The Ombla HPP Multipurpose Hydro Project

PRESENTATION CONTENT:

- GENERAL
- GENERAL SITE DATA
- HYDROLOGICAL DATA
- IDEA
- INVESTIGATION WORKS
- PROJECT BASIC IDEA
- TECHNICAL CONCEPT
- TECHNICAL SOLUTION
- CONCLUSION
The Ombla HPP Multipurpose Hydro Project

GENERAL
The Ombla HPP Multipurpose Hydro Project

MAIN PURPOSE:

- POWER GENERATION
- THE CITY OF DUBROVNIK POTABLE WATER SUPPLY
The Ombla HPP Multipurpose Hydro Project

is

pioneering attempt to build a power plant using for power generation water from an underground karst aquifer
The Ombla HPP Multipurpose Hydro Project

GENERAL SITE DATA
Ombla spring

- Some five kilometers from the Dubrovnik core there is Rijeka Dubrovačka bay.
- At the far end of the bay lies underground Ombla River spring
The Ombla HPP Multipurpose Hydro Project

HYDROLOGICAL DATA
Ombla spring hydrologic data

- **mean annual discharge** .................. $Q_{\text{mean}} = 24.0$ m$^3$/s
- **max 100-year discharge** .................. $Q_{\text{max}/100} = 113$ m$^3$/s
- **min. 100-year discharge** ............... $Q_{\text{min}/100} = 2.4$ m$^3$/s
- **dry periods in spring catchment area** may last more than 90 days

**THE OMBLA SPRING HAS NEVER DRIED OUT**
there must be an large underground reservoir storing water and discharging it at the spring
The Ombla HPP Multipurpose Hydro Project

IDEA

Use water at the Ombla spring for power generation
The Ombla HPP Multipurpose Hydro Project

INVESTIGATION WORKS
Investigation work tasks

Determination of underground reservoir

- Determine possible impoundment of the underground reservoir
- Determine underground flow directions
- Locate all active and fossil cave conduits
- Filling and emptying process
Ombla spring chachment area hydrogeologic characteristics

Dolomite barrier

Chachment area border

LIMESTONE

Damage in dolomite barrier

UNDERGROUND RESERVOIR AREA

Flysch

Underground conduit
Rock categories

- **Eocene flysch** represents impermeable hydrogeological barrier

- **Triassic dolomite** is a poorly permeable rock with local deviations

- **Jurassic limestone** is permeable rock. The limestone is dominated by typical karst porosity with conduits and caverns of large sizes (hydrogeological collector/aquifer)
Ombla catchment area filling and emptying investigations

Filling and emptying process and underground reservoir behaviour was considered and clarified in numerical model
Ombla catchment area filling and emptying

- Stormwater penetrates the soil and creates an underground reservoir in the Ombla spring catchment area of 600 km²

- Underground reservoir is emptied through the damaged dolomite barrier and the main conduit placed in the southern part of the catchment area

- Difference between min. and max. groundwater table reaches up to 200 m

- The underground stream length from the sinks to the spring reaches up to 30 km
The Ombla HPP Multipurpose Hydro Project

PROJECT BASIC CONCEPT

IDEA

At the Ombla spring construct the dam to create the sufficient water pressure needed for power generation
DAM SITING

Basic condition - find location of the dam without causing environmental damage???

Two possibilities

- Location in Rijeka Dubrovačka bay in front of spring site
- Location under the ground
DAM SITE IN THE BAY

- Barrier damage
- Piezometric line
- Underground caves area
- Ombla spring
- Underground reservoir area
- Drainage conduit area
DAM SITE IN THE BAY
DAM SITE UNDER THE GROUND

- Barrier Damage
- Caves Area
- Grout Curtain
- Omla Spring
- Underground reservoir area
- Drainage conduit area
The Ombla HPP Multipurpose Hydro Project

TEHNICAL CONCEPT
POWER-GENERATION HERNESSING USING UNDERGROUND DAM

THE DAM BODY CONSISTS OF A NATURAL ROCK Mass WITH A WATERPROOF SCREEN (GROUT CURTAIN)
DETERMINATION MAIN DAM CHARACTERISTICS AND PRECISE DAM SECTION LOCATION

- Dam height over sea level
- Dam perimeter
Grout curtain  (300,000 m²)

GROUTING
12 m DISTANCE - PRIMARY BOREHOLES
6 m DISTANCE - SECONDARY BOREHOLES

GROUTING
12 m DISTANCE - PRIMARY BOREHOLES
6 m DISTANCE - SECONDARY BOREHOLES
3 m DISTANCE TERTIARY BOREHOLES

JET GROUTING IN ONE DIRECTION
DISTANCE  1 m

LIMESTONE & DOLOMITE
FLYSCH
FAULT ZONE
PROJECT CAPACITY SELECTION AND DETERMINING CHARACTERISTICS OF GENERATING UNITS

Key points for project capacity selection (turbine discharge) and determining characteristics of generating units are:

- discharge duration curve along connected with possible mean annual output
- pool elevation lowering during one year
- biological minimum discharge 4 m³/s

PROJECT CAPACITY SELECTION ALONG WITH OPTIMUM DAM HEIGHT ELEVATION WAS DETERMINED ON MATHEMATICAL MODEL
CAPACITY SELECTION

Research result on a mathematical model

- Under the condition when the pool elevation is at 130.00 m a.s.l. and the biological minimum at low streamflow totals 4.0 m³/s, the natural outflow duration curve is visibly transformed.

- The pool elevation lowering is planned to the level of 75.00 m a.s.l.

- Power Plant discharge 60 m³/s
- Genaratig units 2x 24 m³/s + 2x6 m³/s
- Optimum dam height 130 m a.s.l.
The Ombla HPP Multipurpose Hydro Project

TECHNICAL SOLUTION
THE OMBLA HPP MULTIPURPOSE HYDRO PROJECT

GROUT CURTAIN

POWERHOUSE AND SWITCHYARD

DUBROVNIK WATERWORKS PUMPING STATION
Q=510 l/s

RIJEKA DUBROVAČKA BAY

Qmax=120 m3/s

Howell-Bunger valves capacity Q=2x60 m3/s

Slide gate capacity Q=120 m3/s

Q=2x24 m³/s+2x6 m³/s

DUBROVNIK WATERWORKS

MAIN DRAINAGE CONDUIT

ACCES TUNNEL

SPRING CAVE

TAILRACE TUNNELS

WATER CHAMBER

HEADRACE TUNNEL

INTAKE STRUCTURE

VERTICAL SHAFT

OVERFLOW

GROUT GALERIES

WATER CHAMBER

INTAKE STRUCTURE

POWERHOUSE AND SWICHYARD

DUBROVNIK WATERWORKS PUMPING STATION
Q=510 l/s

RIJEKA DUBROVAČKA BAY

Qmax=120 m3/s

Howell-Bunger valves capacity Q=2x60 m3/s

Slide gate capacity Q=120 m3/s

Q=2x24 m³/s+2x6 m³/s
HPP Ombla in Rijeka Dubrovačka bay
BEAUTIFUL LANDSCAPE OF RIJEKA
DUBROVAČKA BAY WILL BE PRESERVED
HPP TECHNICAL DATA

- Mean annual discharge.................................24.0 m³/sec
- Max. gross head........................................128.8 m
- The power plant capacity..............................68 MW
- Rated discharge........................................60 m³/s
- Average annual output..............................225 GWh
- Turbines
  - rated discharge.................................2x24 m³/s+2x6 m³/s
  - rated power......................................2x27.6 MW+2x5.6 MW
- Generator..............................................2x30 MVA+2x8 MVA
- Switchyard 110 KV..........................metal-enclosed, three-pole, SF₆
- Operating mode................................run-off-the-river

- Planned Dubrovnik Waterworks capacity is about 1500 l/s potable water
- The project costs are estimated at EUR 150 millions
- The construction is planned to last about 4,5 years.
HPP location characteristics

- All the Ombla HPP equipment and structures will be placed under the ground
- The plant is completely hidden under the ground
- The natural harmony of the Ombla spring area will be conserved
CONCLUSION

- The Ombla HPP concept is a completely new approach to the water power harnessing in power generation which can only be implemented under adequate hydrogeological conditions.

- Locating of the entire facility under the ground reduces the construction costs and prevents its environmental impact.

- Successful implementation of this project could encourage other countries with karst areas to look into the possibility of building similar projects.
THANK YOU FOR YOUR ATTENTION