WATERSTORAGE BASIN FOR THE PRODUCTION OF ARTIFICIAL SNOW AT THE SKI RESORT „GUTÂIUL DOAMNEI CAVNIC", MARAMUREŞ COUNTY

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Abstract

This paper presents the ski area arrangement "Gutâiul Doamnei Cavnic", located in northern Romania to development in the area of existing ski facilities. This arrangement includes a significant investment of City Hall Cavnic including the following objectives: "Gutâiul Doamnei" Telegondola, „The Apostles" ski lift, four ski slopes and connecting braces - which are ski trails linking the main slopes, a lower and an upper ancillary building, access roads and parking, water supply and sewerage, electricity supply, etc.

The main elements of the plants for artificial snow production, to be presented in the paper are as follows: water catchment, feed pipe, waterstorage basin, high pressure pumping station equipped with blowers, sewage water treatment station, high pressure network for water distribution to cannons for artificial snow production, the drainage network to catchment and discharge of foreign waters, discharge pipe of the bottom of waterstorage basin, waterstorage basin overflow.

Contractor work, won the auction, S.C. TERMOGAZ Company Haţeg, and the University "Politehnica" Timisoara, Faculty of Hydrotechnical Engineering is the designer of hydrotechnics works and plants for artificial snow production, presented above.

Key words: waterstorage basin, artificial snow, high pumping station, thermo blowers, cannons, ski lift, slope, braces connection, leg.

INTRODUCTION

To extend the ski period from 1-2 months per year at least 4 months per year provided slopes with artificial snow production plants since the implementation. This requires a buffer basin of water, a high pressure pumping stations, distribution network equipped with hydrants which can be easily installed snow cannons and of course the other constructions, plants and afferent auxiliary equipment.

Location

The Cavnic city is located in northern Romania, the heart of Maramures County, on DJ 184 and DJ 109 F roads linking the cities of Baia Mare and Sighetul Marmaţiei. The city occupies a narrow valley, very picturesque, at the foothills and Mogoşa on a length of 500 m, 550 m at Flotation and 1050 m at Raota district. The city occupies a narrow valley, very picturesque, at the foot Mogoşa Gout and a length of 500 m, 550 m and 1050 m flotation Raota district.

The site being studied is opposite the slopes near the Icon slope and extends near DJ 109 F from an altitude of approximately 960 m to 1205 + 1220 m, under rocks known as "The Three Apostles."

From the administrative point of view, the territory considered, which will make the new ski slopes and cable transport plants, are located within the jurisdiction of the Cavnic city, Maramures County.

Access to the ski slopes, respectively at the lower station of the “Gutâiul Doamnei” telegondola be done on the county road DJ 184 and DJ 109 F until the right of the "Icon" slope where after about 50 m on the forest road, that will be properly arrange, is reached to the car parking at the base of the ski slopes designed.

Ski arrangement elements

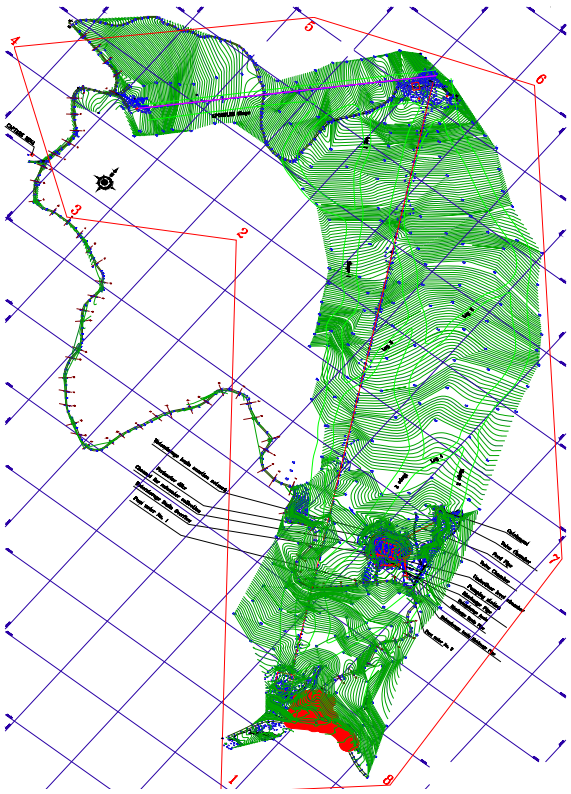


Fig.1. General Plan of site (Sc 1:2000)

a) *“Gutâiul Doamnei” Telegondola TG8* will be built to serve the three ski slopes (slope 1, 2 and 3), and to facilitate access of tourists in summer season on “Gutâiul Doamnei”, the upper station will be located at an altitude of 1217 m and the lower station will be located near the car parking which will be arrange at the ski slope base, at an altitude of 951.70 m, the route will link the two stations in a straight line.

b) *“Apostles ski lift TK2”* is a unidirectional, mono-cable lift, running one-way form of traction devices bi-post permanently coupled to the cable carrier tractor. Lower station, clamping devices of towing skiers, is that the altitude of 1068 m in the finish area of the ski slope, and the upper station, the separation of skiers at an altitude of 1221 m. The route in a straight line joining the two stations.

c) *„Slope 1”* – starting point of the arrival of the gondola lift station. The slope route starts south-westerly direction and takes place on the slope length of 2340 m, departure

altitude of 1170 m, arrival altitude of 953 m, 11% slope, 245 m difference in height and a width of 40 m, resulting an area of 9.4 ha.

d) *„Slope 2”* – place in the right side of the telegondola in climbing direction, the last 250 ml is just below the telegondola. The starting point is the share of 1204.00 m and 970.00 m point of arrival rate, there is a difference of 245 m and an average gradient of 13%. The slope length of 2160 m and a width of 35 m resulting a surface of slope of 7.6 ha.

e) *„Slope 3”* – has route on the right side of the telegondola, too, is still being served by it, the slope has a length of 2035 m, departure altitude of 1211 m, arrival altitude of 959 m, 12% slope, 245 m difference in height and a width of 30 m, resulting in an area of 6.1 ha.

f) *„APOSTLES Slope”* – is served by ski lifts with the same name and follows straight its route, slope length is 824 m, departure altitude 1221 m, arrival altitude 1068 m, 18.6% slope, 153 m level difference and a width of 50 m, resulting in an area of 4.1 ha.

g) *Braces connection* –are actually ski trails what make the connection between the main ski slopes, allowing skiers to various combinations of routes depending on individual desire and fantasy.

Leg 1 having the following characteristics: length 280 m on the slope, the horizontal length of 275 m, width of 26.68 m, 1200 m high share, the share of lower 1140 m, level difference of 60 m, slope 16%, the total area S = 0.8 ha.

Leg 2 having the following characteristics: length 320 m on the slope, the horizontal length of 317 m, width of 26.68 m, 1108 m high share, the share of lower 1076 m, level difference of 32 m, slope 3.1%, the total area S = 1.0 ha.

Leg 3 having the following characteristics: length 360 m on the slope, the horizontal length of 358 m, width of 26.68 m, 1086 m high share, the share of lower 1069 m, level difference of 17 m, slope 10%, the total area S = 1.1 ha.

Leg 4 having the following characteristics: length 160 m on the slope, the horizontal length of 158 m, width of 26.68 m, 1048 m high share, the share of lower 1044 m, level difference of 4 m, slope 7%, the total area S = 0.5 ha.

Leg 5 having the following characteristics: length 437 m on the slope, the horizontal length of 432 m, width of 26.68 m, 1000 m high share, the share of lower 957 m, level difference of 43 m, slope of 5%, the total area S = 0.6 ha.

k) Water Supply – The project provides water supply station of Annex Building from the lower and upper station.

l) Sewerage – The project involves the construction of one sewerage network to serve the upper and lower station annex buildings and sewage water station for household wastewater.

m) *Beat Snow Machines* – It provides three beat snow machines, two medium and one small.

n) *Electricity Supply* – For electricity supply will be realize a line LEA 20kV and will be placed two transformer points, located in the telegondola lift station area, at the intersection of the Apostles slope with the Ramp. Consumer’s connection at the transformer points 20 / 0.4 kV will be made through underground networks

Given the relatively low altitude and the tendency to change global climate conditions to ensure optimum efficiency - economic exploitation of this area, it is necessary to make permanent use of the slopes conditions both at the beginning of winter, as and during it, thereby prolonging the operating time optimally at least four calendar months. Also for one resistant slope, during the operation using artificial snow so early winter to ensure that the substrate resistance to natural snow and the winter to refresh and maintain the surface in terms of quality ski slope. Required water buffer stock to produce snow during operation is

carried out in a waterstorage basin with volume of 35,000 cubic meters will be filled with a torrent of nearby dams.

The main elements of artificial snow plants are: water catchment, feed pipe, waterstorage basin, high pressure pumping station, high pressure water distribution network for artificial snow production, foreign water drainage network in the waterstorage basin, overflow waterstorage basin, discharge pipe of bottom waterstorage basin.

MATERIAL AND METHODS

Water Catchment

Water catchment is carried in the stream bed of the torrent located at rate of 1029.50 through works consisting of two reinforced concrete sills having cross sectional dimensions of 1.00 m x 2.50 m x 6.00 m (Fig.2).These sills are built into the ground at a depth of 0.50 m. The distance between the two sills is 8.00 m. Between sills is fitted a collector drain with 300 mm diameter and length of 8.00 m. Area between displaced land and sills is filled with an inverse filter having a thickness of 1.00 m. Collector drain will be extended through the pipe PEID, PN10 to the valves chamber CV1 located near the catchment. Valves chamber CV1 shall be from PEID with circular form. The chamber will be covered with a lid and frame non carriageable. The valves chamber CV1 designed will install a sectorization valve Dn 300 mm.

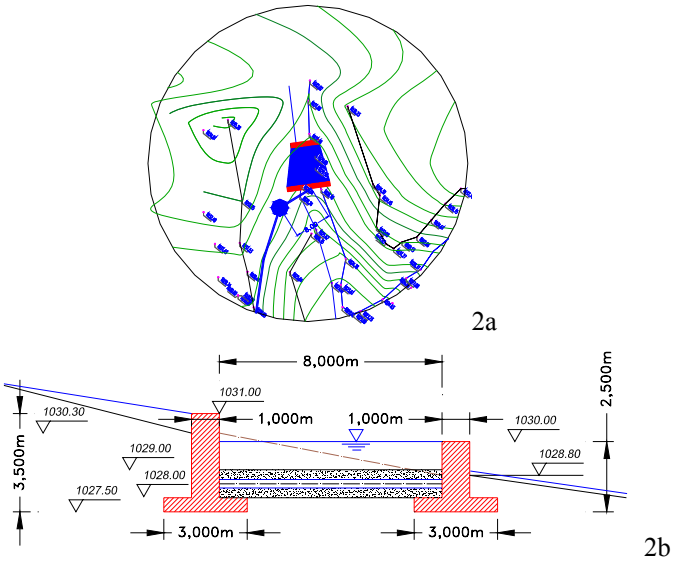


Fig.2. Capture water from the stream a) plan view b) longitudinal section

Feed Pipe

Pipeline routes are located in the green of the forest. Proposed pipelines will be of P.E.I.D, PE80 L=140,2 m, PN10, De 315 mm.(Fig.3)

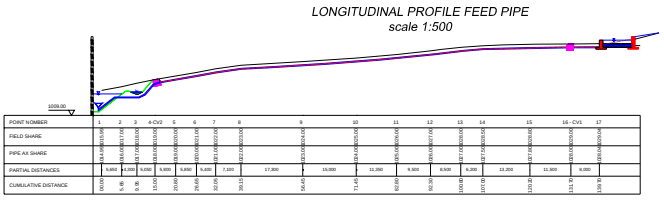


Fig.3. Longitudinal profile, feed pipe

On the feed pipe will be made a valves chamber CV2 located in the vicinity of the waterstorage basin. CV2 valves chambers that will executed will be of PEID of circular form. The chamber will be covered with a lid and frame carriageable. In the valves chamber designed it will be mounted a sectorization valve Dn 300 mm and one branching necklace PEID 315/28 mm through which is mounted the turbidity transducer.

Electro valve will be controlled by pressure ultrasonic transducer mounted in waterstorage basin. When the waterstorage basin fills transducer will command the valve closing, respectively when the basin water level drops due to pumping transducer will command the valve opening.

As a measure of protection is provided for mounting a transducer in the chamber CV2 that will command the electro valve closing for the situation in which abstraction has high turbidity. These situations occur in the event of heavy rain torrent caught disturbing.

After the valve chamber CV2 in the waterstorage basin on the feed pipe is provided an umbrella form weir for the stored energy dissipation on the feed.

Waterstorage Basin

Waterstorage basin will be done by earthworks (Fig.4 and Fig.5), leveling and compacting in the clearing zone, relatively plan, existing, at a rate of approximately 1011 m. The excavation works will be performed on depths between 0.1 and 5.50 m deep. Waterstorage basin surface is 7500 square meters and the water volume is 35,000 cubic meters.

The outline of waterstorage basin will be a perimeter dike having the following characteristics: inner slope parament of 1:1.5; outside slope parament of 1:2; dam crest width of 1.00 m; dam height to maximum water level (that share the waters arrester) is of 0.75 m; dam crest share is of 1015.75 m, the maximum rate of water is 1015.00 m.

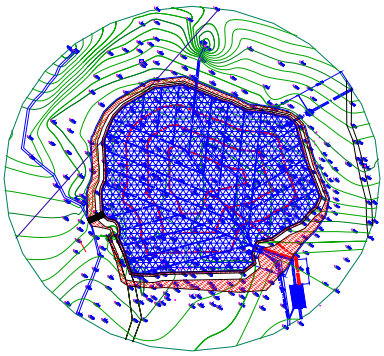


Fig.4. Waterstorage basin in plan view

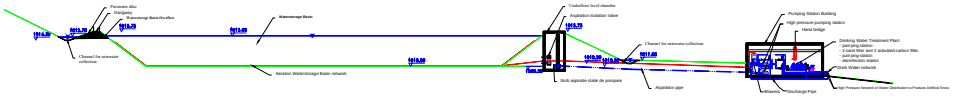


Fig.5. Longitudinal profile through the waterstorage basin and Annex Building

On the outside of the perimeter dam will be a channel for rainwater collection and disposal. Perimeter channel of a trapezoidal form is characterized by: the interior parament slope of 1:2; external parament slope of 1:2 slope; channel bottom width of 0.50 m; channel depth of 0.50 m, the minimum rate of the bottom channel is 1014.50 m.

After completion of the earthworks, dams and canals slopes profiling on the bottom of waterstorage basin and sides of dams will be placed a geotextile layer thickness of 5.0 mm and then a layer 2.5 mm thick geomembranes for waterproofing. Geomembrane film will be joined by hot solder. Geomembrane will be spent over a width of 0.80 m in the dam body to share of 1015.30 m.

Over geomembrane film is placed a geotextile layer 5 mm thick with a protective role, over which will sit over a 10 cm layer of ballast for proper ballast geomembranes and its stability to any water infiltration under basin.

In the waterstorage basin provides a aspiration underfloor level chamber, concrete pump, drum type, wet, with dimensions of 3.00 m x 3.00 m. Underfloor level chamber crest share is of 1015.75 m and bottom underfloor level chamber share of 1009.50 m. Underfloor level chamber will be built of waterproof concrete and waterproof on the outside with geomembrane. Underfloor level chamber will be built into the dam body, thus ensuring water insulation from underfloor level chamber. Underfloor level chamber will be covered with an insulated concrete cap with a manhole in insulated metal panel. Also underfloor level chamber will be provided with a metal ladder for access.

High Pressure Pump Station

Pumping station (Fig.6) is a reinforced concrete building having dimensions: 12.00 m x 6.00 m. Headroom is 5.00 m. The station will be equipped with a beam rolling equipped with a manual tackle of 3 tones that will be installed on building beams at a height of +4.20 m. All electrical panels should be at the rate of + 2.00 m with a ramp access provided by the metal stairs. In this station will be installed the following equipment:

- ***High pressure pumping station consists of the following elements***: two centrifugal pumps 1+1R with the following characteristics: Q = 25 l/s = 90 mc/h, H = 450 m, P = 160 kW driven variable speed by frequency converter with related links and associated fittings on the exhaust pipe, discharge, separation discharge pumps, purge excess water, pump priming, pumping station discharge.

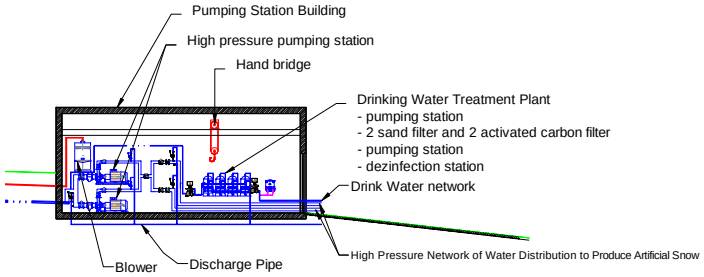


Fig.6. Longitudinal profile through the pumping station

Pumping station has the aspiration supplied from waterstorage basin from aspiration underfloor level chamber through the pipe PEID, PE80, PN10, of 225 mm L = 30 m through a manually operated valves DN 200 mm (Centric rubber butterfly valve PN10, with the manual reducer) located in aspiration underfloor level chamber.

Pipes from the pumps discharge serving the water distribution network for artificial snow producing.

Thermo blower's station (ciller) to cool the basin water temperature under 2 ° C consists of the following elements:

1 blower having : Q = 2,2 mc/min = 132 mc/h p=6-8 bar; P= 15 kW with electromotor, acoustic casing with 76/98 dB noise limit, Dn 50 mm pressure pipe with non-return valve, safety valve, condensing plant takeover with the storage vessel.

Thermo blowers expected to drive have provided an electrical control panel with local manual and automatic command, depending on the timing plant, allowing interconnection with the operation of pumps, on air flow indicated by air mass flow meter and turbidity indicated the transducer on the feed pipe.

Inside the high pressure pumping station is provided for mounting on a bypass pipe of a pneumatic valve (servo) that at a preset pressure, ensuring underground pipes network safety during snow production.

Deviation pipe shall discharge surplus water not used in the production of artificial snow in the basin of water, protecting the network from any pressure that might occur in it.

Sewage water treatment station consists of the following elements: two centrifugal pumps 1+1R with characteristics: Q = 10 mc/h, H = 40 m, P = 1,8 kW with related fittings on suction and discharge pipes, self-cleaning mechanical filter with 120 micron, water meter with pulse transmitter, 1+1R piece sand filter with treatment capacity Q1=10 mc/hour at V1=10mc/mp/hour respectively Q2=20 mc/hour at V2=20mc/mp/hour, including automatic washing system and hydraulic command with water under pressure, 1+1R piece activated carbon filter with treatment capacity Q1=20 mc/hour, 1 piece chlorination station (two dosing pumps 1+1R automatic 5-10 g / hour) and a hypochlorite container of 300 l and chlorine sensor, two centrifugal pumps 1+1R with characteristics Q = 10 mc/h, H = 250 m, P = 10,5 kW with related fittings on suction and discharge pipes (manually operated valves Dn 50 mm - 4 pcs., end flaps Dn 50 mm - 2 pcs.) with the role of pumping treated water.

High Pressure Network of Water Distribution to Produce Artificial Snow (Fig.7)

Pipes routes are located on the edge of the slopes No. 1 and No. 3 and the Apostles slope. (Fig.1 and Fig.7)

Proposed pipes will be ductile iron as follows: DN 200 mm, PN63

Location of the proposed pipe will be on a parallel route, if possible, with the side slopes, DN 150 mm, PN63, DN 125 mm, PN63, DN 100mm, PN63, DN 80 mm, PN63.

On the projected distribution network will be installed connecting the 62 ground hydrants connecting to snow cannons. Hydrants will be located in a green area within 2 m from the slopes. Hydrants are equipped with pressure regulating valves at 200 mca.

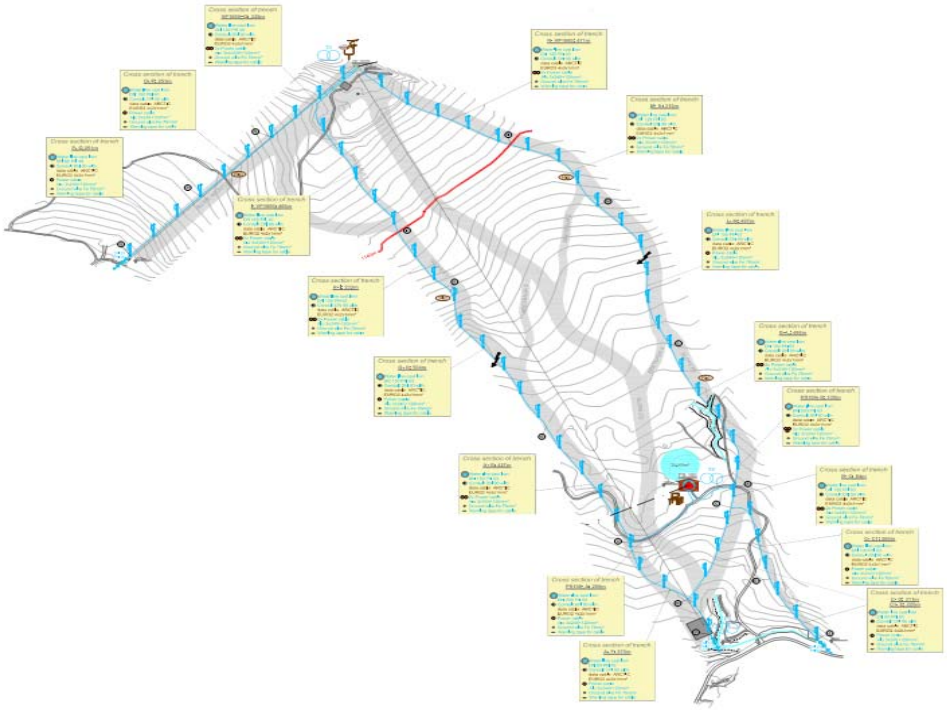
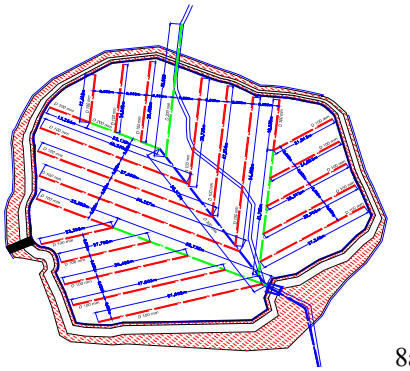


Fig.7. Overview snow cannons

Foreign Water Drainage Network under the Waterstorage Basin Area

Since the waterstorage basin is located on a relatively clearing area existing plan at a rate of approximately 1011 m are possible existence of natural springs under the waterstorage basin.

In this respect it provides a drainage system (Fig.8) made of corrugated pipe Dn 150 mm covered with geotextile and placed in a channel filled with inverse filter with dimensions of 0.5 m x 0.5 m. Water collected in the waterstorage basin through this drainage system are run through a pipe PEID, PE80, PN10, De 160 mm, L = 40 m to the stream after the pumping station.



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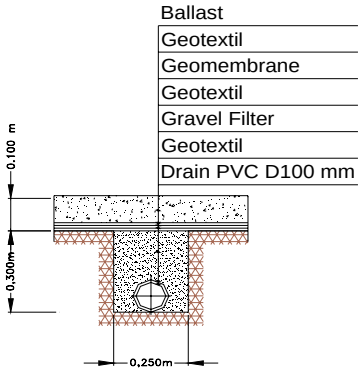

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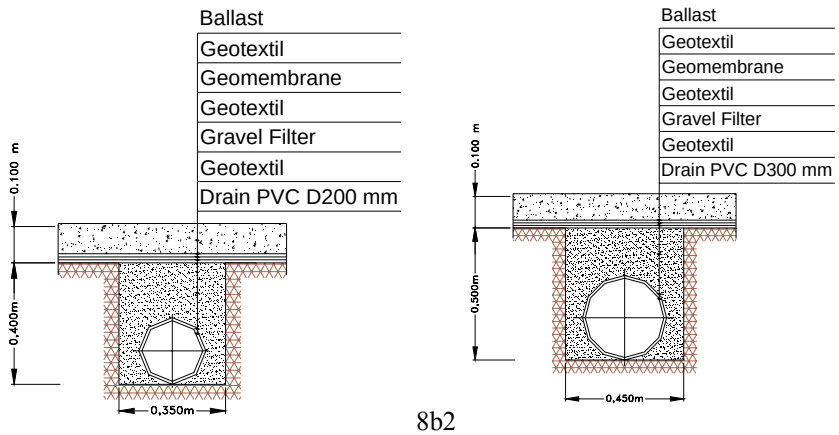

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Fig.8. Location of drainage network under the waterstorage basin (a) and cross sections through the drainage networks (b1, b2, b3)

Waterstorage Basin Overflow

For disposal of rainwater from rain water accumulated on the surface provided an arrester (Fig.9). This arrester is dimensioned including an emergency situation on the feed pipe so that it can take over the entire flow trapped.

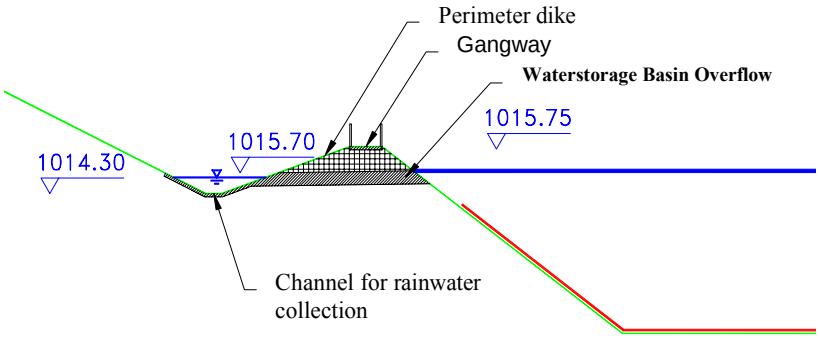

Fig.9. Detail overflow waterstorage basin

Arrester is achieved by a massive concrete having crest at rate of 1015.00 m and is profiled as a weir with practical profile. Arrester is weir width of 3 m.

Discharge Pipe of the Bottom Waterstorage Basin

Discharge pipe of the waterstorage basin will be of PEID, PE80, PN10, De 315 mm, L = 40 m to the stream after the pumping station (Fig.1).

Discharge pipe will be laid in the ground at an average depth of 1.20 m below the ice. To protect the pipe in the event of burglary, over the layer of sand covering the pipe, intended placing a reflective warning tape inserted wire detection.

Discharge pipe will be fed from the pump aspiration underfloor level chamber through a manually operated valves Dn 300 mm.

RESULTS, DISCUSSION AND CONCLUSIONS

Arrangement ski area “Gutâiul Doamnei Cavnic", Maramureş county is an investment of Cavnic Town Hall, obtained from the EU structural funds, which includes the achievement of telegondola, a ski lift, four ski slopes and a few braces connecting the main slopes.

- For cooling water in the basin to reach the temperature below 2 ° C needed to produce artificial snow by snow cannons, are provided thermo blowers plants (ciller).
- To ensure stability during operation, having regard to the technical conditions of the slope, the drainage system to capture water infiltration and foreign waters, provided is rich, and geomembranes above the bottom layer of ballast has provided a 10 cm thick over a geotextile filter with a protective role.
- All waterstorage and associated buildings are planned to be fenced with a wire mesh fence netting less than 5 cm to achieve sanitary protection zone and prevent human and animal access inside.
- To protect the water distribution network to hydrants that feeds producing snow cannons, in case of moving them from one hydrant to another, it might appear eleven days between simultaneous stopping of pumps and such a pressure pump in the network, expected within pumping station a bypass pipe to the waterstorage basin, which has provided with a pneumatic valve automatically opens at a preset pressure.
- Given the altitude at which water must be pumped to produce artificial snow on the slopes has become the choice of special high-pressure pump (up to 40 atmospheres), resulting in a network of underground pipes with hydrants along the slopes, to be carried out using the ductile iron.
- Future „Gutâiul Doamnei – Cavnic” ski resort is a complex work requiring interdisciplinary knowledge and which will create a sustainable infrastructure that will provide great joy of winter vacations for professional and amateur skiers.

REFERENCES

1. Project: Establishment of the ski area “Gutâiul Doamnei Cavnic", Maramureş county. Fitting capture, waterstorage basin overflow, pumping station and blowers, treatment station for producing snow plant for the slopes;

2. Dăscălescu N., Şerban N., Manghiuc A., The Reservoir for snow-drift from Poiana Braşov, Scientific Bulletin of the "Politehnica" University of Timişoara, Romania, Transactions on Hydrotechnics, Tom 55 (69), Fascicola 1, 2, 2010, pag.227-231;

3. www.Termo-Alpin Austria, TECHNOALPIN AG/SPA, KOPEMIKUSSTRASE, 6A I-39100, BAZEN

4. www.grindfos.ro, GRUNDFOS POMPE ROMÂNIA, Str. Biruinţei 103, Pantelimon RO - 077145 Ilfov

5. www.Dopelmajer.au, DOPPELMAYR SEILBAHNEN GMBH AUSTRIA RICKENBACHERSTRASSE, 8-10, 6961, WOLFURT, AUSTRIA

6. xxx – Ski slope and ski lift “Speranta”, Resort Borsec, Harghita county, Project no. P23/ 2008, Designer: SC CADASTRE PROFESSIONAL DESIGN CENTER SA Petrosani, Beneficiary: BORSEC CITY, Performer: SC TERMOGAZ COMPANY SA Hateg

7. xxx - Ski area development in the tourist zone Parang Project no. P.09/2008, Designer: SC CADASTRE PROFESSIONAL DESIGN CENTER SA Petrosani, Beneficiary: PETROSANI CITY, Performer: SC KRANZ SRL Pitesti