CONSTRUCTION SPECIFICATIONS

GROUND + 2 FLOORS RESIDENTIAL BUILDING

KINGDOM OF SAUDI ARABIA

PROJECT TITLE: Al-Nakheel Residential Complex - Building A
PROJECT LOCATION: Riyadh, Kingdom of Saudi Arabia
CLIENT: Al-Mashriq Real Estate Development Company
CONSULTANT: Gulf Engineering Consultancy LLC
PROJECT TYPE: Residential Building (Ground + 2 Floors)
TOTAL BUILT-UP AREA: 2,400 m^2
PLOT AREA: 800 m^2

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1. GENERAL REQUIREMENTS

1.1 PROJECT OVERVIEW

The project consists of the construction of a three-story residential building (Ground + 2 floors) located in Riyadh, Kingdom of Saudi Arabia. The building will accommodate 12 residential units with associated parking, landscaping, and infrastructure facilities.

Building Details:

- Ground Floor: 6 units (2-bedroom apartments)

- First Floor: 3 units (3-bedroom apartments)
- Second Floor: 3 units (3-bedroom apartments)
- Total Units: 12 residential apartments
- Parking: 24 covered parking spaces
- Built-up Area per Floor: 800 m^2
- Total Built-up Area: 2,400 m^2

1.2 CLIMATIC CONDITIONS

The contractor shall design and execute all works considering the harsh desert climate of Saudi Arabia:

- Summer temperatures: 35°C to 50°C
- Winter temperatures: 5°C to 25°C
- Relative humidity: 10% to 60%
- Sandstorms and dust conditions
- Minimal rainfall (average 100mm annually)
- High UV radiation levels
- Prevailing winds from northwest

1.3 STANDARDS AND REGULATIONS

All works shall comply with:

- Saudi Building Code (SBC)
- Saudi Standards, Metrology and Quality Organization (SASO)
- Municipality of Riyadh regulations
- Saudi Electricity Company (SEC) standards
- National Water Company standards
- Saudi Civil Defense requirements
- Occupational Safety and Health Administration (OSHA) guidelines
- International standards where specifically referenced

1.4 MATERIALS AND WORKMANSHIP

1.4.1 General Requirements

- All materials shall be new, of best commercial quality, and suitable for Saudi climatic conditions
- Materials shall bear appropriate quality marks and certifications
- All imported materials require SASO conformity certificates
- Substitution of specified materials requires written approval
- All workmanship shall be executed by qualified craftsmen

1.4.2 Material Storage and Handling

- Materials shall be stored in weatherproof conditions
- Cement and steel reinforcement require covered storage
- Sensitive materials protected from dust and extreme temperatures
- Proper handling equipment and procedures mandatory
- Material testing certificates maintained on-site

1.5 CONTRACTOR RESPONSIBILITIES

1.5.1 General Obligations

- Obtain all necessary permits and approvals
- Provide temporary utilities during construction
- Maintain site security 24/7
- Implement comprehensive safety program
- Coordinate with utility providers
- Submit method statements for all major activities
- Provide as-built drawings upon completion

1.5.2 Insurance and Bonds

- Comprehensive general liability insurance
- Professional indemnity insurance
- Workmen compensation coverage
- Performance bond (10% of contract value)
- Advance payment guarantee if applicable
- Retention bond for warranty period

1.6 PERMITS AND APPROVALS

The contractor shall obtain:

- Building permit from Riyadh Municipality
- Civil Defense approval
- Electricity connection permit from SEC
- Water and sewerage connection permits
- Environmental clearance
- Occupancy certificate upon completion

1.7 UTILITIES DURING CONSTRUCTION

1.7.1 Temporary Electricity

- Coordinate with SEC for temporary supply
- Install proper distribution system
- Provide adequate lighting for night work
- Emergency power backup for critical operations

1.7.2 Temporary Water Supply

- Arrange potable water for construction and workforce
- Install temporary plumbing for site offices
- Water storage tanks with adequate capacity
- Waste water disposal system

1.7.3 Telecommunications

- Temporary telephone connections
- Internet connectivity for project management
- Radio communication system for site coordination

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2. SCOPE OF WORK

2.1 OVERALL PROJECT SCOPE

The contractor shall provide all labor, materials, equipment, and services necessary for the complete construction of a G+2 residential building including but not limited to:

2.1.1 Site Preparation and Infrastructure

- Site clearing and leveling

- Excavation and backfilling
- Utility connections and infrastructure
- Temporary facilities construction
- Access roads and site fencing

2.1.2 Structural Works

- Foundation systems including piles if required
- Reinforced concrete structure for all floors
- Masonry walls and partitions
- Roof structure and waterproofing
- Structural steel works where specified

2.1.3 Architectural Works

- All finishes for floors, walls, and ceilings
- Doors, windows, and glazing systems
- Built-in furniture and fixtures
- Painting and decorative works
- Signage and wayfinding systems

2.1.4 Mechanical Systems

- HVAC systems for all spaces
- Plumbing and sanitary installations
- Fire fighting and life safety systems
- Kitchen and laundry equipment connections
- Mechanical ventilation systems

2.1.5 Electrical Systems

- Power distribution and lighting
- Telecommunications and data systems
- Security and access control systems
- Fire alarm and detection systems
- Lightning protection systems

2.1.6 External Works

- Landscaping and irrigation
- Parking areas and driveways
- External lighting and utilities
- Boundary walls and gates
- Swimming pool and recreational facilities

2.2 EXCLUSIONS FROM SCOPE

The following items are specifically excluded:

- Furniture (except built-in items)
- Appliances (except those specified)
- Decorative items and artwork
- Satellite dish installations
- Solar panel systems (unless specified)

2.3 PHASING AND SEQUENCING

2.3.1 Phase 1: Site Preparation (Weeks 1-4)

- Site mobilization and setup
- Demolition of existing structures
- Site clearing and excavation
- Utility diversions and connections

2.3.2 Phase 2: Structural Works (Weeks 5-20)

- Foundation construction
- Ground floor structure
- First floor structure
- Second floor structure
- Roof construction

2.3.3 Phase 3: Building Envelope (Weeks 16-28)

- External walls and insulation
- Windows and doors installation
- Roof waterproofing
- External finishes

2.3.4 Phase 4: MEP Systems (Weeks 20-36)

- Mechanical systems installation
- Electrical systems installation
- Plumbing installation
- Fire safety systems

2.3.5 Phase 5: Internal Finishes (Weeks 30-44)

- Internal walls and partitions
- Floor finishes
- Wall finishes and painting
- Ceiling works
- Built-in furniture

2.3.6 Phase 6: External Works (Weeks 40-48)

- Landscaping and irrigation
- Parking and driveways
- External lighting
- Site facilities

2.3.7 Phase 7: Testing and Commissioning (Weeks 46-52)

- Systems testing and commissioning
- Authorities approvals
- Final inspections
- Handover preparations

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3. ARCHITECTURAL WORKS

3.1 GENERAL ARCHITECTURAL REQUIREMENTS

3.1.1 Design Philosophy

The architectural design shall reflect contemporary Saudi residential architecture incorporating:

- Climate-responsive design principles
- Energy-efficient building envelope
- Cultural and religious considerations

- Privacy requirements for residential units
- Optimal natural lighting and ventilation
- Barrier-free accessibility compliance

3.1.2 Space Planning

Ground Floor:

- Unit Type A: 2-bedroom apartments (65 m^2 each) - 6 units
- Central lobby and staircase
- Utility rooms and storage
- Covered parking areas

First Floor:

- Unit Type B: 3-bedroom apartments (90 m^2 each) - 3 units
- Central corridor and staircase
- Laundry rooms
- Terraces and balconies

Second Floor:

- Unit Type C: 3-bedroom apartments (90 m^2 each) - 3 units
- Central corridor and staircase
- Roof access
- Terraces and balconies

3.2 EXTERNAL WALLS AND FACADES

3.2.1 External Wall Construction

Load-bearing Walls:

- 200mm reinforced concrete block units
- Integral waterproofing admixture
- Horizontal and vertical reinforcement as per structural drawings
- Mortar: 1:4 cement sand mixture

Cavity Wall System:

- External leaf: 100mm concrete blocks
- Insulation: 75mm rigid polyurethane foam boards

- Air gap: 25mm ventilated cavity
- Internal leaf: 150mm concrete blocks
- Total wall thickness: 350mm

3.2.2 Thermal Insulation

Insulation Requirements:

- External walls: R-value minimum 2.5 m^2K/W
- Roof: R-value minimum 3.5 m^2K/W
- Ground floor: R-value minimum 1.5 m^2K/W
- Material: Extruded polystyrene (XPS) or polyurethane foam
- Continuous insulation layer without thermal bridges

3.2.3 External Finishes

Stone Cladding (Ground Floor):

- Natural limestone blocks, 40mm thick
- Honed finish with anti-slip surface
- Mechanical fixing system with stainless steel anchors
- Color: Riyadh beige to match local architecture
- Joints: 10mm sealed with weather-resistant sealant

Painted Render (Upper Floors):

- Base coat: Cement-based render, 15mm thick
- Intermediate coat: Acrylic-based leveling compound
- Finish coat: Elastomeric paint system
- Color: Sand beige (approved color chart)
- Texture: Fine aggregate finish

3.2.4 Architectural Features

Mashrabiya Screens:

- Laser-cut aluminum panels
- Traditional geometric patterns
- Powder-coated finish: Bronze metallic
- Function: Solar shading and privacy

- Locations: All bedroom and living room windows

Decorative Elements:

- Cast stone cornices and moldings
- Geometric patterns reflecting Islamic architecture
- LED strip lighting integration for night illumination
- Water-resistant and UV-stable materials

3.3 WINDOWS AND GLAZING

3.3.1 Window Systems

Material and Construction:

- Thermal break aluminum frames
- Multi-chamber design for thermal efficiency
- Powder-coated finish: Bronze color
- Hardware: Stainless steel, corrosion-resistant
- Weather sealing: EPDM gaskets throughout

Performance Requirements:

- Air infiltration: Maximum 0.5 $m^3/h.m^2$ at 50 Pa
- Water penetration: No leakage at 600 Pa pressure
- Wind load resistance: As per structural calculations
- Thermal transmittance (U-value): Maximum 2.5 W/m^2K

3.3.2 Glazing Specifications

Double Glazed Units:

- Outer pane: 6mm low-E coated glass
- Inner pane: 6mm clear float glass
- Air gap: 12mm argon-filled cavity
- Spacer: Thermally broken aluminum
- Overall thickness: 24mm

Performance Characteristics:

- Solar heat gain coefficient (SHGC): 0.25 maximum
- Visible light transmittance: 70% minimum

- U-value: 1.8 W/m^{2}K maximum
- Sound reduction: 35 dB minimum

3.3.3 Window Types and Locations

Living Areas:

- Sliding windows: 2400mm x 1500mm
- Fixed glazing with operable ventilation panels
- Integrated insect screens

Bedrooms:

- Casement windows: 1200mm x 1200mm
- Top-hung ventilation windows
- Blackout roller blinds integration

Kitchens and Bathrooms:

- Casement windows: 800mm x 600mm
- Obscure glazing for privacy
- Mechanical ventilation coordination

3.4 DOORS AND ENTRANCES

3.4.1 Main Entrance Doors

Apartment Entry Doors:

- Material: Solid core with steel facing
- Thickness: 45mm security door
- Size: 1000mm x 2100mm
- Finish: Powder-coated steel, wood grain texture
- Hardware: Multi-point locking system
- Security features: Reinforced frame and hinges

Fire-rated Doors:

- 60-minute fire rating where required
- Self-closing mechanisms
- Smoke seals and intumescent strips
- Emergency exit hardware

- Locations: Stairwells and utility rooms

3.4.2 Internal Doors

Living Area Doors:

- Material: MDF with wood veneer
- Thickness: 35mm
- Size: 900mm x 2100mm
- Finish: Clear polyurethane coating
- Hardware: Stainless steel handles and hinges

Bathroom Doors:

- Material: Moisture-resistant MDF
- Finish: Laminate with waterproof edges
- Hardware: Privacy locks with emergency access
- Size: 800mm x 2100mm

3.4.3 Door Hardware

Standard Hardware Package:

- Hinges: 3 per door, stainless steel, ball bearing
- Handles: Lever type, satin stainless steel finish
- Locks: 5-lever mortise locks for security
- Door closers: Where required for fire doors
- Weather sealing: Door bottoms and frames

3.5 INTERNAL WALLS AND PARTITIONS

3.5.1 Load-bearing Internal Walls

Construction:

- 150mm reinforced concrete blocks
- Vertical reinforcement: 12mm bars at 400mm centers
- Horizontal reinforcement: 8mm bars every 3rd course
- Mortar: 1:4 cement sand mixture
- Surface preparation: Rendered both sides

3.5.2 Non-load-bearing Partitions

Standard Partitions:

- 100mm concrete blocks for wet areas
- 75mm concrete blocks for dry areas
- Plaster finish: 12mm cement sand plaster
- Primer and paint system
- Sound insulation where required

Lightweight Partitions:

- Metal stud frame: 75mm galvanized steel
- Board: 12.5mm gypsum board both sides
- Insulation: Mineral wool between studs
- Joints: Taped and filled
- Applications: Non-structural internal divisions

3.6 FLOOR FINISHES

3.6.1 Living Areas and Bedrooms

Porcelain Tiles:

- Size: 600mm x 600mm x 10mm thick
- Quality: First grade, rectified edges
- Finish: Matt with anti-slip properties
- Color: Cream beige with natural stone appearance
- Installation: Adhesive fixing over leveled screed
- Grouting: Epoxy-based grout, color-matched

Preparation:

- Floor screed: 50mm cement sand screed
- Waterproof membrane under wet areas
- Expansion joints at 6m intervals
- Level tolerance: ±2mm in 2m length

3.6.2 Kitchen and Utility Areas

Ceramic Tiles:

- Size: 300mm x 300mm x 8mm thick

- Quality: Commercial grade, slip-resistant
- Finish: Semi-glazed with easy-clean surface
- Color: Light gray with subtle pattern
- Installation: Full adhesive bed application
- Skirtings: Matching tiles, 100mm height

3.6.3 Bathroom Areas

Porcelain Tiles:

- Size: 300mm x 300mm x 9mm thick
- Quality: Vitrified, water absorption <0.5%
- Finish: Anti-slip surface (R11 rating)
- Color: White with marble veining
- Installation: Waterproof adhesive system
- Grouting: Anti-fungal, stain-resistant grout

Wet Area Treatment:

- Tanking membrane: 2-coat liquid applied system
- Wall tiling: 2.1m height in shower areas
- Floor falls: 1:100 to floor drains
- Expansion joints: Sealed with flexible sealant

3.6.4 Staircase and Common Areas

Natural Stone:

- Material: Granite slabs, 20mm thick
- Color: Light gray with polished finish
- Size: Cut to suit stair treads and landings
- Anti-slip strips: Stainless steel inserts
- Installation: Mechanical fixing to concrete substrate

3.7 WALL FINISHES

3.7.1 Living Areas and Bedrooms

Paint System:

- Base: One coat alkali-resistant primer

- Intermediate: One coat undercoat
- Finish: Two coats washable emulsion paint
- Color: Off-white with neutral tones
- Sheen: Matt finish for ceilings, eggshell for walls
- Quality: Premium grade, low-VOC formulation

3.7.2 Kitchen Areas

Ceramic Wall Tiles:

- Size: 200mm x 300mm x 7mm thick
- Quality: Glazed ceramic, easy-clean surface
- Color: White with subtle texture
- Installation: Full adhesive bed to 2.4m height
- Grouting: Stain-resistant, anti-bacterial grout
- Edges: Plastic trim strips, color-matched

3.7.3 Bathroom Areas

Ceramic Wall Tiles:

- Size: 250mm x 400mm x 8mm thick
- Quality: Glazed porcelain, water-resistant
- Color: Light blue with decorative border strips
- Installation: Full height tiling in shower areas
- Grouting: Waterproof, mold-resistant grout
- Accessories: Recessed soap dishes and towel rails

3.7.4 External Wall Render

Three-Coat System:

- Base coat: 10mm cement sand render (1:4 mix)
- Intermediate coat: 5mm polymer-modified render
- Finish coat: 2mm textured acrylic render
- Color: Integral pigment, fade-resistant
- Texture: Fine aggregate finish
- Curing: Water curing for 7 days minimum

3.8 CEILING SYSTEMS

3.8.1 Suspended Ceilings

Living Areas:

- System: Concealed grid suspended ceiling
- Tiles: 600mm x 600mm mineral fiber tiles
- Finish: White with smooth texture
- Edge detail: Shadow line perimeter trim
- Access: Removable tiles for MEP access
- Height: 3.0m finished floor to ceiling

Bathrooms and Kitchen:

- System: Moisture-resistant suspended ceiling
- Material: Calcium silicate boards
- Finish: Washable paint system
- Waterproofing: Above ceiling membrane
- Ventilation: Integration with exhaust fans
- Height: 2.7m finished floor to ceiling

3.8.2 Direct Applied Ceilings

Utility Areas:

- Base: Direct application to concrete soffit
- Preparation: Surface leveling and priming
- Finish: Two-coat paint system
- Color: White emulsion paint
- Texture: Smooth finish
- Maintenance access: Through removable panels

3.9 BUILT-IN FURNITURE AND FIXTURES

3.9.1 Kitchen Cabinets

Base Units:

- Construction: 18mm moisture-resistant MDF carcass
- Finish: Laminate with PVC edge banding

- Doors: Soft-close hinges and drawer slides
- Worktop: 30mm thick engineered stone
- Color: Modern gray with stainless steel handles
- Configuration: L-shaped layout with island

Wall Units:

- Height: 720mm with variable width modules
- Interior: Adjustable shelving system
- Lighting: LED strip lighting under units
- Glass doors: Where specified for display
- Hardware: Soft-close mechanisms throughout

3.9.2 Wardrobes

Master Bedroom:

- Construction: Floor-to-ceiling built-in wardrobe
- Interior: Hanging rails, shelving, and drawers
- Doors: Sliding mirror doors with aluminum frames
- Lighting: Motion-activated LED lighting
- Dimensions: 3.6m wide x 2.7m high x 600mm deep

Secondary Bedrooms:

- Type: Two-door hinged wardrobe per room
- Construction: Similar to master bedroom
- Finish: Wood grain laminate to match doors
- Hardware: Quality European hinges and handles
- Dimensions: 1.8m wide x 2.4m high x 600mm deep

3.9.3 Bathroom Vanities

Master Bathroom:

- Construction: Wall-mounted vanity unit
- Size: 1200mm x 500mm x 600mm high
- Finish: High-gloss white lacquer
- Top: Engineered stone with integrated basin

- Storage: Soft-close drawers with internal organizers
- Mirror: Illuminated mirror with demister pad

Guest Bathrooms:

- Construction: Floor-standing vanity unit
- Size: 800mm x 450mm x 850mm high
- Finish: Wood grain laminate
- Top: Ceramic top with semi-recessed basin
- Storage: Single door with internal shelf
- Mirror: Framed mirror with side lighting

3.10 STAIRCASES

3.10.1 Main Staircase

Construction:

- Structure: Reinforced concrete stair flights
- Treads: 280mm depth with 175mm risers
- Finish: Granite treads with anti-slip nosings
- Handrails: Stainless steel with wood cap rail
- Balustrades: Stainless steel uprights with glass panels
- Width: 1200mm clear width

Lighting:

- Wall-mounted LED strip lighting
- Motion sensor activation
- Emergency lighting integration
- Control: Automatic with manual override

3.10.2 Service Staircase

Construction:

- Structure: Precast concrete stair flights
- Treads: Non-slip ceramic tiles
- Handrails: Powder-coated steel, both sides
- Balustrades: Steel uprights with horizontal rails

- Width: 1000mm clear width
- Fire rating: 2-hour fire resistance

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4. STRUCTURAL WORKS

4.1 GENERAL STRUCTURAL REQUIREMENTS

4.1.1 Design Parameters

Design Standards:

- Structural design in accordance with Saudi Building Code
- Concrete design: ACI 318 with Saudi modifications
- Steel design: AISC standards with local adaptations
- Foundation design: Based on geotechnical investigation
- Seismic design: Zone 2A seismic classification for Riyadh
- Wind loads: As per ASCE 7 with local wind data

Loading Conditions:

- Dead loads: Permanent building elements and finishes
- Live loads: 2.0 kN/m^2 for residential areas
- Roof live loads: 0.6 kN/m^2 for accessible roofs
- Wind loads: 45 m/s basic wind speed
- Seismic loads: 0.15g peak ground acceleration
- Temperature effects: 50°C differential considered

4.1.2 Soil Conditions and Foundation Design

Geotechnical Parameters:

- Soil type: Dense sand and gravel
- Bearing capacity: 250 kN/m^2 at 1.5m depth
- Water table: Not encountered within 5m depth
- Soil density: 1850 kg/m^3 average
- Angle of internal friction: 35°
- Settlement: Limited to 25mm maximum

4.2 FOUNDATION SYSTEM

4.2.1 Foundation Type and Configuration

Strip Foundations:

- Load-bearing walls: 800mm wide x 1200mm deep
- Non-load-bearing walls: 500mm wide x 800mm deep
- Concrete grade: C25/30 with waterproofing admixture
- Reinforcement: 16mm diameter main bars
- Blinding layer: 75mm lean concrete under foundations
- Waterproofing: Crystalline waterproofing system

Isolated Footings:

- Column footings: Size as per structural calculations
- Minimum size: 2.0m x 2.0m x 600mm deep
- Concrete grade: C30/37 with low permeability
- Reinforcement: High-yield steel bars (Grade 460)
- Dowel bars: Adequate length for column connection
- Construction joints: Waterstop installation required

4.2.2 Basement and Retaining Walls

Construction Requirements:

- Wall thickness: 300mm minimum reinforced concrete
- Concrete grade: C30/37 with waterproofing admixture
- Reinforcement: Dual mesh configuration
- Vertical bars: 16mm at 200mm centers both faces
- Horizontal bars: 12mm at 300mm centers both faces
- Construction joints: Every 15m maximum with waterstops

Waterproofing System:

- External membrane: 4mm modified bitumen sheet
- Protection board: 6mm HDPE dimpled membrane
- Drainage: French drain system around perimeter
- Damp proof course: 300mm above ground level
- Internal coating: Crystalline waterproofing paint

- Sump pumps: Where required for groundwater

4.2.3 Foundation Construction Sequence

1. Excavation to formation level with battered sides
2. Blinding concrete placement and curing
3. Waterproofing membrane installation
4. Reinforcement placement and inspection
5. Concrete placement in continuous operation
6. Curing for minimum 7 days with water spraying
7. Backfilling with selected granular material
8. Compaction in 200mm layers to 95% density

4.3 CONCRETE STRUCTURE

4.3.1 Concrete Specifications

Mix Design Requirements:

- Ground floor slab: C25/30 concrete grade
- Upper floor slabs: C25/30 concrete grade
- Beams and columns: C30/37 concrete grade
- Staircase: C30/37 concrete grade
- Cement type: Ordinary Portland Cement (OPC)
- Aggregate: Clean, graded sand and crushed stone

Performance Requirements:

- Compressive strength: As per grade requirements
- Workability: 75-100mm slump for normal concrete
- Durability: 50-year design life for structure
- Permeability: Low permeability for water resistance
- Fire resistance: 2-hour rating for main structure
- Thermal properties: Low heat of hydration cement

4.3.2 Reinforcement Steel

Material Specifications:

- Grade: High-yield deformed bars (Grade 460)

- Sizes: 8mm to 32mm diameter as per drawings
- Welded mesh: A252 and A393 where specified
- Lap lengths: As per structural drawings
- Cover: 25mm minimum to reinforcement
- Tie wires: Galvanized binding wire throughout

Placement Requirements:

- Bar schedule: Strictly as per approved drawings
- Splicing: Mechanical couplers for large diameter bars
- Chairs and spacers: Concrete or plastic spacers
- Inspection: Before and during concrete placement
- Testing: Material certificates and sample testing
- Protection: Adequate cover and concrete quality

4.3.3 Formwork System

Material and Construction:

- Plywood: 18mm marine-grade shuttering plywood
- Timber: Seasoned timber for supports and bracing
- Steel: Scaffolding system for support structure
- Release agent: Non-staining formwork oil
- Tolerances: As per international standards
- Reuse: Maximum 10 uses for plywood forms

Quality Requirements:

- Surface finish: Smooth finish for exposed surfaces
- Alignment: Vertical and horizontal accuracy
- Joints: Tight joints to prevent grout loss
- Stability: Adequate bracing against wind loads
- Removal: After achieving required strength
- Cleaning: Thorough cleaning between uses

4.3.4 Concrete Placement and Curing

Placement Procedures:

- Continuous placement for each element
- Vibration: Adequate compaction without segregation
- Weather protection: Hot weather concreting procedures
- Joint treatment: Construction joint preparation
- Surface finish: As specified for different elements
- Testing: Cube samples for strength verification

Curing Requirements:

- Water curing: Continuous for first 7 days
- Curing compound: Where water curing not possible
- Protection: From direct sunlight and wind
- Temperature: Maintained between 10°C and 35°C
- Membrane curing: Plastic sheeting where appropriate
- Strength testing: 7-day and 28-day cube tests

4.4 FLOOR SYSTEMS

4.4.1 Ground Floor Slab

Construction Details:

- Type: Reinforced concrete slab on ground
- Thickness: 150mm with reinforcement mesh
- Sub-base: 150mm compacted granular fill
- Damp proof membrane: 1000-gauge polythene sheet
- Insulation: 50mm rigid insulation boards
- Reinforcement: A252 mesh with additional bars over supports

Surface Treatment:

- Power floating: For smooth, level finish
- Curing compound: Applied immediately after finishing
- Expansion joints: At 6m centers in both directions
- Movement joints: At building perimeter and changes
- Surface tolerance: ±3mm in 3m length
- Fall: 1:100 minimum to drainage points

4.4.2 Upper Floor Slabs

Structural System:

- Type: One-way reinforced concrete slabs
- Thickness: 200mm for normal loading areas
- Spans: Maximum 6m between supports
- Reinforcement: As per structural calculations
- Support: Beams and load-bearing walls
- Openings: Trimmed with additional reinforcement

Construction Requirements:

- Formwork: Adequate support during curing
- Concrete: Continuous placement where possible
- Vibration: Proper compaction throughout thickness
- Surface: Power floating for smooth finish
- Curing: Water curing for 7 days minimum
- Load application: After 28 days or earlier with approval

4.4.3 Roof Slab

Structural Configuration:

- Type: Flat roof with reinforced concrete slab
- Thickness: 200mm with waterproofing preparation
- Falls: Formed in concrete to drainage outlets
- Insulation: Above slab waterproofing system
- Parapets: Integral with slab construction
- Access: Provision for roof access and maintenance

Waterproofing Integration:

- Surface preparation: Smooth, crack-free finish
- Primers: Concrete treatment before membranes
- Drainage: Adequate falls to roof outlets
- Penetrations: Proper detailing around services
- Expansion joints: Coordinated with structure

- Testing: Water ponding test before finishes

4.5 STRUCTURAL ELEMENTS

4.5.1 Columns

Design and Construction:

- Minimum size: 300mm x 300mm reinforced concrete
- Concrete grade: C30/37 throughout building height
- Main reinforcement: Minimum 8 bars of 16mm diameter
- Ties: 8mm diameter at 200mm centers maximum
- Splicing: Mechanical couplers at alternate levels
- Cover: 40mm clear cover to reinforcement

Construction Sequence:

- Foundation connection: Adequate dowel projection
- Formwork: Reusable column forms with smooth finish
- Reinforcement: Placed and tied before concrete
- Concrete: Continuous placement for full height
- Curing: Water curing and protection from sun
- Tolerance: ±10mm on cross-sectional dimensions

4.5.2 Beams

Structural Design:

- Primary beams: 300mm x 600mm typical sections
- Secondary beams: 250mm x 450mm typical sections
- Concrete grade: C30/37 for all beam elements
- Main reinforcement: As per structural calculations
- Stirrups: 8mm diameter closed stirrups throughout
- Development length: Adequate anchorage at supports

Construction Requirements:

- Formwork: Beam soffit forms with side forms
- Camber: Pre-camber for long spans if required
- Reinforcement: Top and bottom steel as designed

- Concrete: Placement with proper consolidation
- Joint location: At points of minimum moment
- Surface finish: Smooth for exposed beams

4.5.3 Masonry Walls

Load-bearing Masonry:

- Block type: Concrete masonry units (CMU)
- Strength: 15 N/mm^2 minimum compressive strength
- Size: 200mm x 200mm x 400mm hollow blocks
- Mortar: 1:4 cement sand mix with plasticizer
- Reinforcement: Vertical and horizontal as required
- Grout: All reinforced cells filled with concrete

Construction Standards:

- Foundation connection: Starter bars from foundation
- Bed joints: 10mm thick horizontal joints
- Head joints: 10mm thick vertical joints
- Plumb and level: Walls true to line and level
- Reinforcement: Clean bars with proper lap lengths
- Protection: Curing and protection from weather

4.5.4 Precast Elements

Staircase Construction:

- Type: Precast reinforced concrete stair flights
- Grade: C30/37 concrete with smooth finish
- Reinforcement: As per approved shop drawings
- Connections: Cast-in-place connections to structure
- Tolerances: ±5mm on critical dimensions
- Finish: Non-slip surface treatment

Installation Requirements:

- Temporary support: Until permanent connections made
- Grouting: All connections properly grouted

- Alignment: Correct positioning and leveling
- Sealant: Weather sealing at external connections
- Testing: Load testing if required by engineer
- Protection: During and after installation

4.6 STRUCTURAL STEEL WORKS

4.6.1 Material Specifications

Steel Grades:

- Structural sections: Grade S355 steel
- Plates: Grade S275 minimum thickness 8mm
- Bolts: Grade 8.8 high-strength bolts
- Welding electrodes: AWS E7018 or equivalent
- Primer: Zinc-rich primer for protection
- Paint system: Intumescent fire protection where required

4.6.2 Fabrication Requirements

Workshop Standards:

- Cutting: Flame cutting with smooth edges
- Welding: Qualified welders and procedures
- Drilling: Accurate hole positioning and sizing
- Assembly: Trial erection of complex elements
- Quality control: NDT testing of critical welds
- Surface preparation: Shot blasting to Sa 2.5 standard

Tolerances:

- Length: ±3mm for members up to 10m
- Straightness: L/1000 maximum bow in any direction
- Squareness: ±2mm on cross-sectional dimensions
- Hole positions: ±2mm from theoretical position
- Surface: Smooth welds ground flush where required
- Marking: Clear identification of all members

4.6.3 Erection Procedures

Site Installation:

- Sequence: As per approved erection sequence
- Temporary bracing: Adequate stability during erection
- Connections: Bolted connections properly tensioned
- Welding: Site welding procedures and inspection
- Alignment: Final adjustment and permanent bracing
- Protection: Touch-up painting after erection

4.7 WATERPROOFING AND DAMP PROOFING

4.7.1 Below Ground Waterproofing

Foundation Waterproofing:

- System: Crystalline waterproofing admixture in concrete
- External membrane: Modified bitumen sheet waterproofing
- Protection: Geotextile and protection board
- Drainage: Perimeter drainage with filter fabric
- Sump system: Where groundwater is encountered
- Testing: Visual inspection and flood testing

Application Procedures:

- Surface preparation: Clean, sound concrete surface
- Primer: Bitumen primer where required
- Membrane: Overlapped joints with hot-air welding
- Sealing: All penetrations properly sealed
- Protection: Immediate protection after application
- Inspection: 100% visual inspection of completed work

4.7.2 Above Ground Damp Proofing

Damp Proof Course (DPC):

- Material: Flexible DPC material or liquid membrane
- Location: 150mm minimum above ground level
- Width: Full width of wall plus 25mm each side
- Joints: Overlapped joints sealed with mastic

- Penetrations: Proper sealing around services
- Testing: Visual inspection for continuity

Wall Treatment:

- Cavity walls: DPC at all cavity interruptions
- Single skin: Continuous DPC through wall thickness
- Jambs and sills: DPC continuity maintained
- Lintels: Cavity trays with stop ends
- Weep holes: At 450mm centers in external leaf
- Inspection: Regular inspection during construction

4.8 STRUCTURAL TESTING AND QUALITY CONTROL

4.8.1 Concrete Testing

Fresh Concrete Testing:

- Slump test: Every load or every 2 hours
- Air content: For air-entrained concrete
- Temperature: Maximum 32°C at placement
- Workability: Maintained throughout placement
- Bleeding: Visual assessment for segregation
- Setting time: Initial and final set testing

Hardened Concrete Testing:

- Cube samples: 6 cubes per 50m^3 of concrete
- Testing ages: 7 days and 28 days
- Core samples: Where cube strength is low
- Rebound hammer: Non-destructive testing
- Ultrasonic testing: For crack detection
- Load testing: For suspect structural elements

4.8.2 Steel Testing and Inspection

Reinforcement Testing:

- Tensile testing: Every 40 tonnes of reinforcement
- Bend testing: As per material standards

- Dimensions: Check diameter and deformation pattern
- Surface condition: Free from rust and contamination
- Certification: Mill certificates for all steel
- Storage: Proper storage to prevent corrosion

Structural Steel Testing:

- Material certificates: For all steel elements
- Welding tests: Procedure qualification and testing
- NDT testing: Ultrasonic or radiographic testing
- Dimensional checks: As-built dimensions recorded
- Surface preparation: Inspection before painting
- Bolt tension: Calibrated torque wrench verification

4.8.3 Load Testing

When Required:

- Suspect concrete strength results
- Structural modifications during construction
- Innovative structural systems
- Client or authority requirements
- Post-construction verification
- Forensic investigation needs

Testing Procedures:

- Test loads: 1.25 times design live load
- Loading sequence: Gradual application and removal
- Deflection measurement: At critical points
- Duration: 24-hour sustained loading
- Acceptance criteria: Recovery of 75% deflection
- Reporting: Comprehensive test report required

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5. MECHANICAL WORKS

5.1 HVAC SYSTEMS

5.1.1 System Overview and Design Criteria

Design Parameters:

- Outdoor design temperature: 48°C dry bulb, 25°C wet bulb
- Indoor design conditions: 24°C ±2°C, 50% ±10% RH
- Fresh air requirements: 8.5 L/s per person minimum
- Infiltration allowance: 0.5 air changes per hour
- Diversity factors: Applied as per ASHRAE standards
- Equipment sizing: 15% safety factor included

System Configuration:

- Individual apartment units: Split-type air conditioning
- Common areas: Centralized air handling systems
- Ventilation: Mechanical ventilation with heat recovery
- Controls: Digital thermostat control in each zone
- Distribution: Concealed ductwork in ceiling voids
- Refrigerant: R-410A environmentally friendly refrigerant

5.1.2 Apartment Air Conditioning Systems

Equipment Specifications:

- Type: Inverter technology split air conditioning units
- Capacity range: 7kW to 18kW per apartment
- Energy efficiency: Minimum 3.5 COP (Coefficient of Performance)
- Indoor units: Concealed ceiling type with ducted distribution
- Outdoor units: Roof-mounted with acoustic enclosures
- Controls: Wireless remote control with programmable timer

Installation Requirements:

- Indoor units: Suspended from structural ceiling
- Outdoor units: Concrete pads with vibration isolation
- Refrigerant piping: Insulated copper pipes with leak-tight joints
- Condensate drainage: Gravity drainage to external discharge
- Electrical supply: Dedicated circuits with isolation switches

- Commissioning: Full performance testing and balancing

5.1.3 Ductwork and Distribution

Ductwork Materials:

- Supply and return: Galvanized steel rectangular ducts
- Insulation: 25mm thick glass wool with vapor barrier
- Flexible connections: At all equipment connections
- Fire dampers: At fire-rated wall and floor penetrations
- Volume control: Manual balancing dampers throughout
- Access panels: For maintenance at critical locations

Design Standards:

- Velocity: Maximum 6 m/s in supply ducts
- Pressure drop: Maximum 1.2 Pa per meter of duct
- Leakage: Class A ductwork to international standards
- Support: Adequate structural support at required intervals
- Sealing: All joints sealed with appropriate sealants
- Marking: Clear identification of all ductwork

5.1.4 Ventilation Systems

Kitchen Exhaust:

- Extract rate: 20 air changes per hour minimum
- Hood type: Stainless steel canopy with grease filters
- Ductwork: Stainless steel with minimum 6mm thickness
- Fan: Centrifugal type with variable speed control
- Discharge: Through roof with weather protection
- Make-up air: Passive through door undercuts and grilles

Bathroom Exhaust:

- Extract rate: 8 air changes per hour minimum
- Fan type: Axial flow with humidity sensor control
- Ductwork: Galvanized steel with insulation
- Discharge: Through external walls with louvered grilles

- Controls: Automatic operation with manual override
- Noise level: Maximum 35 dB(A) at 1 meter distance

5.1.5 Central Plant Equipment

Air Handling Units (Common Areas):

- Type: Packaged air handling unit with heat recovery
- Capacity: 5,000 m^3/h air handling capacity
- Components: Filters, cooling coils, fans, and controls
- Location: Dedicated plant room with external access
- Sound attenuation: Acoustic treatment for noise control
- Controls: Building management system integration

Chilled Water System:

- Chillers: Air-cooled screw chillers with backup unit
- Capacity: 200 kW total cooling capacity
- Pumps: Primary and secondary chilled water pumps
- Distribution: Insulated steel pipes with expansion joints
- Controls: Automatic lead/lag operation
- Efficiency: High-efficiency equipment with variable speed drives

5.2 PLUMBING SYSTEMS

5.2.1 Water Supply Systems

Potable Water Supply:

- Source: Municipal water supply connection
- Storage: Overhead tank 50,000 liters capacity
- Booster pumps: Variable speed pressure booster set
- Distribution: CPVC pipes for hot water, UPVC for cold water
- Pressure: 2.5 bar minimum at fixtures
- Quality: Potable water meeting Saudi standards

Hot Water System:

- Heaters: Electric storage water heaters per apartment
- Capacity: 200 liters for 3-bedroom, 150 liters for 2-bedroom

- Distribution: Insulated CPVC pipes with circulation return
- Temperature: 60°C storage, 43°C at fixtures
- Controls: Thermostat control with safety cutoff
- Efficiency: High-efficiency units with timer controls

5.2.2 Sanitary and Waste Systems

Soil and Waste Drainage:

- Pipes: UPVC soil and waste pipes with solvent welding
- Stack pipes: 100mm diameter soil stacks with ventilation
- Branch pipes: 50mm for basins, 100mm for WCs
- Gradients: 1:40 for soil pipes, 1:60 for waste pipes
- Ventilation: Stack ventilation through roof terminals
- Access: Rodding eyes at changes of direction

Trap Seals and Ventilation:

- Water seal: 50mm minimum seal depth
- Trap types: P-traps for wall-hung fixtures
- Anti-siphon: Where required by design
- Ventilation: Primary ventilation through soil stacks
- Secondary ventilation: Where trap seal protection needed
- Materials: Same as connected pipework

5.2.3 Stormwater Drainage

Roof Drainage:

- Outlets: Cast iron roof outlets with leaf guards
- Pipes: Cast iron rainwater pipes with protective coating
- Sizing: Based on 100mm/hour rainfall intensity
- Discharge: To site stormwater drainage system
- Overflow: Emergency overflow routes provided
- Maintenance: Access for cleaning and inspection

Surface Water Drainage:

- Collection: Yard gullies and channel drains

- Pipes: UPVC pipes with flexible joints
- Gradients: Minimum 1:150 for surface water drains
- Discharge: To municipal storm drainage system
- Inspection: Manholes at changes of direction
- Protection: Catchpit sumps for sediment removal

5.2.4 Plumbing Fixtures and Fittings

Sanitary Fixtures:

- Water closets: Wall-hung WCs with concealed cisterns
- Wash basins: Semi-recessed basins with pedestals
- Showers: Thermostatic mixer showers with safety cutoff
- Kitchen sinks: Stainless steel single bowl with drainer
- Utility sinks: Ceramic utility basins in laundry areas
- Bidets: Wall-hung bidets with hot and cold water supply

Fixture Specifications:

- Quality: European standard sanitary ware
- Water efficiency: Water-saving fixtures throughout
- Accessibility: Some fixtures to accessibility standards
- Finish: White vitreous china with chrome fittings
- Installation: Wall-hung fixtures with concealed fixings
- Maintenance: Easy-clean surfaces and accessible connections

5.2.5 Pumping Systems

Booster Pump Sets:

- Type: Variable speed drive pump sets
- Capacity: 15 m^3/h at 40m head
- Configuration: Duty/standby arrangement
- Controls: Pressure switch and flow control
- Installation: Dedicated pump room with drainage
- Noise: Acoustic enclosure for noise control

Sewage Ejector Pumps:

- Application: Where gravity drainage not possible
- Type: Submersible sewage pumps with cutting mechanism
- Capacity: 5 m^3/h at 20m head
- Installation: GRP pumping chamber with access
- Controls: Level switches and alarm system
- Power supply: Emergency power backup

5.3 FIRE FIGHTING SYSTEMS

5.3.1 Fire Water Supply

Water Supply System:

- Source: Dedicated fire water tank 100,000 liters
- Pumps: Electric and diesel fire pumps (duty/standby)
- Pressure: 7 bar at most remote sprinkler head
- Pipe sizing: Based on hydraulic calculations
- Materials: Galvanized steel pipes with grooved couplings
- Testing: Weekly pump testing and annual system test

Pump House Design:

- Location: Ground level with external access
- Construction: Fire-rated building with ventilation
- Equipment: Electric and diesel fire pumps
- Controls: Fire alarm system integration
- Power supply: Emergency generator backup
- Drainage: Adequate drainage for testing water

5.3.2 Automatic Sprinkler System

System Design:

- Type: Wet pipe automatic sprinkler system
- Coverage: All areas except specific exclusions
- Sprinkler heads: Quick-response pendent type
- Pipe materials: Galvanized steel with approved fittings
- Design density: Light hazard classification

- Water supply: Calculated for 30-minute duration

Installation Requirements:

- Sprinkler heads: Maximum 4.6m spacing
- Pipe supports: At maximum 3.7m intervals
- Zone control: Separate zones for different areas
- Alarm devices: Water flow switches and pressure switches
- Testing: Hydrostatic testing at 15 bar pressure
- Commissioning: Complete system commissioning and testing

5.3.3 Fire Hose Reel System

Equipment Specifications:

- Hose reels: 25mm diameter x 30m length
- Nozzles: Adjustable spray/jet nozzles
- Cabinets: Recessed stainless steel cabinets
- Location: Maximum 30m travel distance
- Pressure: 2.5 bar at nozzle
- Testing: Monthly pressure testing

Installation Standards:

- Height: 1.5m to center of hose reel
- Access: Clear access for operation
- Signage: Illuminated fire hose reel signs
- Protection: Frost protection where required
- Drainage: Drain valves at low points
- Marking: Clear identification and instructions

5.3.4 Portable Fire Extinguishers

Extinguisher Types and Locations:

- Type A: Water-based for ordinary combustibles
- Type BC: Dry chemical for flammable liquids
- Type CO2: For electrical equipment areas
- Distribution: Maximum 23m travel distance

- Mounting: Wall brackets at 1.5m height
- Signage: Photoluminescent identification signs

Maintenance Requirements:

- Monthly inspections by building management
- Annual servicing by certified technician
- Hydrostatic testing every 5 years
- Replacement: As recommended by manufacturer
- Training: User training for building occupants
- Records: Maintenance records kept on-site

5.3.5 Fire Detection and Alarm System

System Architecture:

- Type: Addressable fire detection system
- Control panel: Microprocessor-based with LCD display
- Detection: Smoke and heat detectors throughout building
- Manual call points: At exit routes and stairwells
- Sounders: Visual and audible alarm devices
- Monitoring: 24-hour monitoring connection

Zone Configuration:

- Floor zones: Separate zone for each floor
- Area zones: Different areas on same floor
- Special zones: Plant rooms and high-risk areas
- Reporting: Detailed reporting to fire service
- Controls: Firefighter control panel at main entrance
- Power supply: 24-hour battery backup system

5.4 MECHANICAL VENTILATION

5.4.1 Car Park Ventilation

System Design:

- Air change rate: 6 air changes per hour minimum
- Extract fans: Jet fans for air movement

- Supply air: Natural supply through openings
- CO monitoring: Carbon monoxide detection system
- Controls: Automatic operation based on CO levels
- Emergency operation: Manual override controls

Equipment Selection:

- Jet fans: Reversible operation for smoke control
- Installation: Suspended from structural ceiling
- Power supply: Emergency power backup
- Noise levels: Maximum 60 dB(A) in car park
- Maintenance: Easy access for servicing
- Controls: Integration with fire alarm system

5.4.2 Stairwell Pressurization

Smoke Control System:

- Purpose: Maintain positive pressure in stairwells
- Supply fans: Centrifugal fans with variable speed
- Air supply: Fresh air from external intake
- Pressure difference: 25-30 Pa above adjacent areas
- Controls: Automatic activation by fire alarm
- Testing: Monthly testing and annual calibration

Installation Requirements:

- Fan location: Dedicated fan room or roof mounting
- Ductwork: Fire-rated ductwork with fire dampers
- Air intake: External intake with weather protection
- Pressure relief: Automatic pressure relief dampers
- Power supply: Emergency generator connection
- Monitoring: Pressure monitoring and alarm indication

5.4.3 Generator Room Ventilation

Ventilation Requirements:

- Heat removal: Based on generator heat rejection

- Air change rate: 20 air changes per hour minimum
- Supply and extract: Balanced ventilation system
- Temperature control: Maximum 40°C ambient temperature
- Controls: Interlocked with generator operation
- Emergency ventilation: Independent of main power supply

5.5 MECHANICAL INSTALLATIONS

5.5.1 Pipe Installation Standards

Installation Methods:

- Support: Pipe hangers at maximum 2m intervals
- Expansion: Expansion joints and loops where required
- Insulation: Thermal insulation for hot and chilled water pipes
- Identification: Color coding and labeling throughout
- Testing: Pressure testing before commissioning
- Access: Maintenance access at all connections

Joint Types:

- Copper pipes: Soldered or compression joints
- Steel pipes: Welded or threaded joints as appropriate
- Plastic pipes: Solvent welding or mechanical joints
- Flanged joints: At equipment connections
- Flexible connections: At all rotating equipment
- Sealing: Appropriate thread sealants and gaskets

5.5.2 Equipment Installation

General Requirements:

- Foundations: Concrete pads with vibration isolation
- Access: Adequate space for maintenance and replacement
- Electrical connections: By qualified electrical contractor
- Controls: Integration with building management system
- Commissioning: Performance testing and documentation
- Training: Operator training and maintenance manuals

Specific Equipment:

- Pumps: Alignment, coupling, and base grouting
- Fans: Balancing, belt tension, and vibration checks
- Heat exchangers: Cleaning and pressure testing
- Chillers: Refrigerant charging and leak testing
- Boilers: Safety valve testing and flue gas analysis
- Control systems: Calibration and sequence testing

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6. ELECTRICAL WORKS

6.1 ELECTRICAL SYSTEMS OVERVIEW

6.1.1 Design Standards and Codes

Applicable Standards:

- Saudi Electricity Company (SEC) standards and regulations
- International Electrotechnical Commission (IEC) standards
- British Standards (BS) for electrical installations
- National Fire Protection Association (NFPA) codes
- Institute of Electrical and Electronics Engineers (IEEE) standards
- Saudi Standards, Metrology and Quality Organization (SASO) requirements

Design Criteria:

- Supply voltage: 380V/220V, 3-phase, 4-wire system
- Frequency: 50 Hz nominal
- Diversity factors: Applied as per standard calculations
- Future expansion: 20% spare capacity in all systems
- Energy efficiency: High-efficiency equipment throughout
- Safety: Comprehensive earth fault protection

6.1.2 Electrical Load Assessment

Connected Loads Summary:

- Lighting load: 15 kW total connected load
- Small power outlets: 25 kW total connected load

- Air conditioning: 150 kW total connected load
- Mechanical equipment: 45 kW total connected load
- Common services: 20 kW total connected load
- Total connected load: 255 kW
- Maximum demand: 180 kW (with diversity)
- Emergency loads: 35 kW essential loads

6.2 POWER SUPPLY AND DISTRIBUTION

6.2.1 Main Electrical Supply

SEC Connection:

- Supply arrangement: Underground cable from SEC network
- Service voltage: 11 kV primary distribution
- Transformer: 500 kVA, 11kV/380V, oil-filled transformer
- Location: Ground-mounted transformer compound
- Protection: 11kV vacuum circuit breaker with protection relays
- Metering: Electronic kWh meter with demand recording

Main Distribution Board:

- Type: Metal-clad switchboard with draw-out breakers
- Rating: 630A main switch with 400A outgoing ways
- Protection: Air circuit breakers with electronic trip units
- Metering: Digital multifunction meters on main incomers
- Indication: LED indication for healthy, trip, and earth fault
- Space: 30% spare ways for future expansion

6.2.2 Sub-distribution Systems

Apartment Distribution:

- Supply: Single-phase 220V supply to each apartment
- Distribution board: 8-way consumer unit per apartment
- Protection: MCBs and RCD protection on all circuits
- Metering: Electronic energy meter per apartment
- Location: Meter room on each floor with SEC access

- Capacity: 15 kW per 2-bedroom, 20 kW per 3-bedroom unit

Common Services Distribution:

- Supply: Three-phase 380V for common services
- Distribution boards: Floor-wise distribution boards
- Circuits: Separate circuits for different services
- Protection: Appropriate circuit protection for each load
- Emergency supply: Automatic changeover to generator
- Monitoring: Power monitoring for energy management

6.2.3 Cable Installation Systems

Cable Types and Routing:

- Power cables: XLPE insulated, armored cables for main distribution
- Branch circuits: PVC insulated cables in conduits
- Installation: Underground in ducts and overhead on cable trays
- Fire protection: Fire-resistant cables in escape routes
- Identification: Color coding and labeling throughout
- Testing: Insulation resistance and continuity testing

Cable Containment:

- Cable trays: Galvanized steel ladder-type cable trays
- Conduits: Heavy-duty PVC conduits for embedded installation
- Trunking: Metal trunking for surface-mounted installations
- Ducting: Underground concrete ducting for main cables
- Support: Adequate support at required intervals
- Access: Accessible for maintenance and additions

6.3 LIGHTING SYSTEMS

6.3.1 Interior Lighting Design

Design Criteria:

- Illumination levels: As per international lighting standards
- Living areas: 200 lux average maintained illuminance
- Kitchens: 500 lux average maintained illuminance

- Bathrooms: 200 lux average maintained illuminance
- Corridors: 100 lux average maintained illuminance
- Stairways: 150 lux average maintained illuminance
- Emergency lighting: 1 lux minimum along escape routes

Lighting Control:

- Apartment lighting: Local switching with dimmer controls
- Common area lighting: Time clock and daylight sensor control
- Stairway lighting: Motion sensor activation
- External lighting: Photocell and time clock control
- Emergency lighting: Automatic operation during power failure
- Energy management: Occupancy sensors in appropriate areas

6.3.2 Light Fittings and Lamps

Living Areas:

- Fitting type: Recessed LED downlights
- Lamp type: 12W LED with 3000K color temperature
- Distribution: Even spacing for uniform illumination
- Controls: Wall-mounted dimmer switches
- Emergency: Emergency LED downlights in circulation areas
- Efficacy: Minimum 100 lumens per watt

Kitchen Areas:

- Under-cabinet lighting: LED strip lights with diffusers
- General lighting: Recessed LED downlights, 15W rating
- Task lighting: Pendant lights over island areas
- Controls: Multiple switching for different lighting zones
- Color rendering: High CRI (>80) for food preparation areas
- Maintenance: Easy lamp replacement without tools

Bathroom Lighting:

- Fitting type: IP44-rated bathroom downlights
- Mirror lighting: LED strip lights with diffused covers

- Shower areas: IP65-rated fittings with sealed construction
- Controls: Wall switches outside of wet zones
- Emergency: Emergency lighting in circulation areas
- Protection: All fittings protected against moisture

6.3.3 External Lighting

Building Facade:

- Accent lighting: LED floodlights for architectural features
- Entrance lighting: Decorative post-top lanterns
- Security lighting: High-intensity LED floodlights
- Controls: Photocell and time clock operation
- Energy efficiency: High-efficacy LED fittings throughout
- Maintenance: Long-life lamps with 50,000-hour rating

Landscape and Pathway:

- Path lighting: Low-level bollard lights along walkways
- Garden lighting: Spike-mounted spot lights for landscaping
- Pool lighting: Underwater LED lights with color-changing
- Safety lighting: Step lights at level changes
- Emergency lighting: Photoluminescent markers for evacuation
- Power supply: Weatherproof distribution boards

6.4 POWER OUTLETS AND SMALL POWER

6.4.1 Socket Outlet Distribution

Apartment Socket Outlets:

- Living rooms: 6 double socket outlets per room
- Bedrooms: 4 double socket outlets per room
- Kitchen: 8 double socket outlets plus dedicated circuits
- Bathrooms: 2 shaver socket outlets (transformer isolated)
- Balconies: 2 weatherproof socket outlets
- Type: 13A socket outlets with RCD protection

Dedicated Circuits:

- Air conditioning: Dedicated circuit per unit
- Kitchen appliances: Separate circuits for major appliances
- Water heaters: Dedicated high-current circuits
- Washing machines: Dedicated circuit with RCD protection
- Cooker circuits: 32A circuits for electric cooking
- Immersion heaters: Timer-controlled dedicated circuits

6.4.2 Small Power Systems

Common Area Power:

- Entrance lobby: Decorative lighting and power for cleaning
- Corridors: Power outlets for cleaning and maintenance
- Stairways: Emergency lighting and power outlets
- Plant rooms: Industrial socket outlets for maintenance
- Parking areas: Power outlets for cleaning equipment
- Lift motor rooms: Adequate power for lift systems

External Power Supplies:

- Garden power: Weatherproof outlets for maintenance
- Car parking: Power outlets for electric vehicle charging
- Pool equipment: Dedicated supplies for filtration systems
- Gate motors: Power supply for automatic gate systems
- Security systems: Uninterruptible power supply systems
- Irrigation: Power for automatic irrigation controllers

6.5 COMMUNICATION SYSTEMS

6.5.1 Telephone System

Infrastructure:

- Cable entry: Underground entry from telephone exchange
- Distribution: Cat 6 structured cabling throughout building
- Apartment provision: 2 telephone outlets per apartment
- Common areas: Emergency telephone in lift car
- Switchboard: PABX system for common areas

- Testing: End-to-end continuity and performance testing

6.5.2 Data and Internet Systems

Network Infrastructure:

- Cable type: Cat 6A cables for high-speed data transmission
- Distribution: Fiber optic backbone with copper distribution
- Apartment provision: 4 data outlets per apartment
- Common areas: WiFi access points in lobbies and corridors
- Equipment rooms: Dedicated IT rooms with climate control
- Testing: Cable certification to Category 6A standards

Wireless Systems:

- WiFi coverage: Complete coverage in common areas
- Access points: High-capacity access points with PoE supply
- Controller: Centralized wireless controller system
- Security: WPA3 encryption and access control
- Bandwidth: Gigabit internet connection to building
- Monitoring: Network monitoring and management system

6.5.3 Television and Satellite Systems

Cable TV Distribution:

- Infrastructure: Coaxial cable distribution to all apartments
- Amplifiers: Distribution amplifiers for signal strength
- Outlets: 3 TV outlets per apartment
- Common antenna: Roof-mounted antenna system
- Satellite provision: Provision for satellite dish installation
- Testing: Signal level testing at all outlets

Audio-Visual Systems:

- Intercom system: Video door entry system to apartments
- Public address: Emergency announcement system
- CCTV monitoring: Closed-circuit television in common areas
- Access control: Electronic access control for building entry

- Integration: Integration with security management system
- Maintenance: Regular testing and maintenance schedules

6.6 SECURITY SYSTEMS

6.6.1 Access Control System

System Architecture:

- Technology: Card-based access control with biometric backup
- Controllers: Distributed controllers throughout building
- Card readers: Proximity card readers at entry points
- Software: PC-based access control management software
- Database: Resident and visitor database management
- Integration: Integration with CCTV and alarm systems

Installation Points:

- Main entrance: Manned reception with access control
- Apartment entrances: Individual apartment access control
- Parking areas: Vehicle and pedestrian access control
- Service areas: Restricted access to plant and service rooms
- Elevators: Access control for floor-wise access
- Emergency exits: Monitoring of emergency exit usage

6.6.2 CCTV Surveillance System

Camera Specifications:

- Type: IP-based megapixel cameras with night vision
- Resolution: Minimum 2 megapixel (1920x1080) full HD
- Storage: Network video recorder with 30-day storage
- Monitoring: 24/7 monitoring capability from security office
- Coverage: All common areas, entrances, and parking areas
- Night vision: Infra-red illumination for low-light conditions

System Integration:

- Network: IP-based system using building data network
- Recording: Continuous recording with motion detection

- Remote access: Authorized remote viewing capability
- Backup: Redundant storage with off-site backup
- Analytics: Video analytics for intrusion detection
- Maintenance: Scheduled cleaning and calibration programs

6.6.3 Intruder Alarm System

Detection Devices:

- PIR detectors: Passive infra-red detectors in common areas
- Door contacts: Magnetic contacts on all external doors
- Glass break detectors: Acoustic glass break detection
- Vibration detectors: For external wall and window protection
- Beam detectors: Perimeter protection for outdoor areas
- Panic buttons: Silent alarm activation points

Control and Monitoring:

- Control panels: Distributed control panels with LCD displays
- Key pads: User interface for system operation
- Central monitoring: 24-hour monitoring station connection
- Mobile alerts: SMS and email notification capability
- Integration: Full integration with access control system
- Testing: Weekly system testing and monthly maintenance

6.7 FIRE ALARM AND LIFE SAFETY SYSTEMS

6.7.1 Fire Detection System

System Architecture:

- Type: Addressable fire alarm system with voice evacuation
- Control panel: Graphical display fire alarm control panel
- Detection: Smoke, heat, and flame detectors throughout
- Manual activation: Break-glass manual call points
- Notification: Visual and audible alarm devices
- Communication: Two-way communication to fire service

Detector Locations:

- Apartments: Smoke detectors in all rooms except bathrooms
- Common areas: Smoke detectors in corridors and lobbies
- Plant rooms: Heat detectors in mechanical and electrical rooms
- Kitchens: Heat detectors to avoid false alarms from cooking
- Parking areas: Smoke detectors with vehicle exhaust immunity
- Lift shafts: Smoke detectors at each floor level

6.7.2 Emergency Lighting System

System Requirements:

- Duration: 3-hour emergency operation capability
- Illumination: Minimum 1 lux along escape routes
- Testing: Monthly function testing and annual duration testing
- Battery backup: Central battery system with monitoring
- Indication: LED indication for normal and emergency operation
- Maintenance: Annual replacement of batteries and lamps

Fitting Locations:

- Exit routes: Continuous lighting along all escape routes
- Stairways: Adequate lighting for safe evacuation
- Fire exits: Illuminated exit signs at all exits
- Plant rooms: Emergency lighting for emergency operations
- Lift cars: Emergency lighting during power failure
- Assembly points: External lighting at assembly areas

6.7.3 Public Address System

System Configuration:

- Amplifiers: Distributed amplifier system with backup
- Speakers: Ceiling-mounted speakers in all areas
- Microphones: Firefighter microphone at fire control panel
- Zoning: Individual zone control for selective evacuation
- Integration: Full integration with fire alarm system
- Testing: Regular testing of all zones and communication clarity

6.8 LIGHTNING PROTECTION SYSTEM

6.8.1 Air Termination System

Lightning Rods:

- Type: Copper lightning rods with pointed tips
- Height: 2m above highest point of building
- Spacing: Maximum 20m spacing on roof perimeter
- Installation: Secure fixing to structural elements
- Testing: Annual resistance testing and visual inspection
- Maintenance: Regular inspection and cleaning

6.8.2 Down Conductor System

Conductor Installation:

- Material: Copper tape or round conductor
- Size: Minimum 50mm^2 cross-sectional area
- Route: Direct route to earth electrodes
- Fixings: Secure fixings at 1m intervals
- Joints: Compression joints throughout system
- Testing: Continuity testing of complete system

6.8.3 Earth Termination System

Earthing System:

- Electrodes: Copper earth rods driven to 3m depth
- Resistance: Maximum 10 ohms earth resistance
- Testing: Annual earth resistance testing
- Bonding: Bonding to main electrical earthing system
- Separation: Minimum 2m separation from other earth systems
- Documentation: Complete test certificates and drawings

6.9 EMERGENCY POWER SYSTEMS

6.9.1 Standby Generator

Generator Specifications:

- Type: Diesel-driven alternator with automatic start

- Rating: 100 kVA continuous rating
- Fuel: 8-hour fuel capacity with day tank
- Starting: Electric start with battery backup
- Cooling: Radiator cooling with thermostat control
- Exhaust: Silenced exhaust system with emissions control

Installation Requirements:

- Location: Dedicated generator room with ventilation
- Foundation: Reinforced concrete foundation with isolation
- Fuel supply: Underground fuel tank with leak detection
- Exhaust system: Externally discharged with silencer
- Control panel: Digital control panel with remote monitoring
- Testing: Weekly automatic testing and monthly load testing

6.9.2 Uninterruptible Power Supply (UPS)

UPS System:

- Type: Online double-conversion UPS system
- Rating: 50 kVA for critical loads
- Battery backup: 30-minute backup duration
- Installation: Dedicated UPS room with climate control
- Monitoring: Remote monitoring and alarm indication
- Maintenance: Annual maintenance by certified technician

Protected Loads:

- Fire alarm system: Complete fire safety system protection
- Emergency lighting: Central battery system backup
- Security systems: CCTV and access control protection
- Communication systems: Telephone and data system protection
- Lift systems: Emergency power for trapped passenger rescue
- Critical mechanical systems: Smoke extraction and pressurization

6.10 EARTHING AND BONDING

6.10.1 Main Earthing System

Earth Electrode System:

- Type: Multiple earth rods connected in parallel
- Material: Copper-clad steel rods, 16mm diameter
- Depth: Minimum 3m depth or to permanent moisture
- Resistance: Maximum 1 ohm total earth resistance
- Testing: Annual earth resistance measurement
- Documentation: Earth resistance test certificates

Main Earth Terminal:

- Location: Main electrical intake room
- Construction: Copper bus bar with multiple connections
- Bonding: All metallic services bonded to main earth
- Lightning protection: Lightning protection system bonding
- Telecommunications: Separate earthing for telecom systems
- Testing: Annual continuity testing of all bonds

6.10.2 Equipotential Bonding

Services Bonding:

- Water pipes: Main water service bonding
- Gas pipes: Main gas service bonding (where applicable)
- Structural steelwork: Building frame bonding
- Cable containment: Metallic cable tray and conduit bonding
- Air conditioning: All mechanical equipment bonding
- Swimming pool: Complete equipotential bonding zone

Bathroom Bonding:

- Supplementary bonding: All exposed metalwork bonded
- Bath and shower: Metal baths and shower trays bonded
- Towel rails: Electric towel rails with bonding connection
- Pipework: All metal water pipes bonded
- Testing: Resistance testing between bonded parts
- Certification: Electrical installation certificates required

7. EXTERNAL DEVELOPMENT WORKS

7.1 SITE PREPARATION AND EARTHWORKS

7.1.1 Site Clearance and Demolition

Existing Structures:

- Survey: Detailed survey of existing structures and utilities
- Demolition: Controlled demolition with dust suppression
- Disposal: Licensed disposal of demolition waste
- Salvage: Recovery of reusable materials where possible
- Safety: Comprehensive safety measures during demolition
- Environmental: Environmental protection during works

Site Clearance:

- Vegetation: Removal of existing vegetation and tree stumps
- Topsoil: Strip and stockpile topsoil for landscaping
- Debris: Remove all surface debris and foreign materials
- Underground: Locate and mark existing underground services
- Access: Maintain emergency access during clearance
- Dust control: Water spraying for dust suppression

7.1.2 Excavation and Earthworks

Bulk Excavation:

- Method: Mechanical excavation with hand trimming
- Levels: Excavation to formation as per drawings
- Support: Temporary support to excavations where required
- Dewatering: Groundwater control measures if encountered
- Material handling: Segregation of suitable and unsuitable material
- Compaction: Controlled compaction of backfill materials

Cut and Fill Operations:

- Survey: Accurate setting out and level control
- Material: Use of on-site material where suitable

- Compaction: Layer compaction to 95% maximum dry density
- Testing: Regular density testing during compaction
- Moisture control: Optimum moisture content maintenance
- Quality control: Continuous inspection and testing

7.1.3 Soil Stabilization

Ground Improvement:

- Assessment: Soil testing to determine treatment requirements
- Stabilization: Cement or lime stabilization where required
- Geotextiles: Separation and reinforcement fabrics
- Drainage: Subsoil drainage systems where needed
- Testing: Plate bearing tests on completed formations
- Certification: Engineering certification of ground treatment

7.2 ROADS AND PAVING

7.2.1 Access Roads and Driveways

Pavement Construction:

- Sub-base: 200mm compacted crushed stone sub-base
- Base course: 150mm dense bitumen macadam base
- Surface course: 40mm hot rolled asphalt wearing course
- Joints: Expansion joints at 25m centers
- Drainage: Adequate crossfall for surface water removal
- Markings: Road markings and signage as required

Construction Standards:

- Preparation: Proof rolling of formation level
- Materials: Approved materials from licensed sources
- Compaction: Rolling with appropriate plant to specification
- Thickness: Accurate thickness control throughout
- Levels: Accurate level control and crossfall
- Quality: Regular quality control testing

7.2.2 Parking Areas

Parking Layout:

- Spaces: Standard 2.5m x 5.0m parking spaces
- Circulation: 6m wide circulation aisles
- Accessible spaces: Disabled parking spaces as required
- Motorcycle parking: Designated motorcycle parking area
- Visitor parking: Adequate provision for visitors
- Service access: Access for emergency and service vehicles

Surface Construction:

- Concrete paving: 150mm reinforced concrete slabs
- Reinforcement: A252 mesh reinforcement throughout
- Joints: Expansion joints every 25m^2 maximum
- Surface finish: Brushed finish for slip resistance
- Drainage: Falls to drainage channels and gullies
- Marking: Painted line marking for space delineation

7.2.3 Pedestrian Areas

Walkways and Paths:

- Width: Minimum 1.5m width for main walkways
- Construction: 100mm concrete base with paving finish
- Surface: Natural stone paving with anti-slip finish
- Joints: Pointing with appropriate mortar mix
- Accessibility: Ramps and tactile paving where required
- Lighting: Adequate lighting for night-time use

Plaza and Gathering Areas:

- Design: Attractive paved areas for resident use
- Materials: Premium natural stone paving
- Patterns: Decorative paving patterns and borders
- Seating: Integrated seating elements where appropriate
- Planting: Integrated planters and landscape features
- Drainage: Adequate drainage without ponding

7.3 LANDSCAPING AND IRRIGATION

7.3.1 Landscape Design Principles

Climate Considerations:

- Plant selection: Drought-tolerant and heat-resistant species
- Water conservation: Low water requirement landscaping
- Soil preparation: Soil improvement for plant establishment
- Microclimate: Creating favorable microclimates
- Maintenance: Low-maintenance landscape design
- Seasonal interest: Year-round landscape appeal

Sustainable Landscaping:

- Native plants: Use of indigenous plant species
- Water efficiency: Drip irrigation and moisture sensors
- Soil health: Organic soil improvement and mulching
- Integrated pest management: Natural pest control methods
- Recycling: Use of recycled materials where possible
- Energy conservation: Strategic planting for building shading

7.3.2 Soft Landscaping

Tree Planting:

- Species selection: Date palms and native shade trees
- Planting: Proper planting techniques and staking
- Soil preparation: Imported topsoil and soil amendments
- Mulching: Organic mulch for moisture retention
- Watering: Deep watering during establishment period
- Maintenance: Pruning and fertilization program

Shrub and Ground Cover Planting:

- Selection: Drought-tolerant shrubs and perennials
- Layout: Mass planting for visual impact
- Spacing: Appropriate spacing for mature size
- Soil: Well-drained soil with organic amendments

- Mulching: Decorative mulch for weed suppression
- Irrigation: Efficient irrigation system installation

Lawn Areas:

- Grass type: Drought-tolerant grass varieties
- Preparation: Proper soil preparation and grading
- Installation: Hydroseeding or turf installation
- Irrigation: Pop-up sprinkler irrigation system
- Maintenance: Regular maintenance schedule
- Alternatives: Consideration of artificial turf in appropriate areas

7.3.3 Hard Landscaping Features

Retaining Walls:

- Construction: Reinforced concrete or natural stone
- Height: Designed for soil retention and safety
- Drainage: Weep holes and drainage behind walls
- Finish: Attractive finish complementing architecture
- Planting: Integrated planting where appropriate
- Safety: Adequate height and barrier protection

Water Features:

- Fountain: Central fountain feature in main plaza
- Construction: Reinforced concrete with waterproof lining
- Pumps: Recirculating pump system with filtration
- Lighting: Underwater lighting for nighttime effect
- Controls: Automatic timer control with manual override
- Maintenance: Easy access for cleaning and maintenance

Garden Structures:

- Pergolas: Timber or steel pergolas for shade
- Gazebos: Covered seating areas for residents
- Planters: Built-in planters with proper drainage
- Benches: Integrated seating throughout landscaping

- Art elements: Decorative elements and sculpture
- Storage: Landscape maintenance equipment storage

7.3.4 Irrigation Systems

System Design:

- Zones: Separate irrigation zones for different plant types
- Controllers: Automatic irrigation controllers with weather sensors
- Coverage: Complete coverage of all planted areas
- Efficiency: High-efficiency irrigation methods
- Monitoring: Soil moisture monitoring systems
- Backup: Manual operation capability

Installation Components:

- Water supply: Connection to building water supply
- Distribution: Underground PVC pipe distribution system
- Sprinklers: Pop-up sprinklers for lawn areas
- Drip irrigation: Drip lines for shrub and tree areas
- Controllers: Weather-based irrigation controllers
- Sensors: Rain sensors and soil moisture sensors

System Features:

- Automatic operation: Fully automated irrigation schedule
- Weather compensation: Adjustment based on weather conditions
- Water conservation: Smart controllers with water-saving features
- Remote monitoring: Smartphone app control capability
- Maintenance alerts: System monitoring and fault indication
- Manual override: Emergency manual operation capability

7.4 EXTERNAL UTILITIES

7.4.1 Electrical Infrastructure

External Power Distribution:

- Cable routes: Underground cable routes to building
- Street lighting: LED street lighting throughout site

- Security lighting: Perimeter and parking area lighting
- Emergency lighting: Emergency evacuation route lighting
- Power outlets: External power outlets for maintenance
- Control systems: Automatic lighting control systems

Installation Standards:

- Cable installation: Underground cables in protective ducts
- Cable marking: Cable route marking and identification
- Earthing: Comprehensive earthing system throughout
- Protection: Circuit protection appropriate to application
- Testing: Complete electrical testing and certification
- Documentation: As-built drawings and test certificates

7.4.2 Communications Infrastructure

External Communications:

- Telephone service: Underground service to building
- Internet service: Fiber optic service connection
- Cable TV: Underground cable TV service
- Mobile coverage: Mobile phone signal enhancement if required
- Emergency communications: Emergency telephone systems
- Public address: External public address capability

7.4.3 Water and Drainage Services

Water Supply Systems:

- Service connection: Connection to municipal water supply
- Distribution: Site-wide water distribution system
- Fire water supply: Hydrant system throughout site
- Irrigation supply: Dedicated irrigation water supply
- Water quality: Water quality monitoring and treatment
- Pressure management: Pressure reducing valves where required

Drainage Systems:

- Surface water: Site-wide surface water drainage system

- Foul drainage: Connection to municipal sewerage system
- Storm water management: Storm water detention if required
- Sustainable drainage: Permeable paving and infiltration systems
- Oil interceptors: In parking and service areas
- Maintenance access: Manholes and inspection chambers

7.5 BOUNDARY WALLS AND GATES

7.5.1 Perimeter Fencing and Walls

Boundary Wall Construction:

- Height: 2.5m high boundary wall around perimeter
- Construction: Reinforced concrete block wall with capping
- Foundation: Strip foundation below frost line
- Finish: Rendered and painted finish both sides
- Gates: Vehicle and pedestrian access gates
- Security: Integration with security systems

Design Features:

- Architectural treatment: Decorative elements and finishes
- Privacy screening: Solid construction for privacy
- Security features: Anti-climb features where appropriate
- Drainage: Adequate drainage at wall base
- Expansion joints: Movement joints at regular intervals
- Maintenance access: Access for maintenance and repair

7.5.2 Access Gates and Barriers

Main Vehicle Gate:

- Type: Sliding automatic gate with access control
- Width: 6m clear opening for vehicle access
- Construction: Steel frame with infill panels
- Operation: Electric motor with remote control
- Safety: Safety sensors and emergency stop
- Access control: Integration with building access system

Pedestrian Gates:

- Type: Single leaf swing gates with access control
- Width: 1.2m clear opening
- Construction: Steel frame matching vehicle gates
- Hardware: High-quality hinges and locks
- Access control: Card reader or keypad entry
- Emergency access: Emergency opening mechanism

Parking Barriers:

- Type: Automatic rising barriers for parking control
- Operation: Integration with parking management system
- Safety: Vehicle detection and safety devices
- Power supply: Mains power with battery backup
- Access control: Ticket system or resident access cards
- Emergency: Manual operation during power failure

7.6 SWIMMING POOL AND RECREATIONAL FACILITIES

7.6.1 Swimming Pool Construction

Pool Structure:

- Construction: Reinforced concrete shell construction
- Size: 20m x 10m recreational swimming pool
- Depth: Variable depth from 1.2m to 2.5m
- Waterproofing: Complete waterproofing membrane system
- Finish: Ceramic tile finish throughout
- Safety: Non-slip finishes and safety features

Pool Equipment:

- Filtration: Sand filtration system with backwash capability
- Circulation: Pumps and pipework for water circulation
- Chemical treatment: Automatic chlorination and pH control
- Heating: Pool heating system for year-round use
- Cleaning: Automatic pool cleaning system

- Safety equipment: Life-saving equipment and first aid

7.6.2 Pool Deck and Surroundings

Deck Construction:

- Material: Natural stone with non-slip finish
- Area: Adequate deck area for pool users
- Drainage: Deck drainage to prevent water accumulation
- Safety: Safety barriers and emergency equipment
- Furniture: Pool furniture and shade structures
- Landscaping: Integrated landscaping around pool area

Pool House Facilities:

- Changing rooms: Male and female changing facilities
- Toilets: Accessible toilet facilities
- Storage: Storage for pool equipment and furniture
- Mechanical room: Housing for pool equipment
- First aid: First aid station and emergency equipment
- Maintenance: Equipment for pool maintenance

7.6.3 Children's Play Area

Play Equipment:

- Age-appropriate: Equipment suitable for different age groups
- Safety: Safety surfacing and protective barriers
- Standards: Compliance with playground safety standards
- Installation: Professional installation and certification
- Maintenance: Regular inspection and maintenance program
- Accessibility: Accessible equipment where possible

Site Preparation:

- Safety surfacing: Impact-absorbing surface materials
- Drainage: Adequate drainage for all-weather use
- Fencing: Safety fencing around play area
- Seating: Seating for parents and supervisors

- Shade: Shade structures for sun protection
- Lighting: Adequate lighting for evening use

7.7 EXTERNAL SERVICES COORDINATION

7.7.1 Utility Coordination

Service Provider Coordination:

- Electricity: Coordination with Saudi Electricity Company
- Water: Coordination with National Water Company
- Telecommunications: Coordination with STC and other providers
- Gas: Coordination for gas supply if required
- Waste management: Coordination with waste collection services
- Emergency services: Access for fire and ambulance services

Installation Coordination:

- Timing: Coordination of utility installations
- Access: Provision of access for utility installation
- Testing: Coordination of testing and commissioning
- Documentation: Collection of completion certificates
- Handover: Coordination of utility service handovers
- Billing: Setup of utility billing and accounts

7.7.2 Authority Approvals

Municipal Approvals:

- Building permits: All required building permits
- Utility connections: Approvals for utility connections
- Road access: Approval for access to public roads
- Drainage connections: Approval for drainage connections
- Environmental: Environmental clearance certificates
- Occupancy: Final occupancy certificates

Regulatory Compliance:

- Fire department: Fire department approvals and inspections
- Civil defense: Civil defense clearance certificates

- Health department: Health department approvals where required
- Municipality: All municipal inspections and approvals
- Utilities: Utility company final inspections
- Insurance: Insurance company risk assessments

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8. QUALITY CONTROL AND TESTING

8.1 QUALITY MANAGEMENT SYSTEM

8.1.1 Quality Assurance Framework

Quality Policy:

- Commitment: Commitment to highest quality standards
- Compliance: Compliance with all applicable standards and codes
- Continuous improvement: Continuous quality improvement program
- Training: Comprehensive training for all personnel
- Documentation: Complete documentation of all quality procedures
- Review: Regular review and updating of quality procedures

Quality Control Organization:

- Quality manager: Dedicated quality manager for the project
- Site engineers: Quality control responsibilities for site engineers
- Testing laboratory: Certified testing laboratory services
- Independent inspection: Third-party inspection services where required
- Client representation: Client quality assurance representation
- Authority inspections: Coordination with authority inspections

8.1.2 Inspection and Testing Plan

Pre-construction Phase:

- Material approval: Approval of all materials before delivery
- Supplier assessment: Assessment of material suppliers
- Sample approval: Approval of material and finish samples
- Method statements: Approval of construction method statements
- Equipment calibration: Calibration of all testing equipment

- Personnel qualification: Verification of personnel qualifications

Construction Phase:

- Daily inspections: Daily quality inspections of all work
- Hold points: Mandatory inspection points during construction
- Testing schedule: Regular testing schedule for all materials
- Non-conformance: Non-conformance reporting and correction
- Progress monitoring: Quality progress monitoring and reporting
- Documentation: Complete documentation of all inspections and tests

8.2 MATERIAL TESTING AND APPROVAL

8.2.1 Concrete Testing

Fresh Concrete Tests:

- Slump test: Every concrete delivery or every 2 hours
- Temperature: Concrete temperature at delivery and placement
- Air content: For air-entrained concrete mixes
- Workability: Workability assessment throughout placement
- Setting time: Initial and final setting time testing
- Bleeding: Assessment of bleeding and segregation

Hardened Concrete Tests:

- Compressive strength: Cube tests at 7, 28, and 56 days
- Frequency: Minimum 6 cubes per $50m^3$ of concrete
- Core tests: Core samples where cube strength is questionable
- Permeability: Water permeability testing for water-resistant concrete
- Durability: Chloride penetration and carbonation tests
- Non-destructive testing: Rebound hammer and ultrasonic testing

8.2.2 Steel Testing and Inspection

Reinforcement Steel:

- Material certificates: Mill certificates for all reinforcement steel
- Tensile testing: Tensile strength and elongation testing
- Bend testing: Bend test for ductility verification

- Dimensions: Verification of bar dimensions and deformation pattern
- Surface condition: Inspection for rust, oil, and other contamination
- Storage: Inspection of storage conditions and identification

Structural Steel:

- Material certificates: Certified material test certificates
- Dimensional inspection: Verification of member dimensions and tolerances
- Welding inspection: Visual and non-destructive testing of welds
- Surface preparation: Inspection of surface preparation for painting
- Bolt testing: Testing of high-strength bolt installations
- Erection inspection: Inspection during erection process

8.2.3 Masonry and Blockwork Testing

Block Testing:

- Compressive strength: Compressive strength testing of concrete blocks
- Absorption: Water absorption testing of masonry units
- Dimensions: Dimensional accuracy and consistency testing
- Visual inspection: Visual inspection for cracks and defects
- Delivery inspection: Inspection of blocks on delivery
- Storage: Proper storage and protection of blocks

Mortar Testing:

- Mix design: Verification of mortar mix proportions
- Consistency: Workability and consistency testing
- Compressive strength: Mortar cube testing at 7 and 28 days
- Bond strength: Bond strength testing where required
- Workability: Workability period and retempering assessment
- Weather protection: Protection of mortar work in extreme weather

8.3 CONSTRUCTION TESTING PROCEDURES

8.3.1 Foundation Testing

Soil Testing:

- Bearing capacity: Plate bearing tests on foundation bearing surfaces

- Density testing: Density testing of backfill materials
- Laboratory testing: Comprehensive soil testing in accredited laboratory
- Groundwater: Monitoring of groundwater conditions
- Settlement monitoring: Settlement monitoring during and after construction
- Geotechnical review: Review by geotechnical engineer

Foundation Construction:

- Excavation inspection: Inspection of excavated foundation levels
- Reinforcement inspection: Inspection before concrete placement
- Concrete placement: Continuous inspection during concrete placement
- Curing monitoring: Monitoring of concrete curing procedures
- Waterproofing testing: Testing of waterproofing installation
- Backfill testing: Compaction testing of backfill materials

8.3.2 Structural Testing

Concrete Structure:

- Formwork inspection: Inspection of formwork before concrete placement
- Reinforcement inspection: Detailed inspection of reinforcement placement
- Concrete placement: Continuous monitoring during placement
- Curing inspection: Daily inspection of curing procedures
- Strength testing: Comprehensive strength testing program
- Dimensional survey: Survey of completed structural elements

Load Testing:

- When required: Load testing of suspect structural elements
- Test procedure: Controlled loading and deflection measurement
- Safety measures: Comprehensive safety measures during testing
- Instrumentation: Precision measurement instruments
- Reporting: Detailed test reports with recommendations
- Remedial action: Remedial measures if required

8.3.3 MEP Systems Testing

Mechanical Systems:

- Pressure testing: Pressure testing of all pipework systems
- Flow testing: Flow and pressure testing at fixtures
- Performance testing: Performance testing of all mechanical equipment
- Balancing: Air and water balancing of HVAC systems
- Commissioning: Complete commissioning of all mechanical systems
- Documentation: Complete commissioning documentation

Electrical Systems:

- Insulation testing: Insulation resistance testing of all circuits
- Continuity testing: Continuity testing of all connections
- Earth testing: Earth resistance and continuity testing
- Functional testing: Functional testing of all electrical systems
- Load testing: Load testing of generators and UPS systems
- Certification: Electrical installation certificates

8.4 FINISHES QUALITY CONTROL

8.4.1 Architectural Finishes

Wall Finishes:

- Surface preparation: Inspection of substrate preparation
- Material approval: Approval of all finish materials
- Application inspection: Inspection during application
- Thickness measurement: Measurement of applied thickness
- Adhesion testing: Adhesion testing of applied finishes
- Final inspection: Final inspection for defects and consistency

Floor Finishes:

- Substrate inspection: Inspection of floor substrates
- Level testing: Testing of floor levels and falls
- Installation inspection: Inspection during installation
- Joint inspection: Inspection of expansion and construction joints
- Surface testing: Testing of surface finish and slip resistance
- Protection: Protection of completed floor finishes

8.4.2 External Works Quality Control

Paving and Roadworks:

- Sub-base inspection: Inspection and testing of sub-base materials
- Compaction testing: Density testing of compacted layers
- Thickness measurement: Measurement of pavement thickness
- Level survey: Survey of pavement levels and crossfalls
- Surface inspection: Inspection of surface finish and texture
- Line marking: Inspection of road marking and signage

Landscaping:

- Soil testing: Testing of imported topsoil and amendments
- Plant inspection: Inspection of plants on delivery
- Installation inspection: Inspection of planting installation
- Irrigation testing: Testing and commissioning of irrigation systems
- Establishment monitoring: Monitoring of plant establishment
- Maintenance handover: Handover of maintenance requirements

8.5 TESTING DOCUMENTATION AND CERTIFICATION

8.5.1 Test Records and Certificates

Laboratory Testing:

- Accredited laboratories: Use of accredited testing laboratories only
- Test certificates: Original test certificates for all tests
- Sample identification: Clear identification of all test samples
- Chain of custody: Proper chain of custody for all samples
- Storage: Proper storage of test samples where required
- Reporting: Timely reporting of all test results

Site Testing:

- Test procedures: Standardized test procedures for all site tests
- Equipment calibration: Regular calibration of testing equipment
- Personnel qualification: Qualified personnel for all testing
- Weather conditions: Recording of weather conditions during testing

- Documentation: Complete documentation of all site tests
- Non-conformance: Immediate reporting of failed tests

8.5.2 Quality Documentation System

Document Control:

- Document numbering: Systematic numbering of all quality documents
- Version control: Version control for all quality procedures
- Distribution: Controlled distribution of quality documents
- Updates: Regular updating of quality documentation
- Storage: Secure storage of all quality records
- Retrieval: Easy retrieval system for quality documents

Record Keeping:

- Test records: Complete records of all testing activities
- Inspection records: Detailed records of all inspections
- Non-conformance records: Records of all non-conformances and corrections
- Material certificates: Complete material certification records
- As-built documentation: As-built drawings and specifications
- Handover documentation: Complete handover documentation package

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