G x 509

OLLSCOIL na hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY
SECOND SEMESTER EXAMINATIONS, 1999

B.E. DEGREE
HIGHWAYS AND PAVEMENTS
B.E. Degree: Paper 2

Professor A. R. Cusens;
Professor P. E. O'Donoghue;
M. J. Brennan.

Time allowed: two hours.
Answer all questions.

1. (40%)

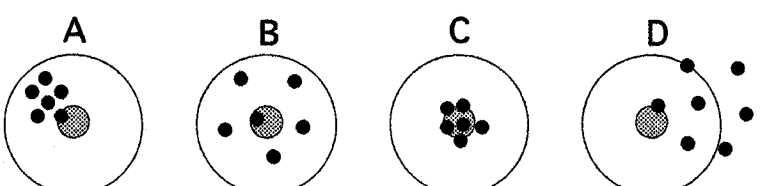
(a) Three stockpiles of aggregate, A, B and C, are available for the production of dense bitumen macadam (DBM). The specification limits for the DBM and the gradings of the stockpiles are given below. By trial and error, determine the optimum combination of the stockpiles that will meet the required specification. In developing your solution, concentrate on the material passing the 3.35 mm and 75 μm sieves and on the material retained on the 10mm sieve.

SIEVE SIZE mm	DBM specification	Aggregate A	Aggregate B	Aggregate C
20	100	100	100	100
14	95-100	100	100	100
10	70-90	12	98	100
6.3	45-65	1.2	49	99
3.35	30-45	1.0	6.5	73.4
1.18	15-30	1.0	3.9	35.3
0.075	3-7	0.8	2.6	11.3

(b) The production tolerances on the 3.35 mm, 1.18 mm and 75 μm sieves of the mixing plant are ±5%, ±2% and ±1%, respectively. Comment of the suitability of your optimum blend.

(c) The relative densities of the aggregates in the stockpiles, A, B and C, are 2.69, 2.65 and 2.72, respectively. The relative density of the bitumen is 1. For a bitumen content of 4.6%, determine the maximum theoretical density of the DBM using your optimum blend of the aggregates.

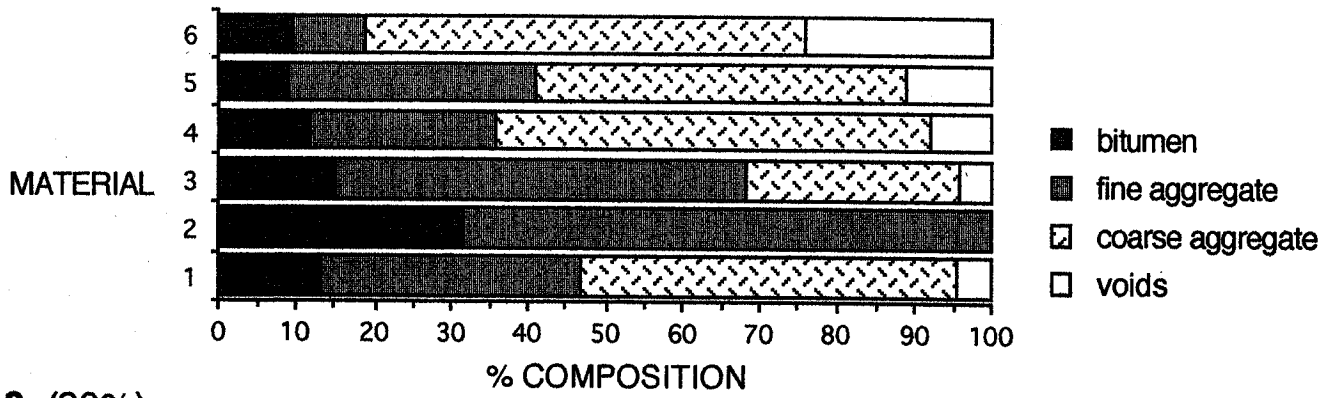
2. (10%)



(a) Of the four rifle range target boards shown above, A, B, C and D, which board represents a result that can be described as precise but not accurate?

(b) The standard deviation of a series of penetration tests is 1.41 dmm. What is the repeatability of the test result?

p.t.o.



3. (20%)

(a) The volumetric compositions of six bituminous materials, namely, mastic asphalt, 14 mm asphaltic concrete, 14 mm dense bitumen macadam, 14 mm porous asphalt, 30/14 hot rolled asphalt and 14 mm grave-émulsion are shown above. Note the number of the material that best represents its volumetric composition. (Note: fine aggregate < 2.36mm sieve.)

(b) Describe how hot rolled asphalt and grave-émulsion are compacted.

4. (10%)

Produce an annotated sketch or a flow diagram showing the main operations at a batch mix plant with a dryer for recycled material.

5. (10%)

The hydrocarbons in bitumen comprise asphaltenes, resins, aromatics and saturates. How do these elements combine to form bitumen? What happens to them during production, laying and finally in service?

6. (10%)

(a) Explain the layout of the Heukelom bitumen test data chart and the purpose for which it is used.

(b) Using this chart, explain the advantages of using polymer-modified bitumen.