

## STANDARDS AUSTRALIA

**Amendment No. 2**  
to  
**AS 3600:2018**  
**Concrete structures**

**REVISED TEXT**

The 2018 edition of AS 3600 is amended as follows; the amendments should be inserted in the appropriate places.

SUMMARY: This Amendment applies to the Table of contents, global change, Clauses 1.1.2, 1.7, 2.1.2, 2.5.2.2, 2.5.2.3, 3.1.1.1, 3.3.4.2, 4.10.2, 4.10.3.2, 5.3.1, 5.6.3, 5.7.2, 5.7.4.1, 6.2.7.1, 8.1.4, 8.1.5, 8.2.1.2, 8.2.1.3, 8.2.1.5, 8.2.1.6, 8.2.1.7, 8.2.3.1, 8.2.3.2, 8.2.3.3, 8.2.3.4, 8.2.4.1, 8.2.4.2.1, 8.2.4.2.2, 8.2.4.2.3, 8.2.4.3, 8.2.5, 8.2.5.4, 8.2.5.5, 8.2.5.6, 8.2.7, 8.2.8.1, 8.2.8.2, 8.3.1.4, 8.3.2.2, 8.3.3, 8.4.3, 8.6.1, 8.6.2.2, 8.6.2.3, 9.5.1, 9.5.2.1, 9.5.3.2, 10.7.3.1, 10.7.4.3, 11.2.1, 11.5.2, 11.6, 11.6.1, 11.6.3, 11.7.4, 11.7.5, 12.5, 12.5.1, 12.5.2, 12.5.3, 12.5.4, 12.5.5, 12.6, 13.1.2.2, 13.1.2.3, 13.1.2.7, 13.3.2.4, 13.3.3, 14.2.10, 14.5.4, 14.6.7, 16.1, 16.3.3.4, 16.4.2, 16.4.4.2.1, 16.4.7.2.1, 17.6.2.5, 17.7.2, 18.4, 18.8, 21.3.1 and 21.3.2, Equations 8.2.1.5, 8.2.4.2.2(1), 8.2.4.2.2(2), 8.2.8.2(2), 8.4.3, 14.6.6, 10.8(1), 10.8(2), 18.3(1), 18.4(2) and 20.4.3(2), Tables 2.2.2, 2.2.5, 2.5.2.3(B), 3.1.1.1, 3.1.2, 3.2.1, 5.6.3, 5.6.4, 5.7.2, 8.6.3 and 13.1.2.3, and Figures 8.2.8 and 18.8.

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AMDT  
No. 2  
MAY  
2021

**Table of contents**

Under Appendices, *delete* 'D' and *replace* with 'C'.

AMDT  
No. 2  
MAY  
2021

**Global change**

*Delete* 'D<sub>c</sub>' and *replace* with 'b' in all instances.

AMDT  
No. 2  
MAY  
2021

**Clause 1.1.2**

Item (a)(i) *insert* 'cylinder' between 'characteristic' and 'compressive'.

AMDT  
No. 2  
MAY  
2021

**Clause 1.7**

- 1 In the definition for 'A<sub>c</sub>' *delete* '(see Clauses 5.6.3 and 7.2.3)' and *replace* with '(see Table 5.6.4 and Clause 7.2.3)'.
- 2 In the definition for 'b' *delete* 'wall thickness (see Table 5.7.2)' and *replace* with 'smaller column cross-sectional dimension if rectangular, or the column diameter if circular (see Table 5.6.3, Table 5.6.4 and Clause 10.7.4.3)'.
- 3 In the definition for 'b<sub>v</sub>' *delete* 'Clause 8.2.6' and *replace* with 'Clause 8.2.1.5'.
- 4 *Add* the following:
 

CMOD = crack mouth opening displacement (see Clause 16.2.1)

COD = crack opening displacement (see Clause 16.2.2)
- 5 *Delete* 'D<sub>c</sub>' including definition.
- 6 In the definition for 'd<sub>f</sub>' *delete* 'tie (see Paragraph C4.2.2, Appendix C)' and *replace* with 'fitment (see Clause 14.5.2.2)'.
- 7 In the definition for 'D<sub>s</sub>' *insert* '; or' after the words 'drop panel'.
- 8 In the definition for 'e' *delete* 'or' and *replace* with 'or'.

- 9 In the definition for  $f_{R,2m}$ , *delete* ‘strengths’ and *replace* with ‘strength’.
- 10 *Add* the following:  
 $f_{R,4m}$  = mean residual flexural tensile strength corresponding to a CMOD of 3.5 mm, determined in accordance with Clause 16.3.3.7
- 11 *Delete* the definition for  $f'_{cp}$  and *replace* with the following:  
‘characteristic compressive cylinder strength of concrete at transfer’
- 12 *Delete* the definition for ‘ $f'_w$ ’ and *replace* with the following:  
‘characteristic residual tensile strength of SFRC corresponding to a COD  $w$ ’
- 13 *Add* the following:  
 $H$  = overall height of a wall measured from the boundary at its base to the soffit or connection at its top, continuing through any intermediate slabs or walls
- 14 *Delete*  $K_s$  and *replace* with  $k_s$ .
- 15 *Delete* ‘ $l_{0,fi}$ ’ and *replace* with ‘ $l_{o,fi}$ ’.
- 16 In the definition for  $\gamma_p$ , *delete* ‘(see Clause 2.5.2.3)’ and *replace* with ‘(see Clause 2.5.2.3); or’.
- 17 *Add* second definition for  $\gamma_p$ , (next line) as follows:  
= load factor for vertical component of prestress (see Clause 8.2)

### Clause 2.1.2

First paragraph, second sentence, *delete* ‘when determining the static earthquake load for the structure to be able to resist the remainder of the earthquake loading inelastically’.

### Table 2.2.2

- 1 *Delete* the fourth row and *replace* with the following:

|                                            |                                                                                                                                                                                      |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (d) Bending with axial compression, where— |                                                                                                                                                                                      |
| (i) $N_u \geq N_{ub}$                      | $0.65k_\phi$                                                                                                                                                                         |
| (ii) $N_u < N_{ub}$                        | $0.65k_\phi + [(\phi - 0.65k_\phi)(1 - N_u/N_{ub})]$<br>and $\phi$ is obtained from Item (b)<br>Short columns with $Q/G \geq 0.25$ ,<br>$k_\phi = 1.0$ , otherwise, $k_\phi = 12/13$ |

- 2 *Add* new Note 2 to table as follows (number existing Note as ‘1’:

‘2 For prestressed beams at transfer  $\phi = 0.6$  (see Clause 8.1.6.2).’

### Table 2.2.5, Note

*Delete* ‘Larger values than’ and *replace* with ‘Values larger than’.

### Clause 2.5.2.2

*Delete* clause text and *replace* with the following:

Except where otherwise stated in the Standard, stress resultants from the effects of prestressing shall be included with a load factor of unity in load combinations for both ultimate and service design.

AMDT  
No. 2  
MAY  
2021

AMDT  
No. 2  
MAY  
2021

AMDT  
No. 2  
MAY  
2021

AMDT  
No. 2  
MAY  
2021

For the case of permanent action plus prestressing force at transfer, the more severe of the following shall be used:

- (a)  $1.15G + 1.15P$ ; or
- (b)  $0.9G + 1.15P$ .

NOTE: See also Clauses 6.2.6 and 8.2.1.3.

AMDT  
No. 2  
MAY  
2021

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#### Clause 2.5.2.3

- 1 Delete Clause title and *replace* with ‘*Actions and load combinations for fatigue*’.
  - 2 Third paragraph, *delete* ‘values’ and *replace* with ‘value’.
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AMDT  
No. 2  
MAY  
2021

#### Table 2.5.2.3(B)

*Delete* table title and *replace* with the following:

#### REPRESENTATIVE VALUE FACTOR FOR PRESTRESS ( $\gamma_p$ ).

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AMDT  
No. 2  
MAY  
2021

#### Clause 3.1.1.1

*Delete* clause text, including title, and *replace* with the following:

##### 3.1.1.1 Characteristic compressive strengths

- (a) The characteristic cylinder compressive strength of concrete at 28 days ( $f'_c$ ) shall be either—
  - (i) taken as equal to the specified strength grade, provided that curing is ensured and that the concrete conforms with AS 1379; or
  - (ii) determined statistically from compressive cylinder strength tests carried out in accordance with AS 1012.9.

The characteristic compressive cylinder strengths of the standard strength grades are 20 MPa, 25 MPa, 32 MPa, 40 MPa, 50 MPa, 65 MPa, 80 MPa, 100 MPa and 120 MPa.

- (b) The characteristic cube compressive strength of grout at 28 days ( $f'_{c,cube}$ ) shall be ascertained in accordance with any of the following methods:
  - (i) Taken as equal to the specified strength grade, provided that curing is ensured.  
*or*
  - (ii) Determined statistically from compressive cylinder strength tests carried out in accordance with AS 1012.9 and converted to cube strength using Table 3.1.1.1.  
*or*
  - (iii) Determined statistically from compressive cube strength tests carried out in accordance with AS 1012.9. The cube strength test result shall be modified to an equivalent cylinder strength in accordance with Table 3.1.1.1.

AMDT  
No. 2  
MAY  
2021

**Table 3.1.1.1**

Add new Table 3.1.1.1 as follows:

**TABLE 3.1.1.1**  
**RELATIONSHIP BETWEEN CYLINDER AND**  
**CUBE STRENGTH AT 28 DAYS**

|                      |    |    |    |    |    |    |    |     |     |
|----------------------|----|----|----|----|----|----|----|-----|-----|
| $f'_c$<br>MPa        | 20 | 25 | 32 | 40 | 50 | 65 | 80 | 100 | 120 |
| $f'_{c.cube}$<br>MPa | 25 | 32 | 40 | 50 | 60 | 80 | 95 | 120 | 150 |

AMDT  
No. 2  
MAY  
2021

**Table 3.1.2**

Delete the table and *replace* with the following:

|                  |        |        |        |        |        |        |        |        |        |
|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_c$<br>MPa    | 20     | 25     | 32     | 40     | 50     | 65     | 80     | 100    | 120    |
| $f_{cm}$<br>MPa  | 25     | 31     | 39     | 48     | 59     | 75     | 91     | 110    | 128    |
| $f_{cmi}$<br>MPa | 22     | 28     | 35     | 43     | 53     | 68     | 82     | 99     | 115    |
| $E_c$<br>MPa     | 24 000 | 26 700 | 30 100 | 32 800 | 34 800 | 37 400 | 39 600 | 42 200 | 44 400 |

AMDT  
No. 2  
MAY  
2021

**Table 3.2.1**

Last row (Type, Stainless steel ribbed bar to BS 6744), column 3, *delete* '650' and *replace* with '500'.

AMDT  
No. 2  
MAY  
2021

**Clause 3.3.4.2**

Delete the second paragraph.

AMDT  
No. 2  
MAY  
2021

**Clause 4.10.2**

Second paragraph, *delete* 'an'.

AMDT  
No. 2  
MAY  
2021

**Clause 4.10.3.2**

Delete clause title and *replace* with the following:

*Required cover where standard formwork and compaction are used*

AMDT  
No. 2  
MAY  
2021

**Clause 5.3.1**

Add new Note 2 as follows (number existing note as '1'):

- 2 Eurocode 2 Part 1.2 Amendment 1 Annex C provides tabulated data for the fire design of a range of slender reinforced concrete columns in braced and unbraced structures. The data in these tables is based on the calculation methods recommended in Note 1.

AMDT  
No. 2  
MAY  
2021

### Clause 5.6.3

- 1 Item (f), *delete* 'Amount of reinforcement  $\leq 4\%$ ' and *replace* with the following:  
'Area of longitudinal reinforcement  $A_s \leq 0.04A_g$ '.
- 2 Equation 5.6.3(2), definitions list, *delete* symbol ' $l_{o.fi}$ ' and *replace* with ' $l_{o.fi}$ ' in two instances.
- 3 After the definition to ' $l_{o.fi}$ ' *delete* the line 'Values for  $l_{o.fi} < 2$  metres are conservative for  $l_{o.fi} = 2$  metres' and *replace* with the following:  
'When  $l_{o.fi} < 2$  m, it is conservative to take  $l_{o.fi} = 2$  m in Equation 5.6.3(2)'.
- 4 In the definition for  $\omega$ , *delete* ' $A_c$ ' and *replace* with ' $A_g$ '.

AMDT  
No. 2  
MAY  
2021

### Table 5.6.3

- 1 Columns 3, 5, 7 and 9 of row 4 of headings, *delete* ' $D_c$ ' and *replace* with ' $b$ '.
- 2 Legend, *delete* ' $D_c$ ' and *replace* with ' $b$ '.

AMDT  
No. 2  
MAY  
2021

### Table 5.6.4

- 1 Heading, second column, *delete* ' $A_c$ ' and *replace* with ' $A_g$ '.
- 2 *Delete* ' $D_c$ ' and *replace* with ' $b$ ' throughout the table.
- 3 Legend, *delete* ' $D_c$ ' and *replace* with ' $b$ '.

AMDT  
No. 2  
MAY  
2021

### Clause 5.7.2

First paragraph, *delete* 'effective'.

AMDT  
No. 2  
MAY  
2021

### Table 5.7.2

- 1 First row of heading, *delete* ' $b$ ' and *replace* with ' $t_w$ '.
- 2 Fourth row of heading, *delete* ' $b$ ' and *replace* with ' $t_w$ ', in all instances.
- 3 Legend, *delete* ' $b$ ' and *replace* with ' $t_w$ '.

AMDT  
No. 2  
MAY  
2021

### Clause 5.7.4.1

First line of the second paragraph, *delete* ' $b$ ' and *replace* with ' $t_w$ '.

AMDT  
No. 2  
MAY  
2021

### Clause 6.2.7.1

Item (d), *delete* 'OCD' and *replace* with 'COD'.

AMDT  
No. 2  
MAY  
2021

### Clause 8.1.4

*Delete* Clause text and title and *replace* with the following:

#### Dispersion angle of prestress and concentrated forces

In the absence of a more exact calculation, the dispersion angle when a concentrated load is applied to a bearing surface shall be  $60^\circ$  (i.e.  $30^\circ$  either side of the line of action of the concentrated load).

NOTE: This Clause includes the dispersion angle of a prestressing force applied at an anchorage.

Tensile splitting or bursting forces that arise from dispersion of a concentrated force shall be designed in accordance with Section 7.

AMDT  
No. 2  
MAY  
2021

### Clause 8.1.5

Item (b), *delete* ‘8.1.11.7 and 8.1.11.8’ and *replace* with ‘8.3.1.6 and 10.7.4’.

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.1.2

- 1 First paragraph, *delete* ‘8.2.5.4’ and *replace* with ‘8.2.5.5’.
- 2 Definition for ‘ $b_v$ ’, *delete* ‘8.2.1.4’ and *replace* with ‘8.2.1.5’.
- 3 After definition of  $b_v$  *delete* the remainder of the clause.

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.1.3

*Delete* clause text and *replace* with the following:

‘Where the factored vertical component of prestress  $\gamma_p P_v$  is included in Clause 8.2, including its subclauses, and where—

- (a)  $P_v$  acts to reduce the shear stress resultant, then  $P_v$  is positive and  $\gamma_p = 0.90$ ; or
- (b)  $P_v$  acts to increase the shear stress resultant, then  $P_v$  is negative and  $\gamma_p = 1.15$ .’

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.1.5

Second sentence, *delete* ‘ $d_d \geq b_w/8$ ’ and *replace* with ‘ $\Sigma d_d \geq b_w/8$ ’.

AMDT  
No. 2  
MAY  
2021

### Equation 8.2.1.5

*Delete* the definition of  $\Sigma d_d$  and *replace* with the following:

‘sum of the widths of prestressing ducts, if any, in a horizontal plane across the web’

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.1.6

*Delete* clause text and title and *replace* with the following:

#### 8.2.1.6 Requirements for transverse shear reinforcement

Transverse reinforcement shall be provided in all regions for any of the following cases:

- (a)  $V^* - \gamma_p P_v > k_s \phi V_{uc}$  . . . 8.2.1.6(1)

where

- (i)  $D \leq 300$  mm,  $k_s = 1.0$ ; or
- (ii)  $300$  mm  $< D < 650$  mm,  $k_s = (1000 - D)/700$ ; or
- (iii)  $D \geq 650$  mm,  $k_s = 0.5$

and  $\gamma_p$  is given in Clause 8.2.1.3.

Irrespective of the above, where it is shown by rational calculation satisfying conditions of equilibrium and compatibility that a shear failure of the structural component under consideration will not cause collapse of the structure,  $k_s$  may be taken as 1.0.

- (b)  $T^* > 0.25 \phi T_{cr}$  . . . 8.2.1.6(2)
- (c) The overall depth of the beam or one-way slab is  $D \geq 750$  mm . . . 8.2.1.6(3)

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.1.7

*Delete* the first sentence and *replace* with the following:

‘Where transverse reinforcement is required, the minimum area ( $A_{sv,min}$ ) provided in a concrete beam or slab shall be calculated from the following equation:’

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.3.1

Delete clause title and text and *replace* with the following:

#### 8.2.3.1 Design strength of a beam in shear and torsion

The design shear strength of a beam ( $\phi V_u$ ) shall satisfy the following:

$$\phi V_u \geq V^* - \gamma_p P_v \quad \dots 8.2.3.1(1)$$

where

$$V_u = V_{uc} + V_{us}$$

and

$$V_{uc} = \text{determined from Clause 8.2.4}$$

$$V_{us} = \text{determined from Clause 8.2.5}$$

$$P_v = \text{vertical component of prestress at the section under consideration (see Clause 8.2.1.3)}$$

$$\gamma_p = \text{prestress load factor determined in accordance with Clause 8.2.1.3}$$

The design torsional strength of a beam ( $\phi T_{us}$ ) shall satisfy:

$$\phi T_{us} \geq T^* \quad \dots 8.2.3.1(2)$$

In addition, web crushing provisions of Clause 8.2.3.3 shall be satisfied.

NOTES:

- 1 Values for  $\phi$  are given in Table 2.2.2.
- 2 Transverse reinforcement calculated for shear and for torsion are additive (see Clause 8.2.5.3).

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.3.2

- 1 Item (b) and Item (b)(ii), *delete* ‘ $d_o$ ’ and *replace* with ‘ $d_v$ ’.
- 2 Second line of the paragraph after (b)(ii), *replace* ‘ $2d_o$ ’ with ‘ $2d_v$ ’ in two instances.
- 3 At the end of the Clause *add* the following:  
‘Notwithstanding the above, the maximum transverse shear at the face of the support shall satisfy the requirements of Clause 8.2.3.3.’

AMDT  
No. 2  
MAY  
2021

### Clause 8.2.3.3

Delete clause title and text and *replace* with the following:

#### 8.2.3.3 Shear and torsional strength limited by web crushing

The combined shear and torsional strength at a cross-section is limited by the shear force when web crushing occurs ( $V_{u,max}$ ), given by—

$$V_{u,max} = 0.55 \left[ 0.9 f'_c b_v d_v \left( \frac{\cot \theta_v + \cot a_v}{1 + \cot^2 \theta_v} \right) \right]; \text{ or} \quad \dots 8.2.3.3(1)$$

$$V_{u,max} = 0.55 \left[ 0.9 f'_{cp} b_v d_v \left( \frac{\cot \theta_v + \cot a_v}{1 + \cot^2 \theta_v} \right) \right] \text{ at transfer} \quad \dots 8.2.3.3(2)$$