

SECTION 35 –DESIGN OF RIGID PAVEMENTS

0716. The CBR design curves given in Figure 7.3 can be used to assess the total thickness of concrete pavement and granular sub-base appropriate to a particular sub grade but they will often give an uneconomical result.

0717. It is sometimes considered that 1 inch of concrete is equivalent to 2 inches of flexible pavement, but this generalization should be treated with caution.

0718. For deliberate construction full calculation is advisable, to check the stresses set up in the slab. Such calculations are not dealt with in this publication, but recommended thicknesses for long-term military roads are given in Table 23.1.

Hasty Estimate of Pavement Thickness

0719. For hasty work, Table 7.2 provides a guide to pavement thickness. The results are sufficiently accurate for most temporary and semi-permanent road construction tasks. For simplicity, commonly available construction materials have been grouped in two grades as follows:

- a. Grade 1 - Stabilised soils
- b. Well-graded crushed rock
- c. Well-graded gravels or gravel/sand mixtures with clay binders.
- d. Grade 2 - Crushed hardcore other gravelly soils.

TABLE 7.2 PAVEMENT THICKNESS-HASTY ESTIMATE

Serial	Subgrade soil	Grade and thickness of construction material in mm		
		(c)	(d)	(e)
(a)	(b)	(c)	(d)	(e)
1	Clay	250	350	400
2	Sand	150	180	200
3	Chalk	100	125	150
4	Gravel	100	125	150
5	Well-graded gravel-sand mixtures with clay binder	Nil	Nil	Nil

Calculation of Pavement Thickness

0720. The strength of a soil is expressed as a California Bearing Ratio (CBR) value. This value is the most important factor in determining pavement thickness.

RESTRICTED

0721. Military engineers are likely to establish the CBR value of a sub grade in two ways:

- a. By measurement, using the Cone Penetrometer (see Annex A)
- b. By estimate, based on field identification and classification of the soil in accordance with the British Soil Classification System.

These methods are further explained in Military Engineering Volume IV, Soil and Construction Materials. Of the two methods, that employing the cone penetrometer can provide a fairly accurate CBR value from 0 to 15%. An estimate based on field identification and classification of the soil provides an approximate CBR value, the accuracy of which depends upon the experience and judgment of the individual responsible for classifying the soil.

0722. Knowing the CBR value of the sub grade and the load classification of the critical user vehicles, the combat engineer can calculate the thickness of pavement required.

0723. Table 7.3 shows the pavement thickness required for flexible pavement. The table can be used to determine:

- a. The total thickness of pavement required on top of a sub grade.
- b. The thickness of each layer of material when more than one type of material is used. The thickness depends on the CBR value of the material in the layer and that of the material underlying it, subject to the minimum requirements detailed in Paragraph 160.

RESTRICTED

TABLE 7.3 DESIGN OF FLEXIBLE PAVEMENTS FOR SHORT TERM ROADS

Ser	Load class of vehicle	Pavment thickness - mm												
		California Bearing Ratio (OBR)												
		3	4	5	6	7	10	12	15	20	25	30	40	41
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
1	4	300	260	230	210	180	160	140	125	105	100	100	100	Minimum depth 100 mm for material>50% CBR
2	8	395	330	300	270	235	210	190	170	140	120	105	100	
3	12	460	385	345	310	270	235	220	190	160	135	120	100	
4	16	490	420	375	335	285	255	230	205	175	150	150	150	Minimum depth 150 mm for material>50% CBR
5	20	515	440	390	350	300	265	240	215	185	155	150	150	
6	24	535	455	405	365	310	270	245	220	190	160	150	150	
7	30	565	480	525	380	320	280	260	230	195	165	150	150	
8	35	595	505	450	400	340	290	270	240	200	175	150	150	

RESTRICTED

0724. For hasty construction, the total thickness of pavement may be reduced to 65% of the value obtained from Table 7.3, subject to complying with Paragraph 160.

0725. For all pavement designs there are minimum CBR values and minimum compacted thicknesses to be observed:

a. Up to MLC 16. The base course, or the upper course where two or more such courses are used, must have a minimum CBR value of 45% and a minimum compacted thickness of 100 mm.

b. MLC 16 to MLC 35. Courses as in Sub-paragraph 160a must have a minimum CBR value of 50% and a minimum compacted thickness of 150 mm.

c. Over MLC 35. For pavement designs over MLC 35, a useful guide is Pettier's formula:

$$t = \frac{1000 + 1500 \sqrt{P}}{I + 5}$$

Where t = thickness (mm)

P = maximum load (tonnes)

I = CBR of subgrade

This formula is less reliable for very low CBRs encountered in high rainfall areas as it tends to overestimate the thickness required.

0726. Unless a metalled road is required for only a very short period, a bituminous surfacing layer, eg surface dressing or grouting, should be superimposed to keep out water and resist abrasion by traffic (see Paragraph 0417).

0727. Example.

a. Requirement. An all-weather road diversion capable of taking MLC 35 traffic is required as soon as possible. The CBR value of the subgrade, measured by a cone penetrometer, has been consistent at 8%. Two sources of construction materials are available, a good sandy soil (CBR 25) near the site and crusher-run stone (CBR 80) from a quarry 13 km away. Transport is limited and therefore full use must be made of material near the site.

b. Solution

- (1) Because transport is limited, a two-layer construction is indicated.
- (2) From Table 7.3, a MLC 35 vehicle and a CBR 8 subgrade require a total pavement thickness of 340 mm.
- (3) The thickness of the upper layer, when placed upon material of CBR 25 (the sand), for a MLC 35 vehicle needs to be 175 mm.
- (4) The thickness of the lower layer is therefore $340 - 175 = 165$ mm.
- (5) For hasty construction, these Figures may be reduced (see Paragraph 159). For the upper layer, 65% of 175 mm is 115mm, but this Figure is below the permissible minimum specified in Paragraph 160.
- (6) The final dimensions are therefore:
 Total thickness = 65% of 340 = 220 mm. Upper layer (CBR 80), minimum 150 mm. Lower layer (CBR 25), $220 - 150 = 70$ mm.

0728. Accuracy. The foregoing clearly indicates that much depends upon the skill of the engineer in determining the nature and strength of the soil: the more accurate the soil classification, the more accurate the pavement design.