



Hydraulic structures. Dams and reservoirs

Elements of dam engineering -1

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

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**Strengthening of master curricula in water resources
management for the Western Balkans HEIs and stakeholders**

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HYDRAULIC STRUCTURES

Dams and reservoirs





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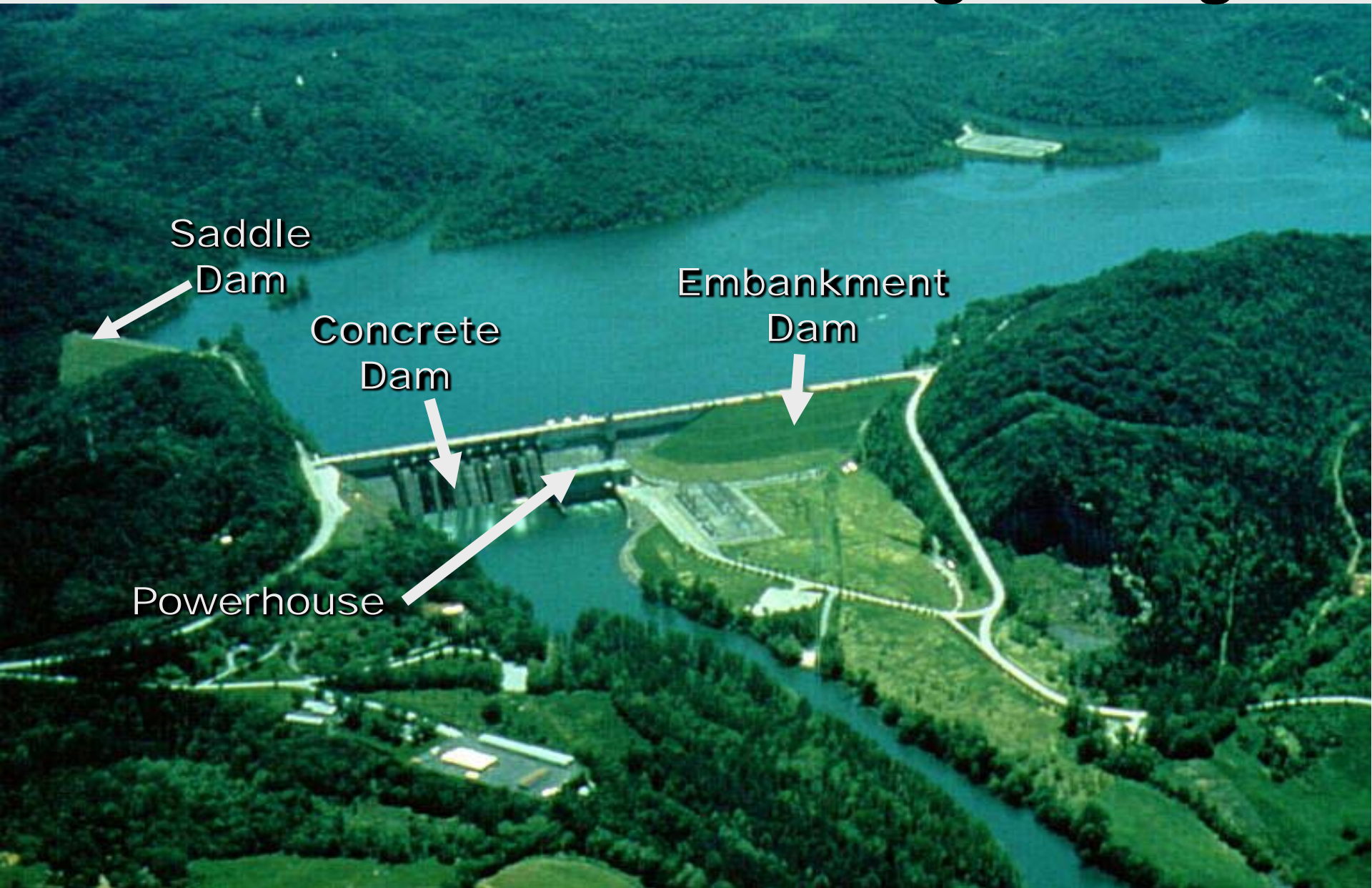
1. (Mo) Elements of dam engineering
2. (Tu) Embankment dam engineering
3. (We) Concrete dam engineering
4. (Th) Dam outlet works and Energy dissipation
5. (Fr) Seminar "Examples of dam construction"

TEXTBOOK

Novak, P., A.I.B. Moffat, C. Nalluri, R. Narayanan. **Hydraulic structures. Fourth edition. Taylor & Francis (2007)**



Q1: Elements of dam engineering



Q1: Elements of dam engineering

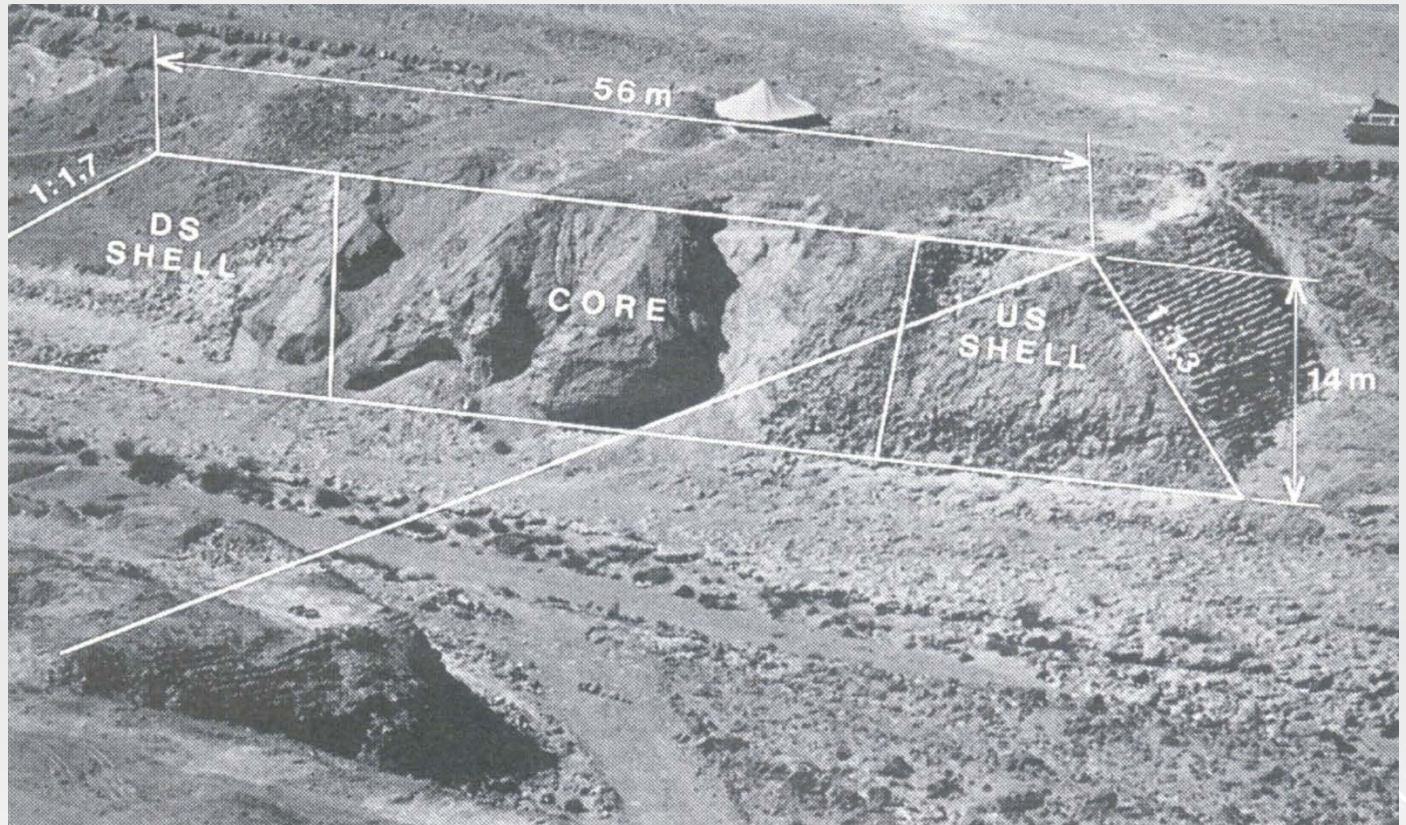
1. Historical perspective
2. Structural philosophy and types of dams
3. Spillways, outlets and ancillary works
4. Site assessment and selection of type of dam



Codex Hammurabi ~ 1750 BC.

§ 53, 54:

IF ANYONE BE TOO LAZY TO KEEP HIS DAM IN PROPER CONDITION AND DOES NOT KEEP IT SO, IF THEN THE DAM BREAKS AND ALL THE FIELDS ARE FLOODED, THEN SHALL HE IN WHOSE DAM THE BREAK OCCURED, BE SOLD FOR MONEY AND THE MONEY SHALL REPLACE THE CORN WHICH HE HAS CAUSED TO BE RUINED.



The oldest dam: SADD EL KAFARA (Egypt) 3100 b.c.
i.e. about 5,000 years ago

Height=14 m, Bcrest=56 m, L=113 m

$W = 0.5 \cdot 10^6 \text{ m}^3$



Bend e Torogh from the upstream side

Iran, about 1450 AD

Height: 20 m, Length: 91 m



Bend e Torogh from the downstream side

Iran, about 1450 AD (*Anno Domini*)

Height: 20 m, Length: 91 m



Cornalvo Dam, Spain

**a Roman gravity dam/earth dam stone facing/, about 100 AD,
in operation about 1,900 years and continues to be functional**

Height: 28 m, Length: 194 m



Proserpina Dam, Spain

**a Roman earth dam with concrete retaining wall lined with stone, about 100 AD,
in operation about 1,900 years and continues to be functional**

Height: 12 m, Length: 428 m



Proserpina Dam, Spain
emptied reservoir from the upstream side
Height: 12 m, Length: 428 m



Kallanai Dam, India

**a composite dam, 100 BC to 100 AD, later reinforced by the British
in operation about 1,900 years and continues to be functional**

Height: 5.4 m, Length: 329 m



Almansa Dam, Spain

**an arc dam in the form of 16 stairs, was completed in 1584
in operation and continues to be functional**

Height: 25 m, Surface of reservoir is 203 km²

Dams: focus points

1. Dams are required to function at or close to their design loading for **extended periods.**



Structural philosophy and types of dams

Dams: for safe retention and storage of water

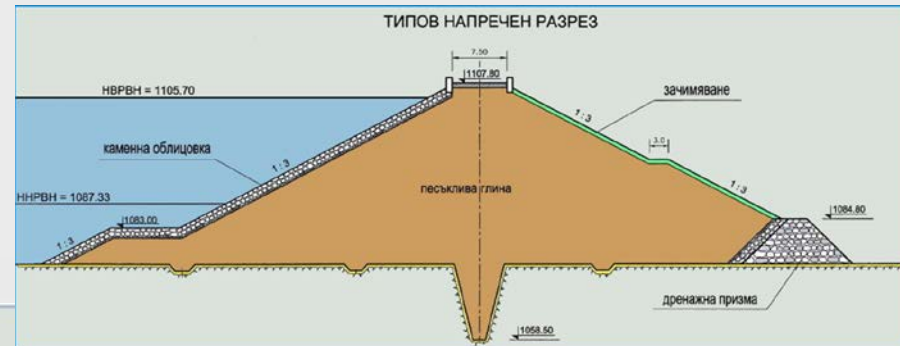
Reservoirs are for

- irrigation,
- water supply,
- hydroelectric power generation,
- river regulation,
- flood control, etc.

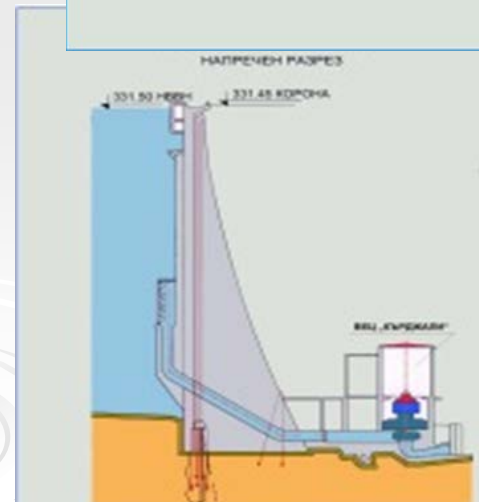
Structural philosophy and types of dams

Dams /construction material employed/

- Embankment dams



- Concrete dams



Dams:

Group

Type

Embankment dams

Earthfill
Rockfill

Concrete dams
(including masonry
dams)

Gravity
Arch
Buttress
Multiple arch

Take a note:

The highest representatives of all dam types are > 300m

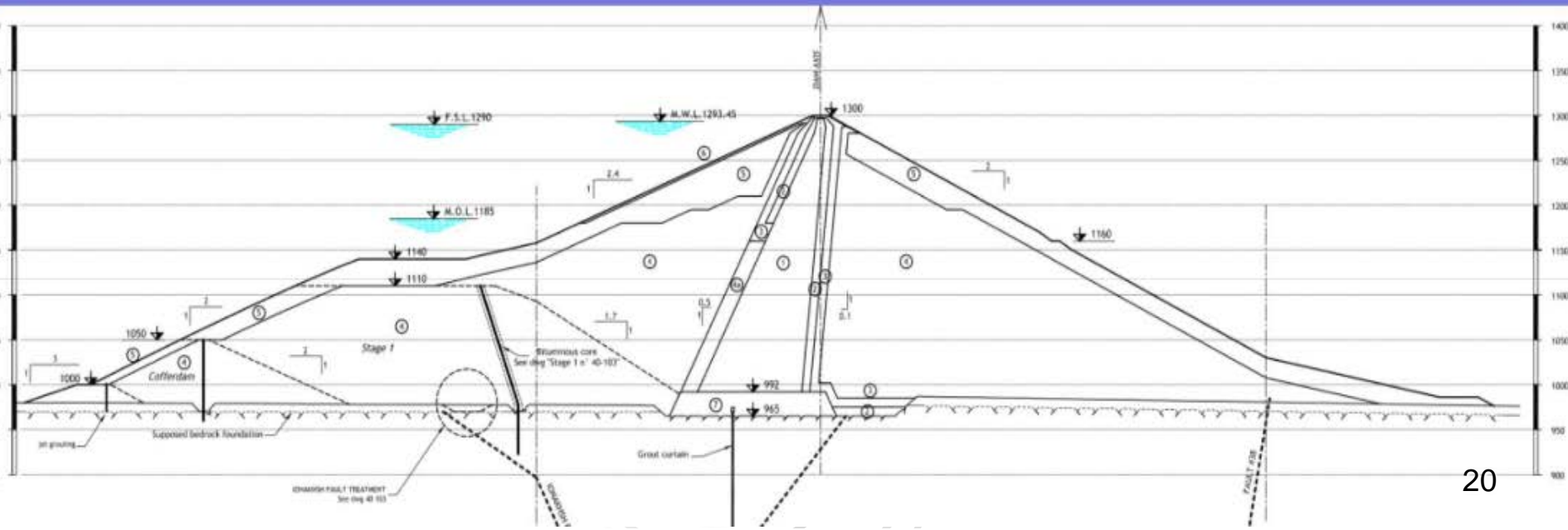
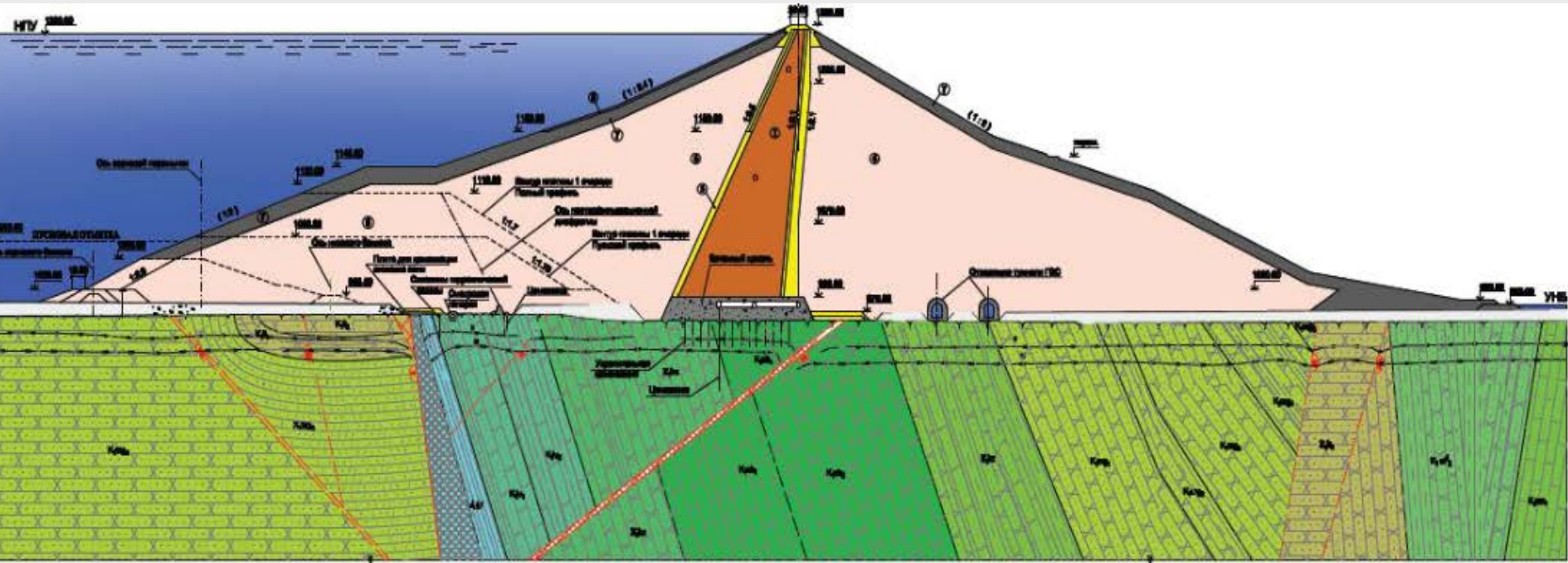


Eiffel Tower,
Paris
300m

The highest Dam is
Rogun Dam, Tadjikistan $H=335\text{m}$
under construction.

Can you guess the dam type?

Rogun Dam Cross Section



Day 01: #1

How to build a dam ?

Dam Construction Film

HOW TO BUILD A DAM

Hydraulic structures > Library

Read the following text:



What does my partner think?



Debate

Important steps in the construction of dams in correct sequence

















Dams: focus points

2. Every dam is **quite unique**

- foundation geology,
- material characteristics,
- catchment flood hydrology etc.

are **sitespecific**