Singapore National Annex to Eurocode 2 : Design of concrete structures
Part 1-1 : General rules and rules for buildings

AMENDMENT NO. 1

September 2010

1. Page 6, National Foreword

Insert after the 5th paragraph:

EN 10080 'Steel for the reinforcement of concrete – Weldable reinforcing steel – General', as referenced in SS EN 1992-1-1, does not include all requirements to fully specify reinforcing steels. EN 10080 should be used in conjunction with the following Singapore Standards, in which full details of the performance characteristics are specified.

SS 560:2010, *Specification for steel for the reinforcement of concrete – Weldable reinforcing steel – Bar, coil and decoiled product*

SS 561:2010, *Specification for* steel *fabric for the reinforcement of concrete*

2. Page 8, Table NA.1 Nationally determined parameters described in SS EN 1992-1-1:2008

Replace the subclauses with those shown in Table NA.1 of this amendment.

3. Page 10, Table NA.1, 5.1.3(1)P

Replace the words under Singapore decision, after item c) (3), 'When analysis is carried out' *with* 'In option c), when analysis is carried out'.

4. Pages 20 to 22, Tables NA.2 and NA.3

Delete Tables NA.2 and NA.3.

5. Pages 23, Table NA.4 Recommended values of w_{max}

Insert the following after the 2nd para under Table NA.4:

In SS EN 1992-1-1:2008, Expression (7.11) the cover, c should be taken as c_{nom}. The use of the resulting value of $s_{r,max}$ in SS EN 1992-1-1:2008, Expression (7.8) will then provide an estimation of the crack width at the surface of the concrete. In some situations, such as structures cast against the ground, c_{nom} will be significantly greater than the cover required for durability. Where there are no appearance requirements, it is reasonable to determine the crack width at the cover required for durability and verify that it does not exceed the relevant maximum crack width.

This may be done by multiplying the crack width determined at the surface by $(c_{min,dur} + \Delta c_{dev})/c_{nom}$ to give the crack width at the cover required for durability, and verifying that it is not greater than w_{max}. This approach assumes the crack width varies linearly with zero width at the face of the bar.

6. Pages 23, Table NA.5 Basic ratios of span/effective depth of reinforced concrete members without axial compression

Replace 'Notes 4 and 5' *and insert* 'Note 6' as follows:

NOTE 4 – The values of *k* in the table may not be appropriate when the formwork is struck at an early age or when the construction loads exceed the design load. In these cases, the deflections may need to be calculated using advice in specialist literature, e.g. the Concrete Society's report on deflections in concrete slabs and beams and an article for the Magazine of Concrete Research entitled *Are existing span to depth rules conservative for flat slabs*?, both of which are referred to in NA.4.

NOTE 5 – When the span/depth ratio obtained from NA.3 or Expressions (7.16a) or (7.16b) is adjusted using either $(310/\sigma_s)$ or $(500/f_{yk})(A_{s,prov}/A_{s,req})$, such adjustment should be limited to a maximum value of 1.5. σ_s should be calculated under characteristic combination of load at serviceability limit state.

NOTE 6 – The absolute value of span/depth may not, in any case, exceed 40K.

7. Page 24, References to non-contradictory complementary information

a) *Replace* 'PD 6687:2005' with 'PD 6687-1, Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3'.

b) *Insert* NA.4.2 as follows:

NA 4.2 Disproportionate collapse

The building shall be designed and constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause. Provisions of EN 1992-1-1 are not sufficient in some respects and, details and design approaches for satisfying this requirement are included in *PD 6687 as non-contradictory complementary information.

*See also SS EN 1991-1-7.

8. Page 25, Bibliography

Replace the list of references with:

Standards publications

BS 8666, Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete. Specification

PD 6687-1, Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3

PD 6687-2, Recommendations for the design of structures to BS EN 1992-2:2005

SS CP 65 Parts 1 and 2, Structural use of concrete

SS 544, Concrete – Complementary Singapore Standard to SS EN 206-1
Part 1 : Method of specifying and guidance for the specifier
Part 2 : Specification for constituent materials and concrete

SS EN 206-1, Concrete – Part 1 : Specification, performance, production and conformity

SS EN 1990, Eurocode – Basis of structural design

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Table NA.1 – Nationally determined parameters described in SS EN 1992-1-1 : 2008 (Amendment)

Subclause	Nationally determined parameter	Eurocode recommendation	Singapore decision
4.4.1.2 (5)	Structural classification and values of minimum cover due to environmental conditions $c_{min, dur}$	Table 4.3N for structural classification. Tables 4.4N and 4.5N for values of $c_{min, dur}$	Use SS 544-1:2009, Tables A.5 and A.11 for recommendations for concrete quality for a particular exposure class and cover reinforcement *c*.
6.2.3 (2)	Limiting values of $\cot\theta$	$1 \leq \cot\theta \leq 2.5$	$1 \leq \cot\theta \leq 2.5$, except in elements in which shear co-exists with externally applied tension (i.e. tension caused by restraint is not considered here). In these elements, $\cot\theta$ should be taken as 1.25.
6.2.3 (3)	Values of v_1 and α_{cw}	$v_1 = v$ as described by Expression (6.3N) or takes the values given in Expressions (6.10.aN) and (6.10.bN) α_{cw} takes the values given in Expressions (6.11.aN), (6.11.bN) and (6.11.cN)	$v_1 = v\,(1 - 0.5\cos\alpha)$ However, if the design stress of the shear reinforcement is below 80 % of the characteristic yield stress f_{yk}, v_1 may be taken as: $v_1 = 0.54(1 - 0.5\cos\alpha)$ for $f_{ck} \leq 60$ MPa $v_1 = (0.84 - f_{ck}/200)(1 - 0.5\cos\alpha) > 0.5$ for $f_{ck} \geq 60$ MPa α_{cw} is as follows: 1 for non-prestressed structures $(1 + \sigma_{cp}/f_{cd})$ for $0 < \sigma_{cp} \leq 0.25 f_{cd}$ 1.25 for $0.25 f_{cd} < \sigma_{cp} \leq 0.5 f_{cd}$ $2.5(1 - \sigma_{cp}/f_{cd})$ for $0.5 f_{cd} < \sigma_{cp} < 1.0 f_{cd}$ where: σ_{cp} is the mean compressive stress, measured positive, in the concrete due to the design axial force. This should be obtained by averaging it over the concrete section taking account of the reinforcement. The value of σ_{cp} need not be calculated at a distance less than $0.5\,d\cot\theta$ from the edge of the support. Note that the values of v_1 and α_{cw} should not be such as to give rise to a value of $V_{Rd,max}$ greater than $200(b_w)^2$ at sections more than *d* from the edge of a support. For this purpose the value of b_w does not need to be reduced for ducts. In the case of straight tendons, a high level of prestress ($\sigma_{cp}/f_{cd} > 0.5$) and thin webs, if the tension and the compression chords are able to carry the whole prestressing force and blocks are provided at the extremity of beams to disperse the prestressing force it may be assumed that the prestressing force is distributed between the chords. In these circumstances, the compression field due to shear only should be considered in the web, i.e. $\alpha_{cw} = 1$. See also 3.1.2 (2)P for a requirement for concrete class > C50/60.

Table NA.1 – Nationally determined parameters described in SS EN 1992-1-1 : 2008 (Amendment)

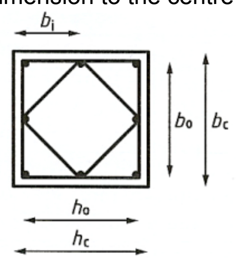
Subclause	Nationally determined parameter	Eurocode recommendation	Singapore decision
6.4.5 (3)	The value of maximum punching resistance adjacent to column $V_{Rd,max}$	$V_{Rd,max} = 0.5 v f_{cd}$	$V_{Rd,max} = 0.5 v f_{cd}$ In addition, v_{Ed} should be limited to $2v_{Rdc}$ at the first control perimeter.
6.4.5 (4)	The distance *kd* of the outer perimeter of punching shear reinforcement from the perimeter U_{out}	k = 1.5	k = 1.5 Unless the perimeter at which reinforcement is no longer required is less than 3*d* from the face of the loaded area/column. In this case the reinforcement should be placed in the zone 0.3*d* and 1.5*d* from the face of the loaded area/column. The first perimeter of reinforcement should be no further than 0.5*d* from the face of the loaded area/column.
9.5.3 (3)	Maximum spacing of transverse reinforcement in columns $s_{cl,tmax}$	$s_{cl,tmax}$ = should take the least of the following three values: a) 20 times the minimum diameter of the longitudinal bars; b) the lesser dimension of the column; c) 400 mm	Use the recommended value for concrete class ≤ C50/60. For concrete class > C50/60, transverse reinforcement should satisfy the following: $\alpha_n \alpha_s w_{wd} \geq 0.04$, in which w_{wd} = (Volume of confining hoops x f_{yd}/volume of concrete x f_{cd}) For rectangular columns: $\alpha_n = 1 - \sum(b_i^2/6)\ b_0\ h_0$ $\alpha_s = [1 - (s/2b_0)]\ [1 - (s/2h_0)]$ where: n is the number of longitudinal bars laterally restrained by links or ties b_i is the distance between consecutive bars that are laterally restrained *s* is the longitudinal spacing of links b_0 and h_0 are the widths of confinement in the two directions (dimension to the centre of links).  For circular columns with circular links: $\alpha_n = 1$ $\alpha_s = (1 - s/2D_0)^2$ For circular columns with spiral links

Table NA.1 – Nationally determined parameters described in SS EN 1992-1-1 : 2008 (Amendment)

Subclause	Nationally determined parameter	Eurocode recommendation	Singapore decision
			$\alpha_n = 1$ $\alpha_s = (1 - s/2D_0)$ where D_0 is the diameter of the confined core (to the centre line of links).
9.8.5 (3)	Values of A_c and $A_{s,bpmin}$	A_c from Table 9.6N $A_{s,bpmin}$ from Table 9.6N	Use the recommended values.
9.10.2.2 (2)	Force to be resisted by peripheral tie: values of q_1 and Q_2	q_1 = 10 kN/m Q_2 = 70 kN	$q_1=(20+4n_0)l_i$ where n_0 is the number of storeys and l_i is the length of the end span Q_2 = 60 kN
11.6.1 (1)	Values of $C_{lRd,c}$, $v_{1, min}$ and k_1	$C_{lRd,c}$, = $0.15/\gamma_c$ $v_{1,min} = 0.28k^{3/2} f_{lck}^{1/2}$ k_1 = 0.15	Use the recommended values.
11.6.2 (1)	Value of v_1	$v_1 = 0.5\eta_1 [1 - f_{lck}/250]$	$v_1 = 0.5\eta_1[1 - f_{lck}/250]$ generally for lightweight concrete, except in Expression (11.6.5), when the recommended value may be used. For lightweight concrete, v_1 should not be modified in accordance with Note 2 of 6.2.3 (3).
12.3.1 (1)	Values of $\alpha_{cc,pl}$ and $\alpha_{ct,pl}$ (plain concrete)	$\alpha_{cc,pl}$ = 0.8 $\alpha_{ct,pl}$ = 0.8	$\alpha_{cc,pl}$ = 0.6 $\alpha_{ct,pl}$ = 0.8
E.1 (2)	Values of indicative strength classes	Table E.1N	Does not apply – see the guidance in 4.4.1.2 (5). See SS 544-1. NOTE – In order to cater to the higher ambient temperatures in Singapore compared to UK, the recommendation is to consider the required concrete for at least one class higher than that based on exposure conditions in accordance with the requirements for UK exposure conditions. The specifier should take into consideration the nature of the element, intended working life, its importance and the cost of maintenance and repair to select the same or higher performance concrete. Different elements in the same structure may be specified with different concrete to optimise cost-efffectiveness.