Balangero: Using Risk as a Key Decision Parameter

By Cesar and Franco Oboni

The Balangero asbestos open pit mine, located 35 km N-W of Turin (Italy), was the largest operation of this kind in Western Europe. The open pit, active from 1917 to 1985, was cut into the ridge of an elongated hill. The mill was located on one side of the hill and the dumps on the other.

Dry tailings were lifted by a conveyor belt from the mill located at the foot of the hill to a location near the ridge. From there they were conveyed through a tunnel to the opposite side of the hill, and then dumped over a natural slope with an approximate angle of 25 degrees from the altitude of about 830 m a.s.l. to the bottom of the valley at 580 m a.s.l.

As the dumping proceeded, a total surface of about 250,000 m2 was progressively covered with tailings thicknesses going from a few meters to an estimated maximum of 60m–80m, resulting in an estimated 60Mm3 dry asbestos tailings dump. This dump, as well as all the production facilities, was abandoned when the mining company abruptly stopped its activities in the early ’80s for economic reasons.

Restoration/Rehabilitation Program

In 1992, a public company formed by the Province of Turin, the Mountain Community of the Lanzo valleys, neighbouring communities and other public stakeholders was mandated by the regional government of Piedmont to organize an international design competition in compliance with regional bylaws. The goals of the competition were to select the best possible alternative to increase the stability of the slopes (over-steepened, critically eroded and prone to mudflows); reduce the dispersion of fibres (long term hazard to the neighbouring population) and re-vegetate the slopes for aesthetic and environmental reasons.

Risk Based Decision Making/ Economic Safety Margin (CDA/ESM) was consistently used by the design team that won the bid. The project is now completed.

The environmental restoration goals were to:

a) Achieve a Sufficient Stability of the Slopes. Gravity and water are the main combined external agents posing a threat to the stability of the over-steepened slopes of the dump. Thus it was necessary to act against gravity to enhance the stability of the slope, and against water to eliminate surface erosion, gullies formation and increase of saturation triggering frequent mudflows along the slope.

b) Minimize the dispersion of asbestos fibres in the area of the mine and surrounding towns during the restoration work and in the long term.

c) Re-vegetate the area, which is located in a densely inhabited area at the Alps foothills. As the dump material was highly sterile and generally too steep to retain humus, a special program of tree and shrub planting was designed, which included the plantation of 45,000 shrubs and trees. Their root system was treated with special fungi that help the rooting/ vegetation process in the sterile slope. A general hydro-seeding of the full area was undertaken, step by step, using a remotely operated helicopter, again to reduce disturbance to the steep slope.

Hauling

One of the major challenges faced by this project was related to the large amount of material to be excavated and disposed of within the mine area, in order to unload the over steepened head of the dump slope. Between the top and the bottom of the slopes 4.5 km of dirt track was present. The preliminary design demanded the removal of about 280,000m3 of residue (mainly sand and gravel) with mixed random asbestos fibres.

The idea to use trucks was quickly discarded due to the environmental risks (Pollution from exhaust fumes and fibre dispersion from the excavated material) and the need to upgrade the tracks to roads. A far better ESM was obtained with the alternative of installing a temporary aerial tramway. This device was designed with a single span of 960 m between the two terminal stations (Criteria: Meeting expected performances; Criteria: Avoiding hazards (settlements, instability of intermediary piers).

The cable car was removed at the end of the earth movement works. The excavated material was wetted at excavation time and remained wet during the full trip from the source to the final resting position, to reduce fibre dispersion. The process proved to be very efficient and only a couple of times, due to very strong winds, the dust monitoring instrumentations displayed critical concentrations of aero-dispersed fibres in the surrounding environment. The aerial tramway produced electricity which was sold to the grid (Criteria: Sustainability).

Slope Stabilization Procedures

The selected slope stabilization procedure received a high ESM based on high probabilities and low costs (of failure to meet the criteria) for various criteria. The procedure can be summarized as follows:

Unloading of the upper part of the slope by digging three big berms and by storing the excavated material at the bottom of the slope on an artificial earth fill 8 m high, using the cable car. The engineered fill was geared towards protection from possible residual mudflows originated in the steeper eastern part of the slope (up to 42°), the lower part of the slope, the Fandaglia creek etc.

Cutting a series of 8 “path-ways,” i.e. small berms 2.5 m wide, along the slope at regular height intervals. The “pathways” were designed to minimize the volume of material to be evacuated. The “pathways” were reinforced with small palisades built with wood logs (20 cm diameter on average) increasing the use of natural materials and reducing the need for concrete and steel. The downhill side palisades were totally covered by earth, whereas the uphill palisades remained visible. This was complemented by a geogrid and densely planted to obtain, once vegetation is mature, a "green retaining structure."

Building whenever deemed necessary composite wood-earth structures to retain the steepest parts of the slope, or create necessary platforms.

Runoff Control

From the hydraulic/water control point of view, surface erosion had created deep (up to 3 m) gullies on the slope in the past. The remedial measures undertaken were the following:

General control of all the surface water falling on the area in the form of rain or snow via a net of small wooden channels (on the average 50 to 100 cm wide). These channels collect surface runoff on the slope thanks to the access created via the top berms and intermediate "pathways." The small dimensions of the channels were designed to limit the use of heavy equipment on the slope and the need for large excavations for their construction. The collecting system is relayed by secondary segments of channels running on top of the berms and on the "pathways." Thus the collected runoff is concentrated into 4 main channels located on the slope along the steepest gradient. These channels – called "water chutes" – were built with wood logs and stones.

The 4 "water chutes" finally converge into a unique main canal, also built just with logs and stones, that allows the water to reach the Fandaglia creek at the foot of the slope. Before the final exit to the external environment, the collected runoff water flows through a decant basin where the fine material and the fibres can be retained.

Finally, sub-horizontal drains were drilled on the slope to control underground water.

Comparative Risk Based Decision Making (CDA/ESM) was used at each and every step of the Balangero's environmental restoration bid to guide the selection among possible design alternatives. As a result, the project features several interesting solutions related to environmental management, such as the use of an aerial tramway that allows the reduction of fossil fuel use, dust and even produces energy that is sold to the regional utility company. ■

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Links and References

- Asbestos: Beyond the Fears
- Comparing Projects by...
- Excess of Mesotheliomas...
- Kiss Approach to Risk...
- Oboni Riskope Associates Inc
- Risk and Decision Making
- Slope Stability and Rockfalls

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