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13th AUGUST 1935: A CATASTROPHIC DAM FAILURE IN THE ORBA VALLEY (PIEDMENT, ITALY)

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INTRODUCTION

Between 1919 and 1926 the "Officine Elettriche Genovesi" (O.E.G.), a large industrial company, built a hydroelectric plant in the municipality of Molare (Piedmont, north-western Italy, Fig. 1). The reservoir created by the barrage of the Torrent Orba (hydrographic catchment of the River Po) by means of two dams had a capacity of 18 million m^3. From 1922 onward construction proceeded rather quickly after changes where made to the original project which led to an increase of height of the Main Dam. The Torrent Orba was barred at Ortiglieto by a 47 m high slightly curved gravity dam (whereas the maximum height originally planned for the dam was 34 m) equipped with four water dischargers. The plant was completed in 1926 and named Main Dam of Bric Zerbino (Fig. 2). This dam could provide a 24,000 metric horsepower hydraulic force.

This achievement, though, posed a serious problem: at one point of the perimeter of the planned impoundment, some 300 m west of the Main Dam, a saddle formed by two ridges would have been at a lower elevation with respect to the maximum storage level. As a consequence, water could have overflowed the saddle and poured out into the underlying riverbed. Therefore, it was held necessary to construct a secondary barrage, made up of a 110 m long and 14 m high summit wall. This barrage was planned and built rather hastily, without the support of adequate geological investigations since, according to the planners, this saddle "was made up of sound rock". The second dam, named Secondary Dam of Sella Zerbino (Fig. 3), was a massive wall of Portland cement on top of which ran the road leading to the adjacent Main Dam. The reservoir resulting from the two barrages stretched upstream for some 5 km with an irregular shape and a maximum width of some 400 m (Fig. 4). The hydroelectric plant fed by this reservoir was built 3 km downstream of the two dams.

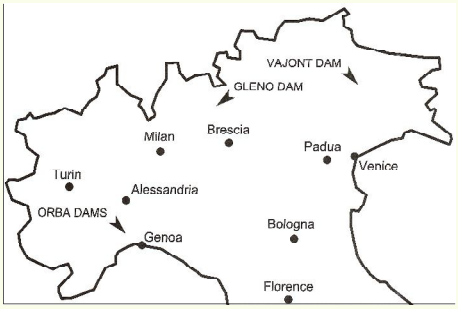

Fig. 1 – Map of northern Italy: arrows show locations of Orba, Gleno and Vaiont dams

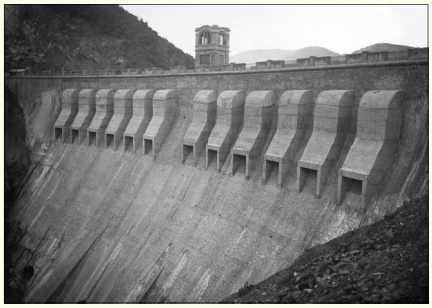

Fig. 2 – The Main Dam of Bric Zerbino showing the twelve dam siphons (O.E.G. photo, 1925)

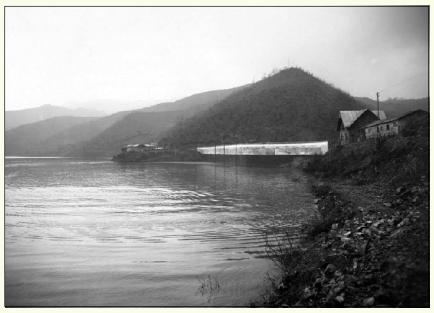

Fig. 3 – The reservoir and Secondary Dam of Sella Zerbino (photo from the mid-1920s)

THE CATASTROPHIC EVENT AND THE AFTERMATH

On the morning of 13th August 1935, after nearly ten years of operation, the rock sill on which the Secondary Dam had been constructed collapsed following a heavy rainstorm. The failure caused the sudden emptying of the reservoir (Fig. 5) and a large amount of water poured into the underlying valley, wreaking havoc along the whole course of the Torrent Orba (Fig. 6) as far as its confluence with the River Bormida, some 50 km away, near the town of Alessandria in Piedmont. At least 111 people lost their lives in the disaster.

The criminal trial held by the Turin Courts in 1938 returned a verdict of acquittal for the managers of the O.E.G. and the designer of the plant. There were multiple causes which led to the disaster and which can be mainly ascribed to the lack of geological investigations within the hydroelectric plant area. In addition, thorough hydrological and hydraulic studies were not carried out, which could have accurately tested the adequacy of the dam's discharge system. Finally, the original project was changed several times in order to reduce building costs and increase the volume of water stored without ever considering the proper safety of the plant. The Orba Valley disaster occurred 12 years after the Gleno disaster (356 lives lost) and 28 years before the Vaiont catastrophe (1917 lives lost).

Fig. 4 – View of the maximum impoundment with the position of the two dams (1 and 2) and the check dam of Ortiglieto (3) on the Torrent Orba

Fig. 5 – Destruction of the hydroelectric plant during the emptying of the penstock (August 1935)

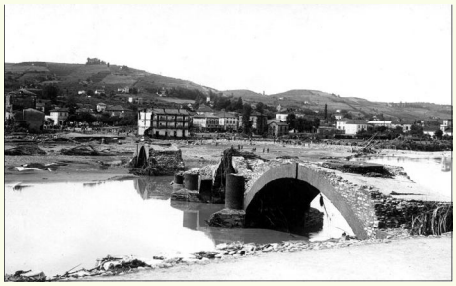

Fig. 6 – Aftermath in the Orba Valley by the village of Ovada (August 1935)

Fig. 7 – The collapsed rock saddle of Sella Zerbino as it appears today showing the jointed mylonite outcrop

FINAL REMARKS

The incident of 13th August 1935 in the Orba Valley preceded the Vaiont catastrophe by nearly 29 years; nevertheless the two events show striking similarities and disturbing analogies. For example, similarly to the Orba Valley's dam, in the Vaiont dam project several increases of the dam's height were introduced (from the original 200 m up to 264.5 m) which heavily reduced the stability of the left shore and slope of the reservoir. Furthermore, in both cases the predisposing factor is to be found in the critical geological and hydrogeological conditions of the slopes surrounding the reservoirs rather than in the actual sites where the dams were built.

As for the Orba Valley, the feasibility of the plant was assessed on the basis of the most suitable site for constructing the Main Dam, as happened at Vaiont. Therefore, it is not a coincidence that the Orba Main Dam and the Vaiont dam survived these disastrous events undamaged, since they had been built in morphologically and geologically suitable sites. Unfortunately, both in the Orba Valley and in the Vaiont Valley the planners and engineers focused their attention nearly exclusively on the engineering works, neglecting the geological context of the two sites and the consequences that a large mass of water could have on the stability of already precarious rock slopes. For example, in correspondence with Sella Zerbino accentuated lateral fluvial erosion on the torrent's right-hand side had shown the presence of particularly jointed rocks and easily recognizable shear zones affecting greenish-blue mylonites (Fig. 7). This unfavourable situation was further aggravated by the total lack of geological investigations even during construction or when, later on, problems concerning water infiltration through the rock sept of Sella Zerbino were not properly assessed. In addition, it should be pinpointed that, in order to save money, the Secondary Dam was poorly and hastily constructed just on the most critical site: the rock sill of Sella Zerbino. Also the discharge system of the Main Dam was completely inadequate, since no meteorological or hydraulic models were elaborated before construction.

The dam which remained standing, named "Main Dam of Bric Zerbino", still lies within a remote, abandoned meander of the Torrent Orba which, after the 1935 collapse, found a new course in correspondence with the rock sill where the failed dam had stood.

Together with the Gleno and Vaiont catastrophes, the Orba Valley disaster represents an unfortunate example of the serious consequences which can be brought about by underestimating or neglecting the geological and geomorphological setting of sites where important engineering works have to be built.