Annex

Amendments to the Code of Practice for Structural Use of Concrete 2013

(November 2020)

Legends:

Amended

Deleted

Annex

Amendments to the Code of Practice for Structural Use of Concrete 2013

Item	Current version	Amendments
1. Contents	3.2 Reinforcing steel 3.2.1 General 3.2.2 Characteristic strength 3.2.3 Strength classes 3.2.4 Elastic modulus 3.2.5 Physical properties 3.2.6 Stress-strain relationships for design 3.2.7 Weldability 3.2.8 Mechanical couplers 3.3 Prestressing tendons 3.3.1 General 3.3.2 Characteristic strength 3.3.3 Ductility 3.3.4 Physical properties 3.3.5 Stress-strain relationships for design 3.4 Prestressing devices 3.4.1 Anchorages and couplers 3.5 New Materials 3.5.1 General	3.2 Reinforcing steel 3.2.1 General 3.2.2 Characteristic strength 3.2.3 Strength classes 3.2.4 Elastic modulus 3.2.5 Physical properties 3.2.6 Stress-strain relationships for design 3.2.7 Weldability 3.2.8 Mechanical couplers 3.3 Welded fabric 3.3.1 General 3.3.2 Materials, Fabrication, Sampling and Testing 3.3.3 Additional requirements for Grade 500A welded fabric 3.4 Prestressing tendons 3.4.1 General 3.4.2 Characteristic strength

Item	Current version	Amendments
	3.5.2 Acceptance requirements 3.6 Design strength at elevated temperatures	3.4.3 Ductility 3.4.4 Physical properties 3.4.5 Stress-strain relationships for design 3.5 Prestressing devices 3.5.1 Anchorages and couplers 3.6 New Materials 3.6.1 General 3.6.2 Acceptance requirements 3.7 Design strength at elevated temperatures
2. Clause 1.4.1 New general term [1]	ultimate limit state (ULS) that state associated with collapse or with other similar forms of structural failure (see clause 2.2.2.1)	ultimate limit state (ULS) that state associated with collapse or with other similar forms of structural failure (see clause 2.2.2.1) welded fabric arrangement of longitudinal and transverse bars of the same or different nominal diameter arranged

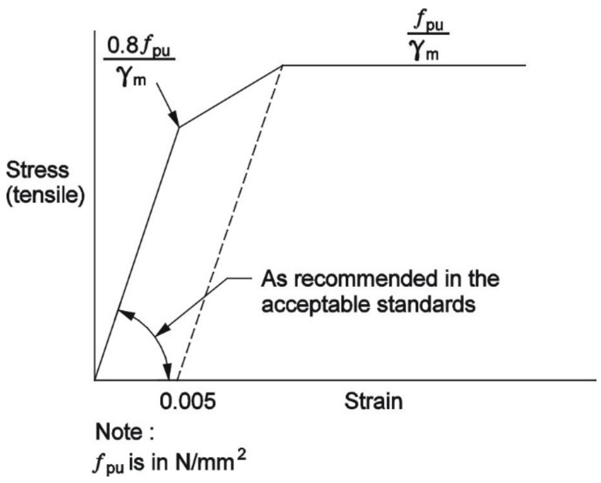
[1] The term “welded fabric” is defined. The terms “fabric” and “welded mesh fabrics” are replaced by “welded fabric” correspondingly.

Annex

Item	Current version	Amendments
		substantially at right angles to each other that are welded together at all points of intersection by electrical resistance welding in a factory using automatic machines (see clause 3.3)
3. Clause 1.5 New symbol [2]	z lever arm γ_f partial safety factor for load	z lever arm α_{min} modification factor for minimum steel ratio for tensile reinforcement and transverse reinforcement γ_f partial safety factor for load
4. Clause 2.2.3.2 1st paragraph [3]	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 clause 3.6, and the partial safety factors for loads and materials should be based on the values given in clauses 2.3.2.7 and 2.4.3.2 respectively.	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 clause 3.7, and the partial safety factors for loads and materials should be based on the values given in clauses 2.3.2.7 and 2.4.3.2 respectively.

[2] Modification factor for minimum steel ratio of tensile reinforcement and transverse reinforcement is introduced to take into account different concrete strengths.
[3] Consequential re-numbering of clause due to insertion of new clause 3.3 for welded fabric.

Item	Current version	Amendments
5. Clause 3.3 New clause [1 & 3]	**3.3 PRESTRESSING TENDONS** **3.3.1 General** This section applies to wires, bars and strands complying with acceptable standards, and used as prestressing tendons in concrete structures. **3.3.2 Characteristic strength** The characteristic strength of a prestressing tendon, unless stated otherwise, means the ultimate strength below which 5% of all possible test results would be expected to fall. **3.3.3 Ductility** The products shall have adequate ductility in elongation and bending. **3.3.4 Physical properties** The following mean values may be used: (a) density 7850 kg/m^3; and (b) coefficient of thermal expansion 12x10^{-6}/^{o}C. **3.3.5 Stress-strain relationships for design**	**3.3 WELDED FABRIC** **3.3.1 General** Unless otherwise stated, the requirements for steel reinforcing bars apply to welded fabric. In each single panel of welded fabric, the bars should be of the same characteristics (type and grade). Bars of different diameters could be used in different directions but only one nominal diameter should be used in each direction. **3.3.2 Materials, fabrication, sampling and testing** The material properties of Grade 500A steel reinforcing bars used for manufacturing the welded fabric should comply with BS 4449 while those of Grade 500B and Grade 500C steel reinforcing bars used for manufacturing the welded fabric should comply with CS2. The fabrication, sampling and testing other than material properties for all welded fabric, i.e. Grade 500A, 500B and 500C should comply with BS 4483. Determination of fatigue properties of steel reinforcing bars used for manufacturing the welded fabric is an optional

Item	Current version	Amendments
	The short-term design stress-strain curve for prestressing tendons is given in figure 3.10 below, with γ_m having the relevant value. For sustained loading, appropriate allowance for relaxation should be made.  **Figure 3.10 - Short-term design stress-strain curve for prestressing tendons**	requirement on the basis of the type of structure in which the welded fabrics are to be cast. **3.3.3 Additional requirements for Grade 500A welded fabric** Grade 500A welded fabric should be manufactured by steel reinforcing bars with diameters from 8 mm to 16 mm. In all conditions, moment redistribution is not allowed. In addition, Grade 500A welded fabric should only be used in the following locations: (a) Slab (i) sections not contributing to the lateral load resisting system; (ii) sections other than column strips of flat slab system and similar slab structures providing structural ties for robustness against disproportionate collapse; and (iii) slab sections with low bending stress, i.e.

Item	Current version	Amendments
		$$K = \frac{M}{f_{cu} bd^2} \le 0.156 \quad for\ f_{cu} \le 45\ N/mm^2$$ $$\le 0.120 \quad for\ 45 < f_{cu} \le 70 N/mm^2$$ (b) Wall Outside confined boundary elements as defined in clause 9.9.3.2. **3.4 PRESTRESSING TENDONS** **3.4.1 General** This section applies to wires, bars and strands complying with acceptable standards, and used as prestressing tendons in concrete structures. **3.4.2 Characteristic strength** The characteristic strength of a prestressing tendon, unless stated otherwise, means the ultimate strength below which 5% of all possible test results would be expected to fall. **3.4.3 Ductility**

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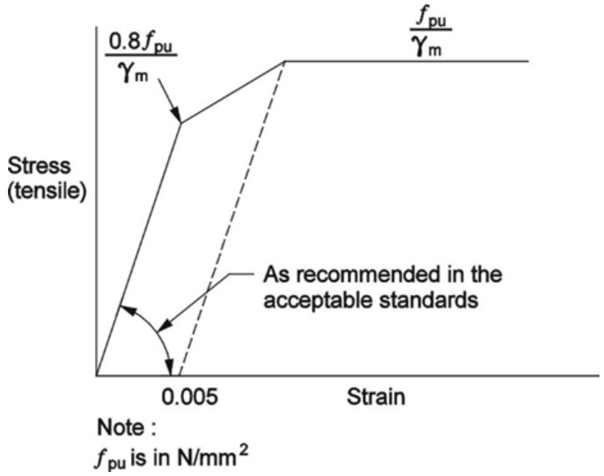
Item	Current version	Amendments
		 **Figure 3.10 - Short-term design stress-strain curve for prestressing tendons**
6. Clause 3.4 [3]	**3.4 PRESTRESSING DEVICES** **3.4.1 Anchorages and couplers** 3.4.1.1 General This section applies to anchoring devices (anchorages) and coupling devices (couplers) in post tensioned construction. All anchorages should comply with the acceptable standards.	**3.5 PRESTRESSING DEVICES** **3.5.1 Anchorages and couplers** 3.5.1.1 General This section applies to anchoring devices (anchorages) and coupling devices (couplers) in post tensioned construction. All anchorages should comply with the acceptable standards.

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	3.4.1.2 Mechanical properties Tendon-anchorage assemblies and tendon coupler assemblies shall have strength, elongation and fatigue characteristics sufficient to meet the basic requirements of section 2.	3.5.1.2 Mechanical properties Tendon-anchorage assemblies and tendon coupler assemblies shall have strength, elongation and fatigue characteristics sufficient to meet the basic requirements of section 2.
7. Clause 3.5 [3]	**3.5 NEW MATERIALS** **3.5.1 General** The requirements of this code of practice are not to be construed as prohibiting the use of new and alternative materials. **3.5.2 Acceptance requirements** The properties of new materials must be adequately demonstrated to comply with the basic requirements of section 2. For this purpose sufficient information must be provided, including manufacturing data, testing and proposed quality controls, to allow independent third party evaluation of such compliance.	**3.6 NEW MATERIALS** **3.6.1 General** The requirements of this code of practice are not to be construed as prohibiting the use of new and alternative materials. **3.6.2 Acceptance requirements** The properties of new materials must be adequately demonstrated to comply with the basic requirements of section 2. For this purpose sufficient information must be provided, including manufacturing data, testing and proposed quality controls, to allow independent third party evaluation of such compliance.

<table>
<tr><th>Item</th><th>Current version</th><th>Amendments</th></tr>
<tr><td>8. Clause 3.6 [3]</td><td>3.6 DESIGN STRENGTH AT ELEVATED TEMPERATURES</td><td>3.7 DESIGN STRENGTH AT ELEVATED TEMPERATURES</td></tr>
<tr><td>9. Clause 8.4.1
1st paragraph [1]</td><td>Reinforcing bars, wires or welded mesh fabrics shall be so anchored that the bond forces are safely transmitted to the concrete avoiding longitudinal cracking or spalling. Transverse reinforcement shall be provided if necessary.</td><td>Reinforcing bars, wires or welded fabrics should be so anchored that the bond forces are safely transmitted to the concrete avoiding longitudinal cracking or spalling. Transverse reinforcement shall be provided if necessary.</td></tr>
<tr><td>10. Table 8.3 [1]</td><td>
<table>
<tr><th rowspan="2">Bar type</th><th colspan="2">β</th></tr>
<tr><th>Bars in tension</th><th>Bars in compression</th></tr>
<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>
</table>
Table 8.3 - Values of bond coefficient β
</td><td>
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Item	Current version	Amendments
11. Table 8.4 [1]	See table below	See table below

Current version

Concrete Grade	Type of anchorage length	f_y 250 N/mm²	f_y 500 N/mm² Ribbed	f_y 500 N/mm² Fabric
30	Tension Compression	36 29	40 32	31 25
35	Tension Compression	33 27	38 30	29 23
40	Tension Compression	31 25	35 28	27 22
45	Tension Compression	29 24	33 26	25 20
50	Tension Compression	28 22	31 25	24 19
≥ 60	Tension Compression	26 20	28 23	22 18

Table 8.4 - Ultimate anchorage bond lengths (l_b) as multiples of bar diameter

Amendments

Concrete Grade	Type of anchorage length	f_y 250 N/mm²	f_y 500 N/mm² Ribbed	f_y 500 N/mm² Welded fabric
30	Tension Compression	36 29	40 32	31 25
35	Tension Compression	33 27	38 30	29 23
40	Tension Compression	31 25	35 28	27 22
45	Tension Compression	29 24	33 26	25 20
50	Tension Compression	28 22	31 25	24 19
≥ 60	Tension Compression	26 20	28 23	22 18

Table 8.4 - Ultimate anchorage bond lengths (l_b) as multiples of bar diameter

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12. Clause 8.4.7 1st paragraph [1]	**8.4.7 Design ultimate anchorage bond stress for fabric** The value of design ultimate anchorage bond stress given in clause 8.4.4 for fabric is applicable to fabric manufactured from bars or wires conforming to the acceptable standards. This is provided that: (a) the fabric is welded in a shear resistance manner conforming to the acceptable standards; and (b) the number of welded intersections within the anchorage length is at least equal to $4A_{s\ req}/A_{s\ prov}$.	**8.4.7 Design ultimate anchorage bond stress for welded fabric** The value of design ultimate anchorage bond stress given in clause 8.4.4 for welded fabric is applicable to fabric manufactured from bars or wires conforming to the acceptable standards. This is provided that: (a) the welded fabric is welded in a shear resistance manner conforming to the acceptable standards; and (b) the number of welded intersections within the anchorage length is at least equal to $4A_{s\ req}/A_{s\ prov}$.
13. Clause 8.7.3.1 [1]	The minimum lap length for bar reinforcement should be not less than 15 times the bar diameter or 300 mm, whichever is greater, and for fabric reinforcement should not be less than 250 mm.	The minimum lap length for bar reinforcement should be not less than 15 times the bar diameter or 300 mm, whichever is greater, and for welded fabric should not be less than 250 mm.
14. Clause 8.7.3.2 1st paragraph [1]	The tension lap length should be at least equal to the design tension anchorage length (see clause 8.4.5) necessary to develop the required stress in the reinforcement. Lap lengths for unequal size bars (or wires in fabric) may be	The tension lap length should be at least equal to the design tension anchorage length (see clause 8.4.5) necessary to develop the required stress in the reinforcement. Lap lengths for unequal size bars (or wires in welded fabric) may

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<tr><td></td><td>based upon the diameter of the smaller bar. The following provisions also apply:</td><td>be based upon the diameter of the smaller bar. The following provisions also apply:</td></tr>
<tr><td>15. Clause 8.7.3.3 1st paragraph [1]</td><td>The compression lap length should be at least 25% greater than the design compression anchorage length (see clause 8.4.5) necessary to develop the required stress in the reinforcement. Lap lengths for unequal size bars (or wires in fabric) may be based upon the smaller bar diameter.</td><td>The compression lap length should be at least 25% greater than the design compression anchorage length (see clause 8.4.5) necessary to develop the required stress in the reinforcement. Lap lengths for unequal size bars (or wires in welded fabric) may be based upon the smaller bar diameter.</td></tr>
<tr><td>16. Table 8.5 [1]</td><td>
<table>
<tr><th rowspan="3">Concrete Grade</th><th rowspan="3">Type of lap length</th><th colspan="3">Reinforcement types</th></tr>
<tr><th rowspan="2">f_y 250 N/mm²</th><th colspan="2">f_y 500 N/mm²</th></tr>
<tr><th>Ribbed</th><th>Fabric</th></tr>
<tr><td rowspan="3">30</td><td>Tension and compression lap length – l_o</td><td>36</td><td>40</td><td>31</td></tr>
<tr><td>1.4 x tension lap</td><td>50</td><td>56</td><td>44</td></tr>
<tr><td>2.0 x tension lap</td><td>71</td><td>80</td><td>62</td></tr>
<tr><td>35</td><td>Tension and compression lap length – l_o</td><td>33</td><td>38</td><td>29</td></tr>
</table>
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<tr><td rowspan="3">30</td><td>Tension and compression lap length – l_o</td><td>36</td><td>40</td><td>31</td></tr>
<tr><td>1.4 x tension lap</td><td>50</td><td>56</td><td>44</td></tr>
<tr><td>2.0 x tension lap</td><td>71</td><td>80</td><td>62</td></tr>
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Item	Current version					Amendments				
						35	Tension and compression lap length – l_o	33	38	29
		1.4 x tension lap	46	52	40		1.4 x tension lap	46	52	40
		2.0 x tension lap	66	75	57		2.0 x tension lap	66	75	57
	40	Tension and compression lap length – l_o	31	35	27	40	Tension and compression lap length – l_o	31	35	27
		1.4 x tension lap	43	49	38		1.4 x tension lap	43	49	38
		2.0 x tension lap	62	70	54		2.0 x tension lap	62	70	54
	45	Tension and compression lap length – l_o	29	33	25	45	Tension and compression lap length – l_o	29	33	25
		1.4 x tension lap	41	47	35		1.4 x tension lap	41	47	35
		2.0 x tension lap	58	66	50		2.0 x tension lap	58	66	50
	50	Tension and compression lap length – l_o	28	31	24	50	Tension and compression lap length – l_o	28	31	24
		1.4 x tension lap	39	44	34		1.4 x tension lap	39	44	34
		2.0 x tension lap	55	62	48		2.0 x tension lap	55	62	48
	≥ 60	Tension and compression lap length – l_o	26	28	22	≥ 60	Tension and compression lap length – l_o	26	28	22
		1.4 x tension lap	36	40	31		1.4 x tension lap	36	40	31
		2.0 x tension lap	51	56	44		2.0 x tension lap	51	56	44

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<tr><td></td>
<td>Notes:
1. The values are rounded up to the nearest whole number and the length derived from these values may differ slightly from those calculated directly for each bar or wire size.

Table 8.5 - Ultimate lap lengths as multiples of bar diameter</td>
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Table 8.5 - Ultimate lap lengths as multiples of bar diameter</td></tr>
<tr><td>17. Table 9.1 [2]</td>
<td>
<table>
<tr><th rowspan="2">Situation</th><th rowspan="2">Definition of percentage</th><th colspan="2">Minimum percentage</th></tr>
<tr><th>$f_y = 250$ N/mm² (%)</th><th>$f_y = 500$ N/mm² (%)</th></tr>
<tr><td>*Tension reinforcement*
Sections subjected mainly to pure tension</td><td>$100A_s/A_c$</td><td>0.8</td><td>0.45</td></tr>
<tr><td>Sections subjected to flexure:
(i) flanged beams, web in tension:
$b_w/b < 0.4$
$b_w/b \geq 0.4$</td><td>$100A_s/b_wh$
$100A_s/b_wh$</td><td>0.32
0.24</td><td>0.18
0.13</td></tr>
</table>
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<tr><th rowspan="2">Situation</th><th rowspan="2">Definition of percentage</th><th colspan="2">Minimum percentage</th></tr>
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<tr><td>*Tension reinforcement*
Sections subjected mainly to pure tension</td><td>$100A_s/A_c$</td><td>$0.8\alpha_{min}$</td><td>$0.45\alpha_{min}$</td></tr>
<tr><td>Sections subjected to flexure:
(i) flanged beams, web in tension:
$b_w/b < 0.4$
$b_w/b \geq 0.4$</td><td>$100A_s/b_wh$
$100A_s/b_wh$</td><td>$0.32\alpha_{min}$
$0.24\alpha_{min}$</td><td>$0.18\alpha_{min}$
$0.13\alpha_{min}$</td></tr>
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Annex

Item	Current version				Amendments			
	(ii) flanged beams, flange in tension:				(ii) flanged beams, flange in tension:			
	T-beam	$100A_s/b_wh$	0.48	0.26	T-beam	$100A_s/b_wh$	$0.48\alpha_{min}$	$0.26\alpha_{min}$
	L-beam	$100A_s/b_wh$	0.36	0.20	L-beam	$100A_s/b_wh$	$0.36\alpha_{min}$	$0.20\alpha_{min}$
	(iii) rectangular section	$100A_s/A_c$	0.24	0.13	(iii) rectangular section	$100A_s/A_c$	$0.24\alpha_{min}$	$0.13\alpha_{min}$
	Compression reinforcement (where such reinforcement is required for the ultimate limit state)				*Compression reinforcement* (where such reinforcement is required for the ultimate limit state)			
	General rule	$100A_{sc}/A_{cc}$	0.4	0.4	General rule	$100A_{sc}/A_{cc}$	0.4	0.4
	Simplified rules for particular cases:				Simplified rules for particular cases:			
	(i) rectangular beam	$100A_{sc}/A_c$	0.2	0.2	(i) rectangular beam	$100A_{sc}/A_c$	0.2	0.2
	(ii) flanged beam				(ii) flanged beam			
	flange in compression	$100A_{sc}/bh_f$	0.4	0.4	flange in compression	$100A_{sc}/bh_f$	0.4	0.4
	web in compression	$100A_{sc}/b_wh$	0.2	0.2	web in compression	$100A_{sc}/b_wh$	0.2	0.2

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<tr><td>Transverse reinforcement in flanges of flanged beams (provided over full effective flange width near top surface to resist horizontal shear)</td><td>$100\,A_{st}/h_f l$</td><td>0.15</td><td>0.15</td></tr>
<tr><td colspan="4">Notes:
1. The minimum percentages of reinforcement should be increased where necessary to meet the ductility requirements given in clause 9.9.</td></tr>
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Table 9.1 - Minimum percentages of reinforcement
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<tr><td>Transverse reinforcement in flanges of flanged beams (provided over full effective flange width near top surface to resist horizontal shear)</td><td>$100\,A_{st}/h_f l$</td><td>0.15α_{min}</td><td>0.15α_{min}</td></tr>
<tr><td colspan="4">Notes:
1. The minimum percentages of reinforcement should be increased where necessary to meet the ductility requirements given in clause 9.9.
2. $\alpha_{min} = 40f_{cu}^{2/3}/f_y$ but not less than 1.0.</td></tr>
</table>
Table 9.1 - Minimum percentages of reinforcement
</td></tr>
<tr><td>18. Clause 9.3.1.1(a) [2]</td><td>The following minimum percentages of total longitudinal reinforcement should be provided in each direction:
(i) f_y = 250 N/mm^2: 0.24% of concrete cross-sectional area; and
(ii) f_y = 500 N/mm^2: 0.13% of concrete cross-sectional area.

Generally secondary transverse reinforcement of not less than 20% of the principal reinforcement should be provided in one-way slabs. In areas near supports transverse</td><td>The following minimum percentages of total longitudinal reinforcement should be provided in each direction:
(i) f_y = 250 N/mm^2: 0.24% of concrete cross-sectional area; and
(ii) f_y = 500 N/mm^2: 0.13% of concrete cross-sectional area.

For tension reinforcement, the minimum percentages of total longitudinal reinforcement should be multiplied by a modification factor, $\alpha_{min} = 40f_{cu}^{2/3}/f_y$ but not less than 1.0.</td></tr>
</table>

Item	Current version	Amendments
	reinforcement to principal top bars is not necessary where there is no transverse bending moment.	Generally secondary transverse reinforcement of not less than 20% of the principal reinforcement should be provided in one-way slabs. In areas near supports transverse reinforcement to principal top bars is not necessary where there is no transverse bending moment.
19. Clause 9.4.1 [4]	Wherever practicable, pure cantilevered slab arrangements should not be used for spans exceeding 750 mm, and beam-and-slab arrangements should be used for spans exceeding 1000 mm. When these requirements cannot be complied with, more stringent control than those given in this Code may be necessary. A cantilevered structure should have such a thickness that the following requirements and the requirements of clause 7.3 are complied with: (a) 300 mm at the support of cantilevered beam; (b) 110 mm for cantilevered slab with span not exceeding 500 mm; (c) 125 mm for cantilevered slab with span greater than 500 mm but not exceeding 750 mm;	Instead of pure cantilevered slab arrangements, beam-and-slab arrangements should be used for spans exceeding 1200 mm. When these requirements cannot be complied with, more stringent control than those given in this Code may be necessary. A cantilevered structure should have such a thickness that the following requirements and the requirements of clause 7.3 are complied with: (a) 300 mm at the support of cantilevered beam; (b) 110 mm for cantilevered slab with span not exceeding 500 mm; (c) 125 mm for cantilevered slab with span greater than 500 mm but not exceeding 750 mm; (d) 150 mm for cantilevered slab with span greater than 750 mm but not exceeding 1000 mm;

[4] Requirements for cantilevered projecting structures are revised.

Item	Current version	Amendments
	(d) 150 mm for cantilevered slab with span exceeding 750 mm. Cantilevered structures should be reinforced with ribbed steel reinforcing bars. Cantilevered slabs should have reinforcing bars in both faces and in both directions. Cantilevered structures exposed to weathering should be provided with: (e) means to prevent accumulation of water; (f) effective waterproofing; (g) adequate fall which should not be less than 1:75; and (h) an effective drainage system. Cantilevered slabs exposed to weathering should be designed for : (i) exposure condition 2 or higher if appropriate; (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/mm^2 when checking the flexural tension under the working load condition.	(e) 175 mm for cantilevered slab with span exceeding 1000 mm but not exceeding 1200 mm. Cantilevered structures should be reinforced with ribbed steel reinforcing bars. Cantilevered slabs should have reinforcing bars in both faces and in both directions. Cantilevered structures exposed to weathering should be provided with: (f) means to prevent accumulation of water; (g) effective waterproofing; (h) adequate fall which should not be less than 1:75; and (i) an effective drainage system. Cantilevered slabs exposed to weathering should be designed for : (j) exposure condition 2 or higher if appropriate; (k) 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/mm^2 when checking the flexural tension under the working load condition.
20. Clause 9.4.2 1st paragraph [2]	The minimum percentage of top tension longitudinal reinforcement based on the gross cross-sectional concrete	The minimum percentage of top tension longitudinal reinforcement based on the gross cross-sectional concrete

Item	Current version	Amendments
	area should be 0.25% for all reinforcement grades. The minimum diameter of this principal reinforcement should be 10 mm.	area should be 0.25% for all reinforcement grades but not less than that stipulated in clause 9.3.1.1(a). The minimum diameter of this principal reinforcement should be 10 mm.
21. Clause 9.5.2.1 1st paragraph [1]	The diameter of the transverse reinforcement (links, loops or helical spiral reinforcement) should not be less than 6 mm or 1/4 the diameter of the largest longitudinal bar, whichever is the greater. The diameter of wires or welded mesh fabric when used for transverse reinforcement should not be less than 5 mm.	The diameter of the transverse reinforcement (links, loops or helical spiral reinforcement) should not be less than 6 mm or 1/4 the diameter of the largest longitudinal bar, whichever is the greater. The diameter of wires or welded fabric when used for transverse reinforcement should not be less than 5 mm.
22. Clause 11.7.5.2(b) [1]	bars or welded mesh fabrics;	bars or welded fabrics;
23. Clause 12.1.8.2 [3]	*Characteristic strength of concrete* The specified characteristic strengths of reinforcement are given in clause 3.2 and those for prestressing tendons are given in clause 3.3.	*Characteristic strength of concrete* The specified characteristic strengths of reinforcement are given in clause 3.2 and those for prestressing tendons are given in clause 3.4.