



Submission No. 0410 – presentation:

# **Innovative approach to the design of stilling basin: improvement of fish migration and scour utilization for energy dissipation**

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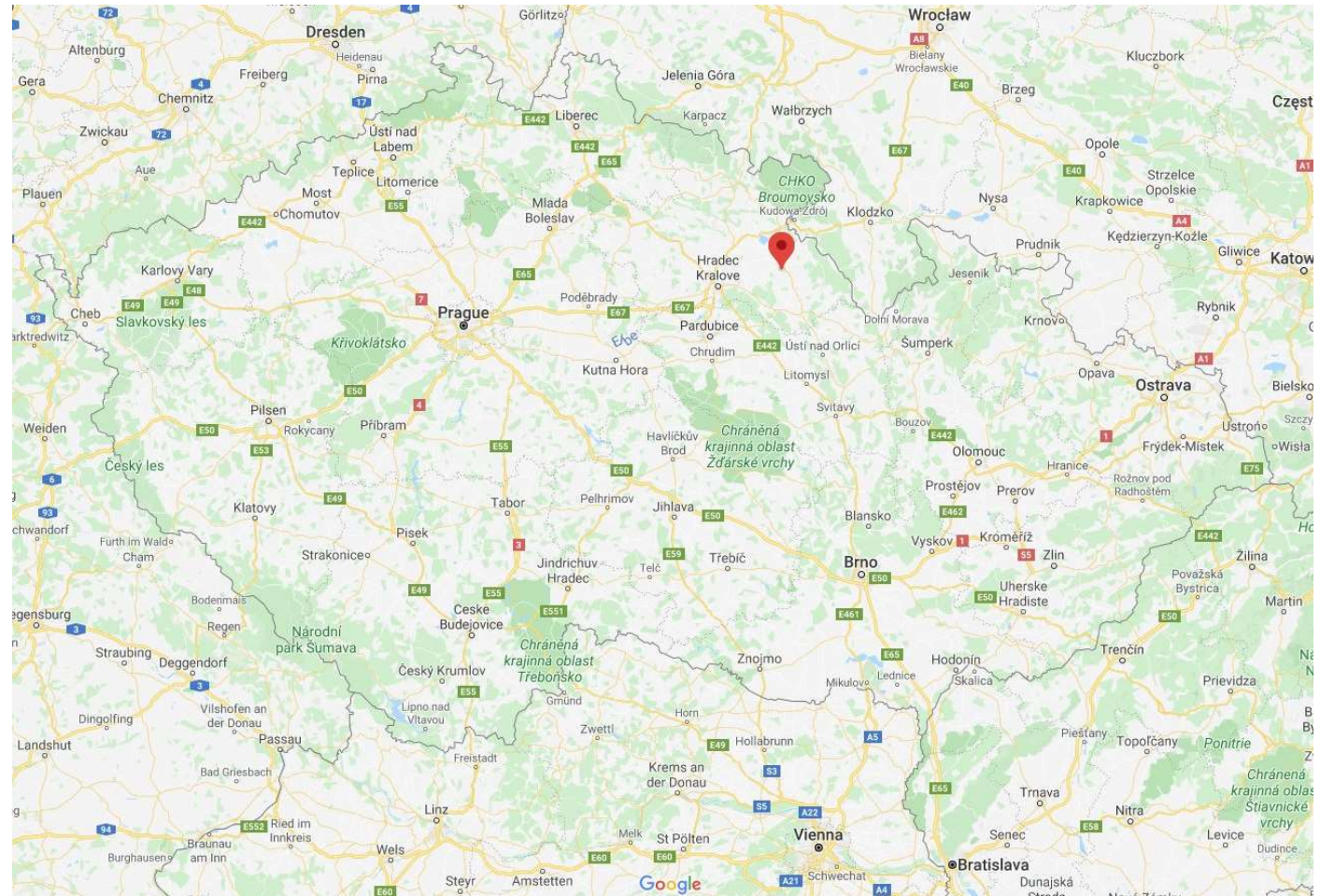
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## Map of the Czech Republic



**Our paper presents an original technical solution which was designed for the currently prepared project Dry Retention Reservoir Měčany (Czech Republic).**

**Current environmental requirements for newly built in-stream hydraulic structures also require ensuring their migration permeability.**



## Motivation for the project:

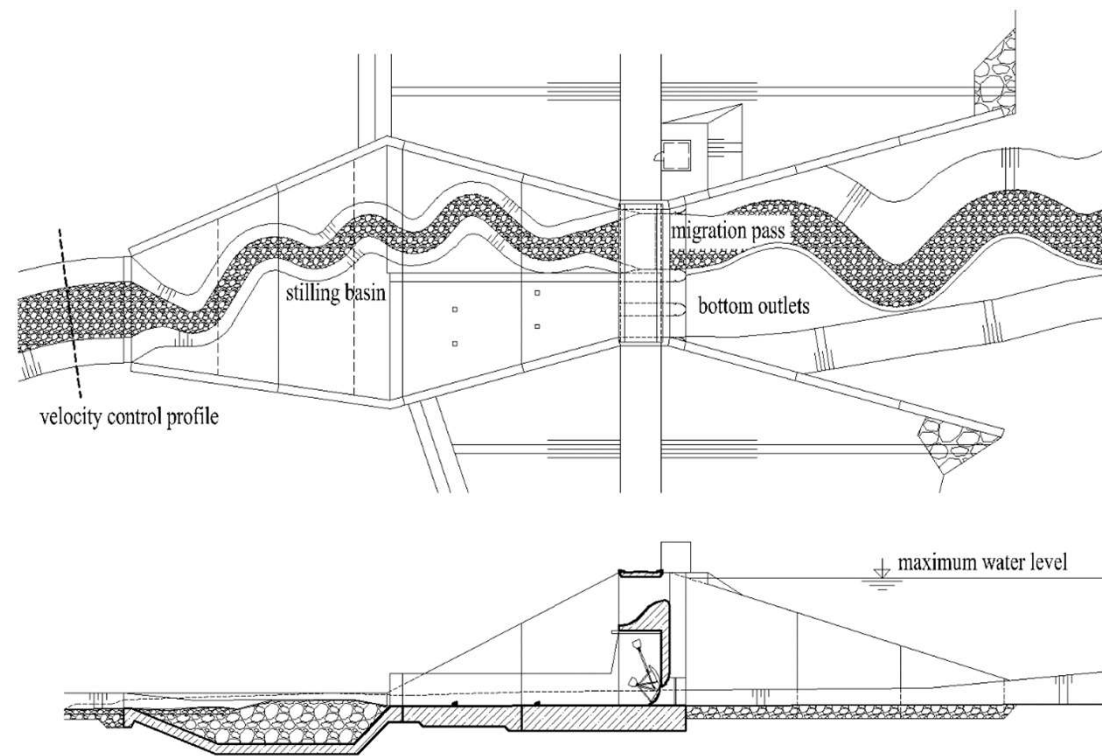
Floods at the Dědina stream water basin in 1997, 1998, 2011



## Proposed solution:

### Dry Retention Reservoir Mělčany (2020 - Project stage)

19-meter-high earthfill dam; storage capacity ca 3.2 mil m<sup>3</sup>; migration pass 6,6 x 1,5m; 2 bottom outlets



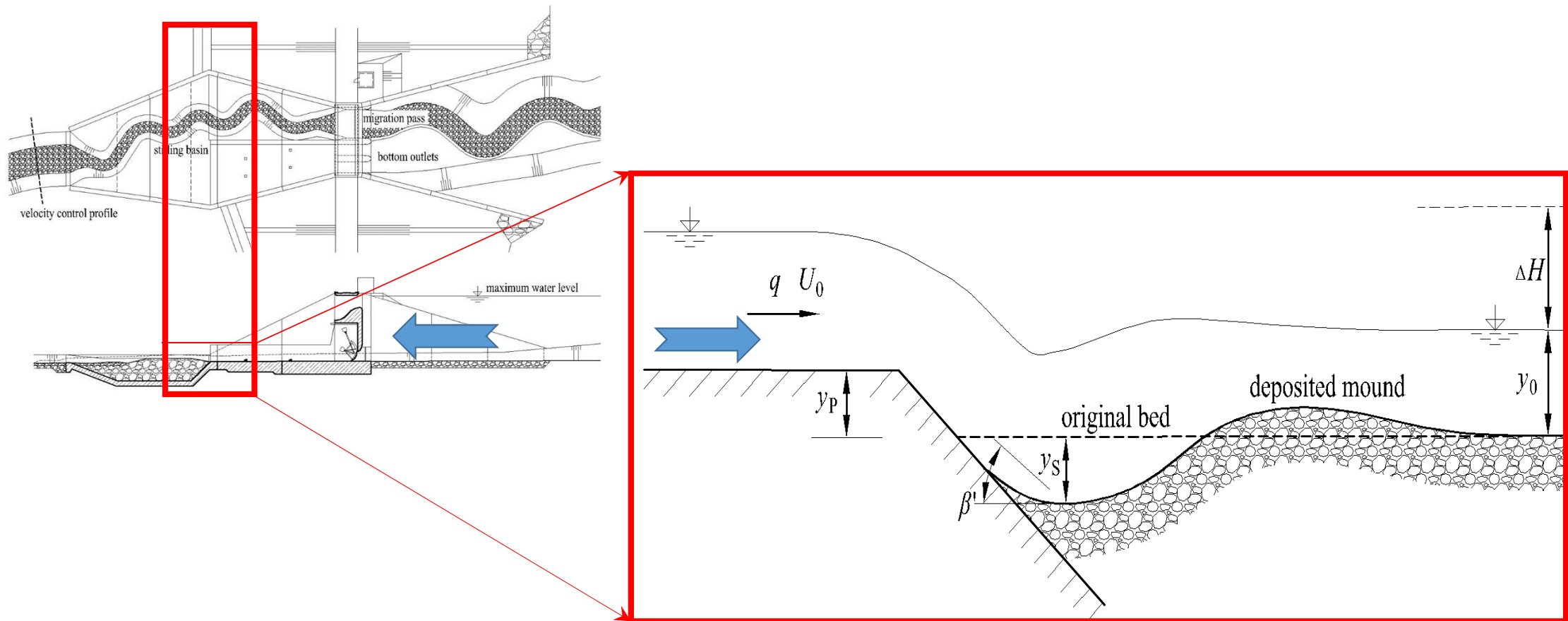
Layout of the combined structure (up) and section of the dam (down).



Visualization of the filled stopping basin and combined structure.

## Proposed solution:

Great attention was paid to the design of the stilling basin



Definition sketch for scour downstream in-stream hydraulic structures

## Different point of view to the purpose/function of the stilling basin

Stilling basin		
<b>Place for:</b>	<b>A:</b> dissipation the energy of water flowing over the spillway	<b>B:</b> migration of animals



### Proposed solution:

To design the „standard“ concrete stilling basin (with depth of several meters). Fill the space with riprap (reducing the energy of water by scour in „standard“ stilling basin) and create a migration pass (depth only decimeters) for water-dependent animals in it.

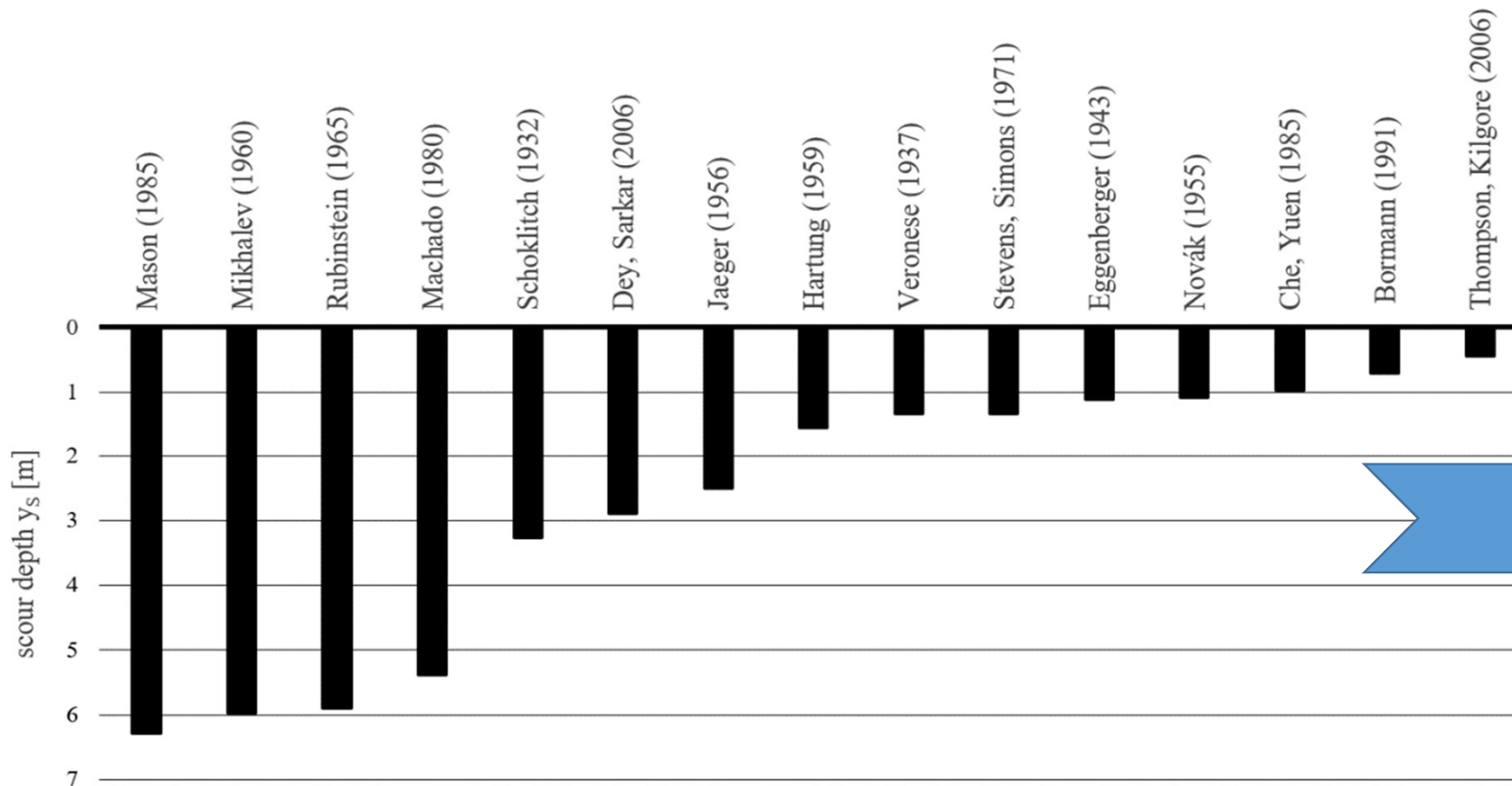


**What should be the parameters (depth of the concrete stilling basin, fraction of riprap filling) for secure design?**



## Scour depth

Several empirical equations to predict the scour depth



As the spread of results is too great and the calculation cannot take account of the asymmetrical arrangement, it was necessary to **verify** the functionality of the **proposed solution on a physical hydraulic model.**

Spread of the depths of scour based on calculations for the Mělčany Structure and  $q = 9.9 \text{ m}^2 \cdot \text{s}^{-1}$ .

## Hydraulic model research

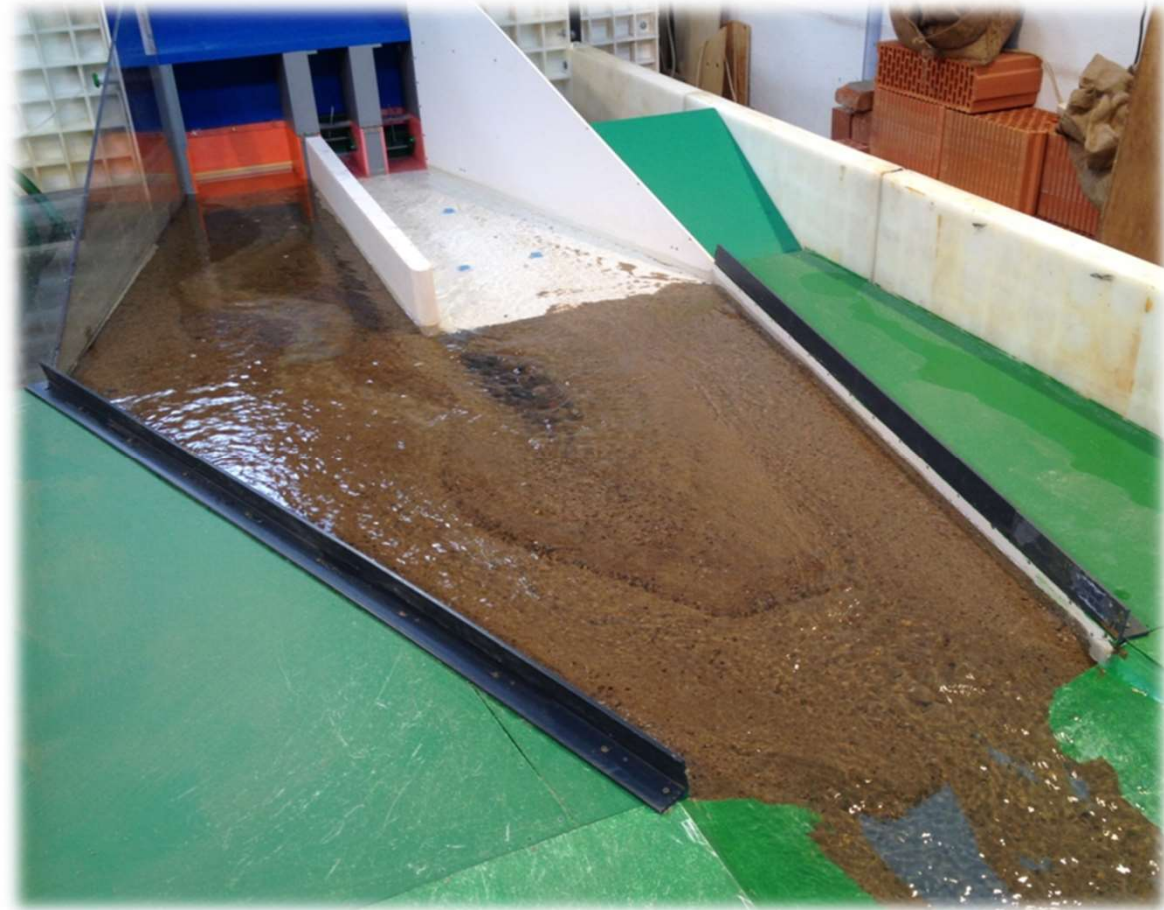
Geometric scale of 1:20, Froude's law of mech.similitude





## Hydraulic model research

Some pictures from the laboratory experiments



## Hydraulic model research



Situation before the experiments (left) and after the experiments with  $Q_{10,000}$  (right).

## Conclusion

1. The research on the combined structure of the Mělčany dam was aimed at verifying the functioning of an innovative design of a **stilling basin that is filled with riprap** (fraction 200-500kg) in normal discharge situations, and in the upper part riprap will be **overlaid with gravel**.
2. Scour was verified for the passage of  $Q_{100}$  up to  $Q_{10\,000}$  floods.
3. It was possible to observe a **decrease in velocities** there after a scour hole formed by up to approximately **20%** compared to the velocities measured at the beginning of the experiment.
4. The measurements were used to assess correspondence with computational methods according to the individual authors. The **best correspondence** was reached based on the calculation according to **Veronese (1937) and Novak (1955)**.
5. The **prepared design** of the combined structure also ensures the migration permeability of the hydraulic structure and **provides suitable conditions from an environmental point of view**.

**Thank you very much for your attention!**

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**<http://hydrotechnika.fsv.cvut.cz/rf2020-0410>**

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*Do not hesitate to contact us, for example at  
ResearchGate - we are **ready** for your questions! 😊*