# Code of Practice for Structural Use of Concrete 2013

The Buildings Department (BD) has set up a Technical Committee (TC) to, among others, collect and consider the views and feedback from the building industry arising from the use of the Code of Practice for Structural Use of Concrete 2013 (Concrete Code 2013). The current Concrete Code 2013 (2020 Edition), which was promulgated in December 2020, incorporated the amendments made and promulgated through circular letters dated 13 June 2017 and 24 November 2020. Taking into account the advice of the TC, the following amendments to the Concrete Code 2013 (2020 Edition) have been promulgated and uploaded to BD website www.bd.gov.hk:

(a) Appendix A – February 2022;

(b) Appendix B – June 2023; and

(c) Appendix C – April 2024.

( YU Po-mei, Clarice )
Building Authority

Ref.: BD GR/1-50/76

This PNAP is previously known as PNAP 296
First issue June 2007
Last revision June 2023
This revision April 2024 (AD/NB2) (Paragraph 1 amended, and Appendix C added)

# Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition)

# ( February 2022 )

Legends:

Amended

Deleted

(6/2023)

Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition) in February 2022 included:

(a) clause 6.2.3 and Figure 6.18b – addition of design requirements for plain concrete linings;

(b) clause 10.3.4.2 and Table 10.2 – revision of the requirements on the use of 100 mm and 150 mm concrete cubes;

(c) clause 11.7.5.4 and Table 11.2 – addition of general guidelines on monitoring early compressive strength of insitu concrete by maturity method; and

(d) Annex A – addition of ASTM C1074-19$^{\varepsilon 1}$ corresponding to the new clause 11.7.5.4.

**Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition)**

| Item | Current version | Amendments |
|---|---|---|
| 1. Contents | 6.2.2 Walls | 6.2.2 Walls<br>6.2.3 Plain concrete linings |
| 2. LIST OF TABLES[1] | Table 11.1 – Objects of production and construction control<br>Table 12.1 – Design flexural tensile stresses for class 2 members: serviceability limit state: cracking | Table 11.1 – Objects of production and construction control<br>Table 11.2 – Correction factor applied to the estimated insitu concrete compressive strength<br>Table 12.1 – Design flexural tensile stresses for class 2 members: serviceability limit state: cracking |
| 3. LIST OF FIGURES[2] | Figure 6.18a - Geometry of the Circular Section<br>Figure 6.19 - Critical section for shear check in a pile cap | Figure 6.18a - Geometry of the Circular Section<br>Figure 6.18b - Interaction Curve for Design of Plain Concrete Lining<br>Figure 6.19 - Critical section for shear check in a pile cap |
| 4. Clause 6.2.3 and Figure 6.18b | - | **6.2.3 Plain concrete linings**<br>*6.2.3.1 General*<br>Plain concrete is suitable for use in structural members with high axial loads and relatively low bending moments. The following criteria can generally be applied to the use of plain concrete lining in tunnels or caverns:<br>(a) the lining curvature is adequate to accommodate axial distribution of external loads;<br>(b) the plain concrete lining is constructed in relatively good rock geology and is always in compression under all load combinations;<br>(c) the effect of imperfection of the concrete lining has been considered by means of rigorous structural analysis of the plain concrete lining; and |

[1] Addition of Table 11.2 corresponding to the new clause 11.7.5.4.
[2] Addition of Figure 6.18b corresponding to the new clause 6.2.3.

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| | | (d) an arch section can be formed by plain concrete in conjunction with a reinforced concrete invert provided the junction between the plain and reinforced concrete satisfies the design requirements specified in clause 6.2.3.2.<br><br>*6.2.3.2 Design of plain concrete lining*<br>(a) Maximum axial load for plain concrete lining<br>The design ultimate capacity of axial load per unit length, $n_{LT}$ and design maximum ultimate bending moment per unit length, $m_{LT}$ ($=n_{LT}\ e_x$) shall be evaluated using the interaction curve as shown in Figure 6.18b.<br><br>(i) The first section (Point 1 to Point 2) of the interaction curve as shown in Figure 6.18b, the highest axial force, is applicable when the eccentricity of the thrust force is less than or equal to 0.1h. The ultimate capacity is calculated using a rectangular stress block over the whole section;<br>For $e_x \leq 0.1\text{h}$<br>$n_{LT} \leq 0.32\text{h}f_{cu}$ 6.63a<br><br>(ii) The second section (Point 2 to Point 3) of the interaction diagram is based on a rectangular stress block approach and is applicable for eccentricity between 0.1h and 0.3h. The stress block is acting over part of the section, and reduces as the eccentricity increases.<br>For $0.1\text{h} < e_x \leq 0.3\text{h}$<br>$n_{LT} \leq 0.4\,(\text{h}-2\,e_x)f_{cu}$ 6.63b<br>where: |

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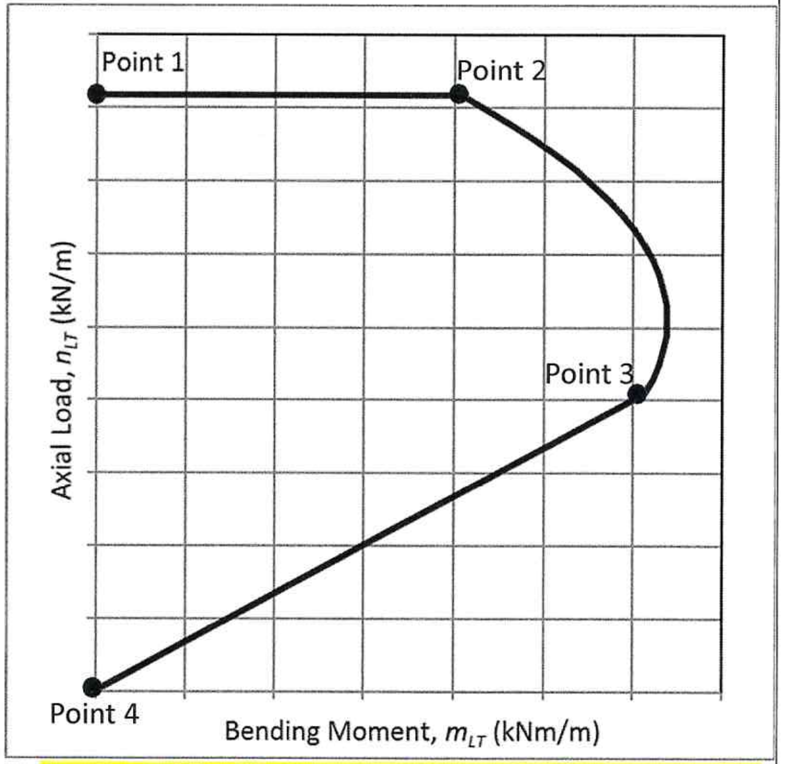
| | | $e_x$ is the resultant eccentricity of load at right angles to the plan of the lining.<br><br>(iii) Cracking restriction limits the use of the strength design method to a maximum eccentricity of 0.3h. The third section (Point 3 to Point 4) of the interaction curve is a straight line down to the point $n_{LT}$ = 0, $m_{LT}$ = 0, as shown in Figure 6.18b.<br><br><br><br>**Figure 6.18b – Interaction Curve for Design of Plain Concrete Lining** |

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| | | (b) Shear strength<br>The design shear stress in the plain concrete lining subjected to shear and axial compression without shear reinforcement can be calculated in accordance with clause 6.1.2.5(k).<br><br>The design shear resistance of plain concrete lining can be checked in accordance with clause 6.2.2.3(r). |
| 5. Clause 10.3.4.2(a) | 10.3.4.2 Concrete Cube Tests During Construction<br>(a) Concrete Cubes<br>The compressive strength of concrete shall be determined by testing 100 mm or 150 mm cubes 28 days after mixing. A representative sample shall be taken from fresh concrete to make test cubes and each sample shall be taken from a single batch. The rate of sampling shall be at least that specified in Table 10.1 and at least one sample shall be taken from each grade of concrete produced on any one day. | 10.3.4.2 Concrete Cube Tests During Construction<br>(a) Concrete Cubes<br>The compressive strength of concrete shall be determined by testing 100 mm cubes, or 150 mm cubes if the maximum aggregate size of concrete exceeds 20 mm, 28 days after mixing. A representative sample shall be taken from fresh concrete to make test cubes and each sample shall be taken from a single batch. The rate of sampling shall be at least that specified in Table 10.1 and at least one sample shall be taken from each grade of concrete produced on any one day. |

<table>
<tr><th>Item</th><th>Current version</th><th>Amendments</th></tr>
<tr><td>6. Table 10.2</td><td>
<table>
<tr><th>Specified Grade Strength</th><th>Compliance Criteria</th><th colspan="2">Column A<br>Average of 4 consecutive test results shall exceed the specified grade strength by at least</th><th colspan="2">Column B<br>Any individual test result shall not be less than the specified grade strength minus</th></tr>
<tr><td></td><td></td><td>150 mm Cubes</td><td>100 mm Cubes</td><td>150 mm Cubes</td><td>100 mm Cubes</td></tr>
<tr><td>C20 and above</td><td>C1</td><td>5 MPa</td><td>7 MPa</td><td>3 MPa</td><td>2 MPa</td></tr>
<tr><td></td><td>C2</td><td>3 MPa</td><td>5 MPa</td><td>3 MPa</td><td>2 MPa</td></tr>
<tr><td>Below C20</td><td>C1 or C2</td><td>2 MPa</td><td>3 MPa</td><td>2 MPa</td><td>2 MPa</td></tr>
</table>
Table 10.2 - Compressive Strength Compliance Criteria
</td><td>
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<tr><td>C20 and above</td><td>C1</td><td>7 MPa<br>(5 MPa)</td><td>2 MPa<br>(3 MPa)</td></tr>
<tr><td></td><td>C2</td><td>5 MPa<br>(3 MPa)</td><td>2 MPa<br>(3 MPa)</td></tr>
<tr><td>Below C20</td><td>C1 or C2</td><td>3 MPa<br>(2 MPa)</td><td>2 MPa<br>(2 MPa)</td></tr>
</table>
Table 10.2 - Compressive Strength Compliance Criteria
</td></tr>
<tr><td>7. Clause 10.3.4.2(b)(i)</td><td>(i) Before 40 test results are available, where there is sufficient previous production data using similar materials from the same plant under similar supervision to establish that the standard deviation of 40 test results is less than 5 MPa for 150 mm test cubes or 5.5 MPa for 100 mm test cubes, compliance requirement C2 may be adopted; otherwise compliance requirement C1 shall be adopted.</td><td>(i) Before 40 test results are available, where there is sufficient previous production data using similar materials from the same plant under similar supervision to establish that the standard deviation of 40 test results is less than 5.5 MPa (5 MPa for 150 mm cubes), compliance requirement C2 may be adopted; otherwise compliance requirement C1 shall be adopted.</td></tr>
<tr><td>8. Clause 10.3.4.2(b)(ii)</td><td>(ii) Where the calculated standard deviation of a set of 40 consecutive test results of concrete judged by compliance requirement C2 of Table 10.2 exceeds 5 MPa for 150 mm test cubes or 5.5 MPa for 100 mm test cubes, compliance requirement for checking the test results shall be changed from C2 to C1 on the 35$^{th}$ day after making the last pair of test cubes in the set of 40.</td><td>(ii) Where the calculated standard deviation of a set of 40 consecutive test results of concrete judged by compliance requirement C2 of Table 10.2 exceeds 5.5 MPa (5 MPa for 150 mm cubes), compliance requirement for checking the test results shall be changed from C2 to C1 on the 35$^{th}$ day after making the last pair of test cubes in the set of 40.</td></tr>
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| 9. Clause 10.3.4.2(b) (iii) | (iii) Where the calculated standard deviation of 40 previous consecutive test results is less than 5 MPa for 150 mm test cubes or 5.5 MPa for 100 mm test cubes, compliance requirement shall be changed from C1 to C2 on the 35th day after making the last pair of test cubes in the set of 40. | (iii) Where the calculated standard deviation of 40 previous consecutive test results is less than 5.5 MPa (5 MPa for 150 mm cubes), compliance requirement shall be changed from C1 to C2 on the 35th day after making the last pair of test cubes in the set of 40. |
| 10. Clause 10.3.4.2(b) (iv) | (iv) For concrete grade not exceeding C60, the calculated standard deviation exceeds 8 MPa for 150 mm test cubes or 8.5 MPa for 100 mm test cubes; or | (iv) For concrete grade not exceeding C60, the calculated standard deviation exceeds 8.5 MPa (8 MPa for 150 mm cubes); or |
| 11. Clause 10.3.4.2(b) (vi) | (vi) The average of the latest 40 cube test results exceeds the grade strength by at least 10 MPa for 150 mm test cubes or 12 MPa for 100 mm test cubes and all individual test results exceeds the grade strength by at least 4 MPa for 150 mm test cubes or 5 MPa for 100 mm test cubes; or | (vi) The average of the latest 40 cube test results exceeds the grade strength by at least 12 MPa (10 MPa for 150 mm cubes) and all individual test results exceeds the grade strength by at least 5 MPa (4 MPa for 150 mm cubes); or |
| 12. Clause 11.7.5.4 and Table 11.2 | - | 11.7.5.4 *Monitoring early compressive strength of insitu concrete by maturity method*<br>After concrete casting, the development of insitu concrete compressive strength at early age can be monitored by the maturity method. The maturity method can be used for estimating insitu concrete compressive strength through measurement of the temperature-time history of concrete of ages up to 14 days after casting, for the purpose of determining the concrete strength for striking of formwork and falsework[1] in lieu of the minimum periods specified in clause 10.3.8.2. In formulating a proposal adopting the maturity method, reference should be made to the acceptable standard in Annex A. The proposal should cover the following: |

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| | | (a) choice of an appropriate maturity function and determination of maturity function constants;<br>(b) apparatuses and their calibration;<br>(c) procedure for developing strength-maturity relationship;<br>(d) procedure for estimating insitu concrete strength;<br>(e) validation of insitu concrete strength;<br>(f) re-calibration and re-validation; and<br>(g) quality assurance and supervision.<br><br>The concrete mix used in the structure should be the same as that used to derive the strength-maturity relationship.<br><br>Taking into account the different conditions between cast insitu concrete and concrete cubes under various curing temperatures in the calibration process, a correction factor as shown in Table 11.2 should be applied to the estimated insitu concrete compressive strength. |

| Type of concrete mix | ≤ 48 hours after concrete casting | > 48 hours after concrete casting |
|---|---|---|
| Concrete mix containing pfa or ggbs | 0.7 | 0.8 |
| Other concrete mix | 0.8 | 0.8 |

**Table 11.2 – Correction factor applied to the estimated insitu concrete compressive strength**

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| | | | 1 Due to the rapid rate of concrete strength development within 24 hours after concrete casting, the maturity method is not suitable for use in justifying minimum periods before striking formwork and falsework of less than 24 hours. | |
| 13. Annex A[3] | BS EN 13263-1:2005 +A1:2009 | Silica fume for concrete. Definitions, requirements and conformity criteria | BS EN 13263-1:2005 +A1:2009<br><br>ASTM C1074-19$^{\varepsilon 1}$ | Silica fume for concrete. Definitions, requirements and conformity criteria<br><br>Standard Practice for Estimating Concrete Strength by the Maturity Method |

[3] Addition of ASTM C1074-19$^{\varepsilon 1}$ corresponding to the new clause 11.7.5.4.

# Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition)

# ( June 2023 )

Legends:

Amended

Deleted

(6/2023)

Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition) in June 2023 included:

(a) Clause 3.2.8.3 and Annex A – Addition of referenced standard ISO 15835-2 for the test method on mechanical coupler; and

(b) Clause 9.9.1.3(b) and Figure 9.6a – Addition of alternative arrangement for links/ties for beam.

## Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition)

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| 1. List of Figures |  |  |
| 2. Clause 3.2.8.3[1] | 3.2.8.3 Performance of type 1 mechanical couplers<br>Type 1 mechanical coupler satisfying the following criteria may be used as an alternative to tension or compression laps:<br>(a) when a representative gauge length assembly comprising reinforcement of the diameter, grade and profile to be used, and a coupler of the precise type to be used, is tested in tension the permanent elongation after loading to $0.6f_y$ should not exceed 0.1 mm; and …… | 3.2.8.3 Performance of type 1 mechanical couplers<br>Type 1 mechanical coupler satisfying the following criteria may be used as an alternative to tension or compression laps:<br>(a) when a representative gauge length assembly comprising reinforcement of the diameter, grade and profile to be used, and a coupler of the precise type to be used, is tested in tension the permanent elongation after loading to 0.6fy should not exceed 0.1 mm[1]; and ……<br><br>[1] Reference may be made to clause 5.4, excluding sub-clause 5.4.4, of ISO 15835-2 for the test method. |
| 3. Clause 9.9.1.3(b)[2] | (b) Anchorage<br>Links should be adequately anchored by means of hooks with bend not less than 135° in accordance with clause 8.5. Anchorage by means of welded cross bars is not permitted. Where …… | (b) Anchorage<br>Links should be adequately anchored by means of hooks with bend not less than 135° in accordance with clause 8.5. Alternatively, links/ties should be adequately anchored by means of hooks bent through an angle of not less than 135° at one end and 90° at the other end, and should be alternated end for end along the longitudinal bars (see Figure 9.6a). Anchorage by means of welded cross bars is not permitted. Where …… |

[1] Addition of referenced standard ISO 15835-2 for the test method on mechanical coupler.
[2] Addition of alternative arrangement for links/ties for beam.

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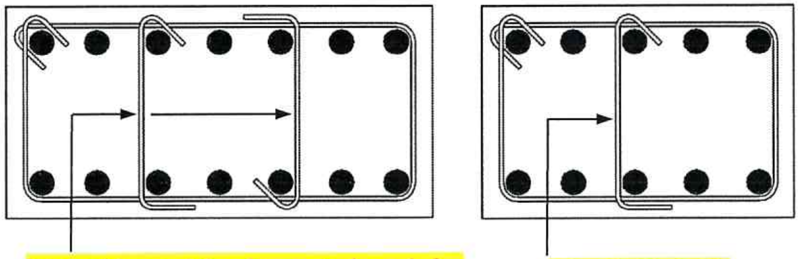
| 4. Figure 9.6a | | | <br><br>Figure 9.6a - Alternative arrangement for links/ties for beam | |
| 5. Annex A | AC 133:2008 | Acceptance Criteria for Mechanical Connector Systems for Steel Reinforcing Bars | AC 133:2008 | Acceptance Criteria for Mechanical Connector Systems for Steel Reinforcing Bars |
| | BS EN 197-1:2011 | Cement. Composition, specifications and conformity criteria for common cements | ISO 15835-2:2018 | Steels for the reinforcement of concrete – Reinforcement couplers for mechanical splices of bars – Part 2: Test methods |
| | | | BS EN 197-1:2011 | Cement. Composition, specifications and conformity criteria for common cements |

# Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition)

## ( April 2024 )

Legends:

Amended

Deleted

(4/2024)

Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition) in April 2024 included:

(a) Clause 3.2.8.3 and Figure 3.9a – addition of maximum allowable permanent elongation for mechanical couplers longer than 100 mm;

(b) Clauses 6.1.2.1, clause 6.9 and Figures 6.21 to 6.25 – addition of provisions for strut-and-tie system;

(c) Figure 9.5(g), (h) and (i) – addition of column transverse reinforcement details;

(d) Clause 11.7.1 – addition of mix proportion for concrete of strength not exceeding 20 $N/mm^2$ for minor structural and non-structural works and clarification of the limitation on the volume of concrete for exceptional project;

(e) Equation 12.2 – rectification of typo in equation; and

(f) Annex A – update of version of standard BS 8500 Parts 1 & 2 and addition of standard BS EN 206:2013.

**Amendments to the Code of Practice for Structural Use of Concrete 2013 (2020 Edition)**

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|---|---|---|
| 1. Contents | 6.8 BEAM-COLUMN JOINTS<br>6.8.1 General principles and requirements | 6.8 BEAM-COLUMN JOINTS<br>6.8.1 General principles and requirements<br>6.9 STRUT-AND-TIE SYSTEM<br>6.9.1 General<br>6.9.2 Modelling and analysis<br>6.9.3 Design |
| 2. List of Tables | Table 11.1 - Objects of production and construction control<br>Table 11.2 - Correction factor applied to the estimated insitu concrete compressive strength | Table 11.1 - Objects of production and construction control<br>Table 11.1a - Mix proportions for concrete for minor structural and non-structural works<br>Table 11.2 - Correction factor applied to the estimated insitu concrete compressive strength |
| 3. List of Figures | Figure 3.9 - Short-term design stress-strain curve for reinforcement<br>Figure 3.10 - Short-term design stress-strain curve for prestressing tendons | Figure 3.9 - Short-term design stress-strain curve for reinforcement<br>Figure 3.9a - Maximum allowable permanent elongation for type 1 mechanical couplers<br>Figure 3.10 - Short-term design stress-strain curve for prestressing tendons |
| 4. List of Figures | Figure 6.20 - Effective joint widths<br>Figure 7.1 - Assumptions made in calculating curvatures | Figure 6.20 - Effective joint widths<br>Figure 6.21 - Nodal condition<br>Figure 6.22 - Static equilibrium of a strut-and-tie model<br>Figure 6.23 - Load distribution area and loaded area for determining the confinement modification factor<br>Figure 6.24 - Classification of nodes<br>Figure 6.25 - Anchorage of tie reinforcements<br>Figure 7.1 - Assumptions made in calculating curvatures |

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| 5. Clause 1.5 | **1.5 SYMBOLS**<br>$F$ design ultimate load (e.g. $1.4G_k + 1.6Q_k$)<br>$f_{cu}$ characteristic compressive strength of concrete | **1.5 SYMBOLS**<br>$F$ design ultimate load (e.g. $1.4G_k + 1.6Q_k$)<br>$F_{tie}$ design resistance of non-prestressed ties<br>$f_{cb}$ design ultimate bearing strength based on the weaker of the two bearing surfaces<br>$f_{ce}$ design compressive strength of the concrete in a strut or a nodal zone<br>$f_{cu}$ characteristic compressive strength of concrete |
| 6. Clause 3.2.8.3[1] | 3.2.8.3 Performance of type 1 mechanical couplers<br>Type 1 mechanical coupler satisfying the following criteria may be used as an alternative to tension or compression laps:<br>(a) when a representative gauge length assembly comprising reinforcement of the diameter, grade and profile to be used, and a coupler of the precise type to be used, is tested in tension the permanent elongation after loading to $0.6f_y$ should not exceed 0.1 mm[1]; and …… | 3.2.8.3 Performance of type 1 mechanical couplers<br>Type 1 mechanical coupler satisfying the following criteria may be used as an alternative to tension or compression laps:<br>(a) when a representative gauge length assembly comprising reinforcement of the diameter, grade and profile to be used, and a coupler of the precise type to be used, is tested in tension the permanent elongation after loading to $0.6f_y$ should not exceed 0.1 mm[1];<br>(b) For couplers longer than 100 mm, the permanent elongation greater than 0.1 mm may be accepted as per Figure 3.9a subject to crack width control requirements in clauses 7.2.1, 9.4.1 and 12.3.4; and<br>(c) the coupler bar…… |

[1] Addition of maximum allowable permanent elongation for mechanical couplers longer than 100 mm.

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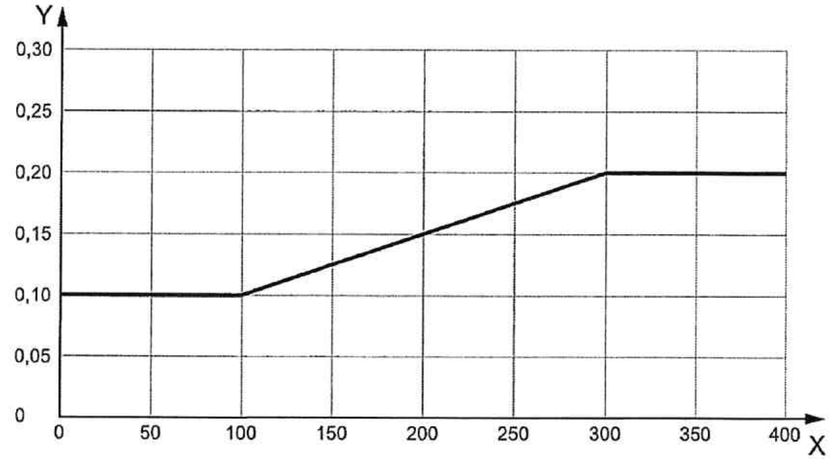
| | | <br>Key<br>X length of the mechanical coupler, in mm<br>Y permanent elongation after loading to $0.6f_y$, in mm<br><br>Figure 3.9a – Maximum allowable permanent elongation for type 1 mechanical couplers |
| 7. Clause 6.1.2.1 | 6.1.2.1 General<br>(a) Design limitations<br>This sub-clause deals with the design of beams of normal proportions. Deep beams (see clause 5.2.1.1(a)) are not considered. For the design of deep beams, reference should be made to specialist literature. | 6.1.2.1 General<br>(a) Design limitations<br>This sub-clause deals with the design of beams of normal proportions. Deep beams (see clause 5.2.1.1(a)) are not considered. For the design of deep beams, reference should be made to specialist literature or strut-and-tie system in clause 6.9. |
| 8. Clause 6.9[2] | | 6.9 STRUT-AND-TIE SYSTEM<br>6.9.1 General<br>Non-flexural components, e.g. locations near supports and concentrated loads, of reinforced concrete structures can be |

[2] Additional of provisions for strut-and-tie system.

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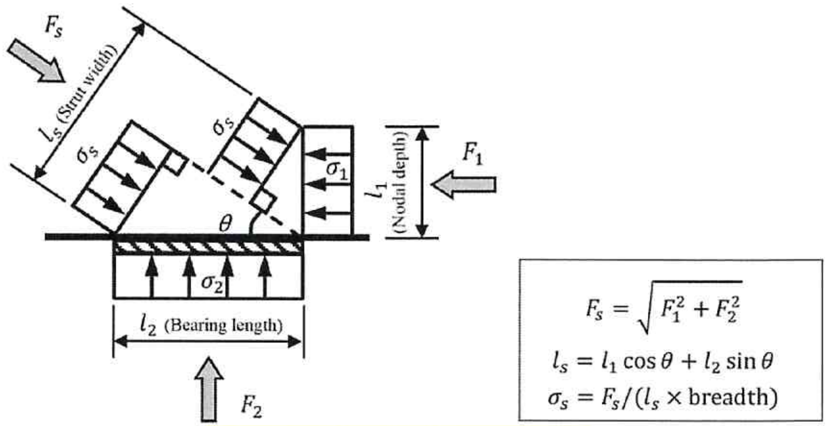
| | | designed using strut-and-tie model. A strut-and-tie model is an idealized pin-jointed truss, comprising concrete compression struts, reinforcement tension ties, and concrete nodes.<br><br>6.9.2 Modelling and analysis<br>The angle between the axis of a strut and the axis of a tie (θ) shall not be less than 25° nor exceed 60°. The boundary forces and the internal forces can be determined based on the static equilibrium and the truss analysis.<br><br>The dimensions of nodes shall be determined based on the nodal condition shown in Figure 6.21 by using the static equilibrium corresponding to shear failure and plastic stress state (see Figure 6.22).<br><br><br><br>Figure 6.21 – Nodal condition |

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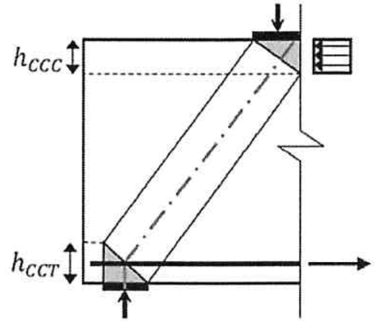
| | | <br>Figure 6.22 – Static equilibrium of a strut-and-tie model<br><br>6.9.3 Design<br>6.9.3.1 Design compressive strength of strut<br>Design compressive strength of concrete in strut $f_{ce}$ should be calculated from:<br><br>$f_{ce} = 0.32 m f_{cu}$ 6.74<br><br>where<br>m is the confinement modification factor taken as $\sqrt{\frac{A_2}{A_1}} \leq 2$,<br>$A_1$ is loaded area,<br>$A_2$ is load distribution area (see Figure 6.23). |

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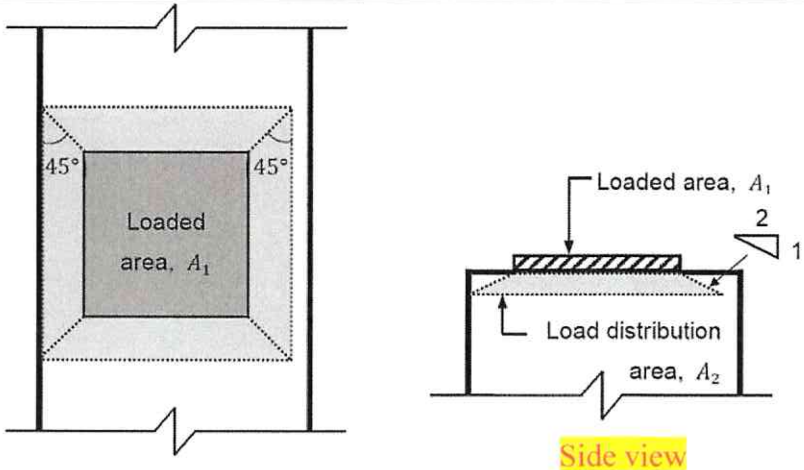
| | | <br><br>Plan view<br>Side view<br><br>Figure 6.23 – Load distribution area and loaded area for determining the confinement modification factor<br><br>6.9.3.2 Design compressive strength of nodes<br>Design compressive strength of concrete at a nodal zone $f_{ce}$ should be calculated as follows:<br><br>$f_{ce} = 0.45mf_{cu}$ for node bounded by struts, bearing areas or both (C-C-C Node) 6.75<br>$f_{ce} = 0.4mf_{cu}$ for node anchoring one tie (C-C-T Node) 6.76<br>$f_{ce} = 0.32mf_{cu}$ for node anchoring two or more tie (C-T-T Node) 6.77<br><br>Classification of nodes is illustrated in Figure 6.24. |

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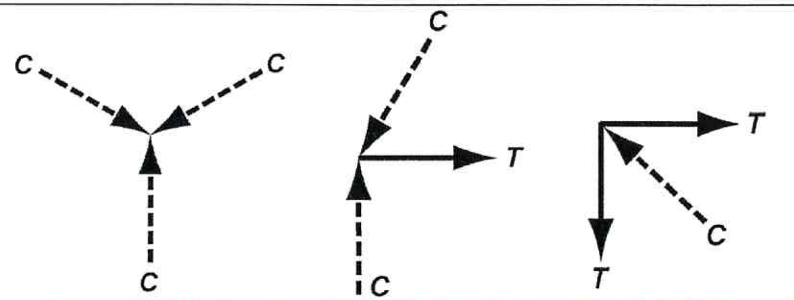
| | |   (i) C-C-C Node (ii) C-C-T Node (iii) C-T-T Node<br><br>Figure 6.24 Classification of nodes<br><br>6.9.3.3 Design compressive strength of bearing<br>Design ultimate bearing strength based on the weaker of the two bearing surfaces $f_{cb}$ should be calculated as follows:<br><br>$f_{cb} = 0.27\mathrm{m}f_{cu}$ for dry bearing on concrete 6.78<br>$f_{cb} = 0.40\mathrm{m}f_{cu}$ for bedded bearing on concrete 6.79<br>$f_{cb} = 0.80\mathrm{m}f_{cu}$ for contact face of a steel bearing plate cast into a member or support, with each dimension not exceeding 40% of the corresponding concrete dimension. 6.80<br><br>An intermediate value of bearing stress between dry and bedded bearings may be used for flexible bedding.<br><br>6.9.3.4 *Ties*<br>(a) Design resistance of ties<br>Design resistance of non-prestressed ties shall be calculated as follows:<br><br>$F_{tie} = 0.87 f_y A_s$ 6.81 |

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| | | (b) Arrangement of ties<br>The reinforcing bars in a tie shall be evenly distributed across the nodal depth such that the centroid axis of the reinforcing bars coincides with the axis of the tie in the strut-and-tie model.<br><br>(c) Anchorage of ties<br>The reinforcing bars in a tie shall be properly anchored to transfer the tension force into the node through adequate anchorage of longitudinal reinforcement in accordance with clause 8.4. The anchorage begins at the location where the edge of strut meets the bearing surface (see Figure 6.25). For straight bars, they shall be extended beyond the node. |

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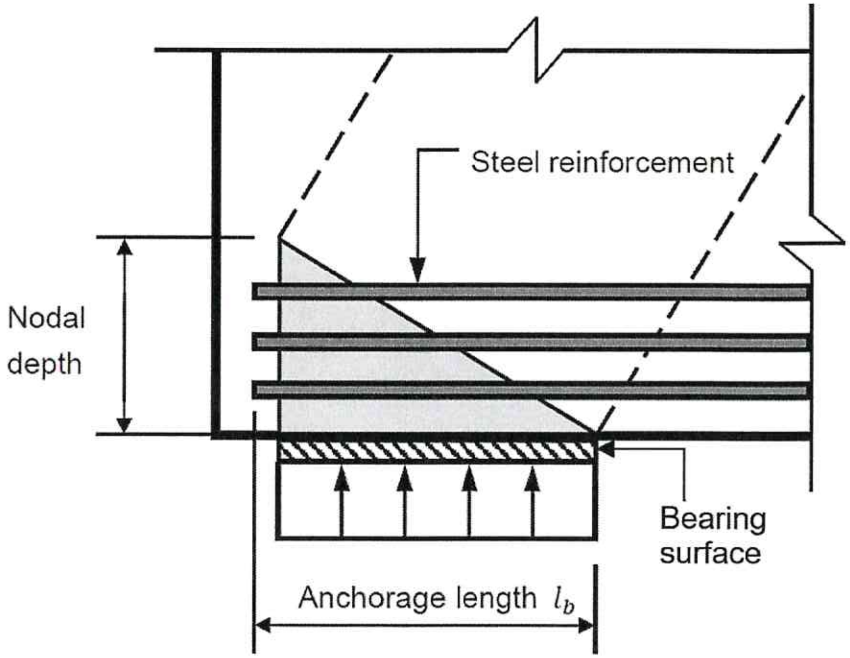
| | | <br><br>Figure 6.25 – Anchorage of tie reinforcements<br><br>6.9.3.5 *Minimum reinforcement*<br>An orthogonal grid of reinforcing bars shall be placed evenly across each face of the section. The minimum percentage of reinforcement is 0.25%. |

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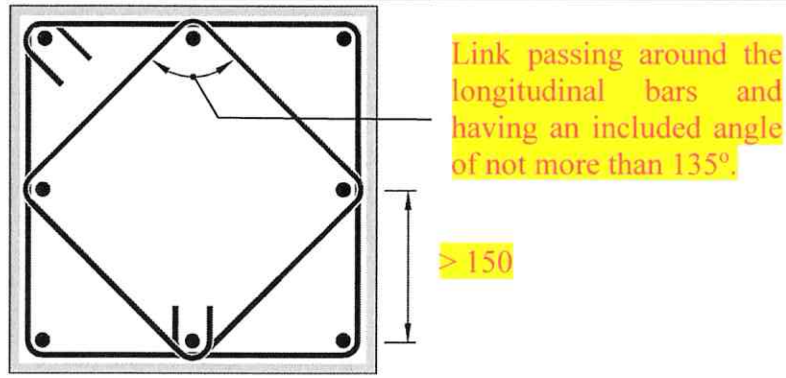
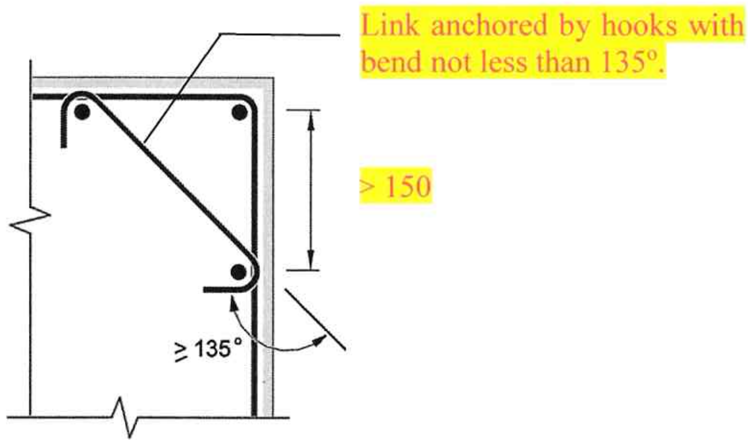
| 9. Figure 9.5[3] | | <br>g)<br><br>h) |

[3] Addition of column transverse reinforcement details.

| Item | Current version | Amendments |
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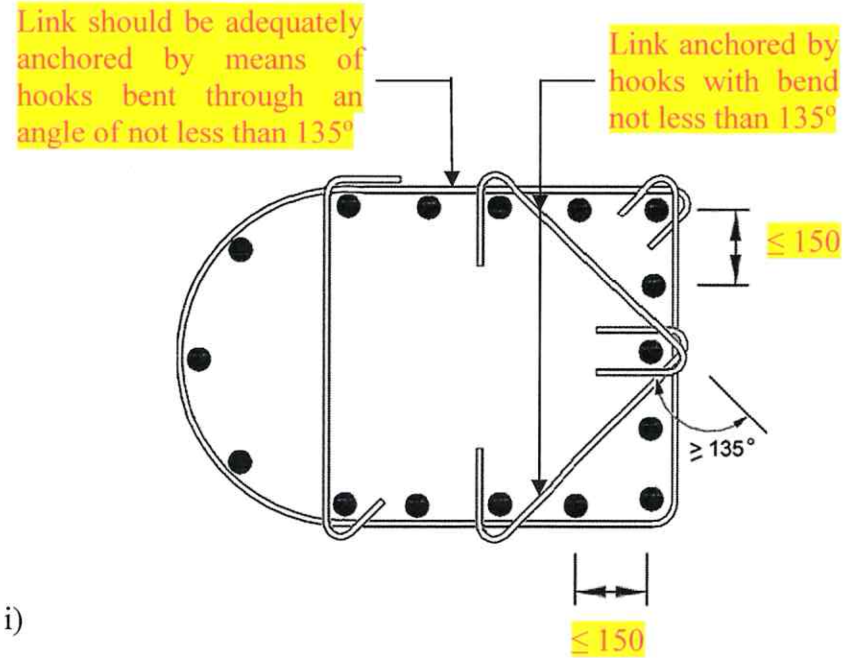
| | | i) <br>Figure 9.5 – Column transverse reinforcement |
| 10. Clause 9.9.2.2(c)[4] | (c) Anchorage<br>Links and ties should be adequately anchored by means of hooks with bend not less than 135° in accordance with clause 9.5.2 (see Figure 9.5b, c, d & e). Where …… | (c) Anchorage<br>Links and ties should be adequately anchored by means of hooks with bend not less than 135° in accordance with clause 9.5.2 (see Figure 9.5b, c, d, e, g, h & i). Where …… |
| 11. Clause 11.7.1[5] | Structural concrete for all works should be obtained from concrete suppliers who are certified under the Quality Scheme for the Production and Supply of Concrete (QSPSC) or similar equivalent, except for those located at remote areas (such as | Structural concrete should be obtained from concrete suppliers who are certified under the Quality Scheme for the Production and Supply of Concrete (QSPSC) or similar equivalent, except for those located at remote areas (such as outlying islands) or where the total |

[4] Addition of Figures 9.5(g), (h) and (i)

[5] Addition of mix proportions for concrete of strength not exceeding 20N/mm$^2$ for minor structural and non-structural works and clarification of the limitation on the volume of concrete for exceptional project.

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| | outlying islands) or where the volume of concrete involved is less than 50 $m^3$. Even for these "exceptional" projects, the structural concrete should be obtained from a supplier operating an approved quality system. | volume of concrete per building project involved is less than 50 $m^3$. Even for these "exceptional" projects, the structural concrete should be obtained from a supplier operating an approved quality system.<br><br>Concrete with strength not exceeding 20 $N/mm^2$ may be made using mix proportions, batching by weight, selected from Table 11.1a for minor structural and non-structural works such as on-grade slabs, blinding layer, U-channels/stepped channels, bedding and haunching for pipe works, concrete footings for posts and fences, and mass concrete fill which does not sustain appreciable loading. |

| Concrete Strength | Material | Weight of aggregate per bag of cement kg | | Maximum free water/ cement ratio |
| --- | --- | --- | --- | --- |
| | | 45 kg bag of cement | 50 kg bag of cement | |
| 10 $N/mm^2$ | Fine aggregate | 145 | 160 | 0.65 |
| | 20 mm coarse aggregate | 185 | 205 | |
| 15 $N/mm^2$ | Fine aggregate | 120 | 130 | |
| | 20 mm coarse aggregate | 165 | 180 | |
| 20 $N/mm^2$ | Fine aggregate | 95 | 105 | |
| | 20 mm coarse aggregate | 145 | 160 | |
| Note: Cement shall be ordinary Portland cement. | | | | |

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| | | | Table 11.1a – Mix proportions for concrete for minor structural and non-structural works | |
| 12. Equation 12.2[6] | $f_{pb} = f_{pe} + \frac{70000\lambda_1}{l/d}\left(1 - 0.7\lambda_2 \frac{f_{pu}A_{ps}}{f_{cu}bd}\right)$ 12.2 | | $f_{pb} = f_{pe} + \frac{7000\lambda_1}{l/d}\left(1 - 0.7\lambda_2 \frac{f_{pu}A_{ps}}{f_{cu}bd}\right)$ 12.2 | |
| 13. Annex A | BS 8500-1:2006 | Concrete. Complementary British Standard to BS EN 206-1. Method of specifying and guidance for the specifier | BS 8500-1:2015 | Concrete. Complementary British Standard to BS EN 206-1. Method of specifying and guidance for the specifier |
| | BS 8500-2:2006 | Concrete. Complementary British Standard to BS EN 206-1. Specification for constituent materials and concrete | BS 8500-2:2015 | Concrete. Complementary British Standard to BS EN 206-1. Specification for constituent materials and concrete |
| | | | BS EN 206:2013 | Concrete – Specification, performance, production and conformity |

[6] Rectification of typo in equation.