determined from the method given in Section 4.4. The constrained modulus D is $\Delta\sigma/0.435CR$, or approximately $\gamma H/2CR$. The compression ratio CR or compression index C_c may be estimated from Table 4.4. The settlement during construction is computed from Eq. 4.14.

With increasing age and height, a landfill's rate of settlement from self-weight decreases. The anaerobic environment at greater depths will reduce the rate of decomposition. In fact, the rate of settlement may eventually become constant once a landfill thickness of about 100 ft (30 m) is reached (Yen and Scanlon, 1975).

4.7.3 Landfill Primary Compression

A typical time–settlement curve for a refuse landfill under an applied load was shown in Figure 4.3. Initially, the settlement occurs rapidly as in primary consolidation, and then it tapers off as in secondary compression. The settlement from primary compression may be computed using Eq. 4.14 or Eq. 4.17. Various parameters for municipal landfill materials are given in Table 4.4.

Since the refuse is not always saturated, the early part of the settlement is denoted as primary compression, not consolidation; consolidation implies full saturation and dissipation of excess pore water pressure. Sowers (1973) stated that this settlement usually occurs in less than a month. The field measured data at several locations from Sheurs and Khera (1980) show that about 70 to 80% of the settlement took place within the first three months. The value of c_v ranged between 0.15 ft^2/day and 5 ft^2/day.

4.7.4 Landfill Secondary Compression

As previously noted, the settlement of a landfill continues after the primary compression (Figure 4.3). The long-term settlement appears to be linear on a log–time scale and can be determined by Eq. 4.33. The average value of C'_α is 0.2, with upper and lower limits of 0.32 and 0.13, respectively. After about 10 years, C'_α reaches a constant value of 0.01 to 0.02. Where soil contents are high, C'_α drops to <0.01.

If the conditions for biological decomposition and chemical reactions are favorable, the rate of secondary compression will be high. To estimate settlement contribution of a landfill from biodegradation, Stulgis et al. (1995) determined the total volatile solids (TVS) as a percentage of dry weight of total solids for a landfill and the amount of lignin in TVS. The proportion of biodegradable matter was obtained by subtracting the relative amount of lignin that is nonbiodegradable from the TVS. The computed amount of strain from biodegradation was estimated to be consistent with C'_α values based on test fill settlement data.

The mass of the total volatile solids minus lignin can be used to establish an upper bound on decomposition settlement. At initial placement, the TVS of municipal refuse is about 78% of the dry weight of the refuse and lignin is about 15% (Barlaz and Ham, 1993). Assuming the total difference is converted to gas, a column of fresh refuse will shrink by about 63%. The assumption is