UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang 1989/90

Mac/April 1990

REE 425 Rekabentuk Jalan dan Lebuhraya

Masa : (3 Jam)

Sila pastikan bahawa kertas peperiksaan ini mengandungi SEMBILAN muka surat tercetak sebelum anda memulakan peperiksaan ini.

Jawab LIMA soalan sahaja.

1. Rekabentuk geometri jalan raya dibuat dengan merujuk kepada saling tindakan pemandu, kenderaan dan jalan raya. Sebutkan beberapa ciri pemandu dan kenderaan yang mempengaruhi rekabentuk geometri.

(20 Markah)

2. (a) Bezakan maksud istilah laju min ruang dan laju min masa.

(b) Bagaimanakah cara menilai kehubungan di antara keadaan lalulintas dan keselesaan yang dialami oleh seseorang pemandu tatkala memandu di atas jalan raya?

(20 Markah)

3. (a) Huraikan maksud istilah berikut:

(i) Jarak penglihatan berhenti

(ii) Jarak penglihatan memotong

(iii) Jarak penglihatan keputusan

(b) Kenapakah jarak penglihatan yang mencukupi perlu disediakan?

(c) Sebutkan beberapa kekangan keadaan pada rekabentuk geometri yang memerlukan pertimbangan jarak penglihatan.

(20 Markah)

...2/-

4. (a) Dalam rekabentuk pengajaran datar, apakah kriteria yang mengawasi rekabentuk:

(i) jalan lurus

(ii) lengkung bulat

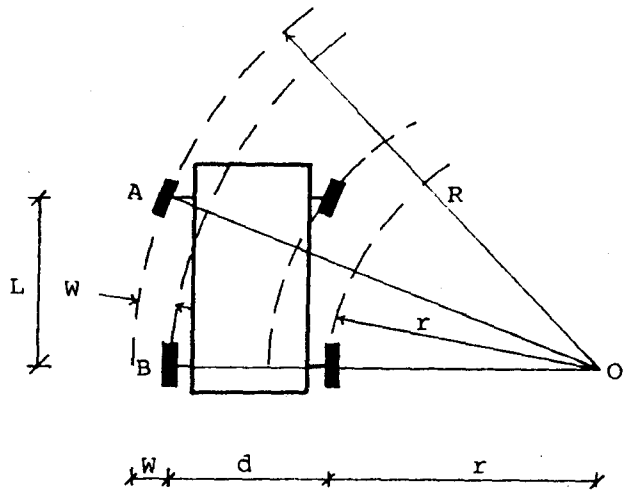
(iii) lengkung peralihan

(b) Kenapakah permukaan turapan perlu dilebarkan pada selekoh?

(c) Berasaskan rajah 1, buktikan bahawa lebar lebih (W) yang diperlukan ialah:

$$W = R - \sqrt{R^2 - L^2}$$

(20 Markah)



Rajah 1

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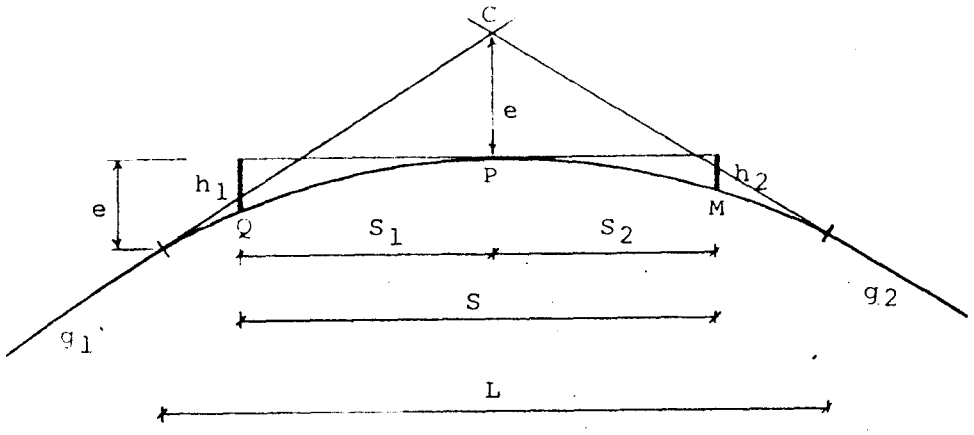
5. (a) Berasaskan rajah 2, buktikan bahawa panjang lengkung tegak yang diperlukan untuk memenuhi kriteria jarak penglihatan ialah:

$$L = \frac{AS^2}{2(\sqrt{h_1} + \sqrt{h_2})^2}$$

(b) Daripada sudut estetika apakah kebaikan wujudnya lengkung peralihan?

(c) Dengan bantuan lakaran, catatkan beberapa prinsip rekabentuk penyaluran.

(20 Markah)



Rajah 2

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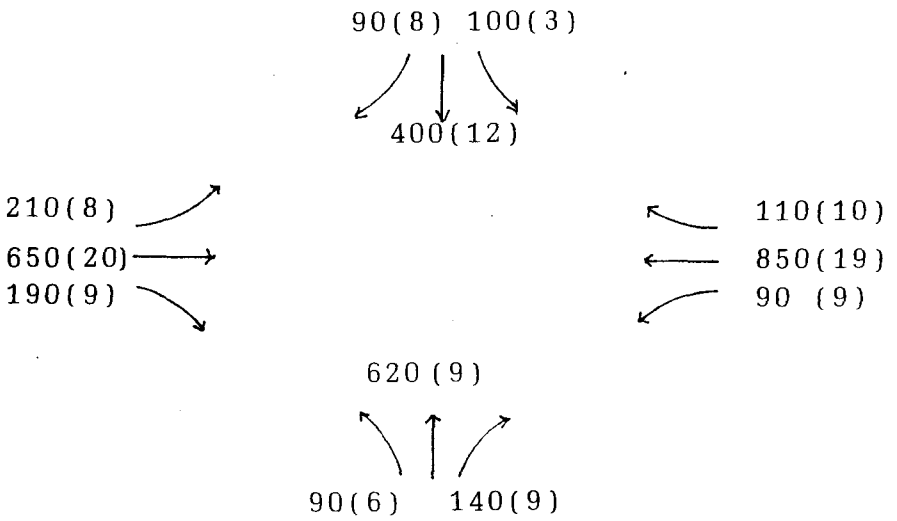
6. (a) Tentukan lebar (w) dan panjang seksyen jalinan (l) sebuah bulatan lazim yang menanggung lalulintas seperti yang ditunjukkan di dalam rajah 3.



Rajah 3

Diberi e_1 = 7.35 m, e_2 = 6.0 m dan $\frac{l}{w}$ = 3.5

(b) Sebutkan beberapa justifikasi pembinaan persilangan bertingkat.

(20 Markah)

7. (a) Bagaimanakah turapan boleh lentur dan turapan tegar menyokong beban tayar?

(b) Senaraikan kebaikan turapan tegar berbanding dengan turapan boleh lentur.

(c) Data berhubung dengan rekabentuk turapan adalah seperti berikut:

Jumlah bertokok gandar piawai = 15×10^6

Nisbah Galas California subgred = 2%

Rekabentuk sebuah turapan tegar.

Gunakan carta dan jadual dari Road Note 29 seperti di dalam Lampiran 1.

(20 Markah)

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6.2 Drainage and weather protection

46 Wherever practicable the water table should be prevented from rising to within 600 mm of the formation level. This may be done by sub-soil drainage, or by raising the formation level by means of an embankment.

It is important to provide efficient permanent drainage to remove water from the subgrade and sub-base, both during construction and during the life of the road. Waterproofing the subgrade or sub-base during construction, e.g. by sealing may also be desirable (Clauses 610, 611). This is dealt with more fully in Road Note No.17 [6]

6.3 Sub-base

47 The minimum thickness of sub-base recommended for the three types of subgrade is given in Table 5. These thicknesses are suitable for roads where no construction traffic is required to use the sub-base.

Where heavy construction vehicles (e.g. loaded trucks) have to be operated over the prepared sub-base laid on 'weak' or 'normal' subgrades, and the designer considers that this will entail a risk of damage, the sub-base should be strengthened. On subgrades with a CBR of 4 per cent or less an additional 150 mm of sub-base is considered sufficient. On other 'normal' subgrades an additional 80 mm should suffice. Type 1 sub-base material (Clause 803), lean concrete (Clause 807) or cement-stabilized material (Clauses 805, 806) will be required for the top 150 mm, unless construction is limited to the summer months when Type 2 sub-base material (Clause 804) may also be used.

Some regulation of the sub-base may be required before the concrete slabs are laid where the sub-base has been used by heavy construction traffic. It may be economical on dual-carriageway roads to confine construction traffic to one carriageway only.

48 No material within 450 mm of the road surface should be susceptible to frost action (see Appendix 1) except as allowed below. When the subgrade is frost susceptible (see para.25), the thickness of the sub-base must be sufficient to give a total thickness of construction over the soil of not less than 450 mm. After the design of the pavement has been prepared this must be checked and, if necessary, the thickness of sub-base increased to give a total pavement thickness of not less than 450 mm.

On roads designed to carry less than 2·0 million standard axles the requirement of a total thickness of 450 mm over frost-susceptible soils may be relaxed where local experience during severe winters has shown this to be permissible.

6.4 Concrete slabs

49 Figure 11 gives the thicknesses required for reinforced and unreinforced concrete slabs in terms of the cumulative number of standard axles to be carried for the three types of subgrade considered in Table 5. The thicknesses are intended to be rounded upwards to the next 10 mm intercept.

50 The designs given in this Note are based on a minimum crushing strength for concrete of 28 MN/m² at 28 days using ordinary Portland cement or Portland blast-furnace cement. If the indirect tensile test is used, an equivalent value should be taken. Air-entrained concrete should be used either for the full depth of the slab or for at least the top 50 mm (Clauses 1001–1004).

51 On residential roads and on similar roads built for light traffic, the pavement may be required to carry comparatively heavy loads associated with the construction of the surrounding development. The possibility of this must be considered at the design stage. With unreinforced concrete, if the road will be required to carry the construction traffic for 100 or more houses or buildings of equivalent accommodation, the alternative design thicknesses shown in Fig.11 should be used. These alternative designs should also be used for factory roads required to carry the construction traffic for large factory development schemes.

6.5 Reinforcement

52 For reinforced concrete the minimum weight of reinforcement required in relation to the cumulative number of standard axles to be carried is given in Fig.12 in terms of weight of long mesh reinforcement and area of steel per unit width of pavement. Reinforcement fabric should be in accordance with BS 4483. Deformed bar reinforcement should be in accordance with BS 4449 or BS 4461. The reinforcement should have 60 mm cover from the surface except for slabs less than 150 mm thick where 50 mm cover should be provided. The reinforcement should terminate at least 40 mm and not more than 80 mm from the edge of the slab and from all joints except longitudinal joints covered by para.53.

At the transverse overlap of reinforcing mats the first transverse wire of one mat should lie within the last complete mesh of the previous mat and the overlap should be not less than 450 mm. No overlap will be needed longitudinally between mats. When deformed bar reinforcement is used the overlap of the bars should not be less than 40 bar diameters.

53 Where a two- or three-lane carriageway width is constructed in one operation, reinforcing mats having transverse wires of 8 mm diameter at 200 mm centres may be used to span the longitudinal joints in place of tie bars (para.65). The longitudinal reinforcement in all mats should be as required by para.52. The 8 mm wires must be long enough to span at least 500 mm either side of the longitudinal joints (para.56).

54 Where a three-lane carriageway is constructed in two widths, transverse reinforcement, consisting of 8 mm diameter wires at 200 mm centres, which may be incorporated in special mats, should be used in slabs wider than 4·5 m. The length of this transverse reinforcement should be 600 mm longer than a third of the slab width and should be placed centrally.

Table 5 **Classification of subgrades for concrete roads and minimum thicknesses of sub-base required**

Type of subgrade	*Definition*	*Minimum thickness of sub-base required*
Weak	All subgrades of CBR value 2 per cent or less as defined in Table 3	150 mm
Normal	Subgrades other than those defined by the other categories	80 mm
Very stable	All subgrades of CBR value 15 per cent or more as defined in Table 3 This category includes undisturbed foundations of old roads	0

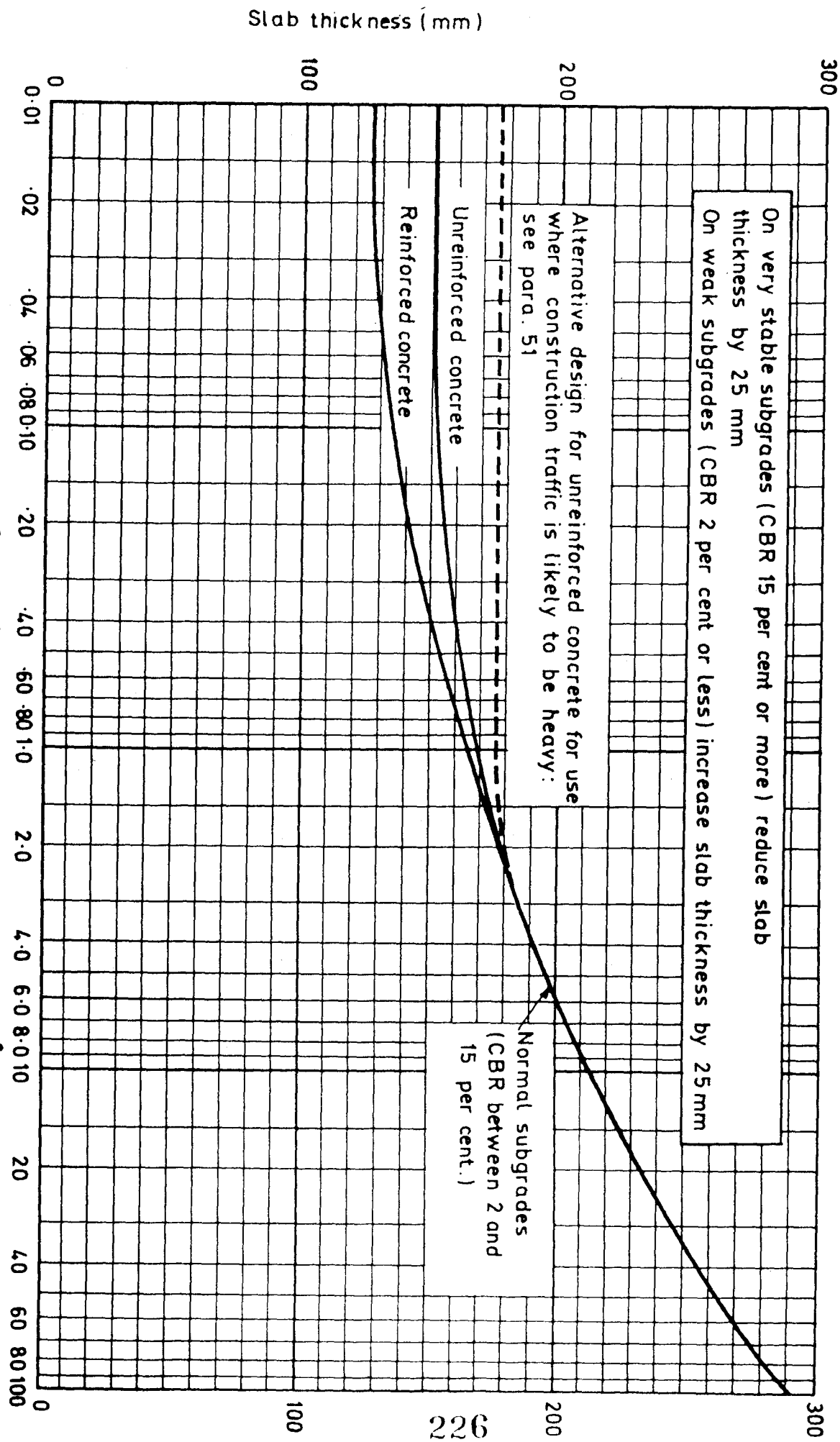

Figure 11 **Concrete: minimum thickness of slabs**

Concrete slabs

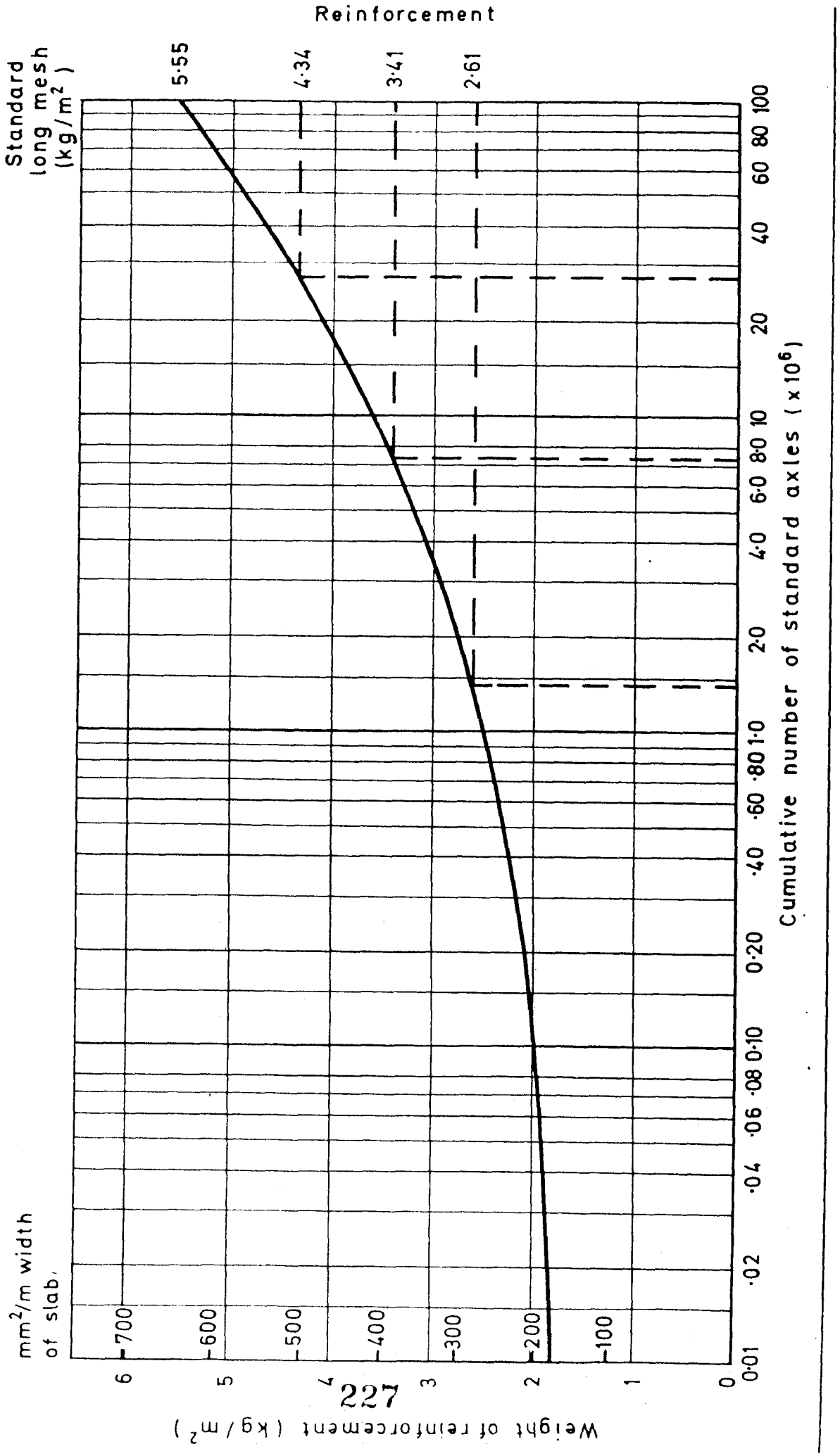

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Figure 12 **Reinforcement: minimum weight for concrete slabs**

Figure 13 **Maximum spacing of joints for reinforced concrete slabs**