



PERSPECTIVES OF THE DAM ENGINEERING IN THE CZECH REPUBLIC - NOW AND NEAR FUTURE

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ABSTRACT

The paper addresses topical issues of dam engineering in the Czech Republic and perspectives in this branch for the near future. In the last 30 years, dam engineering has mostly been in a period of stagnation. The post war boom of extensive construction of dams practically came to an end in the Czech Republic in 1996 by the commissioning of the last modern time dam, the Slezská Harta Dam. The creative capacity in dam engineering successively had to be oriented towards other current issues of hydraulic engineering such as flood protection projects and projects enhancing the safety of hydraulic structures in accordance with current knowledge applied in dam building worldwide. After the floods in 1996, 1997, 2002 and 2006, dam engineers work not only on technical flood protection measures, but also on projects of smaller water reservoirs and polders. After the floods in 1997 and 2002 in particular, studies of larger hydraulic structures are beginning to emerge guided by the top priority purpose of flood protection. After the flood in June 2013, it is evident that the control of flood patterns in some regions will inevitably have to lead to alternative design solutions considering the construction of larger storage capacities in water reservoirs. Dam engineers in the Czech Republic, naturally, also deal with issues of water management adaptation measures related to climate change. However, no patterns have been identified in our region so far on the basis of which adaptation measures could be correctly quantified. Thus, these issues rather remain at the level of alertness resulting in some foresight in the design of new structures.

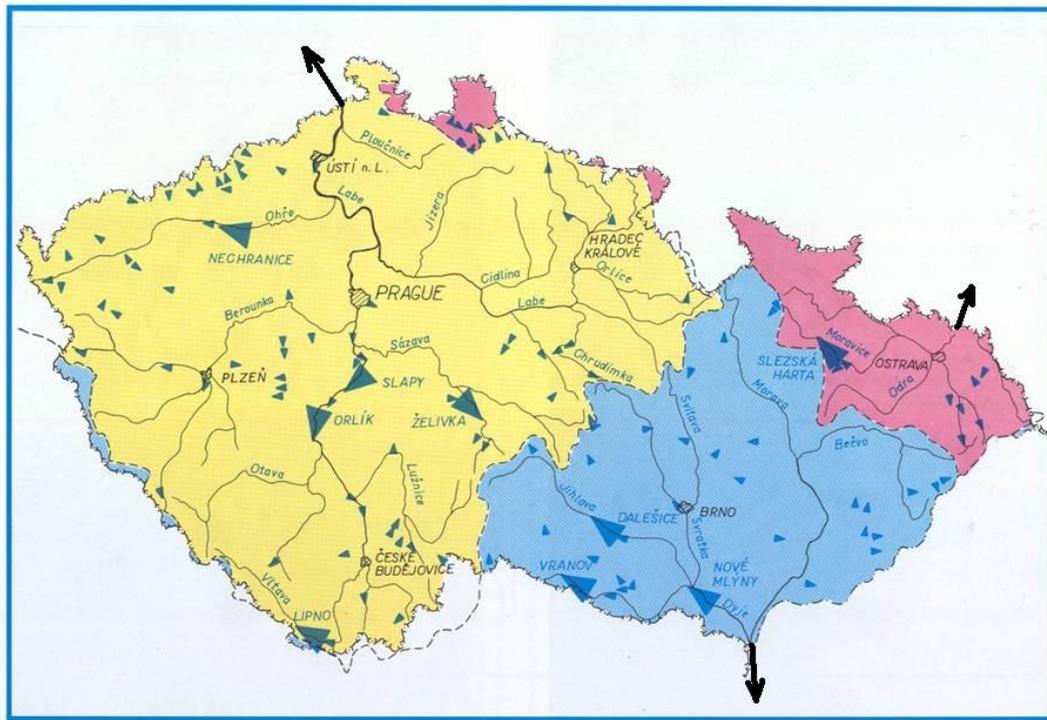
1. Specific position of the Czech Republic territory

The territory of the Czech Republic is literally situated on the roof of Europe. Virtually all rivers flow away from our territory, and almost all Czech streams flowing into the neighbouring states have their sources in our country (Picture 1). The advantage of this fact is that the streams in the Czech Republic are supplied with relatively clean rainwater. The disadvantage is the sole dependence of water management on rainfall and the need for water storage, plus the speed of flood progression. Floods in the upper reaches of streams are generated in a very short period of time, and the necessary reaction times of flood control activities to the course of flooding must be significantly shorter as compared to the neighbouring countries. The importance of dam construction for our water management is, therefore, quite obvious. Water management services in the Czech Republic cannot be provided with adequate reliability and safety without the volumes of water for water supply and without the volumes of empty storage capacity for flood water retention.

2. Post war dam construction

The first great wave of dam construction in the Czech Republic dates back to the beginning of the 20th century. A number of embankment and stone masonry dams were built at that time for the purposes of water supply and flood protection. Together with the development of industry and electrification of that time, the first dams in hydro power generating systems were also built.

The second wave of dam construction came after the Second World War and lasted until the 1980's. In this period covering approximately 30 years, the major dams in the Czech Republic were built. In 1987, the construction of the last large dam – Slezská Harta Dam – began. It was only completed after 10 years of construction, as an alternative of its not finishing and the putting of the unfinished work into harmless condition had also been considered during that time. The paradox is that in the year following its commissioning the dam saved the area below the dam along the Moravice River, the Opava River and the Odra River from even greater tragic flood consequences in the flood of 1997. The new, almost empty dam reservoir was filled up during one single day during this flood. The global inventory of dams currently lists 118 structures of this type situated in the Czech Republic. Only 8 large reservoirs from the Mediaeval Times have been preserved and are still in operation (constructed from 1272 to 1590). Another group of 32 dams were built in the period from 1850 to 1940, whereas only 5 dams in this group were built in the period from 1850 to 1900. After 1943, the remaining 78 dams listed in the ICOLD global inventory were constructed until 1997.

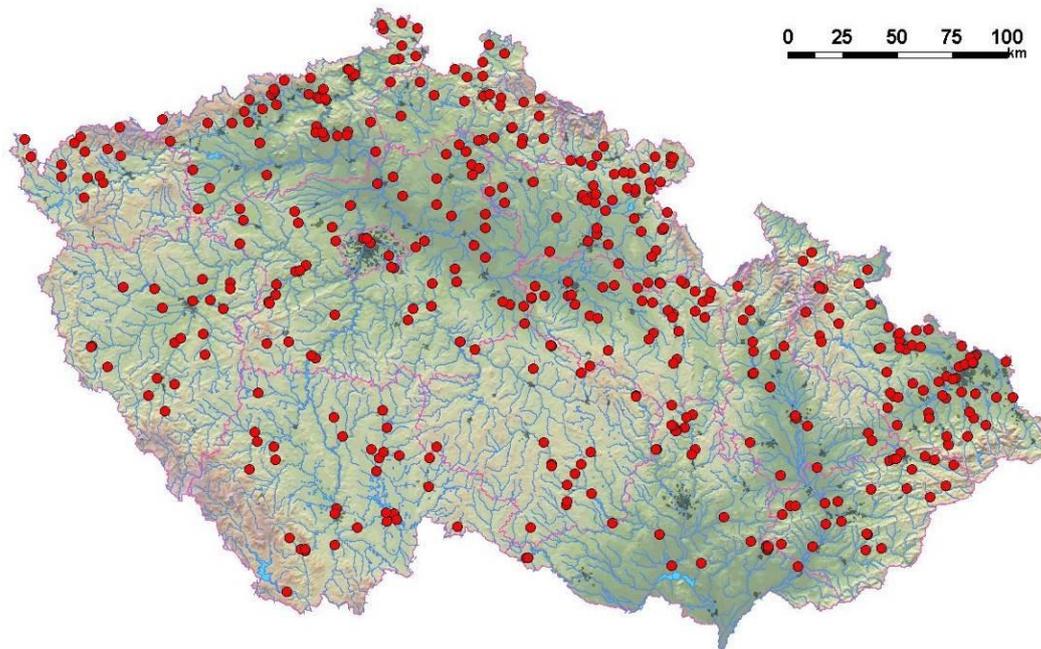


Picture 1 – Czech Republic – most important dams; rivers Labe (North see), Dyje (Black see) and Odra (Baltic see)

3. Twenty years of stagnation in dam construction

After the completion of the dams planned and under construction before 1989, dam construction was completely discontinued. The underlying reasons were mainly on-going social changes, the growth of politically strong opposition to the construction of large hydraulic structures on the part of nature conservationists, the lack of investment and public demand, etc. Despite the stagnation in the construction of new dams, however, activities in the field of dam engineering and hydraulic engineering did not stop even in this period. The professional public, designers and building capacities shifted their focus to the operation and safety of existing dams (Picture 14) and to minor projects primarily related to flood protection and flood prevention (Picture 2, 3).

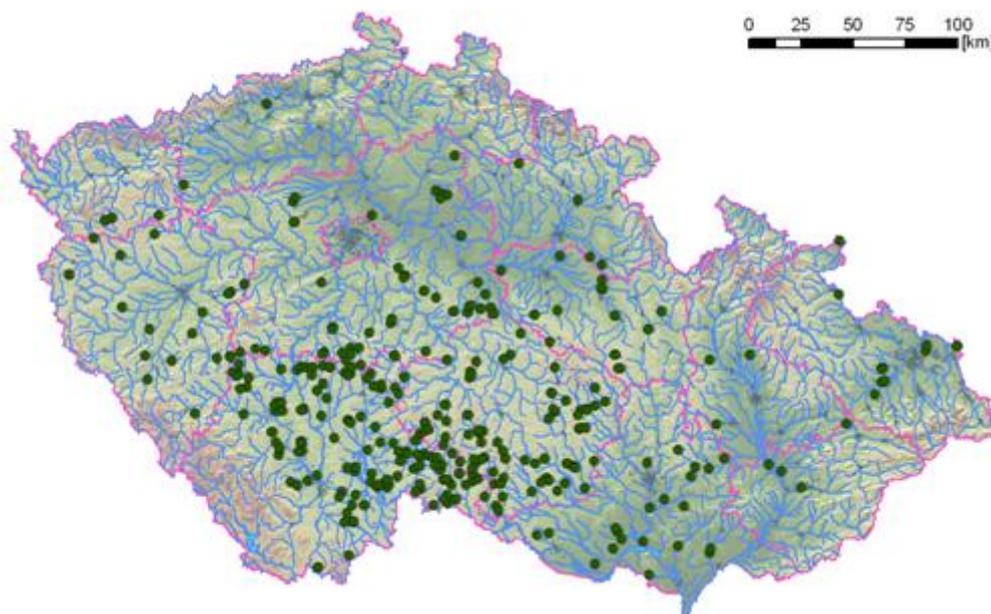
The expertise in the field of dam engineering has been applied to a great extent in the programmes of the Ministry of Agriculture oriented towards technical flood control measures. In the period from 2002 to 2012, investments in the total amount of CZK 21.4 billion (from national resources and loans from the European Investment Bank) were planned and funded by the Ministry of Agriculture. The total of 880 investment projects ranging from flow rate studies to major structural modifications for increasing the safety of hydraulic structures were prepared, designed and built as part of flood prevention measures.



Picture 2 – Flood protection and prevention construction and investment between 2002 and 2012

The flood prevention programmes in sectors close to dam engineering involved, in particular, the construction of small water reservoirs and polders, longitudinal weir systems to protect the flooded areas of towns and settlements and larger investment projects enhancing the safety of dams during floods. The last mentioned activity was primarily focused on increasing the storage capacity of emergency spillways of dams in accordance with new findings in the area of ensuring the reliability and safety of dams during floods. The motivation for the application of investments in this area was both the experience from regional and local floods and the extended knowledge and new experience presented at the forum of the International Commission on Large Dams (ICOLD).

Consequently, a relatively large set of flood protection elements which are in their majority analysed and operated as mutually interacting elements within the new system of surface water runoff have been built in the last 10 years. The above mentioned specific geographic location of the Czech Republic is associated with rapid runoff and, hence, with a rapid emergence of floods. It is, therefore, necessary to move technical water management activities and related measures directly to the very areas of the flood appearance in the upper reaches of rivers. To this end, the programmes of the Ministry of Agriculture have recently resulted in the construction of numerous elements close to dam construction by nature (small water reservoirs, polders, water transfers, etc.) in the context of the implementation of the land consolidation programme with flood control effects. In this sector, nearly CZK 0.8 billion have been invested in 108 investment projects. The diversity in the positional and height pattern of the Czech Republic allowed a great boom of pond construction in both the older and more recent history. In the Mediaeval Times, there were around 60,000 ponds and small water reservoirs in the Czech Republic. For various reasons, around 25,000 small water reservoirs and ponds have survived to the present day and are still in operation. They are very close to dam construction and are also of great importance for the retention of water during floods and for water storage for other purposes. For this reason, the capacities of dam engineers have also been focused on ponds in the last 10 years. Here, the total of 360 projects were funded within the Ministry of Agriculture programmes again - reconstructions of dams, dredging of reservoirs and construction of new ponds (picture 3).



Picture 3 – Rehabilitation of small dams and ponds 2007 to 2012

4. Enhancing dam safety in floods

Floods are naturally significantly affected and their consequences are sometimes even dramatically reduced by the transformation effect of reservoirs; on the contrary, however, floods also substantially impact on the dam bodies and on their surroundings. In this context, a major trend in the world and Czech dam construction is to guarantee an increasingly greater safety of dams during floods. The requirements increase with the ever growing standard of living and the growing density of population along rivers. At the same time, however, appropriate correct technical and economic criteria must be adopted in the design of measures for the enhanced dam safety in floods so that the demanded investments are not without limits and arguments in favour of their effectiveness may be raised. The dam engineers' activity in this area is currently developing very intensively. Adding the efforts to consider the impacts of changed climate conditions, the activities of dam engineers have become quite an attractive domain of research. The Soběnov Dam on the Černá River may serve as a practical example of the relationships between floods and dam engineering. The embankment dam of the impounding structure for water supply to a hydraulic power plant broke during the flood in 2002. Subsequently, a new hydraulic structure with enhanced safety and resistance to damage or failure due to overflowing was designed (Picture 4) and built.



Picture 4 – Soběnov – new concrete hydraulic structure after the collapse during 2002 flood – Jiří Švancara

The capacities of emergency structures - spillways – have been increased by principal reconstructions in many dams in our country in the last years – e.g. in Klabava, Hracholusky, Těrlicko, Bystrička, Mšeno, Hvězda, Římov, Koryčany. Projects for numerous other dams have been prepared and are to be launched – e.g. the Šance Dam. In a broader context, the reconstructions of dams also impact on the related sphere of the education of young engineers and the development of related research. The modifications of emergency spillways are practically unfeasible without laboratory research on hydraulic models (Pictures 5, 6, 7, 8, 13).



Picture 5 – Klabava – emergency spillway – before reconstruction

These, in turn, are mostly run by universities with the participation of students who in this way develop their skills for the future application of their knowledge in domestic dam

construction projects, or who are currently participating in projects outside Europe (Asia, Africa) where our design companies are successfully engaged.



Picture 6 – Klabava – emergency spillway – hydraulic model – plan view

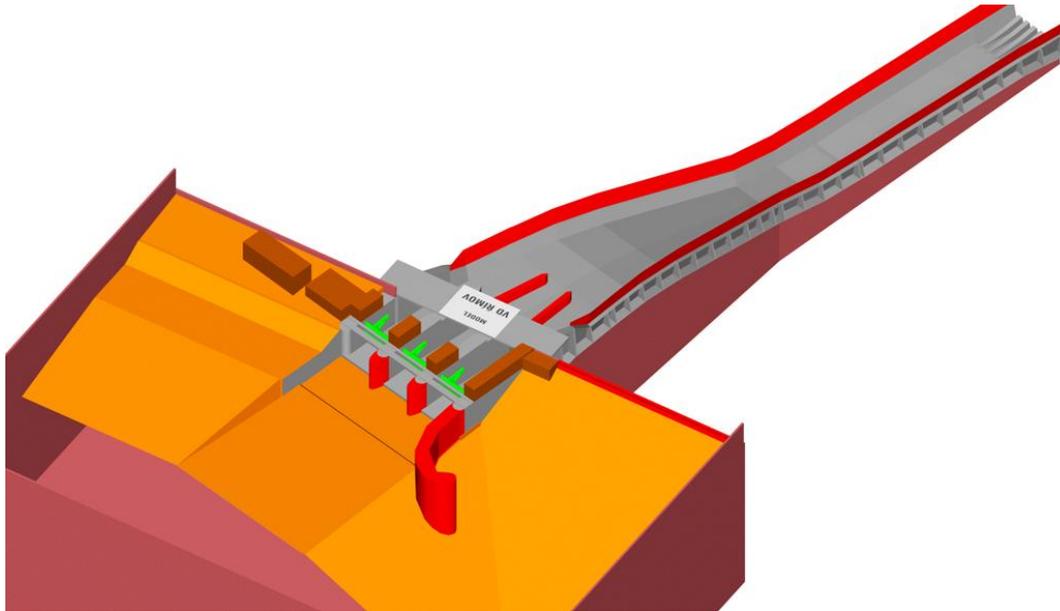


Picture 7 – Těrlicko – rehabilitation of the emergency spillway designed on results of the scale model – under construction

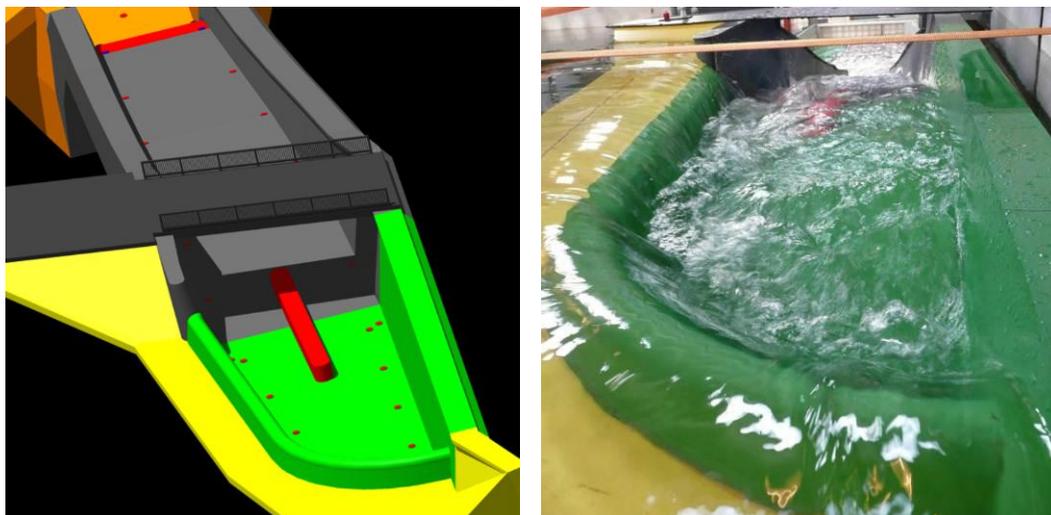
5. New dams

An interesting newly built hydraulic structure similar to a dam that has recently been completed is the concrete body of the Soběnov water-raising step. The new concrete structure was built on the site of a ruptured earthfill water-raising structure (destroyed during the flood in 2002) of the water supply structure for a hydraulic power plant. In the domain of large dams, works aimed at the preparation of the construction of some dams that would allow controlling flood flow patterns and mitigate their consequences were maximised after the disastrous flood affecting the North of Moravia in 1997. In this respect, the project that

has gone the longest way ahead is the design of the Nové Heřminovy Dam on the Opava River, which should significantly mitigate the impacts of large inundations along the Opava River and partly the Odra River. The principal flood protection effect mainly applies to the town of Krnov and also to other municipalities and areas lying between the town of Opava and the dam profile of the Nové Heřminovy Dam. The preparation of this dam project sets high demands, in particular because of the need to relocate a part of the Nové Heřminovy municipality outside the dam inundation level. The majority of problems related to the administrative preparation are presently on the right path to a solution and design works are in progress.



Picture 8 – Římov – geometrical model with designed changes (red) for the construction of the scale model



Picture 9 – Koryčany dam – geometrical model + scale model – analysis of discharge capacity

Another major planned hydraulic structure with a higher probability of its implementation is the Mělčany Polder on the Dědina River in the Elbe River basin. The reservoir was originally designed with a prevailing water storage function; nevertheless, under the pressure of environmentalists' objections, a hydraulic structure with just the minimum permanent water storage was changed into a dry polder.

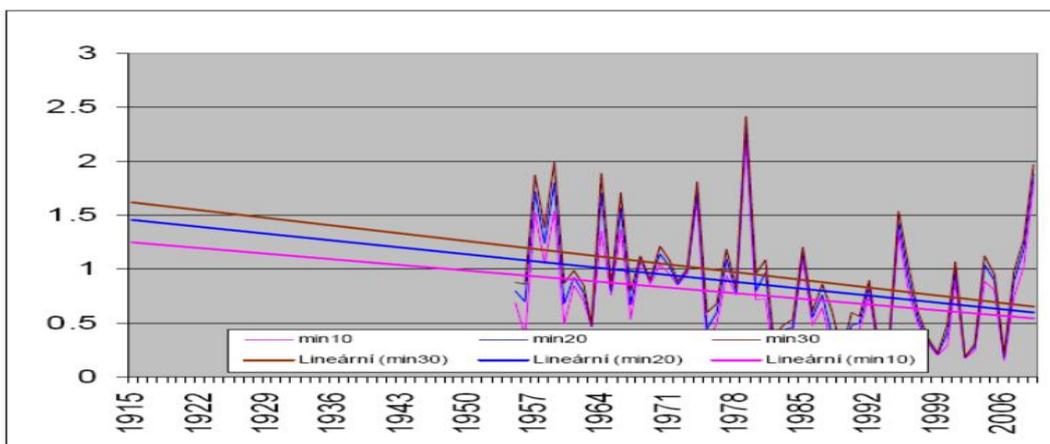
The strategic outlook into dam construction on the territory of the Czech Republic is articulated in the essential document, the Master Plan of Sites for Surface Water Storage. This document contains basic information about 65 dam profiles that are protected as construction sites or for other activities related to the potential future construction of dams should a need for water storage and a subsequent further use of this source for water supply or as a water storage capacity for flood protection purposes arise in the future (picture 10).



Picture 10 – Master Plan of Sites for Surface Water Storage – 65 potential construction sites

6. Future of dam building

All surface water resources related to dams are currently being used with an ever increasing intensity in the Czech Republic. The floods of June 2013, the immediately following droughts in the summer months and some fluctuations in the hydrological regime of water



Picture 11 – Decreasing small discharges on Lužnice river – south Bohemia

streams imply that the existing resources will fail to meet the demands for water management services in the course of time (picture 11).

Therefore, dam engineering must be maintained at the desired level since dam construction in the foreseeable future will also have to meet the increasing quantitative demands for water. Fortunately, the twenty-year period of stagnation has directed the dam engineers' efforts to the operational aspects of dams and to work on hydrotechnical projects of a wider scope, both in the Czech Republic and abroad. It is also thanks to international professional contacts that dam engineering in the Czech Republic is in good condition, which is manifested by design activities in Africa (picture 12) and Asia and partially also by minor hydraulic structures in Europe. The instruction in the field of hydrotechnical structures and dams still belongs to prestigious branches studied at two Technical Universities in the Czech Republic where regular students' activities are accompanied by collaboration on research projects and practical tasks ordered by the administrators of hydraulic structures.

7. Summary

Dam engineering in the Czech Republic has not been affected by the unfavourable period of stagnation in this area in any way. Works on projects related to dam operation, their enhanced safety during floods and works on related projects of other hydraulic structures have preserved and further extended the necessary new knowledge.



Picture 12 – Nyagak hydraulic scheme – Uganda - geometrical model, scale model – 10000 year flood, CTU Prague, finished dam – Filip Kysnar, SWECO Hydroprojekt

Dam engineering is also further developed thanks to the cooperation of Czech dam engineers within the ICOLD and through projects implemented abroad.

Dam construction, however, has suffered some losses in the sector of construction firms capable of performing the necessary large-scale construction work on the adequately high quality level and mastering the prescribed technological processes. There are currently only very few expert-level implementing groups left in the Czech Republic, which relatively easily opens up space for foreign building contractors in the case of an opportunity.

The inundations of June 2013 manifested that flood protection measures designed by dam engineers in the period of dam construction stagnation are effective and of good quality. One third of the costs invested in flood protection during the last 10 years were returned during a single flood in June 2013. It is, therefore, obvious that the professional water management public is able to solve engineering tasks efficiently, in due quality and with the necessary flexibility. The flood of 2013 has also shown that floods can no more be better controlled without accompanying considerations of new dams or significant interventions in their structures. In this light, it is very likely that the period of stagnation in the preparation of dam projects is over and dam engineers will shortly return to new projects of hydraulic structures with dams, apart from their other tasks.



Picture 13 – Harcov dam – scale model for the design of rehabilitation



Picture 14 – Kadaň dam – winter conditions

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