CHAPTER 6
COLLAPSE: ITS IMPORTANCE, FUNDAMENTALS AND MODELLING
J. L. JUSTO

1. Introduction

The widespread construction of rockfill dams has its origin in the California gold rush. Owing to the availability of rock and knowledge of blasting, the miners of the California mountains used rockfill dams to store water for dry season sluicing of placer deposits.

In many of the earlier American dams rock-filling was largely placed by cableways and was sometimes rehandled by derricks. The rock was often dropped from a considerable height, up to 9 m, with the object of breaking up the weaker rocks, breaking off sharp points and thin edges, and attaining, thus, better compaction. An example of this is Strawberry Dam, 43 m high, and ended in 1916.

In some Algerian dams built in the 1930's, the whole of the rock fill was placed by derricks or by hand, using specially selected rock near the upstream face. This method has reduced porosity to 25-32%, and the success to avoid settlement will be commented later.

This technique gave place to that of "high lift" placing, in which the embankment was carried forward in successive end-tips. The rolling of the pieces of rock down the end slopes was intened to have the same effect as the falling of rock as indicated in the previous paragraph: The lift was from 7 to 66 m.

No special efforts were made to wet rockfill during placement.

Strawberry Dam was one of the higher rockfill dams at the time of its completion (1916). It was a concrete face dam (Gomez Navarro and Juan Aracil, 1958). The wetting during construction was scarce, but there was an important flood at this period, that wetted the rockfill.

Dix Dam was, at the end of its construction (1925), a landmark in rockfill embankments. According to our records its height, 84 m, exceeded in more than 50% the preceding height record. The rockfill was little sluiced with monitors during placement, and a flood with a head of 18 m of water saturated the lower part of
the rockfill during construction and produced a maximum settlement of 20 cm due to "collapse" of the rockfill (fig. 1).

![Figure 1. Settlement of Dix River dam during a flood period (v. Nobari and Duncan, 1972).](image)

Although the safety of the dam has never been impaired, leakage was, no doubt, too large (2.7 m³/s). It was constructed with up to 37 m lifts.

Salt Springs concrete face rockfill dam, 100 m high, ended in 1931, was the following landmark. Sluicing ranged from 1/4 the volume of rockfill in the lower half of the dam to much more in the upper part, with an average between the volume of water and volume of rockfill of 2. This sluicing was estimated insufficient by Steele and Cooke (1960). Leakage was 570 l/s.

The same technique was used at Paradela (1958), 110 m high, with lifts of 66 m and a volume of water of 4 times the volume of rockfill. Leakage was 3 m³/s.

The importance of sluicing was clearly revealed during the construction of S. Gabriel n° 2 (Cogswell dam), concrete face and 85 m high.

The rock was cubic gneiss, with a compressive strength of 45 MPa, with less than 3% dust. It was placed in lifts less than 7.5 m high, and non sluiced.

"The contractor chose the use of shotcrete (gunite) as an alternative to concrete for the sub-slab and the laminated facing. Construction of the facing followed placing of the rockfill and the packed rock part thereof, with a minimum of necessary lag and by December 1933 had been about 33% completed.

On December 31, a major storm swept in from the Pacific Ocean which by noon January 1, 1934 had yielded 382.8 mm of rain at the dam. The application of this natural lubrication to the dry rockfill caused the latter to settle, specially that part