SEZAD, other authorities and owner.
• All excavation shall be fenced and barricaded from public access.

3 Shoring System

• Shoring systems are temporary structures deemed to perform satisfactorily for a period of less than two years.
• All adjacent / neighboring infrastructure, utilities, properties, structures shall be protected.
• All shoring works shall be carried out within the plot boundary. For any works outside plot boundary NOC shall be attained from SEZAD, all concerned authorities and plot owner.
• All shoring works shall be designed and carried out by specialist licensed contractor and all drawings and design calculations shall be submitted to SEZAD for NOC prior to any work.
• Shoring system shall be design while considering staged construction.
• In event of anchors in shoring system, approval / NOC shall be attained from SEZAD, related authorities and affected plot owner prior to installation of anchors.
• Anchorage system shall be design in such a way as not to damage / effect any infrastructure, utilities, structure.
• All shoring system shall be closely monitored and actual deflections and other parameters shall be recorded and maintained at site by specialist contractors. In-event of any issue, immediate corrective actions shall be taken by specialist contractor with coordination of main consultant and shall be reported to SEZAD, related authorities and affected owner without any delay.
• Potential risk due to liquefaction shall be considered during design of shoring system especially in areas with high water table and reclaimed areas.
• Surcharge load of construction vehicle / equipment / usage of adjacent infrastructure / property shall be considered in design of shoring system. surcharge loads shall be as per the actual calculations with provision of upcoming development.
• Heavy equipment movement, loading, unloading and storage of

materials shall be done so as not to impair the structural stability of the shoring system.
• De-stressing of anchors shall be done only after the written approval from the main consultant.
• Dewatering shall be stopped only after the written approval from the main consultant.

4 **Engineering Fill / Backfill Material and Compaction**

• Engineering Fill / Backfill Material shall be as per Geo-technical report.
• Minimum requirement of Engineering Fill / Backfill material is it material shall be composed of sand / granular mix inorganic in nature and free from organic material, debris, clay, gypsum, salts or any contaminations.
• It shall be uniformly well graded soil with maximum particle size of 70mm.
• The plasticity index shall not be greater than 10% and Liquid limit shall not be greater than 25%.
• Water soluble salt content shall not be greater than 5%.
• The fill material shall be placed layers not exceeding 150mm thickness and shall be compacted to not less than 95% of maximum dry density.

5 **Dewatering**

• Dewatering shall be done as per SEZAD Environmental Department requirements and approval.
• Care shall be taken while dewatering to avoid any settlement of adjacent ground and structures.
• Care shall be taken while dewatering to avoid any disturbance to natural ground water table of area.
• Dewatering system shall be within plot boundary.
• All dewatering works shall be designed and carried out by specialist licensed contractor and all drawings and calculations shall be submitted to SEZAD for NOC prior to any work.

6 **Shallow Foundation Design Criteria**

• Foundation shall be minimum 1.00m below the natural ground level.
• Foundation shall be placed on leveled and compacted soil greater than 95% of maximum dry density.
• In-case of fractured or loose soil, minimum 1.00m earth below foundation level shall be replaced with engineered fill as per geo-technical recommendation.
•Foundation shall be design for both gravity and lateral loads against net allowable bearing pressure as per geo-technical investigation report.
• Total allowable settlement shall be as per applicable codes.
• Cement type and cement content and concrete cover shall be as per soil investigation report and shall follow recommendation considering chemical analysis of soil and ground water.
• Foundation recommendation shall ensure adequate safety factors

against all factors including uplift, expansion of soil etc.

7

Pile Foundation Design Criteria

• Pile load capacity shall be as per geo-technical investigation report.
• Geo-technical report shall propose the suitable type of pile with allowable working loads in compression and tension considering minimum safety factor of 2.5.
• Minimum pile spacing shall be 2.5 times pile diameter or as per geo-technical report.
• Minimum percentage of reinforcement to be provided for the full length of the piles to provide ductility.
• Piles shall be designed for both gravity and lateral loads.
• Pile shall be design with minimum Horizontal force not less than 5% of pile capacity.
• Piles shall be designed for out of verticality of 1/75.
• Piles shall be designed for Out of position of 75mm.
• Crack width for tension piles shall be less than 0.10 mm and 0.20 mm due to lateral loads.
• Minimum 6 number of vertical bars shall be provided in piles and shall be spaced evenly around.
• Minimum vertical bar size shall be 12mm.
• Minimum stirrup diameter shall be 10mm.

9 SUPERVISION

1. All project shall appoint consultant for supervision of the works.
2. Consultant shall be responsible to supervise all construction activities including (but not limited to) soil investigation, preparatory works, earth works, permanent works.
3. Consultant shall appoint licensed and qualified supervision team to perform the supervision activities.
4. Consultant can designate the supervision of specialized works (e.g. Shoring, Piling, pre-stressing works) to the specialized consultant.
5. Consultant shall ensure all permits, NOCs, approved drawings, documents shall be present at site and shall be produced to authority during any inspection / visit.
6. In-case of failure to present the permits, NOC, approved drawings, documents; SEZAD can stop the work at site without any prior notice or warning.
7. SEZAD or any other authority representative can inspect / visit the site without any prior notice during any time.
8. In event of non-compliance of approved drawings, conditions of permits / NOCs; SEZAD can stop the work at site without any prior notice or warning.
9. Consultant shall ensure complete access to full site and all permits, NOCs, drawings, documents to SEZAD representative.
10. SEZAD representative may instruct any additional tests to ensure quality of works at any time. Consultant shall be responsible to follow the instruction and ensure collection of sample (including core cutting) and testing and presentation of results to SEZAD. Testing shall be carried out by 3rd part labs.
11. All works shall follow the regulatory and compliance requirement of SEZAD.
12. Consultant shall supervise the followings (including but not limited to) works:
    - Geo-technical investigation works,
    - Shoring works,
    - Piling works,
    - Excavation and earthworks, including soil replacement / improvement.
    - All Reinforcement & Concrete Works,
    - All Steel Structures Works,
    - Finishing works,
    - Landscaping works,
    - Paint works.
13. Consultant shall ensure all activities shall be as per approved drawings, SEZAD guidelines / regulations, conditions of permits by SEZAD and / or any other authority and as per construction specifications.
14. No construction activity shall occur without the presence of supervision consultant representative.
15. Engineer(s) and representatives of Consultant, Main Contractor and Specialist Contractor should be available at all times during the concrete pour.
16. Consultant supervision engineer shall ensure the sample collection of all materials (soil replacement / improvement, concrete, reinforcement, pre-stressing cables etc) for testing and all test results shall be available at site all the time and shall be presented to SEZAD on demand.

17 All construction activities and inspections shall be recorded and shall be presented to SEZAD on demand.

18 Request for Inspection (RFI) shall be submitted to SEZAD atleast two (2) days prior to any concreting. RFI forms shall be as per SEZAD compliance templets.

19 Consultant shall ensure record of any deviation during execution from approved drawings and shall prepare the as-built drawing and shall submit to SEZAD before applying for completion certificate.

20 Consultant shall ensure all the activities at site conforms to Health & Safety Regulation & Standards Manual and ensure high quality standards.

21 In event of any violation of SEZAD regulatory compliance requirement, consultant and contactor can be fined as per SEZAD policy.