UNIVERSITI SAINS MALAYSIA

Second Semester Examination

Academic Session 2008/2009

April/May 2009

EAS 181/2 – Concrete Technology
[Teknologi Konkrit]

Duration: 2 hours
[Masa : 2 jam]

Please check that this examination paper consists of **<u>FOURTHEEN (14)</u>** printed pages including appendix before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **<u>EMPAT BELAS (14)</u>** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

<u>Instructions</u>: This paper consists of **<u>SIX (6)</u>** questions. Answer **<u>FOUR (4)</u>** questions only. All questions carry the same marks.

*[**<u>Arahan</u>**: Kertas ini mengandungi **<u>ENAM (6)</u>** soalan. Jawab **<u>EMPAT (4)</u>** soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

All questions must be answered in English.
[Semua soalan mesti dijawab dalam Bahasa Inggeris.]

All questions **<u>MUST BE</u>** answered on a new page.
*[Semua soalan **<u>MESTILAH</u>** dijawab pada muka surat baru.]*

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

1. a) Define: Slump loss

[3 Marks]

b) What is meant by segregation and discuss briefly how segregation can be reduced. List out the situations that encourage segregation.

[10 Marks]

c) Discuss elaborately the factors affecting workability of concrete. List out any **FOUR (4)** tests used to measure the workability of concrete.

[12 Marks]

2. a) Describe briefly the purpose of compaction of concrete.

[5 Marks]

b) Define: (i) Creep and (ii) Shrinkage

[4 Marks]

c) With the aid of diagram, briefly explain the stress-strain curve of concrete.

[8 Marks]

d) Explain briefly the testing procedure of splitting tension test with the aid of neat sketch. Write down the expression to determine tensile strength of concrete cylinder.

[8 Marks]

3. a) With the aid of suitable flow chart, explain the production process of Portland cement.

[8 Marks]

b) The ASTM Specifications for Type IV cement limit the maximum C_3S content to 35 %, the minimum C_2S content to 40 % and the maximum C_3A content to 7 %. Explain the reasons for such limits on these compound compositions.

[4 Marks]

c) Two types of cements A and B have a fineness of 350 m^2/kg and 500 m^2/kg, respectively. Describe the potential differences in term of water requirement, heat development, and rate of strength development for both types of cements. Explain which type of cement will be more suitable for the repair of a highway bridge.

[8 Marks]

d) With the help of a suitable graph, explain the contribution of the four major compound compositions of cement towards strength.

[5 Marks]

4. a) Describe what is meant by pozzolan or pozzolanic material.

[3 Marks]

b) Discuss how the use of mineral admixture could enhance durability of concrete through the pore filling effect.

[8 Marks]

c) A Malaysian builder is constructing a new airport in Libya. The construction work of the airport is performed in hot weather condition. Suggest the potential effect of hot weather condition on setting characteristics of cement and concrete. Propose a suitable chemical admixture to be used in the concrete for the construction of the airport.

[5 Marks]

d) The use of fly ash is normally associated with a reduction in water demand of concrete up to about 15 %.

i) Explain how the water reduction occurs.

ii) A concrete mixture containing Ordinary Portland Cement; 360 kg/m^3 and water/cement ratio; 0.55 exhibits a slump value of 70 mm. If 30 % of the cement content is replaced with fly ash, determine the water content for the concrete mixture to give constant workability (70 mm slump). Assume that at 30 % replacement level, water requirement reduces by 15 %.

iii) If the same water/binder ratio of 0.55 is maintained for the concrete containing 30 % fly ash, explain the expected effect to workability.

[9 Marks]

5. a) Using the guideline on "Design of Normal Concrete Mixes" (BRE Report, 1988 given in Appendix A) and based on the data given below, determine the quantity of materials for a trial mix of 0.05 m^3. Include the attachment used with your answer script.

Characteristic strength: 30 MPa at 28 days
Proportion defective: 5 %
Standard deviation: 4 MPa
Cement type: Ordinary Portland Cement
Aggregate type (coarse): Granite; Aggregate type (fine): River sand
Maximum free water/cement ratio: 0.50
Slump: 90 mm
Maximum aggregate size: 20 mm
Relative density of aggregate (SSD): 2.7
Percentage passing 600 µm sieve: 60 %

[20 Marks]

b) If the sand used in (a) is moist with moisture content of 1.0% and the granite coarse aggregate is dry with water absorption of 0.75%, determine the mix proportions for $1m^3$ and for the trial mix of $0.05\ m^3$.

[5 Marks]

6. a) Using appropriate sketches, briefly describe the **FOUR (4)** probable moisture conditions of an aggregate.

[5 Marks]

b) Briefly explain how the aggregate impact value of a coarse aggregate sample could be determined.

[5 Marks]

c) Table 1 gives the grading of two samples of sand A and B in terms of weight retained on the relevant sieves. Calculate the percentage of weight retained on individual sieve and the cumulative percentage retained for both samples. Then determine the fineness modulus for each sand sample. Based on the fineness modulus values, explain which sand will require greater water content when used in concrete, assuming the quantity and characteristics of other materials used being the same.

Table 1: Grading of Sand

Sieve Size	Weight Retained (g)	
	Sand A	Sand B
10 mm	0	0
5 mm	0	0
2.36 mm	0	74.5
1.18 mm	3.3	140
600 µm	12.5	113.6
300 µm	259.1	74.9
150 µm	173.2	48.9
Pan	8.9	9.1
Total *Jumlah*	457	461

[15 Marks]

(TERJEMAHAN)

1. a) *Berikan definasi kehilangan penurunan atau kehilangan kebolehkerjaan.*

[3 markah]

b) *Apakah yang dimaksudkan dengan pengasingan dan bincangkan secara ringkas bagaimana fenomena pengasingan boleh dikurangkan. Senaraikan keadaan-keadaan yang menggalakkan fenomena pengasingan.*

[10 markah]

c) *Bincangkan faktor-faktor yang boleh mempengaruhi kebolehkerjaan konkrit. Senaraikan mana-mana* ***EMPAT (4)*** *kaedah ujian yang boleh digunakan untuk menganggar kebolehkerjaan konkrit.*

[12 markah]

2. a) *Terangkan secara ringkas tujuan pemadatan konkrit.*

[5 markah]

b) *Berikan definasi: (i) Rayapan dan (ii) Pengecutan*

[4 markah]

c) *Dengan berbantukan rajah, terangkan secara ringkas lengkung tegasan-terikan konkrit.*

[8 markah]

d) *Terangkan secara ringkas kaedah pengujian tegangan belahan (ujian tegangan tak-langsung) dengan berbantukan lakaran. Tuliskan ungkapan untuk menentukan kekuatan tegangan selinder konkrit.*

[8 markah]

3. a) *Dengan berbantukan carta alir, terangkan proses penghasilan simen Portland.*

[8 markah]

b) *Piawaian ASTM untuk simen Jenis IV melimitkan kandungan maksima* C_3S *kepada 35 %, kandungan minima* C_2S *kepada 40 % dan kandungan maksima* C_3A *kepada 7 %. Terangkan sebab-sebab untuk menetapkan limit bagi ketiga-tiga komposisi sebatian.*

[4 Markah]

c) *Dua jenis simen A dan B masing-masing mempunyai kehalusan 350* m^2/kg *dan 500* m^2/kg*. Jelaskan kemungkinan perbezaan dari aspek keperluan air, pembentukan haba dan kadar pembentukan kekuatan bagi kedua-dua jenis simen.*

[8 Markah]

d) *Dengan berbantukan graf yang sesuai, terangkan sumbangan keempat-empat komposisi sebatian utama simen terhadap kekuatan.*

[5Markah]

4. a) *Jelaskan maksud pozolan atau bahan pozolanik.*

[3 Markah]

b) *Bincangkan bagaimana penggunaan bahan tambah mineral boleh meningkatkan ketahanlasakan konkrit melalui kesan pengisian liang.*

[8 Markah]

c) *Sebuah syarikat pembinaan Malaysia sedang membina sebuah lapangan terbang baru di Libya. Pembinaan lapangan terbang berkenaan dilakukan dalam keadaan cuaca panas. Jelaskan kemungkinan kesan cuaca panas kepada ciri-ciri pemejalan simen dan konkrit. Cadangkan satu bahan tambah kimia yang sesuai untuk digunakan di dalam konkrit bagi pembinaan lapangan terbang berkenaan.*

[5 Markah]

d) *Penggunaan abu terbang selalunya dikaitkan dengan pengurangan keperluan air konkrit sehingga 15 %.*

i) *Terangkan bagaimana pengurangan keperluan air yang dinyatakan berlaku.*

ii) *Satu campuran konkrit mengandungi simen Portland biasa (OPC); 360 kg/m^3 dan nisbah air/simen; 0.55 menunjukkan nilai penurunan sebanyak 70 mm. Sekiranya 30 % daripada kandungan simen digantikan dengan abu terbang, tentukan kandungan air untuk campuran konkrit berkenaan untuk memberikan kebolehkerjaan malar (penurunan 70 mm). Anggapkan pada tahap gantian 30 %, keperluan air berkurang sebanyak 15 %.*

iii) *Sekiranya nisbah air/pengikat 0.55 dikekalkan bagi konkrit yang mengandungi 30 % abu terbang, terangkan kesan yang dijangkakan terhadap kebolehkerjaan.*

[9 Markah]

5. a) *Dengan menggunakan kaedah rekabentuk campuran untuk konkrit biasa (BRE Report, 1988 seperti di Lampiran A) dan berdasarkan kepada data-data yang diberikan di bawah, tentukan kuantiti bahan-bahan untuk satu campuran cubaan dengan isipadu 0.05 m^3. Sertakan lampiran yang digunakan bersama kertas jawapan anda.*

Kekuatan ciri: 30 MPa at 28 days
Peratus kecacatan: 5 %
Sisihan Piawai: 4 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: 90 mm
Saiz maksima agregat: 20 mm
Ketumpatan relative agregat (SSD): 2.7
Peratusan pasir melepasi ayak 600 µm: 60 %

[20 Markah]

…9/-

b) *Sekiranya pasir yang digunakan di (a) adalah basah dengan kandungan lembapan 1.0 % dan agregat kasar granit yang digunakan adalah kering dengan penyerapan air 0.75 %, tentukan nisbah bancuhan untuk 1m^3 dan untuk campuran cubaan 0.05m^3.*

[5 Markah]

6. a) *Dengan menggunakan lakaran-lakaran yang sesuai, jelaskan secara ringkas **EMPAT (4)** kemungkinan keadaan lembapan agregat.*

[5 Markah]

b) *Jelaskan secara ringkas bagaimana nilai hentaman agregat boleh ditentukan.*

[5 Markah]

c) *Jadual 1 memberikan penggredan dua sampel pasir A dan B dalam bentuk berat tertahan pada ayak-ayak yang berkenaan. Kira peratus tertahan pada tiap-tiap ayak dan peratus tertahan kumulatif untuk kedua-dua sampel pasir. Seterusnya, tentukan modulus kehalusan bagi kedua-dua sampel. Berdasarkan nilai modulus kehalusan yang didapati, terangkan pasir yang mana akan memerlukan kandungan air yang lebih besar bila digunakan di dalam konkrit, dengan anggapan kuantiti dan ciri-ciri bahan-bahan yang lain adalah sama.*

[15 Markah]

Jadual 1: Penggredan Pasir

Saiz Ayak	*Berat tertahan (g)*	
	Pasir A	*Pasir B*
10 mm	*0*	*0*
5 mm	*0*	*0*
2.36 mm	*0*	*74.5*
1.18 mm	*3.3*	*140*
600 µm	*12.5*	*113.6*
300 µm	*259.1*	*74.9*
150 µm	*173.2*	*48.9*
Pan	*8.9*	*9.1*
Jumlah	*457*	*461*

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APPENDIX A / LAMPIRAN A

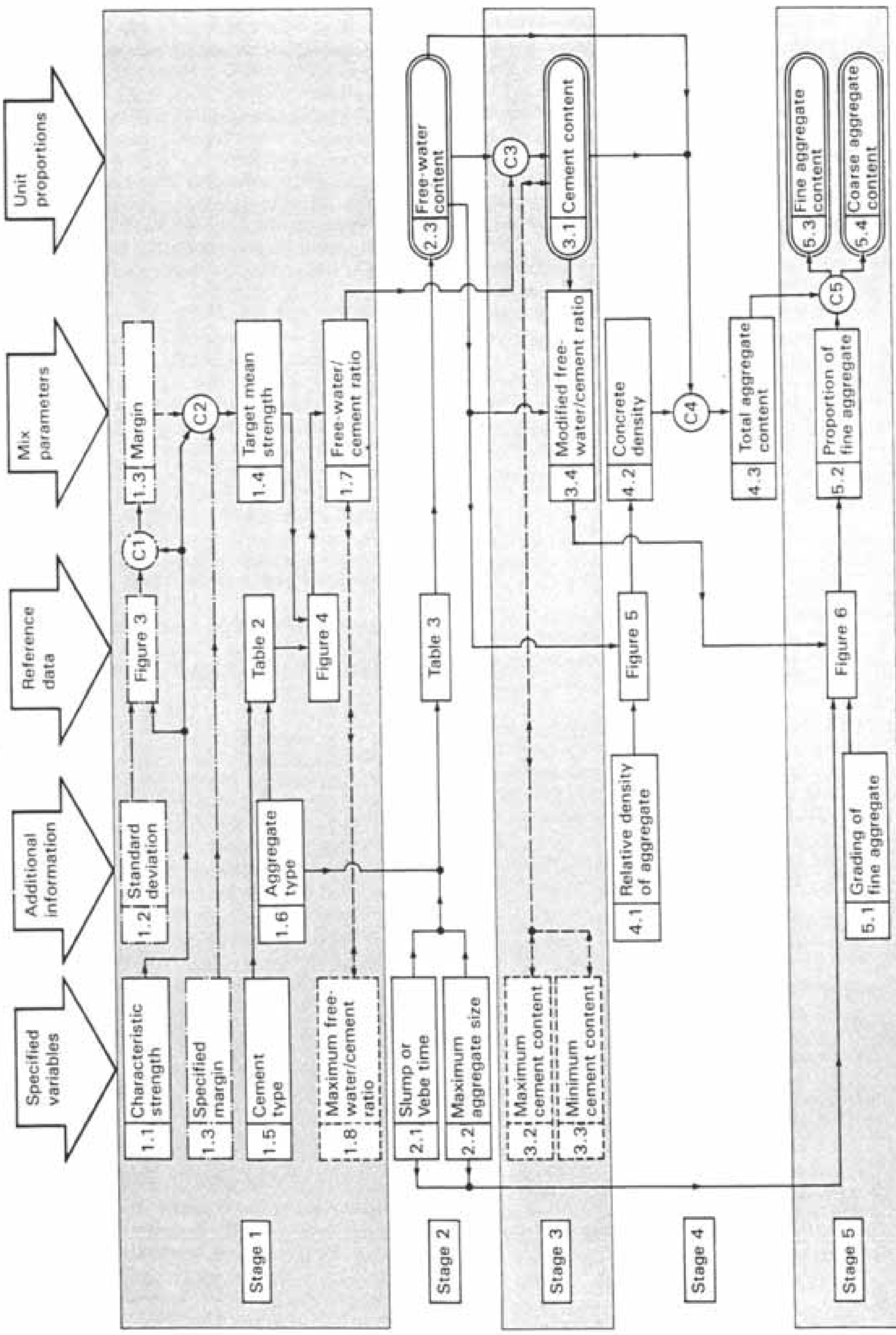

Figure 2 Flow chart of mix design procedure. Items in dashed boxes and with two-way arrows are optional limiting values that may be specified. C = calculation
Items in chain-dotted boxes are alternatives

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	______ } 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.

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

Type of cement	Type of coarse aggregate	Compressive strengths (N/mm^2) 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

$1 N/mm^2 = 1 MN/m^2 = 1 MPa$ (see footnote on earlier page).

Table 3 Approximate free-water contents (kg/m^3) 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:

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

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:

$$\text{Total aggregate content} = D - C - W \qquad \ldots C4$$

(saturated and surface-dry)

where D = the wet density of concrete (kg/m^3)
C = the cement content (kg/m^3)
W = the free-water content (kg/m^3).

*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.

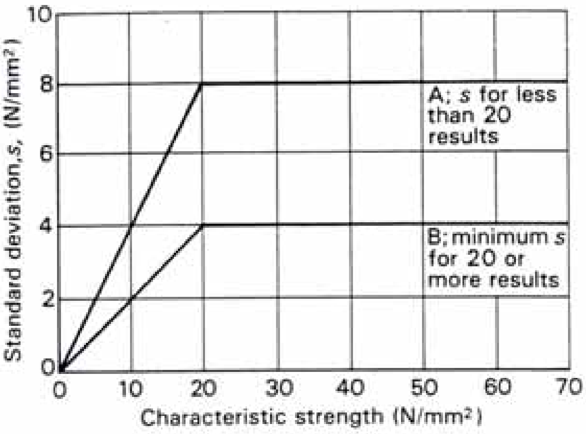

Figure 3 Relationship between standard deviation and characteristic strength

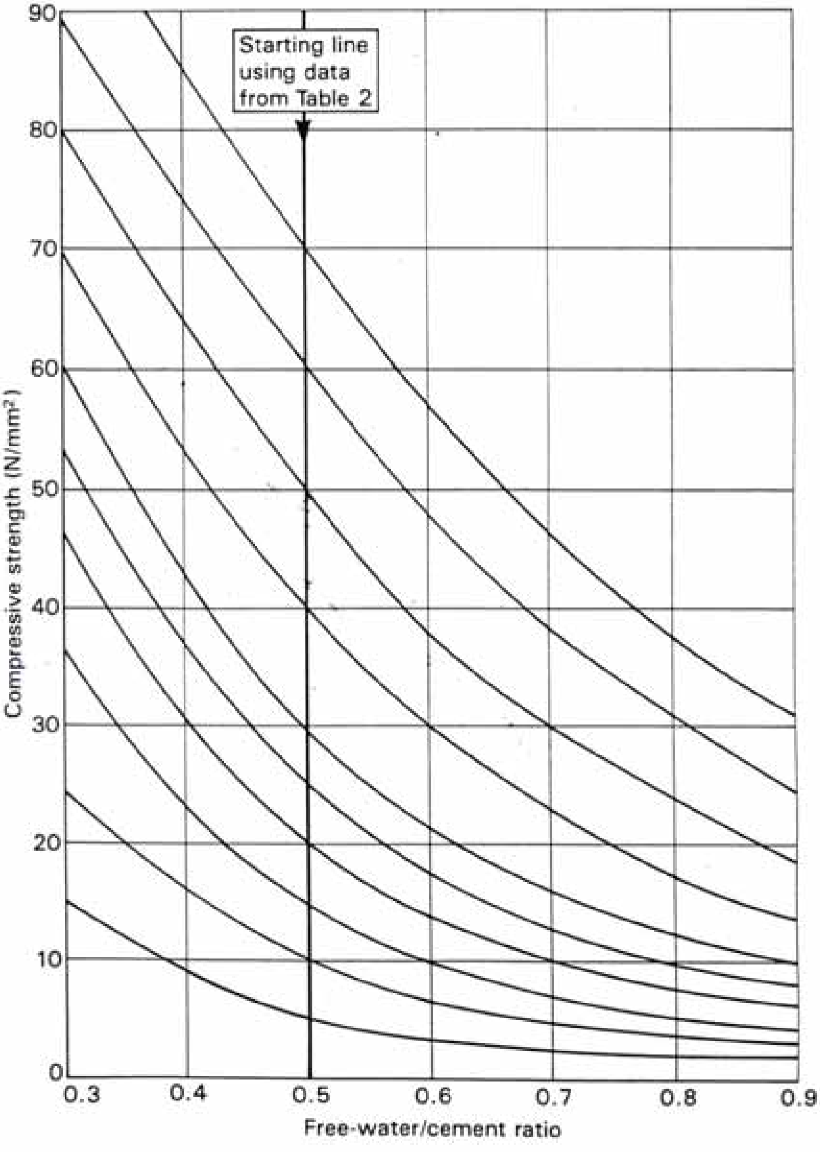

Figure 4 Relationship between compressive strength and free-water/cement ratio

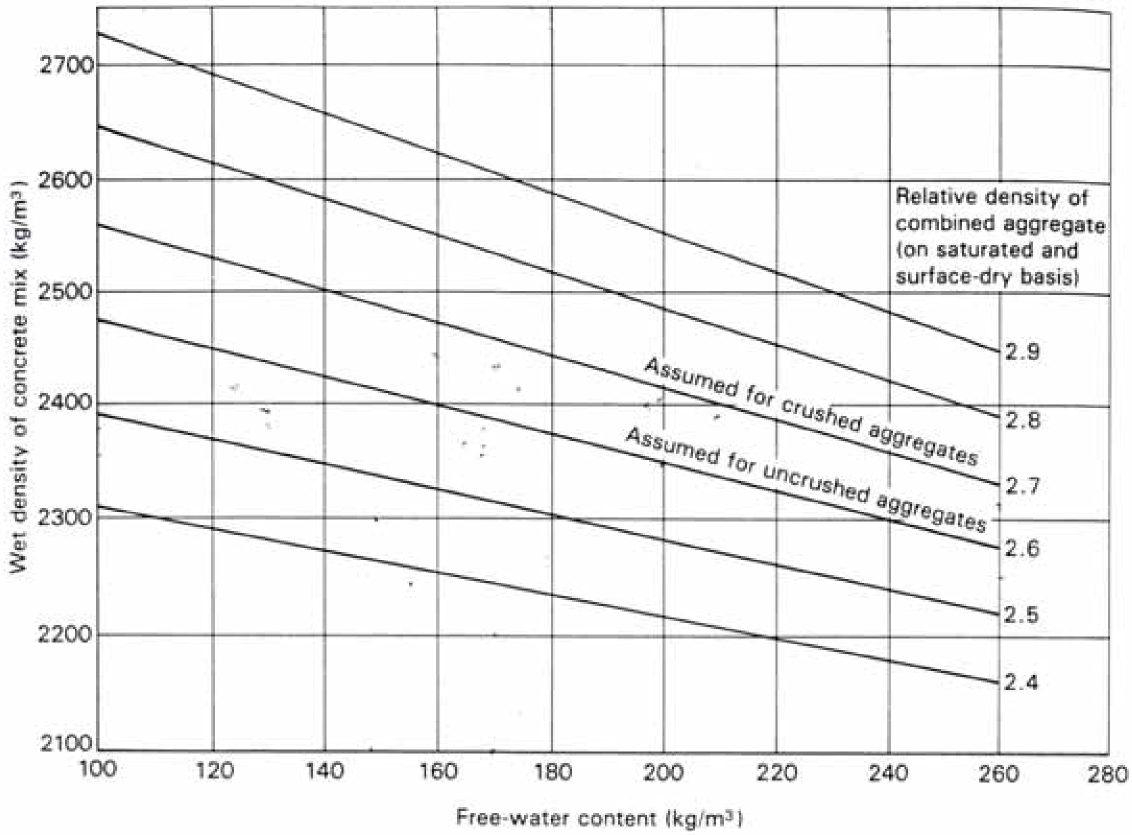

Figure 5 Estimated wet density of fully compacted concrete

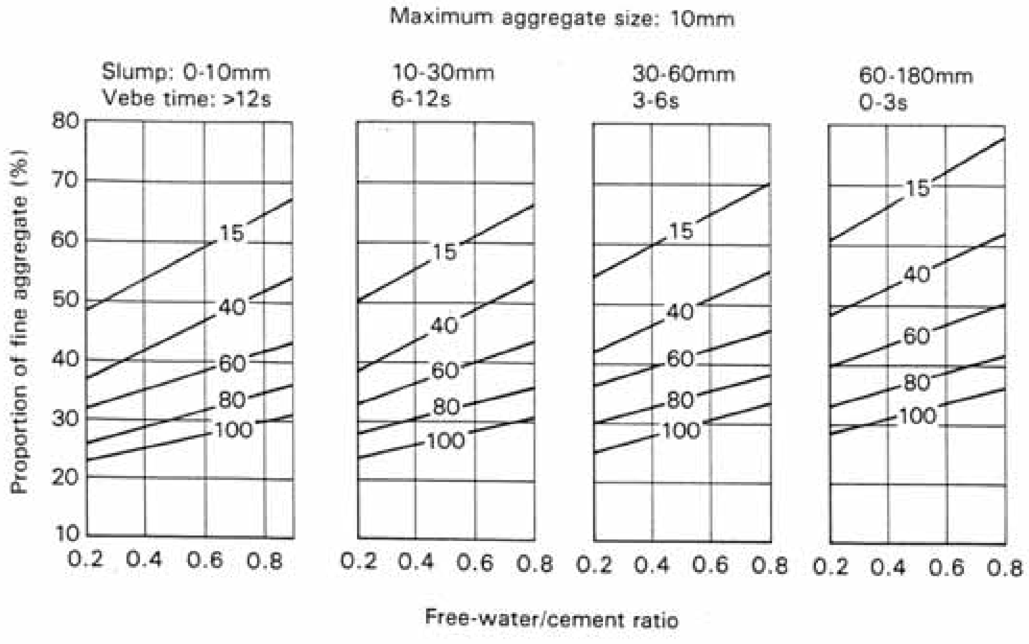

Figure 6 Recommended proportions of fine aggregate according to percentage passing a 600 μm sieve

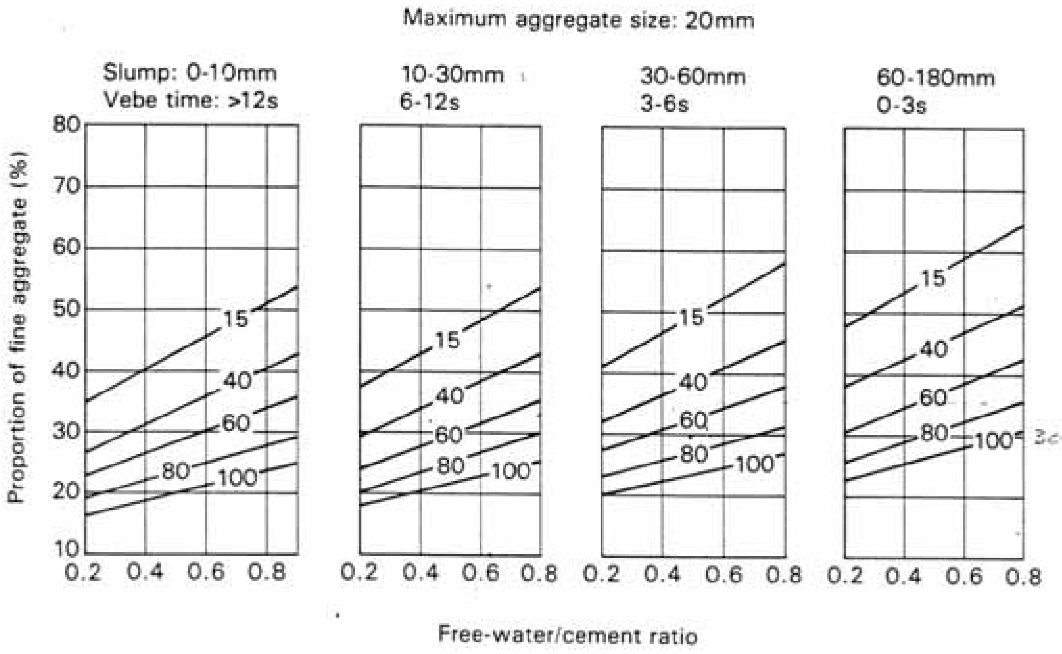

Figure 6 *(continued)*

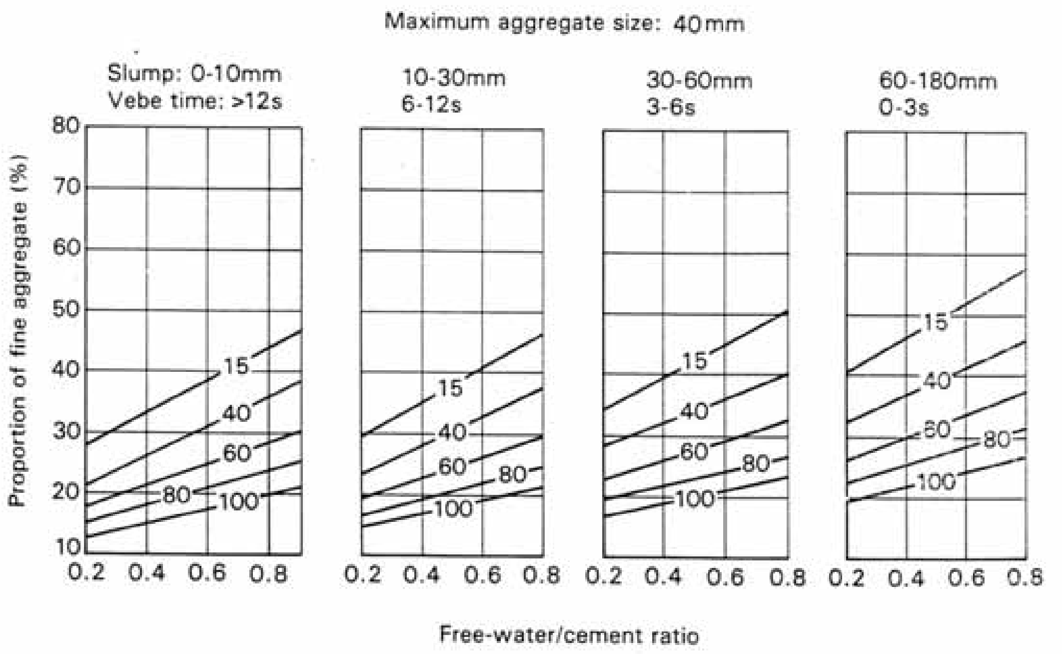

Figure 6 *(continued)*