UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2005/2006
2nd. Semester Examination
2005/2006 Academic Session

April / May 2006

EAS 181/2 – Teknologi Konkrit

EAS 181/2 – Concrete Technology

Masa : 2 jam
Duration: 2 hours

Arahan Kepada Calon:
Instructions To Candidates:

1. Sila pastikan kertas peperiksaan ini mengandungi **SEBELAS (11)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.
   *Ensure that this paper contains **ELEVEN (11)** printed pages including appendices before you start your examination.*

2. Kertas ini mengandungi **LIMA (5)** soalan. Jawab **EMPAT (4)** soalan sahaja. Markah hanya akan dikira bagi **EMPAT (4)** jawapan **PERTAMA** yang dimasukkan di dalam buku mengikut susunan dan bukannya **EMPAT (4)** jawapan terbaik.
   *This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions only. Marks will be given to the **FIRST FOUR (4)** questions put in order on the answer script and **NOT** the **BEST FOUR (4).***

3. Tiap-tiap soalan mempunyai markah yang sama.
   Each question carry equal marks.

4. Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.
   *All questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.*

5. Tiap-tiap soalan **MESTILAH** dijawab pada muka surat yang baru.
   *Each question **MUST BE** answered on a new sheet.*

6. Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.
   Write the answered question numbers on the cover sheet of the answer script.

1. Komposisi oksida satu jenis simen Portland diberikan dalam Jadual 1.

The oxide compositions of a type of Portland cement are given in Table 1.

Table 1: Oxide Compositions of a Portland cement

Oxide Compositions, (%)	
CaO	66
SiO_2	22
Al_2O_3	4.1
Fe_2O_3	4.6
MgO	0.2
SO_3	1.5
K_2O, Na_2O}	0.2
Others	0.5
Loss on ignition	0.7
Insoluble residue	0.2

(a) Tentukan komposisi sebatian utama bagi simen Portland menggunakan komposisi oksida yang diberikan dalam Jadual 1, dan persamaan-persamaan Bogue yang berikut:

Determine the major compound compositions of the Portland cement using the oxide compositions given in Table 1 and the following Bogue's equations:

$$C_3S = 4.07(CaO) - 7.60(SiO_2) - 6.72(Al_2O_3) - 1.43(Fe_2O_3) - 2.85(SO_3)$$

$$C_2S = 2.87(SiO_2) - 0.754(3CaO.SiO_2)$$

$$C_3A = 2.65(Al_2O_3) - 1.69(Fe_2O_3)$$

$$C_4AF = 3.04(Fe_2O_3)$$

(5 markah)

(b) Berdasarkan kepada komposisi oksida yang diberikan dan komposisi sebatian utama yang ditentukan di (a), nyatakan kemungkinan jenis simen Portland berkenaan. Berikan justifikasi anda.

(5 markah)

Based on the given oxide compositions and the major compound compositions obtained in (a), state the most probable type of the Portland cement. Give your justification.

(c) Nyatakan kegunaan utama simen Portland berkenaan. Jelaskan kenapa ia lebih sesuai untuk kegunaan yang dinyatakan.

(5 markah)

State the major use of this type of Portland cement. Highlight why it is more suitable for the particular application.

1. (d) Terangkan **DUA (2)** peranan utama air bancuhan konkrit. Jelaskan bagaimana kesesuaian air bancuhan boleh dinilai.

(10 markah)

*Explain **TWO (2)** major roles of mixing water for concrete. Describe how the suitability of water for concrete could be assessed.*

2. (a) Bincangkan pengaruh bentuk dan tekstur permukaan agregat kasar keatas kebolehkerjaan dan kekuatan konkrit.

(10 markah)

Discuss the influence of shape and surface texture of coarse aggregates on the workability and strength of concrete.

(b) Terangkan kenapa graviti tentu dalam keadaan permukaan kering tepu digunakan dalam rekabentuk campuran konkrit.

(5 markah)

Explain why specific gravity based on saturated and surface dry condition is used in concrete mix design.

(c) Terangkan kenapa taburan saiz partikel atau penggredan agregat adalah penting di dalam rekabentuk campuran konkrit.

(5 markah)

Explain why particle size distribution or gradation of aggregates is important in the design of concrete mix.

(d) Terangkan apakah yang dimaksudkan dengan kapasiti penyerapan, lembapan bebas dan jumlah kandungan air agregat.

(5 markah)

Explain what is meant by absorption capacity, free moisture and total water content of aggregates.

3. (a) Berikan definasi bahan tambah dan jelaskan **LIMA (5)** tujuan penggunaan bahan tambah.

(10 markah)

*Give the definition of admixture and describe **FIVE (5)** purposes of using admixture.*

(b) Terangkan kenapa kebolehkerjaan konkrit adalah penting dan selalunya dijadikan salah satu kriteria pematuhan konkrit dalam banyak kod amalan.

(10 markah)

Explain why workability of concrete is very important and normally adopted as one of the criteria for compliance of concrete in most codes of practice.

3. (c) Jelaskan kesan-kesan penggunaan 30% abu terbang sebagai bahan gantian separa simen, keatas kebolehkerjaan dan kekuatan konkrit.

(5 markah)

Describe the effects of using 30% fly ash as a partial cement replacement material on the workability and compressive strength of concrete.

4. (a) Terangkan apakah yang dimaksudkan dengan pengawetan dan terangkan dengan ringkas tujuan pengawetan.

(5 marks)

Explain what is meant by curing and briefly describe the purpose of curing.

(b) Dengan menggunakan kaedah rekabentuk campuran untuk konkrit biasa (BRE Report, 1988 seperti di Lampiran) serta berdasarkan kepada data-data yang diberikan di bawah, tentukan kuantiti bahan-bahan untuk satu campuran cubaan dengan isipadu 0.06 m^3. Gunakan lampiran yang diberikan dan hantarkan lampiran bersama kertas jawapan anda.

Kekuatan ciri: 40 MPa at 28 days
Peratus kecacatan: 5 %
Sisihan Piawai: 5 MPa
Jenis simen: Simen Portland biasa
Jenis agregat (Agregat kasar): Batuan granit
Jenis agregat (Agregat halus): Pasir sungai
Nisbah air/simen bebas maksima: 0.50
Penurunan: 60 – 180 mm
Saiz maksima agregat: 20 mm
Ketumpatan relative agregat (SSD): 2.7
Peratusan pasir melepasi ayak 600 μm: 60 %

(20 markah)

Using the guideline on "Design of Normal Concrete Mixes" (BRE Report, 1988 given in the appendix) and based on the data given below, determine the quantity of materials for a trial mix of 0.06 m^3. Use the attached appendix and submit the appendix with the answer script.

Characteristic strength: 40 MPa at 28 days
Proportion defective: 5 %
Standard deviation: 5 MPa
Cement type: Ordinary Portland cement
Aggregate type (coarse): Granite; Aggregate type (fine): river sand
Maximum free water/cement ratio: 0.50
Slump: 60 -180 mm
Maximum aggregate size: 20 mm
Relative density of aggregate (SSD): 2.7
Percentage passing 600 μm sieve: 60 %

5. (a) Perihalkan **LIMA (5)** faktor utama yang boleh mempengaruhi kekuatan dan prestasi ketahanlasakan konkrit.

(10 markah)

*Describe **FIVE (5)** major factors which could affect the strength and durability performance of concrete.*

(b) Terangkan apakah yang dimaksudkan oleh terminologi-terminologi berikut:

i) Pengecutan plastik
ii) Pengecutan autogenous
iii) Pengecutan kontang
iv) Rayapan

(12 markah)

Explain what is meant by the following terminologies:

i) Plastic shrinkage
ii) Autogenous shrinkage
iii) Drying shrinkage
iv) Creep

(c) Dengan berbantukan lakaran yang sesuai, perihalkan hubungan tegasan-terikan konkrit yang dibebani.

(3 markah)

With the aid of an appropriate sketch, describe the stress-strain response of concrete under load.

- ooo O ooo -

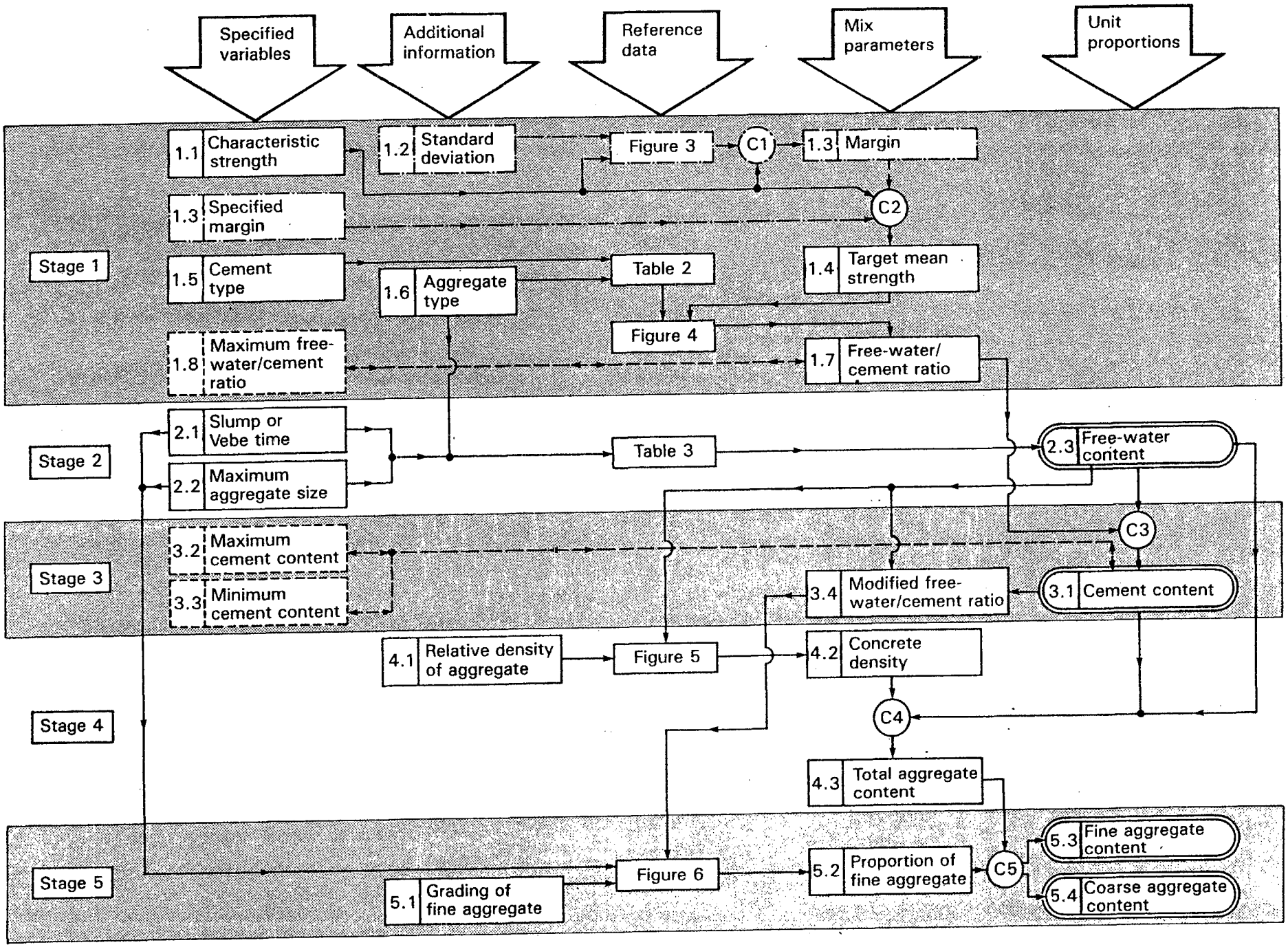

Figure 2 Flow chart of mix design procedure. Items in dashed boxes and with two-way arrows are optional limiting values that may be specified. C = calculation
Items in chain-dotted boxes are alternatives

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	_____
	1.8	*Maximum free-water/cement ratio*	*Specified*	_____ Use the lower value [ ]
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.

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

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

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:

$$\text{Total aggregate content (saturated and surface-dry)} = D - C - W \quad \ldots C4$$

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.

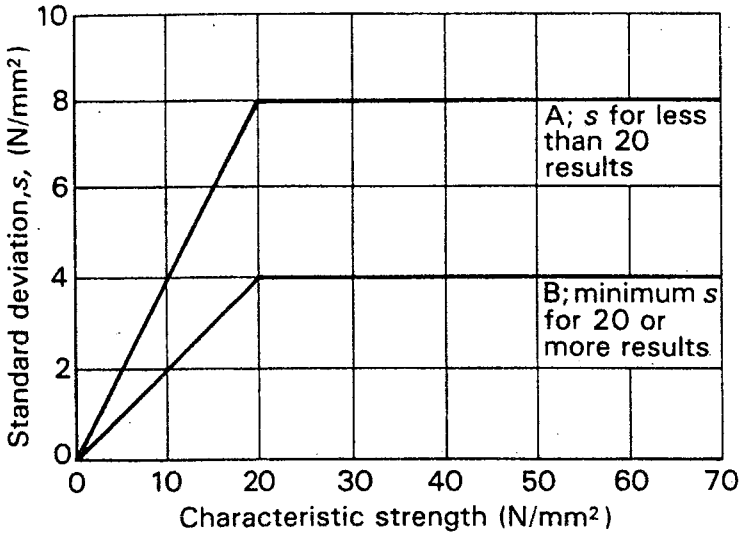

Figure 3 Relationship between standard deviation and characteristic strength

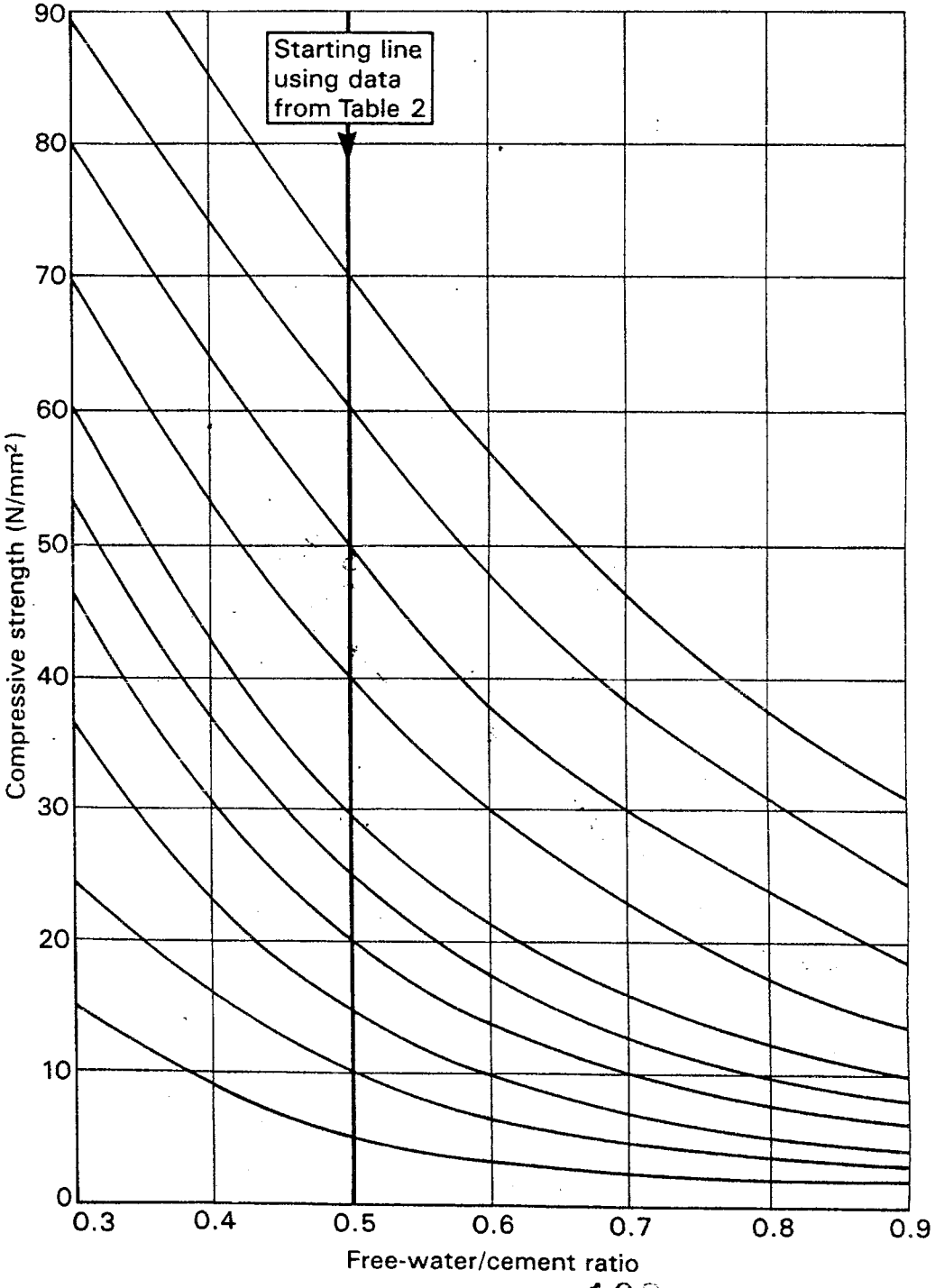

Figure 4 Relationship between compressive strength and free-water/cement ratio

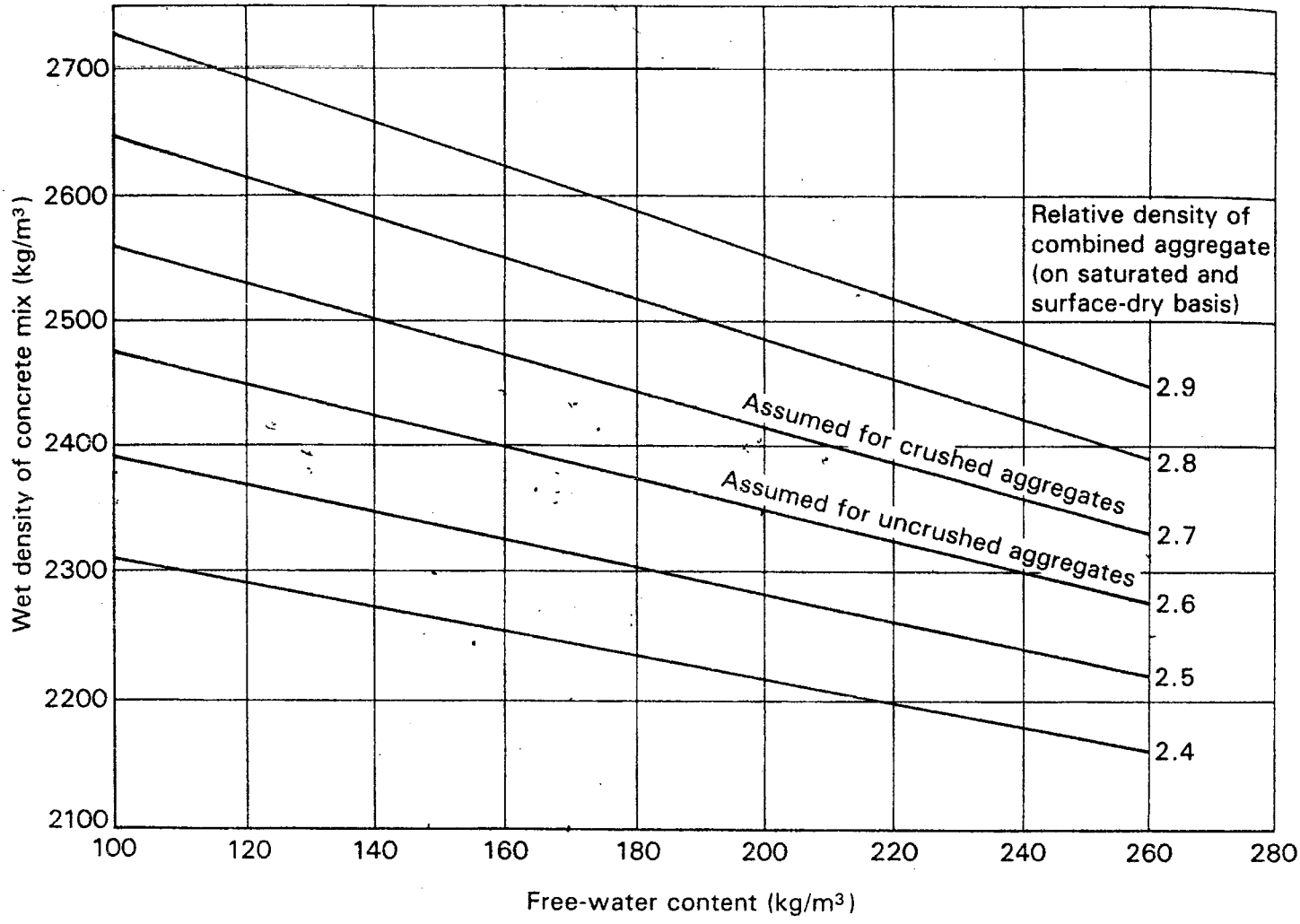

Figure 5 Estimated wet density of fully compacted concrete

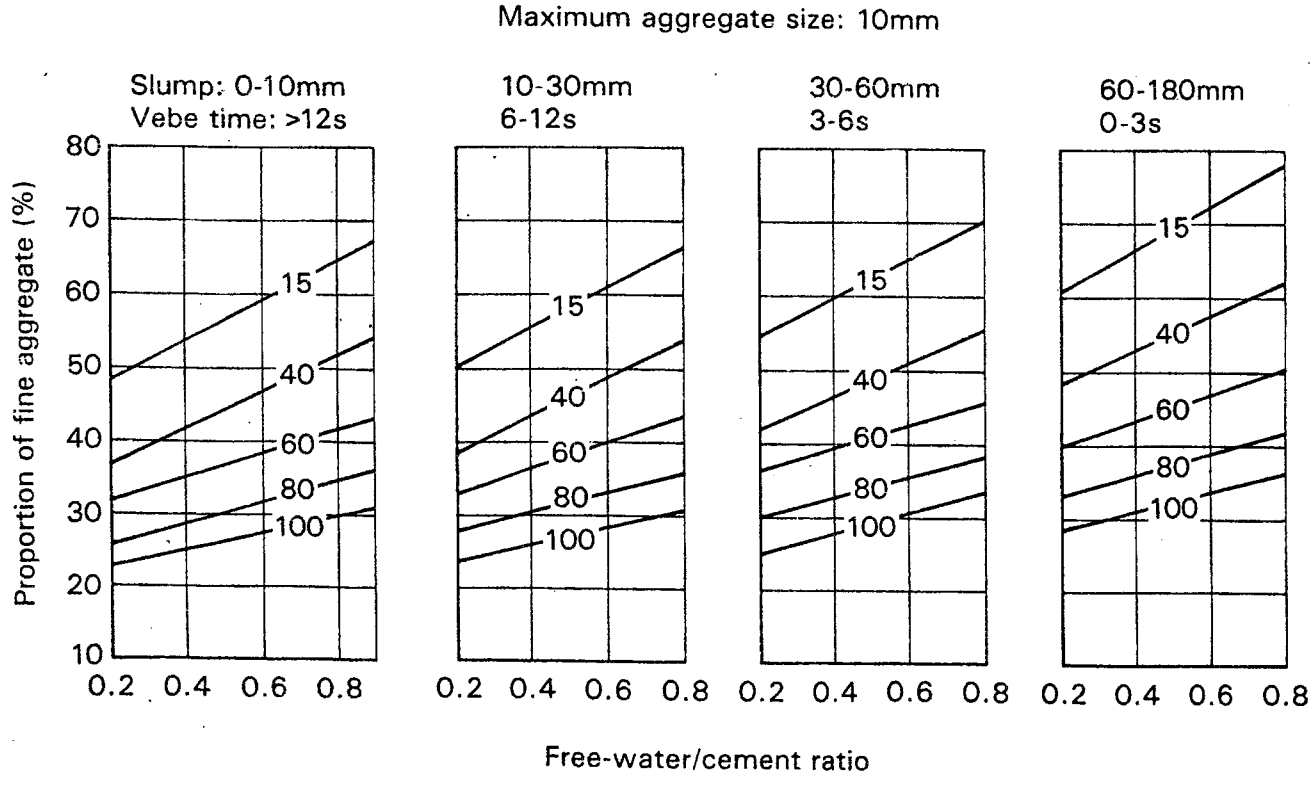

Figure 6 Recommended proportions of fine aggregate according to percentage passing a 600 μm sieve

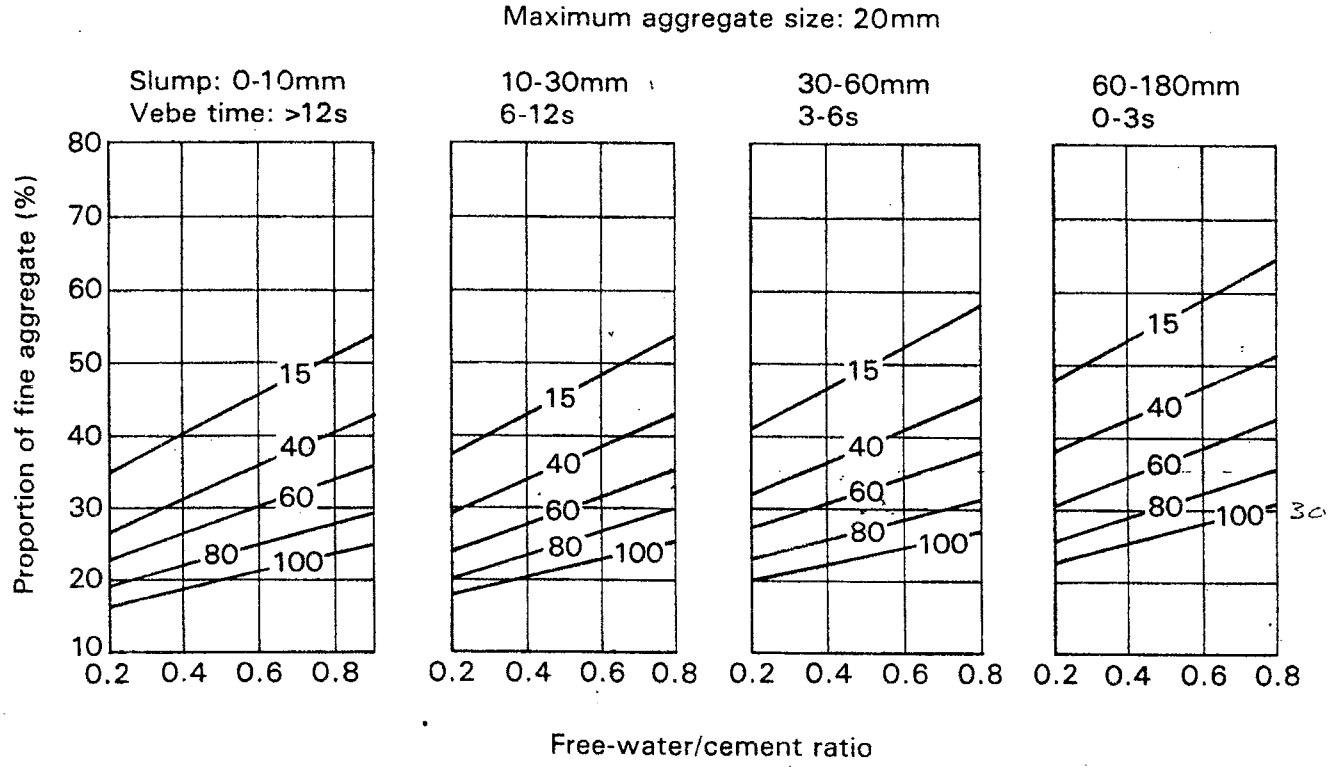

Figure 6 *(continued)*

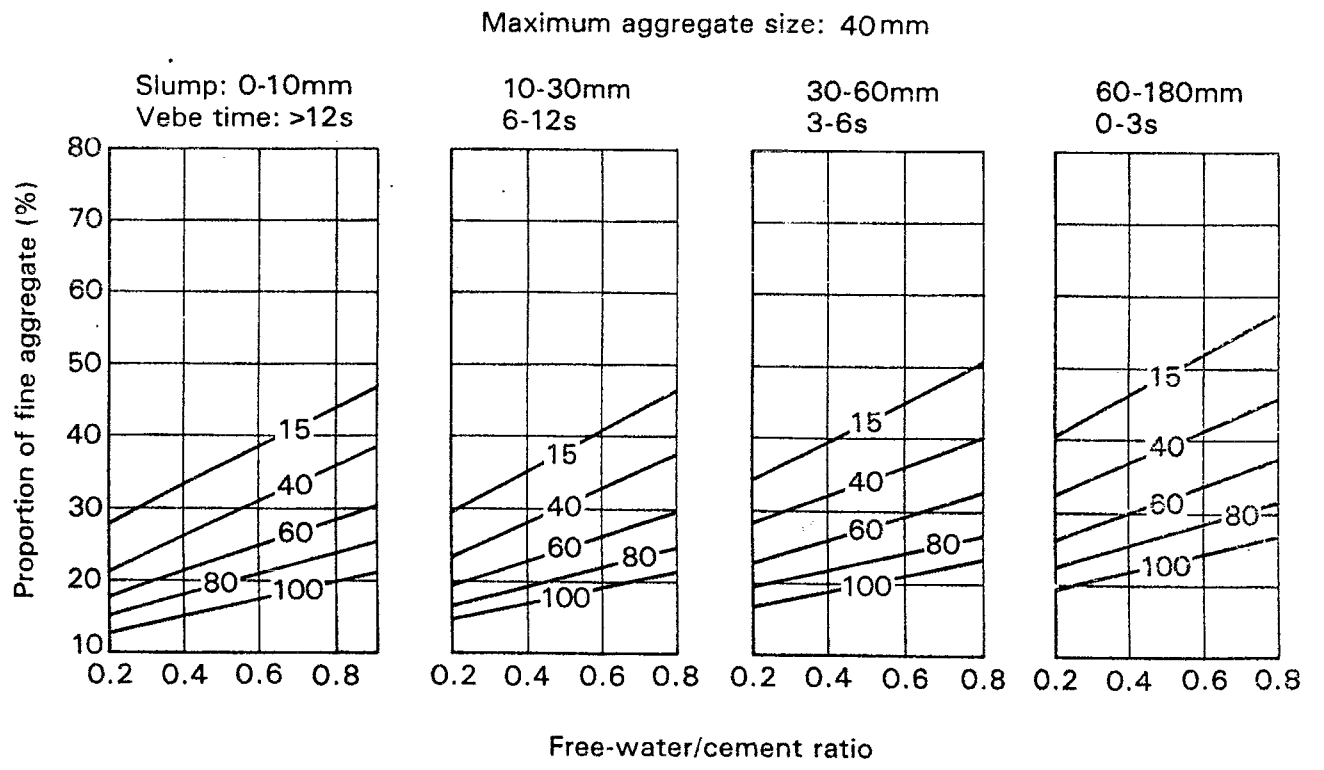

Figure 6 *(continued)*