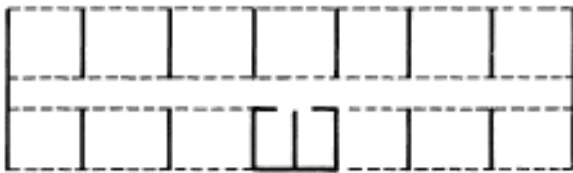


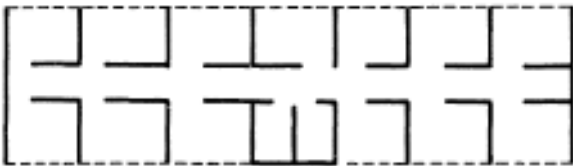
Elevation



(a) Cross-walls without longitudinal walls: unstable



(b) Cross-walls with service shaft: normally stable but vulnerable to accidental damage



(c) Cross-walls with longitudinal walls and service shaft: robust construction

————— Structural walls
----- Non-structural walls

Fig. 1.2 Liability of a simple cross-wall structure to accidental damage.

1.3 STRUCTURAL SAFETY: LIMIT STATE DESIGN

The objective of ensuring a fundamentally stable or robust building, as discussed in section 1.2, is an aspect of structural safety. The measures adopted in pursuit of this objective are to a large extent qualitative and conceptual whereas the method of ensuring satisfactory structural performance in resisting service loads is dealt with in a more quantitative manner, essentially by trying to relate estimates of these loads with estimates of material strength and rigidity.

The basic aim of structural design is to ensure that a structure should fulfil its intended function throughout its lifetime without excessive deflection, cracking or collapse. The engineer is expected to meet this aim with due regard to economy and durability. It is recognized, however, that it is not possible to design structures which will meet these requirements in all conceivable circumstances, at least within the limits of financial feasibility. For example, it is not expected that normally designed structures will be capable of resisting conceivable but improbable accidents which would result in catastrophic damage, such as impact of a large aircraft. It is, on the other hand, accepted that there is uncertainty in the estimation of service loads on structures, that the strength of construction materials is variable, and that the means of relating loads to strength are at best approximations. It is possible that an unfavourable combination of these circumstances could result in structural failure; design procedures should, therefore, ensure that the probability of such a failure is acceptably small.

The question then arises as to what probability of failure is 'acceptably small'. Investigation of accident statistics suggests that, in the context of buildings, a one-in-a-million chance of failure leading to a fatality will be, if not explicitly acceptable to the public, at least such as to give rise to little concern. In recent years, therefore, structural design has aimed, indirectly, to provide levels of safety consistent with a probability of failure of this order.

Consideration of levels of safety in structural design is a recent development and has been applied through the concept of 'limit state' design. The definition of a limit state is that a structure becomes unfit for its intended purpose when it reaches that particular condition. A limit state may be one of complete failure (ultimate limit state) or it may define a condition of excessive deflection or cracking (serviceability limit state). The advantage of this approach is that it permits the definition of direct criteria for strength and serviceability taking into account the uncertainties of loading, strength and structural analysis as well as questions such as the consequences of failure.

The essential principles of limit state design may be summarized as follows. Considering the ultimate limit state of a particular structure, for