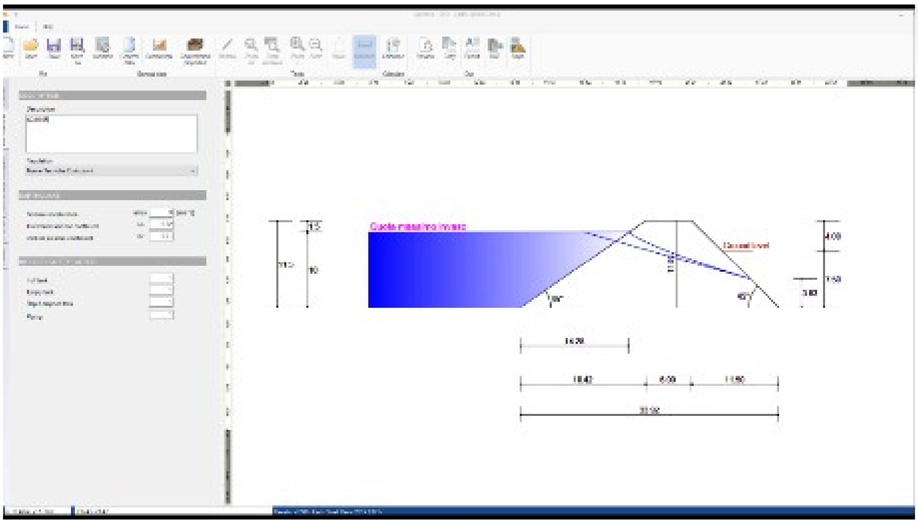
ESD

1 Earth Small Dams – ESD

Earth Small Dams: Software for the check of earth small dams under both static and seismic conditions.



Checks under:

full tank, empty tank, quickly emptied tank.

Hydraulic piping check, determination of the seepage rate through the work, seepage length, saturation line trend.

Location on map of the intervention work.

Representation of the embankment section and saturation line.

Computation report with Theoretical Notes.

Export to dxf and image format.

1.1 Verification

The verification criterion of artificial dams works described bellow is valid for works with an embankment height smaller than 15 meters.

From a static point of view, a global judgment on the stability of the work can be inferred from an approximated procedure that divides the dam into two parts: heel and toe (upstream and downstream), to be examined separately. The subdivision is shown in the diagram of Figure 1: the **RMN** area is divided by the back part **MNS** from a vertical plane **MN**.

In this way, the problem is divided into two partial problems which will be solved referring to the dam thickness unit.

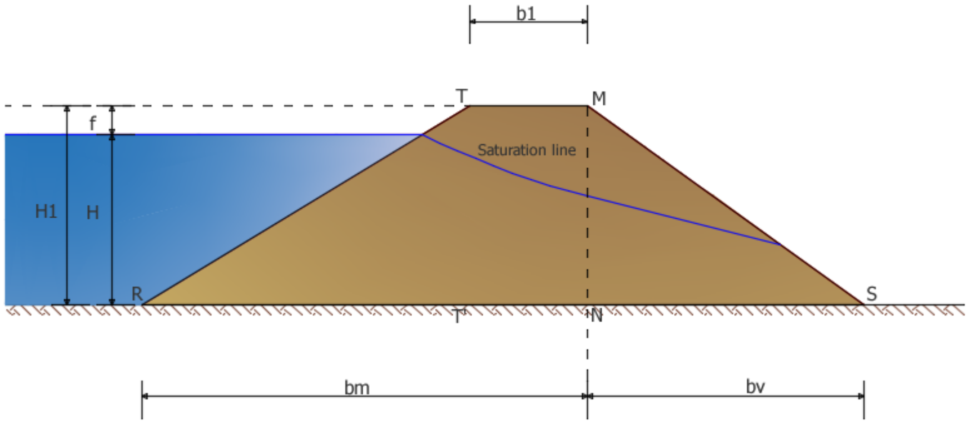


Figure 1

The toe part (downstream) **MNS** acts as a support of the upstream part pushed by the water: the resisting force that opposes the thrust transmitted from the heel (upstream) part manifests, at each elevation, as a shearing effort acting along the base horizontal section (most stressed section).

The verification conditions must be met for: full tank, empty tank, rapid emptied tank.

FULL TANK

The verification condition is expressed by inequality:

$$T_v \leq R_v$$

$T_v = S+F_o+F_v+F_s+F_T$ represents the total shearing effort on the base NS and consists of the following actions:

S hydrostatic thrust invased water
F_O horizontal seismic action of the structural mass
F_V hertical seismic action of the structural mass
F_S inertial action invased water
F_T upstream embankment thrust of the MN section

R_v represents the resistance that the material is capable of developing and it consists of a frictional component and a cohesive component:

$$R_v=P_v\ (\gamma_s)\cdot\tan\varphi+c'\cdot b_v$$

P_v resultant from the vertical actions, in function of γs
c' cohesion

EMPTY TANK

Total shearing effort Tm acting on the base section is given by the relationship:

$$T_m=F_o+F_v+F_T$$

Resistance is expressed by:

$$R_m=P_m\ (\gamma_a)\cdot\tan\varphi+c'\cdot b_v$$

Pm represents the resultant of the vertical actions, function of γa

RAPID EMPTIED TANK

In this situation, there is suddenly a lack of the support action exerted by the hydrostatic thrust against the upstream facing, while the dam's body which did not have time to drain by seepage, remains soaked with water. The total shering effort T_m acting on the base section of the upstream side is defined as:

$$T_m=[0.5 \cdot \gamma_S \cdot H^2_1 \cdot K_A+0.5 \cdot \gamma_W \cdot (2/3 \cdot H)^2+k_h \cdot A_{(RTMSR)} \cdot \gamma_g]$$

The resistance R_m is expressed by the formula:

$$R_m=P_m\ (\gamma g) \cdot \tan\varphi$$

Pm represents the resultant of vertical actions, in function of γ_g

The hydraulic calculation of an earth dam concerns three issues: identification of the "saturation line", calculation of the flow rate and piping check.

The saturation line represents the highest flow line. Below all the points of the saturation line the material is saturated with water and it is under hydrostatic conditions, while above it there is a lack of pression.

It's a convex curve upwards and can be determined graphically as shown in Figure 2.

In order to estimate the flow rate by unit of embankment thickness it is necessary to know the value of the average length of the seepage path. For this purpose, refer to the empirical relationships available in technical literature.

Through this magnitude it is possible to quantify the flow rate with the following relation:

$$Q=4/9 \cdot (k \cdot H^2/L)$$

where:
k is the geometric average of the two coefficients ko kv , ideal permeability coefficient, constant in all directions
L is the average length of the seepage route

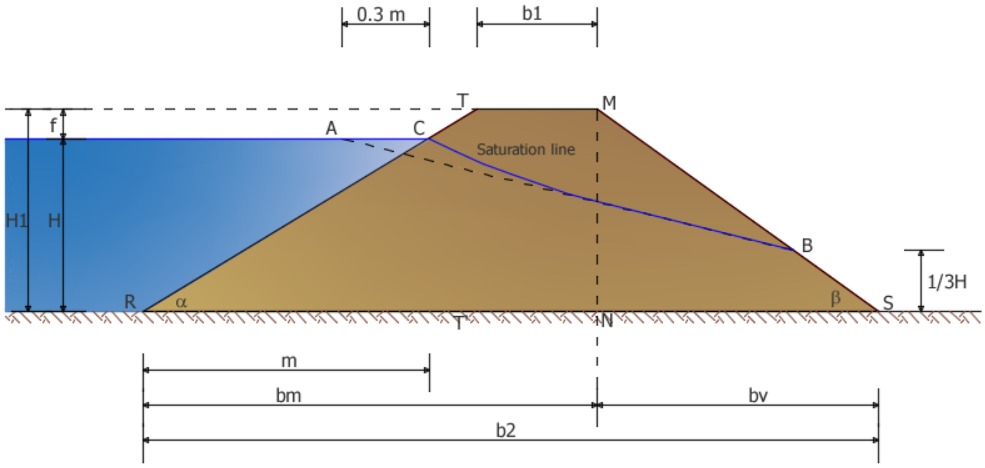


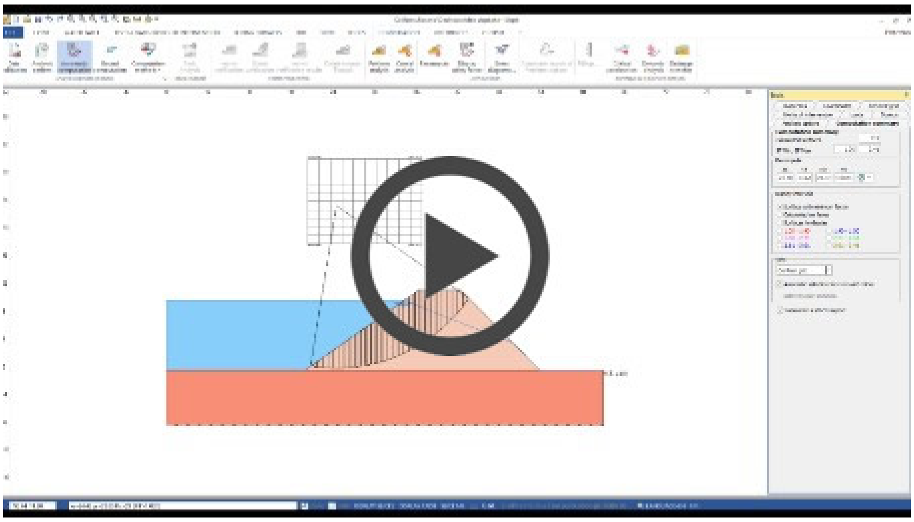
Figure 2

Piping check is made by using the empirical relation of Bligh:

$$\mathbf{L_a > c_m \cdot H}$$

where:
La perimeter development of the foundation profile
cm Critical drag ratio, it depends on the nature of the soil, it can assume values between a maximum of 20 for superfine inconsistent material and a minimun of 4 for very hard and compact clays.

1.2 Global stability Analysis



1.3 Net flow

Attraverso il comando...il programma ESD *(Earth Small Dams)* crea un file di interfaccia per l'esportazione in GFAS del modello di calcolo ad elementi finiti.

Dopo aver creato la mesh, per eseguire l'analisi alla filtrazione occorre definire le caratteristiche geotecniche ed idrauliche (permeabilità verticali ed orizzontali) dei materiali che sono stati assegnati alle regioni del modello di analisi.

Si andranno ad assegnare così i vincoli idraulici sui contorni che definiscono le linee equipotenziali; trattandosi di un moto non confinato, si ipotizza che la linea di saturazione, già nota, sia una linea equipotenziale con carico totale nullo.

Il seguente video mostra le fasi di analisi.

1.4 Geoapp

Geoapp: the largest web suite for online calculations

The applications present in Geostru Geoapp were created to support the worker for the solution of multiple professional cases. Geoapp includes over 40 applications for: Engineering, Geology, Geophysics, Hydrology and Hydraulics.

Most of the applications are free, others require a monthly or annual subscription.

Having a subscription means:

- access to the apps from everywhere and every device;
- saving files in cloud and locally;
- reopening files for further elaborations;
- generating prints and graphics;
- notifications about new apps and their inclusion in your subscription;
- access to the newest versions and features;
- support service throught Tickets.

1.4.1 Geoapp Section

General and Engineering, Geotechnics and Geology

Among the applications present, a wide range can be used for **ESD**. For this purpose, the following applications are recommended:

- Soil Classification
- GeostruMaps
- Converter
- Idraulic
- Haefeli

1.5 Recommended books

Geotechnical, engineering, and geology books

Portal books: explore the library

- **Methods for estimating the geotechnical properties of the soil**

Methods for estimating the geotechnical properties of the soil: semi-empirical correlations of geotechnical parameters based on in-situ soil tests.
This text is designed for all professionals who operate in the geotechnical subsurface investigation. The purpose of this text is to provide an easy reference tool relatively to the means available today.
Theoretical insights have been avoided, for which please refer to the bibliography attached, except in cases where these were considered essential for the understanding of the formulation. The reason for this is obvious: make the text as easy to read as possible.
After a brief introduction about volumetric and density relationships with the most common definitions used for soils, in the following chapters we briefly described some of the most widespread in situ geotechnical testing and correlations to derive empirically geotechnical parameters and a number of useful formulations available today in the field of Geology.
The text concludes with the inclusion of formulas used in Technical Geology, considered of daily use to those working in the sector.
The topics are intended to provide a basic understanding of the in situ geotechnical testing and evaluation of geotechnical parameters necessary to define the geotechnical model.

- **Geotechnical and F.E.M. Analysis System (GFAS)**

Geotechnical and F.E.M. analysis System (GFAS): aims to introduce users to the correct and conscious use of FEM techniques.