UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2002/2003

Februari / Mac 2003

EAS 181/2 – Teknologi Konkrit

Masa : 3 jam

Arahan Kepada Calon:

1. Sila pastikan kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.

2. Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan sahaja. Markah hanya akan dikira bagi **LIMA (5)** jawapan **PERTAMA** yang dimasukkan di dalam buku mengikut susunan dan bukannya **LIMA (5)** jawapan terbaik.

3. Semua soalan mempunyai markah yang sama.

4. Semua jawapan **MESTILAH** dimulakan pada muka surat yang baru.

5. Semua soalan **MESTILAH** dijawab dalam Bahasa Malaysia.

6. Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.

1. (a) Berikan definasi "keanjalan tulen" (pure elasticity). Dengan melukiskan rajah-rajah yang sesuai, jelaskan empat (4) kategori sambutan tegasan-terikan bahan (stress-strain response of material). Berikan satu contoh bahan untuk tiap-tiap kategori.

(12 markah)

(b) Ujian rayapan dan pengecutan telah dijalankan ke atas spesimen-spesimen konkrit berbentuk selinder (garispusat, Ø = 75 mm, panjang, L = 150 mm) yang telah diawet selama tujuh hari. Bagi ujian rayapan, spesimen telah dikenakan beban mampatan sehingga 20% daripada kekuatan mampatan konkrit tersebut. Jika kekuatan konkrit adalah 60 MPa (kekuatan mampatan selinder konkrit pada umur tujuh hari), dan berdasarkan data cerapan di dalam jadual di bawah, tentukan:

(i) Terikan elastik awal (initial elastic strain) dan modulus sekan (secant modulus).
(ii) Nilai pengecutan kering selepas 28 hari.
(iii) Nilai rayapan selepas 28 hari.

(8 markah)

Jadual 1: Purata bacaan tolok terikan (x 10^{-6})

Masa Cerapan	Sampel yang dibebankan (rayapan)	Sampel yang tidak dibebankan (pengecutan)
Sebelum dibebankan	1120	836
Selepas dibebankan	783	836
Selepas 1 hari dibebankan	769	832
Selepas 3 hari dibebankan	758	824
Selepas 7 hari dibebankan	744	817
Selepas 14 hari dibebankan	734	812
Selepas 28 hari dibebankan	722	805

2. (a) Jelaskan bagaimana retak pengecutan plastik berlaku.

(4 markah)

(b) Berikan definasi ketahanlasakan. Dengan melukiskan rajah yang sesuai jelaskan hubungan di antara ketahanlasakan konkrit dengan keadaan pendedahan.

(6 markah)

(c) Jelaskan secara ringkas **LIMA (5)** faktor utama yang boleh mempengaruhi ketahanlasakan konkrit.

(10 markah)

3. Dengan menggunakan kaedah rekabentuk campuran untuk konkrit biasa (BRE Report, 1988 – rujuk Lampiran) dan berdasarkan kepada data yang diberikan di bawah, tentukan kuantiti bahan-bahan untuk satu meter padu konkrit dan untuk satu campuran cubaan dengan isipadu 0.05 m^3.

   Kekuatan ciri: 40 MPa
   Simen: OPC
   Jenis Agregat (Agregat kasar): Hancur; (Pasir): Tak hancur
   Penurunan: 30 – 60 mm
   Saiz maksima agregat: 20 mm
   Ketumpatan relatif agregat (SSD): 2.7
   Peratusan pasir melepasi ayak 600 μm: 30%

(20 markah)

4. (a) Tulis persamaan Bogue untuk peratus komponen utama dalam simen (C_3S, C_2S, C_3A, C_4AF).

(5 markah)

   (b) Terangkan peranan komponen utama C_3S, C_2S, C_3A, C_4AF dalam menentukan kekuatan simen.

(5 markah)

   (c) Kira komposisi Bogue untuk simen yang mempunyai kandungan oksida seperti berikut:

   $SiO_2 = 21.5$; $CaO = 68.0$; $Fe_2O_3 = 1.3$
   $Al_2O_3 = 3.6$; $SO_3 = 2.3$; dan lain-lain = 3.3

(10 markah)

5. (a) Tunjukkan saiz agregat mempengaruhi kadar pengecutan atau pengembangan konkrit. Ambil dimensi rasuk konkrit sebagai d_1, d_2 dan panjangnya L.

(10 markah)

   (b) Kira modulus kehalusan untuk agregat di bawah:

Saiz ayakan	Berat tertahan (g)
10 mm	0
4.76 mm	0
2.36 mm	10
1.18 mm	115.3
600 μm	130.1
300 μm	121.1
150 μm	123.5

(10 markah)

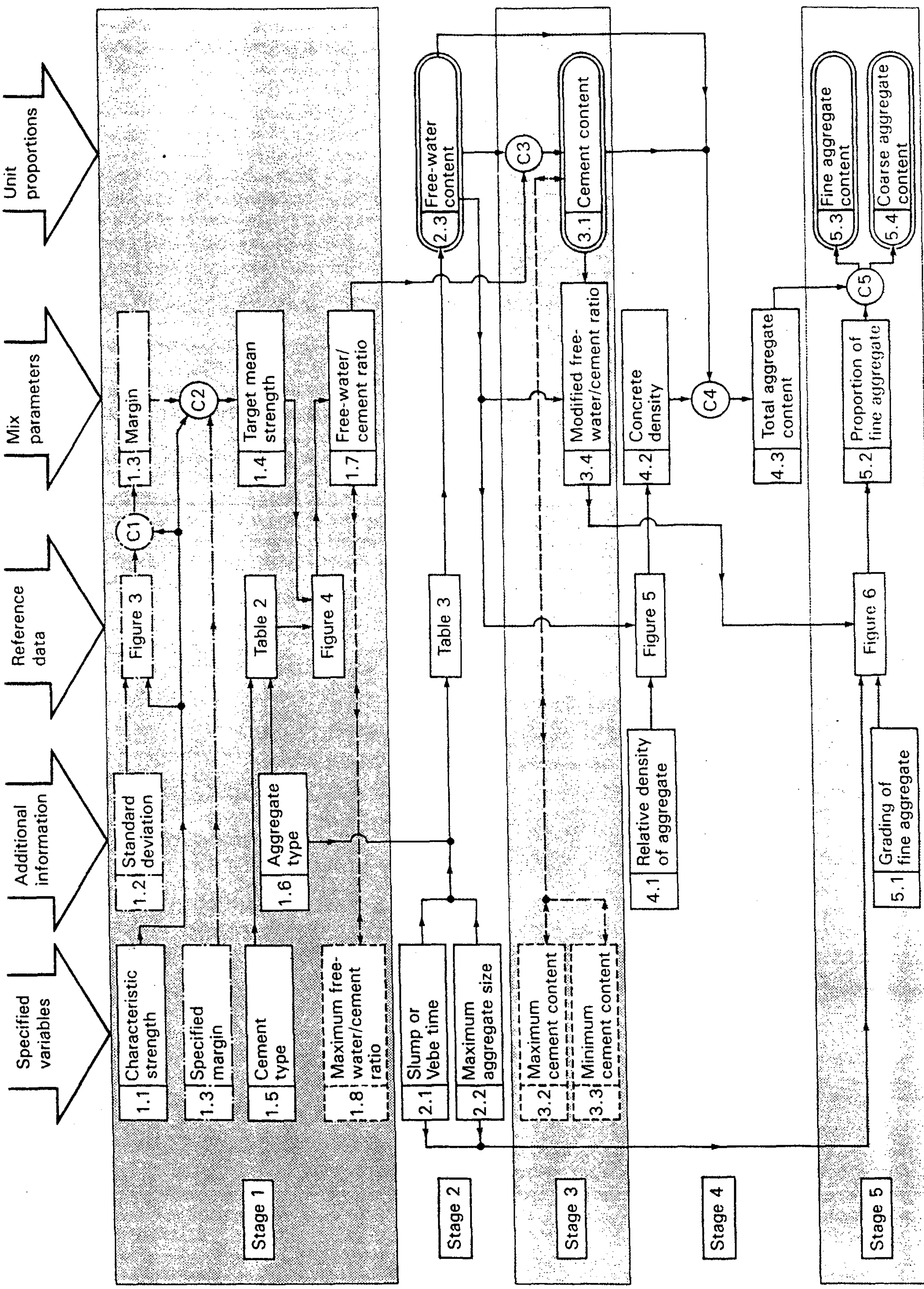

Figure 2 Flow chart of mix design procedure. Items in dashed boxes and with two-way arrows are optional limiting values that may be specified. C calculation
Items in chain-dotted boxes are alternatives

Table 1 Concrete mix design form

Job title ....

Stage	Item		Reference or calculation	Values
1	1.1	Characteristic strength	Specified	______ N/mm² at ______ days; Proportion defective ______ %
	1.2	Standard deviation	Fig 3	______ N/mm² or no data ______ N/mm²
	1.3	Margin	C1 or Specified	(k = ______) ______ × ______ = ______ N/mm²; ______ N/mm²
	1.4	Target mean strength	C2	______ + ______ = ______ N/mm²
	1.5	Cement type	Specified	OPC/SRPC/RHPC
	1.6	Aggregate type: coarse Aggregate type: fine		Crushed/uncrushed Crushed/uncrushed
	1.7	Free-water/cement ratio	Table 2, Fig 4	______ } Use the lower value [ ]
	1.8	*Maximum free-water/cement ratio*	*Specified*	______
2	2.1	Slump or Vebe time	Specified	Slump ______ mm or Vebe time ______ s
	2.2	Maximum aggregate size	Specified	______ mm
	2.3	Free-water content	Table 3	______ [ ] kg/m³
3	3.1	Cement content	C3	______ ÷ ______ = ______ kg/m³
	3.2	*Maximum cement content*	*Specified*	______ kg/m³
	3.3	*Minimum cement content*	*Specified*	______ kg/m³
				use 3.1 if ≤ 3.2 use 3.3 if > 3.1 [ ] kg/m³
	3.4	Modified free-water/cement ratio		______ [ ]
4	4.1	Relative density of aggregate (SSD)		______ known/assumed
	4.2	Concrete density	Fig 5	______ kg/m³
	4.3	Total aggregate content	C4	______ − ______ − ______ = ______ kg/m³
5	5.1	Grading of fine aggregate	Percentage passing 600 μm sieve	______ %
	5.2	Proportion of fine aggregate	Fig 6	______ %
	5.3	Fine aggregate content	C5	______ × ______ = [ ] kg/m³
	5.4	Coarse aggregate content	C5	______ − ______ = [ ] kg/m³

Quantities	Cement (kg)	Water (kg or *L*)	Fine aggregate (kg)	Coarse aggregate (kg) 10 mm	20 mm	40 mm
per m³ (to nearest 5 kg)	______	______	______	______	______	______
per trial mix of ______ m³	______	______	______	______	______	______

Items in italics are optional limiting values that may be specified (see Section 7)

1 N/mm² = 1 MN/m² = 1 MPa (see footnote to Section 3).
OPC = ordinary Portland cement; SRPC = sulphate-resisting Portland cement; RHPC = rapid-hardening Portland cement.
Relative density = specific gravity (see footnote to Para 5.4). SSD = based on a saturated surface-dry basis.

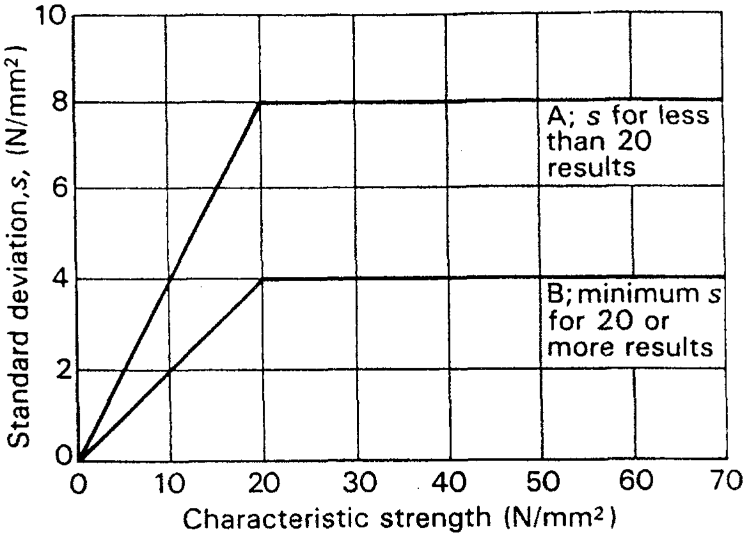

Figure 3 Relationship between standard deviation and characteristic strength

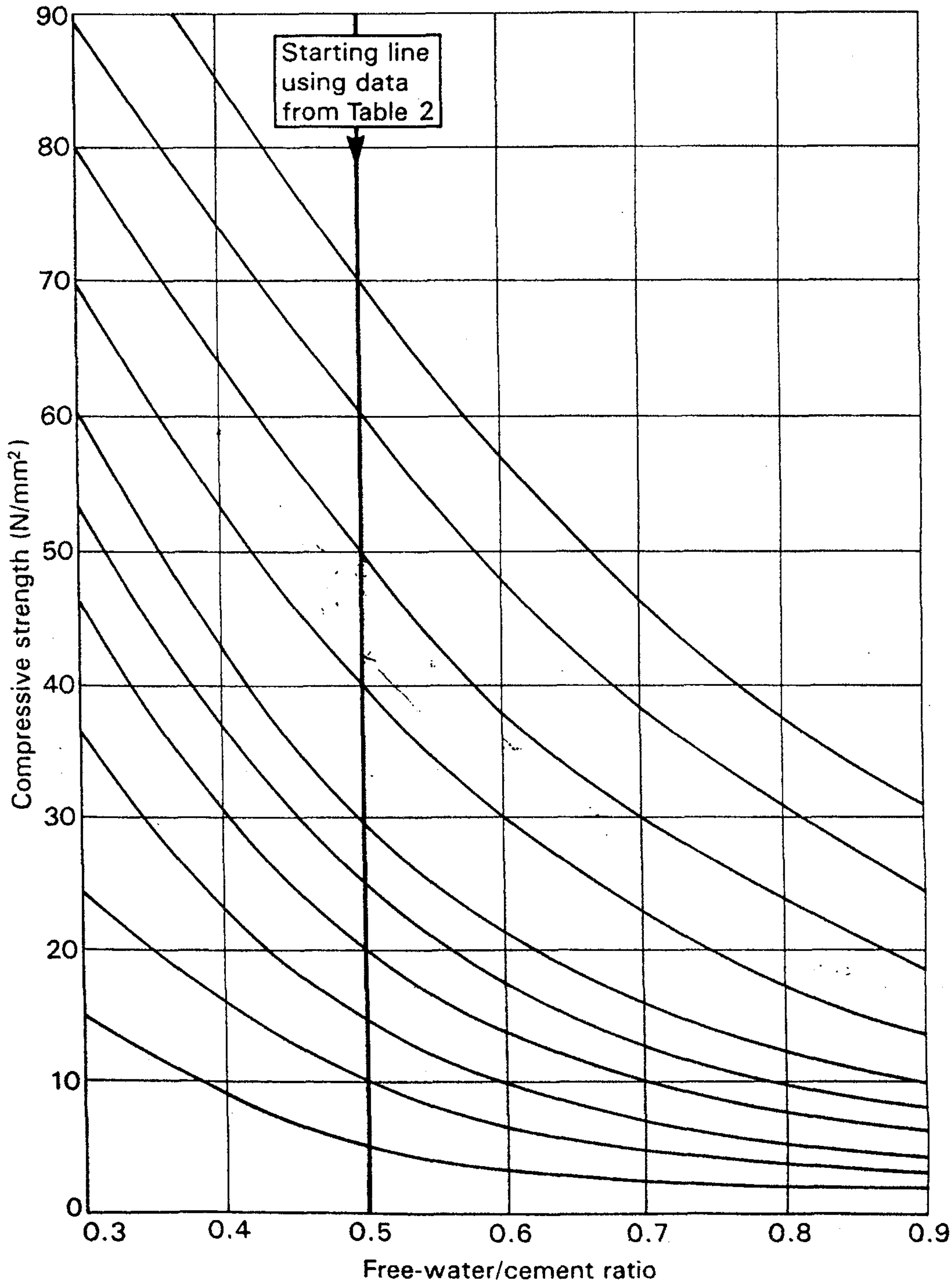

Figure 4 Relationship between compressive strength and free-water/cement ratio

Table 2 Approximate compressive strengths (N/mm²) of concrete mixes made with a free-water/cement ratio of 0.5

Type of cement	Type of coarse aggregate	Compressive strengths (N/mm²) Age (days) 3	7	28	91
Ordinary Portland (OPC) or sulphate-resisting Portland (SRPC)	Uncrushed	22	30	42	49
	Crushed	27	36	49	56
Rapid-hardening Portland (RHPC)	Uncrushed	29	37	48	54
	Crushed	34	43	55	61

1 N/mm² = 1 MN/m² = 1 MPa (see footnote on earlier page).

Table 3 Approximate free-water contents (kg/m³) required to give various levels of workability

Slump (mm) / Vebe time(s)		0-10 / >12	10-30 / 6-12	30-60 / 3-6	60-180 / 0-3
Maximum size aggregate (mm)	**Type of aggregate**				
10	Uncrushed	150	180	205	225
	Crushed	180	205	230	250
20	Uncrushed	135	160	180	195
	Crushed	170	190	210	225
40	Uncrushed	115	140	160	175
	Crushed	155	175	190	205

Note: When coarse and fine aggregates of different types are used, the free-water content is estimated by the expression

$$\tfrac{2}{3} W_f + \tfrac{1}{3} W_c$$

where W_f = free-water content appropriate to type of fine aggregate

and W_c = free-water content appropriate to type of coarse aggregate.

5.3 Determination of cement content (Stage 3)

The cement content is determined from calculation C3:

$$\text{Cement content} = \frac{\text{free-water content}}{\text{free-water/cement ratio}} \quad \ldots C3$$

The resulting value should be checked against any maximum or minimum value that may be specified. If the calculated cement content from C3 is below a specified minimum, this minimum value must be adopted and a modified free-water/cement ratio calculated which will be less than that determined in Stage 1. This will result in a concrete that has a mean strength somewhat higher than the target mean strength. Alternatively, the free-water/cement ratio from Stage 1 is used resulting in a higher free-water content and increased workability.

On the other hand, if the design method indicates a cement content that is higher than a specified maximum then it is probable that the specification cannot be met simultaneously on strength and workability requirements with the selected materials. Consideration should then be given to changing the type of cement, the type and maximum size of aggregate or the level of workability of the concrete, or to the use of a water reducing admixture.

5.4 Determination of total aggregate content (Stage 4)

Stage 4 requires an estimate of the density of the fully compacted concrete which is obtained from Figure 5 depending upon the free-water content and the relative density* of the combined aggregate in the saturated surface-dry condition (SSD). If no information is available regarding the relative density of the aggregate an approximation can be made by assuming a value of 2.6 for uncrushed aggregate and 2.7 for crushed aggregate. From this estimated density of the concrete the total aggregate content is determined from calculation C4:

Total aggregate content $= D - C - W$ ...*C4*
(saturated and surface-dry)

where D = the wet density of concrete (kg/m³)
C = the cement content (kg/m³)
W = the free-water content (kg/m³).

*The internationally known term 'relative density' used in this publication is synonymous with 'specific gravity' and is the ratio of the mass of a given volume of substance to the mass of an equal volume of water.

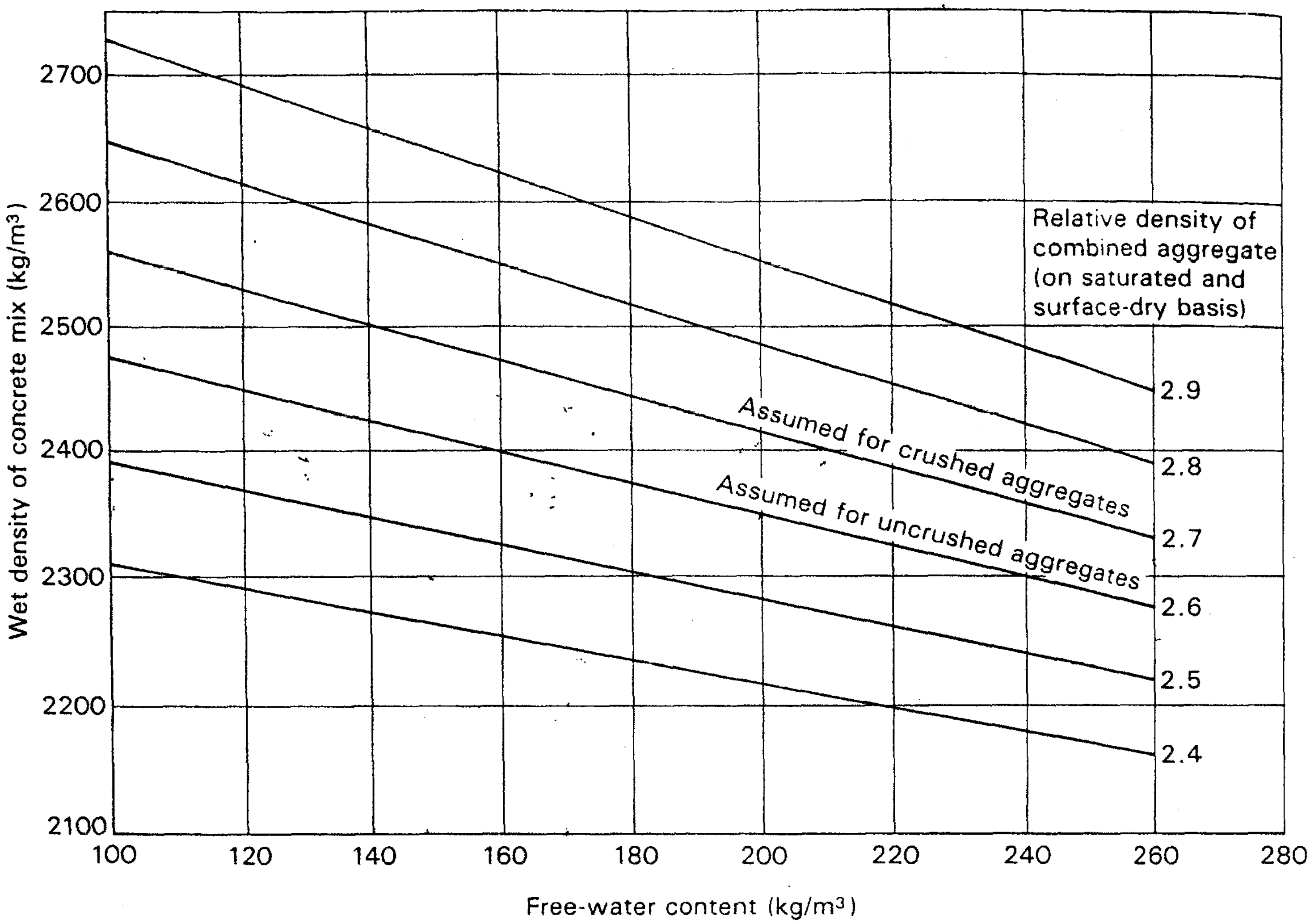

Figure 5 Estimated wet density of fully compacted concrete

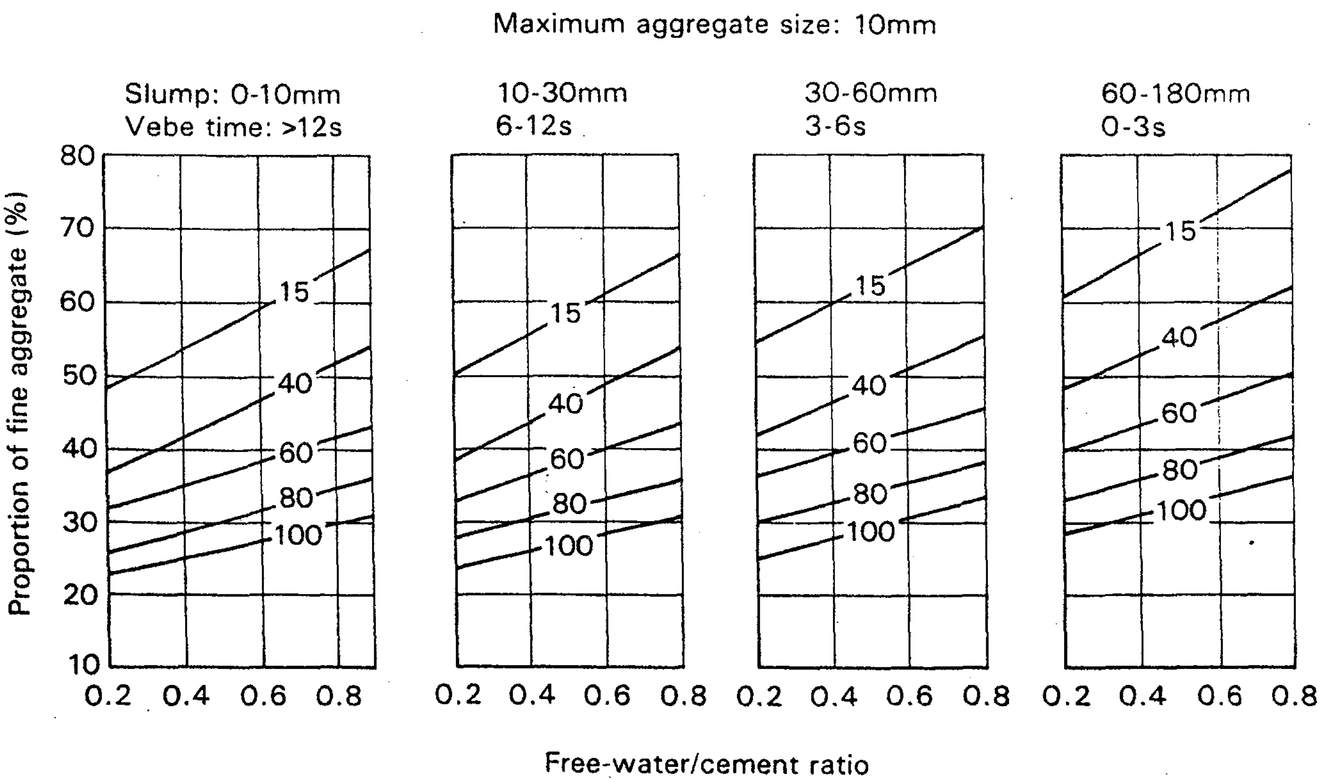

Figure 6 Recommended proportions of fine aggregate according to percentage passing a 600 μm sieve

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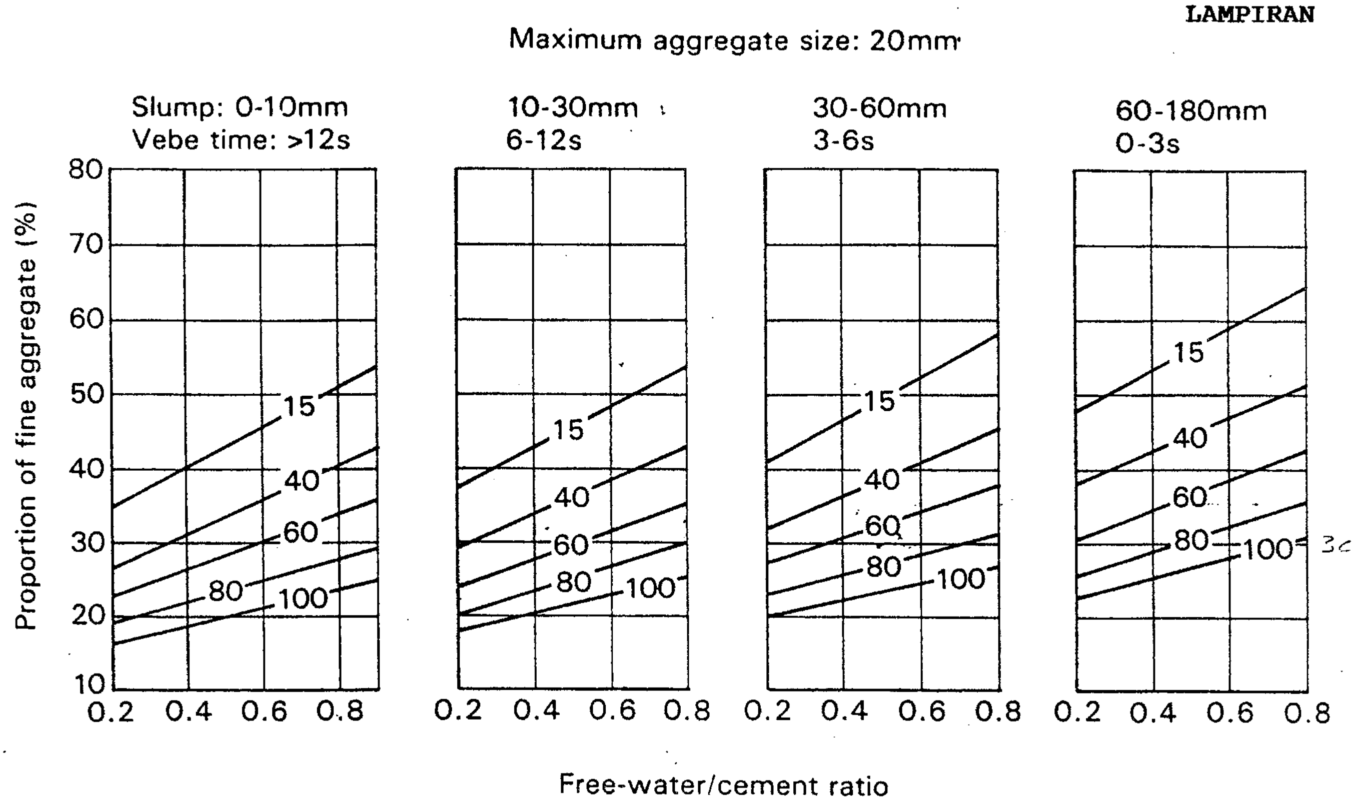

Figure 6 *(continued)*

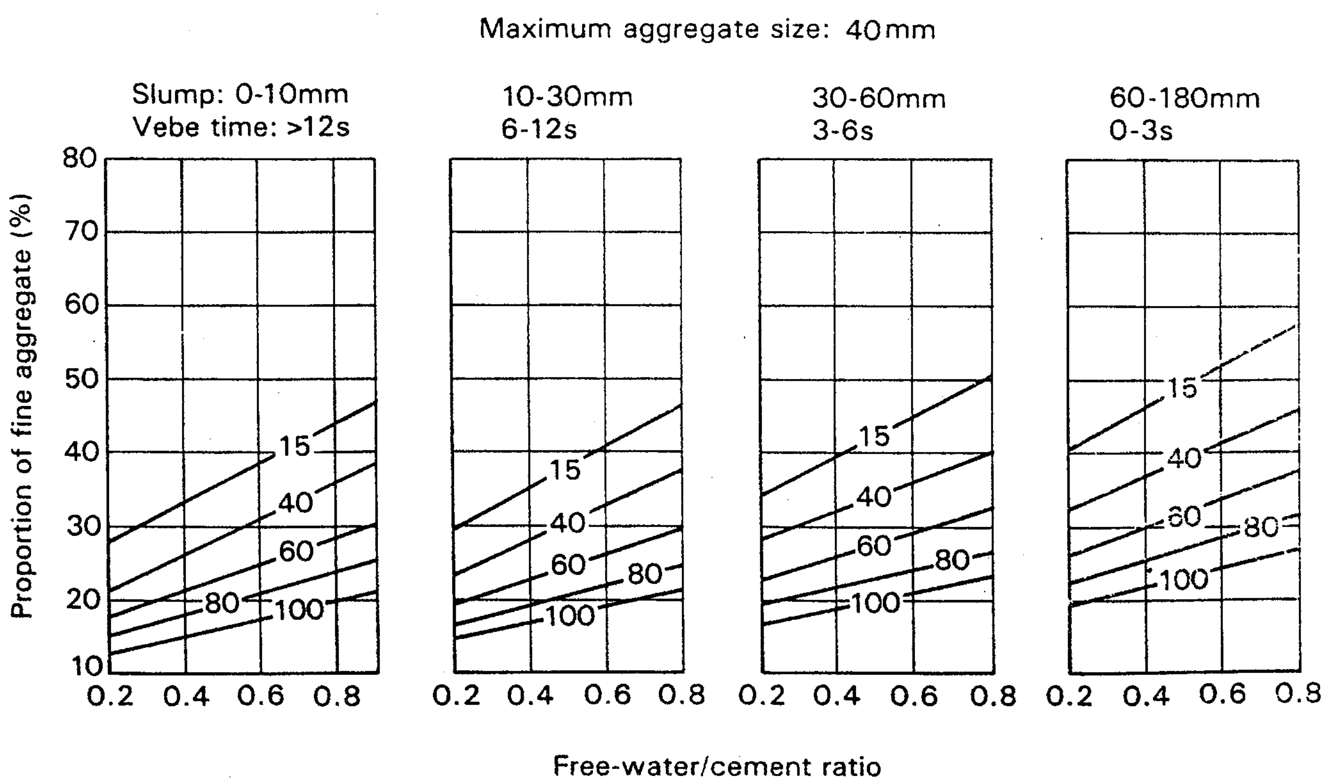

Figure 6 *(continued)*