



# **Abu Dhabi EHSMS Regulatory Framework (AD EHSMS RF)**

**EHS Regulatory Instrument**

**Code of Practice**

**EHS RI - CoP 42.0 – Tilt-Up and Pre-  
Cast Construction**

**Version 2.0**

**February 2012**

## ACKNOWLEDGEMENTS

With gratitude Abu Dhabi EHS Center acknowledges the great support provided by the Executive Council in facilitating the issuance of Abu Dhabi Emirate Environment, Health and Safety Management System (AD EHSMS) and its implementation at Emirate level.

The issuance of the system would not have been possible without the supervision, diligent efforts and productive recommendations of the AD EHS Center Board of Directors.

These documents (Regulatory Instruments) constitute the efforts of the Abu Dhabi EHS Center and the concerned Sector Regulatory Authorities who worked together to integrate all relevant regulatory requirements under *AD EHSMS RF*. The input, contribution and constructive views of all sectors is highly appreciated.

May these documents prove to be beneficial and helpful in system implementation and in expanding the knowledge in the EHS field.



DEPARTMENT OF MUNICIPAL AFFAIRS دائرة الشؤون البلدية

بلدية المنطقة الغربية  
WESTERN REGION MUNICIPALITY  
بلدية مدينة العين  
AL AIN CITY MUNICIPALITY  
بلدية مدينة أبوظبي  
ABU DHABI CITY MUNICIPALITY



هيئة مياه وكهرباء أبوظبي  
Abu Dhabi Water & Electricity Authority

دائرة النقل  
DEPARTMENT OF TRANSPORT



مكتب التنظيم و الرقابة  
Regulation & Supervision Bureau



هيئة الصحة - أبوظبي  
HEALTH AUTHORITY - ABU DHABI



مجلس أبوظبي للتعليم  
Abu Dhabi Education Council  
التعليم أولاً Education First



ZonesCorp  
الهيئة العامة للمناطق  
الاقتصادية المتخصصة



سلطة أبوظبي للرقابة الغذائية  
ABU DHABI FOOD CONTROL AUTHORITY



مركز إدارة النفايات - أبوظبي  
The Center of Waste Management - Abu Dhabi



هيئة أبوظبي للسياحة  
ABU DHABI TOURISM AUTHORITY

## Table of Contents

1.	Introduction .....	6
2.	Training and Competency.....	6
3.	Requirements .....	7
3.1	Roles and Responsibilities .....	7
3.2	Planning and Assessment.....	9
3.3	Design Documentation.....	12
3.4	Design for Handling, Storage and Transport .....	12
3.5	Handling, Storage and Transport .....	14
3.6	Erection Process.....	16
3.7	Incorporation into Final Structure .....	20
4.	References.....	20

## Preface

This Abu Dhabi EHS Regulatory Instrument was developed by the Building and Construction Sector Regulatory Authority as the primary Competent Authority for this topic to set the minimum mandatory requirements.

Every effort was made in developing this document so that it does not conflict with existing local or federal laws and regulations. In case of conflict, requirements of the existing local and federal laws and regulations shall prevail, and all concerned are obliged to bring the same to the attention of AD EHS Center for resolution.

This AD EHS Regulatory Instrument has been developed, reviewed and approved, following the process as described in *AD EHSMS Implementation Guideline: The Integration of EHS Requirements in the Emirate of Abu Dhabi*, by the following stakeholders:

- Abu Dhabi EHS Higher Committee;
- Abu Dhabi EHS Center;
- Environment Agency Abu Dhabi;
- Department of Municipal Affairs;
  - Abu Dhabi City Municipality;
  - Al Ain City Municipality;
  - Western Region Municipality;
- Department of Transport – Abu Dhabi;
- Abu Dhabi Water and Electricity Authority;
- Health Authority - Abu Dhabi;
- Higher Corporation for Specialized Economic Zones (ZonesCorp);
- Center for Waste Management – Abu Dhabi;
- Abu Dhabi Tourism Authority;
- Abu Dhabi Food Control Authority;
- Abu Dhabi Education Council;
- Regulation and Supervision Bureau; and
- Other Relevant Federal and Local Competent Authorities.

The AD EHSMS consists of the following hierarchy of documents:

- AD EHSMS RF Elements - Mandatory System Requirements

EHS Regulatory Instruments:

- Standards and Guideline Values - Mandatory EHS threshold and exposure levels
- Codes of Practice - Mandatory EHS technical requirements – subject specific
- Mechanisms - Mandatory system implementation processes and procedures

Guidelines:

- Technical Guidelines - Non-mandatory guidance on how to implement an EHS Regulatory Instrument
- AD EHSMS Guidance Documents - Non-mandatory guidance and interpretation of an *AD EHSMS RF* concept and/or principle

Further, this document is not intended to conflict with any contractual obligations in effect at the time of its issuance. However, all future contracts shall adhere to applicable requirements stated herein, and existing long term contracts shall be brought into compliance with its requirements as soon as reasonably practicable as stipulated by relevant subject authorities.

This document will be reviewed periodically as part of the continual improvement cycle.

## 1. Introduction

- (a) This Code of Practice (CoP) applies to all employers within the Emirate of Abu Dhabi. This CoP is designed to incorporate requirements set by Abu Dhabi EHS Center and Sector Regulatory Authorities in the Emirate of Abu Dhabi.
- (b) This CoP establishes the requirements and standards so that the risks associated with tilt-up and pre-cast concrete elements are assessed, that control measures are implemented in accordance with the hierarchy of controls and that control measures are implemented to prevent injury, illness and disease to persons who might be exposed to risks arising from those activities.
- (c) This CoP covers:
- safe design;
  - prefabrication and casting;
  - handling, storage, transportation; and
  - erection.
- (d) Pre-cast concrete elements not included in the scope of this CoP include concrete pipes, bridge beams and culverts.
- (e) In this CoP a pre-cast concrete element means a concrete panel or other pre-cast concrete element, made in either an on-site or off-site casting yard that is cast and then lifted into position to form part of a structure / building / services infrastructure, or part of a structure / building / services infrastructure.
- (f) In this CoP 'tilt-up' means:
- an essentially flat pre-cast concrete panel cast in a horizontal position, usually on site; initially lifted by rotation about one edge until in a vertical or near vertical position, and
  - transported and lifted into position if necessary; and then stabilized by bracing members until incorporated into the final structure.
- (g) In this CoP 'shop detailer' means the person responsible for preparing the shop drawings of the elements. The shop detailer may also be the pre-caster or a company or person responsible to the pre-caster.
- (h) In this CoP 'shop drawing' means a detailed drawing of a tilt-up or pre-cast concrete element used in the manufacturing process.

## 2. Training and Competency

- (a) Employers shall ensure that EHS training complies with the requirements of:
- AD EHSMS RF – Element 05 – Training and Competency;*
  - AD EHS RI – Mechanism 7.0 – AD EHS Professional Entity Registration; and*
  - AD EHS RI – Mechanism 8.0 – AD EHS Practitioner Registration.*

- (b) In accordance with *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation* Section 3.2.5 employers shall ensure employees required to implement the requirements of this CoP are trained in tilt-up and pre-cast construction and understand the risks associated with this type of construction and the control measures implemented by the employer;
- (c) Employers shall ensure all employees involved in the tilt-up and pre-cast concrete elements and activities are trained to recognise and respond to hazards associated with this type of work.
- (d) Employers shall maintain a record of the required training that contains the following information:
  - (i) name and ID number;
  - (ii) Emirates ID number;
  - (iii) subject(s) of training;
  - (iv) date(s) of training; and
  - (v) person(s) providing the training.
  - (vi) training provider.

### 3. Requirements

#### 3.1 Roles and Responsibilities

##### 3.1.1 Employer

- (a) Employers shall undertake their roles and responsibilities in accordance with the general requirements of *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation* Section 3.2.5.
- (b) Employers shall undertake their specific roles and responsibilities in accordance with the following:
  - (i) tilt-up and pre-cast concrete work is appropriately planned, organised and supervised;
  - (ii) to consult with designers and builders to ensure that safety matters are considered in all aspects of the design work for all pre-cast concrete element construction work;
  - (iii) those involved in tilt-up and pre-cast concrete and the equipment are trained and competent;
  - (iv) the location where tilt-up and pre-cast concrete elements work is done is safe; and
  - (v) tilt-up and pre-cast concrete equipment appropriately maintained and inspected.

##### 3.1.2 Principal Contractors

- (a) In the case of the Building and Construction Sector, Principal Contractors shall undertake their roles and responsibilities in accordance with the general requirements of *AD EHS RI – CoP 53.0 – EHS Management during “Construction Work”*.

- (b) Principal Contractors shall undertake their specific roles and responsibilities in accordance with the following:
- (i) ensure that employers have all available descriptions of the site, including design drawings, site surveys, plans of services and information on the nature and location of hazardous materials, the nature of building materials and the building or structure's relationship to surrounding properties;
  - (ii) relevant authorities and utility service providers are notified and all necessary approvals are obtained before work commences; and
  - (iii) the workplace is secured.

### 3.1.3 Employees

- (a) Employees shall undertake their roles and responsibilities in accordance with the general requirements of *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation* Section 3.2.7.
- (b) Employees shall undertake their specific roles and responsibilities in accordance with the following:
- (i) following information provided by the employer regarding tilt-up and pre-cast concrete equipment use; and
  - (ii) observing the tilt-up and pre-cast concrete elements safe work practices and operating procedures prescribed by the employer, including the observation of warning signs.

### 3.1.4 Designers

- (a) Designers shall undertake their roles and responsibilities in accordance with the general requirements of *AD EHS RI – CoP 20.0 – Safety in Design (Construction)*.
- (b) Designers shall undertake their specific roles and responsibilities in accordance with the following:
- (i) the structural design shall take into account the particular requirements of pre-cast concrete structures to ensure that the pre-cast concrete elements can be erected safely, for example: design in fall protection tie off points;
  - (ii) special care is taken during design and construction to guard against progressive collapse;
  - (iii) the slenderness and stability of tilt-up and pre-cast concrete elements is taken into account;
  - (iv) the specification of the strength of concrete takes into account the strength required at lifting, as well as the requirements for in-service loading, durability and ease of construction;
  - (v) the concrete strength required at lifting is in accordance with the lifting insert manufacturer's specifications, and
  - (vi) concrete specifications are clearly shown on the drawings and include any special requirements which may include cement content and water-cement ratio.

## 3.2 Planning and Assessment

### 3.2.1 Assessment

- (a) Employers shall ensure the following:
- (i) an assessment of the various risks is undertaken and systems of work are established which are safe to all parties involved or affected including the public;
  - (ii) that appropriate control measures are implemented in order to manage activities safely and without risk to health;
  - (iii) that for the Building and Construction Sector the management of tilt-up and pre-cast concrete requirements are included in the Pre-Tender Environment, Health and Safety Plan in accordance with *AD EHS RI – CoP 53.0 – EHS Management during “Construction Work”*; and
  - (iv) that associated safe systems of work and site rules are included in the Environment, Health and Safety Construction Management Plan (EHS-CMP) in the case of the Building and Construction Sector in accordance with *AD EHS RI – CoP 53.0 – EHS Management during “Construction Work”*.

### 3.2.2 Documentation

- (a) Employers shall include the following information in the documented systems of work:
- (i) design documentation including:
    - 1) proprietary documentation;
    - 2) prefabricator’s inspection and statement;
    - 3) risk assessment(s);
    - 4) structural design drawings; and
    - 5) element documentation including marking plans, shop drawings and erection documentation.
  - (ii) the proposed sequence of work and the complete construction and erection sequences shall be planned before the pre-cast concrete elements are fabricated;
  - (iii) details of the stabilization methods (temporary and permanent) to be used while pre-cast concrete elements are being erected in order to guard against the collapse of a pre-cast concrete element, panel or structure;
  - (iv) the methods used need to be appropriate to ensure appropriate structural strength and continuity of the structure and its parts, both during the erection phase and in the finished structure;
  - (v) the methods used need to safely transmit applied loads through the structure;
  - (vi) crane requirements need to be taken into account;
  - (vii) signed copies of any changes made to specifications and/or signed instructions, advice or diagrams made or issued by an engineer;
  - (viii) a copy of any notification to a relevant authority responsible for the regulation of pre-cast concrete element construction work; and
  - (ix) a copy of any report, license or authority required to carry out pre-cast concrete element construction work.

### 3.2.3 Risk Assessment

- (a) Employers shall ensure prior to the undertaking tilt-up and pre-cast concrete work a risk assessment be conducted for the selection of appropriate control measures in accordance with *AD EHSMS RF – Element 02 – Risk Management*.
- (b) Employers shall ensure the risk assessment considers the following hazards associated with the use of tilt-up and pre-cast construction which may include:
- (i) hazard identification and risk assessment shall be considered at each stage of the pre-cast concrete element construction work, including:
    - 1) design;
    - 2) prefabrication;
    - 3) handling, storage and transport;
    - 4) erection and temporary bracing;
    - 5) fixing into final structure;
    - 6) brace removal; and
    - 7) modification and/or demolition.
  - (ii) contributing hazards may include:
    - 1) the features of the site such as sloping ground, rough surfaces, holes and other obstructions;
    - 2) overhead power lines and/or underground utilities;
    - 3) weather conditions, particularly locations that are prone to gusty wind conditions;
    - 4) working at height;
    - 5) manual handling;
    - 6) sites with many activities being undertaken at the same time;
    - 7) hazardous substances including curing compounds and release agents, and
    - 8) the movement of traffic and mobile plant on and adjacent to the site.
  - (iii) the most significant hazard posed by pre-cast concrete elements is that of severe crush injuries resulting from:
    - 1) the uncontrolled collapse of pre-cast concrete elements during handling and erection, including while temporarily braced or when elements are being modified or removed; and
    - 2) a person being caught between pre-cast concrete elements, between pre-cast concrete elements and mobile plant or between pre-cast concrete elements and other structural components.
  - (iv) factors that may contribute to the likelihood of an uncontrolled collapse and injury include:
    - 1) faulty design, including the use of incorrect components or inappropriate concrete strength;
    - 2) faulty lifting inserts or connectors;

- 3) poorly secured loads or incorrect methods used for loading or unloading elements for transport;
  - 4) weakness in pre-cast concrete elements due to inappropriate modifications;
  - 5) incorrect lifting and erection practices, including the unsafe use of rigging;
  - 6) lifting before the pre-cast concrete element has reached its design strength;
  - 7) weakness resulting from errors whilst fabricating the pre-cast concrete elements;
  - 8) inappropriate lifting equipment for the task;
  - 9) inappropriate or unstable work area for the cranes;
  - 10) inappropriate structural capacity of footings;
  - 11) damage to pre-cast concrete elements and/or weakness of subsequent repairs; and
  - 12) inappropriate temporary storage facilities, including racking systems, suspended floors or beams.
- (v) environmental factors may also increase the likelihood of an injury for persons undertaking pre-cast concrete element construction work and may include:
- 1) the wind speed may exceed specifications for the safe erection of the pre-cast concrete elements;
  - 2) wet weather may cause instability in the crane standing area or erection area, refer to *AD EHS RI – CoP 11.0 – Safety in the Heat*; and
  - 3) extremes in temperature may make it unsafe for those persons erecting the pre-cast concrete elements.

### 3.2.4 Documented Safe Systems of Work

- (a) In accordance with *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation* Section 3.2.5 employers shall ensure documented safe systems of work are developed, implemented and include:
- (i) a detailed erection scheme;
  - (ii) phasing of the work, particularly with that of other affected contractors;
  - (iii) special requirements relating to the safe erection of the structure shall be highlighted at the pre-contract stage;
  - (iv) special site conditions such as close proximity of other buildings or access restrictions;
  - (v) ground conditions particularly with regards to conditions that may need to be considered when positioning a crane;
  - (vi) Personal Protective Equipment (PPE) is selected by considering standards and requirements that apply to construction generally and to tilt-up and pre-cast construction in accordance with *AD EHS RI – CoP 2.0 – Personal Protective Equipment*; and
  - (vii) cranes and lifting gear shall be selected and used in accordance with the requirements of *AD EHS RI – CoP 34.0 – Safe Use of Lifting Equipment and Lifting Accessories*.

### 3.3 Design Documentation

#### 3.3.1 Proprietary Documentation

- (a) Employers shall ensure that where proprietary systems for tilt-up or pre-cast concrete construction are used the manufacturer's specifications and erection procedures are to be available on site and briefed to the erection crew.
- (b) Employers shall ensure all components used on site, within a particular system, shall be compatible and different proprietary components shall not be mixed without confirmation of compatibility from the supplier and the designer.

#### 3.3.2 Structural Design Drawings

- (a) Employers shall ensure that the structural design drawings are prepared by an engineer which details all the structural design considerations including details of the base requirements for the final structure.
- (b) Employers shall ensure the structural design drawings, including the approval of any proposed proprietary or manufactured inserts and fixings, are signed off by a competent engineer.

#### 3.3.3 Marking Plan

- (a) Employers shall ensure a marking plan (layout plan) is prepared by the shop detailer which shall show the location of each pre-cast concrete element in the final structure along with the erection/assembly sequence.

#### 3.3.4 Erection Documentation

- (a) Employers shall ensure the erection documentation prepared by the engineer shall cover every aspect of the erection process, including:
  - (i) erection sequence;
  - (ii) orientation (position relative to each other) of the pre-cast concrete elements;
  - (iii) configuration and size of erection braces and, where applicable, knee braces and cross-bracing provided by the engineer;
  - (iv) bracing details including type and angle, designed and certified by an engineer;
  - (v) requirements for erection brace footings, brace fixings and concrete strength of the brace footings at the time of erection by an engineer;
  - (vi) levelling shim details for erection, and
  - (vii) the requirements for grouting specified by an engineer.

### 3.4 Design for Handling, Storage and Transport

#### 3.4.1 General Requirements

- (a) Employers shall ensure the design for handling pre-cast concrete elements considers:
  - (i) the size, weight and shape of the pre-cast concrete element;

- (ii) whether the pre-cast concrete element is to be lifted by the edge or the face;
- (iii) whether the pre-cast concrete element is to be rotated during erection;
- (iv) cast-in fittings;
- (v) handling and storage loads including:
  - 1) the effect of suction and adhesion at separation from the formwork or casting bed;
  - 2) dynamic and impact loading during transportation;
  - 3) erection and bracing loads;
  - 4) wind load on the braced panels during erection;
  - 5) construction loads including any backfill and surcharge loads;
  - 6) permanent, imposed and other loads; and
  - 7) the increase in design loads due to wind load and seismic load;
- (vi) additional reinforcement; and
- (vii) the brace footings.

### 3.4.2 Size and Shape of Pre-Cast Concrete Elements

- (a) Employers shall ensure the following:
  - (i) when determining the size and shape of pre-cast concrete elements, consideration is given to the:
    - 1) size, capacity and configuration of the crane(s) available to undertake lifting and erection;
    - 2) manufacturing restrictions;
    - 3) location and proximity of overhead power supplies;
    - 4) access to and around the site;
    - 5) bracing, propping and grouting requirements, and
    - 6) the transport restrictions.
  - (ii) the load capacity of lifting inserts are assessed; and
  - (iii) when fixed length multi-legged slings are to be used for lifting pre-cast concrete elements, any two of the lifting inserts shall be capable of supporting the total load.

### 3.4.3 Lifting Inserts

- (a) Employers shall ensure the following:
  - (i) lifting inserts are configured in accordance with the manufacturer's recommendations, including component reinforcement for the direction of the applied load;
  - (ii) when selecting lifting inserts, consideration is given to the suitability of the component for the task to be undertaken and this information shall be included in the shop drawings;

- (iii) the number of lifting inserts required is assessed and dependent on several factors including the pre-cast concrete element size and shape, insert capacity and insert location; and
- (iv) the location of lifting inserts is interrelated to the reinforcement design and the proposed erection procedures.

#### **3.4.4 Cast-in Fixings**

- (a) Employers shall ensure the following:
  - (i) cast-in fixings such as threaded inserts, weld plates or brackets are to be designed and specified by an engineer and shall be installed as per the manufacturer's recommendations for proprietary items;
  - (ii) where reasonably practicable, to minimise the chance of error, fixings shall be standardised for all pre-cast concrete elements on an individual project;
  - (iii) where permanent fixings or connections are also intended for temporary use during construction, the erector shall verify that such use will not compromise their long term performance; and
  - (iv) impact driven fixings, including explosive charge driven fixings, shall not be used unless confirmation is received from the engineer that this method of fixing is acceptable.

#### **3.4.5 Wind Loads**

- (a) Employers shall ensure the wind loading is calculated on pre-cast concrete elements and take into consideration the variances depending on the size of the elements, wind speed and wind direction.

### **3.5 Handling, Storage and Transport**

#### **3.5.1 Handling**

- (a) Employers shall ensure the following:
  - (i) the rigging system to be used on site for each pre-cast concrete element is set out in the erection documentation;
  - (ii) verification that the pre-cast concrete element and brace footing concrete has attained the specified strength for lifting and that the brace fixing bolts are available on site;
  - (iii) during handling, minimise the likelihood of impact between the pre-cast concrete elements; and
  - (iv) the transporter is made aware of any site-specific hazards prior to the transporting of any pre-cast concrete elements.

#### **3.5.2 Storage**

- (a) Employers shall ensure the following:
  - (i) the pre-cast concrete elements are stored in a position that is safe and does not present a risk to those on site;

- (ii) racking systems, frames and supports are designed by an engineer for the shape, size and weight of the pre-cast concrete element;
- (iii) approval and written instructions are obtained from the engineer before a pre-cast concrete element is stored horizontally;
- (iv) approval and written instructions are obtained from the engineer before a pre-cast concrete element is stored on a suspended floor slab or beam; and
- (v) during storage, minimise the likelihood of impact between the pre-cast concrete elements and vehicular or plant movement by providing barriers or restricting access.

### 3.5.3 Planning Crane Requirements

- (a) Employers shall ensure that crane selection, access and sitting are conducted in accordance with *AD EHS RI – CoP 34.0 – Safe Use of Lifting Equipment and Lifting Accessories*, which shall include:
  - (i) the crane selection, access and sitting;
    - 1) the crane shall be located with consideration given to the erection sequence of the pre-cast concrete elements to avoid any possibility of the rear of the crane slewing into braces supporting previously erected pre-cast concrete elements; and
    - 2) where two or more cranes are operating they shall be sited so as to prevent them operating in each other's airspace. Where this is not reasonable practicable, procedures shall be established to prevent unplanned contact between them.
  - (ii) written procedures, including a risk assessment of these procedures, for setting up and dismantling the crane and for the lifting method shall be used;
  - (iii) selection of lifting gear and accessories including, if rotation is to be carried out, the appropriate snatch block for rotation of pre-cast concrete elements while suspended; and
  - (iv) means to disengage the rigging gear from the concrete panel once it has been temporarily fixed into position.
- (b) Employers shall ensure documentation relating to the selection, erection and dismantling of a crane used during concrete construction work is retained by the person with control of the construction project until completion of the construction project.

### 3.5.4 Transport

- (a) Employers shall ensure the transporter has been appropriately instructed in the safe transportation of pre-cast concrete elements including panels, with particular attention given to:
  - (i) overhead power lines and load height restrictions on the site;
  - (ii) other activities on the site at the time of transportation;
  - (iii) recognised routes for over-dimensional loads;
  - (iv) site limitations and local street access;

- (v) the site specific traffic management plan; and
  - (vi) differential road cambers as these may induce a torsion load on long pre-cast concrete elements.
- (b) Employers shall ensure that at the entrance of the construction site, the transporter is provided with specific information relating to the site roads and any hazards that may be present which could affect the safe transportation of the load.

### 3.5.5 Loading and Unloading

- (a) Employers involved with the transportation of pre-cast concrete elements shall ensure the following;
- (i) pre-cast concrete elements are loaded in a sequence compatible with the required unloading sequence at their intended final destination;
  - (ii) each pre-cast concrete element is individually secured as the unloading sequence can lead to instability of loads;
  - (iii) pre-cast concrete elements are loaded so that identification marks are visible before and during unloading;
  - (iv) when unloading, individual pre-cast concrete elements shall not be released until the crane has taken the initial load of that element; and
  - (v) the location of lifting inserts on pre-cast concrete elements is checked to ensure they are compatible with the lifting system to be used and lifting inserts shall be clearly identified to assist in the loading and unloading stages.

### 3.5.6 Support Frames

- (a) Employers involved with the transportation of pre-cast concrete elements shall ensure the following:
- (i) the frames used to support pre-cast concrete elements during transportation shall be designed to withstand the loads and forces which may act on the components during loading, transportation and unloading; and
  - (ii) where a frame system that is not an integral part of the transport vehicle or trailer, it shall be appropriately secured and be capable of withstanding any forces applied during loading, transportation and unloading.

## 3.6 Erection Process

### 3.6.1 Planning Considerations

- (a) Before erecting pre-cast concrete elements, the employer shall plan the construction and erection sequences. The erection sequence of panels shall be specified on the shop drawings and modified for each project as required.
- (b) Employers shall ensure that the planning process includes consideration of the following:
- (i) casting and delivery sequence;
  - (ii) erection sequence and structural stability during erection, including temporary braces, props and fixings;

- (iii) pre-cast concrete element sizes;
- (iv) crane size, configuration, mobility and access;
- (v) working radius of the crane shown on a crane layout drawing;
- (vi) height access equipment appropriate to the construction methods.
- (vii) site limitations and local street access; and
- (viii) underground power lines and other utilities.

### 3.6.2 Structural Stability – Preventing Unplanned Collapse

- (a) Employers shall ensure progressive collapse is prevented by providing either:
  - (i) appropriate structural strength and continuity of the structure and its parts; or
  - (ii) alternative load paths that cause applied forces to be safely transmitted through the structure.
- (b) Employers shall ensure the following:
  - (i) the regular inspection of the braces and bracing inserts, fixings and connections;
  - (ii) the torque of the brace bolts is checked 24 hours after erection, unless otherwise instructed by the anchor manufacturer and again at appropriate intervals after installation as determined in the erection planning stage; and
  - (iii) daily visual inspection of all braced and bracing pre-cast concrete elements.
- (c) Employers shall ensure the stability of the structure is monitored and maintained during the erection phase.

### 3.6.3 'No-Go' zones

- (a) Employers shall ensure the following:
  - (i) only persons directly involved (including supervisors and engineers) with the lifting of pre-cast concrete elements are allowed access to an area where lifting is taking place;
  - (ii) measures shall be implemented to prevent access to areas where persons could be struck in the event of a pre-cast concrete element falling or become crushed between a pre-cast concrete element and any other hard surface;
  - (iii) where reasonably practicable, loads are not to be suspended over, or travel over, a person. Where this is not reasonably practicable to achieve an effective back-up slinging system that is designed by an engineer is to be used. The back-up system shall be capable of containing all of the suspended pre-cast concrete element in the event of a failure of the primary slinging system;
  - (iv) the establishment of a 'no-go' zone will necessitate the erection of appropriate signage and/or barriers depending on the ease of access and the presence of employees, other employees or members of the public; and
  - (v) where a footpath, road or other access way is located in an exclusion zone, all members of the public and all traffic shall to be prevented from passing through the zone while pre-cast concrete element construction work is being undertaken.

### 3.6.4 Pre-Cast Concrete Construction Pre-Start Requirements

- (a) Employers shall ensure the following before commencing construction work involving pre-cast concrete elements:
- (i) ensure an engineer has provided a certification letter that certifies the temporary support system for the pre-cast concrete elements;
  - (ii) ensure that all employees involved in pre-cast concrete construction have been fully briefed on the safe system of work and control measures identified in the risk assessment;
  - (iii) confirm that all the pre-cast concrete elements have attained the minimum required concrete strength for lifting and erection as specified on the shop drawings;
  - (iv) confirm that the brace footings have attained their required strength before the pre-cast concrete elements are erected;
  - (v) ensure that provision has been made for safe working at heights, in accordance with *AD EHS RI – CoP 23.0 – Working at Heights*;
  - (vi) make sure that locating dowels or other horizontal restraints are fitted before pre-cast concrete elements are lowered and that levelling shims are correctly located;
  - (vii) confirm that the means of support, including falsework, are appropriate for the intended purpose and are correctly located;
  - (viii) check that appropriate clear space is available for the safe propping and bracing of pre-cast concrete elements and ensure that where required braces are pre-fitted to the elements; and
  - (ix) determine if weather conditions are acceptable for pre-cast concrete construction work to proceed.

### 3.6.5 Rigging of Pre-Cast Concrete Elements

- (a) Employers shall ensure that all rigging of pre-cast concrete elements and associated components is carried out in accordance with the requirements set out in *AD EHS RI – CoP 34.0 – Safe Use of Lifting Equipment and Lifting Accessories*.

### 3.6.6 Pre-Cast Concrete Construction Safe Working Requirements

- (a) Employers shall ensure the following during the erection of pre-cast concrete elements;
- (i) no person shall work on a pre-cast concrete element that is leaning towards them or be placed between a pre-cast concrete element being lifted and another wall or object, where movement of the pre-cast concrete element could cause crushing;
  - (ii) in all circumstances where a lift has been stopped, procedures such as wedging or jacking shall be carried out;
  - (iii) during the lifting process, any braces that have been pre-fitted shall not hang below the level of the base of the pre-cast concrete element;

- (iv) where, in unusual circumstances, it is necessary to attach braces to the pre-cast concrete element after it has been positioned, the pre-cast concrete element is to be held securely by the crane while the braces are attached; and
- (v) once erection of the pre-cast concrete element and bracing has been completed, the employer shall check braces, brace bolts and pins at regular intervals to ensure they maintain the required capacity.

### 3.6.7 Erection Employees

- (a) Employers shall undertake the following:
  - (i) nominate one person in the erection crew to be responsible for the direction and coordination of the erection sequence;
  - (ii) ensure all employees involved in the erection of pre-cast concrete element construction are trained and competent in working lifting equipment and accessories; and
  - (iii) the crane operator holds a license appropriate for the type and capacity of the crane in use, taking into account the maximum rated capacity of the crane.

### 3.6.8 Operating Mobile Plant near Braces and Pre-Cast Concrete Elements

- (a) Employers shall ensure where it is necessary to operate mobile plant in close proximity to braces and pre-cast concrete elements, control measures are to be implemented, including the use of:
  - (i) a spotter, to signal the plant operator to stop the plant in the event of any part of the plant approaching a brace or pre-cast concrete element;
  - (ii) barricades to ensure separation of plant and braces, and
  - (iii) temporary hazard warning indicators such as hazard tape, cone and plank barriers and/or signage are provided to make the brace positions obvious, particularly where braces are close to access areas.
- (b) Employers shall ensure mobile plant is not operated or allowed to travel close to, erected pre-cast concrete elements and braces unless there is a sound reason, such as the use of a mobile elevating work platform to assist in the installation or removal of braces.

### 3.6.9 Installation, Inspection and Removal of Temporary Bracing

- (a) Employers shall ensure the following:
  - (i) bracing is installed in accordance with the approved shop drawings unless prior written approval is obtained from an engineer;
  - (ii) bracing connected to one pre-cast concrete element shall not be connected to another braced pre-cast concrete element for support unless this is clearly specified on the shop drawings;
  - (iii) brace locking pins are provided with retaining devices to prevent unintentional dislodgement of the locking pin and due to wind or construction load vibrations, brace locking pins shall be checked on a regular basis while in use;

- (iv) before installation all bracing shall be inspected and checked by a competent person;
- (v) regular inspections of all bracing, inserts, fixings and connections is undertaken in accordance with the inspection schedule prepared by a competent engineer; and
- (vi) superimposed loads are not applied to pre-cast concrete elements in the temporary braced condition unless clearance is obtained from a competent engineer and any such loads shall be specifically allowed for in the design.

### 3.7 Incorporation into Final Structure

- (a) Employers shall ensure the following:
  - (i) where the pre-cast concrete elements are to be attached to structural steel, an engineer is to detail all connection methods and these shall to be followed during construction;
  - (ii) documentation signed by the engineer shall be provided that clearly shows where materials can be stored, the maximum allowable quantity of stored materials and any other conditions that need to be achieved;
  - (iii) the engineer shall take into account the following factors when determining whether the structure is appropriate for storing materials:
    - 1) the design loadings of the final structure and assurance that the loads applied by stored materials will be less than these loadings;
    - 2) consideration of both point and distributed loads applied during the lifting and storage process (eg. storing concrete panels on timbers on a suspended slab will transfer concentrated loads to the slab in the area of the timber);
    - 3) the effect of incomplete bracing and stiffening on the structure's stability compared to the stability that would exist if the building was complete; and
    - 4) additional loading other than the dead weight of the pre-cast concrete element applied during crane landing of the element on the structure (eg. impact loading).

## 4. References

- *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation*
- *AD EHSMS RF – Element 02 – Risk Management*
- *AD EHSMS RF – Element 09 – Compliance and Management Review*
- *AD EHS RI – CoP 2.0 – Personal Protective Equipment*
- *AD EHS RI – CoP 11 – Safety in the Heat*
- *AD EHS RI – CoP 20.0 – Safety in Design (Construction)*
- *AD EHS RI – CoP 21.0 – Permit to Work Systems*
- *AD EHS RI – CoP 22.0 – Barricading of Hazards*

- *AD EHS RI – CoP 23.0 – Working at Heights*
- *AD EHS RI – CoP 34.0 – Safe Use of Lifting Equipment and Lifting Accessories*
- *AD EHS RI – CoP 53.0 – EHS Management During “Construction Work”*

© Abu Dhabi EHS Center 2012

This document is and shall remain the property of the AD EHS Center. The document may only be used for the purposes for which it was intended. Unauthorised use or reproduction of this document is prohibited.