Appendix

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

(February 2022)

Legends:

Amended

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Appendix

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

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3. LIST OF FIGURES[2]	Figure 6.18a - Geometry of the Circular Section Figure 6.19 - Critical section for shear check in a pile cap	Figure 6.18a - Geometry of the Circular Section Figure 6.18b - Interaction Curve for Design of Plain Concrete Lining 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** *6.2.3.1 General* 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: (a) the lining curvature is adequate to accommodate axial distribution of external loads; (b) the plain concrete lining is constructed in relatively good rock geology and is always in compression under all load combinations; (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. *6.2.3.2 Design of plain concrete lining* (a) Maximum axial load for plain concrete lining 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. (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; For $e_x \leq 0.1\text{h}$ $n_{LT} \leq 0.32\text{h}f_{\text{cu}}$ 6.63a (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. For $0.1\text{h} < e_x \leq 0.3\text{h}$ $n_{LT} \leq 0.4\ (\text{h}-2\ e_x\ )f_{\text{cu}}$ 6.63b where:

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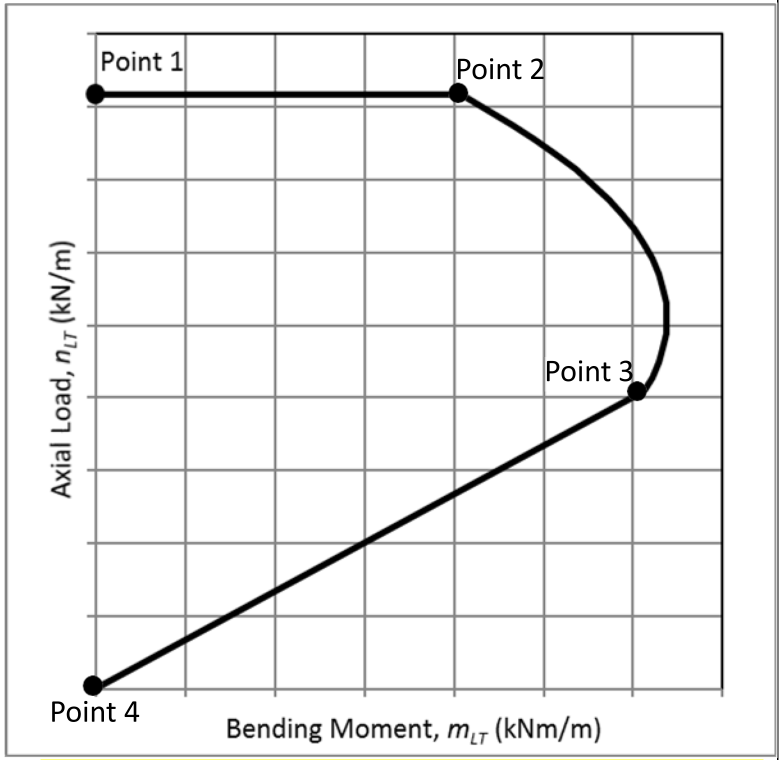
		e_x is the resultant eccentricity of load at right angles to the plan of the lining. (iii) Cracking restriction limits the use of the strength design method to a maximum eccentricity of 0.3h. The third section (Point 3 to Point 4) of the interaction curve is a straight line down to the point n_{LT} =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

<table>
<tr><th>Item</th><th>Current version</th><th>Amendments</th></tr>
<tr><td></td><td></td><td>(b) Shear strength
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).

The design shear resistance of plain concrete lining can be checked in accordance with clause 6.2.2.3(r).</td></tr>
<tr><td>5. Clause 10.3.4.2(a)</td><td>10.3.4.2 Concrete Cube Tests During Construction
(a) Concrete Cubes
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.</td><td>10.3.4.2 Concrete Cube Tests During Construction
(a) Concrete Cubes
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.</td></tr>
<tr><td>6. Table 10.2</td><td>
<table>
<tr><th rowspan="3">Specified Grade Strength</th><th rowspan="3">Compliance Criteria</th><th colspan="2">Column A</th><th colspan="2">Column B</th></tr>
<tr><th colspan="2">Average of 4 consecutive test results shall exceed the specified grade strength by at least</th><th colspan="2">Any individual test result shall not be less than the specified grade strength minus</th></tr>
<tr><th>150 mm Cubes</th><th>100 mm Cubes</th><th>150 mm Cubes</th><th>100 mm Cubes</th></tr>
<tr><td rowspan="2">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>C2</td><td>3 MPa</td><td>5 MPa</td><td>3 MPa</td><td>2 MPa</td></tr>
<tr><td>Below</td><td>C1 or C2</td><td>2 MPa</td><td>3 MPa</td><td>2 MPa</td><td>2 MPa</td></tr>
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(3 MPa)</td></tr>
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(3 MPa)</td><td>2 MPa
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	C20 | | | | | Table 10.2 - Compressive Strength Compliance Criteria	Below C20 | C1 or C2 | 3 MPa (2 MPa) | 2 MPa (2 MPa) Table 10.2 - Compressive Strength Compliance Criteria
7. Clause 10.3.4.2(b) (i)	(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.	(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.
8. Clause 10.3.4.2(b) (ii)	(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 35th day after making the last pair of test cubes in the set of 40.	(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 35th day after making the last pair of test cubes in the set of 40.
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.

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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* 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: (a) choice of an appropriate maturity function and determination of maturity function constants; (b) apparatuses and their calibration; (c) procedure for developing strength-maturity relationship; (d) procedure for estimating insitu concrete strength; (e) validation of insitu concrete strength;

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		(f) re-calibration and re-validation; and (g) quality assurance and supervision. The concrete mix used in the structure should be the same as that used to derive the strength-maturity relationship. 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** 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.

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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	Silica fume for concrete. Definitions, requirements and conformity criteria
			ASTM C1074-19$^{\varepsilon 1}$	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.