Co-funded by the
Erasmus+ Programme
of the European Union

Hydraulic structures. Dams and reservoirs

Elements of dam engineering -2

Assoc. Prof. Maria Mavrova
University of Architecture, Civil Engineering and Geodesy - Sofia

Sofia winter School 29 November – 10 December 2021
Date: 6 December 2021

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Q1: Elements of dam engineering

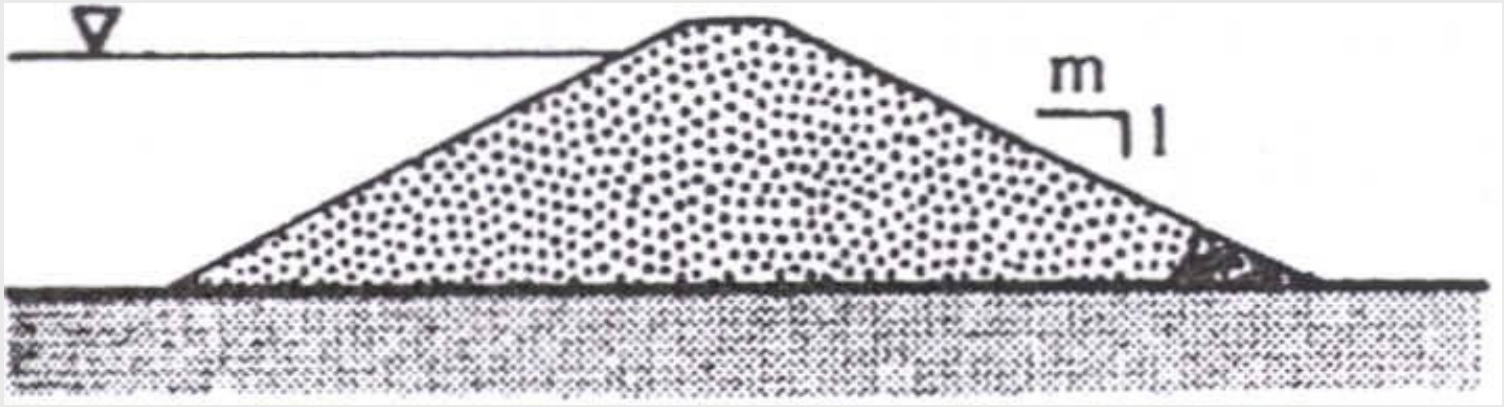
Q1: Elements of dam engineering

1. Historical perspective
2. **Structural philosophy and types of dams**
3. Spillways, outlets and ancillary works
4. Site assessment and selection of type of dam
5. Loads on dams

Embankment dam types and characteristics

- **earthfill** or **rockfill** dams.

earthfill and earthfill-rockfill embankment dams

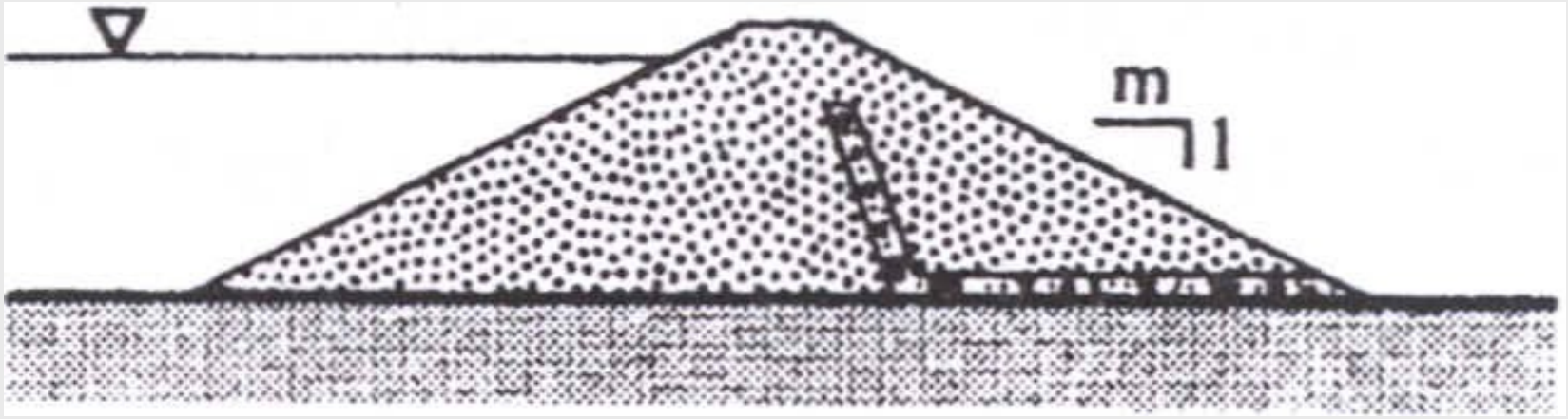


(a) Homogenous with toe-drain:

small secondary dams

m = 2.0-2.5

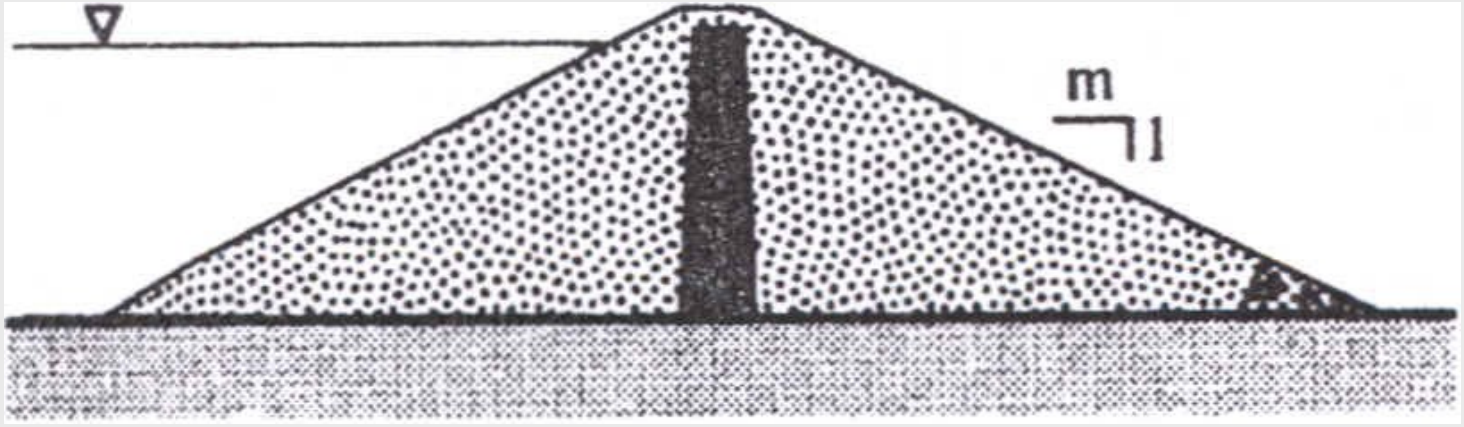
earthfill and earthfill-rockfill embankment dams



(b) Modern homogeneous with internal chimney drain

m = 2.5-3.5

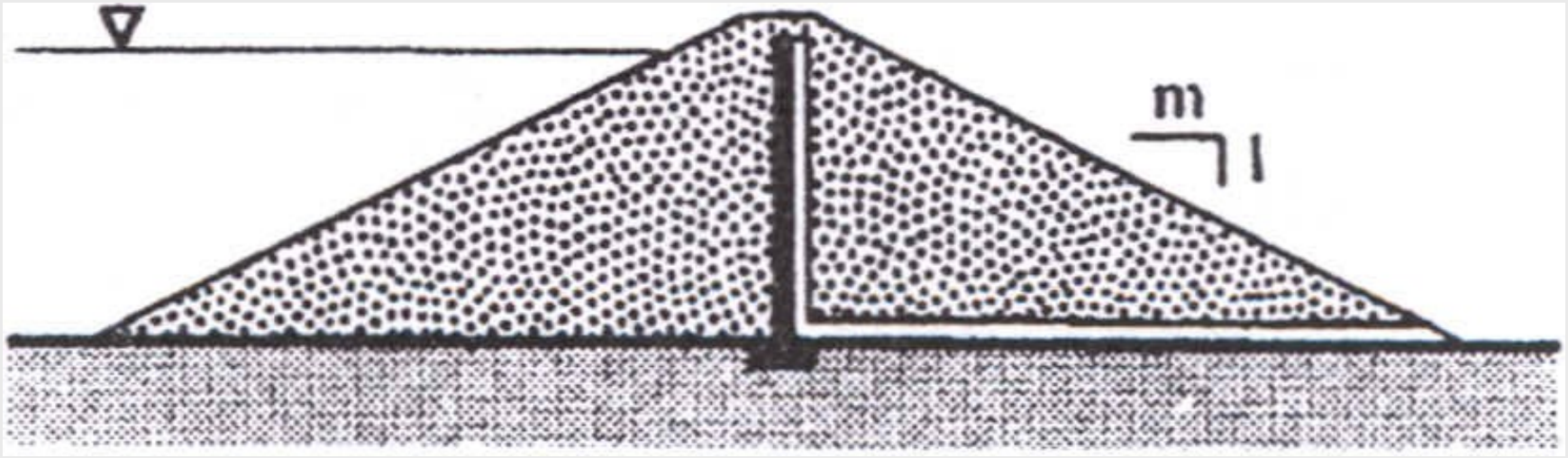
earthfill and earthfill-rockfill embankment dams



(c) Thin central clay core:

m = 2.5-3.5

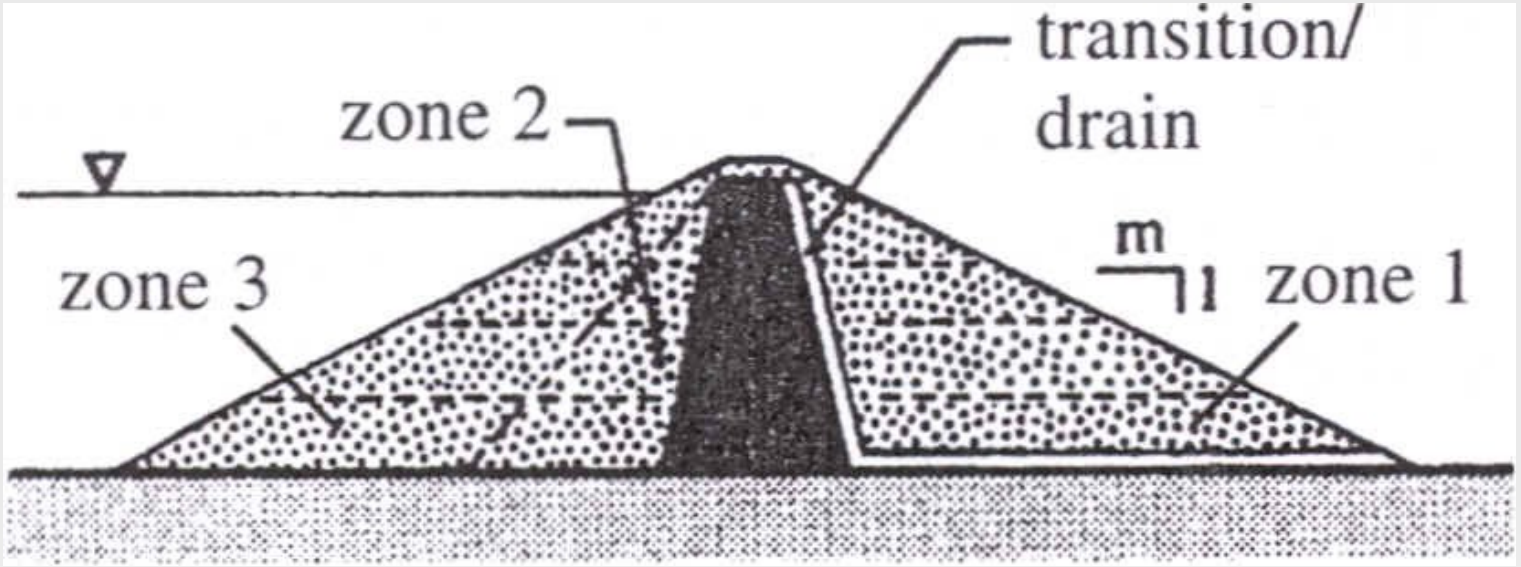
earthfill and earthfill-rockfill embankment dams



(d) Central concrete core: smaller dams - obsolescent

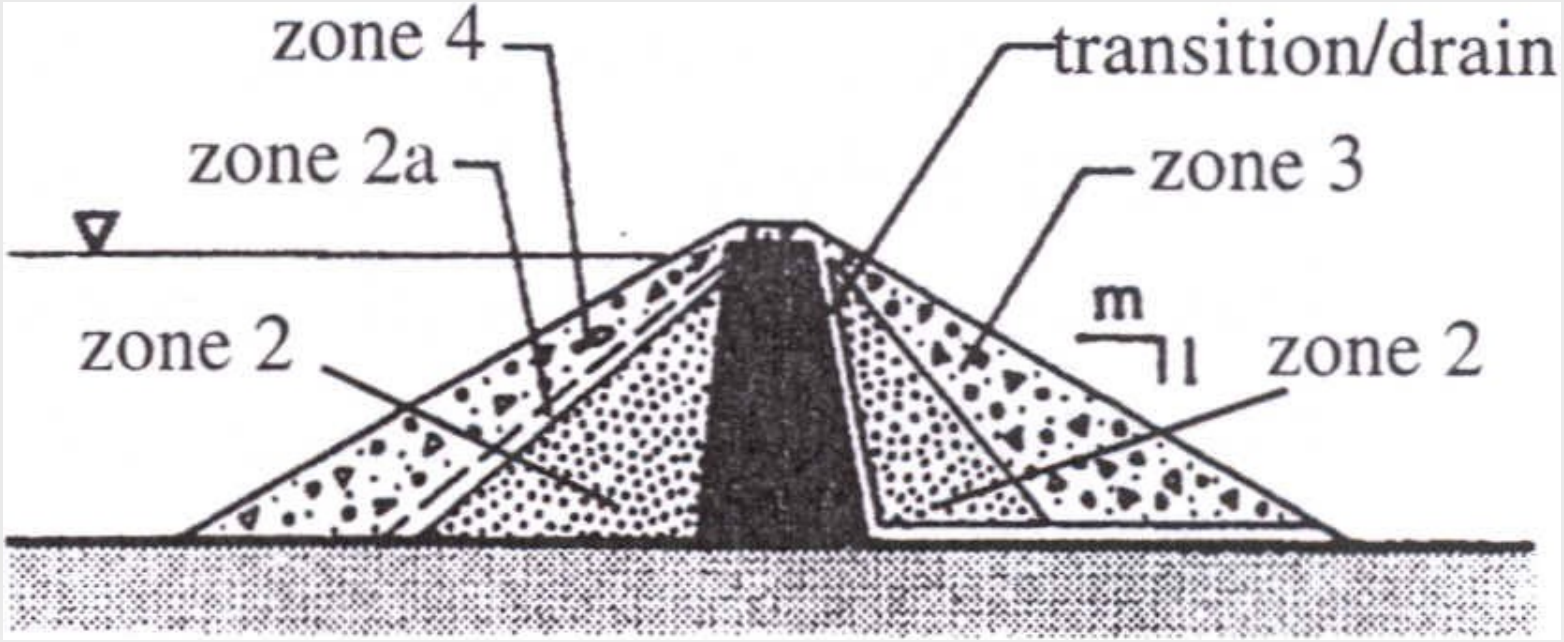
m = 2.5-3.5

earthfill and earthfill-rockfill embankment dams



(e) Wide rolled clay core:
with transitions zones and drains:
! base drain
m = 2.5-3.5

earthfill and earthfill-rockfill embankment dams

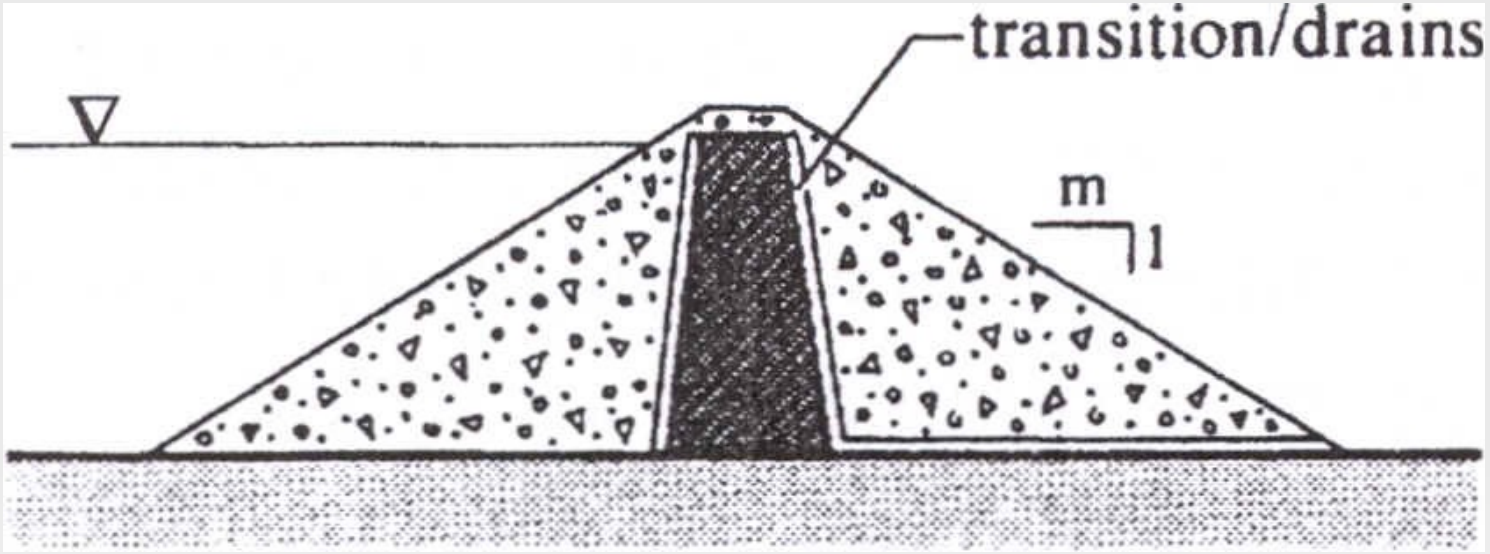


(f) Earthfil-rockfill with central rolled clay core:

zoned with transitions and drains

***m* = 1.6-2.0**

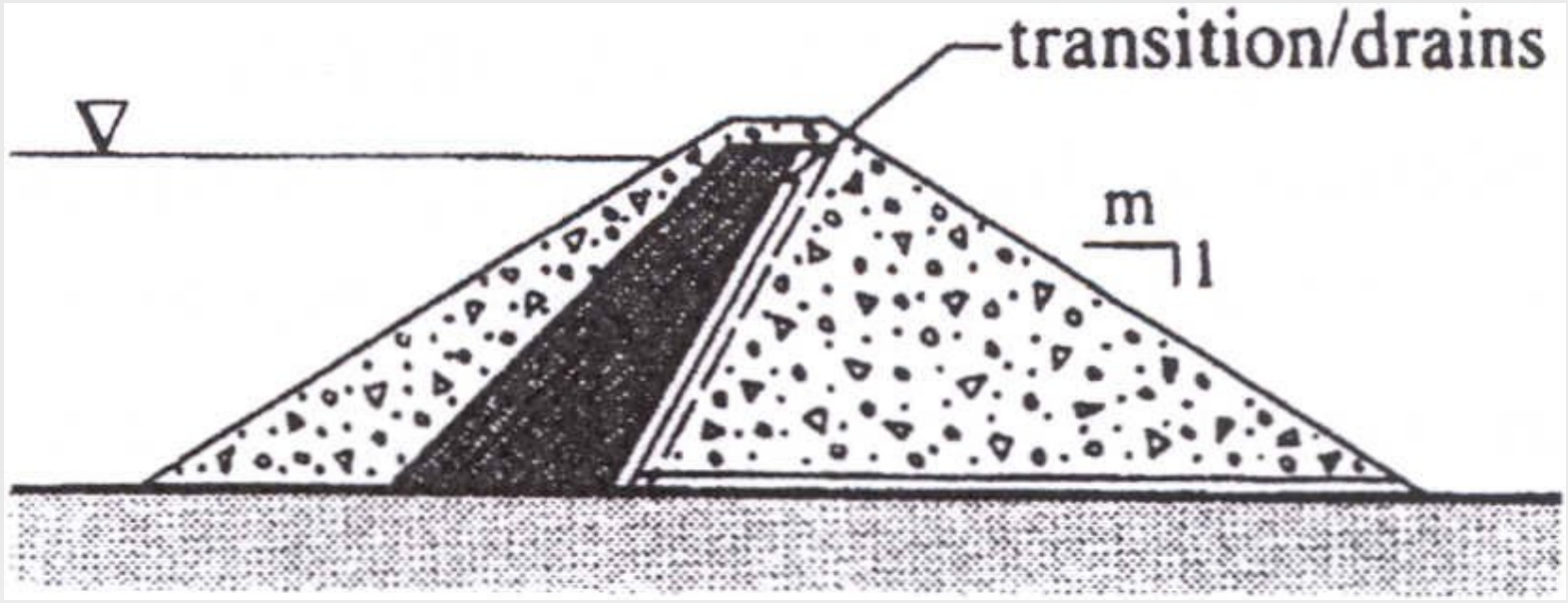
Principal variants of rockfill embankment dams



(a) Central rolled clay core

m = 1.6-2.0

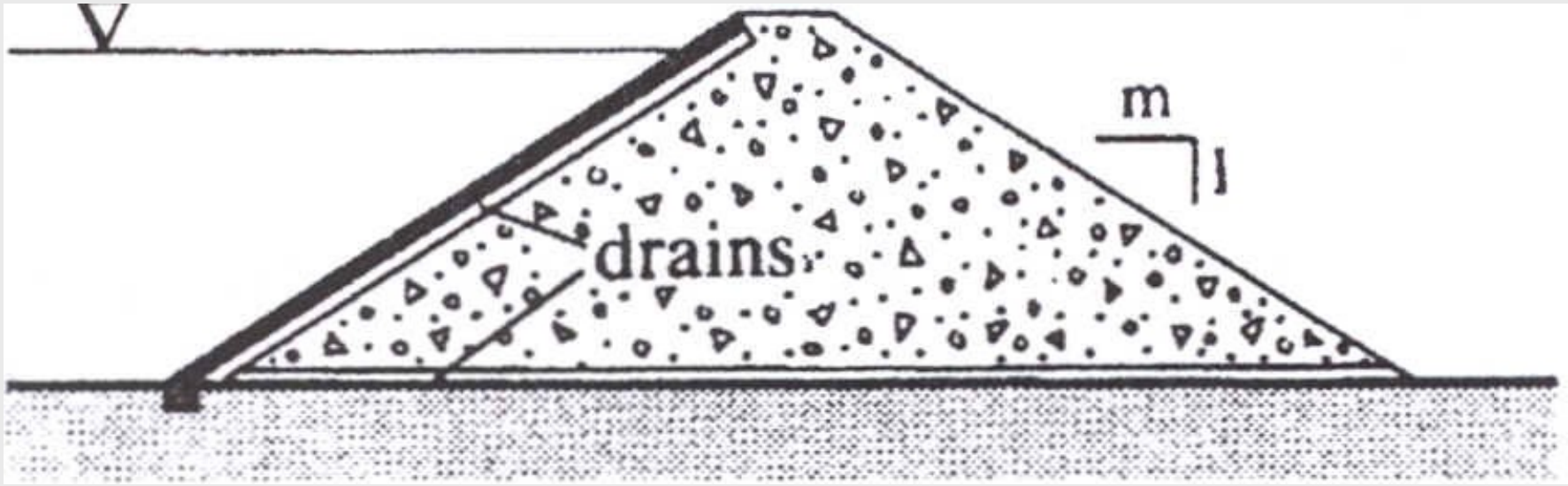
Principal variants of rockfill embankment dams



(b) Inclined rolled clay core

m = 1.6-2.0

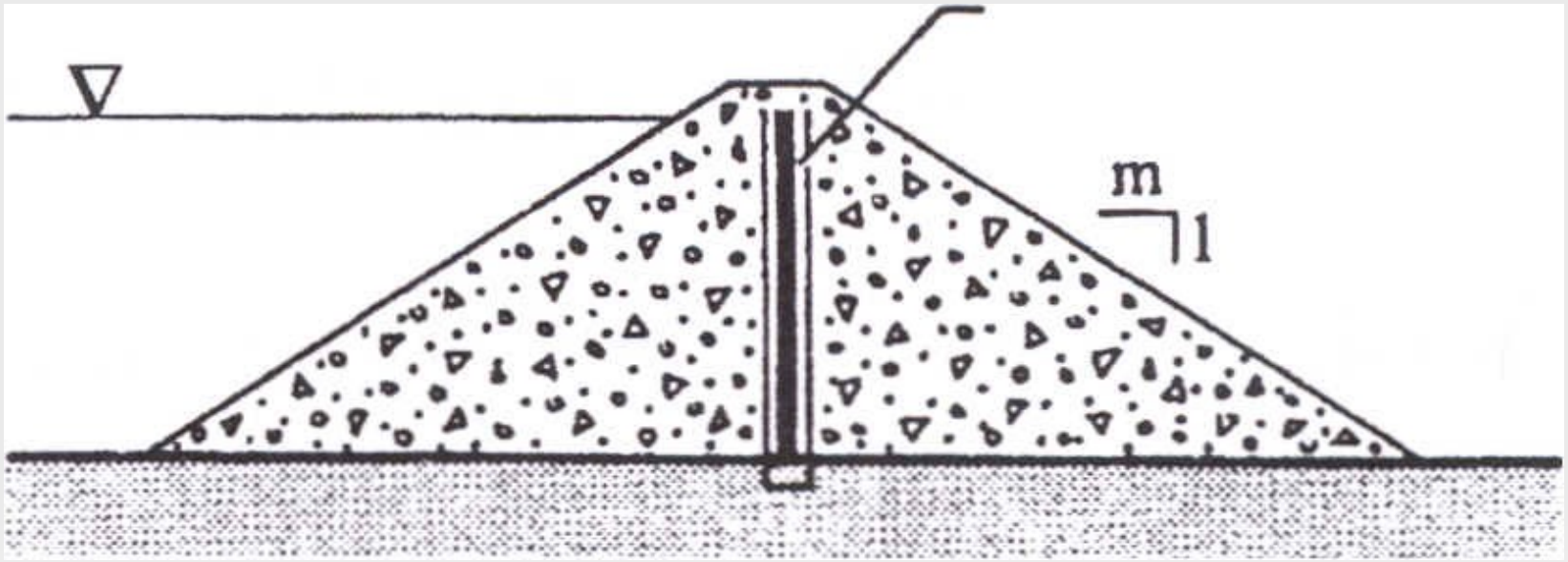
Principal variants of rockfill embankment dams



(c) Decked: upstream asphaltic or concrete membrane

m = 1.6-2.0

Principal variants of rockfill embankment dams



(d) Central asphaltic membrane

m = 1.6-2.0

Table 11.1 Earth–rock dams higher than 200 m (* under construction).

Dam	State	Constructed (year)	Height (m)	Volume of dam $m^3 \times 10^3$	Volume of reservoir $m^3 \times 10^6$
1. Rogun*	Tajikistan	(?)	335	75,900	13,300
2. Nurek	Tajikistan	1980	300	58,000	10,500
3. Chicoazen (Manuel Torres)	Mexico	1980	261	15,370	1613
4. Tehri	India	2006	261	22,750	2600
5. Alberto Lleras (Guavio)	Colombia	1989	243	17,755	787
6. Mica	Canada	1973	242	32,111	24,700
7. La Esmeralda	Colombia	1976	237	11,400	760
9. Oroville	USA	1968	230	59,635	4297
10. Irape	Brazil	2006	208	10,300	
11. Keban	Turkey	1974	207	15,586	30,600

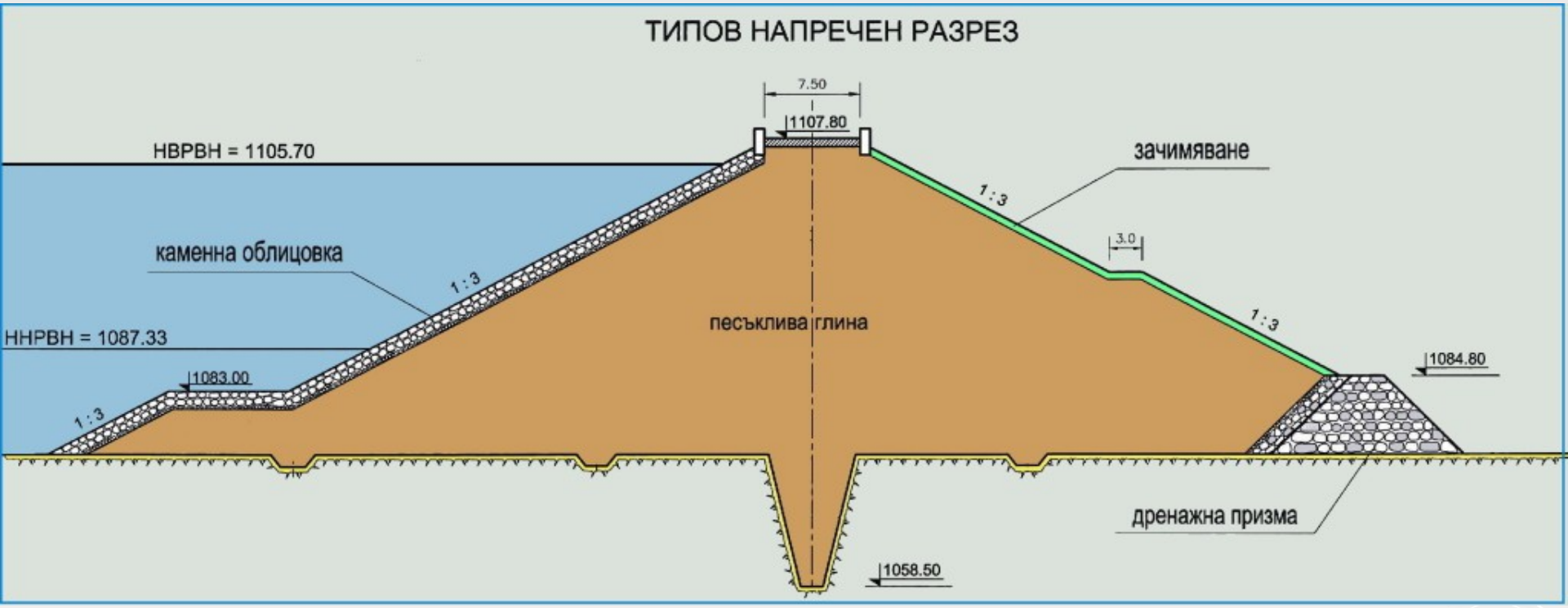
Advantages of the embankment dams

- the suitability to sites in *narrow and wide* valleys and relatively steep sided gorges, too
- applicability to a *different foundation conditions*, from rock to soft soils
- the *use of natural materials*, minimizing the need to import or transport large quantities of materials or cement to the site;
- the *construction process is highly mechanized*;

The most important disadvantage include damage or destruction by overtopping!!!

Batak Dam

Batak Dam

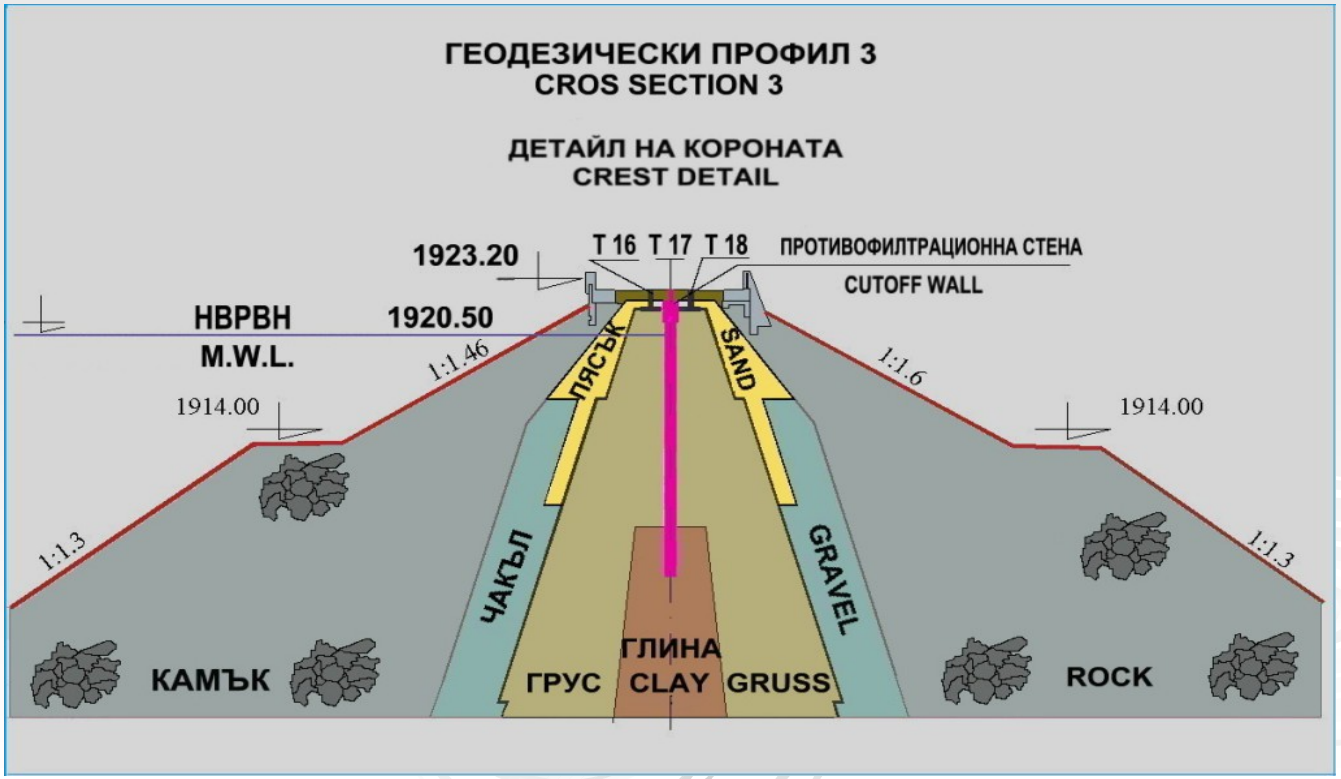


Type - earthfill dam with stone membrane
Year of building – 1959
Hight of the dam – 35 m

Length of the dam crest – 300 m
Total volume – $310*10^6$ m^3
Catchment area – 463,39 km^2

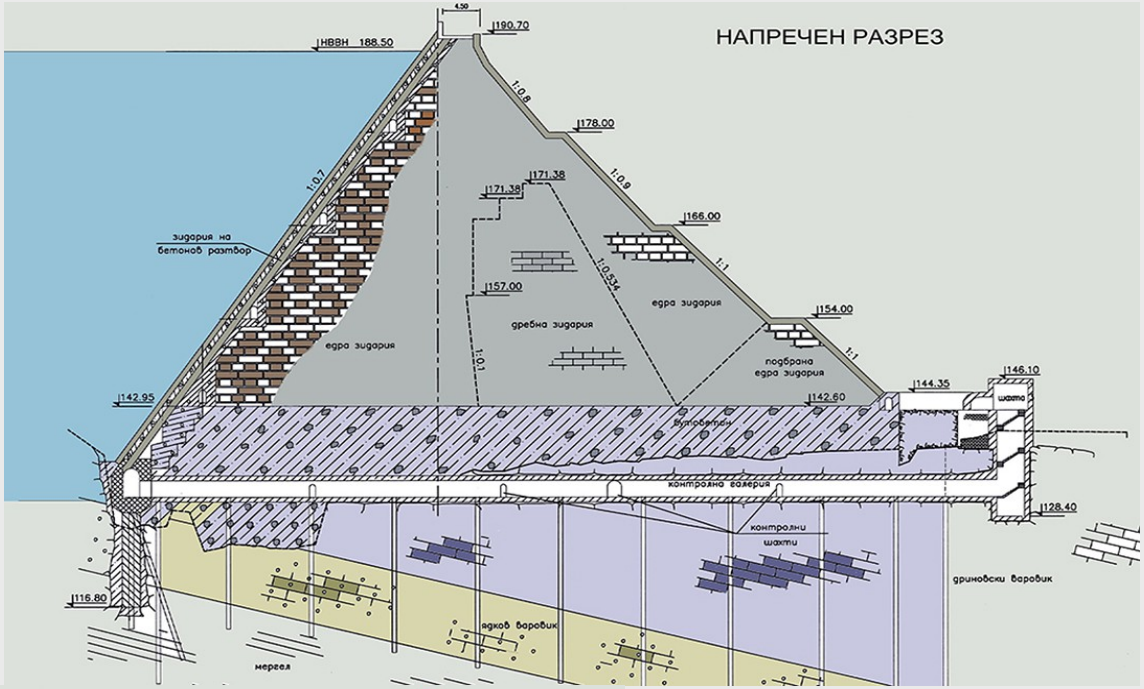
Belmeken Dam

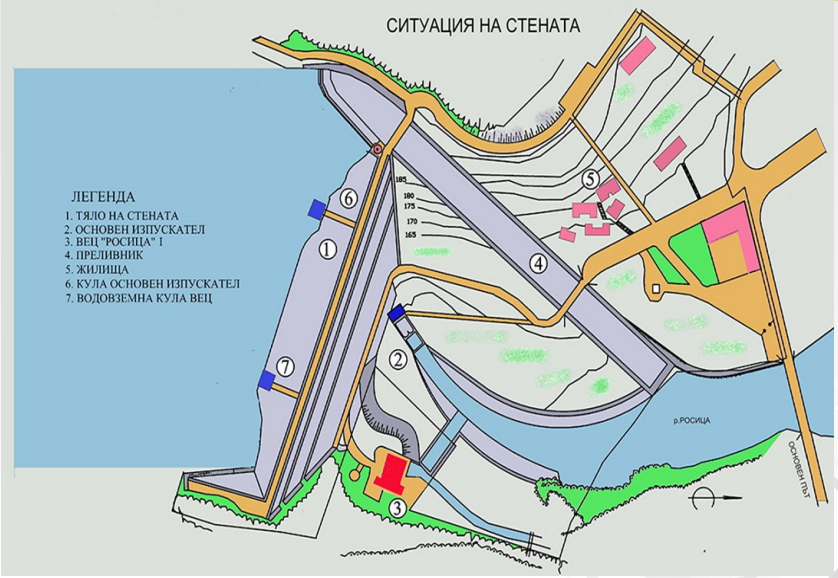
Type - rockfill dam
Year of building – 1974
Hight of the dam – 88,2 m
Length of the dam crest – 737,5 m
Total volume – $144*10^6$ m^3
Catchment area – 219 km^2



Aleksander Stamboliyski Dam

Aleksander Stamboliyski Dam





Type - stone masonry dam
Year of building – 1953
Hight of the dam – 66 m
Length of the dam crest – 300 m
Total volume – $205{,}569*10^6$ m^3
Catchment area – 1478 km^2