Code of Practice
for
Structural Use of Concrete
2004

BUILDINGS DEPARTMENT

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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:

(a) enhanced concrete shear value;
(b) high strength concrete of up to 100 MPa;
(c) increased protection to reinforcing bars under different exposure conditions;
(d) detailing of reinforcement bars to enhance the ductility of the structure;
(e) criteria for dynamic analysis for tall buildings under wind load; and
(f) robustness requirements.

Application of the Code

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

/(a) .....

c dead and imposed loads referred in clause 2.3 of this Code
is the dead and imposed loads stipulated in the Building
egulations 16 and 17.

d be used in its entirety. Selective deviation from this Code

drawn to the fact that there are some provisions in the Code
ements to some particular regulations in the extant Building
o promote the use of the Code, I am prepared to grant
Building (Construction) Regulations upon receipt of an
form. Appendix A contains a list of such Building
would require modifications.

nt time for transition to the Code, a phasing-out period to be
is allowed for the use of the existing Code of Practice for
7 (the 1987 Code). That is, starting from 16 December 2006,
dation plans, with design based on the 1987 Code will not
new building development or alteration and addition (A&A)
approval of the structural plans or foundation plans with
has been made on or before 15 December 2006, the design
lans submissions for that building development or A&A
e 1987 Code.

ailable for viewing in the Buildings Department website
under the "Codes of Practice and Design Manuals" page of
he document may be downloaded subject to terms and
site.

Yours sincerely,

(Marco M H WU)
Building Authority

Appendix A

egulations that may require modifications

	Relevant Clause/Table in the Code	Remark
m^3.	Clause 4.2.6	Where the cement content exceeds 550 kg/m^3, modification of the B(C)R will be required.
ent d.	Table 4.2 and Clause 4.2.5.4	Where the cement content is less than the minimum specified, modification of the B(C)R will be required.
be	Clause 10.3.4.2	Where 100 mm concrete cubes are used, modification of the B(C)R will be required.
a for	Table 10.2	Where the C2 criteria in Table 10.2 of the Code are used, modification of the B(C)R will be required.

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

$$E_c = 3.46\sqrt{f^*_{cu}} + 3.21 \qquad 3.1$$

where:

E_c is the static modulus of elasticity,

f^*_{cu} is the cube compressive strength in N/mm^2.

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

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

Material Properties (continued)

3.1.8 Drying shrinkage

An estimate of the drying shrinkage strain of plain concrete ε_{cs} at any instant is given by the product of five partial coefficients:

$$\varepsilon_{cs} = c_s K_L K_c K_e K_j \qquad 3.5$$

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

Exposure condition	Type of exposure
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 walling.
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 $\leqslant$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)

Conditions of exposure (see clause 4.2.3)	Nominal cover (mm)						
Lowest grade of concrete	C20/25	C30	C35	C40	C45	C50	C55
Condition 1	35	30	30	30	25	25	25
Condition 2	--	40	35	35	30	30	30
Condition 3	--	--	--	--	45	45	45
Condition 4	--	--	--	--	--	55	50
Condition 5	--	--	--	--	(2)	(2)	(2)
Maximum free water/cement ratio	0.65	0.65	065	0.55	0.45	0.40	0.35
Minimum cement content (kg/m^3)	290	290	290	300	340	380	380

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/m^3.

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)

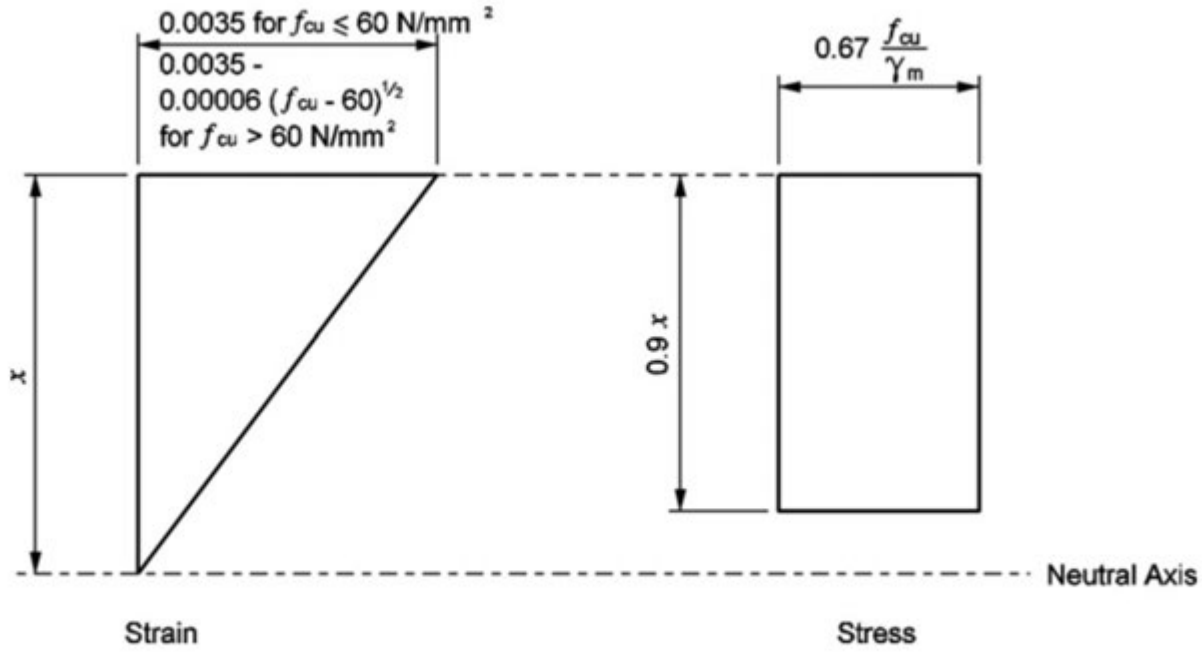


Figure 6.1 - Simplified stress block for concrete at ultimate limit state

High Strength Concrete (continued)

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:

$$v = \frac{V}{b_v d} \qquad 6.19$$

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 N/mm^2, whichever is the lesser, whatever shear reinforcement is provided (this limit includes an allowance for γ_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/s^2
Office building, hotel	0.25 m/s^2

High Rise Building Design (continued)

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 $H/500$ 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:

Function	Peak Acceleration
Residential Apartment	$0.15 m/s^2$
Office building, hotel	$0.25 m/s^2$

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

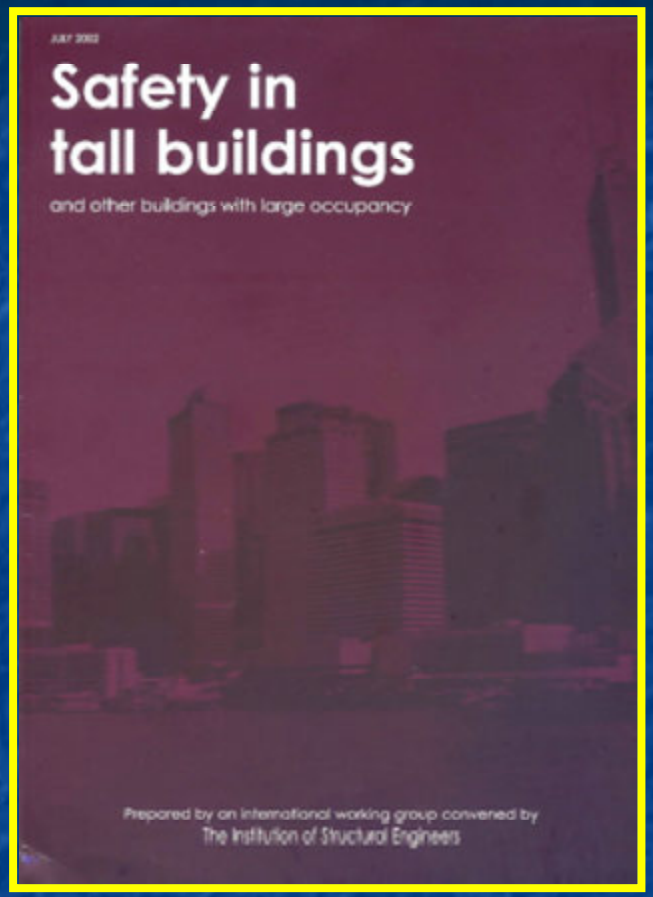
   Section 6.4 of the code

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

Reinforcement Detailing (continued)

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
   - New Zealand standards NZS 3101 : Part 1 : 1995

Concrete Sampling & Testing

- Sampling Rates
- Concrete Cubes

  100mm

  150mm

Thank You