Code of Practice for Structural Use of Concrete 2004
To: All Authorized Persons and Registered Structural Engineers

Dear Sir/Madam,

Code of Practice for Structural Use of Concrete 2004

I have great pleasure to announce the publication of the Code of Practice for Structural Use of Concrete 2004 (the Code). The Code may be used with immediate effect.

Special Features of the Code

The Code provides guidance on the design, analysis and construction of concrete structures. It adopts the limit state design approach, which should in general provide a more rigorous and economical design than the conventional permissible stress design method. The preparation of the Code has taken into account the local conditions, work practices and development of new technologies in analysis, design and strength of materials. An extensive review of international standards and published literature has been conducted prior to drafting of the Code.

Special features of the Code include:

1. Enhanced concrete shear values;
2. High strength concrete of up to 100 MPa;
3. Increased protection to reinforcing bars of differing exposure conditions;
4. Detailing of reinforcement bars to enhance the durability of the structure;
5. Criteria for dynamic analysis for tall buildings under wind load; and
6. Robustness requirements.

Application of the Code

Subject to the following conditions, the compliance with the requirements of the Code may be considered as evidence to satisfy the Building (Construction) Regulations as far as concrete design is concerned.

<table>
<thead>
<tr>
<th>Relevant Clause/Table in the Code</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clause 4.25</td>
<td>Where the cement content exceeds 550 kg/m³, modification of the B(C)R will be required.</td>
</tr>
<tr>
<td>a) Table 4.2 and b) Clause 4.25.4</td>
<td>Where the cement content is less than the minimum specified, modification of the B(C)R will be required.</td>
</tr>
<tr>
<td>Clause 10.3.4.1</td>
<td>Where 100 mm concrete cubes are used, modification of the B(C)R will be required.</td>
</tr>
<tr>
<td>a) Table 10.2</td>
<td>Where the C2 criteria in Table 10.2 of the Code are used, modification of the B(C)R will be required.</td>
</tr>
</tbody>
</table>

Yours sincerely,

[Signature]

(Marc M H Wu)

Building Authority
Objectives of the Code

1. Limit state approach
   - Local conditions and practice
   - New technologies and materials
   - Supplementing / updating legislation, regulations, guidelines

2. Promote knowledge and technology

3. Enhance competency of Hong Kong engineers
Basic Strategy on the Code of Practice

- Extensive review of different codes
- BS 8110 as the basic reference
- Eurocode format (CEB/FIP Model Code format)
- Local Hong Kong conditions
- Appropriate new developments and research to be incorporated
- Asian Model Code development
Initial Study Topics

1. Current building control system and requirements
2. Literature review on the limit state design codes
3. Survey on current design concept, practice and guidelines in Hong Kong
4. Survey on current design concept, practice and guidelines in overseas countries
5. Use of high strength concrete
6. Stability and robustness of concrete structures
7. Vibration and deflection of concrete structures
8. Cracking in concrete structures
9. Durability of concrete structures
10. Safety in Tall Buildings
11. Loading
12. Detailing
13. Fire engineering considerations
14. Shear capacity in concrete design
15. Grouting of prestressing tendons
16. Performance based criteria
Special Topics Discussion & Research on further 8 subjects

1. Design working life
2. Cover to steel reinforcement
3. Wind-induced motions
4. Floor vibrations
5. Sampling & testing on concrete compressive strength during construction
6. Load testing
7. Quality scheme for the production and supply of concrete
8. Pile cap design
Local Characteristics and Special Features in the Code of Practice

1. Material properties
2. Durability
3. High strength concrete
4. Concrete sampling and testing
5. High rise building design
6. Incorporation of PNAPs
7. Robustness
8. Reinforcement detailing
9. Pile cap design
10. Grouting of prestressing tendons
Material Properties

\[ E_c = 3.46 \sqrt{f_{cu}^*} + 3.21 \]

where:
- \( E_c \) is the static modulus of elasticity,
- \( f_{cu}^* \) is the cube compressive strength in N/mm\(^2\).

<table>
<thead>
<tr>
<th>Concrete cube compressive strength (N/mm(^2))</th>
<th>Design value of elastic modulus (kN/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>18.7</td>
</tr>
<tr>
<td>25</td>
<td>20.5</td>
</tr>
<tr>
<td>30</td>
<td>22.2</td>
</tr>
<tr>
<td>35</td>
<td>23.7</td>
</tr>
<tr>
<td>40</td>
<td>25.1</td>
</tr>
<tr>
<td>45</td>
<td>26.4</td>
</tr>
<tr>
<td>50</td>
<td>27.7</td>
</tr>
<tr>
<td>55</td>
<td>28.9</td>
</tr>
<tr>
<td>60</td>
<td>30.0</td>
</tr>
<tr>
<td>65</td>
<td>31.1</td>
</tr>
<tr>
<td>70</td>
<td>32.2</td>
</tr>
<tr>
<td>75</td>
<td>33.2</td>
</tr>
<tr>
<td>80</td>
<td>34.2</td>
</tr>
<tr>
<td>85</td>
<td>35.1</td>
</tr>
<tr>
<td>90</td>
<td>36.0</td>
</tr>
<tr>
<td>95</td>
<td>36.9</td>
</tr>
<tr>
<td>100</td>
<td>37.8</td>
</tr>
</tbody>
</table>

Note:
1. Where the mean or characteristic value of elastic modulus is required, the appropriate mean or characteristic strength should be selected from this table.

Table 3.2 - Design values of elastic modulus for normal-weight concrete
3.1.8 **Drying shrinkage**  
An estimate of the drying shrinkage strain of plain concrete $\varepsilon_{cs}$ at any instant is given by the product of five partial coefficients:

$$\varepsilon_{cs} = c_s K_L K_{c} K_{e} K_j$$

where:
- $c_s$: 4.0, Hong Kong modification factor to allow for properties of the crushed granitic aggregate,
- $K_L$: coefficient relating to the environment, see figure 3.6,
- $K_c$: coefficient relating to the composition of the concrete, see figure 3.3,
- $K_e$: coefficient relating to the effective thickness of the section, see figure 3.7,
- $K_j$: coefficient defining the development of shrinkage relative to time, see figure 3.5.
## Durability

<table>
<thead>
<tr>
<th>Exposure condition</th>
<th>Type of exposure</th>
</tr>
</thead>
</table>
| 1 Mild             | Internal concrete surfaces  
                   | External concrete surfaces protected from the effects of severe rain or cyclic wetting and drying e.g. concrete finish with mosaic tiles, painting or render  
                   | Concrete surfaces continuously under water, or rarely dry - not sea water  
                   | Concrete in contact with non-aggressive soil |
| 2 Moderate         | Internal concrete surfaces exposed to high humidity e.g. bathrooms and kitchens.  
                   | External concrete surfaces exposed to the effects of severe rain or cyclic wetting and drying e.g. fair faced concrete, concrete with cladding secured by dry or mechanical fixing, curtain wailing. |
| 3 Severe           | Concrete surfaces exposed to sea water spray through airborne contact but not direct exposure, i.e. structures on or near the coast  
                   | Concrete surfaces exposed to corrosive fumes |
| 4 Very Severe      | Concrete surfaces frequently exposed to sea or flowing water with pH ≤4.5  
                   | Concrete in sea water tidal zone down to 1 m below lowest low water level |
| 5 Extreme          | Concrete surfaces exposed to abrasive action machinery, metal tyred vehicles or water carrying solids |

Note:
1. Cement bedding for finishes should be ignored in exposure considerations

**Table 4.1 - Exposure conditions**
### Durability (continued)

<table>
<thead>
<tr>
<th>Conditions of exposure (see clause 4.2.3)</th>
<th>Nominal cover (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest grade of concrete</td>
<td>C20/25</td>
</tr>
<tr>
<td>Condition 1</td>
<td>35</td>
</tr>
<tr>
<td>Condition 2</td>
<td>--</td>
</tr>
<tr>
<td>Condition 3</td>
<td>--</td>
</tr>
<tr>
<td>Condition 4</td>
<td>--</td>
</tr>
<tr>
<td>Condition 5</td>
<td>--</td>
</tr>
<tr>
<td>Maximum free water/cement ratio</td>
<td>0.65</td>
</tr>
<tr>
<td>Minimum cement content (kg/m³)</td>
<td>290</td>
</tr>
</tbody>
</table>

Notes:
1. This table relates to normal-weight aggregate of 20 mm nominal size.
2. Cover not less than the nominal cover corresponding to the environmental exposure condition plus any allowance for loss of cover due to abrasion.
3. Consideration should also be given to cover requirements for fire protection (see clause 4.3) and the safe transmission of bond forces (see clause 8.7).
4. For prestressed concrete, grade C30 or lower should not be used and the minimum cement content should be 300 kg/m³.

Table 4.2 - Nominal cover to all reinforcement (including links) and minimum concrete grade to meet durability requirements for reinforced and prestressed concrete.
High Strength Concrete

1. Local research and test results

2. Decrease in ductility with high concrete strength above 60MPa
   - Section 6.1.2.4
   - Moment redistribution

3. Shear resistance
   - Section 6.1.2.5
   - Maximum stress $0.8 \sqrt{f_{cu}}$ or 7.0MPa
   - Minimum links Table 6.2
High Strength Concrete (continued)

Figure 6.1 - Simplified stress block for concrete at ultimate limit state
6.1.2.5 Design shear resistance of beams

(a) Shear stress in beams

The design shear stress \( v \) at any cross-section should be calculated from:

\[
v = \frac{V}{b_v d}
\]

where:

\( b_v \) breadth of section (for a flanged beam this should be taken as the average width of the rib below the flange).

In no case should \( v \) exceed:

- \( 0.8 \sqrt{f_{cu}} \); or
- \( 7.0 \text{ N/mm}^2 \), whichever is the lesser, whatever shear reinforcement is provided (this limit includes an allowance for \( \gamma_m \) of 1.25).
High Rise Building Design

1. Two approaches
   - Static Analysis
   - Dynamic analysis

2. Static analysis
   - Limiting deflection H/500 at top of a building

3. Dynamic analysis
   - 1 in 10 years return period
   - 10 minutes duration wind speed
   - Peak acceleration

   Residential apartment 0.15 m/s²
   Office building, hotel 0.25 m/s²
7.3.2 Excessive response to wind loads

Excessive accelerations under wind loads that may cause discomfort or alarm to occupants should be avoided. A static or dynamic analysis could be employed taking into account the pertinent features of the structure and its surroundings. Limiting deflection at the top of a building to $1/500$ when considering a static characteristic wind load should result in an acceptable environment for occupants in normal buildings.

Partitions, cladding and finishes, etc. need to be specifically detailed to allow for the anticipated relative lateral deflection in any one storey under the characteristic wind load.

Where a dynamic analysis is undertaken, the maximum peak acceleration of the building should be assessed for wind speeds based on a 1 in 10 year return period of 10 minutes duration with the following limits:

<table>
<thead>
<tr>
<th>Function</th>
<th>Peak Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Apartment</td>
<td>0.15 m/s$^2$</td>
</tr>
<tr>
<td>Office building, hotel</td>
<td>0.25 m/s$^2$</td>
</tr>
</tbody>
</table>

The use of dampers on tall and slender buildings should be supported with dynamic analysis and specialist literature should be consulted.
Robustness

1. Section 2.3.1.4 of the code
Section 6.4 of the code

2. Ronan Point Explosion
   World Trade Centre attack

3. International codes
   - BS 8110
   - Eurocode 2

4. Accidental and impact loads
   - Section 2.3.1.4 (d) on vehicular loads
   - Section 2.3.2.6 on ULS load factor
Reinforcement Detailing

1. Section 8 of the Code on General requirements

2. Section 9 of the Code on detailing and particular rules

3. Basic references
   - BS 8110
   - Eurocode 2
   - Local experience and research
1. Ductility design
   - Section 9.10 of the code
   - Section 9.10.2.2
   
   Columns recommendations on transverse reinforcement

2. Beam – column joint
   - Section 6.8 of the code
Concrete Sampling & Testing

- Sampling Rates
- Concrete Cubes
  - 100mm
  - 150mm
Thank You