Appendix B (DOE) Method Form

BS - CONCRETE MIX DESIGN (DOE)

DOE METHOD OF CONCRETE MIX DESIGN: The British method of concrete mix design, popularly referred to as the "DOE method", is used in the United Kingdom and other parts of the world and has a long established record. The method originates from the "Road Note No 4" which was published in Great Britain in 1950. In 1975 the note was replaced by the "Design of Normal Concrete Mixes", published by the British Department of the Environment (DOE). In 1988 the "Design of Normal Concrete Mixes" was issued in a revised and updated edition to allow for changes in various British Standards.

DOE mix design generally involves the following stages.

1. Determine the target strength
2. Determine the water/cement (W/C) ratio according to the target strength, types of cement and aggregate.
3. Determine the water content, W, from required workability, size and type of aggregate.
4. Determine cement content, C, from W/C ratio and water content.
5. Estimate the density of wet fresh concrete, D, based on relative density of combined aggregate and water content.
6. Determine the total aggregate content from D, C, and W.
7. Determine the proportion of fine aggregate according to the fineness of fine aggregate, maximum aggregate size, slump/Vebe time and W/C.
8. Determine coarse aggregate.

Specified Strength and Target Strength For Mix Design

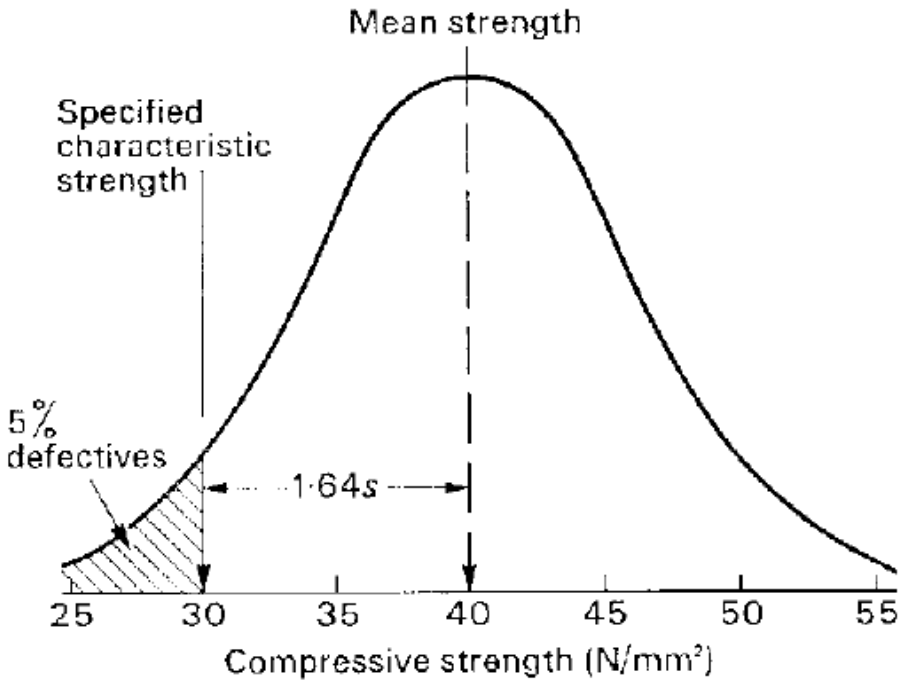
a. Variation and probability of concrete strength finding standard deviation and k values to calculate the margin.

b. Characteristic strength Probability and statistics have been widely adopted in engineering to describe structure failure and material properties. In the old practice, concrete strength is specified using "minimum strength". From the probability theory adopted today, there is always a possibility, however remote, that the strength of concrete falls below a specified strength. Therefore concrete strength is specified in term of "Characteristic Strength". The characteristic strength is the strength below **2** which a specified proportion of test results, often called "defectives", may be expected to fall. The characteristic strength may be defined to have any proportion of defectives, BS 5328 "Concrete" and BS8110 "Structure use of concrete" adopt 5% defectives level for the determination of characteristic strength.

c. **Target strength for mix design**
As a results of variability of concrete it is necessary to design the mix to have a mean strength greater than the specified characteristic strength by an amount termed the **margin**. Thus the **target strength**, fm, is

fm= fc+ ks ……..(3)
where
fc= specified characteristic strength
s = standard deviation
k = constant depending on the defective level associated with the specified strength. ks is termed the margin.

Normal Distribution



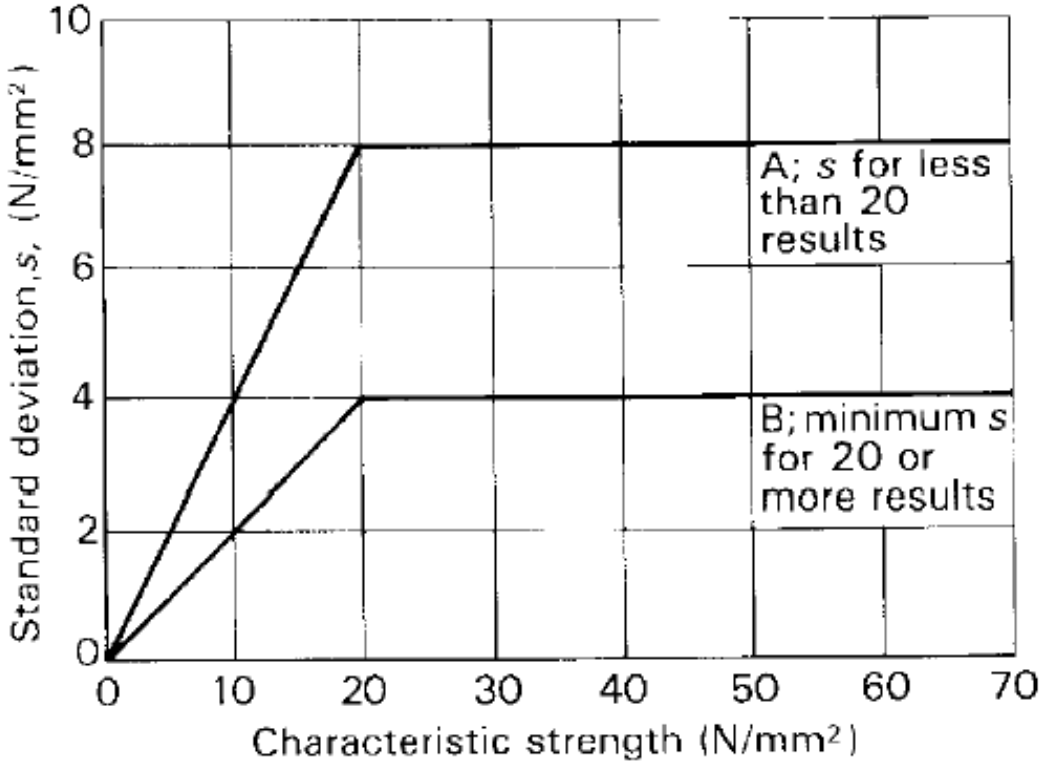
Mean = failure level+ z x standard deviation.

A table of z (or n) values for various values of percentage failures **3**

(Table 1.10.1 in section 1.10 of the notes)

Percentage failure permitted	Z value
16	1.00
10	1.28
5	1.64
2.5	1.96
2	2.05
1	2.33

Figure 3



- **Find w/c by:**

1. Finding strength from table 2 (with w/c =0.5)
2. Using this strength with w/c 0.5 to drew a curve parallel to other curves in the figure 4
3. Intersection of the line that represent target strength with this curve will determine w/c

Table 2 Compressive strength of concrete made with w/c 0.5 as per 1988 British Method

S. No.	*Type of cement*	*Type of coarse aggregate C.A.*	*Compressive cube strength at the age in MPa*			
			3 days	7 days	28 days	91 days
1.	Ordinary portland cement (type I)	Un crushed	18 — 22	27 — 30	40 — 42	48 — 49
2.	Sulphate resisting cement (type V)	Crushed	23 — 27	33 — 36	47 — 49	55 — 56
3.	Rapid hardening portland cement (type III)	Un crushed crushed	25 — 29 30 — 34	34 — 37 40 — 43	46 — 48 53 — 55	53 — 54 60 — 61

Note. Higher value may be adopted

Figure 4

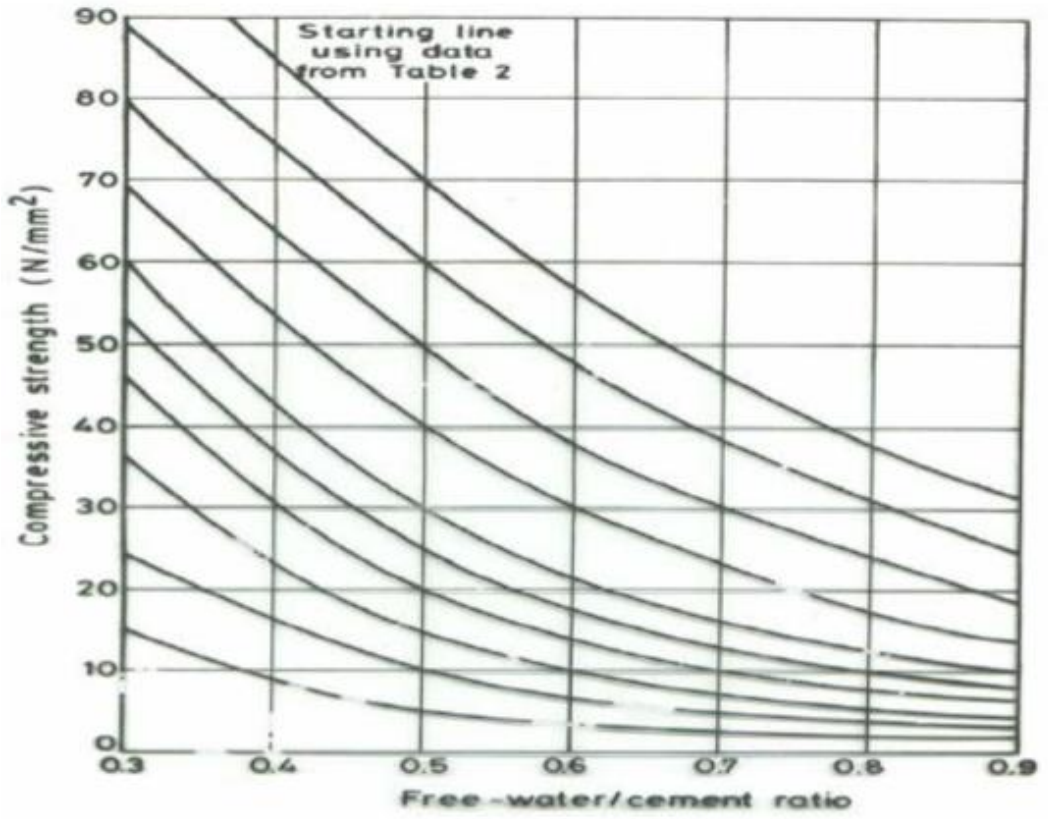


Table 3 Approx water contents (kg/m^3) required to give workability					
Slump (mm)		0-10	10-30	30-60	60-180
Vebe time (s)		more than 12	6-12	3-6	0-3
Maximum aggregate size (mm)	Type of aggregate				
10	Uncrushed	150	180	205	225
	Crushed	180	205	230	250
20	Uncrushed	135	160	180	195
	Crushed	170	190	210	225
40	Uncrushed	115	140	160	175
	Crushed	155	175	190	205

• Calculate total Aggregate content

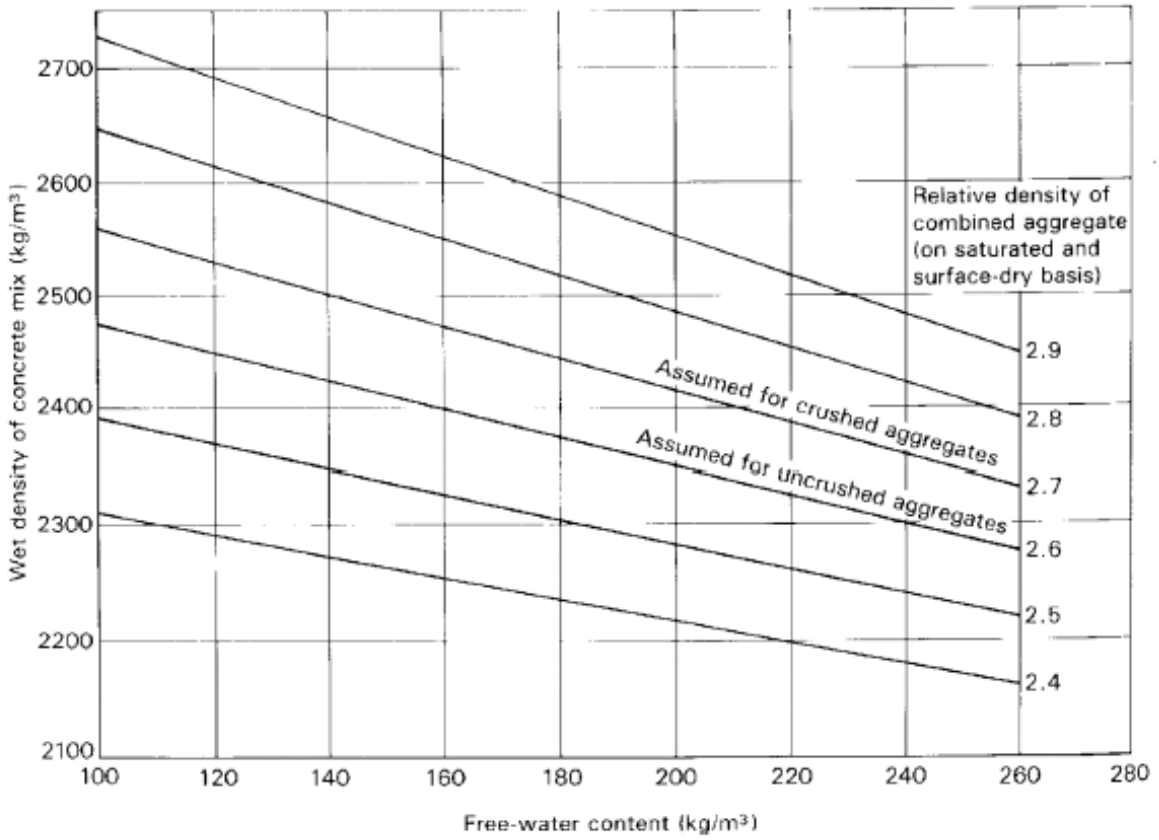
• Total aggregate content = Wet density-C-W

• C: cement content Kg/m3

• W:water content Kg/m3

• Wet density from figure 5 depending on specific weight of aggregate and water content

Figure 5



To find the percent of fine aggregate

• Using figure 6 to find the percent of fine aggregate through knowing :

1. Slump and V-B time
2. Max aggregate size
3. Water to cement ratio w/c
4. By knowing the zone of grading for the aggregate, 2 values would be obtained (take the average)

Figure 6 (10mm)

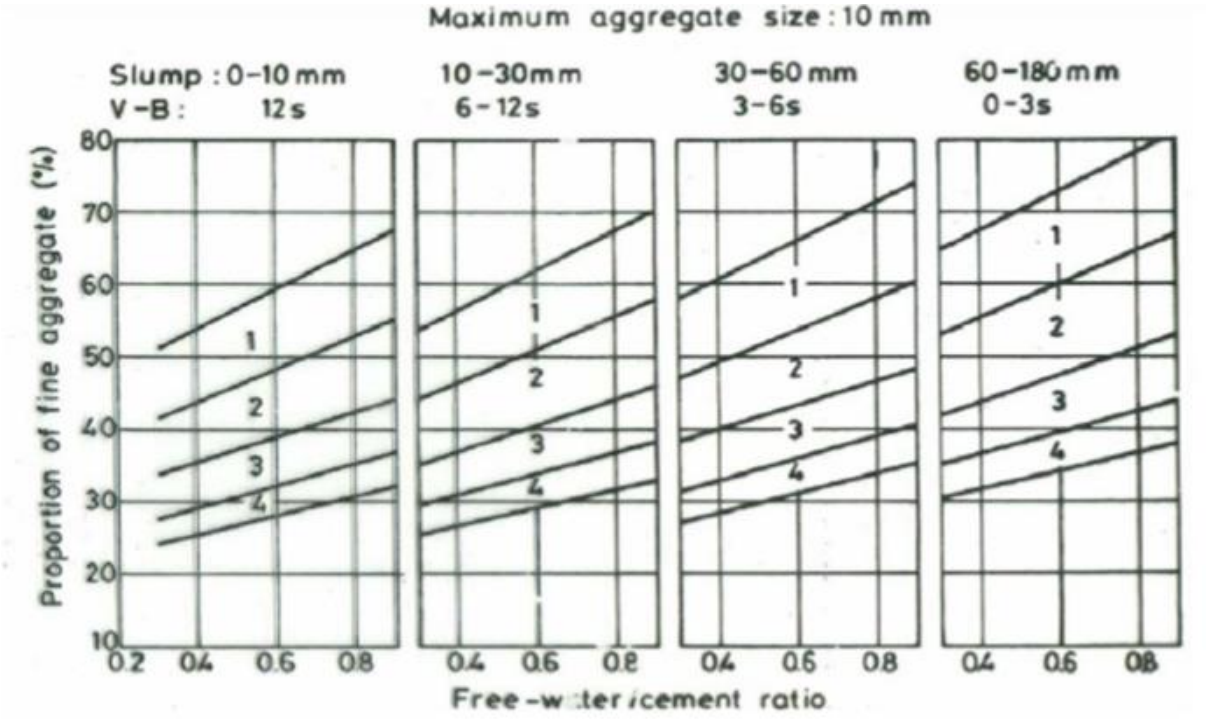
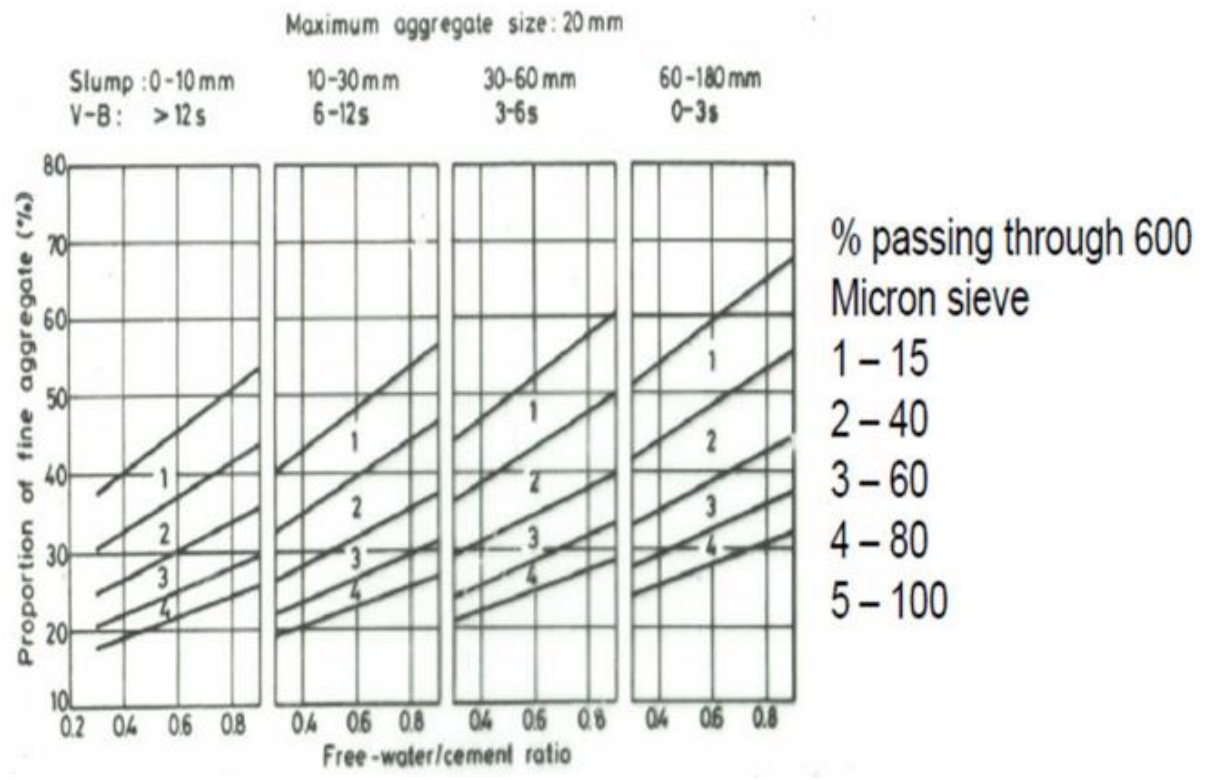
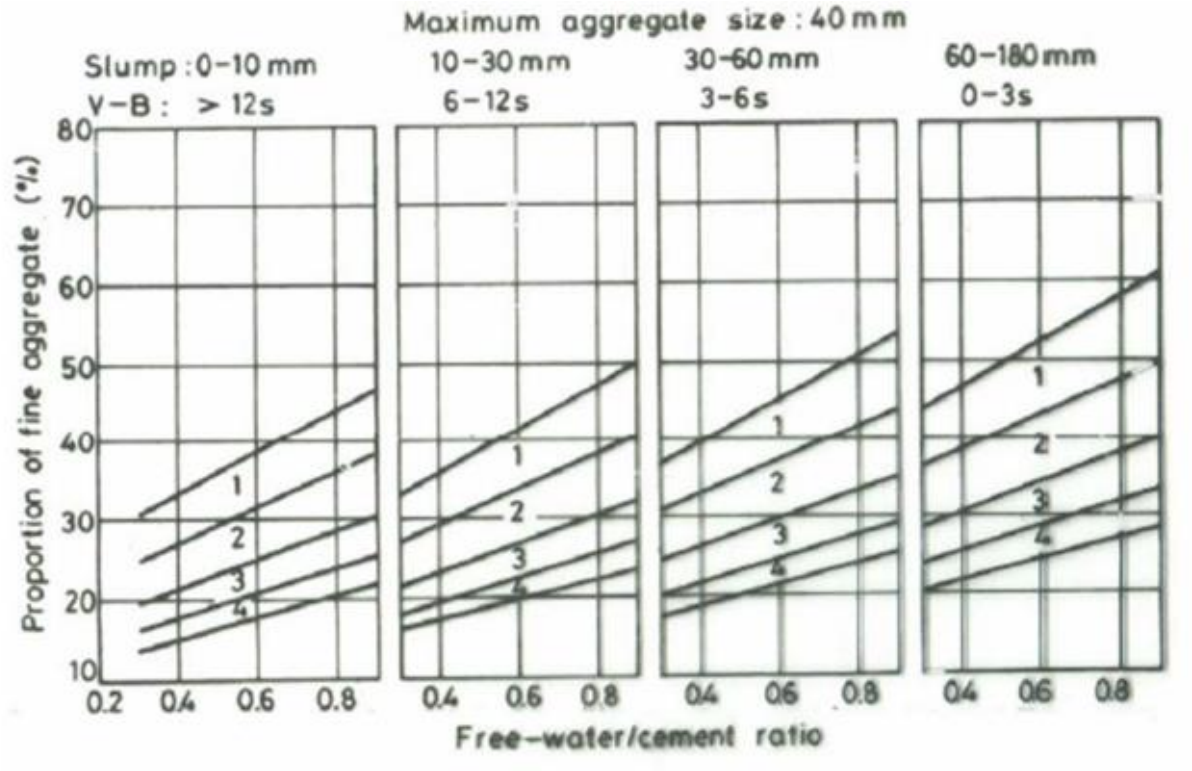


Figure 6 (20mm)





• Calculate Fine Aggregate content

• Fine aggregate content Fagg = pw×(Wagg) kg/m3

• Pw (percent of fine agg.) is determined from graphs

• Cagg= Wagg-Fagg

Material	**Content (Kg/m^3)**
water	
Cement	
Fine aggregate	
Coarse aggregate	
Density	
w/c	
Mix proportions (cement:sand:gravel)	**X:Y:Z**