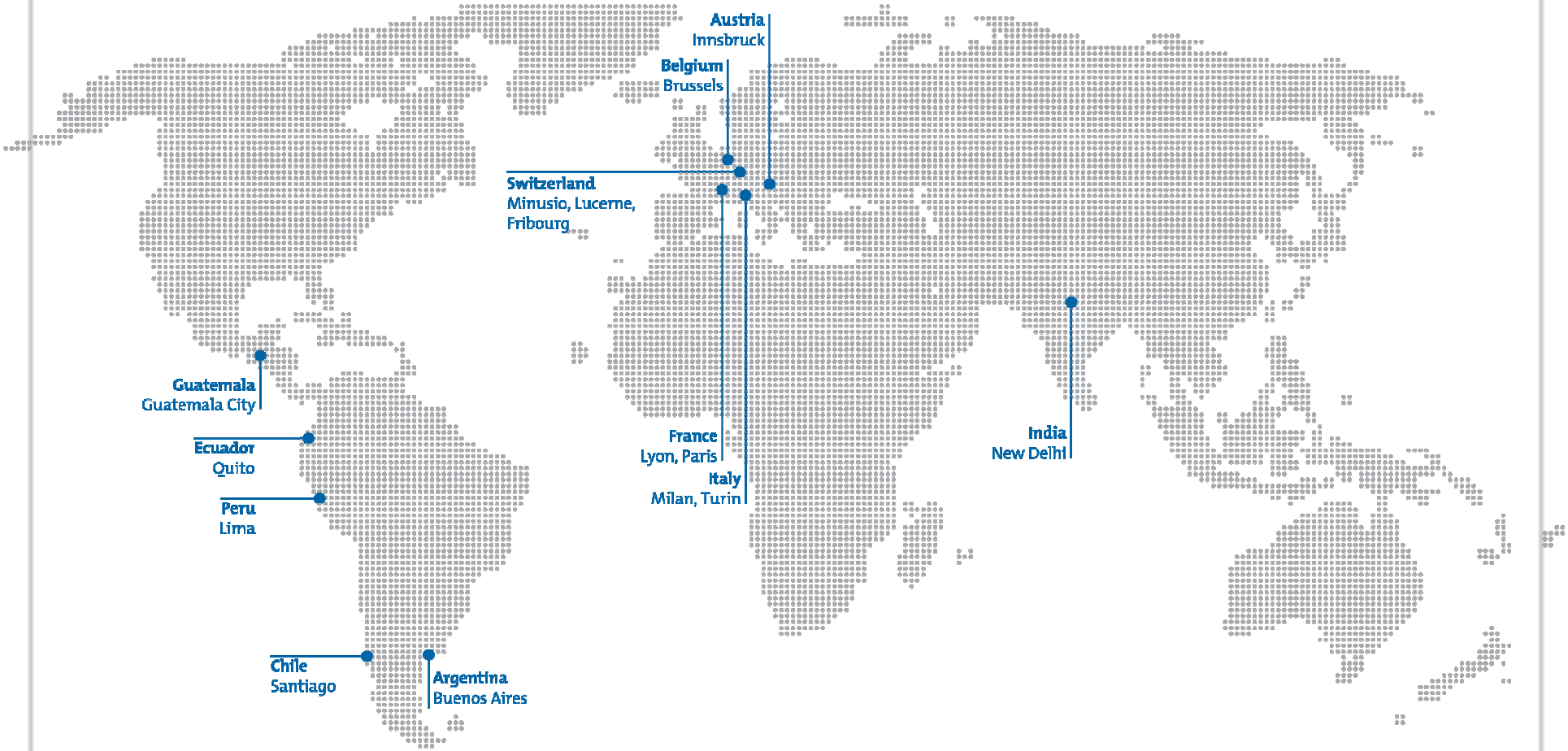
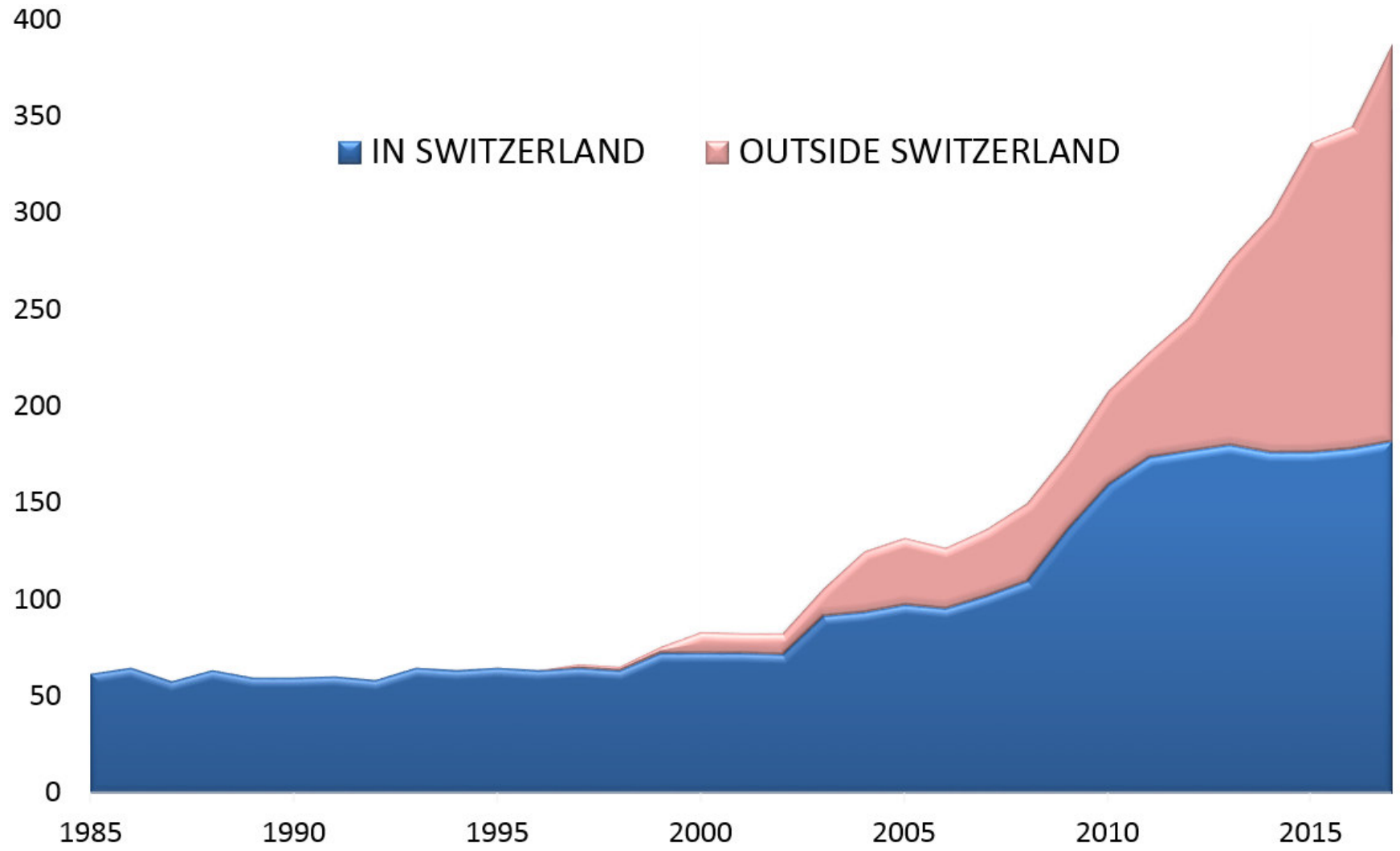
Lombardi

Minusio, 04.2018

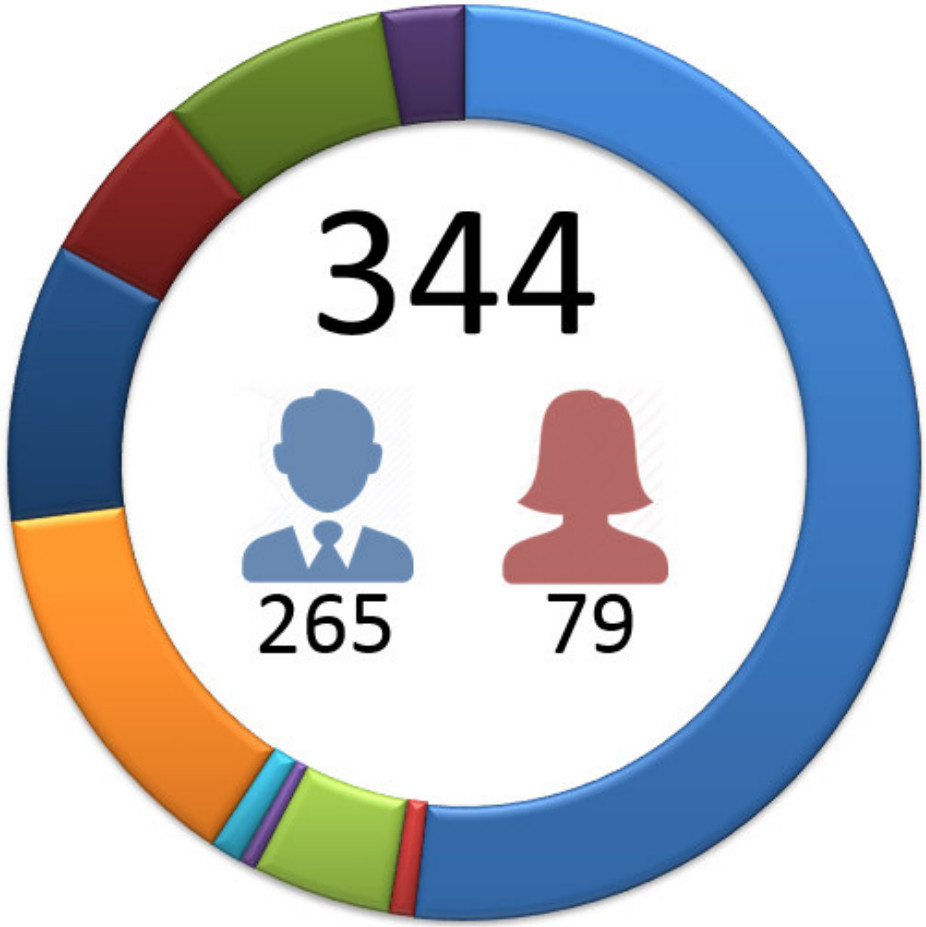
LOMBARDI group / www.lombardi.ch



1984-2016 – development of workforce

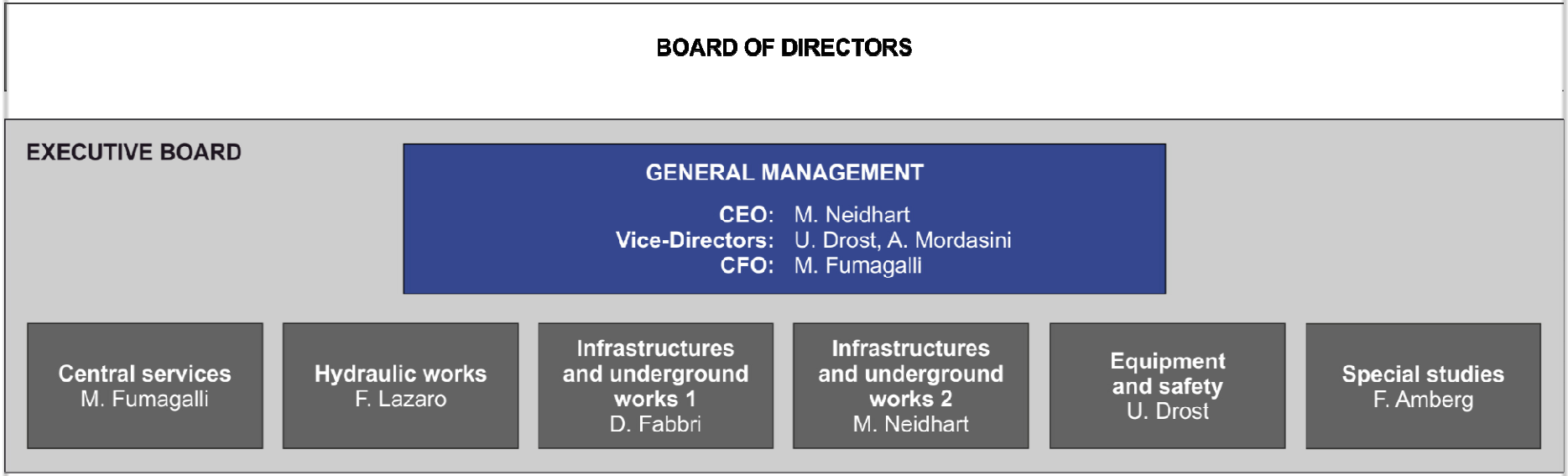


LOMBARDI group (2018)



178	Switzerland
3	Ecuador
17	Peru
2	Chile
4	Austria
47	Italy
34	France
21	Belgium
28	Guatemala
10	India

Organisation chart of Lombardi Ltd

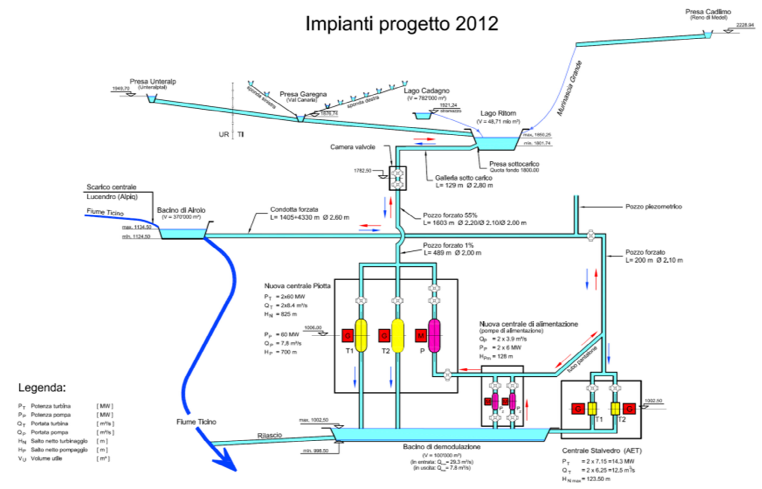


Hydraulic works

Muttsee Dam, Switzerland

- Low and high head plants
- Dams (arch, gravity, embankment)
- Appurtenant structures (diversion, spillway, bottom outlets, etc.)
- Free flow and pressure tunnels
- Powerhouses (civil and electromechanical infrastructures)
- River engineering

Ritom PSP (120 MW), Switzerland



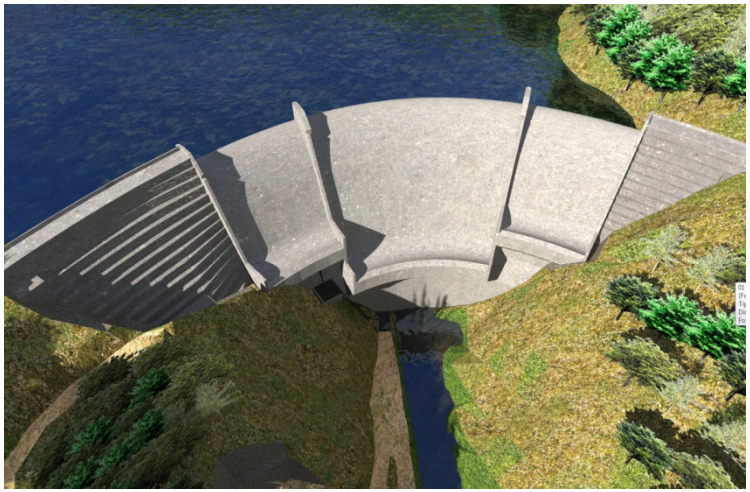
- *Client*:
- Ritom SA (FFS e AET)

- *Key aspects of the Project* :
- New pumped-storage plant
- New water intake structure in the lake Ritom
- New inclined shaft L= 1.6 km, D=2.2 m
- New steel lined tunnel L=500 m, D=2.0 m
- New outdoor powerhouse
- Two Pelton units P= 2 x 60MW, Q= 2 x 8.4 m^3/s
- One Pump unit P= 60MW, Q= 7.8 m^3/s

- *Services provided* :
- Final design

- *Period*:
- Period of services : 2015 – in progress

Arenal HPP, Honduras



- *Client*:

•Energías Limpias del Yaguala, S.A. de C.V.

•*Key aspects of the Project*:

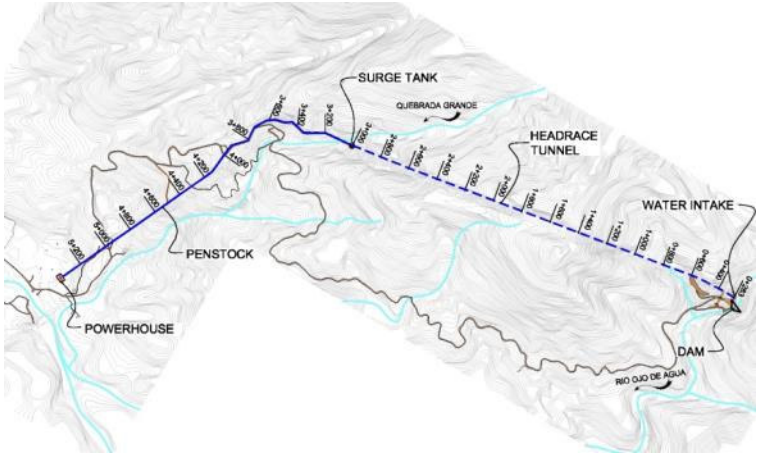
- RCC arch-gravity dam, H=93.5 m
- Headrace tunnel, L=4.52 km, S=28.5 m^2
- Penstock, L=110 m, D=2.40 m
- Outdoor powerhouse equipped with two Francis units, P= 60 MW

•*Services provided*:

- Final design
- Detailed design and construction drawings
- Site Supervision

- *Period*:
- Period of services: 2015 – 2020

Ojo de Agua, Honduras



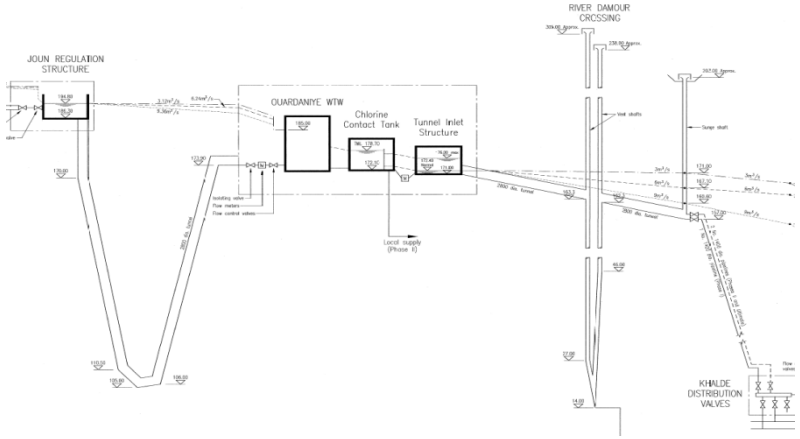
- *Client*:
- Sociedad Hidroelectrica Olanchana SA de C.V. (SHOL)

- *Key aspects of the Project*:
- Gravity dam H=41.5 m
- Water intake Q=6 m^3/s
- Headrace tunnel L=2.9 km, S=10 m^2
- Penstock L=2.3 km, D=1.7 m
- Powerhouse equipped with 2 Pelton units (P=2x11.25 MW)

- *Services provided*:
- Detailed design
- Detailed design and construction drawings
- Site supervision

- *Period*:
- Construction period: 2013 – 2015
- Period of services: 2013 – 2015

Greater Beirut Water Supply Project, Lebanon



- *Client*:

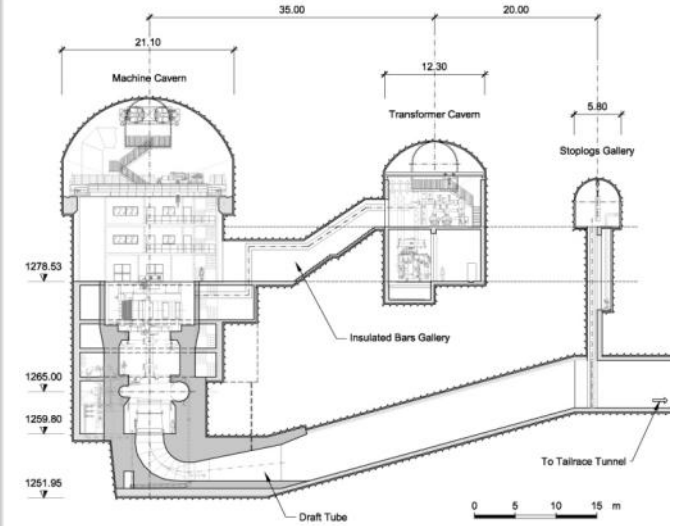
•CMC-Ravenna, Italy

- *Key aspects of the Project* :
- 3 hydraulic tunnels L_{tot}=24 km, D=2.8 m
- Twin pipeline L=5.4 km, D=1.4 m

•*Services provided* :
- Final design
- Detailed design and construction drawings
- Site assistance to the client during construction

- *Durée*:
- Construction period : 2016 – 2019
- Period of services : 2015 – 2019

Cerro del Águila HPP, Perú



- *Client*:
- Cerro del Águila SA

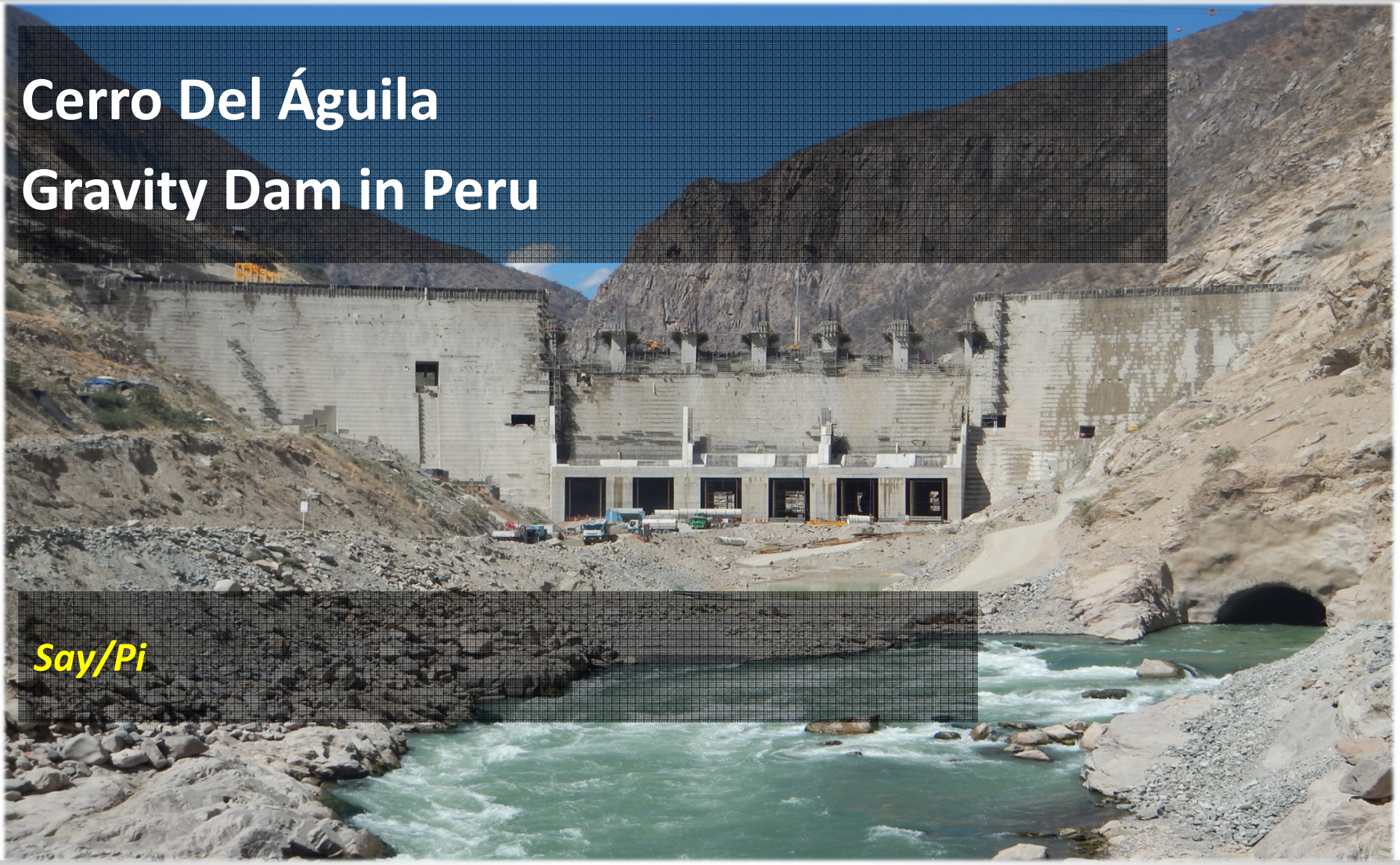
- *Key aspects of the Project*:
- RCC dam H=80 m L= 265
- Spillway capacity 7'000 m^3/s
- Bottom outlet capacity 5'000 m^3/s
- Water intake Q=210 m^3/s
- Headrace tunnel L=5.7 km, S=93 m^2
- Underground powerhouse (B x L x H=18 x 86 x 46 m) equipped with 3 Francis units (P=510 MW)
- Tailrace tunnel L=1.9 km, S=90 m^2

- *Services provided*:
- Detailed design and construction drawings
- Assistance during construction

- *Period*:
- Construction period: 2012 – 2016
- Period of services: 2012 – 2016

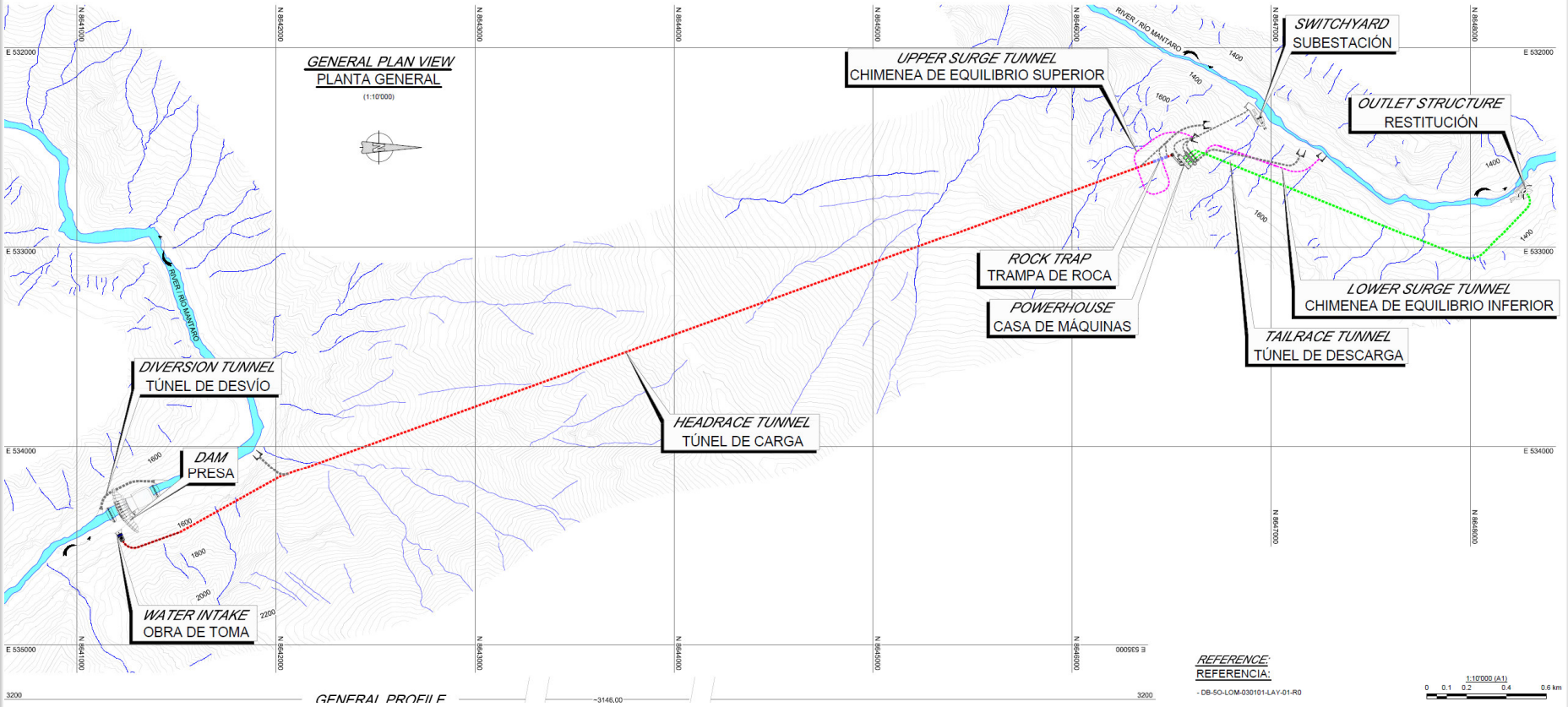
Lombardi

Cerro Del Águila
Gravity Dam in Peru

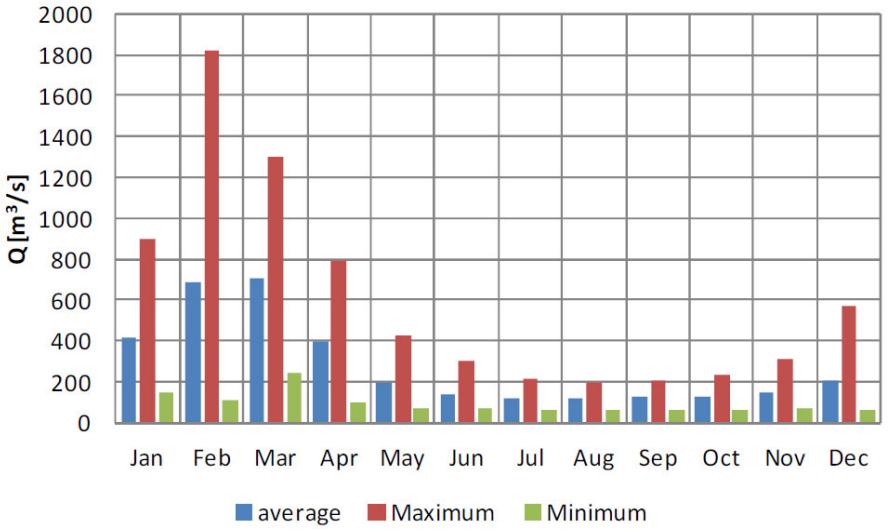


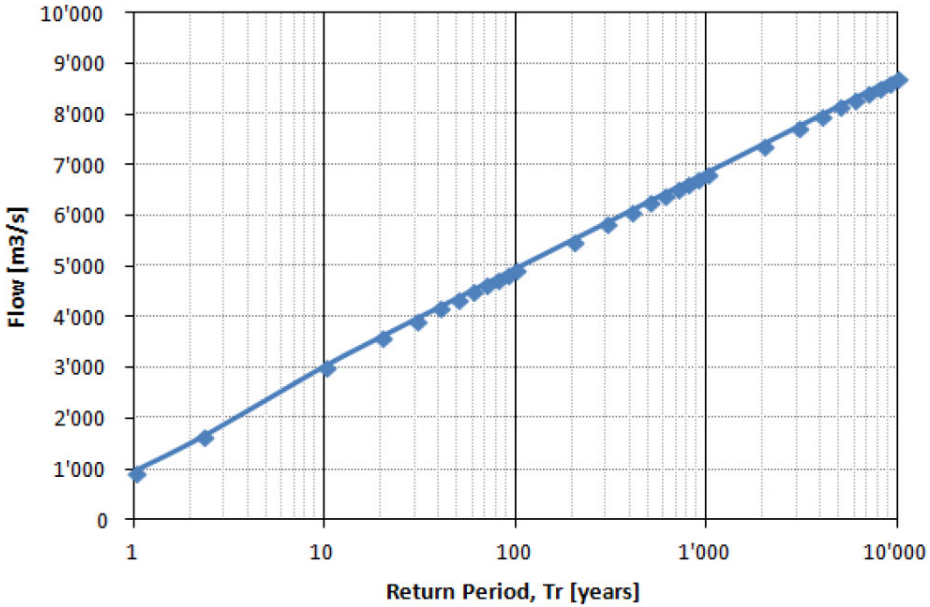
Say/Pi

1. General layout of the project: planimetry



1. Hydrology of the site





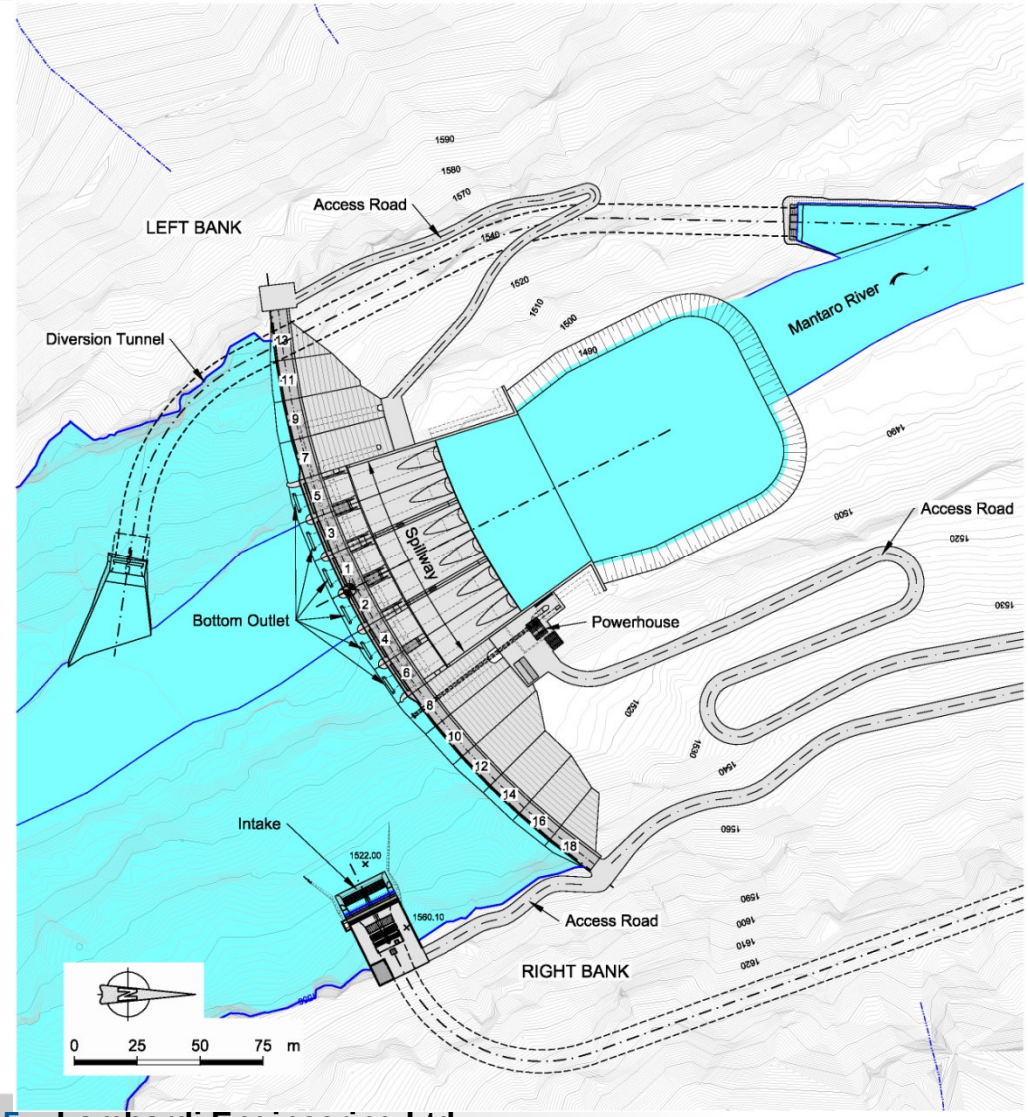
Q Average / Min. / Max. flow: 270 / 70 / 1'800 m^3/s

Q $_{Tr=1000}$= 6'100 m^3/s

PMF= 12'000 m^3/s

Sediment transport = 3.5 Mm^3/year !!

2. Dam site layout



Artificial reservoir and dam

Dam type: gravity dam (arch form)

Dam height: 90 m (El. 1470-1560 m asl)

Dam crest length: 270 m

Total impoundment volume: ~37 Mm^3

Bottom outlet:

6 x 2 slide gates

b x h = 4.60 x 6.00 m

max. capacity: 5'000 m^3/s

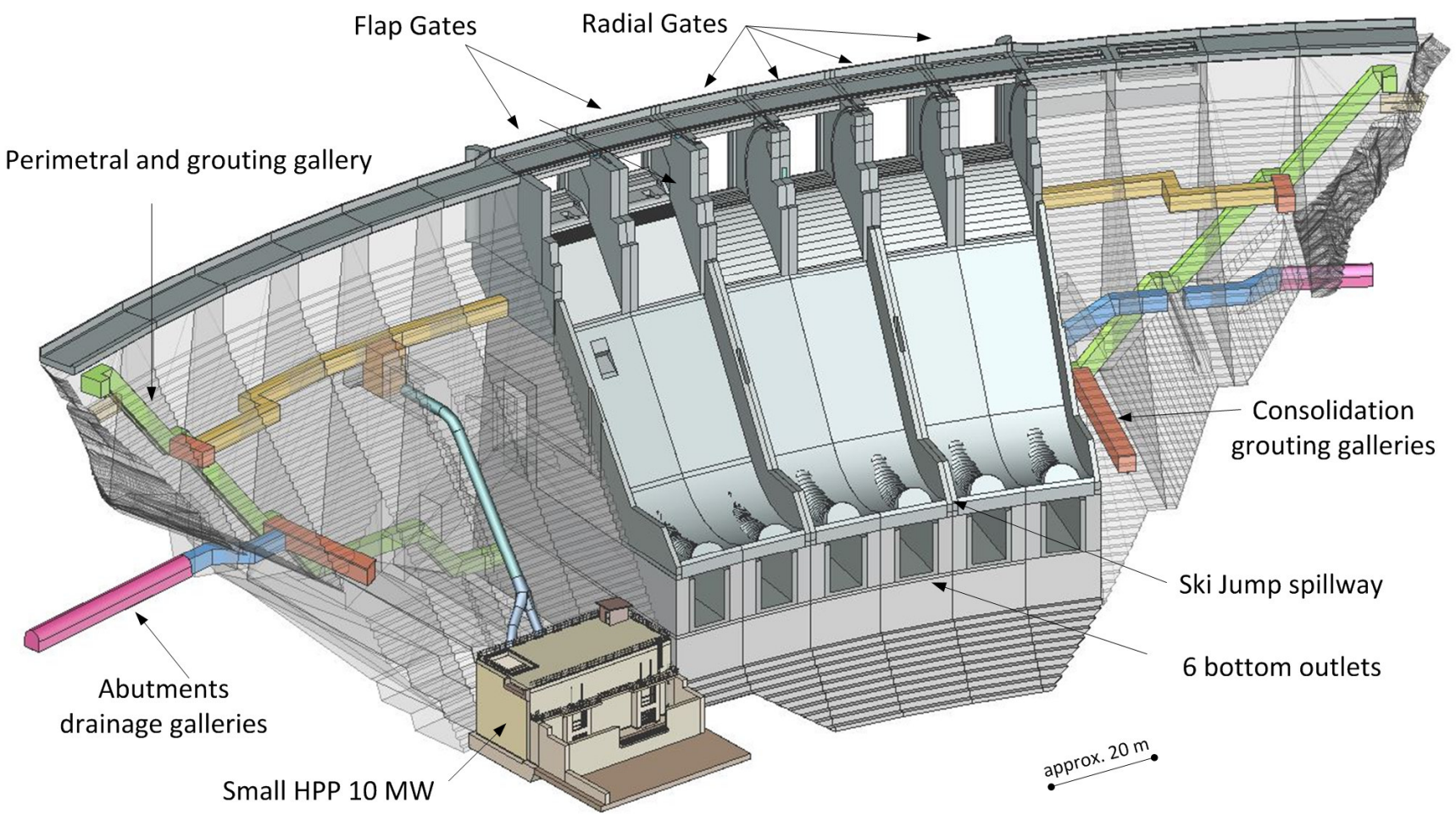
Surface spillway:

4 x radial gates: b x h = 12.00 x 12.00 m;

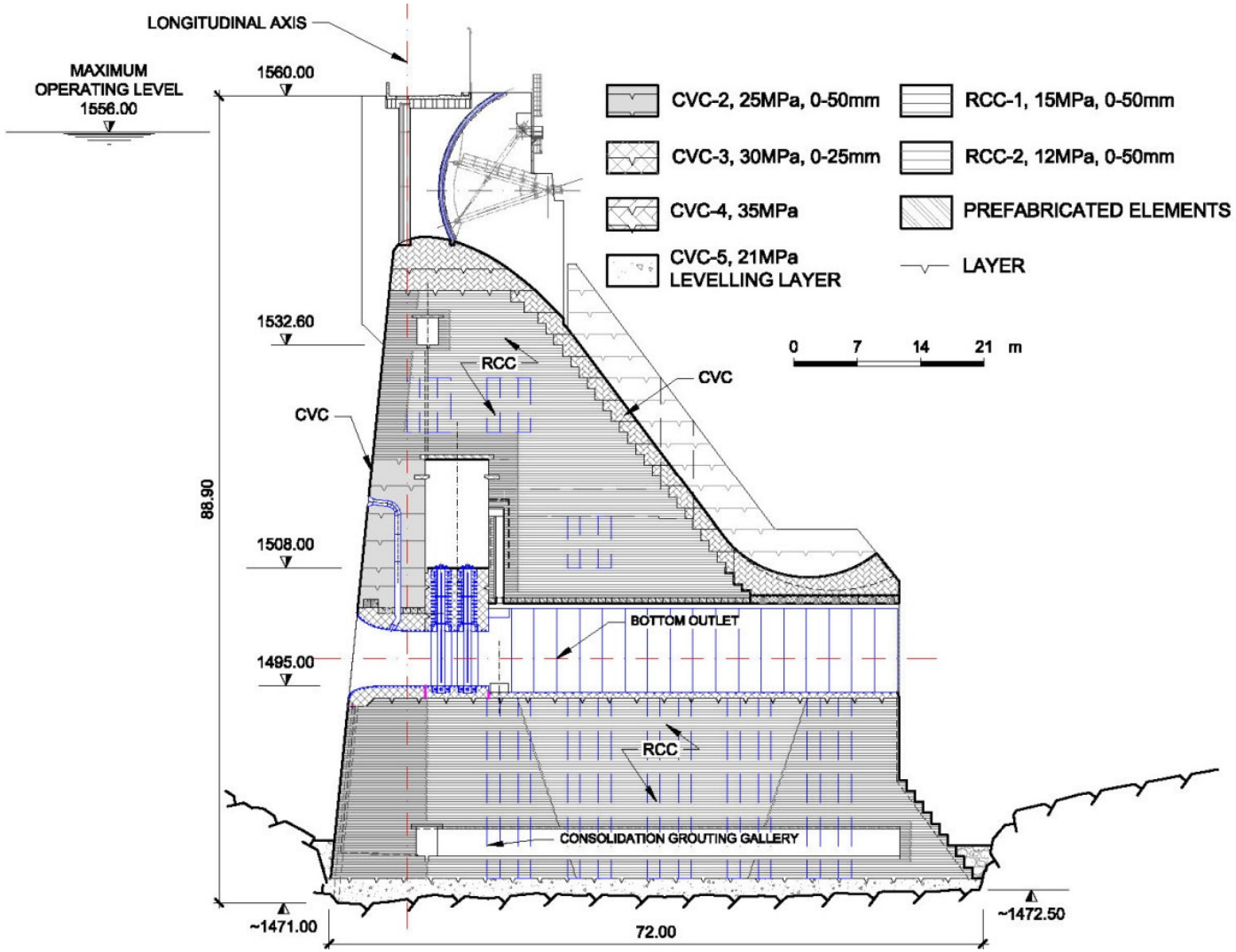
2 flap gates : b x h = 12.00 x 5.50

Max. capacity: 7'000 m^3/s

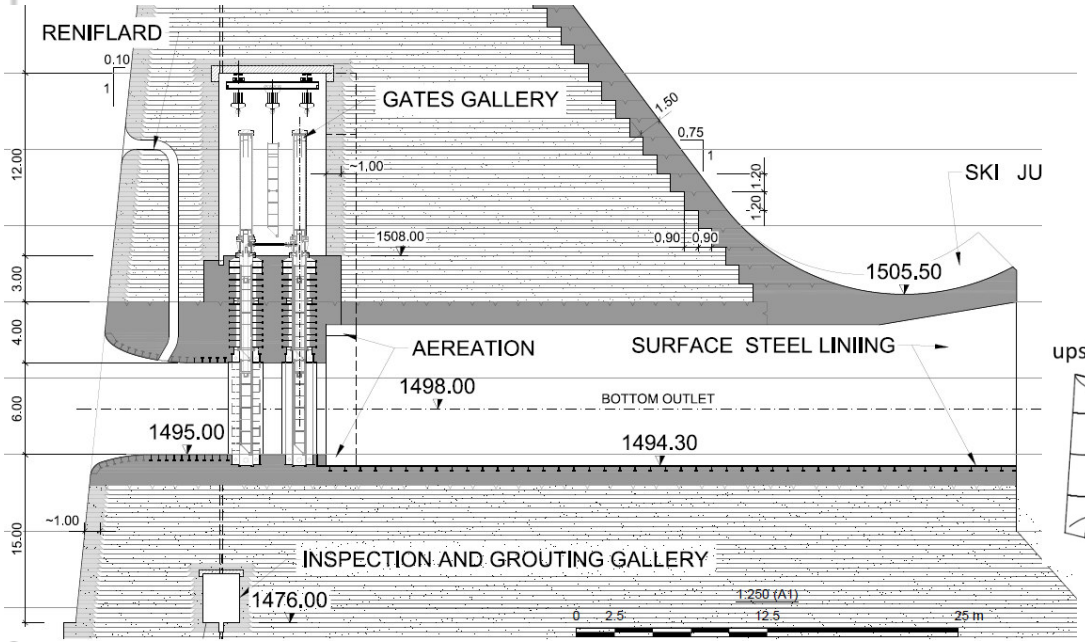
2. Main features of the dam

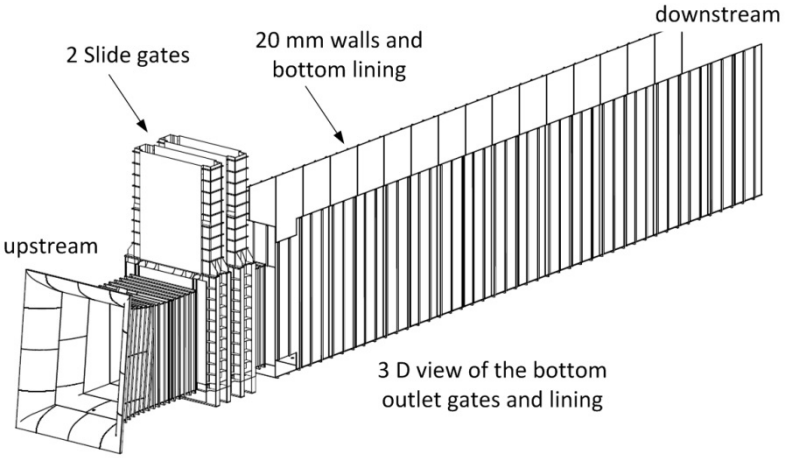


2. Typical central block of the dam



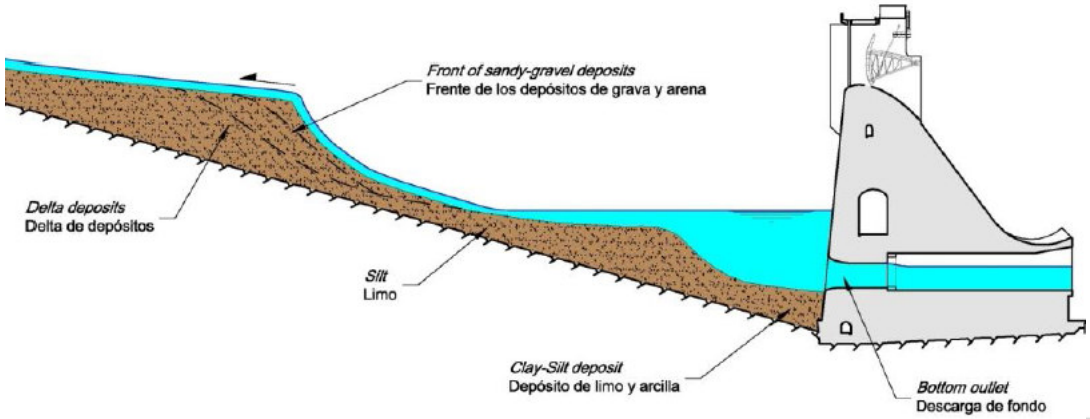
2. Typical central block of the dam





Q max= 1'100 m^3/s

Q sediments= 0.5 Mm^3 / 5 days

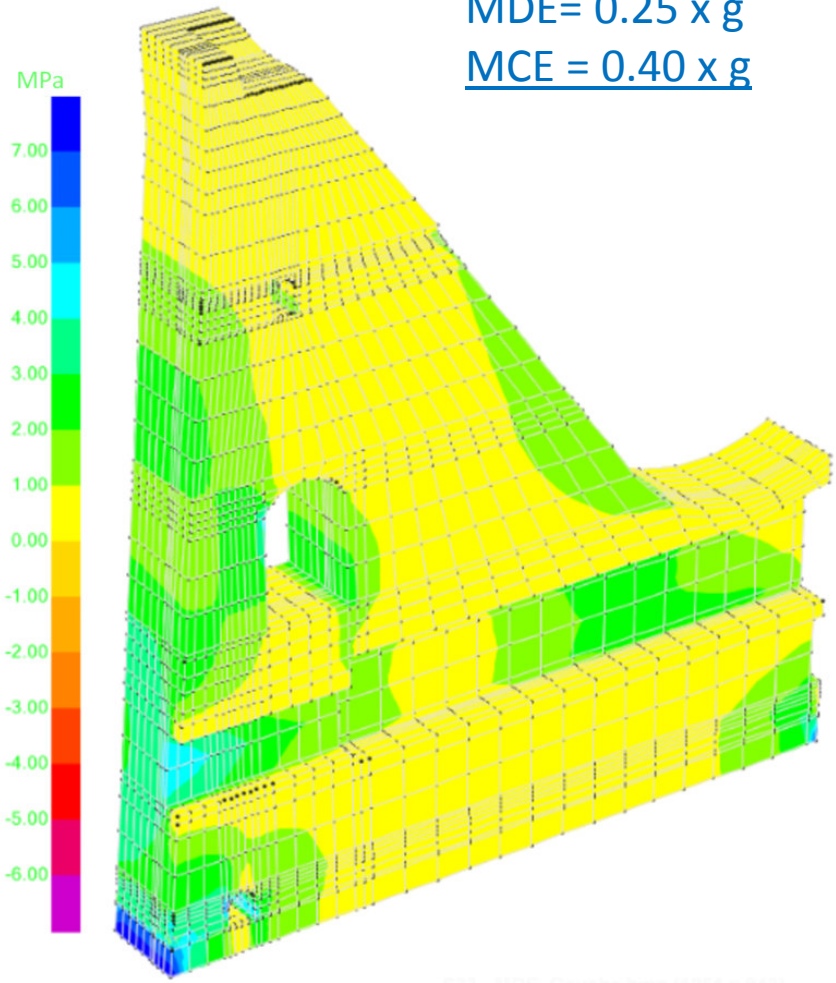


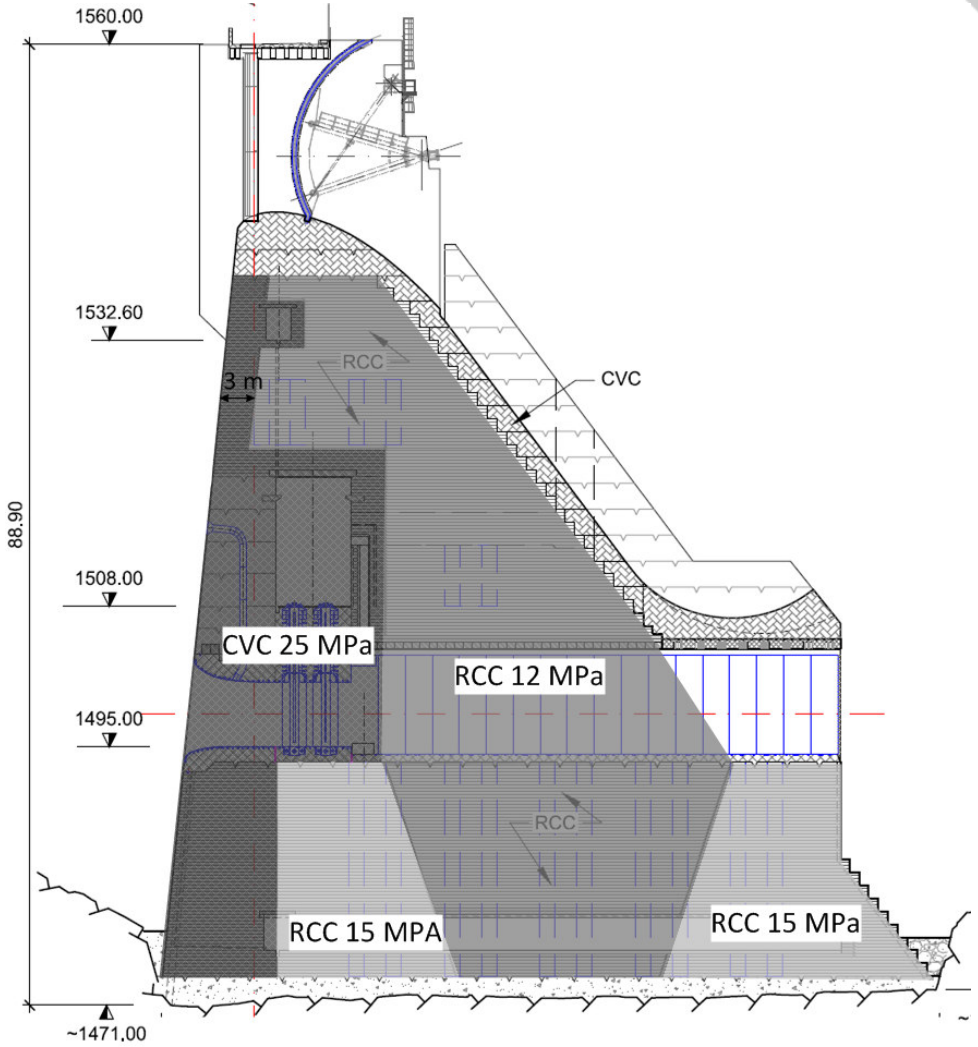
3. Dam zoning as function of CVC/RCC/Quality

Stresses [MPa]

MDE= 0.25 x g

MCE = 0.40 x g





3. Mix design

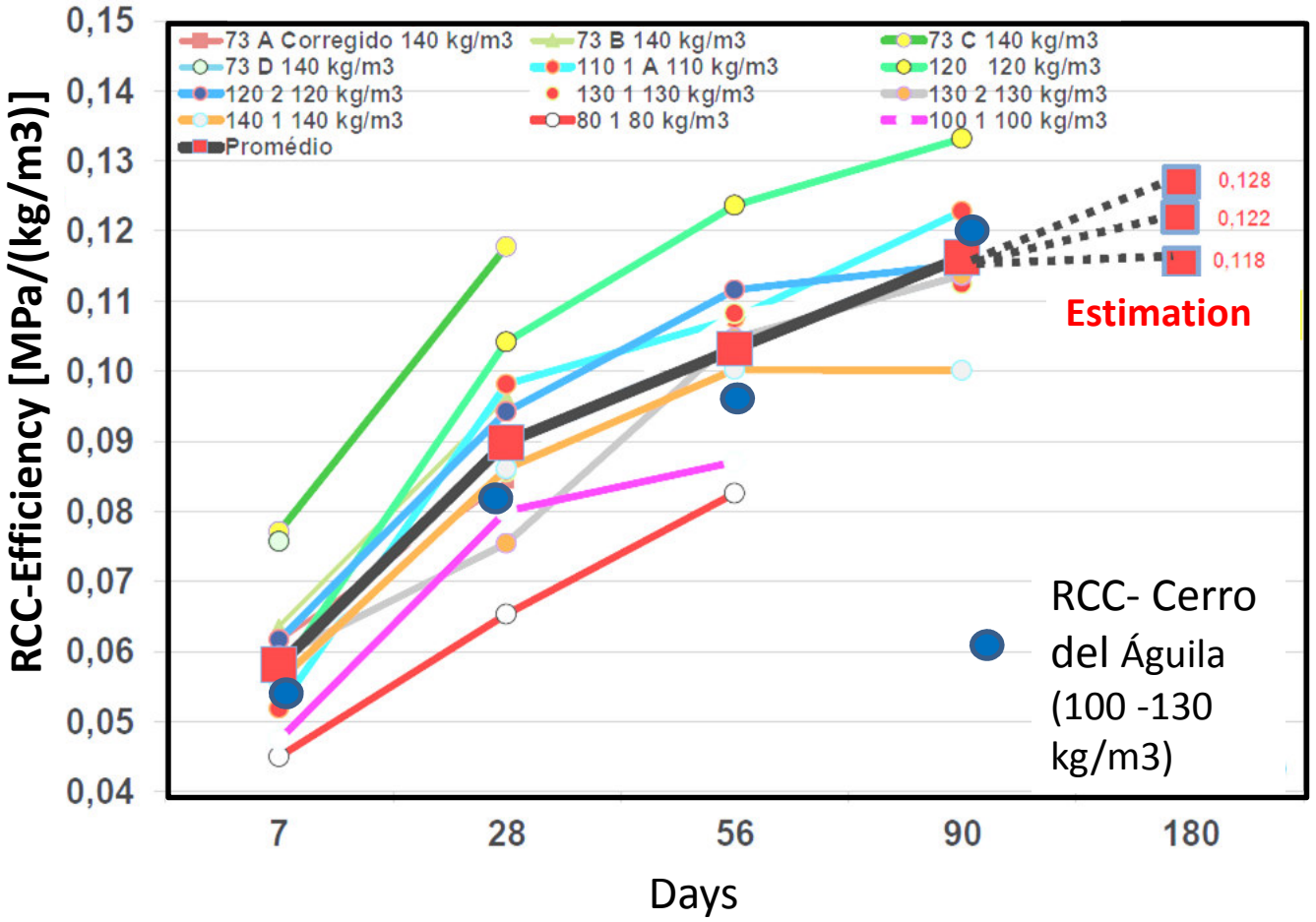
Concrete typology	RCC 1	RCC 2	CVC 1	CVC 2
Construction methodology	Roller compacted	Roller compacted	Conventional massive	Conventional massive
Specified compressive strength of concrete [MPa]	15	12	15	25
Mean compressive controlled strength of concrete [MPa]	15<fcj<19	12<fcj<14	15<fcj<19	25<fcj<30
Age [days]	180	180	180	180
Consistency / slump	Vebe 20±5 sec.	Vebe 20±5 sec.	Slump 100±25 mm	Slump 100±25 mm
Cement [kg/m^3] **	130	100	200	280
Water [kg/m^3]	130±2	132±2	190±5	185±5
Sand [kg/m^3]	1095	1104	985	948
Aggregate (25-5 mm) [kg/m^3]	795	815	605	565
Aggregate (50-25 mm) [kg/m^3]	275	275	400	380
Admixtures	Set retarder/water reducer	Set retarder/water reducer	Set retarder/water reducer + Superplasticizer	Set retarder/water reducer + Superplasticizer
Theoretical density [kg/m^3]	2430±20	2430±20	2380±20	2380±20

** Type IP-23 % Pozzolan

3. Full scale test section

3. Extraction and testing cores

3. Efficiency of the mix components



4. Galleries and concrete transportation

4. Galleries and concrete transportation

4. Cold joint treatment

4. Cold joint treatment

4. Contraction joints (every 2 layers of 30 cm)


RCC joints cutting


RCC joints


CVC joints

4. Shear keys

2000 m3/s flood diverted through the bottom outlets


Thanks for you attention
Lombardi