EGYPTIAN CODES FOR DESIGN AND CONSTRUCTION OF BUILDINGS

By

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HBRC

- Housing and Building National Research Center is the leading research institutes in Building and construction in Egypt.

- It is also fully responsible for issuing codes and specifications related to the construction industry.

- It cooperates with other national and international research institutes and universities in many research projects aiming at developing the construction industry.
Publications of HBRC

Codes, Technical Specifications and Documents

- Set of basic infrastructure codes.
- Set of structural building codes.
- Set of codes for building works services.
- Set of codes for complementary works.
- Set of environmental engineering codes.
- Set of architectural concepts codes.
- Technical specifications for building systems.
- Technical specifications for works' items.
- Documents of contracts.
Codes In Egypt

- First code for reinforced concrete design was published in 1956.
- The government enforced the construction sector to follow codes since 1964.
- First print of codes for concrete structures, soil mechanics & foundation and electrical connections in buildings were published before 1980.
### EGYPTIAN CODES FOR BUILDING & CONSTRUCTION

#### (100) Basic Infrastructure Codes
- (101) Potable water, sanitary wastewater and lifting plants
- (102) Potable/sewage water pipelines
- (103) Operating & maintenance of potable water, wastewater treatment stations
- (104) Rural and urban highways

#### (200) Structural Building Codes
- (201) Calculation of loads & forces on structures and buildings
- (202) Soil mechanics & foundation design
- (203) Design & construction of concrete structures
- (204) Design & construction of masonry works
- (205) Steel construction
- (206) Planning & Design and construction of bridges
- (207) Construction of project management
- (208) Fiber reinforced polymers

#### (300) Building Work Services Codes
- (301) Plumbing engineering
- (302) Electrical installation
- (303) Electrical & hydraulic elevator
- (304) Air conditioning & cooling systems
- (305) Fire protection
- (306) Energy efficiency
- (307) Ventilation works
- (308) Lighting works
- (309) Multi utilities structures safety
- (310) Moisture & water insulations

#### (400) Complementary Works Codes
- (401) Finishing work

#### (500) Environmental Engineering
- (501) Reuse of wastewater
- (502) Solid wastes

#### (600) Architectural Concepts
- (601) Handy capt requirements
- (602) Housing design & planning

#### (700) Technical Specification For Building Systems

#### (800) Technical Specification of Work Items

#### (900) Documents of Contracts

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**Workshop - 27-29 November 2006, Varese, Italy**
**Procedure of Issuing a Code**

- Formation of a standing committee from professionals, researchers and university staff members.

- The standing committee is concerned with the scope, the framework and the development of the code.

- Subcommittees meet to exchange ideas and discuss issues related to the development of the various areas. They make use of other related international codes, international and national research work and local experience of their members.
Procedure of Issuing a Code (Cont.)

- The outcome of the efforts of the subcommittees is a draft of the code that is forwarded to those who are interested (professionals – researchers – university staff members).

- A workshop is held to discuss the results of reviewing the draft of the code.

- A final copy is prepared and officially issued.

- The code is updated every five years.
Why we are here

- To work together towards common interests.
- To communicate easier and properly
- Start the process and keep working
Contracts

To go to the international 4 contracts:

- with ICCF to enhance the code enforcement system in Egypt
- With IAS to accredit our laboratories
- With ICC to adopt a system for training inspectors
- With ICC also to certificate inspectors
The provisions of calculations of the seismic effects on buildings and bridges in the Egyptian Code for the Calculation of Loads and Forces on Structural and Masonry Works have been completely revised in the 2001 version.

They follow “the Eurocode 8 – General rules and seismic actions”.
Seismic Zones

Egypt is subdivided into five seismic zones as follows:
- The first zone: ground acceleration = 0.1g
- The second zone: ground acceleration = 0.125g
- The third zone: ground acceleration = 0.15g
- The fourth zone: ground acceleration = 0.2g
- The Fifth zone: divided into two zones:
  - zone 5 - a ground acceleration = 0.20g - 0.25g
  - zone 5 - b ground acceleration = 0.25g - 0.30g
The Egyptian Code for the Calculation of Loads and Forces in Structural and Masonry Works

- The calculation of the seismic effects depends on the expected structural performance during an earthquake. The balance between the strength of the structure and its ductility is characterized by the values of the response modification factor (R). The code provides values for (R) depends on the chosen lateral load resisting elements. These values are slightly different than those mentioned in the Eurocode-8.
The Egyptian Code for the Calculation of Loads and Forces in Structural and Masonry Works

- Depending on the structural characteristics of the building, one of the following methods may be used for calculating seismic effects:

  - Equivalent static Method (Simplified modal response spectrum method) for buildings meeting the regularity criteria
  - Multi-Modal response spectrum method for all types of buildings
  - Alternative methods (Time History Analysis)
The Egyptian Code for the Design and Construction of Concrete Structures

Contents

1. Scope and design principles
2. General considerations for the design of sections
3. Analysis of structural elements
4. Elastic (working stress) design method
5. Limit states design method
6. Structural details
7. Quality control and assurance
8. Construction
9. Prestressed concrete
10. Materials and mixes of reinforced and prestressed concrete

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The Egyptian Code for the Design and Construction of Concrete Structures

- Provides the minimum requirements to be satisfied for the design and construction of reinforced concrete elements and structures.
- Is based mainly on the limit states design method.

- Ultimate strength limit state
- Instability limit state
- Serviceability limit state
Safety provisions when using Limit states design

1- The use of load factors to increase the working loads.

2- The use of material strength reduction factors

\[ \gamma_c \] Strength reduction factor for concrete
\[ \gamma_s \] Strength reduction factor for reinforcing steel
\[ \gamma_{sp} \] Strength reduction factor for prestressing steel
Material Strength Reduction Factors

Flexure, shear, torsion

Concrete strength reduction factor
\[ \gamma_c = 1.5 \]

Reinforcing steel reduction factor
\[ \gamma_s = 1.15 \]

Compression with or without flexure

Concrete strength reduction factor
\[ \gamma_c = 1.5 \left( \frac{7}{6} - \frac{e/t}{3} \right) \geq 1.5 \]

Reinforcing steel reduction factor
\[ \gamma_s = 1.15 \left( \frac{7}{6} - \frac{e/t}{3} \right) \geq 1.5 \]
The Egyptian Code for the Design and Construction of Concrete Structures

- It has gone through major change in its 2006 edition where the following modifications were introduced:
  - A comprehensive section dealing with the earthquake resistant design of RC structures was introduced to cope with the major revision of the Egyptian Code for Calculations of loads on Structures. It follows in many aspects the Eurocode – 8 and the Canadian Code.
  - A section about the application of the Strut-and-Tie Model in the design of RC members and structures was added.
The Egyptian Code for the Design and Construction of Concrete Structures

- The chapter dealing with the design of prestressed concrete was completely revised and partial prestressing was permitted.

- The chapter dealing with quality control and quality assurance of reinforced and prestressed concrete was revised.
The Egyptian Code for the Design and Construction of Masonry works

Contents

1. Scope and design principles
2. Design of walls and bearing elements
3. Materials and quality control
4. Design of walls and bearing elements
5. Arches, vaults and domes
6. Nonbearing walls used as partitions
7. Earthquake resistance of masonry works
8. Insulation works
9. Site investigation and construction works
The Egyptian Code for the Design and Construction of Masonry works

- The code has been recently updated to promote the use of engineered masonry (structural masonry) in Egypt.

- Design procedures implemented in this code are based on the working stress design method (elastic theory).

- The code provides design guidelines for unreinforced as well as reinforced masonry.
The Egyptian Code for the Design and Construction of Masonry works

- In seismic zones 4 and 5, unreinforced masonry is not permitted.

- The code contains many recommendations, especially for seismic design of masonry buildings. Such recommendations are based on the increased awareness and understanding of factors influencing the seismic behavior of masonry structures.
The Egyptian Code for the Use of FRP in Construction Fields

Contents

1. Scope and design principles
2. Properties of FRP
3. Durability of FRP
4. Strengthening and repair of reinforced concrete structures using FRP
5. Concrete reinforced with FRP bars

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The Egyptian Code for the Use of FRP in the Construction Fields

- Egypt took the lead in publishing a code for the use of FRP in construction fields.

- The Standing committee and the specialized subcommittees make use of the related international codes and guidelines, together with the local experience and the research work carried out in Egypt and abroad.

- The design principles mentioned in the code are limited to the use of FRP systems for externally strengthening concrete elements.
The Egyptian Code for the Use of FRP in the Construction Fields

- The use of FRP is limited to the cases in which the fibers are subjected to tensile stresses only.
- The code provides design guidelines for strengthening structural members for:
  - flexure through bonding FRP reinforcement with fibers oriented along the length of the member.
  - shear through bonding FRP reinforcement with fibers oriented normal or inclined to the length of the member.
- It also provides guidelines for increasing the ultimate strength and ductility of columns through providing additional confinement to the cross-section.
The Egyptian Code for the Use of FRP in the Construction Fields

- The design of the strengthening works is carried out using the limit states theory.

- Material strength reduction factors for concrete and reinforcing steel are those mentioned in the Egyptian Code for the Design and Construction of Concrete structures. Material strength reduction factors for FRP are taken according to the nature of use, type of failure and the importance of the member ($\gamma_f = 1.4 - 1.7$).
The Egyptian Code for the Use of FRP in the Construction Fields

- Safety of FRP strengthened structures against fire is based on a design philosophy that suggests the possibility of losing the strengthening system, in addition to some other damages in the structure, in a fire with no possibility of the structure being collapsed.
The Egyptian Code for the Design and Construction of Steel Structures

- The current code for the design and construction of steel structures uses the Allowable Stress Design method.

- In the process of continuous development, HBRC has prepared a new code for the design and construction of steel buildings.

- The new code is based on limit-states philosophy, including both strength and serviceability criteria, called Load and Resistance Factor Design (LRFD).
The Egyptian Code for the Design and Construction of Steel Structures

- In the new version of the Egyptian code for the Design and Construction of Steel structures the use of either the working stress design method or the LRFD method is permitted.

- The Egyptian code for the Design and Construction of Steel structures is mostly consistent with the American Code. Some areas are similar to the Eurocode with adjustments to suit the Egyptian practice.
Contents

1. Site investigation
2. Laboratory tests
3. Shallow foundations
4. Deep foundations
5. Foundations subjected to vibrations
6. Problematic soils
7. Slope stability
8. Founding on rocks
9. Side supporting systems

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Egyptian Code of Practice for Soil Mechanics and Foundation Design

Part 1 - Site investigation
- Types of borings (manual, mechanical, open pits)
- Selection of boring numbers and locations
- Selection of borings depths
- Soundings (CPT, CPTU, Dilatometer, etc.)
- Field tests

Part 2 - Laboratory tests
- Tests for determining soil properties
- Tests for rocks
Egyptian Code of Practice for Soil Mechanics and Foundation Design

Part 3 - Shallow foundations
- Bearing capacity determination
- Settlement computations
- Limits for acceptable settlement values
- Typical values to be used in geotechnical design
- Causes for foundation failures

Part 4 - Deep foundations
- Classification of pile types
- Single pile capacity determination in various soil types
- Acceptance criteria for piles
- Pile load tests
- Pile groups
Egyptian Code of Practice for Soil Mechanics and Foundation Design

Part 5 - Problematic soils

- Types of problematic soils (swelling, collapsible, liquefiable soils, soft clays, sand dunes, etc.)
- Site exploration in case of problematic soils
- Tests for expansive soils
- Tests for collapsible soils
- Precautions for founding on swelling soils
- Precautions for founding on collapsible soils
- Precautions for founding on soft clays
Egyptian Code of Practice for Soil Mechanics and Foundation Design

Part 6 - Foundations subjected to vibrations

- Earthquakes
- Seismic liquefaction
- Machine foundations
- Vibrations due to blasting
- Special structures (pipelines, tunnels, dams, elevated structures)
- Isolation of foundations
Egyptian Code of Practice for Soil Mechanics and Foundation Design

Part 7- Side supporting systems

- Earth pressure computation
- Gravity walls
- Bridge abutments
- Diaphragm walls
- Cellular cofferdams
- Reinforced earth walls
- Soil nailing
- Supporting systems in marine works
Egyptian Code of Practice for Soil Mechanics and Foundation Design

Part 8 - Slope stability

- Slope failures
- Design soil parameters
- Total stresses and pore water pressure computations
- Methods of slope stability analysis
- Settlement computations
- Filed studies
- Protection and treatment of slopes
- Use of geotextiles in slope stability
Part 9 - Founding on rocks

- Rock classification
- Site exploration
- Shallow foundations
- Deep foundations
- Slope stability of rocks
- Rock mass anchorage
- Problematic rocks
Harmonization of Egyptian Standards
Construction Products Sector

- EOS (Egyptian Organization Standardization) commenced an initiative to harmonize all Egyptian standards in coordination with industrial modernization centre IMC.

- The objective of such harmonization initiative is to promote & increase Egyptian export, facilitate trade by removal of technical barriers to trade, achieve better competitiveness of Egyptian goods, and to ensure that the harmonization practice is embeded in the Egyptian standard making process.
Harmonization of Egyptian Standards
Construction Products Sector

- Phase I of project ended in May 2006 with more than 3400 Egyptian standards harmonized according to international practices.

- Phase II of project started and includes all the remaining standards in the Egyptian catalogue.

- Harmonized standards represents engineering industries (33%), food industries (19%), chemical industries (23%), textile industries (12%), and various other fields (13%).
Harmonization of Egyptian Standards
Construction Products Sector

- Engineering: 33%
- Food: 19%
- Chemical: 23%
- Textile: 12%
- Documentation: 1%

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Harmonization of Egyptian Standards
Construction Products Sector

- EOS issued about 250 standards in the field of construction products about which 25% is mandatory.

- Nearly all Egyptian standards in the field of construction products are harmonized with the international, European, or foreign standards.
### Cement Standards

<table>
<thead>
<tr>
<th>Egyptian harmonized standards</th>
<th>European Reference</th>
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<tbody>
<tr>
<td>ES 4576-1, Es 4756-2</td>
<td>EN 197-1 “cement – part 1: Composition, specifications and conformity criteria for common cements”.</td>
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<tr>
<td>ES 269-1</td>
<td>EN 413-1. “ Masonary Cement – Part 1: Composition, specification and conformity Criteria”.</td>
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<tr>
<td>ES 469-2</td>
<td>EN 413-2: “ Masonary Cement- Part 2 : Test methods”</td>
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Concluding Remarks

- Egypt, through the HBRC, is interested in developing and enforcing the adoption of codes and standards related to the construction industry.

- Egypt is interested in cooperating with the European partners in the areas of standards, technical and environment regulations.

- Egypt is interested in being a member of a network aiming at information exchange and technical cooperation.
Concluding Remarks

- Exchange Experience through establishing a mechanism for mutual attendance of main meetings both in the European Union and in Egypt.

- The aim of this mechanism is to ensure that both parties are familiar with the latest and recent techniques and materials and to exchange local experience of each party.