To All Authorized Persons
Registered Structural Engineers
Registered Geotechnical Engineers
Registered Inspectors
Registered General Building Contractors
Registered Specialist Contractors
Registered Minor Works Contractors

Dear Sir/Madam,

Amendments to Code of Practice for Structural Use of Concrete 2013

Subsequent to the publication of the Code of Practice for the Structural Use of Concrete 2013 (the Code), the Technical Committee (TC) set up by this department regularly collects views and feedbacks received from the practitioners and the stakeholders arising from the use of the Code, and reviews the contents thereof for the necessary update.

2. Having considered the TC’s recommendations, amendments to the Code for supplementing some updated technical information on structural use of concrete are promulgated with immediate effect and have been uploaded to the Buildings Department website http://www.bd.gov.hk under the “Codes of Practice and Design Manuals” page of the “Publications and Press Releases” section.

3. The major amendments include:-

   (a) replacement of the term “cement content” by “cementitious content” which is the combined mass of cement, silica fume and either pulverised-fuel ash or ground granulated blastfurnace slag;

   (b) revision of the minimum cementitious content for various concrete grades given in Table 4.2;

   (c) new requirement specifying that post-fire investigation should include an assessment on the type and extent of remedial works to be carried out in order to restore the effectiveness of the adopted method for reducing the risk of concrete spalling in high strength concrete;

   (d) …
new guidelines for design of flange beams taking into account the longitudinal shear stress at the interface between the flange and web;

ew guidelines for shear design of circular columns;

refinement of beam-column joint design;

new guidelines to facilitate the assessment of crack width for structures with design crack widths limited to 0.1mm;

an alternative method for designing exposed cantilevered slab by limiting the stress of deformed high yield steel reinforcing bars to 100N/mm² as given in Appendix A of PNAP APP-68;

exemption of ductility design requirement for walls in single storey structures;

construction requirements for external cantilevered slabs with a span exceeding 750mm as stipulated in paragraph 9 of Appendix A to PNAP APP-68;

additional details of anchorage of links;

alternative details of column transverse reinforcement as given in BD’s circular letter dated 29 April 2011;

guidelines for temporary resumption of concreting works under the situations as described in clauses 10.3.4.2 (iv) and (v) of the Code; and

coring test requirements and corresponding acceptance criteria for further testing required under regulation 63 of the Building (Construction) Regulations.

Yours faithfully,

(LEE Yun-choi)
Assistant Director / New Buildings 2
for Building Authority
## Amendments to the Code of Practice for Structural Use of Concrete 2013

<table>
<thead>
<tr>
<th>Item</th>
<th>Clause/Annex</th>
<th>Current Version</th>
<th>Amendments</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 1    | Clause 1.1    | The following are outside the scope of this Code of Practice:  
(a) particular aspects of special types of buildings and civil engineering works, such as membrane, shell and composite structures, viaducts, dams, pressure vessels, and reservoirs  
(b) no fines concrete, aerated concrete, glass fibre reinforced concrete, and concrete containing lightweight or heavy aggregate or structural steel sections. | The following are outside the scope of this Code of Practice  
(a) particular aspects of special types of buildings and civil engineering works, such as membrane, composite structures, viaducts, dams, pressure vessels, and reservoirs  
(b) no fines concrete, aerated concrete, glass fibre reinforced concrete, and concrete containing lightweight or heavy aggregate or structural steel sections. | The word “shell” is deleted as clause 5.2.1.1 covers the design of shell structures. |
| 2    | Clause 1.4.1  | General terms  
acceptable standards standards acceptable to the Building Authority (BA) as given in Annex A  
cantilever projecting structure a structural element that cantilevers from the main structure for example, canopies, balconies, bay windows, air conditioning platforms etc.  
design working life the period of time during which a structure that has undergone normal maintenance is unlikely to require major repairs | General terms  
acceptable standards standards acceptable to the Building Authority (BA) as given in Annex A  
cantilever projecting structure a structural element that cantilevers from the main structure for example, canopies, balconies, bay windows, air conditioning platforms etc.  
cementitious content the combined mass of cement, silica fume and either pulverised fuel ash or ground granulated blast furnace slag per cubic metre of compacted concrete. For silica fume, the dry mass shall be used  
free water/cement ratio the ratio between the mass of the free water in the concrete mix and the cementitious content  
design working life the period of time during which a structure that has undergone normal maintenance is unlikely to require major repairs | Definitions of “cementitious content” and “free water/cement ratio” are given. |
| 3    | Clause 1.5    | \( f_{cu} \) Characteristic compressive strength of concrete  
\( f_{tp} \) design tensile stress in the tendons  
\( f_{pe} \) design effective prestress in the tendons after all losses  
\( f_{pu} \) estimated design service stress in the tension reinforcement  
\( f_y \) characteristic yield strength of reinforcement  
\( f_{yr} \) characteristic yield strength of the shear reinforcement  
\( f_k \) characteristic dead load  
\( h \) depth of cross section measured in the plane under consideration, or thickness of wall  
\( b_{agg} \) maximum size of coarse aggregate  
\( r \) thickness of a beam flange  
\( l_e \) effective span of a beam or slab  
\( l_b \) basic anchorage length for reinforcement  
\( l_a \) effective height of a column or wall in the plane of bending considered  
\( M \) design ultimate moment at the section considered  
\( N' \) design ultimate axial force  
\( n_b \) number of bars in a reinforcement bundle  
\( Q_k \) characteristic imposed load  
\( R_m \) tensile strength of reinforcement | \( f_{cu} \) characteristic compressive strength of concrete  
\( f_{tp} \) design tensile stress in the tendons  
\( f_{pe} \) design effective prestress in the tendons after all losses  
\( f_{pu} \) estimated design service stress in the tension reinforcement  
\( f_y \) specified characteristic yield strength  
\( f_{yr} \) specified characteristic yield strength of the shear reinforcement  
\( f_k \) characteristic dead load  
\( h \) depth of cross section measured in the plane under consideration, or thickness of wall  
\( b_{agg} \) maximum size of coarse aggregate  
\( r \) thickness of a beam flange  
\( l_e \) effective span of a beam or slab  
\( l_b \) basic anchorage length for reinforcement  
\( l_a \) effective height of a column or wall in the plane of bending considered  
\( M \) design ultimate moment at the section considered  
\( N' \) design ultimate axial force  
\( n_b \) number of bars in a reinforcement bundle  
\( Q_k \) characteristic imposed load  
\( R_m \) tensile strength | Definition of symbols \( f_y \) and \( R_m \) is unified and amended to “specified characteristic yield strength” and “tensile strength” respectively. |
### Clause 1.5 (Cont’d)
- \( \tau_b \): spacing of bent-up bars
- \( \tau_p \): spacing of links along the member
- \( \tau \): design ultimate shear force
- \( \tau_{sb} \): design shear resistance of bent-up bars
- \( w_k \): characteristic wind load
- \( z \): depth to the neutral axis of a concrete section
- \( \lambda \): lever arm
- \( \gamma_p \): partial safety factor for load
- \( \gamma_{sf} \): partial safety factor for strength of materials
- \( \nu \): design shear stress at a section
- \( \nu_z \): design ultimate resistance shear stress of the concrete
- \( \delta \): diameter of reinforcing bar or prestressing duct
- \( \delta_{eh} \): equivalent diameter of a bundle of reinforcing bar

### Definition of symbols
- \( s_{f}, v_{sf}, v_{sx}, v_{sy}, \beta_{v_x}, \beta_{v_y}, \Delta_{x}, \text{ and } \Delta_{F_d} \) are added.

### Clause 2.2.3.2
- A note to specify the circumstances where fire limit state checking is added.

### Clause 3.2.3 & Table 3.3
- Definition of symbol \( f_y \) is unified and amended to “specified characteristic yield strength”.

### Table 3.3 - Strength of reinforcement

<table>
<thead>
<tr>
<th>Grade</th>
<th>Specified characteristic strength, ( f_y ) (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>500B</td>
<td>500B</td>
</tr>
<tr>
<td>500C</td>
<td>500C</td>
</tr>
</tbody>
</table>

### Check of structural integrity
The structural integrity of the building and its members should be checked for the effects of the design fire. In the checking, the strength of concrete and reinforcement should be based on the values given in clauses 2.3.2.7 and 2.4.3.2 respectively.

### Check of structural integrity
The structural integrity of the building and its members should be checked for the effects of the design fire. In the checking, the strength of concrete and reinforcement should be based on the values given in clauses 2.3.2.7 and 2.4.3.2 respectively.

**Note:** Fire limit state is required to be checked if the cover of concrete members does not comply with the provisions of the Code of Practice for Fire Safety in Buildings or the design strength of concrete is greater than 60 MPa.
<table>
<thead>
<tr>
<th></th>
<th>Clause</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Clause 3.2.8.4</td>
<td>Performance of type 2 mechanical couplers Type 2 mechanical coupler should satisfy the following criteria:</td>
<td>Performance of type 2 mechanical couplers Type 2 mechanical coupler should satisfy the following criteria:</td>
<td>Definition of symbols $f_y$ and $R_m$ is unified and amended to “specified characteristic yield strength” and “tensile strength” respectively.</td>
</tr>
<tr>
<td></td>
<td>(a) The splicing assemblies shall be tested to establish that they comply with the requirements given in clause 3.2.8.3.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Static tensile test: The splicing assemblies must develop in tension the greater of 100 percent of the specified tensile strength, $R_m$, of the bar, and 125 percent of the specified yield strength, $f_y$, of the bar.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Static compression test: The splicing assemblies must develop in compression 125 percent of the specified yield strength, $f_y$, of the bar.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Cyclic tension-compression test: The splicing assemblies shall be tested in four stages, as given in Table 3.4, and must sustain Stages 1 through 3 without failure. If the conditions of acceptance for the static tension test are complied with in Stage 4, the static tension test may be omitted.</td>
<td>(d) Cyclic tension-compression test: The splicing assemblies shall be tested in four stages, as given in Table 3.4, and must sustain Stages 1 through 3 without failure. If the conditions of acceptance for the static tension test are complied with in Stage 4, the static tension test may be omitted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Clause 4.2.1</td>
<td>General One of the main characteristics influencing the durability of concrete is its permeability to the ingress of water, oxygen, carbon dioxide and other potentially deleterious substances. Permeability is governed by the constituents and procedures used in making the concrete. With normal-weight aggregates a suitably low permeability is achieved by having an adequate cement content, a sufficiently low free water/cement ratio, complete compaction of the concrete, and sufficient hydration of the cement through proper curing.</td>
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<td>The original term “cement content” is replaced by “cementitious content”. The definition for “cementitious content” is given in Clause 1.4.1 in item 2 above.</td>
</tr>
<tr>
<td></td>
<td>(c) the environment (clause 4.2.3);</td>
<td>(c) the environment (clause 4.2.3);</td>
<td>Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) the type of cement (clauses 4.2.5 and 4.2.7);</td>
<td>(d) the type of cementitious material(s) (clauses 4.2.5 and 4.2.7);</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(e) the type of aggregate (clauses 4.2.5 and 4.2.7);</td>
<td>(e) the type of aggregate (clauses 4.2.5 and 4.2.7);</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(f) the cement content and water/cement ratio of the concrete (clause 4.2.6); and</td>
<td>(f) the cementitious content and water/cement ratio of the concrete (clause 4.2.6); and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(g) workmanship, to obtain full compaction and efficient curing (clauses 10.3.5 and 10.3.6).</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Clause 4.2.1</td>
<td>Where the minimum dimension of the concrete to be placed in one continuous operation is greater than 600 mm, and especially where the cement content is 400 kg/m³ or more, measures to reduce the temperature such as using material with a slower release of heat of hydration should be considered.</td>
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</tr>
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<td>Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).</td>
<td></td>
</tr>
</tbody>
</table>
### Table 4.2 - Nominal cover to all reinforcement (including links) and minimum concrete grade to meet durability requirements for reinforced and prestressed concrete

<table>
<thead>
<tr>
<th>Conditions of exposure (see clause 4.2.3)</th>
<th><strong>Nominal cover (mm)</strong></th>
<th>Conditions of exposure (see clause 4.2.3)</th>
<th><strong>Nominal cover (mm)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C20/25</td>
<td>C30</td>
<td>C35</td>
</tr>
<tr>
<td><strong>Lowest grade of concrete</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- slabs only</td>
<td>30</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>- other members</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Condition 2</td>
<td></td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Condition 3</td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Condition 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition 5 (see note 3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum free water/cement ratio</td>
<td>0.65</td>
<td>0.65</td>
<td>0.60</td>
</tr>
<tr>
<td>Minimum cement content (kg/m³)</td>
<td>290</td>
<td>290</td>
<td>290</td>
</tr>
</tbody>
</table>

Notes:
1. This table relates to normal-weight aggregate of 20 mm nominal size. Adjustments to minimum cement contents for aggregates of nominal sizes other than 20 are given in clause 4.2.5.4.
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 4.3.3) and the safe transmission of bond forces (see clause 6.7).
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

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<tbody>
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<td>C30</td>
<td>C35</td>
</tr>
<tr>
<td><strong>Lowest grade of concrete</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- slabs only</td>
<td>30</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>- other members</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Condition 2</td>
<td></td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Condition 3</td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Condition 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum free water/cement ratio</td>
<td>0.65</td>
<td>0.65</td>
<td>0.60</td>
</tr>
<tr>
<td>Minimum cement content (kg/m³)</td>
<td>290</td>
<td>310</td>
<td>330</td>
</tr>
</tbody>
</table>

Notes:
1. This table relates to normal-weight aggregate of 20 mm nominal size. Adjustments to minimum cementitious contents for aggregates of nominal sizes other than 20 are given in clause 4.2.5.4.
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4. For prestressed concrete, grade C30 or lower should not be used and the minimum cementitious content should be 300 kg/m³.

---

### Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).

- Values are adjusted as a result of including silica fume and pfa or ggbs in the “cementitious content”.
- Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).
Adjustment to cement contents for different sized aggregates

The minimum cement contents given in Tables 4.2 relate to 20 mm nominal maximum size of aggregate. For other sizes of aggregate they should be modified as given in Table 4.3 subject to the condition that the cement content should not be less than 240 kg/m³ for the exposure conditions covered by Table 4.2.

<table>
<thead>
<tr>
<th>Nominal maximum aggregate size (mm)</th>
<th>Adjustment to minimum cement contents (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>+40</td>
</tr>
<tr>
<td>14</td>
<td>+20</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>-30</td>
</tr>
</tbody>
</table>

Table 4.3 - Adjustments to minimum cement contents for aggregates other than 20 mm nominal maximum size

Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).

General
The free water/cement ratio is an important factor in the durability of concrete and should always be the lowest value compatible with producing fully compacted concrete without segregation or bleeding. Appropriate values for the maximum free water/cement ratio are given in Tables 4.2 and 4.4 for particular exposure conditions. A minimum cement content is required to ensure a long service life under particular exposure conditions, and appropriate values are given in Tables 4.2 and 4.4. However, the cement content required for a particular water/cement ratio can vary significantly for different mix constituents. Where adequate workability is difficult to obtain at the maximum free water/cement ratio allowed, an increased cement content, the use of fly ash or silica fume, and/or the use of plasticisers or water-reducing admixtures should be considered.

For normal strength concrete, i.e., $f_{cu} \leq 60$ N/mm², a total cementitious content including cement, fly ash and/or silica fume in excess of 650 kg/m³ should not be used unless special consideration has been given to the increased risk of cracking due to drying shrinkage in thin sections or to thermal stresses in thicker sections. For high strength concrete ($f_{cu} > 60$ N/mm²), total cementitious contents should be controlled to avoid large heat of hydration as well as large shrinkage and creep strains. Under normal circumstances, the cement content should be limited to not more than 400 kg/m³.

For concrete made with normal-weight aggregate and used in foundations to low rises structures in non-aggressive soil conditions, a minimum grade of C20 may be used provided the minimum cement content is not less than 200 kg/m³.

For high strength concrete, reference should also be made to requirements in clause 4.3.

Adjustment to cementitious contents for different sized aggregates

The minimum cementitious contents given in Tables 4.2 relate to 20 mm nominal maximum size of aggregate. For other sizes of aggregate they should be modified as given in Table 4.3 subject to the condition that the cementitious content should not be less than 240 kg/m³ for the exposure conditions covered by Table 4.2.

<table>
<thead>
<tr>
<th>Nominal maximum aggregate size (mm)</th>
<th>Adjustment to minimum cementitious contents (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>+40</td>
</tr>
<tr>
<td>14</td>
<td>+20</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>-30</td>
</tr>
</tbody>
</table>

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Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).

General
The free water/cement ratio is an important factor in the durability of concrete and should always be the lowest value compatible with producing fully compacted concrete without segregation or bleeding. Appropriate values for the maximum free water/cement ratio are given in Tables 4.2 and 4.4 for particular exposure conditions. A minimum cementitious content is required to ensure a long service life under particular exposure conditions, and appropriate values are given in Tables 4.2 and 4.4. However, the cementitious content required for a particular water/cement ratio can vary significantly for different mix constituents. Where adequate workability is difficult to obtain at the maximum free water/cement ratio allowed, an increased cementitious content, the use of fly ash or silica fume, and/or the use of plasticisers or water-reducing admixtures should be considered.

For normal strength concrete, i.e., $f_{cu} \leq 60$ N/mm², a total cementitious content including cement, fly ash and/or silica fume in excess of 650 kg/m³ should not be used unless special consideration has been given to the increased risk of cracking due to drying shrinkage in thin sections or to thermal stresses in thicker sections. For high strength concrete ($f_{cu} > 60$ N/mm²), total cementitious contents should be controlled to avoid large heat of hydration as well as large shrinkage and creep strains. Under normal circumstances, the cementitious content should be limited to not more than 400 kg/m³.

For concrete made with normal-weight aggregate and used in foundations to low rises structures in non-aggressive soil conditions, a minimum grade of C20 may be used provided the minimum cementitious content is not less than 200 kg/m³.

For high strength concrete, reference should also be made to requirements in clause 4.3.
Clause 4.2.6.2 & Table 4.4

Unreinforced concrete

Table 4.4 gives recommended values for the maximum free water/cement ratio, the minimum cement content and the lowest grade of concrete to ensure long service life under the appropriate conditions of exposure.

<table>
<thead>
<tr>
<th>Condition of exposure</th>
<th>Concrete not containing embedded metal</th>
<th>Concrete not containing embedded metal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(see clause 4.2.3.2)</td>
<td>(see clause 4.2.3.2)</td>
</tr>
<tr>
<td></td>
<td>Maximum free water/cement ratio (kg/m³)</td>
<td>Minimum cement content (kg/m³)</td>
</tr>
<tr>
<td></td>
<td>C20</td>
<td>C30</td>
</tr>
<tr>
<td>1</td>
<td>0.65</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>0.65</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>0.55</td>
<td>325</td>
</tr>
<tr>
<td>4</td>
<td>0.50</td>
<td>350</td>
</tr>
<tr>
<td>5</td>
<td>0.50</td>
<td>350</td>
</tr>
</tbody>
</table>

Notes:
1. See clause 4.2.3 for adjustments to the mix proportions.
2. See clause 4.2.5.2 for permitted reduction in concrete grade.
3. See clause 4.2.6.1 for concrete used in foundations to low rise structures in non-aggressive soil conditions.

Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).

Clause 4.2.6.3

Mix adjustments

The cement contents given in table 4.4 apply to 20 mm nominal maximum size aggregate. For other sizes of aggregate they should be changed as given in table 4.3.

Differs aggregates require different water contents to produce concrete of the same workability and therefore at a given cement content, different water/cement ratios are obtained. In order to achieve a satisfactory workability at the specified maximum free water/cement ratio, it may be necessary to modify the mix as described in clause 4.2.6.1.

When pfa or ggbs is used, the total content of cement plus pfa or ggbs should be at least as great as the values given in tables 4.2 and 4.4. In these conditions the word 'cement' in 'cement content' and 'water/cement' ratio means the total content of cement plus pfa or ggbs. Good curing is essential with concrete made from these materials (see clause 10.3.6).

Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).

Clause 4.3.1.2(b)

Methods to reduce risk of concrete spalling

At least one of the following methods should be provided.

(a) Method A: A reinforcement mesh with a nominal cover of 15mm. This mesh shall have wires with a diameter ≤ 2mm with a pitch ≤ 50 x 50mm. The nominal cover to the main reinforcement shall be ≥ 40mm, or
(b) Method B: Include in the concrete mix not less than 1.5 kg/m³ of monofilament propylene fibres. The fibres shall be 6 – 12 mm long and 18 – 52 μm in diameter, and shall have a melting point less than 180°C, or
(c) Method C: Protective layers for which it is demonstrated by local experience or fire testing that no spalling of concrete occurs under fire exposure, or
(d) Method D: A design concrete mix for which it has been demonstrated by local experience or fire testing that no spalling of concrete occurs under fire exposure.

Methods to reduce risk of concrete spalling

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(b) Method B: Include in the concrete mix not less than 1.5 kg/m³ of monofilament propylene fibres. The fibres shall be 6 – 12 mm long and 18 – 52 μm in diameter, and shall have a melting point less than 180°C, or
(c) Method C: Protective layers for which it is demonstrated by local experience or fire testing that no spalling of concrete occurs under fire exposure, or
(d) Method D: A design concrete mix for which it has been demonstrated by local experience or fire testing that no spalling of concrete occurs under fire exposure.

A note is added to require that post-fire investigation should include an assessment on the type and extent of remedial works that are required to restore the effectiveness of the adopted method for reducing the risk of concrete spalling.

Legend: revision/addition
Clause 5.2.1.2(a)

Note 1: Unless $\Delta_{bf}$ is taken as $\leq 0.1\Delta_{b}$, the shear stress between the web and flange should be checked and provided with transverse reinforcement.

**Figure 5.2** - Effective flange width parameters

For structural analysis, where a great accuracy is not required, a constant width may be assumed over the whole span. The value applicable to the span section should be adopted.

---

Note 1:

(a) Unless $\Delta_{bf}$ is taken as $\leq 0.1\Delta_{b}$, the shear stress between the web and flange should be checked and provided with transverse reinforcement.

**Figure 5.2a** - Effective flange width parameters

(b) The longitudinal shear stress, $\tau_{sc}$ at the interface between one side of a flange and the web, should be taken as:

$$\tau_{sc} = \frac{d_{fr}}{h_{b} h_{f}}$$

where:

- $h_{b}$ is the thickness of the beam flange
- $d_{fr}$ is the longitudinal length of the flange beam under consideration (see Figure 5.2b) of which the maximum value may be assumed to be half the distance between the section where the moment is 0 and the section where the moment is maximum. Where point loads are applied, this length should not exceed the distance between the point load and the face of the flange
- $d_{fr}$ is the change of compressive force in the flange over the length $d_{fr}$

Method for designing flange reinforcements in flange beams is added.

Legend: revision/addition
Method for designing flange reinforcements in flange beams is added.

Figure 5.2b – Notations for the connection between flange and web

(a) Transverse reinforcements per unit length Auvw should be determined by assuming the flange to behave as a braced framework consisting of concrete struts and ties formed by transverse reinforcements and using the following equation:

\[ 0.87F_{Auvw} = \varphi \pi h_b \cot \theta \]  \hspace{1cm} (6.3c)

where:

- \( A_{vw} \) is the area of flange transverse reinforcement
- \( b \) is the spacing of the flange transverse reinforcement

For the purpose of avoiding failure of the concrete struts in the flange, the following condition should be satisfied:

\[ w \leq (0.88F_{Auvw}) \sin \theta \cos \theta \]  \hspace{1cm} (6.3c)

In the absence of more rigorous calculation, the following recommended values for \( \cot \theta \) can be used:

- \( 1.0 \leq \cot \theta \leq 2.0 \) for compression flanges (45° ≤ \( \theta \) ≤ 26.5°)
- \( 2.0 \leq \cot \theta \leq 1.25 \) for tension flanges (26.5° ≤ \( \theta \) ≤ 38.6°)

(a) In case of combined shear between the flange and the web, and transverse bending, the area of steel should be the greater of that determined by Equation 5.3b or half that determined by Equation 5.3b plus that required for transverse bending.

(b) Minimum longitudinal flange reinforcement should be provided in accordance with Clause 9.3.1. Longitudinal tension reinforcement in the flange should be anchored beyond the end required to transmit the force from the beam to the web at the section where this reinforcement is required (see Figure 5.2b).

(c) For structural analysis, where a great accuracy is not required, a constant width may be assumed over the whole span. The value applicable to the span section should be adopted.
<table>
<thead>
<tr>
<th>Clause</th>
<th>Notes</th>
<th>Clarification of the definition of (v_{sx}) and (v_{sy}) by amending the word “edge” to “supporting beam” for clarity.</th>
</tr>
</thead>
</table>
| 6.1.3.3(g) | Loads on supporting beams The design loads on beams supporting solid slabs spanning in two directions at right angles and supporting uniformly distributed loads may be assessed from the following equations:
\[
\begin{align*}
\nu_{xy} &= \beta_{xy} \frac{L_y}{I}\, \text{or} \\
\nu_{yx} &= \beta_{yx} \frac{L_x}{I}\, \text{or} \\
\rho_{sx} &= \beta_{sx} n_x \, \text{or} \\
\rho_{sy} &= \beta_{sy} n_y
\end{align*}
\]
where:
- \(\nu_{xy}\) is the design end shear on strips of unit width and span \(L_y\) and considered to act over the middle three-quarters of the edge,
- \(\nu_{yx}\) is the design end shear on strips of unit width and span \(L_x\) and considered to act over the middle three-quarters of the edge,
- \(\beta_{sx}\) and \(\beta_{sy}\) are the shear force coefficients shown in Table 6.7.
| Notes | Loads on supporting beams The design loads on beams supporting solid slabs spanning in two directions at right angles and supporting uniformly distributed loads may be assessed from the following equations:
\[
\begin{align*}
\nu_{xy} &= \beta_{xy} \frac{L_y}{I}\, \text{or} \\
\nu_{yx} &= \beta_{yx} \frac{L_x}{I}\, \text{or} \\
\rho_{sx} &= \beta_{sx} n_x \, \text{or} \\
\rho_{sy} &= \beta_{sy} n_y
\end{align*}
\]
where:
- \(\nu_{xy}\) is the design end shear on strips of unit width and span \(L_y\) and considered to act over the middle three-quarters of the supporting beam,
- \(\nu_{yx}\) is the design end shear on strips of unit width and span \(L_x\) and considered to act over the middle three-quarters of the supporting beam,
- \(\beta_{sx}\) and \(\beta_{sy}\) are the shear force coefficients shown in Table 6.7. | A typo is rectified.
| 6.1.3.5 – Table 6.8 – Note 1 | \(v_{x} = 0.4\) for \(f_{ck} \leq 40\text{ N/mm}^2\) or \(0.4f_{ck}^{0.03}\) for \(f_{ck} > 40\text{ N/mm}^2\) with the value of \(f_{ck}\) not to be taken as greater than \(80\text{ N/mm}^2\) |
A new clause to provide guidelines for the design of shear reinforcement in circular columns is added.

**Clause 6.2.1.4 (e)**

The design shear strength of columns may be checked in accordance with clause 6.1.2.5(k).

For rectangular sections in compression no check is required provided that \(\Delta N / V\) does not exceed 0.68 and \(\nu\) does not exceed the maximum value given in clause 6.1.2.5(k).

\[
\begin{array}{cccccccc}
N & 0 & 0.1 & 0.2 & 0.3 & 0.4 & 0.5 & 0.6 \\
\beta & 1.00 & 0.89 & 0.77 & 0.65 & 0.53 & 0.42 & 0.30 \\
\end{array}
\]

Table 6.14 - Values of the coefficient \(\beta\)

**Clause 6.2.1.4 (f)**

Design concrete shear stress

The design shear strength of columns should be checked in accordance with clause 6.1.2.5(k).

Design shear resistance of rectangular column

For rectangular sections in compression, no checking is required provided that \(\Delta N / V\) does not exceed 0.68 and \(\nu\) does not exceed the maximum value given in clause 6.1.2.5(k). Otherwise, shear resistance of rectangular columns should be checked in accordance with clause 6.1.2.5.

\[
\begin{array}{cccccccc}
N & 0 & 0.1 & 0.2 & 0.3 & 0.4 & 0.5 & 0.6 \\
\beta & 1.00 & 0.89 & 0.77 & 0.65 & 0.53 & 0.42 & 0.30 \\
\end{array}
\]

Table 6.14 - Values of the coefficient \(\beta\)

**Clause 6.2.1.4 (g)**

Design shear resistance of circular column

Shear resistance of circular columns should be checked in accordance with clause 6.1.2.5 with the following definitions:

\[ f = \sqrt{v/\sin\alpha} \]

\[ d = \pi (1 + \sin\alpha) \]

\[ \sin \alpha = 2h / (\pi d) \quad (0 < \alpha < \pi/2) \]

Legend: revision/addition
A new clause to provide guidelines for the design of shear reinforcement in circular column is added.

---

Clause 6.2.1.4 (c) (Cont’d)

(2) For Table 6.2, the term \(v_0 + v\) should be replaced by \(v\) such that nominal links should be provided when \(0.5v_0 < v < v_0\) and shear reinforcement should be provided when \(v < 0.8v_0\) or 7.0 kN/mm².

(3) For Table 6.3, calculation of \(v_0\), \(A_a\) should be taken as half the total area of longitudinal steel and \(b_d\) should be determined as equation 6.58a.

(4) Provision of shear reinforcement

Shear reinforcement can be either fixed with circular links (see equation 6.58b) or spiral links (see equation 6.58c). The spacing of links is in the direction of the height of the circular columns. The shear design for the cross section should be analysed from the following equations:

\[
A_a \geq \frac{2\pi s_c (V - V_0)}{0.87 f_{y,c}} \quad \text{6.58b}
\]

or

\[
A_a \geq \frac{\pi s_c (V - V_0)}{0.87 f_{y,c} (1 - 0.22s_c / c)} \quad \text{6.58c}
\]

where:
- \(s_c\) is the spacing of circular links along the member for equation 6.58b or the plan spacing of spiral links along the member for equation 6.58c

Note: Since each link is cut twice by the shear plane, \(A_{a,ef}\) is twice the cross sectional area of the link.
22 Clause 6.8.1.2
Design forces
The design forces acting on a beam-column joint shall be evaluated from the maximum internal forces in all members meeting at the joint under the most adverse load combinations at ultimate limit state as specified in Table 2.1, with the joint in equilibrium.

For lateral load resisting frames, where critical zones may be located at beam ends adjacent to the beam-column joint, the design forces should be calculated by taking the provided amount of longitudinal beam reinforcement in the critical zones at yield, i.e. $f_y$. With gravity load dominated frames where reversal moments will not occur at the beam end, yielding of bottom beam reinforcement need not be considered.

23 Clause 6.8.1.3 - equation 6.71
Joint shear stress
The horizontal joint shear stress computed with equation 6.71 shall not exceed $0.2\,f_yu$,

$$\tau_h = \frac{V_{h}}{b'h'} \leq 6.71$$

where
- $V_{h}$ is the total horizontal design joint shear force in the direction being considered, i.e. either $V_{hx}$ or $V_{hy}$ as appropriate.

24 Clause 7.2.1 - Table 7.1
The terms “Quasi-permanent load combination” and “Frequent load combination” are deleted.

25 Clause 7.2.3 - equation 7.2
$$\epsilon_m = \epsilon_1 \left( \frac{b(h-2l) - (w-x)}{3E_dA_d(d-2)} \right)$$

26 Clause 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 $2000$ mm when considering a static characteristic wind load should result in an acceptable environment for occupants in normal buildings.

Table 7.1 - Limitations of maximum estimated surface crack widths

<table>
<thead>
<tr>
<th>Exposure condition</th>
<th>Reinforced members with unbonded tendons</th>
<th>Prestressed members with bonded tendons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, and 3</td>
<td>0.3 mm&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.2 mm</td>
</tr>
<tr>
<td>4</td>
<td>0.3 mm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.2 mm</td>
</tr>
<tr>
<td>Water retaining structures&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:
1. For exposure condition 1, crack width has no influence durability and this limit is set to guarantee acceptable appearance. In the absence of appearance conditions this limit may be relaxed.
2. Water retaining structures refer to the use of water tanks and the like used in general building works and not meant to include large civil works retaining structures.

The design forces for beam-column joint of lateral load resisting frame should be calculated under the most adverse load combinations at ultimate limit state as specified in Table 2.1, with the joint in equilibrium.
The beam-column joint design should be calculated by taking the “required” amount of longitudinal beam reinforcement instead of the “provided” amount of longitudinal beam reinforcement.

The effect of all forces on the beam-column joints including beneficial column shear forces should be considered in deriving the total horizontal design joint shear force $V_{h}$.

The equation for the determination of average strain $\epsilon_m$ for a limiting design surface crack width of 0.2mm is added.

The height $H$ for determination of building deflection should be measured from the highest floor level excluding plant rooms / roof features and alike.
<table>
<thead>
<tr>
<th>Clause</th>
<th>7.3.4.4 – Table 7.4 – Note 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 7.4 - Modification factor for tension reinforcement</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Service stress</strong></td>
<td><strong>M/ld²</strong></td>
</tr>
<tr>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>100</td>
<td>2.00</td>
</tr>
<tr>
<td>150</td>
<td>2.00</td>
</tr>
<tr>
<td>167</td>
<td>2.00</td>
</tr>
<tr>
<td>200</td>
<td>2.00</td>
</tr>
<tr>
<td>250</td>
<td>1.90</td>
</tr>
<tr>
<td>300</td>
<td>1.60</td>
</tr>
<tr>
<td><strong>(γf = 250)</strong></td>
<td><strong>333</strong></td>
</tr>
<tr>
<td><strong>(γf = 500)</strong></td>
<td><strong>333</strong></td>
</tr>
</tbody>
</table>

**Notes:**
1. The values in the table are derived from the following equation:
   \[ M = \left( \frac{\gamma_f}{\gamma_M} \right) \frac{f_t}{f_d} \left( \frac{1}{x} \right) \]
   where:
   - \( M \) is the design ultimate moment at the centre of the span or, for a cantilever, at the support.
   - The design service stress in the tension reinforcement in a member may be estimated from the equation:
     \[ f_t = \left( \frac{25}{3} \right) \left( \frac{f_{ult}}{f_d} \right) \] see clause 6.1.2.4 (b) for definition of \( f_d \)
   - For a continuous beam, if the percentage of redistribution is not known but the design ultimate moment at mid-span is obviously the same as or greater than the elastic ultimate moment, the stress \( f_{ult} \) in this table may be taken as \( 23 \) \% of \( f_d \)

<table>
<thead>
<tr>
<th>Clause</th>
<th>7.3.4.5 – Table 7.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 7.5 - Modification factor for compression reinforcement</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F₆, prest</strong></td>
<td><strong>Factor</strong></td>
</tr>
<tr>
<td>100</td>
<td>0.00</td>
</tr>
<tr>
<td>150</td>
<td>0.05</td>
</tr>
<tr>
<td>200</td>
<td>0.25</td>
</tr>
<tr>
<td>250</td>
<td>0.35</td>
</tr>
<tr>
<td>300</td>
<td>0.50</td>
</tr>
<tr>
<td>350</td>
<td>0.75</td>
</tr>
<tr>
<td>400</td>
<td>1.00</td>
</tr>
<tr>
<td>450</td>
<td>1.50</td>
</tr>
<tr>
<td>500</td>
<td>2.00</td>
</tr>
<tr>
<td>550</td>
<td>2.50</td>
</tr>
<tr>
<td>600</td>
<td>≥ 3.00</td>
</tr>
</tbody>
</table>

**Notes:**
1. The values in this table are derived from the following equation:
   \[ M = \frac{100 F_{6, prest}}{b d} \left( 1 + \frac{100 F_{6, prest}}{b d} \right) \] see clause 6.1.2.4 (b) for definition of \( F_{6, prest} \)
2. The area of compression reinforcement \( A_{6, prest} \) used in this table may include all bars in the compression zone, even those not effectively tied with links.

**Legend:**
- Revision/addition

Typos are rectified.
Typos are rectified.

The term “deflection” in the title is amended to “curvature” to tally with the figure.

A bracket is added to the denominator of equation 8.2 for clarity.
Values for design ultimate anchorage bond stress

Values for design ultimate anchorage bond stress, \( f_{bu} \), may be obtained from the equation:

\[
f_{bu} = \beta \sqrt{f_{cu}} \tag{8.3}
\]

where:
- \( f_{cu} \) is the characteristic compressive cube strength of concrete, limited to 60 N/mm² for the purpose of calculating ultimate anchorage bond stress,
- \( f_{bu} \) is the design ultimate anchorage bond stress,
- \( \beta \) is a coefficient dependent on the bar type.

For bars in tension in slabs or in beams where minimum links have been provided in accordance with Table 6.2, the values of \( \beta \) may be taken from Table 8.3. These values include a partial safety factor, \( \gamma_{M} \), of 1.4.

<table>
<thead>
<tr>
<th>Bar type</th>
<th>Bars in tension</th>
<th>Bars in compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain bars</td>
<td>0.28</td>
<td>0.35</td>
</tr>
<tr>
<td>Ribbed bars</td>
<td>0.50</td>
<td>0.63</td>
</tr>
<tr>
<td>Fabric (see clause 8.4.6)</td>
<td>0.65</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Table 8.3 - Values of bond coefficient \( \beta \)

In beams where minimum links in accordance with Table 6.3 have not been provided, the design anchorage bond stresses used should be those appropriate to plain bars irrespective of the type of bar used. This does not apply to slabs.

Minimum ultimate anchorage bond lengths

The ultimate anchorage bond length, \( l_{bu} \), should be greater than or equal to the value calculated from:

\[
l_{bu} > \frac{f_{bu}}{0.87f_{y}} \tag{8.4}
\]

where:
- \( f_{bu} \) is the design ultimate anchorage bond stress,
- \( f_{y} \) is the yield stress of the bar.

Values for anchorage bond lengths are given in Table 8.4 as multiples of bar diameter.

Minimum ultimate anchorage bond lengths

The ultimate anchorage bond length, \( l_{bu} \), should be greater than or equal to the value calculated from:

\[
l_{bu} > \frac{f_{bu}}{0.87f_{y}} \tag{8.4}
\]

where:
- \( f_{bu} \) is the design ultimate anchorage bond stress,
- \( f_{y} \) is the yield stress of the bar.

Values for anchorage bond lengths are given in Table 8.4 as multiples of bar diameter.

Typos are rectified.

A bracket is added to the denominator of equation 8.4 for clarity.
<table>
<thead>
<tr>
<th>Clause 8.4.6 – Figure 8.1</th>
<th>Clause 8.4.8</th>
<th>Clause 8.5 – Figure 8.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The symbol “C” is amended to “c” in order to tally with the notation used in Equations 8.5 and 8.6.</strong></td>
<td><strong>An equation for calculating the minimum support width for anchor bars less than or equal to 12mm in diameter is added to tally with the minimum bend radius for hooks and loops given in Table 8.2.</strong></td>
<td><strong>Additional details of anchorage of links for hooks with 150° &amp; above is added. Original detail of 180° hook is covered by the new details and hence is deleted.</strong></td>
</tr>
<tr>
<td><strong>Figure 8.1 - Requirements of a bend anchorage</strong></td>
<td><strong>Figure 8.1 - Requirements of a bend anchorage</strong></td>
<td><strong>Figure 8.2 - Anchorage of links</strong></td>
</tr>
<tr>
<td>Clause 8.6</td>
<td>Figure 8.3</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td><strong>Figure 8.3 - Welded transverse bar as anchoring device</strong></td>
<td><strong>Figure 8.3 - Welded transverse bar as anchoring device</strong></td>
<td></td>
</tr>
<tr>
<td>The symbol “C” is amended to “c” in order to tally with the notation used in Equations 8.5 and 8.6.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clause 8.7</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8.7 LAPS AND MECHANICAL COUPLERS</strong></td>
<td><strong>8.7 LAPS</strong></td>
</tr>
<tr>
<td><strong>8.7.1 General</strong></td>
<td><strong>8.7.1 General</strong></td>
</tr>
<tr>
<td>Forces are transmitted from one bar to another by:</td>
<td>Forces are transmitted from one bar to another by:</td>
</tr>
<tr>
<td>(a) lapping of bars, with or without bends or hooks;</td>
<td>(a) lapping of bars, with or without bends or hooks;</td>
</tr>
<tr>
<td>(b) welding; or</td>
<td>(b) welding; or</td>
</tr>
<tr>
<td>(c) mechanical devices assuring load transfer in tension and compression in joints where imposed loading is predominantly cyclical bars should not be joined by welding.</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clause 8.7</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8.7 LAPS AND MECHANICAL COUPLERS</strong></td>
<td><strong>8.7 LAPS</strong></td>
</tr>
<tr>
<td><strong>8.7.1 General</strong></td>
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</tr>
<tr>
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<tr>
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</tr>
<tr>
<td>(c) mechanical devices assuring load transfer in tension and compression in joints where imposed loading is predominantly cyclical bars should not be joined by welding.</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clause 39</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clause 8.7.2 &amp; Figure 8.4</strong></td>
<td><strong>Figure 8.4 - Adjacent laps</strong></td>
</tr>
<tr>
<td>(d) the clear transverse distance between two lapping bars should not be greater than 40 or 50 mm, otherwise the lap length should be increased by a length equal to the clear space exceeding 40 or 50 mm, whichever is greater.</td>
<td>(d) the clear transverse distance between two lapping bars should not be greater than 40 or 50 mm, otherwise the lap length should be increased by a length equal to the clear space exceeding 40 or 50 mm, whichever is greater.</td>
</tr>
<tr>
<td>(a) the longitudinal distance between two adjacent laps should not be less than 0.3 times the lap length l′ and</td>
<td>(a) the longitudinal distance between two adjacent laps should not be less than 0.3 times the lap length l′ and</td>
</tr>
<tr>
<td>(f) in case of adjacent laps, the clear distance between adjacent bars should not be less than 20 mm.</td>
<td>(f) in case of adjacent laps, the clear distance between adjacent bars should not be less than 20 mm.</td>
</tr>
<tr>
<td>The permissible percentage of lapped bars in tension at any section may be 100% where the bars are all in one layer, or 50% where the bars are in several layers.</td>
<td>The permissible percentage of lapped bars in tension at any section may be 100% where the bars are all in one layer, or 50% where the bars are in several layers.</td>
</tr>
<tr>
<td>All bars in compression and secondary (distribution) reinforcement may be lapped in one section.</td>
<td>All bars in compression and secondary (distribution) reinforcement may be lapped in one section.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clause 40</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Figure 8.4 - Adjacent laps</strong></td>
<td><strong>Figure 8.4 - Adjacent laps</strong></td>
</tr>
<tr>
<td>Wall thickness should normally comply with both the general detailing rules given in clauses 8.9 to 8.9.5 and the particular rules for ductility given in clause 8.7. However, members not contributing in the lateral load resisting system or walls for single storey structures do not need to conform to the requirements of clause 8.9.</td>
<td>Walls for single storey structures are exempt from the ductility design requirement.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clause 41</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cantilevered slabs exposed to weathering should be designed for:</strong></td>
<td><strong>Cantilevered slabs exposed to weathering should be designed for:</strong></td>
</tr>
<tr>
<td>(i) exposure condition 2 or higher if appropriate;</td>
<td>(i) exposure condition 2 or higher if appropriate;</td>
</tr>
<tr>
<td>(j) estimated maximum crack width not exceeding 0.1 mm under serviceability limit state.</td>
<td>(j) estimated maximum crack width not exceeding 0.1 mm under serviceability limit state.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clause 9.4.1(j)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cantilevered slabs exposed to weathering should be designed for:</strong></td>
<td><strong>Cantilevered slabs exposed to weathering should be designed for:</strong></td>
</tr>
<tr>
<td>(i) exposure condition 2 or higher if appropriate;</td>
<td>(i) exposure condition 2 or higher if appropriate;</td>
</tr>
<tr>
<td>(j) estimated maximum crack width not exceeding 0.1 mm under serviceability limit state or the stress of deformed high yield steel reinforcing bars used should not exceed 100 N/mm² when checking the flexural tension under the working load condition.</td>
<td>(j) estimated maximum crack width not exceeding 0.1 mm under serviceability limit state or the stress of deformed high yield steel reinforcing bars used should not exceed 100 N/mm² when checking the flexural tension under the working load condition.</td>
</tr>
</tbody>
</table>

**Legend:** revision/addition
Clause 9.4.4
Details and construction
Cantilevered structures, especially those projecting over streets, should be detailed in such a manner that they may be demolished or replaced without affecting the safety and integrity of the main structure of the building.
Cantilevered structures should be cast monolithically with and at the same time as the directly supporting members. Construction joints should not be located along the external edge of the supporting members. In case this is unavoidable, the construction method must ensure that the finished product should have a structural strength and integrity not inferior to that provided by monolithic construction, and should not invite ingress of water through the joint.
 Adequate bar spacers should be provided to maintain the position and alignment of the steel reinforcing bars. Every endeavour should be made to avoid steel reinforcing bars from being displaced or depressed. Concrete works should strictly comply with requirements stipulated in clause 10.3.
Where a wall is designed to support a cantilevered slab, it should have adequate thickness to allow the proper anchorage of the main reinforcing bars of the cantilevered slab.

The additional construction requirements for external cantilevered slab with a span exceeding 750mm as stipulated in paragraph 9 of Appendix A to PNAP APP-68 are incorporated.

Clause 9.5
COLUMNS
This clause deals with columns for which the larger dimension \( h_c \) is not greater than 4 times the smaller dimension \( h_c \).

The symbols “hc” & “hc” are deleted.

Clause 9.5.2.2
Rectangular or polygonal columns
All corner bars, and alternate bars (or bundle) in an outer layer of reinforcement should be supported by links, with or without crossties, passing around the bars and having an included angle of not more than 135\(^\circ\) (see figure 9.5a). No bar within a compression zone should be further than 150 mm from a restrained bar.
Links should be adequately anchored by means of hooks bent though an angle of not less than 135\(^\circ\) (see figure 9.5b). Crossies should be adequately anchored by means of hooks bent through an angle of not less than 135\(^\circ\) at one end and 90\(^\circ\) at the other end, and should be alternated end for end along the longitudinal bars (see figure 9.5c). Where there is adequate confinement to prevent the end anchorage of the link from “kick off” (see figure 9.5e), the 135\(^\circ\) hook in the links or crossies may be replaced by other standard hoods given in figure 8.2.

Rectangular or polygonal columns
All corner bars, and alternate bars (or bundle) in an outer layer of reinforcement should be supported by links, with or without crossties, passing around the bars and having an included angle of not more than 135\(^\circ\) (see figure 9.5a). No bar within a compression zone should be further than 150 mm from a restrained bar.
Links should be adequately anchored by means of hooks bent through an angle of not less than 135\(^\circ\) at one end and 90\(^\circ\) at the other end, and should be alternated end for end along the longitudinal bars (see figure 9.5d). Where there is adequate confinement to prevent the end anchorage of the link from “kick off” (see figure 9.5e), hooks with bend not less than 135\(^\circ\) in the links or crossies may be replaced by other standard hooks given in figure 9.2.

Textual refinements and typos are rectified.
The alternative details of column transverse reinforcement as stipulated in BD’s circular letter dated 29 April 2011 are incorporated.

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**Clause 9.5.2.4 and Figure 9.5f added**

**Clause 9.9.1.3 (a)(i)**

- **Type is rectified.**
<table>
<thead>
<tr>
<th>Clause</th>
<th>Anchorage</th>
<th>Anchorage</th>
</tr>
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<tbody>
<tr>
<td>9.9.1.3(b)</td>
<td>Links should be adequately anchored by means of 135° or 180° hooks in accordance with clause 8.5. Anchorage by means of welded cross bars is not permitted. Where there is adequate confinement to prevent the end anchorage of the link from &quot;kick off&quot;, the 135° hook may be replaced by other standard hooks given in figure 8.2 (see figure 9.7).</td>
<td></td>
</tr>
<tr>
<td>9.9.2.2(c)</td>
<td>Links and ties should be adequately anchored by means of 135° hooks in accordance with clause 8.5. Anchorage by means of welded cross bars is not permitted. Where there is adequate confinement to prevent the end anchorage of the link from &quot;kick off&quot;, the 135° hook may be replaced by other standard hooks given in figure 8.2 (see figure 9.7).</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 9.7 - Typical confinement in beam](image)

Legend:
- revision/addition

Textual refinements and typos are rectified.
The alternative beam shear link details as stipulated in BD's circular letter dated 29 April 2011 are incorporated.
The typical beam-column joint shear reinforcement details as stipulated in BD’s circular letter dated 29 April 2011 are incorporated.

Clause 9.9.2.4 and Figure 9.7a added

9.9.2.4 Shear reinforcement in beam-column joints

Typical details of shear reinforcement in beam-column joints are given in figure 9.7a.

Notes:
1. Vertical shear reinforcement may be provided by vertical bars or inverted U-bars with adequate anchorages into column above or below the joint.
2. T.A.L. = Tension Anchorage Length

a) Beam-column joint - elevation showing vertical shear reinforcement

Notes:
1. Horizontal shear reinforcement may be provided by U-bars.
2. Shear reinforcement should not extend outside column section.

b) Beam-column joint - plan showing horizontal shear reinforcement

Figure 9.7a - Beam-Column Joint Shear Reinforcement
Clause 9.9.3.2

Confined boundary elements are the edge regions or intersections of the cross-sections of walls, which are strengthened by confining reinforcement as specified in this clause.

(a) Type 1 confined boundary element

Type 1 confined boundary element refers to the shaded portions of the walls in Figure 9.11(a), and should be provided with vertical reinforcement satisfying the following requirements:

(i) not less than 0.6% of the sectional area of the structural boundary element;
(ii) not smaller than 12mm in diameter and not less than 6 in number; and
(iii) each vertical bar is tied with links of at least 10mm diameter and vertical spacing not exceeding 250 mm.

(b) Type 2 confined boundary element

Type 2 confined boundary element refers to the shaded portions of the walls in Figure 9.11(a), and should be provided with vertical reinforcement satisfying the following requirements:

(i) not less than 0.8% of the sectional area of the structural boundary element;
(ii) not smaller than 16mm in diameter and not less than 6 in number; and
(iii) each vertical bar is tied with links of at least 10mm diameter and vertical spacing not exceeding 200 mm.

(c) Type 3 confined boundary element

Type 3 confined boundary element refers to the shaded portions of the walls in Figure 9.11(b), and should be provided with vertical reinforcement satisfying the following requirements:

(i) not smaller than 16mm in diameter and not less than 6 in number; and
(ii) spacing not exceeding 150mm; and
(iii) each vertical bar is tied with links of at least 12mm diameter and vertical spacing not exceeding 150 mm.

Confined boundary elements are the edge regions or intersections of the cross-sections of walls, which are strengthened by confining reinforcement as specified in this clause.

(a) Type 1 confined boundary element

Type 1 confined boundary element refers to the shaded portions of the walls in Figure 9.11(a), and should be provided with vertical reinforcement satisfying the following requirements:

(i) not less than 0.6% of the sectional area of the structural boundary element;
(ii) not smaller than 12mm in diameter and not less than 6 in number; and
(iii) each vertical bar is tied with links or ties of at least 10mm diameter and vertical spacing not exceeding 250 mm.

(b) Type 2 confined boundary element

Type 2 confined boundary element refers to the shaded portions of the walls in Figure 9.11(a), and should be provided with vertical reinforcement satisfying the following requirements:

(i) not less than 0.8% of the sectional area of the structural boundary element;
(ii) not smaller than 16mm in diameter and not less than 6 in number; and
(iii) each vertical bar is tied with links or ties of at least 10mm diameter and vertical spacing not exceeding 200 mm.

(c) Type 3 confined boundary element

Type 3 confined boundary element refers to the shaded portions of the walls in Figure 9.11(b), and should be provided with vertical reinforcement satisfying the following requirements:

(i) not less than 1% of the sectional area of the structural boundary element;
(ii) not smaller than 16mm in diameter and not less than 6 in number; and
(iii) spacing not exceeding 150mm; and
(iv) each vertical bar is tied with links or ties of at least 12mm diameter and vertical spacing not exceeding 150 mm.

Links and ties should be adequately anchored by means of hooks with bend not less than 135° in accordance with clause 9.2.2 (see Figure 9.5(b, c, d, e, f)). Where there is adequate confinement to prevent the "kick off" of the hook, hooks with bend not less than 135° may be replaced by other standard hooks given in Figure 8.2.

The vertical bar in the confined boundary elements of walls should be tied with links or ties.

For links and ties, where there is adequate confinement to prevent the "kick off" of the hook, hooks with bend not less than 135° may be replaced by other standard hooks given in Figure 8.2.
The symbols “b_c” and “h_c” are amended to “C_x” and “C_y” respectively to tally with the symbols in clause 1.5.
The conditions for temporary resumption of concreting works are added.

The coring test requirements and corresponding acceptance criteria for further testing required under regulation 63 of the Building (Construction) Regulations are added.

Consequential amendments (see remarks for Clause 4.2.1 in item 7 above).

A typo is rectified.
<table>
<thead>
<tr>
<th>Page</th>
<th>Clause</th>
<th>Revision/Adoption</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>12.12.3.1</td>
<td>(b) Cover against corrosion</td>
<td>The exposure conditions for the structural element should be assessed in accordance with clause 4.2.4.3 and the required nominal cover, grade and associated mix limitations obtained from Table 4.2. The recommendations of clause 4.2 for concrete materials and mixes also apply to Table 4.2 except that the minimum cement content should not be reduced below 300 kg/m³.</td>
</tr>
<tr>
<td>57</td>
<td>13.2</td>
<td></td>
<td>The term “characteristic live load” is amended to “characteristic imposed load”.</td>
</tr>
<tr>
<td>58</td>
<td>Annex A</td>
<td></td>
<td>The list of acceptable standards is updated to include the testing standards for post-tensioning systems.</td>
</tr>
</tbody>
</table>

**Legend:***
- Revision/Adoption
- Revision/Adoption
- Revision/Adoption

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**TEST LOADS**

The total load to be carried (W) should be not less than 1.0 times the characteristic dead load plus 1.0 times the characteristic live load, and should normally be the greater of (a) the sum of the characteristic dead load and 1.020 times the characteristic imposed load or (b) 1.2 times the sum of the characteristic dead and imposed loads. In deciding on suitable figures for this, and on how to apply the test load to the structure, due allowance should be made for finishes, partitions, etc and for any load sharing that could occur in the completed structure, i.e. the level of loading should be representative and capable of reproducing the proper internal force system reasonably closely.

| BS 4462:2005 | Steel fabric for the reinforcement of concrete: Specification |
| BS 4480:1980 | Specification for hot-rolled and hot-rolled and processed high tensile alloy steel bars for the prestressing of concrete |
| BS EN 460-4:2006 | Admixtures for concrete, mortar and grout: Test methods: Determination of bleeding of concrete |