SECTION 2

PERMANENT CONTROLS

To deal efficiently with a recurring problem of river flooding it is important to identify firstly the cause of the problem. Doing so aids understanding and evaluation of the potential severity of river flooding, especially with regard to flood plain occupation. Having assessed the flood hazard, assuming that this is possible, it is then feasible to make rational analyses and decisions on how best the effects of potentially disastrous river floods can be ameliorated through a system of permanent controls or restrictions imposed upon the use of land and property.

FLOOD HAZARD

2.1 The dangers of flood waters are associated with a number of different criteria, not necessarily independent of each other, but creating different types of clearly recognizable hazards. A summary of the criteria and related hazards is given below.

(a) Depth of water - Building stability against flotation and foundation failures, (Fig. 2.1) flood proofing, and vegetation survival, have different degrees of tolerance to inundation. In each case these can usually be identified and depth hazard established.

(b) Duration - Time of inundation is of utmost importance since damage or degree of damage is often related to it. This applies to structural safety, the effect of interruption in communications, industrial activity and public services, and the life of plants.

(c) Velocity - High velocities of flow create high erosive forces and hydrodynamic pressures. These features often result in complete or partial failure of structures by creating instability or destroying foundation support. (Fig. 2.2) Dangerously high velocities can occur on the flood plains as well as in the main river channel.

(d) Rate of rise - The importance of rate of rise of river level and discharge is in its relation to the time available for giving flood warnings or making arrangements for evacuation and flood fighting arrangements. Rate of rise can therefore influence planning permission for flood plain occupation and its zoning.

(e) Frequency of occurrence - Total potential damage in a flood plain relates to the cumulative effect of depth, duration and velocity hazards measured over a long period of time. This will very often, but not exclusively, influence decisions on planning permission, especially if the hazard can be measured in quantitative terms. Cumulative frequency of occurrence of the various hazards is therefore a major factor in the development of land use. It is a factor that farming communities throughout the world have always taken into account, usually on the basis of experience and intuitive reasoning, in deciding the type and intensity of agricultural or livestock farming to employ in regions susceptible to floods.

(f) Seasonality - Inundation of land during a growing season can have a completely destructive effect on agricultural production, as severe in fact as a prolonged drought. Discomfiture and general subsistence levels of affected communities are also considerably influenced if flood waters occur during cold weather and if they derive predominantly from snowmelt with possible ice flows. Seasonality in large floods is therefore an important influence on severity of flood hazard.

Flood Estimation

2.1.1 As a first step in assessing flood hazard and its manifold criteria, the hydrologist carries out a programme of flood estimation which concerns the determination of probable future flood discharges and associated characteristics. In the majority of cases it entails the estimation of flood peak discharges (and river levels) and their frequency of occurrence at a given river cross section. Alternatively, it may involve the estimation of a maximum of very extreme conditions. When occasion demands, a full hydrograph* of flooding is developed for the derived peak discharge. This implies the importance and hence estimation of flood volume. It is done only if methods of storage control are to be designed and operated, or if the section for which estimation is initially carried out is remote from the reach at which disaster prevention is necessary and a flood routing exercise is therefore required to determine appropriate changes in peak discharges. Standard hydrological methodology in flood estimation generally endeavours to assess only those flood characteristics related to criteria of water depth (and discharge), frequency of occurrence, maximum possible severity, rates of rise of water level and duration of critical stages.**

In many practical situations the method or methods adopted depend on available data, regional characteristics, and the hydrologists intuition. It is often a most difficult exercise to undertake; estimates are frequently obtained having a marked degree of uncertainty. For this reason, the use of more than one method to estimate flood flows and levels for any single application is recommended.

Flood frequency analysis

2.1.1.1 When a significant number of years of river level and/or discharge data are available for a single river cross section, standard methods of frequency analysis can be applied to determine the probable frequency by which a given river peak discharge (level) will be equalled or exceeded. The procedure of analysis is usually graphically based and consists mainly of plotting observed peak discharges in order of magnitude against a probability scale. The inverse of the probability scale is a scale of "Return Period" which is simply the average interval of time (T years) that occurs between flood events having peak discharges exceeding some prescribed (critical) value. (This value for instance could be the discharge at which the river flows bankfull.) To determine values of T for plotting, recorded flood peak discharges are ranked in order of magnitude (m) such that if there are N years of data the value of T is calculated by the equation $T = \frac{m}{N + 1}$ for a

Note: * A hydrograph is the graphical representation of the variation of stage or discharge with time.

** Stage is a term used for height of water surface above some fixed datum.

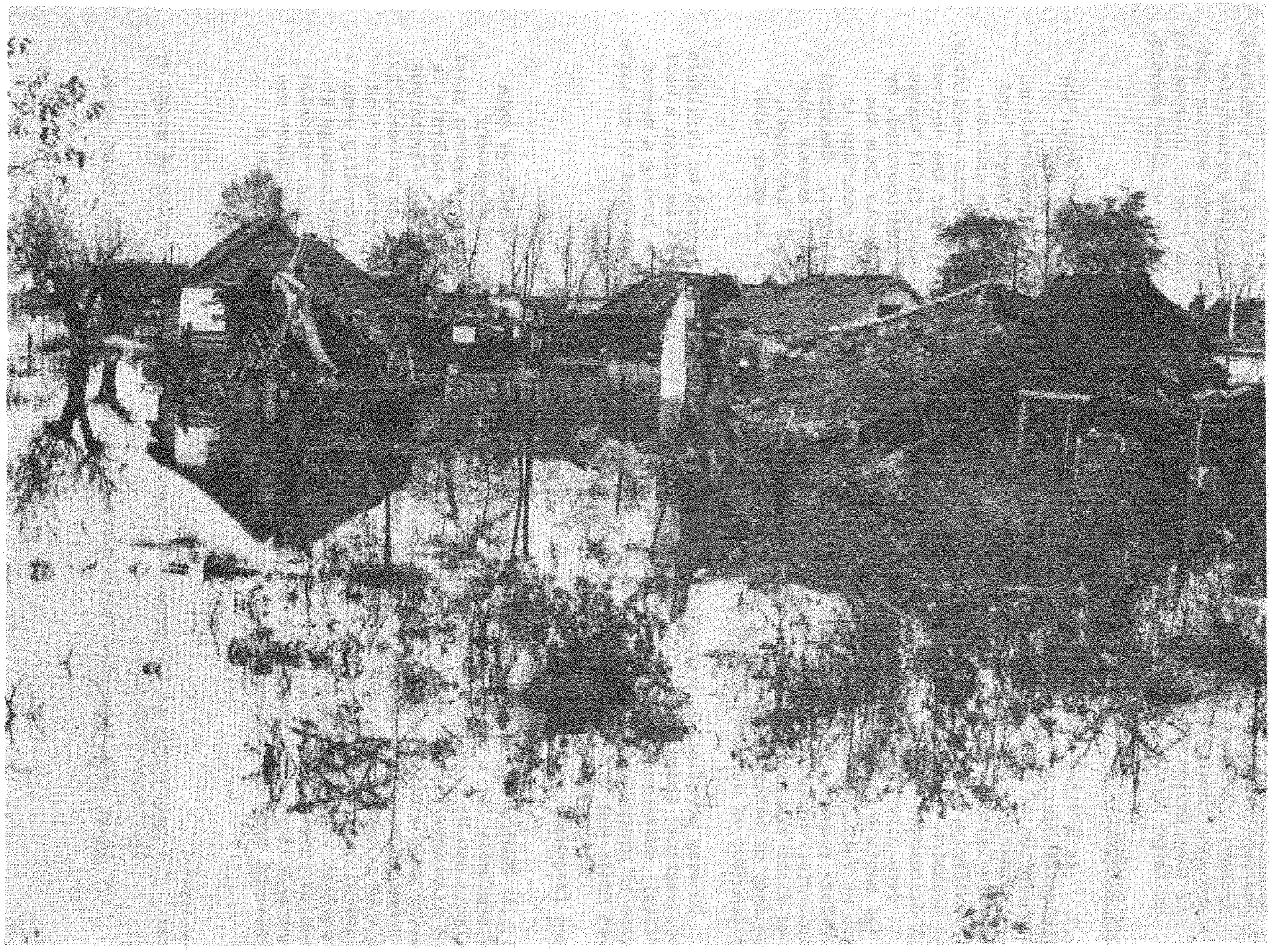

FIG. 2.1 - Structural Failures due to Flooding, Hungary