

CODE

COMMENTARY

Table 19.3.2.1—Requirements for concrete by exposure class

Exposure class		Maximum w/cm ^[1,2]	Minimum f'_c , MPa	Additional requirements			Limits on cementitious materials
				Air content			
F0		N/A	17	N/A			N/A
F1		0.55	24	Table 19.3.3.1 for concrete or Table 19.3.3.3 for shotcrete			N/A
F2		0.45	31	Table 19.3.3.1 for concrete or Table 19.3.3.3 for shotcrete			N/A
F3		0.40 ^[3]	35 ^[3]	Table 19.3.3.1 for concrete or Table 19.3.3.3 for shotcrete			26.4.2.2(b)
			Cementitious materials ^[4] — Types			Calcium chloride admixture	
			ASTM C150	ASTM C595	ASTM C1157		
S0		N/A	17	No type restriction	No type restriction	No type restriction	No restriction
S1		0.50	28	II ^{[5][6]}	Types with (MS) designation	MS	No restriction
S2		0.45	31	V ^[6]	Types with (HS) designation	HS	Not permitted
S3	Option 1	0.45	31	V plus pozzolan or slag cement ^[7]	Types with (HS) designation plus pozzolan or slag cement ^[7]	HS plus pozzolan or slag cement ^[7]	Not permitted
	Option 2	0.40	35	V ^[8]	Types with (HS) designation	HS	Not permitted
W0		N/A	17	None			
W1		N/A	17	26.4.2.2(d)			
W2		0.50	28	26.4.2.2(d)			
				Maximum water-soluble chloride ion (Cl ⁻) content in concrete, percent by mass of cementitious materials ^[9,10]		Additional provisions	
				Nonprestressed concrete	Prestressed concrete		
C0		N/A	17	1.00	0.06	None	
C1		N/A	17	0.30	0.06		
C2		0.40	35	0.15	0.06	Concrete cover ^[11]	

^[1]The w/cm is based on all cementitious and supplementary cementitious materials in the concrete mixture.

^[2]The maximum w/cm limits do not apply to lightweight concrete.

^[3]For plain concrete, the maximum w/cm shall be 0.45 and the minimum f'_c shall be 31 MPa.

^[4]Alternative combinations of cementitious materials to those listed are permitted for all sulfate exposure classes when tested for sulfate resistance and meeting the criteria in 26.4.2.2(c).

^[5]For seawater exposure, other types of portland cements with tricalcium aluminate (C₃A) contents up to 10 percent are permitted if the w/cm does not exceed 0.40.

^[6]Other available types of cement such as Type I or Type III are permitted in Exposure Classes S1 or S2 if the C₃A contents are less than 8 percent for Exposure Class S1 or less than 5 percent for Exposure Class S2.

^[7]The amount of the specific source of the pozzolan or slag cement to be used shall be at least the amount that has been determined by service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag cement to be used shall be at least the amount tested in accordance with ASTM C1012 and meeting the criteria in 26.4.2.2(c).

^[8]If Type V cement is used as the sole cementitious material, the optional sulfate resistance requirement of 0.040 percent maximum expansion in ASTM C150 shall be specified.

^[9]The mass of supplementary cementitious materials used in determining the chloride content shall not exceed the mass of the portland cement.

^[10]Criteria for determination of chloride content are in 26.4.2.2.

^[11]Concrete cover shall be in accordance with 20.5.

19.3.3 Additional requirements for freezing-and-thawing exposure

19.3.3.1 Concrete subject to freezing-and-thawing Exposure Classes F1, F2, or F3 shall be air entrained. Except as

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R19.3.3.1 A table of required air contents for concrete to resist damage from cycles of freezing and thawing is