## SECTION 77: DESIGN OF FLEXIBLE PAVEMENT

Flexible Pavement Design Procedures

1615. Compared with many other engineering design procedures, the design of flexible pavements remains in the developing stage. The main factors involved in pavement design are:

a. Vehicle Characteristics.

(1) Wheel loading.

(2) Wheel configuration.

(3) Number of axles.

(4) Tyre pressures.

(5) Speed (stresses on the pavement increase at low speeds).

b. Pavement Characteristics:

(1) Thickness and quality of materials.

(2) Edge loading (due to lateral positioning of vehicles on the road).

(3) Material fatigue (due to vehicle load repetition).

(4) Temperature behaviour.

1617. Design procedures have developed mainly in two directions:

a. Procedures based on theoretical and laboratory analyses of the static and dynamic stresses induced by traffic.

b. Construction and observation of experimental test roads over a number of years.

With so many factors involved, some conflicting and the effects of some not yet well understood, it is perhaps not surprising that the purely theoretical procedures have not yet proved very successful. Reliance still has to be placed mainly on empirical design procedures derived from existing pavement performance results.

Methods of Design

1618. Methods of design are described in detail in references such as Highways by C A O'Flaherty and Design and Performance of Road Pavements by D Croney. Methods can be summarised as follows:

a. Methods based on Precedent. Methods based on precedent are really design procedures by rule of thumb, laying down standard thicknesses of pavement for particular types of road. They have the disadvantage of specifying possibly weak pavements on weak subgrades and unnecessarily thick pavements on strong subgrades.

b. Empirical Methods. Empirical methods using the dispersion angle for load distribution assume that the wheel load is distributed at a fixed angle downwards. The thickness of pavement necessary to prevent overstress of the subgrade is based on assumption. One such method is the Massachusetts formula, and the Load Classification Number (LCN) method for design of airfield pavements (see Military Engineering Volume XIX RE Support for Air Operations) is another example.

c. Empirical Methods using Soil Classification Tests. Empirical methods using soil classification tests depend mainly on formulae incorporating the particle analysis, liquid limit and plasticity index of the soil involved. They are based on previous experience of the thickness required for various wheel loads on different types of soil. Such methods include the Group Index Method and the Michigan Pedological Method.

d. Empirical Methods using a Soil Strength Test. Empirical methods using a soil strength test normally use particular forms of penetrations or bearing tests. The results of these determine the necessary pavement thickness, based on past experience or test road results. Such methods include the California Bearing Ratio (CBR), the British Design Procedure and the Stabilometer method.

e. Methods based primarily on Theory. The methods are based on completely theoretical analyses of the stresses and strains within the pavement and subgrade combined usually with certain arbitrary assumptions.

f. Mechanistic Methods. Mechanistic methods were traditionally used for the design of rigid pavements but are now more commonly used for the design of flexible pavements. They use the same design principles for a road as for any other structure:

(1) Specify the loading.

(2) Estimate the size of component.

(3) Consider the materials available.

(4) Carry out structural analysis using theoretical principles.

(5) Compare critical stresses, strains or deflections with allowable values.

(6) Make adjustments to material or geometry until satisfactory results are achieved.

(7) Evaluate the economic feasibility of the results.

## Calculation of Pavement Thickness

1619. The design of roads in forward areas is based on:

a. The CBR value of the subgrade (see Section 77).

b. The maximum single wheel load to which the pavement will be subjected.

1620. The road is normally required to take vehicles up to a particular load classification. The relationship between load class and maximum single wheel load is given in Table 16.1.

**TABLE 16.1 LOAD CLASSES AND MAXIMUM SINGLE WHEEL LOADS**

| Serial | Load class of vehicle | Maximum single wheel load (kg) |
|---|---|---|
| (a) | (b) | (c) |
| 1 | 4 | 1,135 |
| 2 | 8 | 2,495 |
| 3 | 12 | 3,625 |
| 4 | 16 | 4,535 |
| 5 | 20 | 4,990 |
| 6 | 24 | 5,440 |
| 7 | 30 | 6,120 |
| 8 | 35 | 6,800 |
| 9 | 40 | 7,710 |
| 10 | 50 - 120 | 9,070 |
| 11 | 150 | 9,525 |

1621. For hasty construction in forward areas, the total thickness of pavement may be reduced to 65% of the value obtained from the design curves (see Paragraph 0748). There are, however, minimum CBR values and minimum compacted thicknesses that must be observed:

a. Up to Class 16 or 4,535 kg Wheel Load. A single course base, 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. Class 16 to Class 35 or 6,800 kg Wheel Load. Courses as in Sub-paragraph 0744a must have a minimum CBR value of 50% and a minimum compacted thickness of 150 mm.

1622. Unless a metalled road is required for only a very short period, a bitumen surfacing layer, eg surface dressing or grouting, should be superimposed to keep out water and resist abrasion by traffic.